Fronts in Western Boundary Currents: A Comparative Study between the Brazil-Malvinas and the Kuroshio-Oyashio Confluence regions

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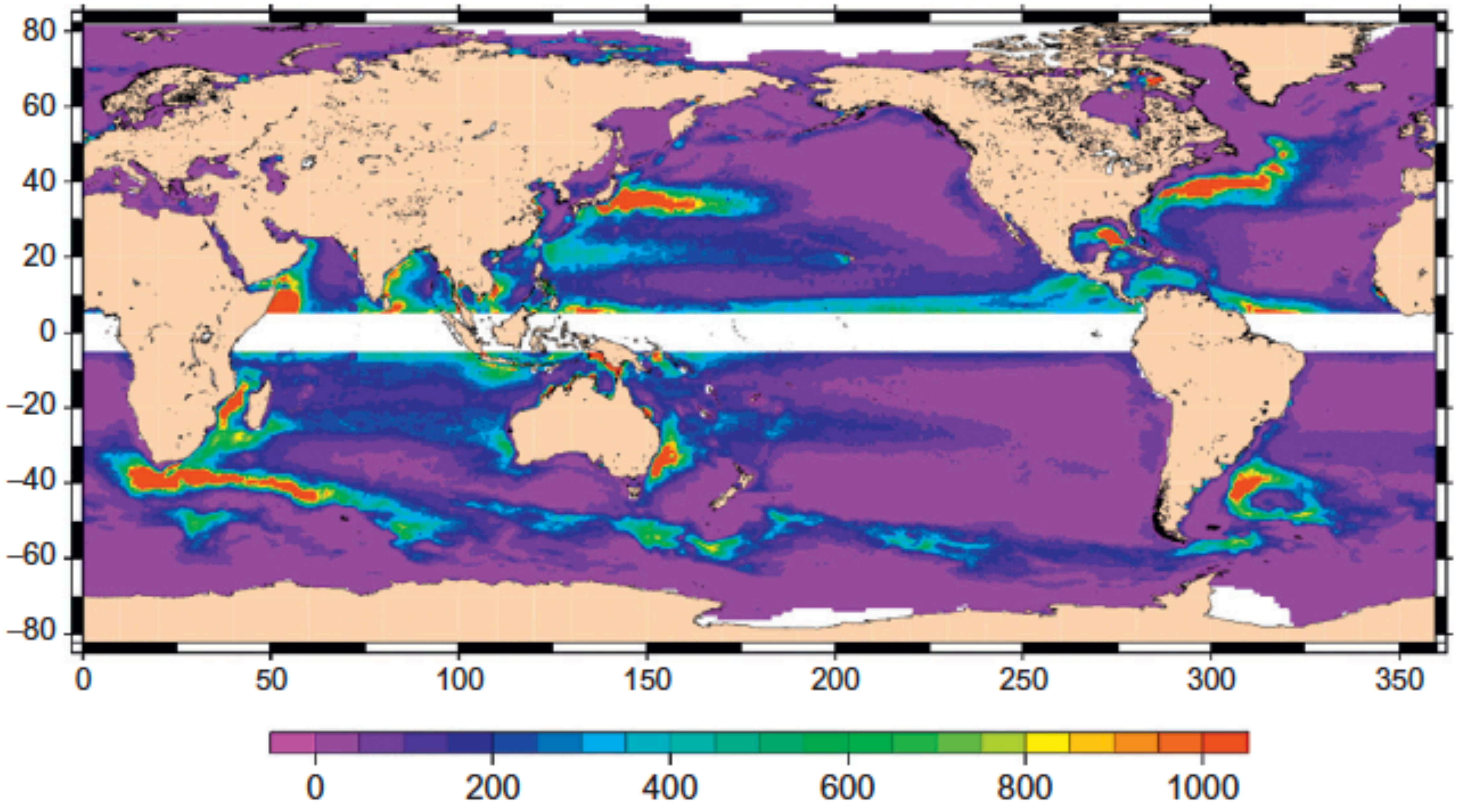
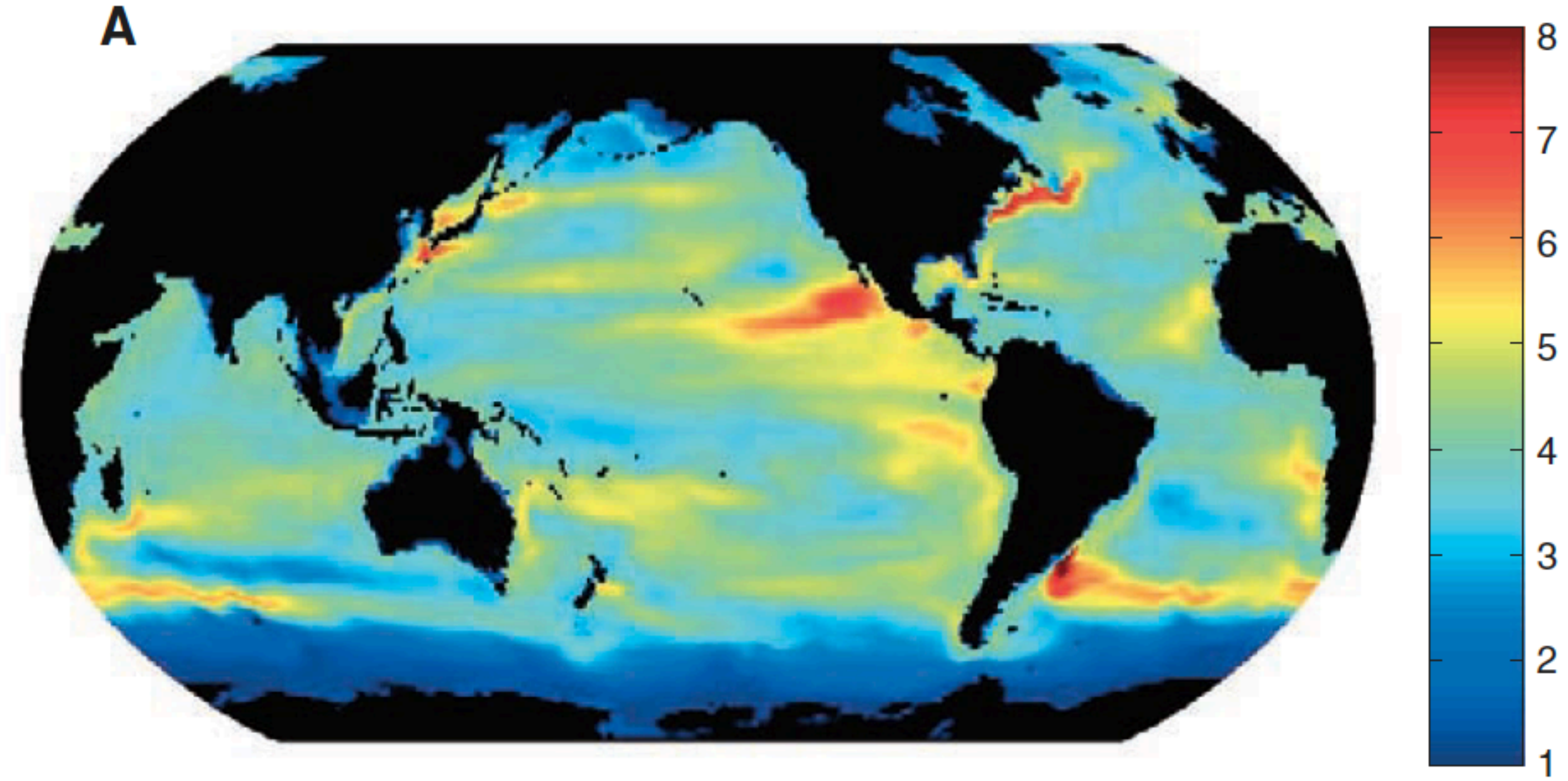
The University of Tokyo)

WBC's are hotspots of everything



EKE (cm/s)^2



Barton et al. 2010

Strong Currents - Confluence of waters of different types - Frontal variability - Important for connectivity and consequently phytoplankton diversity.

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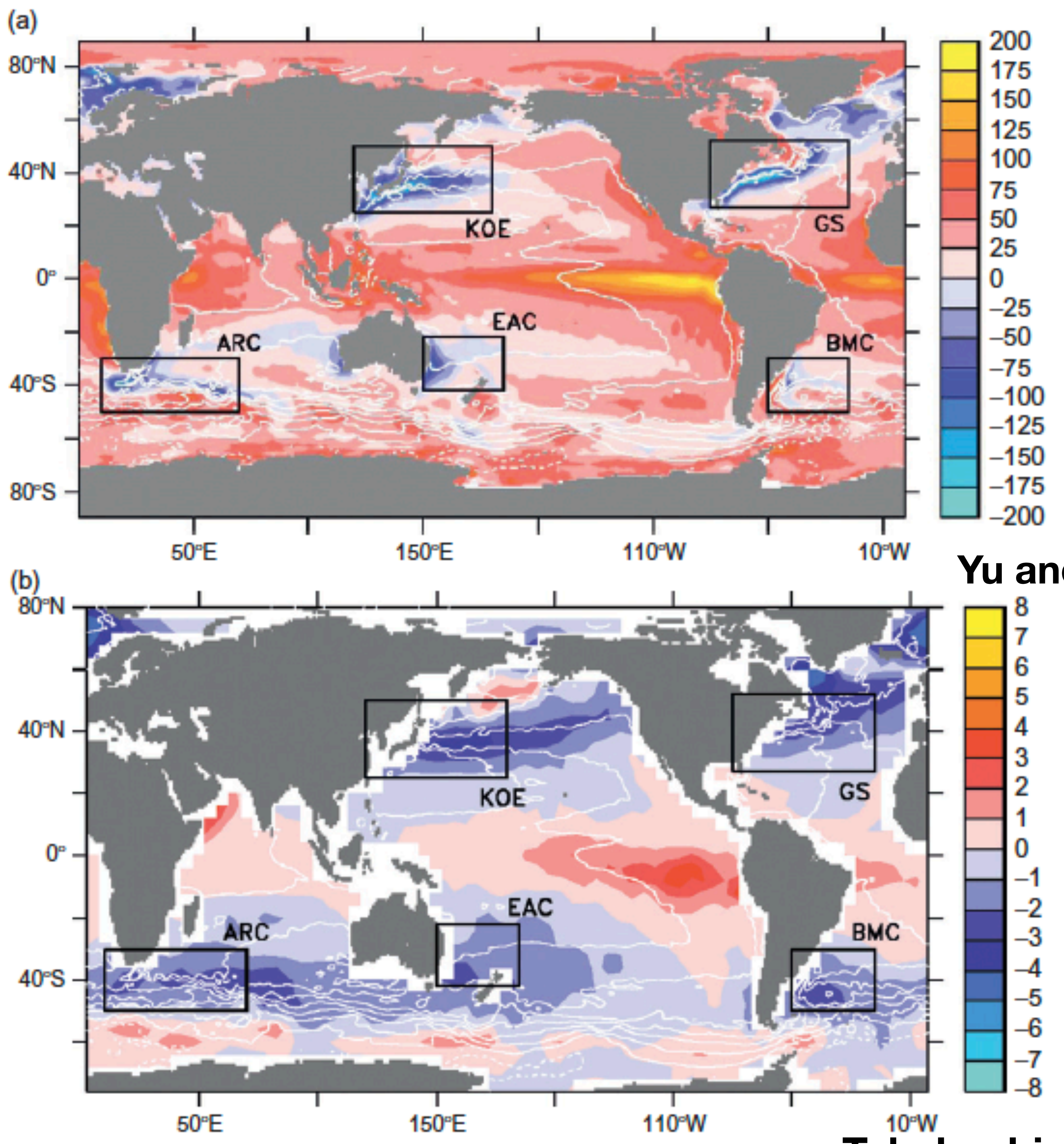


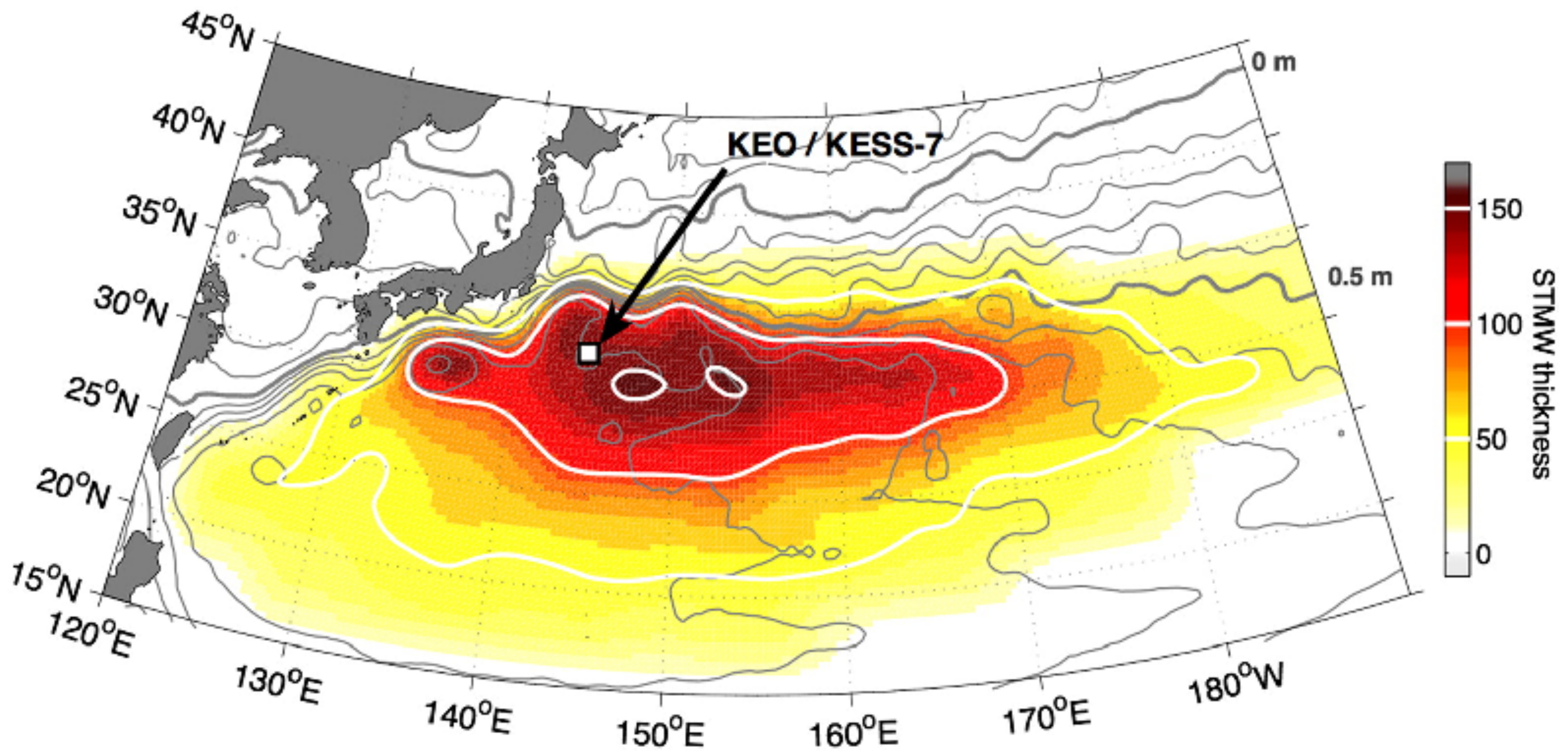
Yu and Weller, 2007

Takahashi et al., 2009

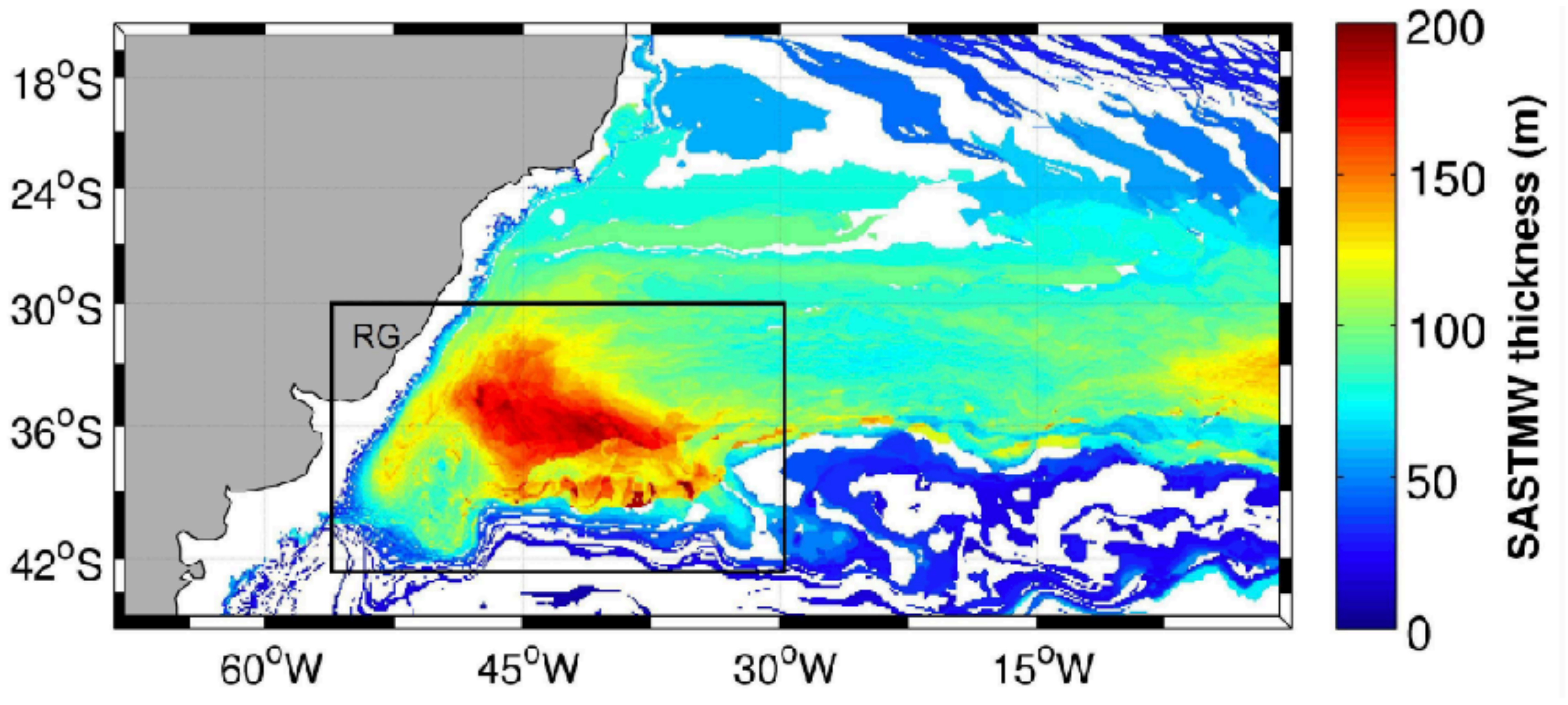
Imawaki et al. 2013

WBC's are sites of increased turbulent heat flux release to the atmosphere.

