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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The North Atlantic variability structure, storm tracks, and precipitation depending on the polar vortex strength" *by* K. Walter and H.-F. Graf

Anonymous Referee #2

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This paper investigates the relationship between the Northern Hemisphere polar stratospheric vortex and the tropospheric storm tracks. The study uses simple data analysis methods to determine the structure of the tropospheric storm-tracks when the stratospheric polar vortex is in either a weak or strong state. While the study presents interesting conclusions about the structure of tropospheric variability in each of these stratospheric states, it does not provide any dynamical explanation for these changes. I also found it a little difficult at times to find the features suggested by the text, which are generally of small spatial scale. I also think the paper overextends its conclusions somewhat, particularly in the abstract. To support some of the conclusions made by the paper a comprehensive set of carefully designed numerical modeling studies would be required. In general the paper also needs some further editing to make the language a

little easier to follow. I have tried to point out some of the obvious mistakes in the technical details section, but there may be some others I have missed. In summary, I think that the paper is touching on some very important and illuminating issues, but a lot more work needs to be done before comprehensive conclusions about the interaction of the stratospheric vortex and tropospheric storm-tracks can be made.

Specific Comments

1. p6128 l19 'Our results show it is essential to include the state of the upper dynamic boundary conditions (the polar vortex strength) in any study of the variability of the North Atlantic'. While I have some sympathy for this viewpoint I do not believe that this (or any other study) has proved this point beyond doubt. Also the characterization of the stratosphere as a boundary condition should be justified.

2. p6130 l24-29 I think a distinction should be made here between normal stratospheric variability as typified by the Matsuno example and changes to that variability due to external climate forcings (volcanoes, ozone loss etc.). During all winters the stratospheric vortex has some kind of variability. I would suggest that this should not be characterized as shifts in different stratospheric regimes. Climate forcings may indeed shift the vortex in various different stratospheric regimes, of the type suggested by Palmer (JoC, 1999) and described for the stratosphere by Scaife and James (QJRMS, 2000) but the evidence for this is less than conclusive.

3. p6131 I think the discussion of wave processes is a little confused here. Do the authors mean to make a distinction between reflection, refraction and absorption of planetary waves or do they consider all three processes to be essentially the same? A more recent discussion of planetary wave reflection and its influence on the troposphere can be found in Perlwitz and Harnik (JoC, 2003)

4. p6132 l21 All of the results in this paper use monthly mean data. Is the time reso-

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lution of this data sufficient to examine the relationship between the stratosphere and troposphere? Most data analysis studies put the timescale for large stratospheric influences somewhere between 10-46/60 days (see for example Baldwin et al., Science, 2003; Charlton et al., QJRMS, 2004). Did the authors consider repeating their analysis with daily data and defining the onset of strong and weak vortex regimes in the same style as Baldwin and Dunkerton (Science, 2001)?

5. p6133 l 12 The data is low pass filtered to include only fluctuations with periods less than 15 days. Is the upper tropospheric data used daily data? How are discrepancies between the monthly stratospheric and daily tropospheric data? Which parts of the daily data are used, is a month of daily data taken for each month with strong or weak stratospheric vortex?

6. p6133 l14 As per my previous comments I still find the figures a little small and difficult to examine in the printed copy. Would there be any way to include colour so that it is easier to read them?

7. p6133 l22 'This indicates that the PNA is not dependent on the state of the polar stratospheric vortex.' While it is true that a PNA pattern exists in both Fig 1(a) and (b) is it not also the case the magnitude of teleconnectivity shows large changes between SVR and WVR (from 0.6 to 0.7 in the Pacific centre) and show some sign of changing pattern between the two phases (the centre over North Western North America moves by something like 15 degrees of latitude between SVR and WVR)?

8. p6134 Given that the definition of SVR and WVR is for absolute values of the lower stratospheric flow and not anomalies then it is perhaps not surprising that many of the WVR events occur during March when the vortex is naturally weakening due to the seasonal cycle. Would it not be better to define vortex regimes based on anomalies fro climatology in the stratospheric winds? The sentence 'The vertical propagation characteristics of planetary waves are the same within

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one regime independent of season' is somewhat confusing, perhaps the authors could expand on this point?

9. p6134-6135 Is the fact that the teleconnection patterns change when different tropospheric filtering is used not a major weakness of the analysis? Does this not suggest that the distinction drawn between the two teleconnection patterns in the North Atlantic in the WVR is a sampling artifact?

10. p6135 l20 'However, it will not be sufficient for studies concerning the dynamic background of these' Do the authors mean that monthly resolution is not adequate to understand the dynamics of the link between flow in the lower Stratosphere and upper Troposphere ?

11. p6136 What is the sensitivity of the correlations quoted to the definitions used to define the indices?

