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Evaluation of eddy resolving models: Methods and examples

Lars Petter Røed[1] and Nils Melsom Kristensen

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[1]**Also affiliated with Department of Geosciences, University of Oslo, Norway**

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Outline

- Introduction and background
  - Why eddy resolving models?
  - NorKyst-800
- Model evaluation
  - Forecast versus climatological skill
  - Domain size
- Numerical Ocean Weather Prediction (NOWP) Research Learning Loop
- Energy diagnostics
- Conclusions

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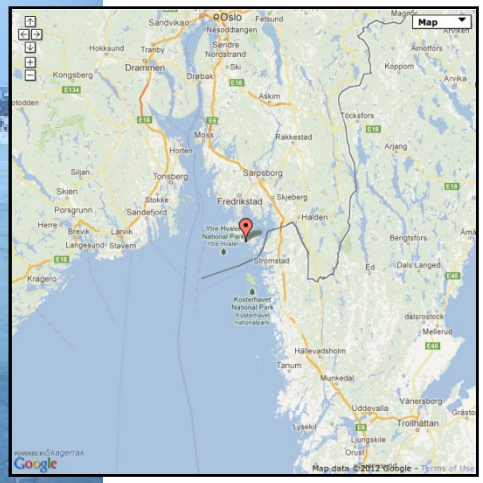
Why eddy-resolving models?

Most accidents happen close to the coast!



The «Godafoss» accident Feb 17, 2011

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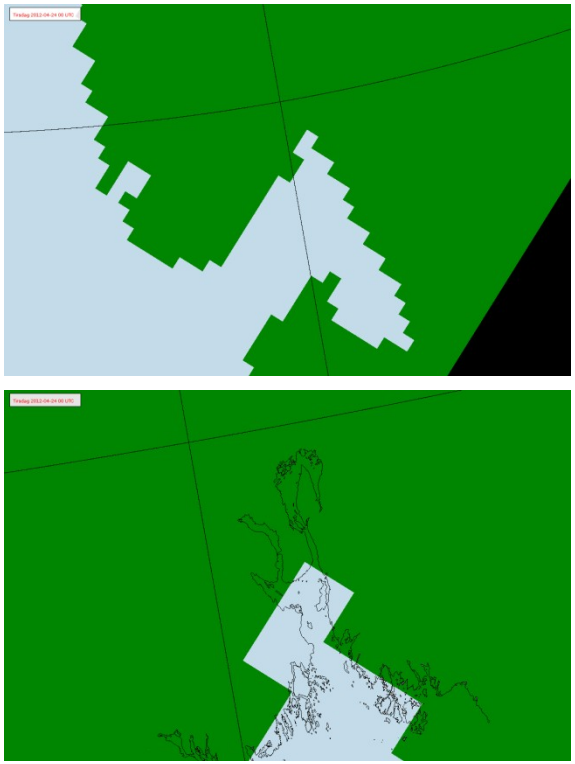
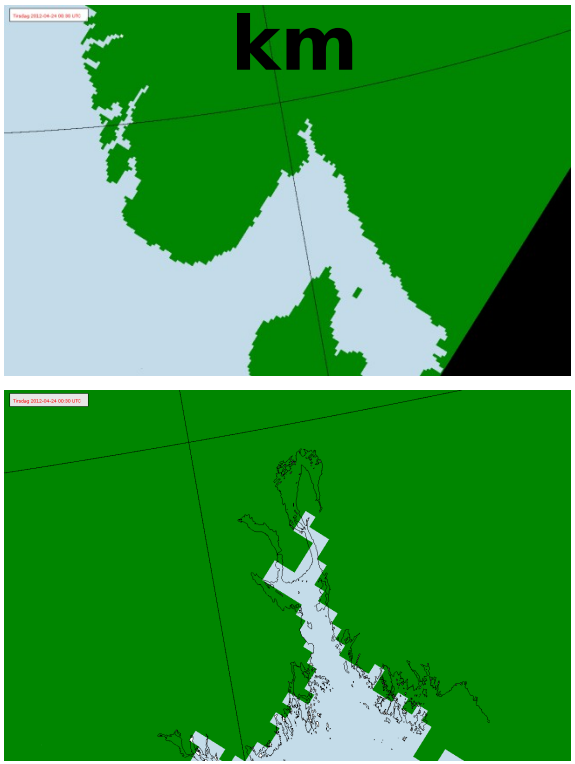
Why eddy-resolving models?

Need to resolve *coastline irregularities*

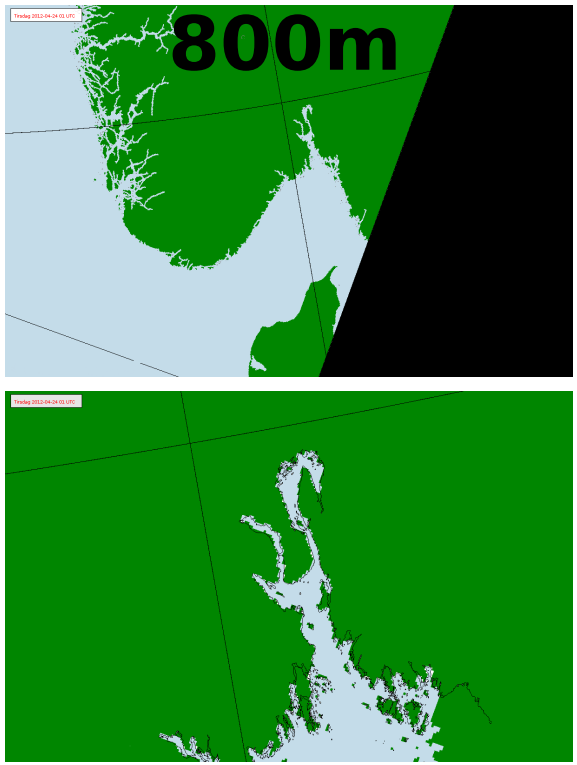
Arctic 20 km



Nordic 4 km



NorKyst-800m



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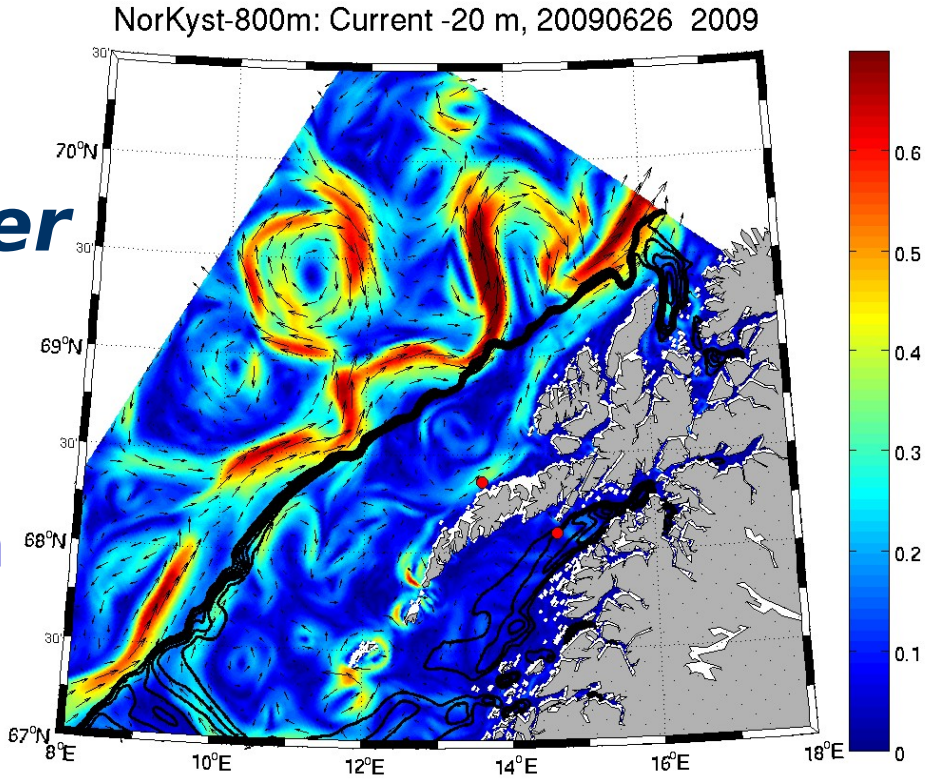
Why eddy-resolving models?

