Cover Page for Proposal Submitted to the National Aeronautics and Space Administration

NASA Proposal Number

10-OSFC10-0013

NASA PROCEDURE FOR HANDLING PROPOSALS

This proposal shall be used and disclosed for evaluation purposes only, and a copy of this Government notice shall be applied to any reproduction or abstract thereof. Any authorized restrictive notices that the submitter places on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

SECTION I - Proposal Information

Principal Investigator	E-mail Address	Phone Number
Shenfu Dong	sdong@rsmas.miami.edu	305-361-4372

Street Address (1)	Street Address (2)
4600 Rickenbacker Cswy	

City	State / Province	Postal Code	Country Code
Miami	FL	33149-1031	US

Proposal Title : **Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic**

Proposed Start Date	Proposed End Date	Total Budget	Year 1 Budget	Year 2 Budget	Year 3 Budget
01 / 01 / 2011	12 / 31 / 2013	790,447.00	129,546.00	569,082.00	91,819.00

SECTION II - Application Information

NASA Program Announcement Number	NASA Program Announcement Title
NNH10ZDA001N-OSFC	Ocean Salinity Field Campaign

For Consideration By NASA Organization *(the soliciting organization, or the organization to which an unsolicited proposal is submitted)*
NASA , Headquarters , Science Mission Directorate , Earth Science

Date Submitted	Submission Method	Grants.gov Application Identifier	Applicant Proposal Identifier
05 / 28 / 2010	Electronic Submission Only		

Type of Application	Predecessor Award Number	Other Federal Agencies to Which Proposal Has Been Submitted
New		

International Participation	Type of International Participation
No	

SECTION III - Submitting Organization Information

DUNS Number	CAGE Code	Employer Identification Number (EIN or TIN)	Organization Type
152764007	1NV47	590624458	8H

Organization Name (Standard/Legal Name)	Company Division
University Of Miami, Key Biscayne	SPONSORED PROGRAMS - RSMAS

Organization DBA Name	Division Number
UNIVERSITY OF MIAMI ROSENSTIEL MARINE	

Street Address (1)	Street Address (2)
4600 RICKENBACKER CSWY	

City	State / Province	Postal Code	Country Code
KEY BISCAYNE	FL	33149-1031	USA

SECTION IV - Proposal Point of Contact Information

Name	Email Address	Phone Number
Shenfu Dong	shenfu.dong@noaa.gov	305-361-4372

SECTION V - Certification and Authorization

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in the Cover Sheet/Proposal Summary in response to this Research Announcement, the Authorizing Official of the proposing organization (or the individual proposer if there is no proposing organization) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in the two Certifications and one Assurance contained in this NRA (namely, (i) the Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs, and (ii) Certifications, Disclosures, and Assurances Regarding Lobbying and Debarment and Suspension.

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Authorized Organizational Representative (AOR) Name	AOR E-mail Address	Phone Number
Bonnie Townsend	btownsend@rsmas.miami.edu	305-421-4084

AOR Signature *(Must have AOR's original signature. Do not sign "for" AOR.)* **Date**

PI Name : **Shenfu Dong**	NASA Proposal Number
Organization Name : **University Of Miami, Key Biscayne**	**10-OSFC10-0013**

Proposal Title : **Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic**

SECTION VI - Team Members

Team Member Role	Team Member Name	Contact Phone	E-mail Address
PI	**Shenfu Dong**	**305-361-4372**	**sdong@rsmas.miami.edu**
Organization/Business Relationship: **University Of Miami, Key Biscayne**		Cage Code: **1NV47**	DUNS#: **152764007**
International Participation: **No**	U.S. Government Agency:		Total Funds Requested: **0.00**
Co-I/Science PI	**Molly Baringer**	**305-361-4306**	**Molly.Baringer@noaa.gov**
Organization/Business Relationship: **NOAA/NESDIS/ORA**		Cage Code: **3WWE0**	DUNS#: **130072577**
International Participation: **No**	U.S. Government Agency: **National Oceanic and Atmospheric Administration (NOAA)**		Total Funds Requested: **0.00**
Co-I/Science PI	**Eric Bayler**	**301-763-8127 x 102**	**Eric.Bayler@noaa.gov**
Organization/Business Relationship: **NOAA/NESDIS/ORA**		Cage Code: **3WWE0**	DUNS#: **130072577**
International Participation: **No**	U.S. Government Agency: **National Oceanic and Atmospheric Administration (NOAA)**		Total Funds Requested: **0.00**
Co-I/Science PI	**Gustavo Goni**	**305-361-4339**	**gustavo.goni@noaa.gov**
Organization/Business Relationship: **National Environmental Satellite, Data And Information Service**		Cage Code: **1DJC8**	DUNS#: **039261847**
International Participation: **No**	U.S. Government Agency: **National Oceanic and Atmospheric Administration (NOAA)**		Total Funds Requested: **0.00**
Co-I/Science PI	**Rick Lumpkin**	**305-361-4513**	**Rick.Lumpkin@noaa.gov**
Organization/Business Relationship: **National Environmental Satellite, Data And Information Service**		Cage Code: **1DJC8**	DUNS#: **039261847**
International Participation: **No**	U.S. Government Agency: **National Oceanic and Atmospheric Administration (NOAA)**		Total Funds Requested: **0.00**

PI Name : **Shenfu Dong**

Organization Name : **University Of Miami, Key Biscayne**

NASA Proposal Number

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Proposal Title : **Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic**

SECTION VII - Project Summary

The objective of this project is to investigate the processes governing sea surface salinity variations in the tropical and subtropical North Atlantic Ocean, specifically to assess the importance of eddy processes in the variability of the upper ocean salinity maximum in the subtropical North Atlantic. We propose to carry out two shipboard surveys during spring and autumn 2012 to reach the main scientific goals. A suite of observations, including numerous CTD/LADCP casts from the sea surface to 500 m depth, XBTs, deployment of salinity-measuring surface drifters and Argo floats, IMET meteorological observations, and continous underway ADCP, will be collected to perform process studies.

As noted in the reports of the US CLIVAR Salinity Working Group and the SPURS Workshop, no part of the climate system is as important to society as the global hydrological cycle. Ocean salinity is an important indicator of this cycle. As an equation of state variable, salinity plays a critical role in global climate through its effects on ocean circulation, stability and variability. Changes in ocean salinity have a direct impact on the ocean¿s ability to absorb, transport, and store heat, freshwater and carbon dioxide. Understanding salinity variability is vital for improving our understanding of ocean circulation patterns and the global climate system.

Despite its importance in the global hydrological cycle and climate system, our knowledge of salinity remains limited, in large part due to the lack of available observations. With the recent advances in the global ocean observing system and upcoming salinity measurements from space, it is now feasible to perform process studies of ocean salinity. These studies can only be accomplished through a combination of in situ and remotely-sensed measurements. The salinity maximum region in the subtropical North Atlantic is identified as the initial focus of the NASA Salinity Processes of the Upper-Ocean Regional Study (SPURS) observational and modeling effort. The existence of salinity maxima in the center of the subtropical gyres in each ocean has been well known; however, it has not been well understood what processes establish and maintain the salinity maximum. Observations collected from the proposed shipboard surveys will be invaluable for examining the regional salinity budget and for quantifying the physical processes responsible for the formation and variability of the salinity maximum, as well as for quantifying the uncertainties in the marine hydrological cycle.

Relevancy: This proposal is in response to the NASA Research Announcement ROSES¿2010, NNH10ZDA001N-OSFC ¿Ocean Salinity Field Campaign¿, known as the Salinity Processes in the Upper-Ocean Regional study (SPURS). The proposed shipboard surveys will make a significant contribution toward improved understanding of the physical processes responsible for the location, magnitude, and maintenance of the salinity maximum in the subtropical North Atlantic, and toward understanding the role of eddies in upper ocean salinity variability.

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SECTION VIII - Other Project Information

Proprietary Information

Is proprietary/privileged information included in this application?
Yes

International Collaboration

Does this project involve activities outside the U.S. or partnership with International Collaborators?
No

Principal Investigator	Co-Investigator	Collaborator	Equipment	Facilities
No	**No**	**No**	**No**	**No**

Explanation :

NASA Civil Servant Project Personnel

Are NASA civil servant personnel participating as team members on this project (include funded and unfunded)?
No

Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year
Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs

PI Name : **Shenfu Dong**	NASA Proposal Number
Organization Name : **University Of Miami, Key Biscayne**	**10-OSFC10-0013**

Proposal Title : **Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic**

SECTION VIII - Other Project Information

Environmental Impact

Does this project have an actual or potential impact on the environment?	Has an exemption been authorized or an environmental assessment (EA) or an environmental impact statement (EIS) been performed?
No	**No**

Environmental Impact Explanation:

Exemption/EA/EIS Explanation:

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SECTION VIII - Other Project Information

Historical Site/Object Impact

Does this project have the potential to affect historic, archeological, or traditional cultural sites (such as Native American burial or ceremonial grounds) or historic objects (such as an historic aircraft or spacecraft)?

No

Explanation:

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SECTION IX - Program Specific Data

Question 1 : Short Title:

Answer: Eddy's Role in the Variability of the Upper-Ocean Salinity Maximum

Question 2 : Type of institution:

Answer: Educational Organization

Question 3 : Will any funding be provided to a federal government organization including NASA Centers, JPL, other Federal agencies, government laboratories, or Federally Funded Research and Development Centers (FFRDCs)?

Answer: No

Question 4 : Is this Federal government organization a different organization from the proposing (PI) organization?

