Apr 5th, 1:30 PM - 1:45 PM

Sensitivity of the regional ocean acidification and carbonate system in Puget Sound to ocean and freshwater inputs

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Speaker
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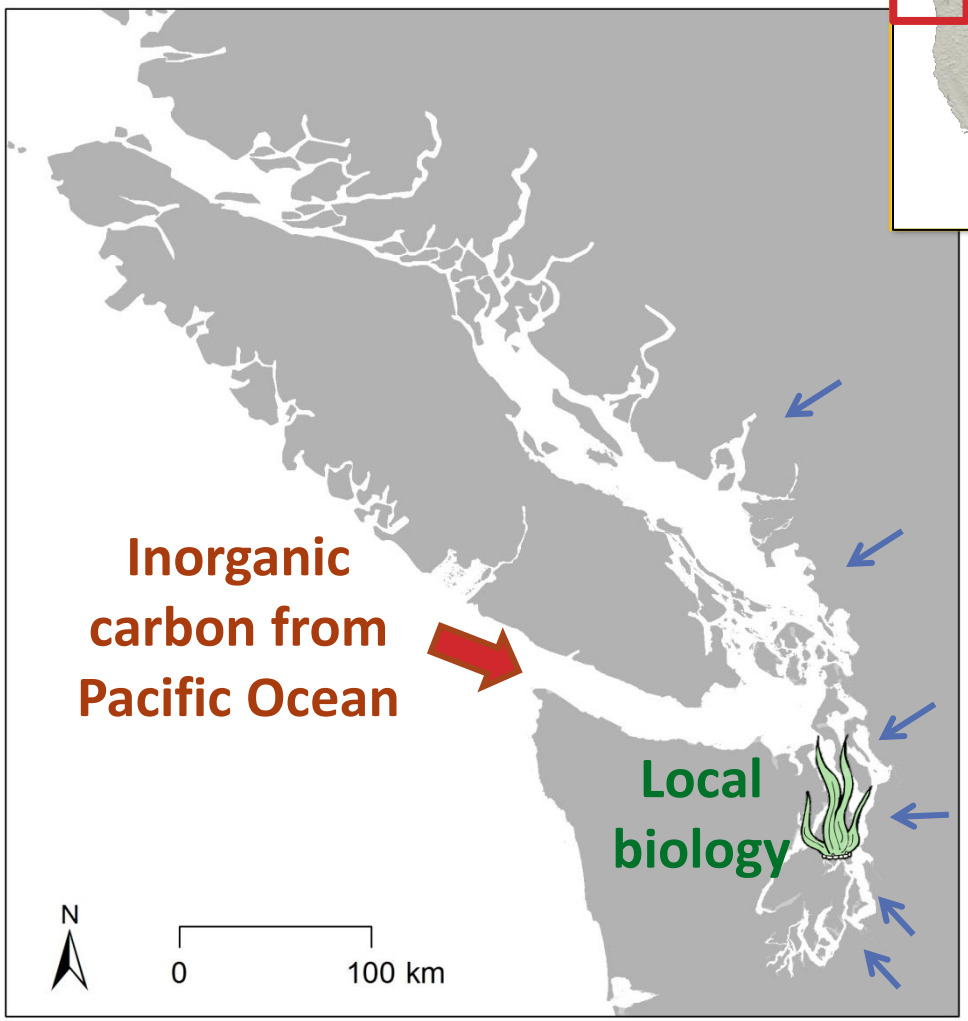
Washington State Department of Ecology

Acidification in the Salish Sea

- **What affects pH in the Salish Sea?**

Increasing local atmospheric pCO_2



Discharges from:

- Rivers
- Wastewater treatment plants
- Industrial waste treatment facilities
- Municipal storm water systems

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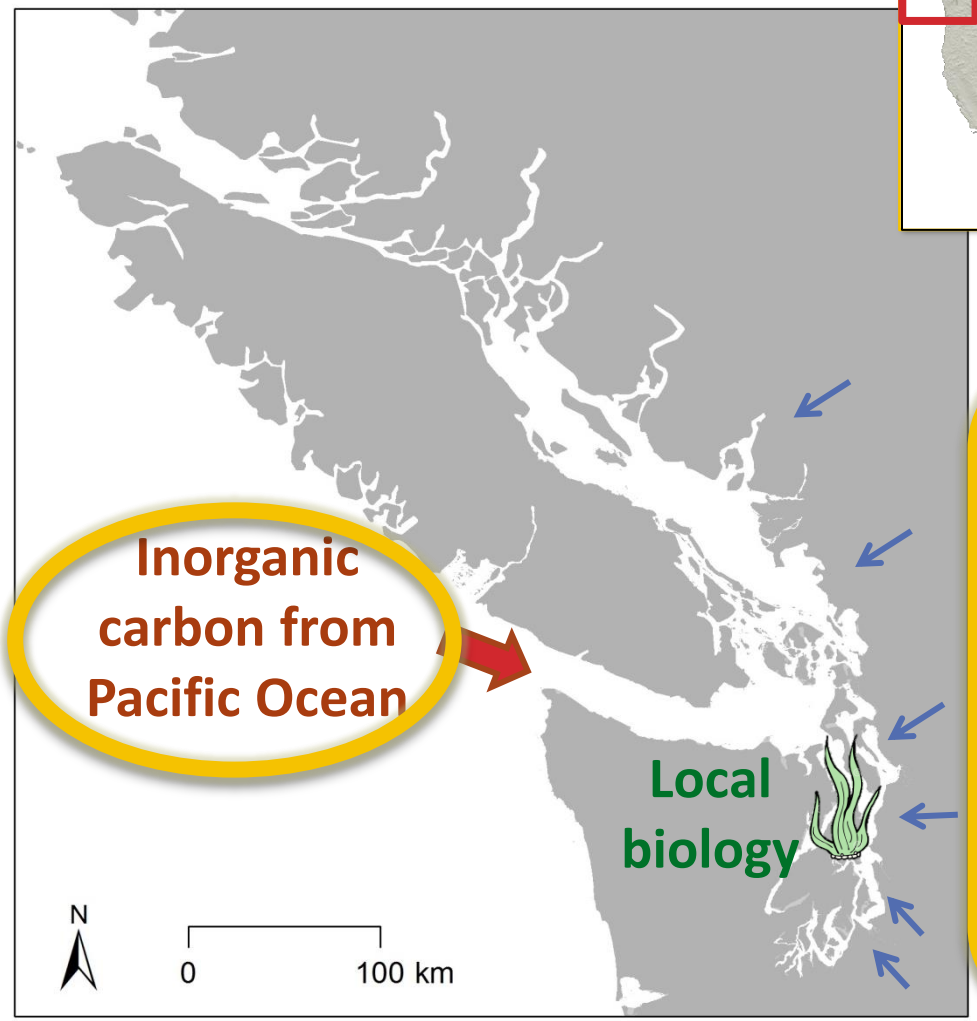

