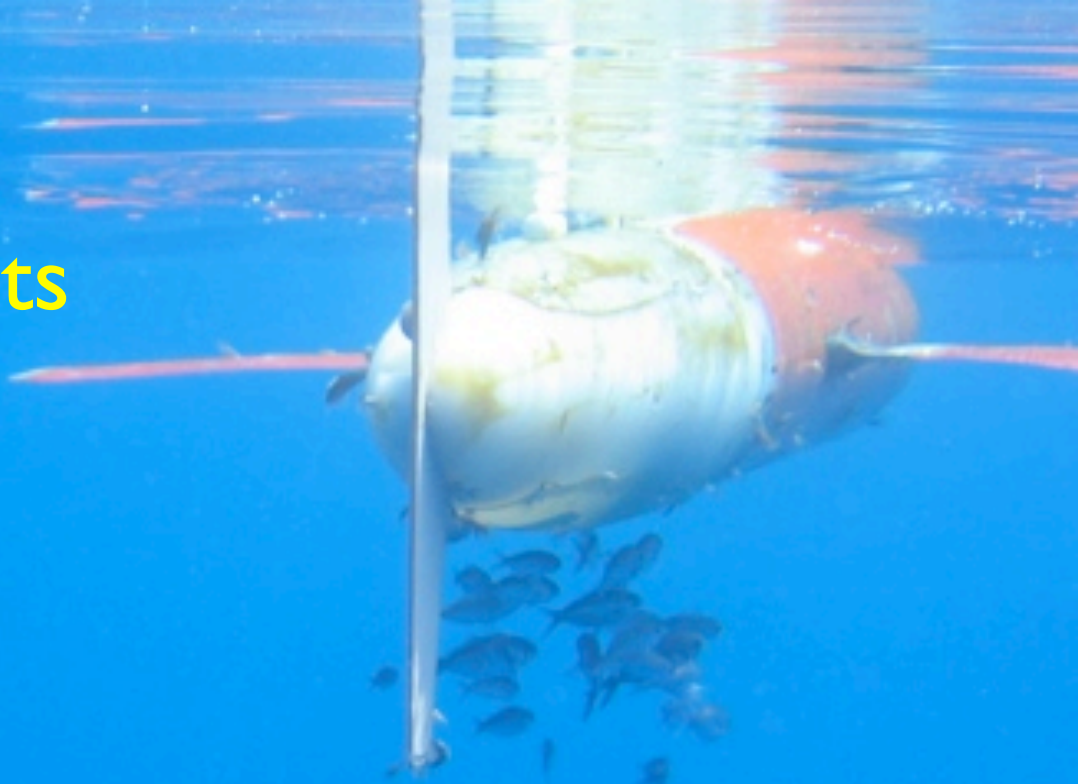
Measuring South Pacific low-latitude western boundary currents with ocean gliders: A pilot study



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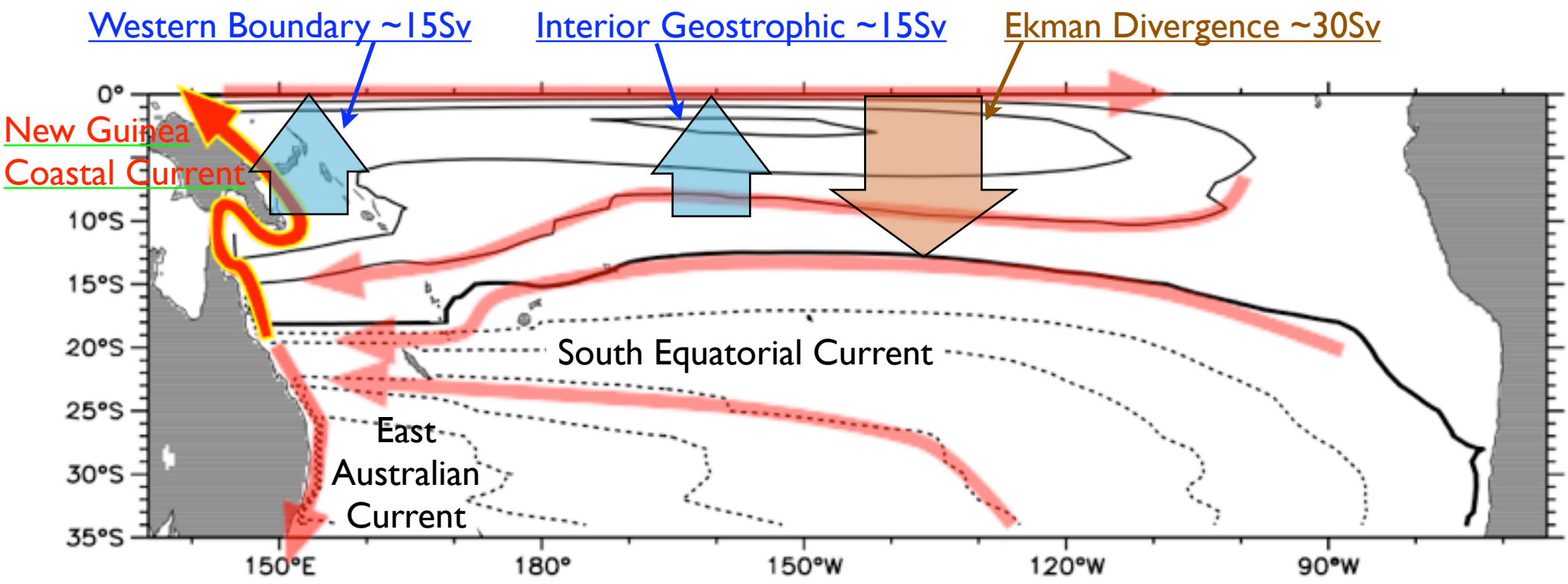
Other international collaborators:

- Solomon Islands Meteorological Service
- University of Papua New Guinea
- Bureau of Meteorology (Australia)

South Pacific mean circulation

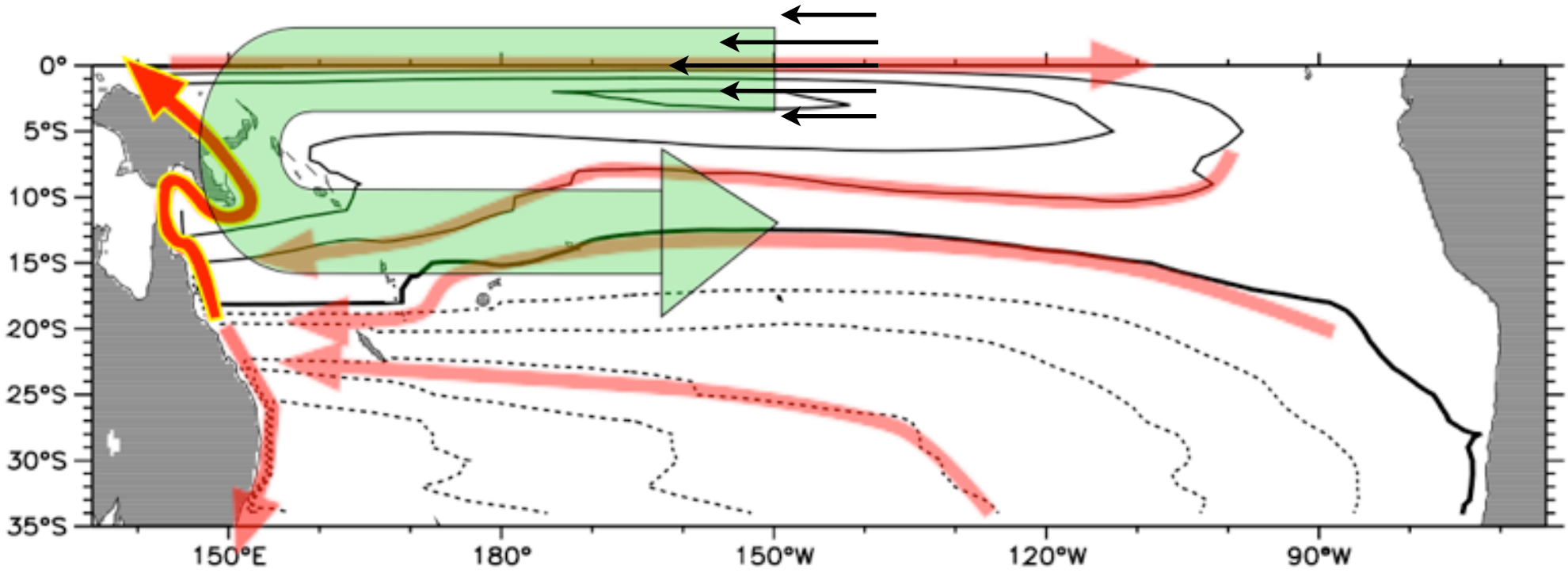


Work on the subtropical-equatorial exchange points to the importance of the western boundary limb of the circulation: Transport that determines the properties (temperature, salinity, carbon content) of the equatorial cold tongue.

La Niña transport anomalies

ENSO modifies western boundary transports:

