INPE-253/P-001

SATELLITE REMOTE HYDROMETEOROLOGICAL EXPERIMENT
A PROPOSAL SUBMITTED TO THE
U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FOR THE NIMBUS-F MISSION, TWERLE
BY THE
INSTITUTO DE PESQUISAS ESPACIAIS (INPE), BRAZIL

I - TECHNICAL SECTION

This proposal is in the form of a final review draft. Mistakes have been detected in the text, which however do not affect the basic character of the proposal.

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PRESIDÊNCIA DA REPÚBLICA
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INSTITUTO DE PESQUISAS ESPACIAIS
São José dos Campos - Estado de S. Paulo - Brasil

October 6, 1972

Ref.:C.1119-DG/72

To
National Aeronautics and Space Administration
Office of International Affairs
Washington, D.C. 20546
U.S.A.

Dear Sir,

We are submitting with this our proposal for participation in the TWERLE experiment (Nimbus F Mission) according to your Memo. Change 43 of 23 March 1972. We have met the requirements specified on item III-6 of NHB 8030.1A, whenever our proposal characteristics allowed. If our proposal is approved we anticipate that many government agencies and universities will profit from the experiment.

Sincerely yours,

Fernando de Mendonça
General Director

RVC/sag

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3 - TECHNICAL SECTION

3.1 - Stations

3.1.1 - Introduction

Fixed platforms will be utilized containing the sensing and transmitting equipment. Each station will handle the outputs of 4 sensors which convert physical parameters into electric signals. These signals are amplified, digitized, multiplexed and together with a series of housekeeping information phase modulate a VHF carrier. Each station is composed basically of 4 main parts, as follows:

i) Sensors;

ii) Sensors/Transmitter input interface;

iii) Antenna System;

iv) Power Supply;

3.1.2 - Sensors

3.1.2.1 - Hydrological Sensors

a) Water Level - a straingage bulge is used. Gages are attached to a steel membrane which divides a enclosing chamber into

two parts, one opening to the air through a duct and another connected to the water.

Variations of static pressure inside the chamber, which acts as a tranquilizer as measured by membrane deformation gives an indirect measure of the water column above. Fig. A gives a shetch of the sensor.

b) Evaporation - An apparatus similar to that in the previous item is used. In this case a much more sensitive membrane is employed, with convenient protection against precipitation water penetration.

c) Rainfall - Same as items above, with convenient modifications.

d) River discharge - Any conventional water current mater with electrical output will be used, like the weather measure F581 (this with water level and river cross section gives flow-rate).

3.1.2.2 - Meteorological Sensors

a) Pressure - An apparatus like the weather measure B211 - LVDT-C Microbars - graph with electrical output will be used.

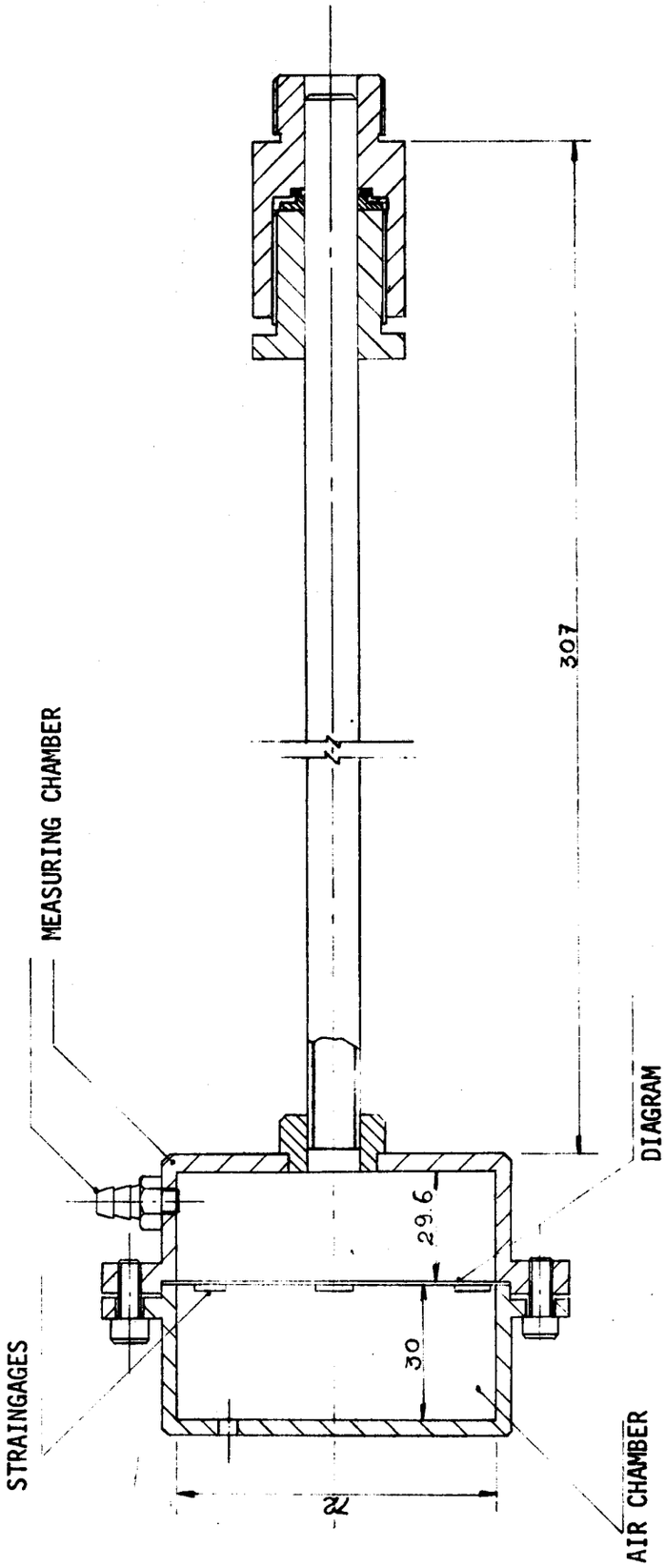
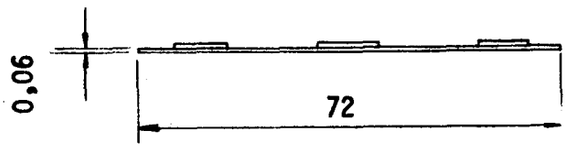
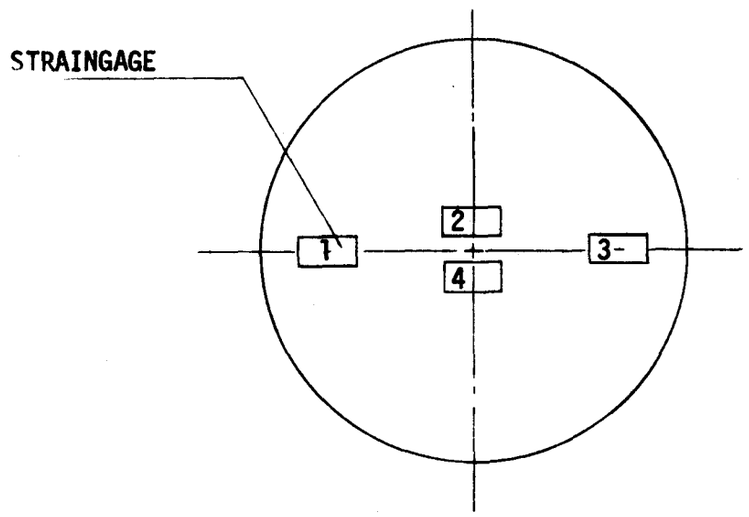
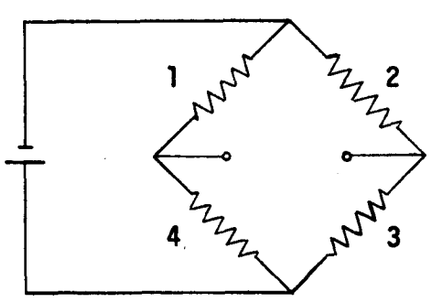

MEASURING CHAMBER
STRAINGAGES
DIAGRAM
AIR CHAMBER
307
29.6
30
27

FIG. A-1







STRAINGAGE BRIDGE CIRCUIT

Shihkoh
g. RESIST. 120,0 Ω (± 0,3%)

FIG. A-2

b) Temperature - A digital termometer with a convenient analog output like the DIGITEC 501. Digital termometer will be employed.

c) Rainfall, and

d) Evaporation - Same as b) & c) in 3.2.1.

3.1.3 - Interface

Is basically composed of:

a) Operational Amplifier - to provide a convenient signal level from sensors.

b) Low pass filter - to eliminate undesired fluctuations of the parameter being measured.

