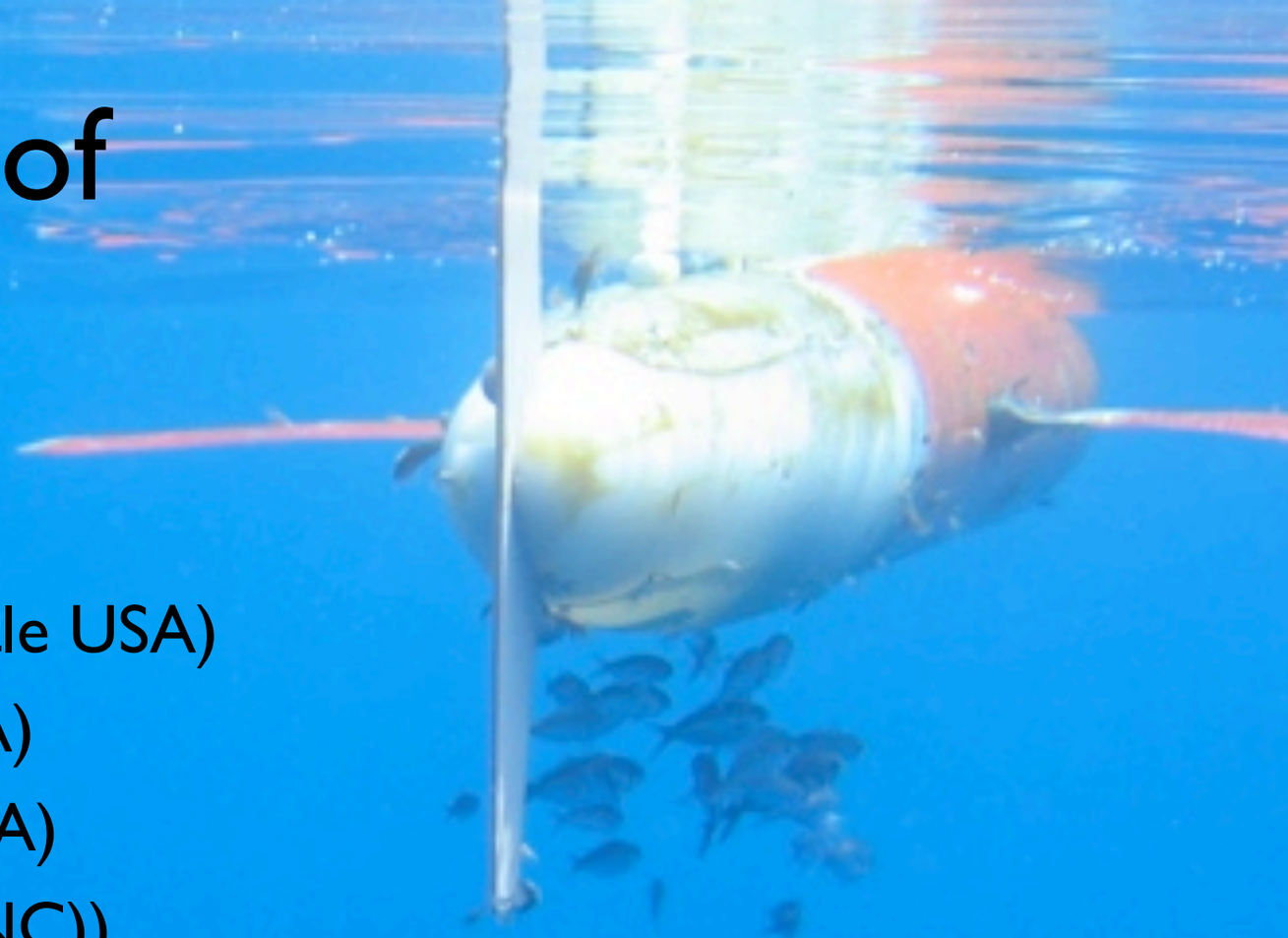
Glider time series of Solomon Sea transport

William S. Kessler (NOAA/PMEL, Seattle USA)
Russ Davis (Scripps, La Jolla USA)
Jeff Sherman (Scripps, La Jolla USA)
(Lionel Gourdeau (IRD, Nouméa, NC))



Motivated by the western boundary ambiguity in McPhaden and Zhang (2002, 2004).

- Build a time series of NGCU transport for ENSO studies
- Test the use of gliders for longterm monitoring of WBCs

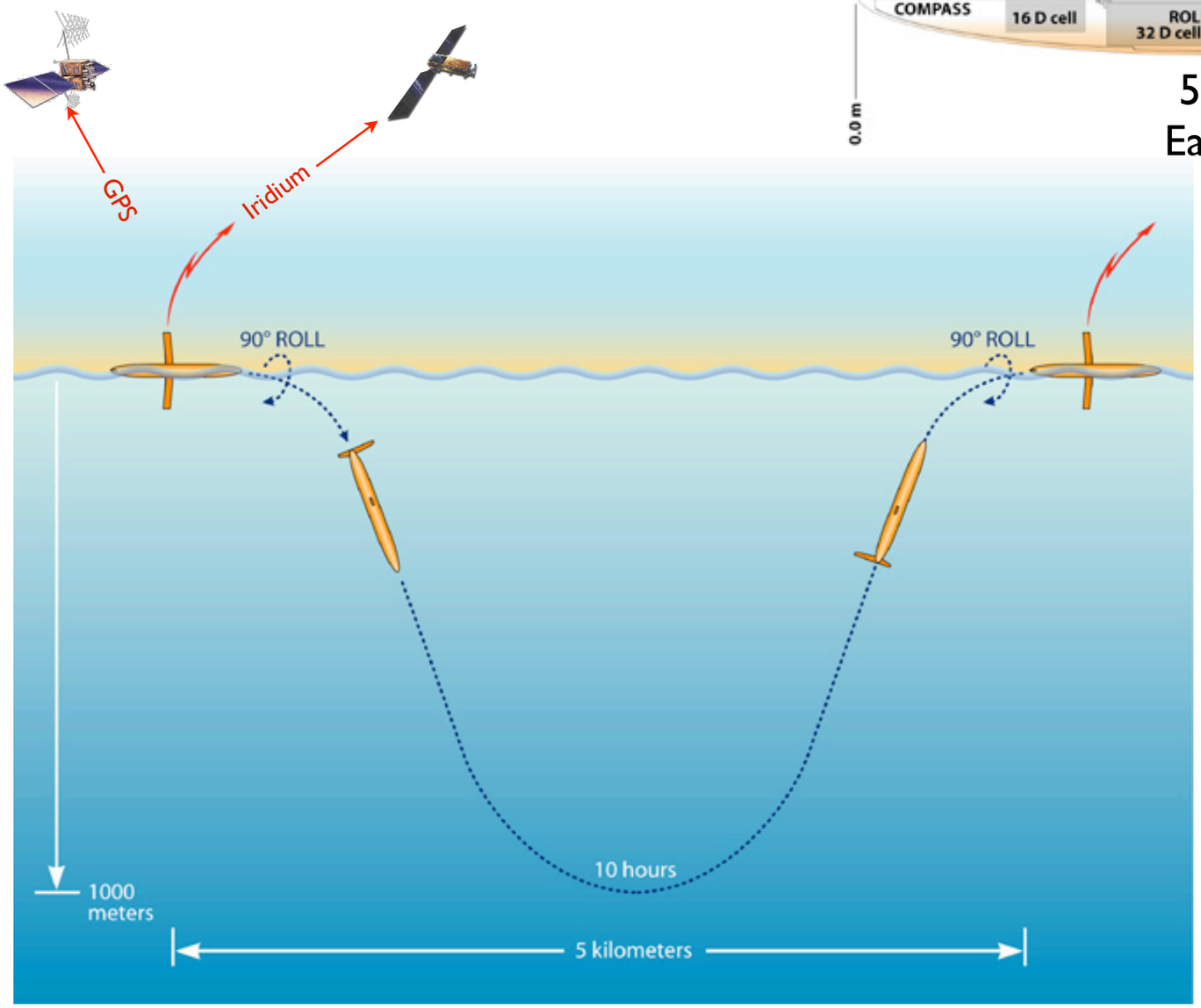
Davis, R.E., W.S. Kessler and J.T. Sherman, 2012: Gliders measure western boundary current transport from the South Pacific to the equator. *J.Phys.Oceangr.*, 42(11), 2001-2013.

