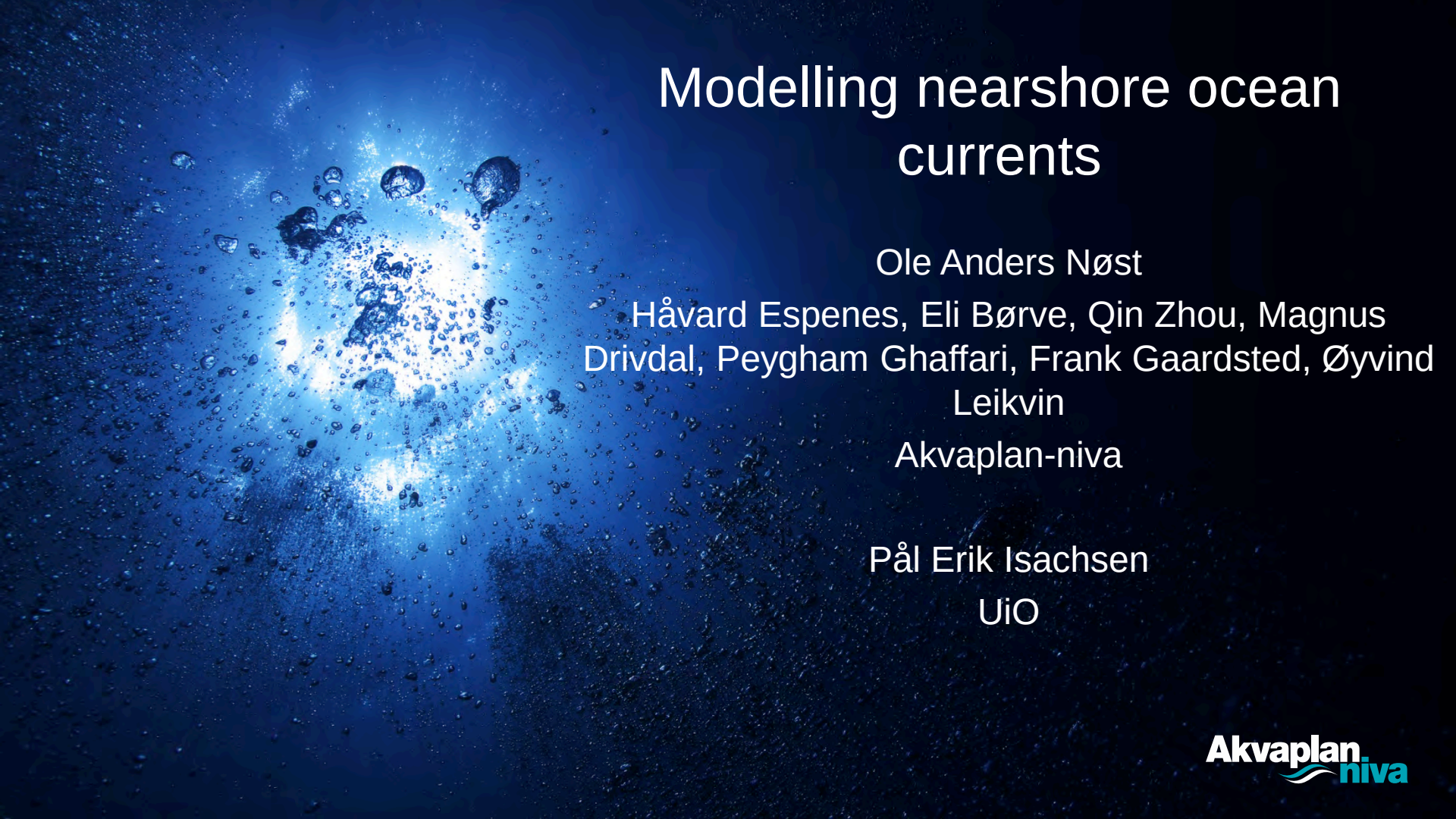


Modelling nearshore ocean currents

Ole Anders Nøst

Håvard Espenes, Eli Børve, Qin Zhou, Magnus Drivdal, Peygham Ghaffari, Frank Gaardsted, Øyvind Leikvin

Akvaplan-niva

Pål Erik Isachsen

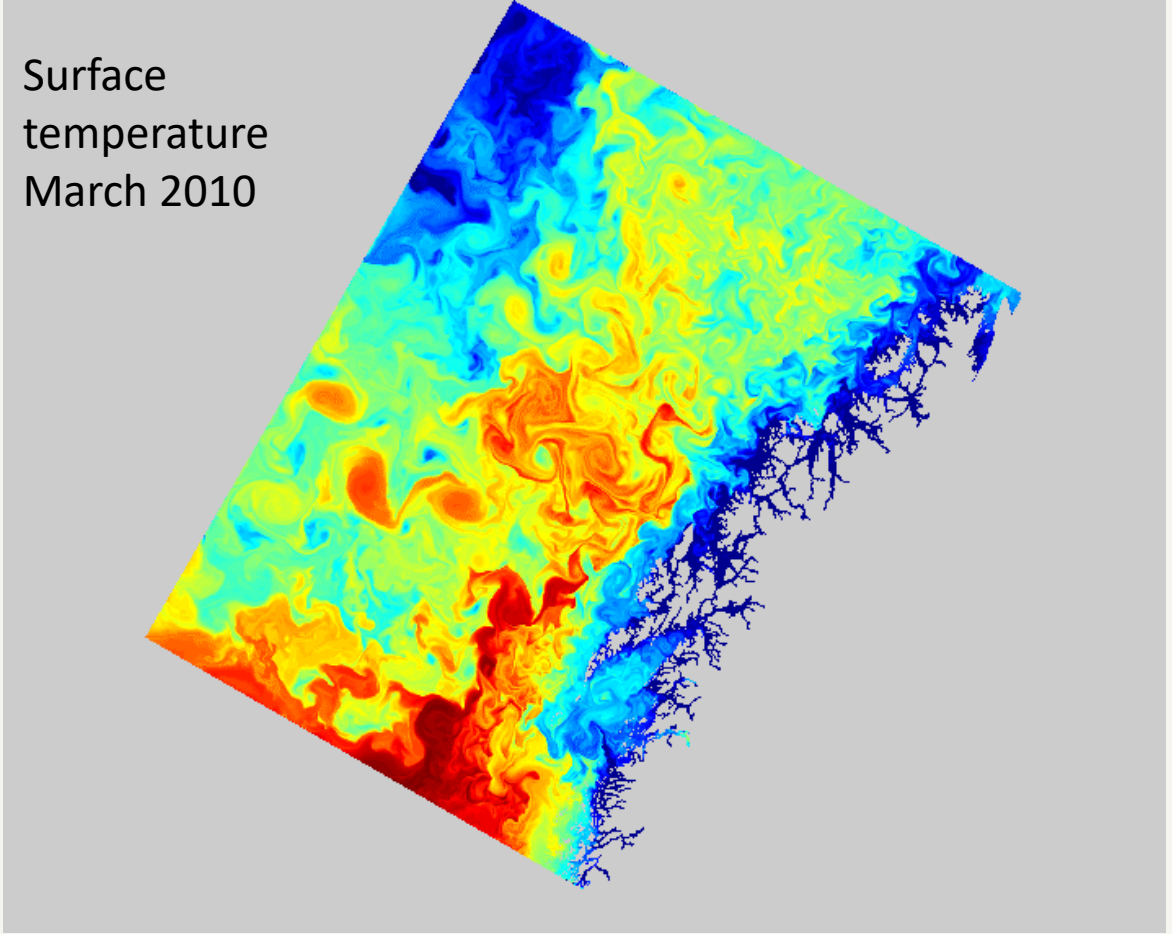
UiO

The Norwegian Atlantic Current and Coastal Current

The Norwegian coastal circulation is influenced by the Norwegian Atlantic Current (NAC) and the Norwegian Coastal Current (NCC).

NAC and NCC dominate the water mass composition along the coast.

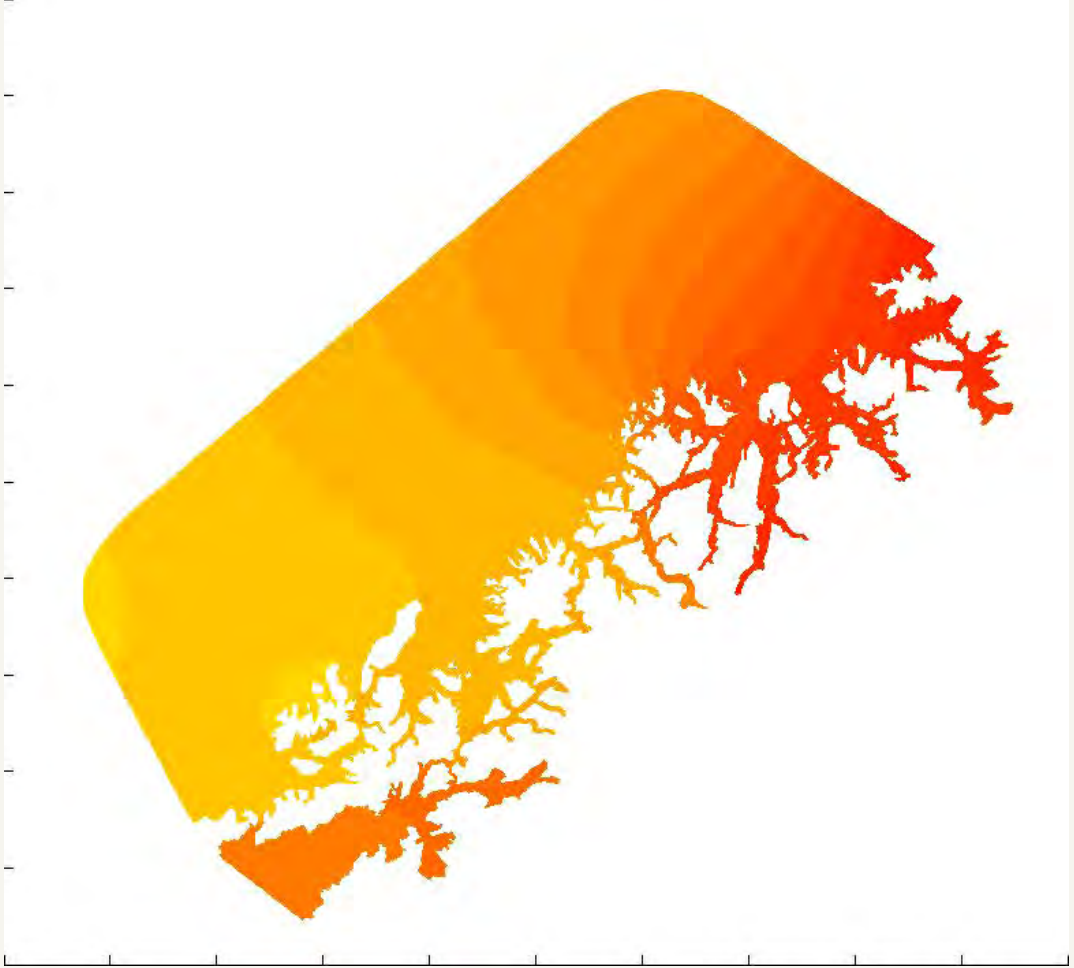
The horizontal resolution of the model used to create the animation is 800 meters. To resolve the nearshore circulation, much finer resolution is needed.



Akvaplan niva

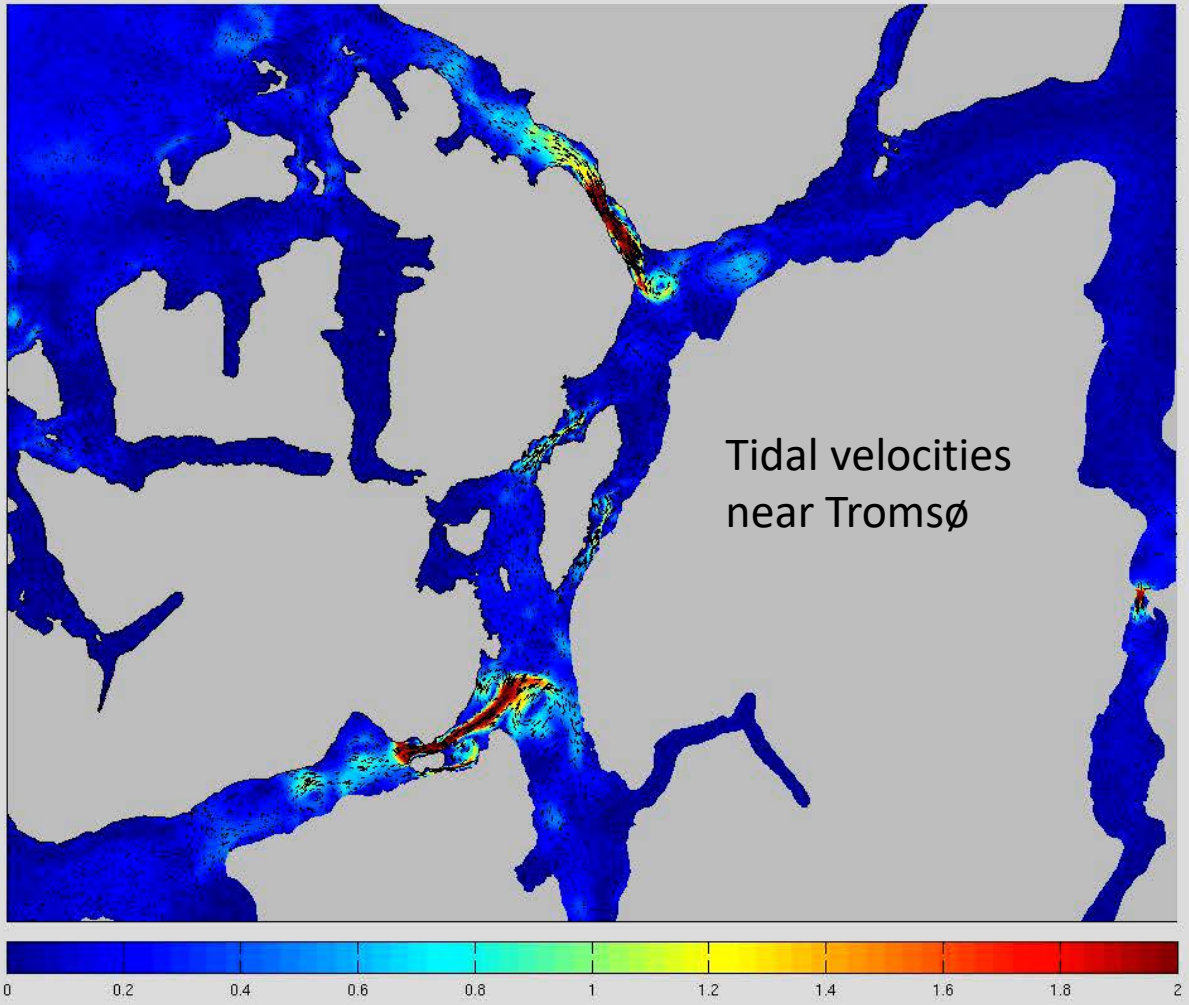
Tideal wave

The tide is a wave moving with the coast on the right side.

