

A NEW NORTH ATLANTIC LOW PRESSURE RECORD

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ON 14/15 December 1986, the explosive deepening of a very active depression between Greenland and Iceland resulted in the central pressure falling below 920mbar. As far as can be ascertained, this is the lowest barometric pressure known to have been recorded in the North Atlantic Ocean, and very possibly the lowest in the world outside of tropical storms (and possibly the centres of violent tornadoes).

The synoptic situation at midnight GMT on 15 December is indicated on Fig. 1, together with the track of the storm and central pressure at six-hourly intervals since its formation off the south coast of Newfoundland during the afternoon (GMT) of 13 December. The depression formed as a vigorous wave on the polar front which lay 100–200km off the coastline of Nova Scotia and Newfoundland in an exceptionally pronounced thermal gradient. At 1200 GMT the air temperature on the Nova Scotia coast (about 46°N 60°W) was about -7°C; 1000km to the north-east, in interior Québec, temperatures were below -25° on the edge of an intense anticyclone (1041 mbar) over the Great Lakes, while 1000km to the south-east a ship at 39½°N 52°W reported +21°. By 1800 GMT that day Low W was identified as a closed isobar on an open wave at about 42½°N 53½°W, with a central pressure of 986mbar. Also on the chart at this time was Low V at about 52°N 47°W (slightly more than 1000km to the north-east). This was in a slightly more advanced state of development, having formed about 18 hours earlier in the Gulf of St Lawrence in a similarly-pronounced thermal gradient, with a central pressure about 978mbar at this time. During the subsequent six hours Low W moved very rapidly north-east (covering some 530 nautical miles, 980km, an average speed of almost 90 knots) while Low V moved less rapidly east-north-east on a converging course. At midnight on 14 December Low W lay near 47°N 43°W with a central pressure about 970mbar. Over the next six hours it continued its rapid north-eastward movement, albeit at a slightly slower rate, covering about 400 naut. mi. (740km) to give an average speed of about 67 knots. By this time (0600 GMT) the depression was the major feature of the North Atlantic chart; the central pressure was about 956mbar (at about 52°N 36½°W) and occlusion had begun. At this time Low V was still shown as a separate feature at 54°N 40°W (with a central pressure of 960mbar) but soon became absorbed into the circulation of Low W. There can be little doubt that the absorption of another vigorous feature into what was already a mature depression resulted in considerable invigoration of the system, for over the next six hours the depression deepened explosively (26mbar): it is noteworthy that this was twice the rate before the incorporation of Low V into its circulation.

Over the next six hours the by-now combined system continued to move quickly (covering about 300 naut. mi., 560km, an average of 50 knots) but the course was turning all the time from north-east to a more northerly track. At 1200 GMT the depression was centred about 56½°N 33°W with a central pressure of 930mbar; ship EFMA at 56°N 29½°W reported a pressure of 938.8mbar, and a wind of south-easterly 60 knots. At 1800 GMT its central pressure was about 920mbar, centred about 59½°N 35°W, and the depression was now moving north-north-westward. Over the previous six hours it had covered about 185 naut. mi. (340km) and thus averaged about 31 knots, but after 1800 the depression slowed to only a few knots. At 1800 GMT ship UYIR at about 61½°N 33½°W reported a pressure of 926.2mbar, having fallen 19.1mbar in the previous three hours. At midnight 15 December the same ship (now about 61°N 37°W, some 100 naut. mi., 195 km, from its position six hours earlier) reported 920.2mbar; the reported wind was north-easterly 60 km, and thus it seems likely that the ship was still some distance from the centre of the depression. The British Meteorological Office assessed the centre of the depression to be about 916mbar at this time (Fig. 1), but the

