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Analysis of Antarctic long term ozone sounding time-series

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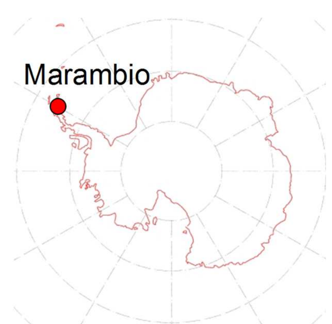
Introduction

Severe ozone loss has been observed in the Southern Hemisphere polar vortex since the mid 1980s. The decrease in emissions of ozone depleting substances has led to expect that the stratospheric ozone would slowly recover over the next decades.

Ozone soundings have been made in Marambio, which is situated on the Antarctic Peninsula, since 1988, i.e. soon after the discovery of the Antarctic 'ozone hole'. The ozone sounding record at Marambio (64°S, 57°W) now covers more than two decades of nearly continuous ozone profile data.



Due to the location the soundings from Marambio often sample the vortex collar region. The ozone profile time-series at Marambio was studied together with data from other sounding stations and Earth observation data. Data form the FinROSE chemistry-transport model was also used.

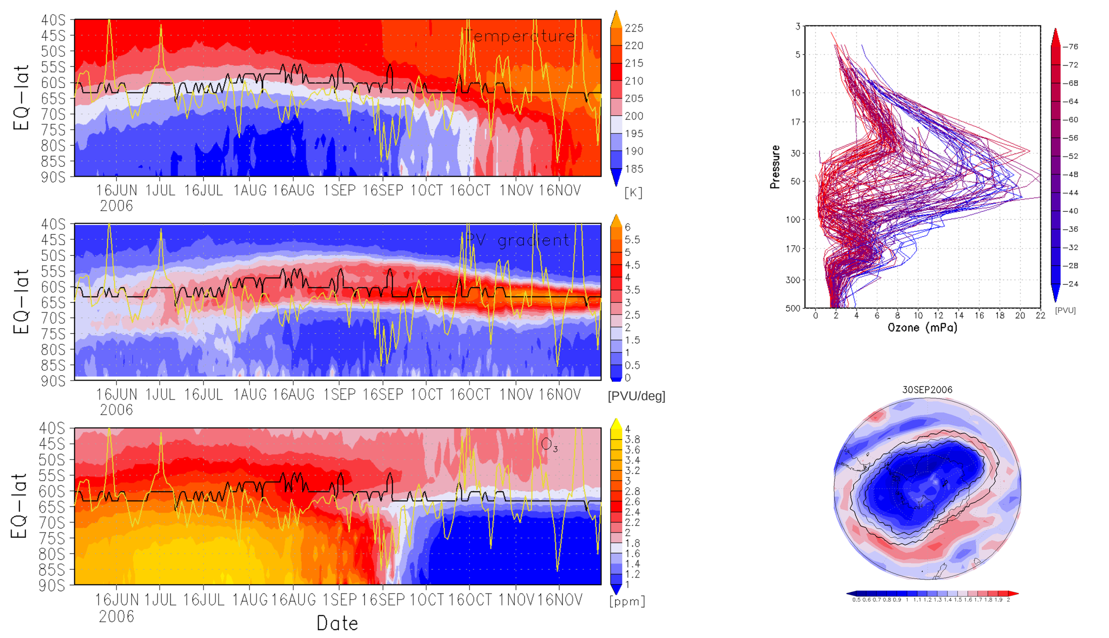


Figure 1. An example of the zonal mean distribution of temperature (ECMWF – upper panel) and ozone (FinROSE – lower panel) at 500 K on equivalent latitudes. The middle panel shows the PV gradient. The yellow line indicates the equivalent latitude of Marambio. The black line indicates the vortex edge, determined according to Nash et al. 1996. The map shows the ozone distribution above Antarctica at the 475 K level. The black contour lines indicate the vortex edge and the collar region. The Marambio ozone soundings in October are shown color coded according to PV at 475 K.

Modelling and data

The FinROSE-ctm (Damski et al., 2007) is a global model of the stratosphere and mesosphere. The model produces the distribution of around 35 species. The chemistry describes around 110 gas phase reactions and 37 photodissociation processes. The model chemistry 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) (Thölix et al., 2010).

