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MASTER

CONTINENTAL SHELF PROCESSES AFFECTING THE OCEANOGRAPHY
OF THE SOUTH ATLANTIC BIGHT

PROGRESS REPORT

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INTRODUCTION

During the last year significant developments took place in our understanding of the South Atlantic Bight. The papers included in this progress report summarize some, but not all, of these findings.

Some of the results are summarized as follows:

Onslow Bay flushing rates can be determined using a model based on an exponential dilution model.

Eddy induced nitrate flux accounts for most input of new nitrogen into shelf waters.

Tarballs in the Gulf Stream are not transported to the nearshore because of an apparent inner shelf density front.

A major discovery during the year was an intense bloom of chlorophyll associated with eddy and possibly Gulf Stream induced upwelling. Continuous surface mapping for temperature, salinity, and chlorophyll along a 300km segment of the Gulf Stream front defined the spatial scales of a large diatom patch localized within the core of a spin off eddy centered over the 200m isobath off Jacksonville, Florida (see Figure 1). The $2 \mu\text{g}\cdot\text{liter}^{-1}$ surface chlorophyll isopleth enclosed an area greater than 1000km^2 with an alongshore dimension of about 130km. Surface chlorophyll exceeded $5 \mu\text{g}\cdot\text{liter}^{-1}$ within the upwelled cold core of the eddy which is 10-100X the concentration found in Gulf Stream or resident shelf surface water. Small diatoms dominated the patch with maximum observed abundance greater than $10^6 \text{ cells}\cdot\text{liter}^{-1}$. The same species comprised the offshore deep chlorophyll maximum suggesting continuity between it and the surface patch. The results provide the first evidence that eddies propagating along the Gulf Stream front lead to localized zones of very high near-surface productivity. Vertical sections through the upwelling zone demonstrate the intense uplifting of the isopleths (Figure 2). The dome structure is typical of this feature. Upwelling events such as the one described here may partially explain why pelagic fish such as menhaden and bluefish migrate to the South Atlantic Bight to spawn during the winter and early spring.

Figure 1. Surface temperature distribution (20-22 April, 1979). Dashed line indicates Gulf Stream front as determined by satellite on 20 April, 1979. Note low temperature (21°C) eddy core. Surface salinity distribution (20-22 April, 1979). Note low salinity eddy core. Surface chlorophyll distribution (20-22 April, 1979). Note that chlorophyll maximum coincides with the coldest and lowest salinity water that forms the eddy core.

Figure 2. Vertical sections of temperature, nitrate and chlorophyll for transect through eddy.

PUBLICATIONS AND MEETINGS

During the past year 6 papers and 5 technical reports were published or are in press. Another 5 papers and technical reports are in the final stages of preparation. The titles of each follow:

Papers Published or in Press in Reviewed Journals or Books

- Paffenhofer, G.-A., D. Deibel, L.P. Atkinson and W.M. Dunstan. The relationship of concentration and size distribution of suspended particulate matter to hydrography in Onslow Bay, North Carolina. Deep-Sea Research. in press.
- Lee, T.N., L.P. Atkinson and R. Legeckis. Detailed observations of a Florida current spin-off eddy on the Georgia continental shelf. Deep-Sea Research. in press.
- Atkinson, L.P. and L.J. Pietrafesa. A flushing model of Onslow Bay, North Carolina based on intrusion volumes. J. Physical Oceanography. in press March issue.
- Kim, H.H., C.R. McClain, W.D. Hart, L.P. Atkinson and J.A. Yoder. U-2 aircraft borne ocean color scanner for studies of ocean chlorophyll. J. Geophysical Research. in press.
- Atkinson, L.P., J.J. Singer and L.J. Pietrafesa. The volume of summer subsurface intrusions of Gulf Stream water into Onslow Bay, North Carolina. Deep-Sea Research. in press.
- Singer, J.J. and L.P. Atkinson. Summertime advection of low salinity surface water into Onslow Bay, North Carolina. Estuarine and Coastal Marine Science. in press.

