PMEL

Pacific Marine Environmental Laboratory

Pacific Western Boundary Currents

Solomon Sea Glider Program

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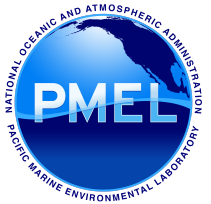
Collaborators: Hristina Hristova (JIMAR/PMEL)

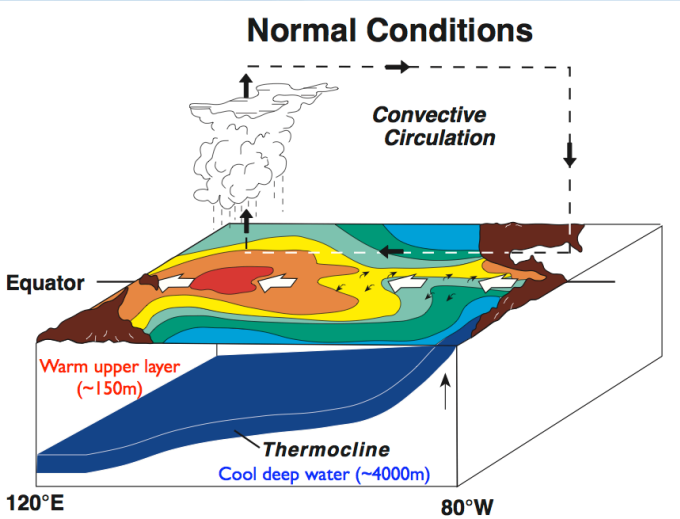
Additional collaborations with Scripps and UCLA,

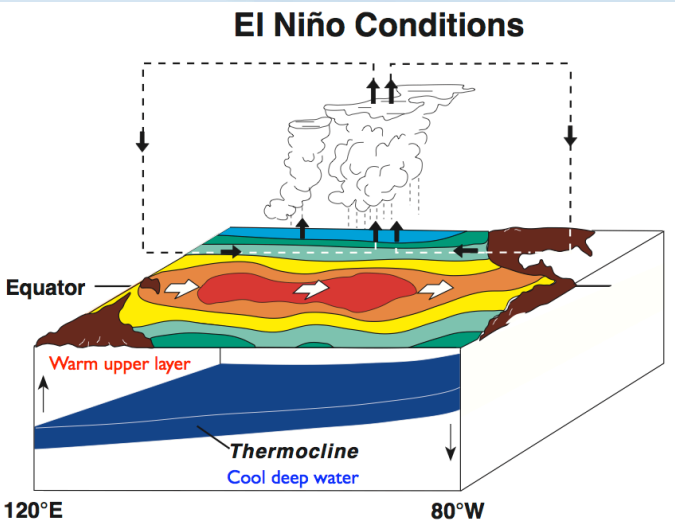
and in the region we could not do this work without the help of:
The Bureau of Meteorology (Australia),
The Solomon Islands Meteorological Service,
The University of Papua New Guinea



Background and Relevance

We often think of ENSO as a zonal "sloshing"….

