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A Decadal-scale Air-sea Interaction Theory for North Atlantic Multidecadal Variability: the NAT-NAO-AMOC-AMO Coupled Mode and Its Remote Influences

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ABSTRACT

North Atlantic region shows prominent multidecadal variability. Observational analysis shows that the North Atlantic Oscillation (NAO) leads the oceanic Atlantic Multidecadal Oscillation (AMO) by 15-20 years and the latter also leads the former by around 15 years. The mechanisms are investigated using simulations from a fully coupled model, and a NATNAO-AMOC-AMO Coupled Mode is proposed to explain the multidecadal variability in North Atlantic region. The NAT-NAO-AMO-AMOC coupled mode has important remote influences on regional climates. Observational analysis identifies a significant in-phase relationship between the AMV and Siberian warm season (May to October) precipitation. The physical mechanism for this relationship is investigated using both observations and numerical simulations. North Atlantic sea surface temperature (SST) warming associated with the positive AMV phase can excite an eastward propagating wave train response across the entire Eurasian continent, which includes an east–west dipole structure over Siberia. The dipole then leads to anomalous southerly winds bringing moisture northward to Siberia; the precipitation increases correspondingly. Furthermore, a prominent teleconnection pattern of multidecadal variability of cold season (November to April) upper-level atmospheric circulation over North Africa and Eurasia (NA–EA) is revealed by empirical orthogonal function analysis of the Twentieth Century Reanalysis data, and this teleconnection pattern is referred to as the Africa–Asia multidecadal teleconnection pattern (AAMT). A strong inphase relationship is observed between the AAMT and Atlantic multidecadal variability (AMV) and this connection is mainly due to Rossby wave dynamics. The AAMT acts as an atmospheric bridge conveying the influence of AMV onto the downstream multidecadal climate variability.