
Thermally driven cross-shore flows in stratified lakes

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Abstract

Sloping boundaries in stratified aquatic systems function as critical zones for environmental dynamics. While their role in energy dissipation is well documented, their capacity to trigger large-scale motions remains underexplored. This presentation examines thermally driven cross-shore flows on sloping boundaries under weak wind conditions, focusing on 'thermal siphons' (TS), a dynamical process whereby local free convection transitions into horizontal circulation over sloping topography. Thermal siphons arise from bathymetrically induced density gradients when uniform surface buoyancy fluxes (differential cooling or heating) are applied across a lake. During differential cooling above the temperature of maximum density, TS generate an overturning circulation characterized by downslope density currents and compensating surface return flows within a convective boundary layer. Through synthesis of field observations, laboratory experiments, and high-fidelity numerical simulations, we present the temporal evolution, formation mechanisms, water transport characteristics, and cross-shore exchange pathways of thermal siphons.

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