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UNEXPECTED OCCURRENCE OF FOG

by

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Abstract

A case study of rapid formation of fog in the rear of migratory high pressure ridges over southern Finland.

Observations of fog in a high pressure area confirm the hypothesis that the point where the anticyclonic curvature of the isobars changes to a cyclonic one must be accompanied by clouds or fog, if the air is initially humid on the ground (cf. [3], [4], [5]). Both condensation nuclei and water vapour are transported upwards from the top of the humid layer on the ground or of the ground fog, resulting in extension and thickening of the fog or cloud layers. If there is a humid layer higher up, the transfer of water vapour by downward diffusion augments the ground fog [1].

SYNOPTIC EXAMPLE (September 12—13, 1955). The weather situation on the night of September 12—13, 1955, in south Finland, is an illustrative example, confirming the previous statement. To assist the micro-analysis of the charts the isobars have been drawn at intervals of one mb.

Weather Summary: At 1800[1]) of September 12, 1955 (Fig. 1), an anticyclone was centred over south-eastern Europe with a wedge extending to the north-west across south Finland to central Scandinavia. The polar air, which had passed during the forenoon over south and central Finland behind a cold front, now moving north-eastwards in anticyclonic circulation over south Finland, had warmed and moistened near the ground.

[1]) The time here is given as GCT.

The cold air was still marked by the rise in pressure, the large cumulus clouds, the good visibility and the squalls (Fig. 2). But there was no change in wind direction.

A pressure trough with cold front stretched south-westwards to central Sweden from the depression in the north (Figs. 1 and 2). A weak isolated low-pressure centre formed over the Gulf of Bothnia during the following night (Figs. 3 and 4).

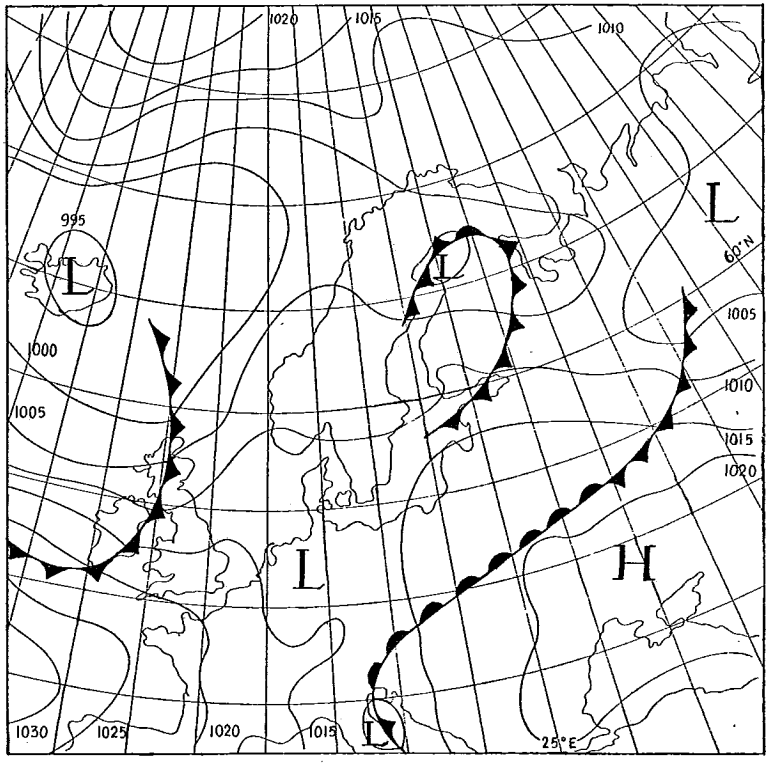

Fig. 1. Synoptic surface chart, Sept. 12, 1955, 1800 GCT.

A second depression had built up south of Denmark (Fig. 1), a warm front running from it to the north-east (Figs. 3—4). Developments were taking place in the depression and the pressure fell steadily during the night owing to the passage of the wedge over south Finland to the east and the approaching of the new depression from south-west. The large area of rain ahead of the front reached the Finnish coast on the morning of September 13 (Fig. 5).

