

Non-linear aspects of the tidal dynamics in the Sylt-Rømø Bight, south-eastern North Sea

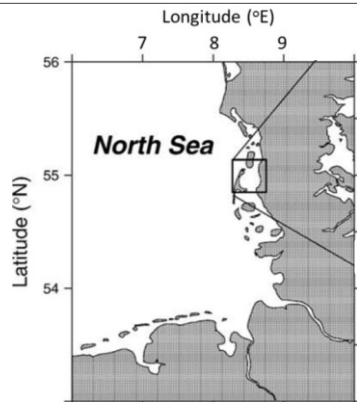
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FESOM-C current stage

- Cell-vertex finite volume discretization
- Any configurations of triangular, quadrangular or hybrid meshes
- External/internal modes
- Terrain following vertical coordinate
- 3rd-order upwind horizontal advection schemes
- Implicit 3d-order vertical advection schemes, implicit vertical viscosity
- Biharmonic horizontal viscosity augmented to the Smagorinsky viscosity
- GOTM turbulence library for the vertical mixing
- Rivers through solid boundary in streaming form/ Rivers as open boundary conditions
- Standard atmospheric forcing module
- Tidal potential /Open boundary prescription of amplitudes and phases for 12 harmonics
- Wetting/drying
- Particle tracking Lagrangian module

