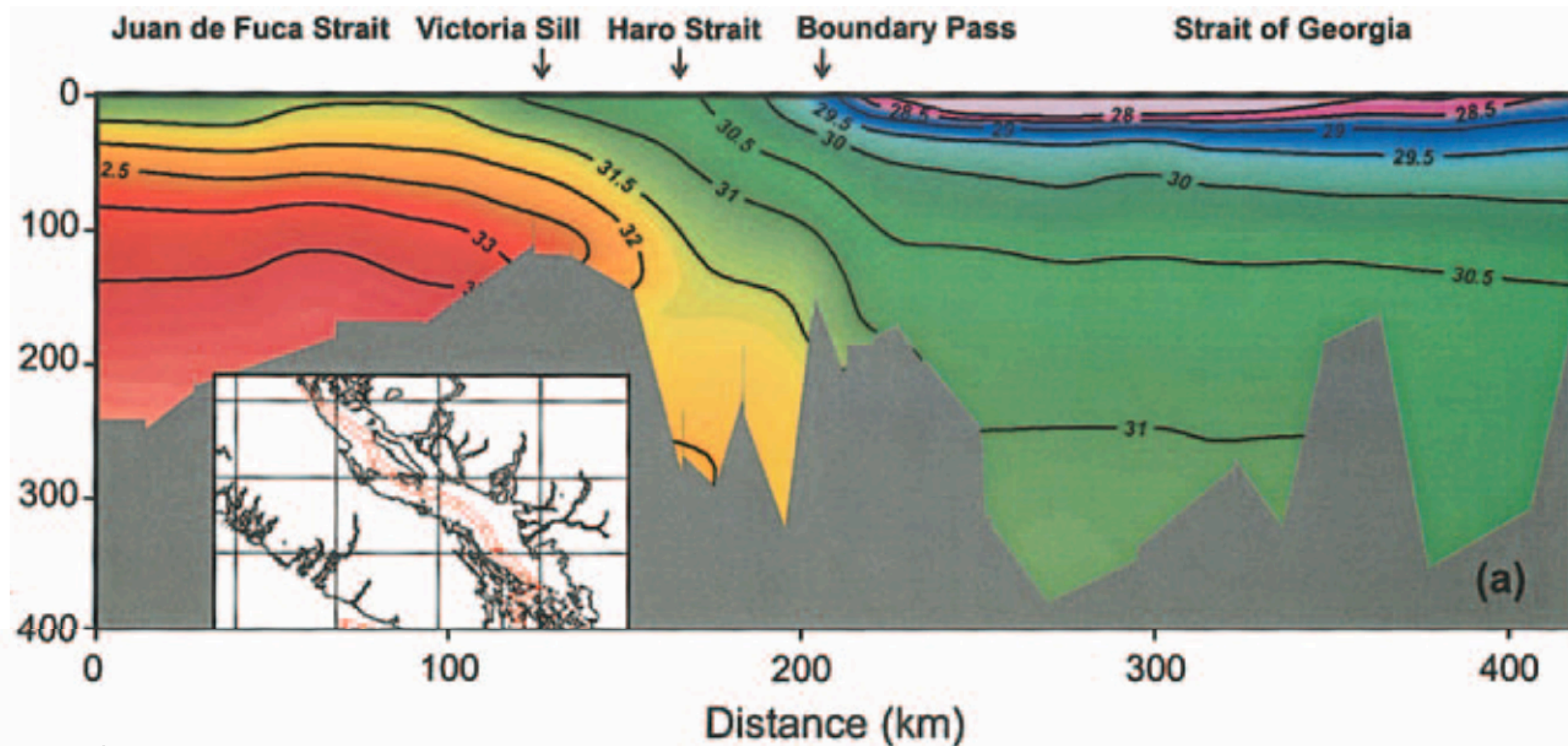# Water column observations to better constrain overturning circulations
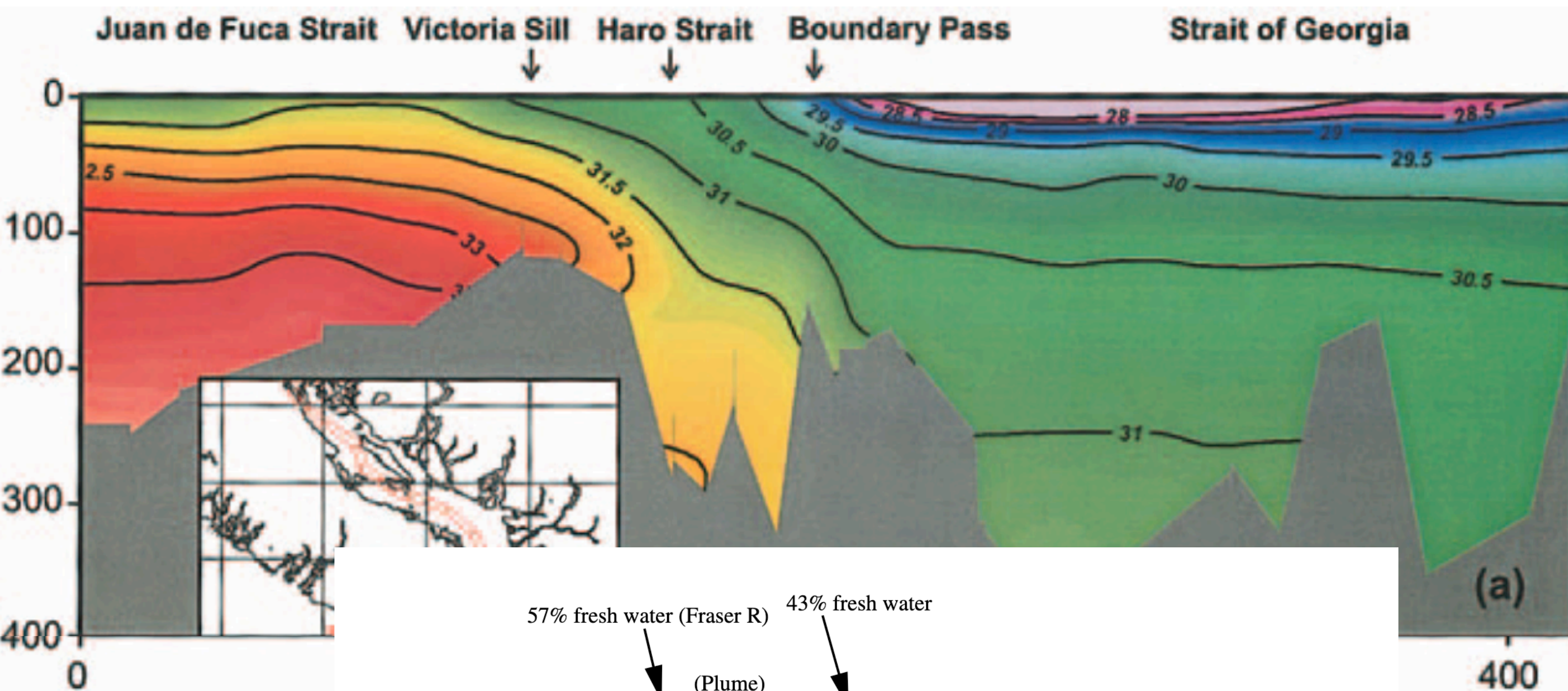
Jody Klymak
University of Victoria


*Masson and Cummins 2004*

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Science question: How strong is overturning circulation?

