OCEANS PROTECTION PLAN

Port-scale forecast models and relocatable modelling on the Pacific coast of Canada

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Government of Canada Gouvernement du Canada

Canada

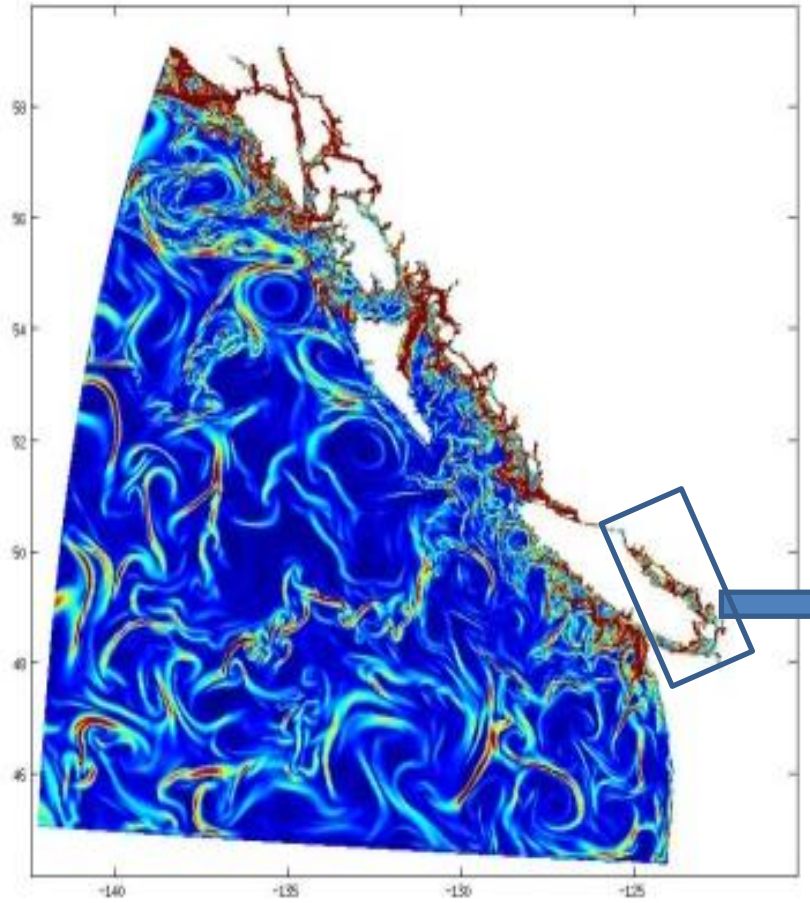
In operations: ECCC's coastal systems

Coastal **I**ce-**O**cean **P**rediction **S**ystem – **E**ast and **W**est

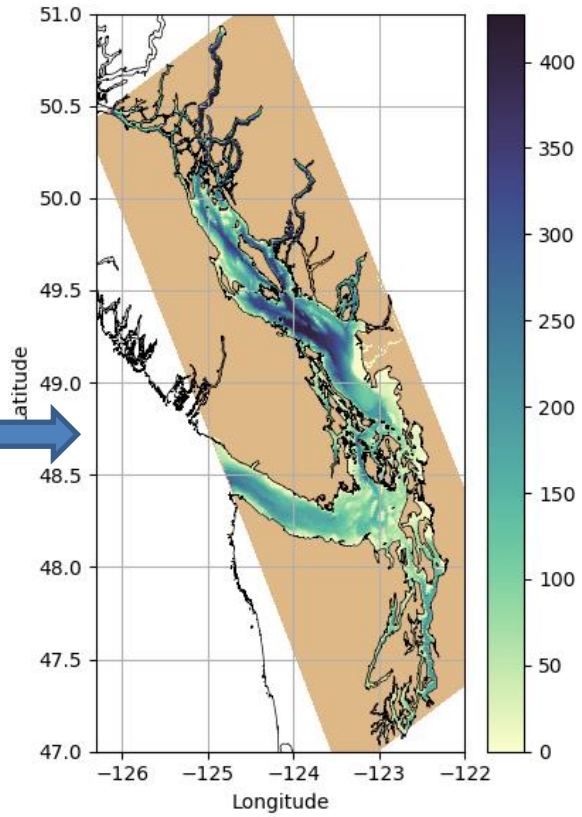
Forced by regional system (RIOPS, 1/12 deg)

