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Short term predictions of oceanic drift

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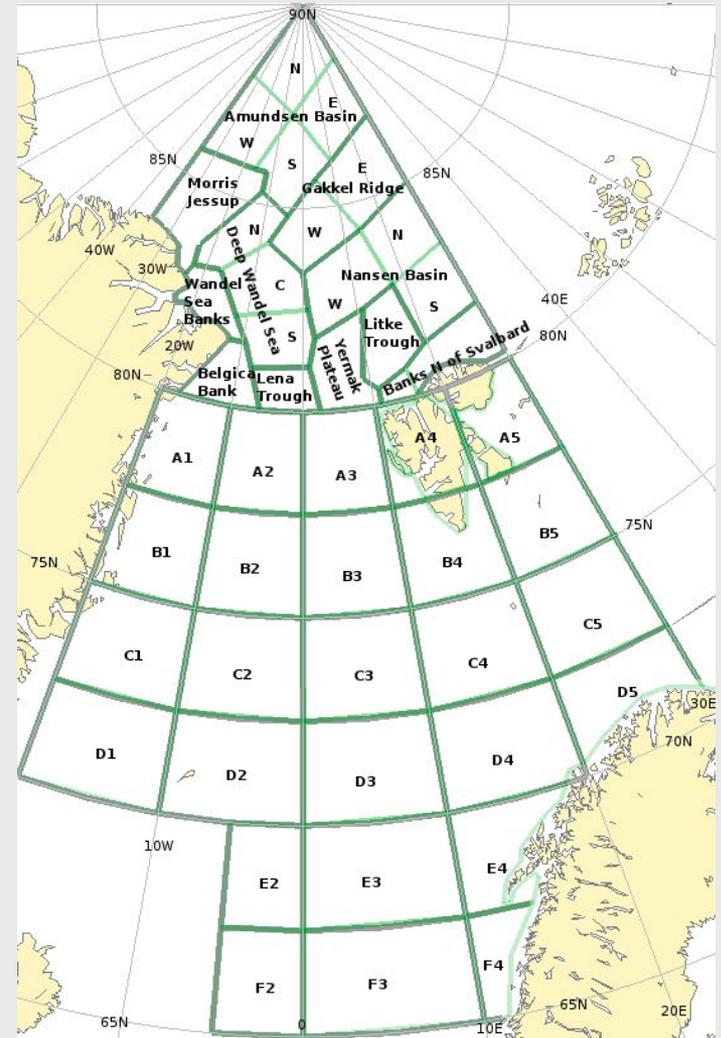
Trondheim, November 29, 2018

The Division for Ocean and Ice

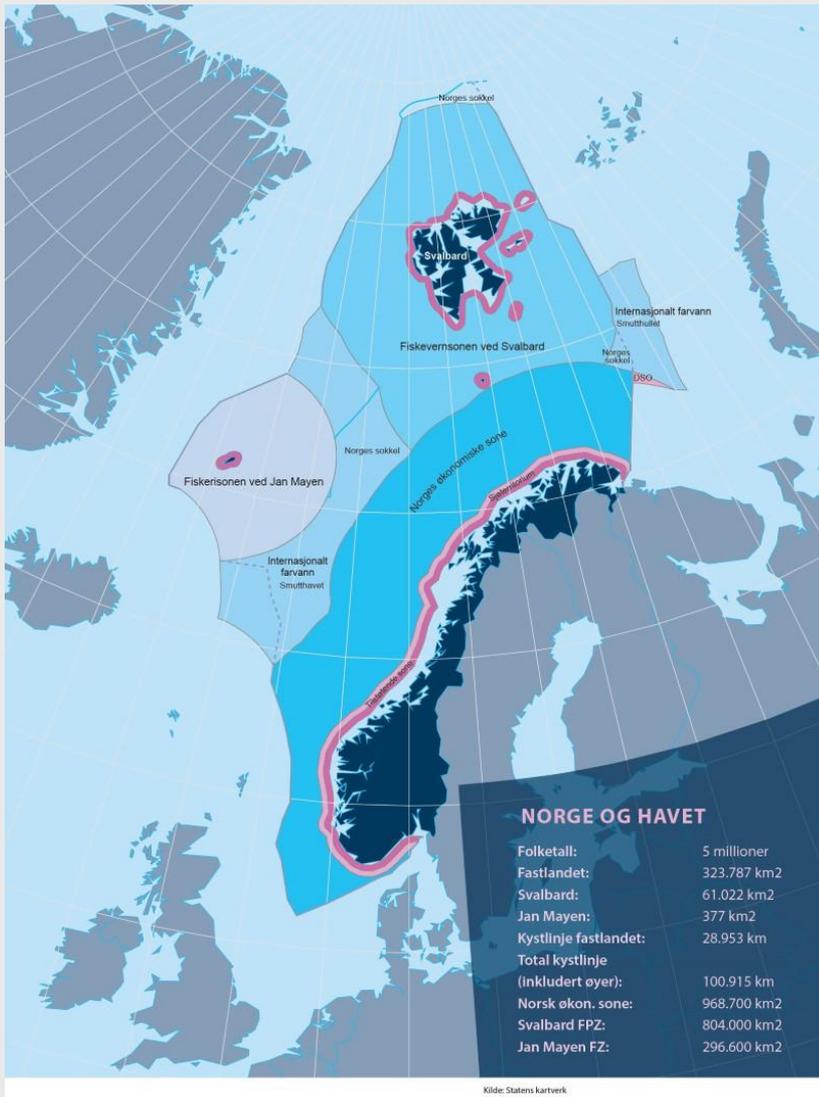
- We provide forecasts for
 - ocean currents,
 - surface waves,
 - storm surge,
 - sea ice,
 - hydrography (salinity, temperature).
- Our mission is to safeguard life and property:
 - search-and-rescue,
 - oil spills and ship drift,
 - navigation and offshore operations.



