

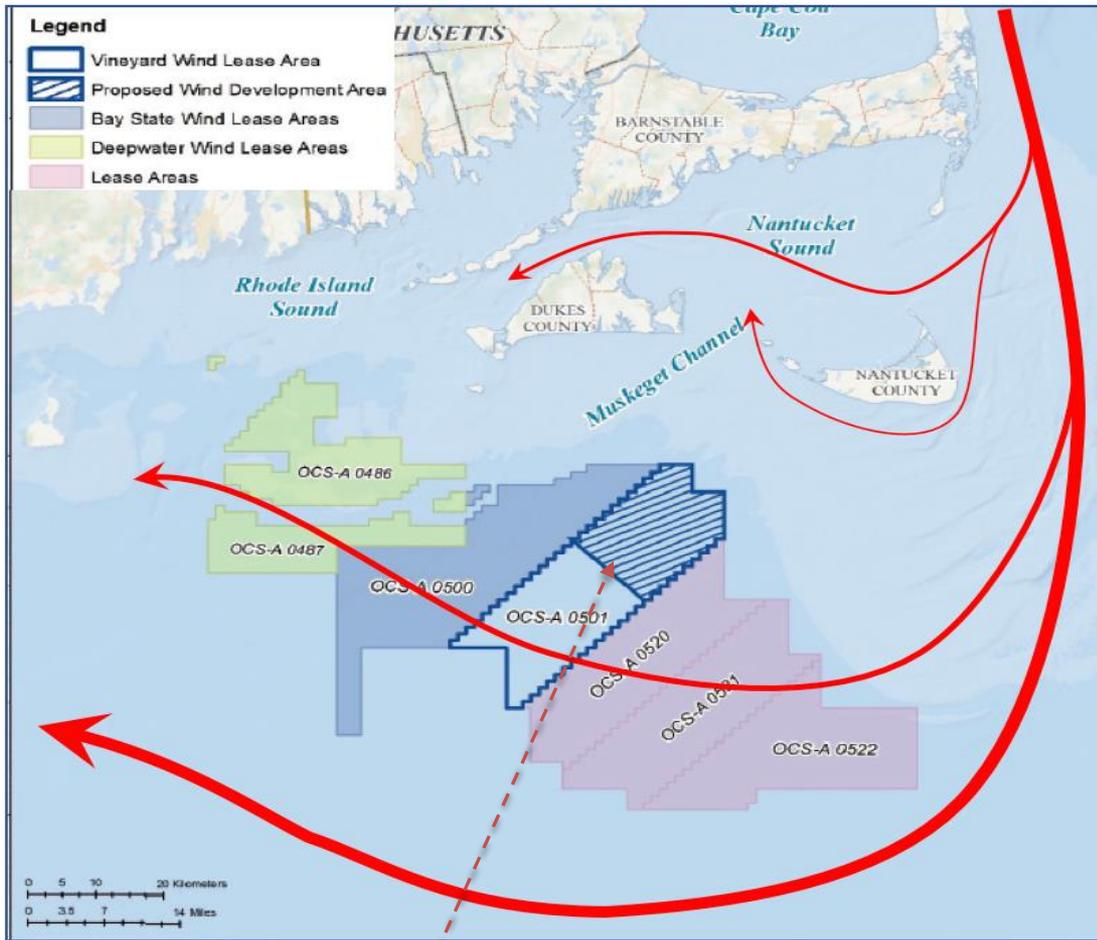
Assessing Potential Impacts of Offshore Wind Facilities on Regional Sea Scallop Larval and Early Juvenile Transports

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School for Marine Science and Technology
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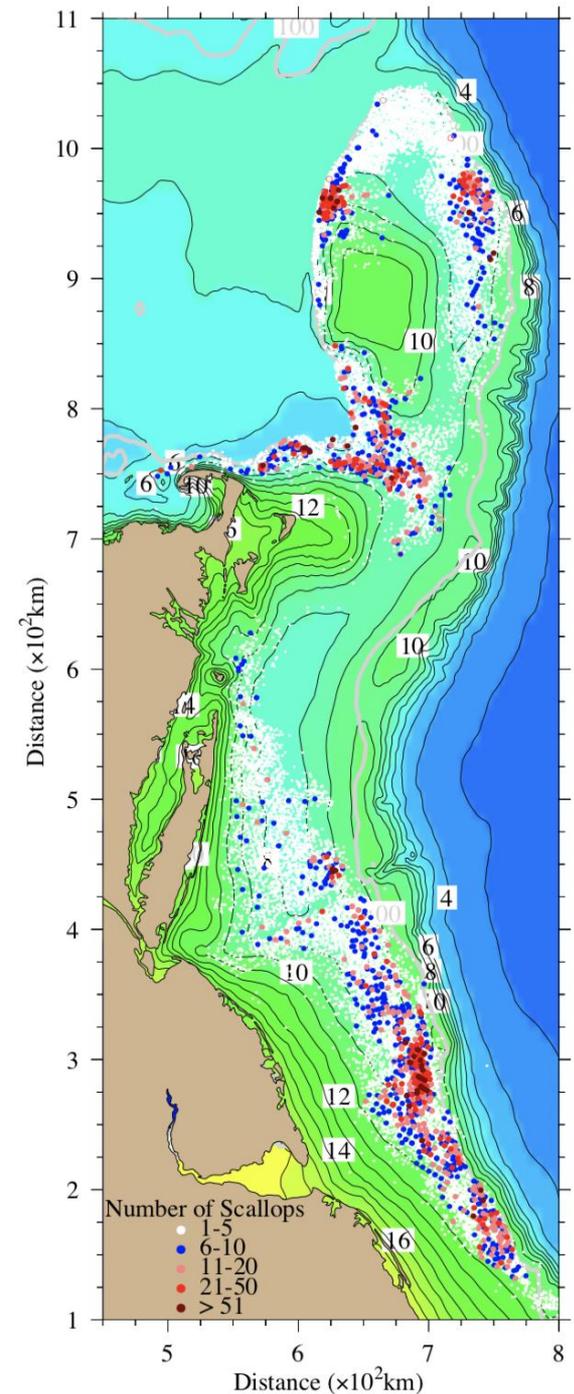
Scott Gallager and Robert C Beardsley
Woods Hole Oceanographic Institution, Woods Hole, MA 02543

NOAA Grant Number: NA19NMF450023

Could the offshore wind renewal energy developmen affect the connectivity of scallop between George Bank/South South Channel and Mid-Atlantic Bight?



Vineyard Wind Leased Area: OCS-A-0501

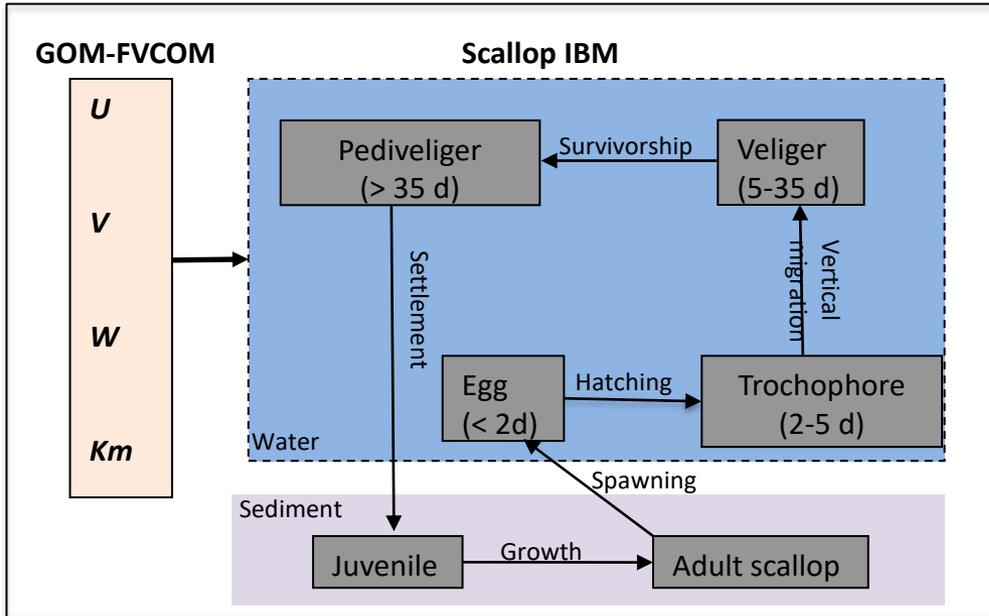


Objectives

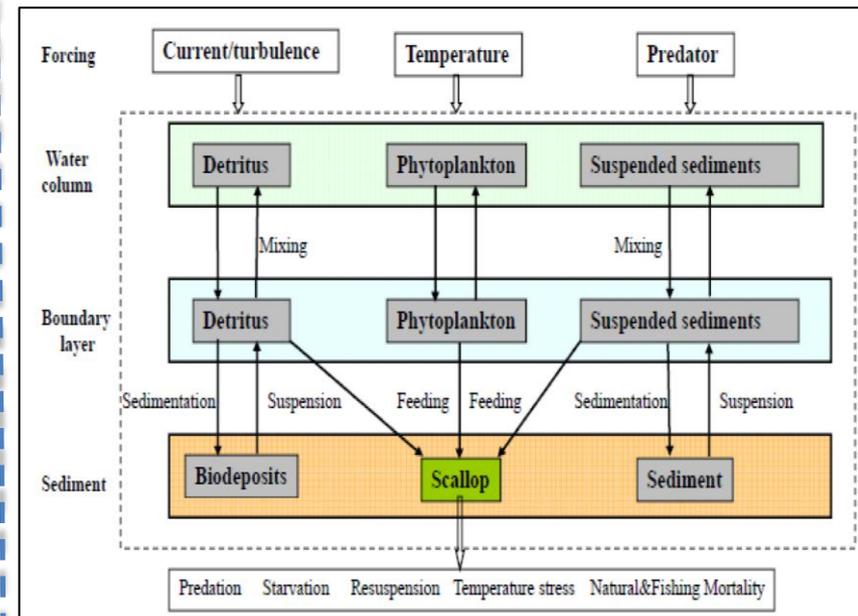
- Couple the scallop-IBM model with a high-resolution (up to ~1.0 m), wind turbine-resolving subdomain FVCOM ocean model under the framework of NECOFS (NS-FVCOM-scallop-IBM);
- Identify years which show the connectivity of sea scallop population between Georges Bank/Great South Channel and New England shelf as well as Mid-Atlantic Bight through the scallop-IBM experiments for 1978-2016;
- Repeat the scallop-IBM experiments for those years under the 3-D physical fields from NS-FVCOM for the cases with and without inclusion of wind turbines;
- Conduct sensitivity analysis of larval transport/dispersion, subsequent recruitment and connectivity between regions (e.g., GB to MAB) to the offshore wind turbine development as spawning patterns/locations and intensities change on the upstream GB and GSC;
- Repeat the above experiments with different designs of offshore wind turbine development

Sea Scallop Individual-Based Model (Scallop-IBM)

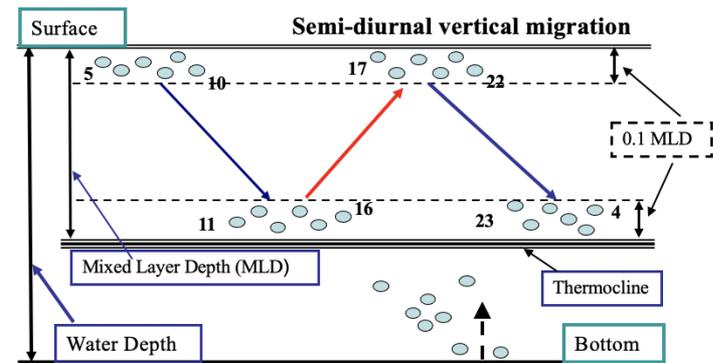
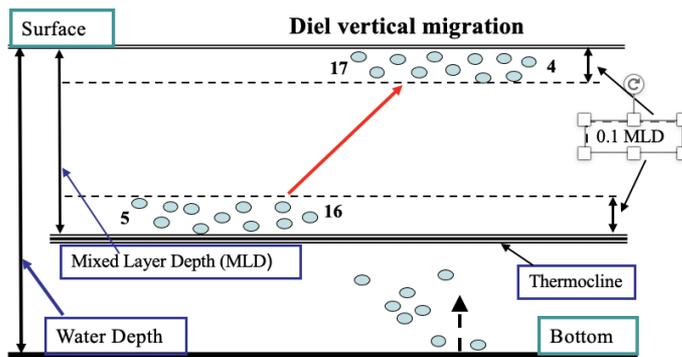
Four pelagic stages:
Egg, trochophore, veliger, and pediveliger



