

# Nanosatellites and Small Satellites in Brazil

Walter Abrahão dos Santos  
walter.abrahao@inpe.br

DIPST - Divisão de Pequenos Satélites  
Coord. Geral de Engenharia Tecnologia e Ciência Espacial



# Summary

- Introduction
  - INPE's Space Activities
  - INPE's Prospective Contributions
- Ongoing Projects
- Future Projects

# INPE's Activities



## INPE: CONVERTING DATA INTO KNOWLEDGE



### SATELLITES

Earth observation, scientific, and data collection satellites



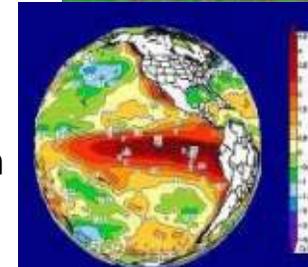
### GROUND SYSTEMS

Satellite control, reception, processing and distribution of satellite data



### ANALYSIS AND MODELLING

Space Weather, Weather Prediction and Earth System Science



### SOCIETAL BENEFITS

Innovative products to meet Brazil's needs



# INPE's Prospective Contributions



## ❑ Ground Stations:

- Support for UHF, VHF, S and X-Bands.
- Ground Station locations at various locations

## ❑ Mission Data Pre-Processing and Forwarding

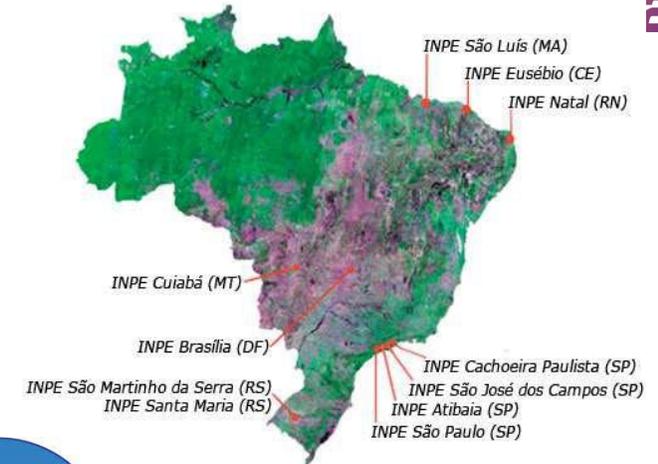
- Mission data may be pre-processed at INPE and forwarded to PI's

## ❑ Concurrent Systems Engineering

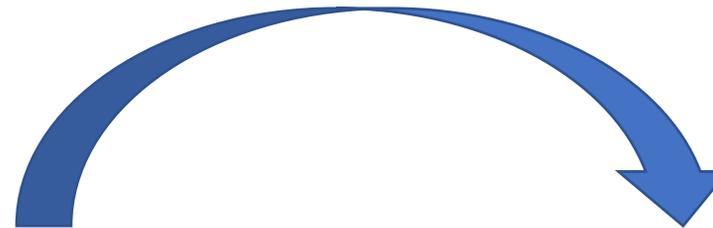
- Mission conceptual studies using simultaneous engineering beforehand

## ❑ AIT – Assembly Integration and Testing at LIT

- A comprehensive testing environment.



# INPE's Postgraduate Studies



## Space Engineering and Technology

### Areas of Concentration



Astrophysics



Space Engineering and  
Technology



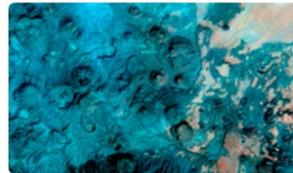
Space Geophysics



Applied Computing



Meteorology



Remote sensing



Earth System Science



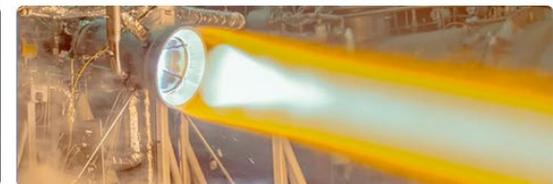
Space Mechanics and Control (CMC)



Science and Technology of  
Materials and Sensors (CMS)



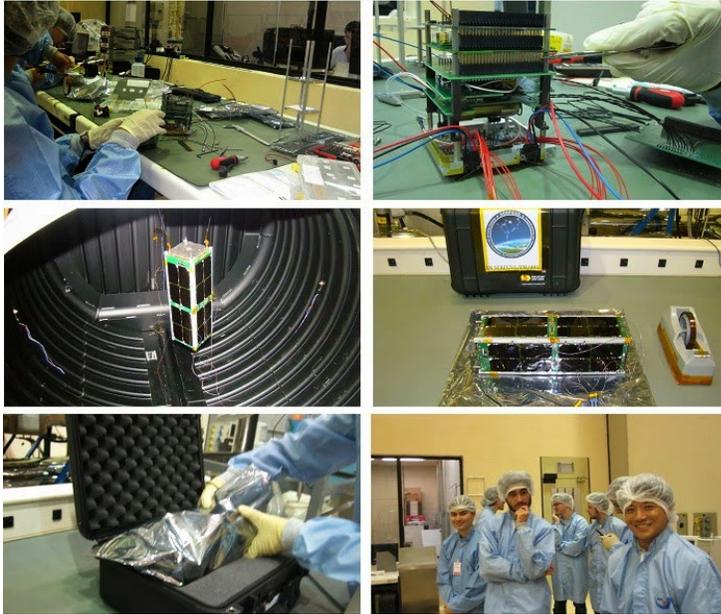
Space Systems Engineering and  
Management (CSE)



Combustion and Propulsion (PCP)

The Space Engineering and Technology Course is formed by several areas of concentration covering, in a complete and detailed way, the entire process involved in the development of space, aerospace and terrestrial engineering solutions. **Meet :**

# On-the-Job training and Internships



<http://brazilinspace.blogspot.com.br/2014/09/o-programa-serpens.html>



<http://phys.org/news/2013-09-pico-satellites-brain-board.html>



# INPE's LEO Sats

## Low Earth Orbit (LEO)



### NAME

Launch Year  
Manufacturer  
Mass (kg)

