Numerical Study of Three-Dimensional Circulation and Hydrography in Halifax Inlet Using a Nested-Grid Ocean Circulation Model

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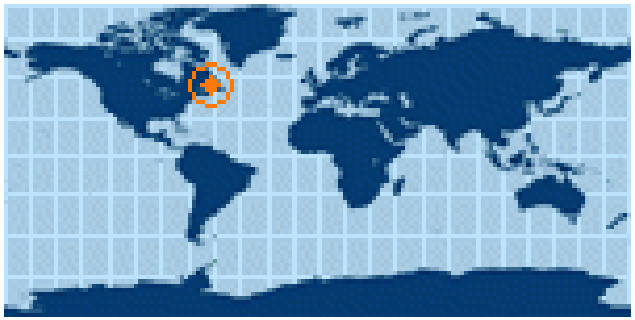
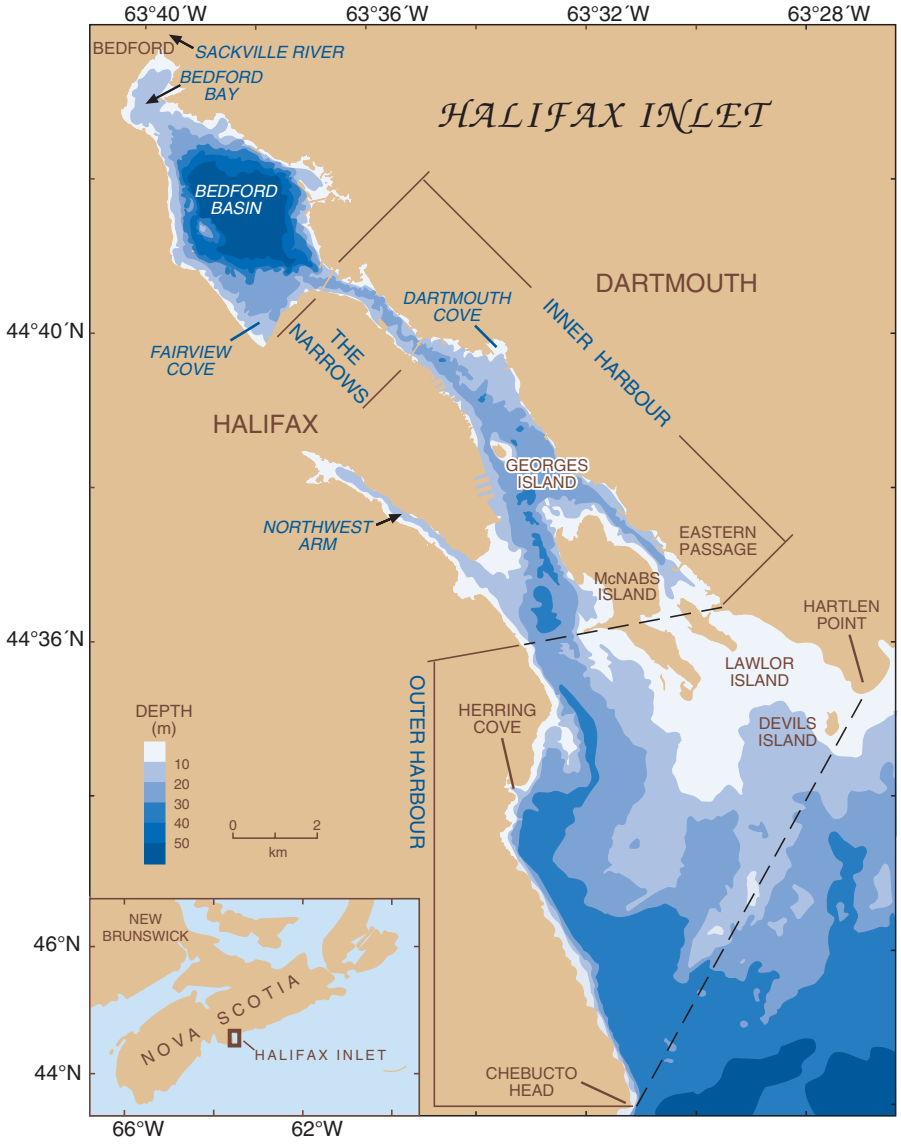
1. Introduction

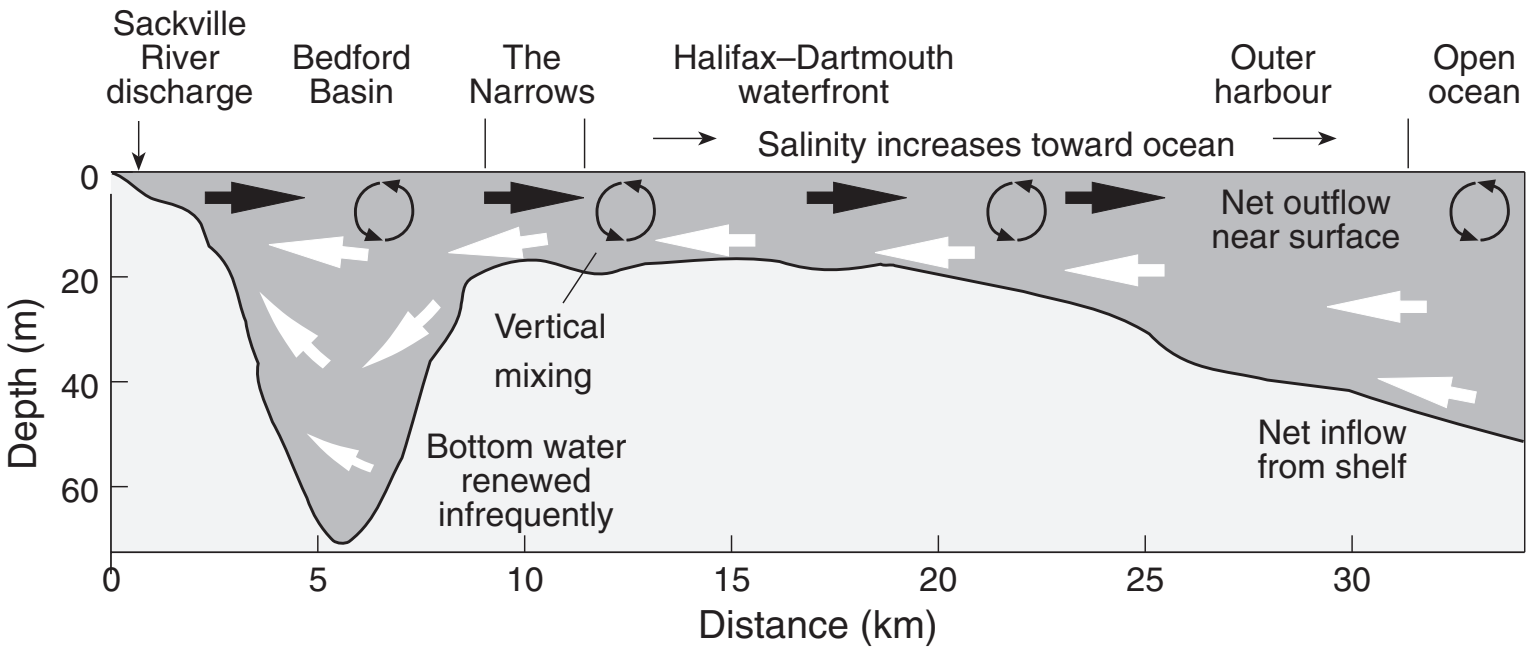
Halifax Inlet enjoys a variety of uses which include:

