pressure, temperature, and density of the air being known, we ought to be able to follow the isotherms and adiabatics through the varying conditions in cyclone and anticyclone at all levels. Thus Hertz has given the adiabatics for the dry, rain, and hail stadia, and it is practicable to follow a given air mass through the varying thermodynamic conditions.

ELECTROMETRY.

Proper apparatus for measurements in atmospheric electricity.

Mascart-Kelvin electrometers for the determination of the potential of the air. The type of voltmeter known as the multiple quadrant electrometeter, or substantially Lord Kelvin's air Leyden, should be installed with an automatic register for continuous records of the electrification of the air.

Elster and Geitel's apparatus, modified, for records of the air "leakage" of electrical charge under the influence of ultra-violet light.

Brontometer, for use in the study of the strains and stresses in air between highly electrified clouds or cloud and earth. The name brontometer is used, but some more appropriate type of instrument than the present is desired. It now gives the time of each lightning flash, the duration of thunder, the changes in direction and force of the wind, in temperature, humidity, and barometric pressure during a thunderstorm; but there is wanting the photographic auxiliaries to delineate the character of each discharge. The true character in space and the dimensions of the discharge are determinable by such means. The potential fluctuations added to such data will enable us to study the strains and ruptures in the atmosphere after the thunderstorm as completely as a plate of fractured armor can be stbdied after a test.

PHYSIOLOGY AND BIOLOGY.

The known properties of atmospheric air are clearly of great importance in all physiological and biological research. In the latter, atmospheric environment must be an effective factor in the variation of species, and in the former, at the very outset, do we not meet an intimate relation between the irritability of nerve and muscle and atmospheric conditions? How important to know the atmospheric conditions as influencing exhilaration and fatigue. The so-called "sensible" temperature, for example, enables one to live in the temperatures of the Northwest in winter, and renders temperatures higher by 30° elsewhere unbearable.

Such a laboratory, then, studying the properties of atmospheric air, would, we firmly believe, influence research in every department of applied science. In agriculture the value is apparent; in economics, history, hygiene, botany, geology, and biology questions now unanswered would be disposed of. In that much-dreamed-of consummation, the conquest of the air, when transportation shall be by air ships and communication by air runners or disturbances of the electrified air, the contributions to knowledge from such a laboratory would be incessant and without price. Aye, in directions now unthought of, the aero-physicist would push onward in the great region now unexplored.

SUNSTROKE IN CALIFORNIA AND ARIZONA.

By W. F. R. PHILLIPS, M. D., in charge of Section of Climatology.

The topic for this paper was evolved from the statistics collected when investigating the sunstrokes of August, 1896, a report on which was published in the MONTHLY WEATHER REVIEW for November, 1896.

During a considerable part of the month of July, 1896, the Pacific States suffered from a somewhat protracted spell of hot weather, during which, as will hereinafter appear, a number of cases of sunstroke occurred. The importance of this latter fact subsists in the peculiar reputation that the climate in general of this region has all along borne in respect to sunstroke. It is popularly supposed that sunstroke in the dry and hot climates of Arizona and California, and of the Cordilleran Region in general, is an extremely rare occurrence; indeed the statement is occasionally made that it never occurs in them.

Hirsch, in his magnificent work on geographical and historical pathology (Handbook of Geographical and Historical Pathology, Vol. III, 1886), expresses the current opinion of the day as to the freedom of the Trans-Rocky Mountain Region from sunstroke. He says:

In remarkable contrast to the frequency of the seizure in those parts of the North American Continent of which we have spoken heretofore [the Atlantic Seaboard and Central States], is the comparative immunity of the Pacific Coast. According to Blake and Gibbons there was hardly anything heard of sunstroke among the gold diggers in California.

The care, patience and labor with which Hirsch collected statistics, and the conservatism and ability with which he compiled and discussed them, give to his statements great authority. How far the reputation of the Pacific Region for immunity from sunstroke may rest upon the currency of any of these statements it is not the object of the writer to discuss. It is, however, proper to observe that the authorities, Blake and Gibbons, upon whom Hirsch rested his statement as to the frequency of sunstroke in the Pacific Region, wrote, respectively, in 1852 and in 1857, when this vast region was but beginning to have a population, and when (considering the peculiar circumstances and excitement attending the rush of people to the gold fields) it is highly probable that little attention was paid to careful registration of statistics regarding disease and its correlated phenomena.

