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# Observed and CMIP-simulated links between North Atlantic climatological winter jet latitude and inter-annual to decadal ocean-atmosphere coupling

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Decadal variability in indices of North Atlantic (NA) atmospheric circulation plays a major role in changing climate over western Europe. However, reproducing characteristics of this variability in climate models presents a major challenge. Climate models broadly exhibit weaker-than-observed multi-decadal variability in atmospheric circulation indices. A prominent explanation for this is that model-simulated links between anomalous sea-surface temperatures (SSTs) and atmospheric variability are too weak. The dominant mode of basin-wide NA SST variability is Atlantic multi-decadal variability (AMV), which on multi-decadal timescales is expressed more strongly over the NA sub-polar gyre (SPG). SSTs over the SPG region ($SST_{SPG}$) are therefore the main focus here.

Studies to date have shown that variability in the North Atlantic Oscillation (NAO) exhibits strongest correlations with AMV indices in late winter, but the reasons for this are not clear. Here we show that this stronger late-winter correlation is particularly clear for $SST_{SPG}$ and coincides with a climatological equatorward shift of the eddy-driven NA westerly jet from early-to-late winter. To help gain dynamical insight, indices of eddy-driven jet latitude (JLI) and speed (JSI) were correlated with $SST_{SPG}$ and it was found that they exhibit more pronounced early-to-late winter shifts in correlations than for the NAO; In particular, correlations strengthen from early-to-late winter for JLI while weaken for JSI. Our results suggest that the jet-$SST_{SPG}$ linkages progress through winter from JSI dominant in early winter to JLI dominant in late winter.

CMIP5 and CMIP6 models were then evaluated for representation of these observed characteristics in ocean-atmosphere linkages. Consistent with the observed sub-seasonal links between climatological jet latitude and atmosphere-ocean correlation strength, CMIP models with larger equatorward jet biases exhibit weaker JSI-$SST_{SPG}$ correlations and stronger JLI-$SST_{SPG}$ correlations. A pronounced early-winter equatorward bias in jet latitude in CMIP models could partially explain the weaker-than observed linkage between SSTs and atmospheric variability.