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Ozone and UV September 2004

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The aim of this research letter is to present an overview of the meteorological conditions relevant to the ozone distribution and UV Index during the Southern Hemisphere spring and summer. This is not an ozone-hole statement; the ozone-hole statements can be found at http://kelly.ho.bom.gov.au/htdocs/ozone/index.asp and at http://www.wmo.ch/web/arep/arep-home.html.

During the early 1980s a significant loss of the springtime Antarctic ozone was first observed. Since then, satellite and ground-base observations have shown that this depletion is caused by the presence of halogen-containing gases (chlorine and bromine) that have been released into the atmosphere during the last 40 years. The rapid ozone depletion over the Antarctic is observed when low stratospheric temperatures initiate chemical processes in the presence of sunlight. The Antarctic winter temperatures (below –78C or 195K) allow the formation of polar stratospheric clouds (PSC) activating chemical processes that increase ozone depletion. Figure 1 illustrates the zonal distribution of temperature over the South Pole from May 2003 to December 2003 from defined GASP analysis. The dark blue-to-lilac colours indicate temperatures below 195K during the winter months. The cold polar stratospheric air is kept relatively isolated from mid-latitudes by strong winds around the Antarctic during spring. This region is known as the Antarctic polar vortex.

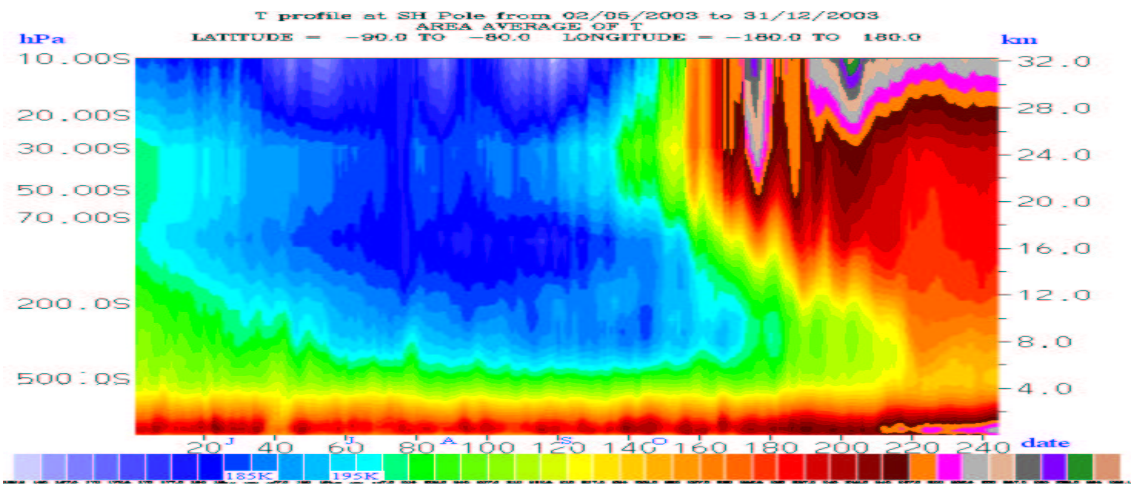

Figure 1. GASP vertical temperature distribution over the South Pole for May-December, 2003.

The stratospheric meteorological conditions have a strong influence on the year-to-year variations in Antarctic ozone depletion. Last year the ozone hole reached an area close to the record size observed in 2000, as reported in the ozone statement (http://www.wmo.ch/web/arep/arep-home.html). In contrast the 2002 ozone hole was the smallest since 1988. The Antarctic ozone hole usually reaches its maximum size in September and maximum depletion in September-October. Figure 2 illustrates (from left to right) the TOMS October 2003 monthly mean ozone, the TOMS October monthly mean ozone over the period 1997 to 2001, and the difference between the two. The figure shows that in October 2003, the ozone maximum was located to the south east of Australia, while, for the October monthly mean over 1997-2001, it was located to the south of Australia. The difference shows an ozone reduction to the west of Antarctica and an increase to the east, reaching up to Southern of Australia. To the north of Australia a reduction from about 10 to 30 DU for October was observed. This is important since ozone decreases are in general accompanied by UV increases (WMO, Scientific Assessment of Ozone Depletion: 2002 at http://www.unep.org/ozone/Publications/index.asp), and the UV Index levels to the north of Australia are usually "high" (6-7 UV Index units) or "very high" (8-10 UV Index units) even during spring (http://www.bom.gov.au/weather/national/charts/UV.shtml.