The census of 1850 gave California a population of 92,597; in 1860 the population of Arizona, then a county of the territory of New Mexico, was given as 6,482. To-day California has more than 1,200,000, and Arizona, perhaps, more than 60,000 inhabitants. The populations of the other states and territories comprised in the Cordilleran Region have also increased greatly since Blake and Gibbons wrote.

In weighing the statements concerning the climatology of this region by early writers, we should take into consideration the sparsely settled condition of the country, the character and mode of life of its earlier settlers, the virginity of the soil and its freedom from the contaminations that accompany density of population, the lack of means of ready communication and the probable want of system in recording and registering the facts pertaining to the medical climatology of the country.

As relevant to the special subject of this paper the following extracts from two California journals are taken from issues just prior to the termination of the very hot weather previously referred to:

All over the great interior valleys of California men and women have succumbed to the terrible heat of the fire month. Fresno, Merced, Bakersfield, Stockton, Sacramento, Los Angeles, San Bernardino, Riverside, and many other towns have furnished victims for the prostrating solar rays. * * * The heat was not greater than has often been encountered before, but the atmosphere lacked that dryness which has always been the pride of California, and as a result thermic fever has claimed its victims by scores. * * * So thoroughly grounded in the old practitioner is the belief that in California "neither hydrophobia nor sunstroke" is ever encountered, that it is only after the most indubitable evidence that we can be persuaded to call the dread heat stroke by its proper name.—*San Francisco Examiner, July* 26, 1896.

The heated term commenced July 3 and lasted nineteen days. The first victim was J. Pellegrini, a laborer on the Valley road, who died at Herndon. Joe Toma, an employee at the City Bakery, succumbed to the heat a few days later. Then came in rapid succession the deaths of Lena Johnson, of Easton, John Stokes, and James Downing.

Such a record has never occurred in the history of Fresno, even in the hottest summers. The usual percentage of sunstroke cases in the country is so small that it is not worth consideration. * * * Weather Observer Bolton says that a striking feature of the three weeks' spell was the number of warm nights. Usually there are only about three nights in July when it is difficult to obtain sleep, the temperature usually falling to 60° with a refreshing breeze. In the past three weeks, however, a temperature of 75° and upward was noted on nearly every night from the 4th to 13th, inclusive. * * * the humidity was also higher than for eight years past, being as high as 55 to 65 per cent in the mornings.—*Fresno Daily Evening Expositor, July* 24, 1896.

The following statistics of sunstroke in California and Arizona were obtained in response to the circular issued by the Chief of the Weather Bureau, August 20, 1896:

Phœnix, Ariz.......	6	deaths from sunstroke.	
Fresno, Cal.........	4	" " "	
San Luis Obispo, Cal.	1	" " "	
Red Bluff, Cal.......	1	" " "	5 cases recovered.
Total...........	12		5

Total events 17.

All the above sunstrokes occurred in July, 1896, with the exception of two of the deaths at Phœnix, Ariz., one of which occurred in June and the other in August.

The authorities for the above statistics are for Phœnix, Ariz., A. M. Tuttle, City Health Officer; Fresno, Cal., Dr. C. H. Adair, County Health Officer; San Luis Obispo, Cal., Dr. G. B. Nichols; Red Bluff, Cal., Drs. G. W. Westlake, J. A. Owen, and John Fife. Therefore, on excellent information, we have for several localities in California knowledge of eleven cases of sunstroke, and for one locality in Arizona of six cases of sunstroke, in all seventeen cases, fifteen of which occurred during the hot weather that prevailed over the Pacific Region during a part of July, 1896.

The following comparison, instituted between the sunstrokes occurring in the Cordilleran Region during July, 1896, and those occurring in the Appalachian Region in August, 1896, is deemed of sufficient importance to bring to notice.

