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The 2009 Antarctic Ozone Hole Summary: Friday 4 September 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 utilised 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 the third week of August, the ozone minimum in the Antarctic ozone hole had dropped rapidly to 160-170 DU (similar to 2007), about 1 week earlier than 2006 and 2008, a week later than in the 2005 hole, and about 3 weeks earlier than the 1979-2005 mean. From the last week of August into the first week of September the ozone minimum stayed in the 160-170 DU range, similar to 2007 (Figure 1, top panel).

At this stage the 2009 Antarctic ozone hole is heading for the 'deep' category (as have all ozone holes since the early 1990s except for 2002). By the first week of September, the ozone hole area reached over 22 million km^2 (Figure 1, bottom panel), which is very similar to the 2007 hole at the same date, and about 4 million km^2 larger than the 2008 hole. The 1979-2005 average ozone hole was only 10 million km^2 by this date.

Figure 2 (top panel) shows that the estimated daily ozone deficit by the first week of September had reached 13 million tonnes (similar to the past 4 ozone holes), while the average ozone amount in the hole (averaged column ozone amount in the hole weighted by area (Figure 2 bottom panel) shows a minima of about 190 DU at the same time (similar to the past 4 ozone holes). The really rapid ozone decline in 2005, 2006, 2007 and 2008 did not start until the end of the first week of September – presumably this will be the case for 2009.

Total column ozone data over Australia and Antarctica for 21 August – 1 September are shown in Figure 3. The Antarctic polar night region still covers about half of Antarctica, with the 220 DU contour being virtually completely exposed by 23 August. The vortex appears quite symmetrical and therefore likely cold and stable. The ozone maximum that formed in the ridge immediately south of Australia by the third week of August reached a maximum around 26 August, before moving on to the east and somewhat dissipating.

It should be noted that until the polar night reduces to be smaller than the ozone hole, the above metrics are subject to noise and inaccuracies.