Two benthic stages: Juvenile, and adult

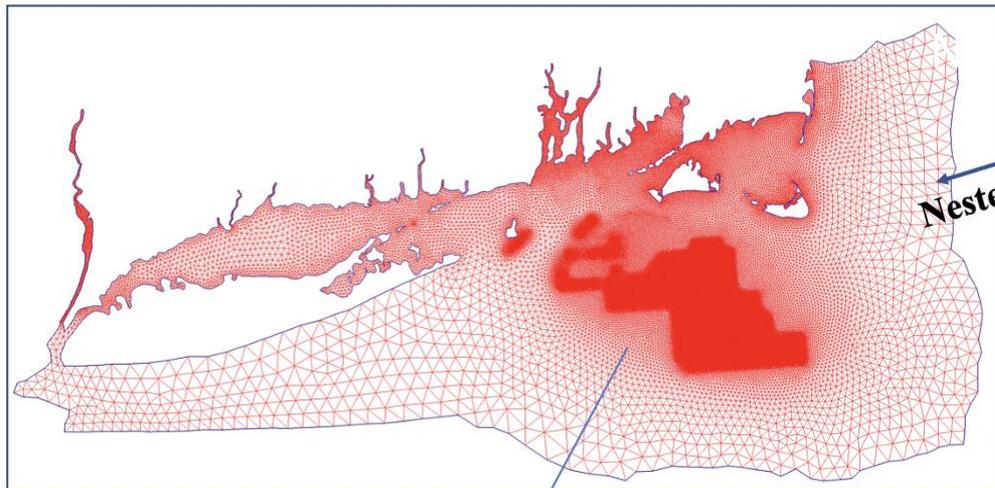


Vertical migration in the ocean mixed layer

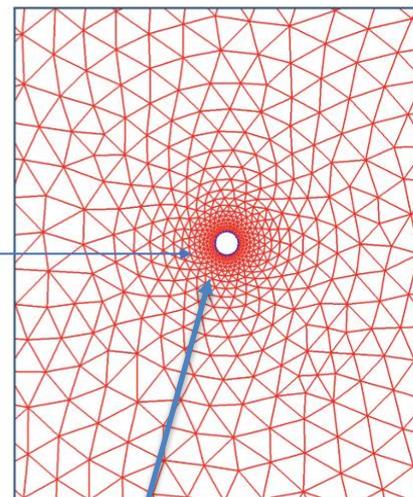
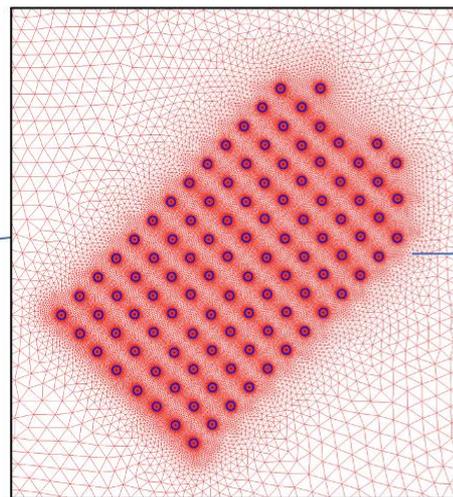
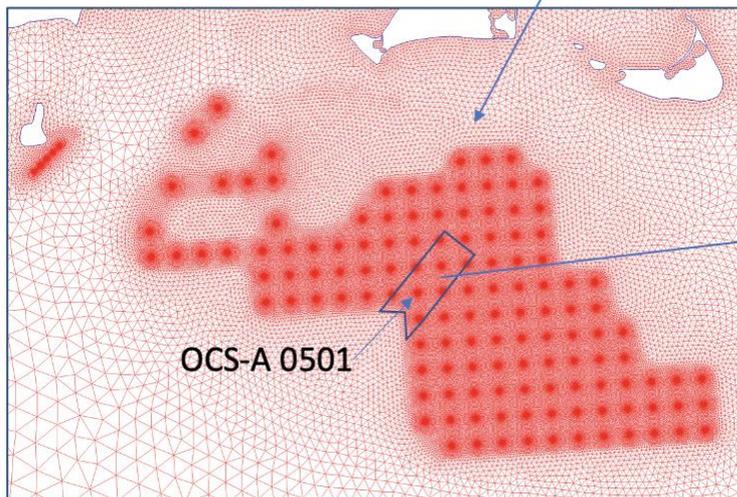
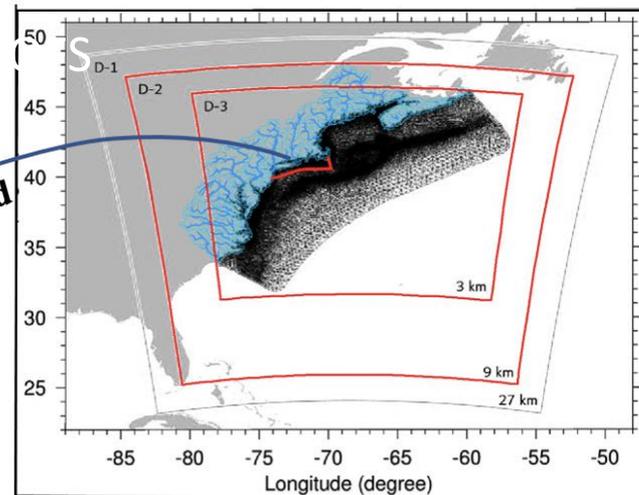


A Nested Subdomain Wind Turbine-resolving FVCOM (NS-FVCOM)-NECOFS System

NS-FVCOM

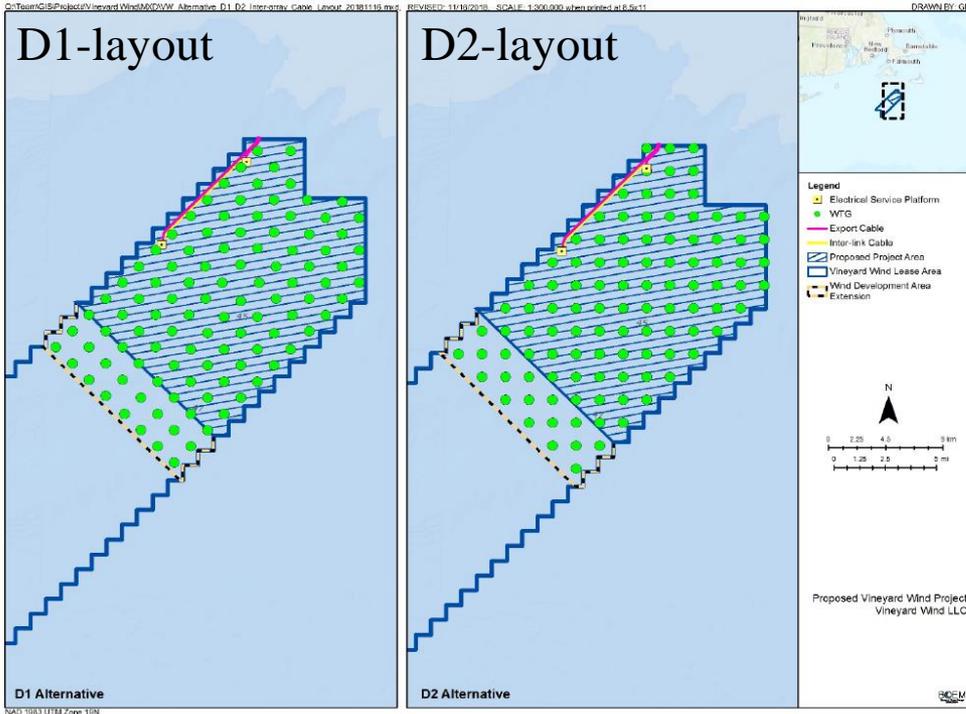


NECOFS

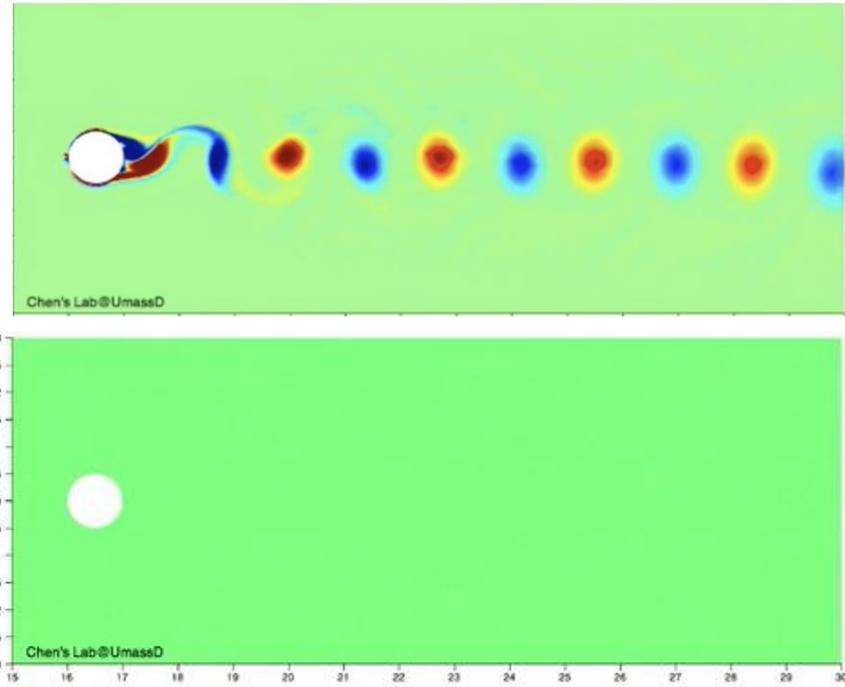


~1.0 m resolution

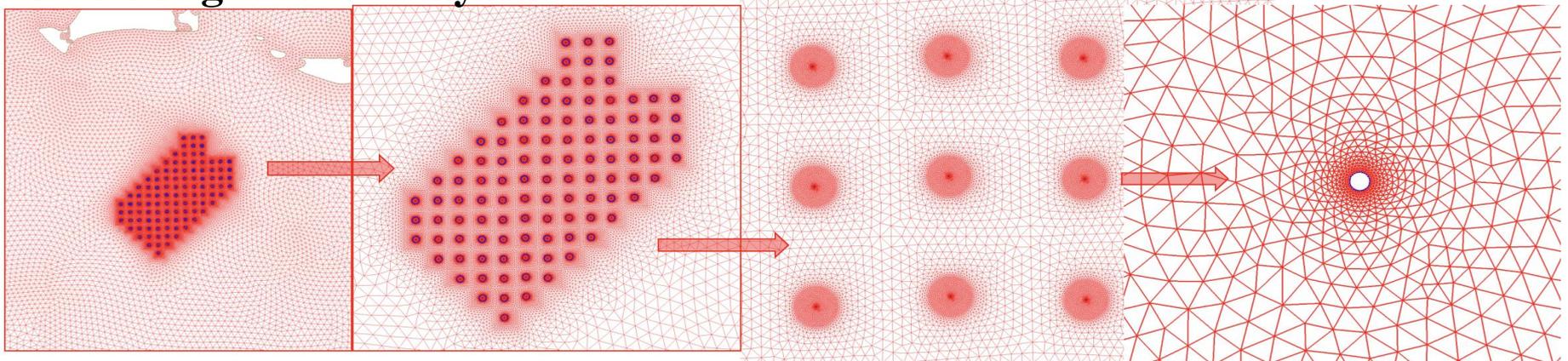
Vineyard Wind proposed two alternative layouts (D1 and D2)



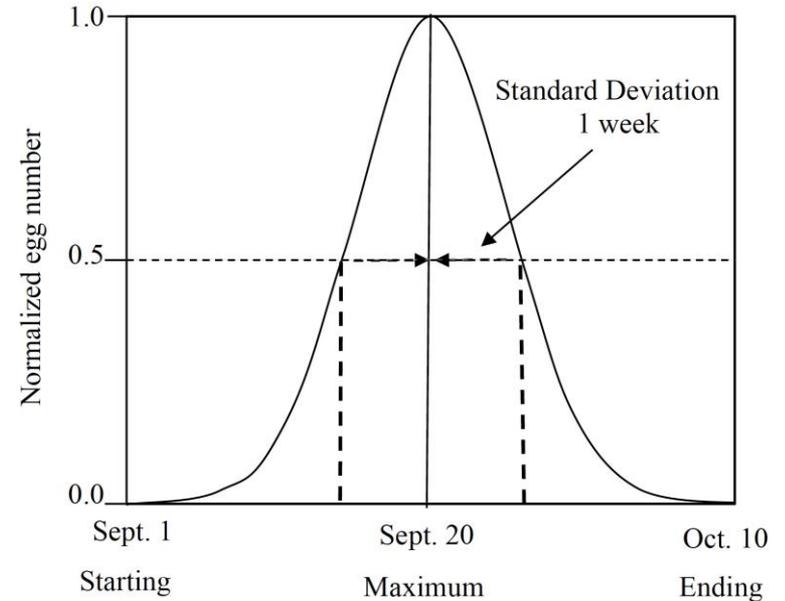
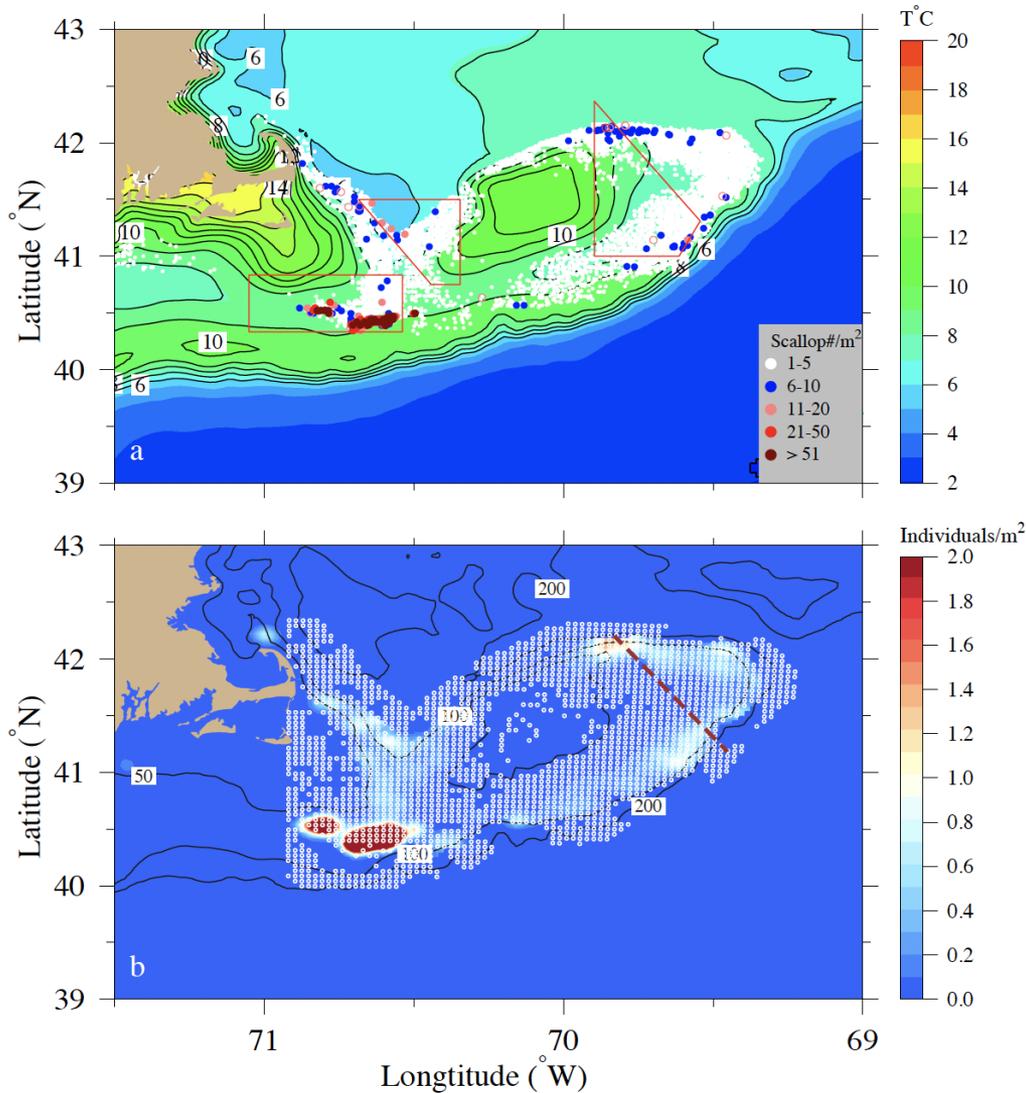
Vortex Wake



Grid designs for D2-layout

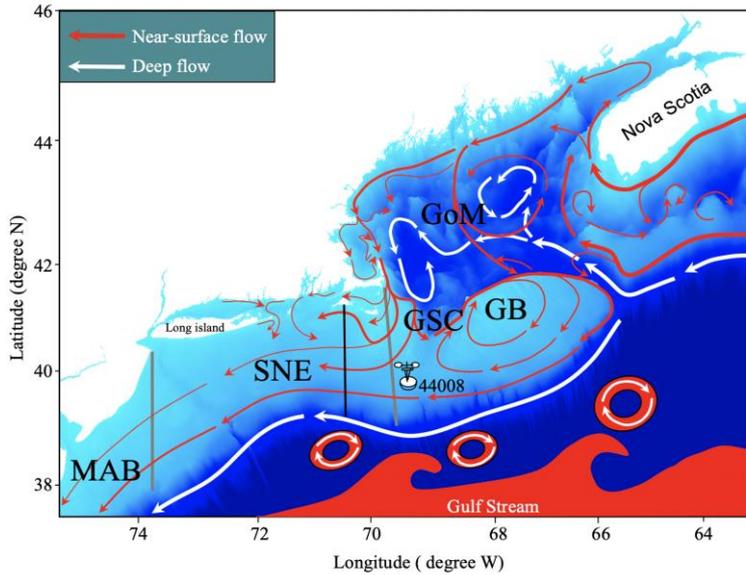


A 39-year scallop-IBM simulation (1978-2016)