La Niña tends to weaken the circulation in the west



Our goal is a sustained time series

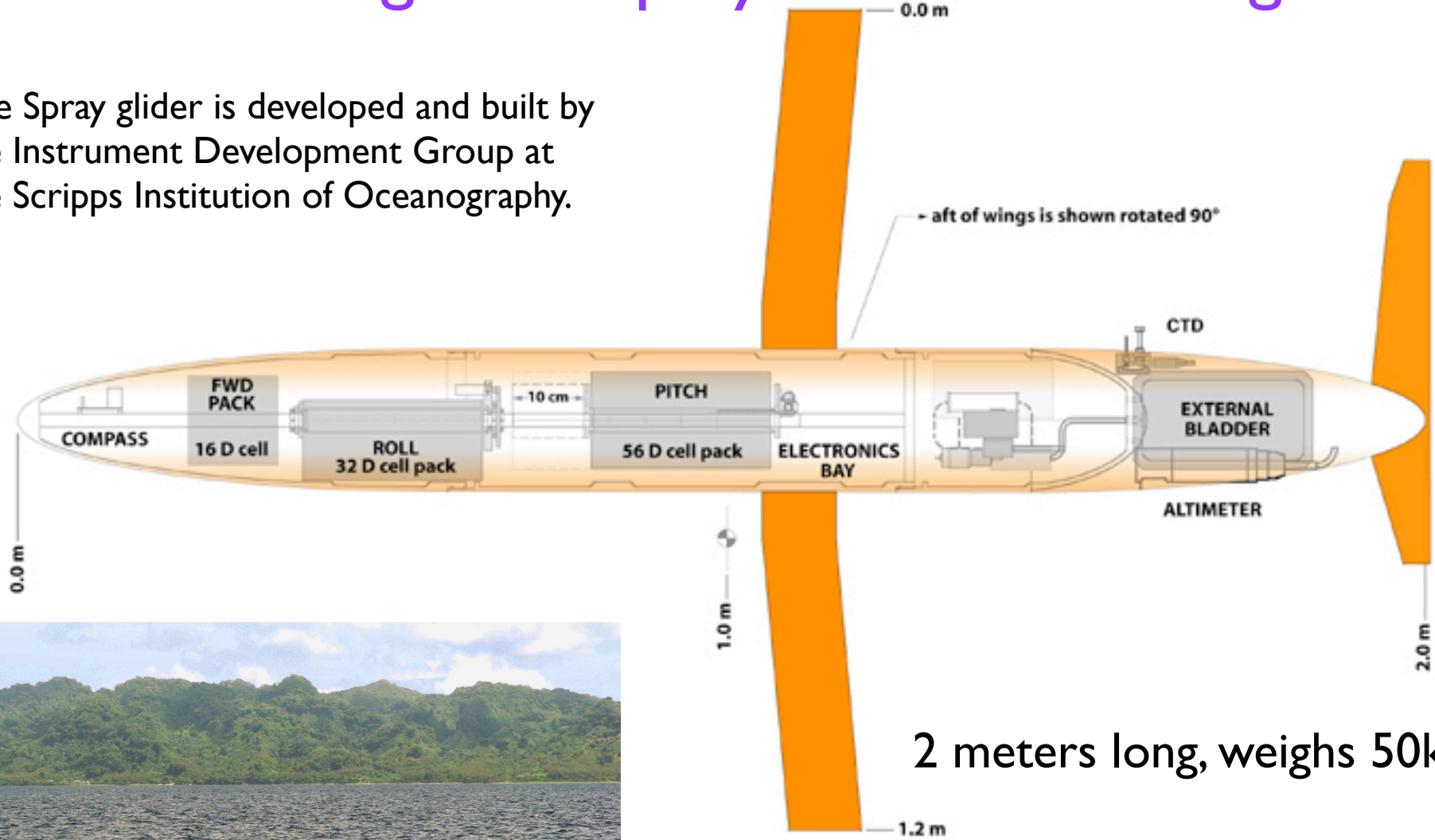
of the western boundary transport to the equator.

Two motivations:

1. Climate (CLIVAR): subtropical-equatorial communication
2. Testbed for WBC monitoring strategy

The ocean glider "Spray": Schematic diagram

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

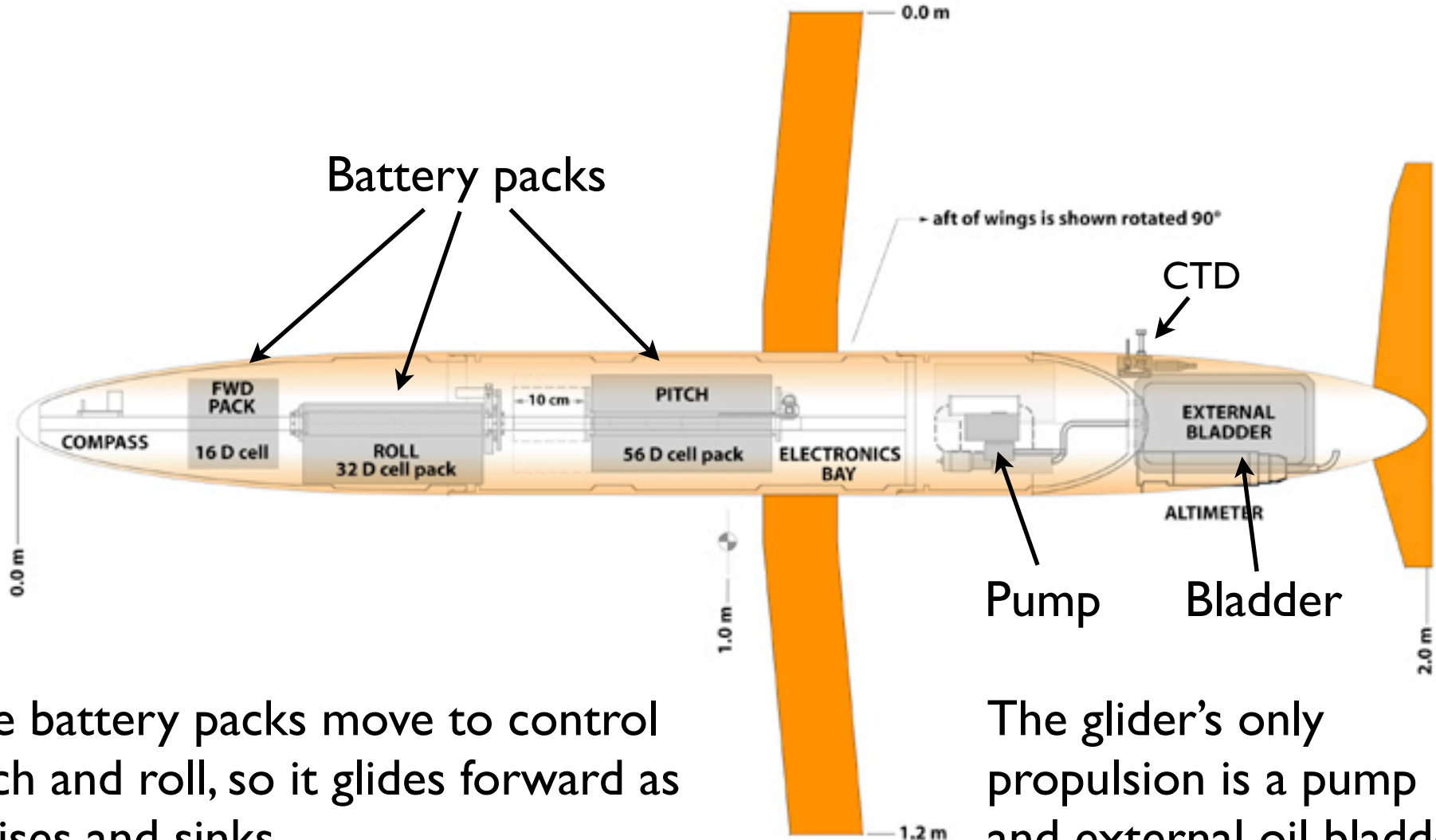



Savo Island, Ironbottom Sound, Solomon Islands

2 meters long, weighs 50kg

⇒ Work from small boats near shore, much cheaper than a ship.

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

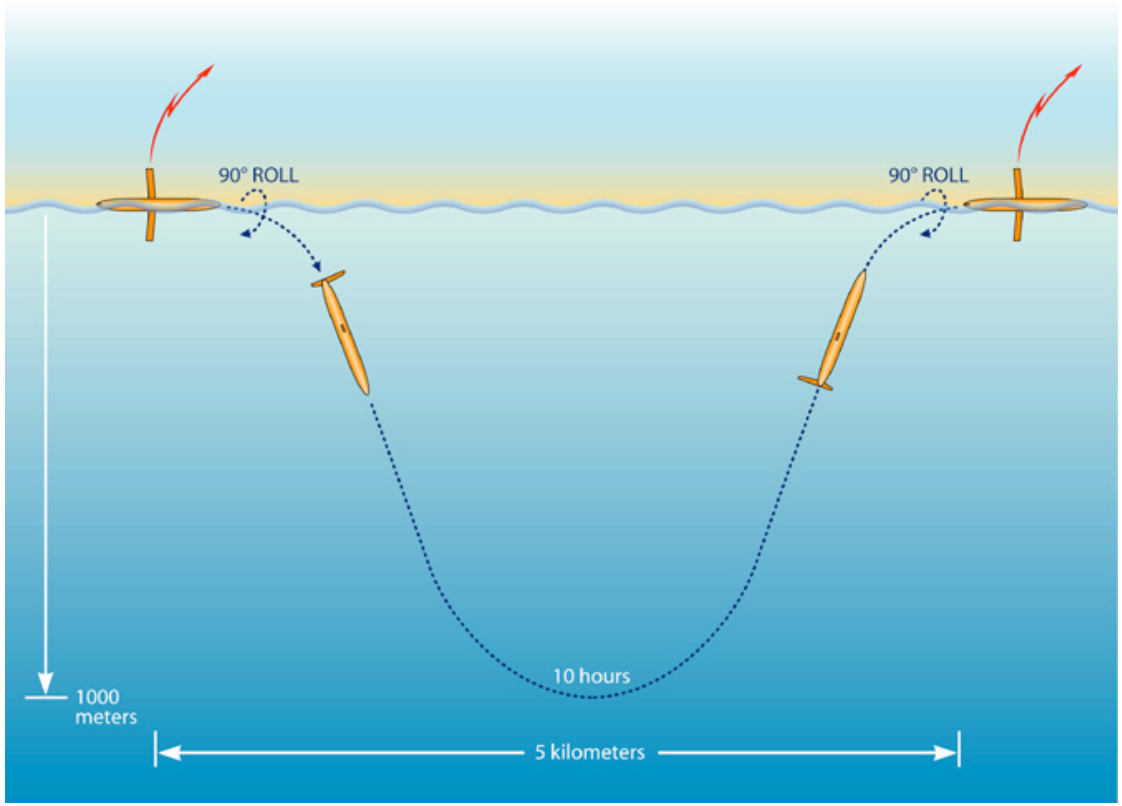


The battery packs move to control pitch and roll, so it glides forward as it rises and sinks.

It moves very slowly (~20 km/day).

The glider's only propulsion is a pump and external oil bladder. The pump inflates and deflates the bladder to change its density.

