Influence of a Weakened AMOC on the El Niño-Southern Oscillation

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The El Nino-Southern Oscillation (ENSO) drives the single largest interannual climate variability globally. However, how and why ENSO has changed in the past and how it may change in the future in association with changes in the mean state of the climate system are poorly understood. Climate modeling studies with General Circulation Models (GCMs) demonstrate that ENSO variability increases in response to a weakened AMOC associated with a large freshwater perturbation in the North Atlantic. We propose that the response of ENSO is highly sensitive to the tropical Pacific mean state biases present in GCMs and that the presence or absence of tropical Pacific mean state biases, as well as the magnitude of the AMOC reduction, can lead to a wide range of ENSO responses. We test this hypothesis using a linearized coupled atmosphere-ocean model of the tropical Pacific in addition to a series of fully coupled GCM simulations with the Community Earth System Model (CESM) in which freshwater perturbations were imposed to the North Atlantic. An identical set of experiments was also performed with CESM, but with the addition of heat flux corrections to reduce mean state biases in the tropics before the freshwater forcing was imposed. The processes responsible for the changes in ENSO variability due to the freshwater perturbation (with and without biases in the starting mean state) are quantified using an offline intermediate model of the tropical Pacific. Understanding the sensitivity of ENSO to such mean state changes and to biases in the mean state of the tropical Pacific in GCMs is critical for constraining past and future ENSO variability.