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Responsible author			
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UNITED STATES-BRAZIL JOINT COMMITTEE ON SPACE ACTIVITIES

FIRST DRAFT OF BRAZILIAN PROPOSALS

25-26 May 1983

Brasília

## CONTENTS

A - GEODYNAMICS .....	1
B - GLOBAL TROPOSPHERIC EXPERIMENT .....	2
C - COOPERATION IN BALLOON EXPERIMENTS .....	3
D - EXCHANGE OF SCIENTIFIC PERSONNEL .....	6
D.1 - INPE's proposal .....	6
D.2 - CTA's proposal .....	7
E - TECHNOLOGY UTILIZATION (TRANSFER OF TECHNOLOGY) .....	8
F - SEARCH AND RESCUE (SARSAT) .....	9
G - USE OF THE SPACE SHUTTLE .....	10
H - COOPERATION FOR THE USE OF GOES VERTICAL ATMOSPHERIC SOUNDER (VAS) .....	11
I - GOES-TYPE DATA COLLECTION PLATFORMS .....	13
J - USE OF LOW-ORBIT METEOROLOGICAL SATELLITES (TIROS-N) FOR ENVIRONMENTAL DATA COLLECTION (DCP) .....	14
K - PARTICIPATION IN THE LANDSAT PROGRAM .....	15
L - FUTURE ACTIVITIES USING REMOTE SENSING SATELLITES .....	16
M - COOPERATION IN THE RESEARCH OF ENVIRONMENTAL SATELLITE DATA APPLICATIONS .....	17
N - SATELLITE CONTROL AND OPERATION .....	18
O - SATELLITE INTEGRATION AND TESTING .....	19
P - TRAINING AND TECHNICAL ASSISTANCE .....	21
Q - SOLAR PHYSICS .....	22
R - RADIO - ASTRONOMY .....	23
S - RADIOMETRIC INSTRUMENTATION .....	24

## A - GEODYNAMICS

Scientific cooperation between U.S. and Brazil in this field has existed for many years.

A project was recently been approved by NASA to use the V.L.B.I. technique for tectonic plate research. The INPE's Itapetinga facilities are under consideration and, if the proposal is approved, it will receive a Mark III terminal and a hydrogen Maser. This project forecasts operations for several years, starting in 1984. Further technical details will be established by a NASA Principal Investigator expected to visit Brazil soon. This cooperation could be reinforced if INPE's researchers participated on workshops of the projects every six months at NASA/GSFC.

## B. GLOBAL TROPOSPHERIC EXPERIMENT

With regard to the Global Tropospheric Experiment (GTE) proposed by NASA, INPE could participate in the design of the experiment over Brazil, and in the sampling of gases, aerosols, and environmental parameters, as well as in the handling and analysis of the data.

INPE could also coordinate the involvement of researchers and the use of sampling and analysis instruments from various Brazilian research institutions with programs in atmospheric physics and chemistry.

In the case of the NCAR, INPE could participate in experiments to measure vertical profiles of gases and aerosols in regions of interest such as large urban centers, the Northeast region, the Amazon forest, the "Pantanal" (marshes) and others. Different gases could be sampled with airplanes and balloons with payloads made by the NCAR (Atmospheric Chemistry and Aeronomy Division - ACAD). These instruments could also be used to obtain concentration data of intense localized pollution sources in order to find correlations with multi-spectral data of the Landsat satellites.

About the current program with NOAA (Ozone Dobsonian spectrophotometry) and NASA (Electrochemical composition soundings), INPE could extend them to other regions of Brazil if additional equipment is provided.

## C - COOPERATION IN BALLOON EXPERIMENTS

INPE has collaborated in Astrophysics, Geophysics and air chemistry experiments onboard of balloons and aircraft over Brazilian territory. These experiments were conducted with groups belonging to NASA/Goddard Space Flight Center, NRL/Naval Research Laboratory; University of California/Space Laboratory and Lawrence Laboratory; University of New Hampshire/Physics Department; Princeton University/Physics Department; NCAR/National Center for Atmospheric Research - Air Quality Division and NSBF/National Scientific Balloon Facility.

CNPQ/INPE and NASA/NSBF would sign a Memorandum of Understanding on cooperation in Scientific Stratospheric balloon flights from Brazil (a similar MOU between CNPq/INPE and NSF/NSBF exists but is not valid anymore).

