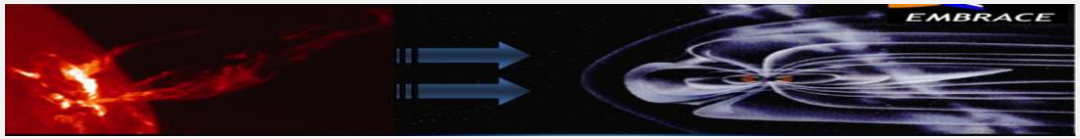


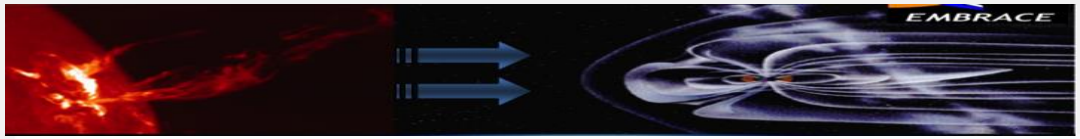
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE

Brazilian Space Weather Program:

EMBRACE

Presented by:
J.E.R.Costa



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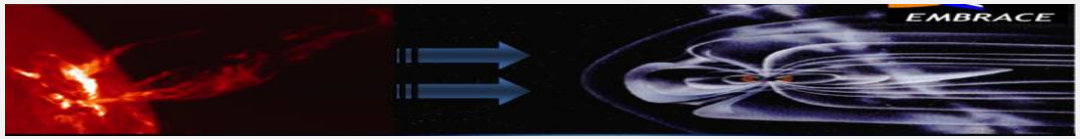
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE

Brazilian Studies and Monitoring of Space Weather

INAUGURATION YEAR

Space Weather Workshop – Boulder-CO
23-27 April, 2012



OUR PLAN

The program has a focus on monitoring the regions of the equatorial Ionosphere and the SAMA (South America Magnetic Anomaly). The main concerns are to model peculiarities of the Brazilian Ionosphere such as equatorial electrojet, the ionization anomaly, the plasma bubbles and the consequences for radio propagations

- Program started in 2008 with a four-year installation plan (plus one).
- EMBRACE is aimed to establish a “Space Weather Information and Prediction Centre”.
- Plans to establish and enhance INPE’s ground based monitoring systems.
- Ionospheric modeling with IT applications on the web for alerts, monitoring and predictions.

ROUTE TO TODAY

South America Singularities

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INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