Domain of interest

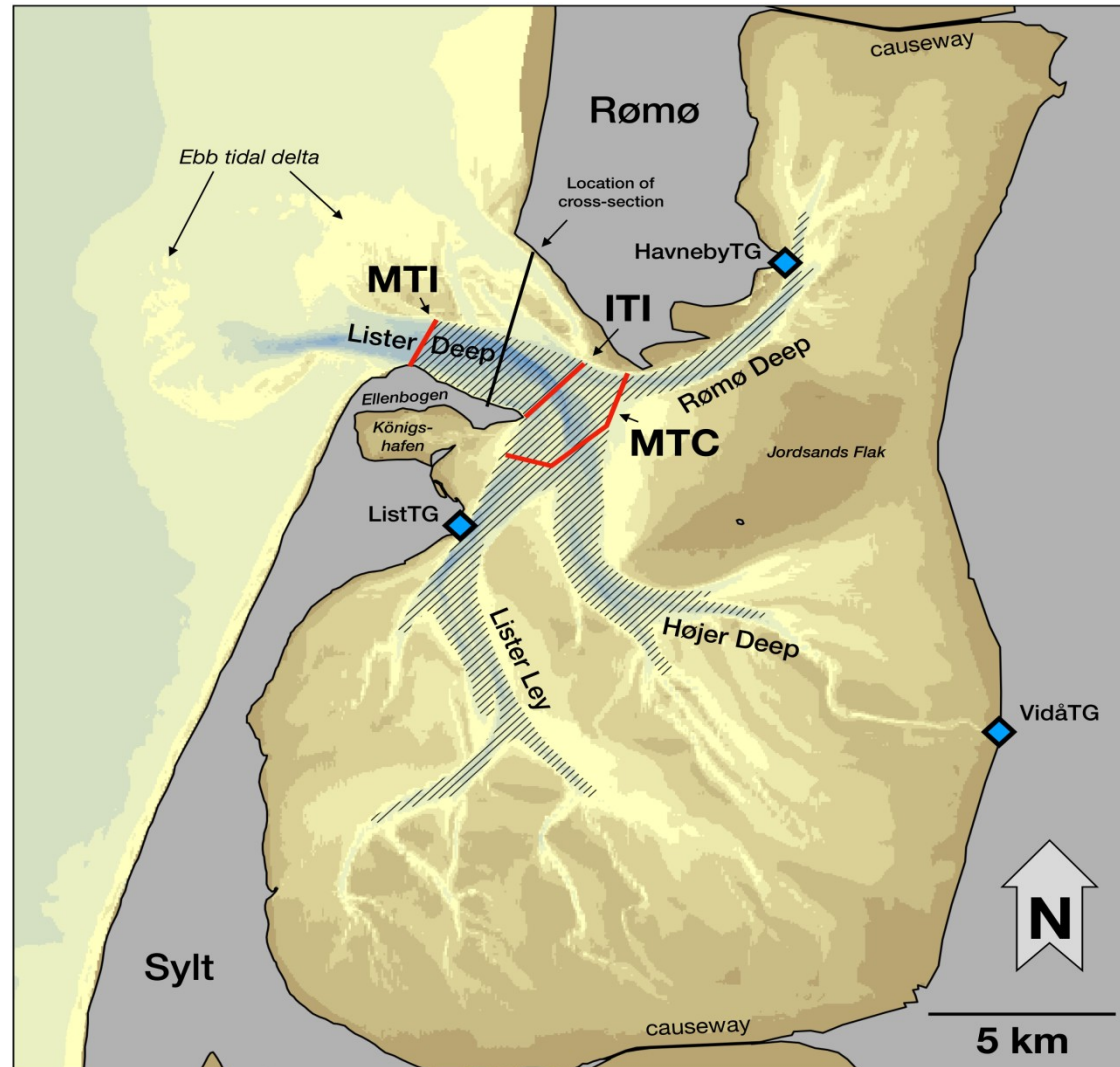


Legend

- ◆ Tide gauges
- ADCP Transects
- Land areas
- Areas with MBES data

Water depth, in meter

- > -1
- 1 - 0
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40



Initial problem

