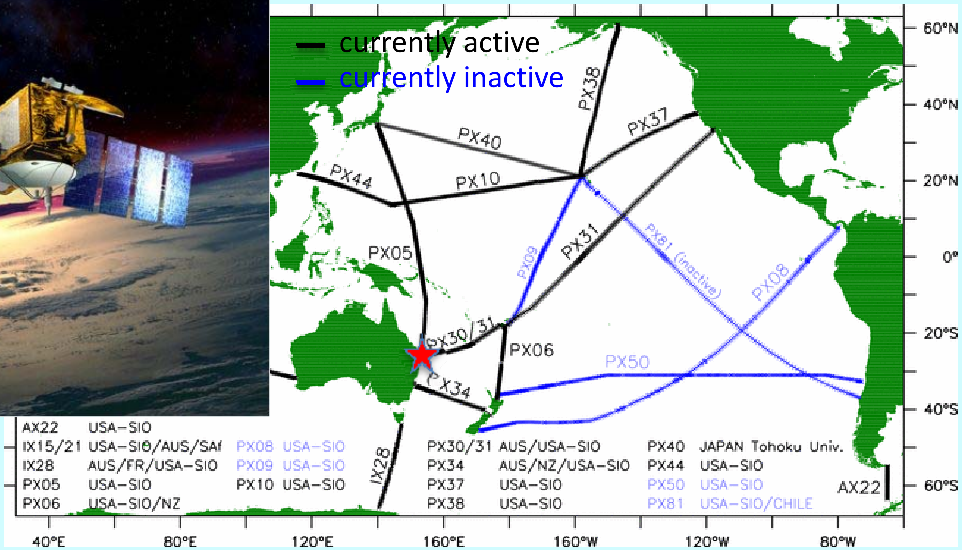
Western Boundary Current velocity and transport: combining Altimetry, XBT, and Argo



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Motivation

❑ Western Boundary Currents (WBCs)

play an essential role in the meridional distribution of heat, mass, and freshwater of the global ocean

constitute the primary pathway for basin-scale heat exchange between the tropics and the midlatitudes

❑ WBCs are narrow meandering jets of large vertical extent, which makes sampling challenging

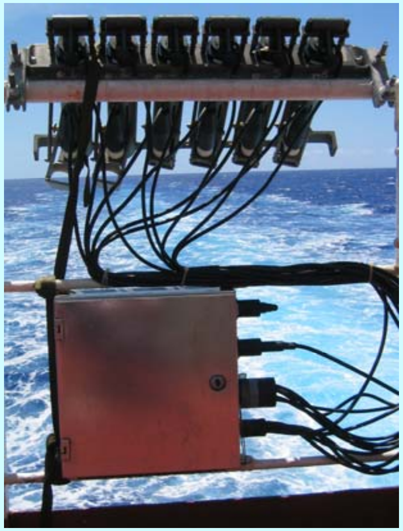
HRX suited for 0-800 m shear estimates

Argo “ill-suited” for sampling WBCs?

❑ Our goal here is to give best estimates of mean subtropical WBC transport and later to estimate the time-variability

Outlines

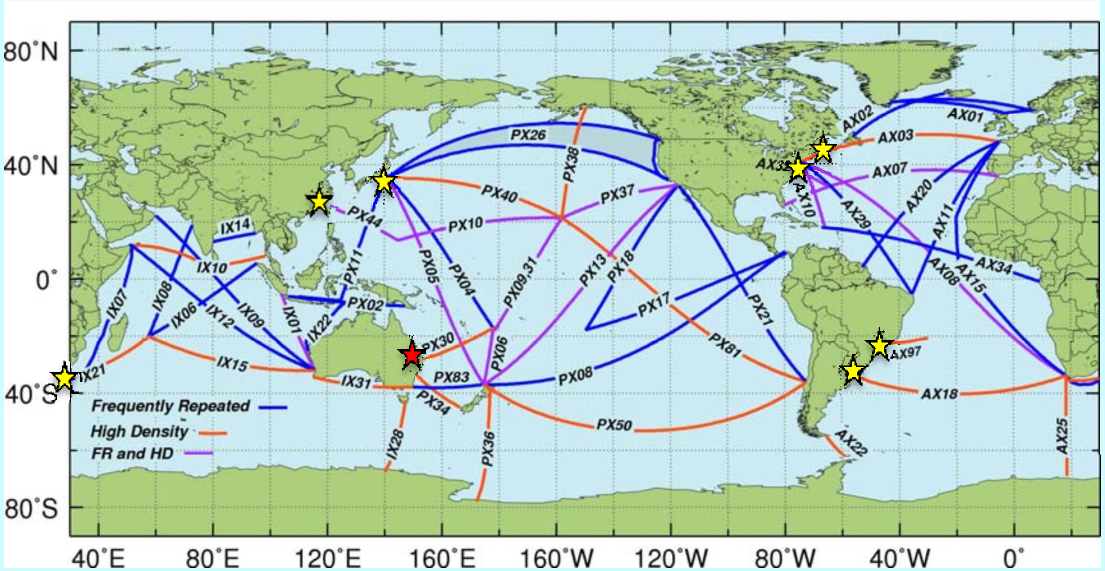
- ❑ Method: HRX, Argo, and Altimetry data



- ❑ The East Australian Current (EAC): velocity and transport estimates

- ❑ The other boundary currents: Kuroshio, Gulf Stream, Brazil Current, Agulhas Current

- ❑ Conclusion

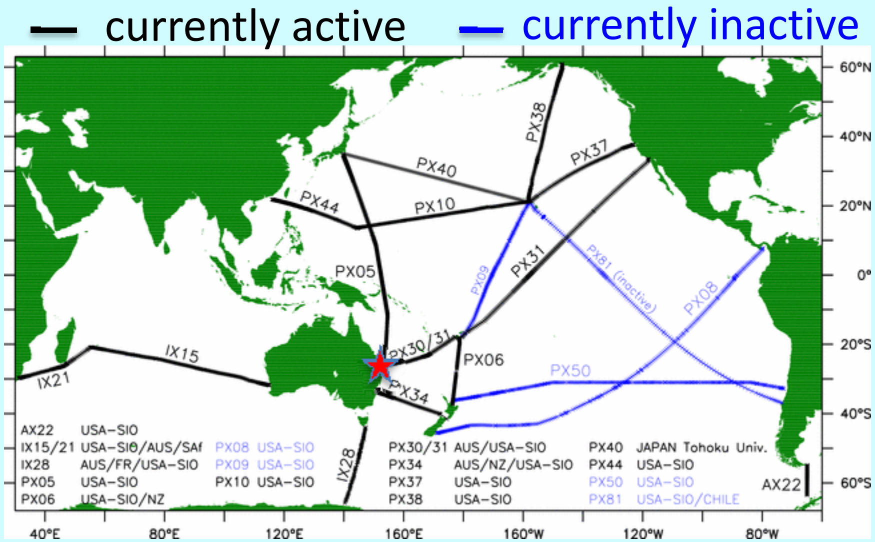


Method

HRX

- ❑ Jan2004-Dec2012 (3-4 transects/yr)
  PX30 (AUS/SIO) 32 transects (1991)

