github.com/opendrift

OpenDrift

a generic framework
for trajectory
modeling

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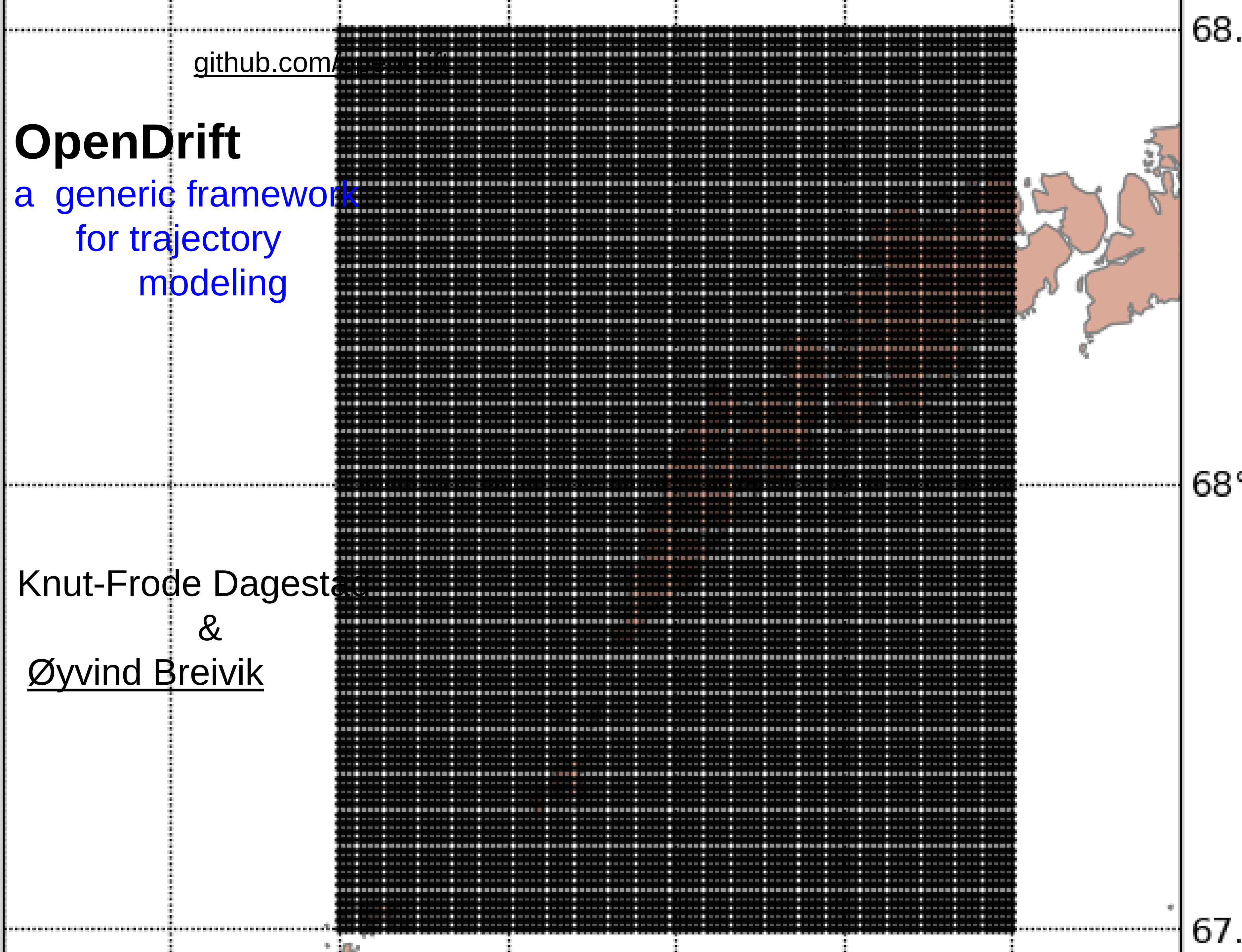

