OBSERVATIONS

ON THE

WINDS AND MONSOONS;

ILLUSTRATED WITH

A CHART, (Missing)

AND ACCOMPANIED WITH

NOTES, GEOGRAPHICAL AND METEOROLOGICAL.

RAREBOOK
QC
931
C24
1801

BY

JAMES CAPPER,

FORMERLY COLONEL AND COMPTROLLER GENERAL OF THE ARMY AND FORTIFICATION ACCOMPTS ON THE COAST OF COROMANDEL.

Prius ignotum ferro quam scindimus æquor,
Ventos et varium Cœli prædiscere morem
Cura sit. VIRG. GEORG. I.

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1801.

National Oceanic and Atmospheric Administration

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OBSERVATIONS

ON THE

WINDS AND MONSOONS.

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TO

THE MOST NOBLE

JOHN STUART,

MARQUIS OF BUTE,

EARL OF WINDSOR AND BUTE,

VISCOUNT MONTJOY AND KINGARTH,

BARON MOUNTSTUART OF WORTLEY,

BARON CARDIFF OF CARDIFF CASTLE, MOUNTSTUART, CUMRA, AND INCHMARNOCH,

LORD LIEUTENANT OF THE COUNTIES OF GLAMORGAN AND BUTE,

ONE OF HIS MAJESTY'S MOST HONOURABLE PRIVY COUNCIL, &c. &c. &c.

MY LORD,

WHEN it is understood, that from my earliest youth I have constantly been honoured with your Lordship's friendship, it cannot be expected, by those who are acquainted either with your character or my own, that I should begin this address in the usual style of dedications. No, my Lord! at this advanced period of our acquaintance, I shall not risk your displeasure by ad-

dressing you, for the first time, in the language of flattery. Your Lordship however, I trust, will allow me to explain, in a few words, my reasons for requesting you to patronise what, in all probability, may be one of the last, and, I flatter myself, not the least interesting productions of my pen. Seven short and very happy years are elapsed, since I took possession of this elegant and comfortable retreat, which, entirely unsolicited on my part, you were pleased to provide for me, when health, and various other considerations, induced me to retire from the more active scenes of life. The advantages derived from a mild climate, a fertile and beautiful country, and, above all, from a friendly and hospitable society, into which, under your Lordship's auspices, I have been most kindly and liberally received, have now entirely restored me to health, and enabled me once more to resume those studies, which, on my first return to Europe, indisposition had obliged me to relinquish. Thus possessed by your

kindness of comforts infinitely more valuable than any which could have been obtained by the mere gifts of fortune, I beg, that your Lordship, as the immediate author of these various enjoyments, will have the goodness to excuse my offering you this public acknowledgment of gratitude, respect, and affection, with which,

MY LORD,

I HAVE THE HONOUR TO BE,

YOUR MOST OBLIGED,

AND FAITHFUL SERVANT,

JAMES CAPPER.

CATHAY,
March 25, 1801.

CORRECTIONS.

Page 16, line 12, for *Hindostan*, read *Hindustan*.
— 57, — 25, for *Bourdonai's*, read *Bourdonnais'*.
— 76, — 4, for *N.* read £.
— 196, — 7, for *being*, read *not being*.
— 202, — 6, for *expanse*, read *expense*.

PREFACE.

IT has for many years been customary with me, in all countries where I have occasionally resided, to keep a meteorological table, including, when practicable, an account of the tides and prevailing currents; intending always towards the close of an active life, if health and leisure should permit, to communicate my observations to the public.

It was my original design to publish this information in the form of a plain narration of facts; but having paid constant attention to the subject for more than twenty years, vanity at length suggested to me a hope, that I might venture a step further, and attempt to account, in some measure, for the variety of the winds and weather in different parts of the globe, and particularly for the monsoons in the East Indies.

Nevertheless, these hints or suggestions, such as they now appear to be, are submitted to the consideration of the public with no idle pertinacity of opinion: they are intended, and, I trust, not absolutely in vain, for the benefit of mankind in general. So far therefore from feeling displeased at the detection of any errors, it is my wish to propose a free and candid discussion of a subject, in which every human being is interested. All I shall ever insist upon is the truth of my own facts. These I am confident are indisputable, as far as they go; and it will truly afford me the greatest satisfaction to see them hereafter employed, as perhaps they may be, to much greater advantage.

It may probably be thought, and with great appearance of reason, that I have borrowed largely from Bacon, Halley, Franklin, Bishop Watson, Kirwan, and other eminent philosophers. In some cases also I may be charged with presumption for differing in opinion from such high authorities. But although in the paths of philosophy, I am ambitious of treading in the steps of those respectable guides, I feel at the same time, that it is my duty to profit by the lights derived from experience, and not to be

dazzled, or misled by the splendor of even the greatest name. I profess to borrow from Bacon, and Halley (the former in particular) the general principles of the following hypothesis; expecting only to confirm by a series of facts what those eminent philosophers have in some respects conjectured, though not absolutely said before me. But in justice to the father of true philosophy in England, may I in this place be allowed to observe, that whoever carefully peruses Bacon's works, will find in them the germ of almost every modern discovery, both in natural philosophy, and in chemistry.

When I have ventured to differ from Dr. Halley, and seemed to make additions to his system, it was not without much previous enquiry, and subsequent deliberation; nor could all the solicitations of self-love so far deceive me, as to induce me to oppose my opinion to his, unless supported by incontestible facts; but he himself has invited a further enquiry into the subject, and I have obeyed him.

The learned and ingenious Bishop Watson will, I am convinced, pardon the liberty I have taken in making considerable extracts from his chemical essays in support of

my hypothesis. Those who would afford useful information, respecting the same subjects on which he has written, can do little more than repeat his sentiments, which they may disguise, but will seldom improve, by clothing them in different language.

Amongst a variety of other authorities from which I have collected information of the winds and weather in England, my acknowledgments are particularly due to my much respected friend, the Rev. Dr. Hunt of Margam, for having lent me the meteorological tables of his late uncle, Dr. John Robertson. They were kept by him at Axbridge, Pitcomb, Westcomb, and other places in Somersetshire, for upwards of twenty-five years, and bear every mark of great accuracy, joined to a complete knowledge of the subject. This valuable and authentic register serves to confirm what is stated in the body of the present work, as taken from the journals of Major Hayman Rooke, of Mansfield Woodhouse in Nottinghamshire: Of these I had availed myself before the tables of Dr. Robertson were received, otherwise I should have preferred making an abstract or abridgment of the latter, as being rather more circumstantial, though probably not more correct.

To show what winds and weather may be expected on outward and homeward-bound passages to and from the East Indies and China, I have made an abridgment of some journals of different ships, which specify particularly the time when, and place where, they crossed the line, both to the eastward and westward of the Cape of Good Hope, the time of their arrival at the Cape itself, and the length of the voyage to or from India.

As it is one of the principal objects of this work to show what effects are produced on the atmosphere by the presence of the sun, I have also carefully noted the height of the thermometer, as well as the exact latitude and longitude, where the several ships respectively met with or lost the different trade winds; and have marked the general changes they experienced in passing through the temperate zones, where the winds become variable.

The Cape of Good Hope being now in our possession, we may hereafter expect to obtain a regular account of the winds and weather of this southern extremity of Africa: at present I have been able to profit only by the general observations of D'Apres, and some other navigators; and likewise to extract some meteorological ob-

servations from the voyage of Dr. Andrew Sparman: but the latter are rather observations made on a journey inland towards the east coast, than a meteorological table kept at the Cape itself.

In treating of the regular monsoons of India, I have often availed myself of the information of Mons. D'Apres, author of that admirable work, the *Neptune Oriental*. Nevertheless, in some few respects I have found it necessary to differ from him, particularly respecting a comparison of the winds which prevail in the Arabian Gulf and the Persian Gulf. But his Work is intended to describe the course of the winds only, and not to account for the causes of them, otherwise it might have been prudent implicitly to adopt his sentiments. After having so often benefited by his advice, it would be highly ungrateful not to acknowledge my obligations to him both as a navigator and an author.

But as he has written only on the hydrography of the East Indies, I have added, amongst the notes and illustrations, a journal of the weather for twelve months kept on shore at Madras; in which are noted the winds upon the coast, and inland, at different seasons of the year, and

in which is particularly stated the commencement and duration of the long-shore winds, and the land and sea breezes, which never extend more than three or four leagues out at sea.

These winds which blow at the same time, but in a different direction from the regular monsoon, will probably be considered as a strong presumptive proof of the truth of this hypothesis.

For information on the subject of the winds and weather in Egypt and the Arabian Gulf, added to my own slight knowledge of them, I have in general had recourse to the work of Mr. Volney, which is very deservedly admired for the correctness of the narrative, and for the depth and ingenuity of the remarks. As the inundation of the Nile has always excited the attention of the curious, I have likewise had recourse to authentic materials for marking the regular period of its return: in one of these sources of information each particular year, during the course of thirty years, is distinguished, wherein that dreadful scourge of the human race, the plague, appeared in the city of Cairo. It is a prevailing opinion in Egypt, that this malady commences about the winter sol-

stice, continues through the spring to the summer solstice, and generally (the natives say always) ceases with the overflowing of the Nile. Humanity requires, that great pains should be taken to ascertain this fact; for if the time of its commencement and duration can be clearly established, we shall have advanced one step at least towards a discovery of its cause; and the cause once discovered, in this as in every other dangerous disease, the fatal consequences may possibly by medical skill be in future prevented.

It has always appeared to me worthy of observation, and indeed I have already mentioned it in a former work, that in Hindostan, where, in some parts, the climate is nearly the same as in Egypt, the religion of a considerable portion of the natives precisely the same; where the cities are built in the same style, and all their habits of life of course are perfectly similar; the plague, that species of it, at least, which proves so destructive to the inhabitants of Cairo, has never yet appeared. But so far from the overflowing of the Ganges in the Delta of Bengal being considered as salutary, in the South and S. E. extremities of that province, it is considered as the most unhealthy season of the year.

This difference in the climates of Egypt and Bengal, countries which in many respects resemble each other, may probably be imputed to the following circumstances. The two principal rivers run in diametrically opposite directions. The Nile from the south to the north, and the Ganges from the north to the south; so that the former enters the sea beyond the tropic, and the latter within it. The Delta of Egypt below Cairo, therefore, is in a temperate climate, in an open and populous country, properly drained and well cultivated, with a fertile soil, composed of loam and sand; whilst that of Bengal, below Calcutta, is neither drained nor cultivated, for the tides from the Gulf of Bengal introduce in the southern part of the Delta great quantities of sand and sea salt, and of course leave considerable stagnant pools of water amongst the brushwood, which altogether produce noxious vapours, that render the air of these parts extremely unwholesome.

Whilst then the overflowing of the Nile brings health and fertility to the Egyptians, who have always employed the waters of that river for the improvement of their lands, the Ganges in the Delta, for want of proper management, brings with its fertilizing qualities, near the sea at least, disease and death.

But as these subjects will hereafter be more fully discussed, we will not dwell any longer on them in this place, but proceed to a further elucidation of the general plan of the work, and an explanation of the motives which induced me to undertake it.

When the thought first occurred of attempting to investigate the causes of the winds, great doubts of success arose in my mind, from the apparent number and variety of them, even of those within the tropics, where they are most regular; but as I proceeded, these difficulties gradually vanished, for the tempest, the tuffoon or typhon, the hurricane, and the tornado, were soon discovered to be mere distinctions without the shadow of difference; and only the English, the Greek, or Persian, the Italian, or Spanish name for a whirlwind.

This point gained, my next enquiry was into the nature of what are generally called the trade winds and the monsoons.

With the treatise of Dr. Halley before me, added to my own knowledge on these subjects, I was surprised to find the following description of the trade wind in Dr. Johnson's Dictionary. "Trade wind, the monsoon, the

" periodical wind between the tropics." And again, under the article, Monsoon, " Monsoons are shifting trade " winds in the East Indian ocean, which blow periodi- " cally; some for half a year one way, others but for three " months, and then shift and blow for six or three months " directly contrary."

On a reference to Bailey likewise, I found his explanation of the trade wind equally unsatisfactory; he defines it " a wind which at certain times blows regularly one way " at sea, within the tropics; which, he adds (probably by way of marking the origin of the term) is of great service to ships in trading voyages.

But the trade wind, as it has hitherto been called, blows always, not at certain times, from the east toward the west; and in all parts of the ocean within the tropics, where it is beyond the influence of the land, it is subject to very slight variations from that point: In the northern tropic, a few degrees beyond that side of the equator, it varies only a point or two, more or less, to the northward; and so likewise at the same distance to the south of the equator, it inclines occasionally rather more or less to the southward. But as those winds are equally useful both to trading

ships and men of war, they might, I think, with more propriety be called, the perennial winds, being the only current of air which constantly moves the same way in any part of the world. In the following treatise, accordingly, I shall beg leave to distinguish them by the name of the northern and southern perennial winds.

The term monsoon is not derived, as is often supposed, from the name of a famous mariner, but from the Persian word *Mousum*, Season: There are two winds of this name, distinguished in India, by the N.E. and S.W. monsoons, which in some respects may be said to change alternately every six months, according to the situation of the sun in the ecliptic. But it is not necessary in this place to anticipate what I hope the reader will find fully explained in the body of the work. At the same time the obvious distinction between the perennial winds and the monsoons, must be carefully remembered, as contributing much towards illustrating the principles of this theory.

The ancients no doubt clearly understood the nature of winds, but those last mentioned must of course have been perfectly unknown to them. The discovery of such as prevailed at a distance from land, was reserved for the more

enlightened ages of the fifteenth and sixteenth centuries, when mariners by the help of the compass could venture to extend their voyages beyond sight of land; and indeed when lights of various kinds, connected with this subject, suddenly burst forth upon the world, and dispelled the mists of error, with which mankind had long been surrounded.

Amongst the principal causes which produced these advantages in favour of modern times, may be considered the revival and confirmation, if not the discovery of the true planetary system of Copernicus.

Those who would now wish to be perfectly understood, when treating of the winds, must previously make a new catalogue of them, including all such as have been lately discovered, and this addition made, they may then venture to enquire into their several causes and effects.

In this manner it is my intention to proceed; and to begin by making a new division of those, with which I am acquainted, into four different classes, or rather genera, of which, the first excepted, there are many different species.

The perennial; the periodical; the topical; and the general.

The perennial, as before observed, is the only wind which blows the same way throughout the year.

The periodical includes principally the monsoons, the Mediterranean etesian, or periodical winds, the tropical land wind, the khumseen, the scirocco, the long-shore wind, the harmattan, and the land and sea breezes.

The topical includes the sumyel, the mistral, and the Bengal north wester, which are all of them irregular, topical, and temporary, blowing always from the same point at particular places in sudden gusts, but of short duration.

The general winds are those which prevail in all parts of the world beyond the tropic, and might with equal propriety be called variable winds. These can only be discriminated from each other by the different degrees of velocity with which the current of air moves, and will be more clearly distinguished by a table of their velocities, which will therefore be added amongst the notes and illustrations.

The tempest, I have before observed, is both in cause and effect the same as a hurricane, or whirlwind: I shall therefore use these words synonimously, and place them in the first order, or degree of violent winds.

The storm, or what the English seamen call a hard gale, is likewise, I believe, nearly the same; I shall, therefore, make use of the former for the land, and the latter for the sea term, and reckon these in the second class: The French also sometimes speak of des orages, storms, as temporary gusts of wind, or squalls; which latter however in their own marine language are called "des grains de vent."

The gale has different gradations, as a hard gale or storm, approaching towards a tempest, a fresh gale, and a moderate gale; but the latter approaches towards a very fresh breeze. Then follows a moderate breeze, and finally a gentle breeze, which I consider as the slowest sensible motion of the air, not unappositely, though rather fantastically described, by a fine gentleman sailor in his journal, "gentle breezes languishing to a calm."

But it must not be understood that this treatise is solely intended for nautical purposes, for since I have retired from

the more active scenes of life, it has been my constant employment to keep a regular journal of the winds and weather, particularly in the delightful country, where I have had the happiness to reside during the last seven years ; and to apply as well as I am able meteorological observations to the purposes of rural and domestic life. The country gentlemen and farmers, therefore, I hope will find some useful hints on the subject of gardening and farming both in England and Wales, such as, I trust, may in many respects contribute to their health, their profit, or at least to their amusement.

No doubt can be entertained, but that many individuals are far better qualified to publish their thoughts on this branch of philosophy, but no one seems disposed to begin. I therefore take the liberty of presenting to my readers a kind of anomalogical alphabet : those who follow may form the letters into syllables, their successors again may arrange the syllables into words and sentences, and thus at length mankind may be gradually taught to peruse without difficulty every page in this great book of nature. Every line of her wonderful work is open to the inspection of the active and intelligent reader, and we may reasonably conclude that the greatest degree of comfort and happiness will fall

to the share of those, who possess the most extensive and perfect knowledge of its contents.

In the geographical remarks of this work, I have sometimes found myself at a loss to fix on the most appropriate amongst a variety of names, which are frequently given to the same spots of the globe, particularly in the hydrographical part of it.

To avoid running into an error myself, or inadvertently misleading the reader, I have occasionally taken the liberty of differing from some of our greatest geographers, who indeed too often differ from each other, and consequently, for want of precision in the use of geographical terms, cause great obscurity and perplexity both to writers and readers.

Whilst consulting maps, when the picture of them immediately strikes the eye, no error or confusion can arise to those, who are in any degree conversant in geography, from places being described by different appellations; but the person who in reading should meet with a remark relating to the Red Sea, would in all probability not know the place alluded to, if mentioned by the name of the Ara-

bian Gulf, as it is frequently called by different geographers: neither would he clearly comprehend that that, which is sometimes called the Arabian Sea, is at other times named the Indian Sea. Besides, both these are equivocal terms, for the former might relate either to the Gulf of Sind, or what is usually called the Red Sea, as the latter might as well denote any other branch of the Indian Ocean.

In the map, therefore, I have adopted the name of the Arabian Gulf, for the Red Sea; of the Gulf of Sind, for what is often called the Arabian Sea: and I have substituted the Gulf of Bengal, for what is usually termed the Bay of Bengal. The same definition perhaps will nearly apply to all seas, gulfs, and bays, namely, that they are a part of the ocean, or sea, nearly surrounded by land, excepting where they immediately communicate with the ocean; but all of them are easily distinguished by their different magnitudes, for there may be many gulfs in one sea, and many bays in one gulf; as the Gulf of Finland, and the Gulf of Bothnia, in the Baltic Sea; and the Bay of Campeachy, and the Bay of Honduras, in the Gulf of Mexico. The Mediterranean and the Baltic are properly seas. The Caspian and the Dead Seas, not having any

apparent communication with the ocean, may, I think, be distinguished by the particular name of Inland Seas.

The inferior portions of the ocean or sea, nearly surrounded by land, are properly gulfs; and the smallest gulfs ought in my opinion to be uniformly called bays. But if other writers do not choose to follow the new arrangement which I have thought necessary to adopt, it will at least answer an useful purpose for the present, by rendering the following observations intelligible according to the chart annexed. But it is not in meteorology or geography only, that we are apt to be misled by an inconsistency and confusion in the technical language of the sciences. The French Academicians have shown the necessity of reforming the chemical nomenclature, in which cause and effect have been hitherto often reciprocally confounded; and even in astronomy itself, the old exploded language of Ptolemy is at this moment used to explain the diametrically opposite system of Copernicus. But, in short, the vocabulary of every branch of philosophy requires reform at least every hundred years, so as to include all discoveries made during the preceding century; nor shall we ever thoroughly comprehend the secrets of nature, till we have thus gradually

rejected all extraneous jargon, and have learned to speak and write in such language as is consistent with the improvements of science.

OBSERVATIONS

ON THE

WINDS AND MONSOONS.

BEFORE we enter into a particular history of the winds, we must endeavour to ascertain what is the nature of wind in general. Seneca says, *ventus est aer fluens.* Pliny, *nihil aliud quam fluxus aeris.* This definition, for we may consider both as the same conveyed in different words, has been implicitly adopted by the most eminent modern philosophers.

Bacon first, and Halley after him, have considered wind as nothing more than the motion of the inferior current of air; and the expansion of it by heat, and the contraction of it by cold, are evidently the immediate causes of its motion.

Heat and cold then, as Lord Bacon wisely observes, *(See Note* 1.) may be considered as the hands of nature, with which she chiefly worketh; the one rarefying, the other contracting bodies. The truth of Lord Bacon's opinion, and the propriety of these definitions of wind, may be easily demonstrated by various means, but particularly

by a simple experiment, mentioned by many authors, and quoted by Adams, in his Lectures on Natural Philosophy. Let the air of a room (he says) be heated by a good fire, while the air of the adjoining chamber is cold; then let the door of the two rooms be thrown open, and the cold air being heaviest will enter the heated room in a strong current, or in other words, as a violent wind. But this experiment goes still further, for it shows that in the narrow compass of a doorway between a hot and cold room, whilst the cold or denser body of air enters into the heated room at the lower part of the doorway, the heated air being rarefied, becomes specifically lighter, and ascending, passes the contrary way into the cold room, at the upper part of the same doorway; and in the middle of this opening, exactly between these two currents, the air appears to have but little or no motion. The best mode of trying this experiment is by introducing the flame of a candle into the doorway between a hot and a cold room. The flame will be strongly drawn towards the heated room if held near the bottom of the doorway, where the air is most dense; and it will be drawn towards the cold room, with somewhat less strength, if held near the top of the door; whilst in the midway, between the top and bottom, the flame will remain nearly perpendicular. By this plain and satisfactory experiment, then, it may be ascertained that heat and cold produce that motion of the air, which in common language is called wind, and this principle, simple as it is, if applied to any body of the atmosphere, will be found universally to produce the same effects upon it to any extent. The theory of the learned Dr. Halley himself seems in a great degree founded upon it. In treating of the causes of the perennial or trade winds he observes, " Some have inclined to propose the diurnal rotation of the earth " upon its axis, by which as the globe turns eastward, the loose and

" fluid particles of the air, being so light as they be, are left behind, " so that in respect of the earth's surface, they move westward, and " become a constant easterly wind. This opinion seems plausible, " for these winds are found only near the equinoctial, in those pa- " rallels of latitude where the diurnal motion is swiftest; and I should " readily assent to it, if the constant calms in the Atlantic Ocean " near the equator, the westerly winds near the coast of Guinea, and " the periodical westerly monsoons under the equator in the In- " dian seas, did not show the insufficiency of that hypothesis. Besides, " the air being kept to the earth by the principle of gravity, would " acquire the same degree of velocity that the earth's surface moves " with, as well in respect of the diurnal rotation, as the annual round " the sun, which is about thirty times swifter.

" It remains therefore to substitute some other cause capable of " producing a like constant effect, and not liable to the same ob- " jections, but which is agreeable to the known properties of the " elements of air and water, and the laws of the motions of fluid " bodies. Such a one is, I conceive, the action of the sun upon the " air and water as he passes over the ocean, considered together with " the nature of the soil and the situation of the adjoining continents.

" I say, therefore, that according to the laws of statics, the air " which is less rarefied, or expanded by heat, and consequently more " ponderous, must have a motion towards those parts which are " more rarefied and less ponderous, to bring it to an equilibrium. " And secondly, that the presence of the sun continually shifting to " the westward, that part towards which the air tends by reason of " the rarefaction, made by its greatest meridian heat, is with him car-

" ried westward, and consequently the tendency of the whole body " of air is that way. Thus a general easterly wind is formed, " which being impressed upon all the air of the vast ocean, the " parts propel one the other, and so keep moving till the next return " of the sun, whereby, so much of the motion as was lost, is again " restored, and thus the easterly wind is made perpetual.

" From this same principle it follows, that this easterly wind " should, on the north side of the equator, be to the northward of the " east, and in the south latitudes to the southward; for near the line, " the air is much more rarefied, than at the greater distance from it, " because of the sun's being twice vertical in the year, and at no " time distant above 23½ degrees, at which distance the heat, be- " ing as the sine of the angle of incidence, is but little short of the " perpendicular ray; whereas under the tropics though the sun stays " long vertical, yet he is as long 47 degrees off, which is a kind of " winter, wherein the air so cools, as that the summer heat cannot " warm it to the same degree with that under the equator, where- " fore the air to the northward and southward being less rarefied " than that in the middle, it follows, that from both sides it ought " to tend towards the equator. This motion, compounded with the " former easterly wind, answers all the phenomena of the general " trade winds, which, if the surface of the globe were sea, would " undoubtedly blow all round the world, as they are found to do in " the Atlantic and Ethiopic oceans." No person can peruse this reasonable hypothesis without clearly comprehending the nature of the perennial or trade wind, nor without perceiving that it is founded on the principle of heat and cold, as explained at the commencement of this work, and demonstrated by the experiment mentioned by

Mr. Adams, the truth of which, however, is still further illustrated by what Dr. Halley observes of the winds in those latitudes, just beyond the tropics.

" As the cool and dense air, (says this philosopher) by reason of " its greater gravity, presses upon that which is hot and rarefied, it " is demonstrative, that this latter must ascend in a continual stream, " as fast as it rarefies, and that, being ascended, it must disperse itself " to preserve the equilibrium, that is, by a contrary current, the " upper air must move from those parts where the greatest heat is: " so by a kind of circulation, the N. E. trade wind below will be " attended with a S. W. above, and the S. E. with a N. W. wind " above. That this is more than a bare conjecture, the almost instan- " taneous change of the wind to the opposite point, which is fre- " quently found in passing the limits of the trade winds, seems to " assure us: but that which above all confirms this hypothesis, is the " phenomenon of the monsoons, by these means most easily solved, " and without them hardly explicable."

The experiment of the different currents of air between two rooms, the one heated, the other cooled, is here exactly demonstrated upon a more extensive scale; for while the N. E. trade, or inferior current of cold air is pressing into the hot room, the warm or superior current of air, having ascended, moves in a contrary direction to the S. W. to restore the equilibrium; and so likewise the reverse, in the opposite hemisphere.

Had this excellent philosopher been at leisure to pursue this subject to its utmost extent, no further consideration of it would have

been necessary: but with that candour which distinguishes all true friends to science, he has acknowledged that he derived great part of his information respecting the monsoons in the East Indies from others; and as he deems the theory incomplete, he invites all persons who may have opportunities of obtaining more perfect knowledge on this subject from experience, to add to his collection.

In compliance with this invitation, I shall beg leave to add my mite, the result of repeated observations made during upwards of thirty years occasional residence within the tropics, and from the experience which I have had in more than twenty times crossing the equinoctial line, besides coming from India by the Arabian Gulf, and returning thither by the Great Desert, and the Persian Gulf. It is not (as the Dr. observes) the work of one, nor of a few, but of a multitude of observers, to bring together the experience requisite to compose a perfect and complete history of the winds.

If we admit his hypothesis of the causes of the perennial wind, which in my humble opinion cannot well be disputed, we must also agree with him, that if the whole globe were sea, those tropical winds would evidently blow all round it, being only interrupted in their progress by great bodies of land and high mountains.

In order to show what effects are produced by these interruptions, we will in the first place endeavour to take a cursory view of the state of the different winds between the two great continents of Africa and America, which bound the Southern Atlantic, called after the ancient geographers the Ethiopic Ocean, particularly that part of it about half way between them, and which is beyond the influence of either coast. *(See Note 2.)*

The west coast of Africa, from Cape de Verd to 2 or 3 degrees S. is said to be generally flat with a sandy soil. That part of it, therefore, which is situated near the equator, must be excessively hot at all seasons of the year, but particularly about the two equinoxes. Within many leagues of this coast, then, the sea for nearly ten months of the year, being much cooler than the land, the current of air to restore the equilibrium must necessarily come almost constantly from the westward, according to the situation of the sun and the bearings of the land. But it will very seldom vary much from the western point near this coast, except at the two solstices. During the harmattan, and sometimes at other seasons, the wind will occasionally blow, a few hours before day, off the land, a circumstance perfectly well known to all commanders of ships in the Guinea trade, who are generally obliged to stand out from the coast, as near as they can to the westward of the N. or S. according to their destination, to catch the perennial winds; and until they reach them, they are constantly baffled by squalls and calms accompanied with violent thunder and lightning, and frequently they meet with water spouts.

On the opposite coast of America, for the same reason, the wind blows almost constantly towards the E. varying perhaps a few degrees N. or S. according to the nature and situation of the neighbouring coast, and also to the sun's place in the ecliptic; for on this coast there are likewise periodical winds, a sort of monsoons varying from the N.E. to the S.E.

In that part of Brazil, which extends from the latitude of 5 degrees S. to the tropic, the wet season begins in April, when the wind

changes to the S.E. with fresh gales accompanied with thunder and lightning. But in September, when the wind shifts to the N. E. it brings with it a clear sky and fair weather. There is no country on this continent within the tropics, where the heats are more tolerable, or the air more salubrious than in this part of America; for it is not only frequently refreshed with breezes from the sea, but, being mountainous, it also abounds with lakes and rivers, which often overflow their banks, so that the climate of the inland country is equally temperate with the sea coast.

But in the middle of this ocean, between the two great continents, and a very few degrees E. and W. of that central meridian, the regular perennial winds constantly prevail, subject to some slight variations according to the situation of the sun. Whilst he is near the equator, ships find great difficulty in passing the line, at which season they are sometimes becalmed until his declination increases to 7 or 8 degrees; but when it amounts to 15 degrees N. or S. they generally cross it with a fresh breeze, and particularly when he is near either solstice. The perennial wind in both hemispheres varies likewise at these times; for when the sun is in Cancer, the S. E. perennial extends to 4 or 5 and even 6 degrees across the line to the northward, inclining more to the S. than the E. On the contrary, when he is in Capricorn the N. E. perennial extends an equal number of degrees to the south of the equator, but it inclines more to the northward. All which facts clearly prove, that the lower current of air, being rarefied by the reflected heat of the sun, ascends, and the equilibrium is restored by a large body of dense air, which rushes forward in a right line, and with a strong current, to fill up the vacuum.

The early Portuguese and other European navigators, in attempting to sail towards the Cape of Good Hope, were greatly obstructed in their voyages thither by not adverting to these circumstances: but the use of the compass was then very little known. Most of them therefore endeavoured to keep close to the west coast of Africa, by which means, being then also ignorant of the real geography of this continent, they expected to shorten their distance; but thus situated they necessarily encountered constant calms and tornadoes, and seldom performed their voyage out and home in less than two or three years: whilst some other adventurers, nearly about the same period, in trying to avoid these inconveniences, fell in with the American coast, and were likewise detained by the S.E. wind, which of course retarded their progress on that side, for they could not without great difficulty, and that only at particular seasons, make their way to the southward.

But the better informed modern navigators, profiting by long and dear bought experience, have lately learned to keep nearly the mid-channel, where they are assisted by constant perennial winds, and where they may yet allow some room for leeway in the southern tropic, a precaution particularly necessary whilst the sun is near our summer solstice, for at that time the S. E. perennial* wind inclines very much towards the southward. Both outward and homeward bound India ships pass the equator in the Atlantic in about 18 or 20 degrees W. By keeping this course they never fall in with the coast of

* Tautology and repetition are studiously avoided as much as possible throughout the work; but the reader well knows that philosophical demonstrations do not admit great variety of expression, and will therefore allow that ornament of style must be sacrificed to perspicuity and precision.

America, either going to the Cape of Good Hope, or returning from it; and at the same time they avoid the calms on the coast of Africa.

After having passed the southern tropic 3 or 4 degrees, ships which sail from Europe between February and May seldom find themselves more than 26 or 28 degrees W.; which by the trenching away of the American coast to the westward in these latitudes, is nearly about half-way between the two continents. The winds in these latitudes, in the month of May, are generally found variable, as if alternately and equally attracted by both continents; but as vessels advance to the southward in the months of May and June, and approach towards Africa, the wind between the latitude of 28 and 35 degrees S. comes round to the westward, and generally blows fresh from the N. W. until they have passed the Cape of Good Hope.

The wind just beyond the bounds of the perennial coming from this quarter, seems in some degree to confirm Dr. Halley's theory of the superior current of air in this situation forming a contrary current at the commencement of the temperate zone. This observation must be confined to particular seasons within certain limits, and not be considered as invariably the case, even in the southern Atlantic; for in those same parallels of latitude, the winds are light and variable, coming often from the S. E. and veering occasionally to almost every point of the compass. To the eastward of the Cape the S.E. wind blows frequently during their winter with considerable violence for several days successively. But the southerly winds to the eastward of the Cape *(See Note 3.)* blow with most violence when the sun is in Capricorn, that is during their summer months; for when the land on the extremity of the east coast of Africa is

heated by the presence of the sun, the colder air from the antarctic circle, put in motion by the sun's melting the ice in those frozen regions, frequently rushes forward towards the land near the Cape of Good Hope with considerable force.

Bacon long since, and even Pliny before him, has in effect observed, that, from the vicinity of lofty mountains covered with snow, the winds blow periodically when the snow begins to melt. *Ubicunque siti sunt montes alti & nivales, ab ea parte flant venti stati ad tempus quo nives solvuntur.* A fact to which I shall frequently have occasion to refer in the course of this work.

I shall defer entering any further into investigations of the causes of the frequent and sudden changes of the wind in the temperate and frigid zones, until I have more particularly explained the nature of those within the tropics.

The S. E. perennial wind blows constantly some few degrees to the eastward of Madagascar at all seasons of the year, as far nearly as the Island of Java, where it comes within the reach of the regular monsoon; and indeed between the Island of Madagascar and the main land of Africa, commonly called the Mosambique Channel, the perennial winds are checked by the proximity of the two great bodies of land, and consequently partake of the nature of the monsoons.

But the name as well as the nature of the monsoons is misunderstood; the word, as before observed in the preface, is not derived from the name of a great mariner, but clearly from the Persian word, Mousum, meaning season. In tropical countries there are but two

seasons: those in Hindustan are distinguished by the N. E. and S. W. monsoons. But farther to the eastward and southward of the line, and the Gulf of Bengal, the monsoons blow from different quarters. The N. E. becomes in those parts the N. W. and the S. W. becomes the S. E. The causes of those changes and the original causes of the monsoons I shall hereafter attempt to explain, but first I shall endeavour to point out some generally prevailing errors respecting the course and changes of them in different parts of Hindustan, derived in all probability from the early navigators to India. As neither ancient nor modern geographers have yet fixed, with any degree of precision, the names or boundaries of the different oceans, seas, and gulfs, where the monsoons prevail, to avoid further interruption and trouble, I shall beg leave in this place to make a new division of them.

The Gulf of Bengal is apparently so called on account of the rich and fertile province of that name, situated at the north, or head of it. *(See Note 4.)* In this gulf therefore no alteration is proposed. The S. W. boundaries of this gulf I shall fix at Dondre Head, on the Island of Ceylon, latitude 5° 50′ N. and longitude 80° 48′ E. of Greenwich. And for the S. E. side, Acheen Head, latitude 5° 30′ N. longitude 95° 30′ E. For the northern extremity, the well known city of Calcutta, latitude 22° 34′ 45″ N. longitude 88° 29′ 30″ E. On the W. side of the peninsula, the coast of Malabar, with Cape Guardafui, on the coast of Africa, forms another considerable gulf, frequently called the Arabian, but generally the Indian Sea: but this latter in particular seems to be a name equally applicable, and often applied to the Gulf of Bengal, and even to the seas to the eastward and southward, and consequently is very indefinite; whilst the Arabian Sea may be confounded with the Red Sea or Arabian Gulf. Adopting

therefore in a great measure the plan of the oriental geographers, I shall name this sea the Gulf of Sind. The river Indus giving the name to the first, and Hindustan divided by the Ganges to the second division. The river Indus will then be placed at the head of one bay, and the Ganges at the head of the other; Tatta, a considerable city, situated on the former, and Calcutta on the latter. Tatta, according to Major Rennel, is in the latitude of 24° 50′ N. longitude 67° 37′ E. Cape Guardafui to the S. W. latitude 12 degrees N. longitude 52° 30′ E. and Cape Comorin to the S. E. in the latitude of 7° 56′ N. longitude 78° 5′ E.

From the ſouthern extremity of these two gulfs to the tropic of Capricorn, extending likewise eastward from the east coast of Africa to the west side of New Holland, I shall denominate the Indian Ocean, this being a considerable portion of the ocean leading to both gulfs in India, as well as to China and the eastern islands, including all India, both within and without the Ganges. From that parallel of latitude to the south pole, including that part of the ocean situated between the E. of Africa and the W. of New Holland, I shall call the Great Southern Ocean. These new divisions may not, perhaps, be deemed in every respect strictly accurate, but they will answer our purpose, and therefore, without further preface, we will now proceed to make some observations on the different monsoons and prevailing winds within these boundaries.

The winds in the Gulf of Bengal are generally ſaid to blow six months from the N. E. and the other six from the S. W. This is far from being precisely true respecting any part of India; it is, however, ſufficiently accurate for our present purpose, and therefore I shall in

part adopt this position as well as the common country name of monsoon; trusting, that in the course of this enquiry I shall be able to account for the several deviations of the wind from the monsoon points, and at the same time in some measure to explain the causes of them.

From the island of Ceylon to Balasore Roads, the N. E. monsoon is said to begin, near the coast of Coromandel, early in October. *(See Note 5.)* But in fact between the two monsoons, the expiration of the one and the commencement of the other, the winds and currents are variable on this coast, partaking of both; frequently, however, calms prevail during the whole month of September, and even early in October, with a strong current from the N. E. towards the S. W. At this period we must remember that the sun is fast approaching towards the equinoctial, which he crosses nearly about the 22d of September. As his declination afterwards increases from 7 to 15 degrees S. which is between the 10th and 31st of October, his absence from the northern hemisphere begins to be felt; and as he at the same time rarefies the air both by sea and land to the southward of the equator, the warm air then over the Indian Ocean, but particularly over the eastern side of the continent of Africa, as usual ascends, and the cold air from the N. meeting the perennial east wind, they pass forward progressively, beginning where the rarefaction takes place, and probably continuing to an immense distance, and thus form the N. E. monsoon. The exact point where the northerly wind terminates I shall not, in this place, attempt to ascertain; but we may venture to suppose, that it must be at least as far towards the N. E. as the west side of the Thibet and Napal mountains, separating India from China, and which in winter are always covered with

snow. From this frozen eminence a current of cold air will move with considerable velocity towards the tropic, on the approach of the sun, until the equilibrium is restored; but at the latter end of January, the sun again beginning to return towards the N. produces a sensible effect on the air; for in proportion as he approaches towards the equator, the current of air in the Gulf of Bengal, near the land, takes a different direction. About this time the wind, immediately on the coast of Coromandel, no longer blows violently or regularly from the N. E. as in the commencement of the monsoon, but first abates in strength (like a current of water when the level is nearly restored) and then changes daily to regular land and sea breezes, which of course, near the coast, are obviously occasioned by the alternate rarefaction of the air by sea and land.

When the earth begins to be violently heated in the course of the day, the rarefied air ascends, and the cooler air from the sea comes in to supply its place; but the exhalations raised during the day are condensed in the cool of the evening, during the absence of the sun, and falling down in copious dews refresh the earth, when the sea becomes warmest, and the current of air, a few hours after sun-set, goes from the land to the sea, and produces what is called the land wind. It must be remembered, that these alternate land and sea breezes do not take place until some time after the change of each monsoon, when its strength begins to abate; for at the commencement of either, the monsoon itself blows incessantly for a month or five weeks immediately on the coast, and continues, with trifling deviations from the N. E. or S. W. according to the respective seasons. Nor do the land and sea breezes at any time extend above three or four leagues from the shore.

Mr. Clare, in his Treatise on the Motion of Fluids, shows the cause of these breezes by an easy and familiar experiment. "Take," he says, "a large dish, fill it with cold water, and into the middle of this "put a water-plate filled with warm water: the first will represent "the ocean, the latter an island, rarefying the air above it. Blow out "a wax candle, and if the place be still, on applying it successively "to every side of the dish, the fuliginous particles of the smoke, "being visible and very light, will be seen to move towards the dish, "and rising over it, point out the course of the air from sea to "land.

"Again, if the ambient water be warmed, and the dish filled with "cold water, when the smoking wick of the candle be held over the "centre of the plate, the contrary will happen, and show the course "of the wind from land to sea."

During the continuance of the land and sea breezes on the coasts of Coromandel and Malabar, both in the N. E. and S. W. monsoons, the wind on shore seems regularly to follow the course of the sun, and passes very perceptibly round every point of the compass in twenty-four hours.

These winds blow constantly every year on the coast of Coromandel to the latter end of January, and continue during February and to the beginning of March, subject to very slight variations; but as the sun approaches towards the vernal equinox, the winds again become variable for some days, as they were about the autumnal equinox, until his declination is upwards of 7 degrees N. when the S. W. monsoon sets in, and often on the south part of the coast, with consider-

able violence. This change or reflux of air appears to be put in motion by the same means as that which comes from the opposite quarter; for as the sun's altitude increases daily in the northern hemisphere, the extensive body of land in the N. E. part of Asia must become much hotter than the ocean, and consequently a considerable degree of rarefaction will be produced over that part of the continent, whilst at the same season an immense body of cold air will come both from the Indian Ocean and the continent of Africa, in the southern hemisphere, to restore the equilibrium. The principal tracts of land of different temperatures on the two continents, bearing very nearly N. E. and S. W. of each other, will therefore become alternately the two opposite extreme points of rarefaction and condensation, and necessarily, according to this theory, be the immediate causes of the N. E. and S. W. monsoons.

