Abstract View

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A Method of Objective Analysis for Currents in a Lake with Application to Lake Ontario

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ABSTRACT

The mean circulation in large takes is nearly nondivergent in character. This paper takes advantage of this fact to represent the flow field in terms of the transport streamfunction. The horizontal velocity vector (**v**) and the vertical component of vorticity are then given by $\mathbf{v} = \mathbf{k} \times H^{-1}\boldsymbol{\Delta}\Psi$ and $\zeta = \boldsymbol{\Delta} \cdot H^{-1}\boldsymbol{\Delta}\Psi$, where Ψ is the transport streamfunction, $\boldsymbol{\Delta}$ the horizontal gradient, and $H = H(x,y)$ the equilibrium depth of the lake. If the vorticity field $\Psi(x, y)$ is known, Ψ can be determined from the above inhomogeneous equation with $H^{-1}\Psi = 0$ on the boundary. The current vector is then obtained from the other equation. In practice, however, currents are measured and not vorticity. Therefore, the proposed objective analysis procedure expands the transport streamfunction in terms of the eigenvectors of the self-adjoint problem $\boldsymbol{\Delta} \cdot H^{-1}\boldsymbol{\Delta}\Psi_\alpha = \mu_\alpha\Psi_\alpha$ with $H^{-1}\Psi_\alpha = 0$ on the boundary. The eigenvalues μ_α and eigenvectors Ψ_α are characteristic of the particular lake and are determined numerically by a Lanezos procedure. The expansion coefficients are determined by minimizing the squared error between the calculated **v** field and available current meter data. Since the Ψ_α functions for the entire domain of the basin are known, the currents can be reconstructed at any point. This method has been applied to data gathered in Lake Ontario during the winter months of 1972–73 as part of the International Field Year for the Great Lakes (IFYGL).

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