The complex spatial and temporal structure of the Atlantic Meridional Overturning Circulation

As a result of the higher surface density in the Atlantic compared to other basins, cooling results in deep reaching convection and dense water formation. These dense waters travel southward at depth and are returned to the surface mainly due to wind-driven adiabatic upwelling over the Southern Ocean. As a result of this overturning circulation in the Atlantic, commonly referred to as the Atlantic Meridional Overturning Circulation (AMOC), the Atlantic Ocean transports heat northward in both hemispheres. The simplicity of this zonal-average circulation belies the complex geometry of water mass transformations and the near surface and deep currents which make up the AMOC, which have recently become apparent through new observations and high-resolution model simulations.

Due to the role of the AMOC in ocean heat transport, much effort has been placed in understanding variations in the AMOC. The AMOC exhibits substantial variability on interannual timescales and much smaller variability on interannual to decadal timescales. AMOC variability depend strongly on region, with high-frequency, wind-driven variability dominating in the subtropics and low-frequency wind and buoyancy driven variability dominating in the subpolar North Atlantic. On decadal and longer timescales, large-scale, meridionally coherent AMOC variations are seen in models, and these modes of variability appear related to buoyancy forcing anomalies over the subpolar North Atlantic. Low-frequency AMOC variations may underpin interannual to decadal predictability of sea surface temperatures in the Atlantic.

The AMOC plays a central role in the response of the climate to anthropogenic forcing, as it is a primary means for transporting heat and carbon from the surface to the deep ocean, and some of the model spread in warming can be traced to differences in models' representation of the AMOC. The AMOC also responds to climate change; the AMOC is projected to decrease as a result of increasing greenhouse gas concentrations. AMOC changes can imprint themselves onto regional and global climate. Temperature trends over the twentieth century and climate change projections show a conspicuous region of cooling over the Atlantic subpolar gyre, which has been termed the "warming hole," and studies have attributed this warming hole to changes in the ocean circulation.