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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Predicting decadal trends in cloud droplet number concentration using reanalysis and satellite data" *by* Daniel T. McCoy et al.

Anonymous Referee #2

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General comments

In this paper, the authors used the filtered MODIS level 2 swath data which considered only low liquid clouds (cloud tops below 3.2 km) to calculate the daily-mean CDNC at 1°x1° resolution with the approach introduced in their previous work (McCoy et al., JGR, 2017). Then they validated their CDNC date set by comparing with aircraft measurements from the Antarctic Peninsula, Northern China, and the Peruvian and Californian stratocumulus decks. The comparison shown that the correlation between aircraft and satellite observations can be high up to 0.68. With multiple linear regression between MODIS CDNC and MERRA2 reanalysis masses of sulfate, black carbon,

organic carbon, sea salt, and dust at 910 hPa model level, the authors found CDNC across many different regimes can be reproduced by a simple power law fit to near-surface sulfate, with smaller contributions from other aerosols. Their investigation also indicated that decadal time scale reduction of CDNC over Asia and North America is agreed with the reduction of OMI observed SO2 over the same regions due to emission controls. This paper is well organized and presented. It is a good application and expansion of the work of McCoy et al., JGR, 2017.

Special comments

Page1Line1: The authors filtered MODIS L2 data set with low liquid clouds assumption. Therefore, 'low cloud droplet number concentration' is better than just say 'cloud droplet number concentration'.

Page2Line14-16: How do the authors average these daily time scale data set to the multi-year mean as shown in Figure 1?

Page2Line26-27: Could the authors provide brief descriptions on how the effective radius and optical depth values are retrieved by MODIS.

Page3Line5: Do the values of cloud fraction in MERRA2 also exceed 80% at the grids where MODIS cloud fractions exceed 80%?

Page3Line8-10: Is MODIS AOD used for nudging MERRA2 aerosol emission or mass loading?

Page4Line16-19: Validation of MODIS CDNC with aircraft measurement is important. Can the authors provide the data set of aircraft measurement employed in this study? What are the major differences of CDNC from McCoy et al., JGR, 2017 and CDNC from Bennartz and Rausch, ACP, 2017 comparing to aircraft measurement?

Page5Line26-27: As discussed by the authors previously, the coefficients in table 1 can be varied at different regions due to different atmospheric chemistry and physics processes. It is well known that atmospheric chemistry and physics processes also

be impacted by seasonal changes of emission and atmospheric environment. How do these factors impact the authors' conclusion?

Page7Line8: Please add space between 'OMI' and '('.

Page7Line16-17: There are numbers of significant disagreements of OMI SO2 peaks and MODIS CDNC peaks. More detailed discussions and explanations are requested here.

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