Death rate from sunstroke per 100,000 *of population, calculated for the several localities and months.*

Place.	Month.	No. deaths from sunstroke.	Population, census 1890.	Death rate.
New York / Brooklyn	Aug., 1896	1,045	2,321,644	45
Philadelphia	Aug., 1896	218	1,046,964	21
Baltimore	Aug., 1896	98	434,439	23
Boston	Aug., 1896	66	448,477	12
Total		1,427	4,251,524	33
Fresno County, Cal. (including Fresno)	July, 1896	4	32,026	12
San Luis Obispo County, (including San Luis Obispo)	July, 1896	1	16,072	6
Tehama County (including Red Bluff)	July, 1896	1	9,916	11
Total		6	58,014	10
Maricopa County, Ariz (including Phœnix)	July, 1896	4	10,986	36
Total		10	69,000	14

In the preparation of the above statement regard has been had simply to the statistical facts as reported. In order that the rates shown for each locality might be as fairly comparable with one another as practicable, they have been calculated for deaths only and for the populations as given by the census of 1890. No allowance has been made for any change in population since that time. These rates are, therefore, probably a little too great in every instance. The reason for using deaths instead of cases is that the information regarding the former is more complete.

On their face these rates show that sunstroke is about as frequent in certain localities of California and Arizona as it is in some of the large cities of the Atlantic Coast States.

Although the statistics are few and for this reason the facts that they bring out may be regarded by some as without significance, yet they seem to intimate that we may, perhaps, hear more of sunstroke in the Cordilleran States as the densities of their populations approximate those of the Atlantic and Central States, just as we are now hearing of the development of phthisis in climates where for years it was supposed that it was impossible for tubercular disease to originate.

These statistics, when considered in conjunction with the meteorologic conditions prevalent at the time, may be held to demonstrate that the causation of these particular sunstrokes was not high relative humidity, as suggested by some of the western daily papers. To prove this proposition it is only necessary to show that the meteorologic conditions were at the time such as to permit a free evaporation of the perspiration.

Selecting the stations for which we have meteorologic data, *i. e.*, Fresno, Cal., and Phœnix, Ariz., and only those days upon which sunstrokes were reported and selecting out of these only that day which had the highest relative humidity we find the following: The days of highest relative humidity of those on which sunstroke occurred were at Fresno, July 11, and at Phœnix, July 13. The meteorologic conditions with respect to temperature, humidity, and wind movement on these days were as follows:

	Mean temperature.	Mean dew point.	Mean relative humidity.	Total wind.
	°	°	*Per cent.*	*Miles.*
Fresno, Cal., July 11	94	47.5	25	175
Normal for July	85	44	24	....
Phœnix, Ariz., July 13	90	66.5	56	118
Normal for July	90	63	41	....

These meteorologic conditions, upon their face, appear favorable for evaporation, and the following confirms this conclusion:

Fitzgerald has given an empirical formula for calculating the amount of water evaporated from a surface of water under any given meteorologic conditions. This formula was deduced from a series of accurate observations made from 1876 to 1882 at the Chestnut Hill Reservoir, near Boston. The formula is approximately (Report C. S. O., 1887, part 2, p. 376):

$$E=0.0166\,(V-v)\,(1+\tfrac{1}{2}W)$$

in which

E = the depth of water in inches evaporated in one hour.

V = vapor pressure in inches of mercury corresponding to the temperature of the water.

v = vapor pressure corresponding to the dew-point in the free air.

W = velocity of wind in miles per hour at the level of the water surface.

In the evaporation of the perspiration of the human body we may take for granted that the temperature of the perspiration will be the same as that of the skin, and we may assume, without much likelihood of error, that on a very warm day the temperature of the skin is between the average temperature of the body, 98°–99° F., and that of the wet-bulb thermometer. We shall be safe in saying that the temperature of the perspiration under the meteorologic conditions above stated was at least as high as 90°. Taking 90° then as the temperature of an evaporating surface of water Fitzgerald's formula shows that from a perfectly wet surface, exposed under meteorologic conditions as they existed at Fresno, July 11, 1896, and Phœnix, July 13, 1896, there would have been evaporated in twenty-four hours a layer having a depth of 1.95 and 1.2 inches, or from each square foot of surface about 276 and 173 cubic inches of water, respectively.

The superficial area of an average man is given as 16 square feet, therefore, from such a surface and under these assumptions, there would have been evaporated in twenty-four hours at Fresno, July 11, 1896, and at Phœnix, July 13, 1896, something like 18 and 16 gallons, respectively.