Technical Reports Published

Since this contract furnishes basic oceanographic data to other projects, it is vital that the data are released in usable and accessible form. This

is assured by publishing all acquired data and pertinent calibration data and plots in technical reports. The titles of reports released in 1979 follow:

Deschamps, J.R., L.P. Atkinson, J.J. Singer, W.S. Chandler and T.N. Lee.

Hydrographic observations in the Georgia Bight (December 1976).

Georgia Marine Science Center Technical Report, 79-1. pp. 97.

Atkinson, L.P., A. Edwards, J.J. Singer, W.S. Chandler and G.-A. Paffenhofer.

Hydrographic observations in the Georgia Bight (July 1977). Georgia

Marine Science Center Technical Report, 79-3. pp. 126.

McCarthy, J.E., L.P. Atkinson, J.J. Singer and W.S. Chandler. Hydrographic

observations off Savannah, Georgia (Winter/Spring 1976). Georgia

Marine Science Center Technical Report 79-2. pp. 41.

Lasley, S.R., L.P. Atkinson, J.J. Singer and W.S. Chandler. Hydrographic

observations in the Georgia Bight (April 1978). Georgia Marine Science

Center Technical Report 79-5.

Kim, H.H., C.R. McClain, L.R. Blain, W.D. Hart, L.P. Atkinson and J.A. Yoder.

Ocean chlorophyll studies from a U-2 aircraft platform. NASA Technical

Memorandum 80574. 27 p.

Papers in Final Preparation

The following papers will be submitted to journal editors within 1 month. Approximately 5 papers are in the intermediate draft stage.

A surface diatom bloom in response to eddy-forced upwelling in the South

Atlantic Bight. with J.A. Yoder, T.N. Lee, H.H. Kim and C.R. McClain.

Pelagic tar off Georgia and Florida in relation to physical processes.

with C. Cordes, J.O. Blanton and R.F. Lee. (submitted to Marine Pollution Bulletin).

Technical Reports in Final Preparation

The following technical reports will be in press in March.

Singer, J.J., L.P. Atkinson, W.S. Chandler and S.S. Bishop. Hydrographic observations off Savannah and Brunswick, Georgia (March, May and September, 1977 and January 1978).

Singer, J.J., L.P. Atkinson, W.S. Chandler. Onslow Bay XBT Data: 1975. (OBIS I, II, III and IV).

O'Malley, P.G., L.P. Atkinson, J.J. Singer and W.S. Chandler. Hydrographic observations in the Georgia Bight (July and August 1979).

Oral Presentations

We have presented the general results of DOE sponsored oceanographic studies at major national or international meetings.

June 1979 Upwelling events in the South Atlantic Bight: Gulf Stream induced nutrient flux compared to other sources. 42nd Annual Meeting of the American Society of Limnology and Oceanography. Stony Brook, NY.

February 1980 Upwelling off the southeastern United States-an overview. International Decade of Ocean Exploration International Symposium on Coastal Upwelling. University of Southern California, Los Angeles.

Other talks, not listed, have been given to regional groups and other Government agencies.

FIELD OBSERVATIONS DURING THE PAST YEAR

Field work was a smaller part of our effort during '79-'80 as we prepared for GABEX-I. Cruises under this contract or cooperatively with other contracts are summarized in Table 1.

TABLE 1. Department of Energy funded cruises 1975 to 1980.

