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TROPICAL OCEANS-GLOBAL ATMOSPHERE (TOGA) EXPERIMENT PLANNING FOR THE BRAZILIAN PARTICIPATION IN TOGA GLOBAL CLIMATE PROGRAM

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14. Abstract/Notes

The main goal of the Tropical Oceans-Global Atmosphere Experiment (TOGA) is to study the interannual variability of the coupled ocean-atmosphere system and its impact upon global climate. TOGA is supposed to take a decade to be completed starting in January, 1985, and Brazil is among the participant nations. This work was prepared by the Ad Hoc Brazilian TOGA Committee presented at the TOGA conference, held in Paris, September, 1984. It contains the preliminary Brazilian intentions and needs within the framework in TOGA. It includes: oceanographic and atmospheric data collection and storage, oceanic and atmospheric modeling, and research priorities.

15. Remarks

(*) Ad Hoc Brazilian TOGA Committee.

Paper presented at the TOGA Conference, UNESCO, Paris, 17-21, September, 1984.

## 1. INTRODUCTION

There has been a growing body of evidences suggesting that the tropical oceans affect the global atmospheric circulation in time scales which range from months to decades. It is widely recognized that interannual events in the Tropics are caused by ocean - atmosphere interactions. Both statistical and modelling studies have linked SST anomalies in the tropical oceans to anomalous atmospheric circulations. Moura and Shukla (1981) have shown that SST anomalies in the Tropical Atlantic are correlated to drought occurrences in Northeast Brazil. It is also known that El Niño episodes cause a dramatic impact upon the South America western countries due to negative effects on the fishing industry and also to droughts and floods. The unusually strong 1982-83 El Niño affected the climate of distant points all over the world and most of South America. It has possibly caused the floods in Southern Brazil, droughts in the Amazon and Northeast Brazil, in addition to excessive rainfall in coastal Peru and Ecuador.

A region constantly affected by tropical Atlantic interannual variability is the drought-prone Northeast Brazil, where three or more droughts may occur within a decade. Moura and Shukla (1981) have shown that such droughts are linked to the simultaneous occurrence of positive SST anomalies north of Brazil (near $15^{o}N$, $45^{o}W$) and negative SST east of Brazil (centered approximately at $5^{o}S$, $25^{o}W$ and $15^{o}S$, $5^{o}W$) (Figure 1). They have suggested a mechanism of ITCZ strengthening associated with warmer-than-normal waters to the north and subsidence over the colder water in South Atlantic and in Northeast Brazil and adjacent ocean. This subsiding air, in turn, would cause a decrease in humid convection and precipitation. Recent observational studies (Nobre and Moura, 1984) have shown that for extremely dry years in Northeast Brazil, teleconnection patterns often appear between the tropical atmosphere and higher latitudes. These patterns are already evident several months before the March-April rainy season, notably in December (Figure 2a). It is remarkable that for very wet years these teleconnection patterns also show up, but with their phase inverted with respect to the dry years (Figure 2b). This important result demonstra

tes that the interannual variability of the Tropical Atlantic is not a localized phenomenon and northeast droughts are regional manifestation of planetary-scale phenomena (Moura and Kagano, 1983).

