

# INPE

## Plans & Strategic Objectives

October 1st 2020

# Introduction

GOES and NOAA's LEO satellites has been used in many meteorological and environmental applications at INPE over the last years;

GOES-East satellites are usually positioned over Brazil, observing all country, neighboring countries as well the surrounding Pacific and Atlantic oceans;

NOAA LEO satellites are used for high latitudes applications and to support NWP data assimilation globally (DBNet);

However, due to the continental dimension of the country in the tropical region, it is necessary to improve the coverage for ALL Sensors and in ALL conditions (including PMW and hiperespectral) over the tropics.

# Rationale

- ❑ Hyperspectral will be used not only in IR but also in the UV, VIS, NIR and MW
  
- ❑ Passive MW experiences are undergoing and/or planning phase. ACCP (Aerosol and Cloud, Convection and Precipitation), WSF-M (Weather System Follow-on - Microwave), CIMR (Copernicus Imaging Microwave Radiometer)
  
- ❑ Active MW on GEO orbit is seen as a possibility
  
- ❑ Radio-occultation technique (like COSMIC2) will be generalized, using additional frequencies to maximize the sensitivity to atmospheric variables (incl. cloud/precip). Commercial sector is a new player. For the future, a new constellation of satellites with high inclination will provide a denser coverage of the global ionosphere.*
  
- ❑ Smaller sats constellation in different orbital planes on equatorial orbits could be a valid option due to faster and more flexible decision processes. However, they have shorter life cycles and more limited scope*

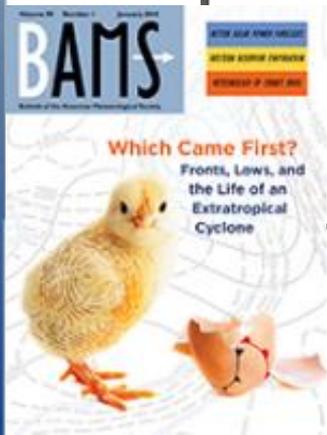
# GOES-10/12 dedicated to South America

## A SUCCESSFUL PRACTICAL EXPERIENCE WITH DEDICATED GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITES GOES-10 AND -12 SUPPORTING BRAZIL

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The GOES-10 and -12 experience improved the environmental monitoring of South America and demonstrated the importance of international scientific communication for advancing satellite meteorology.

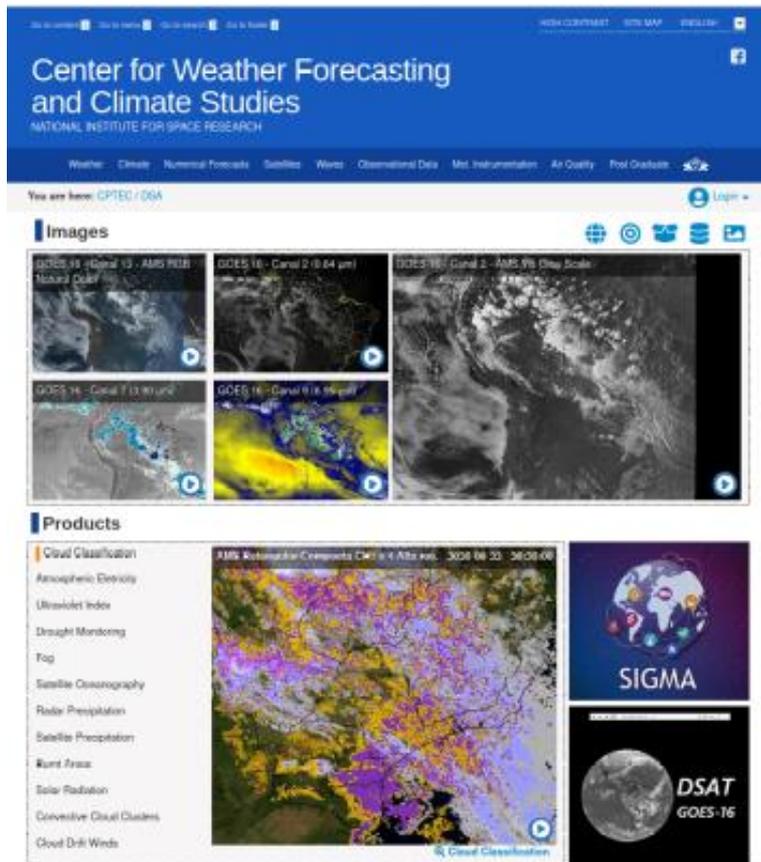
Downloaded from [http://journals.ametsoc.org/monographs/10.1175/1520-0476\(2014\)14\(0020\)\\_1a117y.pdf](http://journals.ametsoc.org/monographs/10.1175/1520-0476(2014)14(0020)_1a117y.pdf)