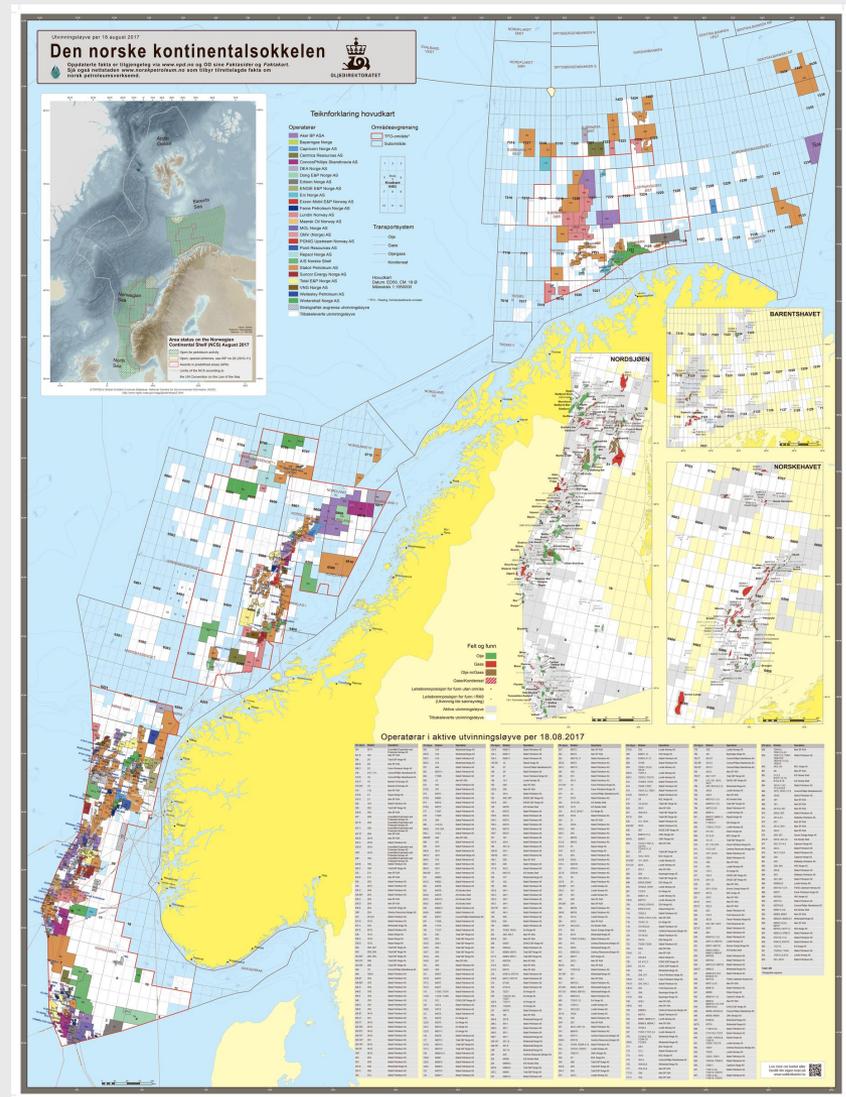
Search-and-rescue (Arctic Council)



MET Area XIX (WMO)



Norway's maritime borders



Oil and gas industry

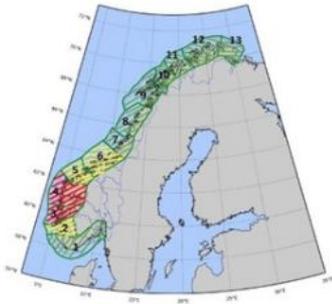


Du er her: Forsiden • Aktuelt • Regjeringen skrur på trafikklýset

Regjeringen skrur på trafikklýset

Pressemelding | Dato: 30.10.2017

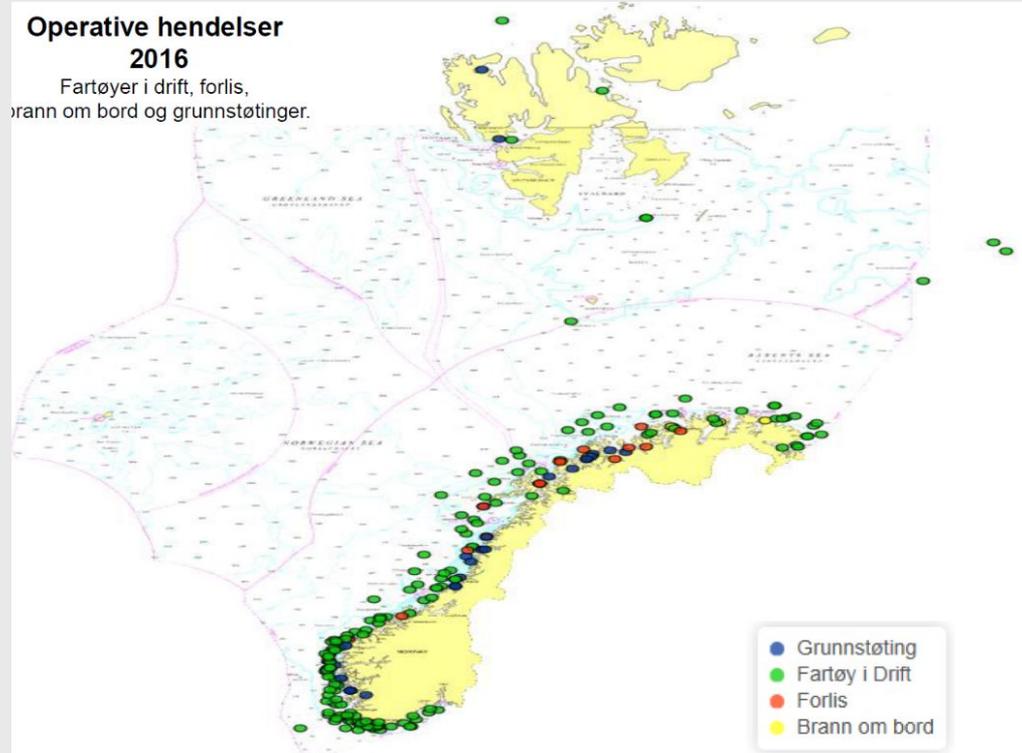
Regjeringen har besluttet hvilke farger de 13 ulike produksjonsområdene for oppdrett av laks, ørret og regnbueørret får i 2017. Beslutningen kan potensielt gi en vekst på om lag 24 000 tonn.