A dive of the Spray glider



500-1000 m

← 3 km (3-5 hr) →

20 cm/s

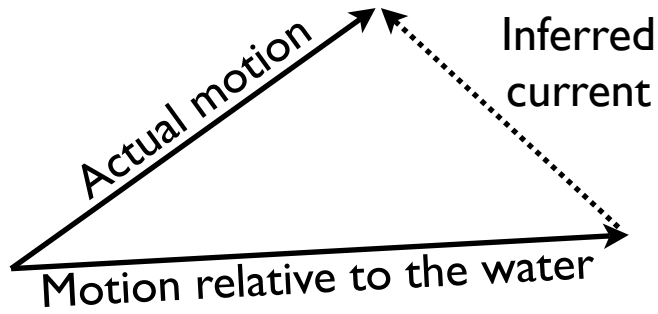
Range about 4 months or 2000km

Dives to 500-1000m in 3-5 hr, moves forward 2-4 km.
→ Very dense sampling

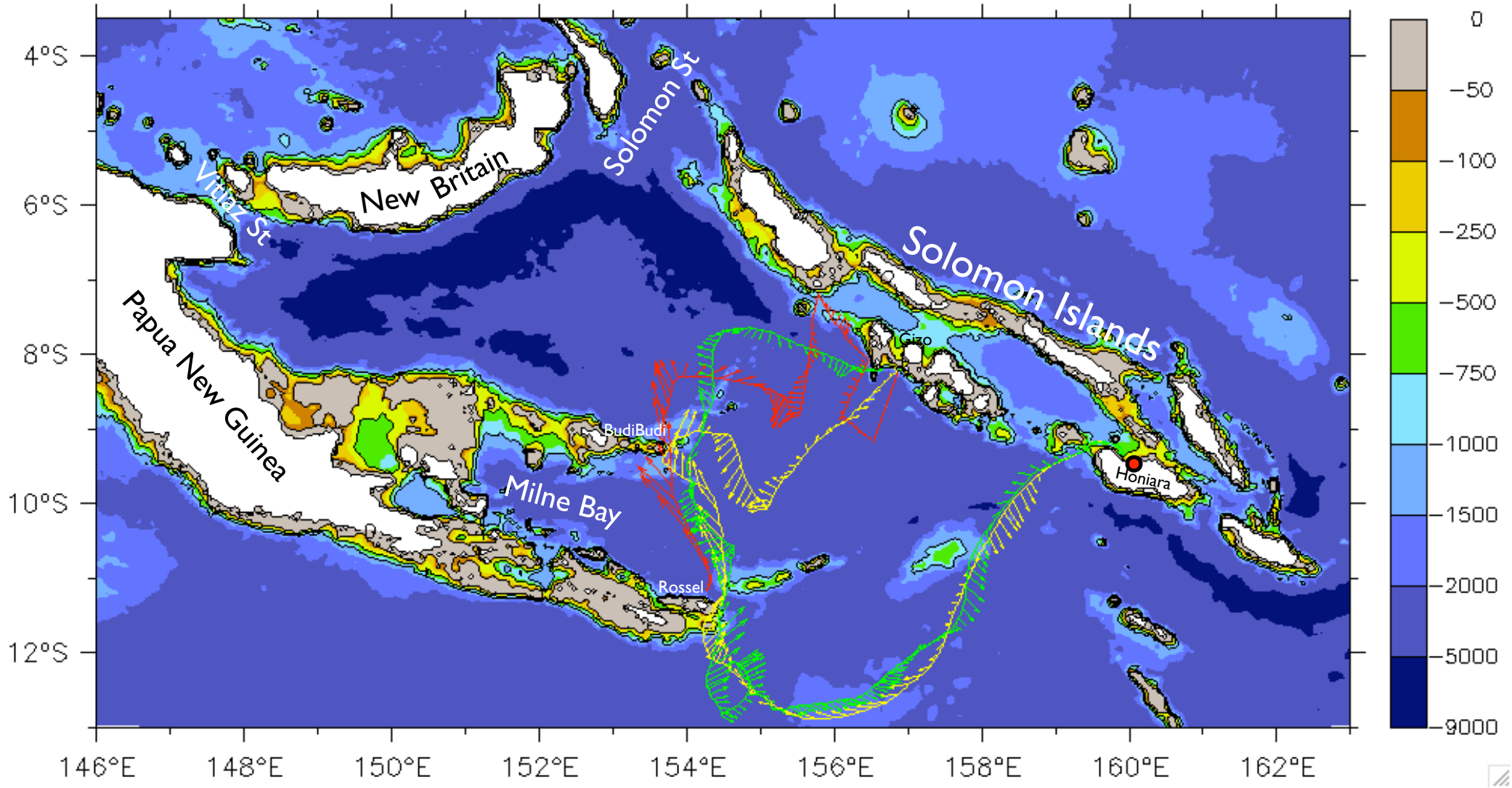
Argo-comparable T-S profiles, plus ...

Data reported by Iridium satellite each time it surfaces.

Infer <u>vertical-average</u> absolute currents by the glider's drift:



4 glider surveys so far (3 completed, 1 in progress)



Red = Aug-Nov 07 (Rossel, PNG to Gizo, Solomon Islands)

Yellow = Nov 07-Feb 08 (Honiara to Gizo via Rossel)

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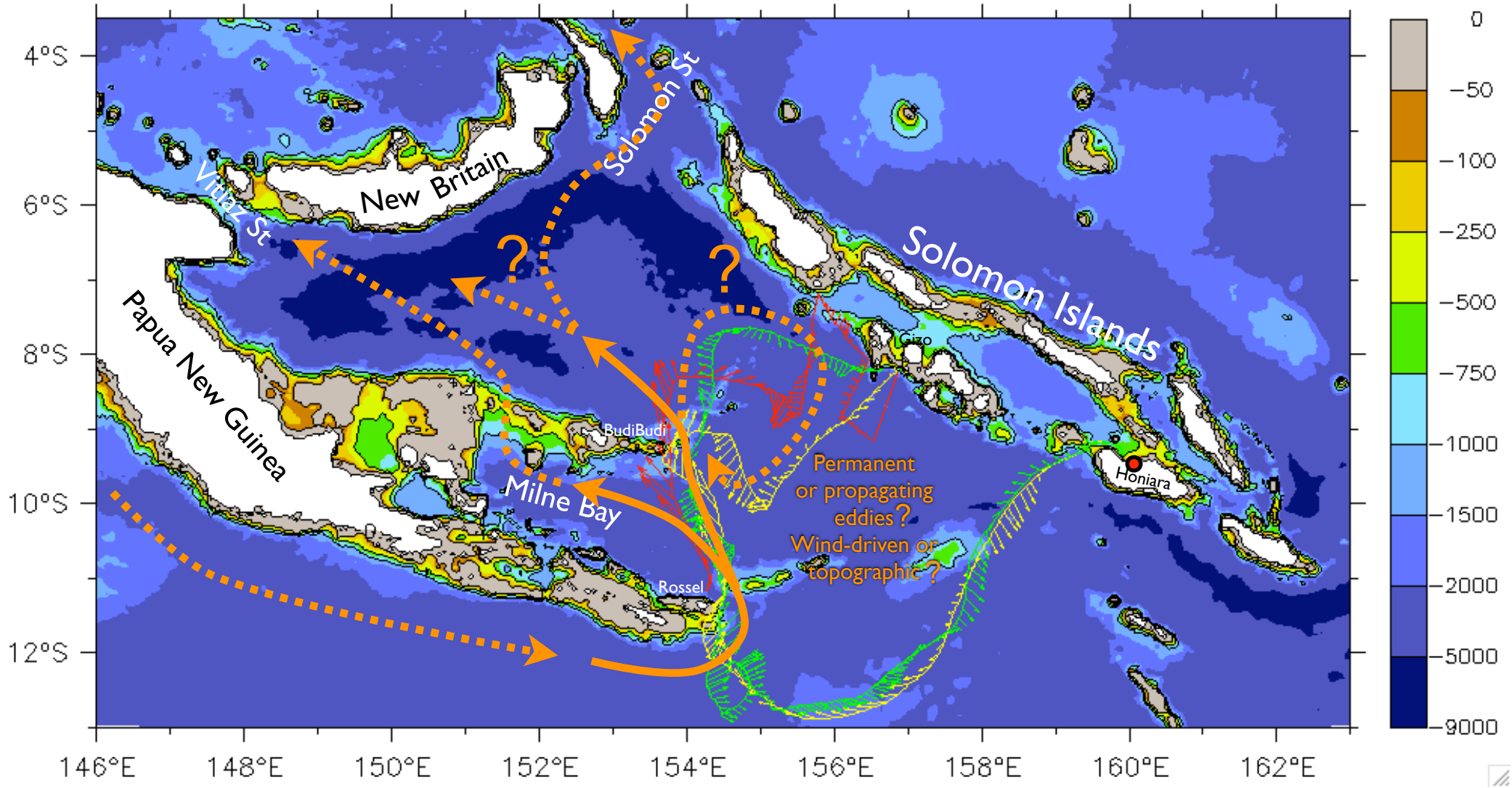

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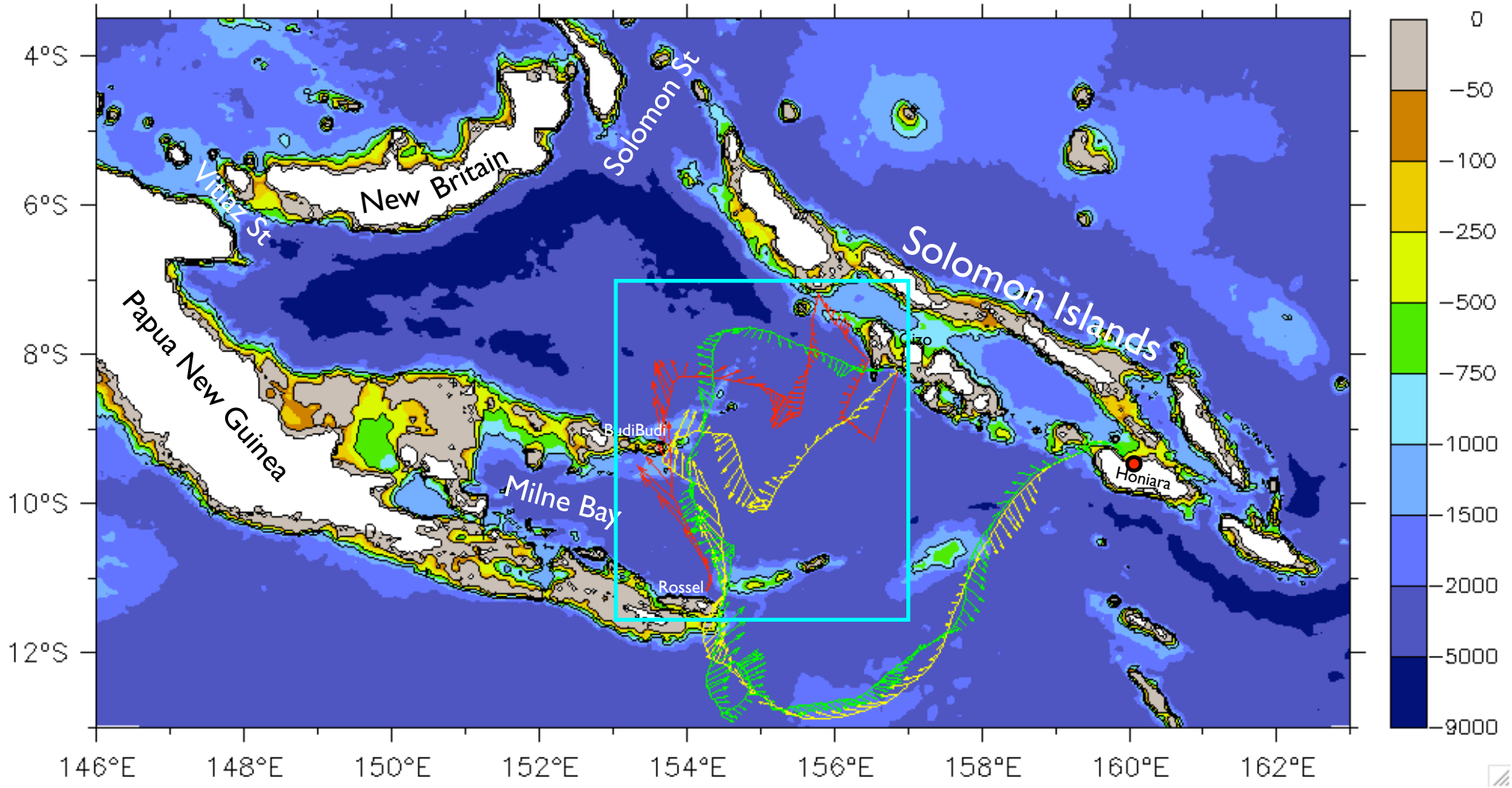

