# Assimilation of infrared limb radiances from MIPAS in the ECMWF system

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ECMWF is developing the capability to directly assimilate radiances from limb sounders in a global data assimilation system. It is the first time that direct assimilation of limb radiances has been attempted. The prototype developments are being carried out for the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), onboard the Envisat satellite (e.g., European Space Agency, ESA, 2000). MIPAS is a very high spectral resolution interferometer (0.025 cm-1, unapodised), measuring infrared limb radiances in 5 spectral bands between 685 and 2410 cm-1, providing a total of 59,605 spectral points (i.e., channels). In normal scanning mode, MIPAS provides observations at 17 tangent heights in the range of 6-68 km, with a field of view of 3 km in the vertical at the tangent point.

As a first step for the assimilation, a new fast radiative transfer model to compute MIPAS radiances has been developed and validated (Bormann et al. 2004). The model, referred to as RTMIPAS, uses the regression-based methodology of RTTOV (e.g., Saunders et al. 1999), commonly used for nadir radiance assimilation at NWP centres. RTMIPAS can simulate the effect of variable water vapour and ozone; for other gases included in the model a fixed climatological profile is assumed. Tangent linear and adjoint versions of the model have also been developed.

RTMIPAS can reproduce radiances calculated with a line-by-line (LBL) model to an accuracy that is below the noise-level of the instrument for most spectral points and tangent heights (Figure 1), while offering significantly more rapid radiance calculations compared to currently available radiative transfer models. The comparison of RTMIPAS transmittances with LBL equivalents indicates that the accuracy of the RTMIPAS transmittance model is comparable to that of similar regression-based radiative transfer models for the Earth-looking geometry. First comparisons of real MIPAS observations with RTMIPAS-simulated radiances from ECMWF short-term forecasts show differences in line with expected values given the error characteristics of the observations, RTMIPAS, and the forecast data.

A set of MIPAS channels/tangent heights has been selected for assimilation studies and the information content of the selected data relative to the NWP background has been characterised. This shows that assimilation of MIPAS radiances has the potential to significantly reduce the expected analysis error of temperature in the stratosphere and lower mesosphere above about 30 km. For water vapour and ozone, MIPAS can add significant information to the background fields throughout the stratosphere and lower mesosphere. Offline evaluation of MIPAS observations with a 1-dimensional variational (1DVAR) assimilation scheme show encouraging results with impact of MIPAS radiances in regions as expected from the information content studies.

RTMIPAS has been implemented as a new observation operator in the ECMWF system, and assimilation trials will commence shortly. The first implementation assumes local horizontal homogeneity for the limb radiance calculations, but work is also in progress to use a 2-dimensional version of RTMIPAS, allowing a more accurate representation of the limb viewing plane. Simulation studies have shown that a 2-dimensional operator is expected to result in lower errors for the

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observation operator for more strongly absorbing MIPAS channels and views with lower tangent heights. Also, a 2-dimensional operator may lead to an altered and more adequate horizontal structure of the analysis increments from MIPAS radiances.

Bormann, N., M. Matricardi, and S.B. Healy, 2004: RTMIPAS: A fast radiative transfer model for the assimilation of infrared limb radiances from MIPAS. ECMWF Technical Memorandum No 436, ECMWF, Reading, UK., 49 pp [to appear in *Quart.J.Roy.Meteor.Soc.*].

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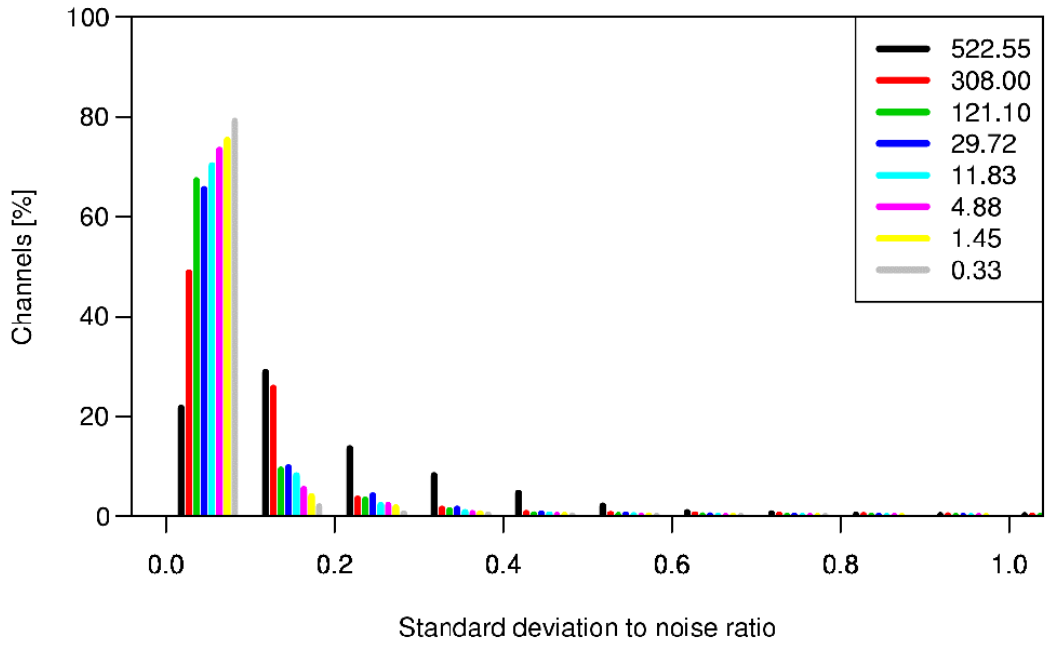


Figure 1: Distribution of the number of MIPAS channels [%] versus the standard deviation of the RTMIPAS-LBL radiance differences, scaled by the MIPAS noise. Results for 8 selected tangent pressures are shown, with tangent pressures [hPa] indicated in the legend.