- ❑ spatial transect sampling resolution of 30-40 km along track increasing to 10 km near boundaries



Argo

- ❑ Jan2004-Dec2012 Argo float profiles [Roemmich and Gilson., 2009]

- ❑ Average of 20-50 floats per 1° x 1° bins in the Tasman Sea
  "High resolution" 11 points per depth level (instead of 100) in the linear fit

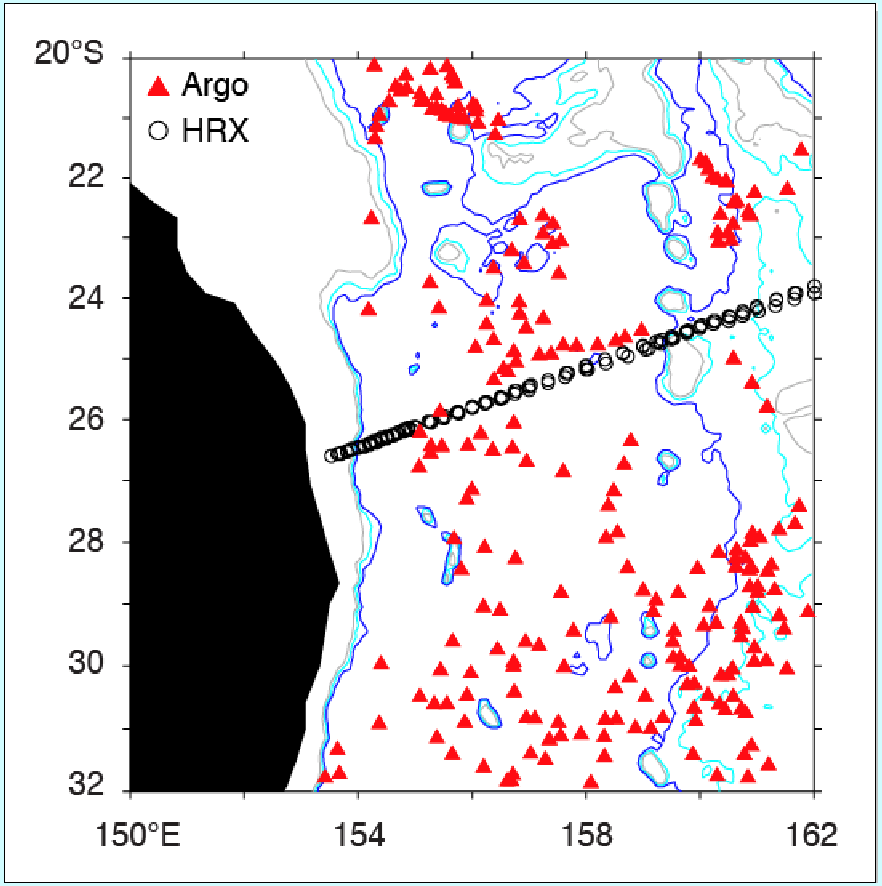
- ❑ Argo trajectories
  binned over 3°(latitude) x 0.5° (longitude) bins

Altimetry

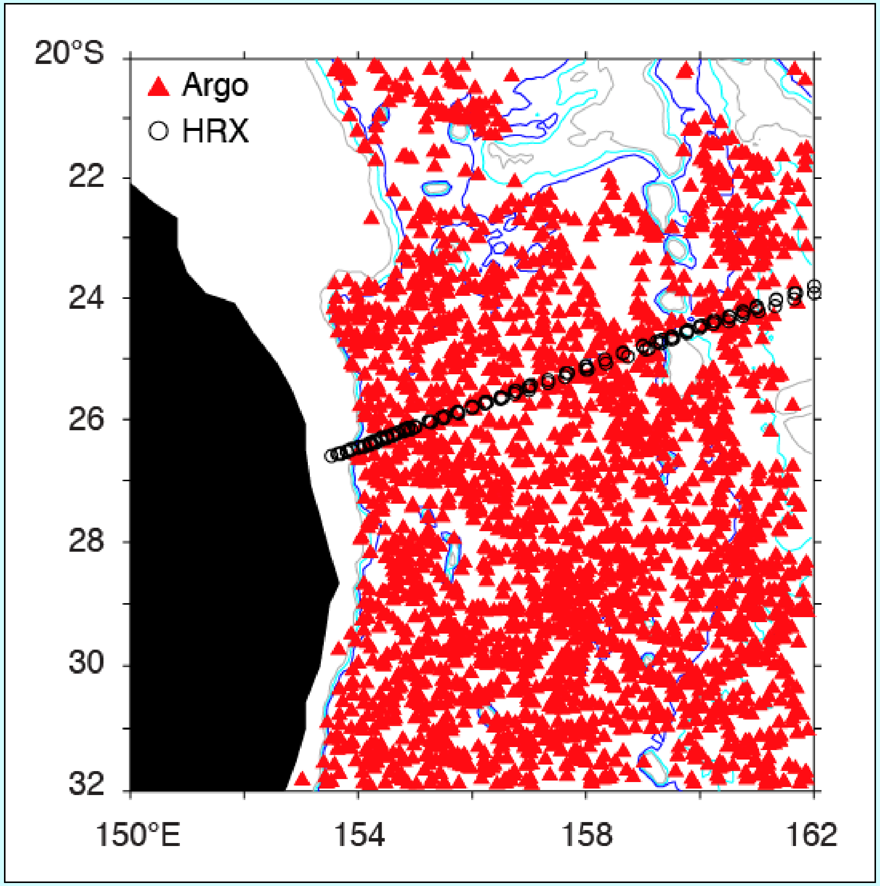
- ❑ Ssalto/Duacs weekly fields projected onto a 1/3° x 1/3° grid