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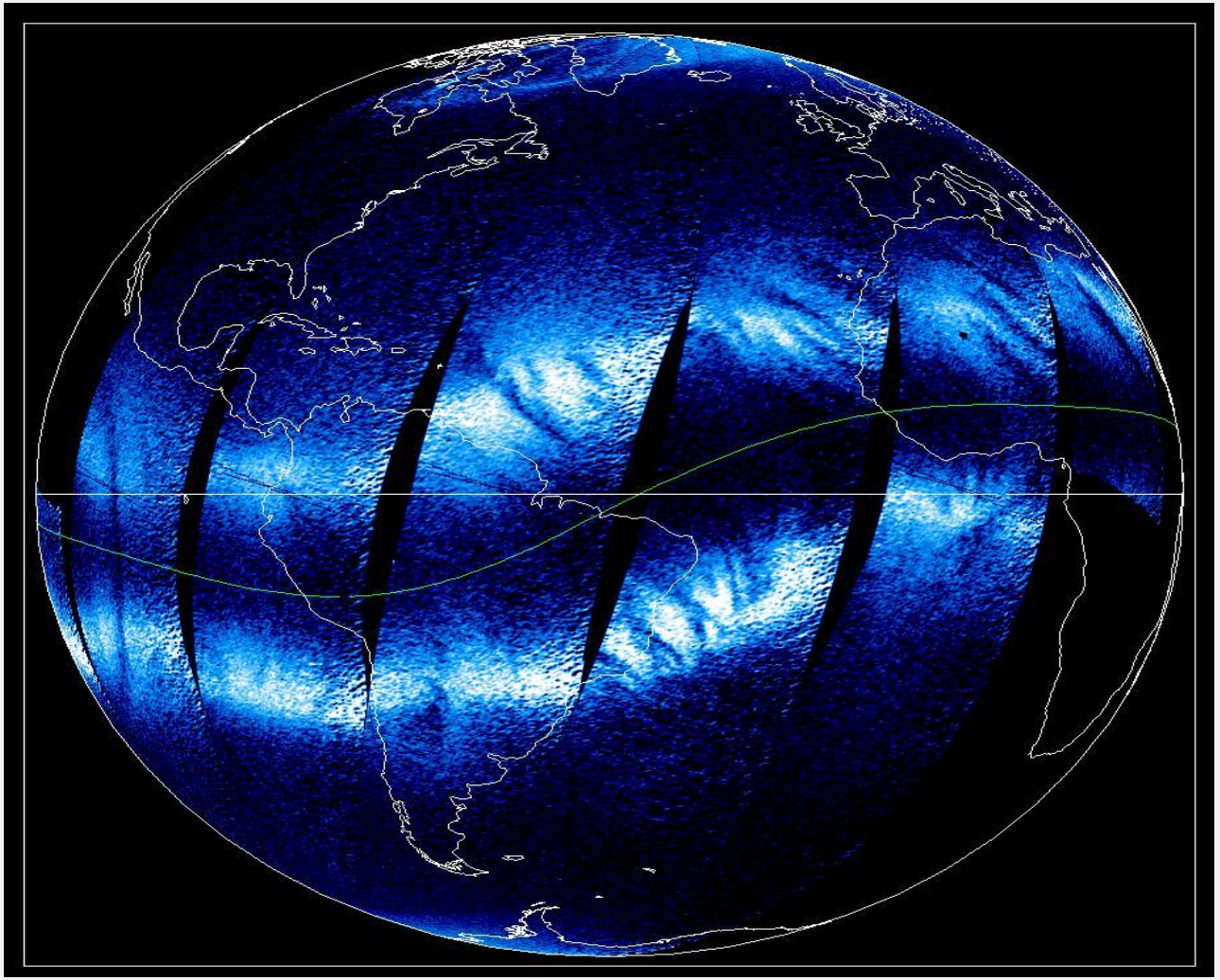
EQUATORIAL ANOMALY AND PLASMA BUBBLES



