US GEOTRACES South Pacific and Southern Ocean section cruise (GP17-OCE)

Cruise leaders: Ben Twining, Jessica Fitzsimmons, Greg Cutter

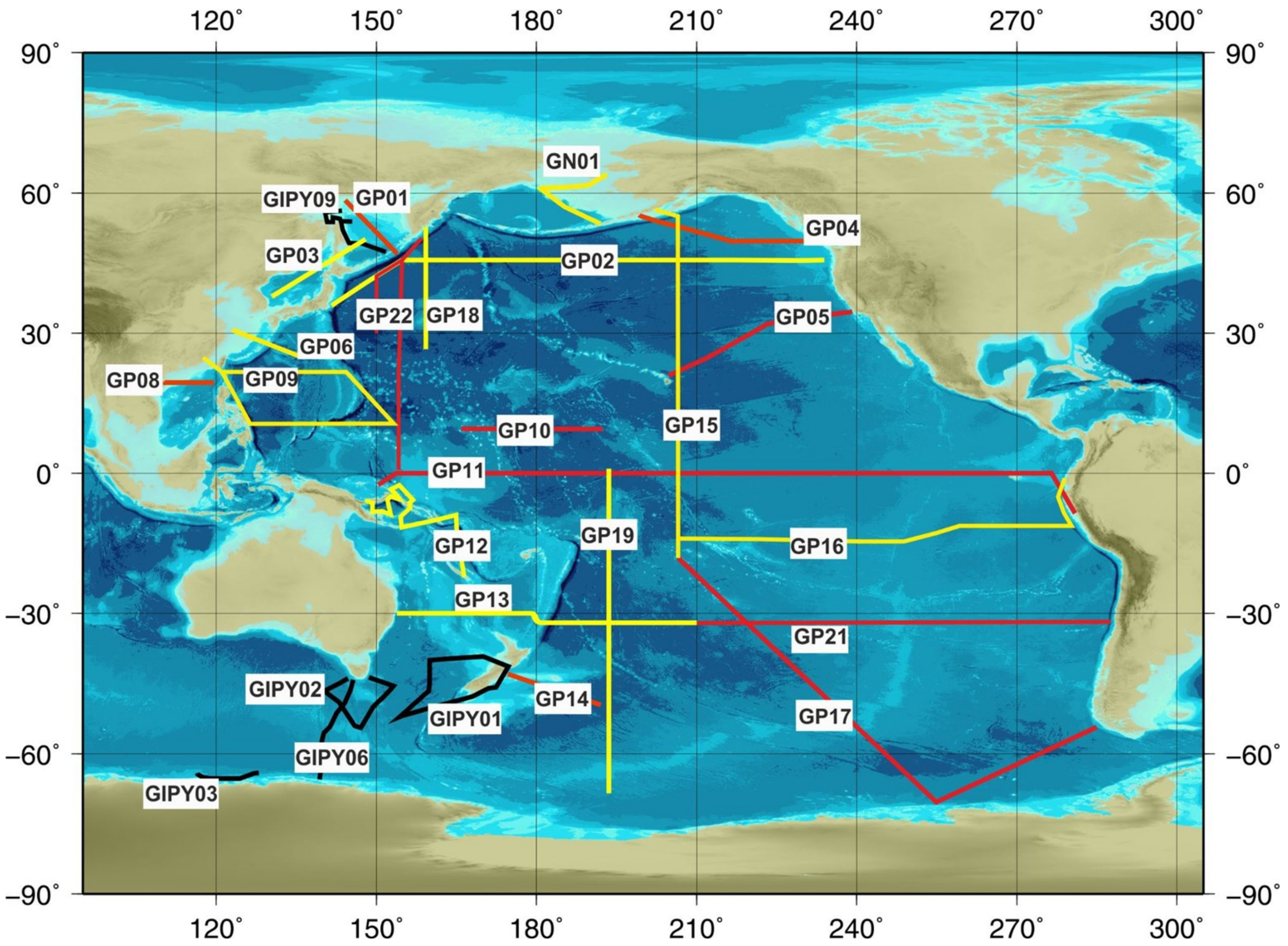
Pre-Cruise Workshop

18-18 March 2022

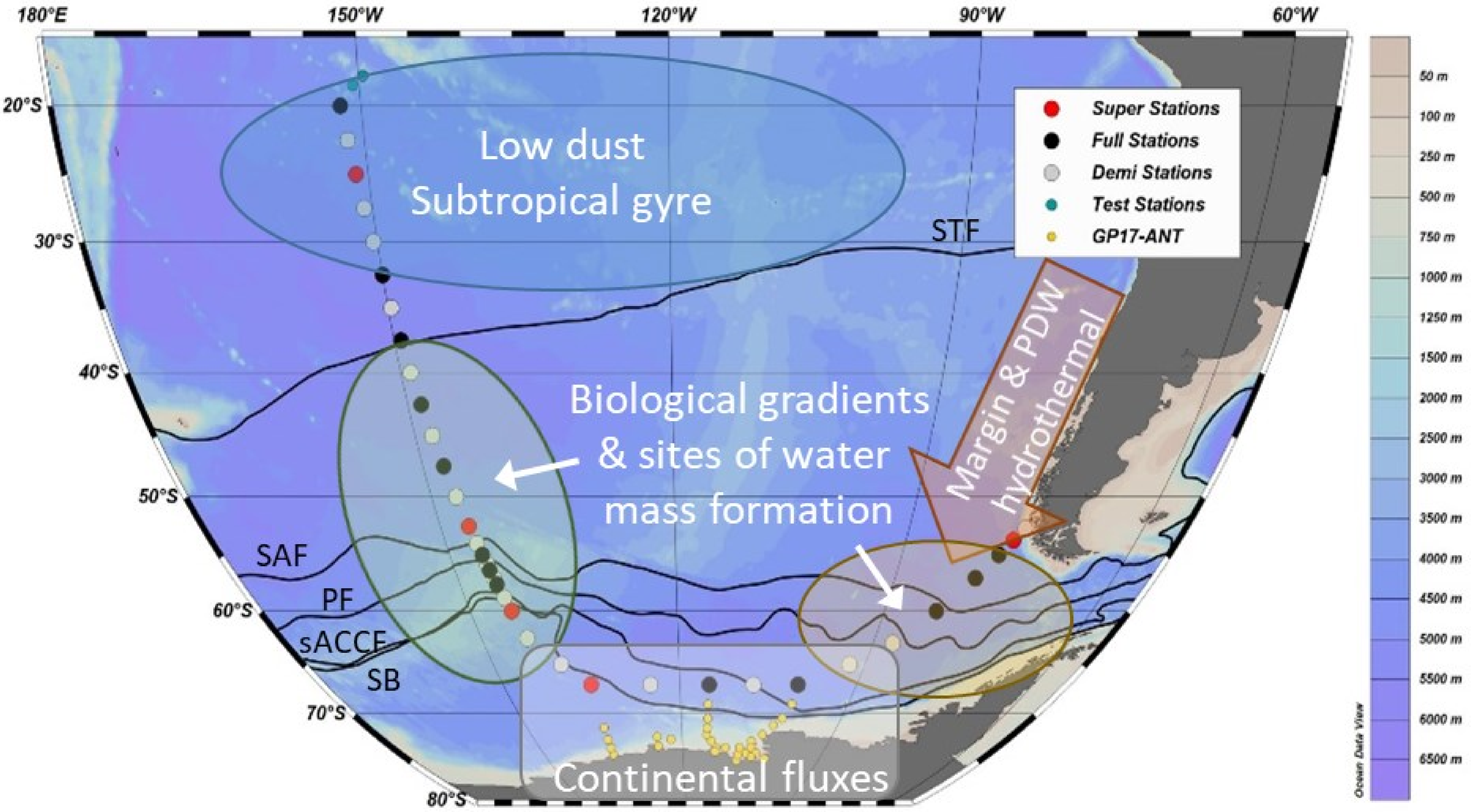
Old Dominion University

- Cruise Overview
- Management Team responsibilities
- Issues to be resolved at this workshop

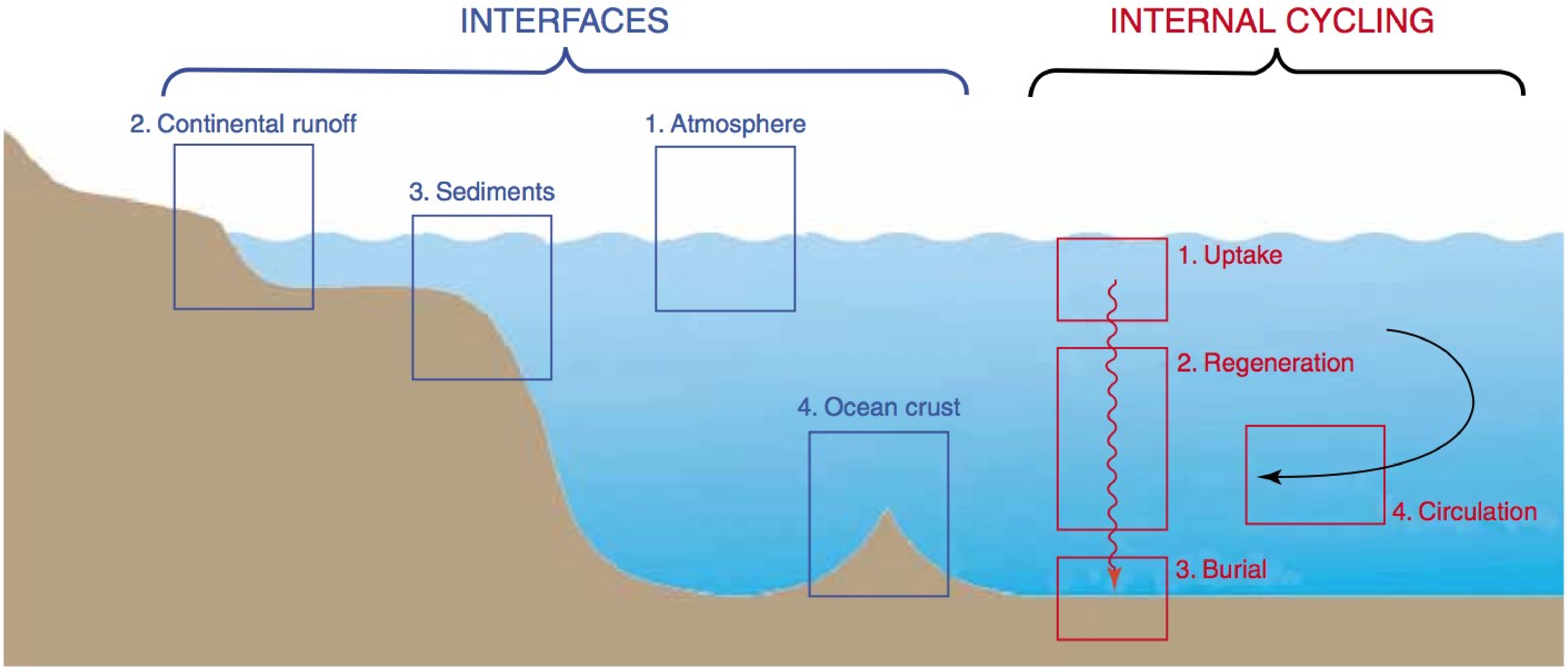
GP17-OCE in the context of Pacific basin cruises



