Offshore wind farms and (possible) impact on ocean dynamics and biogeochemstry

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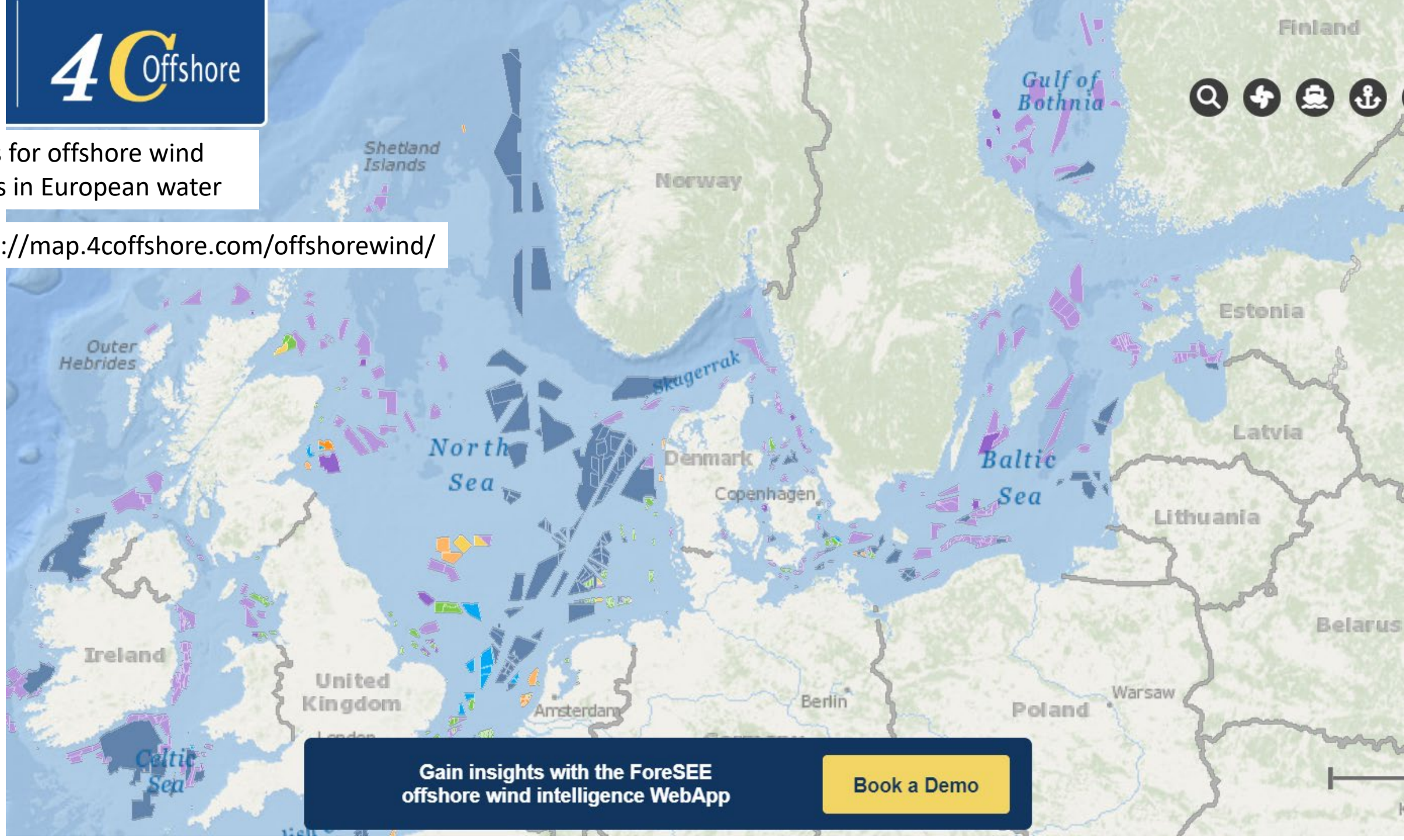
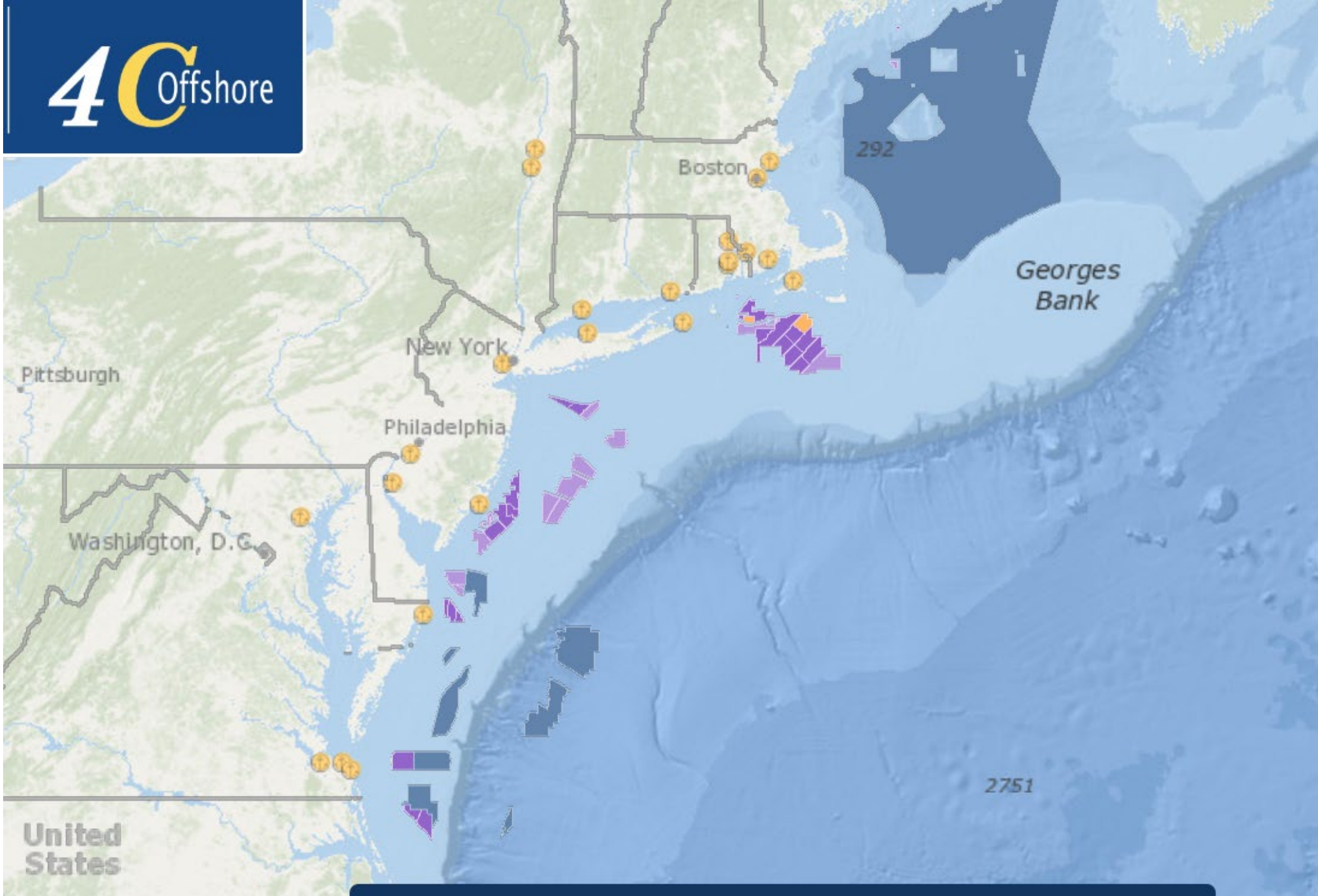
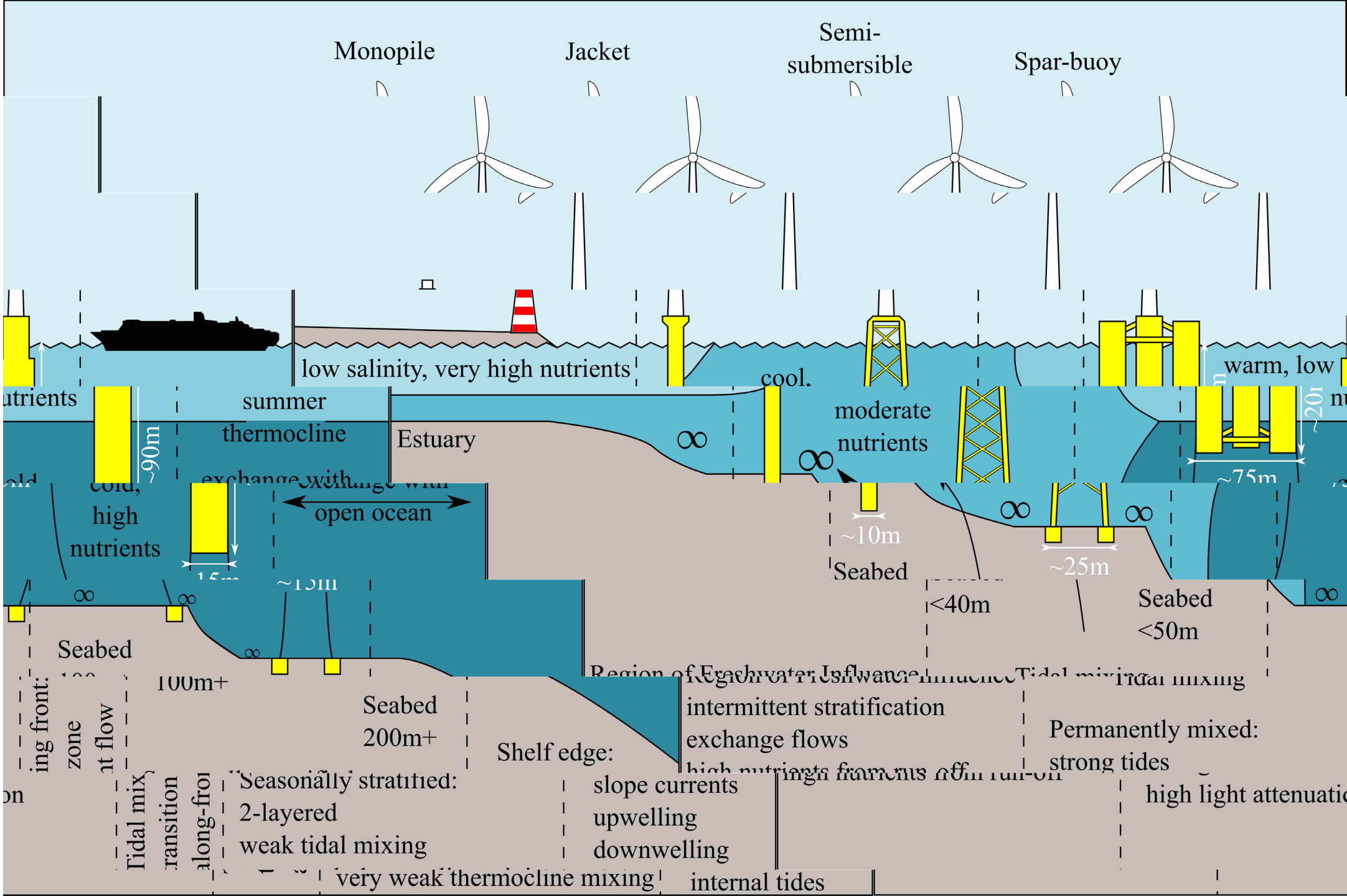
Sweden