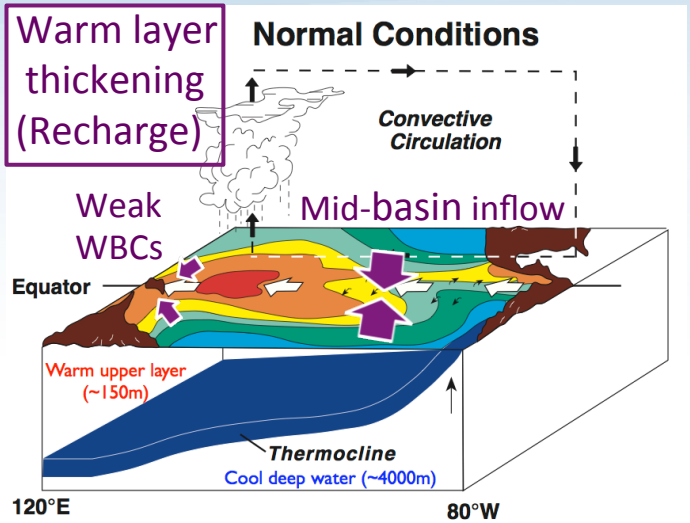


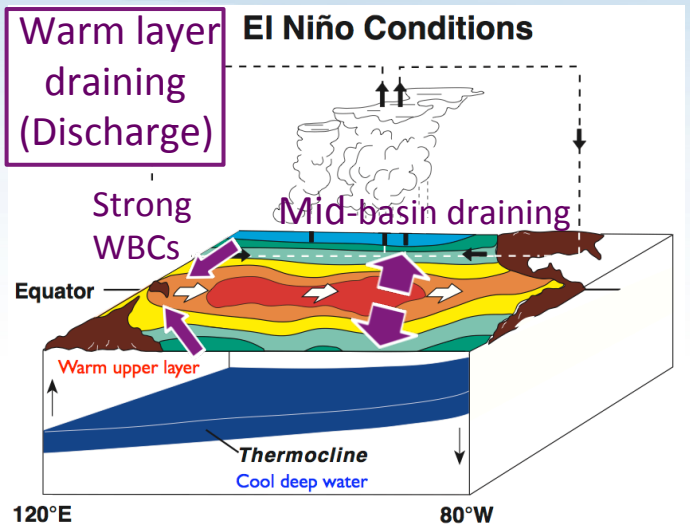


… but here we consider ENSO's role in *meridional* redistribution: draining the warm mass that accumulates under normal trades.

Background and Relevance

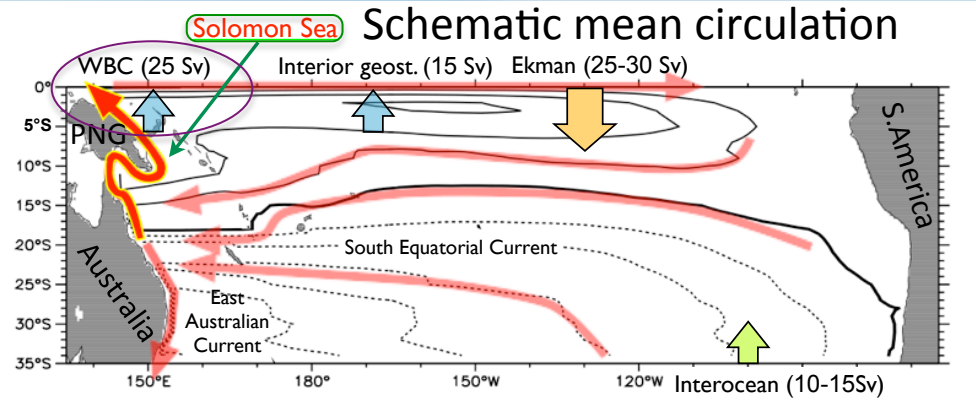
The western boundary currents act counter to the larger mid-basin flows:

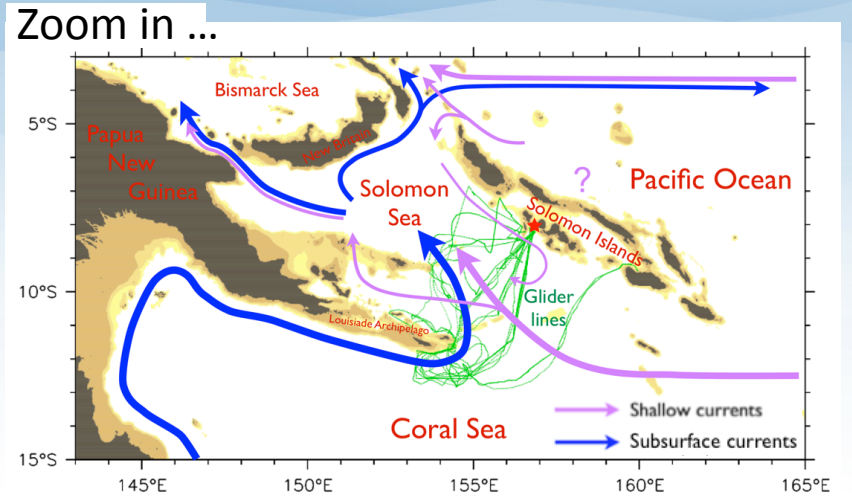




The WBC RMS is perhaps 40% that of the mid-basin transport, but has not been previously measurable.

Background: Mean circulation





The Solomon Sea carries the western boundary transport of the South Pacific to the equator, balancing the interior-basin contributions.