Answer: N/A

Question 5 : Does this proposal include the use of NASA-provided high end computing?

Answer: No

Question 6 : Research Category:

Answer: 8) Ground-Based field research in support of NASA Missions (including astronomical observations, field research, field campaigns)

Question 7 : Team Members Missing From Cover Page:

Answer:

Question 8 : This proposal contains information and/or data that are subject to U.S. export control laws and regulations including Export Administration Regulations (EAR) and International Traffic in Arms Regulations (ITAR).

Answer: No

Question 9 : I have identified the export-controlled material in this proposal.

Answer: N/A

Question 10 : I acknowledge that the inclusion of such material in this proposal may complicate the government's ability to evaluate the proposal.

Answer: N/A

Question 11 : Ship Time Requirements:

Answer:

Ship time requests for two 35-day cruises during spring and autumn 2012 have been submitted to NOAA for a research vessel such as the R/V Pisces or Ronald H. Brown. Those requests are linked to this proposal, although the two decisions may not be made concurrently.

Additional SPURS-funded efforts could also be accommodated aboard the NOAA vessel, should we be awarded the ship time, to the limit of the scientific party size and deck space available on the ship.

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Organization Name : **University Of Miami, Key Biscayne**	**10-OSFC10-0013**

Proposal Title : **Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic**

SECTION X - Budget

Cumulative Budget

Budget Cost Category	Funds Requested ($)			
	Year 1 ($)	Year 2 ($)	Year 3 ($)	Total Project ($)
A. Direct Labor - Key Personnel	0.00	71,944.00	26,999.00	98,943.00
B. Direct Labor - Other Personnel	70,380.00	220,685.00	22,318.00	313,383.00
Total Number Other Personnel	1	5	1	7
Total Direct Labor Costs (A+B)	70,380.00	292,629.00	49,317.00	412,326.00
C. Direct Costs - Equipment	10,000.00	19,200.00	0.00	29,200.00
D. Direct Costs - Travel	7,500.00	30,000.00	7,500.00	45,000.00
Domestic Travel	7,500.00	30,000.00	7,500.00	45,000.00
Foreign Travel	0.00	0.00	0.00	0.00
E. Direct Costs - Participant/Trainee Support Costs	0.00	0.00	0.00	0.00
Tuition/Fees/Health Insurance	0.00	0.00	0.00	0.00
Stipends	0.00	0.00	0.00	0.00
Travel	0.00	0.00	0.00	0.00
Subsistence	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
Number of Participants/Trainees				0
F. Other Direct Costs	0.00	35,600.00	3,000.00	38,600.00
Materials and Supplies	0.00	11,200.00	0.00	11,200.00
Publication Costs	0.00	3,000.00	3,000.00	6,000.00
Consultant Services	0.00	0.00	0.00	0.00
ADP/Computer Services	0.00	0.00	0.00	0.00
Subawards/Consortium/Contractual Costs	0.00	0.00	0.00	0.00
Equipment or Facility Rental/User Fees	0.00	0.00	0.00	0.00
Alterations and Renovations	0.00	0.00	0.00	0.00
Other	0.00	21,400.00	0.00	21,400.00
G. Total Direct Costs (A+B+C+D+E+F)	87,880.00	377,429.00	59,817.00	525,126.00
H. Indirect Costs	41,666.00	191,653.00	32,002.00	265,321.00
I. Total Direct and Indirect Costs (G+H)	129,546.00	569,082.00	91,819.00	790,447.00
J. Fee	0.00	0.00	0.00	0.00
K. Total Cost (I+J)	129,546.00	569,082.00	91,819.00	790,447.00
Total Cumulative Budget				790,447.00

PI Name : **Shenfu Dong**	NASA Proposal Number
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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2011	**12 / 31 / 2011**	**Project**	**1**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Dong，Shenfu	PI	0.00				0.00	0.00	0.00
							Total Key Personnel Costs	0.00

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	Programmer	12			51,750.00	18,630.00	70,380.00
1	Total Number Other Personnel					Total Other Personnel Costs	70,380.00

Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	70,380.00

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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2011	**12 / 31 / 2011**	**Project**	**1**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
1	Computer Server	10,000.00
	Total Equipment Costs	10,000.00

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	7,500.00
2. Foreign Travel	0.00
Total Travel Costs	7,500.00

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		0.00
2. Stipends		0.00
3. Travel		0.00
4. Subsistence		0.00
Number of Participants/Trainees:	**Total Participant/Trainee Support Costs**	0.00

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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2011	**12 / 31 / 2011**	**Project**	**1**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	0.00
2. Publication Costs	0.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	0.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
Total Other Direct Costs	0.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	87,880.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
MTDC	53.50	77,880.00	41,666.00
Cognizant Federal Agency: DHHS, Darryl Mayes, 202/401-2808		**Total Indirect Costs**	41,666.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	129,546.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	129,546.00

PI Name : **Shenfu Dong**	**NASA Proposal Number**
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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2012	**12 / 31 / 2012**	**Project**	**2**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Dong, Shenfu	PI	0.00	5.5			52,900.00	19,044.00	71,944.00
							Total Key Personnel Costs	71,944.00

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	R. Garcia, Technician	3.5			34,237.00	12,325.00	46,562.00
1	K. Seaton, Technician	3.5			28,422.00	10,232.00	38,654.00
1	P. De Nezio, Technician	3.5			31,678.00	11,404.00	43,082.00
1	Programmer	8			36,570.00	13,165.00	49,735.00
1	F. Bringas, Technician	3.5			31,362.00	11,290.00	42,652.00
5	**Total Number Other Personnel**					**Total Other Personnel Costs**	220,685.00

Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	292,629.00

PI Name : **Shenfu Dong**	NASA Proposal Number
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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2012	**12 / 31 / 2012**	**Project**	**2**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
1	XBTs	19,200.00
	Total Equipment Costs	19,200.00

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	30,000.00
2. Foreign Travel	0.00
Total Travel Costs	30,000.00

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		0.00
2. Stipends		0.00
3. Travel		0.00
4. Subsistence		0.00
Number of Participants/Trainees:	Total Participant/Trainee Support Costs	0.00

PI Name : **Shenfu Dong**	NASA Proposal Number
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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2012	**12 / 31 / 2012**	**Project**	**2**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	11,200.00
2. Publication Costs	3,000.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	0.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
8 . Other: **CTD Calibration**	3,000.00
9 . Other: **Standard Water**	14,400.00
10 . Other: **Shipping Costs**	4,000.00
Total Other Direct Costs	35,600.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	377,429.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
MTDC	53.50	358,229.00	191,653.00
Cognizant Federal Agency: **DHHS, Darryl Mayes, 202/401-2808**		Total Indirect Costs	191,653.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	569,082.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	569,082.00

PI Name : **Shenfu Dong**	**NASA Proposal Number**
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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2013	**12 / 31 / 2013**	**Project**	**3**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Dong, Shenfu	**PI**	**0.00**	**3**			**19,852.00**	**7,147.00**	**26,999.00**
							Total Key Personnel Costs	**26,999.00**

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	**Programmer**	**3**			**16,410.00**	**5,908.00**	**22,318.00**
1	**Total Number Other Personnel**					**Total Other Personnel Costs**	**22,318.00**

Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	**49,317.00**

PI Name : **Shenfu Dong**

Organization Name : **University Of Miami, Key Biscayne**

NASA Proposal Number

10-OSFC10-0013

Proposal Title : **Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2013	**12 / 31 / 2013**	**Project**	**3**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
	Total Equipment Costs	**0.00**

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	**7,500.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**7,500.00**

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		**0.00**
2. Stipends		**0.00**
3. Travel		**0.00**
4. Subsistence		**0.00**
Number of Participants/Trainees:	**Total Participant/Trainee Support Costs**	**0.00**

PI Name : **Shenfu Dong**	NASA Proposal Number
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SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2013	**12 / 31 / 2013**	**Project**	**3**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	0.00
2. Publication Costs	3,000.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	0.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
Total Other Direct Costs	3,000.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	59,817.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
MTDC	53.50	59,817.00	32,002.00
Cognizant Federal Agency: DHHS, Darryl Mayes, 202/401-2808		Total Indirect Costs	32,002.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	91,819.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	91,819.00

Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic

A proposal to the NASA Ocean Salinity Field Campaign**:** NNH10ZDA001N-OSFC

May 2010

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Requested Funds: $790,447

Proposed Period: January 1, 2011 to December 31, 2013

Collaborative Research: Assessing Eddy variability and its Impact on Changes of the Upper-Ocean Salinity Maximum in the North Atlantic

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(1: CIMAS/U.Miami-NOAA/AOML, 2: NOAA/AOML, 3:NOAA/NESDIS)

Summary

The objective of this project is to investigate the processes governing sea surface salinity variations in the tropical and subtropical North Atlantic Ocean, specifically to assess the importance of eddy processes in the variability of the upper ocean salinity maximum in the subtropical North Atlantic. We propose to carry out two shipboard surveys during spring and autumn 2012 to reach the main scientific goals. A suite of observations, including numerous CTD/LADCP casts from the sea surface to 500 m depth, XBTs, deployment of salinity-measuring surface drifters and Argo floats, IMET meteorological observations, and continous underway ADCP, will be collected to perform process studies.

As noted in the reports of the US CLIVAR Salinity Working Group and the SPURS Workshop, no part of the climate system is as important to society as the global hydrological cycle. Ocean salinity is an important indicator of this cycle. As an equation of state variable, salinity plays a critical role in global climate through its effects on ocean circulation, stability and variability. Changes in ocean salinity have a direct impact on the ocean's ability to absorb, transport, and store heat, freshwater and carbon dioxide. Understanding salinity variability is vital for improving our understanding of ocean circulation patterns and the global climate system.

