Exploring wind-driven primary production through numerical modelling

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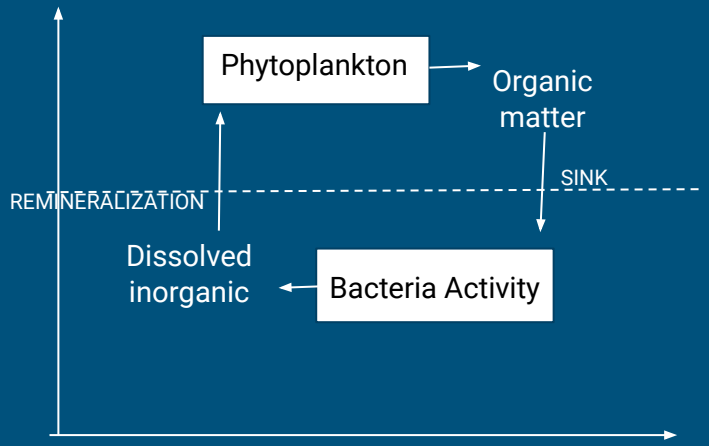
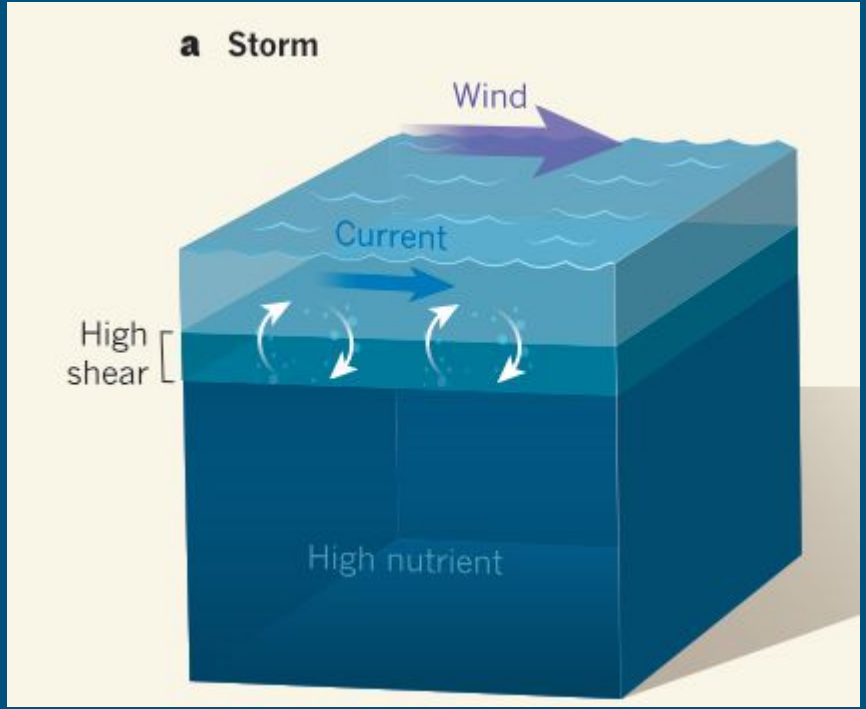
Wind-driven turbulence → mixing

- Sunlight + inorganic nutrients → planktonic photosynthesis
- Sink of excrement and dead cells in organic forms
- Remineralization by microbial activity to dissolved inorganic forms
- Problem: how to bring these nutrients to the surface?
- wind-driven turbulence



Wind-driven turbulence → mixing

- Classical mechanism of wind-induced nutrient pump
  (Findlay et al., 2006; Marra et al., 1990)



Palter (2015)

