STOP PRESS: Large ozone hole predicted

A large ozone hole is expected to form over Antarctica this coming spring.

At the end of July, trends in the temperature and dynamics of the Antarctic stratosphere were starting to creating conditions favourable for a large ozone hole to form.

The trends were similar to those observed in 2000 when the ozone hole was of record size, and in complete contrast to 2002 when the hole was the much smaller.

At Davis, stratospheric clouds were detected in late May, which was about six weeks earlier than they were seen in 2001 and 2002. This is directly related to atmospheric temperatures, which this year have generally been a few degrees below average throughout the Antarctic stratosphere.

When the sun returns to Antarctica in the spring, the atmosphere becomes disturbed. The level of disturbance is variable from year to year, and this impacts on the final magnitude of the ozone hole. However, present indications are that the hole this year will be large.

and major disturbances to the polar vortex. Significantly, the vortex broke down during October, several weeks earlier than expected. An unprecedented event occurred on 23 September 2002 when a sudden warming in the vortex caused the ozone hole to split into two components. One part of the hole drifted towards South America and dissipated, while the other portion re-centred itself over the pole before dissipating a few weeks later (Figure 1).

Was 2002 an unusual year and what can we expect in the future? It is possible that 2002 provided us with an example of natural variability in the atmosphere that acts on decadal or longer timescales. Modelling of best-estimate greenhouse gas and ozone depletion scenarios suggest that planetary wave heating of the polar stratosphere should be decreasing. However, a recent analysis of more than 50 years of assimilated stratospheric data for the Arctic found no evidence to support this view. Interestingly, what is becoming clearer is the strong upward dynamical link, driven by planetary wave activity, that exists between the troposphere and stratosphere over the winter pole, and the importance of teleconnections (recurring and persistent large-scale patterns of pressure and circulation anomalies that span vast geographical areas, an example being the El Niño phenomenon) in the global climate system. The 'smoking gun' for 2002 may well be found in a geographical region outside Antarctica.

The Antarctic ozone hole appeared more benign during 2002, but the problem is far from solved.

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Antarctica Online

Australian Antarctic Division ozone fact file: <http://www.aad.gov.au/default.asp?casid=2850>

Other website references:

Scientific Assessment of Ozone Depletion: 2002, United Nations Environment Programme; <http://www.unep.org/ozone/index-en.shtml>

The Ozone Hole Tour, Cambridge University: <http://www.atm.ch.cam.ac.uk/tour/index.html>

Ozone data at NASA/Goddard: <http://toms.gsfc.nasa.gov/ozone/ozone.html>

Investigating ozone depletion above Davis

A new program of stratospheric ozone studies has been established at Davis by the AAD's Space and Atmospheric Science (SAS) group and the Bureau of Meteorology (BoM). This effort represents the first time Australia has made in-situ measurements of stratospheric ozone in Antarctica, and is part of the larger investigation of the composition, dynamics and climate of the middle atmosphere being undertaken at Davis by the SAS program.

The program makes use of balloon-borne ozonesondes launched by BoM staff at Davis to profile ozone concentration from the ground to altitudes of up to 35km. Ozonesondes are a well-established means of measuring ozone, and are regularly launched at about 40 stations world-wide, including 9 in Antarctica. At the heart of each ozonesonde is a chemical cell containing a dilute solution of potassium iodide. Air is passed through the cell by a pump, and a reaction takes place between ozone and the solution which produces an electrical current proportional to the ozone concentration. A standard meteorological radiosonde is incorporated in the balloon payload, and this provides additional data on pressure, temperature and humidity during the flight. The readings, together with signals from an on-board GPS receiver which provide location information for the determination of wind speed and direction, are telemetered to a ground receiving station.

The operational aspects of the Davis program are being coordinated by the Bureau's Ozone Monitoring Unit (OMU). Through the OMU, the Bureau

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Davis Bureau of Meteorology personnel (L-R) Cathie Saunders, Geoff Fulton and David Morgan watch the first ozonesonde ascend.

maintains an extensive and long-term commitment to ozone measurement, including programs of ozonesonde launches at Macquarie Island and Melbourne, and ozone total column abundance measurements at Macquarie Island and five Australian centres. Importantly, Macquarie Island is the only subantarctic site from which ozonesondes are launched.

The Davis ozone study has three main aims;

- To investigate the influence of atmospheric gravity waves and planetary waves on ozone depletion, and the climatology of ozone above Davis. Although there is a broad understanding of the processes that lead to ozone depletion, there are still discrepancies between observations and model predictions. This limits the usefulness of models in predicting future ozone levels. Aspects of these discrepancies may relate to small-scale thermodynamic processes associated with the action of natural wave processes in the atmosphere. The ozone measurements at Davis combined with data from the lidar and the recently commissioned VHF radar will provide new data on these processes.
- To provide local ozone data to aid in the derivation of temperature profiles from the Davis lidar, and to provide in-situ temperature measurements in the upper stratosphere for comparison with lidar observations. These measurements will contribute to assessing the long-term climatology of the stratosphere above Davis.
- To contribute to international efforts in the understanding of ozone depletion through participation in the European Union program 'Qualitative Understanding of Ozone Losses by Bipolar Investigations' (QUOBI), and contribution of data to the World Ozone and Ultraviolet Radiation Data Center.

The ozonesondes are currently being flown monthly, and from mid-June to mid-October the flights will be made at weekly intervals to coincide with the time of maximum interest in ozone levels. The launch schedule will be coordinated with operation of the Davis lidar and activities of the QUOBI program. QUOBI is an international effort led by Germany's Alfred Wegener Institute for Polar and Marine Research that involves regular ozonesonde launches by Antarctic and Arctic stations during their respective winter and spring seasons. The ozonesondes launched by stations in the QUOBI program attempt to sample the ozone concentration in parcels of air that are carried from one observing site to another by the stratospheric flow, thereby providing information for the refinement of chemical models of the atmosphere.

A further important aspect of the Davis program will involve collaborative research with Chinese scientists who are operating a program of ozone total column abundance measurements using a ground-based spectrophotometer at Zhong Shan station near Davis. Comparison of data from the two sites will enable calibration and consistency checks for the different measurement techniques that are employed.

The first ozonesonde was successfully launched on 20 February 2003, and we look forward to the exciting new data to follow.

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Antarctica Online

Further information:
Description of the QUOBI project; <http://www.nilu.no/quobi/>
Ozone monitoring by the Bureau of Meteorology; <http://www.bom.gov.au/inside/oeb/atmoswatch/aboutozone.shtml>

Beautiful, mysterious polar stratospheric clouds

Polar stratospheric clouds (PSCs) play a central role in the formation of the ozone hole in the Antarctic and Arctic. PSCs provide surfaces upon which heterogeneous chemical reactions take place. These reactions lead to the production of free radicals of chlorine in the stratosphere which directly destroy ozone molecules. Despite two decades of research, the climatology of PSCs is not well described, and this impacts on the accuracy of ozone depletion models. The timing and duration of PSC events, their geographic extent and vertical distributions, and their annual variability are not well understood. The AAD's Space and Atmospheric Sciences group encourages people travelling south to keep a lookout for these clouds, and to report any sightings. This information is potentially useful to compare with observations by the Davis lidar, satellite measurements and predictions of atmospheric models.

MALCOLM LAMBERT

Type I PSC veil at Davis, July 2001

PSCs form poleward of about 60°S latitude during the winter and early spring in the altitude range 10km to 25km. The clouds are classified into Types I and II according to their particle size and formation temperature. Type II clouds, also known as nacreous or mother-of-pearl clouds, are