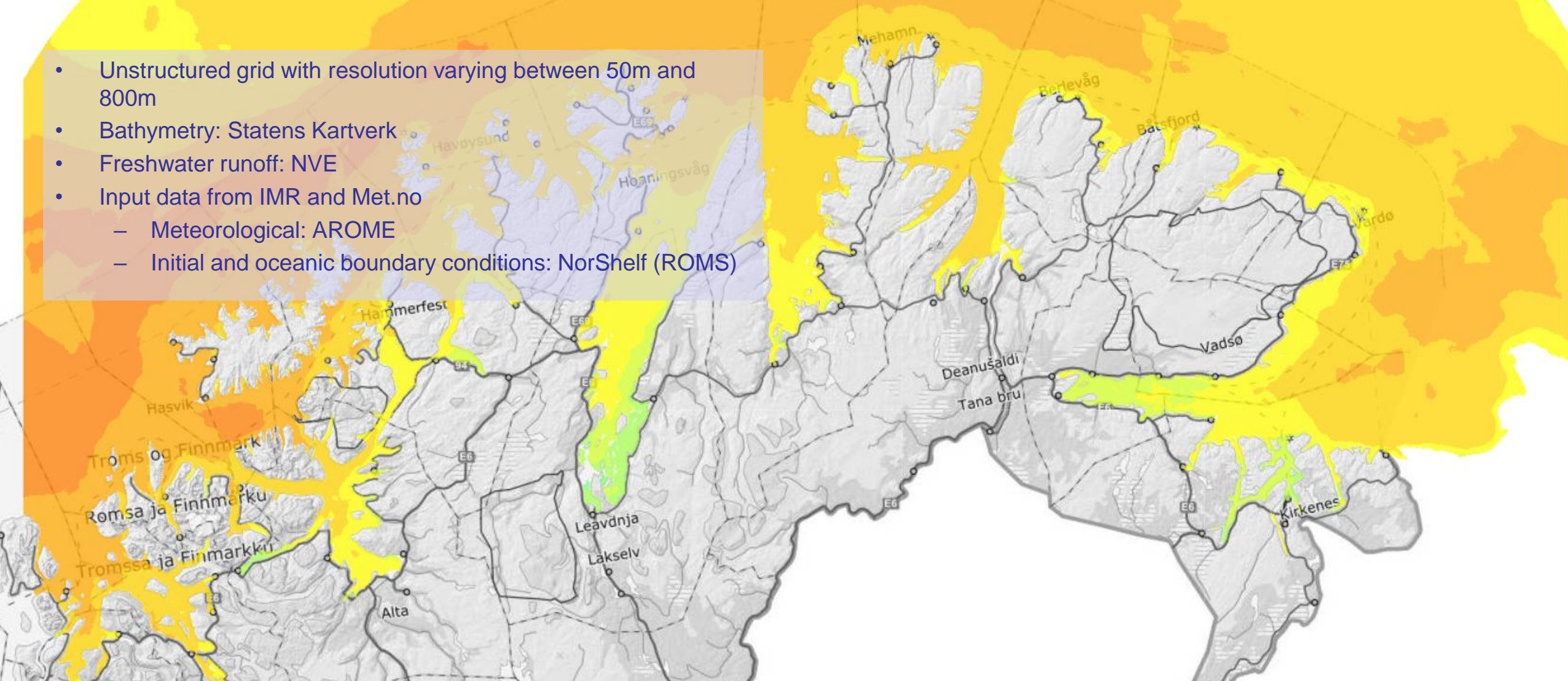


Modeling of hard-bottom sites using FVCOM and tracer approach

Frank Gaardsted
Magnus Drivdal

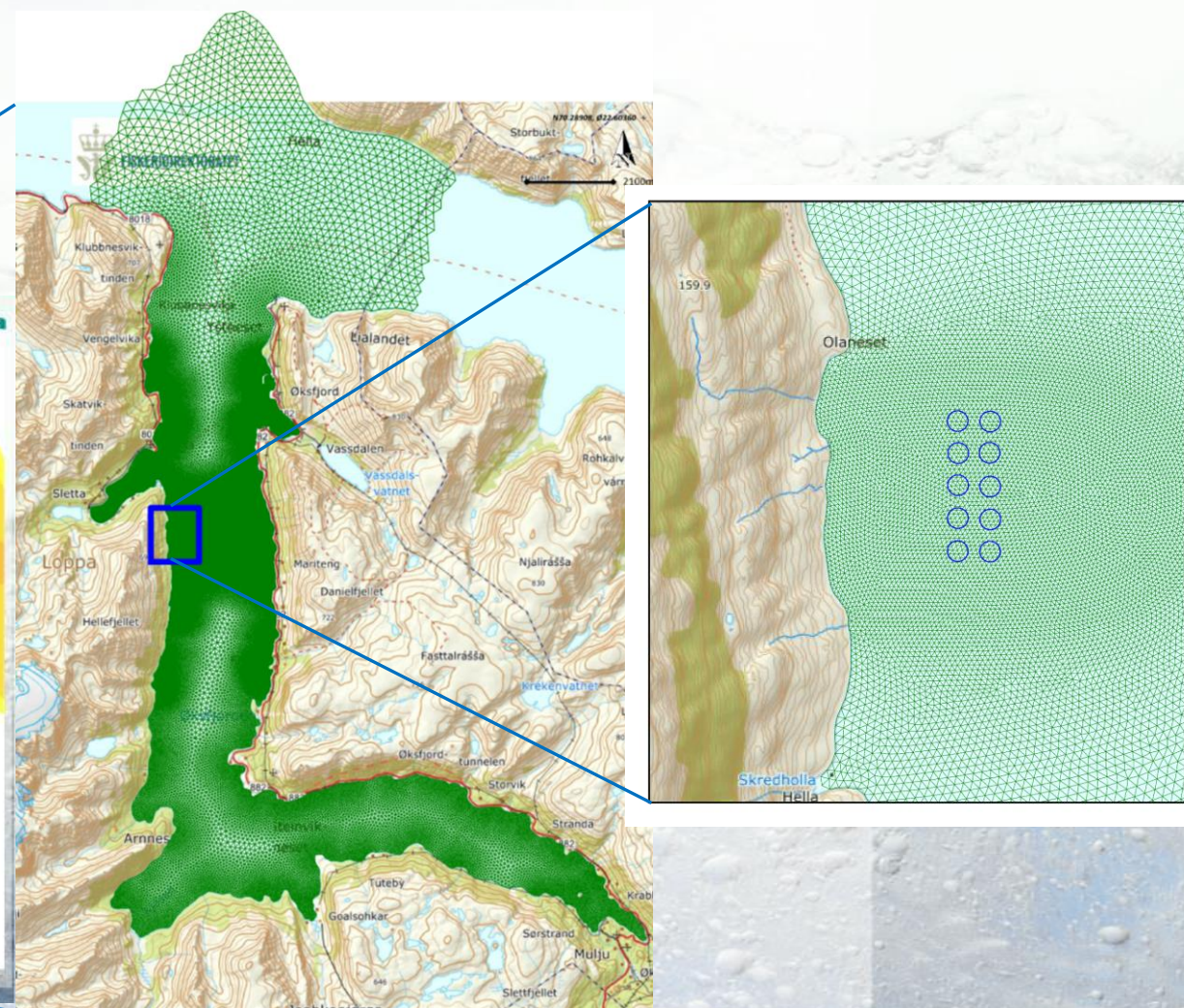
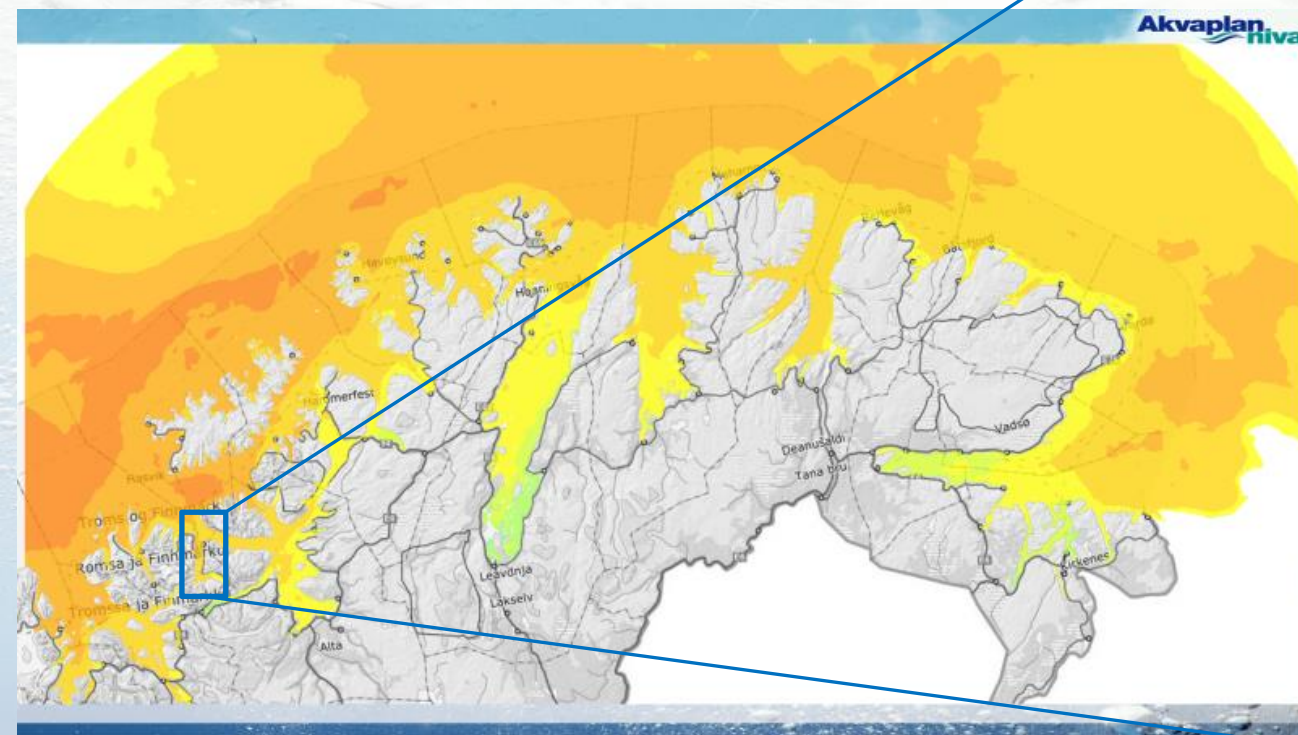
Regional FVCOM model covering Finnmark