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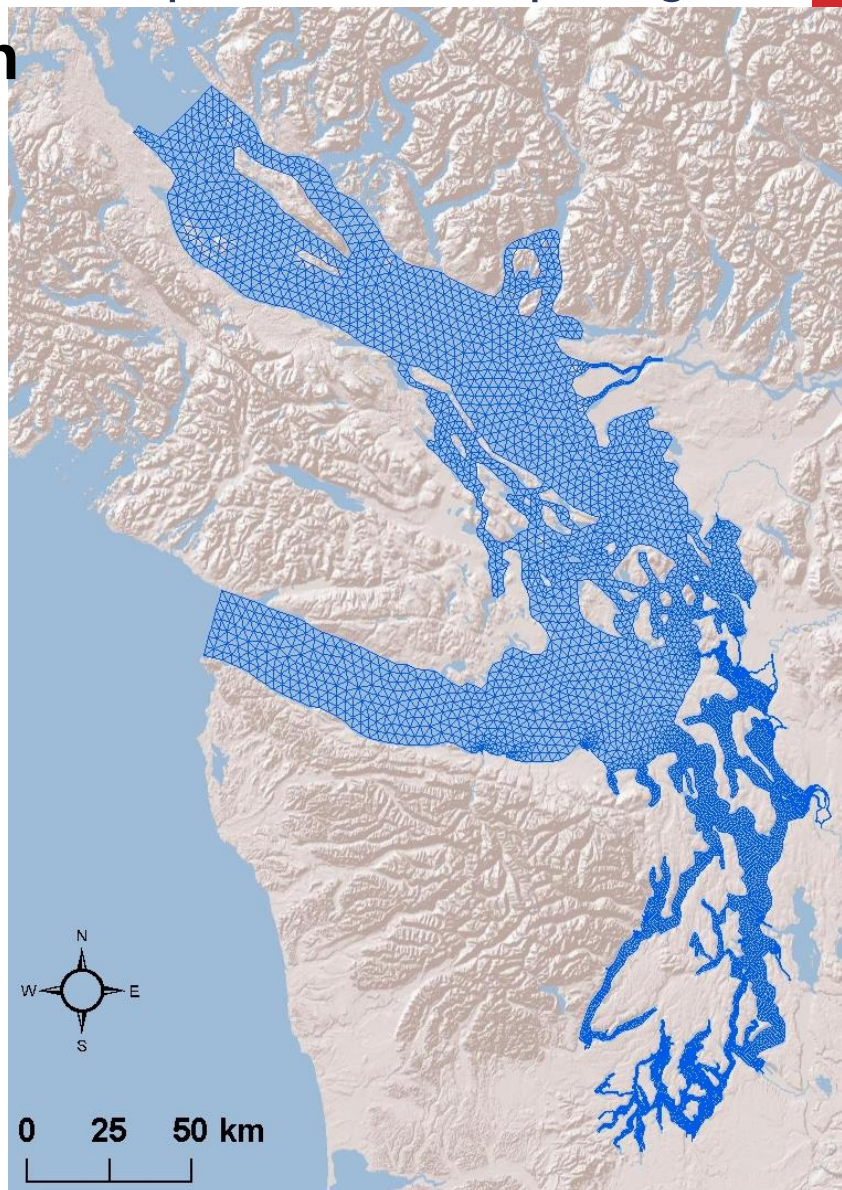
Salish Sea Model (SSM)

http://salish-sea.pnnl.gov/

- **Finite Volume Community Ocean Model (FVCOM, *Chen et al 2003*)**
- **Resolution:** from ~60 m to ~ 3 km
- **Atmospheric forcing from WRF**
- **Tides** (8 harmonics)
- **Runoff:**



Kim and Khangaonkar (Env Modeling & Software, 2011)
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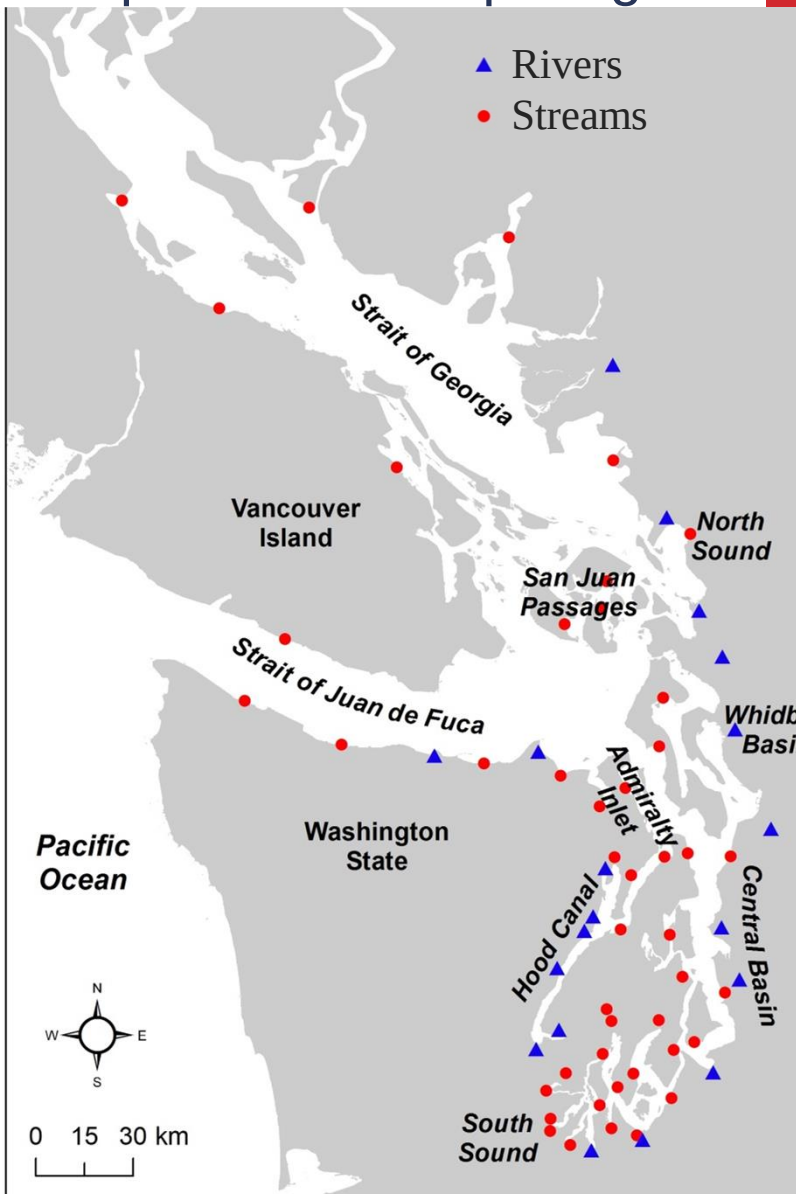
  - 19 major rivers
  - 45 streams
  - 99 wastewater discharges



