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Discussions

Interactive comment on "The gyre-scale circulation of the North Atlantic and sea level at Brest" *by* P. L. Woodworth et al.

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Comments on the Woodworth et al. 2009 paper, General

This is a splendid paper, well done. The authors have used a great deal of work in data archaeology to determine long records of sea level to extend the comparisons, originally by Miller and Douglas (2007), in slightly different form, to a longer time interval. Sea level on the west coast of Europe is reasonably correlated, at periods of order 15 - 30 years, with atmospheric pressure in roughly the center of the North Atlantic gyre. The analogous comparisons by Miller and Douglas were between sea level and local atmospheric pressure. The implication of course is that the correlations also must be with the large-scale circulation of the main N. Atlantic gyre circulation. This is an extremely important point. It implies that sea level changes result from the circulation,

in some form, rather than requiring fluid to be added or subtracted from the ocean. It is well known that sea level pressure is one of the elements of the North Atlantic Oscillation; almost everything of the large-scale atmospheric circulation is coherent at these time scales. The NAO has periods on the order of decades or less; the similar coherence between atmospheric pressure and other variables at the longer periods of the present work, often called the Atlantic multi-decadal oscillation, so far as I know, is yet to be shown. The idea that the correlations would be similar at longer periods seems plausible, but remains an untested assumption.

Specific Comments: One uncertainty about the extent to which the circulation of the main gyre is involved comes to mind. It is clear that the NAO is well correlated with the curl of the wind stress. However, the variable that is shown here to be well correlated with sea level is atmospheric pressure at the coast (or at the center of the gyre, pick your favorite). Atmospheric pressure gradients in the East-West direction are or course synonymous with winds in the North-South direction. Sea level at the coast is known to be highly correlated with longshore winds. In the present case, the scales of the longshore wind field are not clearly known. Thus, it is possible to speculate that these low-frequency sea level signals along the west coasts of the continents are related as much to possibly broad long-shore currents, as to the circulation of the entire gyre. The data to test this speculation may be hard to find. That is, do the fluctuations in sea level extend fairly extensively across the entire ocean, or are they restricted to a more narrow band close to the coast? No matter which result turns out to be true, it is clear that some part of the large-scale circulation is involved, rather than massive amounts of extra water. For completeness the spectrum of the atmospheric pressure at Brest is shown below; it is based on the data of Kuttel et al. (kindly provided by P. Woodworth) shown in Figure 2 of the paper here. It is in the variance-preserving form, in which the area under the curve shows the amount of power at the various frequencies. We see that the amount of variability at periods between five and $\sim$eight years is considerably greater than at longer periods. There is modest bump at 15 years.

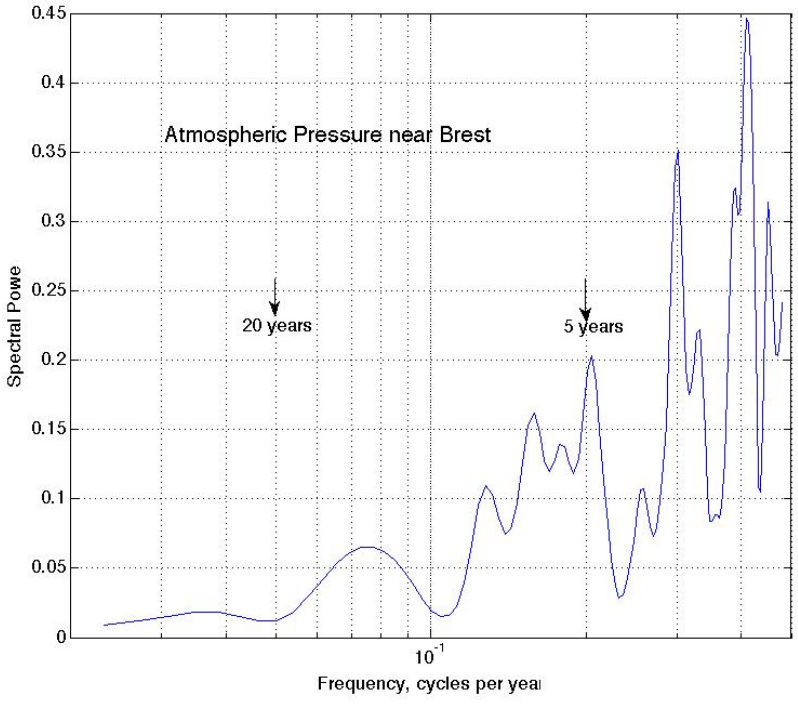

Fig. 1. Spectrum of Atm Pressure at Brest