(a)

- *Pawlowicz et al 2007:*
- Surface exchange?
  - Estuary
  - 3-6 month residence time
- Deep exchange?
  - Set by deep water renewals
  - 1-3 years residence time ->
    65 days?

a) Strait of Georgia - summer

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# Salish Sea overturning circulations drivers

Masson and Cummins 2004
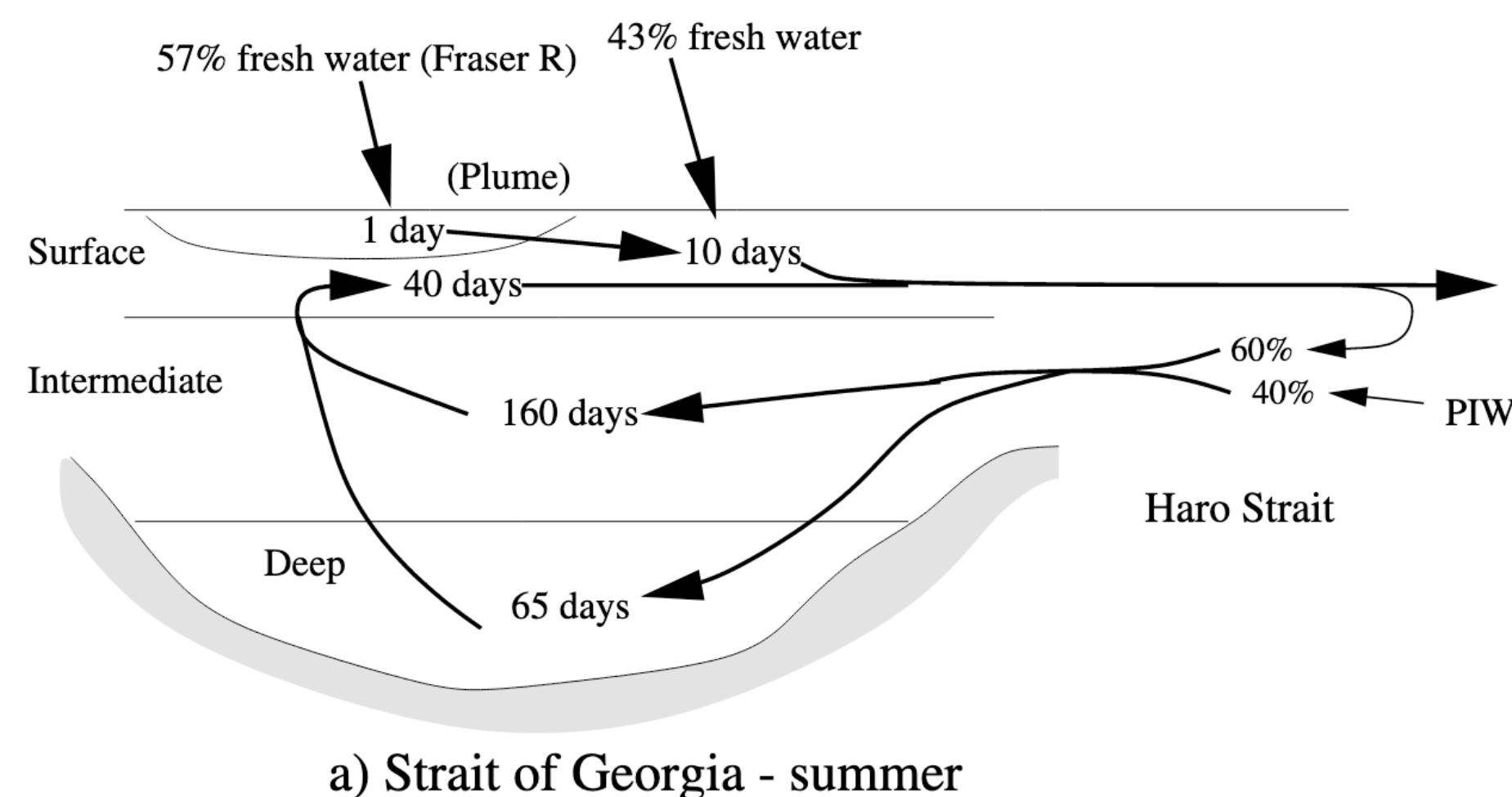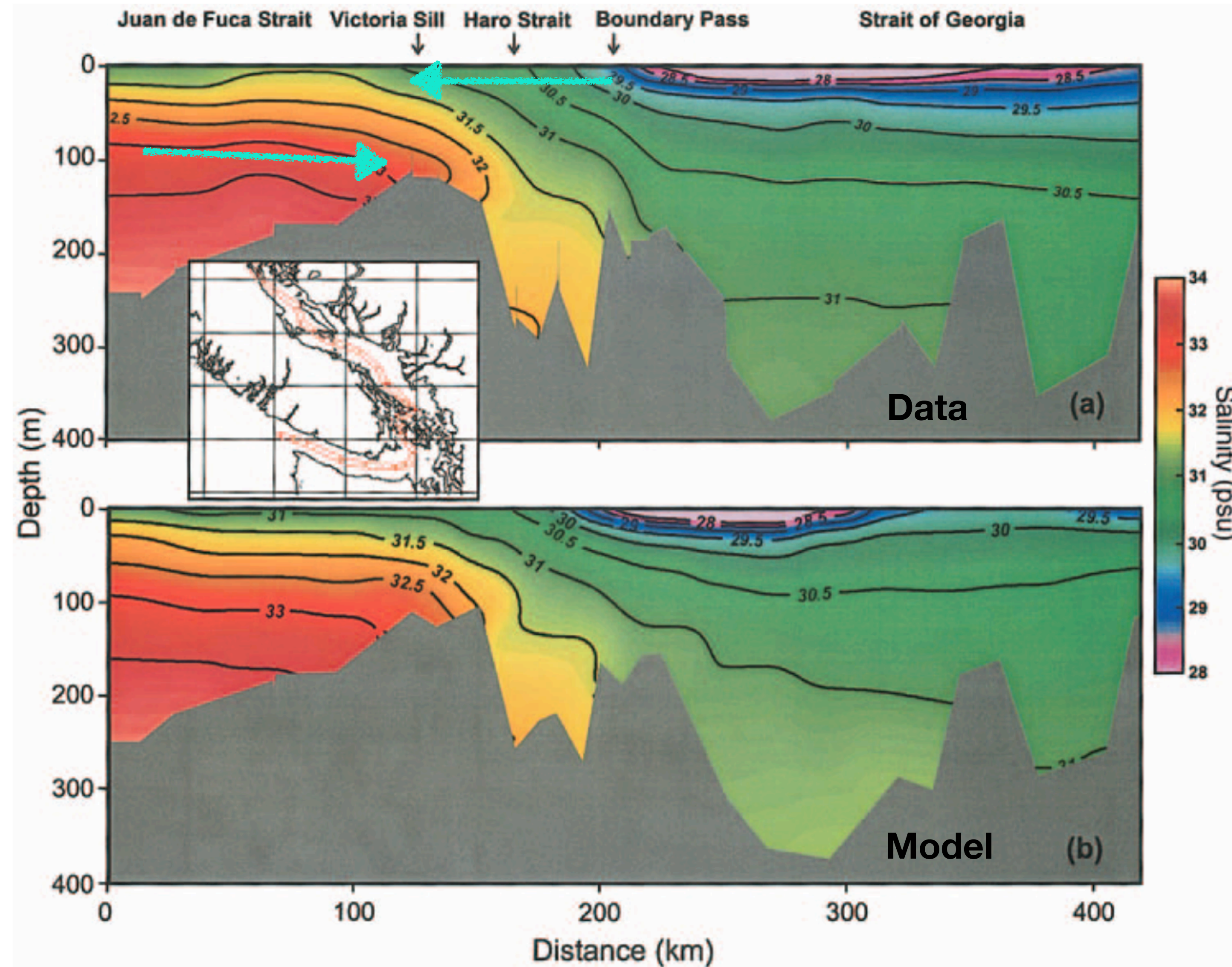
- Drivers:
  - Ocean
  - River
  - Mixing
  - Wind, but second order for overturning/renewal

