Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2017-361-AC4, 2017

Atmospheric Measurement Techniques Discussions

Interactive comment on "Global Spectroscopic Survey of Cloud Thermodynamic Phase at High Spatial Resolution, 2005–2015" *by* David R. Thompson et al.

David R. Thompson et al.

david.r.thompson@jpl.nasa.gov

Received and published: 22 December 2017

Summary: We generally agree with the reviewer suggestions and have incorporated them into a new version, appended as a supplement with changes tracked in red. A point-by-point response follows below, with reviewer comments in blue.

Multilayered cloud systems: I found no description on how multilayered cloud systems are detected and handled in this study. In my view, "ice" cloud region shown in Fig. 2 looks like a multilayered cloud system with an optically thin, high cloud above an optically thick, low cloud deck. I am not sure on this because I am not an expert of

Printer-friendly version

Discussion paper

this kind of imagery, but I was wondering why “ice” cloud region is more reflective than “mixed phase” cloud region.

In fact, the reflectance of the mixed phase is slightly higher than for the ice phase. This is captured in our new plot. It is indeed possible that the ice cloud hides a liquid cloud below (see below).

Satellite measurements show that multilayered cloud systems are quite common in the tropics and mid-latitude storm track regions. Thermal infrared measurements by AIRS are sensitive to the upper cloud, but the SWIR reflectance from Hyperion should be more sensitive to the lower cloud, depending on the optical thickness of upper cloud. If so, there should be more liquid cloud occurrence in Hyperion’s results than in AIRS, in specific latitude zones. Is this a possible reason for statistically significant Hyperion–AIRS differences in the tropics and mid-latitude storm track regions, as in Figs 7 and 8? The authors just mentioned that distributions from the two instruments generally agreed and the differences were ascribed to sampling error and spectroscopic sensitivity difference. In my opinion, if there is a statistically significant difference, that difference is valuable to be discussed and should be clarified in the manuscript. In that way, this comparison is not just a “sanity check” but more valuable.

This is an excellent point - to the degree that there is very optically thin ice cloud above a liquid cloud, AIRS and Hyperion might give two different answers. We agree that this is one potential explanation for differences in AIRS and Hyperion, in addition to spatiotemporal sampling. More generally, AIRS and Hyperion will be sensitive to different altitudes within a large cloud. We have added a note to this effect in the AIRS section, and with due deference to the reviewer, will incorporate this phraseology directly: “Another potential contributor to the discrepancy is sensitivity to different altitudes in large or multilayer cloud systems. Multilayered clouds are abundant in tropical regions and and mid-latitude storm tracks. In cases where, for example, a translucent ice cloud overlays an optically thin liquid cloud, the two instruments would measure different thermodynamic phase.”

On the comparison with AIRS: Oceanic and continental averages of cloud phase fraction can be derived from AIRS data. How can the difference between them explain the difference between results from the Hyperion and AIRS? It would be more insightful to compare the Hyperion's results with AIRS oceanic and continental averages.

We absolutely agree that the next natural step in a comparison would be a closer comparison of specific spatiotemporal subsets. It was not obvious how to do that in a paper of this scope, since there is insufficient direct coincidence to provide strong statistics, and there are other differences beyond the continent/ocean biases - for example, the fact that Hyperion observed only during the day, with observations concentrated in areas with human populations. Our response to reviewer 3 describes some of the other differences. We felt that the current evaluation was a simple story, and that a partial remedy of sampling differences might mislead the readership into expectations of precise alignment.

Page 6, Line 30, "The mixed phase clouds were ... nearly absent from the tropics": It seems to be not nearly absent.

Agreed; we changed "nearly absent" to "less abundant."

Page 9, line 15, "thin cloud": Is this an optically thin, high (or low) cloud?

We have modified the sentence for clarity: "We also expected differences in sensitivity; AIRS was far more sensitive to optically thin clouds, while the Hyperion analysis intentionally excluded thin clouds with a strict detection threshold." Hyperion thresholds applied to both high and low altitude clouds.