- Recreation
- Military
- Shipping
- Fishing
- Research activities



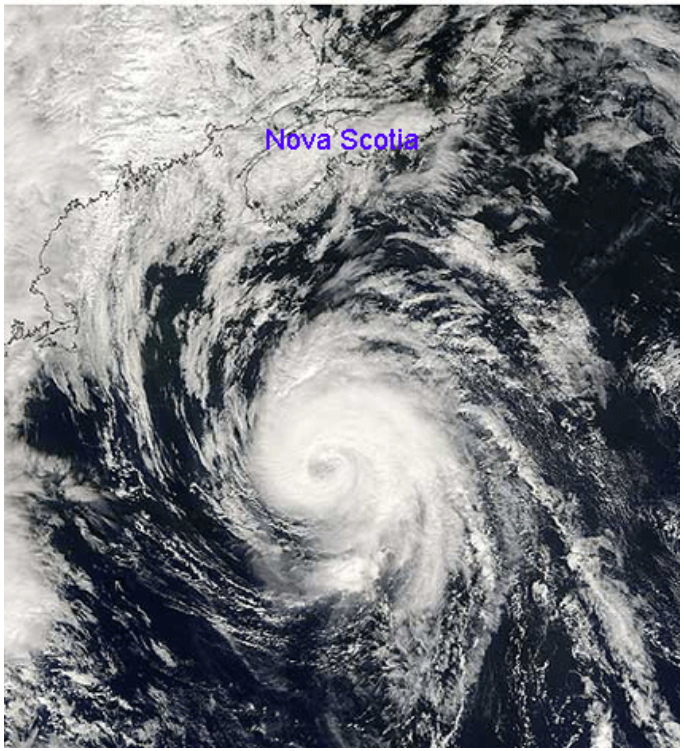


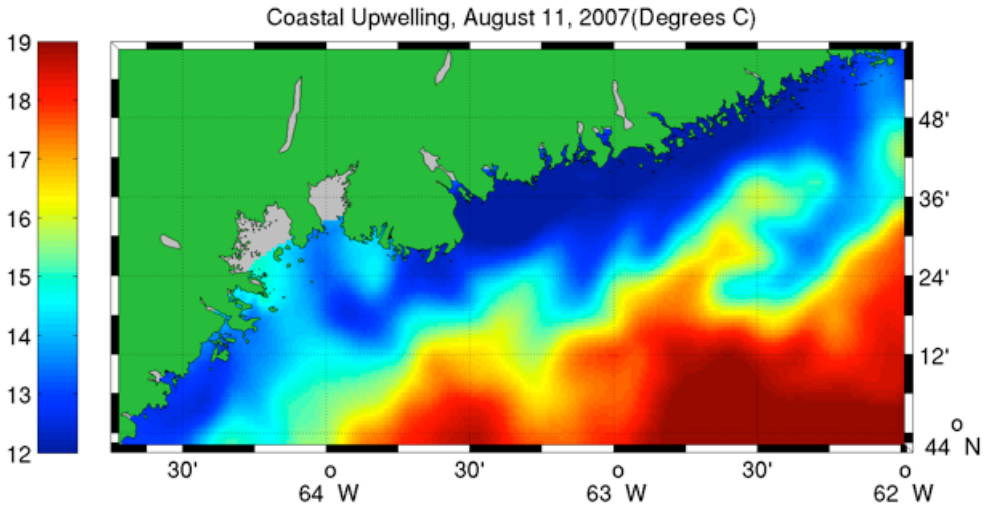
2. General Physical Oceanography of Halifax Inlet



Schematic of Two-layered Estuarine Flow in Halifax Inlet

Storm Surge & Coastal Upwelling



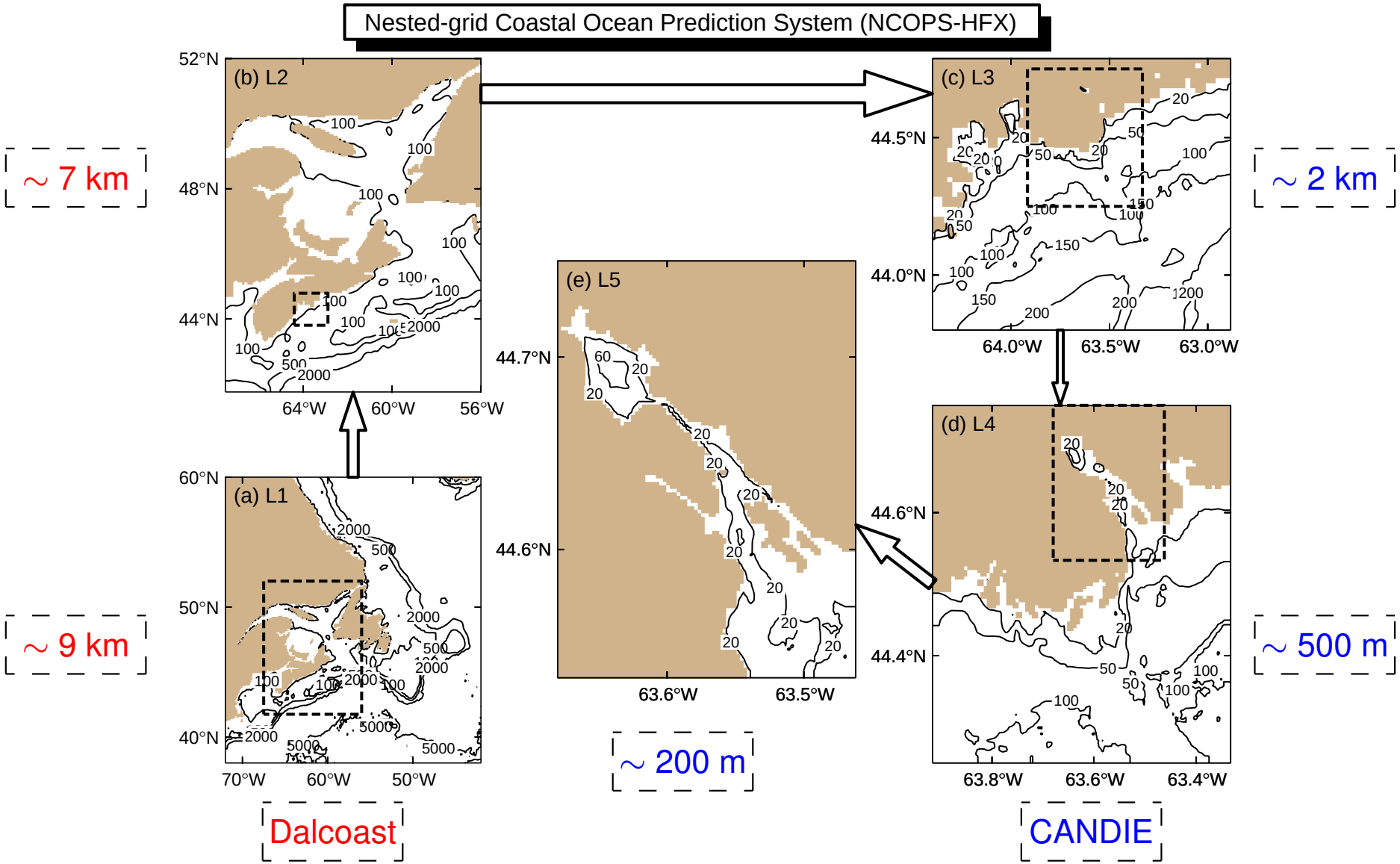


http://gsc.nrcan.gc.ca/coast/storms/juan/images/juan-satellite.gif
http://bbomb.ceotr.ca/images/processedData/webImages/satellite/WaterTemperature.png

Main Scientific Issues to be Addressed:

- What is the seasonal variability of TS in Halifax Inlet?
- How does the inlet respond to tides, wind, freshwater discharge?
- What is the dispersion rates in Halifax Inlet?

