The First Global GARP Experiment (FGGE):

Measurements on Board NOc Prof W Besnard of USP and the Visit to São Pedro and São Paulo Rocks

By,

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ABSTRACT

This is an account on the cruises of NOc Prof W Besnard to the Equatorial Atlantic for the FGGE (First Global GARP Experiment) in 1979 and on a set of data acquired by the NOc Almirante Saldanha from the Brazilian Navy, during the GATE (GARP Atlantic Tropical Experiment) in 1974. The Cruises resulted from a combined work between Lamont Doherty Observatory of Columbia University (LDO-CU) NY, the Massachussets Institute of Technology (MIT), Woods Hole Oceanographic Institute (WHOI) all from USA, the Instituto Astronômico e Geofísico, IAG-USP, and the Instituto Oceanografico, IO-USP, both from the University of Sao Paulo, Brazil. The description goes over the nomination of: A) – The participants of each cruise to the Equatorial Atlantic during SOP I, (Special Observation Period I) and SOP II. B) – The description of the equipments for Meteorological Upper air soundings and on board measurements , C) The description of the Oceanographic Equipment for oceanic measurements, including Lamont´s Ocean/Wind/Pressure Buoy, Lamont´s Inverted Echo Sounder (IES), as well as, T/S and water sampling (STD & Rousette) provided by IO-USP. D) -The description of the Cruises and the planning of data gathering . E) – The description of T and S, the measured currents, and also currents from GATE Russian data. F)-The analyses of Nutrients (PH,Si,Na and O2) were also based on France and German data and G) –The description of the visit to Saint Paul´s and Saint Peter´s Rocks.

Preliminary results of the combined effort are summarized as follows : 1)- FGGE and GATE analyses suggest the occurrence of bursts and depletions of Nutrients along the Equatorial Atlantic belt. 2)-Based on GATE (winter) and FGGE (summer), T ,S ,Nutrients Si,Ni, Ph and O2 data series, local and seasonal invariants (constants) were firstly estimated for the Western Equatorial Atlantic. 3) – Theoretical and spectral analyses (only frequencies) of currents at 33 W indicated the occurrence of meridional components with periods from 3.6 to 2.4 cy/day and zonal components with frequencies ranging from 3.3, 2.6 and 2.2 cy/day, all of them apparently related to wind action over the entire equatorial area . 4) - Tidal analyses of Inverted Echo Sounders (IES) data showed the occurrence of internal waves of tidal origin, as indicated by pronounced diurnal, semidiurnal, third and non linear fourth, diurnal components. 5) – Analysis by the periodogramme, the smouthed auto-covariance function, and the maximum entropy methods were applied to GATE and FGGE mean temperature data series built from several series of the undercurrent layer, showed diurnal, semidiurnal and non linear fourth, fifth and sixth diurnal spectral bands, also related to internal waves. The analyses showed also a long period oscillation of nearly 15 days associated to the undercurrent meandering along the equatorial line. 6) – The first visit of an University Oceanographic Ship to SPSP had the aim of installing there a pressure and wind measuring station, which was done very successfully . Apart from that the entire FGGE experiment and visit to SPSP gave , most of all, the opportunity to participate with many scientists from various countries, in the first global investigations of the "unknowns" of the weather variability and also a glimpse on the secrets of the birth and preservation of life in the Planet Earth.

International Equatorial Atlantic Programmes – up to 1979 -

- Since the Equalant International Expeditions in the sixties (1960-1964) of last century, scientific knowledge of the Equatorial Atlantic waters has grown considerably, with the GARP(Global Atmosphere Research Programmes) as:
- GATE (GARP Atlantic Tropical Experiment) in the austral winter of 1974 and
- The FGGE (First Global GARP Experiment) during the year of 1979.
- Equalant cruises were planned with an emphasis on the hydrological and biological aspects, while GATE and FGGE emphasized the dynamical aspects, naturally emerging from their stated objectives, as weather forecasting and climatological understanding.

A –PARTICIPANTS of

- SOP I (First and Second Cruise)
- SOP II (Third Cruise)

A1-Participants on Board the NOc Prof W Besnard (SOP I)

- **A1-Participants of the first cruise of SOPI**, from 16 January of 1979 to 8 of February of 1979, were as follows: 1 - Afranio Rubens de Mesquita, Chief Scientist, IO-USP. 2 - Ely Joel Katz, LDO-CU. 3 - John Bruce, WHOI.4 - Jose Carlos Beccenery, IO-USP. 5 - Harrison Han Sun Chien, IAG-USP.6 **-** Richard Novack, WHOI. 7 - Gerard Chaplin, WHOI. 8 - Mario Festa, IAG-USP. 9 - Paulo Mancuso Tupinamba, IO-USP. 10 - Thales Trigo Jr, IAG-USP. 11 - Oswaldo Ambrosio Jr, IO-USP. 12 - David Bitterman, WHOI. 13 - Gilberto Ivo Sarti, IO-USP 14 - Wilson Ribas, IO-USP.

SOP I First Cruise. From the left: Gilberto Sarti, Ely Joel Katz, Mario Festa, Gerard Chaplin ,Harrison Han Sun Chien, David Bitterman,Jose Carlos Becceneri, John Bruce, Afranio Rubens de Mesquita and Paulo Mancuso Tupinamba

A2-Participants of the second cruise (**Still during SOPI)**, from 17 of February to 8 of March of 1979,

- 1 - Rolf Rolland Weber, Chief Scientist, IO-USP. 2 - Oswaldo Ambrosio Jr, IO-USP 3 - Paulo Mancuso Tupinamba, IO-USP. 4 - Reyner Rizzo, IO-USP. 5 - Jose Mario Conceição de Souza, IO-USP. 6 - Rosana Sacachiro, IO-USP. 7 - Linda Nishihara, IO-USP, 8 - Gilberto Ivo Sarti, IO-USP. 9 - Lourivaldo de Souza, IO-USP. 10 - Rolando Ravazini, IO-USP. 11 - Eduardo Pinheiro, IOUSP. 12 - Milton de Moraes. IAG-USP. 13 - Rubens J. Villela, IAG-USP.

A3-Participants of the Third cruise of the NOc Prof W Besnard (During the SOP II)
-July 1979-

- : 1 - Afranio Rubens de Mesquita, Chief Scientist, IO-USP. 2 - Ely Joel Katz, WHOI. 3 - Paulo Mancuso Tupinamba, IO-USP. 4 - Jose Mario Conceição de Souza, IO-USP. 5 - Mario Festa, IAG-USP. 6 - Reyner Rizzo, IO-USP. 7 - João Batista de Assis Leite, IO-USP. 8 - Gerard Chaplin, LDO-CU. 9 - Krunoslav Esteban Dragnovic, LDO-CU.

EQUIPMENTS

B-THE ATMOSPHERE

B- Equipments for Measuring the Atmosphere

- **The NAVAID System of upper air measurements** was provided by the WMO (World Meteorological Organization), who also organised the training course for the University personnel (IAG-USP) in Helsinki, so that the equipment could be used on board the NOc Prof W Besnard.

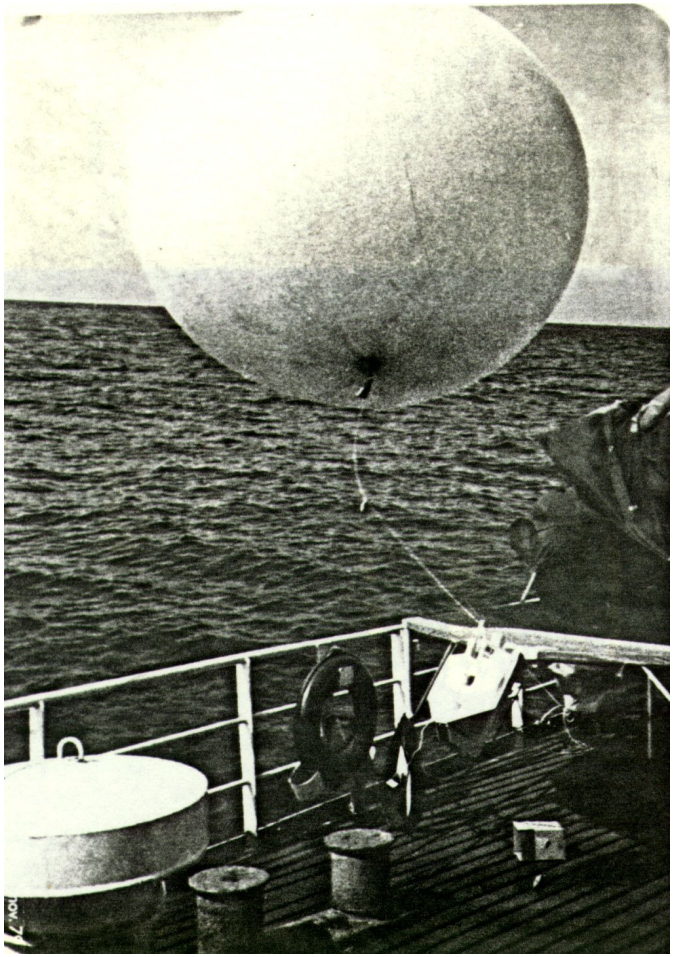
- The system was used to measure routinely at synoptic hours, the winds (force and direction), relative humidity, air temperature and pressure, during SOPI and with some restrictions in SOPII.

- The Omega system of navigation was used for wind measurements. Figure below show the launching of an upper air system being operated on board the NOc Prof W Besnard.

- All data were recorded on disckettes and sent to WMO after the cruises, via Directory of Hydrography and Navigation (DHN), Brazilian Navy.

- Data from solar radiation with the Sun Photometer and particulate aerosol with the "Aerosol Sampling Apparatus" sent to RSMAS (Rosenstiel School of Marine Sciences) (USA).

B1-Radio Sonde –Upper Air Measurements (Wind, Pressure,Humidity,etc)

