MIPAS comparisons with HIRDLS V2.04.09 radiances and L2 products

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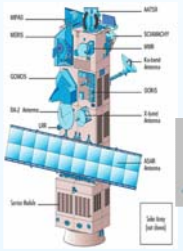
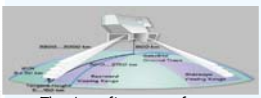
Abstract

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) is a Fourier Transform spectrometer which measures in the infrared from 685 wavenumbers to 2410 wavenumbers. MIPAS is a limb viewing instrument on ESA's ENVISAT satellite which launched in March 2002. Since August 2004 MIPAS has been operating at a reduced spectral resolution of 0.0625 cm-1. For selected test day the HIRDLS v2.04.08 radiances have been directly compared to those measured by MIPAS for the 10 HIRDLS channels which are completely covered by the MIPAS spectral bands. A local optimal estimation retrieval code (the MIPAS Orbital Retrieval using Sequential Estimation (MORSE)) has been used to retrieve volume mixing ratio (VMR) profiles for all HIRDLS species from the ESA level 1B reduced resolution MIPAS data. These profile have been compared to HIRDLS v2.04.08 level 2 retrievals. A simulated MIPAS radiance spectrum which covered the full HIRDLS spectral range was created by using the MIPAS retrieved profiles as the input for a forward model (the oxford Reference Forward Model (RFM)). This simulated MIPAS spectrum allowed HIRDLS radiances to be indirectly compared to HIRDLS v2.04.08 radiance for channels which direct comparisons are not possible.

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS)

MIPAS was launched on 1st March 2002 on ESA's ENVISAT satellite and measures infrared emission spectra from the limb of the atmosphere. Since August 2004 MIPAS has been operating at a spectral resolution of 0.0625cm-1. MIPAS has both a backwards (used for routine observations) and a sideward view (used for special observations).

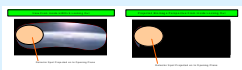




The above figures are from http://envisat.esa.int

The High-Resolution Dynamic Limb Sounder (HIRDLS)

HIRDLS is a limb viewing infrared radiometer which was launched in July 04 on board NASA's AURA satellite. Due to a problem during launch all but ~20% of the viewing aperture is blocked with what is thought to be a piece of insulation (kapton). However using varies correction to account for the kapton retrieval can be carried out for the routine products, which are pressure temperature, O3, H2O, HNO3, CH4, N2O, NO2, N2O5, ClONO2, F11 and F12.

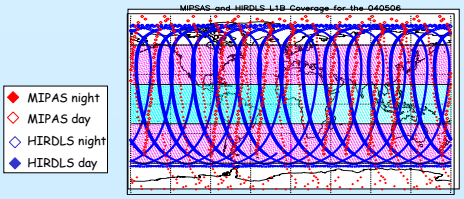


These figures show the viewing aperture with a clear view (left) and with the blockage (right)

The above figures are from the Aura webpage

Spatial Coverage

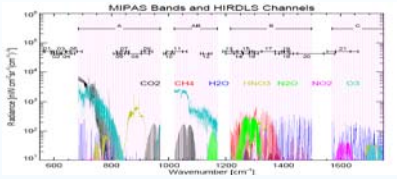
As both the HIRDLS and MIPAS instruments are capable of obtaining near global coverage within one day there are good data coincidences in both time and location. An example of the daily coverage of both MIPAS and HIRDLS is shown below.



This plot shows the location of each MIPAS (red) and HIRDLS (blue) scan taken on the 28th Jan 05. The coloured bands represent the three latitude band over which the data was averaged.

Spectral Coverage

The spectral ranges of MIPAS and HIRDLS are split up into five bands (A, AB, B,C and D) and twenty-one channels respectively. For one of the HIRDLS channels to be completely covered by the MIPAS spectral range the filter function of that channel must lie within one of the MIPAS spectral bands. Of the twenty-one HIRDLS channels only ten lie completely within completely one of the MIPAS spectral bands

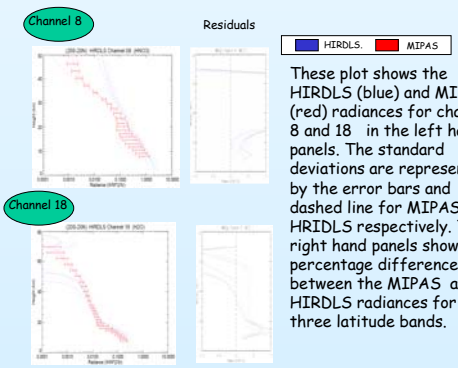


This plot shows the spectral coverage of the HIRDLS channels and the MIPAS bands along with the spectrum of several species.