When dedicated to South America, GOES-10 allowed improve the precision of various satellite products due the continuity of images (no only full disk each 3 hours during hurricane seasons) and the increase in temporal resolution.

Also, the coverage extended to the southmost as possible

# GOES-16 Meteorological Applications at INPE



The screenshot shows the website interface for the Center for Weather Forecasting and Climate Studies at INPE. The main navigation bar includes links for Weather, Climate, Numerical Forecasts, Satellites, Waves, Observational Data, Met. Instrumentation, Air Quality, and Prod. Diagnostics. The current page is titled 'Images' and displays a grid of satellite imagery from GOES-16, including channels 13, 2, 1, 13, and 18. Below the images is a 'Products' section with a list of available data products and a corresponding visualization of cloud classification over a geographical area.

**Center for Weather Forecasting and Climate Studies**  
NATIONAL INSTITUTE FOR SPACE RESEARCH

You are here: CPTED / OSA

**Images**

- GOES 16 - Canal 13 - AMS 1638 - Multispectral
- GOES 16 - Canal 2 (0.64 µm)
- GOES 16 - Canal 1 - AMS 163 Day Scale
- GOES 16 - Canal 13 (0.64 µm)
- GOES 16 - Canal 18 (0.64 µm)

**Products**

- Cloud Classification
- Atmospheric Density
- Ultraviolet Index
- Drought Monitoring
- Fog
- Satellite Oceanography
- Radar Precipitation
- Satellite Precipitation
- Burn Area
- Solar Radiation
- Convective Cloud Clusters
- Cloud Drift Winds

AMS Radiometric Elements Ch1 - 4 Atm sat. - 3026 06 20 - 36:08:08

**SIGMA**

**DSAT GOES-16**

GOES-16/ABI VIS-IR Imagery, RGBs and GLM data for Weather Monitoring and Nowcasting;

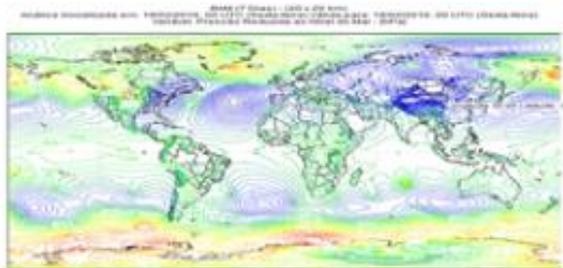
Products for validation, development and applications in weather monitoring and assimilation in numerical models:

- *Wind Motion Vectors*
- *Solar and Terrestrial Radiation*
- *Precipitation*
- *Convective system analyses*
- *Imagery Classification (clouds types)*
- *Sea Surface Temperature*
- *Lightning activity*
- *Among others*

# GOES-16 Data assimilation at CPTEC/INPE

- Using GSI (Gridpoint Statistical Interpolation) System in:

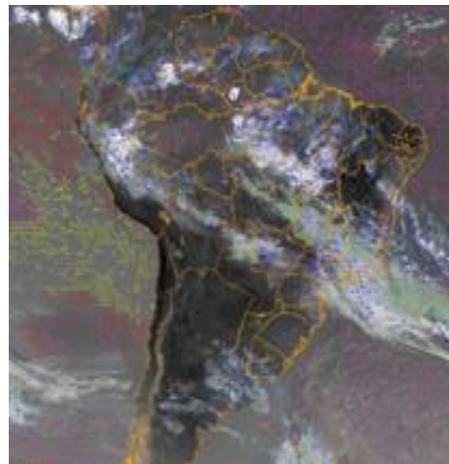
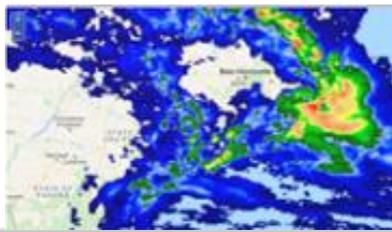
- Global