TAN ✈️ Floripa 🇧🇷

### CREDO-1

2016  
EMPTAN/INPE  
0.7 kg

### Sat-1

2019  
UFSC  
1 kg

### AESP-14

2015  
ITA  
1 kg

Nano 🇧🇷 Nano 🇧🇷

### SatC-Br1

2014  
UFSM/INPE  
1 kg

### SatC-Br2

2021  
UFSM/INPE  
1.7 kg

### SERPENS

2019  
UnB/AEB  
5 kg

### ITASAT

2018  
ITA  
8 kg

### UNOSAT

2003  
Unopar  
9 kg

### VCUB1

2022  
Visiona  
12 kg

Dove- 🇧🇷

### OSCAR 17

1990  
AMSAT  
13 kg

### SACI-1

1999  
INPE  
60 kg

### SACI-2

1999  
INPE  
60 kg

### SATEC

2003  
INPE  
65 kg



### SCD-1

1993  
INPE  
110 kg



### SCD-2

1998  
INPE  
115 kg



### SCD-2A

1997  
INPE  
115 kg



### AMAZONIA 1

2021  
INPE  
640 kg



### CBERS-1

1999  
INPE/CAST  
1,450 kg



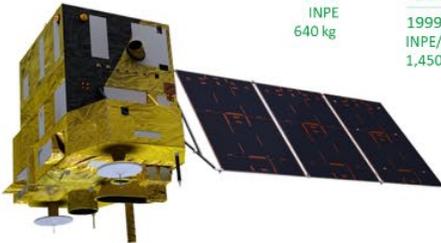
### CBERS-2

2003  
INPE/CAST  
1,450 kg



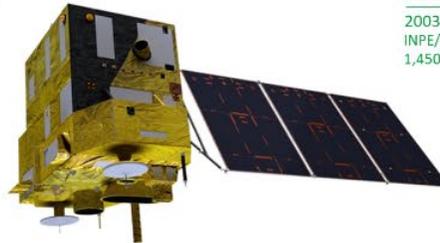
### CBERS-2B

2007  
INPE/CAST  
1,450 kg



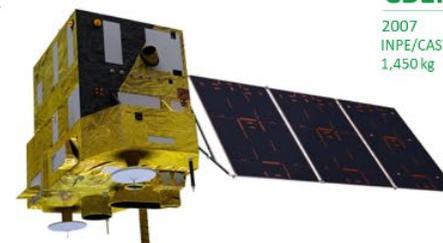
### CBERS-3

2013  
INPE/CAST  
2,080 kg



### CBERS-4

2014  
INPE/CAST  
2,080 kg



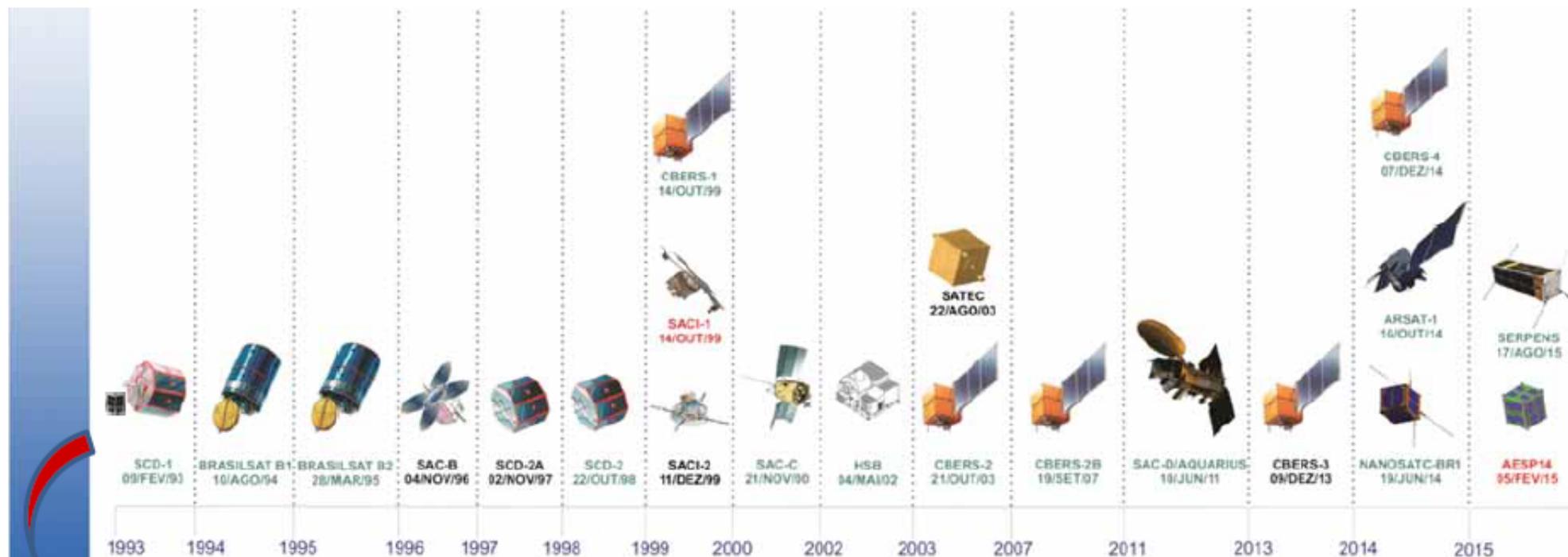
### CBERS-4A

2019  
INPE/CAST  
2,080 kg

### Author

Danilo Miranda  
<https://br.linkedin.com/in/danilomiranda-51137951>  
#BrazilHighTech  
v1.1, July 22, 2021

# INPE's Sats Timeline

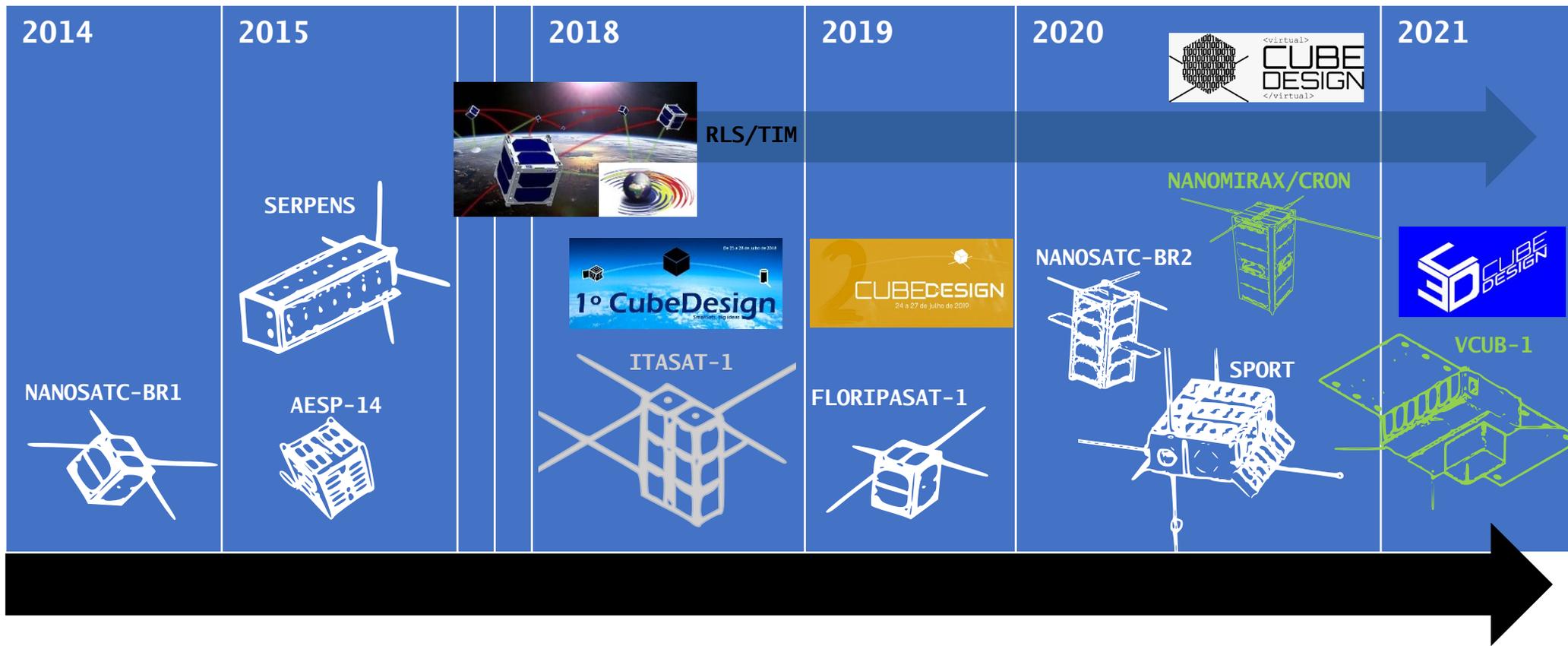


DOVE-OSCAR-17 NASA/NORAD number: 20440  
 Launch by the civil and electric engineer **Junior Torres de Castro** (amateur radio operator with callsign PY2BJO), Date: 22 January 1990, Kourou, French Guiana, Ariane V-35. Orbit type: Circular LEO, inclination 98.6 degrees, altitude 800 km. **Weight: 9 kg**  
 Stabilization: Passive magnetic. Beacons : 145.825 synthesized voice or 1200 bps FM AFSK, AX.25 telemetry. 2401.2205 MHz, 1200 bps BPSK, 1 Watt (S Band)

