On the stochastic null hypothesis for Atlantic multi-decadal variability

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Observations show a multidecadal signal in the North Atlantic Ocean, but the underlying mechanism and cause of its timescale remain unknown. Proposed mechanisms include external forcing and internal dynamics, involving both coupled ocean-atmosphere and uncoupled stochastic atmospheric forcing. This presentation focuses on the later as the null hypothesis for Atlantic Multi-decadal Variability (AMV).

Previous studies have suggested that the North Atlantic Oscillation (NAO) may drive AMV. To further address this issue, the global ocean general circulation model, NEMO, is driven using a 2000 year long white noise forcing associated with the NAO. Focusing on key ocean circulation patterns, we show that the Atlantic Meridional Overturning Circulation (AMOC) and Sub-polar Gyre (SPG) strength both have enhanced power at low frequencies but no dominant timescale, and thus provide no evidence for an oscillatory ocean-only mode of variability. Instead, both indices respond linearly to the NAO forcing, but with different response times. The variability of the AMOC at 30N is strongly enhanced on timescales longer than 90 years, while that of the SPG strength starts increasing at 15 years. The different response characteristics are confirmed by constructing simple statistical models that show AMOC and SPG variability can be related to the NAO variability of the previous 53 and 10 winters, respectively. Alternatively, the AMOC and the SPG strength can be reconstructed with Auto-regressive (AR) models of order seven and five, respectively. Using these methods to reconstruct ocean variables can be useful for prediction and model intercomparison.