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Analysis of ozone distribution in the Antarctic vortex collar region

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Introduction

The ozone depletion within the Antarctic vortex is nearly complete around 20 km, however in the collar region the depletion is limited and may be more sensitive to changes in the stratospheric halogen loading (EESC). Here ozone sounding profiles were used to study the ozone distribution in the Antarctic vortex collar region.

FMI has made ozone soundings in cooperation with Argentina at Marambio (64° S, 57° W), since 1988. Due to the location the soundings from Marambio often sample the vortex collar region. The ozone profile timeseries from Marambio was used together with data from other sounding stations and Earth observation data. Data of ozone and other constituents from the FinROSE chemistry-transport model was also used. All data is classified into vortex collar and in-vortex cases. Additionally, the ozone distribution on equivalent latitudes is studied.

The FinROSE-ctm (Damski et al., 2007) is a global model of the stratosphere and mesosphere. The model produces the distribution of 35 species. The chemistry describes around 110 gas phase reactions and 37 photodissociation processes, and includes heterogeneous processing and PSC sedimentation. The tropospheric abundances are given as boundary conditions. The model was run with a horizontal resolution of 3 by 6 degrees at 35 hybrid levels, from the surface up to 0.1 hPa (ca. 65 km). The model is driven by ERA-Interim winds and temperatures (Thölix et al., 2010).

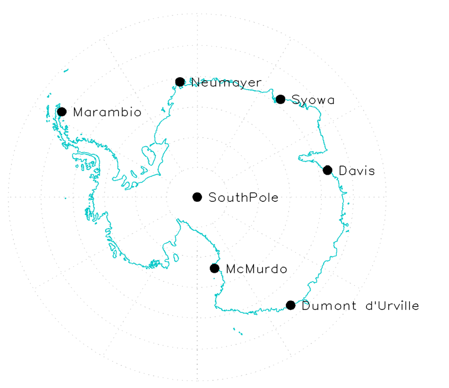

Figure 1. Ozone sounding data was used from the Marambio, South Pole, Neumayer, Dumont d'Urville, McMurdo and Davis stations.

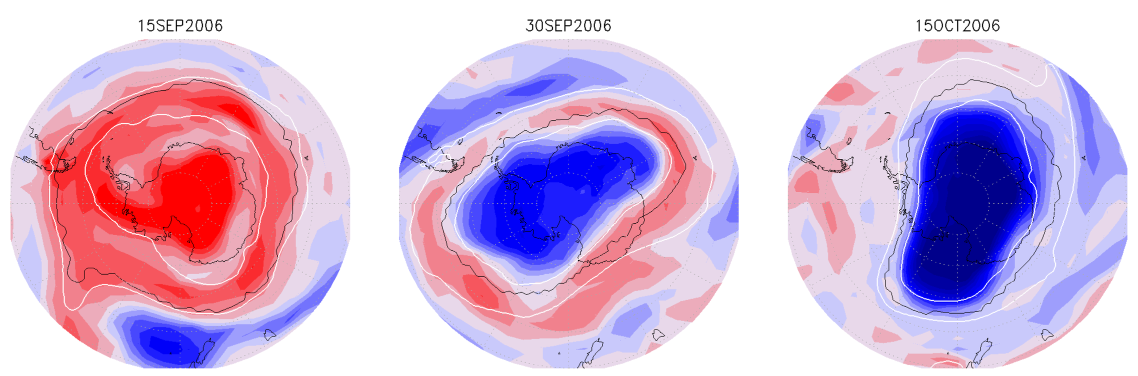

Figure 2. Ozone distribution above Antarctica at the 475 K isentropic level. The black contour lines indicate the vortex edge, determined according to Nash et al., 1996. White contour lines indicate the vortex collar region, which is defined from the gradient in the MPV distribution ($\geq$ 2PVU/deg) on equivalent latitudes (Karpechko et al., 2005).

