

## ***Interactive comment on “Transport mechanisms for synoptic, seasonal and interannual SF<sub>6</sub> variations in troposphere” by P. K. Patra et al.***

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General Comments: This paper compares simulations of SF<sub>6</sub> from an online ACTM with continuous measurements at 6 surface sites and diagnoses the model transport mechanisms responsible for SF<sub>6</sub> variations on different timescales. The purpose is to use a tracer with simple emissions to assess the validity of the model transport for applications such as inverse modeling of CO<sub>2</sub>. The paper is generally well-written and deserving of publication in ACP. The analysis of the model transport components and their contribution to SF<sub>6</sub> variability is the key unique feature of this paper.

There are two important points that should be addressed by the authors prior to publication. The first is that while the section on the mean age of air in troposphere provides an interesting analysis of the model transport timescales, the relevance of the mean

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age to SF6 transport and variability is never discussed. For example, there is an extensive discussion in Section 3.2 of the mixing barriers along the equatorward edges of the subtropical jet streams, as well as their seasonal behavior. Yet there is no mention of how these mixing barriers impact the transport of SF6 and the seasonal variability in interhemispheric exchange. In Section 3.4, the authors do mention that the convective mass transport is limited to the top of the Hadley cells, which matches their finding of a large gradient in mean age in the Tropical Tropopause Layer, but even then there is no explicit tie-in to the age diagnostic. In general, the age analysis is underutilized with respect to SF6 transport and is not used to provide any insight beyond the analysis of transport components. I recommend that the authors combine the component analysis and the age diagnostic in discussing SF6 transport and variability. The second point that should be addressed is the inability of the model to capture the large increase in inter-hemispheric exchange time seen cases 1 (all stations) and 2(BRW,MLO,SPO,SMO) in the observations in April. The lack of an April peak in the model at the remote stations is particularly interesting, given that the exchange time calculated with the hemispheric mean mixing ratio clearly has a larger amplitude seasonal cycle. Which stations contribute the most to the April peak, and why is the model unable to reproduce the amplitude at those stations?

Specific Comments: Section 2.3 - What was the length of the mean age simulation?

Section 3.1 - Figures 2 and 3 are very low resolution and very difficult to read.

Section 3.2 - There is not enough contrast between the color contours on the lower half of the scale in Figure 3. This makes it hard to see the large age gradients that indicate mixing barriers. Again, there is no discussion of how the features in the age distribution affect SF6 transport. Since there are no vertical profiles of SF6 presented for direct comparison, this should probably be done as part of the discussion in Sections 3.4 and 3.5.

Section 3.3, P. 12749 lines 23-27 and P. 12750 lines 24-28 - Case 5 clearly has larger

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seasonal variability than Case 2 and is closer to the observed variability using the station data for Case 2. The transport component analysis could be used to diagnose the reason for the low variability in the exchange time seen in the model for these stations, and included as part of the discussion in Section 3.5.

Section 3.4, P. 12751 lines 22-24 The height limit for convection should be explicitly tied to the gradient in mean age.

Section 3.4, P. 12752 lines 19-27 How does the meridional advection relate to the mixing barriers diagnosed by the age tracer?

Technical Comments: P. 12742, lines 27,28 - the description of the decomposition of the time series is somewhat confusing because the minus signs are indistinguishable from the hyphens. The authors may consider substituting the word "minus" for "-".

P. 12750, line 28 - "Timming" should be corrected and "are" should be inserted in "maxima altered".

Supplement, Line 31 - Should read "shows a comparison of".

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