- Regional over South America



- Convective scale



Today assimilate:  
Atmospheric Motion  
Vectors (AMV) from  
GOES-16/ABI

Future:

CPTEC intent explore in data assimilation  
other products from GOES-16:

- Clear Sky imager radiances;
- GOES imager effective cloud cover data

# Which applications could be improved?

- **Atmospheric Variables:** wind, precipitation, severe weather monitoring, radiation, cloud classification, etc. by increasing spatial, spectral and temporal resolutions.
- **NWP & Nowcasting:** high temporal and spatial resolution on hyperspectral IR sounder and MW sounder for short cycle regional NWP data assimilation - Future nowcasting applications.
- **Fire Weather:** High frequency and spatial resolution imagery for fire detection, smoke monitoring and burnt area mapping.
- **Ocean:** High frequency and resolution ocean color products, and ocean surface wind vectors obtained from a GEO platform (VIS-NIR-TIR, MWI sensors) for ocean weather and environmental monitoring and data assimilation.
- **Atmospheric chemistry:** UV sounder.
- **Disaster management:** flood mapping, power-outage (low light sensor).

## Next generation satellites - How Brazil could benefit from it?

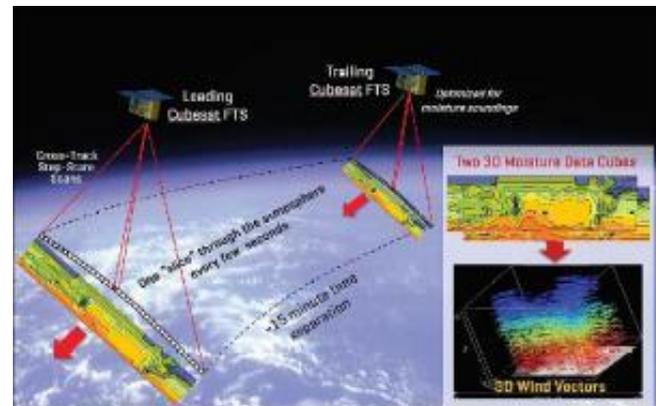
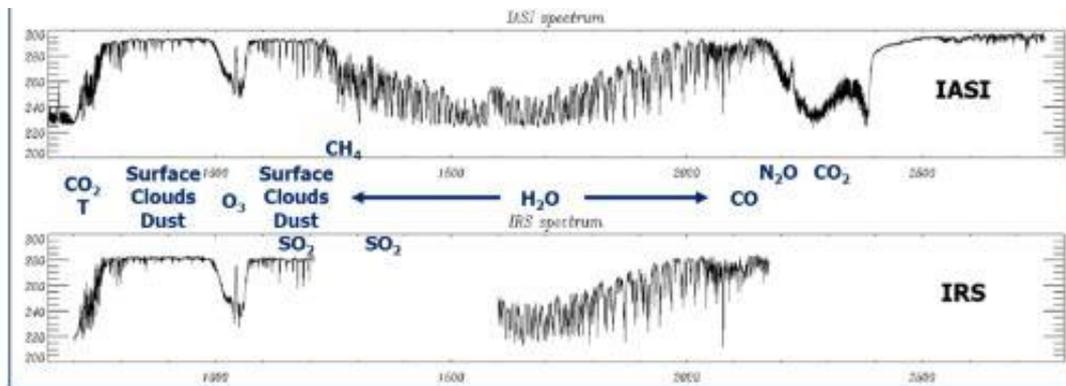
- High frequency hyperspectral sounder in a GEO satellite or a constellation of smallsats to support NWP;
- Synthetic aperture high frequency microwave imager in a **GEO** satellite or constellation of smallsats to improve temporal resolution of atmospheric profiles or precipitation estimates;
- Increase the temporal resolution to **5 minutes for full disk** scan to support nowcasting operations as well some derived products (ex: winds, firespots, precipitation, SST);
- Promote platforms on equatorial orbit ( $\pm 30$  degrees) for precipitation measurements - Brazil is mainly an equatorial country (i.e., radio occultation);