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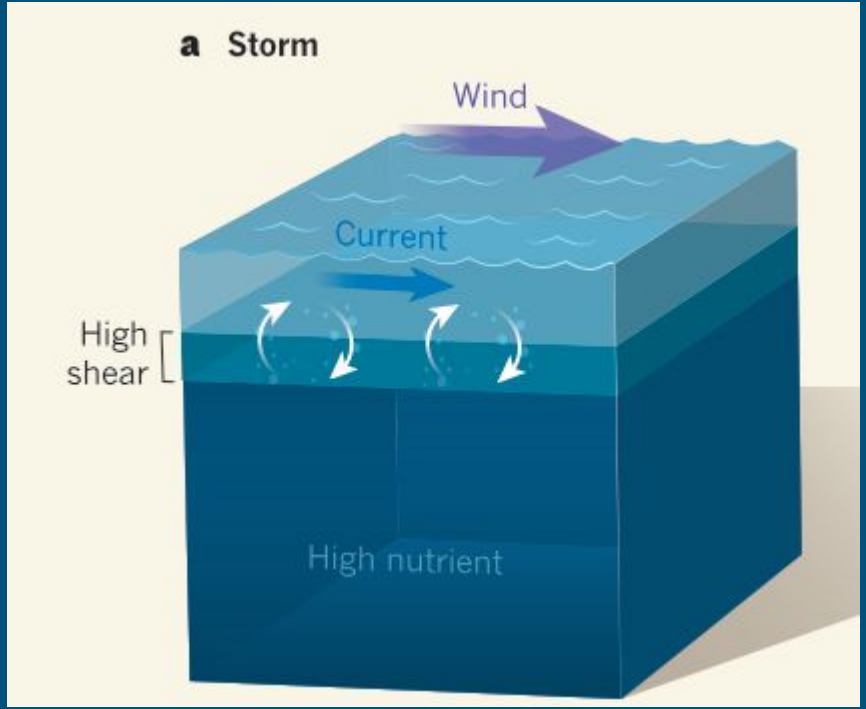

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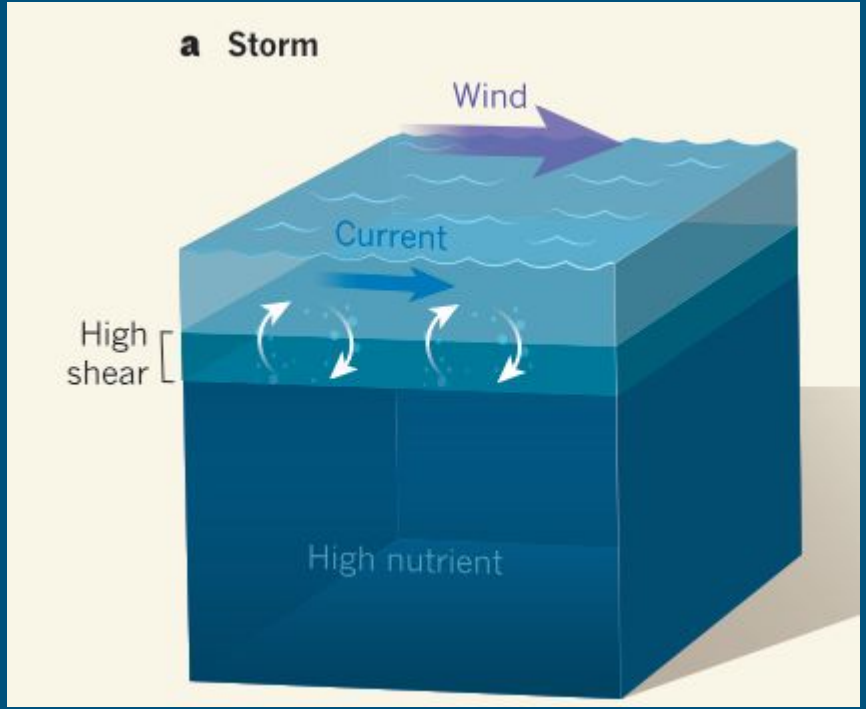
- days to weeks
  (Babin et al., 2004; Rumyantseva et al., 2015)