3.1.4 - Transmitter

Consists of:

a) Sequential Switch - receives analogic signals from the interface of the 4 sensors and, in a convenient sequence, send them to an analogic-to-digital converter.

b) Analog-to-Digital Converter - Converts analog signals received from the switch at a 100 bits/sec rate. For each codified channel corresponds a 8 bit train. Each full minute converter furnishes a 32 bit train corresponding to 320 msec.

c) Word Generator - generates a 14 bit - 140 msec word. These 14 bits contain information regarding the station like identification, etc.

d) Mode Generator - generates a 2 bit - 20 msec word. (In our case there are 4 channels per station so that a single bit group, like 00 or 01 may be used, incorporated into the identification generator. Thus, identification generator would provide also mode bits).

e) Frame Synchronization Generator - generates a 8 bit digital word with 80 msec.It carries information needed for synchronization of the frame demultiplexing at the receiving end.

f) Time multiplexer - it is a logical device coupling analog-to-digital converter output with all other generators output in a sequential mode to get the final 1 sec frame. It is mainly composed of a command pulse generating circuit controlling a sequential adder. The generator also provides inhibiting pulses to inhibit transmission during 59 sec out of each 60 sec allowing for only one 1 sec frame to

be transmitted each minute.

g) Master Clock - generates a 100 Hz rectangular wave which serves as command and reference for the previously described circuits. This frequency is sent through multiplexer immediately after the acquisition carrier time during 80 msec. It will be used, a posteriori,to synchronize the decodifying and demultiplexer master clock.

h) Carrier Generator - Is basically a crystal oscillator. Crystal is kept in an oven, in series resonance, 5th overtone. Natural frequency is 66 866 667.00 Hz. A triple frequency is obtained from this in a tripler circuit with nominal output of 200.6MHz.

i) Phase Modulator - Frame digital signal phase modulates the 200.6MHz carrier with a maximum total phase shift of 30^{o}. Modulator is of RC type with a varicap:An electronic switch is at the modulator output, triggered by a pulse from command pulse generator subunit, with a function of disconnecting modulator output from the adjoining unit input during the 59 sec. the transmitter is off.

j) Frequency doubler - exciter - consists of a frequency taking the carrier to its nominal 401.2 MHz output and phase shift to its nominal value of 60^{o}, and exciter providing necessary power to conveniently drive the power amplifier.

k) Power Amplifier - Provides output required at the antenna in 401.2 MHz. By considering a safety margin, an estimated 2W output power for the transmitter is specified.

3.1.5 - Antenna System

Antenna is of spinal feeder with ground reflector type to ensure adequate radiation pattern. It is main characteristics will be:

input impedance: 50Ω

radiation pattern: nearly hemispheric

fo: 401.2 MHz

direction of maximum gain: vertical (90^{o})

3.1.6 - Power Supply

Station may work both on line 110/220V, 60Hz or on battery 12V,DC.

Power consumption: during stand-by, only frequency doubler and exciter are deativated. In battery operation this will give a high average power consumption. To minimize power drain during stand-by a detailed study will be performed so that circuits can be turned off with exception of the carrier generator and master clock which must be continuously.

Fig. B shows a block diagram of the station system.

3.2 - Measurements

3.2.1 - Introduction

It is inttended to have the followin stations:

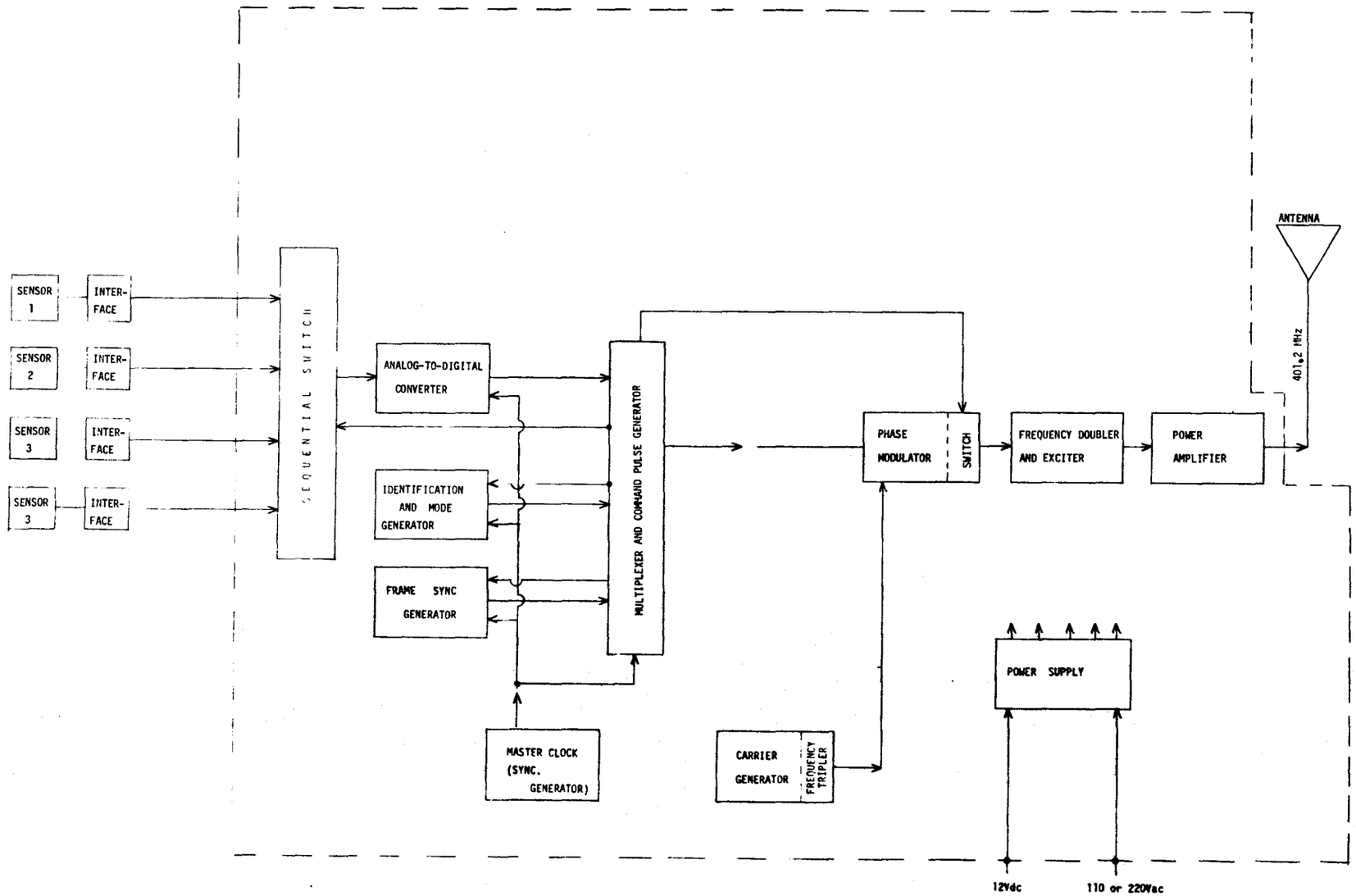
a) A fixed platform in the Amazon River region upstream of Manaus, about 150Km;

b) One floating buoy at location 12ºS and 30ºW;

c) 25 fixed platforms in the state of São Paulo carrying hydrological measurements.

The antecipated products from the 25 fixed platforms in the State São Paulo, consisting of information on rainfall, evaporation, water level and river discharge at selected points, will be of direct use, not only for the hydrological systems in the state of São Paulo, but also in forming accurate estimates of the water resources in the state.

SIMPLIFIED BLOCK DIAGRAM FOR STATIONS - TWERLE



Platforms in (a) and (b) will supply data regarding pressure, temperature, rainfall and evaporation. When combined with surface information from the reporting observatories, their analyses are expected to throw light on as yet non understood equatorial systems with a particular focus on data sparse regions. The sites for both (a) and (b) above, which be in the data gaps, have been chosen from this point of view.

3.2.2 - Objectives and Major Requirements

Meteorological information of hydrological utility over the important state of São Paulo is at present available only through a few reporting stations. In order to assess the areal distribution of the parameters of hydrological interest, it is necessary to augment the number of stations from which daily reports will be available through a quick transmission channel. In fact this group of stations will perform a pilot experiment aimed mainly to size the desirable operational network to be stablished in the state. After considering the fact that we have an important river basin in the state of São Paulo, it is felt that an additional grid of 25 river points will serve the purpose of hydrological estimatives. The river valleys and the 25 stations are being selected under these criteria so as to acomplish the characteristics of an experimental and pilot network. In considering the locations of each of these 25 stations the potential importance of each of the water water sources for hydrological operations has been kept in view.

