

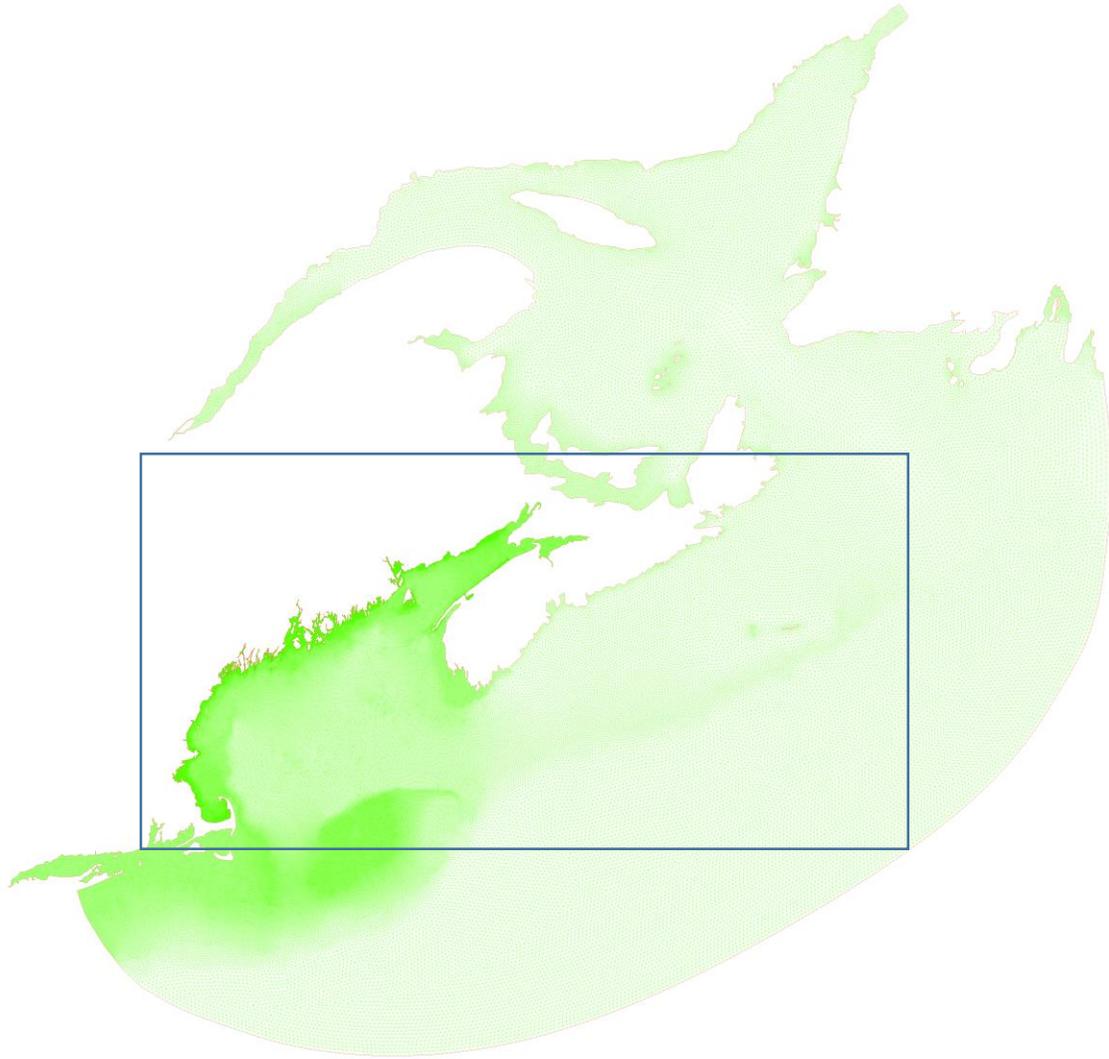
# NorthEast Shelf Seas (NESS) Model - A SCHISM Application

Huijie Xue, Zhengui Wang, Denghui Li



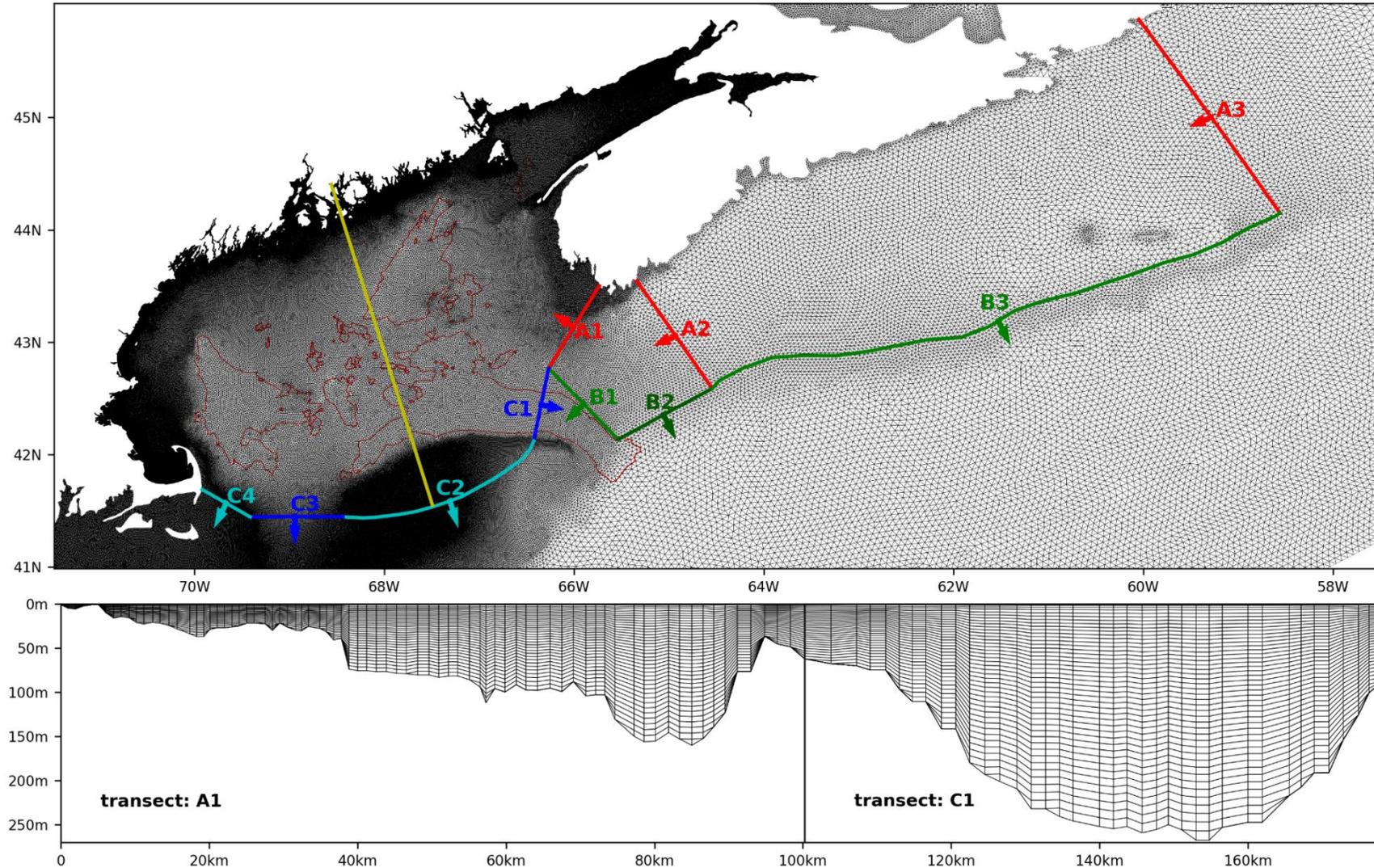
School of Marine Sciences  
University of Maine

# Model Set Up - Mesh



- Domain: the shelf seas from Long Island Sound to the Gulf of St. Lawrence
- Unstructured triangle grid:
  - 684K elements and 355K nodes;
  - horizontal resolution from 100 m nearshore in the Gulf of Maine to 6 km offshore
- Bathymetry data: the US Coastal Relief Model and GEBCO

