

Western Washington University

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Salish Sea Ecosystem Conference

2022 Salish Sea Ecosystem Conference (Online)

Apr 26th, 1:30 PM - 3:00 PM

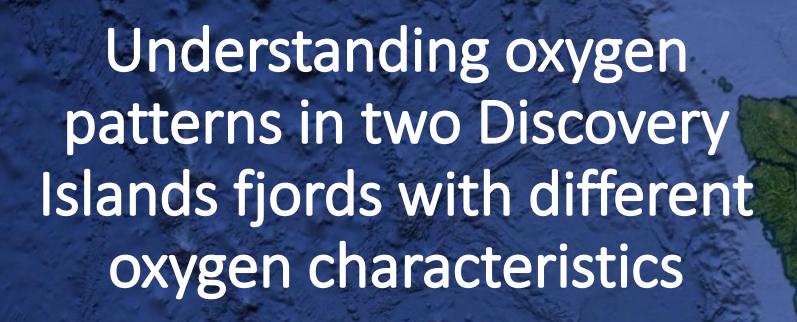
Understanding oxygen dynamics in two Discovery Islands fjords with different oxygen characteristics (oxic vs. hypoxic subsurface waters)

Dr. Laura Bianucci

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Bianucci, Dr. Laura, "Understanding oxygen dynamics in two Discovery Islands fjords with different oxygen characteristics (oxic vs. hypoxic subsurface waters)" (2022). *Salish Sea Ecosystem Conference*. 254. https://cedar.wwu.edu/ssec/2022ssec/allsessions/254

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Laura Bianucci, Mike Foreman

Institute of Ocean Sciences, Fisheries and Oceans Canada

Jen Jackson, Wiley Evans, Alex Hare

Hakai Institute, Canada

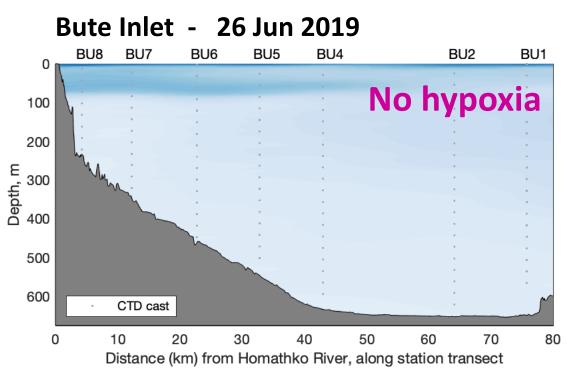


Model Description Model Evaluation Results Summary

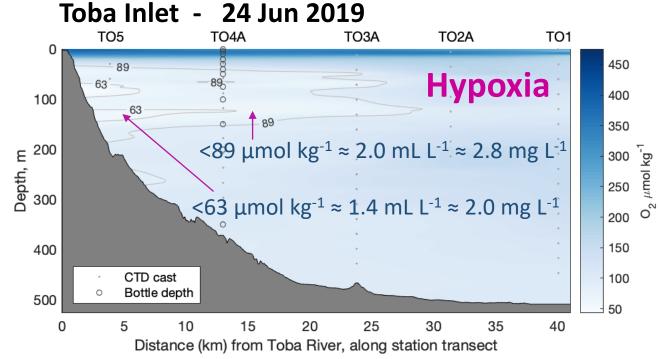
Why study O₂ in Discovery Islands?

