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Circulation patterns in open, wide and deep lacustrine embayments with different aspect ratios

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Numerical simulations were carried out to examine the effect of different horizontal aspect ratios on wind-induced circulation within open, wide and deep lacustrine embayments. Two adjacent embayments in Lake Geneva, Switzerland, located between Morges and Lausanne on the north shore of the lake, were compared. These embayments were selected because of their similar exposure with respect to wind forcing. However, their aspect ratios are different, making them ideal case studies to evaluate the impact of the aspect ratio on the resulting circulation pattern. A previously validated 3D hydrodynamic model (Delft3D-FLOW) was employed to simulate currents in the lake for the year 2010. Detailed over-lake maps of wind, temperature and humidity were used as input to drive the model. The embayments were compared in terms of circulation patterns and conditions leading to gyre formation. Furthermore, we carried out a systematic comparison, focusing on the embayment aspect ratio by constructing different “synthetic” embayments with aspect ratios in the range 1 - 4. Subsequently, the flow field within these embayments was computed for typical meteorological regimes (dominant wind regimes and seasonality). In particular, the generation of gyres was compared for different cases. The results revealed that, even for large aspect ratios (~ 3), wind-induced circulation can still occur in open, wide, and deep lacustrine embayments. The results showed that, as expected, gyres are formed less frequently as the embayment aspect ratio increases. For this reason, gyres are much more probable in the Morges embayment than in Vidy Bay.