Despite its importance in the global hydrological cycle and climate system, our knowledge of salinity remains limited, in large part due to the lack of available observations. With the recent advances in the global ocean observing system and upcoming salinity measurements from space, it is now feasible to perform process studies of ocean salinity. These studies can only be accomplished through a combination of in situ and remotely-sensed measurements. The salinity maximum region in the subtropical North Atlantic is identified as the initial focus of the NASA Salinity Processes of the Upper-Ocean Regional Study (SPURS) observational and modeling effort. The existence of salinity maxima in the center of the subtropical gyres in each ocean has been well known; however, it has not been well understood what processes establish and maintain the salinity maximum. Observations collected from the proposed shipboard surveys will be invaluable for examining the regional salinity budget and for quantifying the physical processes responsible for the formation and variability of the salinity maximum, as well as for quantifying the uncertainties in the marine hydrological cycle.

Relevancy: This proposal is in response to the NASA Research Announcement ROSES–2010, NNH10ZDA001N-OSFC "Ocean Salinity Field Campaign", known as the Salinity Processes in the Upper-Ocean Regional study (SPURS). The proposed shipboard surveys will make a significant contribution toward improved understanding of the physical processes responsible for the location, magnitude, and maintenance of the salinity maximum in the subtropical North Atlantic, and toward understanding the role of eddies in upper ocean salinity variability.

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Results from Prior Research

Dong et al. (2009) examined the seasonal cycle of mixed-layer salinity and its causes in the Southern Ocean by combining remotely-sensed measurements and *in situ* observations. The domain-averaged terms of oceanic advection, diffusion, entrainment, and air-sea freshwater flux (evaporation minus precipitation) are largely consistent with the seasonal evolution of mixed-layer salinity. The seasonal cycle in the mixed-layer salinity is largely attributed to the oceanic advection and entrainment; air-sea freshwater flux plays a minimal role. The spatial structure of salinity tendency in each month is also well captured by the sum of contributions from air-sea freshwater flux, advection-diffusion, and entrainment. However, substantial imbalances in salinity budget exist locally, particularly in regions with strong eddy kinetic energy and sparse *in situ* measurements. Sensitivity tests suggest that a proper representation of the mixed-layer depth, a better freshwater flux product, and an improved surface salinity field itself are important to close the budget.

S. Dong recently served as co-chief scientist for the U.S. CLIVAR/CO_2 Repeat Hydrography Program's P06 cruise (Leg 1, November 21, 2009-January 2, 2010). The transect across the Pacific was undertaken to track the changing uptake patterns of carbon dioxide in the ocean, as well as to assess changes that have occurred in the biogeochemical and physical properties of the ocean over the past several years. Changes in temperature/salinity have been observed in the Antarctic Intermediate Water.

R. Lumpkin**:** Collaborative Research: CLIMODE (NSF). The overarching goal of CLIMODE, a multi-institution collaborative effort, was to understand the processes governing the formation and maintenance of Eighteen Degree mode water in the subtropical North Atlantic. Lumpkin's contribution to this project was aimed at improving our knowledge of lateral eddy mixing in the upper ocean, and included deploying an array of 60 satellite-tracked surface drifting buoys. Preliminary results were presented at the March 2008 Ocean Sciences meeting in Orlando and at the August 2008 CLIMODE PI meeting in Woods Hole. Lumpkin has submitted an article on this subject to the Journal of Geophysical Research (with co-author Shane Elipot) arguing that the observed drifter dispersion is consistent with surface quasigeostrophic theory, but not with standard quasigeostrophic turbulence.

References

Dong, S., S. L. Garzoli, and M. O. Baringer, 2009: An Assessment of the Seasonal Mixed-Layer Salinity Budget in the Southern Ocean. *Journal of Geophysical Research*, 114, C12001, doi:10.1029/2008JC005258.

Lumpkin, R. and S. Elipot, 2010: Surface Drifter Pair Spreading in the North Atlantic. *J. Geophys. Res.-Oceans*, submitted April 2010.

Elipot, S., R. Lumpkin and G. Prieto, 2010: Modification of Inertial Oscillations by the Mesoscale Eddy Field. *J. Geophys. Res.-Oceans*, accepted May 2010.

1. Introduction

As noted by the US CLIVAR Salinity Working Group (2008) and the SPURS Workshop report (2010), no part of the climate system is as important to society as the global hydrological cycle. The ocean contains 97% of the global water and contributes 80% of surface water flux (Schmitt, 1995). Yet, the oceanic component of the hydrological cycle is poorly understood. The ocean also acts as a salt reservoir, which is approximately conserved over the global oceans. Thus, the distribution of ocean salinity can be used to estimate freshwater flux (e.g., evaporation, precipitation) and transport, and ocean mixing processes (Lukas and Lindstrom, 1991). Ocean salinity can also be used as an indicator of the strength of the hydrological cycle.

Temperature and salinity are the two fundamental ocean state variables. In contrast to the extensive studies and great interest of ocean temperature, ocean salinity has received much less attention, due in large part to the lack of data, and also because ocean salinity is generally perceived to have no direct influence on ocean-atmosphere interaction. However, through its modification of oceanic density fields, salinity can impact ocean circulation and mixing (e.g. Fedorov et al., 2004; Huang et al., 2005), which, in turn, affects ocean temperature. Thus, salinity can play a substantial role in ocean-atmosphere interaction and the global climate system, in particular at lower latitudes where the existence of a barrier layer, referred to the layer between the bottom of a shallower halocline and the top of the thermocline, has been observed (Lukas and Lindstrom, 1991; Sprintall and Tomczak, 1992; Godfrey et al., 1999) and at high latitudes where the thermohaline circulation is dominated by salinity. The formation and erosion of the barrier layer exerts a large influence on surface mixed layer dynamics. Its impact on the entrainment of cooler thermocline waters into the surface mixed layer regulates the heat and momentum exchanges between the ocean and the atmosphere.

In recent years, great interest in the Atlantic Meridional Overturning Circulation (AMOC) has been aroused due to its potential links to past abrupt climate change and anthropogenic climate forcing (e.g., Broecker, 1997; Stocker and Schmittner, 1997; Gregory et al., 2005). Sea surface salinity at high latitudes is believed to play an important role in affecting the intensity of the AMOC through contributions to the variability in the formation of the North Atlantic Deepwater (e.g. Rahmstorf, 1995; Häkkinen, 1999). The strength of the AMOC governs the amount of deep waters exposed to the ocean surface and, hence, impacts oceanic uptake of carbon dioxide, suggesting that salinity may be influential in determining the future climate.

In order to characterize and predict changes in the global hydrological cycle and global climate system, it is critical to advance our knowledge of the processes controlling ocean salinity variability. Improving the salinity monitoring system is essential for identifying changes in ocean salinity and understanding the physical processes responsible for those changes.

2. Background

Despite the importance of salinity in the global hydrological cycle and climate system, our understanding of the physical processes and feedbacks involving ocean salinity remains limited, in large part due to the lack of observations. Differences in the freshwater input are a principal

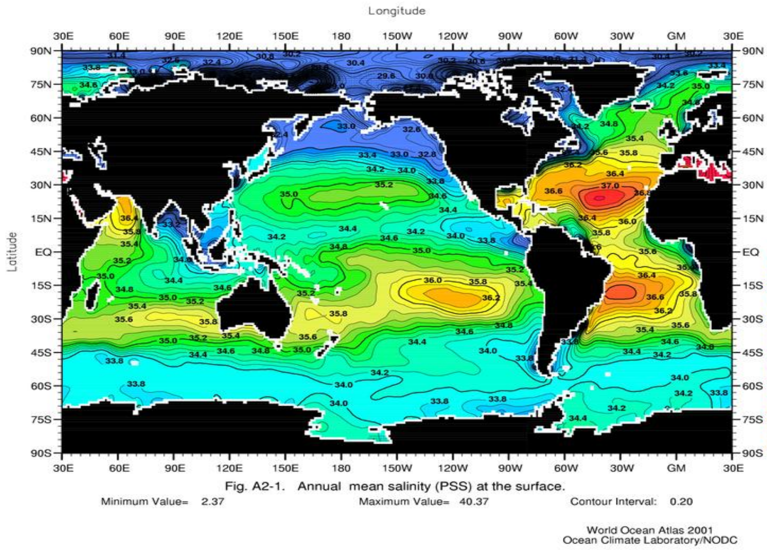

Figure 1. Time-mean sea surface salinity from World Ocean Atlas 2001. Adapted from the SPURS report (2010).