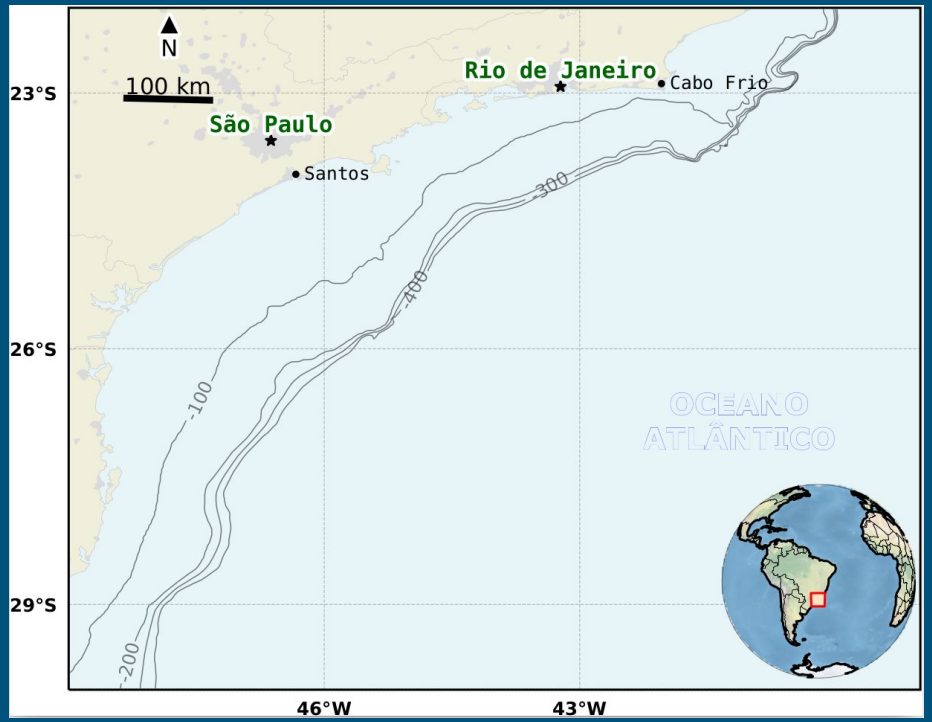
Palter (2015)

Wind-driven turbulence → mixing

- Global warming may suppress the upward nutrient supply
- Stronger stratification → more energy necessary
  (Palter, 2015)

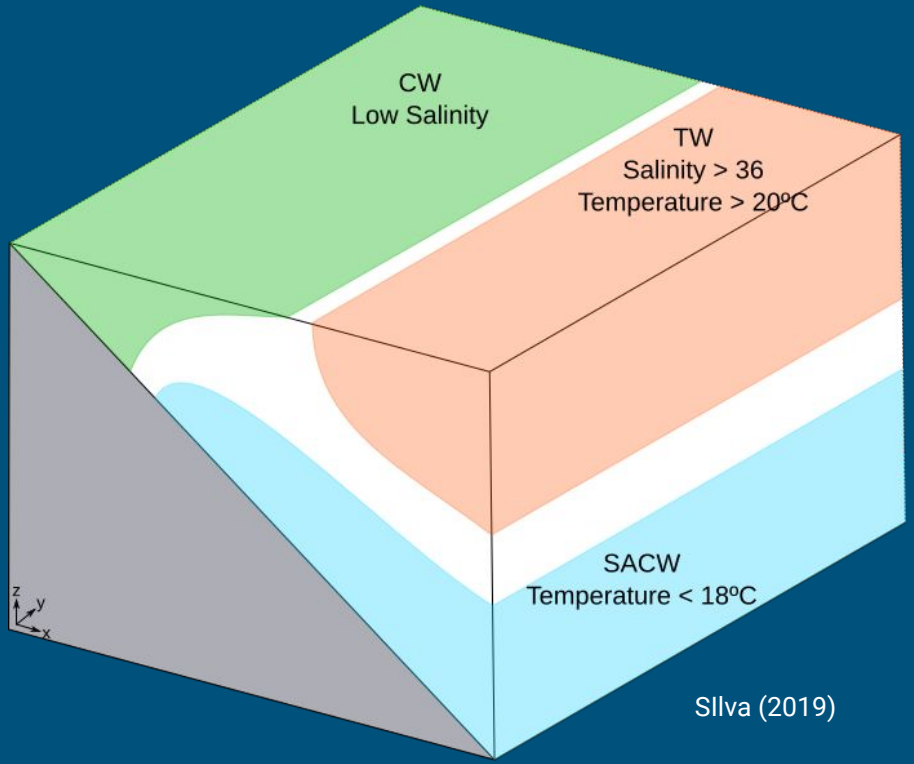
South Brazil Bight characterization

- 20% of national industrial fishing
  (Paes and Moraes, 2017)



South Brazil Bight characterization

- 20% of national industrial fish
  (Paes and Moraes, 2017)
- Hydrographic properties (Miranda, 1982):
  - Tropical Water (TW);
  - South Atlantic Central Water (SACW);
  - Coastal Water (CW)



SIlva (2019)