Results

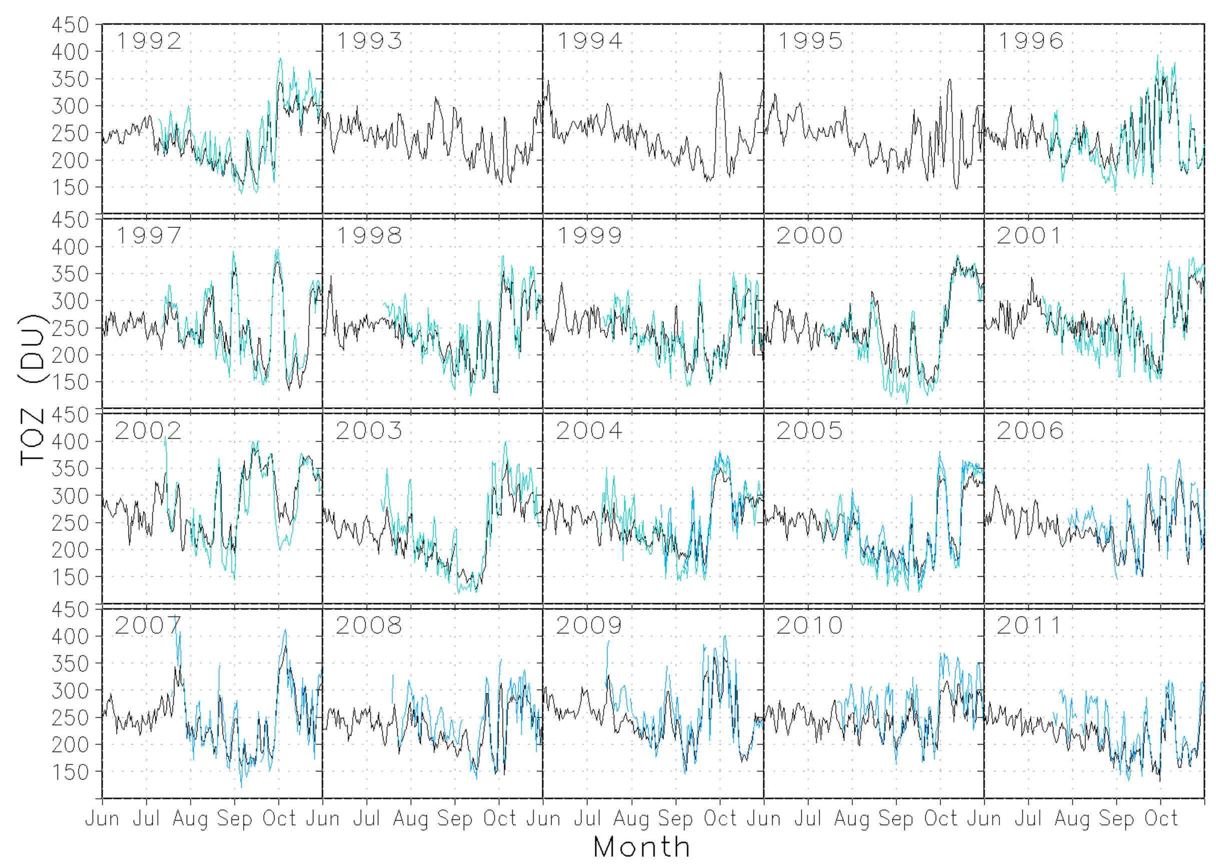

Figure 3. Total column ozone above Marambio 1992–2011, June to October. The black line shows FinROSE model data, cyan TOMS data and blue OMI data. The total ozone shows a large variability due to the location of Marambio close to the vortex edge.

