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MIPAS-B observations for the validation of target parameters of MIPAS-Envisat and ILAS-II

Embedded in the Envisat validation programme of the chemistry instruments MIPAS, GOMOS, and SCIAMACHY two balloon flights were carried out with MIPAS-B, the balloon borne version of MIPAS. The first one at mid-latitudes during the night of 24/25 September 2002 from Aire sur l'Adour, France, was adjusted to the night-time overpass of orbit 2975. Here, a perfect match in terms of time and location of air masses sounded by MIPAS and GOMOS on Envisat could be achieved. The second flight was carried out in the late winter arctic vortex on 20/21 March 2003 from Kiruna, Sweden, matching evening and morning overpasses of Envisat (orbits 5508 and 5515). Prior to this MIPAS-B observation, a limb scan of the Japanese sensor ILAS-II aboard ADEOS-II was performed some degrees east of the MIPAS-B measurement with a temporal offset of about 4.5 hours. Here, MIPAS-B temperature, N_2O, CH_4, and $ClONO_2$ data are compared to level-2 results obtained from MIPAS on Envisat (ESA operational data version 4.55, called "MIPAS-E/ESA", and semi-operational profiles retrieved at IMK, called "MIPAS-E/IMK") as well as first results from ILAS-II (version 01.11) that have been available so far.

Measurements and Meteorological Situation

MIPAS-B:	Flight #11 (mid-latitudes)		Flight #13 (arctic vortex)
Location/date:	Aire sur l'Adour, 24 Sep. 2002		Kiruna, 20 Mar. 2003
	Seq. S	Seq. N3	Seq. N3a
Mean time:	21:50 UT	22:21 UT	20:56 UT
Mean coordinates:	39.9°N, 1.1°E	47.0°N, 0.7°E	65.8°N, 14.6°E
Float altitude:	38.8 km	38.4 km	31.1 km
Lowest tangent alt.:	11.3 km	5.9 km	11.1 km
MIPAS-Envisat:	Orbit 2975		Orbit 5508
Mean time:	22:06 UT	22:07 UT	21:10 UT
Mean coordinates:	41.7°N, 1.6°E	46.4°N, 0.6°E	66.0°N, 14.1°E
ILAS-II:	Not yet in orbit		Occult. 20030320540
Mean time:	-	-	16:23 UT
Mean coordinates:	-	-	65.8°N, 26.1°E

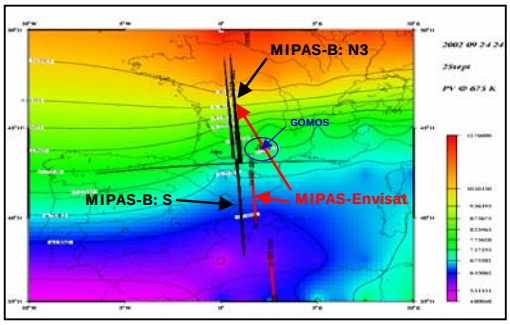

Fig. 1a: Colour-coded potential vorticity (PV) field at the 675 K (~26.5 km) level from 25 Sep. 2002, 00 UT, including MIPAS-B balloon trajectory with lines-of-sight (black, drawn up to the position of the individual tangent points), MIPAS-Envisat limb sequences (red) and nearest GOMOS occultation (blue); match of Envisat evening overpass (orbit: 2975). The gradient in potential vorticity denotes that different air masses have been sounded in the northward and southward direction, respectively.

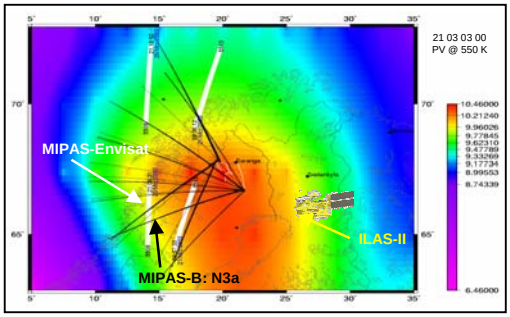

Fig. 1b: Colour-coded PV field at the 550 K (~23 km) level from 21 March 2003, 00 UT, including MIPAS-B balloon trajectory with lines-of-sight (black), MIPAS-Envisat limb sequences (white) and ILAS-II occultation (yellow); match of Envisat evening (orbit: 5508) and morning overpasses (orbit: 5515).

MIPAS-B Data Analysis

- Radiative transfer: Calculated with KOPRA (Karlsruhe Optimized and Precise Radiative transfer Algorithm) [*Stiller et al.,* 2002] and HITRAN spectroscopic data. Cross section data of $ClONO_2$ originate from *Wagner and Birk* [2003].
- Retrieval tool: Uses analytical derivative spectra calculated by KOPRA [*Höpfner et al.,* 2002]. The atmospheric retrieval grid was chosen with a vertical spacing of 1.0 km. A Tikhonov-Phillips regularization approach constraining with respect to the form of an a-priori profile was used.
- Error estimation: Includes random noise as well as the mutual influence (covariance) of the fitted parameters, temperature errors, pointing inaccuracies, and spectroscopic data errors (1 σ).
- A priori temperature-pressure: Radiosonde and ECMWF data up to 0.1 hPa; above: standard (mid-latitude summer and arctic winter) profiles. Temperature retrieval within CO_2 microwindows near 810 and 950 cm^{-1}.

