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The 2009 Antarctic Ozone Hole Summary: Tuesday 6 October 2009

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Instrumentation

Data from the Ozone Monitoring Instrument (OMI) on board the Earth Observing Satellite (EOS) Aura, that have been processed with the NASA TOMS Version 8.5 algorithm, will be utilized again this year in our weekly ozone hole reports. OMI continues the NASA TOMS satellite record for total ozone and other atmospheric parameters related to ozone chemistry and climate.

In 2008 stripes of bad data began to appear in the OMI products, apparently caused by a small physical obstruction in the OMI instrument field of view. NASA scientists guess that some of the reflective Mylar that wraps the instrument to provide thermal protection has torn and is intruding into the field of view. On 24 January 2009 the obstruction suddenly increased and now partially blocks an increased fraction of the field of view, leading to the larger stripes of bad data that are seen in current OMI images. Affected data have been flagged and removed from the images. NASA thinks that some of the data may be recoverable but a fix may take months to create and test. However, once the polar night reduces enough then this should not be an issue for determining ozone hole metrics, as there is more overlap of the satellite passes at the polar regions which essentially 'fills-in' these missing data.

Lastly, all of the OMI ozone data have been reprocessed/updated and were released in June 2009. These have now been reprocessed by CSIRO, which has resulted in small changes in the ozone hole metrics we calculate. As such, these metrics may be slightly different for previous years for OMI data (2005-2008).

The 2009 ozone hole

The OMI data show that the ozone minimum dropped below 220 DU in early August, about two weeks later than in 2005-2008, and about a week later than the 1979-2005 mean. By the end of August, the ozone minimum in the Antarctic ozone hole had dropped rapidly to 160 DU (similar to 2008), about 1 week earlier than 2006 and 2007, and 1-2 weeks later than in the 2005 hole. By the third week of September the ozone minimum continued to drop rapidly to 115 DU, similar to 2007. By the last week of September the ozone minimum dropped below 100 DU, deeper at this time than any of the past 4 ozone holes. The ozone minimum stayed below 100 DU for about a week, returning to above 100 DU at the beginning of October. By October 3, the ozone minimum had recovered to 103 DU. This below 100 DU period in late September could define the ozone minimum for this year, with an ozone minimum of 96-97 DU, the lowest ozone minimum of the past 3 years (Figure 1, top panel).

The 2009 Antarctic ozone hole is very 'deep', but is unlikely to be a 'record breaking' in terms of ozone hole area. During the first and second weeks of September, the ozone hole area remained in the 22-23 million km^2 range, which is very similar to the 2007 hole during the same date range, and about 4 million km^2 smaller than the 2005, 2006 & 2008 holes at the end of the second week of September. By the third week of September the ozone hole area had risen to about 24.5 million km^2, about 3 million km^2 smaller than the 2005, 2006 & 2008 holes at the same time and has stayed at that area for the past week. The ozone hole area achieved by mid-September (24.5 million km^2) looks like being the maximum ozone hole area this year. The 2009 area looks similar to 2007 (Figure 1, bottom panel).

Figure 2 (top panel) shows that the estimated daily ozone deficit by the end of the third week of September had reached 33 million tonnes, which is now larger than the 2007 & 2008 ozone holes, but less than the 2005 & 2006 ozone holes at the same time. The ozone deficit has continued to grow, reaching 36 million tonnes in the last week of September, larger than the past 4 ozone holes, except for the record deficit (45 million tonnes) achieved in 2006, at the same date. By the first week of October, the ozone deficit in the hole had declined to 27 million tonnes, similar to the behaviour seen in the 2007 hole, but now significantly less than the 2006 and 2008 holes.

The average ozone amount in the hole (averaged column ozone amount in the hole weighted by area, Figure 2 bottom panel) continued to drop rapidly to a minima of about 155 DU during the third week of September, similar to 2005 & 2006 ozone holes and about 13 DU lower than the 2007 & 2008 ozone holes at the same time. By the last week of September the minimum dropped to 150 DU, very similar at this time to 2005 and 2006, lower than 2007 and 2008. The average ozone in the hole stayed at this 150 DU level for over a week, before showing signs of a rapid recovery to 157-158 DU by October 3.

