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# Final

# Cruise Report

# R/V MAURICE EWING Cruise EW9306

Submitted by

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November 17, 1993

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**Introduction** The objective of the cruise was to set an array of moored current meters to study deep flows in the western Brazil Basin (the deep western boundary currents there) and to release some RAFOS (SOFAR spelled backwards) floats to measure deep flows in the interior of the Brazil Basin. The work was done as part of the Deep Basin Experiment which is a part of the World Ocean Circulation Experiment. The principal investigators envolved are Georges Weatherly of the Florida State University (moored current meter array) and Nelson Hogg and Brech Owen of the Woods Hole Oceanographic Institution (RAFOS floats).

**Cruise Narrative** The cruise was aboard the R/V MAURICE EWING and occurred between September 23 and October 3 1993. Rio de Janeiro, Brazil was both the departure and returning port, and the cruise name was EW9306 A list of the scientific party is given in Table 1 and a list of the ship's officers and crew is found in Table 2.

Table 1. Scientists and Technicians aboard EW9306

| Name | Position | Affiliation |
|---|---|---|
| Weatherly, Georges | Chief Scientist | Florida State University |
| Araujo, Carlos | Scientist | University of the State of Rio de Janeiro |
| Borisov, Sergey | Scientist | Florida State University |
| Budhypramono, Stef. | Technician | Lamont Doherty Earth Observatory |
| De Madron, Xavier | Scientist | Florida State University |
| Fontainha, J. Alex. | Observer | DHN, Brazilian Navy |
| Francis, Bruce | Sci. Officer | Lamont Doherty Earth Observatory |
| Hunley, David | Engineer | Florida State University |
| Kelley, Edward | Scientist | Florida State University |
| Laurikov, Oleg | Engineer | Shirshov Institute of Oceanology |
| Leidhold, Chris | Technician | Lamont Doherty Earth Observatory |
| Nonato, Luiz | Engineer | Institute of Oceanography, Univ. State of Sao Paulo |
| Ritch, John | Technician | Florida State University |
| Soltanovsky, Igor | Scientist | Shirshov Institute of Oceanology |

Table 2 Officers and Crew aboard EW9306

| Name | Position | Name | Position |
|---|---|---|---|
| James E. O'Loughlin | Master | Newton, Gil E. | O/S |
| Pica, Stephen M. | Chief Engr. | Blythe, Andrew B. | Steward |
| Mello, Louis J. | Chief Mate | Ureta, Javier A. | O/S |
| Gould, Gary G. II | First Engr. | Bellanger, Denis A. | Cook |
| Phillips, David L. | Second Mate | | |
| Walsh, Albert H. | Second Engr. | | |
| Landow, Mark C. | Third Mate | | |
| Reid, Richard D. | Third Engr. | | |
| Heinze, Blaine A. | Boatswain | | |
| Maker, Greenleaf C. | Oiler | | |
| Barros, Larry W. | A/B | | |
| Spruill, Machael L. | Oiler | | |
| Graham, David G. | A/B | | |
| Uribe, Guillermo F. | Oiler | | |
| Patch, John A. | A/B | | |
| Matos, Francisco N. | Electrician | | |

The weather and seas were fine for the whole cruise. The ship's equipment worked well. No time was lost either due to weather or equipment failure. The only surprise was that one of the spooled mooring lines was not terminated at the end which was not visible until the line was spooled out. Due to the combined efforts of the science party, the officers and the crew a termination in the Kevlar line was effected in two hours time and the current meter mooring launch then completed. The launchings of the current meter moorings and RAFOS floats generally went well. The antenna of the ARGOS beacon on one of the moorings was broken off during launch, but the beacon was easily retreived from the water and a repacement antenna installed.

The chief scientist and science officer were notified shortly before the cruise that the Brazilian navy would not view favorably any research done in their territorial waters which was not described in the clearance request. This resulted in only data from international waters being taken with the Acoustic Doppler Current Profiler. Some CTD data were taken in Brazilian waters until it could be determined if the Brazilian navy considered this data an integral component of the cleared current studies, and this data was subsequently destroyed when it became evident that they did not.

Figure 1 shows the nominal ship's track, and the numbered dots are the locations of the current meter moorings.

