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Atmospheric Measurement Techniques Discussions

Interactive comment on "Footprint-scale cloud type mixtures and their impacts on Atmospheric Infrared Sounder cloud property retrievals" *by* Alexandre Guillaume et al.

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The manuscript attempts to answer the following questions: How many different cloud types co-exist within a particular area? What cloud type mixtures are more prevalent? How do answers to the above two questions depend on area size? (side question that emerges: at what spatial scale does one encounter the greatest diversity of distinct cloud type mixtures?). These all sound kind of philosophical questions, but the authors find practical relevance (at least for the first question) for AIRS (and AMSU) scales cloud retrievals. The link to AIRS allows the authors to make one the major compromises of the study: only cloud type identification of the topmost cloudy layer matters because that's where AIRS is most sensitive even though the data source identifying cloud type provides vertical profile information. The other major compromise is

that when identifying cloud mixtures, the frequency of occurrence of each cloud type does not matter, in other words cloud mixtures consisting of the same cloud types are treated as equivalent even if the contributions of a cloud type are different. These two simplifications, along with an additional one where the spatial arrangement of the cloud types is ignored allow the authors to reduce the dimensionality of the problem and make the analysis tractable. This is overall quite a difficult paper to read, but I find the results of the first part quite fascinating (I was less excited about the implications for AIRS retrievals–although I understand that these findings are important for understanding the quality of the AIRS retrievals), so I recommend acceptance of the article to AMT. As you can see below, I have some inquiries some of which are also of the philosophical kind I'd like the authors to consider.

– What does the cloud type from 2B-CLDCLASS mean? The names of cloud types are the same as the ones used by surface observers, but are they related? Some description of the physical meaning of the cloud types given their method of identification by the 2B-CLDCLASS algorithm is needed. I'm sure the authors are aware that another version of the product currently exists, 2B-CLDLASS-LIDAR where the CALIPSO lidar assists in the identification of the cloud type. Why was this newer product not used? (I suspect the authors may have started the work before this product was released). If the authors were to use 2B-CLDCLASS-LIDAR and the results changed in a major way, how would that undermine the fundamentals and motivation for the first part of the study? What if a completely different cloud type product was used, e.g., based on passive satellite observations where cloud type is identified by location in a cloud-top-pressure/cloud-optical-thickness joint histogram (the authors briefly touch on this in the last paragraph, but only with regard to the AIRS application – I'm more interested in the cloud scene climatology aspects)?

– It seems to me that the results depend completely on how frequently 2B-CLDCLASS identifies certain cloud types based on its internal definitions. Yes, the authors do not often find mixtures containing stratus (St) simply because St is extremely rare in

2B-CLDCLASS, probably unrealistically so given other methods identifying St (I mean, cloud types will always be loosely defined). I think one figure that the paper needs to include is the global frequency of the different cloud types according to 2B-CLDCLASS at its native resolution. This will give immediately clues on why certain cloud type mixtures (scenes) will be rare right off the bat (the authors kind of bring this this up already in some instances, e.g., p. 6, line 4). With DC, Cu, and St being rare according to 2B-CLDCLASS, one would expect that scenes containing those will also be rare.

– It is unfortunate that the abbreviation for certain cloud types changes throughout the text, tables, and figures: As becomes AlSt, Ac becomes AlCu, Ci becomes ci, DC becomes Dc, and so forth. Please fix and make consistent throughout!

– I don't understand panel d in Fig. 2. Whatever it depicts, it does not appear to have a very interesting pattern!

– I recognize that the authors make a valiant effort in section 3.3, but that part of the paper remains a hard read. In this section, line 8 of p. 8 indicates that 200 possible mixed scenes were identified which seems to contradict the 194 figure quoted earlier (p. 5, line 23). Are these numbers for areas of different size (e.g., a third figure of 210 different scenes emerges for 105 km). Please clarify, 194, 200, and 210. Moreover, I found odd that the authors state (p. 7 line 2) that "The maximum number of observed cloud scenes (210) at a particular horizontal scale (105 km) remains unexplained" when the section that immediately follows tries to explain exactly that. Am I missing the subtle distinction? Section 3.3 tries to explain why the maximum number happens at 105 (not sure it succeeds), but why this maximum number is 210 remains as the unexplained mystery?

– Can the same scale be used for the y-axis of Figs. 7 and 8? You say that that the common panels of these two figures (single cloud type scenes) should look very similar (inclusion of clear-sky notwithstanding), but the comparison is hampered by different y-axis range.

– Somewhere in section 2 mention what the maximum optical thickness retrievable by AIRS is.

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