

## ***Interactive comment on “Tomographic retrieval approach for mesoscale gravity wave observations by the PREMIER Infrared Limb-Sounder” by J. Ungermann et al.***

**Anonymous Referee #1**

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### **General remarks:**

The paper by Ungermann et al. discusses a retrieval method to exploit the approximately 50km along track sampling of IRLS, a candidate FTIR instrument for ESA's upcoming PREMIER mission. The method should enable high resolution 3D composition profiles along the line of sight (LOS). While very plausible, the power of this method will need to be validated if the instrument is flown or with other instruments with similar characteristics that might have been flown before. The method is applied in this work apparently to temperature profiles, not to compositional profiles. However, the retrieval concept can be useful beyond this particular instrument and it seems thus of interest

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for the larger remote sensing community.

The paper addresses relevant scientific questions within the scope of AMT. The outcome of the approach to measure atmospheric profiles seems novel. The results are promising and the limits of applicability are explored. The method is explained clearly enough that the results can be reproduced by other scientists given the appropriate tools. Maybe some remark about the lack of final experimental validation should be introduced given that the whole study is theoretical. In general, however, the method described is very interesting and I would recommend publication.

There are several suggestions and questions listed below in regards to possible clarifications. The remarks are related to the text via a page number and a line number: p5:10-12 means page 5, lines 10-12.

### **Major remarks:**

- In page 2811:27-28 this paper should clarify that, pending validation, the strength of IRLS is in enabling this retrieval technique. The paper shows strong evidence that it is the retrieval what will probably enable 70 km resolution along-track, 750m in the vertical and 25km in the across track direction, but the statement in 2823:28 that PREMIER IRLS is the first limb sounder with a horizontal resolution comparable to nadir sounders may not be correct. To claim that it is the first such instrument would require proof that other instruments such as MLS, TES, and, especially, GNSS radio occultation cannot deliver similar horizontal resolutions to capture monochromatic gravity waves no matter what retrieval scheme is used. This is not done and probably outside the scope of this paper.

- p2831:18-24 The correlation length of the covariance matrix is a free parameter which influences the retrieval noise. Is there a criterion to decide the appropriate length for real measurements? How could one distinguish real from noise induced oscillations?

### **Minor remarks:**

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- The paper omits the role of clouds but some gravity waves can be associated to convection and clouds, others can produce local cooling and lead to clouds. In page 2810:15 and in the summary, is the achievable vertical resolution for GW observations limited to clear sky? In 2832:18 the summary would be more accurate if it specified that the analysis has been proven for monochromatic GWs in clear sky conditions.

**Technical remarks:**

- p2811:1:9 EGA or ESA?

- p2812:1:2 Tomographic limb sounding for atmospheric composition retrievals is already reviewed in Gurevich G., 1995: 'Application of satellite tomography methods for the improvement of atmospheric sounding inversion algorithms'. Geoscience and Remote Sensing Symposium, 1995. IGARSS '95. 'Quantitative Remote Sensing for Science and Applications', vol 2. Meeting 10-14 Jul1995, page(s): 1195-1197. doi: 10.1109/IGARSS.1995.521182

-p 2814:2 "has has"

-p 2816:18 What are the variables used from the Remedios et al. (2007) climatology? Temperature? MIPAS (and PREMIER) can retrieve several, but the manuscript's discussion seems focused on temperature profiles. I think that this distinction may be relevant because for compositions sounding it is relevant to know how the composition fields relate to the thermodynamic/temperature profiles.

- p2819:9 Is formula (1) correct with  $z - z_{t-x}^2$ ? Line 2819:17 defines  $z_t$ ; 2819:18 describes  $-x^2/2R_E$ .

- p2820:15 F(x) the forward model should be introduced here, instead of doing it at 2821:20.

- p2822:9 "unperturbed a priori"?

- p2822:20 What is the variable and units of the color maps in figure 6?

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- p2823:14,22,27 p2825:24 Could FWHM be spelled out?

- p2832:15 As described in the discussion paper, PREMIER IRLS would be analyzing the mid-troposphere and the UT/LS parts of the atmosphere.

- p2832:25 Could a similar retrieval approach be used for other sounders?

- Is it possible to make figures 7, 8 and 11 larger?

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