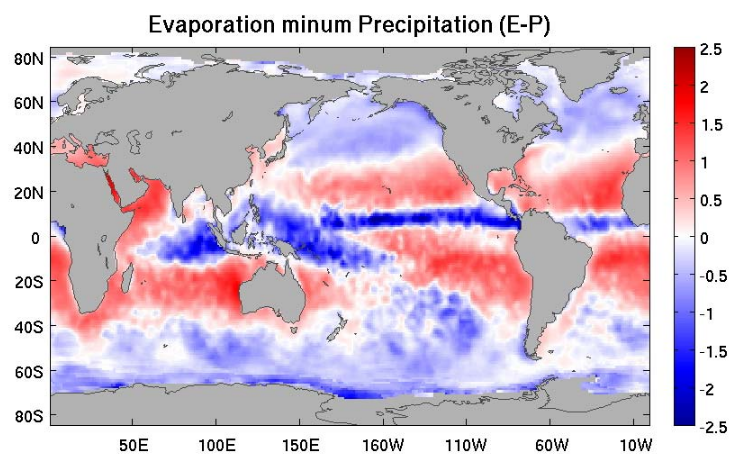

Figure 2. Time-mean freshwater flux (evaporation minus precipitation) from the National Oceanography Center, Southampton (NOC). Unit is meters/year.

cause for differences among climate models. The pioneering development of satellite remote-sensing missions for salinity is an important new capability for earth observation and climate research. The Europe Space Agency's Soil Moisture and Ocean Salinity (SMOS) mission, launched in November 2009, and the joint United States/Argentina Aquarius/SAC-D, expected to launch late in 2010, will provide global sale sea surface salinity on weekly and monthly time scales. These salinity measurements will be a great data source for advancing our knowledge of the physical processes involving in salinity variability. However, satellite salinity retrievals need to be validated using in-situ measurements prior to their application in studies of the global hydrological cycle and climate system.

Large-scale changes of ocean salinity in certain regions during recent decades have been revealed from available observations. A number of studies have described freshening in high latitudes (e.g. Curry and Mauritzen, 2005; Josey and Marsh, 2005; Curry et al., 2003; Wong et al., 1999; Bindoff and Mcdougall, 2000), while Curry et al. (2003) found a systematic increase in salinity at low latitudes of the North Atlantic Ocean. However, it is still unclear whether and how these observed changes can be attributed to natural variations. Physical processes responsible for long-term regional salinity changes remain unknown. Clearly, there is a need to evaluate the causes and implications of those changes to the global water cycle and climate dynamics in order to better understand the future climate.

Not only are the physical processes responsible for the long-term changes in the sea-surface salinity not well understood, it is also not clear what controls the time-mean distribution of the sea-surface salinity and its seasonal evolution. Although the time-mean distribution of sea surface salinity (Figure 1) shows a positive relationship to net freshwater flux (evaporation minus precipitation), with high salinities in the evaporative subtropics and reduced salinities in the tropics and subpolar regions with high precipitation (Figure 2), the regions with high/low salinities and positive/negative freshwater flux are not well collocated. For example, the salinity maximum in the subtropics is generally located to the poleward side of the regions with high evaporation. Although this displacement has been attributed to the Ekman advection transporting high salinity poleward in the subtropics (O'Connor et al., 2005), the roles of different physical processes in forming and dissipating the salinity maximum have not been well studied and are not fully understood.

As articulated in the SPURS report (2010), the time rate of change of salinity in an outcropping layer of thickness *h* is determined by a combination of surface freshwater flux, horizontal advection, vertical entrainment, and mixing processes. The rate of change, ss expressed in the SPURS report is determined by:

$$\underbrace{h\frac{\partial\langle S\rangle}{\partial t}}_{a} = \underbrace{-h\langle\vec{u}\rangle\bullet\nabla\langle S\rangle}_{b} \underbrace{-\nabla\bullet\int_{-h}^{0}\hat{\vec{u}}\hat{S}dz}_{c} \underbrace{-\left(\langle S\rangle - S_{-h}\right)\left(\frac{\partial h}{\partial t}+\vec{u}_{-h}\bullet\nabla h + w_{-h}\right)}_{d} + \underbrace{\left(E-P\right)S_0}_{e} + \underbrace{SSM}_{f} \tag{1}$$

where $\langle\ \rangle = \frac{1}{h}\int_{-h}^{0}(\ )dz$, $\hat{(\ )}$ is the departure from the vertical average, and the subscript *-h* denotes the value of a parcel at the base of the layer. Term (*a*) in equation (1) is the time rate of change of salinity; terms (*b*) and (*c*) represent advection by the vertically averaged flow and that by the vertically sheared flow, respectively; term (*d*) includes entrainment/detrainment and subduction/obduction through the base of the layer; term (*e*) is surface forcing from evaporation *(E)* and precipitation *(P)*; and term (*f*) represents mixing by small scale turbulence (internal gravity waves, microstructure, etc.) at the base of the layer.

It is essentially impossible to evaluate each of the terms in equation (1) from in-situ measurements to assess the instantaneous evolution of the sea-surface salinity at the various spatial and temporal scales. In practical terms, studies of the sea-surface salinity budget would require integrating the in situ and remotely-sensed components of the salinity monitoring system. Great progress has been made in the use of profiling Argo floats, surface drifters and gliders for measuring water properties and velocities. It is now feasible to consider a dedicated effort to quantify the physical processes governing changes in sea-surface salinity.

It is challenging to close the budgets in (1) in any given control volume due to the uncertainties in the existing measurements, even with present and soon-to-be available technology. As articulated in the SPURS report, process studies in regions where a few of these terms in equation (1) are expected to dominate is more practical as a first step towards improving our understanding of the physical processes and feedbacks involving ocean salinity. The salinity maximum region in the subtropical North Atlantic has been identified as the initial focus of an observational and modeling effort based on numerous aspects of the region.

3. Objectives

The proposed project aims to answer many of the remaining fundamental questions about the processes governing changes in the upper ocean salinity maximum, specifically in the subtropical North Atlantic. Our primary objectives are to:

(1) Examine some of the physical processes responsible for the formation and variability of the salinity maximum in the subtropical North Atlantic.
(2) Identify the different processes controlling the seasonal cycle of sea-surface salinity.
(3) Assess the role of eddies (in advection and mixing) in changes of the upper ocean salinity in the salinity maximum region.

In order to achieve these objectives, we plan to carry out two shipboard surveys of the subtropical North Atlantic, during spring and autumn 2012. Each of the two shipboard surveys will take about 35 days. The timing of the cruises is planned according to the seasonal cycles in the sea surface salinity and freshwater fluxes (evaporation minus precipitation) in the salinity maximum region. The sea-surface salinity maximum is relatively lower during spring and higher during autumn (Figure 3a). Although the freshwater flux is positive year round in the salinity maximum region, i.e. excessive evaporation over precipitation, its magnitude is higher during spring than in autumn (Figure 3b).

This out-of-phase relationship between the seasonal cycles of salinity and freshwater fluxes suggests that the seasonal evolution of the salinity maximum may be controlled by the oceanic processes. The main goal of the two shipboard surveys during spring and autumn 2012 is to identify what oceanic processes are responsible for the seasonal variations in sea surface salinity in the subtropical North Atlantic, in particular to quantify the role of eddy processes in salinity changes during different seasons.

Ship time requests for two 35-day cruises during spring and autumn 2012 have been submitted to NOAA for a research vessel such as the R/V *Pisces* or *Ronald H. Brown*. Those requests are linked to this proposal, although the two decisions may not be made concurrently. Additional SPURS-funded efforts could also be accommodated aboard the NOAA vessel, should we be awarded the ship time, to the limit of the scientific party size and deck space available on the ship.

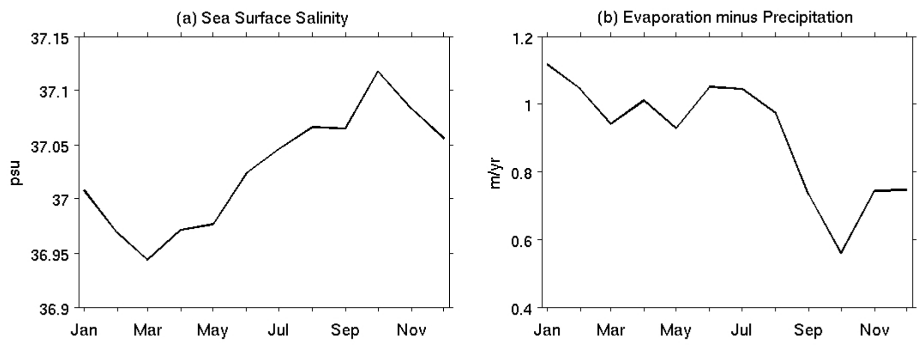

Figure 3. Spatially (15°N-30°N, 30°W-50°W) averaged (a) Sea surface salinity from the World Ocean Atlas 2005, and (b) evaporation minus precipitation from the National Oceanography Center, Southampton (NOC).

4. Shipboard Measurements

The proposed shipboard surveys aim to conduct CTD measurements for two box regions (Figure 4), with one box surrounding the salinity maximum (hereafter referred as "Box A"), and the other just to its south (Box B). Box A corresponds to a region where geostrophic currents, the horizontal salinity gradient, and freshwater fluxes are weak, which gives less surface salinity variance and relatively higher signal to noise ratio. Thus, the ageostrophic advection (mainly Ekman advection), mixing, and subduction processes potentially play dominant roles in salinity changes in Box A. The region bounded by Box B is associated with large freshwater flux, a significant surface salinity gradient, and potentially stronger eddy activity.

