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Interannual oscillations and the weather over the North Atlantic

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The interannual oscillations have small amplitude with respect to the amplitudes of mid-latitude weather systems, like the winter cyclones. Thus it is not clear how these weak oscillations affect the weather systems. We explore this problem over the North Atlantic basin (NAB) by using the NCEP-NCAR reanalysis on a 2.5x2.5 degree grid for 1949–2012.

We partition the North Atlantic into into four rectangular regions, divided by the 45 W meridian and the 40 N parallel. The winter average (DJFM) of the daily transient kinetic energy of the geostrophic wind (GTKE) over these four quadrants was calculated at the 500-hPa level. The mean of the GTKE over each region shows prominent year-to-year variability. The GTKE variability contains three oscillatory modes, with periods of 8.7, 5.6 and 2.7 years. These oscillatory modes are highly significant statistically and close in period to the interannual oscillations found in the North Atlantic Oscillation (NAO) index (Feliks et al. 2010, 2013).

The correlations between the winter average of the NAO index and the spatial GTKE average in the four quadrants are: NE = 0.82, SE = –0.79, NW = 0.54 and SW = –0.56. So the role of the NAO is significantly more prominent as expected in the eastern NAB, and there is a phase opposition between the northern and southern quadrants. The absolute value of the GTKE in the NE is larger by an order of magnitude than in the SE. The interannual oscillatory modes of the GTKE in the NE and those of the NAO index are completely synchronized.

Only in the winter does the spatial average of the GTKE over any quadrant exceed a threshold value of 220 $m^2 s^{-2}$; this value corresponds roughly to the presence of a strong winter storm within the given quadrant. The number of days during which the GTKE exceeds this value changes significantly from year to year; it is between 6 to 83 days in the NE quadrant and between 0 and 1 day in the SE quadrant. This number of days correlates with the NAO index at 0.85; the threshold value chosen here maximizes this correlation, but the latter is not very sensitive to reasonable changes in the threshold.

In the years when the GTKE is large, the NAO index is positive, and the prominent synoptic-scale oscillations in GTKE have periods of 11, 9 and 5 days; in the years when the GTKE is weak, the NAO index is negative, and the prominent oscillations have periods of 8 and 6 days. These results are statistically significant with respect to a battery of tests.