- ❑ SSH anomaly relative to 1993-1999 adjusted to a 2004-2012 mean

Argo and XBT profiles for 2010

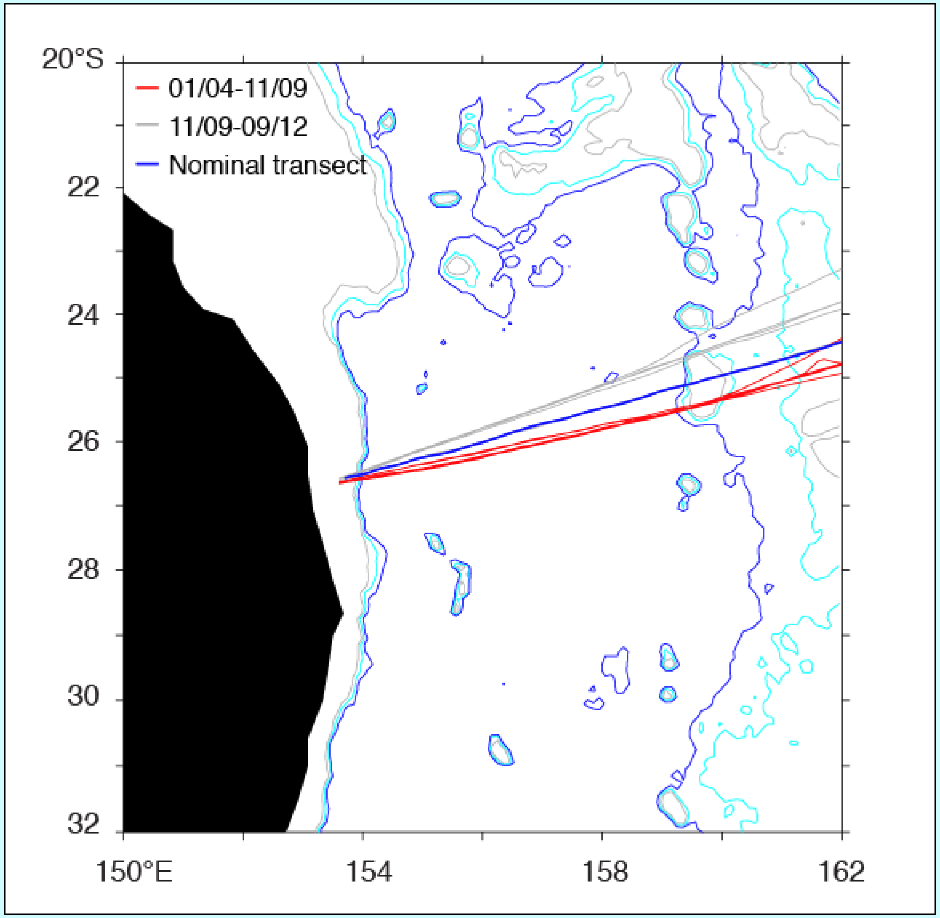


Argo profiles for 2004-2012 and XBT profiles for 2010



Argo accumulates many profiles in WBC regions, but HRX transects obtain much denser coverage along selected lines. HRX sampling extends further shoreward than Argo (in shallow region and strong EAC shear).

Combining XBT and Argo

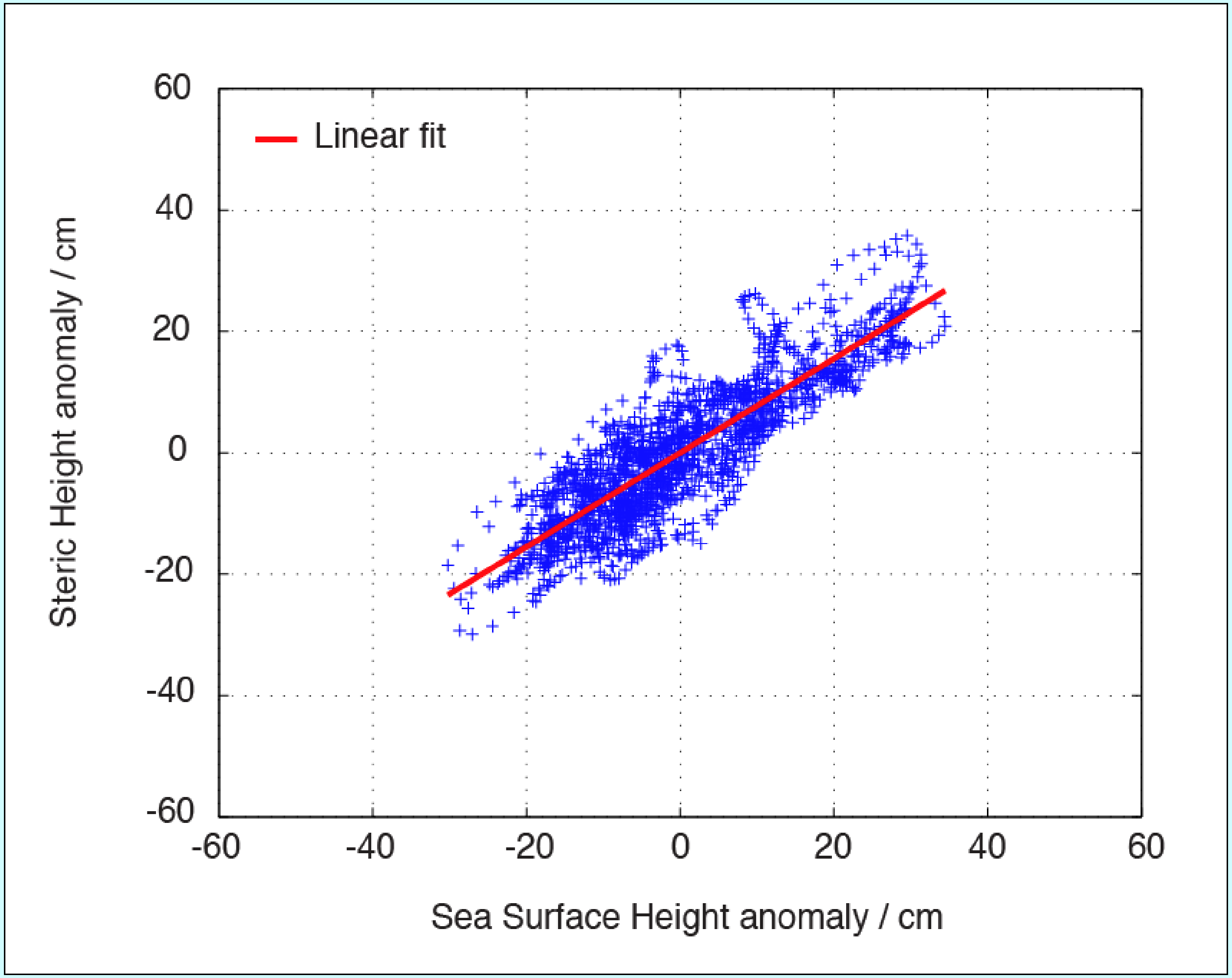


XBT temperature profiles along each track are projected onto a nominal transect using Argo map of temperature.

