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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Statistical analysis of water vapour and ozone in the UT/LS observed during SPURT and MOZAIC" *by* A. Kunz et al.

A. Kunz et al.

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We thank referee 2 for the careful reading, the detailed questions and the useful comments on our paper. The revised version contains nearly all of them. The referees comments are repeated first (in italic type) and we reply to the respective statements.

>> *I think the description of the data would be a lot better if the results of the CIRRUSIII campaign were presented first, even in discussing the water vapor instruments in section 2. Certainly the top panel is not statistical, and would show the correspondence of the water vapor sensors. I think this comparison (at least the top panel) could go into section 2 since it is more validation.* <<

This is a good point and we already discussed about this modification before submitting the first version of this paper. Of course, the top panel of Fig. 7 shows the

H_2O mixing ratio of both instruments (MOZAIC sensor and FISH) during one CIRRUS flight and would be suitable to show this figure at the beginning of the paper when discussing the measurement instruments in section 2. A disadvantage of this idea is that the figure contains further information concerning the data selection in section 3. So we would have to discuss on this figure on several places in the paper, the last time when showing the variance analysis of H_2O during this CIRRUS III flight. Further the figure shows data from a different measurement campaign (CIRRUS) which should not stay in the foreground of this paper. So we decide to show the two pictures with results concerning the CIRRUS campaign together in a more compact manner.

>> *The part of the variance that was most interesting was the lack of intraseasonal variance in the MOZAIC ozone data. This would be a much more interesting study if you speculated on why that is the case. Does it have to do with dynamics in the UT/LS, or does it have to do with ozone chemical timescales? It is probably beyond the scope of this work, but could model (either a CTM like CLaMS or a Coupled Chemistry Climate Model) help understand this?* <<

Indeed model studies with CLaMS can help to understand and analyse this fact and are further worth of to be evaluated with the help of the developed statistical tools in this publication. As the rewiever already mentioned, this goes beyond the scope of this work and the comparison with CLaMS results is taken into account in future. We are not intented to analyse the underlying atmospheric processes in our paper for several reasons (see response to referee 2 for detailled reasons). Nevertheless we think the marginal increasing MOZAIC O_3 variance on the interseasonal timescale between 10 and 100 days has to do with dynamics in the extratropical tropopause region above Europe. The ozone concentration in the vicinity of the tropopause depends on dynamical processes such as the break up of the polar vortex in spring and the following downward transport of ozone in the atmosphere or the latitudinal shift of the jet streams between summer and winter. Due to the permeability of these jet streams there is an isentropic transport and exchange of ozone across the jet core from the

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tropics to the extratropics. All these processes play a role on a seasonal timescale and there is a change and variability from season to season. Therefore you find a more sharp enhancement of MOZAIC O_3 variance on a 10 to 200 timescale. Thouret et al. (2006) studied the climatology and inter-annual variability of MOZAIC O_3 from 1994 to 2003. Figure 5 of this publication shows very well the ozone seasonal cycles above Europe. The lower stratosphere (upper troposphere) exhibits a pronounced maximum of O_3 in spring (summer) and a minimum in autumn (winter). This demonstrates the seasonal dependency of O_3 and the change from maximum O_3 concentration to minimum concentration on a half year timescale.

>> Minor points
L48: "The data set is based on 36..."
L53: "The aircraft was based at the Hohn military base in northern..."
L102: "The sensor is mounted..." <<
Modifications are performed.

>> L105: The MOZAIC sensor may also be subject to a moist bias due to evaporation of small or shattered ice crystals during compressional heating. Since these points then appear supersaturated, this is less of an issue in your analysis since you would throw out most of these points. <<
Of course, the evaporation of ice crystals leads to a supersaturation in the Rosemount housing. Data under supersaturated conditions with a relative humidity $R_i > 100\%$ are eliminated in our analysis by the second selection criterion.

>> L230: I guess I am not surprised that these data are different due to the sampling differences, and I do not think this comparison worthy of so much space in the paper. The statistical analysis seems properly done, but it merely says what you conclude in the end: there are probably sampling issues here. <<

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This comment refers to the description of the Kolmogoroff-Smirnoff test performance. Of course, the result of this classical test is the difference between the distribution functions of H_2O and O_3 in SPURT and MOZAIC and the concluding remark of probable sampling differences. We think the space of this discription is still necessary for the reader to understand the performance and the results of the test. But we finally decided to remove the sentences (p.12572,l.15-l.22) with the discussion about means and medians, because it is a repetition in text and is already discussed at the end of section 3.1 in combination to the frequency distributions in Fig 5.

>> L291: I think this is the first time you are using the CIRRUS campaign acronym. What does it stand for? More importantly, the project itself needs to be described in the text. Obviously the figure shows two sensors, the MOZAIC and FISH (SPURT) being compared. Are they on the same aircraft or different aircraft? More details are necessary. <<

There is no clear acronym for the CIRRUS campaign. The name arises from the cirrus clouds in the upper troposphere, which are extensively investigated during the campaign. To clarify the open questions the following text is included in the revised paper:
The motivation of the three CIRRUS campaigns between 2002 and 2006 was to investigate the formation mechanism of cirrus clouds, their radiative effects and to study the chemical or microphysical properties of the cloud particles. Both the FISH instrument and the MOZAIC sensor, already described in section 2, were onboard the Learjet 35 A during the last CIRRUS III campaign in November 2006. The CIRRUS III midlatitude cirrus field experiment took also place at the Hohn military base. Six flights mainly inside and outside frontal cirrus clouds were performed in the altitude range from 7-12km between 45-70 °N. So we can perform an inflight comparison of both instruments and show the results of a variance analysis with data sampled under the same spatial and temporal conditions.

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