Coincident with regions where CO2 is absorbed from the atmosphere.



Rainville et al. 2013

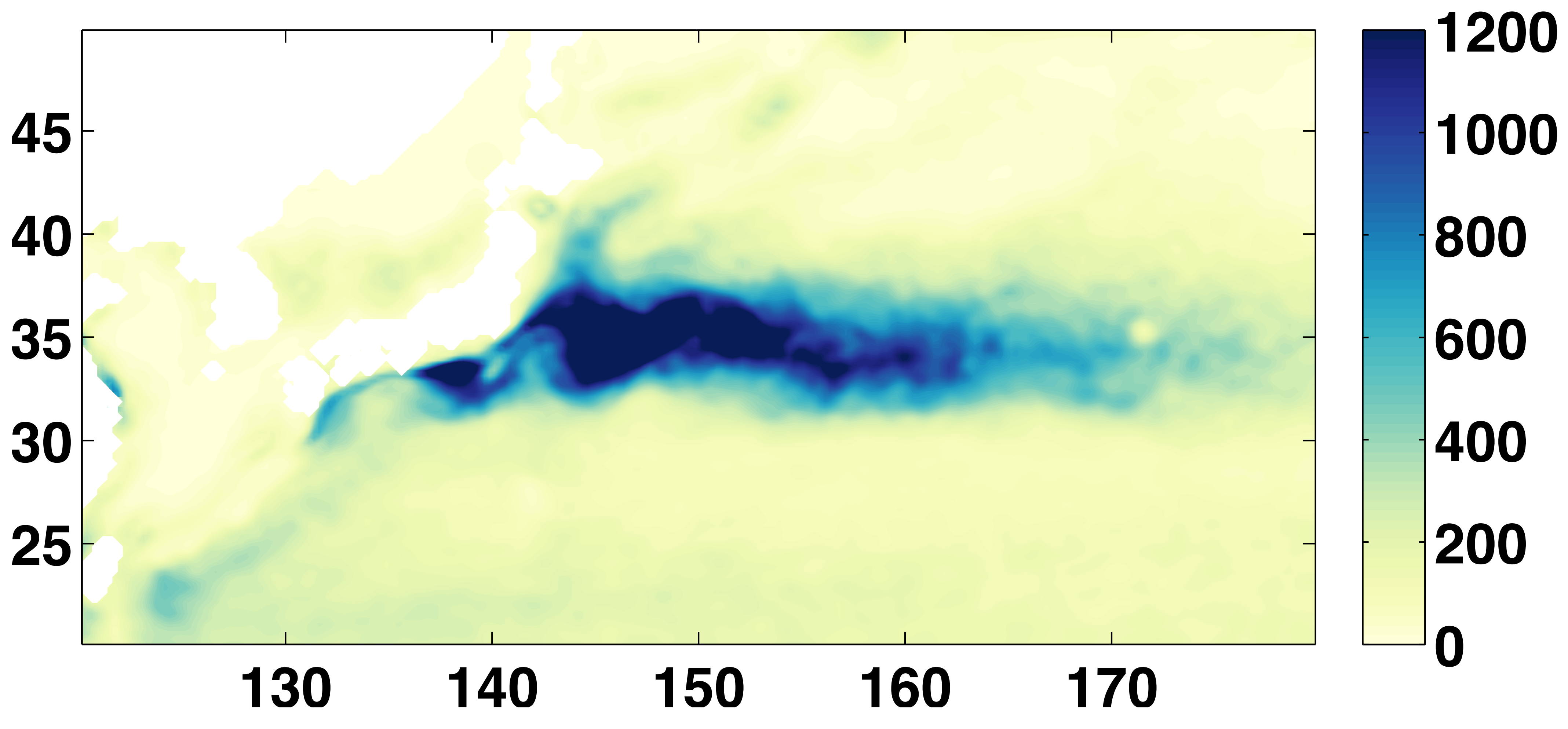


Matias and Calil, in prep.

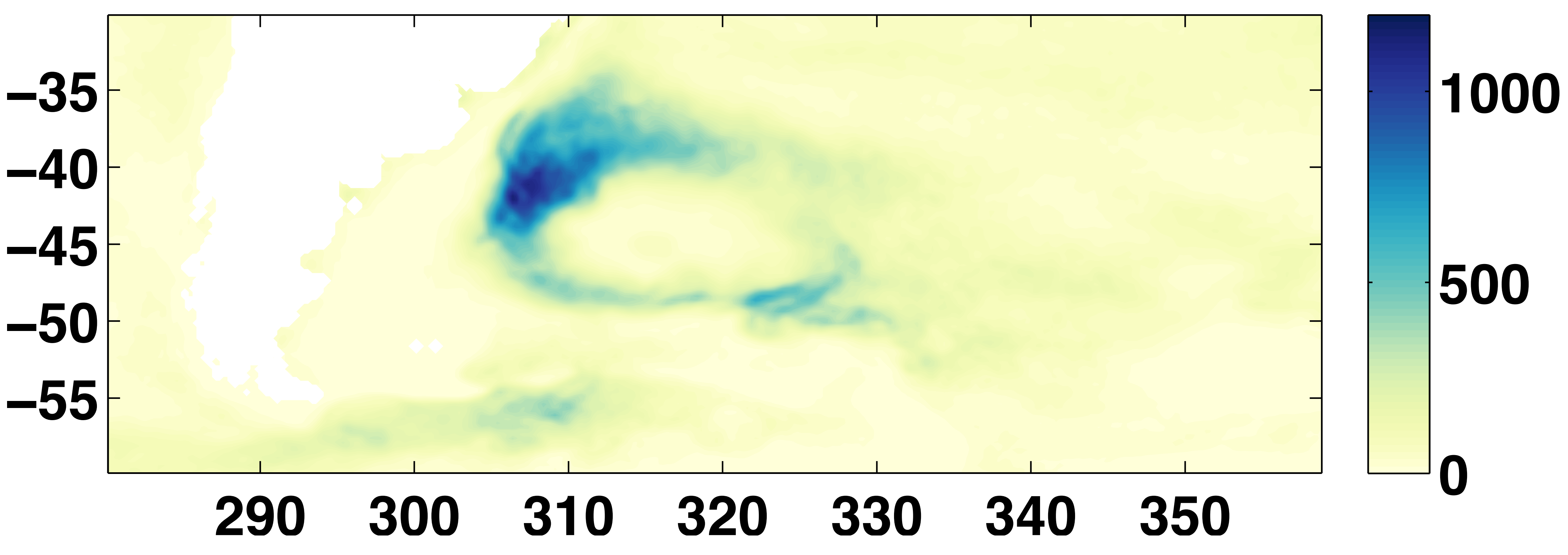
Confluence regions and associated recirculation gyres are important sites of subtropical mode water formation.

Subduction of carbon will be larger In these regions.

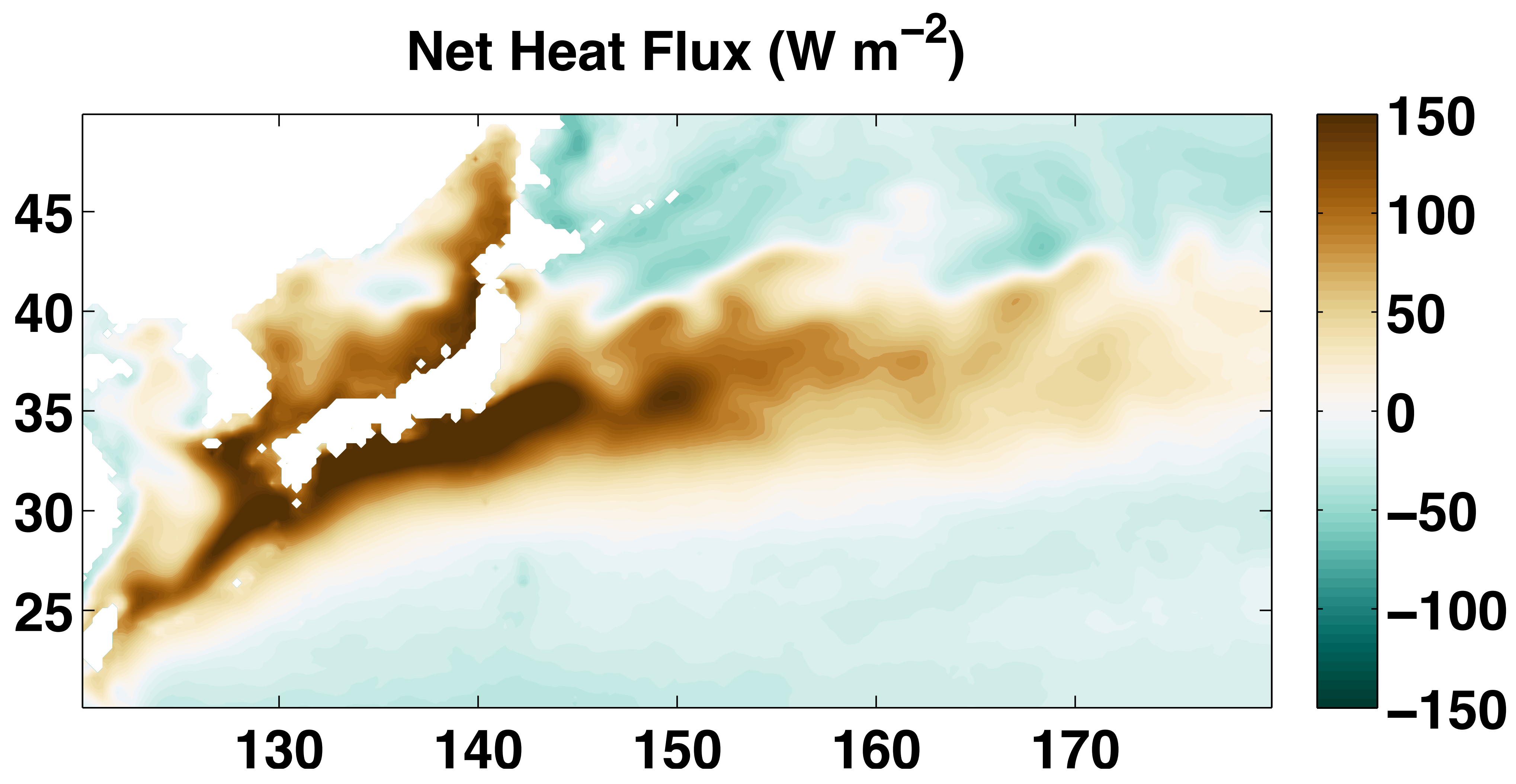
Eddy Kinetic Energy from AVISO $(cm/s)^2$

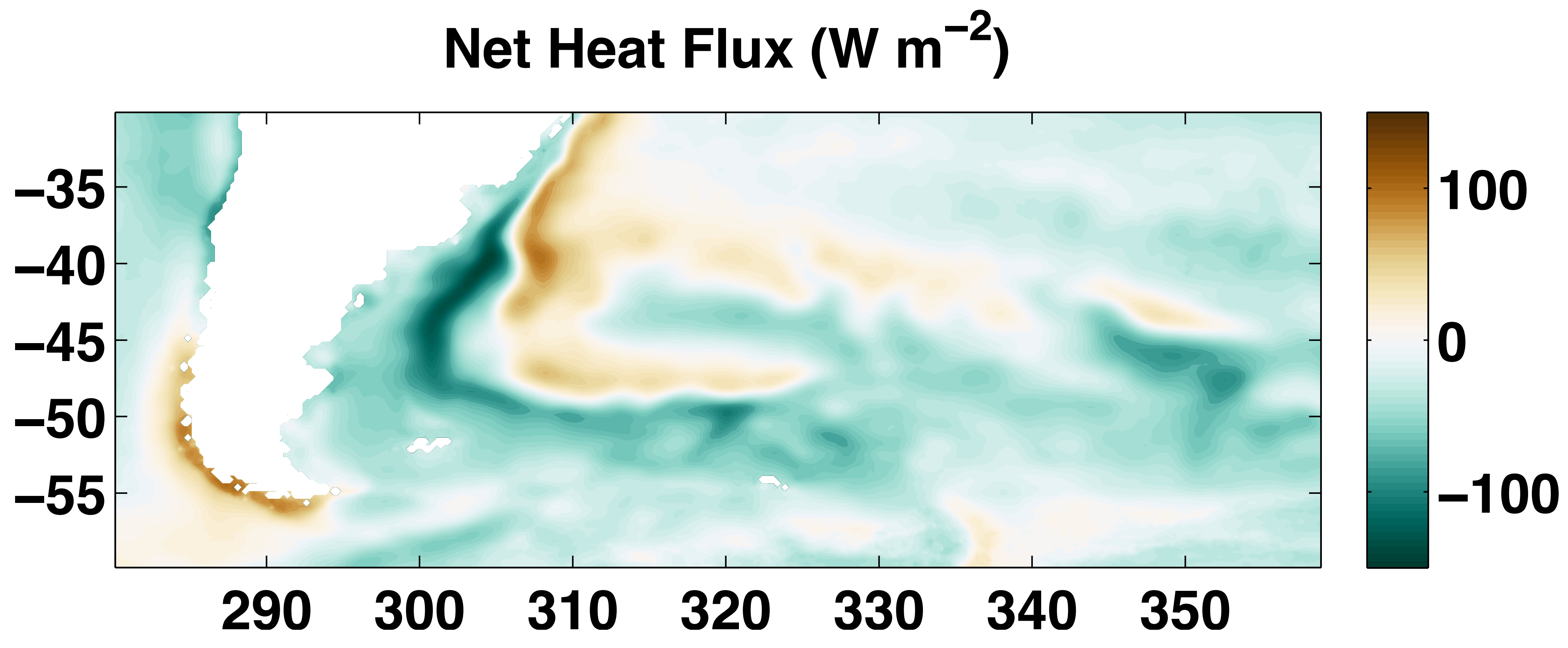


Variability mostly dominated by the Kuroshio Extension front at ~ 35ºN.



Collision between the Brazil and Malvinas currents. Interaction with the Zapiola rise.





