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ON THE FORMATION OF THUNDERSTORMS OVER THE BRITISH ISLES IN WINTER,

BY

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ON THE FORMATION OF THUNDERSTORMS OVER THE BRITISH ISLES IN WINTER.

By E. V. Newnham, B.Sc.

Although thunderstorms* are rare in winter over eastern England, they occur more often further west and north. For instance, in January during the eight years 1900–1907, storms were reported on one or two days only on the east coast of England, but on 19 days at Blacksod Point, 14 at Stornoway and 11 at Valencia. Buchan has shown that they are quite common in winter in the west of Scotland, but very rare in the east.†

In recent years Cave has studied through several winters the conditions accompanying the formation of thunderstorms, observing the type of weather map with which the storms are associated. He observes‡ that they occur most often when a depression is passing eastwards beyond or over Scotland, with more or less straight isobars and a steep pressure gradient over the United Kingdom, but does not explain why they do not always occur under these conditions.§

It is generally admitted that, for the formation of thunderstorms in summer, instability over a height of several thousand feet, caused by a suitably rapid fall of temperature with height, is essential,** and that in many instances the powerful heating of the lower layers of the atmosphere by the sun is mainly responsible in bringing this about. It seems reasonable to suppose that in winter also instability is in general essential, but, solar radiation being relatively feeble, it can only be the heat imparted by the warm ocean to the lower layers of cold currents of air, which is likely to give rise to conditions analogous to those accompanying thunderstorms in summer. Storms should, therefore, seldom occur in air that has not come from very cold regions and subsequently crossed a considerable stretch of ocean.

Evidence based on a study of the previous history of air reaching the British Isles, on occasions when thunderstorms occurred, supports this theory, and will now be given.

The investigation covers the period 1900–1907 for the month of January only, and for statistics relating to the occurrence of

* In this paper the occurrence of either thunder or lightning is taken to constitute a thunderstorm.

† *Journal of the Scottish Meteorological Socy.* Vol. V., p. 329, Edinburgh, 1880.

‡ *Reports and Memoranda of the Advisory Committee for Aeronautics.* No. 507.

§ Buchan, in 1869 (*Q. J. Scottish Met. Socy.*, No. XXIV.), had pointed out that the thunderstorms occurring in western Scotland in winter were usually associated with deep depressions, but, like Cave, could not explain why such depressions do not always give rise to thunder.

