EGU25-10747, updated on 15 May 2025
https://doi.org/10.5194/egusphere-egu25-10747
EGU General Assembly 2025

Ocean–atmosphere feedbacks key to NAO decadal predictability

Panos J. Athanasiadis[1], Casey Patrizio[1], Doug M. Smith[2], and Dario Nicolì[1]
[1]CMCC Foundation - Euro-Mediterranean Center on Climate Change, Italy.
[2]Met Office Hadley Centre, Exeter, UK

Recent studies using initialised large-ensemble re-forecasts have shown that the North Atlantic Oscillation (NAO) exhibits significant decadal predictability, which is of great importance to society given the significant climate anomalies that accompany the NAO. However, the key physical processes underlying this predictability, including the role of ocean–atmosphere interactions, have not yet been pinned down. Also, a critical deficiency in the representation of the associated predictable signal by climate models has been identified in recent studies (the *signal-to-noise problem*), still lacking an explanation.

In this study, the decadal prediction skill for the NAO and the interactions of the associated atmospheric circulation anomalies with the underlying ocean are assessed using retrospective forecasts from eight decadal prediction systems and observation-based data. We find considerable spread in the NAO skill across these systems and critically, that this is linked to differences in the representation of ocean–NAO interactions across the systems. Evidence is presented that the NAO skill depends on a direct positive feedback between subpolar sea surface temperature anomalies and the NAO, which varies in strength across the prediction systems, yet may still be too weak even in the most skillful systems compared to the observational estimate. This positive feedback is opposed by a delayed negative feedback between the NAO and the ocean circulation that also contributes to disparities in the NAO skill across systems. Our findings therefore suggest that North Atlantic ocean–atmosphere interactions are central to NAO decadal predictability. Finally, it is suggested that errors in the representation of these interactions may be contributing significantly to the *signal-to-noise problem*.