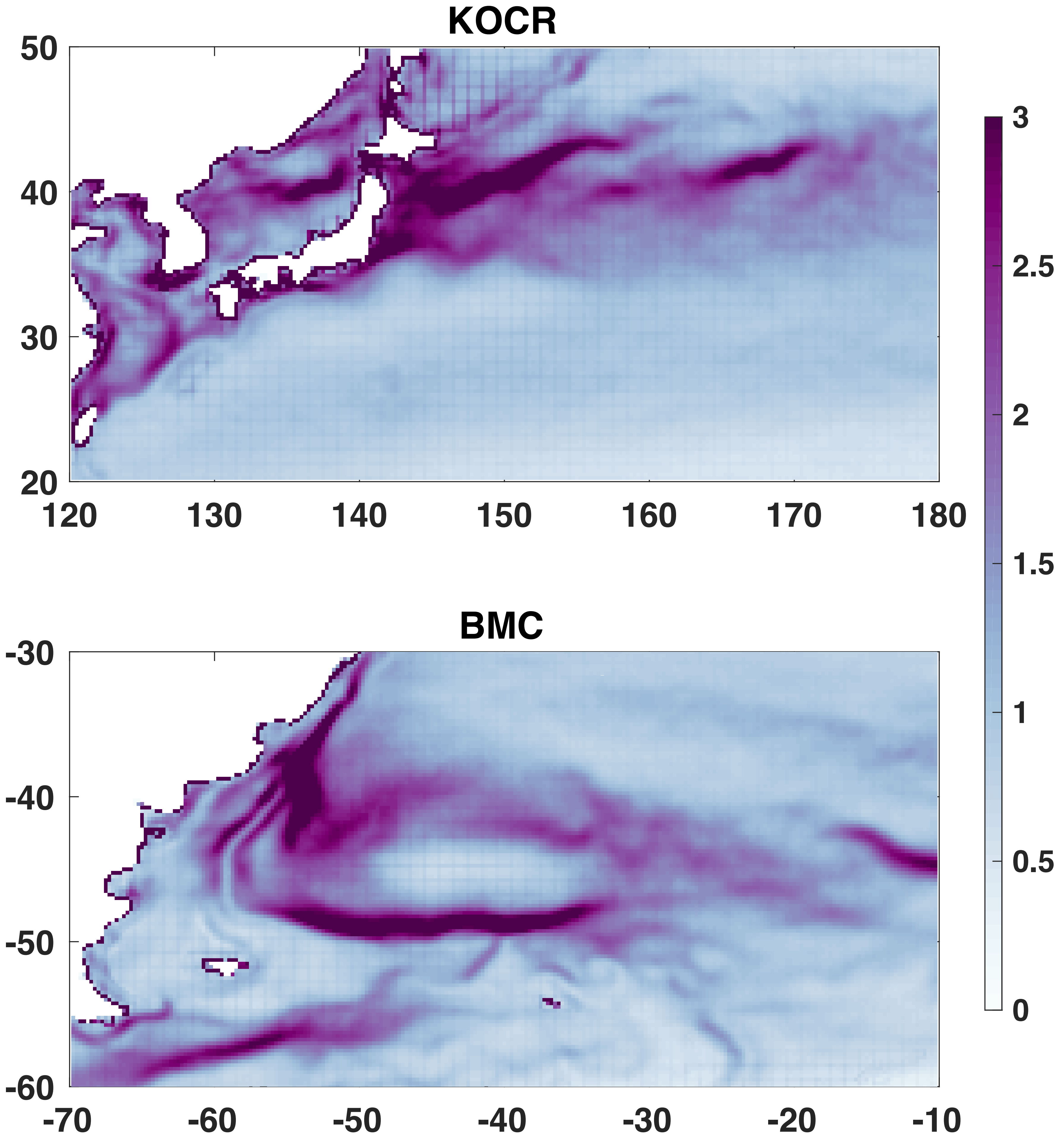
Poleward heat transport in KOCR is much larger than in the BMC.

Possible causes:

Much larger transport of the Kuroshio than the Brazil Current.

Large air-sea temperature/humidity differences because of continental origin of air masses in the KOE.

$$|\nabla T|(\times 10^{-5\circ}Ckm^{-1})$$



KOCR - two quasi-remanent features, known as the Isoguchi jets (Isoguchi et al. 2006). Responsible for transporting warm waters from the Kuroshio northwards.

In the BMC, C-shaped pattern due to confluence of Brazil and Malvinas currents, Brazil Current overshoot and Malvinas Current retroflection.

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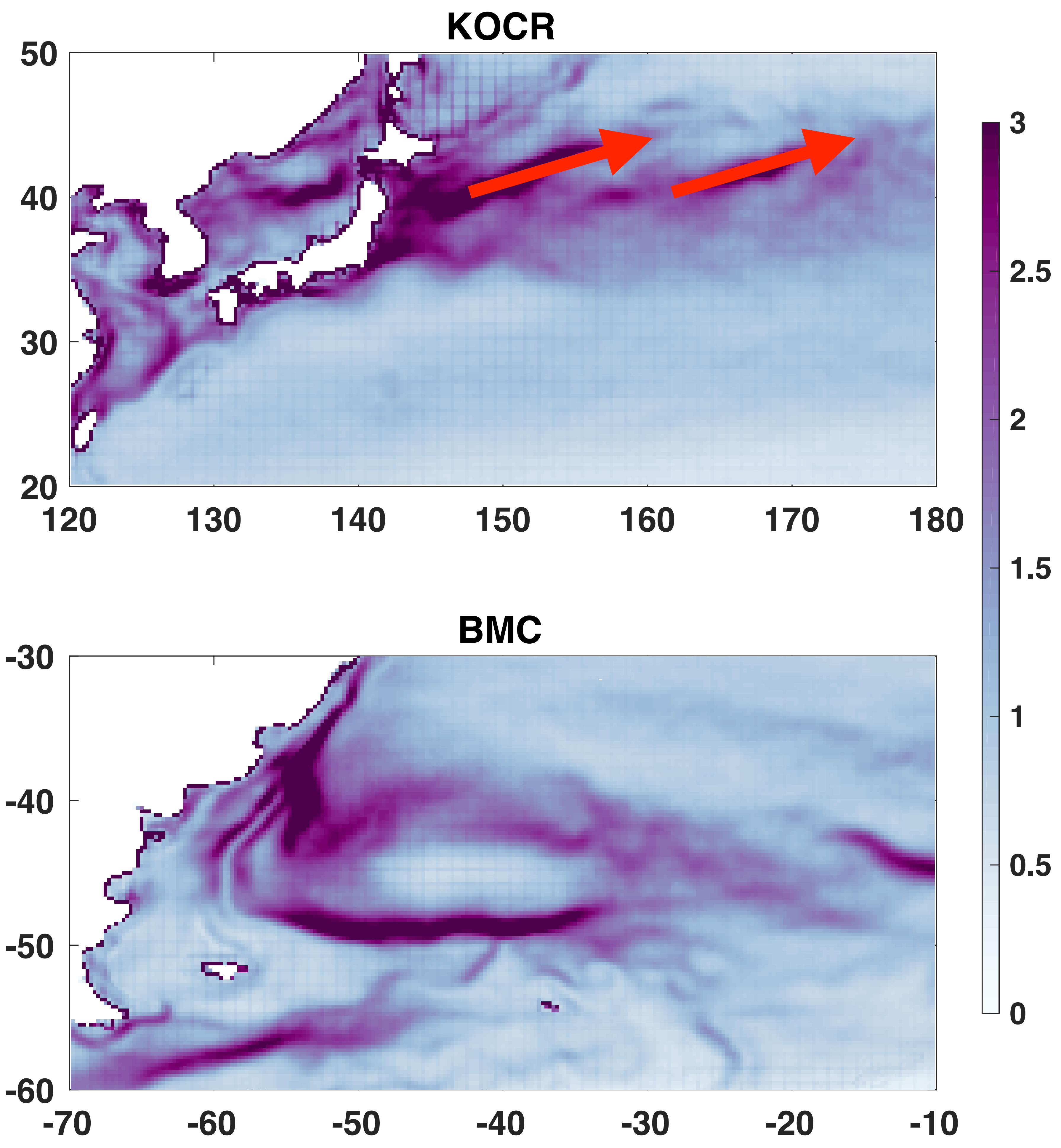

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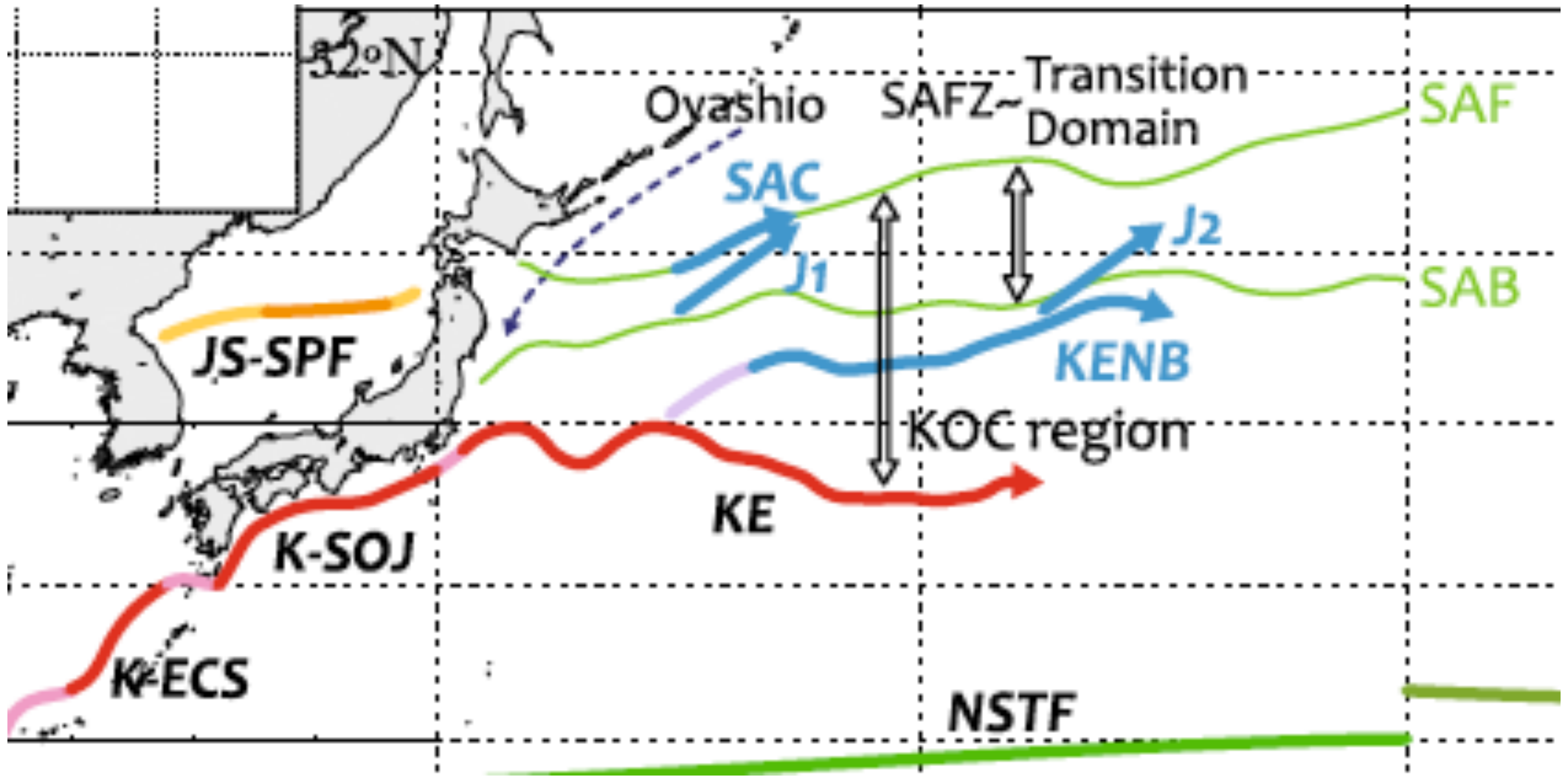
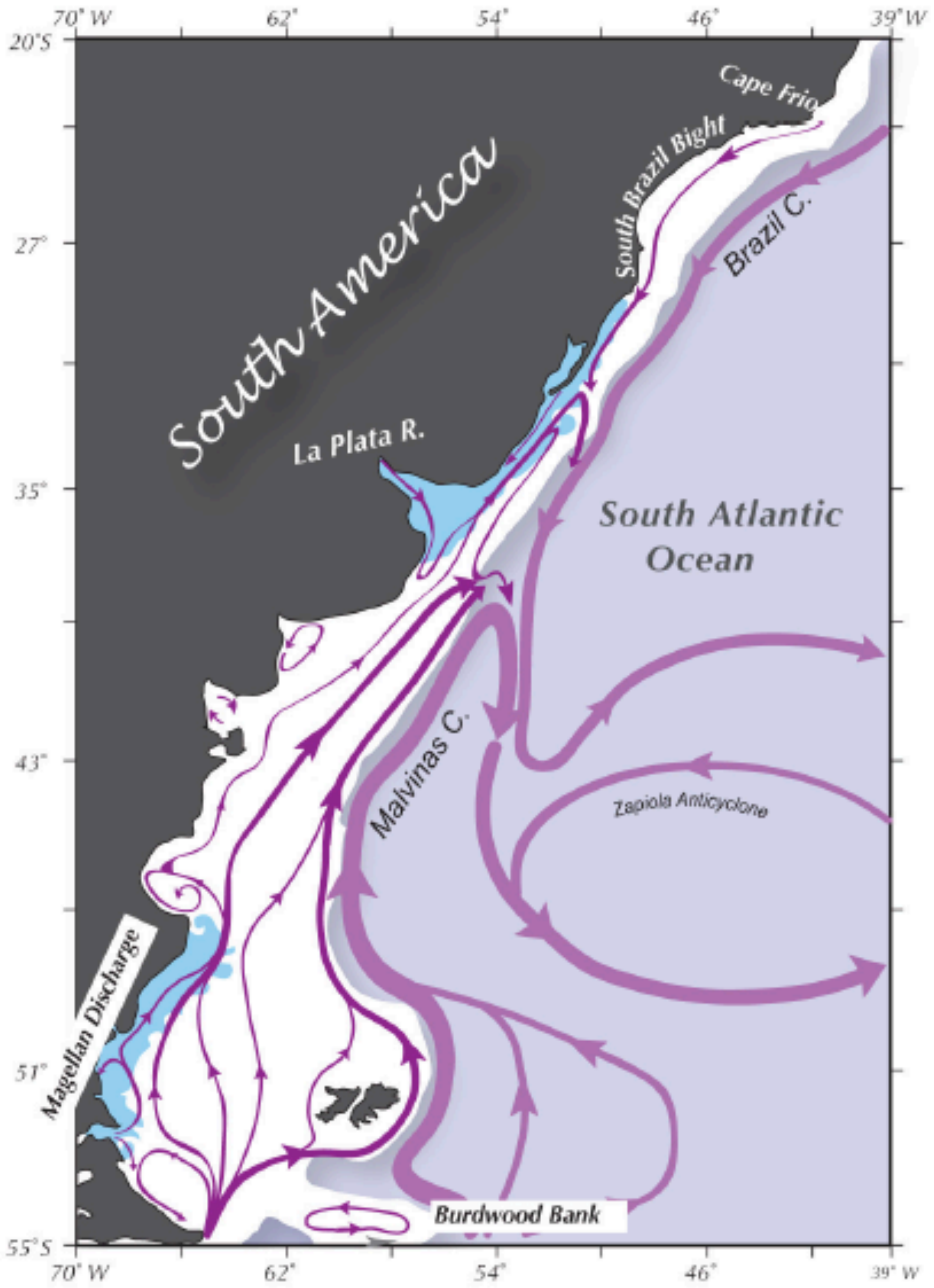