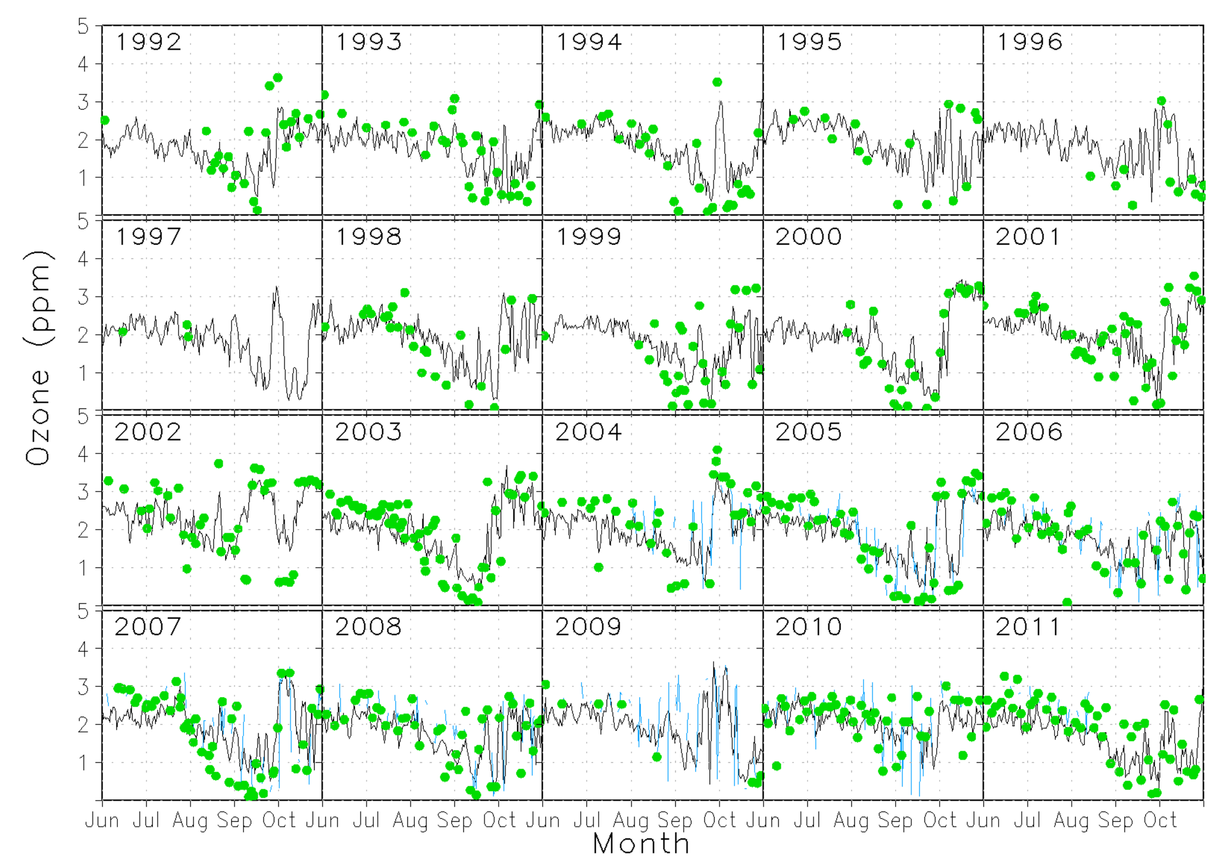

Figure 4. Ozone mixing ratio at 54 hPa above Marambio, 1992–2011. The black line shows FinROSE model data, cyan line MLS data and green dots sounding data.