Total column ozone data over Australia and Antarctica for 22 September – 3 October are shown in Figure 3. The vortex appears relatively symmetrical, and therefore likely cold and stable, up to 21 September, with a significant elongation towards the Indian Ocean during 22-26 September. The elongation weakened around September 29-30 before elongating again in the Indian Ocean/African direction by October 3. This current elongation is very pronounced and all of the Antarctic coast south of Australia has experienced unusually high ozone levels since the beginning of October.

The ozone hole passed over the southern tip of South America during 24-26 September. Much of the Antarctic coast south of Australia was not under the ozone hole during the period 19-24 September and 29 September – 3 October. A ridge of ozone formed to the south and west of Australia during 6-9 September, then intensified and moved east to be situated south of Australia on 11-12 September. The maximum ozone in this ridge (> 500 DU) is the highest that has been seen for many years. This ridge dissipated during 14-15 September, with another intense ridge forming south of Australia during 16-25 September, dissipating on 26 September. The ridge reformed over the southern Indian Ocean on 30 September and has intensified and moved to south of Australia by 3 October. It is very intense with areas of ozone levels above 500 DU over the Antarctic coast, very unusual to be this far south and this intense. It currently looks like one of the least stable vortices for this time of the year.

It is difficult to predict where the hole will go from here – it could break up early or re-intensify. It will not retain its current distorted configuration for long.