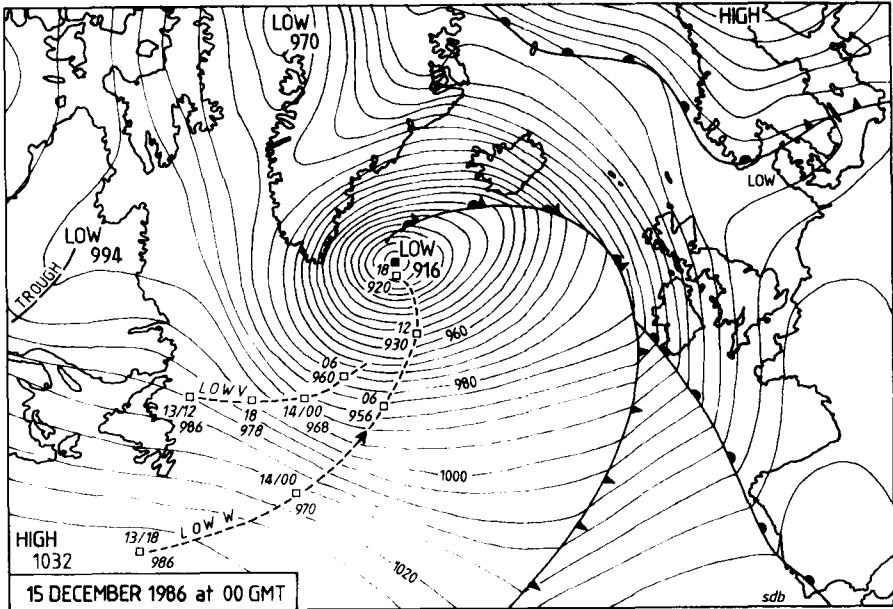


Fig. 1 Atlantic surface analysis at 0000 GMT on 15 December 1986, showing depression track (Low W) and central pressure (mbar) during the preceding 30 hours. The track and central pressure of Low V until incorporation with Low W is also shown (see text). The isobars are drawn every 4 mbar

West German meteorological service enclosed the depression with a 915 mbar isobar, indicating a pressure possibly as low as 912–913 mbar.

After midnight the centre of the depression executed a small loop (probably as a result of coming up against the mass of cold air over Greenland) and returned south-eastwards for a few hours before moving slowly north-east once more. At 0600 the depression centre lay near $61\frac{1}{2}^{\circ}\text{N } 30\frac{1}{2}^{\circ}\text{W}$ with a central pressure of 920 mbar; a buoy at $62^{\circ}\text{N } 33^{\circ}\text{W}$ reported 926.6 mbar at this time, confirming the exceptional depth of the depression. At 1200 the depression was almost stationary at $61\frac{1}{2}^{\circ}\text{N } 31^{\circ}\text{W}$, central pressure 930 mbar; a buoy at $62^{\circ}\text{N } 32^{\circ}\text{W}$ reported 932.3 mbar. Winds on the southern and western edges of the storm were strongest at this time, with north-westerly 75 knots reported from a ship at $61\frac{1}{2}^{\circ}\text{N } 38^{\circ}\text{W}$ and west-south-westerly 70 knots (accompanied by a heavy sleet shower) from another ship at $55\frac{1}{2}^{\circ}\text{N } 30^{\circ}\text{W}$. At 1800 GMT 15 December the centre lay near $62\frac{1}{2}^{\circ}\text{N } 29\frac{1}{2}^{\circ}\text{W}$, at 936 mbar, slow-moving and filling slowly.

PREVIOUS DEEP DEPRESSIONS IN THE NORTH ATLANTIC

The ship report of 920.2 mbar at midnight GMT 15 December is, as far as is known to the author, the lowest documented barometric pressure recorded anywhere in the North Atlantic, while the extreme depth of the depression, about 915–916 mbar at its lowest, would also seem to be without parallel. Pressures below 935 mbar are uncommon, but have been recorded on a number of occasions. The lowest known observation prior to 15 December 1986 was one of 921.1 mbar on the ship *Neier* at $49^{\circ}\text{N } 26^{\circ}\text{W}$ on 5 February 1870 (*Shipping Gazette*, 9 February 1870, as reported in *Q. J. R. Meteorol. Soc.*, 28, 1902, pp. 39–40), accompanied by ‘a most violent hurricane from west-south-west to west-north-west for six hours . . . ship hove to for five hours’ (and thus the ship may have been some distance from the centre). The value is supported

by the observation of 925.5 mbar on board HMS *Tarifa* at about 51°N 24°W (Marriott 1884, p. 121) 'by a standard barometer, fully examined and believed to be correct'. At Reykjavik, Iceland, 924 mbar was recorded on 4 February 1824 (Meteorological Office 1975, p. 59). The lowest barometric pressure on record for the British Isles, 925.6 mbar at Ochertyre, near Crieff in Perthshire, was recorded on 26 January 1884 (Marriott 1884) as a deep and still deepening depression moved north-east across Northern Ireland and central Scotland at about 25 knots.

