Referee comments on Extreme events in total ozone over Arosa — Part 1: Application of extreme value theory by Reider, Staehelin, Maeder, Peter, Ribatet, Davison, Stubi, Weihs, and Holawe.

Overall Comments: This paper uses peaks over threshold extreme value methods in quantifying stratospheric ozone holes and ozone highs at Arosa, Switzerland, which is the world's longest ozone record. It is well written and easy to follow. In general, the methodology chosen seems appropriate. While I might have handled some issues differently in places, I think most of the methods chosen are appropriate and defensible. In other words, I do not think that my comments below will appreciably change conclusions.

Specific Comments:

1. It is not clear whether autocorrelation is accounted for in the analysis. Is any declustering of threshold exceedence runs done? Certainly, one expects daily ozones to be heavily correlated in time.

2. While daily ozones have seasonal means and variances, it is not evident to me that a seasonally varying threshold is physically appropriate here. I thought the health hazard involved ozone lows. This would seem to suggest a constant threshold — and then an analysis of a periodic process crossing this time-homogeneous threshold, irrespective of season of threshold exceedence. This said, I don't object to the seasonal threshold as the authors seem more interested in trends.

3. For purposes of extremes, I think the authors would have been better to convince me that the tails of the detrended and deseasonalized data are non-Gaussian rather than the entire distribution. This could have been accomplished with a kernel density estimate comparison overlayed with a normal density fit. I don't think the quoted p-values are appropriate for correlated data anyway.

4. The methods used in developing the seasonal (daily) thresholds came across as somewhat ad hoc. Given the near sinusoidal shapes in Figure 8, why not fit a seasonal GPD model of form

$$F_\nu(x) = 1 - \left[1 + \xi\left(\frac{x - u_\nu}{\sigma_\nu}\right)\right]_+^{-1/\xi}$$

where ν represents the season and satisfies $1 \leq \nu \leq 365 = T$ (ignore leap year data), and the seasonal parameters have the sinusoidal form

$$u_\nu = A + B\cos\left(\frac{2\pi(\nu - \tau)}{T}\right); \quad \sigma_\nu = C + D(\cos\left(\frac{2\pi(\nu - \xi)}{T}\right)?$$

I suppose that one would be forced to choose A, B, and τ "ad-hocly", but C, D, and ξ could then be easily estimated via likelihood. Extensions of the results to fitting a time homogeneous threshold would then be clear. I have left the ξ parameter constant for the reasons discussed in Coles (2001).

5. I would appreciate the authors stating the LOESS smoothing parameters so that their analysis could be reproduced. It do not think it matters much, but the trend seems undersmoothed. It might be worth noting that the so called hinge function used in meteorology — a constant up until

the onset of ozone depleting substances and then linear thereafter — is a parametric trend perhaps worth investigating.

Trite Comments:

1. Equation (1) should be $\min(X_i) = -\max(-X_i)$.

2. The reference to Lund and Reeves (2002) should be deleted. The reference to Lund *et al.* (1995) should not be for extreme value theory, but rather for the fact that they do not find a significant trend in the monthly data up to 1980.

3. It might be best to employ notation that emphasizes that Equation (2) is for the amounts over the threshold.

4. Page 8, line 20, "From this two" to "From these two".

5. Page 13 line 18, "on annual scale" to "on an annual scale".

6. Multipaneled graphics. I tend to read across the page first rather than down. The Chinese may do otherwise. :)

Robert B. Lund, June 21, 2010.