Traffic lights for the salmon farming industry

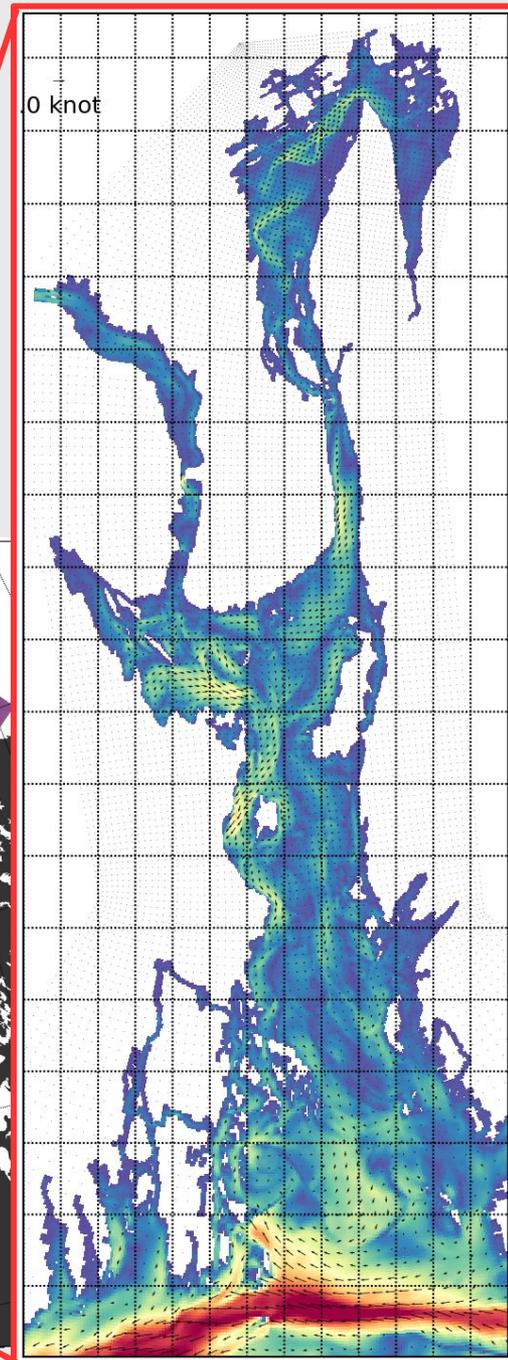
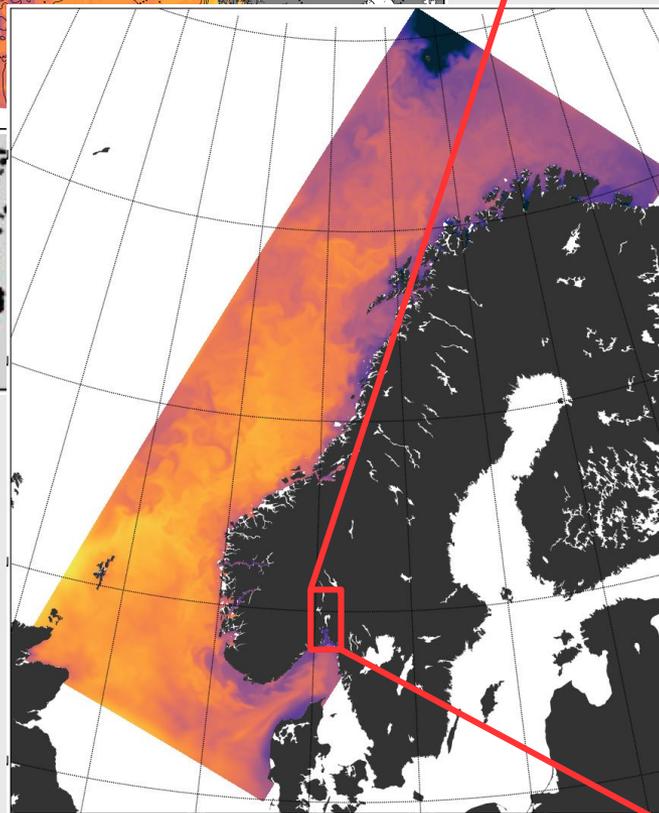
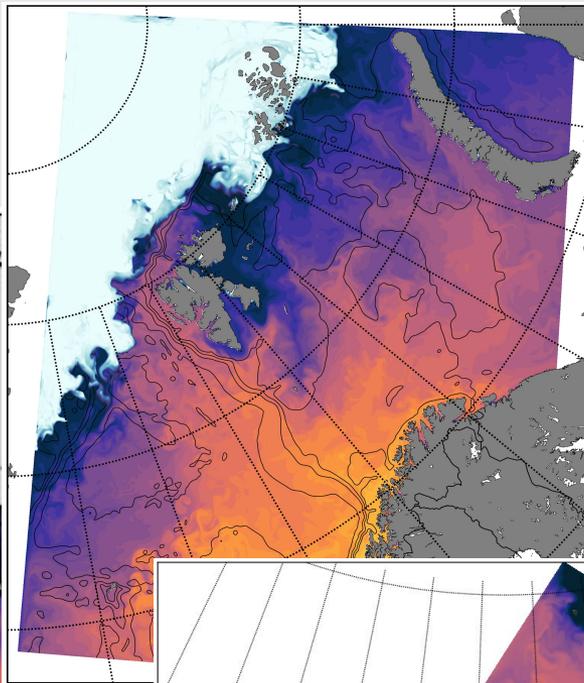
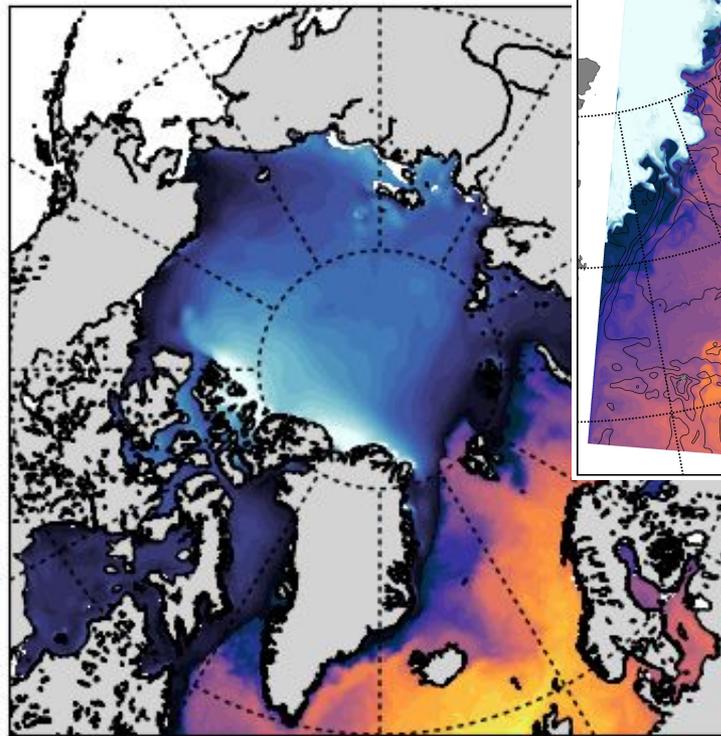
Operative hendelser 2016

Fartøyer i drift, forlis, brann om bord og grunnstøtinger.



Joint Rescue Coordination Centres: incidents at sea in 2016

Ocean models



- 1) Copernicus ARC MFC (w/NERSC and IMR)
- 2) NorKyst-800m
- 3) Barents-2.5km
- 4) Fjord models

Some outstanding challenges w.r.t oceanic drift

- Details of the mean *Lagrangian* flows, on both the air and water side, very close to the (wavy) surface.
- Anisotropic horizontal dispersion due to waves and/or direct influence by floating material (sea ice, oil spills).
- The transients of air-sea fluxes of momentum and energy, oceanic turbulence, and upper ocean stratification processes.

Drifter experiments

- We have collected drifter data from many field experiments in the last ten years, focusing on the upper ocean currents.



