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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A numerical process study on the rapid transport of stratospheric air down to the surface over western North America and the Tibetan Plateau" *by* Bojan Škerlak et al.

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General comments:

This is a very nice paper that presents a relatively high resolution modelling study (7 km horizontal grid spacing) of two cases of stratosphere to troposphere transport. In both cases stratospheric air descends down to the planetary boundary layer though the mechanisms leading to that descent differ for the two cases. The paper is clearly and concisely written and the results support the conclusions drawn. I recommend it for publishing subject to consideration of the following minor comments.

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Specific comments:

1. Abstract p1 L16: Here it says that that the surface concentrations reach peak values of 10-20% in both cases which raises the question '% of what'. Add 'of the imposed stratospheric value' or similar.

2. Although the focus of the study is on the processes leading to the transport of air from the stratosphere down to the boundary layer, rather than on the concentrations of tracer reached in the boundary layer, the paper would benefit from comparison of the concentrations found with those found in some of the comparable (i.e. using passive tracers) modelling studies referenced in the introduction to the paper. The papers referenced don't focus on transport down to the boundary layer, but it might be useful to compare the transport into the upper-troposphere with your study since this transport is an essential pre-requisite to the deeper transport.

3. Robustness of transport across tropopause: Related to the above comment, it would be useful to include some discussion as to the potential issues with the realism of the transport across the tropopause surface as this is likely to be strongly dependent on the vertical resolution and on the implicit (and any explicit) diffusion in the model (which may or may not be realistic). Presumably the tracer is initialised as a step function across the tropopause - the model would be unlikely to be able to retain this step function even in the absence of any 'physically realistic' transport. How does the tracer advection scheme differ from the advection scheme used for prognostic variables in the model?

4. Importance of convection: how important is convection in your case studies? The daytime growth of the boundary layer and associated turbulent mixing is key to transport in both cases, but there is no mention of the possible role of convective mixing (the type 4 mechanism in your Fig. 1). If convection does have a role in your case studies you might want to consider whether a convection-permitting simulation may yield more or less transport into the boundary layer. For example, we (Chagnon and

Gray, 2010: https://doi.org/10.1029/2010JD014421) found relative insensitivity to the explicit representation of convection. There was a reduction in the spatial extent in the tracer transported into the lower-troposphere. In one of the cases, a case with mid-level convection, there was a substantial increase in the total tracer transported to lower tropospheric levels with explicit convection (but very little difference for the other two cases).

Technical corrections:

1. p1 L21: change to 'studies have revealed'.

2. p2 L10: change to 'question of whether'.

3. p5, L11: The resolution will be several times ($\sim$6) that of the grid spacing which is the value you give here.

4. Fig 3-6: Labelling of geopotential height contours. I appreciate that the contour interval is included in the caption, but there is no indication of actual values. Can at least a few of the contours be labelled please?

5. Fig 5, right column panels: It would be nice if the domains of the cross sections could be extended to the left so that the start region of the layer of high stratospheric tracer concentrations could be determined.

6. p11, L19: Please move the statement about the relationship of local and UTC time from p14 L4 to here (where the text refers to the 'afternoon of 14 June').

7. p14, L32: correct typo 'advecction'.

8. p18, L10: add 'transport' after 'vertical'.

9. p18. Consider hyphenating 'horizontally-averaged' and 'vertically-confined' to aid readability.

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