Proposed cruise track

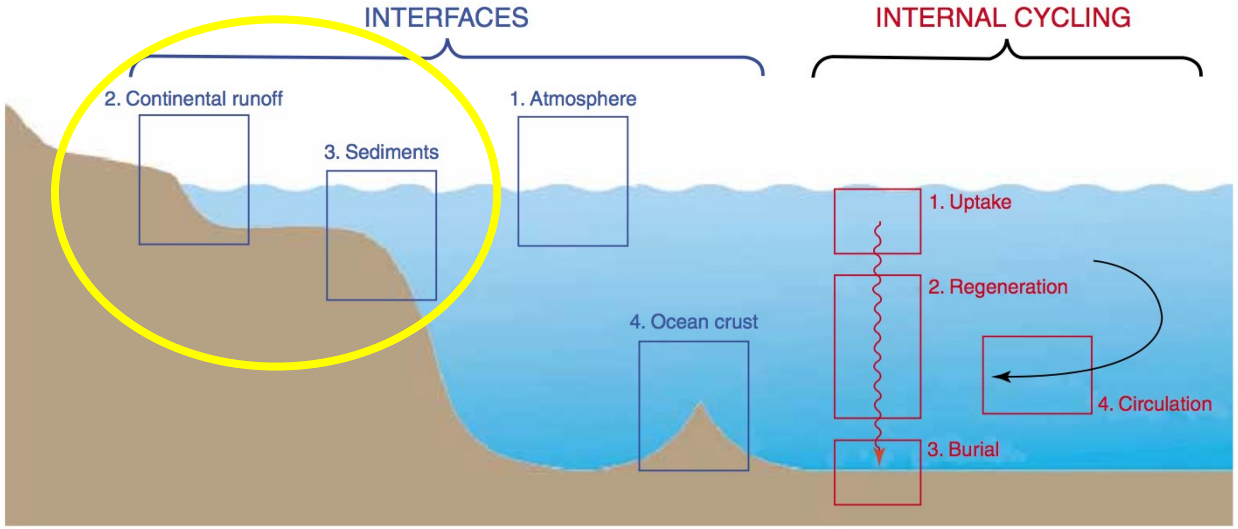


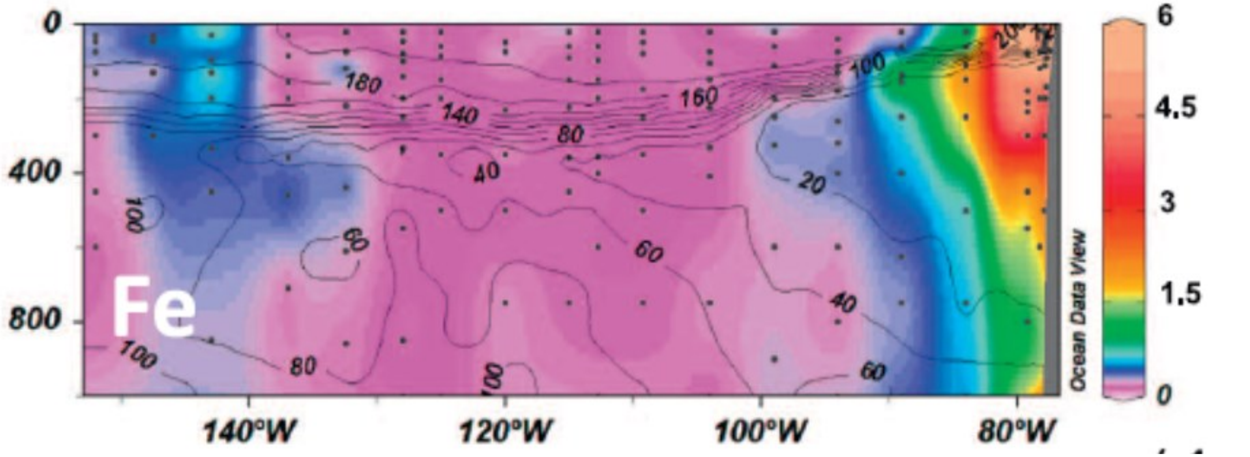
GEOTRACES Science Questions



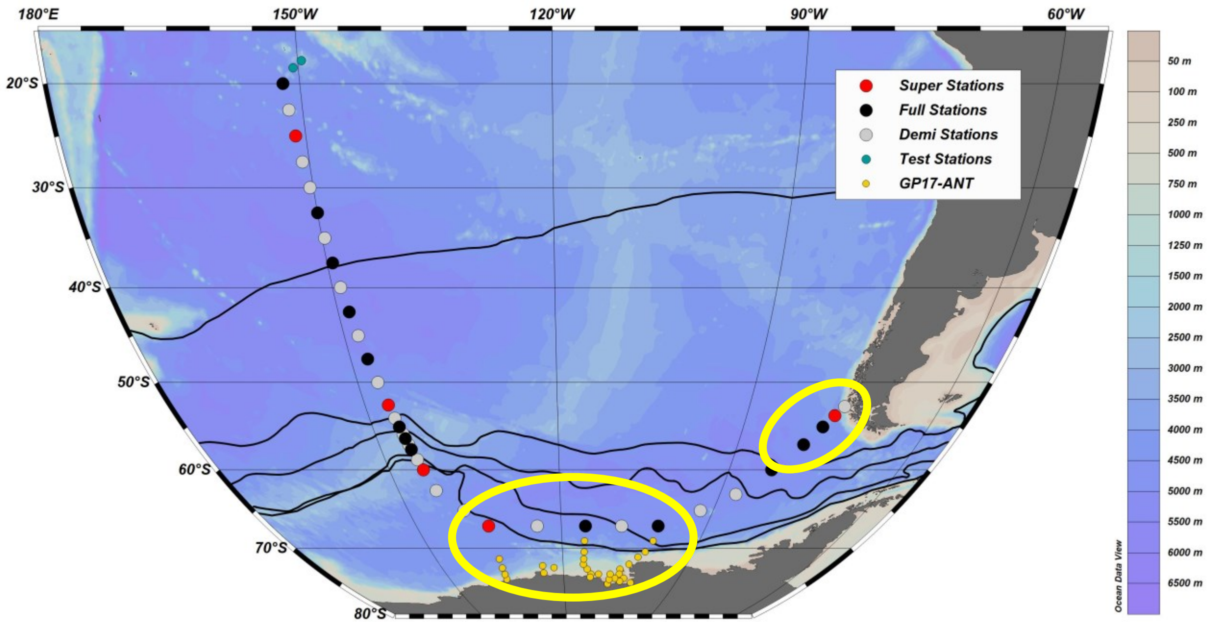
All of these can be examined on the GP17-OCE cruise

Margin interfaces

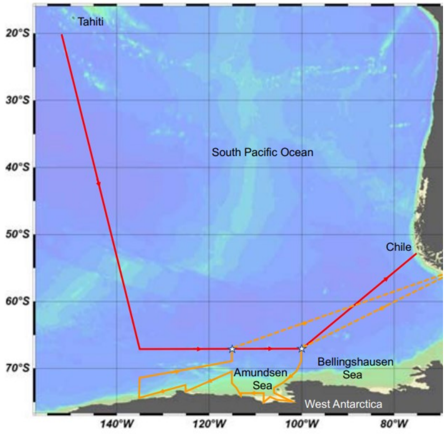


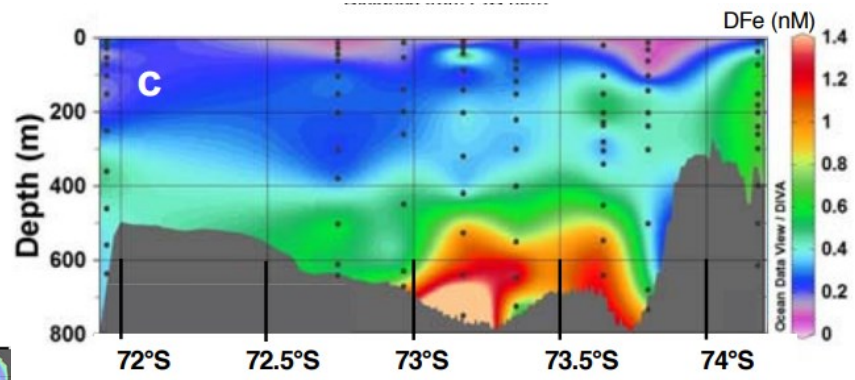


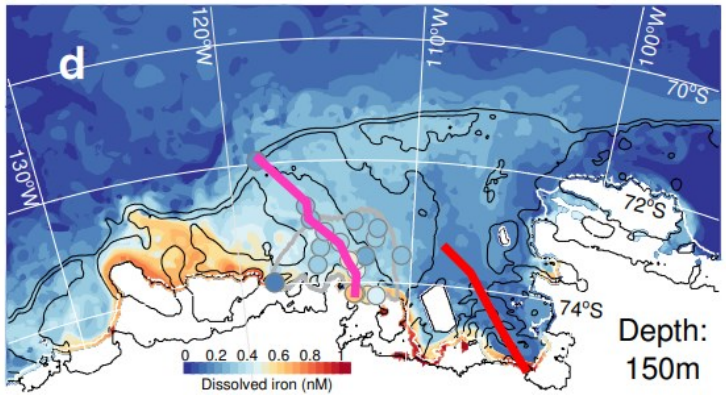
(Lee et al. 2017)



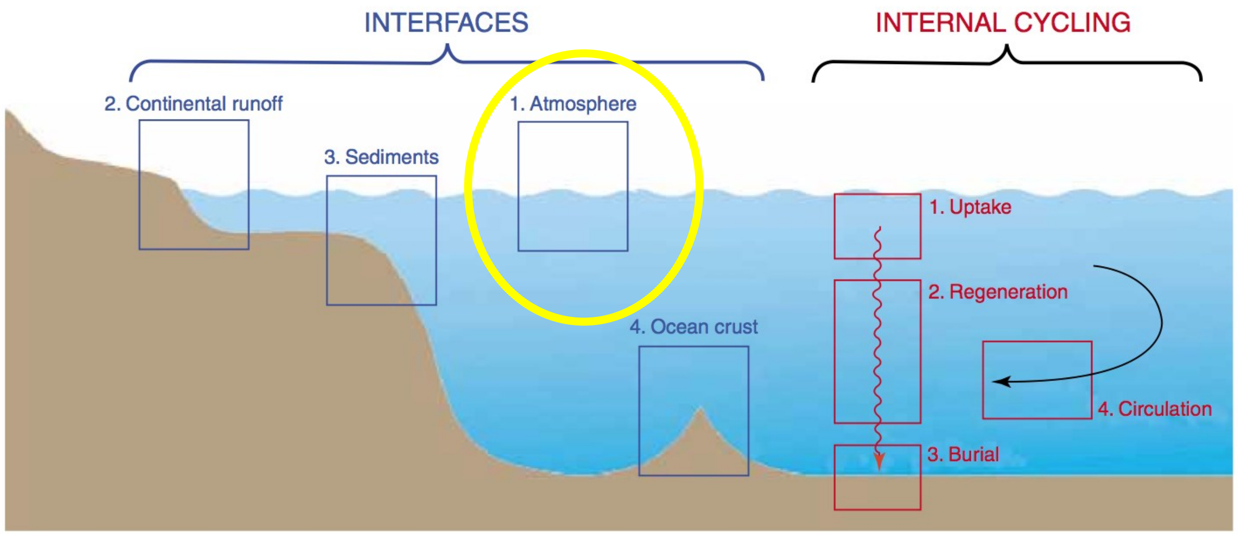
(Sherrell et al. 2015, St-Laurent et al. 2019)

