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Title:

Variability in the North Atlantic and North Pacific basins in CCSM3: Implications of both statistical equilibrium and global warming simulations.

Abstract:

The nature of the variability in the northern ocean basins is investigated through a detailed analysis of multi-century integrations of CCSM3 of both pre-industrial and present-day perpetual seasonal cycle conditions and also of five Global Warming scenarios.

In the different perpetual seasonal cycle simulations, the modeled North Pacific decadal variability, in terms of Sea Surface Temperature and Sea Surface Salinity (SST and SSS), is in close accord with the observed Pacific Decadal Oscillation (PDO) and has a typical period of 20 years.
A detailed analysis of the statistical equilibrium runs confirms that the underlying mechanism of the PDO is a basin wide mode of ocean adjustment to changes of the Aleutian low pressure system. The analysis also suggests that the advection of spice anomalies from the central and western Pacific to the Bering Sea sets up the typical 10 years timescale for triggering the PDO reversal.
In all the Global Warming simulations, while the SSS variability continues to be dominated by the same mode of variability, the SST appears to be dominated by lower frequencies. The fact that the PDO and the warming trend in SST share some similarities indicates a possible coupling between the two.

Under no warming, the Meridional Overturning Circulation (MOC) variability in the North Atlantic is shown to be dependent upon the chosen control simulation. Under preindustrial perpetual seasonal cycle conditions, the MOC variability is characterized by a well-defined periodicity of 60 years, while, under present-day conditions, the MOC is only dominated by a wide spectrum of low-frequencies. The source of the MOC periodicity appears to be a modified subpolar gyre circulation which is able to sustain a strong coupling between the horizontal and overturning circulations. In both control simulations, the MOC is shown to respond with a delay of 10 years to synchronous temperature and salinity anomalies in the deep water formation sites located in the subpolar gyre.
Based upon the global warming runs, for the simulations initialized from the pre-industrial statistical equilibrium run, the North Atlantic variability continues to be dominated by strong coupling between the horizontal and overturning circulations if the imposed forcing is weak. More generally, the delayed response of the MOC to density anomalies in the deep water formation sites is conserved under sufficiently weak forcing.