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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Ozone, Carbon monoxide and Nitrogen oxides time series at four Alpine GAW mountain stations in Central Europe" *by* S. Gilge et al.

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First we'd like to thank the reviewer for the detailed and constructive comments! It really helped improving the paper!

General Comments The paper presents continuous long term data series of O3, NO2 and CO from four Global Atmospheric Watch (GAW) stations in the alps and surrounding area. The paper goes into great detail on the quality assurance of the data, including traceability of calibration standards. There is a large section discussing the long term statistical trends of the data from all 4 sites, including analysis of seasonal trends, as well as trends in different wind sectors. The authors then speculate as to pos-

sible reasons for the observed trends (changing emissions, changing meteorology). Generally the paper is well written and interesting. The discussion of measurement techniques and data quality control is a very good one and gives the reader confidence in the data discussion later in the paper. Whilst the paper does not contain particularly firm scientific reasons for the observed trends (global and regional models would be required for this), I feel it will be of great value for the scientific community to see these long term trends from the 4 sites. I have no doubt that this publication will lead on to many others by this group and others.

In summary I recommend publication of the manuscript in ACP subject to the minor changes suggested below.

Paper length and Structure I did find the paper long and at times difficult to follow. I do wonder if the authors would be better to combine sections 3 and 4 (data description and discussion). While reading section 4 I found myself constantly flicking backwards to the relevant part of section 3 to look at the description of the data that was being discussed, It may be easier for a reader to follow if the discussion of each part came immediately after the data description. A conclusions section could then follow this. I also wonder why the order of the species in the data description and data discussion are different (this added to the difficulty in following the paper).

REPLY: This was actually a difficult decision for us during writing the paper, and we are supported in our decision by reviewer #1. We chose this structure for a number of reasons. One is that the paper has its focus on the thorough presentation of the high quality long-term measurements which is done in the results section. The discussion of the observed features is more qualitative and interpretations might change somewhat in future in the light of evolving scientific understanding whereas the results section will remain as it is. We changed the order of components because we intended to start discussion with the last presented results, as we thought this might be easier for the reader to follow. Furthermore, presentation of the results starts with the compound where most data are available (O3) and goes to those compounds with less

complete data sets (CO and NO2). In the discussion, however, the interpretation of ozone trends requires some tropospheric chemistry, thus, it needs to consider CO and nitrogen oxides as major players. Furthermore, the short life-time of NO2 enables in first approximation to separate local/regional from hemispheric impacts, and due to its character as primary trace gas it is expected to be most simple in interpretation. Thus, the discussion goes from more simple chemistry and only local and regional influences (NO2) to more complex chemistry and a mix of local, regional and hemispheric influences (O3). We have tried to shorten the text whenever possible, however there was no big reduction possible without loss of clearness.

Figures I find the figures showing the annual percentiles and linear trends (e.g. figure 4) quite small and difficult to read. Could they be stretched in the vertical to allow the author to more clearly see the trends in the different percentiles?

REPLY: Enlarging the figures would be in our interest, too, but the four graphs (for the four stations) should be on the same page for comparison of the different behaviour of the sites. It is the Journals choice how large they are printed.

Specific Comments Page 19077 Line 15: The description off the different CO instruments sued does not appear to match the information given in table 2. Could the authors please make clearer which instruments were used at the different sites for different time periods?

REPLY: The Referee is right. Text and table were changed accordingly.

Page 19080 Line 20-25: It should be made clear to the reader that an NO standard C8017 is used to calibrate the NO2 measurement (conversion efficiency of the converter and sensitivity of the NO detector) by way of gas phase titration. This is in fact mentioned in the section about the JFJ measurement, however it should be made clear at this point.

REPLY: The text has been changed to clarify this point.

Page 19085 Line 18: If the period 1995-2007 is being considered throughout the paper doesn't this make figure 1 unnecessary? There are a large number of figures in the paper and it may make sense to combine figures 1 and 3.

REPLY: Figure 1 shows the long ozone time series and the overall increasing trend. This is the context for the investigations in this paper, because the increasing behaviour has changed. Please, see also the revised text and the answer to referee #1 concerning this topic. For that reason we feel figure 1 is needed.

Page 19087 Line 29: It is stated that the seasonal trends show very similar values in winter / spring and summer / autumn for the high sites. Looking at figure 10 this does not appear to be the case for the ZUG site where the spring / winter values are very different. This is also the case for JFJ between 1998 and 2000. the authors should rewrite this paragraph to it better describes what is shown in figure 10.

REPLY: We followed this suggestion and changed the text accordingly.

Page 19089 Line 5-10: The authors should speculate as to why the observed trends on NO2 do not replicate emission changes from Italy and for Germany / Switzerland. For instance, could this be due to inaccurate emissions data?

REPLY: This is discussed in chapter 4.1. and chapter 5 (Page 19099, line 19 up to page 19100, line 12).

Minor comments Page 19074, line 28: larger not lager REPLY: Done

Page 19075, line 8: should be enables 'us' line 15: 'The' is needed at the start of the Sentence REPLY: Done.

Page 19076 Line 26: I do not understand this sentence. Do the authors mean freely advected 'to' from all sides? Please clarify

REPLY:The referee is right: The respective sentences were rewritten to clarify the meaning.

Page 19078 Line 13: Please rephrase this sentence REPLY: Done

Page 19084 Line 16: the formula would be better in the centre of the page not within the text. REPLY: Done

Page 19085 Line 22: ‘are’ is missing from the sentence REPLY: Done

Page 19086 Line 26: should read ‘being’ re-evaluated REPLY: Done

Page 19092 Line 15: should be ‘unusually’ REPLY: Done

Page 19093 Line 1-5: this sentence needs restructuring REPLY: Done

Page 19096: Line 20: 1970’s not 1970ies Line 21: after not since Line 25: should read ‘the’ most pronounce increases. REPLY: Done

Page 19097: Line 21 why is (photo-) in brackets? REPLY: Brackets were deleted.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 19071, 2010.