A common trajectory framework for oceanic applications

OpenDrift

Operational ocean trajectory forecasting at MET Norway

Oil drift **Ship drift** **Search and Rescue**

Requirement: 30-minute response time by meteorologist on duty

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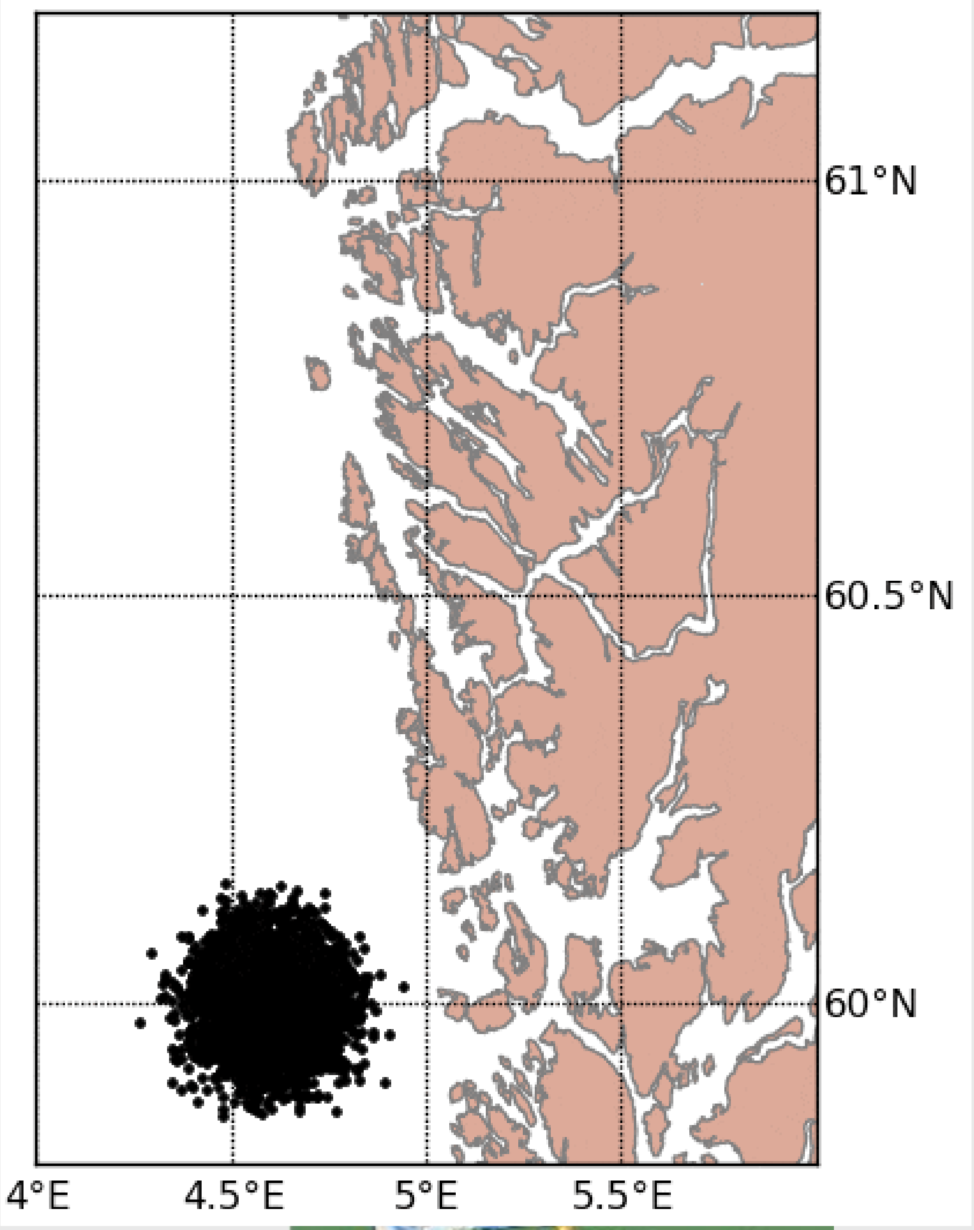
Ocean trajectory modelling at MET Norway