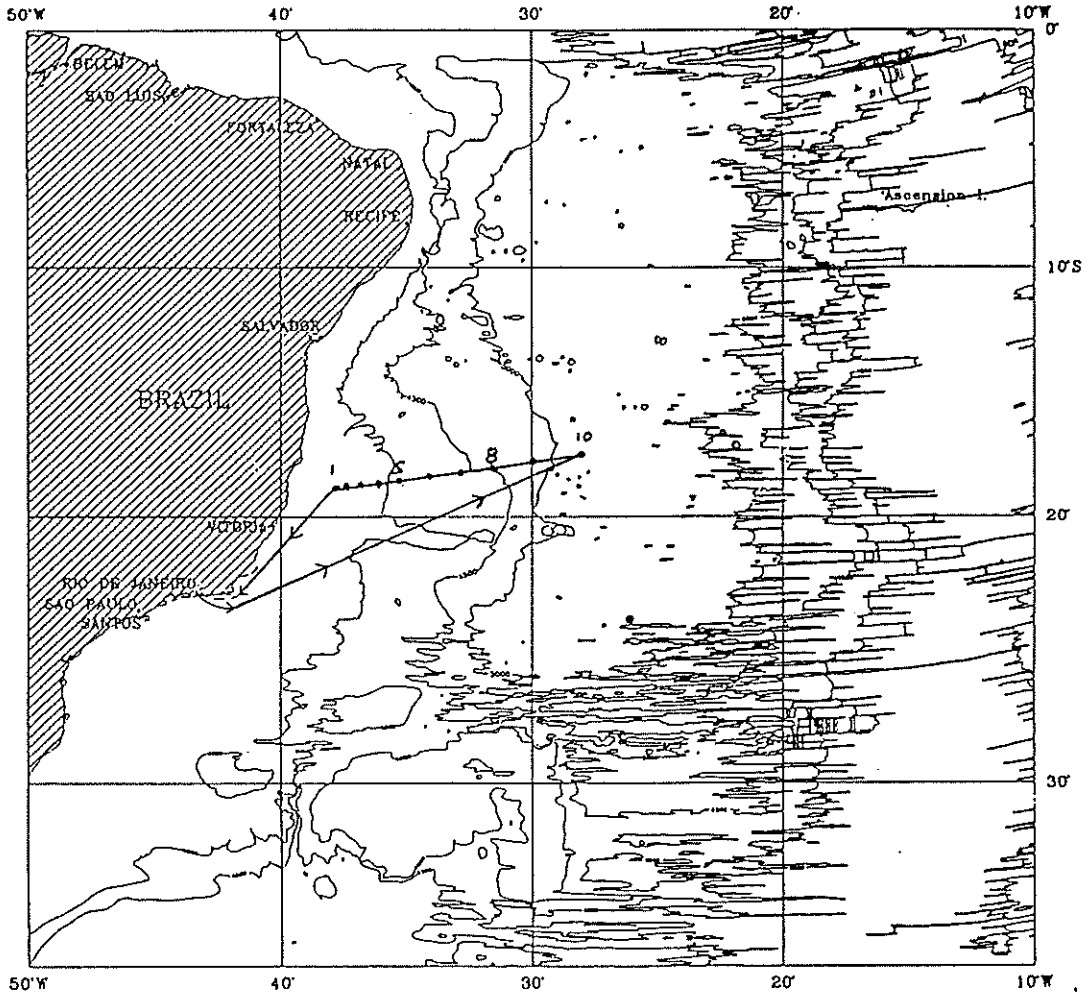


Figure 1. Sketch of the cruise track of ME9306. Numbered solid circles are current meter mooring locations. 4000m, 4500m and 5000m depth contours are indicated.

CURRENT METER MOORINGS Current meter moorings were installed as planned at the 10 sites indicated in Figure 1. A total of 26 Florida State burst sampling current meters and 8 Shirshov Institute of Oceanology Potok II current meters were installed. Figure 2 is a vertical cross-section sketch of the current meter placements. Further details are found in Table 3.

