High-resolution modelling of 3D hydrodynamics in coastal archipelagos

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Dynamics of the coastal seas are affected by eutrophication, over-fishing, coastal construction and climate change. To enable the sustainable development of these areas, monitoring and modelling of the state of the sea are needed. The Archipelago Sea, located in the northern part of the semi-enclosed and brackish water Baltic Sea, is one of the most complex coastal areas with over 40 000 small islands and islets. It is also very vulnerable area already heavily stressed with eutrophication. Applicable modelling tools are needed to support the decision making and to provide sufficiently reliable information on the effects of the planned actions on the state of the coastal waters.

We used 3D hydrodynamic model COHERENS to model the Archipelago Sea area with high spatial resolution of 0.25 nmi. Boundary conditions for this limited area were provided from coarser resolution, 2 nmi, Baltic Sea grid. In order to evaluate the performance of the high-resolution coastal model implementation a comprehensive measurement dataset was gathered, including hydrographic data from three intensive monitoring stations and several more rarely visited monitoring or research stations.

The hydrodynamic model was able to simulate the surface temperature and salinity fields and their seasonal variation with good accuracy in this complex area. The sharp depth gradients typical for this area provided some challenges to the modelling. There was some over mixing and related to too strong vertical currents in the steep slopes of the deeper fault lines. Also the water exchange between the more open sea and coastal areas through narrow channels between the islands is not sufficiently well reproduced with the current resolution, leading to too high bottom temperatures.