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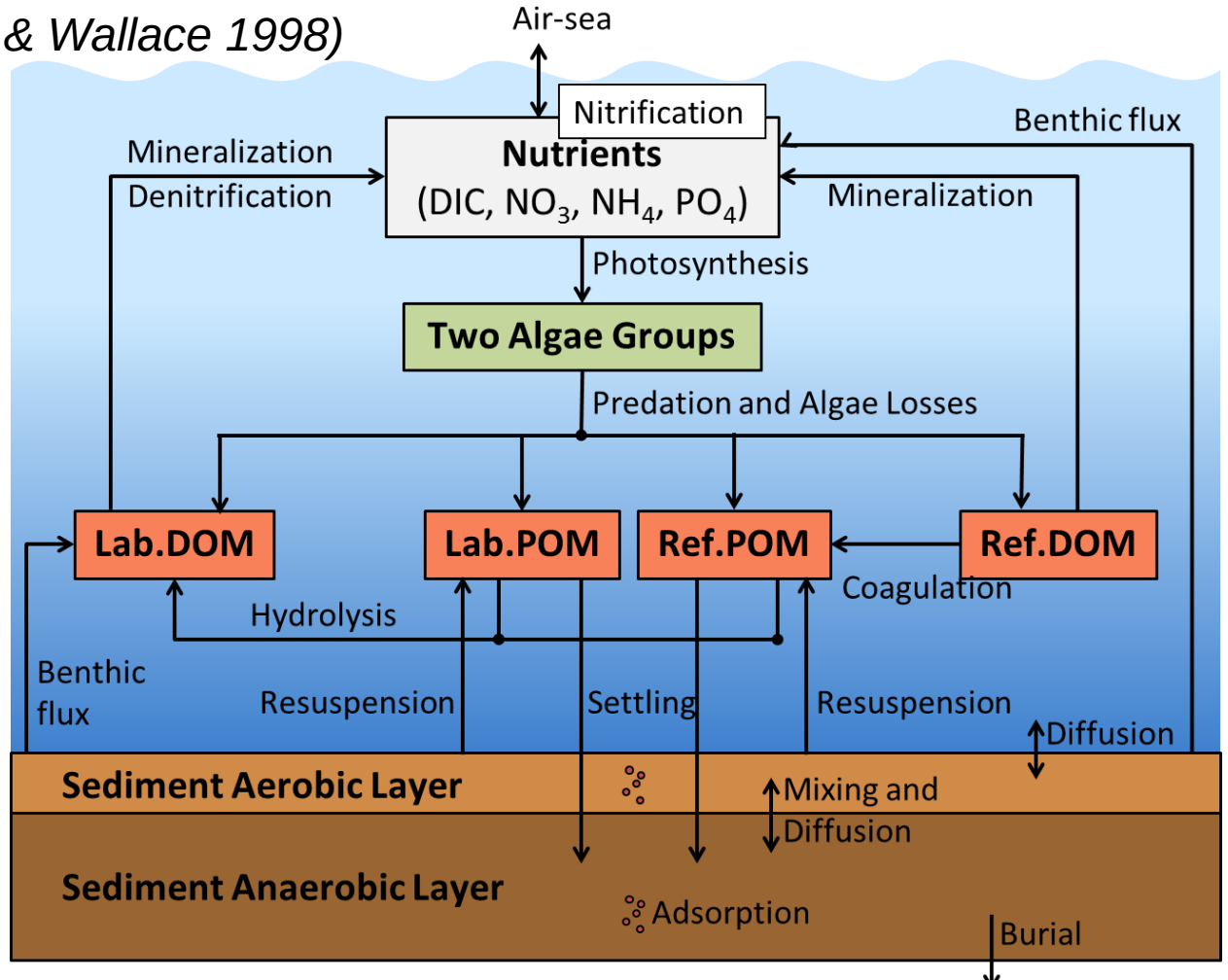
FVCOM-ICM

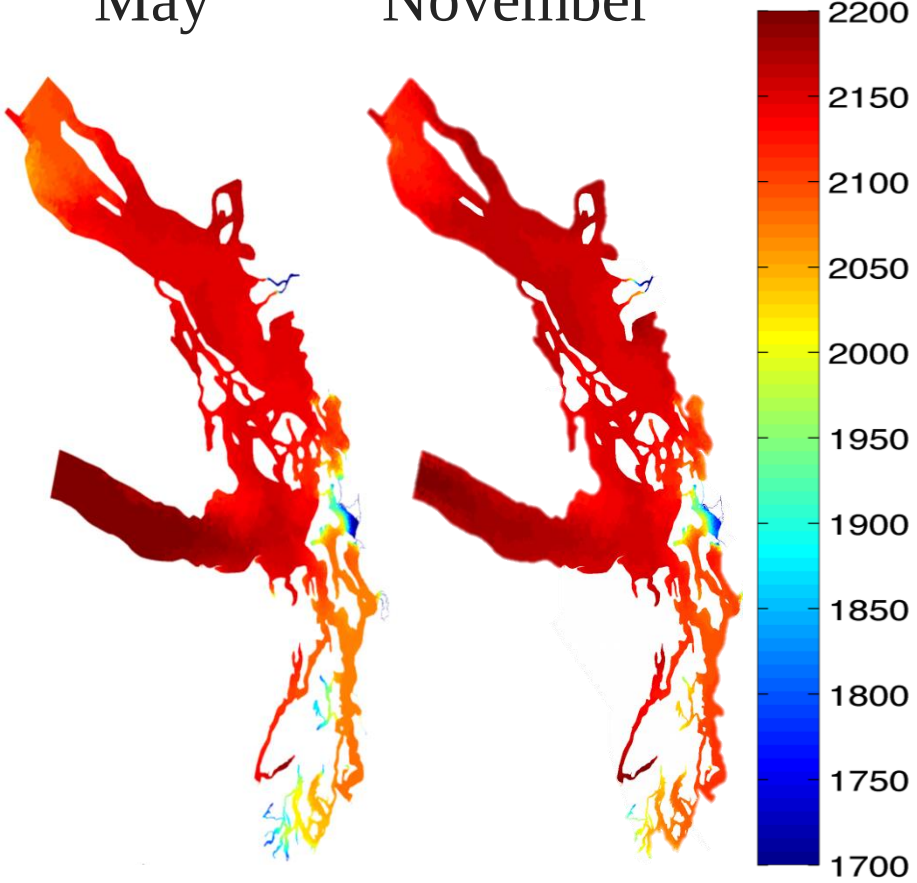
- **Water quality model based on CE-QUAL-ICM** *(Cerco et al. 1995)*
- **Sediment module** *(DiToro 2001)*
- **pH module** *(Lewis & Wallace 1998)*