Date	Cruise #	Data	Comment
6-7 Aug 1975	AD-75-01	14BC	Onslow Bay Mooring Cruise (P)
4-14 Sept 1975	E-9-75	212BC/112XBT	Onslow Bay Intrusion Study (P)
13-14 Oct 1975	AD-75-2	20BC/15XBT	Onslow Bay Mooring Cruise (P)
8-11 Dec 1975	AD-75-3	98C/59XBT	Onslow Bay mooring Cruise (P)
13 Feb 1976	BF-76-2	4BC	Georgia Bight (NP)
26 Feb 1976	BF-76-3	21BC	Georgia Bight (P)
10 Mar 1976	BF-76-6	68C/5XBT	Georgia Bight (P)
29 Mar 1976	BF-76-9	78C/4XBT	Georgia Bight (P)
29 Apr 1976	BF-76-13		Test (NP)
5-6 May 1976	BF-76-15	16BC	Georgia Bight (P)
19 May 1976	BF-76-17		Test (NP)
26 May 1976	BF-76-18	2BC	Georgia Bight (aborted), (P)
7 June 1976	BF-76-23		Test (NP)
17 June 1976	BF-76-24		Test (NP)
14-18 July 1976	BF-76-UBS	42LIU/11XBT	Onslow Bay Study (P)
21-23 July 1976	BF-76-086	45CTD	Onslow Bay Study (P)
28 July-6 Aug 1976	BF-76-087	30CTD/32XBT	Onslow Bay Study (P)
14-16 Aug 1976	BF-76-088	42CTD	Onslow Bay Study (P)
18 Aug 1976	BF-76-089	4CTD	Onslow Bay Study (P)
8 Oct 1976	BF-76-30	42CTD	Georgia Bight, Front Hunt 1 (P)
14 Oct 1976	BF-76-32	49CTD	Georgia Bight, Front Hunt 2 (P)
15 Oct 1976	BF-76-33	34CTD	Georgia Bight, Front Hunt 3 (P)
17-18 Oct 1976	BF-76-39	88CTD	Georgia Bight, Front Hunt 4 (P)
9-15 Dec 1976	CI-76-12	37CTD/38XBT	Georgia Bight (P)
8-9 Mar 1977	BF-77-14	35XBT	Georgia Bight (P)
8-16 Apr 1977	AD-77-4	86CTD/30XBT	Georgia Bight (P)
19 Apr 1977	BF-77-29	14XBT	Georgia Bight (P)
21 Apr 1977	BF-77-30	14RSS	Georgia Bight, Front Hunt 5 (P)
26-27 May 1977	BF-77-38	15CTD/1XBT	Georgia Bight (P)
4-10 July 1977	CI-77-03	61CTD/30XBT	Georgia Bight (P)
10-11 Aug 1977	BF-77-54	22XBT	Georgia Bight Intrusion Study I (Paffenhofer)
12-15 Aug 1977	BF-77-54	34XBT	Georgia Bight Intrusion Study II
17-21 Aug 1977	BF-77-54	42XBT	Georgia Bight Intrusion Study III
22-23 Aug 1977	BF-77-54		Georgia Bight Intrusion Study IV
26-27 Aug 1977	BF-77-54	23XBT	Georgia Bight Intrusion Study V
13-14 Sept 1977	BF-77-57	14CTD/12XBT	Georgia Bight (P)
5-9 Nov 1977	CI-77-07	55CTD	Georgia Bight (P)
23-27 Jan 1978	CI-78-01	248C/24XBT	Georgia Bight (P)
17-21 Feb 1978	BF-78-07	13CTD	Tests (NP)
17-23 Apr 1978	CI-78-04*	59CTD/19XBT	Georgia Bight (IP)
9-12 May 1978	BF-78-21	28CTD/12RSS	Georgia Bight, Front Flux (P)
9-12 May 1978	KJ-78-01	26 RSS	Georgia Bight, Front Flux (P)
3-10 August 1978	CI-78-06(13)	16CTD/59XBT	Georgia Bight (IP)
8-14 Nov. 1978	CI-78-08**	50CTD/4XBT	South Atlantic Bight (P)
13-19 March 1979	PP-79-01**	43CTD/16XBT	South Atlantic Bight (P)
27 May-2 June 1979	PP-79-02**	52 CTD	South Atlantic Bight (P)
5 July-17 Aug. 1979	BF-79-34	28CTD/194XBT	Georgia Bight Intrusion Study (IP)
22-29 Aug. 1979	PP-79-03**	52CTD	South Atlantic Bight (P)
3-4 Oct. 1979	BF-79-51	8XBT	Georgia Bight (IP)
15-17 Oct. 1979	BF-79-55	4XBT	Georgia Bight (IP)
26 Oct.-3 Nov. 1979	CI-79-02**	55LIU/53XBT	South Atlantic Bight (IP)
6-10 Nov. 1979	CI-79-02(L3)	72CTD	Georgia Bight, Front Flux (IP)
6-10 Nov. 1979	BF-79-59	69RSS	Georgia Bight, Front Flux (IP)
5 Dec. 1979	BF-79-65		Georgia Bight (IP)
7-8 Jan 1980	KJ-80-1		Georgia Bight (IP)

