02 INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS(PI/PD) and co-PRINCIPAL INVESTIGATORS/co-PROJECT DIRECTORS

Submit only ONE copy of this form **for each PI/PD and co-PI/PD** identified on the proposal. The form(s) should be attached to the original proposal as specified in GPG Section II.C.a. Submission of this information is voluntary and is not a precondition of award. This information will not be disclosed to external peer reviewers. ***DO NOT INCLUDE THIS FORM WITH ANY OF THE OTHER COPIES OF YOUR PROPOSAL AS THIS MAY COMPROMISE THE CONFIDENTIALITY OF THE INFORMATION.***

PI/PD Name: Marlos Goes

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☒ Hispanic or Latino ☐ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☒ None

Citizenship: (Choose one) ☐ U.S. Citizen ☒ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☐

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☐

Ethnicity Definition:
Hispanic or Latino. A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.
Race Definitions:
American Indian or Alaska Native. A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community attachment.
Asian. A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.
Black or African American. A person having origins in any of the black racial groups of Africa.
Native Hawaiian or Other Pacific Islander. A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.
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PI/PD Name: Francisco J Beron-Vera

Gender: ☒ Male ☐ Female

Ethnicity: (Choose one response) ☒ Hispanic or Latino ☐ Not Hispanic or Latino

Race: (Select one or more)
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White

Disability Status: (Select one or more)
- ☐ Hearing Impairment
- ☐ Visual Impairment
- ☐ Mobility/Orthopedic Impairment
- ☐ Other
- ☐ None

Citizenship: (Choose one) ☐ U.S. Citizen ☒ Permanent Resident ☐ Other non-U.S. Citizen

Check here if you do not wish to provide any or all of the above information (excluding PI/PD name): ☒

REQUIRED: Check here if you are currently serving (or have previously served) as a PI, co-PI or PD on any federally funded project ☒

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List of Suggested Reviewers or Reviewers Not To Include (optional)

SUGGESTED REVIEWERS:
Not Listed

REVIEWERS NOT TO INCLUDE:
Not Listed

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE/if not in response to a program announcement/solicitation enter NSF 11-1

NSF 11-1 **08/15/11**

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S) (Indicate the most specific unit known, i.e. program, division, etc.)

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University of Miami Rosenstiel School of Marine&Atmospheric Sci

AWARDEE ORGANIZATION CODE (IF KNOWN)

0015362010

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

4600 RICKENBACKER CSWY
KEY BISCAYNE, FL 33149-1031

NAME OF PRIMARY PLACE OF PERF

University of Miami, RSMAS

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University of Miami, RSMAS
4600 Rickenbacker Cswy.
Key Biscayne ,FL ,331491031 ,US.

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☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Variability of the South Atlantic Subtropical Gyre and its Impact on the Inter-Hemispheric Water Transport**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **400,835**	**36** months	**03/01/12**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____
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_____
☐ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.G.1)

PI/PD DEPARTMENT
CIMAS

PI/PD FAX NUMBER
305-361-4457

PI/PD POSTAL ADDRESS
4600 RICKENBACKER CSWY

KEY BISCAYNE, FL 331491031
United States

NAMES (TYPED)	High Degree	Yr of Degree	Telephone Number	Electronic Mail Address
PI/PD NAME **Marlos Goes**	**DPhil**	**2006**	**305-361-4533**	**m.goes@miami.edu**
CO-PI/PD **Francisco J Beron-Vera**	**ScD**	**2001**	**305-361-4873**	**fberon@rsmas.miami.edu**
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

Electronic Signature

CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the Authorized Organizational Representative or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, lobbying activities (see below), responsible conduct of research, nondiscrimination, and flood hazard insurance (when applicable) as set forth in the NSF Proposal & Award Policies & Procedures Guide, Part I: the Grant Proposal Guide (GPG) (NSF 11-1). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Conflict of Interest Certification

In addition, if the applicant institution employs more than fifty persons, by electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution's expenditure of any funds under the award, in accordance with the institution's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

The following certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:
(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.
(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF Grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)
(This certification is not applicable to proposals for conferences, symposia, and workshops.)

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Kimberly Miller**	**Electronic Signature**	**Aug 16 2011 9:28AM**

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER
305-421-4079	**kmiller@miami.edu**	**305-421-4131**

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

A. Project Summary

Intellectual merit

Several studies have suggested that the South Atlantic Ocean plays an important role in the long term variability of the global thermohaline circulation and in the advection of heat and salt into the northern hemisphere. The main conduit for the inter-hemispheric water exchange is the western boundary, more specifically the North Brazil Undercurrent/Current system (NBUC/NBC). Recent studies have found a positive correlation between the strength of the NBC and rings shed in its retroflection region. Furthermore, a considerable part of the northward NBC transport is accomplished by such rings, which have recently shown a strengthening in their activity in synchrony with a similar strengthening in the activity of rings shed in the Agulhas leakage region. The main pathway between the NBC retroflection and Agulhas leakage regions is the South Equatorial Current, whose bifurcation latitude at the western boundary has been linked to the strengths of the NBC and South Atlantic gyre circulation.

The goal of this project is to unveil the mechanisms for the strengthening of the NBC and their link to the circulation in the South Atlantic, which is obscured by the mesoscale-, wind- and thermohaline-driven forcings in the region. The proposed work will involve a thorough investigation of the variability of the South Atlantic subtropical gyre and its link to the NBC transport from seasonal to interannual time-scales. To accomplish our goal we will produce a novel gyre scale dataset for the South Atlantic region based on a synthetic profile methodology, and use it along with boundary current time series, state-of-the art ocean model reanalyses. Finally, process-oriented experiments based on an earth system model will be produced to simulate the main modes of variability in the North and South Atlantic, the North Atlantic Oscillation (NAO) and South Atlantic Mode (SAM), respectively. The climate model grid will be modified to an eddy-permitting resolution, and the impact of these modes of variability on the inter-hemispheric transport will be studied.

Broader impacts

This project will improve the overall understanding of the variability of the circulation in the South Atlantic, and infer its link to the variability of the NBC from large- and meso-scale perspectives. At the same time the project will advance our knowledge of the vertical and horizontal structure of the subtropical gyre, detect variability in the regional circulation patterns, and diagnose the mechanisms of variability and the impacts on aspects of the inter-hemispheric water exchange. As a result the proposed study will improve our understanding of the stability of the Atlantic Meridional Overturning Circulation in climate model projections. As part of the proposed work, we will assist a postdoctoral fellow in developing the necessary skills to pursue a successful research career. Finally, the project will involve an ethnically diverse team of researchers, and will strengthen the scientific link between the University of Miami and the Brazilian Federal University of Rio Grande (FURG).

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For font size and page formatting specifications, see GPG section II.B.2.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

C. Project Description

C.1 Results from prior NSF support

Goes (PI): Goes has not had any NSF support previously.

Beron-Vera (co-PI): Beron-Vera has been previously supported by NSF under grants CMG0417425 (``Collaboration in Mathematical Geosciences: Nonintegrable Hamiltonian Systems in Ocean Dynamics,'' $950K, 10 October 2004-30 September 2008) and CMG0825547 (Collaboration in Mathematical Geosciences: ``Nonintegrable Hamiltonian Systems in Geophysical Fluid Dynamics,'' $760K, 1 October 2008-30 September 2012). The main subject of investigation in these projects is the study of transport and mixing using ideas from dynamical systems theory. The main discovery has been the association of transport barriers with zonal jets in the Earth's atmosphere and planetary atmospheres independent of the background distribution of potential vorticity. In close relation to the topic of this proposal, dynamical systems tools were employed to demonstrate that oceanic eddies, defined as closed contours of sea surface height (streamfunction), do not always trap and translate within slugs of water over distances as long as commonly believed. This suggests that the generally accepted idea that oceanic eddies are important interhemispheric water exchange agents should be carefully reviewed. The aforementioned specific results are published in Beron-Vera et al. (2010) and Beron-Vera et al. (2008), respectively. Over twenty additional peer reviewed papers on related topics acknowledge support from these grants. Two PhD students and 1 MSc student were supported by these grants.

C.2 Introduction

The subtropical gyre is the main dynamic feature in the upper circulation of the South Atlantic. Fed by waters from the Agulhas leakage region and Sub-Antarctic front, the South Equatorial Current (SEC) flows westward across the basin, and closes the northern part of the gyre circulation. The southern SEC (from now on just SEC) bifurcates off the Brazilian coast at different latitudes and depths. In its bifurcation, the SEC feeds into the North Brazil UnderCurrent/Current [NBUC/NBC], which flows northward across the equator, and the Brazil Current, which flows southward along the Brazilian coast. On its northward path, part of the NBC retroflects eastward in the equatorial region, and the other part flows northward along the coast, mostly in the form of rings (e.g., Didden and Schott, 1993; Johns et al., 1990; Richardson et al., 1994).

