RV SONNE

SO298 "Equatorial Pacific GEOTRACES GP11"

April 14 - June 2, 2023

Guayaquil (Ecuador) – Townsville (Australia)

3rd Weekly Report (April 24 - 30, 2023)

On the equator with the EUC and assessing particles in the ocean

We are now just over 2 weeks into our cruise programme, and sailing along the equator at 124°W (236°E) towards the Islands of Kiribati. We are still sailing into the currents, which us slowing us down. But as projected by the models shown in Windy.com, the strength of the west to east currents should be decreasing as we progress towards the west. Instead of 3 to 4 knows a few days ago, the currents have today decreased to 1.5 knots. In a few days time we hope that there will be no currents opposing the ship's direction but perhaps a current carrying us faster to Kiribati. The wind has now picked up and is pushing us faster to the west.

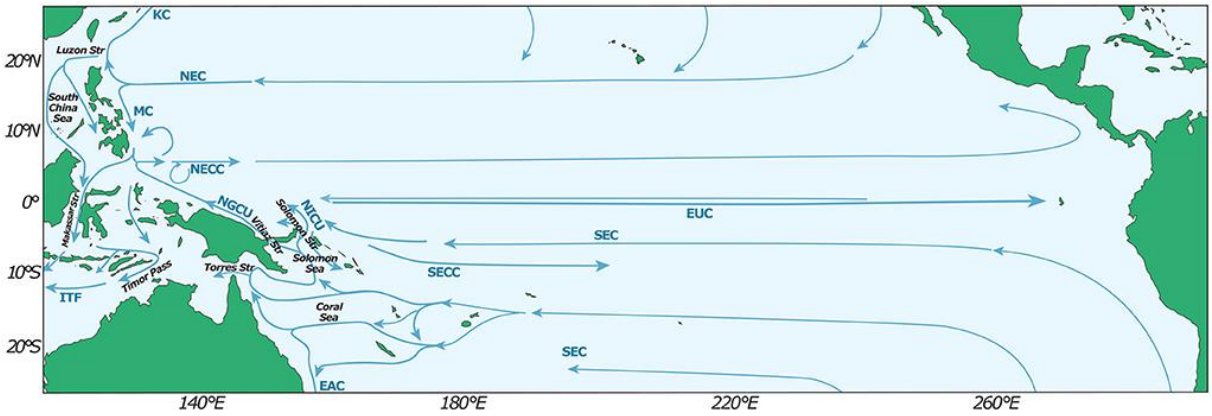

Fig. 1: Current systems in the Pacific Ocean. Surface current in the equatorial Pacific is typically from east to west, and Equatorial Undercurrent is below 50 m. Figure from Stellema et al., 2022. The position 260°E equates to 100°W.

As mentioned in my weekly report from last week, the current in the surface waters is the Equatorial Undercurrent (EUC; Fig. 1), which is typically found at depths below 50 m, but has decided to surface for our cruise. We expected a surface current from east to west (Fig. 1), with speeds up 2 knots, but the situation is different at the moment. There is a gradual deepening of the EUC from ca. 70 m to 200 m from east to west with the deepening of the thermocline (Fig. 2). The EUC typically sits between ±2° latitude and reportedly reaches a maximum of ~1.15 ms^{-1} near 120°W (240°E), but our own observations in the surface ocean were stronger. The EUC carries colder nutrient-rich waters from the west Pacific to the east Pacific upwelling regions, and thereby facilitating high primary productivity and the development of oxygen minimum zones. We observed high nutrient concentrations over the last week in surface waters, with nitrate levels up to 8 µM (Fig. 3), facilitating enhanced productivity along our cruise track.

