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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Sensitivity of US air quality to mid-latitude cyclone frequency and implications of 1980–2006 climate change" *by* E. M. Leibensperger et al.

Anonymous Referee #2

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This study of ozone pollution episodes in the northeastern USA and their relationship to changes in emissions and cyclone frequency is intriguing but in its present form fairly unconvincing due to the discrepancy between a significant decline in the cyclone frequency between the NCEP/NCAR and NCEP/DOE reanalyses. I read this paper and formulated my own basic response prior to reading the comments of Referee#1 and the reply by the authors. All of my major concerns were brought up by Referee#1 and the response by the authors has allayed some of those concerns, but not entirely.

Most importantly the paper has to convincingly answer the question of whether or not there is a significant decreasing trend in cyclone frequency above the northeastern

USA and southeastern Canada between 1980 and 2006 based on observations and reanalyses.

Here is a review of the observational/reanalysis evidence:

1) NCEP/NCAR reanalysis says yes at 99% confidence level, with a trend of -0.15/yr

2) NCEP/DOE says no at 99% confidence interval. When confidence is relaxed to 95% the uncertainty ranges from -0.15/yr to +0.08/yr. So the trend could be as negative as the NCEP reanalysis, but it could also be zero or it could also be positive. What would the interval be at the 99% confidence level? The authors point out in their response to Referee#1 that the NCEP/DOE reanalysis only extends back to 1980, perhaps to give some explanation as to why this data set does not show a trend. But I find this point to not have any weight because the time period of interest is 1980-2006, which is fully covered by both reanalyses.

3) Wang et al [2007] analyzed surface pressure across Canada and found that during summer in the region of the Great Lakes (within the regions explored by the present study): "the trend pattern is characterized by significant increases in the number of cyclone deepening events on the east coast with decreases of marginal significance in the Great Lakes area". So this does imply some decrease in cyclones but it's not entirely conclusive because it's only for a portion of the study region, the decrease is of marginal significance, and the time period analyzed is 1953-2002, rather than 1980-2006.

4) The papers by Gulev et al. and McCabe et al. apply to winter so they are not relevant to this summertime analysis.

Given that the Wang et al paper seems to support the NCEP/NCAR reanalysis, but that the NCEP/DOE reanalysis (which has better physical parameterizations and error fixes than NCEP/NCAR) shows no significant decreasing trend, I would say that the jury is still out on the existence of a significant decreasing trend.

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Further information is required to explore the discrepancy between NCEP/NCAR and NCEP/DOE. A good check on the accuracy of the cyclone tracks identified by the two reanalyses is to compare them to the NOAA Daily Weather Maps. These maps are available for 12 UTC above North America every day over many decades and archived at: docs.lib.noaa.gov/rescue/dwm/data_rescue_daily_weather_maps.html These maps are hand drawn by expert NOAA weather forecasters and based on surface observations rather than the reanalyses, so they can be considered to be somewhat independent of the reanalyses.

Most of the discrepancy between the two reanalyses appears to be driven by the years 1981, 1985 1988 and 2003, when the differences between cyclone numbers is greatest, as shown in your Figure 4.

My recommendation is as follows: Take the years of 1981, 1985 1988 and 2003 and print out all of the daily weather maps for June, July, and August (I realize this is a lot of paper). Take a clean overhead projector transparency and trace the outline of the 70-90W and 40-50 N box that matches up to the daily weather maps. With this template count all of the cyclones in the box for each day. Then compare this count (and the cyclone positions) with the 12 UTC cyclone positions of the two reanalyses. Which reanalysis matches the observations best?

Until this ground-truthing of the reanalyses is conducted I don't have any confidence that there is a significant decreasing trend in cyclone frequency above the study region during summer from 1980-2006, and therefore have no confidence in the major conclusions of the paper. Hopefully the NOAA daily weather maps can reveal which reanalysis is the most accurate in terms of cyclone tracks and frequency.

minor comments Figure 1. The images are too small and the pressure values cannot be seen

Figure 2. I would also like to see a plot of Reanalysis 1 for 1979-2006

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Figure 3. The boxes only extend from 90W to 75 W instead of to 70 W.

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