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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Atmospheric composition and thermodynamic retrievals from the ARIES airborne TIR-FTS system – Part 2: Validation and results from aircraft campaigns" *by* G. Allen et al.

Anonymous Referee #1

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The paper by Allen, Illingworth et al. is the 2nd part of a work where the authors illustrate the measurement and retrieval capabilities of ARIES (Airborne Research Interferometer Evaluation System) – a Thermal InfraRed Fourier Transform Spectrometer (TIR-FTS) operated at various geophysical situations on the UK Facility for Airborne Atmospheric Measurements (FAAM) BAe- 146 aircraft. The first part of the paper (with Illingworth as first author) addressing the technical aspects and the retrieval capabilities based on simulated data has been published already meanwhile in AMT (7, 1133-1150, 2014).

This paper by Allen et al., addresses retrieval results from aircraft campaigns with ARIES deployments and associated validation with in-situ data. Trace-gas-concentration and thermodynamic profiles have been retrieved and validated for this study throughout the troposphere and planetary boundary layer over a range of environmental variability using data from aircraft campaigns over around London, the US Gulf Coast, and the Arctic Circle. Vertically-resolved retrievals of temperature and water vapour (H2O), and partial-column retrievals of methane (CH4), carbon monoxide (CO), and ozone (O3), over both land and sea, were compared to corresponding measurements from high-precision in-situ analysers and dropsondes operated on the FAAM aircraft.

Together with Part 1 , already published (see above), the paper may serve as a reference of the capabilities of the ARIES system. Beyond that it is of general interest for the atmospheric science community as it reflects the capabilities and limitations of NADIR sounding in the thermal infrared (TIR) with a spectrometer of moderate spectral resolution equivalent to that of the space-borne IASA instrument operated within the METOP programme but used on an aircaft operating in the middle or upper troposphere. Interestingly, the sensitivity and the capability to resolve vertical structures of parameters with DOFS significantly greater than 1 seems to depend on the altitude where the aircraft is operating within the troposphere illustrating the difference of using such an instrument from inside or well above the atmosphere. The paper appears generally as a careful study taking into account most important validation issues. It is clearly structured and very well written. It is certainly appropriate for the Journal after a number of points are properly addressed as detailed below:

Major points:

1. Important details on in-situ instrumentation used for the validation are missing, most relevant those about systematic uncertainties and sampling density. Are the systematic errors of the in-situ measurements taken into account in the analyses of the ARIES biasses? 2. How was the in-situ data mapped in time and space to the vertical profiles

or partial columns retrieved from ARIES data? What was the mismatch in time and space between the in-situ and the remote sensing data? 3. The authors compare the quality and capabilities of retrievals from ARIES measurements at many places with those delivered by IASI, arguing that aircraft remote sensing can help to bridge spatial sampling scales between groundbased and satellite platforms. It would be a valuable complement to the paper if this was demonstrated by comparing collocated IASI results to ARIES and in-situ observations.

Minor points:

Please explain how observations from different observer altitudes have been combined to the mean profiles.

p3408, l12: 'Sect. 2.3' should read 'Sect. 2.2 and 2.3' (?)

At several places you state the the residuals were 'featureless', which is in contradiction to some of the Figures, such as Figs. 4b, 8b, 10b. Furthermore, where do the 'spikes' in the NESR of Fig. 4b come from? How is the NESR from real atmospheric spectra calculated?

Panels c&d of Figs. 4,8,8,10,13: Legends are hard to read, fonts too small.

A brief explanation of the various error components would be useful for people that have not read Part 1 of the paper and, in general those, who are not that used to retrieval error budgets.

In the conclusions it is stated that the results compare well to ground-based CH_4 measurements from the TCCON network, but neither a reference is given nor a comparison is shown in the manuscript.

References: Part 1 paper: cite correctly (now published in AMT) Table 2: Spectral ranges for H_2O and CH_4 retrievals are overlapping partly, I guess therefore, that CH_4 is co-retrieved with H_2O. Table 3: Check Figure caption.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 3397, 2014.