

North Atlantic climate far more predictable than models imply

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Quantifying signals and uncertainties in climate models is essential for climate change detection, attribution, prediction and projection. Although inter-model agreement is high for large-scale temperature signals, dynamical changes in atmospheric circulation are very uncertain, leading to low confidence in regional projections especially for precipitation over the coming decades. Furthermore, model simulations with tiny differences in initial conditions suggest that uncertainties may be largely irreducible due to the chaotic nature of the climate system. However, climate projections are difficult to verify until further observations become available. Here we assess retrospective climate model predictions of the last six decades and show that decadal variations in north Atlantic winter climate are highly predictable despite a lack of agreement between individual model simulations and little predictive ability of raw model outputs. Crucially, models underestimate the predictable signal of the North Atlantic Oscillation (NAO, the leading mode of north Atlantic atmospheric circulation variability) by an order of magnitude. Consequently, compared to perfect models, 100 times more ensemble members are needed to extract the NAO signal, and its climate impacts are underestimated relative to other factors. To address these limitations, we implement a two-stage post-processing technique that first takes the variance-adjusted ensemble mean NAO and then selects the ensemble members with the required NAO signal. This approach yields skilful decadal predictions of European and eastern North American winters. Atlantic Multidecadal variability is also improved, suggesting skill does not arise solely from the north Atlantic Ocean. Our results highlight the pressing need to understand why the signal-to-noise ratio is too small in climate models, and the extent to which correcting this model error would reduce uncertainties in regional climate change on timescales beyond a decade.