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Cross-Gyre Ventilation of the Subtropical Gyre: An Internal Mode in the Ventilated Thermocline

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ABSTRACT

A model of cross-gyre geostrophic flow is presented. It is a two-layer model of the (Northern Hemisphere) subtropical thermocline above a resting lower ocean. The northern boundary of the gyre is taken to be a latitude circle on which the Ekman pumping vanishes.

In distinction to previous theories, the meridional geostrophic velocity at the line of vanishing Ekman pumping is not zero. Instead, an internal mode is found which consists of southward, potential-vorticity-conserving flow in the lower layer and northward flow in the upper layer. There is net transport across the gyre boundary, in agreement with the Sverdrup relation.

The theory describes the longitudinal extent of the internal mode. Sufficient distortion of the isolines of potential vorticity by the wind-stress curl south of the gyre boundary is required in order to allow the flux of fluid in the internal mode to penetrate into the subtropical gyre. The model is presented as an additional example of gyre ventilation, in this case due to interaction with a neighboring gyre rather than the sea surface. Attention is drawn to the similarity of the calculated flow with the circulation pattern for the eastern North Atlantic proposed by Saunders.

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