MASTER

CONTINENTAL SHELF PROCESSES AFFECTING THE
OCEANOGRAPHY OF THE SOUTH ATLANTIC BIGHT
Progress Report

June 1, 1978 thru May 31, 1979

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SUMMARY OF PAST ACCOMPLISHMENTS

During the last four years of DOE support we have made 38 cruises into the South Atlantic Bight (Table 1). During the past year, four papers were published, two technical reports distributed, and six papers submitted for publication. In addition, three papers are in the final production stage and three technical reports are submitted for distribution.

Details of last year's accomplishments are found in the accompanying progress report. Two of the most significant observations of the past year are summarized below.

Nitrogen Inputs to the South Atlantic Bight

Recent observations have given new insights to the nitrogen dynamics of the South Atlantic Bight.

We have two reliable measurements of nitrate flux into shelf waters from the Gulf Stream which are schematically shown in Figure 1. Calculations given in Lee, Atkinson and Legeckis (see progress report) indicate an annual flux of 57,200 tons N due to the passage of eddies. Haines (1974) estimated inputs of new nitrogen from rivers and precipitation of 12,600 tons and 7,500 tons, respectively. Thus eddies alone are a significant, if not dominant, source of new nitrate to shelf waters.

In summer 1978 a stranded water mass mid-shelf off Jacksonville contained over 400 tons N, a small fraction of the possible net flux from eddies. This may indicate that net flux from eddy passage may effect only the outer shelf. This hypothesis is consistent with observations of intrusion penetration across the shelf.

CRUISES

Table 1. Department of Energy funded cruises 1975 to 1978.

Date	Cruise #	Data	Comment
6-7 Aug 1975	AD-01-75	148C	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	48C	Georgia Bight (NP)
26 Feb 1976	BF-76-3	228C	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	168C	Georgia Bight (P)
19 May 1976	BF-76-17		Test (NP)
26 May 1976	BF-76-18	28C	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-76-085	42CTD/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 (NP)
14 Oct 1976	BF-76-32	49CTD	Georgia Bight, Front Hunt 2 (NP)
15 Oct 1976	BF-76-33	35CTD	Georgia Bight, Front Hunt 3 (P)
17-18 Nov 1976	BF-76-39	18CTD	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		Georgia Bight (IP)34XBT/28C
8-16 Apr 1977	AD-77-4	57CTD/59XBT	Georgia Bight (P)
19 Apr 1977	BF-77-29	14XBT	Georgia Bight (P)
21 Apr 1977	BF-77-30	14RS5	Georgia Bight, Front Hunt 5 (P)
26-27 May 1977	BF-77-38	13CTD/3XBT	Georgia Bight (IP)
4-10 July 1977	CI-77-03	61CTD/30XBT	Georgia Bight (P)
10-11 Aug 1977			Georgia Bight Intrusion Study I (Paffenhofer)
12-15 Aug 1977			Georgia Bight Intrusion Study II
17-21 Aug 1977			Georgia Bight Intrusion Study III
22-23 Aug 1977			Georgia Bight Intrusion Study IV
26-27 Aug 1977			Georgia Bight Intrusion Study V
13-14 Sept 1977	BF-77-57	14CTD/12XBT	Georgia Bight (IP)
5-9 Nov 1977	CI-77-07	55CTD	Georgia Bight (IP)
23-27 Jan 1978	CI-78-01	18BC/24XBT	Georgia Bight (IP)
17-21 Feb 1978	BF-78-07	13CTD	Tests (NP)
12-23 Apr 1978	CI-78-04*	59CTD/19XBT	Georgia Bight (IP)
9-11 May 1978	BF-78-21		
	KJ-78-1		Front Flux 26CTD/12RS5(26CP)
3-10 Aug 1978	CI-78-06	36CTD/59XBT	Georgia Bight (IP)26RS5(26CP)

Ships: BF=Blue Fin; CI=Columbus Iselin; E=Eastward; AD=Advance II

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

CTD=Conductivity/temperature/depth profile; BC=bucket cast; CP=current profile; RS5=Beckman RS5 used

*DOE/BLM Funded

Figure 1.

April 1978 Eddy Experiment

We have had several spring eddy experiments leading up to the full scale 1980 experiments. Following is a brief account of the April 1978 and preliminary results.

This cruise was one of the first that was a cooperative BLM-DOE effort. The BLM goal was to obtain a quasi-synoptic map and we, the DOE contractors, wanted to make event scale measurements during an eddy passage. The resulting cruise, which was in two legs, is shown in Figures 1-6. The quasi-synoptic map suitable for BLM purposes (Fig. 1) covered the southern part of the South Atlantic Bight. The event scale experiment consisted of repeated onshore-offshore sections (Fig. 2-6) in the Brunswick area and one alongshore section at the shelf break.

Although plots are still being made, two typical profiles are presented (Fig. 7 and 8). The temperature profile (Fig. 7) shows intense upwelling at the shelf break (stations 34-37) and intrusion of the upwelling water half-way across the shelf. The high salinities (Fig. 8) over the mid-shelf indicate the eddy induced upwelling had flooded Gulf Stream water over most of the shelf.