Extreme events are associated with eddies or ***Oceanic Weather***

- Need to resolve *instabilities* and the *processes* leading to them



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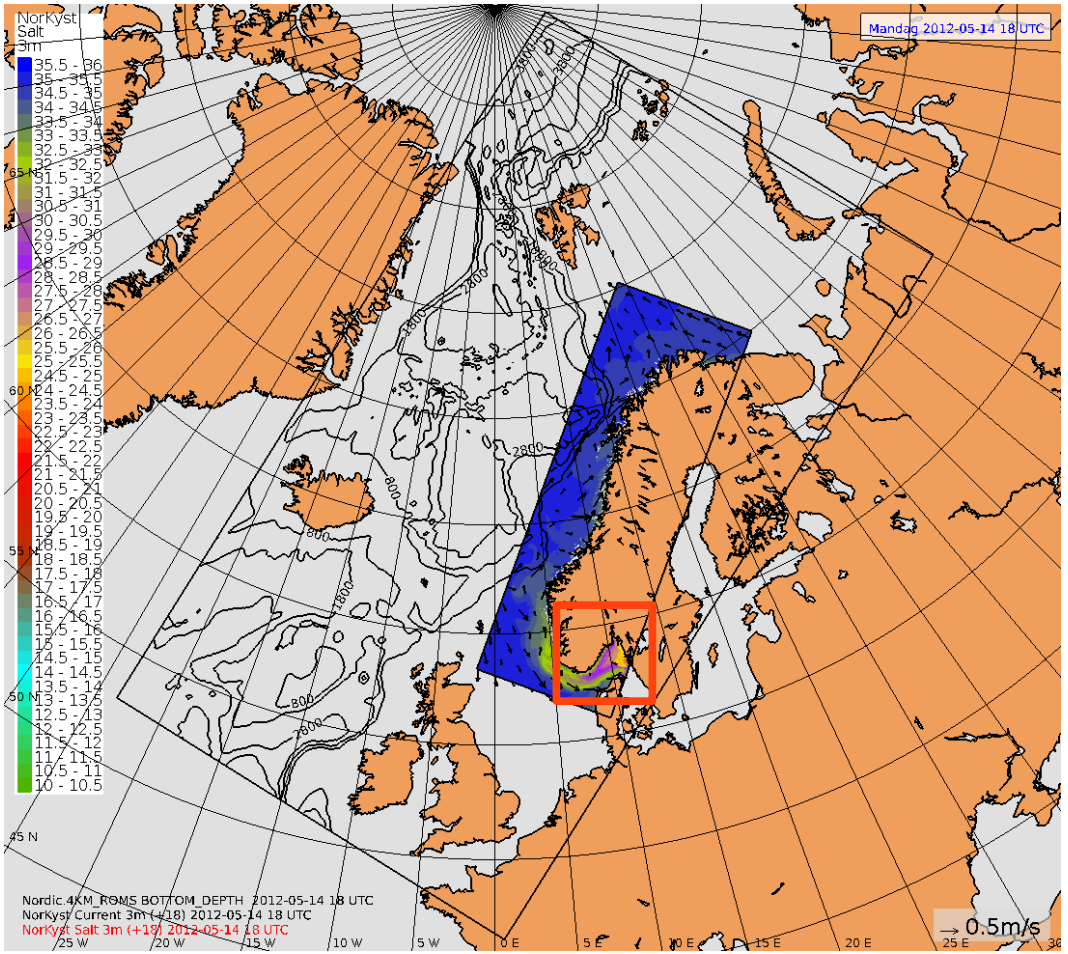
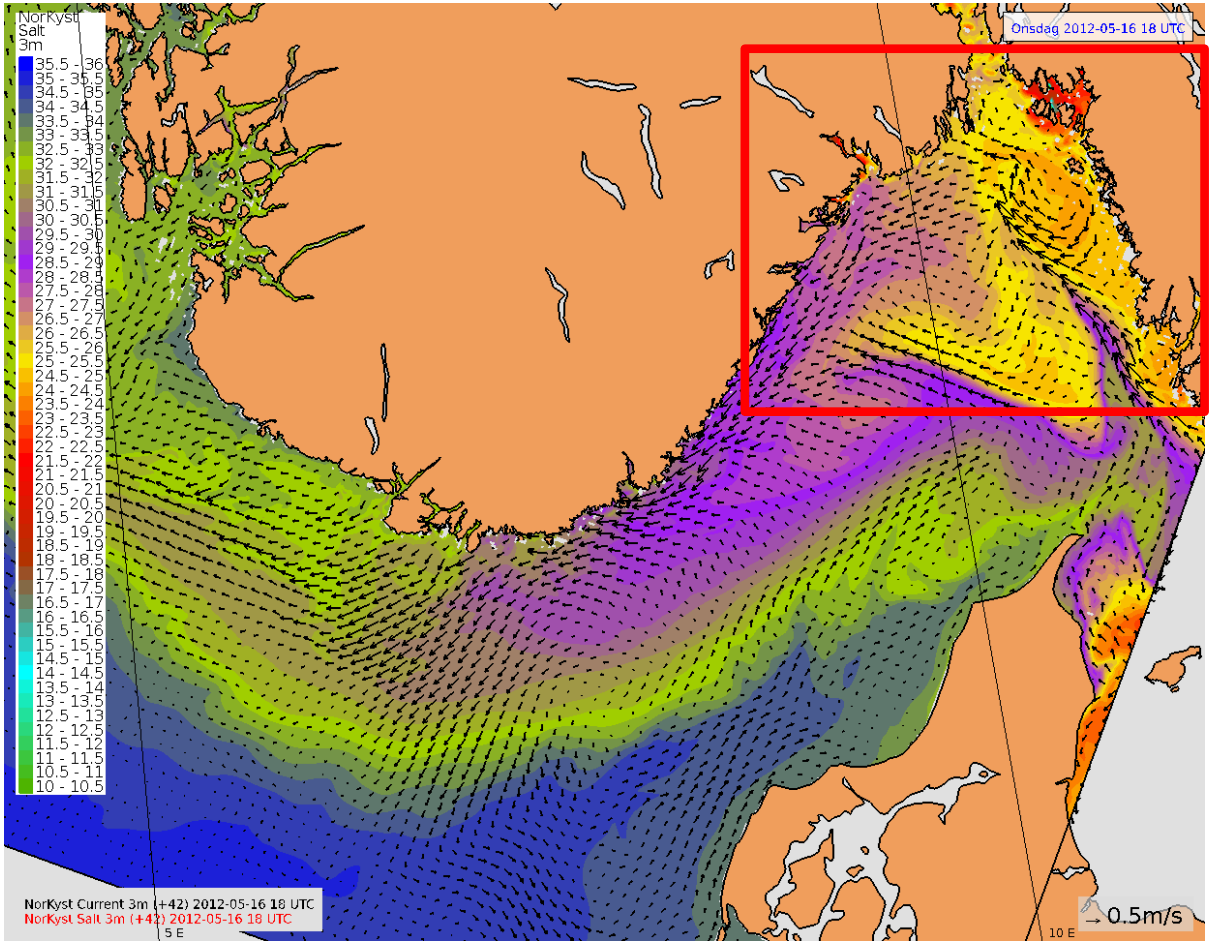
The met.no NOWP system

- Triply nested model system:
  - Arctic 20 km
  - Nordic 4km
  - NorKyst-800
- Collaboration
  - met.no
  - IMR
  - NIVA



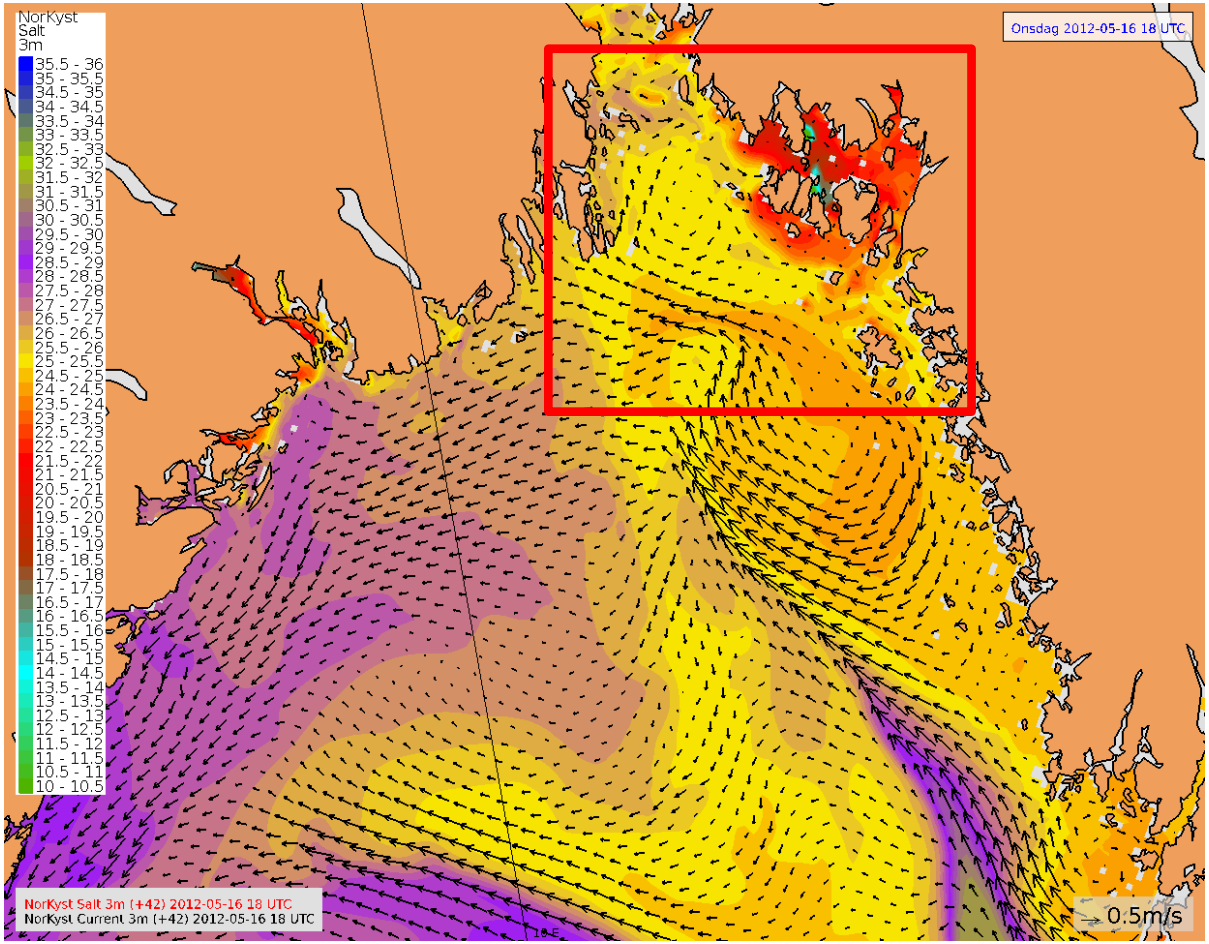
Norwegian example: NorKyst 800 m

- Zoom 1:
  - Skagerrak
  - Lead time 42 hrs
  - Every 8th vector shown
  - Salinity 10–36 psu