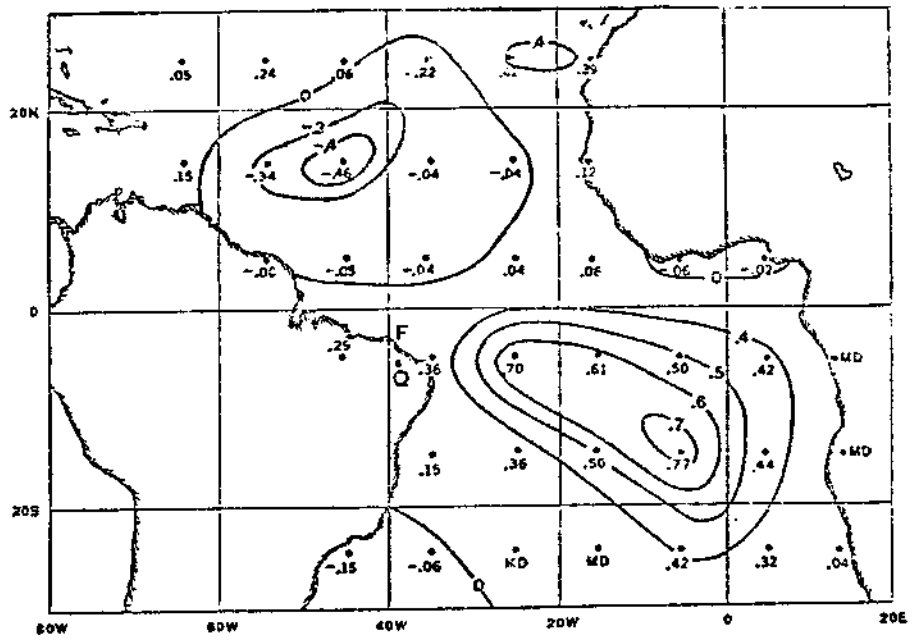



Fig. 1 - Correlation coefficients between March SST anomalies in the Atlantic and the normalized average March-May precipitation for Fortaleza and Quixeramobim.

SOURCE: Moura and Shukla (1981).

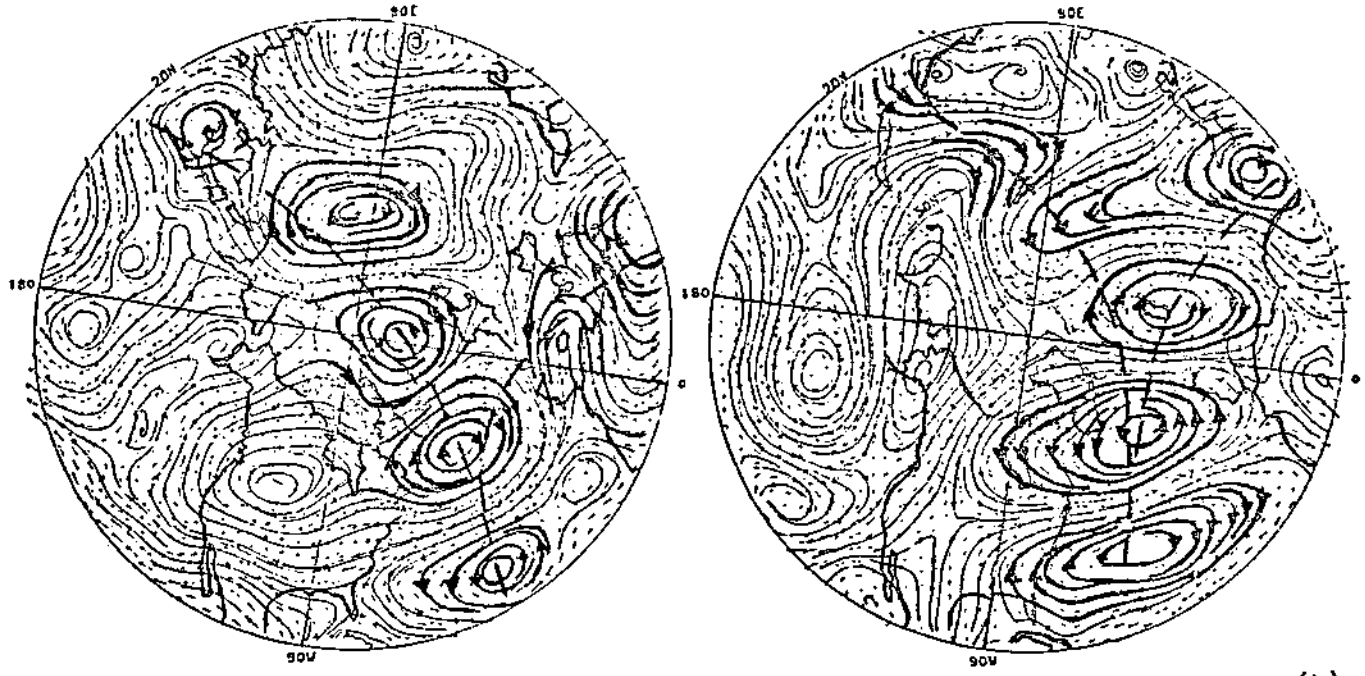



Fig. 2 - Average 200mb circulation deviations for the Northern Hemisphere. (a) Composite of dry years in Northeast Brazil (Dec. 1969, Dec. 1975, Dec. 1979 and Nov. 1971). (b) Composite of wet years in Northeast Brazil (Dec. 1963, Dec. 1972 and Jan. 1974).