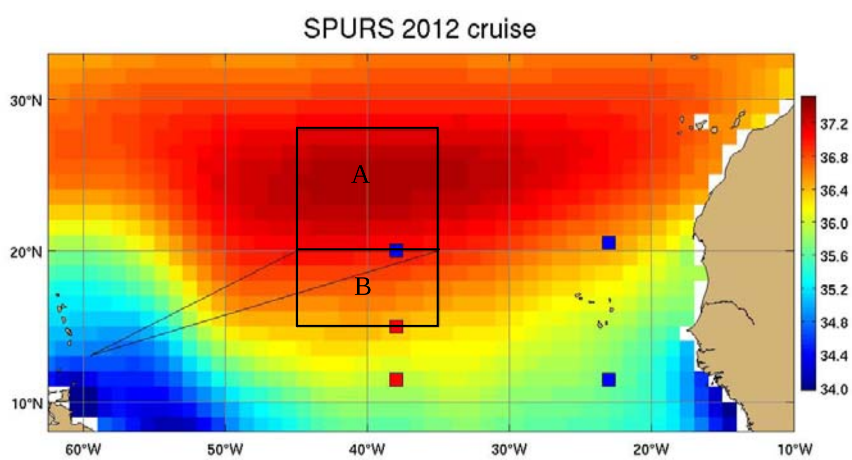

Figure 4. Proposed track of a 35-day SPRUS cruise (black lines). Background shading is climatological mean surface salinity from World Ocean Atlas 2005. Blue and red squares indicate some of the PIRATA Northeast Extension ATLAS sites and PIRATA backbone moorings, respectively.

We propose to conduct CTD/LADCP casts at ¼ degree spacing to characterize eddy advection. Since we are interested in the upper ocean, the CTD measurements will only extend from the sea surface to 500 m depth. XBTs will be deployed mainly between the CTD casts, occasionally at the location of CTD casts for calibration purpose. Besides the CTD and XBT measurements, shipboard measurements will also include continuous underway ADCP. In addition, continuous surface temperature and salinity from an underway thermosalinograph (TSG) and in-situ IMET observations of precipitation and other fields needed to parameterize evaporation will be collected.

The shipboard surveys will also provide platform for the deployment of salinity-measuring surface drifters, profiling Argo floats, and gliders. Our study will include drifter and float deployments; glider activities could be accommodated aboard the NOAA vessel but need to be funded separately from this proposal. Specifically, we note that if an eddy with an unusual surface salinity signature is discovered, we will target it for additional extensive CTD measurements and deployment of salinity-measuring surface drifters, as well as gliders if requested by the corresponding PI. This provides us a great opportunity to track an interesting feature and to better quantify the role of eddies in salinity variability.

In summary, the shipboard measurements include:

- CTD/Lowered-ADCP
- Continuous underway ADCP
- XBTs, mainly in between CTD casts
- TSG
- IMET metrological observations
- Platform for deploying drifters, Argo floats and gliders

Real-time satellite measurements, including sea surface temperature (SST), sea surface height (SSH) and winds will be used to guide the shipboard surveys (see section 5), which will allow us to carry out measurements across the eddies in a zigzag pattern.

5. Satellite Data

The January 2010 SPURS Workshop Report envisions the need for salinity, temperature, and ocean velocity data resolved at meso and larger scales by satellites and an array of profiling floats, surface drifters, gliders and other *in situ* instruments. Wind, temperature, and precipitation estimates will be useful in determining surface fluxes at the largest scales. Ekman downwelling estimates are desired; therefore, ocean vector wind measurements are needed to augment climatological values. Eddy contributions are also needed.

We propose to provide observation data sets in near-real time for the duration of the SPURS field campaign for at-sea guidance when deploying and operating *in situ* instrument systems, as well as for preparatory observing system simulation experiments (OSSEs) in advance of the SPURS field experiment. The vision is to extract satellite data for the SPURS domain, with a surrounding buffer area to provide context, and provide these data sets, along with AOML's *in situ* data via a dedicated web portal on NOAA's existing CoastWatch/OceanWatch Caribbean/Gulf of Mexico Node site (http://cwcaribbean.aoml.noaa.gov/). Existing data includes sea-surface temperature (SST), near-real-time surface winds, sea height anomalies, geostrophic currents, upper-ocean heat content, XBT profiles, and ocean color. Proposed potential satellite data sets include:

1. *Sea-Surface Temperature (SST)*:
    a. *Infrared*
        i. *Polar-orbiting* – – NOAA Polar Operational Environmental Satellites (POES), ESA METOP-series
        ii. *Geostationary*, NOAA Geostationary Operational Environmental Satellite (GOES), Meteosat Second Generation (MSG)
    b. *Microwave* – The advantage of microwave sensor is its cloud penetrating property, which gives all-weather SST measurements. Microwave SST data streams include the polar-orbiting NASA Aqua AMSR-E, DoD Coriolis Windsat, and ISRO-CNES Megha Tropiques MADRAS.
    c. *Blended products* - NOAA operational GOES-POES blend; real-time blended SSTs from NOAA's developmental infrared-microwave blend of POES, GOES, Aqua/AMSR-E data; and selected Group for High-Resolution SST (GHRSST) data sets.
2. *Sea-Surface Salinity (SSS):* NASA Aquarius and ESA Soil Moisture – Ocean Salinity (SMOS). The availability of SMOS salinity is subject to a concurrent ESA Category-1 Data proposal with authorization for either redistribution or use in derived products.
3. *Sea-Surface Height (SSH):* NOAA Jason-1, NOAA Jason-2, ESA Envisat, and available Cryosat-2 SAR altimeter data.
4. *Ocean Surface Wind (OSW)*:
    a. *Wind vector:* ESA METOP ASCAT, DoD Coriolis Windsat, and ISRO Oceansat-2 SCAT. The availability of ISRO Oceansat-2 SCAT winds depends on authorization.
    b. Wind speed: NASA Aqua AMSR-E and DoD DMSP SSM/I
5. *Ocean Surface Currents (OSC)*: NOAA Ocean Surface Current Analyses – Real time (OSCAR) combined geostrophic plus Ekman flows derived from altimetry and surface wind observations. NOAA CoastWatch/OceanWatch – geostrophic flow (to include Ekman flow in the very near future).
6. *Precipitation*:
    a. Microwave: DMSP/SSMIS, POES-MetOp/AMSU, Aqua/AMSR-E
    b. *Infrared* (NOAA GOES – developmental)
    c. *Blended products* – TRMM Multi-satellite Precipitation Analysis product (TMPA)*, CPC Morphing Technique (CMORPH)**
        i. * Huffman et al. (2007)
        ii. ** Joyce et al. (2004)

7. *Ocean Color:* MODIS/Aqua, MERIS/Envisat, and ISRO Oceansat-2 OCM- pending authorization. Ocean color data can provide visual identification/confirmation of mesoscale features.
8. *Insolation*: GOES Surface and Insolation Product (GSIP)

Numerous tools already exist on the Node's site, including an ERDAP server, a THREDDS server, OGC Web services and a WebGIS interface. This data will be made available to the SPURS Information System (SPURSIS).

6. Data Sharing and Distribution

Combining and integrating the data collected is critical for accomplishing the goal of SPURS. The shipboard measurements proposed here will be invaluable to those working on salinity budgets and to evaluate the uncertainties in existing freshwater flux products. All data will be quality controlled and freely distributed through an AOML webpage and the SPURS information system (SPURSIS) to SPURS and Aquarius PIs. XBT, TSG, drifter and float data will be placed in the GTS in real-time and on AOML webpages.

7. Proposed Research

The in-situ observations will be combined with satellite measurements to estimate some of the terms in equation (1) for the regions bounded by Box A and Box B separately. Our analyses will be focused on identifying and monitoring eddies, their thermal structure, and assessing their role in salinity advection and mixing. Details of the proposed analyses are described in the following. Questions to be addressed from these analyses are,

- *What are the physical processes responsible for the formation and variability of the salinity maximum in the subtropical North Atlantic?*
- *What is the role of eddy processes in changes in subtropical salinity maximum?*
- *Is the lack of variability in sea-surface salinity in the subtropical North Atlantic, compared to the seasonal cycle in freshwater flux, due to eddy diffusion?*
- *Is Ekman advection responsible for removing salinity increase due to excess evaporation over precipitation in the region just to the south of salinity maximum (Box B)?*

Time Rate of Change of Sea-Surface Salinity: term (a) in equation (1)

The time rate of change of sea-surface salinity in the two boxes will be estimated from satellite surface salinity measurements, as well as from salinity profiles from Argo floats. The US-Argentine Aquarius/SAC-D and European SMOS surface salinity satellite missions will provide weekly and monthly salinity maps, which can be used to estimate surface salinity changes integrated in Box A and Box B. The profiling Argo floats in the North Atlantic are dense enough to generate monthly maps of salinity for the upper 2000 m water column on a $1°\times1°$ spatial grid. The seasonal variations in sea-surface salinity can be estimated from those maps.

Horizontal Advection: terms (b) and (c) in equation (1)

The horizontal advection terms can be split into two components: Ekman and geostrophic advection. The separation into these two components will help us quantify the role of geostrophic and ageostrophic advection in surface salinity variability. The LADCP and continuous underway ADCP provide total velocity fields along the ship tracks, as will drifter trajectories for total surface velocity. Altimeter-derived sea surface height will provide the geostrophic component in the upper layers. Temperature/salinity from CTD casts will be used to get the vertical structure of the geostrophic velocity. Winds from *in situ* IMET and satellite data will provide the Ekman component. Those estimates will be compared with shipboard ADCP measurements to help us better estimate the role of advection when shipboard measurements are not available. The underway TSG measurements and CTD casts provide estimates for surface salinity gradients. High-resolution sections of salinity and velocity can be created from shipboard measurements (described in the following) to better determine horizontal advection.

Eddy Processes:

The focus of the research done with data obtained from these cruises will be on quantifying the eddy's role in terms of advection and mixing, which contributes to terms *(b)*, *(c)* and *(d)* in equation (1). The shipboard surveys will provide detailed information about the horizontal and vertical structure of temperature, salinity and velocity fields within the eddies. To quantify eddy mixing, we will use satellite measurements (SST, SSH) to track those eddies identified during the cruises. Based on the temperature/salinity relationship with the sea surface height, we will monitor the evolution (location, size, and vertical thermal structure) of the eddies and changes in their temperature/salinity after the cruises. This information, together with salinity profile data available at the AOML Argo DAC, will allow us to investigate further the formation and erosion of eddies and their contribution to changes in salinity in the study region. Furthermore, these altimetry and Argo observations will allow us to quantify the mixing condition during the cruise compared to previous years.