** See, for example, *Professional Notes No. 8*, by C. K. M. Douglas. (M.O. publication No. 232h, 1920.)

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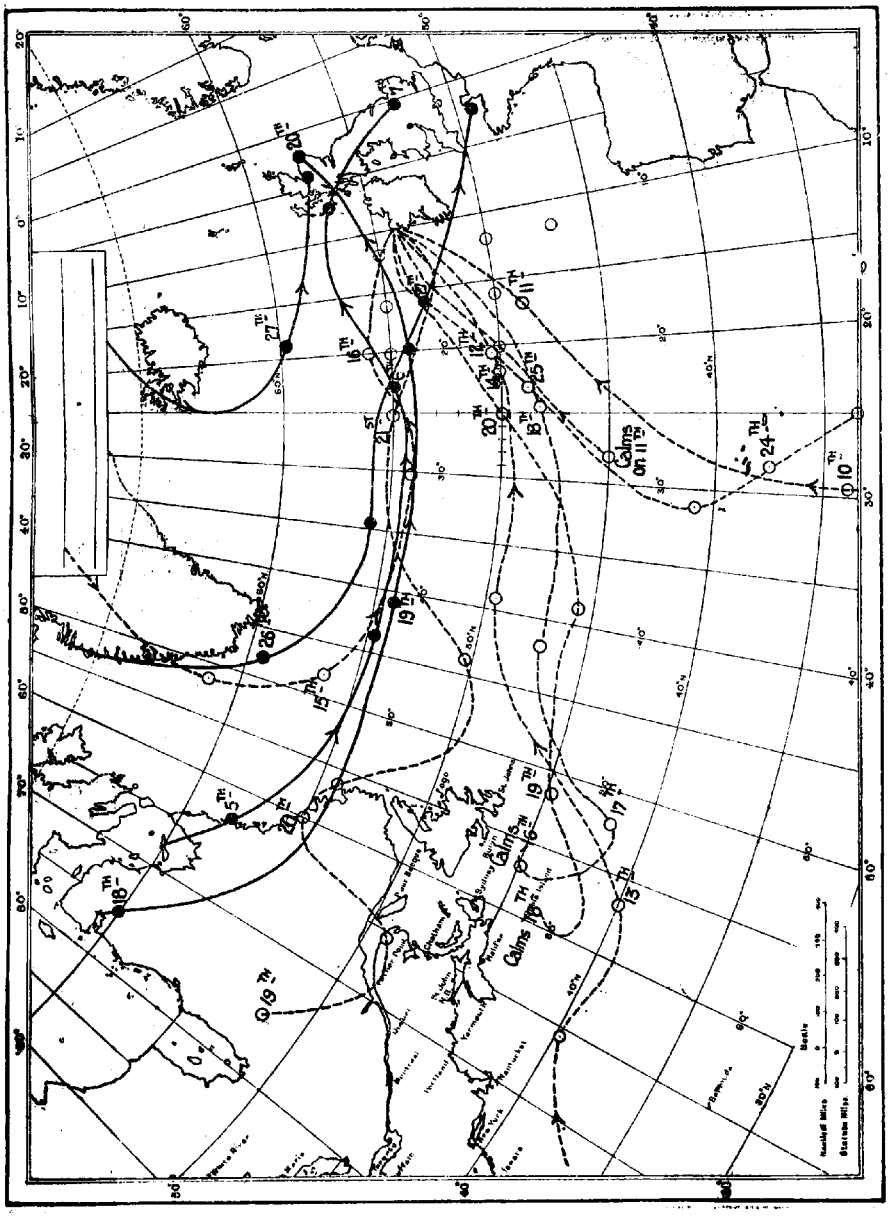

Period: January 1900. *Trajectories for air which was accompanied by thunderstorms when crossing the British Isles are printed with full lines———. Those for air which was not accompanied by thunderstorms are printed with pecked lines– – – –. The small circles indicate the position of the air at 12 hour intervals, the date in each case being printed against the position at 8h.*

