

## Reply to referees: C. M. Hall et al.:Tropopause height at 78°N 16°E: average seasonal variation 2007-2010

The authors thank the two anonymous referees for their constructive comments and general encouragement.

To referee#1:

### *Major comments*

1. Indeed the paper to some extent reproduces the exploratory work done earlier. However we should stress that the earlier study was really a presentation and validation of a method of determining tropopause location from the radar data. Here we present considerably more data and (thankfully) strengthen the previous (tentative) result. We also include ozone data and explore physical mechanisms to a greater extent.
2. Obviously one would not necessarily expect any meteorological feature to repeat in a well behaved way, and indeed the tropopause height and its inter-annual variation is no exception. We will produce a new figure for inclusion in a revised manuscript (Figure 6), by way of a summary and that complies with the referee's request showing the time-series as a whole rather than monthly climatologies. It should be noted that we do not have ozone total column density for the entire period, so the values given will be derived from the monthly climatology presented earlier in the paper.
3. The WMO model, shown for completeness really, is somewhat dated and perhaps cannot be expected to perform well for the latitude of our observations. So essentially we illustrate room for improvement of the model.
4. The two maxima / minima in the tropopause data (predicted, by the way by the WMO model) are shown well in our proposed new figure. We can anticipate interplay between the ozone and tropospheric temperature combined with the state and position of the overlying polar vortex, repercussions of the QBO on the high-latitude stratosphere and the "summer-on/winter-off" nature of high-latitude insolation.

### *Minor comments*

The missing information in the figure will be included in a revision

## To referee#2

### *Major comments*

1. Within the timescale of this study we have not been able to obtain stratospheric or 500mBtemperatures, although we have considered such additional information would be conducive. Indeed, in later work (although beyond a revision of this paper) we would try to obtain better ozone data and also information on the state and position of the polar vortex.
2. We propose including a new figure (as described above) showing the time-series as whole rather than monthly climatologies. This would illustrate the effect the referee points to better. As mentioned in the reply to referee#1, we can anticipate interplay between the ozone and tropospheric temperature combined with the state and position of the overlying polar vortex, repercussions of the QBO on the high-latitude stratosphere and the “summer-on/winter-off” nature of high-latitude insolation. Later work (again beyond a revision of this paper) could involve a longer time-series allowing us to investigate these effects.
3. Our statement about the coincidence of the winter ozone minimum with the secondary tropopause height maximum is indeed incorrect. We would wish to change this to stating the autumn ozone minimum precedes the secondary (winter) tropopause height maximum. Again, we don't have stratospheric temperatures readily available and this (valuable) inclusion would have to wait for further studies. However it has already been demonstrated that there *is* a strong correlation between total ozone and 50 hPa temperature in Tromsø, based on 60 years of data in Hansen & Svenøe (JGR doi:10.1029/2004JD005387, 2005)
4. As stated in point 2 above, the system is, as the referee states, complex. We agree the state and location of the polar vortex is important for the location of the observations - confirmed for example by Manney, G.L. and J.L. Sabutis, Development of the polar vortex in the 1999-2000 Arctic winter stratosphere, Geophys. Res. Lett., 27, 2589-2592, 2000.

### *Minor comments*

1. Indeed the latitude should be 78, not 79.
2. A Lee filter is good at removing the outliers, being a “despeckle” filter and we've found it to perform better than a boxcar in many circumstances. We can elaborate on this in a revised manuscript.
3. In a revision we would improve the legibility of the figures in general.
4. We can include the explanation of the difference between meteorological and radar tropopauses in a revision, using text from the paper(s) referred to.
5. and 6. True, the references should be Santer et al. and Zängl.