Date: 14 December 2020

Purpose: Reply to referee 1

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Specific comments:

1. While it is nice to add discussions about the implication of dust detection techniques in aerosol assimilation and weather forecast (sections 4-5), some details (although quite informative) are not very relevant to this study (e.g., lines 5-11, page 23). I suggest shortening these parts to keep the paper concise.

I removed the following two paragraphs along with stated references from the assimilation section:

Two types of approaches for the assimilation of aerosol exist. As summarized in (Penny et al., 2017, Zupanski, 2017), one type is a weakly coupled data assimilation (WCDA) and a second type is a strongly coupled data assimilation (SCDA). In the WCDA framework, assimilation of aerosol is conducted independently of the assimilation of coupled atmospheric component, although the resulting analysis is used to initialize a coupled aerosol-atmosphere forecast to allow interaction between the two components (e.g., Sekiyama et al., 2010, Rubin et al., 2017). In contrast, in the SCDA framework, assimilation of aerosol and atmospheric components is performed simultaneously, treating the coupled aerosol-atmosphere system as a single integrated system (e.g., Liu et al., 2011, Lee et al., 2017).

Analysis and forecast of dust or aerosol distribution can benefit from the assimilation of satellite data that may contain a dust or aerosol signal. Satellite data of aerosol generally fall into two categories: satellite derived aerosol retrieval products and satellite radiances affected by aerosol. An example of the former category is satellite retrieved aerosol optical depth (AOD; e.g., Hsu et al. 2006, Levy et al. 2013, Remer et al. 2013). Channel differencing of infrared brightness temperatures, ABI Tb(10.35 μm) - Tb(12.3 μm), discussed in this manuscript belongs to the latter category. For both the retrieved products and the satellite radiances, a forward operator is required for the assimilation of data into an NWP model. In particular, an accurate and fast radiative transfer model is critical for enabling direct assimilation of satellite radiances (Weng, 2007).

Relevant assimilation references that were also removed:

Hsu, N. C., Tsay, S. C., King, M. D. and Herman, J. R.: Deep Blue retrievals of Asian aerosol properties during ACE-Asia, IEEE Trans. Geosci. Remote Sens., 44(11), 3180–3195, doi:10.1109/TGRS.2006.879540, 2006.

Levy, R. C., Mattoo, S., Munchak, L. A., Remer, L. A., Sayer, A. M., Patadia, F. and Hsu, N. C.: The Collection 6 MODIS aerosol products over land and ocean, Atmos. Meas. Tech., 6(11),

2989–3034, doi:10.5194/amt-6-2989-2013, 2013.

Liu, Z., Liu, Q., Lin, H. C., Schwartz, C. S., Lee, Y. H. and Wang, T.: Three-dimensional variational assimilation of MODIS aerosol optical depth: Implementation and application to a dust storm over East Asia, J. Geophys. Res. Atmos., 116(23), 1–19, doi:10.1029/2011JD016159, 2011.

Penny, S. G., Akella, S., Alves, O., Bishop, C., Buehner, M., Chevallier, M., Counillon, F., Draper, C., Frolov, S., Fujii, Y., Karspeck, A., Kumar, A., Laloyaux, P., Mahfouf, J.-F., Martin, M., Peña, M., Rosnay, P. de, Subramanian, A., Tardif, R., Wang, Y. and Wu, X.: Coupled Data Assimilation for Integrated Earth System Analysis and Prediction: Goals, Challenges and Recommendations. [online] Available from: https://www.wmo.int/pages/prog/arep/wwrp/new/documents/Final_WWRP_2017_3_27_July.pdf, 2017.

Remer, L. A., Mattoo, S., Levy, R. C. and Munchak, L. A.: MODIS 3 km aerosol product: Algorithm and global perspective, Atmos. Meas. Tech., 6(7), 1829–1844, doi:10.5194/amt-6-1829-2013, 2013.