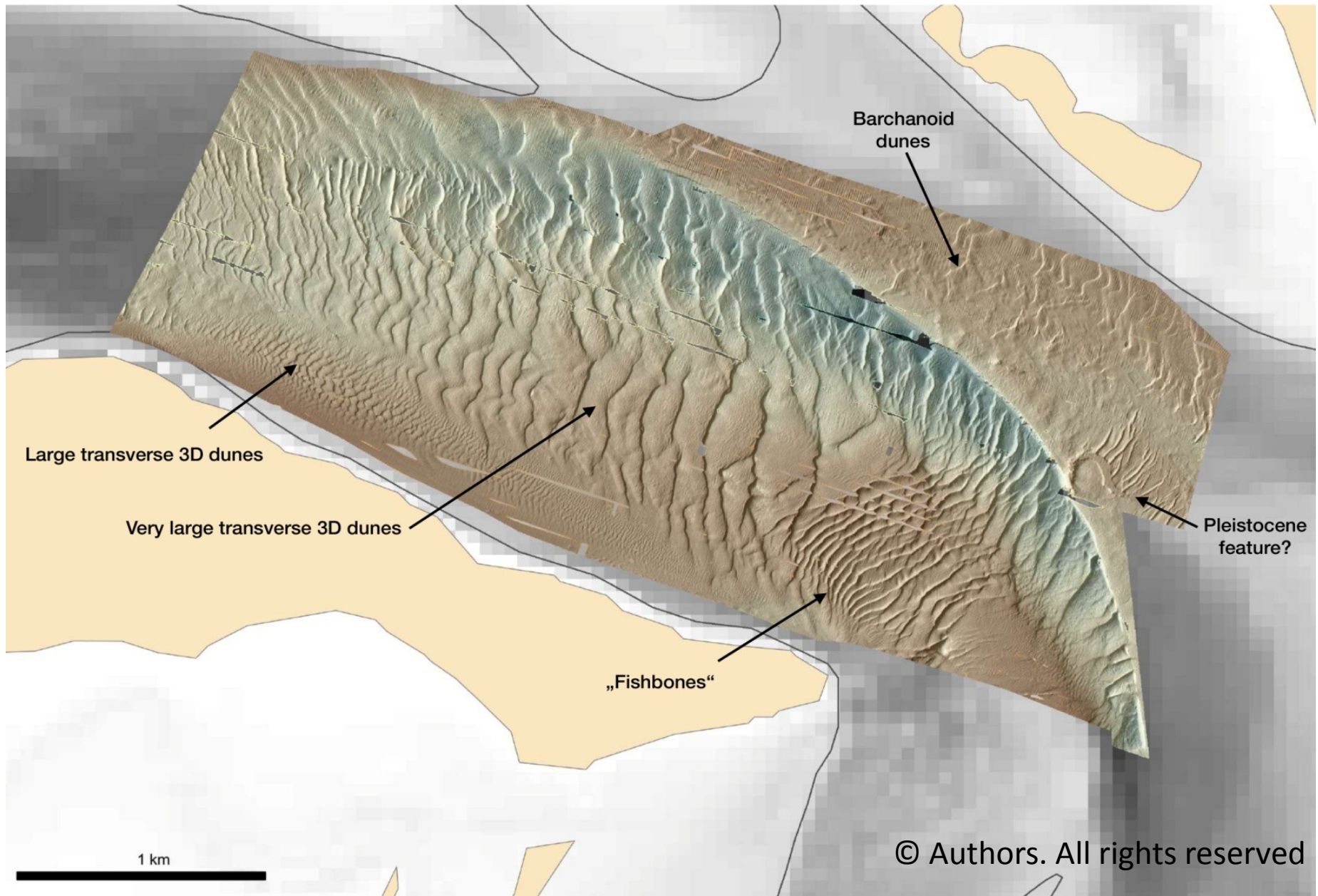
- Estimates of the mean water volume entering the basin during flood and leaving during ebb (the tidal prism) vary from 4 to $6.3 \cdot 10^8 \text{ m}^3$
- Different estimates of suspended matter fluxes and the sediment budget