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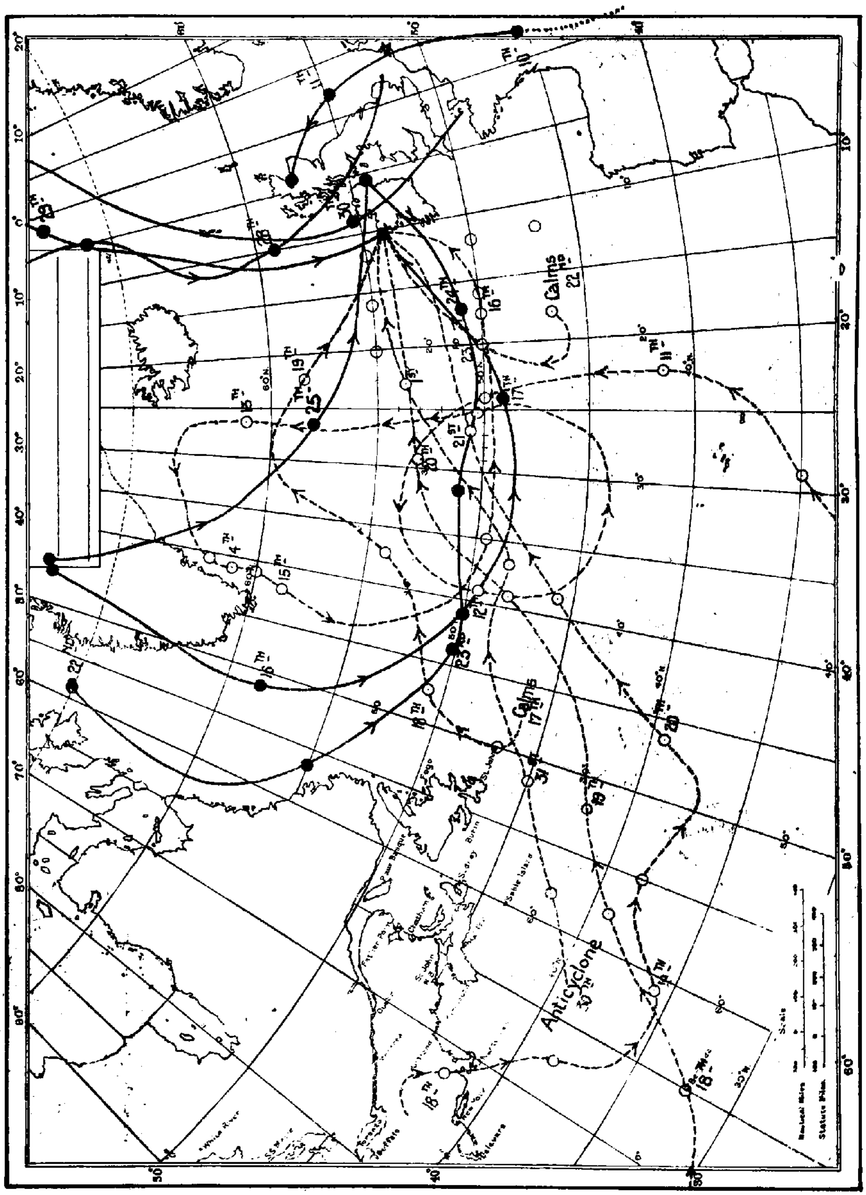

Period: January 1901. Trajectories drawn in the same manner as in Figure 1.

With thunderstorms ————

Without thunderstorms - - - - - -

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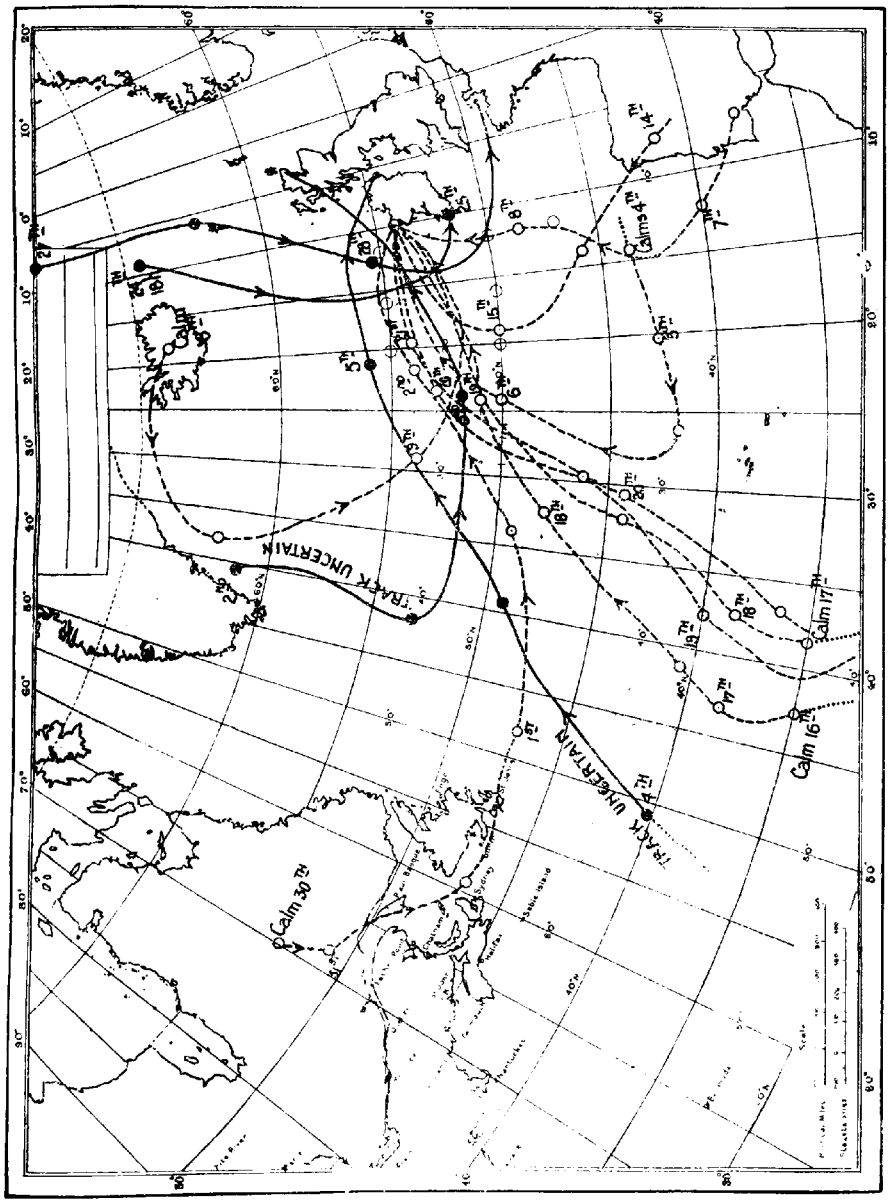