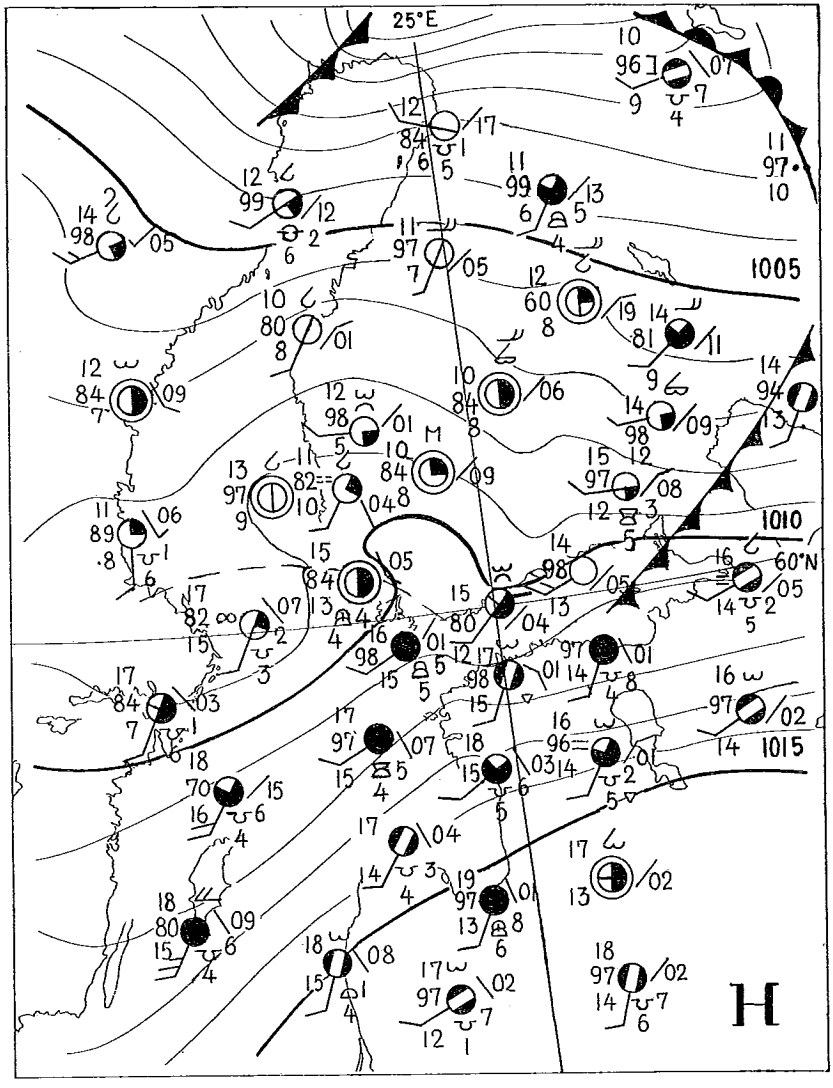

Fig. 2. Detailed surface chart, Sept. 12, 1955, 1800.

Detailed analysis. On the detailed chart for 1800 of September 12, 1955 (Fig. 2), when the motion had slowed down, ground fog or patches of fog were reported at a number of stations around the axis of the ridge as a result of cooling below the dew point by radiation over the land, especially around midnight. The pressure was rising east of the ridge,

but sinking west and south of it. The pressure gradient was weak over south and central Finland, with correspondingly light winds or calm. There were mostly high and medium clouds at the inland stations. Altocumulus castellatus, the indicator of high-level instability [7] was reported from some inland stations east of the axis. On the south-west