Collaborators:

- IRD Nouméa + Toulouse
- Solomon Islands Meteorological Service
- University of Papua New Guinea
- Bureau of Meteorology (Australia)

The Spray glider is essentially an Argo float with wings and movable batteries

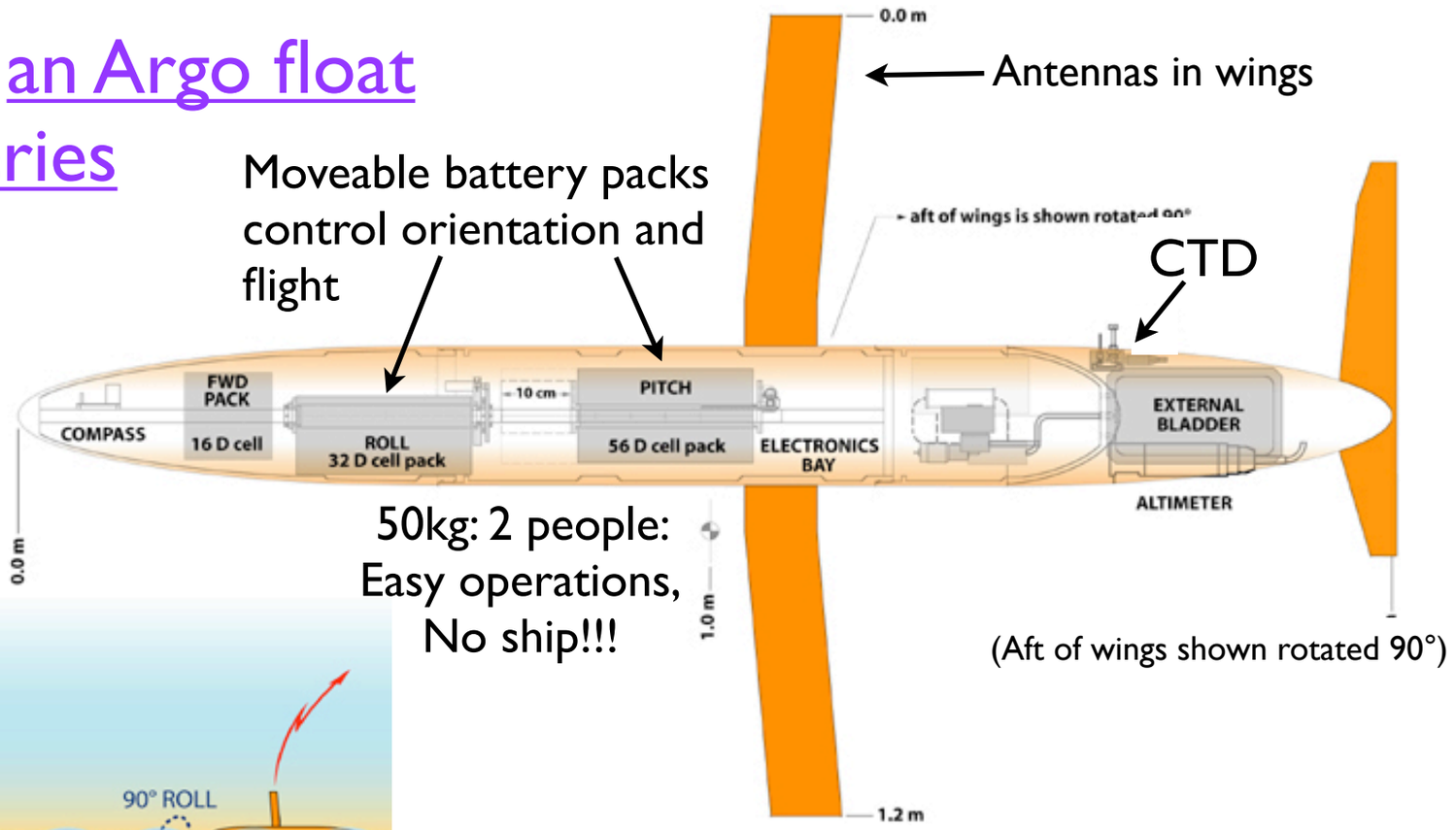
The Spray glider is developed and built by the Instrument Development Group at Scripps.



← 500-1000 m →

← 3 km (3-4 hr) →

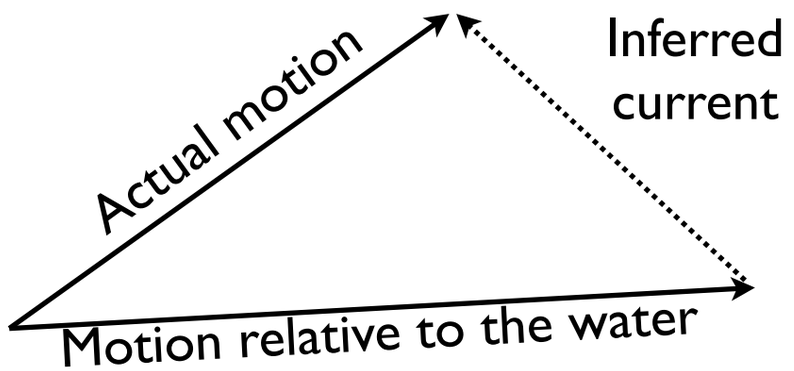
Range 4-5 months at 20 cm/s = 2500+km



Very dense sampling (~ resolve tides)

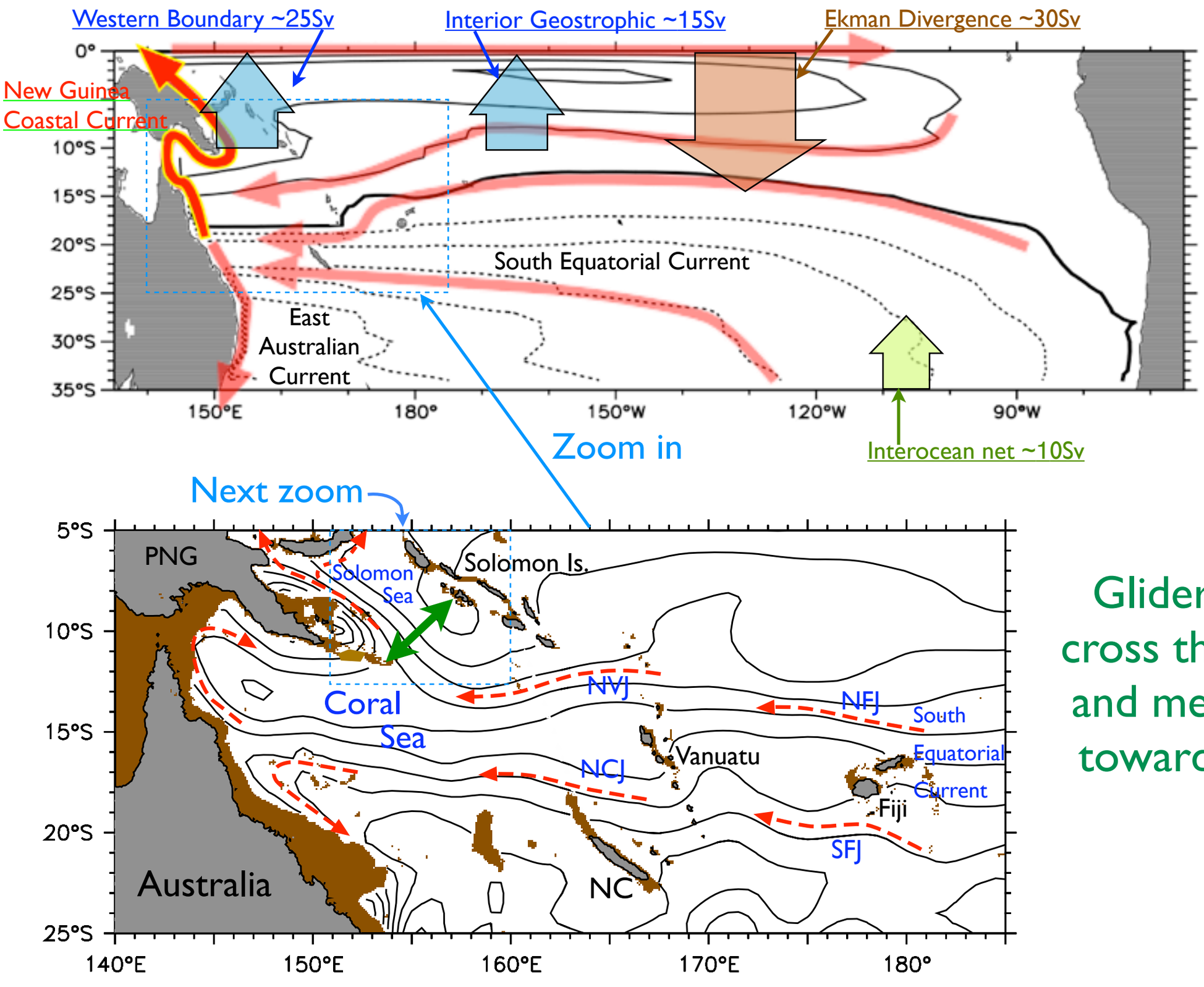
Argo-comparable T-S profiles:
geostrophic relative currents

Infer vertical-average absolute currents by the glider's drift:



Not so simple in practice...

