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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantifying transport into the Arctic lowermost stratosphere" *by* A. Werner et al.

Anonymous Referee #2

Received and published: 24 February 2009

General comments:

This study uses aircraft measurements of long-lived species in order to quantify transport of air from the polar vortex, midlatitude lower stratosphere, and troposphere into the lowermost stratosphere based on a mass-balance calculation. While there are some studies in the literature showing that the polar vortex influences lowermost stratospheric air during spring in a qualitative way, the here presented study attempts to quantify this effect (to my knowledge) for the first time using observations, which is of interest to the community. The authors carefully identify possible shortcomings and sensitivities of the method and account for those properly. I therefore recommend publication after some minor revisions.

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Specific comments:

P1409 L3-8: This is just one side of the coin. There are a couple studies showing that isentropic transport is not the only way to influence tracer distributions in the LMS. Diabatic processes through convective events (Poulida et al. 1996, Hegglin et al. 2004), pyro-convection (Fromm et al. 2006), or radiative processes (Zierl and Wirth 1997, Bourqui 2006) are as well important, although their relative importance has not yet been quantified. Please complete this discussion in the manuscript.

P1411 L3: see previous comment, add 'cross-isentropic' to 'quasi-isentropic' in i)

P1411 L17-20: except for H2O, since air parcels are being dehydrated when crossing the tropical cold-point tropopause.

P1415 L4-11: I don't understand this point. Do you try to say that although the latitudinal and therefore spatial variability is high (which is due to strongly changing inner-vortex values), the temporal variability at least at mid-latitudes is small?

P1415 L21: How did you determine the natural variability with a limited data set?

P1416 L10-11: Which observations do tell you this? For example, a compilation of O3-N2O correlation slopes in the lowermost stratosphere by Hegglin and Shepherd (2006) shows changes in the slopes of around 15

P1427 L14-15: I'm wondering about the consistency between your results which indicate that tropospheric influence is close to zero above 360K and the results from Hoor et al. (2004) which shows that there is substantial influence from the tropical troposphere during autumn and winter, i.e. between 30 and 50%, at altitudes up to 370K.

Figure 8: The tropospheric fraction above 360K is negative, which is unphysical. Doesn't this imply an error in the boundary conditions or a missing transport process?

Technical comments:

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P1408 L1-3: suggest rewriting this sentence (it sounds awkward) and starting next sentence with 'The LMS...'.

P1409 L3: correct 'Haynes and Shepherd'

P1412 L12-13: Please spell out and shortly explain 'QR' and 'QL'. Not everybody knows what these acronyms mean.

P1412 L25: Please provide the campaign period or flight days.

P1413 L15: What is the accuracy of the FISH measurements?

P1415 L19: delete 'K' in between '60' and 'ppb'.

P1420 L24: Could you say already here on what the normalization and the weighting factor are based on (just in a couple words)?

P1423 L10: change 'lead' to 'led'

Figure caption 9: rather write 'Same as in Fig. 8, but for the AVC campaign.'

Additional References:

Bourqui, M. S.: Stratosphere-troposphere exchange from the Lagrangian perspective: a case study and method sensitivities, Atmos. Chem. Phys., 6, 2651-2670, 2006.

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Hegglin, M. I., D. Brunner, H. Wernli, et al.: Tracing troposphere-to-stratosphere transport above a mid-latitude deep convective system, Atmos. Chem. Phys., 4, 741-756, 2004.

Hegglin M. I., T. G. Shepherd (2007), O 3 -N 2 O correlations from the Atmospheric Chemistry Experiment: Revisiting a diagnostic of transport and chemistry in the stratosphere, J. Geophys. Res., 112, D19301, doi:10.1029/2006JD008281.

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Poulida, O., Dickerson, R. R., and Heymsfield, A.: Stratosphere troposphere exchange in a midlatitude mesoscale convective complex: 1. Observations, J. Geophys. Res., 101, 6823-6863, 1996.

Zierl, B., and V. Wirth, 1997: The role of radiation for stratosphere-troposphere exchange in an upper tropospheric anticyclone. J. Geophys. Res., 102, pp. 23,883-23,894.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 1407, 2009.