Atmos. Chem. Phys. Discuss., 11, C2211–C2215, 2011
www.atmos-chem-phys-discuss.net/11/C2211/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the aerosol weekly cycle spatiotemporal variability over Europe" *by* A. K. Georgoulias and K. A. Kourtidis

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Received and published: 23 April 2011

We would like to thank Dr Weedon for his constructive comments that have substantially improved the quality of the revised version of our paper.

Major points:

1) "Perhaps this reflects how I viewed the figures, but figs 1, 5, 7 and 8 are far too small for the mapped information to be readily interpreted and for the lettering to be legible. I realise a lot of information needs to be shown, but it would be much better to have a few clear figures with the text plus additional information figures provided as supplementary information."

Answer: We agree with Dr Weedon that the aforementioned figures appear too small

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in the printed version of our manuscript. This is possibly because of the standard templates used for the production of the discussion paper. Also we have to notice that in the ACPD version the pages are printed as "two in one" and this makes the panels even smaller. We will collaborate closely with the production team of ACP to obtain the best possible figure quality (we have also provided the production team with all the individual subfigures appearing in the manuscript). Following the reviewers' suggestions we have omitted Figs. 1e, 1f, 1g, 1h where the aerosol flagged WCI patterns are presented in the revised version of the manuscript (since these maps are only used diagnostically) and we included them as a supplementary figure (Supplfig. 1). Now Figs. 1a-1d are bigger and clearer. The same we did with Fig. 8. We have included the seasonal aerosol flagged WCI maps as a supplementary figure (Supplfig. 2). However, we decided not to remove any of the other panels appearing in the manuscript. We tried to reduce the margins around the panels in Figs. 1, 3, 4, 5, 6 and 7 (the colorscale has been added in the caption "0-9 m/s") in order to increase the size of these figures. We did not want to keep only one sensor (TERRA or AQUA) in the text and provide the other sensor figures as supplementary material because the use of both sensors is a significant point of this paper. Since the two sensors, overpass different time of the day, we get an insight into the diurnal variability of the weekly cycle. Moreover, due to the fact that the data used here from the two sensors are for different time periods, we also get some insight into the stability of the patterns throughout the years.

2) "I assume the authors have used . . . The periodogram is well known to be a poor estimator of the spectrum and therefore requires some form of spectral window (smoothing) to increase the degrees of freedom. . .emerging from the spectral background"

Answer: We strongly agree with Dr Weedon about the fact that the periodogram is a poor estimator of the spectrum. We would like to thank Dr Weedon for giving us the opportunity to correct this in the revised version of our paper. A three-point Hanning window was applied three successive times for smoothing, in order to reduce the erratic fluctuations in the periodogram values, and obtain 8 degrees of freedom (see

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Weedon, 2005). This brought some changes in our results since now statistical significance according to the spectral analysis applied on the timeseries was indicated at the 95% confidence level for both MODIS TERRA and AQUA data for Central Europe and for MODIS TERRA data for South-Western Europe. Statistical significance at the 90% confidence level for the MODIS AQUA dataset was indicated for South-Western Europe. Significance is not indicated now for the region of Eastern Mediterranean showing that this was possibly an artifact inserted by the use of the periodogram. In the revised version of our manuscript we refer to the smoothing technique we have applied in order to increase the degrees of freedom and we present the corrected spectral analysis results in the text and in Table 2, where the statistical significance of the 7-days periodicity was given. The 6 and 8-day periodicities are not statistically significant according to the spectral analysis applied on the timeseries.

3) "Appendix B of Bell et al 2008 JGR (cited by the authors) discusses how TRMM estimates of precipitation incorporate small-amplitude weekly cycles simply due to variations in timing of the orbits of the satellite. Since the AOD data analysed here are entirely satellite-derived, it is important that the authors discuss, and convincingly discount, any weekly cyclicity in estimated AOD as potentially induced by 7-day or 6-day satellite orbital periods."

