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Variability Changes in the Tropical Atlantic in CMIP6

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Climate variability in the Tropical Atlantic is complex and significantly different than that in the Pacific. A strong ocean-atmosphere coupling is present, sea surface temperature (SST) variability in this region impacts the hydroclimate of the surrounding continents and influences the meridional displacement of the Intertropical Convergence Zone (ITCZ). We observe a decrease in the variability of the Tropical Atlantic after 1970 in both CMIP6 models and observations. Most of the Tropical Atlantic interannual variability is explained by equatorial and meridional modes. The Atlantic Zonal Mode (AZM) characterizes an equatorial cold tongue. The Atlantic Meridional Mode (AMM) represents an interhemispheric SST anomaly gradient. Both modes respond to positive ocean-atmosphere feedback: the Bjerkens Feedback controls most of the dynamics underlying the AZM; and a thermodynamic feedback amplifies the AMM, the WES (wind-evaporation-SST) feedback .

The observed winds relaxation after 1970 in both the equatorial Atlantic region and in the Tropical Northern Atlantic (TNA) plays a role in the decrease of Tropical Atlantic variability, for each mode predominant season. With respect to the AZM, a widespread warming trend is observed in the equatorial Atlantic accompanied by a weakening trend of the trade winds. This drives a weakening in the Bjerkens Feedback by deepening the thermocline in the eastern equatorial Atlantic and increasing the thermal damping. Even though individually the TNA and Tropical South Atlantic (TSA) show increased variability, the observed asymmetric warming in the Tropical Atlantic and relaxed northeast trade winds after the 70s play a role in decreasing the AMM variability. This configuration leads to positive WES feedback, increasing further the TNA SST, preventing AMM from changing phases as before 1970.

Associated with SST, trade wind trends and decreased Tropical Atlantic variability, the African Sahel shows a positive precipitation trend. The southwest wind anomaly (trade wind relaxation) over the Tropical North Atlantic carries more humidity into the Sahel region, therefore increasing precipitation. As a consequence of the observed trends and decreased variability especially in the AMM, the ITCZ tends to shift northward, which acts on maintaining the increased precipitation over the Sahel.