Then ... SmallSats Initiatives started popping around



# Smallsats Timeline in Brazil

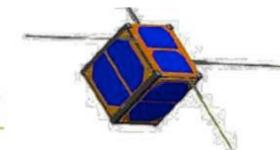


## What are the main advantages of CubeSats?

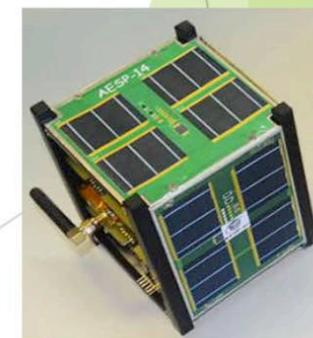
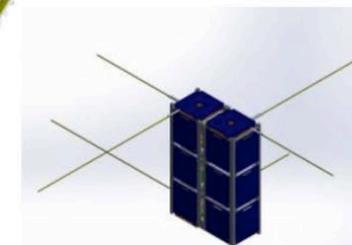
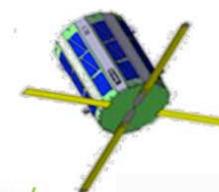


## Previous smallsats developed in Brazil

- ▶ **NANOSATC-BR1 (UFSM / INPE)**
  - ▶ 2014, 1U Architecture, 600km Altitude, <http://www.inpe.br/crs/nanosat/>
  - ▶ **Assess data from South America Magnetic Anomaly & Brazilian's Ionospheric Electrojet**
- ▶ **SERPENS-1 (AEB)**
  - ▶ 2015, 3U Architecture, International Colaboration
  - ▶ UnB, Univ. Vigo, Sapienza, Cal Poly, Morehead, UFSC, UFMG, UFABC, IFF
- ▶ **CONASAT**
  - ▶ First CubeSat constellation (in development)
- ▶ **Tancredo I (UbatubaSat Project)**
  - ▶ 2017, TubeSat (~10x13cm), <http://www.ubatubasat.com/>
- ▶ **ITASat-I (ITA)**
  - ▶ 6U Architecture (in development), <http://www.itasat.ita.br/>
- ▶ **AESP-14 (ITA / LIT-INPE)**
  - ▶ 2015, 1U Architecture, 400km Latitude, <http://www.aer.ita.br/~aesp14/>

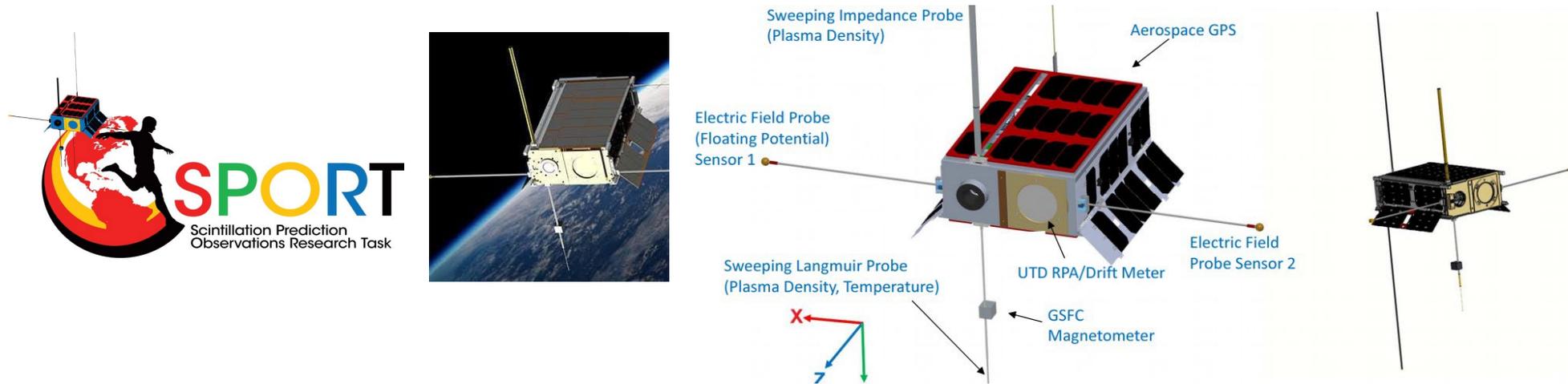


**CONASAT**



# SmallSats - Projects

## ❑ SPORT (Scintillation Prediction Observations Research Task) (6U-Cubesat):



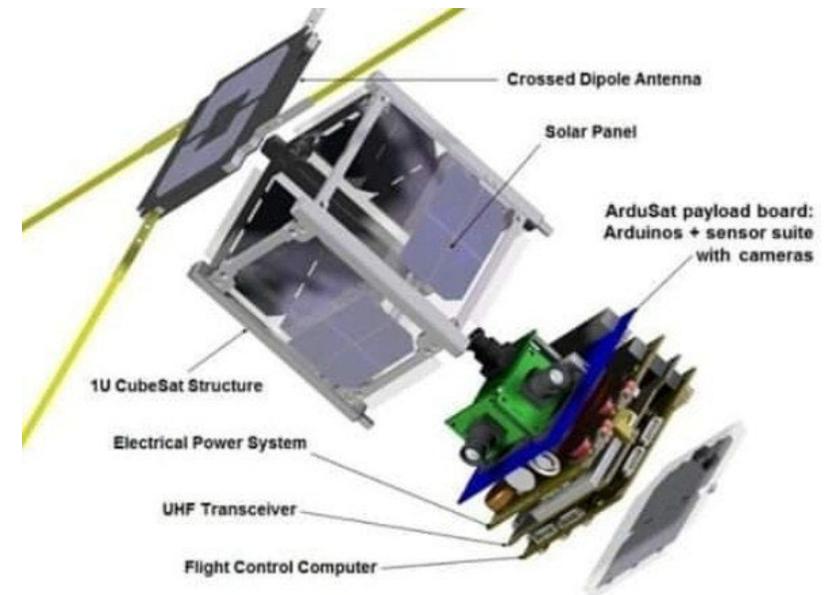
- NASA, AEB, ITA and INPE partnership to study the preconditions leading to equatorial plasma bubbles in the ionosphere.
- The Platform provided by ITA, payloads provided by NASA.
- AIT will be done with ITA personnel with LIT support and its technical staff.
- Mission operations will be done by INPE through its ground stations.
- INPE will receive, archive and distribute mission data at the Brazilian Monitoring and Study of Space Weather Program (EMBRACE) facilities and disseminate the processed data to the scientific community.

