바람의 회전응력, 지형, 그리고 성층화가 성층 호수의 물 순환에 미치는 영향

Effects of Wind Stress Curl, Topography, and Stratification on the Basin-scale Circulations in a Stratified Lake

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Abstract

Basin-scale motions in a stratified lake rely on interactions of spatially and temporally varying wind force, bathymetry, density variation, and earth's rotation. These motions provide a major driving force for vertical and horizontal mixing of inorganic and organic materials, dissolved oxygen, storm water and floating debris in stratified lakes. In Lake Tahoe, located between California and Nevada, USA, basin-scale circulations are obviously important because they are directly associated with the fate of the suspended particulate materials that degrade the clarity of the lake. A three-dimensional hydrodynamic model, ELCOM, was applied to Lake Tahoe to investigate the underlying mechanisms that determine the characteristics of basin-scale circulations. Numerical experiments were designed to examine the relative effects of various mechanisms responsible for the horizontal circulations for two different seasons, summer and winter. The unique double gyre, a cyclonic northern gyre and an anti-cyclonic southern gyre, occurred during the winter cooling season when wind stress curl, stratification, and Coriolis effect were all incorporated. The horizontal structure of the upwelling and downwelling formed due to basin-scale internal waves found to be closely related to the rotating direction of each gyre. In the summer, the spatially varying wind field and the Coriolis effect caused a dominant anti-cyclonic gyre to develop in the center of the lake. In the winter, a significant wind event excited internal waves, and a persistent (2 week long) cyclonic gyre formed near the upwelling zone. Mechanism of the persistent cyclonic gyre is explained as a geostrophic circulation ensued by balancing of the baroclinc pressure gradient (or baroclinic instability) and Coriolis effect. Topographic effect, examined by simulating a flat bathymetry with constant depth of 300m, was found to be significant during the winter cooling season but not as significant as the wind curl and baroclinic effects.

Key words : Basin-scale circulation, Double gyre, Internal wave, Lake Tahoe, ELCOM,

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