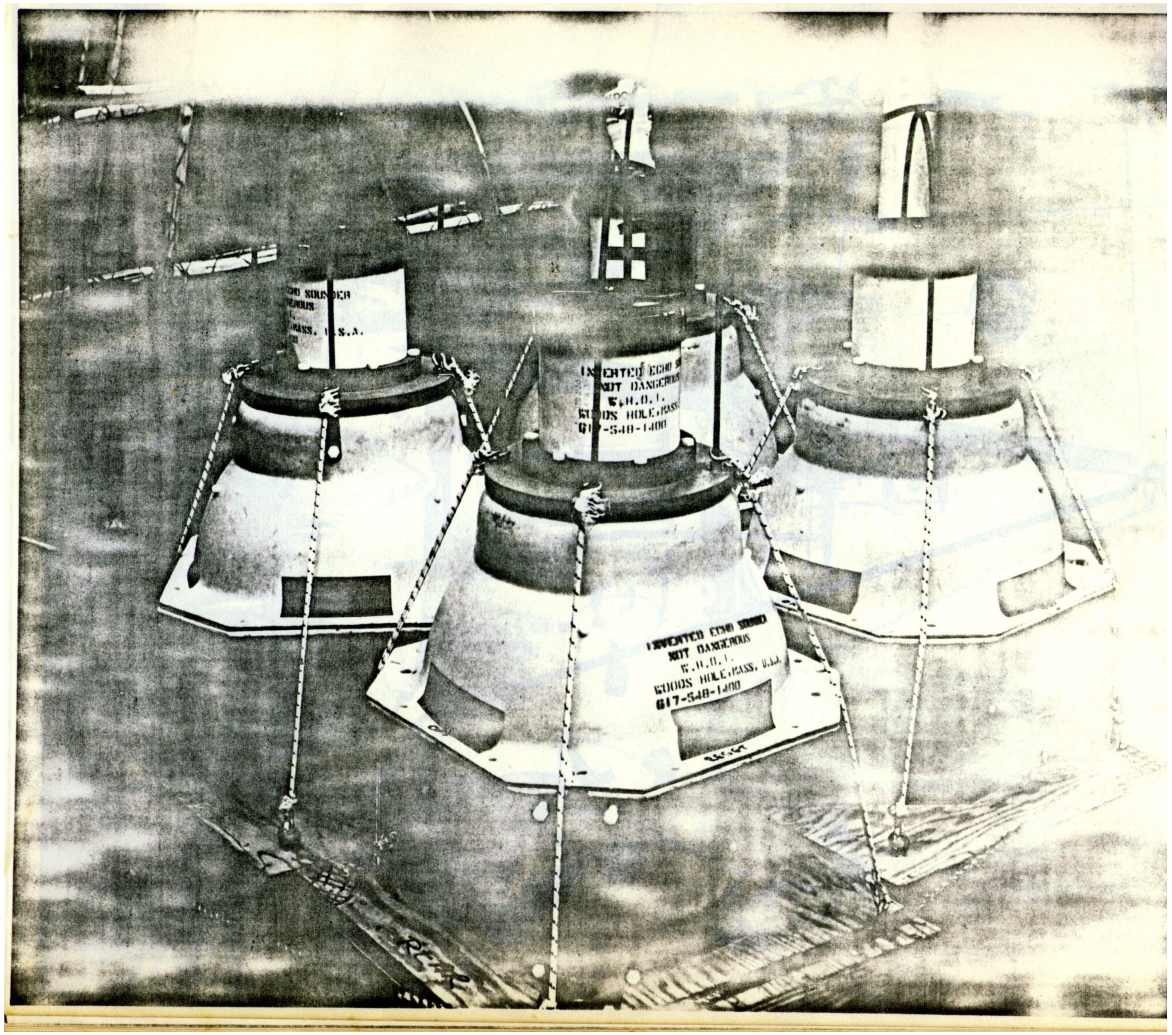


C- Measuring THE OCEANS

C1-Equipments for measuring the Ocean

- 1-Ocean-Wind Recording Buoy (Lamont-CU)
- 2-Inverted Echo Sounders (Lamont-CU)
- 3-Echo Sounders Deployment (Lamont-CU)
- 4-Braincon Currentmenter (Lamont-CU)
- 5-AANDERAA Currentmeters (IO-USP)
- 6-Lauching of STD 9040 (IO-USP)
- 7-STD Deck Equipment (IO-USP)
- 8-Rousette for Chemical Sampling (IO-USP)

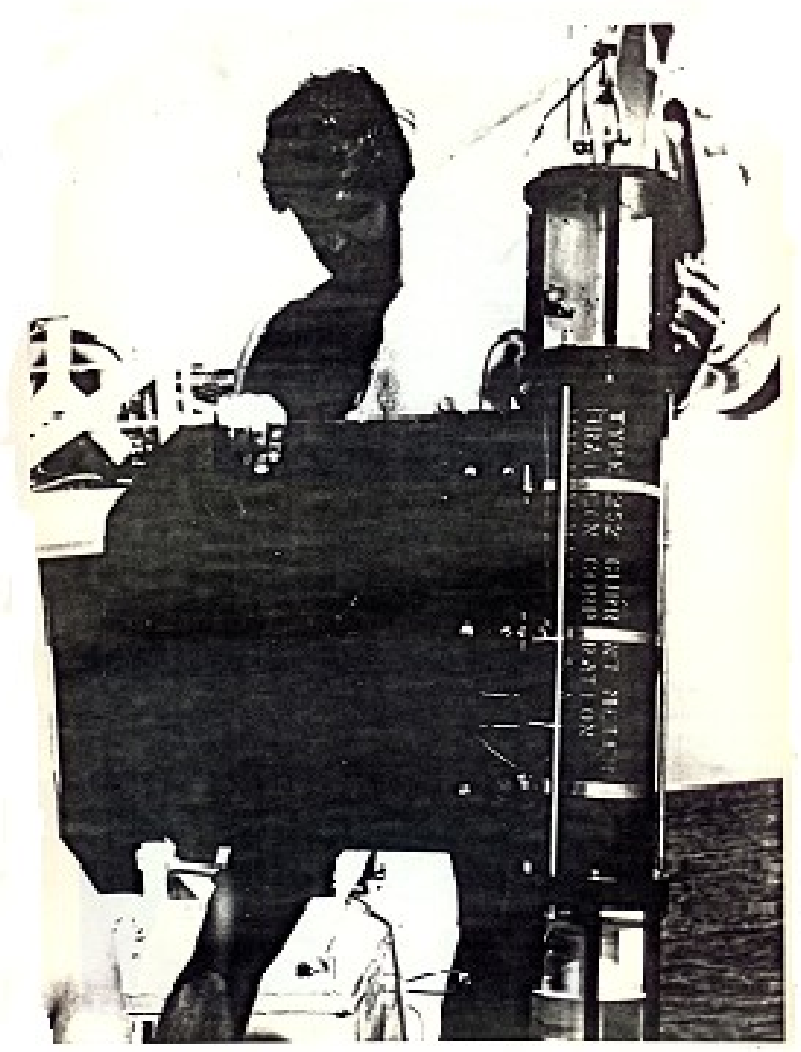
2)- Inverted Echo Sounders



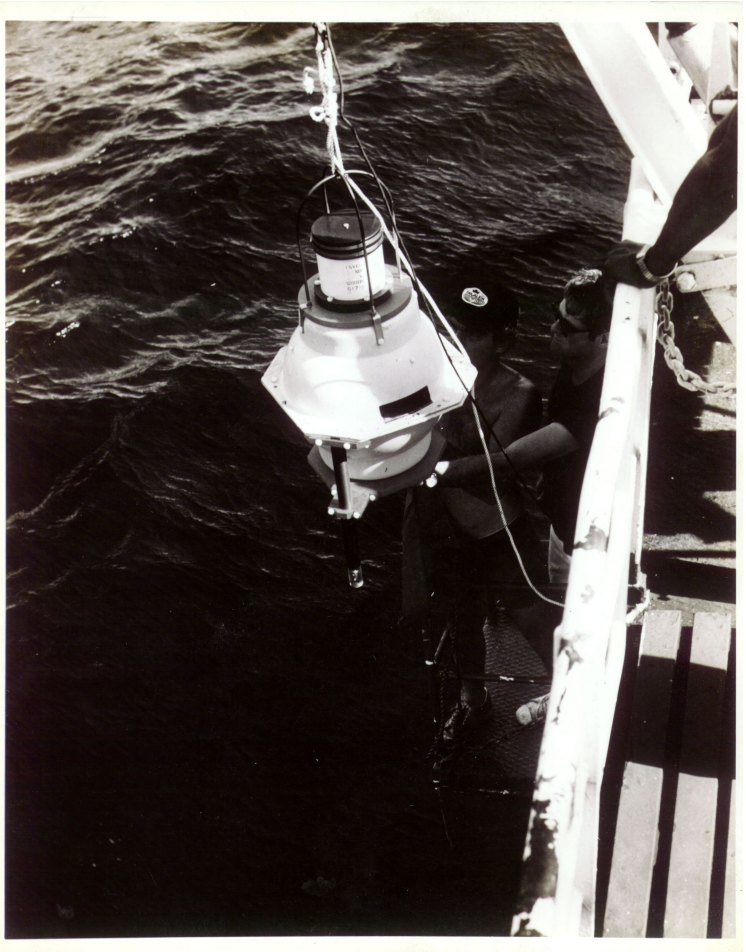
1)-Sea Surface Ocean/Wind recording Bouy being deployed near to 40W on a Sea Mount

4)-Braincon Currentmeter

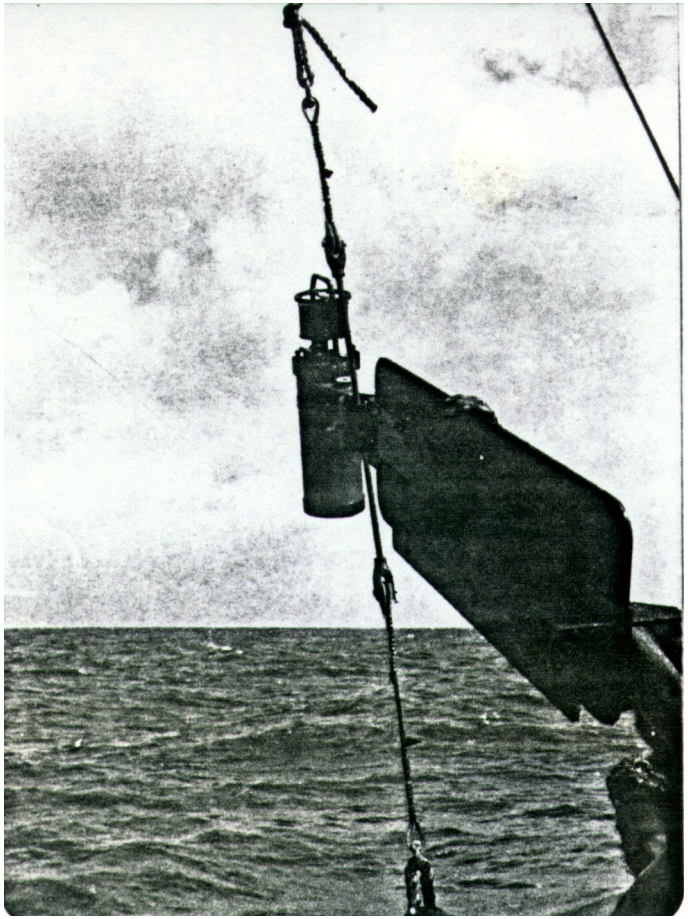
Thales inspects the currentmeter before launching



