

General comment:

This is an excellent paper which describes a genuine scientific experiment using collocated hyperspectral infrared and microwave atmospheric soundings for retrieval of its thermodynamic states. The approach and methodologies applied to the experiment appear sound, and the presentation of the retrieval results is clear. There is some lack of clarity/rigor in the presentation details of the experiment methodologies and of the measurement parameters/conditions. Those aspects are commented below for improving further the quality of the paper. Minor editorial comments are listed at the end.

Comments for improving the lack of clarity/rigor in the presentation details of the experiment methodologies and of the measurement parameters/conditions:

Lines 72 – 82: 2 Field campaigns

It would be good, for the readability, to summarise the field campaigns in a table format together with relevant information such as the dates, locations, experiment configurations (geometry & polarization), wind condition, additional in-situ measurements, etc.

Lines 83 – 133: Figures S1, S2, ..., S7

Figures S1, S2, .., S7 are mentioned in the text, but are nowhere to be found. It is not understandable whether they are referring to those of a specific reference paper. Please clarify!

Lines 115 – 121: ERA5 re-analysis dataset

The description of the re-analysis dataset used as the a priori dataset should be improved. For instance, why is it necessary to have a historical Februaries dataset from 1944 to 2022? Do the 9 grid boxes correspond to 3x3 boxes with the center box containing the Ottawa Airport? In which of the boxes is the campaign instrumentation located? A map with the campaign location, ERA5 grids and flight path would be helpful for the readers.

Line 170: Eq. 9

As  $K$  can be negative (Figs. 6d & 6e), wouldn't it better to use  $|K|$  in Eq. 9?

$S_{e,diag}$  can in general be improved by averaging of independent measurement samples, limited by the Allan variance of the instrumentation. Please explain how the instrumentation data have been averaged for achieving the optimum  $S_{e,diag}$ .

Lines 213 – 214: Radiosonde data

How well are the collocation of the radiosonde measurements with respect to the AERI/HiSRAMS profile?

Lines 334 – 336: "... we adopt an elevated surface boundary condition at altitude of 429 m ..."

Please include a short explanation how the land surface emissivity is artificially reduced during the retrieval.

Lines 428 – 429: “The temperature and water ... ~~decrease~~increase with distances away ... in single instrument retrievals **due to the increasing atmospheric attenuation**.

Editorial comments:”

Figures 2, 5, 10 & 12: Please expand the horizontal axis for a better visualization of the different retrieved profiles.

Line 50: “However, recent advancements in ~~microwave~~digital Fast Fourier Transform (FFT) ~~filter~~spectrometer techniques have led to the development of ...”

Line 87: “The AERI forward model **which** we adopt is ...”

Line 118: “The vertical coordinate ~~we~~ adopted in ...”

Line 224: “However, it is noted in **Figure 2** that AERI exhibits a more pronounced ...”

Line 504: “...European Space Agency (ESA contract 4000123417/NL/LA) for **the HiSRAMS development and permission for its use**, and ...”