Ocean currents and wind is needed for all applications

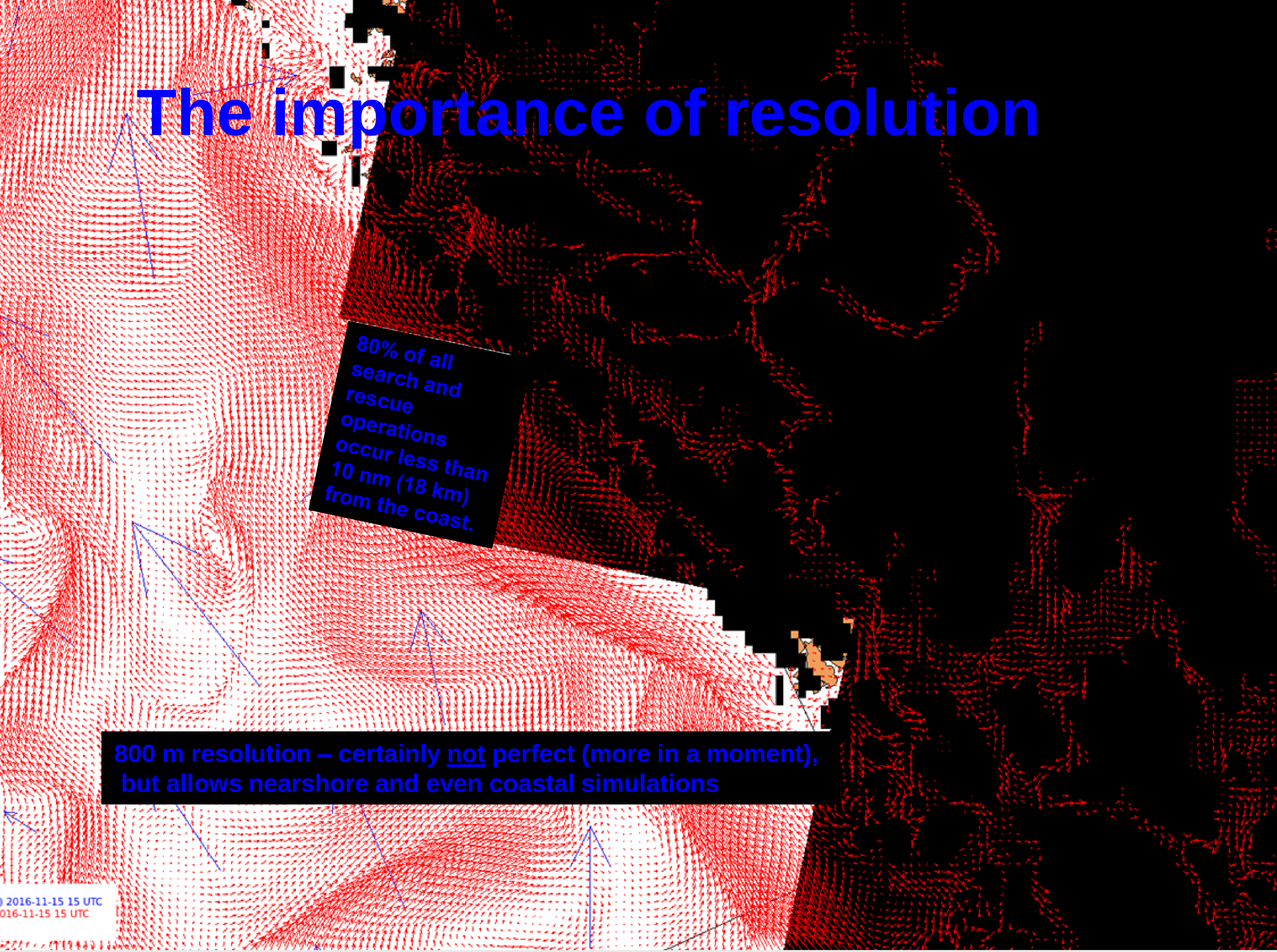
Wave parameters required for some

Location of incident is not known in advance

⇒The trajectory model must be run offline, ie, not run as part of an ocean model



The importance of resolution

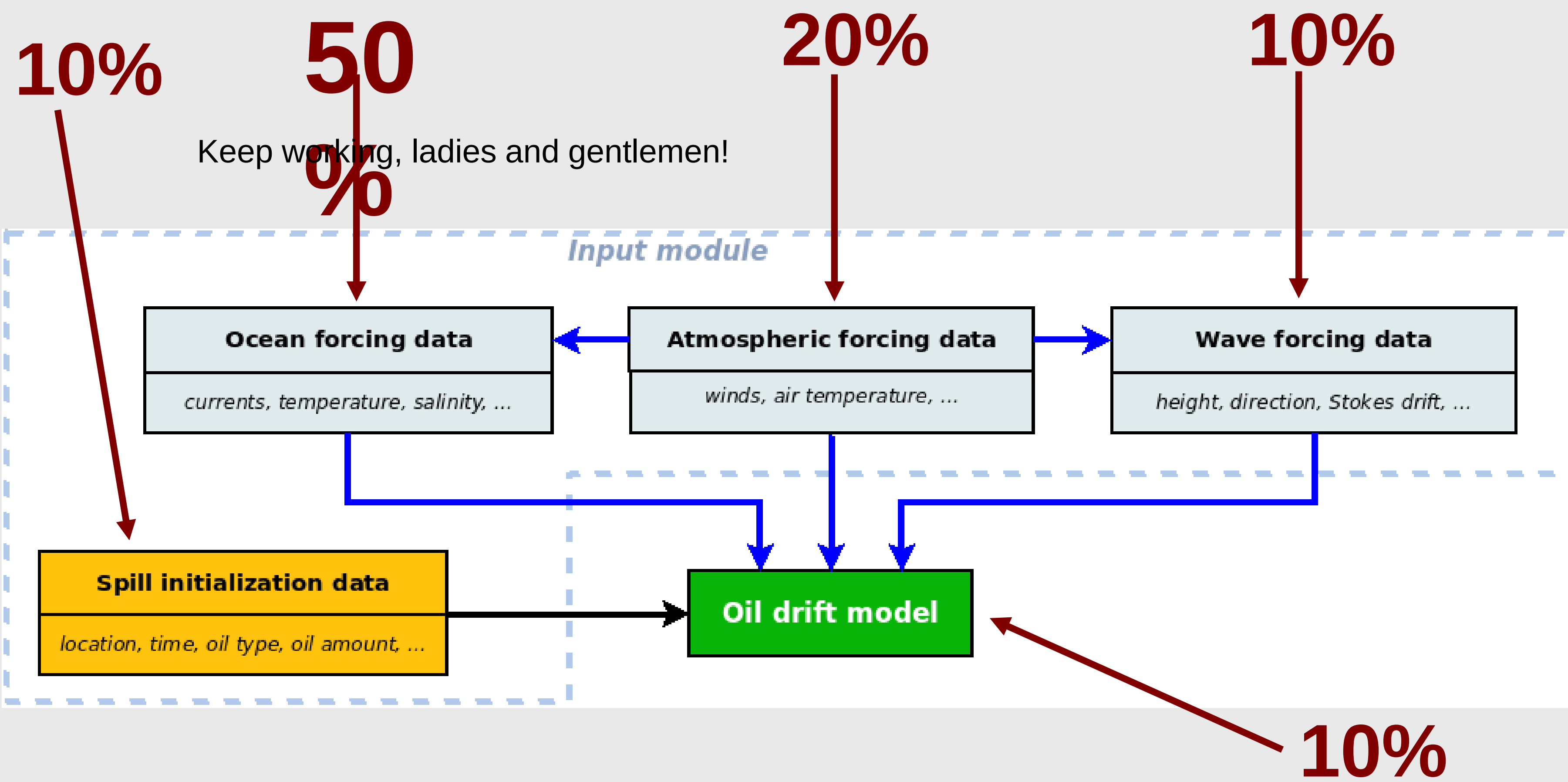


80% of all search and rescue operations occur less than 10 nm (18 km) from the coast.