The NBC presents a strong seasonal cycle. It reaches its maximum strength during the months of August-September, and the minimum transport during April-May (Johns et al., 1998). Previous studies suggest a positive correlation between the number of rings shed and the strength of the NBC (e.g. Garzoli et al., 2004; Goes et al., 2009). Deep rings are generally formed when the NBC is in its strongest phase, and the NBC retroflection is fully

developed. At this time, rings can reach depths of 800m due to great contribution of the NBUC transport in intermediate layers (Garrafo et al., 2003; Fratantoni and Richardson, 1996). At other times of the year, the rings can be very shallow, spanning only the upper 150m of the water column. In fact, the structure of the rings can be very complex (Wilson et al., 2002), and different mechanisms can be responsible for the generation of rings with depth. For instance, Ma (1996) showed that NBC rings can be generated either as a consequence of the reflection of westward propagating equatorial Rossby wave packets deepening the thermocline, or during the spin up by wind forcing. Jochum and Malanotte-Rizzoli (2003) proposed independent formation mechanisms for shallow and subsurface rings. In their model, surface rings are produced by reflection of Rossby waves generated by an unstable NECC on the North Brazil coast. Subthermocline and intermediate water rings are generated by a different process, in which an intermediate western boundary current crossing the equator breaks down into vortices due to the presence of a thin boundary layer unable to provide, by friction, the necessary change in potential vorticity. Deep rings are interpreted as the merger of a surface ring with one of the intermediate rings.

The total contribution of NBC rings to the inter-hemispheric transport is estimated to be around 5-6Sv per year (Goni and Johns, 2001), but recent estimates, such as the one performed during the North Brazil Current Experiment (Johns et al., 2003), show NBC rings transport as high as 9 Sv per year of South Atlantic waters into the northern hemisphere. These estimates confirm the NBC rings as one of the biggest contributors for the inter-hemispheric transport in the upper Atlantic Ocean.

Recently, there has been an observed increase of eddy kinetic energy (EKE) in the NBC retroflection and the Agulhas leakage regions (Figure 1). A link between the eddy variability in the two regions has been previously suggested by Witter and Gordon (1999) and Byrne et al. (1995). Due to strong seasonal and interannual variability, this relationship is difficult to verify. Besides, the South Atlantic is a source and recipient of inter-oceanic fluxes, and any attempt to determine these contributions independently can lead to an ill-posed problem (Garzoli and Matano, 2011). The northward flow of the NBC is comprised of contributions from the wind-driven circulation, subtropical-cells, and the Meridional Overturning Circulation (MOC; e.g. Johns et al., 1998; Zhang et al., 2003; Goes et al., 2005). Therefore, changes in this circulation pattern may have significant implications for climate variability, both locally (e.g. Goldenberg et al., 2001; Sutton and Hodson, 2005) and globally (e.g. Vellinga and Wu, 2004; Zhang et al., 2011).

Because of the many contributions to the NBC transport, its variability from seasonal to decadal is related to various factors. Climate models find that the variability in decadal time-scales are linked to the Labrador Sea water mass formation, and therefore to the AMOC variability (Zhang et al., 2011). In seasonal to interannual time-scales, the wind-driven variability seems to be the dominant forcing (Johns et al., 1998). However, Johns et al. (1998) and Zhang et al. (2011) do not account for the variability of inter-temporal time-scales, assuming either that in decadal time-scales the wind driven circulation is constant, or that in

interannual time-scales the North Atlantic Deep water mass formation is constant.

Indeed, recent studies demonstrate using climate model experiments that the two processes act equally to the NBC transport, and that they can cancel each other if variability in both components is accounted for (Levermann et al., 2007; Delworth and Zeng, 2008).

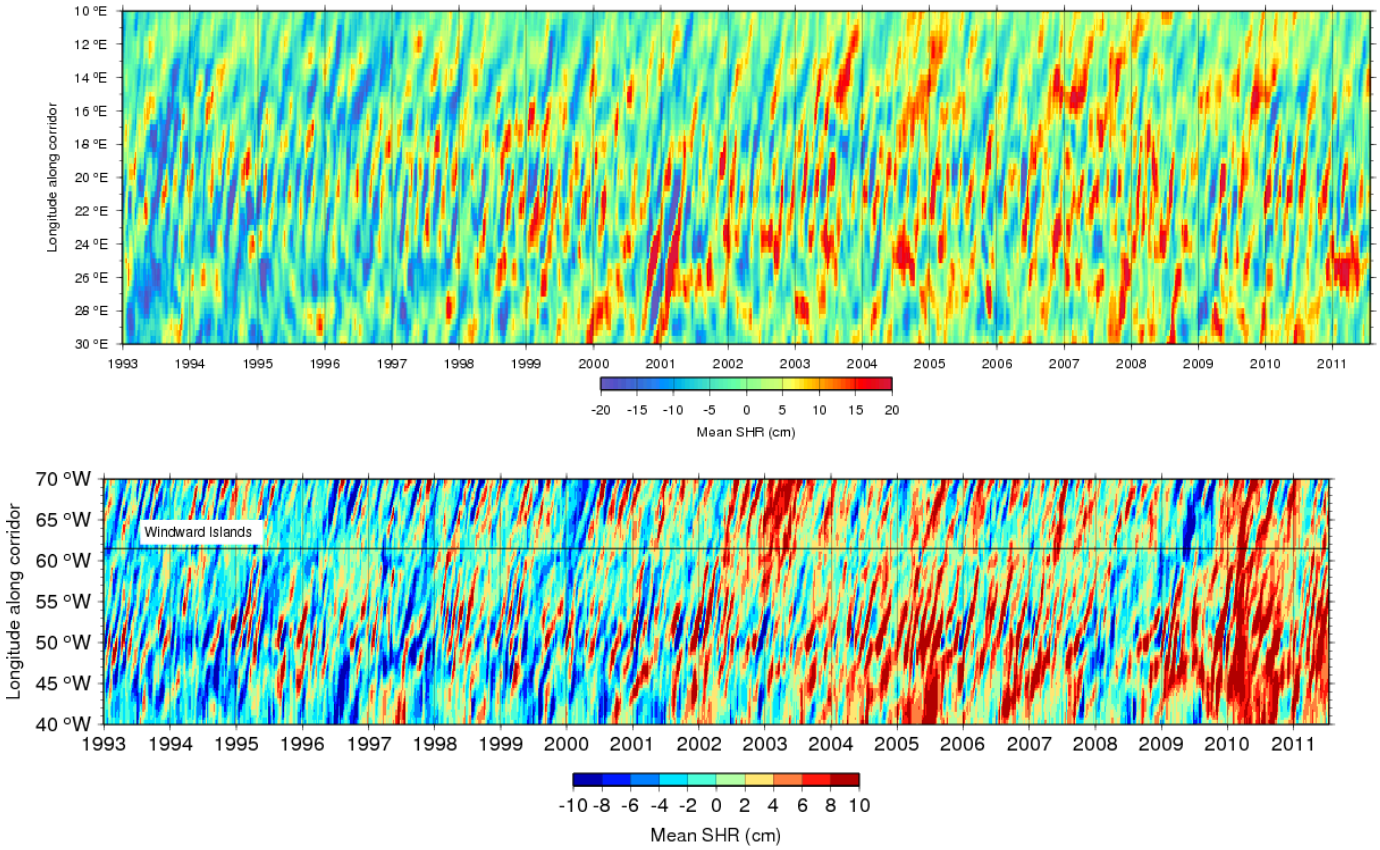

Figure 1: Mean sea height residual (SHR) space-time diagram for the: (upper) NBC retroflection region, and (lower) Agulhas current retroflection region. The anticyclonic warm rings can usually be identified by their large positive SHR values (redish colors). The SHR values are obtained by removing the annual signal of the altimetric sea height anomaly.

Climate model projections show a potential strengthening and poleward shift of the Southern Hemisphere westerlies under future climate change (Saenko et al. 2005; Stouffer et al. 2006a), and, in fact, some observations confirm this trend (Gillet and Thompson, 2003; Toggweiler, 2009).

Changes in the wind forcing may be responsible for the recent increase in Agulhas leakage (Biastoch et al., 2009; Lee et al., 2011). Model results show that increased Agulhas leakage leads to an enhanced horizontal super-gyre and a positive trend in salinity of the NBC core, which produces low-frequency variability in the Atlantic MOC (AMOC). However, a link between the EKE variability in the NBC region and the increased Agulhas leakage has yet to

be explained.

