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Evaluation of Submesoscale Variability Captured by a Glider Mission and high-resolution numerical experiments in the Gulf of Finland, Baltic Sea

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The development of submesoscale phenomena in seas is recognized with the refinement of observational and model grids. While in situ measurements are discrete and limited in time and/or space, numerical models could fill the entire sea with simulation data. Three high-resolution glider missions were conducted in the Gulf of Finland, Baltic Sea, in 2018–2019 with an aim to detect submesoscale processes. We captured frontal submesoscale features affecting water column structure in spring 2018. In this study, a three-dimensional hydrodynamic model GETM (General Estuarine Transport Model) with eddy-resolving grid spacing of 0.5 nautical miles and submesoscale permitting grid spacing of 0.125 nautical miles is used to simulate the dynamics in the study area. We compare the model results with the measurements, present differences, and propose probable explanations.

The submesoscale processes are related to the energetic mesoscale flow field and they contribute to the energy transfer at smaller scales. We investigate the statistical features to characterize the submesoscale structures in the simulated area during the glider missions. The regions of order one Rossby and Richardson numbers characterize the spots with active submesoscale dynamics. Further, horizontal buoyancy gradients are one of the primary sources of submesoscale processes. We propose that the smaller-scale tracer patterns at a lateral scale up to a km demonstrated an ageostrophic secondary circulation. The phenomenon illustrates the relation between horizontal and vertical structures. The high-resolution simulation allows us to have a three-dimensional view of the submesoscale features and describe the events that permitted the smaller-scale structures to arise along with some estimate for the re-occurrence of the event.