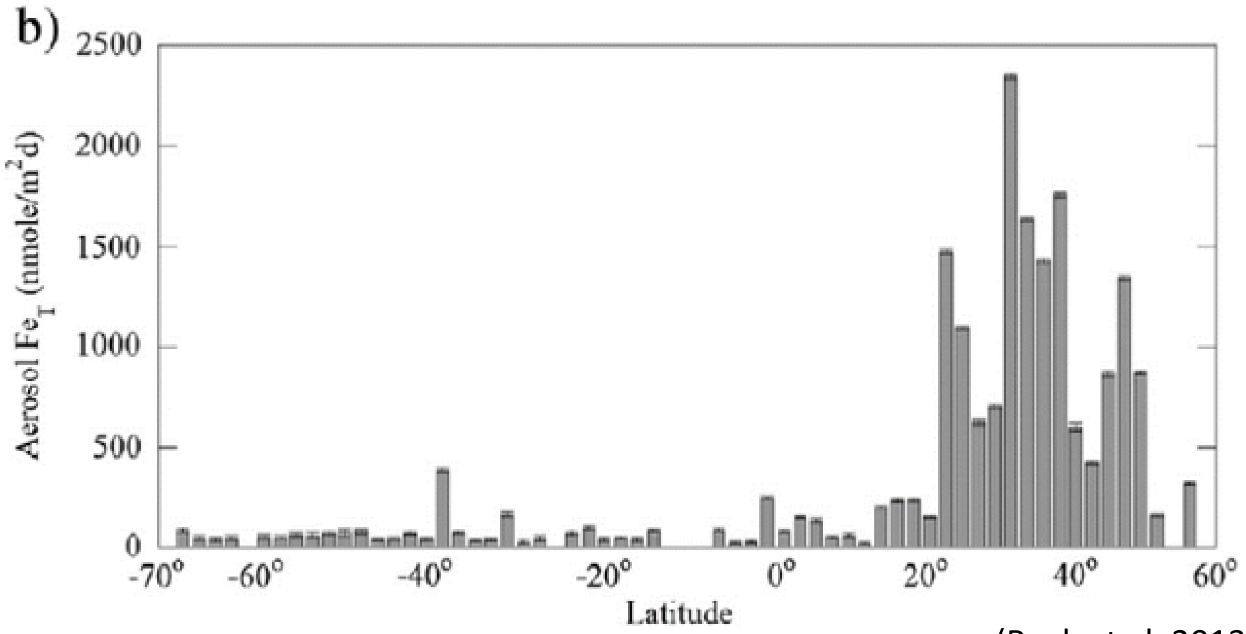






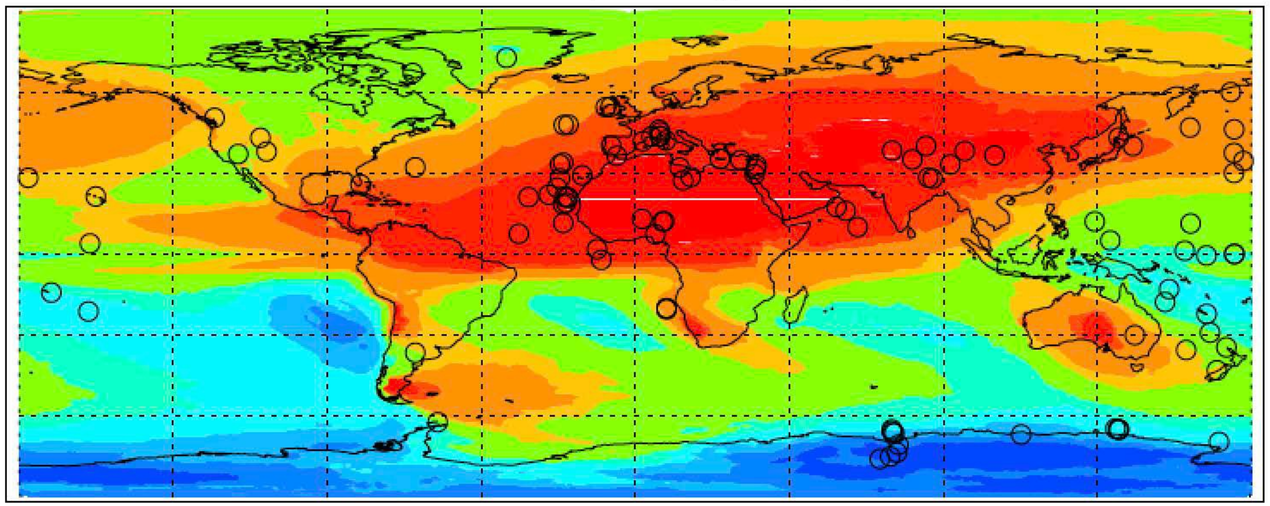
Atmospheric interface

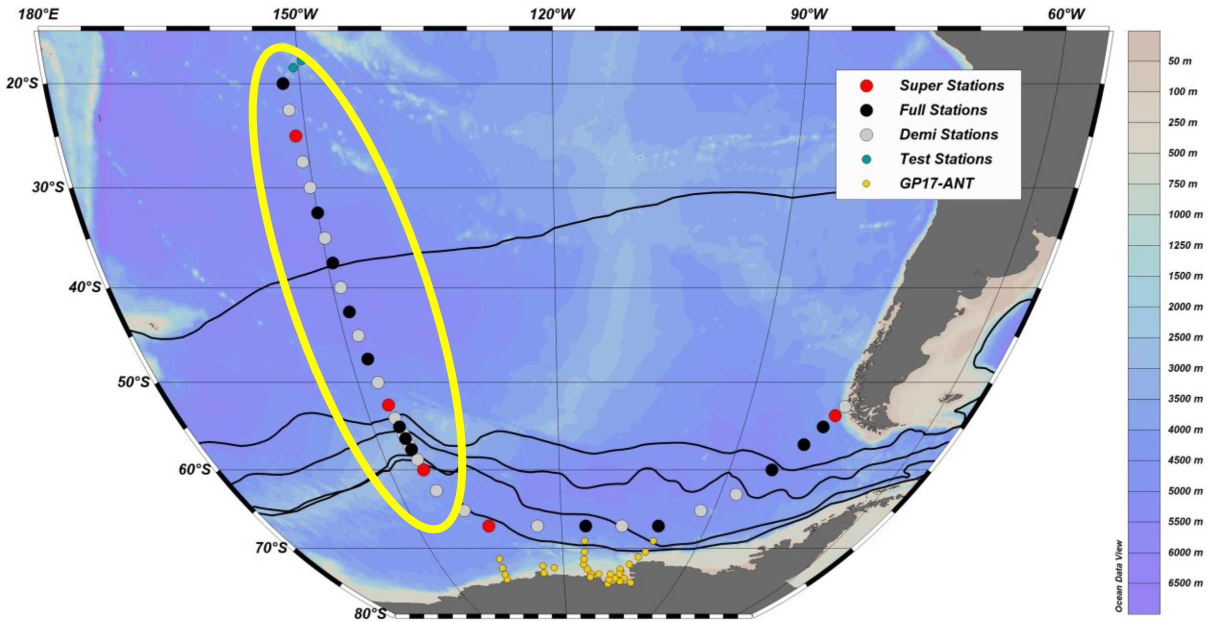




(Buck et al. 2013)

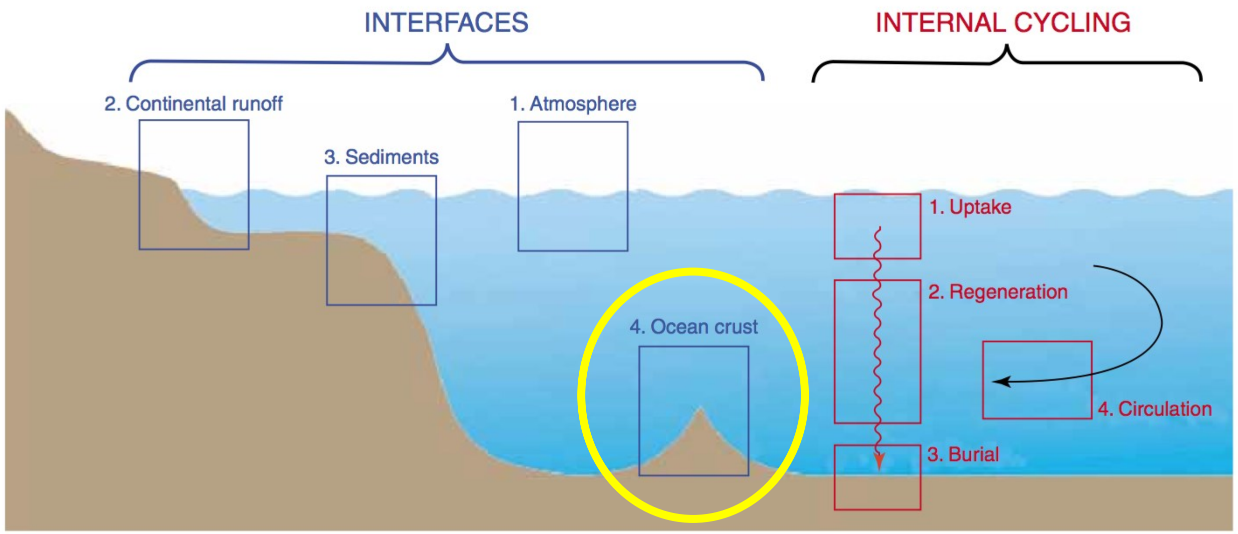
b. Model Deposition (g m^{-2} yr^{-1})