The Agulhas and NBC regions are connected via the South Atlantic subtropical gyre (SASG). The SASG is linked to the inter-hemispheric transport through three main pathways (Fratantoni et al., 2000): 1) an intermediate western boundary current, 2) western boundary transport in the surface layer including time-dependent NBC ring shedding, and 3), interior surface Ekman transport.

The subtropical gyre can have compensating effects between increased salinity and temperature, and its variability can be attributed to wind-induced heaving of isopycnals over time (Lozier et al., 2010) that produce only small changes in zonal density gradients. Wind-induced redistributions of heat and freshwater primarily alter the west-east contrast in density across the basin and thus impact the MOC. If this relationship holds, the overturning circulation responds to the property changes, instead of driving them.

Recent studies have analyzed trends in the SASG. Vianna and Menezes (2011) use altimetry to suggest that the SASG has been slowly migrating southward and growing in amplitude, with the NBUC and the SEC intensifying a few cm s^{-1} during the altimetry period. Similarly, a southward shift in the Brazil Current Front has been detected in the last 15 years (Goni et al., 2011; Lumpkin and Garzoli, 2011). It is still questionable if this variability is driven by the southward trend in the zero wind stress curl in the southern South Atlantic, a spin-up of the gyre due to decadal intensification of the wind stress curl associated with the southern hemisphere's annular mode (Roemmich et al., 2007; Cai, 2006), or a result of a bi-decadal oscillation caused by internal perturbations linked to the AMOC variability (Danabasoglu 2008).

The contribution of the SASG to the interhemispheric transport via the NB(U)C may be measured on the edges of the SEC bifurcation. There is a potential relationship between the position of the SEC bifurcation and the NBUC (Silva et al., 2011), in which the NBUC is stronger and the Brazil Current is weaker when the SEC bifurcation reaches its southernmost position during May-July. If this relationship holds on interannual and decadal timescales, observations off the SEC bifurcation region may help diagnose the link between the gyre circulation and the NBC strength. Measurements offshore from the SEC bifurcation can detect if the strengthening of the NBC is related to AMOC only or if it is accompanied by changes in the wind driven circulation and gyre variability as well.

Several modeling studies in the last decade focus on the variability of the AMOC caused by global warming and by freshening of the Northern North Atlantic (e.g. Hu et al., 2008; Stouffer et al., 2006). Indeed, AMOC projections are deeply uncertain, and it is unlikely that the AMOC can collapse in climate models under the impact of global warming (Goes at al., 2010; Meehl et al., 2007; Schmidt, 2005) unless they are forced simultaneously with a strong freshening of around 1Sv (Brady and Otto-Bliesner, 2010). The NBC in climate models is very sensitive to the forced freshening in the north and may even reverses the direction of its flow (Chang et al., 2008) whenever climate models undergo an AMOC collapse. The feedback that

controls the stability of the MOC, among others, can be related to the wind stress curl over the tropical-subtropical Atlantic (Laurian and Drijfhout, 2010), which directly impacts subtropical gyre strength (Jiang et al., 2008). However, non-eddy resolving models represent the boundary currents as a viscous flow that may be more stable than in nature. Therefore, future investigation of the relationship between the SASG variability and the NBC necessarily requires the use of high resolution models and observations.

C.3 Scientific Issues and Hypothesis

We hypothesize that the strength of the South Atlantic gyre circulation is a major agent for the variability in the NBC at time-scales ranging from interannual to decadal. This effectively makes the SA gyre a filter for the variability of the inter-ocean exchange of mass. This hypothesis is based on current knowledge in the field, and is stated in Section 1 (Introduction) of this proposal. A summary of the current knowledge relevant for the proposed work is given below:

i) Current modeling studies do not show an obvious link between the Agulhas leakage and the NBC variability on time-scales up to decadal (e.g. Biastorch et al., 2009).

ii) Salinity anomalies brought into the subtropical gyre can compensate temperature variability, and the Ekman driven flow can drive the MOC changes in the SA (Lozier et al., 2009).

iii) The link between the SEC bifurcation in the western SA with the strengthening of the NBC (Silva et al., 2009) lends credence to the hypothesis that there is a relationship between the variability of potential vorticity (PV) in the SA gyre (Rhines and Young, 1982) and PV from the cross-hemispheric transport.

Specifically, we want to address the following questions:

1. How variable is the subtropical gyre, and what are the dominant time scales?

2. Are there long-term trends in the shedding of NBC and Agulhas rings? If so, how are they related to each other, and what are the mechanisms for the recent increased variability of ring shedding in the western Atlantic region?

3. Is the SEC bifurcation region a good region to detect changes in the AMOC, and attribute if changes in the NBC transport/rings are related to gyre variability?

4. Is the South Atlantic a dominant factor for the variability of the Atlantic upper-ocean inter-hemispheric water exchange?

C.4. Research Methodology and Tasks

C.4.1. Research Tasks

To quantify the variability of the SASG and WBCs, we will use several datasets, including satellite altimetry height, profile floats from Argo array, high density XBT data, CTD sections from the World Ocean Circulation Experiment (WOCE) and other projects. In a first stage we are going to use sea surface height anomalies (SHA) to calculate the modes of variability of circulation in the South Atlantic. For this we are going to perform EOF analysis on the SHA fields. Once the main large-scale modes of variability are determined, we will diagnose the mechanisms for the variability in different parts of the basin. Contributions to circulation variability must include Sverdrup, Ekman and Rossby forcings, with the latter being a result of propagating Rossby waves with defined latitude-dependent phase speed (Qiu and Chen, 2006). With this analysis, we will be able to estimate the time-scales of adjustment that influence the basin, and the regions where eddy variability dominates the signal in comparison to Rossby waves.

The modes of variability will be linked to the annual variability seen in the years of Argo data, used to define the regions of maximum variability with depth, and used to link temperature and salinity forcings to the density variability. In addition, a comparison with WOCE data will be performed to look for interdecadal variability. Synthetic profiles are going to be estimated for the south Atlantic from Argo and altimetry using a method similar to the one applied by Willis and Fu (2008) for the North Atlantic. This relatively new technique can make robust estimates of upper ocean circulation every two or three years during the whole period of altimetric records. It consists of producing a linear regression, as a function of position and depth, of the satellite sea surface height (SSH) onto the density anomalies derived from the subsurface floats data. Density anomalies are then combined with the mean density profile at each location to generate the time varying total density fields. Density data are interpolated using an optimal interpolation method (e.g. Lavender et al., 2005), which calculates a correlation function dependent on meso- and large-scale decorrelation lengths. We will perform a validation by comparing the synthetic method with the original Argo data to assess the applicability of the method for the region. Geostrophic velocities relative to 2000m can be calculated using the dynamical method (thermal wind equation). Absolute velocities can be retrieved by adjusting the geostrophic fields to velocities derived from floats drifting at 1000m. This methodology will improve on estimates of the variability of the SA gyre viewed only from the surface, and will produce a 20-year long time series of gyre variability with depth.

The contribution from temperature and salinity to the total density changes in the basin can be calculated by retrieving synthetic profiles from the altimetric heights using the method of Carnes et al. (1990), in which the temperature and salinity profiles are generated through EOF decomposition of the original profiles and projected onto the SSH fields. Defining the

contribution of temperature and salinity to the density changes can be done using the methodology of Lozier et al. (2010), by just using the equation of state of the sea water, keeping either the salinity or temperature constant.

After this procedure, the time series of the NBC, Brazil Current, Benguela Current and Agulhas leakage will be analyzed in terms of periodicity, trends and eddy variability. The transports of these currents are going to be generated using either altimetry in conjunction with hydrography (CTDs, XBTs repeated transects), similar to what was done for the Kuroshio region (e.g. Imawaki and Uchida, 1997), or by estimating the absolute transport with the Mean Dynamic Topography, from products such as GRACE and GOCE gravity models (e.g. Rio and Hernandez, 2004, Vianna and Menezes, 2011). Of particular interest will be an effort to assess the significance of calculations of transport by NBC rings (Goni and Johns, 2001; Castelão et al. 2011) using novel Lagrangian dynamics tools (Beron-Vera et al. 2008; 2010). Utilization of such tools has revealed that standard transport calculations, which do not take into account the possibility of eddy-background water exchanges, may be overestimated.

As a result, this observational effort will generate a unique dataset that will provide a full picture of the circulation and water mass transformation in the south Atlantic, and will allow us to infer mechanisms for the recent changes by relating to trends in the large-scale and regional wind fields, and radiative forcing.