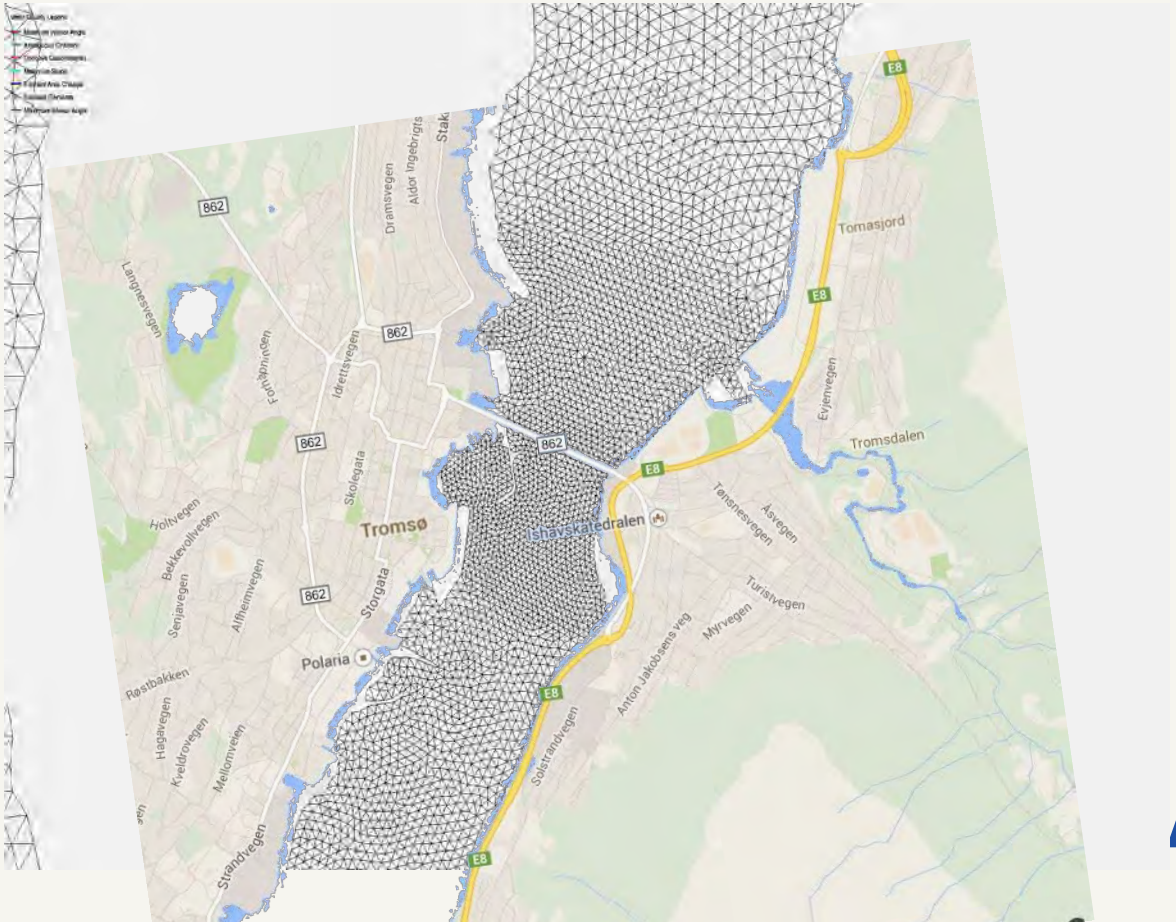


Tides causes strong currents near shore.

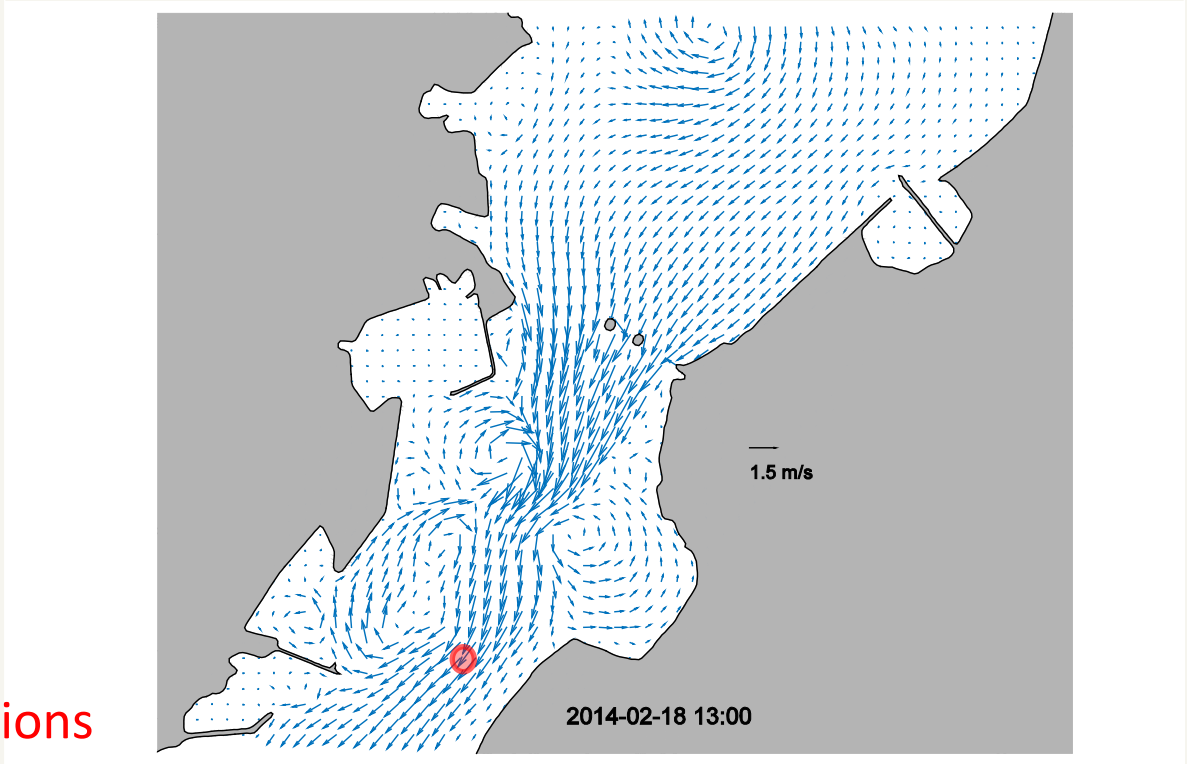
The model results shown in the animation are made using the same model as on the previous slide showing tidal wave along the coast.



Unstructured grid for Troms



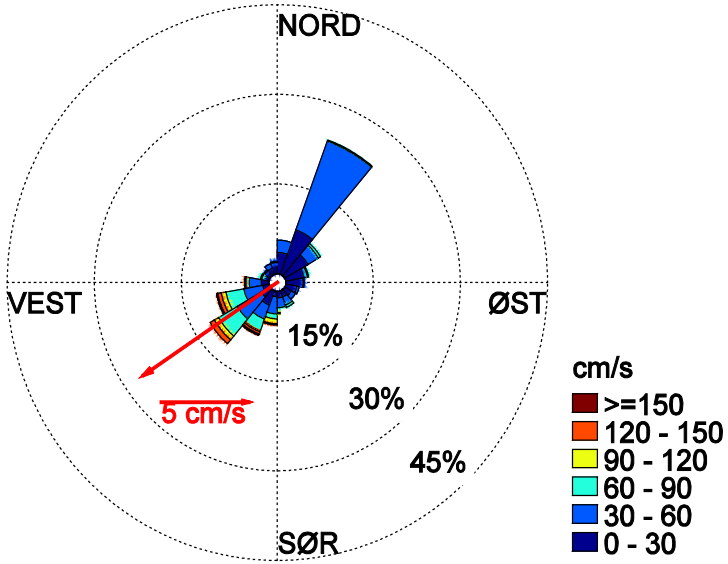
Tromsøsundet circulation snapshot. Many features of the circulation near the harbour is resolved.



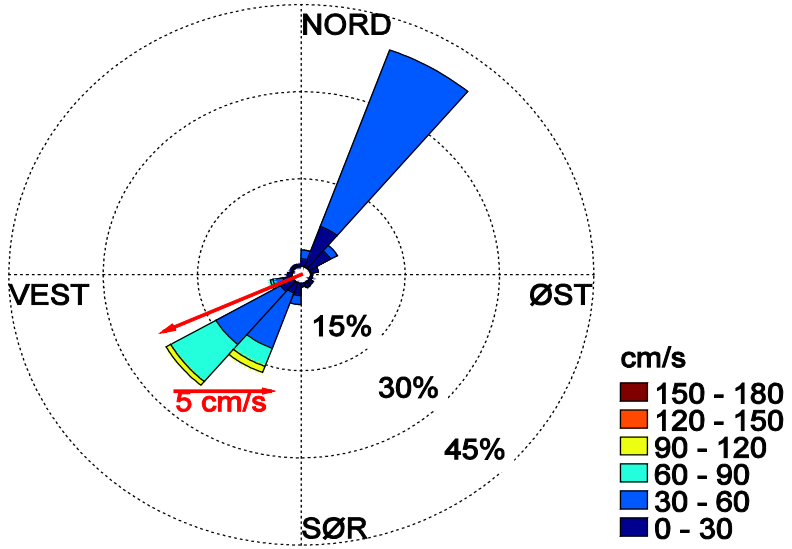
Observations

Tromsøsundet

Model



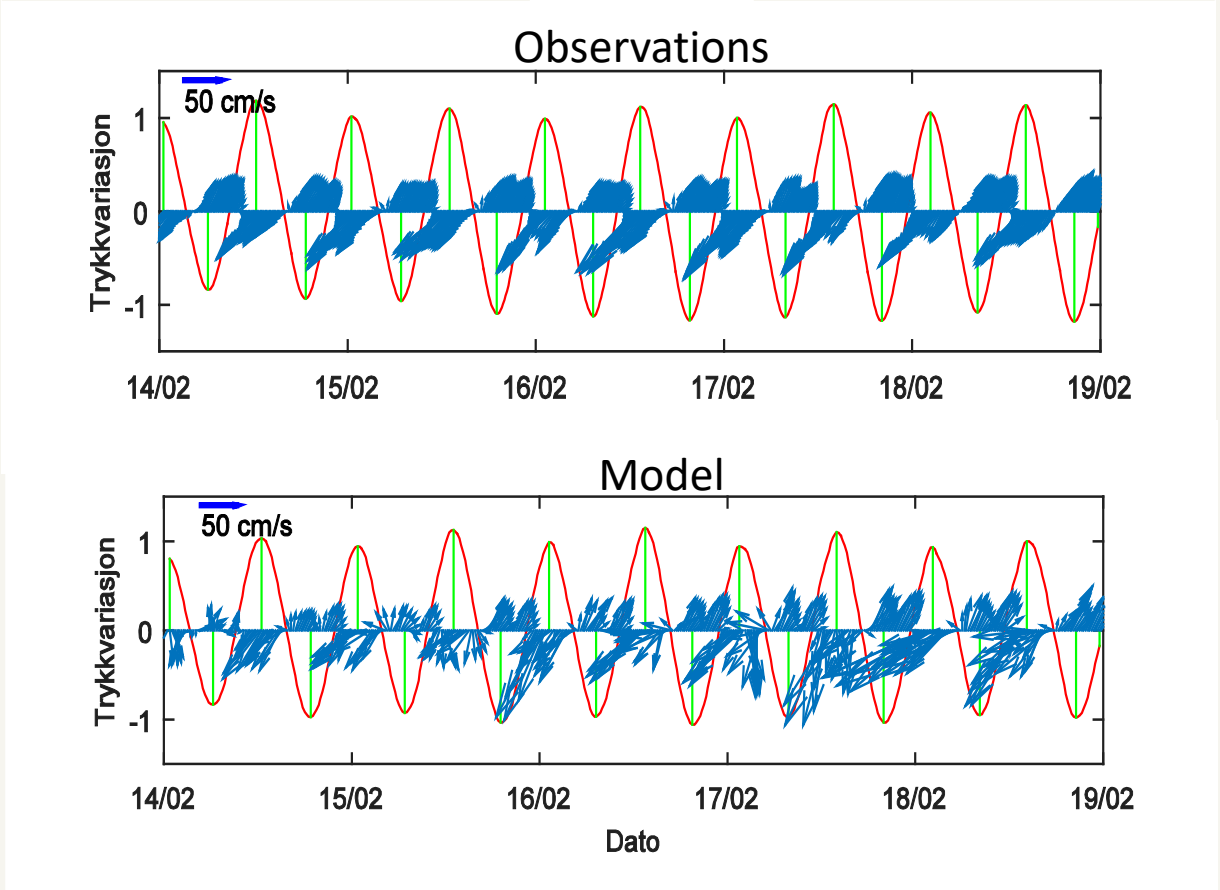
Observations



Tromsøsundet

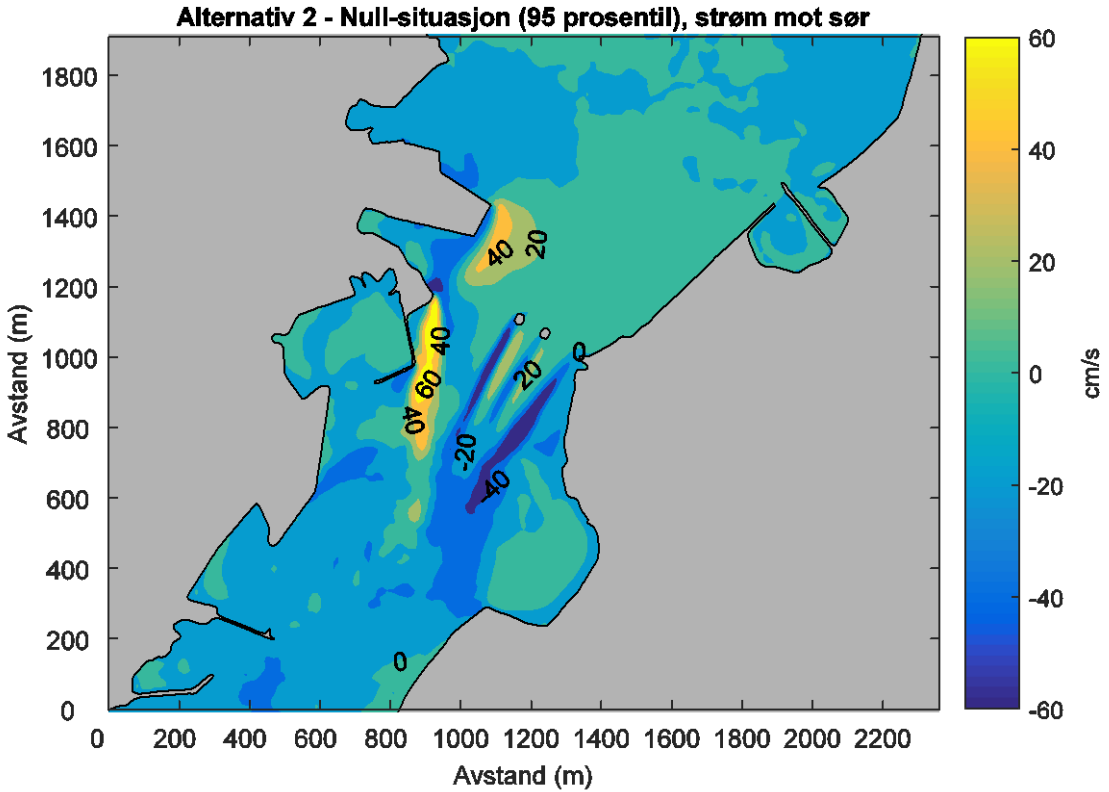
Compares well with observations.