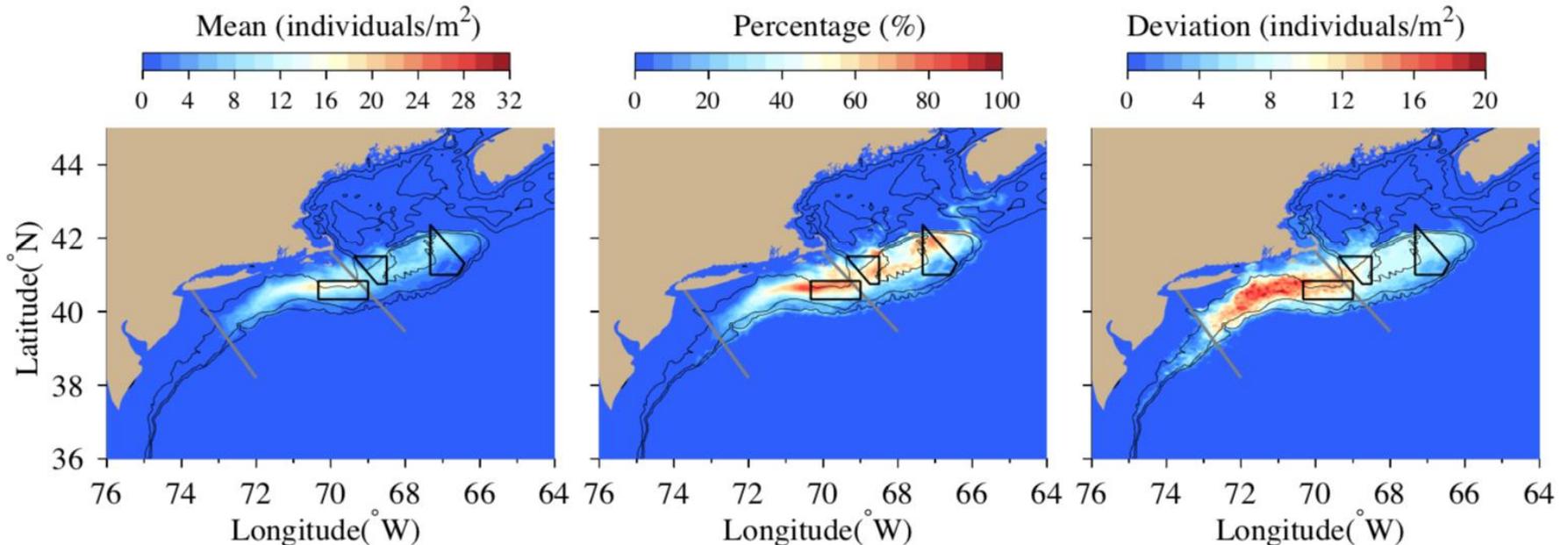
Spawning stocks determined by interpolating scallop abundance data onto the model grids. Scallop data were from NOAA, SMAST/UMASSD, BIO-Canada

39-year simulation results of scallop larval dispersion and settlement

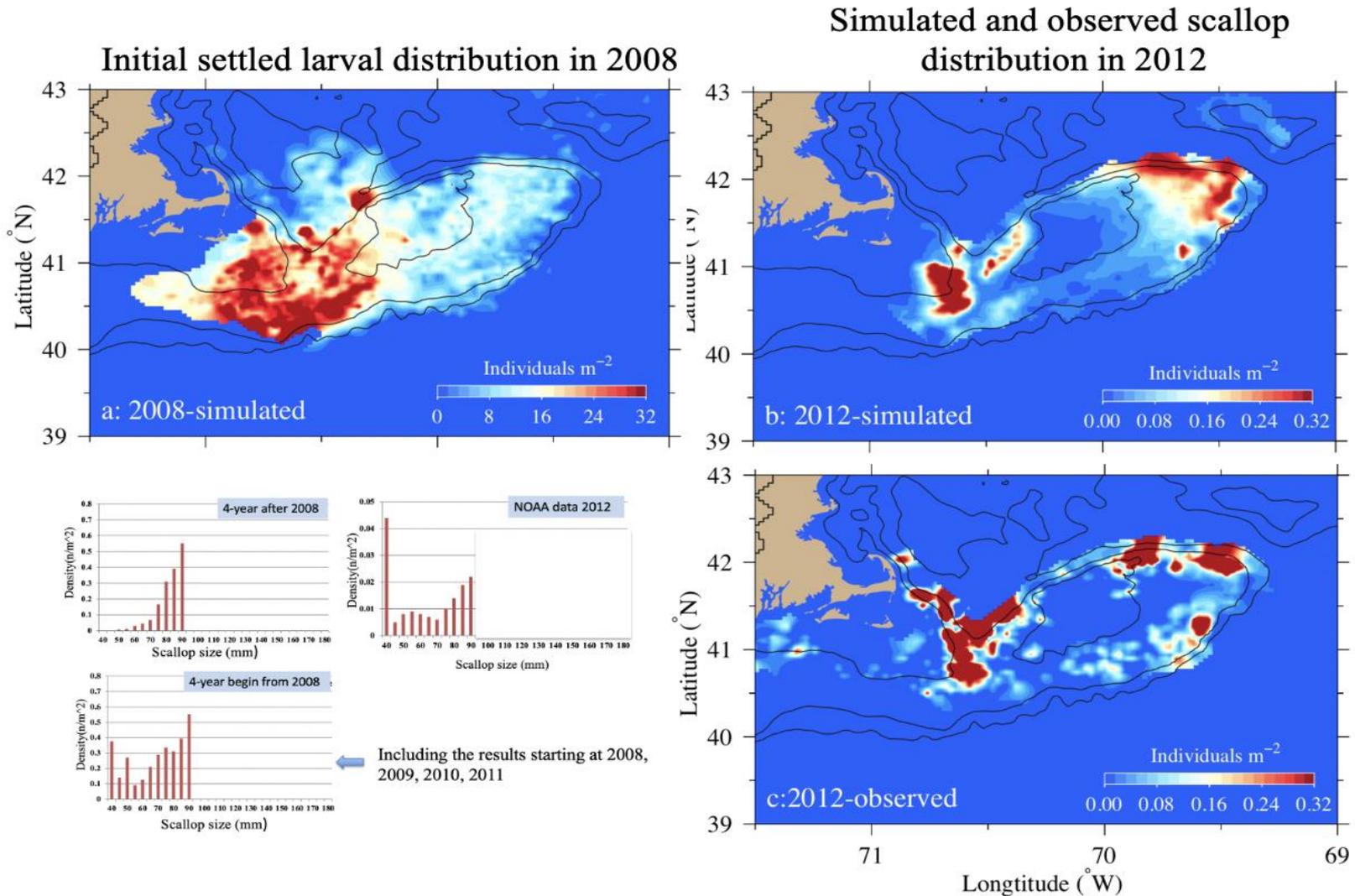


The 39-year (1978-2016) Scallop-IBM results show that Regardless of whether larval swimming behaviors in the OML were considered, the Southern New England (SNE) shelf is a region featuring a maximum scallop larval interannual variability (*Chen et al., 2021*).

Swimming-enssembled larval distributions

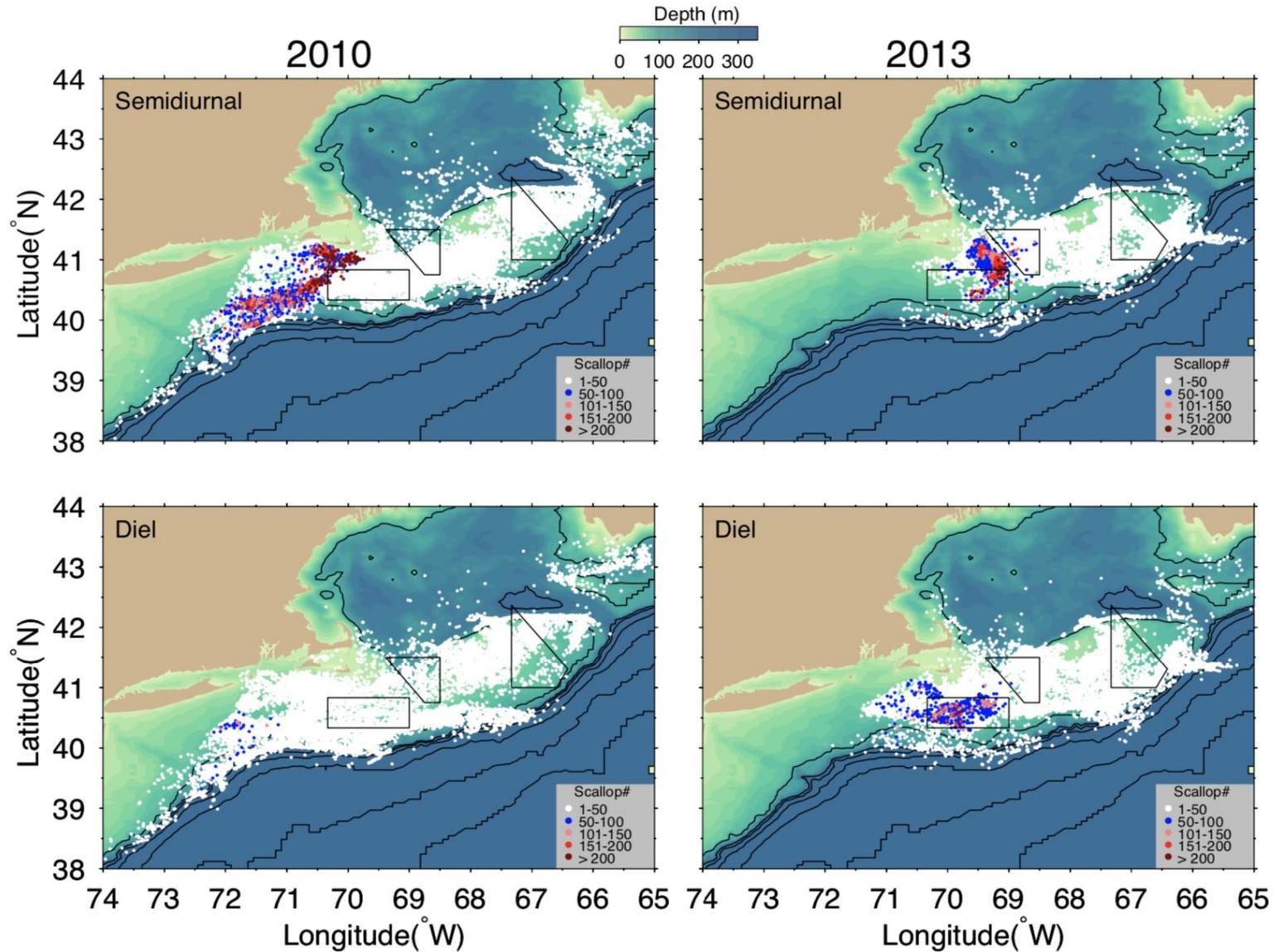


An example of the benthic model experiment results

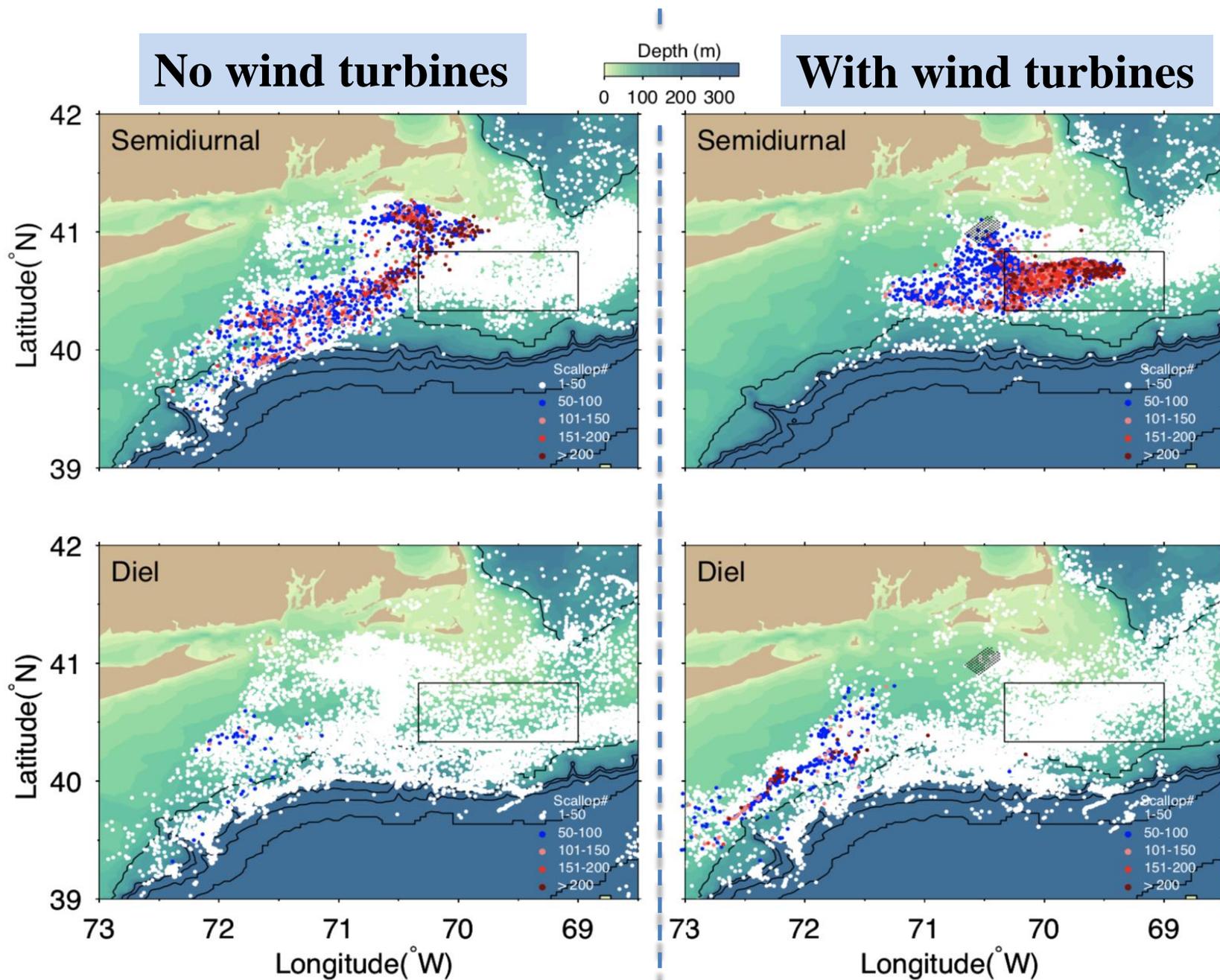


Note: Comparison was made only with the NOAA data, SMAST/Canadian data are still under processing status