XBT shear below 800 m depth inferred using Argo shear along nominal transect.

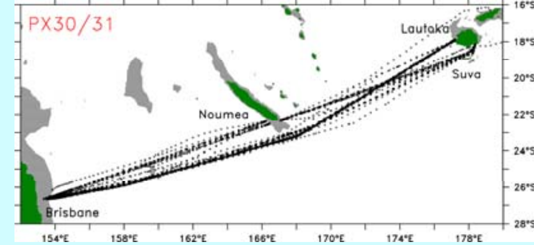
XBT absolute velocity computed using Argo trajectories.

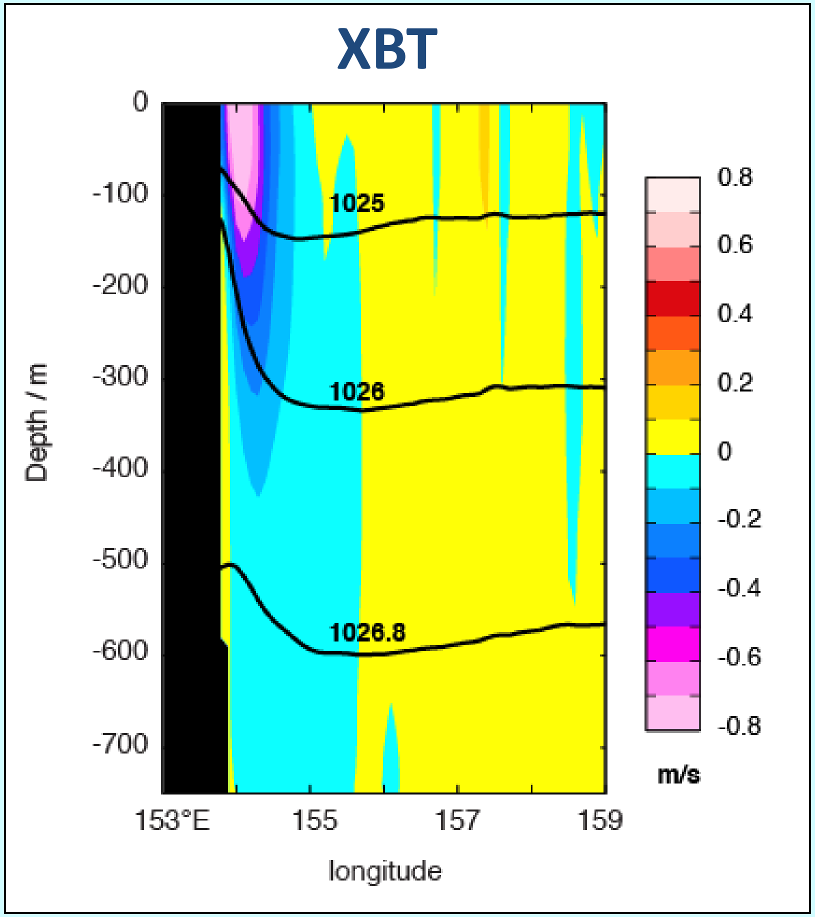
Combining XBT and Altimetry

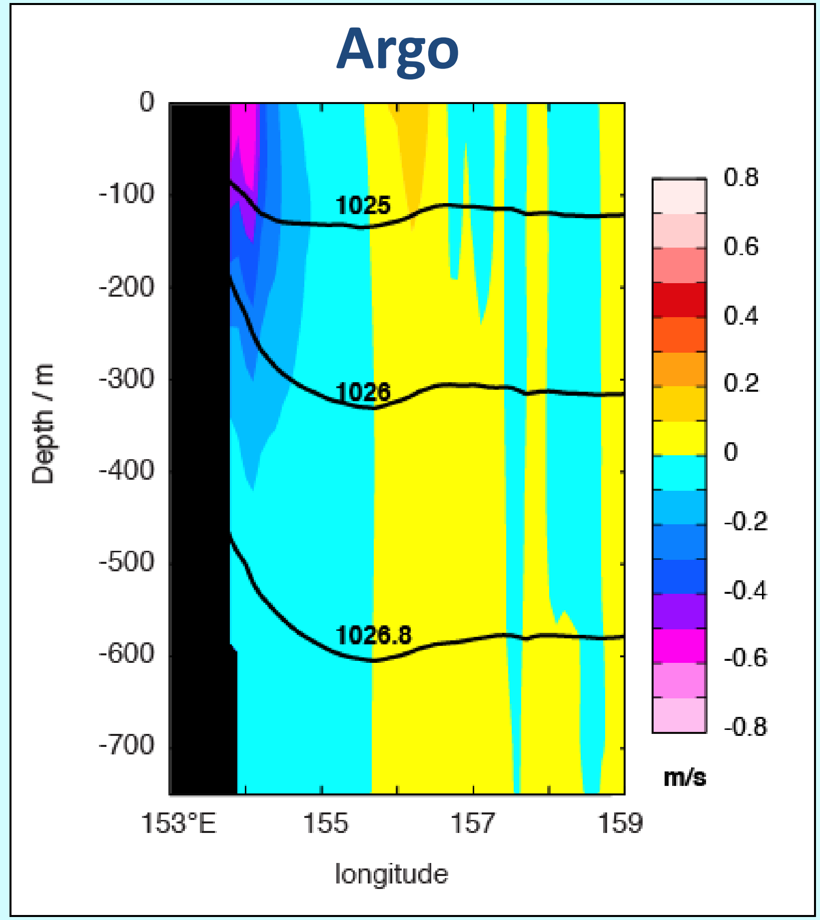


Coefficient of determination is 0.75 west of 159°E (in the EAC region)
~ 75% of the variance of the steric height is explained by the altimetry