800 m resolution – certainly <u>not</u> perfect (more in a moment), but allows nearshore and even coastal simulations

Errors in oil drift models

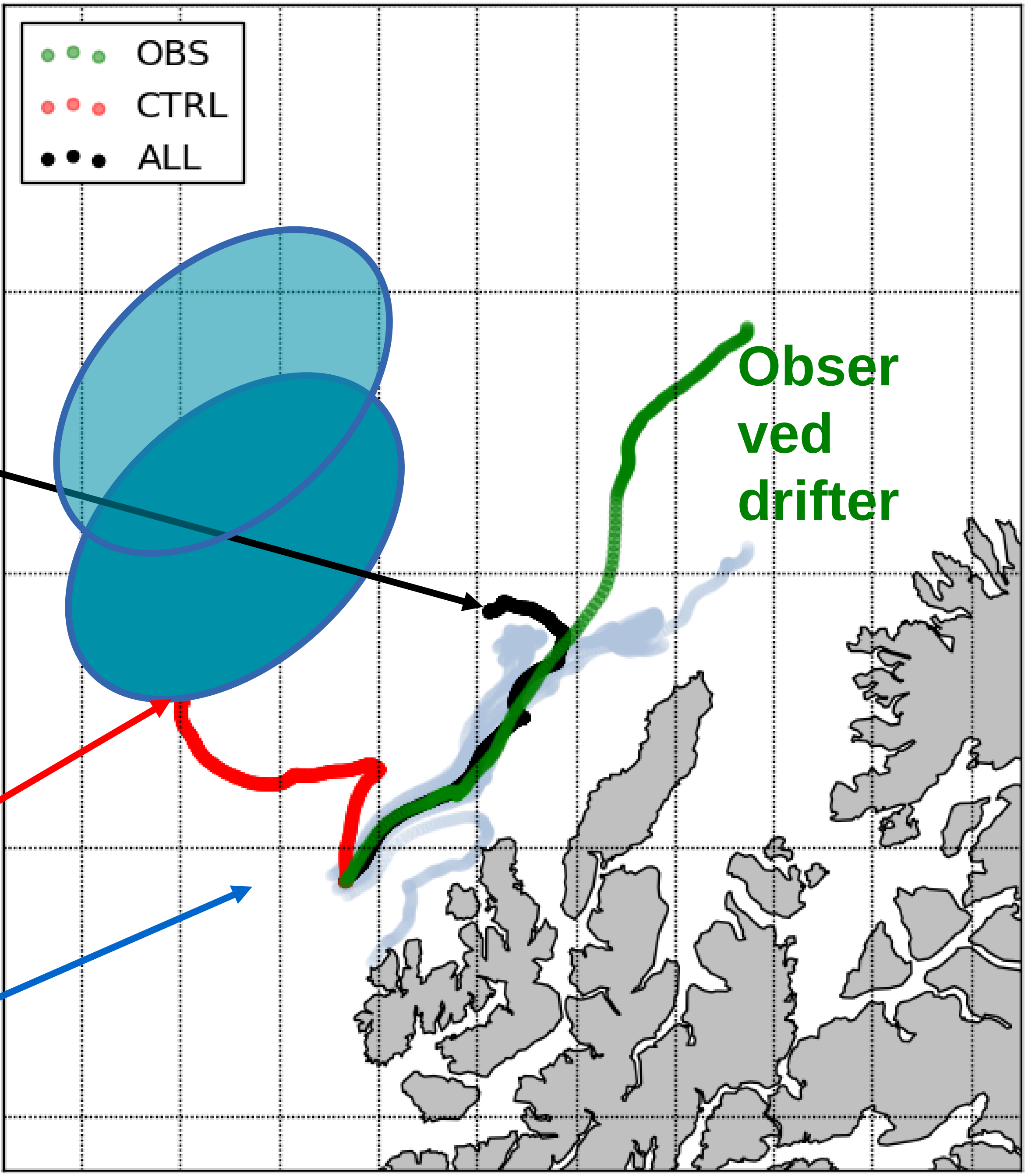
Keep working, ladies and gentlemen!



A. K. Sperrevik, K. H. Christensen, & J. Röhrs: Constraining energetic slope currents through assimilation of high-frequency radar observations,
Ocean Sci., 2015.

How to improve?

