

IODP Proposal Cover Sheet

945 - Full

Brazilian Equatorial Margin Paleocyanography

Received for: 2018-10-01

Title	Paleocyanography of the Brazilian Equatorial Margin (PBEM)		
Proponents	Luigi Jovane, Aristoteles de Moraes Rios Netto, Gerson Fauth, Fabrizio Frontalini, Nicolas Waldmann, Aradhna Tripathi, Tom Dunkley-Jones, Daniel Pavani Vicente Alves, Babette Hoogakker, Werner Piller, Jorge Figueiredo, Ronaldo Carrion, Marcio Yamamoto, David Iacopini, Gavin Foster, Katharina Billups, Peter Vrolijk, Appy Slujs, Martino Giorgioni, Fabio Florindo		
Keywords	Paleocyanography, Atlantic, Ceará, Potiguar, Equatorial	Area	Brazilian Equatorial Margin

Proponent Information

Proponent	Luigi Jovane
Affiliation	Instituto Oceanografico da Universidade de Sao Paulo
Country	Brazil

Permission is granted to post the coversheet/site table on www.iodp.org

Abstract

Tropical regions are a major source of heat to mid- and high-latitudes. The Atlantic Ocean-Atmosphere system is unique as it is the only system that currently transports heat across the equator. Therefore, accomplishing accurate global climate reconstructions, documentation and implementation of Atlantic climates in large-scale climate models is essential. This, however, has been hampered for most of the Cenozoic due to the lack of sufficient low-latitude sediment records. Here we propose to investigate paleocyanographic changes across the Cenozoic driven by longer and shorter term forcings from the Eocene greenhouse to icehouse conditions in the Quaternary, through the reconstruction of atmospheric, oceanographic and biological processes. The Brazilian Equatorial Margin (BEM) is a passive and stable continental margin that developed following the opening of the central Atlantic Ocean in the Mid-Cretaceous. A peculiar aspect of this margin is that it remained tectonically "passive" and approximately at the same equatorial latitude since its formation and, consequently, it has maintained continually an oligotrophic inter-tropical environment. This project will take advantage of these unique attributes for obtaining high-quality sedimentological, paleoclimatic, and paleocyanographic data for the Cenozoic, proposing to drill transects across the BEM from the uppermost part of the continental slope to the abyssal plain near Fortaleza (Ceará and Potiguar Basins). The expected stratigraphic continuity along these transects will allow the detailed study of the relation between pCO₂, sea-level and climate changes throughout the Cenozoic by constraining the fundamental parameters for calculating the climate sensitivity. This stratigraphic record will define the low-latitude climatic response to the major Cenozoic climatic events, such as the EECO, MECO, EOT, OMT, MCO and iNHG (see text for details). Sediments are expected to yield calcareous and organic microfossils, which will allow for studying the response of tropical ecosystems to these climatic events and also provide independent substrates for climate and carbon cycle reconstructions. By undertaking a depth transect of sites selected from a wealth of seismic reflection data, progress on all of the scientific objectives will be achieved even if some unresolvable geologic risks (e.g., hiatuses) are found in the cored sections. In particular, these sites were chosen to establish a landmark for high-resolution Eocene-Mio/Pliocene tropical climate reconstructions, which will provide the following outcomes: 1) detail the relationship between tropical climate (temperature), sea-level and atmospheric pCO₂; 2) evolution of the Atlantic Meridional Overturning Circulation driven by longer (tectonic) and shorter term (solar input) forcings.

Scientific Objectives

1. Investigate the intrinsic relationship between climate, sea-level and atmospheric pCO₂ from Eocene to the Mio/Pliocene
Hypothesis 1.1 - Does the relationship between sea-level fluctuations on the Brazilian continental shelf, atmospheric CO₂, and local and regional climate vary as a function of background climate state?
Hypothesis 1.2 - How the CCD in the Central Atlantic is affected by the major pCO₂ and climatic variations during the Cenozoic?
2. The relationship between Atlantic Meridional Overturning Circulation (AMOC) and South American monsoon system (SAMS) is a response to the major climatic events of the Cenozoic?
Hypothesis 2.1 - Is the onset of the SAMS related to the uplift of the Andes causing a restricted air-circulation across South America, compared to Pre-Andes conditions, during cooler/dryer events?
Hypothesis 2.2 - Does intense SAMS phases lead to fresher surface waters in the South Atlantic, which are carried across the equator by the NBC? Intervals of enhanced cross-equatorial heat transport can be linked to stronger AMOC and intensified NADW formation in the Nordic Seas (for example between 2 and 1.5 Ma).
Hypothesis 2.3 - Does the circulation in the Atlantic Ocean underwent several changes in response to tectonic and paleogeographic modifications, such as retroflexion of the NBC in response to a weakening of the AMOC or to possible phases of upwelling due to continuation of El Nino into the Equatorial Atlantic when Panama was opened?