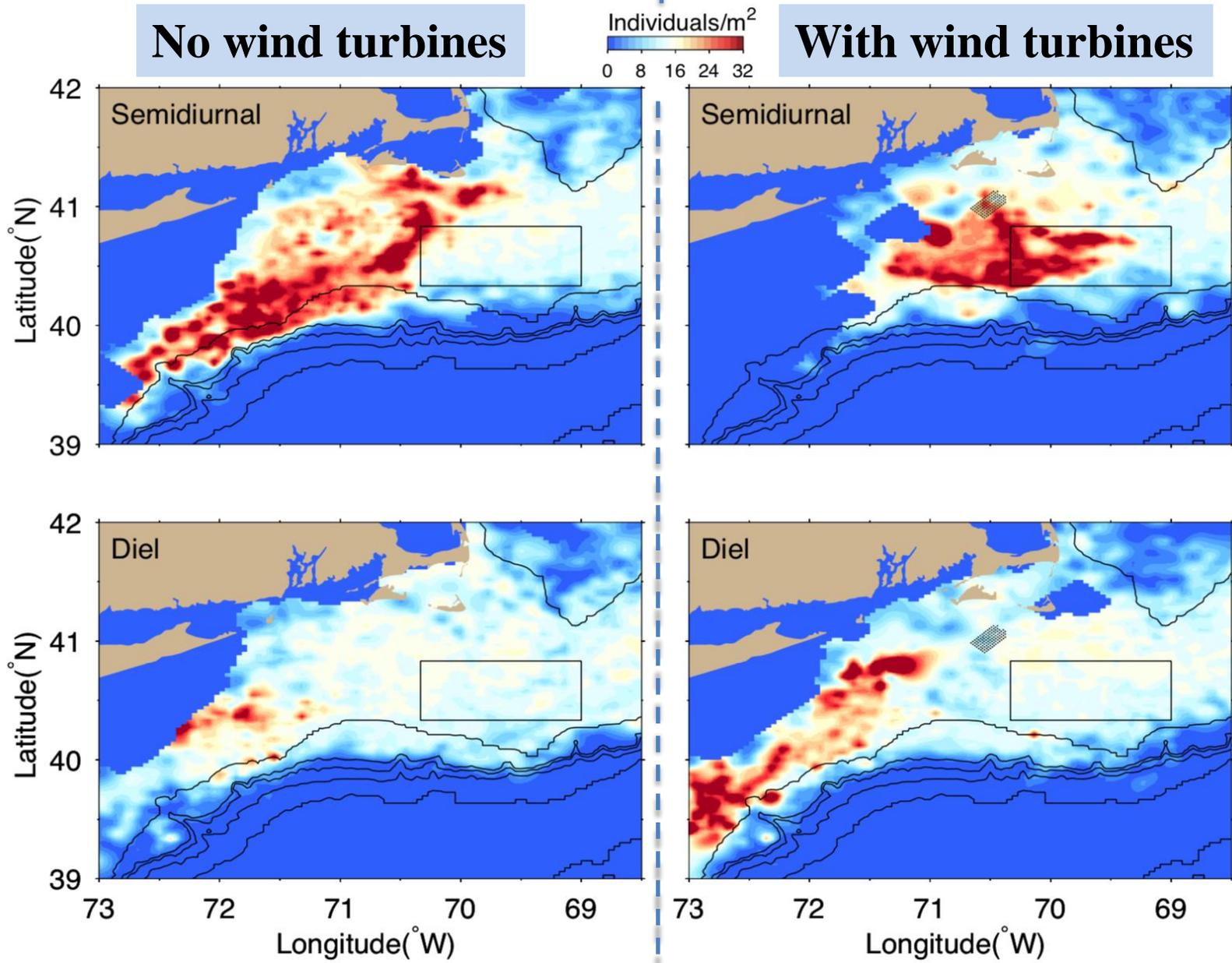
Year selections for pilot experiments with NS-FVCOM/NECOFS-Scallop-IBM



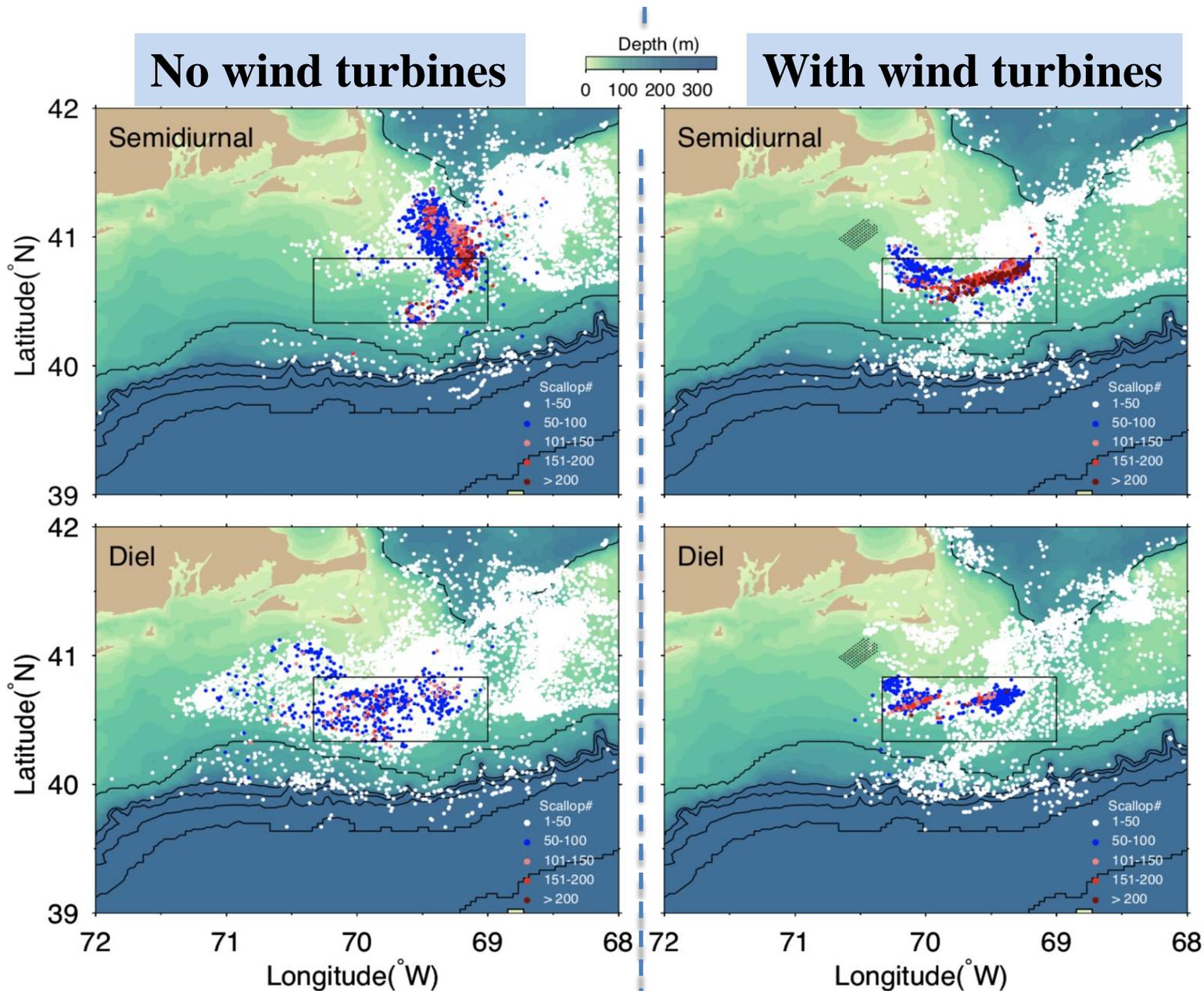
Year 2010 experiment: super-individual settling locations



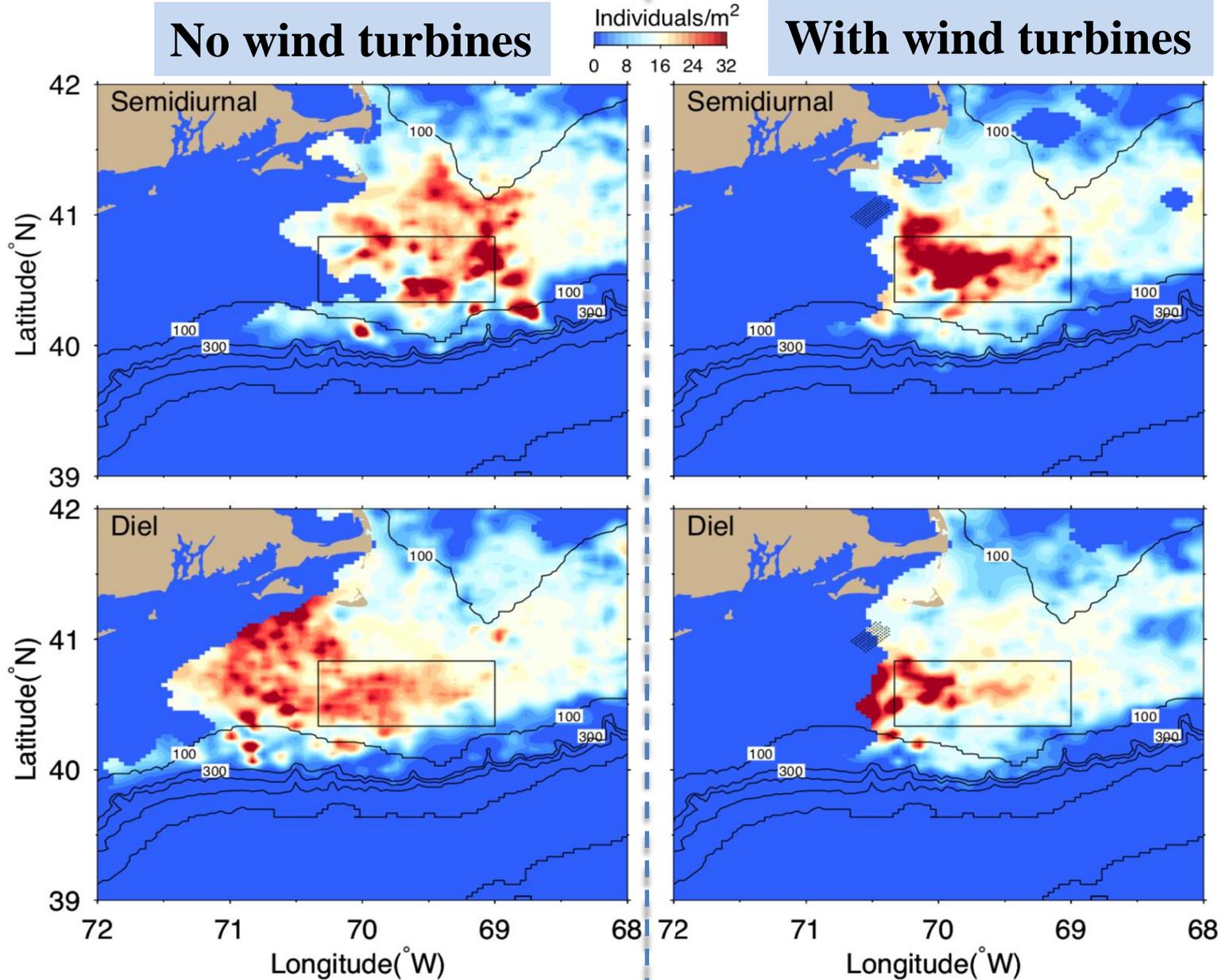
Year 2010 experiment: scallop larval density distributions



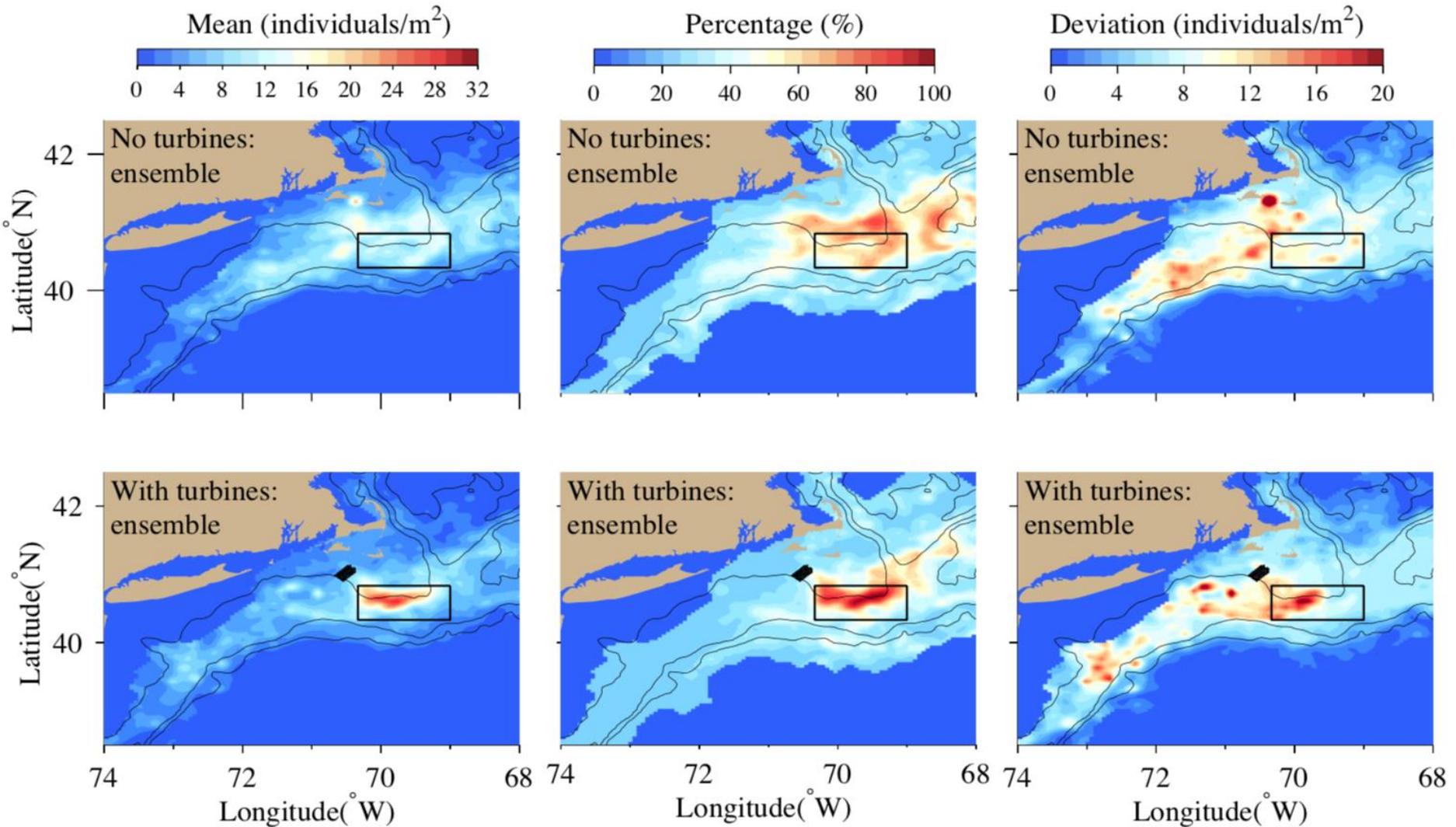
Year 2013 experiment: super-individual settling locations