Also the double peak in velocity maximums are reproduced (Espenes, 2018).



Changing the geometry has effect

The change in coastal geometry due to fillings into the sea.

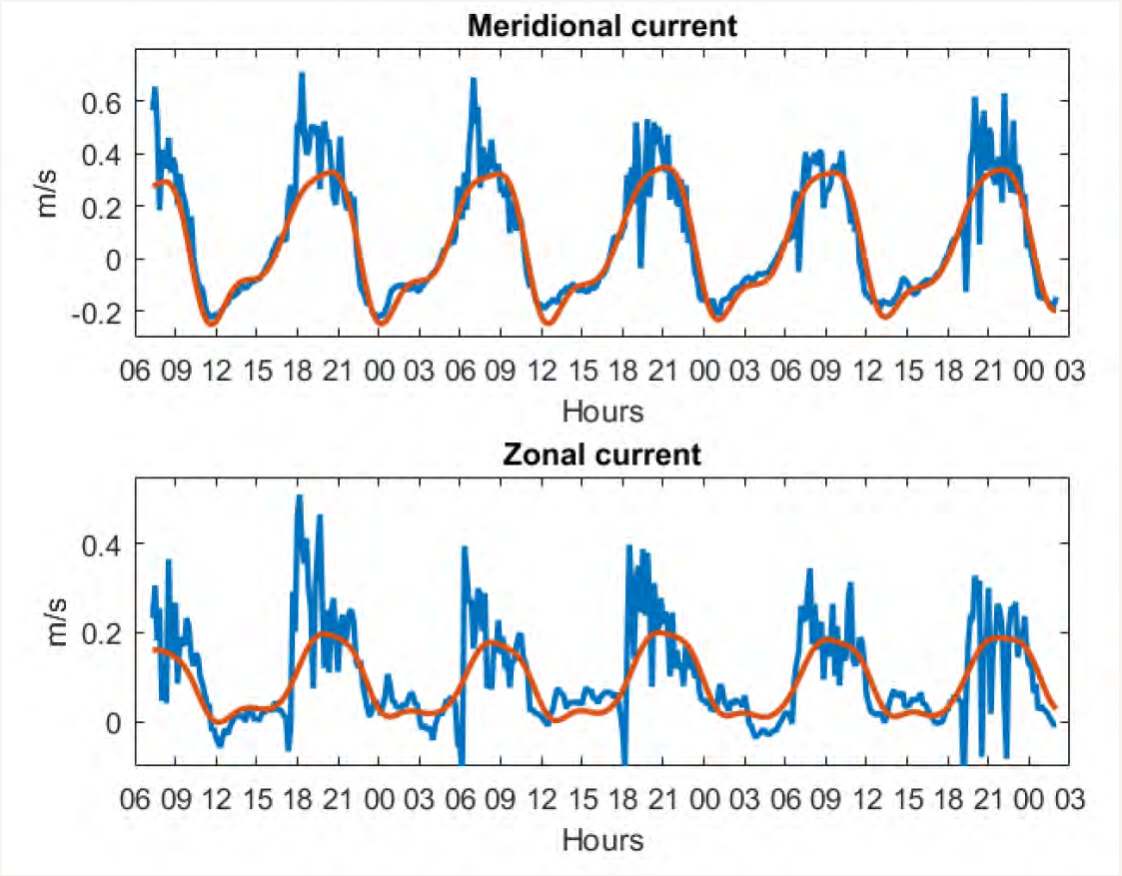


Eddies generated by tidal jets

The figure shows observed currents in Tromsøysund.

Red curves are build up by harmonic components, while blue curves are the raw data.

The same features are also shown in models forced by tides only.



Eddies generated in Tromsøysund tidal jet.

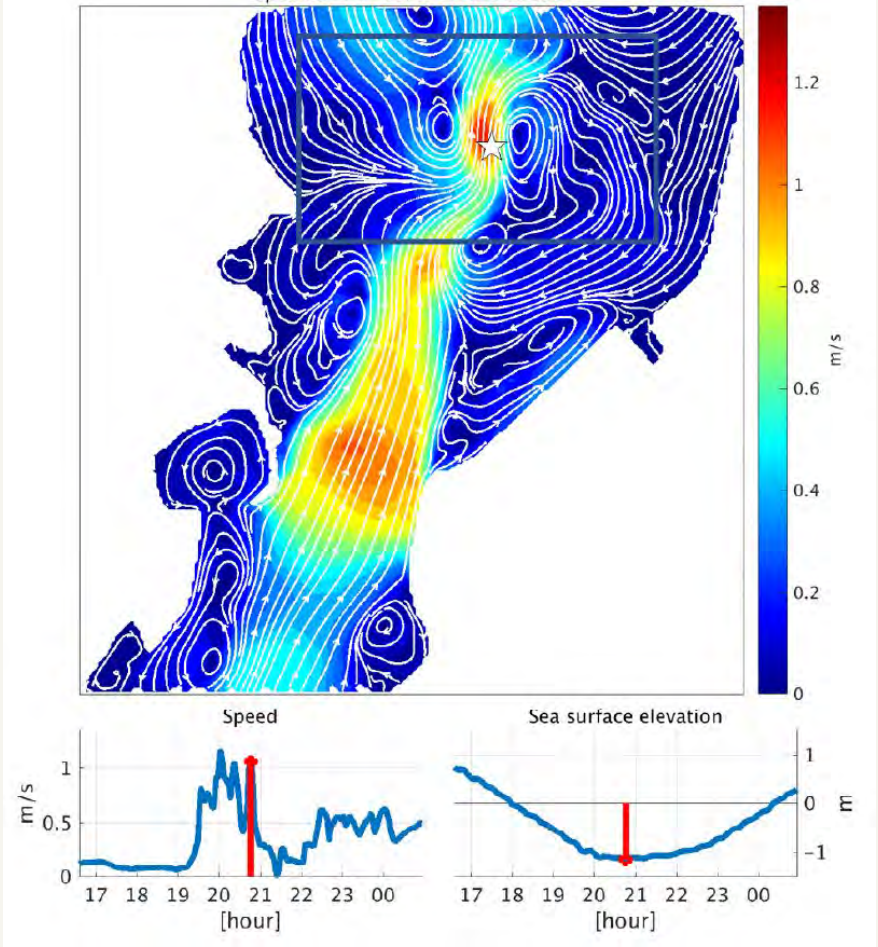
Eddy dipoles are constantly being formed and travel away from the strait. These dipoles act as narrow constrictions, forming a travelling velocity maximum between them. Each time a dipoles passes the current meter, we see a maximum in velocity.

Figure:

Upper: Velocities (colors) and streamlines.

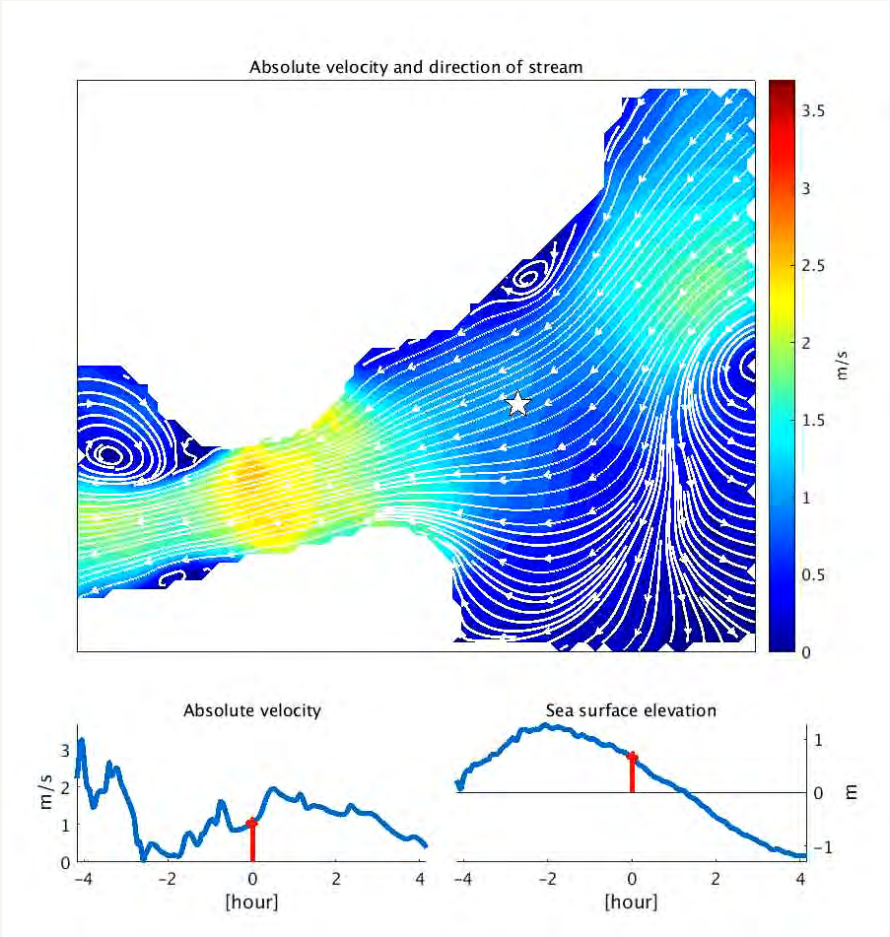
Lower left: Current time series from the location marked by a star.

Lower right: Sea surface elevation.

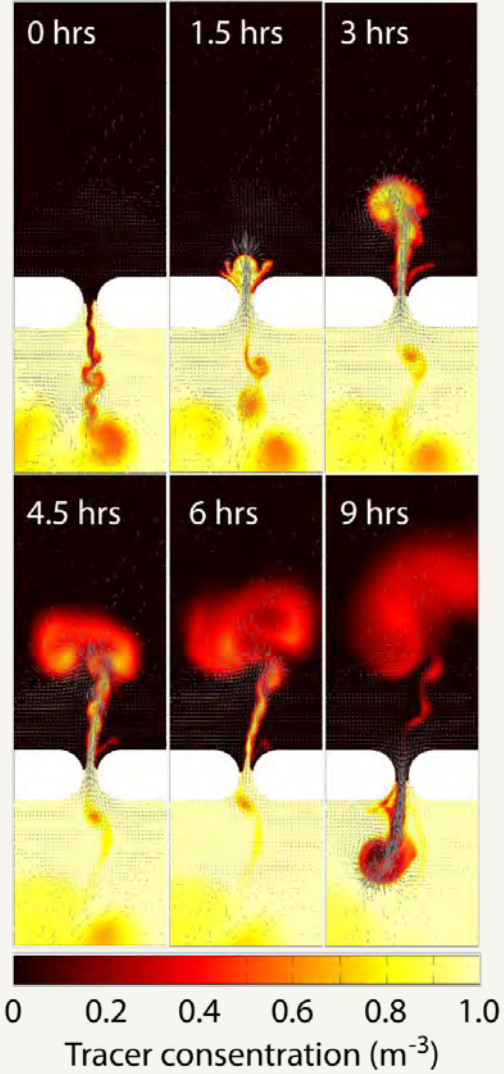


Eddies generated in Tromsøysund tidal jet.

- Animation showing how eddy dipoles causes velocity variations (at the star location) in Rystraumen south of Tromsø



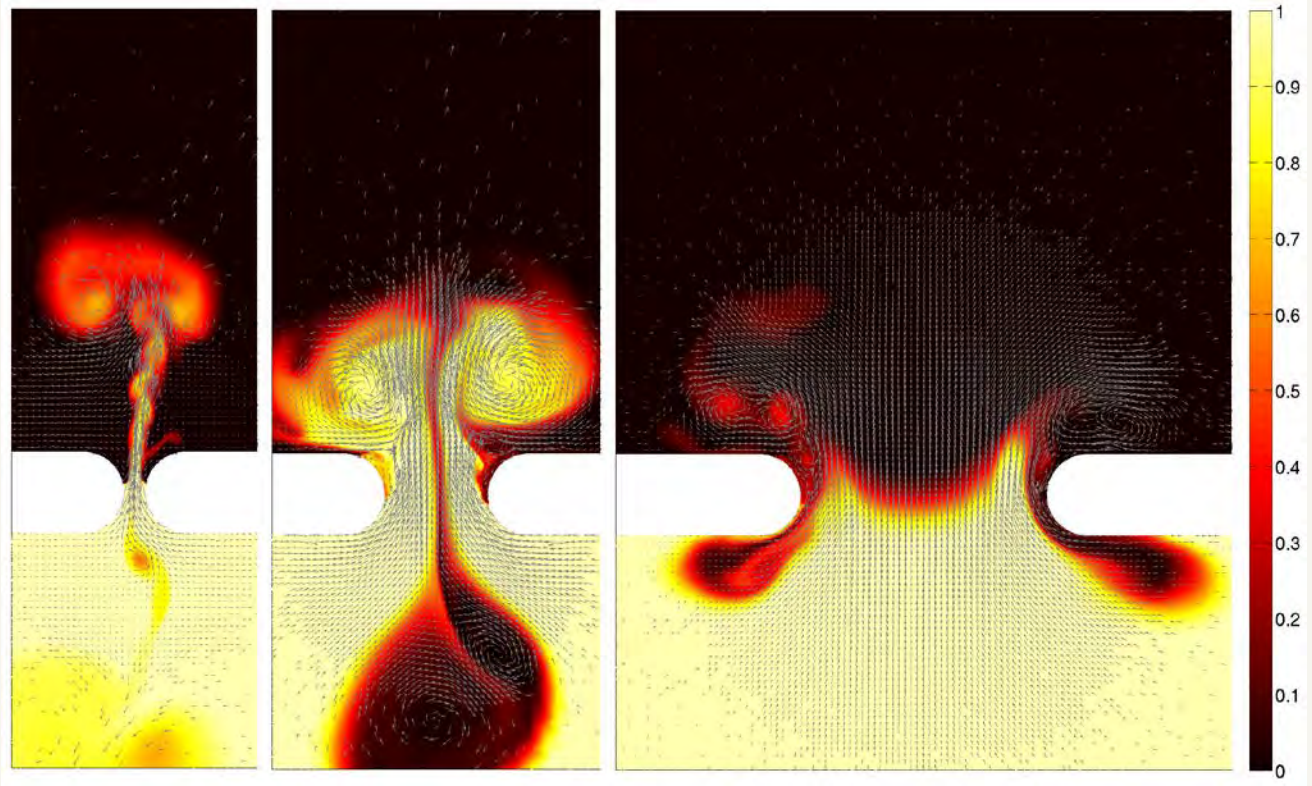
Net tracer transport caused by tidally generated dipole eddies.