Ozone sounding data was used from the Marambio, South Pole, Neumayer, Dumont d'Urville and McMurdo stations. Model data was also compared to MLS, TOMS and OMI data.

Results

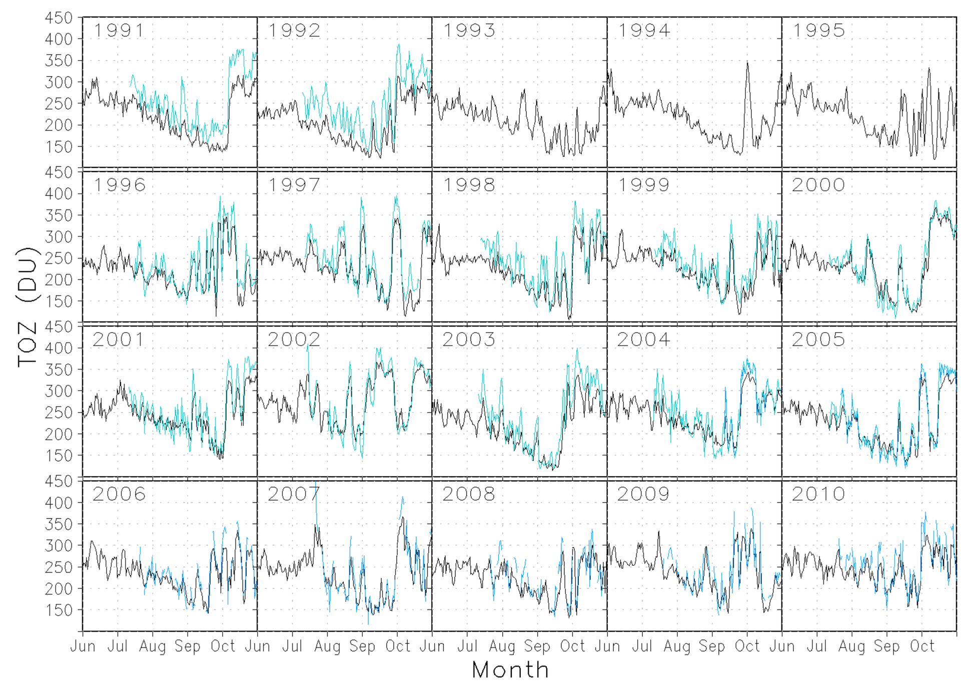


Figure 2. Total column ozone above Marambio 1991–2010, June to October. The black line shows FinROSE model data, TOMS data is shown in cyan and OMI in blue. The total ozone shows a large variability due to the location of Marambio close to the vortex edge.