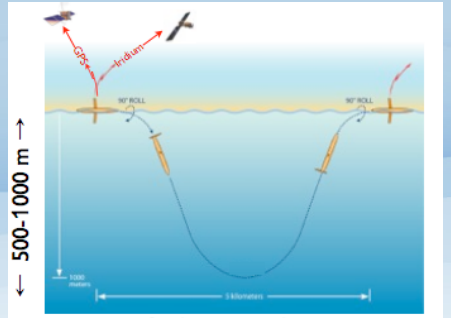
Although assumed important, previously it was only known as a residual of the others.

Its flows are complex and multi-layered, with sources from both mid-basin (via a subsurface current along the coast of Australia) and a shallow inflow from the tropics.

Questions and issues:

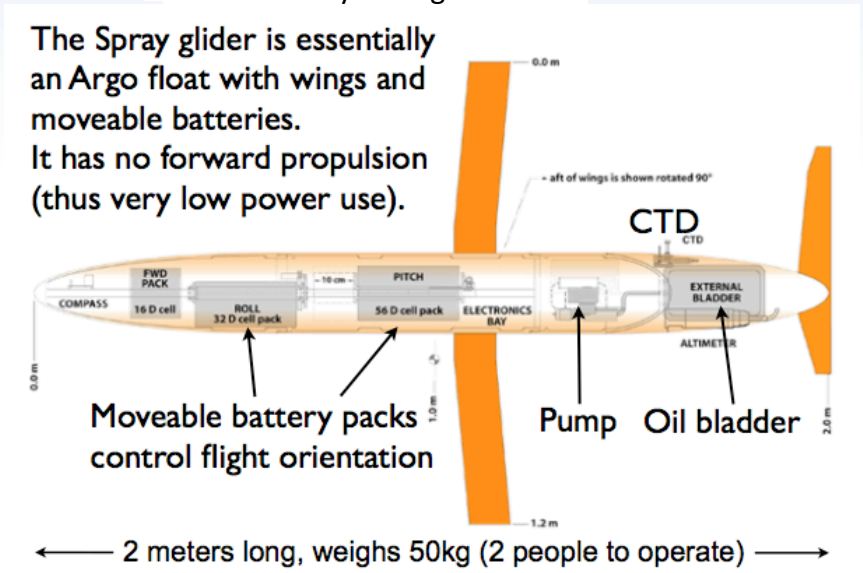
- How does the mass transport vary on ENSO and slower timescales?
- How do the heat and salt fluxes vary, and how do they contribute to the equatorial region?
- Are gliders an appropriate tool for measuring western boundary currents?

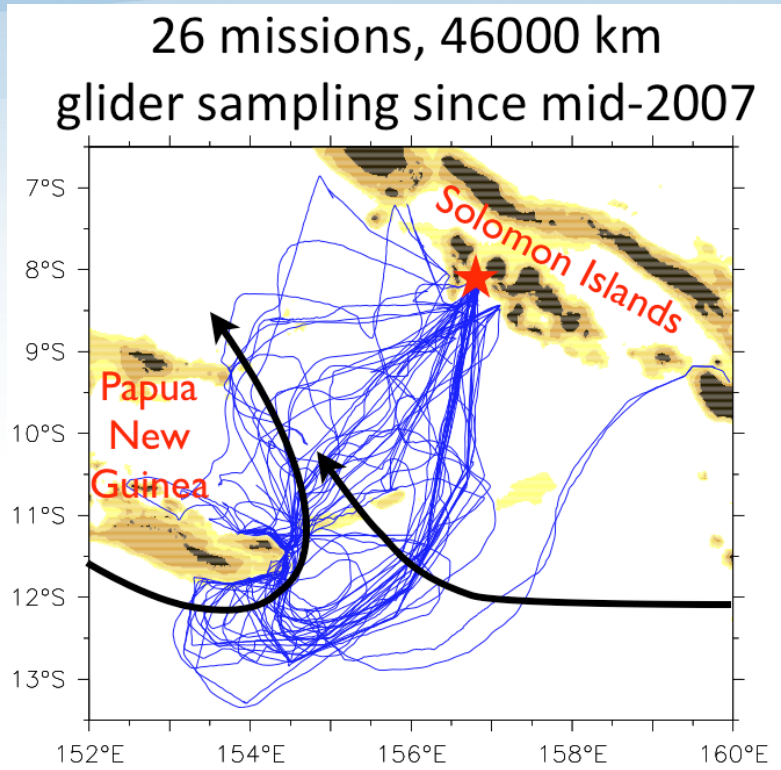
Fieldwork: Strategy



20-25 cm/s (~20km/day)
Range 5 months ~ 2500+ km
Infer velocity from glider drift