3. Nested-grid Coastal Circulation Model



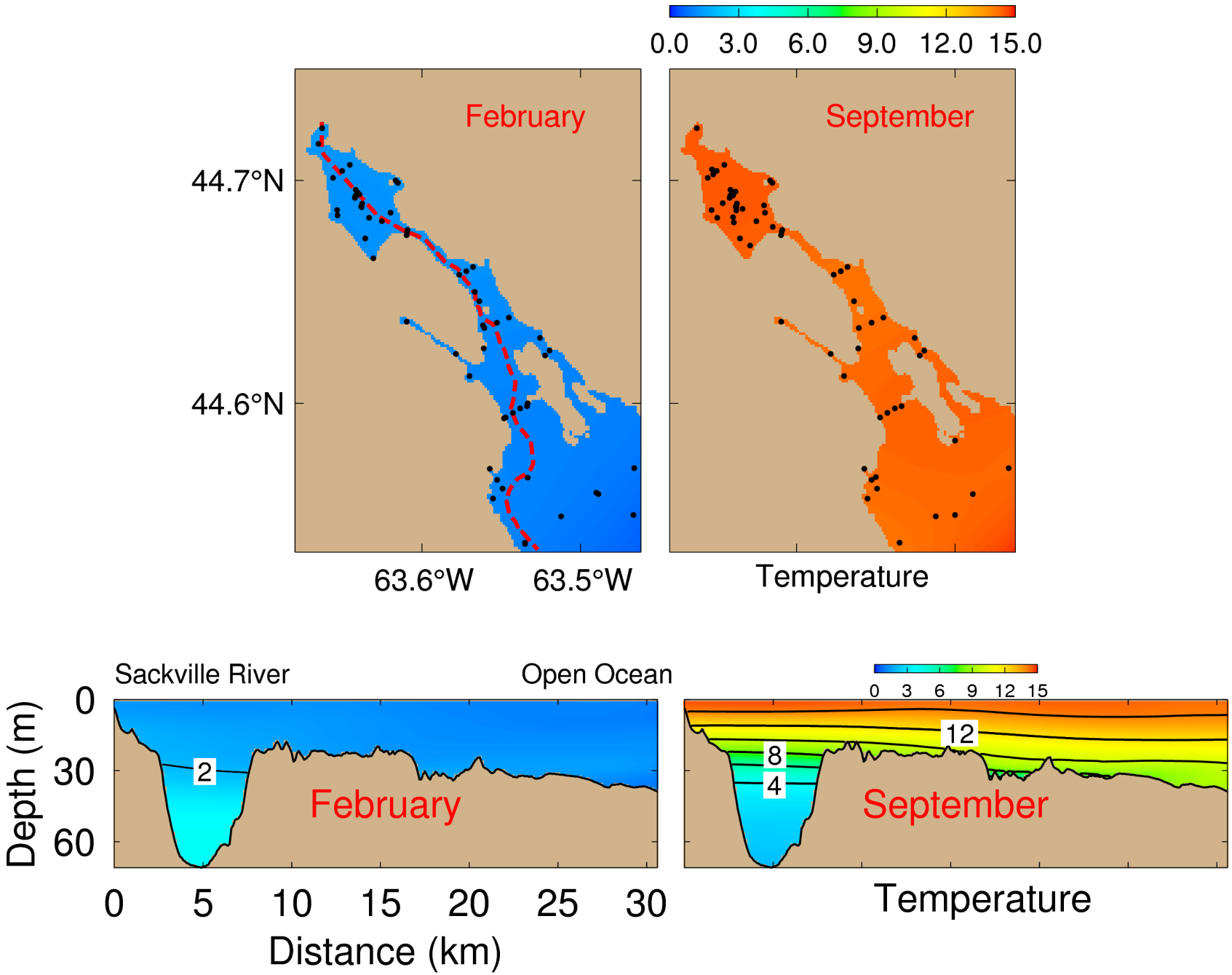
Main Features of NCOPS-HFX:

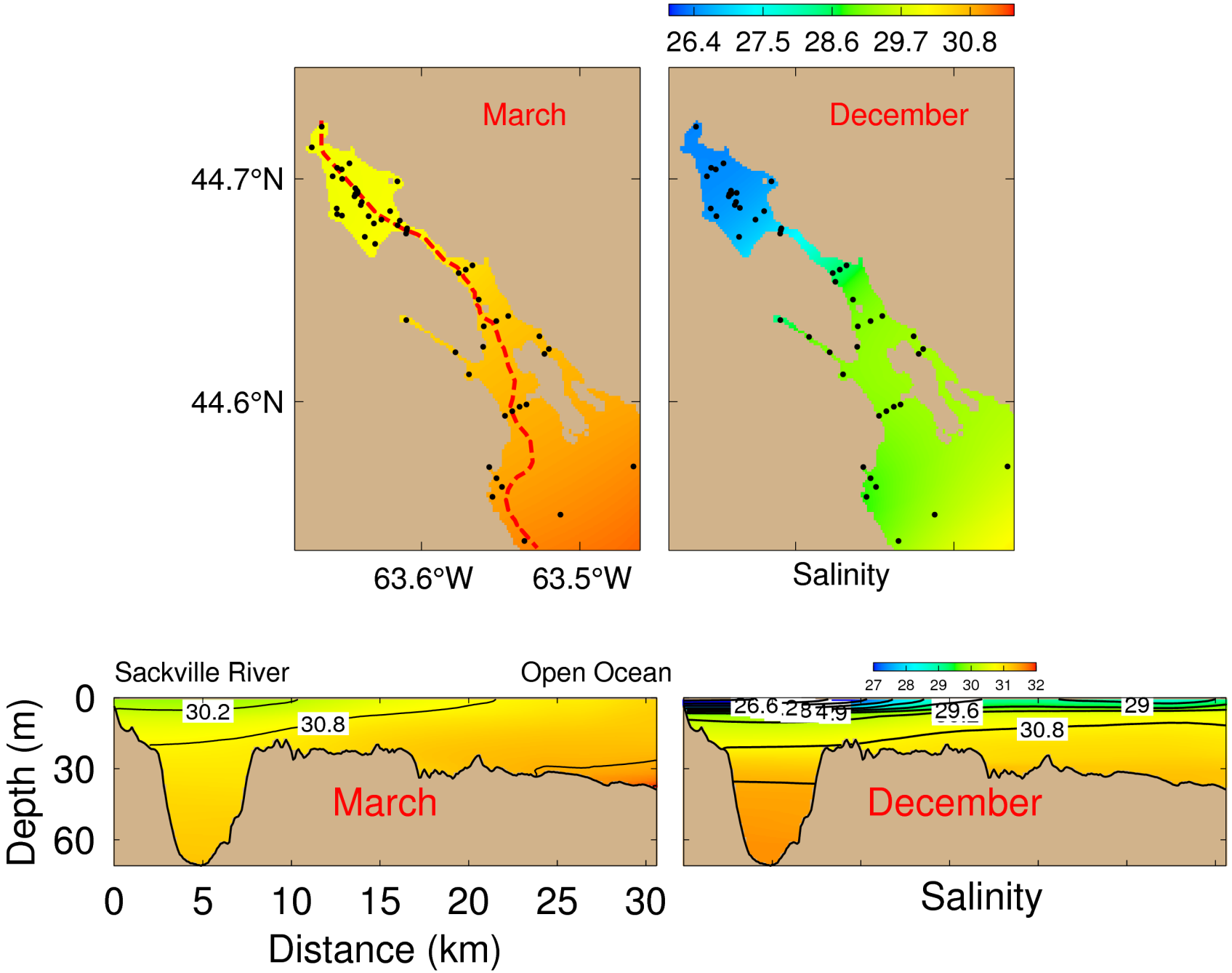
- Five submodels with different horizontal resolutions
- Based on Dalcoast (POM) and CANDIE
- Driven by WebTide and meteorological forcing, heat flux, water discharge
  - 1-hourly surface elevation and depth-mean currents along the open boundary of submodel 2
    (submodel 1, WebTide and seasonal mean climatology)
  - 3-hourly numerical weather forecasts wind (MSC)
  - 6-hourly surface heat flux (NCEP Reanalysis data)
  - Daily observed Sackville River discharge
  - Constant fluvial and sewage effluent along the coastline of Halifax Inlet
- One-way nesting
- Operational capability