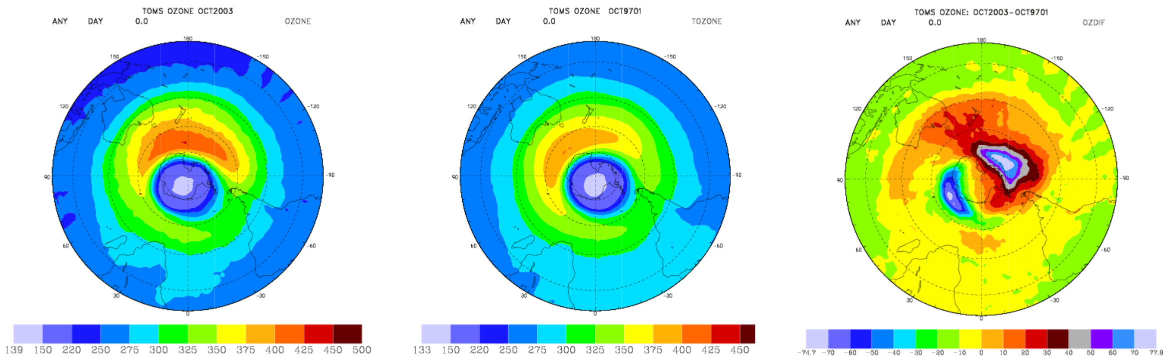

Figure 2. From left to right: TOMS October monthly mean for 2003,1997 to 2001 average, and differences.

For 2004, since June, the polar stratospheric temperatures from GASP have remained below the PSC formation temperature. The zonal temperature distribution over the South Pole from January 2003 to the present day can be seen in Fig 3 (left) and at http://comms.ho.bom.gov.au/gasp/uvo3.html. Since early August 2004 a warming is observed from 20 to around 28 km in Figure 3 (left). The 50hPa GASP temperature distribution shows an example of the region with temperatures below the PSC critical value that covers an area slightly larger than Antarctica shown by the dark blue contour in Figure 3 (right) and at http://comms.ho.bom.gov.au/gasp/uvo3.html.

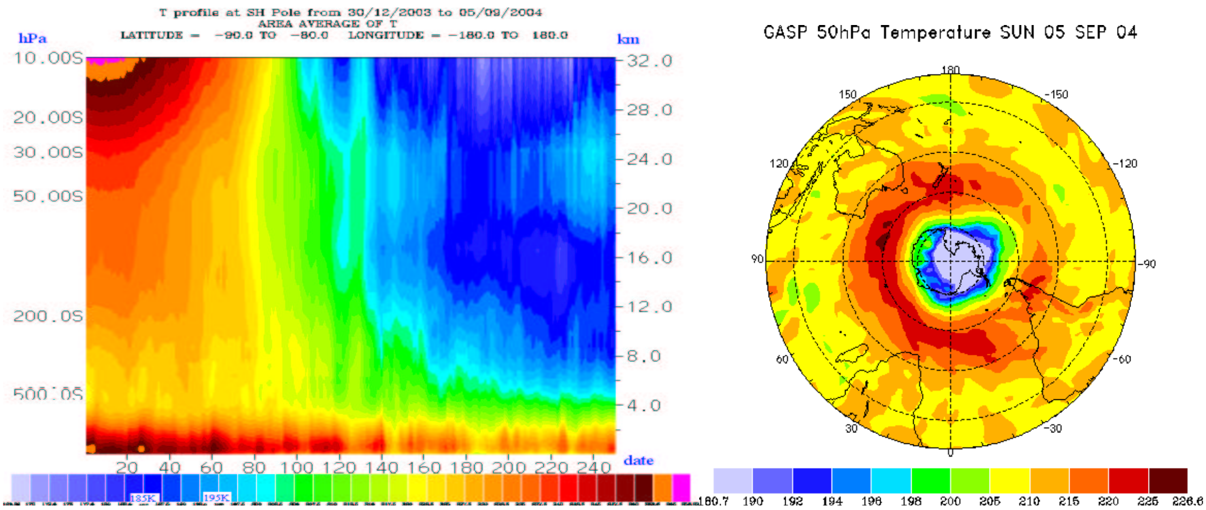

Figure 3. GASP vertical temperature distribution over the South Pole (left) (where date denotes days from 30th December 2003 to 5th September 2004) and 50hPa temperature distribution for the Southern Hemisphere (right) for 5th September 2004.