# Next generation satellites - How Brazil could benefit from it?

High frequency hyperspectral IR sounder in a GEO satellite or a constellation of smallsats to support NWP;

- MTG-IRS InfraRed Sounder

- The HyperCube mission
- CIRAS (CubeSat Infrared Atmospheric Sounder)



# Next generation satellites - How Brazil could benefit from it?

Synthetic aperture high frequency microwave imager in a GEO satellite or constellation of smallsats to improve temporal resolution of atmospheric profiles or precipitation estimates;



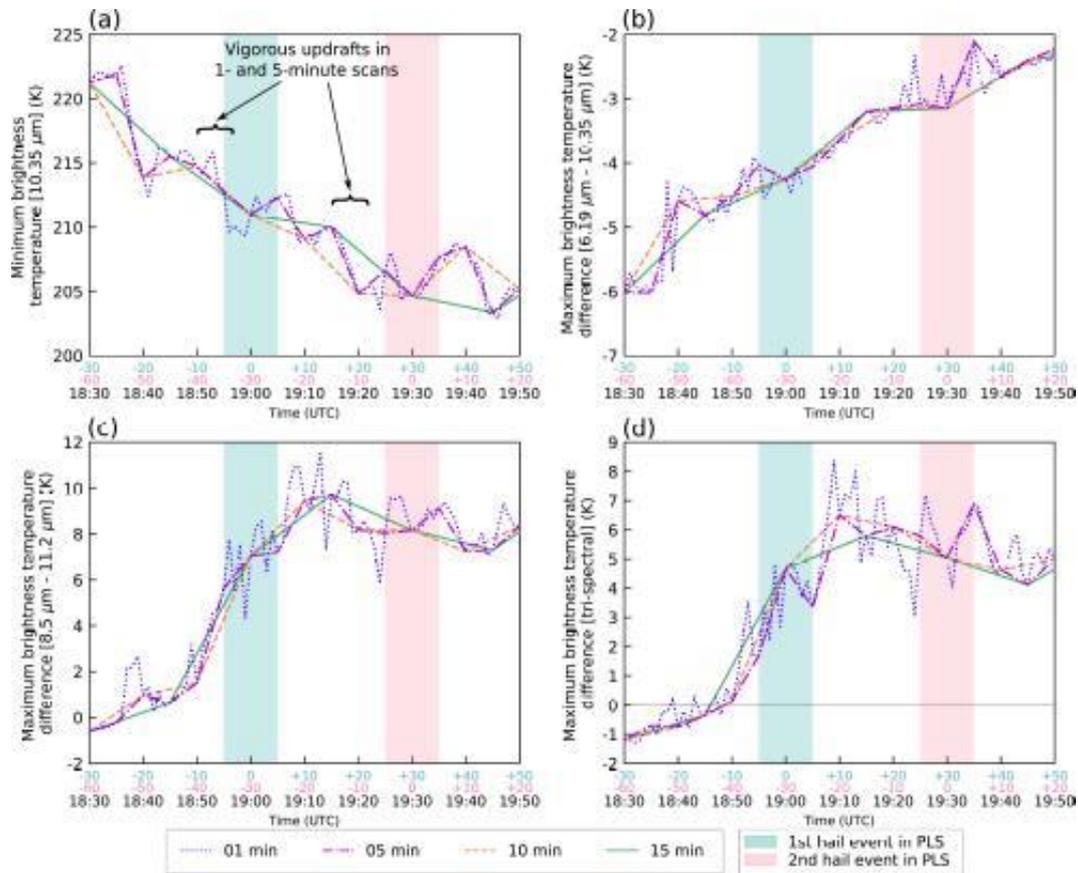
GeoSTAR (Geostationary Synthetic Thinned Aperture Radiometer)



TROPICS (Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats)



