Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., author comment AC1
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Reply on RC2

Qing Yue et al.

Author comment on "Evaluating the consistency and continuity of pixel-scale cloud property data records from Aqua and SNPP (Suomi National Polar-orbiting Partnership)" by Qing Yue et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-391-AC1, 2022

We would like to thank the reviewer for the encouragement and suggestions on this study. Below we have responded point by point to all the comments. Line numbers and page numbers are based on the revised version (clean version). **The reviewer's original comments are in bold** and the revised text is shown within quotation marks.

Main Comments:

- **The algorithm descriptions could have a few more details, especially for the imagers. For example, the different shortwave infrared channels used by MODIS and VIIRS have 'implications' as mentioned in line 218, but I suggest to briefly explain what they are for liquid and ice cloud effective radii retrievals. Also, some brief description on the "differences in LUTs" that are mentioned on line 241 would be good. It is also unclear to me what the difference between CLDPROP and MYD06 ice phase algorithm is. It is stated on line 241 that CLDPROP "removes the dependence on the cloud top solution method in MYD06." Do you mean it does not rely on cloud top height?**

Following the reviewer suggestions, we have added more discussions to summarize the major differences between the imager retrieval algorithms, which include the SWIR channel differences and the impact on cloud microphysical property retrieval, and explanation on LUT updates, and the IR channel differences and impact on cloud top determination, as well as more details on cloud phase algorithm changes. Please see Line 240-263 on Page 10-11: "The continuity CLDPROP products use only spectral channels common to both MODIS and VIIRS. The algorithm has direct heritage with the Collection 6.1 MODIS atmosphere cloud retrievals (MYD06), with cloud-top property datasets provided by the CLouds from AVHRR (the Advanced Very High Resolution Radiometer) - Extended (CLAVR-x) processing system (Heidinger et al. 2012, 2014) to account for more limited information for cloud-top property retrieval. CLAVR-x produces cloud phase reported as Cloud_Phase_Cloud_Top_Properties in the MODIS-VIIRS continuity cloud products. Since VIIRS does not have IR channels in the 13 µm CO_2 absorption band, the MODIS CO_2 slicing solution for cloud top pressure retrievals for cold clouds is replaced with an IR window channel optimal estimation approach coupled with a Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)-derived *a priori* (Heidinger et al. 2019). This in turn affects the optical property cloud phase algorithm (reported as Cloud_Phase_Optical_Properties in CLDPROP products), which removes the cold cloud sanity check applied in the MOD06/MYD06 that is based on the CO_2-slicing solution. The spectral mismatch of the MODIS 2.13 μm and VIIRS 2.25 μm channels also bring further changes to the Cloud_Phase_Optical_Properties retrieval by modifying the spectral cloud effective radius (Re) test approach. In the Version 1.1 MODIS-VIIRS continuity cloud product used in this study, the 2.25 μm test is omitted and the 1.61 μm test is duplicated. Moreover, this channel spectral differences compel changes in the look-up tables (LUT) of spectral liquid cloud reflectance used in the retrieval, which include the use of an updated liquid water imaginary index of refraction dataset in the shortwave infrared region (Kuo et al. 1993) and an updated complex index of refraction dataset for 3.7 μm (Wagner et al. 2005). Such differences in LUTs result in changes of cloud effective particle size (Re) (Platnick et al. (2020) that, along with cloud optical depth (COD), are used to derive cloud water path. Moreover, the ice crystal absorption at 2.25 μm is weaker than that at 2.13 μm.”.

- **I would suggest to separate ice-only and liquid-only FOVs in figures 7, 8 and 9. Alternatively, these could be provided in a supplement and the differences in results for ice-only and liquid-only FOVs can be discussed in the paper. Especially ice crystal absorption is much weaker at 2.25 micron compared to 2.13 micron, so there could be greater differences for ice clouds between MODIS and VIIRS than for liquid clouds.**

The comparisons on ice- and liquid-cloud-only FOVs are carried out following reviewer’s suggestions. Results are included in the supplement file and main differences are discussed in the manuscript.