• In 2019, Bute and Toba Inlets showed different oxygen characteristics





Motivation



Model Description | Model Evaluation Motivation

Results

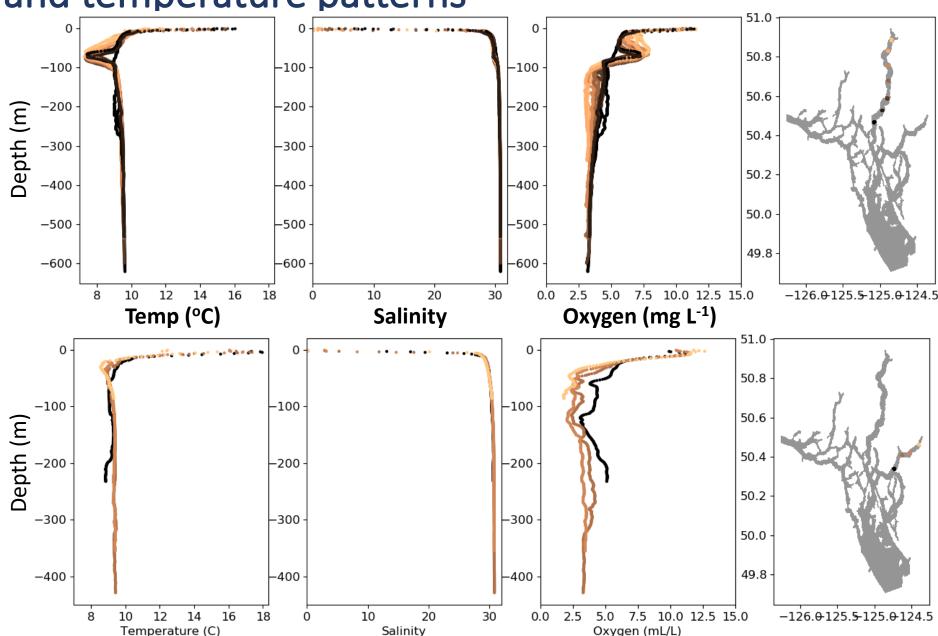
Observed oxygen and temperature patterns

Bute

12 Jun 2019 26 Jun 2019



24 Jun 2019



Model Description Model Evaluation Motivation

Results

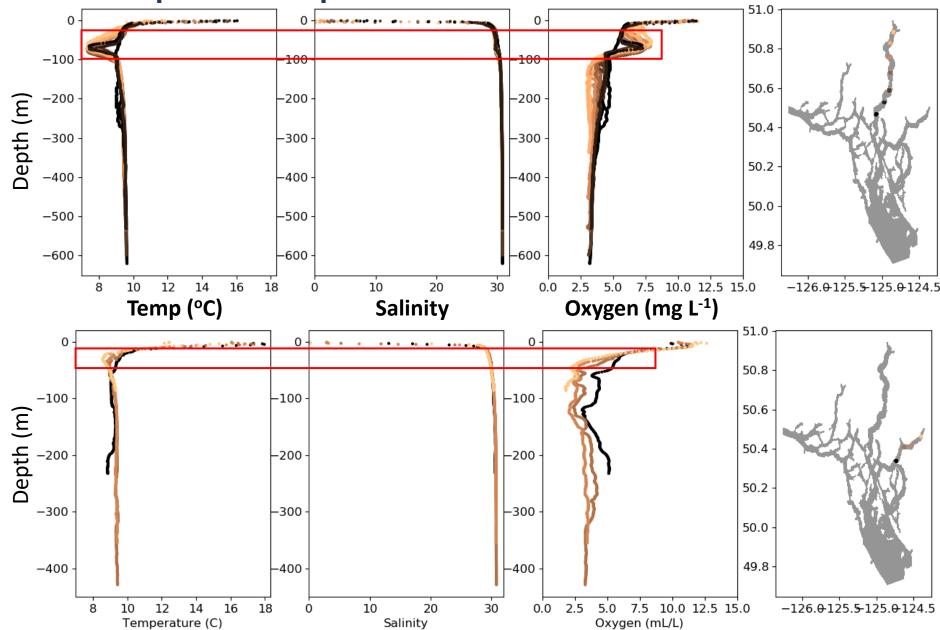
Observed oxygen and temperature patterns