But to those who have not considered the nature of the monsoons in India, it may appear somewhat inconsistent with this theory, that the N. E. monsoon, which blows with great force in October and November on the Coromandel coast, is scarcely felt a few degrees to the westward on the Malabar coast, and so *vice versa*. The S. W. monsoon, which blows with great strength on the Malabar coast in April, May, June, and July, is never felt with any degree of violence on that of Coromandel after its commencement, nor even then, excepting very far to the southward. It is true both coasts are in the northern hemisphere, and might be supposed subject to the same effects from the situation of the sun; and so they certainly are in some degree, for the wind blows nearly in the same direction on both sides the peninsula; but on referring to the map, it will be found that the two coasts are separated by a double range of mountains, running almost N. and S. the one immediately bounding the

coast of Malabar, the other nearly in the middle of the peninsula called the Ballagat, or country above the Passes; both which serve alternately as a screen to either coast during the different monsoons. Besides they not only break the force of the wind, or current of air, but these mountains, being less electrified than the clouds coming from the sea, attract them, and it is supposed, when nearly in contact, take away their electrical fire, and cause them to precipitate the water they contain.

It was not, originally, the immediate object of this work to account for the immense quantity of rain which constantly falls every year in India, during the different monsoons; nor shall I endeavour to solve this difficulty without very great doubt of success; nevertheless, as violent rains invariably accompany the change of the monsoons, it seems necessary to make the attempt, more especially as the two subjects seem on all occasions to be intimately related, or rather inseparably connected.

Clouds are generally believed to be formed by vapours raised by solar or subterraneous heat from moisture in the earth, or in greater quantities from water itself, and when so raised they are kept suspended in the middle regions of the atmosphere in the form of clouds, until by some means not yet indisputably ascertained, the water is again precipitated to the earth in rain.

It may be necessary to premise, that in treating of this subject I shall generally make use of the word vapour for that which arises from water or any other fluid, and of the term exhalation for that which comes from the land.

By some authors it is supposed, that both vapours and exhalations are small vesiculæ detached, as before observed, from the earth or water by heat, and which must be specifically lighter than the air, or they could not ascend. When they have passed through the denser medium near the earth, attracted by the dry air above them, they continue to ascend till they arrive at a cold region, where they become condensed, and remain suspended, as before observed, in the form of clouds. In this state they continue floating, till by some new agent they are converted *into rain, hail, snow, mist, &c.* Others again, who equally admit that the clouds are formed by these vesiculæ, think that they coalesce in the upper regions of the atmosphere, forming into little masses until they become too heavy to be any longer suspended, and then descend in rain. But this hypothesis cannot be well founded, for the vapours are perpetually ascending into the upper regions of the atmosphere, which are always cold, and consequently, according to this theory, they would again be precipitated in rain as soon as they have arrived at a certain height, which would almost constantly produce regular showers. The same objection applies to the system of Dr. Derham, who accounts for rain by supposing the vesiculæ to be full of air, which (he says) becoming contracted in the colder regions, the watery shell, thus thickened, becomes heavier than the air, and is precipitated in rain by its comparative weight. But Dr. Franklin, in his Observations on Electricity, seems to account most rationally for the formation of the clouds and precipitation of rain. "The sun supplies (or seems to supply,) "he says, common fire to all vapours raised from the sea, or exha- "lations from the land. Those vapours, which have both common "and electrical fire in them, are better supported, than those which "contain only common fire; for when vapours rise into the coldest

" region above the earth, the cold will not diminish the electrical
" fire, if it doth the common. Hence clouds formed by vapours raised
" from fresh waters within land, from growing vegetables, moist
" earth, &c. more speedily and easily deposit their water, having
" but little electrical fire to repel and keep the particles separate.
" So that the greatest part of the water raised from the land is let
" fall on the land again; and winds blowing from the land to the
" sea are dry, there being little use for rain on the sea, and to rob
" the land therefore of its moisture, in order to rain on the sea,
" would be contrary to the unerring distributions of Nature.

" But clouds formed by vapours raised from the sea, having both
" fires, and particularly a great quantity of the electrical, support
" their water strongly, raise it high, and being moved by winds, may
" bring it over the middle of the broadest continent from the middle
" of the widest ocean. How these ocean clouds, so strongly sup-
" porting their water, are made to deposit it on the land where it is
" wanted, is next to be considered.

" If the ocean clouds are driven by winds against mountains,
" those mountains, being less electrified, attract them, and on contact
" take away their electrical fire (and being cold, their common fire
" also;) hence the particles close towards the mountains, and towards
" each other. If the air was not much loaded, it would only fall in
" dews on the mountain tops and sides, form springs, and descend into
" the vales in rivulets, which united make larger streams and rivers.
" But being much loaded, the electrical fire is at once taken from
" the cloud, and on leaving it the particles coalesce for want of that
" fire, and fall in heavy showers.

"When a ridge of mountains thus dams the clouds, and draws "the electric fire from the cloud first approaching it, that which "next follows, when it comes near the first cloud (now deprived "of its fire) flashes into it, and begins to deposit its own water. "The first cloud again flashing into the mountains, the third ap-"proaching cloud, and all the succeeding ones, act in the same man-"ner as far back as they extend, which may be over many hundred "miles of country."

It is evident from the geographical situation of the peninsula of India, that the clouds which are conveyed over it in both monsoons, must be saturated with moisture. In the N. E. monsoon the vapours will be raised from the sea in the Gulf of Bengal, and as they approach the land on the coast of Coromandel, the clouds, in the manner above described, will be made to discharge their contents in great torrents of rain. So likewise in the S. W. monsoon, the vapours will be raised in the Gulf of Sind and the Indian Ocean, and they also, in the same manner, will discharge their contents on the Malabar coast and amongst the Ballagat mountains.

But as an additional proof of the truth of this hypothesis, it may be observed that the quantity of rain, which falls in the principal part of South America, as well as in this part of India, is constantly in proportion to the height and extent of the mountains, to the length of time that the wind continues to convey the clouds towards the land, and to the extent of the sea or ocean whence the water is evaporated which forms those clouds.

The principal features of both these countries bear a striking resemblance to each other. Those of the peninsula of India being in miniature almost precisely the same as those of America in the same parallel of latitude. The former is situated between the Gulf of Bengal and the Gulf of Sind; the latter between the South Atlantic and the Pacific Oceans. Both countries have a lofty ridge of mountains, which run through the centre of them from N. to S.; and both have large rivers, apparently in exact proportion to the size of their respective mountains, which discharge themselves towards the E. into the sea.

If this comparison be pursued, and the general resemblance, with its consequences, are considered, it will be found that the quantity of rain, which falls in all these different countries, is nearly in proportion to the extent of the ocean near which they are situated, and to the height of their different mountains. The temperature of the sea in all of them is supposed to be nearly the same.

The Gulf of Sind is much more spacious than the Gulf of Bengal. The coast of Malabar is much more mountainous than that of Coromandel, and, therefore, although the winds blow nearly an equal length of time on either coast, the hills on the former being more numerous, and the sea more spacious than the latter, the rains on the Malabar coast will be more abundant than those on the coast of Coromandel.

The South Atlantic Ocean is infinitely more extensive than the Gulf of Sind. The American mountains are beyond all comparison higher than any in the peninsula of India; and the N. E. and

S. E. winds alternately prevail the whole year on the east coast of America; whereas on either coast of India, the monsoon is never said to blow above six months, and, to speak strictly, does not continue above half that time. For all these reasons, therefore, the rains in America are probably more abundant than on either coast of the peninsula of India. I say probably more abundant, as I am not in possession of any meteorological tables kept in Brazil; and during an accidental residence of ten weeks at the Bay of All Saints, it was not in my power to obtain much information from the Portuguese on those subjects. For the present, therefore, we must form our opinion of the quantity of rain which falls, from the number and magnitude of the rivers. This mode of judging will, without doubt, be deemed exceptionable; for in all probability the Amazon and La Plata, the two principal rivers of America, are considerably augmented by the snows which are constantly melted amongst the Cordilleras, where their sources are supposed to lie. But if we admit this objection to be well founded, it still may be contended, that the numberless inferior contributary streams, which in any other situation would be deemed very considerable rivers, and are in fact much larger than those on the southern part of the peninsula of India, are most of them formed by vapours conveyed by the east winds from the Southern Atlantic Ocean to the inferior branches of the Andes, where they are compelled to precipitate their contents in the manner described by Dr. Franklin. It may perhaps be thought that this comparison, and all the inferences deduced from it, are equally applicable to other countries, and particularly to Africa. But the geographer will soon find, that although the continents of Asia and America somewhat resemble each other, both in shape and situation,

yet Africa, which also terminates in a cape to the southward, having no ridge of lofty mountains, running from N. to S. like the two former continents, the rivers of that country are few in number, and those comparatively small. But to return to a further account of the monsoon on the coast of Coromandel.

The island of Ceylon, which lies to the southward of the Coromandel coast, and where the peninsula becomes extremely narrow, partakes of both monsoons, but principally of the S. W. The wind immediately on the coast, at the commencement of this monsoon, takes nearly the same direction as the coast itself. From the latitude of 9 to 13 degrees, the coast lies nearly N. N. E. and S. S. W. and from the latitude of 15 degrees to the head of the gulf called Balasore Roads, it runs almost N. E. and S. W. The S. W. monsoon therefore on this coast blows at first along shore, from which cause it is called the Long Shore Wind. The nature of the soil on the coast probably contributes to give it this direction; for the soil being, in some respects, like the Gulf of Guinea on the coast of Africa, low and sandy, the air near the earth must consequently be much rarefied under almost a vertical sun, and the denser air, coming across the Indian Ocean or the Gulf of Sind, will follow that direction on the coast to fill up the vacuum. But these winds continue only to the end of May or the beginning of June, when the sun being near the summer solstice, the hot land wind on the coast of Coromandel commences, and continues about six weeks. To understand the causes of this sudden change, we must again advert to the geography of the country, and consider the state of the atmosphere at this period on the two coasts.

The southern part of the peninsula, from the latitude of 16 degrees to Cape Comorin, may be divided longitudinally into three parts, beginning at Madras, which is situated in the longitude of 80° 28′ 45″ E. About 2 degrees to the westward of that meridian is a range of mountains, forming the eastern boundary of the Valley of Baramaul, where the high land of Mysore commences, commonly called the Ballagat, or country above the Passes. This high or table land of Mysore rises at least 2,000 feet above the coast of Coromandel, and runs through the peninsula from N. to S. nearly in the longitude of 78½ degrees. Two degrees farther to the westward is another range of mountains, which may be considered as the boundary of the Malabar coast; and the country situated between these two meridians, from 76 to 78 degrees, is properly the country of Mysore. With this sketch of the map of the country before us, and with a recollection of the first principle of this hypothesis, it will not be difficult to account for the hot land wind prevailing in the Carnatic during the months of May and June.

The sun's declination in the month of May is between 15 and 22 degrees N.; he will therefore before the end of this month have been vertical over all these countries, and consequently have produced a considerable degree of heat in the Carnatic; but at the same time the double range of mountains to the westward will have arrested the clouds brought thither by the S. W. monsoon, and made them precipitate their contents both on the Malabar coast and in the Mysore country. The principal point of rarefaction then, at this season, will be the Carnatic, which may, as usual, be considered as the heated room, and the nearest cold body of air will come from the table land of Mysore to restore the equilibrium.

In the Carnatic, during the months of May and June, the thermometer of Farenheit in the shade is generally at 90 or even 100 degrees and upwards, whilst near the mountains the same kind of thermometer will not be more than 70 or 80 degrees at the utmost. The current of air then will move from the mountains across the Carnatic towards the coast of Coromandel, and of course produce the hot land winds, but they are severely felt only on the east side of the Carnatic, at a distance from the mountains: at Amboor, and even at Vellore, which are situated near them, those winds are neither extremely hot, nor of long duration; and in the narrow part of the peninsula, in the beautiful little province of Coimbatore, although so far to the southward, in consequence of their vicinity to the hills, the inhabitants are never incommoded by land winds.

This rarefaction in the Carnatic, and the current of air which comes from the Ballagat Mountains, and blows from the W. to the E. to fill up the vacuum, are sufficiently strong inland to counteract the effects of the monsoon in this part of the peninsula; but the westerly wind soon loses its effect on coming to the coast, for it never extends above one or two leagues out to sea, where the S. W. monsoon blows incessantly at this season of the year.

But within a month after the summer solstice, the current of the S. W. monsoon begins to slacken, when the regular land and sea winds again commence upon the coast of Coromandel, and continue with slight variations for a month or six weeks. Towards the end of August, as the sun approaches the line, the heat in Asia and the cold in Africa begin to abate; consequently the monsoon daily becomes more faint, and like the slack water between the flood and

ebb tides, the air in the Gulf of Bengal has little motion: Frequently it moves about in eddies, and after it has fluctuated between the two monsoons for three weeks, sometimes almost a month, being attended with squalls from different quarters, the N. E. wind at length prevails, and like the change of tides, moves at first with considerable rapidity. But the tremendous gales, or rather hurricanes, which sometimes blow in the gulf at this season, and bear down every thing before them, seldom happen precisely at the beginning of the monsoon, nor does it appear that they are the effect of a current of air like the monsoon, blowing constantly from the same quarter for several months, but rather resemble whirlwinds, which proceed principally from some sudden change in the upper regions of the atmosphere, and which, though extremely violent, are merely local and temporary. But before we conclude the account of the S. W. monsoon in Hindustan, it may be proper to observe, that this monsoon brings the violent rains into the provinces of Bengal and Bahar, which generally begin at Calcutta about the middle of June, two months after their commencement to the southward of the gulf.

It has been supposed, and with some apppearance of reason, that the S. W. monsoon *(See Note 6.)* in the province of Bengal, and the countries immediately to the N. of it, commences near the hills of Thibet; but, for my own part, I am disposed to think they begin further to the southward. The water may first appear in the rivers to the northward, from the melting of the snow on the mountains; but the range of hills, which separate Bengal and Bahar, and even those to the eastward of the Ganges, in the same parallel of latitude, are sufficiently high and extensive to attract the electric fluid from the clouds, as they approach them from the sea saturated with moisture:

consequently, in this case, the rains will begin where this change in the atmosphere takes place; but this point might be easily ascertained by a comparison of meteorological tables kept in the country. A knowledge both of the time and place where the rains begin must be considered of great importance to the inhabitants of Hindustan, among whom the crops of rice depend on a sufficient supply of water.

In the Gulf or Bay of Bengal, Major Rennel observes, the monsoon blows from the S. S. W. and S. W. Yet in the eastern and northern parts of Bengal it blows from the S. E. and E. S. E. Such a variation of the wind, within so small a distance, appears to me a further confirmation of this theory; for whilst the points of rarefaction in the northern provinces at this season will of course be the land to the westward; the melting of the snow on the mountains of Thibet to the eastward will produce a current of cold condensed air, sufficiently strong to counteract the regular course of the monsoon; instead therefore of blowing from the S. S. W. and S. W. as it does near the sea, it will blow constantly at this season, as the above author remarks, from the E. S. E. and S. E.

But before we conclude our account of the different winds in Bengal, it is necessary to observe, that late in the month of March, until the commencement of the S. W. monsoon, there are sometimes temporary strong gusts of wind in the southern part of the Delta from the N. W. accompanied with thunder and lightning. They generally come on late in the afternoon, and are preceded some hours by an appearance of dark heavy clouds in that quarter. The well-informed natives of that country call these sudden gusts Tuphan, a name familiar to the classic scholar; but the causes of them, and

further particulars of their effects will hereafter be more minutely considered. I shall therefore for the present only observe, that in my opinion they may be imputed to the air in the south part of the Delta being rarefied by almost a vertical sun, and the nearest body of cold air coming from the neighbouring mountains, which divide the provinces of Bengal and Bahar, to fill up the vacuum.

Dr. Halley seems to consider the hurricanes which blow occasionally in the month of October in the Gulf of Bengal, as of a similar nature to those in the West Indies, in which probably he is right; but at the same time it is evident, that he has been misinformed respecting the time they generally happen in the East. He observes that our seamen suppose them to be the breaking up of the monsoon. In this circumstance the mariners have misled the philosopher; for the hurricanes seldom happen near the change or breaking up of the monsoons, but generally many days after their commencement, and sometimes about the middle of them. Both the N. E. and S. W. monsoons blow at first in fresh gales, but neither of them encrease to violent hurricanes. It is from very obvious causes already sufficiently explained, that the one dies gradually away before the other begins. But we will first adduce unquestionable proofs of these facts, and then endeavour to ascertain the causes of them.

The first hurricane on the coast of Coromandel, mentioned by Mr. Orme, in his History of Hindustan, was that which destroyed Le Bourdonai's fleet, after he had taken Madras in the year 1746. He attacked this fort in September, which surrendered to him in less than a month, on condition that private property should be protected.

But Dupliex, the governor of Pondicherry, disputed the right of the admiral to make such a capitulation, and insisted on his seizing all property, both public and private. The correspondence on this subject, in which the virtuous admiral strenuously defended the rights of individuals and his own honour, detained him at Madras with his squadron much longer than otherwise he intended to have stayed; and on the 2d of October came on a hurricane, which in a few hours destroyed almost the whole French fleet, and in which twenty other ships of different nations were driven on shore. One of the ships, says Mr. Orme, foundered in an instant, and only six of the crew were saved. But it must be remembered that four vessels laden with effects sent from Madras, with three others lately arrived at Pondicherry from Europe, were not affected by this hurricane; the violence of which, therefore, did not extend more than 60 or 80 miles to the southward.

On the 31st of October, 1753, Mr. Orme mentions also a violent hurricane on land, which was felt mostly near Wandiwash; but as the same author, who is in general equally minute and correct, takes no notice of any bad consequences happening from it at sea, we may reasonably suppose that it did no mischief either at Madras or Pondicherry, although its principal violence was felt nearly half-way between both, and not more than 60 miles in a direct line from either.

The next, which occurred during the N. E. monsoon, was on the 30th of December, 1760, during the siege of Pondicherry. On the evening of that day the weather was fair, the rains had ceased, and there were regular land and sea breezes; but a heavy swell rolled in on the shore from the S. E. The next morning the sky was of a

dusky hue, accompanied with a closeness in the air, but without that wild irregularity which prognosticates a hurricane. Towards the evening, however, the wind freshened from the N. W. and at eight at night encreased considerably. About midnight the wind veered round to the N. E. fell calm with a thick haze, and in a few minutes after flew round to the S. E. whence it blew with great violence. Almost all the ships might have been saved, had they taken the advantage of the wind blowing off the land, but the roaring of the wind and sea prevented the captains from hearing the signals for standing out to sea, and many of the ships were wrecked. The Newcastle, Queenborough, and Protector, were driven on shore a few miles S. of Pondicherry, and the crews were saved. The Norfolk, Admiral Stevens, returned next day; and on the 7th came in the Salisbury from Trinco Trincomalay S. and the Tiger from Madras N.; so that in these opposite directions of E. N. and S. the violence of the storm had not been felt. It is observed by mariners in the East Indies, that these hurricanes usually happen once in five years; but for this opinion I can find no reason, either from what I have heard from others or have myself observed.

The next in succession to that of 1760-61, was in 1763. On the 20th of October in that year, many days after the N. E. monsoon had apparently commenced, the wind began to slacken, and the clouds in the evening appeared uncommonly red, particularly on the day preceding the hurricane. On the morning of the 21st a strong wind blew off the land, and in the course of a few hours flew all round the compass. At this time the Norfolk man of war, Admiral Cornish, with the America and Weymouth, and the Royal Charlotte country ship of four hundred tons, remained in Madras roads, with

several other countryvessels. The wind began to blow from the N.W. and continued from that quarter for three or four hours, of which time the men of war availed themselves to put to sea, but it then suddenly changed to the eastward, and prevented most of the country ships from following their example. After having blown with incessant violence for fourteen hours, and with almost equal strength from every point of the compass, it at length ceased, but literally left only wrecks behind. All the veſſels at an anchor were lost, and almost every person on board perished; but the men of war and the Royal Charlotte returned into the roads on the 24th. The former had felt the gale very severely whilst near the coast, but without sustaining any material injury; the latter vessel likewise, from staying rather too long at anchor, had lost her fore and main masts, and was otherwise much damaged.

The last of these hurricanes on the coast of Coromandel, which it seems necessary to mention, is that which happened on the 29th of October, 1768. Of this sufficient notice was given, but the officers of the Chatham Indiaman, then in the road, did not avail themselves of it; for on the preceding evening the sea was violently agitated, the sun set in a haze deeply tinged with red, with every other prognostic of a gale of wind. But unfortunately there had been a misunderstanding between the captain and officers, and the former being on shore, the latter, probably waiting for orders, remained at anchor, notwithstanding they might have put to sea with the N. W. wind, which, as usual at the commencement of these hurricanes, blew off the land. The governor and council, who foresaw the danger even time enough to have prevented the loss of the ship, ordered signal guns to be fired with shot, by way of directing the officers to weigh

anchor and stand out to sea; but either they did not hear the guns, or were two punctilious in waiting for orders, and in consequence of this inflexibility were lost, for the ship was never seen or heard of after the close of the evening of the 29th. It is possible they were not able to distinguish the signal guns, for many of the inhabitants of the fort, during the violence of the hurricane, did not hear them, and the flashes of the guns might be mistaken by the officers of the ship for those of lightning. The vessels, lying at this time at a single anchor in the open road of Pondicherry, were not in the least disturbed by this hurricane; neither were the effects of it in the smallest degree felt at any of our settlements to the northward. Ships which put to sea in due time very soon get beyond their influence to the eastward, and it is very well known that they never extend far inland. All these circumstances properly considered, clearly manifest the nature of these winds, or rather positively prove them to be whirlwinds, whose diameter cannot be more than 120 miles, and the vortex seems generally near Madras or Pulicat, where a branch of the Ballagat Mountains extends towards the sea. Those which happen in the N. E. monsoon generally fall with most violence within a few leagues of this place, and never, I believe, reach to the S. of Porto Novo.

But at the commencement of the S. W. monsoon, violent gales are sometimes felt on the east side of Ceylon and the southern extremity of the coast; these however should be considered rather as the tail of that on the Malabar coast, which extends itself over Cape Comorin, near the southern extremity of the peninsula. In that quarter, however, such gales seldom occur, and are always of short duration.

One instance only is to be found in Mr. Orme's history of a violent hurricane to the southward. In this instance, which happened on the 13th of April, 1749, near Porto Novo, on the coast of Coromandel, two of the company's ships were stranded near Cuddalore; and the Namur, one of Admiral Boscawen's squadron, with the Apollo hospital ship, foundered. This is the only instance known to me, in thirty-five years, of a hurricane on the Coromandel coast during the S. W. monsoon, and the effects of this were not felt beyond 11 degrees N.

On the coast of Malabar, however, this monsoon frequently blows with considerable strength at the commencement; but it must be observed that it does not begin at the same time on all parts of the coast, nor does it proceed rapidly in its course towards the N. For although the change of the monsoon generally takes place at Anjengo about the time the sun becomes vertical at that place, it never reaches Bombay before the middle or rather the end of May; the latitude of the former is about 8° 30′ N. and of the latter 19 degrees. On the 12th of April the sun is vertical at Anjengo, and about the 15th of May at Bombay. If then the difference of latitude and declination be compared, it will be found that the sun and the monsoon move almost precisely together, at the rate of about twenty miles per day: A circumstance, which above all others tends to prove that the sun's motion in the ecliptic is the primary, if not the sole cause of the motion of the air, or rather of the course of the wind, at least in this part of the world, I mean on the Malabar coast.

Monsieur D'Apres however remarks, that the N. E. monsoon, in the Mosambique Channel, begins at the north end of Madagascar,

and amongst the Comero Islands, in the first week of November; and at St. Augustine's Bay to the southward, at the end of the same month. If the distance of these two places in like manner be divided by the number of days, it will be found to correspond nearly with the daily difference of the sun's declination; consequently, this fact will further corroborate the truth of this hypothesis; for the correspondence between the motion of the monsoon and the daily difference of the sun's declination is exactly the same, not only in India, but likewise in both the northern and southern hemispheres.

I have no authentic account of hurricanes on the Malabar coast; but I recollect to have heard of one which happened in the month of May, 1762, off Goa, and of a second near Anjengo, which took place, I believe, about the middle of April, 1779. One of the company's cruisers was at that time lying at an anchor in the road; it attempted, too late, to put to sea, but was never afterwards seen.

From these accounts it seems very clear, that hurricanes never happen at the breaking up of the monsoons, nor precisely at their commencement, but rather sometime after the change, and that they are local and of short duration. But this description of them is not confined to the Malabar coast, nor to that of Coromandel, they rage with equal if not superior violence in the southern hemisphere, particularly about the latitude of 20 degrees S. near the French Islands, where many ships have been in great danger of perishing from their effects, amongst the rest the Ilchester Indiaman, in the year 1757. But the most accurate and authentic account, which I have received of hurricanes in these latitudes, was that of the hurricane

which the Britannia Indiaman encountered in the year 1770. On the 10th of March, about midnight, the wind suddenly burst upon the ship from the S. E. and blew with considerable force, but shifted all round the compass in the course of a few hours. Between five and six in the morning a sudden gust carried away their topmasts and gib boom, when lying to under a balanced mizen; and nearly about the same instant the jolly boat, hanging over the side by the mizen chains, was suddenly whirled up into the mizen shrouds, whence it fell into the sea, and was dashed in pieces. The wind having blown nearly with equal strength from opposite quarters, prevented the sea from rising, so that at the end of ten hours, when it subsided, the sea bore but very little appearance of having been violently agitated.

The following day, the rigging being repaired, they proceeded a few leagues to the westward, and met a French vessel that had not felt the hurricane; they were likewise overtaken by another ship which had followed the same track as the Britannia without suffering the least inconvenience from it. These circumstances prove positively, that in an east and west direction, this hurricane had not extended above 30 leagues, and likewise that the ship was nearly in its centre.

Thus then it appears that these tempests or hurricanes are tornadoes, or local whirlwinds, and are felt with at least equal violence on the sea coast, and at some little distance out at sea. But there is a material difference in the situation of the sun when they appear at different places. On the coast of Coromandel, for example, they seldom happen, particularly to the northward, except when the sun is

in the opposite hemisphere. On the Malabar coast they rage with most violence during the monsoon, whilst the sun is almost vertical. Near the island of Mauritius they are felt in January, February, and March, which may be deemed their summer months. And in the West Indies, according to Mr. Edwards's History of Jamaica, the hurricane season begins in August and ends in October.

As they happen, then, in different places at different seasons, they cannot well be ascribed, like the monsoons, to any particular situation of the sun in the ecliptic; neither, as they do not happen regularly every year, can they be deemed periodical. But as during their continuance the wind blows all round the compass, and nevertheless is not felt in any direction at a distance of more than sixty or eighty miles, we may venture to conclude that whirlwinds are solely owing to violent and sudden changes, both in the upper and lower regions of the air. When the lower regions of the atmosphere are from any cause considerably rarefied, and the air in those of the upper at the same time becomes very much condensed, according to the principle of gravity, the air in the upper regions will descend, and necessarily cause a whirlwind, perfectly similar to that produced by sinking a heavy body in water; the parts adjacent will immediately concentre to a point, and rush with a whirling circular motion towards the bottom with great violence.

" Whirlwinds," *(See Note 7.)* says Dr. Franklin, in one of his letters on philosophical subjects, " are of two kinds; one from the air " ascending, and the other from the air descending. A fluid mov- " ing from all points horizontally towards a centre must either ascend " or descend; but air flowing on or near the surface of land or water,

" from all sides towards a centre, must necessarily at that centre " ascend, the land or water hindering its descent. But if these con- " centring currents be in the upper region of the atmosphere, they may " indeed descend and cause a whirlwind; and when this current has " reached either the earth or water, it must spread, and probably blow " with great violence to a considerable distance from the centre. Of " the two kinds of whirlwinds, that which ascends is the most com- " mon; but when the upper air descends, it is perhaps in a greater " body, extending wider as in thunder gusts, and without much " whirlwind." If then this opinion be well founded, a common gale of wind, of moderate extent and short duration, may be supposed to proceed from the former; but when violent, of long continuance, and with less variation, from the latter.

It would not, perhaps, be a matter of great difficulty to ascertain the situation of a ship in a whirlwind, by observing the strength and changes of the wind: If the changes are sudden and the wind violent, in all probability the ship must be near the centre or vortex of the whirlwind; whereas if the wind blows a great length of time from the same point, and the changes are gradual, it may be reasonably supposed the ship is near the extremity of it.

Another extraordinary circumstance respecting these hurricanes should likewise be mentioned, as tending to a discovery of their causes; that they most frequently, it might perhaps with propriety be said always, occur near large bodies of land, but are not known at sea within the tropics, at least in that part of the ocean remote from the continent, or even at a considerable distance from extensive islands. It is a well known fact, as the name itself implies, that the Pacific

Ocean is exempt from tempests. So likewise is the middle of the South Atlantic Ocean, particularly from the equator to the latitude of 16 degrees S. A violent gale of wind, for instance, was never known at the little island of St. Helena, which lies at the distance of nearly a thousand miles from the west coast of Africa, and still further from the eastern coast of America. The mean temperature of St. Helena is, I believe, 72 degrees instead of 79, which is the mean temperature of places on the continent, in the same parallels of latitude; but the variations there throughout the year, both of the thermometer and barometer, are very trifling. It must here be again remembered, that the vapours raised from the ocean have a larger portion of both common and electrical fire, and are, therefore, more firmly supported in the form of clouds than those which come from the land; that in these oceans an equal temperature almost constantly prevails, and that all the circumambient air is filled with homogeneous vapours. In every wide expanse of ocean, therefore, unbroken by a continent or extensive island, no sudden changes are likely to take place in the atmosphere; but, on the contrary, where the clouds, which are formed by exhalations from extensive bodies of land, approach those which are derived from the ocean, violent and sudden alterations must necessarily occur; for, as it has been frequently before remarked, the land clouds will attract both common and electrical fire from those clouds, which come from the ocean, until the equilibrium is restored; and during this operation such changes must necessarily happen in the atmosphere, as will produce strong currents of air, and in general whirlwinds. Near every part of the continent of Asia, in the Gulf of Bengal, on either coast of Africa near the island of Madagascar, and even in the vicinity of the islands of Mauritius and Bourbon, where also there are volcanoes, whirlwinds occasioned by

sudden changes in the atmosphere will, at certain seasons, frequently occur. But in the Pacific Ocean, *(See Note 8.)* and in the central parts of the North and South Atlantic, they will seldom happen. Ships in crossing the North Atlantic scarcely ever meet with hard gales of wind before they approach the Western Islands, where likewise there are volcanoes. But in the islands of Bermudas, which are situated in the Northern Atlantic Ocean, about the latitude of 32 degrees N. and at the distance of six hundred miles from the coast of America, hurricanes, I believe, are almost unknown, but thunder and lightning, with temporary gusts of wind, or violent squalls, are very common. Were these islands of less extent, or had they been placed within the tropic, it is probable they would have been as exempt even from tempests as St. Helena, or the islands in the Pacific Ocean; but situated in the temperate zone, and not very remote from America, they are subject occasionally to sudden and violent gusts from the N. W. which probably originate on that continent. The Bermudas, *(See Note 9.)* however, enjoy a delightful climate, not unlike the finest weather of an European spring, or the early part of summer, whence, probably, they derive their name of the Summer Islands. But the causes of whirlwinds, or violent gales of wind, being in some measure, we hope, explained, we will return to a further consideration of the regular monsoons.

In the Mosambique Channel the monsoons correspond nearly with those on the Malabar coast, if not in their commencement at least in their duration. The S. W. monsoon begins in April and continues till November. The N. E. then succeeds, and continues until April; but the S. W. monsoon in this channel is the fair sea-

son, and the wind varies sometimes towards the S. E. and E. S. E. on either coast, about the middle of November, where also there are, generally, regular land and sea breezes. The N. E. monsoon, as was before observed, begins early in November near the Comero islands, and the north end of Madagascar, but seldom extends beyond St. Augustine's Bay to the southward, which is near the southern tropic. But on the east side of Madagascar, beyond the islands of Bourbon and Mauritius, towards what are called the Eastern Islands, the S. E. perennial prevails all over the Indian Ocean, from the latitude of 11 to 28 degrees S. whilst to the S. and eastward of the islands of Java and Sumatra, the N. W. and S. E. monsoons alternately prevail at the different seasons of the year. The S. E. monsoon in these seas, according to Monsieur D' Apres, commences in the month of April and continues till November, when it changes to the N. W.; but between the two monsoons the winds and currents there, as in other places, are light and variable. Throughout the whole extent of the Eastern Isles, as far as Timor and Solor, the N. W. monsoon brings bad weather; this wind is violent and accompanied with rain. The stormy weather continues all January and until the middle of February, it then abates, and entirely ceases about the end of March. In the month of April the variable winds render the weather mild, and the sea is affected only by occasional squalls of short duration. In May the S. E. wind becomes settled, and blows incessantly in June and July with considerable strength: during this time, however, the weather is fine, with a clear serene sky until the end of September. In the month of October the S. E. monsoon dies away, and the winds become variable till they again settle in the N. W. As Dr. Halley mentions the difference of the monsoon in this part of the Indian Ocean S. of the equator, but does not attempt

to account for it, I shall in this place take upon me to offer some conjectures on the subject.

The earth, during the summer, as it has often been before observed, receives and retains a greater degree of heat from the sun than the sea, which, by its constant motion and change of surface, is at this season infinitely cooler than the land, particularly in the torrid zones; but during the winter, in the temperate zones, the sea is much warmer than the land, particularly in high latitudes. In the summer, therefore, the great body of air, near very extensive continents, will of course move from the sea to the land, and in winter quite the contrary will happen. Now if we refer to the map, we ſhall find New Holland an immense tract of land to the S. E. of the Sunda and Molucca Islands; and, if unbroken by a mediterranean sea, almost equal in extent to all the land in Europe. It is situated partly within and partly beyond the tropic. When therefore the sun is near his highest declination N. which of course is the winter of the southern hemisphere, and rarefies the air over the continent of Asia, the current of air in the southern hemisphere, independently even of the regular perennial wind, will move from the S. E. to restore the equilibrium to the N. W.: On the contrary, in the month of November, December, and January, whilst the sun is nearly vertical over a part of New Holland, the current of air through the Sunda and Molucca islands will come from the N. W. to fill up the vacuum made by the rarefaction, and thus occasion an alternate monsoon of S. E. and N. W.

This obvious manner of accounting for the N. W. and S. E. monsoons on the east side of the Indian Ocean, would not have

escaped the discernment of the learned Dr. Halley, had he not become weary of the subject, or directed his attention towards pursuits of still greater importance. He closes his remarks concerning this subject with observing, " On this same principle, " to the southward of the equator in part of the Indian Ocean, " the N. W. winds succeed the S. E. when the sun draws " near the tropic of Capricorn. But I must confess that in this " latter occurs a difficulty not easily to be accounted for, which " is, why this change of the monsoons should be any more in " this ocean than in the same latitudes in the Ethiopic Ocean, " where there is nothing more certain than a S. E. wind all the " year."

Having said every thing that appears to me necessary respecting the monsoons in the Gulf of Bengal, the Gulf of Sind, and the Indian Ocean, I shall offer a few words on the winds in the China seas, and afterwards direct the reader's attention to the winds in the Arabian and Persian Gulfs.

In the Gulf of Siam, on the coasts of Cambodia or Camboge, of Cochin China, and in the Gulf of Tonquin and China (according to Monsieur D'Apres de Mainvillette) the S. W. monsoon commences on the coast in the course of the month of April; but out at sea in those parts it does not change until a month later. It is for this reason, that on the north part of Borneo to the Islands of Paragoa and Luconia, it is seldom known to blow constantly but from the 1st to the 15th or 20th of May. As the S. W. monsoon continues only about six months, and commences near the coast, it there ceases first likewise in the same manner, and is immediately succeeded by the

N. E. Thus, it is evident, the N. E. and S. W. monsoons reign constantly to the north of the line to the eastward, as well as in the gulfs of Bengal and Sind; whilst the N. W. and S. E. monsoons to the eastward, are absolutely confined to the south of the line, within the reach of the influence of New Holland. It has been already observed that the word, Monsoon, موسم, is derived from the Persian word Mousum, season. The violent hurricanes in those seas are, by our sailors, called Tuffoon or Typhon; this term is derived either from the Greek τυφων, or from the Persian word Toofan, توفان, a whirlwind or tempest. Whether the Greeks or Egyptians gave this word to the Persians, or received it from them, it is not necessary in this place to determine; but these and many other professional terms used by mariners in all parts of the east, both by the natives and Europeans, respecting the winds and weather, together with many of the ports of great resort on the different coasts in the Indian seas being called by a particular country name, with the addition of بندر, Bender, signifying a port, and Banksala, بنكساله, a magazine, render it extremely probable, and we may say almost certain, that the Persians were the earliest navigators of the Indian, and perhaps the China seas. The Portuguese succeeded them, and adopted the sea terms of their predecessors, which are now used by all other maritime nations, being however very much disguised by different European orthography *(See Note 10.)* and pronunciation.

In the Arabian and Persian Gulfs, according to Monsieur D'Apres, the winds are very different, although he remarks they are separated only by Arabia. " They blow (says this author) in the Red Sea " almost nine months in the year from the southward, that is from

the end of August to the 15th of May, and sometimes to the end of that month, when the wind changes to the N. and N. N. W. and generally continues in that quarter to the end of August, but sometimes the land and sea breezes prevail.

In the Gulf of Persia the N. W. wind blows from the month of October to July, and about three months from the opposite quarter. These winds, however, are not so regular as those in the Red Sea, being often interrupted by fresh gales from the S. W. principally from Cape Moçandon, and sometimes by land breezes.

The Arabian and Persian gulfs are not only separated by Arabia, but the major part of the former is within the tropic, whilst the northern part of it, like the whole of the Gulf of Persia, from Muscat to Bossora, is situated beyond the tropic. In comparing the winds of these gulfs, therefore, we must make a distinction between the northern and southern division of the Arabian Gulf. From the entrance of the Streights of Babelmandel to the city of Yambo, the S. W. monsoon prevails at the same time as it does in the Gulf of Sind, that is from April to September. But from the 15th of May to the beginning of August, the S. W. monsoon is extended, or rather elongated, from Yambo to Suez, notwithstanding the latter is almost 8 degrees beyond the tropic. This wind is called by the Arabs the Khumseen, (Fifty) being supposed by them to precede the overflowing of the Nile about fifty days. The reader perhaps will excuse a short digression to explain the causes of these phenomena.

It is now nearly ascertained, that the sources of this river lie in the Mountains of the Moon, which are situated in Africa, between

the latitude of 6 and 9 degrees north of the equator. Their height is not yet known with any degree of precision, but they are said to run from east to west. Nearly at right angles with these, and almost due north of them, are two other ranges of considerable hills; the one forming in some measure the southern and western coast of the Arabian Gulf, the other inland almost parallel to them, from the latitude of 22 degrees to Lower Egypt. The bed of the river Nile *(See Note* 11.*)* lies nearly in the middle, between these two last ranges of hills. Soon after the vernal equinox, therefore, when the S. W. monsoon takes place in the Indian Ocean, the clouds from the southern hemisphere are conveyed towards the Mountains of the Moon, and likewise to Abyssinia and Nubia. It has been already shown, that the rains in India constantly keep pace with the progress of the sun; so likewise do the same causes produce the same effects in this part of Africa, and also in Upper Egypt. They begin to the southward in the middle of April, and move progressively with the sun to the northward, so as to reach the boundaries of Upper Egypt before the end of June.

The Nile and other tropical rivers, however, derive but a small portion of their waters from their apparent sources, nor can the water which falls in the bed of any of these rivers prove a sufficient supply: all of them must principally be formed by an accumulation of several contributary streams, and therefore at those places, where they discharge themselves into the sea, no tropical river can possibly be at the greatest height, until some time after the solstice, but particularly those rivers, which come from mountains sufficiently high to be constantly covered with ice and snow.

But even if we suppose the Nile to be supplied by the rain only, which falls amongst the different ranges of hills, those contributary streams which lie towards the northern part of it, will not be filled till towards the middle, and sometimes the end of June; the water will then be some time in running from the contributary streams to the bed of the Nile; and finally, from the place of their junction, if we suppose the stream to run at the rate of five miles per hour, or one hundred and twenty miles per day, some days must necessarily elapse before the main river can reach the sea, or rather Lower Egypt. Before the end of June the rise of this river at Cairo is almost imperceptible; but it continues to increase a few inches, more or less, every day throughout the whole month of July, until about the beginning of August, when the daily increase suddenly amounts to forty-eight inches, and then the river is considered as completely filled. It appears by observations continued at Cairo for thirty years with the mikias or nilometer, that it was never later than the first or second week of August, when the river was at the height of sixteen cubits of twenty-eight inches each. The inhabitants are then permitted by public proclamation to appropriate the water to the purposes of husbandry. Nevertheless the rains still continuing in Upper Egypt, and near the Mountains of the Moon, very little diminution of the waters appear until towards the beginning of September.

The Khumseen wind blows in the northern part of the Arabian Gulf, as far as the sea coast of the Delta.

It is very well known that the soil of Upper, and even of a part of Lower Egypt, on one side of the Arabian Gulf, and of Arabia Petrea and Arabia Deserta on the other, consists chiefly of rocks and

sands. As the sun approaches towards the solstice, and from very obvious causes, for a month or six weeks afterwards, the atmosphere over those countries must be excessively rarefied; whilst this rarefaction continues to the northward, the air to the N. after the commencement of the rains, being infinitely more cold and dense, will be impelled forward towards the N. to restore the equilibrium, and consequently produce the Khumseen wind, which for the same reason will precede the overflowing of the Nile, and begin first near the principal point of rarefaction. But as the sun approaches again towards the autumnal equinox, the earth to the northward becomes cool, the Khumseen ceases to blow, the river begins to fall, and the N. W. wind again commences, and continues to blow all the rest of the year.

