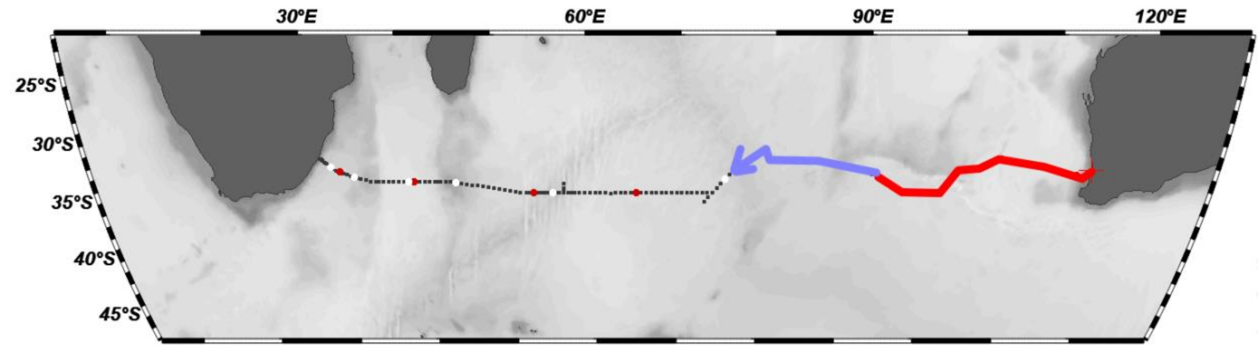
I05_2023 Weekly update 8/14/2023

Update 3 of 7

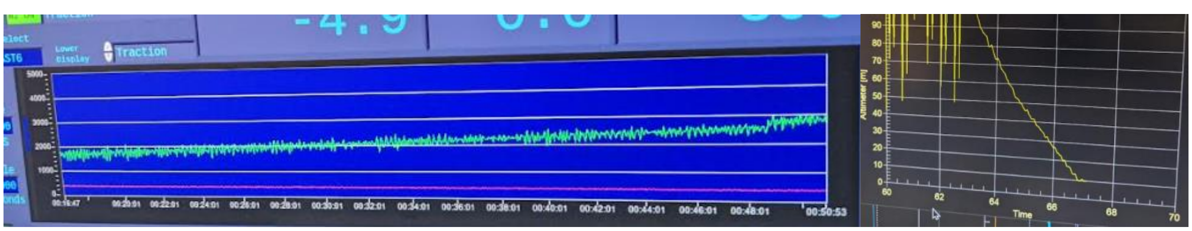


A map of our planned cruise track with the completed stations covered in previous weeks with a red line and completed since the last update with a blue line. Upcoming planned and potential float deployment locations have larger dots.

Highlights (as of 8/14)

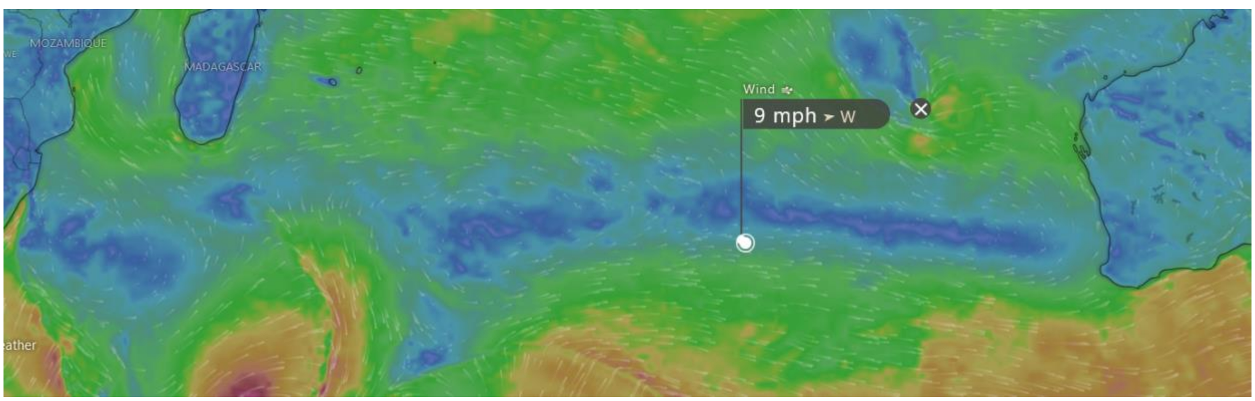
- 89 stations (32 new since last update) completed with 23 stations (8 new) with biological measurements, 6 of which were from separate bio casts.
- 6 floats (2 new) and 7 drifters (3 new) deployed: 1 SQUID float, 1 biogeochemical Argo float (*Sweet Caroline*), 2 "Directional Wave Spectra Barometric Drifters" (DWSBDs), and 1 drifter from the National Oceanographic and Atmospheric Administration (NOAA).
- ~0 hours of weather or mechanical delays!
- Can't get enough I05 updates? Check out the I05 blog with updates from scientists and crew appearing at the bottom as they are written.

