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The Role of Forcings in the Twentieth-Century North Atlantic Multidecadal Variability: The 1940–75 North Atlantic Cooling

Alessio Bellucci (1), Annarita Mariotti (2), Silvio Gualdi (1,3)

(1) Fondazione Centro EuroMediterraneo sui Cambiamenti Climatici (CMCC), Bologna, Italy (alessio.bellucci@cmcc.it), (2) NOAA, Climate Program Office, Silver Spring, Maryland, (3) Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy

Results from a study inspecting the origins of multidecadal variability in the North Atlantic sea surface temperature (NASST) are presented. The authors target in particular the 1940–75 "warm-to-cold" transition, an event that is generally framed in the context of the longer-term Atlantic multidecadal variability (AMV) cycle, in turn associated with the Atlantic meridional overturning circulation (AMOC) internal variability. Here the authors examine the ability of uninitialized, historical integrations from the phase 5 of the Coupled Model Intercomparison Project (CMIP5) archive to retrospectively reproduce this specific episode of twentieth-century climatic history, under a hierarchy of forcing conditions. For this purpose, both standard and so-called historical Misc CMIP5 simulations of the historical climate (combining selected natural and anthropogenic forcings) are exploited. Based on this multimodel analysis, evidence is found for a significant influence of anthropogenic agents on multidecadal sea surface temperature (SST) fluctuations across the Atlantic sector, suggesting that anthropogenic aerosols and greenhouse gases might have played a key role in the 1940–75 North Atlantic cooling. However, the diagnosed forced response in CMIP5 models appears to be affected by a large uncertainty, with only a limited subset of models displaying significant skill in reproducing the mid-twentieth-century NASST cooling. Such uncertainty originates from the existence of well-defined behavioral clusters within the analyzed CMIP5 ensembles, with the bulk of the models splitting into two main clusters. Such a strong polarization calls for some caution when using a multimodel ensemble mean in climate model analyses, as averaging across fairly distinct model populations may result, through mutual cancellation, in a rather artificial description of the actual multimodel ensemble behavior.
A potentially important role for both anthropogenic aerosols and greenhouse gases with regard to the observed North Atlantic multidecadal variability has clear implications for decadal predictability and predictions.
The uncertainty associated with alternative aerosol and greenhouse gas emission scenarios should be duly accounted for in designing a common protocol for coordinated decadal forecast experiments.