- Unstructured grid with resolution varying between 50m and 800m
- Bathymetry: Statens Kartverk
- Freshwater runoff: NVE
- Input data from IMR and Met.no
 - Meteorological: AROME
 - Initial and oceanic boundary conditions: NorShelf (ROMS)

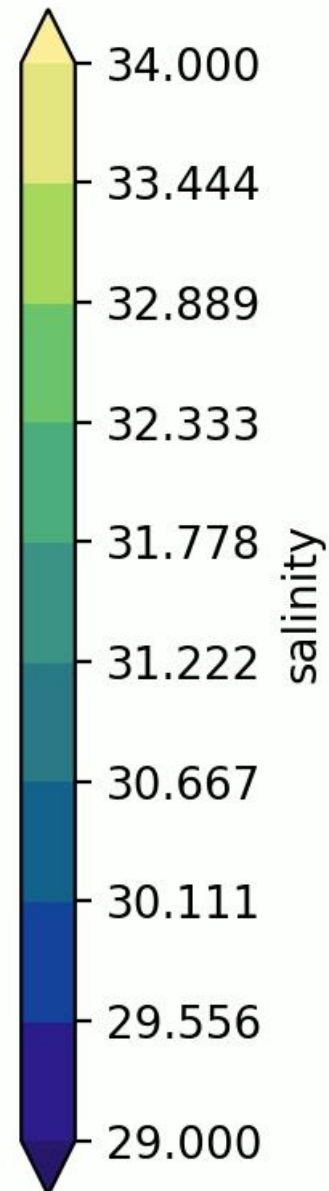
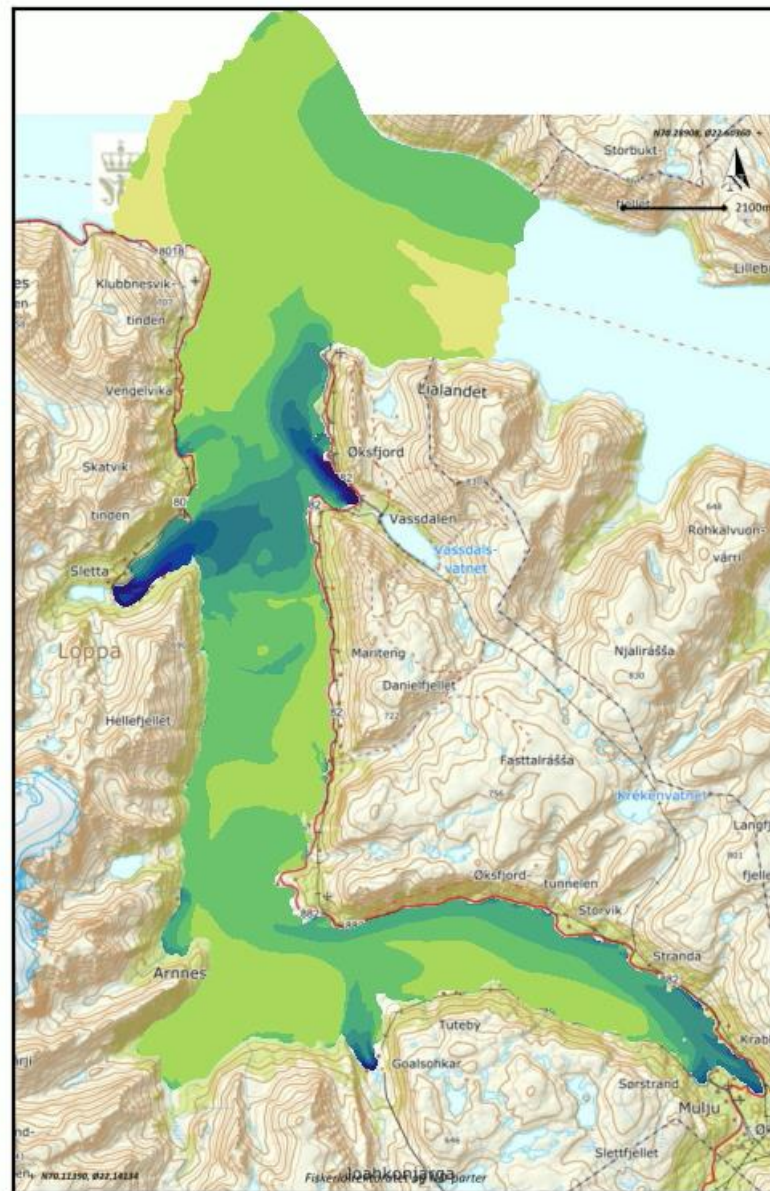


Olaneset – hydrodynamical model setup (FVCOM)

- High resolution grid (~5m at Olaneset) covering Øksfjorden
- Nested into regional Finnmark model
- High resolution bathymetry data collected by NGU in this project



Surface salinity



Olaneset - Deposition model - FABM

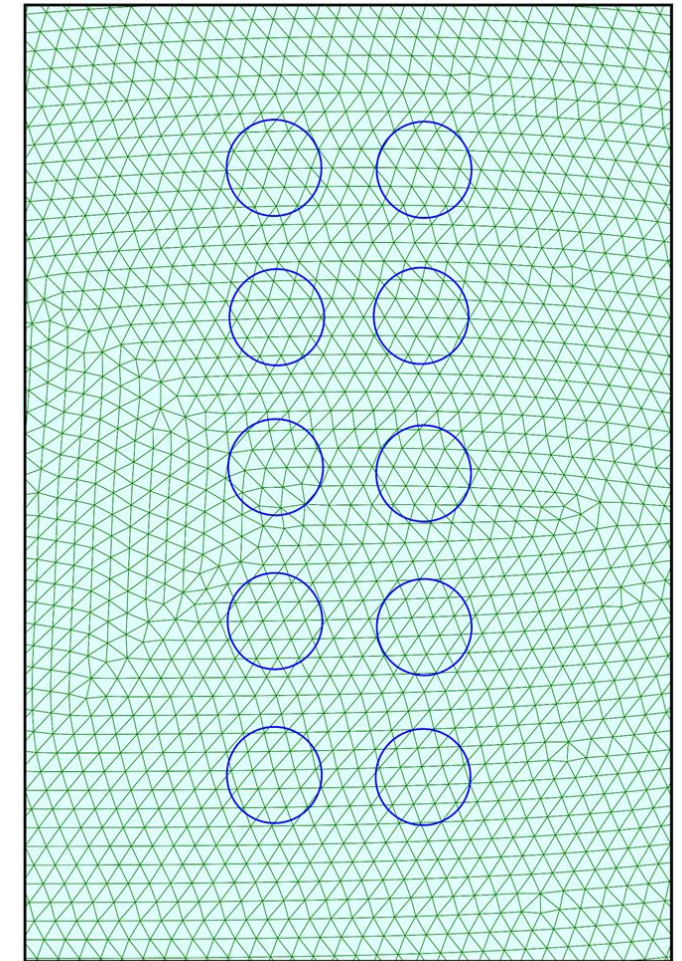
- Sedimentation model built within the Framework for Biogeochemical Models (FABM)
- Online coupling to FVCOM: concentration calculated every time step
- Organic waste from fish farms split into 6 size classes representing faecal pellets and 2 size classes for feed spill