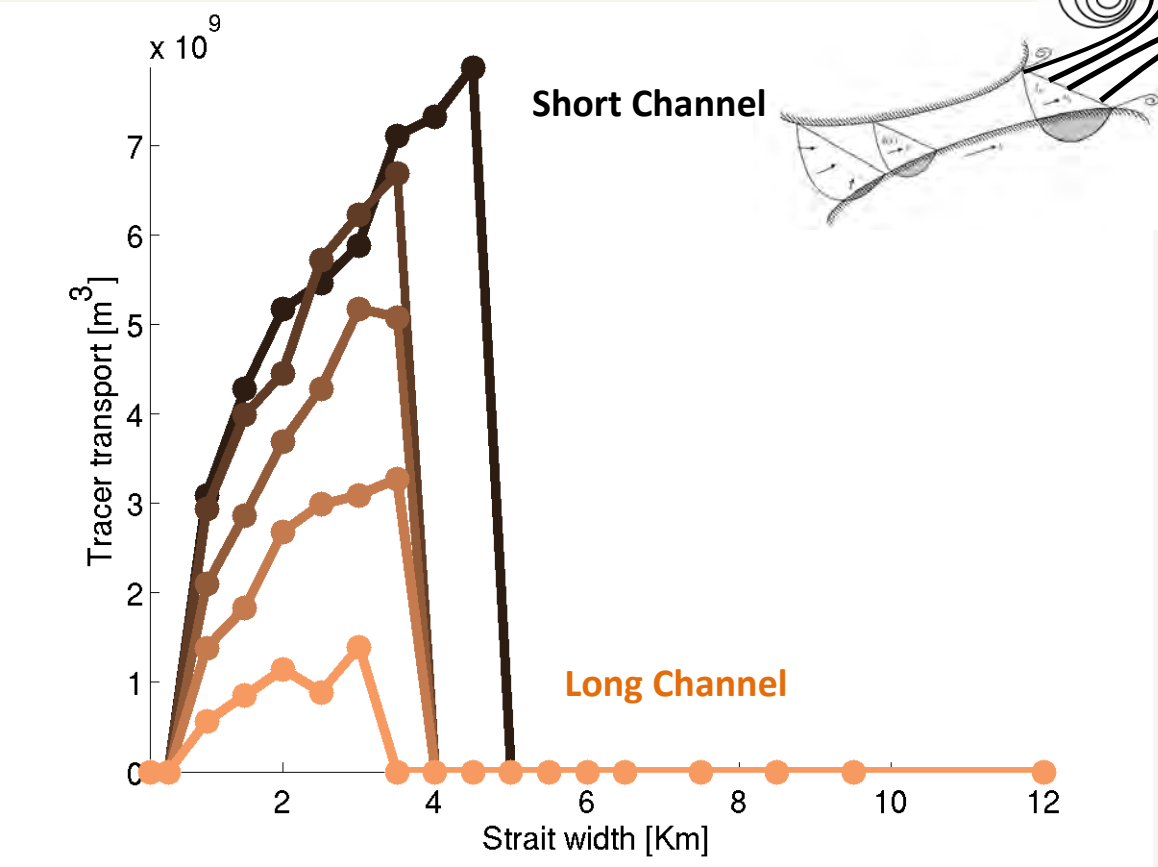
Channel widths

Eddy dipoles in three different channel widths, at the same time in the tidal period.

The wides channel has no net tracer transport.



Short and narrow channels are expected to have largest net tracer transport

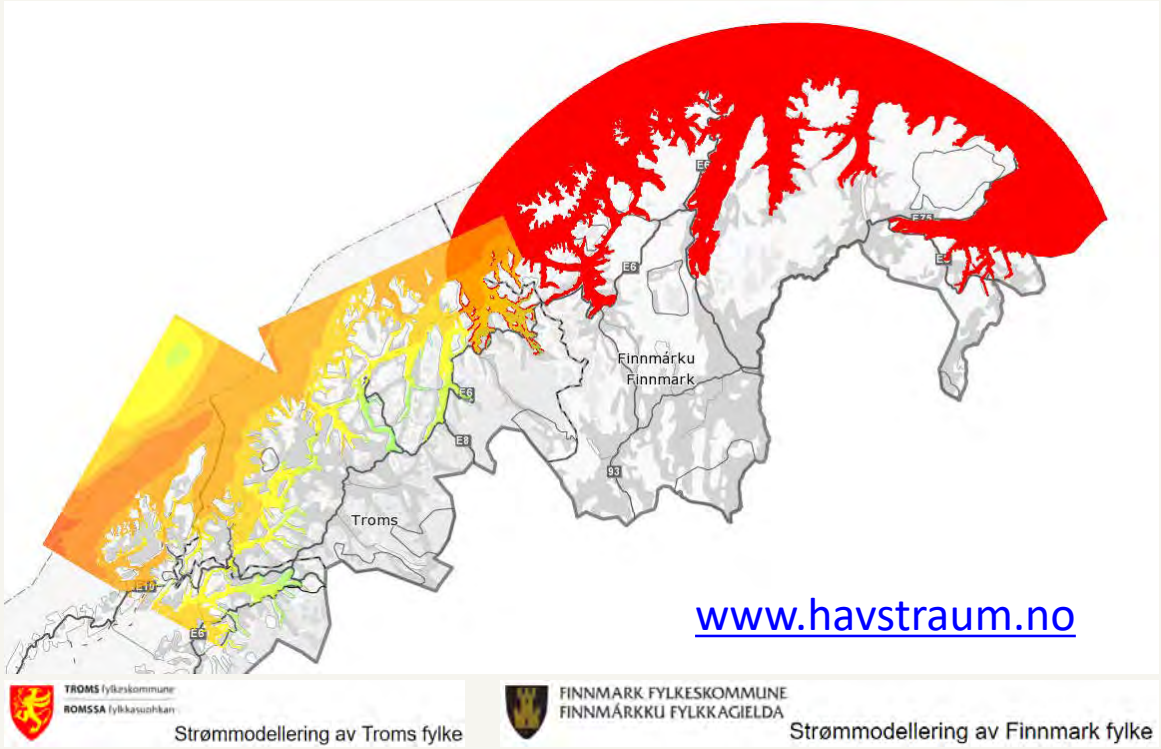


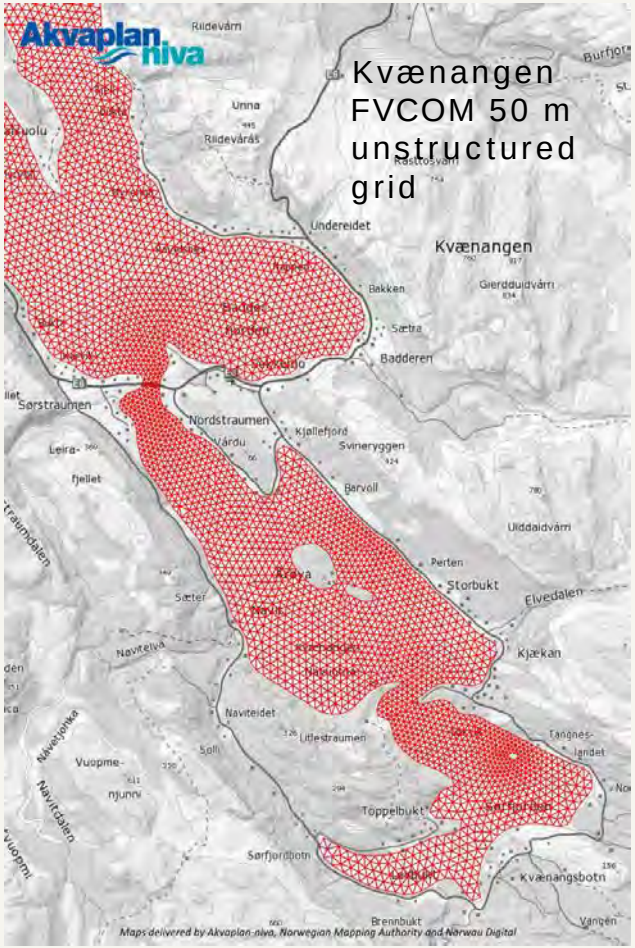
Akvaplan niva

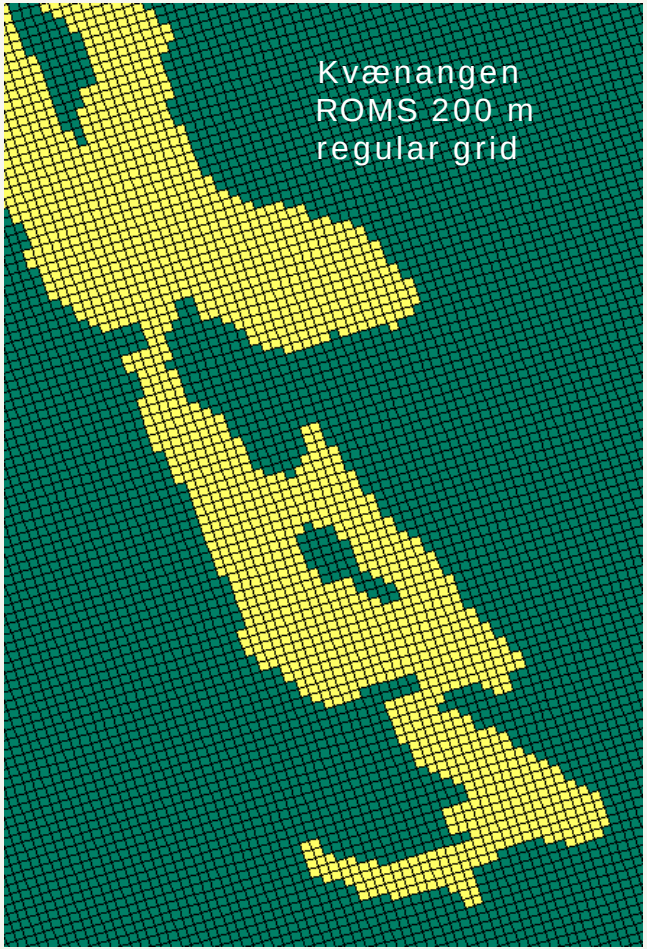
Comparison of two model in Kvænangen, Troms

Domains of models run in Troms and Finnmark. They overlap in northern Troms.

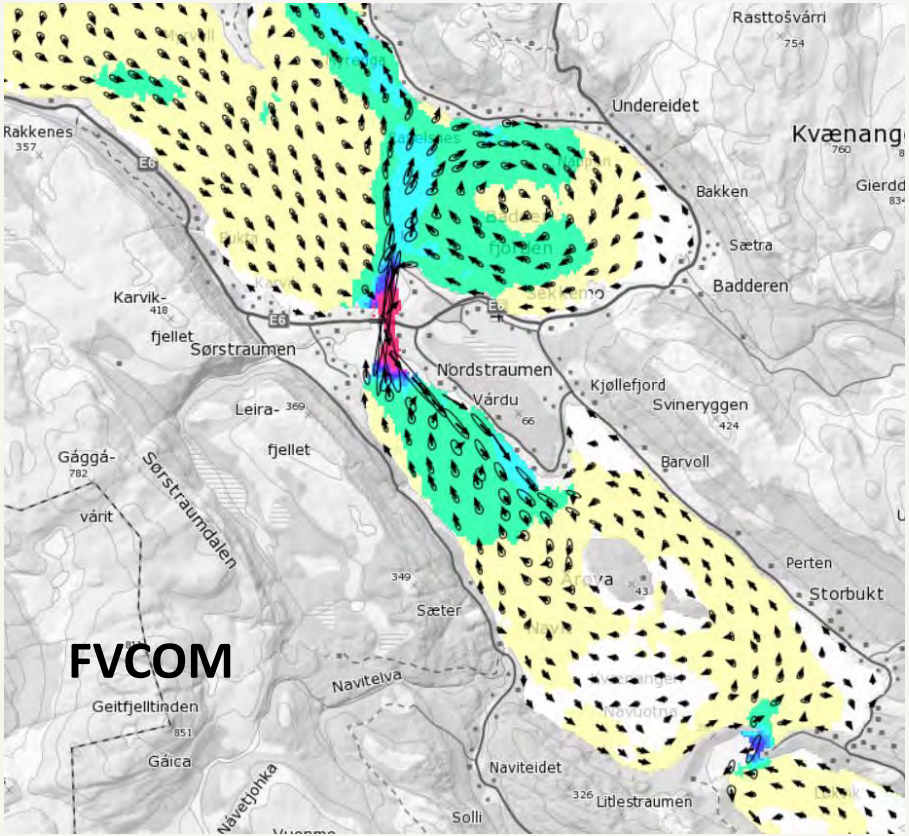
The models are run with full tidal and atmospheric forcing.