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

Proposed Sites (Total proposed sites: 12; pri: 5; alt: 7; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
PBEM-01B (Alternate)	-0.8407644444 -37.7896324444	4373	1004	0	1004	Moderate-resolution Eocene-Mio/Pliocene Central Atlantic deep-water paleoceanographic history from a constant equatorial setting. Measure deep-water circulation and carbonate compensation depth (CCD) changes will be reconstructed with a suite of geochemical proxies. Correlation to shallower sites will test if changes in the CCD in the equatorial Atlantic are related to sea-level or climate changes. Test if the onset of the SAMS can be related to uplift of the Andes causing restricted air-circulation across South America and can change the NBC, NADW, AMOC, AADW.
PBEM-03B (Alternate)	-3.2061111111 -37.5886111111	259	955	0	955	High/Moderate-resolution Eocene- Mio/Pliocene Central Atlantic shallow-water paleoceanographic history from a long-term persistent oligotrophic equatorial setting. Sea-level changes SST, pCO ₂ , and productivity will be reconstructed using respective proxies. Test if sea-level changes that are linked to pCO ₂ and the macrofaunal response to warming conditions. We expect to drill hemipelagic clays, marls, and calcareous ooze as primary lithologies. Bioclastic foraminiferal carbonate sands, limestone conglomerate, and hardgrounds are uncertain possible secondary lithologies although these lithologies still provide critical information about sea-level changes. Test if the onset of the SAMS and the relation with the changes of the NBC, NADW, AMOC, AADW.
PBEM-04B (Alternate)	-3.4156583333 -37.5198055556	280	902	0	902	High/Moderate-resolution Eocene- Mio/Pliocene Central Atlantic shallow-water paleoceanographic history from a long-term persistent oligotrophic equatorial setting. Sea-level changes SST, pCO ₂ , and productivity will be reconstructed using respective proxies. Test if sea-level changes that are linked to pCO ₂ and the macrofaunal response to warming conditions. We expect to drill hemipelagic clays, marls, and calcareous ooze as primary lithologies. Bioclastic foraminiferal carbonate sands, limestone conglomerate, and hardgrounds are uncertain possible secondary lithologies although these lithologies still provide critical information about sea-level changes. Test if the onset of the SAMS and the relation with the changes of the NBC, NADW, AMOC, AADW.
PBEM-05A (Primary)	-2.4445006388889 -36.963564305556	3450	524	0	524	Moderate-resolution Eocene-Mio/Pliocene Central Atlantic deep-water paleoceanographic history from a constant equatorial setting. Measure deep-water circulation and carbonate compensation depth (CCD) changes will be reconstructed with a suite of geochemical proxies. Correlation to shallower sites will test if changes in the CCD in the equatorial Atlantic are related to sea-level or climate changes. Test if the onset of the SAMS can be related to uplift of the Andes causing restricted air-circulation across South America and can change the NBC, NADW, AMOC, AADW.
PBEM-06A (Primary)	0.1214523056 -37.0647670833	4493	528	0	528	Moderate-resolution Eocene-Mio/Pliocene Central Atlantic deep-water paleoceanographic history from a constant equatorial setting. Measure deep-water circulation and carbonate compensation depth (CCD) changes will be reconstructed with a suite of geochemical proxies. Correlation to shallower sites will test if changes in the CCD in the equatorial Atlantic are related to sea-level or climate changes. Test if the onset of the SAMS can be related to uplift of the Andes causing restricted air-circulation across South America and can change the NBC, NADW, AMOC, AADW.
PBEM-07A (Alternate)	0.1376591111 -34.9521935000	4567	492	0	492	Moderate-resolution Eocene-Mio/Pliocene Central Atlantic deep-water paleoceanographic history from a constant equatorial setting. Measure deep-water circulation and carbonate compensation depth (CCD) changes will be reconstructed with a suite of geochemical proxies. Correlation to shallower sites will test if changes in the CCD in the equatorial Atlantic are related to sea-level or climate changes. Test if the onset of the SAMS can be related to uplift of the Andes causing restricted air-circulation across South America and can change the NBC, NADW, AMOC, AADW.
PBEM-09C (Primary)	-2.94746 -38.6048343	1578	820	0	820	High/Moderate-resolution Eocene-Miocene Central Atlantic intermediate-water paleoceanographic history from constant equatorial slope setting. Water circulation, OMZ fluctuations, pCO ₂ , CCD changes, and detrital input will be determined with a suite of proxies and compared to the reconstructions from shallower and deeper sites to obtain a complete view on a depth transect across the BEM. Test how was the condition before the onset of the SAMS, Amazon, NBC, and changes in the NADW, AMOC, AADW since the early Eocene.

