Atmos. Chem. Phys. Discuss., 9, C6332–C6334, 2009
www.atmos-chem-phys-discuss.net/9/C6332/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Increase of upper troposphere/lower stratosphere wave baroclinicity during the second half of the 20th century" *by* J. M. Castanheira et al.

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Received and published: 29 October 2009

General Comments:

This paper presents a trend analysis to assess the UTLS baroclinic wave energy trends using multiple data sets and a normal mode decomposition method. Three sets of trends are presented to support the hypothesis of an increase in UTLS baroclinicty: 1) Trends in baroclinc wave energy for a range of modes, 2) trends in the vertical structure of the eddy available potential energy, and 3) trends in the frequency of the double tropopause occurrence. The paper concludes that, consistent with the meridional temperature gradient change due to the climate change, there is a positive trend in UTLS baroclinicity over the last five decades. I find the method and results interesting. Anal-

yses presented are of high technical quality. I do have significant reservations to the conclusions due to ambiguities in several arguments. The issues are discussed below, along with some suggestions for the authors to consider.

Specific Comments:

1. The vertical structure functions and their corresponding altitudes

The paper made a claim that the "deep" modes (indices 1-4) are most relevant to the UTLS, which is not at all obvious from the vertical structure functions (fig. 1). The example in the appendix is very helpful. It shows that the power spectrum for the UTLS geopotential height anomaly peaks at the m=4 mode, which is the last of the deep mode. Both fig. 1 and fig. A1 indicate that modes m=1-3 are mostly relevant to stratosphere. Fig A1 further shows that several "shallow" modes (m=6, 7) have significant contributions to the UTLS anomaly, more so than the lower index deep modes (1-3). Overall, the correspondence between the vertical structure function and the vertical range they represent is given in a hand-waving fashion. A more accurate identification is necessary. For example, what is the vertical range of the UTLS in the pressure space for the interest of this study? Is it possible to order/rank the modes that contribute the most to the region?

2. The opposite trends in the deep vs shallow modes

The opposite trends of the deep and the shallow modes add to the ambiguity discussed in the previous point. While the m=4 mode contributes the most to the UTLS and has a positive trend, the shallow modes, some of which also contribute to the UTLS has significant negative trends. How are the opposite trends compensates each other in the range of UTLS? I find this result very interesting yet the interpretations too hand-waving. What are the uncertainties in this analysis? What are the effects of the truncation?

3. The use of double tropopause (DT) trends as a test to support the normal mode

energy analyses

The significant DT trends found in the radiosonde data are an interesting result by itself. This analysis, however, is introduced as an independent “test” to support the results of the normal mode energy analysis (P 18602). The connection between DT events and baroclinicity is discussed in the opening paragraph of section 3.2. I find this discussion speculative and unsatisfying. The mechanisms controlling the DT occurrence are not yet well understood. If the authors want to use the DT trends to support the baroclinicty trends, on what basis, how, and how much the two are related need to be addressed better.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 18597, 2009.