South Brazil Bight characterization

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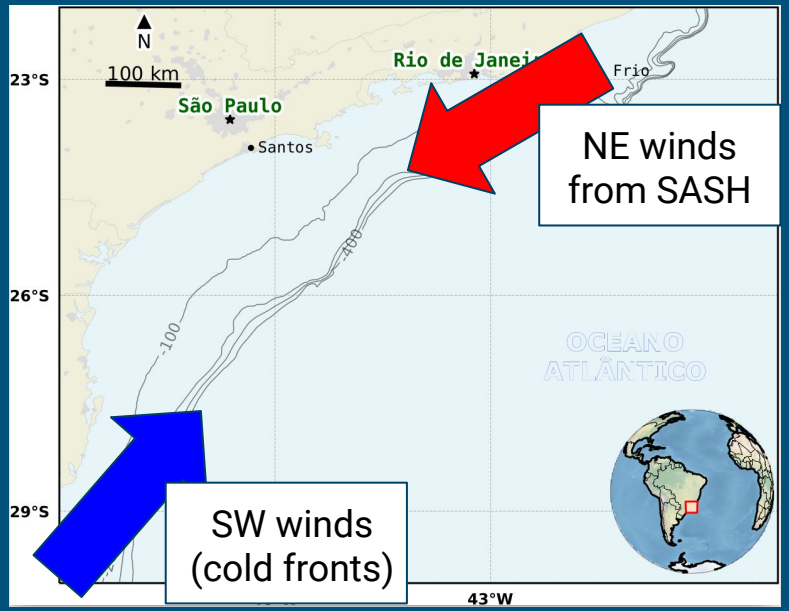
  (Paes and Moraes, 2017)
- Hydrographic properties (Miranda, 1982):
  - Tropical Water (TW);
  - South Atlantic Central Water (SACW);
  - Coastal Water (CW)
- Wind regime (Castro and Miranda, 1998):
  - Typical wind regime: NE winds (SASH)
  - Perturbation (6-11 days): SW winds (Cold front)
    (Stech and Lorenzetti, 1992)



South Brazil Bight characterization

- NE winds:
  - advection of SACW
  - strong stratification
  - nutrient-rich waters below the thermocline
- SW winds:
  - more energy → thermocline breakdown
  - mixing waters

Objective

- Explore the applicability of the mixed-layer model (Kearney, 2012) in the South Brazil Bight
- Investigate the hydrographic properties seasonal variability comparing with the available literature

Material and methods

- Mixed-layer model (Kearney, 2012)
  - wind, heat, salinity and temperature
  - Dissipation term (Mellor, 2001)
  - Turbulence closure scheme (Mellor & Yamada, 1982)
  - Wind speed formulation (Large & Pond, 1981) for surface BC
  - Quadratic bottom drag law for bottom BC

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- NP box model (Sarmiento and Gruber, 2006)
  - loss rate
  - remineralization rate
  - growth rate
  - Monod (1949) formulation

