



Global overturning circulation and freshwater balances

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The relation between the global overturning circulation and freshwater transports is examined. The global circulation is to some extent down-gradient in terms of steric height distributions, at all depths from the surface to the bottom, based on observational syntheses. Diapycnal upwelling in both the Southern Ocean and the Indian/Pacific Oceans is integral to the global overturn, in addition to downwelling in the well-known deepwater source regions. The distribution of diapycnal fluxes depends mainly on the small salinity differences between ocean basins that arise from the pattern of atmospheric water vapor transports. The equatorward freshwater transports from the high latitude southern and northern hemispheres are carried by the surface overturning cells in the south, and by North Atlantic Deep Water and North Pacific Intermediate Water formation in the north; the dynamical difference is due to the open Drake Passage in the south. The required freshwater export from the Pacific to the Indian/Atlantic Oceans follows multiple pathways; the flux of fresh water from the Pacific to the Atlantic through Bering Strait is seen to have a greater influence on North Pacific overturn than on the properties of North Atlantic Deep Water.