**ISS Launch:** Aug, 2022 and **Decommissioning:** Out/2023

# Ongoing Projects – Aldebaran-1

## ❑ Aldebaran-1 (UFMA Cubesat 1U):

- **Mission:** Capacity-building with several social functions, such as retransmitting signals to assist in the rescue of fishermen and vessels in the region of the municipality of Raposa-MA.
- It would receive the signal from the lost fisherman and send it to the nearest station, indicating the location where the fisherman would be, so that he could be rescued as quickly as possible. Another function would be to map fire zones in regions of Maranhão.
- The project is a partnership between the Brazilian Space Agency (AEB) and the Federal University of Maranhão (UFMA) to develop one of the first Brazilian-owned nanosatellites.
- The Launch date: 2025-6 (TBC)



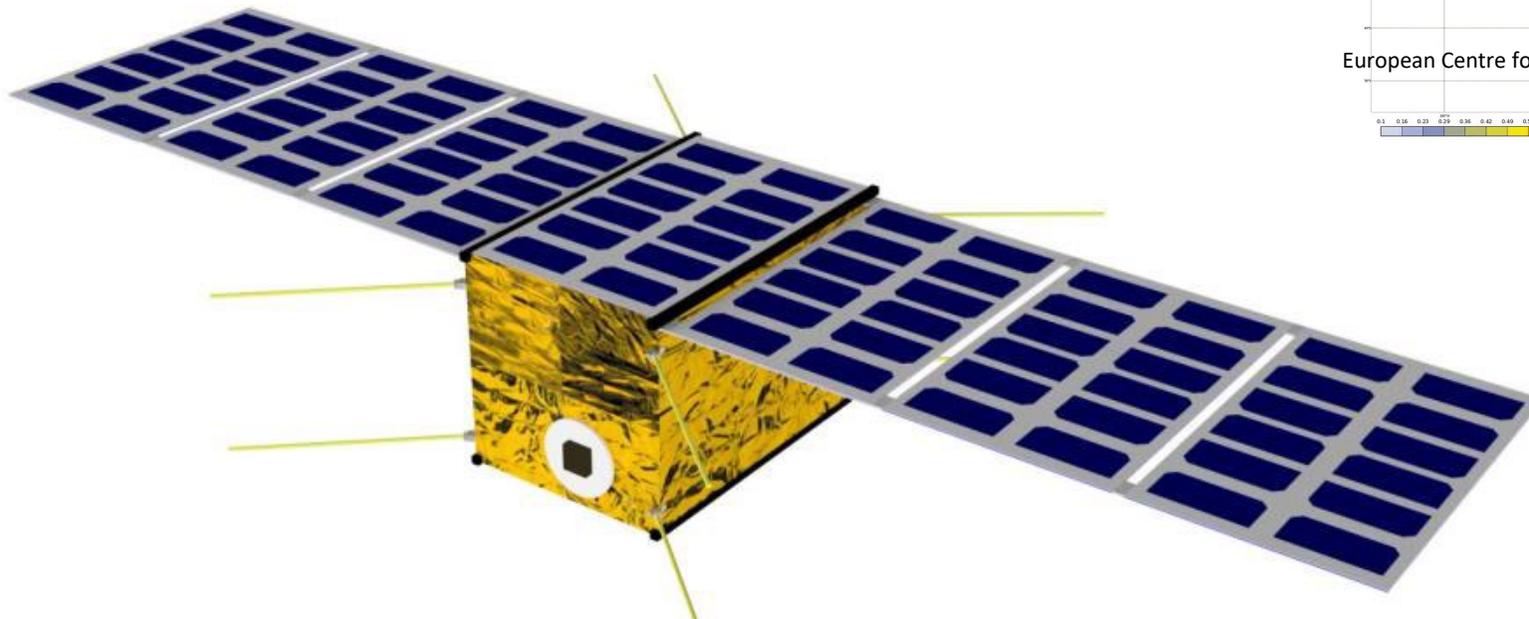
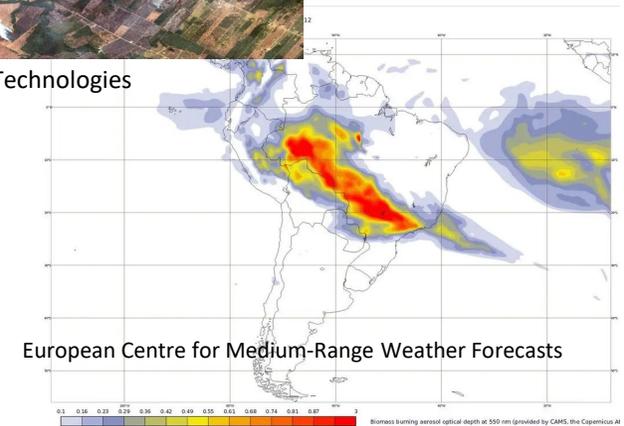
# Ongoing Projects – P30 Platform

## □ TURISAT (MicroSat, 30kg class):

- **Mission:** Forest and Biomes Fires monitoring
- To provide an operational system for monitoring fires in forests and other Brazilian biomes.
- It can contribute to the definition of public policies to combat fires in these areas.
- Mission considers a microsatellite constellation).  
Launch date: 2026 (TBC)