There is a pronounced asymmetry in the tidal water level and current velocities behavior, caused by complex morphological features and by the general shallowness of the research area

The analysis of bedforms based on **seismic profiles** revealed that the area is represented by a **complex spatial pattern of the flood- and ebb-dominated subaqueous dunes**

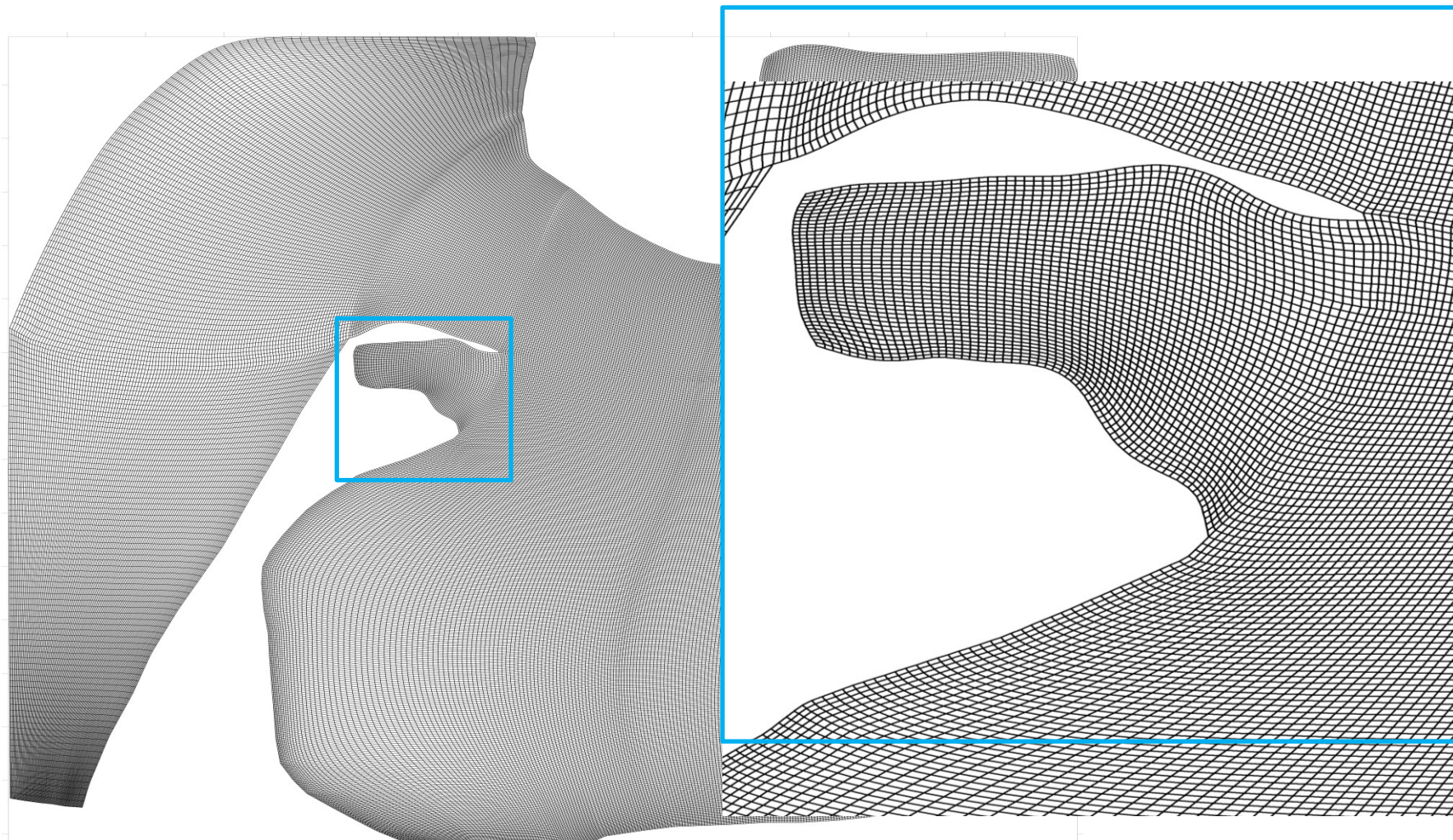
Bedform peculiarities

1st MBES survey



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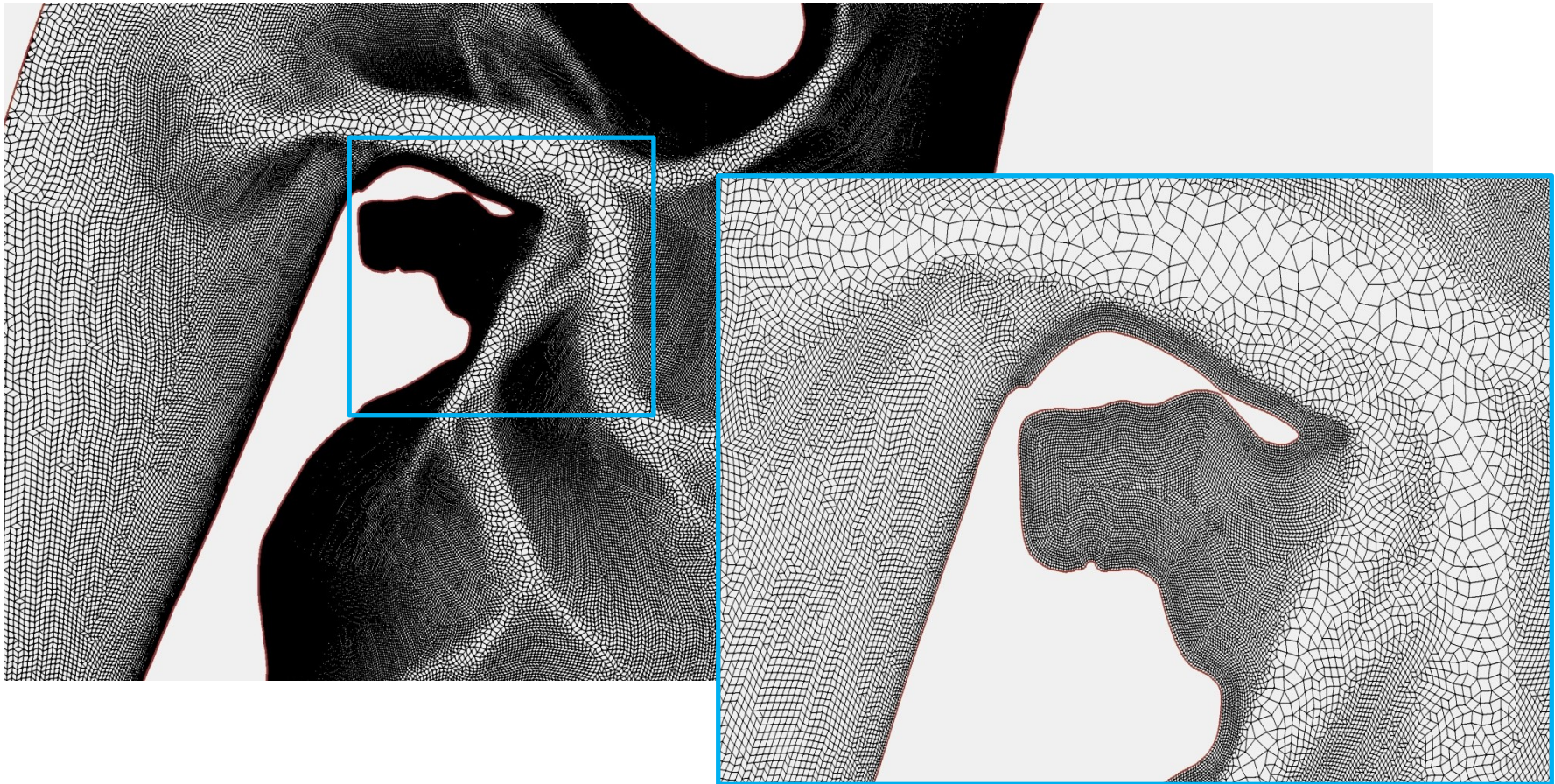
Curvilinear grid – first grid



