The *Polar Low* Phenomenon

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When you examine your NOAA channel-4 infrared images during the winter months, you may from time to time spot what looks like a miniature cyclone in the Barents Sea or the North Atlantic Ocean. What you are observing is almost certainly a *polar low*.

Just such a phenomenon was observed by Ferdinand Valk in December 2003, and his image is reproduced opposite. The *polar low* is the whorl of cloud which fills the Barents Sea and obscures the southern part of the island of Novaya Zemlya.

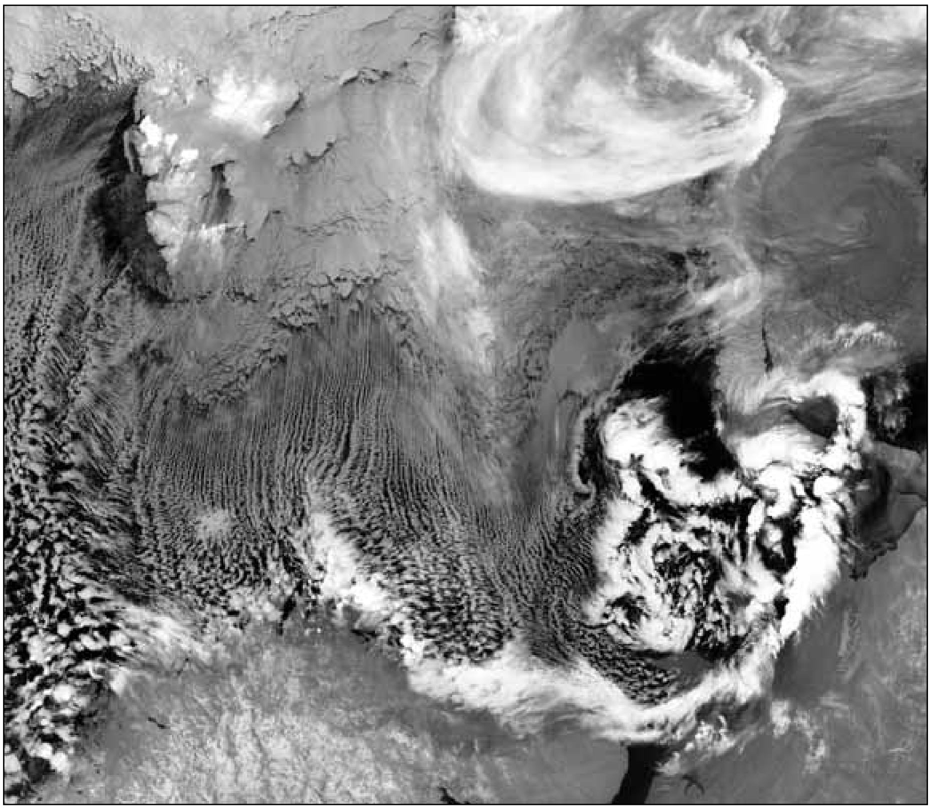

Figure 1 - NOAA 17 - 09:14 UT on December 21, 2003 (© Ferdinand Valk)

What is a Polar Low?

During long Arctic winter nights, cold air builds up to create what is known as the *polar front*, the boundary between cold air to the north and warmer air to the south. A *polar low* is a small cyclone with windspeeds near to or above gale force, which forms in the cold air far north of the *polar front* itself.

The European Polar Low Working Group [1] defines any cyclone to the north of the polar front, and which has a spread of less than 2000 km across, as a 'meso-scale cyclone' or 'mesocyclone'. The classical *polar low* is included as a subtype, restricted to very intense maritime systems stretching up to 1000 km and where the near-surface winds exceed 15 metres per second (30 knots).