SSM results: year 2008 simulation

Monthly mean bottom DIC

May November



Monthly mean bottom pH

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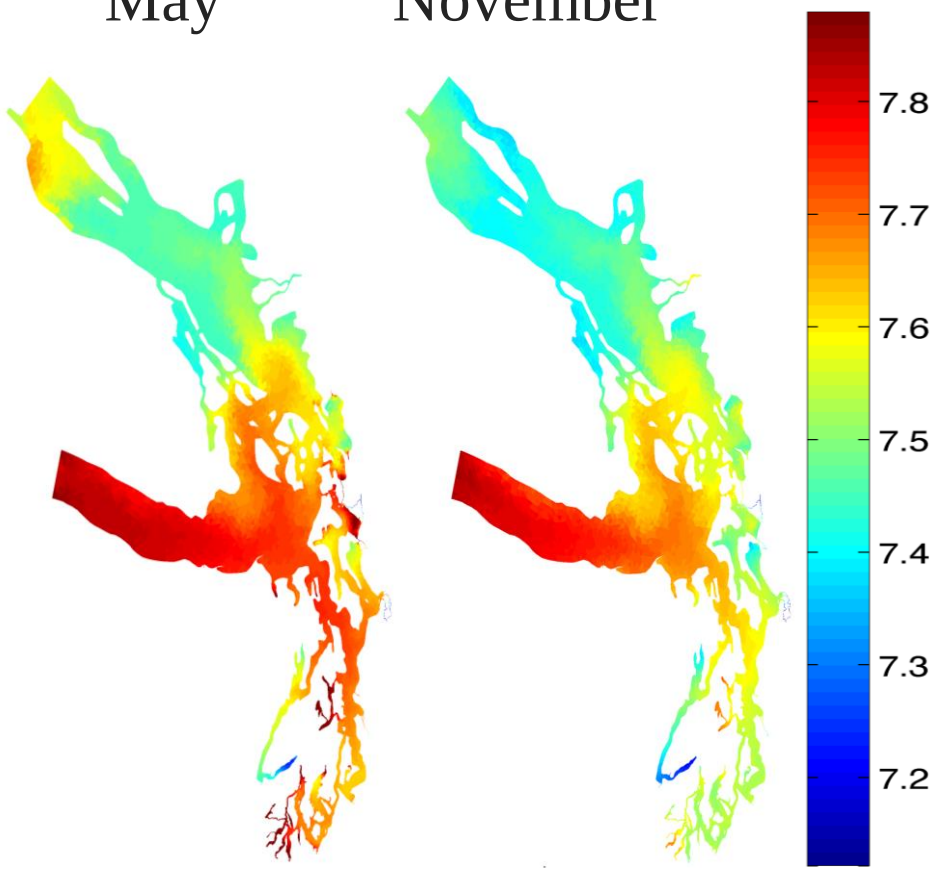
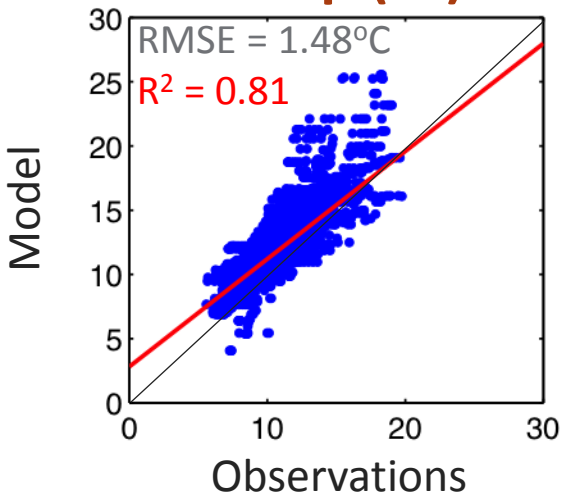
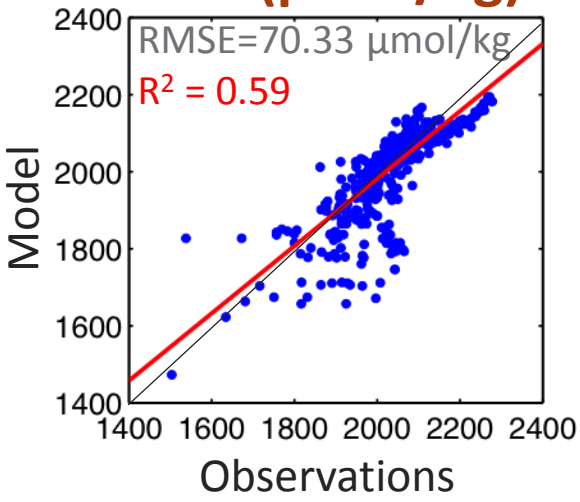


SSM vs. Observations

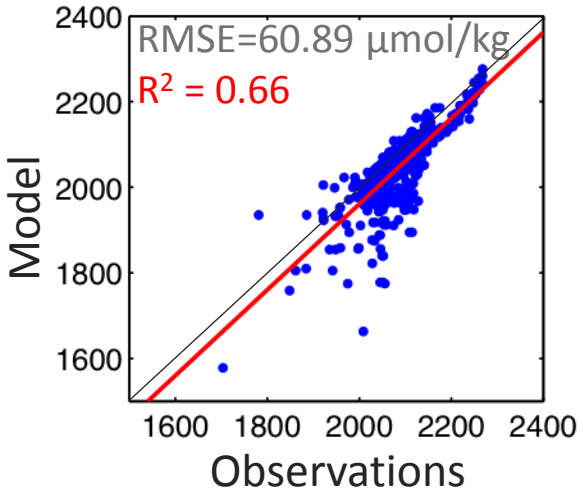
Temp (°C)



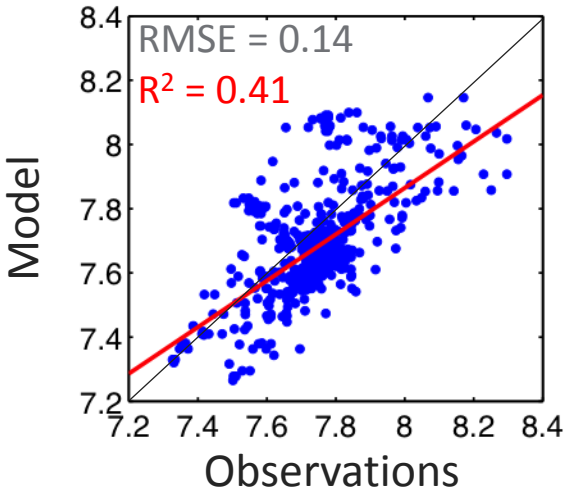
DIC (µmol/kg)

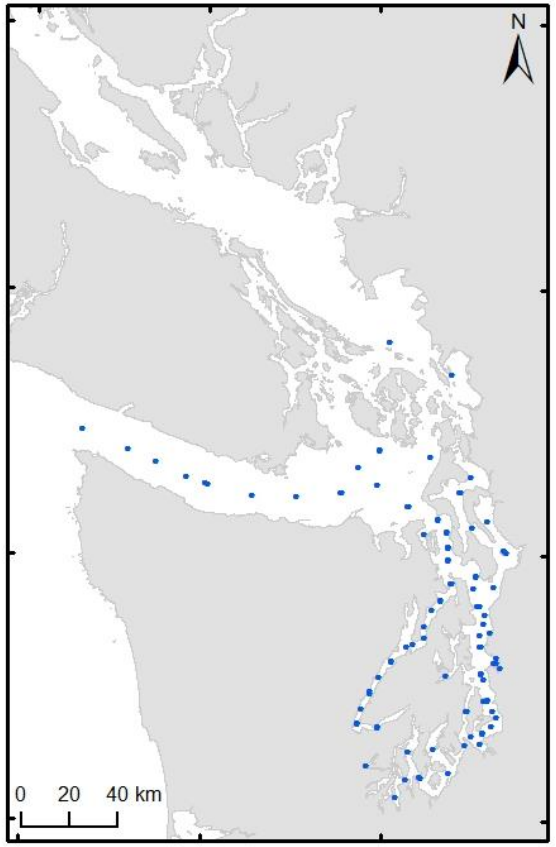


Alkalinity (µmol/kg)



pH (total scale)

