Interaction between Tropical Atlantic Variability and the Atlantic Meridional Circulation: mechanistic regional modeling studies

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Ocean-atmosphere interaction plays an important role in climate variability. This interaction is strongest in the tropical regions, where anomalous sea surface temperature (SST) can modulate moist convection in the atmosphere. The El Nino-Southern Oscillation (ENSO) phenomenon, which dominates tropical air-sea interaction, has a global impact through teleconnections. This makes it difficult to discern the signal of tropical air-sea interaction in other basins in observational analysis and global modeling studies. A regional modeling approach can help focus attention on Atlantic variability. Two such modeling approaches are described, one using a simplified regional ocean model and the other using a regional atmospheric model. The regional ocean modeling study, which involves coupling to a global atmosphere, shows that tropical Atlantic variability responds nonlinearly to changes in the Atlantic Meridional Overturning Circulation (AMOC). In the Gulf of Guinea region, SST increases rapidly when the AMOC strength decreases below a threshold value. The regional atmospheric modeling studies, which are uncoupled, address the impact of Atlantic SST on floods in the Midwestern U.S. and hurricane activity. The strength of the Great Plains Low Level Jet is correlated with Atlantic SST, and this can impact summer time flooding in the Midwest by affecting the moisture supply. The mechanistic regional modeling approach also helps distinguish between the overlapping impacts of ENSO and the Atlantic Meridional Mode (AMM) on hurricane activity. It is shown that positive ENSO and negative AMM both tend to weaken hurricane activity, but their effects do not act cumulatively. Negative ENSO and positive AMM strengthen hurricane activity, and can act cumulatively to produce the most intense signal.