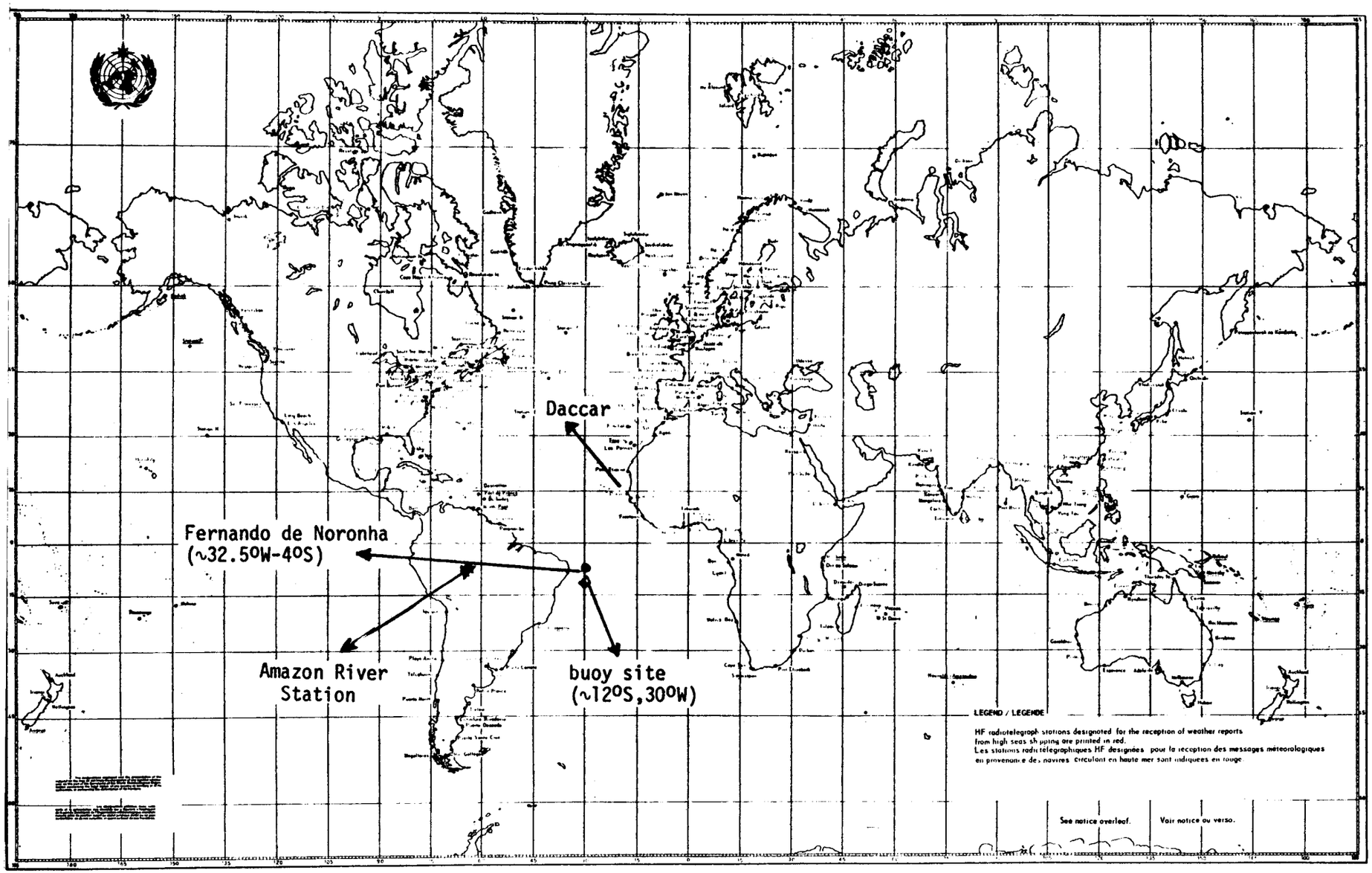
Further, the fact that the data from these points will serve to initiate rainfall and run-off studies over the limited area of the state of São Paulo has been taken into account. Platforms in this group will measure through the allotted four channels the four parameters, namely: rainfall, evaporation, water level and river discharge. This choice has been made from the point of view of hydrological information though it could be probably desirable to obtain temperature and humidity values as well, the fact that only 4 channels for transmission are available leaves no choice as the temperature and relative humidity are considered less important than the parameters named above.

The objective of setting up a floating buoy in the approximate location of $12^{o}S$, $30^{o}W$ is to gather surface meteorological data at a point not directly accessible in the shipping lanes. Experience in setting up such buoys has shown that their best location, from the information point of view, should be at the center of the data gap.

Previous experience with this was obtained for instance, during the International Indian Ocean Expedition when a buoy (named Normandy) was situated approximately midway between Vishakapatnan and Andaman Island (in the approximate geometrical centre of Bay of Bengal) in the data gap, providing information utilized in the analysis of charts. The daily data which were available for more than one year

enabled some important modifications of the analysis which were made without those data. In particular, mention may be made of pre-monsoon and post-monsoon situations where a moving low-pressure area could definitively be traced in a much better manner with just one piece of information supplied by Normandy.

As far as Brasil is concerned, the Island of Fernando de Noronha ($\sim 4^{o}S$, $32.5^{o}W$) supplies data for an otherwise data sparse region. There is a wide data gap in the Atlantic equatorial region from that point to Dakar. The proposed location of the buoy is shown in Fig. C along with the locations of Dakar and Fernando de Noronha. It will be noticed that the buoy lies in the approximate centre of the data gap, considering the equatorial region as whole. It needs hardly be over emphasized that the meteorological behavior of the Equatorial region in the Atlantic and East Pacific oceans is quite different from the behavior over the Indian Ocean, as far as seasonal variations are concerned. There is for example, the fact that the Indian Ocean have monsoons, while the regions above mentioned do not. Even with informations supplied from one point (as located on Fig. C), it would be possible to obtain information regarding questions like whether there is a cross equatorial flow in equatorial regions of the Atlantic. The buoy should transmit in the allotted 4 channels pressure, temperature, rainfall and evaporation. The inclusion of wind at the buoy level would be very valuable and perhaps it should be number 3 in its priority.


Daccar
Fernando de Noronha
(~32.5°W-4°S)
Amazon River
Station
buoy site
(~12°S,30°W)
LEGEND / LEGENDE
HF radiotelegraph stations designated for the reception of weather reports from high seas shipping are printed in red.
Les stations radiotélégraphiques HF désignées pour la réception des messages météorologiques en provenance de navires circulant en haute mer sont indiquées en rouge.
See notice overleaf.
Voir notice au verso.

However, since it would require 2 channels to transmit the required informations, it was decided to opt for the rainfall and evaporation combinations. The information about rainfall in conjunction with satellite pictures would be more useful than the velocity information about wind.

Regarding the platform in the Amazonic Region we have the following considerations: The location of routine observing centres in Brasil shows a rather wide data gap between Manaus in Brasil and the observing stations in Equador and Peru, in the equatorial region. Taking this into account the suggested site of the plaftorm in the Amazonic region 15 approximately 150km upstream of Manaus. In proposing this the existence of stations north of the Equator and south of the proposed location has also been considered. Since their joint observation would permit a detailed examination in the North-South plane. The four parameters to be measured are pressure, temperature, rainfall and evaporation. Again the surface wind had to be eliminated for reasons already given in the preceding paragraph. Two important equatorial problems which deserve particular mention are sizes of large scale equatorial eddies and their morphology and, of course, the problem concerned with cross equatorial transport, if any. In making an attempt at obtaining quantitative information regarding these problems one is often forced just because of lack of data in data sparse region to use analysis of spectral type over

limited regions. Since the extension of the analysis made over a limited region to a wider region is always quantionable, a similar analysis attempted even with one or two stations in the data gap regions would have a greater validity.

Hence for purposes concerned with the problems named above the location of the buoy over the sea region and the platform over the Amazon Region would be of great value. Naturally the question of increasing information points to 4 or 6 had to be considered and concensus was obtained that the cost/benefit factor would limit the choice to two platforms only.

Major requirements are:

1) Instrumentation - ahead described;

2) Ranges for the elements were obtained mainly from an examination of the Brazilian National Department of Meteorology files and also from other hydrological and meteorological related agencies.

For pressure, temperature, evaporation and rainfall the averages and extremes for Manaus and Belem have been examined to determine the ranges to be set for the instruments for the Amazon platform and the buoy. The 24 hourly maximum values for the Amazonic regions over a period of 30 years is 200mm, and for the evaporation

130mm. The ranges of pressure and temperature in that region are 998-1025 mb and 18-38^{o}C respectively. Considering a safety margin the following ranges were stablished for the instruments on the platform and buoy:

A) Pressure: 990 - 1030 mb

B) Temperature: 15 - 40^{o}C

C) Rainfall: 250 mm

D) Evaporation: 150 mm

For the hydrological stations, six sites data were examined to set the ranges for evaporation and rainfall measurements. The 24 hourly maximum obtained for the State of São Paulo were:

A) Rainfall: 400 mm

B) Evaporation: 300 mm

A 10% safety margin on the higher side should serve as a good range considering that extremes of rainfall and evaporation have been evaluated for a period of about 30 years.

For water level and river discharge 3 different locations were choosen where those parameters are estimated to attain extreme values:

1) Paranã River, at Porto Jupiã:

$\theta_M \simeq$ 27620 m^3/s, $h_M \simeq$ 11,80m

$\theta_m \simeq$ 1320 m^3/s, $h_m \simeq$ -0,4 m

2) Paranã River, at Porto Guaria

$\theta_M \simeq$ 34900 m^3/s, $h_M \simeq$ 3,16 m

$\theta_m \simeq$ 2890 m^3/s, $h_m \simeq$ 0,32 m

3) Tibagi River, at Porto Iataizinho

$\theta_M \simeq$ 6032 m^3/s, $h_M \simeq$ 8,04 m

$\theta_m \simeq$ 28 m^3/s, $h_m \simeq$ 1,12 m

3.2.3 - Background and Justification

3.2.3.1 - Hydrologic Stations

The river data over potentially important regions have generally been small in number and certainly nor suficient to permit simple tasks, like determination of safety factors in the design of hydrological equipments and evaluation of extremes. Also, knowledge of parameters leading to a better understanding of a hydrological system regime is mandatory for correct choice and adequate use of water resources . Such data have a direct significance also for rainfall and run-off studies. They are of definite help in deep water location studies, which are of particular importance in many regions in the state of São Paulo.

