Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-110-RC1, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Intra-annual variations of regional aerosol optical depth, vertical distribution, and particle types from multiple satellite and ground-based observational datasets" *by* Bin Zhao et al.

Anonymous Referee #1

Received and published: 8 May 2018

Aerosol radiative effect is a hot topic in the science community, which is dependent on the aerosol optical properties, size distribution, aerosol types, and their vertical distribution. While many studies have examined the seasonal and diurnal variations of aerosols, few studies have examined the vertical distributions of aerosol amount and types, which can strongly affect the aerosol radiative effect and corresponding thermal impacts on the profiles of temperature. Using multi-satellite observations along with the surface observations of aerosols, this study examines the the seasonal and diurnal variations of aerosol column loading, vertical distribution, and particle types over

three populous regions: the Eastern United States (EUS), Western Europe (WEU), and Eastern and Central China (ECC). Interesting statistical characteristics about the dominant aerosol types and vertical distributions have been obtained. The paper is also organized and written well.

Detailed Comments:

Line 45-48: I am not sure if the climate effects of CO2 also depends on its intra-annual variability, particularly considering the higher outgoing longwave radiation from surface in summer than in winter.

Line 49-54: Not only the scattering and absorption properties, but also the size distribution and vertical distribution of aerosols can also cause problems. Zheng et al. (2017, ACP) have shown that the vertical distribution of AOD could have strong impacts on the aerosol concentration (mass concentration) within PBL, which directly affect cloud properties and then change cloud radiative forcing. Garrett et al. (2004, GRL) showed that nucleation mode aerosols and accumulation mode aerosols have very different scattering radiative effects.

Line 54-58: Besides to the TOA radiative balance, convective clouds development, absorptive and non-absorptive aerosols have different impacts on the surface radiative cooling effects, as shown by Yang et al. (2016, JGR) which demonstrated that more absorptive aerosol can cause more surface cooling effects.

Line 59-63: The vertical distributions are also important for aerosol-cloud interaction since only the aerosols near cloud bases have strong interaction with cloud properties. Zhao et al. (2018, Earth and Space Science) showed Twomey effect using in-situ aircraft observations in East China instead of anti-Twomey effect found using column aerosols based on satellite observations.

Line 101-103: You may indicate the data observation time, such as day time and night time.

Line 158: I would suggest “variations of AODs with heights below 200 m”

Line 162-167: The different time representation errors could be noticeable for monthly average. For example, Wang and Zhao (2017, JGR) showed that the MODIS cloud time representation errors could be up to 3-4% for monthly average (10 years data) while much smaller for yearly average and much larger for daily average. However, this might not affect the findings/conclusions of this study. You may simply indicate/inform the noticeable time representation error of 3-4% (Wang and Zhao, 2017) while what they studied are cloud coverage instead of aerosols.

Line 267-269: I highly agree with this analysis. By doing this, the effects of PBL and relative humidity could be minimized.

Line 303-304: Yang et al. (2018, AR) also showed the winter vs summer patterns (high in winter, low in summer) of inter-regional transport (between pearl river delta and Hongkong) of aerosols; Garrett et al. (2010, Tellus B) also showed the strong transport in winter and weak transport in fall for aerosols from mid-latitudes to Arctic. Actually, the vertical distribution of aerosols is very interesting in the Arctic, with high values at heights around 2-7 km, mainly caused by long-range transport from other regions such as mid-latitudes.

Line 374, acts -> act, strengthens -> strengthen

Line 400-405, Since AOD includes the impacts of relative humidity, is it possible that relative humidity also contributes to the diurnal variation of AOD? Another possible contribution might be the growth of fine aerosols, as indicated by Zhao et al. (2018, AAS), the growth rates of fine mode aerosols generally starts from the morning time with a growth rate of around 2-7 nm/hour (1.7-6.5 nm/hour near Beijing region in summer). They could become accumulation mode from fine mode aerosols at night time or on next day (then day time) making AOD larger.

Line 462-465: I agree that absorbing aerosols could play different roles to convection

and clouds from non-absorbing aerosols. However, I think both absorbing aerosols and non-absorbing aerosols will reduce the direct solar radiation reaching the surface, causing surface cooler and further affect convection and clouds in similar way (of course, no absorption of solar radiation in the air), while the effects could be weaker than absorbing aerosols.

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