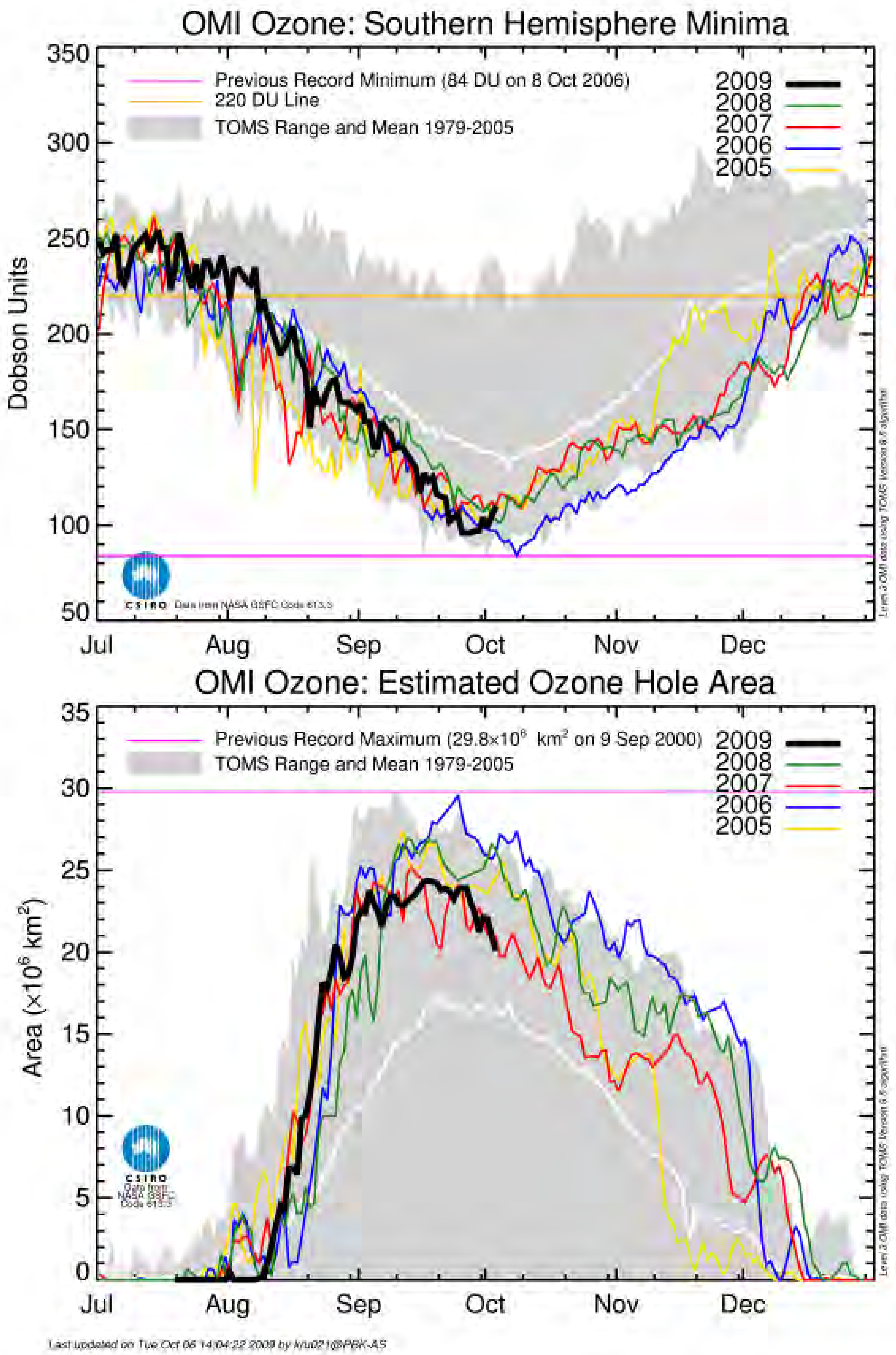

Figure 1: Ozone hole depth (top panel) and area (bottom panel) based on OMI satellite data, as of October 3, 2009.