It is true, as was before mentioned, that almost the same winds prevail at the same season in the Gulf of Persia as in the northern part of the Arabian Gulf; but the eastern shore of the former being covered with both hills and forests, the Khumseen will neither begin quite so soon in the Gulf of Persia as in Upper Egypt or Arabia, nor even continue to blow there with equal strength. But before we quit the consideration of the winds in the Arabian and Persian Gulfs, it may be expected, that we should endeavour to account more explicitly for the N. W. wind continuing to blow in those places for upwards of nine months.

From the end of August to our winter solstice, the sun is constantly declining towards the S. and during his return, until the vernal equinox, his influence is not much felt in the temperate zone of the northern hemisphere: the northern part of the Arabian Gulf,

during these eight or nine months, will therefore be much warmer than the countries still farther to the northward and westward, and consequently the current of air will come from that quarter to fill up the vacuum occasioned by the rarefaction of the air over the sea. A line drawn through the centre of the Arabian Gulf, from the Streights of Babelmandel to Suez, would nearly be N. W. by N. and S. E. by S. and therefore, according to this theory, during the absence of the sun, that is from August to April, or the beginning of May, the wind in the northern part of the Arabian and Persian Gulfs must generally blow from the N. W. by N. towards the point of rarefaction, which is the middle of the northern part of the Arabian Gulf. But from Gedda, or rather Yambo, to Mocha, where the land, in the day at least, is always warmer than the sea, either southerly winds or land and sea breezes will prevail during nine months of the year, and northerly winds only during the depth of our winter, from November to the end of January, which corresponds with the account of the winds in this gulf as given by Monsieur D'Apres. But we will now pass over the Isthmus of Suez, and consider how far this theory is applicable to the winds in the Mediterranean.

The Mediterranean is bounded to the N. by Europe, to the S. by Africa, to the E. by Syria, Palestine, and Asia Minor, and to the W. by the Atlantic Ocean. But in an enquiry of this nature, this sea should be divided into two parts, by a line drawn through the Faro of Messina, from the S. W. side of Sicily to Cape Bon, on the coast of Africa. From this line westward, to the Streights of Gibraltar, we will call the western side of the Mediterranean;

and from the same point to Syria, Palestine, and Asia Minor, the eastern side.

Throughout the whole Mediterranean, but mostly in the eastern branch, including the Adriatic and the Archipelago, the N. W. winds prevail in the summer months. During the winter they are variable, but the S. E. and S. W. blow frequently with great force near the two solstices.

In Greece, particularly in the Morea, which is almost surrounded by the sea, the Etesian winds, according to Aristotle, and other Grecian writers, blow about forty days, with their prodromi which precede them, as their name itself implies, about eight or ten days, making about fifty, both these together correspond nearly in their commencement and duration with the Khumseen wind in the Arabian Gulf. But the summer Etesiæ in Greece and the Morea come from the N. W. and the Khumseen from the S. W. These winds are likewise noticed by Pliny and Seneca, and also by Cicero, (Nat. Deor. ii. 53.) who says that in Italy they are equally comfortable and salutary to men, beasts, and birds, and likewise beneficial to vegetation, by moderating the violent heat of the weather during the inclement season of the dog days.

When the sun advancing towards the N. *(See Note* 12.*)* has begun to rarefy the atmosphere of the southern countries of Europe, the spring Etesiæ commence in the Mediterranean, which, according to the ancients, blow in Italy during the months of March and April, and were called by the Roman writers the Favonii. Their in-

fluence at first will be but slightly felt, but as soon as the earth becomes considerably warmer than the Mediterranean, the current of air will then move from the sea towards the land, and consequently produce the Favonii or gentle western breezes, to which those authors allude.

For some weeks after the equinox, the warmth of the sun will not be very sensibly felt on the frozen Alps; but as his declination increases, some time even before the summer solstice, a part of the ice and snow on those mountains will begin to dissolve, and, according to the observation of Lord Bacon, put the air in motion from the northward, to fill up the vacuum produced by the rarefaction of the air over the southern part of Italy. This wind, therefore, at first will be light and variable, and give rise to the Prodromi, but will increase as the sun advances, so that this northerly current of air from the Alps, and westerly current of air from the Atlantic Ocean, continuing to move at right angles, and nearly with equal velocity from the same distance, will at length unite and produce a N. W. wind on the western part of Italy, which is the part whence the summer Etesiæ are said to blow.

In this manner it appears to me we may account for the periodical winds which are known to prevail both in Greece and Italy, and throughout every branch of the Mediterranean. But in the autumn all these winds become variable, sometimes blowing from the sea towards the coast, and at other times in a contrary direction. These frequent changes may probably be attributed to the sudden alteration in the temperature of the sea and land; for as the sun regularly declines towards the equinoctial, the earth, both on the continent of

Europe to the northward, and of Africa to the southward, gradually cools again, subject for some time to slight variations, either on the earth or the sea, which must necessarily produce variable winds in the Mediterranean, until some weeks after the autumnal equinox. The western branch of the Mediterranean, situated between the Alpine regions to the N. and the continent of Africa to the S. *(See Note* 13.*)* must at all seasons be subject to violent changes of both wind and weather, particularly in the months of March and September, about the two equinoxes, when the sudden variations of heat and cold are greater than at any other time of the year. But as during the winter season the sea will generally be warmer than the land on either side, a current of air will move sometimes towards the Mediterranean from the continent of Europe, and nearly at the same time perhaps from that of Africa, which, late in autumn and throughout the winter, will produce opposite currents of air in every part of the sea, particularly near the respective coasts; and to these opposite currents of air may probably be imputed also the sudden storms, accompanied with heavy showers of rain, that frequently occur on the African side of the Mediterranean, during the early part of winter. The gusts of wind at this time, though violent, are generally of short duration.

Whilst we are considering the nature of the winds in this part of the world, it seems necessary likewise to add a few observations on those which prevail in other parts of Africa, besides such as immediately relate to the boundaries of the Mediterranean.

The northern division of Africa, between the latitude of 18 and 30 degrees, possesses but few of those advantages enjoyed by other

countries, which are situated in the same hemisphere, and at an equal distance from the equator: and whilst those parts of Asia and America, in the same latitudes, are blessed with a fertile soil and a wholesome air, the interior of Africa, in those latitudes, is almost one immense sandy waste, called by the Arabians, to mark its pre-eminence, Sahara, The Desert: *(See Note 14.)* In this desert are said to arise many noxious vapours.

But those parts of America, and the peninsula of India, which are near the ocean, with a range of hills or lofty mountains extending from N. to S. are abundantly supplied with rain. On the contrary, the interior of the northern part of Africa is remote from the sea, its mountains are neither high nor numerous; and instead of running N. and S. so as to intercept the clouds in their passage from the E. they extend in almost parallel lines from E. to W. and therefore the sources of the rivers, which exist in the northern division of Africa, are found not far from either coast, and principally between the latitude of 20 degrees and the equator. The Niger, the Senegal, the Gambia, the Benin, the Jamour, and others of inferior note on the western side, have probably their sources amongst the mountains already described, of which, according to the best accounts, there are a double range between the latitude of 12 and 18 degrees N.; but the interior of the country from 20 to 28 degrees, and even Arabia Petrea and Arabia Deserta, which are nearly in the same parallel of latitude, and resemble this part of Africa in almost every feature, are likewise equally desolate and barren.

In plains of this description, of 12 or 15 degrees from N. to S. and 25 degrees from E. to W. like the Sahara, almost entirely destitute

of vegetation, and not refreshed by cool air from the sea or the mountains, nothing less can be expected than a parched dreary desert, almost uninhabitable either by man or beast. In these regions blow the Khumseen, the Sumyel, and likewise the Harmattan. The first of these, however, is a mere land wind. The second often proves immediately fatal to animal life. The Harmattan, on the contrary, is not only harmless, but by the Fantee nation, on the west coast of Africa, where it is best known, is considered as salutary: the name, if we suppose it to be of Arabic derivation, Rahamut, implies the merciful, the beneficent. This wind blows in January and February from the interior of Africa, between Cape de Verd and Cape Lopez, towards the Atlantic Ocean. It comes on at any hour of the day, at any time of the tide, and at any period of the moon. It generally blows twenty-four or forty-eight hours together, but sometimes five or six days; and it has been known even to continue for fifteen or sixteen without intermission. It is said by Mr. Norris, who was surgeon on the Gold Coast, to stop the progress of fluxes, intermittent fevers, and all epidemic diseases.

When the small-pox broke out amongst the slaves purchased on this coast, seventy of them were inoculated; but the Harmattan coming on at the same time, not one of the whole number had either sickness or eruption. The Harmattan is always attended with a sort of mist or fog, so extremely dense as to render objects invisible at the distance of a few yards; the sun even at noon appears through it of a deep red, and very minute particles subside from the misty air, which are said to make the grass and the skins of negroes appear whitish. Many attempts have been made, but hitherto in vain, to ascertain the nature of this dust; but the general salubrious state of

the air, which it impregnates, shows that its properties are not unwholesome. At the same time it is proper to observe, that this wind is never accompanied with dew, and is at the same time of a nature so uncommonly desiccative, that it not only withers but quite parches the leaves of vegetables; and even salt of tartar, when nearly dissolved, if exposed to it, becomes perfectly dry again in the course of three or four hours.

Doctor Lind, however, in speaking of it, asserts on the information of an officer, who had been in that country, that at some seasons it was malignant, and even fatal to mankind. But if the Doctor's information were correct, it must be supposed this officer had lived in some particular situation to leeward of marshes or fens, where the air might become partially loaded with putrid exhalations; for not only Mr. Norris, but likewise Mr. Park himself, ascribes very salutary effects to it, having, as he observes, experienced immediate relief from sickness, both at Dr. Laidley's, and Kamalia, during the Harmattan.

From the paper of Dr. Fothergill read at the Royal Society on the 7th of December, 1780, of which Mr. Norris's report to him forms a considerable part, it appears, that the Doctor had collected with great care many curious facts respecting this wind; but in pursuing the enquiry into the causes of it, he has confined himself rather too much to local and external appearances: we will therefore make use of his well authenticated facts and ingenious observations as far as they go, and at the same time avail ourselves of the information to be derived from the general principles of this theory, by which means we shall hope to trace back the course of the Harmattan from the

sea coast towards the land, and thus gradually follow it to its source.

The course of the Harmattan, in the Gulf of Guinea, is universally allowed to be nearly N. E. and sometimes in places to the northward, it inclines more towards the E. But although Mr. Park does not take much trouble to account for this wind, thus much at least we may learn from his authority, added to the joint testimonies of Mr. Norris and others, that it comes from the mountains situated between the latitudes of 12 and 15 degrees N. which extend several hundred miles from W. to E. probably as far as the Mountains of the Moon. From this long range of mountains a current of cold air will move at right angles from the N. and meeting in the tropic with the perennial, commonly called the trade wind, from the E. they will jointly form a N. E. wind, which blows frequently at this season towards the western coast of Africa, and particularly to the Gulf of Guinea. For if we suppose that during the winter solstice, and for some weeks after, the sea in the Gulf of Guinea is at a temperature of 80 degrees, as it is stated to be in Mr. Norris's journal, and that at the same time the mountains in question are at a much lower temperature, as they certainly are, being further N. and mountains at all times being colder than plains, the apparent mystery seems in some measure explained; for whilst this difference of temperature exists, the land at 72, and the sea at 80 degrees, the current of air must necessarily, on the principles of gravity, move in a N. E. direction from the mountains towards the coast and Gulf of Guinea, to restore the equilibrium; and if there be any volcanos amongst the mountains, it is possible a volcanic powder may be brought from them in this cool current of air, so as to cover the whole surface of

the country, and the skins of the inhabitants, with what is called a white powder. However this presupposes such volcanic eruptions to be either constant or periodical, which is by no means probable; and therefore without travelling so far back as the mountains themselves in search of the place whence this powder is said by some authors to come, we will suppose it to be the finer particles of the dust of the intermediate soil between the mountains and the sea, which is raised into the atmosphere by this cold and heavy body of air. These appearances are very common in many parts both of Arabia and Africa, where sand storms at particular seasons are extremely violent, and produce clouds of dust sufficiently dense to cause such a mist, as to make the sun appear, even at mid-day, of a deep red. But we are also to enquire still further into the causes of the salubrious qualities of the air.

This current of air then being both cold and dry, *(See Note* 15.*)* and passing from the mountains over a barren desert, where it meets with no moisture, must, on its reaching the sea, cause a considerable degree of evaporation, and consequently produce all the effects which are said to be experienced from it in the Gulf of Guinea, both on animal and vegetable life. For all animals, whilst the evaporation of the moisture from their bodies continues, will feel a strong sensation of cold, and at the same time their skin will be parched; for cold winds blowing upon warm and moist bodies, powerfully promote evaporation in them. And when in like manner the moisture of vegetables is evaporated, the leaves of all plants will be parched, and some of them will wither and die. To the former, therefore, the Harmattan may be considered as extremely beneficial, and particularly in checking the progress of epidemics: never-

theless, by absorbing all the moisture of vegetables, it may prove at the same time extremely prejudicial to them, especially to those of a delicate habit. Trees of every kind seem to derive their sap through their roots from the ground; but the moisture which keeps them alive, and by which they flourish, most probably is received through the absorbents of the leaves from the atmosphere itself. When therefore the Harmattan prevails, and the leaves are parched, their absorbing powers are suspended, at least whilst this drying wind continues; but unless it be of uncommonly long duration, as soon as the moisture of the atmosphere is restored, the cause being removed, the effect speedily ceases.

The Sumyel, strictly speaking, should rather be considered as an Asiatic than an African wind; for although it is said to prevail to the eastward of Beled-ul-Gerid, and the Lybian Desert, it is felt with its greatest force on the great Desert of Arabia, and sometimes in countries bordering on the Gulf of Persia. On the derivation of the term authors are very much divided, but they all agree respecting its appearance and effects.

Mr. Volney seems to consider the Sumyel the same as the Khumseen, and he calls it the Shamyala, supposing the name to be derived from Sham, the country of Syria.

But I am rather disposed to adopt the derivation of Sir. J. Chardin, Yel, Turkish, wind, and Sum, Arabic, poison, particularly as the Persians likewise call it Bâd Samoum, which is precisely the same signification, poisonous wind. Nor should this wind be confounded with the Khumseen and Scirocco, which proceed from the same

cause, and are exactly the same in appearance and duration as the land wind of India. The two latter blow for seven or eight weeks, at the latter end of May, all June, and part of July, in almost all inland countries situated within and near the northern tropic; but the natives of those countries in general do not esteem these hot winds particularly unwholesome, whereas the Sumyel blows only occasionally, and is a transient pestiferous current of air containing a deleterious gas, that in its passage always proves fatal both to man and beast. It is true, that the Sumyel in one respect resembles the Khumseen, for it generally appears during the hottest time of the year, but the gusts of it are merely local and instantaneous.

The air on the N.W. side of the Desert of Arabia, whence the Sumyel comes, assumes for some minutes before it is felt a dusky hue. It moves with considerable velocity, and is accompanied with a hissing noise. Those who are attacked by this wind are generally destroyed. Some persons however have escaped its dreadful effects, who, on perceiving its approach, have thrown themselves prostrate on the ground, and enveloped their heads in many folds of cloth, or those who have put their faces close to the ground in the dust until it has passed. Camels are said to be sensible of its approach, and take this method of their own accord to avoid its fatal effects. Sir J. Chardin observes likewise, that persons, who are killed by it, are not much changed in external appearance, but that their limbs are very easily separated from the body.

A further and more modern account of this wind has also been published in the Annual Register, Vol. IX. taken from the relation

of Mr. Vanderhulse, who was long resident for the Dutch at Ormuz, and who came from thence to Bombay in the year 1763.

If the exact spots could be discovered whence this exhalation proceeds, it is possible, that we might hereafter ascertain the cause of its mortal effects. In the mean time, we have little to guide us in our researches, except the circumstances already mentioned, particularly its external appearance and dreadful consequences. Respecting the former Dr. Priestley observes, that nitrous air or gas will combine rapidly with vital air, forming red clouds during the combination, and at the same time heat is given out from the new combination. Here then we perceive a similarity in the colour of the clouds and the heat; but whence the deleterious effects proceed is not yet explained. Many writers have supposed them to arise from the naphtha, petroleum, and other bituminous substances, which are said to burst forth in flames from the earth in the countries to the N. W. of the great Desert of Arabia. Although bitumen and nitrous acid combined will certainly cause a flame, yet it does not seem probable, that unless to this mixture is also added some poisonous mineral, that it would produce a gas fatal to animal life, especially after having been some minutes combined with the general mass of atmospheric air. It is not, I confess, in my power to explain this phenomenon, but at the same time, as a matter of curiosity, it may be proper to remark, that the name of the country, where the noxious vapours are most prevalent, is called, by the Persees, Arz-ur-began, or Arz-ur-paican, the Land of Fire, or perhaps it may be, As-sur-began, which may be interpreted from the Persian language, Assyria without life, or in which no human being can exist.

The hot winds, which Mr. Volney enumerates in Syria, Africa, and Spain, and which he likewise, says Mr. Neibuhr, met with in Arabia, Surat, and Bombay, are, beyond a doubt, merely the common land wind of Hindustan, for which I have endeavoured to account in treating of those winds, which prevail on the peninsula of India at the same season. After giving a faithful and lively description of similar winds in Egypt, interspersed with many excellent remarks upon their effects, he concludes with observing, that this subject offers a multitude of problems calculated to excite the curiosity of the naturalist. He has specified, in regular succession, five of these problems, which I shall attempt to solve according to the principles of this theory.

1st. Whence proceeds this connection of the seasons, and the progress of the sun, with the various winds, and the points from whence they blow?

2dly. Why throughout the Mediterranean does the wind most frequently blow from the N. in so much that we may say it continues in that point nine months out of twelve?

3dly. Why do the easterly winds return so regularly after the equinoxes? and why are the winds in general higher at this period?

4thly. Why are the dews more abundant in summer than in winter? and why, since the clouds are caused by the evaporation of the sea, and that evaporation is more copious in summer than in winter, why, notwithstanding, are there more clouds in winter than in summer?

5thly. In short, why is rain so rare in Egypt, and why do the clouds rather collect in Abyssinia?

The first is answered by the first paragraph of this work, and in every subsequent page of it. The variety of seasons is produced by the alternate effects of heat and cold on the earth and the water. The progress of the sun N. or S. produces heat when he is present, and his absence in like manner is the immediate cause of cold.

The motion of the inferior current of air, commonly called wind, is caused by the rarefaction of the air on one side, and by its condensation on the other.

2dly. The northern shore of the Mediterranean is the foot or base on which the continent of Europe seems to rest. During nine months of the year, the earth of the southern part of Europe, the water of the Mediterranean, and the earth on the north coast of Africa, Syria and Palestine, must be considerably warmer than the countries situated to the N. of a line drawn E. and W. through the centre of France, from the latitude of 45½ degrees, by the foot of the Alps, across Tyrol and Austria towards Hungary, including all the different branches of the Alps: As the degree of rarefaction of the air will always be in proportion to the degree of warmth communicated from the earth or the sea to the inferior current of air, the wind will therefore blow nine months of the year from the N. near the foot of the Alps, towards the Mediterranean and the countries adjacent. But during the other three summer months, whilst the sun remains near its highest altitude, the northern regions will evidently be as warm or warmer than the southern, at which time

the current of air from the north side of the Alps will move towards the plains of those countries. In the opinion of Dr. Halley, the hottest weather may take place under the poles, the constant heat and light of the sun more than compensating for his obliquity; for, as he observes, a weak force acting for a long time, may produce as great, or a greater effect, than a stronger force acting for a shorter time.

3dly. The winds in general are higher, and, it might be added, more variable, during the equinoxes, because the sun at that season is equidistant from the two poles. Whilst the point of rarefaction from the heat of the sun is exactly in the centre, the cold from the two poles will condense the air at the two extremities, and these two immense bodies of cold air, moving with equal velocity through nearly the same space, will act with peculiar violence on the intermediate currents of air between the equator and the poles, so as to produce strong variable and even opposite currents of air in both hemispheres, according to the state of the atmosphere over the sea or land in different parts of the globe. But within the tropics in particular, the superior current of air may, at this season, suddenly become more dense and heavier than the inferior current of air, and thus produce the descent of a large body of air, and occasion those whirlwinds of great extent, the causes of which I have already attempted to explain, in treating of the monsoons in India, and off the islands of Mauritius and Bourbon. But when the sun is sufficiently advanced in the northern tropic to warm the Atlantic Ocean, without being high enough to produce a complete thaw in the regions to the N. E. of the European continent, the principal point of rarefaction in the atmosphere will be over the Atlantic Ocean, and the inferior current

of air will come from the E. and N. E. at this season to fill up the vacuum, and consequently produce E. and N. E. winds very soon after the vernal equinox.

On a reference to the meteorological tables of Dr. Robertson, kept in Somersetshire, and to those of Major Hayman Rooke at Mansfield Woodhouse, I do not find that easterly winds prevail so much in Europe after the autumnal equinox, as Mr. Volney supposes. They come sometimes about the winter solstice, and continue during the month of January, accompanied by hard frosts, at which season the North Atlantic Ocean will be the point of rarefaction, and the coldest body of air will come from the E. and N. E. or occasionally perhaps from Greenland, which is situated to the N. W. and N. N. W.

4thly. Dews are said to be vapours and exhalations raised from the earth by the heat of the day, which being afterwards condensed by the cold air of the evening and night, in the higher regions of the atmosphere, are again precipitated on the earth. They will of course, therefore, be more abundant in summer than in winter. But it is to be doubted, if in all countries, and at all times in any country, there are more clouds in winter than in summer. For example, in frosty weather in France, there are fewer clouds than in summer, especially during the solsticial rains. But when the air is sufficiently dry, either in winter or summer, to absorb the moisture raised by evaporation, the transparency of the atmosphere will be preserved, and few clouds will appear. On the contrary, when the atmosphere is almost saturated with moisture, and the inferior current of air has but little motion, the vapours in the form of clouds must necessa-

rily remain stationary; but this, I apprehend, may happen equally either in winter or summer.

5thly. It seldom rains in Egypt, and the clouds rather collect in Nubia and Abyssinia, because there are no mountains in Lower Egypt, and a great many to the southward. The Mountains of the Moon arrest the clouds in their progress from the S. during the S. W. monsoon; at this season, therefore, no rain will come so far N. as Lower Egypt; and the clouds at other times which come from the N. W. not meeting with any mountains to attract the fire by which they are supported, pass over the Delta, and afterward precipitate their rain in Upper Egypt. But this want of water in Egypt is, however, amply compensated by the inundation of the river, and by copious dews at night, especially in hot weather.

Mr. Volney's observations on the weather in Egypt and the Levant, from the well known abilities and veracity of the author, being generally received as indubitable facts, I have taken this opportunity of trying the merits of this theory upon the test of the problems he has proposed for solution; and if any doubt should arise of my having succeeded in explaining the causes of the winds which he mentions, still I flatter myself, that if this work accidentally falls in his way, when he reconsiders the subject, he will at least be induced to admit the distinction made between the Sumyel and the Khumseen. The former is local and momentary, the latter general in all hot countries, and of long duration, as the name itself implies. The one instantaneously proves fatal to both man and beast; the other is in some countries considered as salutary, and no where so noxious as to produce instant death.

But after having considered the causes and effects of the winds both by land and sea within the tropics, and likewise in the southern part of the temperate zone, it is my intention in the next place, to show in what manner the same general causes operate upon the winds in Great Britain, where, doubtless, the winds and weather are much more variable than within or even near the tropic; but, nevertheless, if we make allowance for some obvious differences of climate owing to its geographical situation, the same causes will, I trust, be found to produce, even in England, the same effects.

Among the number of valuable meteorological tables kept in England, to which it will be necessary to refer in the course of this enquiry, I shall first make use of that kept by Major Hayman Rooke, at Mansfield Woodhouse, in Nottinghamshire, of which the following is an abstract or abridgment.

The year in this table is divided into three parts, of four months each; the first beginning in February and concluding with May; the second in June and ending with September; and the last in October and finishing with January. Each line contains the various winds for the months included in the respective divisions, as will be easily perceived by a reference to the table; to which is added, first, the total of each different division; and, afterwards, that of the whole, for ten years. The account of the temperature is extracted from Dr. Heberden's Table of the mean heat of London for ten years, as published in the Philosophical Transactions: I have added also the temperature of the night for the same period, as given by Lord J. Cavendish; and have taken the mean both of the day and night as being, when taken together, the true mean heat of the whole twenty-four hours.

Years.	Temperature.	Months.	East.	West.	North.	South.	N. E.	S. E.	N. W.	S. W.	Rain.
			Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.
1785	Mean heat of these months, day and night included.	Feb. Mar. April, May	4	10	2	1	32	15	46	10	17
1786		... D° ...	18	36	12	3	18	5	17	11	27
1787		... D° ...	10	34	5	4	15	16	14	22	36
1788		... D° ...	17	26	4	4	18	20	18	13	40
1789	....	... D° ...	14	32	1	7	18	11	21	16	52
1790	43 6	... D° ...	9	21	3	5	30	14	12	28	33
1791	....	... D° ...	17	27	15	2	11	14	17	17	34
1792	....	... D° ...	1	12	6	24	14	5	13	46	49
1793	....	... D° ...	1	10	8	3	18	10	33	37	33
1794	....	... D° ...	0	11	6	3	7	3	22	68	46
			91	219	62	56	181	113	213	268	367
1785	...	June, July, Aug. Sep.	0	35	4	0	14	31	23	29	50
1786	....	... D° ...	12	50	8	4	13	7	14	14	48
1787	....	... D° ...	6	42	0	4	18	9	20	24	50
1788	....	... D° ...	4	36	3	7	16	5	19	32	60
1789	....	... D° ...	8	13	4	9	5	20	17	46	72
1790	57 7	... D° ..	2	46	2	6	6	17	17	26	61
1791	....	... D° ...	11	24	1	5	11	17	20	33	47
1792	....	... D° ...	6	11	1	9	7	6	25	57	69
1793	....	... D° ...	0	9	1	4	10	5	37	56	48
1794	....	... D° ...	0	2	1	3	11	9	39	57	40
			49	268	25	51	111	126	231	374	545
1785	...	Oct. Nov. Dec. Jan.	2	30	6	3	12	15	27	29	45
1786	....	... D° ...	11	24	10	9	15	31	16	7	36
1787	....	... D° ...	3	29	10	5	5	11	33	26	46
1788	....	... D° ...	11	29	13	3	15	5	27	20	22
1789	....	... D° ...	5	21	1	1	5	28	17	45	56
1790	41 3	... D° ...	18	27	1	6	11	23	17	20	44
1791	....	... D° ...	4	17	0	17	11	8	29	37	57
1792	....	... D° ...	1	17	2	8	18	10	26	41	52
1793	....	... D° ...	0	15	1	8	6	3	20	70	42
1794	....	... D° ...	0	6	0	9	5	20	26	57	39
			55	215	44	69	103	154	238	352	439
		Total ...	195	702	131	176	395	393	682	994	1351

Note.—The mean heat of the day only, in these months, is as follows:

	Dr. Heberden.	Mr. Kirwan.
For the first four months	$46\frac{1}{2}$	$50\frac{1}{2}$
The second division	$61\frac{1}{4}$	60
The third division	44	$44\frac{3}{4}$

The mean heat of spring, March, April, and May, is $48\frac{1}{3}$; of autumn, September, October, and November, 52. The autumn will be hotter than the spring, from the earth having been heated by the summer.

It may be thought, perhaps, that the most natural division of the year would be the four seasons, according to equinoxes and solstices. But the cold months of the winter being divided between the spring and autumn will make three gradations of temperature, the hot, the temperate, and the cold, and these will best show the effects of heat and cold on the atmosphere: but other more cogent reasons have likewise induced me to adopt this arrangement, which will hereafter be more particularly explained.

According to Major Rooke's register, the W. the N. W. and S. W. are the prevailing winds at all seasons of the year, if we except the spring. Taken for the whole year together, they exceed in number those from the E. the N. E. and S. E. for the same period, nearly in the proportion of three to one; but of all the western points, that of S. W. blows most frequently. The N. and S. are not materially different, and the N. E. and S. E. are always precisely the same; but during the months included in the first division, there are many more easterly and north easterly winds than at any other time. In the autumnal division, the westerly prevail more than in the spring. And during the four hot months, there are more westerly winds than either in the spring or autumn.

These facts, respecting the course and duration of the winds at different seasons in England, being ascertained for ten years, we will examine how far their causes apparently correspond with the principles of this theory.

In February and March the sun, after an absence of some months, again begins to approach this hemisphere. He crosses the equinoc-

tial about the 20th of March, being at this time equidistant from both poles: the point of rarefaction being in the centre, different currents of air will rush forward from opposite points to restore the equilibrium, and of course occasion sudden strong fluctuations of wind in almost every part of both hemispheres, which are generally called equinoctial gales. But as his northern declination increases, this violent agitation of the air ceases, and the winds become regular, not only in the torrid, but likewise in the temperate and frigid zones. According to Mr. Kirwan, the greatest variation of temperature in England, within the space of twenty-four hours, happens always during the equinoxes; that of the vernal he states at 20 degrees, and that of the autumnal at 18 degrees. These sudden daily changes of the wind and weather *(See Note* 15.*)* are, I think, imputable to the causes I have already attempted to explain; from which causes likewise Mr. Kirwan very judiciously infers, that the vernal and autumnal colds which prevail at these seasons, particularly in England, proceed.

Whilst we find by a further reference to the preceding table, that in England during the four hot months the winds from the W. to the S. W. prevail, we shall likewise perceive that the days marked rainy in that division greatly exceed in number those of any other division of the year. But we cannot have too many authentic proofs of these facts, on which the truth of this theory seems, in some measure, to rest: I shall therefore beg leave to quote the respectable authority of Bishop Watson, and likewise two extracts from the Philosophical Transactions, in order to prove that the greater part of the rain in England is supplied by evaporation from the Atlantic Ocean; that the winds in this part of the world, like those in the tropics, are nothing more than the motion of the

inferior current of air; and that heat and cold are the immediate causes of this motion.

Soon after the thought occurred to me of pursuing this enquiry, Bishop Watson informed me, that in measuring the quantity of rain which falls annually at his seat near Ambleside, in Westmoreland, he always divided the year in the manner specified in the preceding table, and which, from his example, I have thought proper to adopt. In the course of ten years experience, he has regularly found that about twenty-three inches of rain fall in the course of the whole year.

In the first four months five inches, in the second eleven inches, and in the third seven inches; whence it appears that almost as much rain falls at Ambleside during the four hot months, as during the whole remaining part of the year.

Extract from the METEOROLOGICAL JOURNAL of the Royal Society of London, for the Year 1797.

February . . . Inches	0. 219	
March	0. 777	
April	1. 859	
May	1. 436	
		4. 291
June	4. 223	
July	1. 288	
August	2. 789	
September	4. 061	
		12. 361

October	Inches 2. 001	
November	1. 473	
December	1. 611	
January	0. 960	
		6. 045

The mean quantity of rain for seven years, from 1774 to 1780 inclusive, at the Royal Society, is also 23.006 inches.

These tables, and Bishop Watson's account, confirm that of Major Rooke and Dr. Robertson, and clearly demonstrate, that as much rain falls in England during the four hot months, as during the other eight months of the year. The winds, as registered in the preceding table, from the W. the N. W. and S. W. which bring the vapours from the Atlantic Ocean at this season to these islands, exceed those in number from the E. the N. E. and S. E. nearly in the same proportion of three to one, whence from these two well ascertained facts together, it is fair to infer that the rain in these countries is produced by the vapours raised from the Atlantic Ocean, and brought towards the land by the westerly currents of air.

Soon after the vernal equinox, when the sun begins to diffuse only a moderate warmth throughout the northern regions, the Atlantic Ocean being at that time much warmer than the land, the current of air will then begin to move from the E. and N. E. and produce the easterly winds, which blow during the latter end of March, all April, and part of the month of May, in a direct line across the British islands to the ocean; but in the course of the month of May, when

his declination increases to 15 degrees and upwards, his influence will then be considerably felt in Germany, Poland, Ruſſia, and even Siberia. The whole continent, to its northern extremity, by the sun being at this time almost constantly above the horizon, daily becomes warmer, so that by the end of June or the beginning of July, these countries are probably as hot, or even hotter, than the more southern countries of Europe. From the end of May therefore to the end of August, the atmosphere over the whole northern part of the continent will be considerably rarefied, and consequently the ocean in summer being infinitely cooler than the land, the inferior current of air will then generally move from the Atlantic lying to the S. W. of these islands, to restore the equilibrium to the N. E.

The manner in which the clouds are made to precipitate the rain having been already sufficiently explained, I shall conclude this part of the subject with observing, that these similar physical causes produce similar effects in Europe, in India, in Arabia, and in Persia, on the eastern coast of America, and likewise in every part of Europe. It may, I believe, be confidently asserted, that the rains in all parts of the globe are universally in proportion to the temperature, to the extent and proximity of the adjacent ocean, and to the height and extent of the mountains in the country; and as land in summer is hotter than the ocean, the moist vapours of the ocean will be conveyed towards the land, whilst the superior heat of the earth continues. With respect to these islands it is well known, that in Ireland, which is bounded to the W. by the Atlantic, they have more rain than we have in England; and in Wales and the west of England, there is infinitely more rain than on the east coast of Great Britain, the

greatest quantity falling invariably in that part of the country that is the most mountainous, and which is situated nearest the ocean.

Whilst a principal part of the rain which falls is ascribed to a precipitation of the water raised by evaporation from the ocean, or exhalations from the land, I do not mean to assert that some portion of the rain is not also to be ascribed to a combination of hydrogen and oxygen in the upper regions of the atmosphere; but if any means can be devised of correctly ascertaining the quantity of moisture raised from the sea and land, and the quantity of rain which falls in the course of the year, the former being deducted from the account, it will no longer be difficult to ascertain what quantity of rain is to be attributed to the newly discovered combination of hydrogen and oxygen.

According to Dr. Brownrig, in his Art of making Common Salt, p. 189, the evaporation of some parts of England, during the months of May, June, July, and August, is fixed at 73. 8 inches, and the evaporation of the whole year at no more than 140 inches. The mean heat of these four months, according to Dr. Heberden's table of the mean heat of London, will be 57. 7 degrees, and the rain which falls, on an average, 11 inches. Without the parade of a calculation, which cannot at present be fixed by me with any degree of precision, the heat, the vapour, and the rain, may be stated thus for this period, May, June, July, and August, 57. 7 temp. 73. 8 vap. 11. 0 rain.

It is probable that nearly the same proportions always exist between the temperature, the vapour, and the rain, during the other

divisions of the year; but I must confess myself not yet sufficiently advanced in meteorological knowledge to ascertain the exact proportion, nor indeed am I in possession of instruments which I consider as adequate to the purpose of obtaining it. The rain gauge now in use does not seem to give, with any degree of precision, the quantity of rain that falls, even within the compass of a few miles, and still less of that which falls on a more extensive space; nor have I been able to meet with any account respecting the evaporation which has satisfied my judgment; but all I can at present discover is, that heat and the motion of the air are its principal causes. On this point all authors agree, and it is generally admitted, that evaporation is almost four times as great from the vernal to the autumnal equinox, as from the autumnal to the vernal equinox, which corresponds nearly with the quantity of rain said to fall during these respective periods. It may, however, be necessary to premise, that it is now generally understood, and may be easily believed, that the atmosphere, when exhausted of its water by precipitation, will again absorb a certain quantity, just as a dry sponge will draw up water into its pores; a large volume of air, coming over an extensive tract of land, can of course have acquired, comparatively, but little moisture in its passage, and will, consequently, absorb all the moisture it meets with on the surface of the land until it is nearly saturated, whence the east wind in all places on the western side of England is said to be a drying wind.

Monsieur Le Roy observes also, that in France certain winds, blowing in a particular direction, are more unfavourable to evaporation than others. The N. and N. W. according to this author, which are likewise extremely cold in the south of France, acce-

lerate evaporation in Languedoc, and the S. W. retards it. The reason of this is sufficiently clear, for the air brought by the N. and N. W. passes over a long tract of land in coming to Languedoc, and will, therefore, like a dry sponge, absorb in its passage much of the moisture of the earth, whilst the air brought by the S. W. wind, which comes immediately from the sea, being already saturated with moisture, will not take up any more, and consequently is unfavourable to evaporation.

But the experiments on evaporation by Doctor Halley, and the result of them, is contained in the following articles: Common water being salted (says the Doctor) to about the same degree as the water of the sea, and exposed to heat equal to that of a summer's day, did, from a circular surface of about eight inches diameter, evaporate at the rate of six ounces in twenty-four hours, whence by a calculus he finds, that the thickness of the pellicle or skin of water evaporated in two hours, from its whole surface, was the fifty-third part of an inch; but for a round number he supposes it only the sixtieth part of an inch. In twelve hours it will evaporate the tenth of an inch, which quantity, he observes, will be found abundantly sufficient to furnish all the rains, springs, dews, &c.

In effect, on this principle, every ten square inches of the surface of water yield in vapour, *per diem*, a cubic inch of water, and each square foot half a wine pint; every space of four feet a gallon; of a mile square, six thousand nine hundred and fourteen tons; and a square degree, of sixty-nine miles English, will evaporate thirty-three millions of tons a day; the whole Mediterranean then,

said to contain one hundred and sixty square degrees, at least five thousand two hundred and eighty millions of tons. Phil. Transactions, No. 189. or Abridgment, Vol. II. p. 108.

The preparation of salting common water to the same degree as that of the sea, and the exposure of it to the heat of a summer's day upon a measured surface, may have enabled Dr. Halley with the help of proper instruments, nearly to ascertain the quantity of water evaporated by a certain degree of heat in any two given hours, and whilst the wind comes from a particular quarter, blowing all that time with equal strength; but it does not appear, because it evaporates the sixtieth part of an inch in two particular hours, perhaps in the middle of the day, during a fresh breeze from the N. E. and when the barometer is at 30 degrees, that it would therefore continue to evaporate in the same proportion during the whole twenty-four hours, with the wind from the S. W. and the barometer at 29. 50 degrees; for when the heat is lessened or increased, or when the wind changes, increasing or dying away, and the pressure of the atmosphere is increased or lessened, the quantity of vapour will be augmented or diminished. Besides, not only the evaporation will be less in winter than during the other seasons, but a material alteration must take place every hour of the night, and probably every two hours of both night and day. This calculation, therefore, I consider as extremely vague and uncertain; at the same time I admit the principle to be very just, and erroneous only with respect to quantity.

Bishop Watson has likewise made several ingenious experiments and excellent remarks on the subject of evaporation, as mentioned in the

third volume of the sixth edition of his Chemical Essays, which I shall beg leave occasionally to notice, but in making the experiment of the inverted glass to collect the exhalation from the earth, it occurred to me, that the glass must attract and retain a greater degree of heat than exists in the atmosphere itself, and therefore, as far as heat operated, the experiment was defective. Besides, the air in the glass being confined, the vapour was not what it would have been in the open air, assisted by the motion of the atmosphere. For evaporation, as Mr. Kirwan justly observes, is greatly increased by a current of air flowing over the evaporating surface, not only because the evaporating surface is thereby increased, but also because unsaturated air is constantly brought in contact with it; hence it is remarked, that calm days are always hottest. The great quantity of water, said to be raised by evaporation in any country, still appears to me doubtful. The means of making this discovery are certainly in our power, but I cannot find that they have yet been successfully employed.

According to Doctor Halley and Mr. Le Roy, it is greater in the south of Europe than in the north. And as Bishop Watson observes, it is infinitely greater in Bengal, whilst the sun is nearly vertical, than in any part of Europe: the heat in Bengal (he says) in the summer months is variable, in the shade from 98 to 120 degrees, and in the sun it probably does not fall short of 140 degrees; hence after the earth has been thoroughly drenched by the overflowing of the Ganges, immense quantities of vapour must be daily raised, to the amount, perhaps, of five or six thousand gallons from an acre in twenty-four hours; whereas when a thermometer was laid in the grass on a summer's day in England, it never ex-

ceeded 96 degrees; the greatest quantity of evaporation given was only at the rate of three thousand nine hundred and forty-six gallons, about half of what is supposed to be evaporated during the summer solstice in Bengal.

It may still be some years before the exact proportion of the temperature, the vapour, and the rain, may be settled; in the mean time, therefore, I shall take the present opportunity of observing, that as the southern parts of the temperate climates in the northern hemisphere, in the summer, have much more heat, and consequently vapour, than those in the north, so likewise they have more rain, and within the tropics the heat, the vapour, and the rain, exceed all those of the temperate climates, nearly in proportion to the different temperatures; nor do I doubt but they will hereafter be found to be precisely in proportion to each other.

The immediate causes of the precipitation of rain likewise still remain in doubt; however, Doctor Franklin, Beccaria, and Doctor Heberden, seem all agreed, that, when clouds are filled with moisture, the precipitation of water must be ascribed to some property of electricity.