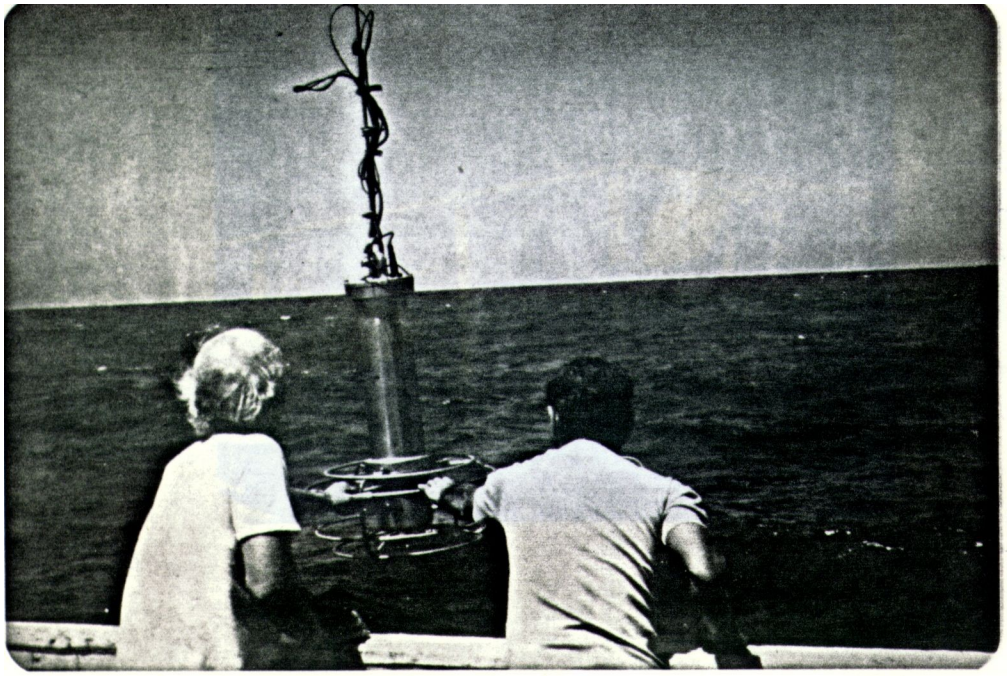
3)-Deployment of an IES



5)-AANDERAA Currentmeter being launched



6)- STD 9040 being launched



7)-STD 9040 Deck Unit

A R de Mesquita operates it

8)-STD 9040 and Rousete Sampler resting on board while other work goes on

D - PROF W BESNARD CRUISES

PLANNED MEASUREMENTS

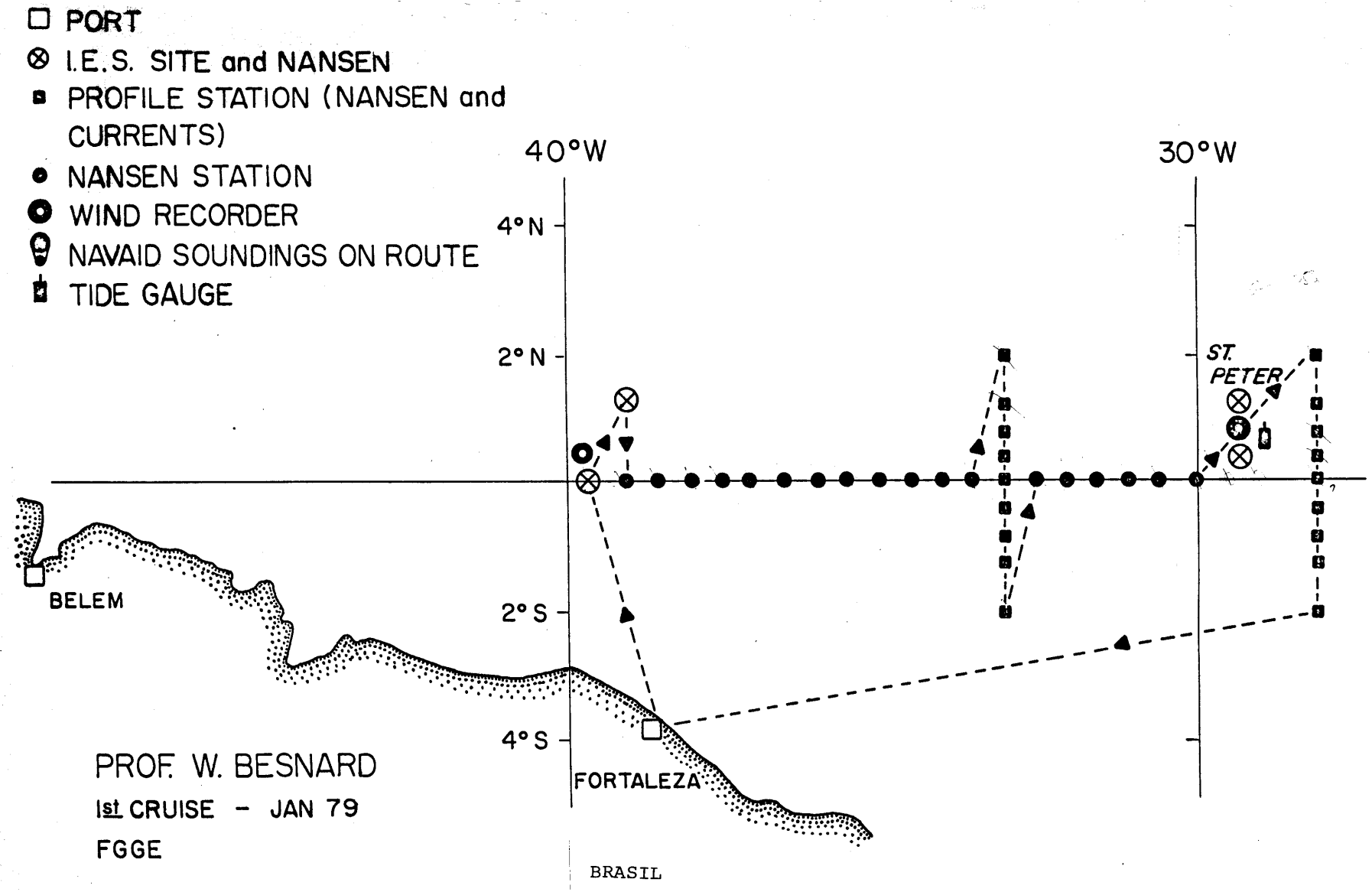
SOP I

SOP II

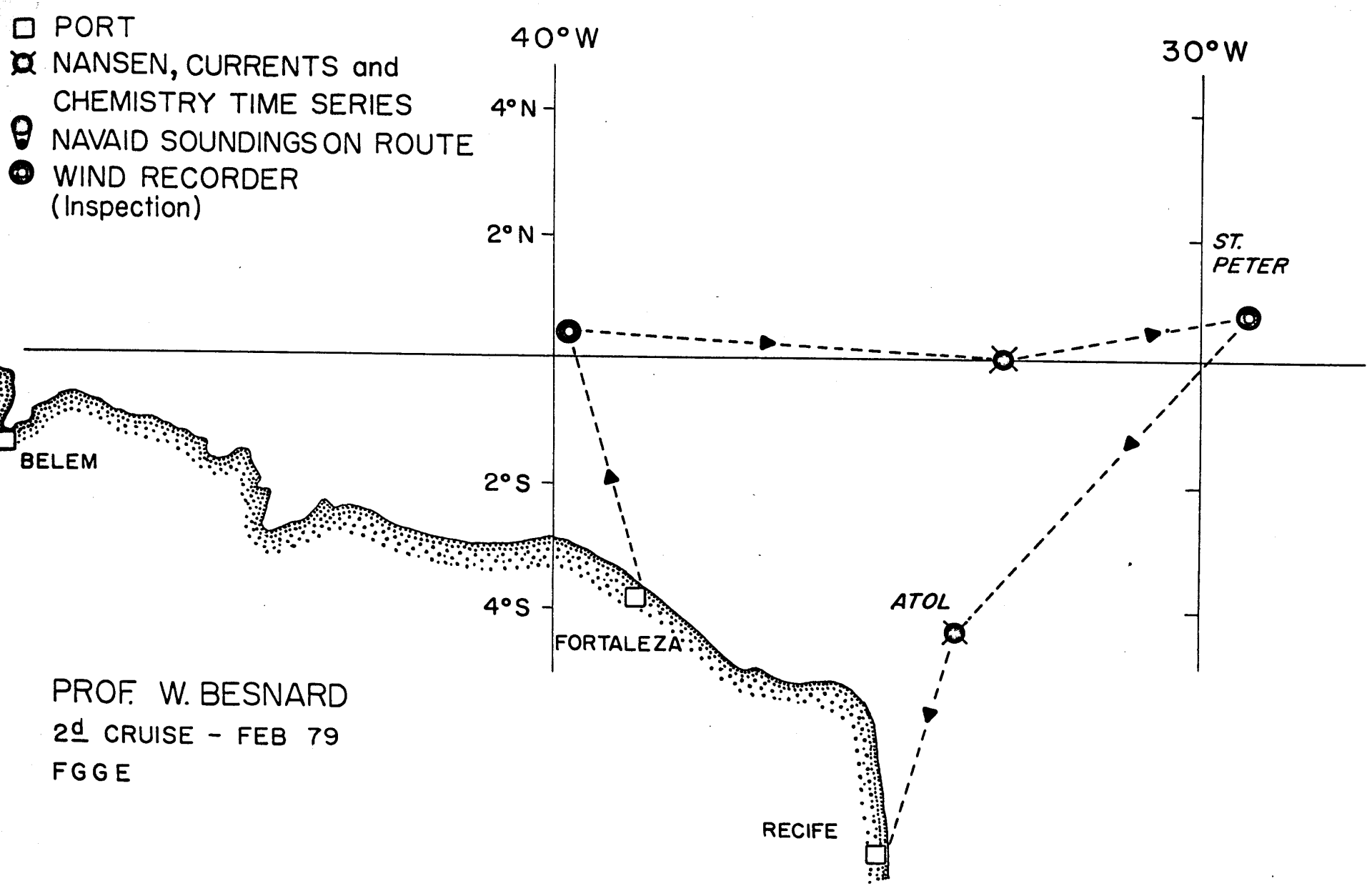
D-Oceanic Cruises - Positions of Measurements

- (SOP-1)-First Cruise:Positions and Measurements during Special Period of Observations -Austral Summer 1979.
- (SOP1)-Second Cruise: Positions and Measurements –Austral Summer1979.
- (SOP-II)-Third Cruise: Positions and Measurements. Austral Winter – 1979.

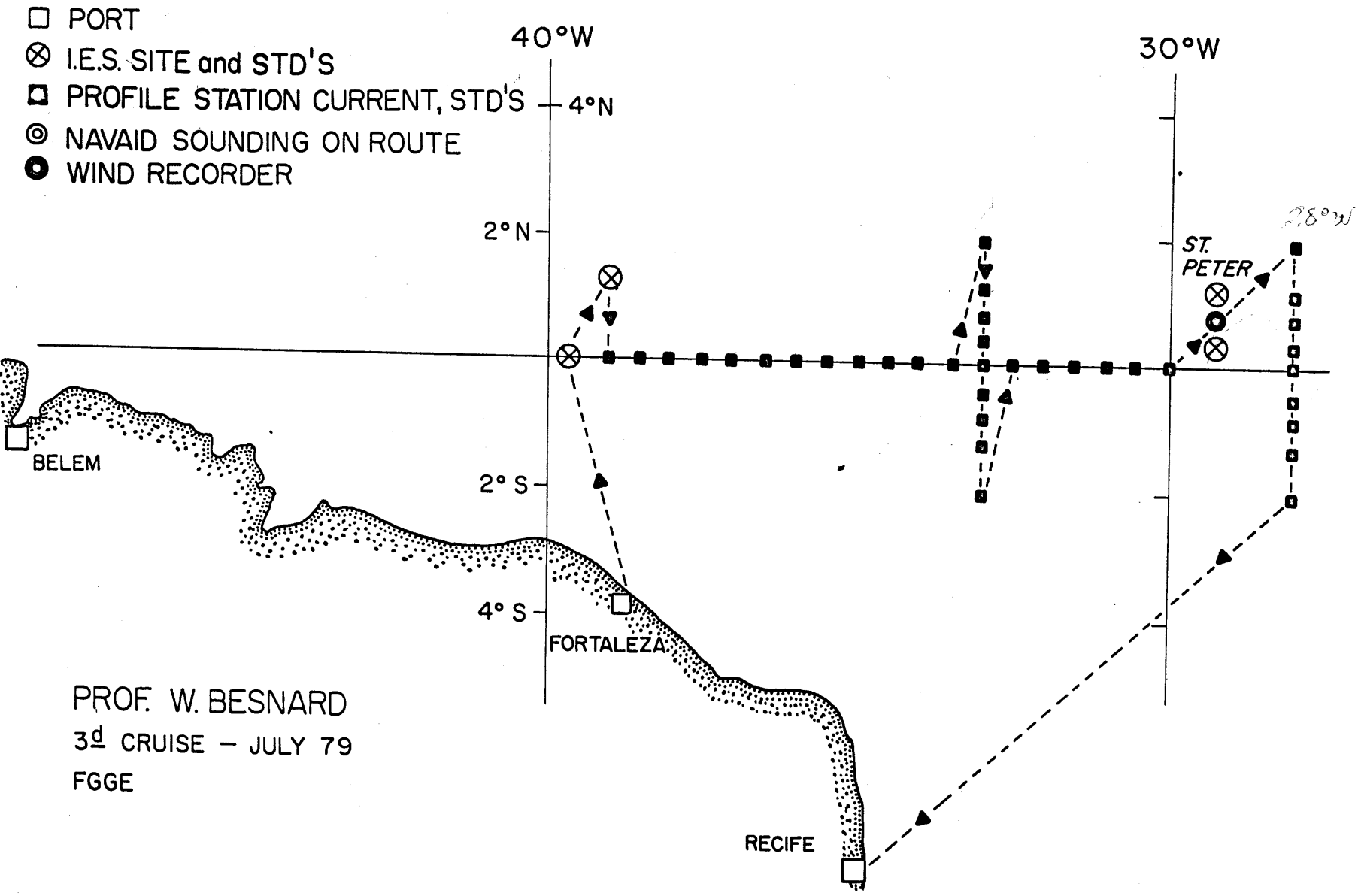
D1 –First Cruise (SOPI)



