lightships. The *Humber* lightship reported exceptionally large snowflakes on the *25th* and *26th*. Snowfall for $4\frac{3}{4}$ hr. ending at 04.15 hr. on the *1st* at *Mid Barrow* lightship was reported as "continuous, but at times really thick," whereas at *Barrow Deep*, ten miles to the north-east, it was reported as "very light and of short duration."

During *March* snowfall was confined to but one day, at the *Dudgeon*, *Smith's Knoll* and *Cork* lightships respectively.

The late and somewhat heavy snowfalls of the *24th–25th April* were fairly widespread, but were not reported from the *Outer Gabbard*, *Barrow Deep*, *Mid Barrow* and *Tongue* lightships off the east coast, nor from the *Helwick* or *English and Welsh Grounds* vessels in the Bristol Channel. At the *North Goodwin* it was sufficiently thick for the fog-horn to be sounded because of the reduced visibility, and the *Varne* reported a "storm of 45 minutes duration." The *Royal Sovereign* reported squalls of snow and hail, and the *Owers* "light sleet or snow for 30-minute periods." The *Royal Sovereign* and *St. Goven* lightships alone experienced any snow on the *26th*, the early hours of which day produced the heaviest late-April snowfall for 31 years over inland districts of south-east England.

SUMMARY

East Anglian Area. The Map (Fig. 2, p. 525) shows the distribution of snow-days in this area for the season, together with that at adjacent shore stations. Broadly, it would seem that the snowfall at sea tends to be slightly less than on adjacent coasts; but the distribution shows considerable variation, with a maximum of 8 days at *Barrow Deep* and the *South Goodwin*. The minimum of 3 days occurred at the *Outer Gabbard*, *Mid Barrow*, *Tongue* and *Royal Sovereign* lightships. It will be of interest to see if the marked minimum at *Mid Barrow* and *Tongue* lightships is maintained in future seasons if the adjacent land and ship stations should again have at least twice the number of snow-days.

Bristol Channel. The season's distribution of snow-days in the Bristol Channel is shown in Fig. 3 (p. 525). It will be noted that the snowfall was, again, somewhat irregular, *Helwick* and the *English and Welsh Grounds* reporting none at all and *Scarweather* the maximum of 5 days.

D. L. C.

REVIEWS

THE GLACIAL ANTICYCLONE THEORY EXAMINED IN THE LIGHT OF RECENT METEOROLOGICAL DATA FROM GREENLAND. Part 2. FRANÇOIS E. MATTHES *and* ARTHUR D. BELMONT. (Prepared by the junior author from notes of the senior author after his death.) *Transactions, American Geophysical Union*, Vol. 31, No. 2, 1950, p. 174–82.

PART 1 of this paper was reviewed in the *Journal of Glaciology*, Vol. 1, No. 2, p. 79. Part 2 was to have dealt with the upper air data, but Dr. Matthes died before he could write it. Actually it is doubtful whether sufficient material yet exists for such a study to be fruitful. But he left a number of further notes on surface weather in Greenland, and the junior author has collected and arranged these and added some later material. This forms a valuable summary of the weather prevailing over an inland ice cap, and it leaves no doubt that the persistent anticyclonic conditions, and the maintenance of the ice sheet entirely by low-level condensation, which constitute Hobbs's theory, are a great exaggeration if not an illusion. Quiet weather prevails for less than half the time, and the main element in maintaining the ice sheet is clearly seen to be the snow brought by barometric depressions.

This must not be taken as implying that the great cold mass of Greenland does not influence the general weather situation—far from it. The normal sequence of events seems to be that depressions approaching Greenland, generally from the south-west, are diverted, and their centres travel northwards along either the west or the east coast. But a vigorous depression has a diameter of well over a thousand miles, and its wind system extends far across the inland ice, giving south-westerly winds on the west or easterly winds on the east. The easterly depressions are the more vigorous and hence the greatest accumulation of snow lies well to the east. These winds are frequently strong enough to sweep away the surface layer of cold air and bring a complete reversal of wind direction and a great rise of temperature, especially in winter. Weaker storms are not able to sweep away the surface air, and in these the cyclonic circulation overrides the cold air and snow or freezing rain falls through it. This condition, occasionally though rarely met with in England, where it brings the "glazed frost," is probably quite common in Greenland. It is fair to say that the *centres* of most storms avoid the inland ice, but very occasionally an exceptionally intense depression is deep enough to ignore the ten thousand foot plateau and pass directly across Greenland from west to east—instances of this are quoted. The controversy exists because observations are so sparse and the width of the country is near the critical limit between non-interference with the tracks of depressions and complete blocking.

One other interesting point emerges. Greenland is not a simple dome, but has at least three centres of elevation, each of which has its own system of outflowing surface winds. This topography is not possible by Hobbs's theory, according to which it would be rapidly smoothed out, but it is to be expected if the main source of supply is cyclonic snowfall, for then each separate dome would tend to be maintained by the increased local snowfall to which it gave rise.

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THE ALTA AVALANCHE STUDIES. M. M. Atwater *and* F. C. Koziol. Published by the Forest Service, U.S. Department of Agriculture. 96 pages, tables, illustrations, maps.

In a letter to the reviewer, Mr. J. M. Herbert, Assistant Chief of the Division of Recreation and Lands of the U.S. Forest Service, writes that in addition to being interested in glaciology from a water yield and watershed aspect the service is interested in the recognition and control of avalanches endangering ski-ing districts as well as highways and railroads in the Western States.

The work under review, dealing with ten years' observation of avalanches at Alta in the Wasatch National Park, Utah, is interesting to the outsider rather as indications of the trend of American avalanche research than as a detailed guide on the subject. It refers essentially to local conditions over a small area.

The authors give ten factors responsible for safe or dangerous conditions after a fall of snow:

(1) Old depth of snow, (2) Type of surface, (3) New depth of snow, (4) Type of snowfall, (5) Weight of snow, (6) Rate of fall, (7) Wind force, (8) Wind direction, (9) Temperature, (10) Settlement (inches of settlement per inch of fall).

To this might have been added the humidity of the wind to which reference is made later on in the work, but which the reviewer believes to be of prime importance.

Very detailed analyses of each major snow storm have been compiled and by this method it is claimed that some accuracy can be obtained in forecasting avalanches. The authors recognize that there are, and probably always will be, minor factors of apparently trivial size which may just make the difference between release and non-release of an avalanche. The aim is to bolster experience rather than to enunciate scientific rules and with this approach the reviewer strongly agrees. This work will be studied with profit both by the ski-mountaineer and the theoretical man.

G. Seligman