Doctor Heberden, in a curious paper read at the Royal Society on the 7th of December, 1779, demonstrates, that the quantities of rain collected during twelve months, from July 1776 to July 1777, in rain gauges placed at different heights near the same spot, have been very widely different; one was placed on the ground, the second upon a house, and the third upon the highest tower of Westminster Abbey. In the first was received 22. 608 inches, in the second

18.139 inches, and in the third 12.009 inches. The Doctor's reflection on this table is, that probably some hitherto unknown property of electricity is concerned in this phenomenon. This power (he adds) has undoubtedly a great share in the descent of rain, which hardly ever happens if the air and electrical appearances be sufficiently dry, without manifest signs of electricity in the air. Hence it is that in Lima, where there is no rain, they never have any lightning or thunder; and, as Monsieur Tournefort was assured, it never rains in the Levant but in winter, and that this is the only season in which any thunder is heard. If, therefore, this appearance could be accounted for, it would probably lead us to some more satisfactory causes of the suspension of the clouds and the descent of rain.

The city of Lima *(See Note* 16.*)* is situated immediately to the westward of the Cordilleras, which mountains therefore will attract and arrest the clouds transported thither from the South Atlantic Ocean, and, in making them precipitate the moisture they contain on the eastern side, will of course take from them their electric fire. If this supposition be well founded, whilst it confirms this theory, it will serve also to explain the cause of there being neither thunder, lightning, nor rain, in Lima.

With respect to its never raining in the Levant but in winter, the assertion of Monsieur Tournefort is rather too general as it stands in his letter; for although it thunders and rains there most in winter, during the continuance of the W. and S.W. winds, which by the Arabs are emphatically called the parents of the rains, yet in both branches of the southern shore of the Mediterranean, it both thunders and rains at other seasons.

According to Mr. Volney, Vol. I. p. 352, thunder is frequently heard in the Delta as well as in Syria, but with this difference, that in the Delta and the plains of Palestine, it is extremely rare in summer, and more frequent in winter, while in the mountains, on the contrary, it is more common in summer, and is very seldom heard in either country in winter.

It seems necessary to correct these errors of Monsieur Tournefort, which apparently have misled Dr. Heberden in his conclusions on this subject.

Mr. Volney, who is seldom mistaken, and never, I believe, wilfully misinforms his readers, still farther observes, that in Syria and Egypt it most frequently thunders in the rainy season, or about the time of the equinoxes, especially in autumn; it is likewise remarkable, that it never comes from the land side, but always from the sea. The storms in both countries proceed from the Mediterranean generally in the morning and evening, and rarely in the middle of the day; they are accompanied with violent showers, and sometimes with hail. Storms come also from the Arabian Gulf to the parts adjacent in Upper Egypt.

According to Mr. Shaw, who kept a meteorological register at Algiers, from the year 1730 to 1733, both years inclusive, the rains begin there about the 25th of September, and continue through the winter to the end of April. In the autumn of 1730 and the spring of 1731, he puts down thirty inches of water; and in the autumn of 1732 and the spring of 1733, he has inserted forty-four inches in his register. It appears, that the heaviest rains fall in October and November at this

place, and that from May to the end of August they entirely cease. He observes, likewise, that in the course of twelve years the thermometer fell twice only to the freezing point at Algiers, the country was then also covered with snow, nor did it ever rise during that time to sultry, except when the wind came from the Sahara. The barometer at Algiers never varies more than one inch three tenths, that is from twenty-nine inches one tenth to thirty inches four tenths.

It does not appear necessary to dwell much on the winds which prevail in England during the autumn, for the temperature of the air at this season will not be very materially different from that of the spring, and therefore, if heat and cold are the primary causes of the course and strength of the wind, the winds at this season ought very nearly to resemble those of the spring.

However it must be observed, that the early part of the autumn is certainly somewhat warmer than even the end of the spring, which probably may be ascribed to the earth retaining much of the heat communicated by the rays of the sun during the summer, whereas in the spring, particularly the early part of it, the earth, and consequently the atmosphere, still in some degree retain the cold communicated to them during his absence in the southern tropic. By these means only we can account for the difference which actually does exist between the winds of these two seasons. They blow, as already repeatedly observed, principally from the E. and N. E. during the spring, and frequently from the W. and N. W. during the autumn. This warmth of the summer remains in some degree until the middle of November, called by the French the little summer of St.

Martin, which generally commences about the 10th and ends before the 25th of that month.

At this time the sun seems to reach a point, whence, from the obliquity of his rays, his warmth is no longer felt in Great Britain; suddenly the earth and the air become cold, and the autumn gives way to the winter. At this time, likewise, heavy dews, mists, and fogs prevail; these will of course be the most prevalent, when the difference between the heat of the air in the day time and at night is greatest. The hotter the day (according to Bishop Watson's Chemical Essays, Vol. III. p. 80.) the greater is the quantity of water dissolved; and the colder the night, the greater will be the quantity of moisture precipitated. If no moisture be observable towards the close of the day, this may be occasioned by there being little difference in the air at noon and at night; or that difference may be considerable, and yet the air may be saturated with moisture, and in that case it may even in the night be warm enough to retain all the water it had dissolved in the course of the day. The city and suburbs of London are proverbially subject to fogs at this season of the year, the cause of which may be easily comprehended from another ingenious and very satisfactory remark of the same author. "The smoke of the chimney (says he) consists "principally of water in the state of vapour, and it is really asto-"nishing to see how quickly in particular states of the atmosphere "it is dissolved in air. It has been often remarked that the smoke "of Mount Vesuvius seems much stronger and is more visible "in rainy than in fair weather; the reason is obvious, aqueous "vapours are more easily dissolved in a dry serene air, than in one

" which is so saturated with moisture that it can dissolve no more. " The quantity of water contained in the air, even in the dryest " weather, is very considerable. We may be said to walk in an " ocean, although the water of it commonly does not become the " object of our senses. We cannot see it, nor whilst it continues " dissolved in the air, do we feel that it wets us, *(See Note* 17.*)* " still it is water, though it be neither tangible nor visible, just as " sugar when dissolved in water is still sugar, though we can neither " see nor feel it."

Every man knows that in December the winter is completely set in; at this time the sun is near the winter solstice, and whilst the earth in England, a few feet below the surface, retains a heat of at least 48 degrees of Farenheit's scale, the air at this season is often much below the freezing point, and even at noon seldom rises to 45 degrees. The mean of the sea at this time will be about 48 degrees. According to my hypothesis then, the principal current of air in Great Britain will begin to move from the E. and N. E. towards the east side of the Great Atlantic Ocean, whilst it is a well known fact that on the coast of North America, the winds for the very same reason come from the W. and N. W. at this season; that is in both cases the dense and cold air comes from the land, which is cold, towards the sea, where the atmosphere is infinitely warmer. The wind at the same season and in the same parallel of latitude, coming from opposite points of the compass, and in both instances from the land to the sea, clearly evinces the cause to be the same as what has been supposed to give motion to the air in every other part of the globe.

It may be imagined by those who are not accustomed to contemplate the operations of nature on an extensive scale, that these opposite currents of air in the northern latitudes will seldom extend so far as from the northern parts of Germany, Poland, and Russia, across the continent of Europe, to the island of Great Britain and the Atlantic Ocean; but Dr. Franklin, in his correspondence with Mr. Alexander Small, dated the 12th of May, 1760, affords us a proof that a current of air in America moved many hundred miles during a violent N. E. storm, probably from the Gulf of Mexico to Boston, and which he accounts for in a very curious and satisfactory manner. I shall beg leave to use his own words.

" About twenty years ago we were to have an eclipse of the moon " at Philadelphia, about nine o'clock; I intended to observe it, but " was prevented by a N. E. storm, which came on about seven with " thick clouds as usual, that quite obscured the whole hemisphere; " yet when the post brought us the Boston newspaper, giving an ac- " count of the same storm in those parts, I found the beginning of " the eclipse had been well observed there, though Boston lies " N. E. of Philadelphia about four hundred miles. This puzzled " me, because the storm began so soon with us as to prevent any " observation, and being a N. E. storm, I imagined it must have " begun rather sooner in places further to the north eastward, than " it did at Philadelphia; but I found that it did not begin with " them till near eleven o'clock, so that they had a good observation " of the eclipse, and upon comparing all the other accounts I re- " ceived from the other colonies of the time of the beginning of the " same storm, and since that of other storms of the same kind, I " found the beginning to be always later the further north-eastward.

" Hence I formed an idea of the cause of these storms, which I
" would explain by a familiar instance or two.

" Suppose a long canal of water stopped at the end by a gate.
" The water is quite at rest till the gate is open, then it begins to
" move out through the gate; the water next the gate is first in
" motion, and moves towards the gate; the water next to that first
" water moves next, and so on successively till the water at the
" head of the canal is in motion, which is last of all. In this case
" all the water moves indeed towards the gate, but the successive
" times of beginning motion are the contrary way, videlicet, from
" the gate backwards to the head of the canal.

" Again, suppose the air in a chamber at rest, no current through
" the room till you make a fire in the chimney; immediately the
" air in the chimney, being rarefied by the fire, rises, the air next the
" chimney flows in to supply its place, moving towards the chimney,
" and in consequence the rest of the air successively, quite back to
" the door. Thus to produce our N. E. storms, I suppose some
" great heat and rarefaction of the air in or about the Gulf of
" Mexico, the air thence rising has its place supplied by the next
" more northern cooler, and therefore denser and heavier air, that
" being in motion is followed by the next more northern air, &c. &c.
" in a successive current, to which current our coast and inland
" ridge of mountains give the direction of N. E. as they lie N. E.
" and S. W. I have not my notes with me in England, and cannot
" from my memory say the proportion of time to distance, but I
" think it is about an hour to every hundred miles."

This description of a N. E. storm in America contains a clear and complete illustration of the theory of the monsoons in India, and in fact of every other wind; but the circumstances of the gale happening precisely at the same time and at the same place, where the eclipse was visible, seems likewise to deserve attention. It is thought by many, that the moon, being an opaque body, can produce no effect on the wind, whereas common opinion, founded on the experience of many ages, teaches us to believe that gales of wind generally happen at places where eclipses are visible, and likewise that changes of wind in the temperate zones frequently happen at, or rather after, the full and change, and even at the quadratures of the moon. Some eminent philosophers have supposed that there are tides in the atmosphere as well as in the ocean, but that from the extreme rarity of the air they are not easily seen. For my own part I should imagine, that there will be this difference between the tides of the ocean and those of the atmosphere. *(See Note* 18.*)* Those of the ocean are principally owing to the attraction of the moon, for the sun's influence in raising the tides by attraction is but small in comparison with that of the moon; whereas those of the atmosphere, being the effect of rarefaction, will be most influenced by the sun; but strictly speaking, the latter probably ought rather to be considered as a current than a tide, for the air will not ebb and flow alternately like the water, but will follow the sun in a continual current, as in his diurnal progress he heats and rarefies the atmosphere.

But if we consider the nature of an eclipse, both of the sun and moon, we may perhaps discover some reason to expect a difference in the motion of the air at all places where the moon's shadow or

penumbra falls. When the sun's light to any part of the earth is so far intercepted by the moon, that he appears wholly or partly covered, he is said to undergo an eclipse, although, properly speaking, it is only an eclipse of that part of the earth obscured by the shadow of the moon; and on the contrary, when the earth comes between the sun and the moon, the moon falls into the shadow of the earth, and having no light of her own, she suffers a real eclipse from the interception of the sun's rays. If then we suppose, that the motion of the air, that is the wind, is caused by the light and heat of the sun, whatever deprives any part of our atmosphere of a portion of that heat and light, must necessarily be supposed to cause some extraordinary motion in that part of the atmosphere where this deprivation takes place, and consequently when the sun's light and heat to any part of the earth are intercepted by the moon, as in a solar eclipse, a current of air will rush forward to the point of rarefaction with that degree of velocity, as to produce what is called a gale of wind. How far the same causes, acting in a less degree, are likely to produce a proportionate effect at the new moon or the quadratures, will probably be best ascertained by a long series of observations regularly made and carefully recorded in meteorological tables.

In my attempt to account for the motion of the air, or, in other words, the wind, it will no doubt by many be thought, that I have hitherto confined myself too much to the operation of the direct and reflected heat of the sun upon the earth; for if these were the sole causes of wind, as the sun's course is perfectly regular, the wind would consequently be in like manner periodical, scarcely admitting of even the alteration of a day. But thus far I have only endeavoured to explain the primary cause of the general course of the winds; it

remains to add a few remarks on temporary and topical currents of air.

Heat, or rather caloric with electric fire, is known to rarefy the air, and is therefore the immediate cause of its motion. This heat is known to exist in various forms, both in the body of the earth and in the atmosphere; wheresoever, therefore, it is disengaged in great quantities by adventitious circumstances, in either one or the other, which it evidently may be by various causes, a greater or less body of the atmosphere may, by these means, be put in motion, and consequently produce a wind, or many winds, within the compass of a few degrees, of a few miles, or even of a few yards. Every common fire that is kindled, either within or without doors, produces a similar effect in proportion to its size. When therefore it is said, that the rarefaction of the air in Russia, in the months of June, July, and August, is likely to produce S. W. winds in England, or on the contrary, that the rarefaction of the air over the Atlantic, about the vernal equinox, will produce easterly winds in England, it must not be understood that no other winds will blow in any part of Russia, or of this country, during these months; but only that the winds between the W. and the S. will probably be those, which for the most part prevail in summer, and those from the E. and N. E. such as prevail in the spring. It may often happen that considerable quantities of caloric, which is perhaps the most abundant element in nature, or of electric fire, which abounds likewise both in the earth and the atmosphere, may one or both of them be imperceptibly disengaged from the surrounding bodies, and produce the sudden rarefaction of a great body of atmosphere for many days successively; and this may occasion, for that time, even opposite currents of air within a narrow

compass: but still I must contend, that on an average of ten, or even of one hundred years, the S. W. wind will prevail in England during the months of June, July, August, and September, and the E. and N. E. in March and April; which must be principally ascribed, as, it has been already mentioned, to the alternate rarefaction of the air at the different seasons, both in the countries to the N. E. of Great Britain, and likewise over the North Atlantic Ocean. The same argument will of course apply to topical and temporary winds in other parts of the globe, but less to those countries which are situated within the tropics, than in England; for the continual heat of the sun in the torrid zone, especially towards the equator, will be sufficient to prevail over every other inferior degree of heat, particularly at that time and within that space where he is nearly vertical.

After having assumed as known facts, that the easterly winds invariably prevail in the western part of Europe, and particularly in the British Channel during the months of March and April, we will in the next place attempt to show the advantages to be derived from a knowledge of these facts, especially when applied to ships outward bound to India. In following them through the progress of the voyage at different seasons, we shall likewise derive further information respecting the winds in different latitudes, according to this system, and thus by uniting practice with theory we, shall hope, in some measure, to confirm an hypothesis by proofs derived from experience.

The ships bound from England to India generally sail in two different fleets, the first is usually dispatched in December, or early in

January, and the second in April or May. The first of these, even in winter, is sometimes fortunate enough to have a temporary current of N. E. wind, which carries the ships clear of the Channel, and across the Gulf or Bay of Biscay into the N. E. perennial. In this case also they will frequently have a tolerable voyage as far as 24 or 25 degrees S. but in these latitudes they will often be baffled with strong southerly winds, especially as they approach the southern part of the western coast of Africa to pass the Cape of Good Hope. If we suppose them, for example, to arrive there about the end of February or the beginning of March, the S. the S. W. and S. E. winds, which then prevail, will retard their progress round the Cape. The N. W. winds blow only with some degree of constancy and violence from May to August, as is well known by the orders of the Dutch respecting the entrance of ships into Table Bay; but after having passed the Cape at this season, no vessel can enter the Mosambique Channel during the continuance of the N. E. monsoon, and those even which are bound to Bombay are obliged to go the eastward or windward passage, between Madagascar and New Holland. If we suppose them to pass the south end of Madagascar about the time of the equinox, they will find the winds light and variable between the tropic and the line; nor must they expect a fresh S. E. perennial, until they have got to the northward of the sun. As they arrive near the Maldivi Islands, or the coasts of India, they will find the S. W. monsoon set in, and sometimes near the entrance of the Gulf of Bengal, accompanied with hard gales of wind. For the same reason it is dangerous to approach the coast of Malabar at this season of the year.

In consequence, therefore, of these various obstacles, ships which sail from England in November and December, or early in January,

seldom perform their voyage in less than five or six months, and consequently do not arrive above a month before those which sail between two and three months after them. Unless therefore in cases of great emergency, it would be most eligible to postpone the departure of the first fleet to the end of February or the beginning of March, and to delay the second to the end of April or the beginning of May.

If the E. and N. E. winds prevail in the British Channel during the months of March and April, this will of course be the most favourable season for ships to leave England, which are bound either to the East or West Indies; for this is not only a leading wind down the Channel, but if it continues for a few days, it will very soon convey the ships, which avail themselves of it, into the N. E. perennial, and thus secure the most doubtful part of the outward-bound passage. In passing the sun, as they will do in the northern tropic, they may be subject to temporary calms just where he is vertical; but it is very possible they may pass him with light winds, and, by crossing the line between 18 and 20 degrees W. of London, secure their passage to the Cape of Good Hope in the course of six or seven weeks.

It is the practice of some navigators when outward bound, and whilst still far to the westward, to run into the latitude of 36 or 37 degrees S. on a supposition that the N. W. wind blows with greater strength in the high latitudes; but this notion is contradicted both by theory and practice, for after they have passed a few degrees beyond the tropic, the N. W. wind will be found to blow almost

invariably at this season, between the latitude of 28 and 30 degrees, and near the continent of Africa, with most regularity and strength, between 30 and 35 degrees.

In the vicinity of the Cape at this season, this wind blows almost incessantly, generally increasing near the land until the ships have passed the bank. A few degrees to the eastward, the wind will sometimes come for a day or two from the S. E. but the prevailing wind on both sides during these winter months is unquestionably the N. W. The struggle seems to be between the cold air from the pole and the reflux of air near the S. E. trade.

After having passed the Bank of Lagullus, ships should take a good offing to the eastward, even those which intend going the windward passage, for immediately round the Cape there is often a strong set on the land, whilst at the entrance of the Mosambique Channel from Cape Corientes, the current runs frequently with considerable violence to the S. E. so that between the south end of Madagascar and the main land of Africa, the utmost care is necessary to avoid running either upon one coast or the other. The Doddington Indiaman was wrecked near De Lagoa Bay, in the year 1756, by standing too soon to the northward, immediately after having rounded the Cape; and a few degrees further northward many ships have likewise nearly been lost on the opposite side, by an error of near four degrees in the easting, according to the dead reckoning.

The first instance that occurred to myself was in the Prince of Wales Indiaman, in the year 1762. In company with the Britannia,

we fell in with the land about midnight, near St. Augustine's Bay, at the time we supposed ourselves to be near mid-channel between this island and the continent.

The second instance was in 1785, in a French ship, the Notre Dame du Mont Carmel. The following extract from our journal will best explain our situation. Fresh gales and good weather. At day-light saw the land, the body of it bearing N. E. distance six or seven leagues. According to D'Apres' chart this shoal, the Star Bank, lies in 44° 10′ E. of Greenwich, and latitude 25° 10′ S. In the morning a man on the fore top sail yard called out "breakers," which were not more than a mile and a half distant on each bow. This bank lies only five leagues from the coast of Madagascar, and is very low, therefore no ship should pass the latitude of St. Mary's after dark, unless well assured of the longitude.

A French Indiaman, St. Jean Baptiste, was lost at eight o'clock in the evening, in the year 1777, and thirty-nine only of one hundred and twenty people were saved: the carpenter and boatswain's mate of our ship were amongst the number of the saved. They reached St. Augustine's Bay in the yawl, but on landing they were made slaves by the natives. Nineteen only of the thirty-nine survived their captivity, in which they remained seven months, and then were ransomed by a Dutch ship. We probably owed our preservation to an excellent chronometer, made by Arnold, which gave us, at eight A. M. the longitude of 43° 9′ 45″ E. that nearly corresponded with our lunar observations; nevertheless the Captain could scarcely believe at the time, that, after having struck soundings on the Bank of Lagullas, such an error as four degrees of longitude could exist in the ship's reckoning:

however, at nine P. M. he put the ship about, and stood off and on until day-break, a precaution by which, in all probability, we were saved from shipwreck.

The Aurora frigate, which was lost, after leaving the Cape of Good Hope, in the year 1768-9; and the Cato, with Admiral Parker on board, neither of which have ever been heard of since they left that place, were very probably both cast away either on the coast of Africa or the island of Madagascar.

In the months of July and August the S. W. monsoon is at its greatest height, and the current of air being almost equally attracted by both coasts, ships in this season sail almost right before the wind in the middle of the channel, but on either coast, as I have already observed, there are regular land and sea breezes; both these facts serve to corroborate the truth of this theory. At an equal distance likewise from both shores, the thermometer suspended in the captain's apartment was seldom above 75 degrees, or lower than 68 degrees, but there is a sensible difference in the heat near either coast. The sea during this monsoon is also remarkably smooth, being covered to the eastward by the immense island of Madagascar, and to the westward by the coast of Africa, so that at this time it would be a remarkably pleasant navigation, were there not many dangerous shoals in it, most of which, however, are laid down with great accuracy in D'Apres' chart. For all these reasons, ships sailing from England in March and April, which are bound to the Malabar coast and the Arabian or Persian gulfs, should of course go the inward passage. Besides the advantages already mentioned, they may easily procure refreshments, either at the island of Madagascar, or at

Johanna; and therefore vessels with troops on board, that are bound even to any part of the Gulf of Bengal, would do well to follow the same route. Provisions, fruit, and water, are good, cheap, and abundant, at either of these islands.

But notwithstanding these advantages, which are extremely agreeable to passengers, the safest, and perhaps the most expeditious route, is the outward passage; for after having struck soundings on the bank off the Cape, by steering so as to make an E. by N. course good until clear of all danger, the voyage from the Cape to Madras, by these means, may be easily performed in six, or at the utmost in seven weeks.

In the present improved state of navigation, when not only the mariners are more skilful, but the ships are much better constructed and founded than they formerly were, a copper bottomed vessel, with able observers, furnished with chronometers and proper instruments, may venture to undertake the voyage to India at almost any season of the year; but the merchant who is to consider the expences incurred by delay, and the wear and tear of his ship, or the passenger, who wishes to avoid all the difficulties, inconveniencies, and dangers of contrary winds, should keep in mind, that, by sailing from England in the spring, he may be certain, with tolerable good management, of performing the voyage in less than sixteen weeks, perhaps in fourteen; and that, by embarking either much sooner or later, he probably will not arrive in India in less than five or six months.

The winds which prevail in different parts of India have been already sufficiently described, where I treated of the monsoons in the former part of this work, but I have as yet only slightly mentioned

the currents, which are likewise periodical: when both are perfectly understood and duly observed, the navigation of the Indian seas cannot be attended with either difficulty or danger.

The currents in the Indian Ocean, *(See Note* 19.*)* the Gulf of Sind, and the Bay of Bengal, almost invariably take the same course as the winds. During the S. W. monsoon they constantly run from the S. W. to the N. E. and at the change, the wind and current go together from the N. E. to the S. W. The cause of this connection between the wind and water seems almost to speak for itself. From the vernal to the autumnal equinox, that is during the S. W. monsoon, the lower current of air, and also the water of the southern hemisphere, are put in motion to fill up a vacuity caused by the rarefaction of the atmosphere and the evaporation of the ocean and seas in the northern hemisphere, both of which are increased near the land; and on the contrary, from the autumnal to the vernal equinox, when the sun is in his return to the tropic of Capricorn, the atmosphere being rarefied over every part of the southern hemisphere, the wind and current, operated upon by the same causes, will move in a contrary direction from the N. E. to the S. W. The wind and current in this manner constantly following the same direction, and invariably changing at the same time, serve almost to place the truth of this hypothesis beyond a doubt; but as a further confirmation of it, the strength of the current is always in proportion to the force of the wind, and both grow gradually weaker towards each equinox, or rather at the end of each monsoon.

The immense body of water which is brought from the southward into the Gulf of Sind and the Gulf of Bengal, during the S. W. mon-

soon, very probably arises from the quantity of ice and snow, which has been dissolved in the southern polar regions during the summer solstice of that hemisphere, and which, as the sun increases the evaporation in the northern hemisphere, runs rapidly towards the Indian gulfs to restore the equilibrium, and it will move with a force proportionable to the density of the atmosphere, to the body of the water, and to the extent of the different gulfs. To these causes very probably may be ascribed likewise what is usually called the surf or surge, which breaks with great violence during the S. W. monsoon on the Coast of Coromandel. The southerly current flowing into the Gulf of Bengal in a continual stream during several months successively, this gulf, as it fills, being stopt at the northern extremity, must be supposed to throw the water upon the adjacent coasts with considerable force. On the Coromandel side the surf is likewise increased by the opposition of the land winds which blow off shore in June and July; but when the current changes with the monsoon, and comes from the N. E. the surf must still continue to be high at the commencement of the monsoon, whilst the wind continues to blow this vast body of water with great force directly on the coast; but it begins to abate, and almost entirely to cease, in January and February; for notwithstanding many considerable rivers have emptied themselves into the gulf, and apparently increased the quantity of water, the N. E. current in its return having ample room for expansion both in the Indian and Southern oceans, the principal current will concentre to a point in the middle of the gulf, whilst only a moderate drain runs towards the different coasts, which, therefore, does not raise any surf on that of Coromandel at this season of the year.

The surf on the southern part of the Malabar coast, near Anjengo, is often high, and if it is not equally high on every part of it, as it is on the southern part of the Coromandel coast, yet we must remember that the Gulf of Sind is much more spacious than the Gulf of Bengal; and likewise, that a large portion of the water, which flows into the former, has greater room for expansion, both in the Arabian and the Persian gulfs.

The voyage from India, like that from Europe, may, by skilful mariners, in well founded ships, be undertaken at almost any season of the year; but the most favourable time to sail is between the beginning of October and the middle of March. After the commencement of the N. E. monsoon, favoured by both winds and currents, ships will soon get clear of the Gulf of Sind or the Gulf of Bengal, very probably cross the line with a fresh breeze, and not be detained by calms between the monsoon and the S. E. trade. By arriving at the Cape about the middle of November, they may expect moderate and fair winds, it being the beginning of the summer. The weather is usually mild, and the strongest winds generally come from the S. E. which of course are the fairest that can blow. To the westward of the Cape the winds will be light but generally fair, and in five or six days will carry a ship into the regular S. E. perennial. In short, no difficulties from violent or contrary winds are to be expected at this season, until the ship reaches the latitude of 30 or 35 degrees in the northern hemisphere. If no time is lost by the way, in all probability the ship will pass the line from the Southern Atlantic Ocean about the end of January, whilst the sun still continues far to the southward, and therefore it is not likely, that the ship will

be detained by calms, provided she keeps about the longitude of 18 or 20 degrees W. of Greenwich.

The principal obstacles in the homeward bound passage at this season, commence near the mouth (commonly called the chops) of the Channel, where it is probable a ship may at this season encounter E. and N. E. winds, which frequently oblige those which are homeward bound in the spring, after having been baffled for some time, to bear away for Ireland. In many respects this step must be extremely inconvenient and uncomfortable, particularly to paſſengers, whose constitutions being often impaired by a long residence in India, are but ill calculated to bear the extreme coldness of the weather, and the subsequent journey from Ireland to England.

To avoid these inconveniencies, therefore, I should recommend to passengers who can command their time, to embark in India in the month of January. It is possible indeed they may meet with a gale of wind, or rather a whirlwind, in the latitude of the French islands; but this seldom happens, and with proper precautions can hardly be considered as dangerous. The passage round the Cape will probably be expeditious and pleasant, and by arriving in June, they will certainly have S. W. winds at the entrance of the British Channel. With the whole summer before them, they will again be gradually inured to their native climate, and be fully prepared in the course of five or six months to encounter the severity of the ensuing winter.

After having considered the winds, the weather, and the currents, which prevail in different parts of the globe, with the time of

their commencement and duration, we must enter into a further investigation of this theory, and trouble the reader with some additional remarks on the various causes of heat and cold, which, after the illustrious Lord Bacon, we have supposed to be the hands with which nature performs the chief of her operations.

The sun I consider as the principal source of heat and light, and therefore that, when present, he communicates to all surrounding bodies an increase of his emanations, and that, when he is absent, a certain degree of cold and darkness must of course take place. The alternate changes of summer and winter, and even of day and night, sufficiently indicate the effects of this planet; but probably these emanations of the sun do not reach far beneath the surface of the earth, for in cellars, caves, and springs, which are only fifteen or twenty feet deep, we find constantly a regular temperature, which corresponds nearly with the mean heat of the country; for which reason, of course, cellars and deep caves, according to our feelings, are warm in winter and cold in summer.

Monsieur de Mairan is allowed to be the first who discovered that the winter's cold is tempered by the internal heat of the earth imparted to the lower regions of the atmosphere, and which he calls a central emanation, supposing it to proceed from an immense mass of fire or heat in the centre of the earth. Whilst Mr. Kirwan very justly gives Monsieur de Mairan the credit of being the first discoverer of this internal heat, he at the same time completely refutes the doctrine of its being imputable to internal fire; for as he justly observes, if such a mass of fire existed in the centre of the earth, the lower we descended towards it the greater degree of heat we should experience; whereas at the bottom of the mines of Joachimstadt,

which are one thousand seven hundred feet deep, the temperature of the air is only about 52 degrees, corresponding nearly with the mean heat of the country at the surface of the earth in Bohemia; whence it is evident, that the constant internal heat of the earth is not owing to a central fire.

But the French Academicians, particularly the father of modern chemistry, Lavoisier, has discovered a new fluid, to which he has given the name of caloric, and which he supposes to exist in all bodies with which we are acquainted. This fluid matter communicating what is generally denominated heat, cannot itself, strictly speaking (as Lavoisier observes) be called heat, for the same term must not be made to express both cause and effect; adopting, therefore, this new chemical term, we will say that all bodies are immersed in caloric, and are preserved in a state of solidity or fluidity by the attraction of the particles to this matter of heat. If it subsists in all bodies, and of course both in the body of the earth and in every matter of which it is composed, and likewise in water, this fluid then, or perhaps the intestine vibratory motion of matter produced by the diurnal motion of the earth, may possibly occasion the internal heat which was necessary for the preservation of vegetation in high latitudes during the winter season, and for many other wise purposes, which at the present moment are not clearly understood.

But to this internal heat of the earth and the ocean, from whatever cause it proceeds, may be ascribed, according to this system, most of the winds which prevail in different parts of the globe. When this heat is increased near the surface by the presence of the sun,

and the earth becomes hotter than the ocean, as of course it will do invariably in the summer, the inferior current of air will move from the ocean to the land; and when the sun is absent, or his rays fall with considerable obliquity on the land, remaining there only a short time, the inferior current of air will generally move from the land to the sea. In short, as the air will ascend where it is most rarefied, and the heavier body of cold air, which is nearest to it, will always move forward to restore the equilibrium, by this constant motion of the atmosphere, what in common language is called wind is produced.

In the next place I shall attempt to show by what means the atmosphere is supplied with water; in what manner the winds are rendered the vehicle for conveying this moisture to the earth; and by what means these waters are again returned to the sea, carrying with them the salts from the land, so as to keep up the saltness of the ocean.

In the absence of the sun in the winter solstice, immense masses of ice and snow are collected in the polar regions, which by these means become so many reservoirs of water, deposited there by the hand of nature in a solid form until the return of the sun, when they are in part dissolved, and, being again put in circulation, serve to increase the quantity of water in the sea.

During the whole of the summer solstice in each hemisphere, including the three hottest months, the quantity of ice and snow thus dissolved, in those regions, must be prodigious. If when this operation is performing the sun was suddenly to disappear, and this mass

of water to be again immediately congealed, the first dissolution would have taken place in vain; but the course of the sun is gradual, and as he continues his progress either N. or S. one atmosphere is progressively warmed, whilst the other is proportionably cooled: with the former a vacuum is formed, which is filled up by the cold denser air put in motion by its gravity to restore the equilibrium: this motion of the air consequently conveys with it the increased body of water from the polar regions, and carries with it this additional mass towards the tropics and the equator.

When the polar currents of air and water, if we may use this expression, reach the torrid zone, the constant heat of the sun, which is increased likewise by the heat of the earth as it approaches the land, causes a considerable increase of evaporation, or, in common language, a distillation of the sea water, leaving behind in the ocean all its saline qualities. Here likewise the wisdom and goodness of providence is evident, for the gravity of the salt prevents its rising into the air so as to ruin vegetation.

Doctor Franklin mentions this circumstance, but ascribes it to there being a greater affinity between air and water, than between either water and salt, or salt and air; and therefore he says, the water quits the salt and embraces the air, otherwise our rains would be salt, a doctrine not wholly admitted by modern chemists; but in either case we may find, as he properly observes, in this, as in every other operation of nature which is clearly understood, that we have reason to adore Him with praise and thanksgiving, who hath duly proportioned and given proper qualities to all his works.

When the sun has crossed the line from the southern hemisphere, and is daily approaching towards the tropic of Cancer, the currents of air and water, which come from the cold towards the warmer hemisphere, bring with them an ample supply of water, both fresh and salt, the former in the atmosphere, the latter in the ocean itself. By means of heat and motion the sea water, as it approaches that part of the globe where the sun is vertical, is immediately evaporated, and thus becoming fresh, increases the water in solution in the atmosphere so as to saturate it, when it is afterwards poured down in abundant showers to cool and refresh the earth and promote vegetation.

But the bounty and omniscience of providence has, doubtless, at the beginning, foreseen what is requisite, and provided a sufficient supply of every kind of matter for the purposes of the creation, so as to admit of the various chemical processes they were destined to undergo in this terrestrial laboratory; thus the superfluous part of the distilled water is made to return again into the sea through the channels of the different rivers, by which means likewise it brings what, doubtless, is a necessary supply of salts from the earth to the ocean, and by these means at the same time keeps up the supply of fresh water for the earth, and of salt for the ocean, which, it is said, in the course of eight hundred or a thousand years would otherwise have become fresh. This supposition, however, does not appear to be well founded; for the lakes and inland seas, which have no direct communication with the ocean, are, by means of the animal, vegetable, and mineral salts of the earth, conveyed to them through the channels of the adjacent rivers, rendered as salt as even the ocean

itself; and those lakes, on the contrary, which have an immediate communication with the ocean, always retain their original freshness. The Caspian Sea, the Dead Sea in Palestine, and the lakes of Mexico and Titicaca, in Peru, are proofs of the former, whilst the lakes of North America and those of Switzerland, many of which also from their magnitude merit the name of inland seas, are equally clear proofs of the latter. The River St. Lawrence conveys the waters of these American lakes into the Atlantic Ocean, as do likewise the Rhone, the Rhine, and other inferior rivers, convey the waters of the European lakes into the Mediterranean and the German Ocean.

With respect to the primary cause of the saltness of the ocean, which has been the subject of much discussion, both in ancient and modern times, if it be admitted that fish, and animals of different kinds, which cannot live out of salt water, existed at the creation, we must also allow that salt water was at that time provided for their existence. Without waiting therefore for a positive illustration of this hypothesis from experiment, we may venture from these premises to conclude, that the waters of the ocean were originally impregnated with a certain portion of salt, and that the quantity is constantly increased by the waters flowing into the body of the ocean from the different rivers; but in what degree this saltness of the ocean originally existed, or is annually augmented, can only be ascertained by observations hereafter regularly made and carefully recorded in different parts of the globe.

Whilst the several continents, which are situated near the ocean, are supplied with water by evaporation from the ocean, this vast

bason is again replenished with fresh water, both from the atmosphere and the earth. Switzerland, Russia, Thibet, and Tartary, and other inland countries, are also furnished with water from the reservoirs deposited on the summits of their lofty mountains, which, from their stupendous height, must be almost constantly covered with ice and snow.

In the tables of Mr. Kirwan, which are founded on the information of Messieurs Bouguer, De la Condamine, and Tobias Mayer of Gottingen, the point of congelation is different in every different latitude, being always in proportion to the distance of the mountains from the equator, where the mean height of the lower term of congelation is fixed at fifteen thousand five hundred and seventy-seven feet. According to this calculation, the Alps in Switzerland, at the height of seven thousand six hundred and fifty feet and upwards, may be considered as reservoirs of this description. Those of Thibet, between the latitude of 30 and 35 degrees N. at ten thousand seven hundred and eighty-four feet; and those between Tartary, Russia, and Siberia, which are between 40 and 55 degrees of N. latitude, at five or six thousand feet.

But in looking over the map of the western side of Europe, we find some of the lofty mountains of Switzerland almost equal in height to the Andes near the equator. From this frozen eminence and its environs descend the Rhine, *(See Note 20.)* the Rhone, the Danube, and other great rivers, with all their contributary streams, which serve to fertilize the south of Europe. Here also are many extensive lakes, besides that which Monsieur Bouffler fancifully observes in his letters from Switzerland, " Old ocean has sent as

" his miniature picture to the Swiss near Geneva." Deprived of these reservoirs, the S. of France and the S. E. of Germany would become barren deserts, as would likewise the countries further eastward, did they not also possess the same advantage from the mountains of Russia and Lithuania; from these latter reservoirs flow the Don, the Wolga, the Nieper, the Niester, and many other great rivers, through which, with the aid of human art and industry, communications might be opened that would facilitate commerce, and, according to Czar Peter's plan, unite the Caspian to the sea of Asoph, and all these through the Black Sea and the Mediterranean, with the ocean itself. *(See Note 21.)* Continuing our course to the eastward and northward, we find the Jaik emptying itself into the north of the Caspian from a branch of the Caucasus, where it approaches the Tobol; this latter river rises in the mountains which separate Siberia and Tartary; running northward it joins the Irtis, which empties itself into the Gulf of Oby, in the Frozen Ocean. From this same chain of mountains run also the Oby, the Jenesei, the Lena, and many other great rivers, towards the Northern Ocean. Their sources have not yet been thoroughly explored, but they pass through the most extensive tract of land unbroken by sea in the whole globe. But the great valley of Tartary, formed by the mountains situated between the latitude of 32 and 60 degrees N. well deserves the attention of the philosopher and historian. From this *officina gentium* has issued many, probably most, other nations; and indeed I doubt not but it will hereafter be known, that either as travellers or conquerors, the Tartars have pervaded the four quarters of the world. But to pursue our geographical enquiries.

Descending again to the S. and E. we meet with another range of mountains or reservoirs, whence come the Euphrates, the Indus, the Ganges, the Bramhapooter, the Hoamho, the Kiang Kiu, and numberless other rivers of inferior note.

The first of these, the Euphrates, and its twin sister the Tigris, both take their rise in the mountains of Caucasus, and after forming a junction near Corna, to the north of the city of Bossora, disembogue themselves into the Gulf of Persia, a few miles below that place.

As these two rivers, throughout their whole course, are situated beyond the tropic, we cannot suppose that they are entirely filled from the solsticial rains. Their sources lie in that branch of the Caucasus situated between the Caspian and the Black Sea, near Derbend, where the mountains are sufficiently lofty to retain snow and ice, and thus supply water to these rivers, which therefore necessarily overflow about the summer solstice.

Few eastern rivers have attracted more attention in ancient, or less in modern times, than the Indus: this may partly be ascribed to the expedition of Alexander, a circumstance that made it known in Europe at a very early period. Lying directly in the route by land from India to Persia, the countries through which it runs, previous to the discovery of the passage round the Cape of Good Hope, must have been very much frequented; but since that period, especially after the decline of the power of the Portuguese, they have been almost entirely neglected. The northern branches of this river extend

from the longitude of 66 degrees E. to that branch of the Imaus or Himmalah mountains in the longitude of 76 degrees E. including a space E. and W. of at least five hundred miles: all these branches unite below the city of Multan, and there appear almost as one considerable stream until it approaches the sea, where it again divides, and disembogues itself by many different channels into the Gulf of Sind, below Tatta.

The northern Delta of this great river, if we may be allowed the expression, is situated in the mountains of the eastern Caucasus, which probably derive a considerable portion of their waters from ice and snow deposited on their summits; but as the main collected stream of the river towards the sea is situated within, or very near the tropic, after having made due allowances for the water coming from those branches which are situated far to the northward, we may reasonably attribute a great part of its water to evaporation from the ocean, and to the subsequent monsoon wind and rains.

The Ganges has long been considered as rising near Hurdwar, commonly called the Cow's Mouth, in the country of Serinagar, about the latitude of 30 degrees N. and longitude 80 degrees E. of Greenwich; but we now learn from that able and indefatigable geographer, Major Rennel, that there are two other more remote branches, inclining considerably further N. in a direct distance of near three hundred miles. The Ganges (says the Major) thus appears to the incurious spectator to derive its original springs from this chain of mountains; and the mind of superstition has given to the mouth of the cavern the form of the head of a cow, an animal held in great veneration by the Hindoos.

From this second source (as it may be termed) of the Ganges, its course becomes more easterly than before, through the rugged country of Serinagar, until at Hurdwar it finally escapes from the mountainous tract, in which it has wandered about eight hundred British miles.

Camhi, Emperor of China, in the year 1717, sent persons of Peking, a distance of two thousand five hundred miles, to explore the head of the Ganges: until the result of this expedition was known in Europe, it was believed, on the faith of the Hindoos, that the springs of this river were at the foot of Mount Himmala, or Imaus.

The Bramhapooter issues from another branch of the same ridge of mountains, and after running in almost opposite directions, the one to the E. and the other to the W. to the distance of one thousand two hundred miles, the two rivers gradually approach each other again, and at length meet at near two thousand miles from their source below Dacca, and then, under the general name of the Ganges, enter the sea at the N. E. side of the Gulf of Bengal.