Period: January 1902. *Trajectories drawn in the same manner as in Figure 1.*

With thunderstorms ———
Without thunderstorms - - - - - -

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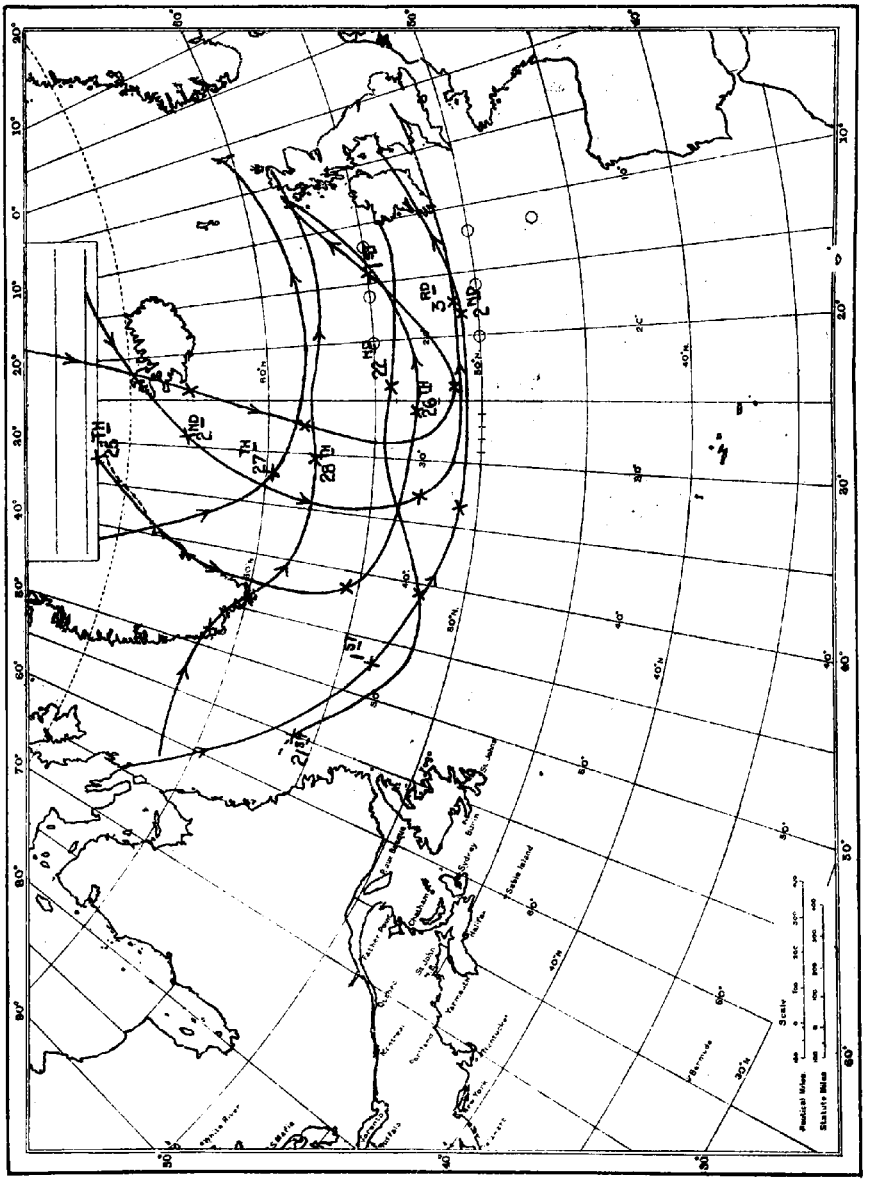