Plans for offshore wind farms in European water

https://map.4coffshore.com/offshorewind/

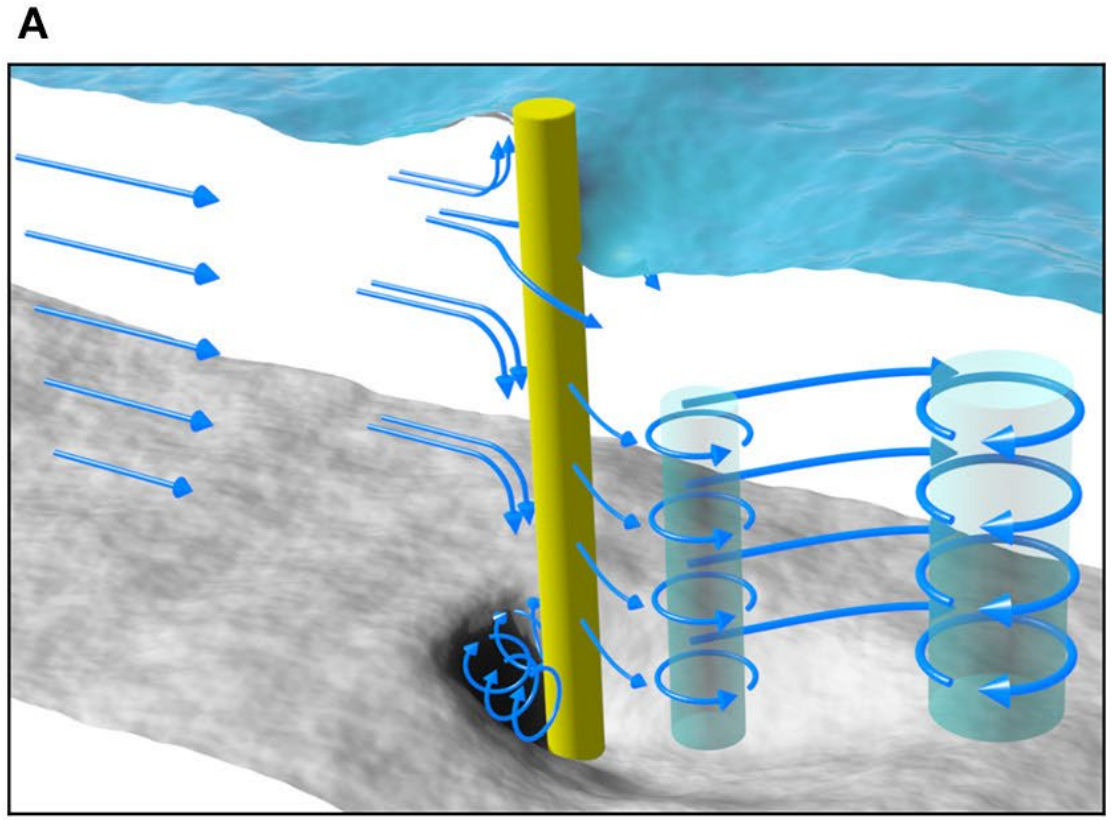


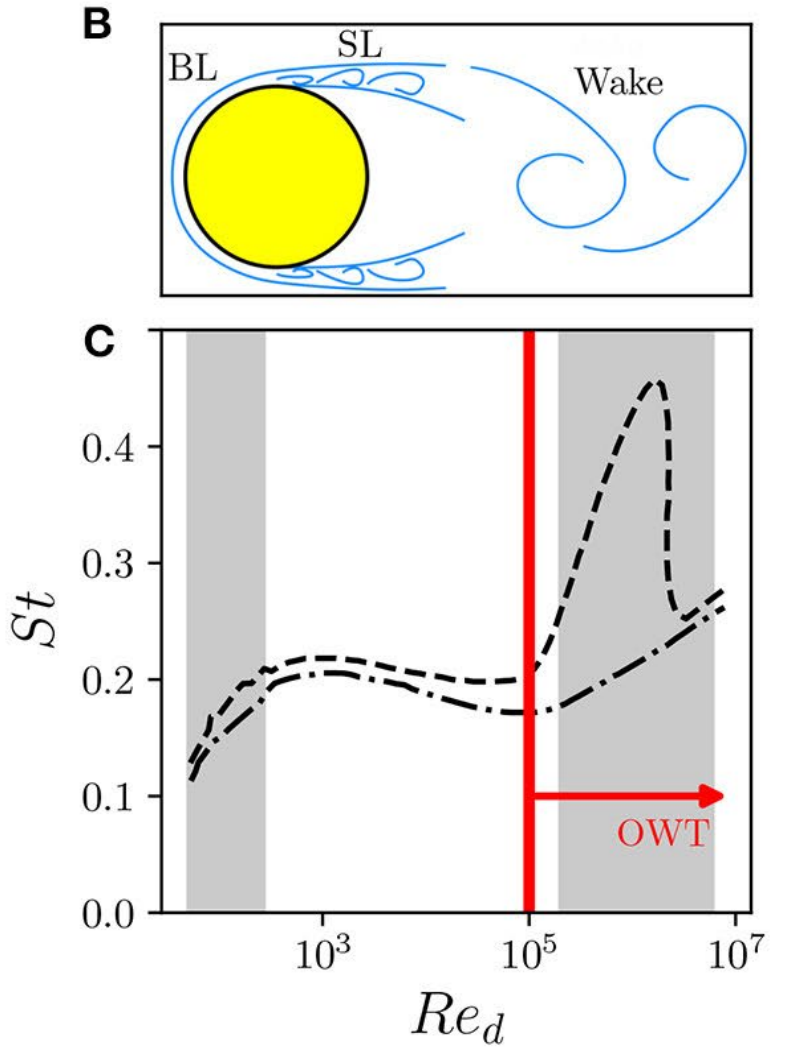

4C Offshore
Boston
New York
Pittsburgh
Philadelphia
Washington, D.C.
292
Georges Bank
2751
United States