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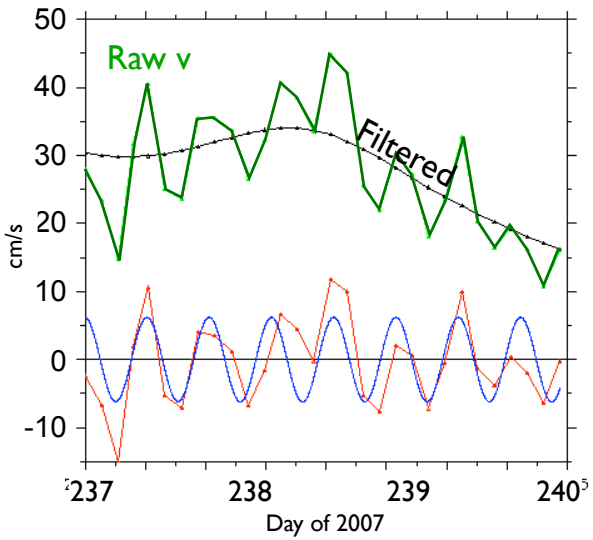
Vector absolute current above 500m

(Tide-filtered)

An example of tide-filtering

Gaussian objective mapping with a time-scale of 1.5 days.



(1st mission, mid-2007)
(Pre-La Niña)

8Sv

8Sv

Solomon Islands

Solomon Sea

Papua New Guinea

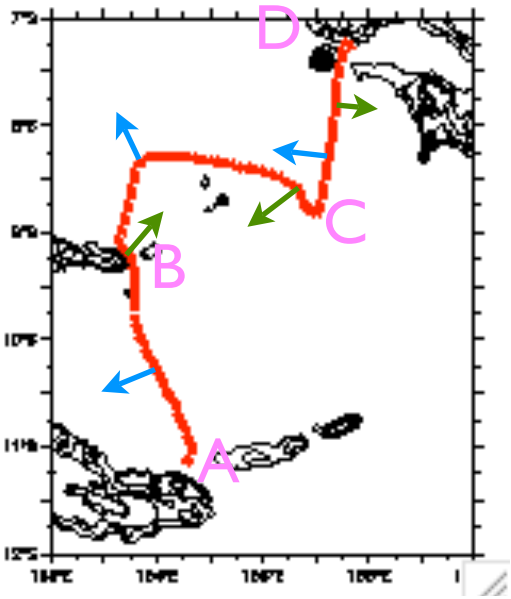
0.25 m s^{-1}

7.0°S
7.5°S
8.0°S
8.5°S
9.0°S
9.5°S
10.0°S
10.5°S
11.0°S
11.5°S
153°E
154°E
155°E
156°E
157°E

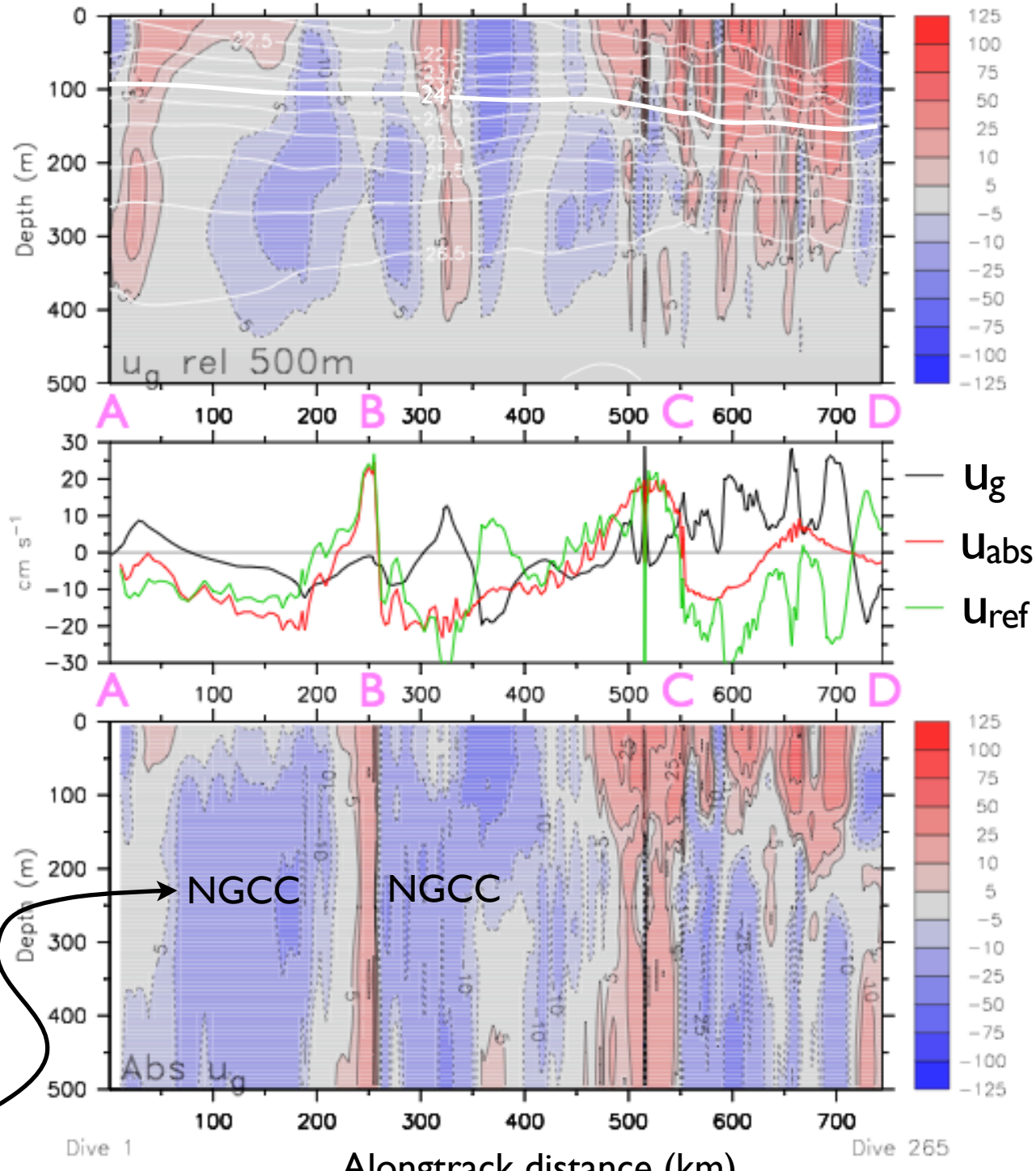
(Every other vector plotted)

Absolute crosstrack geostrophic currents from glider motion and relative geostrophy

1st mission



Isopycnals above 25 slope down across the Solomon Sea.
Upper shear is *southward*: WBC is an undercurrent.