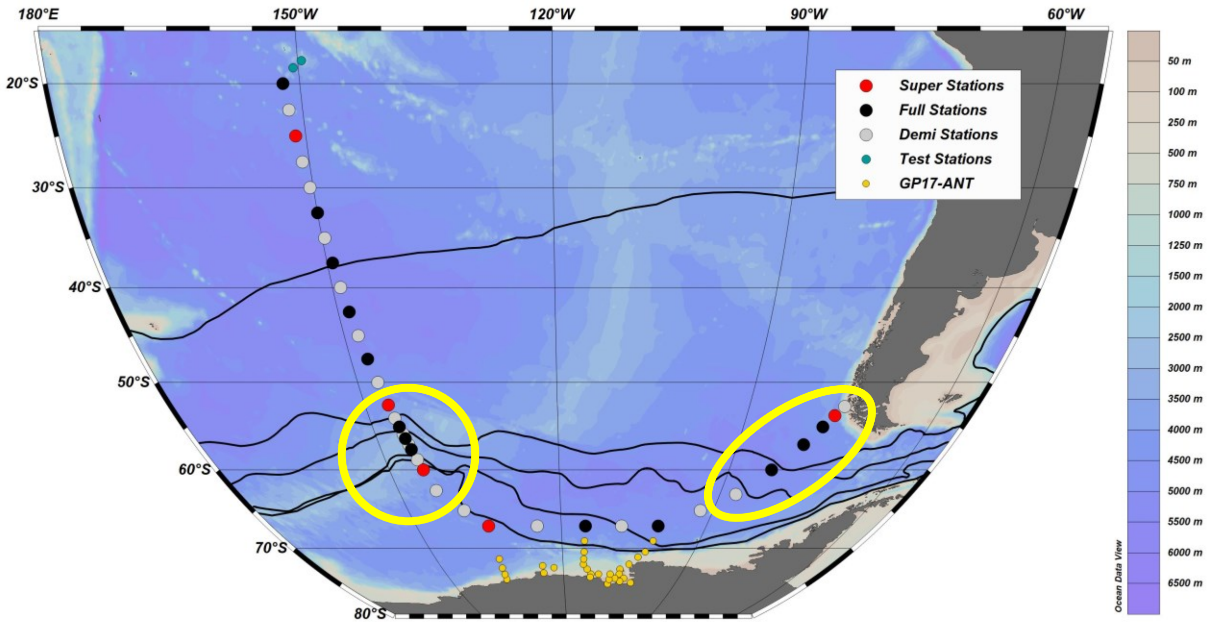


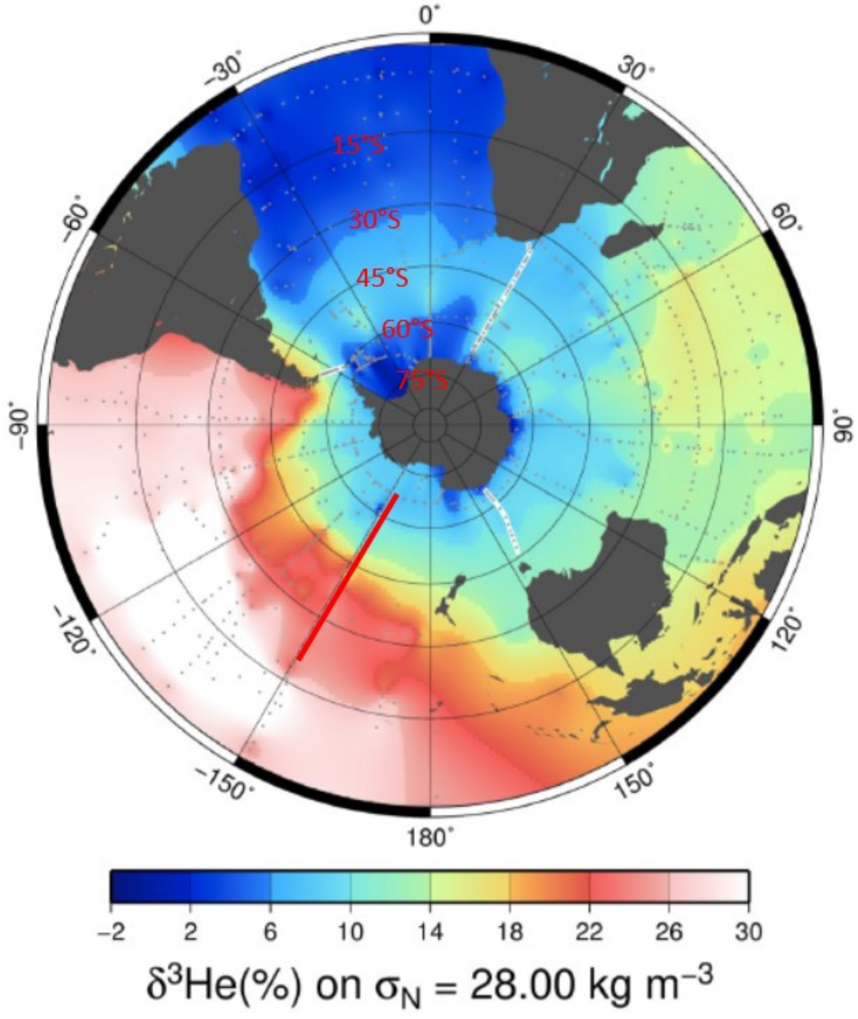


(Albani et al. 2014)

Hydrothermal interfaces

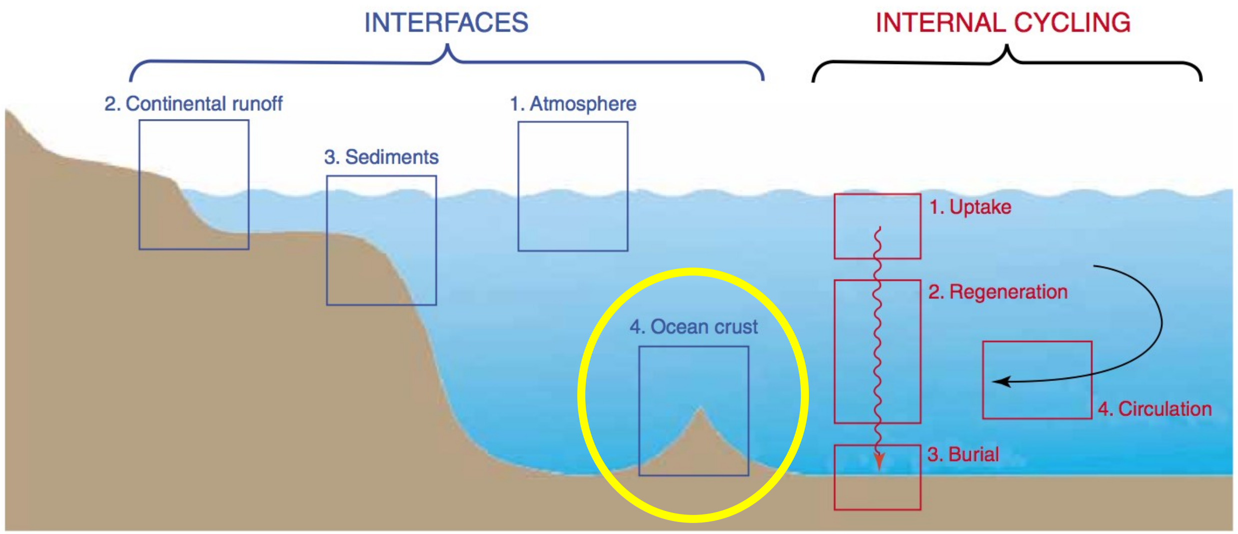


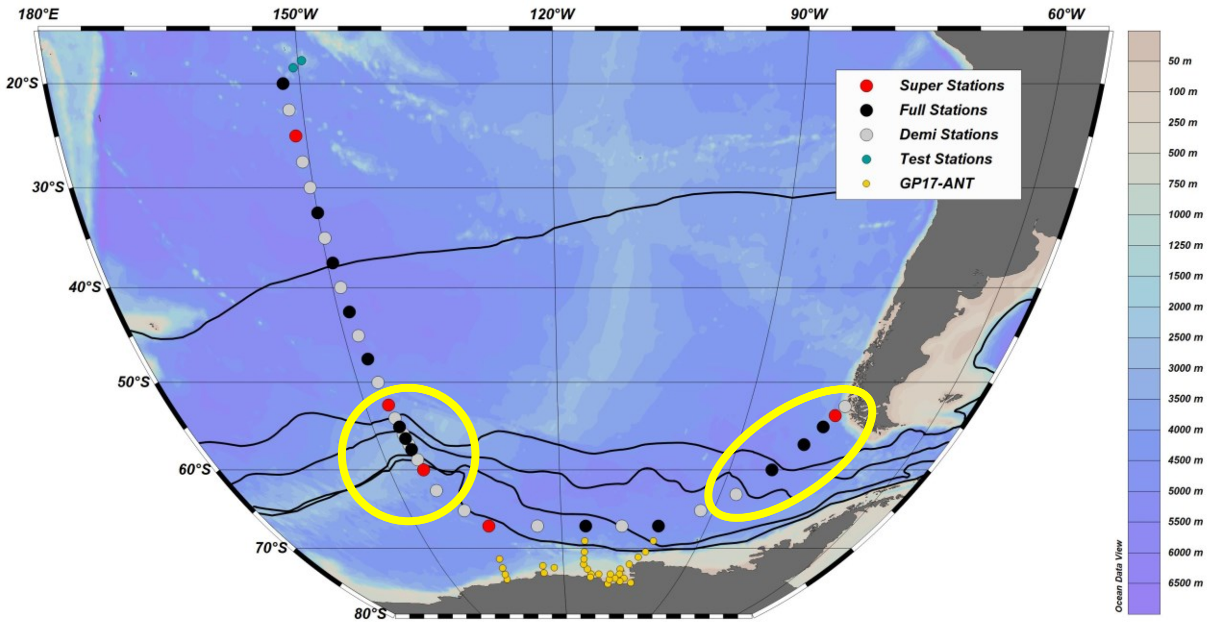


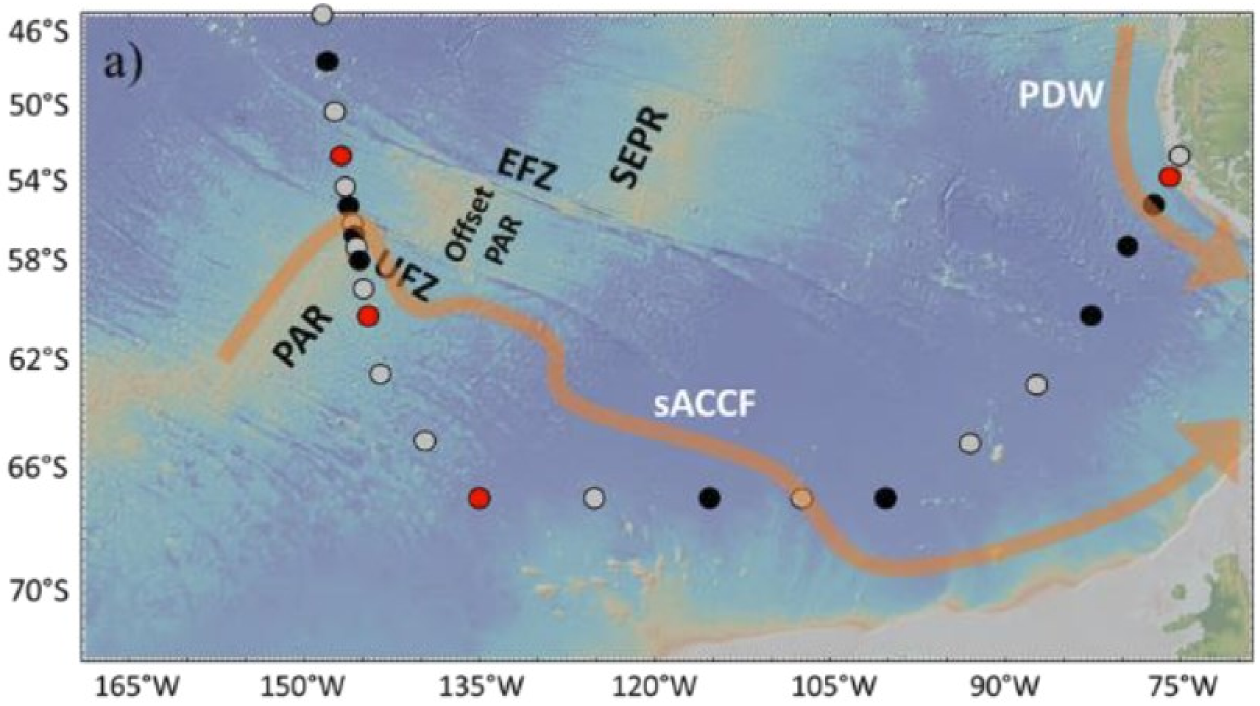


(Jenkins 2020)