Monthly Mean TS Climatology

Constructed using Barnes' algorithm from $\sim$ 500,000 points of TS observations ranging from year 1915 to 2008 including:

- Weekly or bi-weekly CTD surveys in Halifax Inlet between year 2004-2007 (HHWQMP) 80%
- Hydrographic Climate Database between year 1915-2008 (Fisheries and Oceans Canada, DFO) 20%

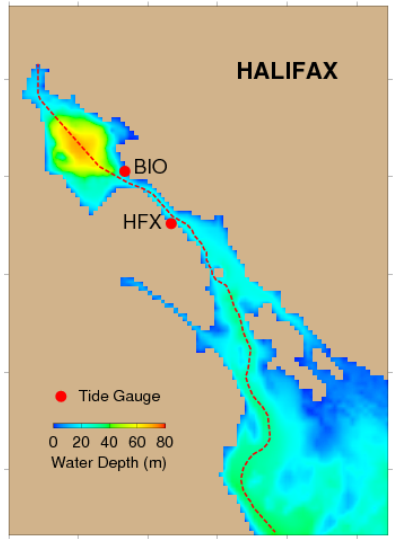

0.0 3.0 6.0 9.0 12.0 15.0
February
September
44.7°N
44.6°N
63.6°W
63.5°W
Temperature
Sackville River
Open Ocean
Depth (m)
0
30
60
2
February
0 3 6 9 12 15
12
8
4
September
0 5 10 15 20 25 30
Distance (km)
Temperature

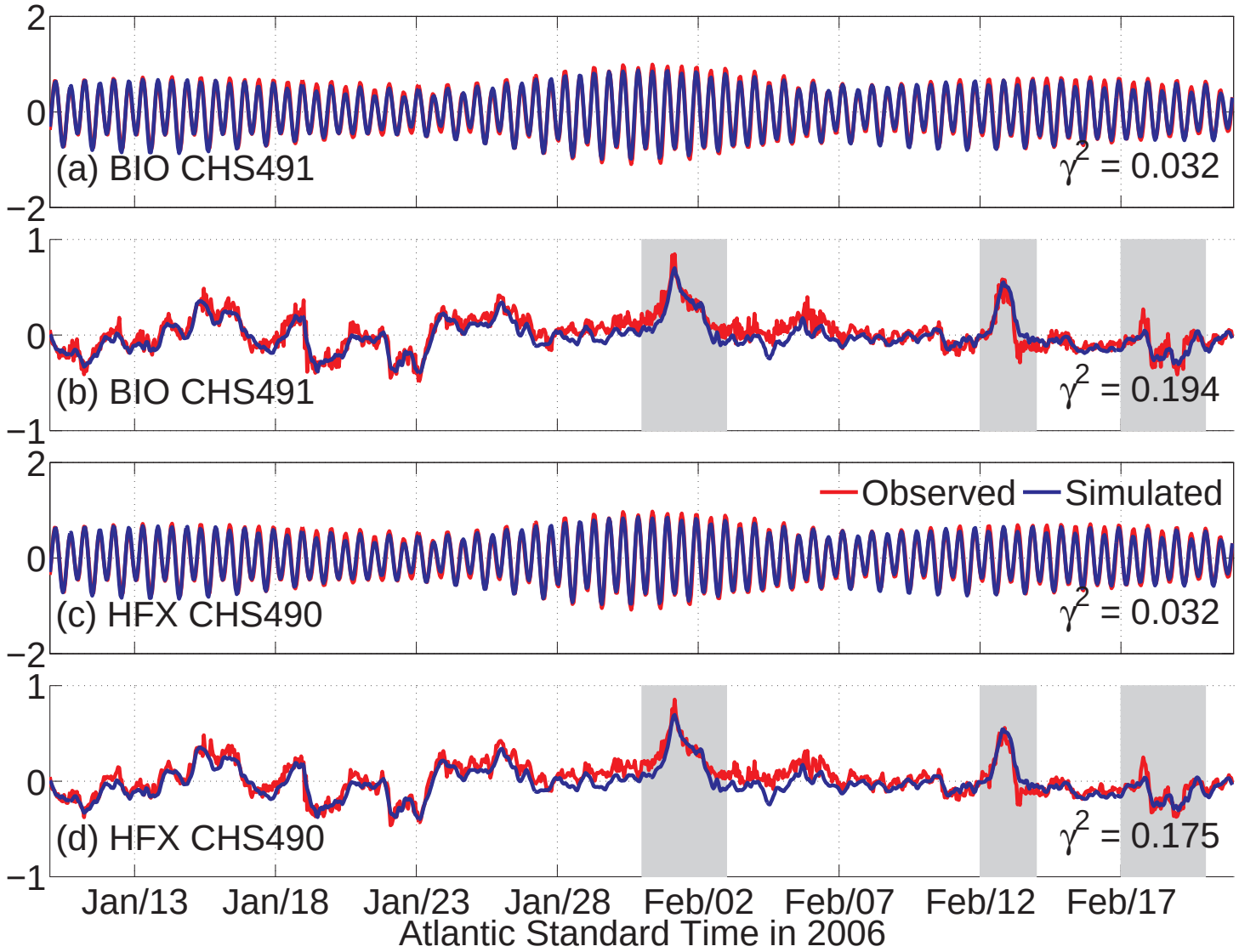

26.4 27.5 28.6 29.7 30.8
March
December
44.7°N
44.6°N
63.6°W
63.5°W
Salinity
Sackville River
Open Ocean
Depth (m)
0
30
60
30.2
30.8
March
0 5 10 15 20 25 30
Distance (km)
27 28 29 30 31 32
26.6 28 4.9
29.6
29
30.8
December
Salinity