Geostrophic velocity relative to 800 m near Brisbane

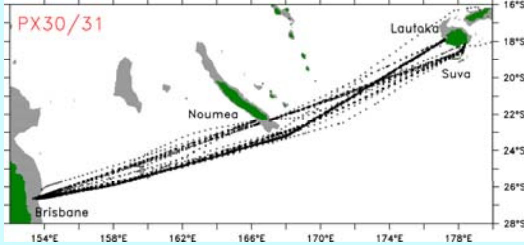


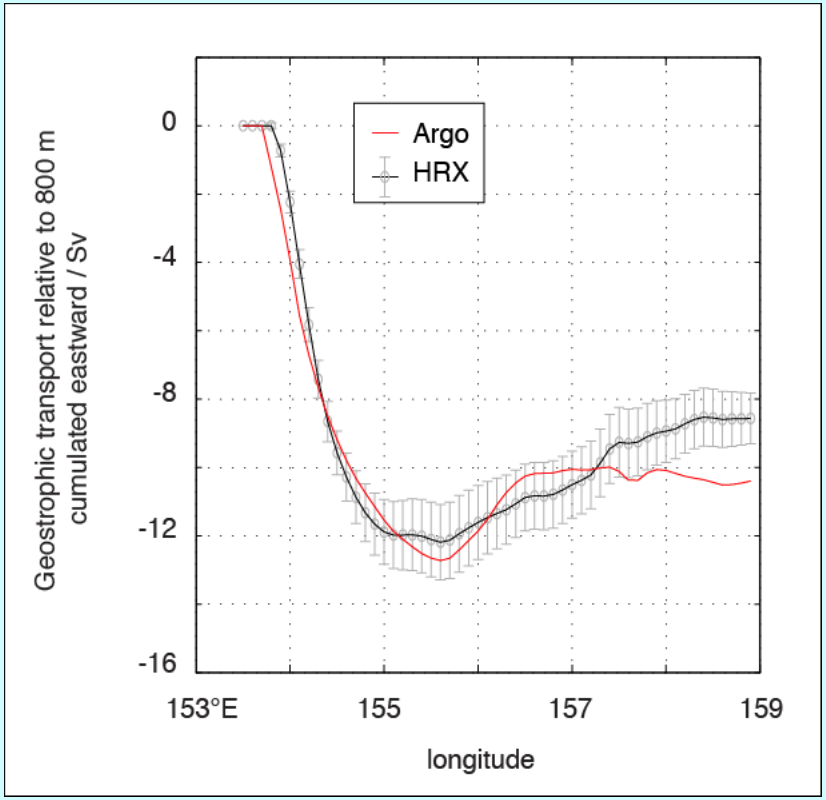


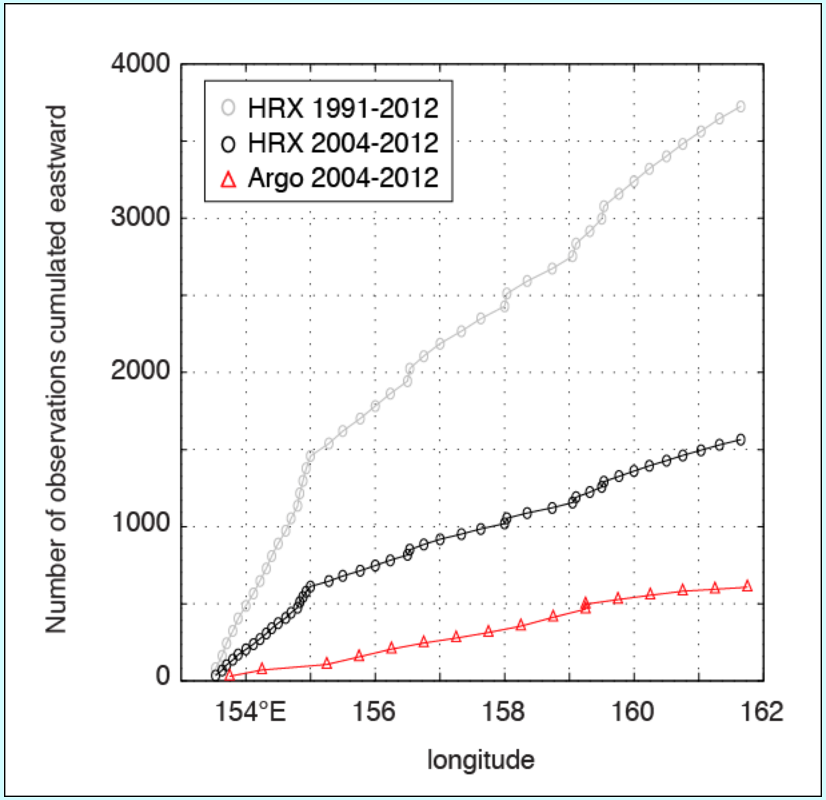


The core of the EAC is of greater magnitude using XBT than Argo.
The offshore limit of the EAC extends further offshore using Argo than XBT.

0-800 m Geostrophic transport near Brisbane

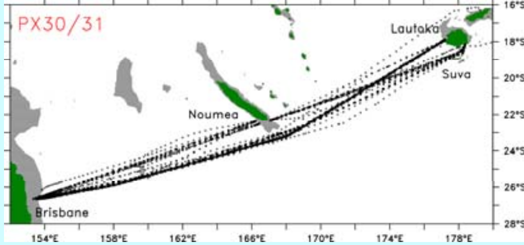




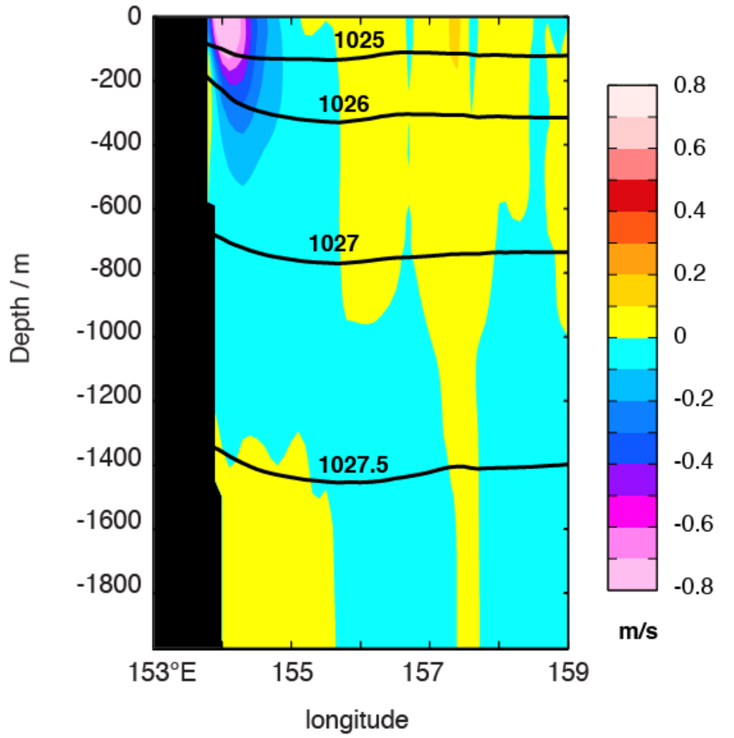


0-800 m EAC transport is 12 Sv using XBT and Argo. For estimating geostrophic shear across the given track in the upper 800 m, HRX transects have less random error and sampling/coverage bias (from along-current averaging and near-shore data) than Argo.