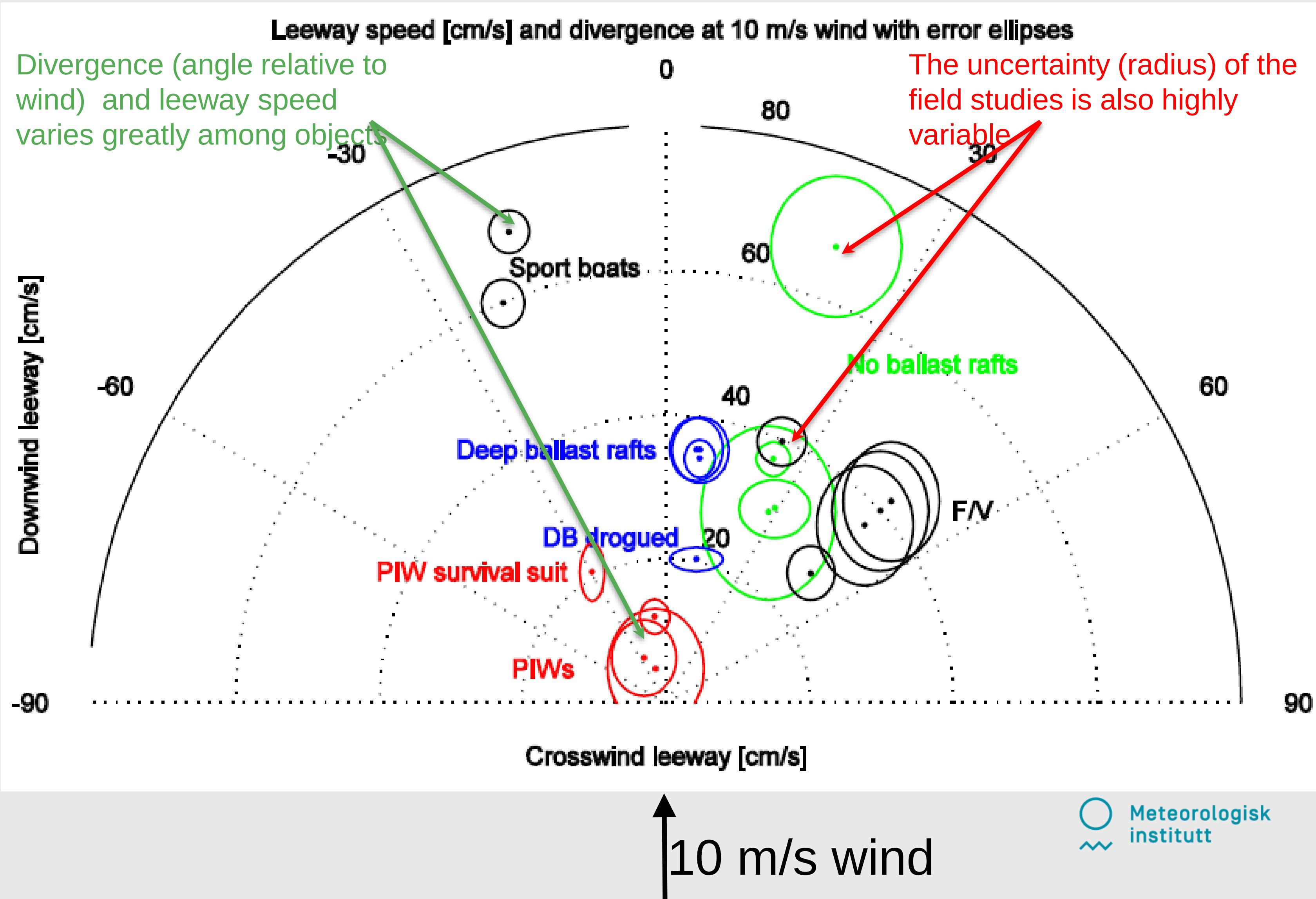
Simulated drifter, HF radar currents assimilated in a ROMS 4DVAR system