Ships: BF=Blue Fin; CI=Columbis Iselin; E=Eastward; AD=Advance II; KJ=Kit Jones

Abbreviations: NP=not publishable; P=published; IP=In preparation

*DOE/BLM Funded

** Principally BLM Funded

PAPERS AND REPORTS PUBLISHED UNDER THIS CONTRACT

- 1975 Atkinson, L.P. and D. Wallace. The source of unusually low surface salinities in the Gulf Stream off Georgia. Deep-Sea Research 22: 913-916.
- 1976 Atkinson, L.P., and J. Hall. The distribution and production of methane in the Georgia salt marsh. Estuarine and Coastal Marine Science 4: 677-686.
- 1976 Dunstan, W.M., and L.P. Atkinson. Sources of new nitrogen for the South Atlantic Bight. pp. 69-78 in M. Wiley, ed. Proceedings of 3rd International Estuarine Research Conference, Galveston, Texas.
- 1977 Atkinson, L.P. Modes of Gulf Stream intrusion into the South Atlantic Bight shelf waters. Geophysical Research Letters 4(12): 583-586.
- 1978 Atkinson, L.P., J.O. Blanton, and E. Haines. Shelf flushing rates based on the distribution of salinity and freshwater in the Georgia Bight. Coastal and Estuarine Marine Science 7(5): 464-472.
- 1978 Atkinson, L.P., G.-A. Paffenhöfer, and W.M. Dunstan. The chemical and biological effect of a Gulf Stream intrusion off St. Augustine, Florida. Bulletin of Marine Science 28(4): 667-679.
- 1978 Blanton, J.O., and L.P. Atkinson. Physical transfer processes between Georgia tidal inlets and nearshore waters. pp. 515-532 in J. Wiley, ed. Estuarine Interactions. Academic Press.
- 1978 Pietrafesa, L.J., J.O. Blanton and L.P. Atkinson. Evidence for deflection of the Gulf Stream at the Charleston Rise. Gulf Stream 4(9): 3, 6-7.
- 1979 Atkinson, L.P., J.J. Singer, and W.S. Chandler. The 9400 CTD Systems reliability, calibrated and data acquisition. in Proceedings of Fifth STD/Ocean Systems Conference and Workshop. Grundy Environmental Systems, San Diego. In press.
- 1980 Atkinson, L.P., J.J. Singer, and L.J. Pietrafesa. The volume of summer subsurface intrusions of Gulf Stream water into Onslow Bay, North Carolina. Deep-Sea Research. In press.
- 1980 Singer, J.J. and L.P. Atkinson. Summertime advection of low salinity surface water into Onslow Bay, North Carolina. Estuarine and Coastal Marine Science. In press.
- 1980 Atkinson, L.P. and L.J. Pietrafesa. A flushing model of Onslow Bay, North Carolina, based on intrusion volumes. Journal of Physical Oceanography. In press.

