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Observations and unstructured-grid simulations of tidally-generated eddies in a complex coastal environment

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The Norwegian coastline is made up of a multitude of long and narrow fjords and straits. The near-shore flow here is severely restricted by the complex geometry, with subsequent consequences for the net transport and dispersion of biogeochemical material through the coastal zone.

One possibly important transport mechanism in such complex environments is non-linear pumping by vortex dipoles, generated by tidal currents through fjord and strait openings. Previous laboratory studies have demonstrated the transport capacity of such structures. And recent modelling studies have shown that the laboratory results should be relevant for coastal scale applications, also along the Norwegian coast. But there are still few observational studies of their existence and transport efficiency.

Recent mooring observations from Tromsø, Northern Norway, shows intermittent velocity maxima downstream of a tidally-dominated constriction. We reproduced similar signals using a high-resolution setup of the unstructured-grid ocean model FVCOM. The model shows that the velocity extrema occur when dipole vortices shed away from the constriction and propagate downstream to the mooring locations. We hypothesize that such dipoles develop when the constriction geometry allows for flow separation on both sides of the constriction, and that the dipoles leave the constriction when the dipole-generated sea surface depression is strong enough to break the adverse pressure gradient conditions required to achieve flow separation. The frequency of dipole formation - and velocity extrema - then depends on the forcing strength and constriction geometry.