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How big is the signal to noise ratio of the winter NAO?

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Recent ensemble seasonal prediction results using a high resolution version of the Met Office Hadley Centre climate model HadGEM3 show high predictability of the winter North Atlantic Oscillation (ensemble mean DJF NAO correlation with observations greater than 0.6) in re-forecasts of the last 20 years. The amplitude of ensemble mean NAO signals, however, is much smaller than in observations, despite the magnitude of NAO variability overall being realistic. This suggests the predictable signal is small compared to the contribution of unpredictable weather noise, with a signal-to-noise ratio of only about 0.2 for the DJF mean. Such a low ratio implies a much smaller ensemble mean correlation than the high value obtained (given the size of ensembles used). Here we use large synthetic ensembles of DJF NAO values to show that this apparent contradiction can be resolved if the signal-to-noise ratio in year-to-year winter mean NAO is significantly larger in reality than is found in the model. The range of real-world signal-to-noise values found to be consistent with the modelling results suggests that potentially most of the variability in mean winter NAO is externally controlled rather than being predominantly a result of weather noise. This would represent a paradigm shift in understanding of wintertime atmospheric circulation in the North Atlantic region. The small amplitude of NAO signals in the climate model suggests shortcomings in the representation of physical processes linking NAO drivers with atmospheric responses. This implies a need for greater focus on the study of processes such as the detailed simulation of mid-latitude weather systems and air-sea interaction in high resolution models.