Dorrell et al 2022

Flow around the fundaments will create mixing

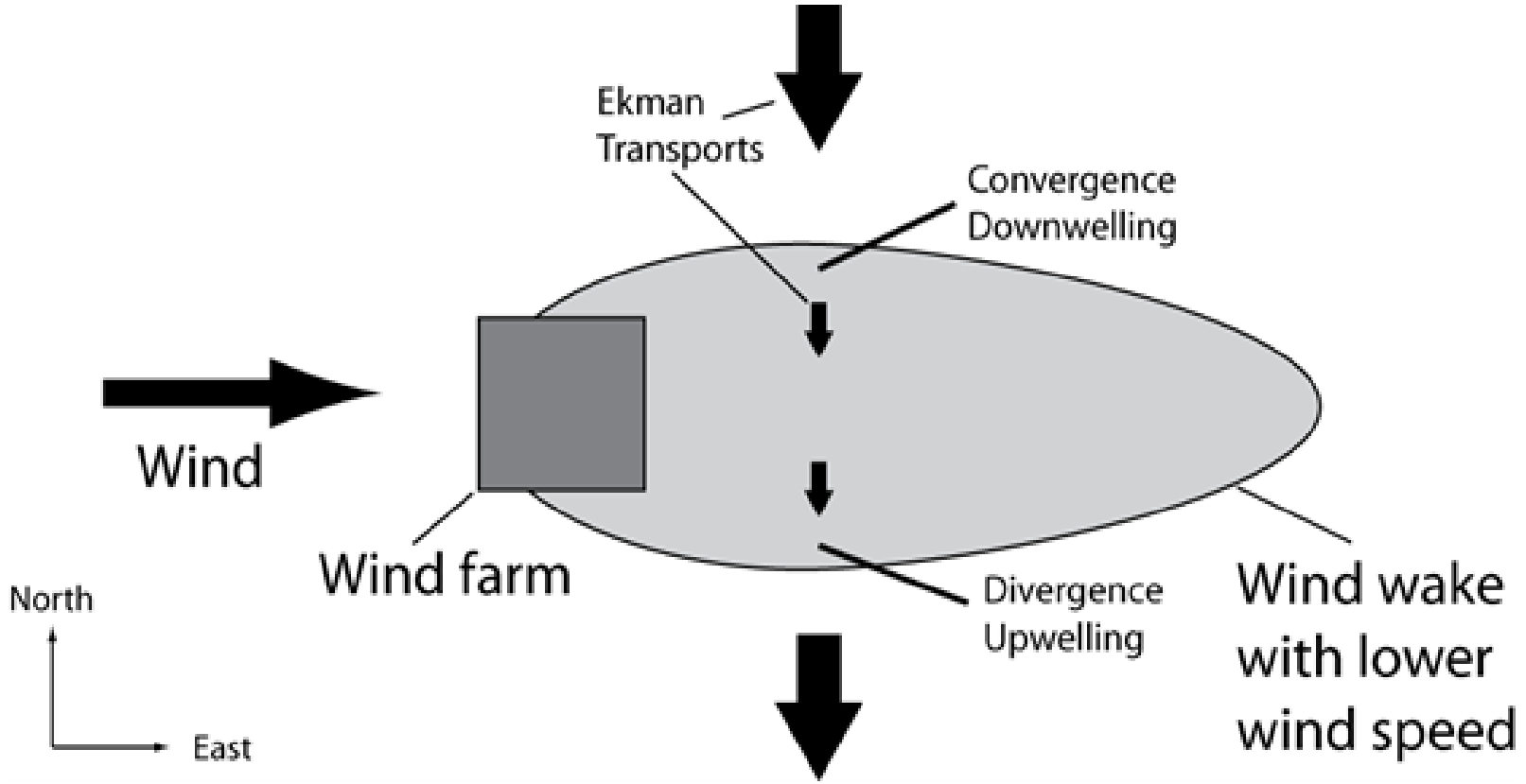




Carpenter et al 2016
Dorrell et al 2022

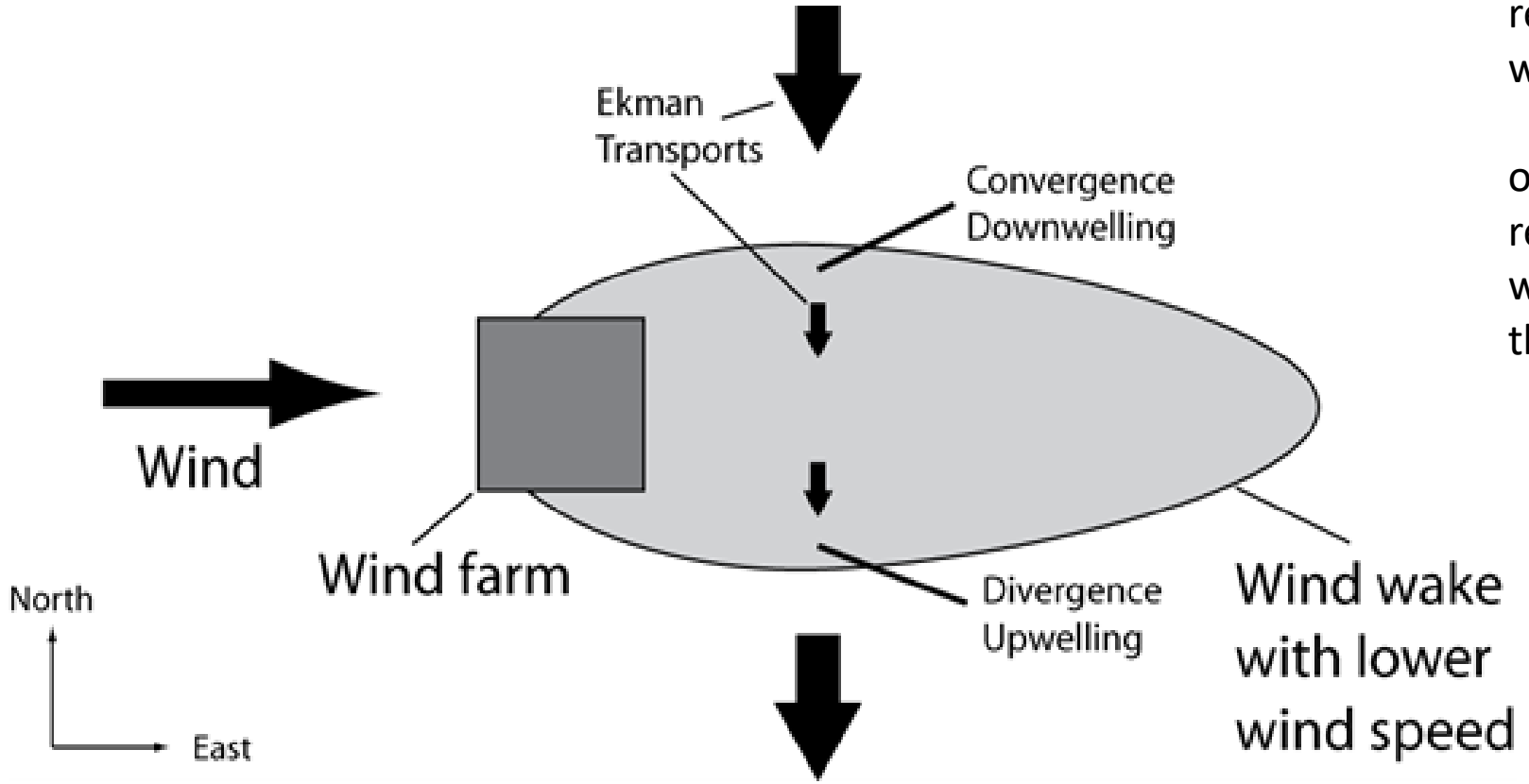
Dorrell et al 2022

Wind wake and ocean dynamics



Broström (2008)

Wind wake and ocean dynamics



Say, 20% reduction in wind speed,