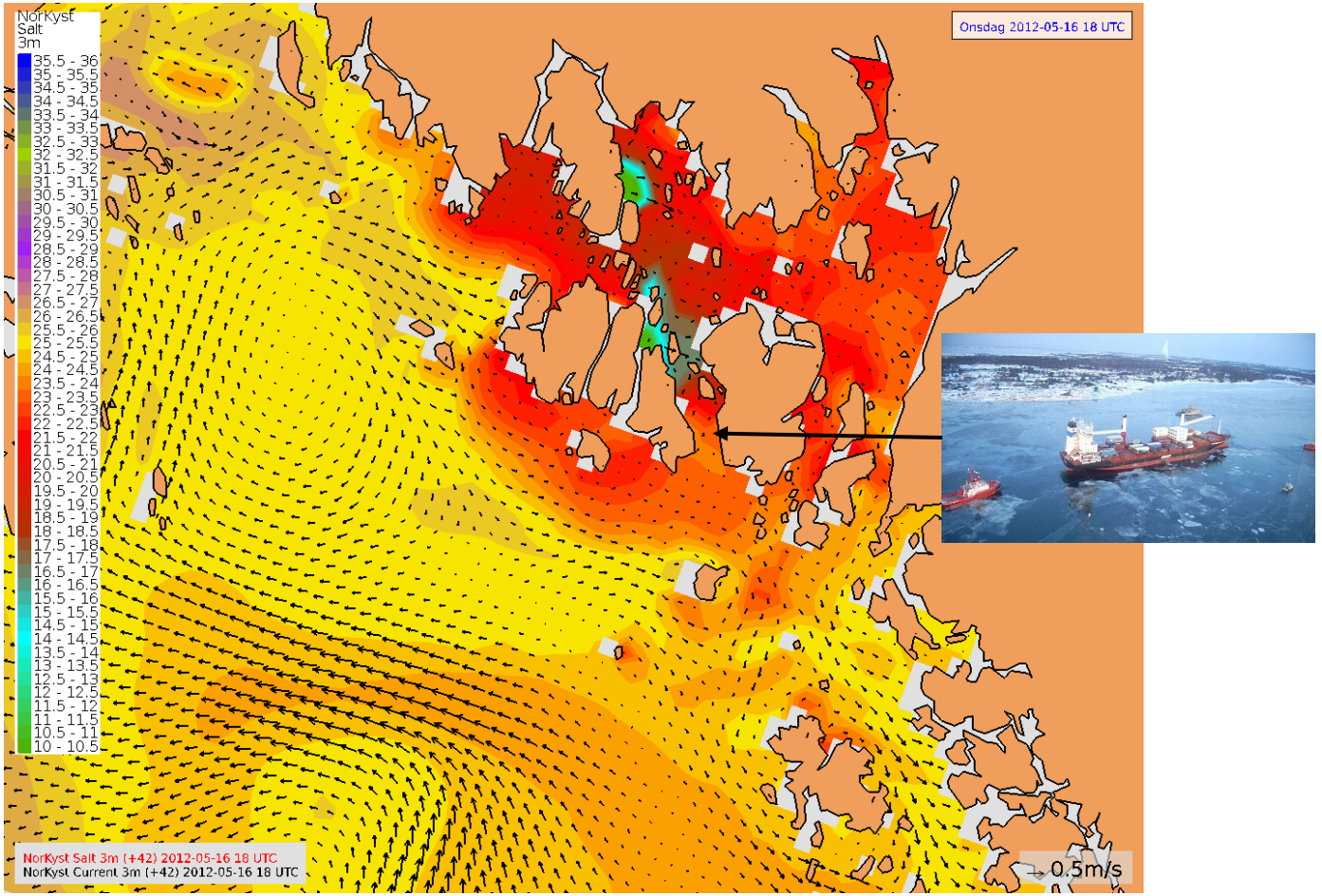
Norwegian example: NorKyst 800 m

- Zoom 2:
  - NE Skagerrak
  - Every 3rd vector
  - Salinity 10–36 psu



Norwegian example: NorKyst 800 m

- Zoom 2:
  - Every vector



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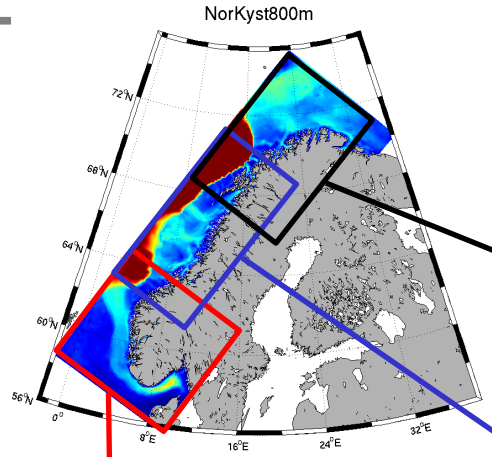
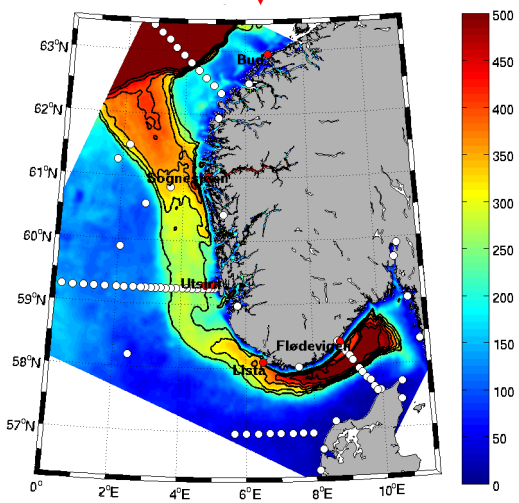
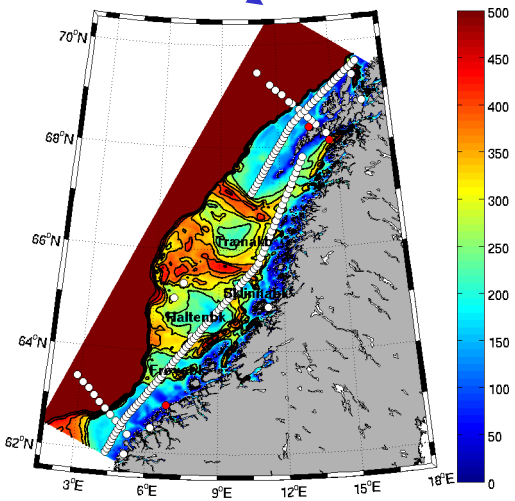
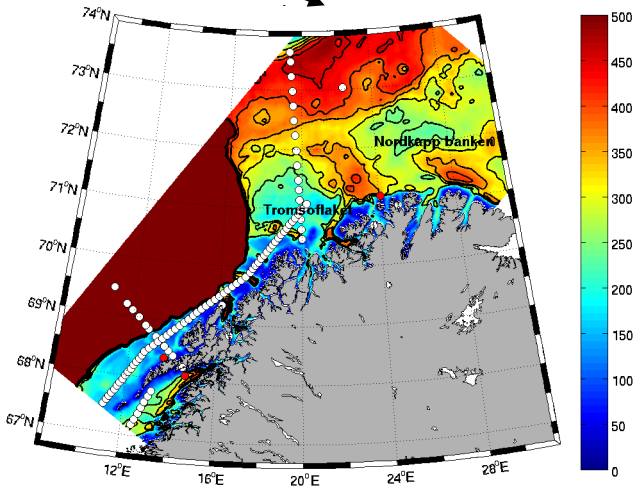
Computational burden?



- Small *geographical* area, but heavy on the *computer*
- Does splitting make a difference?