Comparison of Tidal & Non-tidal Sea Levels

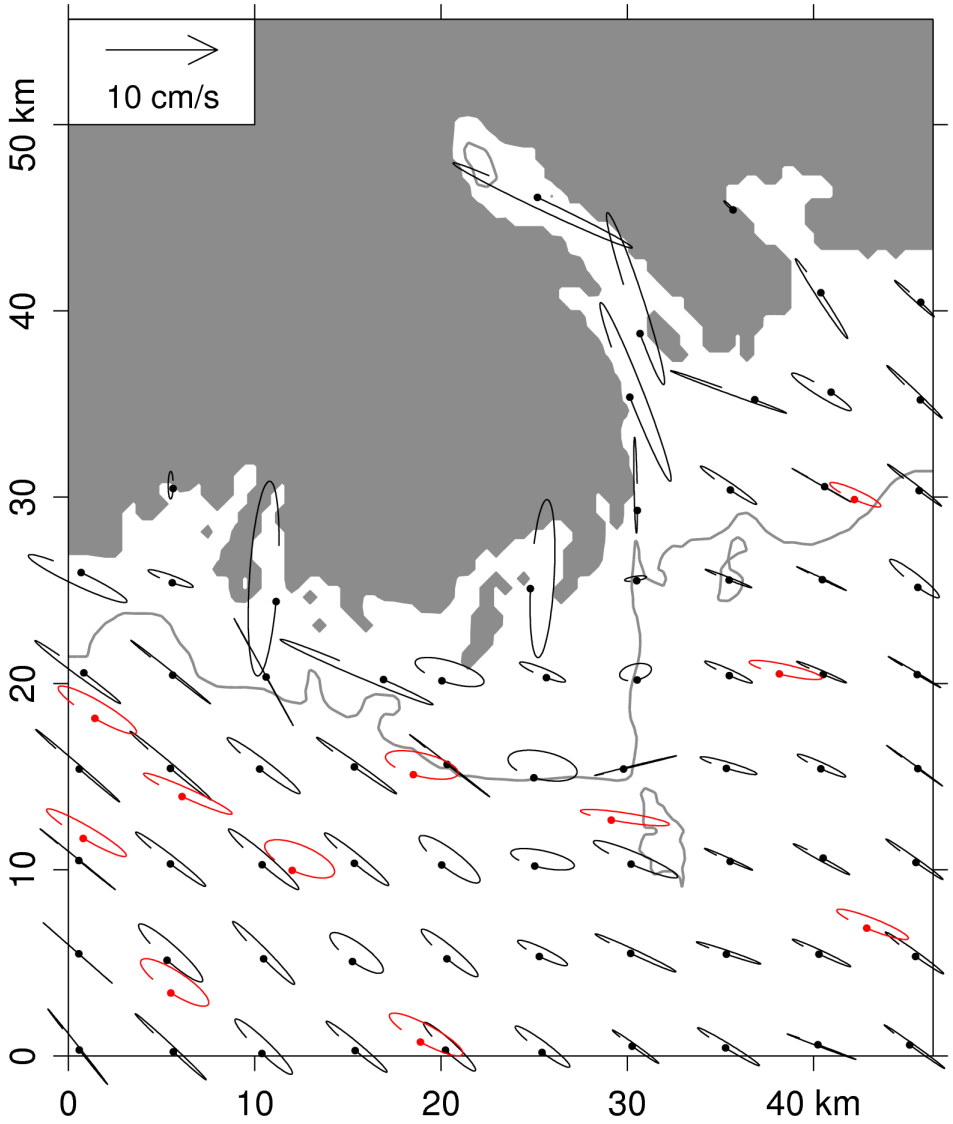
Tidal

Non-tidal





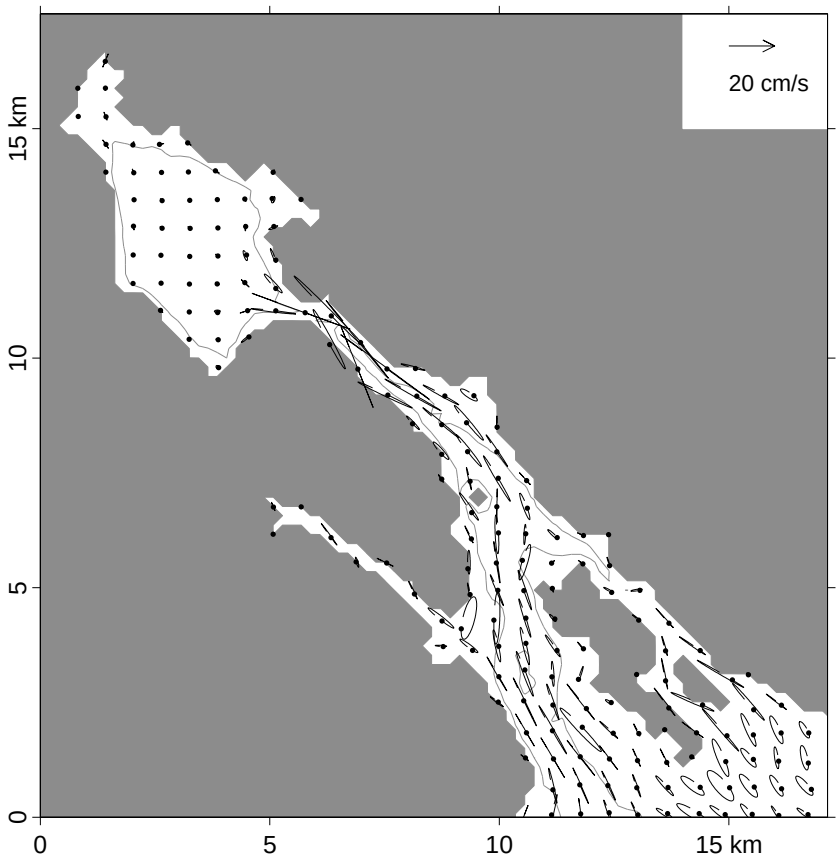
Comparison of Tidal Currents



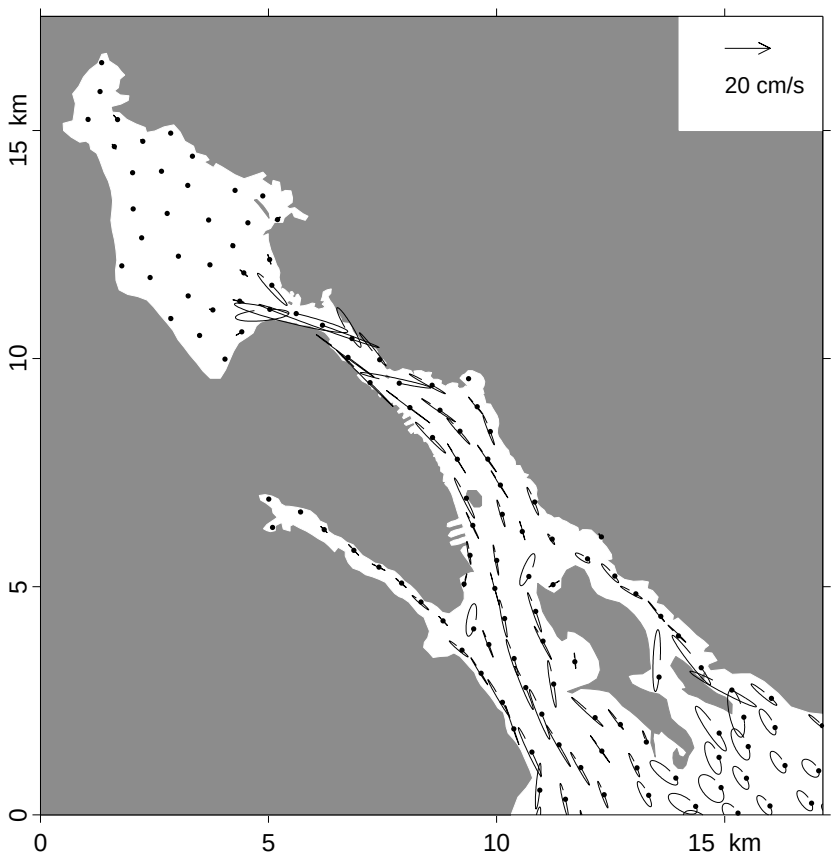
Submodel 4
(each 10 points)

WebTide
(actual points)

