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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Clouds over the summertime Sahara: An evaluation of Met Office Meteosat retrievals using airborne remote sensing" *by* John C. Kealy et al.

Anonymous Referee #1

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This paper attempts to evaluate the performance of the UK Met Office cloud mask and cloud top height (CTH) retrievals applied to the Meteosat SEVIRI geostationary imager over the Sahara. The evaluation relies on lidar and radiometer observations obtained from the BAe-146 aircraft flown from Fuerteventura as part of the Fennec program in June 2011 and 2012. The authors show good agreement (or at least explainable comparisons) between the SEVIRI derived cloud detection and CTH and that retrieved by the aircraft instruments, and include a first-look Saharan cloud fraction "climatology" as well as a brief foray into the mechanisms that drive cloud formation in the region.

The text is exceptionally well written, the results are clearly presented, and I find no significant deficiencies in the analysis. I therefore recommend the paper for publication

after only minor revisions.

General Comments

The authors enter somewhat treacherous territory when attempting to evaluate a satellite derived cloud mask, for which the answer to "What is a cloud?" is often "I know a cloud when I see it." As they rightly point out, the design of a cloud mask, and the "accuracy" of cloud detection and derived cloud fractions, are determined in part by the science questions asked, e.g., detecting/removing clouds for a clear sky retrieval product vs detecting clouds for a cloud retrieval product. This in addition to the spectral channel information, sensor spatial resolution, etc. Many investigations lack an appropriate level of consideration for these distinctions, but the authors do a nice job here. My only quibble with the cloud mask analysis (and it is indeed only nit-picking) is the use at times of the term "validation," which implies a comparison of a given retrieved parameter with the direct-measured truth. I would suggest using the term "evaluation" as is done in the title and abstract, in particular because a satellite derived cloud mask is an ill-defined parameter and the fact that the "truth" used here, from the lidar and radiometer, are in fact retrievals themselves.

The authors are on more solid ground with the CTH evaluation, though I have a concern with the analysis as presented. The authors acknowledge that partly cloudy pixels that are treated as overcast will often yield biased CTH retrievals, and they include a nice discussion of the mechanisms for these biases. However, in Fig. 7 they use the SEVIRI derived effective cloud amount N to show the relationship between sub-pixel cloudiness and cloud top biases instead of the aircraft derived cloud fractions. The authors themselves acknowledge that N is not explicitly calculated and should be used with caution. I suggest they either re-create this figure using the SEVIRI pixel-level aircraft cloud fractions instead of N, or add a figure/panel showing CTH biases as a function of the aircraft cloud fractions like what was done for the cloud mask analysis in Figs. 5 and 6. I believe this would be a much more defensible approach.

Specific Comments

p. 3, line 14: I assume the Hocking (2011) cloud mask is a widely-used product at the Met Office?

p. 4, Eqns. 1, 2: Should N be a function of cloud top pressure p?

p. 4, line 17: How is the channel variance defined?

p. 5, line 32: Can the authors comment on the size of the across-track field of view?

p. 6, lines 9-12: How frequent are these missed detections?

Section 2.2: I assume a down-viewing imager that could be co-located with the lidar and radiometer was not flown? This would have been useful for evaluating the lidar and radiometer cloud masks.

p. 7, line 10: Why are above-aircraft cloud detections not useful for the cloud mask comparison?

p. 7, lines 21-25: The across-track FOV of the aircraft is obviously not as wide as a SEVIRI pixel, so the aircraft derived cloud fractions do not sample the entire SEVIRI pixel. Can the authors comment on the impacts of this?

p. 7, lines 29-30: Can cloud movement cause an overestimation of the SEVIRI cloud mask uncertainty? As defined the uncertainty implies the assumption that changes in pixel-level cloud mask are due to cloud formation/dissipation.

p. 9, lines 19-25: Can the authors comment on the role of SEVIRI cloud mask "false positives" in regards to the positive cloud mask results having aircraft cloud fractions below 0.1?

Fig. 7a: The x-axis label states the units as (km), however the tick labels appear to have units (m).

Fig. 9b: What spectral channels are used to create this RGB?

Section 4.1: Could cloud mask false positives also be due to solar reflectance tests?

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