– **See Jean-Philippe's talk 45min from now**

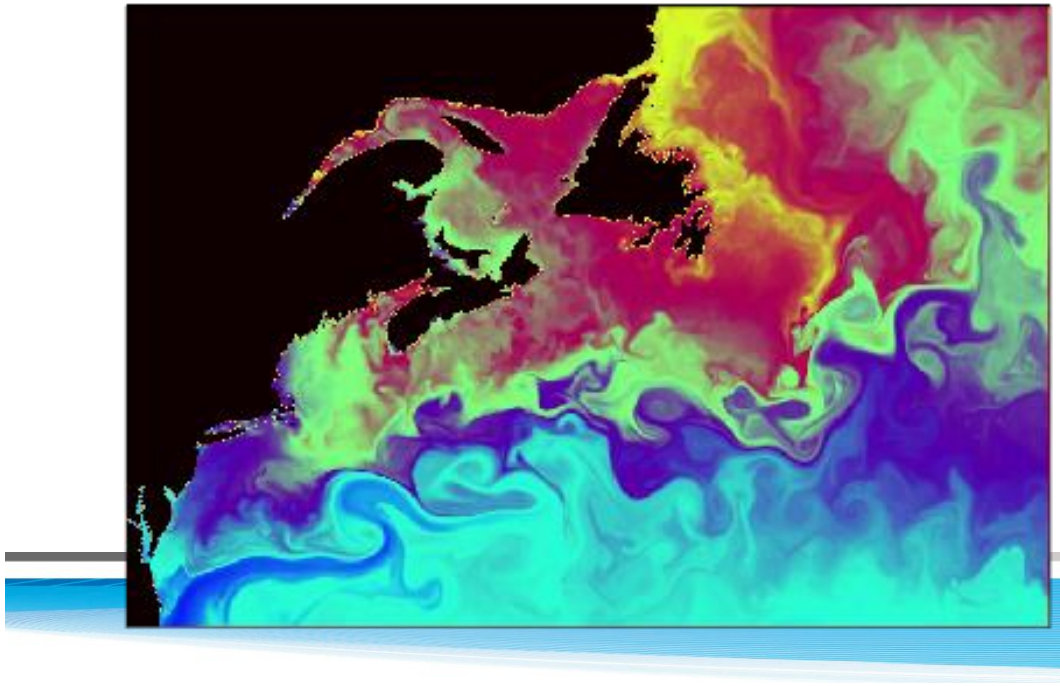
CIOPS-W 1/36 deg



Salish Sea 500

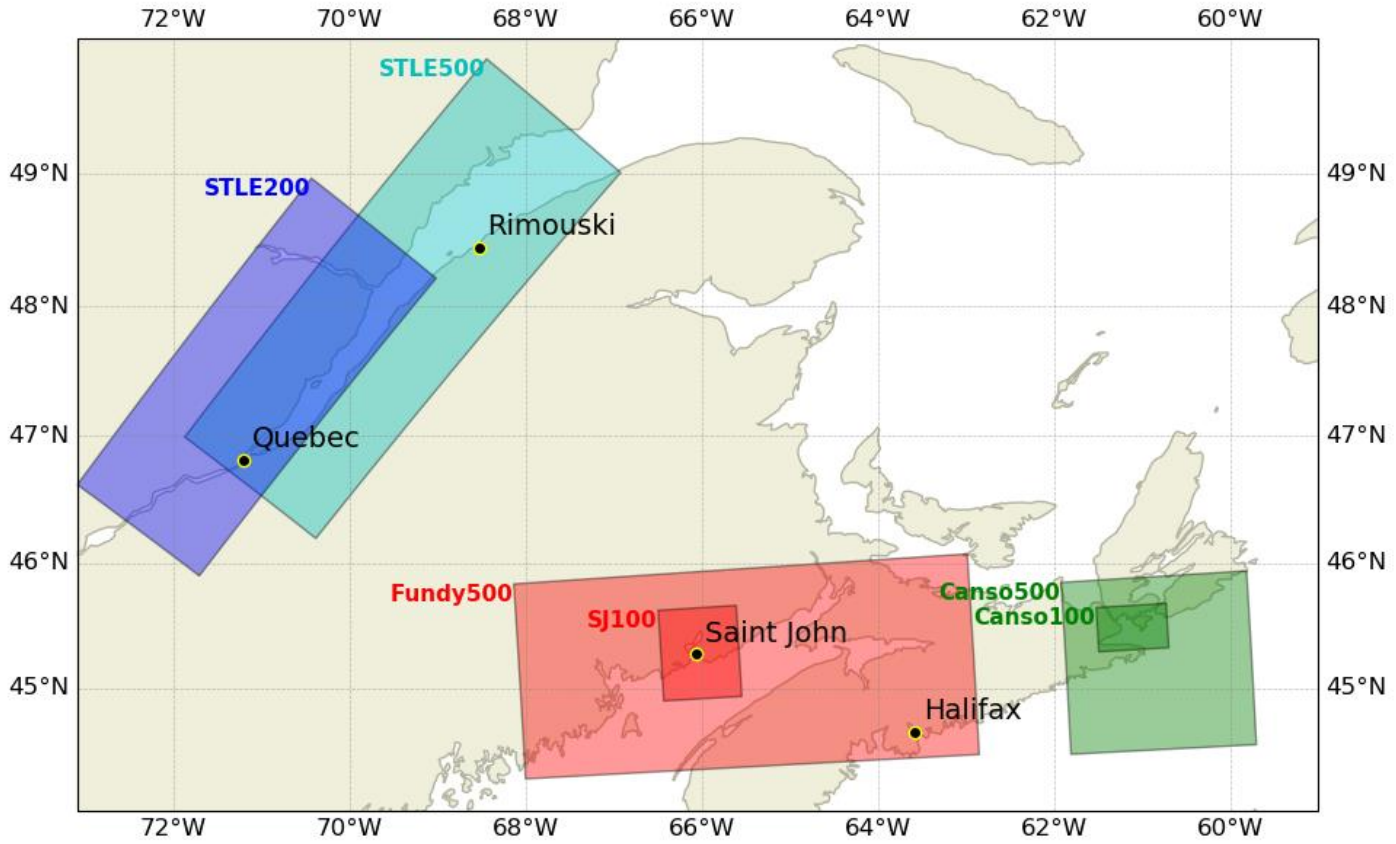


CIOPS-E 1/36 deg



Port Ocean Prediction Systems: east coast

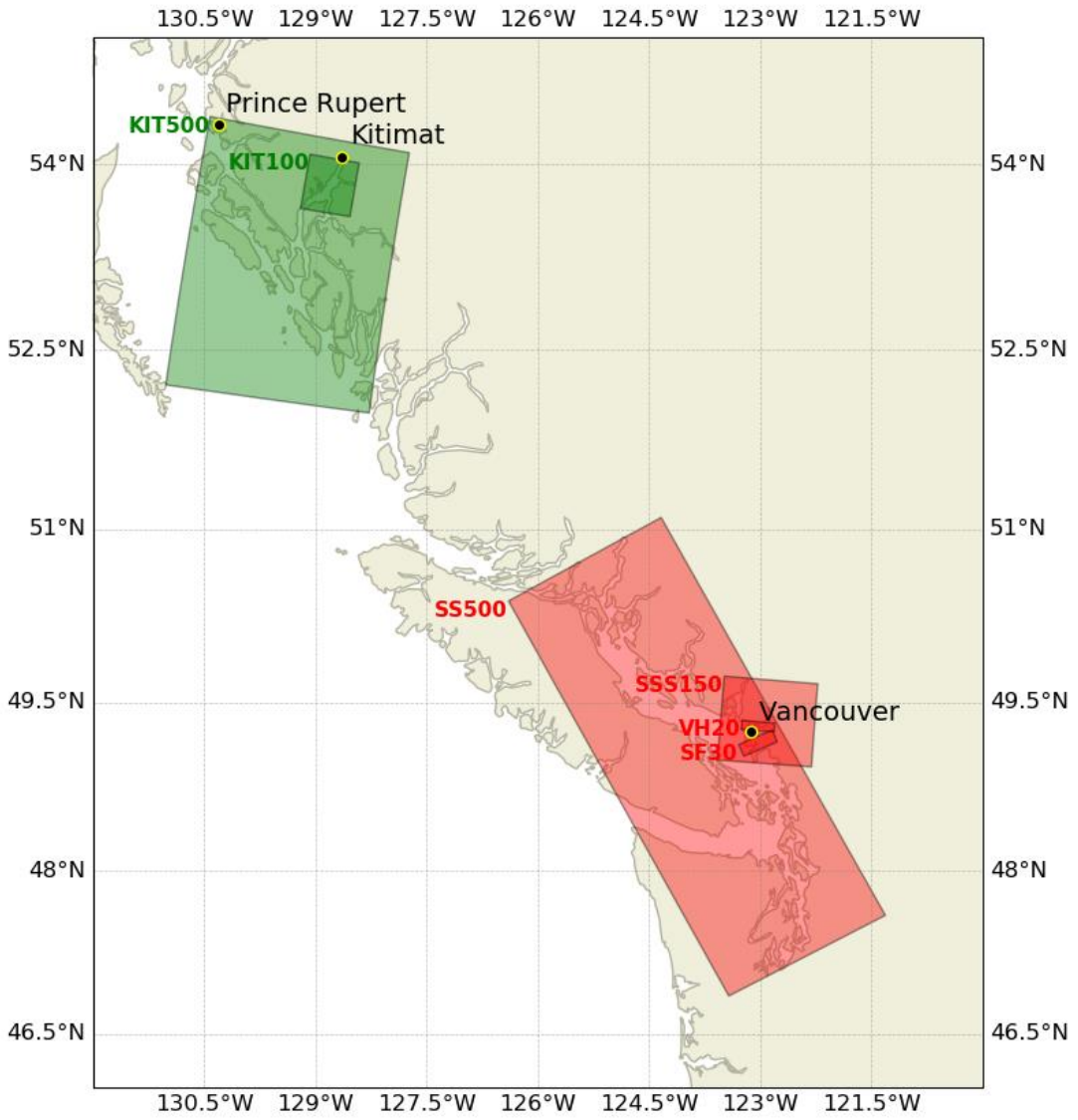
- To support electronic navigation and emergency response (spills, search & rescue, salvage, …)
  - St Lawrence Estuary
    - **See Simon's talk 4h ago**
  - Strait of Canso
  - Saint John Harbour
    - **See Stephanne's talk tomorrow**
- Boundaries from CIOPS-E
- Surface from ECCC's HRDPS 2.5km