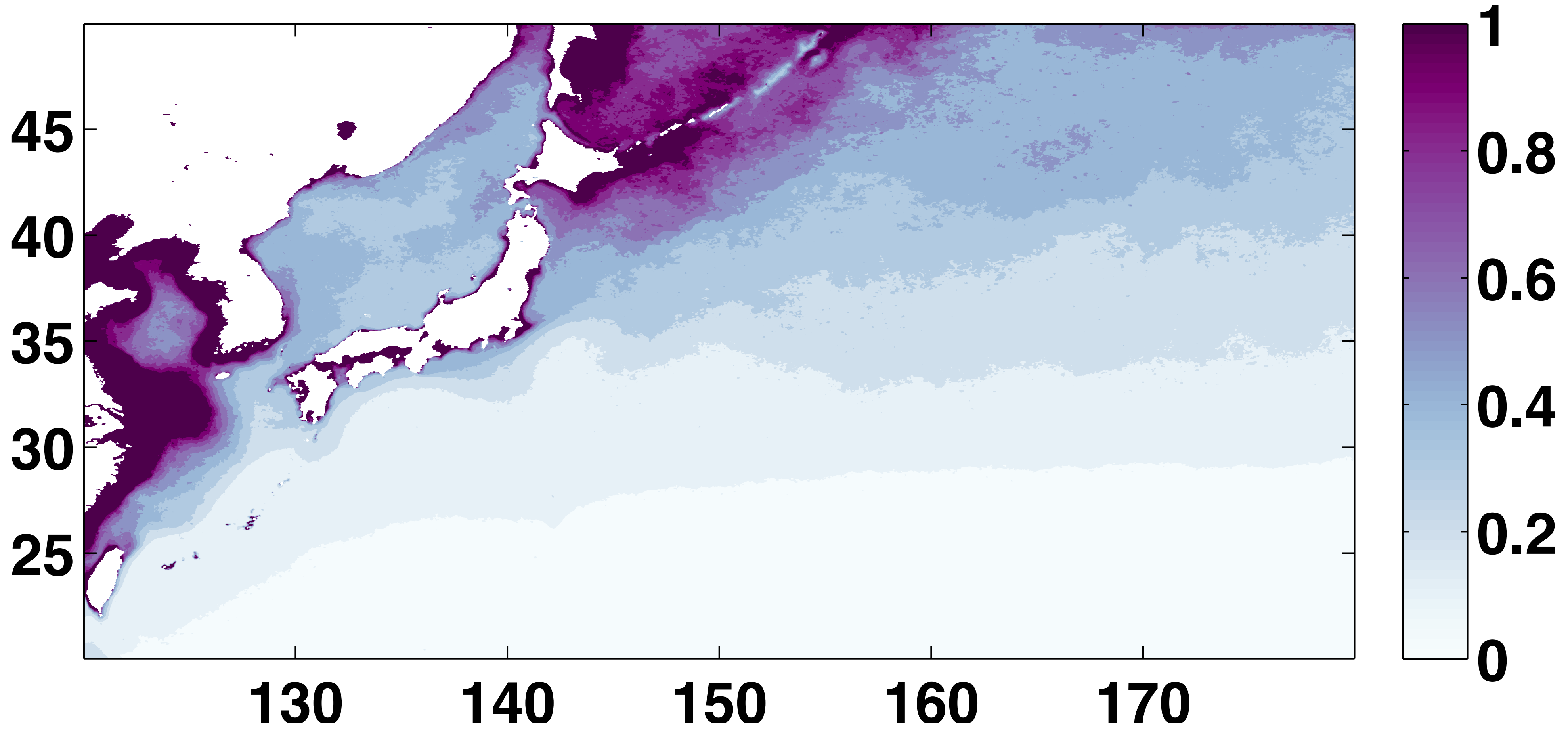
Kida et al. 2015

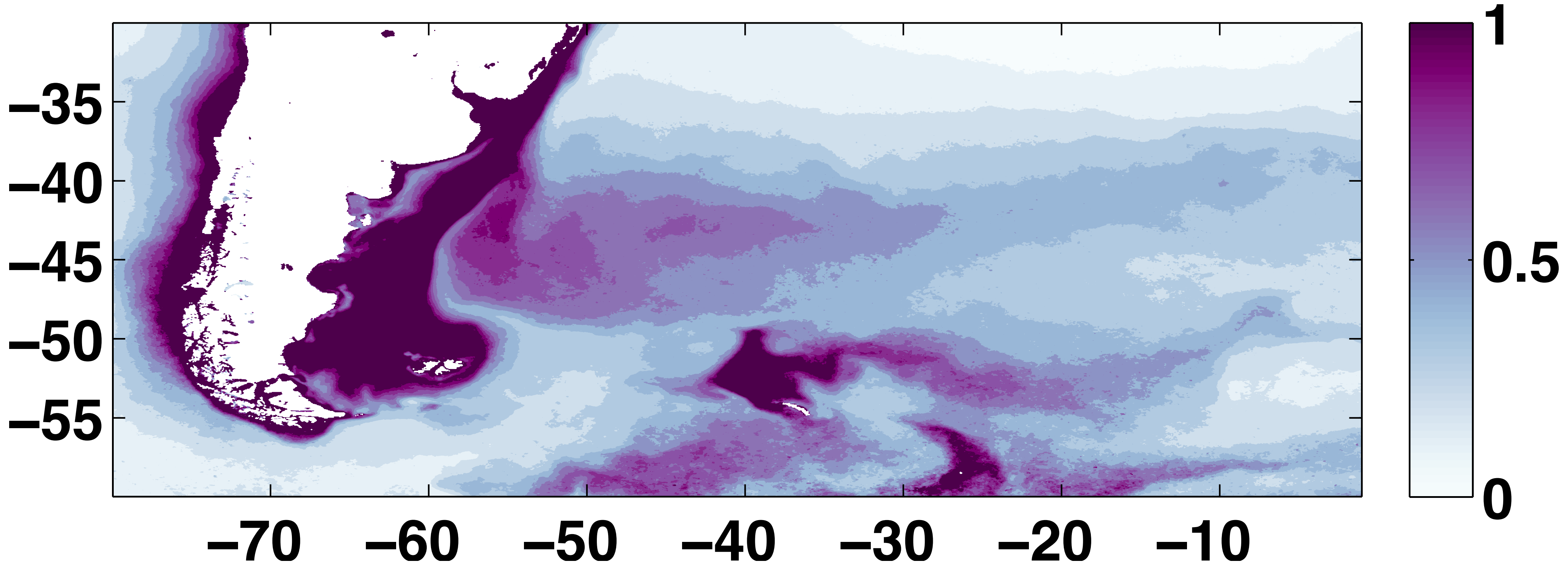


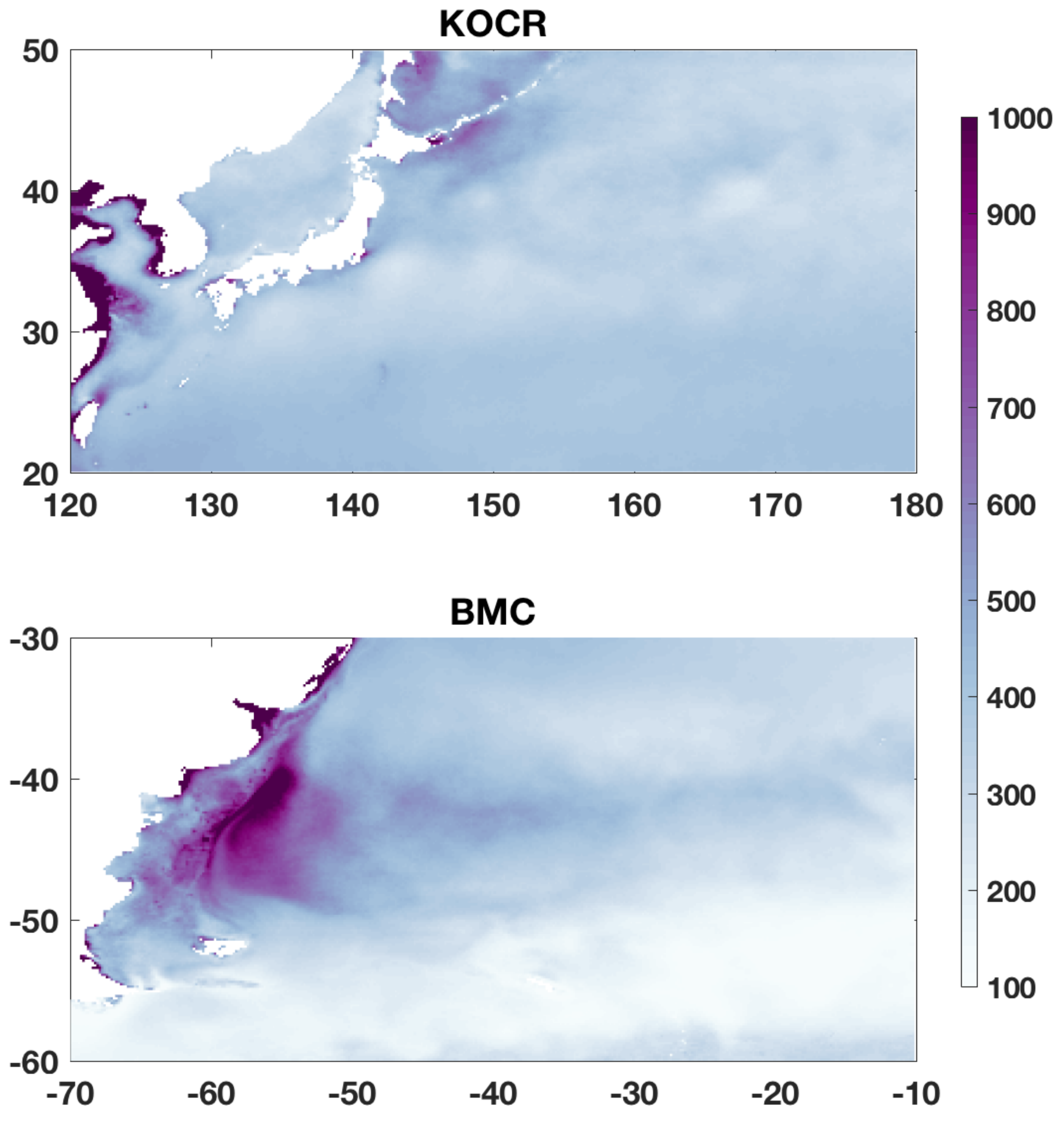
Matano et al. 2010

Biomass and Productivity Patterns

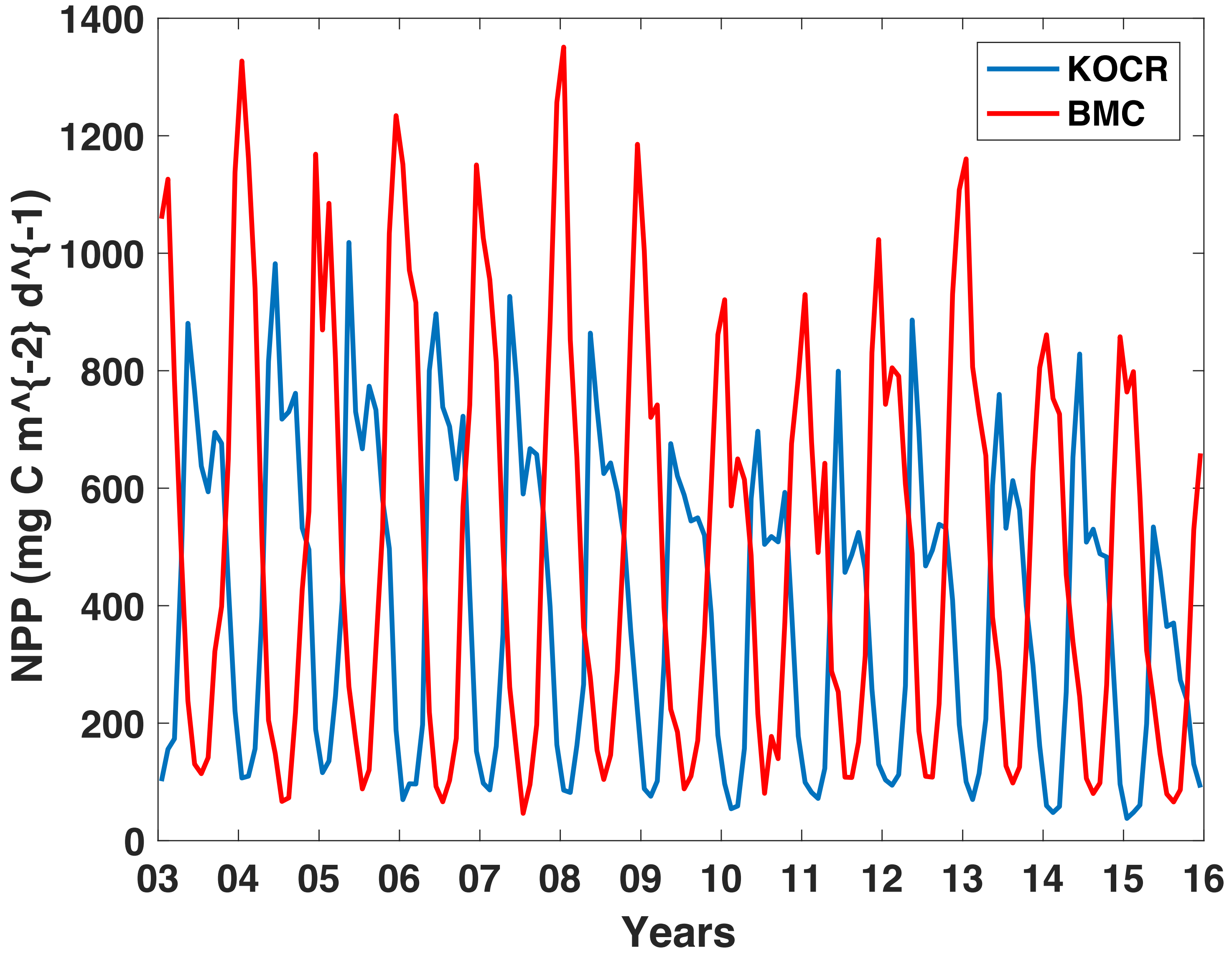
Average Chlorophyll-a from MODIS







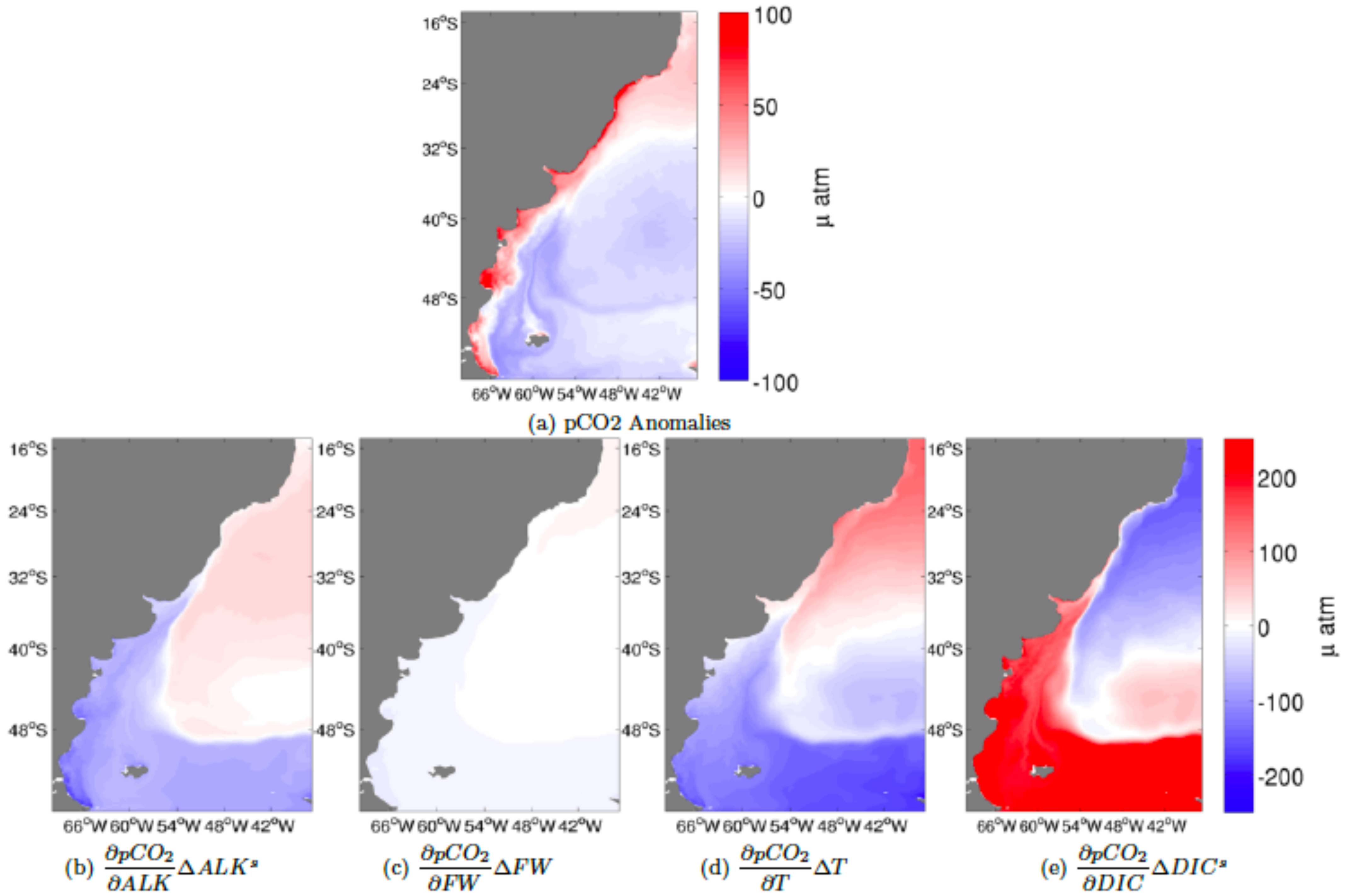
Average NPP (CbPM model)

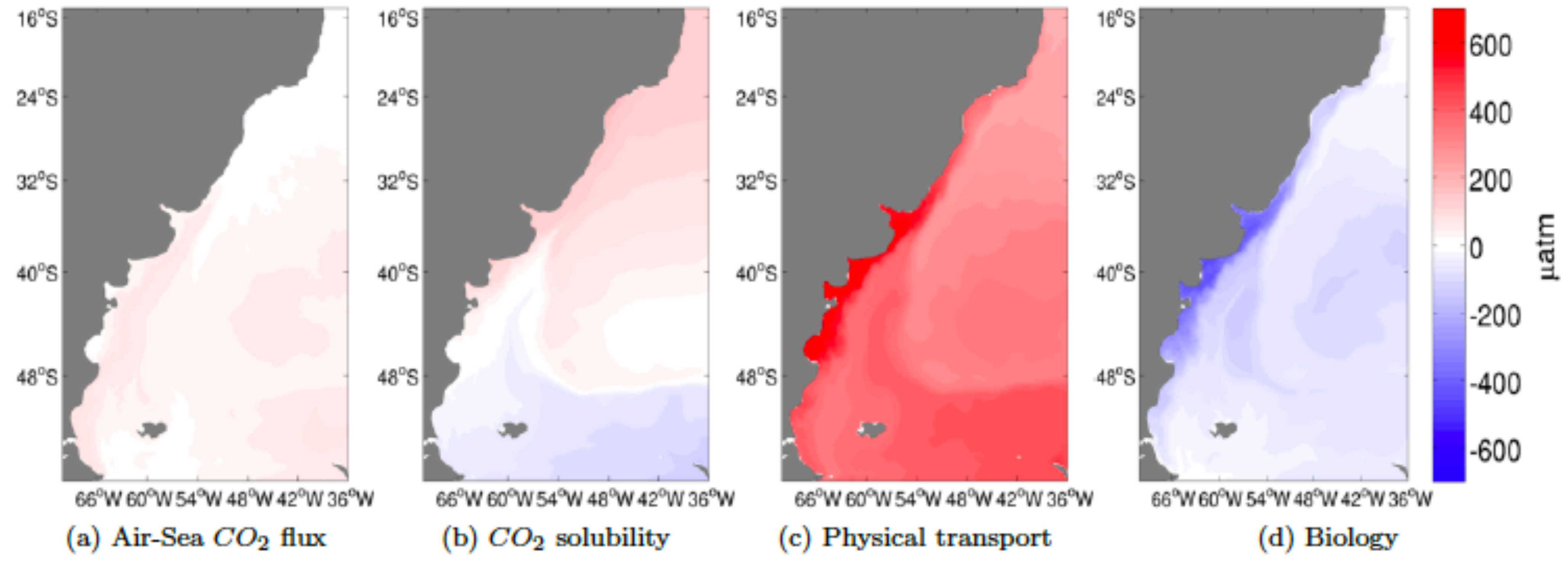


Area-averaged time-series of NPP shows BMC more productive.