It has been doubted from respectable authority, whether the swelling of the Ganges and Bramhapooter, previous to the commencement of the rainy season in the flat countries, is in any degree owing to the melting of the snow in the mountains. Until these countries are better known, this question must in some measure remain in doubt. The infinite number of contributary streams which fall into both those immense rivers, and some of them near the tropic, affords us great reason for thinking this opinion well founded: at the same

time, when it is considered that the mountains of Himmala or Imaus are constantly covered with ice and snow, so as to be visible from the southward at the distance of one hundred, and some say one hundred and fifty miles, and that the sources of the Ganges and Bramhapooter lie amongst these mountains, in like manner as the rivers of western Europe are supposed to be filled by the melting of snow on the glaciers of Switzerland, so likewise we must suppose those eastern rivers derive a considerable portion of their waters from the same kind of source, especially as it appears that snow sometimes falls amongst them in the month of May.

From an extended eastern branch of this double range of mountains, which separates Hindustan from Independent and Chinese Tartary, flow many considerable rivers, the major part of which, however, unite either in the Amur, the Hoamho, or the Kiang.

The Amur is supposed to have its source in the Lake of Baycal: It enters the ocean to the eastward, in the latitude of 55 degrees N. in the gulf, or rather the sea, of Kamschatka, where it gives its own name to a small island at the mouth of it, and likewise to the neighbouring streights. The city of Albasin, situated on its banks, lies in the direct route of the caravan, which formerly went annually from Moscow to Peking.

The Hoamho or Yellow River, according to Witsen's map of Great Tartary, runs from the W. to the E., between the kingdom of Tongut and the N. E. side of India, to China. It crosses the province of Xiensi, then approaches the great wall of China, and after inclining

towards the S. mounts suddenly again northward, and finally discharges itself into the Gulf of Nanking.

The Chinese have joined the Hoamho to the Gulf of Kiang by a canal, which begins in the province of Nanking, crosses Xantung and part of that province, and terminates at Kiang. This river runs with uncommon rapidity, and is said to overflow the neighbouring countries to a very considerable extent.

The Kiang or Blue River has its sources in the mountains of Thibet, passes through the provinces of Yunan Pontchew and Hunquan, and discharges itself into the sea in the province of Nanking.

The Chinese proverb says, The ocean has no bounds, nor the Kiang any bottom.

It is not merely to mark the rise and courses of these rivers that we have entered into this geographical dissertation, but rather to illustrate the principles on which this hypothesis is founded; for from a view of this picture or map, if we may be allowed to use either of these expressions, it may be easily perceived by what means these extensive inland countries are supplied with water.

In the centre of Asia, the most extensive tract of land in the world, and the most remote from the ocean, we find placed a double range of most stupendous glaciers, to receive the moisture raised by evaporation during the heat of summer, which of course falls afterwards on their summits in the form of snow, constantly accumu-

lating throughout the winter, until a part of it is again dissolved at the return of the sun in the following summer.

Air then is evidently the vehicle by which this moisture is raised: by no other means could it attain to a height sufficient to be deposited on these reservoirs, so as afterwards to fall with force sufficient to impel the rivers forward in their long and devious courses from the mountains to the sea.

The countries on the southern side of these mountains, particularly those towards the centre of them, are acknowledged to be the most populous and fertile part of the old world, which must be ascribed to the advantages they derive from these reservoirs.

Hereafter probably, when by an intercourse with more enlightened nations the Tartars are become civilized, and are taught, under a mild and regular government, to cultivate the arts of peace, the eastern parts of Russia, and at least the southern part of even Siberia itself, will become as fertile as the northern parts of Germany and Poland.

It is generally, but erroneously, I believe, supposed, that the climate of Tartary and that of the south of Siberia is too cold to admit of great improvements in agriculture and the concomitant parts of husbandry; but from the latitude of 50 to 60 degrees, and a few leagues distant from the mountains, a country, watered by so many large rivers, can require nothing but industrious inhabitants to render it at least as habitable as any part of Europe in the same parallel of latitude.

The Frozen Ocean to the northward, which constantly remains a solid mass of ice for almost nine months of the year, will probably keep the neighbouring coasts in nearly the same state to the end of time; but the countries to the S. of the latitude of 60 degrees, extending from the Baltic W. to the sea of Kamschatka E. may certainly be cultivated, whenever the fostering hand of government is extended towards the inhabitants to civilize and protect them, and whenever they are allowed to enjoy unoppressed the fruits of their own labour.

If we take a cursory view of the rest of the globe, we shall find that the same causes produce universally the same effects, both physical and moral. The northern parts of America at present, in many respects, resemble those of northern Asia: the interior of the former has yet been but imperfectly explored, but from those features of it which are known we may easily trace the probable resemblance of the rest.

From Canada to Georgia, *(See Note 22.)* particularly to the westward of the lakes, the climate of the new continent is infinitely colder than any part of Europe or Africa in the same latitude, and nearly corresponds in temperature with those of Asia. It seems probable, therefore, from this apparent analogy, that the interior of North America, between the latitude of 34 and 50 degrees, greatly resembles the countries of Thibet and Tartary both in population and cultivation.

The western part of northern Europe is situated either near the sea, or is supplied with water by the means of glaciers; whilst that

part S. of Switzerland and Tyrol has no glaciers, but is bounded or nearly surrounded by the Mediterranean. The Apennine mountains run entirely through Italy from N. to S. The whole of Europe also is in an improved state of cultivation, and has no very considerable forests; Europe therefore is now much milder than either Asia or America.

But Africa, *(See Note 23.)* which is not supposed to have any glaciers as reservoirs in the broadest part to the northward, nor any range of hills running N. and S. within the tropic, to produce regular periodical rains in the interior of this great continent, has therefore only a few rivers, and none to be compared in magnitude with those in the other parts of the globe; and the different climates of Africa, therefore, are much warmer than those of the other continents, as is very obvious from the extraordinary dark complexions of the natives, and the general appearances in nature.

It is possible that the bowels of the earth in this continent may contain gold, silver, and jewels, equal in quantity, and the latter perhaps even superior in quality, to what have been discovered on the opposite side of the southern Atlantic; but should curiosity, private interest, or public spirit, induce a continuance of the late attempts of the Europeans to explore the interior of this country, they probably will find scarcely any thing on the face of the earth to reward their painful researches, particularly on that part of it inland, which is situated immediately within the tropics. Let us, however, remember, that the arts and sciences once flourished on the northern part of this continent; that Carthage long disputed with

Rome the sovereignty of the world, and rivalled their ancestors, the Phenicians, in naval enterprizes and trade. When therefore the bigoted, ferocious, and intolerant spirit of Mahometanism, which now is evidently on the decline, has entirely died away, the present piratical states of Barbary, enlightened by true philosophy, may also emulate the conduct of their predecessors, and cultivate commerce and those arts which now they endeavour to destroy.

After ages, likewise, will probably behold colonies, immensely rich and extensive, established at the southern extremity of Africa. The variety of safe and commodious harbours, the goodness of the climate, and above all the central situation of the Cape of Good Hope, will probably hereafter render it the great emporium of the world. Whilst then the interior of the central part of this country, from physical causes, will ever continue an uninhabitable desert, the northern and southern extremities, and perhaps even the eastern and western coasts, may in the course of time give birth to nations equally rich and respectable.

Although these observations may appear at first sight in some measure foreign to the subject immediately under discussion, the traveller, who examines these scenes with the great book of nature and the page of history open before him, will probably be induced to pardon a digression, which may for a moment divert his attention to the connection between the physical, the moral, and the political history of the world. But let us neither soar too high into the regions of fancy, nor wander too far into the doubtful paths of futurity, from the principal object of the work, which for the present, there-

fore, I will conclude with a brief recapitulation of the meteorological observations, as applicable to private and domestic purposes in Great Britain, and at the same time will attempt to show in what manner, being entirely stript of all technical ornament, they may be rendered intelligible, and, I trust, useful to different classes of people in this country.

The tables *(See Note 24.)* in the Philosophical Transactions, those of Bishop Watson, Dr. Robertson, and Major Hayman Rooke, all tend to prove, that the rainy season of these islands commences in June, and continues for the two or three subsequent months; and that the greatest quantity of rain falls almost invariably in the month of July. This is the fact: let us consider what use may be derived from it by the farmer.

In the neighbourhood of London, from the great command of manure and the goodness of the roads, the farmer is able to bring forward his grass, and to mow it sometimes at the beginning of June, and always by the end of the month: thus he completely finishes his hay harvest before the summer solstice; the solsticial rains therefore which follow, but seldom commence before this time, are extremely beneficial to him: they bring forward the aftermath, they swell the corn and increase the length of the straw; and having finished one harvest the farmer is completely prepared for the other. But it is only within a very few years, that agriculture was in such an improved state, even near the capital, as to admit of an early hay harvest; and I am sorry to say, that nine years in ten at least, in the highly gifted county of Glamorgan, even at the present day, the hay is regularly spoiled in making. But let not this circumstance be considered

as reflecting upon the farmers of that country, who are far from deficient either in industry or a competent knowledge of their business. Their country, possessing every possible natural advantage, has not, until lately, had any good turnpike roads; manure was to be had only in small quantities; the little there was it became difficult and expensive to put on the land, and consequently they could not bring forward their grass to be cut before the middle of July. The rains therefore, so beneficial to the London farmer were hurtful to them; but as it happened almost every year, they patiently submitted to what they considered irremediable, for being situated near the sea, they supposed it the natural consequence of their climate and soil.

But turnpike roads being now made throughout the country, and safe, expeditious, and cheap conveyances being opened, by means of the canals, from the interior of the country to the sea, and labourers of every description resorting in great numbers to the hills, where they are employed to work the mines of iron, lime, and coal, the produce of the country will in future be consumed on the spot, and necessarily increase the quantity of manure. In the course of a few years then, the vallies at least will come into a high state of cultivation, and both the hay and corn harvests in Glamorganshire will be as early and productive as those of any other county of Great Britain. The experienced farmer would not thank me for any remarks on the great advantages to be derived from having fodder of a superior quality for his horses, cattle, and sheep.

As the solsticial rains are always accompanied with westerly and south westerly winds, the mariner will readily comprehend, that this

season is unfavourable for ships outward bound to the West Indies and America, and consequently the reverse for those which are homeward bound from those countries.

It is usual for English travellers to fix the middle of July for their summer excursions, but they must constantly expect to be interrupted by heavy showers of rain. To one class of them however this circumstance may be considered as an advantage: It has lately been the fashion to visit Wales, and amidst its wild romantic scenery, the water falls are in the height of their beauty at this season.

The next meteorological general fact worthy of observation is, that frequent violent gales of wind happen soon after the autumnal equinox. Without dwelling much on the advantages of these high winds, which are known to strip the trees of their leaves, and are said to contribute greatly, by the agitation of them, to the fall of the sap, I shall beg leave to observe, that the little summer of St. Martin, which follows these gales, and is probably the effect of them, continues from the beginning to the 22d of November. This interval of clear weather is particularly useful to the farmer and the gardener; to the former in ploughing and sowing winter and summer fallows, to the latter in pruning and dressing his trees after the fall of the leaf, and when the return of the sap is completed.

As to the winter, it is well known that little is to be done in the country at this time, except the carrying of manure; but it is important both to the farmer and gardener to remember, that the hard weather seldom begins before Christmas, and in very severe winters a hard frost is generally preceded or accompanied, in the early part of

it, by a heavy fall of snow. Thus secured, the wheat and herbage of every kind is safe from external cold, for snow being a non-conductor of heat, the internal warmth of the earth, which at all seasons is equal at least to 48 degrees of Farenheit's thermometer, rises, and is retained near the surface, and when the thaw takes place, vegetation, having been preserved under this excellent covering of the sheet of snow, is found to be in a very advanced and improved state.

The mariner at this inclement season will seldom go to sea if he can avoid it, but voyages to the West Indies may be undertaken in the winter, provided there is a good outset from the Channel by the help of easterly or north easterly winds. As the spring approaches the easterly winds commence: the March winds and April ſhowers, says the honest countryman, bring forth May flowers; and it is supposed, that the motion of the trees at the vernal equinox contributes to raise the sap and develope nature, which seems to have been in a state of torpor or necessary repose during the winter. The prudent farmer avails himself of these winds also to sow his oats, barley, peas, beans, potatoes, &c. The drying quality of these winds, on which I have already pretty fully expatiated, takes from the earth what would otherwise be a superabundant degree of moisture on the surface of it.

At this season, likewise, the British mariner becomes particularly active. He may undertake his voyages to all countries situated to the southward of these islands; and if bound to the East Indies in particular, he may perform the voyage almost to a certainty in less than four months. The N. E. winds being favourable for ships outward bound, they are of course adverse to those that are

homeward bound; therefore it would be prudent to postpone, if possible, entrance into the Channel to the end of May, or the beginning of June.

In short, the spring is the most favourable season for outward bound ships, and the summer for those returning home. In the autumn the winds generally incline to the W. but rather towards the N. than the S.; and in winter they are often from the N. E. but the heavier gales of wind almost always come from the N. W. *(See Note 25.)*

After having pointed out to the farmer and gardener, the mariner and the traveller, the winds which prevail at different seasons of the year, and which, in examining several meteorological registers kept in Great Britain for upwards of fifty years, I have found to be almost as periodical as those in the tropics, I shall proceed to a further application of this hypothesis to domestic purposes.

It appears that in these islands the W. and S. W. winds prevail three-fourths of the year, and the E. and N. E. only one-fourth. In all parts of Great Britain the S. W. is esteemed the most rainy point of the compass.

In building houses, granaries, or storehouses of any kind, therefore, in all parts of Great Britain and Ireland, great care should be taken not to place buildings to the E. or N. E. of any lake or standing pool of water, but particularly of marshes or fens; and where a choice is permitted, it would perhaps be prudent to erect our habitations to the W. and S. W. of every river and canal, for if situated to the east-

ward of them, according to this hypothesis, the wind will blow upon the buildings three-fourths of the year, bringing with it the additional moisture of the river or canal, and consequently will render it damp and unwholesome; whereas if placed westward of these sources of moisture, the air from the eastward, which is rather too dry, in passing over large bodies of water, will absorb a certain quantity of the moisture in solution in the atmosphere, and the dampness of it of course will be by these means in some degree diminished: but at all events as the wind blows from the eastward three months of the year only, a house thus situated will be less damp than one placed to the westward, exactly in proportion to the difference of time each different wind blows, that is, as three to nine, and for this reason every person should recollect that the W. and S. W. sides of a house are always the most damp.

It seems needless to expatiate on the necessity of applying these observations in particular to situations near marshes or fens. The fatal consequences of the exhalations from these places are very well known, and therefore I shall content myself with having pointed out to those, who are unavoidably obliged to live near them, the most effectual means of partly avoiding their effects. If any persons can for a moment entertain a doubt of their baneful influence, I must beg leave to refer them to the first book of the classical and elegant poem on Health by the learned and ingenious Dr. Armstrong, whose salutary advice I shall not attempt to disguise in the tame language of prose; nor would I wish, by a partial quotation, to deprive the reader of the pleasure of gratifying himself by a general reference to the original.

Although our atmosphere in particular places is impregnated with noxious vapours, fortunately for the inhabitants of these islands they are not subject to the baneful influence of poisonous winds; nor can they scarcely consider themselves exposed to the ravages of hurricanes. The tempests, which sometimes are known in our temperate climate, can scarcely be deemed more than storms, especially when compared with those in the tropic. But a brief recapitulation of the fundamental principles of our theory will best distinguish the names and characters of every kind of wind.

All winds are supposed to be produced by the joint effects of rarefaction and condensation. These two principles acting near the middle of the South Atlantic, the Pacific, or any other wide expanse of ocean unbroken by land, will produce two currents of air, one from the E. following the course of the sun, and another nearly N. or S. from the frozen regions near the pole. These two currents of air moving through nearly an equal space, and nearly with equal velocity, over a surface of equal temperature, at length unite and form a N. E. and S. E. perennial, commonly called a trade wind.

Where a considerable body of land intervenes, particularly in the tropics, new points of rarefaction and condensation take place, sufficiently powerful to counteract the former more remote, and therefore more feeble causes, and thus the monsoon, or any other periodical wind will be formed.

But in high latitudes, near extensive tracts of both sea and land, where the points of rarefaction and condensation are more irregular

but moderate, and the changes of temperature much more frequent, the winds in those parts of the globe will necessarily become more variable, and also less violent.

But perhaps it will be asked, by what means opposite currents of air are observed in the same place; or, in common language, while the wind blows one way, why the clouds apparently move another. The term wind, mentioned as something distinct from the current of air in this question, is, I believe, the cause of all the doubts and perplexities, and very often in this inquiry misleads even experienced philosophers themselves. For my own part, I feel little doubt that these opposite currents of air are imputable to electrical agency, as they almost always precede thunder storms; for when a considerable portion of the atmosphere in the upper regions is rarefied by means either of electrical or common fire, the surrounding bodies of air will suddenly rush towards the point of rarefaction to fill up the vacuum. But when all the phenomena of electricity, and the various causes of heat, are perfectly known, it will, I doubt not, be as easy to calculate and predict the course and strength of winds, as it now is to foretel the flux and reflux of the tides, and the regular return of eclipses.

NOTES AND ILLUSTRATIONS.

(NOTE 1. *See page* 29.*)*

ILLUSTRATION OF LORD BACON'S HYPOTHESIS.

THAT heat and cold are the hands with which nature performs her principal works, seems confirmed by the construction of the globe, for not only in the northern and southern hemispheres, there are regular gradations of heat from the equator to the poles, but a similar difference of temperature is likewise found from the surface of the earth to a certain height in the atmosphere itself.

From the equator to the bounds of the tropic, is commonly called the torrid zone; from thence to the arctic and antarctic circles, the temperate zone; and from thence to the pole, the frigid zone. So likewise in the body of the earth there is a constant heat, which varies like the climates at different seasons, but is always hottest near the earth, and decreases gradually from thence to the lowest term of congelation in the atmosphere. The body of the earth, therefore, may be considered as the perpendicular torrid zone; the lower term of congelation in the atmosphere, the frigid zone; and the space between, the temperate zone; but this hypothesis is best elucidated by lofty mountains, the bottom of which is comparatively warm, the middle temperate, and the summit cold.

To those who are not conversant with these subjects, it might at first appear unaccountable, that on the summits of lofty mountains the air should be colder than in vallies, for as heat and light are considered as coming from the sun, mankind in general suppose, that the nearer we approach it the more sensibly we must feel its effects: but when we are removed from the direct influence of the solar rays, the natural warmth, which we feel near the earth, is derived from its constant mean heat, increased or

diminished by the addition or diminution of the rays of the sun; for in their passage through the air they do not communicate heat to the surrounding atmosphere. Near the focus of a burning glass, which fuses metals, the circumambient air is not in the smallest degree affected by it, which clearly proves that air is a non-conductor of heat. For this reason also, when the surface of the earth is heated by the rays of the sun, and covered by a sheet of air, it is a long time retained there, and but slowly returned into the atmosphere. This seems to be one of the principal causes of the warmth of vallies, and of the great degree of cold on the summits of mountains, where, according to some philosophers also, the rarity of the air being greater than below, it becomes a better conductor both of heat and electricity, so that the tops of hills must always be colder than vallies. But if for the reasons above mentioned, the principal body of heat is found near the surface of the earth, the further we are removed from it, the greater degree of cold we must necessarily feel, and consequently the summit of the highest mountains must always be the most cold.

Thus in all parts of the globe the hands of nature seem extended both horizontally and perpendicularly; with one she rarefies and with the other condenses the air, and by these means, as Lord Bacon observes, regularly performeth all her works.

(NOTE 2. See page 34.)

ABSTRACT OF THE JOURNALS OF TWO SHIPS OUTWARD BOUND TO THE COAST OF COROMANDEL, WITH COMPARATIVE REMARKS.

The Harcourt English East Indiaman, which sailed from Spithead, April the 21st, 1773; and the Notre Dame du Monte Carmel, from L'Orient, on the 16th April, 1785.

THE Harcourt weighed anchor with a fresh breeze at N. E. which continued between the E. and N. until we arrived at St. Jago, on the 14th of May, from the Land's End. Until our arrival at this island the thermometer, suspended in the captain's apartment, was between 56 and 72 degrees. We stopped there but forty-

eight hours, and crossed the Line on the 3d of June, in the longitude of 20 degrees W. The thermometer on that day was 79½ degrees. In the latitude of 7 degrees N. the perennial died away, and the wind became variable from the S. E. and S. W. and was sometimes at N. W. and the weather cloudy. In the latitude of 2° 33′ N. we got the S. E. trade, which continued to blow a fresh breeze at S. E. by S. until we reached the latitude of 22° 55′ S. and longitude 30 degrees W. which was on the 17th of June: at this time the thermometer was 77½ degrees. When we lost the perennial, the wind came from the N. E. then from N. N. W. for three days, and afterwards came round to S. W. by S. and S. W. On the 25th it settled in the N. W. Our latitude 30° 55′ S. longitude 14° 40′ W. This wind continued until we approached the Cape of Good Hope, when it blew two days from the N. E. and N. N. E.

On the 9th of July, in the latitude of 34° 50′ S. and longitude 18° 34′ E. being off the Cape, the wind was variable, W. by N.; S. W.; S. E.; N. E.; E. by S. The thermometer from 60 to 71 degrees.

On the 26th of July, in latitude 20° 30′ S. and longitude 40 degrees E. we got the S. W. monsoon; thermometer 73½ degrees; and on the 31st July we came to an anchor at the Island of Johanna, latitude 12° 10′ S. and longitude 44° 12′ E. thermometer 77 degrees.

On the 4th of August we sailed from thence. On the 8th the wind blew a few hours from the S. S. E. and S. E. in the latitude of 7° 57′ S. and 47 degrees E.; but from that time to the arrival at Madras, on the 4th of September, we had a constant fresh S. W. monsoon, even in crossing the Line on the 15th of August; and the thermometer was from 75½ to 81 degrees.

THE Notre Dame du Monte Carmel sailed from port L'Orient for Pondicherry on the 6th of April, the wind at E.; latitude 47° 44′ 34″ N. longitude 3° 22′ 35″ W. of Greenwich.

On the 10th of May we crossed the Line in the longitude of 18° 28′ W. thermometer 81 degrees. From the latitude of 33 to 28 degrees N. and longitude between 17° 48′

and 18° 49′ W. we had three days of N. W. and W. N. W. winds, but afterwards the regular N. E. perennial as far as the latitude of 7° 45′ N. and longitude 18° 28′ W. The winds then became light and variable, blowing all round the compass. On the 9th of May the S. E. trade commenced in latitude of 2° 31′ N. longitude 17° 28′ W. From the Latitude of 43 degrees N. to the line, the thermometer was from 59 to 81½ degrees. The perennial wind continued to the 29th of May, in latitude 26° 8′ S. longitude 26° 32′ W. thermometer 73 degrees. The wind variable all round the compass to the 8th of June, principally from S. E. to S. W. On the 9th, the N. W. wind began to blow, and continued to the 19th. When in the latitude of 35 degrees S. and longitude 17° 4′ W. the thermometer at 60½ degrees, we had light winds and variable, principally from the S. E. but sometimes E. N. E. and N. E. which continued to the 3d of July, when it came round to the westward, sometimes to the N. and sometimes to the S. W. On the 10th of July, we got the S. W. monsoon in the latitude of 21° 38′ S. longitude 42½ degrees E. thermometer 73½ degrees. On the 19th, we anchored at Johanna, latitude 12° 10′ S. longitude 44° 12′ E. On the 23d of July we sailed with a S. E. wind, which soon turned to the S. W. and carried us to the Line in seven days, and to Pondicherry on the 17th of August. The thermometer from Johanna from 77 to 86 degrees.

The General Coote Indiaman, outward bound from England towards Madras, 1791.

THIS ship left the Downs, January the 28th, but the wind shifting to the westward she was obliged to anchor again in Torbay: she sailed again the 3d of February with a strong wind at N. N. E. which continued with little variation to the 11th. When in latitude 28° 3′ N. they saw the Grand Canary Islands. The wind still continuing from the eastward, and in general with fresh breezes, carried them into the N. E. perennial on the 15th of February, in latitude 19° 29′ N. longitude 21° 29′ W. thermometer 65 degrees. This wind continued to the 22d of February, in latitude 4° 16′ N. longitude 18 degrees W. thermometer 82 degrees; from thence light breezes with squalls and calms, accompanied with frequent thunder, lightning, and hard rain. Crossed the Line on the 1st of March, longitude 15° 37′ W. thermometer 81 degrees; still light airs and calms from S. to S. W. On the 6th the S. E. perennial commenced from the southward with light airs, and sometimes squalls and calms, in the latitude of 3° 53′ S. longitude 17 degrees W. thermometer 81½ degrees. It was not till the 9th of March that the perennial wind

became steady, and blew with strength; thermometer in that time from 82 to 85 degrees. On the 13th, the thermometer at 85 degrees, the perennial died away in latitude 16° 30′ S. longitude 18° 30′ W. succeeded by calms and light baffling airs, variable; those light airs continued to the 24th, when the winds became stronger, but variable from N. to E. and N. W. latitude 25° 11′ S. longitude 13° 30′ W. thermometer from 85 to 80½ degrees, with frequent squalls and rain. From that time to the 2d of April light breezes variable as before, with squalls, calms, and rains at different times; latitude 32° 30′ S. longitude 1° 9′ E. and thence to the Cape hard gales of wind with smart squalls from the S. W. and W. and very heavy sea. From the 9th of April, latitude 34° 46′ S. longitude 16° 50′ E. about 2 degrees W. of the Cape of Good Hope, they had for some time in general very bad weather, variable winds and squalls, chiefly from S. E. to E. S. E. continuing very unsettled weather, and strong gales attended by very hard squalls from N. E. to E. latitude 38 degrees S. longitude 39 degrees E. then variable two days from S. to E. after which it blew from the north eastward again in very hard gales and squalls until the 2d of May, in latitude 36 degrees S. longitude 65° 47′ E. when it moderated with fair weather and some calms. On the 11th of May, in the latitude 27 degrees S. and longitude 75 degrees E. the wind came round from the westward to the S. E. when the S. E. perennial commenced with squalls and heavy rain, and began to blow a very hard gale, which on the 13th carried away the fore-top-mast, two top-gallant-masts, steering sail-booms, and jib-boom, &c. The gale continued blowing nearly in the same manner till the 19th, in latitude 7 degrees S. longitude 80 degrees E. when it became moderate, inclining to the southward.

The 21st of May commenced the S. W monsoon, in latitude 1° 40′ S. longitude 82 degrees E. which increased to a very hard gale, accompanied by squalls and heavy rain, but it became more moderate from the 26th, in latitude 7° 50′ N. longitude 81 degrees E. and on the 29th of May we anchored in Madras Roads.

July the 10th, sailed for China, with the wind at S. S. E. but on leaving the land got the S. W. monsoon, which for the most part blew strong, with some hard squalls and rain. Afterwards, inclining to the westward, had strong gales, hard squalls, and heavy rain, on the 18th and 19th, about the latitude 6 and 7 degrees N. longitude 95½ degrees E. The 19th, saw the coast of Sumatra, from thence very variable winds and weather, frequent calms and very hot, with lightning in general in the night, between eight o'clock in the evenings and three in the mornings. July the 27th, anchored off Quedo Pulo Pinang, in the Streights of Malacca. Watering, &c. detained the ship five

days. Whilst here much lightning, some rain and squalls. August the 2d, sailed hence; along the coast of Pinang, frequent lightning and very hot weather; thermometer one day at 90 degrees. The 25th, got clear of the streights, and entered the regular S. W. monsoon; very hot and sultry; still lightning as before; sometimes very hard squalls and heavy rain. September 1st, latitude 14 degrees N. longitude 113 degrees E. the wind became variable from the W. N. W. with very unsettled weather; squalls and rain, accompanied with lightning as before, and in general with much thunder. The 10th, anchored in Macoa Roads.

Comparative Abstract of the different outward bound Voyages.

HARCOURT.	Days	NOTRE DAME, &c.	Days	GENERAL COOTE.	Days
From Spithead to the Line....	41	From L'Orient to the Line.....	35	From Torbay to Line.....	26
—— thence to Cape of Good Hope.....	37	—— thence to Cape of Good Hope.....	42	—— thence to Cape of Good Hope..... ..	40
—— thence to the Line E. of Cape.....	34	—— thence to the Line, E. of Cape.....	39	—— thence to the Line, E. of Cape.....	42
—— thence to Madras.....	20	—— thence to Pondicherry	18	—— thence to Madras.....	8
	132		134		116

The Harcourt and Notre Dame du Monte Carmel sailed nearly at the same season, but the former stopped at St. Jago, which caused a delay of four or five days, and this being admitted, the voyages to the Line were nearly of the same length. The winds were found variable in the same place, about the latitude of 7 degrees N. and the thermometers of each were nearly the same. The former got the S. E. perennial in the latitude 2° 33′ N. and the latter in 2° 31′ N. This wind continued with the Harcourt to the latitude 22° 55′ S. but with the French ship to 26° 30′ S. It is particularly worthy of remark, that the French ship crossed the Line in 18° 23′ W. longitude, and had therefore three days westerly winds, which the Harcourt avoided by being in 20 degrees W. longitude further from the coast of Africa; and also that the Harcourt lost the S. E. perennial four or five days sooner than the French ship, by being further to the westward, and of course too near the coast of America.

Hence also it appears, that both the N. E. and S. E. perennials blow most regularly exactly in mid channel, equally distant from both coasts of Africa and America.

The General Coote had a much quicker passage from Torbay to the Line than either of the other two ships; but from thence to the Cape of Good Hope, and from the Cape to the Line they were nearly the same number of days. From the Line to Madras the General Coote was only eight days; but if due allowance be made for the Harcourt and French ship stopping four or five days at the Island of Johanna, and for the course pursued by the General Coote from the Cape to the Line, it does not appear there is much difference in the length of the voyage from the Cape to the Coromandel Coast, whether ships go the Outward Passage or through the Mosambique Channel. It is, however, very evident, that assisted by the S. E. perennial in mid channel, between Madagascar and New Holland, and afterwards by the S. W. monsoon, the General Coote seldom went less than seven knots per hour from the Line to the Coast of Coromandel.

The General Coote Indiaman, homeward bound from China towards England, 1791-2.

SAILED from Macoa on the 9th of December, the wind at N. E. fresh gales and squalls at various times, which continued between the N. and E. generally blowing hard till the 18th of December, when they entered the Streights of Banca, after which it came from N. by W. to W. by S. with frequent squalls, rain, thunder, and lightning. Throughout the Streights of Sunda, the winds and weather much the same as in the Streights of Banca. December 29th, got clear of the Streights, the winds light and variable from the westward and southward, weather variable with some rain.

1792. On the 4th of January, latitude 8° 30′ S. longitude 100° 55′ E. they got the S. E. perennial, which commenced in a light breeze and strong swell from S. and S. by E. It continued to the latitude 21° 40′ S. longitude 67° 28′ E. The wind then, the 19th of January, came round to the northward, and was afterwards westerly, with frequent squalls and calms, accompanied with rain and variable weather for five days, to the latitude 25° 36′ S. longitude 60 degrees E. From this time the wind came to the S. E.

and eastward, with fresh gales, which carried them, on the 1st of February, into latitude 31° 34′ S. longitude 43° 20′ E. when they experienced a very heavy squall from the S. W. the wind then went back to the southward and eastward, blowing fresh gales, and afterwards variable winds and weather.

On approaching and rounding the Cape of Good Hope had very strong gales from E. to S. E. latitude 35° 39′ S. after which moderate breezes westerly and variable from N. W. to S. till on the 17th of February, latitude 29° 30′ S. longitude 10° 30′ E. they got the S. E. perennial again, which came round from the S. and S. S. E. in a fresh gale. Arrived at St. Helena February 23d; sailed again March the 1st, with a fresh trade.

On the 5th, passed the Island of Ascension, distant three leagues.

The 8th, crossed the Line, longitude 18° 50′ W. On the 11th, the perennial died away, and was succeeded by a very heavy squall from the N. E. in latitude 4° 33′ N. longitude 21° 30′ W. The first and middle parts of the next twenty-four hours the wind was variable from the northward, and in the latter part commenced the N. E. trade, with moderate breezes. On the 23d, observed an eclipse of the sun, in latitude 24 degrees N. longitude 42 degrees W. The whole of the twenty-four hours was attended with hard squalls and rain at times, as was also the preceding and two following days. On the 26th, the trade declined into calms and variable light winds; latitude 30° 32′ N. longitude 45° 30′ W. After two days and a half variable winds, in latitude 32° 12′ N. longitude 43° 30′ W. the wind came from the W. S. W. and continued in strong gales from W. to S. until the 4th of April; it was then variable from N. W. to S. and S. E. but on the 6th it came again from S. by W. in hard gales and squalls, latitude 44 degrees N. longitude 18 degrees W. The wind continued between the S. and W. points until they reached the latitude 49 degrees, longitude 2° 40′ W. being the 10th of April, and on the 12th saw the Lizard, the wind still from S. W. to S. S. E.

The Phœnix Indiaman, homeward bound, from Madras towards England, 1792.

SAILED January 19th from Madras, in latitude 13° 4′ 54″ N. longitude 80° 28′ 45″ E. with the N. E. monsoon and fine weather to the 24th, in latitude 6° 39′ N. longitude 86° 17′ E. when the wind became variable from N. W. to S. and S. E. On the 30th crossed the Line in longitude 86° 37′ E. with fine winds from S. E. to S. S. E. and hot sultry weather till the 2d of February, latitude 2° 27′ S. longitude 86 degrees E. thermometer from 84 to 82 degrees. From that time the winds were variable, with fine weather till the 9th, in latitude 8° 36′ S. longitude 87° 44′ E. when it became squally and unsettled; thermometer from 85 to 82 degrees.

On the 18th of February, in latitude 12° 35′ S. longitude 79° 7′ E. got the S. E. perennial, which continued to the 2d of March, latitude 28° 20′ S. longitude 45 degrees E. with pleasant weather in general; thermometer from 84 to 77 degrees; afterwards variable winds from S. to E. and W. to the 9th, in latitude 33° 38′ S. longitude 33° 52′ E. From the 18th, latitude 35¾ degrees, S. longitude 19½ degrees E. to the 23d of March, the winds were variable, chiefly from N. E. to N. by W. Saw the Table Land on the Cape of Good Hope, and on the 24th the S. E. perennial commenced again, in latitude 32° 34′ S. longitude 15° 35′ E. the thermometer from March 2d to this time being between 80 and 67 degrees.

Arrived at St. Helena April 5th; sailed again the 17th, crossed the Line on the 25th, longitude 21° 15′ W. thermometer 82 degrees. The perennial wind continued to the 27th April, latitude 3 degrees N. longitude 21° 40′ W. when it became variable till the 2d of May, in latitude 9° 5′ N. longitude 25 degrees W. The N. E. perennial then commenced, and continued to the latitude 30° 17′ N. longitude 39 degrees W. May 16th. Then calms and light airs for three days, and afterwards the wind came from the W. and N. W. in fresh breezes, and sometimes hard gales, which continued, and carried her, on the 30th of May, in sight of the Lizard.

The Bona Ventura, homeward bound, from China to Ostend, 1792-3.

SAILED December 21st, during the N. E. monsoon, wind E. N. E. fresh breeze, some squalls of thunder, lightning, and rain, on approaching the Streights of Banca,

which we entered January 1st, and the wind came round immediately from E. N. E. to W. In the streights the wind was westerly from N. W. to W. sometimes little wind, at other times fresh gales and squalls; and on leaving the Streights of Sunda, January 9th, the wind was still variable to the westward and southward, had much rain, squalls, and calms; but afterwards it drew round to the southward and S. E. in latitude 10° 15′ S. longitude 101° 37′ E. January 14th, with light breezes and fine weather, increasing to a fine S. E. perennial, which carried us into latitude 19° 53′ S. longitude 75° 45′ E. the 27th, blowing strong the three last days at E. and E.•by N.; afterwards fresh gales continuing, it inclined to the northward, latitude 22° 57′ S. longitude 72° 12′ E.: then moderate breezes, variable from N. W. to W. S. W.

February the 1st and 2d, light airs, variable, but mostly calm, with almost incessant heavy rain nearly all the forty-eight hours, latitude 23° 16′ S. longitude 70¼ degrees E. and then moderate breezes from the north eastward, but frequently interrupted by sudden squalls, and sometimes great falls of rain of ten and twelve hours duration. February 8th, in latitude 25° 42′ S. and longitude 60 degrees E. got the S. E. perennial again, blowing strong with a continuance of hazy weather, which terminated in heavy constant rain for seventeen hours, and little wind south westerly on the 13th, in latitude 28° 40′ S. longitude 45 degrees E. The next day very bad weather, heavy rain and hard squalls, the wind blowing a very hard gale at W. S. W. and S. W. with a large sea, which lasted three days, and then came round to the eastward in latitude 28° 47′ S. longitude 40° 22′ E. February 16th. Afterwards variable winds from E. to S. and N. On the 25th of February, latitude 34° 31′ S. longitude 23 degrees E. saw the land to the eastward of the Cape, wind from N. N. W. to W. which blew a heavy gale the 27th, in latitude 35° 18′, longitude 22¼ degrees E. and carried away the main-tack and sheet, and split some of the sails; were obliged to lay-to under close-reefed main-top-sail several hours, the sea running very heavy. In beating to windward had many violent squalls, the wind continuing in the same quarter with frequent hard rain. March 6th, made Cape False, distant six leagues, wind shifting that day from N. W. to S. E. moderate breezes, arrived at Table Bay the 7th. Sailed hence March the 10th, wind southerly, fresh breeze and clear weather. The S. E. perennial commenced the 12th, in latitude 30¼ degrees S. longitude 13 degrees E. Arrived at St. Helena March 23d, where we stayed fourteen days, and sailed April 6th. A moderate perennial for the most part and good weather,

which continued to the latitude of 2½ degrees S. longitude 14½ degrees W. April 13th, when the weather became variable with light winds.

Crossed the Line the 16th, in longitude 16 degrees W. Met the N. E. perennial May 2d, latitude 7° 57′ N. longitude 21½ degrees W. which at the commencement inclined much to the northward for three or four days; but from the longitude of 30 degrees W. latitude 13 degrees N. it became more easterly, so as to be frequently for some time at E. the last two or three days. May 20th, in latitude 29° 23′ N. longitude 40 degrees W. the perennial died away with some light squalls and rain, succeeded by increasing breezes from S. to S. W. and afterwards westerly. In latitude 35 degrees N. longitude 37 degrees W. the wind, after a calm of ten hours, shifted round the compass from N. by E. to S. and S. E. and back to S. again, which increased on the 27th to a very heavy gale, the air thick, foggy, and sometimes rain, which continued five days, the wind blowing from S. S. E. to S. S. W. with a very large sea. More moderate on the 3d of June, latitude 48° 50′ N. longitude 13 degrees W.; it then came from the N. W. to N. E. and June the 6th from S. to S. W. The next day made the Scilly Islands; the 8th arrived at Spithead.

Comparative Abstract of the different homeward bound Voyages.

GENERAL COOTE, FROM CHINA.	Days	PHŒNIX, FROM MADRAS.	Days	BONA VENTURA, FROM CHINA.	Days
From Macoa to the Line	11	To the Line	11	From Macoa to the Line	12
—— thence to the Cape of Good Hope	55	From thence to the Cape of Good Hope	53	—— thence to the Cape of Good Hope	56
—— thence to St. Helena	14	—— thence to St. Helena	13	—— thence to St. Helena	13
—— thence to the Line	9	—— thence to the Line	9	—— thence to the Line	11
—— thence to the Lizard	34	—— thence to the Lizard	35	—— thence to the Land's End	50
	123		121		142

From these three journals the time each ship stopped at any port in the way has been deducted, the remainder therefore may be considered as the regular course of

the voyage, excepting five or six days lost by the Bona Ventura in beating off the Cape to get into that port

It will be thought rather extraordinary that the voyages of the General Coote and Phœnix should be so nearly of equal length to the Cape, considering that the former came from China and the latter from Madras, in which there is a difference of near 10 degrees of latitude, and 33 degrees of longitude. But this must be ascribed to the General Coote having sailed sooner than the Phœnix, so as to have a stronger monsoon.

There does not appear to have been much difference in the rate of sailing of these ships, for from the Cape home they went each stage, if we may be allowed to use that expression, within a day of the same time. As to the Bona Ventura, they lengthened their run from the Cape to the Channel, by keeping too near the coast of Africa and crossing the Line westward of the Cape, in the longitude of 16 degrees, instead of 20 degrees W. which carried her within the reach of the light baffling winds off the coast of Africa. Some allowances also may be made for this ship not being in such good condition as the regular Indiamen, which are unquestionably as fine ships, as well founded, and as skilfully navigated as any ships in the world.

(NOTE 3. See page 38.)

METEOROLOGICAL OBSERVATIONS MADE AT THE CAPE OF GOOD HOPE, AND THE EASTWARD COAST, DURING A MILD WINTER, AND WITH FARENHEIT'S THERMOMETER. BY ANDREW SPARRMAN, M. D. &c. &c.

1775. May—During the first half of this month the thermometer kept fluctuating between 53 and 63 degrees, and during the latter half between 50 and 58 degrees, excepting on the 27th, when it was at the lowest, or 49½ degrees, although the day was clear with sunshine. The rainy days in this month were the 11th, 12th, 15th, 16th, and 30th. Amongst these the three first were the worst, and accompanied with tempestuous N. W. winds; so that when he passed Zout River on the 11th, the water was no higher than the horse's knees, but when he re-passed it on the 15th, the water had risen so high, in consequence of the rain, as to reach the saddle.