- On sounder-sounder comparison, please see Fig. S1-S2 and discussions on Line 404-409: “Further separating the sounder FOVs into ice- and liquid-cloud-only categories shows that such inconsistency in cloud amount detection between the sounder algorithms exist in both categories as illustrated in Fig. S1 and S2. The sounder FOV is determined as ice/liquid-cloud-only when over 80% of collocated cloudy MODIS pixels are in ice/liquid thermodynamic phase in the MYD06 optical property cloud phase retrievals. Better agreements between sounder cloud products are found for ice-cloud-only FOVs.”.
- On sounder-imager comparison, please see Fig. S3-S6 and discussions on Line 458-462: “The results are further analyzed for ice- and liquid-cloud-only sounder FOVs (Fig. S3-S6), which are determined using the same criteria as in the previous section. It is clear that the disagreements between the sounder and imager CTP retrievals are mainly originated from the liquid-cloud-only sounder FOVs (Fig. S5 and S6), while good agreements are found for ice-cloud-only conditions (Fig. S3 and S4).”
- On imager-imager comparison, please see Fig. S7-S10 and discussions on Line 475-477: “especially for cold clouds as shown in Fig. S7, where the correlation coefficients for CTPs from different imager cloud retrievals are less than 0.52 for ice-cloud-only conditions (Fig. S7) but larger than 0.79 for liquid-cloud-only cases (Fig. S8).”. Line 483-491: “Separating results into ice- and liquid-cloud-only conditions, the COD (Re) correlation coefficients between the MODIS and VIIRS continuity cloud products are 0.84 (0.70) and 0.82 (0.75) for ice- and liquid-cloud-only conditions, respectively, as shown in Fig. S7 and S8. Although such good agreements between the two imagers are encouraging, the correlation for Re from the two CLDPROP products is lower than that for COD, with a much weaker correlation on the ice cloud Re retrievals. This reflects the effect of spectral channel and spatial resolution differences between MODIS and VIIRS, as well as the related adjustments made to the continuity algorithms, such as the liquid phase LUT for cloud microphysical retrievals, especially the impact of weaker ice crystal absorption at 2.25 μm (VIIRS) than at 2.13 μm (MODIS).” Line 501-503: “with a much lower correlation on CTP (r = 0.44) for ice-cloud-only conditions (Fig. S9) but a high correlation (r = 0.71) for liquid-cloud-only FOVs (Fig. S10).”Line 504-506: “The impact from the differences in CTP algorithms thus

shows up more strongly on the higher statistical moments and on cold cloud scenes.".

- **Related to this, I wonder if there also are differences between ice-only and liquid-only FOVs in the sounder to sounder and the sounder to imager comparisons. Could you at least comment on that?**

Please see our response to Main Comment #2.

Minor and specific comments:

- **Line 114: I suggest to include an outline of the paper as is customary.**

The outline is added on Line 113-118 as suggested: "This article is organized as follows. Section 2 describes various cloud products and their retrieval algorithms analyzed in this study, as well as the method used to create pixel-scale collocated datasets between sounders and imagers across different satellites. Section 3 shows the detailed comparisons of cloud properties and their joint histograms from different algorithms and sensors, and the discussions on implications on retrieval algorithm development and instrument differences. A summary and set of conclusions are presented in Section 4."

- **In Table 1, I'd suggest to include the spatial resolution of the products**

The spatial resolution is added in Table 1.

- **In table 1, I suggest to spell out NSR and FSR, so it's clear what the difference is between those two rows.**

NSR and FSR are spelt out in Table 1 as suggested.

- **Figure 1 and 2: The yellow lines are very hard to see, especially the dashed one. I suggest to use a different color.**

Yellow lines in these figures and symbols in other plots are changed to a different color (dark goldenrod) for better visualization of the results.

- **Figures 5 and 6: The addition of the magenta lines make the middle panel plots very busy, and the number indicating the contour line values are almost impossible to read. These should be made more clear. Making these panels bigger might help.**

Fonts in all plots are increased as suggested. The number of contour levels in Fig. 5 and 6 is reduced so that the 0.1 ECF contour is more clear, with the third rows in these plots to show results removing the ECF < 0.1 FOVs.

Please also note the supplement to this comment:
https://amt.copernicus.org/preprints/amt-2021-391/amt-2021-391-AC1-supplement.pdf