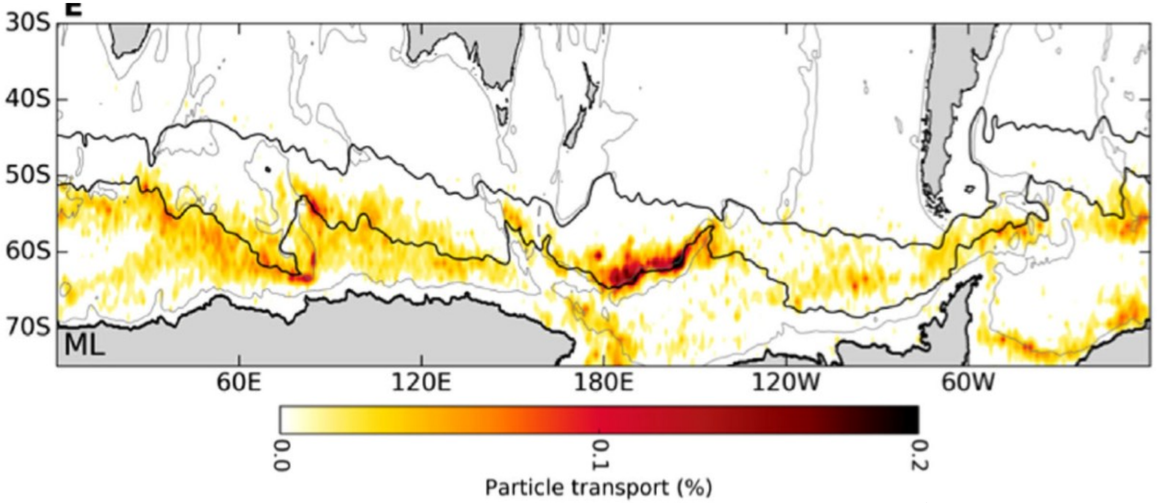
Hydrothermal interfaces





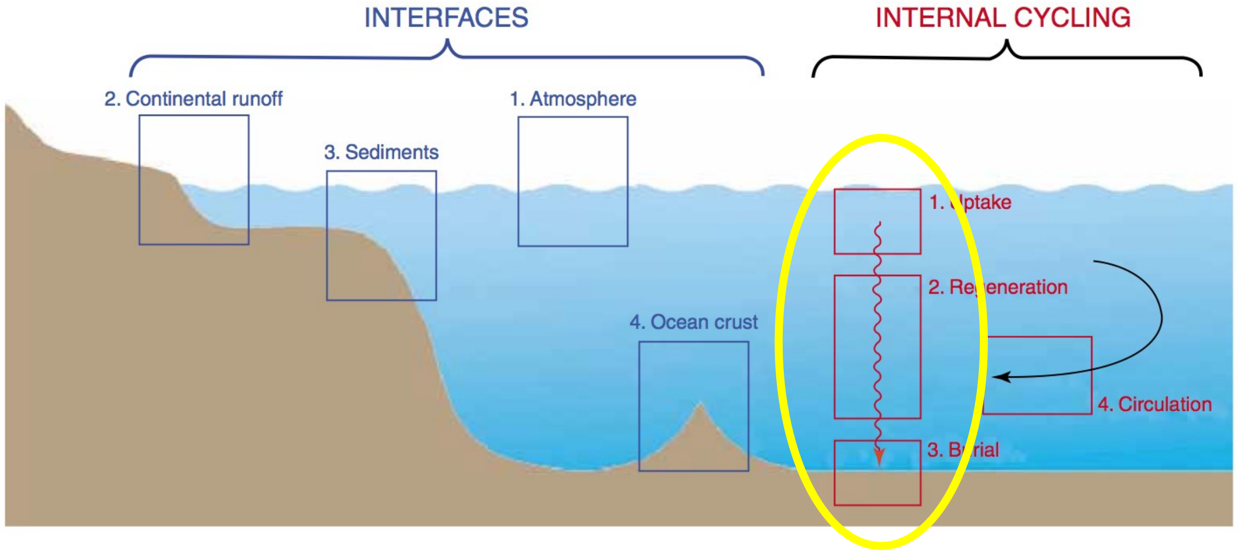


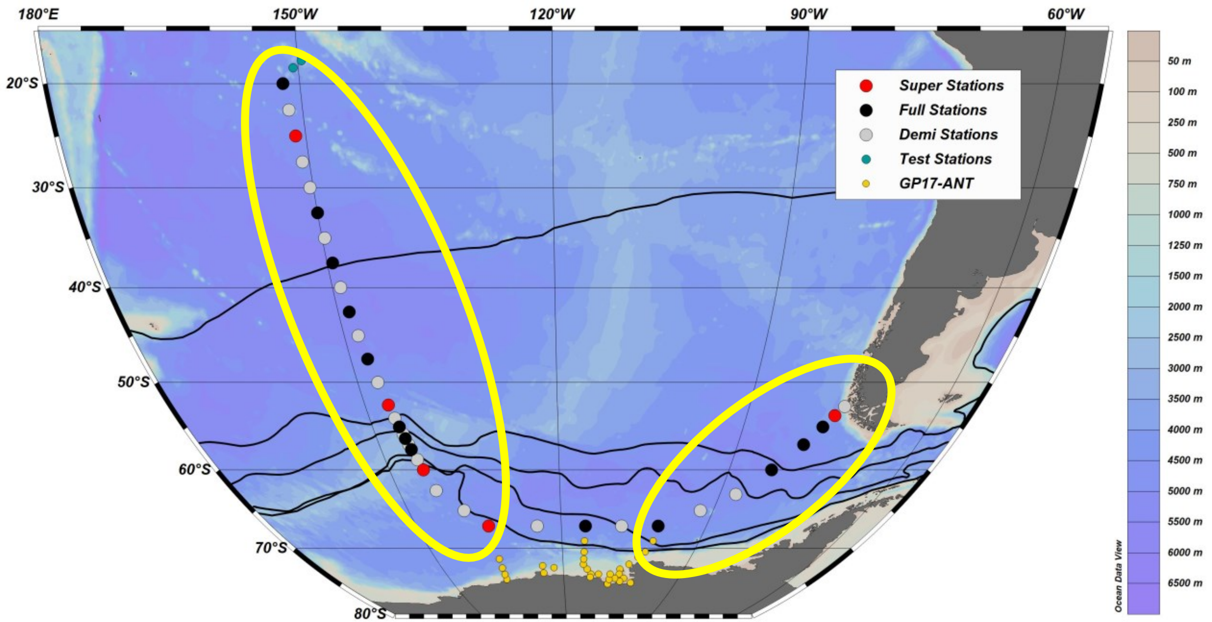
(Fitzsimmons 2022)

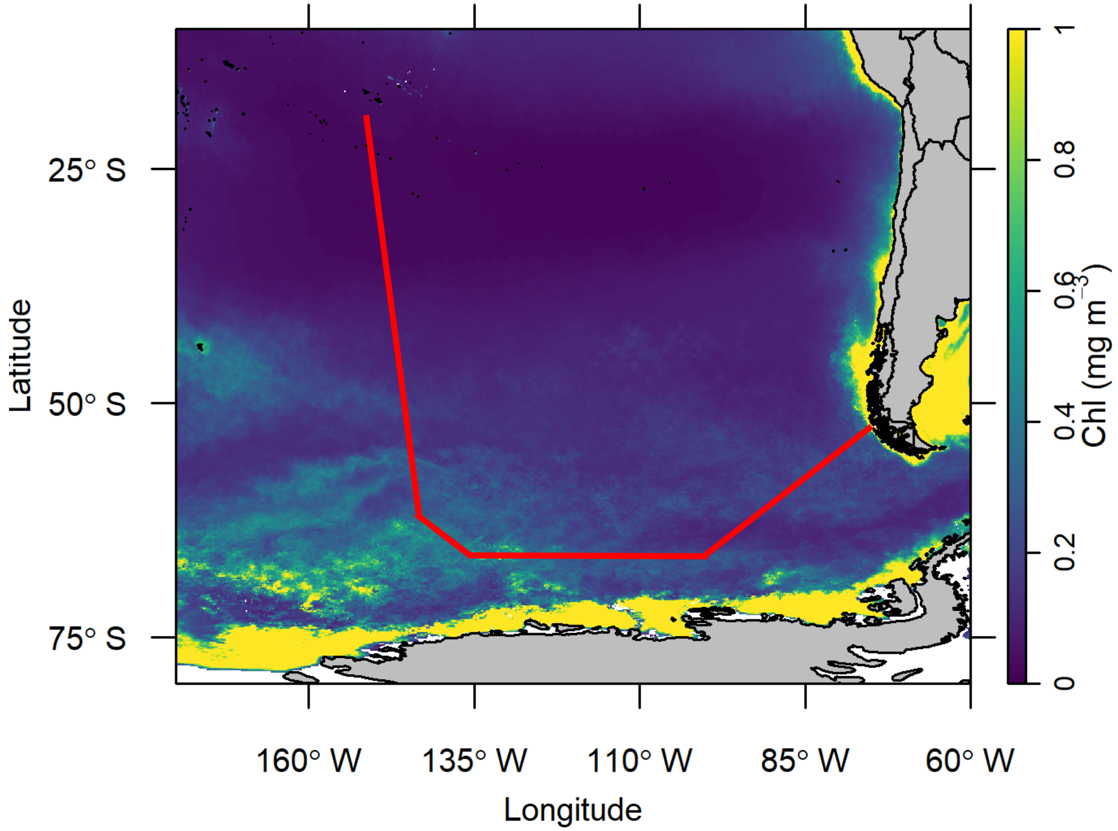


(Tamsitt et al. 2018)