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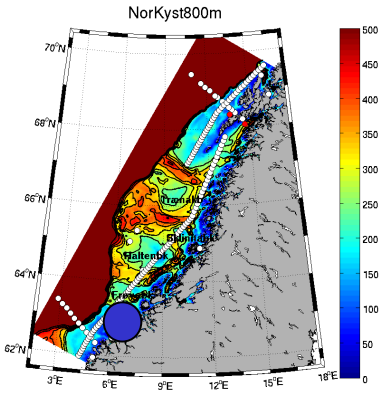
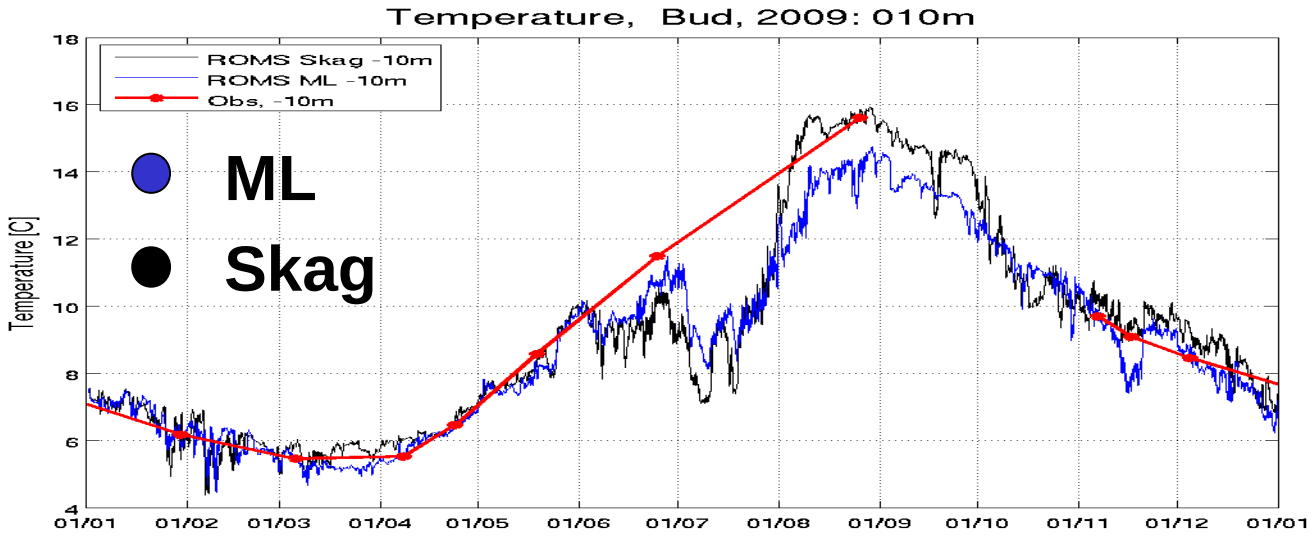
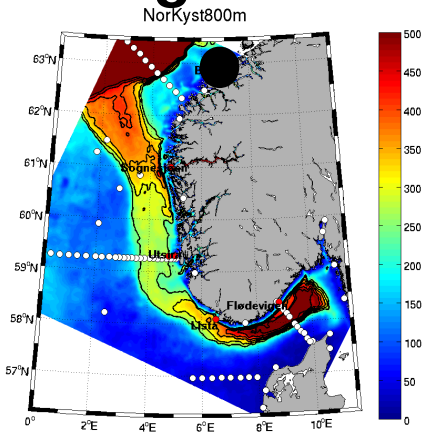
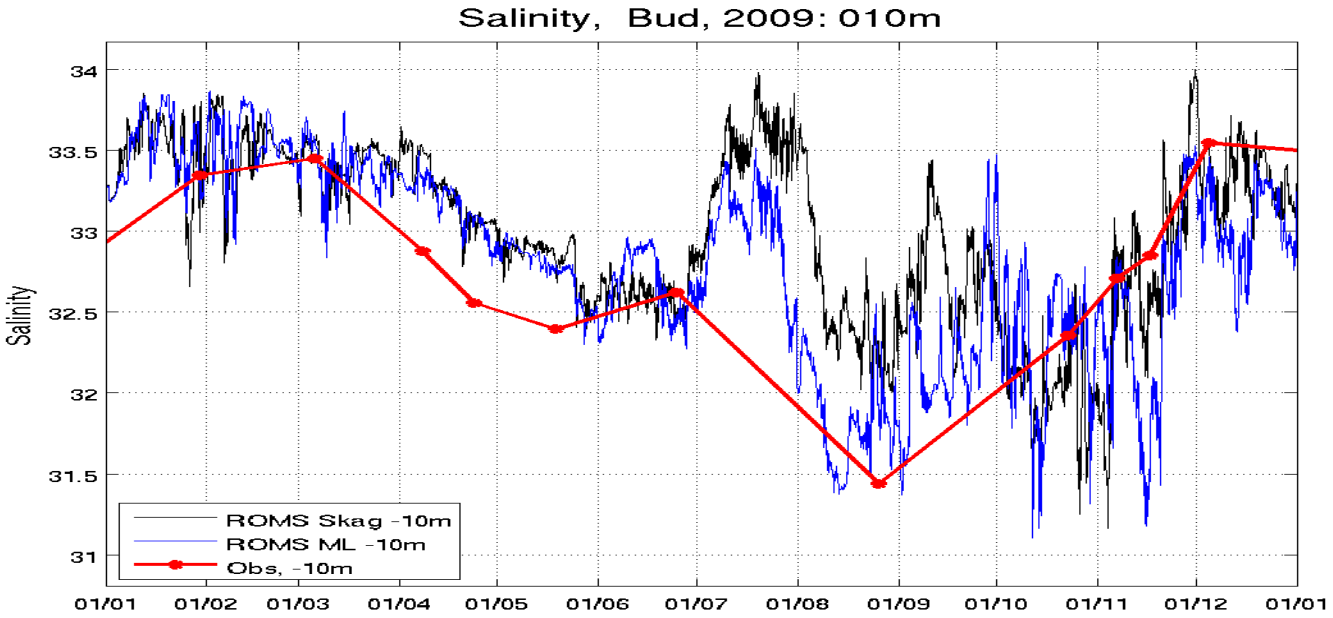