SVP: 15 m depth

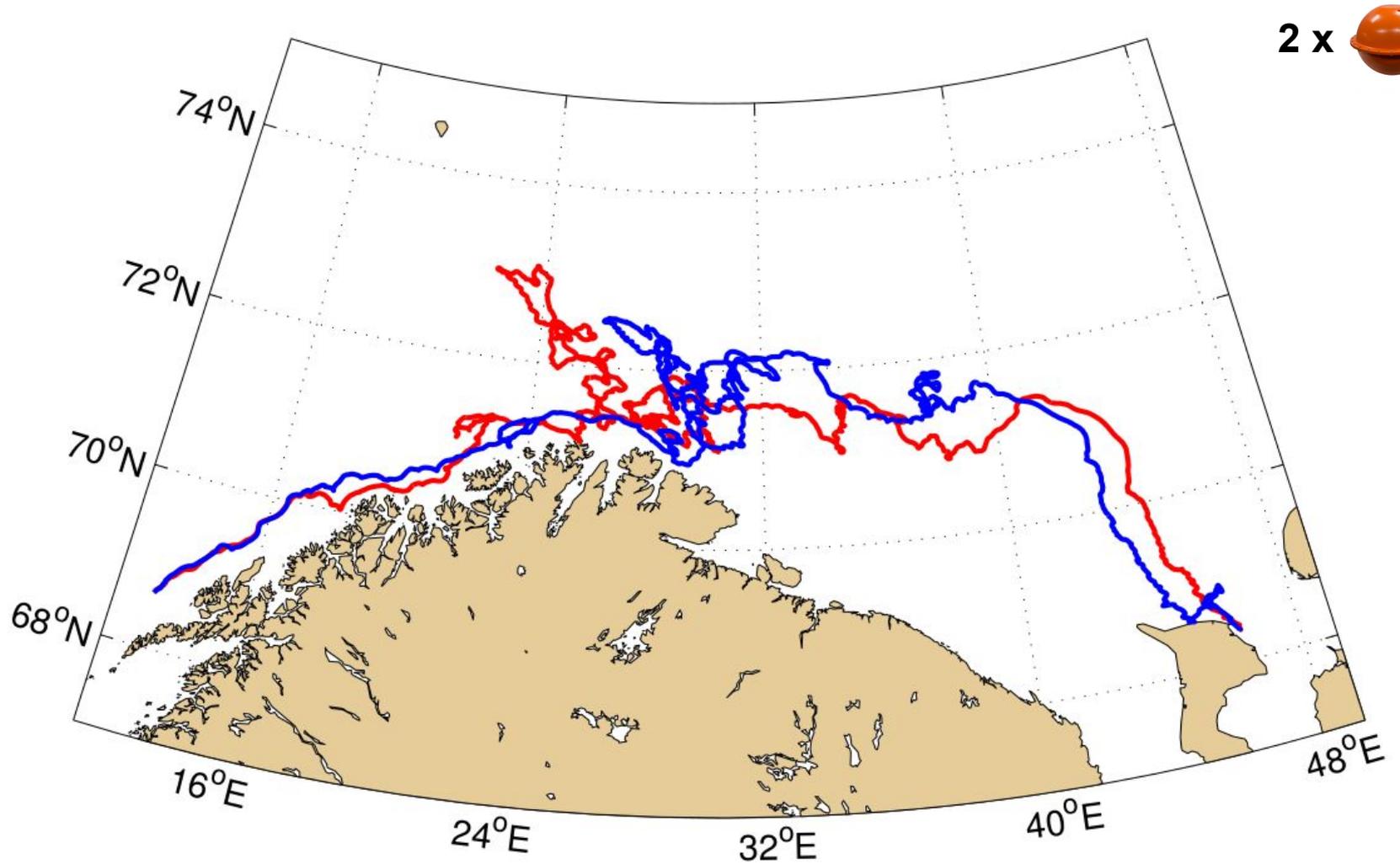


CODE: 0.7 m depth



iSphere: 0 m depth

On the usefulness of large N



On the cost of large N

100 x  = 3 x



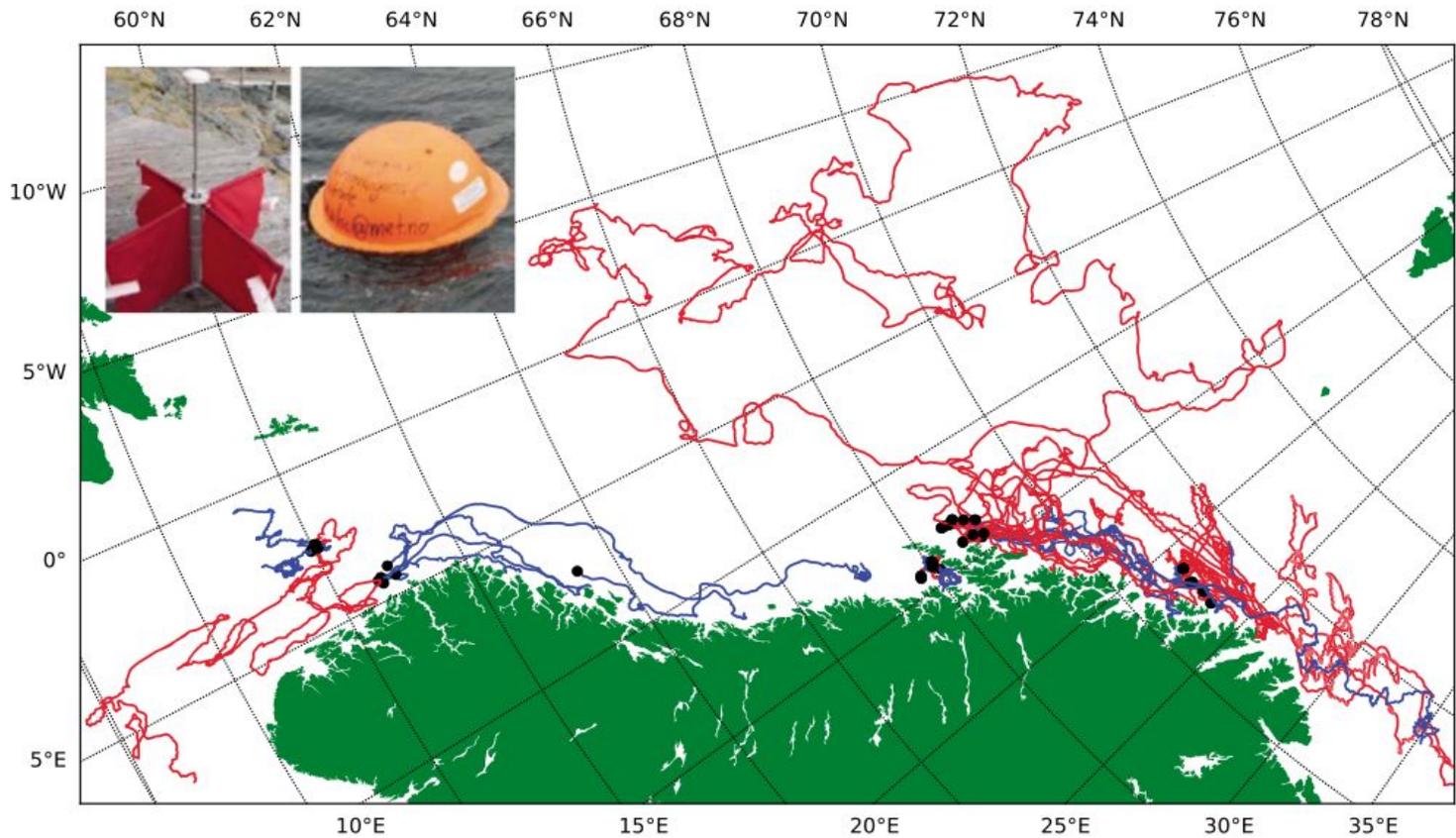


Figure 1. The trajectories of the CODE drifters (blue) and iSphere drifters (red) used in this study. A total amount of 25 CODE and 41 iSphere drifters are used, providing 405 and 1072 drifter days, respectively. The inset photographs show (left) CODE and (right) iSphere drifters.

