

7-19-2006

Collaborative Research: Agulhas-South Atlantic Thermohaline Transport Experiment (ASTTEX)

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Recommended Citation

Byrne, Deirdre A., "Collaborative Research: Agulhas-South Atlantic Thermohaline Transport Experiment (ASTTEX)" (2006).
University of Maine Office of Research and Sponsored Programs: Grant Reports. 182.
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Final Report for Period: 03/2001 - 02/2006**Submitted on:** 07/19/2006**Principal Investigator:** Byrne, Deirdre A.**Award ID:** 0099177**Organization:** University of Maine**Submitted By:****Title:**

Collaborative Research: Agulhas-South Atlantic Thermohaline Transport Experiment (ASTTEX)

Project Participants**Senior Personnel****Name:** Byrne, Deirdre**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Pettigrew, Neal**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Duncombe Rae, Christopher**Worked for more than 160 Hours:** Yes**Contribution to Project:****Post-doc****Graduate Student****Undergraduate Student****Technician, Programmer****Name:** Wallinga, John**Worked for more than 160 Hours:** Yes**Contribution to Project:**

Designed ASTTEX validation mooring; began construction of ASTTEX current meter moorings.

Name: Mangum, Linda**Worked for more than 160 Hours:** Yes**Contribution to Project:**

L. Mangum participated in the pre-cruise preparation, and on the deployment cruise assisting N. Pettigrew in current meter and validation mooring work as well as measurement of salinity samples.

Other Participant**Research Experience for Undergraduates****Organizational Partners****Kent State University**

Please see relevant under Contributions.

University of Rhode Island Graduate School of Oceanography

R. Watts continues to work with D. Byrne on refinement and testing of the GEM-ETTA method which will be used to interpret the PIES data, and to provide principal supervision to graduate student S. Baker.

Marine & Coastal Mgmt., R. of S. Africa

As a PI in the Benguela Environment Fisheries Interaction and Training (BENEFIT) program, Dr. C. Duncombe Rae organized and coordinated the participation of three African technicians (F. Frantz and R. Roman, South Africa; J. Titus, Namibia) and one African scientist (A. Iita, Ministry of Fisheries and Marine Resources, Namibia) on the ASTTEX deployment cruise. Dr. Duncombe Rae also participated in the cruise, supervising the direct measurement of dissolved oxygen in addition to supplying all the necessary reagents and an auto-titrator for this activity. Additional support for the project included the donation of 144 XBT's which proved invaluable for several rapid surveys we were able to undertake between mooring deployments, and the use of the MCM calibration lab and autosalinometer for the post-cruise analysis of a large number of salinity samples taken underway.

Other Collaborators or Contacts

The GoodHope project, led by PI S. Speich (LPO/IFREMER), has begun high spatial resolution monitoring of the thermal structure in the upper 750 m along most of the ASTTEX line. These data will be available to us as additional calibration/validation. ASTTEX is now an official component of GoodHope, a CLIVAR-Southern Ocean contribution.

At the invitation of Dr. J. Lutjeharms, D. Byrne spent part of project years 3 and 4 as a visiting scientist in the Dept of Oceanography at the University of Cape Town. This opportunity provided valuable access to and expertise in locally held (regional) databases.

Activities and Findings

Research and Education Activities:

In year 4 of the project, the ASTTEX moorings were recovered. All of the equipment that had been deployed in FY 2 was successfully brought on board. Data records were obtained from 23 of 25 instruments. Two instruments (one inverted echo sounder and one SeaCat) apparently failed on deployment or shortly thereafter. The recovery cruise was carried out in April 2004 aboard the RRS Discovery. In February 2005, in conjunction with other colleagues working in the region, we held a special session at AGU to highlight results from this project and from the Agulhas Undercurrent Experiment. We had an oral and a poster session and both were well-attended. All of the mooring data were calibrated during this year, and in addition, a high-resolution MODIS SST dataset has been added to the basic data stream to help constrain surface temperatures.

Findings:

From analysis of our mooring data, the Agulhas Throughflow appears to average 15 Sv, which is equal to the amount of NADW production in the North Atlantic. However, some of this probably recirculates in the South Atlantic and exits to the Indian Ocean rather than participating in a cross-equatorial exchange.

We believe this mean value to be representative of the Throughflow over long periods of time, based in part on a comparison of the deployment period with the decade preceding it in the altimetric record. That said, temporal variability was large, with 2 distinct phases -- one of enhanced interocean exchange and one with very little.

In addition to the long-awaited results above, we were able to clearly distinguish (and measure) in the mooring data the northern branch of the South Atlantic current and the Benguela current. To our knowledge these are the first time series measurement of both currents. We presented

some of these more detailed findings at a special meeting of the Benguela Current Large Marine Ecosystem project in Cape Town in May 2006.

Publications are anticipated shortly on these results.

Training and Development:

Several African graduate students, scientists and technicians participated in the recovery cruise to obtain training in instrument preparation, deep-ocean mooring deployment, and 'best-practice' (i.e., WOCE standard) hydrographic observational methods. Two US graduate students also participated in the cruise; S. Baker-Yeboah (URI) and J. Mathis (U Miami).