Ionosphere Irregularities

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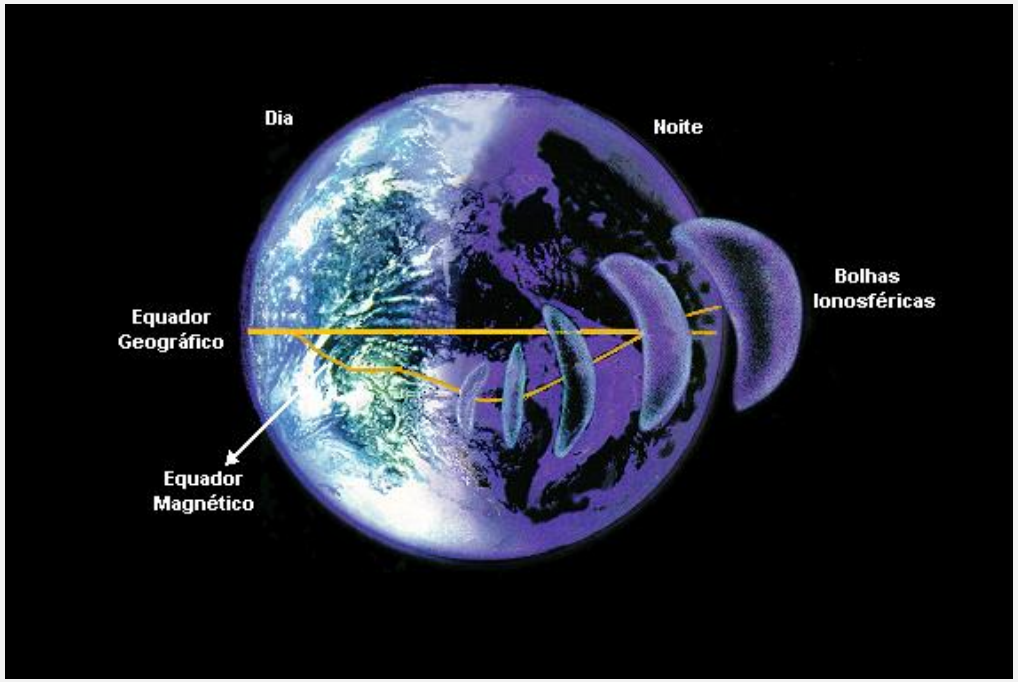
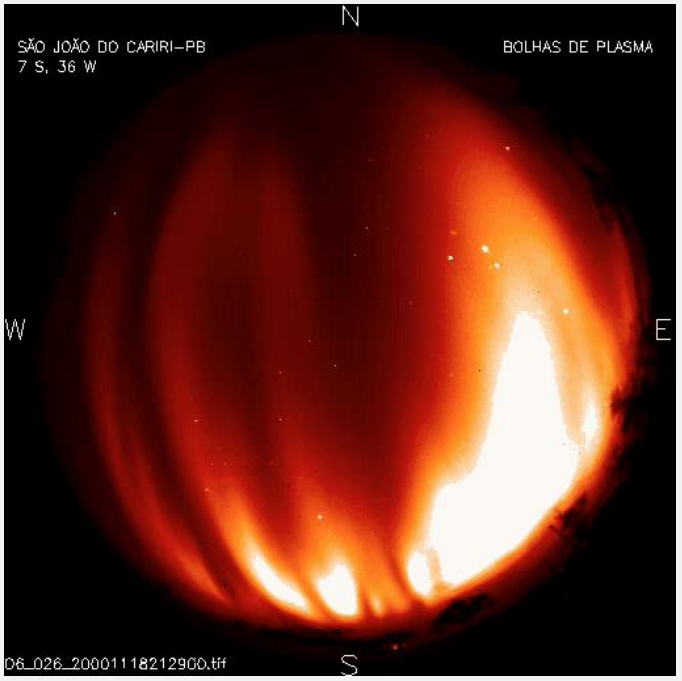
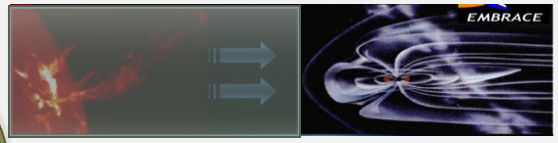
EQUATORIAL PLASMA BUBBLES