After making due allowance for the effects of clothing, and for the fact that all the superficial surface of the individual is not equally exposed to evaporative influences, and also for the fact that at the level in which man habitually moves the velocity of the wind is somewhat less than that given by Weather Bureau anemometers, it would yet seem that at Fresno and Phœnix, on the dates specified, a man could have evaporated from three to four times as much water as would have been normally supplied by the perspiration, and, therefore, that the causation of sunstrokes upon those days could not have been due to any meteorologic obstacle in the way of the evaporation of the water of perspiration. In other words these sunstrokes were not caused by the traditional high relative humidity. Without going into details it can be stated that practically the same argument applies to the other days and places.

From a consideration of the various statistics from different localities that have come under the writer's notice, it seems that sunstroke is as frequently associated with a very low relative humidity as it is with a very high relative humidity. Apparently the first one to call attention to the occurrence of sunstroke with a low relative humidity was Dr. A. J. Miles, of Cincinnati, in a paper read before the American Public Health Association in 1881 ("Sunstroke Epidemic of Cincinnati," Public Health, Vol. VII), and this present paper confirms his statements.

RELATIVE HUMIDITY INSIDE AND OUTSIDE OF BUILDINGS.

By A. J. HENRY, Chief of Division of Records and Meteorological Data.

In Weather Bureau Bulletin No. 19—Report on the Relative Humidity of New England and Certain Other Localities—some results are given of observations on the relative humidity within and without the Weather Bureau building in Washington, D. C. The conclusion there reached was that outside hygrometric observations could not be depended upon to give the humidity conditions within, except when the temperatures outside and inside were substantially the same.

The observations, as will be seen by a reference to the bulletin above mentioned, consisted in a simple determination of the relative humidity of the air in the observer's office and in the standard thermometer shelter on the roof. They were continued from the date of publication of the bulletin above mentioned, April 22, with a few interruptions, to June 18, 1896.

The new material confirms in a general way the conclusion heretofore reached. It is worthy of mention, however, that while there is close agreement between the relative humidity inside and outside, so long as the temperatures are the same, many cases will arise when the inside and outside temperatures differ by a considerable amount even in the warmer part of the year.

The greatest differences between the relative humidity inside and outside are found when the outside air is saturated, or nearly so, and, also, after a period of rain, when the temperature of the outside air has fallen considerably below the temperature of the room. During the period included between the dates above mentioned the differences between outside and inside (outside—inside) ranged from 36 per cent below to 28 per cent above; that is to say, the inside fell 36 per cent below the outside on one occasion and rose 28 per cent above it on another.

On 14 days out of the 45 (31 per cent of the time) the variation was over 10 per cent at the hour of observation, 2 p. m.

It is obvious, from a consideration of the weather conditions at the time some of the greatest differences were observed, that better ventilation, or perhaps a more perfect mechanical mixture of the air outside and inside, would have resulted in a closer agreement between the calculated humidity values.

The observations were made originally for the purpose of determining how far the ordinary hygrometric observations made in standard roof shelters could be safely used as indicating the probable moisture conditions in cotton mills in the immediate vicinity. It has been shown that the variation in a closed room is much smaller than in the open air as would naturally be expected, and that the agreement between the humidity of a room and that of the outside air depends almost wholly upon the amount of ventilation and the temperature of the room. It is possible, of course, to increase the moisture in a room much beyond the natural amount, but it will always be necessary to provide for a renewal of the air at short intervals, since the limit of endurance in a still, hot and damp atmosphere is soon reached.

Relative humidity inside and outside of the Weather Bureau building, Washington, D. C.

