Interbasin exchange and mixing in the hypolimnion of a large lake: The role of long internal waves

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ABSTRACT: We conducted a combined field and numerical study of the effects of episodic internal Kelvin-type waves on bottom boundary turbulence and the exchange of a passive tracer between the main basin and the side basin of a large lake (Lake Geneva). High-resolution measurements of the vertical current structure near the entrance of the 25-km-long and 70-m-deep side basin revealed that hypolimnetic current speeds frequently exceed 0.2 m s^{-1}, leading to a turbulent bottom boundary layer several meters thick with logarithmic current profiles and to a region of strong shear across the thermocline. The time series and vertical structure of the currents were reproduced by a threedimensional numerical model of the lake. It was demonstrated that, after episodes of strong winds from the northeast and southwest, exchange flows due to internal Kelvin waves were able to temporarily half or double the hypolimnetic volume of the side basin, leading to an irreversible exchange of up to 40% of the hypolimnetic water in the side basin of Lake Geneva within only a few wave cycles. With the help of the numerical model, it was shown that the key mechanisms of exchange are horizontal dispersion by resolved scales and, to a small extent, shear dispersion in the bottom boundary layer. It is suggested that bottom boundary-layer turbulence and the interbasin exchange can explain the structural differences in the oxygen profiles observed in the side basin and the main basin, respectively.