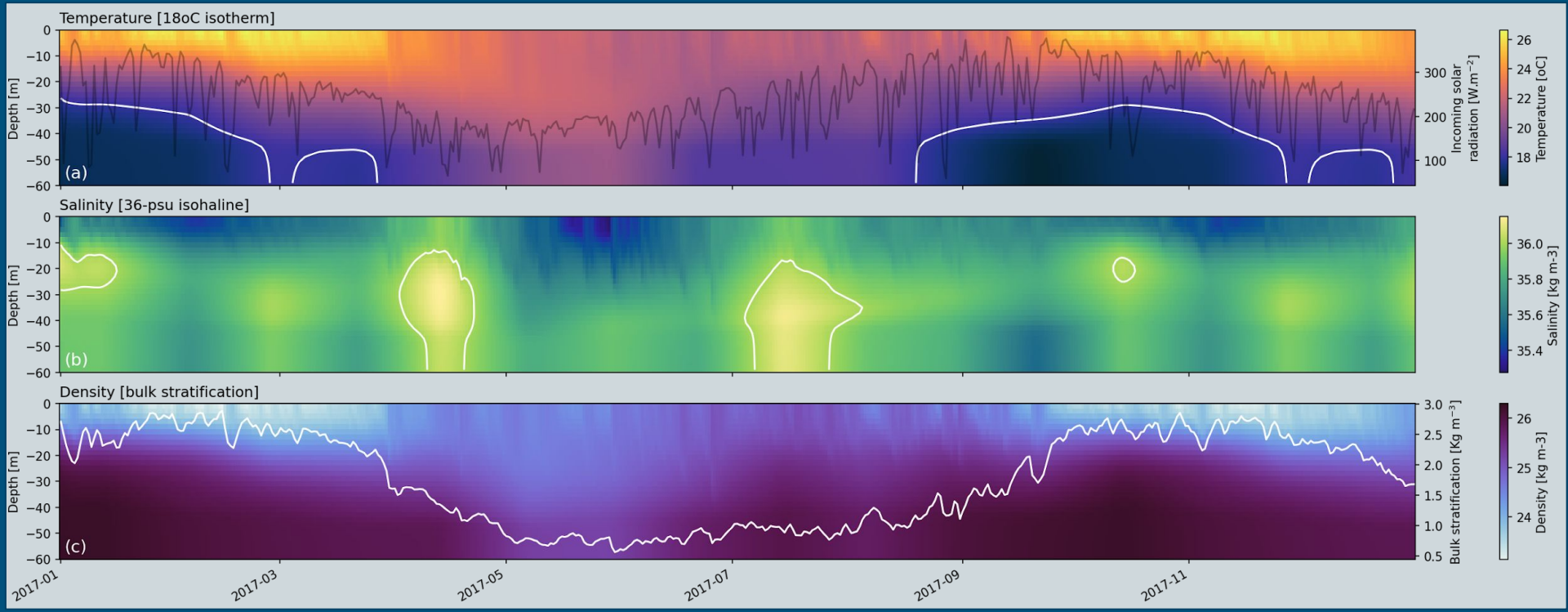
Material and methods

- World Ocean Atlas (2018)
  - initial Conditions: T, S
  - relaxation scheme: T, S
  - stratification maintained by horizontal advection (Castro, 2014)

- CMEMS (Mercator)
  - Initial conditions for chl-a and NO^-_3

- ERA5 (Herbarsch et al., 2020)
  - wind (speed/direction)
  - sea surface and air temperature
  - dew point temperature
  - incoming solar radiation

Results and Discussion



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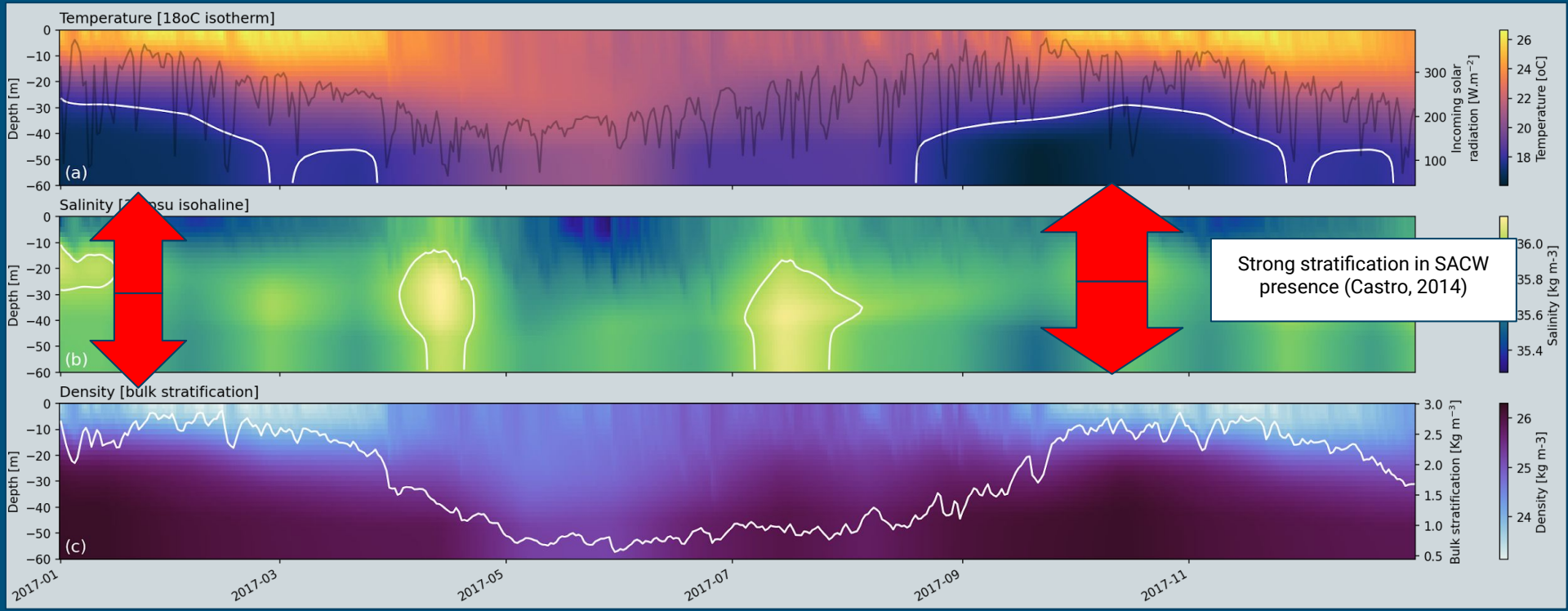