Salish Sea overturning circulations drivers
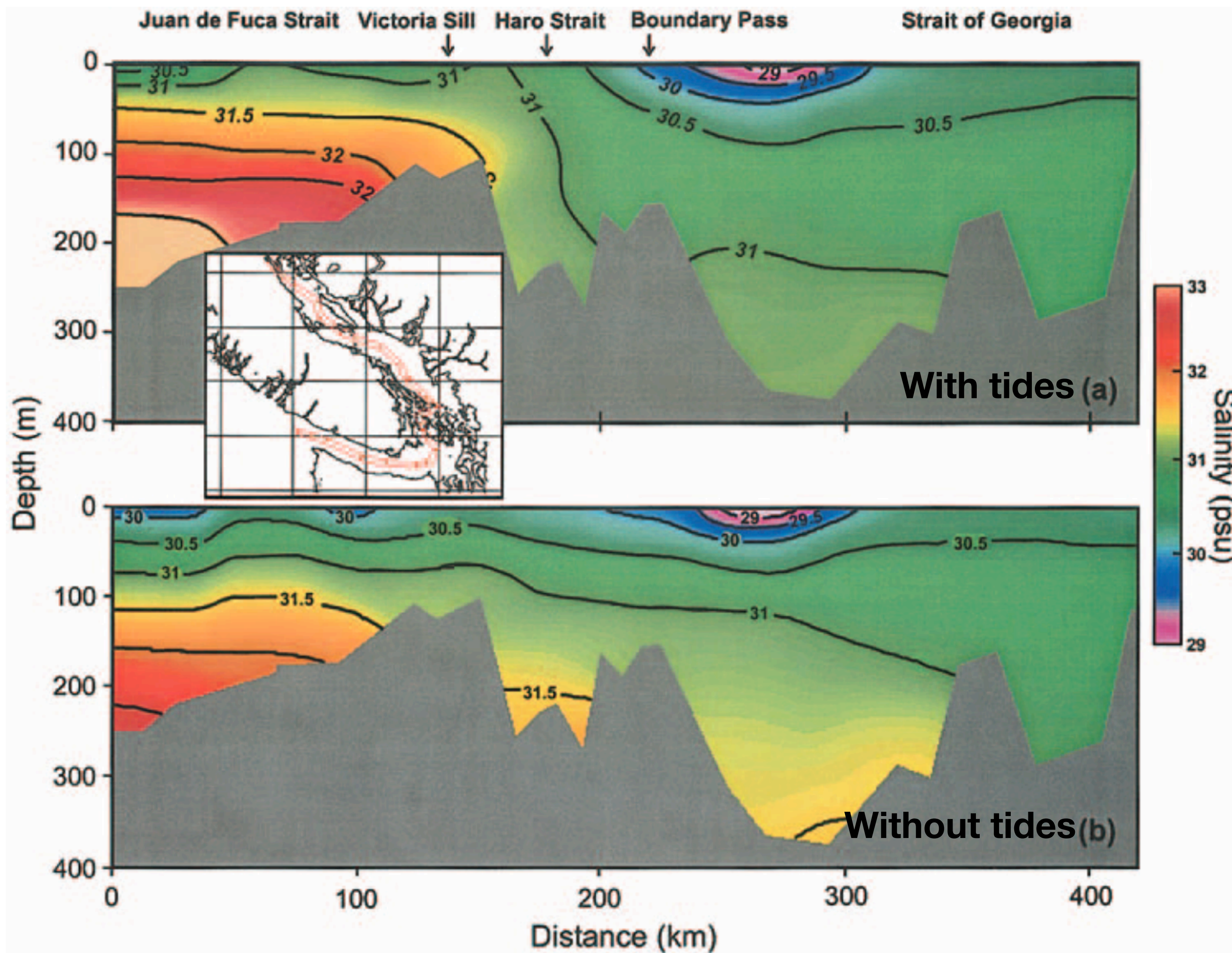