South America Singularities



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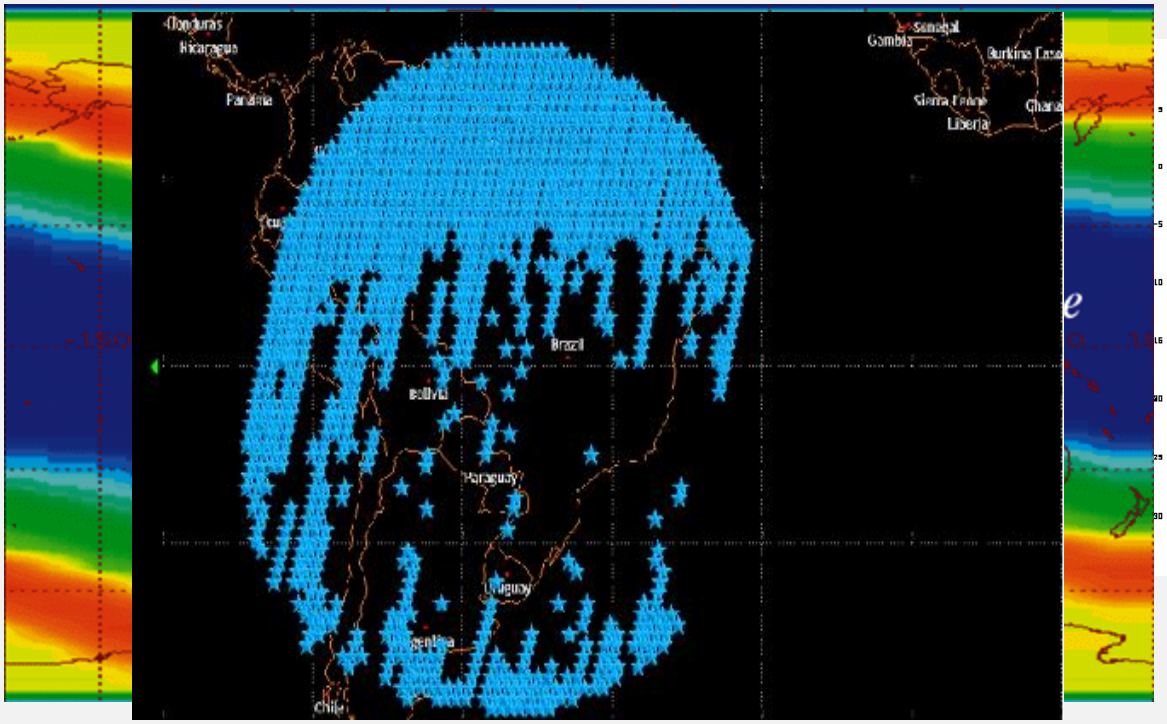
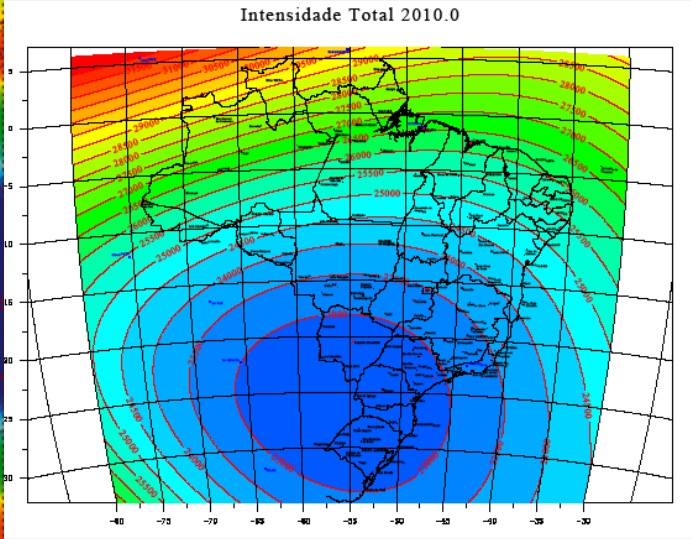
SOUTH AMERICA MAGNETIC ANOMALY



GEOMAGNETIC FIELD INTENSITY OVER SOUTH AMERICA



Courtesy of National Observatory, Brazil

Figure: Protons and electron flux greater than 0.5 MeV in low Earth orbit measured by the NASA/SAMPEX satellite.
SAMPEX (Solar Anomalous and Magnetospheric Particle Explorer)
(Source: www.aero.org)

SAMA region:

from 26,000 to 23,000 nT

in the last 100 years,

12 % of decrease

Regional Centre & Instruments Pipeline

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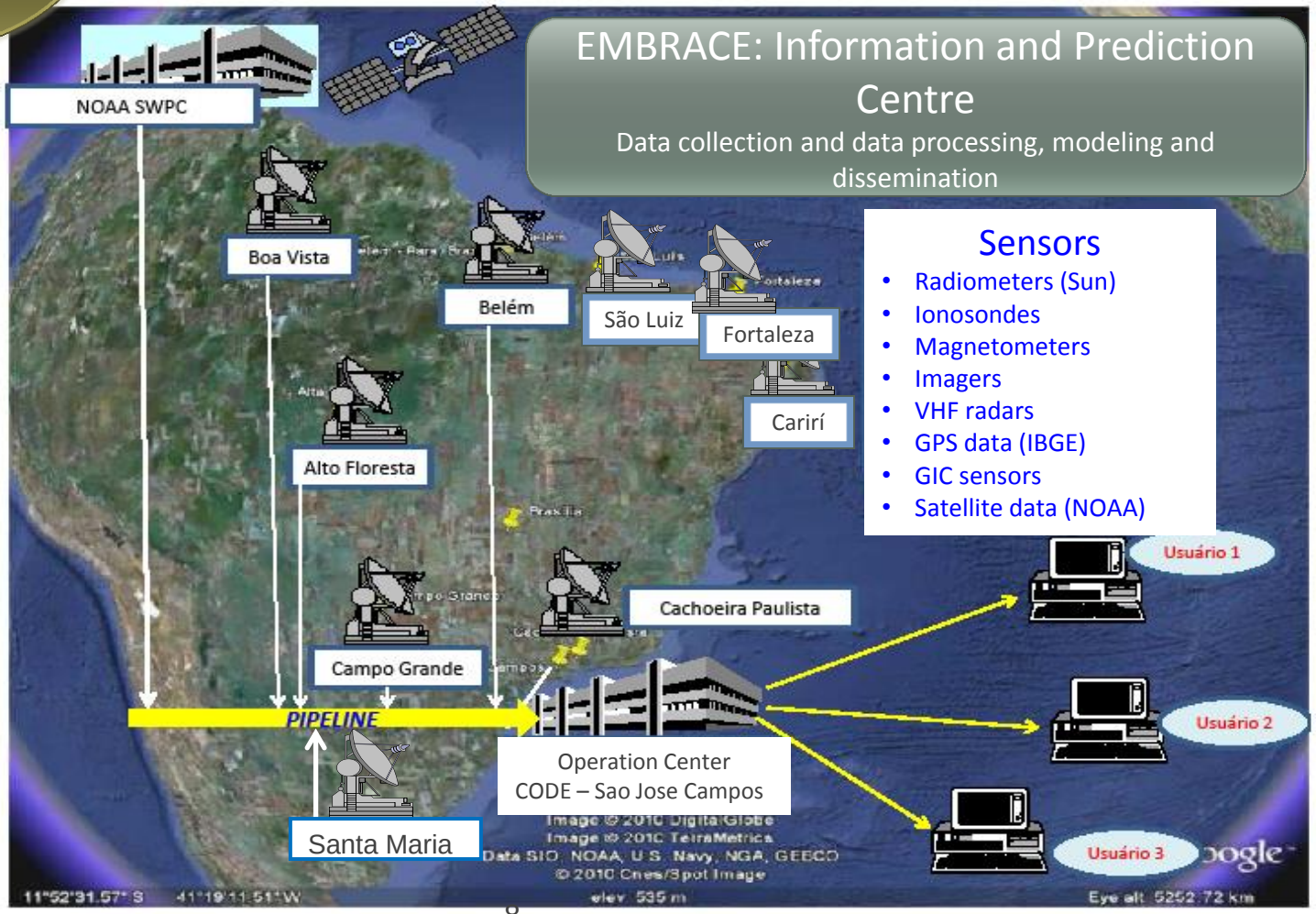
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE'S DATA COLLECTION AND FLOW