Autonomous
Low power
Cheap
Long endurance





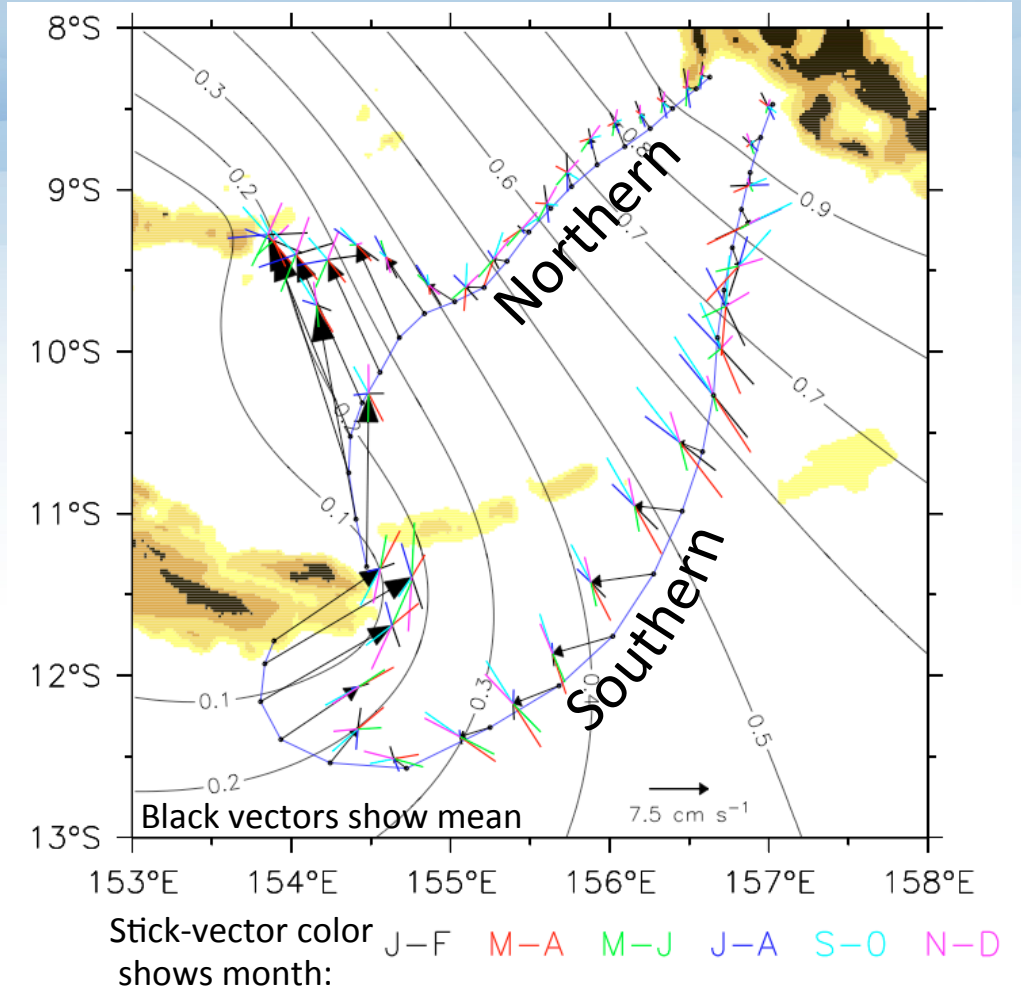
Quality:

Absolute -average velocity

Mean and annual cycle

Most of the mean transport is in the WBC, But most of the annual cycle variation is in mid-basin (the same is true for ENSO).