The proposal envisages launchings of balloons with U.S. payloads in Brazil with exclusive responsibility of NSBF and joint U.S. - Brazilian payloads with INPE/NSBF launch responsibility. Concerning the joint US-Brazil experiments, INPE held discussions with the respective U.S. laboratories and agreed to propose to NASA/NSBF to provide INPE with balloons and possible equipment (Launch, telemetry/telecommand); CNPq/INPE would provide then, the necessary support for the launchings in Brazil. Among the many collaborative proposals, the following are under consideration:

- PULSAR TELESCOPE (Collaboration with Prof. E.L. CHUPP/UNH)

To design and develop a gamma-ray telescope for studies concerning solar and stellar gamma-ray radiation with materials already existing in the Astrophysics Department of INPE and Physics Department of UNH, to be flown onboard of stratospheric balloon in March-April and October-November 1984 during the wind turn-around period in Brazil.

NASA/NSBF would provide:

- per diem for one INPE electronic engineer and one INPE researcher in the field for a two month period at New Hampshire for tests of the telescope.
- Two stratospheric balloons (11.6 MCF) for the telescope launches in Brazil.

CNPq/INPE would provide:

- expenses for stay and travel inside Brazil during balloon campaign for one electronic engineer and one scientist of UNH for a period of two months, and payment of all expenses involved in the balloon launch and rescue.
- PROJECT LONG DURATION FLIGHT IN SOUTHERN HEMISPHERE  
(Collaboration with Prof. Robert Lin, Space Science Laboratory-University of California).

To develop a simple x-ray telescope with approximate payload weight of 150 kg for solar and geophysical observations. The balloons expected to circle the southern hemisphere between 30 and 40 km would be launched from INPE's Balloon Launching Facility (Cachoeira Paulista) during the two first months of 1984 and 1985.

NASA/NSBF would provide:

- Two stratospheric balloons suitable for long duration flights around the world at an altitude of 30 to 40 km.
- Ground and on-board telemetry units and time of TDRSS satellite to relay the scientific data.
- The necessary telemetry experts and launch crew during the launching period.

CNPq/INPE would provide:

- All the infrastructure facilities and technicians for launching the balloons from Cachoeira Paulista or another airport (including other flights of NSBF's interest).
- To provide the data to interested U.S. scientists.

● PROJECT LONG DURATION "TURN-AROUND" FLIGHT IN CENTRAL BRASIL

To launch, in 1984, two stratospheric balloons with INPE's telescope GELI 1 for studies concerning gamma-ray emission lines from the galactic center. The launchings would be made in March-April 1984 during the turn-around period of winds at 40 km altitude with facilities available at Anápolis Air Force Base or the airport of Montes Claros, Minas Gerais.

NASA/NSBF would provide:

- Two stratospheric balloons of 11.6 MCF.
- Mobile telemetry station with PCM/FM facilities and two onboard telemetry/telecommand units.
- Technical personnel for launching and telemetry/telecommand operations.

CNPq/INPE would provide:

- All the available infrastructure including materials and personnel for launching U.S. payloads or from other countries desiring launches at the same period in the southern hemisphere, therefore reducing operational costs.



## D - EXCHANGE OF SCIENTIFIC PERSONNEL

### D.1 - INPE's PROPOSAL

INPE's proposal is to intensify exchange programs through existing and new programs. These should be settled between Brazil and U.S. in the following areas:

- 1 - Geophysics and Aeronomy.
- 2 - High Energy Astrophysics, Solar Physics and Radioastronomy.
- 3 - Materials for Space Applications.
- 4 - Plasma Physics.
- 5 - Meteorology Research and Applications.
- 6 - Chemistry of Propellents.
- 7 - Informatics and Computation Engineering.
- 8 - Remote Sensing Research and Applications.
- 9 - Large Space Programs Management.
- 10- Satellite Technology, Integration, Testing and Operation.

INPE should send to the U.S. not less than 60 men-month and not more than 120 men-month, every year, during a period of five years. Identical figures and conditions are valid for U.S. professionals regarding Brazil.

These programs would involve researchers and engineers of both countries. Salaries and travelling expenses should be paid by the sending country. Per diem expenses should be paid by the host country.

## D.2 - CTA's PROPOSAL

The Aeronautical Institute of Technology (ITA) is willing to start the program immediately in the following areas:

- Computer Engineering.
- Computational Aerodynamics.
- Software Engineering.
- Material Science.