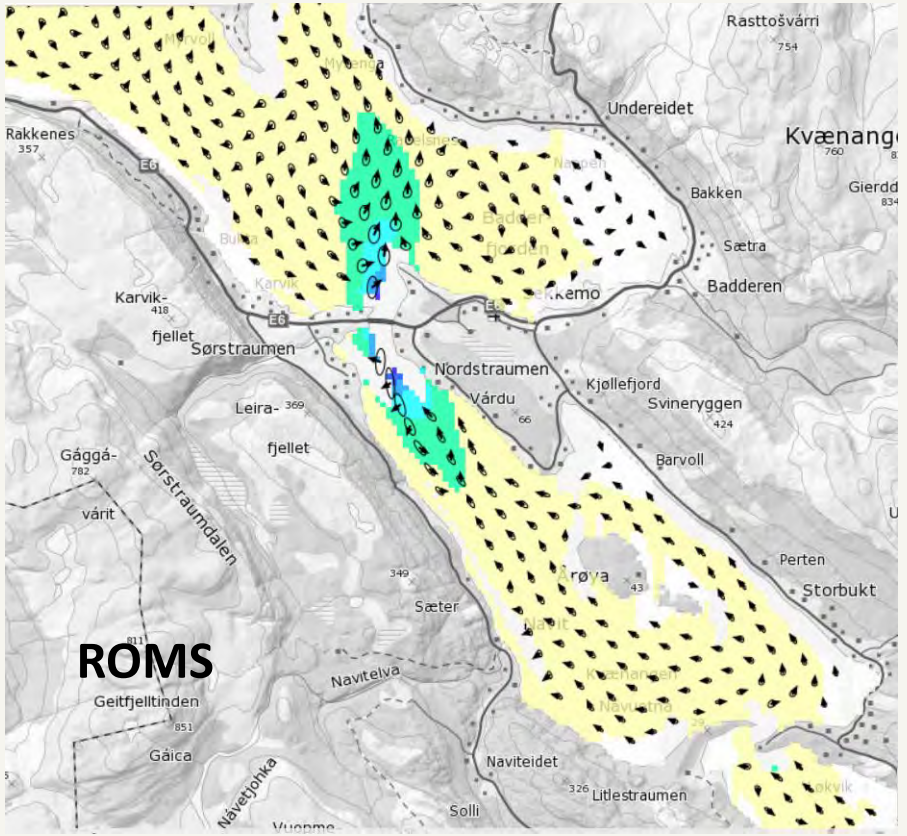


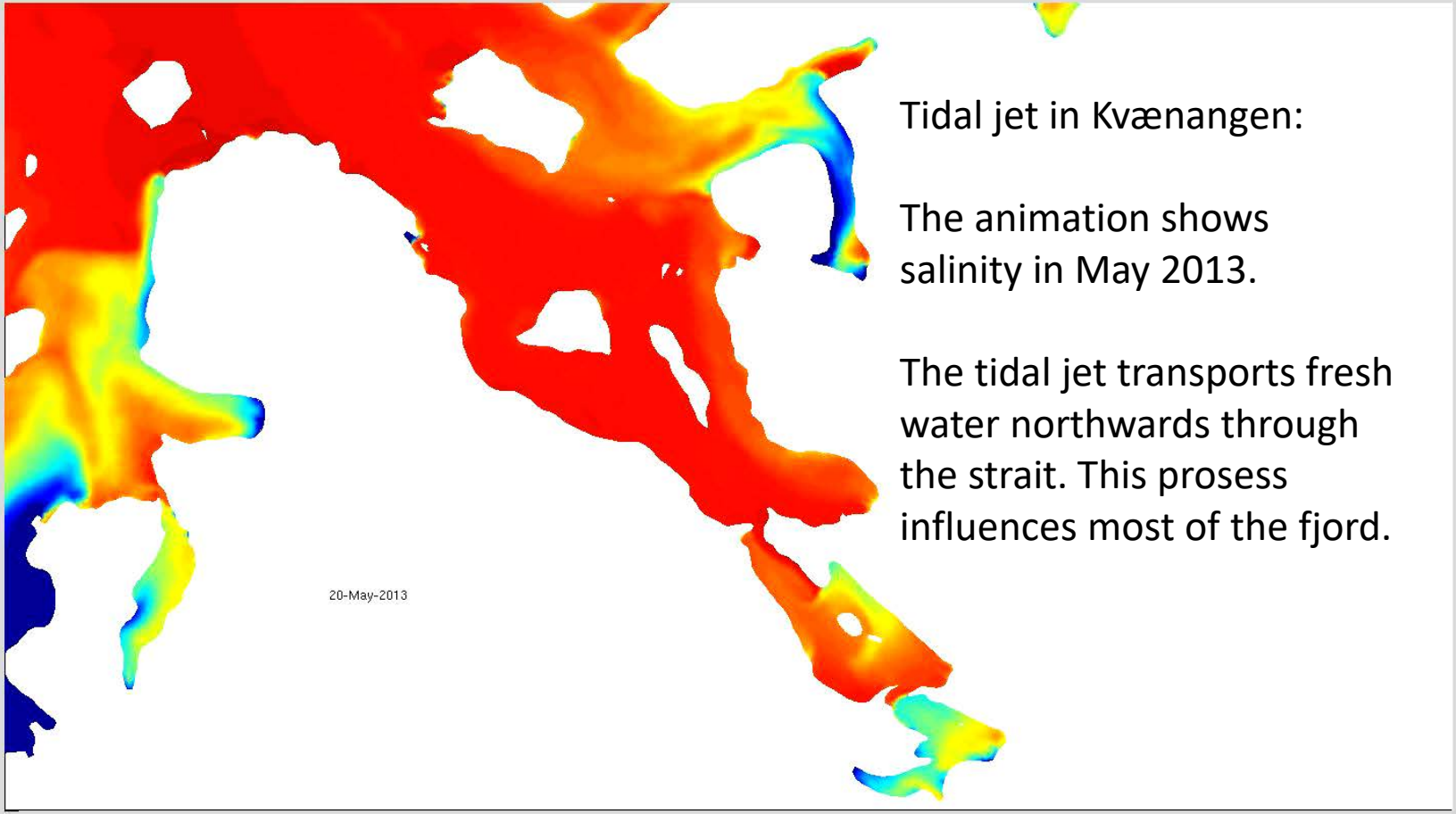




Akvaplan niva


FVCOM
Rasttošvárri
754
Undereidet
Kvænang
760
Rakkenes
357
E6
Bakken
Gierdd
834
Sætra
Badderen
Karvik-
418
fjellet
Sørstraumen
Nordstraumen
Kjøllefjord
Svineryggen
424
Várdu
66
Leira-
369
fjellet
Barvoll
Gággá-
782
várit
Sørstraumdalen
Perten
Storbukt
349
Sæter
43
Navitelva
Geitfjelltinden
851
Gáica
Naviteidet
326
Litlestraumen
Solli
Návetjohka


ROMS
Rasttošvárri
754
Undereidet
Kvænang
760
Rakkenes
357
E6
Bakken
Gierdd
834
Sætra
Badderen
Karvik-
418
fjellet
Sørstraumen
Nordstraumen
Kjøllefjord
Svineryggen
424
Várdu
66
Leira-
369
fjellet
Barvoll
Gággá-
782
várit
Sørstraumdalen
Perten
Storbukt
349
Sæter
43
Navitelva
Geitfjelltinden
851
Gáica
Naviteidet
326
Litlestraumen
Solli
Návetjohka



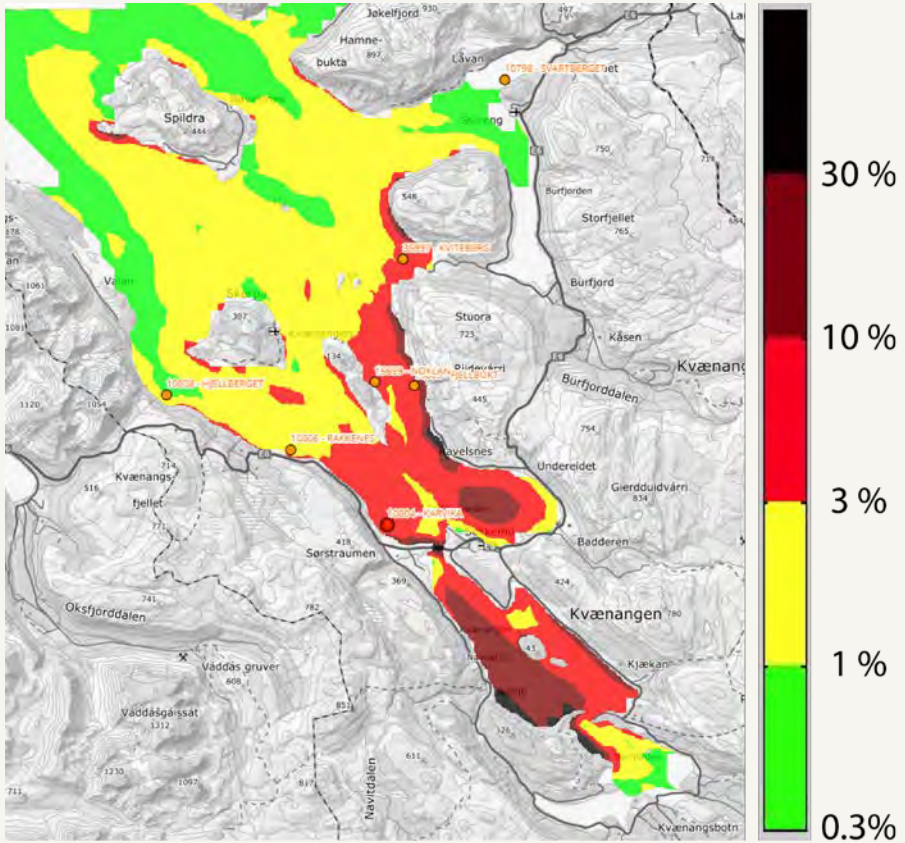
Tidal jet in Kvænangen:

The animation shows salinity in May 2013.

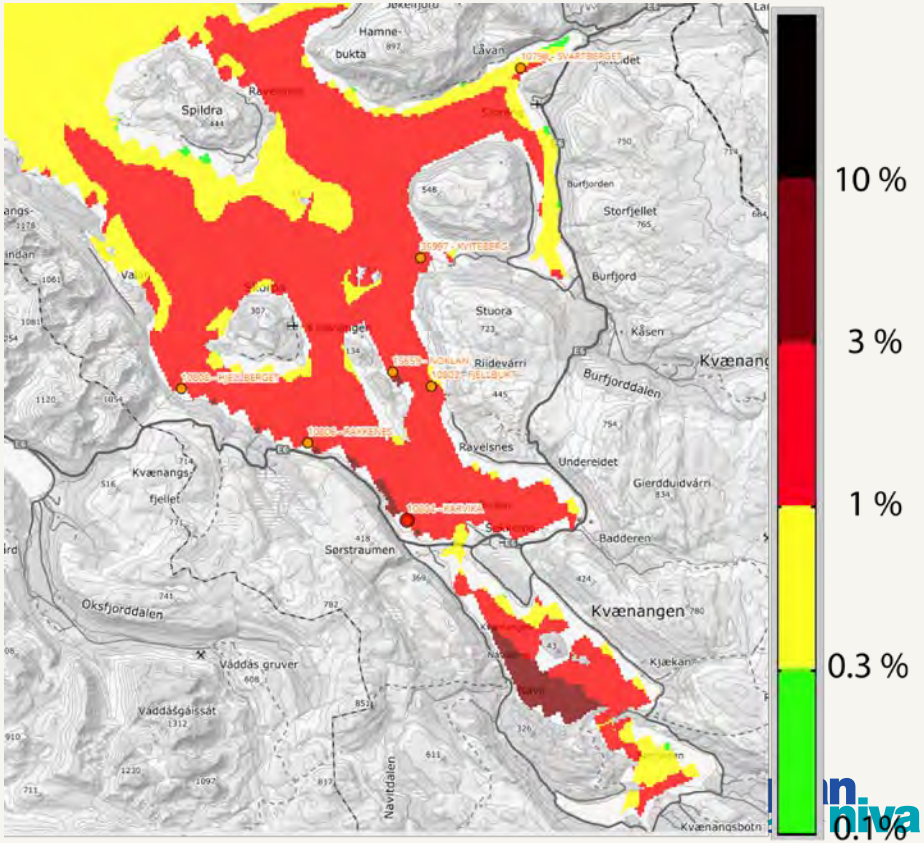
The tidal jet transports fresh water northwards through the strait. This prosess influences most of the fjord.