Comparison of Tidal Currents

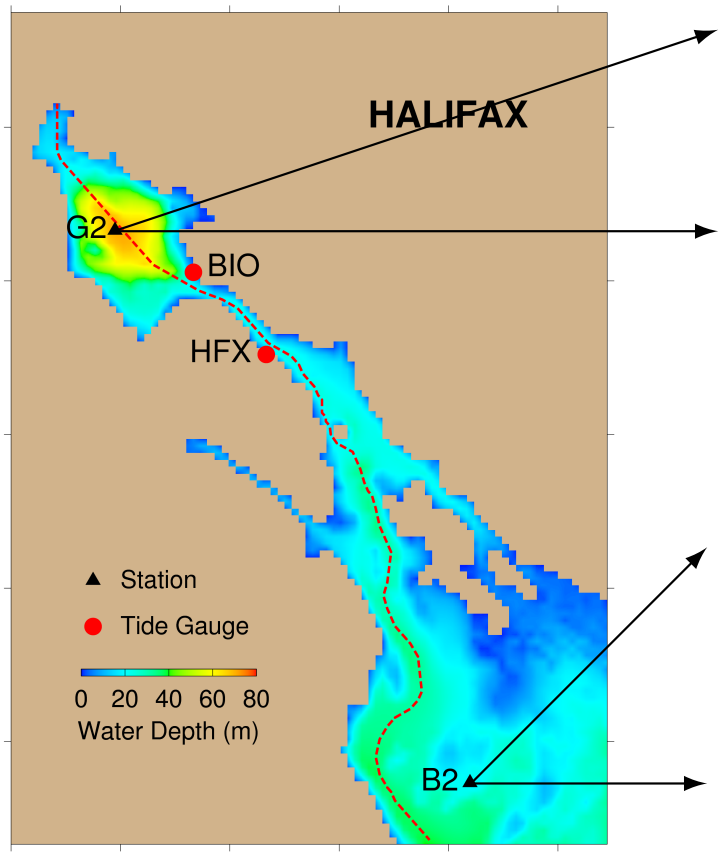


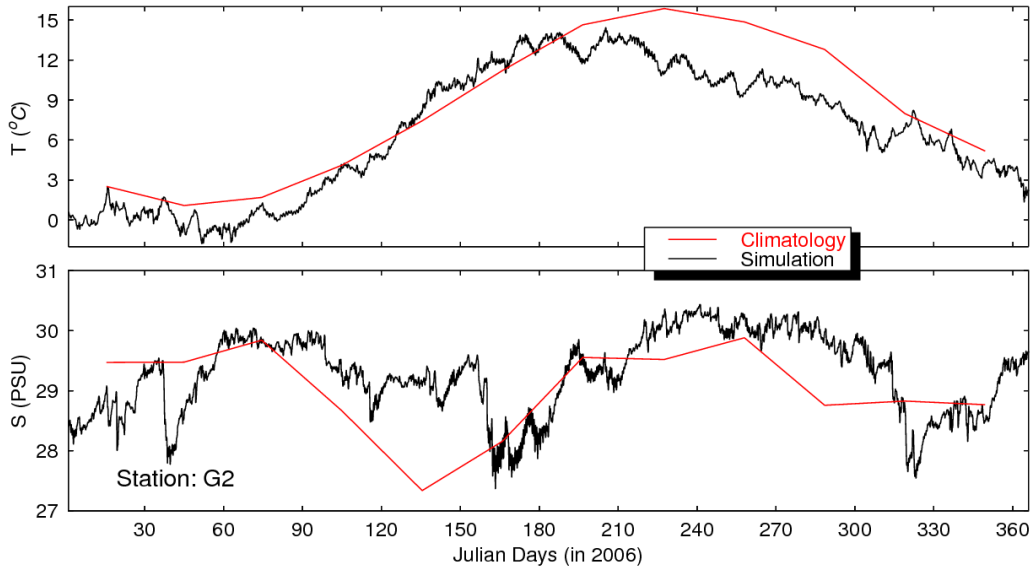
Submodel 5

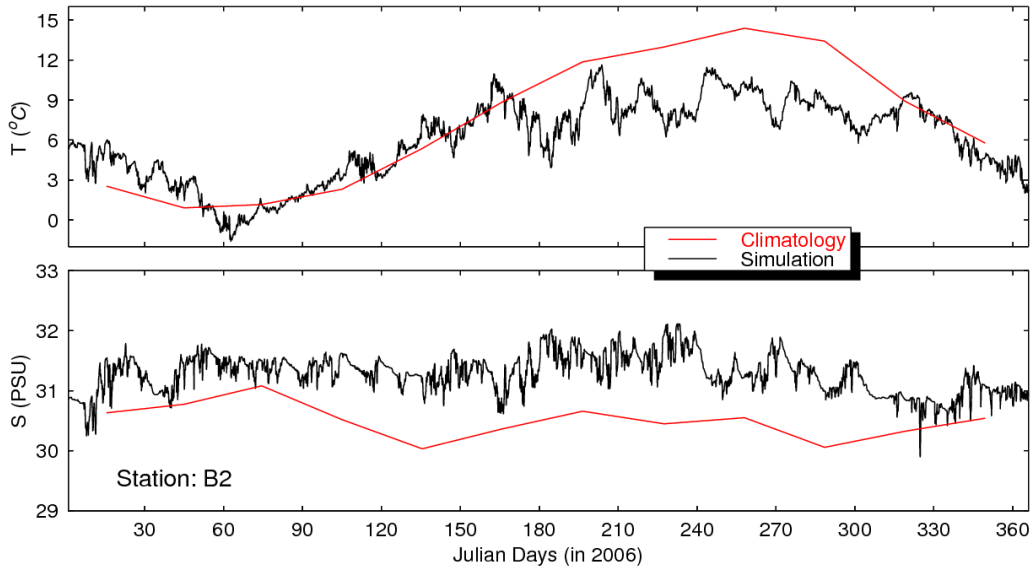


WebTide