Bute

12 Jun 2019 26 Jun 2019

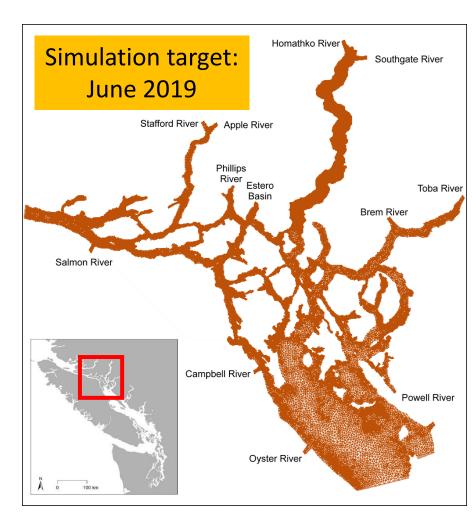


24 Jun 2019



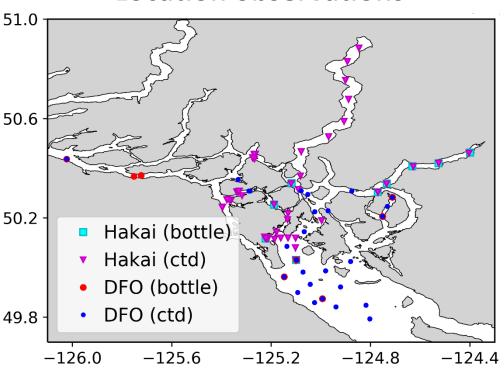
Physical Model: FVCOM

- Finite Volume Community Ocean Model, v4.1 (Chen et al. 2006)
- Unstructured triangular grid (~41K nodes)
 Horizontal resolution: 20 m to 1 km
- 20 terrain-following sigma levels
 Vertical resolution: 1 cm to 100 m
- Winds and surface fluxes: High Resolution (1 km)
 Deterministic Prediction System
- Initial, open boundary conditions:
 Observations + SalishSeaCast (Soontiens et al. 2016)
- Rivers: 12 (discharge available in 4; no temperature observations)