(Röhrs and Christensen, 2015)

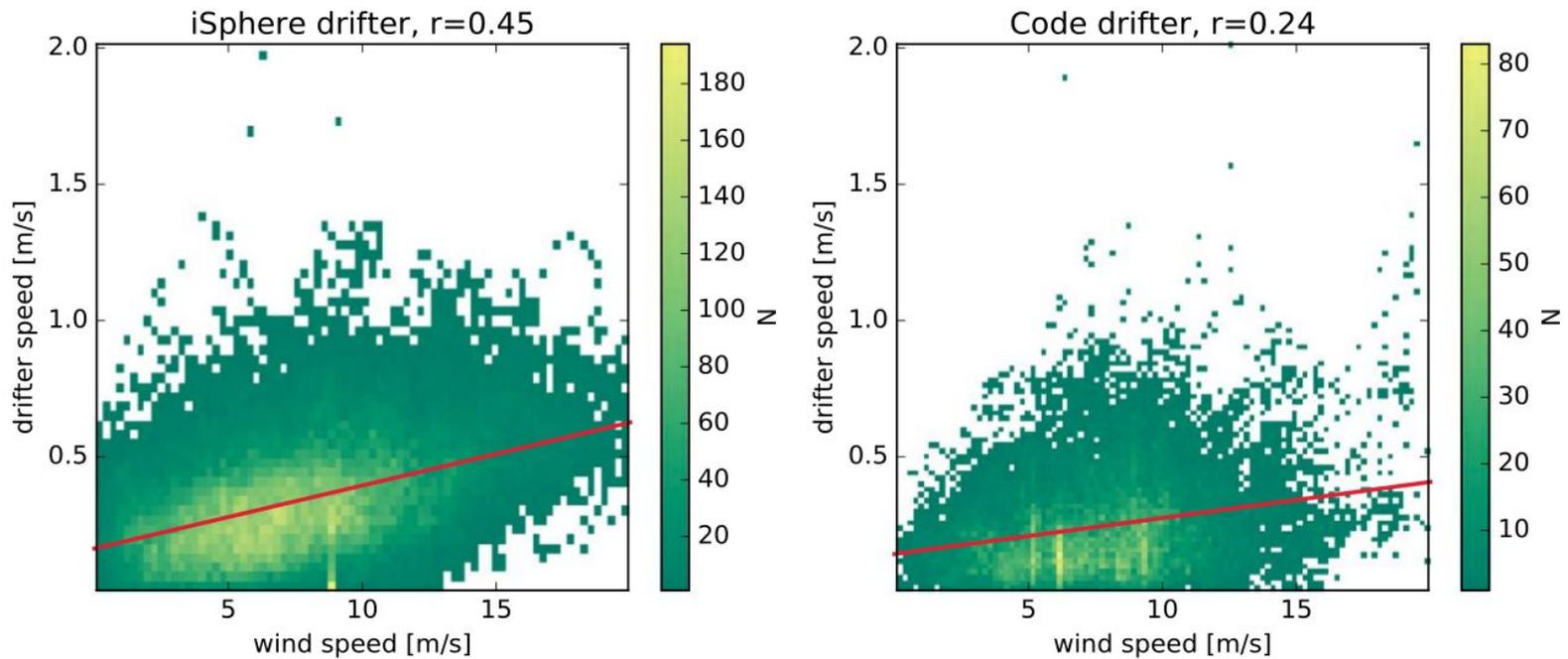
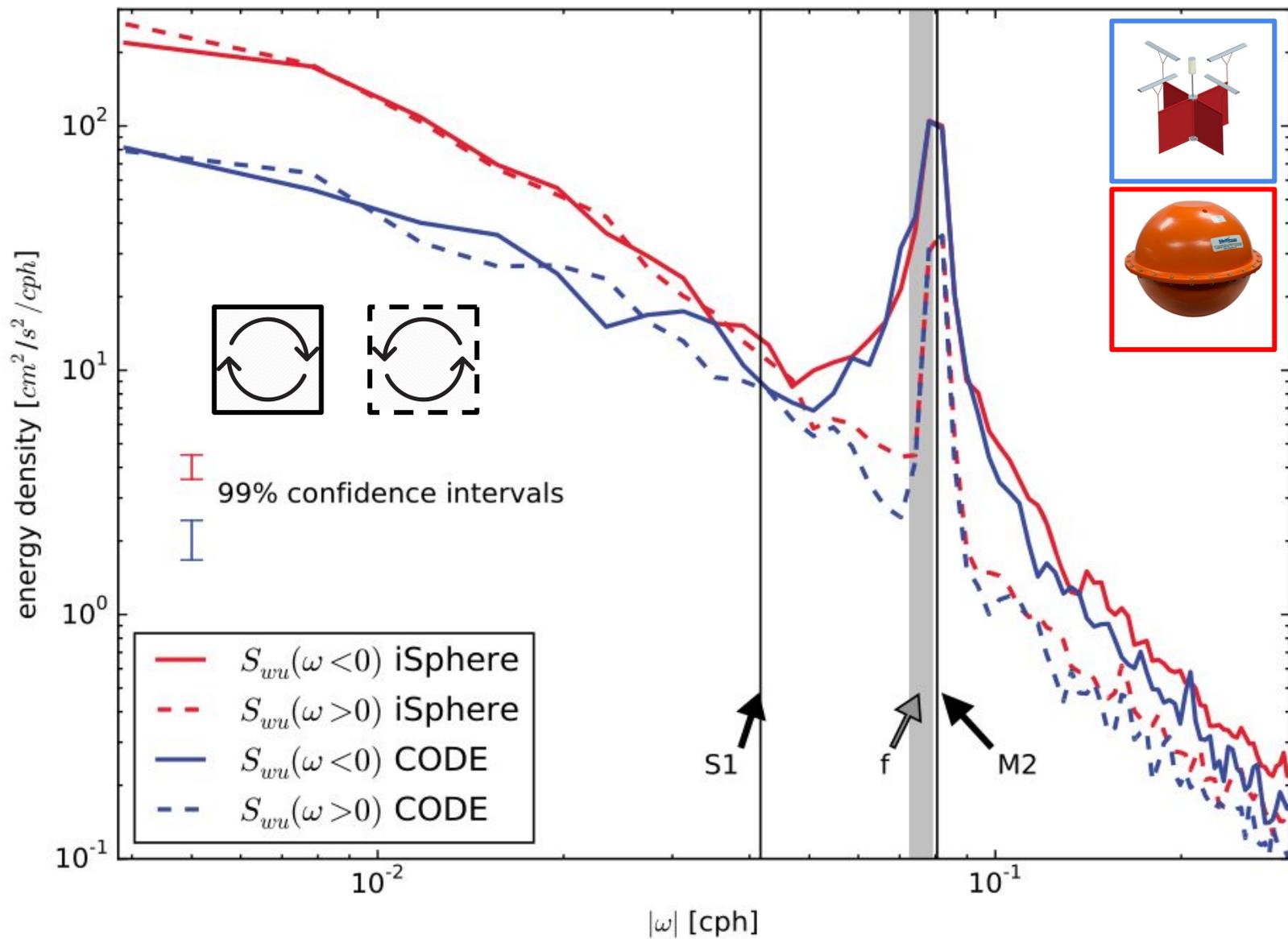
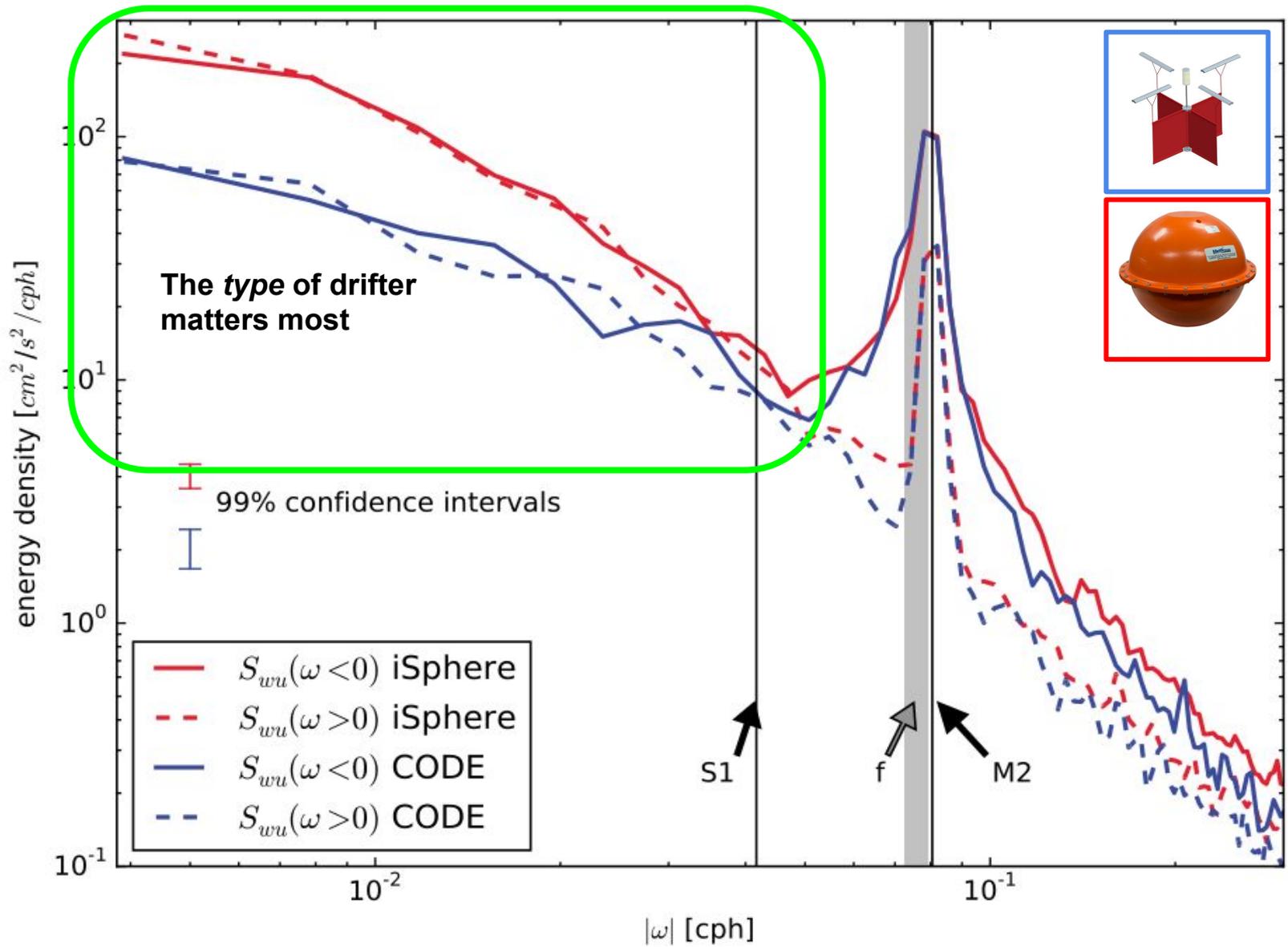