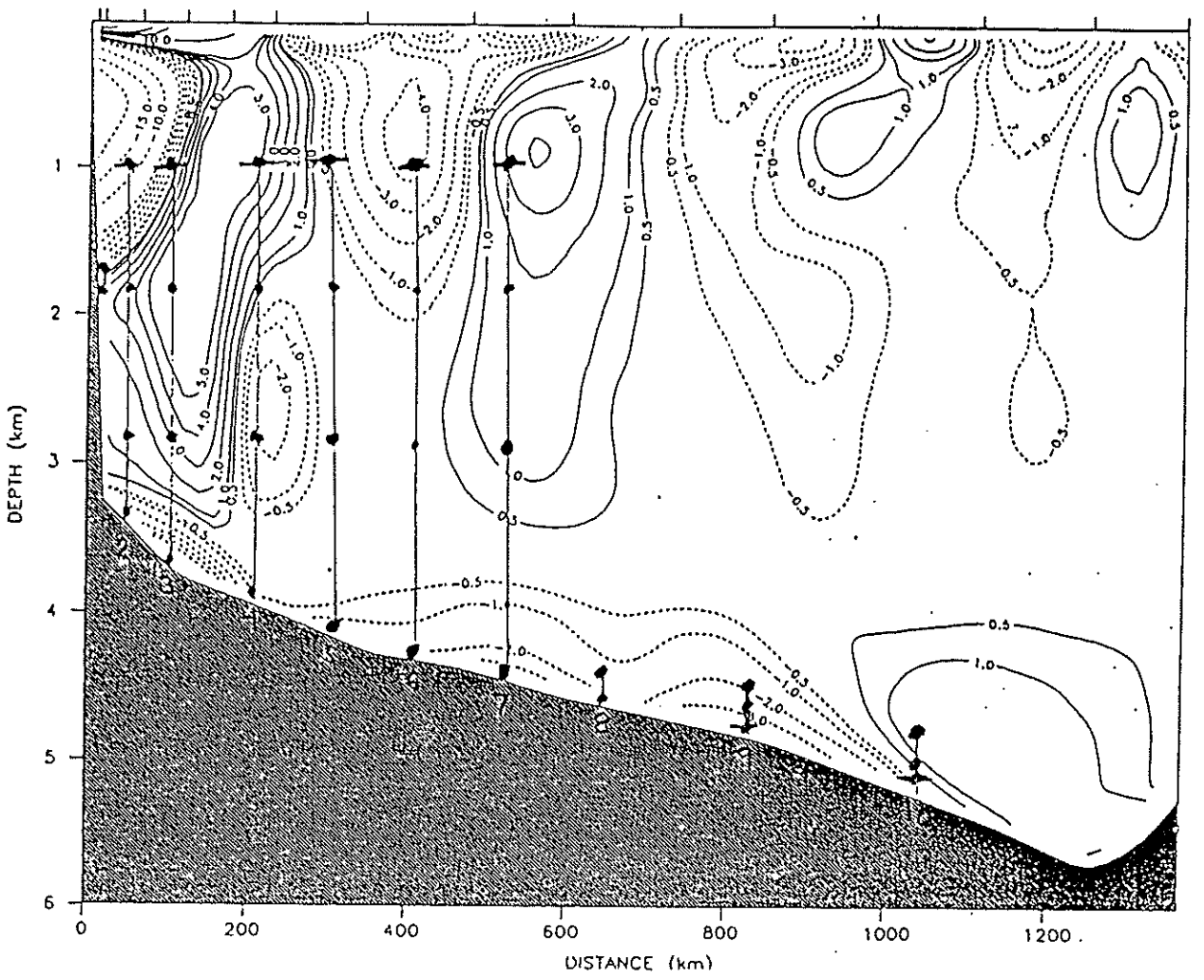


Figure 2. Vertical cross-section showing location of Florida State University burst sampling current meters (solid circles) and Shirshov Institue of Oceanology Potak II current meters (solid circles with bar). Current meter site numbers are indicated. Solid (dashed) contours are southward (northward) geostrophic flows inferred from SAVE 2 data with the 2 degree isotherm being the level of no motion. Figure is from De Madron and Weatherly, 1993 manuscript submitted to J. Mar. Res.

Table 3. Information regarding current meter moorings. A two-digit S/N is a Florida State University current meter while a three-digit S/N is a Shirshov Institute of Oceanology current meter. Current meter depths are in m. Lat and long are in degrees and minutes.

| | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| lat (S) | 18 52.1 | 18 44.3 | 18 39.9 | 18 33.5 | 18 25.9 | 18 17.2 | 18 06.9 | 17 57.9 | 17 44.7 | 17 25.2 |
| long (W) | 37 47.8 | 37 15.4 | 36 45.6 | 35 40.0 | 34 51.9 | 33 55.4 | 32 49.4 | 31 39.9 | 30 00.3 | 28 00.4 |
| water depth (m) | 1738 | 3491 | 3773 | 4015 | 4153 | 4372 | 4440 | 4640 | 4748 | 5316 |
| date (time,GMT) anchor over | 10/01/93 (1408) | 10/01/93 (0156) | 09/30/93 (1817) | 09/30/93 (0610) | 09/29/93 1859) | 09/29/93 (0827) | 09/28/93 (2103) | 09/28/93 (0918) | 09/27/93 (1638) | 09/27/93 (0100) |
| current meter depths (S/N) | 1618(22) 1731(11) | 900(836) 1800(20) 2800(26) 3391(07) | 900(564) 1800(03) 2800(01) 3673(35) | 900(057) 1800(13) 2800(27) 39015(19) | 900(826) 1800(17) 2800(15) 4053(29) | 900(830) 1800(16) 2800(31) 4053(29) | 900(408) 1800(09) 2800(30) 4340(34) | 4520(18) 4633(10) | 4548(06) 4648(25) 4785(820) | 4916(12) 5216(18) 5313(834) |

