VALIDATION OF MIPAS TEMPERATURE PROFILES BY STRATOSPHERIC BALLOON AND AIRCRAFT MEASUREMENTS

C. E. Blom(1), C. Camy-Peyret(2), V. Catoire(3), K. Chance(4), H. Oelhaf(1), J. Ovarlez(5), S. Payan(2), M. Pirre(3), C. Piesch(1) and G. Wetzel(1)

(1) Forschungszentrum Karlsruhe GmbH, Institut für Meteorologie und Klimaforschung, Postfach 3640, 76021 Karlsruhe, Germany, Email: cornelis.blom@imk.fzk.de
(2) Laboratoire de Physique Moléculaire et Applications (LPMA), Université Pierre et Marie Curie, case 76, 4 place Jussieu, 75252 Paris Cedex 05, France, Email: camy@ccr.jussieu.fr
(3) Laboratoire de Physique et Chimie de l’Environnement (LPCE), CNRS and University of Orléans, France, Email: valery.catoire@cnrs-orleans.fr
(4) Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA, Email: kchance@cfa.harvard.edu
(5) Laboratoire de Météorologie Dynamique (LMD), CNRS-IPSL, Ecole Polytechnique, 91128 Palaiseau cedex, France, Email: joelle.ovarlez@polytechnique.fr

ABSTRACT

We report on the validation of profiles of the MIPAS processor of ESA version 4.61 with correlative data derived from balloon and aircraft measurements. The activities were part of the ENVISAT Stratospheric Aircraft and Balloon Campaign (ESABC) [1]. The paper includes contributions from five experiments flown on stratospheric balloons and one from the high-altitude aircraft Geophysica.

1  INTRODUCTION

Accurate temperature measurements from MIPAS are essential for the retrieval of the trace gases. Especially species derived from the short-wavelength channels such as NO₂, but also the retrieved CH₄ and N₂O profiles, strongly depend on the temperature retrieved. Profiles of HNO₃ and O₃ derived from the long-wavelength channels are less sensitive to temperature errors.

The number of temperature measurements from the ESABC is quite limited. This is especially true for the 2003 validation campaigns for which most of the version 4.61 data were not available at the time of the ACVE-2 meeting. Thus general conclusions or even statistical treatment of the temperature profiles is certainly not possible and should come from the sondes and Lidar measurements, which both are part of the GBMCD subgroup, and from intercomparisons with satellite measurements and meteorological fields made within the MASi subgroup. Nevertheless, some of the case studies reported from the ESABC subgroup show interesting results for individual orbits.

In July 2002 ESA initiated the latitudinal tuning of the MIPAS scans. The exact knowledge of the location of the MIPAS tangent points appeared extremely useful for the planning of all subsequent balloon and aircraft missions of the ESABC programme.

2  BALLOON-BORNE OBSERVATIONS

2.1  MIPAS-B results

On 24 September 2002 a mid-latitude flight was made with the MIPAS-B instrument [2]. For this flight a perfect coincidence in time and location was obtained with two MIPAS scans of orbit 2975 (Fig.1).

Fig. 1. Colour-coded plot of potential vorticity (PV) at the 675 K isentropic level above Spain and France, overlaid with MIPAS-Envisat orbit 2975 (red bars) and collocated MIPAS-B scans (black bars). In addition, one of the adjacent GOMOS occultations is shown. The northernmost scan of MIPAS-E is completely matched by the north looking MIPAS-B scan (N3).
Fig. 2 compares the temperature profiles of MIPAS-B and MIPAS-Envisat for one of the scans of orbit 2975. The collocation shown in this example is better than 20 min in time and better than 100 km in location. Above 100 hPa pressure altitude the difference between MIPAS-B and MIPAS-Envisat is within the combined errors of the two experiments, below 100 hPa the MIPAS-Envisat measurements are up to 2 K too cold.

The comparison of the temperature profiles with MIPAS is shown in Figure 3. The version 4.61 data for this flight were the only high-latitude temperature profiles available for the time of the meeting. Above 100 hPa km there is an excellent agreement between MIPAS and ELHYSA. Below 100 hPa the differences are somewhat larger, partly due to the lower resolution of the MIPAS measurements. It has to be pointed out that the H$_2$O measurements from the same ELHYSA flight gave also excellent agreement with MIPAS H$_2$O between 15 km and 27 km [4].

2.3 SPIRALE results

On 21 January 2003 SPIRALE [5] made a balloon flight from ESRANGE with a reasonable good coincidence in time and space with one of the MIPAS scans of orbit 4677. The SPIRALE profile was obtained near ESRANGE at (67.8°N; 25.1°E) between 19 and 21 UTC while MIPAS measurements were made at 19:52 UTC at a location slightly south (at about 65.7°N; 33.5°E). Unfortunately no version 4.61 data were yet available and comparison was made with profiles of the ESA processor version 4.55 (see Figure 4).