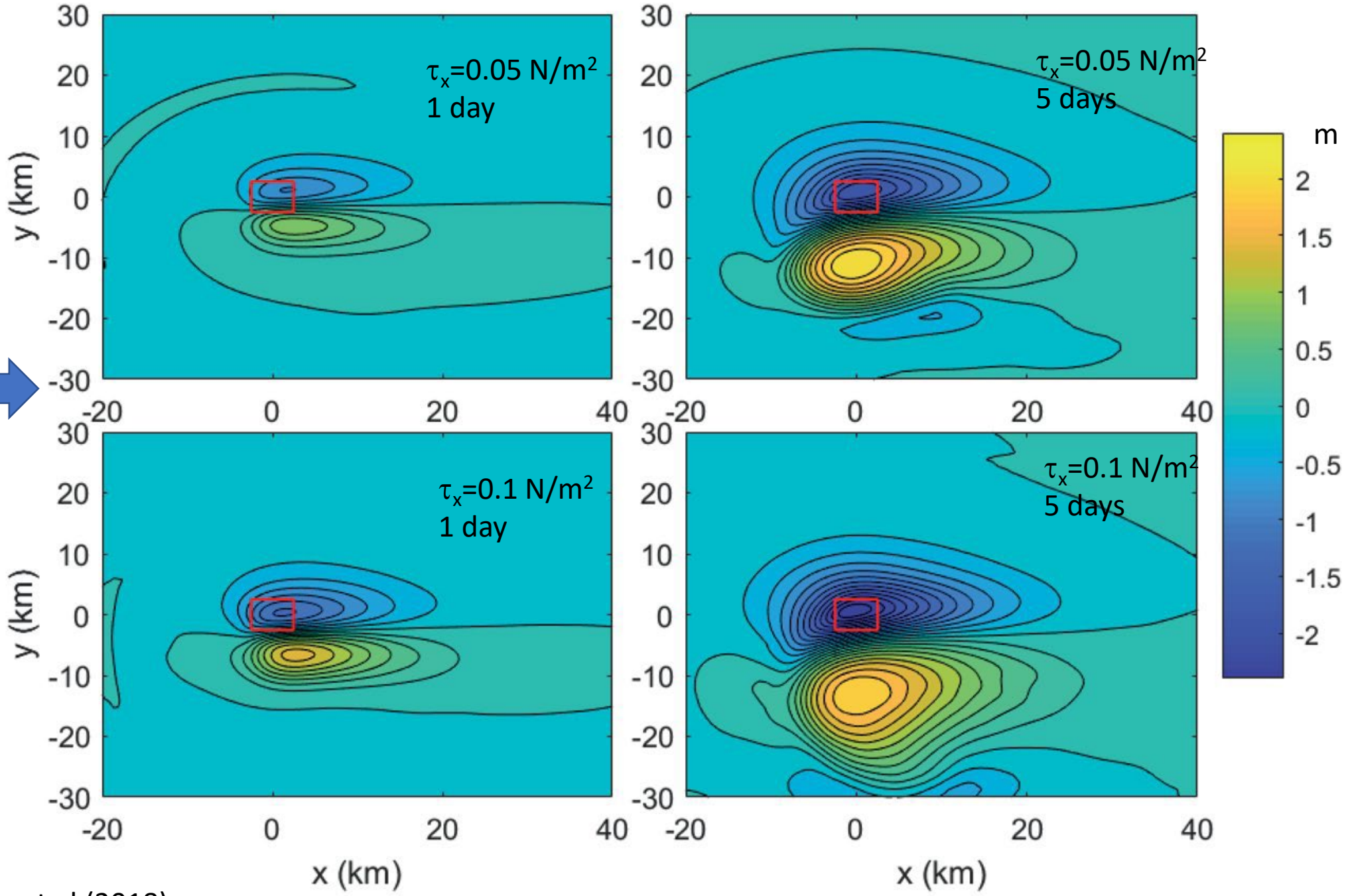
or 40% reduction in wind stress at the surface

Broström (2008)

Upwelling/ Downwelling dipole in idealized 3D model

Wind direction

Change in thermocline position



Broström (2008): Broström et al (2018).

Dipole dynamics
Barotropic case

Wind direction

Wind for 10 hours.
New wind after 240 hours.

