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Interactive Comment

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

**P. Hoor et al.**

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### General comments

We thank Eric Ray for his comments. The main points of his comment are the interpretation of the phase relationship and the maximum of $CO_2$ in the lowermost stratosphere of summer suggesting biomass burning as an alternative explanation for the observation (see also comment by Andreas Stohl). The second point refers to the transport time scale which we deduced for the tropospheric fraction of air which may contribute to the lowermost stratosphere beyond the mixing layer.

### Detailed reply

Each SPURT campaign consisted of at least four mission flights of which more than 50% of each flight were performed in the lowermost stratosphere (we added a sentence on that). During August 2002 $CO_2$-values from three flights contribute to the mean $CO_2$-

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values in former Fig. 7 above the mixing layer ($\Delta\Theta > 25$ [K]). Thus, the observed mean stratospheric $CO_2$ mixing ratios in former Fig. 7 at the highest $\Theta$ and $\Delta\Theta$-surfaces, respectively, are not the result a single event (e.g. a plume). This is also indicated by the absolute values of CO which are in a typical stratospheric range as well as in the overall correlations between CO, $O_3$ and $CO_2$. During the summer campaign as a whole non-compact correlations appear in the mixing layer indicating much more variability and TST than during the rest of the year as one would expect due to stronger convective activity in the extratropics. Above, correlations remain compact. These findings indicate that biomass burning is unlikely to have caused the highest $CO_2$-values at largest distances from the tropopause. Otherwise, the air in the lowermost stratosphere must have been totally mixed and 'filled up' with biomass burning air to explain our observed background values, which can't be totally excluded, but is unlikely.

During one of these flights we encountered only once for a short period of 10 minutes a region in the stratosphere which exhibited a peak in CO (from 30 ppbv to 65 ppbv) at $\Theta = 360$ K and a PV of 7 - 8 PVU accompanied by a dip in ozone from 350 ppbv down to 200 ppbv. $CO_2$ during this short flight section is enhanced by 0.5 ppmv on a background level of 372 ppmv, which is in the stratospheric range of our whole August data set. Importantly, $NO_y$ and $N_2O$ are anticorrelated which indicates a more stratospheric character of air. Furthermore, no enhanced NO was measured during that flight section. However, in scatterplots this episode does not appear as a strong deviation and is within the stratospheric correlations.

The second main point concerns the comparison of our deduced transport times for air entering the stratosphere at the tropical tropopause being subsequently transported quasi horizontally to higher latitudes. The various time estimates in the cited literature arise from the different methods and altitude coordinate systems which have been applied to investigate this transport pathway. In our discussion the main focus is on the fact, that there is a significant amount of young air originating at the tropical tropopause which contributes to the 'background' composition of the extratropical stratosphere. It's



ACPD

4, S1152–S1154, 2004

Interactive Comment

not our intension to contrast the cited studies, and we sharpened the text of the conclusion. In the extratropical lowermost stratosphere this tropical tropospheric fraction of air might even dominate over tropospheric air from the extratropics. As shown in the current study the latter mainly affects the mixing layer.

We changed our Fig. 2 by by coloring the tropopause.

Concerning the rank correlation we added a citation since the method is not commonly used, but useful to analyze monotonic data, which is the case in our study.

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



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4, S1152–S1154, 2004

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