# Next generation satellites - How Brazil could benefit from it?



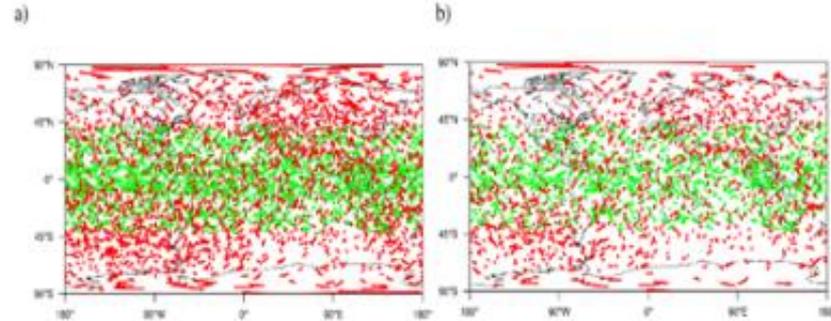
Temporal variations of some satellite-derived parameters each 1 (blue dotted line), 5 (magenta dot-dashed line), 10 (orange dashed line), and 15 (green continuous line) minutes. **The occurrences of vigorous updrafts [8 K (15 min)<sup>-1</sup> decrease in 10.35- $\mu\text{m}$  Tb] noticed in 1- and 5-min scans but not in 10- and 15-min scans are indicated.**

(Ribeiro, B. Z., et al, 2019: An Evaluation of the GOES-16 Rapid Scan for Nowcasting in Southeastern Brazil: Analysis of a Severe Hailstorm Case. *Wea. Forecasting*, 34, 1829–1848)

# Next generation satellites - How Brazil could benefit from it?

Convective-scale data assimilation of radio occultation observations from new generation satellite can improve the representation of the deep convection on Amazon.

The impact of the convective-scale assimilation in the Amazonian region using synthetic radio occultation data simulated from next generation satellites can be explored to evaluate the improvement of the representing convective activity on Amazon;



Cosmic-2 data in different assimilation time window

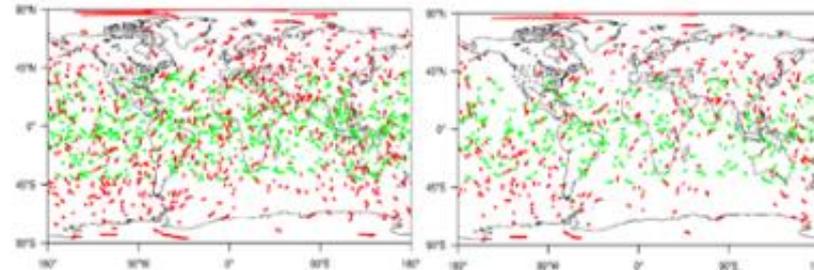


Fig.1. Spatial distribution of the COSMIC-2A (green) and COSMIC-2B (red) observations for (a)  $\pm 3$  hours, (b)  $\pm 2$  hours, (c)  $\pm 1$  hour, and (d)  $\pm 30$  minutes assimilation time windows.



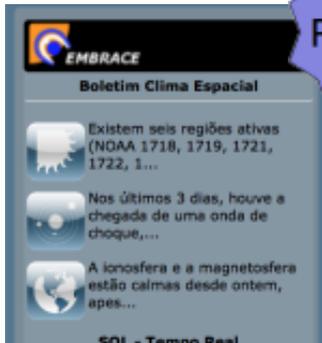
- GEONETCast-Americas low-cost meteorological products receive stations;
- INPE participated in nearly 90% of the installations;
- Many products derived from GOES-R and JPSS are disseminated through the system.



# EMBRACE is a Regional Warning Center in Brazil

Uses EXIS X-Ray Sensor on GOES 16 to issue alerts and will use COSMIC 2 to monitor and understand ionosphere irregularities

