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We may have one of the e-poster sessions as part of a wine reception on Tue 8th Nov. Would you be available for this? (Delete as appropriate): No.

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This study presents the application of ocean numerical modeling to gain understanding of the dynamics of exchange flows through sea straits and across submerged sills. The restricted density-driven exchange flows are generated in oceans, seas and coastal margins when adjacent water bodies with different densities are connected by narrow channels (i.e. straits) and/or natural topographic obstructions on the seafloor (e.g. submerged sills). Numerical model simulations, combined with scaled laboratory experiments, have proven to be a powerful tool to help understand the restricted oceanographic flow processes occurring within these complex regions.

We have conducted laboratory-scale numerical simulations using a non-hydrostatic 3-dimensional model (Bergen Ocean Model, referred to as BOM) in both non-rotating and rotating frames of reference (the latter considering Earth rotation effects through inclusion of Coriolis accelerations). These BOM simulations are shown to reproduce the main dynamic flow patterns and density structure of the large-scale exchange flows generated through an idealized trapezoidal sill-channel, with a lower layer saline intrusion (see sill-channel geometry in Figure 1). The numerical results also show that the saline intrusion flux across the sill is initially reduced and then eventually fully blocked under increasing net-barotropic flow conditions imposed in the counterflowing upper freshwater layer (Grifoll et al., 2022). The BOM simulations are also extended to consider rotating exchange flow dynamics, and demonstrate that the inclusion of Coriolis forces increases the overall blockage of the saline intrusion layer by the upper freshwater layer flow compared to equivalent non-rotating exchange flows. Based on these rotating exchange flow simulations, the numerical results reveal a distinct secondary cross-channel circulation pattern, characterized by Ekman dynamics in the lower dense water layer and the presence of two anticlockwise circulation cells in the upper freshwater layer. The strength and coherence of these secondary flow cells are also strongly controlled in the along-channel direction by the proximity of the overspill at the end of the trapezoidal sill-channel crest, with the significant increase in the densimetric Froude number (i.e. increase in inertial factors) at this location implying a relative decrease in the influence of rotation and dominance of non-hydrostatic flow effects.

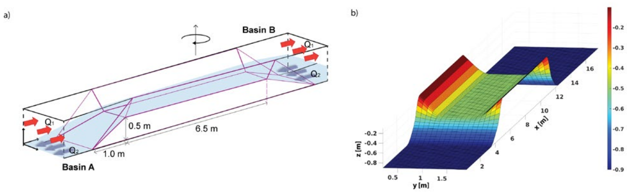

Figure 1. (a) Schematic representation of the trapezoidal channel-sill including counterflowing lower saline Q_2 and upper freshwater Q_1 layers. (b) Numerical mesh used for the BOM simulations.

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References

Grifoll, M., Cuthbertson, A., Berntsen, J., (2022). Numerical experiments of uni- and bi-directional exchange flows in a rotating trapezoidal sill-channel Proceedings of the 39 th IAHR World Congress 19-24 June 2022.