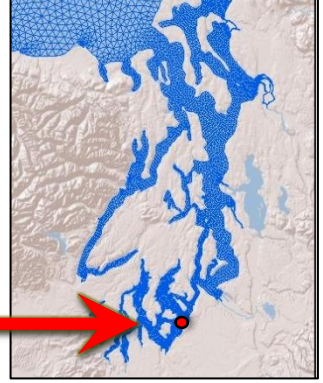




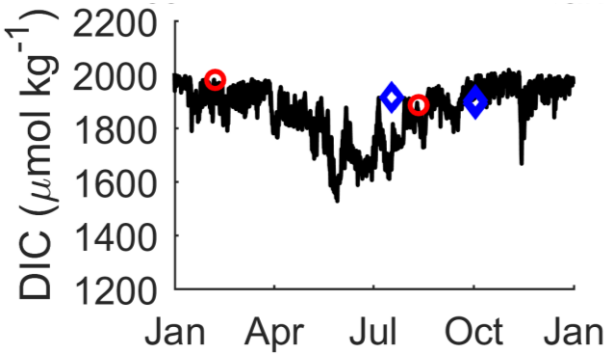
SSM vs. Observations: Time series

Model (2nd yr)
Obs UW 2008
Obs UW other years

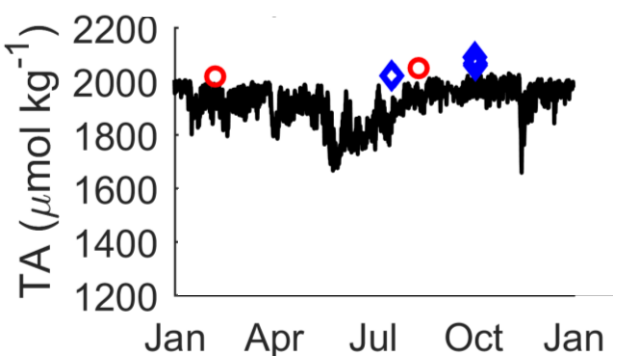
Gordon Point



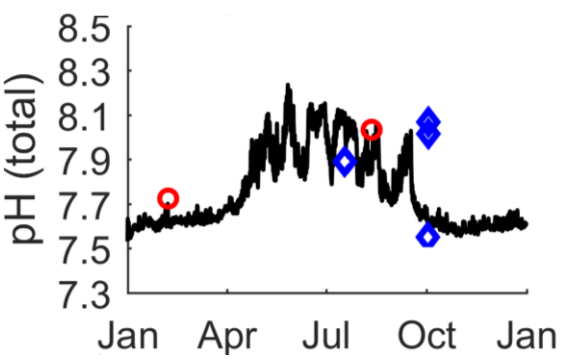
Surface DIC



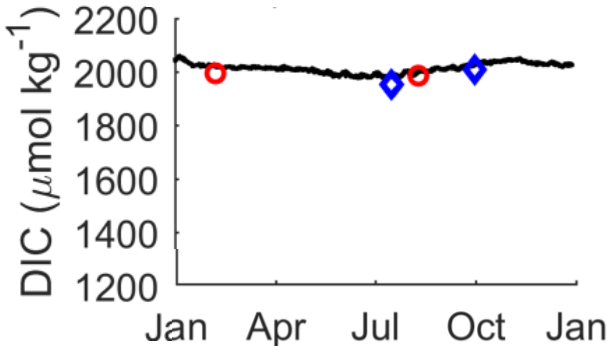
Surface Alkalinity



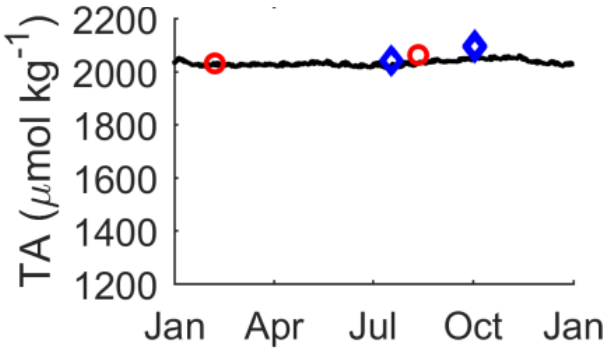
Surface pH



Bottom DIC



Bottom Alkalinity



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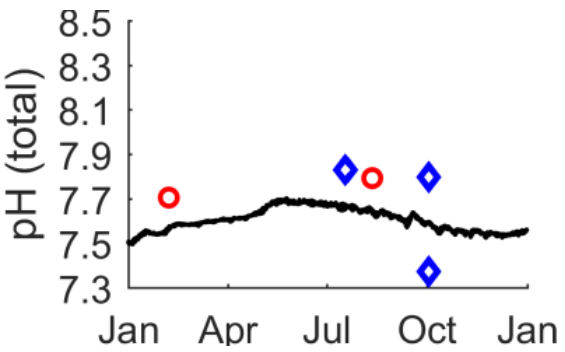

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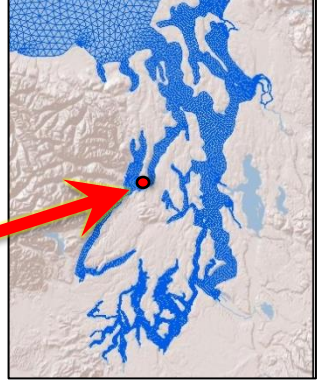
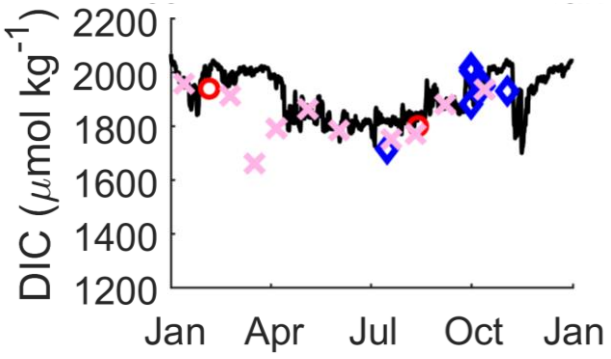
Model (2nd yr)
Obs UW 2008
Obs UW other years
Obs ECY 2014/15

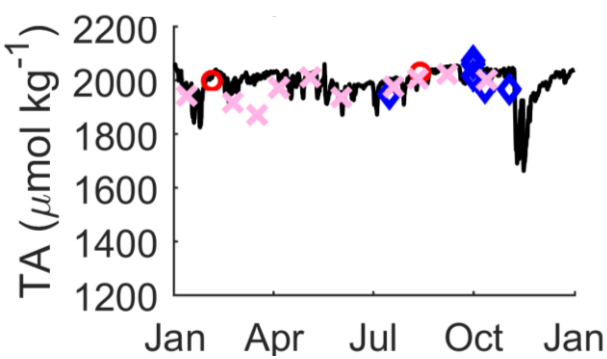
Hood Canal



Surface DIC



Surface Alkalinity



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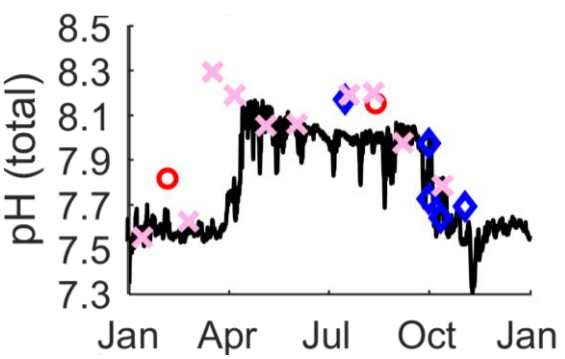
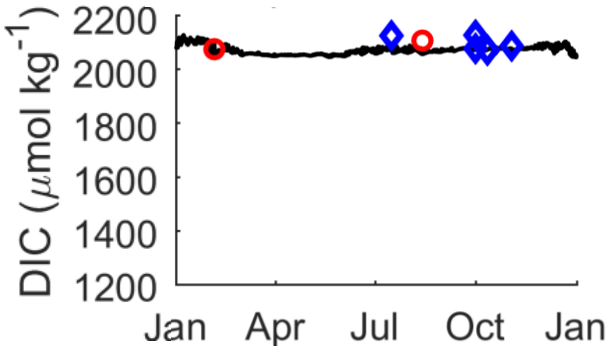