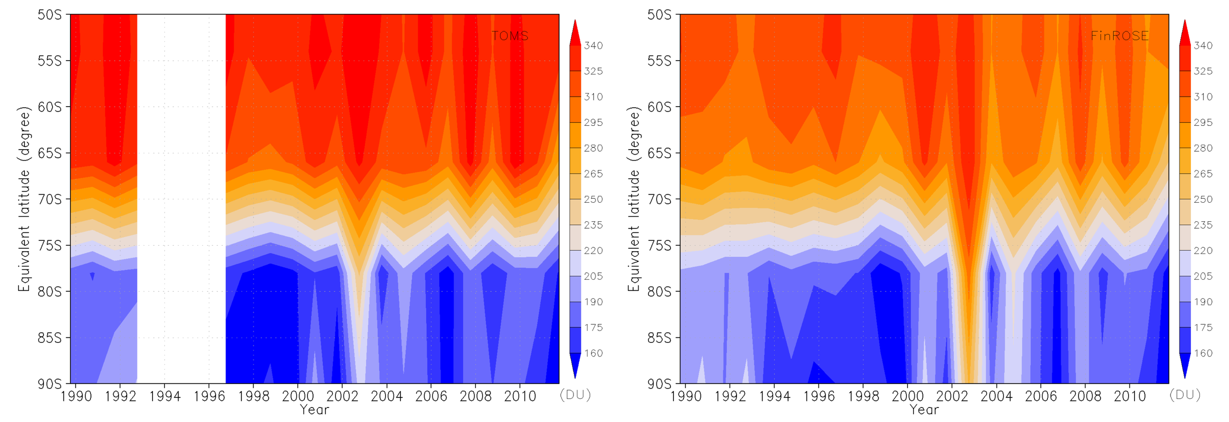

Figure 5. The total ozone column on equivalent latitudes (left–TOMS & OMI, right–FinROSE). The equivalent latitude is determined at the 475 K level.

Figure 6. The upper panels show the amount of total ozone in each year, both as a vortex average and vortex collar average (left–September, right–October). The lower panels show the monthly average of EESC (ppbv) and temperature (K) at the 475 K level. (Left–September, right–October).

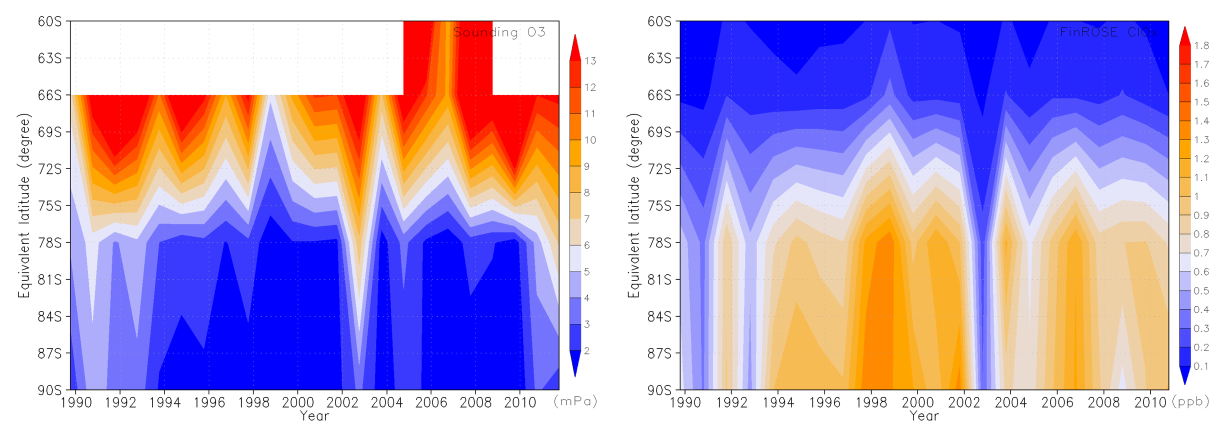

Figure 7. The distribution of ozone and ClOx on equivalent latitudes at the 475 K level. Left panel ozone partial pressure (mPa) from ozone soundings. Right panel shows ClOx (ppb) from FinROSE model. A monthly average for October is shown for each year.

