EMS Annual Meeting Abstracts
Vol. 16, EMS2019-560, 2019

Signal and noise in regime systems: a hypothesis on the predictability of the NAO

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The North Atlantic Oscillation (NAO), being the dominant mode of variability in the North Atlantic, plays a critical role in modulating European and North American climate, particularly during the winter months (December-January-February). For many years, seasonal forecasts using general circulation models (GCMs) showed no significant skill at predicting the NAO, and it was thought that the NAO was essentially chaotic with little or no inherent predictability.

This view has been challenged in recent years. In particular, studies conducted by the UK Met Office reported significant skill in predicting the
wintertime NAO with their seasonal prediction system over a 35 year hindcast period. However, at the same time, a very low signal-to-noise ratio was observed, as measured using the "ratio of predictable components" (RPC) metric. This behaviour has since been shown to be a feature of many other seasonal prediction systems, leading to this being dubbed a 'signal to noise paradox'.

Several studies have also shown that the North Atlantic climate is influenced by the existence of quasi-persistent weather regimes. We analyse both the skill
and signal-to-noise ratio using a new statistical model, which assumes NAO predictability is driven by regime dynamics. We show that if the system is approximately bimodal in nature, with the model consistently underestimating the level of regime persistence each season, then both the high skill and high RPC value of the Met Office hindcasts can easily be reproduced. Underestimation of regime persistence, a common model error, could be attributable to any number of sources of model error, including imperfect regime structure or errors in the propagation of teleconnections. This gives one potential solution to the 'signal to noise paradox'.