The feasibility of using earth based platforms for such measurements in conjunction with satellites has already been demonstrated, also allowing information from sites of difficult access to be available at a single analysing centre within a short period of time. Registration of water levels is of great importance as far as flood-forecasting is concerned. During long spells of rain the question even assumes an immediacy as was the case during the last week of August, 1972 when a continuous spell of rain in the far south of Brasil gave rise to near flood conditions in Rio Grande do Sul. At that particular time great anxieties were expressed about possible conditions over the southern part of the state of São Paulo. It is hence imperative to gather the useful data for river level and discharge over a number of points, with an accuracy and reliability greater than those usually provided by mannual observations. Once that there are 5 main river basins in the state of São Paulo, a 25 stations (5 stations per basin) network was considered to the adequate for the measurements envisaged. In some cases we have more than one station in the same river. This is justified by the consideration that with such multiple measurements it would be possible to determine the point of maximum utilization.

3.2.3.2 - Buoy and Stationary Platform on the Amazonic Region

Rather wide data gap exists in the equatorial regions both over the continental regions and over the oceans. The importance of the flow in the equatorial regions, on the otherhand, is almost

inversely proportional to the number of observations. To mention one aspect, the large scale eddies in the equatorial regions serve partially to transport masses from southern to northern hemispheres or vice-versa in Indian Ocean. The symmetrical disturbances over the oceans obviously cannot contribute to a net transport in a given season. It is of some importance to find out some information regarding the size and symmetry of such disturbances. Over the Western Atlantic where monsoons in the strict sense of the word do not exist, the equatorial disturbances and the waves in the easterlies do exist. Since the primary reason for the transport of air from one to the other hemisphere is the unbalance of the masses of the two, it follows that the enclosing of such a wide gap in the equatorial and tropical regions might contribute to a better understanding of the dynamics of the equatorial flow. A number of existing controversies requires for their discriminations some data over the euqatorial region. The customary method of filling the data gaps with speculative analysis is to this extent not only subjective, but also non-discriminative. Each piece of information in this context has a great value at least in the sense that the information can consistent only with one group of hypothesis rather than another. Two particular areas may be state in this context.

1) Organized cloud clusters and their movement in equatorial regions:

In the Pacific, an examination of satellite cloud photographs has shown that moving cloud clusters of approximately 2^{o} radius exist in an organized form, which can also be traced in the pressure fields. Even a casual look at the equatorial region in the satellite cloud photographs shows such entities to exist over the South American equatorial regions.

It would be hence possible to study the pressure and precipitation fields associated with such systems.

2) The size of equatorial eddies:

It is known that closed circulations stridding both sides of the equator exist and have pressure distributions which have received particular attention from the South-African meteorologists. Their surface counterparts can be studied through the pressure and temperature fields on a synoptic basis and also on a statistical basis through an examination of cross-correlation coeficients, etc.

It is certainly not possible to assert that two more pieces of surface data will throw complete light on such questions. But if the two additional surface data are from the centers of data gaps, their capacity to give synoptically and statistically accepted results cannot be under-estimated.

3.2.4 - Approach

In a concise and general form, the investigation is mainly intended to provide data for:

a) A consistent and broad study of the hydrological and hydrological related system in the state of São Paulo.

b) A better understanding of the up-to-date poorly known South-American equatorial region in what concerns the characteristics of the main meteorological systems that give rise to the weather in that area.

A third and indirect objective, of technological nature, is the improvement of existing skill and development of new ideas in the construction of physical sensors and highly realiable electronic systems.

The buoy station, will probably give greater dividends, in this respect.

Investigation has started with the definition of the areas to be surveyed, needs and main objectives as states.

Also station elements of the system were defined. Next step in the technical sense will be development of circuitry, assembly of parts, laboratory tests, field tests and operation.

Scientific part will continue up to the stations operation with studies regarding improvement of methods for data utilization and models to be tested with measurements results. After stations start transmitting,data processing and archieval will be performed and conclusions prepared after a minimum amount of results become available.

In a few sites, according to possibilities, ground truth measurements are intended to test the operation of the stations.

A three month test period using 2 or 3 selected stations in the network at the beginning of the experiment, is also intended with specific purpose of compiling statistics bearing on the accuracy of the observatories.

A supporting study will be done in connection to a revision in the parameter's ranges as soon as more detailed data in punched card form becomes available. (This punching is being done presently by INPE for the National Department of Meteorology).

An auxiliary study will be the brightness pattern of clouds over the State of São Paulo in relation to the subsequent

rainfall, taking into account the movement of clouds.

Performance Criteria

Acceptable precisions for the parameters, as received for processing are:

1) Rainfall 1 mm;
2) Temperature 0,25°C;
3) Pressure 0,1 mb;
4) Evaporation 1.0 mm;
5) Water level 10cm;
6) Flow rate: 5% (?) - (to be confirmed)

A success will result if:

a) The verifier stations (with ground truth measurements) show acceptable consistency;

b) Information has no serious gap of more than 5 days; and

c) At least 75% of the hydrological station network report daily results.

3.2.5 - Data Reduction and Analysis

All data received will be put on punched cards for

immediate processing. Programs will be ready by the time the first bunch of results arrives so that analysis with regard to accomplish what was previously described will be done. A B6700 processing facility is available at INPE and will be used for this purpose. A data file giving surface data up to 1970 for more than 300 stations all over the country will also be availabe at that time and will be used in conjunction with the satellite meteorological data cards to generate information as required by the research envisaged.

3.2.6 - Results expected

The main results expected in general are:

a) Detailed evaluation of the potential of each one of the main water resources in the state of São Paulo.

b) Average meso-scale structure and other statistical information from a study of the 4 parameters distributions over the 25 station.

c) Information regarding the extreme sizes of equatorial eddies.

d) Better delineation of precipitation vs. evaporation meridional profiles.

e) Better evaluation of equatorial transport and harmonic components over the equatorial regions.

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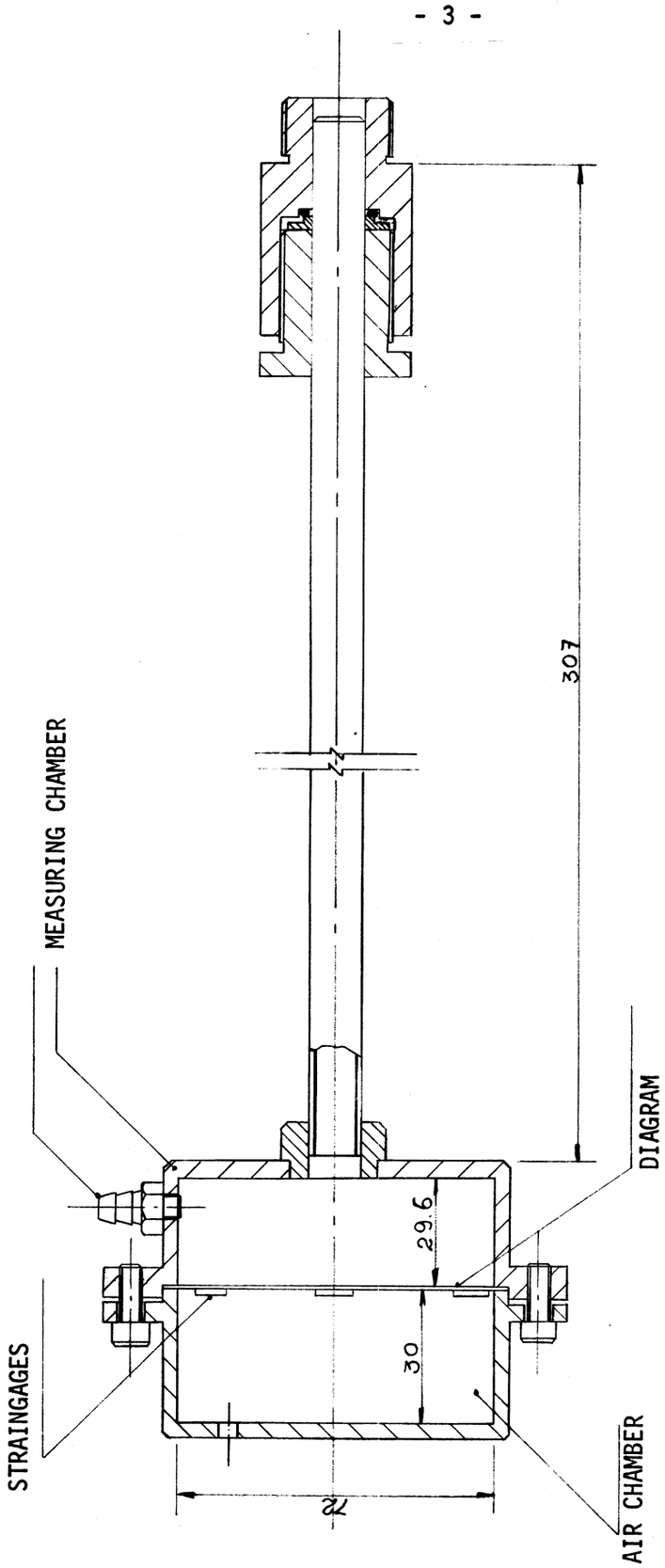
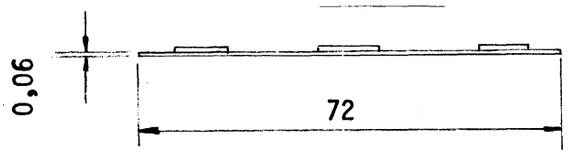
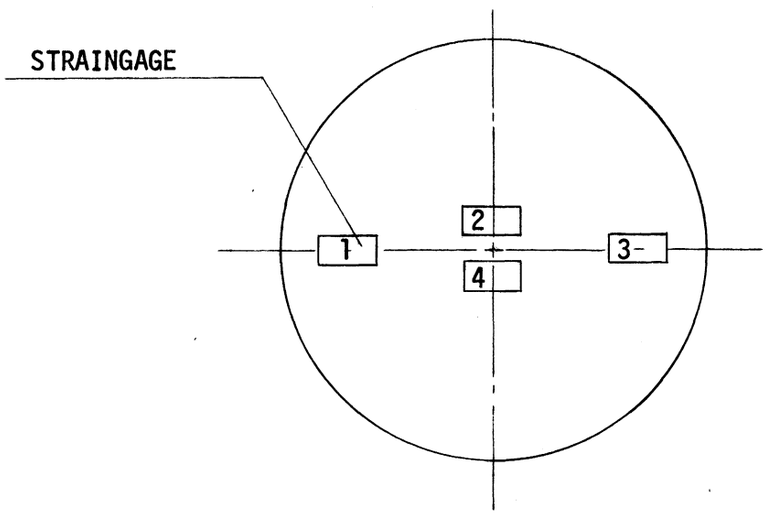
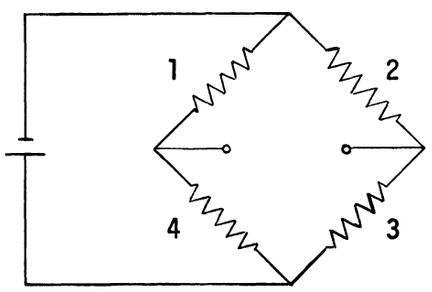

