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Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Atmospheric composition and thermodynamic retrievals from the ARIES airborne FTS system – Part 1: Technical aspects and simulated capability" *by* S. M. Illingworth et al.

**Anonymous Referee #2**

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The paper of Illingworth et al. is the first part of a work where the authors illustrate the retrieval capability of the ARIES (Airborne Research Interferometer Evaluation System) airborne Fourier transform Spectrometer that is operated on board of UK FAAM aircraft (Facility for Airborne Atmospheric Measurement). In this paper the authors present the technical aspects of the instrument and assessed the retrieval capability in simulation with respect to the Temperature, Water Vapour, Ozone, Carbon Monoxide and Methane. The application to real observations is (supposed to be) presented in a parallel paper not indicated here. The retrieval scheme presented, the Manchester Air-

borne Retrieval Scheme (MARS), is a straightforward application of Rodgers' Optimal Estimation. The simulation results are discussed assuming that the aircraft flies at an altitude of 7 km and solely for nadir-viewing spectra. In this configuration the authors found maximum degrees of freedom for the signal (DOFS) for the retrievals of about 4 and 3 respectively for Temperature and Water Vapour. Maximum DOFS are less than 1 for Carbon Monoxide and Ozone and 1.45 for the Methane. To assess the capability of the measurement system the author compared retrieved and simulated-truth partial atmospheric columns. The authors state that, this comparison illustrated that the retrieval system performances are aligned with the OEM ones. The article is clear and very well written and based on its topic, it is for sure appropriate for the Journal. Therefore I recommend publication before a couple of points are properly addressed, which are shown below:

1. The first critical point is related to the organization of the whole study. I think that it would have been better if the work was not split in two parts or if the present paper showed at least a sample of preliminary results with real observations. In fact, neither the instrumental set up here described nor the methodology are novel or original.

   (a) Regarding the instrument, for sure the authors know that the American Scanning HIS and NAST-I FTS instruments have similar spectral characteristic and both these instruments have shown (operated on board of aircrafts) their capability to retrieve geophysical parameters with an accuracy comparable with the one here stated (the authors can for sure add here relevant references).

   (b) Moreover, the MARS methodology, as the authors state in the section 4.1, is not original and some parts seem to me to be less than state-of-art (e.g. see point 2 below) and it is fully based on Rodger Optimal Estimation Methodology.



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(c) The need of real observations in this paper is increased by the basic error in figure 1, the unique "Measurement" shown in this paper. This figure is misleading since it is not representative for the observations used for the retrieval. Contrary to what is stated, observed spectrum in Figure 1 is evidently a down-welling spectrum (Atmospheric windows radiance is lower than the Carbon Dioxide, Ozone and Water Vapour bands radiance). Please change this Figure with an aircraft up-welling radiance ARIES measurement.

2. The second point is related to the references incompleteness in the introduction section, where the authors neglects some capability of IASI instruments and they show a French bias in the description of the state-of-art. Into details (page 10835, L26 to page 10836, L5) describing IASI retrieval capability the authors mentioned only $CH_4$ and $O_3$, but no mention is provided for $CO_2$, CO and $N_2O$. In 2004, Lubrano et al Tellus B, showed the possibility to retrieve $N_2O$ from IASI radiance using IMG radiance as a proxi (this article is also cited in the IASI ATBD). The IASI capability to retrieve $CO_2$ has been shown in Grieco et al. Appl Opt, 2011. In this paper the authors exploit the partial scansion of the interferograms in order to insulate the $CO_2$ signature enabling the retrieval of $CO_2$ columnar amount with accuracy of about 7 parts per million by volume at the level of each single field of view. Similar methodology has been applied to IASI data to retrieve $CO$,$CO_2$, $CH_4$ and $N_2O$ (Grieco et al. Optic Express 2013, - both the Grieco et al. articles are mentioned in the CNES web page devoted to IASI publications). In the Grieco et al. work the columnar amount of these gases are retrieved with better accuracy than the one in the current paper. And this point should be discussed in the paper.

3. Third Point. The cloud detection methodology is based on Brightness Temperature difference (8 – 11 $\mu$m). If this difference is larger than 1 K, the spectrum is classified as cloudy. This test is largely correct for sea surface, however for other surface features it could fails (e.g. think about desert sand, Masiello et al. Appl



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Opt 2004). It is not clear here if the authors propose their method for sea surface alone. Again this point should be clarified and discussed.

4. Minor Point. Table 1-6. Please add absolute units for retrieved geophysical parameters.

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