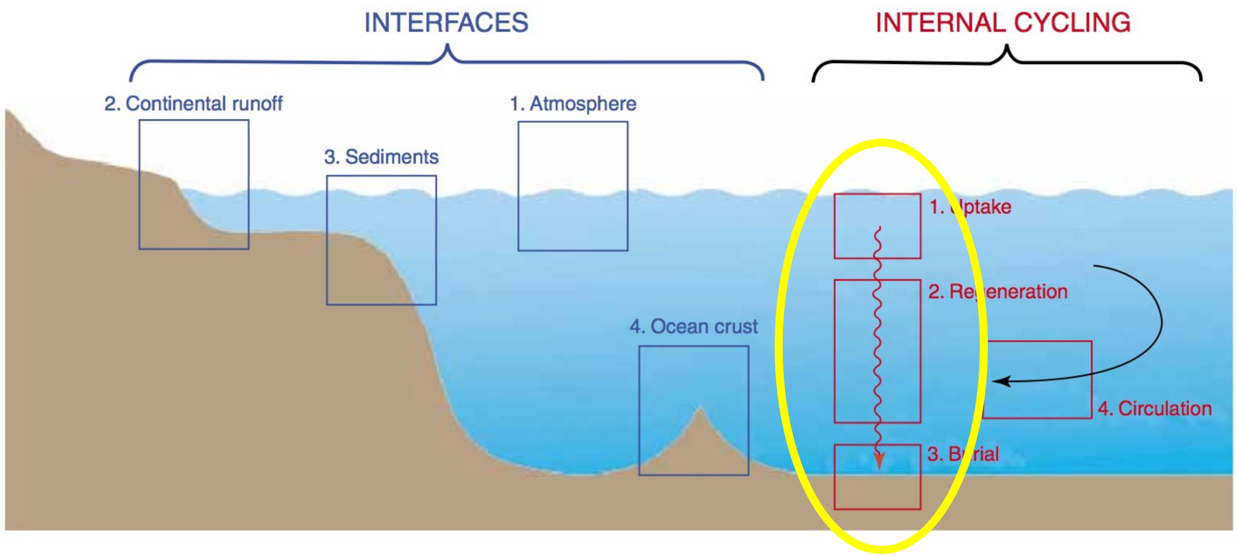
Productivity gradients

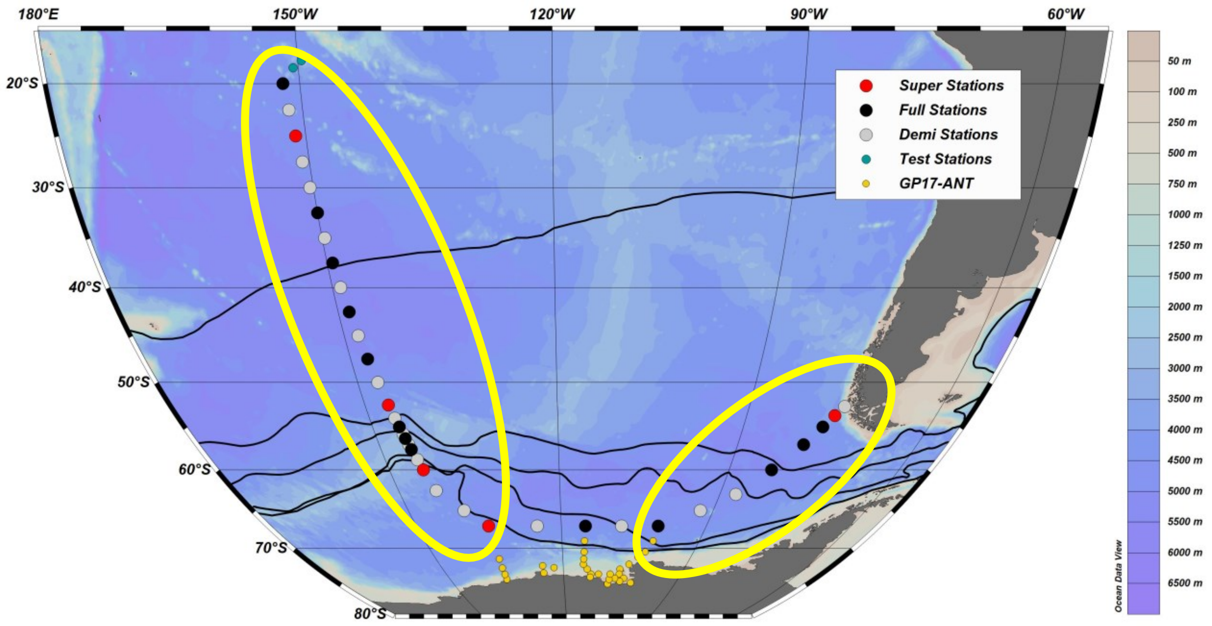


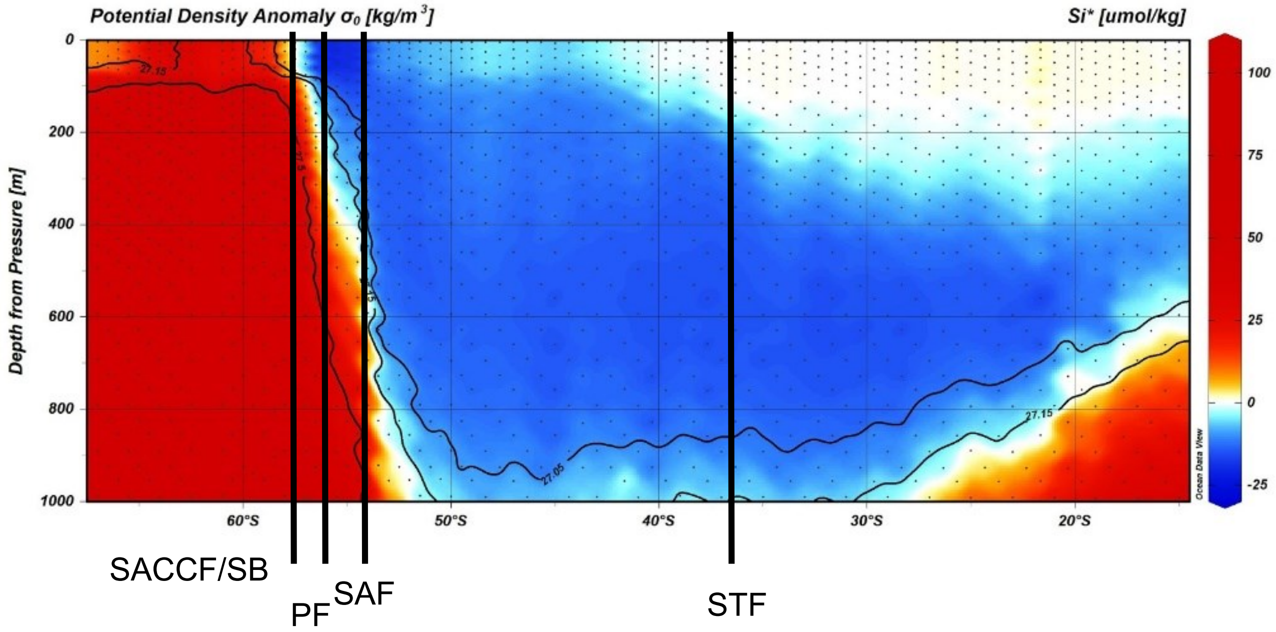




Productivity gradients

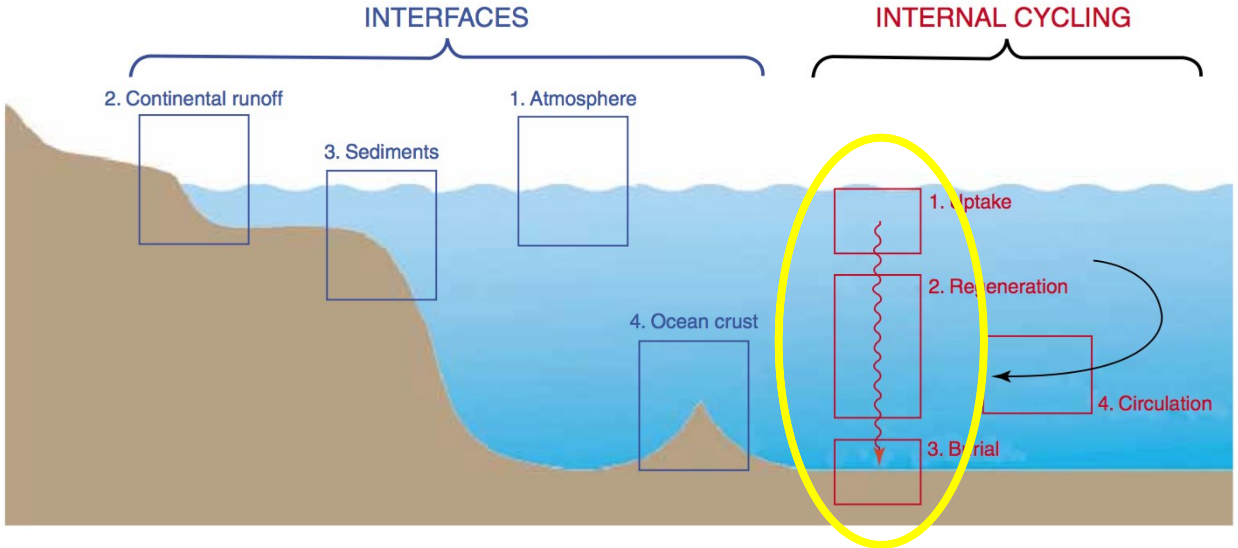


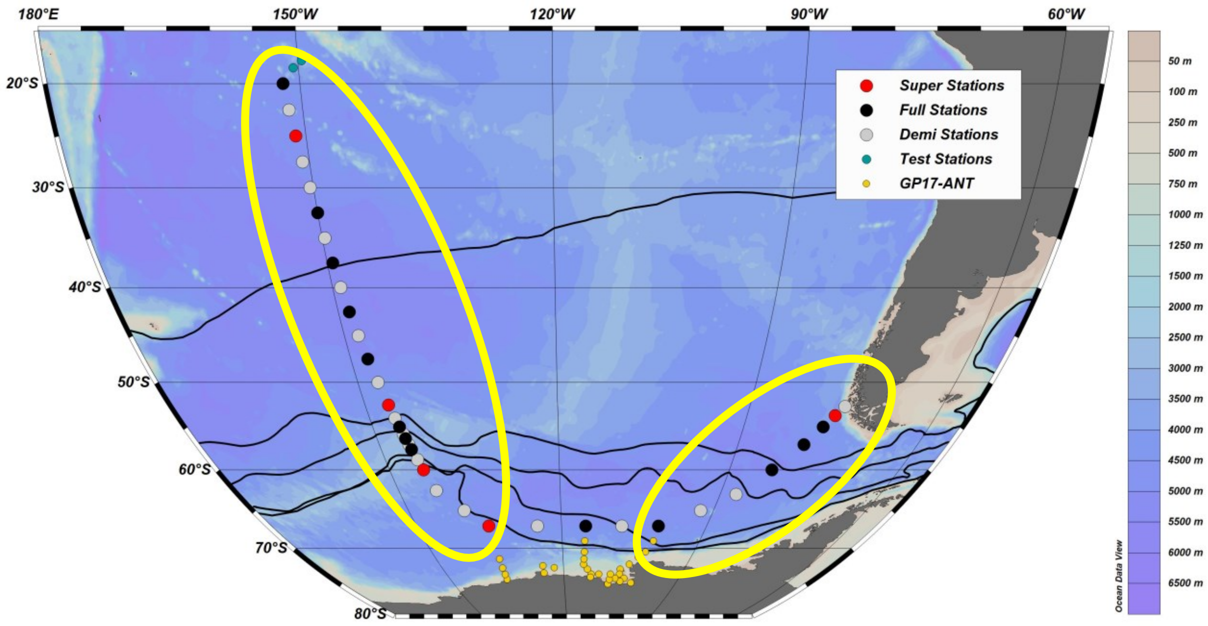


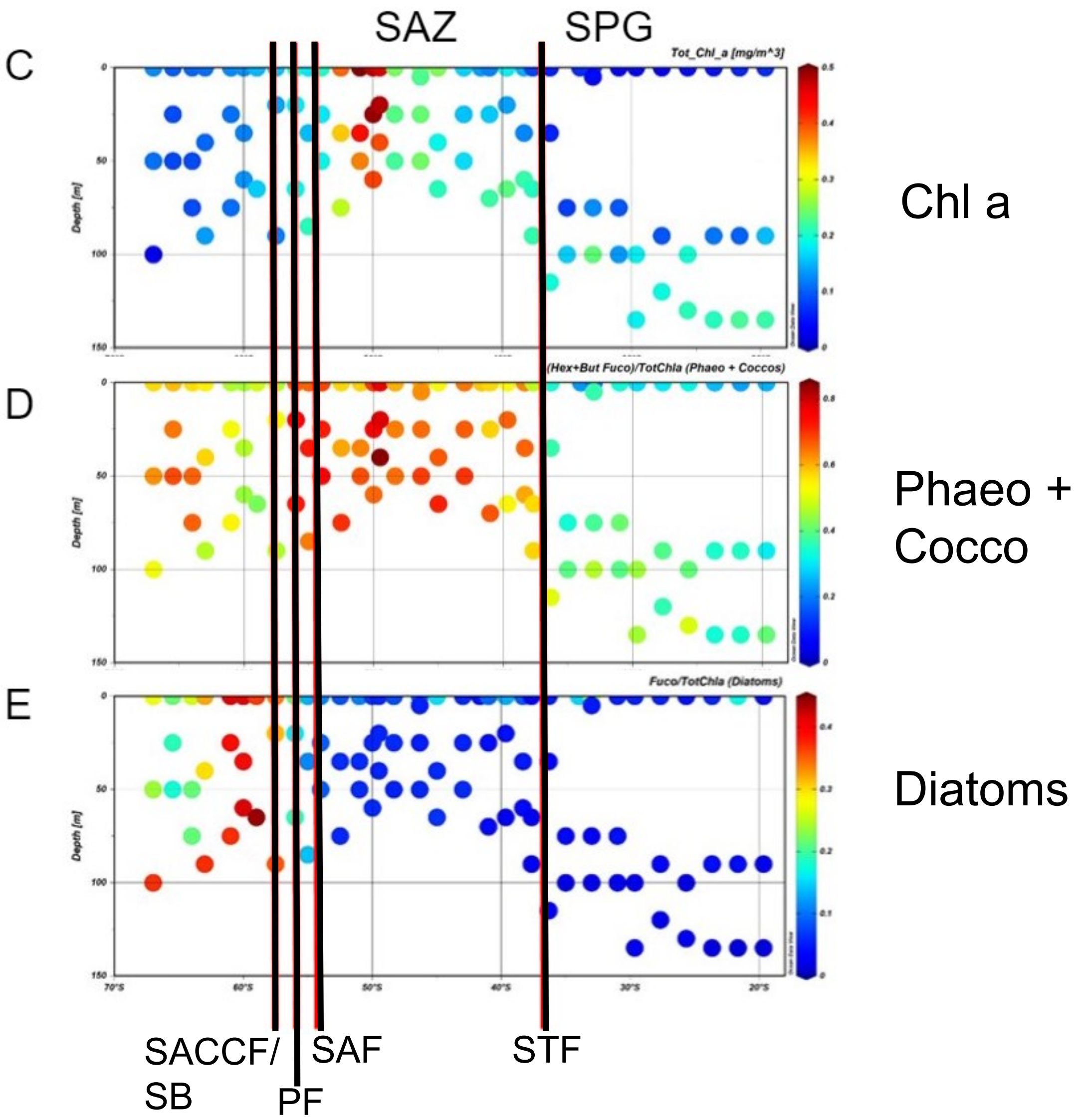


GO-SHIP P16S data

Productivity gradients

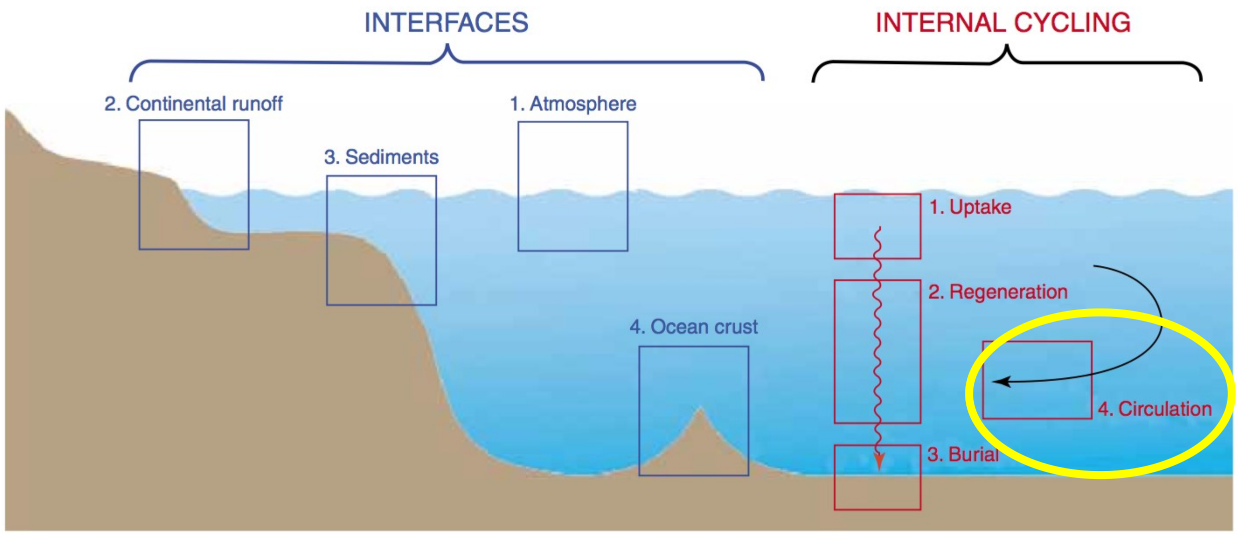


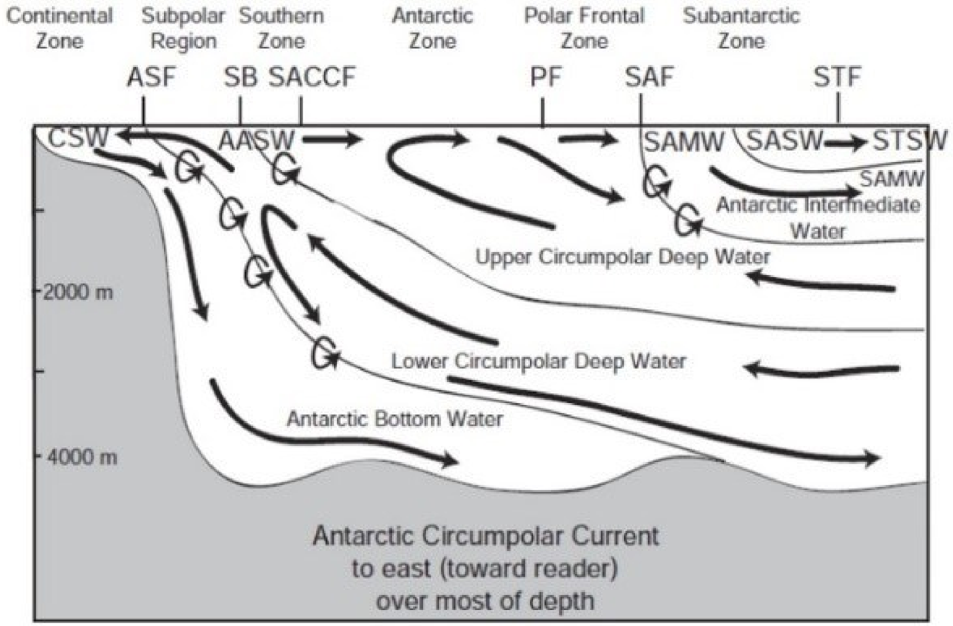




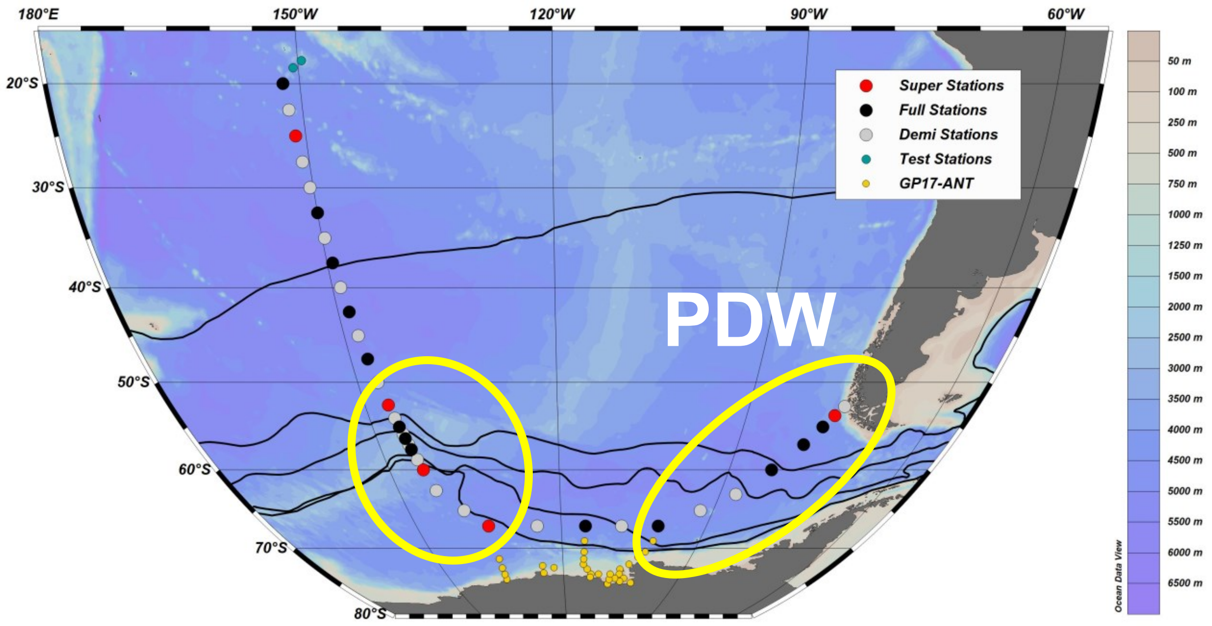
GO-SHIP P16S data

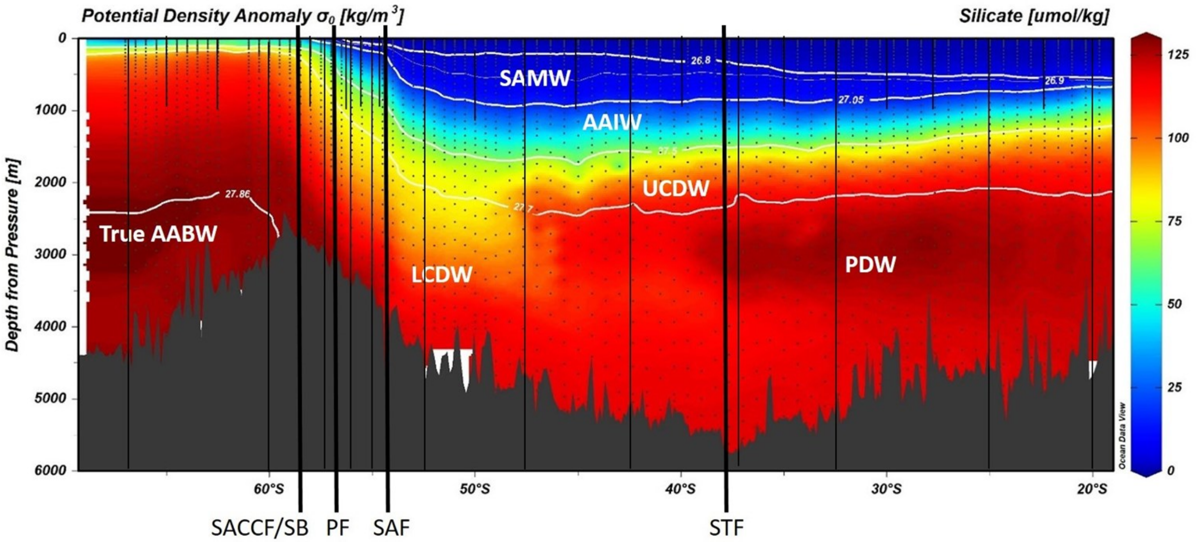
Water mass formation



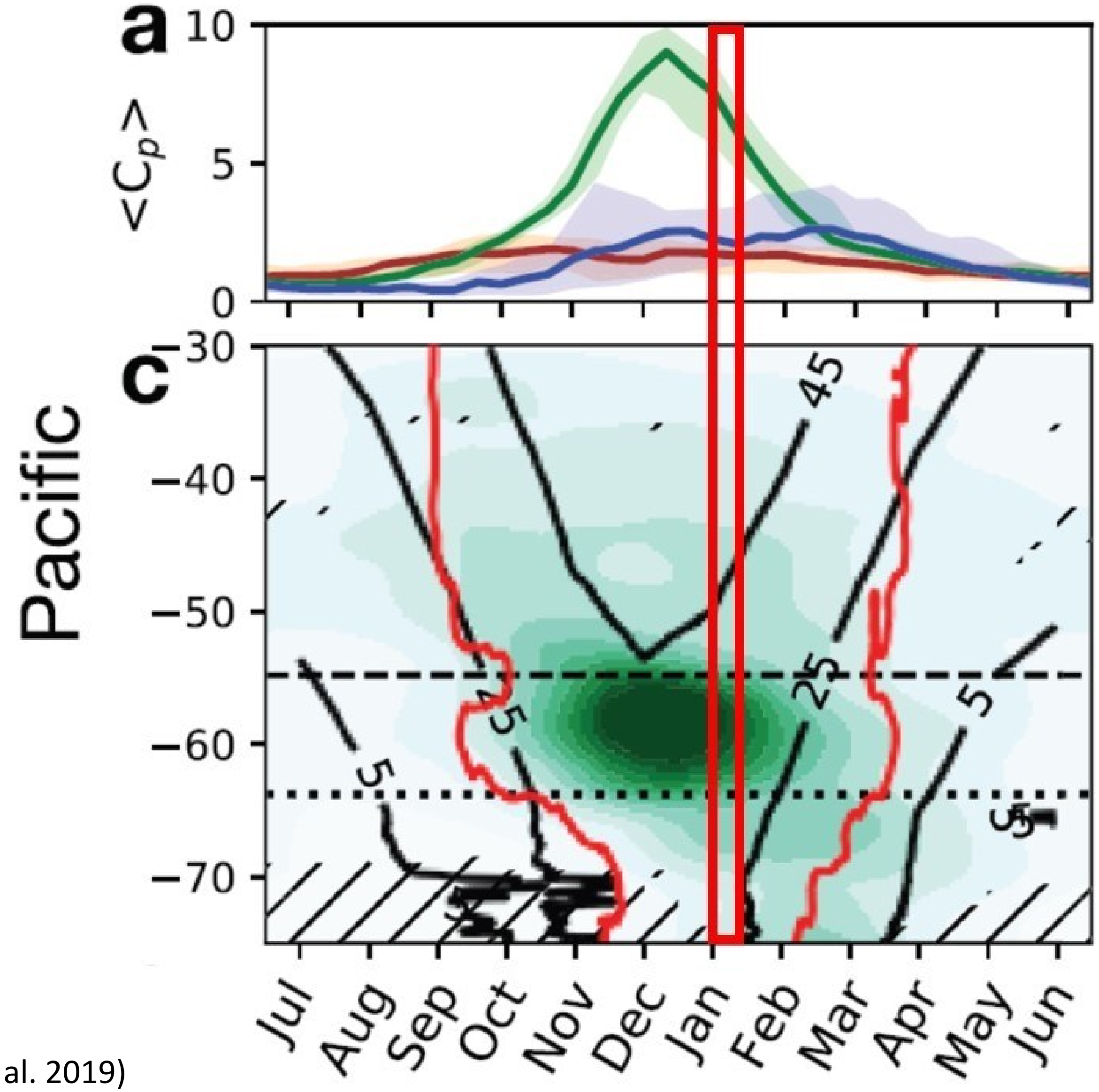


(Talley et al. 2011)

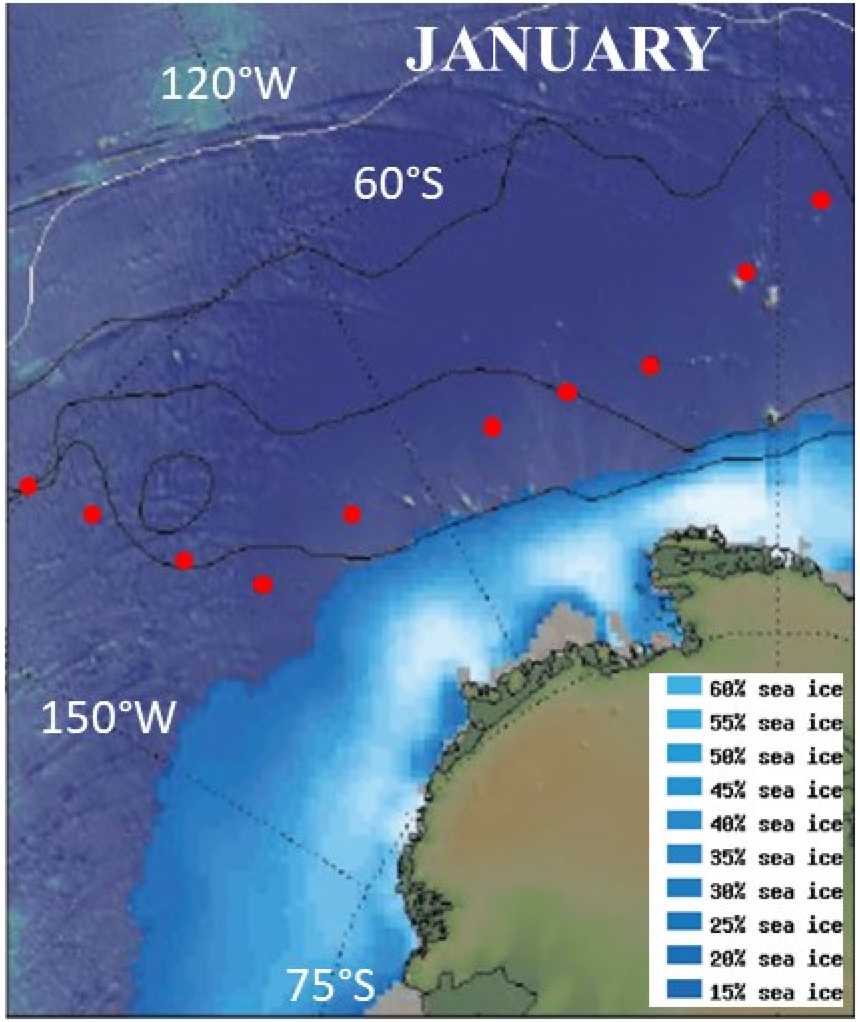




Cruise timing: threading the spring bloom–ice melt needle



(Uchida et al. 2019)



(NSIDC ice climatology, 1979-2007)

Some GP17-OCE highlights

- Region of unparalleled influence on global carbon and climate dynamics
  - 80% of global deep waters surface in ACC region
- Ultra-oligotrophic South Pacific Gyre
  - Impacts of productivity? Scavenging? TEI processes at ultra-deep Chl max?
- Southern Ocean regulation of global biological pump efficiency
  - Upwelling hotspots? Sources of TEIs to region?
  - Processes controlling composition of SAMW and AAIW?
- Dispersal of continental sources of micronutrients
  - Impact of margin on Pacific Deep Water TEIs?
  - Distal extent of Antarctic inputs?
- Outflow of micronutrients carried by Pacific Deep Water
  - Stabilization and scavenging of TEIs away from sources?

Management team responsibilities

1. Plan and coordinate a 55-day research cruise in 2022-2023;
2. Obtain representative samples for a wide variety of TEIs using a conventional CTD/rosette and GEOTRACES Trace Element Sampling System, as well as facilitate sampling for atmospheric aerosols, large volume particles and radionuclides, and upper ocean large volume radionuclides;