Masson and Cummins 2004

- Drivers:
  - Ocean
    - Observations and regional simulations
  - River
    - Mostly Fraser but local rivers matter too
  - Mixing
    - Major challenge
    - Sets what water can renew at sills
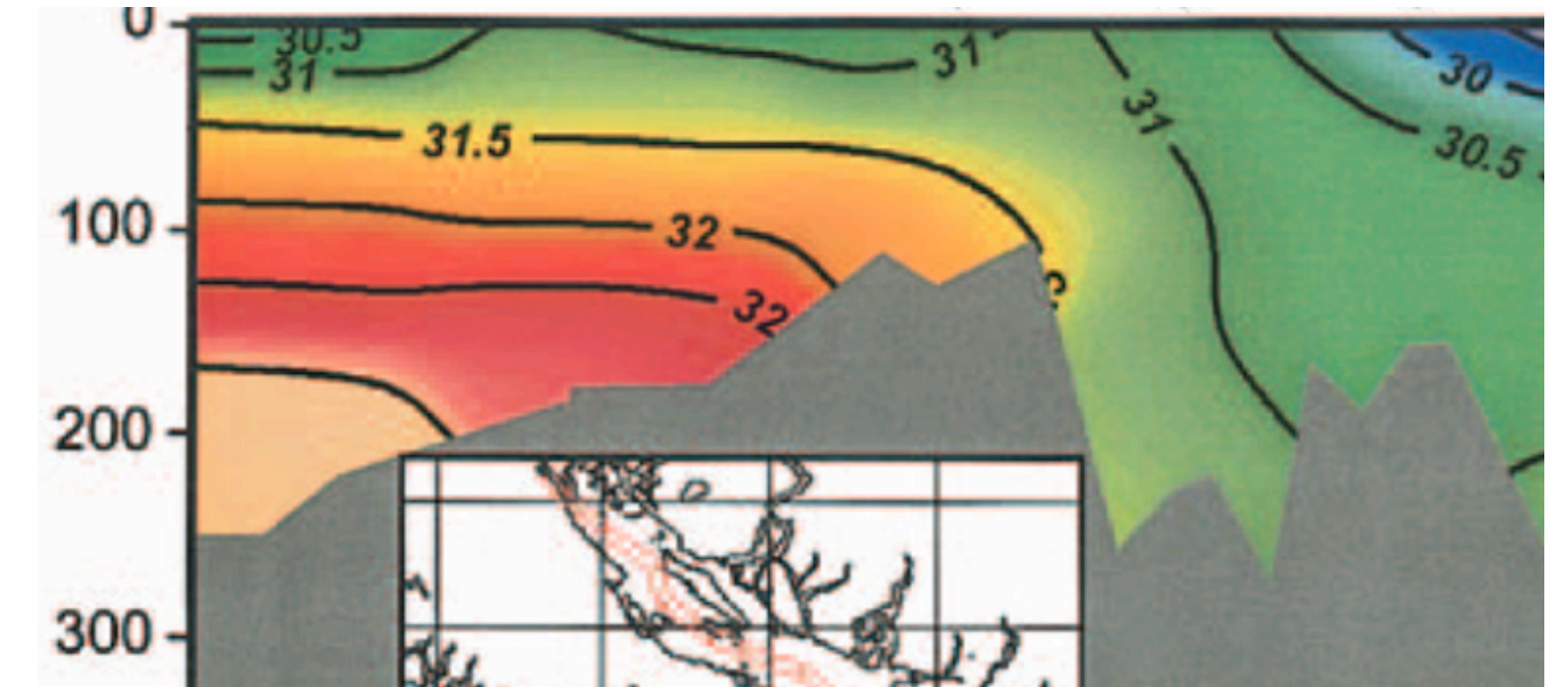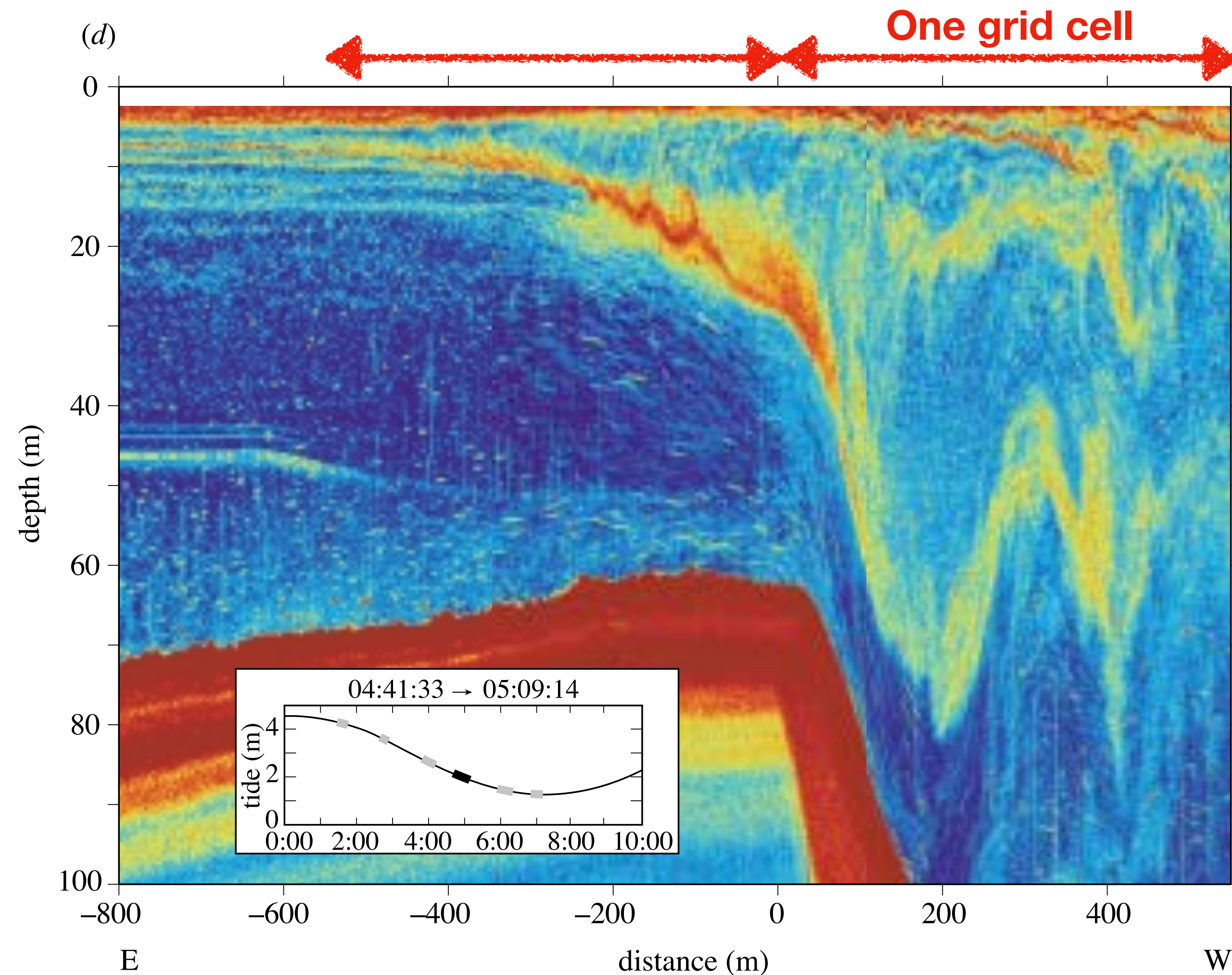   - Sets the density and water properties in the basins
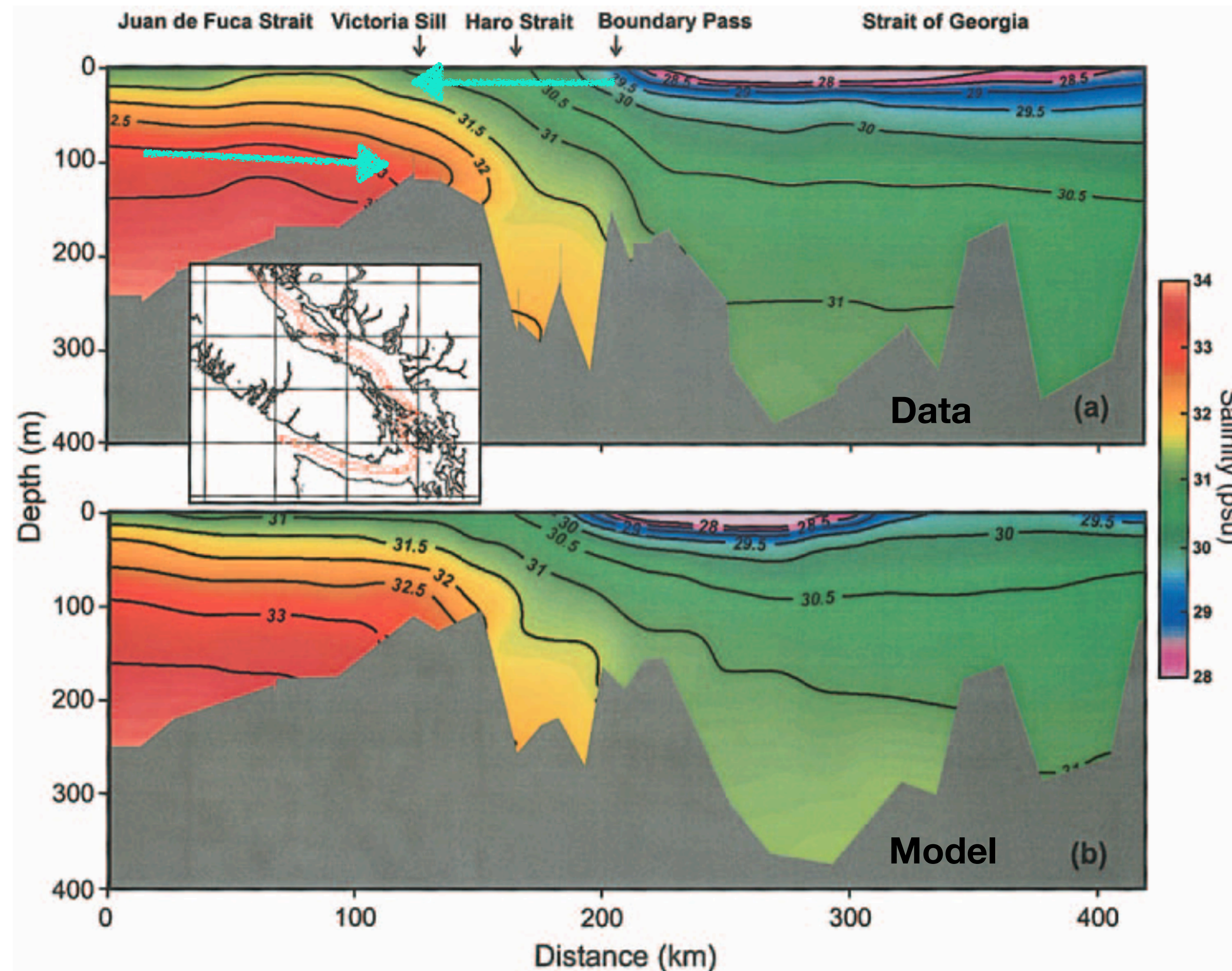
Overturning sensitivity to mixing