Maxar Technologies

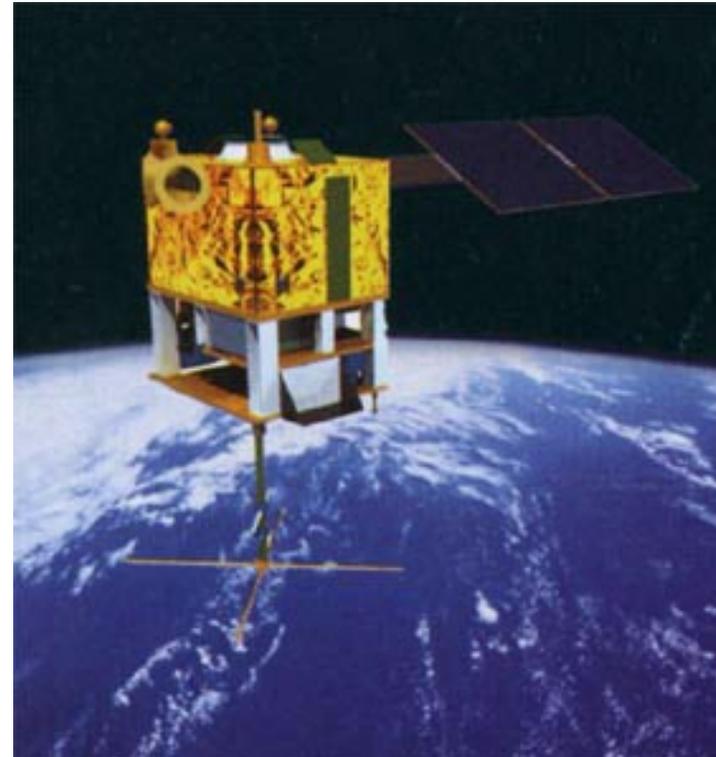


# Ongoing Projects – P100 Platform

## ❑ MULTI-MISSION PLATAFORM

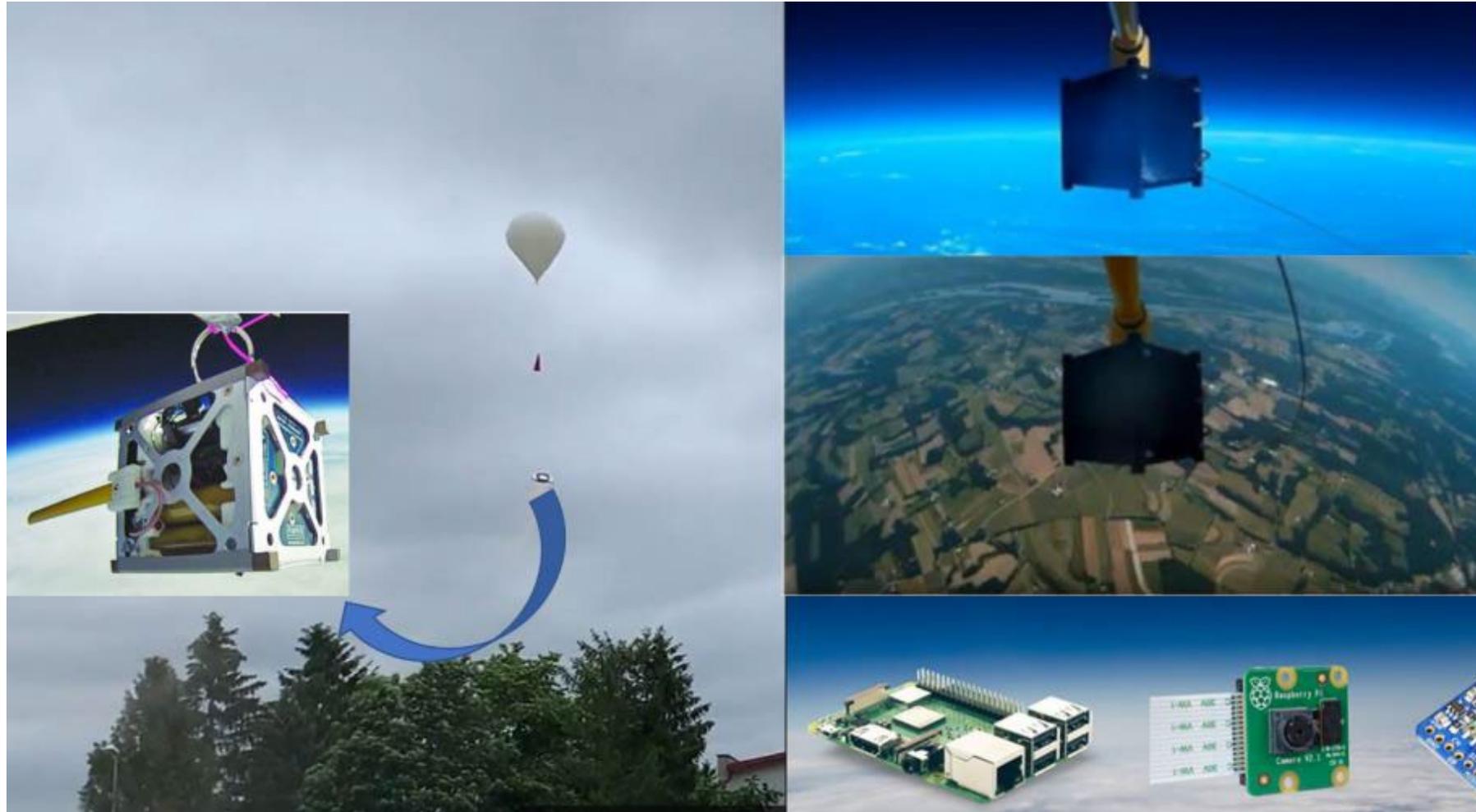
(MiniSat, 100kg class):

- Main objective: Design a multi-mission service platform for 100 kg class satellites.
- The first mission could make use of this platform is EQUARS mission - EQUARS (Equatorial Atmosphere Research Satellite)



[https://space.skyrocket.de/doc\\_sdat/equars.htm](https://space.skyrocket.de/doc_sdat/equars.htm)

# BallonSat - Multi-Mission Platform for Stratospheric Balloon



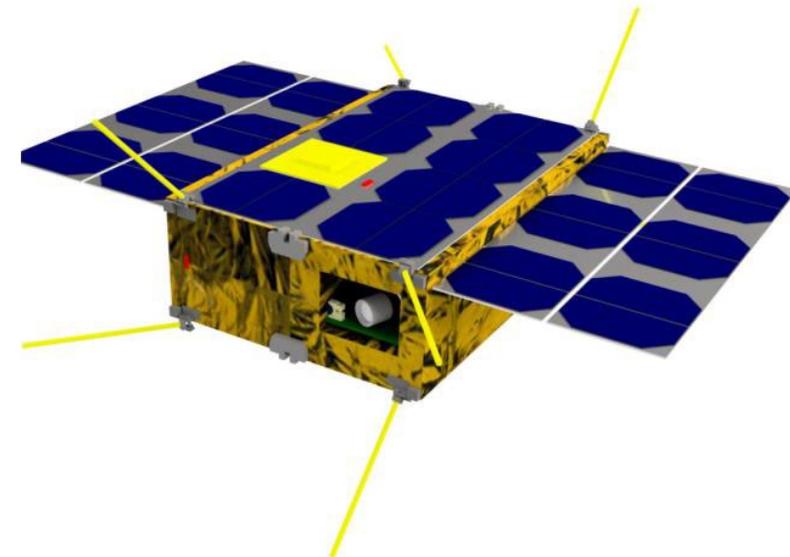
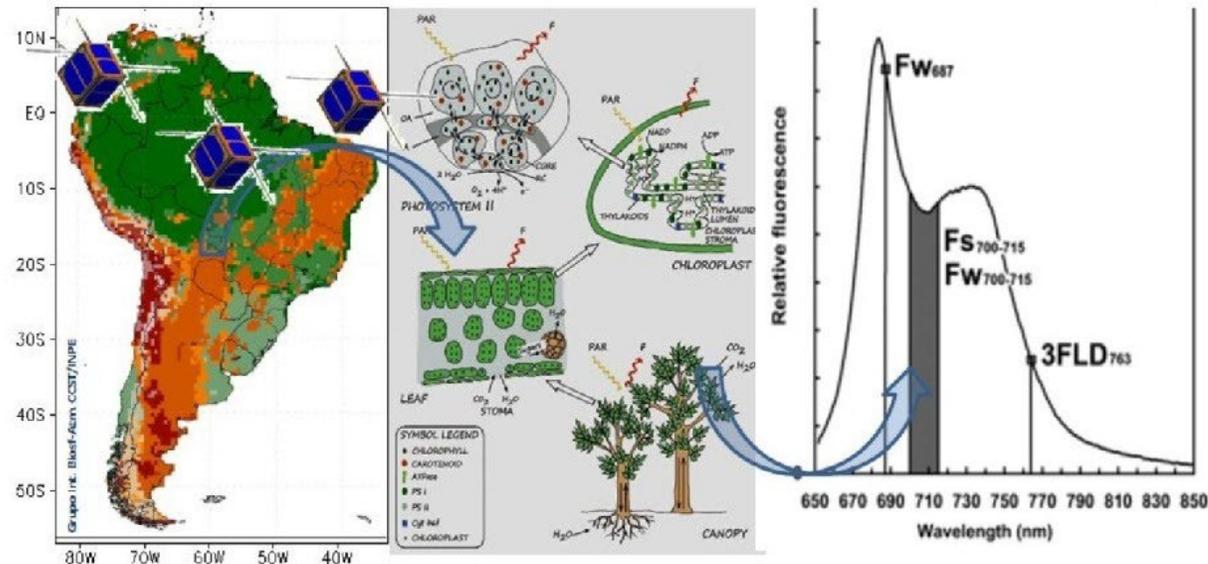
- Developed to be used as a telemetry, remote controls and georeferencing system that, coupled to a stratospheric balloon, can help in the testing and evaluation of technological systems and scientific experiments that use stratospheric flights.

