Interactive comment on “A kernel-driven BRDF model to inform satellite-derived visible anvil cloud detection” by Benjamin Scarino et al.

Referee Comments – Martin Setvák, CHMI

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General Comments

The paper focuses on automatic detection of anvils of deep convective clouds (DCC), based on BDRF model developed by the authors. Various anvil detection techniques or products are being used in (satellite-based) nowcasting systems, thus any new similar method can enhance credit of the satellite data. This gains on importance with recent onset of new generations of GEO satellites, such as Himawari-8/9, GOES-R series, FY-4A series, or GEO-COMPSAT-2A, or the upcoming third generation of Meteosat satellites (MTG). For these reasons I welcome the submitted paper and recommend it for publication.

Thank you for your time and insight in reviewing our manuscript. You will find our responses to your comments below with indicated changes in the text where applicable.

Specific Comments

Page 2, Lines 25 – 29
I would be somewhat more conservative about usefulness of the WV-IR BTD method, namely for the overshooting tops (OT) detection. It depends not only on availability of appropriate WV channel and scanning geometry, but for specific cases namely on presence and total amount of water vapor in the lower stratosphere, above the storms, and its vertical thermal profile. Reading this part as it is written now may impose an impression that this technique is broadly used for OT detections, being reliable – which is far from the reality. However, I do not dispute its use for detection of DCC in general.

We agree with your assessment. Although Ai et al. (2017) did demonstrate capability for WV-IR BTD to detect OT, it was neither reliable nor the main focus of their BTD to noise ratio, which rather was DCC detection. Also, given that our manuscript does not directly concern OT, it is probably better to not mention OT in this discussion. Therefore, we have removed the sentence that started, “Ai et al. (2017)… ” originally appearing on Page 2, Line 26. We have also muted our emphasis on WV-IR BTD reliability in general (Page 12, Line 4 and Page 14, Line 8) and introduced the fact that WV bands on legacy GOES have very strong VZA dependency (Page 2, Line 30 and Page 11, Line 38)

Page 4, Lines 1 – 2

As written, *its application in enhancing anvil cloud detection (and thereby OT detection) capability*, it may seem that the method can be directly used for OT detection. Though the authors elaborate this statement later in the paper, perhaps a more accurate wording might help here.

In order to better convey that the BRDF model does not directly enhance OT detection, we have adjusted the sentence to read, "… its application in enhancing anvil cloud detection capability and cloud optical depth (COD) parameterization" (Page 4, Line 3).

Page 4, Lines 16 – 17

Can there be any impact of the location of the satellites – Himawari-8 providing data namely for DCC above the ocean, while GOES satellites depicting namely storms above the continent? I'm not speaking here about different underlying surface, but rather about different types and concentrations of the condensation nuclei above continent and oceans, which may affect the cloud top microphysics and thus also its reflectance (BRDF) …

True there are regional differences in DCC reflectance owed to different microphysics, but they should not have a significant impact on our results. Doelling et al. (2018) measured a 0.8% difference in the count response between the TWP region and the Meteosat region from ~2003-2007, which is the largest regional difference they observed. This corresponds to ~0.9% difference in reflectance and is not enough to have meaningful impact on predicted nominal reflectance from the BRDF model.

Page 14, Line 13 and 24

… *should exhibit spatially uniform cold temperature values* … You discuss here the impact of colder overshooting tops, but how about the enclosed warm areas of storms exhibiting cold-Vs or cold rings? How does the algorithm deal with these?

The warm areas of such features are evaluated in the same way as the rest of the anvil using the 22-km moving window. These portions are not warm enough to negate detection, but they are likely to be assigned lesser IR anvil ratings than the colder portions. As far the anvil BRDF is concerned, enclosed warm areas would likely be excluded from the reflectance LUT aggregations because they would not pass the BT homogeneity test. These rare exclusions, however, should not significantly influence the nominal reflectance predicted by the BRDF model, and therefore the final VIS anvil mask results would not be affected. We have added these details to the text on (Page 15, Line 17).

Other comments

I can hardly discuss the technical details of this work (as I have no personal experience in this area), however from an observational perspective and long-term personal experience with satellite observations of storm tops, the individual steps, their settings and parametrization seem to be reasonable and justified. I hope that the authors plan extension (or verification) of

this work also to the GOES-16 and GOES-17 data, and possibly also to Meteosat's SEVIRI and future FCI data.

Thank you again for your comments. Extension of the BRDF model of expected anvil reflectance is planned to follow the launch of MTG.