Karlsruhe Institute of Technology

Institute of Meteorology and Climate Research (IMK)
Atmospheric Trace Gases and Remote Sensing (ASF)

Comparison of MIPAS IMK/IAA ozone with Umkehr measurements

Laeng, A. and Petropavlovskikh, I.

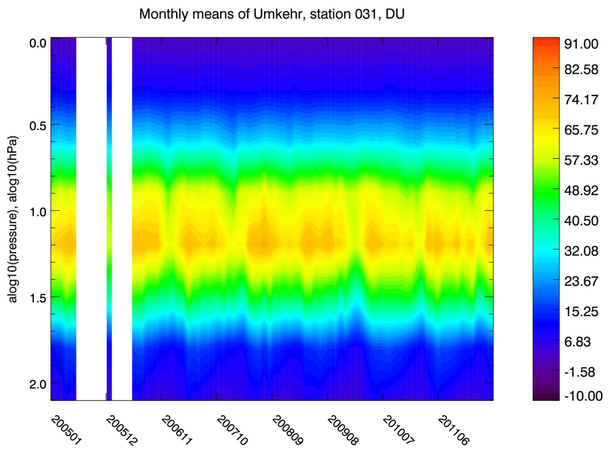
MIPAS IMK/IAA

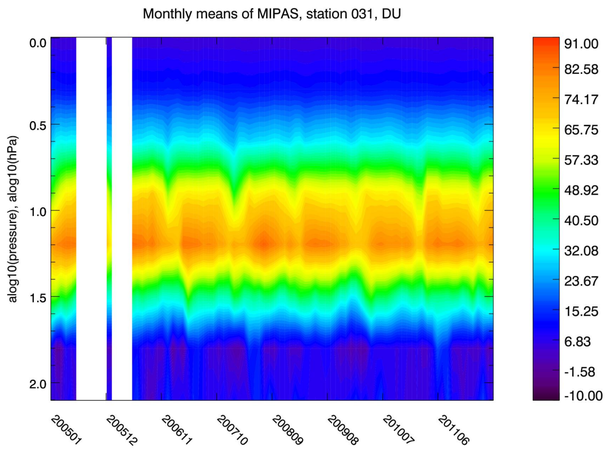
• IR limb emission spectrometer, day and night , >1000 profiles/day, 30 trace species, temperature and cloud comp
• Data provided on a fixed altitude retrieval grid
• IMK/IAA processor, (von Clarmann et all 2003), (von Clarmann et al, 2009)
• Tikhonov-constrained global fit (regularization towards smoothness of the profile)
  - altitude-dependent MWs different from ESA's;
  - all-zero a priori profile (smoothness);
  - ozone retrieved within third step in the retrieval chain (after T-LOS and H2O).
• Retrieval error covariance matrices and AK available for each profile; assessment of systematic and parameter errors and horizontal AK for selected cases
• Vertical resolution: from 2 to 6 km
• Dataversion: V5R_O3_220 and V5R_O3_221

