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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Seasonality and extent of extratropical TST derived from in-situ CO measurements during SPURT" *by* P. Hoor et al.

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This manuscript discusses the seasonality of transport from the troposphere to the extratropical stratosphere based on in situ trace gas measurements from a number of aircraft flights. The main finding is that air is mixed into a shallow layer in the lowermost stratosphere, best described by a potential temperature range of up to 20 K higher than the local tropopause value, during all seasons. The set of measurements analyzed in this study is impressive due to the types of species measured and the location and range of seasons sampled. The analysis of the CO2 measurements may be pushed a little too far, but in general the CO2 data add a unique contribution. This study supports the findings of previous transport studies but refines the depth of the mixed layer in the lower stratosphere and the seasonality of the transport.

Specific comments

It's not entirely clear to me how many flights you are analyzing. Were there two flights each SPURT campaign? Maybe just make this a little more clear since it's hard to tell from Figures 1 and 2.

In Section 4.2 you use a Spearman's rank correlation. IŠm not familiar with this technique, is it commonly used? If not then perhaps at least a reference or another sentence or two describing it would be helpful.

In Section 5.1 you mention the upper tropospheric latitudinal gradients of CO agree with climatology. I don't think there really is an upper trop. CO climatology. The papers you cite have very little data in this region so your measurements are as much a climatology as any previous measurements. The variability in upper trop. CO from mission to mission is interesting and seems to be more than just a latitudinal gradient. It's probably outside the scope of your paper to discuss this but I found it interesting.

Section 5.2 is a nice use of CO2 to refine the possible transport pathways into the lowermost strat. I have a couple of comments on this section. One is in regards to Andreas' comment about the August 2002 CO2 in the lower strat. CO2 mixing ratios of 372-373 ppmv were measured during CRYSTAL-FACE in early July 2002 in a plume of air in the lowermost strat. This plume contained significant evidence of being recently influenced by biomass burning, including CO $>$ 150 ppbv and a large fraction of biomass particles. Thus, the plume was recently injected by convection into the lowermost stratosphere and advected downstream to our observation area. I have recently submitted a paper to JGR analyzing the mixing and transport of this plume. One of the calculations was to derive the mixing ratios of various trace gases at the time they were convectively injected into the stratosphere. This was essentially the convective boundary condition to the mixing problem. These CO2 mixing ratios were found to be in the range of 374-378 ppmv. These are significantly higher CO2 mixing ratios than at any level shown in your Figure 7 during this time. The convection

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downstream of a fire is clearly a unique occurrence but it could have a significant impact on a large region of the lowermost stratosphere based on the CRYSTAL-FACE measurements. This is not to say that what you have done is incorrect, but as Andreas said, it is a possible source of elevated CO2 in the lower stratosphere during summer and so the extratropical convective pathway cannot necessarily be ruled out.

My second comment is in regards to the last paragraph of this section where you cite a few different studies of transport time scales in the lower strat. The time scales range from no more than 1.5 months to 2-4 months to less than one year. Are you intending to contrast these studies? From your Figure 8 you infer a time scale of roughly 1 month from the tropical to extratropical lower strat. Maybe you should discuss the consistency of your time scale with all of these studies.

Technical comments:

Section 1, para. 1, line 8: "subject TO large uncertaintiesĚ"

Para. 2, line 1: "predominantly" is misspelled.

Para. 2, line 2: "several years AS part OF the Brewer-DobsonĚ"

Para. 4, line 3: comma after "In addition"

Para. 5, line 1: "BesideS these case studies, the results of Dessler et al. (1995), Fischer et al. (2000) and Ě"

Para. 5, line 3: donŠt need a comma after "both"

Last para., line 10: "an overview OF the experimental setup"

Section 2.1, para. 1, line 5: "overview OF the trace gasĚ"

Para. 1, line 6: "investigated. THE GOAL WAS TO EXAMINE seasonal variationsĚ"

Para. 1, line 9: "consisted of northbound and Ě"

Section 2.2, para. 1, line 4: "overview OF the payloadĚ", switch "techniques" and

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Interactive Comment

"used".

Para. 3, line 2: "pressure inlet allows THE INSTRUMENT TO OPERATE at a pressureĚ"

Para. 4, line 2: "ECMWF data with 60 VERTICAL levels correspondingĚ"

Section 3, para. 1, line 7: "THE two flightsĚin October 2002 COVERED A RELATIVELY smaller latitude range."

Para. 2, line 1: "The data sampled during eachĚ"

Section 4.1, para. 1, line 9: "IN THE STRATOSPHERE NEAR the local tropopause, in general, values ABOVE BACKGROUND are observedĚ"

Para. 4, line 5: "would appear as A mixing lineĚ"

Section 4.2, para. 3, line 4: "Thus, the regionĚ" donŠt need "respective"

Section 5.1, para. 3, line 1: "end points of THE ten-dayĚ"

Para. 3, line 2: "We selected only TST-trajectories THAT SPENT AT LEAST 24 HOURS IN BOTH THE TROPOSPHERE AND STRATOSPHERE."

Para. 6, line 5: "indictative OF a tropopause break."

Para. 8, line 4: "equivalent latitude, WHICH IS in closeĚ"

Section 5.2, para. 1, line 1: comma after "tropopause"

Para. 1, line 5: "address" is misspelled.

Para. 3, line 9: comma after "Similarly,"

Para. 4, line 4: "long-lived"

Para. 4, line 8: "linear" is misspelled.

Para. 5, line 7 and 9: "mid June" not "mid of June"

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Para. 6, line 5: "tropopause. THIS TYPE OF MIXING CANNOT EXPLAIN the propagationĚ"

Para. 7, line 2: "affected by air THAT enteredĚ"

Section 6, para. 1, line 11: "Pan et al. (2003) suggest the extratropical tropopause CAN BE VIEWED as a layerĚ"

Figure 2 is a little hard to look at in black and white. Perhaps you could make it color?

Figure 8: Why isnŠt the surface data continued further in time to compare to SPURT 7?

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 1691, 2004.