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Evidence of coupling in ocean–atmosphere dynamics over the North Atlantic

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The investigation of low-frequency variability (LFV) in the mid-latitude atmosphere, for instance of the North Atlantic Oscillation (NAO), is currently attracting considerable interest. One of the main reasons is LFV's potential to enable predictions beyond the generally accepted upper bound of weather forecasting skill of 10–15 days in mid-latitudes. To understand the development of the LFV in the atmosphere, it is necessary to clarify how it interacts with the other components of the climate system, in particular the ocean. The usual strategy to clarify the coupling between the ocean and the atmosphere is to analyze the one-way sensitivity of either component to forcing by the other. In the present work, we adopt a different strategy by investigating the projections of atmospheric and oceanic fields, based on reanalysis datasets, onto a reduced phase space. The latter ocean–atmosphere subspace is dynamically defined here by relying on the leading modes of the Vannitsem et al. (2015) idealized low-order model. This approach allows one to isolate the dominant modes of the coupled system's observed variability.

The coupled projection is then analyzed using multichannel singular spectrum analysis (M-SSA). The results suggest that a dominant low-frequency signal with a 25–30-yr period already mentioned in the literature is a common mode of variability of the atmosphere and the ocean. A new score for evaluating the internal nature of the common variability is then introduced and it confirms the presence of coupled dynamics in the ocean–atmosphere system that includes a significant large-scale atmospheric component. The physical nature of this coupled dynamics is also discussed.

Reference

Vannitsem S., J. Demaeyer, L. de Cruz, and M. Ghil, Low-frequency variability and heat transport in a low-order nonlinear coupled ocean-atmosphere model, Physica D, 309, 71–85, 2015.