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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Airborne in-situ measurements of vertical, seasonal and latitudinaldistributions of carbon dioxide over Europe" *by* C. Gurk et al.

**C. Gurk et al.**

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Reply to anonymous referee #4

We thank the referee for her/his comments, which we have taken into account in a revised version of our manuscript. In detail, we made the following changes to address the points raised by the referee:

P7316-L8: We changed the text by replacing uptake by with exchange with.

P7316-L10-11: We skipped this part of the sentence.

P7316-L20-21: We added deforestation as a source of anthropogenic CO2.

P7317-L4: We added the following sentence: Stephens et al. (2007) in a recent pub-

lication emphasized that this vertical information is necessary to improve CO2 budget calculations based on inverse modelling.

P7317-L27-38: We prefer to leave the description of the instrument function as it is, since we believe that it is important to know the operation principle to judge on the measures taken for quality control and assurance.

P7318-L17: We believe that the rather good agreement between our observations and ground-based measurements described in section 4.1 indicate that our water vapour corrections made are sufficient and are adequately represented in our estimate of the total uncertainty.

P7319-L18: The instrument precision as given in the manuscript is based on the reproducibility of in-flight calibrations. This reproducibility is affected by a number of instrument fluctuations, including pressure variations and pressure differences between sample and reference cells. We believe, that it is therefore not necessary to specify individual noise sources, as long as they are accounted for in the measurement procedure for the determination of the instrument precision.

P7319-L9-10: Four different gas standards provided by NOAA have been used for the determination of the multi-point calibration function. A change with time of the polynom has not been observed, based on regular calibrations with 2 NOAA standards.

P7319-L14: We do not know which paper the reviewer is referring to.

P7319-L16-17: Temperature measurements in the gas flows of the sample and reference cell show that both temperatures are equal, indicating that the time delay in the sampling line is long enough to equilibrate the gas temperature to the constant temperature of the analyser.

P7319-L16-17: Changed to 0.06 ppm.

P7321-L4: During refuelling stops the time between landing and take-off is generally less than 2 hours. Systematic differences between landing and take-off were not ob-



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served. A measure of the atmospheric variability, which includes differences between individual profiles, is given by the standard deviation of the mean documented in figure 3.

P7321-L12: This should indicate that only profile data are shown in figure 3 and no data from constant pressure/altitude flight legs are included.

P7321-L11: The higher variability in these profiles is due to local enhancements in CO2 (and CO) during the approach to Keflavik airport indicating a pollution layer of unknown origin at about 6 km altitude.

P7321-L17: We replaced gradient by latitude difference.

P7322-L20: We do not know what the referee is exactly asking for. This paragraph contains a general statement about processes that can have an influence on individual profiles based on results from a publication by Gerbig et al. In the following we then investigate the influence of synoptic transport and mixing with stratospheric air on the profiles.

P7322-L20: As already mentioned in the discussion of the enhanced variability during the approach to Kaflavik positive anomalies of CO2 are in general associated with CO enhancements, indicating pollution layers due to convective transport or local aircraft emissions.

P7323-L1-3: We erased the statement.

P7323-L15-19: We completely agree with the referee. Therefore we originally added a note of caution in the original manuscript (P7323-L28 and further on) that SPURT measurements are snapshots and that therefore in particular seasonal trends are of limited use for detailed comparisons with other data sets.

P7323-L20-26: We added the following sentence: This is in good agreement with observations by Nakazawa et al. (1993) who observed seasonal variations of the order of 10 ppm in the boundary layer decreasing to 7 ppm in the altitude range between 8



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km to the local tropopause.

P7324-L12: As discussed in Hoor et al., 2004 this indicates transport from the tropical upper troposphere in contrast to local mixing with the extratropical upper troposphere.

P7324-L13-15: A discussion of the seasonal variation of cross-tropopause transport is beyond the scope of this paper and can be found in the paper by Hoor et al., 2004.

P7325-L3-4: see comment above for P7322-L20.

P7326-L5-11: In principle with agree with the referee, that the propagation of the surface seasonal cycles into the free troposphere indicates a strong influence of surface sources and their seasonal change on the profiles. The decrease in the seasonal amplitude also indicates that this influences decays with increasing altitude. In addition a general decrease (increase) of the mean CO2 concentration is observed in the fall and winter (summer) seasons, that is associated with a decrease in the CO and an increase in the O3 profiles. This could indicate an aging of the airmasses with increasing altitude as discussed by Gerbig et al. 2003 or mixing with stratospheric air as discussed in Sawa et al., 2004 and Shia et al., 2006. Our study based on tagged stratospheric O3 in a 3D CTM supports the later interpretation, but we have to admit that we ca not exclude a larger airmass age as responsible for the change in concentration with altitude. Thus we changed the phrase most likely here to likely and in the conclusions (P7327-L4-6) most probably to probably.

Figure 1: The full names of MFC and PC are now included in the figure caption.

Figure 3: The tropopause height was determined from the 2 PVU surface. We modified the text by adding (P7322-L2-3): (determined as the 2 PVU surface with 1 PVU = 10-6 m2s-1Kkg-1)

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Interactive comment on Atmos. Chem. Phys. Discuss., 8, 7315, 2008.