# Examining western boundary current variability using a consistent multi-platform approach

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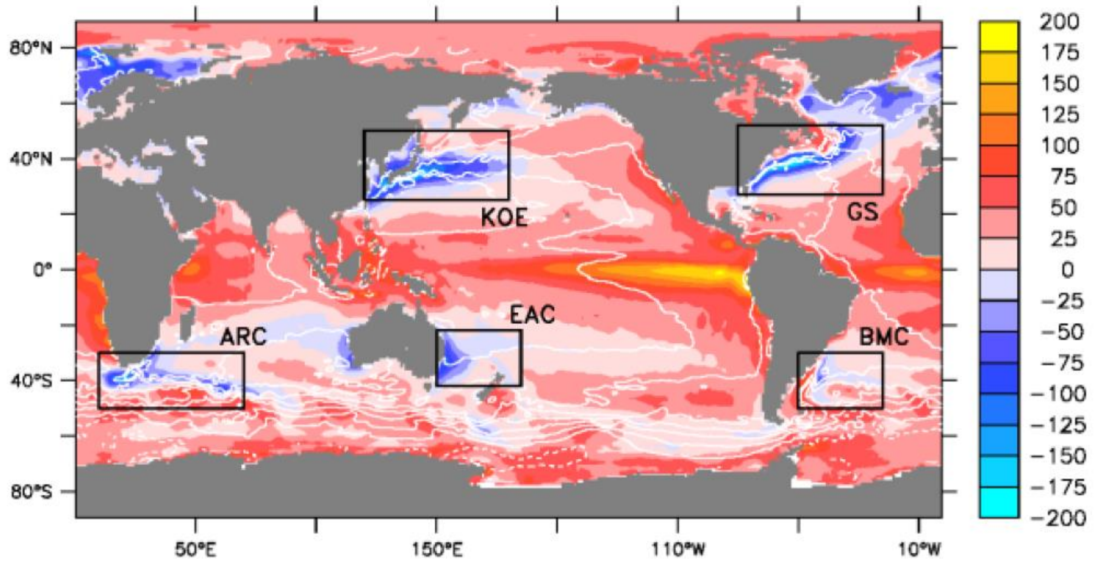
# Background

- WBCs are strong poleward-flowing currents on the western side of ocean basins.
- Highly dynamic regions.
- Difficulty in making long-term subsurface observations -> uncertainty in interannual and longer variability.

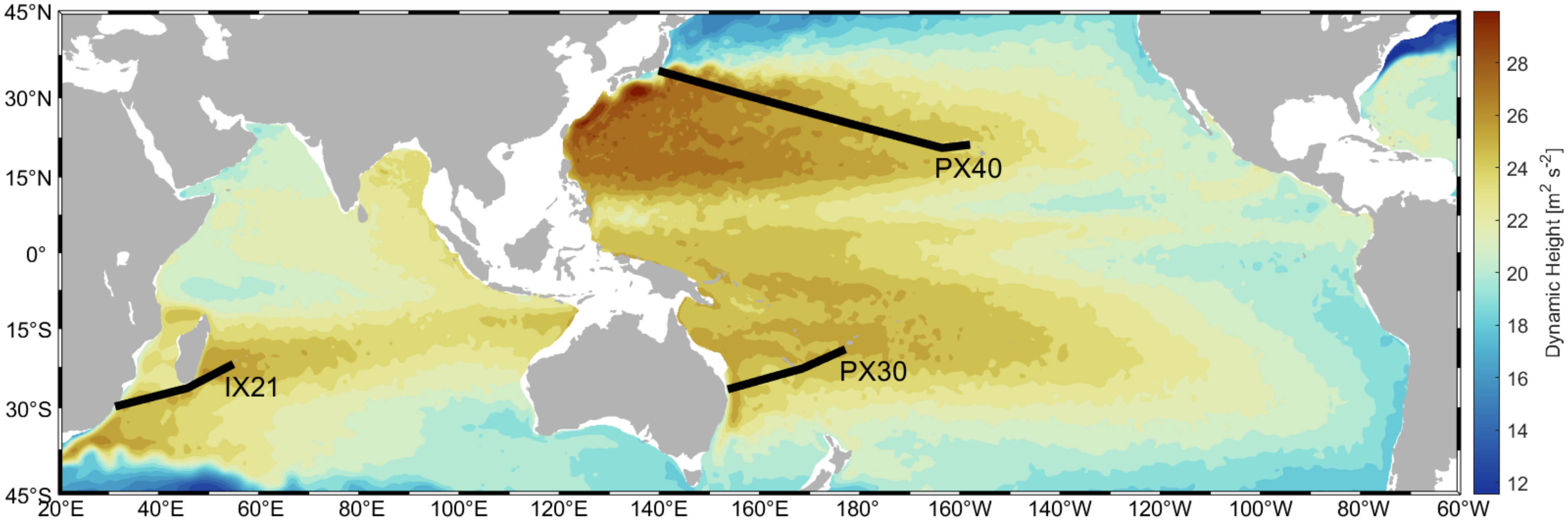
Mean net surface heat flux [W/m$^2$]
(Cronin et al. 2010)




WBC and extension region abbreviations
ARC – Agulhas Return Current
KOE – Kuroshio-Oyashio Extension
EAC – East Australian Current
GS – Gulf Stream
BMC – Brazil+Malvinas Currents

# Introduction

Observe WBC variability over seasonal to decadal time scales using velocity estimates between the surface and 1975-m computed from complementary HR-XBT, Argo, and satellite altimetry observations.



