BIBLIOGRAPHICAL NOTES.

CLOUD MEASUREMENTS AT BLUE HILL OBSERVATORY.

H. H. CLAYTON AND S. P. FERGUSSON. *Measurements of Cloud Heights and Velocities. From observations made at the Blue Hill Meteorological Observatory under the direction of A. Lawrence Rotch*, A. M. Annals of the Astronomical Observatory of Harvard College, Cambridge, Mass., 1892. Vol. XXX., part iii., pp. 205–268, plate I.

The introduction to this report, written by Mr. Clayton, tells us that systematic cloud observations have been carried on at the Blue Hill Observatory for five years. Four methods have been used in determining cloud heights. The base of very low clouds was determined by walking down the hill, whose summit is 126 meters above the surrounding lowland, until the under surface of the cloud was encountered. The angular elevation of the patches of light on cloud layers at night above the electric lights of neighboring cities often served to measure their altitude. Shadows of detached clouds were watched while passing over known points on the adjacent lowland; and by combining the actual velocity of the shadow and the angular velocity of the cloud, its height is deduced. Simultaneous triangulation with theodolites like those used at Upsala was carried on from two stations, 1,178 meters apart and connected by telephone. One of the theodolites and a plotting machine for the reduction of observations are illustrated in the frontispiece.

The accuracy of the several methods of measurement is carefully investigated. The error by triangulation averages only two or three per cent of the height; by altitude of bright patches over cities at night, the error is much greater. The propable error in velocities is somewhat more than in heights; but it is within reasonable limits.

One of the most instructive chapters in the report concerns cloud nomenclature. The system of Hildebrandsson and Abercromby is adopted, but only after a careful comparison of all other systems. The comparisons drawn between different cloud names illustrate at once the difficulty that must embarrass any one who attempts to discuss observations made by others than himself, and at the same time supplies the most comprehensive series of definitions, by which the records of one system may be translated into another. These comparisons are made after a familiarity with the definitions employed in our Weather Bureau, after examination of various cloud atlases, especially the Hildebrandsson-Koeppen-Neumayer photographic atlas; after studying a large collection of cloud photographs gathered in different parts of Europe by Mr. Rotch and there named by experts; after personal conference with Hildebrandsson during the International Meteorological Congress at

Munich in 1891, with Vettin at Berlin, and with observers at Upsala and at Kew. There is therefore probably no one in this country who has so broad an experience in the observation and naming of clouds as Mr. Clayton; and we hope that his experience may be preserved to us by the preparation of an atlas of cloud photographs for the guidance of American observers in this difficult field. The following table gives Clayton's condensed definitions of cloud names, after Abercromby and Hildebrandsson:

Cirrus (C). Thin, fibrous, detached, feather-like clouds.
Cirro-stratus (CS). Thin, white veil, more or less fibrous.
Cirro-cumulus (CK). Small, white, cottony balls in flocks. Flocks of small, detached, fleecy clouds.
Alto-cumulus (AK). Large, more or less rounded balls, flat discs, or rolls of fleecy clouds in flocks. White, except here and there a dark shading.
Alto-stratus (AS). A gray or blue veil, through which the sun and moon are faintly visible.
Strato-cumulus (SK). Large gray balls or rolls in close contact.
Cumulus (K). Piled clouds, with conical or hemispherical tops and flat bases.
Fracto-cumulus. Flat, broken clouds of the cumulus type.
Cumulo-nimbus (KN). Massive clouds from which showers fall.
Nimbus (N). A dense, dark sheet of ragged cloud from which rain or snow usually falls.
Stratus (S). Elevated fog floating in the air (Hildebrandsson). A thin, uniform layer of cloud at a very low level; detached, flat, structureless clouds (Abercromby).

The discussion of the results of the tables and reductions is a valuable addition to our knowledge of clouds in this country. Indeed, it has no predecessor that needs to be named in connection with it.

Clouds of the same kind are found to be lower in winter than in summer, although the base of the cumulo-nimbus forms an exception to this rule. Moreover, the diminution of winter height is of about the same proportion in the higher as in the lower clouds; hence, the decrease of actual height in winter is more marked in the upper than in the lower clouds. Cumulus clouds are shown to form at a greater height at noon (1,777 meters) than in the morning (1,439) or early evening (1,513). The base of these clouds is highest in spring (1,496 meters), decreases in summer (1,489) and autumn (1,412), and is least in winter (1,286); but their velocity is greatest in winter and least in summer.

The loftiest cirrus clouds at Blue Hill were found at 14,930 meters; 13,376 at Upsala, and 13,664 at Kew, or somewhat less than ten miles at the highest.

The mean cloud velocities indicate that the entire atmosphere from the lowest to the highest cloud level moves almost twice as fast in winter as in summer. The mean velocity of the highest clouds in winter is over 50 meters per second, or 100 miles an hour; and the highest velocity, 103 meters per second, or 230 miles an hour, shows that the upper currents sometimes flow with enormous velocities. A consideration of Vettin's results at Berlin, gained by the fading illumination of clouds at sunset, leads Clayton to the statement that the mean annual velocity of the cirrus over northern Ger-

many is 21.3 m. p. s.; while in this part of our country it is 35.9. The lower clouds of the two regions do not differ greatly in velocity. It is found that clouds of the cirro-cumulus type, that is, clouds which move in flocks, have a greater velocity than clouds of the cirro-stratus type at the same or even at a somewhat greater height. This is true all the year, but is more marked in winter. I infer that the reason for this will be found when the different kinds of clouds are studied with reference to the cyclonic centres about which they are formed; for the cyclonic circulation may at one part accelerate and at another part retard the general movement of the atmosphere in which it is developed.

The prevailing direction of cloud movement at all heights and in all seasons is from a westerly point. Indeed, above the level characterized by the alto-cumulus clouds (4,000 meters), the drift is scarcely ever from any other point. There is an important difference between the surface winds at Blue Hill and the drift of the cirrus clouds. The winds have a northerly or northwesterly source in winter; but the cirrus clouds drift from these points in summer. The midway levels of cumulus and alto-cumulus clouds depart little from an average northwest source both in summer and winter. Hildebrandsson has found just the opposite relation between the surface winds and the cirrus clouds in Europe; the winds being southwesterly and the cirrus more northerly in winter. This is well explained by the distribution of temperatures over continental areas; the surface winds tending to flow obliquely out from cold areas and obliquely inward towards warm areas, while the upper currents drift in compensating courses. The cirrus tend to move around areas of high temperature in the same order as the surface winds blow around areas of high pressure.

It is gratifying to know that Mr. Clayton is at present engaged in a discussion of the Blue Hill cloud observations with reference to cyclones and anti-cyclones. We may count on as careful work in this important subject as appears in the volume before us; we shall therefore expect results that will give critical indication of the behavior of the higher clouds over low and high pressure areas, and thus aid in the interesting discussion now in progress among meteorologists regarding the causes of the secondary atmospheric movements.

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