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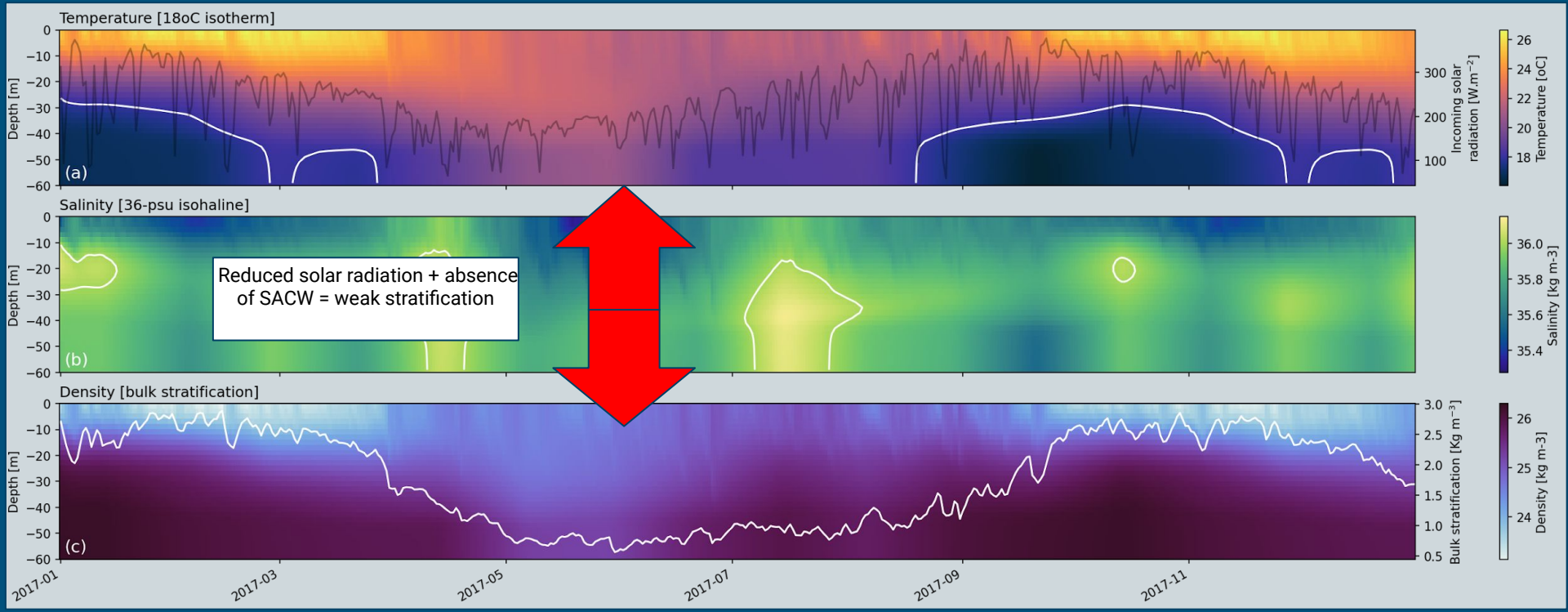