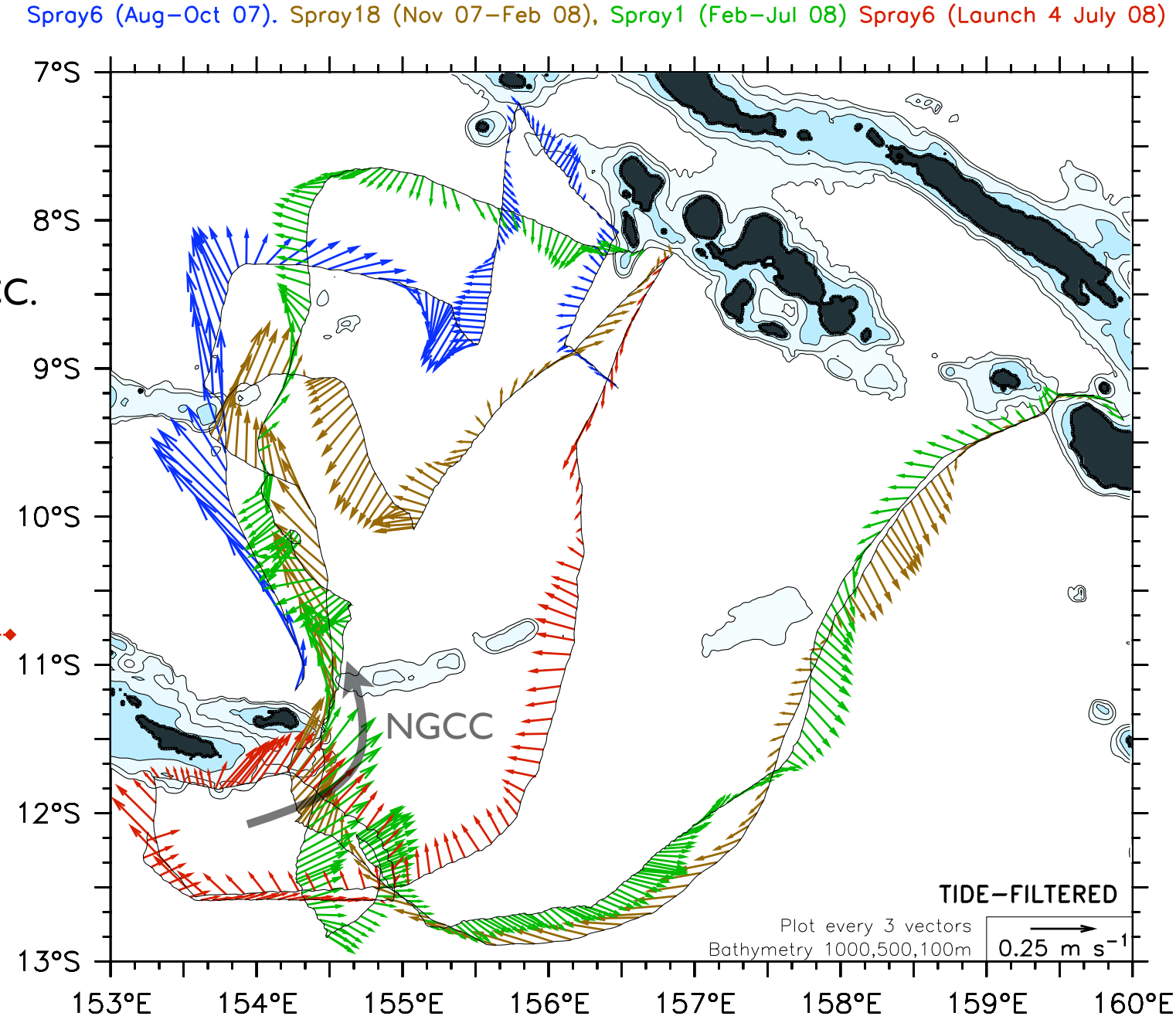


Glider currents: 4 missions in continuous rotation

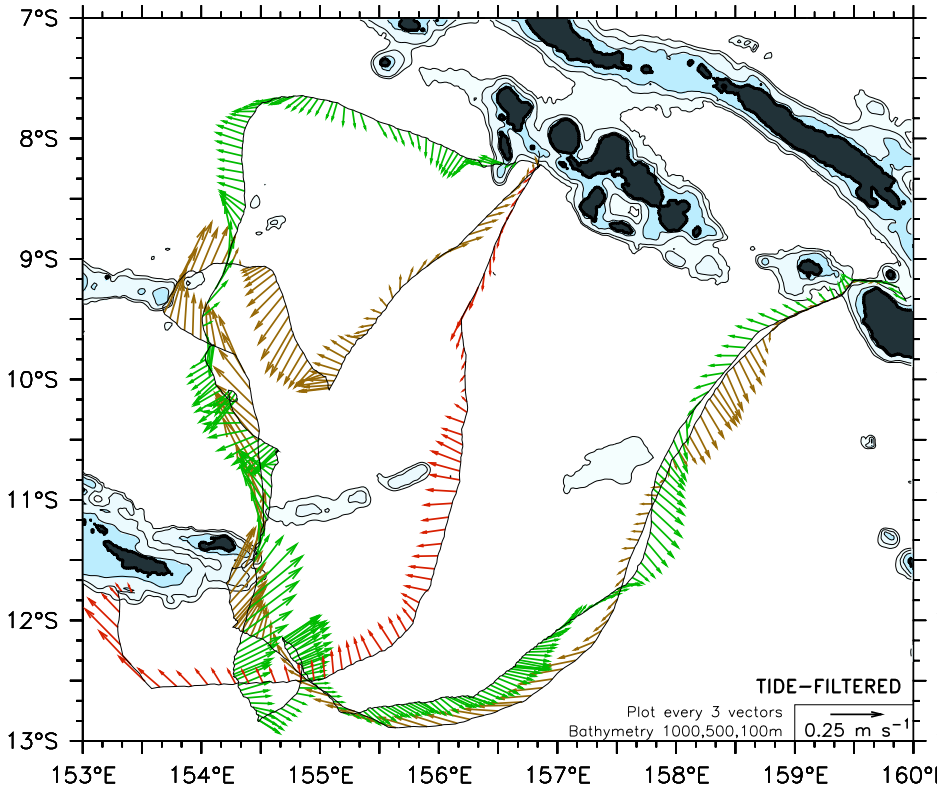
After 4 missions, is there a discernable "background"?

- The only consistent feature is a strong NGCC.
- Many of the large-scale features seen can be explained, but ....

Sampling is non-synoptic.

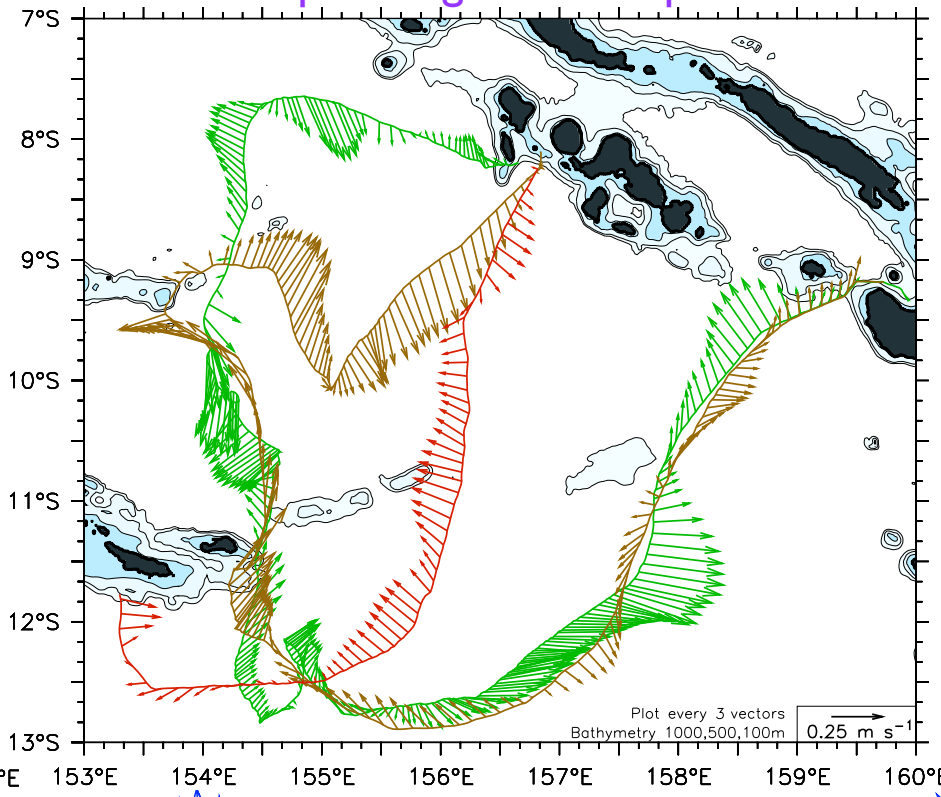


Observed currents



Bluelink (BOM/MOM4) model currents

Sampled at glider time/position

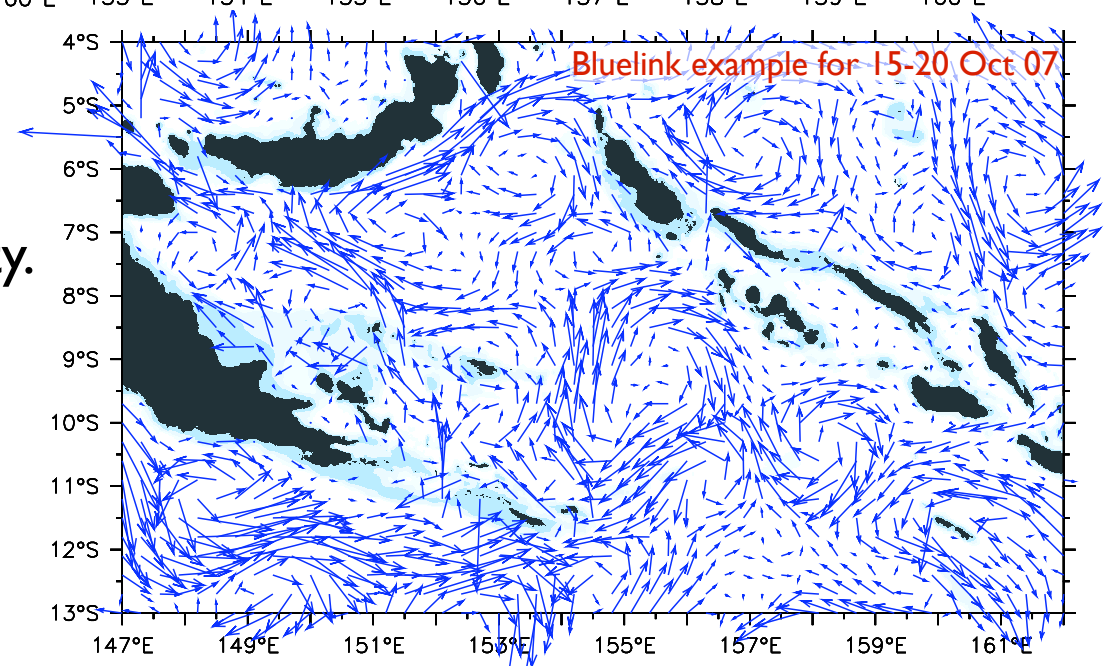


Model simulations help interpret the glider sampling (eddy vs large-scale).

Glider data helps evaluate model fidelity.