Skag





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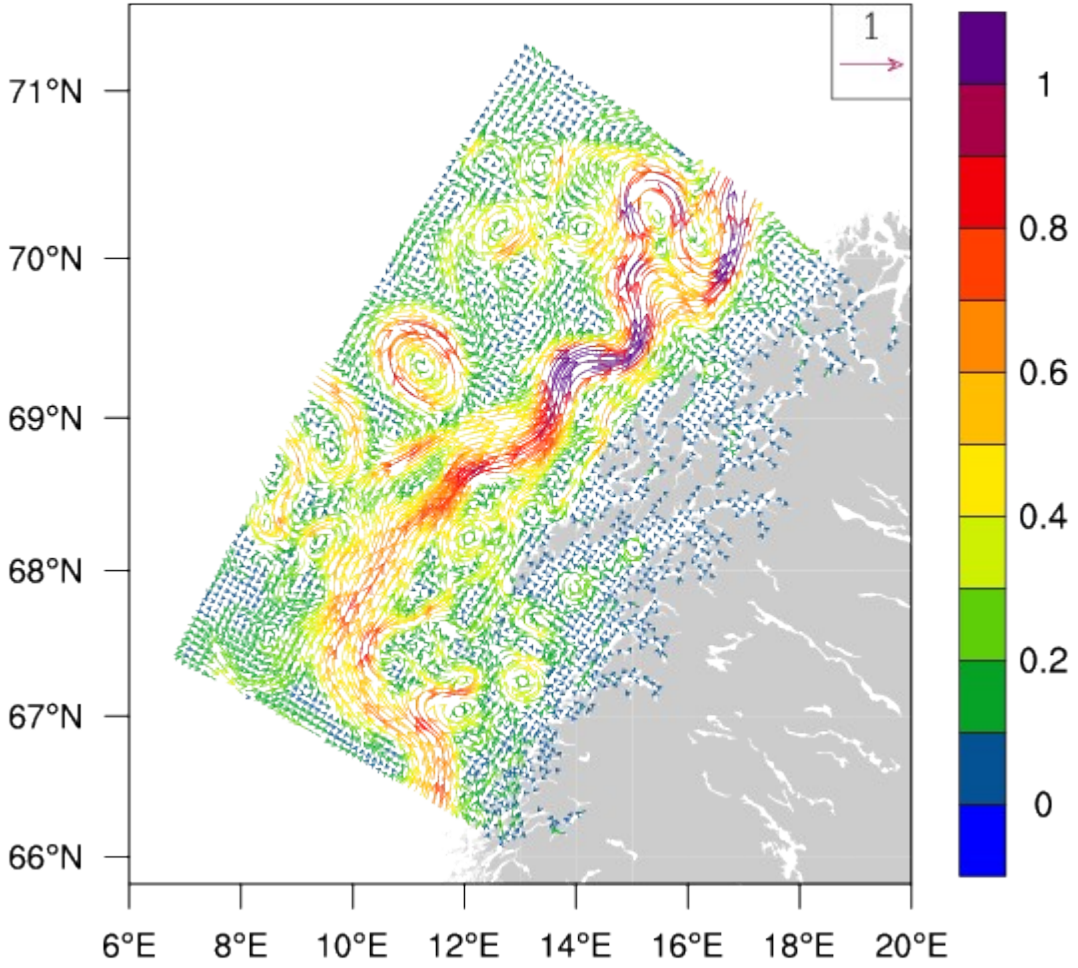
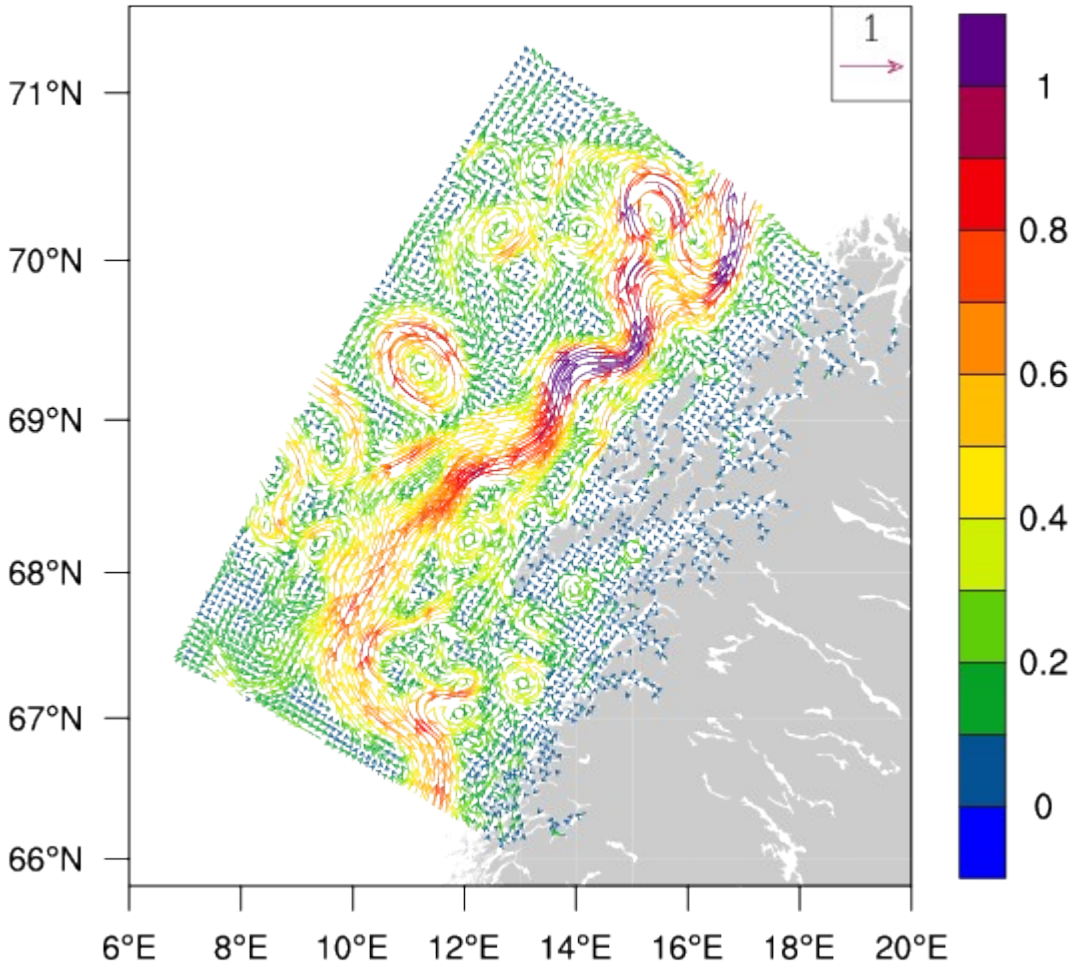
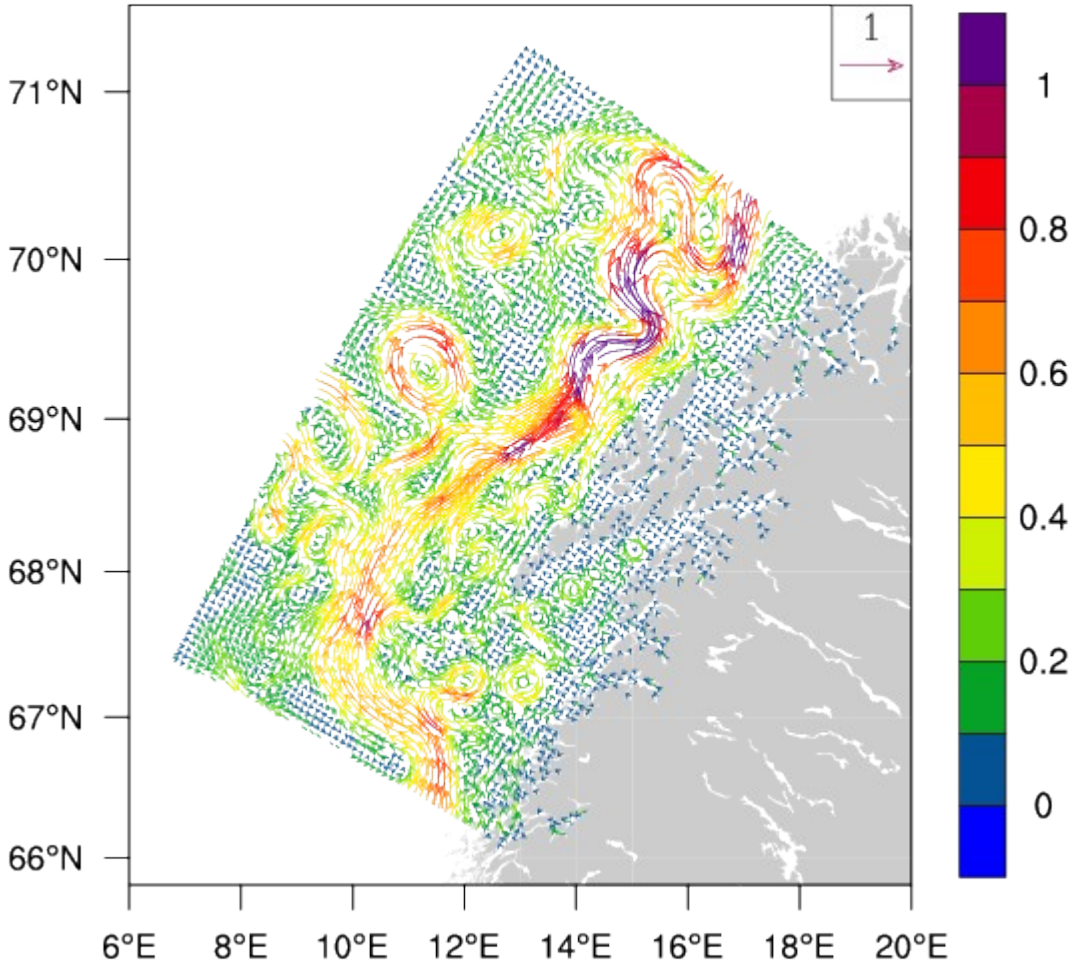
Example: Eddies in Lofoten-Vesterålen