June—The thermometer was between 54 and 60 degrees. There was a fall of either snow or rain on the 1st, 2d, 3d, 4th, 14th, 27th, until the 31st inclusive; besides these there were a few other cloudy days, attended with a high wind, but the remainder resembled the fine summer days in Sweden. On the 3d it rained violently, when it happened that a quantity of water which in the preceding days had been collected on the mountain, burst its way down to the town and filled the canals there, at the same time overflowing some of the streets; so that for several minutes it rose to the height of two or three feet against the houses. It likewise washed away a small wall belonging to a stone house, and carried it under the building, at the same time rushing into divers cellars.

July—The thermometer kept between 54 and 59 degrees. The rainy days were the 6th, 7th, 8th, 11th, and 12th. Clouds without rain the 3d, 9th, 10th, 13th, and 14th.

From the Bath to Zwellendam.

August—The 1st and 2d days cloudy. On the 7th and 8th violent rains and north easterly winds. On the 9th mizzling rain. On the 21st, 23d, and 29th, it rained, with the wind at S. E. All the rest were fine days.

As I mentioned before, I had lost in my way to the Bath the small thermometer, according to the scale of which the degrees have been given, so that subsequent to this period it was from another thermometer of Farenheit's, procured for me by Mr. Immelman from the Cape, that my observations were made, which I shall continue to give in the same manner as I began. The 22d and 23d, thermometer 56 degrees; 24th, 53 degrees; 29th, 56 degrees; 30th, 52 degrees; 31st, 48 degrees. This month seemed to correspond nearest with the month of May in our northern climates.

Amongst the Houtniquas, E. of the Cape, about two or three hundred miles, in March and April it rains most; and on the contrary, during the months of May, June, and July, the depth of winter at the Cape, it is here quite dry, though frequently cool and bleak; the N. W. wind prevails; when it comes to the N. it brings with it the warmth of summer, but it is thought to occasion stiffness in the joints of milch cows. I was assured it never rained during the north wind, probably on account of the chain

of mountains which extend from E. to W. proving a barrier to keep the clouds on the other side, or else by virtue of their attraction, detaining these condensed vapours on their summits.

September—The rainy days were the 8th, 9th, 16th, 20th, 21st, 24th, 25th, and 29th; and the last of these days was remarkable for S. E. winds and rain; thermometer, for the most part, early in the morning between 49 and 50 degrees; in the middle of the day between 76 and 80 degrees; and in the evening, at sun set, between 50 and 60 degrees.

In going through Lange Dal.

October.—The temperature nearly the same as that of the preceding month, the rainy days were 9th, 10th, 19th, 20th, 22d, 23d, 26th, 27th, and 28th.

From Lange Dal to Sea-Cow River.

November—The weather in this month was warmer than in any of the preceding, especially towards the conclusion of it, when we quitted Lange Kloof and Kromme River, and came to the plains by the sea side. The thermometer generally rose at about eight o'clock in the morning from 65 to 70 degrees in the shade. The rainy days were the 11th, 16th, 17th, 18th, 19th, and 26th; sometimes with a south-east and at other times a south-westerly wind. The other days being fine and fair, the N. W. and W. winds almost always prevailed.

Journey from Boshies'-Man's River to Quammedacka.

December—The 15th, thermometer at Niew Jaars-drift in the shade was 80 degrees. The 16th, at Bruntjes Hoogte, at noon, it was 84 degrees. The 17th, at Hevy, five o'clock in the morning, it was 60 degrees; and at two P. M. 80 degrees. The 18th, at Quammedacka, seven o'clock A. M. it was at 60 degrees; and at three P. M. 84 degrees. On the 19th, at the same place in the morning, it was sixty degrees; the same day, twelve o'clock, 84 degrees; and at three P. M. 95 degrees; thermometer hung under the tilt of the waggon. At the same place the 21st, at nine A. M. it was at 52 degrees; at twelve at noon 82 degrees; and at half past three P. M. 95 degrees.

On passing Visch River the 22d, the day was violently hot; we neglected the thermometer in the day, but it was observed at ten P. M. to be seventy-eight degrees. On the 23d, at five in the morning, it was seventy-four degrees; at noon, ninety-nine degrees; in the afternoon it rose to 100 degrees. 24th, at the same place, at noon, it was 84 degrees, towards the evening 76 degrees. The 25th it rose to 100 degrees. The 26th at noon, thermometer 79 degrees. 27th, at seven in the morning, it was at 60 degrees; at noon 95 degrees; and at five P. M. 83 degrees. At five a shower of rain with thunder and lightning, and at nine in the evening thermometer 79 degrees.

Proceeding towards Visch River, the 30th, at Agter Bruntjes Hoogte, the thermometer in the morning and evening was from 60 to 67 degrees. The 31st, or New Year's Eve, the winter months of July and August were always colder at that place than at the Cape, so that the snow lay upon the ground for a couple of days together about two inches deep.

1776. January—The weather in general dry, a little rain on the night of the 21st.

February—The 16th a violent storm from the N. W. towards night the wind came round to the S. E. less violent, accompanied with rain. The 17th small rain and little wind. On the 18th, in the morning, thermometer 67 degrees. The 28th and 29th, near Sea-Cow River, wind S. E. and rain all the 29th.

March—The 1st and 2d rainy, wind S. E. thermometer 72 degrees. The 15th rain throughout. The 23d, at Honingklip, very heavy rain; as also the 24th and 25th with less violence. The 28th, 29th, and 30th, rain more or less, the wind at the times always westerly.

At Krombeek River, a yeoman, who was a great observer of the weather, had remarked, that the most violent winds were the N. W. and S. E. that the former was generally most violent, that the west wind was the warmest, and what was very extraordinary, that the north wind was the coldest.

He informed me, likewise, that the S. E wind was not near so cold here as it was at the Cape, and that the west wind used to set in every evening. Foul weather mostly came into this country with an easterly or westerly wind.

Though violent rains fell at that time at the Cape, or on the other side of Hex River, they seldom extended as far as this place, the wind becoming only colder; likewise when it rains here it seldom extends to the other side of the last mentioned river.

April—The 10th left Hex River; and on the 15th got back again to the Cape.

(*NOTE* 4. *See page* 40.)

ORIGIN OF THE NAMES OF DIFFERENT COUNTRIES IN THE EAST INDIES.

THE early Persian navigators considered all the countries of Hind and Sind, taken together, as divided into three parts.

The first, Guzerat, bounded to the W. by Gazna, Multan, and Makhran. The second, that which we call Malabar, is situated to the E. or rather the southward of Guzerat, and is named by the Arabs Beled-ul-fulful, or the country of pepper. The third and most eastern is called Mabar, which in Arabic means the passage; by some persons it is supposed to mean the Gulf of Bengal, from Cape Comorin to Acheen Head, on the coast of Sumatra.

The first of these, Guzerat, is probably derived from the Persian or Arabic word Gezeret, an island, or rather a peninsula, being situated at the entrance of the Persian Gulf: the early Persian navigators were most likely to give it this name.

The word Malabar is not known but by adoption to the natives of the western peninsula of India. This however seems also to be derived from the same persons, who, after having made the Malabar Coast, proceeded further eastward, where they fell in with the Malays at Sumatra, on the eastern side of the Gulf of Bengal, and have therefore given one name to all those countries, denominating them Malia-bar, or the countries of the Malays. In the Persian language bar signifies country, as Zenge-bar the country of the Zenges; so Malia-bar is probably the country of the Malays.

Edrissi remarks that the inhabitants of Comr, by which perhaps is meant Cape Comorin, are Malays, and that they practise piracy in brigantines of sixty cubits

long, which carry one hundred and fifty men each. But this description of their habits of life bears a much stronger resemblance to the Malays, than to the natives either of the Malabar or the Coromandel Coast, or to those of the adjacent islands of Lacidivi, Maldivi, or Ceylon, or even of the Comoro Islands.

The Malays still continue to practise piracy in their well known prows, which the natives of the latter countries have never done: this is a strong presumptive proof, that the early Persian navigators confounded the natives of the eastern, and perhaps the western side of the peninsula of India, with the inhabitants of Malacca or Sumatra, and called them altogether Malai, with the adjunct of Bar, to describe all the countries from the present Malabar Coast to China.

It may perhaps be objected, that the distance of Sumatra from the peninsula of India is too great to admit of such a mistake. But the geography of these countries appears, from another very striking circumstance, to have been rather hastily settled by the Persians, whose information of the eastern seas must have been incorrect. They place a considerable island to the eastward of Cape Comorin, in the way to China, called Sila, to which must be added the Hindu word Dive, an island, which makes Siladive, or the Island of Sila. This, it will be allowed, might easily have been corrupted to Silandive, the true name of the island of Ceylon. Very little doubt, I think, can be entertained of the truth of this etymology.

But Abd-ul-Mowal, according to Herbelot, places Sila near China; fortunately, however, there is no island of a similar name in the China seas, and therefore, in this case, we will venture to suppose, that Abd-ul-Mowal, hearing that Sila or Silan (now Ceylon) was to the eastward of Cape Comorin, has on hearsay testimony only ventured to carry it still further east towards China; for cinnamon, which is the produce of this island only, and not cultivated in China or elsewhere, is called by the Persians, Dar Cheen, and by the Arabs, Dar Sena, China pepper, which is a strong proof that both these nations formerly considered Ceylon, where only it is produced, as situated in, or at least very near China; and if they could fall into such an egregious error in the one instance, it is almost certain they were equally mistaken in the other. The word Mabar, a passage, which describes the third Persian, or rather Arabian division of India, is probably still preserved in the word Manar: the letters B and N are easily mistaken in writing

either the Persian or Arabic languages, particularly if the diacritical mark be omitted. The Gulf or Bay of Manar is situated between the east side of the peninsula of India and Ceylon.

(NOTE 5. See page 42.)

OBSERVATIONS ON THE WEATHER AT MADRAS, 1776.

JANUARY.—In the beginning of this month the mornings and evenings sometimes cloudy *from seven in the morning to twelve at noon.* For two or three days the wind was along shore N. E. by N. but in general in the middle of the day it was easterly, the atmosphere clear, and the sun extremely hot. The thermometer never above 82 degrees, and generally from 80 to 81, in a room open to the N. E. At two o'clock in the morning of the 19th, a squall from the N. W. in which quarter it looked cloudy the evening before. It rained very hard the mornings of the 19th and 20th, cleared up in the evening of the 20th; heavy dew and cold at night; land and sea breezes; thermometer at 78 degrees in the mornings until the end of the month; weather fair; hot in the middle of the day.

February.—The beginning, thermometer at 81 to 82½ degrees. The 4th, an eclipse of the moon, beginning at six hours one minute on the S. side. In the evening the wind settled at N. by E. blew hard, extremely cold, raising great clouds of dust. The next day it blew from the E. and S. E. with no land wind. On the 6th, the wind settled at E. S. E.; the land wind prevailed at night until the 15th, then continual sea wind at E. by S. until the 20th; after that land and sea winds alternately; the sea winds blew from twelve at night to nine in the morning. Mean of thermometer 79 degrees in the morning, 83 and 84 degrees at noon.

March.—The beginning of this month the mornings and evenings cool; the 7th, in the morning, a long shore wind, very damp; many people had violent colds; the sun generally rose and set in a haze; this kind of weather continued to the end of the month; nights damp, the middle of the day excessively hot; thermometer from 84 to 88 degrees.

April.—Land winds at night; long shore winds from nine in the morning to noon; it then came round to the E. till the 3d, then regular land and sea breezes morning and evening, foggy and close, to the 14th; then to the 17th land and sea-breezes with hazy weather. The next eight days cloudy, with occasional hard showers of rain. The remainder of the month land and sea winds; the latter came on about noon and continued to sun set. The first part of this month the mean of the thermometer 82 degrees, the latter part 85½.

May.—The first part of the month, in the morning, calm, with sometimes light long-shore sea-breezes of short duration, and afterwards land wind. On the 13th, a violent long-shore wind, then the same as before, and the weather uncommonly close to the 24th, when the land wind commenced, raising great clouds of dust. On the 30th, in the morning, a small shower of rain fell, and the sea-wind blew from six to nine in the evening; the same on the following day. The mean of the thermometer for the first fifteen days from 85 to 87 degrees; and from that time to the end of the month from 87 to 91.

June.—On the 1st and 2d, regular land and sea-breezes; the 3d, violent long-shore wind. On the 4th, morning fair, noon cloudy, in the evening rain.—N. B. More than two hundred pieces of cannon fired in salutes; query whether it occasioned the rain? —On the 5th, land-wind all day, and likewise on the subsequent days to the 24th; on that day a sea-breeze at ten A. M. and in the evening cloudy and rain. On the 29th, the land and sea wind changed alternately four different times. On the 30th, it rained in the evening. To the 15th, the mean of the thermometer 86 degrees; to the latter end of the month 94.

July.—The first part of the month, land wind in the morning till one, two, or three P. M. then light sea breeze till evening. On the 2d, a heavy shower of rain from eleven A. M. to six P. M. The same kind of wind and weather continued, with occasional showers, to the end of the month. On the 31st, a visible eclipse of the moon, beginning on the N. side at two minutes morning, total at one hour fifty minutes, and ending at three hours forty-eight minutes. Mean of thermometer first part of the month 83 degrees, latter part 88.

August.—The first part of the month, land and sea breezes, both moderate, the former dry, but not hot. On the 15th, it rained hard during the night. The remainder

of the month fair, not hot, but dry. Mean of thermometer, the first part, 81 degrees, the latter, 86.

September.—The first part of this month, wind westerly. At night on the 2d and 3d, lightning. On the 5th and 6th, showers in the evening. On the 7th, wind N. W. hard rain at night. On the five subsequent days the same sort of weather. On the 15th, the Hilsborough, and on the 17th, the Godfrey Indiamen arrived from Bengal. On the remainder of the month the evenings very close and cloudy, sometimes rain in the night. Thermometer 81 to 84 degrees.

October.—The first part of the month winds light, inclining to the E. and sometimes southerly, to the end of the month, accompanied with occasional showers of rain towards the 26th, and continuing to the 31st. Thermometer from 85 to 83½ degrees.

November.—On the 1st, rain with land and sea breezes. The 2d, fair with variable wind easterly, sometimes strong, to the 18th. The rains then began, and continued incessantly to the end of the month, except the 26th, when it ceased for a few hours. Mean of thermometer 82 degrees.

December.—The first part in general fair, with strong N. E. winds. Rain the 5th and 6th and the 11th. The rest of the month a clear sky and fair weather, except the 21st, which was cloudy with rain. Mean of thermometer 78 to 76 degrees.

N. B.—In the months of April and May, forty or fifty miles inland, and even on the coast of Coromandel itself, almost every evening incessant flashes of lightning are perceived at a great distance westward, over the Balliagat Mountains: The rivers Cauvery and Pallaru, whose sources lie amongst them, discharge themselves to the eastward in the Gulf of Bengal, which, filling at the same time, is a strong presumptive proof at least of the truth of Dr. Franklin's system.

Table of Thermometer and Barometer, with the Mean of each Month, for Fourteen Months, kept at Madras.

MONTHS.	THERMOMETER.			BAROMETER.		
	Greatest.	Least.	Mean.	Greatest.	Least.	Mean.
1777.						
March	87	67	77	30. 3	29. 18	30. 0½
April	88	73	80½	30. 0	29. 17	29. 18½
May	102	76	88½	30. 0	29. 15	29. 17½
June	100	79	89½	29. 18	29. 14	29. 16
July	99	75	87½	29. 19	29. 15	29. 17
August	98	75	86½	30. 0	29. 17	29. 18½
September . . .	91	76	83½	29. 19	29. 16	29. 17½
October	88	76	82	30. 2	29. 16	29. 19
November . . .	85	65	75	30. 4	29. 17	30. 0½
December	87	66	76½	30. 4	29. 19	30. 1½
1778.						
January	82	64	73	30. 4	30. 0	30. 2
February	86	65	76½	30. 4	30. 0	30. 2
March	89	69	79	30. 2	29. 17	30. 0½
April	94	73	83½	30. 2	29. 16	29. 19
May	104	77	90½	29. 19	29. 15	29. 17

(NOTE 6. See page 55.)

MONSOON. COMMENCEMENT OF IT.

IT is generally supposed that the N. E. monsoon, in every part of India, commences near the hills; in all probability at least it is most violent near them, for mountains being colder than plains will of course attract a greater proportion of the common and electric fire from the clouds, and make them precipitate a greater quantity of rain, by which means it appears to me, that the purposes of nature are much better answered, than if the rain fell near the coast, for the hills, or mountains, being generally inland, a large portion of the country is benefited by the quantity of water in the rivers, and by the length of their course. But the fact respecting the time and place

where the monsoon commences, might be easily ascertained by a comparison of dates, when the monsoon actually commences, on either coast of the peninsula of India, and the Balliagat Mountains to the northward, in the provinces of Bengal and its dependencies.

(NOTE 7. *See page 65.*)

WHIRLWINDS.

THE ancients supposed, that there were great varieties of whirlwinds, of which Pliny and Seneca give different accounts.

The Typhon, τυφων, is defined by them, *vortex igne factus*, a vortex produced by fire, which causes dreadful hurricanes of wind, and destroys all things that come within its reach.

The Prester comes from πρηθω, *incendo, inflammo.* It was said to break forth with strong flashes of lightning, and to be generally accompanied with an Ecnephias.

The latter is from νεφος, *nubes*, and is described as a sudden and impetuous wind, bursting forth from a dark cloud with little rain.

The Exhydria was a violent whirlwind, attended with a great quantity of rain, and in fact the principal difference between an Exhydria and an Ecnephias was in the quantity of rain or water, which they were supposed to contain.

These whirlwinds are evidently of the same family, all the features of them being exactly similar, with some slight variations of character.

When a sudden and violent change is produced by fire, either common or electrical, in a considerable body of the atmosphere, the air from all sides suddenly rushes forward, and consequently concentring to a point, forms a vortex; and when the cohesion of the air is broken, it will also of course precipitate the water it contains, and produce an Ecnephias or Exhydria; or where there is but little moisture in the at-

mosphere, a Typhon or Prester. The two first are probably the ascending whirlwinds, the others those which descend.

Air ascending or descending, says Dr. Franklin, may form the same kind of eddies or whirlings, the parts of air requiring a circular motion, and receding from the middle of the circle by a centrifugal force, and leaving there a vacancy. If descending, it will be greatest above and will lessen downwards. If ascending, it will be greatest below and will lessen upwards, like a speaking trumpet standing with the largest end on the ground.

When the air descends with violence in some places, it may rise with equal violence in others, and form both kinds of whirlwinds. The air in its whirling motion receding every way from the centre or axis of the trumpet, leaves there a vacuum, which cannot be filled through the sides, the whirling air as an arch preventing; it must then press in at the open ends. The greatest pressure inwards must be at the lower end, the greatest weight of the surrounding atmosphere being there; the air entering rises within, and carries up dust, leaves, and heavier bodies, that happen to be in its way, as the eddy or whirl passes over land.

If it passes over water, the weight of the surrounding atmosphere forces up the water into the vacuity, part of which by degrees joins with the whirling air, and adding weight, and receiving accelerated motion, recedes still further from the centre or axis of the trump as the pressure lessens, and at last, as the trump widens, is broken into small particles, and so united with air as to be supported by it, and become black clouds at the top of the trump.

Thus these eddies may be whirlwinds at land and water spouts at sea. A body of water so raised may be suddenly let fall, when the motion, &c. has not strength to support it, or the whirling arch is broken so as to admit the air falling into the sea. It is harmless, unless ships unfortunately happen to be directly under it; but if in the progressive motion of the whirl it has moved from the sea over the land, and there suddenly breaks, violent and mischievous torrents are the consequence.

(*NOTE* 8. *See page* 68.)

TEMPERATURE OF THE TWO HEMISPHERES.

THE land in both hemispheres is much hotter in summer and colder in winter than the sea; and there being infinitely more land in the northern than in the southern hemisphere, the former, taken altogether, is much more subject to the extremes of heat and cold than the latter. For the same reason, the heat of the summer months will be less violent in the torrid zone of the S. than in that of the N. and also in those parts of the temperate zone beyond the influence of the land. The islands of St. Helena, Mauritius, and Bourbon, and those in the Pacific Ocean of the southern hemisphere, which are remote from the continent, are well known to enjoy a much milder and more regular climate than any of those to the N. which are most of them nearer great bodies of land; but at the same time, from the unquestionable report of Captain Cook, and other circumnavigators of the globe, it appears that the higher latitudes, towards the antarctic circle, are colder than those to the N. This seems in some measure a contradiction to the first position, as there is scarcely any land in this part of the Great Southern Ocean; it must however be remembered, that the sun is much longer in the northern than in the southern hemisphere. According to Mr. Cassini, he is 186 days 14 hours 53 minutes passing through the former, and only 178 days 14 hours 56 minutes passing through the latter, the annual difference therefore is 7 days 23 hours 57 minutes, amounting in a century to upwards of two years. So far then as heat and light are communicated to us from the sun, and produce warmth in either hemisphere, nearly in that proportion the antarctic is probably colder than the arctic circle. At Cape Horn and the Cape of Good Hope, therefore, which extend far towards those cold regions of the south pole, the winds at particular seasons will be more violent and the weather colder than in any of the same parallel of latitude to the northward. This observation however must be confined strictly to the headlands and places near the ocean; for as land is colder than water in an unfrozen state, the interior of North America and northern Asia, which are still uncultivated, must in winter be covered with ice and snow, and therefore those particular regions will be at least equally cold with those in the southern hemisphere, and the countries adjacent much more so than those of the same latitudes in Europe; but should the west side of North America be cleared and cultivated, the whole of that continent will become nearly as temperate as any country in the centre of Europe equally distant from the sea.

(*NOTE 9. See page 68.*)

ISLANDS OF BERMUDAS.

IT is to be regretted that invalids in Europe, especially those afflicted with pulmonary complaints, do not prefer a voyage to the islands of Bermudas, to visiting either the south of France or Lisbon; for the mild regular climate of these islands is infinitely preferable to that of any place on the continent, and even to the island of Madeira, which is near the coast of Africa; besides, the voyage to Bermudas, added to the purity of the air, together with the abundance and quality of the fruits and vegetables, would probably restore all those to health, who are to be recovered either by good air or wholesome food.

But the reputation of these islands has suffered from the report of the early navigators, who formerly visited them in small vessels, and who were perhaps terrified by the occasional storms of thunder and lightning, and still more by the rocks and shoals with which they are said to be surrounded. The report of one or two timid or wonder-working travellers, at that early period, was probably sufficient to justify the character given of these islands by our immortal Shakspeare, who makes Ariel, in the Tempest, tell Prospero,

> " Safely in harbour
> " Is the king's ship; in the deep nook, where once
> " Thou call'dst me up at midnight to fetch dew
> " From the still vex'd Bermoothes."

Mr. Malone, in a note on this passage, says, thus the islands now known by the name of Bermudas, were frequently, though not always, called in our author's time. Hackluyt, in his Voyages, 1598, calls " the sea about the Bermudas a hellish place " for thunder, lightning, and storms." So likewise the continuator of Stowe's Annals, 1615, describing the arrival of the English at these islands in 1609, " Sir George " Somers sitting at the sterne, seeing the ship desperate of relief, looking every mi- " nute when it would sinke, he espied land, which according to his and Captain " Newport's opinion shou'd be that dreadful coast of the Bermodes, which islands " were, of all nations, said and supposed to be inchanted, and inhabited with witches

" and devils; which grew by reason of accustomed monstrous thunder, storme, and " tempest, neere unto those islands; also for that the whole coast is so wonderous " dangerous of rockes, that few can approach them but with unspeakable hazard " of shipwreck."

The learned Editor in this instance proves, that his inimitable author was correct, as far as the information of his day went, in making Ariel speak in the manner he does of these islands; but more modern and authentic accounts, amongst which is that of the learned Bishop Berkley, to whom Pope attributes every virtue under heaven, justifies also, I flatter myself, what has been said of them in this work. If the modern accounts are most deserving of credit, some unhappy invalid may, perhaps, be tempted to seek benefit from a voyage to the Summer Islands, in which some authors say perpetual spring prevails, and where also the inhabitants are strangers to most of our diseases.

(NOTE 10. *See page* 72.*)*

UNIVERSAL LANGUAGE.

THE Germans, like most other European nations, are daily making considerable improvements both in the arts and sciences; and should another Czar Peter, or Catherine the Second, appear, the Russians may equal, if not surpass, their neighbours, both in literary and scientific pursuits; but the discoveries of each will be concealed from the other, and both from the rest of Europe, unless the German and Russian languages should become more generally known. Many good maps of these countries, particularly of Russia, are extant, which are not legible to the rest of the world. It is therefore to be lamented that mankind will not adopt some universal language, in which all books on art or science may be written, especially on geography.

It is no less curious than true, that the whole circle of theoretical knowledge is comprised in twenty six letters, ten figures, and seven notes. The master, and still more perhaps the mistress, of music may, by the infinitely various combinations of these seven notes, convey the most enchanting sounds, and excite almost any sentiment in

the mind of a foreigner without the help of words. So likewise all persons conversant in figures can solve arithmetical problems proposed to them by strangers of any nation. Still however the long wished for universal language of letters remains to be introduced, and, were this plan adopted, it would probably produce an easy and friendly intercourse amongst all enlightened men. National jealousy may perhaps prevent the adoption of any living language for this purpose; we must therefore have recourse to those of the ancients; of these the Greek is unquestionably the most copious, and in many other respects preferable; but no man will be offended at the preference given to the language of Cicero, Horace, and Tacitus. The characters of the Latin correspond with those of the modern living languages, and in fact there is so much relation between this dead, and the greatest part of the living languages in the south of Europe, that very little difficulty could occur in the execution of this plan, particularly with the Spaniards, Portuguese, and Italians. Every nation would of course preserve their vernacular tongue to be used amongst their own countrymen, and employ the Latin only in the arts and sciences, and in their communications with foreigners. To render our own conversation intelligible in it, we must in the first place adopt the same pronunciation of the vowels in Latin as is in general use all over the continent; and when this alteration is made, a person tolerably well educated might travel from one end of Europe at least to the other, without the help of an interpreter. Most gentlemen are, at present, obliged to learn three or four languages imperfectly, besides the Greek and Latin; but in this case two only would suffice for every purpose, both of public and private life.

If any persons doubt the practicability of this plan, I would recommend them to read what Montaigne says on this subject. In his admirable essays will be found by what means his father pursued to teach him to speak and write Latin fluently, and also with what ease it was accomplished. They will perceive, that if it was made the colloquial language at all schools, both to boys and girls, that in less than twenty years it would become perfectly easy and familiar to every well educated person in Europe. In geography it would be singularly useful, for the names of places on the maps and charts would then, of course, be readily understood by sailors and travellers of all nations, and in a few years every man would peruse with pleasure the instructions of geographers in that elegant language. But I will not attempt to point out the advantages that would arise from the adoption of this plan, as they will occur to almost every person who will take the trouble of reflecting a little on the subject. It is certainly practicable, and ought not to be considered as chimerical.

(*NOTE* 11. *See page* 74.)

OBSERVATIONS ON THE NILE.

Account of Signor Gabrielli for Thirty Years, when the Nile at Cairo became Sixteen Cubits high, each Two Feet Two Inches English; Two French Royal Feet, according to Maillet; but Twenty-eight Inches according to Sr. Gabrielli.

1692.	August 9.	1707.	August 10.
1693.	. . . . . 7.	1708.	. . . . . 4.
1694.	Sept. 1, Plague.	1709.	. . . . . 9.
1695.	August 13.	1710.	July 28.
1696.	. . . . . 14.	1711.	August 10.
1697.	. . . . . 11.	1712.	. . . . . 6.
1698.	. . . . . 7.	1713.	. . . . . 3, Plague.
1699.	. . . . . 15.	1714.	. . . . . 1.
1700.	. . . . . 5, Plague.	1715.	July 26.
1701.	. . . . . 17.	1716.	August 17.
1702.	. . . . . 15.	1717.	. . . . . 15, Plague.
1703.	. . . . . 18.	1718.	. . . . . 22, Plague.
1704.	. . . . . 2.	1719.	. . . . . 5.
1705.	Sept. 19, Plague.	1720.	. . . . . 9.
1706.	August 9.	1725.	. . . . . 15.

According to Maillet, to cover all the adjacent grounds it is necessary that the waters in the Nile should increase to forty-eight feet.

Daily Increase of the Nile from June 29th to July 31st, 1714. *By J. Gagnier*

June 29th, N. S. 1714, the Nile was five cubits high.

June 30.	3 inches increase.	July 16.	8 inches increase.
July 1.	2	17.	15
2.	3	18.	25
3.	2	19.	15
4.	4	20.	10
5.	3	21.	8
6.	4	22.	6
7.	6	23.	7
8.	4	24.	8
9.	5	25.	7
10.	4	26.	8
11.	3	27.	10
12.	5	28.	15
13.	4	29.	20
14.	6	30.	30
15.	8	31.	48
	66		240

These tables demonstrate both the annual and diurnal increase of the Nile, which commences in June, nearly about the same time as the periodical rains in Hindustan.

The first shows when the river was at the greatest height at Cairo, for thirty years successively, during which period the plague appeared six times in the city. But it must not be understood that the plague broke out when the river was full: on the contrary, it had raged in the city at the beginning of the year, and it ceased soon after the inundation began. It is always observed by the inhabitants, that although this disorder rages with great violence during the preceding months, it completely ceases when the river has reached the height of sixteen cubits. It is probable that the great volume of fresh atmospheric air, which accompanies this body of water from Upper Egypt,

may correct the noisome mephitic vapours, which have been long hovering over this populous city, and, by thus changing the state of the atmosphere, remove the causes of this dreadful malady.

It is also possible that the ample supply of fresh water itself may somewhat contribute towards restoring the inhabitants to health; but this alone would not produce such a sudden salutary effect as the change of air, for the water of the river is at first extremely turbid, and unfit for drinking, until it has had some time to settle. In removing filth, however, it may immediately produce beneficial effects.

The second table, by marking the daily gradual increase of the Nile at Cairo, according to the nilometer, shows more in detail the progress of the rains. Until a few days after the summer solstice the river has not reached a third part of its common annual height, and the daily increase of the water for the first fourteen days of July is sometimes as low as two inches, on an average about four inches, and does not amount to eight inches until the 15th of the month. These circumstances prove, that there are no large contributary streams near the Delta, or even in Upper Egypt, for the common drains of the country, within two or three hundred miles, are sufficient to increase the river to the height of two inches. So far therefore the maps of Upper Egypt, in which no rivers appear to unite with the Nile to the north of the tropic, are probably correct.

The first of any magnitude is the Albara, in the latitude of 17° 50′ N. which comes from the S. E. The second the Bahar al abiad, or White River, in the latitude of 15° 50′ N. which comes from the S. W. but the sources of both these rivers lie considerably within the tropic, and therefore they are filled with the rains which fall in the southern countries during the S. W. monsoon.

All due allowances being made for the time of the falling of the rain in the inferior streams amongst the mountains, and for the collection of the waters in the principal stream of the Nile, as likewise for their subsequent course to Cairo, it is not to be expected that the augmentation of the river should in general be very considerable at the city before the middle of July, as marked by the table; nor that it should be completely full there, before the beginning of the month of August, when the whole accumulation of the waters, flowing from the different contributary streams, has had time to enter the bed of the river, and to arrive at the Delta: but the river must still con-

tinue flowing to the middle of September, to supply the quantity of water withdrawn for the purpose of inundating Lower Egypt; otherwise, when the irrigation of the land begins, as it generally does about the end of July or the beginning of August, the river would fall at once to its lowest ebb.

The Nile and the Ganges seem greatly to resemble each other; not merely as a matter of curiosity, therefore, we will endeavour to draw a comparison between them, and at the same time distinguish the most essential points in which they apparently differ.

The sources of the Nile are said to lie amongst the Mountains of the Moon, between the latitude of 6 and 11 degrees N.; but I do not in this case affect great precision, for to me it appears extremely difficult to say where the real fountain head of this river lies.

It is not yet determined, I believe, whether we are to judge from the extent of its course or the magnitude of the stream. From the Mountains of the Moon, however, the Nile runs northward upwards of one thousand eight hundred miles, and empties itself into the Mediterranean, in the Delta of Egypt, the coast between the northern branches of the Delta being about the latitude of 31° 12′ N.

The source of the Ganges is said to lie amongst the Mountains of Imaus or Himmalah, between the latitude of 30 and 32 degrees. This river runs in a diametrically opposite direction to the Nile, its course being from the N. to the S. The Ganges enters the sea in the Gulf of Bengal, in about the latitude of 21° 30′ N. The course of the Nile is perhaps rather longer than that of the Ganges, but the latter greatly exceeds the former in breadth, so that undoubtedly the Ganges contains much more water than the Nile.

The Nile begins to increase at Cairo early in the Month of June. According to Major Rennel the Ganges increased at the Jellinghy, near the Delta, in May. He states it to have risen six feet in that month; at the end of July the Nile is generally full, so likewise is the Ganges at the same time. The height of the Nile is twenty-feet, that of the Ganges about thirty or thirty-one feet. The sources of the Nile, and all the considerable streams which serve to form this river, lie within the tropic. On the

contrary, all those great contributary streams, which serve to fill the Ganges, have their sources N. of the tropic, whence I should infer, that the waters of the Nile are principally derived from the solsticial rains, and those of the Ganges in a great measure from the snow and ice melted by the presence of the sun about the same period; and to these united causes I should impute the superior magnitude of the Ganges.

The heat of the sun will, in this instance, from the same cause, produce different effects, for within the boundaries of the sources of the Nile the heat will cause a great degree of evaporation at sea, and also a considerable degree of rarefaction of the atmosphere on land; and the sea being cooler than the land at this season, the clouds saturated with moisture will of course come towards the land, and be made to precipitate their contents in rain amongst the Mountains of the Moon, in the manner described in the body of the work, by which means, I suppose, that the inundation of Lower Egypt is produced. But the sources of the Ganges, and its contributary streams, lying amongst the Mountains of Himmalah, the heat of the sun, from the solstice to the end of July, will produce there a great quantity of water from evaporation, but still more from the melting of the ice and snow on the mountains; and although we may allow, that in that part of the river, which runs through the Delta, the head of which is very near the tropic, some addition will be made to its waters by the solsticial rains, we must also suppose that by far the greater part of the water of the Ganges comes from ice and snow, melted on the mountains of Himmalah. After the comparison of the two rivers we will add a few remarks on the two countries through which they flow.

Egypt, according to both sacred and profane history, has formerly been considered as the granary of Palestine and Rome. So early as in the days of Abraham a famine prevailed in the former; and during the seven years of scarcity afterwards predicted by Joseph, the other sons of Jacob were sent thither from the Land of Canaan to seek for grain for seven years successively, and that fertile country afforded, during those times of scarcity, a sufficient supply for the inhabitants both of Egypt and Palestine.

The Egyptians have always been sensible of the advantages they derive from this river, and to avoid the fatal consequences of an accidental scarcity of water, they have from the earliest ages erected a mikias or nilometer to ascertain the increase of the

inundation, so that they might regulate the irrigation of their lands according to the supply they received from the fountain head.

Bengal, which in many respects resembles the Delta of Egypt, is likewise called by the Orientals Jennet ul Bellad, or the Paradise of Countries, and like Egypt, Bengal generally supplies grain to the neighbouring southern countries of India, where the mountains being low, and the rivers comparatively small, the harvests frequently fail.

The province of Bengal ought, with good management, never to be subject to famine; for, if my conjectures are true, the supply of water must be infinitely more certain in the Ganges than in the Nile. It is to be doubted, as I have already observed, whether the Mountains of the Moon, where the sources of the Nile are supposed to lie, are high enough to be covered with ice and snow in that latitude. But the great range of mountains, whence the waters of the Ganges, and many of its contributary streams, flow, are visibly covered with ice and snow, which on these northern mountains may be considered as perpetual, and a great portion of both being annually melted by the presence of the sun during the summer solstice, this supply can never fail.

It may then be asked, by what means the famine happened some years since, which almost desolated the province of Bengal?

It was partly owing to a want of the same precautions, which are constantly taken by the Egyptians for ascertaining the quantity of water in the river by means of a nilometer, with proper dams, which ought to be erected throughout the Delta of Bengal, in every considerable branch of the Ganges.

It would perhaps be very sound policy in every European nation to adopt the same plan at home; for by these means, not only great improvements might be made in agriculture, but by preserving the water with proper economy, commerce might be considerably facilitated by the more general use of water carriage. Nor should we forget that these nilometers might become more correct rain gauges than any now in use. But after having mentioned the famine in Bengal, and ascribed it partly to the want of a judicious economy and appropriation of the water of the Ganges, in justice to the servants of the East India Company who governed Bengal at that time, and who have

unjustly incurred much odium on that account, I must take upon me to say, that after a very diligent enquiry, made a few years afterwards on the spot, no European at that time derived the smallest pecuniary advantage from the monopoly of grain.

I have even heard a gentleman named as having contributed towards the general distress, by converting rice grounds into fields of opium, and from the sale of which he is said to have acquired immense riches; but it is well known that opium does not thrive in the same kind of ground in which rice is planted; the one requires a dry, the other a wet soil. Besides, if we admit that four or five hundred acres, or even as many thousand, were taken from the rice grounds of the provinces of Bengal, Bahar, and Orissa, for the purpose of planting opium, the defalcation of this small quantity of land, from countries infinitely more extensive than those of Great Britain, would not have been felt but as a drop of water in the sea. The misfortune originated in the folly or iniquity of the native farmers, or grain merchants, themselves.

It should be known that the scarcity happened in a season of uncommon drought, which followed one of unusual plenty. When the native farmers, or perhaps the merchants, during the plentiful year, had sold and exported as much grain as they could, they destroyed a prodigious quantity of the remainder in order to keep up the price; and consequently, when the subsequent crops failed, an universal distress pervaded the whole country. It was by these means that thousands of the wretched inhabitants of Bengal perished through hunger in the granary of India.

But for the credit of the East India Company's servants, and even for the honour of the nation itself, it is to be lamented that this matter was not at the time made the subject of a public enquiry, and entirely cleared up to the satisfaction of the whole world.

In a free country the trade in grain, as in other articles of commerce, only requires encouragement and protection; almost every restraining law cramps and destroys its vital principles, contributing sometimes to introduce the evils it was intended to prevent; but in Bengal, which is a conquered country, and produces in a plentiful year at least four times as much rice as is requisite for the consumption of its inhabitants, public granaries may be established, and government, as part of the payment of the revenues, might receive into them, at a reasonable price, the surplus of the consumption

of these provinces. After having reserved a sufficient quantity to supply a possible deficiency in the ensuing crop, the remainder might be exported to those countries on the Coromandel and Malabar coast, where often this article of the first necessity to an Indian is extremely scarce and dear. The same plan might likewise be extended to the province of Tanjore, which is the granary of the Carnatic, and these precautions being taken, it would be almost certain, that no famine could ever happen in any country subject to the government of the East India Company.

(NOTE 12. *See page* 78.*)*

THE SIROCCO,

CALLED sometimes Scirocco, or Sciloco, comes in the south part of Italy and Sicily from the S. E.; it blows occasionally with great force in the month of July, but sometimes commences faintly about the summer solstice.

This wind resembles the Khumseen, and the land wind in all tropical countries, not only in its appearance and effects, but likewise in the time of its commencement. It must be allowed, that it does not blow in the southern part of Europe without intermission for forty or fifty days, nor does it continue quite so long as those winds do in Asia and Africa, but it is extremely oppressive during the time it lasts, even to the Sicilians and Neapolitans.

According to Mr. Brydone, the inhabitants of Palermo do not understand in what manner to guard against its effects so well as the natives of Hindustan; for the Sicilians content themselves with merely shutting their windows, and where there are no shutters they hang up a wet blanket instead of them, which must be very soon dried; but the wiser Indian puts a curtain of grass before the window or door, which he constantly wets on the side exposed to the wind, and thus by keeping up a constant evaporation, the air which passes into the room is rendered perfectly cool.

Mr. Kirwan observes, that the degree of cold, produced by evaporation when the air is warmer than the evaporating surface, is much greater than that which is produced when the evaporating surface is the warmer of the two. In this instance the air without is at 112 degrees even in the shade, and the evaporating surface, when frequently moistened, not more than 75 degrees. The most opulent and luxurious of the Hindoos make a sort of hut of perfumed grass, which is kept constantly moistened, and exposed to the land wind, in which they live at a temperature of 60 degrees during the extreme heat of the day, and the continuance of the land wind.

The Sirocco has been supposed by some people to come from the opposite coast of Africa, and by others to be the effect of sulphureous vapours from the earth; if, however, it came from the continent of Africa, it would be felt with great violence at sea, in the channel of Malta, and on the island itself; but the Sirocco is not felt at this time on any part of the sea which separates Sicily from Africa, but, like the land wind of India, it is confined to the shores on both sides, whilst the sea wind on the southern shores of Europe, opposite to Africa, is, at this season, always cool and refreshing.

Mr. Brydone observes, that the Sirocco is felt with most violence at Palermo, situated on the N. W. side of Sicily, and on the continent it is infinitely worse in the interior of the country near Naples, than in the southern part of Calabria: these circumstances positively prove, that it is nothing more than the air, which acquires a considerable local degree of heat from the surface of the earth at the hottest season of the year, and in its ascent is impelled forward by the S. E. wind, so as to acquire additional heat as it proceeds towards the N. W. side of the island.