Fig. 1. Quasi-synoptic South Atlantic Bight station map. Between stations 33 and 105 the time series data were collected off Brunswick.

Fig. 2. Brunswick Section 1. 17-18 April 1978.

Fig. 3. Brunswick Section 2. 18 April 1978.

Fig. 4. Brunswick Section 3. 19 April 1978.

Fig. 5. Brunswick Section 4. 20 April 1978.

Fig. 6. Brunswick Section 5. 21 April 1978.

Fig. 7. Temperature Section. Brunswick section 17-18 April 1978.

Fig. 8. Salinity Section. Brunswick section 17-18 April 1978.

August 1978 Georgia Bight Intrusion Experiment

The August Iselin cruise marked our first observation of a stranded intrusion in the South Atlantic Bight. The cruise was also the first in which the BLM synoptic map (Leg I of the cruise) allowed us to make a prognosis of the next few days' conditions in the Bight and plan the DOE event cruise (Leg III: Leg II was a BLM-DOE mooring cruise). Near bottom temperatures during Leg I indicated no active upwelling or intrusion activity over the outer shelf. However, the first Leg III map of near bottom temperatures (Fig. 1) indicated a large mass of cold water stranded off St. Augustine.

A vertical section through the intrusion (Fig. 2) on 8 August indicated a large mass of nitrate rich water 5-10 m thick about 70 km offshore. Chlorophyll observation (Fig. 2, by Dr. Yoder) indicated phytoplankton growth on the edge of the intrusion. A later section on 12 August (Fig. 3) revealed a decrease in nitrate concentrations and an increase in chlorophyll concentrations. Over the 4 days, phytoplankton had responded to the growth possibilities and consumed most of the nitrate available. Figure 4 shows a time series of observations at the drogue site which approximated the center of the intrusion.

The sampling pattern also produced detailed maps of the intrusion from which we calculated the following:

- Intrusion volume 84 km^3
- Mass of nitrate in intrusion 400 tons N

During the cruise several cooperative experiments were run such as:

- N^{15} nitrate uptake experiments with Ms. Hofmann and Dr. Yoder.
- Drogue tracking and time series sampling with Dr. Paffenhofer.

- Vertical chlorophyll sampling with Dr. Pomeroy.

This data set will probably prove to be one of our most interesting.

Fig. 1. Near-bottom temperatures showing cold water invading shelf.

AUGUST 8, 1978

Fig. 2. Vertical section through stranded intrusion off Jacksonville. Note high chlorophyll at edge of high nitrate water mass.

AUGUST 12, 1978

Fig. 3. Same section as Figure 2 but four days later. Note decrease of nitrate and increase of chlorophyll.

Fig. 4. Time-series of nitrate and chlorophyll at drogue station.

Shelf Edge Mixing Processes

The detailed CTD data is causing a new appreciation of the dynamic mixing processes at the shelf break. An example of the complicated situation follows.

In April 1977 during the eddy passage experiment we made several sections off Savannah that demonstrated the complex interleaving and diffusive process. The Savannah section (Fig. 1) shows the Gulf Stream was about 130 km offshore. Shelf waters were 16-18°C and salinity increased offshore. The arrows in the salinity plot show the inferred direction of movement of waters in the onshore/offshore direction that would produce the observed salinity distributions. A T-S plot of the stations in this section (Fig. 2) shows the interleaving of waters. This is especially clear at station 63. Also note that nearshore stations (53-54) are stratified because of salinity in contrast to offshore where stratification is due to temperature.

In Figure 3 the distribution of runoff and Gulf Stream is shown as a percentage freshwater present. It was assumed that Gulf Stream waters had a salinity of 36.3‰ and runoff was 0‰. Even in the nearshore runoff was only 10% of the water column and at the shelf break it was less than 1‰. The submergence of the freshwater fraction towards the outershelf followed the observed density distribution (Figure 1) implying some degree of isentropic mixing at the shelf break,

Figure 2. Temperature-Salinity plot. Station numbers: large letters; Depths: small letters.

Figure 3. Percentage freshwater in section off Savannah. Assumed base salinity - 36.3ppt.

Master data set - We are continuously updating our master data file that contains most hydrographic data available from the National Oceanographic Data Center. The following figures indicate the geographic distribution of all available data by month. The master set does not yet contain data from the four Bureau of Land Management cruises in 1977 or the more recent BLM cruises. These will be added when available. The lack of January data is startling but understandable.

January

February

March

April

May

June

July

August

September

October

November

December

Computer Contouring

The most time consuming aspect of data analysis is plotting and contouring the data. This effort alone consumes a considerable amount of our manpower and because of that we have, over the past few years, been looking for a suitable computer contouring package. Within the last few months one has been developed by Mr. Tom Curtin at North Carolina State University that does a very good job contouring very difficult profiles. We are working with Tom on the development of this package and hope to implement it on our system within the next six months. A sample plot follows: