

## ***Interactive comment on “Weekly cycles in precipitation in a polluted region of Europe” by C. W. Stjern***

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Thank you for very constructive comments on this manuscript.

——MAIN COMMENTS——

1. Title: I chose to mention only precipitation in the title as this is the main focus of the study, but I have now taken your advice and modified the title to indicate that other meteorological variables were analyzed as well.
2. Page 1779 Line 25-29: As suggested by Mr. Barmet and Mr. Kuster, I have now performed Kruskal Wallis tests on the 6- and 8-day weeks, which enhances the gravity of the 6-/7-/8-day test. Still, and particularly in the cases where indications of a weekly cycle are found based on the three tests used, I agree that it would be advantageous

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to investigate the robustness of this cycle with an extra test. I have therefore followed your advice and performed a Monte Carlo analysis based on the method described in Hendricks Franssen (2008), paragraph [7]. I then calculate how many of these 100 randomized weekly cycles have phase-to-phase amplitudes equal to or above what was found for the original data. For instance, precipitation amount (which did not pass any of the three tests) had a weekly cycle amplitude of 16%. From the Monte Carlo experiment, 81% of the 100 random cycles had amplitudes of this magnitude, underlining the non-significance of the original data. On the other hand, NO<sub>2</sub> (which passed all three tests) showed an amplitude of 19%, and from the Monte Carlo experiment none of the random cycles actually had amplitudes of this magnitude.

3. Page 1780 Line 18: You are right that there exist more than 30 SYNOP stations in this relatively large region – in fact, a first selection gives a total of 60 stations. However, the MARS archive (which originally goes from 1983) has limited access to data for the first years at many of these stations, which means that when I restrict my analysis to stations with more than 75% data coverage, I end up with only 30 stations. A comment on this is now added to this part of the manuscript.
4. Page 1780 Line 21-26: This is now made more clear in the text – observations of precipitation are made every 12 hours, so two measurements were summed to give a daily precipitation sum. For the other meteorological variables, measurements were available for 00, 06, 12 and 18 UTC, and daily means were created simply by averaging the four values. Further analyses of weekly cycles were based on these daily values.
5. Page 1781 Line 8: Yes, the 31-day running mean was calculated according to a moving window, and this is now stated in the text.
6. Page 1781 Line 16-21: See answer to point #2.
7. Page 1781 Line 22-24: Yes, the absence/presence of spectral peaks are deemed by visual inspection.

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8. Page 1781 Line 16-26: Again, see answer to point #2.

9. Page 1783 Line 9: I understand the expectation that the 7-day periodicity in SO<sub>2</sub> should show up on the periodogram. However, recall that for instance Barmet et al. (2009) studied pollution measurements from four urban sites, and that their periodograms with clear 7-day peaks showed measurements of PM<sub>10</sub> and not sulphur dioxide. While particulates are bound to display local and faster day-to-day variations, gases such as sulphur dioxide will be more subject to long range transport and can not be expected to show as clear weekly cycles. Moreover, the only pollution measurement data available to me in this study were data from the EMEP network, whose stations are almost exclusively placed on rural locations. This will also weaken the weekly cycles as compared to similar measurements from purely urban locations. Finally, as mentioned in the section presenting the SO<sub>2</sub> results, power plants (which is the major source of SO<sub>2</sub> in the region) may have much less distinct weekday-weekend differences than the major sources of PM<sub>10</sub> such as traffic. While it would be highly interesting to see analyses of pollution measurements within the urban regions of the Black Triangle area as well as analysis of other pollution species, I still believe that the sulphur dioxide measurements are useful as they demonstrate the presence of a weekly cycle even in these remote locations, indicating that the background concentrations in the region experience such a cycle. I have now made an extra comment on this, and have additionally included weekly cycles of nitrogen dioxide, which turns out to show more clear weekly cycles than SO<sub>2</sub>.

10. Page 1784 Line 6-9: Thank you for making me aware of the works discussing these. I have now removed the reference to these two papers at this and other places in the manuscript. I have however included them instead in the introduction, together with references to the works questioning them, as an illustration of the conflicting results of studies of weekly cycles and the role of statistical methods in this.

11. Page 1784 Line 19: The level of significance in the Kruskal-Wallis testing was chosen to be 5 %, so that tests giving p-values higher than 0.05 were deemed to be

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statistically insignificant. This is now accounted for in the methods chapter.

12. Page 1784 Line 22: Absolutely, I by no means meant to imply that 3 significant weekly cycles out of 30 was a strong indication of anything else than chance. I have now used your example (that we already expect 1.5 of the stations to have significant cycles by chance) to illustrate this fact to the reader.

13. Page 1785 Line 20: You are right, this is not true for all studies of weekly precipitation cycles in Europe, and I see now that the majority of the studies of weekly cycles in Central Europe actually show maximum precipitation amounts on Saturdays, while the sentence in question was written mainly with the results of Sanchez-Lorenzo [2008] in mind. The sentence is now rewritten.

14. Page 1786 Line 27-29: I agree that the variables that show signs of significant weekly cycles should be tested further to investigate the possibility of the significance occurring by chance. As mentioned in point no. 2, a Monte Carlo experiment has now been performed on summertime light precipitation, which did show signs of a weekly cycle. The original data showed a weekly cycle amplitude of 20%, but from the Monte Carlo experiment 10% of the random cycles actually had amplitudes of this magnitude, illustrating that cycles of this magnitude are indeed not that unlikely to occur by chance.

15. Page 1801 Figure 9: Thank you for this consideration – Mr. Kuster in his Short Comment also made a comment regarding this figure, arguing that the climate is naturally growing increasingly continental towards the east, which is likely to have contributed to the observed correlation. I have chosen to remove figure 9 and substantially shorten subsection 4.5, including a comment that the observed correlation between weekly cycle amplitude and longitude may instead be a result of spatial autocorrelation among the stations. The mention of the correlation is also removed from the abstract.

——MINOR COMMENTS——

1. Page 1784 Line 15: I agree – “although” is now changed to “and” in the text.

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2. Page 1787 Line 9: Thank you, “weak” is now changed to “week” in the text.

3. Page 1795 Figure 3: I agree that references to the 2004-2008 period should make clear that the period is clean relative to the more polluted 1983-1987 period, and that it is not exceptionally clean in general. This is now specified in the last paragraph of Chapter 3 (I choose to use the term “the cleaner period” for the 2004-2008 period) and changed everywhere else in the manuscript.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 1777, 2011.

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