Introduction

Circulation of water throughout the world’s oceans occurs by one of two major modes: surface currents or thermohaline circulation. The former reside in the upper few hundred meters of the oceans and are predominantly controlled by winds. The latter is regulated by temperature (thermo-) and salinity (-haline). Together, these two physical parameters dictate particular ocean water mass densities, the driving force behind large-scale, deep circulation. In general, as a result, thermohaline circulation causes warm water to flow poleward near the surface; in turn, this warm water cools and becomes more dense. The
water mass then sinks and begins flowing south toward the equator.

- See Toggweiler and Key (2001) for an excellent introduction to thermohaline circulation.
- See also this introduction from NOAA: http://oceanservice.noaa.gov/educat...conveyor1.html

---

**Deepwater Formation**

Where does it all begin? Thermohaline circulation is driven by the formation of North Atlantic Deep-Water (NADW). Because the Earth is a sphere, the sun’s energy warms the globe unequally, with most of the energy concentrated along the equator and the least amount of energy reaching the poles. The Gulf Stream facilitates the movement of warm equatorial waters through the tropics and sub-tropics north to the North Atlantic. Along this transit, the water becomes more saline due to evaporation. As the salty mass proceeds northward toward the sub-Arctic regions, it also cools. It can cool enough for sea ice to form, which leaves salt behind, causing the water to become even saltier and more dense. Consequently, water jettisoned to the Norwegian Sea and Arctic Ocean by the Gulf Stream becomes dense enough to sink out, and thus NADW is formed.

---

**Transit Through the Ocean**

“This animation first depicts thermohaline surface flows over surface density, and illustrates the sinking of water in the dense ocean near Iceland and Greenland. The surface of the ocean then fades away and the animation pulls back to show the global thermohaline circulation,” (Olsen et al 2013).
Locations of Deep Water Formation

Locations of Intermediate Water Formation

Potential source: Antarctic Intermediate Water Mass Formation in Ocean General Circulation Models, Jacob V. T. Sørensen
http://journals.ametsoc.org/doi/abs/...l%3E2.0.CO%3B2

Transit of Heat, Salt, Nutrients

References

- Good source for descriptions and media: http://earthobservatory.nasa.gov/Fea...evidence_2.php
- Good source for media and description of transit of deep water: http://www.grida.no/climate/vital/32.htm
- General Information, also a good image at bottom of page to potentially include. http://www.ncdc.noaa.gov/paleo/ctl/thc.html
- REALLY great for multimedia (animations and diagrams) from NASA/Goddard Space Flight Center Scientific Visualization Studio: http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=3884
- BEST IMAGE EVER of live, constantly updated maps on thermohaline circulation: https://www.google.com/maps/d/viewer...l.k6ZBBt9lvWw4