Table 2. Settling velocity distribution for salmon faecal material. Source: Bannister et al. (2016)

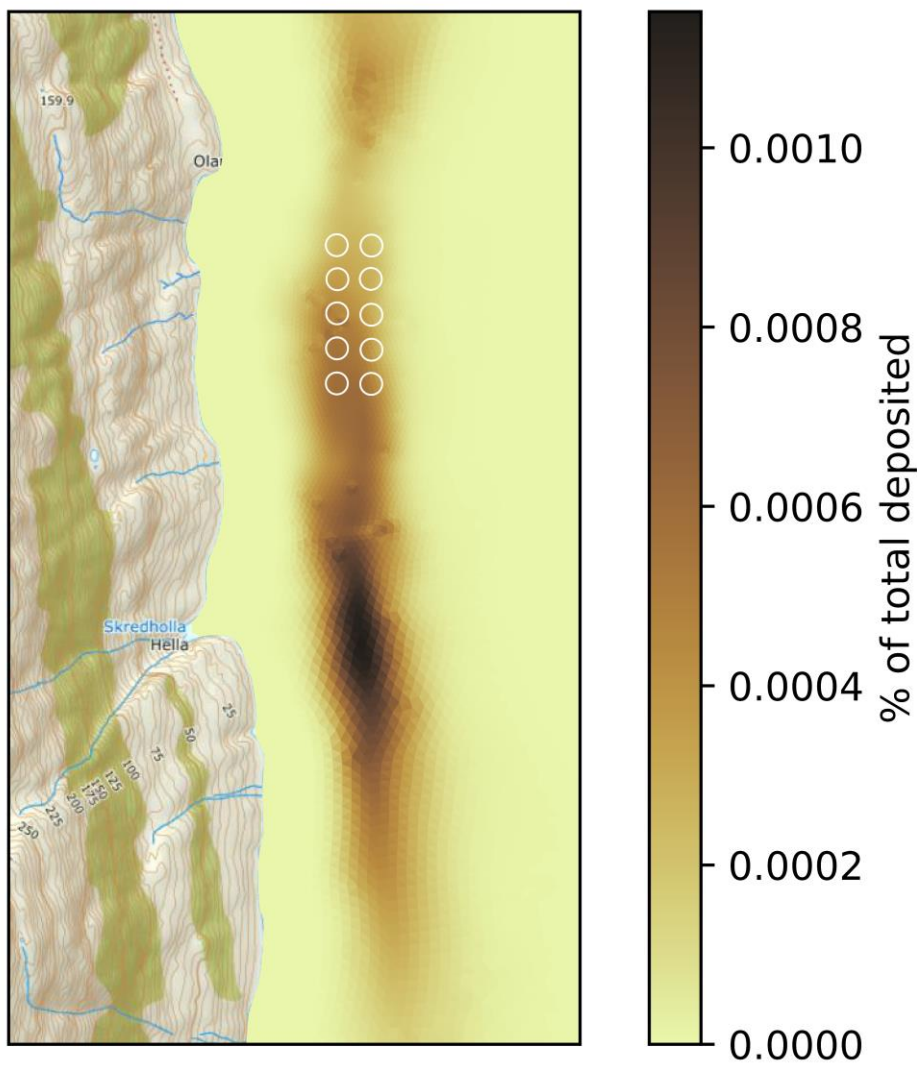
	Proportion of particles [%]	Settling velocity [$cm\ s^{-1}$]
Tracer 6	66.2	5.0 – 10
Tracer 5	18.9	2.5 – 5.0
Tracer 4	3.2	1.5 – 2.5
Tracer 3	2.6	1.0 – 1.5
Tracer 2	2.8	0.5 – 1.0
Tracer 1	6.3	< 0.5

Carvajalino-Fernández et al. 2020

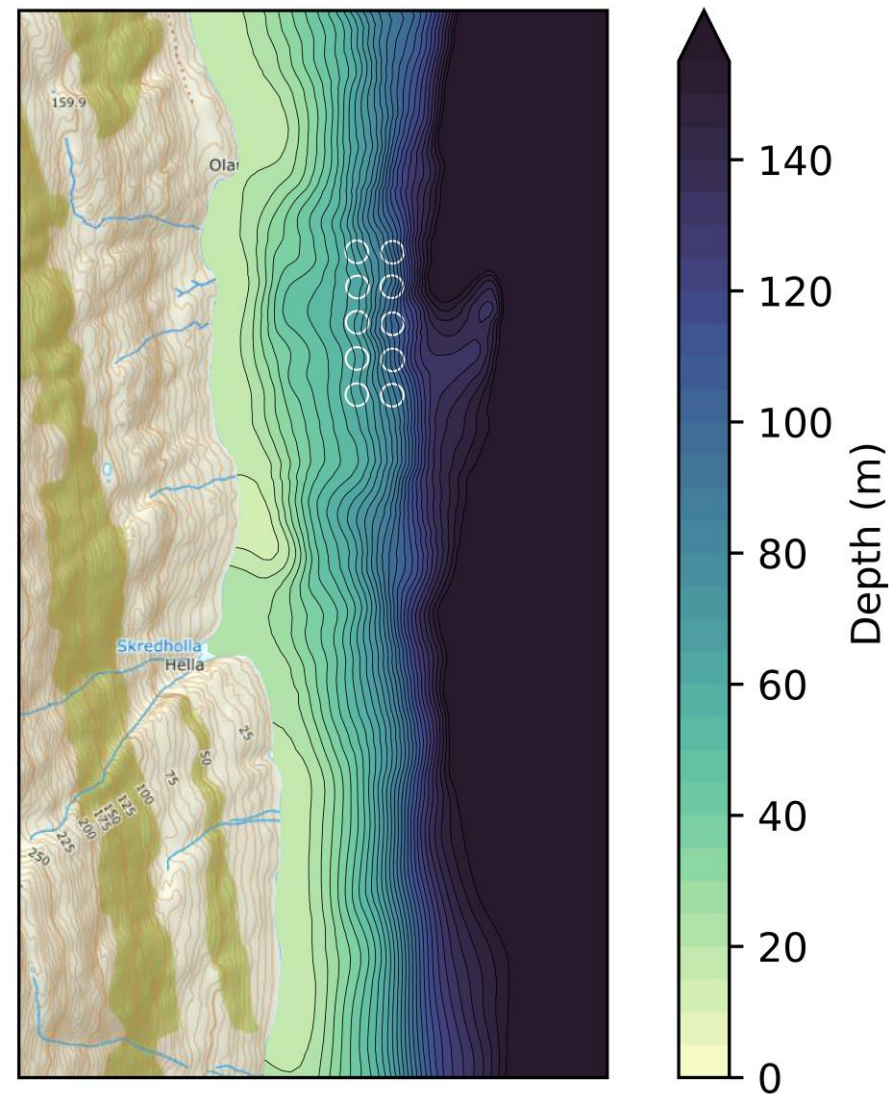
- Release simulated as a flux ($g\ m^{-2}\ s^{-1}$) through the area of each cage at 20 m depth
- Two scenarios:
 1. Without resuspension
 2. With resuspension (constant critical shear stress)



