Abstract View

Volume 4, Issue 3 (July 1974)

Journal of Physical Oceanography
Article: pp. 392–399 | Abstract | PDF (496K)

On Wind-Driven Lake Circulation

Stanley J. Jacobs

Dept. of Atmospheric & Oceanic Science and Dept. of Applied Mechanics & Engineering Science, The University of Michigan, Ann Arbor 48104

(Manuscript received November 30, 1972, in final form January 21, 1974)

DOI: 10.1175/1520-0485(1974)004<0392:OWDLC>2.0.CO;2

ABSTRACT

We consider here the flow induced by applying a wind stress at the surface of an initially quiescent lake. It is assumed that the Ekman number, based on an eddy viscosity, is small, and that the Rossby number is at most of the order of (Ekman number)$^{1/2}$. Under these conditions, which are met in practice, a linear theory is applicable. The linear problem is solved using boundary layer methods. There are essentially five distinct regions: an outer region in which the horizontal velocity is independent of depth, Ekman layers at the upper and lower boundaries, a corner region at the edge of the lake at which the Ekman layers meet, and a shear layer adjacent to the corner region. Study of the Ekman layers provides the equations which hold in the outer and shear layer regions, and consideration of the corner region provides the boundary condition. The outer flow proves to he geostrophic and directed along curves of constant depth. The shear layer is needed to satisfy the boundary condition of zero net outward transport at the edge of the lake. If the wind stress is constant, or, more generally, has zero line integral around curves of constant depth, the transport is confined to the shear layer.