IODP Proposal Cover Sheet

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Drake Passage Paleoceanography

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Title	Pio-Pleistocene Dynamics of the Pacific Antarctic Circumpolar Current
Proponents	Frank Lamy, Robert Anderson, Guiseppe Cortese, Oliver Esper, Karsten Gohl, Helge Arz, Ian Hall, Claus-Dieter Hillenbrand, Christian Hübscher, Carina Lange, Lester Lembke-Jene, Ulysses Ninnemann, Katharina Pahnke, Alina Polonia, Josesph Stoner, Dirk Nürnberg, Alfredo Martinez-Garcia, Ralf Tiedemann, Gabriele Uenzelmann-Neben, Gisela Winckler
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Proponent Information

Proponent	Frank Lamy
Affiliation	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung
Country	Germany

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Abstract

The Antarctic Circumpolar Current (ACC) is the world's strongest zonal current system that connects all three major ocean basins of the global ocean, and therefore integrates and responds to global climate variability. Its flow is largely driven by strong westerly winds and constricted to its narrowest extent in the Drake Passage (DP). Transport of fresh and cold surface and intermediate water masses through the DP (cold-water route) strongly affect the Atlantic Meridional Overturning Circulation (MOC) together with the inflow of Indian Ocean water masses (warm-water route). Both oceanographic corridors are critical for the South Atlantic contribution to MOC changes. In contrast to the Atlantic and Indian sectors of the ACC, and with the exception of drill cores from the Antarctic continental margin and off New Zealand, the Pacific sector of the ACC lacks information on its Cenozoic paleoceonography from deep-sea drilling records. To advance our knowledge and understanding of Plio/Pleistocene atmosphere-ocean-cryosphere dynamics in the Pacific and their implications for regional and global climate and atmospheric CO2, IODP proposal DYNAPACC proposes the recovery of 150 to 600 m long, high-resolution Plio/Pleistocene sediment sequences at: (1) Three primary sites located on a cross-frontal transect in the central Pacific between the modern Polar Front (Site CSP-3A) and the Subantarctic Zone (CSP-1A/2A). (2) Three primary and two alternate sites (CHI-1A to CHI-5A) at the Chilean Margin. (3) One site from the pelagic eastern South Pacific (ESP-1A) close to the entrance to the DP. The proposed sites represent a depth transect from ~1000 m at the Chilean margin (CHI-4A) to >5000 m in the Bellingshausen Sea (CSP-3A) and therefore allow to investigate Plio/Pleistocene changes in the vertical structure of the ACC –a key issue for understanding the role of the Southern Ocean in the global carbon cycle. All of the 9 proposed primary and alternate sites were surveyed with seismic lines in 2009/2010 and most recently in 2016.The proposed sites are located at latitudes and water depths where sediments will allow the application of a wide range of siliciclastic, carbonate, and opal-based proxies to address our objectives of reconstructing, with unprecedented stratigraphic detail, surface to deep ocean variations and their relation to atmosphere and cryosphere changes through stadial-to-interstadial, glacial-to-interglacial and warmer than present time intervals.

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Scientific Objectives

The overall goal of DYNAPACC is to improve our knowledge of Plio/Pleistocene atmosphere-ocean-ice-sheet dynamics of the ACC in the Pacific and their implications for regional and global climate and atmospheric CO2 based on sediment records with unprecedented resolution. We test two major hypotheses:
(A) ACC dynamics and Drake Passage (DP) throughflow conditioned the global Meridional Overturning Circulation (MOC) and high-low climate linkages on orbital and sub-millennial time-scales since the Pliocene:
- We will quantify the potential role of the DP throughflow (cold-water route) compared to the Agulhas leakage (warm-water route) in driving changes in global MOC on glacial-interglacial and millennial time-scales.
- Changes in the ACC transport through the DP strongly affect the inter-basin water mass exchange in the Southern Ocean and the high-low latitude exchange within the Pacific Eastern Boundary Current system.

(B) Variations in the Pacific ACC determine the physical and biological characteristics of the oceanic carbon pump and atmospheric CO2:
- Atmosphere-ocean-cryosphere interactions and teleconnections between high and low latitudes provide the major link between Antarctica and the low-latitudes. These interactions are believed to control sea-ice cover, AIS dynamics, upper ocean stratification, biological nutrient utilization, and exposure rates of deep-water.
- We will test to which extent processes found to be active in the Atlantic sector can be translated to the Pacific sector, thus allowing to construct a more global picture of the SOs role in nutrient distribution, biogenic export production and their impact on CO2 variations.

Non-standard measurements technology needed to achieve the proposed scientific objectives

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Proposed Sites (Total proposed sites: 9; pri: 7; alt: 2; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CSP-1A (Primary)	-54.2126 -125.4258	3610	180	0	180	Moderate-resolution Subantarctic late Miocene-Quaternary carbonate record from CDW depth, Subantarctic SST, water mass, pCO2, productivity record, may develop to South Pacific reference stable isotope and dust deposition record, (comparable to ODP Leg 177 Site 1090 in Atlantic SO)
CSP-2A (Primary)	-56.1515 -115.1328	4110	300	0	300	Moderate to high resolution Subantarctic Pliocene-Quaternary carbonate record, lowermost CDW, glacial AABW, Subantarctic SST, water mass, pCO2, productivity record, may develop to high resolution South Pacific reference stable isotope record
CSP-3A (Primary)	-60.7361 -115.9063	5130	300	0	300	High resolution Subantarctic Pliocene-Quaternary siliceous ooze record, Polar Frontal Zone, AABW, productivity and sea-ice records, Antarctic end of cross-frontal transect.
CHI-1A (Primary)	-55.51333 -71.63694	2080	300	0	300	High-resolution Pleistocene paleoceanographic records, northern ACC strength before entering Drake Passage, Cape Horn Current, proximal to South American sediment sources, Patagonian ice-sheet variability, Core of Pacific Deep Water, transition to Circumpolar Deep Water.
CHI-2A (Alternate)	-55.58444 -71.86583	1720	150	0	150	High-resolution Pleistocene paleoceanographic records, northern ACC strength before entering Drake Passage, Cape Horn Current, proximal to South American sediment sources, Patagonian ice-sheet variability, Core of Pacific Deep Water, transition to Circumpolar Deep Water.
CHI-3A (Alternate)	-54.5338 -74.2114	1170	150	0	150	High-resolution Pleistocene paleoceanographic records, northern ACC strength before entering Drake Passage, Cape Horn Current, proximal to South American sediment sources, Patagonian ice-sheet variability, Between Pacific Deep Water/Circumpolar Deep Water and Antarctic Intermediate Water.
CHI-4A (Primary)	-52.6877 -75.5849	1100	300	0	300	Pleistocene paleoceanographic records, northern ACC strength before entering Drake Passage, Cape Horn Current, long-term Patagonian ice-sheet variability, potential record of Antarctic Intermediate Water
CHI-5A (Primary)	-52.7227 -75.6077	1170	600	0	600	Pleistocene paleoceanographic records, northern ACC strength before entering Drake Passage, Cape Horn Current, long-term Patagonian ice-sheet variability, potential record of Antarctic Intermediate Water
ESP-1A (Primary)	-54.5790 -76.6490	3870	300	0	300	Plio/Pleistocene paleoceanographic records, northern ACC strength before entering Drake Passage, Cape Horn Current, long-term Patagonian ice-sheet variability, potential record of Antarctic Bottom water