D2-Second Cruise (SOPI)



D3-Third Cruise (SOP II)



E -Currents, Surface Winds and IES Series

- The design of the field work of currents and IES (Inverted Echo Sounders) was established so that to measure the open ocean zonal pressure gradients through series of sea level heights, taken at nearly 40 W on a sea mountain and at 29 W in the SPSP Rocks.
- Simultaneous measurements of atmospheric pressure, wind force and direction, nearly at the same sites, were also planned to estimate the wind stress on the sea surface and the induced oceanic pressure gradients.
- Currents were taken over the side and corrected for the ship's drift by Omega navigation and astronomical navigation via sextant .

E-

MEASUREMENTS OF CURRENTS, SURFACE WINDS AND INVERTED ECHO- SOUNDERS

E1-Equatorial Currents during FGGE. From Reyner Rizzo MSc Thesis (1984)

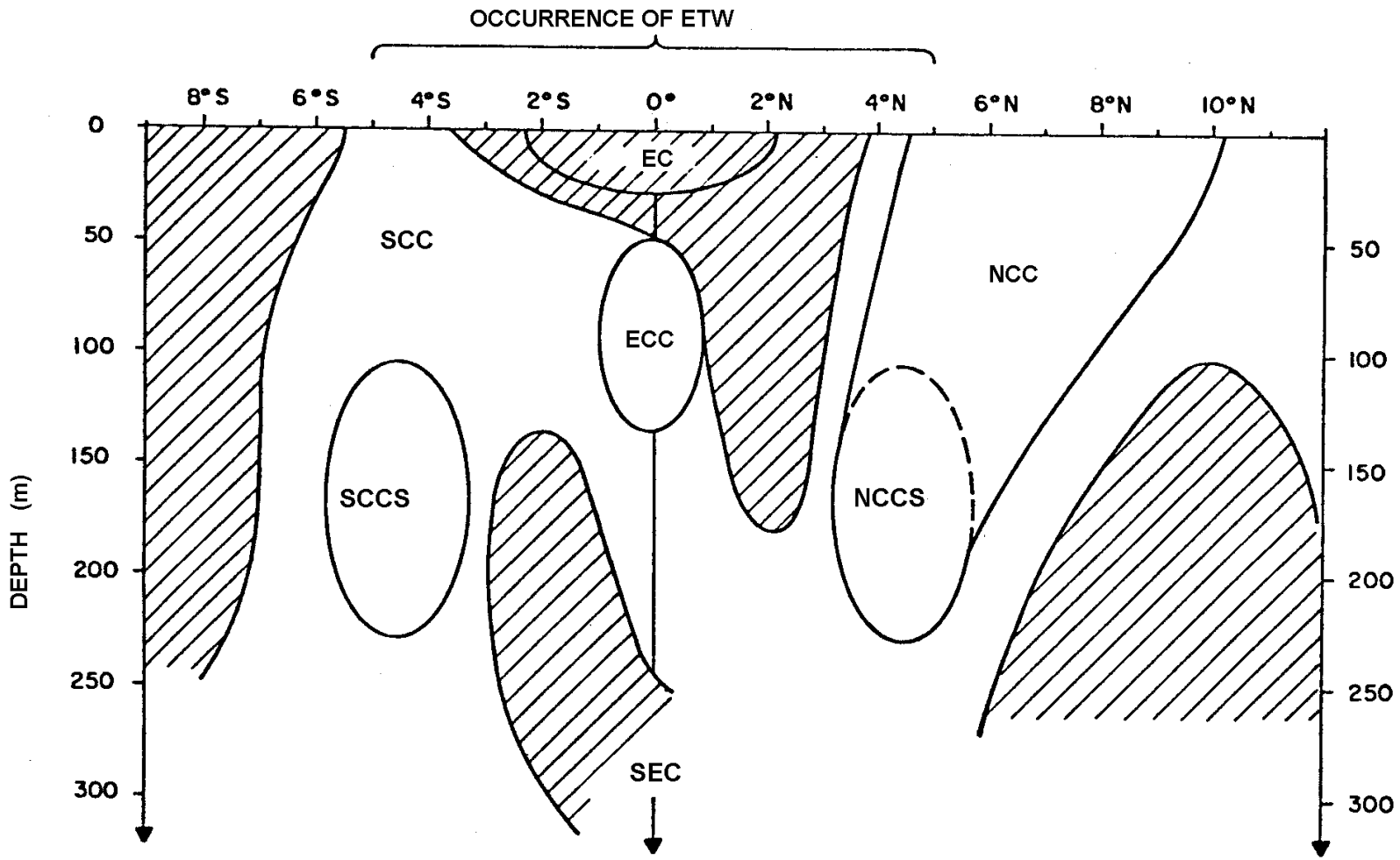


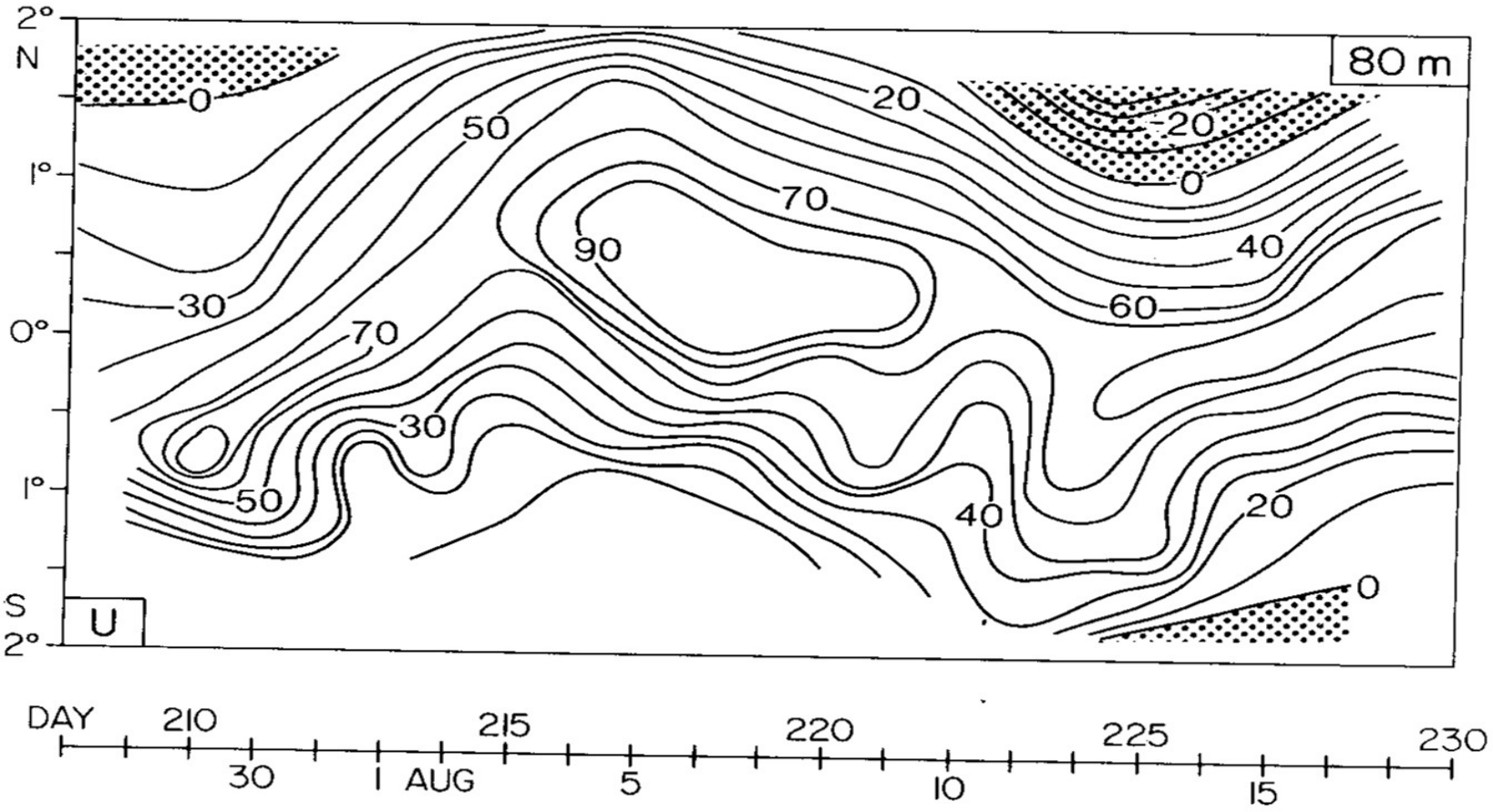
FIGURE I : MEAN ZONAL CIRCULATION IN THE EQUATOR
(HATCHED AREAS INDICATE FLOW TOWARDS WEST)

E 2- Trapped Currents

- Shaded areas in the previous slide indicate currents towards the west, at mean longitude of 35 W. Currents towards the East are : Equatorial Counter Current (ECC),shown submerged with a core at about 100m.
- The Southern Counter Current Submerged (SCCS) and the Northern Counter Current Submerged (NCCS) are surface currents, with cores at about 180 meters, one at 4S and another at 4N.
- Equatorial Trapping of currents occurs between 6 N to 6 S. The undercurrent (ECC), in particular, meanders with its core varying between 0.5 N to 0.5 S with current speeds of about 1.0 m/s and celerity speeds of about 2m/s.

E3-Trapped Equatorial Undercurrent (ECC) at (28 w)

BUBNOV and EGORIKRIN (1981)



E4-Characteristics of the Undercurrent (ECC) at 28 W

- The undercurrent meanders submerged with a phase speed of about 2m/s, at levels within 50 to 120m depth, (Duing et al 1975), performing in one day, according the previous slide, an approximate trajectory along the equator of about 173 km. The estimated wavelenght during 20 days was then 3,300 Km. The ECC is born by pressure gradients in the coast of Brazil, weakens and is absorved by other currents near the coast of Africa after travelling nearly 6,000
- Km.