# Methodology

(Zilberman et al. 2018)

1. Salinity corresponding to HR-XBT measurements from Argo T-S relationships
2. Argo climatology corrects for path differences in individual HR-XBT transects
3. Argo profiles extend measurements in depth from 800-m to 1975-m
4. Satellite altimetry produces monthly time series from nominally quarterly HR-XBT sampling
5. Argo sub-surface velocities provide a reference level at 1000-m parking depth

# Validation

## EAC (Zilberman et al. 2018)

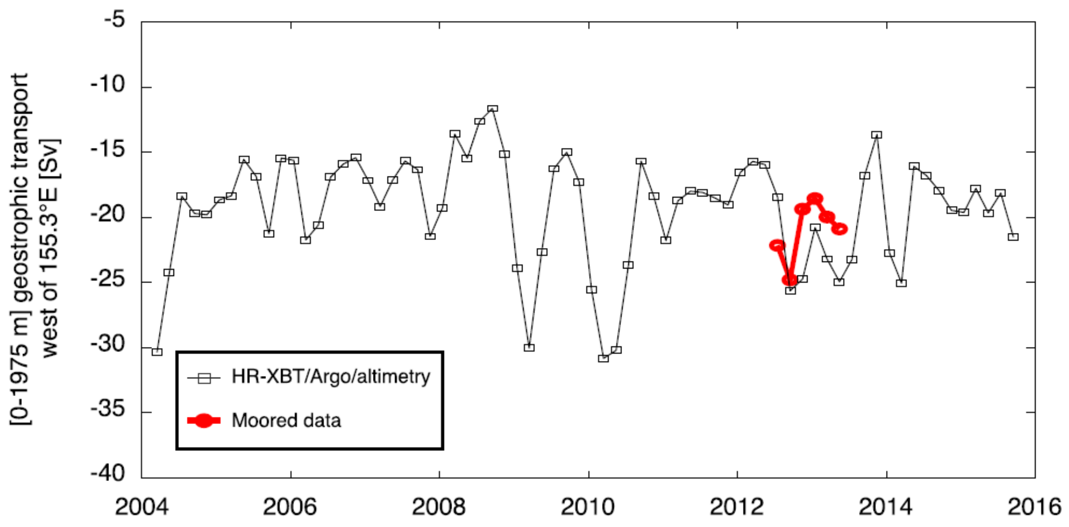
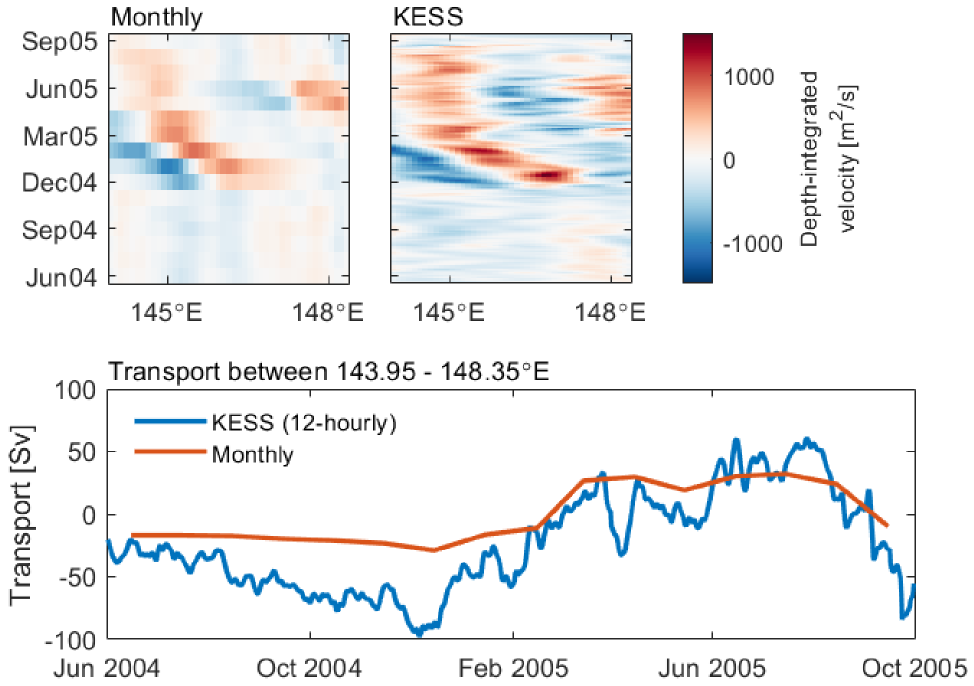



FIG. 10. Time series of the absolute geostrophic transport normal to the PX30 nominal track in the EAC region west of 155.3°E from 2004 to 2015, computed using merged data (black line). Transport estimates using moored data at 27°S (red line). Both series are smoothed with a 4-month running mean.

## Kuroshio Extension System Study




Moored data from Sloyan et al. 2016

http://www.po.gso.uri.edu/dynamics/kess/

Valida

EAC (Zilb ... tudy



# Estimating the Velocity and Transport of Western Boundary Current Systems: A Case Study of the East Australian Current near Brisbane

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ABSTRACT

Western boundary currents (WBCs) are highly variable narrow meandering jets, making assessment of their volume transports a complex task. The required high-resolution temporal and spatial measurements are available only at a limited number of sites. In this study a method is developed for improving estimates of the East Australian Current (EAC) mean transport and its low-frequency variability, using complementary modern datasets. The present calculation is a case study that will be extended to other subtropical WBCs. The method developed in this work will reduce uncertainties in estimates of the WBC volume transport and in the interannual mass and heat budgets of the meridional overturning circulations, improving our understanding of the response of WBCs to local and remote forcing on long time scales. High-resolution expendable bathythermograph (HR-XBT) profiles collected along a transect crossing the EAC system near Brisbane, Australia, are merged with coexisting profiles and parking-depth trajectories from Argo floats, and with altimetric sea surface height data. Using HR-XBT/Argo/altimetry data combined with Argo trajectory-based velocities at 1000 m, the 2004–15 mean poleward alongshore transport of the EAC is 19.5 ± 2.0 Sv (1 Sv ≡ $10^6$ $m^3$ $s^{-1}$) of which 2.5 ± 0.5 Sv recirculate equatorward just offshore of the EAC. These transport estimates are consistent in their mean and variability with concurrent and nearly collocated moored observations at 27°S, and with earlier moored observations along 30°S. Geostrophic transport anomalies in the EAC system, including the EAC recirculation, show a standard deviation of ±3.1 Sv at interannual time scales between 2004 and 2015.

