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NOy from MIPAS/ENVISAT in the South Hemisphere vortex split-up event in September/October 2002

1. Introduction

The change in the abundances of stratospheric ozone (O_3) is a major environmental issue. The change in ozone abundances is controlled by abundances and partitioning of reactive nitrogen reservoir (NO_y). NO_y species are measured by MIPAS during the anomalous Antarctic vortex split-up event. The MIPAS data are analysed to understand the budget and partitioning of NO_y, as well as chemical processes that lead to the observed volume mixing ratios during the 11 days in September/October.

2. MIPAS Data and Data Analysis

Reactive nitrogen species derived from MIPAS/ENVISAT limb radiances spectra are: HNO_3, $ClONO_2$, NO, NO_2, N_2O_5. N_2O, and CH_4 are also retrieved to establish tracer correlations.

Data coverage:
- Temporal: 20-27 September, 11-13 October
- Spacial: Pole ward of 40^o S, 14 orbits per day

The weighted vortex and ex-vortex daily mean is determined on a potential temperature coordinate. The vortex and ex-vortex region are classified on the basis of strong tracer gradient (N_2O) with respect to Ertel's potential vorticity at the isentropic level of θ=475 K.

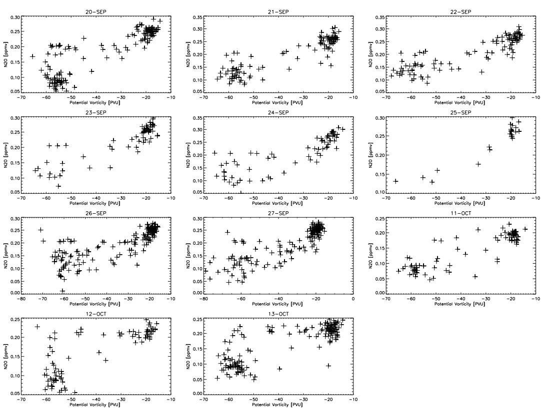

Fig. 1: N_2O vmr (ppmv) as a function of Ertel's potential vorticity (obtained from ECMWF). The boundary region, [-48, -36] PVU, lies between N_2O-rich ex-vortex and N_2O-poor vortex air masses.

3. NO_y Partitioning

Partitioning of NO_y between radicals NO_x and reservoirs (HNO_3, $ClONO_2$, and N_2O_5) should be well understood for modelling of ozone loss.

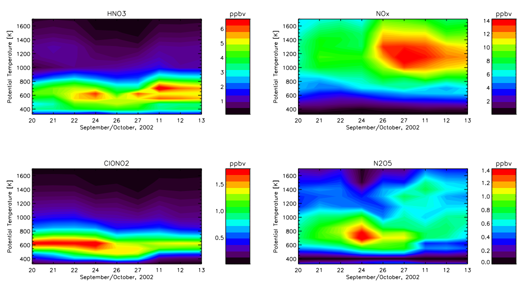

Fig. 2: Daytime NO_y Partitioning inside the vortex.

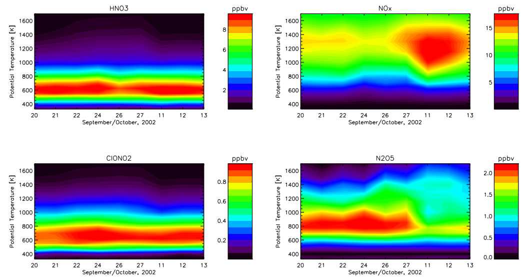

Fig. 3: NO_y Partitioning in ex-vortex airmass.

4. Denitrification

The role of chemistry and transport in the observed anomalous NO_y: N_2O relationship can be distinguished using mixing line method.

The single mixing event scenario gives conservative upper estimates implying that the reported denitrification could have been underestimated.

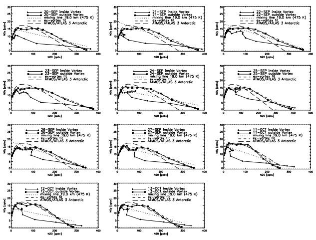

Fig. 4: NO_y:N_2O relationship. Mixing lines determined from the inert tracers are transformed to NO_y:N_2O space. The relationship determined from ATMOS/ATLAS 3 Antarctic observation is used to estimate NO_y using N_2O measured by MIPAS. The difference is comparable to missing NO_y components in this study.

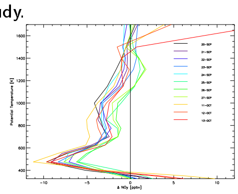

Fig.5:NO_y deficit.

5. Conclusion

- HNO_3 comprises more than 80% in the altitude range of 10 to 15 kms and over 40% of NO_y in the stratosphere below 28 km. NO_x varies between 40% and 100% of NO_y in the middle stratosphere.

- Quasi-horizontal mixing across the vortex edge accounts for 50 - 70 % of the observed deficit in NO_y

- An average denitrification of 5 ppbv is observed before split-up and 2.2 ppbv after the split-up