Clim. Past Discuss., 2, S623–S626, 2006
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Climate of the Past Discussions

Interactive comment on "Atmospheric multidecadal variations in the North Atlantic realm: proxy data, observations, and atmospheric circulation model studies" *by* K. Grosfeld et al.

K. Grosfeld et al.

Received and published: 24 November 2006

Point by point reply to Reviewer 1: cpd-2-S341$_{p.pdf}$

First of all we thank the reviewer for his careful reading of our manuscript and his suggestions. In the following we try to clarify his concerns in replying to each of his points, separately. In the revised version of the manuscript, these argumentation and additions will be included.

Anonymous Referee #1
Received and published: 8 September 2006

The paper "Atmospheric multidecadal variations in the North Atlantic realm:

proxy data, observations, and atmospheric circulation studies" by Grosfeld et al. investigates the long-term variability over the last couple of 100 years in the Atlantic region by use of various observational data and two circulation models of different complexity.
General comments: This paper makes an interesting contribution to the understanding of Atlantic climate variability by using both proxy and observational data as well as model experiments. I recommend publication of the paper after my detailed comments have been satisfactorily addressed by the authors.

Detailed comments:

- Delworth and Mann (2000) show that the AMO has a equivalent barotropic vertical structure. Is this also the case in the model experiments used in this study? If Atlantic SSTs contribute to the forcing of this mode, then I would expect a baroclinic response close to the SST anomalies and the barotropic response downstream. This makes me wonder if the AMO is remotely forced and not locally.

Answer: Concerning the discussion of barotropic or baroclinic vertical structure, we calculated the warm-cold anomalous field for geopotential height at 500 hPa, equivalent to Figure 4g of the manuscript (to be included in the revised version).

It clearly shows a barotropic structure of the dipolar field with a negative anomaly, but reduced horizontal extension over the subtropical North Atlantic. Following the idea of the reviewer that an Atlantic forcing of the AMO would induce a baroclinic vertical structure close to the anomalous SST field, this result speaks for a remote forcing mechanism. In a second paper, which is in revision with Climate Dynamics ("Atlantic and Pacific origins of North Atlantic multidecadal variability" by Grosfeld, Lohmann and Rimbu) we investigate exact this question in different model simulations over the observational period (last 145 years), with prescribed observed SST in the Atlantic or Pacific Ocean and clima-

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tological forcing of mixed layer slab ocean outside. Here we found, that the AMO is forced by two mechanisms, the Atlantic SST which reveals a monopolar SLP field over monopolar SAT at time scales of 60-70 years and a signal of Pacific origin, which is transferred via PNA to the Atlantic at time scales of 80-90 years. Both parts contribute to the AMO signal which is derived from observational data and also from model results shown in this study.

- Is the SLP pattern over the North Atlantic also predictable if only Atlantic SST can be predicted? If the models would be only forced with the observed SST over the Atlantic and with constant climatological SST elsewhere, would this produce the same climate variability over the Europe/Atlantic region?

Answer: Only the SLP pattern associated to North Atlantic SST can be predicted from Atlantic only SST, which is just a part (relatively small) of multidecadal SLP variation in the North Atlantic. The response pattern is different than for global forcing. SLP depicts a basin wide barotropic monopolar pattern and a large scale inter-ocean seesaw between Atlantic and Pacific. The variability pattern over the Euro-Atlantic realm and the associated time scale is different than for global forcing, indicating a specific role of Atlantic forcing on climate system. E.g., in the "Atlantic only" simulation, a large scale negative anomalous pressure system with high values of explained variance over the tropic extends over Europe and the Mediterranean region. In the globally forced model experiment the Atlantic pressure system is not clearly associated with Atlantic SST only, it is also determined by teleconnections from Pacific and therefore, also different in the Euro-Atlantic region. A discussion of the different patterns and the influences of different ocean basins on the AMO is given in Grosfeld et al. (2006).

- The authors are using filters to isolate low-frequency variability. How sensitive are the results on the filter parameters, like cut-off frequencies?

Answer: For the model results we always use 21-years running mean filtering

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which do not depend on cut-off frequencies. With this procedure, the high frequency part is damped, while the low frequency variation remains. For the time series Ras Umn Sidd and Cariaco Basin, we choose Fourier filtering in a band pass of 50-100 years. Because of the length of the time series, a band pass filter enables the elimination of high frequency but also centennial year's variations. Beyond 100 years, the time series are not sensitive against the cut-off frequency. We performed several tests with the high frequency limit and choose it to be below the 60-70 years multidecadal band and higher than the decadal/interdecadal band. Test on different low-cut frequencies (35, 40, 45 years) show similar results than that for the 50 year low cut.

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