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Hydrodynamics and sediment transport in Frænfjorden (Western Norway)

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The mining sector is growing in parallel with the increase societal demands for minerals resources. One of the most important environmental issues of industrial mining is the safe storage of tailings produced from mineral extraction . Traditionally, they have been stored in land dams, but due to the lack of land availability, potential risk of dam failure and topography, several Norwegian coastal areas stored the tailings into submarine placements (Ramirez-Llodra et al., 2015). Several Norwegian fjords contains submarine tailing placements (STP) what has stimulated a social debate about the environmental impacts of large masses of fine-grain particle into the fjord systems. Understanding these impacts is essential into the decision making but requires multiple processes to be well characterised, in particular those relating to the transport of the material. Thus, understanding the fjord dynamics is essential to assess potential changes and to develop best available techniques and robust management plans for the STP.
We present a modelling exercise of the dominant physical processes in Frænfjorden (Western Norway), how their relative importance may depend on geomorphology and forcing, and how, in turn, the dominant physical processes effect sediment transport. The Regional Ocean Modelling System (ROMS), a three-dimensional physical coastal ocean model, was used for a numerical simulation experiment to investigate the coastal dynamics. Based on local wind patterns, a limited set of numerical simulations with idealized wind over realistic bathymetry were performed. Numerical results were compared with an extensive set of numerical experiments and field observations.
Results reveal the variability along the fjord during different wind events as well as a strong relation between the vertical diffusivity and winds. High winds from southwest drive flow that induce the vertical mixing. Other high winds types resulted in the opposite sense and were not a supporting mechanism for the vertical mixing. This analysis supports strong southwest wind-driven forcing play an important role controlling the material transport in Frænfjorden.

References

Ramirez-Llodra, E., et al. Submarine and deep-sea mine tailing placements: A review of current practices, environmental issues, natural analogs and knowledge gaps in Norway and internationally. Mar. Pollut. Bull. (2015), http://dx.doi.org/10.1016/j.marpolbul.2015.05.062