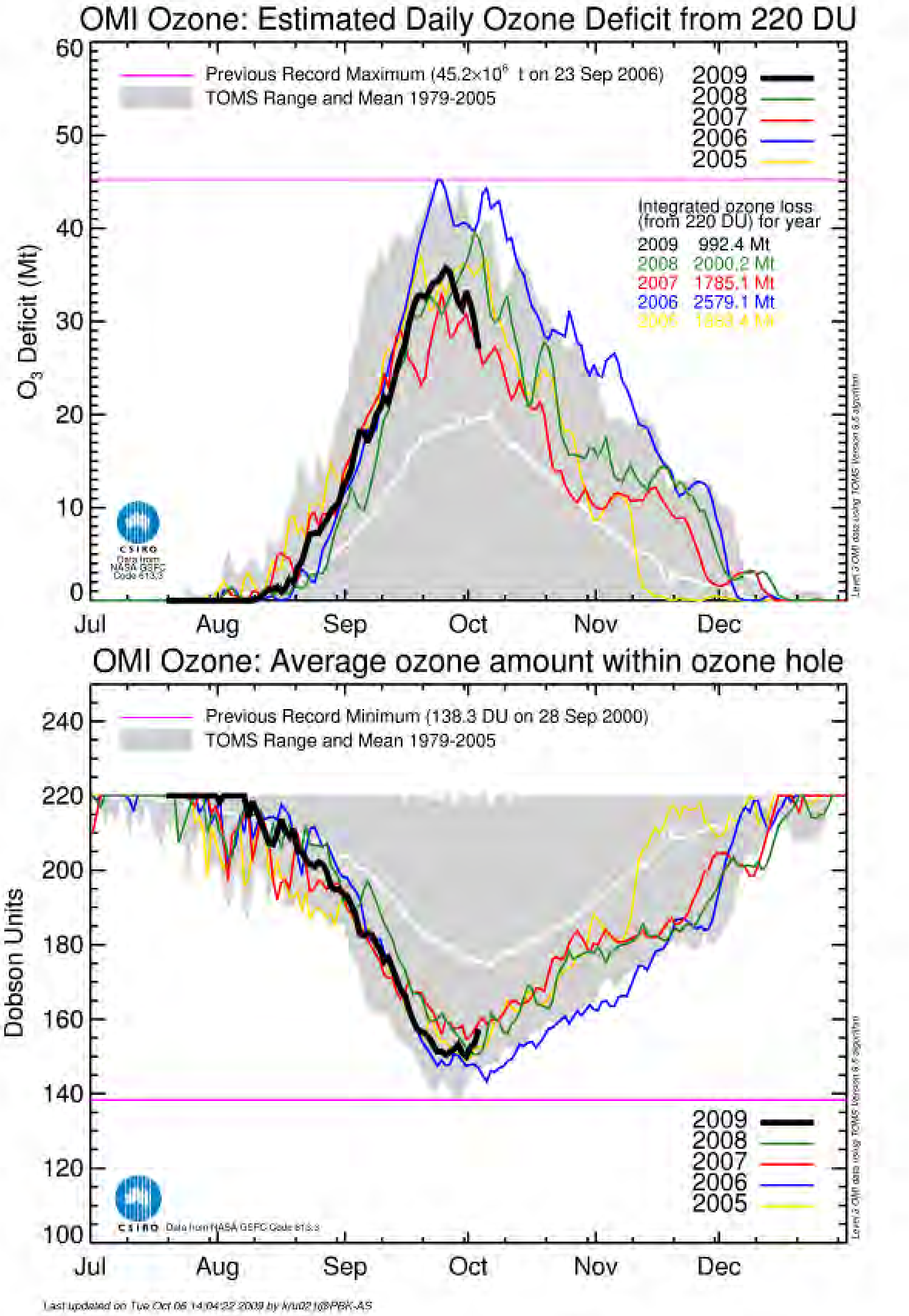

Figure 2: Estimated daily ozone deficit (top panel) and average ozone amount within the ozone hole (bottom panel) based on OMI satellite data, as of October 3, 2009.