E6-GATE Spectra (periods) of Temperature Data Along the Equator (38W,23W and 10W) at (ECC) Level

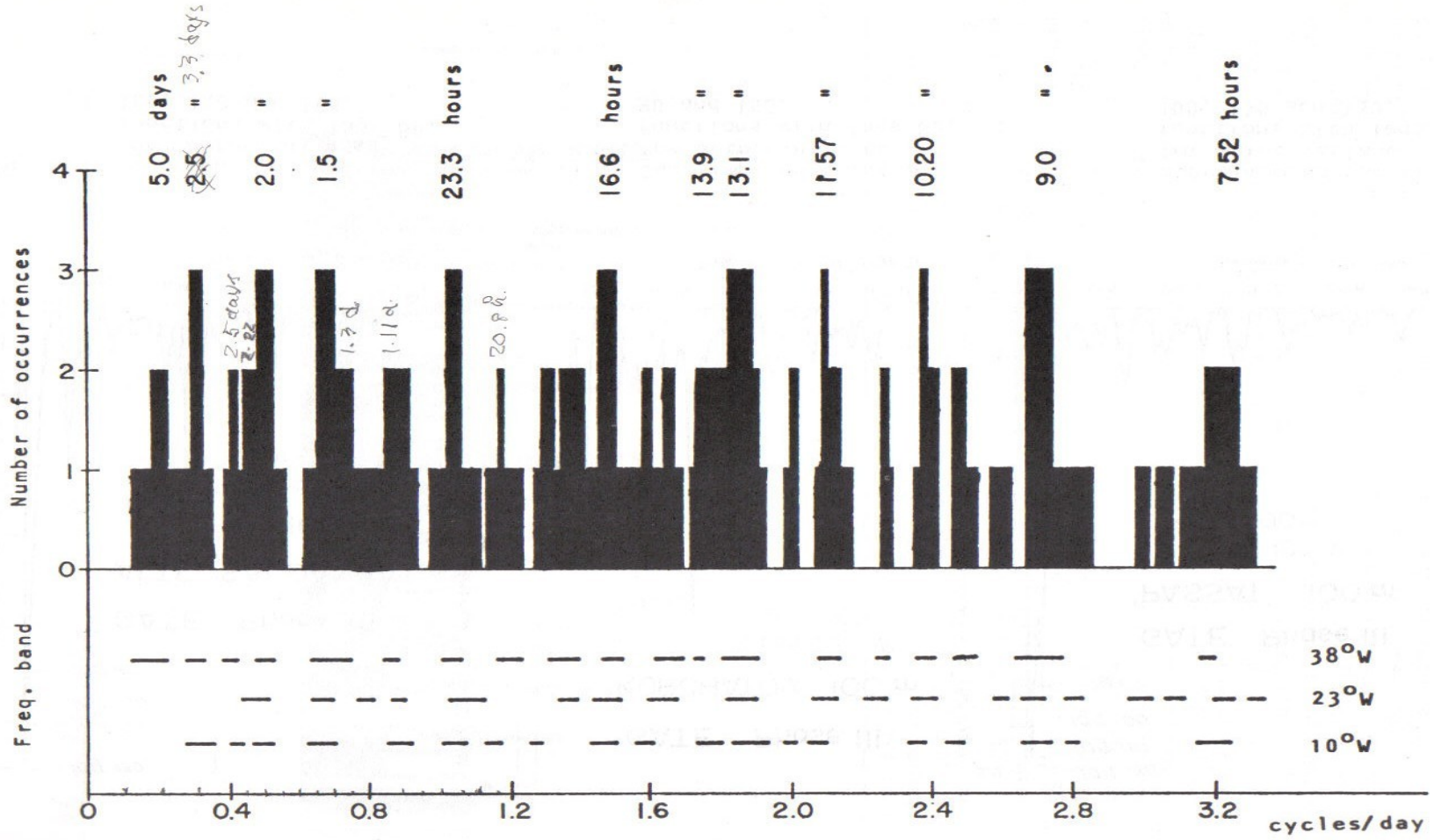


Fig. 13d. Summary of periodicities of temperature layer 2 (100 m)
- Phase III of GATE - Almost simultaneous series from

E5-More on Data Analysis of IES, Currents and Temperature

- IES data series of Flavia(0 03’S;30 57’W), Eliana(0 04’N;39 45’W) & Branca (01-16’N ;39 08’W), were analysed by the Tidal Harmonic Method.
- Series of Currents at 33W were analysed by the Periodogramme, Maxima Entropy and the Smouthed Covariance spectral methods.
- Series of currents were short (13 days) and were treated in a way to overcome that difficulty, so that to obtain better descrimination of the spectral frequencies, disregarding their amplitudes.
- GATE temperature and currents data at 38 W, 23 W and 10 W were also used to estimate the spectral results.

E7-GATE - Analysis of Mean Temperature Data from Various (ECC) Levels – 60 to 100m

The spectral analysis of the mean temperature values is shown to be equivalent to the sum of analyses of several series taken from the 60 to 100m depth layer. The analysis show long periodicities (15 days) related to the ECC meandering and also the diurnal, semidiurnal, terdiurnal, fourth diurnal bands

These tidal (diurnal, semidiurnal and terdiurnal) and the non linear bands were also shown by the tidal analysis of the IES series, suggesting such occurrence in the analyses, as due to internal waves in the equatorial belt with large amplitudes and phases relative to the Greenwich meridian.

"Alme Saldanha" - PHASE III - Oct. 1974

Periodicities

mean series	layer 60-110m		difference	
	4/4	3/4		
15,3	16,7	-	-1,1	
6,3	-	6,4	-0,1	
3,3	3,3	-	0,0	days
1,5	1,4		+0,1	
1,3	-	1,3	0,0	
1,1	-	1,1	0,0	
22,4	-	22,5	-0,1	
20,5	20,9	-	-0,4	
18,7	-	18,8	-0,1	
17,6	17,7	-	-0,1	
16,1	16,3	-	-0,2	
15,0	-	15,2	-0,2	
13,9	-	13,9	0,0	
13,1	13,1	-	0,0	
12,6	-	12,7	-0,1	
11,4	-	11,6	-0,2	
10,5	10,8	-	-0,3	
9,6	-	9,7	-0,1	hours
9,1	-	9,1	0,0	
8,7	-	8,8	-0,1	
8,4	-	8,5	-0,1	
8,0	8,1	-	-0,1	
7,7	-	7,8	-0,1	
7,4	-	7,4	0,0	
7,2	7,2	-	0,0	
6,9	-	6,9	0,0	
6,5	-	6,6	-0,1	
6,3	6,4	-	-0,1	
6,1	-	6,2	-0,1	

E8-Theory of Equatorial Trapped Currents and T/S Data

The analysis of currents, via Theory of Equatorial Trapped Waves (ETW), allowed the determination of the spectral frequencies of meridional and zonal components.

These components were compatible (correspondent) with the frequency results obtained by spectral analysis of the data taken at 33 W and 22 W along the Equator in the ECC levels.

E9-Periods (days) of (ECC) zonal and meridional components at 33W (13 days) and 22 W (21 days): from Theory . From Reyner Rizzo MSc Thesis(1984)

zonal component		meridional component	
33°W	22°W	33°W	22°W
3.3	3.3	3.6	3.5
2.6	2.6	2.4	2.5
2.2	2.3	-	-

TABLE 5.7 - COMPARISON BETWEEN OSCILLATION PERIODS IDENTIFIED IN THE SPECTRA OF CURRENTS AT LONGITUDES 22°W & 33° W

E-9a-Spectral analysis of winds at 33W by the Periodogram and the autoregressive Maximum Entropy methods produced the periodicities shown in the table below

ZONAL WINDS AT 33W				
Periodogram	MME (M=34%)	MME (M=68%)	MME (M=75%)	MME (M=91%)
4.6		4.4	4.8	4.8
-		3.6	4.0	3.9
2.8		-	2.8	2.8
2.2		2.3	2.2	2.3

E9-b -Spectral analysis by the Periodogram and the Maximum entropy aoutorregressive methods of Meridional winds at 33W also identifyed periods ranging 2.0 to 3.3 days

MERIDIONAL WINDS AT 33 W				
Periodogram	MME (M=34%)	MME (M=68%)	MME (M=75%)	MME (M=91%)
5.5	4.8	5.2	5.2	5.0
3.4	3.0	3.3	3.3	3.3
2.5	-	2.4	2.5	2.4
2.0	-	-	2.0	2.0

E9c – Spectral Analyses of Meridional Winds of SPSP also showed by the Periodogram the Smouthed Autocovariance and the Maximum Entropy Methods similar periods as seen in the analyses made in 33 W on board the Prof W Besnard.

MERIDIONAL WINDS AT SPSP

Periodogram	ESC (M=63%)	ESC (M=70%)	MME (M=42%)
4.0	3.8	3.9	4.0
-	-	-	-
2.8	(3.0)	3.0	3.0
2.5	2.5	2.5	2.5
-	(2.1)	2.1	-

E9d- The same correspondence with 33 W is shown by the zonal winds of SPSP

ZONAL WINDS AT SPSP				
Periodogram	ESC (M=63%)	ESC (M= 70%)	MME (M=42%)	MME (M=70%)
4.8	4.6	4.7	4.8	4.8
(4.0)	-	3.9	(4.0)	-
3.0	3.0	3.0	3.0	3.0
2.5	2.6	2.6	2.5	2.5
2.1	2.1	2.1	2.1	2.0

E9e- Isoplets of Spectra of Currents of six depths of the ECC layer at 33 W. show that currents occur in several zonal major bands ranging from 2.0 to 3.3, 4 to 5, days shown by the winds and less precisely 6 to 7, 8 to 10 days. Suggesting the above first bands of currents are wind induced. Rizzo (1984).