Period: January 1903. *Trajectories for air which was accompanied by thunderstorms when crossing the British Isles. The X indicates the position of the air at 8 h. G.M.T. on the date given. Crosses X intermediate between two dots show the position at 20 h. on the earlier of the two dates.*

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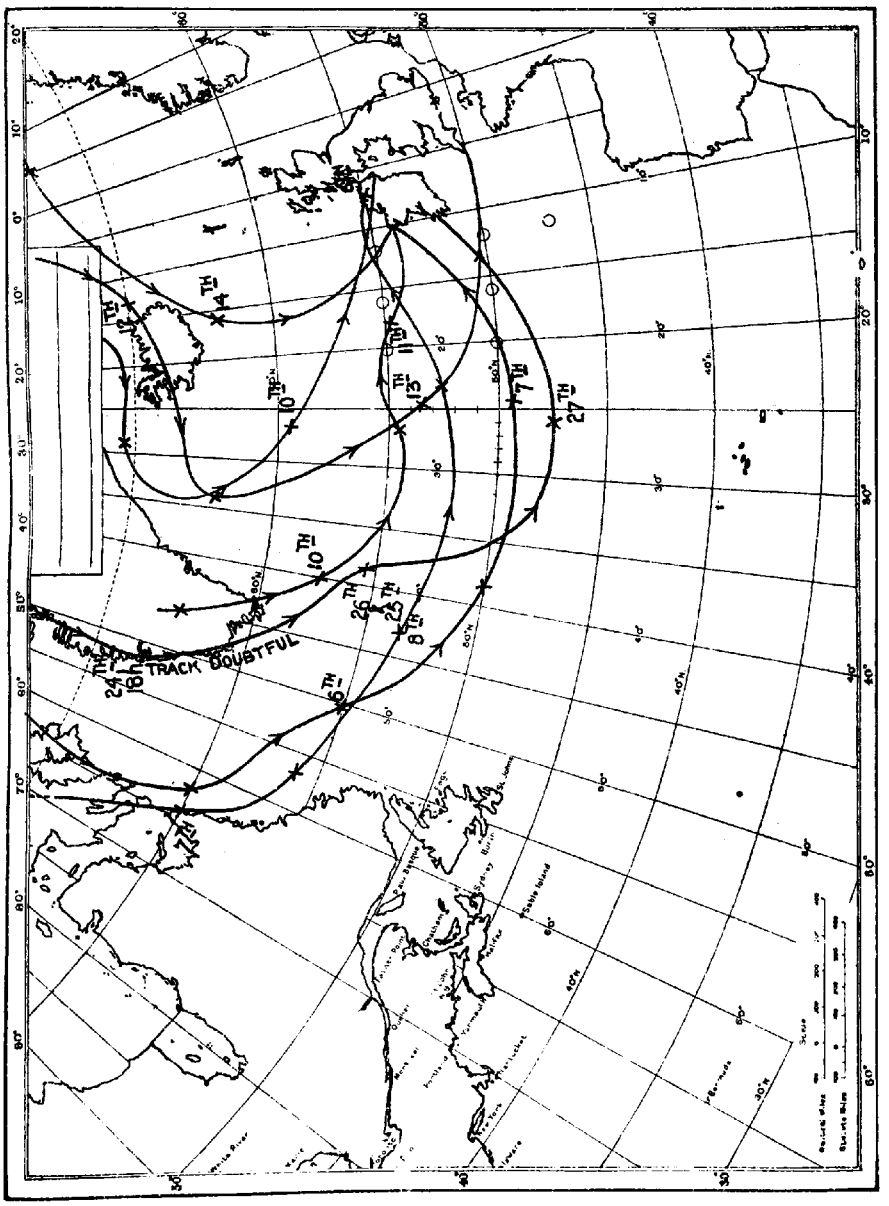