# Model Set Up - Mesh

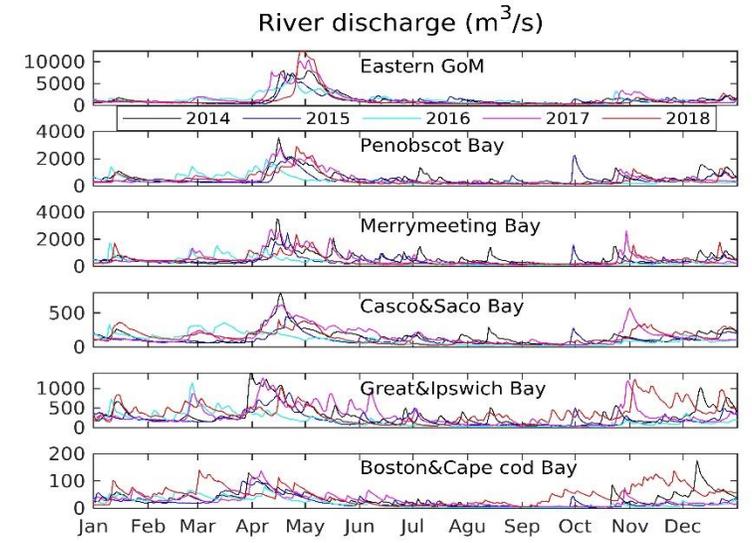
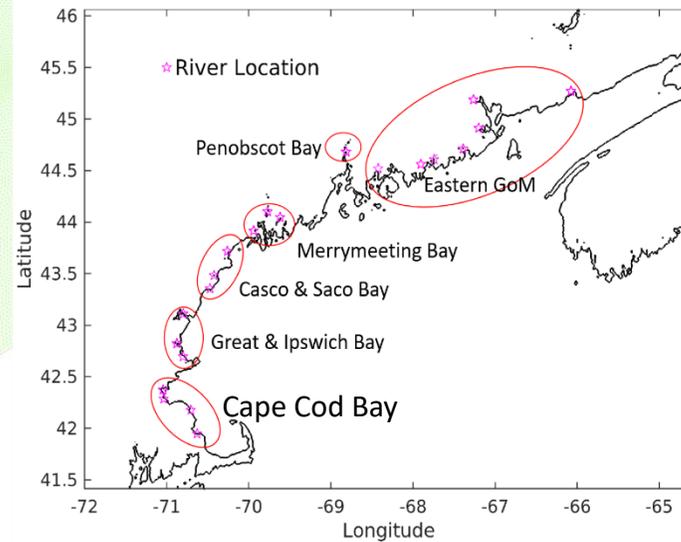
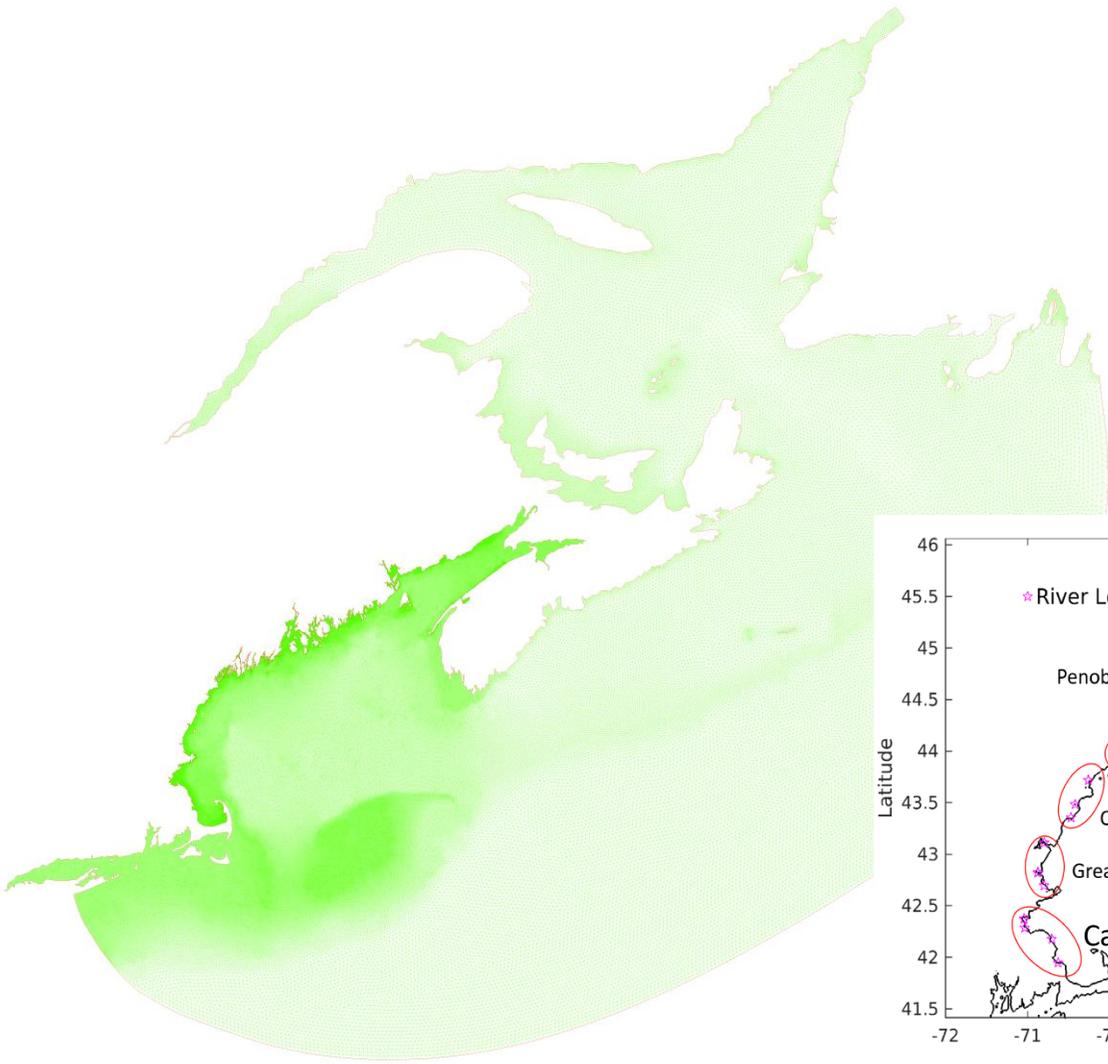


In the vertical

- Localized  $\sigma$  (LSC<sup>2</sup>)
- Maximum 70 levels
- 1 level when  $H < 1$  m
- 25 levels on average

# NESS Model Set Up - Forcing

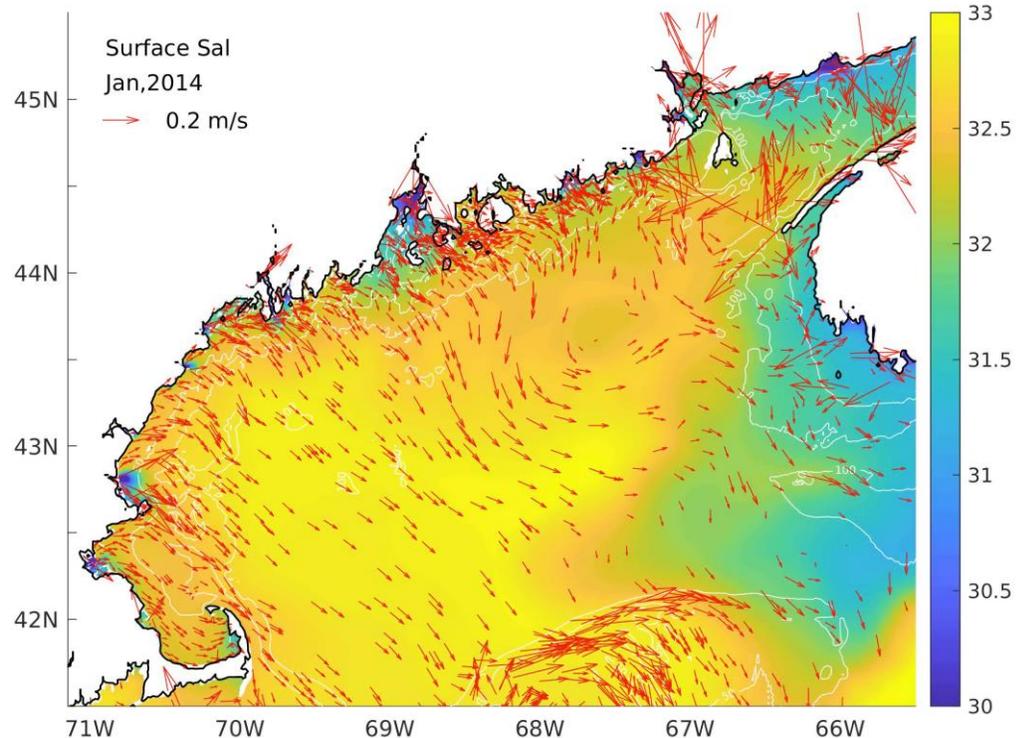
- Meteorological forcing: NARR
- Open boundary: HYCOM reanalysis (6 hourly) + FES2014 for tide
- For US rivers, gauge data are downloaded from USGS or estimated based on the watershed area if not gauged and regressed with a gauged river nearby



- For Canadian rivers (St. John and St. Lawrence), data from Grand Falls & Montreal are used

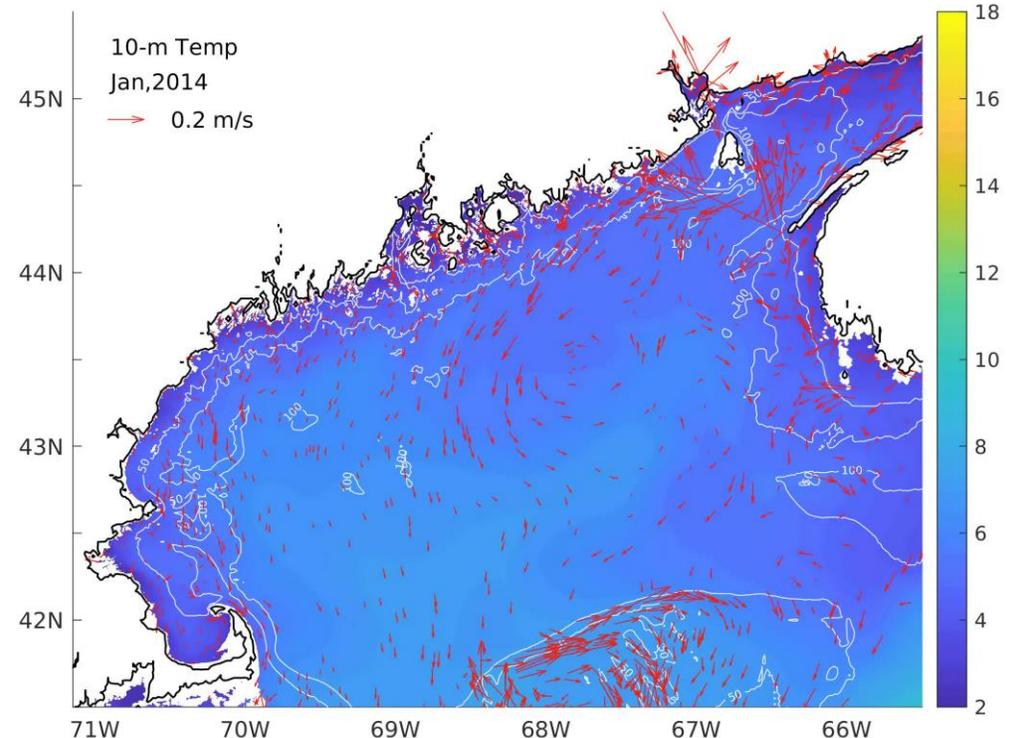
# Simulation of the Gulf of Maine

Monthly Mean S & V @ the Surface



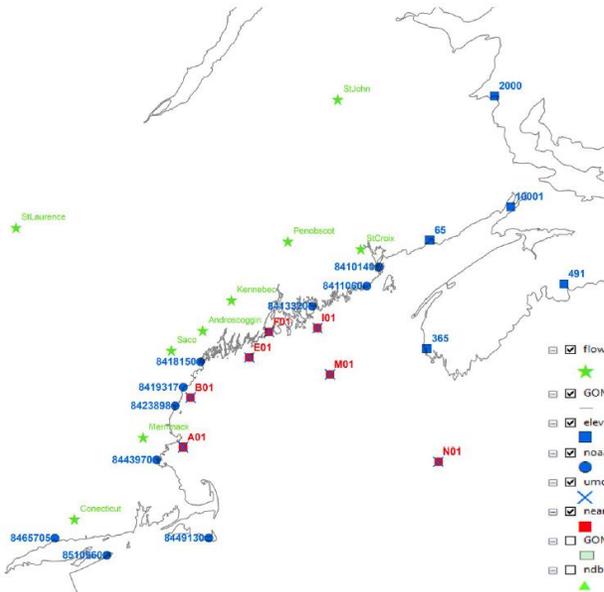
- Scotian Shelf inflow of low salinity water
- River plumes & coastal currents
- Surface wind drift flows