# Ongoing Projects – P10 Platform

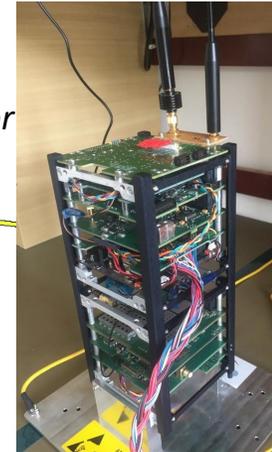
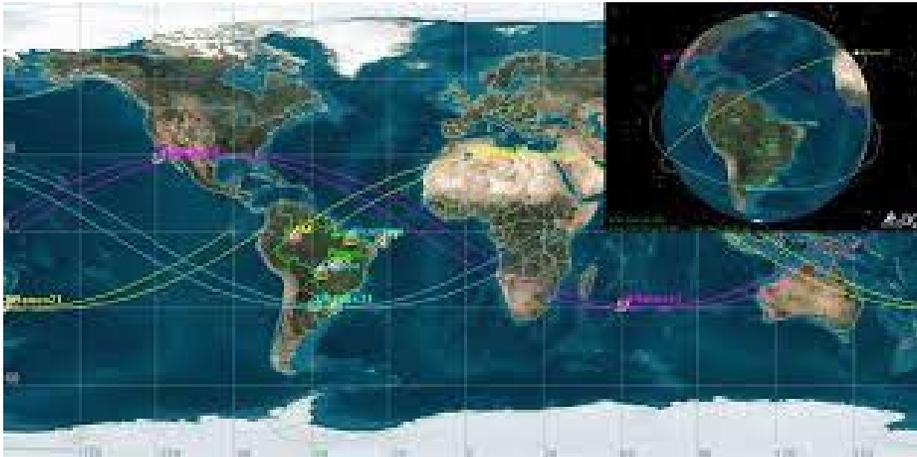
## ❑ BIOMESAT (NanoSat, 10kg class):

- Mission: Forest's Health Monitoring - Prospective photosynthesis activity monitoring from chlorophyll fluorescence
- To develop a space mission to contribute to the provision of data for the planning, monitoring and control of conditions of Brazilian forests.
- Mission considers a nanosatellite constellation.

Launch date: 2024 (TBC)



# ***GOLDS Constellation*** ***(Global Open collecting Data System)*** ***GOLDS-UFSC – Santa Catarina***



***GOLDS - UFSC***

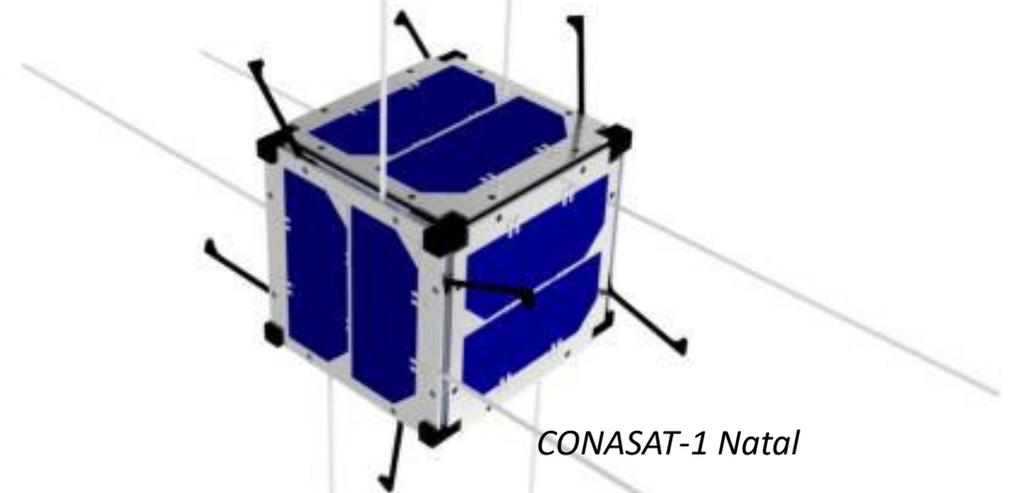
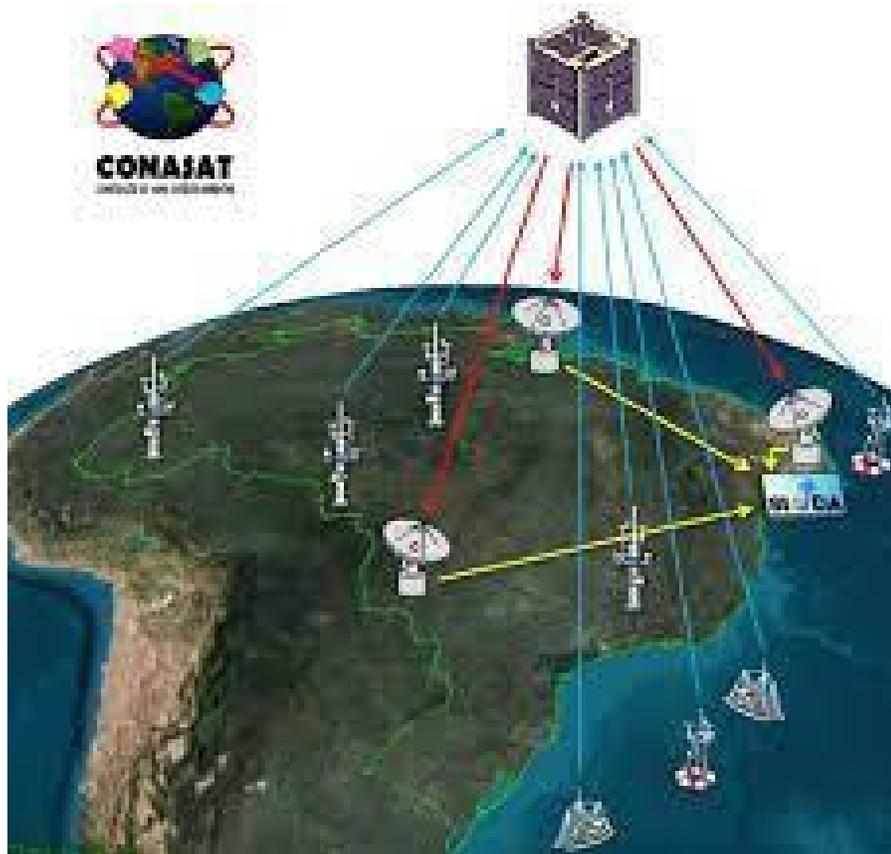
- A collaborative nanosat constellation for environmental monitoring which will provide data for scientists, government institutions and private companies in the country
- Useful in different applications: weather forecasting, studies of ocean currents, tides, atmospheric chemistry, agricultural planning, monitoring of the watershed, river and rain gauge data, monitoring fishing vessel route, etc.
- Open several possibilities for business and science cooperation in space Applications.

# GOLDS-CONASAT

Northeast Spatial Coordination (COENE),



*EDC - Environmental Data Collector*



*CONASAT-1 Natal*

The main results expected with CONASAT are: (1) Guaranteed operation of the SBCDA. (2) Increase in SBCDA's revisit capacity. (3) Increase in the number of SBCDA stations (PCDs) installed in the national territory and (4) Improvement of the environmental data collection service offered by the SBCDA.