Tracer 1

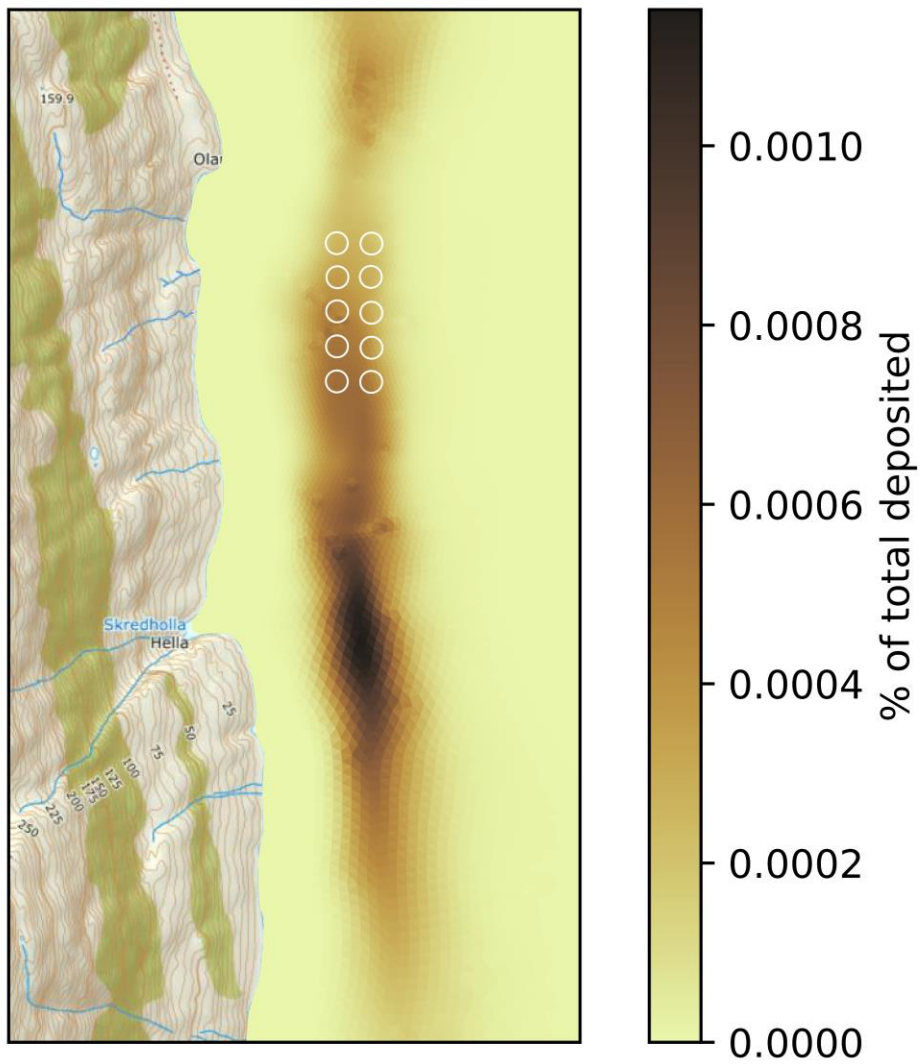


Bathymetry



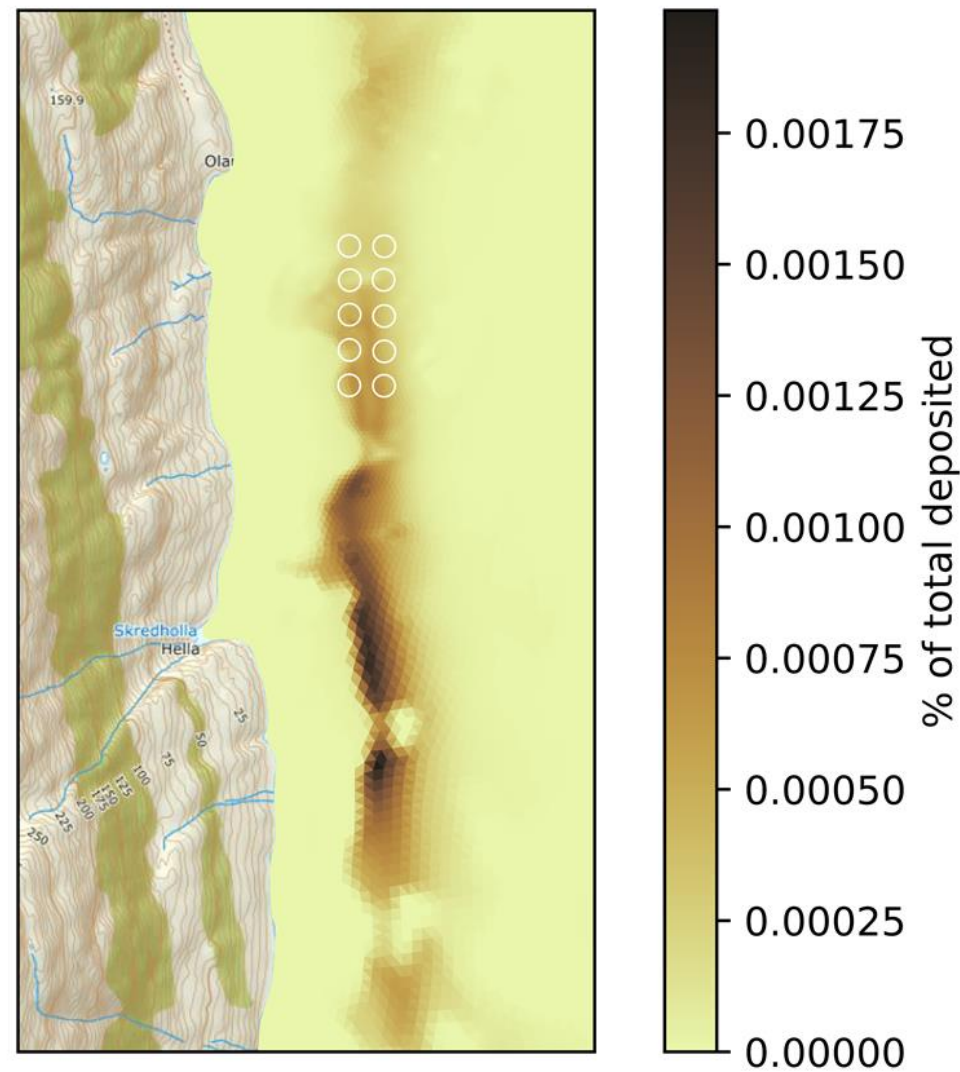
No resuspension

Tracer 1



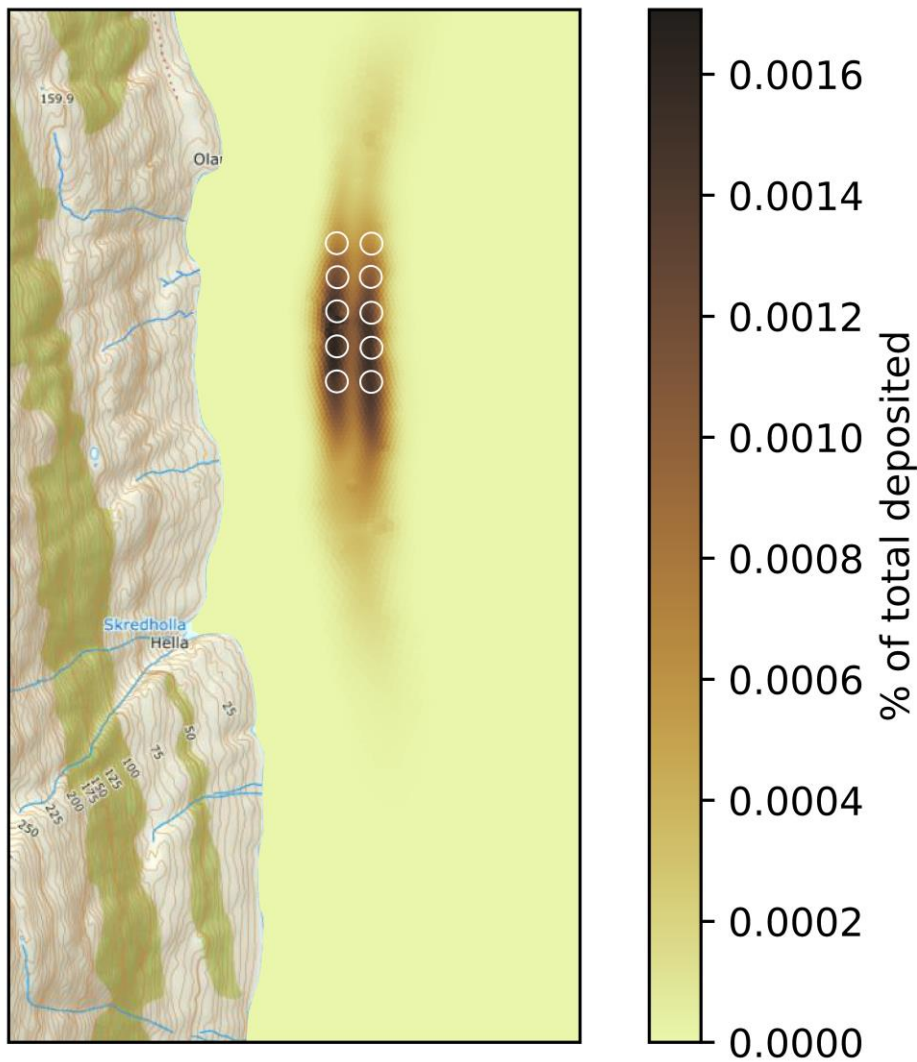
No resuspension

Tracer 1



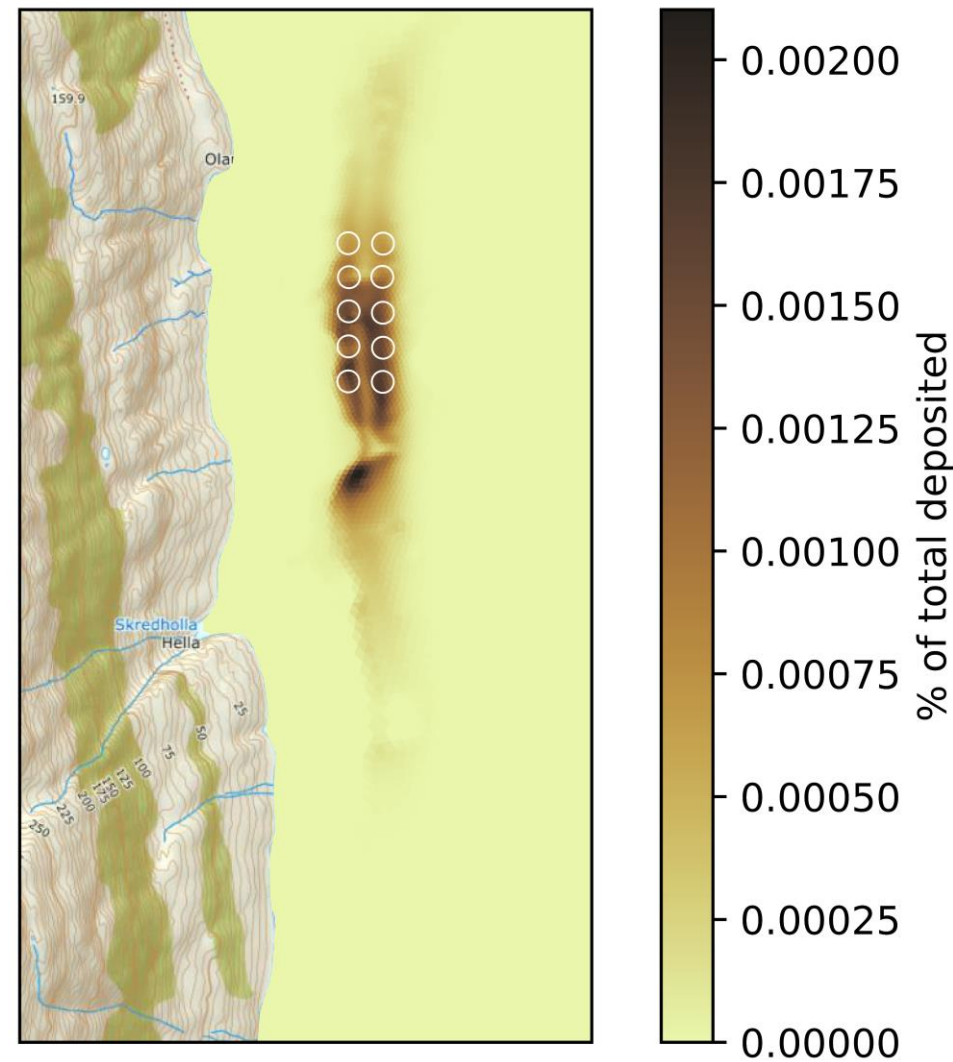
With resuspension

Tracer 2



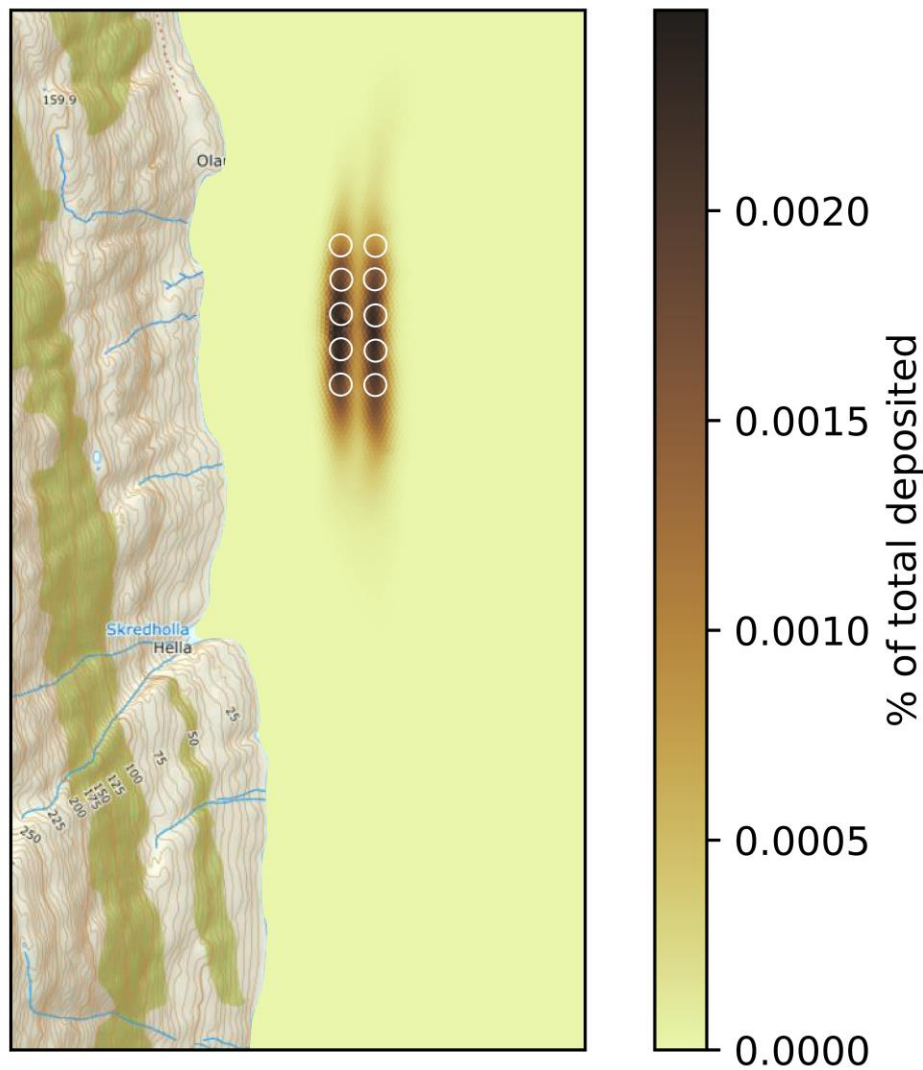
No resuspension

Tracer 2



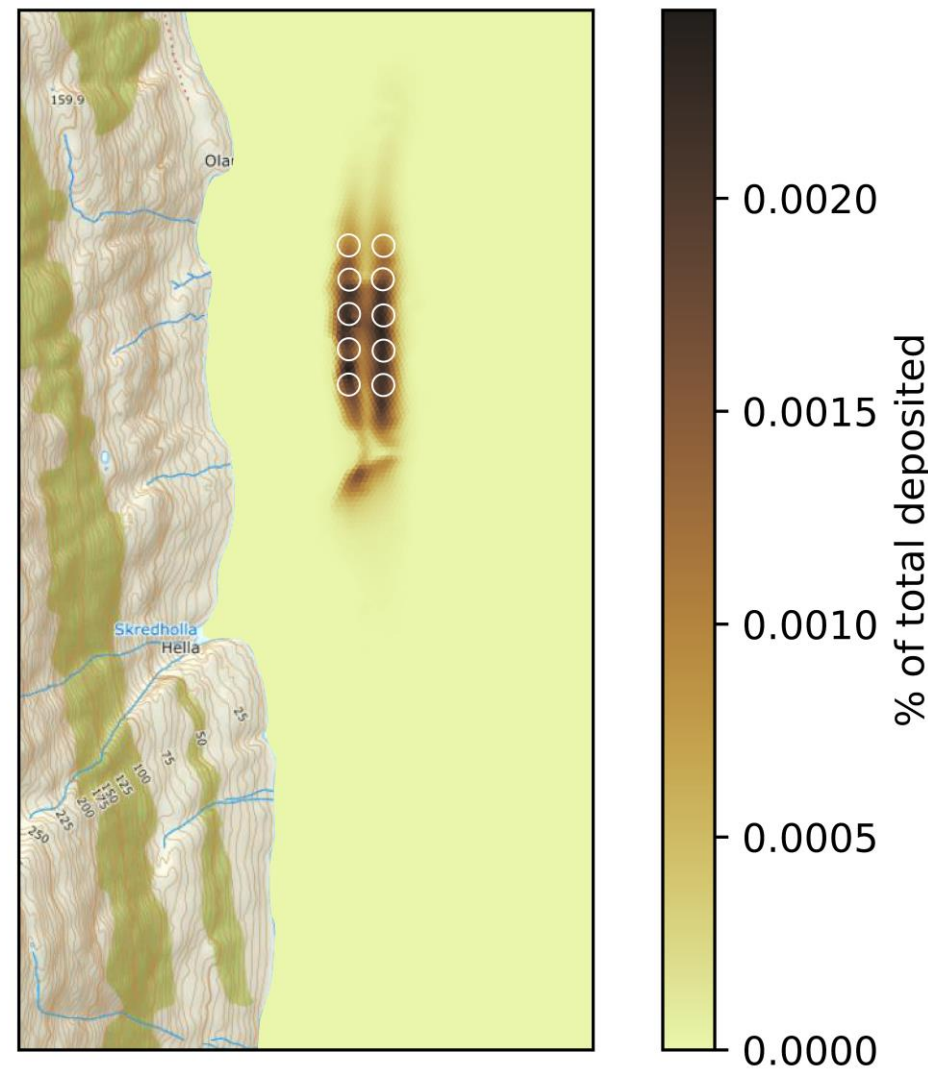