All good news this week: The clouds parted before us and we were treated to a full week and then some of smoother seas, quick transits between stations, efficient deployments, and the nearest thing to sunbathing weather that we could hope for in the austral winter. Our scientists and equipment are hard at work, and we are moving briskly through stations. That's really the whole update!



These pictures might not mean much to most people, but they are almost certain to make an ex or current chief scientist smile. One the left we have the wire tension readout showing how much stress we are putting on the wire holding up our package of equipment (very low or very high numbers are both problematic) and on the right we have the altimeter readout showing how far that package is from a *crash landing on/into the usually-muddy seafloor (we need to get within 10 m of the seafloor, but never touch it). When the boat is bobbing or rocking, the wire causes the package to bob up and down, both of these lines become much wigglier, and the chief scientist becomes stressed. The package of sensors and bottles is worth as much as several James Bond's cars tied together (before Q's aftermarket modifications), so we try to be as good to it as we can be while repeatedly dunking it under several kilometers of salty water.*

When the seas and skies are calm, the boat can safely zip between stations, the winch can safely spool out wire at our maximum rate (of 60 meters per minute), and we can get the rosette and sensor package prepped and waiting on the deployment platform (which is exposed to waves in poorer weather) even before we get on station. Therefore, when everything is going our way, we can haul up a truly impressive amount of water in a week's worth of sampling. However, we eventually run into another limitation: our chemists still have to analyze everything brought aboard before they run out of sample bottles, a feat that is further challenged when we are relentlessly asking everyone to leave their analysis equipment to come collect new samples. Thus, this week had us looking for a bit *more* time between stations. Fortunately, we could make everyone a bit happier this week by reinstituting the separate bio casts for the last ~6 days.

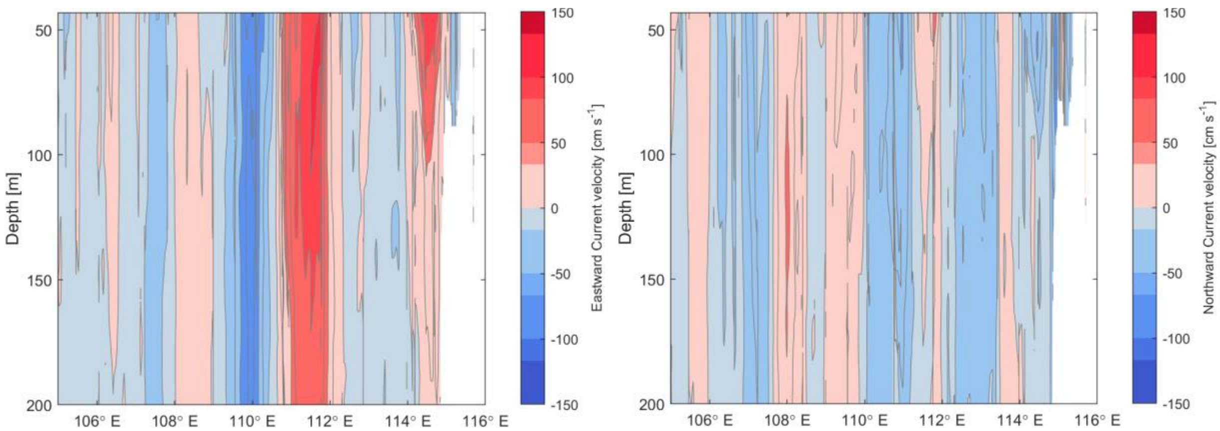


The entire I05 cruise track was briefly blessed with becalmed skies, though we've had a bubble of good weather even when the rest of the track did not.

I promised some data this week and so we will briefly turn back to what happened at station 12, when we saw very strong currents. Next week we will continue with some deep ocean temperature changes from Kay. I'm hoping the week after I'll be able to show some (very) preliminary anthropogenic carbon accumulation estimates relative to 2009.