High resolution numerical reanalysis will be used to overcome limitations of data coverage in time and space, and will provide mass budget analysis for the assessment of the mechanisms of variability in the region. The scales of variability will be investigated consistently from model reanalyses for the region. Numerical model reanalysis will be taken from HYCOM/NAVO ($1/12^{\circ}$ res.) and SODA ($1/2^{\circ}$ res.). A thorough comparison and validation will be performed against the synthetic Argo/altimetry product to assess potential biases in the models, and also regional characteristics. The relationship between the SEC bifurcation position and the transport of the NBC/NBUC will be assessed. This relationship will reveal the link between the gyre scale baroclinic structure and the inter-hemispheric transport.

Finally, numerical experiments will be performed in order to understand the regional variability and the link to large scale processes. Experiments will be produced with the University of Victoria (Uvic; Weaver et al., 2001) coupled climate model of intermediate complexity to test our hypotheses in the region. The UVic model will be improved (Section 3.3) and meshed with a high resolution grid in the South Atlantic region. Experiments with Uvic model will test the impact of the changes of wind stress and wind curl in the South Atlantic, and include analysis of longer time-scales, such as decadal and centennial. To complement previous work that assess the model response to changes in the wind stress field in the southern hemisphere (e.g. Sjip and England, 2008), we will focus on the response of the SASG, and conduct experiments in which the wind stress curl changes in the South Atlantic and North Atlantic using improved grid resolution.

C.4.2. Data

Specifically, the main datasets that will be used in this study included are:

- Hydrography

XBT: XBTs in HD mode are deployed approximately every three months and are deployed approximately 25 km apart in order to measure the mesoscale structure of the ocean to diagnose the ocean circulation responsible for redistributing heat and other water properties globally. For this proposal, we will use the HD XBT transect AX97, which is carried out at the nominal of 23S off the Brazilian coast (Figure 2). The AX97 supports the MOVAR (from the Portuguese: Monitoring the upper ocean transport variability in the western South Atlantic) Project. The fluctuations of the zonally integrated baroclinic transport across this transect will be studied and linked to the variability of the Brazil–Malvinas frontal region. This region is critical since Brazil Current rings are the main mechanism to carry subtropical waters to high latitudes.

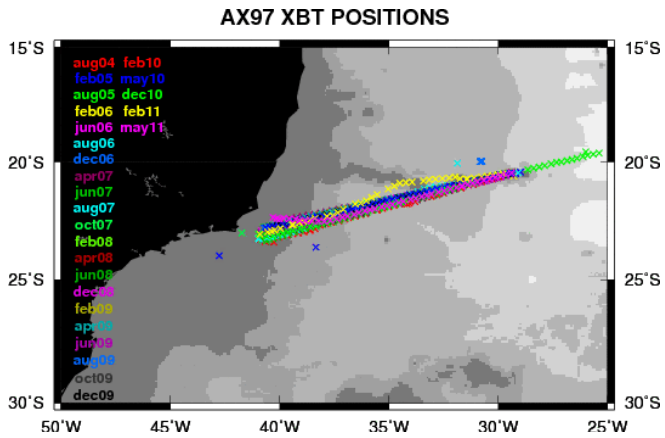

Figure 2: AX97 position and deployment dates (source: http://www.aoml.noaa.gov/phod/hdenxbt/ax_home.php?ax=97)

CTD:

Temperature, salinity and absolute velocity can be retrieved from moorings and cruises data around 11°S and 5°S. This data has previously been published in, for example, Schott et al. (2002) and Schott et al. (2005). First measurements in the western boundary at NBC/NBUC region started in 1990 during the World Ocean Circulation Experiment (WOCE). Such data will be used along with altimetric measurements to produce the NBUC transport estimates.

Argo:

The Argo network (www.argo.ucsd.edu) is now fully implemented, with 3000 floats performing measurements of temperature, salinity and drifting displacement on a basin-wide coverage, for the regions above 2000m deep. In the Atlantic, Argo data can produce annual absolute geostrophic velocity fields in the South Atlantic since year 2008. The velocities will be computed as follows: First we derive annual mean temperature and salinity profiles (with a vertical resolution of 10 dbar), quasi-Lagrangian zonal and meridional velocities at parking depth and drift pressures on a 1° X 1° grid. Due to gaps in the data set (Figure 3a) an objective analysis with decorrelation scales of 15° in latitude and longitude is applied to all data (Figure 3b, top row and right column). Then, the geostrophic velocity with a level of no motion at 1000 dbar is derived from the hydrographic fields and adjusted by using the velocity field derived from the float trajectories. The resulting velocity fields can be used, for example, to analyze the vertical structure of the subtropical gyre and its variability. The quality of these fields is subject to errors introduced by the spatial data coverage (Figure 3a). If additional observations for the interior flow and boundary regimes are available (e.g. synthetic velocity time series), the velocity and hydrographic fields can also be used to estimate the volume and heat transport of the MOC with a relatively low error.

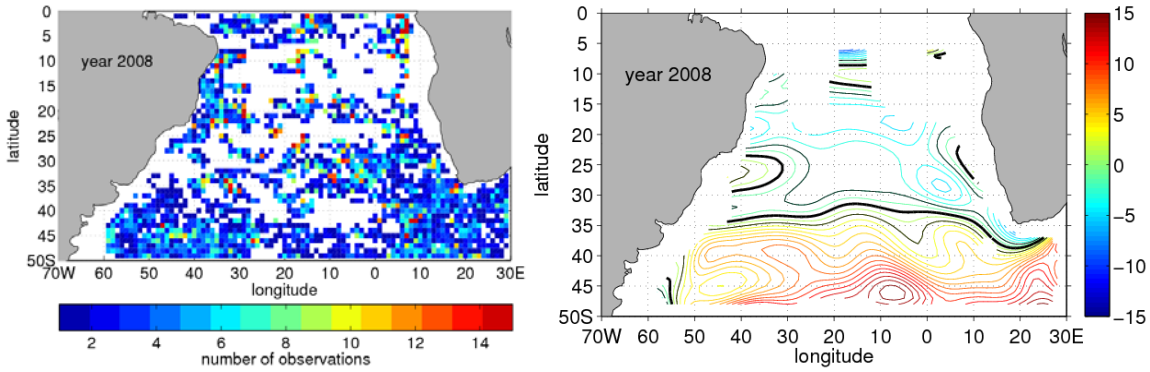

Figure 3: a) Number of observations and b) derived geostrophic velocity (cm/s) derived from Argo data for 2008. (Coutesy of Dr. Claudia Schmid.)

- Satellite Altimetry:

  Data from the Archiving, Validation and Interpretation of Satellite Oceanographic Data Project (AVISO; Ducet et al. 2000), which merges Ocean Topography Experiment (TOPEX)/Poseidon and European Remote Sensing Satellite (ERS) series altimeter data for improved spatial coverage. The delayed mode product DT-MSLA Upd will be used in this study, which provides data on a 1/3° x 1/3° grid every 7 days. There are now 18 complete years of high-precision surface height anomalies data from Jan. 1993 to Dec. 2010.

- Currents transport time series:

Time series of the Agulhas current and NBC rings are freely available under request at NOAA/AOML. These will be used to infer correlations between the gyre circulation and WBC properties. Time-series of the Brazil Current will be produced by Mauricio Mata at FURG, and the one from the NBC can be obtained from existent datasets and altimetry products (Figure 4). To review the calculations of NBC ring transport it will be critical to determine the dominant Lagrangian Coherent Structures (LCS; Haller 2011). Such LCS are material surfaces which act as the centerpieces of patterns formed by fluid particle trajectories, thereby fundamentally controlling transport and mixing.

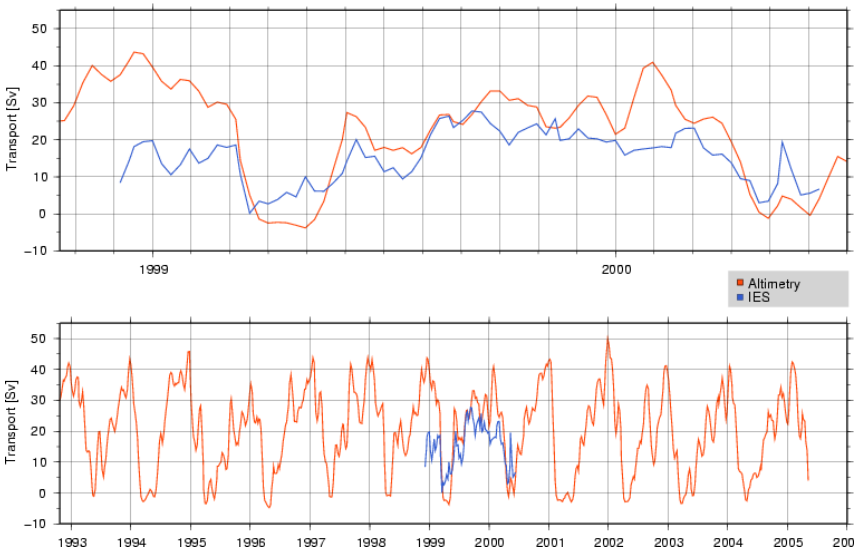

Figure 4: Time series of the geostrophic transport of both northwestward flow (blue) and the retroflected flow (red) of the NBC. The time series of geostrophic transport of the NBC retroflected flow is also estimated across the transect used in Garzoli et al. (2004) (combination of IES and CTD data during the NBC Ring Experiment for the transects IES17 and IES14). A combination of sea height anomaly (SHA) fields from satellite altimetry (AVISO) and climatological data (Levitus) are used to estimate the geostrophic transport.