Bottom DIC



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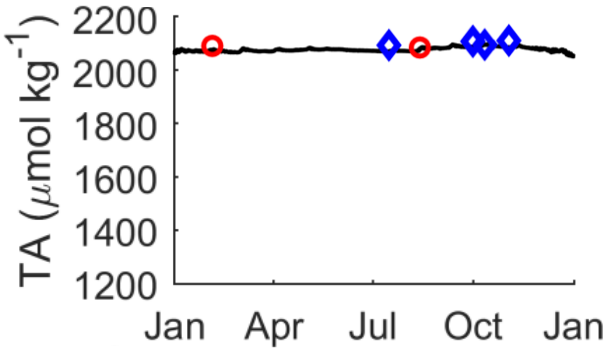

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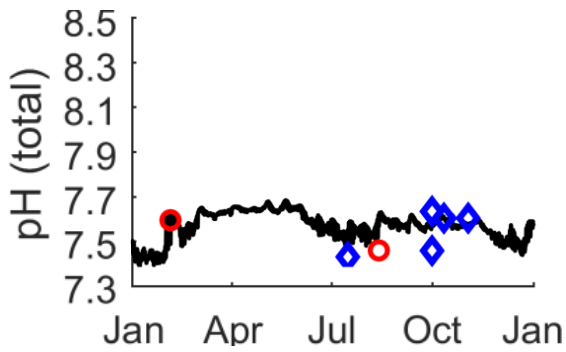
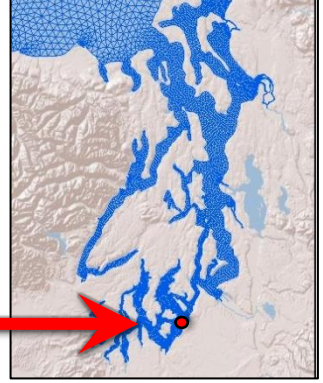


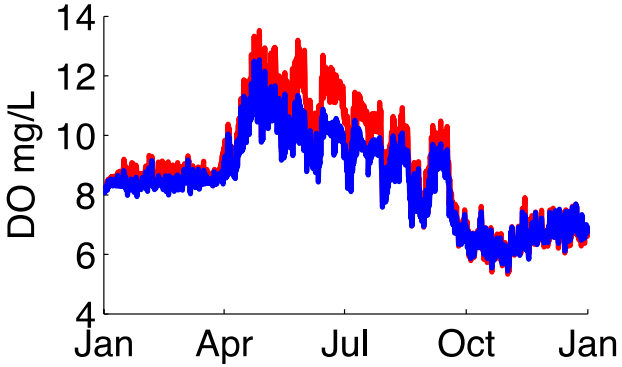
Sensitivity Experiments: River loading

Baseline (1st yr)
No river loading (1st yr)

Gordon Point



Surface Oxygen



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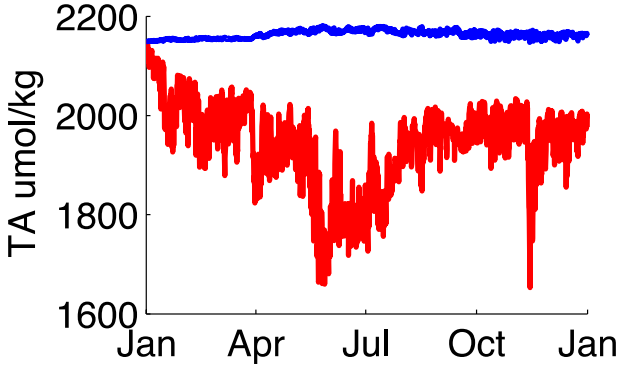

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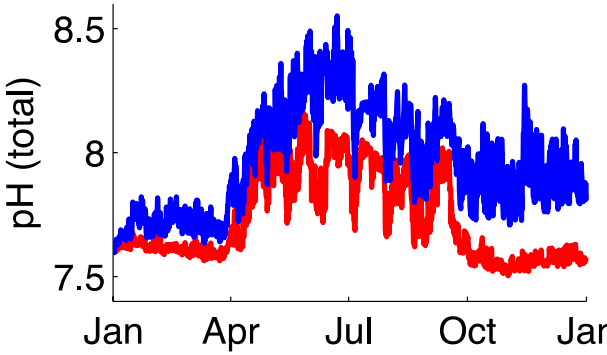

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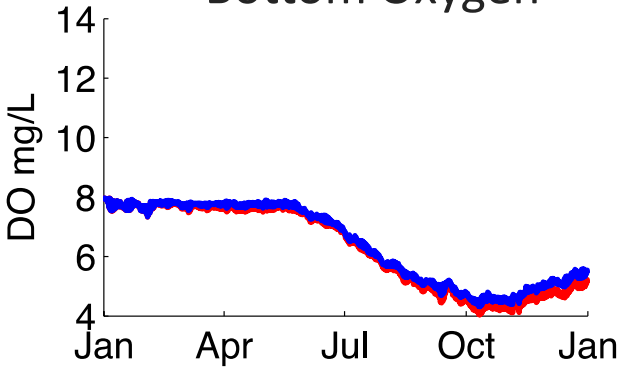

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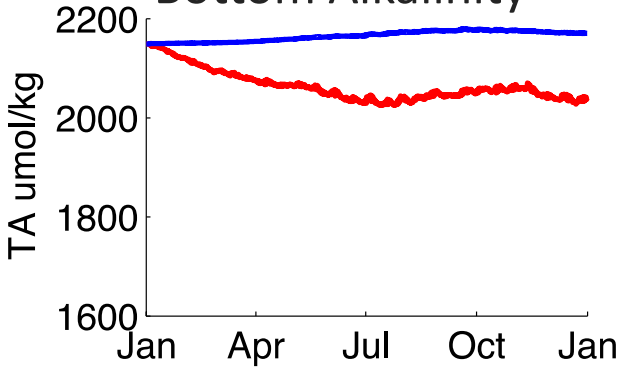

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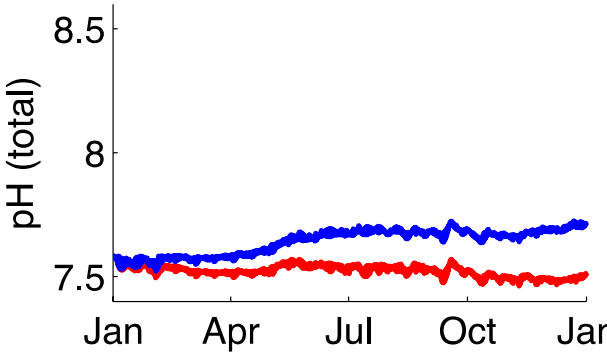