2.4 LPMA results

The LPMA gondola [6] made a flight from ESRANGE on 23 March 2003. The correlative measurements were made during the ascent around 15:38 UTC. The coincidence with MIPAS scans of orbits 5543 and 5551 is shown in Figure 5.

Figure 6 compares the LPMA measurements with so-called meteorological MIPAS data (version 4.57) for the same day. Because of the relatively large difference in time (up to 7.5 hrs) and location a direct comparison only gives a rough indication of the quality of the
MIPAS data and further investigations will be made as soon as the version 4.61 data become available. In addition, comparison of CH₄ and N₂O MIPAS data shows rather large differences between the two considered orbits, probably indicating differences between the air masses sampled in the morning (orbit 5543) and during the night (orbit 5551). The use of a CTM will be helpful to improve the comparison with LPMA measurements.

2.5 FIRS-2 observations

The SAO FIRS-2 far infrared FTS instrument [7] made a balloon flight from Ft. Sumner, NM (34.3°N, 104.2°W) on 20 October 2002, observing at float altitude from approximately 16 to 22 UTC. A very good coincidence in time and location (see Figure 7) was obtained for two scans of orbit 3343 at 17.16 UTC and 17.18 UTC, respectively, but unfortunately, for those particular scans no MIPAS data of version 4.61 were available. Comparison was therefore made with version 4.61 data for several other scans in the region of the FIRS-2 measurements.
3 AIRCRAFT OBSERVATIONS

3.1 MIPAS-STR

On 22 July 2002 MIPAS-STR [8] performed limb measurements from the M55-Geophysica at mid-latitudes during a flight from Forli in northern Italy. For this flight, initially planned together with the IBEX balloon flight from Sicily to Spain, ESA initiated the latitudinal tuning of the MIPAS scans. Although the longitude of the July 22nd scans of orbit 2051 was slightly east of the expected, the profiles obtained still had a good coincidence in time and location with two MIPAS profiles (see Figure 9). For this orbit the version 4.55 data showed pronounced oscillations in the profiles of CH\textsubscript{4}, N\textsubscript{2}O and the temperature [9]. The oscillations were partly due to deficiencies in the radiometric calibrations which are independently performed for forward and backward interferometer sweeps.

![Flight track of the M-55 Geophysica on 22 July 2002](image)

Fig. 9. Flight track of the M-55 Geophysica on 22 July 2002. The MIPAS-STR and MIPAS-Envisat tangent points are colour coded as a function of tangent altitude (6 km = dark blue, 20 km = red).

Figure 10 shows the MIPAS-STR temperature profiles together with the two nearby MIPAS-Envisat profiles of orbit 2051. Also the ECMWF-analysis interpolated at the time and the location of the MIPAS-Envisat tangent points is shown. Above 150 hPa MIPAS-STR temperatures in the south are maximally 3 K lower compared to the northern measurements. Below 150 hPa the profiles are similar since there the tangent point geolocations are overlapping (see Figure 9).

Below 90 hPa MIPAS-Envisat profiles of temperature show significant (up to 5 K) deviations from the MIPAS-STR results as well as from the ECMWF profiles. For higher altitudes the deviations decrease.

![Comparison of MIPAS-Envisat and MIPAS-STR temperature profiles for the mid-latitude Geophysica flight of 22 July 2002](image)

Fig. 10. Comparison of MIPAS-Envisat and MIPAS-STR temperature profiles for the mid-latitude Geophysica flight of 22 July 2002. In the figure 'north' indicate measurements made at the northern flight leg in which MIPAS-STR is viewing to the south. 'South' means measurements from the southern leg in which MIPAS-STR views to the north. The blue dotted lines indicate the flight level of the Geophysica at the northern and southern leg of the flight track.

4 CONCLUSIONS

The balloon measurements of MIPAS-B and ELHYSA above 100 hPa pressure altitude show an excellent agreement of the correlative measurements with the MIPAS-Envisat temperature profiles of version 4.61. In these two cases a perfect coincidence in time and location was obtained. Below 100 hPa the MIPAS temperature profiles seem to deviate from the correlative measurements.

Similarly, the temperature measurements from MIPAS-STR on board the M55-Geophysica show large deviations from the MIPAS-Envisat profiles below 90 hPa pressure altitude.

To draw conclusions from the other balloon experiments is difficult because of the less good coincidences of the correlative measurements with the MIPAS temperature profiles available at the time of the ACVE-2.

Validation activities need to be continued with the inclusion of further validation cases (especially for the year 2003) to achieve a statistically more reliable evaluation. Mismatches have to be corrected with the help of forward/backward trajectory matches to increase the number of coincidences. If necessary, the different
vertical resolutions of the sensors should also be considered during the validation processes as well as error budgets for the calculation of combined errors.

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6 REFERENCES