RAFOS Floats RAFOS floats were launched at some of the current meter mooring sites. No one from Woods Hole Oceanographic Institution was on the cruise, but ample instructions accompanied the floats so that the scientific party could determine where, when and how to launch them. The launches went well, and all the RAFOS floats were set at the designated sites (see Table 4).

Table 4. Specifics about the RAFOS float launches: u and d denote 2500 m and 4000 m drift depths, respectively . The values for site 6 are those for the current meter launch; the floats there were launched within about 15 minutes of the indicated time and the ship had not steamed after the current meter launch.

| | Site 2 | Site 4 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|
| float ID | 155 u | 153 u | 148 u | 146 d | 151 u | 142 d | 149 u |
| time (GMT) | 0205 | 0616 | 0851 | 2111 | 0812 | 1646 | 0136 |
| date | 10/1/93 | 09/30/93 | 09/28/93 | 09/28/93 | 09/28/93 | 09/27/93 | 09/27/93 |
| lat S | 18 44.3 | 18 33.4 | 18 17.7 | 18 07.3 | 17 58.0 | 17 45.2 | 17 25.2 |
| long W | 37 15.3 | 35 40.0 | 33 54.3 | 32 49.3 | 31 40.0 | 30 00.1 | 28 01.6 |
| float ID | | | 143 d | | 141 d | | 140 d |
| time (GMT) | | | 0851 | | 0810 | | 0131 |
| date | | | 09/28/93 | | 09/28/93 | | 09/27/93 |
| lat S | | | 18 17.7 | | 17 57.9 | | 17 25.1 |
| long W | | | 33 54.3 | | 31 40.3 | | 28 01.6 |
| water depth (m) | 1738 | 4015 | 4372 | 4440 | 4640 | 4788 | 5316 |

CTD The intent was to take CTD casts at the moored current meter sites and at some interim stations inbetween them. The Brazilian navy observer noted that no specific mention of CTD casts appeared in the clearance request narrative. However, in the formal agreements between the chief scientist and Brazilian oceanographers, which were required for clearance purposes, it was noted that specific mention was made of CTD casts to be taken on the cruise. The problem was recognized on the weekend steaming towards the first mooring site. The Brazilian naval observer agreed to let us do CTD casts at the mooring sites with the understanding that he would request clarification with his superiors and that if they denied permission for CTD work, all CTD cast data from Brazilian territorial waters would be destroyed. The chief scientist, based on recent experiences doing similar work in Argentinian territorial waters, thought that the CTD casts would be viewed as an integral part of the research and permission would be granted.

CTD casts were attempted at current meter mooring sites 10 - 5 in that order. Of these, three were in Brazilian territorial waters - sites 10, 9 and 8. Due to problems with the Neil Brown Instrument Systems CTD, the data from site 10 was no good. We then switched to a Sea Bird CTD. A problem with the power switch resulted in only a partial cast being obtained at site 9 - the Sea Bird CTD turned off at abut 2300 db. The problem was solved, and good full water column data were obtained at sites 8 - 5.

While steaming to site 4 the Brazilian observer was notified by his superiors that the chief scientist had no authorization to make CTD casts in Brazilian waters. Since the remainder of the cruise was in Brazilian waters, all CTD work was subsequestly halted.

All the CTD data obtained in Brazilian territorial waters were destroyed before the cruise was finished. No copies of it or figures of it were kept by the chief scientist or anyone in his party.

During the cruise the chief scientist requested the Brazilian Embassy in Washington to amend his clearance to include taking of CTD casts at the current meter mooring sites. Because a response before the end of the cruise seemed unlikely, it was thought better to dispose of the CTD before returning to port rather than try to keep the data until a decision had been rendered.

Table 5 summarizes the CTD data collection results including the fate of the data.