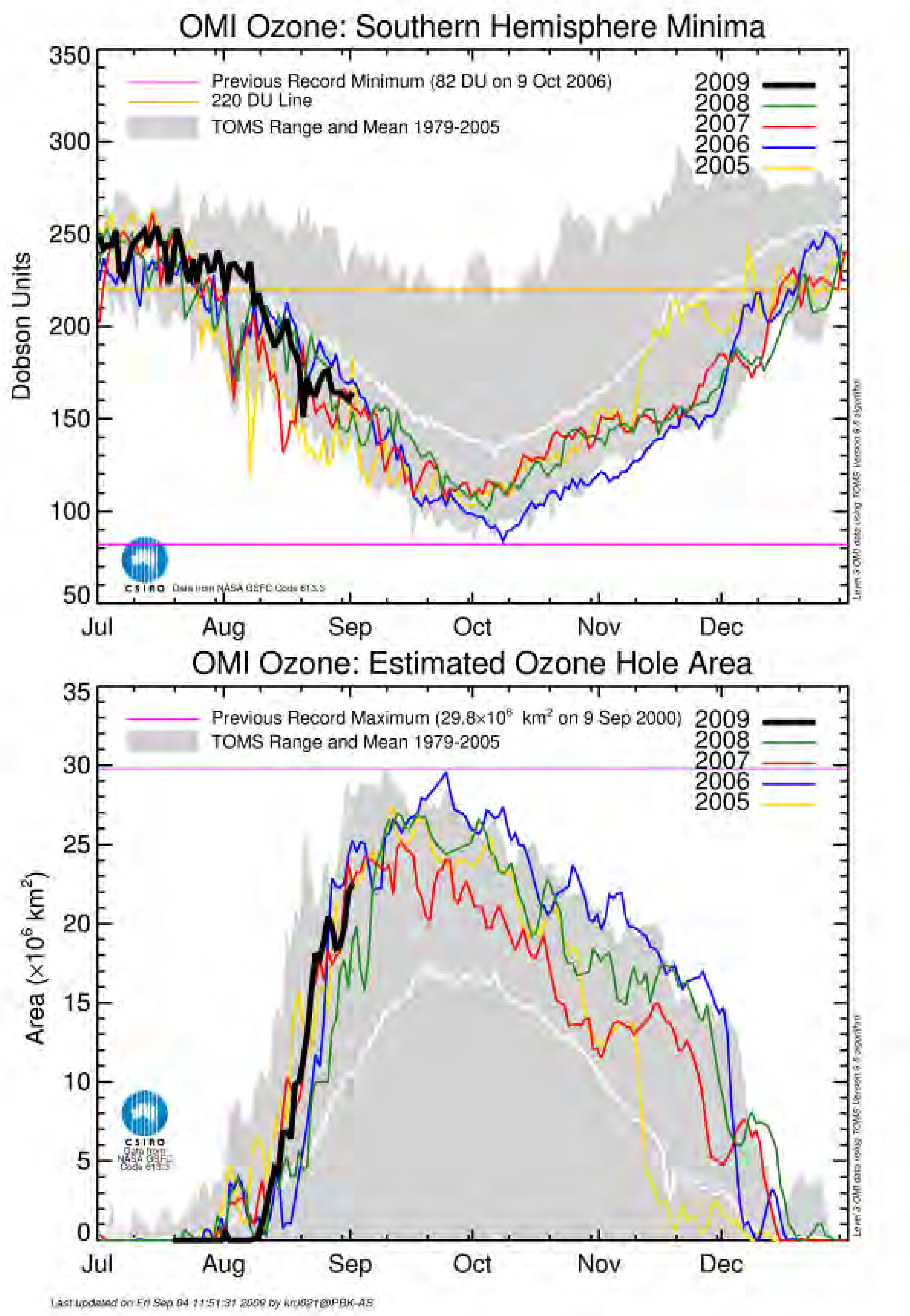

Figure 1: Ozone hole depth (top panel) and area (bottom panel) based on OMI satellite data, as of September 1, 2009.

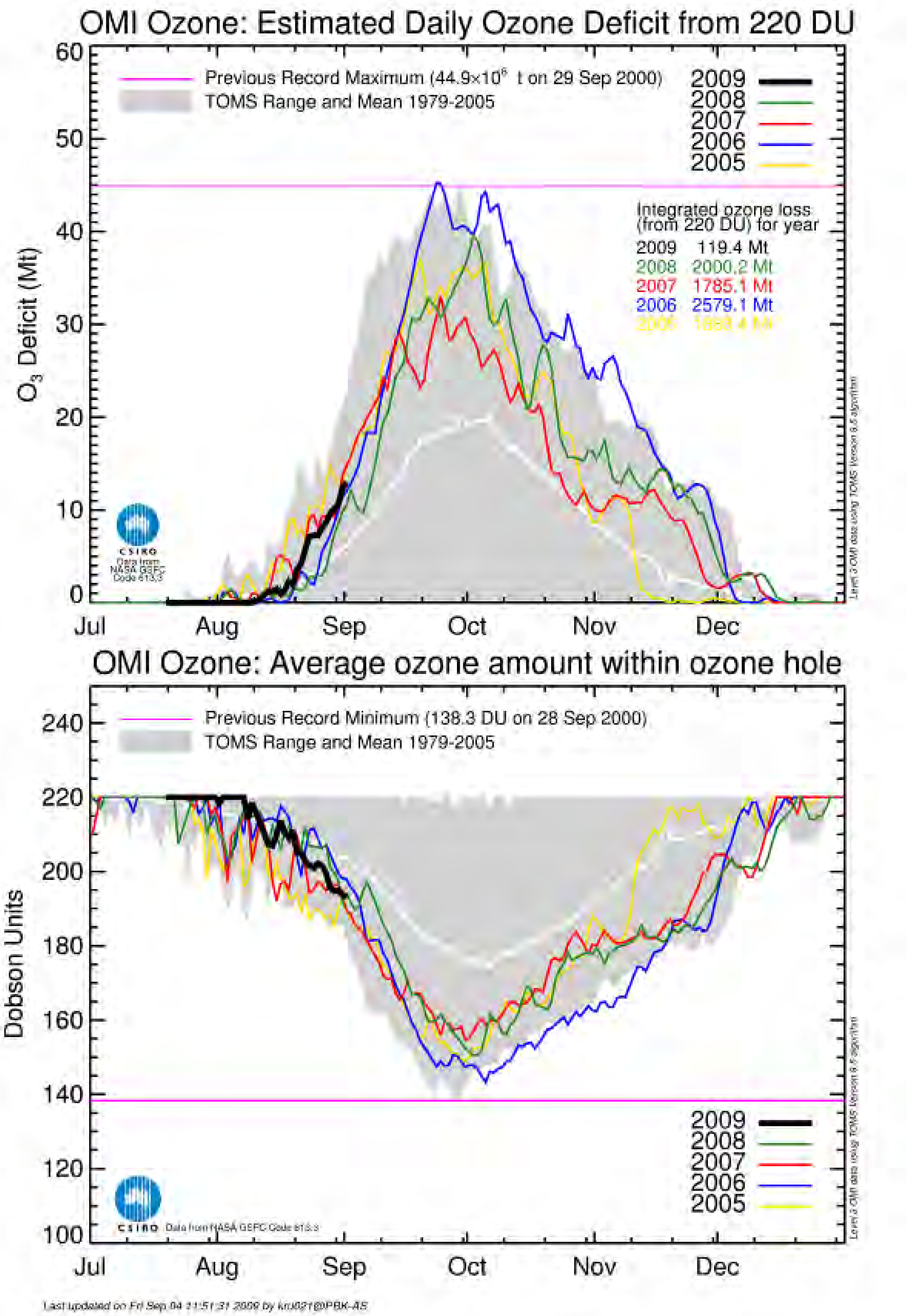

Figure 2: Estimated daily ozone deficit (top panel) and average ozone amount within the ozone hole (bottom panel) based on OMI satellite data, as of September 1, 2009.

