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The buoyancy-driven ocean circulation with realistic bathymetry

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In contrast to the wind-driven ocean circulation, where the concept of a Sverdrup interior and western boundary currents is generally accepted, we lack a simple dynamical framework for rationalizing the buoyancy-driven circulation. Thus most of our intuition is based on numerical solutions, primarily in idealized basins (e.g. Huck et al., 1999; Park and Bryan, 2001). 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 model (the MITgcm) is run with a hybrid resolution scheme, to capture approximately the variation of the deformation radius.

The character of the resulting flow is consistent in many ways with the observed ocean circulation. There is 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. Furthermore, the solutions share many features with solutions obtained with a linear analytical model (Pedlosky, 1969; LaCasce, 2004), suggesting the latter may be conceptually useful, despite lacking bathymetry. We discuss these points, as well as implications for the climate system in general.

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