Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-765-AC1, 2018

Atmospheric Chemistry and Physics Discussions

ACPD

Interactive comment

Interactive comment on "Relationship between Asian monsoon strength and transport of surface aerosols to the Asian Tropopause Aerosol Layer (ATAL): Interannual variability and decadal changes" *by* Cheng Yuan et al.

Cheng Yuan et al.

yc90625@gmail.com

Received and published: 11 November 2018

Anonymous Referee #3 Received and published: 16 October 2018

This study utilizes the MERRA2 reanalysis data to explore the influence of the Asian monsoon system on the Asian aerosol layer near UTLS. The topic is important, as aerosols in such high altitude likely get involved in the long-range transports and exert radiative impacts over the other regions around the world. It is also the first time to exploit MERRA2 in such a topic, even though the uncertainty of MERRA2 aerosol product remains to be gauged. The main finding about stronger Asian monsoon resulting in more abundant aerosols near UTLS reveals the relative importance of two competing mechanisms, i.e. the enlarged convective transport and enhanced precipitation washout in those stronger monsoon years. Therefore, I recommend accepting the manuscript by ACP pending minor revisions.

1) One caveat of using MERRA2 aerosol product is its simplistic treatment of aerosol mixing state in its aerosol model GOCART, as GOCART assumes all aerosol types are externally mixed. Recent modeling studies [e.g. Wang et al., 2018, JAMES] have suggested that the mixing state and aerosol aging processes in GCM or CTM can largely change the aerosol lifetime, and consequently affect the amount of aerosols lifted to UTLS. Recent aerosol optical measurements further supported that even mineral dust can be coated by a significant amount of anthropogenic aerosols over East Asia [Tian et al., 2018, ACP]. Therefore, such a caveat in data and possible implications should be discussed in the paper.

Response: We are grateful for your helpful suggestions. We have carefully read these papers provided by you and add some words and these two references acknowledging the related issues dear to the aerosol communities in the last paragraph. "Moreover, recent modeling studies have suggested that the mixing state and aging processes can largely change the aerosol lifetime during simulation, and consequently affect the amount of aerosols lifted to UTLS, and some optical measurements further support that dust aerosol can be coated by anthropogenic aerosols over East Asia and then significantly enhance absorbing ability (Wang et al., 2018, Tian et al., 2018)."

2) Fig. 2a, the differences between red and blue contour lines are not clear. Can you find a better way to present them? Simply plot the differences of Z100? Fig. 2b is too small to see the details. Please consider to enlarge it.

Response: Figure 2 is plotted to simply present the AMA in strong monsoon years are stronger and northward shifted than that in weak monsoon years. Differences of geopotential height at Z100 has been plotted in Figure 4b, 4d, and 4f. For Figure 2b, we have changed the composition to make it larger. The updated Figure 2 has been attached.

3) For the interannual variability. I think the monsoon strength is definitely linked with some other climate natural variability, such as ENSO. It would be interesting to see some correlation analyses between the AMA strength, aerosol loading, and some natural variability indices, and trend analyses after those natural variabilities get removed.

Response: The strength of monsoon should be linked with some other climate natural variabilities, especially in the long-term scale. ENSO, being a major source of IAV for the monsoon, will certainly contribute to the strength and weakness of the monsoon, as well as aerosol emission, loading, distribution (through winds and precipitation) in monsoon regions. However, this is not the focus of this paper. This paper is focused on the relationship between monsoon strengths, the transport of aerosols from the surface to the ATAL, on interannual to decadal times scales, thus the objective of this paper is not on "what causes the IAV of the monsoon", but rather on "how monsoon IAV can affect aerosol loading and transport to the ATAL". There are others who are already doing research along this line, such as,

Kim, M. K., Lau, W. K. M., Kim, K. M., Sang, J., Kim, Y. H., and Lee, W. S.: Amplification of ENSO effects on Indian summer monsoon by absorbing aerosols, Climate Dynamics, 46, 2657-2671, 10.1007/s00382-015-2722-y, 2016.

Abish, B., and Mohanakumar, K.: Absorbing aerosol variability over the Indian subcontinent and its increasing dependence on ENSO, Global and Planetary Change, 106, 13-19, https://doi.org/10.1016/j.gloplacha.2013.02.007, 2013.

We use only 15 years data here and it may not be sufficient for studying the long-term variabilities (normally they use decades of years data). Also, with such limited data, it is not easy to separate the effect from short- or long-term natural variability. In the following research, we will expand our data and tried to do a separated research focusing on the long-term monsoon (such as ENSO) variabilities affecting the ATAL formation.

4) L114-115, it should be pointed out that this sentence cannot be applied to Fig. 1 as the anomaly definition there is different with the other plots.

Response: We have added some words in this sentence in order to avoid misleading. The sentence has been changed to ’Henceforth, the term “anomaly” in the following parts refers to the difference between SM and WM composites (SM minus WM).’

5) Some typos: L105, annual mean L159, over the western sector

Response: All of the typos have been corrected.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-765, 2018.

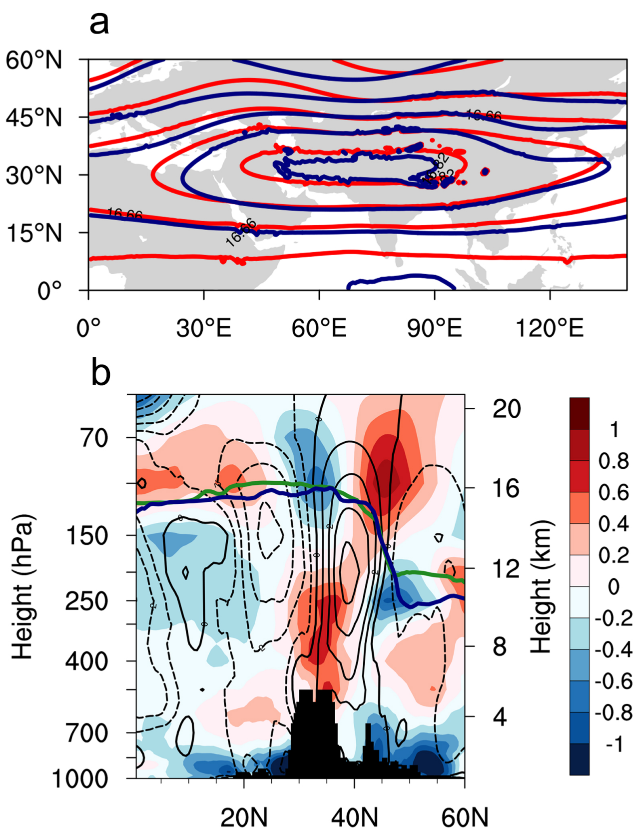

Fig. 1. Updated Figure 2

Printer-friendly version

Discussion paper