Port Ocean Prediction Systems: west coast

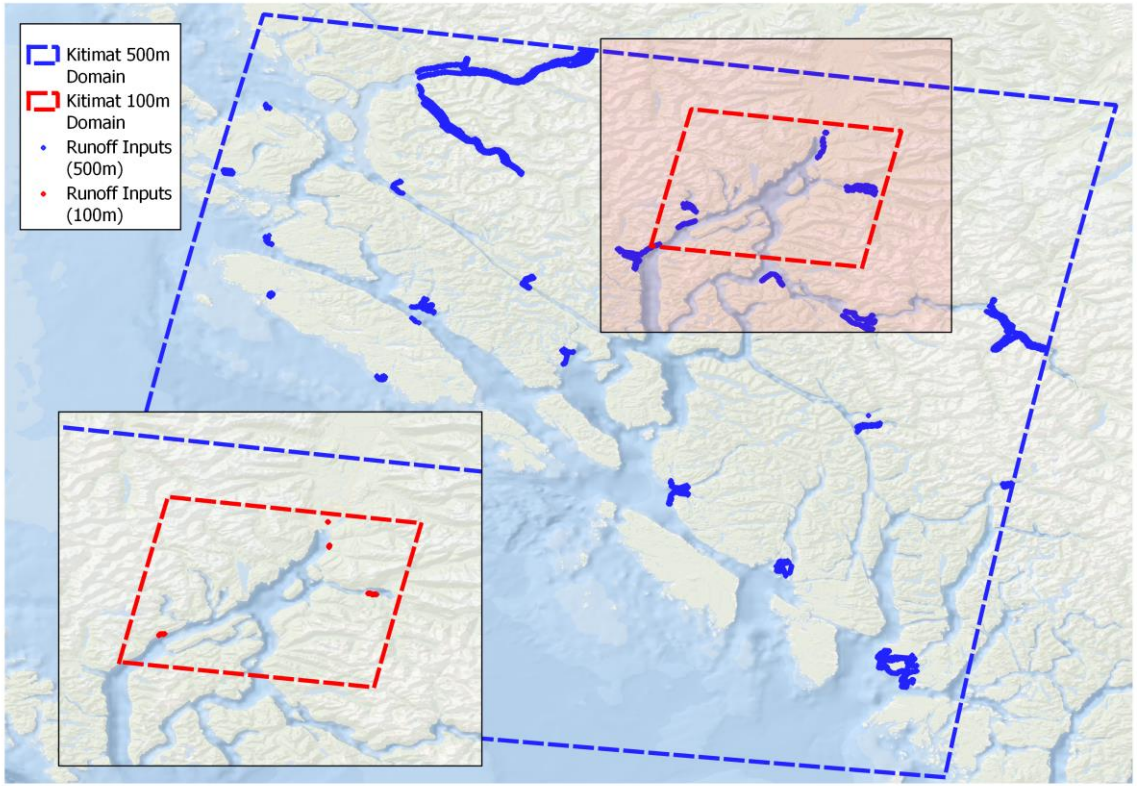
West coast port-scale models

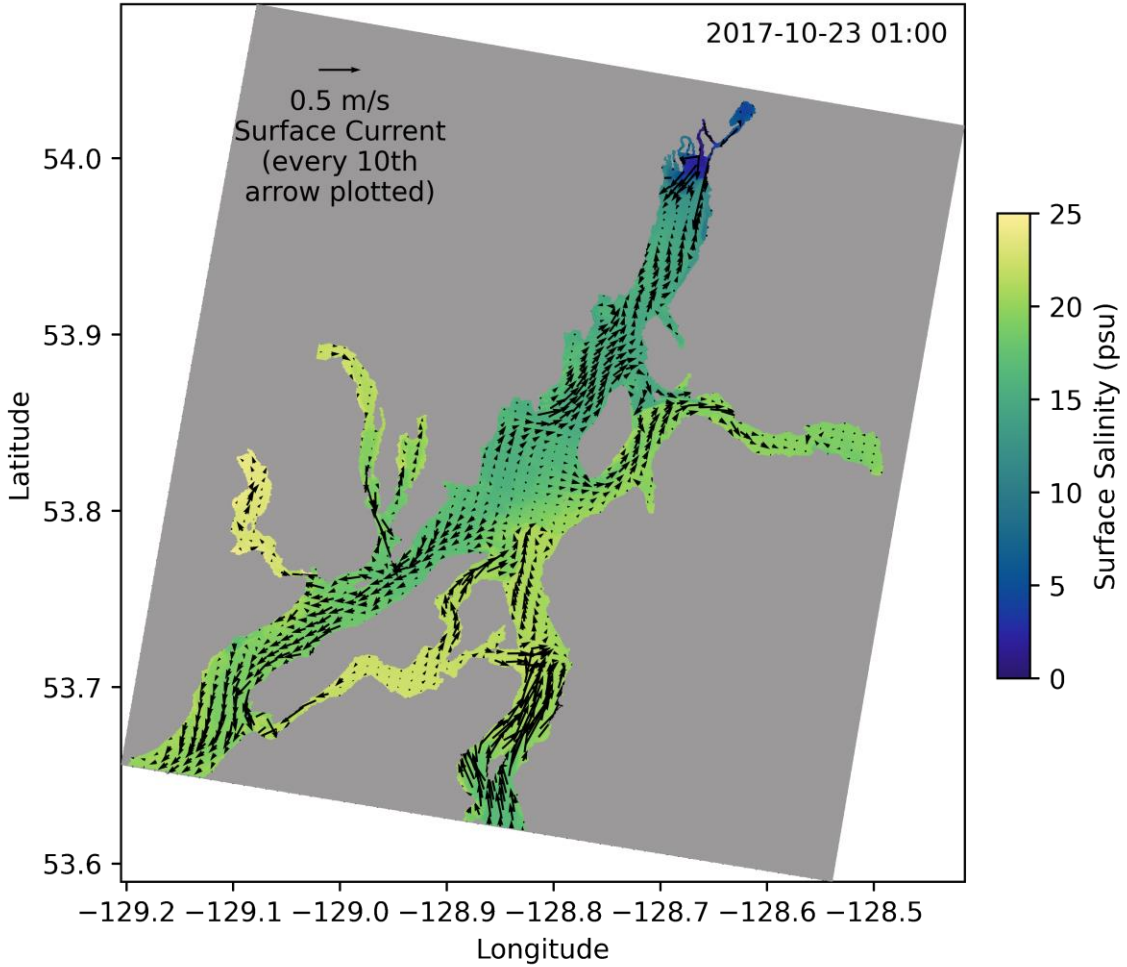
- Kitimat
  - 500m & 100m
- South Salish Sea 150m
  - Vancouver Harbour 20m
  - South Fraser 30m
- 3-5x resolution improvement at each step
- Boundaries from CIOPS-W or Salish Sea 500
  - Tides replaced at 500 & 150 m bdys
- Runoff from gauged rivers, else climatology
- Surface from ECCC's HRDPS 2.5km