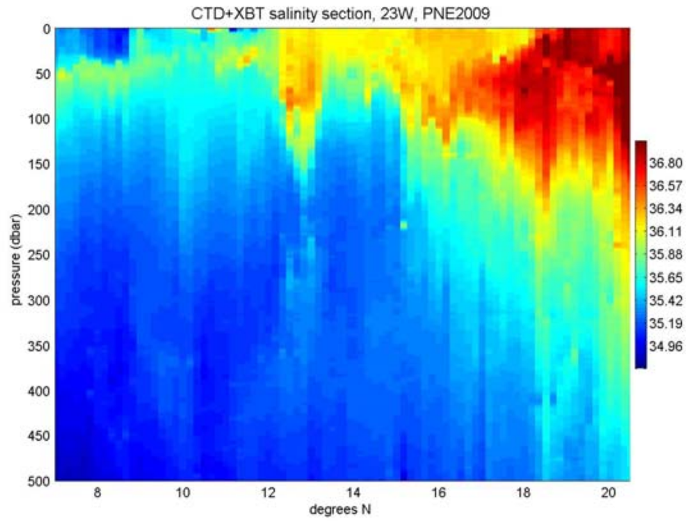

Figure 5. High-resolution salinity section created during the PNE2009 cruise from CTD casts and XBT drops, with the T/S relationship at the casts used to infer salinity from XBT temperature.

To quantify eddy advection, we will divide the velocity fields into mean and eddy components (v'). As described above, the velocity fields, which can be derived from data collected during these cruises, include geostrophic velocity from altimeter SSH and CTD casts; ageostrophic velocity from *in situ* IMET and satellite winds; and total velocity from LADCP, underway ADCP and drifters. Similarly, the salinity sections from CTD/TSG will also be divided into mean and eddy components (S'). The eddy components of velocity and salinity fields will be used to estimate eddy advection and its contribution to salinity anomalies in the two sampled regions (Box A and Box B). Although CTD casts will be conducted at ¼ degree spacing, high-resolution salinity sections can be constructed, with the T/S relationship at the casts used to infer salinity from XBT temperature. An example of the constructed high-resolution salinity section from the 2009 PNE cruise is shown in Figure 5. The underway TSG measurements from the proposed cruises will also be incorporated to create very high-resolution salinity sections. These very high-resolution salinity sections will be combined with the total velocity from the underway ADCP to give an instantaneous snapshot of $\langle v'S' \rangle$.

In addition, Seacat-bearing drifters (funded separately from this proposal by NOAA's Climate Program Office) will measure salinity change in a Lagrangian framework (dS/dt) where advection effect (terms *(b)* and *(c)*) has been removed, which provides a great platform to quantify the role of processes other than advection in salinity change. The possible trajectories and salinity changes measured by drifters deployed within closed-core eddies, which we will deploy if the opportunity presents itself, will be especially valuable.

Although the focus of this work is not on closing the salinity budgets in the two boxes but rather on the eddy flux terms, data collected from the proposed shipboard surveys will be a great source of information for those carrying studies towards closing the salinity budget, and for studies to assess the uncertainties in the evaporation and precipitation products.

8. Education and Outreach

The proposed cruises provide great opportunities to train students for field work. We plan to have at least one Ph.D student to participate in each cruise. S. Dong recently worked with five students during CLIVAR P06 cruises, those students not only learned how data are collected and processed, and the immense effort put into organizing the entire project, the experience also provided them a chance to learn about themselves and their research interests. The cruises will provide students a practical experience to see their textbook-based perspective on oceanography evolving to one incorporating various aspects, which they can never learn in school. The change in perspective will add to the rigor of their future endeavors in oceanography.

9. Work Plan

Here we summarize yearly objectives:

Year 1 Extract and format satellite data for SPURS use, those data will be used to guide the shipboard surveys in Year 2; prepare for the proposed cruises; set up web page for data sharing.

Year 2 Carry out the proposed shipboard surveys to collect data for assessing the role of eddies in changes of the upper-ocean salinity in the salinity maximum region; update web site for near-real time records; perform data quality control and initial analysis.

Year 3 Refine scientific analyses with main focus on quantifying eddy's role in changes of the upper-ocean salinity in the salinity maximum region.

Each year, work-in-progress will be presented at national and SPURS PI meetings. Publications are anticipated in year 2 and year 3.

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Wong, A., N. L. Bindoff, and J. A. Church. 1999: Large-scale freshening of intermediate waters in the Pacific and Indian Oceans. *Nature*, **400**, 440–443.

Biographical Sketches

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EDUCATION

Ph.D., 2004, University of Washington (*Advisor*: Dr. Kathryn A. Kelly)
M.Sc.,1999, University of Washington (*Advisor*: Dr. Kathryn A. Kelly)
M.Sc.,1996, Ocean University of China, China (*Advisor*: Dr. Yong Du)
B.Sc.,1994, Ocean University of China, China

RESEARCH EXPERIENCE

Assistant Research Scientist: CIMAS/University of Miami, 03/2007-present.
Postdoctoral Scholar: Scripps Institution of Oceanography, 04/2004-02/2007.
Research Assistant: University of Washington, 09/1997-03/2004.

OTHER PROFESSIONAL ACTIVITIES

Member of the AMS Air-Sea Interaction Committee (01/2009 - present).

RECENT PUBLICATIONS

Dong, S., S. T. Gille, J. Sprintall, and E.J. Fetzer, 2010, Assessing the potential of the Atmospheric Infrared Sounder (AIRS) surface temperature and relative humidity in turbulent heat flux estimates in the Southern Ocean. *J. Geophys. Res*., **115**, C05013, doi:10.1029/2009JC005542.

Wang, C., and S. Dong. Is the basin-wide warming in the North Atlantic Ocean related to atmospheric carbon dioxide and global warming? *Geophys. Res. Lett*, **37**, L08707, doi:10.1029/2010GL042743

Dong S., S. L. Garzoli, M. O. Baringer, C. S. Meinen, and G. J. Goni, 2009: Interannual variations in the Atlantic Meridional Overturning Circulation and its Relationship with the Net Northward Heat Transport in the South Atlantic, revised for *Geophys. Res. Lett*. **36**, L20606, doi:10.1029/2009GL039356.

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Wang, C., S. Dong, E. Munoz, and S. L. Garzoli, 2010: Seawater density variations in the North Atlantic and the Atlantic meridional overturning circulation. Climate Dynamics, 34, 953-968, doi:10.1007/s00382-009-0560-5.

Wang, C., Z. Song, F. Qiao, and S. Dong, 2009: What signals are removed and retained by using an anomaly field in climatic research? *Int. J. Oceanogr.*, 329754, doi:10.1155/2009/329754.

Xu, Y., J. Li, and S. Dong, 2009: Ocean circulation from altimetry: progress and challenges. *Ocean Circulation and El Nino: New research*. Edited by F. Columbus, Nova Science Publishers, Inc.

Dong S., J. Sprintall, S. T. Gille, and L. Talley, 2008: Southern Ocean mixed depth from Argo float profiles. *J. Geophys. Res.*, **113**, C06013, doi:10.1029/2006JC004051.
Dong, S., S.T. Gille, and J. Sprintall, 2007: An assessment of the Southern Ocean mixed layer heat budget. *J. Climate*, **20**, 4425-4442.
Dong, S., S.L. Hautala, and K.A. Kelly. Interannual variations in upper-ocean heat content and heat transport convergence in the western North Atlantic. *J. Phys. Oceanogr*., **37**, 2682-2697.

Membership: American Geophysical Union, American Meteorological Society

Field Experience: Served as co-chief scientist for the U.S. CLIVAR/CO_2 Repeat Hydrography Program's P06 cruise (Leg 1, November 21, 2009-January 2, 2010)

Recent collaborators: Drs. Sarah Gille, Janet Sprintall, Kathryn A. Kelly, Lynne Talley, Susan Hautala, Chunzai Wang, Silvia Garzoli, Molly Baringer, Christopher S. Meinen, Gustavo J. Goni, Eric J. Fetzer

Gustavo Jorge Goni – Curriculum Vitae

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Education

- Ph.D. in Applied Marine Physics/Ocean Engineering, University of Miami, May 1991.
- M.S. in Acoustics, Pennsylvania State University, January 1996.

Experience

- Division Director: NOAA/AOML/PHOD, May 2009 – Present
- Oceanographer: NOAA/AOML/PHOD, November 1997 – Present
- Adjunct Associate Professor: University of Miami, June 1999 – Present.
- Senior Research Associate: University of Miami, June 1991 - October 1997.

Editorial

Interhemispheric Water Exchange in the Atlantic Ocean, Elsevier Oceanographic Series. **68**, G. Goni and P. Malanotte-Rizzoli, Editors, Elsevier Science, 2003.

Selected Publications

Goni, G.J. , F. Bringas, and P. N. DiNezio, 2010: Low frequency variability of the Brazil-Current front, submitted to *Deep Sea Res,*.

Beron-Vera, F. J., M. J. Olascoaga, and G. J. Goni, 2010: Surface mixing inferred from different multisatellite altimetry measurements, submitted to *Marine Geodesy*..

