the suddenness of the squall, have been lost. Three zones in the life of a squall can be discerned; first, that in which the squall begins, and where it is impossible to give warning; second, that in which the squall reaches its maximum effectiveness, for which warnings are indispensable; and third, that in which the squall is decreasing, in which warnings are unnecessary. The military squall-warning service of the French Army was established to combat the second stage, in which the phenomenon is most dangerous. To determine the existence of squalls and their characteristics, to estimate their force and the danger they present, and to disseminate the information to those interested, were the functions of three distinct divisions in the warning service: The first by the observation posts (*postes d'observation*), the second by the central office where the reports were received, and the third by the *service de diffusion*. The warning service was very efficient and was usually able to warn air-service units three-fourths of an hour before the arrival of the squall; it is estimated that such warnings were given in 85 per cent of the squalls.—*C. L. M.*

FORECASTING LINE SQUALLS IN WEST AFRICA.

By H. HUBERT.

[Abstract reprinted from *Science Abstracts*, July, 1919, pp. 312-313. Original article in Comptes Rendus, 168, Mar. 17, 1919, pp. 567-570.]

From observations made in Senegal in winter it can be shown that line squalls, similar to those experienced in northwest Europe, occur in that region also. The mean direction of propagation is, however, from east to west, instead of from west to east, which is the mean direction of propagation of the line squalls of our latitudes. The mean velocity of propagation is 60 kilometers per hour, the extremes being 44 and 72 kilometers per hour. The direction of the line along which the disturbance is found at any time is generally north-south. The length of the line may exceed 100 kilometers, and the passage of a squall has been traced for hundreds of kilometers Nothing is said as to changes of wind and weather accompanying these line squalls. Further observations are needed in districts adjacent to Senegal in order to investigate these squalls more precisely, but already sufficient stations exist in Senegal to permit of a warning of the approach of the squall to be issued a few hours (up to six or eight) in advance of the event.—*R. C.*

NOTES, ABSTRACTS, AND REVIEWS.

PROGRESS OF METEOROLOGY.

By W. H. DINES.

[Extracts from *Nature*, Nov. 6, 1919, pp. 247-248.]

"The progress of meteorology during the last 50 years has been very marked, as may be seen by a casual reference to the current meterological literature of the period 1865–1875; to a great extent, it resembles the emergence of astronomy as an exact science from the old astrology, but it must be confessed that the Newton of meteorology has not yet appeared.

"Fifty years back the student of meteorology spent much of his time in a vain hunt for weather sequences, and the principle of *post hoc propter hoc* held full sway: the laws of motion and the more recently discovered laws of thermodynamics were in most cases completely ignored, or at least considered as not being applicable to meteorology. This has been largely changed for the better, and one does not now expect to find a cold area explained as being due to the descent of air in an anticlycone from a higher and colder region. Perhaps the pendulum has swung too far the other way, and mathematical analysis may sometimes be used when it is not applicable. On the assumption that air is a perfect fluid, it follows from a strictly mathematical analysis that a sphere exposed to a steady current of wind will offer no resistance to that wind, a result obviously inconsistent with the facts. The assumption made can not be justified, and one can not help feeling that great caution should be used in making assumptions if the result of a complex mathematical investigation into a meteorological question is to be trustworthy. Mathematics, however, afford a most useful and often indispensable aid to meteorology, and of late years especially, although far from exclusively, by their means many useful deductions have been drawn."

The remainder of the paper discusses recent advances in the study of cyclones and anticyclones, being essentially a summary of the material presented by the author in Geophysical Memoir No. 13,[1] an abstract of which, by Mr. W. R. Gregg, has been published in the MONTHLY WEATHER REVIEW.[2] After this discussion he concludes with the observation that "meteorologists have good cause for congratulation in the steady progress that is taking place."

[1] Dines, W. H.: Characteristics of the Free Atmosphere, Geophysical Memoirs, No. 13, Meteorological Office, London, 1919, M. O. 226c, pp. 47-76.
[2] Monthly Weather Review, September, 1919, pp. 644-647.

THE AMERICAN METEOROLOGICAL SOCIETY.

"The organization of the American Meteorological Society on December 29, 1919, in St. Louis, Mo. * * * marks the beginning of a movement not only to push forward investigations of weather processes and climatic conditions, but also to widen the valuable applications of the knowledge already at hand. The great use of meteorology in warfare has shown that there are large possibilities of extending it much more thoroughly into almost every line of human endeavor."[a] Significant of a recognition of this is the fact that nearly half of the present membership of nearly 600 is composed of people who find use for meteorology in their work, yet who are not professional meteorologists, or interested merely as amateurs.

The objects of the society as stated in the constitution are: "The advancement and diffusion of knowledge of meteorology, including climatology; and the development of its application to public health, agriculture, engineering, transportation by land and inland waterways, navigation of the air and oceans, and other forms of industry and commerce." To carry out these objects 11 committees have been formed: 4 to have in hand the advancement and diffusion of knowledge of meteorology, and 7 to have charge of the development of the numerous applications of meteorology to human affairs.

A total of 29 papers were presented at three sessions of the society in St. Louis, December 30 and 31, 1919, and in two sessions at a coordinate meeting in New York City January 3. Joint sessions were held with the American Physical Society and with the Association of American Geographers and National Council of Geography Teachers. In this issue of the REVIEW there are published five of these papers in full, extensive excerpts from

[a] Excerpt from the Bulletin of the Am. Meteorological Society, Jan., 1920, vol. 1.

three, and abstracts of 12. Abstracts of the most interesting discussions are included. The following nine are mentioned here by title only, for the reasons given:

Progress of American Meteorology in 1919. By C. F. Brooks. [The contributions in the REVIEW for the past 12 issues tell the story of this progress. This paper was founded on an article, "Meteorology and Climatology," in the American Year Book, 1919.]