Simulated drifter, no assimilation

HF radar coverage

Leeway - category-based search and rescue (S&R) model



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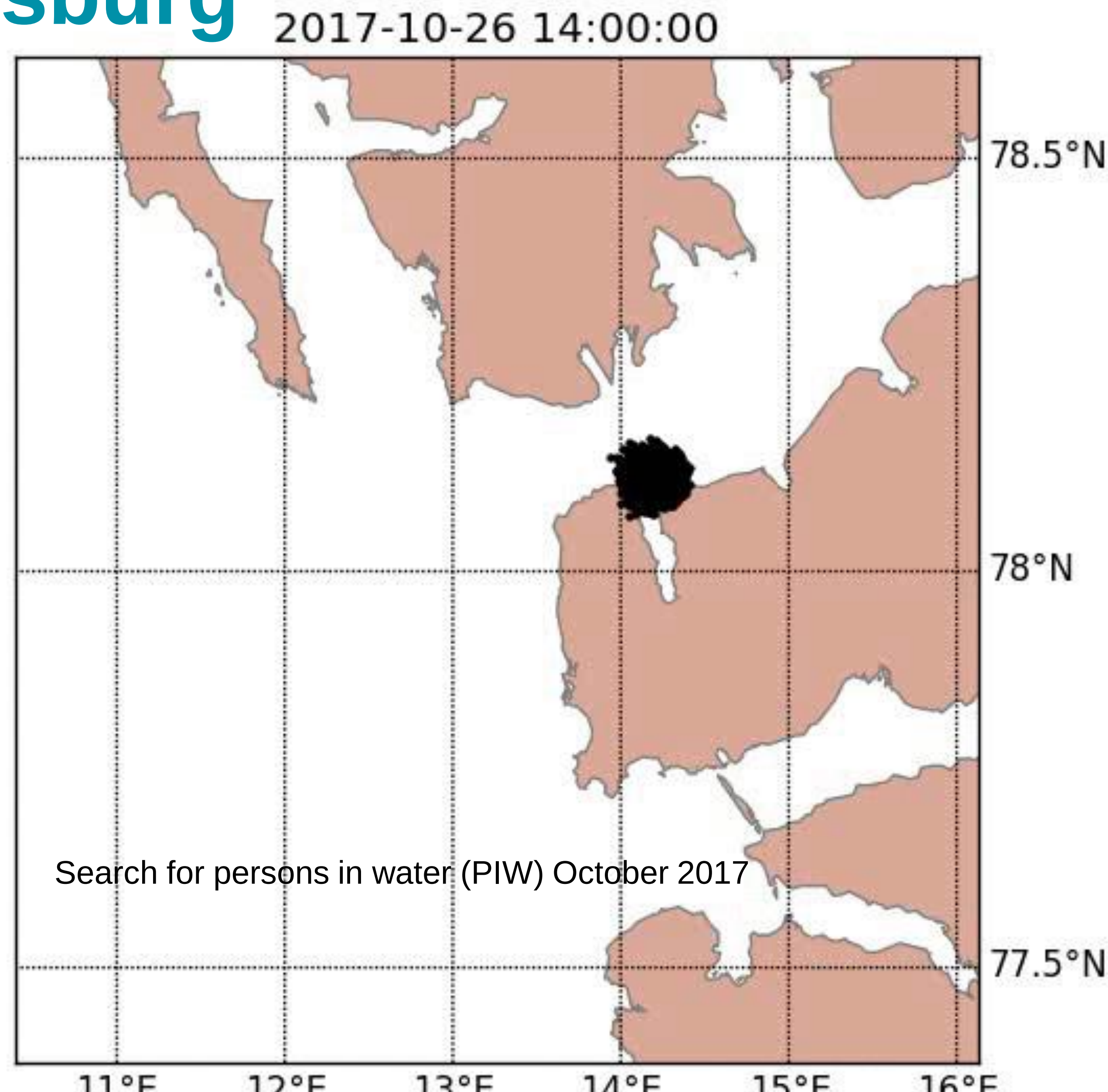
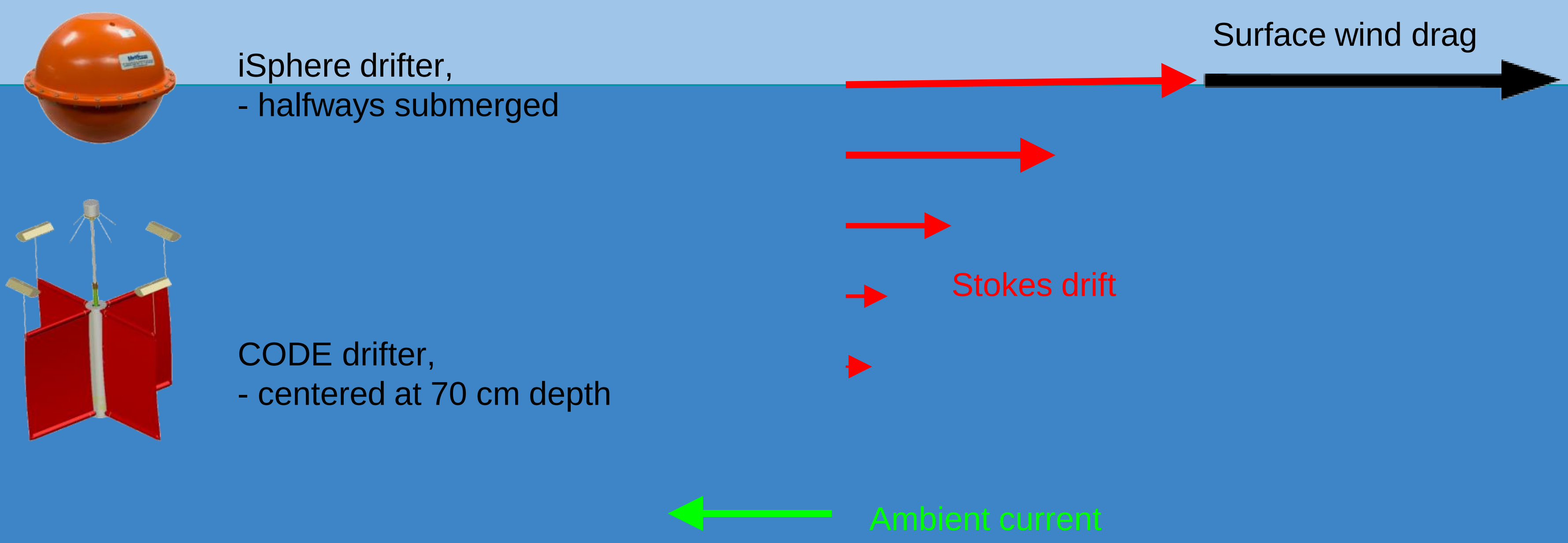
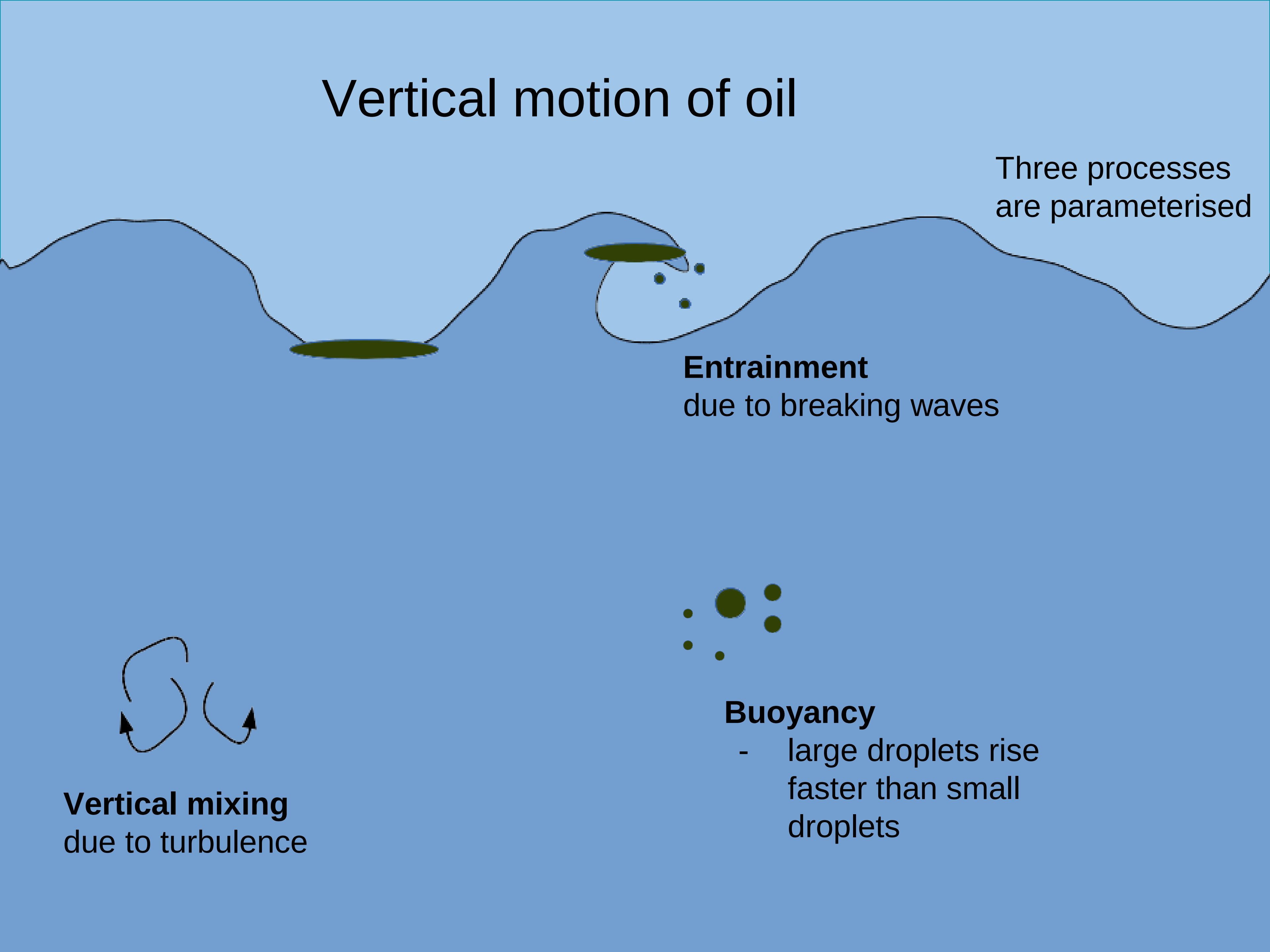