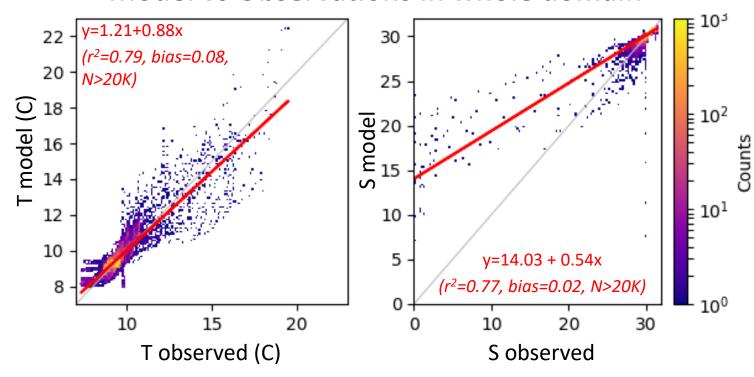


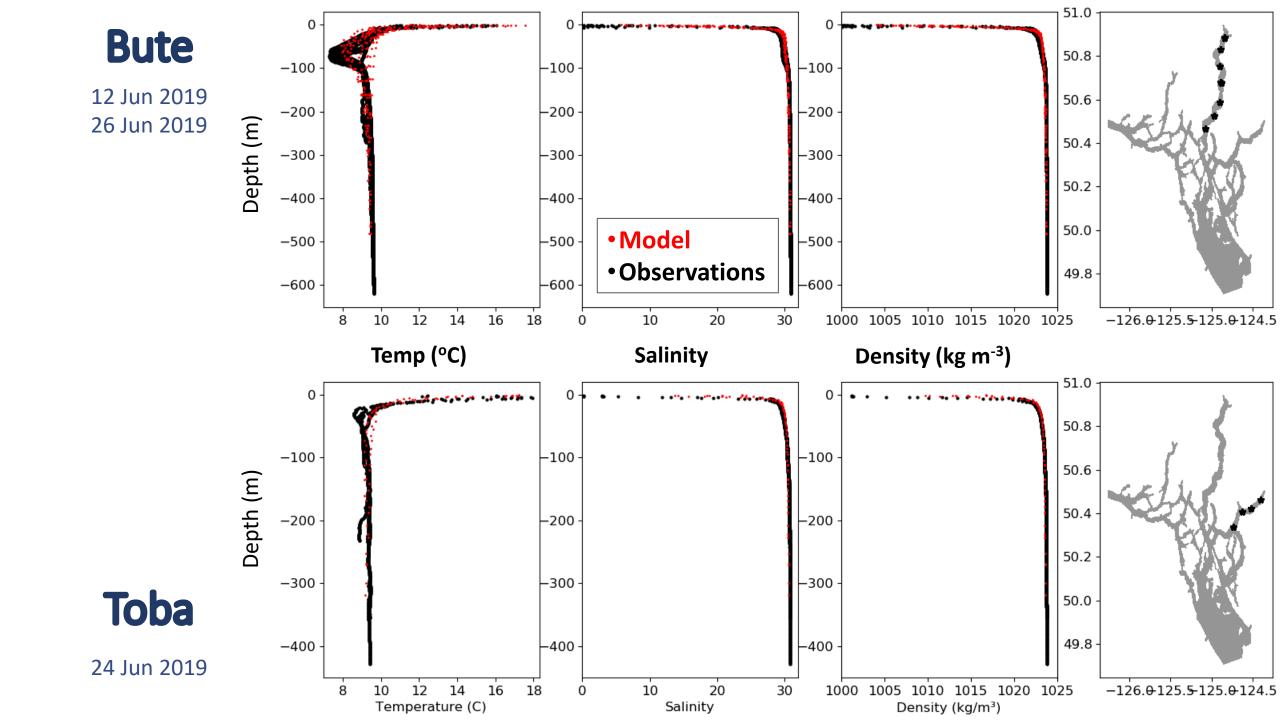
Simulation: 24 May to 27 June 2019

Location observations

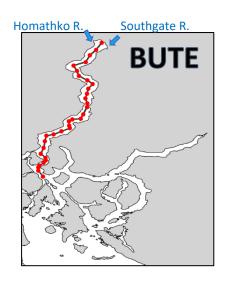


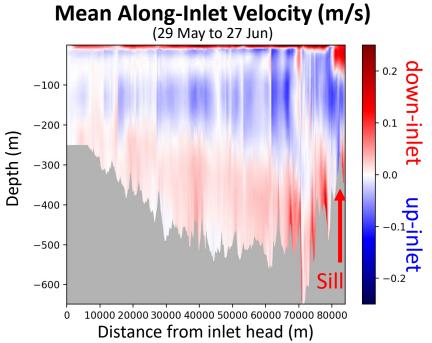
Model vs Observations in whole domain

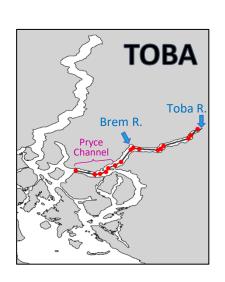


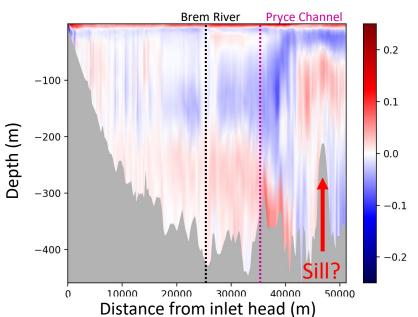


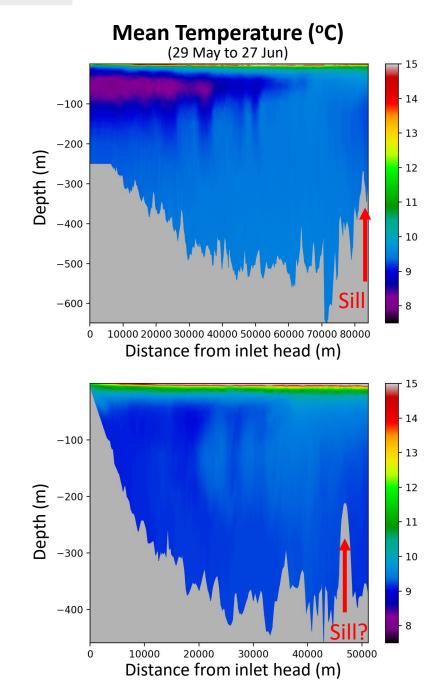
Motivation Model Description Model Evaluation Results Summary