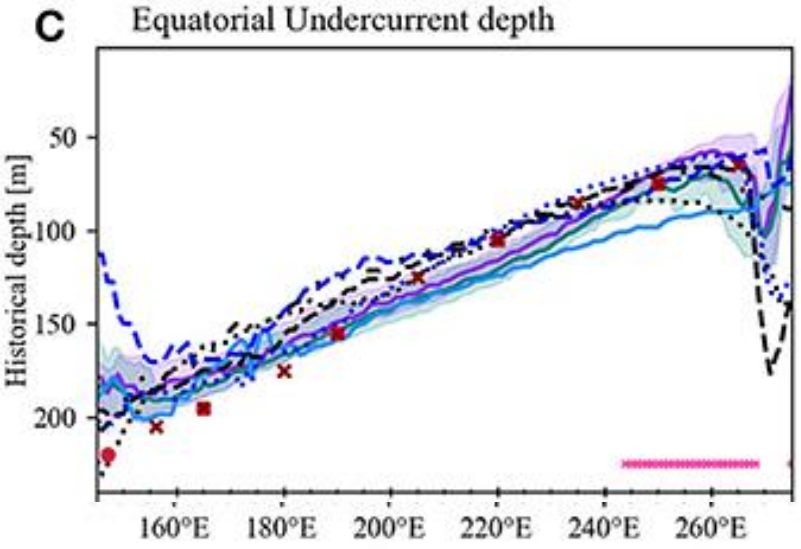

Figure 2: Observed (red dots) and modelled depths of the EUC. The position 260°E equates to 100°W.

Citation: Stellema A, Sen Gupta A, Taschetto AS and Feng M (2022) Pacific Equatorial Undercurrent: Mean state, sources, and future changes across models. Front. Clim. 4:933091. doi: 10.3389/fclim.2022.933091

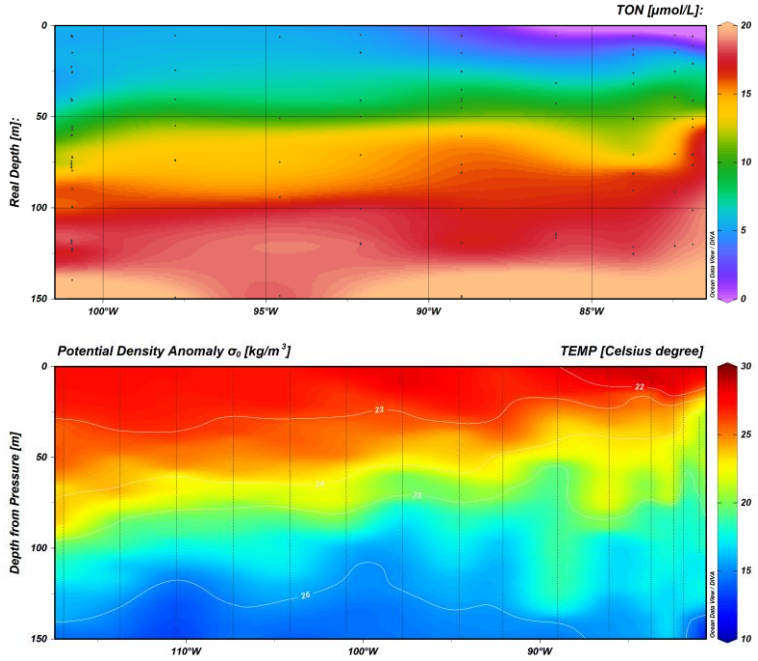

Figure 3a: Temperature (colours) and potential density anomaly (contours) section from Ecuador to 115°W, indicating gradually deepening of pycnocline and thermocline from east to west. Fig. 3b, Section of nitrate+nitrite (TON) from Ecuador to 105°W, indicating nitrate depletion in surface waters in the east towards Ecuador, but replete nitrate concentrations west of 90°W in the shoaled EUC.

We have just finished station 17 and are sailing west again. We have daily stations that last between 6 and 11 h, and after the stations we sail for about 20 hours to the next station. The start time of the stations therefore changes on a daily basis, and sometimes we can sample and handle the samples during the day, and at other stations we do the work deep into the night.