SOURCE: Nobre and Moura (1984).

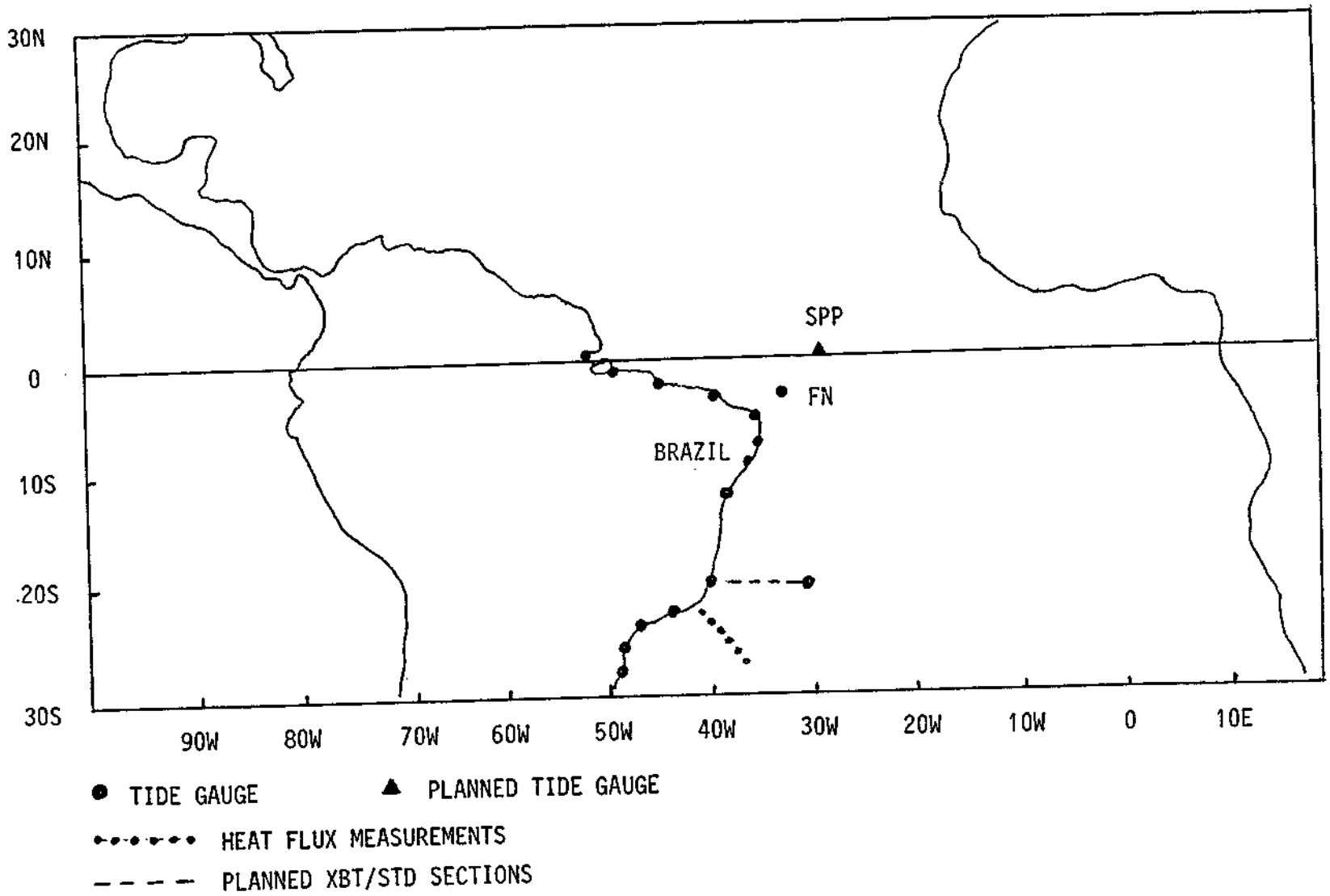
The 1982-83 El Niño event is probably the strongest in this century. Eastern equatorial Pacific SST's were up to 10°C above normal near the South American coast and they persisted for several months. Convection was greatly increased over this region, providing an intense and deep heat source for the tropical atmosphere through condensational heat release. Probably this anomalous Eastern Pacific heat source affected climate and weather over Brazil in two distinct ways: Firstly, through an anomalous Walker cell with ascending motion over the heat source and subsidence over neighboring regions, including Central and Northern Amazon and Northeast Brazil. That could explain the severe 1983 Northeast Brazil drought and the rather unusual dry spell in Amazon during January and February 1983, where many stations reported precipitation