This progressive accumulation of heat from the land, during the Sirocco, may be ascertained by a person heating a piece of paper before the fire, and running the end of his finger along the heated paper; at first it will appear only warm, but as the finger proceeds, and accumulates the heat of that part of the paper over which the finger passes, it will at length become so hot as to be painful.

(*NOTE* 13. *See page* 80.)

MISTRAL.

THE wind known in Provence under this name comes from the Alps to the N. W. It is supposed to contribute greatly to the salubrity of the air, by dispelling the vapours from the marshes and stagnant waters in the southern parts of Provence and Languedoc, where also, as Mr. de Saussure observes, it subjects the inhabitants to great inconvenience, and sometimes to considerable losses.

This excellent philosopher imputes it to three causes;

First, The situation of the Gulf of Lyons, which is terminated by a sort of tunnel formed by the Alps and the Pyrennees, and whose sides, therefore, are the principal scenes of its ravages. All the winds between the N. and the W. are united in this gulf, which by Aulus Gellius is called Circius. (Lib. II. cap. 22.) See also Pliny, (Lib. II. 46.)

The second is, that this gulf, being to the S. is lower and warmer than the parts adjacent, and as the inferior current of air goes always from the cold to the warm point, the Gulf of Lyons must necessarily be the centre of violent winds, both from the E. and the W.

The third cause is nearly included in the two preceding.

(*NOTE* 14. *See page* 81.)

SAHARA.

SAHARA UL ASKI, the complete or pure desert of Africa. The Desert of Arabia is called by the natives Badiat, the Desert, which is corrupted by European orthography into Badoui, and the inhabitants for that reason are improperly called Badouins or

Bedouins. The well known word Saracen is probably derived from Saharakin, the inhabitants of the Sahara or Desert, whence probably the crusaders denominated all the Mahomedans of Palestine, and the adjacent countries, Saracens. Some of the Europeans have converted the K of this word into a C, and others have turned the C into an S or a Z. But in fact the natives of both these countries are the same in religion and laws, and differ only in some of their habits of life. Those who were named Saracens lived in towns situated near the southern coast of the Mediterranean, from Asia Minor to the Streights of Gibraltar; but the Bedouins might with propriety be supposed to derive their name from Be-dawerce, without a sovereign, or independent tribes, not subject to any regular government. The word may also be interpreted, persons having no fixed habitations or buildings raised by art.

In the African desert there are, doubtless, many towns besides that of Lametounah, whence the Marabouts are said to come. The learned Dr. Shaw, who was twelve years resident at Algiers, gives a curious account of a singular kind of traffic carried on between the Western Moors and the Nigritians, living in the desert, not far from the Niger, the origin of which it is not easy to trace *.

On a certain day of a certain moon, the Moorish merchants, being furnished with coral, and coloured glass beads, and other trinkets of that kind, repair to a certain spot in the desert, not far from the above-mentioned river. On their arrival they find deposited on a certain well known spot, many small parcels of gold dust, ranged in due order, at a trifling distance from each other; opposite to each parcel they place their goods and go away, persons unknown and unseen then come in the night and regulate their bargain. If the Nigritians approve of the arrangement, they take the goods and leave their gold dust; but on the contrary, if they disapprove of the bargain, they very honestly take away their own property, and scrupulously leave what was offered them.

This species of traffic has somewhat the air of romance, but those, who are accus-

* If the Niger runs from W. to E. as seems very much believed since the publication of Mr. Park's Travels, it probably terminates in a lake, like the River Jordan in the Dead Sea, sufficiently capacious to receive its waters; and in the centre of Africa, where this lake must be situated, the evaporation from extreme heat would be sufficient to account for the disposal of the water. If this lake does not afterwards communicate by some other river with the ocean, it will add one more to the list of salt water lakes, or inland seas.

tomed to the good faith of the natives of Hindustan, will be easily disposed to believe it probable; for on the coast of Coromandel, not only bags of pagodas, containing each of them one thousand, of the value of four hundred pounds sterling, are transferred from one person to another without being reckoned, but even bulses of diamonds of great stated value are passed from one merchant to another, without the seal being broken to examine the contents of the bulse. Merchants on a great scale well know the truth of that good old moral maxim, that honesty is the best policy. The rest of the world, it is to be hoped (perhaps it is not much to be expected) will hereafter learn to profit by their example.

(*NOTE* 15. *See page* 85.)

COLD PRODUCED BY EVAPORATION.

THE extraordinary degree of cold, which we feel in England on being exposed to the E. and N. E. winds, is probably owing to the extreme dryness of the air, by which the evaporation of the moisture of the body is considerably increased, and which by those who have not activity or strength enough to keep themselves warm by exercise, is best counteracted by the use of flannel, fleecy hosiery, and other stuffs of a similar quality, which being non-conductors of heat, serve to retain the internal warmth and moisture of the body.

Without having recourse to experiments practised by philosophers, to ascertain the degree of cold produced by evaporation, every individual may in a less degree acquire a sufficient knowledge of this fact, by wetting the hand with common water only, and exposing it to the wind, particularly to the E. and N. E. for the moisture will be immediately evaporated, and leave a strong sensation of cold, particularly on that side of the hand which was wetted; this sensation of cold will be still more felt with spirits of wine, and most of all with ether.

The East Indian, during the hot weather, to enjoy the indulgence of cold water, exposes it in a porous vessel to the violent gusts of the hot land wind, which causes a great

degree of evaporation, and cools the water to 55 or 60 degrees, whilst at the same time the external air is upwards of 100 degrees by Farenheit's thermometer.

The degree of cold produced by evaporation, as has been before observed, is much greater when the air is warmer than the evaporating surface, than that which is produced when the evaporating surface is the warmest of the two; for in the first case the dilatation of the vapour is constantly increased, and in the second it is checked. Now the more vapour is dilated, the more fire it absorbs; and hence it is coldest in an exhausted receiver when it dilates most. Hence warm winds, as the land wind of India, the Sirocco, and the Khumseen, which are all of the same kind, are more desiccative than cold winds.

(NOTE 15 *. *See page* 97.*)*

A Synopsis of the Weather at Mansfield Woodhouse, for Ten Years.

Years.	Frost.	Snow.	Rain.	Fair.	Mild or Hot.	Thunder.
1785	87	34	112	219	25	8
1786	68	27	111	203	25	5
1787	48	9	132	224	40	7
1788	72	26	122	218	36	7
1789	52	21	180	164	25	9
1790	47	7	138	220	30	8
1791	63	13	138	213	48	5
1792	53	13	170	183	30	8
1793	59	12	123	230	33	6
1794	53	4	125	236	37	7
Total	602	166	1351	2110	329	70

Temperature at Mansfield Woodhouse, for Ten Years, by Farenheit's Thermometer.

Years.	Date.	Greatest Cold.	Date.	Greatest Heat.	Mean Heat.
1785	February 18 .	24	June 24 . . .	80	52
1786	January 3 . .	25	June 4 . . .	79	52
1787	January 26 . .	28	July 5	79	53
1788	January 14 . .	29	August 3 . .	79	54
1789	January 5 . .	20	August 11 . .	80	50
1790	January 20 . .	28	August 20 . .	80	54
1791	December 19	19	June 7	76	47½
1792	February 21 .	23	August 22 . .	76	49½
1793	January 19 . .	32	July 20 . . .	82	57
1794	January 3 . .	28	July 13 . . .	84	56
Mean of ten Years . . .		25, 6		79, 5	52, 5

The number of days mentioned in the first table, in most instances, exceeds the number of days in a year; but it must be remembered, that the variations in the same day cannot be separately noted in a table. As for example, it may snow and freeze, or freeze and be fair on the same day; but these distinctions have been observed, as often as it was possible.

DECLINATION OF THE MAGNETIC NEEDLE OBSERVED IN LONDON.

Years.	Degrees.	Minutes.	Years.	Degrees.	Minutes.	Years.	Degrees.	Minutes.
1576	11	15 E.	1683	4	30 W.	1750	17	54 W.
1580	11	11	1692	6	0	1760	19	12
1612	6	10	1700	8	0	1765	20	0
1622	6	0	1717	10	42	1770	20	35
1633	4	5	1724	11	45	1774	21	3
1634	4	5	1725	11	56	1775	21	30
1657	0	0	1730	13	0	1777	22	12
1665	1	22½ W.	1735	14	16	1778	22	20¼
1666	1	35½	1740	15	40	1779	22	29½
1672	2	30	1745	16	53	1780	22	41

In the year 1657, the magnetic needle began to change from E. to W. and this variation is supposed to have increased about 9 minutes every year towards the W. At the present time it may be reckoned at about 25° 40′ W. in the Channel.

Those, therefore, who have houses to build, or walls for fruit, and wish to have them due S. must make this allowance for the variation, otherwise they will change the aspect of their buildings upwards of two points of the compass.

(*NOTE* 16. *See page* 107.)

CAUSE OF NO RAIN AT LIMA.

IT seems perfectly consistent with the principles of this theory, that thunder, lightning, and rain, should never be known in Lima, but they do not apply to the Levant. According to Dr. Shaw and Mr. Volney, storms are common in all parts of the southern coast of the Mediterranean, particularly near the two equinoxes; and Mr. Daines Barrington has thrown considerable light on the subject of the greatest quantity of rain falling in rain gauges placed on the earth.

He fixed one, exactly similar to those used by Dr. Heberden, on the summit of Mount Rennig, in Wales, at the height of one thousand three hundred and fifty-feet, and another of the same kind at the foot of the mountain. From the 6th of July to the 29th of October, in the former there fell 8.165 inches, and in the latter 8.766 inches, a difference only of half an inch. Hence it is evident that the quantity of rain is rather in proportion to the approximation of the rain gauge to the earth, than to the height of the situation where it is placed from the level of the sea: we may also from these two experiments venture to infer, that the greater quantity of rain falling in the lower gauge is not to be ascribed to the accumulation of more drops in a descent through a greater depth of atmosphere, as is generally supposed.

The vapour near the surface of the earth, on a hot clear summer's day, about noon, is obviously more dense, than at the height of a few feet from the ground. With a good refracting telescope this difference becomes very perceptible. Objects scarcely visible

on the ground floor of a house, are much more distinct on the first story, and perfectly clear near the top of the house; when, therefore, the cohesion of this vapour is destroyed by the precipitation of the superincumbent clouds, the most water will probably be produced, where the greatest quantity of moisture in the air was held in solution near the earth.

De la Bourdonnais.

A CORRECT history of this respectable man is much to be desired. It is to be hoped, that some elegant writer may hereafter be able to collect materials for such a work, and present to the world an example of skill, courage, and private virtues seldom equalled, and, we may venture to say, hardly ever surpassed.

Mr. Orme, in that part of the History of India which relates to his attack of Madras, gives the following admirable sketch of Monsieur De la Bourdonnais character. His knowledge in mechanics rendered him capable of building a ship from the keel; his skill in navigation, of conducting her to any part of the globe; and his courage, of defending her against any equal force. In the conduct of an expedition, he superintended all the details of the service, without being perplexed either with the variety or number of them. His plans were simple, his orders precise, and both the best adapted to the service in which he was engaged. His application was incessant; and difficulties served only to increase his activity, which always gave the example of zeal to those he commanded.

(NOTE 17. *See page* 111.*)*

OBSERVATIONS ON AIR.

THE common language on a cloudy day is, that, the air being thick and heavy, rain will probably follow.

I do not pretend to inform philosophers when I say, this is one of a thousand instances, in which we are not implicitly to believe our eyes. The barometer falling

shows that the air, which affects the mercury in the tube, is become light, and therefore the mercury descends; for under equal pressure and at like temperatures, air, holding water in solution, has less specific gravity than air alone, and this specific gravity is more or less in proportion to the quantity of water dissolved, consequently before the heaviest showers the air will become light, and the barometer fall; at the same time the air appears thick and turbid to the eye, for the clearness of the air is destroyed by the water in it being in a state of solution. Water may exist in air in three different states: NOT

First, In a state of perfect solution, when the air will be clear, dry, and heavy, and its state of solution still active.

Secondly, In a state of beginning precipitation, when it becomes moist and foggy. Its powers of solution are then diminished, and the air becomes lighter in proportion as its water is deposited.

Thirdly, When the water is completely precipitated, which may happen either by a slow process, or when it descends in brisk rain.

It is generally observed also, that, when the air is thick and heavy, we can scarcely breathe; but the fact is, that when the air is most dry and elastic, and therefore most heavy, our respiration is most free; and when it becomes very much rarefied and light, our respiration is proportionably difficult.

The moisture of the atmosphere is, without doubt, principally formed from the vapour raised from the ocean and earth, nevertheless some portion of it may be ascribed to the combination of oxygen and hydrogen gas, with the addition of caloric sufficient to preserve it in that state, until the electric spark or flash of lightning serves to complete the process. But the admission of one of these systems does not subvert or militate against the other; for as the moisture raised by evaporation is kept suspended in the air, until the cohesion is broken in the manner described by Dr. Franklin, so likewise when water is formed in the atmosphere from this combination of different airs, the water so formed may probably be absorbed by the surrounding air, when in a dry state, but on the contrary, when the air is already saturated with moisture, this addition will of course be precipitated in rain.

Sounds.

IT is well known that sounds are heard more distinctly in the night than in the day, which is supposed to proceed from the stillness of the night, but probably it is rather imputable to the state of the air.

During the day the air is much rarefied by heat and light; the sound in that medium must be proportionably faint; but in the night, during the absence of the sun, the air is condensed, and becomes elastic, and therefore is a better vehicle of sound, and consequently equal sounds will be heard at equal distances much more distinctly in the night than in the day.

In great cities, most persons are either at church, or detained at home, during divine service. If sounds were heard more distinctly during a general stillness, they would be best distinguished at this time; but in fact on a Sunday in summer, whilst many people are in motion, and the streets are crowded with men, women, and children, generally engaged in noisy conversation, sounds are more distinctly heard in the cool of the evening than during the stillness of the mid-day, which is an additional proof, that distinctness of sound is more owing to the state of the air, than to a temporary cessation of noise.

(*NOTE* 18. *See page* 114.)

TIDES IN THE ATMOSPHERE.

IT has long been a favourite opinion of different philosophers, that there are regular tides in the atmosphere: Amongst the rest Musschenbroek observes, that the causes above the atmosphere, which excite wind, are the sun and moon, which, attracting by their gravity, communicate a perpetual motion to the air, such as they do to the ocean, and thereby raise the tides; but in the atmosphere, on account of the rarity

of the air, the tides will be but small; besides, by its heat the sun rarefies the air, and so much the more vehemently, as it acts upon it with more rays, and those perpendicular; therefore because the clouds here and there intercept the rays of the sun, the air of the same region will not all of it be equally rarefied. Vol. II. 1372.

According to this opinion, the tides of the atmosphere, affected by gravity, should be equally regular as those of the ocean, although not so apparent; but if they diminish in proportion to the rarity of the air, they must also be influenced by rarefaction, and therefore near the earth at least be greater in summer than in winter, and during the day than the night.

But Mr. de Saussure, in his enquiry into atmospheric electricity, presents us with some new suggestions analogous to this subject, of which the following is almost a literal translation.

Atmospherical electricity is subject, like the sea, to a flux and reflux, which increases and decreases twice in twenty-four hours; the moments of its greatest force follow some hours the rising and setting of the sun, and those of its greatest weakness precede its rising and setting. This movement presents to us at first sight something extremely capricious; it may however be explained in a very satisfactory manner.

As a clear elucidation of this fact, I shall fix on the 22d of February, 1785, a day which will long be remembered at Geneva, as a day much colder than any other of the same date in the memory of man. My thermometer and hygrometer were suspended on a terrace open to the S. W.; the electrometer on the edge of this terrace gave an electricity equal to that which prevailed in the open country, because the escarpement of the wall of the terrace augments the electricity as much as the vicinity of the house diminishes it. With respect to the barometer, I reduced it according to the method of Mr. de Luc, reducing the height of it to that degree it would have had if the mercury had constantly been at the temperature of 10 degrees of Reaumer, corresponding with 52½ of Farenheit: the place of observation is sixty feet above the level of the lake.

In the following table are inserted the observations of three days, amongst which are included that time in which the greatest cold was felt, it being necessary to explain

what precede and what follow such uncommon phenomena. A gentle S. W. wind prevailed during these three days, and it is a very remarkable circumstance, that for the most part severe cold days at Geneva have always been brought on or accompanied by gentle breezes from the S. W.

Table of Electrical State of the Atmosphere at Geneva.

Date.			Barometer.	Thermometer.	Hygrometer.	Electrometer.	State of the Atmosphere.
Day.	ho.	min.					
21st.	9	15 M.	26 6 7	8 3	89 3	2 0	Pale sun, mottled clouds.
	11	10	26 6 5	4 3	83 9	1 6	Clear sunshine.
	2	10 E.	26 6 1	0 2	69 6	1 1	Ditto.
	5	0	26 6 0	2 3	77 2	1 1	Sun set.
	6	0	26 6 1	5 2	85 0	1 0	Some clouds to the S. W.
	7	0	26 6 0	6 8	89 0	1 8	Perfectly clear.
	8	0	26 6 2	10 0	95 0	1 2	Ditto.
	9	0	26 6 3	10 6	97 5	1 5	Ditto.
	10	0	26 6 3	9 9	95 0	1 2	Little clouds in the southern horizon.
	11	0	26 6 1	12 3	99 1	0 9	The same more extended to the S. W.
	12	0	26 6 0	12 5	hoar frost.	1 2	Ditto.
22d.	1	0 M.	26 5 15	14 3	d°	0 9	Ditto.
	2	0	26 6 0	14 5	d°	1 2	Clouds augmented, and approaching each other.
	6	15	26 6 8	15 0	d°	0 8	Clear.
	7	30	26 5 7	14 7	d°	1 2	Very light fog.
	8	10	26 5 4	14 2	d°	1 1	Ditto.
	9	10	26 5 2	10 7	d°	1 6	Ditto.
	10	10	26 4 15	8 2	d°	2 2	More thick fog.
	11	10	26 4 13	4 8	d°	1 8	Ditto.
	1	10 E.	26 4 3	4 9	d°	1 7	Ditto.
	2	20	26 4 0	0 6	82 0	1 4	Light fog—pale sunshine.
	3	30	26 3 14	0 9	81 9	1 1	Cloudy weather—pale sun.
	5	0	26 3 13	4 3	89 0	1 2	Cloudy.
	6	0	26 3 13	4 6	91 2	2 2	More cloudy.
	7	0	26 3 14	6 1	94 0	1 7	Cloudy—Venus bathing.
	8	0	26 3 14	5 9	hoar frost.	3 7	Cloudy—fog to S. W.
23d.	0	45 M.	26 3 13	4 1	95 0	1 0	Cloudy—more foggy.
	8	5	26 5 0	1 0	81 3	1 2	Ditto.
	10	7	26 5 5	0 0	76 0	0 8	Ditto.
	3	45 E.	26 6 8	0 5	76 0	0 8	Cloudy—sun very pale.
	5	0	26 6 14	0 3	75 3	1 0	Ditto.
	6	0	26 7 3	0 7	74 0	0 8	Ditto.
	7	0	26 7 9	1 7	79 7	2 2	Almost entirely clear.
	8	0	26 7 14	3 7	87 3	1 7	Rather cloudy.
	12	0	26 9 1	3 0	92 0	0 5	More cloudy.

In considering the first eighteen observations of this table (says this author) including twenty-five hours, it must be observed, the sky was almost perfectly serene, the electricity was sufficiently strong at nine A. M. to be marked as the first maximum; from that time it diminished gradually to six in the evening, the period of its first minimum. From this time it increased again to eight o'clock P. M. the second maximum. From that hour it again diminished, making some oscillations to six o'clock the following morning, the period of the second minimum, whence it augmented again to ten o'clock, which may be reckoned the second maximum of the following day; but, as on this last day the weather was rather cloudy, there was not the same regularity as before.

Mr. de Saussure's table does not seem to prove a regular flux and reflux of electricity in the atmosphere, in any degree similar to those of the tides in the ocean; but if its course is not perfectly periodical, the increase and decrease of its quantity seems in a great measure ascertained, and to depend on the presence of the sun.

In winter, the season when I have observed most distinctly the electricity of a serene air, adds Mr. de Saussure, it appeared to me, that the hours, in which it is most feeble, are those included between the time when the fall of the evening dew is finished, and the moment of sun-rise; its intensity afterwards increases gradually almost always before mid-day to a certain maximum, whence it afterwards seems to decline until the subsequent fall of the dews, at which period it is often higher than it has been at any other time of the day; after this it progressively diminishes again during the night till the end of it, but never even then totally ceases in fine weather.

The partial motion of a body of air is probably the effect of rarefaction and condensation, and the general motion of the whole atmosphere is the effect of gravity and attraction; the former, therefore, seems to me most likely to produce local and temporary currents of wind, and the latter to occasion regular periodical tides in the atmosphere.

(*NOTE* 19. *See page* 124.)

CURRENTS IN THE OCEAN.

THE principal currents of almost every part of the ocean seem to be most easily explained upon the principle of evaporation; but those of the North and South Atlantic Ocean and the Mediterranean Sea being most universally known, we will examine them in particular by this criterion.

On the western coasts of Europe, which bound the Atlantic Ocean, it is well known, that during the warm months a constant current runs from N. to S. extending to Africa, as far nearly as the equator, and another opposite current, at the same season, comes likewise to the same point from the southern extremity of Africa, and both of these meet in the Gulf of Guinea.

During ten months of the year, from the beginning of February to the beginning of December, this gulf, which is a central point between the north of the European coast and the south of Africa, is, from very obvious causes, the hottest part of this line. Here then, during these ten months, the greatest degree of evaporation must necessarily take place, and, consequently, as water will always reassume its level, the waters of the adjacent parts of the Atlantic Ocean will flow from that part which is colder, towards this point, in different directions, to restore the equilibrium: this must necessarily produce currents from the north of Europe, the southern extremity of Africa, and also from the western part of the Atlantic Ocean, parallel to the coast, particularly during the two equinoxes. But as a further confirmation of this hypothesis, in the months of December and January, whilst the Harmattan prevails, and the Sun is at its greatest distance from the coast of Guinea, the southern ocean is warmer than this gulf; both the wind and current at that time, which have before come from the north, south, and west, during the ten preceding months, suddenly change, and during the winter solstice both take the opposite direction to the end of January. This regular change, which is perfectly periodical, seems to prove, almost to a mathematical certainty, that the winds and currents in this part of the Atlantic are both regulated by the effects of heat and cold. With respect to the drain along the western coasts of Europe and Africa during the spring, summer, and autumn, we may reasonably impute it to the same cause; for

evaporation, being greater near the coast than out at sea, will likewise at these seasons, particularly in summer, occasion a fall from the ocean towards the coast, and of course, according to this hypothesis, this current will be strong or weak in proportion to the temperature of the different latitudes, and vary very much at different seasons of the year.

Doctor Halley has suggested, that the expense of water by evaporation is sufficient to account for the constant current which runs from the ocean into the Mediterranean, without looking for any other cause; to which, however, it has been objected, that this could not be an adequate reason, as probably there is an equal evaporation both from the sea and the ocean. But this latter objection does not appear to me to be well founded; for in the summer the land is always much hotter than water, and the surrounding air on land is much more dry, consequently the evaporation of all mediterranean or inland seas must be infinitely greater, than that of the ocean in the same parallels, where the air is already saturated, and continues in the same temperature many days successively. Besides, it must be remembered, that the water evaporated from what is generally called the mediterranean seas, is immediately in summer conveyed towards the land, where great part of it remains, being either precipitated there in rain for the benefit of the earth, or retained on the summit of the mountains in the form of ice and snow; and even the remainder is but slowly returned into the different seas and lakes through the channels of the adjacent rivers. The quantity of water thus raised in vapour, and retained there for these beneficial purposes, can only be supplied by a constant current from that part of the North Atlantic, with which it immediately communicates. Should this hypothesis, on further examination, be considered as well founded, it will serve also to account for the equatorial currents; for during the equinoxes, and for some weeks preceding and following them, the evaporation near the equator must be very considerable; the water adjacent, therefore, will flow in to supply the deficiency, and consequently in all parts of the ocean, where it is not obstructed by land, will produce at this season opposite currents from the two poles towards the equator. But an exact account of the currents in the Atlantic, kept for one year, would verify or refute this system; and the strength of the current at different seasons from the ocean to the Mediterranean, through the Straits of Gibraltar, would afford very useful information on this subject.

(NOTE 20. *See page* 134.)

FORMATION AND COURSE OF RIVERS.

According to ancient writers all rivers run into the sea, yet the sea is not full; for unto the place whence the rivers come, thither they return again. This is unquestionably true; but it does not appear, that they clearly understood the regular process of nature in the performance of these works; for they supposed, that it was carried on by means of subterraneous communications between the springs on land and the sea, somewhat analogous to the circulation of the blood in the human body; whereas in fact the water is drawn from the ocean by evaporation, and retained in the atmosphere until the cohesion of the air is broken, and then the clouds precipitate their contents in the form of rain. Besides, in the atmosphere inflammable air is probably perpetually uniting with vital air, and producing great quantities of moisture; and for this reason in considerable islands in the tropics, where the lofty mountains are covered with forests, which greatly facilitate this operation, there is always abundance of rain. Nor must we omit to repeat in this place what is mentioned in the body of the work, that in countries where the mountains are sufficiently high to be within the lowest term of congelation, the great rivers receive a considerable portion of their waters from the melting of the ice and snow near their summits; and all these different accumulations of water being collected into beds in the lowest parts of their respective countries, will be conducted by these channels into the sea, without the aid of any subterraneous passage.

(NOTE 21. *See page* 135.)

CLIMATE OF RUSSIA, FROM TOOKE'S HISTORY OF CATHARINE.

THE greatest degree of cold, since the building of the city of St. Petersburg, was by Reaumurs' thermometer 32½ degrees, or 102¼ of Farenheit's, the 6th of January 1760.

The greatest heat in the shade was 28⅔ degrees, or 96 of Farenheit, the 23d of July 1757, and the 5th of July 1758.

By taking the average of all the thermometrical observations made at the Imperial Academy of Sciences, it is found that the greatest cold happens in the month of January, and that its mean intensity may be estimated at 22 degrees, or 49¼ of Farenheit.

Again, that the greatest heat falls in July; and that its mean force is 23 degrees, or 83¾ Farenheit.

Months.	The Mean Intensity of the greatest Cold.		of the greatest Heat.		Mean Cold of Nights.	of Days.	Mean Heat of Nights.	of Days.
	Reaumur's.	Farenheit's.	Reaumur's.	Farenheit's.				
January . .	22	81½	½	31½	11½	8		
February .	19½	76	2½	39	9½	5		
March . . .	14	59	7	47	7	1		
April	6½	47	13	61	1½	. . . . .	. . . . .	4½
May	*1	34	19	75	. . . . .	. . . . .	5	10
June	*6	46	21½	80	. . . . .	. . . . .	9½	14½
July	*9	52	23	84	. . . . .	. . . . .	12	17½
August . .	*5½	44	21½	80	. . . . .	. . . . .	10½	16
September	*1½	34½	15½	77	. . . . .	. . . . .	6	11
October . .	3½	40	10	55	. . . . .	. . . . .	2	5½
November	11	57	4½	42	3½	½		
December	18	72½	2	36½	7½	4½		

The mark * signifies the degree of heat.

(*NOTE* 22. *See page* 142.)

MISCELLANEOUS OBSERVATIONS RELATIVE TO THE WESTERN PARTS OF PENSYLVANIA, PARTICULARLY THOSE IN THE NEIGHBOURHOOD OF LAKE ERIE. BY ANDREW ELLICOT. ADDRESSED TO MR. ROBERT PATTERSON, VICE PRESIDENT OF THE AMERICAN PHILOSOPHICAL SOCIETY, AND INSERTED IN THEIR TRANSACTIONS, VOL. IV. LATELY PUBLISHED.

DURING the summer season, in the neighbourhood of Lake Erie, fogs are seldom observed on the margin of the lake. The three summer months that I resided at Presqu' Isle, no fogs were seen during the whole time, the horizon was generally clear, and the stars shone with remarkable lustre. The most common winds here generally

resemble the sea and land breezes in the West Indies. From the end of spring till the beginning of autumn, they blow, except at the time of storms, from the lake upon the land during great part of the day, and from the land upon the lake during the night. The change generally takes place between the hours of seven and ten in the morning, and about the setting of the sun in the evening. These breezes, alternately blowing in opposite directions, render those situations contiguous to the lake extremely pleasant during the heat of the summer months, and have most probably a salutary influence upon the atmosphere.

REMARK. Whilst the winds described in this letter serve further to demonstrate the cause of land and sea-breezes, which are, no doubt, felt on all extensive lakes, and in the countries adjacent, the other circumstance respecting the clearness of the atmosphere near Lake Erie is also worthy of observation. In summer the air will be both warm and dry enough to absorb all the vapour which is raised from the lake; but towards the end of autumn, when the air is condensed by cold and replete with moisture, the fogs will prevail all over the countries in the vicinity of those lakes.

(*NOTE* 23. *See page* 143.)

WINDS IN THE WEST PART OF AFRICA AND GULF OF GUINEA.

AHERRAMANTAH, or Harmattan, blows from the 1st of December to the middle of February, ten weeks.

Inakera, a wind upon the coast from S. S. W. to S. S. E. from the 1st of March to the equinox.

Pempina, the tornado season, from March to the end of May, about twelve weeks.

Abrenama, June and July, eight weeks, the rainy season, by the natives called the Old Man's, Woman's, and Children's season.

Atukogan. High winds and squalls, with heavy rains to the middle of August, three weeks.

Worrobokoron. The rains cease three weeks.

Mawarrah. Close foggy weather in September, three weeks.

Boutch. No land-breeze; the wind fresh down the coast for six weeks.

Antrophi. Frequent tornadoes southerly, some rain, called the latter rains, four weeks, continuing to the beginning of December, when the Harmattan commences.

(NOTE 24. *See page* 145.*)*

GENERAL METEOROLOGICAL OBSERVATIONS MADE IN ENGLAND.

THOSE who are furnished with proper instruments, and who carefully observe the information they afford, will not often be mistaken in their judgment of the changes of the weather. The barometer, the thermometer, the hygrometer, and the electrometer, will generally give us timely notice of any material changes in the state of the atmosphere. But before we consider the best, or at least the usual modes of employing these instruments, we will beg leave to mention some common remarks of the peasantry, whose professions requiring them to live much in the open air, their opinions merit very great attention, being the result of local observation, continued from father to son, and verified from the experience of many ages. Amongst the first of these is one, now established into a proverb, that a rainbow in the morning is the shepherd's warning, but the rainbow at night is the shepherd's delight.

In a country with the sea or ocean to the westward, and the wind from the same quarter, this opinion is likely to be true; for at least nine-tenths of the rain in a country so situated would come from that side. If, therefore, the clouds to the westward in the morning are saturated with moisture, which they must be to produce

a rainbow, as these clouds proceed from the W. towards the E. they probably will produce rain; whereas, on the contrary, when the sun sets perfectly clear, and the clouds to the eastward are moist, it is a proof that the wet clouds are past; with a westerly wind, and the shepherd therefore may reasonably expect fine weather on the following day.

When it rains with an east wind, it probably will rain for twenty-four hours. This is another observation, which seems to me applicable to countries situated as above mentioned, with land to the eastward; for in general the weather is dry in these countries with an east wind, but when the cohesion of the air and water is broken, the rain will not be violent, but of long duration.

The weather generally clears at noon, but when it rains at mid-day, it seldom clears up again till sun-set. The air, when dry and warm, continues to absorb and retain the moisture continually evaporated from the earth; as therefore the sun advances towards the meridian, and for an hour or two afterwards, he dries and warms the air, and consequently the rain is likely to cease at that time. But if there should be so much water in solution in the atmosphere, that the heat of the sun is not sufficient to produce these effects, in that case the rain will probably continue some hours longer.

Violent winds generally abate towards sun-set.

If we admit that wind is only a current of air put in motion by the rarefaction of the atmosphere in some particular place, and that this current of air is moving towards the point of rarefaction to restore the equilibrium, we must suppose, that as the Sun declines the rarefaction will diminish, and consequently the velocity of the wind decrease. But this observation, in my opinion, rather applies to the temperate than to the torrid zone; for in whirlwinds and hurricanes the contrary may very often occur.

When the wind follows the course of the sun, it is generally attended with fair weather. This frequent and regular change of wind, which is never more than a moderate breeze, proves that there is no point of considerable rarefaction near, and, therefore, the current of air follows immediately the Sun's course: it always happens in summer, but very seldom when the sun's meridian altitude is less than 40 degrees.

The changes which take place in the atmosphere are principally marked by the rising and falling of the barometer, which apparently is caused by heat and cold, the hands with which nature performs her meteorological operations: by the former the atmosphere is rarefied, and consequently becomes light; by the latter it is condensed, and consequently becomes heavy. Hence probably the old remark, that a storm generally follows a calm; for during a calm the air is rarefied and expanded, and the cold air will rush forward in a strong current to restore the equilibrium, and necessarily produce what is generally called a gale of wind, the violence of which also will of course be in proportion to the degree of the preceding rarefaction.

For these reasons, the barometer falls suddenly whilst the air is expanded before a gale of wind, and rises again gradually as the condensed air returns, and the gale in like manner by degrees subsides.

It must however be observed, that an extraordinary fall of the mercury will sometimes take place in summer, previous to heavy showers of rain, particularly if attended with thunder and lightning; but in spring, autumn, and winter, the sudden extraordinary descent of the barometer indicates principally violent wind.

Upon these principles likewise we may account for the rise and fall of the barometer in the different zones. In the torrid zone, particularly at St. Helena and the islands of the Pacific Ocean, it seldom varies more than three-tenths; at Madras about five-tenths; in the south of Europe not more than one inch and two-tenths; in England it varies two inches and a half, and in Petersburg three inches four-tenths. In the two first the temperature of the atmosphere is not subject to much variation, and never to any great degree of condensation. In the third, reckoning from the tropics to the latitude of 40, the atmosphere may sometimes be suddenly condensed by currents of cold air from the N. and still more so in England. But the greatest variation must necessarily take place on the continent to the northward, where, during the summer, the weather is as hot as within the tropics; and, in winter, the thermometer, for many weeks, continues several degrees below the freezing point.

The thermometer also, which measures the degree of heat in the air near the earth, will contribute towards denoting when changes are likely to take place in the lower regions of the atmosphere; the hygrometer distinguishes the quantity of moisture in

the atmosphere, and the electrometer will point out the quantity of electricity which prevails in it.

The words generally engraven on the plates of the barometer rather serve to mislead than to inform, for the changes of the weather depend rather on the rising and falling of the mercury, than on its standing at any particular height. When the mercury is as high as Fair, or at 30 degrees, and the surface of it is concave, beginning to descend, it very often rains; and on the contrary, when even the mercury is at 29 degrees, opposite to rain, when the surface of it is convex, beginning to rise, fair weather may be expected. These circumstances not being known, or not duly attended to, is the principal cause that farmers and others have not a proper confidence in this instrument.

It must also be observed, that *cæteris paribus*, the mercury is higher in cold than in warm weather, and commonly early in the morning, or late in the evening, than at noon, which seems occasioned by the obvious causes of the atmosphere being condensed by the cold of the night, and rarefied by the heat of the day.

The following observations of Mr. Patrick seem confirmed by experience.

1. The rising of the mercury presages, in general, fair weather, and its falling foul weather, as rain, snow, high winds, and storms.

2. In very hot weather the fall of the mercury indicates thunder.

3. In winter the rising presages frost; and in frosty weather, if the mercury falls three or four divisions, there will certainly follow a thaw; but in a continued frost, if the mercury rises, it will certainly snow.

4. When foul weather happens soon after the falling of the mercury, expect but little of it, and, on the contrary, expect but little fair weather when it proves fair shortly after the mercury has risen.

5. In foul weather, when the mercury rises much and high, and so continues for two or three days before the foul weather is quite over, then expect a continuance of fair weather to follow.

6. In fair weather, when the mercury falls much and low, and thus continues for two or three days before the rain comes, then expect a great deal of wet, and probably high winds.

7. The unsettled motion of the mercury denotes uncertain and changeable weather.

But to these remarks may be added, that, when the barometer suddenly falls two or three-tenths, without any material alteration in the thermometer, and the hygrometer is not much turned towards moist, a violent gale of wind may be expected. When the hygrometer inclines far towards moist, with only a trifling descent in the barometer, it denotes a passing shower and little wind; and when the barometer falls considerably, and the hygrometer turns much towards moist, the thermometer remaining stationary, and rather inclined to rise than fall, both violent wind and rain are likely to follow in the course of a few hours.

General or common Prognostics of the Weather.

Amongst these we may reckon such as are derived from birds, beasts, insects, reptiles, and plants, to which might be added great part of the wood work in houses, as doors, windows, window-shutters, &c.

Birds in general retain in the quill part of their feathers a quantity of oil, which when they feel an extraordinary degree of moisture in the atmosphere, they express, by means of their bills, and distribute it over their feathers, to secure their bodies against the effects of an approaching shower.

Swallows, in pursuit of the flies and insects on which they prey, keep near the earth in wet weather, and in dry weather, from the same cause, they fly much higher.

Domestic animals, as cows and sheep, but particularly the latter, on the approach of rain, feed with great avidity in the open field, and retire near the trees and hedges as soon as they are satisfied. In fine weather they graze and lounge about, eating and resting alternately with apparent indifference.

The pimpernel, commonly called peep-a-day, or shepherd's weather glass, closes its leaves before rain; and the down of the dandelion is much affected by moisture.

All wood, even the hardest and most solid, swells in moist weather. The vapours insinuate themselves into the pores of trees, and also into the wood-work of houses.

Insects and reptiles of all kinds seek or avoid rain according to their respective habits, by these means giving notice of every change of weather.

It is a well known fact, that before rain, particularly in summer, a strong smell is perceived from drains and common sewers, as well as from every other body emitting a great quantity of effluvia. During fair weather, even in the summer, the atmosphere readily absorbs all the vapours and exhalations from the earth until it is completely saturated, and consequently the effluvia from the bodies which emit them, will then be confined and ascend in a narrow compass, like the smoke of a chimney in dry weather, almost perpendicularly; but when the air is saturated with moisture, and becomes rarefied and expanded, as it always does before rain, the volume of air containing the effluvia will be extended horizontally, and diverge from these different bodies as from a centre, and will be sensibly perceived on all sides, but will of course be most perceptible on that to which the current of air or wind moves.

In winter, when the thermometer is between 34 and 40 degrees, the air being in a state of condensation, and the running water being warmer than the land, a mist or fog may be seen rising above the river, particularly when the air is cold and clear; but this vapour is no longer visible when the river is frozen, for though the ice be subject to evaporation, it does not yield so much vapour as water, and the water, in parting with its caloric in the moment of freezing, warms the surrounding air.

To the philosopher all objects in nature, both animate and inanimate, may afford both amusement and instruction, particularly in meteorology; but to observe them with due attention, we must quit the busy scenes of life; "and thus our lives exempt "from public haunts, find tongues in trees, books in the running brooks, sermons in "stones, and good in every thing."

(NOTE 25. *See page* 149.)

BLIGHTS.

BLIGHTS are diseases incident to plants, but affecting them variously. In some the leaves only are withered, in others the leaves and blossoms; some do not lose much either of their colour or shape, others again seem shrivelled or scorched, and very soon entirely perish. Some persons suppose, that blights come from the eastward, and others from the westward; and by many it is believed that they are frosts which descend from the upper regions of the atmosphere. Insects are often found on the trees which have suffered from blights, whence it is also imagined that some kinds of blights proceed from immense number of insects, which are bred in particular places, and are transported by the winds towards the plants which they destroy.

Experience confirms the existence of almost all these different blights. We will offer a few conjectures on the subject, and attempt to explain from what causes they are derived.

In the spring vegetation commences, and frequently in the month of April the peach and nectarine trees are in blossom. About the same time, the earth being warmed by the return of the sun, the current of air will come in strong gusts from the ocean, and produce those winds, which are generally known by the name of the equinoctial gales. The blossoms of those fruit trees, therefore, which are not sheltered towards the westward, will be blown off before the fruit is formed, and produce those blights which affect the blossoms and not the leaves But the current of air which comes from the eastward about the same season, being excessively dry, absorbs all the moisture, both on the leaves and fruit, and produces that parching kind of blight which curls up the leaves and destroys the fruit, and sometimes kills the trees themselves. When the leaves are parched, and the texture of them is broken, the perspirable matter becomes viscous, and by adhering to the leaves affords both shelter and nutriment to insects. When the young are hatched, they begin to prey upon the leaves, and if they are not removed in due time will ultimately destroy the trees. I was led to make these reflections from observations made in my own garden for seven years successively. On the north side of it is a stone wall, coped with brick, of one hundred and thirty yards in length and twelve feet high. Against this wall are planted eighteen peach and nectarine trees, one

Cressan pear, and two or three small vines, kept very closely pruned. The trees are planted in a border of four feet in breadth, on a soil of loam and black earth, of about twenty inches depth, on a gravel. The soil is nearly the same as the rest of the gardens in the valley near Cardiff. The wall is built of the same materials, of the same height, and its aspect corresponds nearly with that of other gardens, being about S. by W. or S. S. W.; and the trees are pruned by the same person who works for many other families in the neighbourhood. Nevertheless, when their trees entirely fail, these have borne regularly every year four times as much fruit as we choose to leave on the trees to ripen; and the fruit, so abundant, has likewise been of the best quality. The trees are about fourteen years old, and consist of the Magdalene, Rambouilet, Royal George, and Newington Peaches, and the Brignon, Etrange, Murray, and Roman nectarines. It may be proper to observe, that no manure is used to these trees, but every year a small quantity of pure virgin earth is put on the border, which is also dug in a good spade deep, both in spring and autumn.