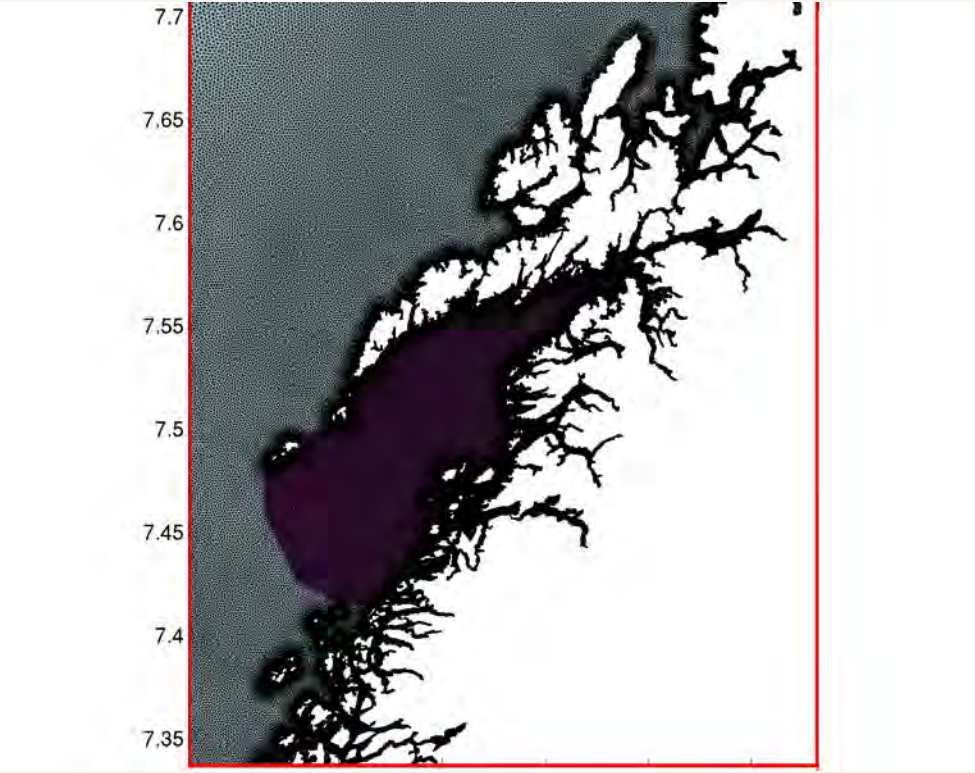
Spreading of salmon lice

FVCOM



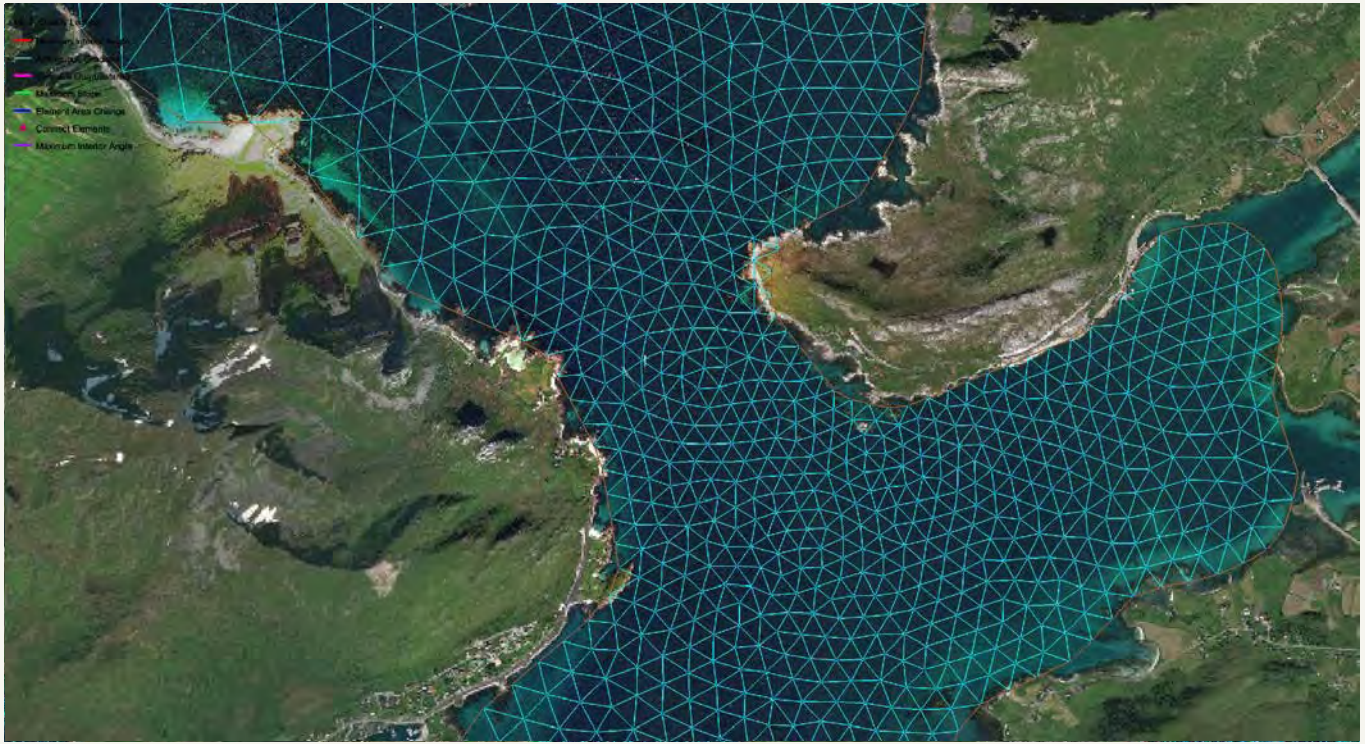
ROMS



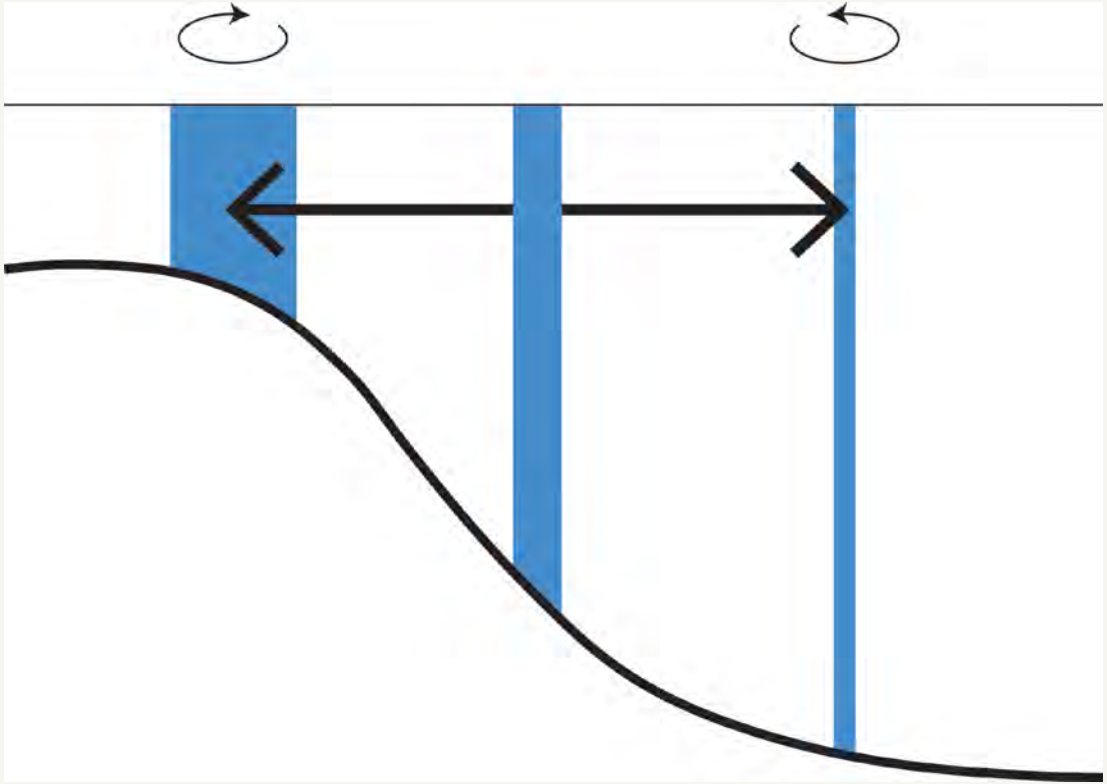

7.7
7.65
7.6
7.55
7.5
7.45
7.4
7.35

Akvaplan-niva's Nordland grid

Oppløsning varierer fra 2.5 km til 30 m

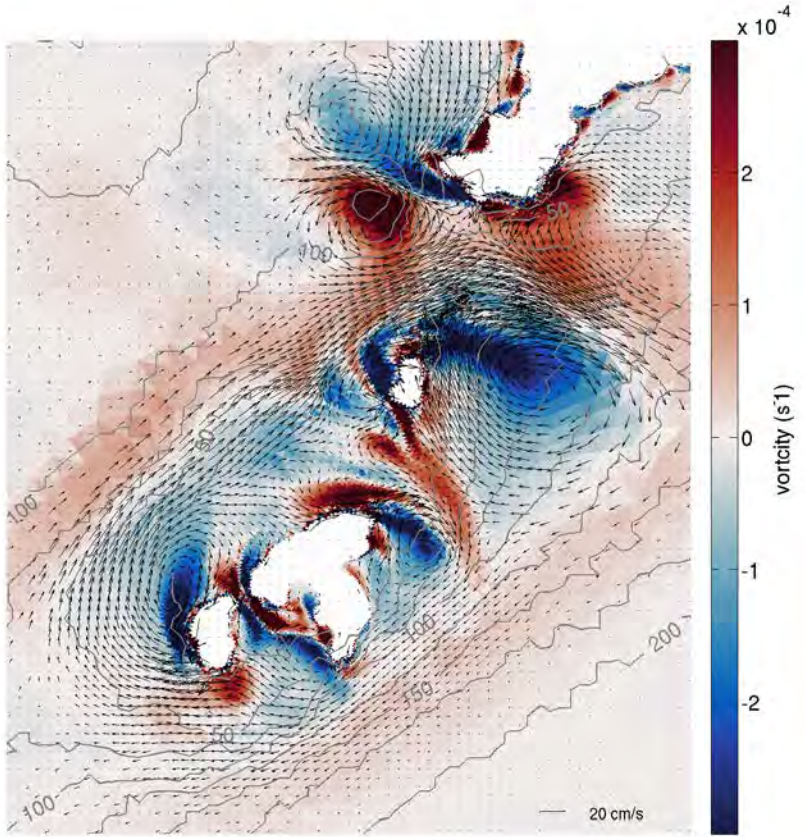


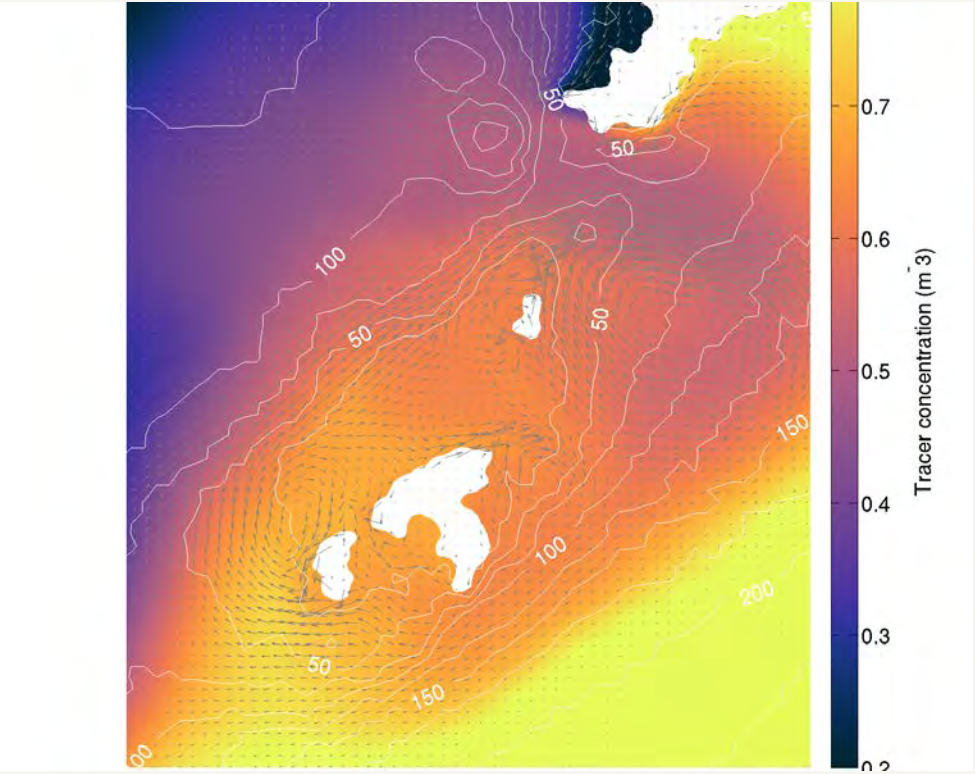
Node number > 1000000; Cell number > 2000000



Røst

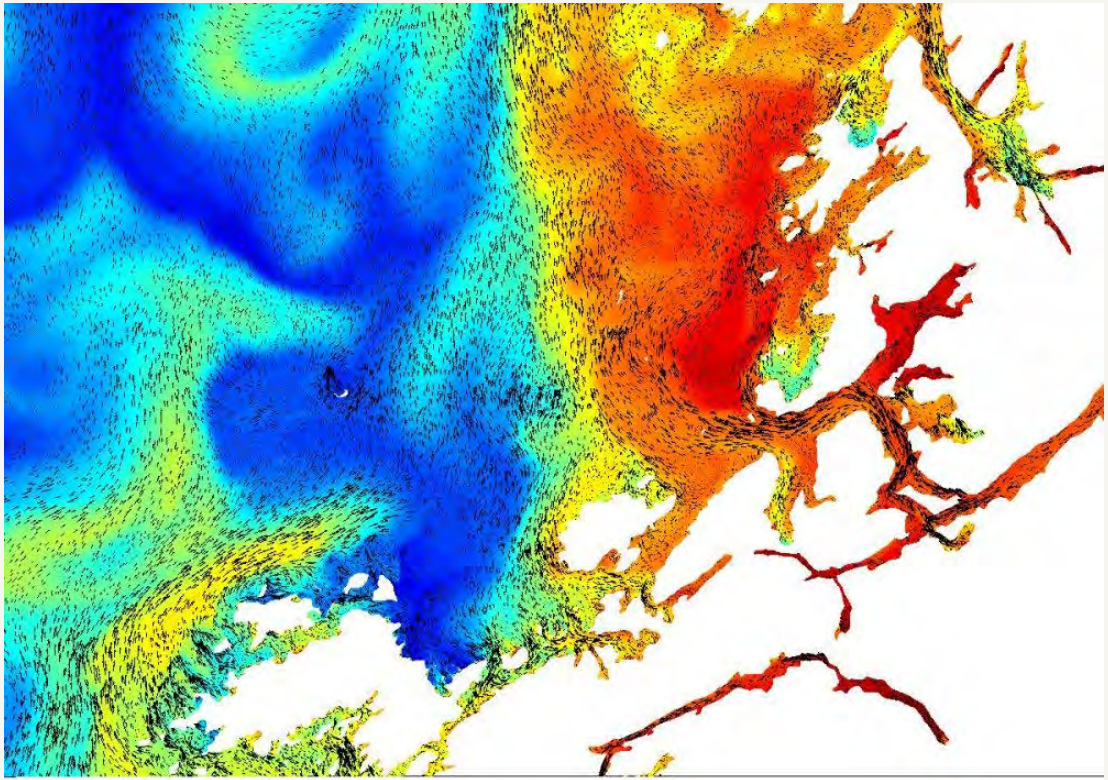
Tidevannsgenererte middelstrømmer




100
50
50
50
150
100
200
50
150
0.7
0.6
0.5
0.4
0.3
Tracer concentration (m-3)

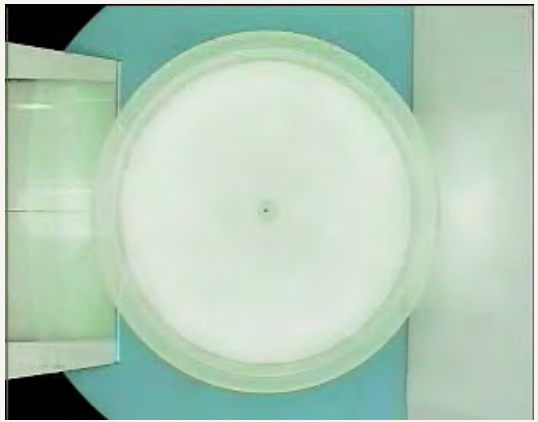
Conclusion

Resolve the geometry of the coastline.