as low as 50% of the climatological values for those months. Secondly, this anomalous heat source probably affected the climate of Brazil indirectly, that is, the interaction of the heat source with the Southern Hemisphere winter subtropical jet stream resulted in jet stream intensification. The faster jet over Brazil may have caused the blocking episode observed in late June and early July 1983 in South America. Due to this blocking situation, cold fronts remained stationary over Southern Brazil, Northern Argentina and Paraguay, causing extensive floods with devastating consequences for the regional economies and populations.

## 2. REQUIREMENTS FOR BRAZIL PARTICIPATION IN TOGA

### 2.1 - OCEANOGRAPHIC DATA

- Sea-level gauges in coastal stations, and in Fernando de Noronha, Trindade and St. Peter and St. Paul Rocks.
- Utilization of drifting buoys transmitting real time data via satellite to be used in continuous monitoring of Tropical Atlantic conditions. One of the critical points of Brazilian interest in TOGA is to determine areas in the Tropical Atlantic in which ocean conditions present high correlations with climatic fluctuation over Brazil, particularly those related to the Northeast Brazil rainfall anomaly. Also it would be desirable to determine which oceanographic and meteorological parameters should be measured in these "centers of action". Once these areas are determined, they would be continuously monitored to aid in medium-range (months) climatic forecasting.
- Cruises by Brazilian oceanographic vessels to participate in specific data gathering missions, either independently or jointly, with oceanographic vessels of other TOGA participating countries.
- XBT transects or, if possible, oceanographic stations with STD, from the Brazilian coast to Trindade Island made regularly by Brazilian ships which supply the island station (frequency: once every two months). Such data would be of great scientific interest, primarily to study aspects related to the Brazil current.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SPP
FN
BRAZIL
TIDE GAUGE
PLANNED TIDE GAUGE
HEAT FLUX MEASUREMENTS
PLANNED XBT/STD SECTIONS

. The country must be prepared to receive and make full use of the products of oceanographic satellites to be launched in the near future.

## 2.2 - OCEANOGRAPHIC DATA CENTER

. It is intended that oceanographic data collected by Brazil during TOGA will be processed and stored in a national data center; then the data will be exchanged with the international data centers which will be established for TOGA.

. It is highly desirable to obtain SEQUAL, FOCAL (and Sections) data sets which describe seasonal variations for the tropical Atlantic, as well as historical records to be kept in the national data center as an aid to ocean-climate interaction studies.

## 2.3 - OCEANOGRAPHIC MODELLING

. A whole hierarchy of oceanic models should be developed starting from simple, one-dimensional ones and progressing towards complex ocean-atmosphere coupled models. Data sets collected during TOGA will be important to test and validate the models. An important aspect of oceanic modelling is to study interannual SST variations in Tropical Atlantic and Pacific forced by the wind stress at the ocean surface. In addition, several features of the Brazil current such as its separation from the coast during some periods may be studied with models validated with the available data sets.

## 2.4 - METEOROLOGICAL DATA

. It is necessary to characterize all atmospheric variables associated with a given fluctuation in the oceanic upper layer. To date only temperature, surface winds and humidity are measured. To determine how SST anomalies affect the atmosphere is of particular importance to Brazil. Do positive SST anomalies indeed become deep sources? If that is the case, how does this transfer mecha

nism operate? Would these heat sources be important in the observed persistence of SST anomalies? Geostationary satellite data will certainly be very useful for such studies.