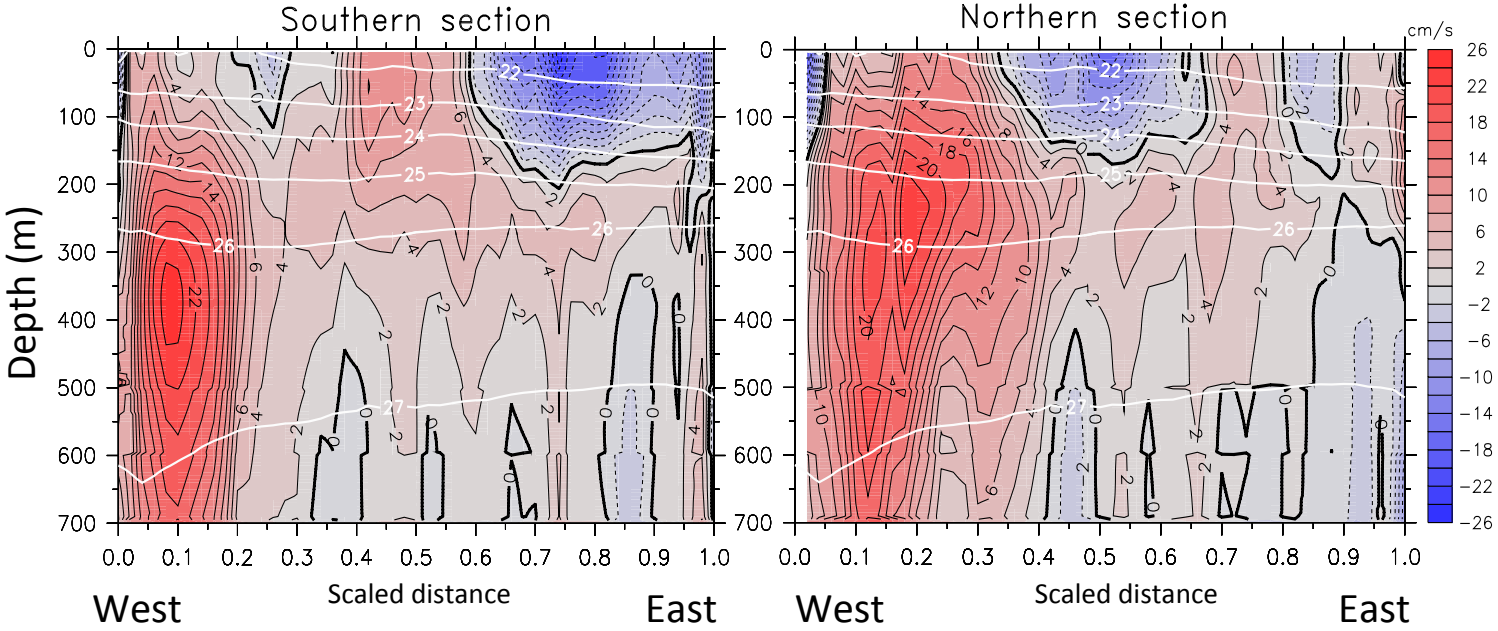
Maximum inflow in Sep-Oct (light blue).