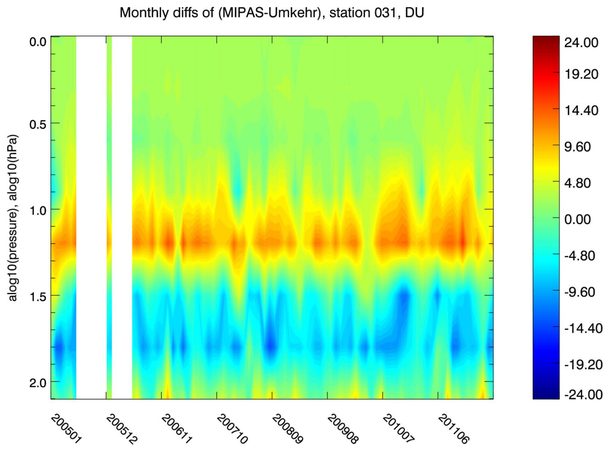
Umkehr

Umkehr is based on zenith sky observation of Solar radiation at two wavelengths in the UV part of the Solar spectrum. One wavelength is strongly absorbed by ozone and another one is not. The ratio is taken as function of SZA. From these observations the optimum statistical solution is found. The vertical smoothing and measurement uncertainties are two main errors of the retrieval. The vertical resolution of Umkehr ozone profiles is derived from AK analysis, where FWHM is~ 5 km, while the bottom layers (pressure between surface and 250 hPa) is derived as double layer. The retrievals are done on the days of the clear sky conditions (clear zenith). The method was developed to minimize a priori contribution into retrieval (Petropavlovskikh et al, 2005). The dataset is also corrected for the stray light contribution, which reduces the typical offset of Umkehr profiles in the upper layers. Above 32 hPa the operational Umkehr retrieval is known to underestimate ozone by as much as 5-10 % when compared to the SBUV profiles (Kramarova et al, AMTD). The problem is corrected in the dataset used in this analysis by including estimates of the stray light contributions to the observed Umkehr measurements.

Station 031: Mauna Loa, lat. = 19.53





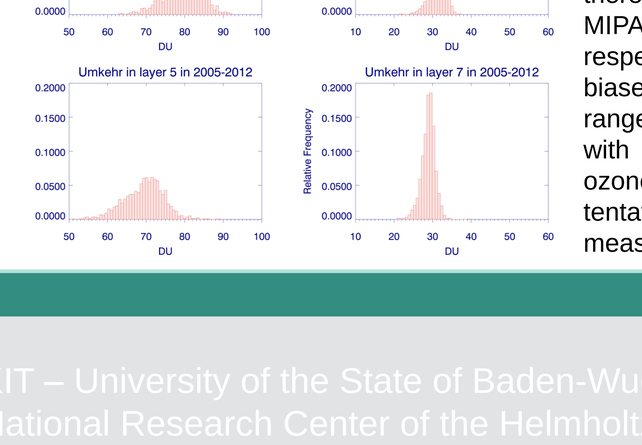


Top panel: plot of ozone profiles as function of time and atmospheric pressure for Mauna Loa (MLO) station (19.5 N, 155 W). The color code on the right side represents ozone (DU) in Umkehr layers (top pressure of the layer is half of the pressure at the bottom). The vertical axes are log10(pressure). Almost daily profiles from 2005 through 2011 have been taken by Dobson instrument at MLO.

Middle panel: the same as panel A, but ozone profiles are from MIPAS satellite overpass (+/- 3 degrees, 24 hours) over MLO station. The traditional MIPAS ozone profiles are derived as mixing ratios as function of tangent height, while the pressure of the height is also derived. The mixing ratio profile were converted to ozone DU and integrated into Umkehr layers for comparisons with Dobson data.

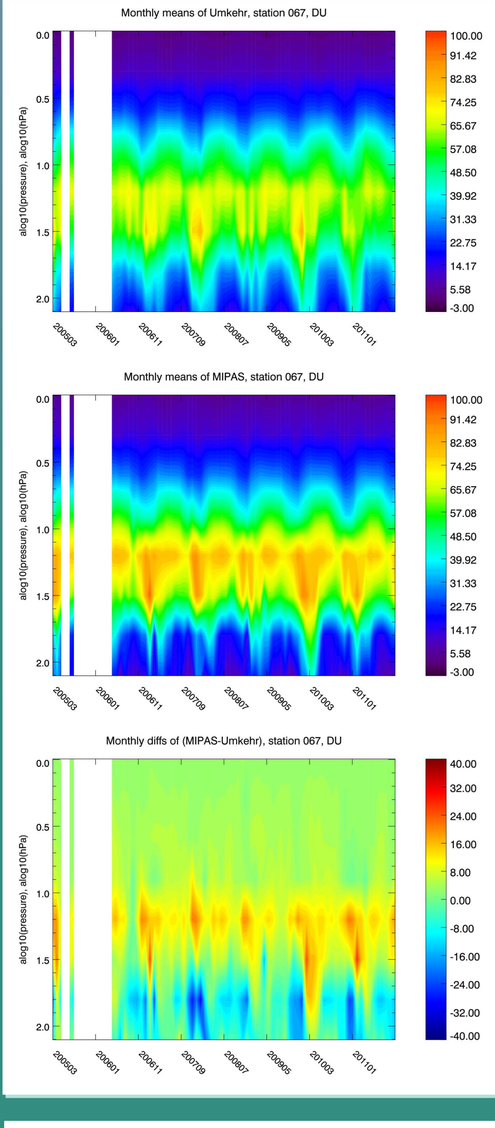
Bottom panel: difference between Umkehr and MIPAS profiles as function of time and pressure. The changes are mostly within +/- 10 %, with the exception of layer between 32 and 16 hPa, where differences are larger (+/- 20 %). The larger differences might be related to the larger AK (~5 km WHM) of the Umkehr retrieval as compared to MIPAS AK (~ 2 km) at this altitude

