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Atmospheric Measurement Techniques Discussions

Interactive comment on "New perspectives on gravity wave remote sensing by spaceborne infrared limb imaging" *by* P. Preusse et al.

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1. In Section 2.1 of their paper, the authors discuss the spatial resolution of a limb sounder in various aspects. On p. 832 l 10 they highlight the importance of the horizontal wave structure of gravity waves. A method how to infer the horizontal resolution of a limb measurement has recently been published (von Clarmann et al., AMT 2, 47–54, 2009). However, instead of discussing the horizontal resolution of limb sounders, the authors discuss the resolution along a single limb ray only (p 830, l 19-21). Is there any scientific reason in doing this? Can the authors provide a method how to infer the horizontal resolution from this quantity?

2. Also in Section 2.1, the authors state that for optical thin conditions most of the measured radiance originates from the part of the ray closest to the Earth around

the tangent point and that measurements are therefore associated with this tangent point. They further conclude that the resolution along the limb ray is limited by a weighting function of Gaussian shape. This conclusion seems to be based on the assumption that the weighting function which assigns the measured radiance to a source region determines the along-line-of-sight resolution. This concept is not correct, because the resolution of a measurement depends on where the information on a target quantity comes from but not where the measured signal comes from. The information depends on the sensitivity of the signal with respect to changes of the atmospheric state $\partial y/\partial x$ and not on the signal y itself. In a transparent atmosphere, i.e., when linear radiative transfer applies, any increase of the number of emitting particles will increase the radiance emitted from this area, but not the sensitivity with respect to particle density. In a semi-opaque atmosphere, i.e., when radiative transfer is nonlinear, increased radiance may even go along with reduced sensitivity. Any localized concentration maximum in the atmosphere would make the horizontal resolution appear to be high according to the criteria of the authors (very limited source region of the majority of the measured radiance) while the sensitivity actually is no better at the position of this concentration maximum. In a transparent atmosphere, where radiative transfer is nearly a linear function of the number of emitting particles, the information-containing term $\partial y/\partial x$ is fully independent of the actual signal if x is concentration or density. For other target quantities – the authors make no clear statement what the target quantity actually is – the relationship is more complicated but the general concept that the information is not identical to the radiance but linked to the sensitivity still holds.

Furthermore, the horizontal resolution of a limb measurement does not depend on a single limb view only but on the measurement geometry of the limb scan as a whole. A method to use the horizontal component of the averaging kernel of the retrieval to characterize the horizontal resolution of a limb sounding is described in the paper mentioned above. The horizontal smearing of information was found

to be substantially smaller than the widths of the weighting functions quoted by the authors of the discussion paper. Could the authors please comment on this discrepancy?

3. Further, the vertical resolution of a limb retrieval is, contrary to the statement of the authors, not limited by the vertical field of view: For MIPAS it has been shown that, due to vertical oversampling of the limb measurements (i.e. tangent altitude increments which are smaller than the vertical extent of the field of view), vertical resolutions better than the vertical extent of the field of view could be achieved (c.f. Chauhan et al., AMTD 2, 439-487, 2009; von Clarmann et al., AMTD 2, 181–236, 2009). These vertical resolutions were estimated on the basis of the averaging kernels of the profile retrievals, as suggested by C.D. Rodgers (e.g. "Inverse Methods for Atmospheric Sounding: Theory and Practice", in: Series on Atmospheric, Oceanic and Planetary Physics, Vol. 2, edited by: Taylor, F. W., World Scientific, 2000.). Do the authors have quantitative estimates on the vertical resolutions of the measurements they refer to? To which degree would the use of state-of-the-art diagnostic tools have impact on their conclusions?

4. In the last paragraph of Section 2.1 two-dimensional retrievals are mentioned but they are neither explained nor is a reference made to earlier work which has established this approach for infrared limb sounding applications (e.g. Carlotti et al., Appl. Opt. 40, 1872–1885, 2001; Steck et al. Appl. Opt. 44, 3291–3301, 2005; there may be more). In Sections 2.2 the Jülich tomographic retrieval approach is introduced. How is this code related to the pre-existing tomographic algorithms? Does it store the full Jacobian as Carlotti et al., or does it use a sequential estimation based decomposition technique to reduce storage, like Steck et al.? Or anything completely different? Without any detailed discussion of the 2D retrieval approach used, it is difficult to judge on the robustness of the method regarding the results presented here.

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