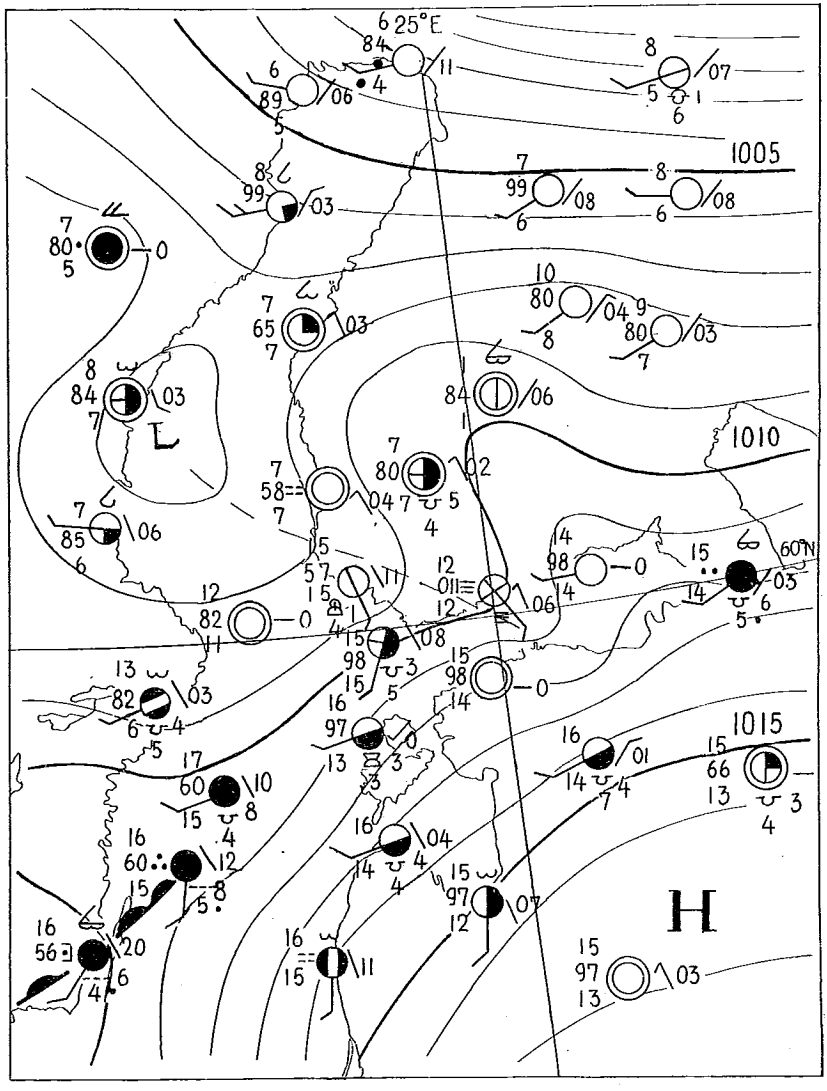

Fig. 3. Surface chart, Sept. 13, 1955, 0000.

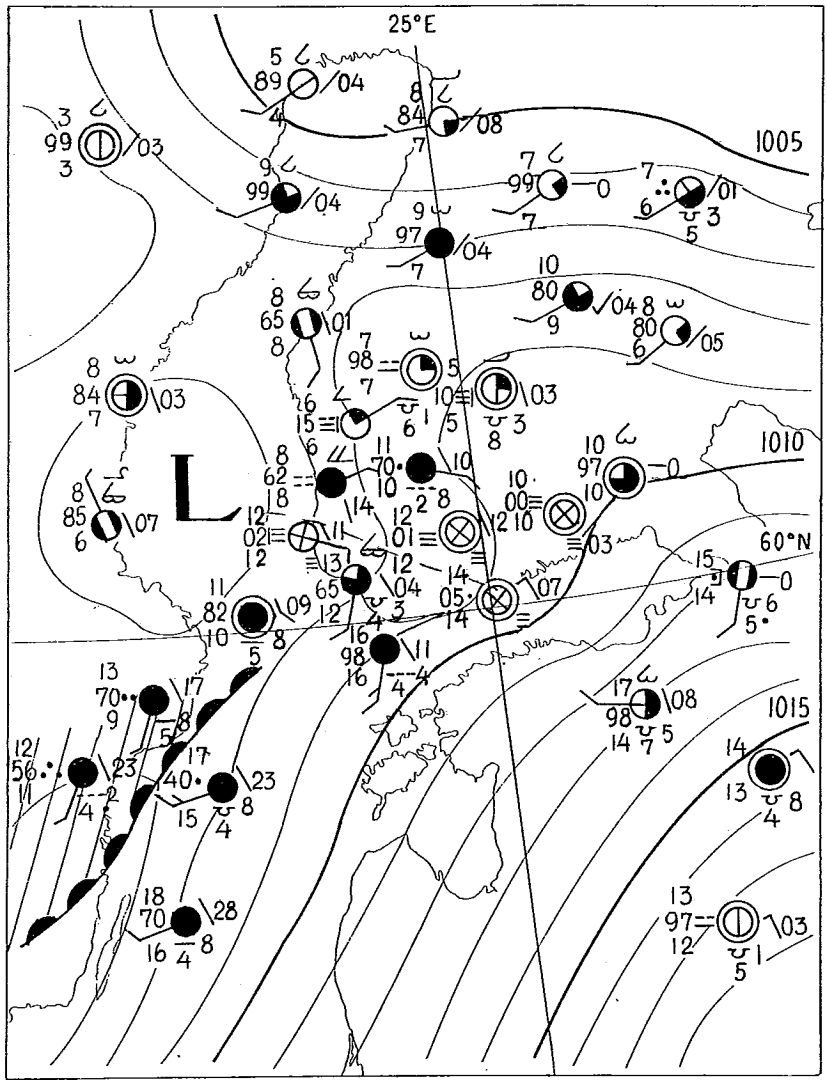

Fig. 4. Surface chart, Sept. 13, 1955, 0300.