Goni G.J., D., and co-authors, 2010: The Ship Of Opportunity Program. In Proceedings of the "OceanObs'09: Sustained Ocean Observations and Information for Society" Conference (Vol. 2), Venice, Italy, 21-25 September 2009, Hall, J., Harrison D.E. and Stammer, D., Eds., ESA Publication WPP-306.

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Goni G. J. and J. Knaff. Tropical Cyclone Heat Potential, In *State of the Climate in 2009*, *Bulletin American Meteorological Soc.*, 2010 (in press).

DiNezio P.N., and G. Goni, 2010: Identifying and Estimating Biases between XBT and Argo Observations Using Satellite Altimetry. *J. Atm. Ocean Tech*, 27(1):226-240.

Dong S., S. L. Garzoli, M. O. Baringer, C. S. Meinen, and G. J. Goni, 2009: Interannual variations in the Atlantic Meridional Overturning Circulation and its Relationship with the Net Northward Heat Transport in the South Atlantic, revised for *Geophys. Res. Lett*. **36**, L20606, doi:10.1029/2009GL039356.

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Johnson, G. C., J. M. Lyman, J. K. Willis, S. Levitus, T. Boyer, J. Antonov, C. Schmid and G. J. Goni, 2009: Ocean Heat Content, Special Issue State of the Climate, 90, S49-S54, *Bulletin American Meteorological Soc.*.

Lumpkin R., G. Goni, and K. Dohan, 2009: State of the Ocean in 2008: Surface Currents. In *State of the Climate in 2008*, *Bulletin American Meteorological Soc.*, 90, S12-S15.

Swart S., S. Speich, I. J. Ansorge, G. J. Goni, S. Gladyshev, J. R. E. Lutjeharms, 2008: Transport and variability of the Antarctic Circumpolar Current south of Africa, *J. Geophys. Res.*, 113, C09014, doi:10.1029/2007JC004223.

Mainelli, M., M. DeMaria, L. Shay, and G. Goni, 2008: Application of oceanic heat content estimation into operational forecasting of recent Atlantic category 5 hurricanes, *Weather and Forecasting*, 23(1), 3-16.

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

Lumpkin, R., and G. Goni, 2008: Surface Currents, *Bull. Am. Met. Soc.*, Special Issue on the state of the climate in 2007, S47-S49.

Goni, G., 2008: Tropical Cyclone Heat Potential, *Bull. Am. Met. Soc.*, Special Issue on the state of the climate in 2007, S43-S45.

Panels and Committees

- IOC-WMO Ship of Opportunity Program, Chairman
- NASA Oean Surface Topography Science Working Team, member
- Tropical Atlantic Climate Experiment (TACE) Implementation Panel, Observations team member
- NOAA XBT and TSG Program, manager

Curriculum Vitae

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Research Interests: Upper ocean dynamics, observations of mesoscale to basin-scale circulation; pathways and physics of the global thermohaline circulation; interannual to decadal variations in ocean climate.

Current projects: Director of NOAA's Global Drifter Program; Principal Investigator, PIRATA Northeast Extension (PNE).

Committees, panels and memberships: Co-chair, PIRATA Science Steering Group; member, NOAA's Southeast and Caribbean Regional Team (SECART), American Geophysical Union and CLIVAR Tropical Atlantic Climate Experiment working group on observations.

Education:

1998 Ph.D. in Oceanography, Univ. of Hawaii at Manoa
1995 M.S. in Oceanography, Univ. of Hawaii at Manoa
1991 B.S. in Physics (Mathematics minor), North Carolina State Univ.

Positions held

2004-	Oceanographer, NOAA/AOML
2002-2004	Assistant scientist, CIMAS (Univ. Miami)
2000-2002	Assistant in research, Dept. Oceanogr., Florida State Univ.
1998-2000	Postdoctorate, Laboratoire de Physique des Océans, IFREMER/CNRS
1996-1998	Graduate Assistant, Dept. Oceanogr., Univ. of Hawaii at Manoa
1995-1996	Teaching Assistant, Dept. Oceanogr, Univ. of Hawaii at Manoa
1991-1995	Graduate Assistant, Dept. Oceanogr, Univ. of Hawaii at Manoa

Some relevant publications

Lumpkin, R. and S. Elipot, 2010: Surface Drifter Pair Spreading in the North Atlantic. *J. Geophys. Res.-Oceans,* submitted April 2010.
Lumpkin, R. and S. L. Garzoli, 2010: Interannual to Decadal Variability in the Southwestern Atlantic's Surface Circulation. *J. Geophys. Res.-Oceans,* submitted March 2010.
Elipot, S., R. Lumpkin and G. Prieto, 2010: Modification of Inertial Oscillations by the Mesoscale Eddy Field. *J. Geophys. Res.-Oceans,* accepted May 2010.
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Griffa, A., R. Lumpkin and M. Veneziani, 2008: Cyclonic and anticyclonic motion in the upper ocean. *Geophys. Res. Letters*, **35**, L01608, doi:10.1029/2007GL032100.

Lumpkin, R. and K. Speer, 2007: Global Ocean Meridional Overturning. *J. Phys. Oceanogr.*, **37** (10), 2550-2562.

Lumpkin, R. and M. Pazos, 2007: Measuring surface currents with Surface Velocity Program drifters: the instrument, its data, and some recent results. Chapter 2 of "Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics", ed. A. Griffa, A. D. Kirwan, A. Mariano, T. Özgökmen and T. Rossby, Cambridge University Press.

Lumpkin, R. and Z. Garraffo, 2005: Evaluating the decomposition of tropical Atlantic drifter observations. *J. Atmos. Ocean. Techn.*, **22** (9), 1403-1415.

Lumpkin, R. and S. L. Garzoli, 2005: Near-surface circulation in the tropical Atlantic Ocean. *Deep-Sea Research, Part I*, **52**(3), 495-518.

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Lumpkin and Speer, 2003. Large-scale Vertical and Horizontal Circulation in the North Atlantic Ocean. *J. Phys. Oceanogr*., **33** (9), 1902-1920.

Sea-going experience:

Chief scientist, 2009 PIRATA Northeast Extension cruise, NOAA ship *Ronald H. Brown*, 11 July – 11 August 2009.

Chief scientist, 2007 PIRATA Northeast Extension cruise, NOAA ship *Ronald H. Brown*, 2—31 May 2007.

Watch leader, CLIMODE-4 leg 1, R/V Knorr, 7—27 February 2007.

Chief scientist, 2006 PIRATA Northeast Extension cruise, NOAA ship *Ronald H. Brown*, 27 May – 18 June 2006.

Watch leader, Abaco (Western Boundary Time Series) cruise, NOAA ship *Ronald H. Brown*, 3—16 February 2003.

Designed, assembled, deployed and recovered current meter moorings off Maui and Oahu as part of Masters study; chief scientist of recovery cruise of one array.

Participant, WOCE section P18 leg 3, 29 March – 27 April 1994.

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Present Position

Oceanographer, ZP V, with the National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratory, Physical Oceanography Division.

Other Affiliations

- **Adjunct Faculty, University of Miami, 2001-present.**
- **Fellow, Cooperative Institute for Marine and Atmospheric Sciences, University of Miami, 2007 – present.**

Education

PhD in Physcial Oceanography, October 1, 1993.
Massachusetts Institute of Technology, Joint Program with the Woods Hole Oceanographic Institution, Cambridge, Mass.
Bachelor of Science in Mathematics, May 1985.
Tulane University, New Orleans, La.

Publications Last Three Years

Meinen, C. S., M. O. Baringer, and R. F. Garcia, 2010. Florida Current Transport Variabilty: An Analysis of Annual and Longer-Periods, *J. Geophysical Research*, accepted.

Cunningham, S., M. Baringer, W. Johns, J. Toole, S. Osterhaus, J. Fischer, A. Piola, E. McDonagah, S. Lozier, U. Send, T. Kanzow, J. Marotzke, M. Rhein, S. Garzoli, S. Rintoul, S. Speich, S. Wijffels, S. Talley, J. Baehr, C. Meinen, A-M. Treguier and P. Lhernminier, 2010. The present and future system for measuring the Atlantic meridional overturning circulation and heat transport, *OceanObs'0*9, accepted.

Goni, G., D. Roemmich, R. Molinari, G. Meyers, T. Rossby, C. Sun, T. Boyer, M. Baringer, S. Garzoli, G. Vissa, S. Swart, R. Keeley, C. Maes, 2010. The Ship of Opportunity Program, *OceanObs'09,* accepted.

Baringer, M. O., T. O. Kanzow, C. S. Meinen, S. A. Cunningham, D. Rayner, W. E. Johns, H. L. Bryden, J. J-M. Hirschi, L. M. Beal and J. Marotzke, 2010. The Meridional Overturning Circulation. *Bull. Am. Met. Soc*., in press.

Dong, S. S. L. Garzoli, M. O. Baringer, C. S. Meinen, and G. J. Goni, 2009. The Atlantic Meridional Overturning Circulation and its Northward Heat Transport in the South Atlantic. *Geophysical Research Letters*, 36(20):L20606, doi:10.1029/2009GL039356.

Dong. S. Silvia L. Garzoli, and Molly Baringer, 2009. An Assessment of the Seasonal Mixed-Layer Salinity Budget in the Southern Ocean. *J. Geophys. Res.*, 114(C12):C12001, doi:10.1029/2008JC005258.

Peterson, T. and M. Baringer, Eds., 2009. State of the Climate 2008, *Bull. Amer. Meteor. Soc.*, 90, S1-S196.

