Ocean's role in climate and climate change

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Abstract

Twentieth century climate change has forced a poleward contraction of the Southern Hemisphere (SH) subpolar westerly winds. The implications of this wind shift for the ocean's thermohaline circulation (THC) is analyzed in models and, where available, observations. Substantial heat content anomalies can be linked to changes in the latitude and strength of the SH westerly winds. For example, the Southern Annular Mode projects onto sea surface temperature in a coordinated annular manner - with a conspiring of dynamic and thermodynamic processes yielding a strong SST signal. Subantarctic Mode Water (SAMW) change can be linked to fluctuations in the wind-drivenEkman transport of cool, low salinity water across the Subantarctic Front. Anomalies in air-sea heat fluxes and ice meltwater rates, in contrast, drive variability inAntarctic Surface Water, which is subducted along Antarctic Intermediate Water (AAIW) density layers. SAMW variations also spike T-S variability in AAIW, particularly in the southeast Pacific and southeast Indian Oceans. The location of zero wind stress curl in the SH can also control the distribution of overturning in the North Pacific/North Atlantic. A southward wind shift can force a stronger Atlantic THC and enhanced stratification in the North Pacific, whereas a northward shift leads to a significantly reduced Atlantic THC and the development of vigorous sinking in the North Pacific. This is because the distribution of wind stress over the Southern Ocean influences the surface salinity contrast between the Pacific and Atlantic basins. The implications of these findings for oceanic climate change are discussed.