. Over the continent upper air soundings of the atmosphere should be made twice a day. This frequency should be increased during special observing periods. The upper air data from Fernando de Noronha and Trindade Islands, as well as from Northeast Brazil and Amazon, and also surface data from the country's synoptic network are especially important.

. Operational algorithms should be implemented to extract automatically meteorological information from satellite data. That would also include vertical temperature profiles (TOVS and VAS).

. All Brazilian ships in oceanographic cruises should launch radiosondes twice a day, at synoptic times, in addition to surface observations.

. The number of ASDAR systems on board transoceanic airline carriers should be increased in order to enhance upper air observations over the oceans.

## 2.5 - METEOROLOGICAL DATA CENTER

. All meteorological data will be kept in national data centers. Researchers should have quick access to processed data. These data centers should also store surface and upper air data, historical records needed for meteorological research, nobably within the scope of TOGA.

## 2.6 - ATMOSPHERIC MODELLING

. The development of numerical models for climate studies should be continued. Data sets collected during TOGA should be used to test and validate such models. The development of models to test the

Northeast Brazil climate's sensitivity to SST variations both in the Tropical Atlantic and in the Pacific is particularly important to Brazil.

## 3. RESEARCH PRIORITIES

The Brazilian participation in TOGA will be accomplished through the development of research programs by Brazilian institutions independently or jointly with foreign institutions. These programs must be directed to fulfil TOGA's objectives, that is, to deal with the tropical oceans and the global atmosphere as a coupled system. The results of these programs should provide physical knowledge on medium and long-range climate prediction (months and years).

### 3.1 - INTERANNUAL, SEASONAL AND MONTHLY ATMOSPHERIC VARIABILITY

- Anomalous atmospheric circulations (teleconnection patterns) over the Atlantic and Pacific and their relations to rainfall anomalies in Brazil, particularly in Northeast Brazil and Amazon.
- El Niño/Southern Oscillation phenomena and their relation to circulation anomalies over Brazil: a) episodes of anomalous subsidence over Amazon and Northeast; b) interactions between anomalous heat sources over the equatorial Pacific and Southern Hemisphere subtropical jet stream.
- Characterization of the mean seasonal cycle of atmospheric circulation over Amazon and Northeast Brazil.
- Relation between tropical SST anomalies, primarily the Pacific, and the occurrence of atmospheric blocking episodes in subtropical and middle latitudes.
- Interannual variability of ITCZ intensity and mean position and rainfall over northern Northeast Brazil.
- Processes involving the transformation of SST anomalies in the tropical oceans into anomalous, deep, atmospheric heat sources.

. Seasonal and interannual variations in trade wind impulses and instability lines over Northern Brazil coastal regions.

. Influence of extra-tropical, synoptic-scale, weather systems on the tropical circulation.

## 3.2 - OCEANIC VARIABILITY

### 3.2.1 - ATLANTIC OCEAN VARIABILITY

. SST variability as a result of oceanographic and meteorological forcing.

. Variability of the coastal circulation along the Brazilian coast as a response to synoptic-scale atmospheric circulation variations.

. Factors responsible for the appearance of SST anomalies.

. Variability of upper ocean heat storage.

### 3.2.2 - PACIFIC OCEAN VARIABILITY

Although logistical difficulties would impair an effective Brazilian participation in oceanographic research in the Pacific, it is very important for Brazil to join in international efforts due to the recognized influence of that ocean on the country's climate.

. SST variability as a result of oceanographic and meteorological forcing.

. Variability of upper ocean heat storage.

. El Niño/Southern Oscillation studies.

## 3.3 - VARIABILITY OF THE COUPLED OCEAN-ATMOSPHERE SYSTEM

. Studies of atmospheric response to large-scale oceanic circulation variations making use of observations and numerical models.

. Parameterization of humidity and momentum fluxes to be used in numerical modelling.

. Climatic studies utilizing CGM's with realistic temporal and spatial distributions of SST.

. Development and validation of coupled ocean-atmosphere models to be used in climate simulations studies.

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