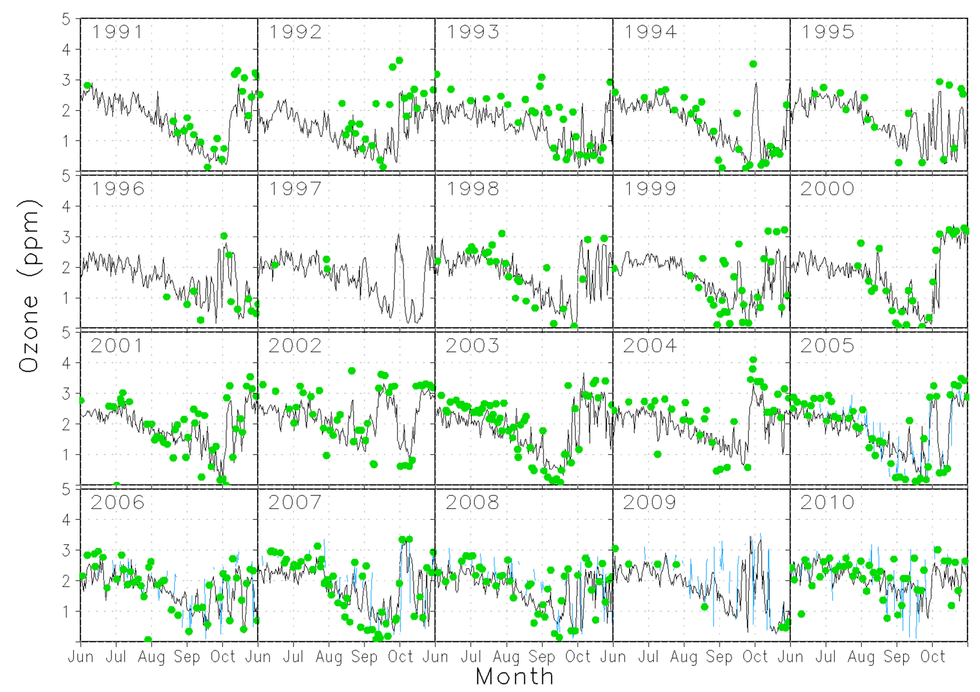


Figure 3. Ozone partial pressure at 54 hPa above Marambio, 1991–2010. The black line shows FinROSE model data. The green dots represents sounding data. The cyan line shows MLS data.

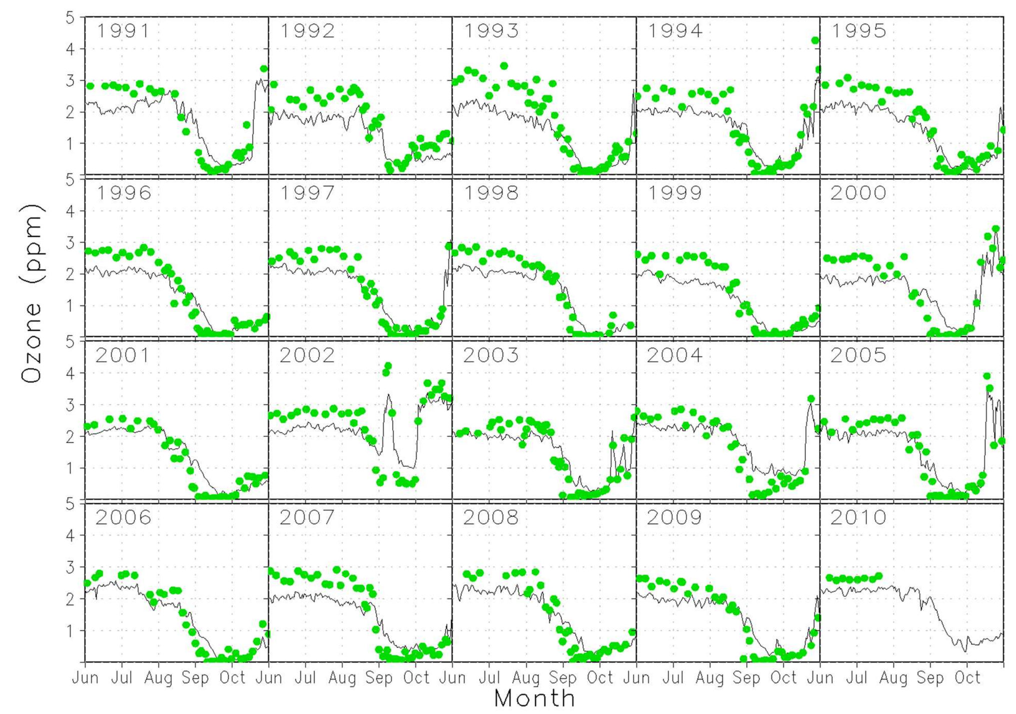


Figure 4. Ozone partial pressure at 54 hPa above the South Pole station, 1991–2010. The black line shows FinROSE model data. The green dots represents sounding data. The evolution of ozone over time is smoother inside the vortex than compared to Marambio.