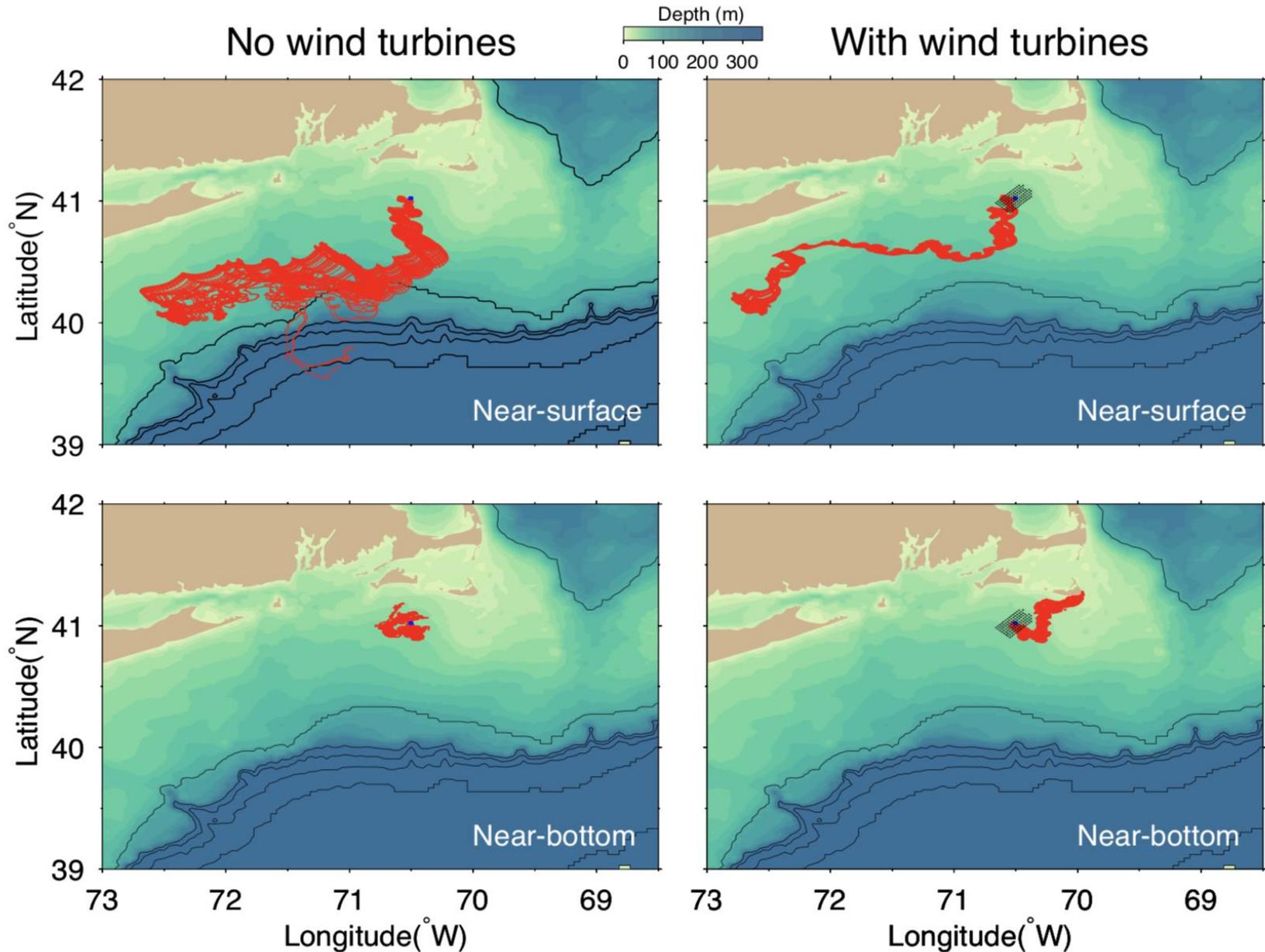
Year 2013 experiment: Scallop Larval density distributions



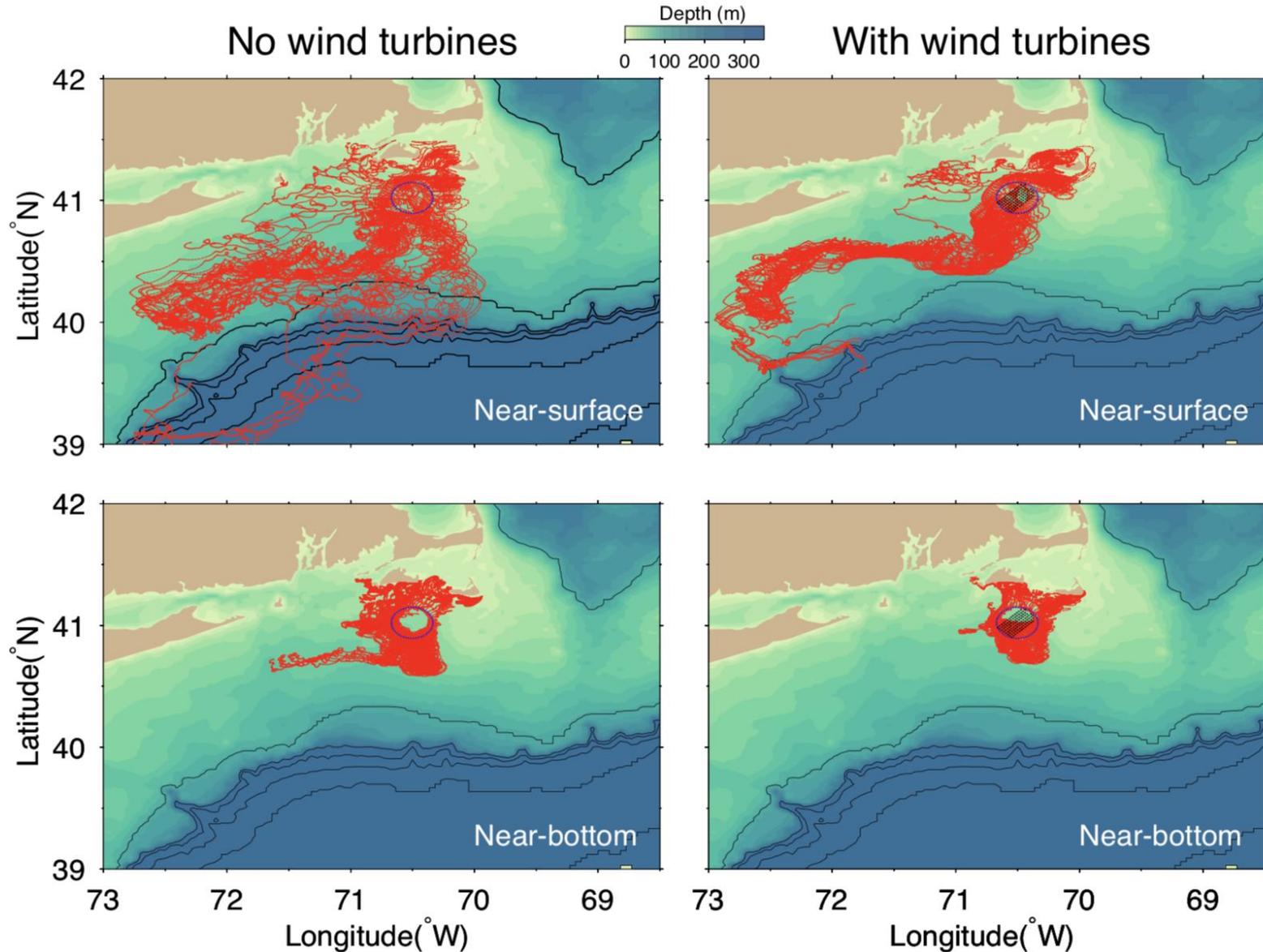
The swimming behavior-ensembled mean, percentage, and standard deviation of settled scallop larvae averaged over 2010 and 2013 for the cases with and without WTGs

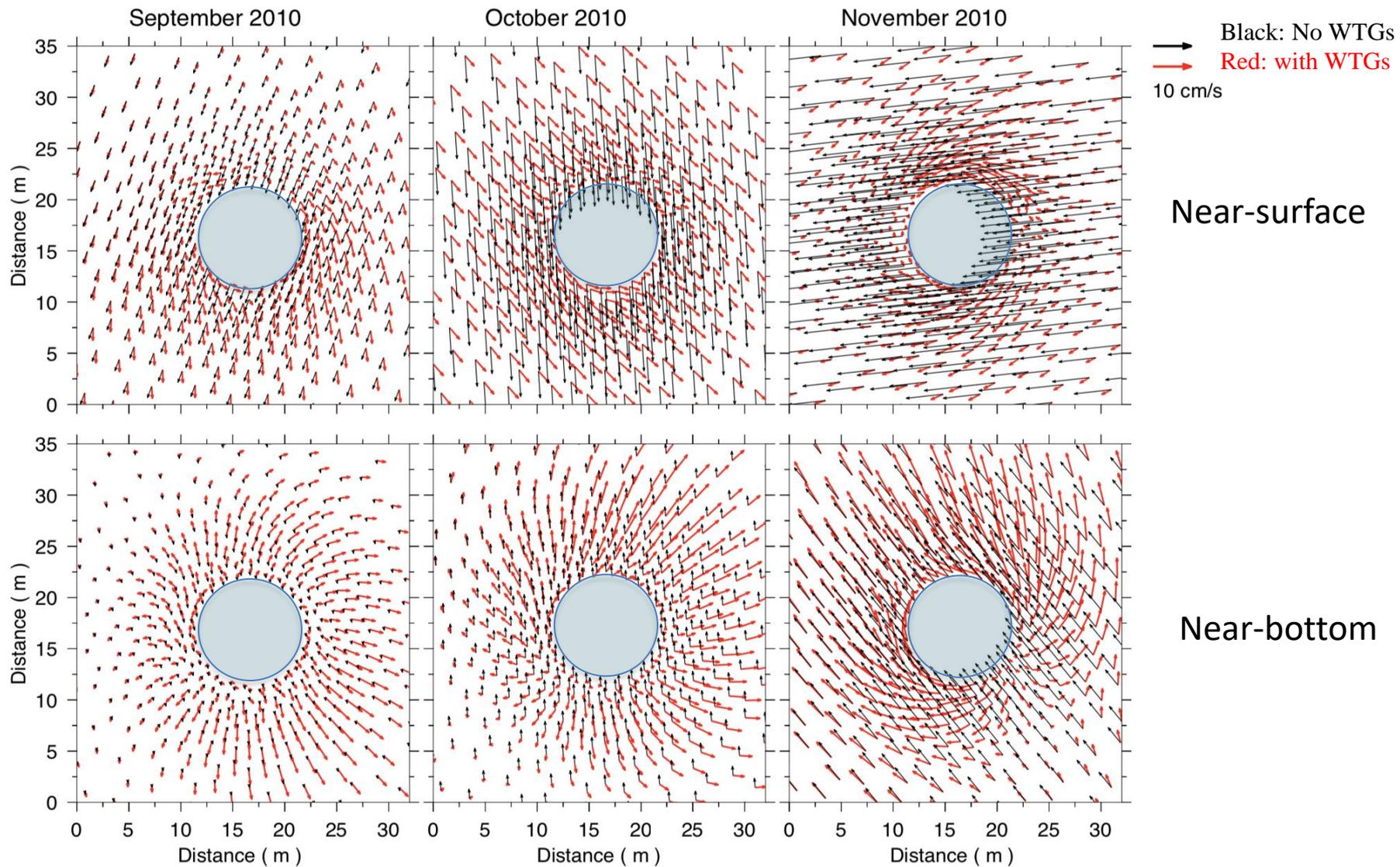
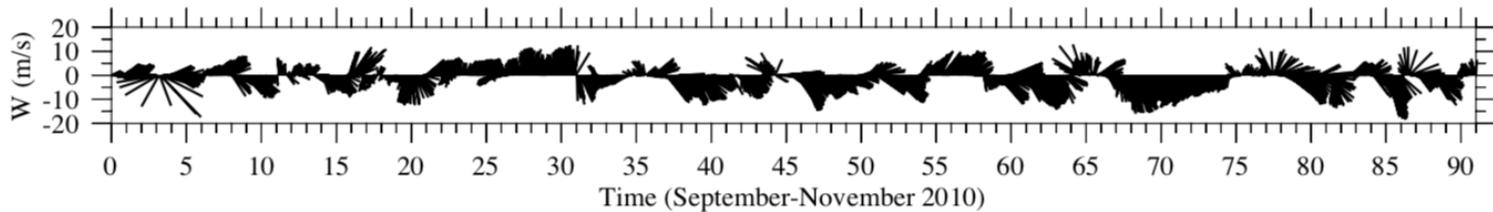


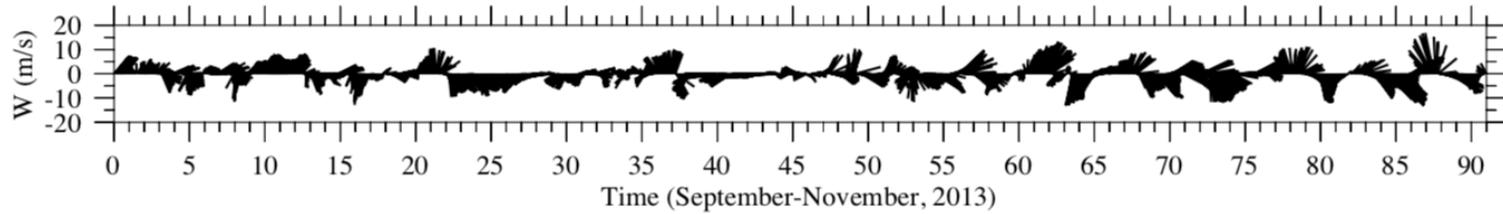
Particle tracking experiments: released 50 particle within WTGs (September 1-30, 2010)



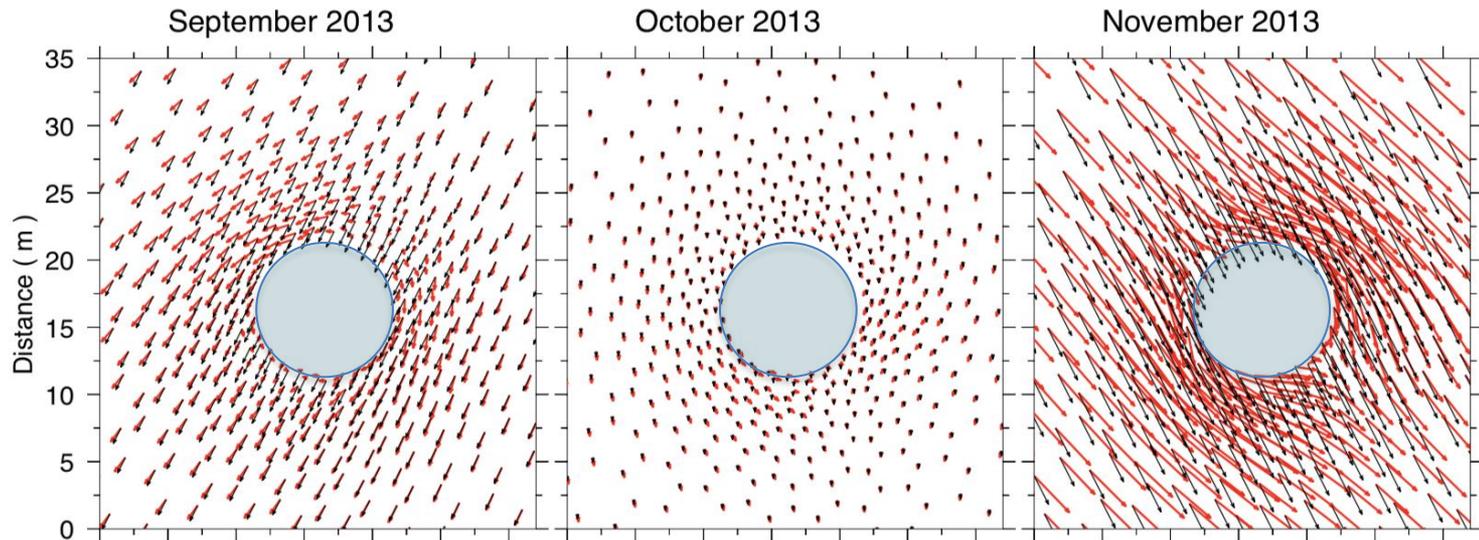
Particle tracking experiments: released 50 particles around the outer edge of the WTGs area (September 1-30, 2010)