Atmospheric variability observed in MIPAS and Umkehr measurements is similar.



Time series of ozone vmr from ozonesondes launched from the same station. Unfortunately because of missing data at 25-30 km, the full comparison of the atmospheric variability observed by ozonesondes launched from this station with those observed by Umkehr and MIPAS is not possible.

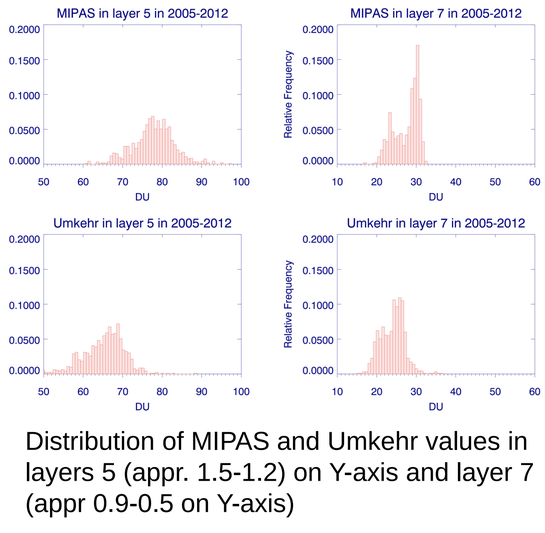
Distribution of MIPAS and Umkehr values in layers 5 (appr. 1.5-1.2) on Y-axis and layer 7 (appr 0.9-0.5 on Y-axis). The histograms have the same shapes and numbers of modes, but there is an offset in the position of the modes. MIPAS is systematically biased high with respect to Umkehr. Similar high and low biases of MIPAS in the relevant altitude ranges have not been found in comparisons with 14 other satellite instruments and ozonesonde data. For this reason we tentatively assign the biases to the Umkehr measurements



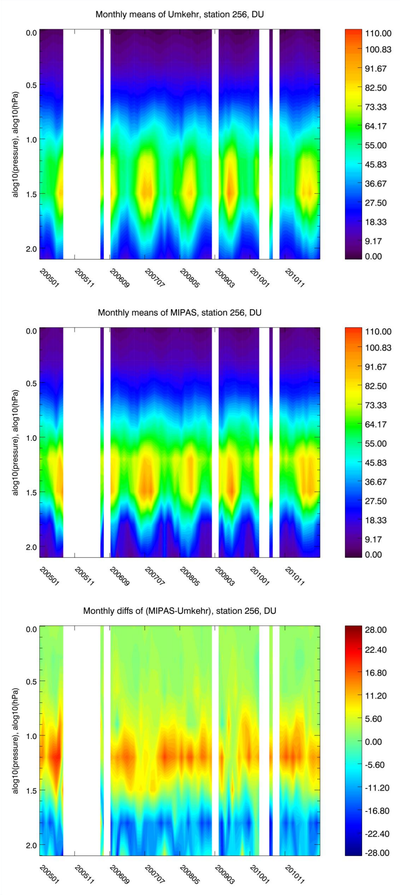
Station 067: Boulder, lat. = 40.03

Similar atmospheric variability is observed in both MIPAS and Umkehr measurements MIPAS values are slightly higher.