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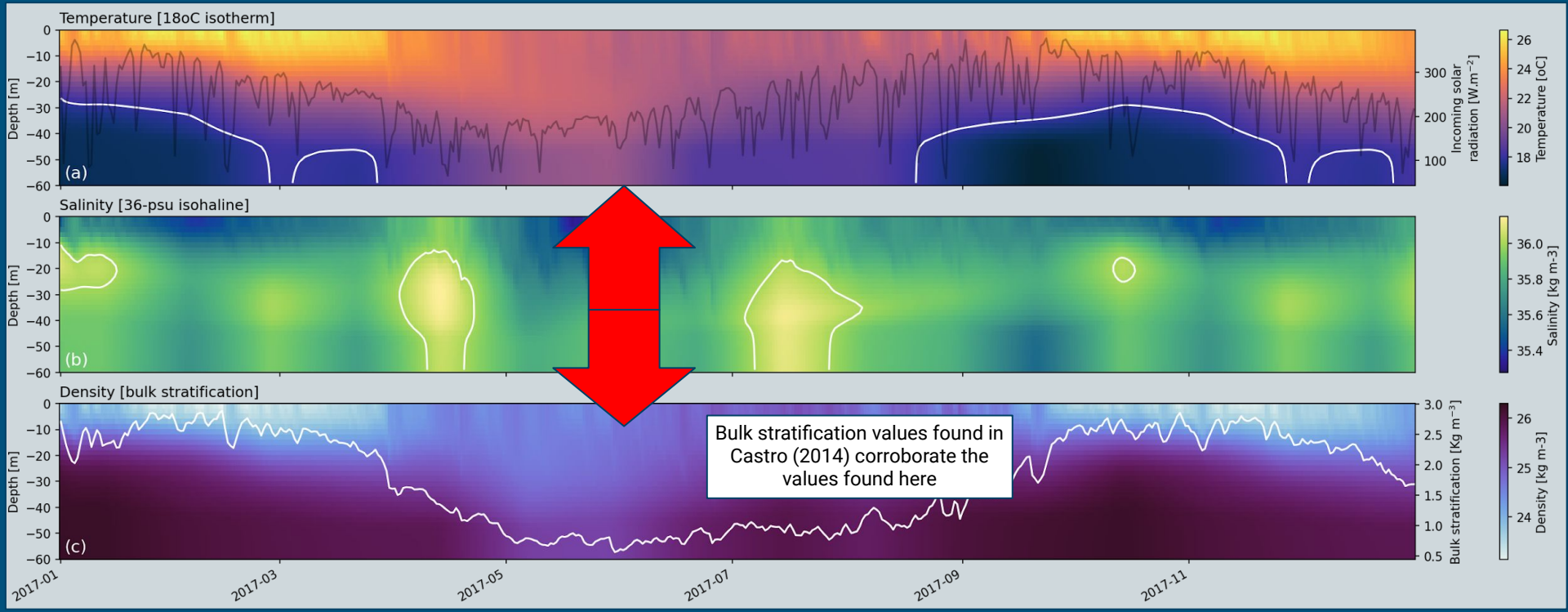

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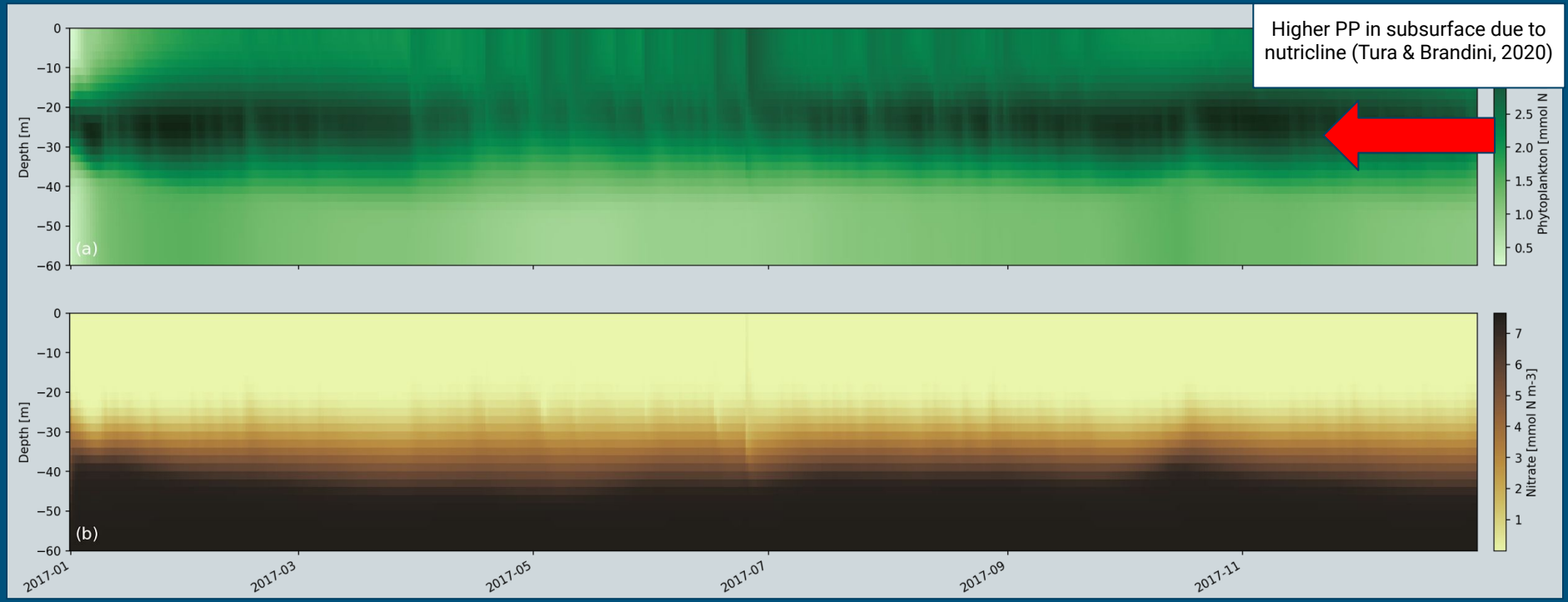