D. Witter teaches oceanography to 150-300 students per semester at Kent State University. The ASTTEX project is described as part of the course curriculum as an example of how oceanography is done today, and to illustrate the scientific principles of thermohaline circulation, and interactions between motion in the ocean at different space and time scales (e.g., basin-scale and mesoscale).

N. Pettigrew teaches a graduate course in Physical Oceanography annually.

R. Watts supervises a number of graduate students in physical oceanography, as well as teaching regularly.

D. Byrne organizes a weeklong climate system workshop at U Maine for a dozen selected middle and high school teachers.

Outreach Activities:

D. Byrne spent project year 4 as a visiting professor at the University of Cape Town (UCT). This has allowed her to raise awareness of the ASTTEX project, its goals and methods, within a wide audience of university and government researchers within South Africa. These interactions greatly enhanced the core research being carried out by ASTTEX PIs. Significant changes in South African and Namibian fisheries are being seen (for example, spawning locations and stock fluctuations) and ASTTEX lead PI D. Byrne and senior scientist C.M. Duncombe Rae have participated extensively in the process of helping to diagnose possible environmental causes and in planning the science that will be required to study these processes more accurately.

N. Pettigrew takes an active role in the state's coastal water quality and environmental regulations. This activity includes testifying as an expert witness at various state task force meetings and legislative hearings, and in situ monitoring activities at proposed and existing netpen aquaculture sites.

D. Witter participated in the Women in Science Career Workshop at Cuyaho a Community College which serves Cleveland, Ohio and the surrounding suburbs. This workshop introduces high school girls to the diversity of career options available within the sciences. At the workshop, the girls interact with working scientists in a number of forums, including keynote speeches, panel discussions, hands-on demonstrations and small-group discussions with women in scientific careers.

Journal Publications

Books or Other One-time Publications

Web/Internet Site

URL(s):

<http://gyre.umeoce.maine.edu/ASTTEX/>

SACOS presentation: <http://gyre.umeoce.maine.edu/ASTTEX/sacos.html>

Deployment cruise report: <http://gyre.umeoce.maine.edu/ASTTEX/deploy.html>

Description:

Other Specific Products

Product Type:

AGU special session

Product Description:

We co-proposed and then convened an AGU special session in Honolulu in February, 2006. The ASTTEX project accounted for 5 abstracts.

Sharing Information:

The session was public.

Contributions**Contributions within Discipline:**

D. Byrne the development of the GEM-ETTA algorithm is now mature.

The current algorithm begins with a distance-squared, weighted average. The averaged (binned) product is then smoothed with a spline, and outperforms other methods such as objective analysis (OA).

Because variability in near-surface ocean conditions introduced by the interocean exchange in the region is of similar amplitude to the seasonal signal, it was not possible to include a seasonal cycle.

Instead, concurrent MODIS SST data are being used to help constrain

near-surface properties. Since the SST data contain both seasonal and non-seasonal, interocean signals this solves the problem.

Processing of satellite altimeter observations in the region of the mooring array and in the South Atlantic as a whole is now complete. These data were analyzed by D. Witter for large-scale patterns of variability, and results presented at AGU Ocean Sciences, 2006.

Contributions to Other Disciplines:

The contributions of the Agulhas Leakage to the carbon

cycle of the Atlantic Ocean has been measured and analyzed by J. Mathis (RSMAS/U Miami) a graduate student who participated in the ASTTEX recovery cruise. With assistance of ASTTEX PIs, Mathis sampled for dissolved organic and inorganic carbon (DOC and DIC) and particulate organic carbon (POC), and was able to quantify a carbon

budget for waters leaving the Indian and entering the South Atlantic Ocean via the Agulhas Leakage. The data provides new insights into the anthropogenic carbon cycle by quantifying the exchange between the waters of the southwestern Indian Ocean which have higher inventories of anthropogenic carbon than those in the South Atlantic.

Contributions to Human Resource Development:

Graduate students funded by this project continue to gain skills and expertise in the field. In addition, a number of African students, technicians, and scientists (3) participated in the recovery cruise to obtain training in observational methods. One additional US graduate student was accommodated on the recovery cruise and was able to make measurements that led to a significant contribution to his field.

Several of the outreach activities conducted as part of this project are directly targeted at young people who are interested in considering a career in science.

Lastly, a significant fraction of project participants are women, including two of the four PIs, the principally supported graduate student, one of the two US technicians supported by the project, and one of the four African trainees. ASTTEX also supports one female, African-American graduate student in physical oceanography whose dissertation will be focused on the analysis of some of the data from the project. In these ways, the ASTTEX project has contributed to the increased participation of underrepresented groups in science and engineering.

Contributions to Resources for Research and Education:

Please see relevant under outreach activities.

Contributions Beyond Science and Engineering:**Conference Proceedings****Categories for which nothing is reported:**

Any Journal

Any Book

Contributions: To Any Beyond Science and Engineering

Any Conference