Interannual variability.

Drivers of pCO_2 variability in the Western South Atlantic





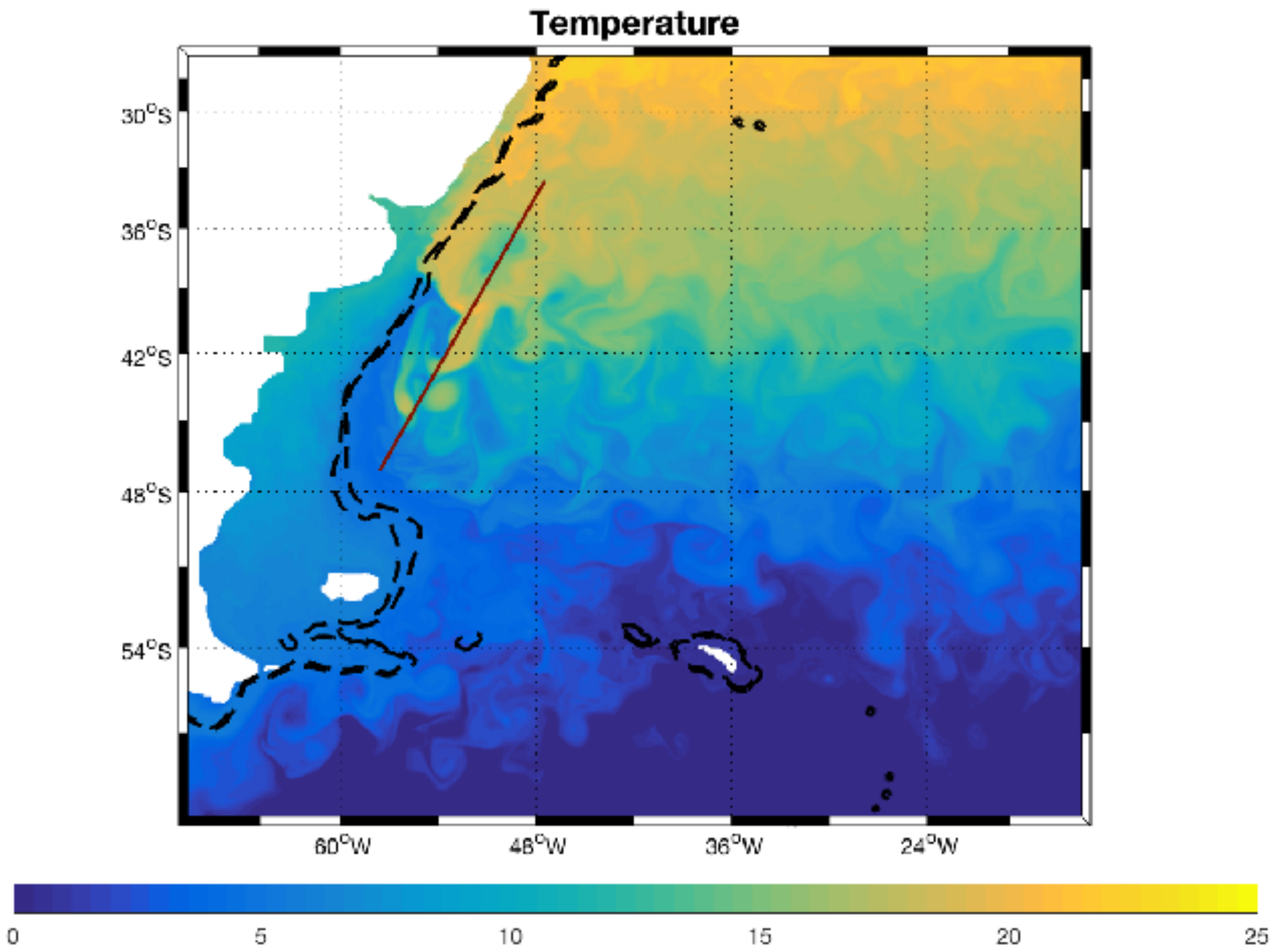
Important drivers vary depending on the region (continental shelf, open ocean south of 30ºS, north of 30ºS).

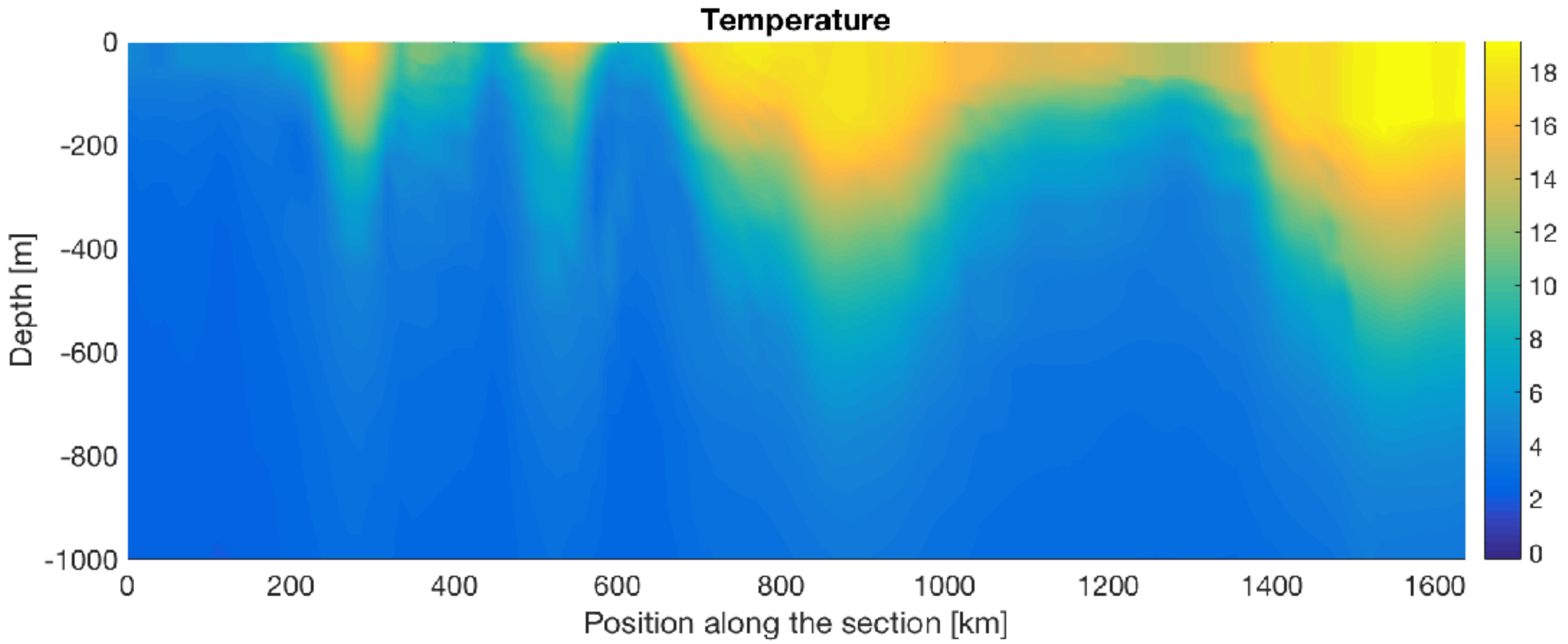
Temperature and DIC control seasonal variability.

Biological production is particularly important in the Patagonian shelf.

Arruda et al. 2015

Regional Model Simulations





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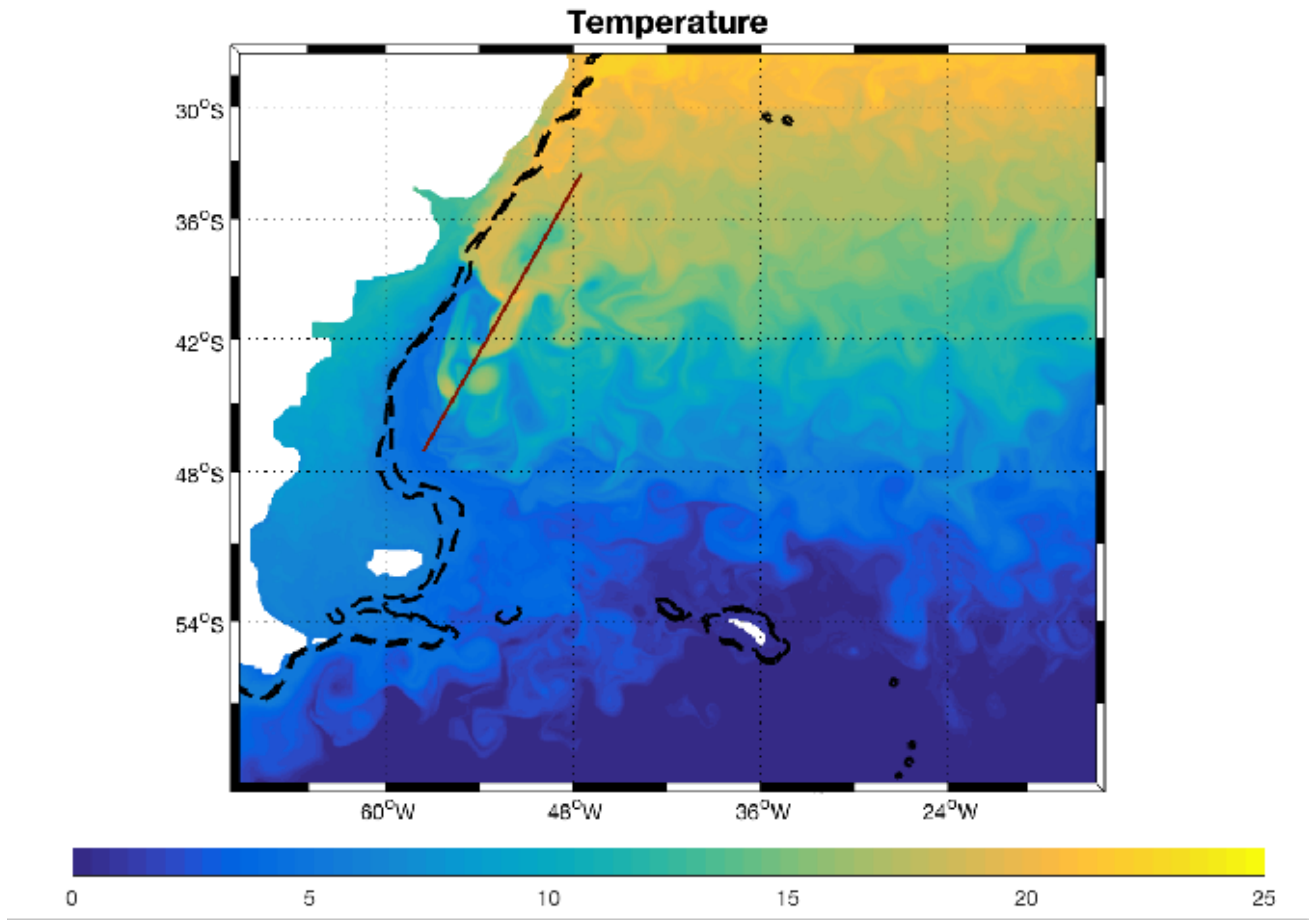
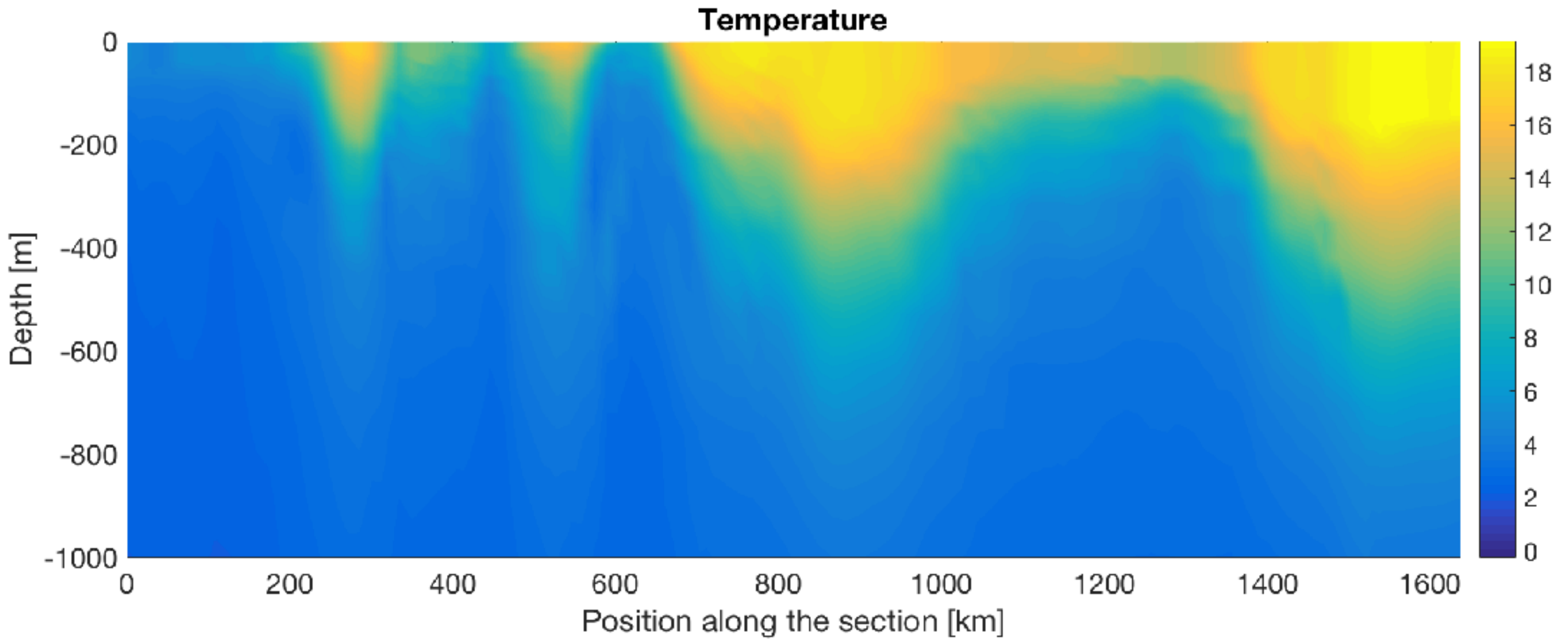
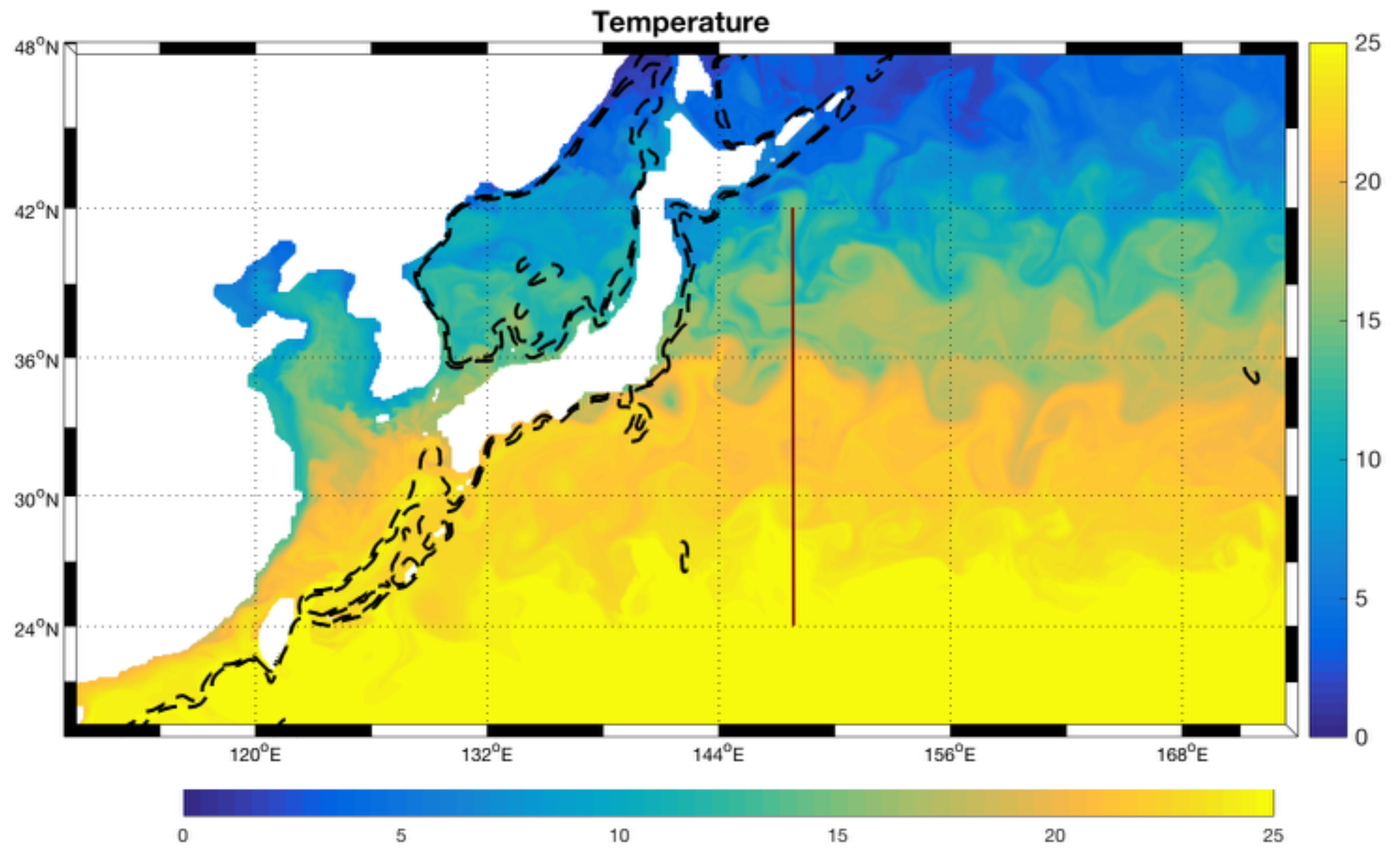
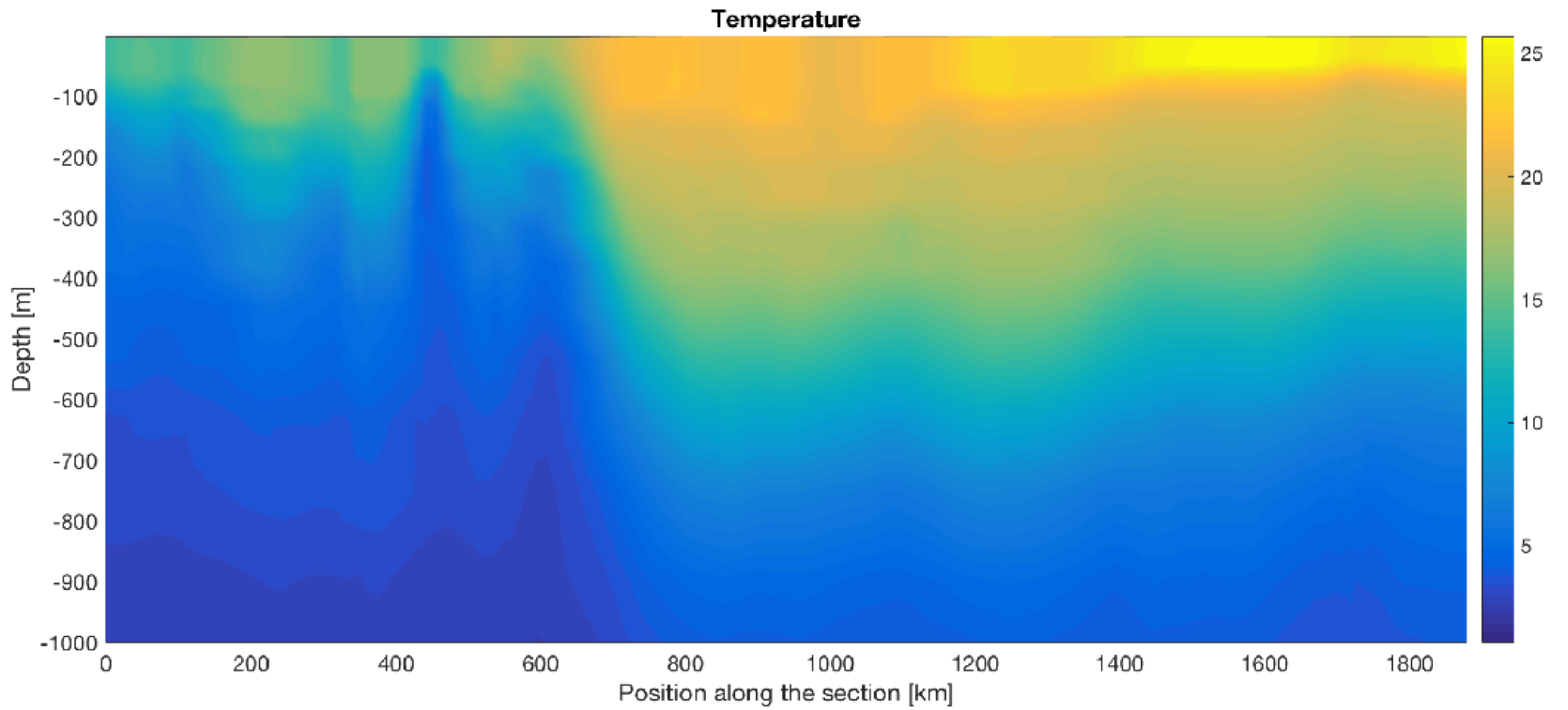


