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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Trends and annual cycles in soundings of Arctic tropospheric ozone" *by* Bo Christiansen et al.

Anonymous Referee #2

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This paper presents an analysis of the annual cycle and trends of Arctic tropospheric ozone from ozonesonde measurements at 9 stations with relatively long records. Measurements from different types of ozonesondes have been adjusted to produce homogenized time series. The time series are analyzed using a Bayesian statistical model to evaluate the annual cycle, trends and changes in the annual cycle. Overall consistent results are found among the different stations, highlighting a clear annual cycle (with an interesting vertical structure), plus small trends and changes in the annual cycle. Overall this is a careful and straightforward analysis that contributes new knowledge on the behavior of Arctic ozone (although the small derived changes must be interpreted in light of geographic location and relatively short time series). The paper is well written and is appropriate for publishing in ACP. I have several comments and suggestions that the authors might consider in revision.

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1) It might be good to include a map showing the station locations. All of the stations analyzed here are from a relatively narrow longitudinal range (∼90 W to 30 E), and so it might not be too surprising to see similar seasonal and long-term variability among stations (especially for the closely-spaced stations in northern Europe). I appreciate that long-term data records do not exist for other longitudes. However, there are two Canadian Arctic stations with long records not included here (Alert and Resolute), for which data is easily available. Is there any reason not to include these in this analysis just for completeness? (and focus the seasonal cycle and trend discussions a little more on regional differences, as noted below).

2) For readers not familiar with Bayesian analyses, could you describe the procedures in a little more simple language? For example, 'Samples from the posterior are obtained by a simple Metropolis-Hastings algorithm and we assume flat priors for all parameters' (p. 5) might not be clear to everyone.

3) The isolation of the annual cycle at all of the stations is a nice result, but can the authors try to explain what is controlling this interesting vertical structure? This appears to me to be some combination of in situ generation / transport at lowest levels, along with downward transport from the stratosphere at upper levels (with influences down to 500 or 600 hPa). It might be useful to include a seasonally-varying tropopause in Fig. 8. Also, note that early winter low-level ozone maximum at Thule and Eureka (Fig. 8) may represent a regional behavior, different from the European sector (all other stations). Including Alert and Resolute could help clarify this behavior.

4) Figures 4 and 6 would be improved if all of the stations used the same time axis (for easier comparisons), and maybe only include the stations with long time series in Fig. 6. It looks like there might be some systematic differences between the polynomial fit in the European region (larger maxima ∼2005) versus those at Thule and Eureka (and useful to include Alert and Resolute if possible). What does the coherence between the troposphere and stratosphere (or lack thereof) in Fig. 6 imply for causes of the long-term variations?

5) The interesting seasonal cycle changes seen in Fig. 10 are relatively small and have different altitude behavior among the three European sector stations (and are not evident at Eureka). From Fig. 9 it looks like the 95% uncertainty levels overlap for almost the entire year at Ny Alesund; how is this consistent with the 1% significant differences at 500 hPa shown in Fig. 10? I think adding results from Alert and Resolute (comment 1 above) might help identify if the small seasonal cycle changes are a north-European regional effect or larger-scale result.

6) Statement on p. 8, l. 15: I disagree that the patterns in Fig. 11 agree on the 'strength and pattern of the change in the annual cycle'. The vertical structure is very different between the white noise and AR1 results in Fig. 11. This is useful information, but makes me more suspicious of interpreting the different station results in Fig. 10.

7) A few minor points: The term 'equivalent barotropic' (p. 6, l. 34) is a dynamical meteorological term and probably not meaningful for ozone (although I understand what you mean). On p. 1, l. 25: 'composition' should be 'deposition'. In Table 1, the last column should be 'average # of soundings'. I thought these were the total number of soundings until I saw Fig. 1.

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