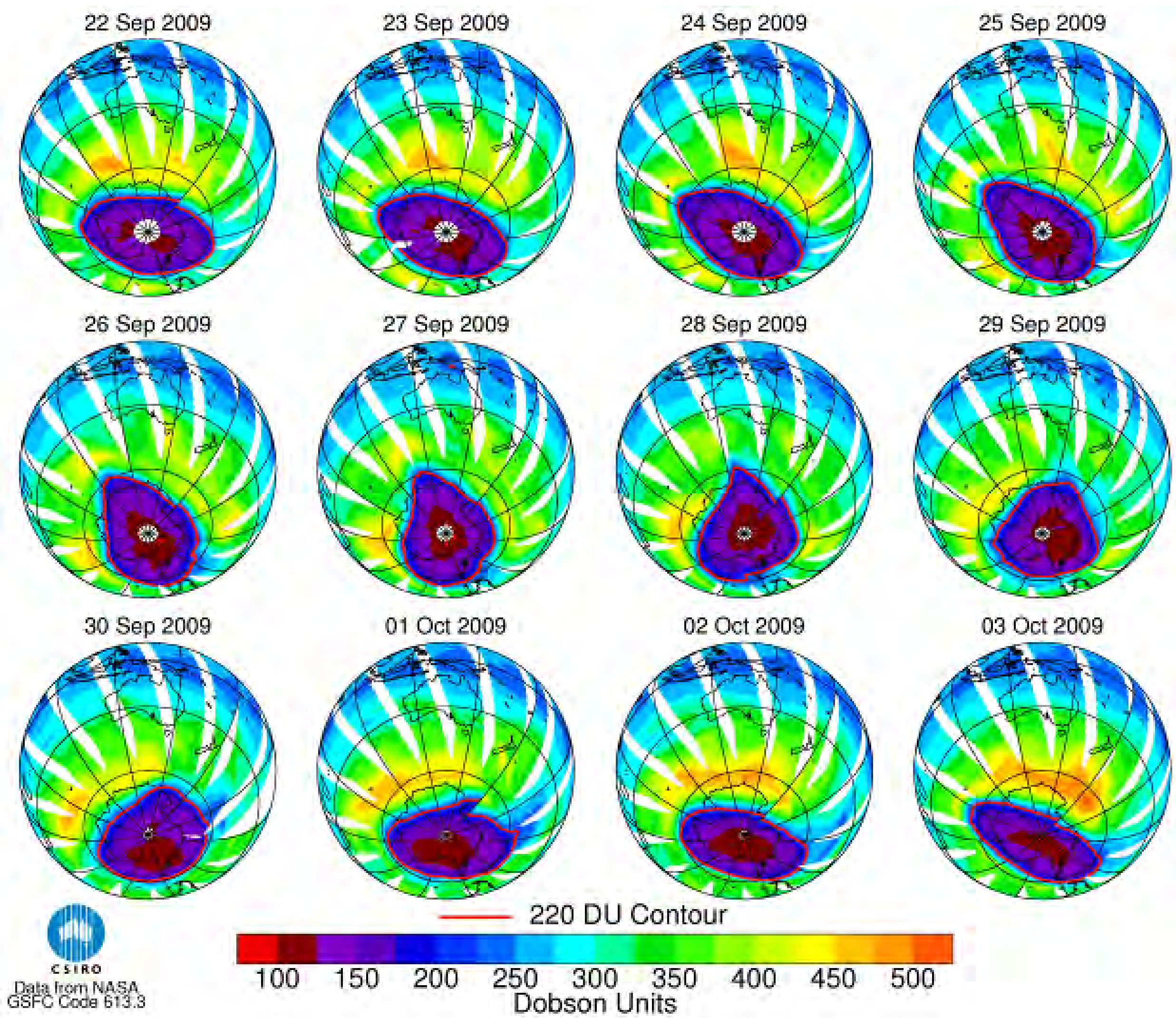

Figure 3: OMI ozone hole images for 22 September to 3 October 2009; the ozone hole boundary is indicated by the red 220 DU contour line. The white area over Antarctica is missing data and indicates the approximate extent of the polar night. The OMI instrument requires solar radiation to the earth's surface in order to measure the column ozone abundance. The white stripes are bad/missing data due to a physical obstruction in the OMI instrument field of view.

Definitions

CFCs: chlorofluorocarbons, synthetic chemicals containing chlorine, once used as refrigerants, aerosol propellants and foam-blowing agents, that break down in the stratosphere (15-30 km above the earth's surface), releasing reactive chlorine radicals that catalytically destroy stratospheric ozone.

DU: Dobson Unit, a measure of the total ozone amount in a column of the atmosphere, from the earth's surface to the upper atmosphere, 90% of which resides in the stratosphere at 15 to 30 km.

Halons: synthetic chemicals containing bromine, once used as fire-fighting agents, that break down in the stratosphere releasing reactive bromine radicals that catalytically destroy stratospheric ozone. Bromine radicals are about 50 times more effective than chlorine radicals in catalytic ozone destruction.

Ozone: a reactive form of oxygen with the chemical formula O_3; ozone absorbs most of the UV radiation from the sun before it can reach the earth's surface.

Ozone Hole: ozone holes are examples of severe ozone loss brought about by the presence of ozone depleting chlorine and bromine radicals, whose levels are enhanced by the presence of PSCs (polar stratospheric clouds), usually within the Antarctic polar vortex. The chlorine and bromine radicals result from the breakdown of CFCs and halons in the stratosphere. Smaller ozone holes have been observed within the weaker Arctic polar vortex.

Polar night terminator: the delimiter between the polar night (continual darkness during winter over the Antarctic) and the encroaching sunlight. By the first week of October the polar night has ended at the South Pole.

Polar vortex: a region of the polar stratosphere isolated from the rest of the stratosphere by high west-east wind jets centred at about 60°S that develop during the polar night. The isolation from the rest of the atmosphere and the absence of solar radiation results in very low temperatures (less than -78°C) inside the vortex.

PSCs: polar stratospheric clouds are formed when the temperatures in the stratosphere drop below -78°C, usually inside the polar vortex. This causes the low levels of water vapour present to freeze, forming ice crystals and usually incorporates nitrate or sulphate anions.

TOMS & OMI: the Total Ozone Mapping Spectrometer & Ozone Monitoring Instrument, are satellite borne instruments that measure the amount of back-scattered solar UV radiation absorbed by ozone in the atmosphere; the amount of UV absorbed is proportional to the amount of ozone present in the atmosphere.

UV radiation: a component of the solar radiation spectrum with wavelengths shorter than those of visible light; most solar UV radiation is absorbed by ozone in the stratosphere; some UV radiation reaches the earth's surface, in particular UV-B which has been implicated in serious health effects for humans and animals; the wavelength range of UV-B is 280-315 nanometres.

Acknowledgements

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