Monthly Mean T & V @ 10 m

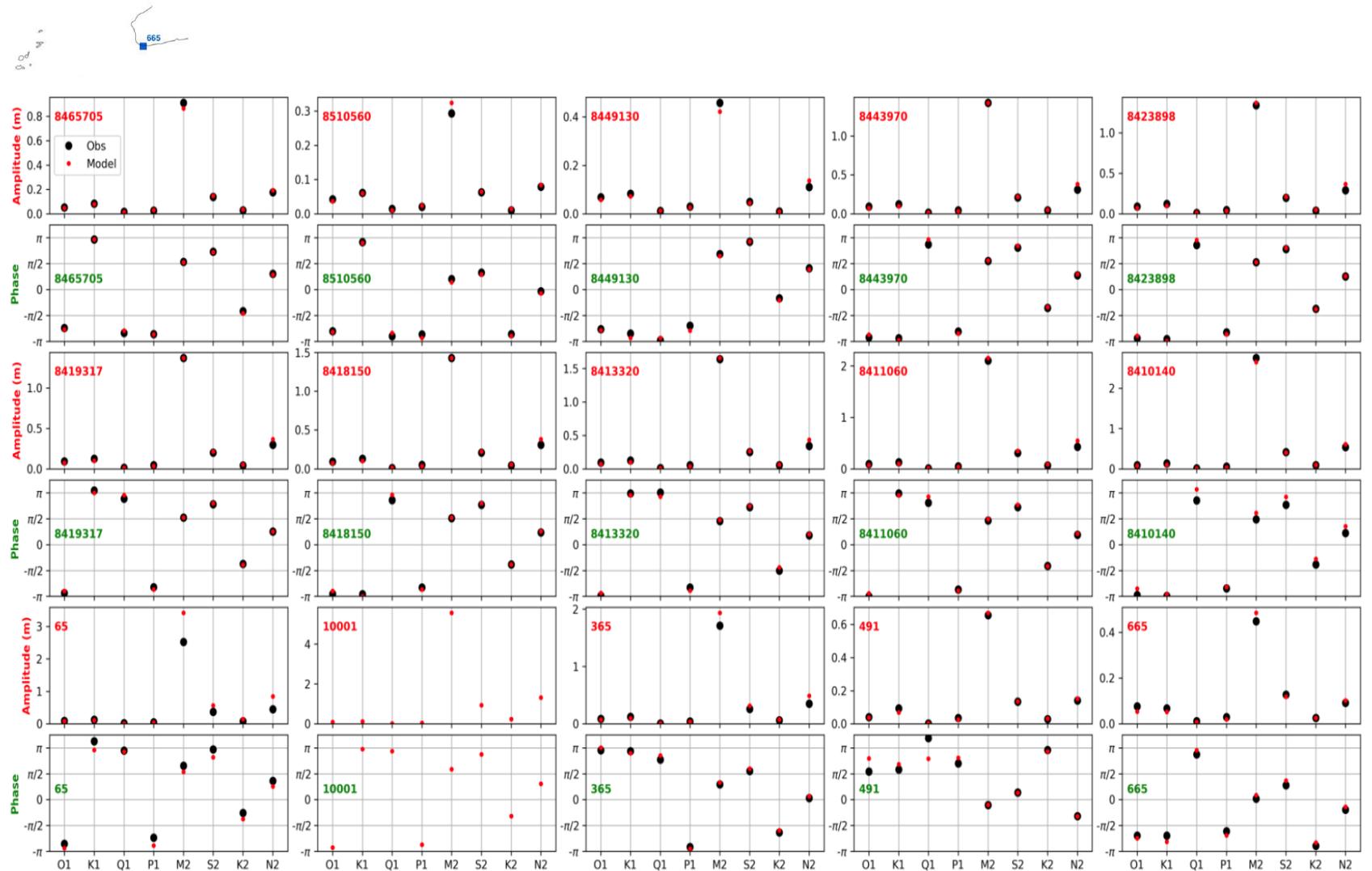


- Seasonal warming and cooling
- Tidal mixing fronts & coastal currents
- Basin scale gyres

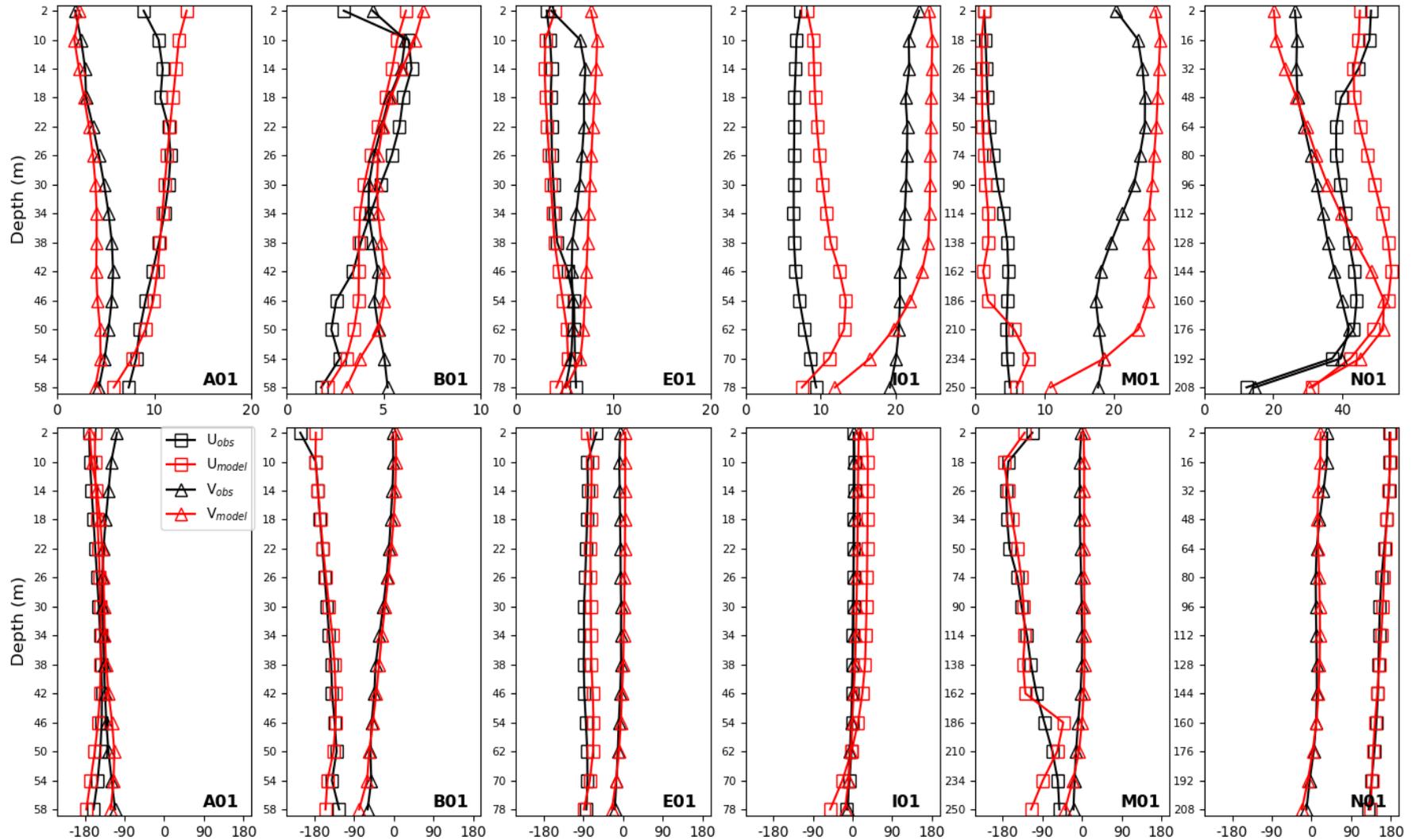
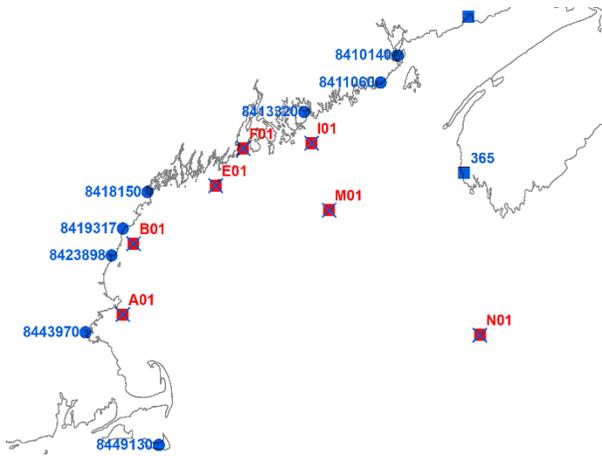
# Model Validation – Tidal Amplitude & Phase



Matches the tidal amplitudes and phases very well!



