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Tidally driven tracer transport in narrow straits in northern Norway

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The challenge of combining rich ecosystems with extensive human industrial activity in vulnerable coastal regions requires a high knowledge about ocean transport dynamics in the respective regions. The Lofoten-Vesterålen (LoVe) area off Northern Norway is an example where prospects of future oil exploration gives concern for the surrounding marine ecosystem. The LoVe peninsula consists of hundreds of islands, which combined with large tidal amplitudes (> 1 m), makes it particularly interesting for investigating tidally-driven tracer transport (pollutants, fish larvae) through the many straits. We set up a numerical tidal model at high (and variable) spatial resolution to investigate two main processes that can produce such tidally-rectified transport. First, we investigate transport by linear dynamics in the strait where the frictional forces are also negligible, i.e. transport by flows where the pressure gradient force and local acceleration approximately balance. When velocity and sea surface height fields are in phase one can obtain a net mass transport through the strait. The mass transport can then also cause tracer transport. Secondly, we investigate transport due to non-linear dynamics giving flow separation and the creation of self-propagating vortex pairs that can trap and transport tracers. The results for the LoVe region indicate a net northward tracer transport through many of the straits which is often correlated strongly with a net mass transport. This correlation suggests that the linear process is the main contributor to the net tracer transport through the LoVe archipelago. The non-linear processes are mainly important inside the straits, where it locally enhances both mixing and transport of tracer in parts of the straits. In two straits we also observe formation of self-propagating dipoles at the strait exits. However, topographic features close to the strait reduce the travel distance of the dipoles, and thereby the tracer transport by these.