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The Atlantic Multi-decadal Variability in observations and in a large historical multi-model ensemble: Forced and internal variability

Bo Christiansen, Shuting Yang, and Annika Drews
Danish Meteorological Institute, Denmark (boc@dmi.dk)

There is an ongoing discussion about the contributions from forced and natural sources to the Atlantic Multi-decadal Variability (AMV). As the AMV influences the general climate in large regions, this question has important consequences for climate predictions on decadal timescales and for a robust estimation of the influence of climate forcings.

Here, we investigate the Atlantic Multi-decadal Variability (AMV) in observations and in a large CMIP6 historical climate model ensemble. We compare three different definitions of the AMV aimed at extracting the variability intrinsic to the Atlantic region. These definitions are based on removing from the Atlantic temperature the non-linear trend, the part congruent to the global average, or the part congruent to the multi-model ensemble mean of the global average. The considered AMV definitions agree on the well-known low-frequency oscillatory variability in observations, but show larger differences for the models. In general, large differences between ensemble members are found.

We estimate the forced response in the AMV as the mean of the large multi-model ensemble. The forced response resembles the observed low-frequency oscillatory variability for the detrended AMV definition, but this definition is also the most inefficient in removing the forced global mean signal. The forced response is very weak for the other definitions and only few of their individual ensemble members show oscillatory variability and, if they do, not with the observed phase.

The observed spatial temperature pattern related to the AMV is well captured for all three AMV definitions, but with some differences in the spatial extent. The observed instantaneous connection between NAO and AMV is well represented in the models for all AMV definitions. Only non-significant evidence of NAO leading the AMV on decadal timescales is found.