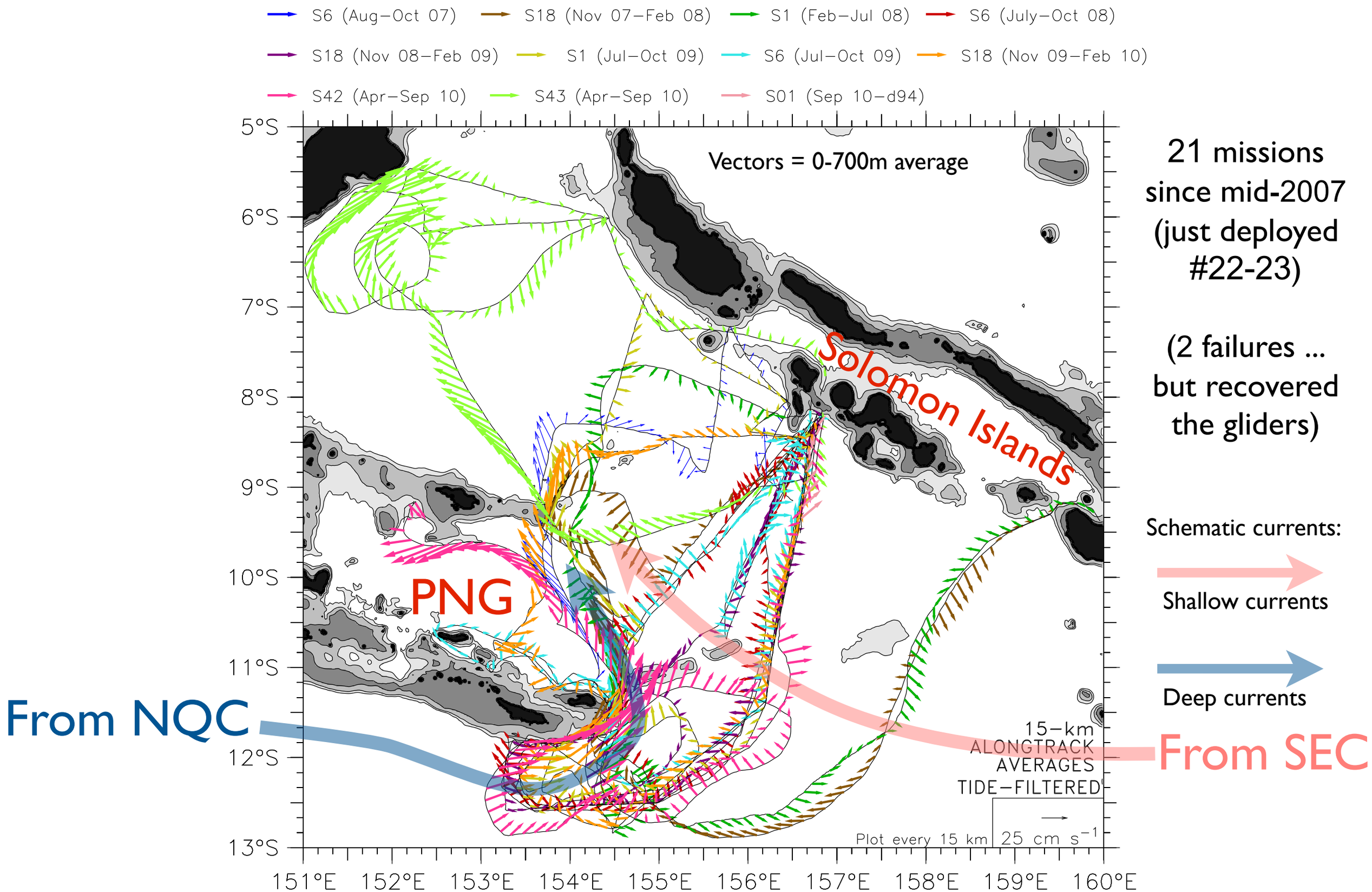
South Pacific average circulation



Island Rule (ERS winds)

Glider experiments cross the Solomon Sea and measure the flow towards the equator.

Glider currents in the Solomon Sea (through 2010 = half the data)



21 missions since mid-2007 (just deployed #22-23)

(2 failures ... but recovered the gliders)

Schematic currents:

Shallow currents

Deep currents

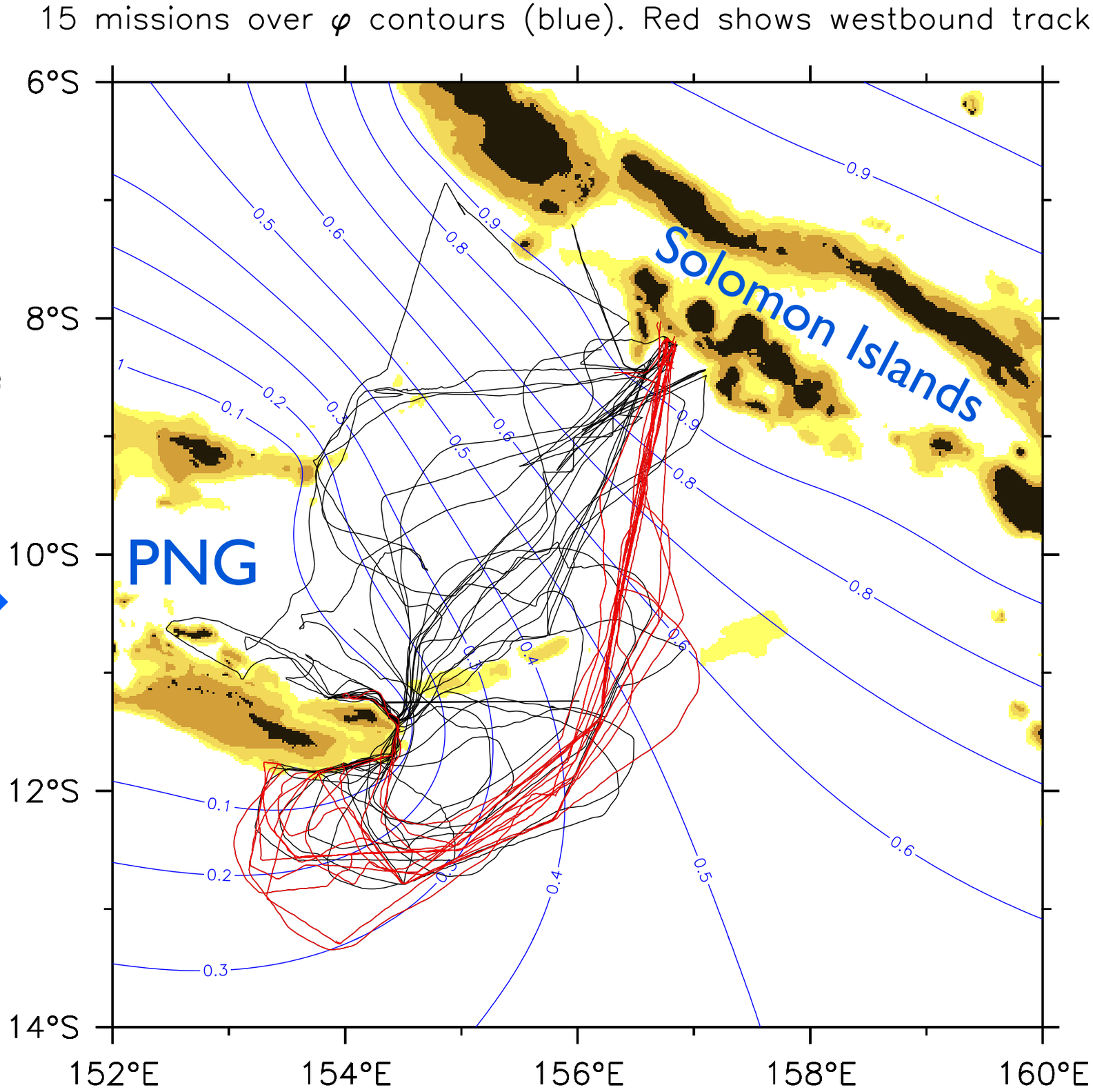
Davis, Kessler and Sherman (2012)

How to be quantitative with the irregularly-distributed glider tracks?

Define a function Φ,
such that: $\nabla^2\Phi=0$, and:
$\Phi=0$ at PNG coast,
$\Phi=1$ at Solomons coast.
Φ is a scaled cross-Sea distance
Consider velocity parallel
to Φ contours "equatorward".

Φ contours are in blue →

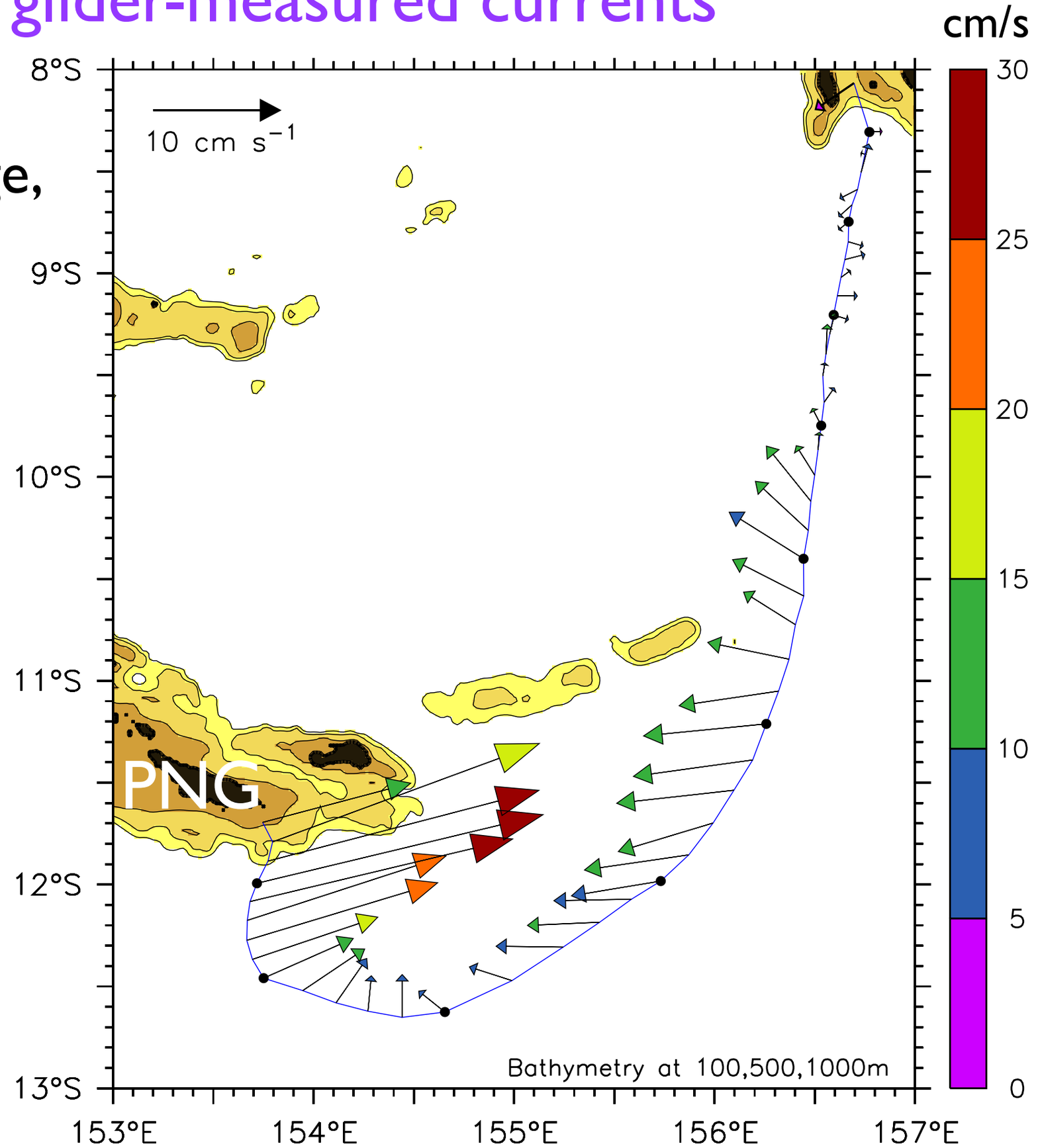
Choose 15 near-repeat
westbound tracks (red).