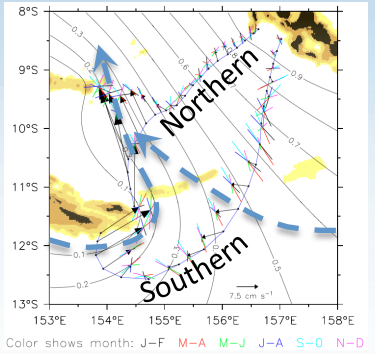


Performance: Vertical structure

Mean absolute crosstrack currents as a function of depth

45 glider sections across the Solomon Sea. Mid-2007 through 2013





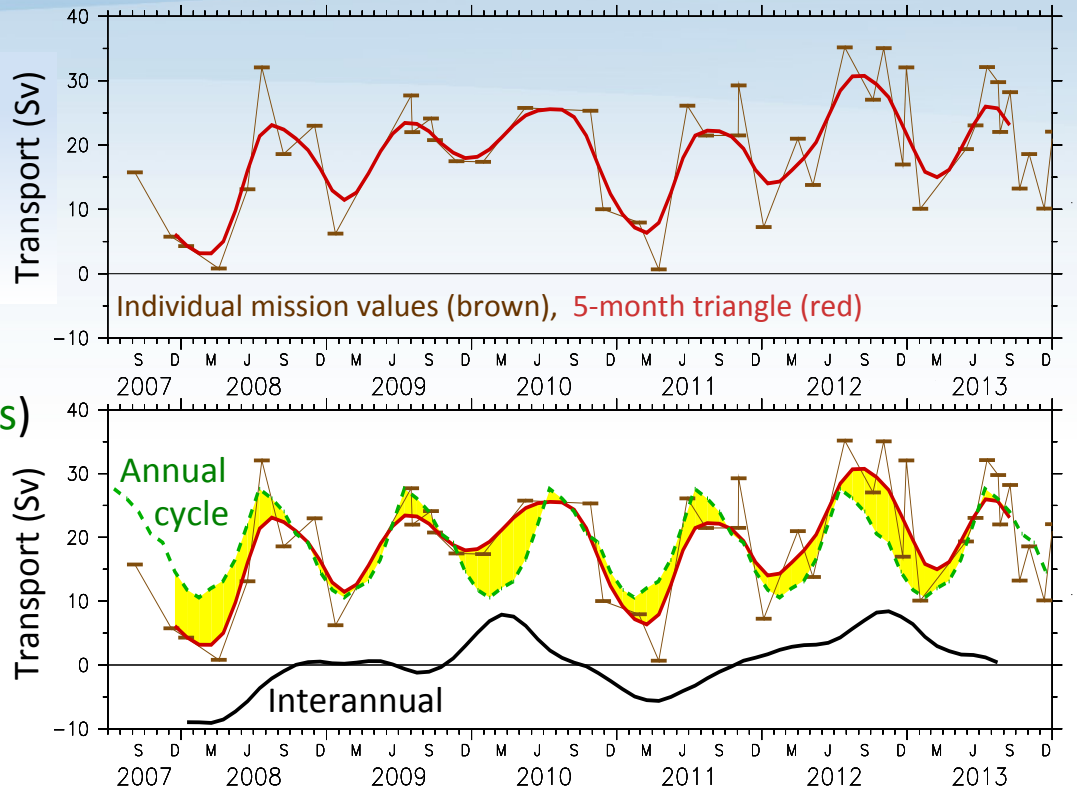
Red = Equatorward

Blue = Poleward

Quality: Well-resolved time series

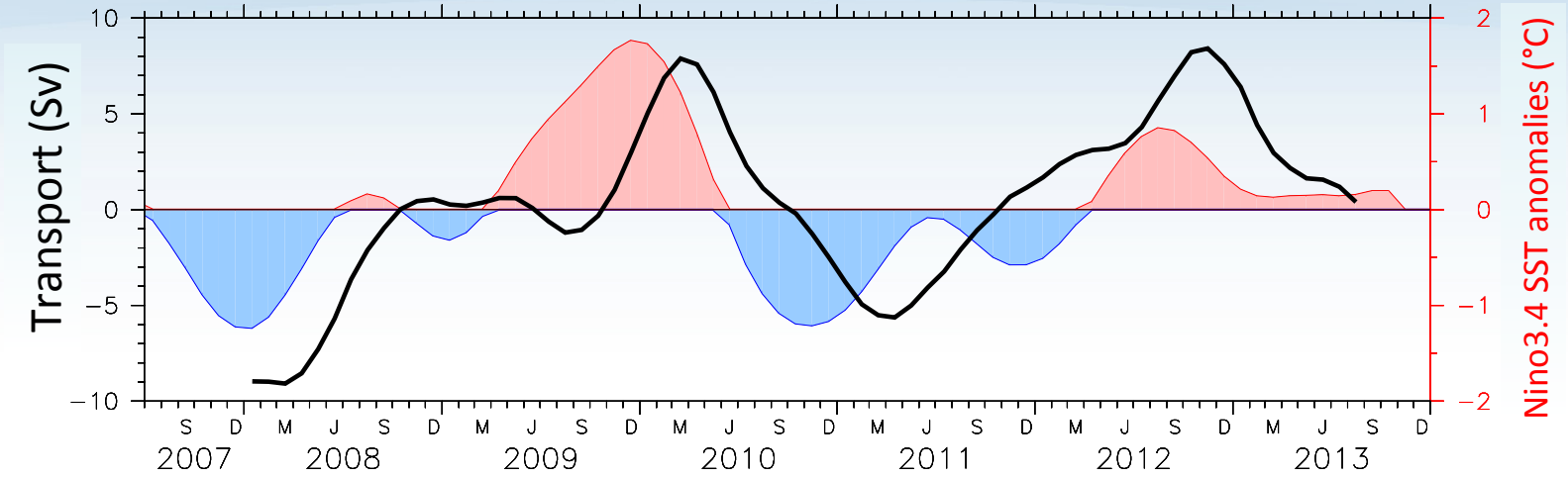
The raw transport values are noisy. Large mission-to-mission changes are due to ubiquitous eddies. (Verified with pressure gauges)

With 7 years of data, we can now resolve the annual cycle (green dashes) and thus interannual variability (yellow fill, lower black line).