At Belfast 927.2 mbar was recorded during the passage of a low that probably deepened to just below 924 mbar over Northern Ireland on 8 December 1886 (Harding 1887). A pressure of 925.5 mbar was reported from SS *Westpool* in the Atlantic on 4 December 1929 (*Meteorol. Mag.*, 68, 1933, p. 18). On 3 January 1933 a very deep depression crossed Iceland from south to north; at 07h the pressure at Reykjavik was 927.2 mbar, and it was thought likely it had been lower earlier (*Meteorol. Mag.*, 68, 1933, p. 18). On 28 November 1838 the barometer at Limerick in south-west Ireland fell to 931.2 mbar (Rohan 1975). On 19 December 1945 a depression moving north and then north-west between Ireland and Iceland deepened to about 927 mbar; at Valentia the lowest recorded was 948.6 mbar at midnight 18/19th. On 27 October 1952 a vigorous depression about 53°N 18½°W was suggested to have been about 922 mbar (Lewis 1983) although on examination of contemporary records a value of 935–936 mbar seems more probable. The lowest pressure on record at Ocean Weather Station *Lima* (59°N 19°W) between 1961 and 1970 was 931.1 mbar at 01h on 16 January 1962. On 10–11 January 1974 a depression deepened to 934 mbar at about 56°N 22½°W (north-west of Ireland). On 19 December 1982 a depression of about 931 mbar lay at 58½°N 15°W (between Iceland and Ireland); as it continued to move west, it caused the pressure to fall to about 936 mbar over the extreme north-west of Scotland during the night of 19/20 December (Burt 1983), the lowest barometric pressure recorded in the British Isles this century. Only two weeks later, on 5 January 1983, Low U deepened to 930 mbar just south of Iceland. On 26 December 1983 a depression of 936 mbar was centred off the south-east coast of Greenland, to be followed by another of 940 mbar off northern Norway on 1 January 1984, another of 938 mbar north-west of the Hebrides on 2 January and another of the same pressure again just south-east of Greenland on 4 January. On 27 November 1984 Low N slow-moving to the north of Iceland was about 937 mbar.

Perry (1983) reproduced a map of the lowest surface-level pressures known to have occurred over the North Atlantic over the period 1931–65. Only the area south-west of Iceland was credited with pressures below 930 mbar, with a small closed isobar indicating 925 mbar or less centred about 60°N 20°W. It is probable, of course, that modern communications and observational networks are far more likely to pin down the position and depth of such extreme depressions than would have been the case even half a century ago, but against this has to be offset the fact that increasing air traffic has resulted in the North Atlantic shipping routes being less busy than they were at that time.

A COMPARISON WITH PLANETARY EXTREMES OF PRESSURE

It would seem that reliably documented barometric pressures of 920 mbar and below have, until this event, been confined entirely to the centres of particularly vigorous tropical storms. Lowest on record anywhere in the world is the 870 mbar recorded by a USAF aircraft dropsonde in the eye of typhoon *Tip* some 500 km west of Guam at 16° 44' N 137° 46' E on 12 October 1979, and there are a handful of other occurrences below 900 mbar on record – for instance 877 mbar at 19°N 135°E in the eye of typhoon *Ida* on 24 September 1958, 886.8 mbar on 18 August 1927 on the Dutch steamship *Sapoeroea* about 750 km east of Luzon in the Philippines (*Nature*, 18 August 1928, p. 251), and 892.3 mbar at Matecumbe Key in Florida during the famous 'Labor Day hurricane' of 2 September 1935 (Ludlum 1982). However, the lowest recorded pressure in the contiguous United States (i.e. excluding Alaska and Hawaii) outside of a tropical storm has been 954.9 mbar at Canton, New York state on 3 January 1913, equalled at

Block Island, Rhode Island on 7 March 1932 (Ludlum 1962) while the lowest on record at Gander, Newfoundland between 1942 and 1971 was 946.3 mbar on 9 February 1964 (Ludlum 1971). The lowest on record for New Zealand is 954 mbar at Taiaroa Head, Otago Peninsula on 16 January 1939, although 945.1 mbar was recorded at Campbell Island (52°S 169°W, almost midway between New Zealand and Antarctica) on 18 July 1982 (Collen 1983), the lowest at that site since records commenced in 1941. In the South Atlantic the lowest recorded pressure at Grytviken on South Georgia (54° 16' S 36° 30' W) in 36 years 1929–64 was 942 mbar (Meteorological Office 1967), while the lowest in a fairly long record at Stanley, Falkland Islands was about 955 mbar (Crewe and Burt 1982).

In conclusion, it is suggested that the depression that deepened to about 915–916 mbar at midnight on 15 December 1986 was the deepest on record for the North Atlantic, and very probably for any temperate latitude. If any readers know of any deeper depressions outside of tropical storms, perhaps they would provide further details.

ACKNOWLEDGEMENT

My thanks go to the Meteorological Office for providing copies of the North Atlantic charts drawn up in the Central Forecasting Office at Bracknell, without which this analysis would have been incomplete.

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BOOK REVIEW

Air: Composition and Chemistry. By Peter Brimblecombe. Cambridge University Press. 1986. Pp 224. Price £25 hardback, £8.95 paperback

This book aims to provide a background in atmospheric chemistry and composition for students of environmental sciences, ecology and chemistry at undergraduate and graduate level. It is the first book in the Cambridge Environmental Chemistry Series and probably covering one of the most important topics in environmental chemistry.