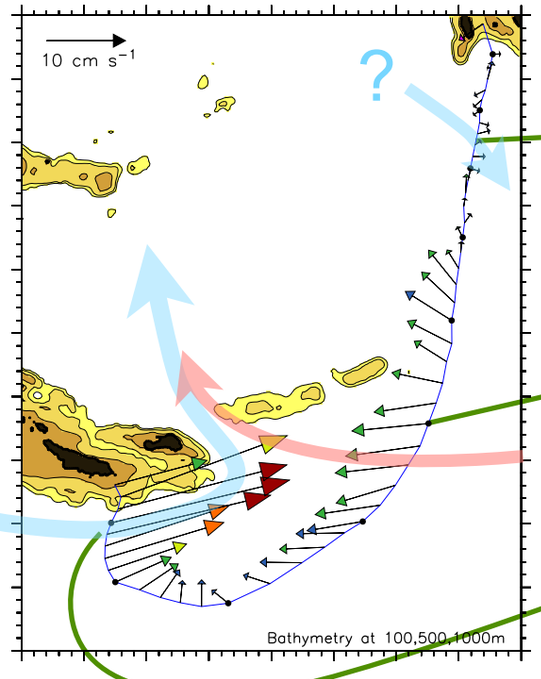
Mean glider-measured currents

0-700m vertical average, averaged on Φ

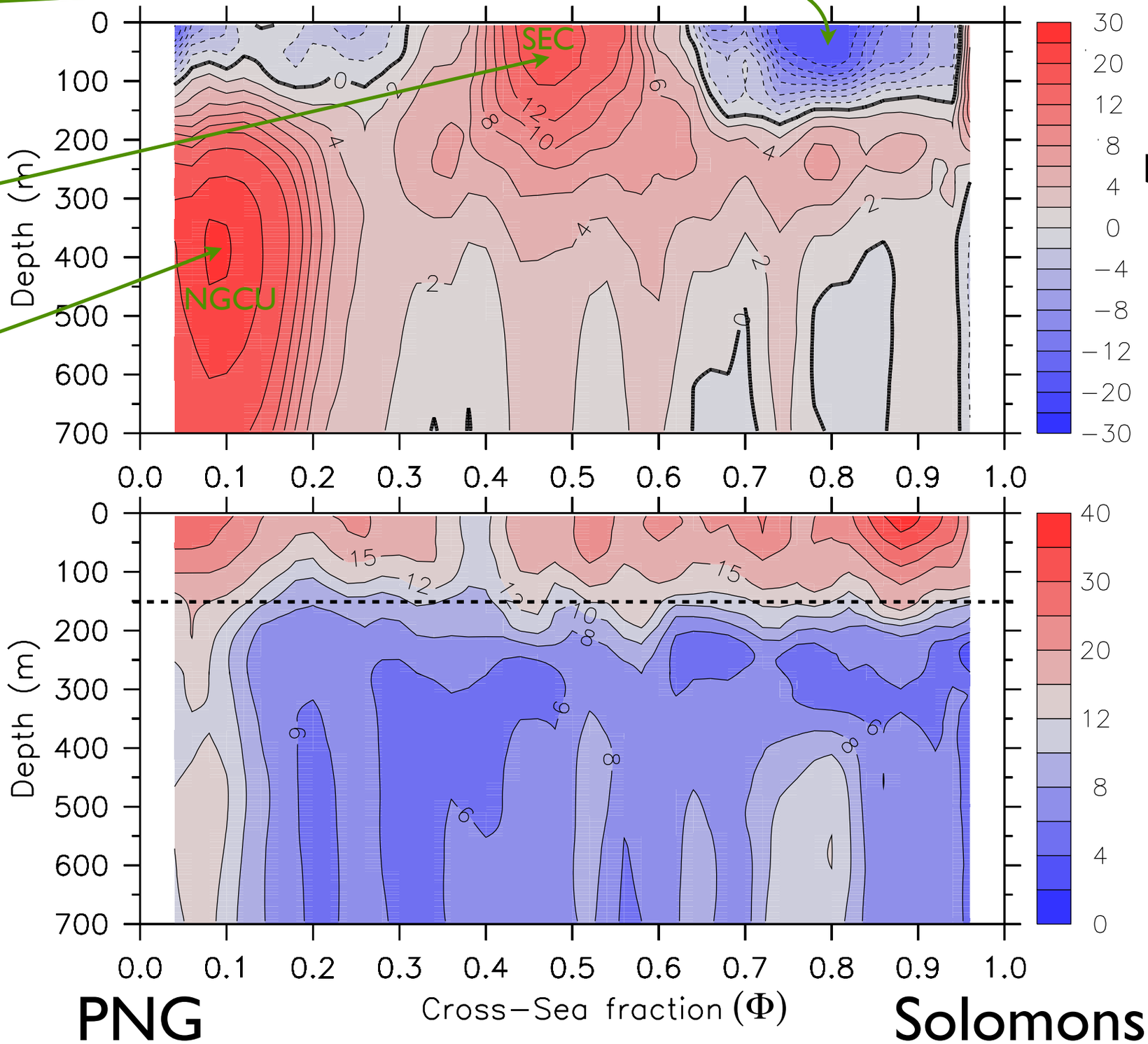
Westbound ~repeated track,
July 2007-Dec 2012



Crosstrack current at the mouth of the Solomon Sea



Aug 2007-Dec 2012



Mean
(red=eq-ward, blue=poleward) (cm/s)

RMS
(red=large, blue=small)

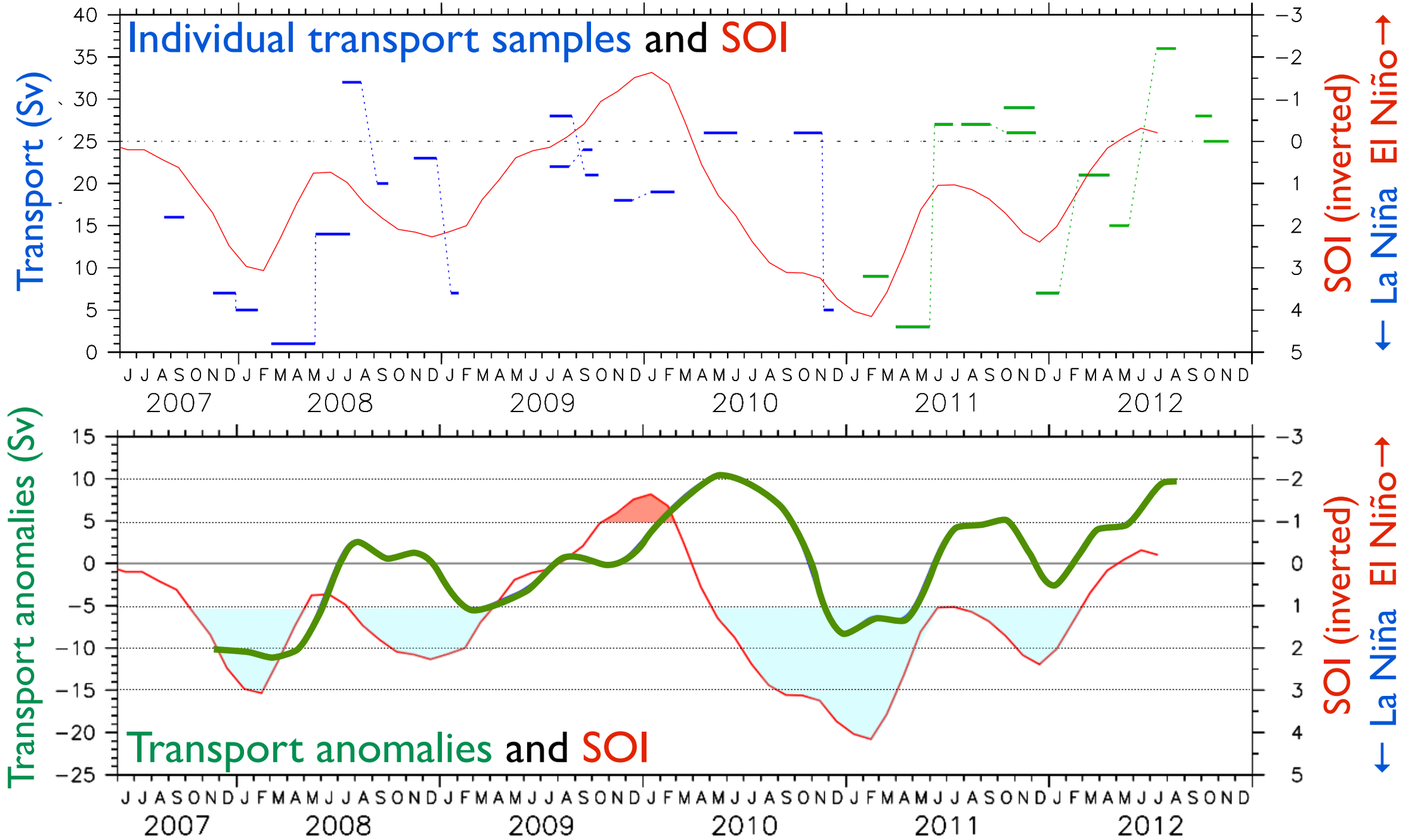
Largest variability:
→ above 150m
→ in the NGCU