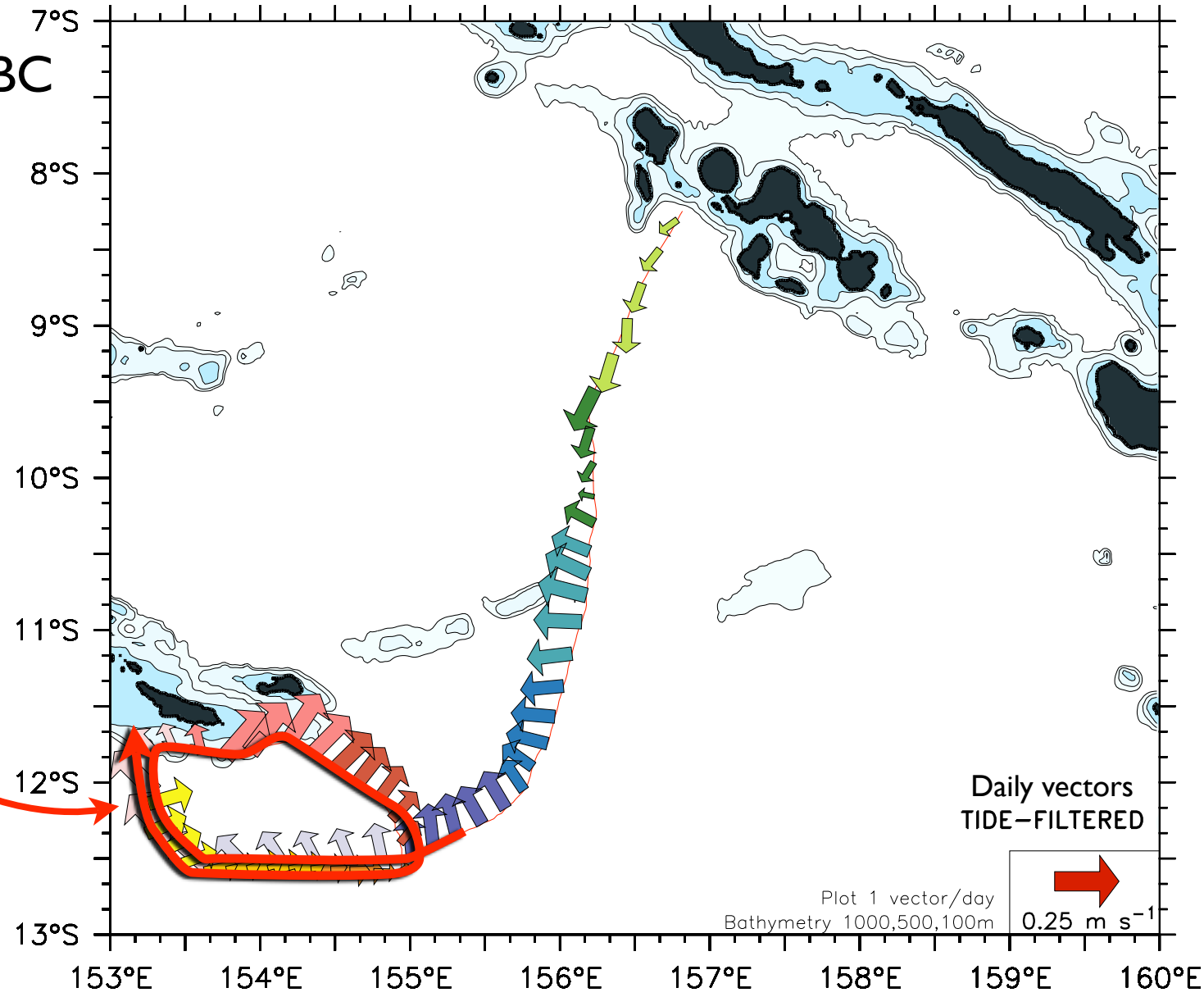
⇒ Collaboration with modelers.

Where is offshore "endpoint"?



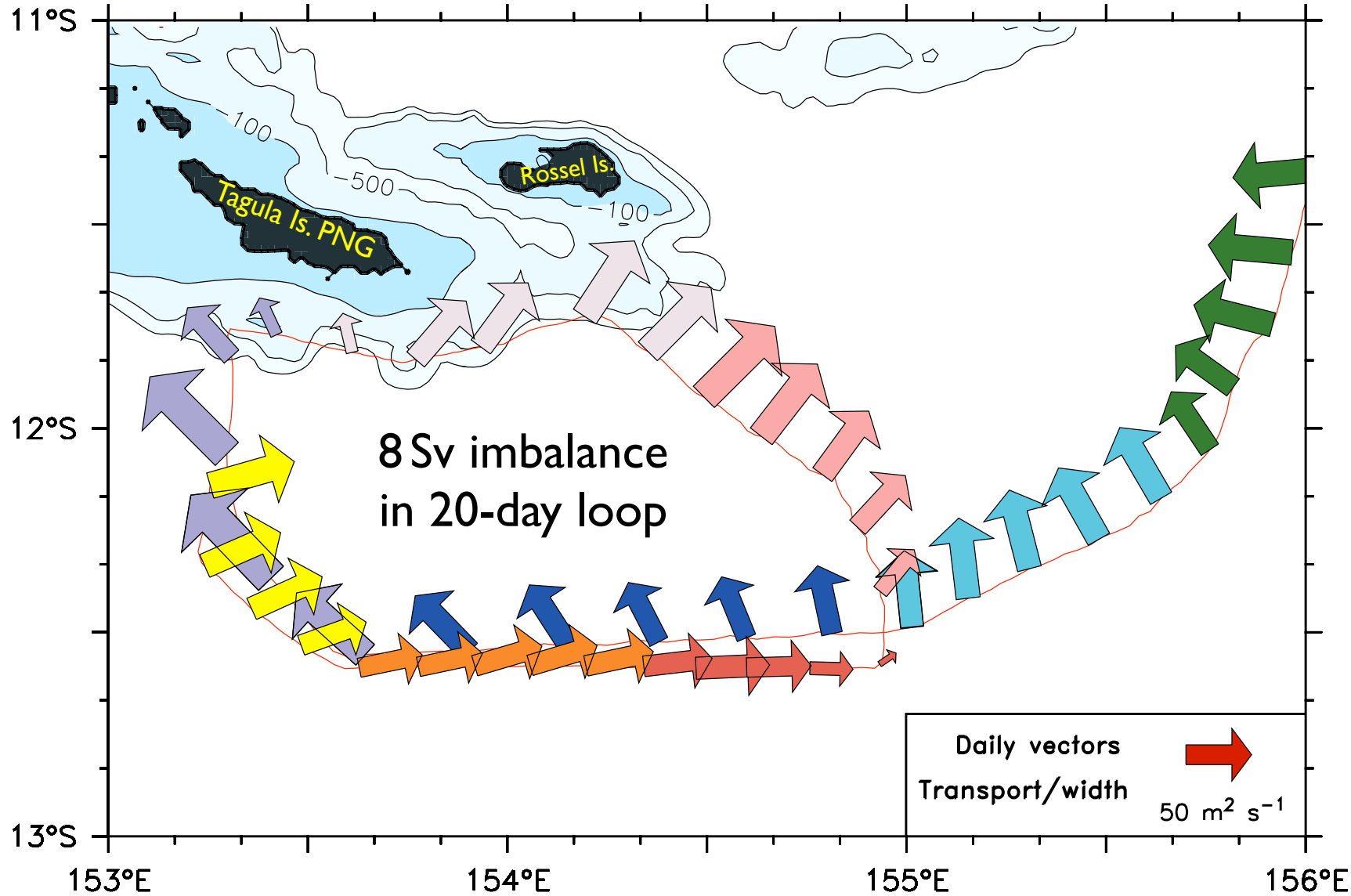
Glider velocity: 4th mission underway

Loop with multiple crossings of the WBC to test sampling



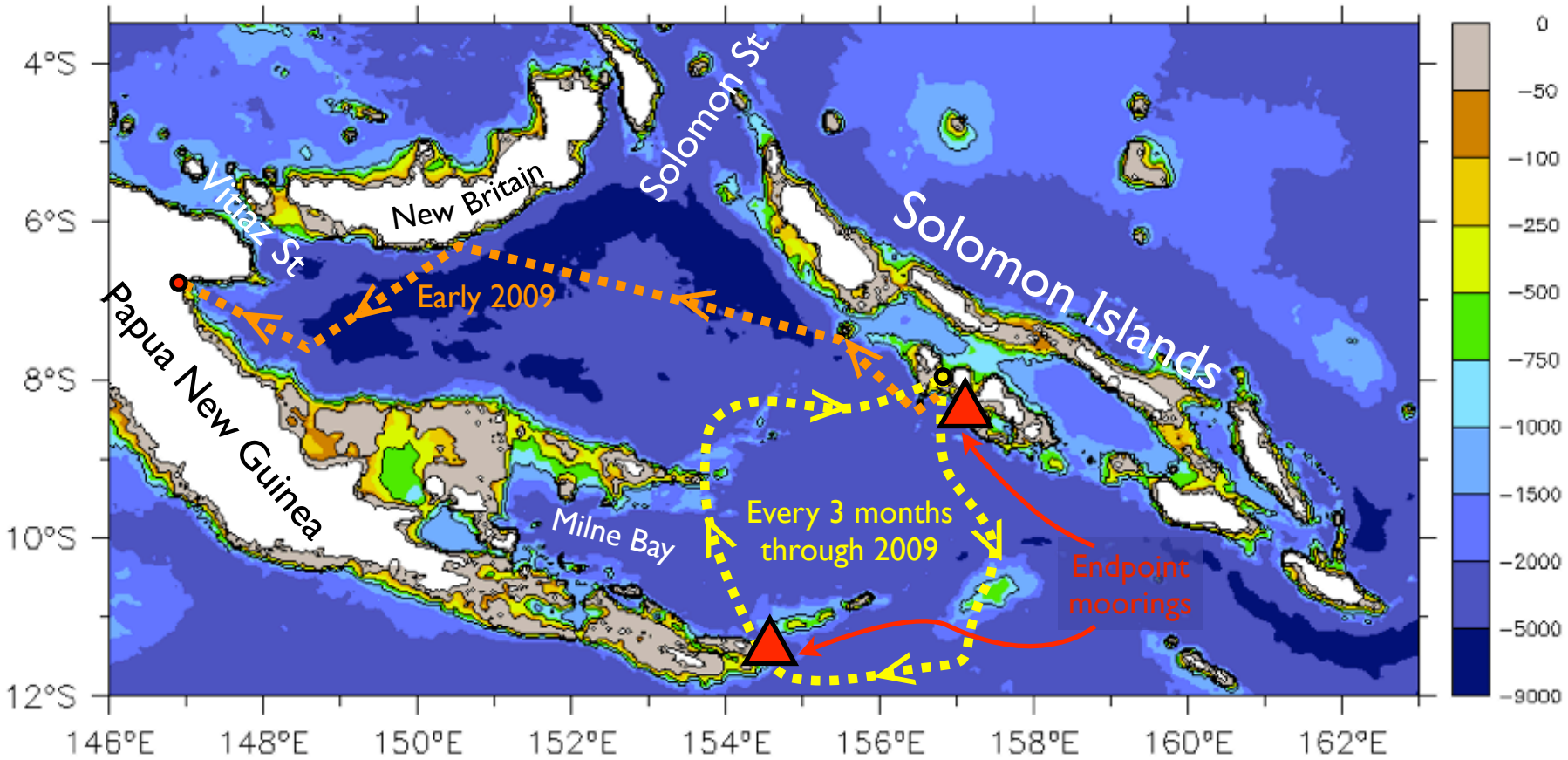
Glider transport: 3 crossings of the WBC in ~25 days

⇒ Non-synoptic sampling: Need additional information!