Underwater Vision Profiler: We are deploying an underwater vision profiler (UVP) on our stainless steel CTD frame (Fig. 4). The UVP 5 is provided by Rainer Kiko (GEOMAR) and operated on board by Anton Theileis, The UVP provides high performance images using a camera that takes rapid pictures of an illuminated parcel of water under the CTD frame. The camera can observe zooplankton and macroscopic particles with a size > 100 µm. A depth profile along our SO298 transect of the UVP data is shown in Figure 5, with enhanced particle (>125 µm) concentrations at a depth of ca. 50 m (chlorophyll maximum). The enhanced particle abundance is related to primary production in the euphotic zone with also increased numbers of zooplankton.

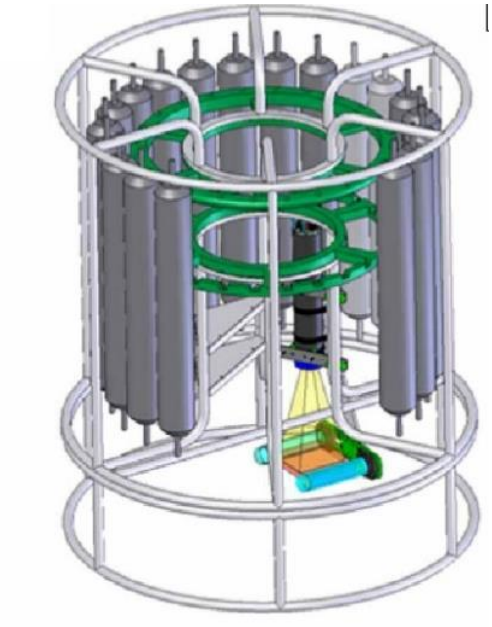

Figure 4: The UVP system in use on SO298. View of the UVP lamps that illuminate a volume of seawater to allow camera to image particles and zooplankton (modified from Picheral et al., 2010, modified by Chris Galley).

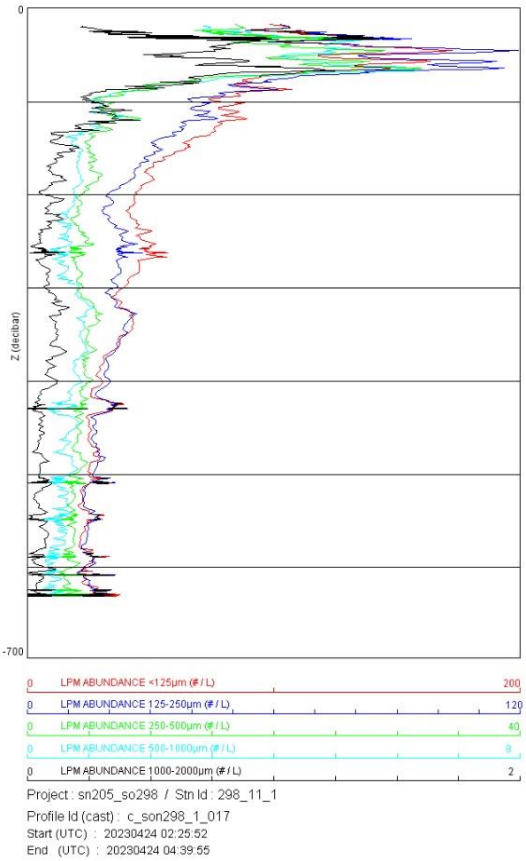

Figure 5: The UVP data with vertical distributions of various particle sizes (station 17, 0°S, 123°W). Maximum in particles numbers at ca. 50 m in the chlorophyll maximum. Data are not yet processed.

Algorithms exist to convert the UVP observations into a sinking particle flux. Our cruise provides the exciting opportunity to combine the UVP data (and calculated sinking flux) with 234 Thorium-238 Uranium disequilibrium based particulate carbon export. This will facilitate the validation of the UVP sinking flux algorithms.

RV SONNE at sea 0°S/124.0°W

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You can follow our Ocean Blog at http://www.oceanblogs.org/so298

Figure 6: RV Sonne sailing towards Australia along the equator in the Pacific Ocean. Photo: Rieke Schäfer.