Date.	Dry thermometer.		Wet thermometer.		Relative humidity.	
	Inside.	Outside.	Inside.	Outside.	Inside.	Outside.
1896.	°	°	°	°	*Per ct.*	*Per ct.*
March 2	72.0	39.0	54.0	36.0	28	75
4	67.5	38.0	50.0	32.0	26	50
5	71.0	41.5	52.0	36.0	24	58
6	74.0	45.5	54.0	40.5	33	64
7	74.0	60.5	56.0	54.5	30	68
9	73.0	46.5	54.0	42.5	25	72
10	70.0	45.0	53.5	39.5	27	61
11	71.0	33.5	56.0	33.5	37	100
12	69.5	27.5	52.0	23.5	26	54
13	72.0	30.0	55.0	27.0	31	67
14	72.0	32.2	53.5	26.0	26	38
16	72.0	33.5	57.0	33.5	38	100
17	68.0	37.0	53.0	33.0	34	66
19	73.0	62.0	63.0	58.0	57	79
20	70.0	36.5	54.0	32.0	33	62
21	73.0	43.0	55.5	39.0	30	70
27	72.0	40.0	55.0	32.0	31	38
28	74.0	49.5	54.0	41.0	33	46
31	74.0	58.0	38.0	50.0	36	56
Mean	71.7	42.0	53.7	37.3	32	64
April 7	70.0	41.0	53.0	34.0	29	46
8	73.0	66.0	54.0	38.0	25	46
9	66.0	50.0	51.0	40.0	32	38
10	72.0	43.0	58.0	40.5	42	81
11	75.0	47.0	60.0	44.0	40	79
12	......	......	......	......	......	......
13	80.0	79.0	65.0	65.0	44	47
14	82.0	83.0	67.0	69.5	43	49
15	79.0	81.0	62.0	62.0	37	33
16	84.0	86.0	66.0	68.0	38	39
17	88.0	91.5	70.0	71.5	40	37
18	89.0	91.0	69.5	70.5	36	37
21	81.0	81.0	65.0	65.0	41	41
22	74.0	63.5	55.5	49.0	28	32
Mean	77.9	69.5	61.2	55.2	37	47
May 2	73.0	63.0	65.0	60.0	65	84
4	74.0	75.5	66.0	60.0	66	38
5	81.0	82.5	65.0	64.5	41	36
6	74.0	56.0	64.0	49.5	58	63
7	69.0	63.0	57.0	52.0	47	46
9	78.0	87.5	70.0	69.0	67	38
11	90.0	91.5	69.5	68.0	36	28
12	86.0	86.0	66.5	66.0	35	34
13	77.8	77.8	67.0	66.2	57	54
14	75.0	74.0	70.0	69.0	78	78
16	79.2	77.0	56.7	57.5	41	28
18	88.0	91.0	74.0	68.0	52	30
20	72.0	56.0	64.0	55.5	65	97
21	69.8	63.0	63.8	61.0	72	89
22	75.8	76.0	70.8	71.8	78	82
23	75.7	75.0	64.0	63.5	52	53
25	71.0	68.0	64.8	63.0	71	76
26	77.3	80.0	71.0	71.5	73	66
27	78.0	79.0	66.2	65.0	54	47
28	78.0	85.5	70.0	73.5	67	56
29	75.0	73.0	61.0	58.0	44	39
30	74.0	73.5	61.0	61.0	47	48
Mean	76.9	75.2	65.8	63.3	58	55
June 1	73.0	72.0	61.3	57.6	51	40
2	72.7	71.7	60.0	57.0	47	39
3	74.8	74.0	61.0	60.0	45	43
4	77.0	66.0	66.0	64.0	54	90
5	75.2	73.8	68.0	65.8	69	66
6	80.5	80.5	67.5	67.5	51	51
8	86.0	87.5	76.0	75.0	57	57
9	80.0	77.0	71.0	68.5	64	65
10	72.5	76.5	60.0	66.0	47	57
11	76.0	77.0	65.0	60.0	55	35
12	78.0	81.5	61.0	61.5	36	30
13	73.0	62.3	65.0	65.8	65	82
15	71.0	68.5	64.5	62.5	70	72
16	73.5	72.5	68.5	67.5	78	78
17	75.0	74.5	69.0	68.5	74	74
18	78.0	79.4	68.0	69.0	60	59
Mean	76.0	74.7	65.7	64.8	58	59

AUTOMATIC CLOUD PHOTOGRAPHY.

By OLIVER L. FASSIG, Observer, Weather Bureau.

The following interesting items are quoted from a letter recently received by the Editor from Mr. Oliver L. Fassig:

Through the kindness of Dr. von Bezold and Professor Sprung, I spent the whole of the month of October at the Potsdam Observatory, and took part in the daily observations of cloud height and velocity which are being carried on there in accordance with the International