MEASURING CHAMBER
STRAINGAGES
DIAGRAM
AIR CHAMBER
307
29.6
30
82

FIG. A-1







STRAINGAGE BRIDGE CIRCUIT

Shihkoh

g. RESIST. 120,0 Ω (± 0,3%)

FIG. A-2

b) Temperature - A digital termometer with a convenient analog output like the DIGITEC 501. Digital termometer will be employed.

c) Rainfall, and

d) Evaporation - Same as b) & c) in 3.2.1.

3.1.3 - Interface

Is basically composed of:

a) Operational Amplifier - to provide a convenient signal level from sensors.

b) Low pass filter - to eliminate undesired fluctuations of the parameter being measured.

3.1.4 - Transmitter

Consists of:

a) Sequential Switch - receives analogic signals from the interface of the 4 sensors and, in a convenient sequence, send them to an analogic-to-digital converter.

b) Analog-to-Digital Converter - Converts analog signals received from the switch at a 100 bits/sec rate. For each codified channel corresponds a 8 bit train. Each full minute converter furnishes a 32 bit train corresponding to 320 msec.

c) Word Generator - generates a 14 bit - 140 msec word. These 14 bits contain information regarding the station like identification, etc.

d) Mode Generator - generates a 2 bit - 20 msec word. (In our case there are 4 channels per station so that a single bit group, like 00 or 01 may be used, incorporated into the identification generator. Thus, identification generator would provide also mode bits).

e) Frame Synchronization Generator - generates a 8 bit digital word with 80 msec. It carries information needed for synchronization of the frame demultiplexing at the receiving end.

f) Time multiplexer - it is a logical device coupling analog-to-digital converter output with all other generators output in a sequential mode to get the final 1 sec frame. It is mainly composed of a command pulse generating circuit controlling a sequential adder. The generator also provides inhibiting pulses to inhibit transmission during 59 sec out of each 60 sec allowing for only one 1 sec frame to

be transmitted each minute.

g) Master Clock - generates a 100 Hz rectangular wave which serves as command and reference for the previously described circuits. This frequency is sent through multiplexer immediately after the acquisition carrier time during 80 msec. It will be used, a posteriori, to synchronize the decodifying and demultiplexer master clock.

h) Carrier Generator - Is basically a crystal oscillator. Crystal is kept in an oven, in series resonance, 5th overtone. Natural frequency is 66 866 667.00 Hz. A triple frequency is obtained from this in a tripler circuit with nominal output of 200.6MHz.

i) Phase Modulator - Frame digital signal phase modulates the 200.6MHz carrier with a maximum total phase shift of 30^{o}. Modulator is of RC type with a varicap: An electronic switch is at the modulator output, triggered by a pulse from command pulse generator subunit, with a function of disconnecting modulator output from the adjoining unit input during the 59 sec. the transmitter is off.

j) Frequency doubler - exciter - consists of a frequency taking the carrier to its nominal 401.2 MHz output and phase shift to its nominal value of 60^{o}, and exciter providing necessary power to conveniently drive the power amplifier.

k) Power Amplifier - Provides output required at the antenna in 401.2 MHz. By considering a safety margin, an estimated 2W output power for the transmitter is specified.

3.1.5 - Antenna System

Antenna is of spinal feeder with ground reflector type to ensure adequate radiation pattern. It is main characteristics will be:

input impedance: 50Ω

radiation pattern: nearly hemispheric

fo: 401.2 MHz

direction of maximum gain: vertical (90^{o})

3.1.6 - Power Supply

Station may work both on line 110/220V, 60Hz or on battery 12V. DC.

Power consumption: during stand-by, only frequency doubler and exciter are deativated. In battery operation this will give a high average power consumption. To minimize power drain during stand-by a detailed study will be performed so that circuits can be turned off with exception of the carrier generator and master clock which must be continuously.

Fig. B shows a block diagram of the station system.

3.2 - Measurements

3.2.1 - Introduction

It is inttended to have the followin stations:

a) A fixed platform in the Amazon River region upstream of Manaus, about 150Km;

b) One floating buoy at location 12ºS and 30ºW;

c) 25 fixed platforms in the state of São Paulo carrying hydrological measurements.

The antecipated products from the 25 fixed platforms in the State São Paulo, consisting of information on rainfall, evaporation, water level and river discharge at selected points, will be of direct use, not only for the hydrological systems in the state of São Paulo, but also in forming accurate estimates of the water resources in the state.

Platforms in (a) and (b) will supply data regarding pressure, temperature, rainfall and evaporation. When combined with surface information from the reporting observatories, their analyses are expected to throw light on as yet non understood equatorial systems with a particular focus on data sparse regions. The sites for both (a) and (b) above, which be in the data gaps, have been chosen from this point of view.

3.2.2 - Objectives and Major Requirements

Meteorological information of hydrological utility over the important state of São Paulo is at present available only through a few reporting stations. In order to assess the areal distribution of the parameters of hydrological interest, it is necessary to augment the number of stations from which daily reports will be available through a quick transmission channel. In fact this group of stations will perform a pilot experiment aimed mainly to size the desirable operational network to be stablished in the state. After considering the fact that we have an important river basin in the state of São Paulo, it is felt that an additional grid of 25 river points will serve the purpose of hydrological estimatives. The river valleys and the 25 stations are being selected under these criteria so as to acomplish the characteristics of an experimental and pilot network. In considering the locations of each of these 25 stations the potential importance of each of the water water sources for hydrological operations has been kept in view.

Further, the fact that the data from these points will serve to initiate rainfall and run-off studies over the limited area of the state of São Paulo has been taken into account. Platforms in this group will measure through the allotted four channels the four parameters, namely: rainfall, evaporation, water level and river discharge. This choice has been made from the point of view of hydrological information though it could be probably desirable to obtain temperature and humidity values as well, the fact that only 4 channels for transmission are available leaves no choice as the temperature and relative humidity are considered less important than the parameters named above.

The objective of setting up a floating buoy in the approximate location of $12^{o}S$, $30^{o}W$ is to gather surface meteorological data at a point not directly accessible in the shipping lanes. Experience in setting up such buoys has shown that their best location, from the information point of view, should be at the center of the data gap.

Previous experience with this was obtained for instance, during the International Indian Ocean Expedition when a buoy (named Normandy) was situated approximately midway between Vishakapatnan and Andaman Island (in the approximate geometrical centre of Bay of Bengal) in the data gap, providing information utilized in the analysis of charts. The daily data which were available for more than one year

enabled some important modifications of the analysis which were made without those data. In particular, mention may be made of pre-monsoon and post-monsoon situations where a moving low-pressure area could definitively be traced in a much better manner with just one piece of information supplied by Normandy.