3. Acquire hydrographic data (CTD, transmissometer, fluorometer, oxygen sensor, etc.) along with discrete samples for salinity, dissolved oxygen, algal pigments, and dissolved nutrients at micro- and nanomolar levels for community use; and deliver these data to the GEOTRACES Data Assembly Centre (GDAC) via the U.S. BCO-DMO data center;
4. Ensure that proper QA/QC protocols are followed and reported, as well as fulfilling all GEOTRACES intercalibration protocols;
5. Prepare the final cruise report to be posted on the GDAC web site;
6. Coordinate all cruise communications between GP17-OCE investigators, as well as with leaders of the proposed GP17-ANT cruise;
7. Conduct Broader Impact efforts that will engage the public in oceanographic research using immersive technology.

GP17-OCE *science* in management proposal

- Hydrographic rosette sensor data (CTD, oxygen, transmissometer, etc.)
- Bottle analyses of salinity, oxygen, macronutrients by the ODF team
- Algal pigment HPLC analyses in the upper ocean
- Nano-nutrient analyses

- GEOTRACES trace metal rosette sensor data (CTD, oxygen, transmissometer, etc.)
- Bottle analyses of salinity and macronutrients by the ODF team
- Shipboard zinc analyses for contamination monitoring
- Trace metal clean surface towed “fish” sampling
- Collection of 0.4 μm-filtered particles onto 25-mm filters

- Facilitate (but not fund) collection of aerosols and large volume pumped particles

High-level cruise details

- Polar Code doesn't allow Global Class vessels south of 60^{o}S due to extent of sea ice and air temperature. Therefore, a waiver is required.