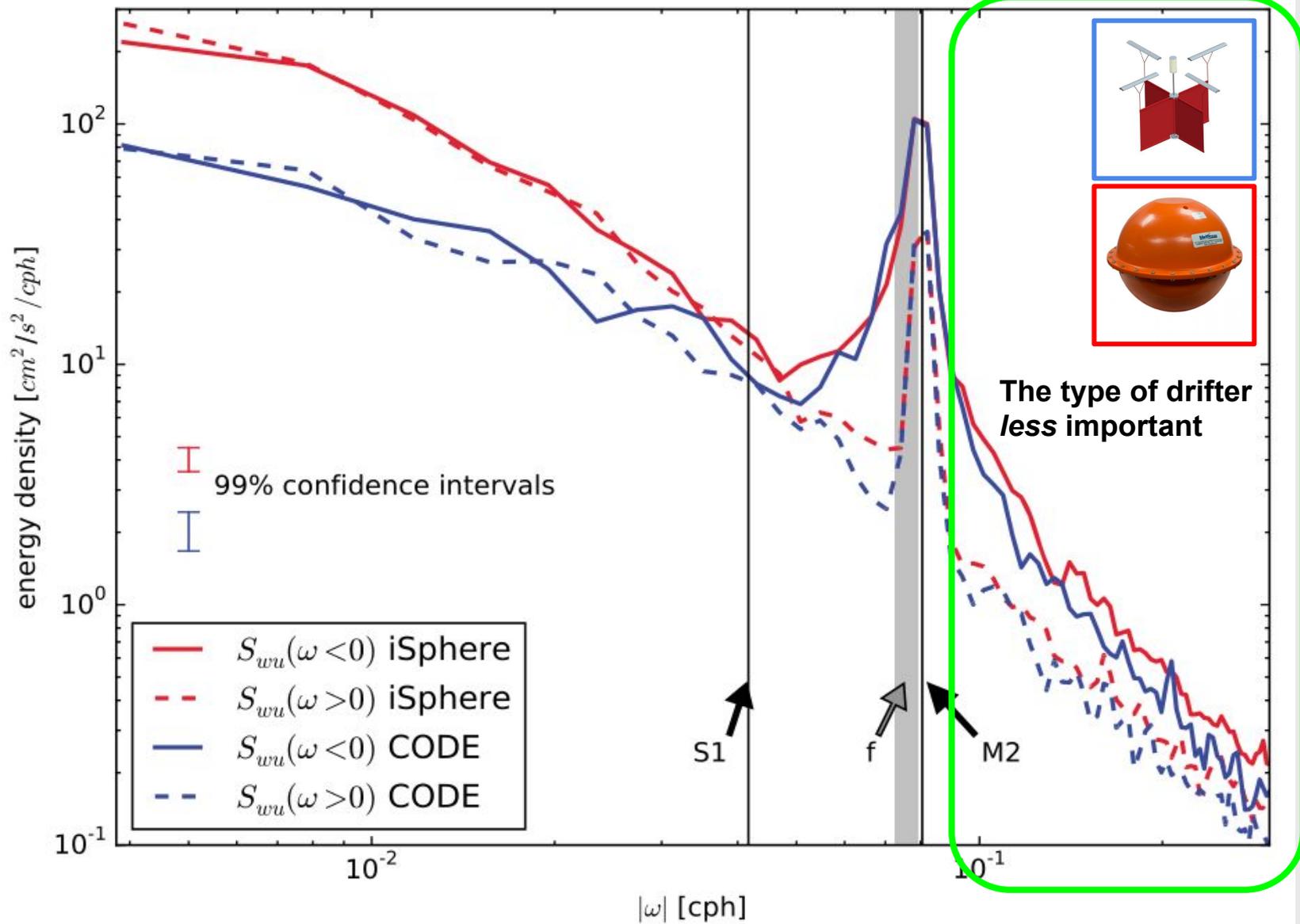
Figure 2. Two-dimensional histogram of wind speed versus drifter speed for (a) iSphere drifters and (b) CODE drifters. The red lines represent linear regressions between wind and drifter speed.