ITA would give priority to the exchange of Professors or Researchers for a period of one year or more, both in Brazil and in the U.S.

In the area of Computer Engineering, Prof. Harry D. Huskey from the University of California, former president of the U.S. Association for Computing Machinery, should be consulted, whenever possible, as he has accepted to act on behalf of ITA in the U.S. to recruit professors in the above mentioned area. Prof. Huskey has a large experience with U.S. foreign exchange programs.

## E - TECHNOLOGY UTILIZATION (TRANSFER OF TECHNOLOGY)

In order to understand the transfer and diffusion of technology it is necessary to take into account specific points, which involve both hardware and software aspects. There are two approaches of interest, the technical-administrative approach and the economic one. The former includes among others typical maturation time; evaluation of the level of attainment of the fixed targets; mechanisms of industrial participation; organizational problems which block the introduction of advanced technology; and appropriate information flows. The latter cares with: market behaviour; scale of production; mechanisms to finance projects; and governmental incentives to intensify industrial participation, among the most important. The knowledge of these points eases the technology transfer processes toward the users and the industrial system.

The transfer of space technology, in a country like Brazil, presents its own features. The needs and priorities are different from those found in leading countries and appropriate technological transfer and diffusion mechanisms must be implemented. Brazil has already some experience in this field and NASA's specialists should profit by studying Brazilian specific cases. Also INPE's specialists will profit by learning about the large experience gathered by the U.S.

This cooperation would be put forth through the exchange of NASA's specialists and INPE's personnel, during three years. INPE would send a total of 6 to 9 researchers and engineers (2 or 3 each year) for 3 months on-the-job training and technical discussions, while NASA's specialists would come to INPE during all program, but concentrated on the beginning of the second and the end of the third years.

F - SEARCH AND RESCUE (SARSAT)

Preliminary discussions between NASA and INPE have been conducted towards the participation of Brazilian DCP satellites in the SARSAT network. In addition, there is a standing Canadian offer, yet to be confirmed, where Canada would donate a Local User Terminal (LUT) to Brazil to be operated by INPE.

NASA has already indicated it would be willing to propose the participation of Brazil in the SARSAT activities.

## G - USE OF THE SPACE SHUTTLE

The following experiments are proposed to be carried on board of the Space Shuttle for the period of 1986 - 1987:

- 1 - Cooperative mission on remote sensing by utilizing a version of the CCD multispectral camera predicted for the remote sensing satellites of the Complete Brazilian Space Mission.
- 2 - Microwave sensor for meteorological applications.

Both experiments are supposed to be flying with a Brazilian payload specialist from INPE on board of the Shuttle. In order to do so, a study should be done before the end of 1983, to verify the available support on board of the Shuttle and to analyze the equipment required to perform both projects successfully.

A continuous exchange of personnel and technical information should occur to design the interfaces between the payload and the Shuttle. Training of Brazilian specialists is also important to get acquainted with NASA procedures.

The American meteorological community would benefit from this proposal in the following general aspects:

- The results obtained at INPE will eventually improve the present knowledge of the tropical atmosphere and its influence on weather forecast for middle and high latitudes.
- The comparison of VAS soundings with ground truth could be carried on at INPE, resulting in the determination of better correction factors for tropical soundings.
- The VAS/GOES soundings could be compared in real time with TOVS/TIROS-N soundings. These would provide better aspect ratio of cloud free areas assessed from sounders with distinct angles of view. These data would be available to the American community.
- The collaboration with respect to GCM's would bring improvements to the Tropical Boundary Layer Modelling aspects of these models, especially the parameterization of surface variables relevant to climate studies.

## I - GOES-TYPE DATA COLLECTION PLATFORMS

The Brazilian proposal is to continue the collaboration on the use of the GOES DCS system which is vital for meteorological and hydrological applications. In the near future, plans call for strengthening the collaboration based on the Memorandum of Understanding signed by the governments of Brazil and U.S. through NOAA and COBAE. This should include an increase in the number of channels available for environmental applications in Brazil.

J - USE OF LOW-ORBIT METEOROLOGICAL SATELLITES (TIROS-N) FOR  
ENVIRONMENTAL DATA COLLECTION (DCP)

There is no specific proposal concerning the use of the ARGOS DCS system on board of the TIROS-N satellite series. The reason is that the system is operated by CNES of France and there is a collaboration with France already being established for the use of ARGOS DCPs for hydrological and oceanographic applications.