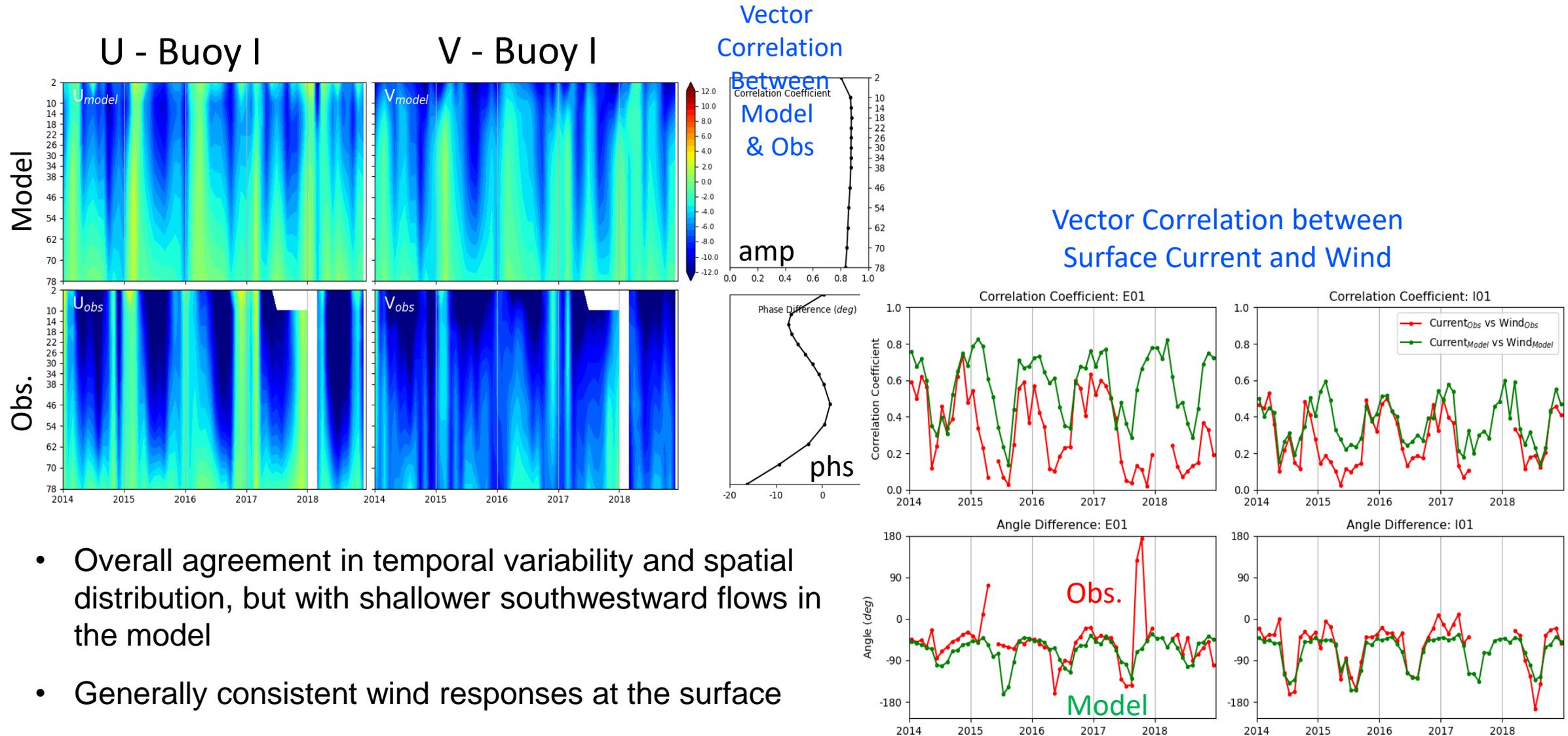
# Model Validation – Tidal Currents



Tidal currents are well reproduced except for the amplitude near the bottom!

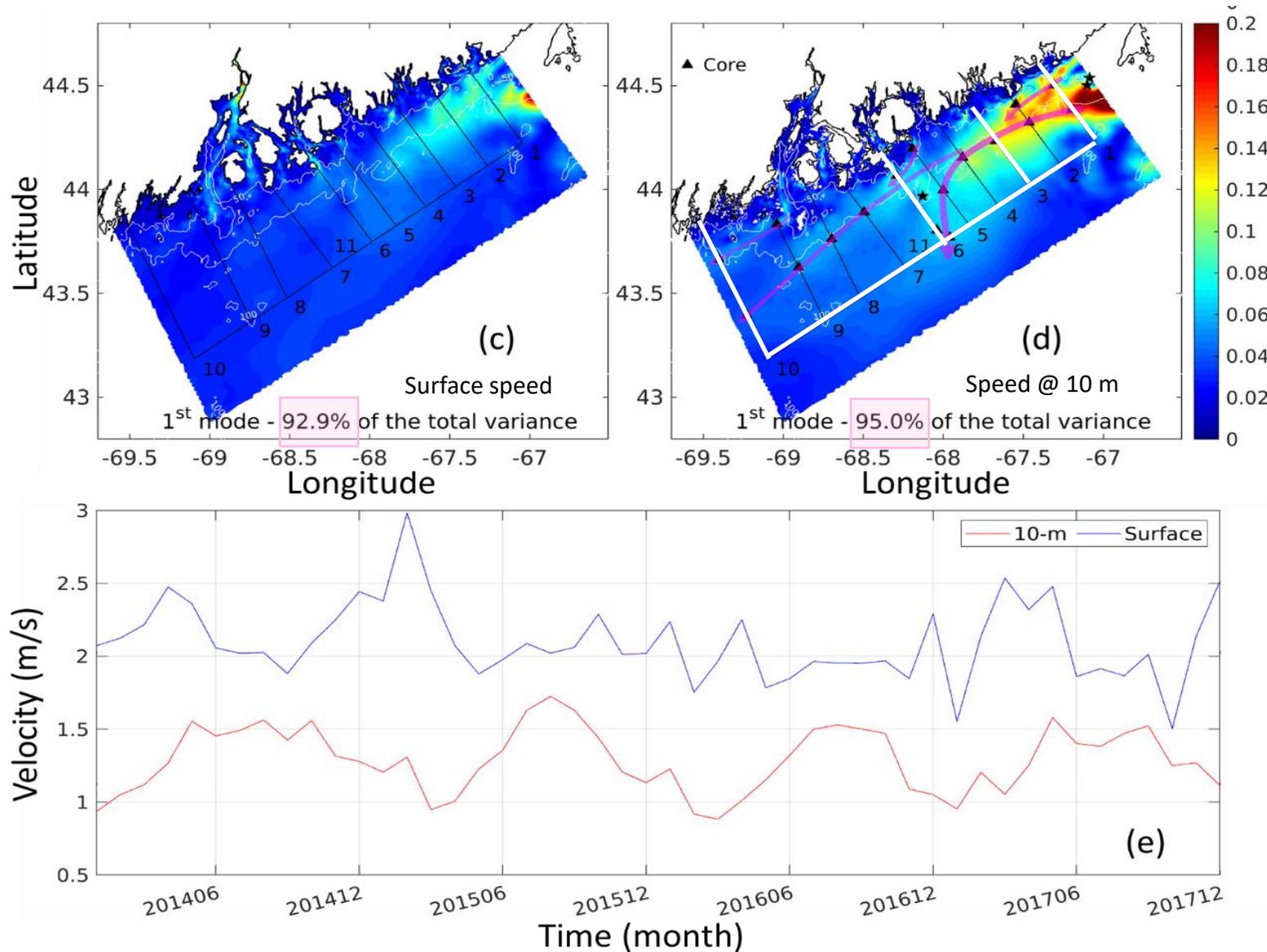


# Model Validation – Subtidal Currents

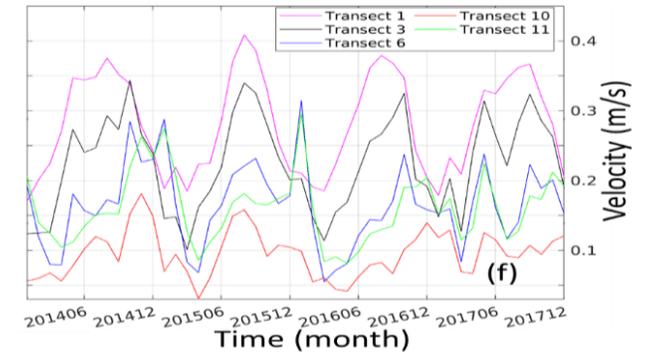


- Overall agreement in temporal variability and spatial distribution, but with shallower southwestward flows in the model
- Generally consistent wind responses at the surface