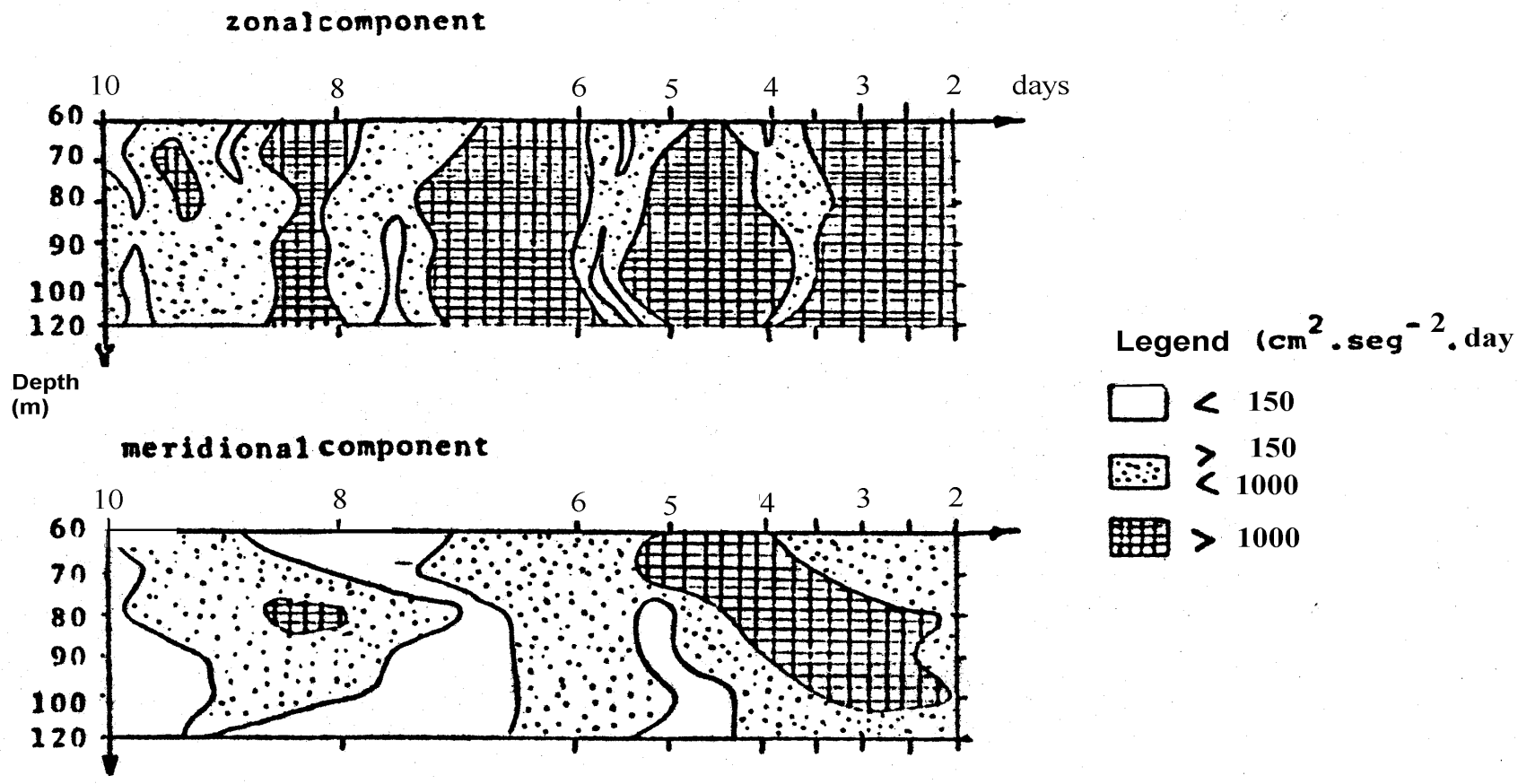


Figure 6 : Isoplets of Power Density Spectra of Currents at 33 W

E10-TIDAL ANALYSIS OF Inverted Echo Sounders (IES) DATA

Tidal Harmonic Analysis of Inverted Echo - Sounders time series, named as Branca, Eliana and Flavia, identifyed enumerous tidal components. Amplitudes and phases of these components are given in cm and degrees, covering oscilations with periods ranging from 1 day to 4 hours. Franco, Harari & Mesquita (1985).Next slide.

Table 1. Statistically useful harmonic constants

Constituents		"BRANCA"				"ELIANA"				"FLÁVIA"		
ol	Angular Frequency (°/h)	H (cm)	± (cm)	GW (degrees)	± (degrees)	H (cm)	± (cm)	GW (degrees)	± (degrees)	H (cm)	± (cm)	GW (degr
	13.3916609	-	-	-	-	4.65	2.09	175.19	26.64	-	-	-
	13.943[illegible]	4.48	1.28	257.29	16.62	5.82	2.09	217.10	21.00	4.47	1.54	235.
	15.0410686	4.30	1.28	236.04	17.35	6.93	2.09	281.59	17.52	1.55	1.54	330.
	16.1391017	-	-	-	-	2.27	2.09	353.08	66.91	1.99	1.54	201.
	16.6834764	2.07	1.28	83.78	38.21	2.79	2.09	246.57	48.43	4.01	1.54	206.
	27.9682084	-	-	-	-	5.46	5.26	190.25	74.42	-	-	-
	28.4397295	15.86	6.95	209.29	26.00	16.05	5.26	194.32	19.14	11.33	4.15	206.
	28.9841042	10.7[illegible]	6.95	206.61	4.94	71.50	5.26	209.11	4.22	61.49	4.15	214.
	30.0000000	30.38	6.95	239.16	13.23	31.13	5.26	244.05	9.73	16.77	4.15	230.
	30.5443747	-	-	-	-	-	-	-	-	4.28	4.15	349.
	42.3827651	-	-	-	-	1.42	1.32	358.03	67.96	-	-	-
	42.9271398	1.52	1.15	184.43	49.29	-	-	-	-	-	-	-
	44.0251728	-	-	-	-	1.64	1.32	311.42	53.53	-	-	-
	44.5695475	-	-	-	-	-	-	-	-	1.57	1.49	93.
	57.9682084	3.92	2.71	34.37	43.84	2.56	2.15	349.07	57.19	-	-	-
	58.4397295	3.09	2.71	201.00	61.49	2.16	2.15	121.03	84.29	-	-	-
	73.4807981	1.10	0.99	222.66	64.83	-	-	-	-	-	-	-
	86.9523127	2.23	1.82	345.58	54.60	-	-	-	-	1.00	0.96	67.
	87.9682084	-	-	-	-	1.73	1.29	350.40	47.85	-	-	-

Tidal Analysis of IES data (Branca, Flavia and Eliana,)

Results show the existence of very **energeticTidal components in mid ocean Equatorial waters**. Amplitudes as large as the Moon M2 (80, 71and 61 cm), and phases (206,209,214 degrees), relative to Greenwich, respectively for the IES Branca,Flavia and Eliana time series. Also for the Sun S2 (30, 31,16 cm) and phases (239,244,230) among others. They are very **much more energetic**, for example, than the correspondent amplitudes and phases of tides of M2 (36cm,180 degrees) and S2=(23 cm,184 degrees) of Cananeia, litoral of the State of São Paulo. Mesquita & Harari (1983).

NUTRIENTS

F -

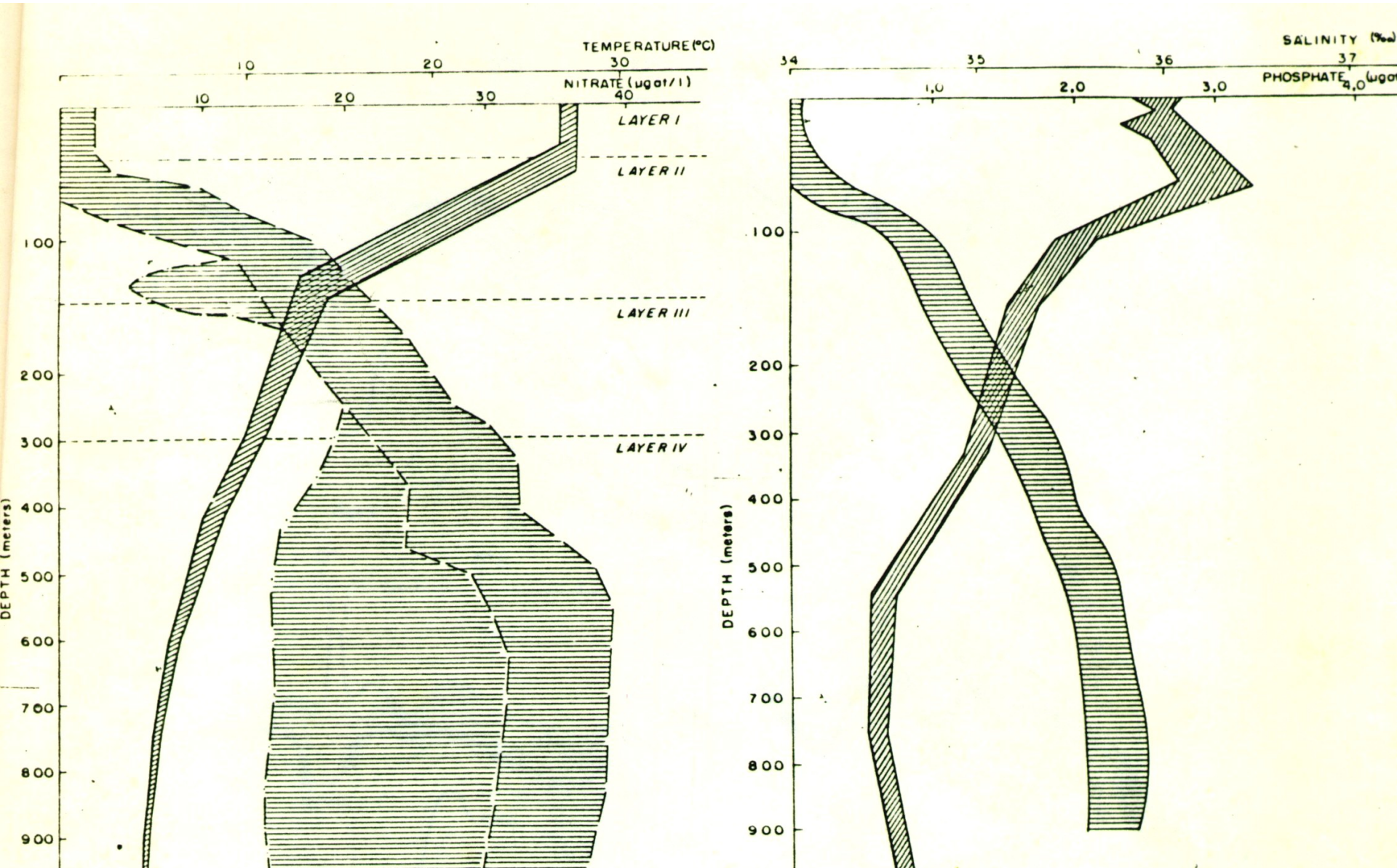
NUTRIENTS

F1- Nutrients (Ni,Ph & Si)

- . The distributions of Nutrients were somewhat depleted from 0-100m depths and increased until the maxima observation depths.
- . Their vertical distributions were generally independent of the horizontal layers which can be devised, based on the vertical distributions of Temperature and Salinity of the Equatorial waters,
- such as: Mixed layer (0 - 30m) Transition layer (30-150m), Intermediate layer (150-300m) and Deep layer (300-1000m).