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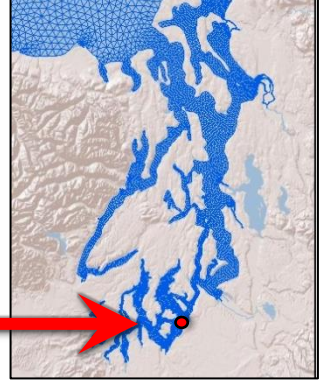
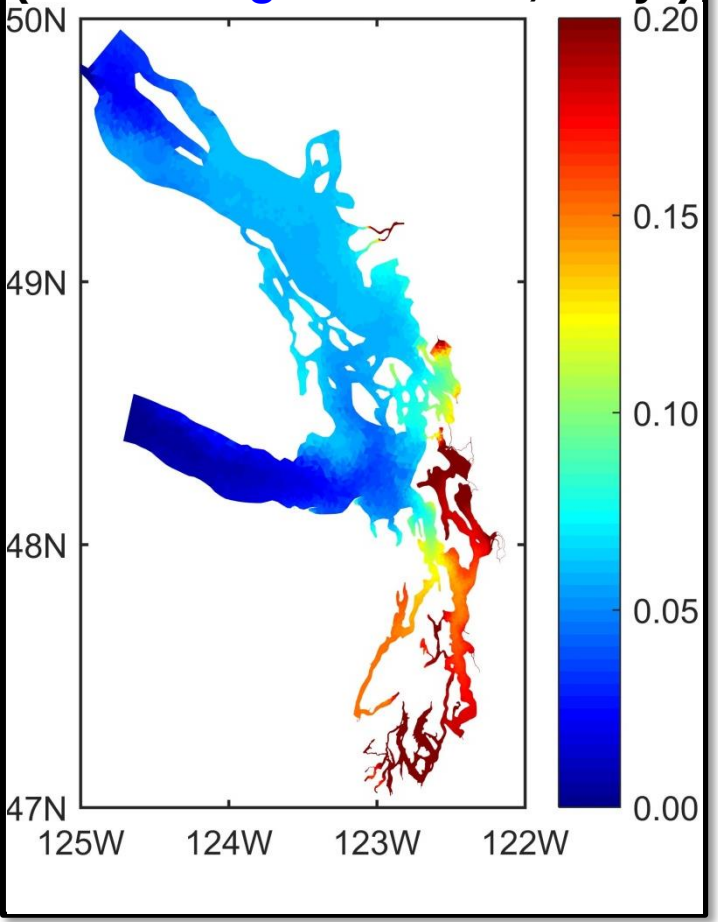
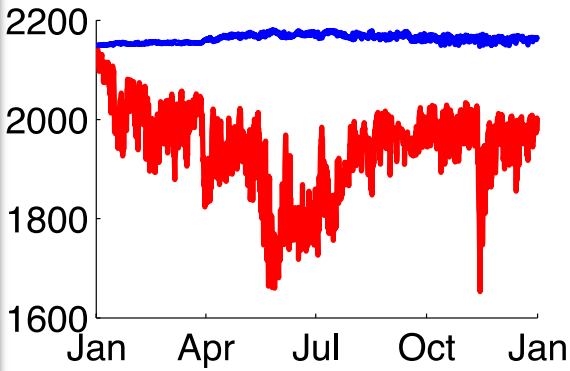


Mean annual ΔpH
(No loading – Baseline, 2nd yr)



Surface Alkalinity



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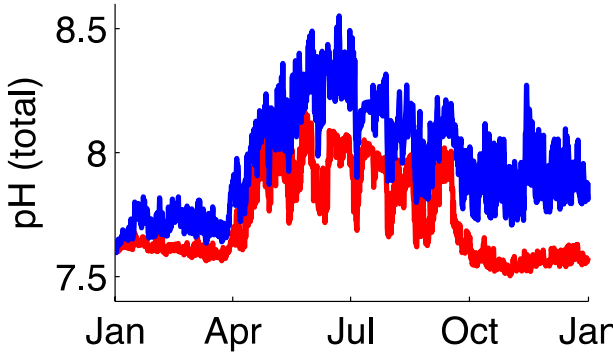

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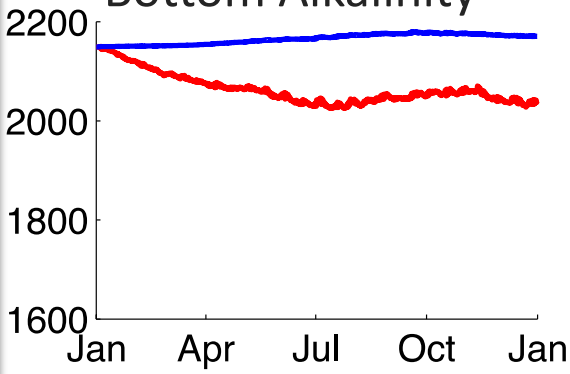

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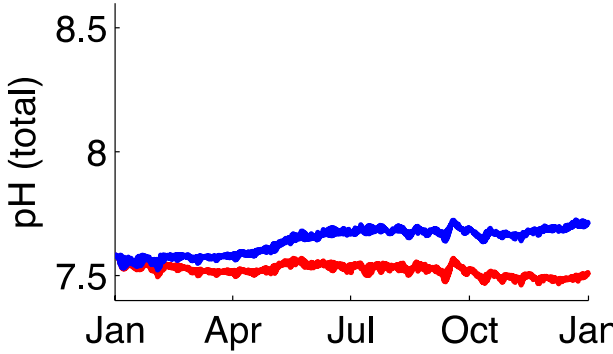
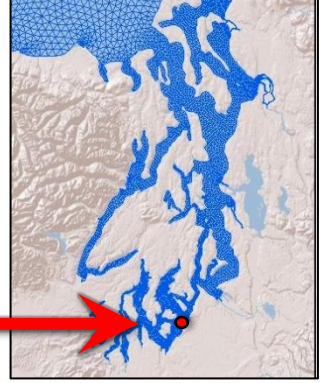


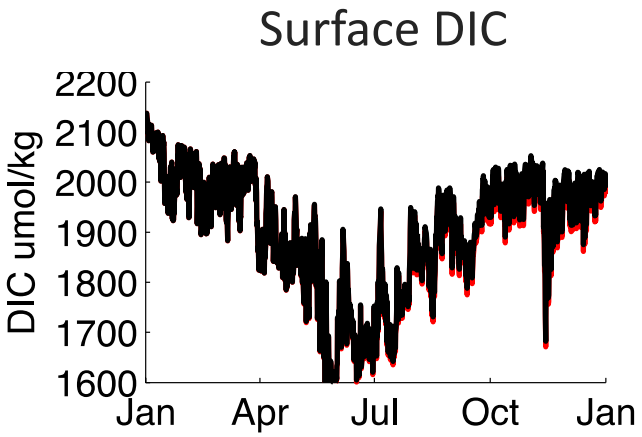
Sensitivity Experiments: Open boundary

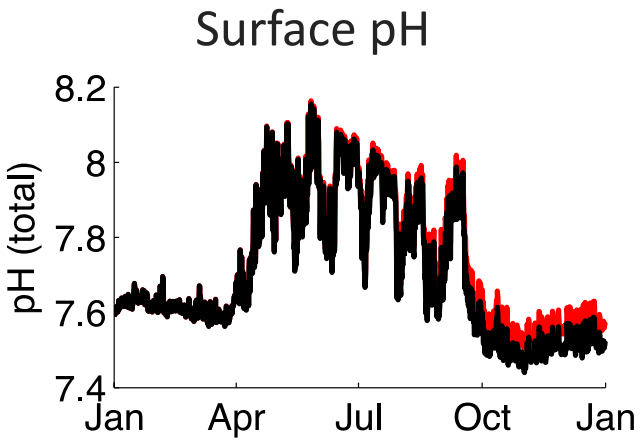
Baseline (1st yr)
DIC_{obc} + 40 (1st yr)

