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Comment on amt-2021-422

Anonymous Referee #2

Referee comment on "Improving discrimination between clouds and optically thick aerosol plumes in geostationary satellite data" by Daniel Robbins et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-422-RC2, 2022

The article of "Improving discrimination between clouds and optically thick aerosol plumes in geostationary satellite data" introduced a technique of using ML to discriminate clouds from very optically thick aerosols in passive sensor (AHI). Correctly categorize clouds and dense aerosol layers can be beneficial to many satellite aerosol products and their applications. In this study, the cloud/aerosol labeling is based on CALIOP CAD score. Author applied parallax correction during the CALIOP and AHI collocation, which is important when generate a refined atmospheric column that is representing AHI observed airmass. It is also informative to include explainable ML decision to reassure the logic behind ML regression relations. The case study in this paper shows promising results of successfully identifying thick dust plume overland.

However, there are some issues that author needs to clarify. One of the issues is the innovative contribution of this paper. As the author mentioned, using Machine Learning to facilitate satellite image recognition/categorization is a hot topic. Many studies have tried using ML/CNN to identify cloud and/or aerosols from passive sensors, for example Marais et al., 2020, Lee et al., 2021, Wang et al., 2020. Some of these studies also uses lidar as benchmark to label particle types. The new contribution from this study that is differ from the already published studies shall be clarified. In addition, more information of the disadvantage and advantage of passive and active remote sensing techniques of clouds and aerosols are needed to justify the benefits of using active sensor to provide typing information. Discussions on potential misclassification in CALIOP of identify spherical fine particles as clouds and how that is going to impact the outcome of this study needs to be discussed in the article. Related to this issue, my biggest concern is that there is little information of the uncertainty/QA procedures used when using CALIOP CAD to identify aerosols and clouds. The CAD > 50 thresholds will likely mark some of the small clouds as aerosols, which is shown in Figure 12. The upper right corner has many fine popcorn clouds, which is marked as potential cloudy in ML output and identified as clear in binary mask. In contrast, the other two cloud products marked this area as cloudy. This can cause large problem in aerosol retrieval. Due to this mislabeling is caused by how clouds are defined, it will not be marked as missing detection of clouds in validation (accuracy score). Plus, an altitude threshold of CAD will mark some elevated aerosols as clouds, such as volcano eruption/stratosphere aerosols, although the percentage of these data will

be very small. It is also not clear to me how the NN model is set up. Is small batch of horizontal pixel from AHI used as input. If so, what is the size of batch? How is CALIOP labeling work for each batch? In terms of validation, due to the ambiguity in determine CALIOP cloud and thick aerosols, external data, such as ground lidar can be used to validate the cloud/aerosol mask as well as more cases of intense smoke from wildfire and pollution are needed. Another suggestion is that if the main purpose of the model is to separate thick aerosols from clouds while maintain reliable cloud mask, instead of comparing the cloud/aerosol mask to other cloud mask products, comparisons between ML cloud mask to cloud mask within other aerosol products is more appropriate. Because cloud mask, which is made to remove "unclear" sky, is known to have "clear sky bias"; while aerosol products try their best to preserve these aerosol scenes. For reader's benefits, reword the description of the parallax correction. From my understand, the pseudo-CALIOP vertical profile is generated using layer information from different CALIOP lidar pulse along the AHI airmass pathway. However, the description of the parallax correction is very confusing mentioning the angle from CALIOP needs to match angles from AHI.