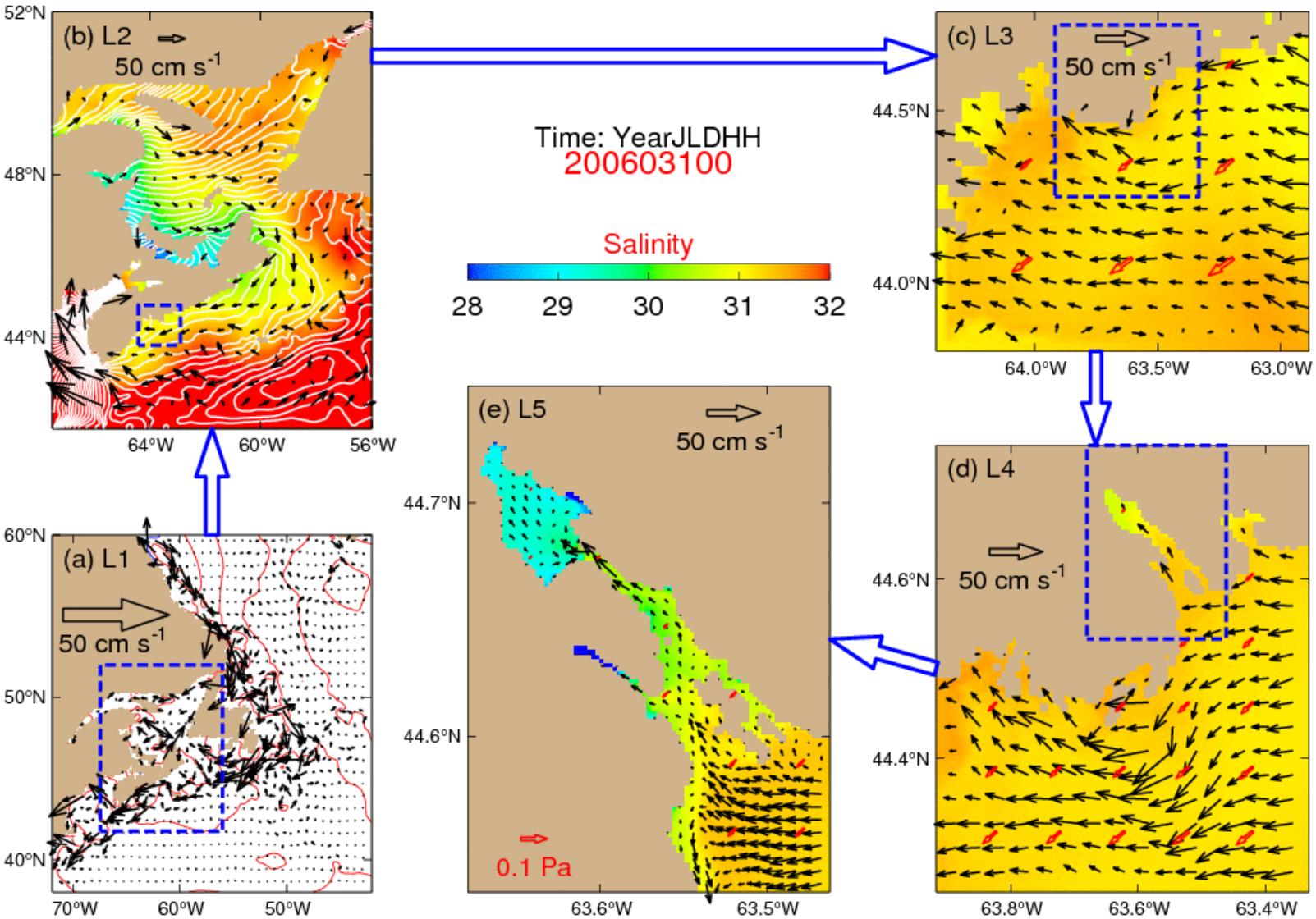
Comparison of Surface T & S

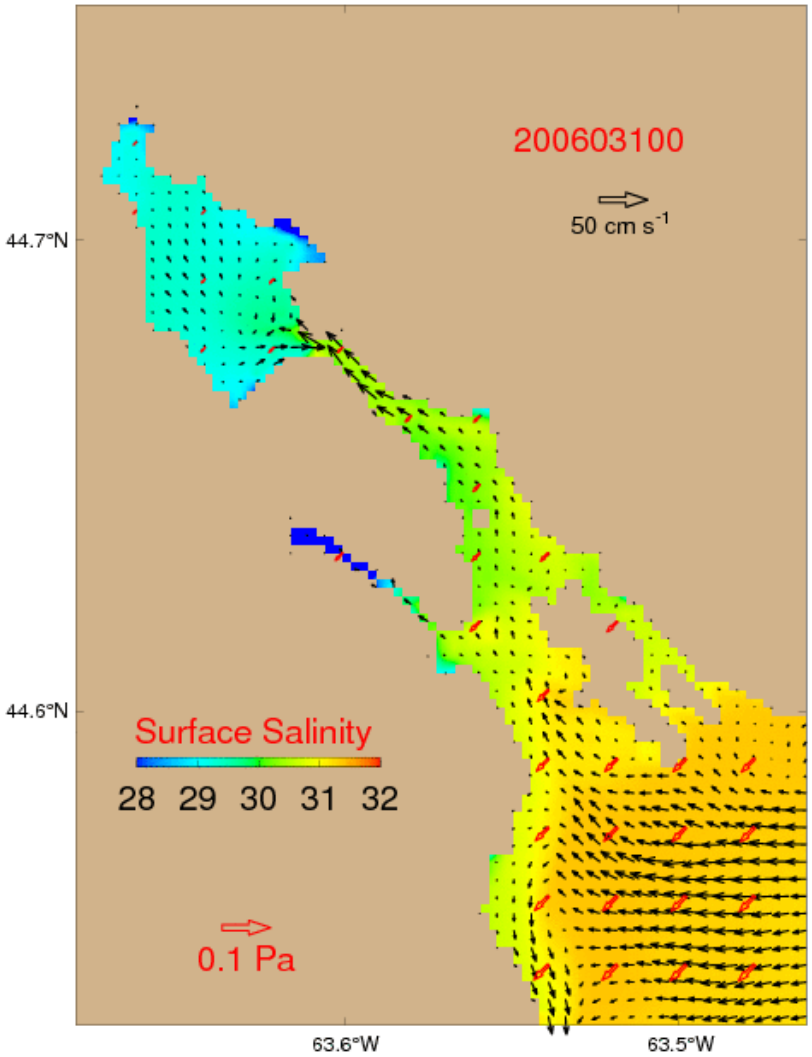




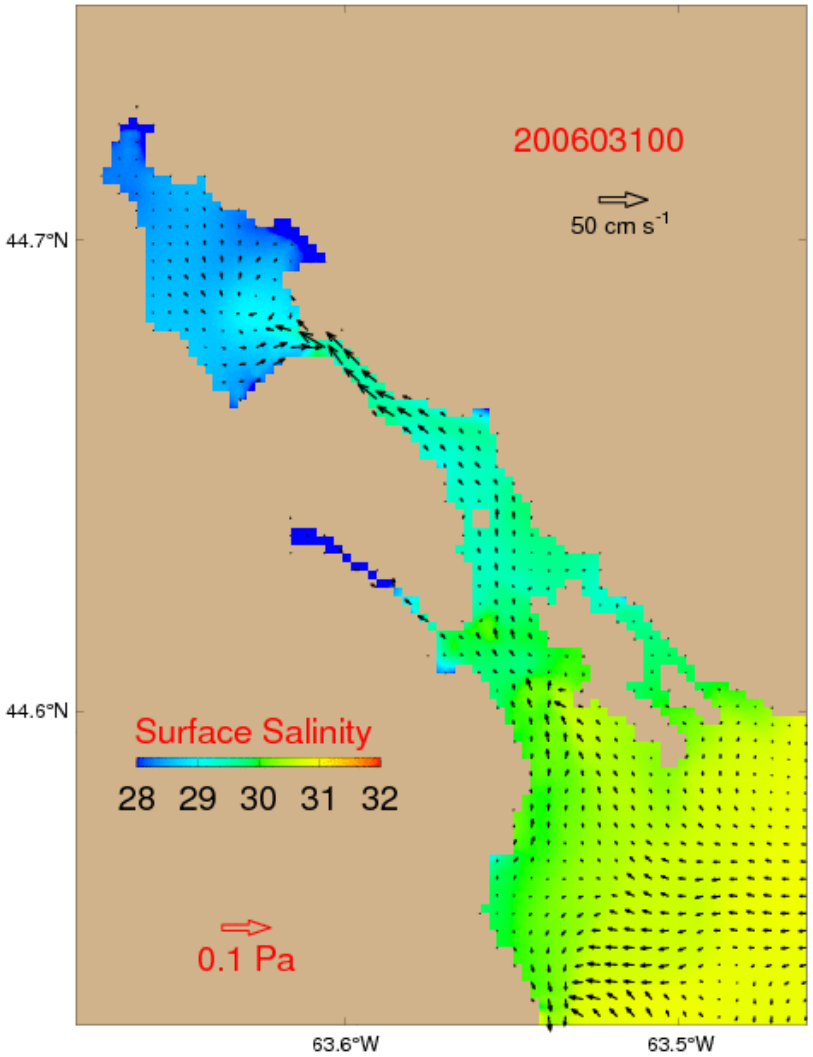


Nested-grid Coastal Ocean Predicting System (NCOPS-HFX)