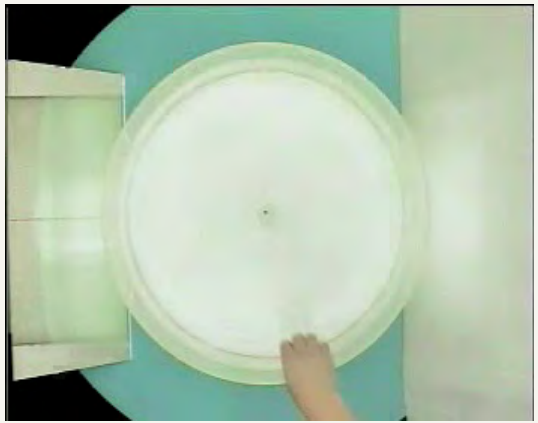


Effect of rotation

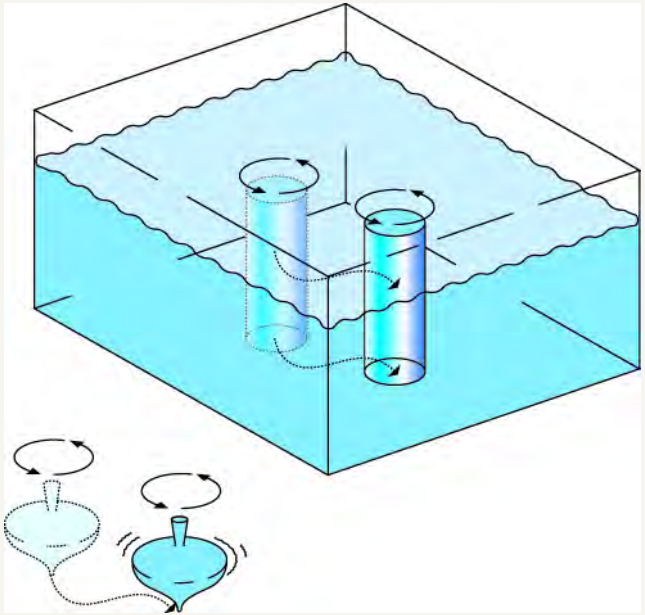
Non rotating



Rotating



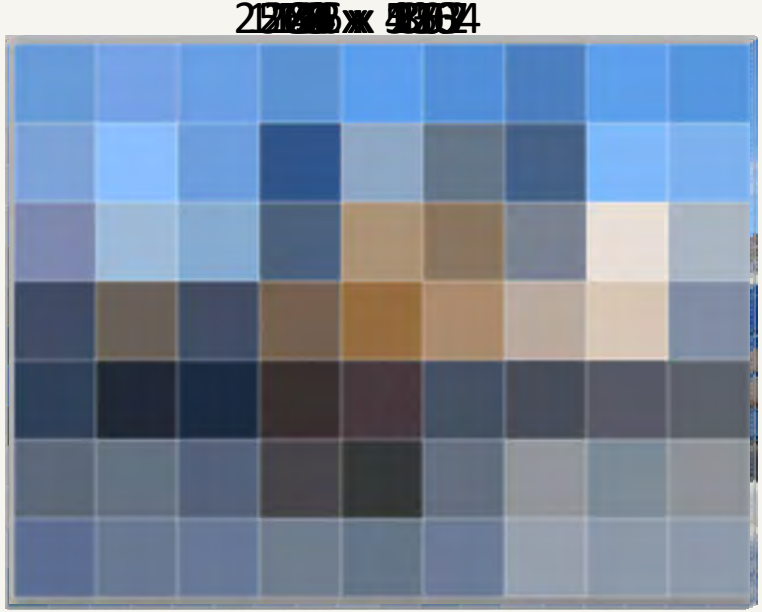
Geostrophic flow



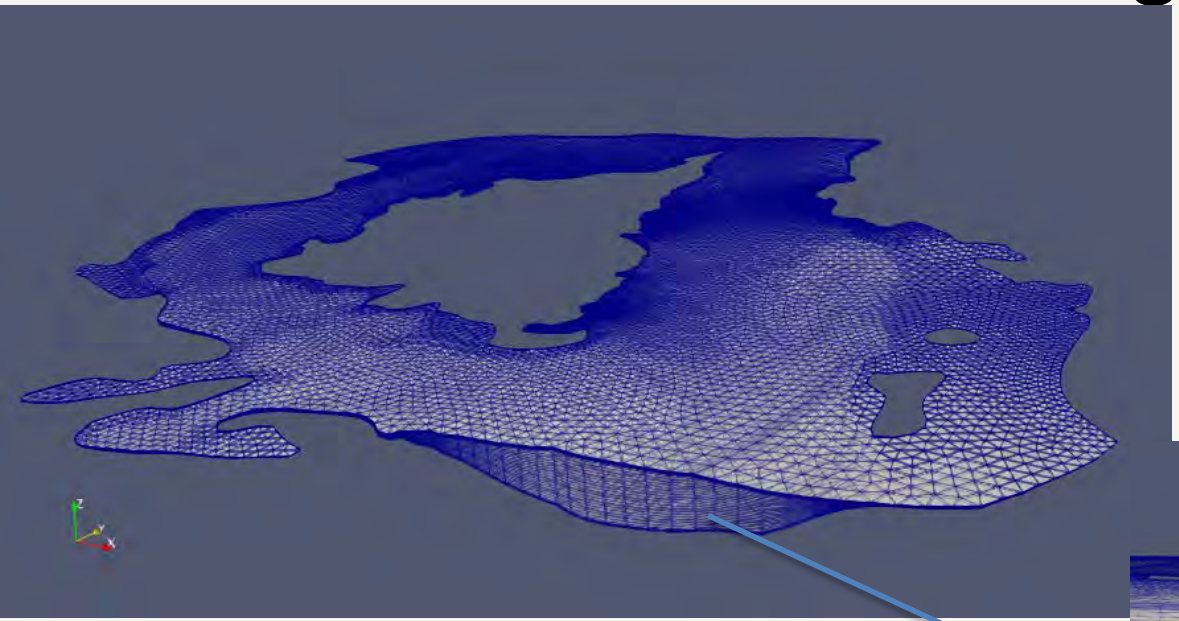
$$\boldsymbol{v} = \boldsymbol{k} \times \nabla p$$

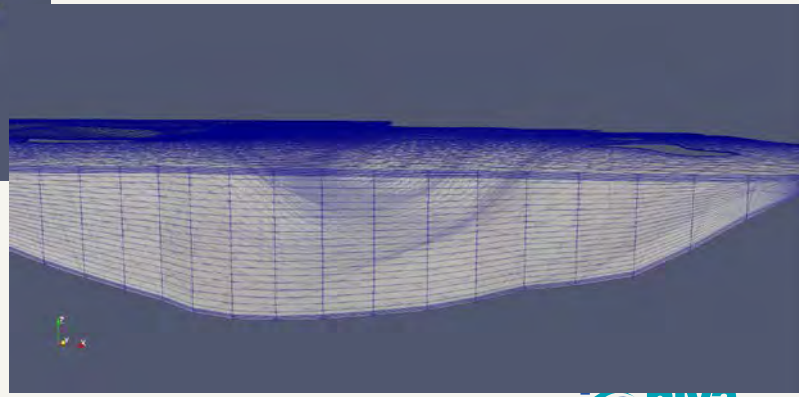
$$\nabla \cdot v = 0 \Longrightarrow \frac{dw}{dz} = 0$$

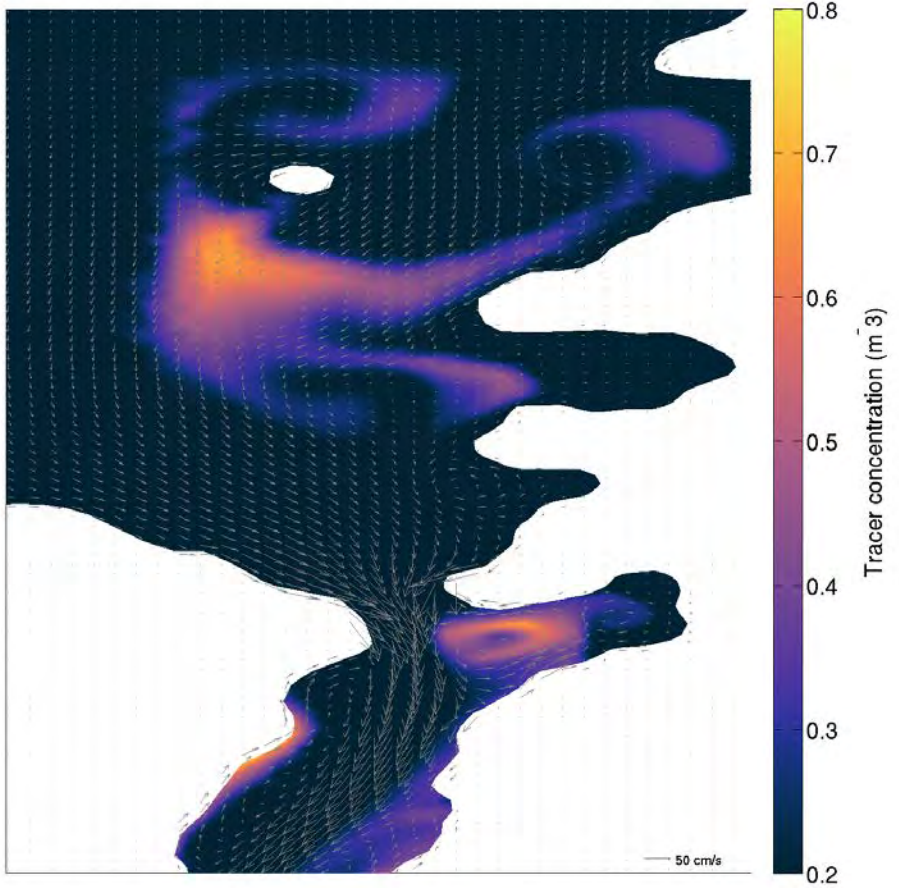
Oppløsning



Økssundet grid



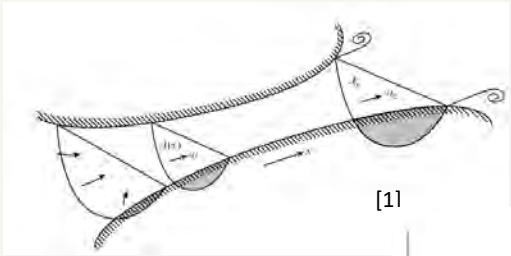



0.8
0.7
0.6
0.5
0.4
0.3
0.2
Tracer concentration (m ⁻3)
50 cm/s

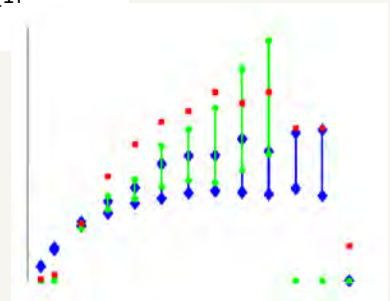
This presentation focuses on the dynamical forces controlling the net-tracer flux through narrow tidal straits


[2]

Tidal straits – what do we know?


[1]

A simple one dimensional channel model

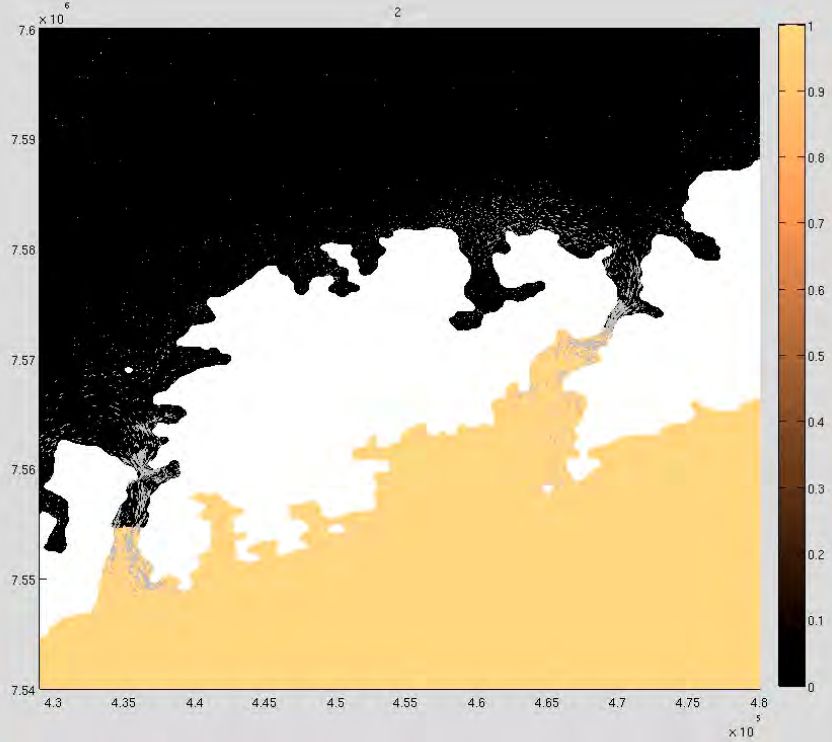


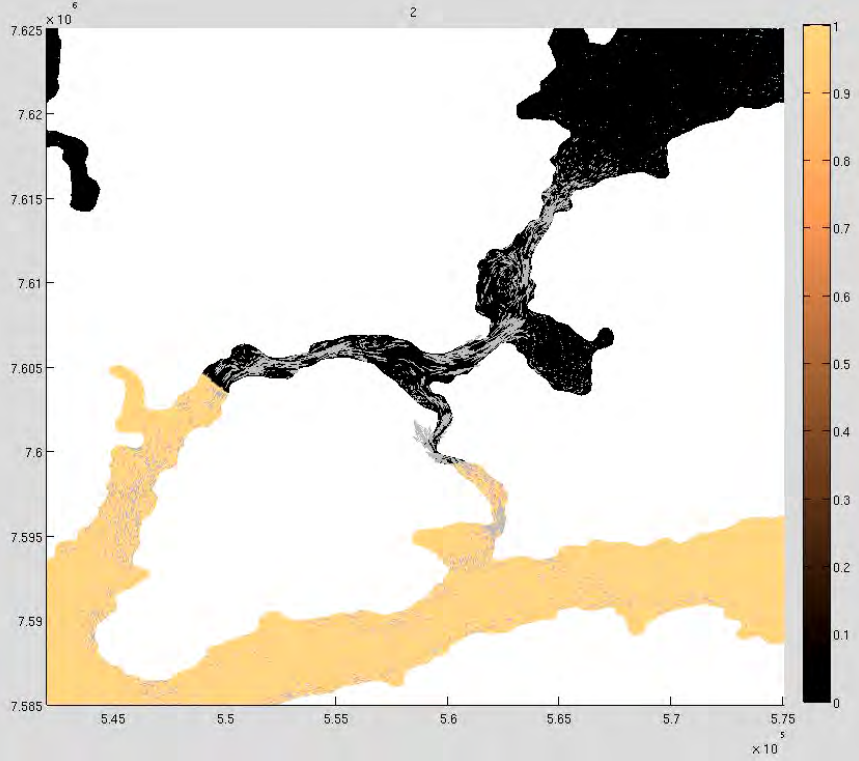
Comparison to an 2D - ocean model

[1] Garret and Cummins (2005)
[2] By Frankemann [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], from Wikimedia Commons