Weak wind
Baroclinic case

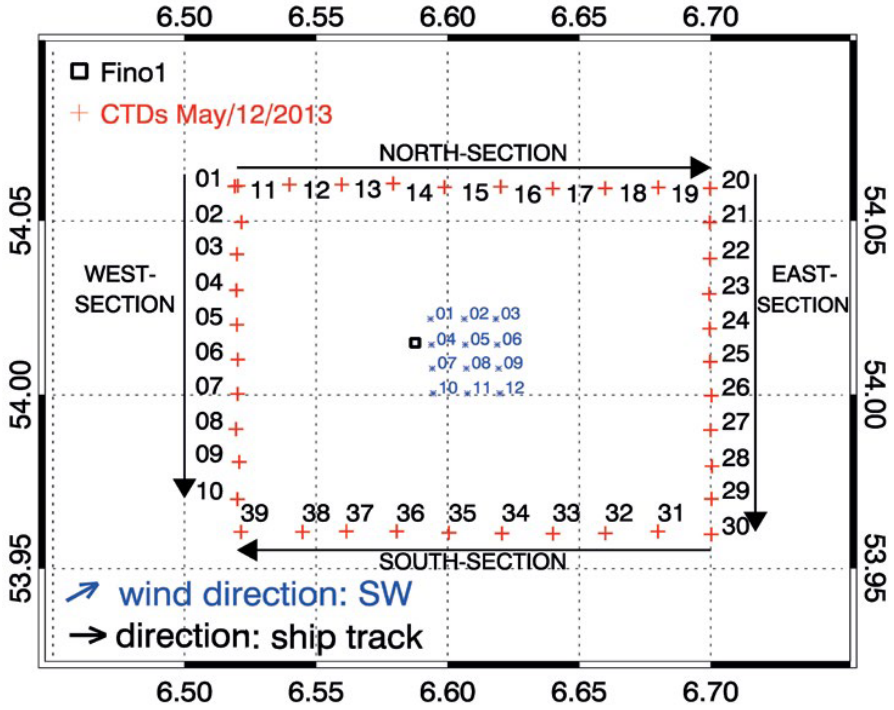
Wind direction

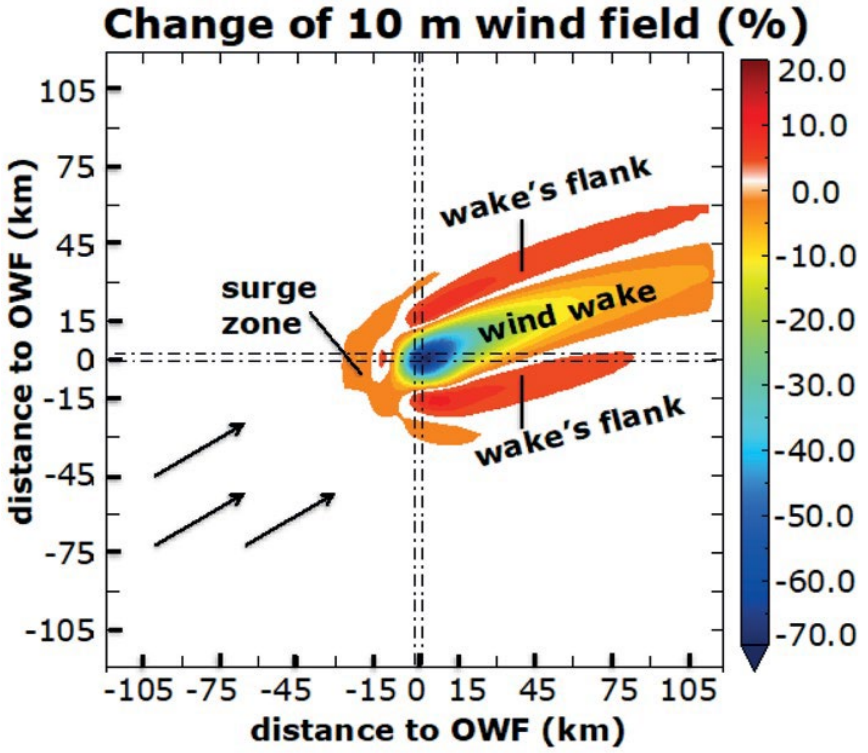
Change in ML depth

Strong wind
Baroclinic case

Wind direction

Change in ML depth





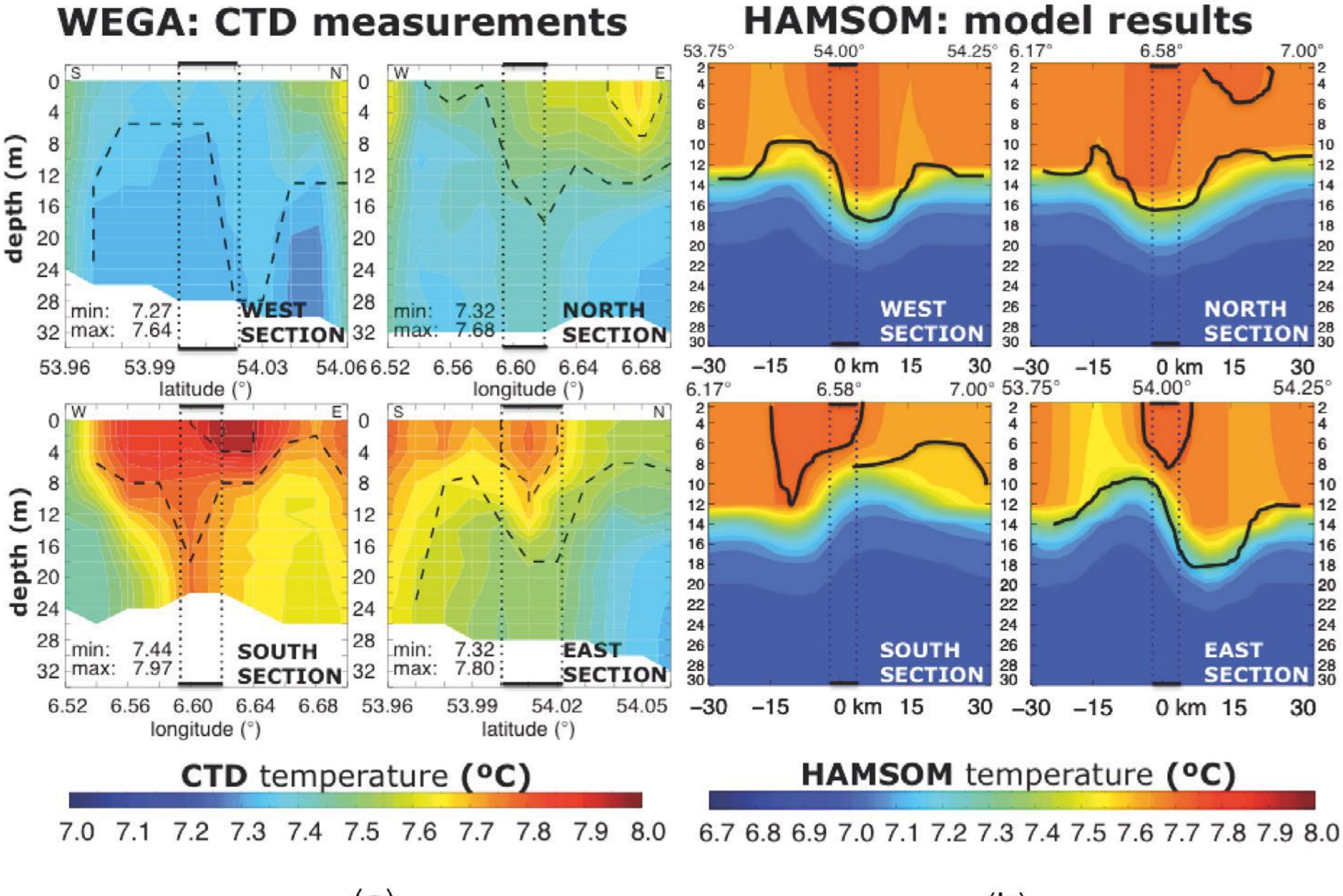
Broström,G. **Ludewig**, E., **Schneehorst**, A., Pohlmann, T. (2018)

