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3

INFLUENCE OF THE ANTARCTIC OZONE HOLE OVER THE SOUTH OF BRAZIL IN 2008 AND 2009

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Abstract: *The Antarctic Ozone Hole is a cyclical phenomenon which occurs over the Antarctic region from August to November each year. The polar vortex turns it into a restricted characteristic dynamics for this region. However, when the polar vortex begins to weaken in October, air masses with low ozone concentration could escape and reach regions of lower latitudes. This study presents the influence of the Antarctic Ozone Hole over the South of Brazil in the years 2008 and 2009. To verify the events of influence, data of ozone total column from Brewer Spectrophotometer installed at the Southern Space Observatory (29.42° S, 53.87° W), in São Martinho da Serra, South of Brazil was used, and OMI Spectrometer overpass data for the same location. In addition to Brewer and OMI data, potential vorticity maps using GrADS (Grid Analysis and Display System) generated with the NCEP data reprocessed, and backward trajectories of air masses, using the HYSPLIT model of NOAA, were analysed. Ozone total column for the days with lower ozone were compared with the climatological average of twenty years for September and October. For statistical reasons, only the days with ozone total column lower than climatological monthly average minus 1.5 times the standard deviation, were analysed. Considering only the days with less ozone, increased absolute potential vorticity and backward trajectories indicating the origin of polar air masses, 3 events in 2008 and 2 events in 2009, with an average decreased about 9.7 ± 3.3% when compared with climatological means, were observed.*

Keywords: mid-latitude, potential vorticity, backward trajectories, Antarctic ozone hole

Introduction

In the Antarctic continent, a significant decrease in total ozone content has been detected from August to November each year. This decrease is known as the Antarctic ozone hole (Farman *et al*., 1985; Solomon, 1999). The atmosphere in the southern hemisphere at high latitudes has undergone marked changes over the past recent decades. According to Hansen (2010), a record of the Antarctic Ozone Hole area occurred during the spring of 2006, reaching a size of 10.6 million square miles. Because of the polar vortex, this is restricted to the region. However, when the polar vortex begins to weaken in late September and October, ozone-poor air masses can escape and reach regions of lower latitudes (Prather & Jaffe, 1990; Semane *et al*., 2006). These events of the Antarctic Ozone Hole which have an influence on the South of Brazil were first observed by Kirchhoff *et al.* (1996). The study developed here presents the events for the years of 2008 and 2009.

Methodology

To verify Antarctic ozone hole influence over South of Brazil, ozone total column data from Brewer MKIII Spectrophotometer #167 installed at the Southern Space Observatory - OES/CRS/CIE/INPE - MCT (29.42° S and 53.87° W), in São Martinho da Serra, Brazil