- To have minimum sea ice, cannot go south of 60^{o}S until after 1 January.
- To capture bloom conditions at ACC fronts, need to be there Nov-early Jan.
- US GEOTRACES depth resolution for regular stations is: 24 depths minimum to 36 depths maximum. Super stations add additional sampling.
- Station times. 24 depths = 33 hrs 36 depths = 38 hours Super = 48 hours Demi = 2 hours
- Globals transit at 12 kts, but "slowing" to 11 kts and 10 kts south of 55^{o}S builds in weather days.
- Crossover station required to meet GEOTRACES intercalibration requirements
- To sample near bloom maxima, as well as sea ice minimum, the cruise needs to go from Tahiti to 67^{o}S to Chile, not the reverse direction.

Implementation: Cruise details

Thus:

- Leave Tahiti 1 December 2022; 55 days at sea to meet Polar Code Waiver
- Occupy 2018 GP15 Station 39 as GP17-OCE Station 1 as internal crossover
- Occupy GP13/GP21 station at 32.5°S 150°W as intercalibration crossover
- Continue to deviate from 152°W (P16) so that bottom of N-S transect is 67°S, 135°W. This avoids sea ice that is much farther north at 152°W.
- Crossovers with GP17-ANT at 67°S, 115 and 100°W.
- Total of 36 stations: 6 Full-24, 7 Full-36, 5 Super, 1 Shelf, and 17 Demi
- Additional Considerations:
    - Polar Code Waiver being processed by SIO
    - 2 stations in French Polynesia EEZ
    - 3 stations in the Chile EEZ; will require one berth for Chilean observer

Goals for this workshop

- Learn each other's science in order to work as a team
- Understand what funded proposals need to be successful
- Finalize:
  - exact station placement/number/type
  - water and particle budgets
  - lab and deck set-ups
  - berths
- Determine what unfunded or non-GEOTRACES science can be accommodated