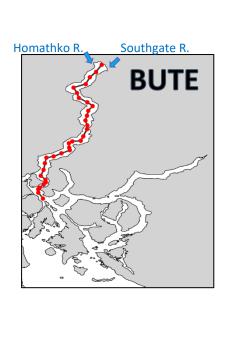


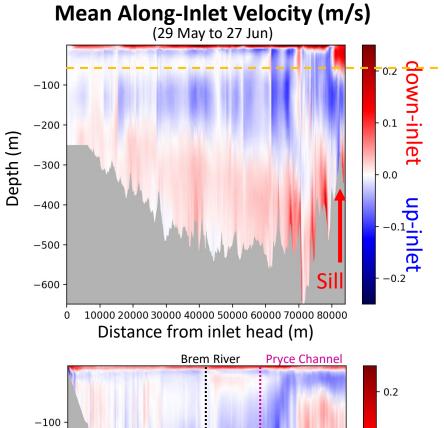


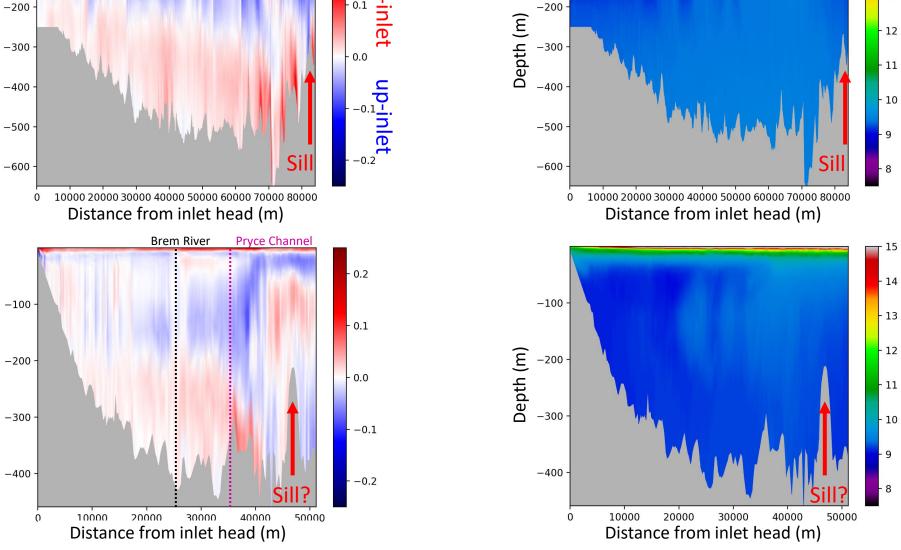








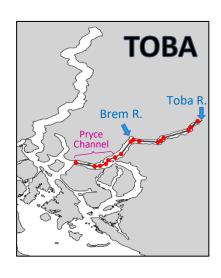




Mean Temperature (°C) (29 May to 27 Jun)

- 14

- 13



Depth (m)

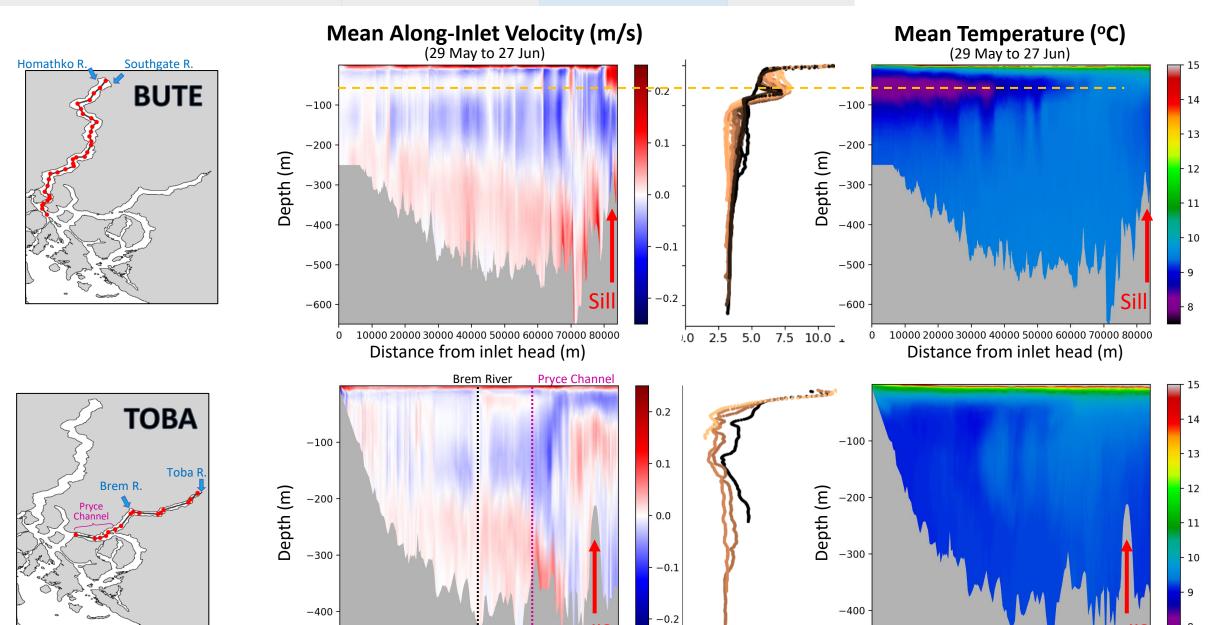
Motivation Model Description Model Evaluation Results Summary