# The Eastern Maine Coastal Current

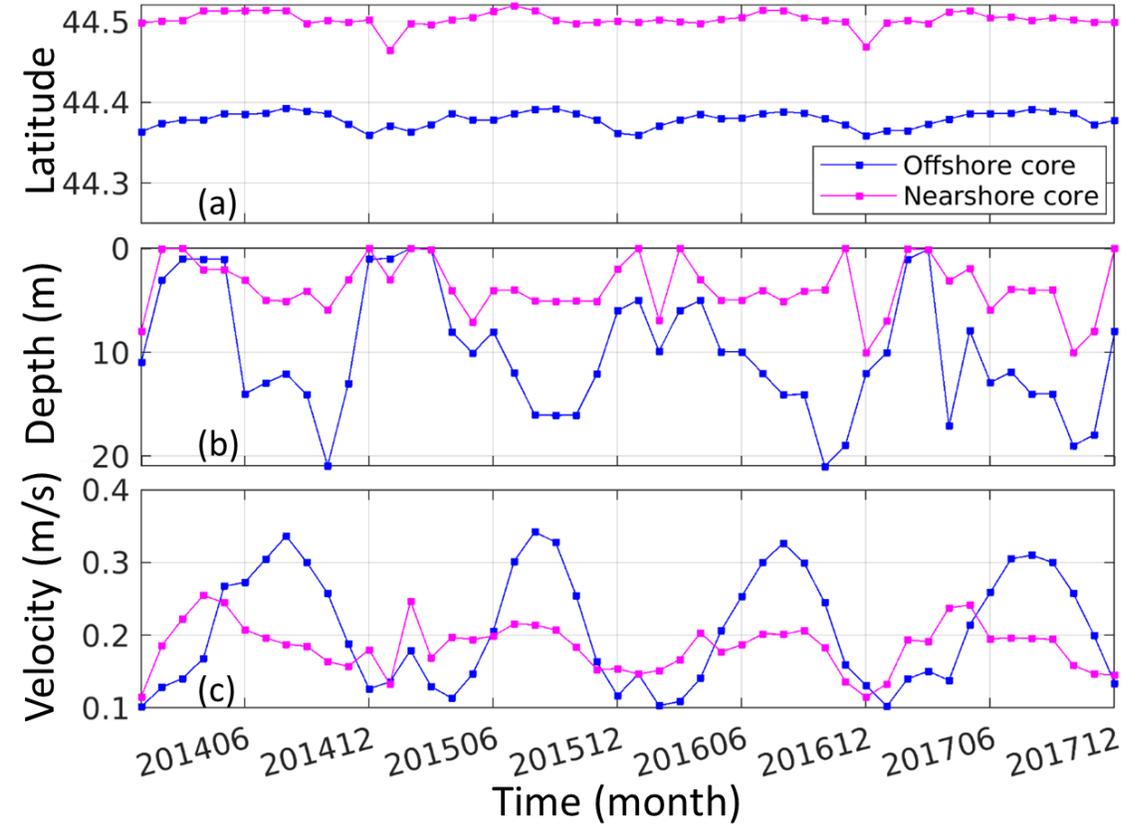
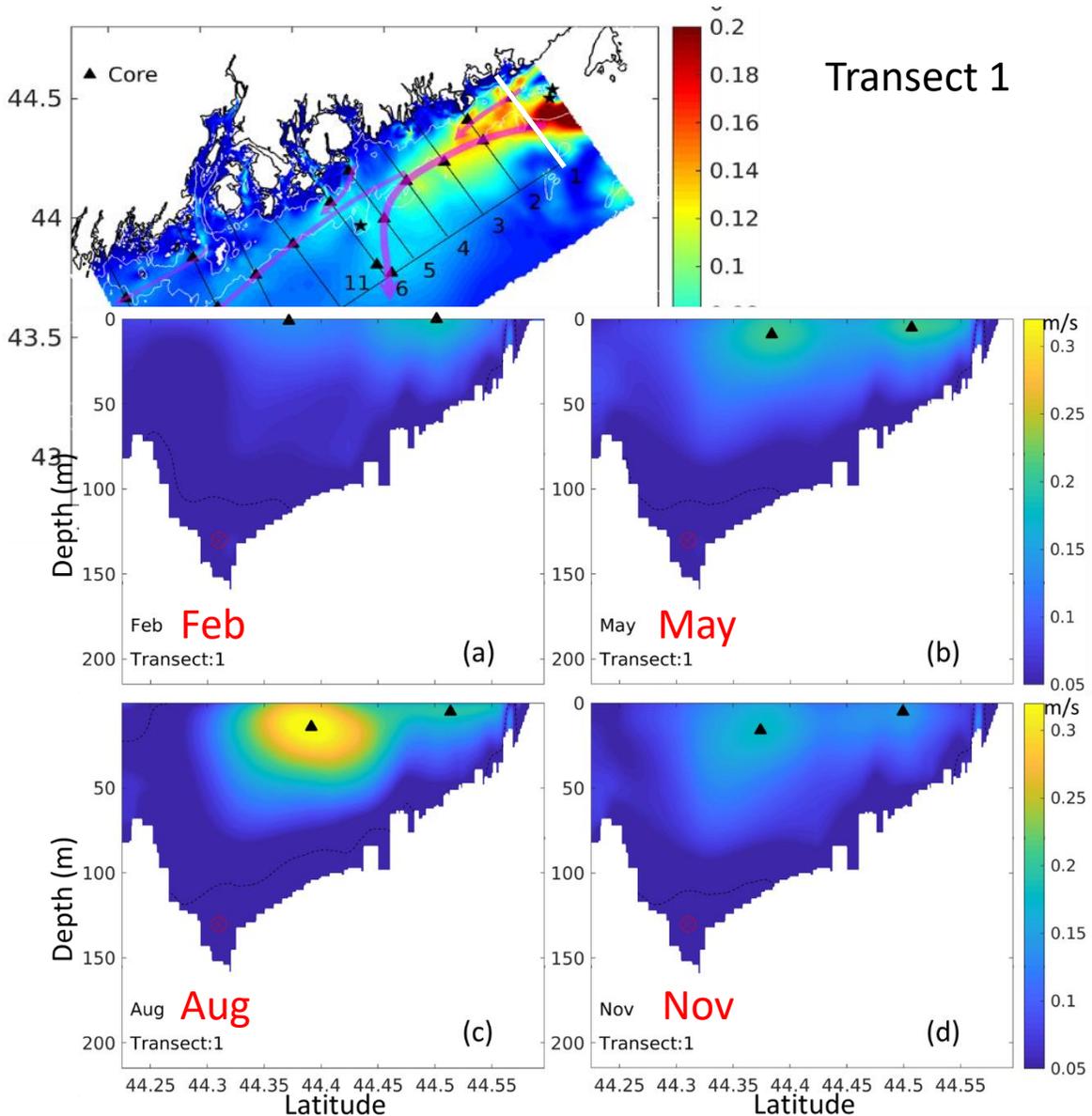


- Multi core structure
- Offshore veering south of Mount Desert Island
- Robust annual cycle @ 10 m
- More variations at the surface



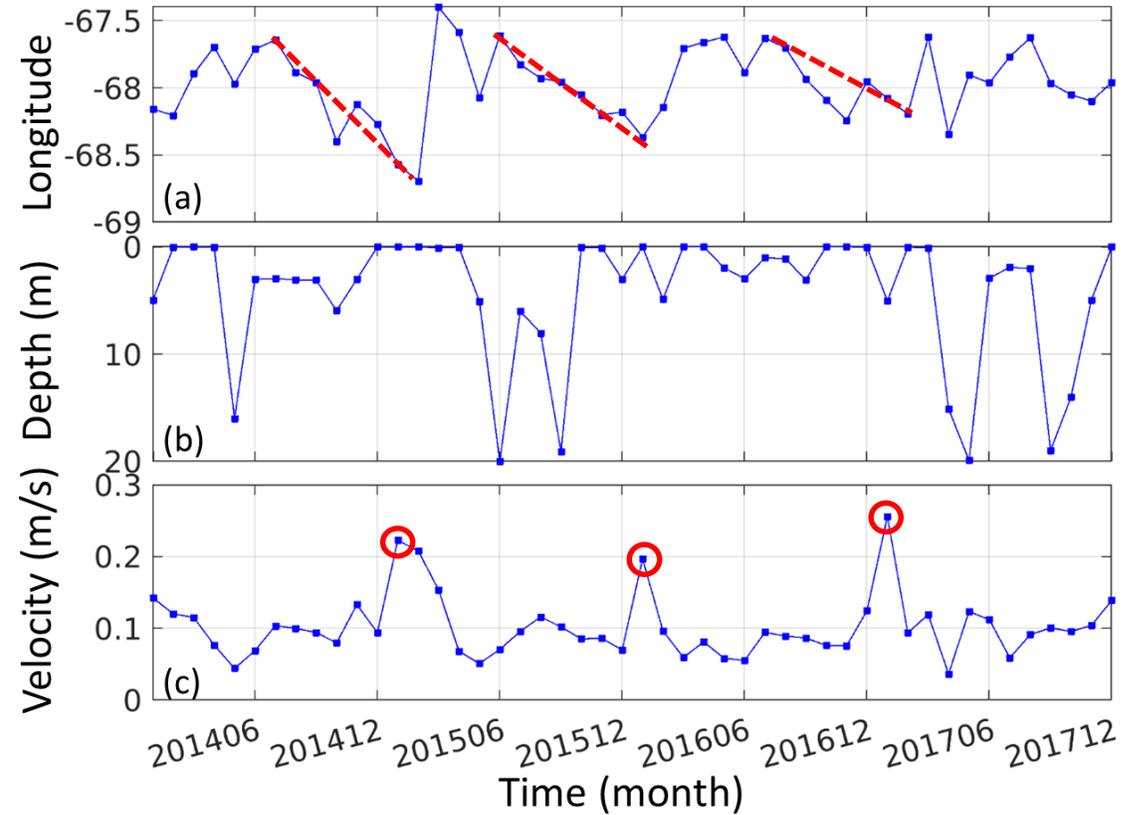
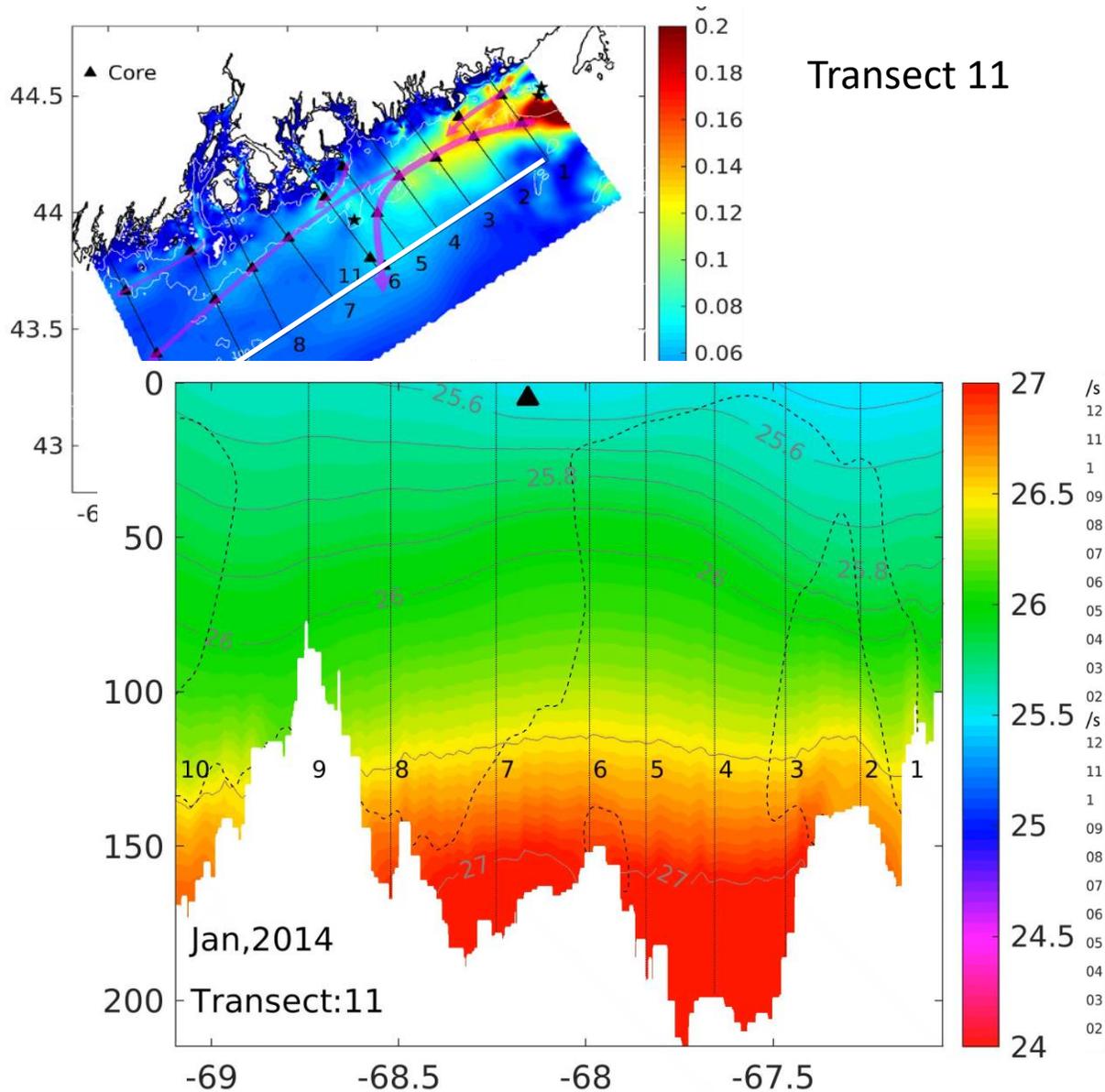
- More stable seasonal cycle in the east (transect 1) than in the west (transect 10)
- Transect 6 and 11 have similar temporal variations