Period: January 1904. *Trajectaries for air which was accompanied by thunderstorms when crossing the British Isles. The X's have the same significance as in Figure 4.*

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thunder or lightning the Daily Weather Reports have been consulted. Trajectories have been drawn for every day on which a storm occurred in January during the five years 1900–1904.* The majority of the storms were found to accompany westerly or south-westerly winds which had been northerly winds before reaching our shores; for purposes of comparison trajectories have been drawn also for westerly winds which were not accompanied by storms, for the three years 1900–1902.

In figures 1 to 3 both classes of trajectory are shown for the years 1900–1902. Those with plain lines are for the days when thunderstorms occurred, while those with pecked lines are for the days without thunder.† These diagrams show that thunderstorms almost always occurred with air from a polar source, and very seldom with air that had come from regions far to the south before turning eastwards across the British Isles. In figures 4 and 5 trajectories are shown for 1903 and 1904, for days with thunderstorms only. Here the polar source of the air is very clearly shown. Statistics relating to occasions when the trajectories were from regions decidedly north or south of the British Isles will now be given, only those cases of thunderstorms which occurred in air crossing the British Isles from between south-west and west being included :

	No. of cases of air from low latitudes.	No. of cases of air from high latitudes.
With thunderstorms (1900–1904)	1	25
Without thunderstorms (1900–1902)	17	2

These figures show that when a thunderstorm occurred with a south-west or west wind, the origin of the air was nearly always in higher latitudes; thus air which traverses a long stretch of ocean seldom gives rise to thunderstorms unless it has come from very cold regions and is presumably itself very cold, but given these conditions storms nearly always occur.

* The trajectories are based on geostrophic winds, and have been constructed with the aid of the weather maps for the North Atlantic prepared by the united efforts of the German and Danish Admiralties. (*Tägliche Synoptische Wetterkarten für den Nordatlantischen Ozean und die anliegenden Teile der Kontinente.* Copenhagen und Hamburg). They may be taken to apply to all levels between 1,000 and 10,000 feet with sufficient accuracy for the purpose in hand. On two occasions, namely, Jan. 29th, 1900, and Jan. 9th, 1903, the distribution of pressure over the Atlantic was, however, changing so rapidly that it was not possible to draw any conclusions as to the track followed by the air. These occasions have been omitted.

† Some of the winds in the " no thunder " class are not from south-west or west because the selection was made from an inspection of the morning charts, whereas the trajectory was in each case constructed with the preceding evening as starting point. The trajectory has been taken to Blacksod Point in every case, and represents, generally, air that reached the central and eastern parts of the British Isles on the following morning, when south-westerly or westerly gradients prevailed.