C.4.3. Models

- **High resolution ocean model**

In the proposed study we will, as described above, analyze different sources of observations. Comparison to high resolution model output is necessary for cross-validation of the mass and heat balance in the region. We will potentially use two high-resolution ocean reanalysis products for this comparison: the HYbrid-Coordinate Ocean Model (HYCOM; Bleck, 2002; Halliwell, 2004) reanalysis and the SODA reanalysis (Carton et al, 2000). The HYCOM reanalysis will span nearly all of the altimetry era (1994-present) and will be available by the end of 2011. It uses the latest version of the U. S. Navy HYCOM ocean nowcast-forecast system (Chassignet et al, 2007), which is run globally on a 0.08° Mercator grid with curvilinear Arctic pole patch. This version uses 3d-var assimilation of all available global

observations. The SODA reanalysis is only eddy-permitting, but it spans the much longer time interval from 1870-2010 and will provide important information on interannual to multi-decadal variability of larger-scale circulation features such as the SASG. In addition to the two reanalysis products, additional information on larger-scale interannual to multi-decadal variability will be provided by two non-assimilative global ocean model simulations. They are the 1° resolution CCSM_POP ocean model simulation forced by the 20th century reanalysis product for 1971-2008 (Lee et al., 2011), and the medium-resolution (0.72°) HYCOM simulation performed at NOAA/AOML that was forced by the NCEP reanalysis product from 1948-2010. The HYCOM reanalysis will be particularly important for studying the impact of eddy fluxes while the two lower-resolution model products will provide important low-frequency, large-scale context for interpreting these results, estimates of terms in the mass, momentum, and scalar equations will be made to assess mechanisms of variability in the South Atlantic. Observational products in conjunction with a high-resolution ocean reanalysis will allow us to investigate the contribution of the gyre circulation to the inter-hemispheric transport and the interannual to decadal circulation variability of the upper 1800m in the South Atlantic.

- Climate model

  According to an OGCM-based study of Hakkinen (1999), the main driver of AMOC variability during the recent decades is the surface heat flux forcing over the North Atlantic sinking regions. In particular, Hakkinen concluded that the general increase of the AMOC since the mid-1980s is largely due to the evaporative cooling over the Labrador Sea in response to the sustained upward trend of the NAO (Hurrel 1995). Eden and Jung (2001) use the Modular Ocean Model (MOM2) to conclude the same, while other fully coupled climate modeling studies also support this conclusion (e.g., Delworth and Greatbatch 2000; Cheng et al.2004).

  In the Southern Hemisphere, the leading mode of atmospheric circulation at low-frequencies is the Southern Annular mode (SAM), which is characterized by a zonally symmetric sea level pressure pattern at polar latitudes with reversal at middle latitudes (Rogers and van Loon, 1982; Silvestri and Vera, 2009). It has been recognized that the SAM pattern is a main contributor of gyre variability in the Southern Hemisphere (Roemmich et al., 2007), and also for the AMOC variability (Sjip and England, 2008; Lee et al., 2011). The SAM index is based on sea level pressure differences (Marshall, 2003), and can be found at http://www.nerc-bas.ac.uk/icd/gjma/sam.html.

  In order to simulate how these two major processes of atmospheric variability contribute to changes in the inter-hemispheric transport, various experiments will be conducted using the University of Victoria Earth System Model of Intermediate Complexity (UVic 2.9; Weaver et al., 2001). The ocean component in UVic is MOM2 (Pacanowski, 1995). The atmospheric component is a single-layer atmospheric energy moisture balance model, which does not apply flux correction and is forced by prescribed winds. Also included in the model are a

thermodynamic sea ice component, terrestrial vegetation (TRIFFID), and an oceanic biogeochemistry based on the ecosystem model of Schmittner et al. (2005b). We will apply changes to UVic model for our proposal goals.

There are number of advantages for using Uvic in comparison to using conventional ocean models. One such advantage is that by coupling with the atmospheric energy moisture balance model, the heat and freshwater are fully conserved in the model atmosphere–ocean system. Therefore, for the purpose of this proposal, incoming radiative forcing is not going to be changed, the only forcing dataset that will require changes is the surface wind stress field. In comparison to more complex climate models, UVic can perform simulations relatively quickly.

We will use an eddy–permitting resolution (0.25° x 0.25°) in the UVic model. As summarized in Table 1, we will introduce atmospheric variability associated with the NAO and SAM in the Uvic model. Anomalous wind stress fields resulting from the NAO and SAM oscillations will be applied in the model by projecting their principal components onto the mean wind field. From these experiments, we will understand how the AMOC and the South Atlantic gyre circulation are affected by the NAO and SAM, and to measure the sensitivity of the inter–hemispheric transport to these modes of variability.

Potentially, other experiments could be included in the present set. As example, water housing experiments and global warming projections. This decision shall be made during the work process, in the light of the results achieved. The following experiments will be performed:

Table 1: The five main experiments to be performed using the high–resolution UVic model.

Experiment Name	Spin–up	Wind forcing characteristics
Control	The model will be spinup for 3000 years, using the uncoupled carbon version, and climatological NCEP winds.	This experiment will be the standard UVic setup, which is run with the NCEP wind climatology. Atmospheric carbon concentration will be selected in the pre–industrial levels.
NAO	Same as control	This experiment uses the NCEP wind climatology for the whole ocean but the northern hemisphere, which is simulated with projected NAO wind forcing.
SAM	Same as control	This experiment uses the NCEP climatology for the whole ocean but the southern hemisphere, which is simulated with projected SAM wind forcing.

NAO + SAM	Same as control	This experiment uses the NCEP climatology for the whole ocean, but with the NAO wind forcing projected in northern hemisphere, and with the SAM forcing projected in southern hemisphere.

C.5. Proposal Team

The proposed study will be carried out at the University of Miami/RSMAS. Quality controlled Argo data product will be provided by the collaboration with Dr. Claudia Schmid from NOAA/AOML at no cost. Dr. Schmid will also advise on the absolute velocity calculation for Argo data. The XBT data at 23°S off the coast of Brazil will be made available by Dr. Mauricio Mata from FURG, who will also assist in the production and analysis of the merged hydrographic/altimetry time series for the Brazil Current. Dr. Mata has his own funding, but we propose a visit by Dr. Mata to Miami to promote the collaboration between the two universities in this and future projects. Dr. Francisco Vera will perform the Lagrangian Coherent Structure calculations of transport. Dr. Beron-Vera has experience in extracting LCS from ocean currents (e.g., Beron-Vera et al. 2008; 2010).

Climate model setup and simulations will be performed by Dr. Marlos Goes with collaboration of Dr. Sang-Ki Lee from Univ. of Miami/CIMAS. Dr. Lee has extensive experience in climate modeling and grid-meshing, and Dr. Goes has a large experience in developing and performing experiments with the Uvic model. Dr. Lee does not request funding from this proposal. Dr. George Halliwell from NOAA/AOML will collaborate with the project at no cost by providing the HYCOM high-resolution ocean reanalyses and the multi-decadal, medium-resolution global HYCOM simulation that will be used in this work, and by advising on the analyses of large- and mesoscale variability. Finally, a postdoctoral research associate will be assigned to work closely to Dr. Goes to construct the synthetic product using Argo and altimetry, and perform the analysis of the model dataset.

C.6. Timeline and Deliverables

C.6.1. Timeline

The proposed study will be performed over a 3-year period, which represents the three phases of the research. The first phase will be deserved to acquiring all necessary datasets, implementation of the synthetic profiles methodology, and development of the improved the climate model. The second phase will be ascribed to climate model runs and reanalysis-data comparison. The third phase is intended for model projection analyses.