Daily Bulletins

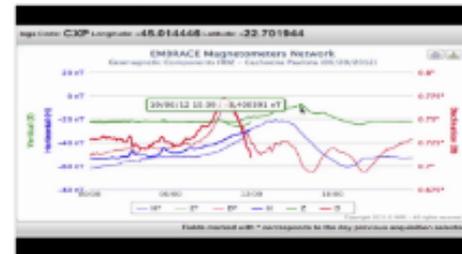


Products

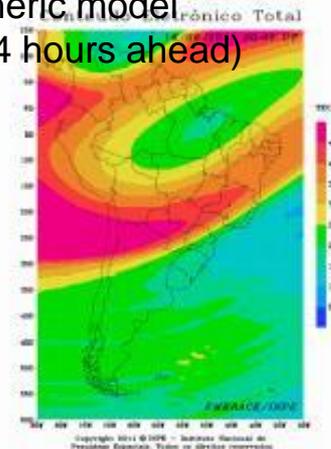
GOES burst alerter



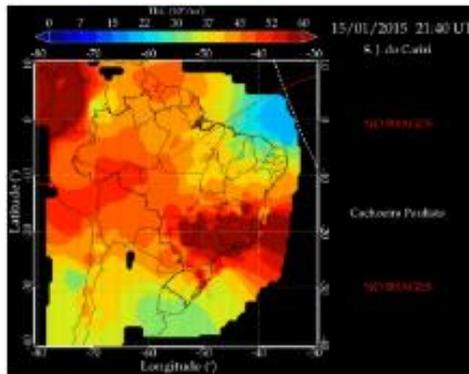
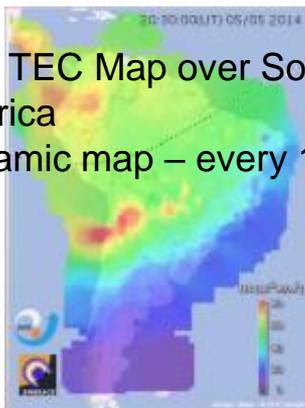
Easy data handling



Ionospheric model (TEC 24 hours ahead)



GPS TEC Map over South America (dynamic map – every 10 min)



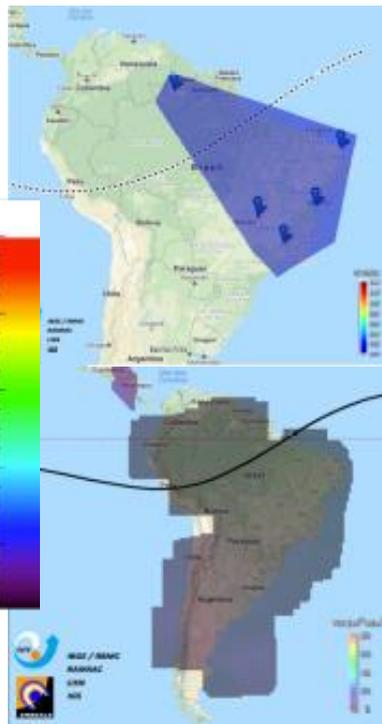
Plasma bubbles and scintillations (realtime)

# EMBRACE - Studies using COSMIC 2



Antenna in Cuiabá

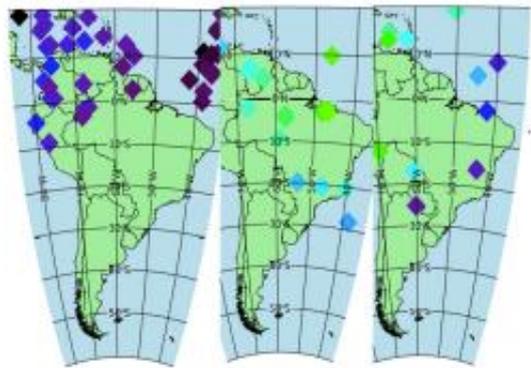
## Ground observations



Using observations of ground network and COSMIC 2, EMBRACE will cross calibrate and get vertical profiles of Ionospheric irregularities using Ne, TEC and S4:

- Pre-reversal enhancement and comparison with digisondes.
- Effects of Geomagnetic Storms (Electric Field Disturbance Dynamo)
- Longitudinal Variability of TEC day-by-day
- Plasma Bubble Seeding and Development
- E-Layer
- Gravity Wave Activity in Neutral Atmosphere
- 3D reconstruction of Ionospheric electron density.

South America Map 2020-07-20T03:00:00; Africa Map 2020-07-20T14:00:00; Asia Map 2020-07-20T21:50:00



**COSMIC 2 data**

Needs real time data!

Thank you!