Upper signal closely tied to ENSO (Davis et al 2012)

Westbound track, July 2007-Dec 2012

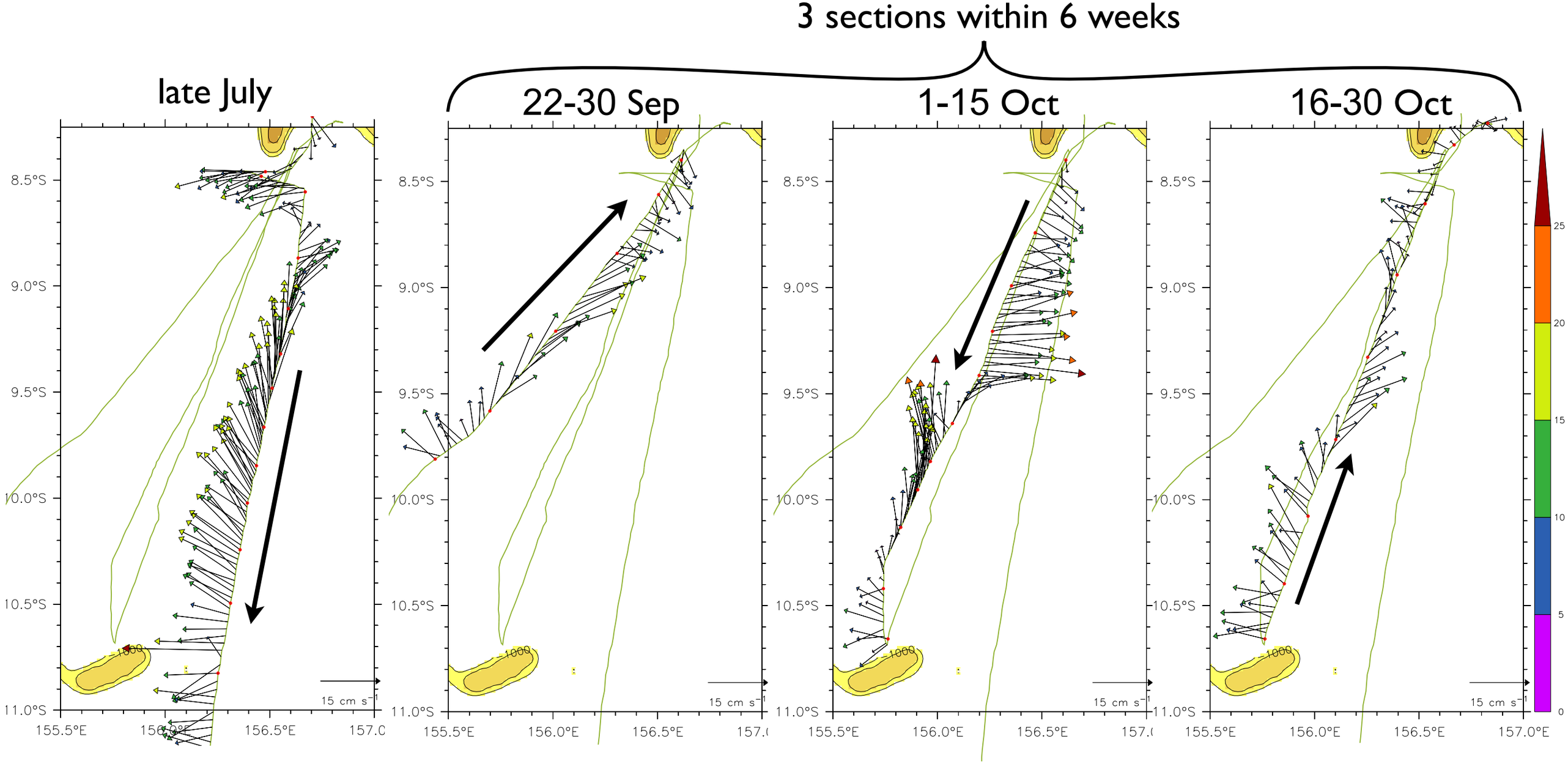
Solomon Sea transport has a strong ENSO cycle

Lags SOI by "a few months"



Transport increases during El Niño and decreases during La Niña.
Interannual RMS = 6 Sv, large events ±10 Sv

Repeat sections in July-October 2009

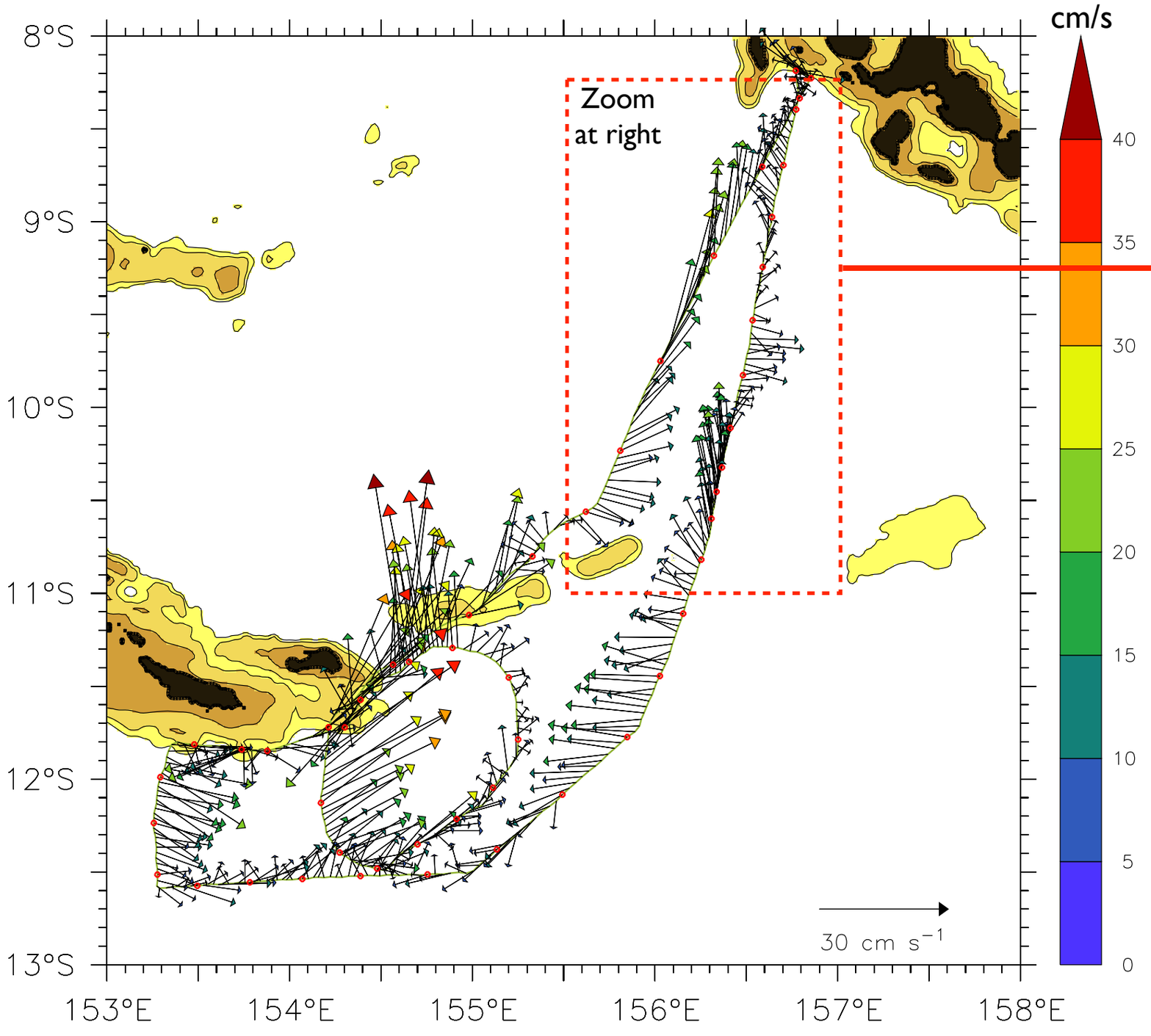


Repeat sections show timescales of evolution over 6 weeks.
Large changes are evident in short times,
these tend to be mesoscale (O(100km)).