Connection to ENSO

Solomon Sea glider transport (black) and ENSO (Niño3.4 SST; color shading)



Solomon Sea transport lags central Pacific ENSO. It is part of the recovery and recharge.

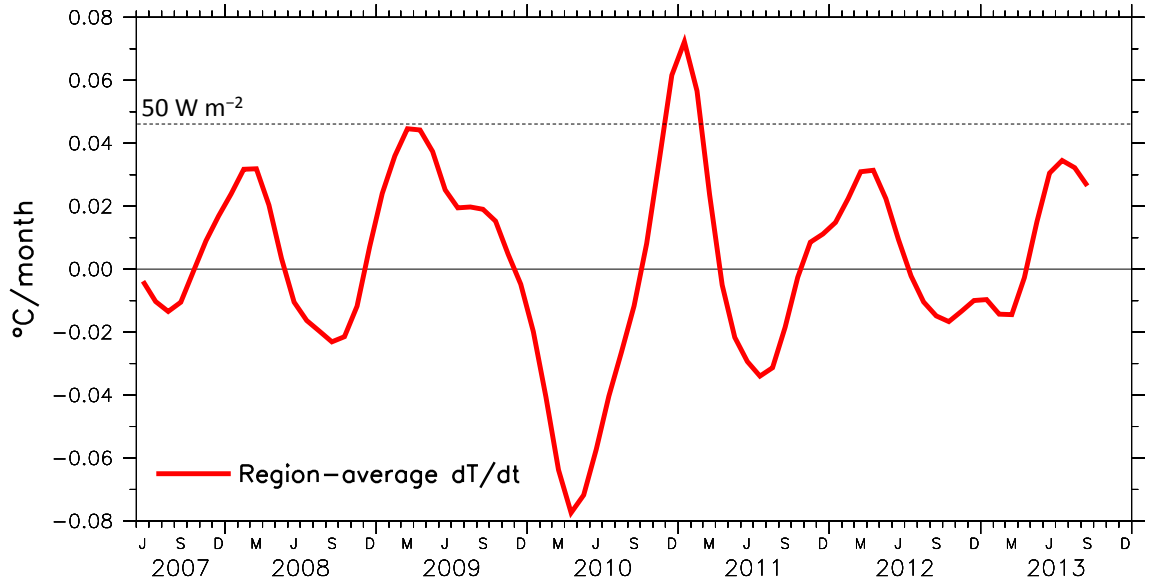
It is NOT a predictor/precursor of El Niño, but forms a substantial part of the recharge: ±8 Sv, even for small/moderate events.