F2-GATE-Temperature/Ni and Salinity/Ph

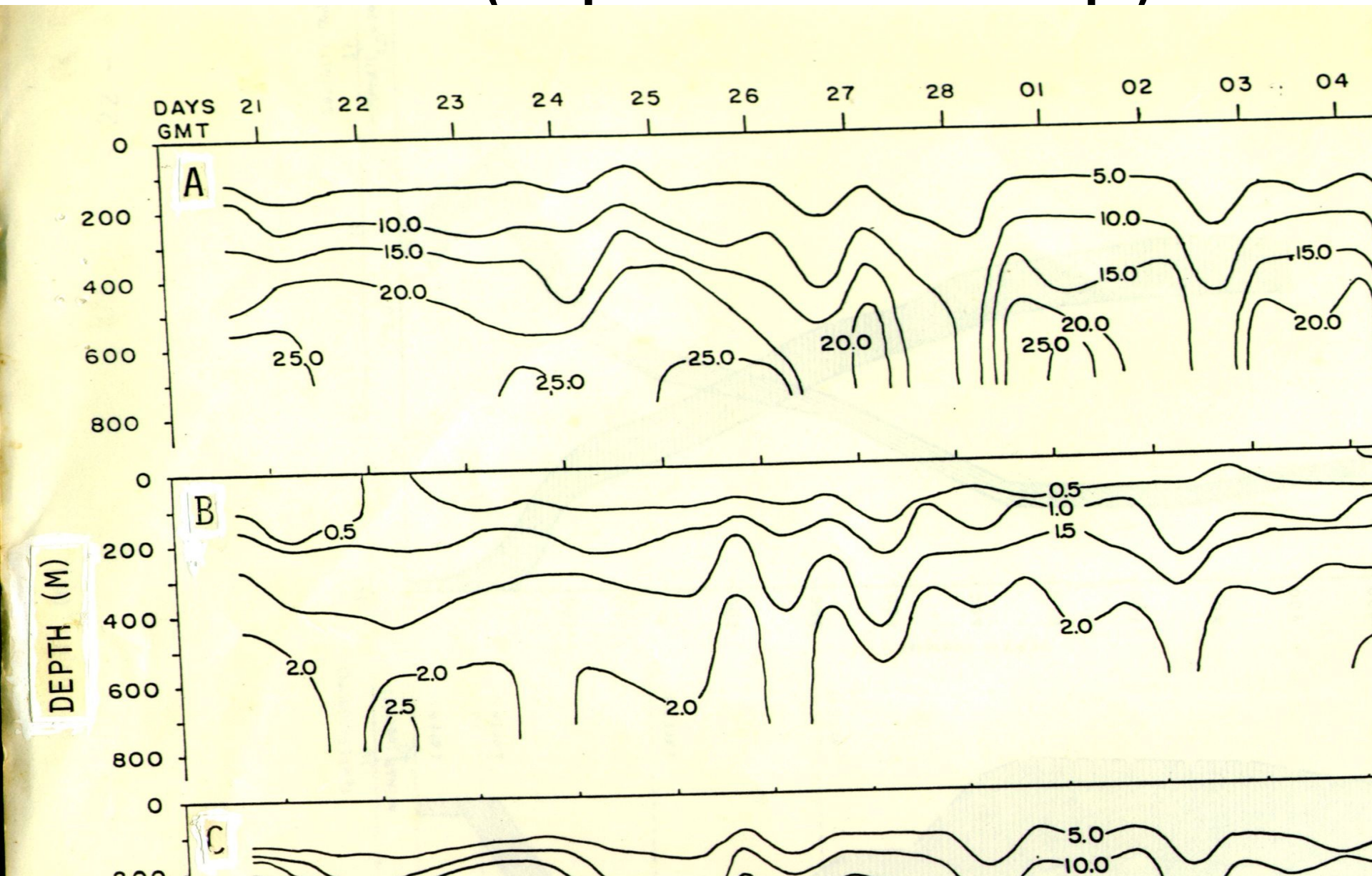
Vertical Distributions along Layers I,II,III and IV



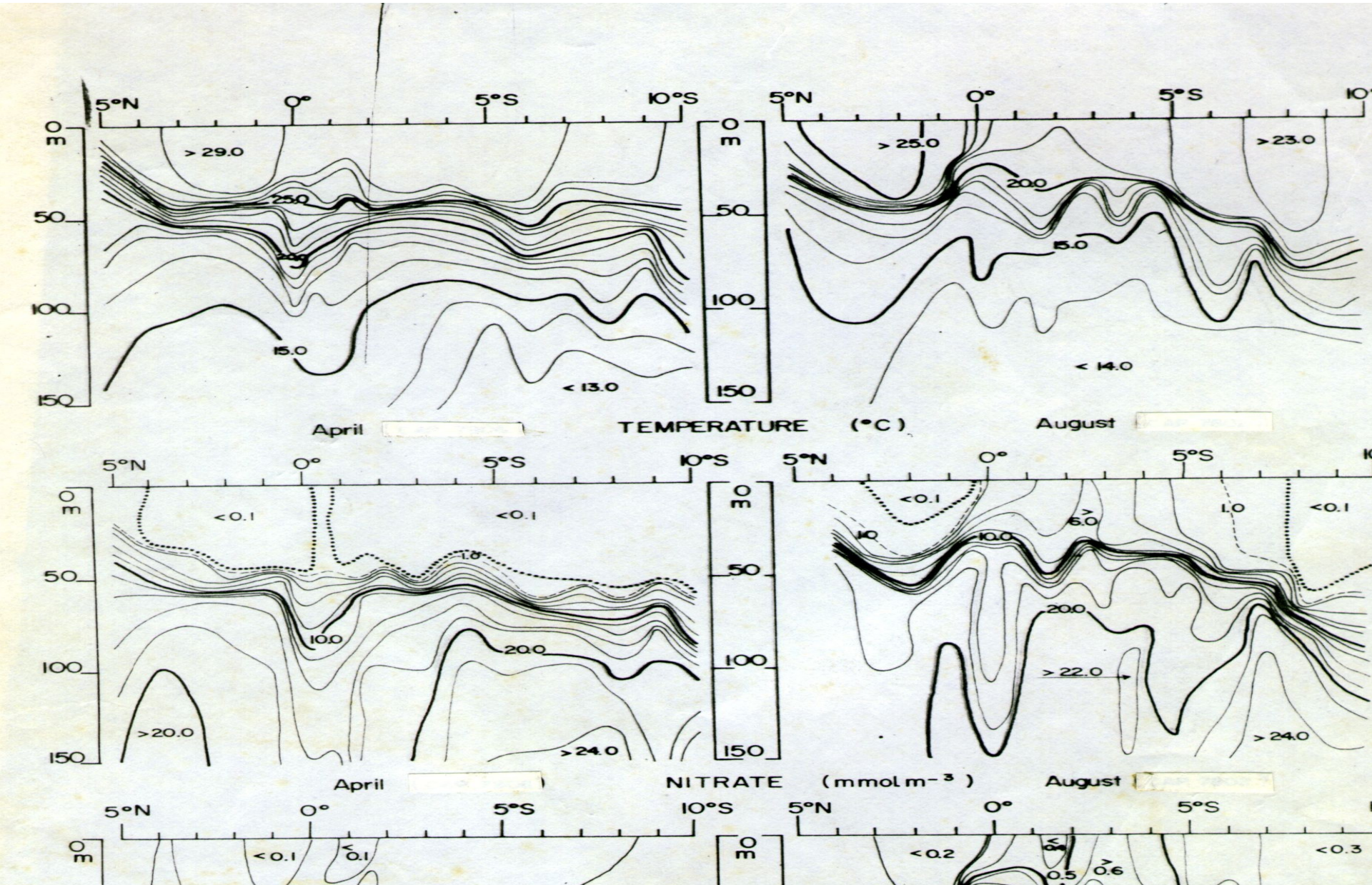
F3-**Nutrients Bursts and Depletions**

- Bursts and depletions are often, for very good reasons, under suspicion of data information in error and frequently they are taken away and not considered in the analyses.
- That was also the case in the present considerations when preparing this topic .
- The description of next three slides, seem to follow the rule and they are here suggested, in view of the many repetitions of the phenomena from different data sets, provided by the various people involved with Nutrients, showing data from different places of the Equatorial belt during FGGE.

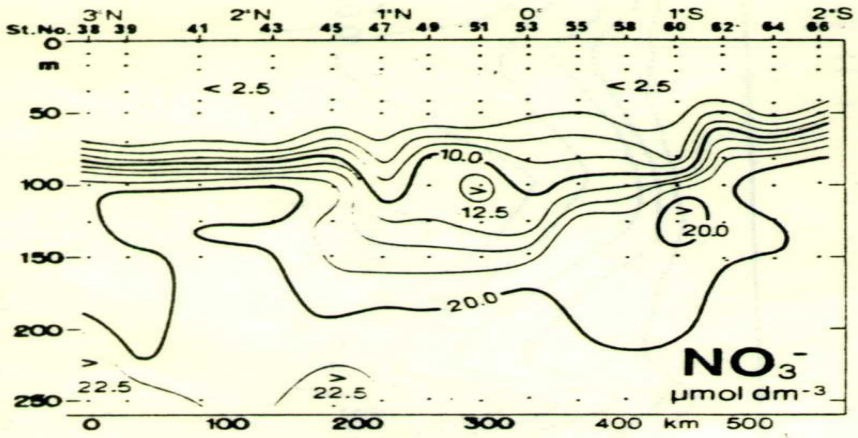
F4-Isoplets of Nutrients at 33 W. Mesquita et al .1980. (umpublished manuscript)

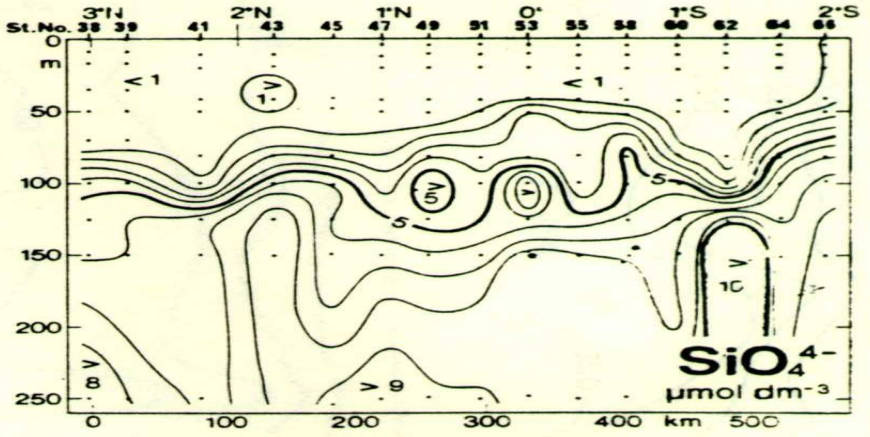


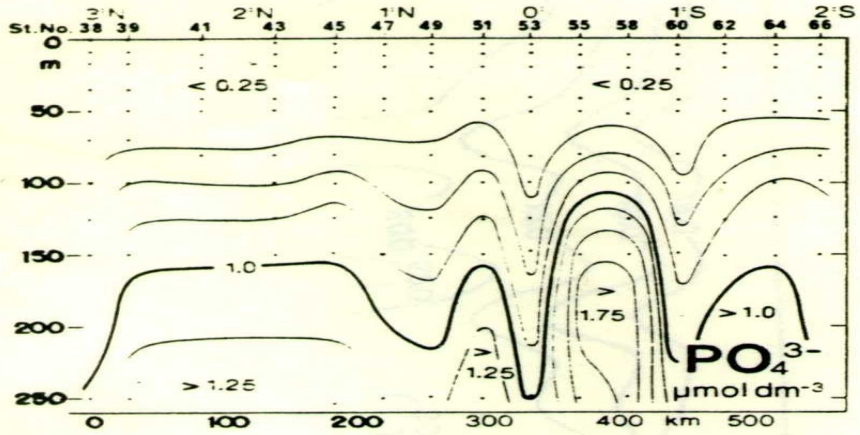
F5- April/August, T, Ni and Ph Nutrients (10S-5N) Sections at 4W - Mesquita et al .1980. (umpublished manuscript)

