An interdecadal oscillatory mode of the Atlantic meridional overturning circulation in a hierarchy of ocean and coupled models

Alexey Fedorov, Florian Sevellec and Les Muir

Yale University

This study focuses on the pronounced decadal to multi-decadal AMOC variability common in coupled climate models. To study such variability, as the first step, we have conducted a stability analysis of a realistic ocean GCM and show the existence in the system of an interdecadal, weakly-damped natural mode of oscillation (an eigenmode) centered in the northern Atlantic and related solely to ocean dynamics. The mode period is approximately 25 years and its mechanism is associated with a westward propagation of temperature anomalies in the upper ocean. These temperature anomalies affect the ocean density field in the North Atlantic and hence ocean circulation. The most efficient way to excite this mode is via perturbations in surface temperature and salinity centered off the east coast of Greenland and Canada, south of the Denmark Strait. Simple estimates indicate that moderate changes in surface temperature or salinity in this region can lead on decadal timescales to variations of the AMOC volume transport on the order of 10-20%. We show that the excitation of this mode depends on oceanic mean convection that allows the deep ocean to feel surface density anomalies. Further, we consider whether this interdecadal mode is present and robust in the coupled models of the CMIP5 project. We find that, indeed, similar AMOC variability related to westward-propagating temperatures anomalies develops in many coupled models (GFDL ESM2M and IPSL CM5A, for example). We argue that the mechanism of these variations in these models is the excitation of the exact same oceanic mode by atmosphere processes in the northern Atlantic.