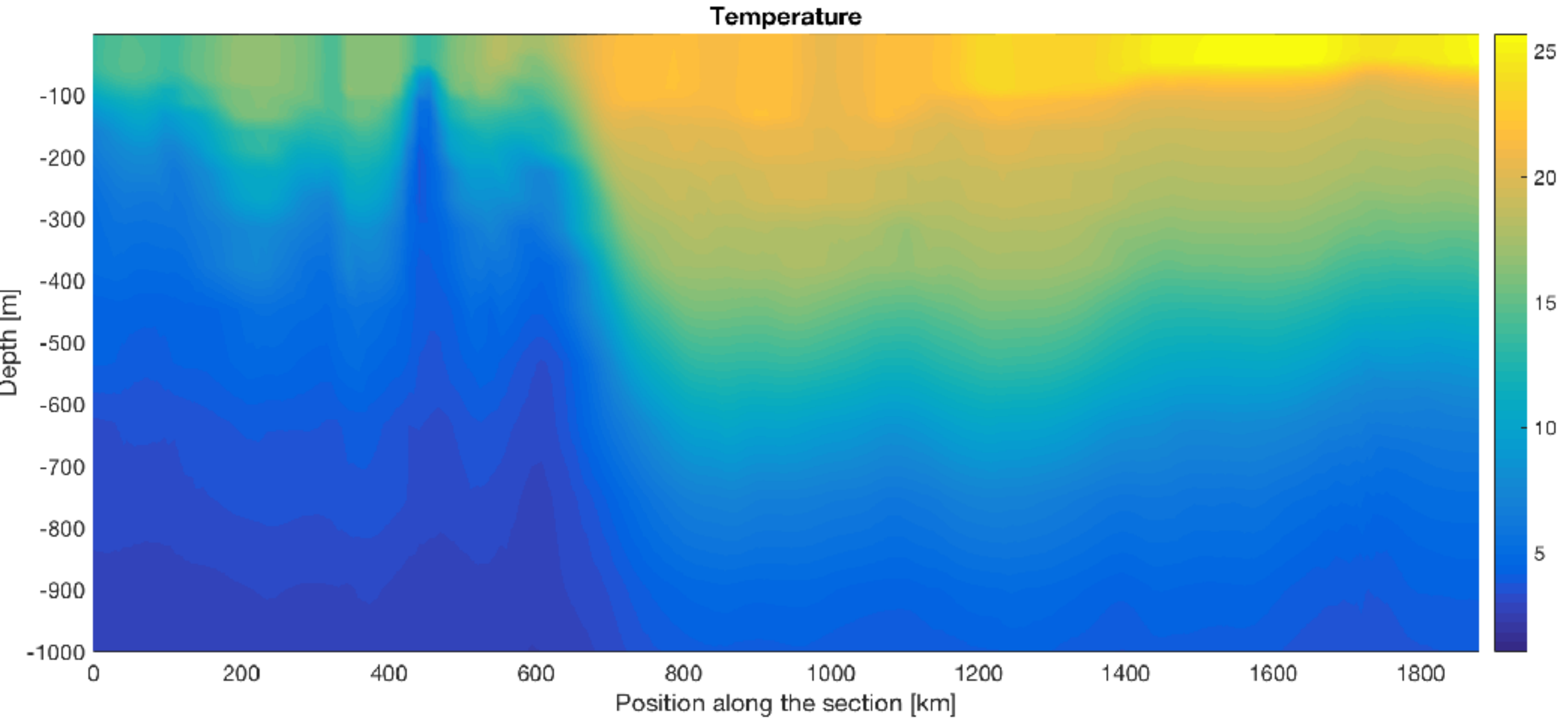


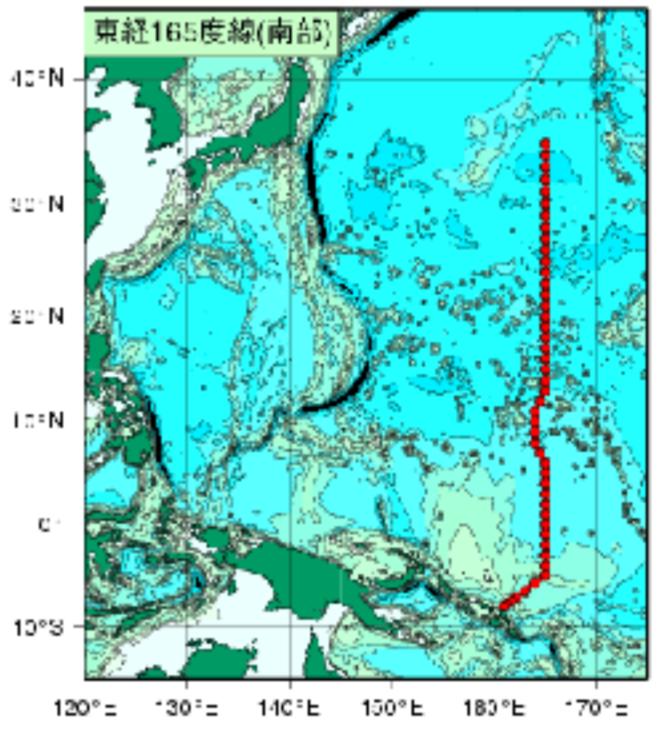


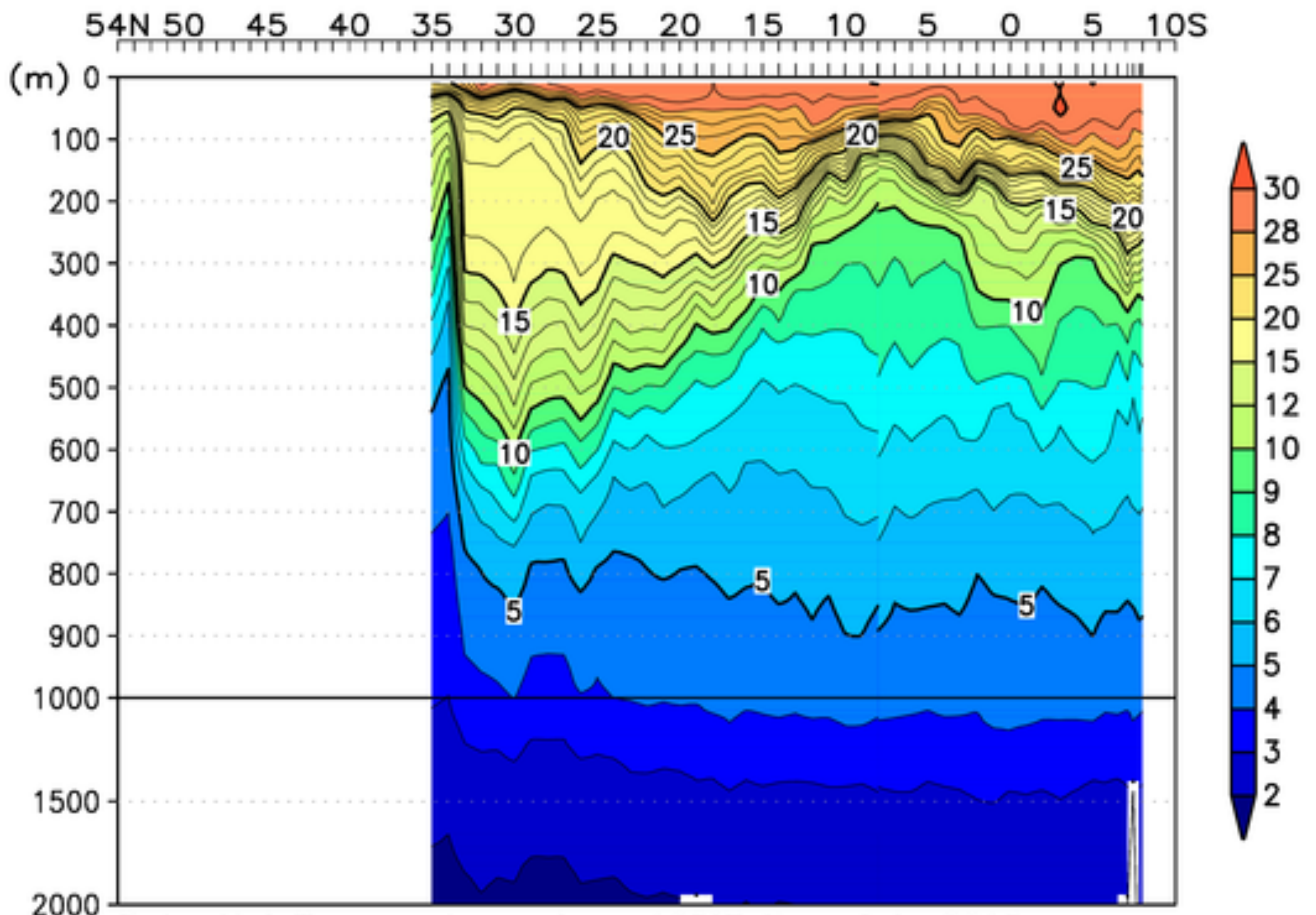


Model validation with available in-situ observations

42ºN 24ºN



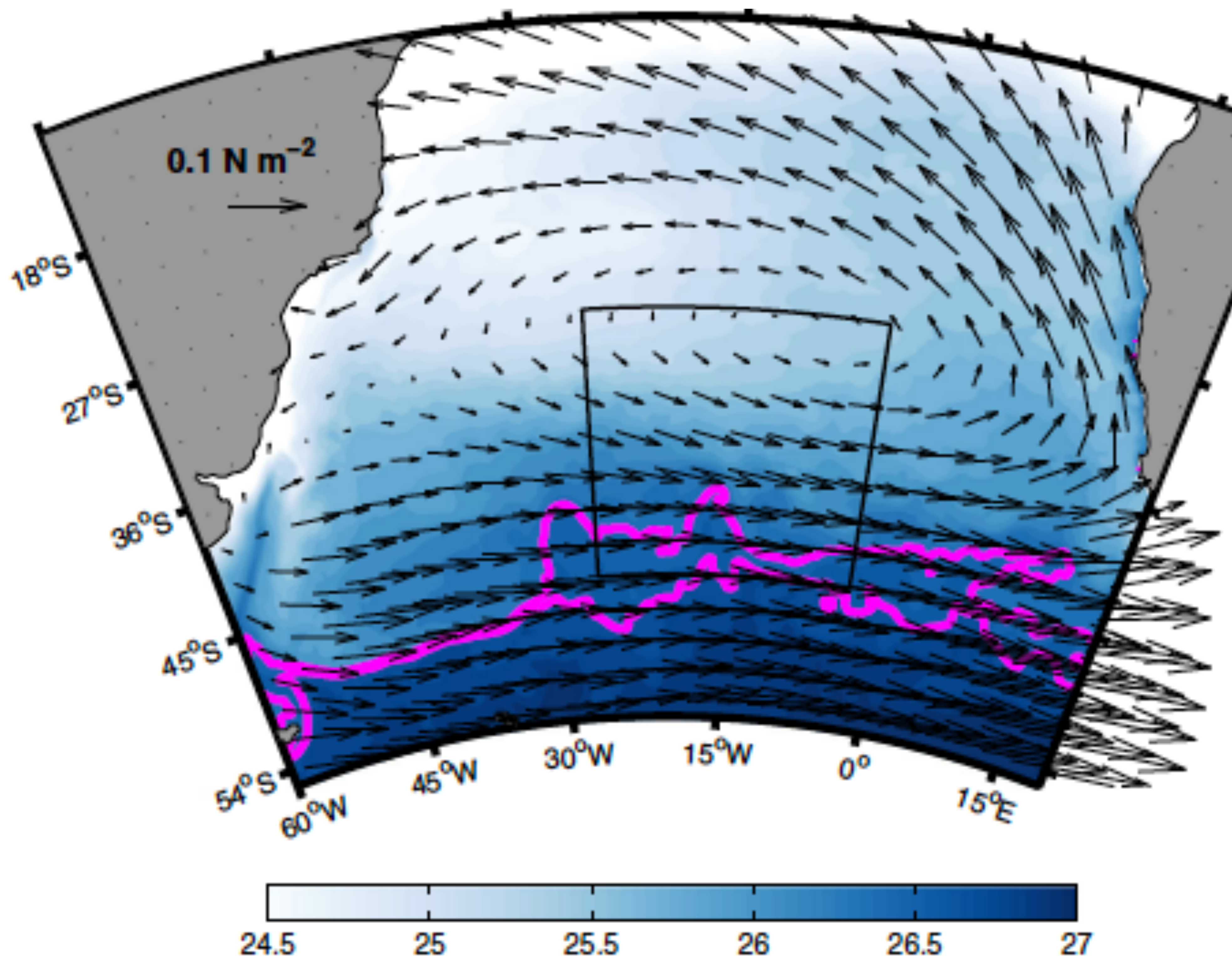




Potential Temperature along 165°E line, July 2015
(C) Japan Meteorological Agency

Climatological run - general circulation and vertical structure are consistent with in-situ observations.