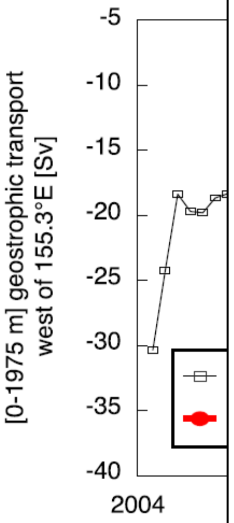
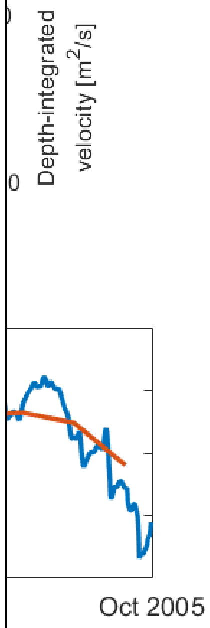



FIG. 10. Time se
track in the EAC
(black line). Trans
smoothed with a 4-

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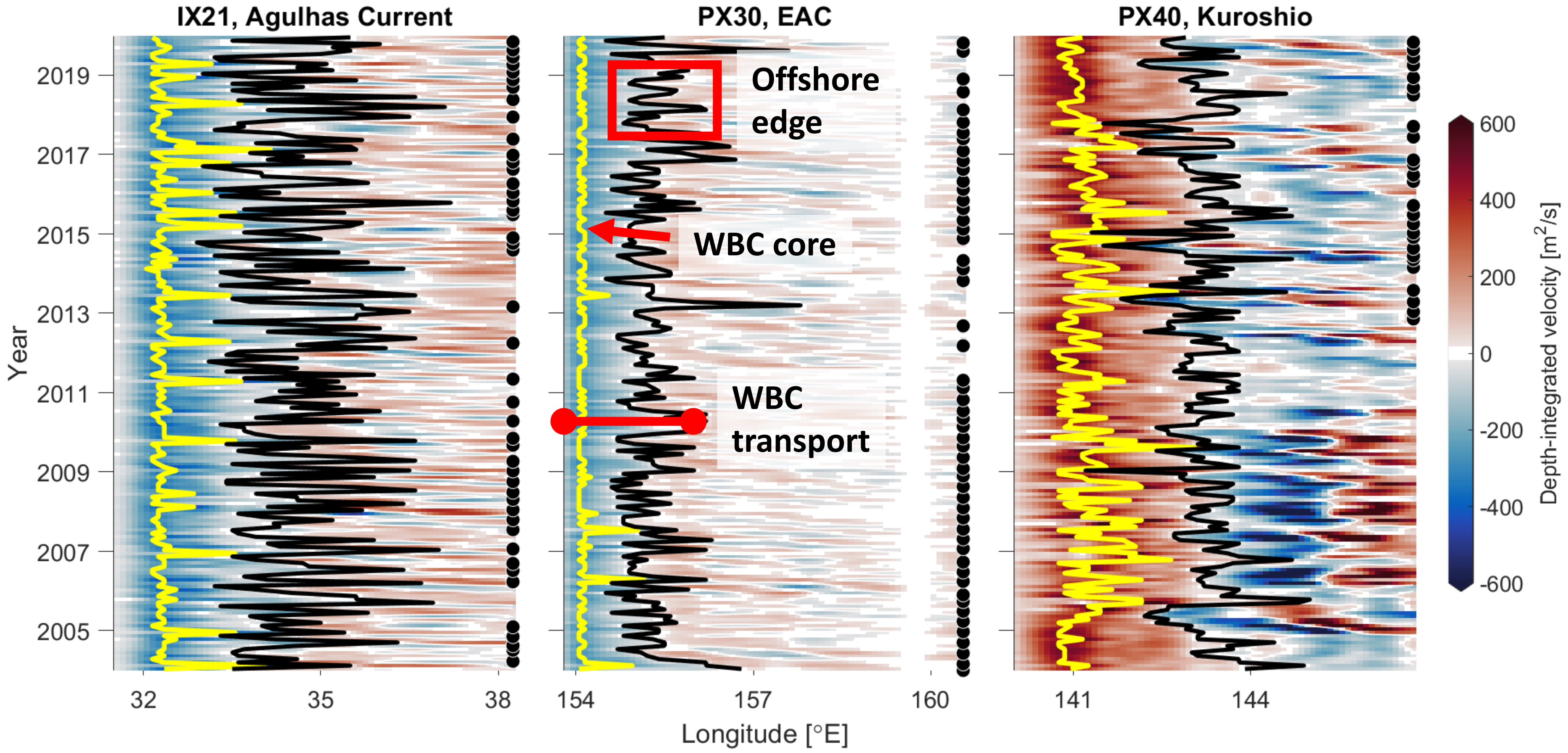
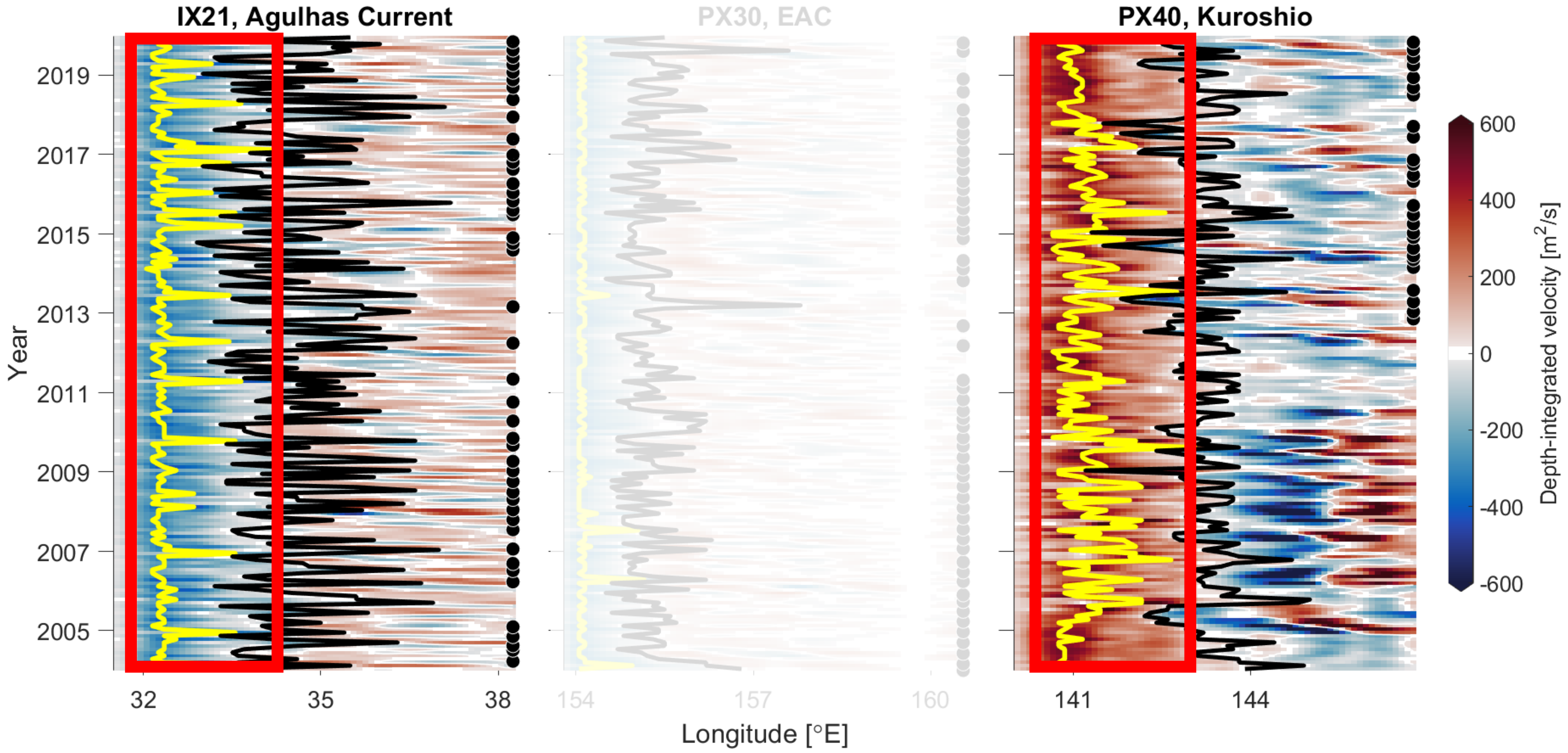
# Results