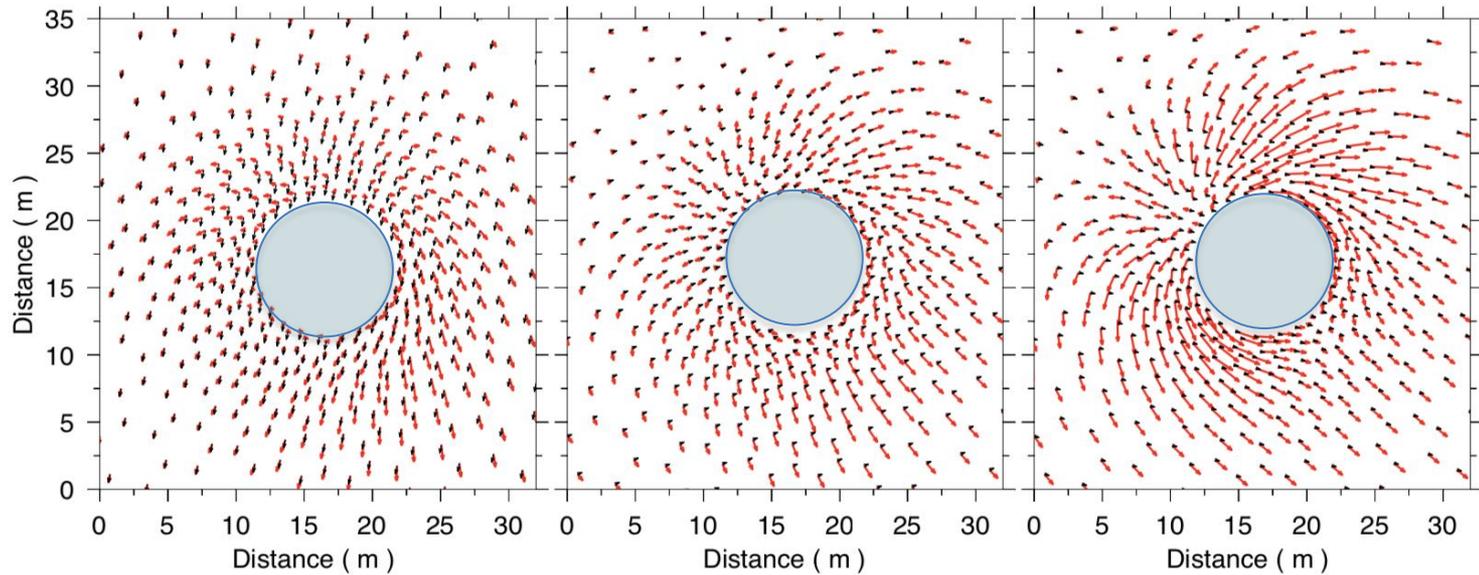


Winds



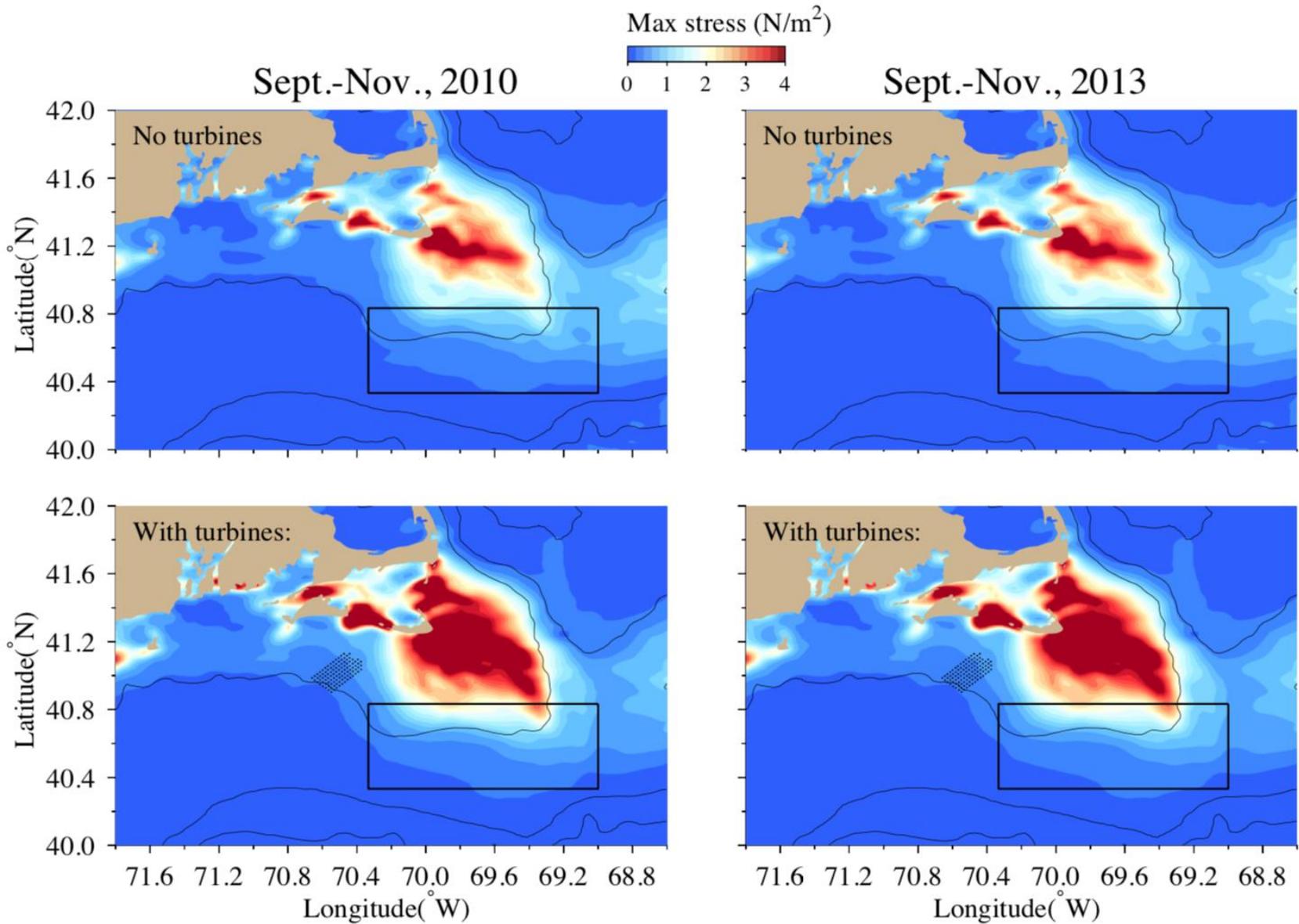
Black: No WTGs
Red: with WTGs
10 cm/s

Near-surface

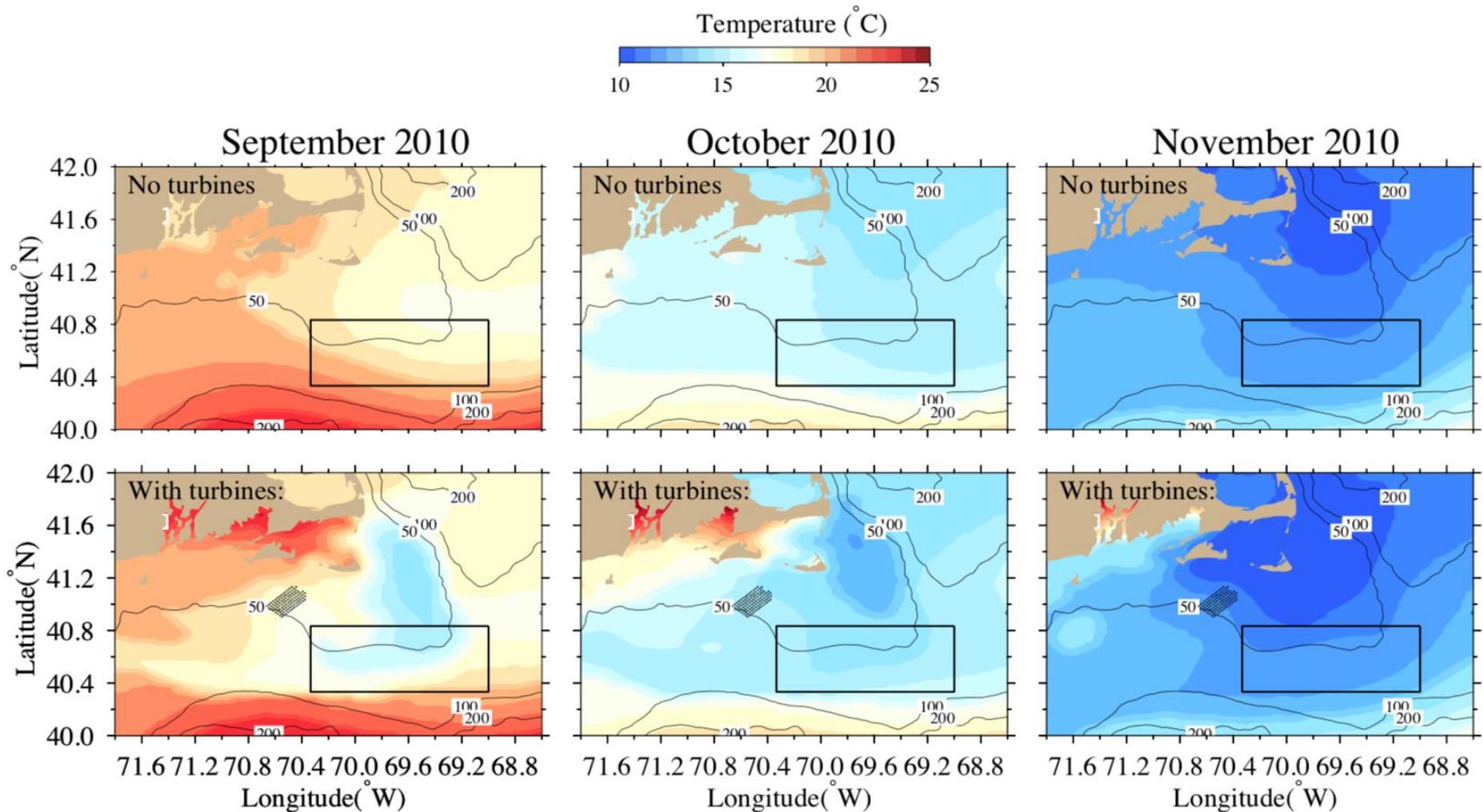


Near-bottom

Bottom stress comparison with and without WTGs



Near-surface temperature comparison with and without WTGs



Near-bottom temperature comparison with and without WTGs

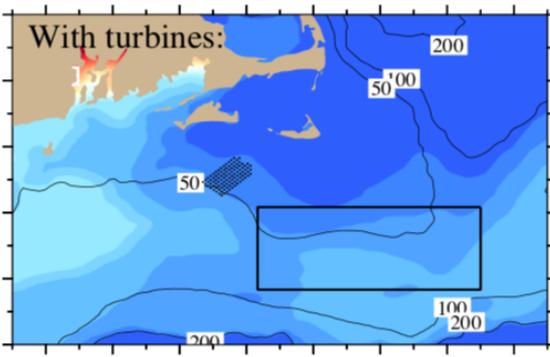
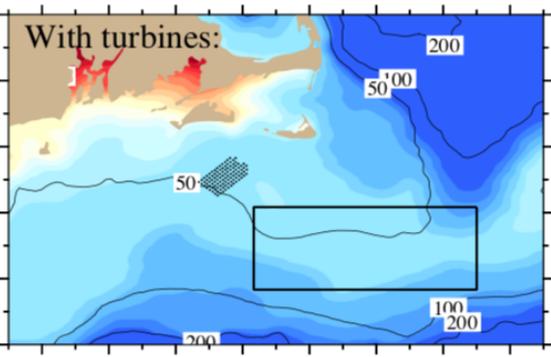
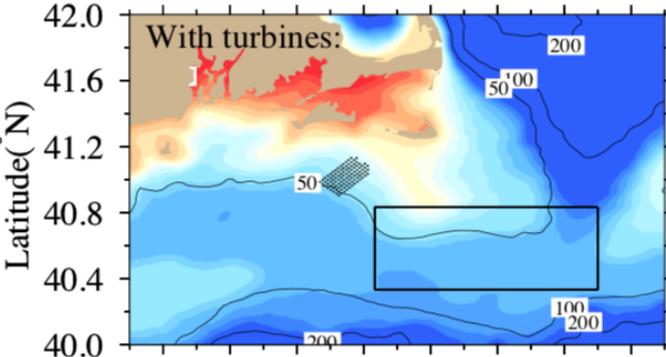
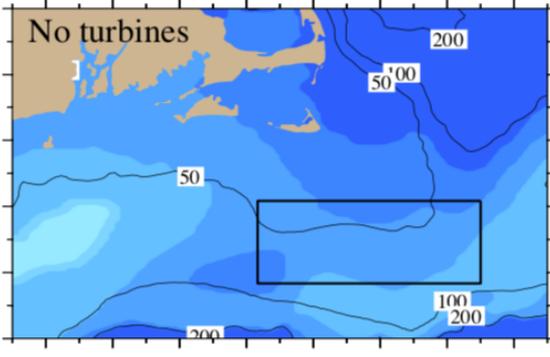
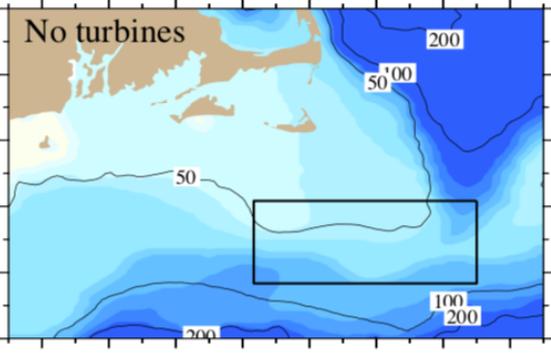
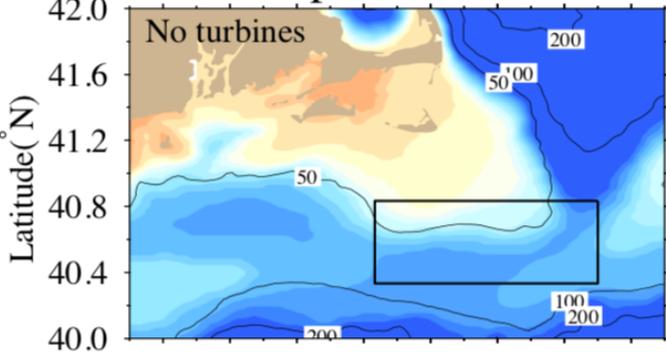
Temperature (°C)



September 2010

October 2010

November 2010



71.6 71.2 70.8 70.4 70.0 69.6 69.2 68.8

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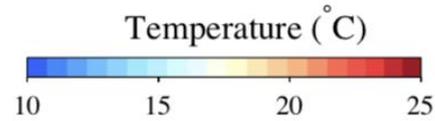
71.6 71.2 70.8 70.4 70.0 69.6 69.2 68.8

Longitude (W)

Longitude (W)

Longitude (W)