Kitimat

- Strongest freshwater inflow on record (Oct 24, 2017) captured

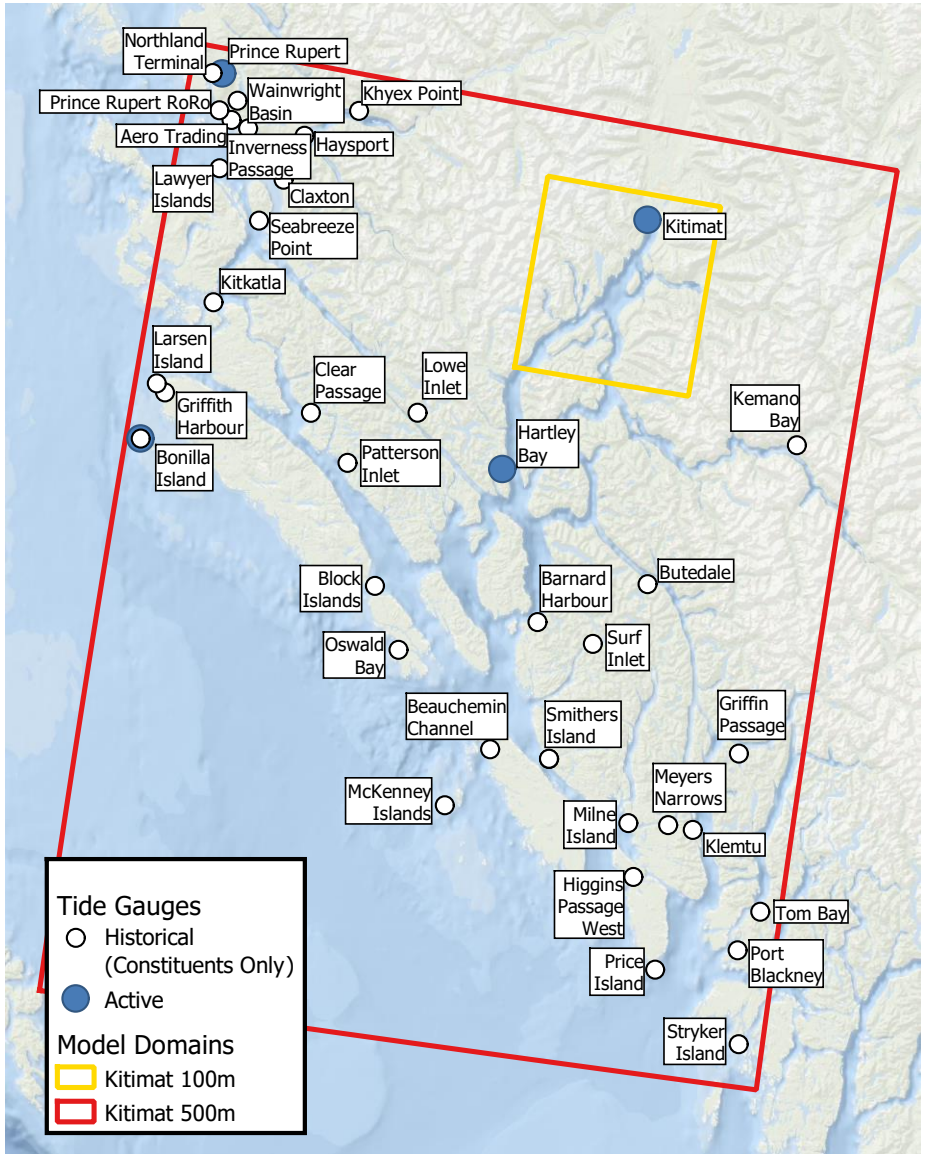




Kitimat Tides

- Tides generally best represented in KIT500&100

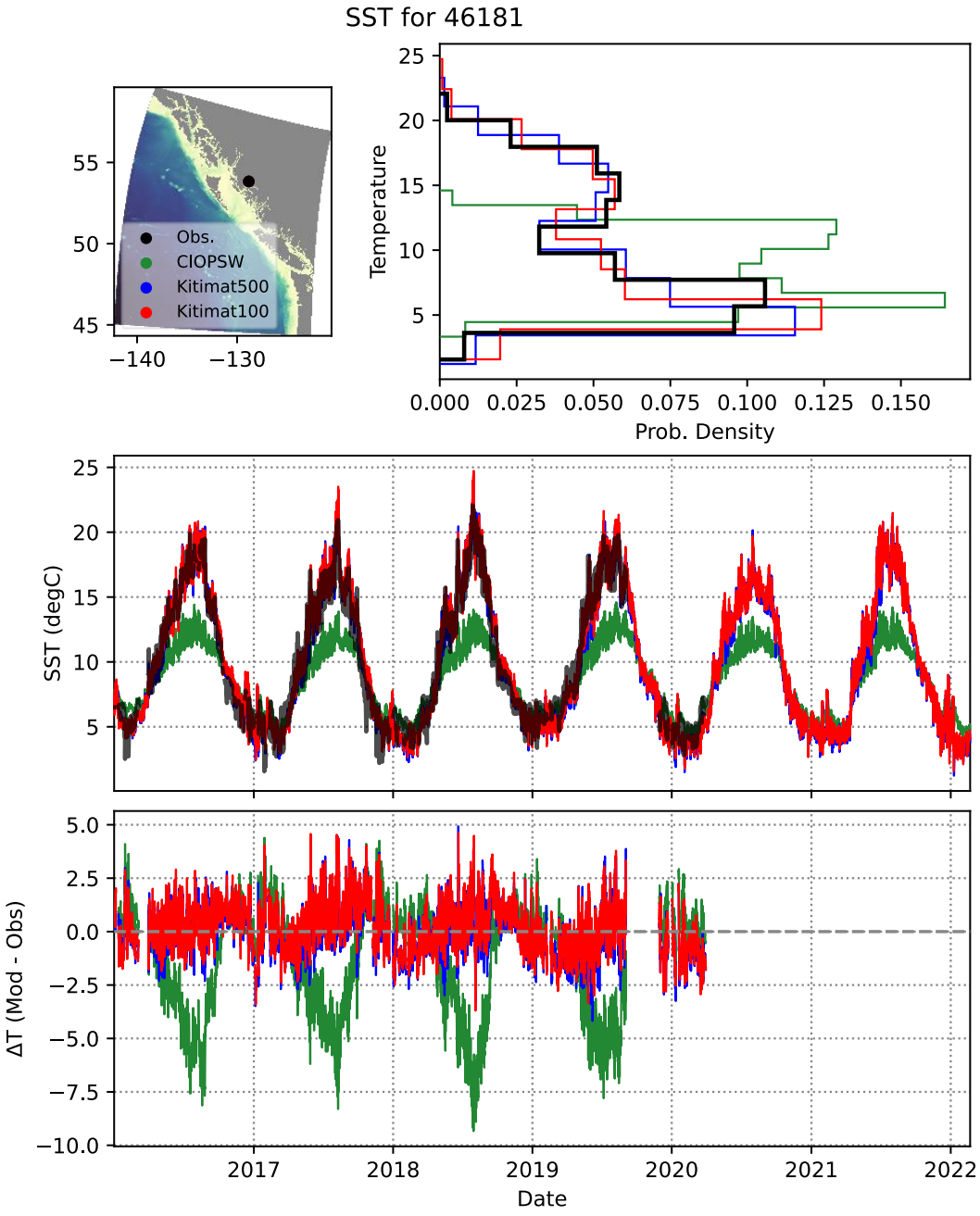
Model			CIOPS-W	KIT500	KIT100
Station	Amp (m)	Phase	Tidal Error (m)		
M2 Constituent					
Kitimat	1.659	258.11	0.111	0.006	0.044
Hartley Bay	1.592	256.57	0.097	0.018	
S2 Constituent					
Kitimat	0.535	289.10	0.043	0.003	0.011
Hartley Bay	0.512	287.55	0.037	0.003	
K1 Constituent					
Kitimat	0.484	255.22	0.008	0.009	0.005
Hartley Bay	0.476	254.92	0.006	0.007	
N2 Constituent					
Kitimat	0.341	234.36	0.020	0.004	0.006
Hartley Bay	0.327	232.56	0.020	0.004	
O1 Constituent					
Kitimat	0.292	239.16	0.002	0.002	0.002
Hartley Bay	0.290	239.04	0.001	0.003	



