

Interactive comment on “Sub-seasonal Variability in the Boundary Layer Sources for Transport into the Tropopause Layer in the Asian Monsoon Region” by Bin Chen et al.

Anonymous Referee #3

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This study presents detailed analyses on the transport source regions from the boundary layer in to the tropopause layer in the Asian summer monsoon region. A Lagrangian trajectory model simulations of more than 10 years are used to identify regions with most frequent boundary layer to tropopause layer transport. Sub-seasonal variabilities of statistics of vertical transport were also explored in detail. The results presented in this study are considered to be of interest among extended scientific community. I have a number of comments and suggestions for the authors might take into consideration.

General Comments

- The goal of this study needs to be mentioned explicitly. I am not sure if the trajectory simulations were aimed at looking at the vertical transport from the boundary layer in

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to the upper troposphere in general or in to the Anticyclone. What do the trajectory simulations and their statistics represent in this study? The results seem to be based on the frequency of vertical transport from the boundary later in to the tropopause layer over a broad region instead of Asian summer monsoon anticyclone itself. I think the authors need to explain what physical processes they are going to focus on and why the trajectory model is a useful tool to use answer their questions.

- Regarding making connections between the physical processes, the authors claim that persistent deep convection over Bay of Bengal is responsible for the vertical transport. And yet, there is no evidence supporting this argument. Without showing a map of convection and its temporal variability over the monsoon region, this statement has no significance.

- Regarding the FLEXPART model simulations used in this study, there are fundamental questions to be answered before the results can be discussed. Those include, 1) What are the fundamental differences between 'tracer-independent' and 'tracer-based' analyses? What are the caveats of 'tracer-independent' method? 2) What is '3D labeling technique'? 3) What is the difference between 'kinematic' versus 'adiabatic' trajectory analysis? 4) How are the BL sources are defined and initialized? 5) How does the model handle deep convection? Is it parameterized? Those should be explained sufficiently to support the results of trajectory model simulations presented here.

- In my opinion, it should be mentioned explicitly that 'tracer-independent' method has its own limitations. If there are no surface sources where the vertical transport occurs, it would make no contribution to the upper tropospheric chemical environment.

- It is not clear the three source regions, e.g., Northern India, Tibetan Plateau, and the southern slopes of Himalayas, are emphasized in this study. I would recommend putting more focus on those regions instead of describing details over multiple geographical regions.

- Three questions listed in introduction have not been answered. The authors might

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want to revisit those questions in conclusion.

- It would be helpful to include figures of actual trajectories especially over the regions where most frequent transport is occurring.
- It is hard to draw conclusions based on the EOF analyses alone without showing physical patterns of the variabilities. What are the physical processes underneath those statistical analyses?

Specific Comments

- Why the summer season is defined as May-July instead of May-Aug or Jun-Aug?
- It is unclear if the analyses period is either 2001-2013 or 2000-2013.
- P2 (L10) – population in the world [reference needed].
- P2 (L19) – meteorologists -> scientists
- P3 (L1-2) – Citations must be organized chronologically.
- P3 (L12-16) – This is a vague statement. It would be helpful to give more specific information or avoid listing all the things one can possibly think of.
- P3 (L21) – In Park et al. (2009), lack of surface emissions and also shallower convection over the Tibetan Plateau may have been mentioned.
- P6 (L2) – Long-range mesoscale transport does not sound right. Long-range transport should be a large scale and mesoscale transport does not represent long-range.
- Why is the model domain restricted to 0-60N latitudes and 0-160E longitudes? And the BL source regions are chosen between 0-50N and 20-160E, which seems rather subjective. The model run is performed from April to August but only the results between May and July have been shown most of the cases. Why is that? It is not clear how the convection is parameterized or represented in the model.
- P7 (L9-10) – What is the reason for using both the dynamical and thermal tropopause

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definitions here?

- P8 (L10-12) – A verb is missing in this sentence.
- P8 (L14) – I wonder how many total cases are there and why 50 high and low cases were chosen. Is this statistically significant?
- Fig. 1 shows both the coefficient of variance (CV) and variance. In my understanding, CV is variance divided by the mean. So, the regions with small CV represent larger mean values. I am not sure how to interpret this result.
- Fig. 1 – Thickness of the black dashed line can be increased for better representation of the region (also in Fig. 2 as well).
- P10 (L5) – ECMWF interim -> ERA interim?
- P10 (L19-20) – that are only infrequently sources -> needs to rewrite this.
- P10 (L22) – Figs. 2a and 2b -> Figs. 1a and 1b
- P11 (L6-7) – This annual variability... of the ASM -> I think there needs to be a reference to this sentence. Does annual variability refer to interannual variability or seasonal variability?
- Fig. 3 (bottom) – Is the time step every 4 days? Maybe longer time steps (fewer data points) can be used to simplify this figure. Also, what do the notable peaks in each year's time series (top panel) represent? Do they represent more frequent transport? What are they correlated with?
- P12 (L2-7) – What do the authors think the reason is for those seasonal differences in the air mass transport?
- P12 (L16) – What do 'net masses' mean?
- P12 (L20) – maximum relative contribution -> maximum contribution
- P13 (L11-12) – This decrease... this region -> A figure or reference is needed to

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support this.

- P13 (L12) – He et al. (2007) should be cited at the end of this sentence.
- P13 (L15-19) – Without showing figures of convection or references, this statement has no basis.
- Fig. 7a – There are only a few years showing 90% power. This does not represent climatological features.
- Fig. 8 – I am not convinced with the results shown here. First, the total variance explained by the three leading EOFs are only 37.1 %. Second, the PC1 seems to represent annual cycle with some added interannual variability. I am not sure how to interpret this result.
- P15 (L24) – I see a dominant negative variability instead of obviously positive values in Bay of Bengal in Fig. 8.
- P16 (L5) – EOFs -> EOF3
- P16 (L12-17) – This paragraph is somewhat confusing to me. I am not sure what the authors try to say. Should we believe the EOF results here or not?
- P17 (L2-5) – This is a vague statement. What is the hypothesis based on? Why do authors think high versus low PCs explain controlling mechanisms to some extent?
- P17 (L10-11) – Northeastern Korea (Fig. 9b) -> I am not sure where the signal is located on the map?
- P17 (L13) – The deep convection (represented by OLR anomalies) are
- P17 (L15-16) – These areas of. . .summer monsoon. -> This has not shown anywhere in the paper.
- P18 (L4) – large deep convection differences -> I am not sure what this sentence means.

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- P18 (L10) – This region is overlaps -> This region overlaps
- Section 4 (conclusion) – This section needs to be rewritten for clarity. It might be better to focus on fewer geographic regions as well.
- P19 (L22) – We hope that the results of this study will provide some clarification of the. . .-> We believe the results in this study has provided clarification of the. . .

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