As far as Brasil is concerned, the Island of Fernando de Noronha ($\sim 4^{o}S$, $32.5^{o}W$) supplies data for an otherwise data sparse region. There is a wide data gap in the Atlantic equatorial region from that point to Dakar. The proposed location of the buoy is shown in Fig. C along with the locations of Dakar and Fernando de Noronha. It will be noticed that the buoy lies in the approximate centre of the data gap, considering the equatorial region as whole. It needs hardly be over emphasized that the meteorological behavior of the Equatorial region in the Atlantic and East Pacific oceans is quite different from the behavior over the Indian Ocean, as far as seasonal variations are concerned. There is for example, the fact that the Indian Ocean have monsoons, while the regions above mentioned do not. Even with informations supplied from one point (as located on Fig. C), it would be possible to obtain information regarding questions like whether there is a cross equatorial flow in equatorial regions of the Atlantic. The buoy should transmit in the allotted 4 channels pressure, temperature, rainfall and evaporation. The inclusion of wind at the buoy level would be very valuable and perhaps it should be number 3 in its priority.

However, since it would require 2 channels to transmit the required informations, it was decided to opt for the rainfall and evaporation combinations. The information about rainfall in conjunction with satellite pictures would be more useful than the velocity information about wind.

Regarding the platform in the Amazonic Region we have the following considerations: The location of routine observing centres in Brasil shows a rather wide data gap between Manaus in Brasil and the observing stations in Equador and Peru, in the equatorial region. Taking this into account the suggested site of the plaftorm in the Amazonic region 15 approximately 150km upstream of Manaus. In proposing this the existence of stations north of the Equator and south of the proposed location has also been considered. Since their joint observation would permit a detailed examination in the North-South plane. The four parameters to be measured are pressure, temperature, rainfall and evaporation. Again the surface wind had to be eliminated for reasons already given in the preceding paragraph. Two important equatorial problems which deserve particular mention are sizes of large scale equatorial eddies and their morphology and, of course, the problem concerned with cross equatorial transport, if any. In making an attempt at obtaining quantitative information regarding these problems one is often forced just because of lack of data in data sparse region to use analysis of spectral type over

limited regions. Since the extension of the analysis made over a limited region to a wider region is always quantionable, a similar analysis attempted even with one or two stations in the data gap regions would have a greater validity.

Hence for purposes concerned with the problems named above the location of the buoy over the sea region and the platform over the Amazon Region would be of great value. Naturally the question of increasing information points to 4 or 6 had to be considered and concensus was obtained that the cost/benefit factor would limit the choice to two platforms only.

Major requirements are:

1) Instrumentation - ahead described;

2) Ranges for the elements were obtained mainly from an examination of the Brazilian National Department of Meteorology files and also from other hydrological and meteorological related agencies.

For pressure, temperature, evaporation and rainfall the averages and extremes for Manaus and Belem have been examined to determine the ranges to be set for the instruments for the Amazon platform and the buoy. The 24 hourly maximum values for the Amazonic regions over a period of 30 years is 200mm, and for the evaporation

130mm. The ranges of pressure and temperature in that region are 998-1025 mb and 18-38^{o}C respectively. Considering a safety margin the following ranges were stablished for the instruments on the platform and buoy:

A) Pressure: 990 - 1030 mb

B) Temperature: 15 - 40^{o}C

C) Rainfall: 250 mm

D) Evaporation: 150 mm

For the hydrological stations, six sites data were examined to set the ranges for evaporation and rainfall measurements. The 24 hourly maximum obtained for the State of São Paulo were:

A) Rainfall: 400 mm

B) Evaporation: 300 mm

A 10% safety margin on the higher side should serve as a good range considering that extremes of rainfall and evaporation have been evaluated for a period of about 30 years.

For water level and river discharge 3 different locations were choosen where those parameters are estimated to attain extreme values:

1) Paranã River, at Porto Jupiã:

$\theta_M \simeq$ 27620 m^3/s, $h_M \simeq$ 11,80m

$\theta_m \simeq$ 1320 m^3/s, $h_m \simeq$ -0,4 m

2) Paranã River, at Porto Guaria

$\theta_M \simeq$ 34900 m^3/s, $h_M \simeq$ 3,16 m

$\theta_m \simeq$ 2890 m^3/s, $h_m \simeq$ 0,32 m

3) Tibagi River, at Porto Iataizinho

$\theta_M \simeq$ 6032 m^3/s, $h_M \simeq$ 8,04 m

$\theta_m \simeq$ 28 m^3/s, $h_m \simeq$ 1,12 m

3.2.3 - Background and Justification

3.2.3.1 - Hydrologic Stations

The river data over potentially important regions have generally been small in number and certainly nor suficient to permit simple tasks, like determination of safety factors in the design of hydrological equipments and evaluation of extremes. Also, knowledge of parameters leading to a better understanding of a hydrological system regime is mandatory for correct choice and adequate use of water resources . Such data have a direct significance also for rainfall and run-off studies. They are of definite help in deep water location studies, which are of particular importance in many regions in the state of São Paulo.

The feasibility of using earth based platforms for such measurements in conjunction with satellites has already been demonstrated, also allowing information from sites of difficult access to be available at a single analysing centre within a short period of time. Registration of water levels is of great importance as far as flood-forecasting is concerned. During long spells of rain the question even assumes an immediacy as was the case during the last week of August, 1972 when a continuous spell of rain in the far south of Brasil gave rise to near flood conditions in Rio Grande do Sul. At that particular time great anxieties were expressed about possible conditions over the southern part of the state of São Paulo. It is hence imperative to gather the useful data for river level and discharge over a number of points, with an accuracy and reliability greater than those usually provided by mannual observations. Once that there are 5 main river basins in the state of São Paulo, a 25 stations (5 stations per basin) network was considered to the adequate for the measurements envisaged. In some cases we have more than one station in the same river. This is justified by the consideration that with such multiple measurements it would be possible to determine the point of maximum utilization.

3.2.3.2 - Buoy and Stationary Platform on the Amazonic Region

Rather wide data gap exists in the equatorial regions both over the continental regions and over the oceans. The importance of the flow in the equatorial regions, on the otherhand, is almost

inversely proportional to the number of observations. To mention one aspect, the large scale eddies in the equatorial regions serve partially to transport masses from southern to northern hemispheres or vice-versa in Indian Ocean. The symmetrical disturbances over the oceans obviously cannot contribute to a net transport in a given season. It is of some importance to find out some information regarding the size and symmetry of such disturbances. Over the Western Atlantic where monsoons in the strict sense of the word do not exist, the equatorial disturbances and the waves in the easterlies do exist. Since the primary reason for the transport of air from one to the other hemisphere is the unbalance of the masses of the two, it follows that the enclosing of such a wide gap in the equatorial and tropical regions might contribute to a better understanding of the dynamics of the equatorial flow. A number of existing controversies requires for their discriminations some data over the euqatorial region. The customary method of filling the data gaps with speculative analysis is to this extent not only subjective, but also non-discriminative. Each piece of information in this context has a great value at least in the sense that the information can consistent only with one group of hypothesis rather than another. Two particular areas may be state in this context.

1) Organized cloud clusters and their movement in equatorial regions:

In the Pacific, an examination of satellite cloud photographs has shown that moving cloud clusters of approximately 2^{o} radius exist in an organized form, which can also be traced in the pressure fields. Even a casual look at the equatorial region in the satellite cloud photographs shows such entities to exist over the South American equatorial regions.

It would be hence possible to study the pressure and precipitation fields associated with such systems.

2) The size of equatorial eddies:

It is known that closed circulations stridding both sides of the equator exist and have pressure distributions which have received particular attention from the South-African meteorologists. Their surface counterparts can be studied through the pressure and temperature fields on a synoptic basis and also on a statistical basis through an examination of cross-correlation coeficients, etc.

It is certainly not possible to assert that two more pieces of surface data will throw complete light on such questions. But if the two additional surface data are from the centers of data gaps, their capacity to give synoptically and statistically accepted results cannot be under-estimated.

3.2.4 - Approach

In a concise and general form, the investigation is mainly intended to provide data for:

a) A consistent and broad study of the hydrological and hydrological related system in the state of São Paulo.

b) A better understanding of the up-to-date poorly known South-American equatorial region in what concerns the characteristics of the main meteorological systems that give rise to the weather in that area.

A third and indirect objective, of technological nature, is the improvement of existing skill and development of new ideas in the construction of physical sensors and highly realiable electronic systems.

The buoy station, will probably give greater dividends, in this respect.

Investigation has started with the definition of the areas to be surveyed, needs and main objectives as states.

Also station elements of the system were defined. Next step in the technical sense will be development of circuitry, assembly of parts, laboratory tests, field tests and operation.

Scientific part will continue up to the stations operation with studies regarding improvement of methods for data utilization and models to be tested with measurements results. After stations start transmitting, data processing and archieval will be performed and conclusions prepared after a minimum amount of results become available.

In a few sites, according to possibilities, ground truth measurements are intended to test the operation of the stations.

A three month test period using 2 or 3 selected stations in the network at the beginning of the experiment, is also intended with specific purpose of compiling statistics bearing on the accuracy of the observatories.

A supporting study will be done in connection to a revision in the parameter's ranges as soon as more detailed data in punched card form becomes available. (This punching is being done presently by INPE for the National Department of Meteorology).

