Launch of an ozonesonde from the balloon filling station on the roof of 'Neumayer Station III'

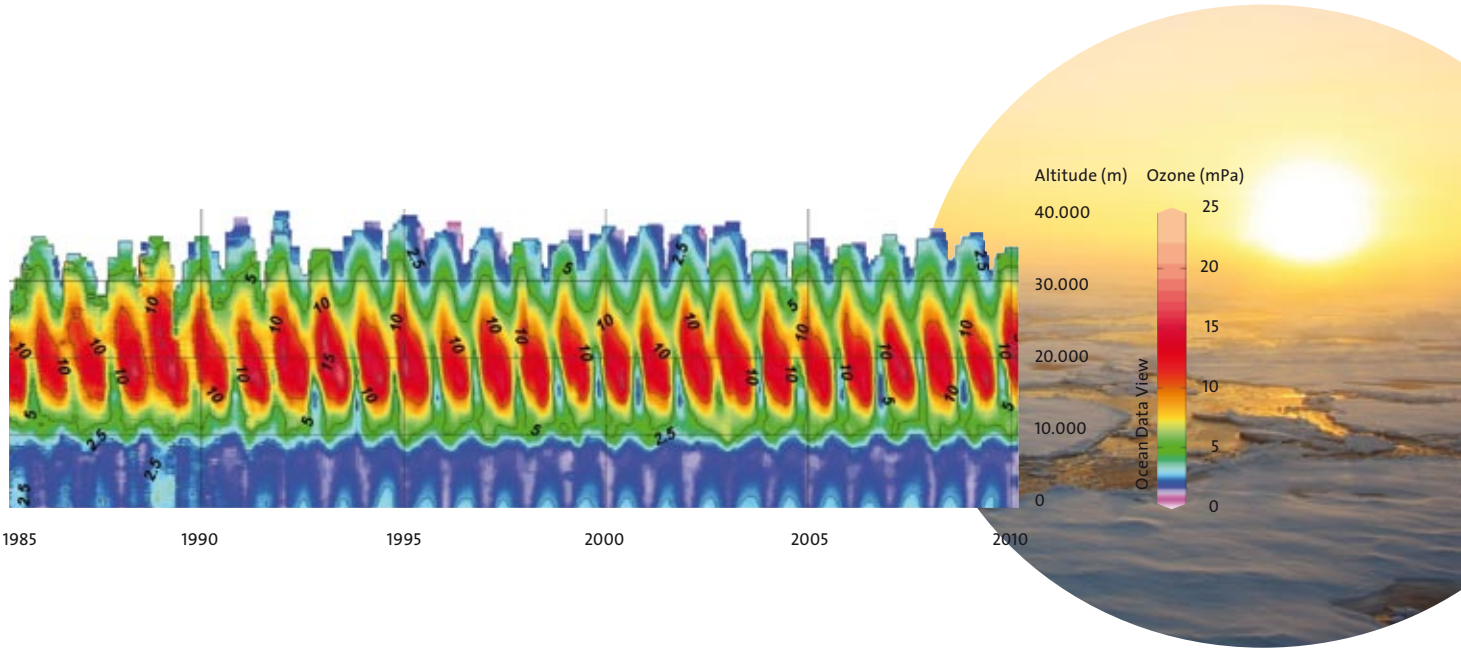
Long-term measurements show: ozone layer above the Antarctic has not yet recovered

The ozone hole above the Antarctic was discovered in 1985. The presumption that chlorofluorocarbons (CFCs) from refrigerators and spray cans damage the ozone layer had already been a subject of discussion among experts for a long time. However, a measurable decline in the ozone layer was found for the first time in the Antarctic, of all places, far away from all anthropogenic CFC sources on the Earth.

This discovery turned out to be of great significance far beyond the Antarctic since it led to the Montreal Protocol in 1987, in which the signatory states agreed to complete elimination of ozone-destroying substances. At the same time as the discovery of the ozone hole at the British Antarctic station Halley, ozone measurements by means of weather balloons started at the 'Georg-Forster station' operated by the German Democratic Republic. After reunification of the two German states Neumayer station took over this measurement programme and has continued it down to today on a continuous basis. Both stations are located in Queen Maud Land in the Antarctic at a latitude of approx. 70° S. Their measurements form a unique continuous time series now lasting over 25 years: a record in the Antarctic!

Weather balloons are released into the atmosphere every day at Neumayer. The rubber balloons filled with helium reach an altitude of up to 37 km within approx. 2 hours before they burst. A small radiosonde attached to the balloon measures the temperature, moisture and wind during this time. An exceptionally large weather balloon that carries an ozonesonde in addition to the radiosonde is used once a week.

Such measurements are expensive and elaborate. In contrast to optical methods, which usually only show the total ozone of the entire air column above a measuring site, ozonesonde provide an altitude resolution of the ozone profile of approx. 25 m. This makes it possible to study the dramatic changes taking place in the ozone layer during the Antarctic spring.



As shown in Figs. 1 and 2, the dramatic ozone depletion is restricted to certain altitudes (15 to 18 km) and seasons. In the last 25 years the mean ozone partial pressure in the Antarctic spring (September to November) has declined (Fig. 3). Whereas the mean values for the ozone layer were around 6 mPa in the 1980s, only half of that has been measured in recent years. At the same time the temperature at this altitude and in this season also changed.

A large part of this trend is attributed to chemical ozone depletion due to anthropogenic CFCs. However, dynamic processes are also discernible. In 1988 as well as in 2002, for example, a collapse of the stratospheric circumpolar vortex over the Antarctic enabled warm and ozone-enriched air to flow from the lower latitudes to the area above the Antarctic.

Although the Montreal Protocol has very successfully stopped the production of CFCs, measurements at the 'Neumayer station' do not yet indicate a recovery of the ozone layer. However, regeneration of the ozone layer is expected in the coming decades. Neumayer will continue to play a major role in research on this process since the construction of the new station facility, completed in 2009, ensures the continuation of these measurements.

Fig 1: Time-altitude section of ozone partial pressure above the Antarctic stations Georg-Forster and Neumayer. The ozone layer lies at altitudes between 10,000 and 25,000 m, identifiable by the high ozone values shown in yellow and red. During the Antarctic spring between September and November the ozone layer regularly weakens, displaying local minimum values in some years (blue) instead of maximum values (red).
Figure: Gert König-Langlo, AWI

Fig 2: Ozone altitude profiles

Ozone altitude profiles, measured above 'Neumayer station'. The dramatic ozone destruction in the Antarctic spring led to the complete depletion of the ozone layer in October 2006.
Figure: Gert König-Langlo, AWI

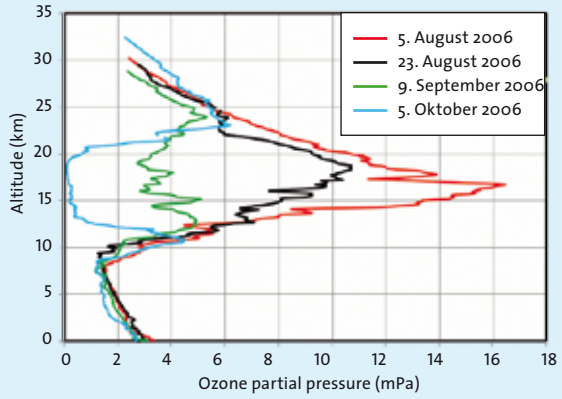


Fig 3: Time series

Time series of the average ozone partial pressure (red) and temperature (blue) from September to October 15 to 18 km above the Georg-Forster and Neumayer stations.
Figure: Gert König-Langlo, AWI