Solar 10.7cm Images

Sun

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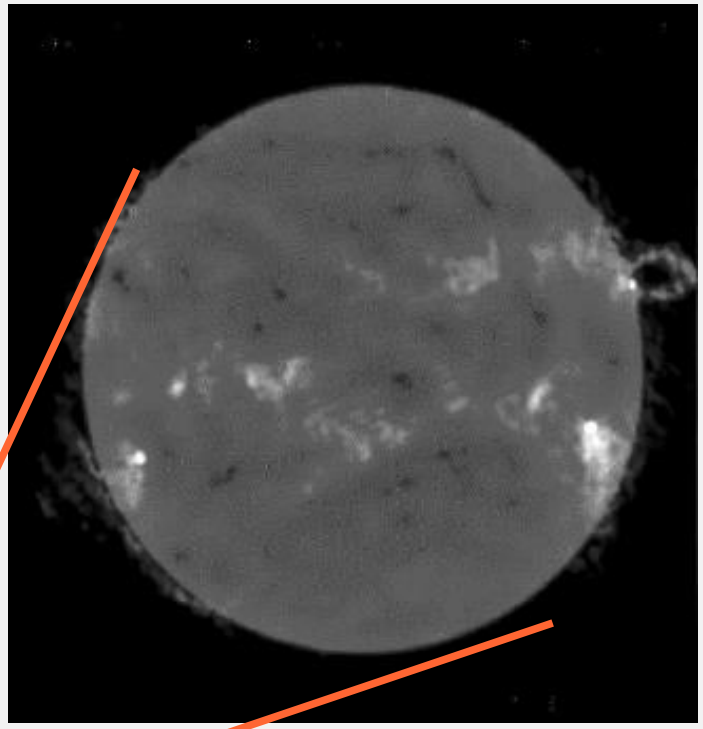
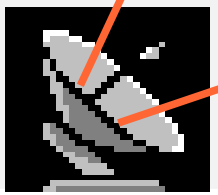
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS
EMBRACE

FLUX DENSITY MEASUREMENTS

Today radio emission at 10.7 cm (2.8 GHz) is spatially integrated and is the best solar activity index

- *F10.7cm (**2.8 GHz**) measures the magnetic field organization of the active regions.*
- *BDA will make maps of the Sun from 1.2 à 1.7 GHz in future will observe **2.8 GHz.***
- *BDA operations will start late this year. EMBRACE will look forward changes in the atmosphere are more relevant*





Solar Radio Tasks

Sun

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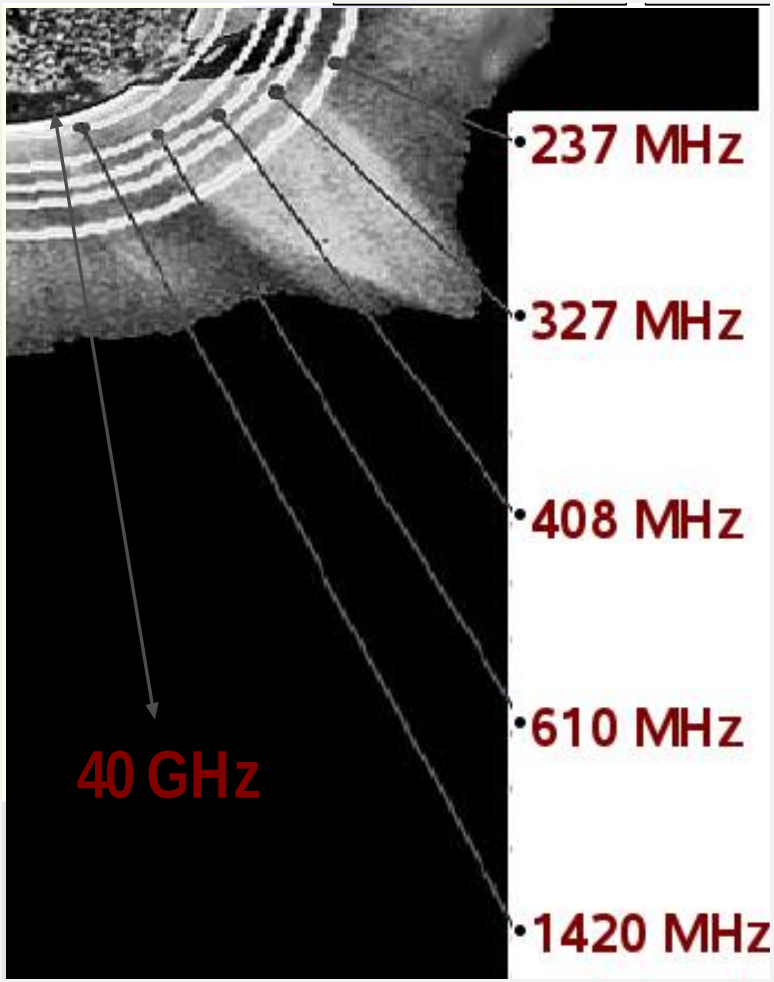
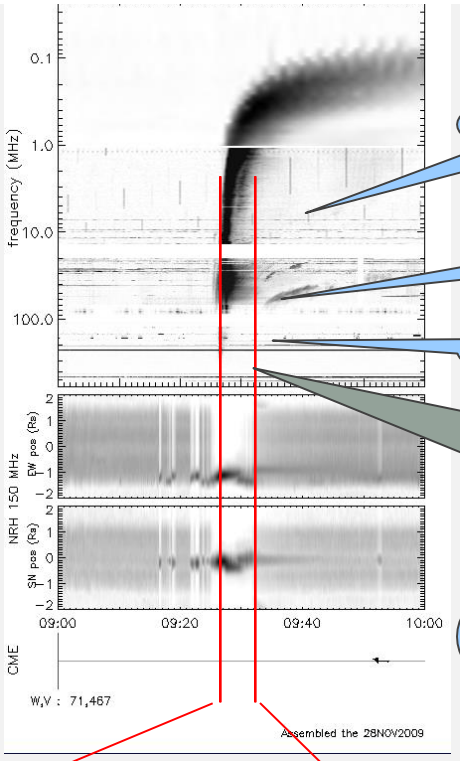
SIGNATURE OF DYNAMICAL PHENOMENA