A *polar low* forms only over the sea, and exclusively during the winter months: it arises when a packet of cold polar air moves across relatively warmer water (such as that provided by the North Atlantic Drift as it sweeps past Iceland and into the Barents Sea). Typically, these *polar lows* show considerable similarity to tropical hurricanes but they are generally only of the order of 400 to 800 km across: some may span as little as 100 km. The polar low illustrated in figure 1 spanned around 900 km. Figure 2 shows the synoptic sea-level pressure chart for the region. The long, trailing comma-shaped tail seen hugging the northern coastline of Russia's Kola peninsula is a characteristic feature of the *polar low*. As the storm matures, spiral cloud bands, often with a clear eye at the the centre of the cloud vortex, look remarkably similar to a tropical cyclone and provide the *polar low* with its alternative appellation, that of Arctic hurricane.

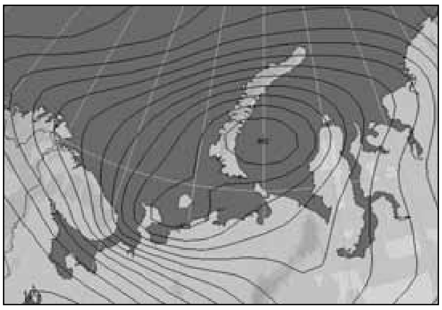

Figure 2 - Sea-level isobars at 12:00 UT on December 21, 2003

For many centuries, seafarers in the north Atlantic and Arctic oceans have recounted tales of fierce storms that seemed to appear from nowhere, often accompanied by strong winds and snowfall [3]. It is highly probable that ships which disappeared without trace over the years may have been the victims of these unpredictable, short-lived cyclones. *Polar lows* show a very characteristic pattern and life cycle during which they produce severe weather consisting of heavy precipitation (usually falling as snow) coupled with strong surface winds.

Eventually, most *polar lows* encounter the coasts of Norway, Scotland and Denmark where their activity rapidly diminishes. In fact, Northern Scotland bore the brunt of just such a polar low in February 1969 during which a gust of wind measured during a violent snow shower at Kirkwall airport in the Orkney Islands was recorded with a speed of 118 knots (218 km/h) .

It was not until satellite imagery arrived on the scene during the 1960's that a better understanding of these storms was realised. Because of their northern position and small scale, and the fact that they appear in the dark winter season, AVHRR-NOAA IR images provide one of the best ways of detecting *polar lows*.

Today we know that *polar lows* are a frequent feature of the relatively warm ice-free waters around the coasts of the Nordic countries, in the Labrador Sea, the Gulf of Alaska and the Sea of Japan. And of course, they are also a feature of Antarctic polar waters.

Lifespan of a Polar Low

A *polar low* can brew up and disperse completely again in a surprisingly short period of time: typically the phenomenon lasts only between 12 and 36 hours.

The illustrations on the right trace the appearance and dispersal of the December 21 *polar low*. Exactly one day before Ferdinand Valk spotted this system, a NOAA-17 channel-4 HRPT segment revealed no sign whatever of any activity of this nature (figure 3) although there was clear evidence that streamers of polar air were heading southwards over the Barents Sea. Early the following day, NOAA-12 imaged a compact polar low encircling the area (figure 4), but just six hours later (figure 1) it was already clearly beginning to show signs of decay. The final image in the sequence came from a NOAA-16 transmission in the early hours of the following day (figure 5), by which time the storm had all but exhausted itself, leaving behind only a few isolated fragments of bright cloud to indicate that it had ever existed.

Further Examples of Polar Lows

Interestingly, a particularly well formed *polar low* appeared in precisely the same region almost exactly one year ago, on December 20, 2002 (figure 6).

Although *polar lows* are generally associated with the Arctic, they can form in the waters of the north Atlantic, in the region between Greenland and Norway and sometimes, rarely, even as far south as the Faeroe Islands. Furthermore, a *polar low* embedded in a southerly moving airstream may on occasions track into the North Sea. We need look back only as far as January 2003 to remind ourselves of one of these relatively rare visitations when much of Britain and the Low Countries experienced paralysing blizzards as a *polar low* made landfall. The culprit coursed down the North Sea, and is illustrated in figure 7, a NOAA-17 channel-4 APT image acquired shortly before noon on that day.

