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**Abstract title**

Downgradient flow in the global overturning circulation

**Abstract text**

At the very largest global scales, including the Atlantic, Pacific, Indian and Southern Oceans, the observed overturning circulation is down-gradient, from high to low pressure, based on observations of the sea surface height and adjusted (absolute) steric height within the deep water layers and the Antarctic Bottom Water layer. Such down-gradient flow is a feature of theories of the very largest scale circulation, and can be explained as a balance between pressure gradient and weak diffusivity in the down-"stream" direction (with geostrophic balance in the cross-"stream" direction). The observations are the well-known global maps of sea surface height derived independently from surface drifter observations, altimetry, and absolute steric height from hydrographic observations. The mid-depth (2000 to 3000 m) and abyssal (4000 m and below) maps are based on hydrographic observations with geostrophic reference velocities selected for mass continuity and consistency with tracer observations. These fields are consistent with southward transport of North Atlantic Deep Water through the Atlantic, northward transport of Antarctic Bottom Water into the Atlantic, Pacific and Indian, and the inter-ocean circulations that move upper ocean waters into these formation regions. The Pacific stands higher than at the surface than the Atlantic because it is fresher, which is also the principal argument for the Pacific-Atlantic asymmetry in deep water formation.

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