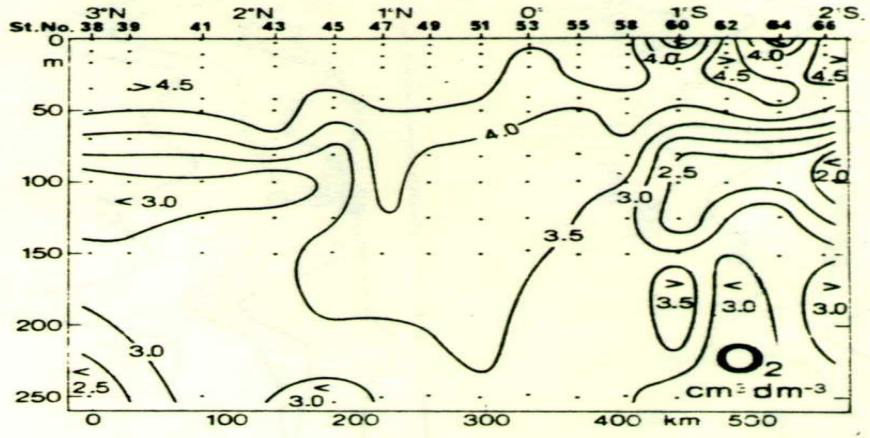


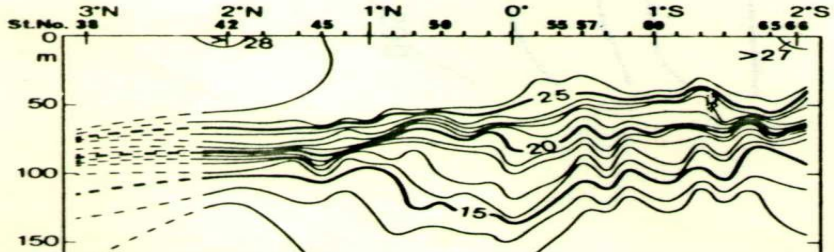
F6-Ni,Ph,Si,O2,Temp and Sal (2 S-3N) Sections at 22 W.- Mesquita et al 1980 (umpublished manuscript)

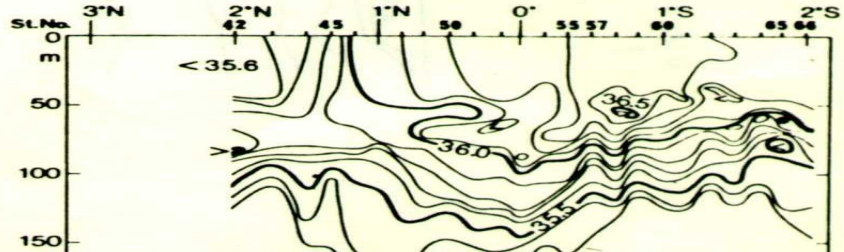












F7-Estimates of Local (33W),Temperature, Salinity and Nutrients Constants

- Values shown in Table I (Next slide) encompass all the main characteristics of the Nutrients variability at (33W).
- The values of alpha for T, beta for S, gamma for Ph, delta for Si and epsilon for Ni, were determined according to layers (0-30m,30-150m,150-300m, 300-1000m), as defined by T & S vertical distribution, Slide E2.
- The variability at each layer were divided by the corresponding maximum value of the variance observed in the water column, giving rise to what can be called as invariant (constant) values at the geographical point and depths of the measurements.

F8-Table I- Local(T,S,Ph,Si & Ni)Seasonal Invariants at different depths at 33 W

Layer	α	β	γ	δ	ϵ
I 0 -30 m	0.25	$0.25/0.87$	0.27	0.45	0.01
II 30-150 m	1.0	1.00	1.00	0.45	0.40
III 150-300 m	$0.2/0.25$	$0.25/0.41$	0.89	0.45	$0.40/0.70$
IV 300-1000	0.05	0.25	1.00	1.00	1.00

F9-First Estimates of Nutrients Seasonal Invariants (Constants) Along the Western Equatorial Atlantic

- On a seasonal basis, (using GATE and FGGE data) the mean content of Nutrients of layers I, II and III showed, in the Western Equatorial Atlantic, characteristics of the austral variability, with lower values in the summer (Jan-Feb.) and higher values during the winter months (Jun-Aug).
- .

F10-Table II – Western Atlantic Equatorial Seasonal Constants of Nutrients

levels	Nitrate	Phosphate	Silicate	Oxygen
θ	6.28	0.24	3.00	1.04
π	3.31	1.13	2.70	0.98
ρ	2.58	1.31	2.49	0.84
layer 0-300m	3.36	1.08	2.62	0.90

F11- Western Atlantic Equatorial Seasonal Constants of Nutrients

The (winter/summer) rates (theta) for layer I, (pi) for layer II and (ro) for layer III of respectively Nitrate, Silicate ,Phosphate and Oxygen.

The most striking aspects of the yearly constants are shown by the layer 0-300m for Nitrate (3.36) and for Silicate (2.62), while they nearly seem even for O2 (0.90) and Ph(1.08).

SAINT PETER'S AND SAINT PAUL'S ROCKS

G-

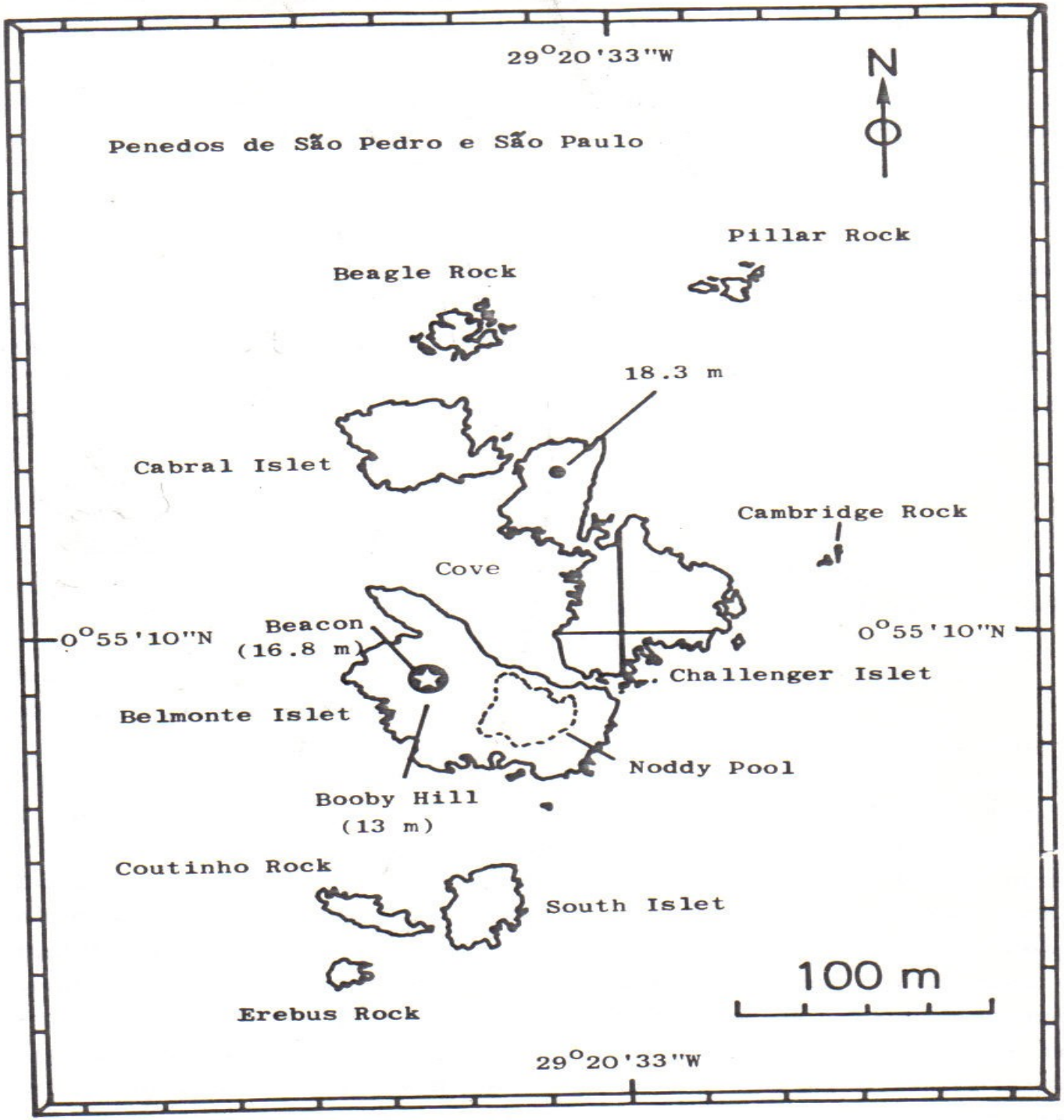
SAINT PETER'S AND SAINT PAUL'S ROCKS

G-The Visit to the “Penedos de São Pedro e São Paulo”

- The Saint Paul’s and Saint Peter's Rocks are a set of sea mountains which emerged from the mid Atlantic Ridge at 0 29'N 30 W.
- In 1930 they were visited by the Brazilian Navy's Tender Ship "Belmont", which installed on the top of the highest peak a light house for navigation purposes.
- The light house was later destroyed by seismic motion of the rocks.

G1-The Visit to Penedos de São Pedro **e São Paulo**

- The history of the "Penedos de São Pedro e São Paulo" starts after the Portuguese discoveries in early sixteen century and they appear on Mercartor's chart of 1538.
- The first known record of a visit to the Penedos , however, was given much later by Delano , who visited there in the US ship "Perseverance" in 1799.
- The occasion of our visit was in 06-08-1979.


29°20'33"W
N
Penedos de São Pedro e São Paulo
Pillar Rock
Beagle Rock
18.3 m
Cabral Islet
Cambridge Rock
Cove
0°55'10"N
Beacon
(16.8 m)
0°55'10"N
Challenger Islet
Belmonte Islet
Noddy Pool
Booby Hill
(13 m)
Coutinho Rock
South Islet
100 m
Erebus Rock
29°20'33"W

G3- Rough Seas at SPSP

G4- Further Roughness at SPSP

G5- YET Further Rough Weather at SPSP

G6- Finally Calm Seas at SPSP

G7- The NOc Prof W Besnard Seen from SPSP

G8- View of the Light House at SPSP

G9- Hard Work Transporting at SPSP

G10- A Line Was Installed at SPSP

Commander Adilson, (left).Paulo (walking). Principal Scientist Afranio (right)

G11- Flags of USP and Noc Prof W Besnard on the Light House at SPSP

G12-View of the Light House at SPSP

Thales and Afranio on Board the Besnard

G13- The Newly Installed Wind Station at Saint Peter´s and Saint Paul´s Rocks

Gilberto Sarti Inspects its Operation

Preliminary Oceanic Results

- **1)- FGGE and GATE analyses suggest the occurrence of bursts and depletions of Nutrients along the Equatorial Atlantic belt.**

- **2)-Based on GATE (winter) and FGGE (summer), T ,S ,Nutrients Si,Ni, Ph and O2 data series, local and seasonal invariants (constants) were firstly estimated for the Western Equatorial Atlantic.**

- **3) – Theoretical and spectral analyses (only frequencies) of currents at 33 W indicated the occurrence of meridional components with periods from 3.6 to 2.4 cy/day and zonal components with frequencies ranging from 3.3, 2.6 and 2.2 cy/day, all of them apparently related to wind action over the entire equatorial area .**

- **4) - Tidal analyses of Inverted Echo Sounders (IES) data showed the occurrence of internal waves of tidal origin, as indicated by pronounced diurnal, semidiurnal, third and non linear fourth, diurnal components.**

- **5) – Analysis by the periodogramme, the smouthed auto-covariance function, and the maximum entropy methods were applied to GATE and FGGE mean temperature data series built from several series of the undercurrent layer, showed diurnal, semidiurnal and non linear fourth, fifth and sixth diurnal spectral bands, also related to internal waves. The analyses showed also a long period oscillation of nearly 15 days associated to the undercurrent meandering along the equatorial line.**

- **6) – The first visit of an University Oceanographic Ship to SPSP had the aim of installing there a pressure and wind measuring station, which was done very successfully . Apart from that the entire FGGE experiment and visit to SPSP gave , most of all, the opportunity to participate with many scientists from various countries, in the first global investigations of the "unknowns" of the weather variability and also a glimpse on the secrets of the birth and preservation of life in the Planet Earth.**

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