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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Strong variability of the Asian Tropopause Aerosol Layer (ATAL) in August 2016 at the Himalayan foothills" *by* Sreeharsha Hanumanthu et al.

Anonymous Referee #2

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Review of "Strong Variability of the Asian Tropopause Aerosol Layer at the foothills of the Himalayan" by Hanumanthu et al., 2020.

Understanding the nature, origin and impacts of the Asian Tropopause Aerosol Layer has been a research focus for nearly a decade. Recent airborne campaigns conducted in Asia during the Summer Monsoons have provided a wealth of information about the ATAL that are rapidly advancing our understanding of this phenomenon. As a part of the StratoClim field experiment that took place in Nepal and India in 2017, this study present results from the balloon flights conducted from Nainatal in August 2017 compared with those obtained in November 2016. The balloon flights reveal an impor-

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tant day-to-day variability of the Scattering Ratio (SR) taken as a relative measure of aerosol loadings. In order to understand the causes of those fluctuations, the authors run the CLAMS trajectory model to distinguish the origin of air masses in the Boundary Layer, the free troposphere and the lower stratosphere from different part of Asia. They concluded that large SR values within the ATAL tend to be associated with air masses from the Tibetan plateau, Himalayan foothills and lands while oceanic origin tend to result in a depletion of UTLS aerosols. Despite some grammatical mistakes and relatively lengthy manuscript, which could be, shorten and better summarize, this is an interesting study, which merits its publication in ACP. However, I suggest significant revisions to make this possible. Because deep convection is a fundamental transport pathways for air mass to move from the Boundary Layer into the Upper Troposphere and Lower Stratosphere during the Monsoon, the coarse resolution of the meteorological field used to run CLAMS likely result in misrepresentation of the vertical transport pathways especially after a few days when the likelihood of encountering deep convection is very high. The manuscript lacks a deeper analysis of the role of convective storms that influence the vertical transport of air masses and those measurements. Other studies have used Cloud Top Temperature as a proxy for deep convection to find out the location where air masses are influenced by deep convection and I believe that this study would need to adopt a similar approach to be more convincing. Below are additional technical comments of this paper that the authors may want to consider:

1) Title. I'm not sure the title translate very well the topics of this paper. Moreover, the term "strong variability" is confusing if not related to time information (in this case day-to-day or intraseasonal variability). 2) P1/L3. I believe that "inside" is not required. It's understood from the previous part of the sentence. 3) P1/L7. "COBALD" does not need to be repeated here. It could be replaced by "compared to those obtained. . ." 4) P1/L12-L13. Not "composition" but scattering ratio. 5) P1/L18-21. This is related to the major comment I have on this study. How realistic is the vertical transport pathway described here relative to direct injection by deep convection ? 6) P2/L5. Chinese emissions have decreased drastically over the past 2 decades so Sulfur emission in Asia

are overall on the decreasing side so this sentence needs to be modified. 7) P2/L9-L11. I would argue that Chinese balloon-borne measurements and ground-based lidar suggested the presence of aerosol layers over the Tibetan Plateau earlier than satellite observations but the extension of the ATAL was indeed discovered through global satellite observations. Refs : Kim, Y.-S., T. Shibata, Y. Iwasaka, G. Shi, X. Zhou, K. Tamura, and T. Ohashi, 2003: Enhancements of aerosols near the cold tropopause in summer over Tibetan Plateau: Lidar and balloonborne measurements in 1999 at Lhasa, Tibet, China. Lidar Remote Sensing for Industry and Environment Monitoring III, U. N. Singh, T. Itabe, and Z. Liu, Eds., Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings, Vol. 4893), 496–503, https://doi .org/10.1117/12.466090. Tobo, Y., Y. Iwasaka, G.-Y. Shi, Y.-S. Kim, T. Ohashi, K. Tamura, and D. Zhang, 2007: Balloon-borne observations of high aerosol concentrations near the summertime tropopause over the Tibetan Plateau. Atmos. Res., 84, 233–241

8) P2/L17. This sentence needs to be more accurately stated. The paper did not suggest the presence of the ATAL in the 90's but the presence of ammonium nitrate and since we do not know the overall contribution of AN within the ATAL, It's hard to formalize a general statement such as the one here. I suggest being more accurate. 9) P2/L26-27. I would suggest targeting the citations that are most appropriate for this statement. 10) P3/L12. I would suggest being quantitative in this sentence. What are the contributions from India and China? 11) P3/L21. Could you explain why the results seem to be consistent with Brunamunti et al., 2018 ? 12) P4/L4. Is there a reference for those estimates? 13) Overall, the introduction could be improved by organizing the different paragraph with titles. 14) P5/L9. A reference to Pandit et al., 2015 could be added here . Ref: Pandit, A. K., Gadhavi, H. S., Venkat Ratnam, M., Raghunath, K., Rao, S. V. B., and Jayaraman, A.: Long-term trend analysis and climatology of tropical cirrus clouds using 16 years of lidar data set over Southern India, Atmos. Chem. Phys., 15, 13833–13848, https://doi.org/10.5194/acp-15-13833-2015, 2015. 15) P6/L4. A calibration adjustment is needed to fit the COBALD raw signal to the molecular scattering. A few lines describing a little better the procedure

could be added here. 16) P6L16. If I'm not mistaken IST=UTC+5h30...(not 6h). 17) P6.L30. You probably mean to say "we identify ice clouds with...." 18) P9L14. Aerosol scavenging also depends on aerosol size and composition, which affect their ability to uptake water. 19) P13L19. How trustable are trajectories run beyond a week ? 20) P14. Table 2 needs to be better explained. What's the definition of the variable in the table? Residence time in a given layer relative to the sum? 21) P30. Figure 15. Why do you choose to take the mean value? I would suggest to plot the same with the value corresponding to the altitude where the model was initialized 22) Figure 15. What are the correlation coefficient values? I'm not sure if you can draw much conclusions from this plot apart overall tendency. 23) P31/L17. This phrase needs to be nuanced. While it is true that the signal-to-noise ratio from the CALIPSO space-borne lidar does not allow studying day-to-day variability of the ATAL, observations from SAGE II/SAGEIII can be potentially used for that. 24) P31/L24. I don't think the impact of convection, which is not well represented in ERA-Interim, has been fully explored and thus must bias most of the trajectory results presented in this paper.

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