- Mixing
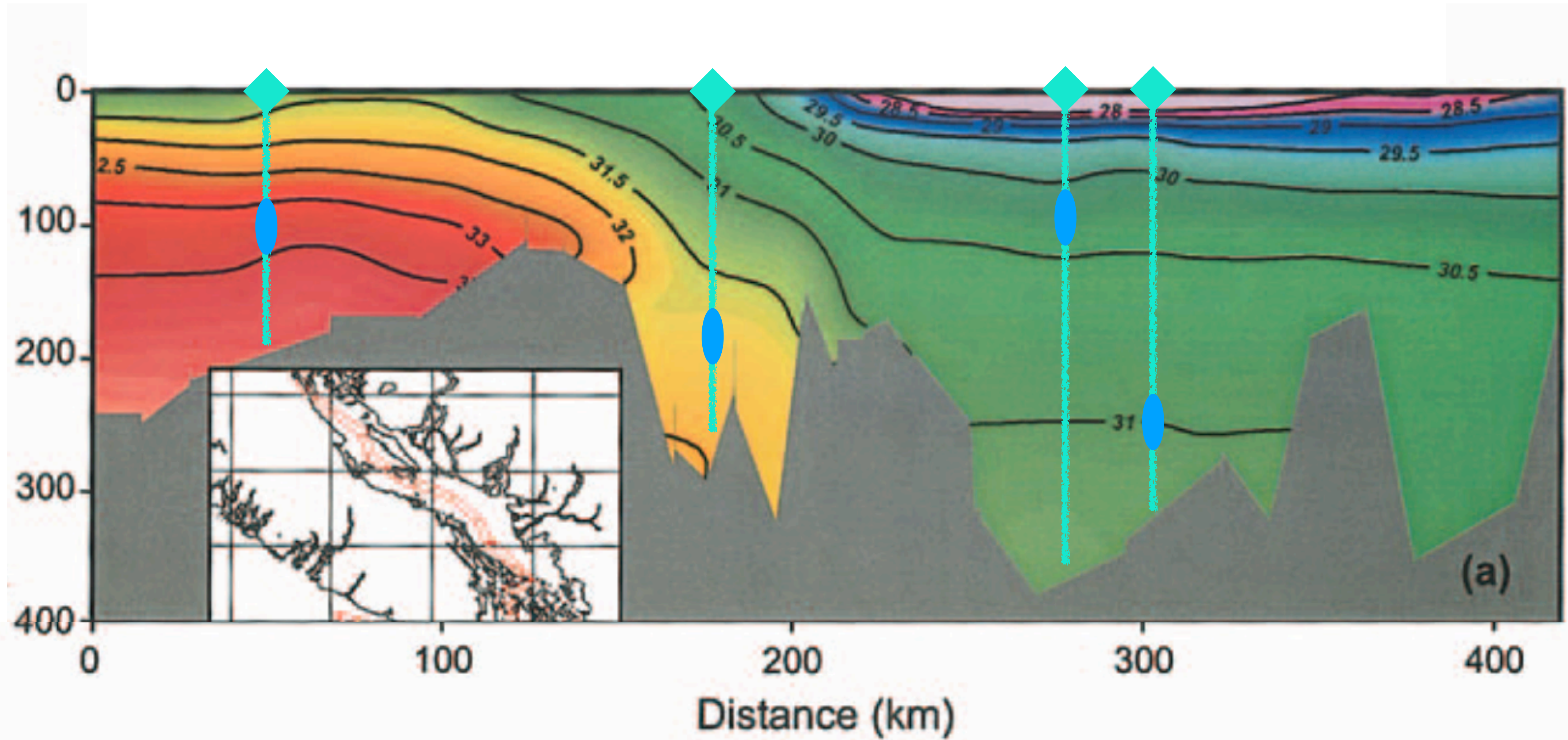 - Strong feedback not he mean state
  - Hard to parameterize correctly
    - e.g. *Soontiens and Allen, 2017*

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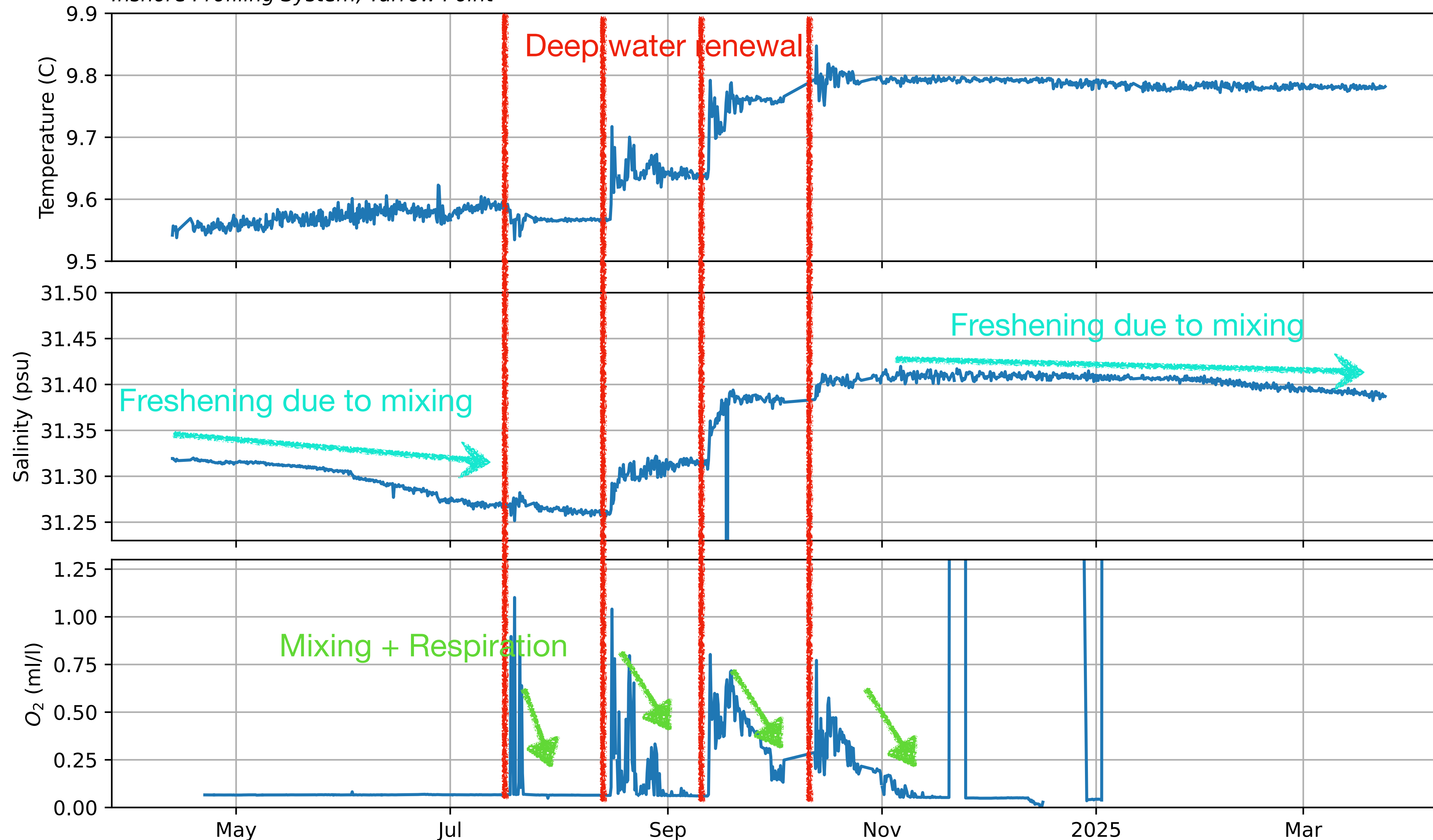# *Overturning sensitivity to mixing*

