

## ***Interactive comment on “Long-range transport pathways of tropospheric source gases originating in Asia into the northern lower stratosphere during the Asian monsoon season 2012” by Bärbel Vogel et al.***

**Anonymous Referee #1**

Received and published: 19 July 2016

This paper presents an analysis of the evolution and transport of air with emission sources in the Asian monsoon region to the northern hemisphere extratropical lower stratosphere using primarily output from the Chemical Lagrangian Model of the Stratosphere (CLaMS) driven with winds from the ERA-Interim reanalysis. Aircraft observations are used to establish confidence in the model simulations and demonstrate linkages between transport signatures and air masses observed in the extratropical lower stratosphere downstream. The main conclusions of the study are that the air lofted into the Asian monsoon anticyclone is confined to the tropical upper troposphere during the monsoon season, but is transported poleward into the extratropical lower

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stratosphere during the breakup of the Asian monsoon anticyclone in early fall via mostly Rossby wave breaking events over the Pacific and Atlantic ocean basins. The paper is well-detailed, well-structured, and well-reasoned. I do not find any fundamental errors in the analysis or questionable claims in the attendant discussion, but I believe the paper will benefit from a bit more cohesion of arguments throughout and a bit more analysis of the seasonality of transport. I recommend that the paper be considered for publication after mostly minor revisions. My general and specific comments to help guide the revisions are provided below.

### **General Comments:**

1. The linkages between transport of the monsoon upper troposphere air to the extratropical lower stratosphere and poleward Rossby wave breaking downstream of the anticyclone are clearly established in the manuscript. However, I feel the authors miss an opportunity to strengthen these points as their analysis expands in the latter part of the paper. Namely, the recent climatological studies of Rossby wave breaking cited in the paper provide support for the observed seasonality and timing of “flooding” of moist monsoon air into the extratropical lower stratosphere and for the dominant locations of poleward wave breaking events pointed out in Figure 16. Such additional detail on these linkages will provide better continuity in the Results section and strengthen the presentation and discussion of the conceptual model given in Figure 16.
2. While the authors do a good job of including observational support for the model results with analysis of a few flights during the TACTS/ESMVal campaign, a more thorough test of the CLaMS model (particularly related to the influence of Asian monsoon air on extratropical lower stratosphere water vapor – i.e., Figure 15) using the same chemical dataset that was used for initialization – Aura MLS – is requested. Is the enhancement in extratropical lower stratosphere water vapor

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at 380 K following breakup of the Asian monsoon anticyclone an observed characteristic? I expect this is a straight-forward test of the model and would go a long way in strengthening the perceived impact of this paper. If not an observed characteristic, this is a questionable result.

3. The naming convention for emission sources outside of the Asian monsoon region is inconsistent in the text and Figures of the manuscript. While the use of “residual” is common and seems to be the primary intention of the authors, “residue” appears in other places (e.g., Figures 5, 6, 14, and 15; Table 2; and Page 12, line 23; Page 12, line 29). Please update the text and figures to refer to this as “residual” throughout.
4. While the figures are (for the most part) visually appealing, an effort should be made to have the spacing, scaling, and text sizes consistent throughout. For example, the color bar labels run into the latitude axes in Figures 3 and 4, the cross-sections are misaligned in Figures 5 and 6, text sizes of the two panels in Figure 7 are different, the bottom panel is unnecessarily displaced from the top three in Figure 12, and the text sizes in Figures 14 and 15 are not legible at normal zoom.

### **Specific Comments:**

Page 1, line 7: “...jet such as the...” should be “jet such that the”

Page 1, lines 16-17: This statement is confusing here. This should be clarified to say that sources from Asia and the tropical Pacific account for ~1.5 ppmv of the ~5 ppmv mean in the extratropical lower stratosphere.

Page 2, line 3: “...is acting...” should be “...acts...”

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Page 3, lines 16-23: This discussion is limited to large-scale transport processes, correct? For example, we know that moist convection (apart from a large organized system like a typhoon) is capable of transporting air across the tropopause but such small-scale processes (though possibly represented to an extent) are not resolved in these models. A bit more detail and context should be given to clarify these points here, which you do reflect on near the end of the paper.

Page 3, line 27: “...are used...” should be “...is used...”

Page 4, line 14: “Measurements of...” should be “Measurements from...”

Page 6, line 30: “...occurs like for all...” should be “...occurs in an equivalent fashion to all...”

Page 7, line 20: “...as for...” should be “...to...”

Page 8, line 12: “...into stratosphere.” should be “...into the stratosphere.”

Page 8, lines 15-18: The Homeyer et al 2011 paper you cite can be referenced here as well.

Page 10, lines 11-12: What do you mean by this statement? It takes 5 weeks for the parcels to be transported from their surface emission locations to the lower stratosphere over Europe? This statement needs to be clarified a bit.

Page 10, lines 19-21: Based on the time series, No. 3 is an aircraft-only signature (i.e.,

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no apparent plume in the CLaMS simulation – at least not to me!).

Page 10, lines 26-18: But is this really dynamics of the AMA or of a downstream RWB event? You have already demonstrated that the latter is the reason this particular air mass crossed the tropopause, correct?

Page 10, line 35: “Northern Hemisphere” should be “stratosphere”

Page 11, line 22: Remove “these”

Page 12, line 25: “...masses on the...” should be “...masses to the...”, and “End October...” should be “End of October...”

Page 12, line 27: “Here, highest contributions are from tropical...” should be “Here, the highest contributions are from the tropical...”

Page 12, line 31: “This is in particular...” should be “This is particularly...”

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