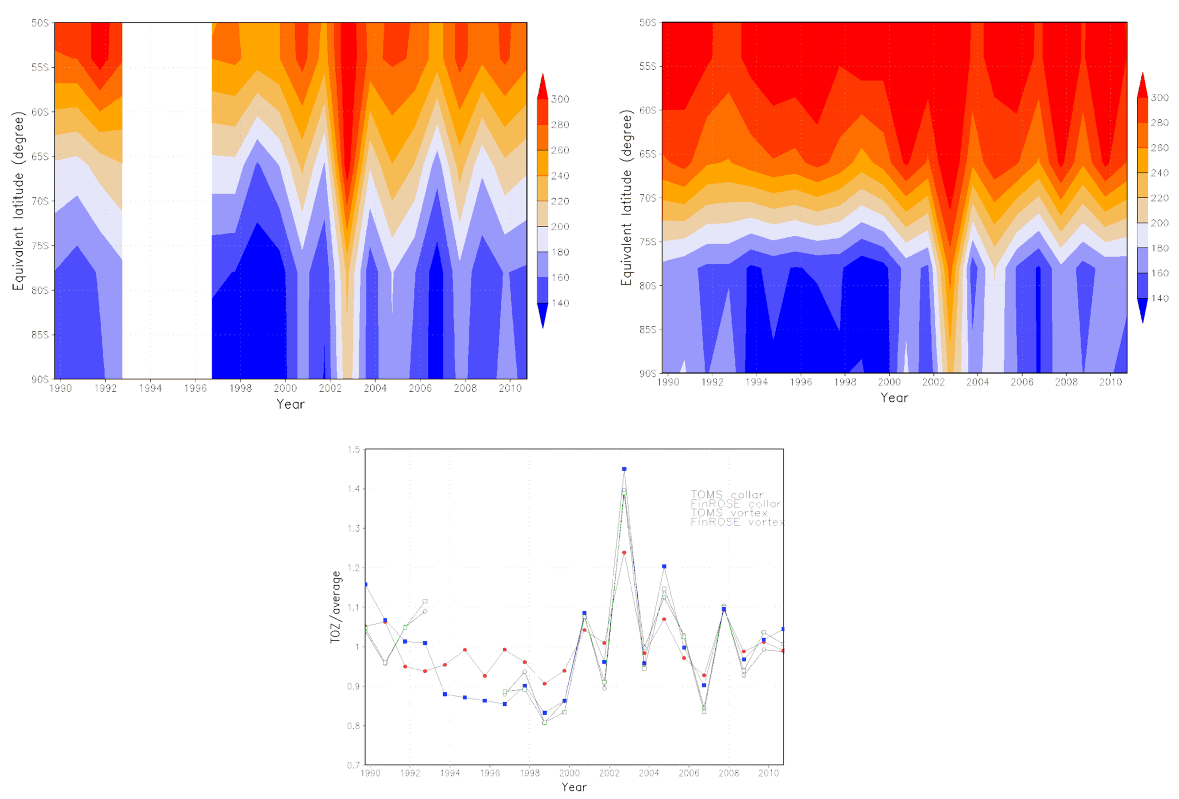


Figure 5. The upper panels show the total ozone column on equivalent latitudes (left – TOMS & OMI, right – FinROSE). The equivalent latitude is determined at the 475 K level. The lower figure shows the relative amount of total ozone in October each year, both as a vortex average and vortex collar average.

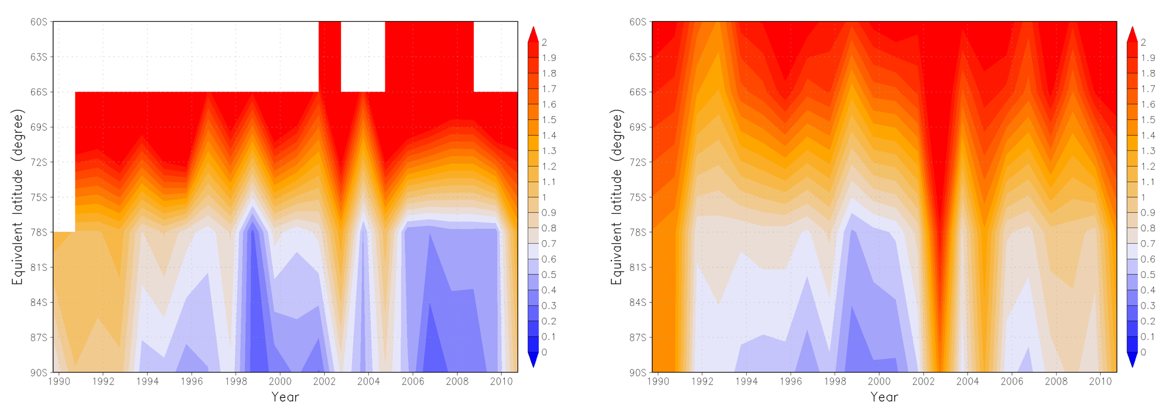


Figure 6. The distribution of ozone partial pressure (mPa) on equivalent latitudes at the 500 K level. Left panel from ozone soundings and right panel from FinROSE.