# The Eastern Maine Coastal Current



- Synchronous movement: onshore in summer but offshore in winter; shallower in spring but deeper in fall
- Nearshore core is strongest in spring; offshore core is strongest in late summer

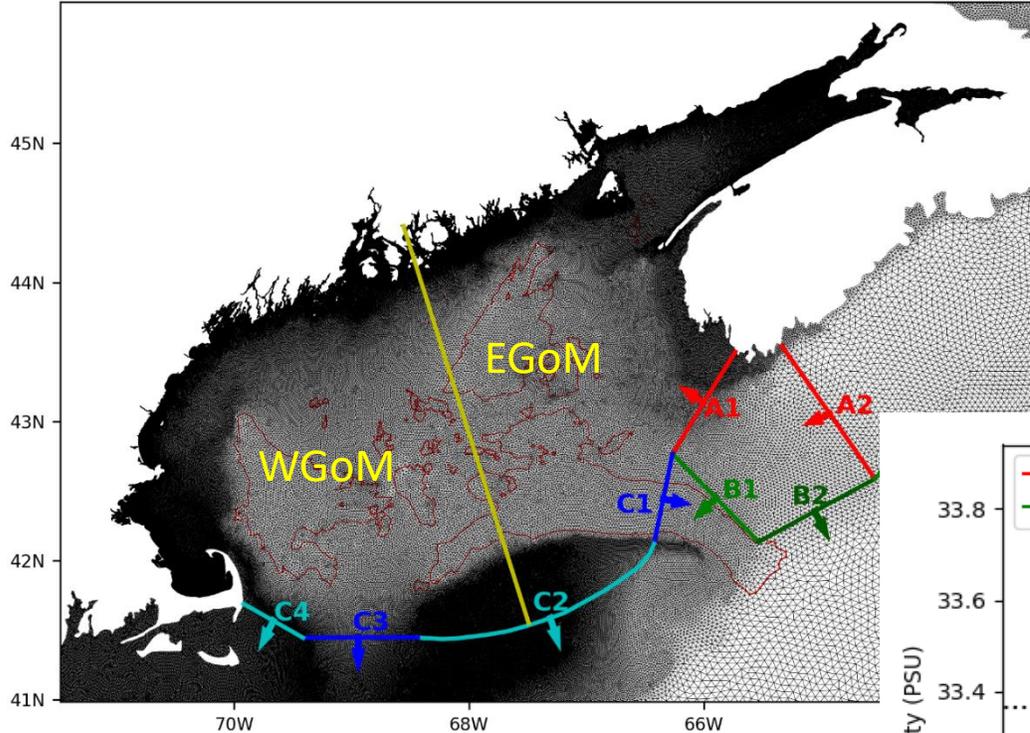
# The Eastern Maine Coastal Current



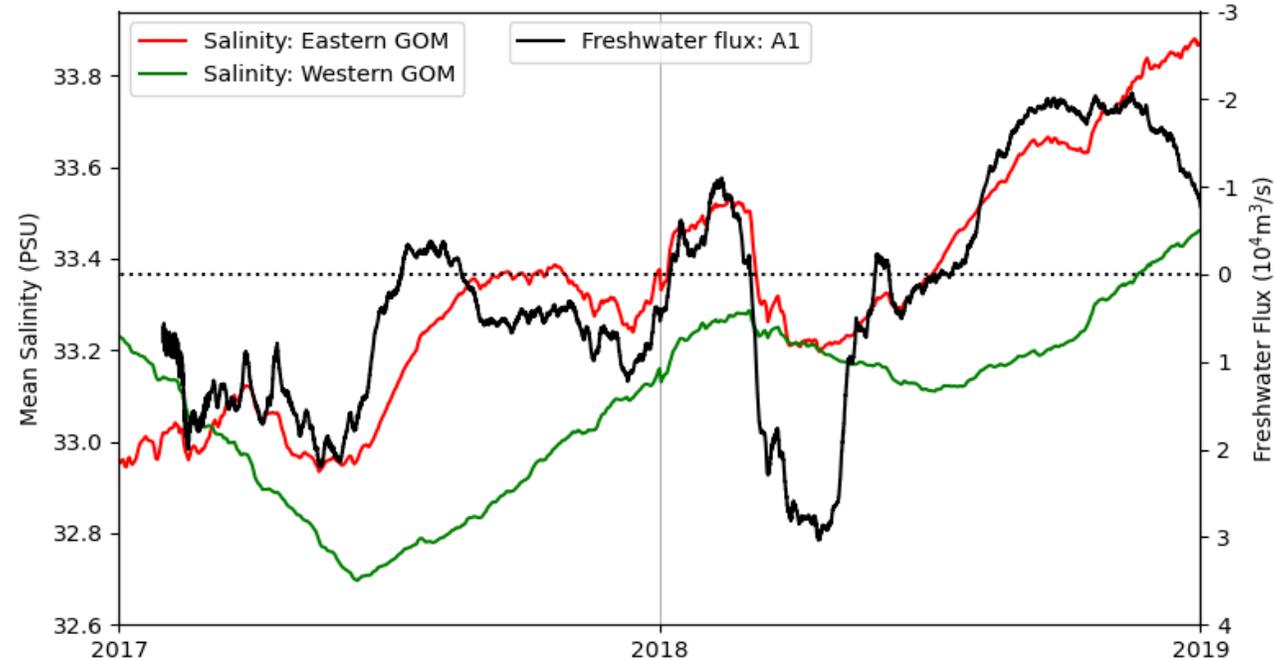
## Offshore veering:

- Stronger in winter
- Shifts westward from summer to winter
- Affected by SSW and SW

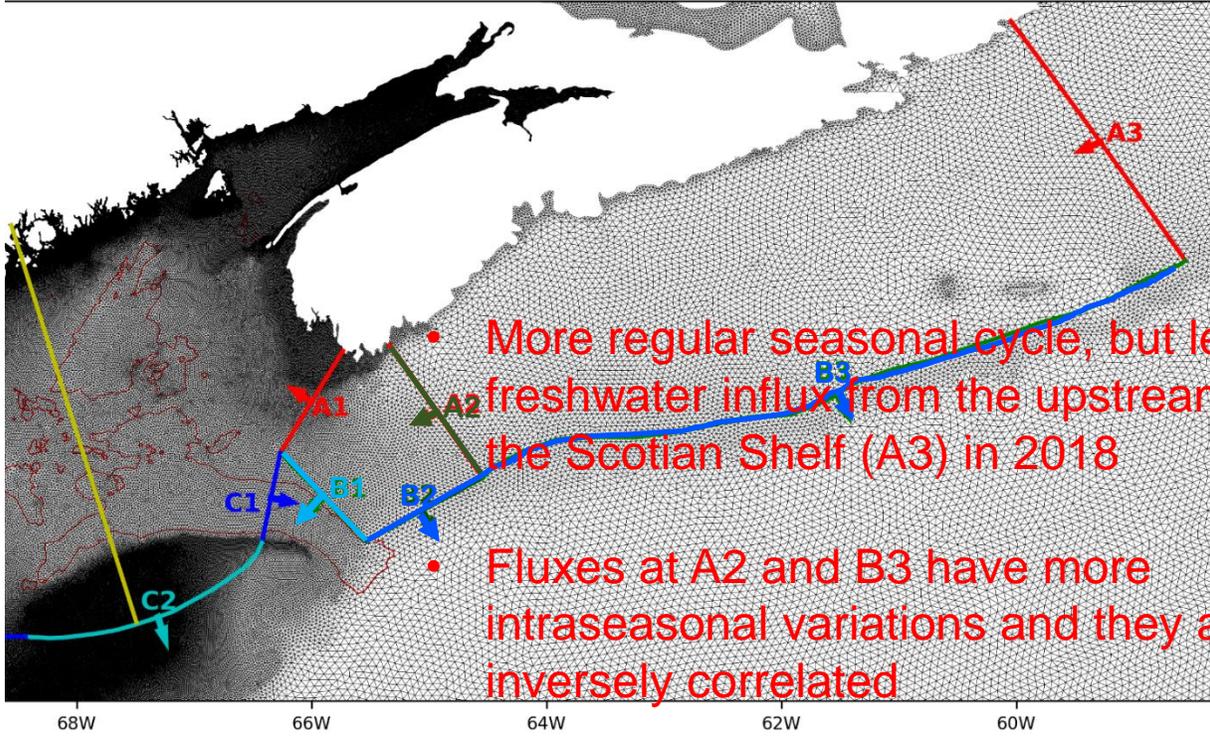
# FreshWater Transport (FWT) in the NSS & Salinity in the GoM



- The Gulf of Maine was noticeably saltier in 2018 than in 2017.
- Influx of freshwater from the Scotian Shelf influences strongly the salinity in the eastern Gulf of Maine.