#### K - PARTICIPATION IN THE LANDSAT PROGRAM

The Brazilian proposal to continue collaborating in the LANDSAT program has as its main point the signature of a new Memorandum of Understanding between COBAE and NOAA, in order to assure the direct access to the data of the LANDSAT satellite series (LANDSAT 4 and its back-up D') throughout the program, estimated to last until the end of the decade.

## L - FUTURE ACTIVITIES USING REMOTE SENSING SATELLITES

It is proposed that INPE participates in several experiments on-board of the Space Shuttle, and more specifically in mission STS-16 (Space Transportation System, no. 26), that will be carried out in 1984, with a series of sensing devices defined by the OSTA-3 (Office of Space and Territorial Applications):

- OSTA-3: sensor - LFC (Large Format Camera); ARS (Altitude Reference System); FILE (Feature Identification and Location Experiment); SMIRR (Shuttle Multispectral Infrared Radiometer); MAPS (Measurement of Air Pollution from Satellites); and the SIR-B (Shuttle Imaging Radar - B). In this last case, a proposal has been submitted to NASA in cooperation with ERIM (Environmental Research Institute of Michigan).
- SAMEX (Shuttle Active Microwave Experiment): imaging radar in bands L and C, varying incidence angle, and HH, VV and HV polarizations.
- FIREX (Free-flying Imaging Radar Experiment): imaging radar for scientific research of land and ocean targets.

Furthermore, there is great interest in the utilization of the MAPSAT, still in the initial stages of viability studies, and the experiments using the SPACELAB, a cooperative effort between ESA (European Space Agency) and NASA.

For the implementation of this cooperation, specially the STS-16, there should be a Memorandum of Understanding with the NSSDC (National Space Science Data Center) of the Goddard Space Flight Center, for reception of STS-16 data collected over Brazilian Territory.

It is also proposed a Consultative Committee to discuss participation, complementarity, compatibility and other related aspects of future remote sensing satellites.

M - COOPERATION IN THE RESEARCH OF ENVIRONMENTAL SATELLITE DATA  
APPLICATIONS

A Memorandum of Understanding involving NASA, NOAA/NESDIS, The University of Wisconsin and INPE is proposed for the development and upgrading of equipments, algorithms for image processing, and personnel training.

In the area of remote sensing, basic research for the understanding of scene radiation through laboratory and field studies, is highly desirable. Thus, a Memorandum of Understanding is proposed with NASA and other institutions involved with AgRISTARS such as LARS (Laboratory for Applications of Remote Sensing) of the University of Purdue, ERIM (Environmental Research Institute of Michigan), and University of California, Berkeley. This cooperation should include equipment loans, exchange of data and data collection procedures and of scientists.

## N - SATELLITE CONTROL AND OPERATION

NASA's Consolidated Deep Space Network (CDSN) has a target of being multimission, as far as possible, and the most economical in terms of manpower. Also, the CDSN will provide support for the low-orbiting satellites which are not compatible with the TDRSS. INPE's Ground Segment has the same target and there will be necessity of foreign support for INPE's satellites, specially during the Launch and Early Orbit phase. Therefore, the mechanism of the proposed cooperation is the following.

During the first year of cooperation (1984), INPE's engineers would participate in the NASA's Ground Segment systems definition Working Groups or receive training in the NASA centers which would be involved with it, e.g. GSFC and JPL. Returning to Brazil they would participate in the definition of INPE's Ground Segment. Once this definition phase is over, it is expected that NASA's engineers will participate in the critical review of the work performed.

During the second year, INPE's engineers would spend some time at GSFC and JPL to acquaint themselves with the acceptance, test and integration procedures of the Ground Segment systems. Returning to Brazil, they would participate on the definition of the Brazilian procedures and it is expected the participation of NASA's personnel on their review.

During the third year, INPE's personnel would be trained at NASA in the Ground Segment operational procedures. Back to Brazil, they would participate in the definition of the procedures to be followed at INPE. A subsequent critical review would have the participation of NASA's personnel.

Procedures for the cross support between INPE and NASA would also be established for the utilization of both Operational Ground Segments.

## 0 - SATELLITE INTEGRATION AND TESTING

In order to envisage a common use of the satellite integration and environmental test facilities in both countries, the Brazilian proposal suggests two different steps for the cooperative activities for the next years.