More specifically, we will proceed as follows:

Year 1: All data will be acquired, which includes gridded Argo 3D profiles and velocities, XBT

AX97 data, cruise data off the coast of South America, satellite altimetry data and the model simulations from HYCOM/NAVO. Implementation of the synthetic profile analysis will be performed, in which Argo and altimetry data will produce a 20-year basin scale dataset of the circulation of the South Atlantic. Altimetry and wind stress data will be used to study the gyre variability and trends in the South and tropical Atlantic, and trends in eddy variability. Modifications in the UVic climate model grid and forcings will be initiated.

Year 2: First set of results will be analyzed. The blended hydrography/altimetry product will be validated. Comparisons of the high-resolution HYCOM reanalysis with the gyre-scale circulation and boundary time series will be performed. Changes in the climate model will be finished. The spin-up runs and experiments will be finalized.

Year 3: The climate model simulations will be investigated. With all products available, a comprehensive study using all information will be performed, and the main hypothesis will be carefully addressed.

C.6.2. Deliverables

Deliverables from this project include an unprecedented dataset of the entire gyre circulation in the South Atlantic using Argo float data in the interior and altimetry/XBT at the boundaries. The scientific community will benefit from these results because for overcoming a historical lack of quality data in the South Atlantic. Argo and altimetry data together will allow for producing a time series of almost 20 years of the 3D circulation in the South Atlantic. We will produce a long time series of the SEC bifurcation, and test if a monitoring system off the bifurcation region can produce information about causes of variability of the North Brazil Current. A comprehensive analysis of data and ocean models will determine mechanisms of the variability of the western boundary currents, and of the vertical and horizontal structure of the South Atlantic subtropical gyre. With a climate model, we will unveil the contribution of the northern and southern forcings to the variability of the inter-hemispheric transport, and consequently, to the ocean heat transport.

Outreach activities: We plan to produce at least three peer reviewed articles in high impact journals, and disseminate our results in scientific conferences and workshops.

Educational Results: We will work closely with a postdoctoral fellow and provide a strong training in data analysis, modeling and ocean climate dynamics.

Collaboration: We will initiate a long-term the scientific collaboration between the University of Miami and the Brazilian Federal University of Rio Grande (FURG). Dr. Goes is recently contracted by the University of Miami and starts with this proposal collaborating with Dr. Beron-Vera and Dr. Lee. The PIs will strengthen the local collaboration with Dr. Schmid and Dr. Halliwell from NOAA/AOML.

Diversity Participation: The participation of Beron-Vera and Goes contributes to broaden the participation of underrepresented groups in science.

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Schmid, C. and S.L. Garzoli (2009): Spreading and Variability of the Antarctic Intermediate Water in the Atlantic. *Journal of Marine Research*, 67(6), 815-843.
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Biographical Sketch

Marlos Goes
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Miami, FL 33149
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marlos.goes@noaa.gov

(a) Professional Preparations:

University of Campinas	Physics	B.Sc	1999
University of Sao Paulo	Oceanography	M.Sc.	2001
University of Reading	Oceanography	Doctorate fellowship	2005
University of Sao Paulo	Oceanography	Ph.D.	2006
The Pennsylvania State University	Climate studies	Post-doc.	2009

(b) Appointments:

2010 - present	Assistant Research Scientist, Cooperative Institute for Marine and Atmospheric Studies, University of Miami
2007-2009	Post-doctoral fellow, The Pennsylvania State University
2007	Visitor Scientist, POGO-SCOR scholarship, University of Maryland
2004-2005	Visitor research Assistant, CAPES scholarship, University of Reading, UK
2002-2006	Graduate Research Assistant, University of Sao Paulo, Brazil
2000-2001	Graduate Research Assistant, University of Sao Paulo, Brazil

(c) Publications

Five publications related to the proposed research:

Goes, M., Urban, N. M., Tonkonojenkov, R., Haran, M., Schmittner, A., and Keller, K. (2010), What is the skill of ocean tracers in reducing uncertainties about ocean diapycnal mixing and projections of the Atlantic Meridional Overturning Circulation?, J. Geophys. Res., doi:10.1029/2010JC006407.

Goes, M., Molinari, R., da Silveira, I., and Wainer, I. (2005), Retroflections of the North Brazil Current during February 2002, Deep Sea Research Part I: Oceanographic Research Papers, V. 52, 4, 647-667.

Goes, M., Marshall, D. P., and Wainer, I. (2009), Eddy Formation in the Tropical Atlantic Induced by Abrupt Changes in the Meridional Overturning Circulation. J. Phys. Oceanogr., 39, 3021–3031.

Goes, M., Wainer, I., Gent, P. R., and Bryan, F. O. (2008), Changes in subduction in the South Atlantic Ocean during the 21st century in the CCSM3, Geophys. Res. Lett., 35, L06701, doi:10.1029/2007GL032762.

Góes, M., and Wainer, I. (2003), Equatorial currents transport changes for extreme warm and cold events in the Atlantic Ocean, Geophys. Res. Lett., 30(5), 8006,doi:10.1029/2002GL015707.

Five additional publications:

R. Olson, R. Sriver, M. Goes, N. M. Urban, H. D. Matthews, M. Haran and K. Keller: A climate sensitivity estimate using global average observations and an Earth System model with a dynamic 3D ocean, submitted to Journal of Geophysical Research, Atmosphere.

Sriver, R. L., Goes, M., Mann, M. E., and Keller, K. (2010), Climate response to realistic tropical cyclone-induced ocean mixing in an Earth system model of intermediate complexity, J. Geophys. Res.-Oceans, doi:10.1029/2010JC006106.

Goes, M., Tuana, N., and Keller, K. (2011), The economics (or lack thereof) of aerosol geoengineering, Climatic Change, doi:10.1007/s10584-010-9961-z.

Bhat, K.S., Haran, M., and Goes, M. (2010), Computer model calibration with multivariate spatial output, in "Frontiers of Statistical Decision Making and Bayesian Analysis", eds. M-H. Chen et al., New York: Springer-Verlag, 2010.

Campos, C. N., Góes, M., Taschetto, A. S., and Wainer, I. (2001), A shift in Atlantic Ocean warm events: A preliminary study. Subtle Signals Newsletter, 1(1).

(d) Synergistic activities

Referee in the state finals of the 2009 Pennsylvania Junior Sciences and Humanities Symposium.
Reviewer for: Research proposals (NOAA, FACEPE/Brazil), and research articles (*Journal Of Geophysical Research*, *Climatic Change*)

(e) Collaborators & Other Affiliations

Collaborators:
Gustavo Goni (NOAA/AOML), Molly Baringer (NOAA/AOML), Klaus Keller (Penn State), Nancy Tuana (Penn State), Ryan Sriver (Penn State), Nathan M. Urban (Princeton), Roman Olson (Penn State), Michael E. Mann (Penn State), Murali Haran (Penn State), Andreas Schmittner (Oregon State U.), Ilana Wainer (U. Sao Paulo), Ernesto Munoz (New Mexico Consortium).

Graduate Advisor:
Ilana Wainer (U. Sao Paulo)

Graduate scholarship advisor:
David P. Marshall (Oxford University)

Visitor Scientist advisor:
James Carton (U. Maryland)

Postdoctoral Advisor:
Klaus Keller (Penn State)

Biographical sketch for Francisco Javier Beron-Vera

Personal data

Born	25 October 1970, Buenos Aires, Argentina.
Marital Status	Married, two children.
Citizenship	Argentine
Address	Division of Applied Marine Physics Rosenstiel School of Marine and Atmospheric Science University of Miami 4600 Rickenbacker Cswy. Miami, FL 33149 USA
Phone	+1 (305) 421-4873
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Hompage	www.rsmas.miami.edu/personal/fberon

Professional preparation

ITBA, Argentina	Oceanography	Licentiate, 1994
CICESE, Mexico	Physical oceanography	MSc, 1996
		ScD, 2001
RSMAS, U. Miami	Dynamics of Hamiltonian systems	2001–2004

Appointments

RSMAS, U. Miami	Research Associate Professor	2010–
RSMAS, U. Miami	Assistant Scientist	2004–2010
	Postdoctoral Research Associate	2002–2004
	Postdoctoral Scholar	2001–2002
CICESE, Mexico	Graduate Research Assistant	1998–2000
	Graduate Teaching Assistant	1997–2000
ITBA, Argentina	Undergraduate Teaching Assitant	1992–1993

Publications

Five publications related to proposed project

Beron-Vera, F. J., M. J. Olascoaga and G. J. Goni (2010). Surface ocean mixing inferred from multisatellite altimetry measurements. *J. Phys. Oceanogr.* 40, 2466-2480.

Beron-Vera, F. J. (2010). Mixing by high- and low-resolution surface ocean currents. *J. Geophys. Res.* 115, C10027, doi:10.1029/2009JC006006.