Technical Reports:

- 1967 Stefansson, U. and L.P. Atkinson. Physical and chemical properties of the shelf and slope waters off North Carolina. Duke University Marine Laboratory Technical Report. 230 pp.
- 1975 Atkinson, L.P. Oceanographic observations in the Georgia Bight. R.V. EASTWARD Cruise E-13-73 and E-19-73. Georgia Marine Science Center Technical Report 75-6.
- 1976 Atkinson, L.P. Oceanographic observations in the Georgia Bight. R.V. EASTWARD Cruise E-3-74 and E-12-74. Georgia Marine Science Center Technical Report 76-1.
- 1976 Atkinson, L.P., J.J. Singer, W.M. Dunstan, and L.J. Pietrafesa. Hydrography of Onslow Bay: September 1975 (OBIS II). Georgia Marine Science Center Technical Report 76-2.
- 1976 Atkinson, L.P., J.J. Singer, and L.J. Pietrafesa. Onslow Bay intrusion study. Hydrographic observations during current meter servicing cruises in August, October and December 1975 (OBIS I, III and IV). Georgia Marine Science Center Technical Report 76-4.
- 1977 Hofmann, E.E., L.J. Pietrafesa, L.P. Atkinson, G.-A. Paffenhöfer, and W.M. Dunstan. A mathematical model of nutrient distribution in coastal waters. Center for Marine and Coastal Studies, North Carolina State University, Technical Report No. 77-2.
- 1977 Pietrafesa, L.J., D.A. Brooks, R. D'Amato, and L.P. Atkinson. Preliminary data report, physical/dynamical observations made in Onslow Bay; summer, fall and winter, 1975. Center for Marine and Coastal Studies, North Carolina State University, Technical Report No. 77-05.
- 1977 Atkinson, L.P., G.-A. Paffenhöfer, and W.M. Dunstan. Hydrographic and biological observations at an anchor station off St. Augustine, Florida, 9-14 April 1975 (R.V. EASTWARD Cruise E-1G-75). Georgia Marine Science Center Technical Report 77-4.
- 1977 Singer, J.J., L.P. Atkinson, W.S. Chandler, and P.G. O'Malley. Hydrographic observations in Onslow Bay, North Carolina: July-August 1976 (OBIS V), Data Graphics. Georgia Marine Science Center Technical Report 77-6.
- 1978 Chandler, W.S., L.P. Atkinson, J.J. Singer, P.G. O'Malley, and C.V. Baker. A CTD System: Description, operation, data acquisition and processing. Georgia Marine Science Center Technical Report 78-7.
- 1978 O'Malley, P., L.P. Atkinson, J.J. Singer, W.S. Chandler, and T.N. Lee. Hydrographic observations in the Georgia Bight (April 1977). Georgia Marine Science Center Technical Report 78-5.

Technical Reports, continued:

- 1979 Deschamps, J.R., L.P. Atkinson, J.J. Singer, W.S. Chandler, and T.N. Lee. Hydrographic observations in the Georgia Bight (December 1976). Georgia Marine Science Center Technical Report 79-1. 97 pp.
- 1979 Edwards, A.L., L.P. Atkinson, J.J. Singer, W.S. Chandler, and G.-A. Paffenhöfer. Hydrographic observations in the Georgia Bight (July 1977). Georgia Marine Science Center Technical Report 79-3. 126 pp.
- 1979 McCarthy, J.E., L.P. Atkinson, J.J. Singer, and W.S. Chandler. Hydrographic observations off Savannah, Georgia (winter/spring 1976). Georgia Marine Science Center Technical Report 79-2. 41 pp.
- 1979 Lasley, S.R., L.P. Atkinson, J.J. Singer, and W.S. Chandler. Hydrographic observations in the Georgia Bight (April 1978). Georgia Marine Science Center Technical Report 79-5.
- 1979 Kim, H.H., C.R. McClain, L.R. Blaine, W.D. Hart, L.P. Atkinson, and J.A. Yoder. Ocean chlorophyll studies from a U-2 aircraft platform. NASA Technical Memorandum 80574. 27 pp.