One grid cell

- Mixing
  - Strong feedback not he mean state
  - Hard to parameterize correctly (eg *Soontiens and Allen, 2017*)
  - Lateral/vertical mixing hard with nearly vertical density surfaces

Observatory?

(a)

Time series view: Saanich BPS, 180m
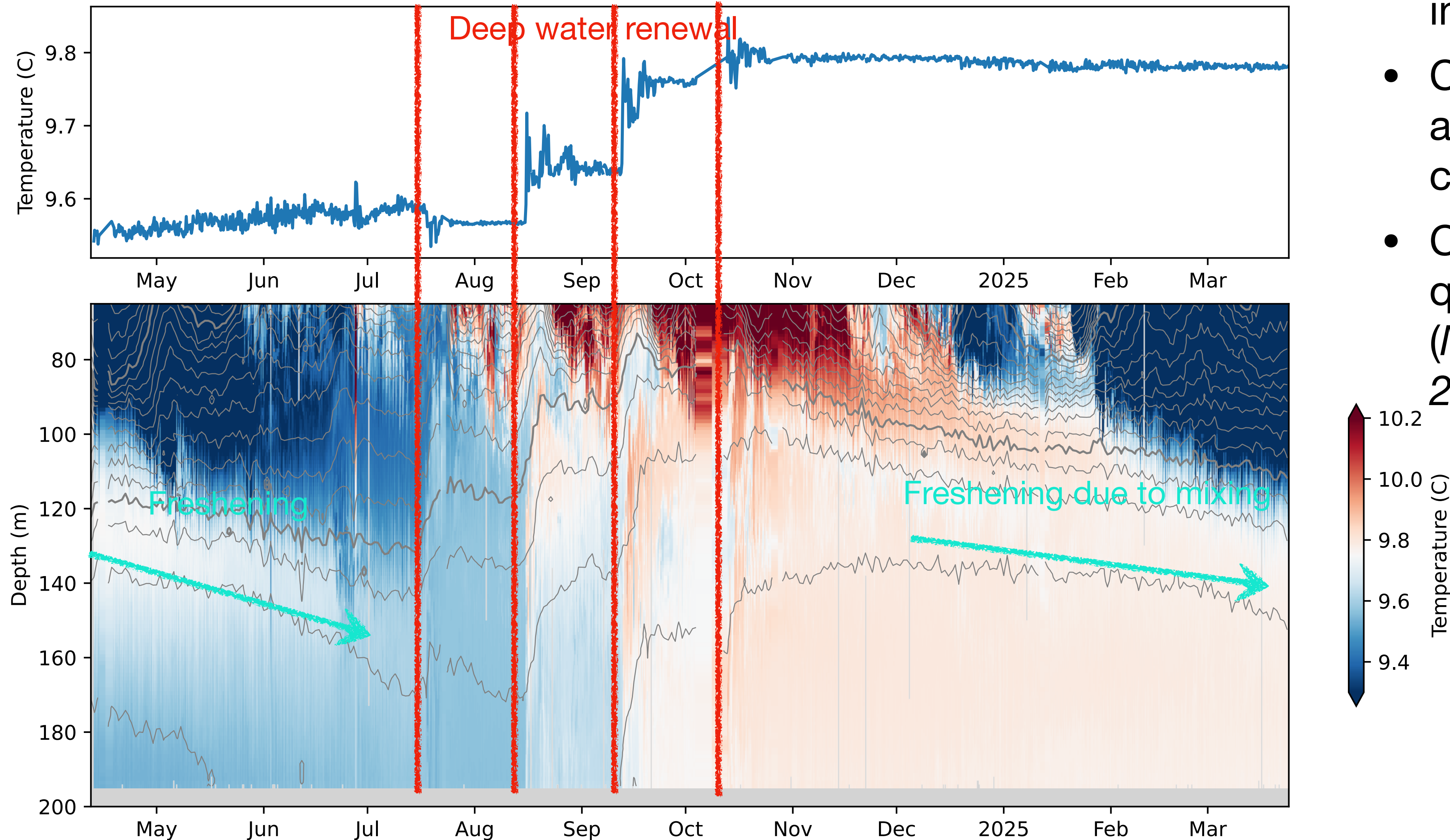

Inshore Profiling System, Yarrow Point

- Qualitatively useful
- Hard to quantify
- Harder for models to compare
  - Timing
  - Value and amount