Resolution varies between 14 and 280 meters

EGU 2020

Hybrid grid – second grid

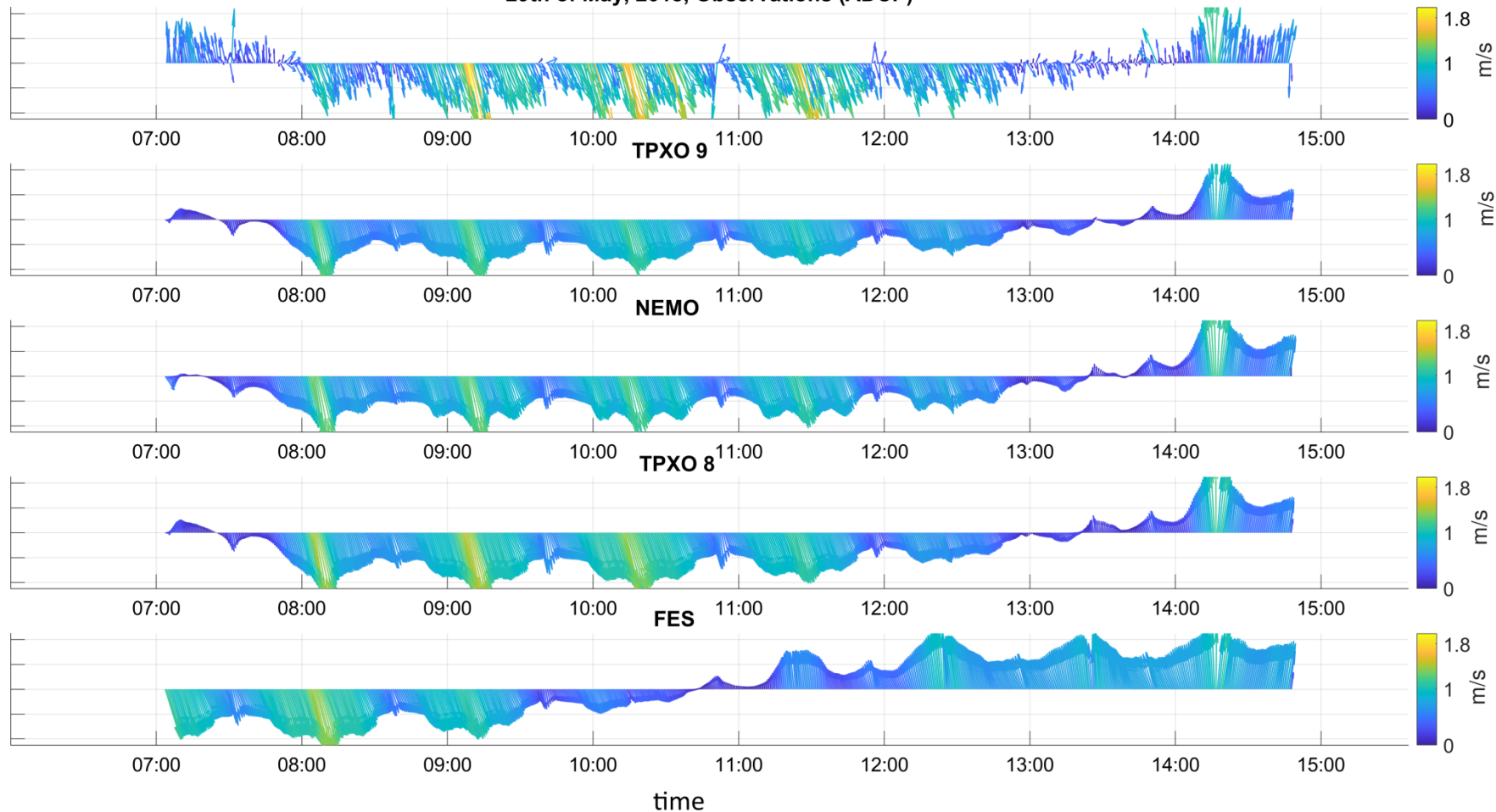


Resolution varies between 2 and 380 meters

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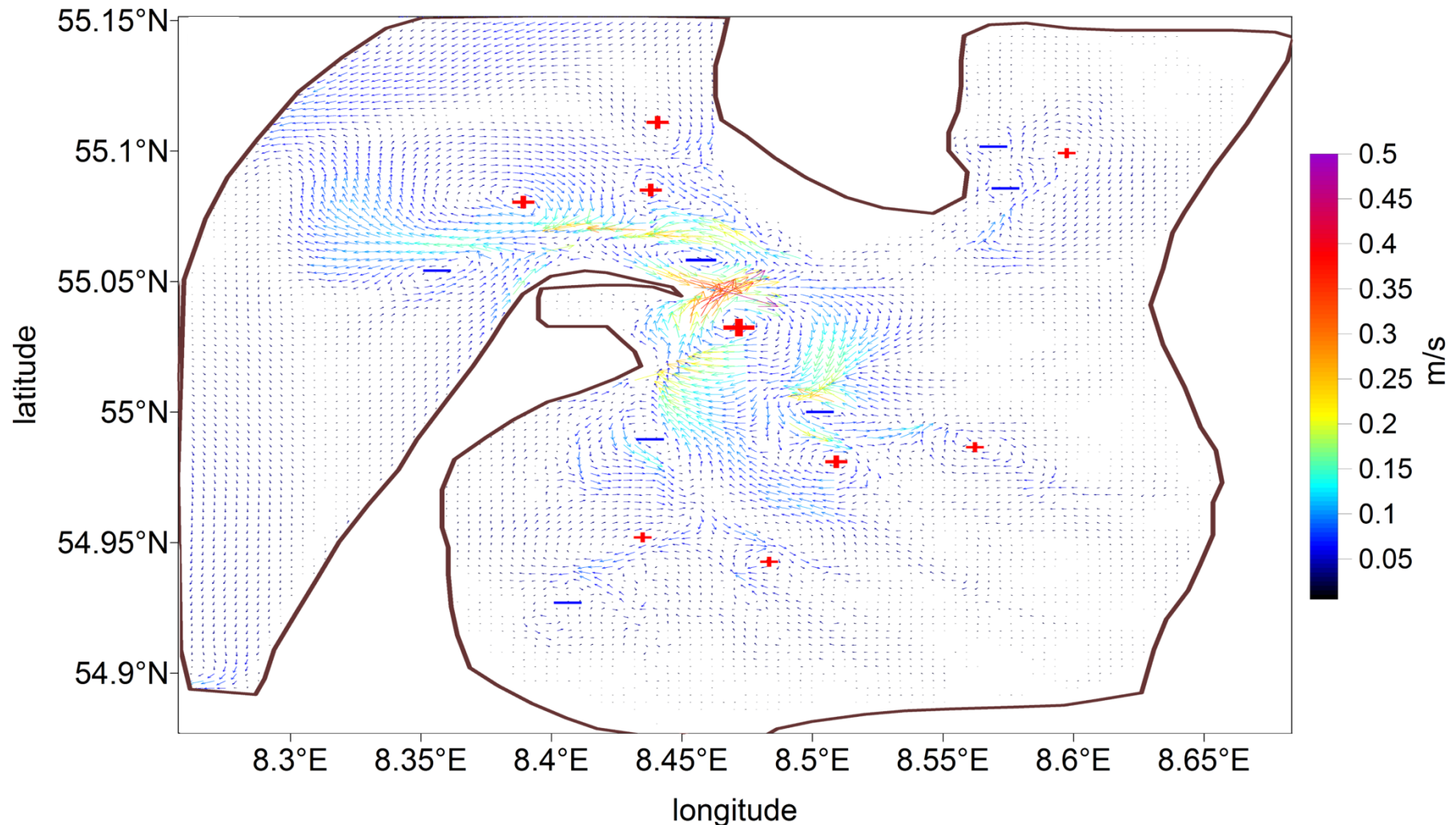
Open boundary conditions

29th of May, 2018, Observations (ADCP)