Drifter speeds and local winds are weakly correlated.

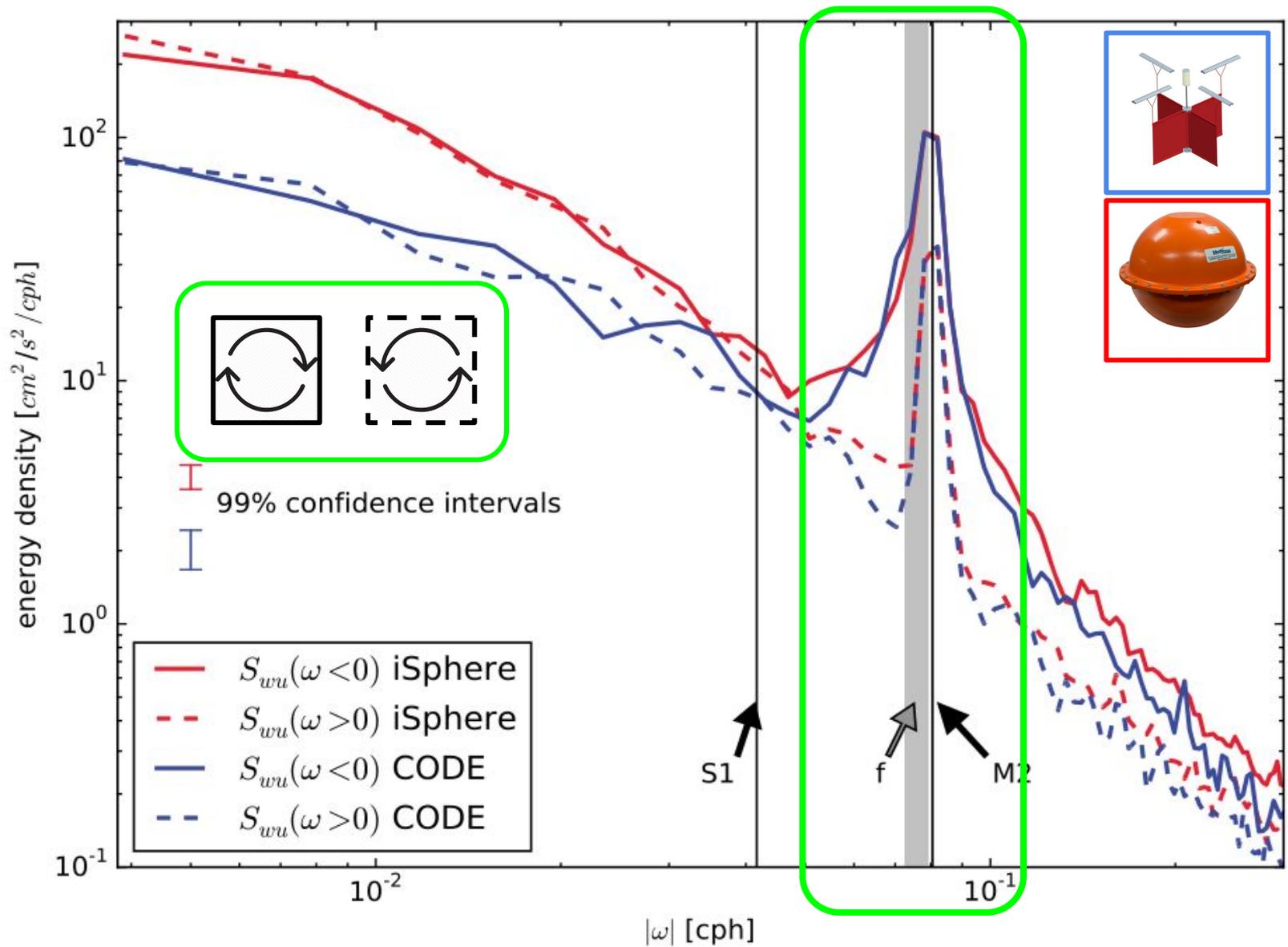




Sub-inertial time scales



Super-inertial time scales



Near-inertial waves (inertial oscillations) are ubiquitous.

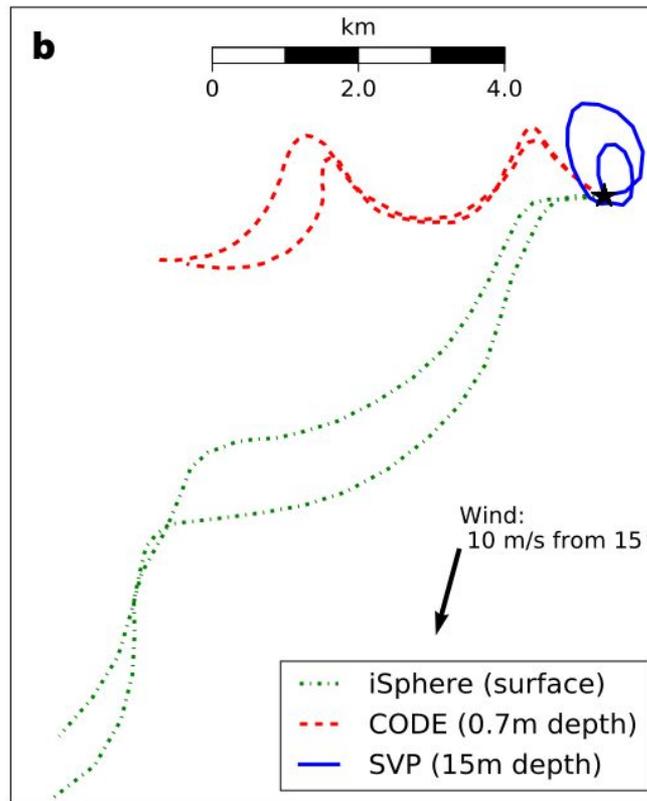
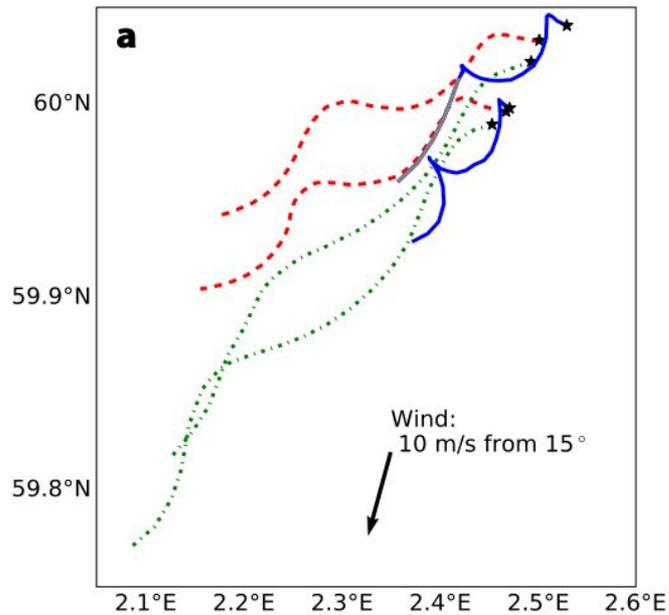