Beron-Vera, F. J., M. J. Olascoaga, M. G. Brown, H. Koçak and I. I. Rypina (2010). Invariant-tori-like Lagrangian coherent structures in geophysical flows. *Chaos* 20, 017514. (Invited contribution to *Chaos* Focus Issue on Lagrangian coherent structures in fluid flows.)

Beron-Vera, F. J. and M. J. Olascoaga (2009). An assessment of the importance of chaotic stirring and turbulent mixing in the West Florida Shelf. *J. Phys. Oceanogr.*, 9, 1743–1755.

Beron-Vera, F. J., M. J. Olascoaga G. J. Goni (2008). Oceanic mesoscale eddies as revealed by Lagrangian coherent structures. *Geophys. Res. Lett.* 35, L12603 doi:10.1029/2008GL033957.

Five other significant publications

Reniers, A. J. H. M., J. H. MacMahan, **F. J. Beron-Vera** and M. J. Olascoaga (2010). Rip-current pulses tied to Lagrangian coherent structures. *Geophys. Res. Lett.* 37, L05605, doi:10.1029/2009GL041443.

F. J. Beron-Vera, M. G. Brown, M. J. Olascoaga, I. I. Rypina, H. Koçak and I. A. Udovydchenkov (2008). Zonal jets as transport barriers in planetary atmospheres. *J. Atmos. Sci.* 65, 3316–3326.

Rypina, I. I., M. G. Brown, **F. J. Beron-Vera**, H. Kocak, M. J. Olascoaga and I. A. Udovydchenkov (2007). On the Lagrangian dynamics of atmospheric zonal jets and the impermeability of the stratospheric polar vortex. *J. Atmos. Sci.*, 64, 3595–3610.

Rypina, I. I., M. G. Brown, **F. J. Beron-Vera**, H. Koçak, M. J. Olascoaga and I. A. Udovydchenkov (2007). Robust transport barriers resulting from strong Kolmogorov–Arnold–Moser stability. *Phys. Rev. Lett.* 98, 104102.

Olascoaga, M. J., I. I Ryipna, M. G. Brown, **F. J. Beron-Vera**, H. Koçak, L. E. Brand, G. R. Halliwell and L. K. Shay (2006). Persistent transport barrier on the West Florida Shelf. *Geohys. Res. Lett.* 33, L22603, doi:10.1029/2006GL027800.

Synergistic activities

Teaching	Undergraduate and graduate courses.
Reviewer	Research proposals (NSF/OCE, CMG, and ATM; CUNY) and research articles (*Atmósfera*; *Deep-Sea Research*; *Geophysical Research Letters*; *Journal of Fluid Mechanics*; *Journal of Geophysical Research*; *Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics*; *Nonlinear Processes of Geophysics*; *Ocean Modelling*; *Tellus*).
Convener	Workshops (*Coherent Structures in Dynamical Systems*, Lorentz Center, Leiden, May 2011) and meeting sessions (*Variability of the South Atlantic*, Meeting of the Americas, Foz do Iguassu, August 2010).
Moderator	Several meeting and workshop sessions.
Member	AGU, AMS, EUROMECH.

Collaborators and other affiliations

M. Brown, M. Olascoaga, and A. Reniers (RSMAS, U. Miami); H. Koçak (U. Miami); G. Goni (NOAA/AOML); I. Rypina (WHOI); J. MacMahan (NPS).

Graduate and postdoctoral advisors

P. Ripa (MSc and ScD Advisor, CICESE, Mexico)
M. Brown (Postdoctoral Advisor, RSMAS, U. Miami)

Thesis advisor and postgraduate–scholar sponsor

I. Udovydchenkov (PhD Thesis Committee Member, RSMAS, U. Miami)

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Miami Rosenstiel School of Marine&Atmospheric Sci

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Marlos Goes

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Marlos Goes - Principal Investigator**	4.00	0.00	0.00	$ **22,834**	$
2. **Francisco J Beron-Vera - Co-Principal Investigator**	1.00	0.00	0.00	**8,336**	
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	5.00	0.00	0.00	**31,170**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	1.00	0.00	0.00	**4,859**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**36,029**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**12,246**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**48,275**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Computer $ **3,000**					
TOTAL EQUIPMENT				**3,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**2,000**	
2. FOREIGN				**6,000**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**3,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**62,275**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
MTDC (Rate: 53.5000, Base: 59275)					
TOTAL INDIRECT COSTS (F&A)				**31,712**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**93,987**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **93,987**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Marlos Goes

ORG. REP. NAME*
Kimberly miller

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

ORGANIZATION	PROPOSAL NO.	DURATION (months) Proposed	Granted
University of Miami Rosenstiel School of Marine&Atmospheric Sci			
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR	AWARD NO.		
Marlos Goes			

FOR NSF USE ONLY

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Marlos Goes - Principal Investigator**	4.00	0.00	0.00	$ **23,975**	$
2. **Francisco J Beron-Vera - Co-Principal Investigator**	1.00	0.00	0.00	**8,753**	
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	5.00	0.00	0.00	**32,728**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	6.00	0.00	0.00	**30,609**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**63,337**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**22,612**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**85,949**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**2,150**	
2. FOREIGN				**6,300**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**3,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**97,399**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 53.5000, Base: 97399)**					
TOTAL INDIRECT COSTS (F&A)				**52,108**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**149,507**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **149,507**	$
M. COST SHARING PROPOSED LEVEL $ **0**	AGREED LEVEL IF DIFFERENT $				

PI/PD NAME	FOR NSF USE ONLY INDIRECT COST RATE VERIFICATION		
Marlos Goes	Date Checked	Date Of Rate Sheet	Initials - ORG
ORG. REP. NAME* **Kimberly miller**			

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Miami Rosenstiel School of Marine&Atmospheric Sci

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Marlos Goes

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Marlos Goes - Principal Investigator**	4.00	0.00	0.00	$ **25,174**	$
2. **Francisco J Beron-Vera - Co-Principal Investigator**	1.00	0.00	0.00	**9,191**	
3.					
4.					
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	5.00	0.00	0.00	**34,365**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**1**) POST DOCTORAL SCHOLARS	6.00	0.00	0.00	**32,139**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**66,504**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**24,075**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**90,579**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**2,308**	
2. FOREIGN				**6,615**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**3,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**3,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**102,502**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 53.5000, Base: 102502)**					
TOTAL INDIRECT COSTS (F&A)				**54,839**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**157,341**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **157,341**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Marlos Goes

ORG. REP. NAME*
Kimberly miller

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Miami Rosenstiel School of Marine&Atmospheric Sci

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Marlos Goes

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Marlos Goes - Principal Investigator**	12.00	0.00	0.00	$ **71,983**	$
2. **Francisco J Beron-Vera - Co-Principal Investigator**	3.00	0.00	0.00	**26,280**	
3.					
4.					
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**2**) TOTAL SENIOR PERSONNEL (1 - 6)	15.00	0.00	0.00	**98,263**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**3**) POST DOCTORAL SCHOLARS	13.00	0.00	0.00	**67,607**	
2. (**0**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	**0**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**165,870**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**58,933**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**224,803**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **$ 3,000**					
TOTAL EQUIPMENT				**3,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**6,458**	
2. FOREIGN				**18,915**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**9,000**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**9,000**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**262,176**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**138,659**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**400,835**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **400,835**	$

M. COST SHARING PROPOSED LEVEL $ **0** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Marlos Goes

ORG. REP. NAME*
Kimberly miller

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification

This budget will cover costs associated with the proposed research over the three year duration of the project. We are requesting funding for three years due to the large computational effort required for this project. Detailed below are the specifics of the budget usage during the proposal work plan:

Salary: Salary is requested for the PIs Marlos Goes (4 months/yr) and Francisco J. Beron-Vera (1 month/yr), and for a post-doctoral researcher to be assigned (6 months/yr). The collaborators S.K. Lee, M. Mata, G. Halliwell, and C. Schmid will work on this project for two months per year at no salary cost to the project.

Travel: The budget includes one domestic travel a year, which will be used to present our results in scientific meetings. The meetings envisioned are the American Geophysical Union annual meeting (AGU) and Climate Variability and Predictability (CLIVAR) meetings. One international travel a year is included for meetings with M. Mata either in Miami or in Brazil, depending on the researcher's schedules. International meetings are crucial to the proposal, since an international collaboration between the host institution and the Brazilian FURG is commencing.

Computer: Data processing and all model simulations will be performed using the high performance computing system at University of Miami and NOAA/AOML. A computer for data storage and analysis associated with this project is budgeted in the first year.

Publication costs: Publication costs for an average of one paper a year is also included, as it is an important deliverable from the project.