# Future Projects

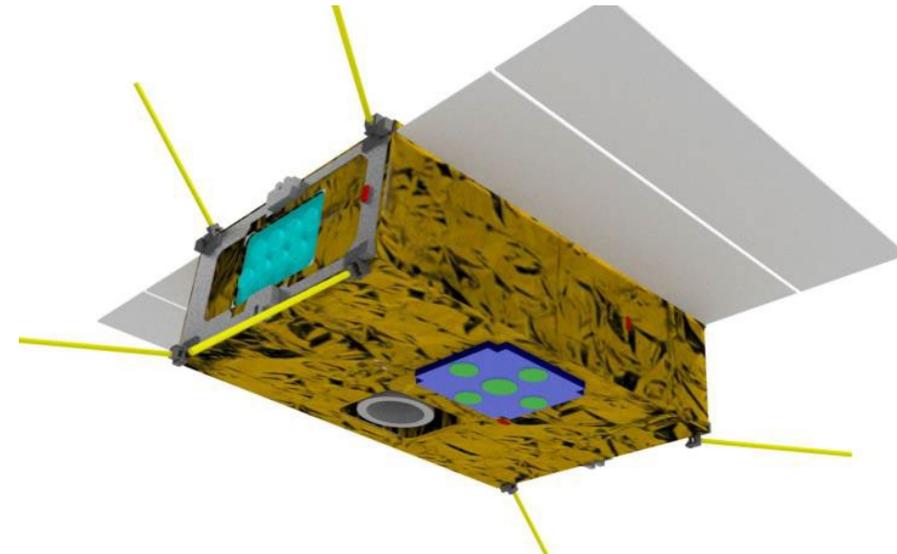
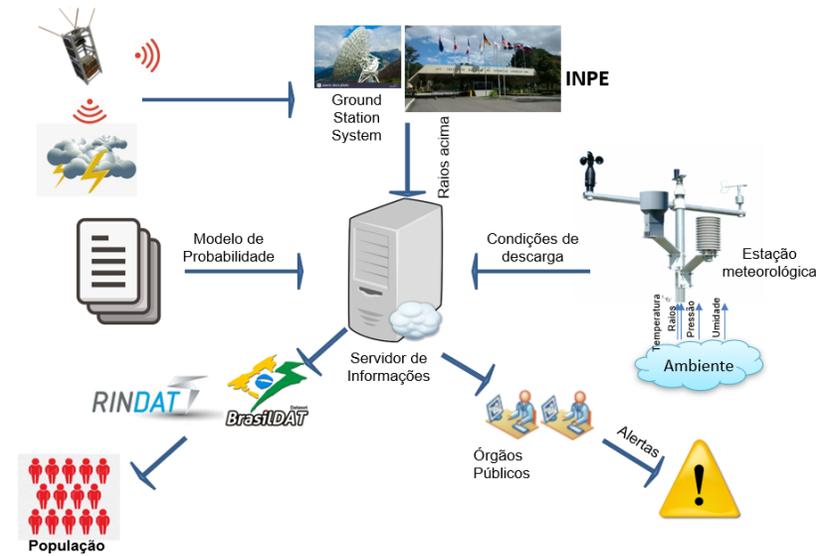
## RaioSAT

### Light monitoring

**Mission:** Intends to detect total lightning (intra-cloud and cloud-to-ground flashes simultaneously) from low cost, open standard CubeSat platform.

- 6-U CubeSat platform
- LEO, inclination of about 25°
- Complete orbit of 98 min
- Footprint over Brazil of approximately 15 to 20 min

#### “To-be” operational scenarios

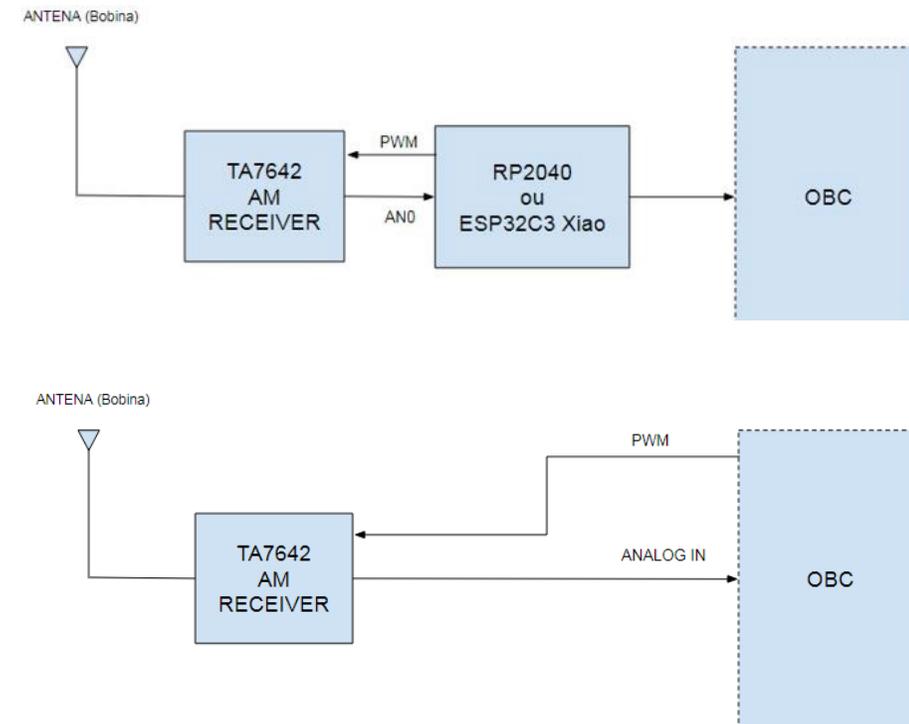
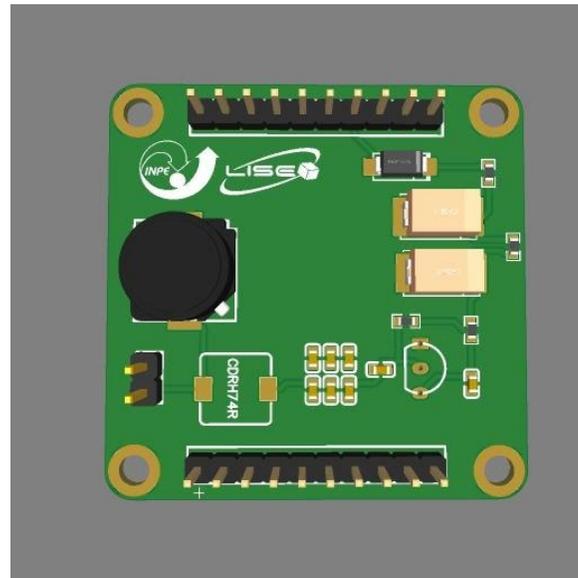
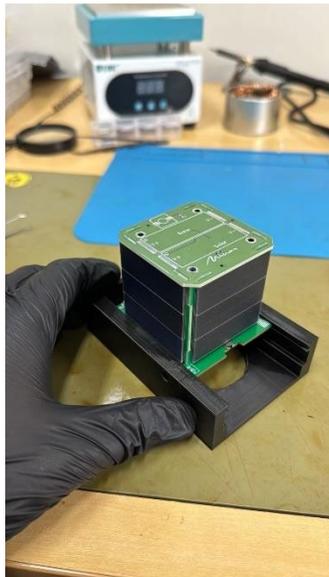


Concept merely illustrative

## Simplified RaioSat Payload On-Board of a Pocketcube

A greatly simplified version of the lightning detector from the RaioSat mission was embarked on the **UaiSat pocketcube mission**.

UaiSat engineering model and its lightning detection payload that uses a TA7642 RF receiver to determine the intensity of a thunderstorm.