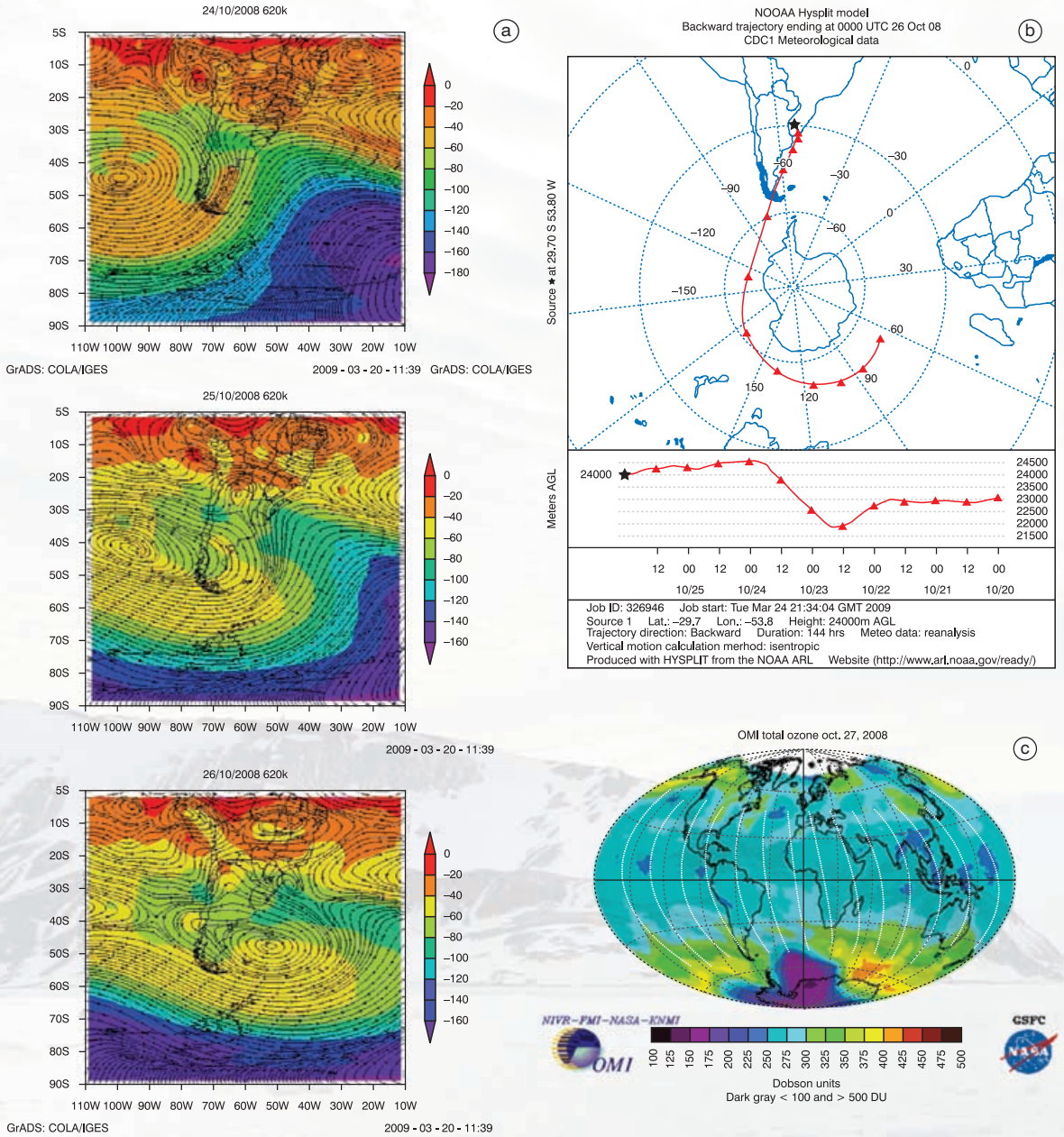

Figure 1. Event of 26 October 2008. a) Maps showing of the increase of the absolute potential vorticity at the level of 620 K from 24 to 26 October, b) backward trajectory generated with the HYSPLIT model showing the polar origin of the air mass over Southern Space Observatory and c) image generated using data from OMI spectrophotometer.

and OMI Spectrometer overpass data for the same location, were used. To verify the Antarctic influence, potential vorticity (PV) maps on isentropic surfaces generated using GrADS, with NCEP reanalysis data, were used. Danielsen (1968) found a good correlation between ozone mixing ratio and potential vorticity (PV) and demonstrated that PV can be used as a tracer of stratospheric ozone. Similar methodology using ozone and PV correlation was used by Semane *et al.* (2006) and Narayana Rao *et al.* (2003), over the Southern Hemisphere and Northern Hemisphere, respectively. In this study, analysis of atmospheric backward trajectories of air masses, using the HYSPLIT model (Hybrid