Like their much larger tropical cousins, *polar lows* tend to decay rapidly when they reach land, due to the loss of the energy supply provided by the relatively warm sea they are traversing. But before they do, they can produce severe weather conditions over the land and this was one such occasion. The cyclone advanced southwards over the North Sea and caused severe

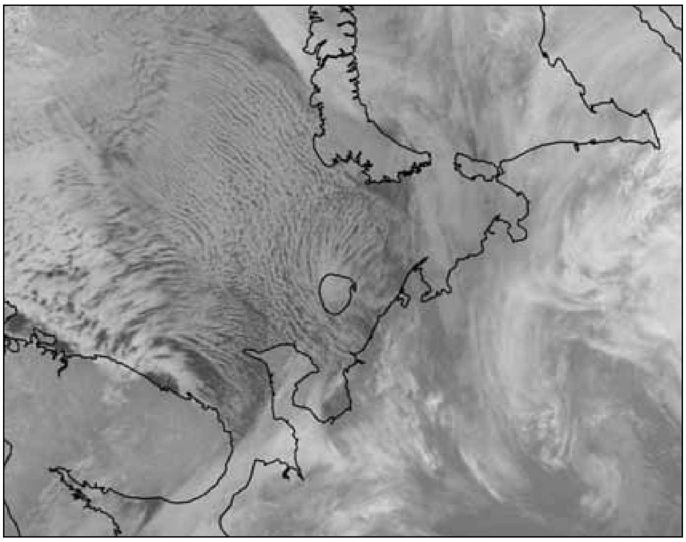

Figure 3 - NOAA 17 - 07:33 UT on December 20, 2003

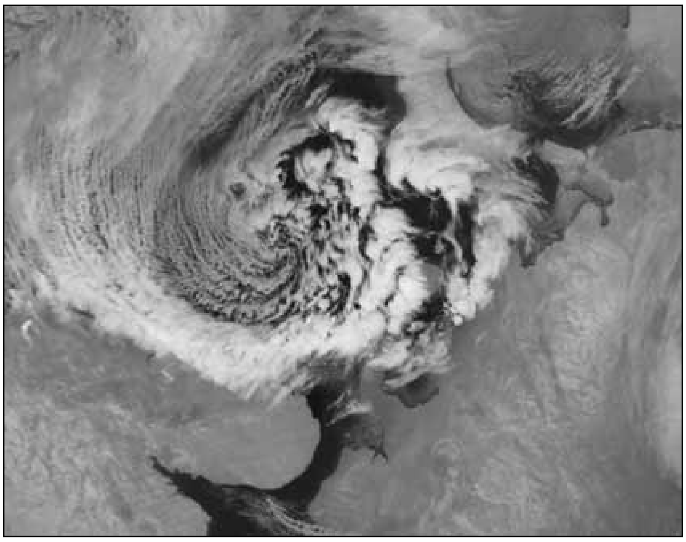

Figure 4 - NOAA 12 - 02:41 UT on December 21, 2003

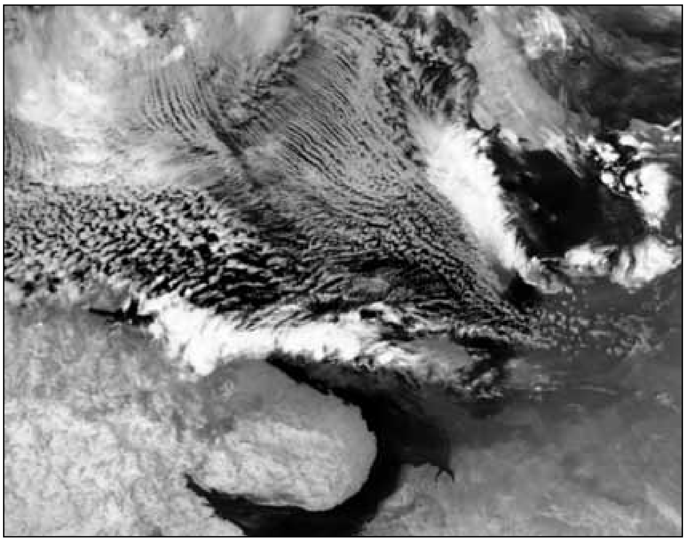

Figure 5 - NOAA 16 - 00:11 UT on December 22, 2003

blizzards over much of eastern Britain as well as over large parts of Holland and Belgium (figure 7) [2]. At some locations on the east coast of England, wind speeds reached force 10!

From that afternoon chaos reigned throughout Great Britain. Stanstead Airport was closed while thousands of travellers were delayed at Heathrow Airport as flights were cancelled; the London underground came to a halt; schools were closed; many workers trying to make their way home after work found themselves in traffic gridlock for many hours; thousands suffered power cuts; snowploughs struggled to keep roads open, with many short journeys taking hours and there were numerous road accidents as up to 15 cm of snow fell in many places. Yet in the corresponding NOAA-17 image the following day, only a tenuous streamer, possibly a remnant of the cyclone's 'comma' tail, remained to tell the tale (figure 8).

References and Further Reading

1. The European Polar Low Working Group
   http://www.meteo.uni-bonn.de/
   mitarbeiter/GHeinemann/eplwg/eplwgop.htm
2. 'Polar low' boven zuidelijke Noordzee
   http://www.knmi.nl/~floor/artikelen/zenit/polarlow/
3. Weather Online
   http://www.weatheronline.co.uk/feature/wf261103.htm
4. Cloud Structure (of the Polar Low)
   http://www.zamg.ac.at/
   docu/satmanu4.0/satmanu/manual/PL/pl1.htm

Images

Figure 2

Synoptic chart created with Digital Atmosphere

Figures 3, 4, 5, 6

Reproduced by courtesy of the SMIS NOAA HRPT telemetry archive at: http://d902.iki.rssi.ru/dataserv/engl/oper_e.shtml