As therefore the trees in my own garden have never failed, and there appears no difference between them and those belonging to my neighbours, excepting that their walls are exposed to the equinoctial gales and the east wind, from both which my wall is sheltered, I am much disposed to conclude, that the blights from which they suffer are to be ascribed to those causes.

It sometimes happens that the nectarine trees have been slightly attacked by a blight, and the peaches have escaped, though planted alternately with the latter on the same wall. As the blight parched and curled the leaves, I suppose that it came from the east in the manner above described; and it is probable, that this current of air attacked the leaves of the nectarines without injuring the peaches, on account of the superior delicacy of the leaves of the former, or perhaps from their being more porous, and suffering more from evaporation. The blight, however, has only once occurred; these remarks, therefore, are intended as mere suggestions or hints on the subject. If the nectarines should frequently suffer, and the peaches never, it may probably be ascribed to the different qualities of their leaves; but if the contrary should happen, we must then refer to some other cause.

A wall with a projecting coping is supposed to be favourable to fruit trees, in protecting their leaves and blossoms from the descent of cold dews, which early in the spring are accompanied with frost; but this plan does not seem to me entirely free

from objection; at least it appears necessary to have this a moveable fence, for when the danger of the frost is over, the descent of the dews are necessary to refresh the trees and swell the fruit, which will never come to perfection from being artificially watered. Besides in hot dry weather the expense of labour for this kind of work would be very heavy; the gardeners would not begin their work in due time; but even if we suppose them to be active and attentive, the absorbents of the leaves and fruit would take up ten times as much moisture in the course of the night, and early in the morning, as they would receive from the sprinkling of the water-pot throughout the whole day.

APPENDIX.

RISE AND PROGRESS OF THE FINE ARTS.

IF we examine into the state of the fine arts at different periods and in different parts of the globe, we shall find invariably that they have been always slow in their progress, and seldom have attained to any degree of perfection, but where they have been immediately employed in the service of religion.

In Hindustan we find immense pagodas of very remote antiquity, surrounded with buildings for the accommodation of pilgrims and travellers, and generally with reservoirs of water of great extent, all formed of hewn stone. These temples, and all their dependencies, are likewise ornamented with statues of their deities in marble, stone, and bronze, executed in a manner that would not disgrace even modern European artists. Their best and only paintings are on the same subjects, and all the rites and ceremonies of their religion, during their principal festivals, are accompanied with music and dancing, for which purpose it is well known that great establishments are formed at every pagoda in Hindustan, from the mountains of Imaus to Cape Comorin.

If we turn our eyes immediately either east or west of Hindustan, on one side we perceive Thibet and China, and on the other Persia and Egypt; in all which countries, during the earliest ages, the most stupendous and magnificent works have been erected for divine worship. If we suppose that the pyramids of Egypt were so many mausolea only, we cannot consider them as in a great measure connected with our present subject.

With respect to the Greeks and Romans, their ablest artists have always employed themselves in the service of the gods. Either the first or the second temple of Diana

at Ephesus might justly be esteemed the wonder of the world, but particularly the latter, erected under the auspices of Alexander the Great, and in which both Praxiteles and Apelles exerted the utmost efforts of their skill. " It was a structure so wonder- " fully great in its composition, and so magnificently adorned, it appeared the work " of beings more than human." Chandler's Travels in Greece.

The most splendid buildings of ancient Rome were the temples erected to their deities, and these were ornamented with the noblest works both of painting and sculpture.

After the decline and fall of the Roman empire, the fine arts were neglected by the Goths and Vandals, who, if not inveterate enemies to the heathen mythology, were at least indifferent to it; and the pure and humble religion which finally erected the banners of the cross on the ruins of the capitol, in the first stages of its progress, gave but little employment to the arts, especially when suffering, like the heathen religion, under the oppression of barbarians.

With respect to the ferocious and bigoted Mahomedans, they introduced, perhaps from Tartary, a new and elegant style of architecture, which they used in building their mosques and their appendages. To them likewise we are indebted for the preservation of some of the arts and sciences, by the translations they made of various works from the Greek and Latin; but painting and sculpture in their mosques are strictly forbidden by the prophet, and therefore had not Charles Martel stopped the progress of the Mahomedans in France, by the victory of Tours, these elegant arts would, in all probability, at this time have been almost unknown in Europe.

For some ages they remained dormant, and a few learned men and artists remained only amidst the ruins of the eastern branch of the old Roman empire; but in the middle of the fifteenth century these were driven from Constantinople by Mahomed the Second, and happily at the same time the Medici family opened an asylum for them in Italy. So that the fine arts again revived in the age of Leo the Tenth, under the auspices of the church, and by the same means very soon extended themselves over the greater part of Europe.

But the reformed religion, which has produced most admirable moral and political effects, both in Germany and England, not admitting the embellishment of sculp-

ture or painting in the churches, and limiting very much the use of music, these different arts have made a slower progress in Germany and Great Britain, than in any other Christian countries on the continent.

The protestant religion, in all its various branches, is established in North America, and the polite arts shine there at this time with only a faint reflected light. I do not presume to say, that they will not hereafter appear in greater splendour in that quarter of the globe; but without entering into the complicated question of their good or bad effects on the moral and political state of the world, we may venture to state our belief, that they will never attain to the perfection in which they formerly existed in Greece and Italy, unless they are by some means or other introduced there under the auspices of religion.

Whilst taking a cursory view of this opinion, we cannot conclude without observing, that in the only countries of America where the arts were known, when the new world was first discovered by the Spaniards, there existed a most magnificent temple of the sun at Peru, of which it is said some vestiges still remain; and likewise eight temples, situated in the centre of the city of Mexico, which abounded in works both of sculpture and painting, whilst the private houses of individuals, and even the palaces of the princes of these countries, were but ordinary buildings in comparison with their places of public worship. Thus then it appears, that in the new as well as in the old world, in both ancient and modern times, the arts flourished only in those places where they have been employed in the service of the divinity.

It was, doubtless, the sublime spirit of religion, which developed the genius of Praxiteles and Apelles, of Raphael and Michael Angelo; nor could any other cause have inspired a nation with that universal zeal and enthusiasm, which are indispensably necessary for works of such uncommon labour, magnificence, and expence, as the pyramids of Egypt, the temple of Diana at Ephesus, or even the church of St. Peter in Rome.

OBSERVATIONS ON TARTARY.

THE boundaries of Siberia and Tartary seem hitherto but very imperfectly defined, nor can they be accurately drawn, until they are correctly ascertained by actual sur-

veys; but in the geographical sketch annexed to this work, I have ventured to suggest the probable existence of a range of mountains between the latitudes of 50 and 55 degrees N. which, if they do exist, may with great propriety be considered as a natural boundary between these two extensive countries. The sources of great rivers generally lie amongst lofty mountains. In these parallels of latitude we find the Oby, the Janesei, and the Lena, and many of their contributary streams. It seems highly probable, therefore, that these immense rivers of northern Asia, which are all of them larger than the Volga, and at least equal to the Amazon or La Plata, take their rise amongst mountains nearly equal both in height and extent to the Andes, or at least to those of Russia and Lithuania.

A second range of mountains to the south of Tartary, and which extend from the Caucasus to the Imaus or Hinimalah eastward, and separate Iran and Turan from Hindustan, may be considered as the southern boundary of Tartary. The rivers which take their rise amongst these last-mentioned mountains, and pass through Hindustan and China, have already been fully described in the body of the work. According to this sketch, Siberia may include the countries N. of 50 degrees to the Frozen Ocean; and from the confines of European Russia W. to Bhering's Straits E.; and Tartary will comprize those between the latitude of 31 to 50 degrees, and from the Black Sea W. to the empire of China E.

The Siberians, according to this distribution, inhabit a barren, or rather an uncultivated country; and those to the northward live in caves, where in their present state of ignorance and poverty they are best secured from the excessive heat of the summer, and the almost intolerable cold of the winter: Nor were people so situated likely at any period to have been sufficiently numerous or enterprizing to migrate into foreign countries; but the Tartars, commonly known in the east by the name of Irangs and Turangs, who possess extensive tracts of beautiful country, interspersed with hills and vallies, were formerly a very powerful people, and either as emigrants, or conquerors, have spread themselves over every part of the old world. Under the names of Scythians, Huns, and Goths, they have conquered the Romans, seized on all their possessions in Africa, and likewise dispersed themselves over all the north of Europe.

"A few years before the birth of Christ (according to Mr. Warton) soon after Mi-
"thridates had been overthrown by Pompey, a nation of Asiatic Goths (or rather
"Huns) who possessed that region of Asia which is now called Georgia, and is con-

" nected on the south with Persia, alarmed at the progressive encroachments of the " Roman armies, retired in vast multitudes, under the conduct of their leaders, Odin " or Wodin, into the northern parts of Europe, not subject to the Roman government, " and settled in Denmark, Norway, and Sweden, and other districts of the Scandina- " vian territory. As they brought many useful arts, particularly the knowledge of " letters *, which Odin is said to have invented, they were hospitably received by the " natives, and by degrees acquired a safe and peaceable establishment in the new " country, which seems to have adopted their laws, language, and religion. Odin is " said to have been styled a god by the Scandinavians, an appellation which the supe- " rior address and specious abilities of this Asiatic chief easily extorted from a more " savage and uncivilized people."

A few centuries subsequent to this supposed irruption of the Asiatic Goths or Huns into the north of Europe, another body of them came from Asia, and after many severe conflicts with the Saxons, it is said that many of the latter established themselves in Saxony; and in the fourth, fifth, and sixth centuries formed alliances with their former opponents. About the year 449 and 450, invited by the Britons, the Saxons came over to these islands, and no doubt brought with them the laws, language, and religion of these new allies. " Alfred, in his Saxon account of the Northern Seas, taken from " the mouth of Ohtha, a Norwegian, constantly calls these nations the Orientals. " And as those eastern tribes brought with them into the north a certain degree of " refinement, of luxury, and splendor, which appeared singular and prodigious among " barbarians, one of the early historians describes a person better dressed than usual, " by saying, he was so well clothed that you might easily have taken him for an " Asiatic †."

In the ninth century, nearly about the time of Alfred, Genghis Khan appeared in Tartary, and had his descendants been as able and enterprising as himself, the Tartars

* It may be objected to these ingenious suggestions of Mr. Warton, in his Dissertation on the Origin of the Romantic Fiction in Europe, that the Tartars are supposed to have been an illiterate people so late as the fourteenth century; for Timur Lung, their emperor, it is said, could neither read nor write; but the ignorance of the sovereign is no proof of the general ignorance of a country. Charlemagne could neither read nor write, when Greek and Latin were known to many of his subjects; nor was Hyder Ally, in Hindustan, in more modern times, further advanced in literature, although he had many men of considerable erudition in every province of Mysore.

† Warton, vid. sup.

probably would have again invaded Europe between the tenth and thirteenth centuries; but happily for Europe, the principal ambition both of Genghis Khan, and also of his great successor, Timur Lung, was to conquer China and Hindustan. The discovery of gunpowder, and the constant improvement in discipline of the European armies, have secured us from the future irruptions of these eastern hordes; and the tide of conquest and civilization seems now more likely to flow in a contrary direction, from the west to the east.

The emigrations of the Goths and Huns are mentioned by the most authentic historians of these dark ages; but we may perhaps derive a further confirmation of them from an investigation of the customs, laws, religion, and, above all, the languages of these people, and by comparing them with those which now exist in Europe. In that part of Tartary situated near the Lake of Baykal, and also in the latitude of 50 degrees, between the rivers Irtish and Oby, many barrows have been discovered, similar to those which now exist on Salisbury Plain, and other parts of England. Those in Tartary are said to contain the remains of ancient warriors. The court of Russia, in the year 1764, sent workmen, attended by an armed force, to open one of those tombs: when the earth was removed, three arches of rude workmanship appeared; in the centre was found the body of a man, with his lance, bow, arrows, and sabre, the latter richly mounted, and near him was deposited, probably, his favourite horse, with a bridle, saddle, and stirrups. The body of this man was extended on a solid plate of gold, and was enveloped in a mantle ornamented with gold fringe, set with diamonds. Under the third arch were deposited the remains of a woman, distinguished also by her dress and ornaments; round the neck was a string of rubies set in gold, and the body, like that of the man, was placed on a gold plate, which, together with that of its companion, weighed forty pounds. This account, which may be thought to have the air of a romance, is confirmed by a letter from M. Demidoff to Mr. Collinson, dated St. Petersburgh, September 11th, 1764, and was extracted from La Gazette de Literature, No. 5, page 6, 1774.

From the shape and dimensions of the barrows in England and those in Tartary being exactly similar, it is highly probable they were formed for the same purposes, and by persons who have been formerly connected. But we need not found this opinion upon the single circumstance of what might be an accidental resemblance of funereal rites; for it must be allowed, that a great similitude of customs and religious ceremonies may exist amongst nations who have had no immediate intercourse with

each other; but where there is a perfect coincidence of language, and not merely in the sound, but absolutely in the sense of compound words, we can no longer resist such a positive testimony in support of a curious hypothesis.

It would be easy to adduce numberless instances of a great similarity of words in Greek, Persian, and Arabic; but almost every person knows the intercourse of various kinds which have formerly subsisted between these nations, as likewise between the Romans and the Orientals, during which time they would reciprocally borrow terms from each other, as the modern Orientals have done from the English, the French, the Dutch, and the Portuguese, and likewise the Europeans from the Orientals. But besides an infinite number of single terms, which the Saxons have borrowed from the Tartars or Persians, they have likewise taken, in some respects, the structure of their language. The terminatiou of the infinitive of verbs in both languages is the same; as likewise of the comparative degree of their adjectives, and also of their diminutives.

The Persian infinitive terminates in en, as kerden sakten, to do; ameden, to come; ruften, to go; bouden and shouden, to be. In Saxon, maken, doen, bieden, &c. In the adjectives the comparative degree in Persian ends in er; bouzourgter, kuchucter, behter. In Saxon, grooter, kliender, beeter. The reader, no doubt, will also be struck with the perfect affinity between the last comparative behter, which is entirely the same in Persian, Saxon, and English. The final syllable of the diminutive is ke, Persian, merdeke; Saxon, mannerke, a little man.

Numberless are the single Persian words precisely the same in sound and sense with the English, and evidently received by us from the Saxon; mader, a mother; broder, a brother; duckter, a daughter; berber, a barber; der, a door; magzen, a magazine, tunder, thunder; mous, a mouse; nam, a name; and bud, bad. But without dwelling on similar single terms, which abound in both languages, we will cite the word wittenagamote as an instance of a compound word of high political import, that has the same sound and signification both in Persian and Saxon. In the former it is derived from Wetten, a native country, and gemmaiet, an assembly. According to Blackstone and Hume, it is the assembly of wise men; but in both languages it literally means the national assembly.

Hence, it appears, that a great similitude may be traced between the customs, religious ceremonies, laws, and languages of the Tartars, the Saxons, and the English; and if the ties of consanguinity cannot be so easily discovered from a personal resemblance, conducted by the unerring guides of laws and languages, we may trace the origin of our parliaments through Saxony and Scandinavia to Tartary. It is very probable the Saxons derived from the Tartars the barrows alluded to; but this mode of interring their heroes is well known to have been practised by the Greeks so early as the siege of Troy, who, it is possible, adopted this custom from the Orientals.

VAPOUR ON HILLS A SIGN OF RAIN.

IT is a common remark in Cardiff, when the summits of the hills are covered with vapour, that the Old Garth has got on his night cap, and therefore it will certainly rain. The remark is very just, for the atmosphere, being already saturated with moisture, will take up no more, so that the vapour which continues to rise from the mountain of course will rest on the summit, and necessarily envelope it in a cloud, which is, therefore, a sign of rain. In vallies, the smoke of the chimney ascending rapidly is a sign of fair weather, and on the contrary, when it descends or remains suspended, for the reasons abovementioned, rain is very likely to follow.

IT is said that Æolus, who was sovereign of the Lipari islands, availed himself of this knowledge to foretel the changes of the weather; and from the truth of his predictions it was supposed he had the direction of the winds, and kept them shut up in caves in his dominions. The smoke of the volcanoes in those islands afforded him a ready means of ascertaining the variations of the wind and weather.

SUBTERRANEOUS WINDS.

IN various parts of Italy and the Valteline, according to Monsieur de Saussure, and in Dalmatia and Cyrene, according to Pliny, there are subterraneous caves, whence

issue cold winds, which blow with considerable strength during the hottest season of the year.

The first noticed by M. de Saussure comes from Monte Testaceo, situated in the Campagna of Rome. This hill is between two and three hundred feet high. The caves occupy the whole circumference of it, and the cool air comes out of the interstices of the earth, which is partly formed of broken urns, amphoræ, and other earthern vases, of which this hill seems in a great measure composed.

The coolness of the internal air seems always in proportion to the heat of that without, for example, the Abbe Nollet, on the 9th of September, 1749, found the internal air of these caves, in the afternoon, 53¾ degrees Farenheit's thermometer, whilst the external air was 72½. And M. de Saussure, on the 1st of July, 1778, found the internal air of one cave 50, and that of another 44¾, whilst the external air was 78⅛.

The next are in Ischia, further south, on volcanic ground, called Ventarolla della Funera. On the 9th of March, 1773, the internal air in these was 45, and the external 62½.

In those of St. Marino, where the summit of the mountain is one thousand eight hundred feet above the level of the sea, the internal air on the 9th of July was 45, whilst the external air was 61½.

Those of Cesi are situated six miles north of Terni. The coolness of their internal air, in summer, is always in proportion to the warmth without, and in winter the wind rushes into these caves with a velocity exactly proportionate to the temperature of the external air. Don Gieuseppe Cesi, the master of these caves, has four Latin lines to describe their history:

Abditus hic ludit vario discrimine ventus,
Et facilis miros exhibet aura jocos;
Nam si bruma riget, quæcumque objeceris haurit,
Evomit æstivo cum calet igne dies, ——

The caves of Chiavenne, in the Valteline, called the Cantines, are composed of hard steatite, lined in different parts with asbestos and flexible arimanthus. On the 5th of August the temperature of the air within them was 45, and that without at the same time was 70½.

M. de Saussure seems to attribute the subterraneous winds in these caves, and the extraordinary coldness of them, to the nature of the soil, assisted by evaporation; but in one part of the enquiry he allows that the stones of the different mountains in question are of very different kinds. The coolness of the winds, therefore, are not likely to be owing to any particular kind of stone; neither can caves, the interior parts of which are completely hidden from the rays of the sun, be subject to evaporation. But mountains are colder than plains, in proportion to their height above the level of the sea. Through those crevices or interstices, therefore, mentioned by M. De Saussure, the cold air from the interior of these mountains will, on the principle of gravity, descend into the caves, and rush out of them again at the line of least resistance, which necessarily must be where the external air is most rarefied.

Now we will suppose, that in summer the mean temperature of the interior of these mountains is 45 degrees, as is mentioned above by M. de Saussure. When the external air is, at the same time, 62 degrees, the cold air must rush out of the caves with considerable force, and increase in velocity in proportion to the increased degree of internal cold and external heat. But if we suppose that the interior of the mountains preserves the mean temperature of 45 degrees during the winter, as probably it does, when the external air in Italy is at 32 degrees, the freezing point, and that in the Valteline much below it, the cold air will of course, in that season, rush into the caves with a violence proportionate to the external cold, or, to use his own words, *En hiver au contraire le vent s'y engouffre avec violence, & d' autant plus que le froid est plus rigoureux.*

If this be a true solution of this problem, the wine merchant and the farmer may always profit by being situated in the vicinity of mountains, or even of high hills, in which, at a small expence, they may form artificial caves, to serve in lieu of magazines or barns. In these they may keep their wine or grain many years in a regular mean temperature, which will certainly preserve them from spoiling. The Romans, for example, are said to have kept their grain fifty years in subterraneous caves, called Siri; and it is not impossible that the caves of Terni and Cesi were the works of their hands. The inhabitants of the different countries in the Levant also observe the same practice at the present time.

The Cesi family, says M. de Saussure, derive great advantage from their caves, not only in preserving wine, fruits, and provisions of all sorts throughout the year, but likewise in conducting cool air, by the means of pipes leading from them into the dif-

ferent apartments of the house, and furnished with cocks placed at their extremities, which regulate the exact quantityof fresh air that is required, and thus give a freshness to the rooms, during the most violent heat of summer.

This species of luxury can seldom be required in England, but a knowledge of these circumstances may be useful to the inhabitants of all hot countries, particularly to those who live in the vicinity of hills and mountains. Even in England we may profit by the hint held out to us, of keeping our wines, grains, and fruits, with fresh and salted meats, as often as we can, in a regular mean heat.

As nearly the mean heat of all countries is in cellars, caves, and caverns, under ground, at the depth of fifteen or twenty feet below the surface, the English farmer might do well to build a barn on arches, and thus form vaults of considerable size, where he may keep his corn or potatoes all the year, without the least danger of their being spoiled, and where they would also be perfectly secure from the depredations of vermin, or the ravages of fire. The air in these vaults might be changed when necessary, as it is in the caves of Cesi, by the introduction of pipes into them. It is true, that the small farmer in England is obliged to carry his grain to market as soon as he can conveniently thrash it, in order to pay his rent, and in the mean time it will keep very well in a rick or stack. But the great farmer, who keeps a considerable quantity in store, might have it thrashed at his leisure, and keep it in these vaults, where it would continue in perfect good condition for many months, and even for many years, if necessary, without the risk of suffering, as has already been observed, either by fire or vermin. It is unquestionably the best kind of depot for that cheap, useful, and wholesome root the potatoe, which generally grows and becomes rotten when put under ground, covered only with earth, the common way of keeping it; whereas in a cellar the shoots may be broken off, and those which are decayed be easily removed, so as not to injure the others which are in a sound state.

This mode of building magazines might be adopted with singular advantage both in Bengal and the Tanjore country, which may be considered as the granaries of India. In the former they might be made in some places at a small expence by the excavation of hills, but in the latter, which is a plain throughout, they could of course be formed only under ground.

It would be no difficult matter to write an useful, and not a very small volume, on this subject. But I shall conclude this note with observing, that the same general application of hot and cold air might be greatly extended by art in all parts of the globe, so as not only to contribute very much to the purposes of luxury, but likewise to conduce greatly both to health and comfort. Few men are so well qualified for such an undertaking as the philanthropic Count Rumford.

A TABLE OF THE DIFFERENT VELOCITIES AND FORCES OF THE WINDS, CONSTRUCTED BY MR. ROUS, WITH GREAT CARE, FROM A CONSIDERABLE NUMBER OF FACTS AND EXPERIMENTS.

Velocity of Wind.		Perpendicular Force on One Square Foot, in Avoirdupois Pounds.	Terms of the Wind.
Miles in one Hour.	Feet in One Second.		
1	1.47	.005 . . .	Almost calm.
2	2.93	.020	Just perceptible.
3	4.40	.044 . .	
4	5.87	.079	Gentle breeze.
5	7.33	.123 . .	
10	14.64	.492	Fresh breeze.
15	22.00	1.107 . .	
20	29.34	1.968	Fresh gale.
25	36.67	3.075 . .	
30	44.01	4.429	Strong gale.
35	51.34	6.027 . .	
40	58.68	7.873	Hard gale.
45	66.01	9.963 . .	
50	75.35	12.300 . . .	Storm.
60	88.02	17.715	Violent hurricanes, tempests, &c.
80	117.36	31.490 . .	
100	146.70	49.200	

SYNOPSIS OF THE WINDS AND TEMPERATURE AT ALEPPO.

MONTHS.	East.	West.	North.	South.	N. E.	S. E.	N. W.	S. W.	Thermometer. Greatest Heat.	Least Heat.	Mean Heat.	
1747.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.				
September 21	...	3	...	...	...	..	6	1	85	78	81½	
October	1	3	...	...	3	1	5	1	83	69	76	
November	4	5	...	...	5	3	7	4	72	60	66	
December	12	1	1	...	9	1	6	1	61	53	57	
1748.												
January	1	1	4	1	16	...	4	4	55	51	53	Mean 68½
February	2	5	1	...	9	1	4	6	60	49	54½	
March	4	6	2	...	13	...	4	2	63	52	57½	
April	5	5	3	1	5	...	9	2	72	58	65	
May	2	12	...	2	1	2	11	1	80	66	73	
June	...	17	2	...	...	...	9	2	82	75	78½	
July	...	5	2	...	...	...	17	7	88	78	83	
August to	...	8	1	...	..	...	11	11	84	79	81½	
September 14	...	3	1	...	2	2	3	3	83	78	80½	
	31	74	17	4	63	10	96	45				

MONTHS	East.	West.	North.	South.	N. E.	S. E.	N. W.	S. W.	Thermometer. Greatest Heat.	Least Heat.	Mean Heat.	
1748.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.				
September 24	...	...	3	...	...	..	4	...	81	74	77½	
October	3	5	9	2	5	...	7	...	81	68	74½	
November	5	3	7	1	5	1	8	...	71	57	64	
December	4	2	4	1	8	5	5	2	57	50	53½	
1749.												
January	7	2	3	3	6	1	3	5	56	50	53	Mean 68
February	7	4	3	...	3	...	5	6	56	50	53	
March	...	10	2	...	5	1	8	5	58	51	54½	
April	3	8	3	1	2	3	7	3	73	55	64	
May	2	9	2	...	4	...	11	3	75	64	69½	
June	...	11	1	...	...	...	17	1	84	73	78½	
July	...	18	...	...	...	...	5	5	86	72	79	
August to	1	18	...	...	...	...	5	6	85	77	81	
September 21	...	8	1	1	...	1	7	3	86	74	80	
	32	98	38	9	38	12	92	39				

OBSERVATIONS ON THE TWO PRECEDING TABLES.

FROM the first of these tables it appears, that the prevailing wind at Aleppo is the N. W. which blows more than half the month of July, and more than a third of May and August, but only four days in the months of January, February, and March, at which times the N. E. wind prevails. In May and June the westerly wind seems prevalent, but in June seventeen days of W. wind, nine of N. W. two of N. and two of S., include the whole month: hence it is evident that the year is divided by one hundred and four of easterly, and two hundred and fifteen of westerly wind, seventeen of N. and four of S. The rest were omitted in the original table. The former prevails from the beginning of December to the end of March, and the latter comprehends the remainder of the year, being most common in the hot weather, from the end of June to the beginning of September. The second table differs but little from the first, but there is rather a larger proportion of westerly wind in the latter. The mean heat of the four cold months, from December to March, is $55\frac{1}{4}$; that of the four hot months $80\frac{1}{4}$; and of the temperate months $56\frac{1}{8}$. But in order to ascertain how far this account of the winds corresponds with the general theory, we must make a few observations on the situation of Aleppo, and endeavour to discover the points of rarefaction and condensation, whence these currents of air proceed.

The city of Aleppo is situated in the latitude of 35° $50'$ N. and about 57° $20'$ E. longitude from London. It is built on the edge of the Great Desert, which lies to the E. N. E. and S. E.; the sea, with a mountainous country and the Black Sea being to the N. and N. W.; the mountains of Armenia, Mingrelia, and Circassia, to the N. by E. and N. N. E.; and the deserts of Africa to the S. E. with the mountainous country on the coast of the Mediterranean to the S.

In the cold months the temperature near Aleppo will be much higher than that of the countries to the N., and, consequently the current of cold air will move towards this place from the frozen mountains of Caucasus, to restore the equilibrium. In the hot months, on the contrary, the land in all the surrounding countries is much hotter than the sea, therefore as the air over the desert to the east, at this season, will be much rarefied, the nearest body of cold air will come from the sea to the W. or from the Black Sea to the N. W. to restore the equilibrium; but at other seasons the wind will be more variable, for the temperature of the land and sea being nearly equal, that is about 56 degrees, the current of air will move different ways, in the manner specified in the table.

ELECTRICITY.

IT is well known from experiment, that the motion of the electric fluid is restrained in dense air, but moves with great freedom in that which is rarefied, and is most active in vacuo. Hence some philosophers have inferred, that at a great height in the atmosphere, where they suppose the air is most rarefied, the electric fluid is most active; but, in fact, the higher we ascend in the atmosphere above the immediate influence of the internal and reflected heat of the earth, the more cold and dense the air becomes. Snow and ice, from this cause, remain perpetually on the summits of very lofty mountains. In every latitude, however, there is a point at which all vapour freezes, and thence it is called by Mr. Bouguer and others, the lower term of congelation of that latitude. The distance of this point from the level of the sea at the equator is fifteen thousand five hundred and seventy-seven feet, but it gradually diminishes from thence to the pole; so that half way between them, in the latitude of 45 degrees, the point of congelation is seven thousand six hundred and fifty-eight feet, and in the latitude of 80 degrees it is estimated at only one hundred and twenty feet. It cannot therefore with propriety be said, that in all latitudes the electric fluid will move with most activity in the higher regions of the atmosphere. In the polar regions, for the reasons abovementioned, it will be considerably checked by the density of the air; and when it has passed the second term of congelation, which, according to the same author, does not exceed twenty-eight thousand feet at the equator, and is only two hundred and seven feet near the pole, it will reach those regions which, according to most philosophers, are filled with air extremely rare, or perhaps with ether. In such a medium it will move with unrestrained activity. These principles, clearly understood, will serve to explain the causes why lightning is more frequent and violent in the torrid than in the temperate zone, and why it regularly decreases from thence to the pole.

It has already been shown that the lower term of congelation near the equator is at a considerable height from the level of the sea, and therefore it cannot in any degree affect the inferior current of air in places thus situated. Here then the atmosphere near the earth will be considerably rarefied, and consequently the electric fluid will at all times be most active in those countries. This serves to account for a fact well known to all navigators of tropical seas, that in crossing the line, particularly near land, mariners invariably meet with sudden and violent squalls, attended by thunder, lightning, and rain, and generally with water spouts. These are common on the

coast of Guinea, and amongst the islands to the eastward of the Gulf of Bengal, and particularly in the Streights of Malacca. They are least frequent and violent about the time of the solstices, when the sun is furthest from the equator, which is also an additional confirmation of this hypothesis.

For the same reasons we seldom have lightning in England, except in the middle of summer or the beginning of autumn, and never in winter or spring, unless the atmosphere has been previously rarefied by an unusual degree of heat, the effect probably of an extraordinary quantity of electric fluid having been disengaged from the earth.

In the higher latitudes of the temperate zone, but above all in the polar regions, the activity of this fluid must, near the earth, be checked by the cold derived from the great proximity of the lower term of congelation; but when it has passed the upper term of congelation, which, as it was before observed, in the latitude of 80 degrees, is only two hundred and seven feet from the level of the sea, it must produce appearances such as we perceive in an exhausted receiver, and which perfectly resemble those of the aurora borealis.

In this manner, perhaps, we may venture to account for the northern lights being visible in high latitudes only. They are seldom seen in this country, and then at a great height, and are consequently faint; but within the arctic circle they are said to be so common, as to afford almost constant light to the inhabitants of those cold regions during their long winter, which begins in October, and does not end till March.

The southern lights, observed by Mr. Forster in his voyage in that hemisphere, and which he represents as much paler than those to the north, may have appeared more faint to him from having been seen at a great distance; or it is possible that the electric fluid from the earth, in the arctic circle, may be more red and brilliant than that which proceeds from the mountains of ice in the antarctic circle.

THE END.

INDEX.

Page

A.

ADAMS, his experiment to show the nature of wind 30
Africa, why it has but few rivers . . 143
——— its future state considered . . 144
Air, observations on 195
Aleppo, synopsis of the winds and temperature at 227
Algiers, meteorological register kept there by Mr. Shaw 108
Amur, its rise 139
Aurora frigate, loss of the 122

B.

Bacon, Lord, illustration of his hypothesis 153
Blights 212
Bona Ventura, homeward-bound, from China to Ostend, journal of the . . 161
Brahmapooter, its rise 138
Brownrig, Dr. his statement of the evaporation which takes place in England 101

C.

Cape of Good Hope, great caution to be observed by Indiamen, outward-bound, after they have rounded the Cape 120
Cape of Good Hope likely to become the emporium of the world 144
—— Meteorological observations made at 164
Cato, loss of the 122
Clare, Mr. his experiment to show the cause of land and sea breezes . . . 44
Cold produced by evaporation 191
Comparative abstract of the different outward-bound voyages of the Harcourt, Notre Dame, du Monte Carmel, and General Coote 158
Comparative abstract of the different homeward-bound voyages of the General Coote from China, Phœnix from Madras, and Bona Ventura from China 163
Currents in the Indian Ocean 124
——— in the Gulf of Sind . . . . . ib.
——— in the Bay of Bengal . . . . ib.
——— in the ocean 201

D.

De la Bourdonnais 195
Desert of Arabia, account of the winds which prevail there 82

Page

Dews, why more abundant in summer than in winter 92
Doddington Indiaman, wrecked near De Lagoa Bay 120

E.

Eclipse of the sun, why, when it takes place, we are to expect a difference in the motion of the air 114
Electricity 229
———, according to Dr. Franklin and others, is the immediate cause of the precipitation of rain . 106
Etesian Winds, their salutary effects noticed by Cicero 78
——— what time they commence in the Mediterranean . . . ib.
Ethiopian Ocean, the early Portuguese, and other European navigators, greatly obstructed in their voyages by not keeping the mid-channel 37
Euphrates, its rise 136
Evaporation, experiments respecting it very uncertain 104
——— greater in the south of Europe than in the north 105

F.

Fine arts, rise and progress of 215
Fogs, cause of them in Autumn . . . 110
Franklin, Dr. his account of the formation of the clouds and precipitation of rain 47
——— his account of whirlwinds 65
Franklin, his account of a current of air which moved many hundred miles in America 112

G.

Gagnier, J. his table of the daily increase of the Nile 181
Ganges, its rise 137
General Coote Indiaman, outward-bound from England towards Madras, journal of the 156
General Coote Indiaman, homeward-bound from China towards England, journal of the 159
Geneva, table of the electrical state of the atmosphere there 199
Gulf of Bengal, whence so called, and its boundaries 40
Gulf of Sind, substituted as a term for the Gulf of Arabia, or Indian Sea 41
Gulfs of Persia and Arabia, description of the different winds which prevail in these gulfs 72

H.

Halley, his theory respecting the trade winds 30
——— on evaporation 103
Harcourt, English East Indiaman, abstract of the journal of the 154
Harmattan, appearances which attend this wind 82
——— its commencement and duration in the interior of Africa . ib.

Page

Harmattan, said to stop the progress of epidemic disorders 82
——— its course in the Gulf of Guinea 84
——— absorbs the moisture of vegetables 86
Heat in Bengal 105
—— mean heat in London 95
Hoambo, its rise and course 139
Hurricane, description of that which destroyed Le Bourdonais' fleet in 1746, on the Coast of Coromandel 57
——— description of that which happened near Wandiwash, on the 31st of October, 1753 58
——— description of that which occurred on the 30th December, 1760, during the siege of Pondicherry . . . . . ib.
——— account of that which took place in October, 1763, in the Madras Roads 59
——— description of that which occurred on the coast of Coromandel, in October, 1768 60
——— description of that which happened during the S. W. monsoon on the coast of Coromandel, in April, 1749 62
———description of one near the French Islands, in the year 1770 . 63
Hurricanes never happen at the breaking up of the monsoons, nor precisely at their commencement, but sometime after the change . . ib.
Hurricanes are local and of short duration . . . . . ib.

Page

Hurricanes, not ascribable to any particular situation of the sun in the ecliptic, nor are they periodical . . 65
——— most frequently happen near large bodies of land, and are not known at sea within the tropics 66

I.

Indus, few rivers have attracted more attention in ancient, or less in modern times 136
—— how far the northern branches of this river extend . . . . . ib.
Islands of Bermudas 177

K.

Khumseen, the S. W. monsoon, so called by the Arabs, and the reason given for it 73
Kiang, its source 140
—— proverb of the Chinese relative to this river . . . . . ib.

L.

Land and sea breezes only extend three or four leagues from the shore 43
Land wind, hot, cause of that which prevails in the Carnatic in May and June 53
Lavoisier, his discovery of a new fluid called caloric 129
Lima, neither thunder, lightning, nor rain known there 107
—— cause of no rain at 194

Page

Lind, Dr. and Mr. Park, at variance with respect to the salutary effects of the Harmattan 83
Long Shore Wind, why so called . . 52

M.

Madras, observations on the weather at 170
——— table of the thermometer and barometer kept there for fourteen months 173
Magnetic Needle, declination of it observed in London 193
Mairan, Mons. de, his opinion with respect to the internal heat of the earth 128
Mansfield Woodhouse, synopsis of the weather there for ten years . . 192
Mediterranean Sea divided into two parts 77
Meteorological table kept in England for ten years 95
——————— observations applicable to Great Britain 145
——————— observations made in England 206
Mistral 189
Monsoons, new division of the different oceans, seas, and gulfs, where the monsoons prevail, with their names and boundaries. 40
Monsoon, its mistaken etymology noticed 39
——— account of the N. E. monsoon on the coast of Coromandel 42

Page

Monsoon, account of the S. W. monsoon in the island of Ceylon 52
——— commencement of it . . . 173
Monsoons, description of those in the Mosambique Channel 68
———, description of those in the China Seas 71

N.

Names of different countries in the East Indies, origin of 168
Navigators of India ships, outward-bound, remarks on the practice of some of them 119
Nile, its source 73
—— how supplied with water . . . 74
—— observations on the 180
—— Signor Gabrielli's account of the Nile for thirty years 180
—— daily increase of the, from June 29th, to July 31st, 1714 181
Notre Dame du Monte Carmel, nearly lost on the coast of Madagascar . . 121
——— abstract of the journal of the 155

O.

Ocean, how supplied with salt . . . 132

P.

Peninsula of India and South America, their resemblance to each other 50
Pensylvania, miscellaneous observations relative to the western parts of 204

Page

Persians, probably the first navigators of the Indian, and perhaps the China seas 72
Phœnix Indiaman, homeward-bound from Madras towards England, journal of the 161
Portuguese succeed the Persians in the art of navigation, and adopt the sea terms of their predecessors . . 72
Prince of Wales Indiaman, falls in with the land about midnight near St Augustine's Bay 120

R.

Rain, an attempt to account for the quantity which falls every year in India 46
—— why it is more abundant in South America than in India 51
—— why it is so rare in Egypt . . . 93
—— in England supplied by evaporation from the Atlantic Ocean . . 97
—— average quantity which falls at Ambleside in Westmorland 98
—— statement of the quantity which fell in London in 1797 . . . . . ib.
—— to what causes the proportions of rain in different parts of the globe are to be ascribed 100
Rain in Britain, the greatest quantity falls in July 145
Rain gauge does not ascertain the quantity of rain that falls with sufficient precision 102
——— Dr. Heberden's experiments with it 106
Rhine, its source 134
Rivers, formation and course of . . . 203
Rooke, Major Hayman, his meteorological table kept in England . . . 95
Roy, Mons. Le, his account both of the winds which are favourable as well as unfavourable to evaporation in France 102
Russia, climate of 203

S.

Sahara, the desert of Arabia so called 81
Saltness of the ocean, its primary cause has been the subject of much discussion 133
Seasons, only two in tropical countries 39
——— whence their connection proceeds 90
Ships, India, what times would be the most eligible for their departure from this country 119
Sirocco 187
Snow melting on lofty mountains is noticed by Pliny as affecting the winds 39
Solsticial rains, their effects on the hay harvest near London, and in Glamorganshire 145
Sounds 197
Sparrman, Andrew, M. D. his meteorological observations made at the Cape of Good Hope 164
St. Jean Baptiste, French Indiaman, lost near St. Augustine's Bay . . . 121
Sumyel, a wind in the Desert of Ara-

Page

bia, which often proves fatal to animal life 82
——— derivation of the term 86
——— how it differs from the Khumseen and Sirocco . . . . . ib.
——— appearances which precede and accompany it 87
——— in what manner its dreadful effects are best avoided . . . . . ib.
Sun, emanation of its heat does not reach far beneath the surface of the earth 128
Surf on the coast of Coromandel during the S. W. monsoon, to what causes it may be attributed 125

T.

Tartary well deserves the attention of the philosopher and historian . . 135
——— observations on 217
Tartary and South Siberia, the climates of these countries erroneously supposed too cold to admit of great improvement in agriculture 141
Temperature of the two hemispheres 176
Thermometer, how affected in the Carnatic, during the hot land-wind 54
Tides in the atmosphere 114. 197
Tigris, its rise 136
Tuphan, a sudden gust of wind, so called in the southern part of the Delta, with the appearances which precede and accompany it 56
Typhon, its etymology 72

Page

U.

Universal language 178

V.

Vapour on hills a sign of rain 222
Volney, Mr. five problems of his . . . 89

W.

Water, what quantity evaporated from the Mediterranean in one day, according to Dr. Halley's calculation 103
Whirlwinds 174
Wind, its definition 29
——— why the north wind most frequently blows throughout the Mediterranean 90
——— why the easterly winds return regularly after the equinoxes, and why the winds are at this period in general higher 91
Winds, view of those which blow between the two great continents of Africa and America 34
Winds, explanation of those within the tropics 39
——— observations on those in the Gulf of Bengal 41
Winds, in the west part of Africa and Gulf of Guinea 205
——— subterraneous 222
——— table of their different velocities and forces 226

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