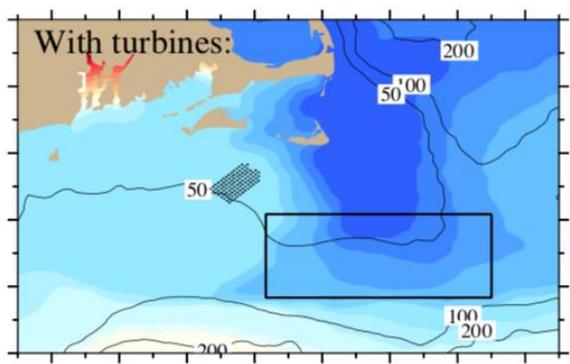
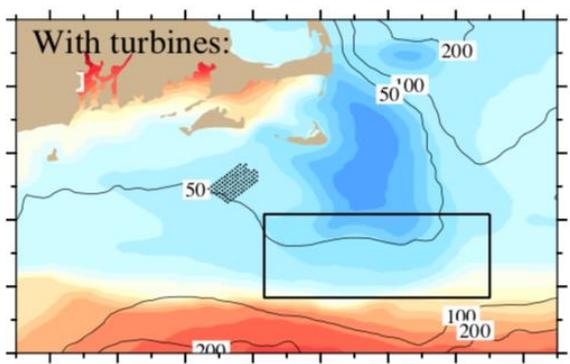
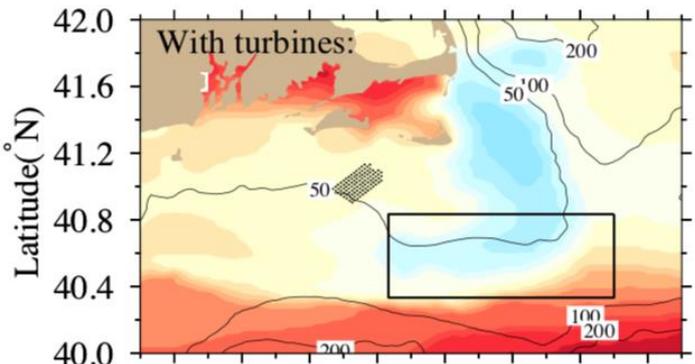
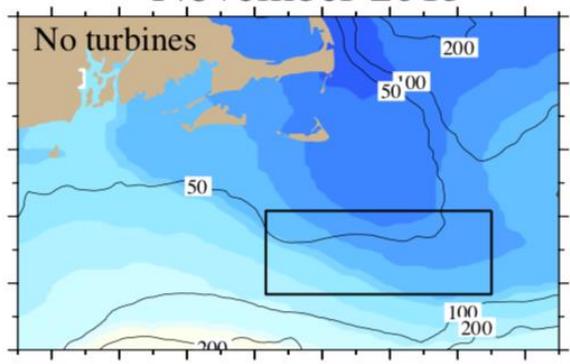
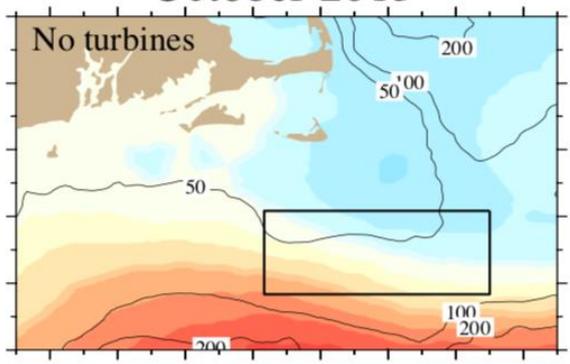
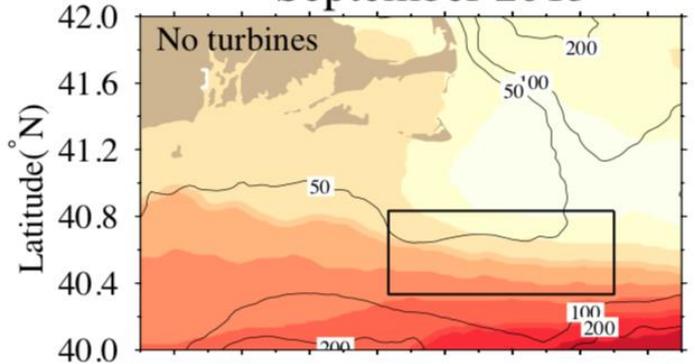
Near-surface temperature comparison with and without WTGs



September 2013

October 2013

November 2013



Longitude (°W)

Longitude (°W)

Longitude (°W)

Near-bottom temperature comparison with and without WTGs

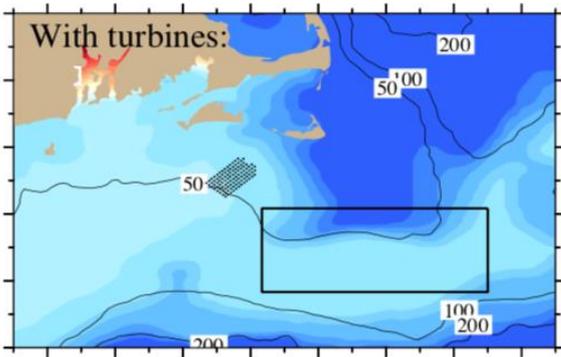
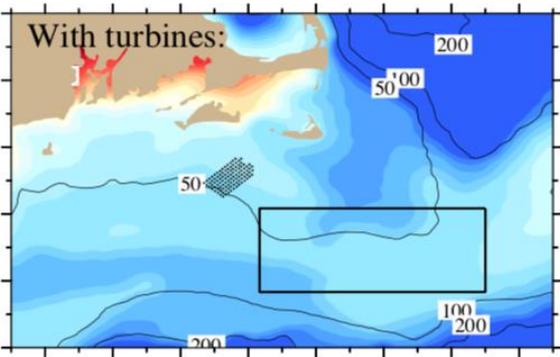
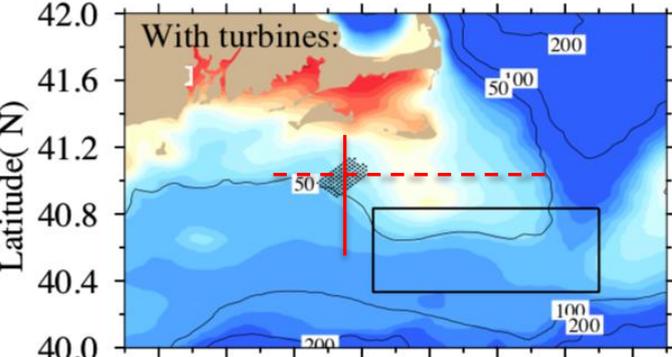
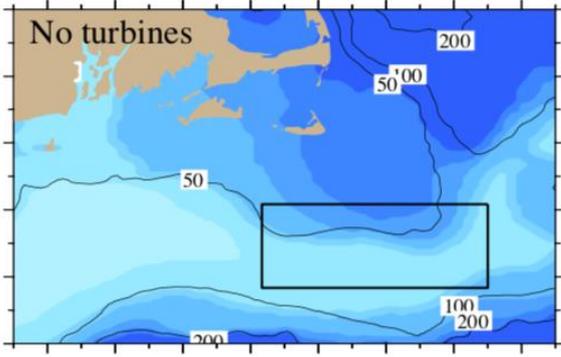
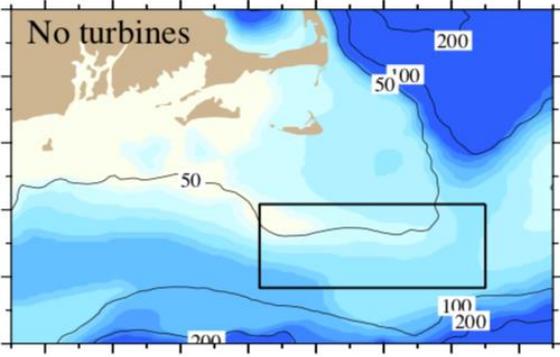
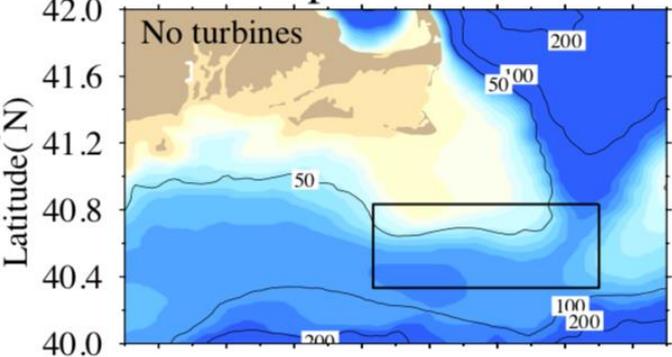
Temperature (°C)



September 2013

October 2013

November 2013

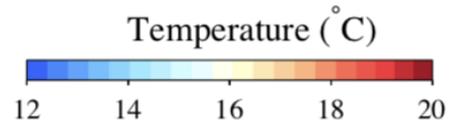


71.6 71.2 70.8 70.4 70.0 69.6 69.2 68.8
Longitude(° W)

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Longitude(° W)

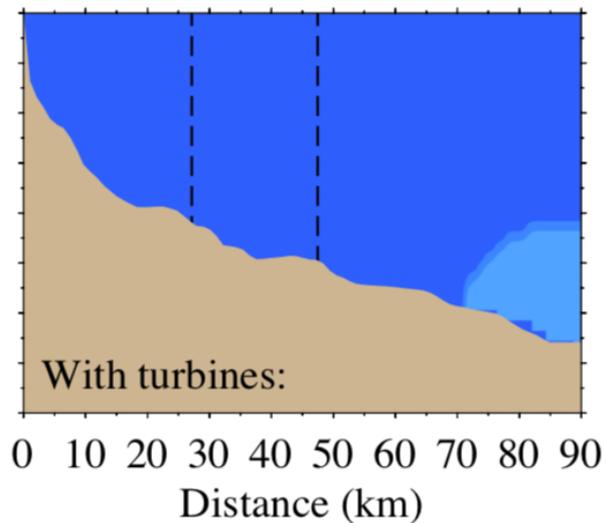
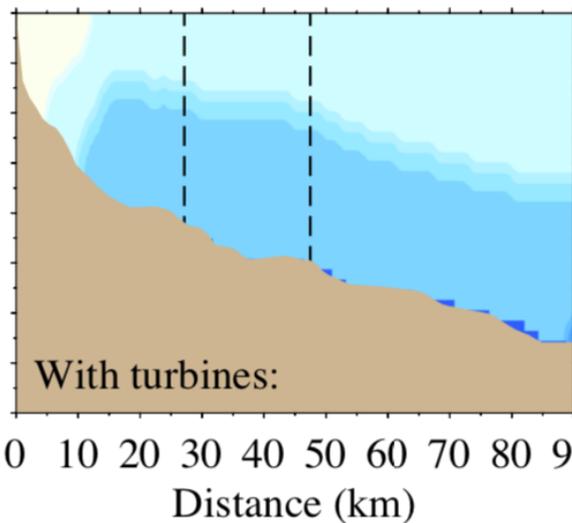
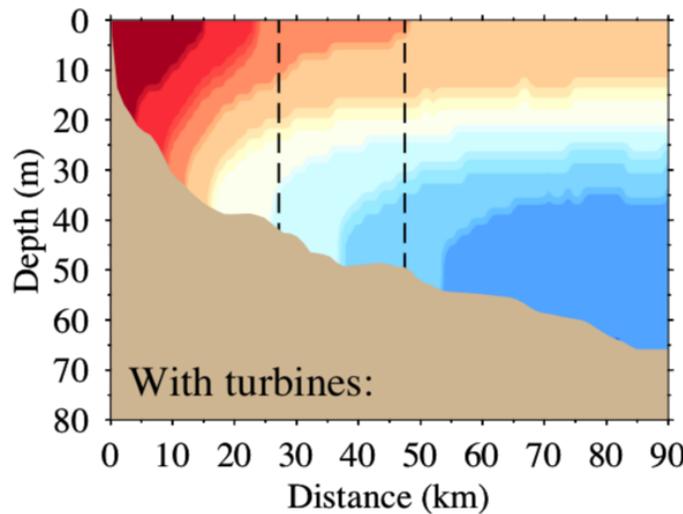
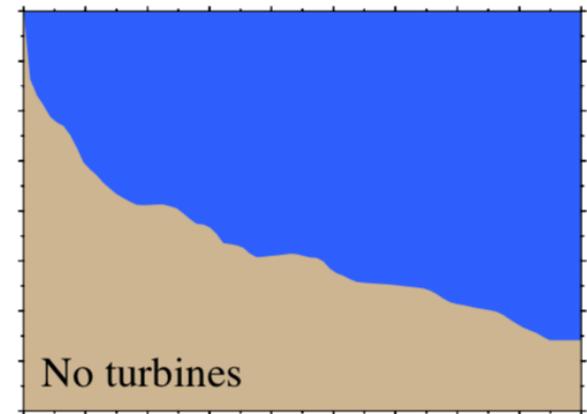
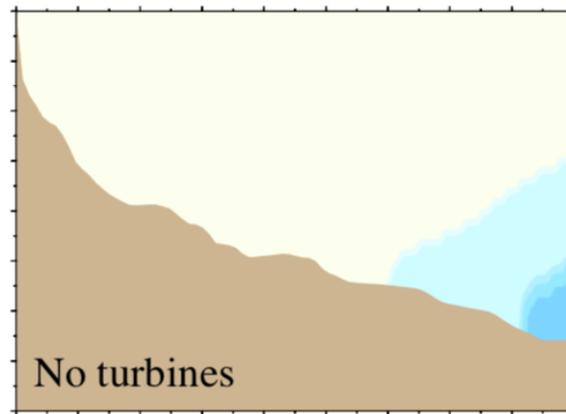
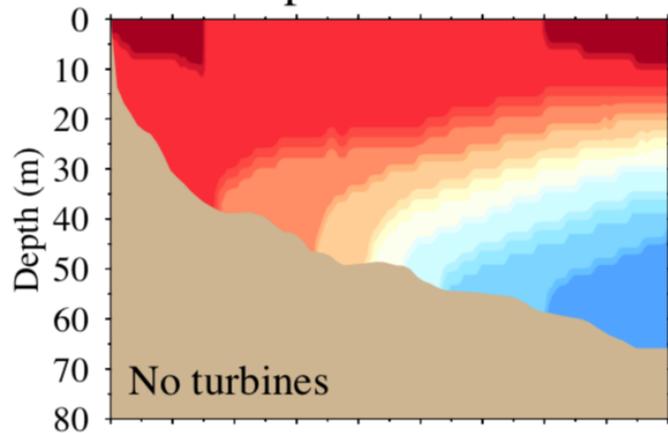
Cross-isobath temperature distributions with and without WTGs