An auxiliary study will be the brightness pattern of clouds over the State of São Paulo in relation to the subsequent

rainfall, taking into account the movement of clouds.

Performance Criteria

Acceptable precisions for the parameters, as received for processing are:

1) Rainfall 1 mm;
2) Temperature 0,25^{o}C;
3) Pressure 0,1 mb;
4) Evaporation 1.0 mm;
5) Water level 10cm;
6) Flow rate: 5% (?) - (to be confirmed)

A success will result if:

a) The verifier stations (with ground truth measurements) show acceptable consistency;

b) Information has no serious gap of more than 5 days; and

c) At least 75% of the hydrological station network report daily results.

3.2.5 - Data Reduction and Analysis

All data received will be put on punched cards for

immediate processing. Programs will be ready by the time the first bunch of results arrives so that analysis with regard to accomplish what was previously described will be done. A B6700 processing facility is available at INPE and will be used for this purpose. A data file giving surface data up to 1970 for more than 300 stations all over the country will also be availabe at that time and will be used in conjunction with the satellite meteorological data cards to generate information as required by the research envisaged.

3.2.6 - Results expected

The main results expected in general are:

a) Detailed evaluation of the potential of each one of the main water resources in the state of São Paulo.

b) Average meso-scale structure and other statistical information from a study of the 4 parameters distributions over the 25 station.

c) Information regarding the extreme sizes of equatorial eddies.

d) Better delineation of precipitation vs. evaporation meridional profiles.

e) Better evaluation of equatorial transport and harmonic components over the equatorial regions.

5 - MANAGEMENT SECTION

5.1 - Work Plan

5.1.1 - Program Management

The whole project will be developed under the scheme of the INPE's systems analysis group. Thus, a matrix organization will be stablished, and a tentative Organogram is depicted in Fig. D.

A monthly progress report will be required from each functional group leader, monthly meetings will be held by the program leader and principal investigator and the development of the project will be continuously monitored by the PCP Group (Program Planning and Control). Personnel in charge of carrying out the management is presented in Fig. D.

5.1.2 - Resumes of Personnel

(Enter here curriculum vitae of all personnel directly involved).

CURRICULUM VITAE

Nome completo: Luis Audaz
Nacionalidade: Espanhola Estado Civil: casado
Nascimento: 03.08.25
Campo de interesse Principal: Meteorologia

RESUMO ESCOLAR DA FORMAÇÃO PROFISSIONAL

Instituição	Conclusão	Título	Especialidade
Universidade de Madrid	1948	M.S.	Meteorologia
Universidade de Chicago	1954	M.S.	Meteorologia

EXPERIÊNCIA PROFISSIONAL

Serviço Meteor.Nacional	Meteorologista
Instituto de Tecnologia	Invest.associado
Observ.Monte Washington	Diretor Cient.
Departamento de Meteorologia	Chefe das Estações Polo Sul e Byrd
Universidade do Novo México	Pesquisador e Diretor do Projeto OMM/ Minter/MA, no NE do Brasil

TRABALHOS PUBLICADOS

1 - Meteorology for Assistant Meteorologists (Text)
(IN collaboration) Madrid, Spain,1951
2 - Study of the Cnary Islands - Puerto Rico Air Route
Puerto Rico Air Route Research Report for Iberia Airlines, 1953.
3 - Rainfall Noarmals for Puerto Rico Through 1950
Research Report, University of Puerto Rico, Rio Piedras, 1954.

4 - Las Operaciones Combinadas y el Meteorologo
Revista Aeronautica, Madrid, Spain, 1954.

5 - An Airborne Cloud Drop Impactor
(with D. P. Keily) Scientific Report, nº 3; Mass. Inst. of Technology Cambridge, Massachusetts, 1957.

6 - A Brief Survey of Airborne Raindrop Collection Methods
(with S. G. Millen, D. P. Kiley) Scientific Report, nº 4.
Mass. Inst. of Technology, Cambridge, Massachusetts, 1957.

7 - A Study of Precipitation Systems by Means of Snow Crystals, Synoptic and Radar Analysis.
(with J. P. Kuettner and R. J. Bourcher) Final Scientific Report to US Army Signal Corps Engineering Laboratories, Mount Washington Observatory, 1958.

8 - Atmospheric Ozone Above La Paz (Bolivia)
Resumen de Labores, Laboratorio Fisica Cosmica, Chacaltaya, Universidad San Andres, La Paz, 1964.

9 - Atmospheric Ozone in Antartica
Journal of Geophysical Research, vol. 70, nº 8, (pp. 1767-1777), 1965.

10 - The Summer 1957-1958 at the South Pole. An Example of an Unusual Meteorological Event Recorded by the Oxygen Isotope Ratios in the Firn.
(with E. Picciotto and S. Doutsch) Earth and Planetary Science Letters, vol. 1 (pp. 202-204), 1966.

11 - Surface Air Radioactivity and Ozone at Amundsen-Soctt Station ($90^{o}S$) Antarctica
Nature, vol. 215, nº 5102 (pp. 722-723), 1967.

12 - On a Relationship Between the Air Temperature and Oxygen Isotrope Ratio of Snow and Firn in the South Pole Region
(with S. Deutsch) Earth and Planetary Science Letters, vol. 3 (pp. 267-274), 1967.

13 - La Antardida Hoy.
Real Sociedad Geografica, Serie B, nº 435, Madrid, Spain, 1964.

14 - El Continente Vestido de Blanco
Revista Aeronautica y Espacial Argentina. Buenos Aires, Argentina, 1965.

15 - Flux Measurements of Atmospheric Ozone over Land and Water
(Journal of Geophysical Research) 74, 6943-6946, 1969.

16 - Turbulent Transport Near the Ground as Determined from Measurements of the Ozone Flux and the Ozone Gradient
(with Victor H. Regener) (Journal of Geophysical Research) 74, 6935-6942, 1969.

17 - A Partial Characterization of the Rainfall Regime of Brazil
Pub. Tecnica nº 4 SUDENE/W.M.O. N.E. Brazil.

18 - Meteorological Conditions Accompanying the Alagoas (Brazil) Floods of March 10-20, 1969.
Bub. Tecnica nº 5 SUDENE/W.M.O. N.E. Brazil Project (in print)

19 - Some Meteorological Aspects of Nor the Istern Brazil's Rain Regime in Reference to the "Sēca" Phenomenon.
Pub. Ter. nº. 10 SUDENE/W.M.O. N.E. Brazil Project (in print).

CURRICULUM VITAE

Nome completo: Heloisa Moreira Torres Nunes
Nacionalidade: Brasileira Estado civil: casada
Nascimento: 29/12/1942 - Uberlândia - MG
Campo de Interesse Principal: Meteorologia

RESUMO ESCOLAR DA FORMAÇÃO PROFISSIONAL

Instituição	Conclusão	Título	Especialidade
U.F.R.J.	1968	B.S.	Meteorologia
Florida State University	1971	M.S.	Meteorologia
Instituto de Pesquisas Espaciais	1969		Space Science

EXPERIÊNCIA PROFISSIONAL

Escola Técnica "Celso Suckow da Fonseca"	1968	Professor
Departamento de Meteorologia Ministério da Agricultura	1968	Pesquisador
Comissão Nacional de Atividade Espaciais - CNAE	1969	Pesquisador
Instituto de Pesquisas Espaciais	1972	Pesquisador-Professor

TRABALHOS PUBLICADOS

1 - Brazilian Participation in the Exametnet Program, LAFE-95, CNAE, 1969.

2 - Mean wind circulation and Associated Weather Producing mechanism over northeast Brazil, Seminar, August 1971, Department of Meteorology, Florida State University.

3 - Frequency of cloud type over South America east of The Andes Mountains, Dean G.A., Nunes, G.S.S., Nunes, H.M.T., Florida State University, INPRESS., 1971.

4 - The Three Dimentional wind structure over South America and Associated rainfall over Brazil, Dean G.A., Florida State University, LAFE 164, INPE - 1971.

5 - Programa de Sensores Remotos - Fase C - Plano da missão da aeronave incluindo adendo com resultados, LAFE 88, INPE - junho 1969.

6 - On the existence of possible disturbances over a selected area in Brazil, (to be communicated for publication in Journal Met. Soc. Japan).

CURRICULUM VITAE

Nome completo: Getulio Soriano de Souza Nunes
Nacionalidade: Brasileira Estado Civil: casado
Nascimento: 22/06/1941 - Teófilo Otoni - MG
Campo de Interesse Principal: Meteorologia

RESUMO ESCOLAR DA FORMAÇÃO PROFISSIONAL

Instituição	Conclusão	Título	Especialidade
U.F.R.J.	1968	B.S.	Meteorologia
Florida State University	1969		Ciências-Espaciais
Florida State University	1970		Meteorologia

EXPERIÊNCIA PROFISSIONAL

Escola Técnica "Celso Suclow da Fonseca" Departamento de Meteorologia	1968	Professor
Departamento de Meteorologia	1969	Previsor de Tempo e Pesquisador
Comissão Nacional de Pesquisas Espaciais - CNAE	1969	Pesquisador
Florida State University	1970	Assistentship
Instituto de Pesquisas Espacias	1972	Pesquisador

TRABALHOS PUBLICADOS

1 - "Distribuição de radiação na região da Amazônia" - a ser publicado.
2 - "Brazilian Participation in the EXAMETNET Program " - LAFE-95 - Meeting held at Mar del Plata, Argentina, 1969.
3 - "The Tri-dimensional wind structure over south America and associated rainfall over Brasil", Florida State University (Participação).
4 - "Frequency of cloud type over South America east of Andes mountain" Florida State University, in press.

