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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quasi-stationary planetary waves in late winter Antarctic stratosphere temperature as a possible indicator of spring total ozone" *by* V. O. Kravchenko et al.

V. O. Kravchenko et al.

genmilinevsky@gmail.com

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We thank Referee for helpful comments and suggestions. Below we respond to the Referee comments point-by-point. RC- Referee Comment; AC – Author Comment.

RC: p. 28950, l. 19-20: In this study the Pearson correlation coefficient is used. However, this is a test for linear correlation, only and it is not outlier-robust. It might be worthwhile to compute the Spearman rank correlation coefficient as well, since this can be used to detect any kind of statistical association and is not sensitive to outliers.

AC: We use the linear correlation method in our analysis considering the previous studies of the relationships between the planetary wave activity and polar total ozone

(e.g., Salby and Callaghan, 2004; Weber et al., 2011). Weber et al. (2011) continue their earlier study and investigate the impact of the Brewer-Dobson circulation (BDC) on ozone build-up in the 1995–2010 period. Combining data from Arctic and Antarctic they show that a compact linear relationship exists between the winter eddy heat flux (a measure of the vertical propagation of planetary waves from the troposphere used to describe variations in the BDC driving) and the spring-to-fall ozone ratio (their Fig. 4). This result demonstrates the broad range of the dynamical disturbances in winter which are linearly coupled with the polar total ozone change in spring: from low wave activity and large Antarctic ozone hole in 2006 to high wave activity and the diminished ozone hole in 2002 and further to the cold and warm Arctic winters.

As an example, in Figure 1.A1 we show the relationships between the two correlated data sets, the QSW amplitude in August at 70° S, 10 hPa, and the ozone hole area in October during 1985-2010. In this case, the Pearson linear correlation coefficient rP = –0.78 is at the correlation peak in Fig. 3e (middle plot). We noted in Sect. 1 that the two diminished ozone hole were observed (1988 and 2002), as a response to the enhanced activity of the planetary waves. These events are presented by the two points in the lower right corners of the Fig. 1.A1a and 1.A1b. Coincidence in the anomaly appearances in the two independently observed variables is demonstrated by Fig. 2.A2.

The long-term tendencies in these time series are different: non-monotonic changes of the total ozone in Antarctic ozone hole (Sect. 3 and Fig. 2.A2a below) and an absence of the clear tendency in the QSW amplitude (Fig. 2.A2b). As a result, scatter diagram in Fig. 1.A1a shows neither purely monotonic nor linear association between the variables. Since a monotonic relationship is an important underlying assumption of the Spearman rank correlation, and taking into account the conclusions by Weber et al. (2011), we have correlated the anomalies of the detrended time series, as explained in Sect. 2. Relationship between the variables in Fig. 1.A1b demonstrates their linear association. By the Spearman rank correlation method, the correlation coefficient rS

= –0.41 (Fig. 1.A1c) is almost two times lower than the rP value (Fig. 1.A1b). Nevertheless, the rS value is statistically significant at the 5% level. For other correlation maxima in Fig. 3, the rS values (significant at the 5-10% level) are in similar relation to the rP values.

The anomalous ozone holes in 1988 and 2002 look like outliers in both samples and, at the same time, they are not observation errors. As the responses to the wave disturbances, these events display real range of the dynamical couplings in the Southern Hemisphere stratosphere. The Spearman rank correlation is less sensitive to outlying values and, in a case of analyzed data, an extent of statistical dependence between the two time series seems to be underestimated by this method. Note that, after exclusion of the anomalous years 1988 and 2002 from the linear correlation, the correlation coefficient remains rather high, rP = –0.56 (significant at the 1% level), that is evidence of the prevailing linear coupling between the correlated variables and is confirmation of the proper use of the correlation method in this study.

RC: p. 28952, l. 18-10: It would be nice to present here or at another place in the paper a scatter plot of QSW activity and TOC. Next to statistical measures (correlation coefficients) a visual inspection of the data may also help the reader to infer the degree of statistical association.

AC: Figures 1.A1 and 2.A2 give examples of the association between the variables in our analysis.

See also Author response in *.pdf file in Supplement.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/11/C14825/2012/acpd-11-C14825-2012-supplement.pdf

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 28945, 2011.

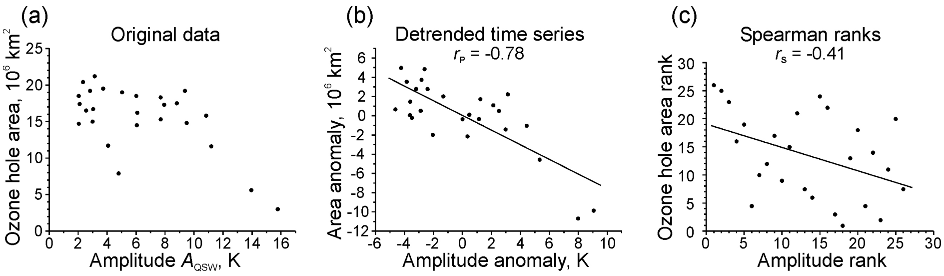

Fig. 1. A1. Variations of the ozone hole area in October and the QSW amplitude in August at 70° S, 10 hPa, during 1985-2010: (a) original data, (b) detrended anomalies and (c) Spearman ranks.

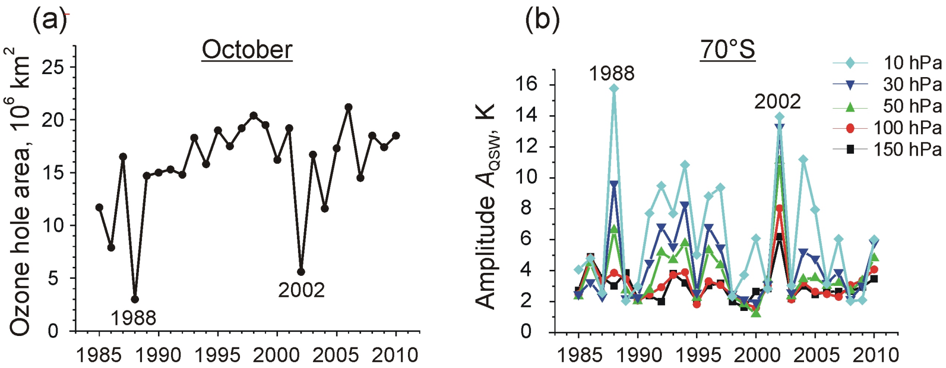

Fig. 2. A2. Interannual variations during 1985–2010 period of (a) the ozone hole area in October and (b) the QSW amplitude at the latitude of 70° S between the NCEP-NCAR pressure levels 150 hPa and 10 hPa.