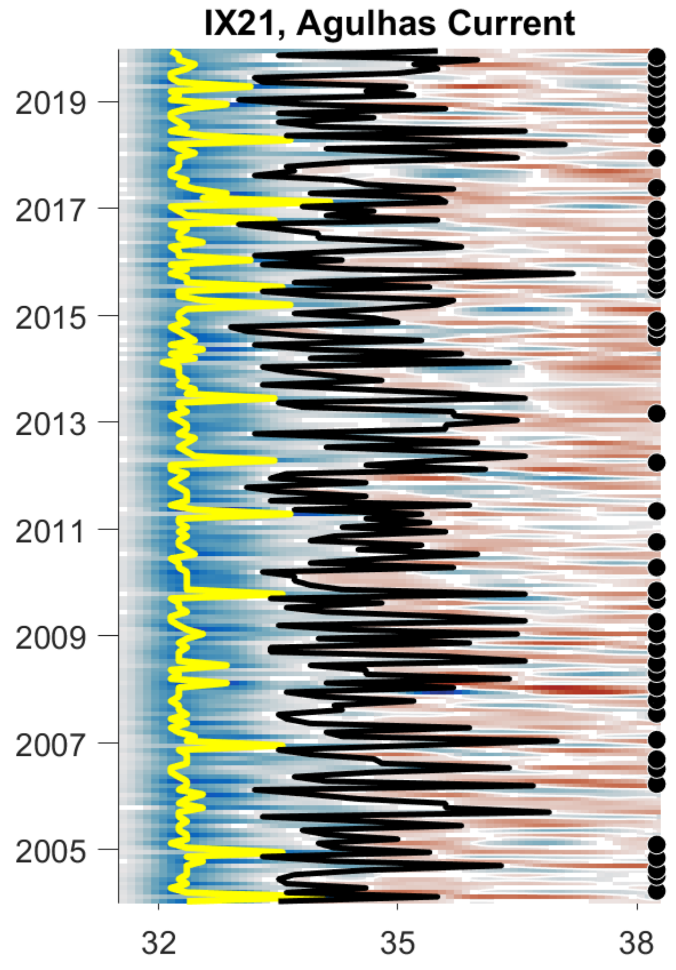
0—1975-m depth-integrated absolute geostrophic velocity [$m^2/s$]