What about sub-mesoscale-scale motion?

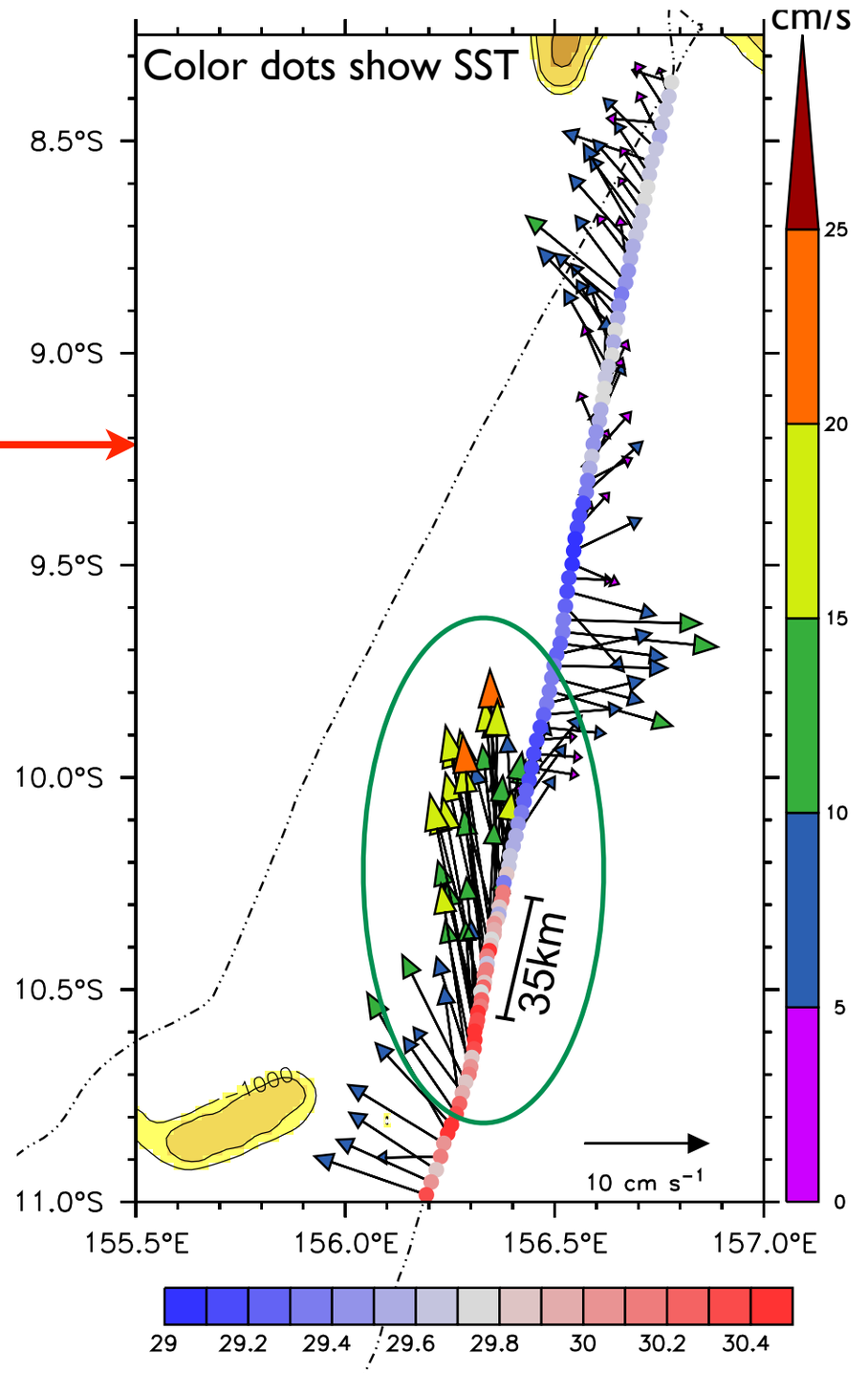
Mission 7 (08B018) Nov 2008-Jan 2009

Individual dive 0-700m velocity



Large-scale features are evident, what about small?

"Squirt" at SST front



Modeling!

Conclude

Gliders are an efficient means to monitor current systems

* with scales small enough that their slow speed
  does not alias time and space: 100km ~ 5 days crossing time,

* and where their 3-4km sampling is useful

⇒ Boundary currents (E and W)

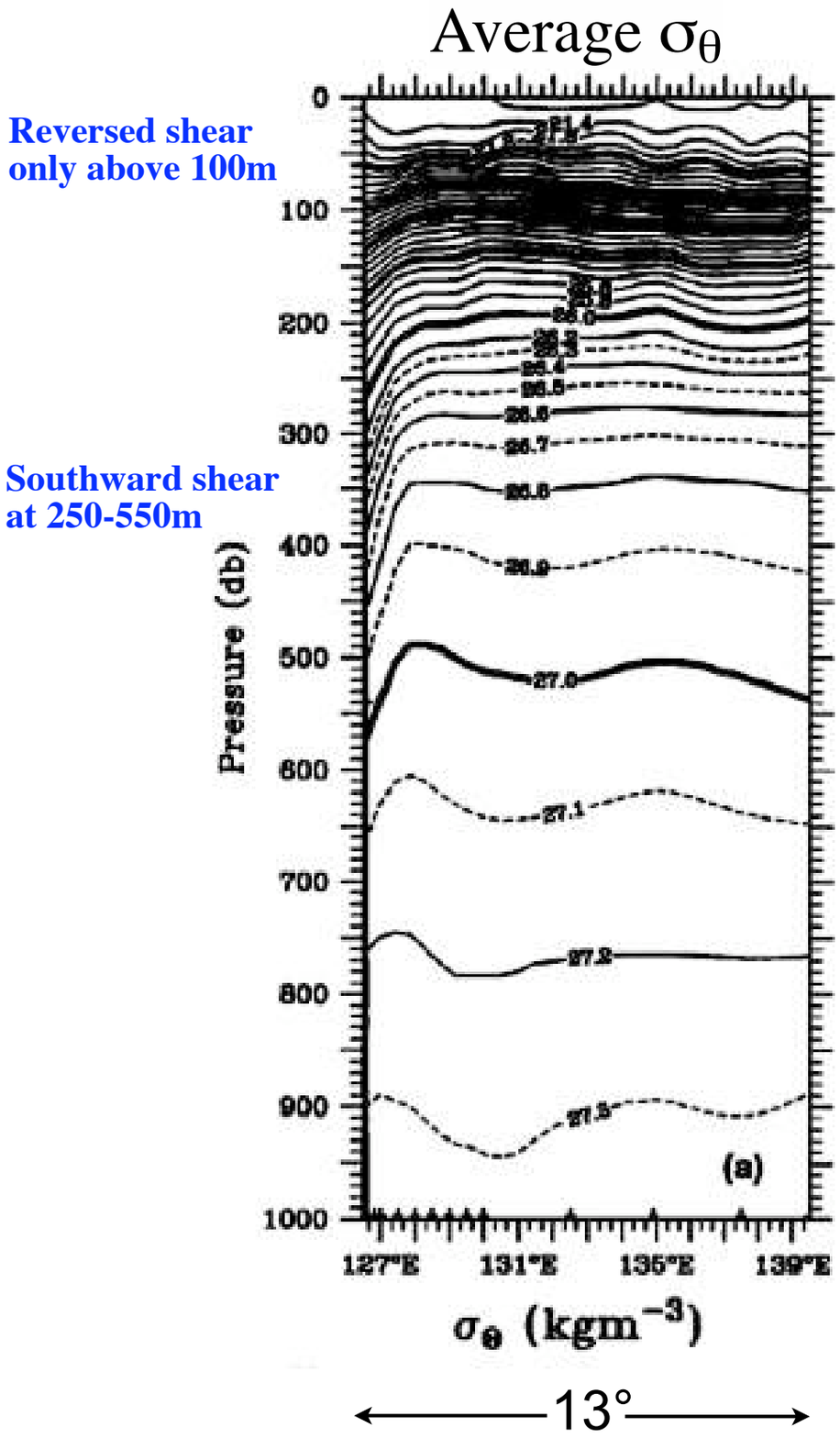
The gliders give unprecedented resolution of the NGCU and the western boundary contribution to the ENSO cycle.
The WBC ENSO signal is large (larger than expected): ±10 Sv
Two distinct sources of equatorward flow: shallow and deep.

