

### General Comments:

Please find my review of 'Impacts of cloud heterogeneities on cirrus optical properties retrieved from spatial thermal infrared radiometry' by T. Fauchez et al., MS No.: amt-2014-166. In this work, the authors explore the impact of cloud property heterogeneities on the retrieval of cloud properties from infrared observations available on such instruments as the Imaging Infrared Radiometer (IIR) and MODIS. The authors first generate simulations of cirrus clouds across a range of expected conditions (cloud optical depths, effective diameter, standard deviation of optical depths in cloud subpixels, etc.). They then compare 3-D and plane parallel radiative transfer calculations for these IR wavelengths to infer expected retrieval errors as a function of cloud profile and specific heterogeneities (e.g. variation in optical depth within cloud structure and in cloud microphysical properties). They find that these uncertainties depend upon the specific cloud state and can often be as large or larger than other uncertainty sources inherent to these IR retrieval approaches.

Overall, the paper topic is quite interesting and scientifically relevant to the remote sensing community. As a scientist who has worked frequently with ice cloud retrievals, I have often wondered about the quantitative impacts of 3-D effects on infrared retrieval cloud products. Yet, I had neither time nor tools to explore this topic. Likewise, the basic execution of the study was performed well. I very much appreciated the rigorous manner in which the authors sought to quantify different sources of error across a wide variety of cloud conditions. On the slightly negative side, I found presentation of the paper somewhat confusing at times given all the different test cases and different sources of errors. I also found some odd word choices and sentence constructions that perhaps could be changed for improved reader comprehension. Overall, I would happily recommend that the paper be accepted with only minor revisions. Please find my specific and technical comments below. These should be considered as suggestions and not so much as required changes.

### Specific Comments:

1. My primary concern is with clarity of presentation.

Pg 8778, Line 23. Please list these 'other possible sources of error' here for clarification

Pg 8781, Line 2: Perhaps list these other sources of error for clarification.

Pg 8785, Line 20: For the description of Split-window and the IIR operational algorithms, it again may be useful to explicitly describe the other sources of error. May help for the reader to keep track of which errors you are discussing and how they differ from the impacts of heterogeneities.

Pg 8781, Line 22: The statement that 'Cirrus 3 to 5 are useful...' needs more justification. Retrieval uncertainties are highly dependent upon cloud state (size of particles, optical depth, etc.) so it is not clear why conclusions using very small particles would hold for larger, more realistic sized particles.

2. Optical property parameterizations, Pg 8782: Do you ever look at the impact of changing ice particle scattering models (Baran vs Yang) for a cloud field constant in all other ways.

Or even for pristine habits, e.g. aggregates can not generate halos that we often see in the real-world associated with nighttime cirrus.

3. Along the lines of comment 2, the shape of the ice particles is determined by a ratio of effective diameters as on Pg 8785. Do heterogeneity effects ever result in the selection of different ice crystal shapes and, if so, what is the impact on retrieved cloud properties. Such information might be especially important for a combined scheme exploiting visible and near-IR measurements that are very sensitive to change in crystal habit.

4. Pg 8782, Vertical variability. It would seem that the impact of vertical variability would depend heavily upon the vertical profile of real-world clouds.

5. Pg 8793: Other Sources of Uncertainty. Have the impacts of water vapor (with associated cloud altitudes) been considered?

#### Technical Comments:

I have a few technical comments or suggestions. These generally refer to choices of words or grammar issues that do not seem quite appropriate given my own working understanding of English. Again, make changes at own discretion as sometimes it is not clear what the authors meant (indicated by ???)

Pg 8778, Line 6: 'One' to 'one cloud field'

Pg 8778, Line 17: Add 'use' or 'assumption' of PPA.

Pg 8778, Line 23: 'more higher' to 'greater'

Pg 8778, Line 24: Not sure if 'incertitude' is the correct word here or ever. Maybe just use 'uncertainty'

Pg 8778, Line 24, 'from' to 'when' ??

Pg 8778, Line 25, 'superior to' to 'is greater than'

Pg 8779, Line 10 and 11: 'spatial' to 'space-based' ??

Pg 8779, Line 17, 'dedicated' ???

Pg 8779, Line 17: 'retrieving' to 'the retrieval of'

Pg 8789, Line 29: eliminate 'The'

Pg 8782, Line 14: Perhaps use a more scientific expression for 'difficult to handle'

Pg 8786, Lines 7-11. Change the (-) symbol at the beginning of each line to make clear it is not (-) in a mathematical sense

Pg 8787, Line 2: change 'PPA' to 'impact of PPA' or something similar

Pg 8787, Line 7: Perhaps the 'tip' or 'point' of the red arrow

Pg 8787, Line 20: 'no' ???

Pg 8788, Line 3: 'negatives' to 'negative'

Pg 8787, Line 4: 'weaker' to 'smaller'

Pg 8790, Line 10: 'than' to 'as'