

Interactive comment on “Single-footprint retrievals of temperature, water vapor and cloud properties from AIRS” by Fredrick W. Irion et al.

Anonymous Referee #2

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Overall assessment. This manuscript tackles one of the most fundamental issues in the field of hyperspectral IR remote sensing, that is the problem of clouds in an inversion scheme. The text is very well written and provides a way forward to the advancement of the inversion problem. All assumptions in the treatment of the cloud a priori are well explained. This lays out the foundation for a constructive conversation on the future directions that IR retrieval developers may want to consider when it comes to address the presence of clouds in an inversion methodology. I suggest this manuscript to be published, pending minor corrections as outlined below.

Minor comments: 1. The authors should add that, besides not needing absorption and scattering in the forward model, another advantage of cloud clearing is that it also does not require a formal cloud geophysical a priori and its error co-variance; it is

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computationally fast; it enables full column retrievals. A limitation, besides assuming constant water vapor in the cluster of FOVs, comes from also assuming uniform surface properties over the cluster of FOVs, which can be challenging over coastal regions.

2. Could the authors explain in few sentences how their work differs from the cited existing methods employed for direct use of cloudy infrared spectra in atmospheric retrievals (Liu, 2009, Blackwell 2005 and Kulawik, 2006a).

3. Can the authors say anything about using a monthly averaged surface emissivity, is this a robust approximation for a given day of the month? Also, have they evaluated the inter-annual variability in the data set to derive a rough assessment of how good of an approximation is to apply the 2003 climatology to the year before? Have they attempted a comparison with the existing surface emissivity regression solution of AIRS v6? If not, can they say few words about their motivation to replace the AIRS v6 method? Also, for completeness, they should include this as part of the list of differences with respect to AIRS v6 on page 2 -3.

4. Do the MODIS cloud parameters come with a formally computed error covariance? Otherwise, what is the source for this?

5. Was there a specific geophysical regime where the use of the 9.6 micron band was problematic, for example the tropical region, or desert areas? The broader scientific community would benefit from a more detailed explanation of what the sentence "We therefore retrieve O3 only as an "interferent" gas within the 14 μm CO2 region, and avoid the 9.6 μm band" means. Did the authors only use channels in the CO2 band for the retrieval of ozone? If not, can they explain more?

6. Section 3.6 Is the approximation of leaving all other variables fixed taken into account in the retrieval equation, for example, similarly to what is done in AIRS v6? Also, in the list of differences from the AIRS v6 approach, the authors stated that this is a simultaneous retrieval approach. Can they more fairly say that this is a two-step sequential approach?

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7. Also about section 3.6, if in within the page limits, can the authors say few words on the convergence criteria, besides mentioning the reference to Bowmann et al, 2006? Are those the same as outlined later in the text? If yes, for clarity, the authors should refer the reader to that section.

8. What enters in the measurement noise covariance term, only instrument noise? Can the authors specify this?

9. As an alternative method to the median of the medians, the authors should try the methodology described in Nalli et al., "Validation of satellite sounder environmental data records: Application to the Cross-track Infrared Microwave Sounder Suite", JGR, 2013, where each layer statistic is weighted by the mean water vapor quantity in the layer. This method was also used in Tobin et al., 2005, JGR and seems to be a well established methodology in the satellite retrieval field.

10. Summary and discussion section. How are the authors planning to extend this retrieval method to multi-layer cloud retrievals. Does the MODIS retrieval output contain multi-layer clouds that can be used as a priori?

11. Could the authors also consider comparing their cloud retrieval products to the AIRS v6 cloud retrieved products?

Technical comments: 1. The broader science community might not be familiar with what "L1b" data are. The author should either keep using the "Level 1" definition for radiance data or explain what the "b" stands for.

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