Future plans

- Funded (NOAA/Scripps/IRD) for deployments every 3 months through 2009. A test mission will attempt approaching Vitiaz St.
  ⇒ Sampling experiments. High-resolution model tests. Use of altimetric SSH.
- A France-Australia-SIO (CORC) experiment (SPICE) funded for 2010-2011.
  ⇒ Endpoint moorings (SIO) and straits moorings (SIO/CSIRO).



Thoughts on the role of gliders for global WBC monitoring

- Gliders are especially appropriate for boundary current monitoring:
  - Work close inshore, dense sampling, cheap.
- Glider motion is slow: non-synoptic sampling even for the relatively short scales of boundary currents:
  - Need complementary instrumentation, and integrate with models. Developing an observing strategy is one of the main goals of the present project. (Glider experiments, endpoint moorings, models).
- Significant logistical issues are different from usual at-sea obs:
  - Local charter boats (need familiarity on the ground, safety standards often much below ours, less-organized infrastructure).
  - Many regions that would be desirable to sample are impossible to work in (Philippines, ...).
  - EEZ issues are crucial, and host countries expect regular scientific interpretation and communication.

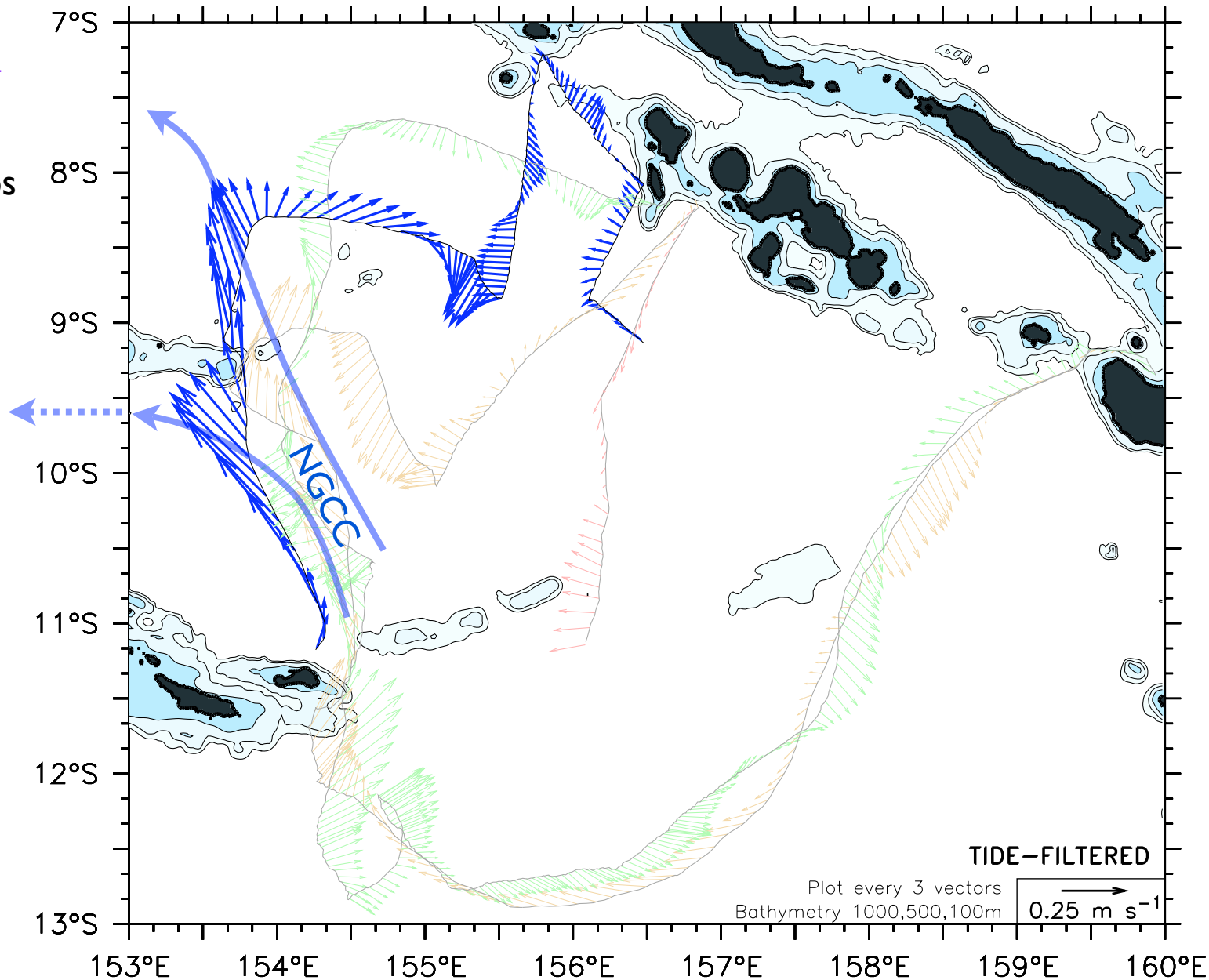
Extra Figures Follow ...

Glider currents: pre-La Niña

Aug-Oct 2007

Pre-La Niña, "normal"

- Strong NGCC, ~18Sv.
- Surprising that perhaps half the transport flowed through the narrow channels and reefs of PNG.