With resuspension

Tracer 3



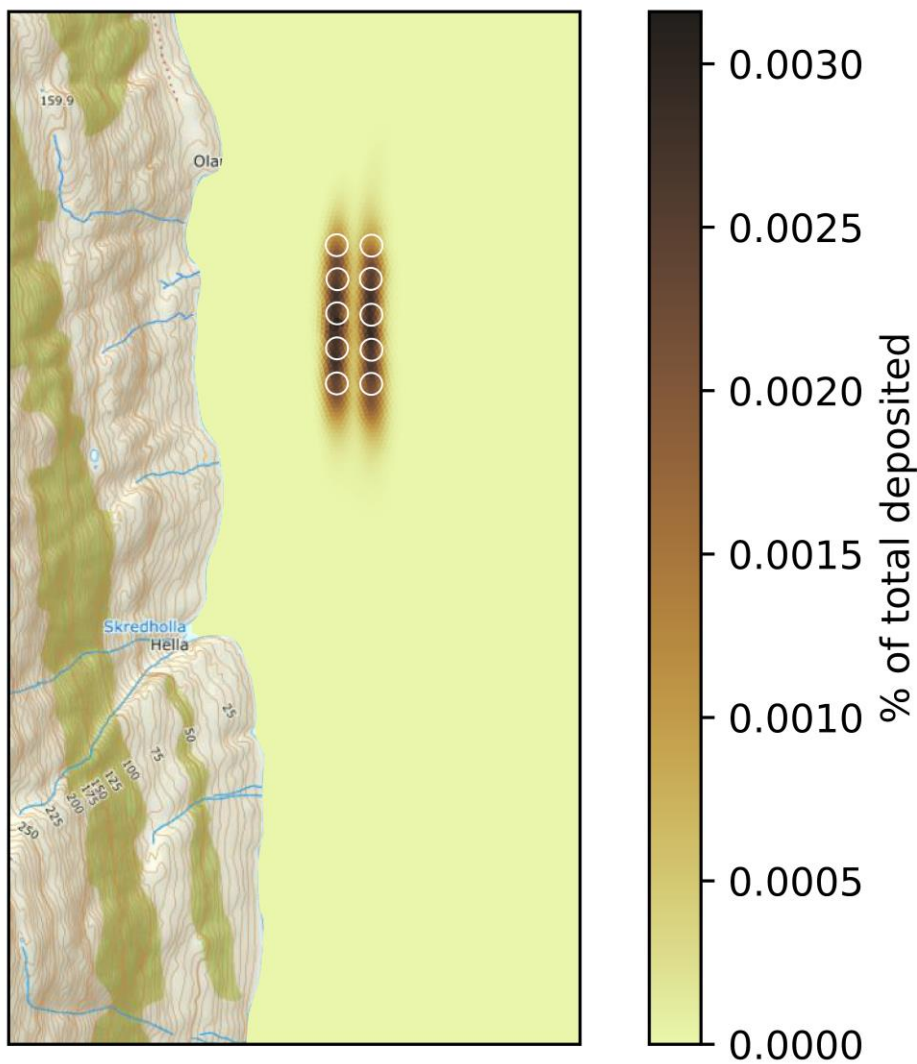
No resuspension

Tracer 3



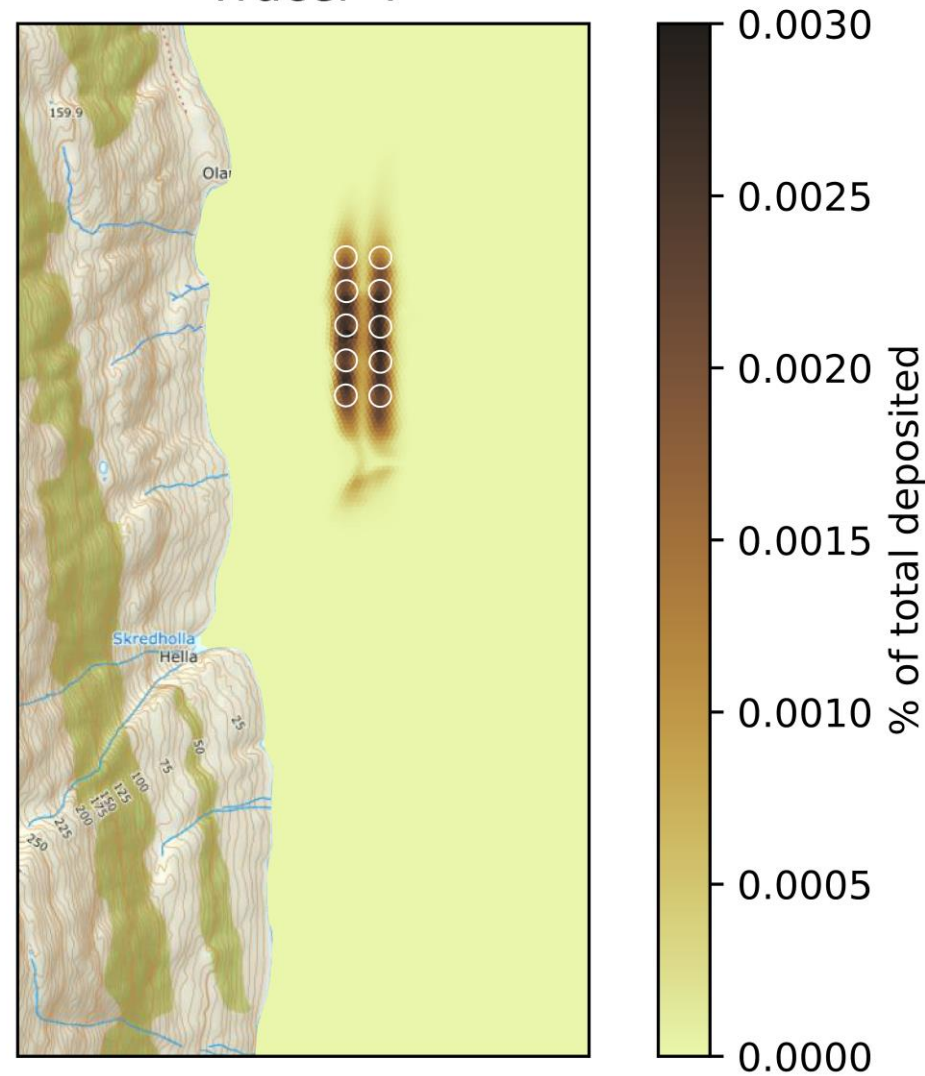
With resuspension

Tracer 4



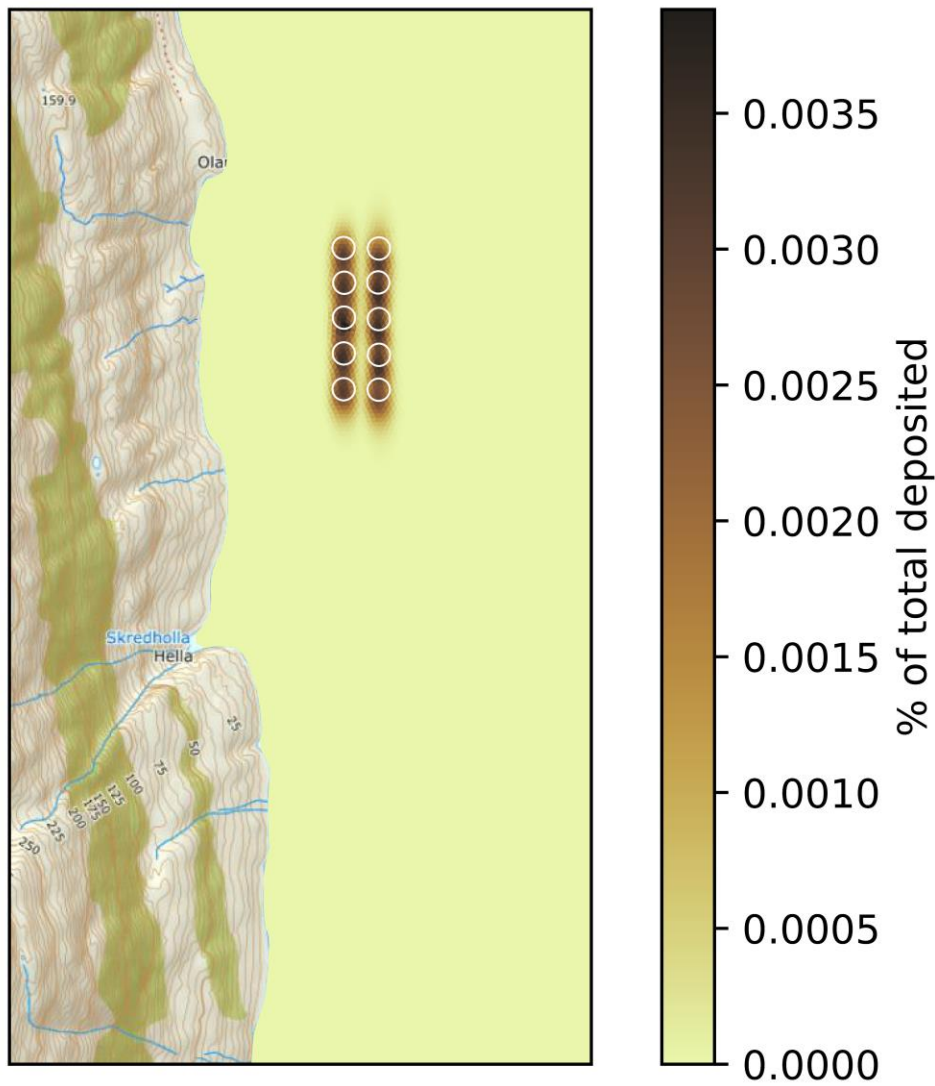
No resuspension

Tracer 4



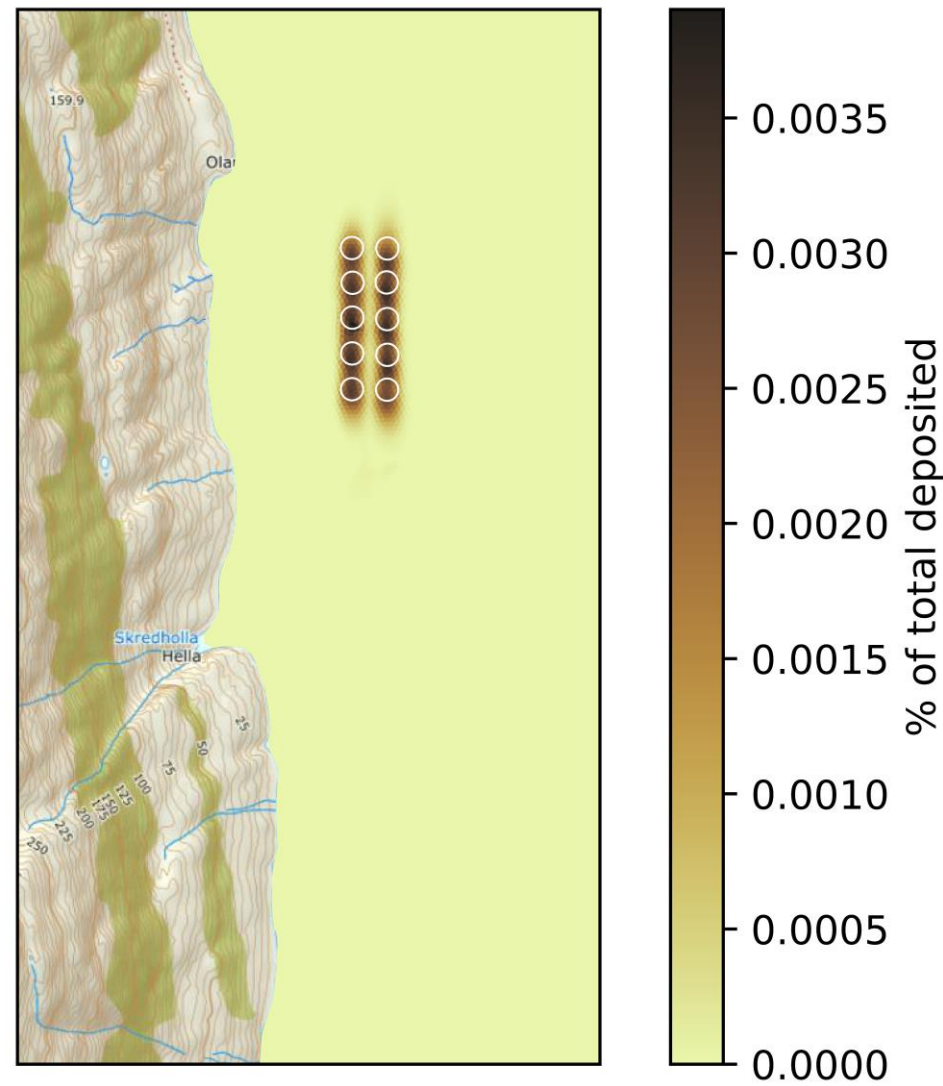
With resuspension

Tracer 5



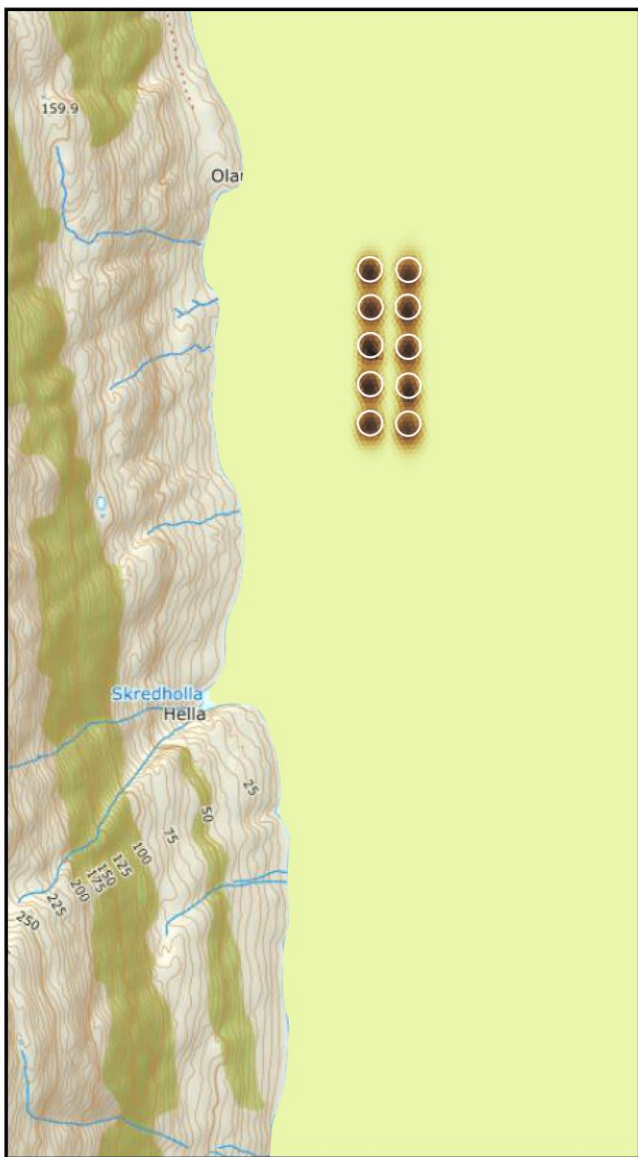
No resuspension

Tracer 5

