

## ***Interactive comment on “Quantifying pollution transport from the Asian monsoon anticyclone into the lower stratosphere” by Felix Ploeger et al.***

### **Anonymous Referee #1**

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The paper explores the transport of air inside the Asian monsoon anticyclone into the stratosphere using a Lagrangian chemistry transport model. Some results are compared to satellite observations of HCN from ACE-FTS and CO from MLS. The results suggest two pathways of transport from the core of the anticyclone into the extratropical and tropical stratosphere. The transport of pollutants into the stratosphere is a topic of high relevance, the methods and the data employed in the paper are adequate, and the paper is nicely written and easy to follow. However, there are a few fundamental issues that should be addressed before the paper is published, listed below.

### *General comments*

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1) The authors argue that they identify a vertical pathway across the tropopause. However, since the initialization of the origin tracer (370-380 K) is not explicitly limited to the troposphere, the derived conclusions regarding cross-tropopause transport are not rigorous. The authors should discuss the position of the initialized tracer relative to the tropopause and analyze the sensitivity of their results to the initial location chosen.

2) It would notably improve the paper if a figure similar to Figure 4 but for CO concentrations were included, comparing the model to the observations. Alternatively, a figure similar to the lower panels of Fig. 3 extended to show CO and the origin tracer on additional levels relative to the tropopause (e.g. up to 50 K above the tropopause). Any of these suggested figures would highlight the differences and similarities between CO and the origin tracer (are they due only to the CO lifetime?), provide further confirmation of the correct representation of transport in the model, and facilitate the comparison of the results with previous works.

3) Figure 2 calls for a more detailed explanation of the large variability in the time series (divided by a factor of 4 in the Figure). In particular, it is unclear to the reader how the standard deviations are defined (with respect to the various years or for each longitude point within each latitudinal band?). This is an important point, because the validity of the conclusions on the seasonality is questioned given the large variability around the time series, and thus it needs to be clarified exactly what the spread represents.

### *Minor comments*

P3L11-18: A description of the data the temporal and spatial resolution should be included, to help the reader understand how the data is employed for the model

C2

comparisons. For example, ACE-FTS data does not allow high-temporally resolved comparison as that in Fig. 4.

P3L25: In Fig. 1d (AMJ) there is little agreement between the model and the observations in the NH. Could you comment on why this might be the case?

P3L26: In Fig. 1a there is a maximum of HCN in the tropical pipe, but no corresponding maximum in the origin tracer. Is this associated with the ascent from the year before?

P3L2-3: It is not clear what you refer to. Could you refer to specific contours?

P3L15: How do you define the lower edge of the tropical pipe?

P3L20: I don't see in Fig. 2 that "the anticyclone air exceeds the extra-tropical amount by half a year". Do you mean that from February until the next summer the tropical and extra-tropical monsoon air mass fractions are approximately equal?

P4L21-24: As mentioned in the major comment 3), a clarification on how the variability is computed and what it implies for the conclusions on the seasonality is needed.

P5L11: "cross-tropopause transport into the stratosphere in the monsoon occurs to a large degree in the vertical direction". You could actually quantify to what degree this happens. This is in line with major comment 2), suggesting a more detailed analysis of CO behavior relative to the tropopause, in the model and the observations.

P6L20: How is this related to the vertical conduit from the boundary layer?

#### *Technical corrections/suggestions*

P1L9: emissions → pollutants

P2L11: tracer-independent

P2L16: "and argue that in terms of air mass transport into the stratosphere, the Asian monsoon. . ."

P2L23-26: I would recommend introducing the tracer here rather than at the Appendix. Specifically mention that it is defined as unity inside the monsoon anticyclone.

P2L31-32: Here and throughout the paper, PV-value and PV-gradient do not need a

C3

hyphen.

Fig. 1: Perhaps the hatching could be removed, as it is hard to distinguish the colors underneath.

Fig. 2: There is a typo either in the legend or in the figure caption, is the level 450 Kor 460 K? Also, the lines are not grey as the caption says, but black.

P5L9: tropopause-based

P5L29: Is it really controversial or just a scientific debate?

P6L10: This does not discard isentropic advection

P6L16: emissions → pollutants

Figure 5: Please add a colorbar.

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C4