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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

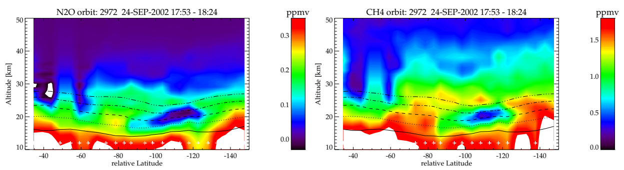

Fig.1: N_2O (left) and CH_4 (right) volume mixing ratios (vmrs) along orbit 2972 of September 24, 2002, versus altitude; black curves indicate the 400 K, 475 K, 550 K, 625 K and 700 K levels of potential temperature (bottom to top). In both datasets the vmrs are biased high at the lowermost altitudes.

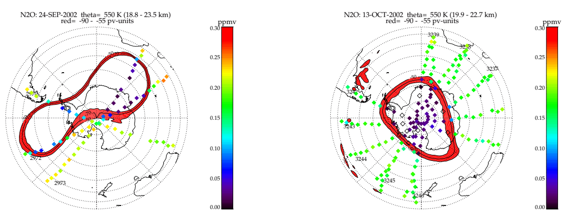

Fig.2: N_2O distribution on the 550 K level of potential temperature on September 24 (left, just before vortex split-up) and on October 13, 2002 (right, after vortex split-up). The red ovals indicate the vortex edge region.

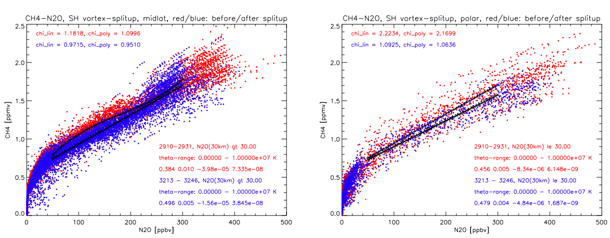

Fig.3: CH_4 versus N_2O, outside (left) and inside the vortex (right), before and after the split-up. Outside the vortex a bulge [1,2] of enhanced CH_4 is visible between 50 and 230 ppbv N_2O before the split-up, whereas after the split-up this part of the correlation is linear. Inside the vortex this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

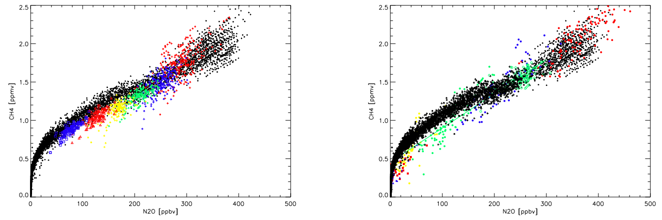

Fig.4: Left: All outside-vortex CH_4 and N_2O data of September 20-21 (black points) and CH_4-N_2O data of October 11-13 on different levels of potential temperature; red crosses: 320-340 K, blue crosses: 400-420 K, green crosses: 460-480 K, yellow crosses: 540-560 K, red triangles: 640-660 K, blue squares: 800-820 K. Right: All outside-vortex CH_4 and N_2O data of September 20-21 as black points and green open circles (460-480 K), and September 20-21 CH_4 and N_2O data from inside the vortex on different levels of potential temperature; red circles: 320-340 K, blue circles: 400-420 K, green filled circles: 460-480 K, yellow circles: 540-560 K, red triangles: 640-660 K, blue squares: 800-820 K.

Ozone

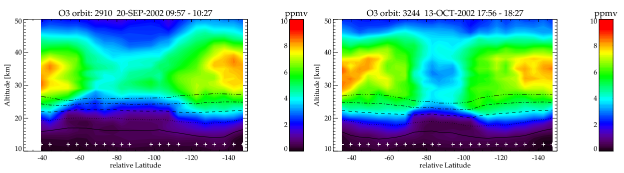

Fig.5: O_3 data of September 20 along orbit 2910 (left) and of October 13 along orbit 3244 (right). On October 13, ozone is reduced in the altitude region 28-38 km.

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.

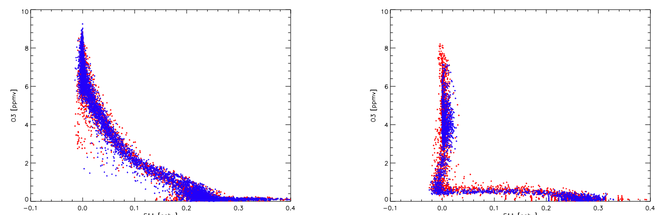

Fig.6: Left: All outside-vortex O_3 and CFC-11 data of September 20-21 (red points) and of October 11-13 (blue points). Right: same as left, but for inside-vortex data.

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 biased 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 K 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 the vortex between 28 and 38 km.

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.