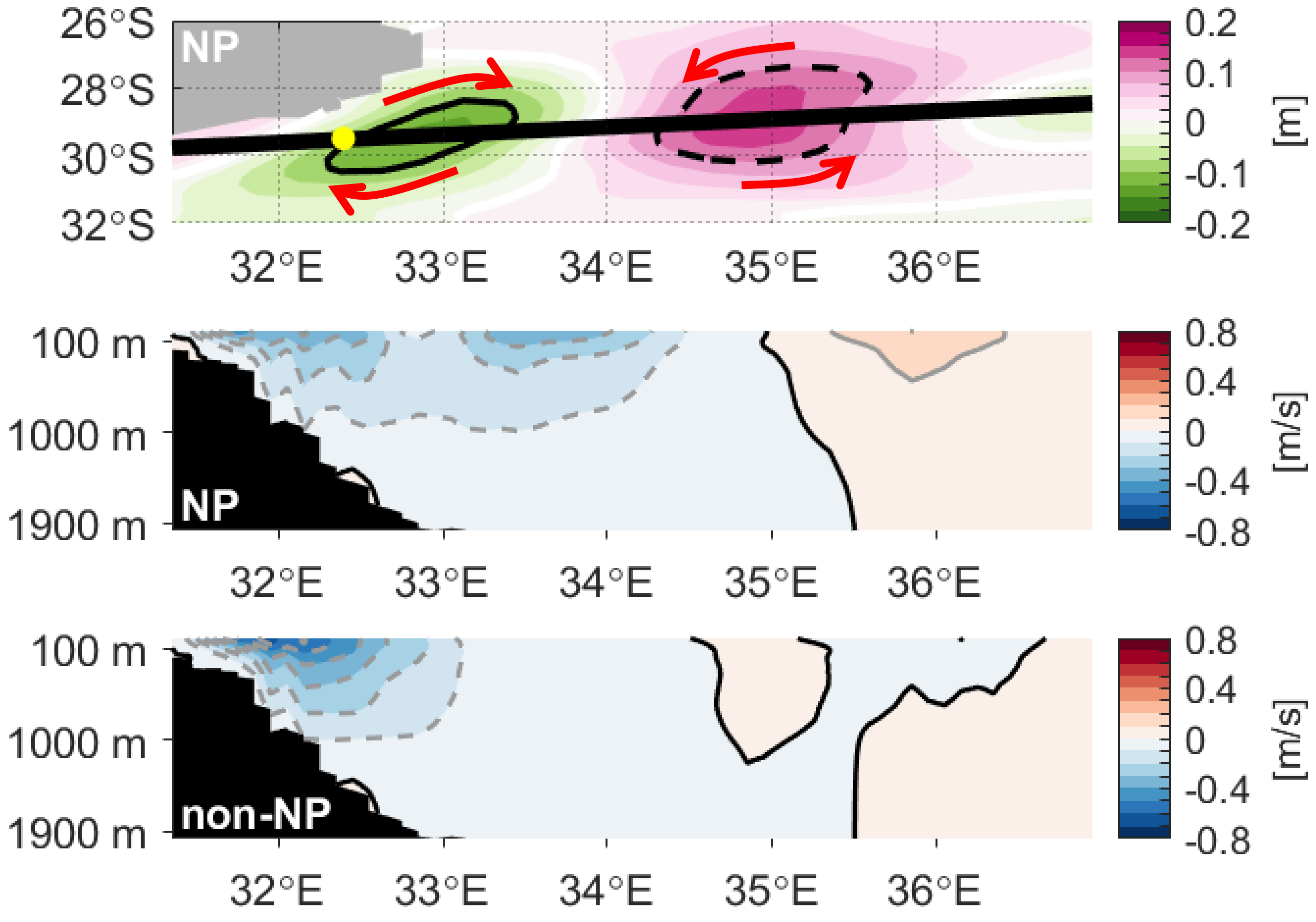


# 1. Core longitude



# Core longitude: Agulhas



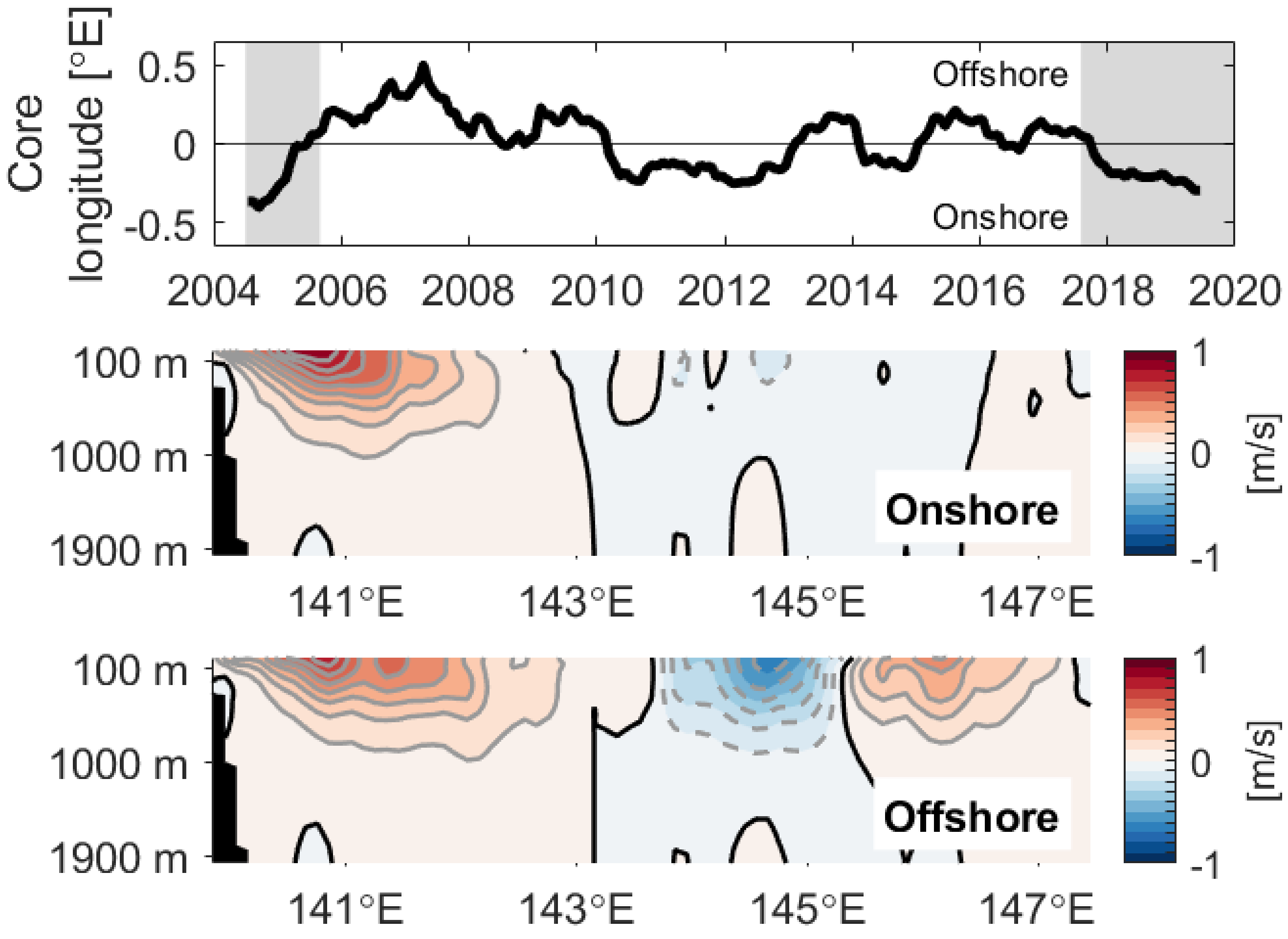




Mean SLA during Natal Pulse events

Mean velocity during Natal Pulse events

Mean velocity during normal periods