In the initial phase-concerning the design and construction of the Brazilian laboratory.- personnel training and technical assistance would be as follows:

### TRAINING OF BRAZILIAN ENGINEERS AT NASA

FIELD OF INTEREST YEAR	TEST PHILOSOPHY ENVIRONM. TESTS	THERMAL VACUUM TEST	EMI/EMC	MECH. TESTS/ MASS PROPERTIES	HARNESS SOLDERING GROUNDING	CHECK OUT STATION TRANSP. LAY-OUT	RELIABILITY OF COMPONENTS	TOTAL
1984	4 m x m	4 m x m	4 m x m	4 m x m	4 m x m	4 m x m	4 m x m	28 m x m
1985	-	4 m x m	4 m x m	4 m x m	-	4 m x m	4 m x m	20 m x m
TOTAL	4 m x m	8 m x m	8 m x m	8 m x m	4 m x m	8 m x m	8 m x m	48 m x m

m x m = men x month

### TECHNICAL ASSISTANCE FROM NASA IN BRAZIL

FIELD OF INTEREST YEAR	THERMAL/VACUUM TESTS EQUIPS & PROCS	MECH TESTS AND MASS PROPERTIES EQUIPS & PROCS	EMI/EMC EQUIPS & PROCS	INTEGRATION PROCS	RELIABILITY OF COMPONENTS	TOTAL
1984			1 m x m		1 m x m	2 m x m
1985	1 m x m	1 m x m		1 m x m	1 m x m	4 m x m
1986	1 m x m		1 m x m	1 m x m	1 m x m	4 m x m
TOTAL	2 m x m	1 m x m	2 m x m	2 m x m	3 m x m	10 m x m

m x m = men x month

The following phase would be related with the operational aspects of the Brazilian laboratory, which would be available to perform tests required by NASA. On the other hand, NASA would offer to INPE the necessary support to perform abroad when necessary very special tests at system level, such as the solar simulation test.

## P - TRAINING AND TECHNICAL ASSISTANCE

INPE and NASA have been successfully cooperating in the Remote Sensing LANDSAT Program.

INPE is presently contemplating the development, manufacture, test and operation of satellites in Brazil. As a consequence of this new involvement, the above mentioned cooperation should be intensified. Such cooperation should be in the form of specific training and technical assistance offered from NASA to INPE.

The following areas should be of special interest:

- a) Satellite Control and Operation (see item O).
- b) Satellite Integration and Testing (see item N).
- c) Activities related to Remote Sensing Satellites.
- d) Other related areas, e.g., Structural and Thermal Control, Analogic and Digital Systems, Orbit Attitude and Control, Space Telecommunications, Propulsion Systems and Large Space Programs Management.

Brazilian proposal consists in receiving from the U.S., mainly from NASA, specific training and technical assistance during a period of, at least, five years. According to this proposal, every year, 36 to 48 men-month — researchers and engineers — from INPE should receive training in the U.S.. The amount of technical assistance to be given by NASA would depend on availability of personnel and common interests.

A joint Memorandum of Understanding would be settled to give full coverage for the proposed activities.

## R - RADIO - ASTRONOMY

1. INPE proposes to continue joint cooperation with M.I.T. - Haystack Observatory which has occurred for many years. It has been consisting of the astrophysical VLBI operation through the use of a Mark II terminal at the Itapetinga Observatory. Proposals by INPE include exchange of experience on cooled radiometers, operations of masers at Itapetinga, and development of new phase locked oscillator at Haystack for use at Itapetinga. Exchange of scientists should be beneficial for both countries, not only for this topic but also for the others below.
2. V.L.B.I. on quasars with Caltech Owens Valley and Itapetinga is expected to be established shortly. Caltech would also furnish additional x-band units.
3. Bi-lateral cooperation should be established with the NRAO - National Radio Astronomy Observatory, Tucson/Kitt Peak operations. Itapetinga observing time is offered to both N.R.A.O. and U.S. radioastronomy community in exchange for seminars, talks and loan of front-ends. N.R.A.O. would provide assistance on radiometers. INPE's acousto-optic spectrography experiments would be held at Kitt Peak including technical stays of INPE's engineers.
4. INPE has and wishes to continue to cooperate in the International Halley Watch Program and has assumed the coordination of related radiosience studies and experiments in the country.



## S - RADIOMETRIC INSTRUMENTATION

### PROPOSAL BY CTA

Development of instrumentation for sounding rocket payloads in the millimetric and submillimetric bands to study surface (land and water) and cloud temperatures. The data would be used in meteorological research.