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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A mid-latitude stratosphere dynamical index for attribution of stratospheric variability and improved ozone and temperature trend analysis" *by* William T. Ball et al.

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Paper's main finding is coherence in the variability of stratospheric temperature and ozone in the tropics and extratropics and in the upper stratosphere and lower mesosphere. The authors attribute this coherence to dynamics, specifically to the stratospheric meridional (Brewer-Dobson) circulation, and propose that an index accounting for dynamical effects could be used in multiple regression analysis as additional regressor. They further build such an index using extratropical upper stratospheric temperatures and demonstrate that the index explains considerable fraction of variability in stratospheric ozone and temperatures. Although the authors present interesting analysis, they still have to show how their analysis is related to previous research and high-

light novel results. The use of regressors accounting for dynamical effects has been discussed in previous WMO Ozone Assessments, discussing their pros and cons. I believe that a more thorough discussion of issues associated with the use of dynamical proxies, as well as relation of the current analysis with previous studies is needed before possible publication in ACP. Please see my specific comments below. Major comments 1. Various dynamical proxies have been used in past to explain stratospheric variability related to dynamics, see examples in Weiss, et al. 2001; Brunner et al. 2006; Mäder et al., 2007; Wohltmann et al., 2005; 2007 and references therein. While a considerable fraction of variability in both ozone and temperatures can indeed be explained by these proxies, this benefit comes at the cost of attributing variability to processes which are themselves dependent on the variables to be explained (wave propagation depends on the mean state of the stratosphere), i.e. one mixes cause and effect. I suggest that these issues should be discussed in the manuscript. Relevant discussion regarding the use of dynamical proxies for attributing ozone variability can be found in Chapter 2 of WMO ozone Assessment 2011 (Sections 2.1.2 and 2.4). References: Brunner, D., J. Staehelin, J.A. Maeder, I. Wohltmann, and G.E. Bodeker, Variability and trends in total and vertically resolved stratospheric ozone based on the CATO ozone data set, Atmos. Chem. Phys., 6 (12), 4985-5008, doi: 10.5194/acp-6-4985-2006, 2006.

Mäder, J.A., J. Staehelin, D. Brunner, W.A. Stahel, I. Wohltmann, and T. Peter, Statistical modeling of total ozone: Selection of appropriate explanatory variables, J. Geophys. Res., 112, D11108, doi: 10.1029/2006JD007694, 2007.

Wohltmann, I., M. Rex, D. Brunner, and J. Mäder (2005), Integrated equivalent latitude as a proxy for dynamical changes in ozone column, Geophys. Res. Lett., 32, L09811, doi:10.1029/2005GL022497.

Wohltmann, I., R. Lehmann, M. Rex, D. Brunner, and J. Mäder, A process-oriented regression model for column ozone, J. Geophys. Res., 112, D12304, doi: 10.1029/2006JD007573, 2007.

Weiss, A. K., J. Staehelin, C. Appenzeller, and N. R. P. Harris (2001), Chemical and dynamical contributions to ozone profile trends of the Payerne (Switzerland) balloon soundings, J. Geophys. Res., 106(D19), 22685–22694, doi:10.1029/2000JD000106
WMO: Scientific Assessment of Ozone Depletion: 2010, Global Ozone Research and Monitoring Project, 52, 516, 2011.

2. There are also problems with using temperature as a proxy representing extratropical wave dynamics. Stratospheric temperature is controlled by a number of processes, such as horizontal and vertical advection, diabatic heating, and not all variability is necessarily directly attributable to extratropical wave forcing. Constructing an index by maximizing correlation, as is done in this study, also maximizes the risk of mixing statistical noise with physical processes. That is why using proxies more directly related to wave activity could be a better choice. While I agree that wave activity proxies such as EP-flux divergence are difficult to calculate, one can try, for example, heat flux evaluated at 100hPa (e.g. Newman et al. 2001), which is quite easy to calculate.

Reference: Newman, P. A., E. R. Nash, and J. E. Rosenfield (2001), What controls the temperature of the Arctic stratosphere during the spring?, J. Geophys. Res., 106(D17), 19999–20010, doi:10.1029/2000JD000061

Other comments: 1. P2L1-5: See Major Comment 1. There are plenty of studies using different set of proxies, not only the six proxies listed here. 2. P2L118: I believe there are older references which show influence of dynamics on stratospheric ozone, e.g. Fusco and Salby 1999 and references therein.

Reference: Fusco, A. C. and Salby, M. L.: Interannual variations of total ozone and their relationship to variations of planetary wave activity, J. Clim., 12, 1619–1629, 1999.

3. P2L22-23: Please note that acceleration of BD circulation leads not only to increase of ozone in the extratropics but also to a decrease in the tropics, thus it is more correct to say that ozone is redistributed, not just increased.

4. P3L27-28: I think smoothing removes short-term variability, not long-term. Please rewrite.

5. P8L4-6: Please see Major Comment 2. I think some caution is needed when using stratospheric temperature as proxy for dynamics.

6. P9L6: ‘Verses’ -> ‘versus’

7. Figure 10: The difference in Fig. 10b between regression results from GOZCARDS and SWOOSH from the one hand and SBUV from the other hand are interesting. It appears like dynamical variability in GOZCARDS and SWOOSH is represented by the other proxies because, after addition of the dynamical proxy, the explained variability changes only little in these data sets, and the total explained variability is quite similar in all four data sets. Do you think it is purely statistical effect or it may be related to the way these data sets are compiled? (Sorry I am not familiar with these data sets.)

8. Figure 11: I am puzzled by why the annual R2 for the w/ MLDS regression in the middle panel is larger than any seasonal one. The result from the w/o regression, where the annual R2 looks like the mean of seasonal results, looks more logical, is it not?

9. Captions to Figure 11: What is distribution peak? Is it the mode?

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