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Profiling timeseries view
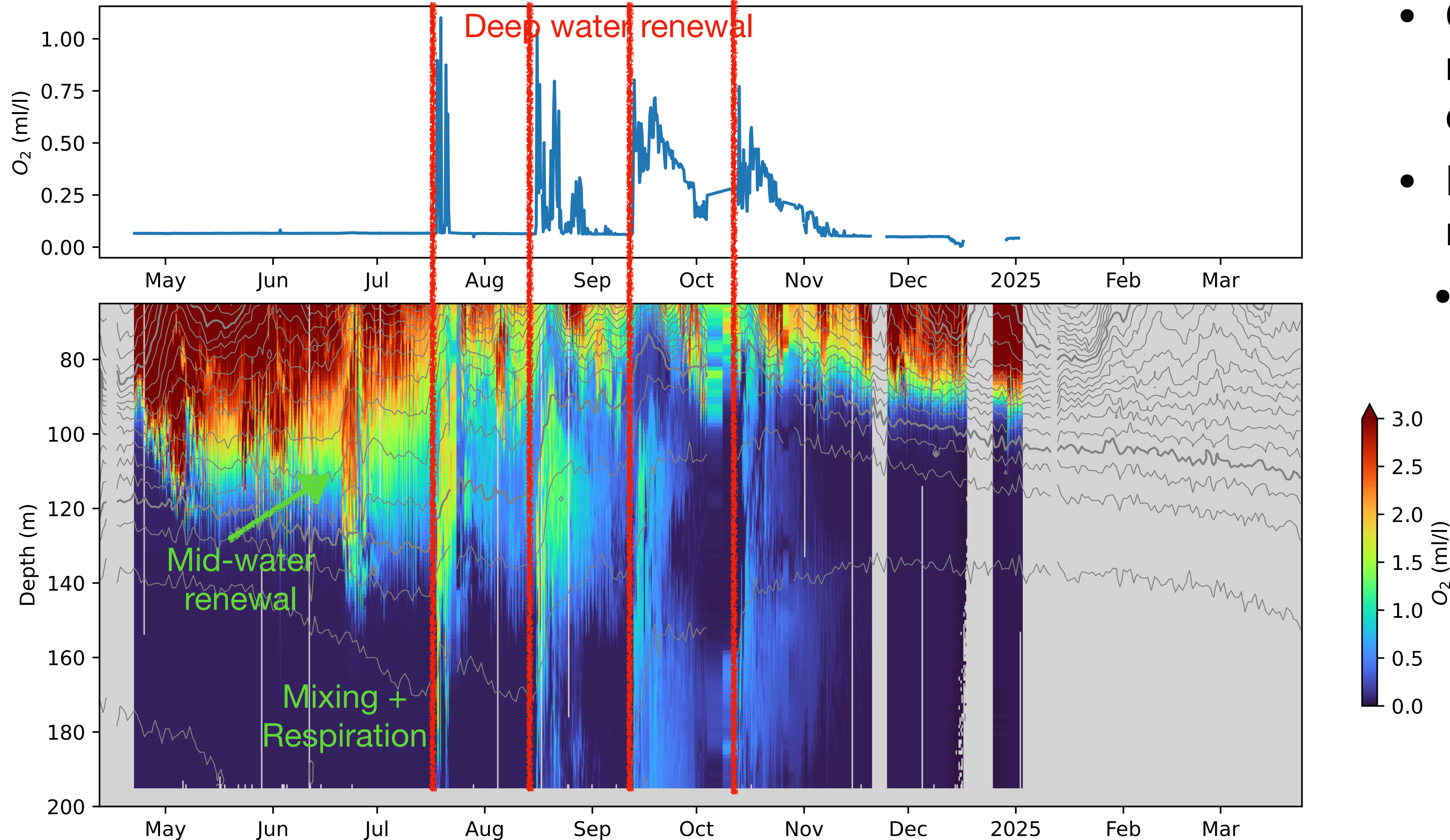

Inshore Profiling System, Yarrow Point

- Same qualitative story, but much more information

- Can quantify amounts and rates of water mass changes

- Can use profiles to quantify mixing rates (*Manning, Hamme, et al 2010*)
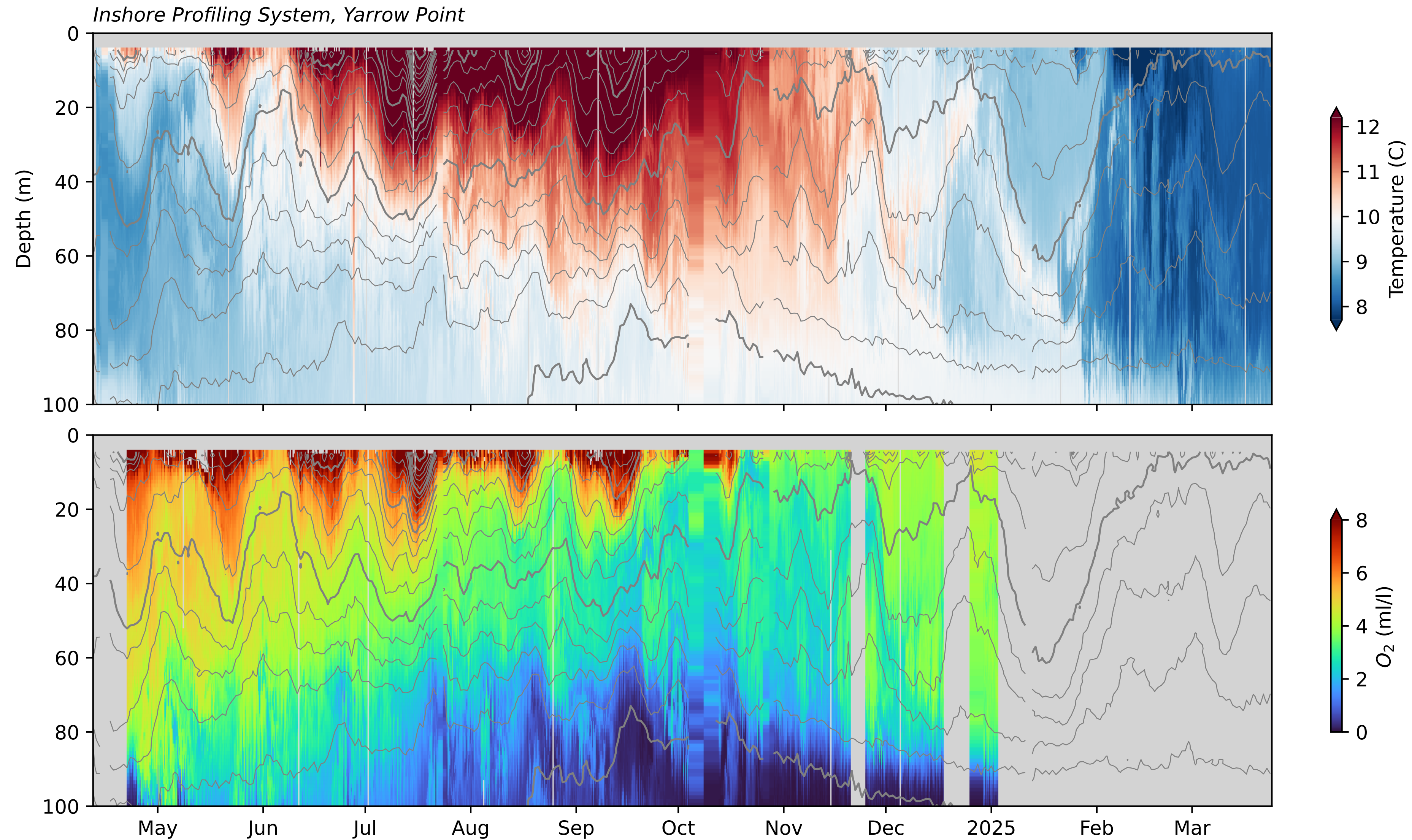
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Profiling timeseries view


Inshore Profiling System, Yarrow Point

- **Water column events more clear**
- **Can get at consumption rates with full water column**
- **Better to compare with numerical simulations**
  - Amount of water or gasses that comes in as important as timing

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Profiling timeseries view: Surface dynamics

Inshore Profiling System, Yarrow Point

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Observatory?