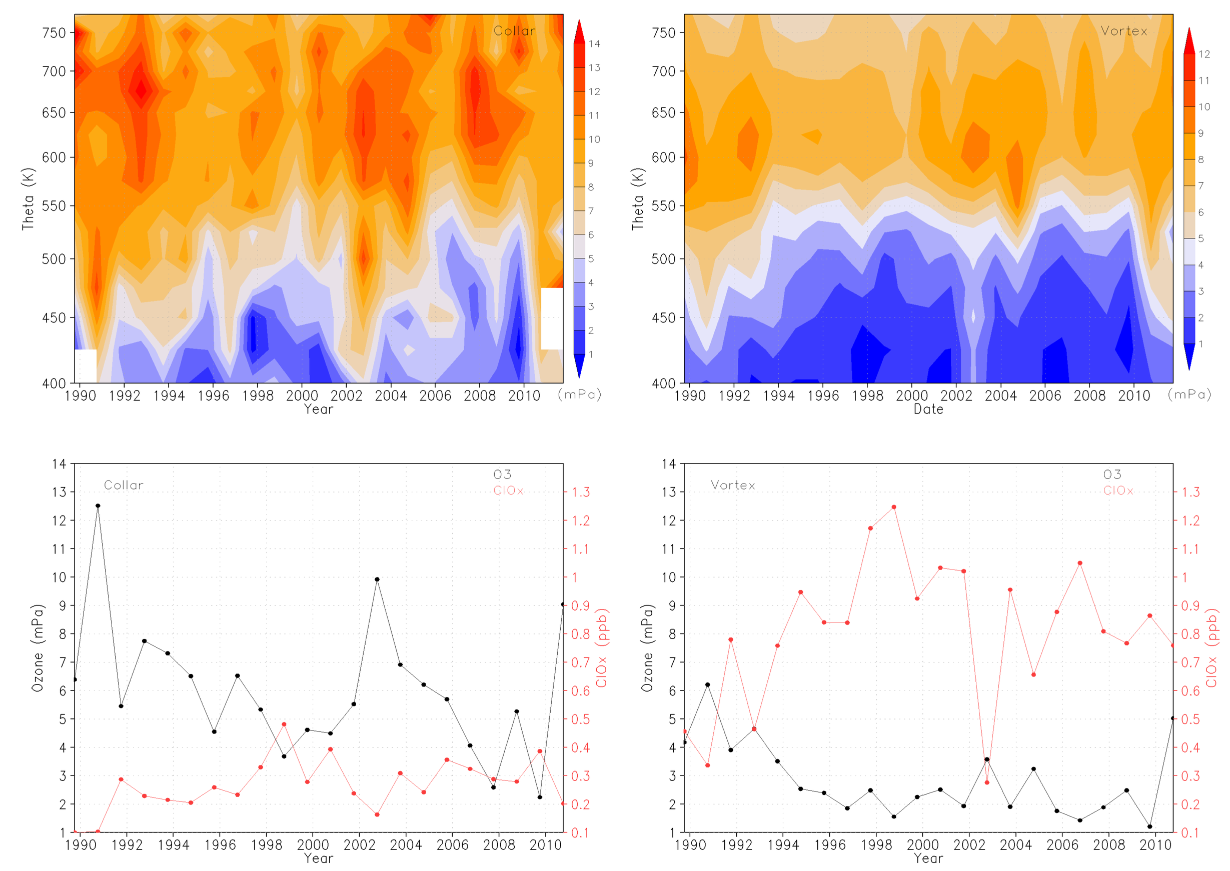

Figure 8. The upper panels show the ozone (mPa) distribution from soundings on potential temperature levels (left–collar, right–vortex). Lower panels show ozone (mPa) from soundings and ClOx (ppb) from model at 475 K (left–collar, right–vortex). A monthly average for October is shown for each year.

Summary

The evolution of ozone in the Antarctic vortex collar was studied using ozone sounding and total column data, as well as model data.

- The EESC peaked around the year 2000 (in the model)
- The increasing trend in EESC before 2000 is seen in the ozone depletion, both in the collar and in the vortex
- The slow decrease in EESC after 2000 could not be detected in the ozone data
- The possible recovery is masked by variations in the meteorological conditions from year to year

Acknowledgements

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References

- Damski, J., Thölix, L.,Backman, L., Taalas, P. and Kulmala,M., 2007: FinROSE - middle atmospheric chemistry and transport model, Boreal Env. Res., 12, 535–550.
- Karpetchko, A., E. Kyr, and B. M. Knudsen (2005), Arctic and Antarctic polar vortices 1957–2002 as seen from the ERA-40 reanalyses, J. Geophys. Res., 110, D21109.
- Nash, E. R., P. A. Newman, J. E. Rosenfield, and M. R. Schoeberl (1996), An objective determination of the polar vortex using Erte's potential vorticity, J. Geophys. Res., 101(D5), 9471–9478.
- Thölix, L., Backman, L., Ojanen, S.-M., 2010: The effects of driver data on the performance of the FinROSE chemistry transport model, IJRS, 31, 24, 6401–6408.

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