Radiance comparisons

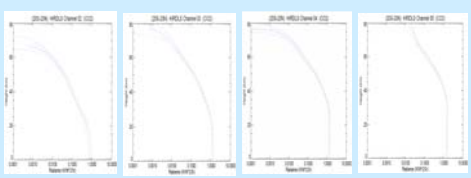
The radiances from HIRDLS processing version v2.04.09 have been compared to the MIPAS L1C radiances obtained from ESA L1B data. The radiances have been directly compared for the 10 HIRDLS channels which are with in the MIPAS spectral range. To produce MIPAS radiances that where comparable to HIRDLS radiances, the MIPAS radiances where integrated over the appropriate HIRDLS filter function for each channel. The data for each test day was averaged over three latitude bands (60S-20S, 20S-20N and 20N-60N).

The results of these comparisons are shown below for channels 8 (the most effected by the blockage) and 18 (the least effected by the blockage.



These plot shows the HIRDLS (blue) and MIPAS (red) radiances for channels 8 and 18 in the left hand panels. The standard deviations are represented by the error bars and dashed line for MIPAS and HRIDLS respectively. The right hand panels show the percentage differences between the MIPAS and HIRDLS radiances for the three latitude bands.

Unfortunately none of the temperature channels are directly covered by the MIPAs spectral range. An indirect way to compare the radiance measured by these channels to MIPAS measurements is to create a simulated MIPAS spectrum for the full spectral range which HIRDLS covers.
The simulated MIPAS radiances are produce using the Oxford Reference Forward Model (RFM) and the MIPAS retrieved profiles. All available MIPAS retrieved profiles for a given day are averaged over the 3 latitude bands for each species to create an input atmosphere for the RFM which produced a radiance spectrum which MIPAS would have seen if it covered the full spectral range of HIRDLS.
These simulated MIPAS radiance are integrated over the appropriate filter function and compared with HIRDLS in the same way as the actual MIPAS measurements.

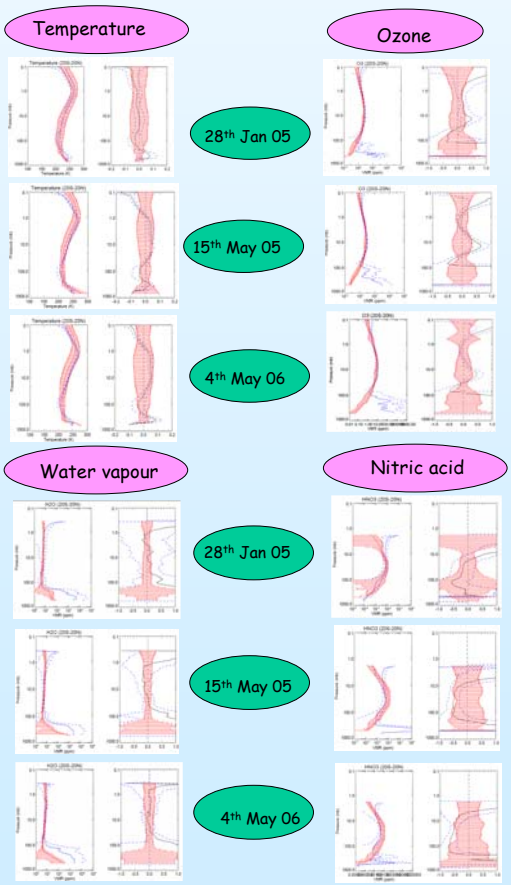


These plot show the HIRDS v2.04.09 radiances (blue) along with the simulated MIPAS radiances (yellow) for the four temperature channels (ch2-ch5).

Level 2 comparisons

A local optimal estimation retrieval code (the MIPAS Orbital Retrieval using Sequential Estimation (MORSE)) was used to retrieve Volume Mixing Ratios (VMR) from the low resolution ESA level 1B MIPAS data. This retrievals uses the RFM and the same microwindows as are used for the ESA operational retrievals. This constrained the solution to be close to an *a priori* solution, in this case a standard climatology. This method is less sensitive to noise than other methods, but can introduce an *a priori* bias into the profiles.

These MIPAS retrievals have been compared to HIRDLS Level2 Produces for the v2.04.09 processing. The data for each test day was averaged over three latitude bands (60S-20S, 20S-20N and 20N-60N). The results for 20S-20N latitude band are show below for temperature, ozone, water vapour and nitric acid. There was very little variation in the results for the different latitude bands. One test day was chosen from each period where a different scan table was used. It can be seen that the results are generally consistent over for the different scan tables.



Conclusions

- The radiances in the HIRDLS temperature channels compare very well with the MIPAS simulated radiances.
- The results showed little variation over the different latitude bands in both the radiance and level2 comparisons.
- Generally both HIRDLS radiances and retrieved produces compare fairly well to MIPAS.
- The results of the radiance and level2 comparisons are generally consistent over the three main scan tables used over the cause of the HIRDLS mission