DYNAMIC SPECTRUM





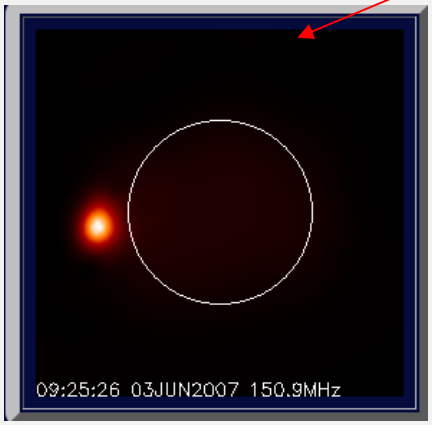
In space

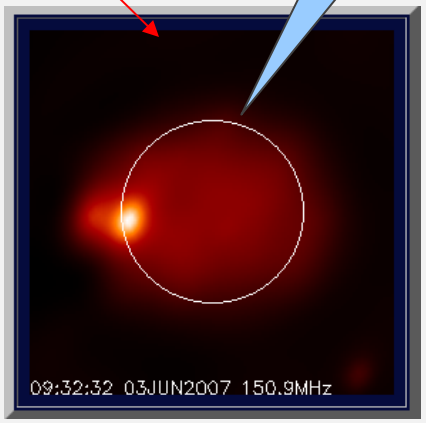
CALLISTO

BSS

SPECM

BDA





Solar Instruments Cachoeira Paulista

Sun

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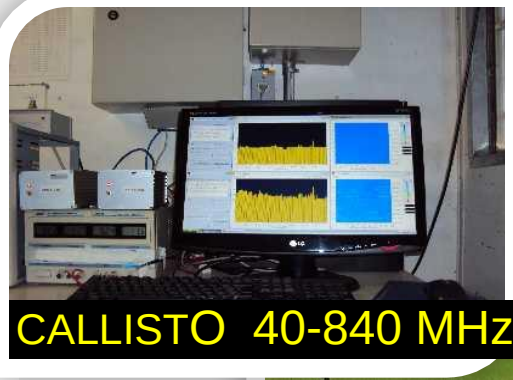
EMBRACE