The cold air is “contained in” by the already well established polar vortex, shown in Figure 4 by the strong GASP potential vorticity (PV) gradient at the 550K isentrope (about 18 km) (top left), reaching well into lower levels, down to the 450K isentrope (about 16km) (top centre) and starting to form at the 380K isentrope (about 13km) (top-right) (a 10-day forecast can also be found at http://gale.ho.bom.au/internal/regn/staf/lld/uv/o3hole.html). Figure 4 also shows an increase in zonal wind from July to August 2004 (bottom left) and an indication of the wave activity illustrated by the difference between the daily zonal wind and the monthly mean (bottom right). Since mid-July a zonal wind anomaly can be seen making its way up (red contour), reaching the lower stratosphere by early August.

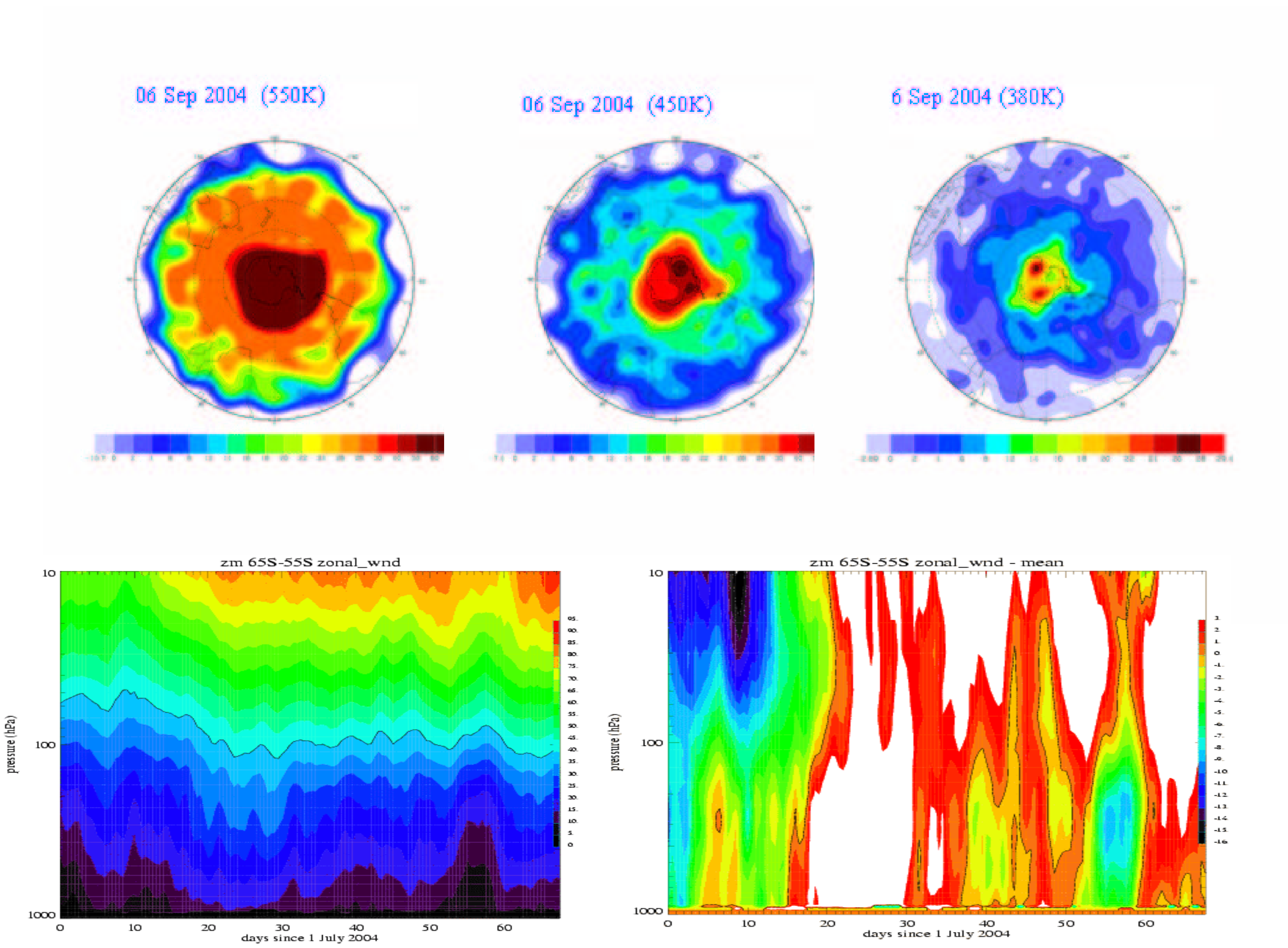

Fig 4. GASP Southern Hemisphere potential vorticity (PV) top from left to right top; 550K, 450K and 380K isentrope and (bottom left) July to August zonal wind and (bottom right) difference from monthly mean (countours intervals on the right).