# Core longitude: Kuroshio

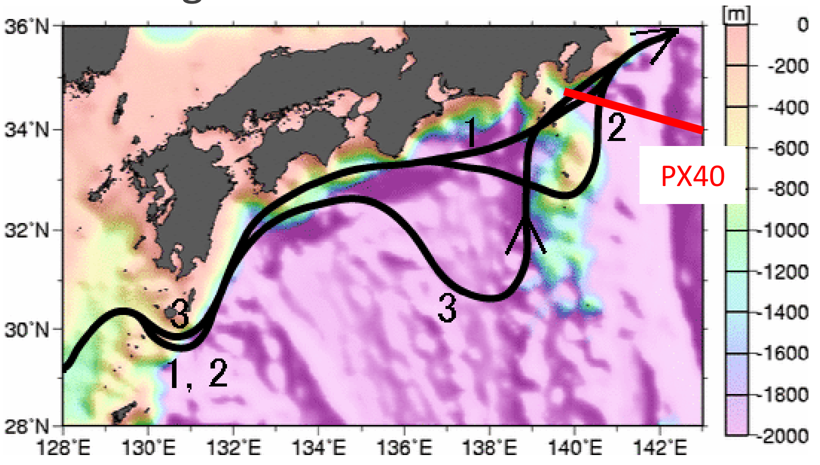



Core longitude interannual variability

Onshore state mean velocity

Offshore state mean velocity

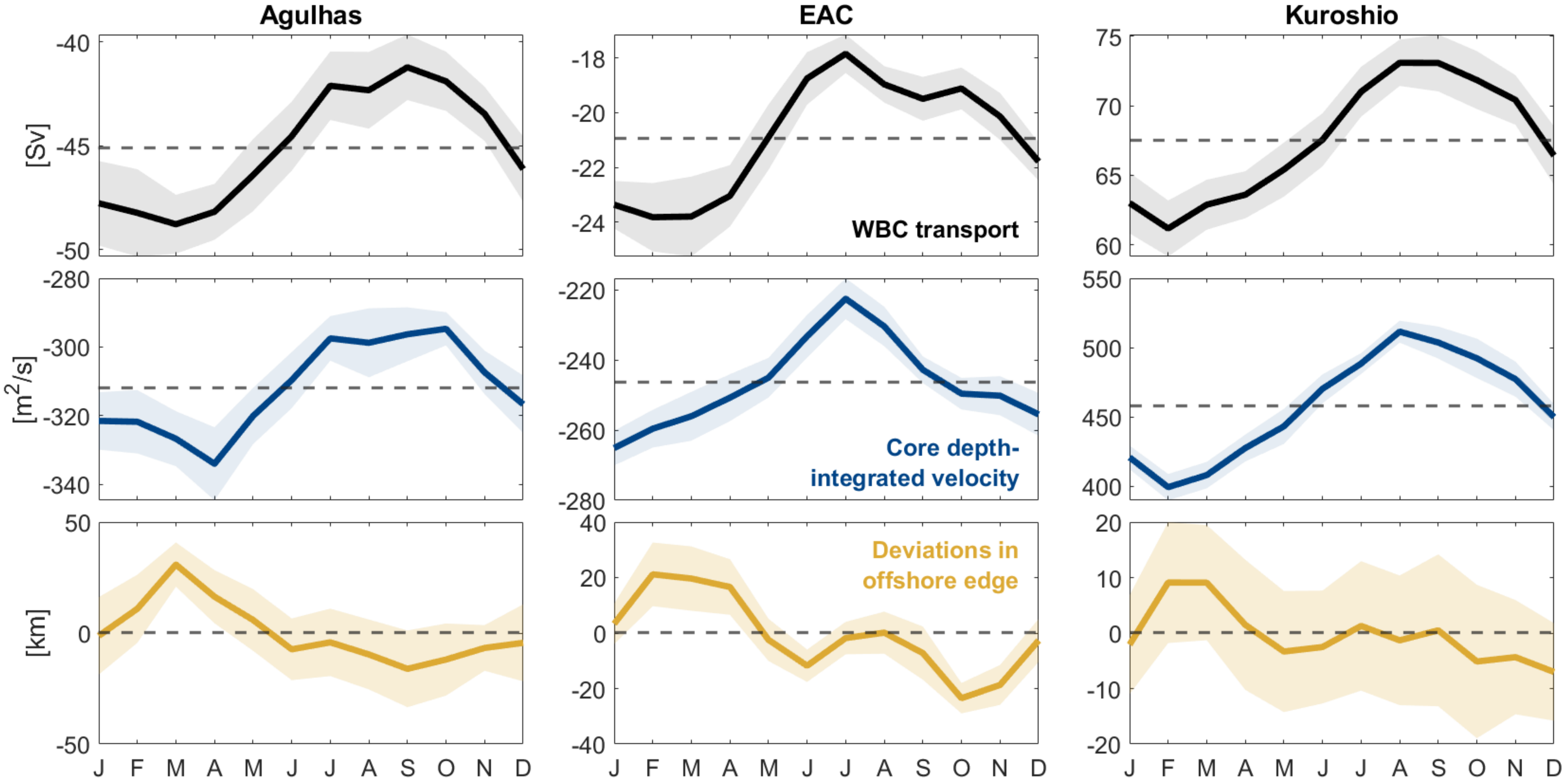
1. nearshore non-large meander
2. offshore non-large meander
3. large meander