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Additional evidence in support of these conclusions was obtained. For the years 1905 to 1907 trajectories were roughly sketched, but are not reproduced here. In January 1905 there was only one thunderstorm, accompanied by hail, reported as having occurred at Leith in the 24 hours ending at 8h. on the 12th. In this case the supply of air was from west of Greenland and had taken two days to reach Scotland.

January 1906 was a remarkable month, in that the region of most numerous thunderstorms was the southern part of the British Isles instead of the north-west coasts, and a notable spell of thundery weather over the English Channel continued from the 3rd to the 10th. Judging from the maps of limited area published in the daily weather reports during this period, the storms occurred with a great variety of distributions of pressure, but the more extended charts showed that the general typeover the North Atlantic remained much the same throughout, and the reason why the storms avoided their usual haunts and migrated down to the south was seen to be closely correlated with an abnormal distribution of pressure over the North Atlantic. Thunder and lightning during this month were reported as follows :—

3rd	<	at Scilly and Jersey.
4th	⌈	Portland Bill.
6th	⌈	Jersey.
8th	⌈	Valencia and < Roche's Point.
9th	⌈	Jersey Clacton and London. < Scilly & Portland Bill.
10th	⌈	Portland Bill.
12th	<	Valencia.
16th	<	Stornoway and Blacksod Point.
18th	⌈	Valencia.

From the 3rd to the 8th the air supply to the Channel was consistently from regions round Hudson Bay and Davis Strait, the time taken varying between 2 and 4 days, but the supply which caused the more numerous storms reported on the 9th was from Greenland, in only 36 hours. At this time the northern districts also began to experience air from polar regions, whereas from the 3rd to the 8th this was not the case, the trajectories mostly leading back to the central part of the very large depression which occupied the whole of the North Atlantic between the British Isles and North America. After this date the low pressure shifted further north and occupied a more normal position, but during the whole of the period from the 3rd to the 18th the English Channel lay in the track of air from regions west of Greenland. The thunderstorm that occurred on the night of the 18th at Valencia represented the close of the period, the British Isles passing out of the polar supply soon afterwards into air from near the Azores. On the 24th a fresh supply from Greenland reached our north-west coasts, taking only about 24 hours, and there was lightning at night at Stornoway. During the remainder of the month there was no more polar air and no more thunderstorms were experienced.

In January 1907 the correlation between polar supply and thunderstorms was also good, except that no storms were reported in the polar supply of the 1st and 2nd. On the 2nd a depression actually crossed Scotland, and in the following night storms occurred in the south only, where the supply was from north of Iceland, and not in the north where the trajectories were unfavourable. The remaining four cases were normal, except that on the night of the 19th the thunder at Valencia accompanied a southerly wind; this had however been part of a northerly current blowing at 80 to 100 m.p.h. down the coast of Labrador two days previously.

It is beyond the scope of this paper to attempt to explain how individual storms are formed in an area of partially warmed polar air. A study of the weather maps during the rather thundery winter of 1919–1920, however, elicited the interesting fact that during the cold month of November 1919, when a prolonged supply of polar air gave many thunderstorms, a number of shallow but quite definite depressions formed, most of which drifted slowly in a south-westerly direction, and the thunderstorms occurred within these depressions, breaking out repeatedly at places over which the latter passed. Examples are furnished by the maps for the 8th, 9th, 11th, 12th, 26th, 27th and 28th. When the supply of polar air is maintained for several days this may possibly be the normal course of events, but in the quite temporary outbursts of polar air from a westerly direction which often occur when a depression passes eastwards beyond or over Scotland definite secondaries are not usually formed. It seems probable that on such occasions the varying height of the land plays an important part, and that the forced ascent of the air when passing over mountain ranges assists the convectional processes which give rise to thunderstorms. Without some such hypothesis it is difficult to account for the far greater number of storms in the extreme west of Scotland and Ireland, as compared with the eastern districts, under these conditions.

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