How the American Meteorological Society can serve geography teachers. By C. F. Brooks. [Of limited interest.]

Aims and achievements of the Blue Hill Observatory. By Alexander McAdie. [To be published in full elsewhere. Not easily subject to abstracting.]

Plans for establishing a network of meteorological stations in Palestine. By P. W. Etkes, New York. [Simply a statement of plans.]

Sunshine in the United States. By R. DeC. Ward. [Published in the Nov. 1919, REVIEW, p. 794-795.]

Explanation of peculiarities of flying in the wind. By J. G. Coffin. [Published in Aviation, New York, Dec. 1, 1919, vol. 7, pp. 383-385.]

The following three are to be published in extended form in later issues of the REVIEW:

Use of laws in teaching climatology. By S. S. Visher.

Preliminary steps in making free-air pressure and wind charts. By C. L. Meisinger.

Clouds and their significance. By C. F. Brooks.

A BUNDLE OF METEOROLOGICAL PARADOXES.

By W. J. HUMPHREYS.

[Excerpts from presidential address, Washington Philosophical Society, Jan. 31, 1920; also, presented in part before American Meteorological Society, St. Louis, Mo., Dec. 30, 1919.]

The scientific paradox is only an exception to some familiar but too inclusive generalization. It therefore has both the appeal of the riddle and the charm of surprise—the suprise, the instant the truth is seen, of a sudden and unexpected discovery.

1. **Air pushed north blows east** (due to the deflective effect of the earth's rotation).

2. **Rain dries the air** (since rain is formed from water vapor previously existing in the air).

3. ***More air goes up than ever comes down.***

As everyone knows, the vertical circulation of the atmosphere is only a gravitational phenomenon consisting of the sinking of relatively cold, and, therefore, also relatively dense air, and its consequent lifting or forcing up of adjacent air that happens to be comparatively warm and light. In short, contracted air descends and expanded air ascends (is buoyed up by the descending denser air). Hence, mass for mass, the *volume* of the ascending air is always larger than that of the descending air. The ratio between the actual ascending and descending volumes, however, or masses, may be anything, as illustrated by chimney circulation, in which the ascent is restricted to a comparatively small volume and mass moving rapidly, while the descend extends to a relatively large volume and mass settling slowly. On the average, though, considering both velocity of vertical movement and volume occupied, or velocity times volume, the atmosphere as a whole is always ascending, a fact not only interesting itself but also of some importance to both the aeronaut and the aviator.

Whatever the volume relations between ascending and descending air may be, it would seem that at least the mass that goes up and the mass that eventually returns must certainly be the same. But, on the contrary, they indeed are far from it, for one of the important constituents of the atmosphere, water vapor, often amounting, in places, to 1 per cent, and occasionally to more than 2 per cent of the whole, invariably ascends as a gas, as a distinct part and parcel of the air; but descends, in great measure, not as a gas at all, not as any part whatever of the air, but as a liquid in the form of rain, or a solid, such as snow and hail.

Paradoxical, therefore, as it may be, a greater mass of *air* actually does go up—more by at least 20,000,000 tons per second, the measure of world-wide precipitation—than ever comes down.

4. **To cool air, heat it; to warm air, cool it.** [Heated air rises and cools more than it was heated, and vice versa.]

5. **Not air that is heated, but air that is not heated, is thereby warmed; not air that is chilled, but air that is not chilled, is thereby cooled.** [Heated air rises and is replaced by other air which is dynamically heated in descent, and vice versa.]

6. **Mixing brings the air to a nonuniform temperature.** [When thoroughly mixed, the potential temperature of the air is the same; hence the temperature gradient is adiabatic and not isothermal.]

7. **The nearer the sun the colder the air.**

[The air grows colder with elevation—the nearer the sun the colder the air—because (1) owing to its transparency to solar radiation it is heated mainly at the surface of the earth, and (2) because, at ordinary temperatures, it emits more radiation than it absorbs. These together so affect the density of the atmosphere as to induce vertical convections, and thereby to establish and maintain, throughout the region in which they are active, a rapid decrease of temperature with increase of elevation.]

8. **The coldest air covers the warmest earth.** [Refers to the air in the stratosphere, which is coldest over the equator. The temperature of the stratosphere seems to depend upon radiation from below, and consequently upon the effective temperature of the earth's surface below; but the heavy cloudiness in equatorial regions makes the effective temperature of the surface there less than that at middle and high latitudes.]

9–10. **As the days grow longer the cold grows *stronger; as the nights grow longer the heat* grows stronger.** As the sun descends the temperature ascends. [Due to lag in heating and cooling the atmosphere.]

11. **The absolute maximum supply of heat in any consecutive 24 hours is not at the equator but at the south pole.** [As some one has remarked, "The sun shines day and night at the south pole." The south pole receives more insolation than the north pole, because the earth is nearest the sun when the south pole is best exposed to its rays. The altitude of the south polar region, the dryness of the air, and the lack of dust in the Antarctic atmosphere assist also.]

12. **The hotter the sun the colder the earth.** [Statistics show that at sun-spot maximum the earth is colder than at sun-spot minimum. At spot maxima there is less ozone produced in the upper atmosphere because the ultra-violet rays, which are the ozone-producing agents, are retained in the then dustier solar atmosphere. Hence at spot minima there will be more ozone in upper atmosphere of the earth. Ozone acts as a shield that decreases the radiation of heat from the earth, and thus keeps it warm, even though there is less total insolation.

13. **The sun rises before it is up; the sun sets after it is down** [due to the bending of the rays by refraction].