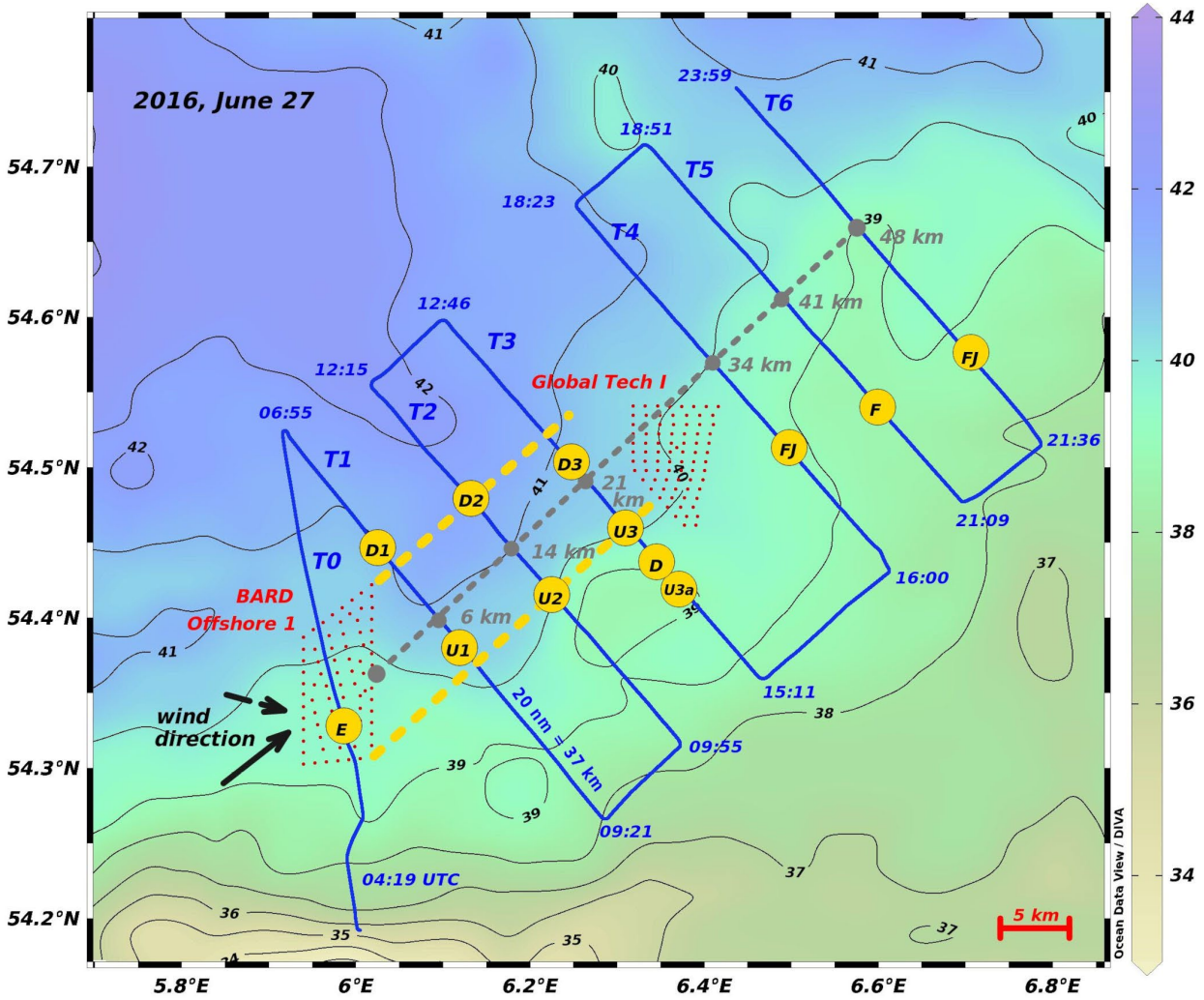
Observations

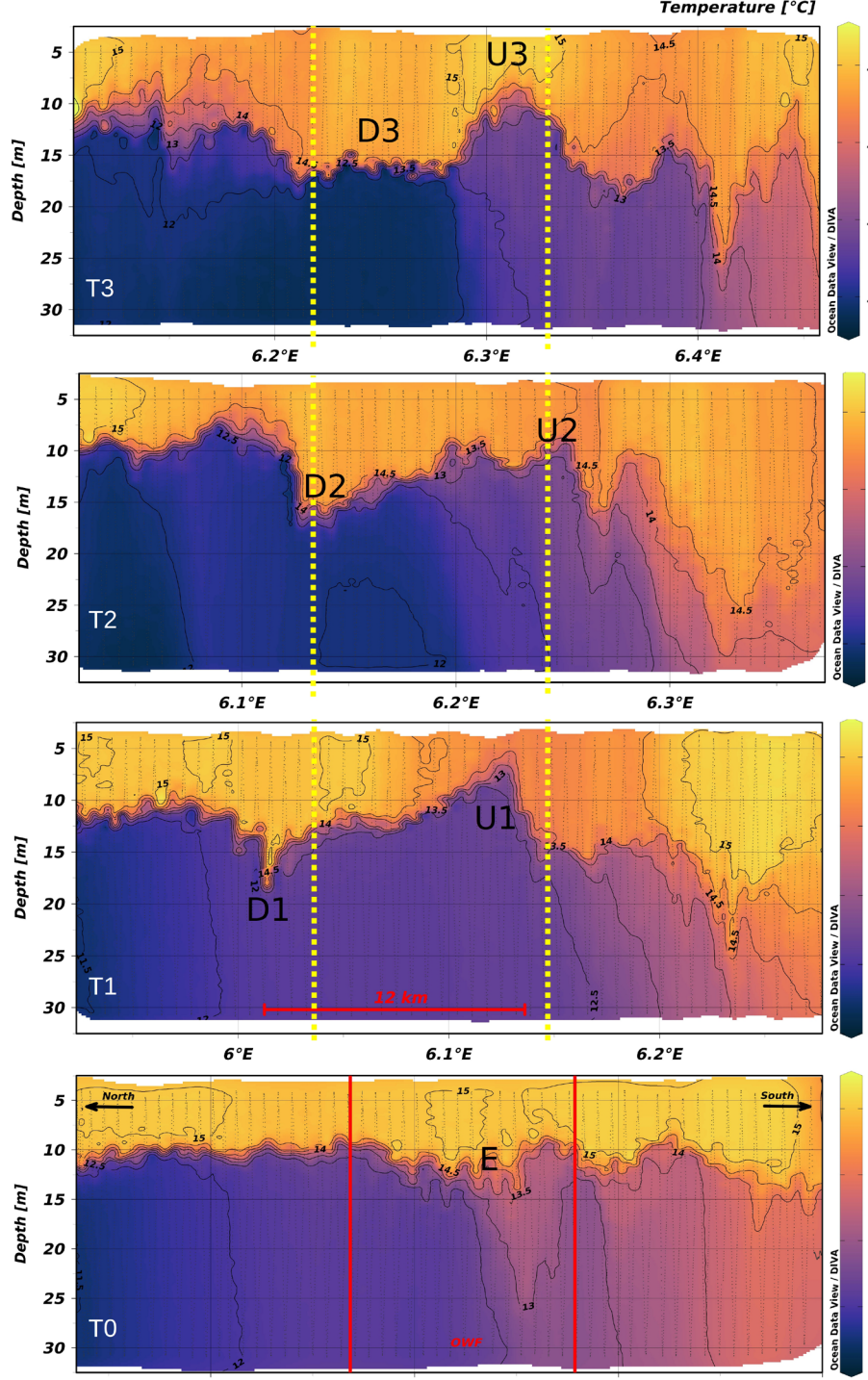
Broström,G.
Ludewig, E.,
Schneehorst, A.,
Pohlmann, T.
(2018)

Figure from my co-authors.