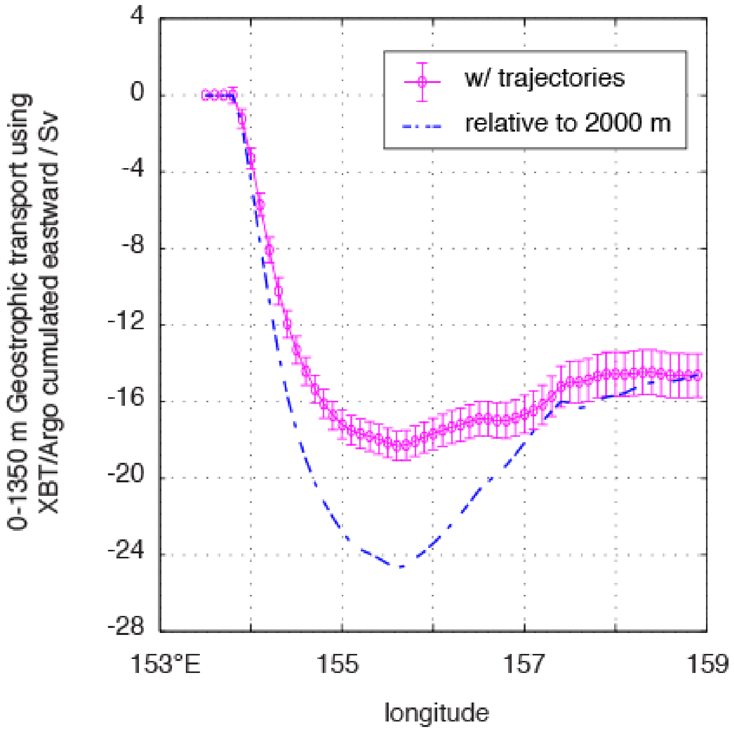
Geostrophic velocity and transport using XBT/Argo near Brisbane



Absolute velocity using XBT/Argo with trajectories

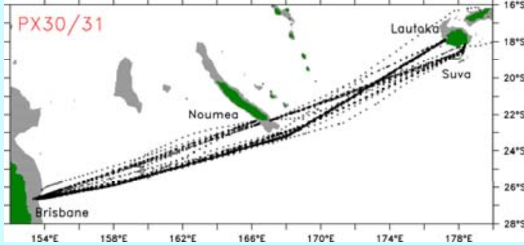


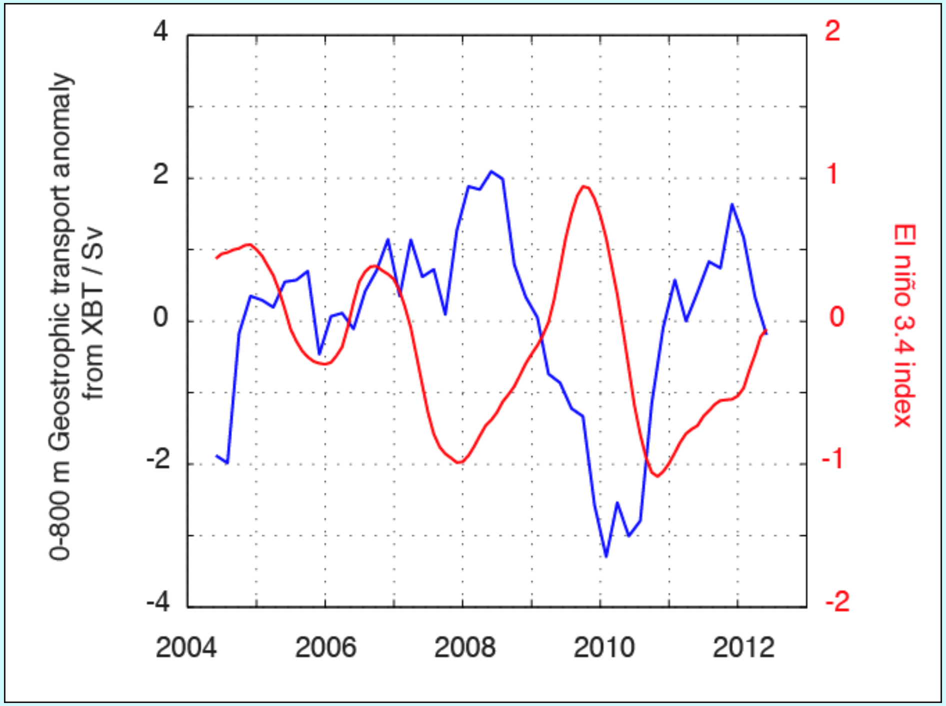
0-1350 m geostrophic transport using XBT/Argo