CURRICULUM VITAE

Nome completo: Rosalvo Pinheiro dos Santos
Nacionalidade: Brasileira Estado Civil: casado
Nascimento: 13/07/1919 - Alagoas - AL
Campo de Interesse Principal:

RESUMO ESCOLAR DA FORMAÇÃO PROFISSIONAL

Instituição	Conclusão	Título	Especialidade
Faculdade Filosofia - U.B.	1967	Bacharel	Física-Meteorologia
Fac. de Educação - U.F.R.J.	1968	Licenc.	Física

EXPERIÊNCIA PROFISSIONAL

Departamento de Meteorologia (M.A.)	1966	Bolsista
Escritório de Meteorologia M. Agricultura	1968	Meteorologista
Instituto de Pesquisas Espaciais	1969	Pesquisador

TRABALHOS PUBLICADOS

1 - "Brazilian Participation in the EXAMETNET Program" - 1969, LAFE-95.
2 - "Brazilian Participation in the EXAMETNET Program" - 1970, LAFE-137.
3 - "Comportamento da Baixa Atmosfera na áreas de teste do Projeto SERE" em Julho de 1969.
4 - "Curso de Treinamento para Operadores de Estações APT" - LAFE-167, Julho de 1971.

Obs.: Todos realizados em grupo.

CURRICULUM VITAE

Nome completo: Roberto Vicente Calheiros
Nacionalidade: Brasileira Estado Civil: casado
Nascimento: 25/08/1941 - Bauru - SP
Campo de Interesse Principal: Eletrônica

RESUMO ESCOLAR DA FORMAÇÃO PROFISSIONAL

Instituição	Conclusão	Título	Especialidade
Instituto Tecnológico de Aeronáutica	1965	B.S	Eletrônica
Instituto Tecnológico de Aeronáutica	1970	M.S.	Interdepartamental

EXPERIÊNCIA PROFISSIONAL

Instituto de Pesquisas Espaciais	1966	Pesquisador
Fundação Educacional de Bauru	1969	Pesquisador
Instituto de Pesquisas Espaciais	1969	Bolsista

TRABALHOS PUBLICADOS

1 - Sistema de tropo-difusão para a Amazônia, 1965.
2 - Projeto de Sistema de Microondas cobrindo o litoral paulista com sistema de radar para proteção da costa, 1965.
3 - Array de 8 antenas IAGY com 20db fonte isotrópica para recepção do satélite geoestacionário Early-Bird, 1966.
4 - Estatística de cobertura de nuvens sobre o Brasil por meio de fotos de satélites meteorológicos e devisão do país em áreas sob o critério de qualidade para fotografias aéreas, 1968.
5 - Aplicação do Método de Monte Carlo para solução de integrais múltiplas da teoria de informação, 1969.

6 - Telecopiadora: dados meteorológicos por telefonia, ITA Engenharia, maio de 1972, vol. 3 nº 5.

7 - Demonstration of the intercontinental exchange of graphic meteorological data utilizing radioteotelephony and telecopies, Bulletin of the American Meteorological Society, vol. 52, nº 11, nov. 1971.

8 - A Note on some characteristics of the flow pattern in January and July over the subtropics of South American Continent, INPE RI-001/TT abril 1972 (em colaboração com V. Brahmananda Rao).

9 - Preliminary Report on Turbulence Studies at Bauru, INPE RI-002/TT maio 1972 (em colaboração com C.M.Dixit e T.V.Ramana Rao).

10 - Mountain waves over Andes: A comparison with meteorology satellite Pictures, a ser comunicado ao "Tellus" - Suécia (em cooperação com R.P.Sarker).

11 - Fotodeteção de sinais de vídeo, ITA Engenharia, maio 1972.

12 - A method for reproduction of meteorological satellite pictures(*) - aceito para publicação e apresentação nos proceedings, National Telecommunications Conference, IEE, Houston, Texas, U.S.A., dez 1972.

13 - Aplicação de fotodeteção de sinais de vídeo à reprodução de fotografias de satélites meteorológicos, aceito para publicação, ITA Engenharia, agosto 1972.

14 - Participação brasileira no Projeto EOLE, (utilização do satélite meteorológico francês EOLE), Relatório Preliminar, julho 1972.

15 - Estimativa de ventos na troposfera, na América do Sul, por meio de fotos de satélites meteorológicos, INPE relatório interno, março de 1971.

16 - Correlation between rainfall and cloud cover infrared from meteorological satellite pictures, (a ser comunicado), julho 1972.

17 - Análise estatística dos ventos de superfície em Bauru, INPE RI (em cooperação com C. M. Dixit), julho de 1972.

(*) Patente requerida.

CURRICULUM VITAE

Nome completo: Renê Antonio Novaes
Nacionalidade: Brasileira Estado Civil: casado
Nascimento: 23/06/37 - Caçapava - SP
Campo de interesse Principal: Economia

RESUMO ESCOLAR DA FORMAÇÃO PROFISSIONAL

Instituição	Conclusão	Título	Especialidade
Academia de Policia Militar de São Paulo	1962	P.M.	Infantaria
Fac. Economia de SJCampos	1966	B.S.	Economia
Universidade de São Paulo	1970	M.S.	Macroeconomia
Centro de Estudos "Almirante Vanderkolk"	1965	Téc.ens.	Ensino-Técnico

EXPERIÊNCIA PROFISSIONAL

Curso Vest.Delta "T" Taubaté	1965	Prof. de Matemática
Policia Militar-Ex. no Posto de Capitão	1968	Comand. de sub-unidade isolada
Assessoria Econômica ao "Grupo de Expansão Ind."Taubaté	1969	Economista
Faculdade de Economia do Sul de Minas-Itajubá	1970	Professor de MICRO ECONOMIA

TRABALHOS PUBLICADOS

1. Plano de Expansão Industrial de Taubaté, SP, Relatório Coletivo

CURRICULUM VITAE

Nome completo: Eve Eni Moreira Santos Cenzi
Nacionalidade: Brasileira Estado Civil: casada
Nascimento: 21/07/1944 - São João da Boa Vista - SP
Campo de interesse Principal: Economia

RESUMO ESCOLAR DA FORMAÇÃO PROFISSIONAL

Instituição	Conclusão	Título	Especialidade
Faculdade de Ciências Econômicas e Administativas do Vale do Paraiba	1968	Econom.	Economia

EXPERIÊNCIA PROFISSIONAL

ERICSSON DO BRASIL Com. & Ind.S.A.	1970	Auxiliar de Economista
Instituto de Pesquisas Espaciais	1971	PCP

TRABALHOS PUBLICADOS

1 - Estudo de Viabilidade de um Satélite para o Sistema Educacional Brasileiro, LAFE-165, 1971 - INPE.

5.1.3 - Performance schedule of the work plan

Tasks

a) Scientific	b) Technical	c) Management
1) Prepare bibliography and get maps for the choosen areas.	1) Study Memo.Change 43 NHB-8030.1A and prepare list of questions	1) Define coordination personnel.
2) Define basic network of stations, localisation of staions and parameters to be measured. Find measurement ranges.	2) Define sensors and adjust ranges	2) Stablish interface with PCP leader
3) Prepare models for test period, consistency analysis and success criteria.	3) Define station	3) Define all tasks and functional groups
4) Work out new theoretical models based on existing ones for hydrological and meteorological choosen areas, define degree of degradation due to lack of data, define specific tests for existing models	4) Develop each circuit. Prepare components list	4) Define operational personnel
5) Analyse data, test models, prepare final reports. Write document recommending for future actions	5) Prepare circuits and perform checks including variations with temperature and power supply.	5) Prepare organogram
	6) Assemble all parts (including sensors) and perform system test at laboratory check for stability. Modify if necessary.	6) Provide administrative support requirements

a) Scientific	b) Technical	c) Management
	7) Perform field tests	7) Prepare PERT Fluxograms
	8) Prepare final report and maintenance plan technical note	8) Check monthly progress report and hold monthly meetings.
		9) Take actions to compensate for delays, reschedule the program when necessary.
		10) Stablish contacts with other data users
		11) Prepare field operations.

5.1.4 - Facilities

5.1.4.1 - Already in existence

INPE's electronic and mechanic laboratories with its specialized personnel will be available, according to the schedule in the previous item, to build the stations and execute all performance tests. Also especialized maintenance will be provided. INPE's B6700 Computing facility will perform all data processing.

5.1.4.2 - New facilities

No new facilities are planned for this experiment. Those already in existence are considered to cover all needs.

see figs.

E —— Management partial chronograms

F —— Technical Development partial chronograms

G —— Scientific Development partial chronograms

Obs.:- All chronograms suppose eventual approval to the program will be given no later than Nov. 31st.