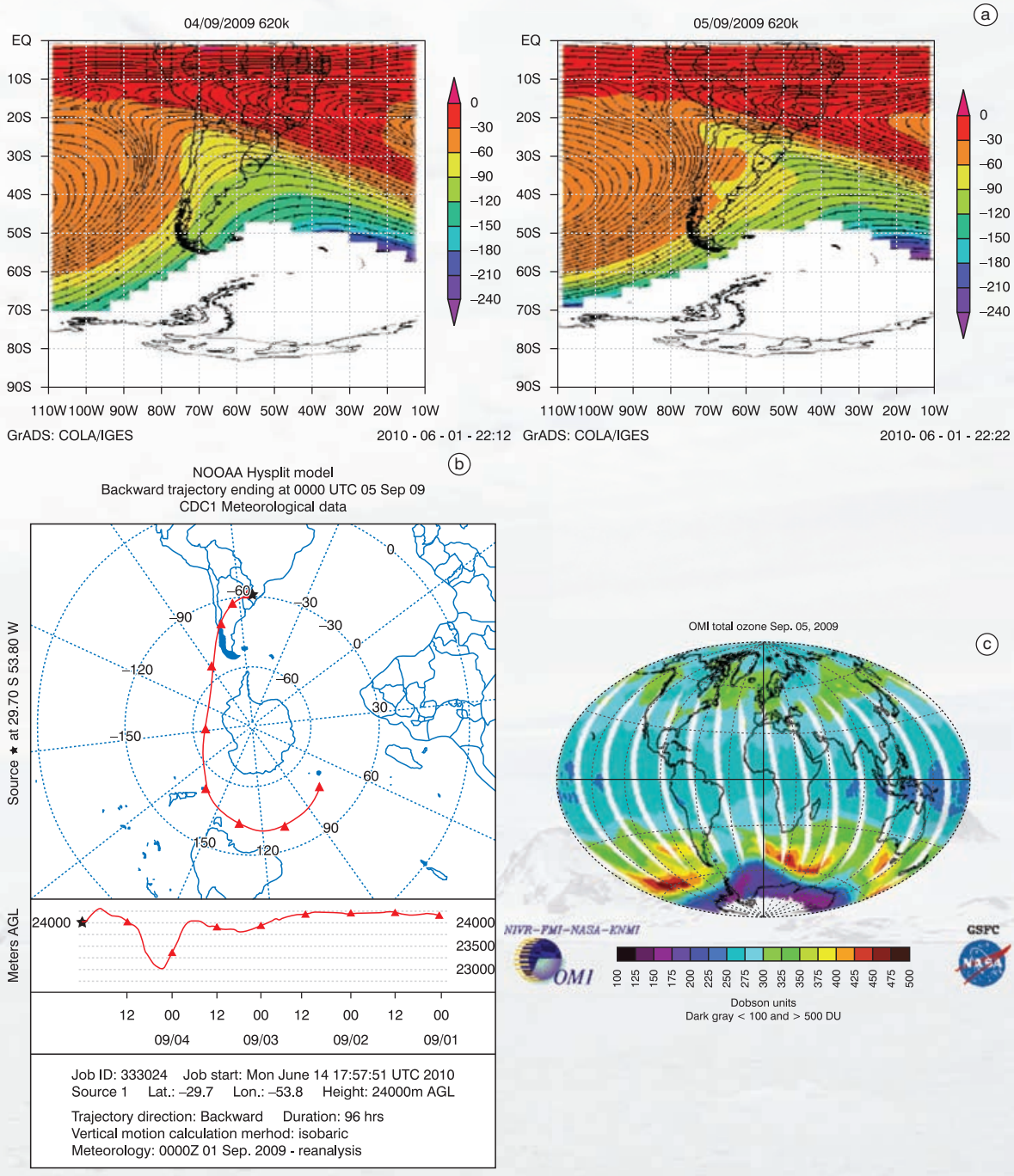

Figure 2. Event of 05 September 2009. a) Maps showing of the increase of the absolute potential vorticity at the level of 620 K from 04 to 05 September, b) backward trajectory generated with the HYSPLIT model showing the polar origin of the air mass over Southern Space Observatory and c) image generated using data from OMI spectrophotometer.

Single-Particle Lagrangian Integrated Trajectory) developed by NOAA and Australia's Bureau of Meteorology, was also used. Ozone total column for the days with lower ozone was compared with the climatological average of twenty years for September and October. For statistical reasons, only the days with ozone total column lower than climatological average minus 1.5 times the standard deviation for the years 2008 and 2009, were analysed.

Table 1. Events of the Antarctic ozone hole influence over Southern Space Observatory with corresponding reduction of ozone.

Events days	Ozone (DU)	Reduction (%)
28/09/2008	275.2	6.9
12/10/2008	267.8	8.1
26/10/2008	266.5	8.5
05/09/2009	261.2	11.6
06/09/2009	249.9	15.5
01/10/2009	270.2	7.3
Average	265.1 ± 8.8	9.7 ± 3.3

Results

Climatological averages of ozone total column measured by Brewer Spectrophotometer at Southern Space Observatory from 1992 to 2009 were 295,6 ± 10,2 DU for September and 291,5 ± 8,9 DU for October. The days of 2008 and 2009 with ozone total column lower than these climatological averages minus 1.5 times the standard deviation was analyzed according to the methodology described above. The examples of 26 October 2008 and 05 September 2009 are shown in Figure 1 and Figure 2, respectively, where an increase of absolute potential vorticity at the level of 620 K (a), the backward trajectories of air masses poor of ozone (b) and OMI data (c) are represented showing the influence of Antarctic Ozone Hole over South of Brazil. Considering only the days with decreased ozone measured at Southern Space Observatory, increased absolute potential vorticity shown at GRADS maps and HYSPLIT backward trajectories indicating the origin of polar air masses, it was observed 3 events in 2008 and 2 events in 2009 presented at Table 1, with an average decreased about 9.7 ± 3.3% when compared with climatological means.

Conclusion

The analysis of all days with decrease of ozone total column at Southern Space Observatory showed the influence of Antarctic Ozone Hole over South of Brazil. 3 events in 2008 and 2 events in 2009, with an average decreased about 9.7 ± 3.3% when compared with climatological means, were observed.

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