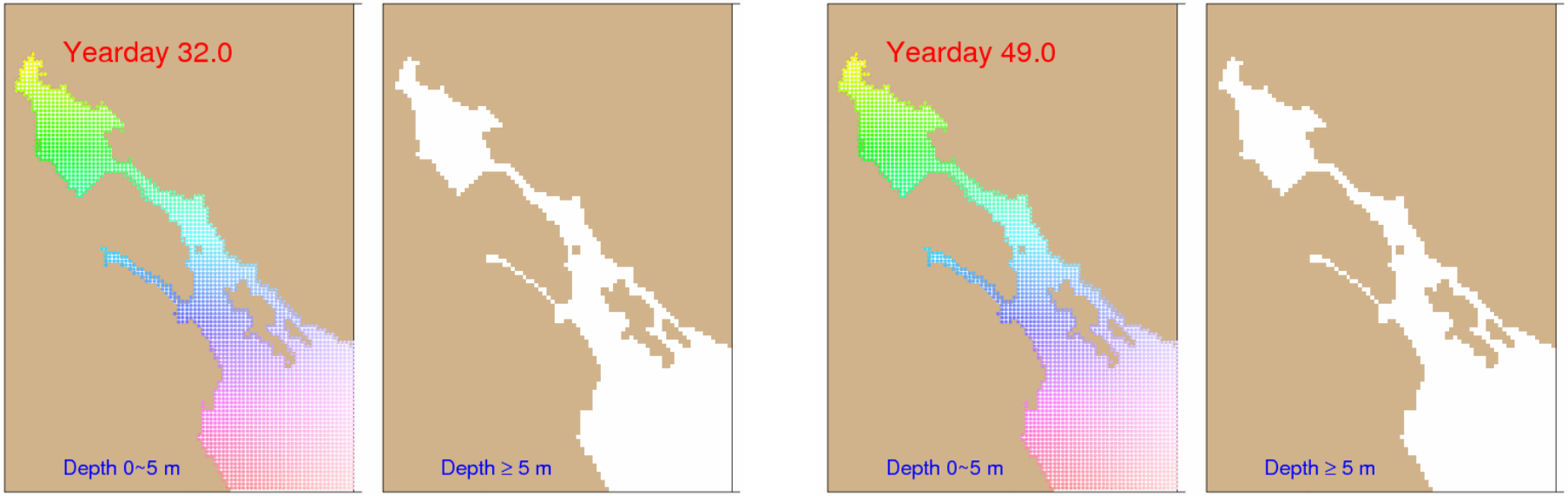
With wind



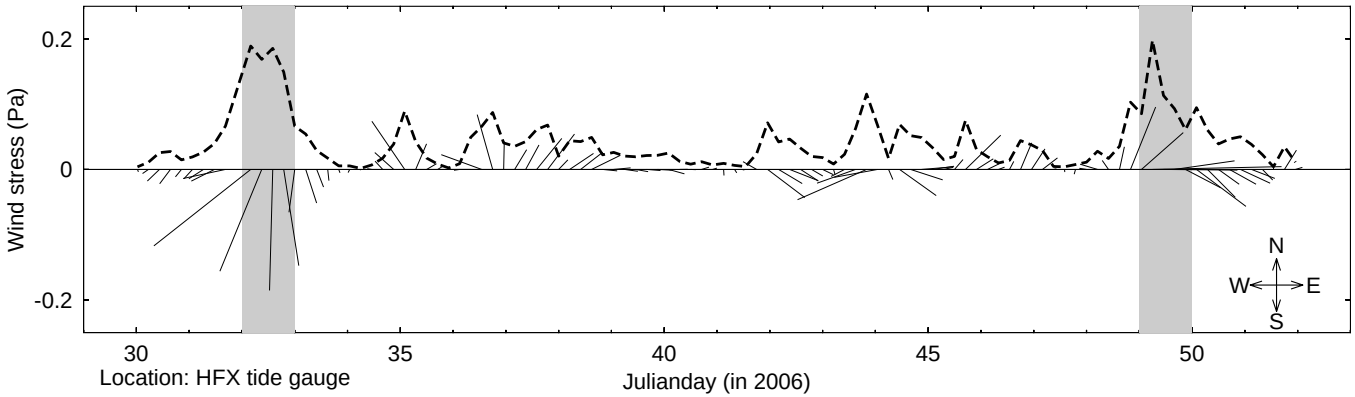
Without wind

4.Dispersion in Halifax Inlet

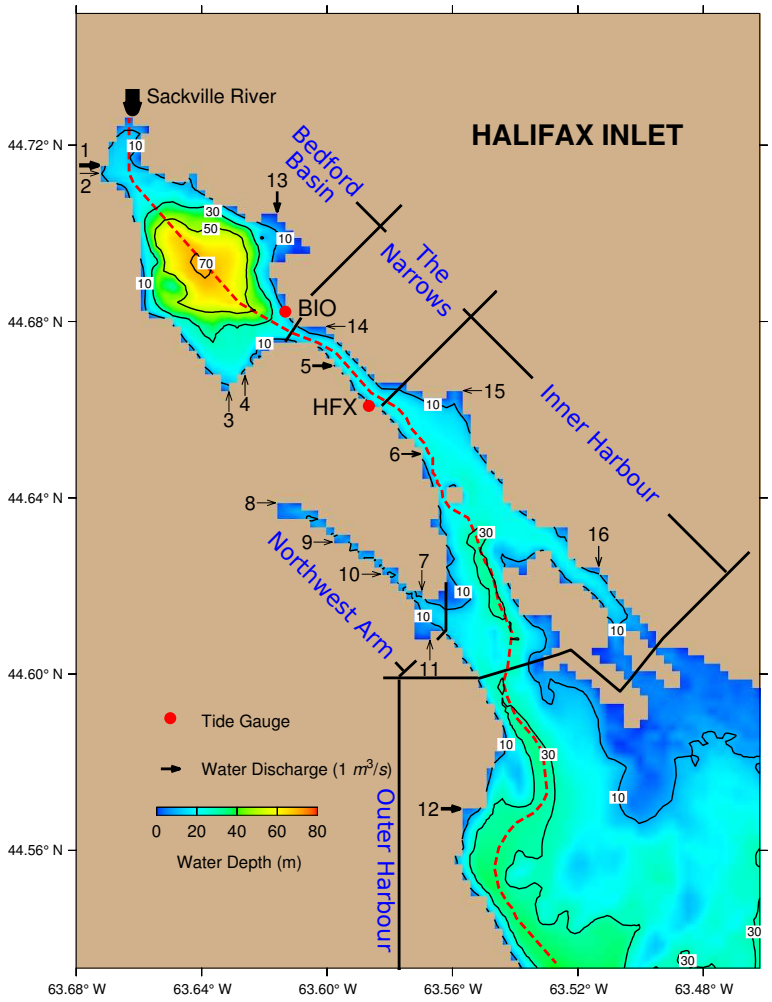
3D Passive Particle Tracking

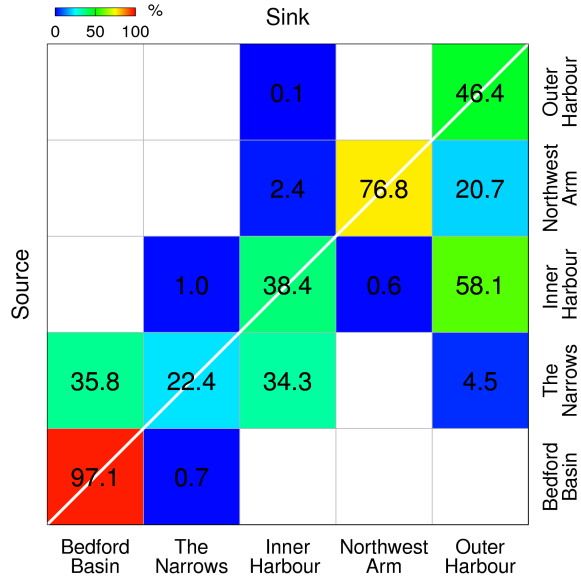


Movements of particles (based on instantaneous baroclinic currents, Feb 2006)

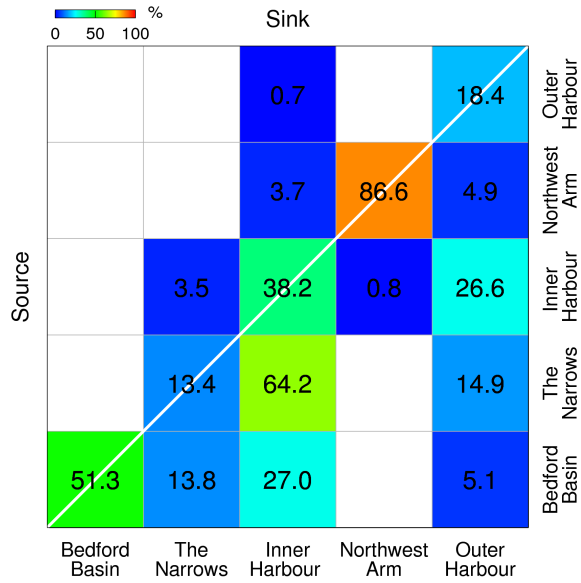


Dynamic Connectivity





Day: 32



Day: 49

Summary

- A 5-level nested-grid ocean circulation model (NCOPS-HFX) was used in simulating the 3D circulation and hydrographic distribution in Halifax Inlet.
- Model results were compared with tide gauge, WebTide and T&S Climatology in Halifax Inlet.
- Model results show coastal circulation and hydrographic distribution in Halifax Inlet are affected significantly by wind, especially during storm period.
- Dispersion and dynamic connectivity in Halifax Inlet were investigated based on particle tracking experiments.

Halifax Harbour

http://pixdaus.com/pics/1212345462z7L8Hdk.jpg