The University of Miami’s negotiated IDC rate is 53.5% with DHHS

Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Marlos Goes

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Variability of the South Atlantic Subtropical Gyre and its Impact on the Inter-Hemispheric Water Transport (this proposal)

Source of Support: NSF

Total Award Amount: $ 400,835 Total Award Period Covered: 03/01/12 - 02/28/15

Location of Project: University of Miami

Person-Months Per Year Committed to the Project. Cal:4.00 Acad: 0.00 Sumr: 0.00

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section 11.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Francisco J. Beron-Vera	Other agencies (including NSF) which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Workshop "Coherent Structures in Dynamical Systems"

Source of Support: NSF

Total Award Amount: $36,490 Total Award Period Covered: 01/01/2011 – 09/30/2011

Location of Project: University of Miami/RSMAS

Person-Months Per Year Committed to the Project % Cal: 0.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaboration in Mathematical Geosciences: Nonintegrable Hamiltonian Systems in Geophysical Fluid Dynamics

Source of Support: NSF

Total Award Amount: $763,266 Total Award Period Covered: 09/01/2008 – 08/31/2012

Location of Project: University of Miami/RSMAS

Person-Months Per Year Committed to the Project. % Cal: 1.0 Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Objective Identification and Tracking of Meso and Submesoscale Eddies and Filaments, and their Role in Interbasin, Inerhemispheric, and Regional Exchanges

Source of Support: NASA

Total Award Amount: $528,523 Total Award Period Covered: 01/28/2010 – 01/27/2012

Location of Project: University of Miami/RSMAS

Person-Months Per Year Committed to the Project % Cal: 3.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Monitoring of surface and surface ocean conditions during the period April-October

Source of Support: NOAA

Total Award Amount: $15,000 Total Award Period Covered: 07/01/2011-12/31/2011

Location of Project: University of Miami/RSMAS

Person-Months Per Year Committed to the Project Cal: 1.0 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Consortium for Advanced Research on Hydrocarbon Transport in the Environment (CARHTE)

Source of Support: GRI

Total Award Amount: $16,995,563 Total Award Period Covered: 09/01/2011-08/31/2014

Location of Project: University of Miami/RSMAS

Person-Months Per Year Committed to the Project. % Cal: 6.0 Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section 11.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Francisco J. Beron-Vera	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Consortia for Gulf Ecosystem Assessment & Recovery Science (C-GEARS)

Source of Support: GRI

Total Award Amount: $19,005,155 Total Award Period Covered: 09/01/2011-08/31/2014

Location of Project: University of Miami/RSMAS

Person-Months Per Year Committed to the Project % Cal: 5.5 Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Variability of the South Atlantic Gyre and its Impact on the Inter-Hemispheric Water Transport (this proposal)

Source of Support: NSF

Total Award Amount: $400,835 Total Award Period Covered: 03/01/12-02/25/15

Location of Project: University of Miami

Person-Months Per Year Committed to the Project. % Cal: 1.0 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project % Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project Cal: 0.0 Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. % Cal: 0.0 Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Facilities, Equipment, and Others at University of Miami

1. Computer Resources

There are several computing facilities available to this project. At the University of Miami, the computing facilities include over 6,000 cores with over 8 terabyte of memory. It comprises a 576 CPU IBM Power5+ SMP cluster, with high-speed interconnect, 96 CPU IBM Power4 SMP cluster, and a 32 CPU Sun Scalable Processor ARChitecture (SPARCIIIi) server.

Data Management Plan

In accordance with the NSF policy on the dissemination and sharing of research results, we agree in share the data product of our research for research related studies, and guarantee the reproducibility of our results.

Data potentially generated from this proposal will be: a 3-D hydrography and horizontal velocity for the South Atlantic ocean; model experiments from a climate model; time series of boundary currents in the South Atlantic ocean. These data products will use only data that is currently publicly available on the internet and in research centers.

Also included as a potential deliverable from this proposal is the methodology to generate synthetic profiles, and statistical methods for data analysis. This methodology can be shared under request.

The data storage plan includes hard disks, available locally at NOAA/AOML and University of Miami during the extent of the project.

Post-doctoral Researcher Mentoring Plan for NSF Proposal

This proposal includes a post-doc who will be funded for 6 months/year during the duration of three years of the project. As part of the University of Miami, the researcher will have access to high quality facilities such as libraries, Wellness Center, computers, offices, and be in contact with professors and other researchers who can provide an excellent opportunity to her/his full development of skills, and engagement in a successful professional career.

Under the Postdoctoral Program office, established in 2006, the researcher development will be complemented with interdisciplinary centers that offer the researcher integration with other postdoctoral fellows, in a combination of lectures, discussions, readings, written exercises, and practical experiences to enhance his/her professional development.

Since this is a joint program between the University of Miami and NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML), a further possibility of interaction with ongoing projects, seminars and researchers will provide one of the best educations in the area.

More specifically, the mentoring plan will include:

- Working closely with the research assistant to assess, modify and establish the development plan based on the UM's Rosenstiel School of Marine and Atmospheric Science (RSMAS) requirements.
- Participation in seminars and courses offered by the University of Miami and NOAA/AOML, which are regularly given at these institutions.
- Dissemination of his/her scientific results in national meetings and workshops. For this aim, travel funds are allocated in the proposal budget for at least once a year.
- Development of writing and reading skills, and preparation of scientific presentations to allow the best quality of deliverables derived from his/her research.
- Preparations and submission of articles to scientific journals.
- Participation in weekly group meetings with the PI's during the development of the research. These meetings will serve to assess, discuss and improve the progress of the research, as well as improve the communication skills of the researcher.
- Participation in NOAA/AOML's summer internship program for improving his/her mentoring skills to undergraduate students.
- Opportunities for teaching assistance in both graduate and undergraduate level courses at UM/RSMAS.
- Participate in interdisciplinary groups inside the university directed to graduate students and post-docs to provide incentive for collaboration, diversity and action in different parts of the campus.
- As a component of a multi-institution collaborative project, the researcher will be motivated to lead and bring new discussions inside the group. This is a great opportunity for the researcher to be part of a group that has been highly successful and devoted to high quality science.

Success of this mentoring plan will be achieved when the post-doc will be performing his/her research independently, being self-motivated, being a valuable contributor to our group and being able to work in a respectful, ethical and objective manner.

MIAMI

ROSENSTIEL
SCHOOL of MARINE &
ATMOSPHERIC SCIENCE

RSMAS/University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149
Phone: 305-361-4521
Fax: 305-361-4412
E-mail: s.lee1@miami.edu

August 15, 201

To whom it may concern:

I acknowledge that I am identified as a collaborator to the investigation, entitled "**Variability of the South Atlantic subtropical gyre and its impact on the inter-hemispheric water transport**" that is submitted by Dr. Marlos Goes to the NSF, and that I intend to carry out all responsibilities outlined for me in this proposal with no cost. I have read the entire proposal and I agree that the proposal correctly describes the nature of my collaboration to the proposed investigation. For the purposes of conducting work for this investigation, my participating organization is Rosenstiel School of Marine and Atmospheric Science (RSMAS) of the University of Miami.

Thank you.

Sang-Ki Lee
Scientist

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami FL 33149

Dr. Claudia Schmid

NOAA/AOML/PHOD
4301 Rickenbacker Causeway
Miami, FL 33149
USA

Miami, August 3, 2011

Dear Dr. Goes:

I am very interested in collaborating in the project "Variability of the South Atlantic subtropical gyre and its impact on the inter-hemispheric water transport". This collaboration will benefit the planned project, by (1) providing access to high-quality hydrographic and quasi-Lagrangian data from Argo and other sources for the joint analysis with SSH from AVISO. (2) providing three-dimensional fields of adjusted geostrophic velocity derived from the data under (1).

I hope your proposal receives funding, so that the the understanding of the variability of the circulation in the subtropical South Atlantic and its contribution to the Meridional Overturning Circulation can be improved.

Yours sincerely,

C. Schmid

Claudia Schmid

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami FL 33149

Dr. George Halliwell
NOAA/AOML/PHOD
4301 Rickenbacker Causeway
Miami, FL 33149
USA

August 3, 2011

Dear Dr. Goes:

Thank you for inviting me to collaborate in the project "Variability of the South Atlantic Subtropical Gyre and its Impact on the Inter-Hemispheric Water Transport". This collaboration will benefit the project, by providing access to two numerical model analyses, specifically the high-resolution HYCOM global reanalysis which will be run from 1994 to the present and a medium-resolution HYCOM global simulation driven by the NCEP/NCAR atmospheric reanalysis from 1948-2010. I look forward to working with project investigators in providing the model fields and assisting in the scientific analysis of these products.

I wish you the best of luck in securing support for this project.

Yours sincerely,

George Halliwell