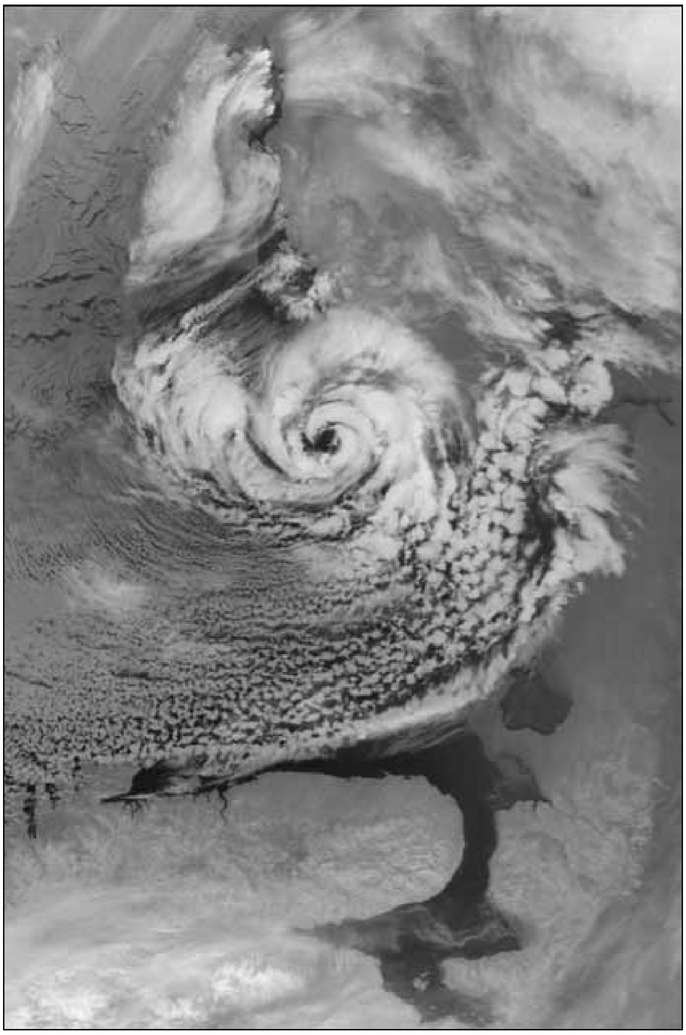

Figure 6 - NOAA 12 - 04:33 UT on December 20, 2002

The images were processed using David Taylor's HRPT Reader, then converted to orthographic projection using his Groundmap program, which also added country outlines.

Figures 7 and 8

NOAA-17 APT images received by Les Hamilton and processed using Craig Anderson's Wxtoimg software

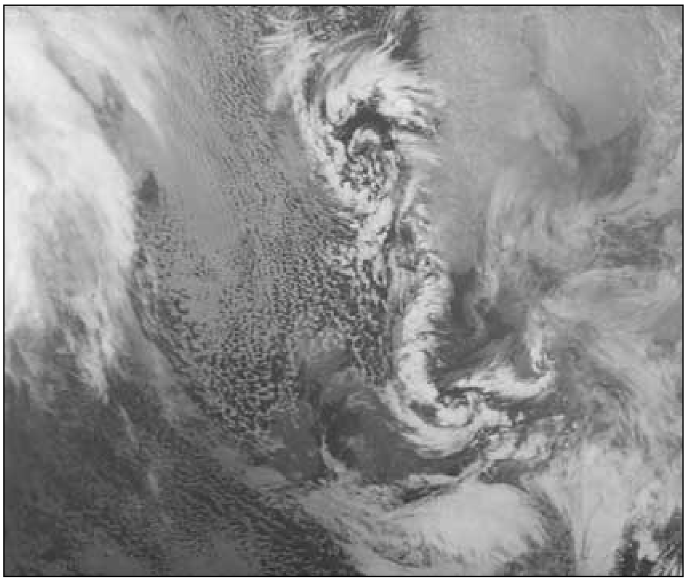

Figure 7 - A *polar low* brings blizzards to Britain and the Low Countries (NOAA 17 - 11:08 UT - January 30, 2003

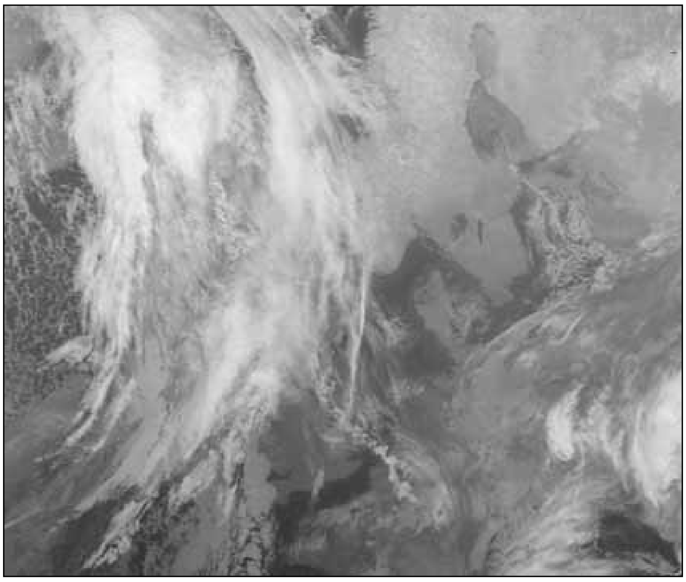

Figure 8 - Next day, the *polar low* has completely disappeared (NOAA 17 - 10:43 UT - January 31, 2003)