FIGURE 1. Trajectories from three different types of drifters as observed during the Norwegian Clean Seas Association's oil-on-water exercise in June 2018: iSphere (green dash-dotted line, 0 m depth), CODE drifters (red dashed line, 0.7 m depth), and SVP drifters (blue solid line, 15 m depth). One of the SVP drifters lost its drogue, after which the line is gray. The trajectories are plotted for two full inertial periods totaling 27.6 hours. Panel (a) shows the actual trajectories, while panel (b) shows the trajectories with the average displacement of one of the SVPs removed and using the same initial position for all units.

NOFO's Oil-on-Water exercise, June 2018

(Christensen *et al.*, 2018)

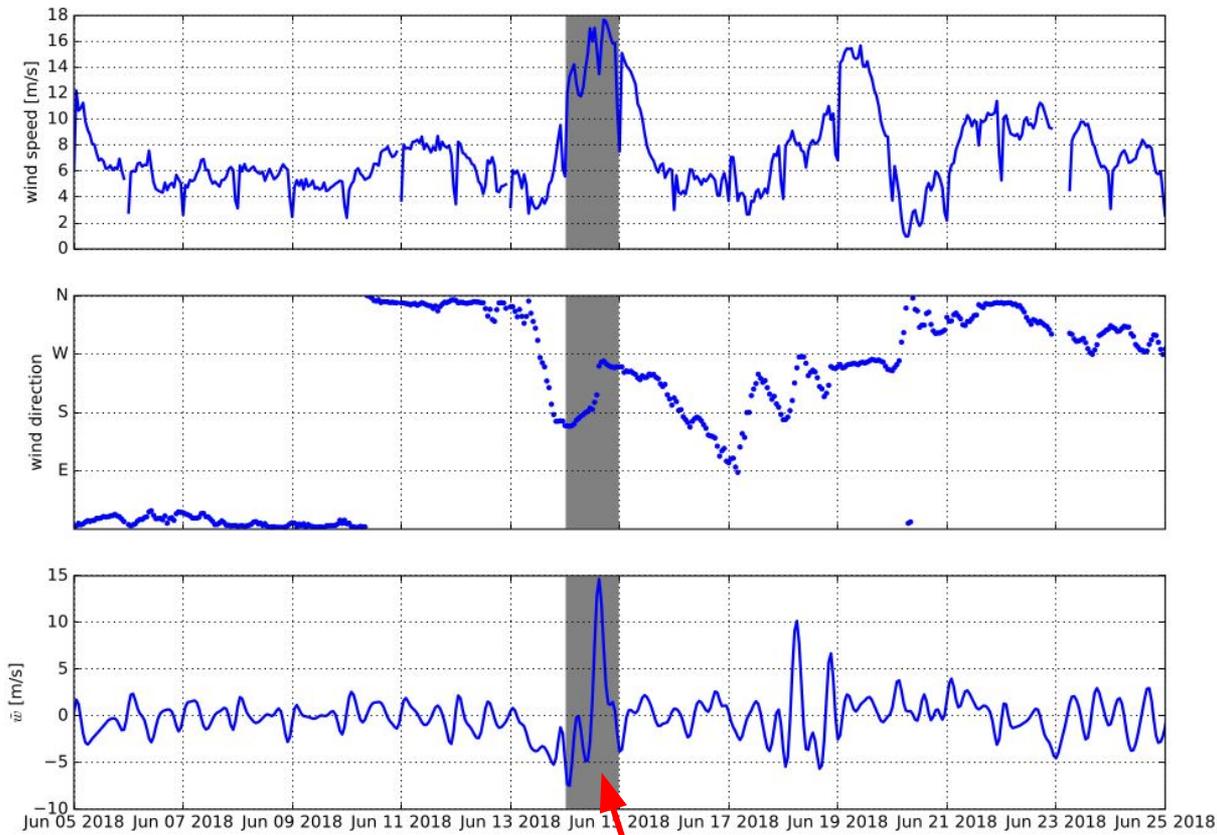


FIGURE 2. Wind speed and direction measured at the Heimdal offshore platform in the North Sea. Gray shading indicates a period with rapidly changing wind in resonance with inertial oscillations. The lower panel shows a filtered wind velocity that isolates the component of the wind close to the inertial frequency (convolution with a complex Morlet wavelet of length equal to $2T_f$).

Wind vector rotates in resonance with inertial oscillations in the ocean.

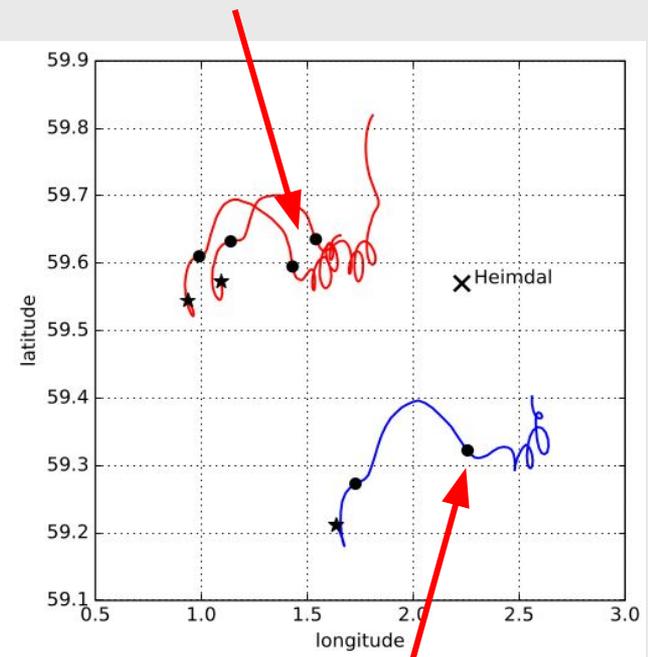


FIGURE 3. Location of the Heimdal offshore platform in relation to drifter trajectories. Drifter trajectories are shown in red for CODE drifters (0.7 m depth) and blue for the SVP drifter (15 m depth), with initial positions marked by stars. The drifters advance from southwest to northeast, and the parts of the trajectories marked with black dots correspond to the gray shaded time period in Figure 2. As is evident from the motion following this period, the resonant changes in the wind resulted in inertial oscillations.

Concluding remarks

- Can it really be so difficult to mass produce a cheap drifter?*
- On short time scales the velocities of submerged drifters are uncorrelated with local winds.
- It is essential to get the *hydrography* right in order to correctly model the upper ocean response to wind and waves.

* Nudge, nudge. Please ask for advice regarding design.



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