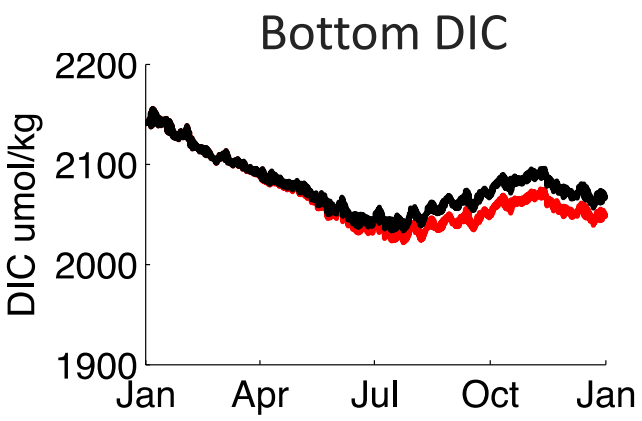
Equivalent to a pH decrease of 0.1 at the OBC

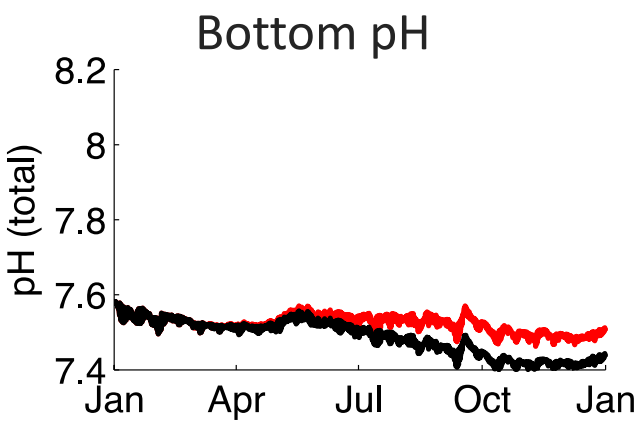
Gordon Point











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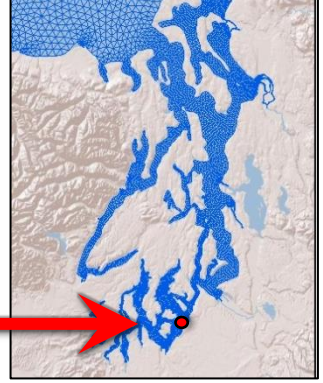
Gordon Point



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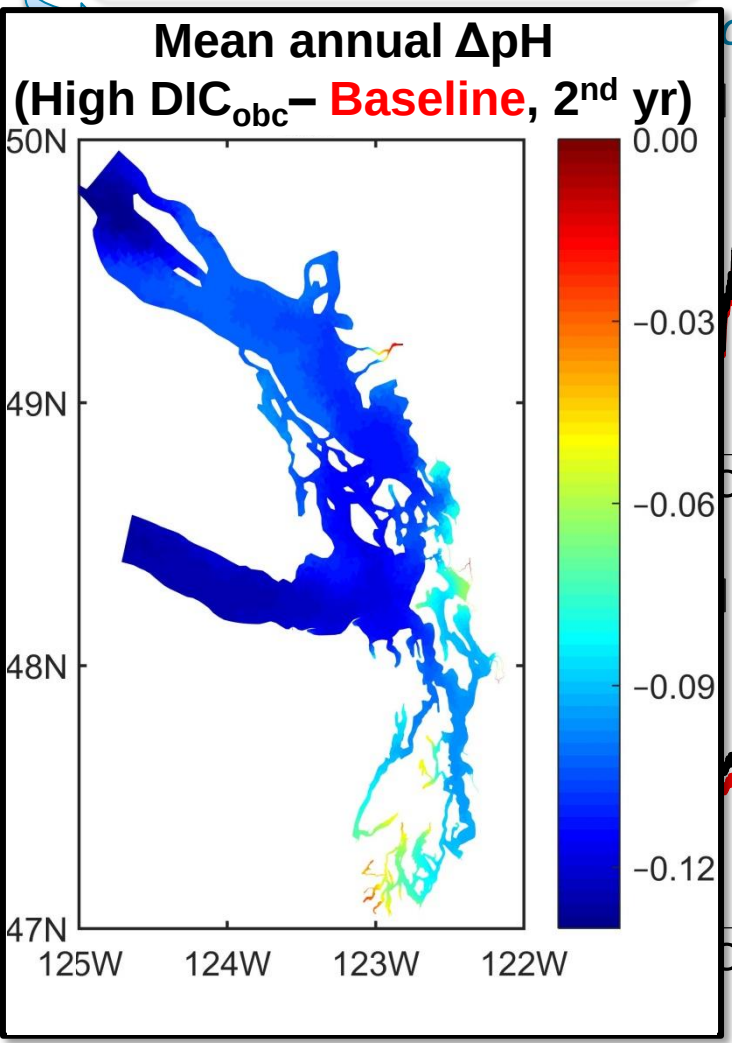

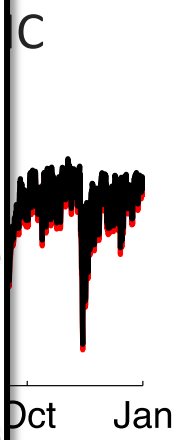

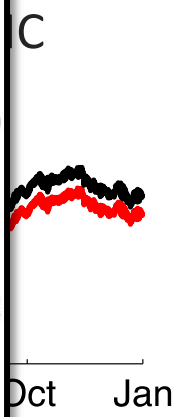

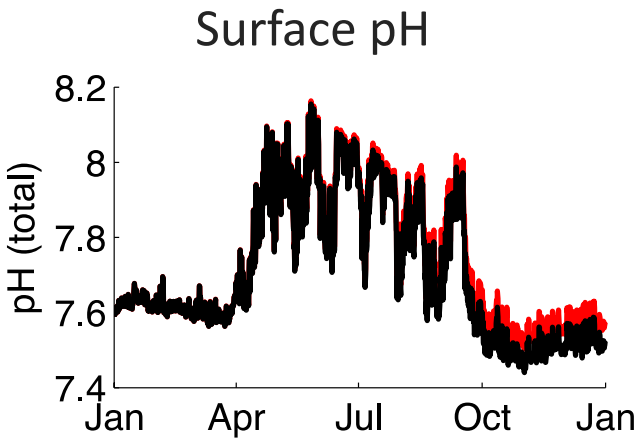

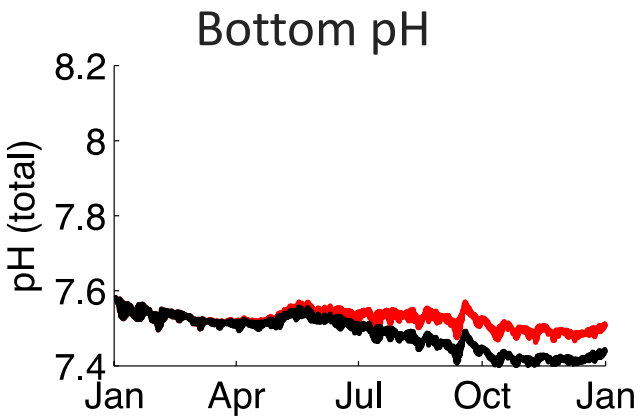

Conclusions based on SSM

- Both **open ocean** conditions and **rivers** influence the **carbonate system in Puget Sound**
  - Open ocean → strongest effect in bottom waters of Puget Sound (due to estuarine circulation)
  - Shallower bays and inlets with strong riverine influence → more resilient to changes in the open boundary
  - Freshwater loading → far-reaching effect beyond river mouth
  - ↑DIC ↓ pH, Ω
    ↑ TA ↑ pH, Ω

    Imbalances in DIC, TA in rivers/ocean matter for pH, Ω response

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Thanks!!!

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