Basin-scale motion in stratified Upper Lake Constance

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ABSTRACT: This paper describes experimental and modeled wind-induced oscillations in Upper Lake Constance with an emphasis on a coherent understanding of the basin-scale internal dynamics in this example of a large and stratified lake. Data were collected with eight Lake Diagnostic Systems (LDSs) consisting of thermistor chains and wind anemometers. The isotherm displacements as measured by the LDSs were interpreted using the three-dimensional hydrodynamic Estuary and Lake Computer Model (ELCOM). Three types of basin-scale waves were found to dominate the wave motion: the vertical mode-one Kelvin wave that had an observed period around 90 h, two vertical mode-one Poincare´ waves that had periods near 8 h and 12 h, and a vertical mode-two Poincare´ wave that had a period near 14 h. After strong westerly winds, upwelling of cold bottom water was observed east of the Sill of Mainau, where the lake's two subbasins connect. The width and length ratios of the subbasins, spatial variations of the wind field, and rotational effects over the lake are shown to play critical roles in the details of the upwelling structure. A sudden fall of the isotherms in Lake U¨ berlingen formed a surge. The reflection of the surge from the northwestern boundary induced a vertical mode-two response leading to an intrusion in the metalimnion that caused a three-layer velocity structure in the smaller subbasin.

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