4 km model ocean model

Horizontal motion of oil depends strongly on depth



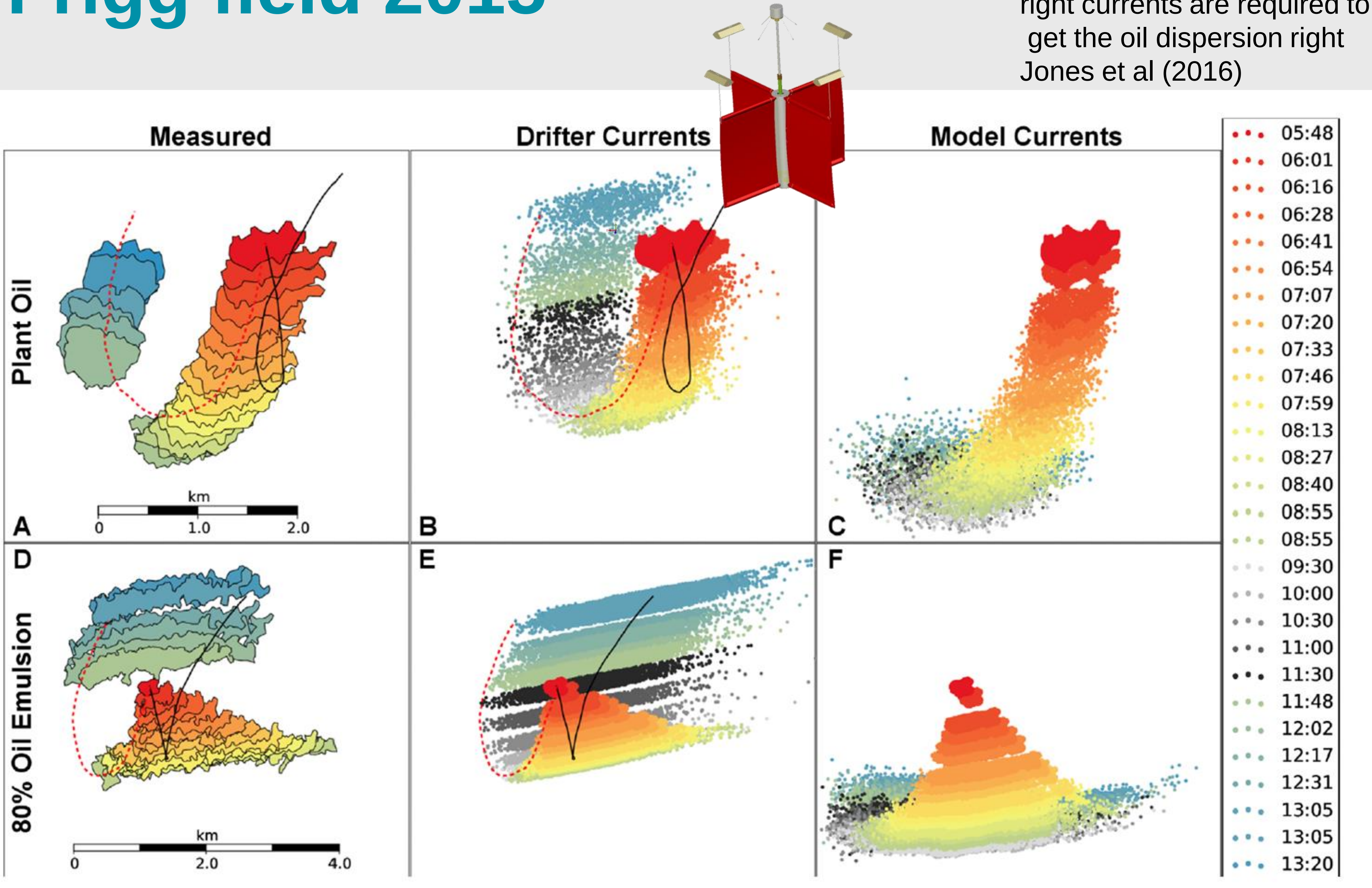

Vertical motion of oil
Three processes
are parameterised
Entrainment
due to breaking waves
Buoyancy
- large droplets rise faster than small droplets
Vertical mixing
due to turbulence

Simulated seafloor oil leakage

The picture can't be displayed.

Measured and modelled oil drift Frigg field 2015

The right mixing <u>and</u> the right currents are required to get the oil dispersion right
Jones et al (2016)



Iceberg module for OpenDrift

A module for the drift of icebergs (**OpenBerg**, not yet publicly available) is being developed by Ron Saper at Carleton University, Canada, with data support from the Canadian Ice Service.

Two different iceberg drift forecasting approaches are being tested:

- One approach uses a drag formulation to calculate wind and water drag forces. The challenge with this approach is that the trajectories are very sensitive to underwater draft, of which information is rarely available.
- The second approach predicts and subtracts the wind and tidal components of the drift, and then analyses the residual for extrapolation. Finally, wind and tidal components are added back in to produce a trajectory forecast.

Concluding remarks

- A new open-source trajectory framework is available on Github: github.com/opendrift
- The code is reusable and based on common standards like NetCDF-CF and Thredds
- The code is used for the operational emergency preparedness at MET Norway and is currently being implemented at the Norwegian JRCCs
- Errors are huge – field work matters, resolution matters, assimilation matters – plenty to do
- Currents remain the biggest source of uncertainty for oceanic trajectory models, and any improvement will translate directly into smaller search areas
- Iceberg modelling is currently under development and will eventually be implemented as an operational service

Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-205
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Discussion started: 30 August 2017

Geoscientific Model Development Discussions

Open Access

Dagestad, K.-F., Röhrs, J., Breivik, Ø., and Ådlandsvik, B.: OpenDrift v1.0: a generic framework for trajectory modeling, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-205, in review, 2017.

OpenDrift v1.0: a generic framework for trajectory modeling

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Abstract. OpenDrift is an open-source Python-based framework for Lagrangian particle modeling under development at the Norwegian Meteorological Institute with contributions from the wider scientific community. The framework is highly generic and modular, and is designed to be used for any type of drift calculations in the ocean or atmosphere. A specific module within the OpenDrift framework corresponds to a Lagrangian particle model in the traditional sense. A number of modules have already been developed, including an oil drift model, a stochastic search and rescue model, a pelagic egg model, and a basic module for atmospheric drift. The framework allows for the ingestion of an unspecified number of forcing fields (scalar and vectorial) from various sources, including Eulerian ocean, atmosphere and wave models, but also measurements or subjective estimates of the same variables. A basic backtracking mechanism is inherent, using sign reversal of the total displacement vector and negative time stepping. OpenDrift is fast and simple to set up and use on Linux, Mac and Windows environments, and can be used with minimal or no Python experience. It is designed for flexibility, and researchers may easily adapt or write modules for their specific purpose. OpenDrift is also designed for performance, and simulations with millions of particles may be performed on a laptop. Further, OpenDrift is designed for robustness, and is in daily operational use for emergency preparedness modeling (oil drift, search and rescue and drifting ships) at the Norwegian Meteorological Institute.

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GOV and ME(T)

- Ocean data assimilation is essential to improving the quality of operational trajectory forecasts
- With an increasing number of nearshore observational networks (HF radars, drifters), the potential for improving surface current forecasts is there
- GOV can help by highlighting the necessity for better surface current products for operational purposes
- Operational trajectory forecasts represent perhaps the clearest motivation for why we need operational ocean forecasts

References

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