Baringer, M. O., and T. Peterson, 2009. Abstract and Introduction, in State of the Climate in 2008, T. Peterson and M. Baringer (eds.), *Bulletin of the American Meteorological Society,* 90, S12-S15.

Baringer, M. O., C. S. Meinen, G. C. Johnson, T. O. Kanzow, S. A. Cunningham, W. E. Johns, L. M. Beal, J. J.-M. Hirschi, D. Rayner, H. R. Longworth, H. L. Bryden, and J. Marotzke, 2009. The meridional overturning circulation, in State of the Climate in 2008, T. Peterson and M. Baringer (eds.), *Bulletin of the American Meteorological Society*, 90, S59-S62.

DiNezio, P. N., L. J. Gramer, W. E. Johns, C. S. Meinen and M. O. Baringer, 2009. Observed interannual variability of the Florida Current: wind forcing and the North Atlantic Oscillation. *Journal of Physical Oceanography*, 39, 3, pp. 721–736, DOI: 10.1175/2008JPO4001.1.

Meinen, C. S., D. S. Luther and M. O. Baringer, 2009. Structure and transport of the Gulf Stream at 68ºW: Revisiting older data sets with new techniques. *Deep Sea Research*, 56 (1), 41-60, doi:10.1016/j.dsr.2008.07.010.

Baringer, M. O., and C. S. Meinen, 2008. The Meridional Overturning Circulation, in State of the Climate in 2007, D. H. Levinson and J. H. Lawrimore (eds.), *Bulletin of the American Meteorological Society*, 89(7), s49-s51, doi:10.1175/BAMS-89-7-StateoftheClimate.

Johns, W. E., L. M. Beal, M. O. Baringer, J. R. Molina, S. A. Cunningham, T. Kanzow, and D. Rayner, 2008. Variability of shallow and deep western boundary currents off the Bahamas during 2004-2005: Results from the 26ºN RAPID-MOC array. *Journal of Physical Oceanography*, 38, 605-623 [DOI: 10.1175/2007JPO3791.1].

Kanzow, T., J. J-M. Hirschi, C. Meinen, D. Rayner, S. A. Cunningham, J. Marotzke, W. E. Johns, H. L. Bryden, L. Beal and M. O. Baringer, 2008. A prototype system for observing the Atlantic Meridional Overturning Circulation – scientific basis, measurement and risk mitigation strategies, and first results. *Journal of Operational Oceanography*, 1, 1, 19-28.

Selected Other Significant Publications

Cunningham, S. A., T. Kanzow, D. Rayner, M. O. Baringer, W. E. Johns, J. Marotzke, H. R. Longworth, E. M. Grant, J. J-M. Hirschi, L. M. Beal, C. S. Meinen and H. L. Bryden, 2007. Temporal Variability of the Atlantic Meridional Overturning Circulation at 26.5ºN. *Science*, 17 August 2007 312: 335-938 [DOI: 10.1126/science.1141304].

Baringer, M. O. and J. Larsen, 2001 Sixteen Years of Florida Current Transport at 27N. *Geophysical Research Letters*, 28, 16, 3179-3182.

Collaborating Scientists Over Last 48 Months

W. E. Johns, L. M. Beal, S. A. Cunningham, T. Kanzow, H. Bryden, J. Marotzke, H. Longworth, M. Grant, J. M. Hirschi, G. Goni, C. Meinen, S. Garzoli, , R. Wanninkhof, R. Feely, C. Langdon, G. Johnson, D. Shoosmith, D. Mayer, C. Mooers, I. Bang, R. Rhodes, C. Barron, F. Bub, D. Hansell, H. Ducklow, K. Lee, A. Macdonald, D. Wallace,

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EDUCATION

Ph.D., Atmospheric and Oceanic Sciences, 2002, University of Wisconsin - Madison
M.Sc., Physical Oceanography, 1991, U.S. Naval Postgraduate School
M.Sc., Meteorology, 1991, U.S. Naval Postgraduate School
B.Sc., Oceanography and Meteorology, 1980, U.S. Naval Academy

RESEARCH EXPERIENCE

Research Scientist: 05/2006 - present
Chief, STAR / Satellite Oceanography and Climatology Division: 01/2002 – 04/2006
Research/Teaching Assistant: University of Madison - Wisconsin, 6/1997 – 01/2002

RECENT PUBLICATIONS

Bayler, E., and Z. Liu, 2008: Basin-scale wind-forced dynamics of the seasonal southern South China Sea gyre. Journal of Geophysical Research (Oceans) doi:10.1029/2007JC004519.

Bayler, E., co-author, 2006: Integrated Global Observing Strategy (IGOS). A Coastal Theme for the IGOS Partnership — For the Monitoring of our Environment from Space and from Earth. Paris, UNESCO 2006. 60 pp. (IOC Information document No. 1220)

Bayler, Eric J., 2004: "Satellite ocean remote sensing at NOAA/NESDIS", The International Society for Optical Engineering (SPIE) conference proceedings, Vol 5548, pp 238-252. (Invited Paper/Speaker)

Bayler, E., 2002: The Dynamics of the Vietnam Summer Recirculation. Ph.D. dissertation, Univ. of Wisconsin-Madison, 165 pp.

Liu, Zhengyu, Wu, Lixin, Bayler, Eric. 1999: Rossby Wave–Coastal Kelvin Wave Interaction in the Extratropics. Part I: Low-Frequency Adjustment in a Closed Basin. Journal of Physical Oceanography: Vol. 29, No. 9, pp. 2382–2404.

Batteen, Mary L., Rutherford, Martin J., Bayler, Eric J. 1992: A Numerical Study of Wind- and Thermal-Forcing Effects on the Ocean Circulation off Western Australia. Journal of Physical Oceanography: Vol. 22, No. 12, pp. 1406–1433.

Membership: American Geophysical Union

Field Experience:

2003 – Field team member, Australian Institute for Marine Science cruise; Great Barrier Reef
1990 – U.S. Naval Postgraduate School cruise; East Greenland Sea

Current and Pending

Dr. Shenfu Dong
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Funded Proposal
Agency: National Science Foundation
Title: Collaborative Research: Dynamics of Eighteen Degree Water from CLIMODE Observations and its Climate Implications
Proposed Time Period: 3/1/2010 – 2/28/2013
Request Funds: $254,671
Point of Contact: Eric C. Itsweire, (703) 292-8582, eitsweir@nsf.gov

Pending Proposals
Agency: National Oceanic Atmospheric Administration
Title: Assessing the Sensitivity of Northward Heat Transport/Atlantic Meridional Overturning Circulation to Forcing in Existing Numerical Model Simulations
Proposed Time Period: 6/01/2010 – 5/31/2013
Requested Funds: $213,405
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Budget: Narrative and Detail

	YEAR 1			YEAR 2			YEA YEAR 3			
	months	%	AMOUNT	nonths	%	AMOUNT	nonth	%	AMOUNT	TOTALS
Principal Investigator:										
Shenfu Dong	0.0	0%	0	5.5	17%	52,900	3.0	25%	19,852	72,752
Supporting Personnel										
R. Garcia	0.0	0%	0	3.5	100%	34,237	0.0	0%	0	34,237
K. Seaton	0.0	0%	0	3.5	100%	28,422		0%	0	28,422
F. Bringas	0.0	0%	0	3.5	100%	31,362		0%	0	31,362
P. De Nezio	0.0	0%	0	3.5	100%	31,678		0%	0	31,678
Programmer	12.0	100%	51,750	8.0	67%	36,570	3.0	25%	16,410	104,730
TOTAL SALARIES			51,750			215,169			36,262	303,181
Fringe Benefits			18,630			77,460			13,055	109,145
TOTAL SALARIES & FRINGE BENEFITS			70,380			292,629			49,317	412,326
CTD Calibration						3,000				3,000
Standard Water						14,400				14,400
O2 Chemicals						7,200				7,200
Supplies						4,000				4,000
Travel Operational						25,000				25,000
Travel (Meetings)			7,500			5,000			7,500	20,000
										0
Publication Costs						3,000			3,000	6,000
Shipping Costs						4,000				4,000
										0
Modified Total Direct Costs:			77,880			358,229			59,817	495,926
Indirect Costs		53.5%	41,666			191,653			32,002	265,321
										0
Computer Server - No Indirect			10,000							10,000
XBTs						19,200				19,200
										0
TOTAL PROJECT COSTS			129,546			569,082			91,819	790,447

Narrative

1. Personnel: Funds are requested for one full-time personnel in Year 1 to extract and format satellite data for SPURS use, and set up the web page. For Year 2, funds are requested for 2 months of salary for S. Dong for data analysis and for 8 months of salary for a programmer to process in situ measurements, as well as continuous to process satellite data. Funds (regular salary and overtime) are also requested for salary for S. Dong and four personnel (3.5 months per individual) to conduct shipboard surveys. Funds are requested in Year 3 for 3 months of salary for S. Dong and a programmer to process and analyze data.

2. Travel: Travel funds are requested for PI/Co-PIs to attend SPURS PI meeting and AGU meetings in each year to present results to date and obtain feedback. Travel funds are also requested to send and to return five personnel from the research vessel for each cruise.

3. Equipment: Funds are requested in year 1 to purchase a computer server requested to provide the capacity for the web data portal. Funds are also requested for equipment charges for XBTs.

4. Materials and Supplies: Funds are requested for standard water, oxygen chemicals, supplies, etc, for material consumed during the cruises.

5. Publications: Funds are requested in Year 2 and Year 3 to cover the cost of page charges for the dissemination of the results in a peer-reviewed journal.