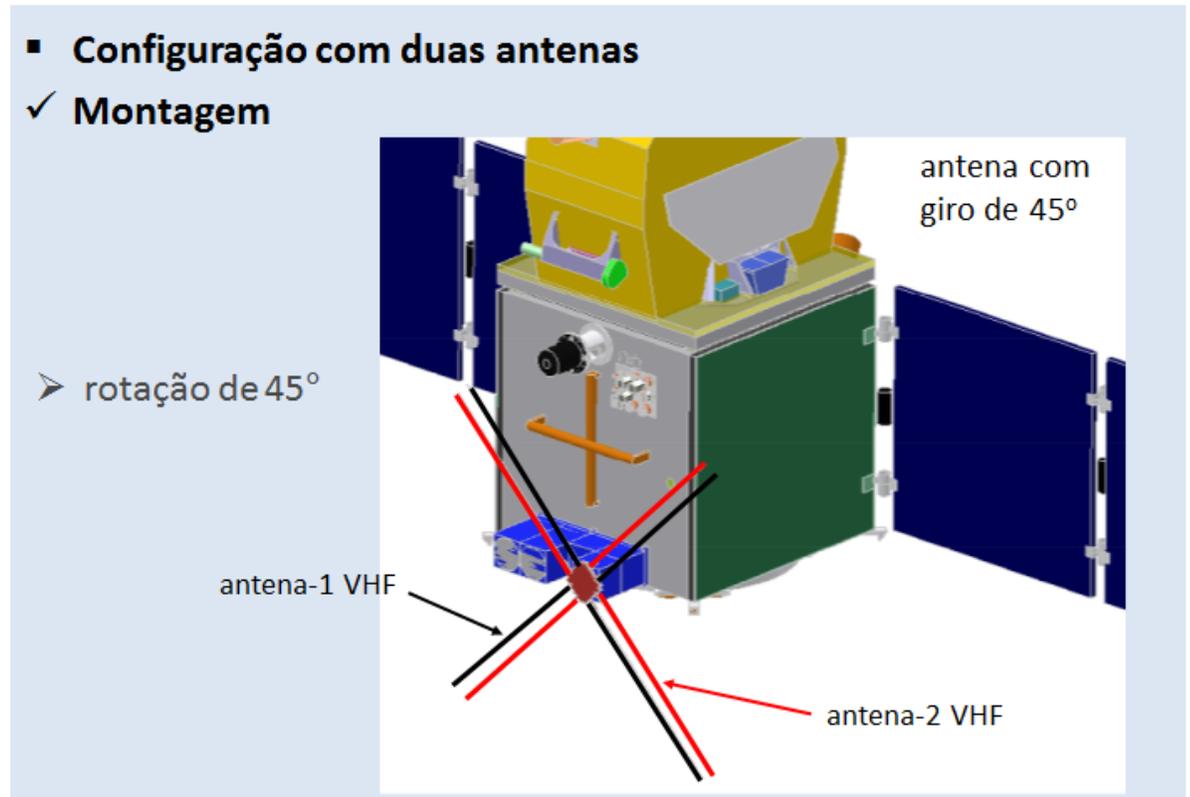
# Future Projects

## RaioSat Experimental Payload inside P100- CO2Image Mission

In order to meet the requirements for science mission like space weather, INPE's SmallSats Division - DIPST is envisaging a micro-satellite platform bus weighing 100 Kg named P-100 which would accept another 100 Kg module for carrying the scientific payload instruments.

As a result of discussions between **INPE and the German DLR**, INPE's systems engineering management is planning a CO2Image mission to study CO2 emissions from space. As the P100 bus side had room for more hardware, it was proposed to incorporate the RaioSat payload as an experiment (RaioExp), considering technical and programmatic aspects

The CO2Image mission aims to detect CO<sub>2</sub> and CH<sub>4</sub> in the atmosphere, with the payload module under the DLR's responsibility and the service module under the INPE's responsibility. The satellite will have a sun-synchronous orbit, with a height of 575 km, and a total mass of 282 kg.



# Future Projects

## *CORBES - Constellation*

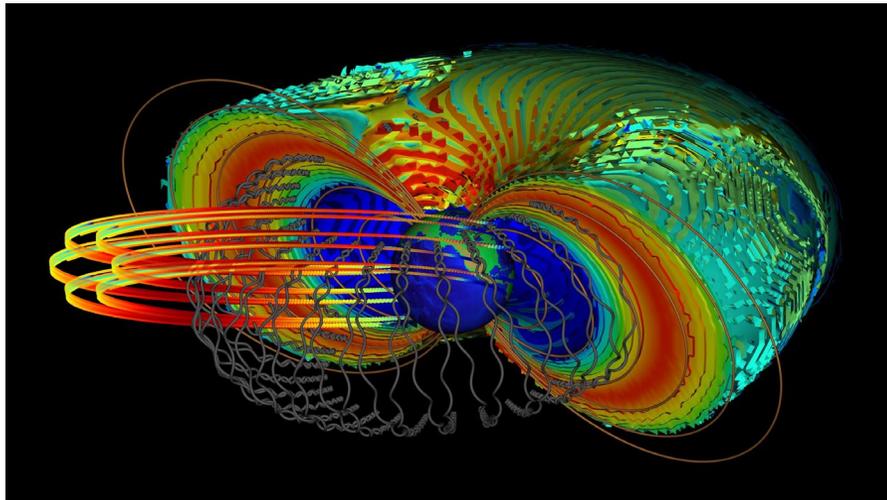


Task Group on Establishing a Constellation of Small Satellites (TGCSS)  
Constellations of SPace Radiation Belts Survey (COSPARS)

Ji Wu, 20201– 2025“吴” <wuji@nssc.ac.cn>

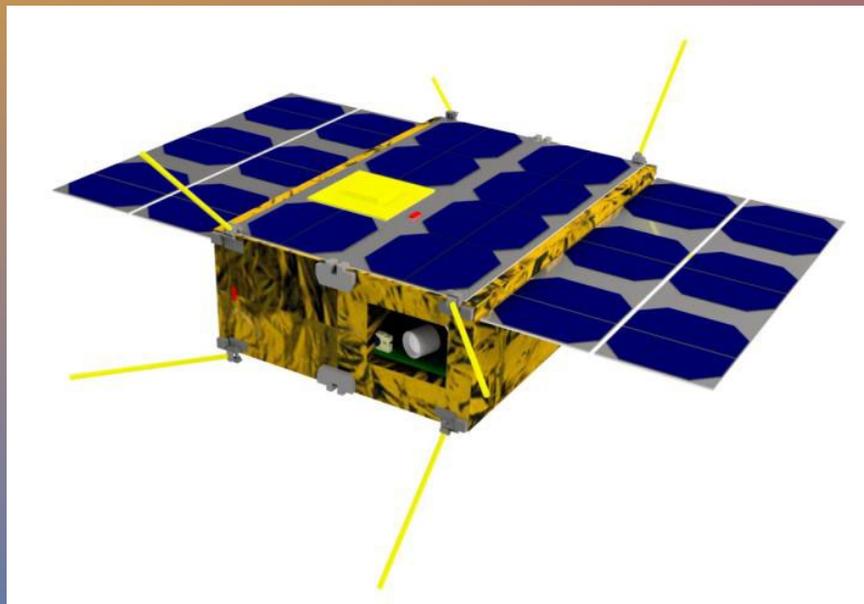
National Space Science Center, Chinese Academy of Sciences

- Address key issues in the domain of space weather, radiation belt research and Earth observation. An international consortium that will develop, launch, and acquire data from a **constellation of small satellites**.
- The small satellites with instruments would need to be provided by Member nations, and there will need to be a major space agency(s) that facilitates launches and data collection. It will be important that the constellation yields useful and important data, so that each contributing nation can state that it is assisting in the solution of an important scientific problem. A particularly useful constellation would be one that measures the plasma conditions in the ionosphere, with sufficient measurement density to substantially improve space weather forecasts.



<https://scitechdaily.com/scientists-discover-how-electrons-close-to-earth-can-reach-almost-the-speed-of-light/>

<https://cosparhq.cnes.fr/scientific-structure/task-group-on-establishing-a-constellation-of->



Muchas Gracias!  
Muito Obrigado!  
Thank you!



# CEDS 2024

[eventos.cmm.uchile.cl/ceds2024](https://eventos.cmm.uchile.cl/ceds2024)



FACULTAD DE CIENCIAS  
FÍSICAS Y MATEMÁTICAS  
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