The histograms has the same shape and number of modes, but there is an offset in the position of the modes. MIPAS has systematically high bias. This bias is tentatively assigned to Umkehr (see Mauna Loa panel)



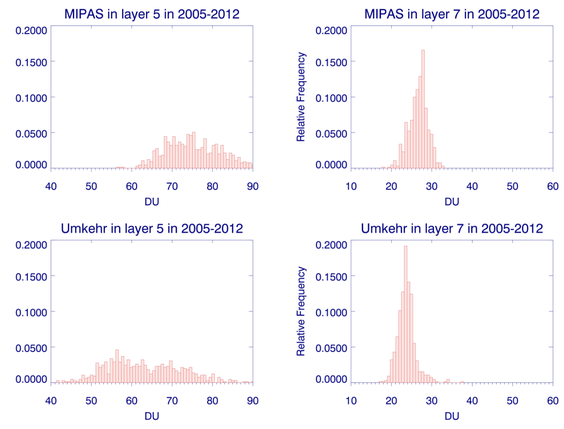
Distribution of MIPAS and Umkehr values in layers 5 (appr. 1.5-1.2) on Y-axis and layer 7 (appr 0.9-0.5 on Y-axis)

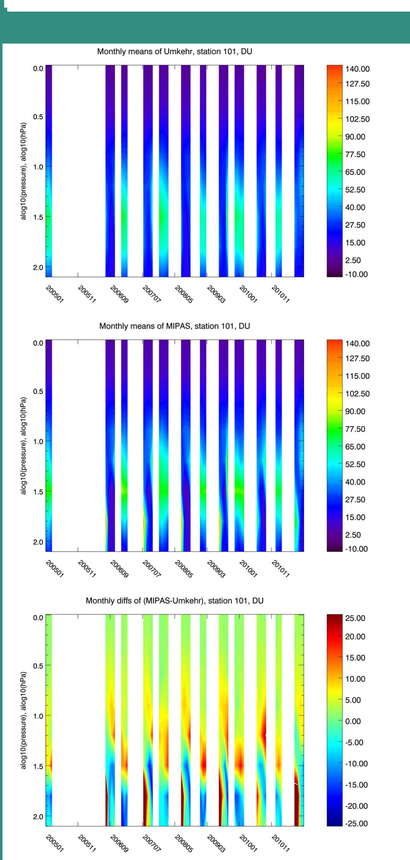


Station 256: Lauder, lat. = - 45.0

Similar atmospheric variability is observed in both MIPAS and Umkehr measurements.

For layer 5, the distributions for both MIPAS and Umkehr are very wide without pronounced structure, and the MIPAS width is wider than the Umkehr width in one case, and narrower in the other. The centroid of the distributions point towards a high bias of MIPAS vs. Umkehr. The bias is tentatively assigned to Umkehr (see Mauna Loa panel)

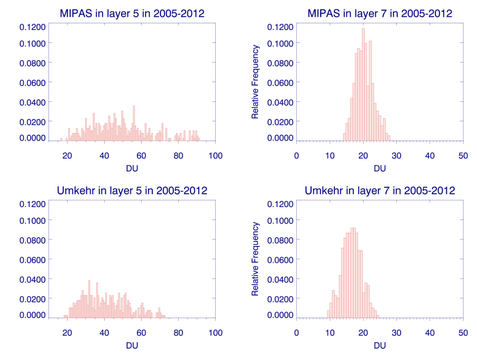




Station 101: Syowa, lat. = - 69.0

Polar station: no measurements during polar nights.
The similar atmospheric variability is observed by both Umkehr and MIPAS.

Histograms: for layer 5, the distributions for both MIPAS and Umkehr are very wide without pronounced structure, and the MIPAS width is wider than the Umkehr width in one case, and narrower in the other. The centroid of the distributions point towards a high bias of MIPAS vs. Umkehr. The bias is tentatively assigned to Umkehr (see Mauna Loa panel)



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