20000

30000

Distance from inlet head (m)

40000



50000

0 2.5

5.0

7.5 10.0 1

Oxygen (mL/L)

30000

Distance from inlet head (m)

20000

10000

40000

50000

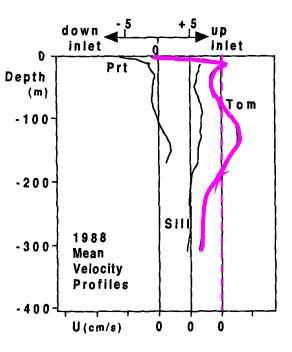
Previous studies show 4-layer flow in summer

Knight Inlet

Motivation

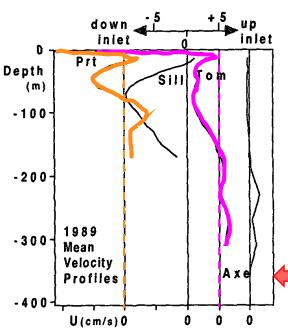
Baker and Pond, J. Phys. Oc. (1995)

Model Description



Mean Along-Inlet Velocities (cm/s)

1-month dataset in spring 1988



Mean Along-Inlet Velocities (cm/s)

1-month dataset in summer 1989



Previous studies show 4-layer flow in summer

Model Evaluation

inlet

Tom

Depth

(m)

-100

-200

-300

1989

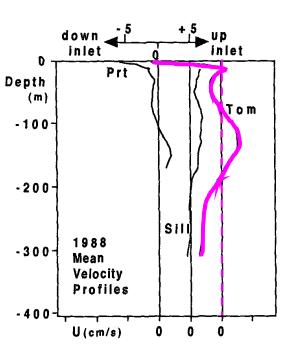
Mean Velocity

Profiles

U(cm/s)0

Knight Inlet

Baker and Pond, J. Phys. Oc. (1995)

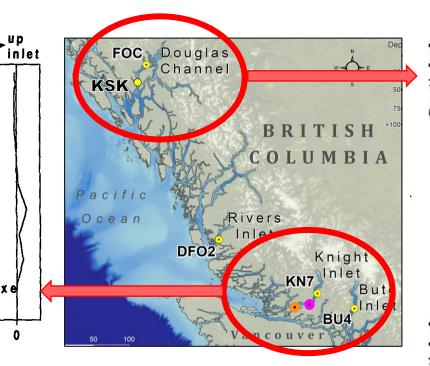


Mean Along-Inlet Velocities (cm/s)

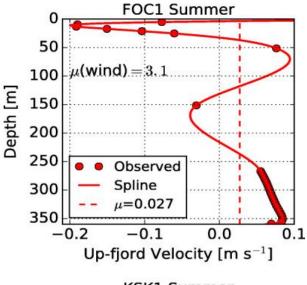
1-month dataset in spring 1988

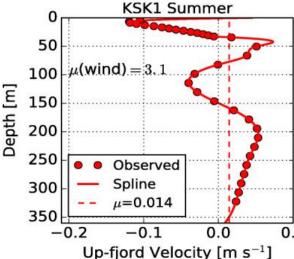
Douglas Channel

Wan et al., JGR:Oceans (2017)



Mean Summer 2015 Along-Fjord Velocity (m/s)





Mean Along-Inlet Velocities (cm/s)

1-month dataset in summer 1989

Motivation

Summary and Future Work

Laura.Bianucci@dfo-mpo.gc.ca

- In the model, Bute Inlet shows a 4-layered flow in summer, consistent with studies in other BC fjords
 - The transition between layers (mean along-inlet velocity ≈ 0) is stable, which allows previously entrained waters (low T, high O_2) to remain at the entrainment depth
- In contrast, Toba Inlet does not show the same clear layering underneath the surface estuarine circulation
 - o This is consistent with the low O₂ feature being more spread out in the water column
- Lots of work to do!
 - Topography and initial conditions need to be improved. Also, river temperature/discharge.
 - Run biogeochemical model once hydrodynamic model is improved. Run longer simulations.
 - Can we explain the observed O₂ differences between Toba and Bute?