Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

Forschungszentrum Karlsruhe, Institut für Meteorologie und Klimaforschung
Postfach 3640, 76021 Karlsruhe, Germany
N. Glatthor, T. v. Clarmann, H. Fischer, B. Funke, U. Grabowski, M. Höpfner, S. Kellmann, M. Kiefer, A. Linden, M. Milz, T. Steck, G. P. Stiller, G. Mengistu Tsidu, and D.-Y. Wang

STUDY OF THE ANTARCTIC VORTEX SPLIT-UP IN SEPT/OCT 2002 BY MEANS OF TRACE SPECIES FROM MIPAS/ENVISAT

Meteorological Situation

Due to a major warming in late September 2002, the antarctic vortex was increasingly distorted after September 21 and broke into two pieces around September 25. Thereafter, one of the vortex fragments intermixed with midlatitude air, whereas the other fragment centered around the south pole again and strengthened until mid-October.

Data

Data were retrieved at IMK from MIPAS/ENVISAT level-1B spectra, which were recorded by limb sounding on 17 tangent altitudes between 6 and 68 km. The dataset consists of more than 61000 datapoints of CH_4, N_2O and O_3, obtained from 58 partial orbits south of 30° S of September 20-27 and of October 11-13, 2002.

Source Gases

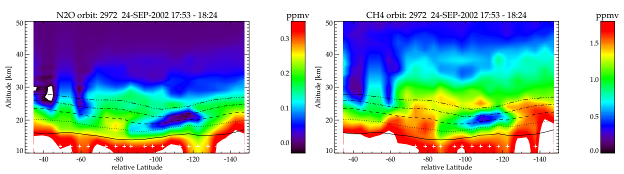

Fig.1: N_2O and CH_4 data of September 24, 2002; left: N_2O latitude-height field along orbit 2972, with 400-700 K levels of potential temperature; right: corresponding CH_4 field. In both datasets the volume mixing ratios are somewhat too high at the lowermost altitudes.

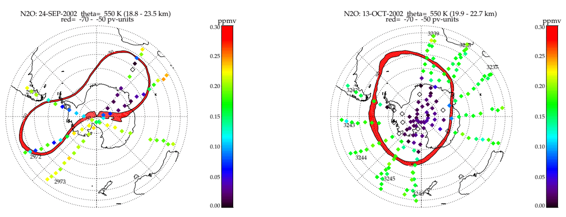

Fig.2: N_2O field and vortex boundary on the 550 K level of potential temperature on September 24 (just before split-up) and on October 13, 2002 (after split-up).

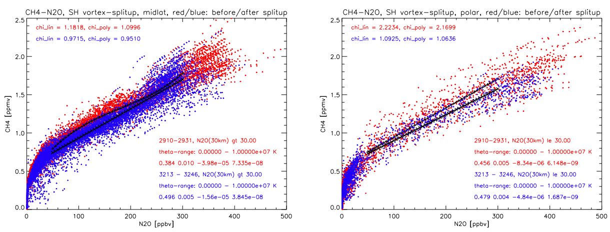

Fig.3: CH_4 versus N_2O, outside (left) and inside the vortex (right), before and after the split-up. Outside the vortex a bulge [1,2] of enhanced CH_4 is visible between 50 and 230 ppbv N_2O before the split-up, whereas after the split-up this part of the correlation is linear. Inside the vortex this part of the correlation is more linear, indicating former intrusion of midlatitude air masses [3].

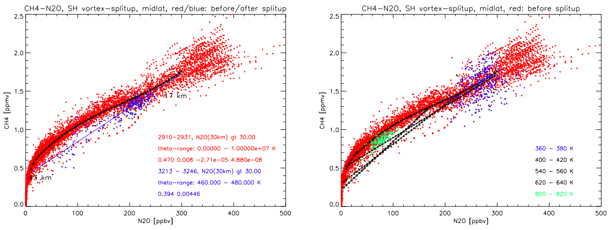

Fig.4: CH_4 versus N_2O, outside the vortex. Left: all data before the split-up and data between 460 and 480 K after the split-up. The latter form a mixing-line between 10 ppbv and 290 ppbv N_2O. This indicates mixing of vortex air, which had subsided from 43 km to 17 km, into extra-vortex air. Right: all data before the split-up and data after the split-up between 360 and 380 K and between 800 and 820 K. Mixing-lines for data between 400 and 420 K (diamonds), between 540 and 560 K (triangles) and between 620 and 640 K (squares).

Ozone

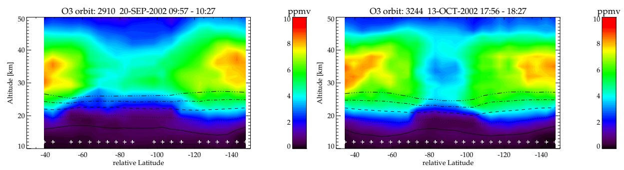

Fig.5: O_3 data of September 20 along orbit 2910 (left) and of October 13 along orbit 3244 (right). Comparison of both days shows, that during this time ozone has been further reduced inside the vortex.

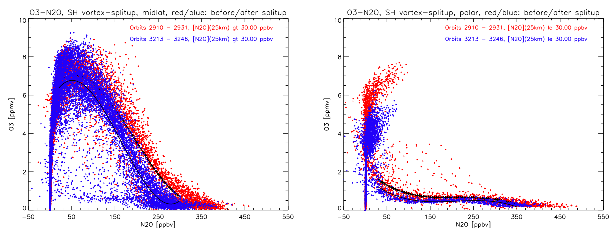

Fig.6: O_3 versus N_2O, before and after the vortex split-up, outside (left) and inside the vortex (right). Ozone reduction is visible in both regions.

Conclusions

- CH_4-N_2O correlation of MIPAS/ENVISAT outside-vortex data is compact and of similar shape as obtained from ATMOS data [1,2].
- CH_4 and N_2O mixing ratios are still too high in the lower atmosphere.
- Scatter of outside-vortex data is equal to the estimated random error.
- Mixing of vortex air into midlatitudes identified between 400 and 700 K levels of potential temperature.
- Mixing of midlatitude air into the vortex has probably already occured before the investigated period.
- Observation of ozone reduction inside (chemical destruction) as well as outside the vortex.

References

1. Michelsen, H. A. et al., Correlations of stratospheric abundances of CH_4 and N_2O derived from ATMOS measurements, Geophys. Res. Lett., 25, 1998.
2. Michelsen, H. A. et al., Correlations of stratospheric abundances of NO_y, O_3, N_2O and CH_4 derived from ATMOS measurements, J. Geophys. Res., 103, 1998.
3. Waugh et al., Mixing of polar vortex air into middle latitudes as revealed by tracer-tracer scatterplots, J. Geophys. Res., 102, 1997.