Potential Importance of Fronts in Productivity/Export



Calil 2017

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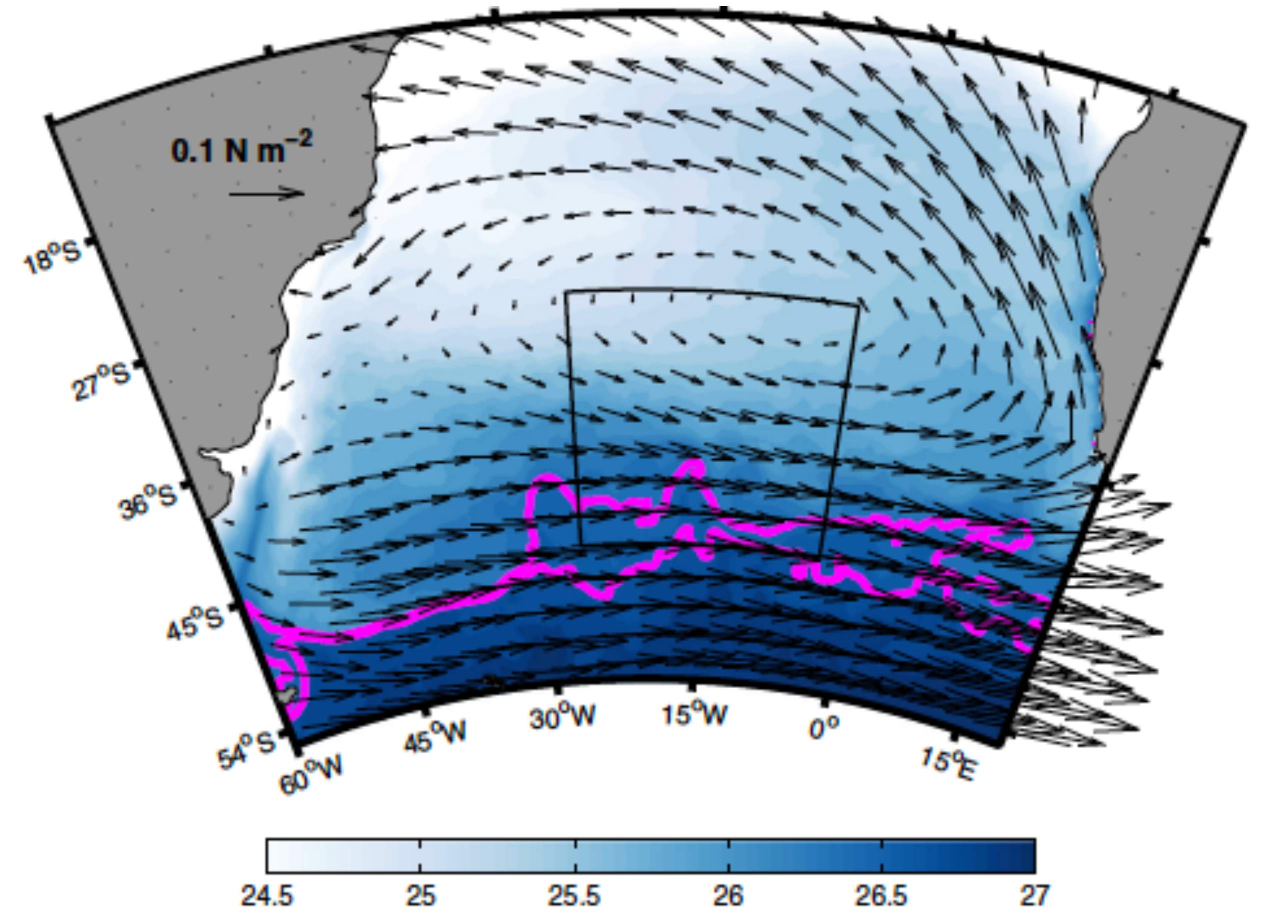

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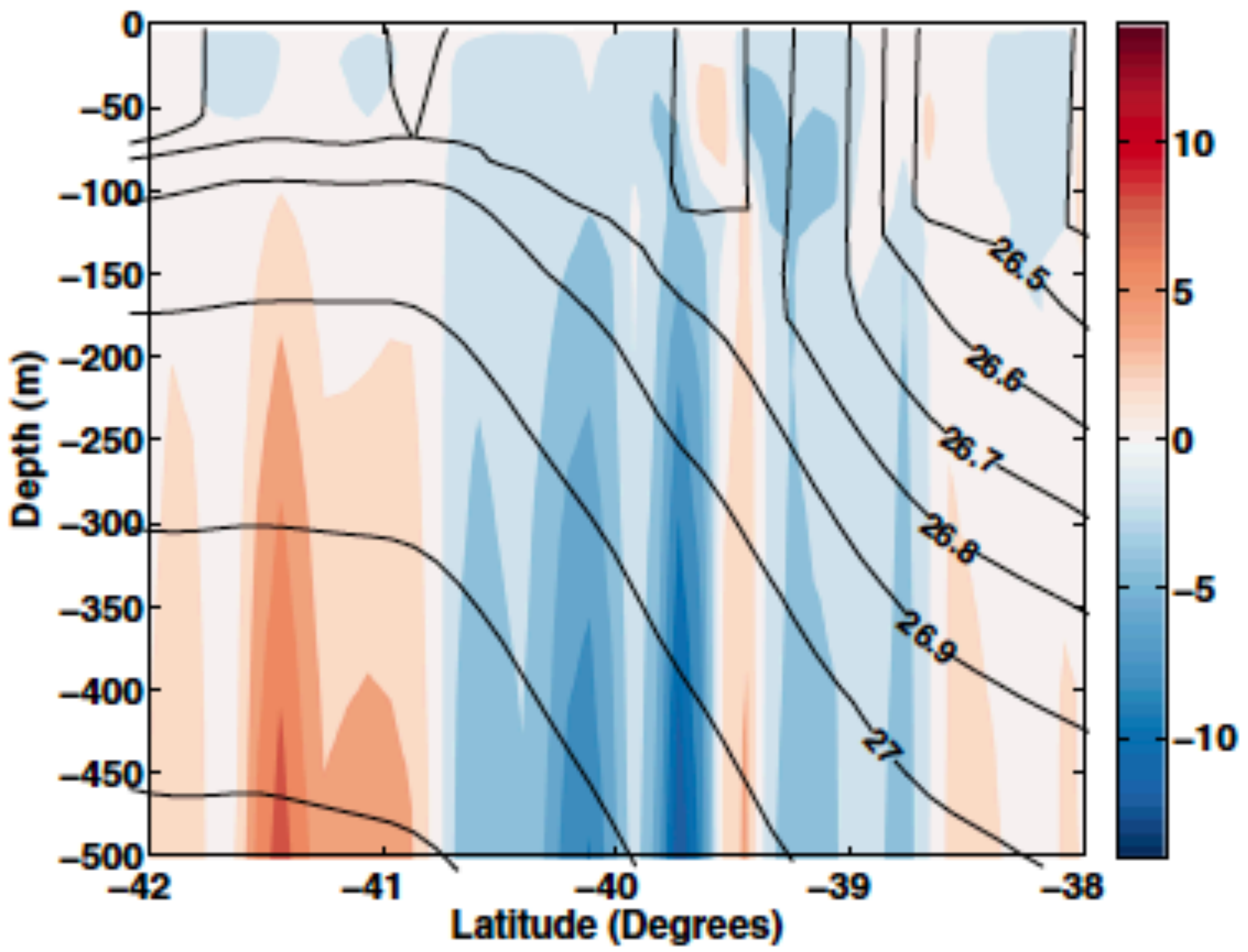
Very large vertical velocities generated where surface fronts are most intense.

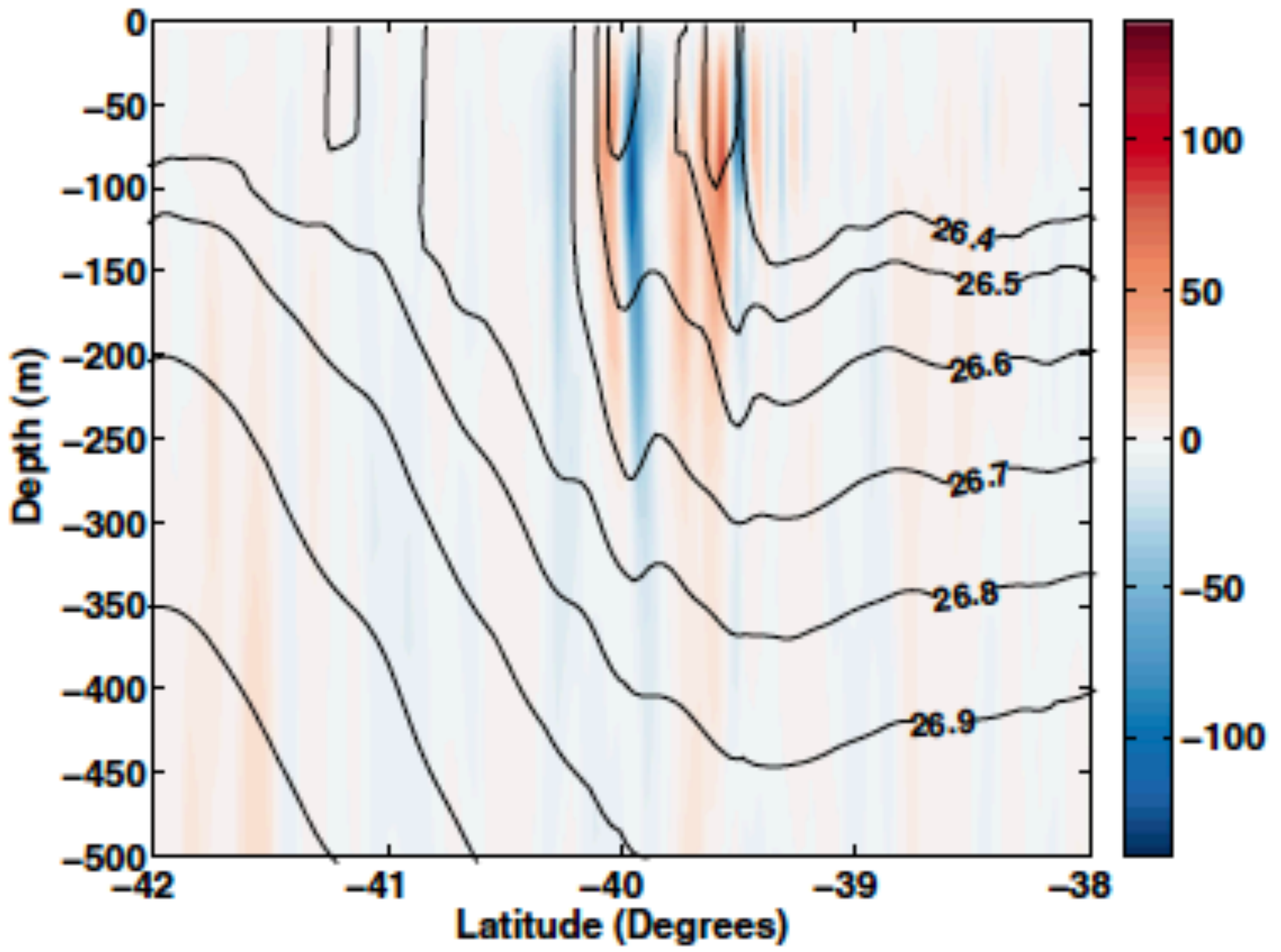
Spatial scales - O(1-10 km)

Requires high-resolution sampling/modeling.

Modeled Vertical Velocity



12 km



4 km

Calil 2017

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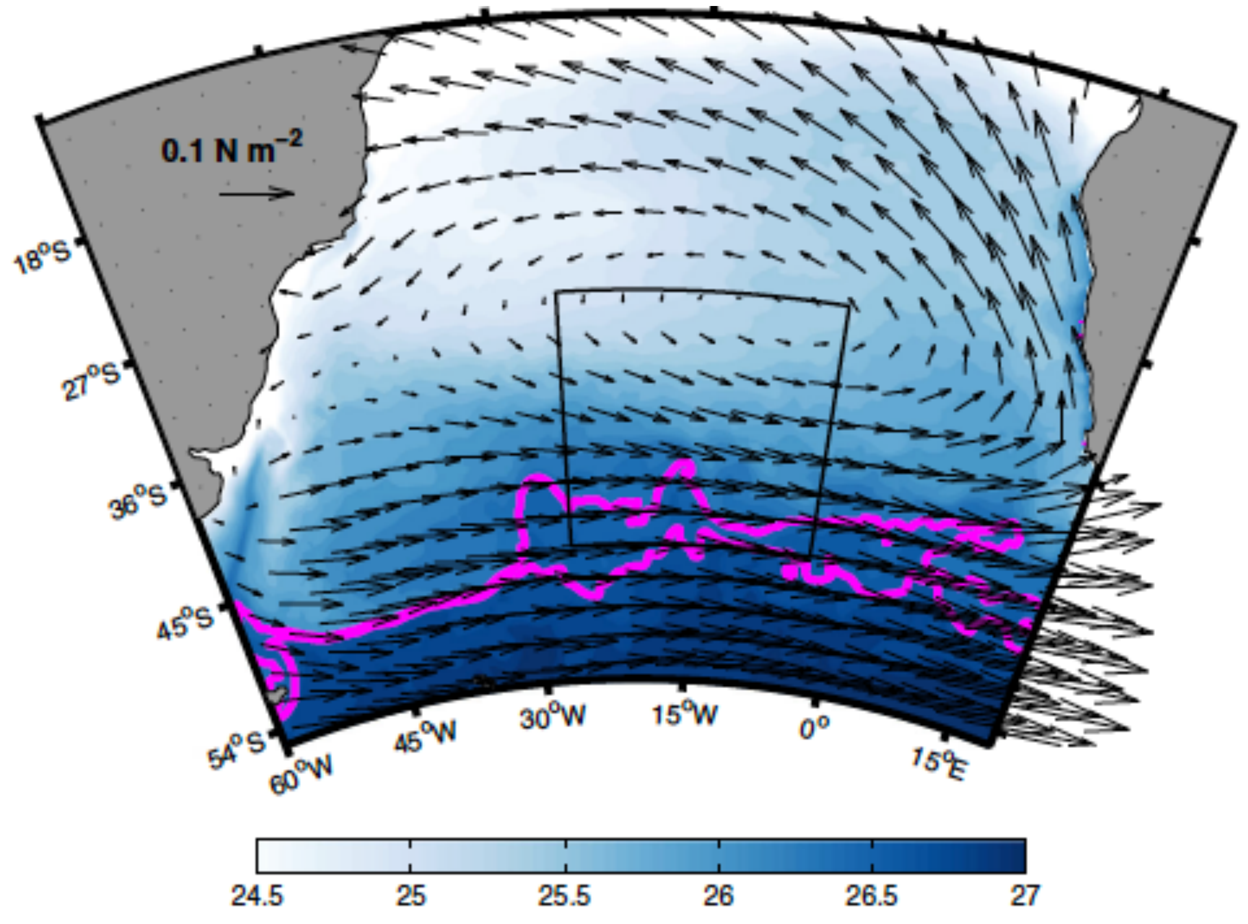

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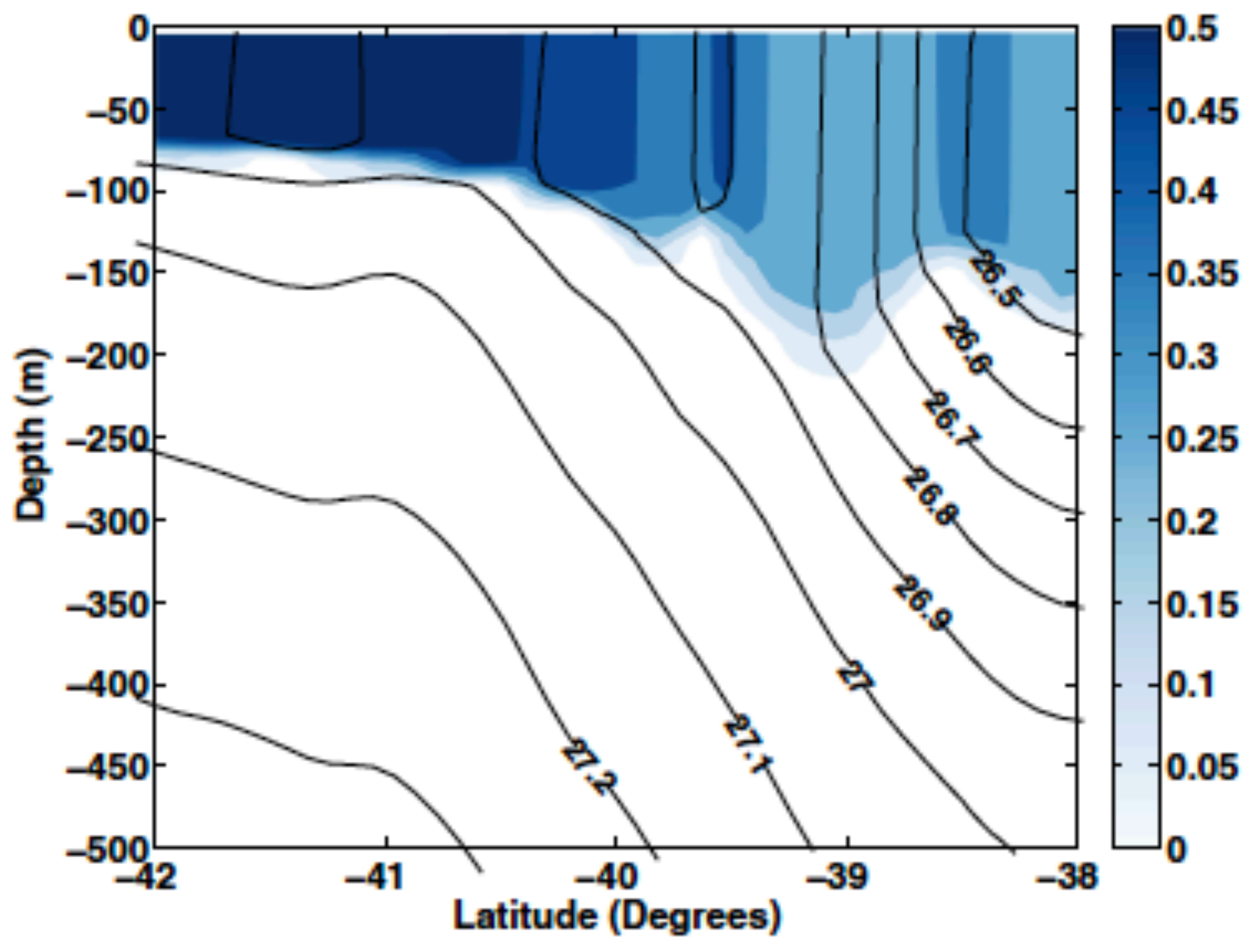
Passive Tracer Concentration