Results and Discussion

- Temperature (see Fig. 2): Good agreement between MIPAS-B (Sep. 2002 flight) and MIPAS-E/ESA operational and the data retrieved by IMK (MIPAS-E/IMK).
- N_2O and CH_4 (see Figs. 3, 4, 6): Unequal shapes of measured mid-latitude profiles on 24 Sep. 2002 indicate that different air masses were sounded towards south and north. Operational profiles still show oscillations which presumably arise from deficiencies in the level-1B data processing chain (amplified by a too weak regularization). While the operational profiles exhibit too large N_2O and CH_4 values in the lower stratosphere, the semi-operational data fits pretty well to the balloon observation. A lack of appropriate Envisat data on 20 March 2003 prevents a sound comparison to MIPAS-B on this date. MIPAS-B and ILAS-II N_2O-CH_4 relationships appear close and tight.
- $ClONO_2$ (see Figs. 5, 7): A high coincidence is obvious between the measured balloon profiles and the semi-operational data in Sep. 2002 and, for most altitudes, in March 2003 as well. Around the vmr-maximum at 23 km (March flight), this holds also for the ILAS-II observation. Below this altitude region, the air masses sounded by MIPAS-B and ILAS-II are not comparable any more.

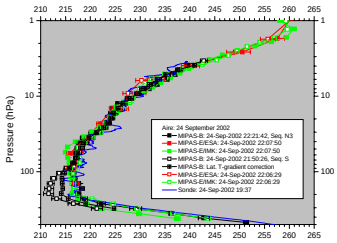

Fig. 2: Comparison of temperature retrieved from MIPAS-B data to MIPAS-Envisat (both operational data, called "MIPAS-E/ESA", and profiles retrieved at IMK, called "MIPAS-E/IMK") and a radiosonde launched from Aire sur l'Adour on 24 September 2002 (left). Below 100 hPa, a strong temperature gradient within the observed air masses is visible (see also: top picture). Therefore, the measured balloon-profile was "transferred" to the location of the satellite measurement, taking into account the latitudinal temperature gradient.

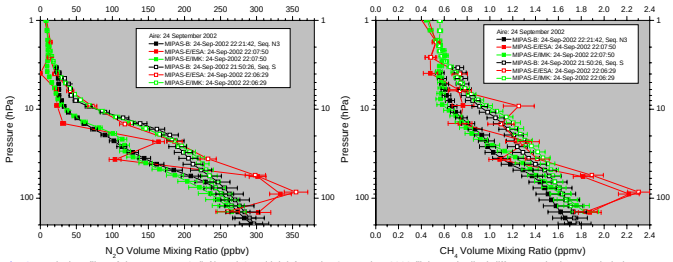

Fig. 3: Vertical profiles of the tracers N_2O (left) and CH_4 (right) from the September 2002 flight. Latitudinal differences in the sounded air masses are obvious in the unequal shape of the observed profiles. This latitudinal gradient is also visible in the potential vorticity field (see Fig. 1a). While the operational data exhibits some oscillations together with very high values near 90 hPa, the semi-operational data retrieved by IMK coincides pretty well with the balloon profiles.

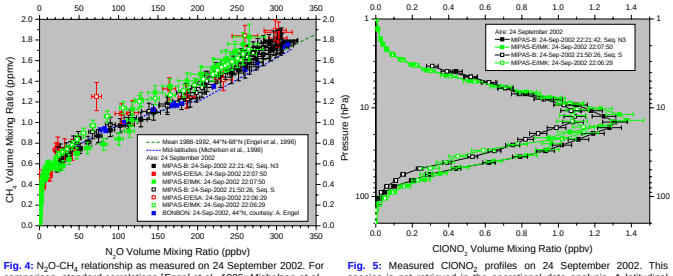

Fig. 4: N_2O-CH_4 relationship as measured on 24 September 2002. For comparison, standard correlations [*Engel et al.*, 1996; *Michelsen et al.*, 1998] are plotted, too. Some outliers are visible in the operational data.

Fig. 5: Measured $ClONO_2$ profiles on 24 September 2002. This species is not retrieved in the operational data analysis. A latitudinal difference in the air masses sounded is also obvious in the vertical profile of this more reactive species.

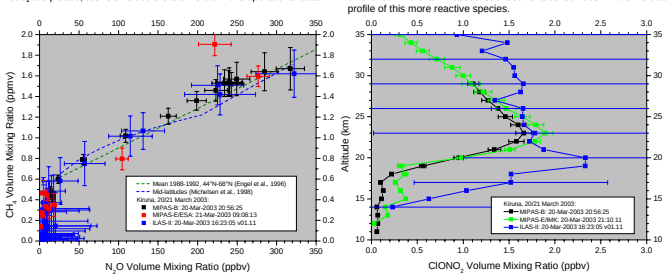

Fig. 6: N_2O-CH_4 relationship as measured on 20/21 March 2003. No N_2O-CH_4 data has been available so far for the 5508 overpass. Therefore, operational data is plotted for the 5515 overpass which took place on the morning after the balloon measurement. The tracer correlation should be independent from the air masses which have been sounded and appears compact for MIPAS-B and ILAS-II. The operational MIPAS data shows an outlier coming from too high CH_4 in the lowermost stratosphere.

Fig. 7: $ClONO_2$ comparison from 20 March 2003. Some differences are obvious between the balloon profile and MIPAS-Envisat. In the altitude region of the vmr-maximum ILAS-II exhibits a high coincidence with MIPAS-B. Even though the ILAS-II measurement is somewhat off the balloon observation, both measurements can be compared to each other since the potential vorticity values are nearly the same at 23 km (cf. Fig. 1b). However, below this altitude region, ILAS-II measured inside the vortex (yielding high $ClONO_2$ values) while the MIPAS-B observation took place outside the vortex; hence the air masses are not comparable any more in the lower stratosphere.

References

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