Gimsøsytraumen/Nappstraumen/Tjeldsund

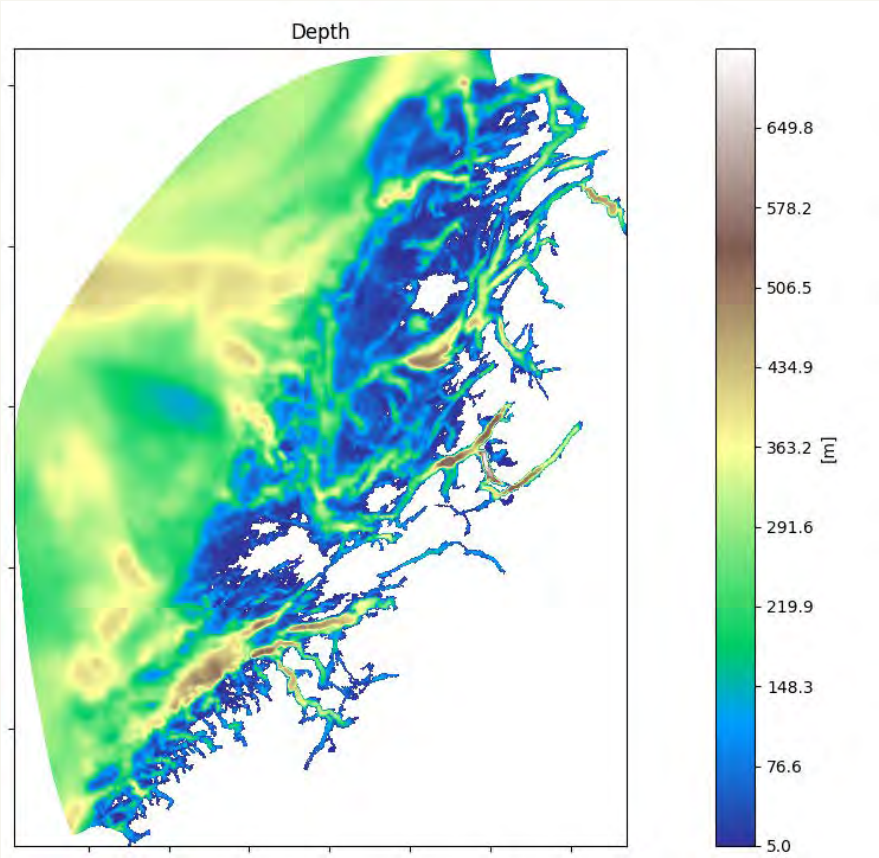
Doktorgradsprosjekt, Eli Børve, Akvaplan-niva og UiO



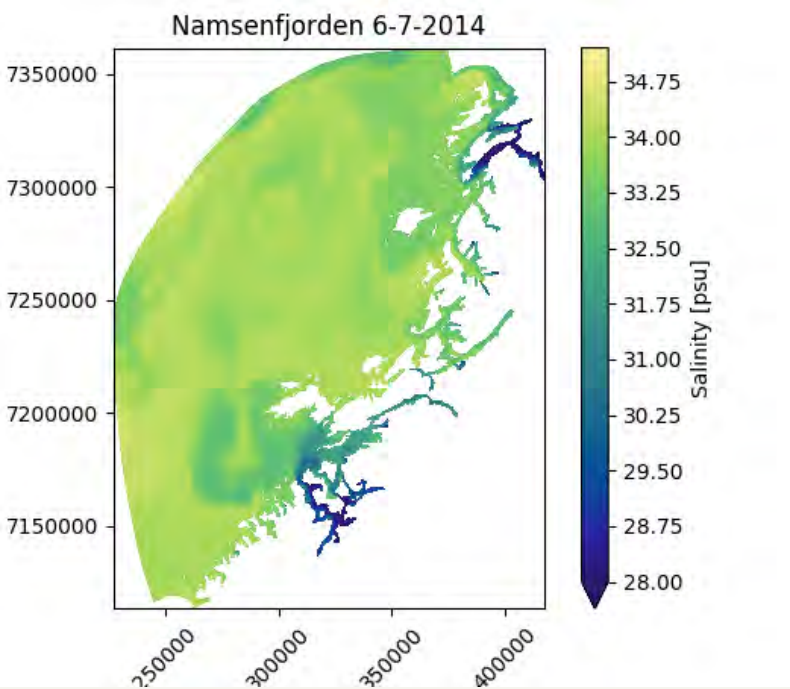


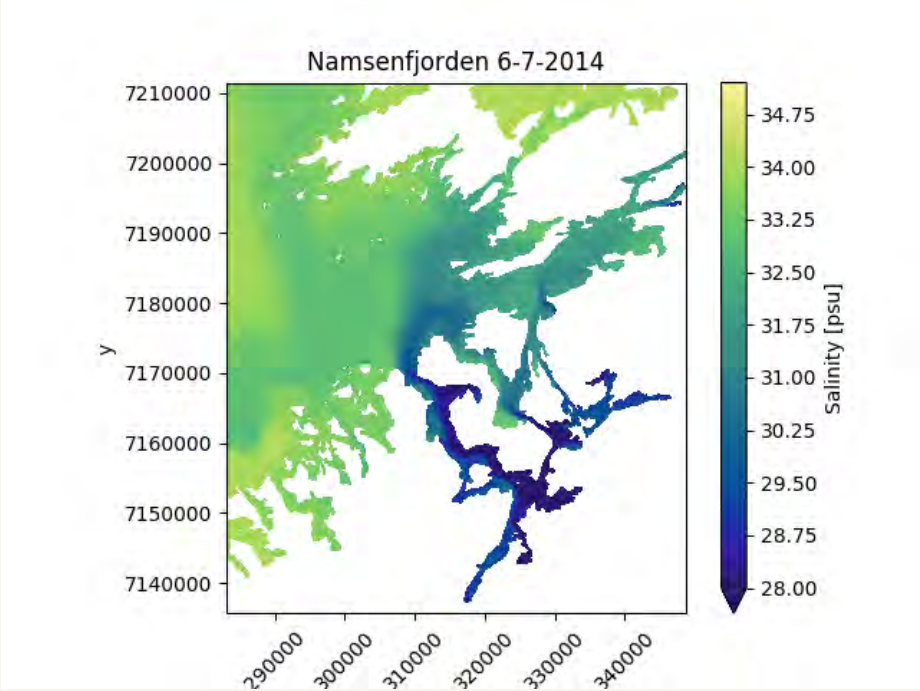
FVCOM Trøndelag

- Modell kjørt for 2014



FVCOM Trøndelag





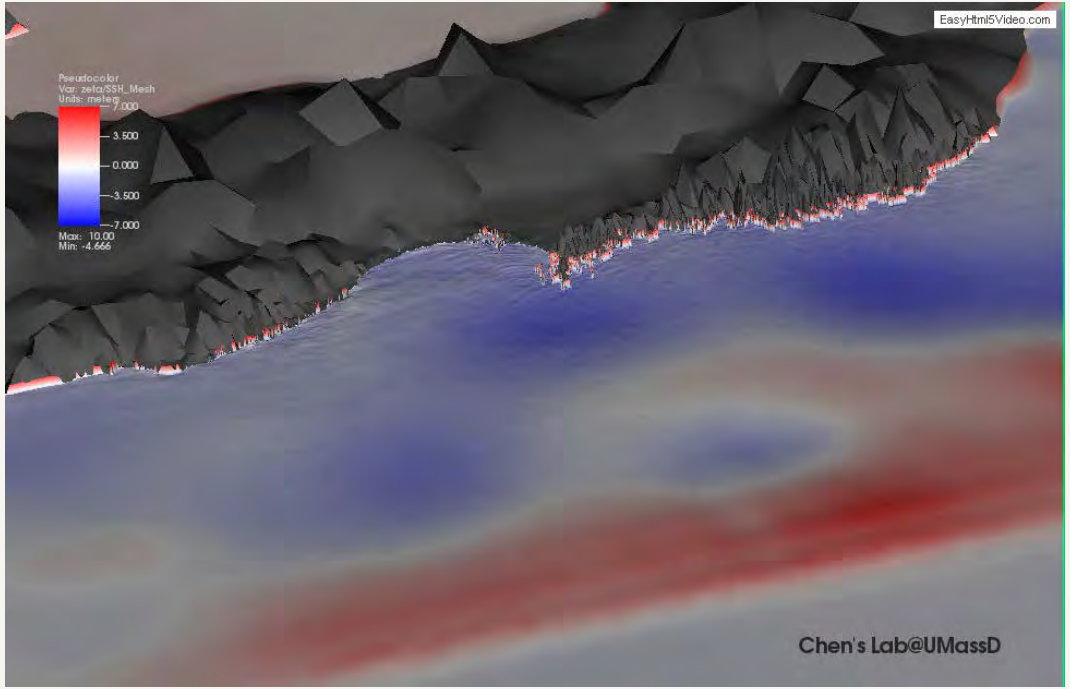
FVCOM

Finite Volume Community Ocean Model

Utviklet ved University of Massachusetts – Dartmouth

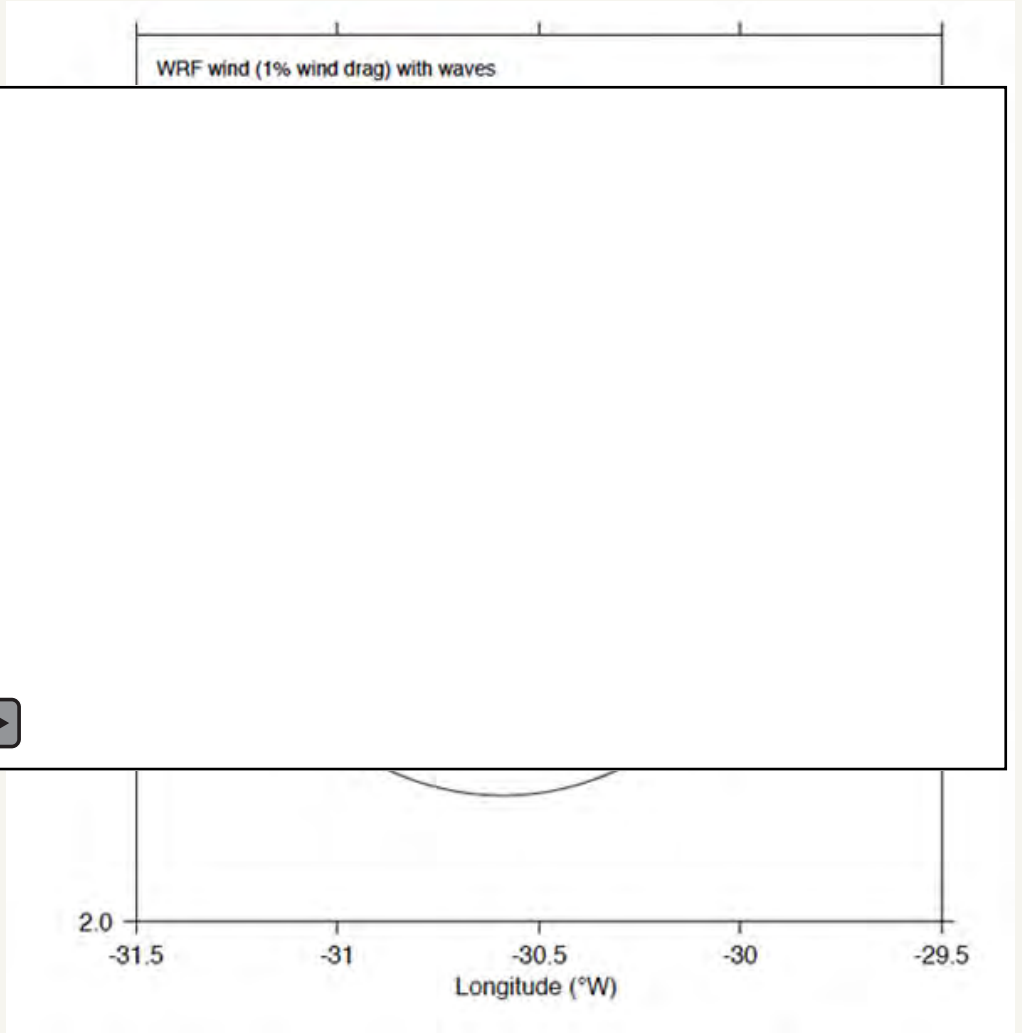
Modellen er tilgjengelig for alle (open source) og er brukt av mange forskningsmiljøer rundt i verden.

Animasjonen til høyre viser en simulering med FVCOM av tsunamien ved Fukishima kraftverket i Japan i 2011.



Air France 447

AF447 styrtet i Atlanterhavet i 2009. Den svarte boksen ble funnet ved hjelp av simuleringer med FVCOM.

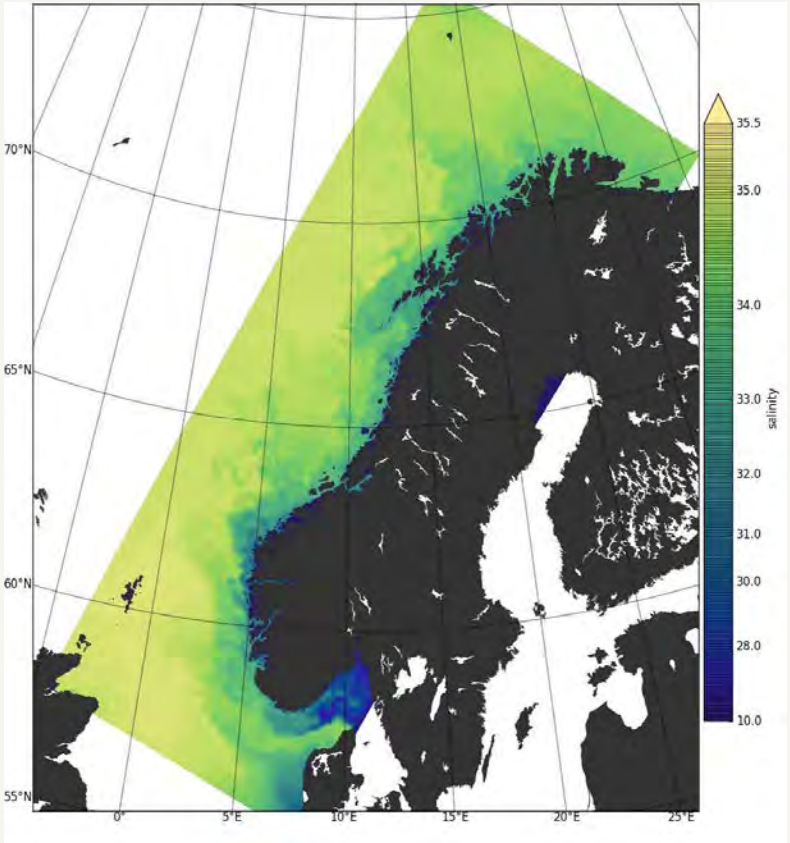


NorShelf

Meteorologisk Institutts operasjonelle modell brukes til å spesifisere strøm, temp og salt på modellens ytre rand.

NorShelf er en data-assimilert modell.

Akvaplan-niva bidrar med Glider data som brukes til å korrigere NorShelf



AROME vær-model

En atmosfære-modell er nødvendig for å drive sirkulasjon i havmodellen.

Tidligere hadde vi et samarbeid med universitetet i Aten, nå bruker vi met.no.

AROME er vær-modellen som er bakgrunn for yr.no.

Data er tilgjengelig helt opp til i dag og inneholder både varsler og reanalyser.