and south coast there were low clouds of cu-types. This must be due to the daytime intense surface heating.

At 0000 of September 13, 1955 (Fig. 3), the ridge, which had been intensified and had moved eastwards was followed by a weak trough,

characterized by a convergence of warm-front type, over the Helsinki district from north-west to south-east. The air was saturated by water vapour on the ridge axis and west of it. In spite of this, ground fog had generally disappeared in the ridge, but immediately that the anticyclonic curvature of the isobars became cyclonic, dense fog developed in the transitional stage. The air began to lift owing to the falling of the pressure as a consequence of the weak frontal effect. The fog may have formed initially as a stratus layer which grew downwards and joined with the ground fog or mist. At Helsinki airport the dew point of the air was higher than the temperature of the cold surface during the fog, the difference between their minimum values being 1 °C. The transport of water vapour by eddy diffusion and real diffusion must therefore have been directed downward to the surface (cf. [2]).

At 0300 an extensive fog area had spread 150—200 km northwards and further north ground fog reappeared round the axis of the ridge in the saturated air (Fig. 4). Warm advection had brought moist air from the Baltic Sea over the fog area in south Finland, and the warm front was approaching from the south-west. The air mass was very stable, with stratus clouds. The pressure was falling generally within the warm maritime air.

At 0600 the fog had disappeared on the south coast, owing to the rain area of the warm front (Fig. 5). Further north, fog or mist was reported at most stations in south or central Finland.

The Helsinki radiosonde ascent at 1500 of September 12 (Fig. 6), showed the existence of a saturated or practically saturated layer between 1 500 and 2 200 m below an inversion, but aloft the air was very dry. The air mass had become quite unstable in the afternoon of September 12 behind the cold front. The lapse rate approaching the dry adiabatic from the ground up to 800—1 000 m was from 1 000 m upwards moist adiabatic up to inversion level 2 200 m, as a result of convection. After thorough mixing the temperature lapse rate is dry adiabatic and specific humidity is constant from the ground to the cloud base [6]. As condensation level we get 1 000 m, which had also been measured as the cloud base at Helsinki airport. The wind sounding showed strong west wind from 1 500 m upwards above the Helsinki district. The sounding confirms the facts mentioned of conditions behind the cold front.

Supplementary observations made at Helsinki airport are tabulated as follows:

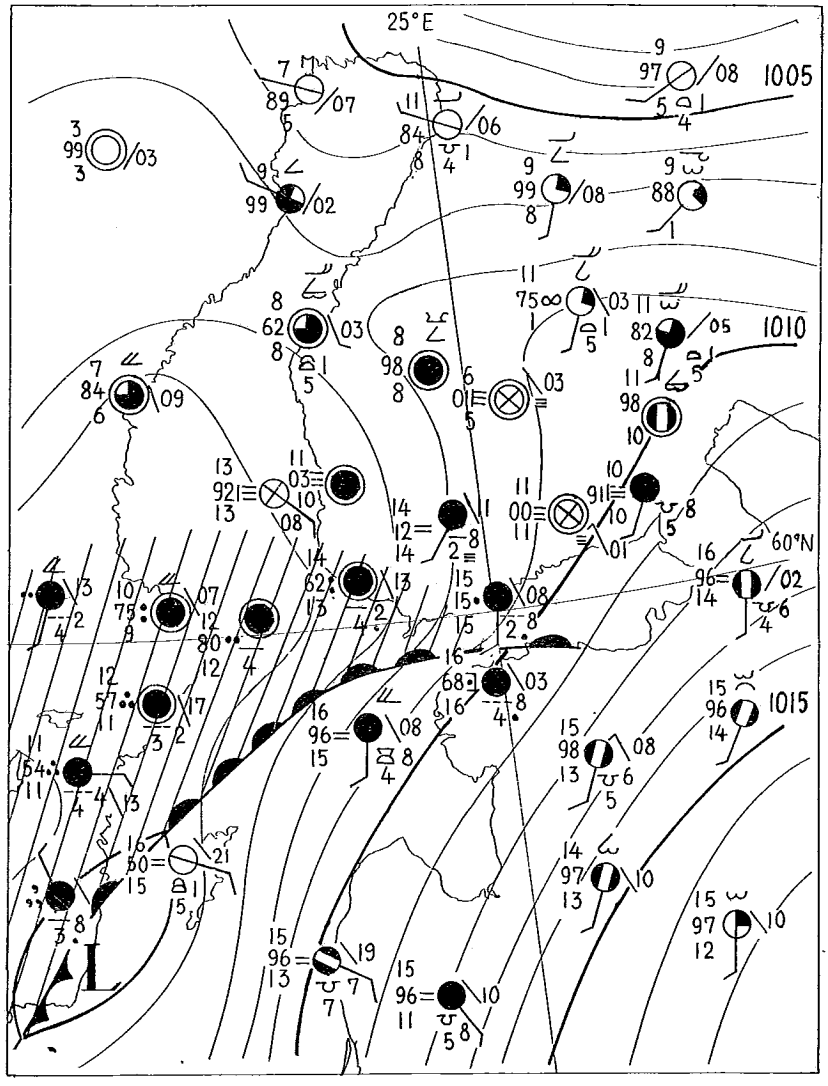

Fig. 5. Surface chart, Sept. 13, 1955, 0600.

Time	Wind	Cloudiness (tenths)	Low clouds (tenths)	Visibility (km)	Temperature (° C)	Dew point (° C)
1400	250° 14 knots (gusty)	7	cu congestus 4	40	19.1	10.4
1500	250° 10 »	5	» » 1	40	18.5	11.3
1600	250° 10 »	4	» » 1	40	17.5	11.2

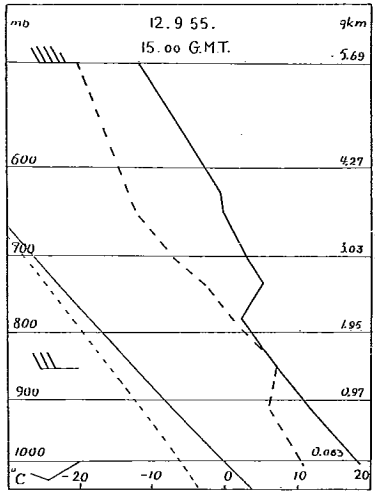

Fig. 6. The Helsinki radiosonde ascent (heavy, solide line) Sept. 12, 1955, 1500. Heavy, broken line indicates the dew point, and thin solid and broken lines indicate the dry-and moist-adiabatics, respectively.

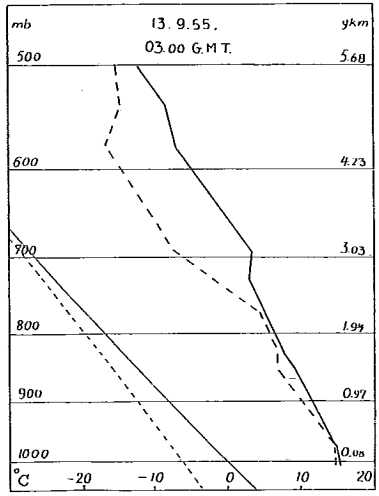

Fig. 7. The Helsinki radiosonde ascent Sept. 13, 1955, 0300. Notations as in Fig. 6.

The data agree well with the results of the sounding.

The sounding at 0300 of September 13 (Fig. 7) revealed weather conditions as in the weather chart in Figure 4, where the warm-front type convergence had approached from the west. The air was saturated from the ground up to 200 m and nearly saturated between 1 600 to 2 200 m. The air mass had became thoroughly stabilized and was humid.

Supplementary observations from the aviation weather station in Helsinki were:

Time	Wind	Visibility (m)	Vertical Visibility (m)	Temperature (°C)	Dew Point (°C)
0200	160° 2 knots	200	30	13.3	13.3
0300	160° 2 »	800	60[1])	14.2	14.2
0400	160° 4 »	1 500	60	15.2	15.1

A fog of this kind appears unexpectedly as a dense fog formation with a very short-time previous warning, the preceding visibility conditions being very good.

[1]) base of clouds.

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