1
71°N
70°N
69°N
68°N
67°N
66°N
6°E
8°E
10°E
12°E
14°E
16°E
18°E
20°E
1
0.8
0.6
0.4
0.2
0


1
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6°E
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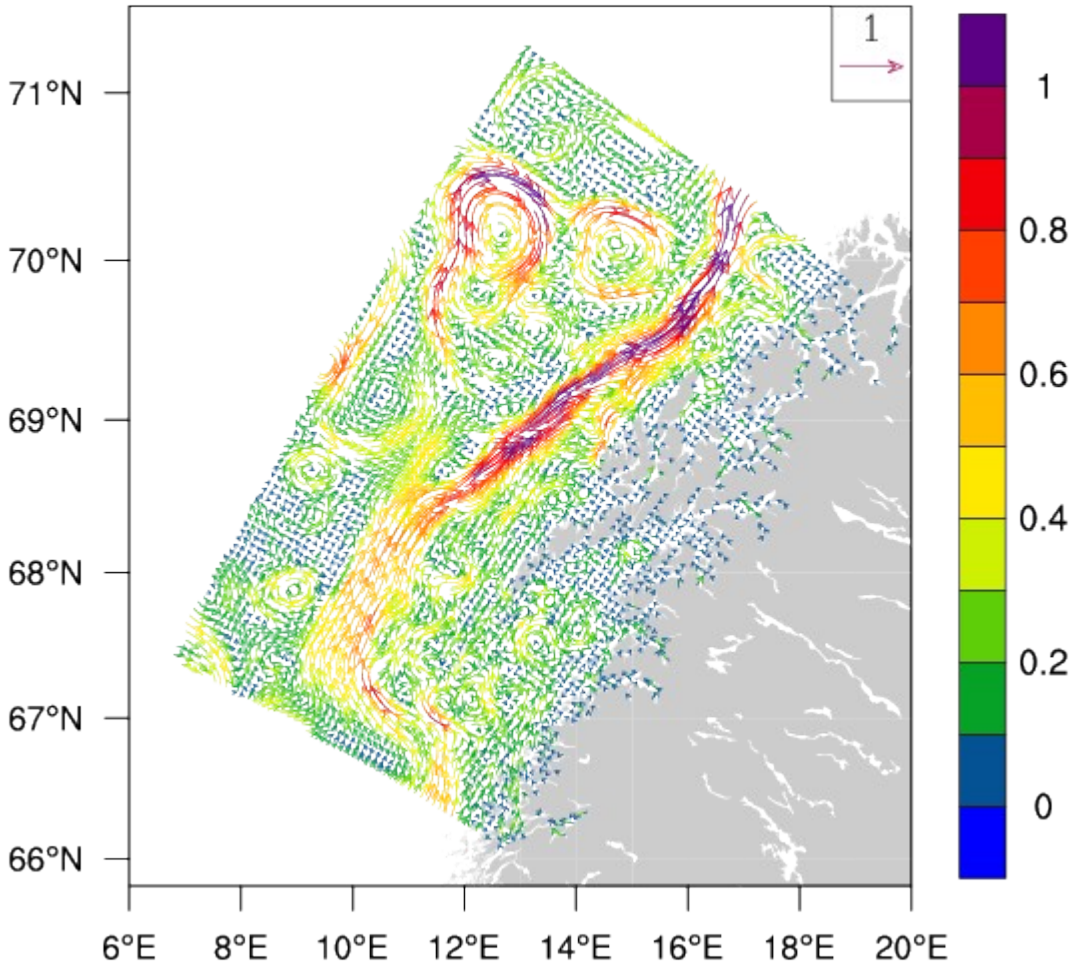
1
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8°E
10°E
12°E
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1
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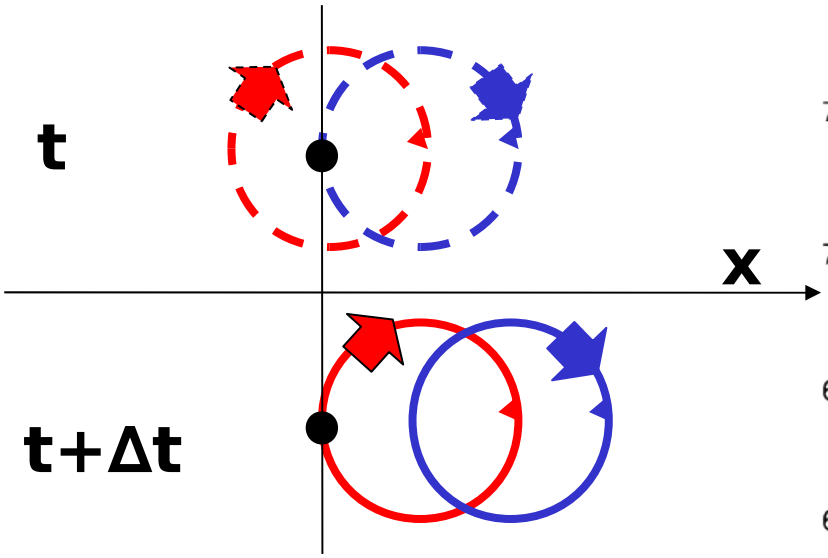
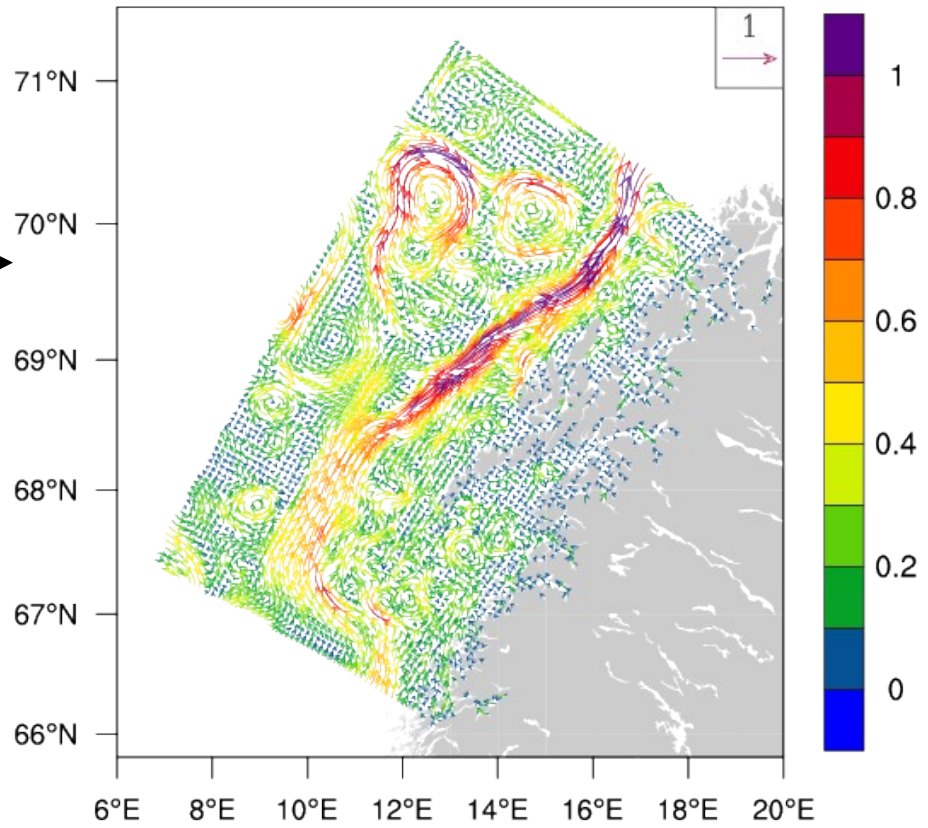
Skill evaluation

- Validation against observations



Model

Observation



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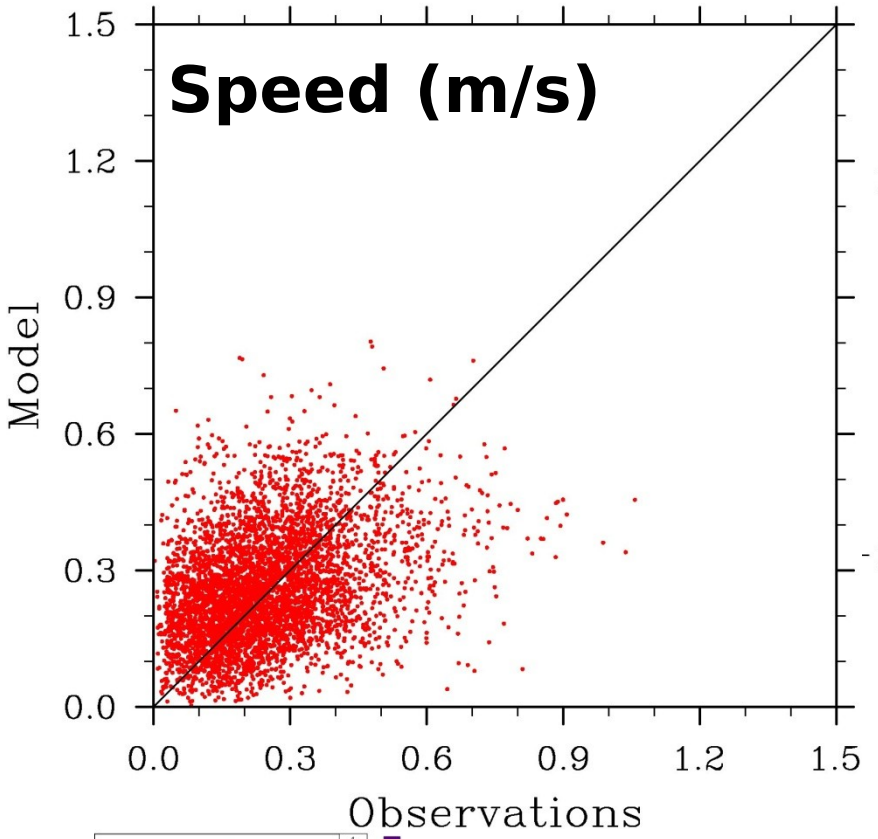
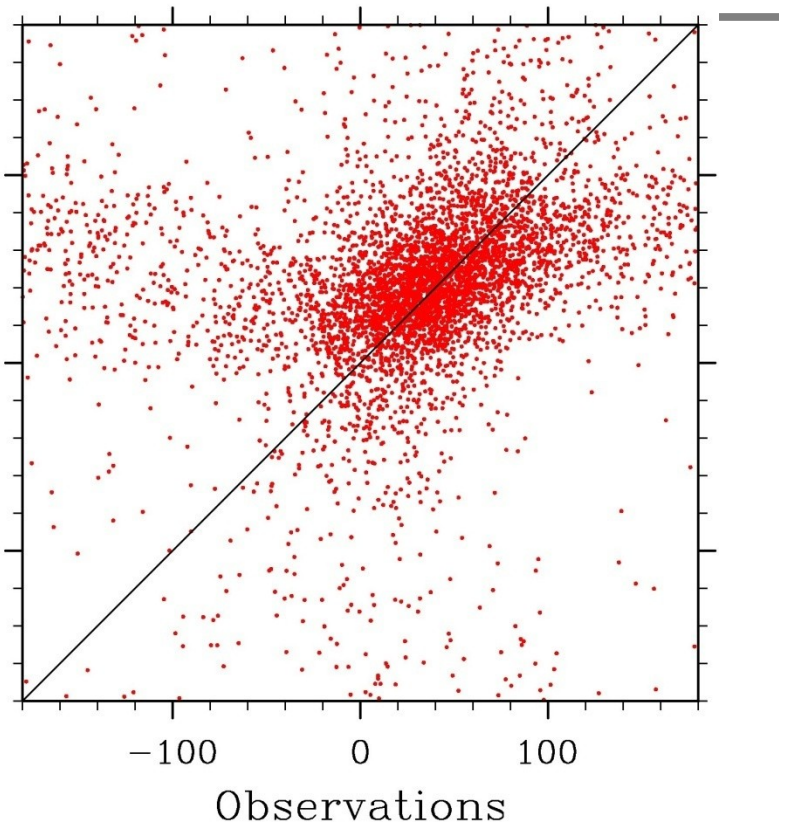
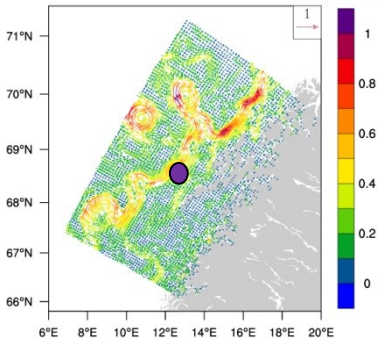
Scatter of surface currents: Skill?