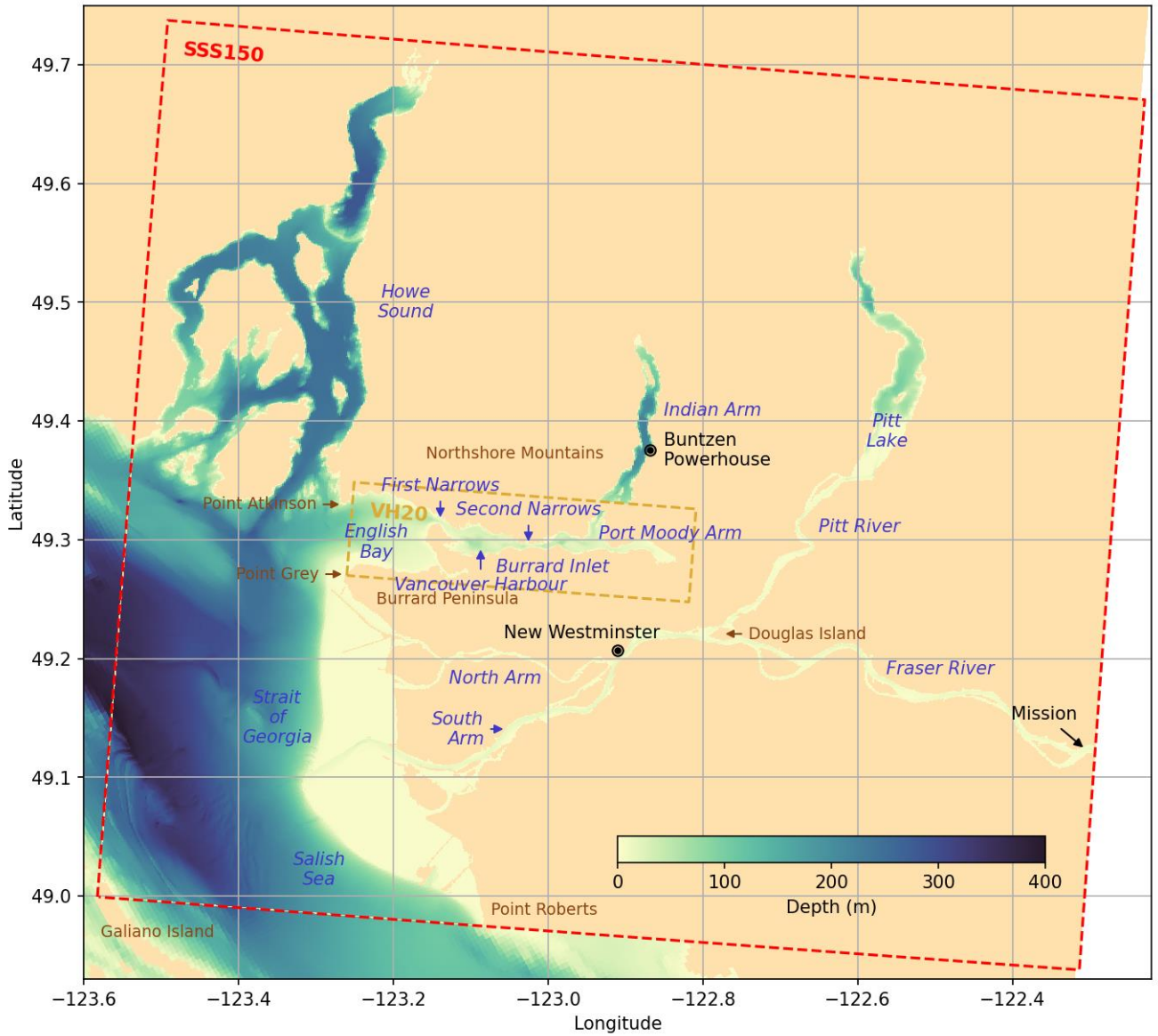
Sea Surface Temperature

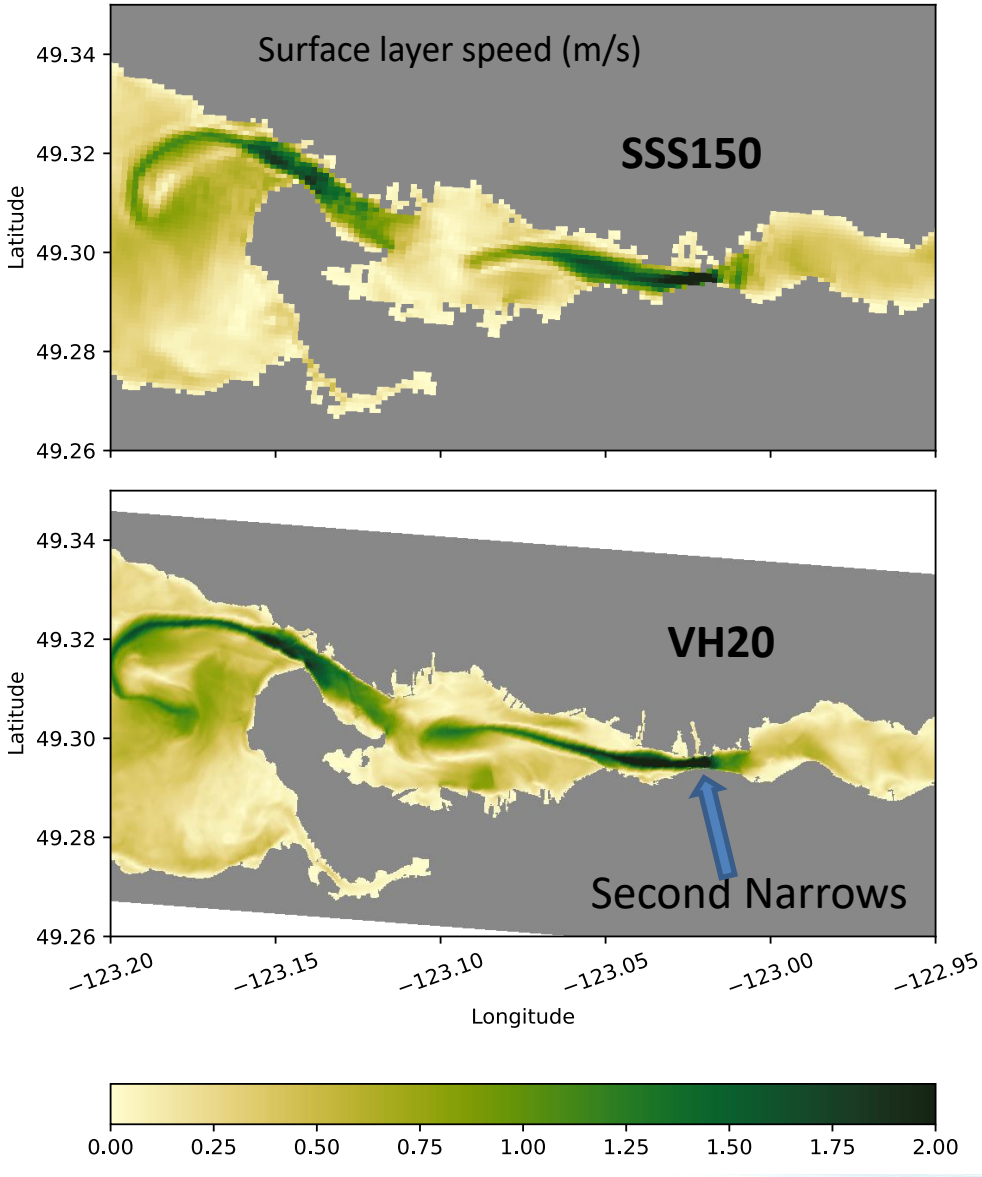
- Summer cold bias in CIOPS-W is greatly improved

