Thermohaline Circulation

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Thermohaline circulation is the part of the ocean circulation that is driven by differences in heating/cooling and evaporation/precipitation/salinity forcing, as opposed to the part of the circulation driven by winds or tides (*see* **Ocean Circulation**, Volume 1; **Salinity Patterns in the Ocean**, Volume 1). The upper ocean thermohaline circulation is difficult to detect because of the strength of the wind-driven circulation there. However, thermohaline forcing (i.e., density differences caused by salinity and temperature differences) dominates the deep ocean circulation, below about 2000 m, which is the depth of the large-scale, wind-driven gyres. In contrast to the wind-driven circulation, the thermohaline circulation is of global scale. The abyssal (deep ocean) thermohaline circulation is driven by deep convection caused by large air–sea heat exchange in winter in isolated high-latitude locations. Such convection is very localized, in patches of about 1 km horizontal extent. Convection in these regions reaches 1500–2000 m depth but rarely to the ocean bottom. The abyssal circulation is also driven by rejection of saline brine during the formation of sea ice in narrowly defined regions – the briny waters increase the density of the underlying seawater. Deep water formation sites include the Greenland, Weddell and Ross Seas whose convection fills the abyssal oceans below about 2000 m and the Labrador and Okhotsk Seas, which fill intermediate depths below about 1000 m. Upwelling of these dense waters is considered to occur throughout the world's oceans and is a major cause for the large-scale, but weak, abyssal currents. The convective source regions and ocean basins are connected through deep western boundary currents (DWBCs). DWBC velocities can reach $0.1\,m\,s^{-1}$, while interior ocean velocities due to the thermohaline circulation are usually less than $0.01\,m\,s^{-1}$. In contrast, speeds of the wind-driven currents of the upper 2000 m of the ocean are about 10 times faster, reaching $1\,m\,s^{-1}$ in boundary currents and about $0.1\,m\,s^{-1}$ in mid-ocean.

See also: **Ocean Conveyor Belt**, Volume 1.

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