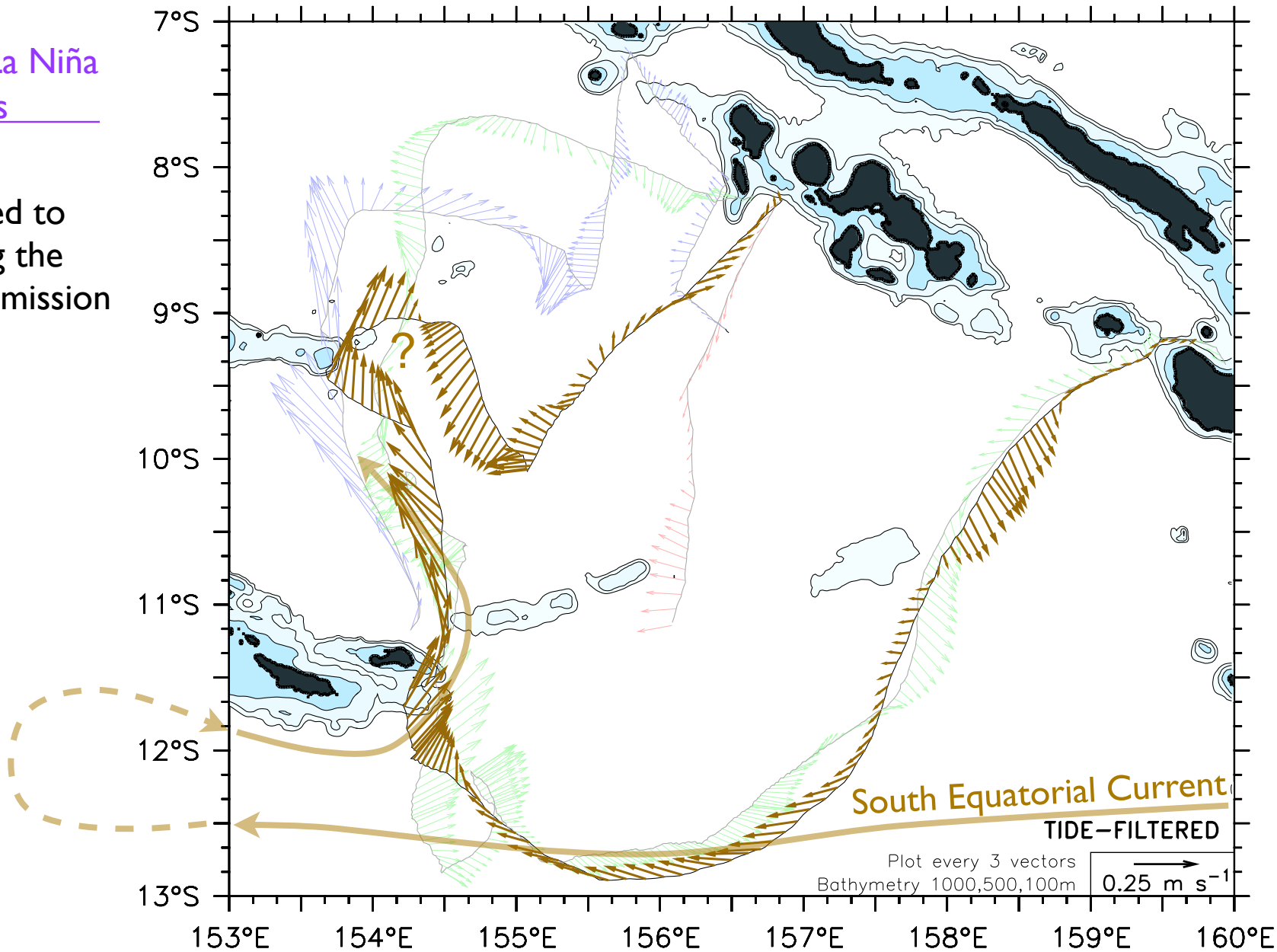


Glider currents: La Niña onset

Nov 2007-Feb 2008

Arrival of the La Niña Rossby waves

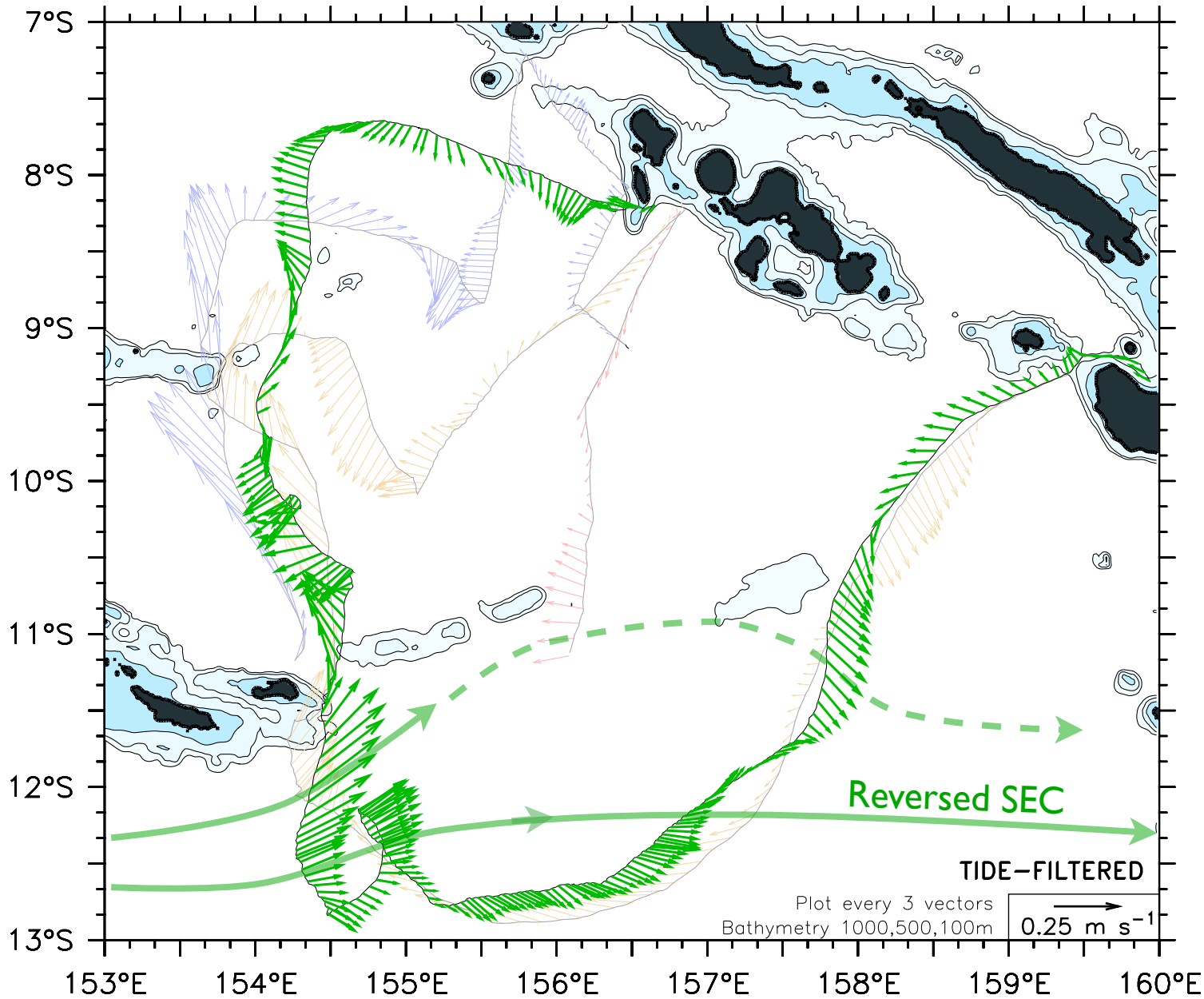
- Strong SEC
- NGCC seemed to reverse during the course of the mission (???)



Glider currents: Strong La Niña

Late in the La Niña

- SEC reversed !
- Weak, disorganized NGCC.



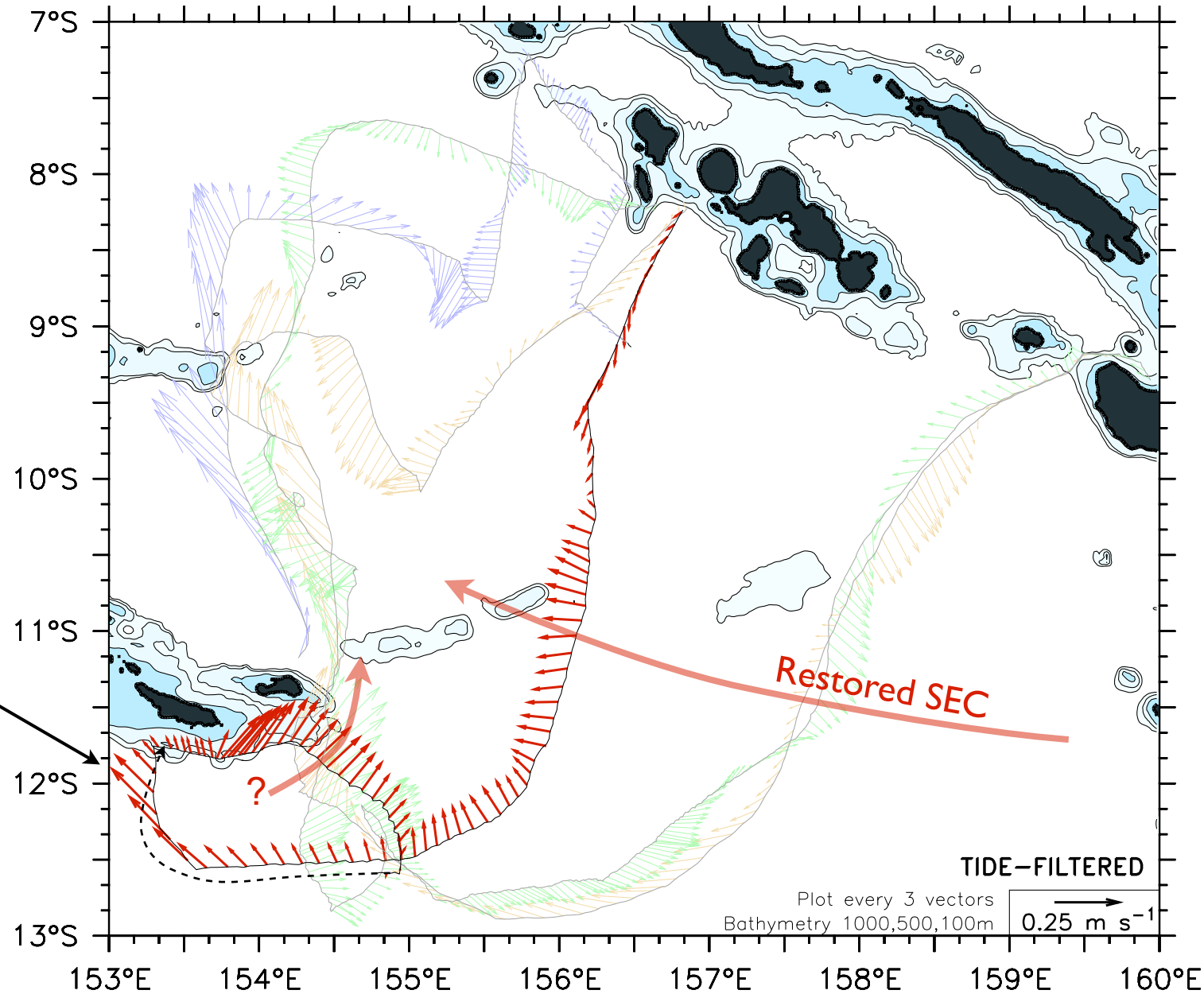
Glider currents: post-La Niña

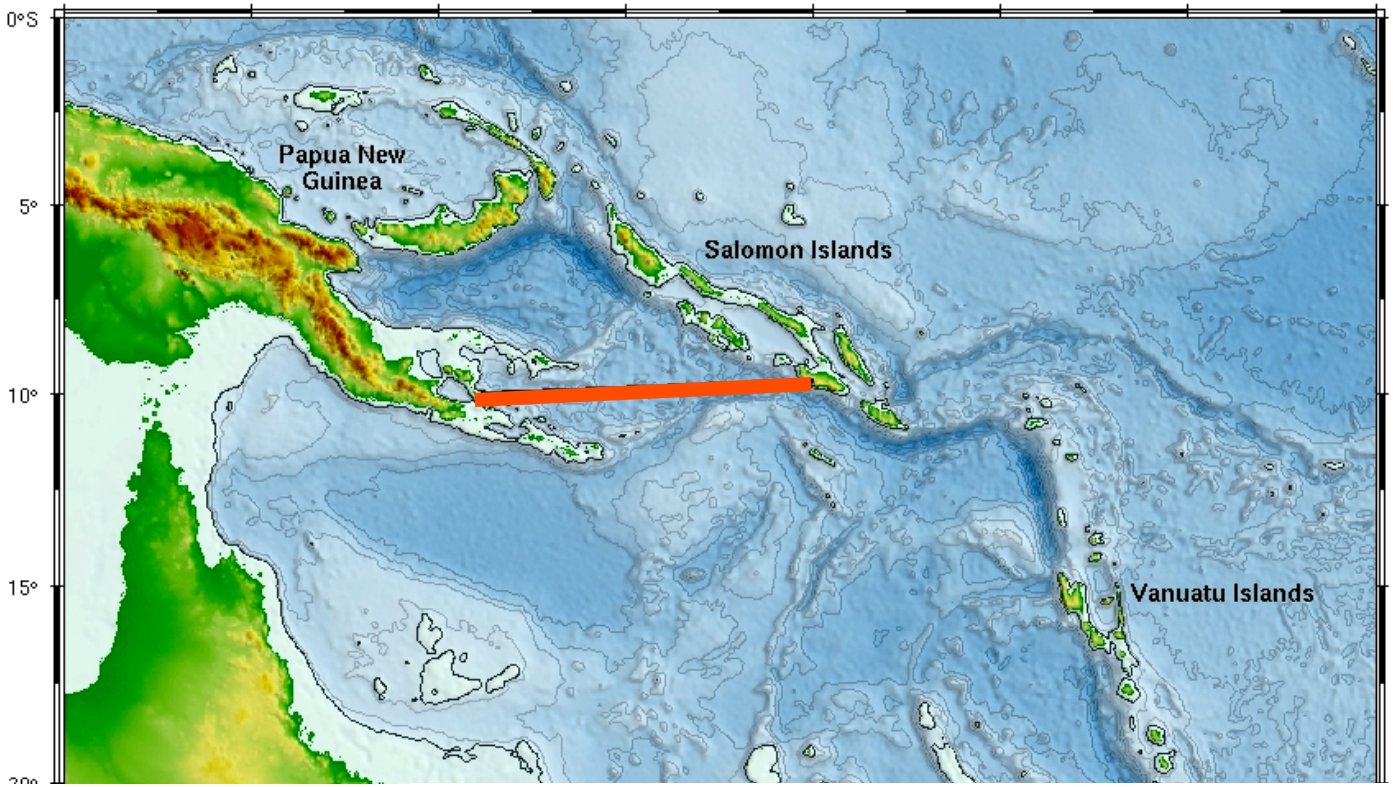
Jul-Aug 2008

Post-La Niña

- SEC, NGCC restored

Making double loop to test sampling





possible transport section across region feeding the EUC

Monitor amount of heat (v'T and vT') carried into EUC...