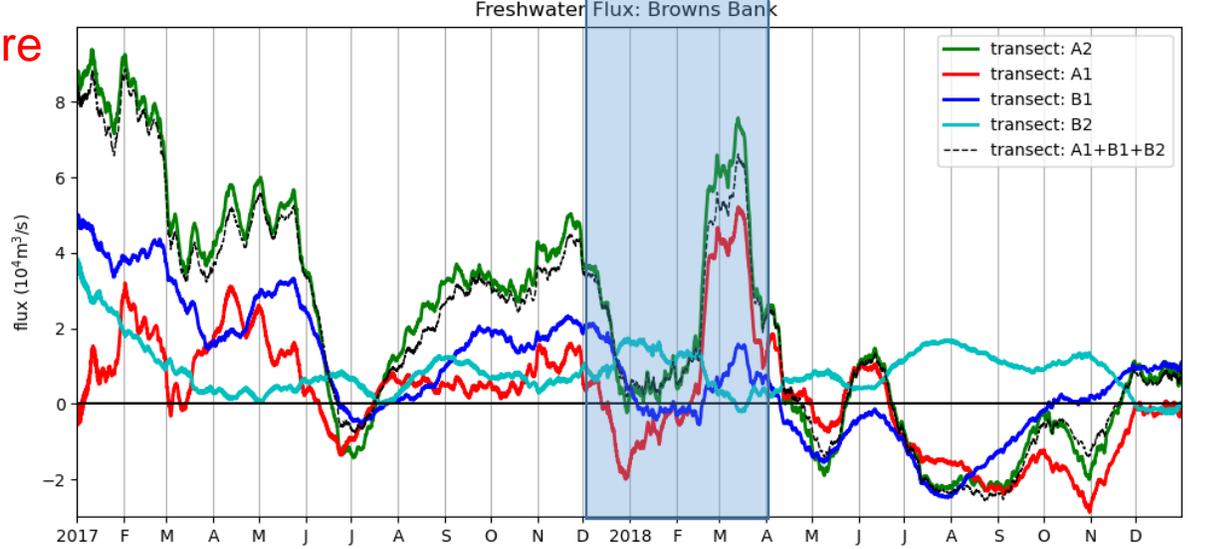
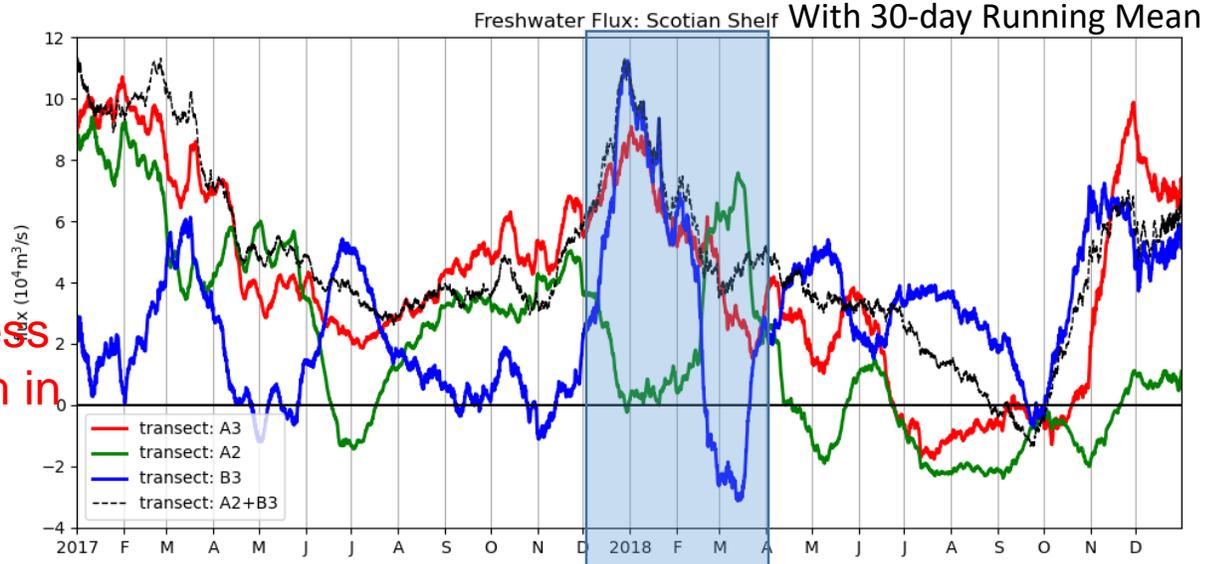
# FreshWater Transport (FWT) in the NSS & Salinity in the GoM



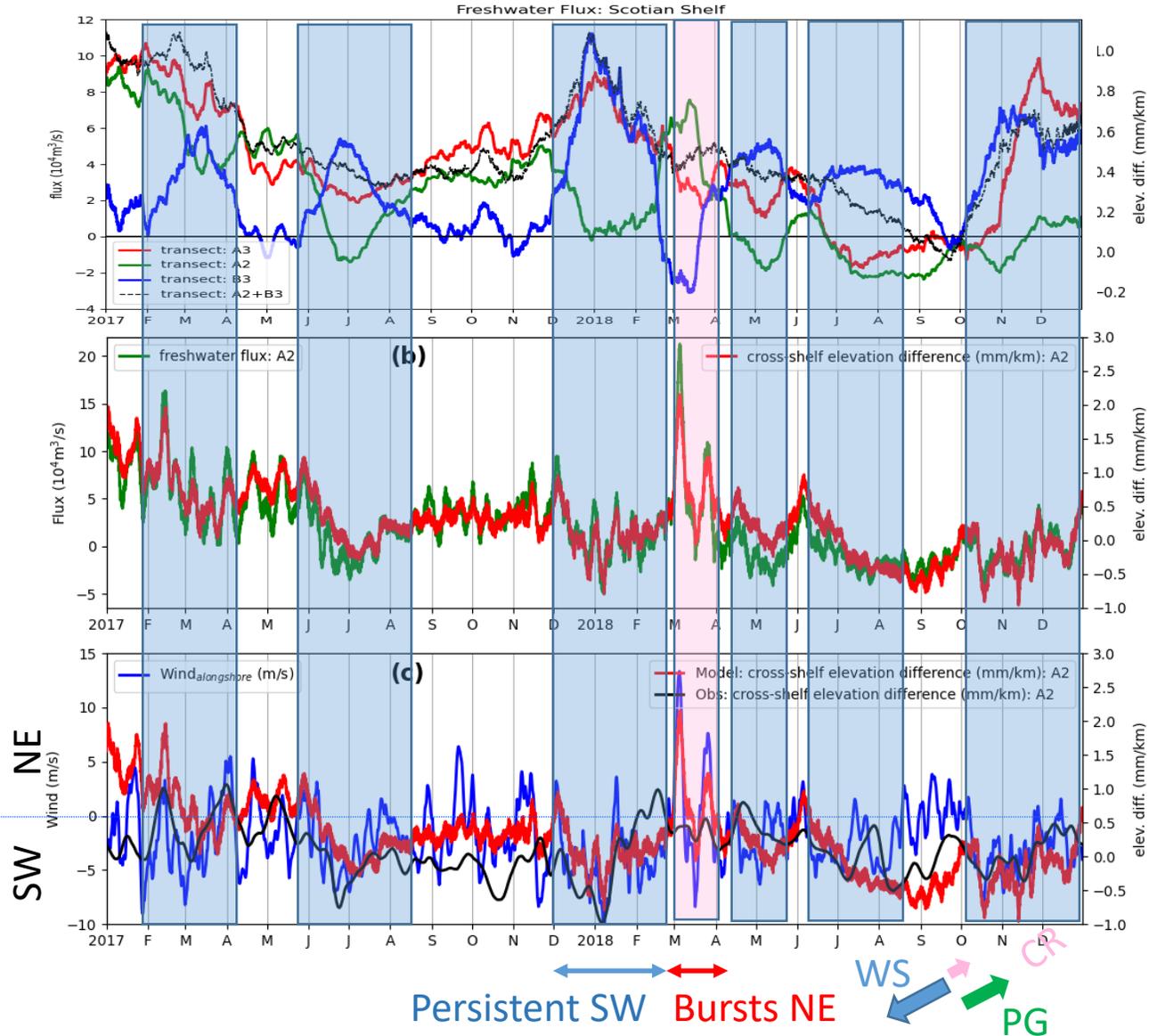
- More regular seasonal cycle, but less freshwater influx from the upstream in the Scotian Shelf (A3) in 2018
- Fluxes at A2 and B3 have more intraseasonal variations and they are inversely correlated

$$Q^F = \int_0^L dl \int_{-H}^{\eta} dz \cdot (F \cdot \vec{U}_{\perp}) = \int_0^L dl \int_{-H}^{\eta} dz \cdot \left( \frac{S_0 - S}{S_0} \cdot \vec{U}_{\perp} \right)$$

- Fluxes around Browns Bank are well balanced, and they (including the one into the Gulf of Maine, i.e., A1) follow that of A2.