Solomon Sea contribution to basin heat transport

Volume-average dT_m/dt

0-700m, 5°S-5°N, width of Pacific

1.4×10^7 km^3

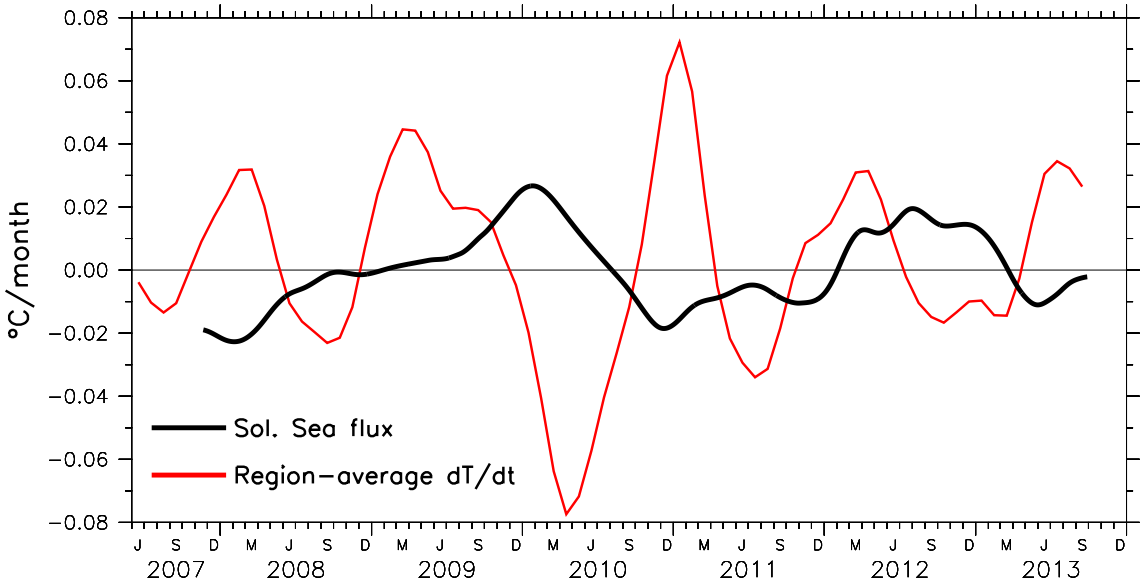


Volume-average temperature changes estimated from Argo have an interannual RMS of **~ 0.028°C/month**.

(Equivalent to a surface heat flux RMS about 30 W m^{-2})

Solomon Sea contribution to basin heat transport

Interannual Solomon Sea anomalous heat flux and dT_m/dt



The Solomon Sea contribution to temperature anomalies in the equatorial zone can be estimated as the integral of vT' across the Solomon Sea glider section ds:

$$\iint v\,(T - T_m)\,dz\,ds / Vol,$$ where:

v, T = glider velocity and temp.

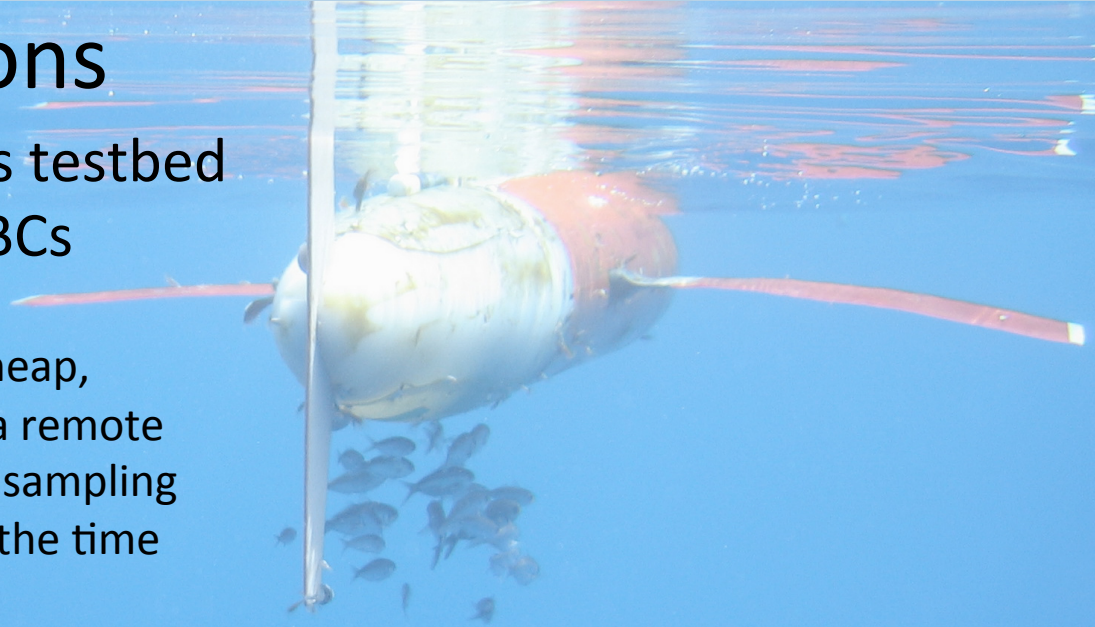
T_m = volume-mean temperature of the basinwide region.

Vol = Region volume ($\sim 10^7$ km^3)

Its variability is about 40% as large as the rate of change of dT_m/dt.

Future Directions

The Solomon Sea is NOAA's testbed for glider monitoring of WBCs



We have shown that gliders are a cheap, feasible method to do this, even in a remote region without infrastructure. Their sampling characteristics are well-matched to the time and space scales of WBCs.

We will monitor the Solomon Sea for 10 years (mid-2017), compare to Argo, satellite and model estimates of the transports and fluxes, and evaluate the need to continue.

The next target should be the corresponding WBC in the Northern Hemisphere (Mindanao Current). With Argo and TAO defining the interior-basin transport, this would enable a complete description of subtropical-equatorial mass and heat exchange.