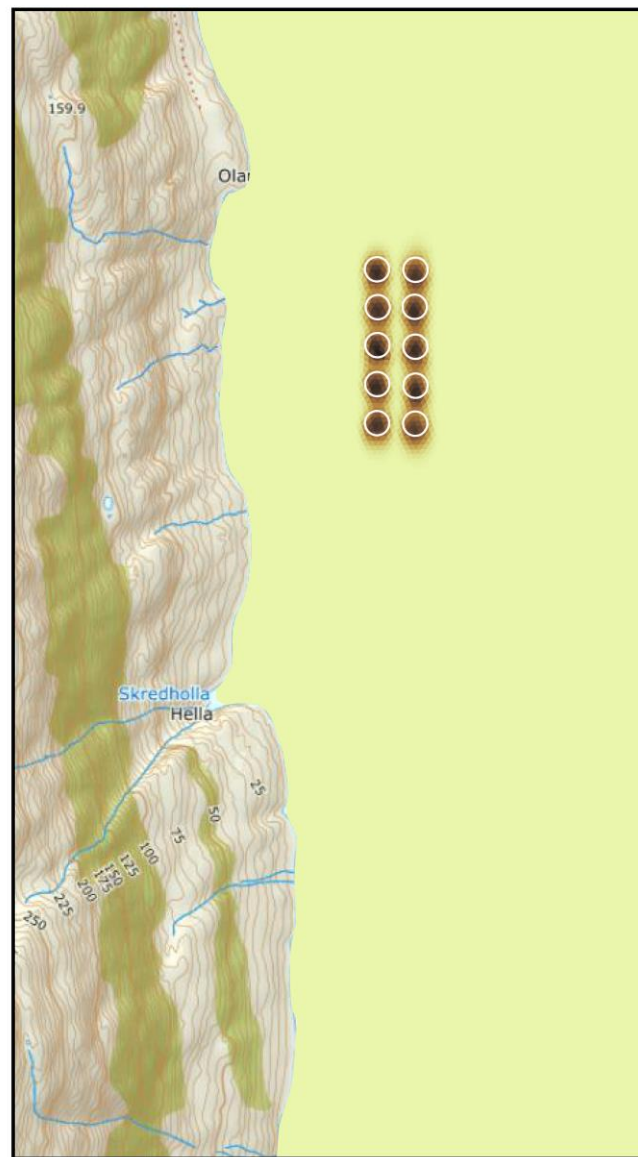


With resuspension

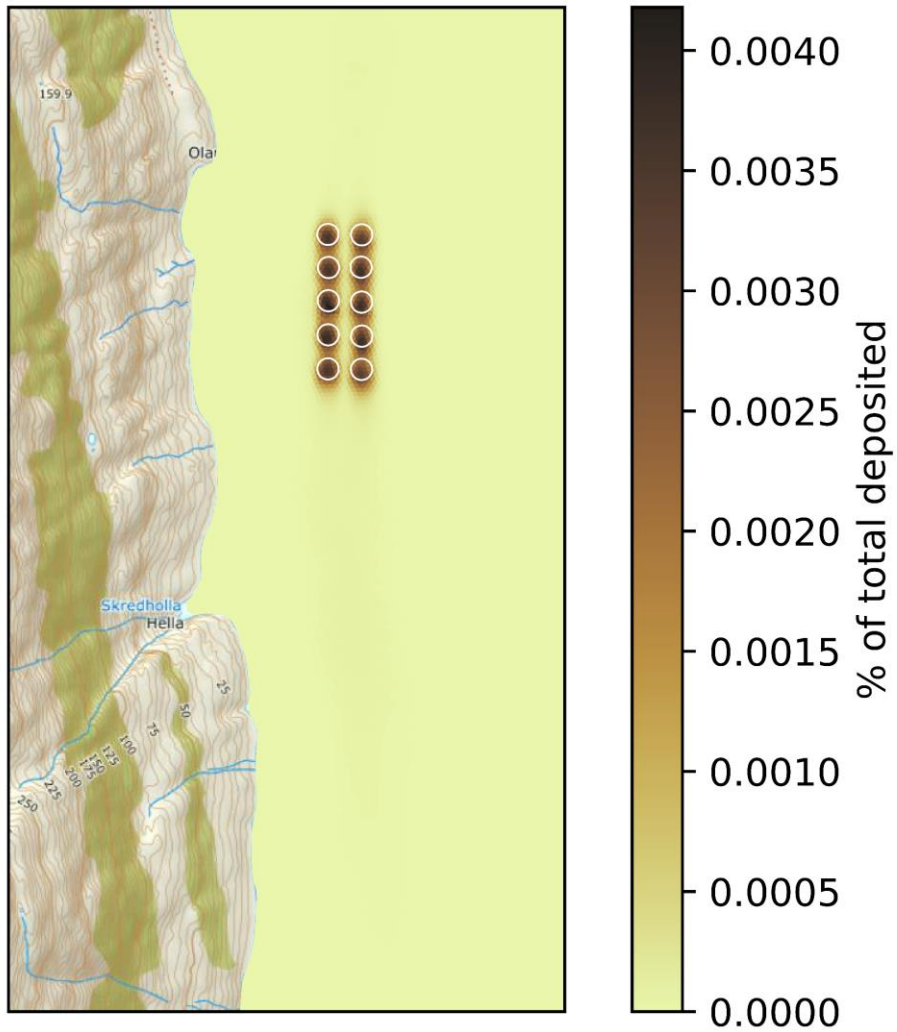
Tracer 6



Tracer 6

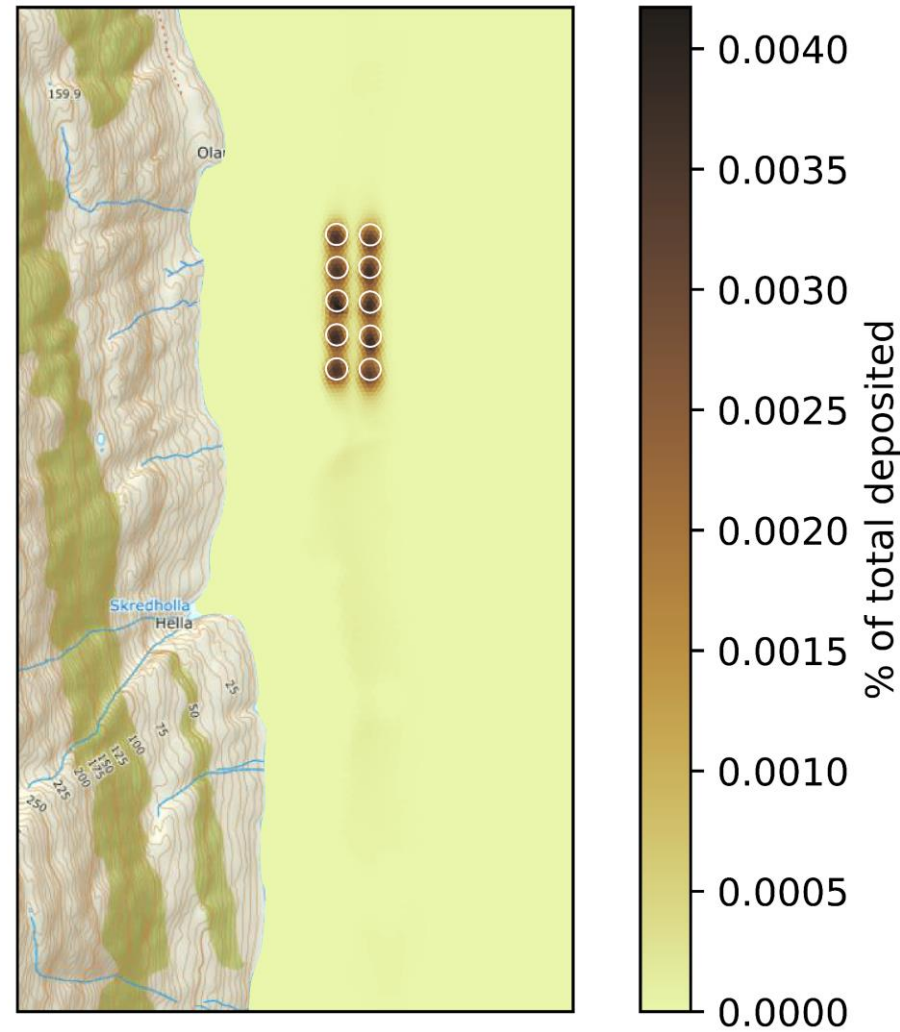


All tracers



No resuspension

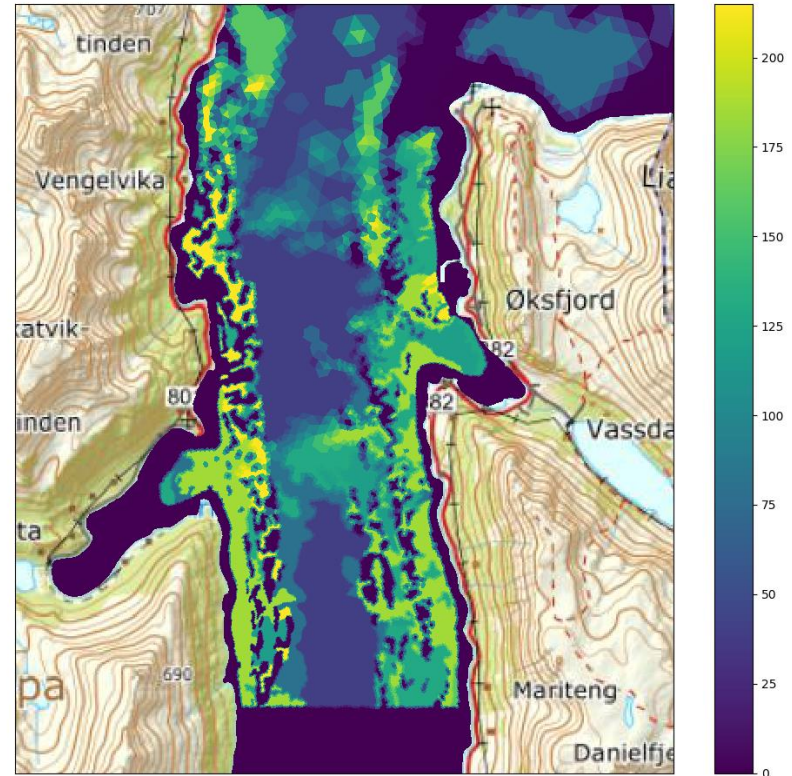
All tracers



With resuspension

Ongoing/remaining work

- Implementation of substrate dependent resuspension
- Model studies of two more farms (Storholmen and Nordnes)
- Comparison to IMR particle model
- Validation against field data



Summary

- An unstructured grid model (FVCOM) has been used to increase the resolution locally around fish farms.
 - Resolve high resolution bathymetry data and spatial current variability
 - Accurate placement of individual cages and discharge of waste
- Without resuspension, the depositional pattern is solely determined by the settling velocity of the waste and the currents in the water column. This generally results in a smooth footprint with bottom concentrations gradually decreasing away from the farm in the main current direction.
- High resolution of bathymetry and currents near the bottom are critical for simulating resuspension accurately. Resuspension generally results in more patchy depositional patterns.