Proposed Sites (Continued; total proposed sites: 12; pri: 5; alt: 7; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
PBEM-10C (Alternate)	-2.906111194444 -38.62867002777	1409	940	0	940	High/Moderate-resolution Eocene-Miocene Central Atlantic intermediate-water paleoceanographic history from constant equatorial slope setting. Water circulation, OMZ fluctuations, pCO ₂ , CCD changes, and detrital input will be determined with a suite of proxies and compared to the reconstructions from shallower and deeper sites to obtain a complete view on a depth transect across the BEM. Test how was the condition before the onset of the SAMS, Amazon, NBC, and changes in the NADW, AMOC, AADW since the early Eocene.
PBEM-12A (Primary)	-3.2294361111 -37.5611777778	253	899	0	899	High/Moderate-resolution Eocene-Mio/Pliocene Central Atlantic shallow-water paleoceanographic history from a long-term persistent oligotrophic equatorial setting. Sea-level changes SST, pCO ₂ , and productivity will be reconstructed using respective proxies. Test if sea-level changes that are linked to pCO ₂ and the macrofaunal response to warming conditions. We expect to drill hemipelagic clays, marls, and calcareous ooze as primary lithologies. Bioclastic foraminiferal carbonate sands, limestone conglomerate, and hardgrounds are uncertain possible secondary lithologies although these lithologies still provide critical information about sea-level changes. Test if the onset of the SAMS and the relation with the changes of the NBC, NADW, AMOC, AADW.
PBEM-13A (Alternate)	-3.3823250000 -37.5475030000	282	962	0	962	High/Moderate-resolution Eocene-Mio/Pliocene Central Atlantic shallow-water paleoceanographic history from a long-term persistent oligotrophic equatorial setting. Sea-level changes SST, pCO ₂ , and productivity will be reconstructed using respective proxies. Test if sea-level changes that are linked to pCO ₂ and the macrofaunal response to warming conditions. We expect to drill hemipelagic clays, marls, and calcareous ooze as primary lithologies. Bioclastic foraminiferal carbonate sands, limestone conglomerate, and hardgrounds are uncertain possible secondary lithologies although these lithologies still provide critical information about sea-level changes. Test if the onset of the SAMS and the relation with the changes of the NBC, NADW, AMOC, AADW.
PBEM-14A (Primary)	-4.072515222 -37.02851975	1800	225	0	225	High/Moderate-resolution Mio/Pliocene-Recent Central Atlantic intermediate water paleoceanographic history along a long-term persistent equatorial setting. Water circulation, CCD changes, and detrital input will be determined with a suite of proxies and compared to reference sea-level and pCO ₂ , stable isotope and dust deposition record. Test the intermediate depth response to major climatic changes at equatorial latitudes, such as the onset of the SAMS, Amazon River, NBC, and changes in the NADW, AMOC, AADW.
PBEM-15A (Alternate)	-4.206811833 -36.7313375	2328	232	0	232	High/Moderate-resolution Mio/Pliocene-Recent Central Atlantic intermediate water paleoceanographic history along a long-term persistent equatorial setting. Water circulation, CCD changes, and detrital input will be determined with a suite of proxies and compared to reference sea-level and pCO ₂ , stable isotope and dust deposition record. Test the intermediate depth response to major climatic changes at equatorial latitudes, such as the onset of the SAMS, Amazon River, NBC, and changes in the NADW, AMOC, AADW.