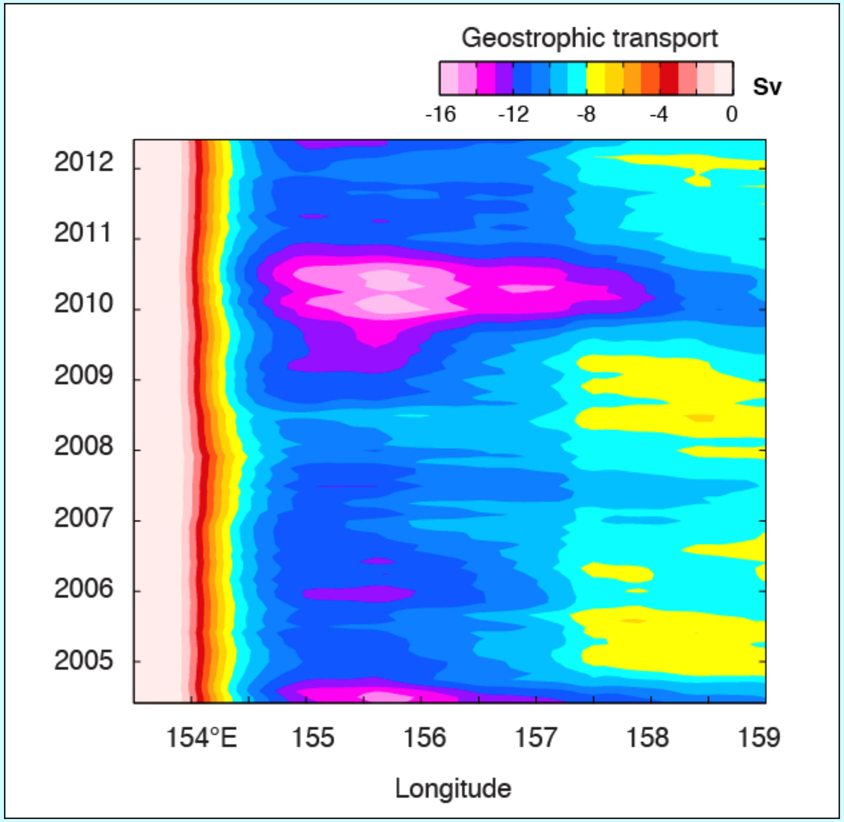


Argo trajectories show less negative velocity than XBT/Argo velocity at 1000/2000 m. Trajectories “feel” the equatorward undercurrent observed in Mata et al. (2000). 0-1350 m EAC transport west of 155.6°E using XBT/Argo w/ ref velocity from trajectories is 18.3 Sv, 6.3 Sv lower than using a level of no motion at 2000 m.

Time variability of EAC transport using XBT and altimetry

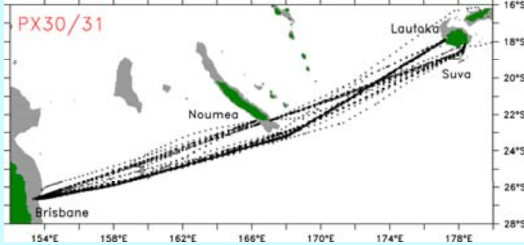


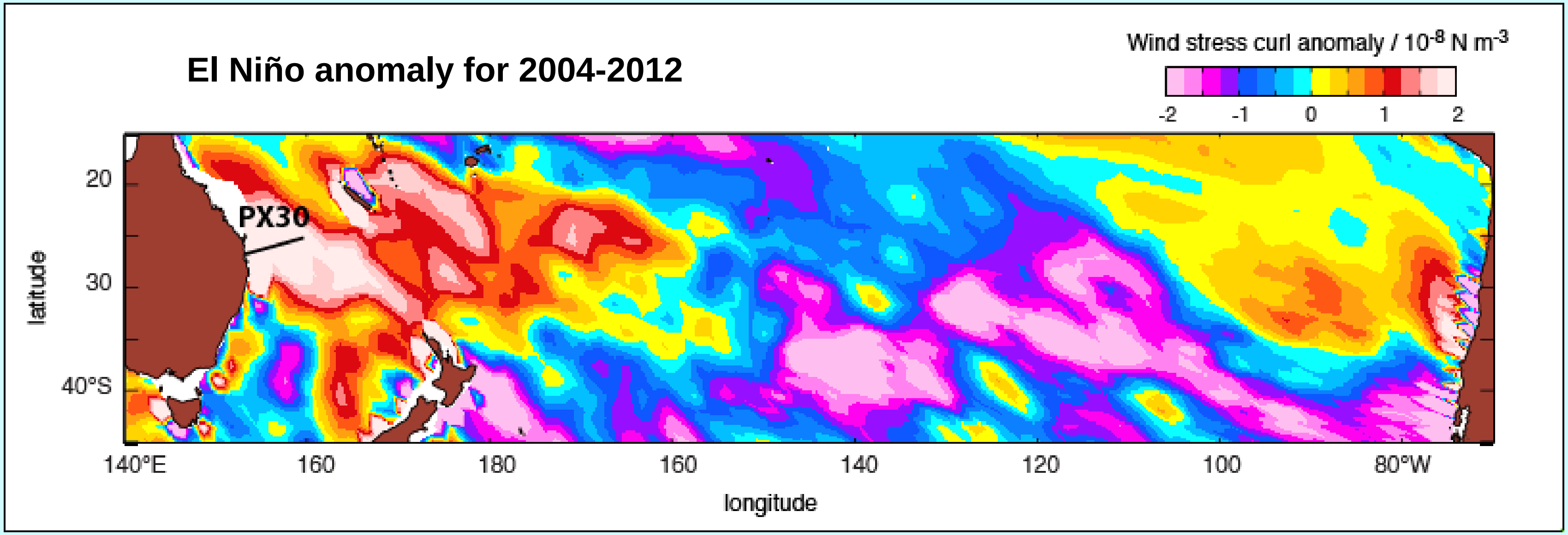




0-800 m geostrophic transport west of 155.5°E computed with XBT/altimetry data shows ± 1.3 Sv variability at interannual time scales. ENSO signature seen in EAC transport anomalies is more evident during strongest El Niño and La Niña events.

Time variability of EAC transport and changes in mid-latitude wind-stress curl related to ENSO





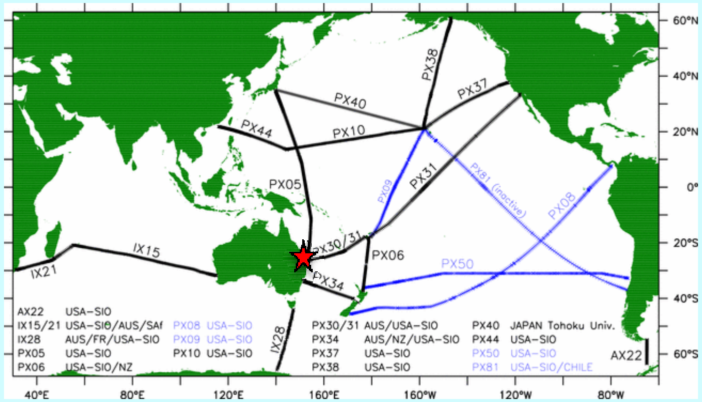
El Niño: wind stress curl is more positive, sea level rises in the western Pacific, poleward EAC transport increases.

