EGU21-2503
https://doi.org/10.5194/egusphere-egu21-2503
EGU General Assembly 2021

Mechanisms of decadal North Atlantic climate variability and implications for the recent cold anomaly

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There has recently been a large focus on identifying the mechanisms responsible for Atlantic multidecadal variability (AMV). However, decadal-scale variability embedded within the AMV has received less attention, despite being a prominent feature of observed North Atlantic sea surface temperature (SST) and important for the climate of adjacent continents. These decadal fluctuations in the North Atlantic Ocean are also a key source of skill in decadal climate predictions. However, the mechanisms underlying decadal SST variability remain to be fully understood. This study isolates the mechanisms driving North Atlantic SST variability on decadal time scales using low-frequency component analysis, which identifies the spatial and temporal structure of low-frequency variability. Based on observations, large ensemble historical simulations and pre-industrial control simulations, we identify a decadal mode of atmosphere-ocean variability in the North Atlantic with a dominant time scale of 13-18 years. Large-scale atmospheric circulation anomalies drive SST anomalies both through contemporaneous air-sea heat fluxes and through delayed ocean circulation changes, the latter involving both the meridional overturning circulation and the horizontal gyre circulation. The decadal SST anomalies alter the atmospheric meridional temperature gradient, leading to a reversal of the initial atmospheric circulation anomaly. The time scale of variability is consistent with westward propagation of baroclinic Rossby waves across the subtropical North Atlantic. The temporal development and spatial pattern of observed decadal SST variability are consistent with the recent observed cooling in the subpolar North Atlantic. This strongly suggests that the recent cold anomaly in the subpolar North Atlantic is, in part, a result of decadal SST variability, and that we might expect it to become less pronounced over the next few years.