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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.

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We want to thank the reviewer for the very thoughtful and constructive comments.

1) We will include a map showing the positions of the stations.

Regarding the data from the Canadian stations, Alert and Resolute, we have only been able to obtain the data from a limited period, 2002-2015. These data are almost always from the winter season. There seem to exist much more data from these stations but we have not been able to retrieve them from the WOUDC or NDACC websites.

We agree that it would strengthen the study to include these stations and we will try again to obtain the data.

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2) As mentioned in the response to the other reviewer the main practical advantage of the Bayesian method (and the reason we use it here) is that we obtain a characteristic ensemble of solutions which systematically provides uncertainties. These uncertainties are not only obtained for all parameters but also for all derived quantities such as trends, annual cycles, differences in annual cycles etc. Another advantage of the model based method is that we can use all data directly without first doing, e.g., monthly averaging.

In the revised version of the paper we will include a more detailed description of the Bayesian method and the Monte-Carlo procedure used for sampling.

3) We have calculated the annual cycle of the tropopause height (in pressure) at the four stations with most data. We have used the temperature definition (lapse rate) and calculated the tropopauses from the ozone-sonde records. There is in general a large scatter in the found tropopauses but for the four stations an annual cycle (monthly) can be seen (attached Fig. 1). The general structure - low tropopause in spring and high in autumn - is the same as reported in, e.g., Zangl and Hionka 2001. There is certainly a connection between the annual cycle in ozone at the upper levels, 100 - 300 hPa, and the annual cycle in the tropopause.

At the lowest levels we agree that the annual cycle must be a combination of in situ processes and transport.

In the revised version of the paper the tropopauses will be included in Fig. 8, the calculation described in the text, and the connection to the annual cycle in ozone discussed. The possible mechanisms at the lowest levels will be mentioned.

4) We will change the time-axes of Figs. 4 and 6. There are probably not enough data to make a distinction between the low-frequency variability in Europe and the Arctic. We agree that the Canadian stations would be good to have included.

It is certainly interesting that for the 5 stations (Scoresbysund, Ny Aalesund, So-

dankyla, Eureka, and Orland) the same form of the low-frequency variability is found both near the surface and in the stratosphere. It would seem that such coherent changes were most easily explained by changes in the circulation, which (at least in winter) couples the stratosphere and the troposphere. We will discuss this a little more in the text, although we find that a deeper analysis of the connection between our results and changes in meteorological parameters falls outside the purpose of the present manuscript.

5) Actually, for Ny Aalesund the 1 % significance levels at 500 hPa in Fig. 10 are found for day 40-90 and around day 200. This is also where the annual cycles and the 95 % error bars are (just) separated in Fig. 9. Again, we agree that the Canadian stations would be good to have included.

By the way, it is probably more correct in the captions to say "statistically different .. to the 99 and 95 % levels" than to say "statistically different .. to the 1 and 5 % levels".

6) We seem to disagree somewhat with the reviewer on this point. The two lowest panels in Fig. 11 have in general the same structure. But we will describe the differences and similarities more detailed in the text.

7) We will avoid "equivalent barotropic" and correct the typos.

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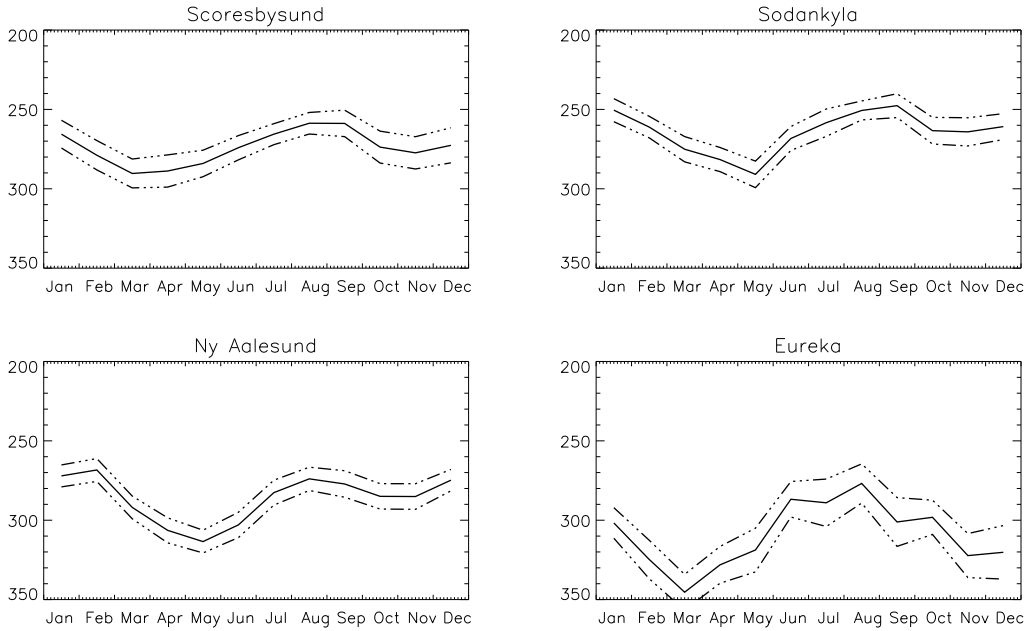

Fig. 1. The annual cycles in the thermal tropopauses (hPa) for the four stations with most data. Dashed curves are +-2 sigma.

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