

## ***Interactive comment on “Spectral analysis of atmospheric composition: application to surface ozone model-measurement comparisons” by D. R. Bowdalo et al.***

### **Anonymous Referee #1**

Received and published: 12 April 2016

This manuscript gives a nice demonstration of the utility of spectral analysis for comparing modelled and observed surface ozone. The analysis is well done and the topic is appropriate for ACP. However before I recommend publication I would like for the authors to revise the manuscript according to my comments below.

#### **Major comments:**

You place a lot of emphasis on macroweather, a relatively new term that I wasn't even aware of. The term does not appear in the AMS Glossary (<http://glossary.ametsoc.org/index.php?title=Special:AllPages/M>), and I had to read about it here: <http://www.cambridgeblog.org/2013/09/expect-macroweather/>. Please provide a definition of macroweather and state how it differs

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from climate. Along these same lines, your description of turbulence and macroweather at the end of page 4 seem to be outside the standard definitions. Looking at the various definitions of turbulence in the AMS Glossary (<http://glossary.ametsoc.org/w/index.php?title=Special:AllPages&from=Tipping-bucket+rain+gauge>) turbulence seems most applicable to the microscale (e.g. it is calculated using the Reynolds number which describes viscosity). The term eddy is also most often used in reference to small scale motions. And here you seem to imply that macroweather encompasses the definitions of synoptic-scale troughs and anticyclones. But from my reading of Lovejoy's description, macroweather is more a time scale than a physical weather system. For example I would not refer to a single synoptic scale trough passing over Europe in the span of 3 days as macroweather, but I would consider a series of troughs and anticyclones passing over Europe during a month to be macroweather. Finally, where do the approximately 5-year ozone fluctuations caused by ENSO fall in the time-scale from macroweather to climate? For example, Lin et al. show that ozone at Mauna Loa and across the western USA is strongly affected by ENSO.

Title: Tropospheric ozone trends at Mauna Loa Observatory tied to decadal climate variability Author(s): Lin, Meiyun; Horowitz, Larry W.; Oltmans, Samuel J.; et al. Source: Nature Geoscience Volume: 7 Issue: 2 Pages: 136-143 Published: FEB 2014

Title: Climate variability modulates western US ozone air quality in spring via deep stratospheric intrusions Author(s): Lin, Meiyun; Fiore, Arlene M.; Horowitz, Larry W.; et al. Source: Nature Communications Volume: 6 Published: MAY 2015

Page 4 lines 21-24 Here you introduce the concept of your analysis using figure 2, but it does not show everything you are describing. For example you mention a scale up to 3000 days, but your figure doesn't even go to 2000. You also mention peaks at 1/3 day and 1/2 and 1/3 year, but I simply cannot distinguish such peaks. Either provide a figure that shows these peaks, or change the description.

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Page 6 line 1 What physical process does the 4th harmonic represent... or the other harmonics?

Page 6 line 16 The EPA AQS database has hundreds of present-day sites for which many years of data are available. Yet this analysis uses just a subset. What were the criteria for limiting the AQS sites?

Page 7 lines 19 Here you almost dismissed one of the most important topics in global ozone analysis, the determination of the seasonal peak. You describe the timing of ozone at polluted sites as being "suggested". Knowledge of the timing is far more than a suggestion; we know exactly when the peaks occur just from looking at the data. The hard part is actually doing this type of analysis for many sites around the world. But fortunately you now have the analysis to show when this happens. The basic reasons for the timing of the peaks is understood as the peaks in the eastern US are now occurring earlier due to changes in emissions as shown by Clifton et al. 2014. There is also lengthy discussion of this topic in Cooper et al. 2014, who show that heavily polluted sites in the US, Europe, and especially China, still have summertime peaks. Figure 7 of Cooper et al 2014 shows the month during which tropospheric column ozone peaks, according to the OMI/MLS satellite product, which can be compared to your surface plot.

Clifton, O. E., A. M. Fiore, G. Correa, L. W. Horowitz, and V. Naik (2014), Twenty-first century reversal of the surface ozone seasonal cycle over the northeastern United States, *Geophysical Research Letters*, 41, 7343-7350, doi:10.1002/2014GL061378

Cooper, O. R., D. D. Parrish, J. Ziemke, N. V. Balashov, M. Cupeiro, I. E. Galbally, S. Gilge, L. Horowitz, N. R. Jensen, J.-F. Lamarque, V. Naik, S. J. Oltmans, J. Schwab, D. T. Shindell, A. M. Thompson, V. Thouret, Y. Wang, R. M. Zbinden (2014), Global distribution and trends of tropospheric ozone: An observation-based review, *Elementa: Science of the Anthropocene*, 2, 000029, doi: 10.12952/journal.elementa.000029

Minor comments: If no explanation is given for a comment, please insert the suggested

C3

text into the appropriate place in the manuscript.

Page 1 line 17 Krupa and Kickert is a very outdated reference for the impacts of ozone on vegetation, please find something more recent and authoritative. You also need a current reference describing the impact of ozone on human health.

Page 2 line 4 You cite Stevenson and Young for an ozone lifetime of months, but they conclude that it's about 22 days. Please correct.

Page 2 line 27 ...this decomposition yields a number...

Page 3 line 25, commas would really help here: If strong periodicity exists on a frequency, not an integer integral on the span of the time series, then

Page 4 line 12, too many stills: will still be underestimated as there are still no frequencies

Page 4 line 19 Here and throughout the paper, ozone is measured in units of ppbv and needs to be reported as such, not as ppb.

Page 5, line 7 What do you mean by eddy?

Page 6 line 1 as it is the highest harmonic for which we find significance.

Page 6 line 2 Here you give two stations as examples, but you tell the reader absolutely nothing about these stations, so what is the reader supposed to learn?

Page 6 line 21 which leads to an over representation of northern continental mid-latitude locations and an under representation of other areas of world.

Page 6 line 28 Homogeneity

Page 7 line 3 Many of your readers won't know where Cape Grim or Cape Point are located, so please add some description.

Page 7 line 4 ...production and loss

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Page 7 line 19 Better to say baseline sites rather than clean sites.

Page 8 line 24 Stratosphere/troposphere exchange

Page 9 line 4 Therefore, on some timescales the model cannot be expected to interpret the observed variability, and this limitation should be considered when preparing model experiments.

Page 11 line 20 Here the discussion is on East Asian emissions but papers by Creilson and Eckhardt are cited which focus instead on the North Atlantic. Unless these papers specifically address the impact of East Asia they should be deleted.

Page 12 line 6 Do you mean lower rather than less?

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, doi:10.5194/acp-2016-172, 2016.