Measuring and interpreting Pacific low-latitude western boundary currents

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Thirteen years of glider sections across the Solomon Sea describe the western boundary pathway from the South Pacific to the equator.

The gliders measure temperature, salinity and the velocity structure and variability in the upper 1000m.

Gliders' 4-hour, 4km-apart profiles and ability to sample to a few km from a coast make them especially suitable for narrow, near-coastal features like boundary currents.

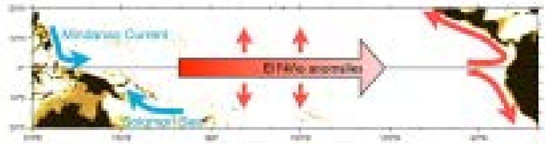
This work demonstrated that gliders can be reliably prepared onshore and launched from small boats in remote regions without modern infrastructure (no ship needed). Dependable time series of otherwise-inaccessible phenomena can be maintained.

The big picture of ENSO anomalies

Accumulation ("recharge") and discharge (El Niño)

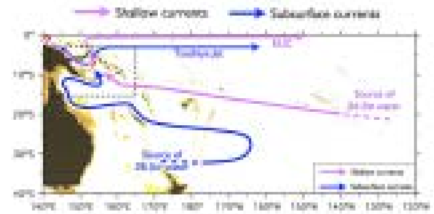
Exchanges between the subtropics and the equator

Low-latitude western boundary currents are a recharge pathway

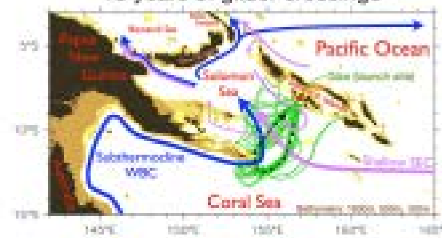


The big picture of South Pacific flow

Two distinct sources feed the Solomon Sea



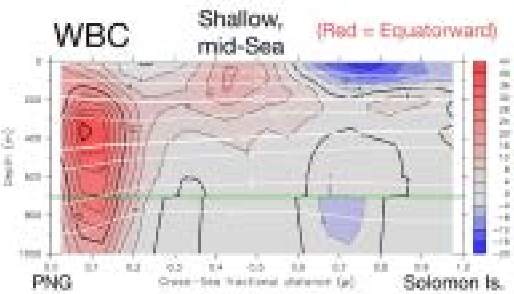
13 years of glider crossings



Green dots show glider dives	25,000 dives	About 4.5 times Earth circumference
136 coast-to-coast sections	116,000 km	

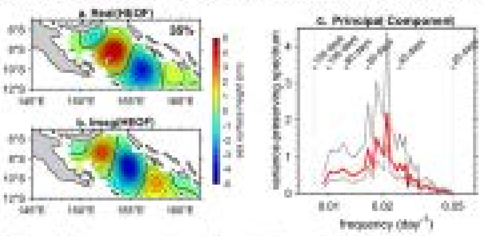
Black dashed arrow shows glider route (pushed north by currents, inconsistent path)

A. Velocity section across the Sea



The western boundary current is remarkably thick and narrow (~80km wide, with its core near 400m and speeds of 40cm/s). It arrives from the coast of Australia. The shallow, mid-sea current carries subtropical water and is much more variable.

C. Eddies dominate short-term shallow currents



The eddies propagate northwest through the sea and are well-detected from satellite altimetry.

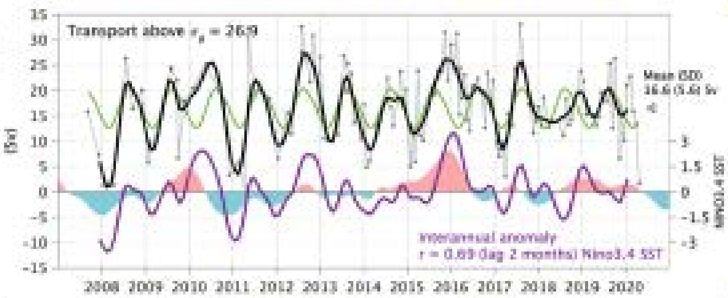
B. Transport variations: Annual and ENSO

Transport by section (light gray). Eddies give monthly variations (see section C)

Low-frequency (black) = Annual+interannual

Annual cycle (green)

Interannual anomalies (purple) correlate with ENSO with a 2-3-month lag



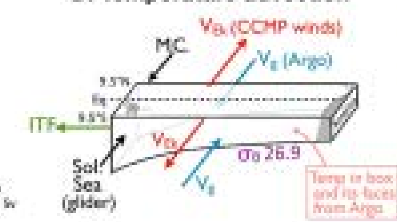
Our time series spans three El Ninos and two La Ninas, which produced large volume transport anomalies, up to 50% of the mean.

Annual transport variability has similar magnitude, with most of the annual cycle a shallow mid-Sea flow driven by wind curl variability over the tropical region east of the Solomon Sea.

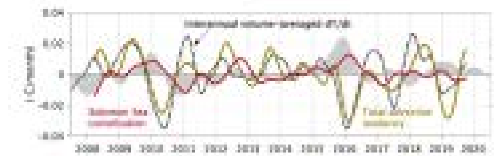
By contrast, ENSO-timescale variance is forced by winds over the entire subtropical South Pacific to at least 30°S, including both the subtropical-origin shallow mid-Sea flow and the thicker western boundary current that carries signals from well into mid-latitudes.

As in other aspects of ENSO, their Solomon Sea signature was not consistent event to event.

D. Temperature advection



A simple method uses glider temperatures and velocity to account for the effects of temperature advection through the Solomon Sea on the tropical Pacific as a whole.



Temperature advection through the Solomon Sea is the largest single element of interannual temperature anomalies of the entire tropical strip. Most of the Solomon Sea signal occurs through velocity changes, not changes of advected temperature.

While this work has proven the potential of gliders to reliably monitor narrow boundary currents, including in remote regions, and show how western boundary currents influence the ENSO cycle, the Solomon Sea is only half of the tropical Pacific western boundary system.

Expanding these observations to the counterpart in the Northern Hemisphere (Mindanao Current off the Philippines) would enable ongoing monitoring of the full influence of western boundary currents on low frequency variability of tropical climate.