12. p6136 Is the strength of the polar vortex in this analysis now defined on a daily basis as suggested by the comment '...when the polar vortex is leading by 1-2 days...' Perhaps the authors could make the procedure adopted in this section a little clearer at the start of the section?

13. p6136 l27 '...very probably to changes in the vertical wind profile' This is highly speculative and should be supported with references or further analysis or removed. Also it is not clear that from a purely data analysis study it is possible to determine that '...western NA-WVR pattern reacts to changes in the polar vortex strength...' might it not also be argued that there is a common cause for both changes?

14. p6137 l25 'This result perfectly matches the results of classic NAO studies' The authors might like to include a reference to some such studies.

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15. p6137 It is not clear to me what question the authors are trying to ask in section 2.3 by comparing the storm-track in different phases of each of the three tele-connection patterns identified in the previous section. If the question is 'What influence does the stratosphere have on the North-Atlantic storm-track?' then wouldn't a more pertinent comparison be between the storm-tracks in SVR and WVR?

16. I found the discussion of Eady growth rate in section 2.3 very difficult to follow. I feel that investigation of this parameter with regard to stratospheric influence may well be very important, but without figures to refer too much of the impact of the discussion of this diagnostic is lost. I would suggest that the panels of Fig 3, 4 and 5 which examine precipitation differences could be replaced by the Eady growth rate diagnostics. Also in a number of sections upper level winds, presumably because of their connection to the stratosphere, are used to explain the changes to the storm-track. Again I have some sympathy for this approach, but would need to see evidence of the features referred to in the text to be able to judge their validity.

17. p6139 l13 '...together with the anomalies at the Norwegian coast, serve as a proxy for the strength of the polar vortex' I am extremely dubious about this point, given the amount of noise in tropospheric precipitation and the very small link between the stratosphere and troposphere (typical increases in skill of statistical tropospheric forecasts which use extra stratospheric information are 5

18. p6140 l5 Do the authors have any physical insight as to what the double dipole pattern apparent in the WVR might represent and why it might occur during weak stratospheric vortex events?

19. p6140 l27 'Climate forecast based on a forecast of the NAO and statistical down-scaling of its effects would lead to wrong conclusions when the state of the strato-sphere is not taken into account' I'm not sure that this conclusion can be reached

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from the analysis presented here. Also I think a key part of any statement like this should include some reference to the quantitative size of any stratospheric influence.

Technical Issues

1. p6128 l16 ‘It is reaching...’ suggest, ‘It reaches...’
2. p6129 l19 ‘...in the order of...’ on the order of.
3. p6129 l29 ‘Under normal conditions in winter, only ultra long planetary waves have the possibility to enter the stratosphere’, suggest, ‘Under normal conditions only ultra long planetary waves can propagate into the stratosphere.’
4. p6131 l19 ‘...has an influence also on...’ suggest, ‘...also has an influence on...’
5. p6131 l23 ‘...which normally is being used...’ suggest, ‘...which is normally used...’
6. p6132 l5 ’...the annual cycle has been removed...’ tense changes here, suggest, ‘...the annual cycle was removed...’
7. p6132 l8 ‘...we did not study trends. Subtracting ten year running means has removed the trends.’, tense changes here, suggest, ‘...we did not study trends, which were removed by subtracting ten year running means from the data.’
8. p6132 l11 ‘The reanalysis data there provide fairly accurate information also...’, suggest, ‘Reanalysis data in the Northern Hemisphere extra-tropics is fairly accurate (Kistler et al., 2001)’
9. p6132 l14 ‘Rainfall estimates have limited reliability mainly when convective rain is considered, but in winter large-scale anomalies may be believed to be right as

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first order estimates...', sentence is confusing, suggest, 'Rainfall estimates have limited reliability in winter, particularly for convective rain, but may be considered accurate to first order...'

10. p6133 l7 'The existence of real teleconnections has been approved....' do the authors mean proved?

11. p6135 l4 'In general, the values then are larger due to the temporal smoothing effect', suggest, 'In general, larger temporal smoothing increases teleconnection values.'

12. p6135 l4 'When monthly mean data are used, in particular the eastern NA-WVR pattern stick out very clearly with values above 0.8 in both centres...', suggest, 'When monthly mean data are use the eastern NA-WVR is particularly prominent, both centres have teleconnection values above 0.8'

13. p6137 l7 'The filtering was done with the band pass filter...' suggest, 'The data were band-pass filtered using the filter of...'

14. p6139 'Cyclones reach north-western Europe more southerly...' It wasn't clear what this sentence meant.

15. p6140 l27 'Climate forecast based...' suggest, 'Climate forecasts based...'

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 6127, 2004.