Direction from north



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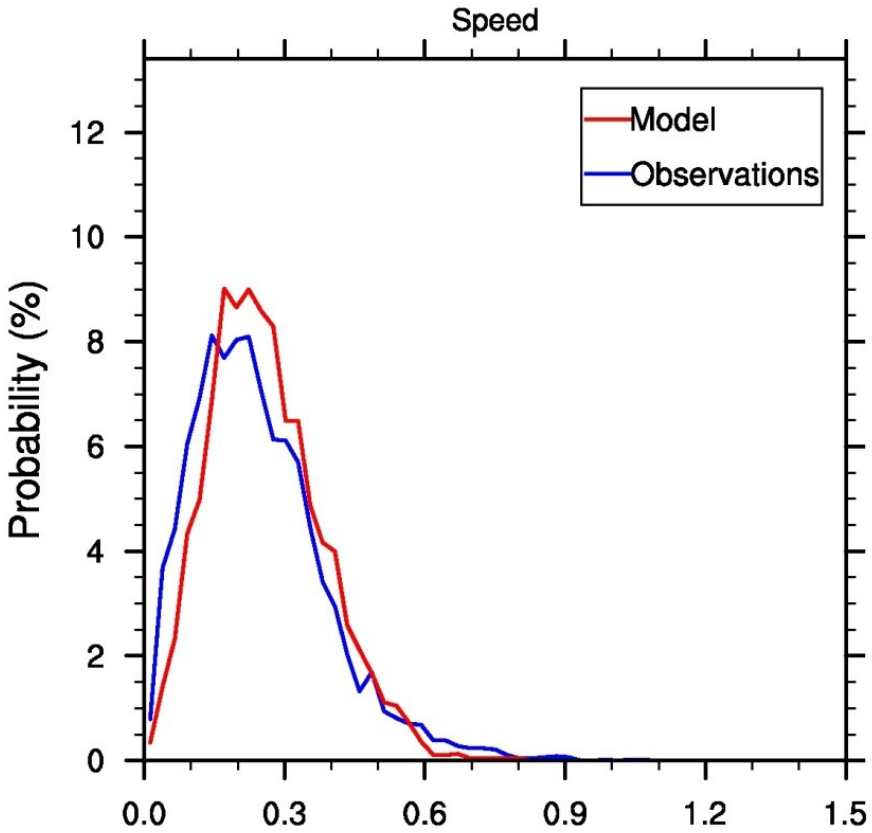
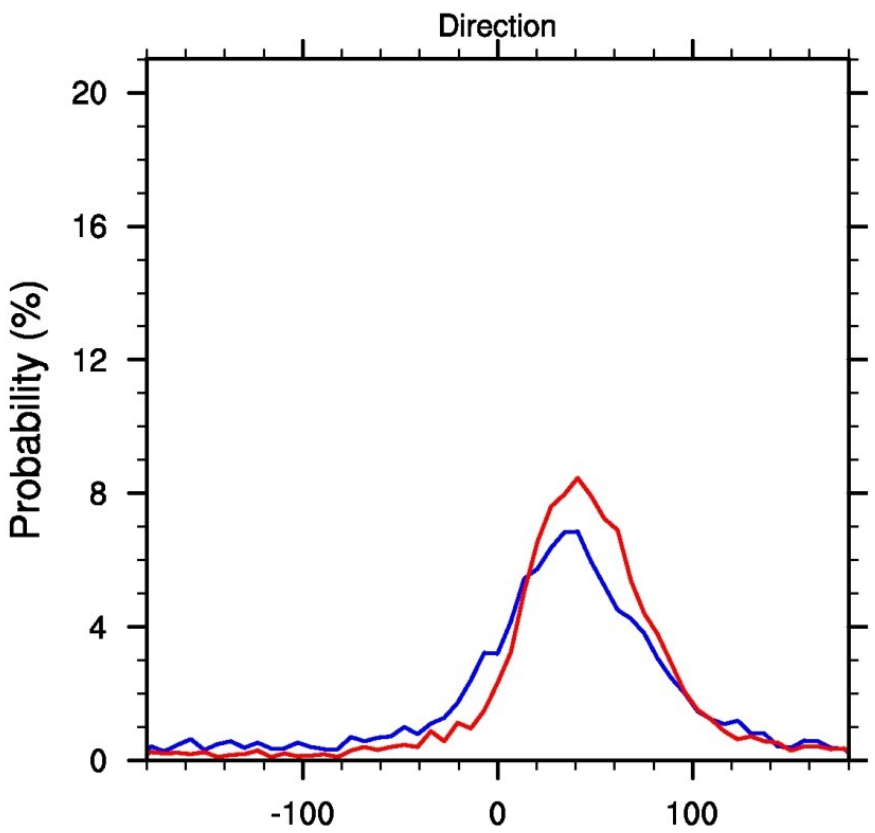
Statistical skill (climate)

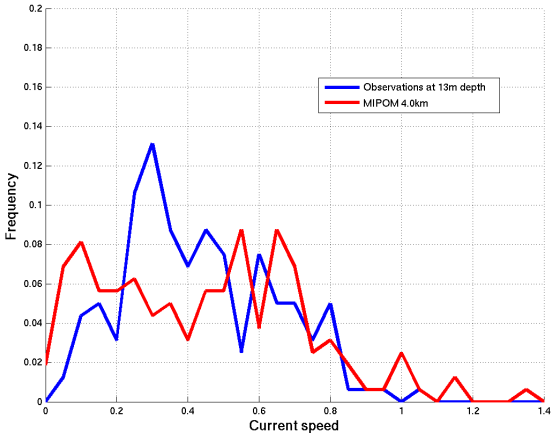


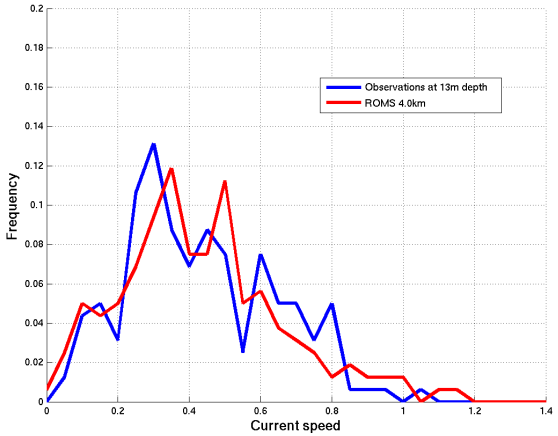


Current speed at 13 m depth

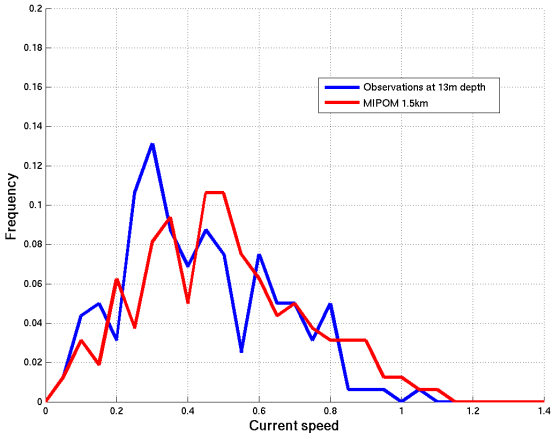
160 days (27.10.1992-4.4.1993)

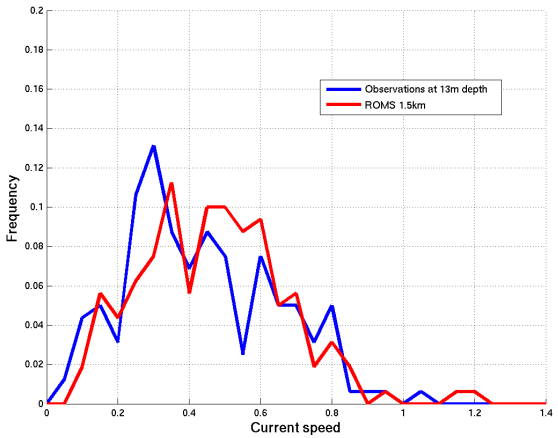
4 km



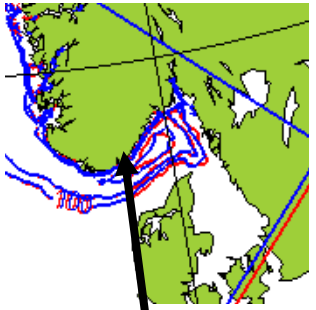


1.5 km





MIPOM **ROMS**



58.37N,8.51 E

Measured depth: 120m

Equilibrium depth:

4km: 233m

1.5km: 163m

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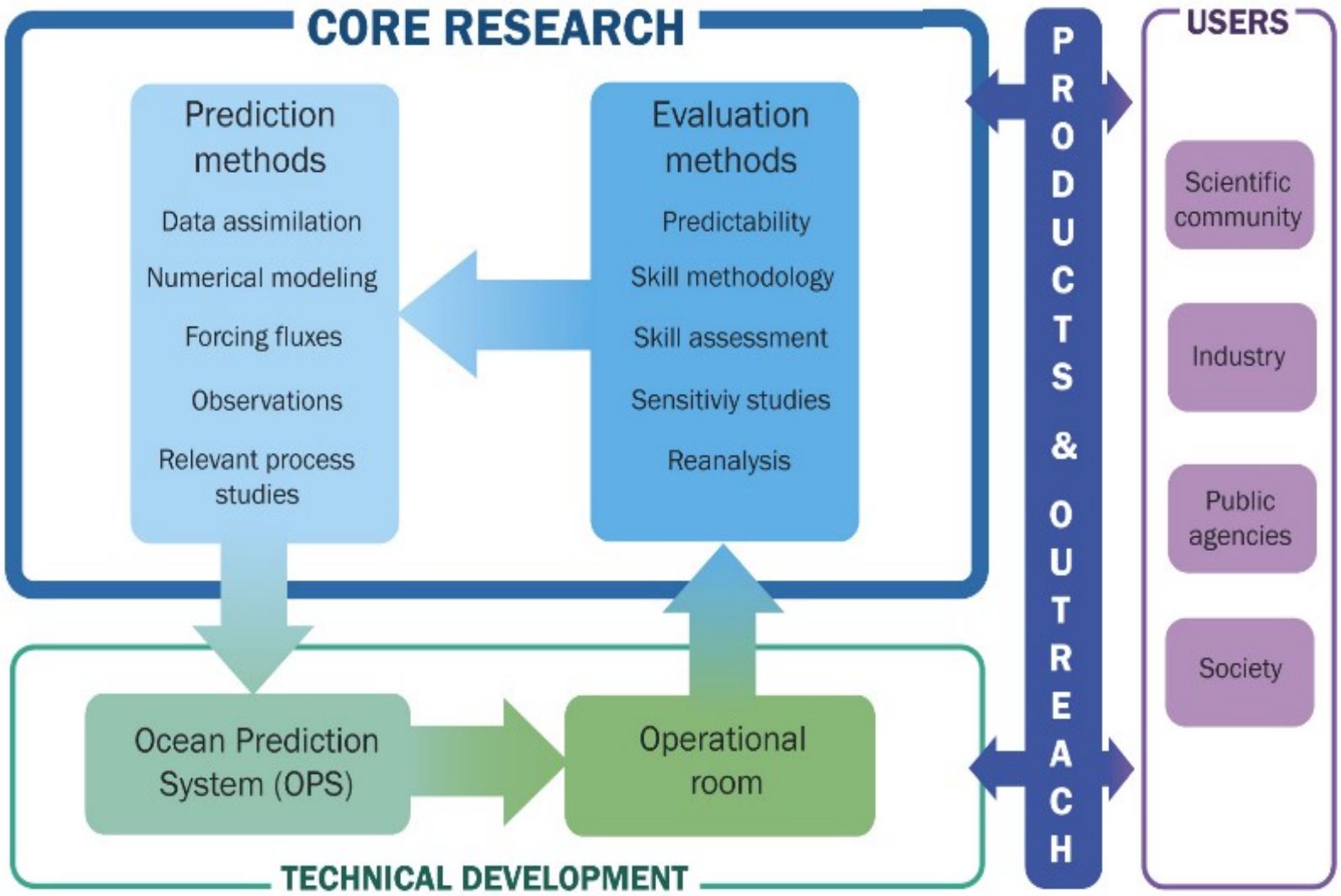
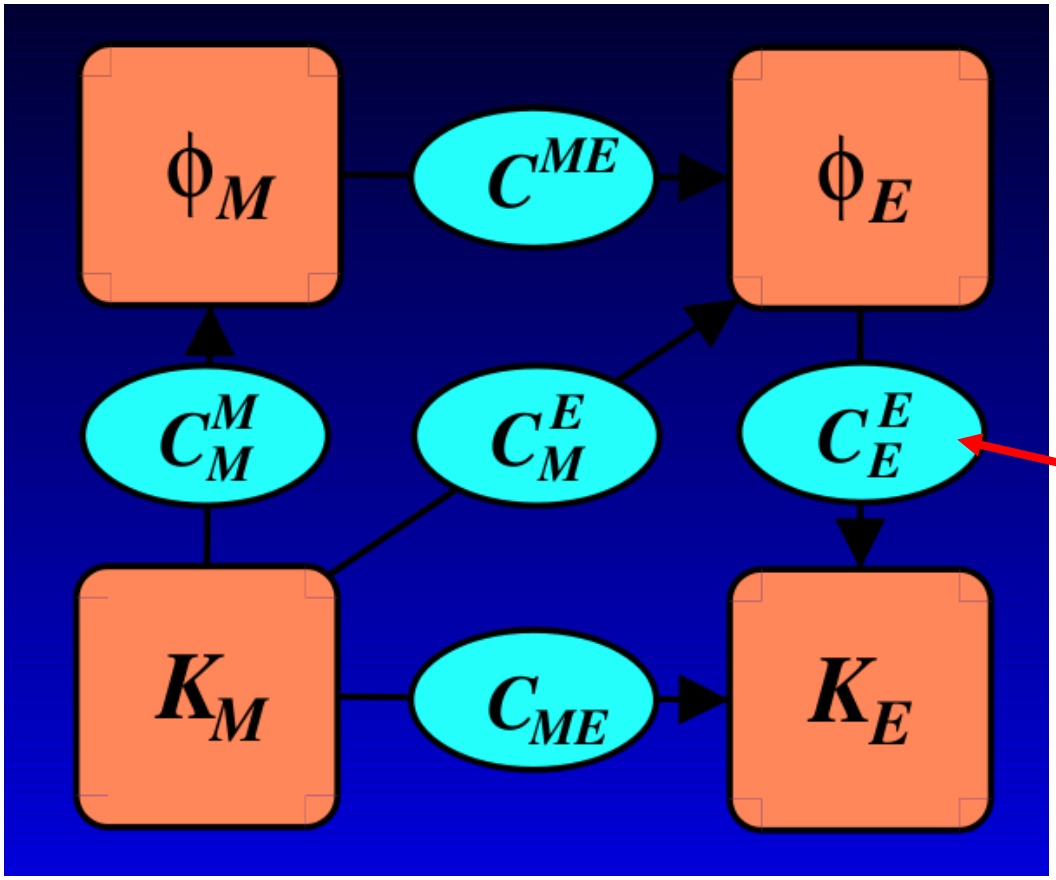
NOWP Research Learning Loop



Energy diagnostics

Potential energy

Kinetic energy



Reversible energy conversion terms

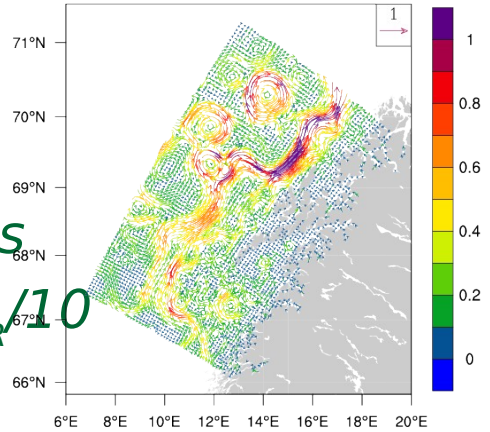
Mean energy

Eddy energy

Conclusions

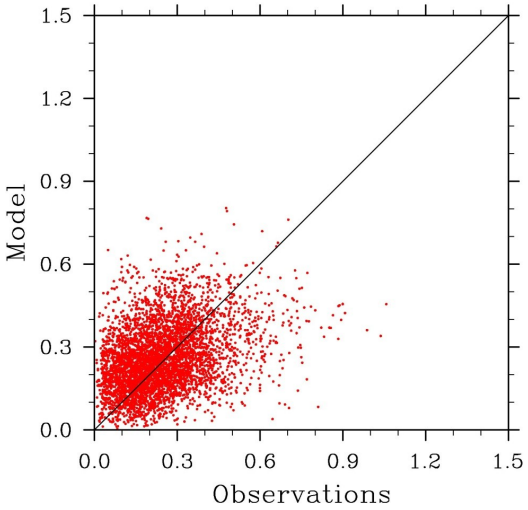
1. Societal needs requires eddy-resolving operational forecasting models

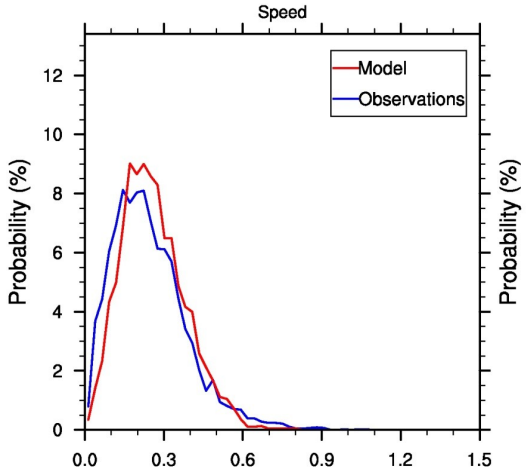
- Most accidents happen close to shore
  - *Grid resolution must resolve coastal irregularities*
- Extreme currents are created by synoptic ocean weather or eddies
  - *Must resolve instability processes*
  - *Grid resolution needed is* $\Delta s \sim L_R/10$



Conclusions

- Model evaluation:
  - Climatological skill vs. forecast skill
  - Good statistics necessary, but not sufficient
  - Good forecast skill always provide good statistics

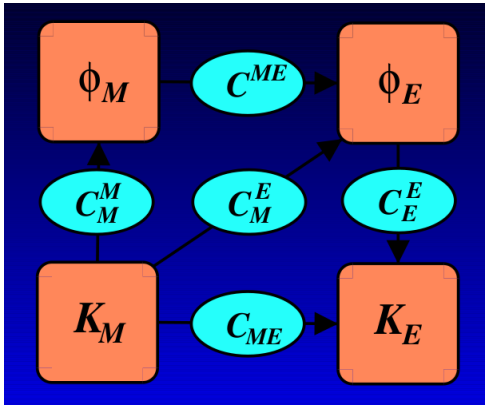




Conclusions

- Size of eddy-resolving area critical
  - In particular upstream end

- Energy diagnostic
  - Useful tool for process studies

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Thank you