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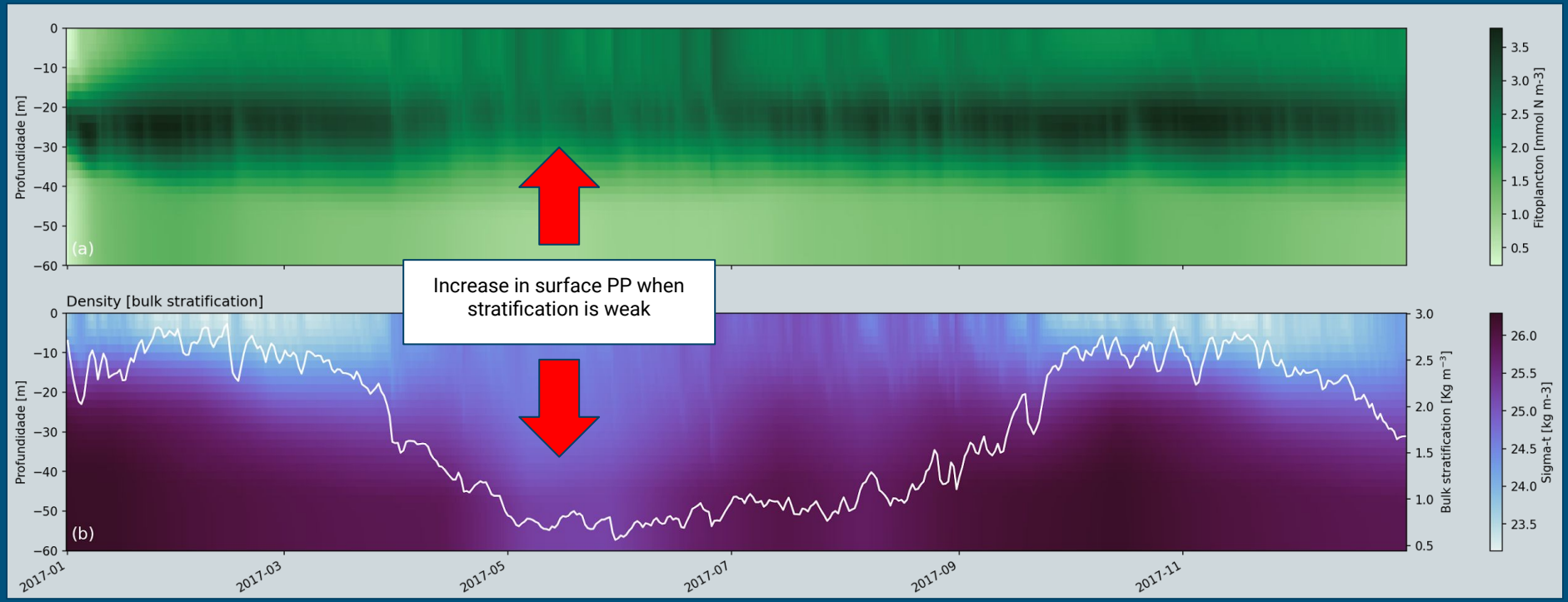

Conclusion and next steps

- We can use a 1D hydrodynamical model coupled with a biogeochemical box model (NPZ?) to investigate wind-driven primary production

Next …

- Calibrate
- Validate
- Adapt

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Obrigado!
Thank you!

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