Table 5. Results of CTD casts.

| Site | Location | Date | Depth (m) | Comments | Fate of Data |
|---|---|---|---|---|---|
| 10 | 17 25.2 S<br>28 00.4 W | 9/27/93 | 5316 | Problem with CTD, no useable data | N/A |
| 9 | 17 44.7 S<br>30 00.3 W | 9/27/93 | 4820 | CTD turned off at 2600 db | destroyed |
| 8 | 17 57.9 S<br>31 39.9 W | 9/28/93 | 4640 | good data | destroyed |
| 7 | 18 06.9 S<br>32 06.9 W | 9/28/93 | 4440 | good data | saved |
| 6 | 18 17.2 S<br>33 55.4 W | 9/29/93 | 4372 | good data | saved |
| 5 | 18 25.9 S<br>34 51.6 W | 9/29/93 | 4153 | good data | saved |

**Acoustic Doppler Current Profiler (ADCP)** Luiz Nonato wanted to gain experience with the ADCP. Since no request for using it in Brazilian waters had been made, the ADCP was only turned on when we were in international waters. The bridge determined that international waters existed between current meter mooring sites 4 and 8, and we relied on them to determine when we were in international waters. L. Nonato took all the ADCP data with him for processing back at the University of Sao Paulo.

**Other** Within a few nautical miles of the current meter mooring sites, the ship's precision depth recorder and hydrosweep were turned on. The intent was to determine whether the depths at the launch sites were within the limits wanted by the chief scientist (+,- 200 m) and to make sure the launch site was not over a seamount or other large bottom feature.

**Acknowledgements** The officers and crew of the R/V MAURICE EWING are especially commended and thanked. Several of the scientific party, including the chief scientist, mentioned that this was the most pleasant and professional ship they had ever worked on. The success and smoothness in which the science was done from this ship is in large part due to its officers and crew. Especial thanks are given to Lou Mello and Blaine Heinze for their efforts on the fan tail, Bruce Francis for interfacing for the science party, and the ship's master, James O'Laughlin, whose pleasant, competent and professional attitude was reflected in all those serving under him. Support by the National Science Foundation under grant OCE-92-06117 is gratefully acknowledged.

## Appendix A. Schedule of delivery of data results and reports

Current meter data. The current meters are to be recovered after about two years. We expect it will take about two years to process the data and to produce a data report. Thus sometime after about October 1997 copies of the data and a data report would be submitted to the Research Vessel Clearance Officer, Office of Ocean Affairs, United States Department of State so that the data can be officially submitted to the Brazilian government.

RAFOS data. The data from the RAFOS floats are to be recovered after about two and a half years. We anticipate it will take about 18 months to process the data, produce trajectories, and write up the results in a technical report. Thus the data from these floats would not be available until four years after their deployment or in October 1997.

## Appendix B. Letter concerning the fate of CTD data collected in Brazilian waters (following sheet).

## Appendix C. Data Reduction Summary EW-9306.

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Appendix B.

October 2, 1993

To whom it may concern:

This is to acknowledge that CTD casts were made in Brazilian territorial waters during the R/V MAURICE EWING cruise ME9306. At the time the casts were made it was unclear whether the Brazilian Navy would consider these casts as an integral component of the research for which clearance had been given. Because it was not possible to obtain clarification of this manner prior to the planned taking of the CTD casts - the problem was discovered over a weekend when the R/V MAURICE EWING was steaming towards its first station - the chief scientist aboard ME9306, Dr. Georges Weatherly, and the Brazilian Naval Observer aboard ME9306, Lt. Josue Alexandre Fontainha, agreed that CTD stations would be taken in Brazilian waters until clarification was received from the Brazilian Navy. In case the Brazilian Navy ruled against the taking of such CTD stations, Dr. Weatherly and Lt. Fontainha agreed that all CTD data collected in Brazilian waters on ME9306 would then be destroyed.

The Brazilian Navy notified Lt. Fontainha during the cruise that Dr. Weatherly was not authorized to obtain CTD data from Brazilian waters aboard Cruise ME9306. Subsequent to the receit of this message and prior to completion of Cruise ME9306 all CTD data, and any figures of that data, taken in Brazilian waters aboard ME93065 were destroyed.

Sincerely yours,

Georges Weatherly
Chief Scientist
R/V MAURICE EWING Cruise ME9306

Sincerely yours,

José Alexandre Fontainha
Josue Alexandre Fontainha
Brazilian Naval Observer
R/V MAURICE EWING Cruise 9306

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