La Niña: wind stress curl is less positive, sea level decreases in the western Pacific, poleward EAC transport decreases

Ongoing effort

❑ Extend our analysis to 2013 for the EAC

additional 3-4 transects for PX30



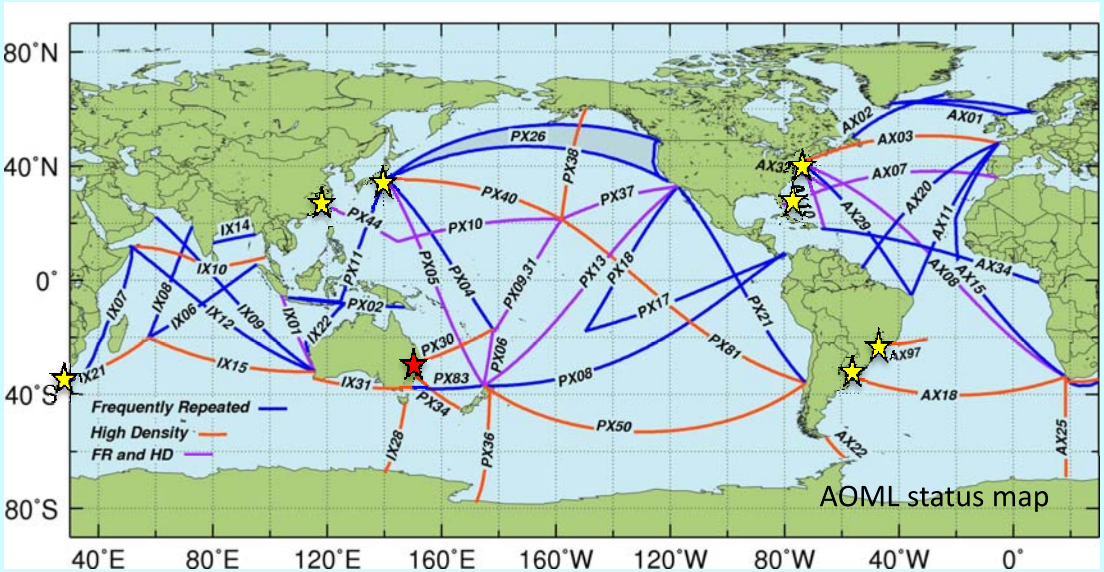
❑ Estimate transport of WBCs of the Atlantic and Indian Ocean for 2004-2013

Kuroshio (Japan/SIO)
PX44 “upstream” (1991-2011) 36 transects
PX05 “downstream” (2009) 13 transects
PX40 “downstream” 30 Transects (1998)

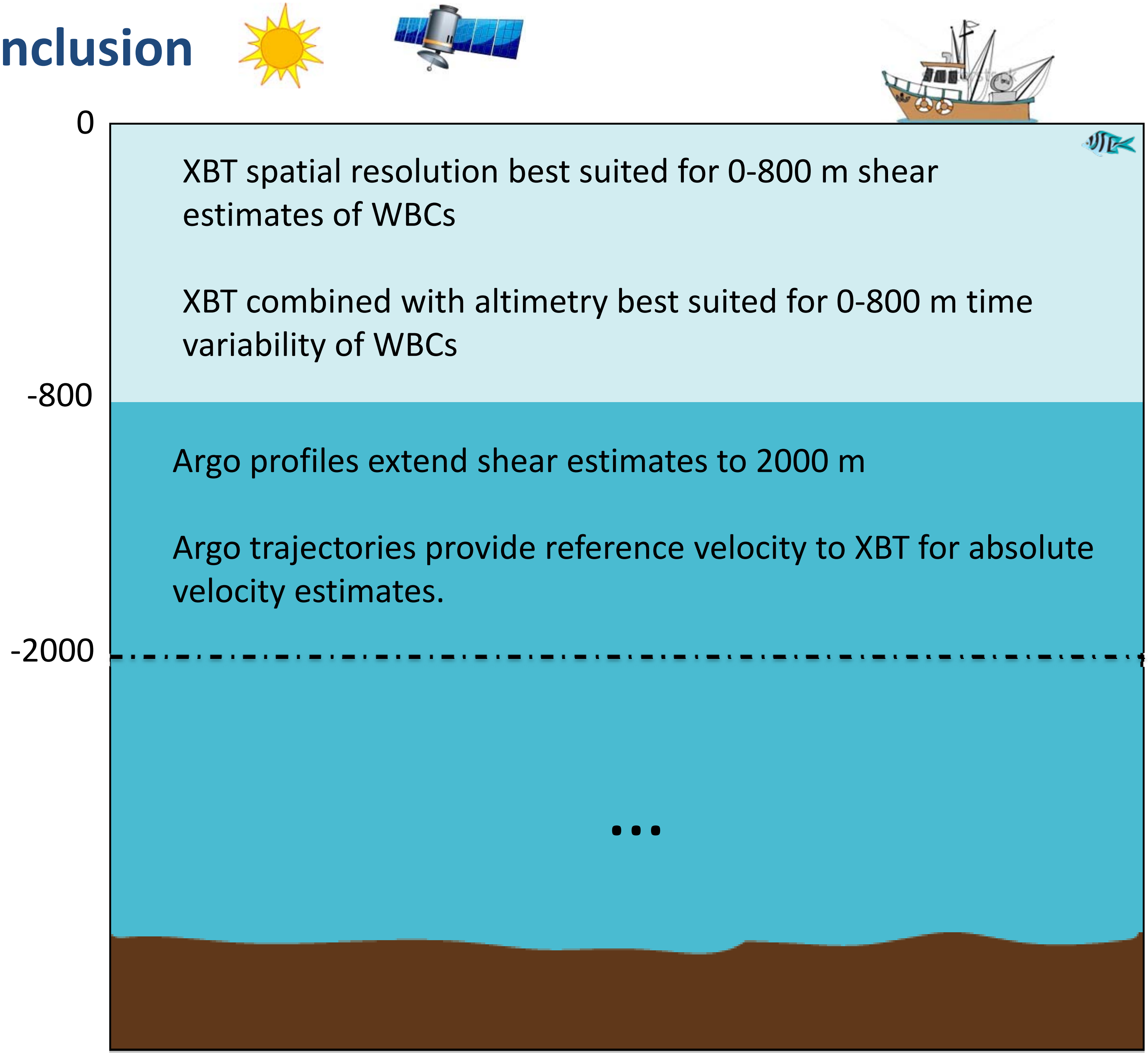
Gulf Stream (AOML)
AX07 “upstream” (1995) 41 transects
AX08 “downstream” (2000) 38 transects

Brazil Current (AOML)
AX97 “upstream” (2004) 33 transects
AX18 “downstream” (2002) 45 transects

Agulhas Current (SIO/AUS/SAf)
IX21 32 transects (1994)



Conclusion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XBT spatial resolution best suited for 0-800 m shear estimates of WBCs
XBT combined with altimetry best suited for 0-800 m time variability of WBCs
-800
Argo profiles extend shear estimates to 2000 m
Argo trajectories provide reference velocity to XBT for absolute velocity estimates.
-2000
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