Japan Meteorological Agency

https://www.data.jma.go.jp/gmd/kaiyou/data/shindan/b_2/kuroshio_stream/kuroshio_stream.html

# 2. Annual Cycle



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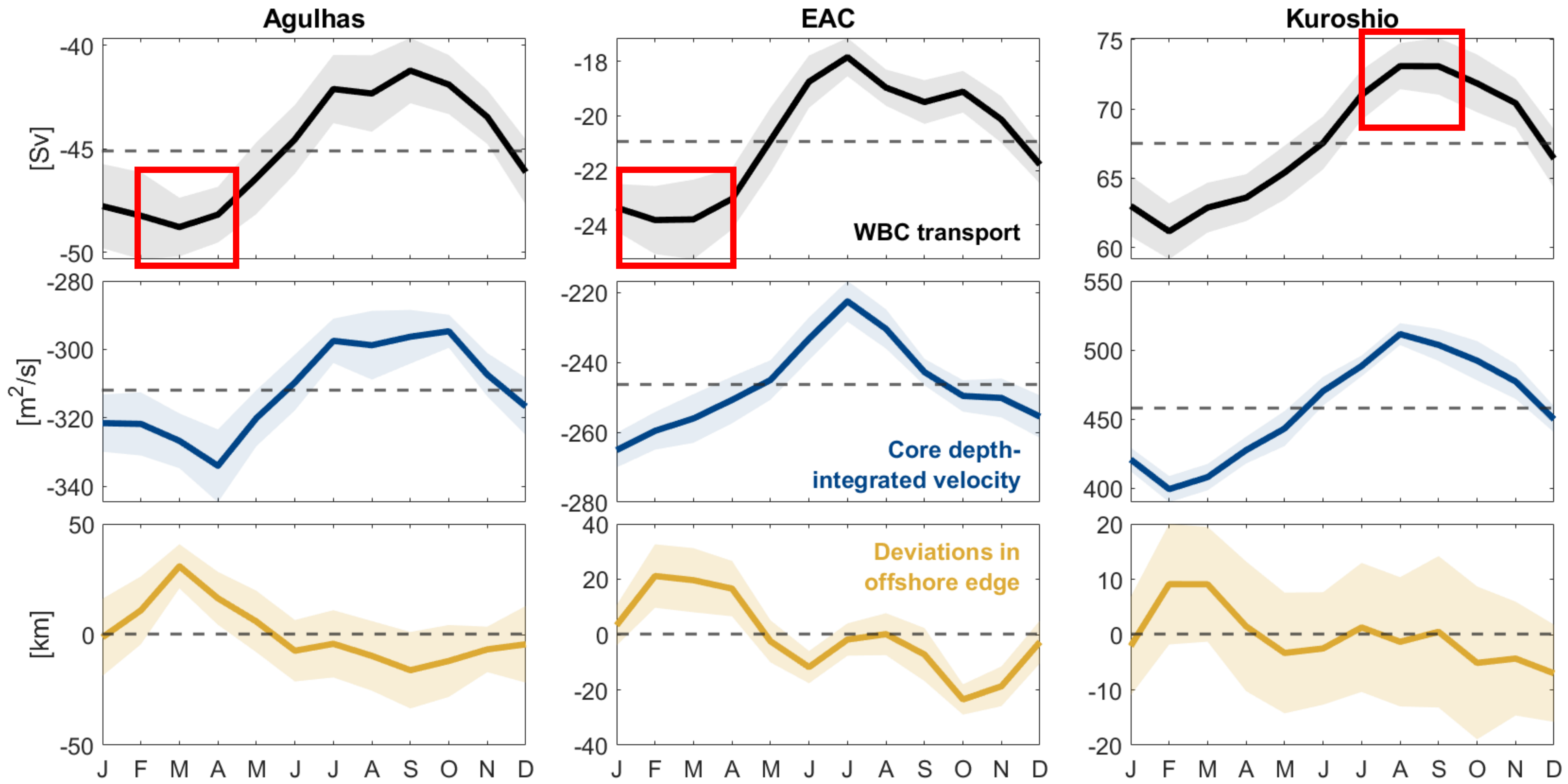

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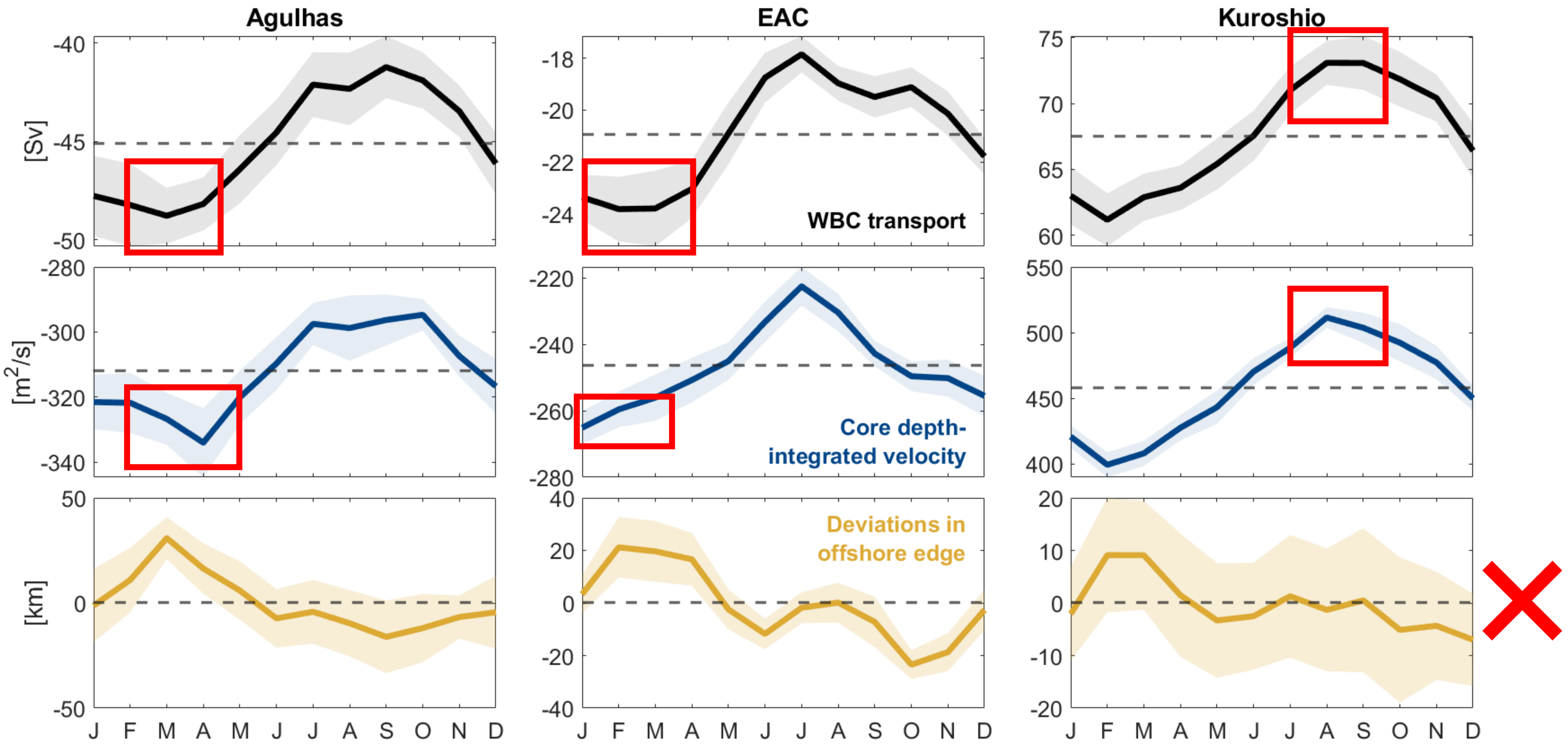
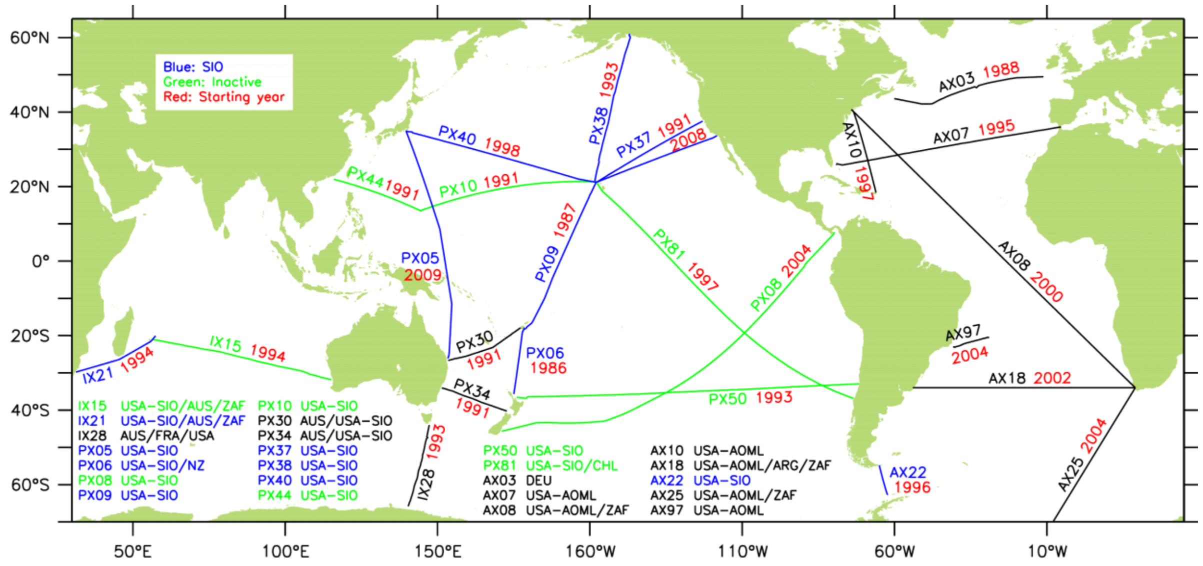


# What’s next?

Explore links between observed WBC variability and marine heatwaves.

Further extend time series back to 1993 using satellite altimetry.

+many more opportunities to examine WBCs using these long time series of subsurface velocity.

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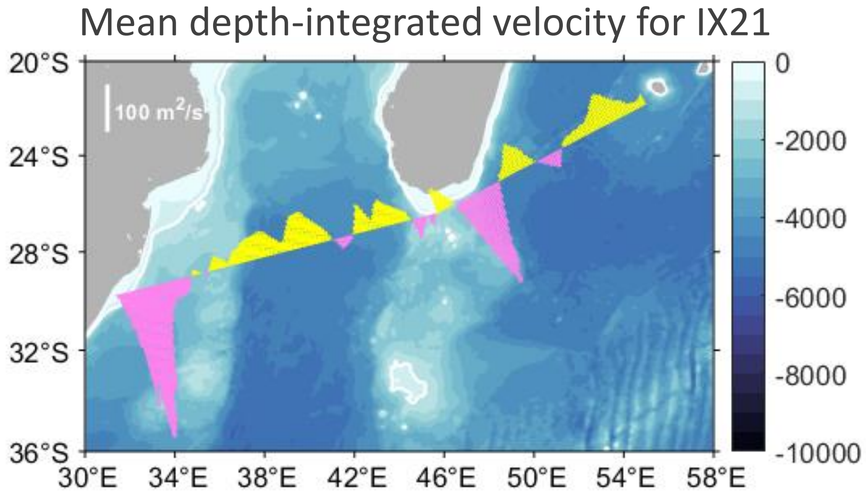
# Key Takeaways




Can combine complementary HR-XBT, Argo, and Satellite Altimetry observations to examine seasonal-to-decadal WBC variability between the surface and 1975-m.

All three WBCs demonstrate similar annual cycles with poleward transport stronger in the summer.

Subsurface observations allow velocity structure to be compared during different states of variability.

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