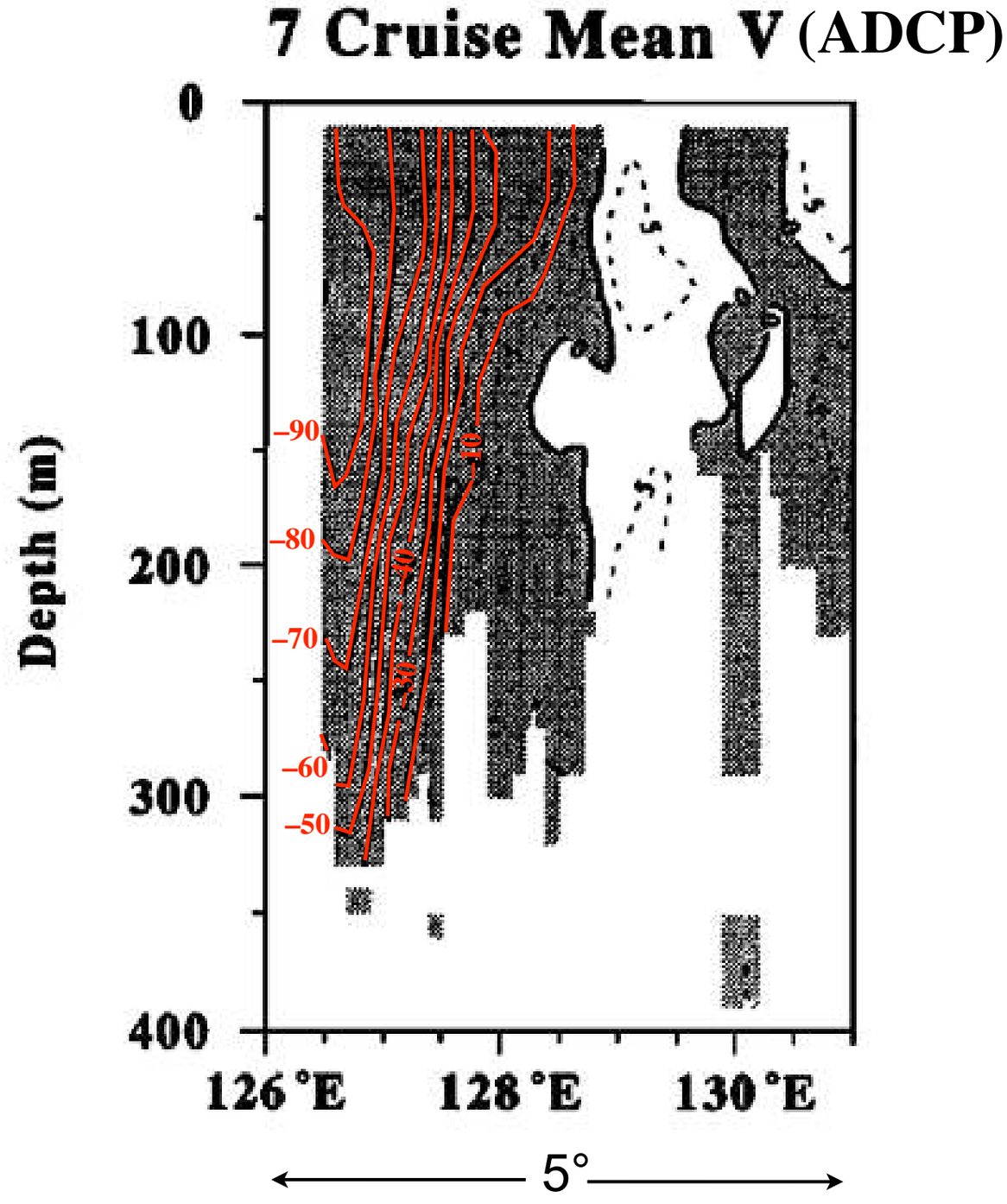
Glider data (with model collaboration) is elucidating the small-scale variability that produces mixing in the WBC, modifying the water properties carried to the equatorial cold tongue. The Solomon Sea is not just a pipe.

Extra slides below

By contrast,

the Mindanao Current is surface-trapped, and shallow

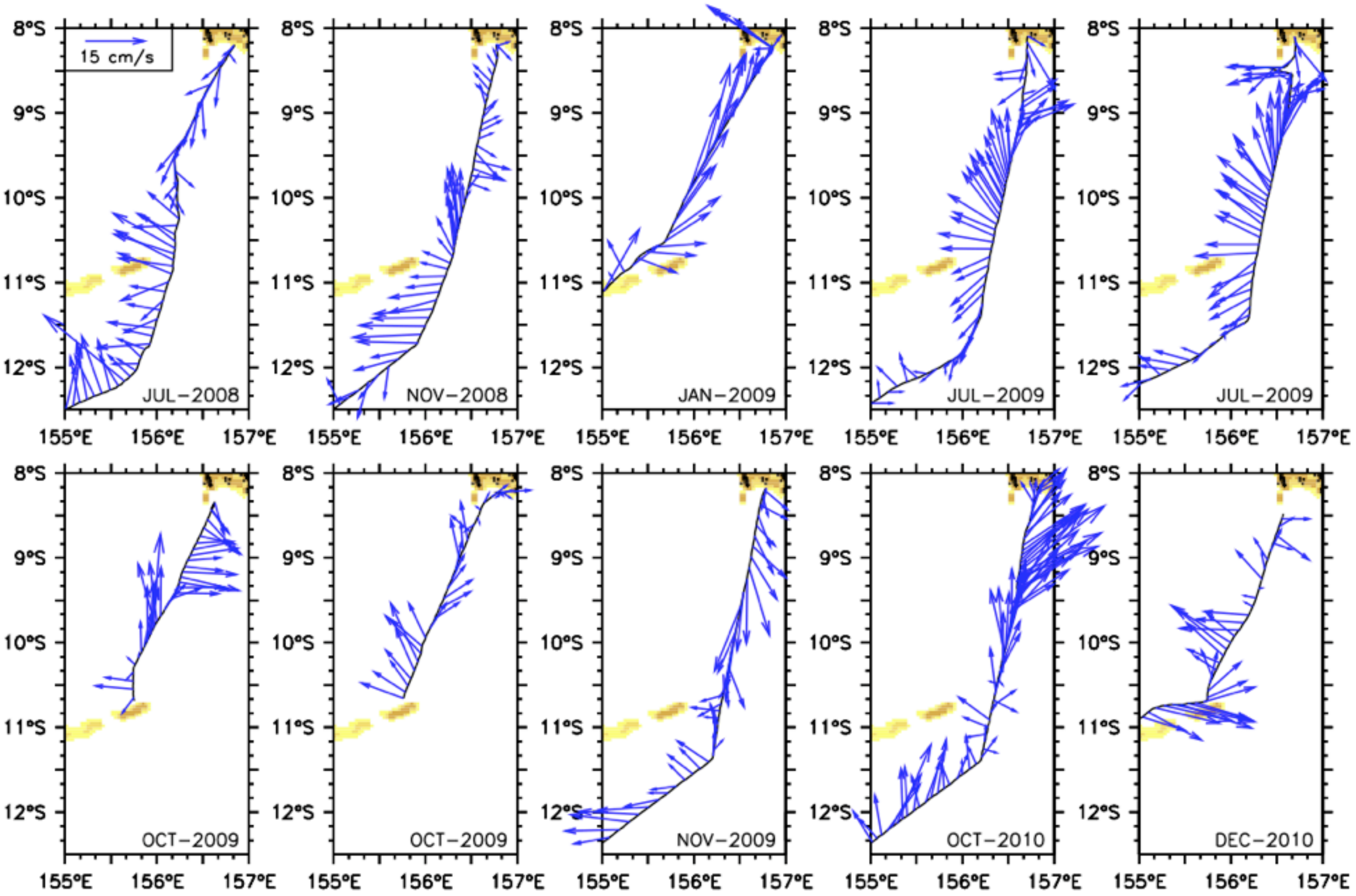




Wijffels, Firing and Toole (1995)

Repeat tracks: strong short-timescale variability in the east

Appears to be dominated by mesoscale (1-200km) eddies with irregular westward motion



PIES moorings deployed in February

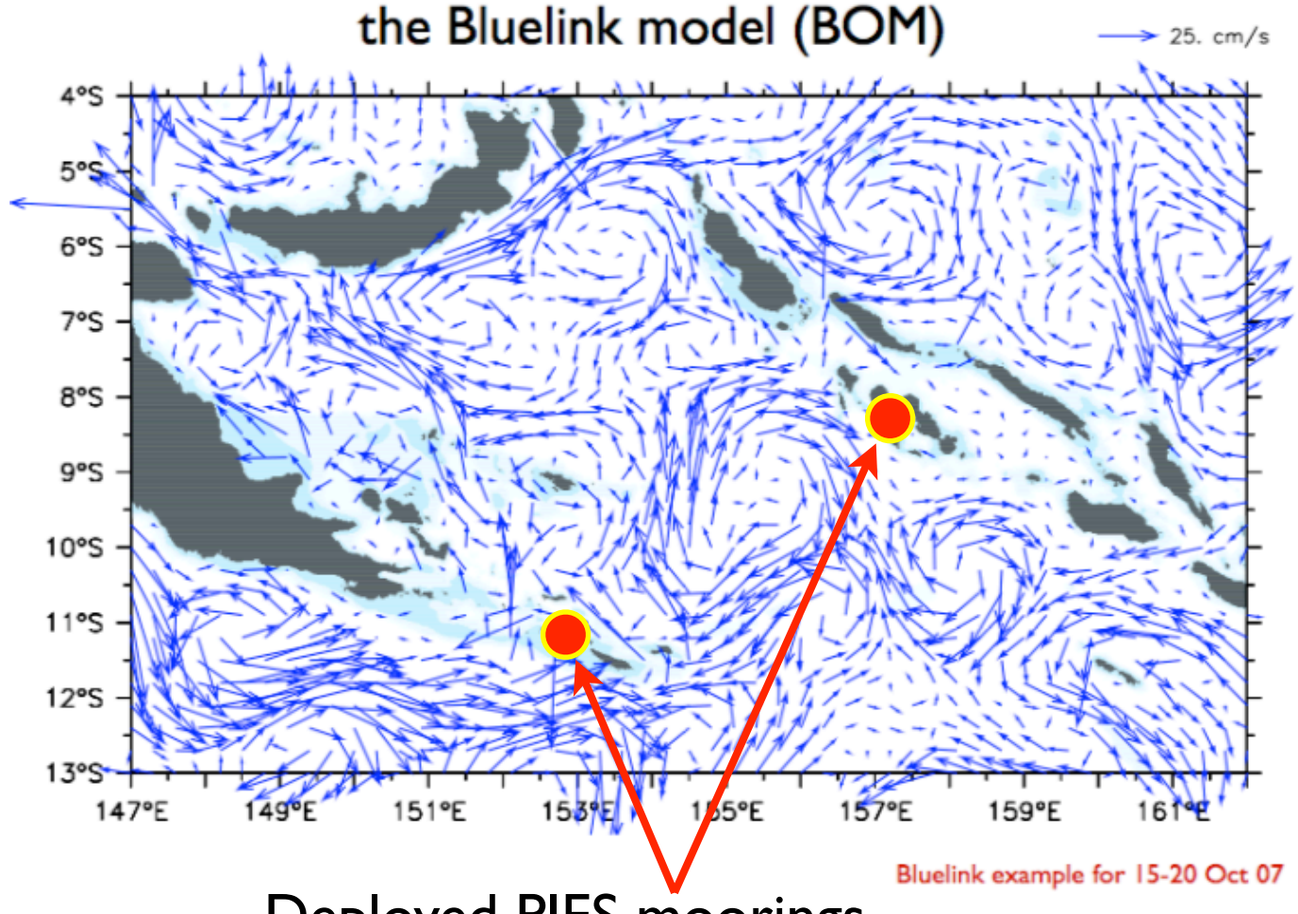
One at each end of the glider line: Misima, PNG and Gizo, Solomon Islands