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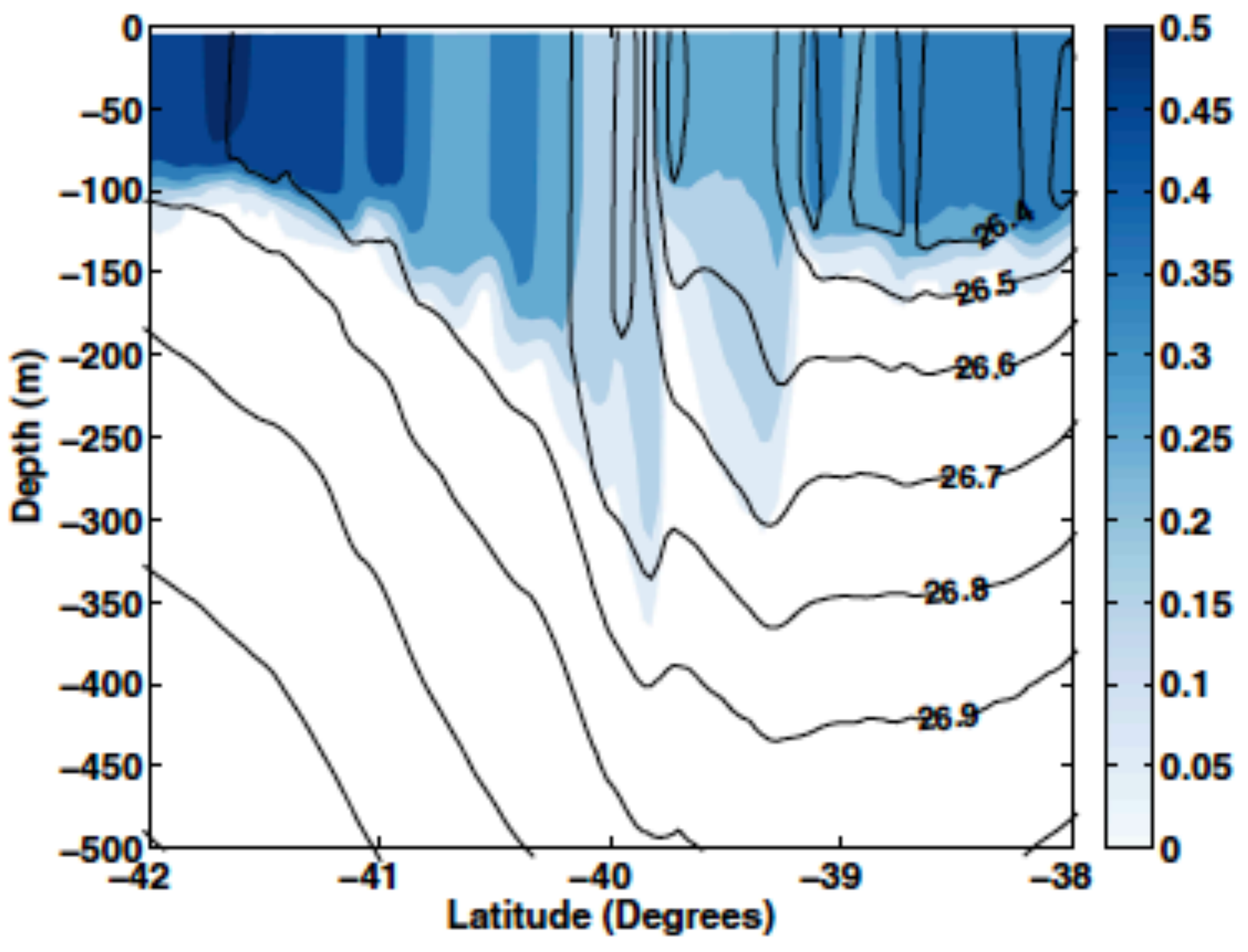

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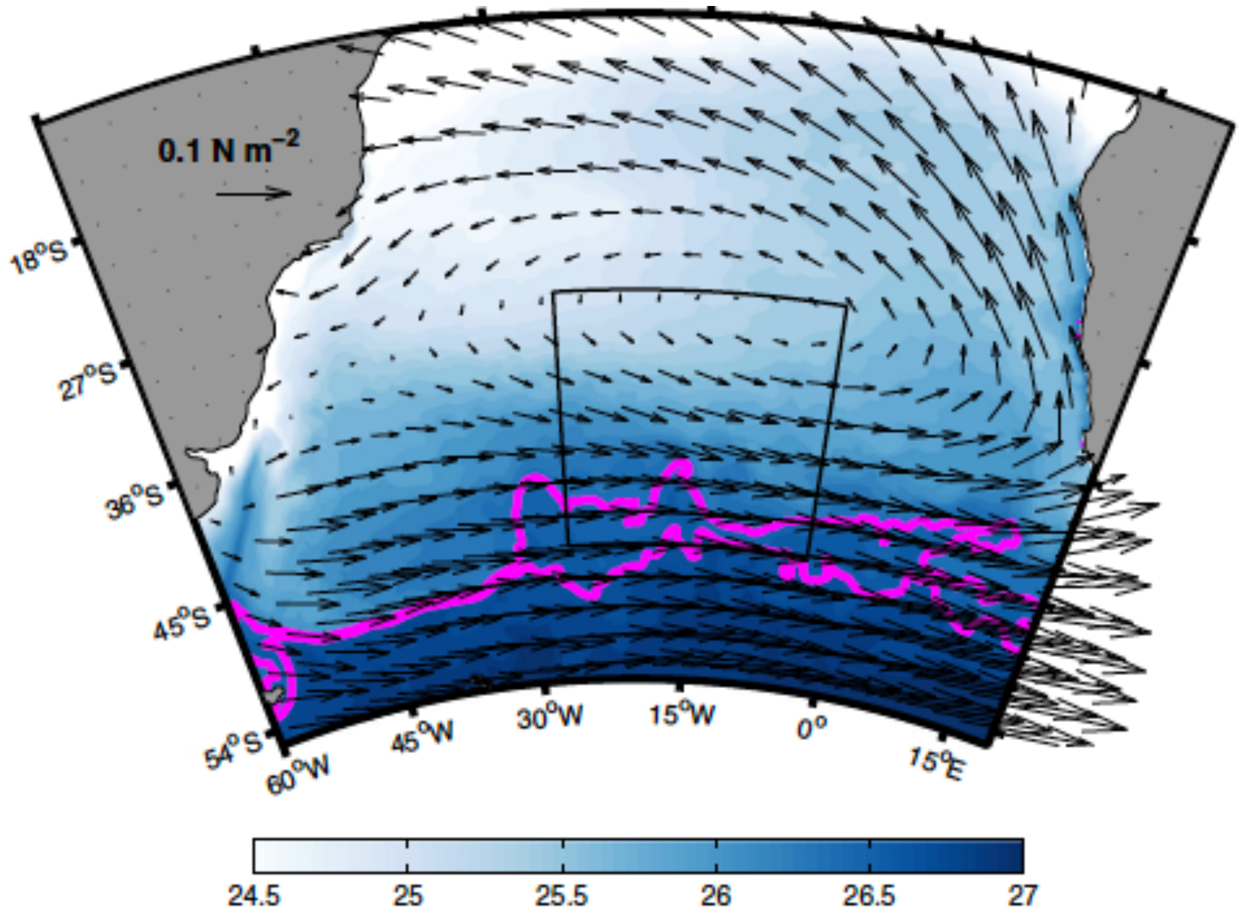

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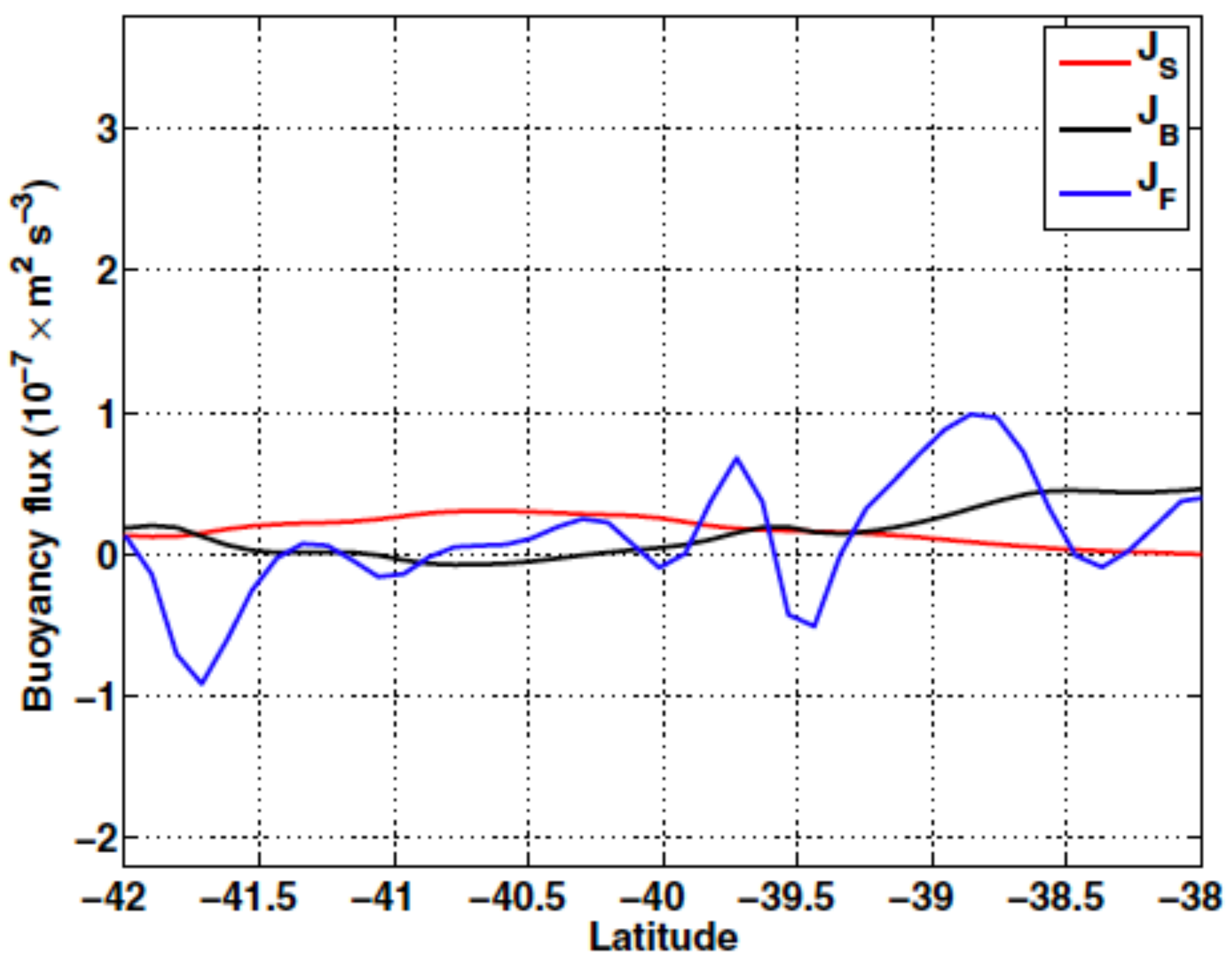
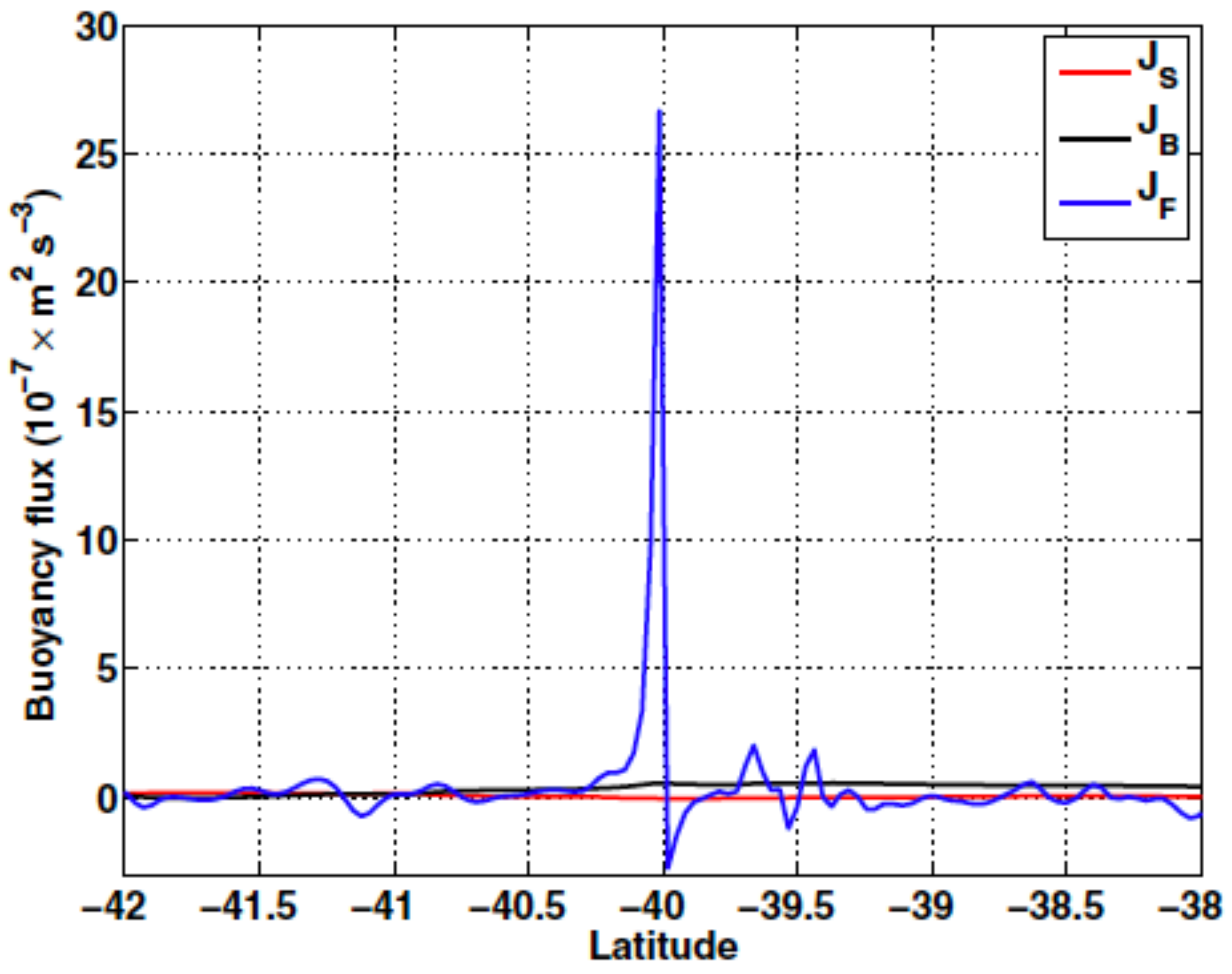
Buoyancy flux induced by heat, haline and frictional sources

$$J = -\frac{g\alpha Q_0}{\rho c_p} + g\beta(E-P)S_0 + M_e\frac{\partial b}{\partial y}$$

Thomas and Lee, 2005; Marshall and Nurser, 1992



12 km



4 km

Calil 2017

Final considerations

The biogeochemical response of the BMC and the KOCR will depend on specific physical characteristics.

Understanding the overall impact of the fronts in the physics and biogeochemistry requires high-resolution sampling and modeling.

Next steps

Similar modeling framework with implementation of biogeochemical model in both regions in order to understand similarities and differences.

In-situ surveys with similar sampling strategy.