Sekiyama, T. T., Tanaka, T. Y., Shimizu, A. and Miyoshi, T.: Data assimilation of CALIPSO aerosol observations, Atmos. Chem. Phys., 10(1), 39–49, doi:10.5194/acp-10-39-2010, 2010.

Weng, F.: Advances in Radiative Transfer Modeling in Support of Satellite Data Assimilation, J. Atmos. Sci., 64(11), 3799–3807, doi:10.1175/2007JAS2112.1, 2007.

Zupanski, M.: Data Assimilation for Coupled Modeling Systems, in Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications, vol. III, edited by S.-K. Park and L. Xu, pp. 1–553, Springer-Verlag Berlin Heidelberg., 2017.

I also removed the following third paragraph from the NWS section:

Being that the mission of the National Weather Service is to provide forecasts and warnings for the protection of life and property, it is vital that NWS meteorologists maintain situational awareness of the development and evolution of a SAL and associated EML as both can quickly jeopardize this mission if overlooked. That is, knowledge of SAL allows NWS meteorologists over South Florida to perform a better diagnosis of the mesoscale environment prior to the onset of cumulus convection. Lower and middle-tropospheric thermodynamic structures, which accompany a SAL, may often be missed by forecast models. An important consequence is for

operational meteorologists to utilize the latest observational capabilities that allow for the identification and tracking of suspended mixed-layer dust plumes.

2. The paper discussed a lot of detailed aspects of infrared detection of dust, while most of them are very useful I think some content is not the main focus of this study and can be cut down. For instance, the discussion about whether air temperatures can explain the lateral changes in Tbs can be shortened (lines 19-24, page 13, lines 6-17, page 14), since the main hypothesis is that total precipitable water plays a major role.

I have to disagree. Values of Tbs for water vapor imagery are influenced by both water vapor and temperature. My goal with the discussion is to demonstrate to a reader that horizontal variations of temperature are unable to explain horizontal variations of values of Tbs of water vapor imagery. Consequently, the text focuses on horizontal variations of water vapor to explain horizontal variations of values of Tbs.

3. Can you add some discussion about whether smoke may affect the detection of dust in the south region (along the black dashed line) in channel difference in Fig. 5?

Yes, such a discussion can only benefit a reader. Consequently, the following text was as the fourth paragraph after Fig. 7:

In addition to dust, smoke from biomass burning over Africa (Fig. 3) existed within the SDR. One open question is that smoke may impact values of Tb(10.35 μm) - Tb(12.3 μm) in such a way as to mask the dust in the SDR. Based on previous satellite observations, Hillger and Ellrod (2003) have shown that if a layer of smoke is optically thick enough in infrared bands, Tbs of smoke will appear cool. However, cool Tbs associated with smoke may be confused with cool, elevated, land surfaces. Further, smoke layers were undetected in values of infrared channel differences. As part of a discussion of the utility of the day-night band on the VIIRS sensor, Miller et al. (2013) also point out the inability of smoke detection by infrared satellite imagery. One consequence of these two studies suggests that smoke within the SDR, was unable to mask dust in the SDR. Another mechanism for dust masking in the SDR is sought.

Minor comments:

1. Which color indicates the negative value in Fig. 7a, light blue?
Fig. 7a is a True-Color image from three reflective bands from VIIRS. As such, there are no negative values. Perhaps you meant Fig. 7b; in this case, the color table for Fig. 7b is the same as that in Fig. 5. Negative values are light blue.

2. Is it possible to enlarge the font size of labels in Fig. 17? Can you add the information about green, white, red contours in the figure caption?

Fig. 17 has been cleaned up a bit. Extra lines that represented a lifted parcel have been removed as the temperature and dewpoint temperature difference is the main focus of both NUCAPS soundings. Pressure level values were increased as were the mixing ratio and temperature values on the horizontal axis. Now one can focus on the T-Td spread in sounding 1 and 2.

3. Lines 16 and 18, acronyms NRD and SRD are used but later NDR and SDR are used.

You have eyes of an Eagle: I changed NRD and SRD to NDR and SDR; respectively.

Kind Regards,

Louie