Alpha Ventus offshore wind farm

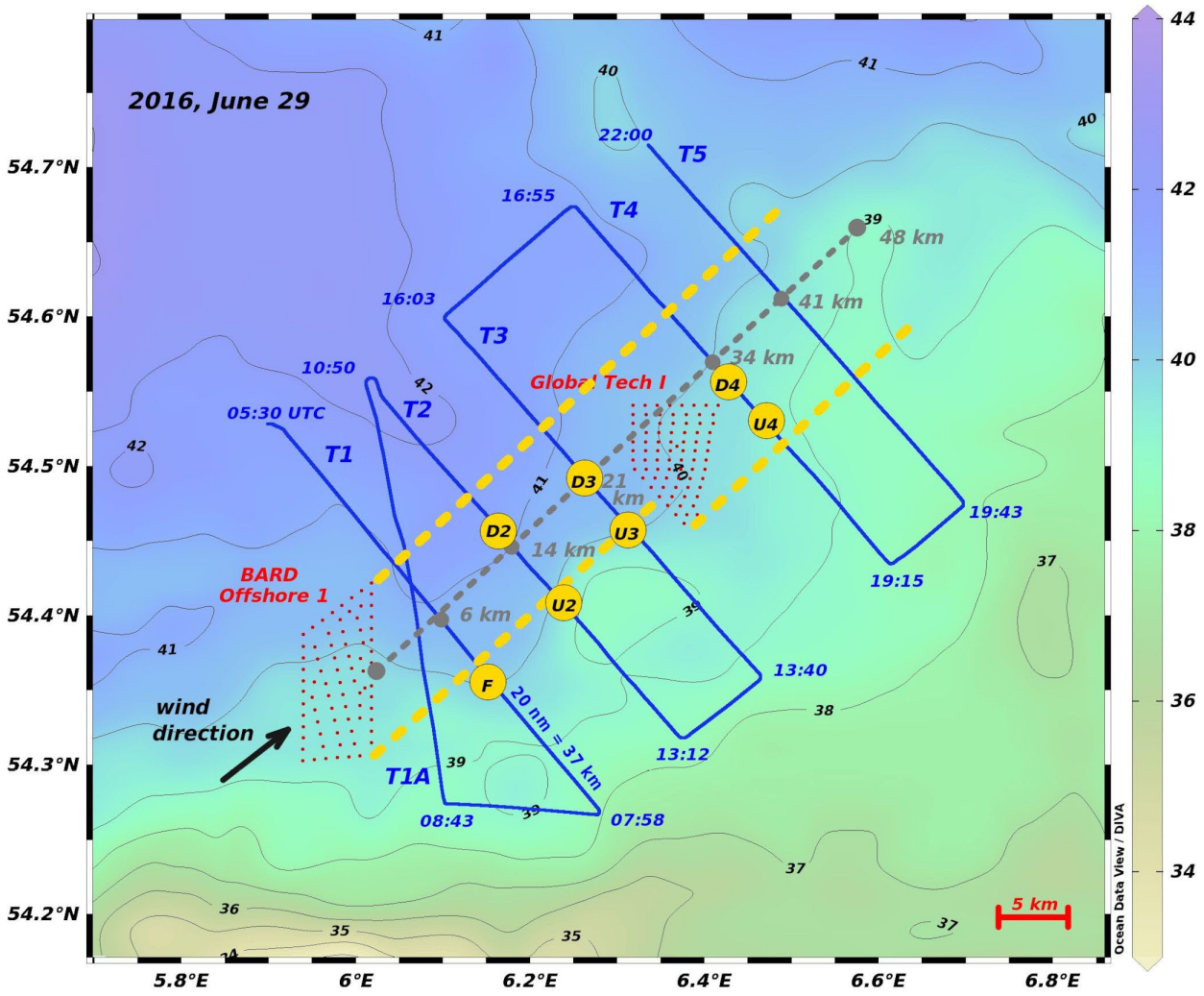


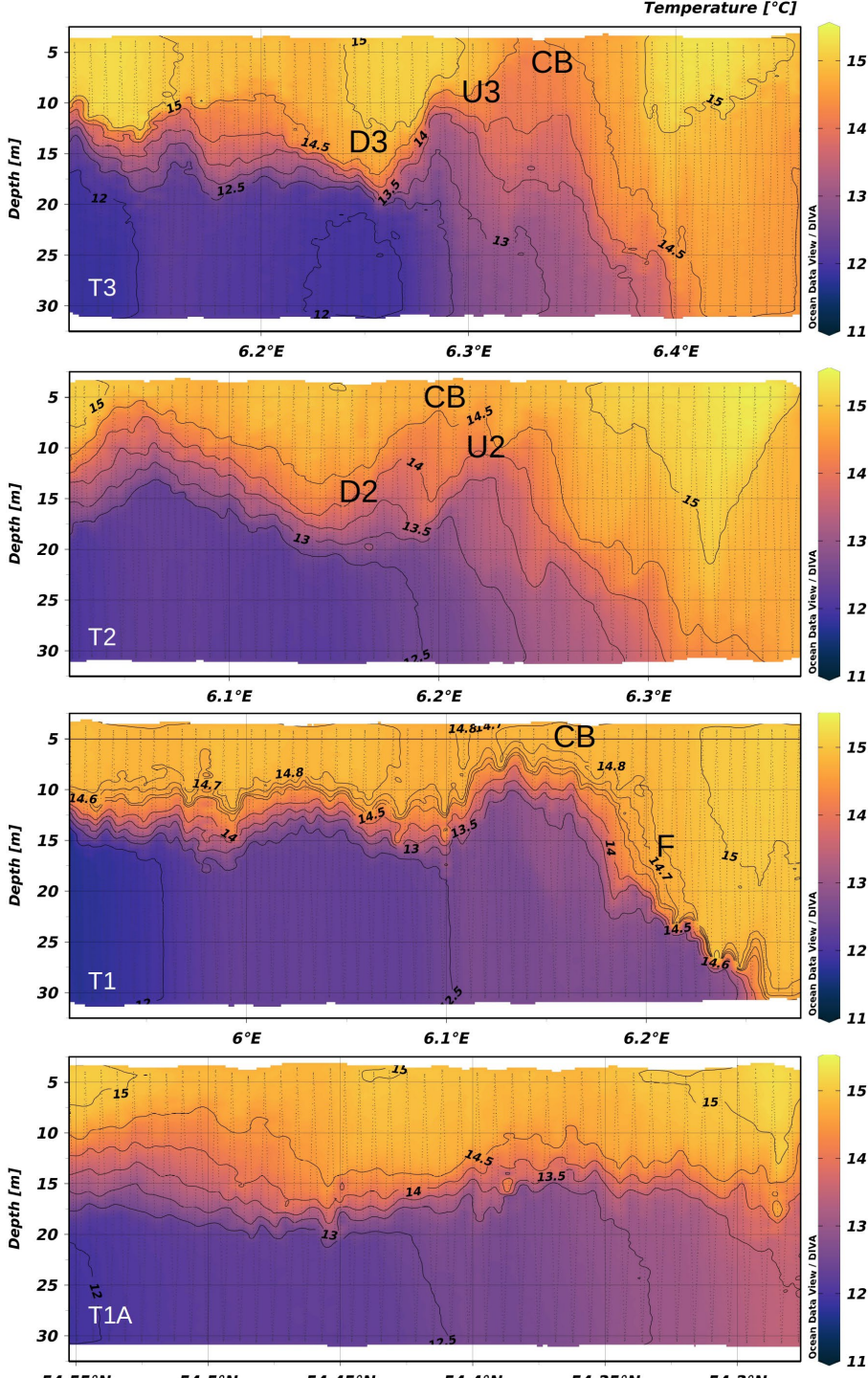




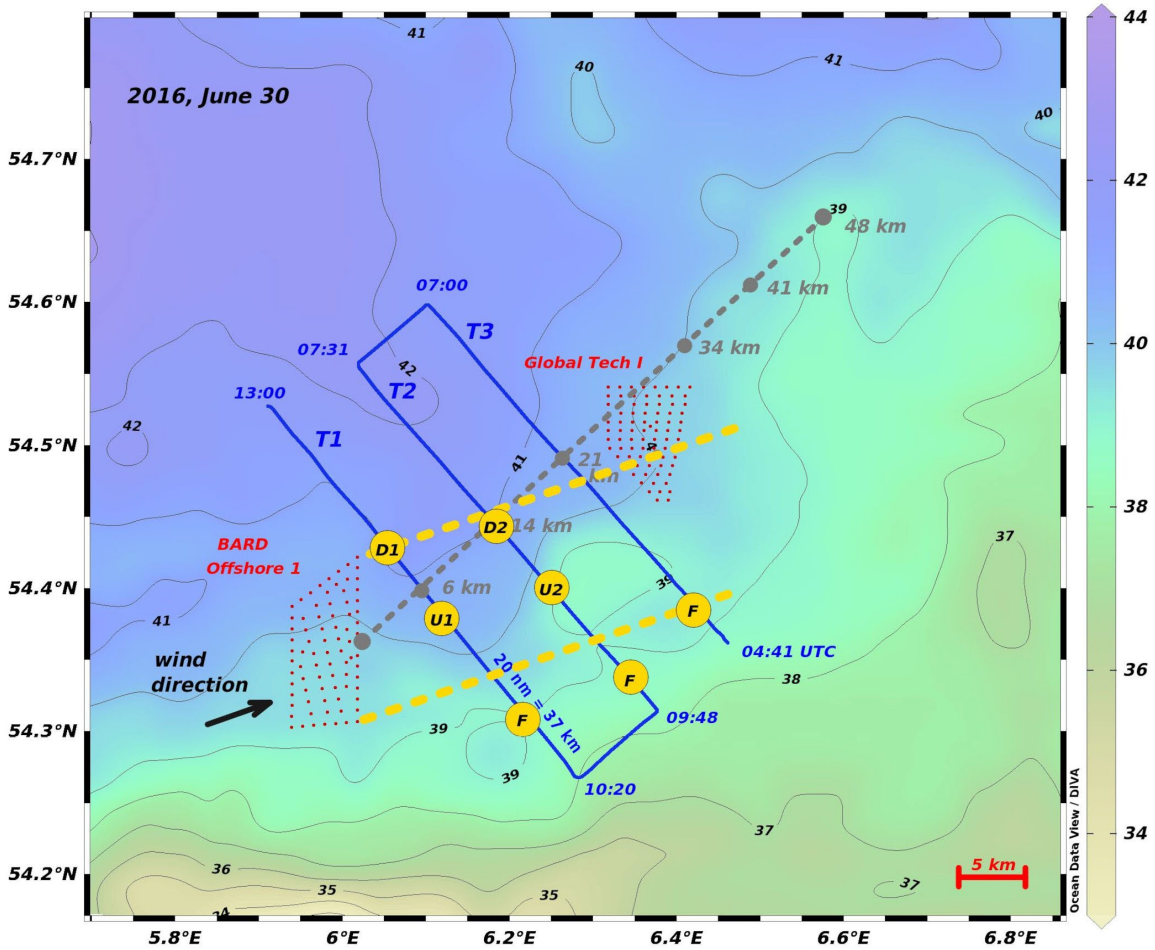
Floeter et al (2022)

The two OWFs that were surveyed, Global Tech I (GTI) and BARD Offshore 1 (BARD), are located at a water depth of around 40 m in the German EEZ, and a distance of approximately 100 km offshore.

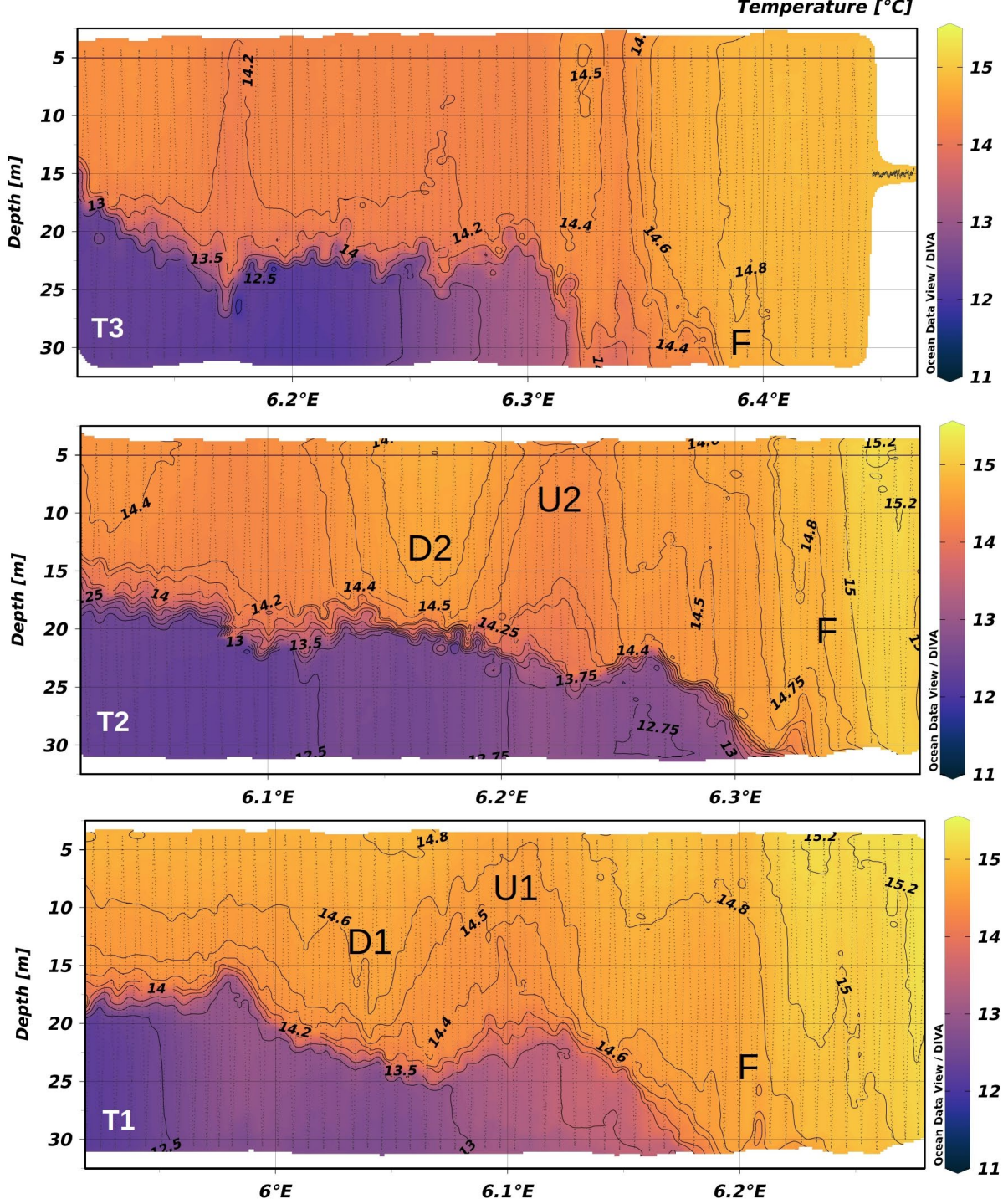




Floeter et al (2022)



Floeter et al (2022)



Models evaluating impact

- Christiansen, N., Daewel, U., Djath, B., & Schrum, C. (2022). Emergence of large-scale hydrodynamic structures due to atmospheric offshore wind farm wakes. Frontiers in Marine Science, 64.
- Daewel, U., Akhtar, N., Christiansen, N., & Schrum, C. (2022). Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the North Sea. Communications Earth & Environment, 3(1), 292.
- Raghukumar, K., Nelson, T., Jacox, M., Chartrand, C., Fiechter, J., Chang, G., ... & Roberts, J. (2023). Projected cross-shore changes in upwelling induced by offshore wind farm development along the California coast. Communications Earth & Environment, 4(1), 116.

A few days old.

There seems to be **no** evaluation of hydrodynamic impact (and how changes in hydrodynamics impact on environment).

Commercial and Research Wind Lease and Grant Issuance and Site Assessment Activities on the Outer Continental Shelf of the Gulf of Mexico

Final Environmental Assessment

Final comments

- Wind wake will create a up- down-welling dipole
  - It is well anchored in theory
  - Seems to be observed
  - Not so easy to detect, why??

- Modelling studies indicate it changes natural environment (Ute Daewel presentation)
  - Say 10-20% for productivity
  - Area signficant larger that OWF area

- The solid structures can also be important
  - Increased mixing
  - Growth of mussles, and transport of organic material to bottom
  - For organisms connectivity, e.g. oil plattforms in North Sea are probably important for connectivity of e.g. *Lophelia Pertusa* (cold water coral)

- Are wind wake upwelling and mixing from fundaments the largest (known) unknowns regarding environental impacts?