Strong currents at stations 12 and 13 (added by Kay)

If you remember from the week 1 update, we experienced very strong currents at stations 12 and 13, which prompted us to continue to station 14 because we could not safely deploy the CTD at station 13. This isn't an area where we would expect strong currents – it was around 32° S, 112° E. The strong currents of the Leeuwin Current are generally confined closer to the coast, and we would expect relatively weak currents across the subtropical gyre. However, at stations 12 and 13 the shipboard ADCP measured eastward currents over 1.2 m/s! These strong currents were seen over the entire upper 200 m. There also appeared to be a strong bottom current at station 12: when the altimeter read 15 m from the bottom, we let out another 10 m of wire and the CTD depth did not increase at all. We repeated with another 10 m of wire and the CTD depth still did not budge. At this point, we had a large amount of wire out and decided to take 15 m from the bottom as our deepest bottle. As we continued traveling west towards station 14, the currents turned westward and were still relatively strong (about 0.5 m/s). Sea surface temperatures at station 12 were significantly warmer than climatology in July, based on Argo data. Strong isotherm tilt was present across the surrounding stations, consistent with geostrophic balance. We hypothesize that this was a warm core Leeuwin Current eddy, which generally propagate westward (with the ship's motion, as we transited from station to station), explaining the long period when we were in strong currents. Lowered ADCP data (coming soon) will give us more insight to the structure of the currents with depth and hopefully give us a better measurement of the near-bottom current.



Shipboard ADCP data highlighting the very strong east-southeast-ward currents near 111° to 112° E, with slower west northwest ward currents just to the west. The band of red in the panel on the left corresponds to the stations where the currents were pushing the CTD underneath the Revelle.

Okay, that figure was the data promised. Now, for the rest of this update I'll write about something that gets me and *very few* other people excited:

Data QC

(Feel free to tab over to the blog entries from our scientists at this point, I won't know or mind.)

GO-SHIP takes data quality very seriously. Our sensor package has two sets of temperature/pressure/conductivity sensors as well as a third reference temperature reading. Our salinity and oxygen measurements on the sensor package are double checked by direct laboratory measurements from every bottle, and the disagreement between these records can be a smoking gun for the rare (but inevitable) instances when our bottles close at a different depth than we intended. Relatedly, we put a lot of emphasis on quality control for all of our measurements, and our analysts have been quality controlling the data that they are producing as they are making measurements and submitting them to our joint data file. It is yet another task that we ask them to do to that becomes harder when they are dealing with an unending cavalcade of new samples.

Between stations, I've been experimenting with software that can help with data quality control on future cruises. The oceanographic community has recently been creating algorithms that can estimate seawater chemistry measurements from one another. For example, if the measured salinity is 34 ppt, the temperature is 4.25 °C, and the latitude/longitude/depth are …. etc., then the algorithm will guess that the dissolved inorganic carbon (DIC) should be, let's say, 2330 µmol kg^{-1}. These algorithms use regressions and various machine learning approaches and are surprisingly good at roughly estimating what the values will be based on past measurements. These estimates are still no substitute for a new measured value and they can never tell us anything truly new about the ocean or how it is changing, but it's still a neat party trick (provided your partygoers are easily impressed and have access to analysis instrumentation to confirm the accuracy of the guess, as they should). That said, one use the algorithms do have is that they are great at revealing when someone miss-typed, e.g., 2234 instead of 2324 µmol kg^{-1}, because the algorithm guess will suddenly be *much* more incorrect for that sample than it was for the samples measured nearby (from off by 6 to off by 96 µmol kg^{-1} in this made-up example that is in no way taken directly from my past experiences messing up data entry while sailing as a DIC analyst). Dr. Larissa Dias is a postdoc working in my research group on, among other things, turning some of these algorithms into code that will assist with cruise data set quality control by calling extra attention to anomalous values, and I've been happily experimenting with some of the associated algorithm logic at sea.

The scientists out here are doing a great job of QC-flagging the anomalous values already, so I'm more hoping their work will help mine rather than the reverse. As anyone who has worked with machine learning knows, there are few things better for algorithm development than well-labeled data sets. My hope is that we can use the estimation routines to generate offsets between the measurements and the estimates, and then we can train machine learning routines that relate those offsets to the expert flagging provided by these skilled scientists (and scientists on past GO-SHIP cruises) to predict how likely an experienced analyst might be to flag a given future value as questionable. The trained up algorithm can then help call the attention of future analysts—in particular analysts on non-GO-SHIP cruises that don't have the benefit of world class analysts doing their quality control—to measurements that could warrant extra QC attention. Relatedly, in past analyses of ocean change I've incorporated datasets from older cruises where the information has been lost about whether quality control was done at all. In these cases, such machine learning tools could do a first pass at flagging outliers even without the benefit of being able to track down the analysts to ask them about their measurements.

More to come in future weeks

Research Technicians Jessica McLaughlin (left) and Royhon Agostine (right) awaiting a CTD recovery while enjoying the glow of an Indian Ocean sunset. Photo credit: Jomphol Lamoonkit