The temperature at Davis (Figure 5 left), from July to mid-September 2004, shows less coverage by the PSCs (white contour-line) than that covered during the same months last year. Over the same period the measured ozone-partial pressure at Davis shows higher values than last year (Figure 5 right) that suggests a relatively slow start to the development of the ozone hole. The temperature increase at 30km showed by the lidar observations at Davis in Figure 6 (left) suggest enhanced planetary wave activity (http://www.aad.gov.au/default.aps?casid=222).

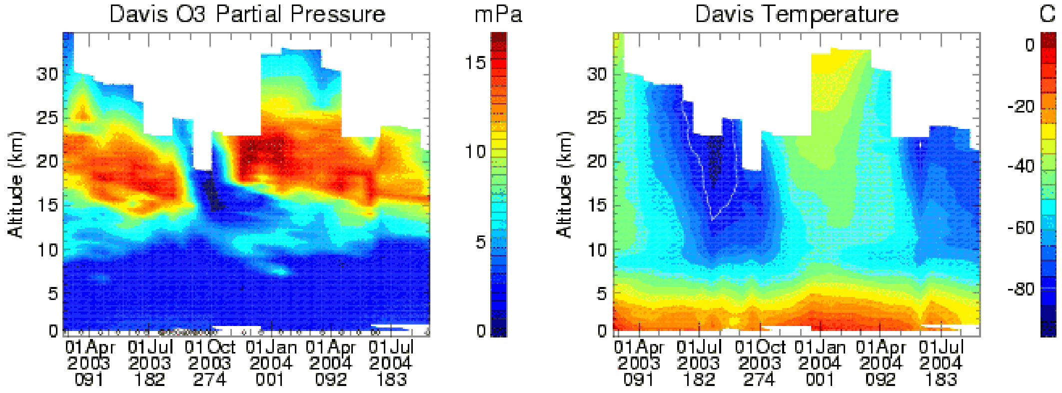

Figure 5. Ozone-partial-pressure (left) and temperature (right) measured by ozonesonde at Davis, Antarctica.

The current 2004 ozone hole area derived from TOMS data is shown in red in Figure 6. The calculated area for 2003 is given in the same figure in black as a reference. If the low stratospheric temperatures (shown at http://comms.ho.bom.gov.au/gasp/uvo3.html) remain cold enough and the polar vortex is sustained, it is anticipated that, with the arrival of the spring sunlight, the ozone depleted area will be very similar to that shown by the contour of the 50hPa temperature from GASP forecasts (shown in dark blue at http://comms.ho.bom.gov.au/gasp/uvo3.html. However, meteorological conditions at the time will clearly affect the outcome.

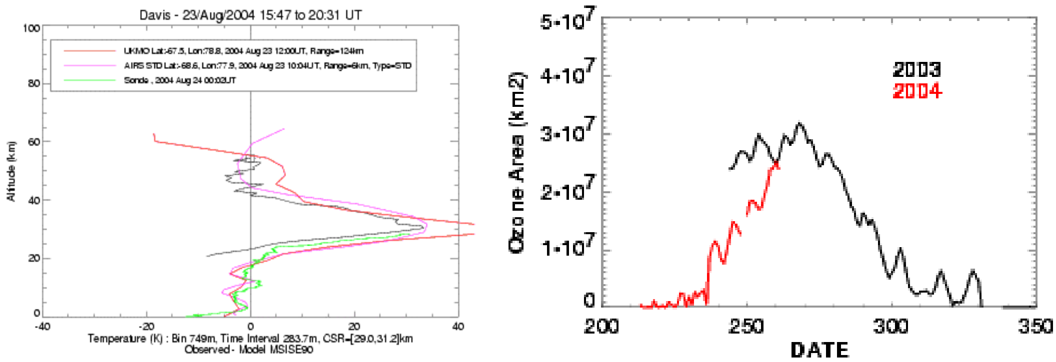

Figure 6. Temperature differences between lidar (black), AIRS (magenta),UKMO(red) and radiosonde (green) with the MISES-00 climatology (http://nssdc.gsfc.nasa.gov/space/model/atmos/nrlmise00.html) (left) and calculated ozone hole for 2003 and 2004(August to 19th September) using TOMS data (right).

Acknowledgements

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http://kelly.ho.bom.gov.au/htdocs/ozone/index.asp
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