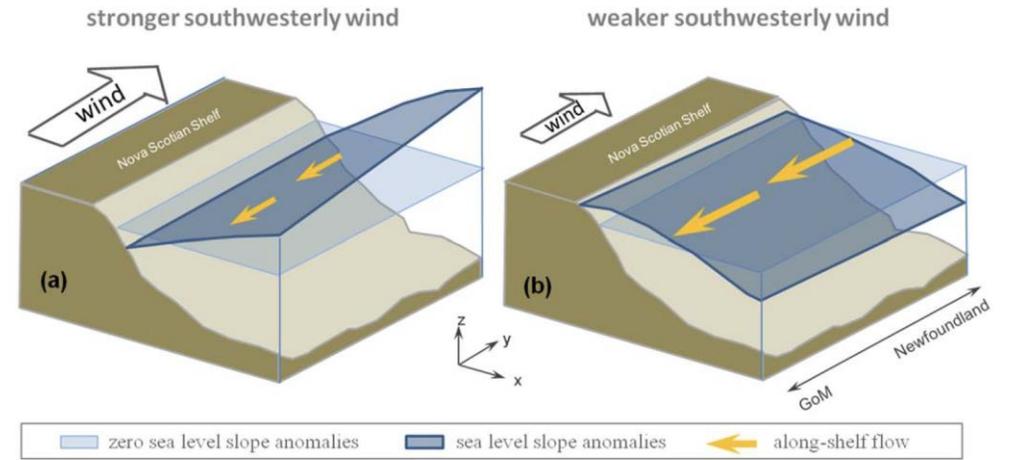


# FreshWater Transport (FWT) in the NSS & Salinity in the GoM



$$\text{CS: } \frac{g \partial \zeta}{\partial x} = -\frac{g}{\rho} \int \frac{\partial \rho}{\partial x} dz + fv$$

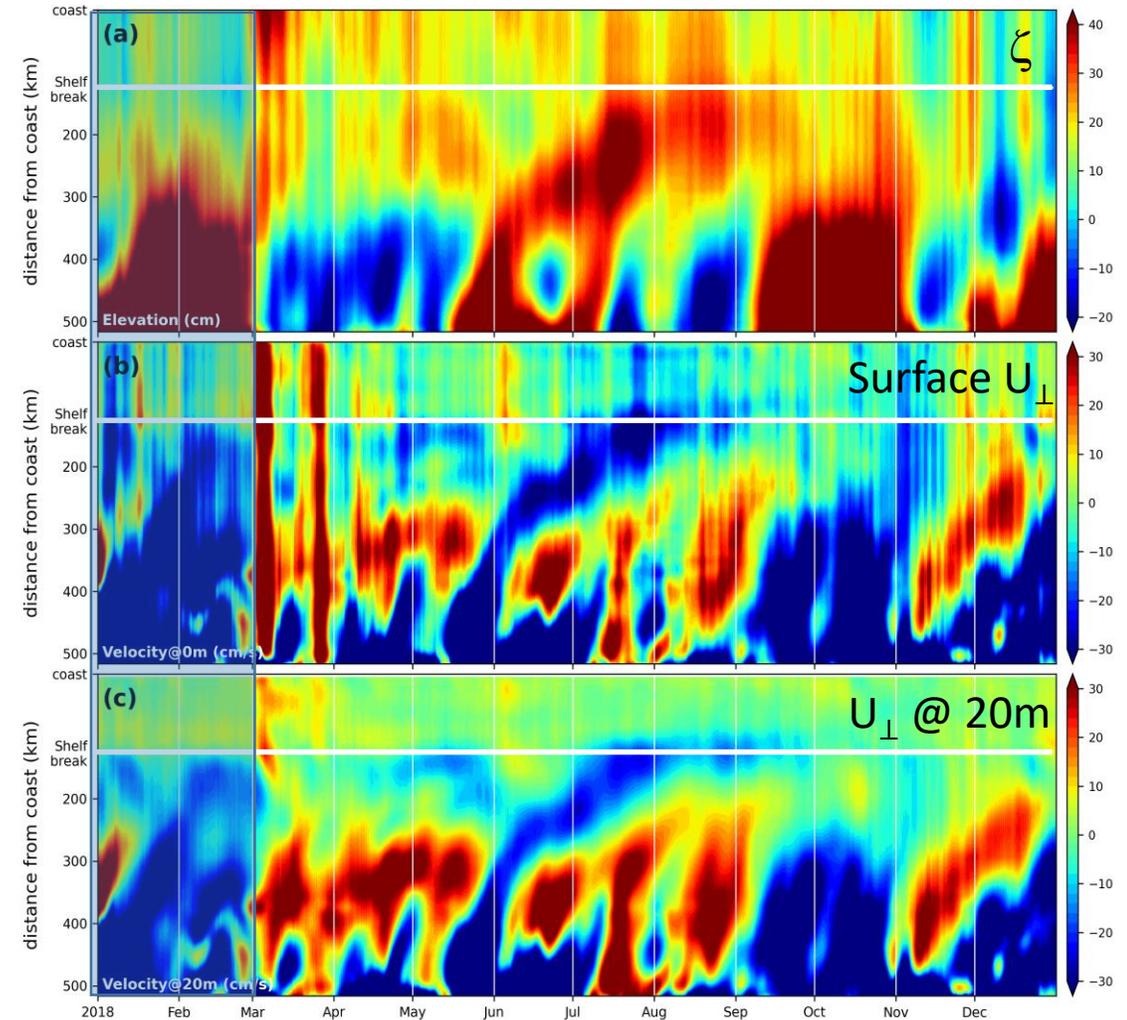
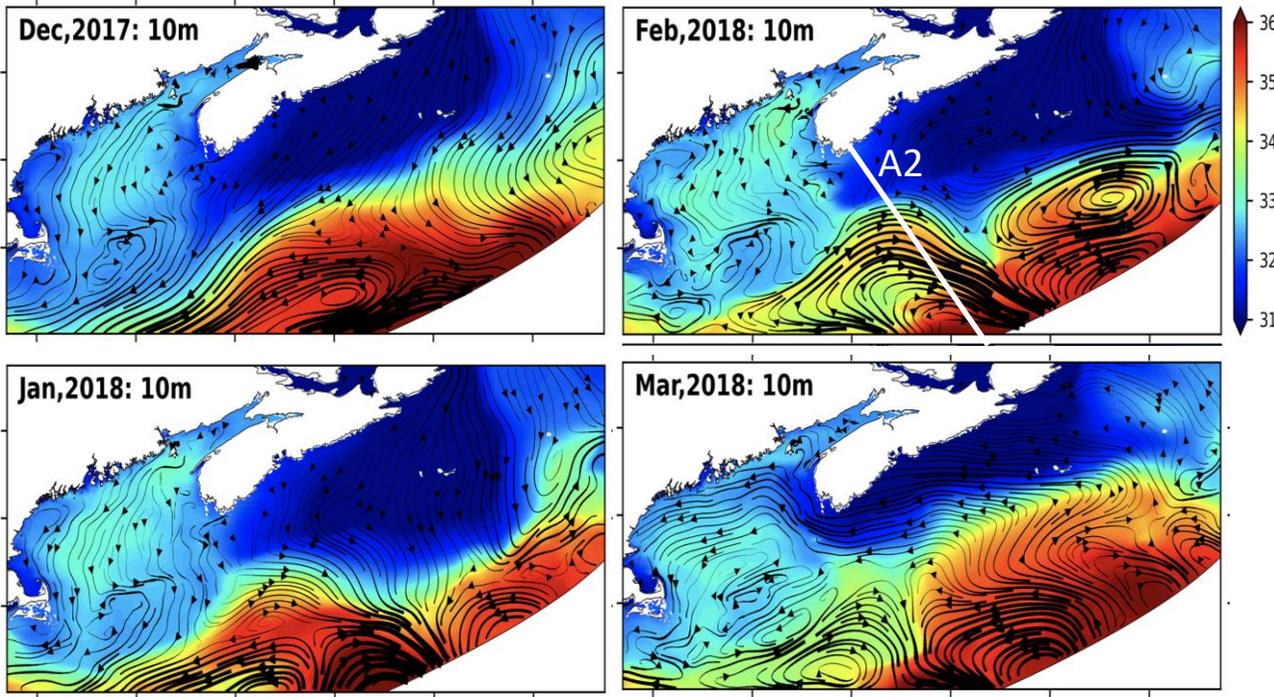
Li et al., JGR Oceans, 2014



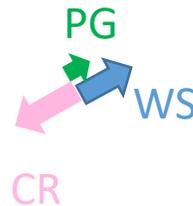
$$\text{AS: } \frac{g \partial \zeta}{\partial y} = -\frac{g}{\rho} \int \frac{\partial \rho}{\partial y} dz - fu + \frac{\tau_s}{\rho h} - \frac{\tau_b}{\rho h}$$



# FreshWater Transport (FWT) in the NSS & Salinity in the GoM

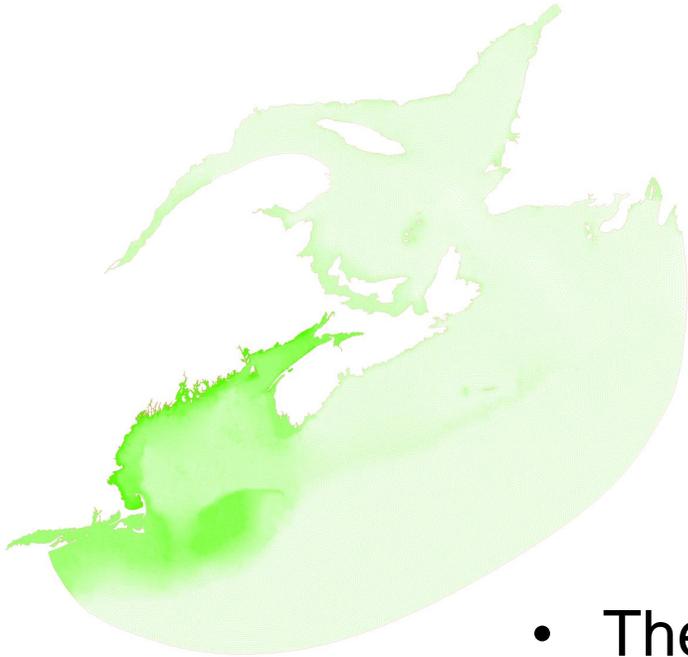


- WCR/AE near the Northeast Channel adds to the blocking effect to further weaken the southwestward FWT.



2018

# Summary



- We have successfully implemented SCHISM to the NorthEast Shelf Seas.
- The model results demonstrated a multi-core structure of the EMCC and showed seasonal evolution of its offshore veering in relation to the Scotian Shelf inflow and Slope Water intrusion.
- The model results also demonstrated the influence of freshwater transport (FWT) in the NSS on the salinity in the eastern Gulf of Maine.
- Other than the seasonal input of freshwater from the upstream, FWT in the NSS is modulated by the alongshore wind and oceanic eddies impinging on the shelfbreak.