The PIES measure the overall pressure difference across the Solomon Sea every 10 minutes.

A PIES (Profiling Inverted Echo Sounder). About 1.4m tall.
Sit on the bottom at 300m for 4 years, nothing at the surface.
PIES data is downloaded acoustically (possibly from a glider).

→ The pressure time series will show the short-term fluctuations that the glider misses.

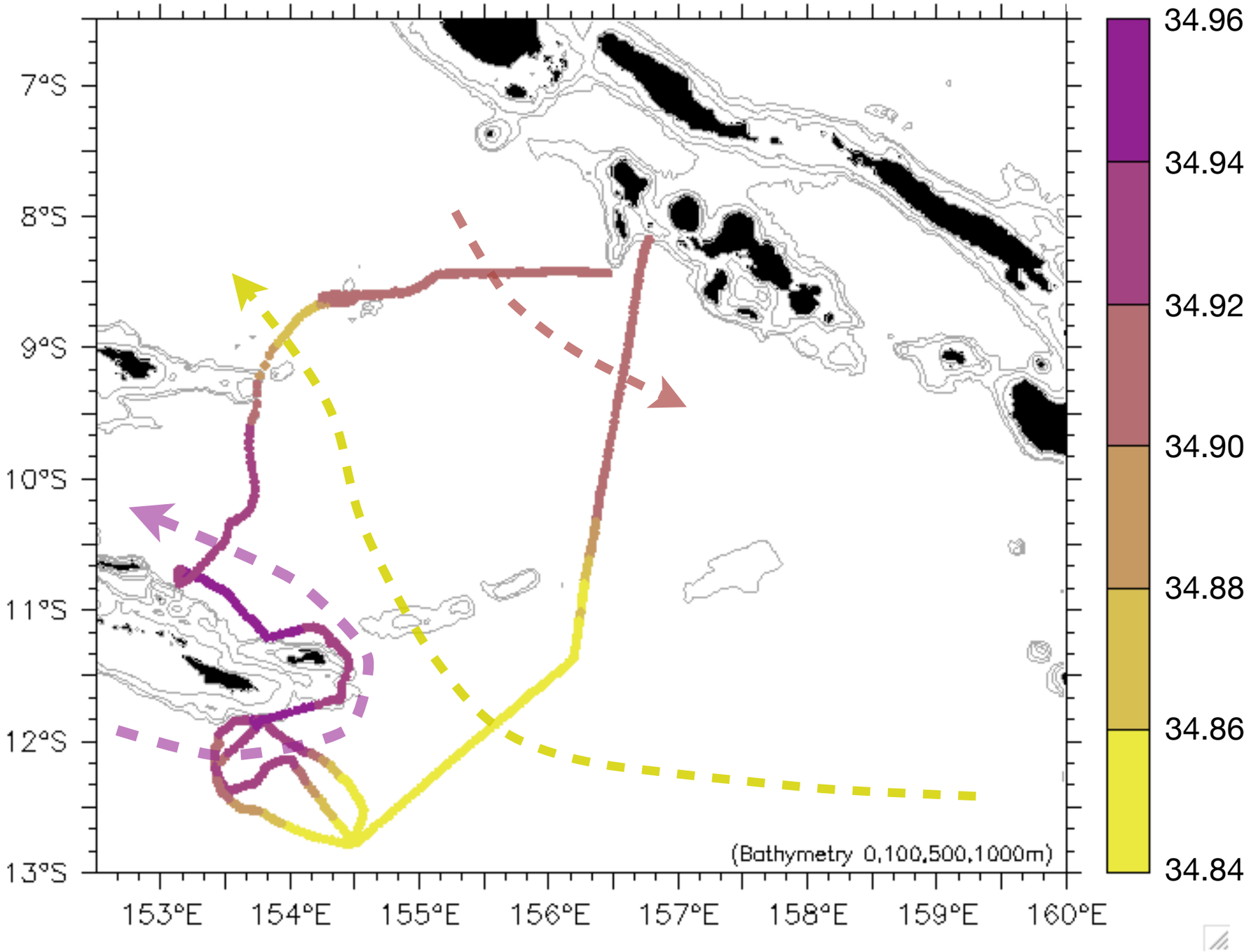
Example of velocity from the Bluelink model (BOM)



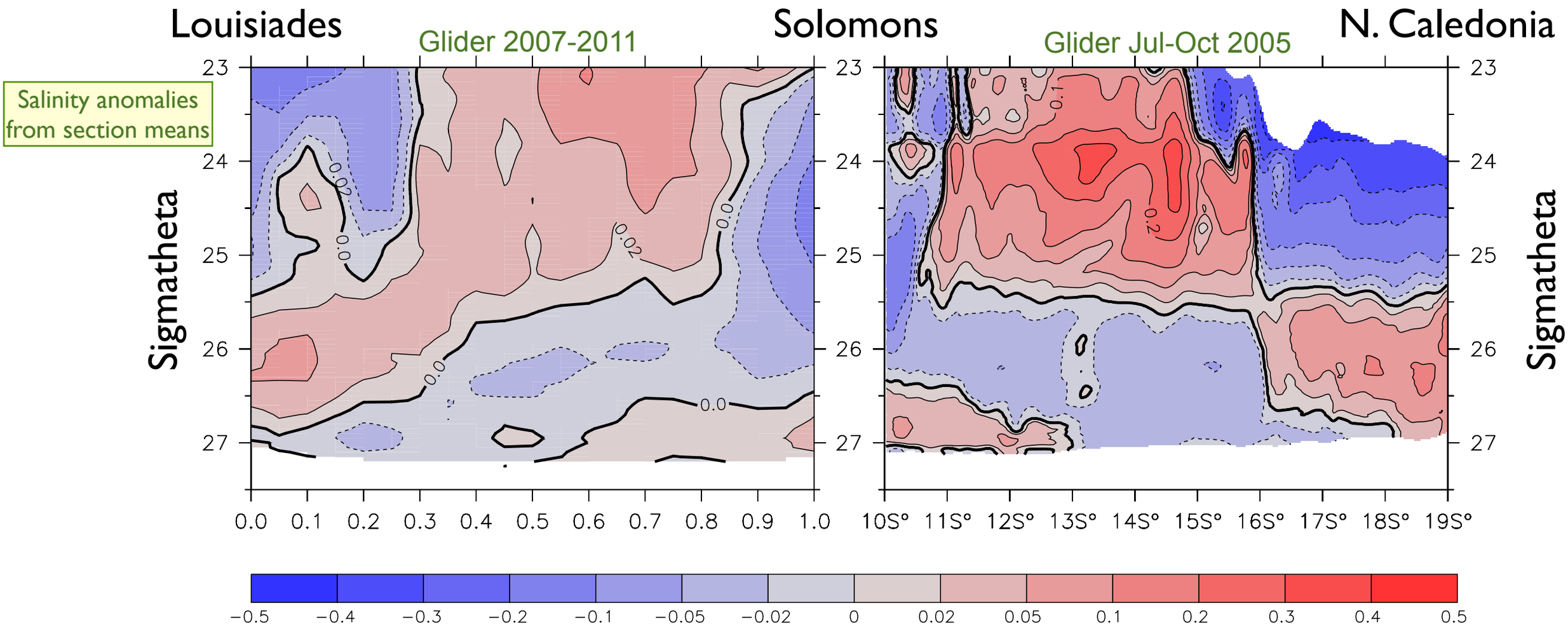
Deployed PIES moorings (internally-recording)

High-salinity signature of the NGCU

Nov 09-Feb 10. Salinity on sigma 26.5. Mean depth ~345m. Mean S 34.90



Salinity anomalies on isopycnals: 2 glider sections from the Solomons



Glider sections from the Solomons to:
- New Caledonia (Jul-Oct 2005)
- Louisiades (15 sections, 2007-ongoing) (green lines at right)

High-S tongues carried across and around the Coral Sea at shallow and mid-depth isopycnals