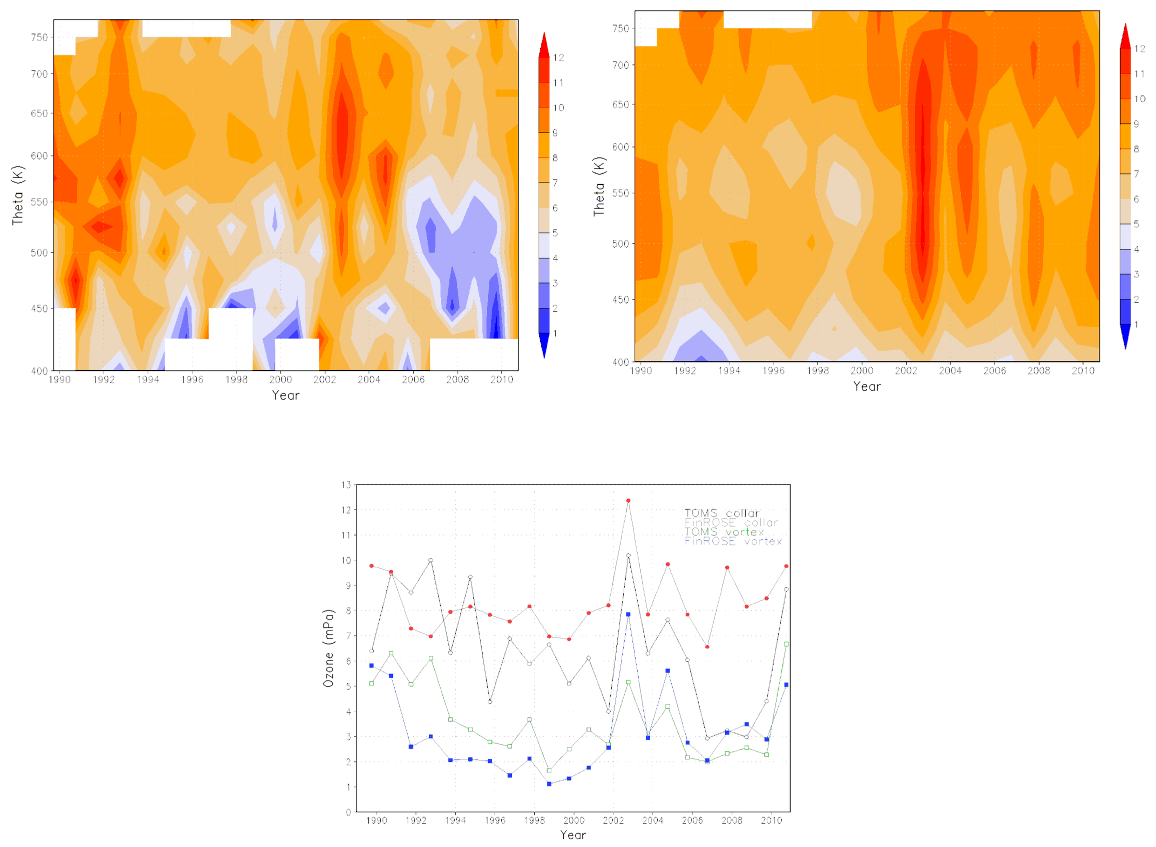


Figure 7. The upper panels show the ozone (mPa) distribution as a vortex collar average on potential temperature levels (Left – soundings, right – FinROSE). A monthly average for October is shown for each year. The vortex collar is defined from the gradient in the PV distribution on equivalent latitudes. The lower figure shows the vortex and collar average of ozone at 500 K in October for each year from soundings and model.

Summary

- The ozone in the vortex collar was studied using ozone sounding and total column data as well as model data.
- The model was found to describe the evolution of SH ozone satisfactorily also close to the vortex edge. Some underestimation of the ozone depletion in the vortex was seen in the model.
- The sounding data sampling the vortex collar is too sparse for trend analysis. Additional data will therefore be included (other sounding stations & remote sensing data).

Acknowledgements

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References

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