Answer: We thank Dr Weedon for giving us the opportunity to discuss this in the revised version of our paper. As discussed in Appendix B of Bell et al. (2008), there is a major difference between the TRMM mission and MODIS TERRA and AQUA, namely that the TRMM mission visits a grid box several days in a row within the same hour of the day and then visits the box for several days about one hour earlier, which is not the case for MODIS TERRA and AQUA. It was discussed in Bell et al. (2008) that the diurnal variation of rainfall might induce a spurious weekly cycle in the TRMM statistics. However, they ruled out this possibility by examining the number of TRMM observations as a function of both the day of the week and the hour of the day. The MODIS instruments are set to a near-polar sun-synchronous orbit and each successive pass

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occurs at roughly the same local sun time within a season. MODIS TERRA flies on a descending (southward) orbit with a daytime equator crossing time at 10:30 LT (morning measurements) and MODIS AQUA flies on an ascending (northward) orbit with a daytime equator crossing time at 13:30 LT (noon measurements) providing almost daily global coverage. An orbit is repeated every 16 days. In this work, we used data from 2 sensors, each on a different satellite, separately for the investigation of the weekly cycle patterns and the weekly variability and the results were in very good agreement for the morning (TERRA) and noon (AQUA) measurements. Unlike precipitation, the AOD typically is not expected to vary substantially within a few hours. So, we conclude that any possible variability in the overpass time of each instrument due to its special orbital characteristics would not be able to introduce such large artifacts that would lead to a spurious weekly cycle. The 16-day repeat cycle could possibly insert 8-day periodicities; however the spectral analysis we applied on the spatially averaged timeseries did not reveal a statistically significant 8-day (or 6-day as suggested by Dr Weedon) periodicity in all cases. Our argument is further supported by analysis of level-2 (10kmx10km resolution) MODIS TERRA data, where we have found correlations in WCI variability and population density (figure not shown here; manuscript in preparation), which would not be the case if the observed WCI was an artifact resulting from orbital periodicities. In addition, we have found a good agreement between independent MODIS and ISCCP cloud cover weekly cycle patterns (unpublished results), which would not be the case if the weekly cycle was an artifact introduced by the special orbital characteristics of MODIS.

The arguments above are now included in the revised version of the manuscript.

Minor points:

1) “Fig 4 APD figures need the uncertainties indicated on the plots. Additionally, the authors apparently still need to indicate in the caption or the text the meaning of the colours used.”

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Answer: We preferred not to show the uncertainties on the APD plots as in previous studies on the weekly cycle of aerosols using satellite data (Xia et al., 2008; Quaas et al., 2009) because this would impair the clarity of the figures. We have used a common scale for the total of the plots which allows for the direct comparison of the weekly variability appearing in different regions (e.g. Central Europe, South-Western Europe, etc.) and for different sensors (MODIS TERRA and AQUA). When the corresponding uncertainties were plotted the weekly variability was not very clear in the plots. Moreover, the bar plots appearing on the first and the third column indicate whether the APDs are statistically different than zero at the 90% confidence level according to a two-tailed t-test. The non-significant APDs are marked with a light blue (TERRA) or yellow (AQUA) bar. We agree with Dr Weedon that there should be an indication of the meaning of the colors used in the plots (blue for TERRA, red for AQUA, significance/non-significance, etc.). In the revised version of our paper we indicate in the text and in the caption the meaning of the colors used.

2) "p1401 lines 14-15 It is stated that spectral analysis was not carried out on the NEE region data due to lack of data in the winter. There are routines available for spectral analysis of data with missing data/data irregularly spaced in time."

Answer: We have some knowledge of possibilities for treating missing data; however, we preferred, given the very large percentage of missing winter values over that region (whole months of data missing), not to go to great lengths with such an analysis on the timeseries. However, we have rephrased the corresponding lines in order to make clear why we decided not to proceed to a spectral analysis.

Minor text changes: We have incorporated all the proposed minor text changes into the revised version of our paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 1385, 2011.