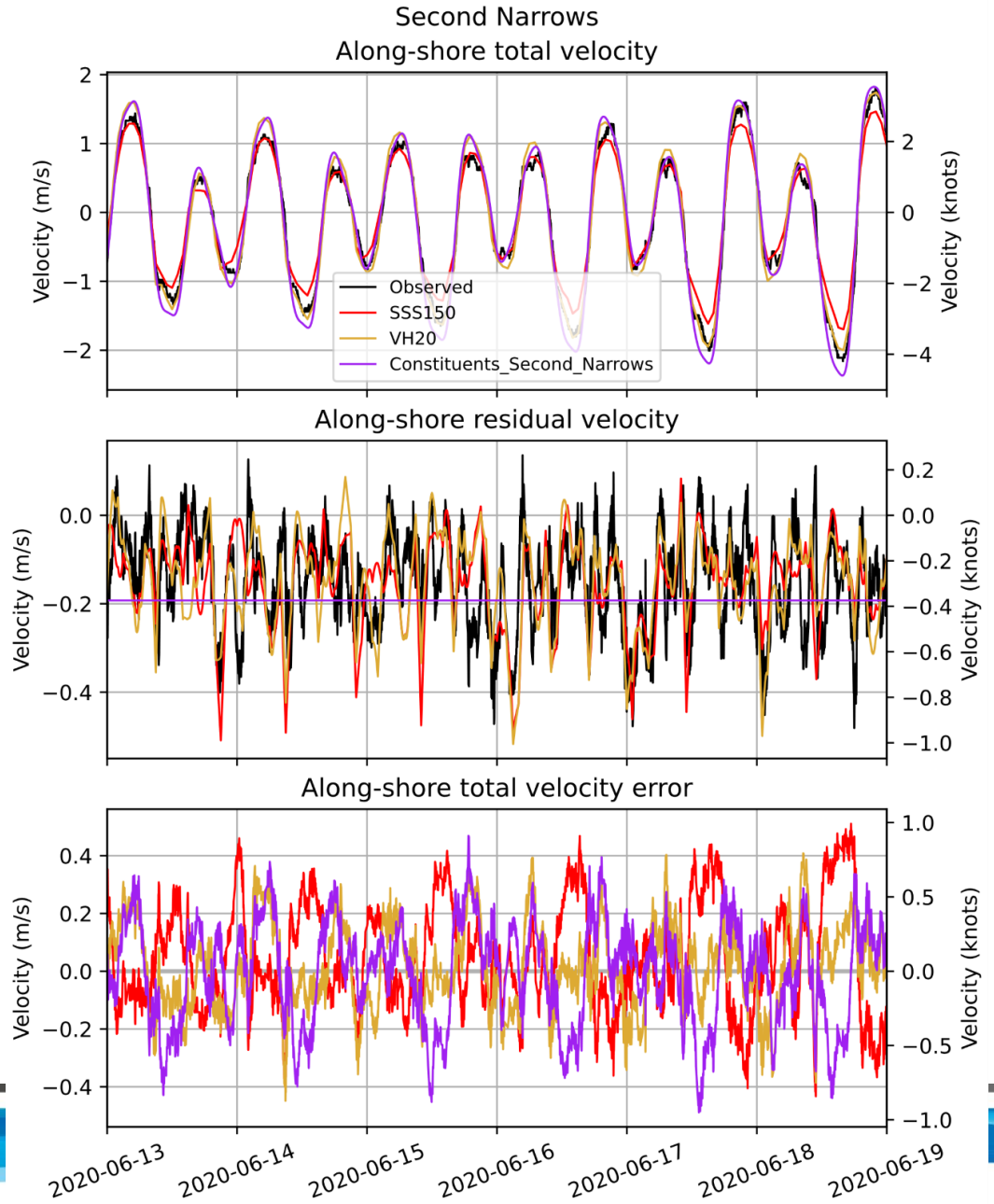
	Bias (deg)			CRMSE (deg)		
Station	CIOPS-W	KIT500	KIT100	CIOPS-W	KIT500	KIT100
46181	-1.361	0.055	0.221	2.51	1.091	1.102