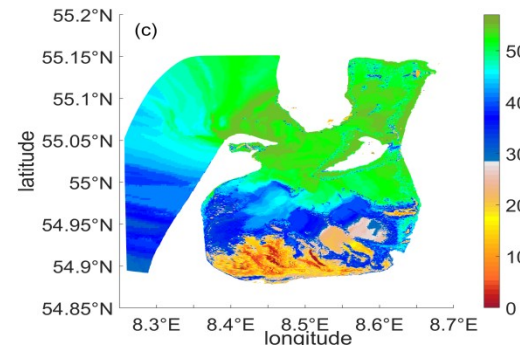
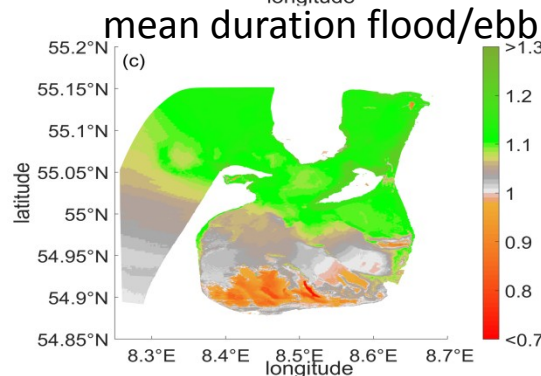
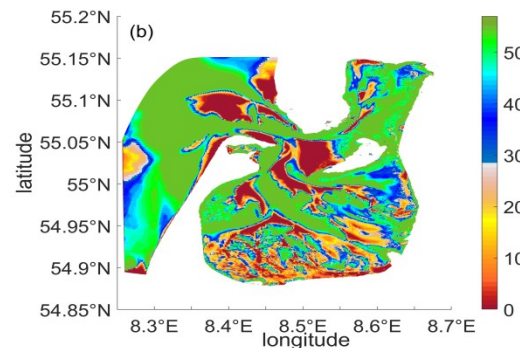
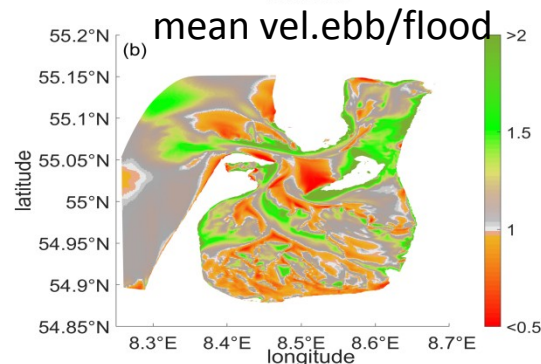
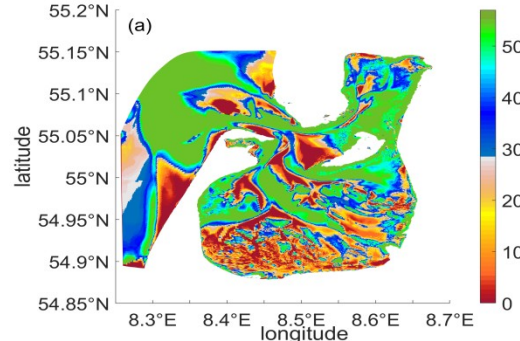
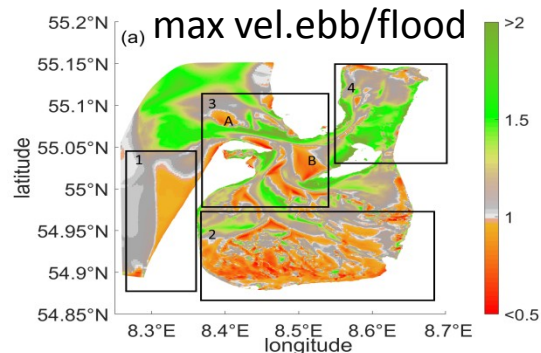
Sum of M2, S2, N2, K2, K1, O1, P1, Q1 and M4 harmonics at the open boundary is prescribed

Tidal residual circulation



The '+' and '-' illustrate the clockwise and counterclockwise rotation of the major gyres.

Tidal asymmetry



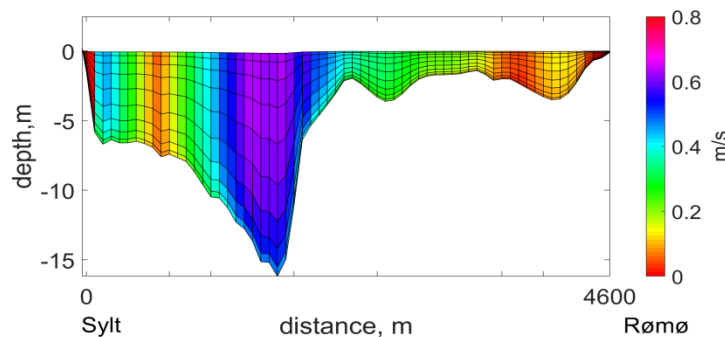
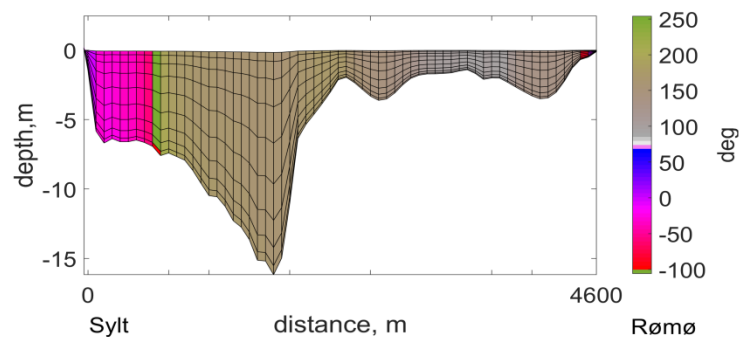
Zone 1: progressive Kelvin wave.

