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On the thermally-driven ocean

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How will the ocean circulation respond to extensive temperature change? Warming over the Arctic Ocean due to the loss of sea ice and snow cover will impact the surface air temperature (Serreze and Farncis, 2006; Screen and Simmonds, 2010) and thereby the Northern Hemisphere (NH) temperature gradient. The ocean circulation will respond, but freshwater from ice melting and shifting storm tracks make it hard to determine the ocean response to temperature changes alone. Attempts have been made to separate the impact of wind, thermal and freshwater forcings on the large scale ocean circulation (Cai, 1994; Saenko et al., 2002; Nycander et al. 2007), but our understanding remains incomplete.

Here we examine numerical solutions of the global circulation with realistic bathymetry, driven solely by surface buoyancy forcing. Explicit wind forcing is excluded, although vertical mixing is retained. The character of the resulting flow is consistent in many ways with the observed ocean circulation,with inflow to and sinking in the Nordic Seas, baroclinic western boundary currents and an overturning streamfunction which closely resembles those obtained in full GCMs and in observations.

The overturning circulation exhibits two thermally-driven cells: one in the Southern Ocean (SO) and one in the Atlantic. We investigate the inter-basin transports, the relative importance of the two overturning cells for the global ocean circulation, as well as the sensitivity of the ocean circulation to changes in buoyancy forcing. We find that reduced Atlantic overturning accelerates the SO circulation, while a reduced SO circulation strengthens the Atlantic overturning considerably.

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