Vancouver Harbour 20 m



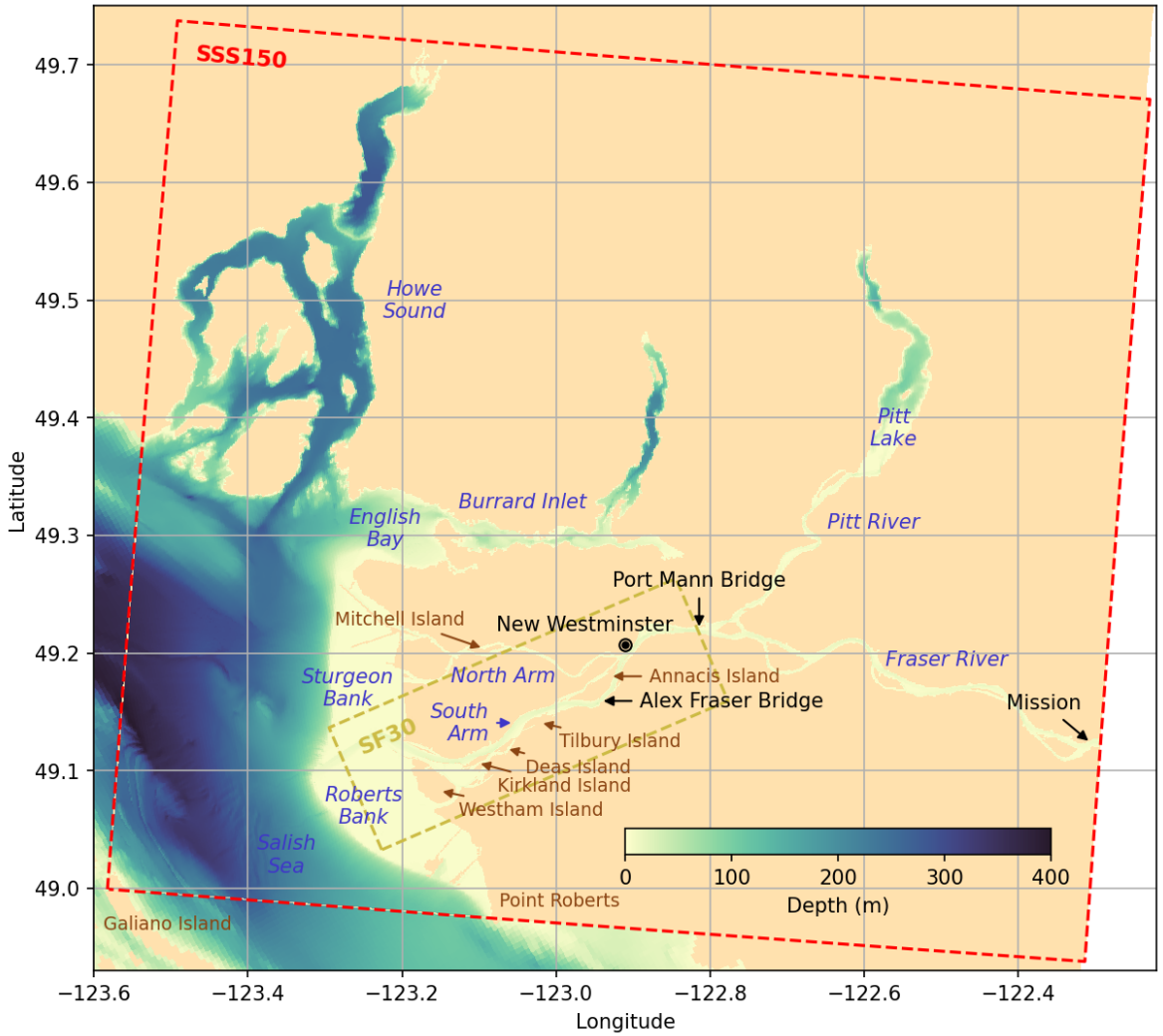




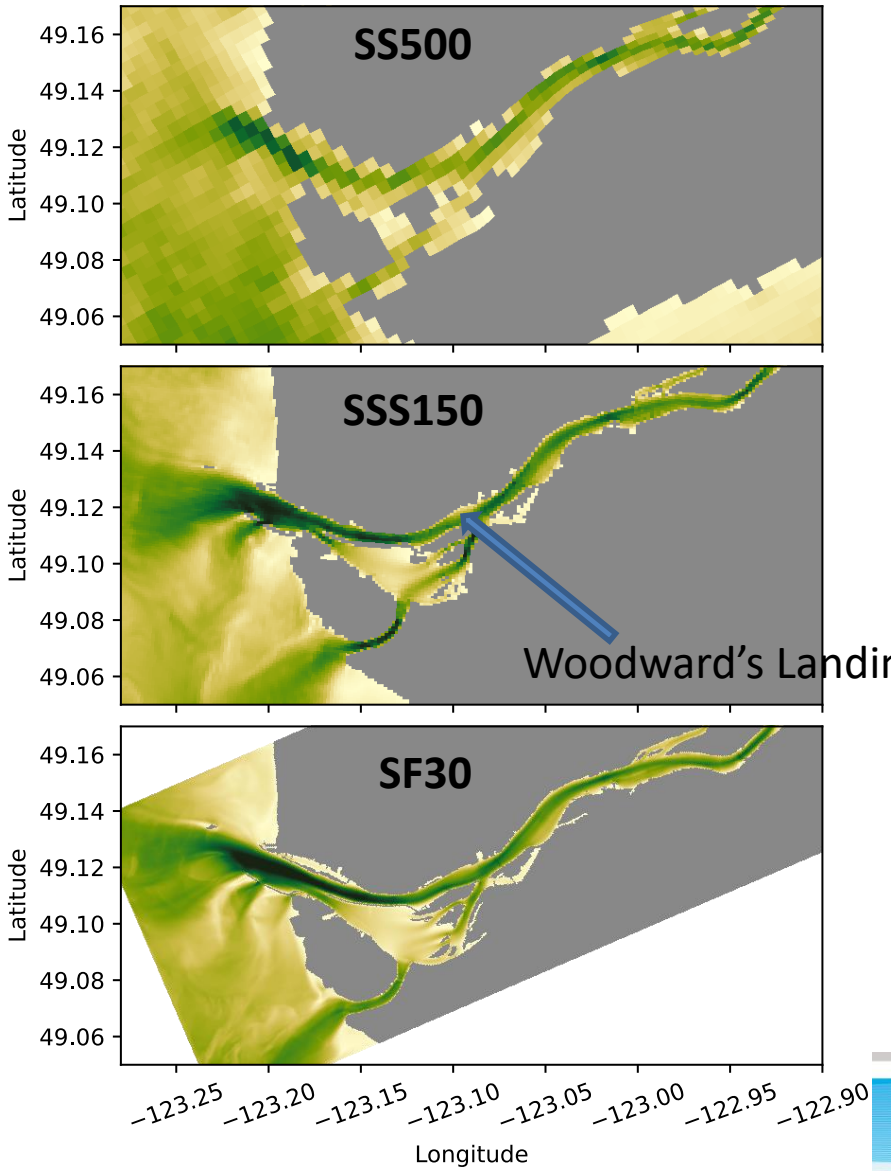
Horizontal ADCP at Second Narrows

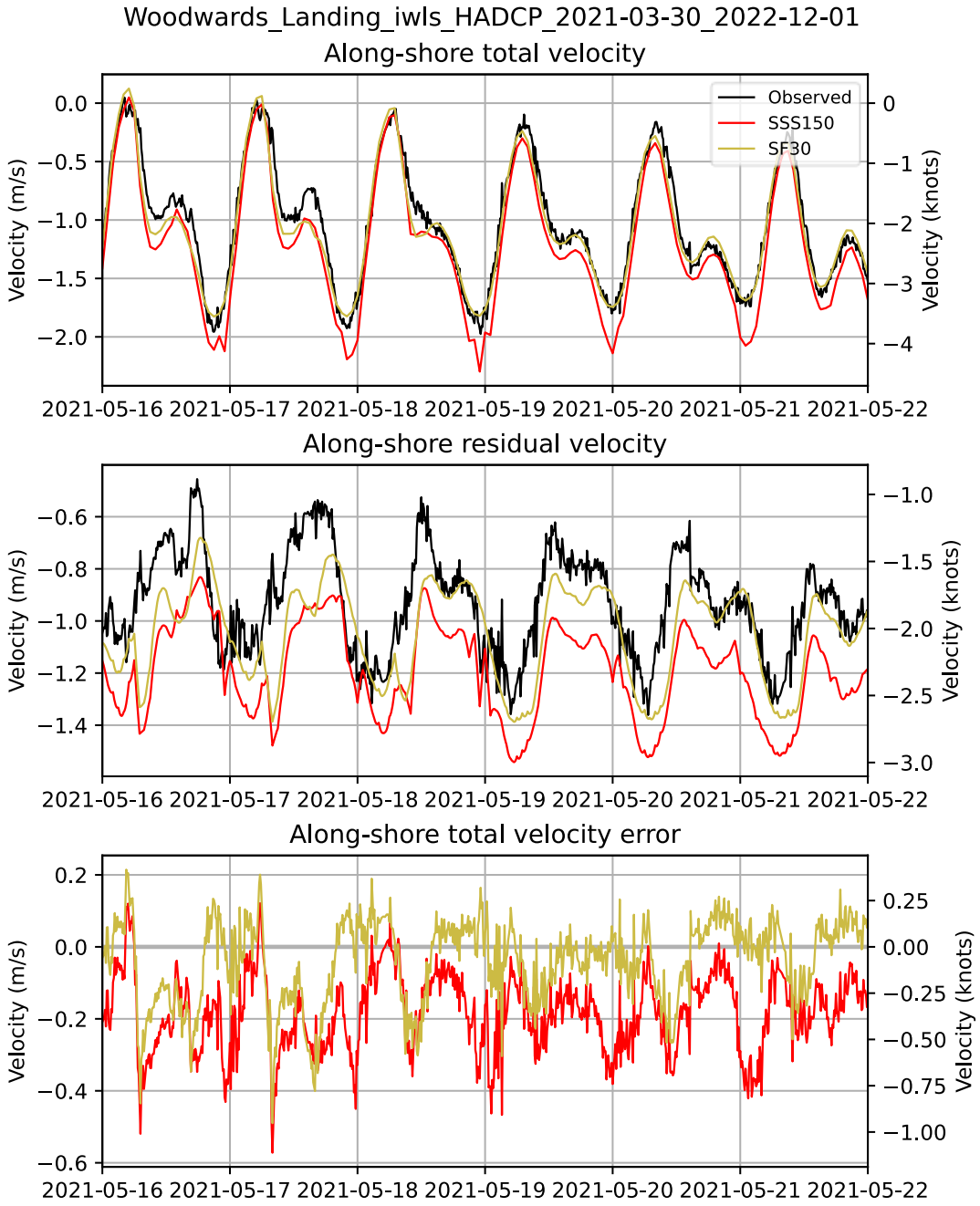
- 7m deep HADCP looking north across the narrows, ~110m span averaged
- SSS150: underestimates tides
- VH20: better, sometimes overestimates tides
- Constituents: more overestimates
- Residual: models capture mean flow
- VH20 looks to be smallest error

South Fraser River 30 m



Surface layer speed (m/s)





Horizontal ADCP at Woodward's Landing

- Average of bins in the range 199-217 m from transducer/shore
- 30 m model outperforms 150 m model
  - Lower bias, better peak current
  - Phase is good in both models

Summary of fixed-location port models

- Version 1 complete, national review held March 2023
  - "Class 4" evaluation documents to be published later this year
  - Models to run in "demo" mode; operationalization later

- Ongoing efforts to develop version 2
  - Error attribution to guide refinements
  - Uncertainty characterization for end users → ensemble runs, sensitivity testing
  - NEMO 4.2+ for wetting & drying
  - Can we develop a hydrological model for better runoff forcing?
  - Can a wave model improve drift prediction?
  - Can we downscale the atmospheric forcing?

Relocatable NEMO system

- Not feasible to cover all of Canada's coastline at 100m or better resolution

- Developing system where we use a GUI to specify a downscale box on a map and:
  - Auto-generate grid**, bathy**, initial conditions and forcing, **populate namelists**
  - Launch spinup run and ongoing nowcast/forecasts

- Trade off hand-tuned model for fast turnover (minutes to hours)
  - Enables responding to active incidents

- Expect quality/reliability increases as we iterate on the automation

- Similar to SURF-NEMO but more focus on operational / real time turnover

Relocatable test case: drifting ship

- Vessel adrift and fully engulfed in fire (May 2, 2022) in Johnstone Strait (North Vancouver Island)

- Two relocatable grids at ~150 m
  - Top: directly forced by CIOPS-W
  - Bottom: replaced barotropic forcing with FES2022 tides

- Direct downscaling not enough!
  - Value added by tide replacement