Zone 2: ratio of tidal amplitude to depth is greatest (increasing from Lister Deep toward the southern part of the zone).

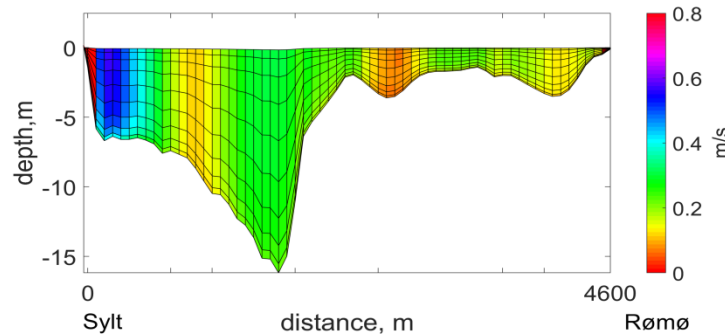
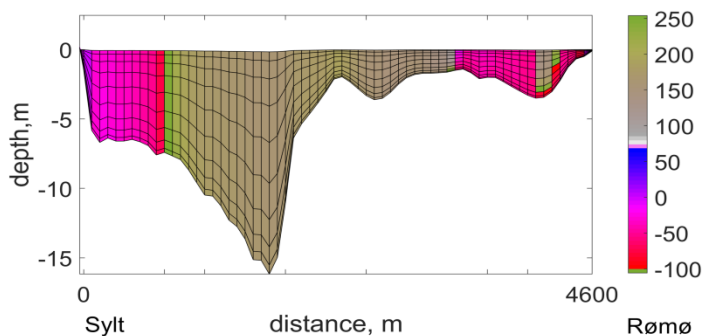
Zone 3: ebb dominated main channel and flood dominated marginal channels.

Zone 4: pattern is opposite to that of zone 3 due to the small volume of intertidal storage and large variation in the “main channel” width.

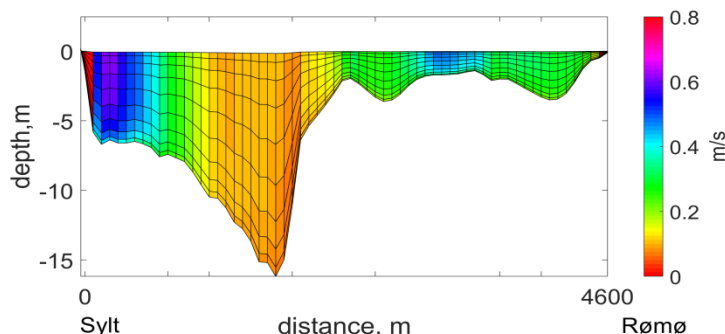
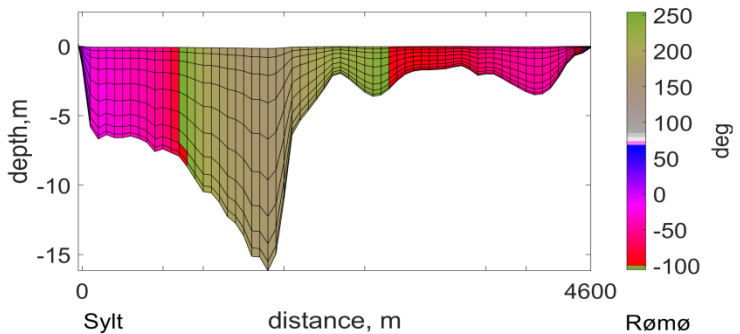
Counter-currents



Left panel: **grey-green** color indicates water **outflow**; **blue-red** color indicates water **inflow**.



The snapshots capture the transition phase from ebb to flood with a **20-minute interval** from one picture to another (top to bottom).



Take home message

Tidal asymmetry analysis can shed light on the velocity behavior, water parcel trajectories and bedform peculiarities.

Thank you! 😊

The full work can be found here:



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Articles

Abstract

Introduction

Model setup

Observational data for
model validation

Results

Discussion

Summary

Data availability

Appendix A

Appendix B

Author contributions

Competing interests

Special issue statement

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Research article

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