- 4 profiling moorings:
  - 8*$450k =$3.6M
- Residence time budgets for each basin
  - Like *Pawlowicz et al 2007,* except more resolution, and other basins
- Upper ocean dynamics each basin
  - Biooptics, gasses, physics
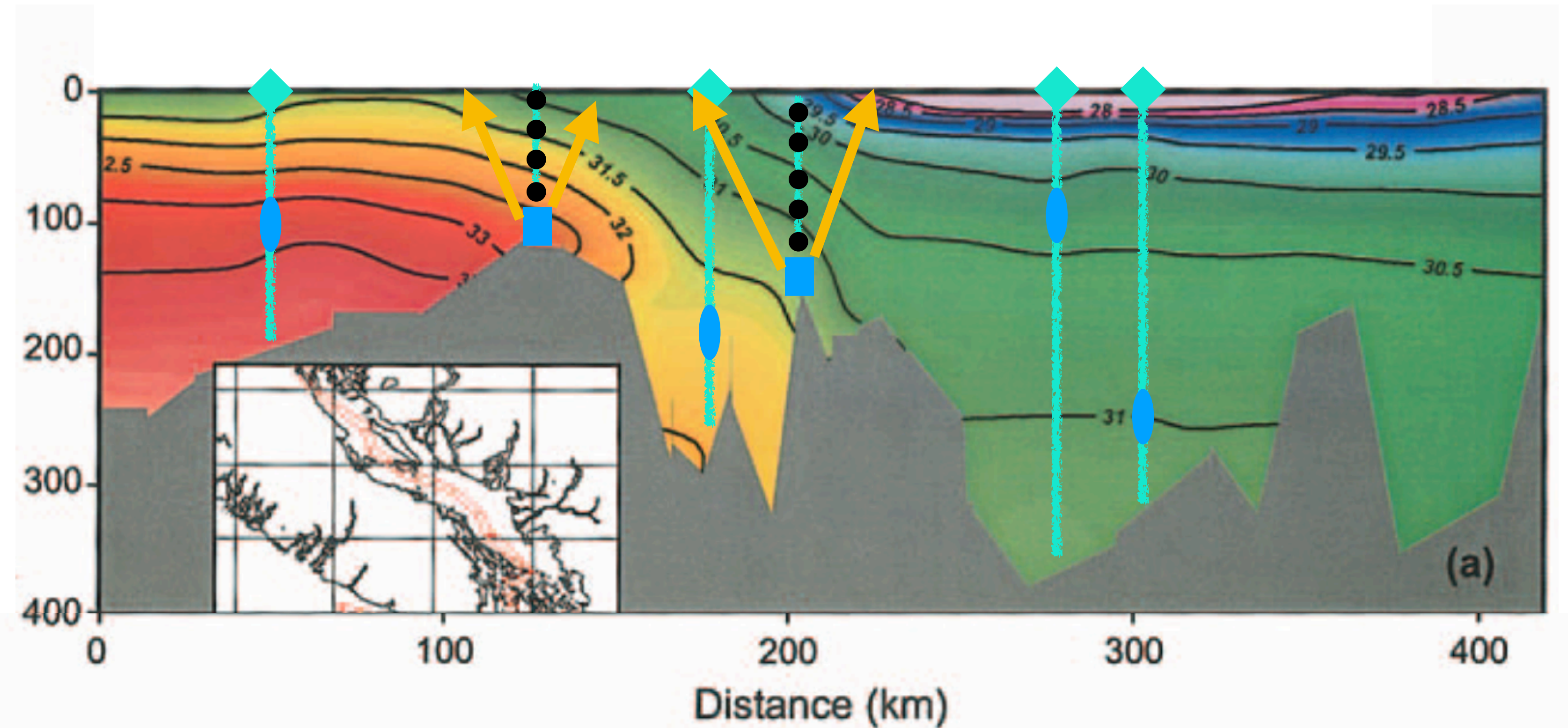- Much better constraint and assimilative/ML ability for models
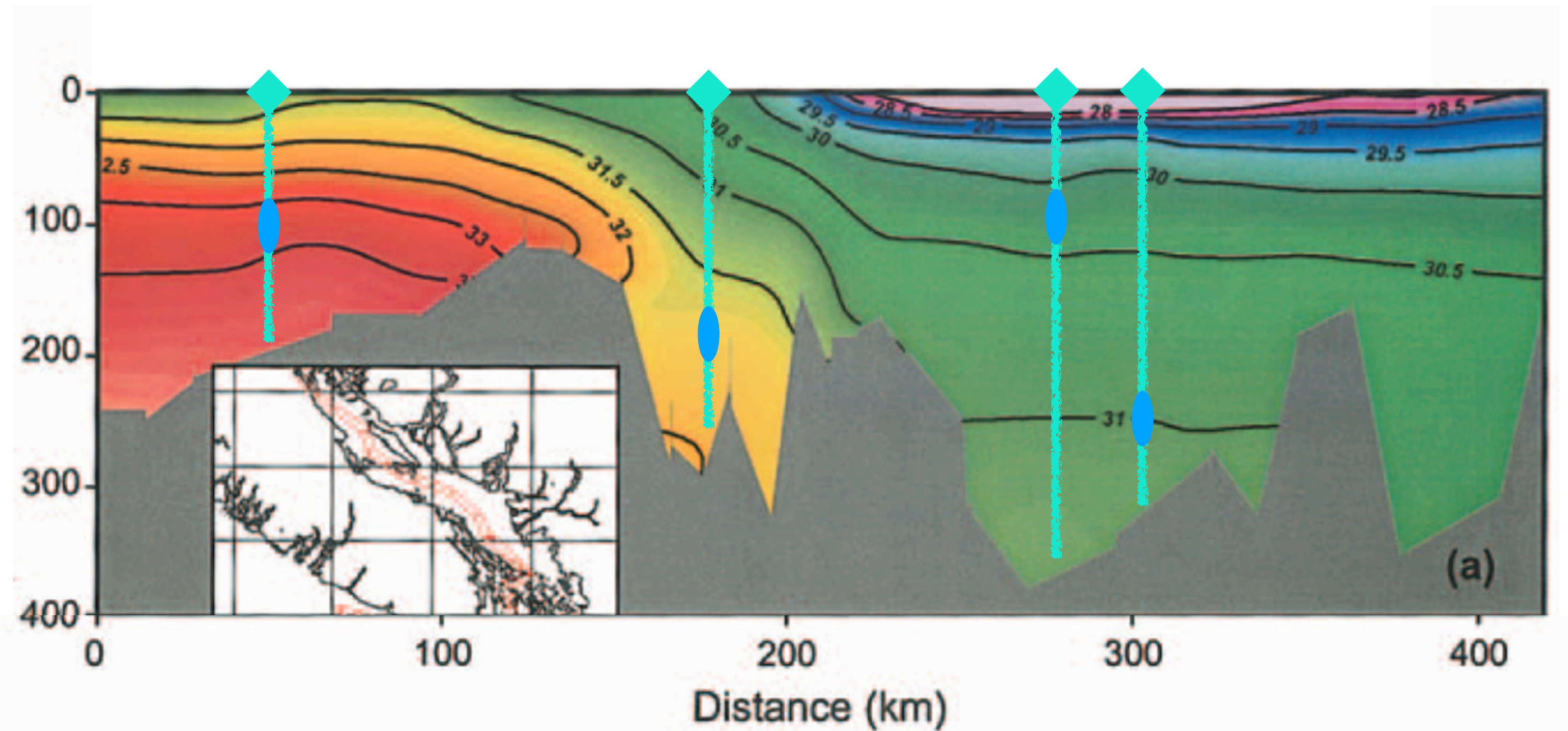
Observatory?

- 4 profiling moorings:
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- Residence time budgets for each basin
  - Like *Pawlowicz et al 2007,* except more resolution, and other basins
- Upper ocean dynamics each basin
  - Biooptics, gasses, physics
- Much better constraint and assimilative/ML ability for models

- Bonus:
  - ADCP moorings at controlling straits
  - Must be high frequency: transport of properties
  - 4*$300k =$1.2 M

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