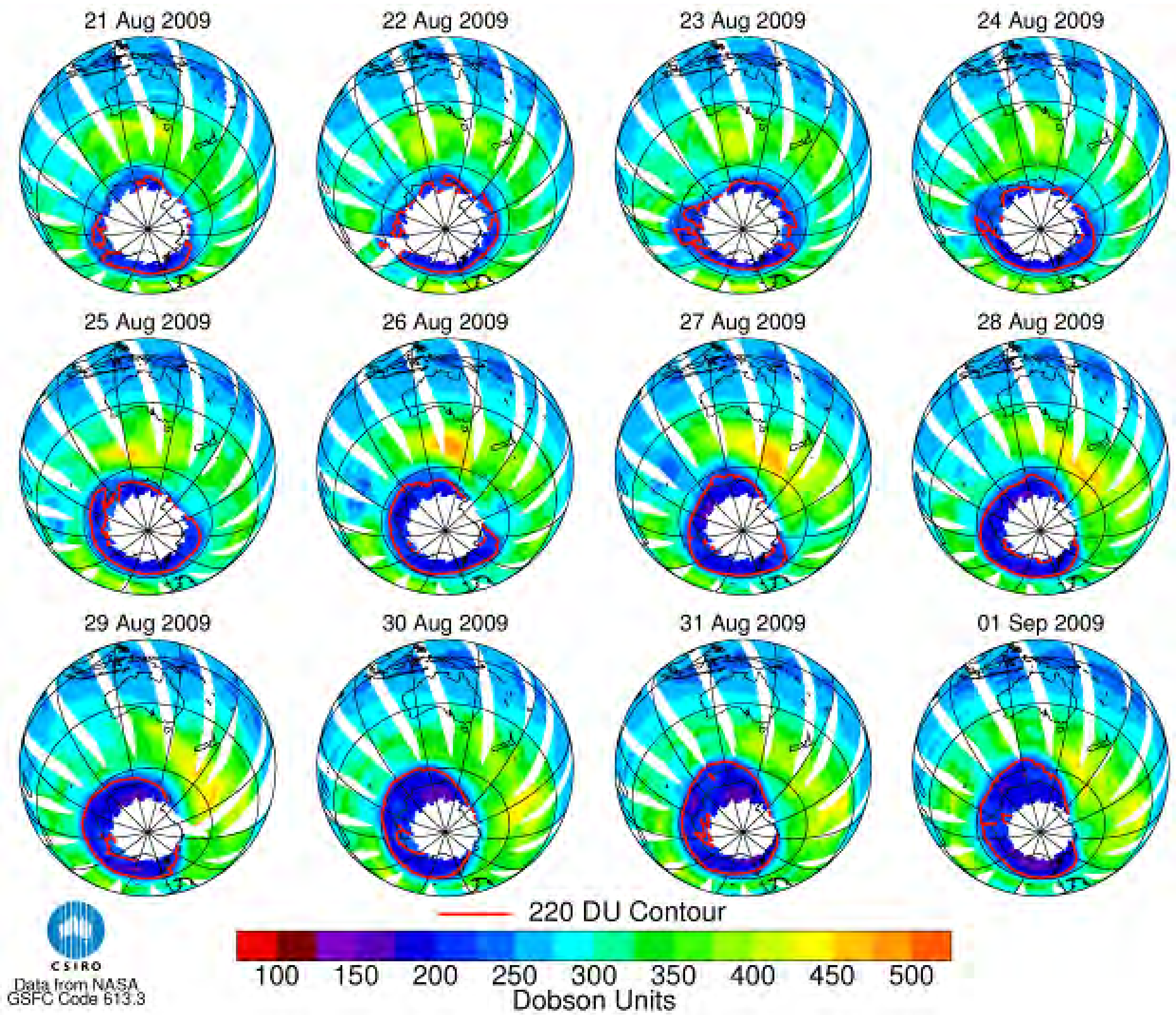

Figure 3: OMI ozone hole images for 21 August to 1 September 2009; the ozone hole boundary is indicated by the red 220 DU contour line. The white area over Antarctica is missing data and indicates the approximate extent of the polar night. The OMI instrument requires solar radiation to the earth's surface 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 15-30 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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