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Impact of winter weather regimes on the North Atlantic oceanic circulation

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The first mode of atmospheric variability in the North-Atlantic is the so-called North-Atlantic Oscillation (NAO), which, for its positive (negative) phase, corresponds to the simultaneous strengthening (weakening) of the Icelandic Low and Azores High. The NAO impact on ocean circulation has been thoroughly studied in literature; however, littlle is known about the role of the other modes of variability, such as the East-Atlantic Pattern (EAP) and the Scandinavian pattern.

The impact of the North-Atlantic atmosphere on oceanic circulation is here investigated through the weather regime paradigm. Weather regimes (WR) defined as large-scale, recurrent, and quasi-stationary atmospheric patterns, are preferred to modes of variability because they account for non-symmetry in space and sign of the atmospheric variability. Ocean-only experiments (here NEMO-based North-Atlantic model model at 0.5 degrees of resolution), forced with daily surface fields reconstructed from one single WR among the four traditionally extracted in the North Atlantic, allow us to assess the sensitivity of the ocean circulation to the type of WR. Our results show that the North Atlantic circulation seems to be the most sensitive to the Atlantic-Ridge WR (AR, positive phase of the EAP), characterized by an anticyclonic wind-anomaly off Europe. Under Atlantic Ridge forcing, the subtropical and subpolar gyres are approximately 15 Sverdrups weaker, and the net mass, heat and freshwater transports are strongly impacted, especially at 42N. The response of the subtropical gyre is fast (in the order of 2-3 years) while it takes about approximately 10 years for the subpolar gyre to stabilize. We also show that the response of the ocean circulation to the NAO is not symmetrical between the positive and negative phase.

Sea-Surface Height (SSH) at Bermuda (Esso-Pier) has been used as a proxy of subtropical gyre variability to assess the validity of the model results. Lead-lag correlations show that SSH anomalies are correlated with AR occurrences (AR leads by 0-2 years). We argue, by the use of a simple baroclinic and barotropic model that the impact of AR on SSH is mostly wind-driven.