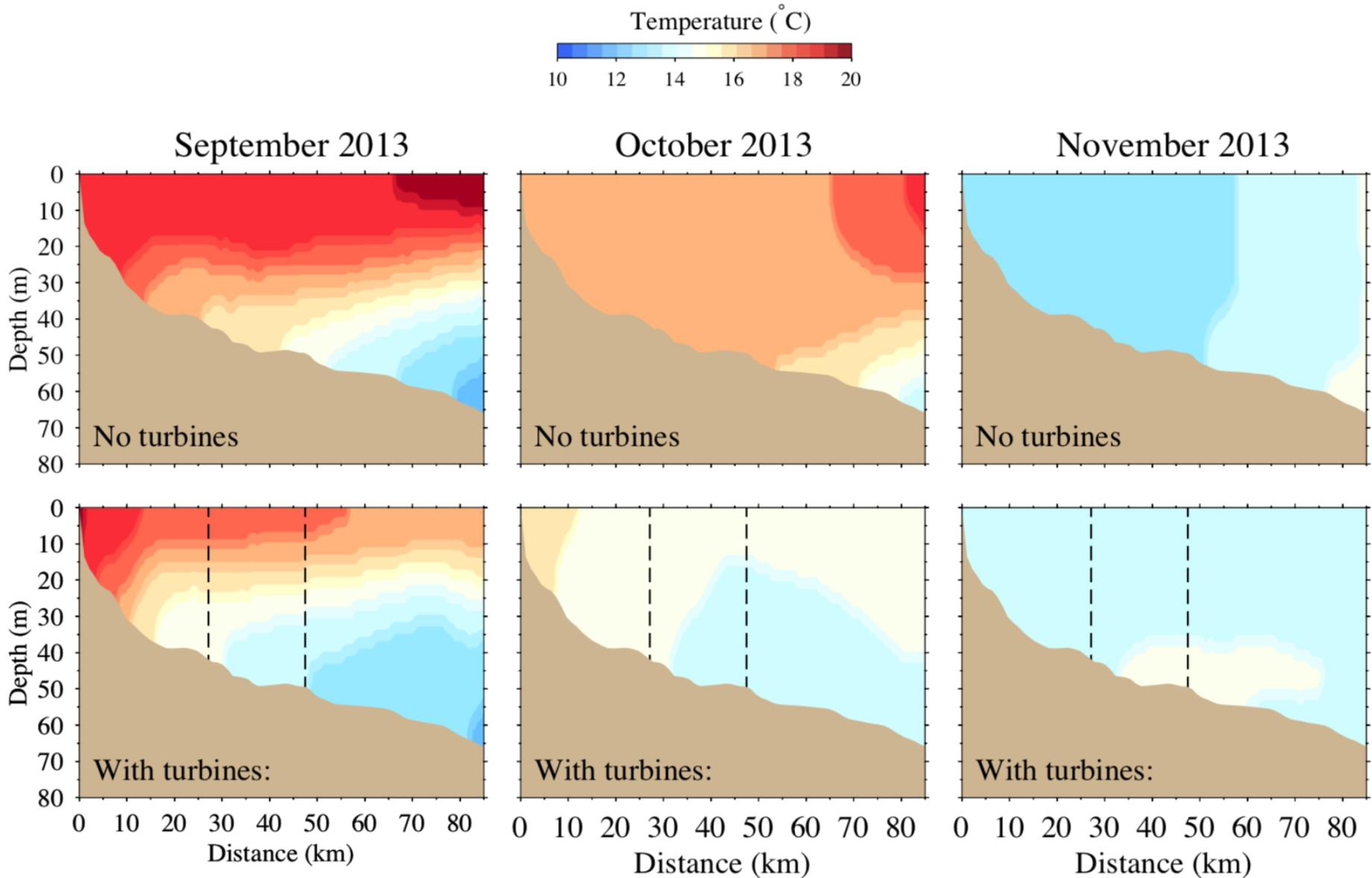
September 2010

October 2010

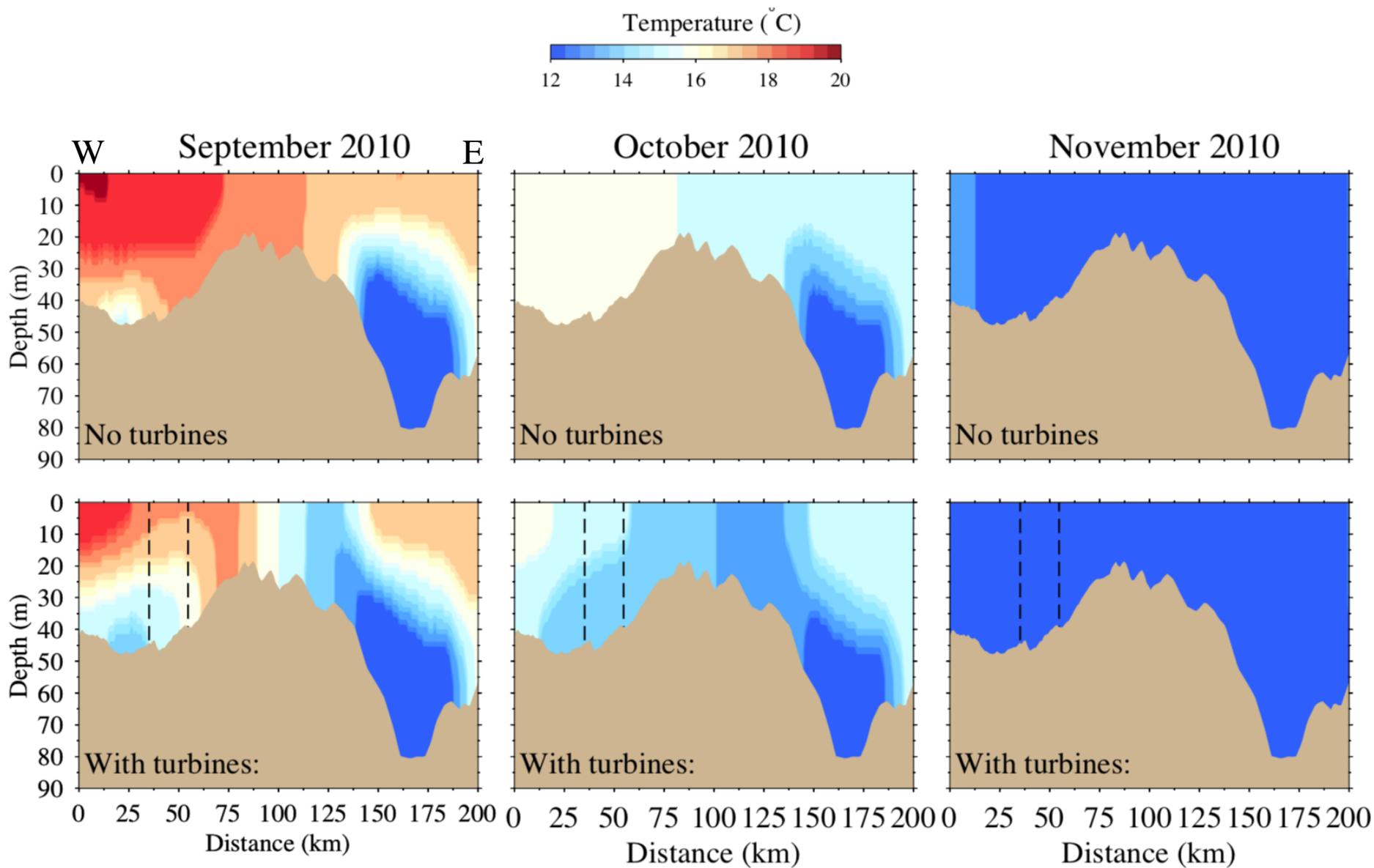
November 2010



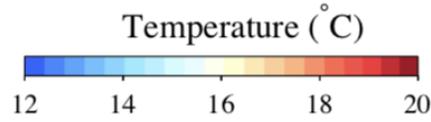
Cross-isobath temperature distributions with and without WTGs



West-east temperature distributions with and without WTGs



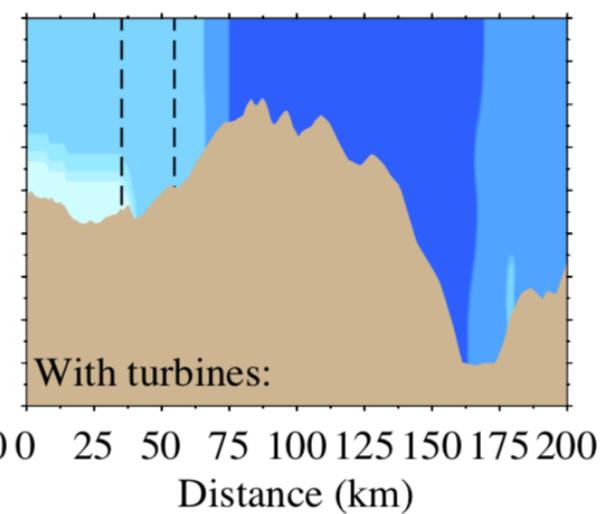
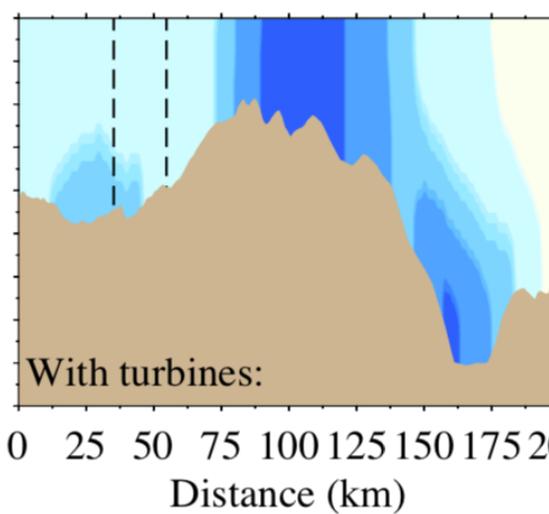
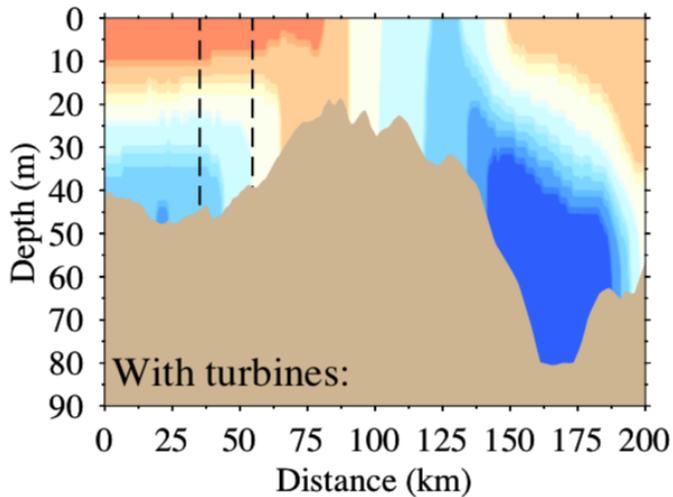
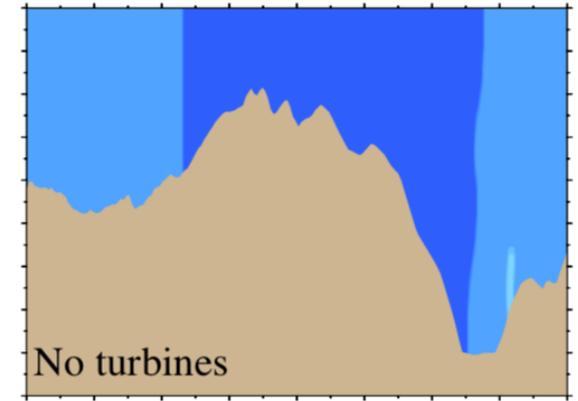
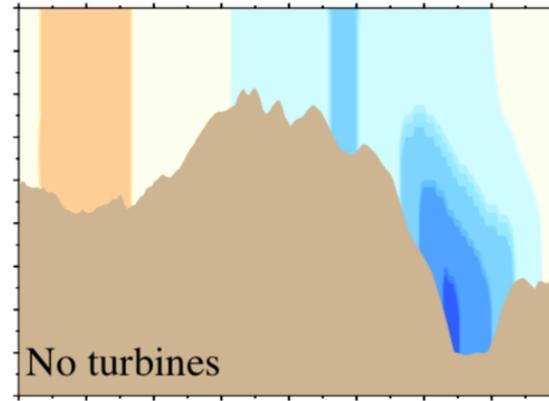
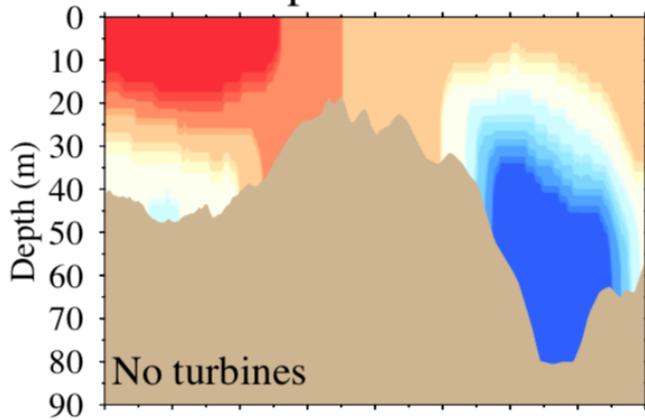
West-east temperature distributions with and without WTGs



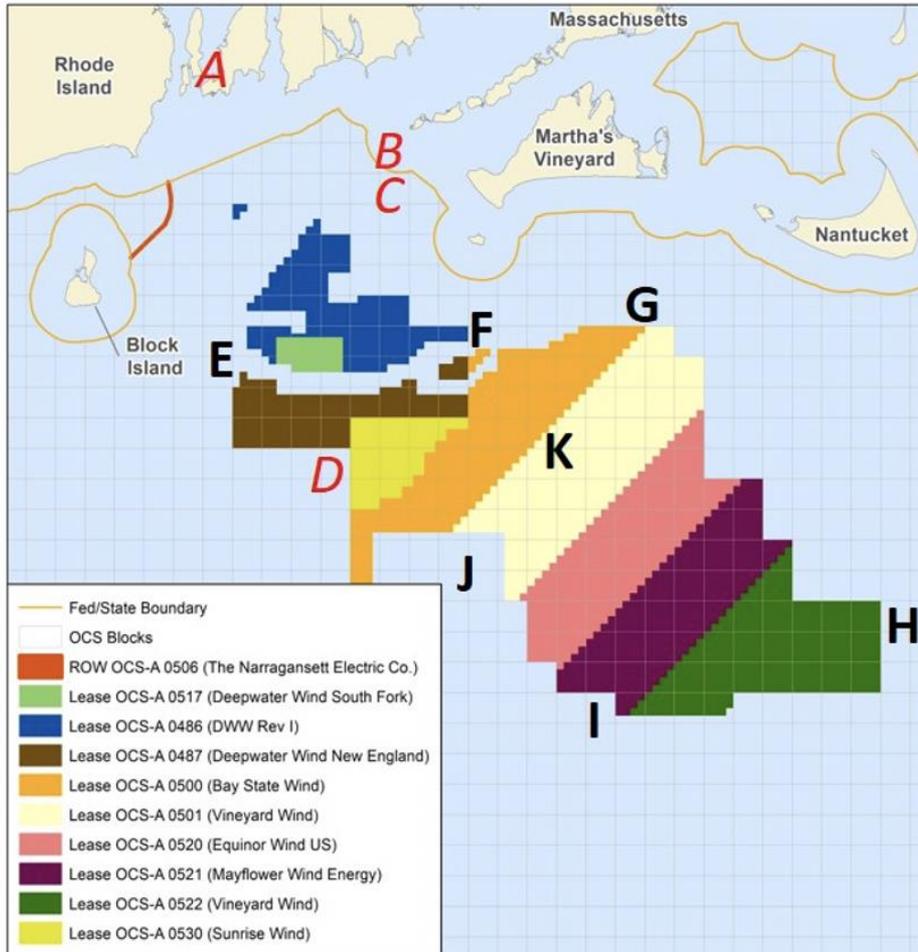
September 2013

October 2013

November 2013



Special Comments



- Our experiments only considered one wind farm development case in the lease area of OCS-A-0501. Several new developments have been taken place in Mass and Rhode Island Waters and the Mid-Atlantic Bight. As the coverage of WTGs extends, the cumulative impacts of WTGs on scallop larval dispersion and transports could change significantly.
- To assess the impact of WTGs on scallop larval recruitment, we need to run the Scallop-IBM to cover the benthic stage with the inclusion of WTGs.

Figure from Dr. Jake Kritzer at NERACOOOS

Summary

- We have successfully developed a wind turbine-resolving physical-biological coupled scallop-IBM model (NS-FVCOM/scallop-IBM) capable of making an assessment of the potential impact of the offshore wind farm development on the connectivity of scallop larvae between Georges Bank/South South Channel and Mid-Atlantic Bight.
- The NS-FVCOM/scallop-IBM shows that the impacts of the offshore wind energy development on scallop larvae could be significant. An modeling assessment should be continued with the inclusion of other leased areas in the region.