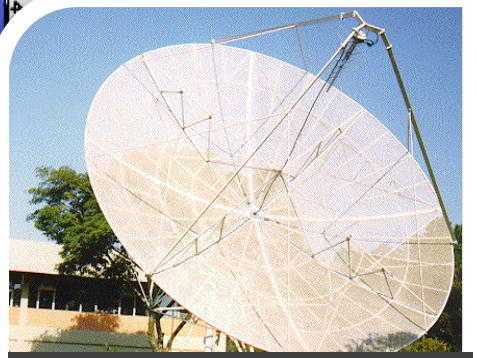
SOLAR MONITORING



CALLISTO 40-840 MHz

BDA 1.2, 1.7, 2.8, and 5.6 GHz

Cachoeira Paulista



BSS 1.0 - 2.5 GHz

SPECM 1-40 GHz

Solar Instruments Atibaia

Sun

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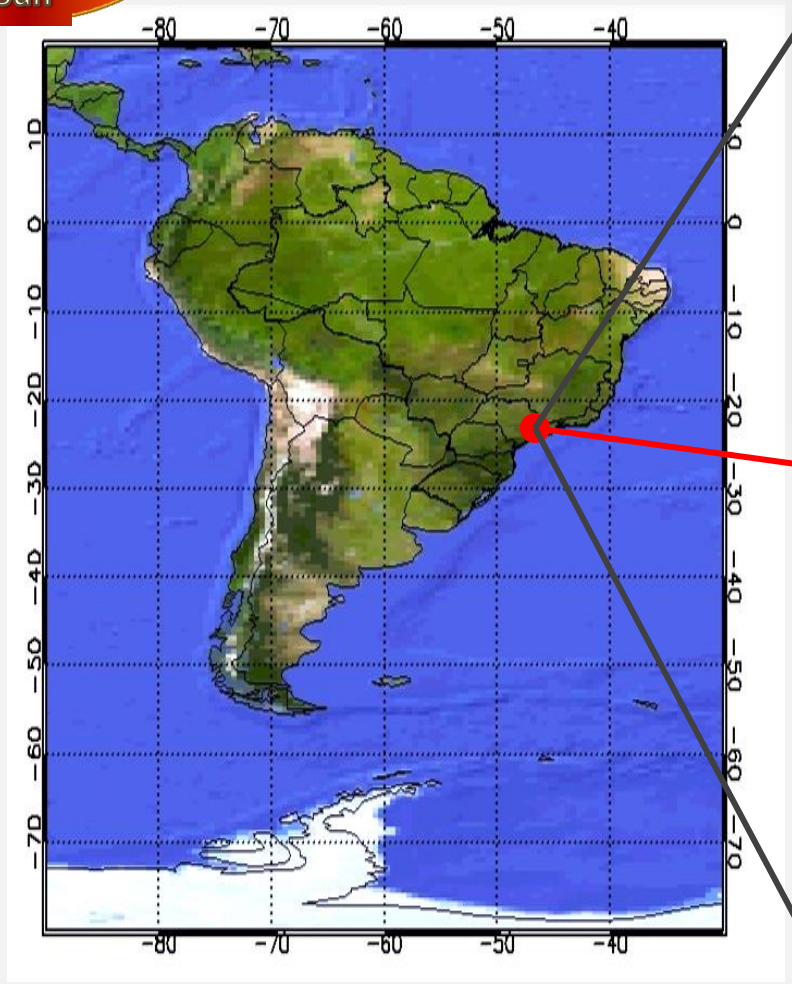
SOLAR MONITORING



Atibaia

Solar Instrument SPUA

Sun

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EMBRACE

SOLAR MONITORING

ALERT SYSTEM: SPUA

12GHz

No Flares for now

SPUA Operation Mode: Sun Tracking

Solar Patrol Un-phased Array (SPUA)

Search Data:

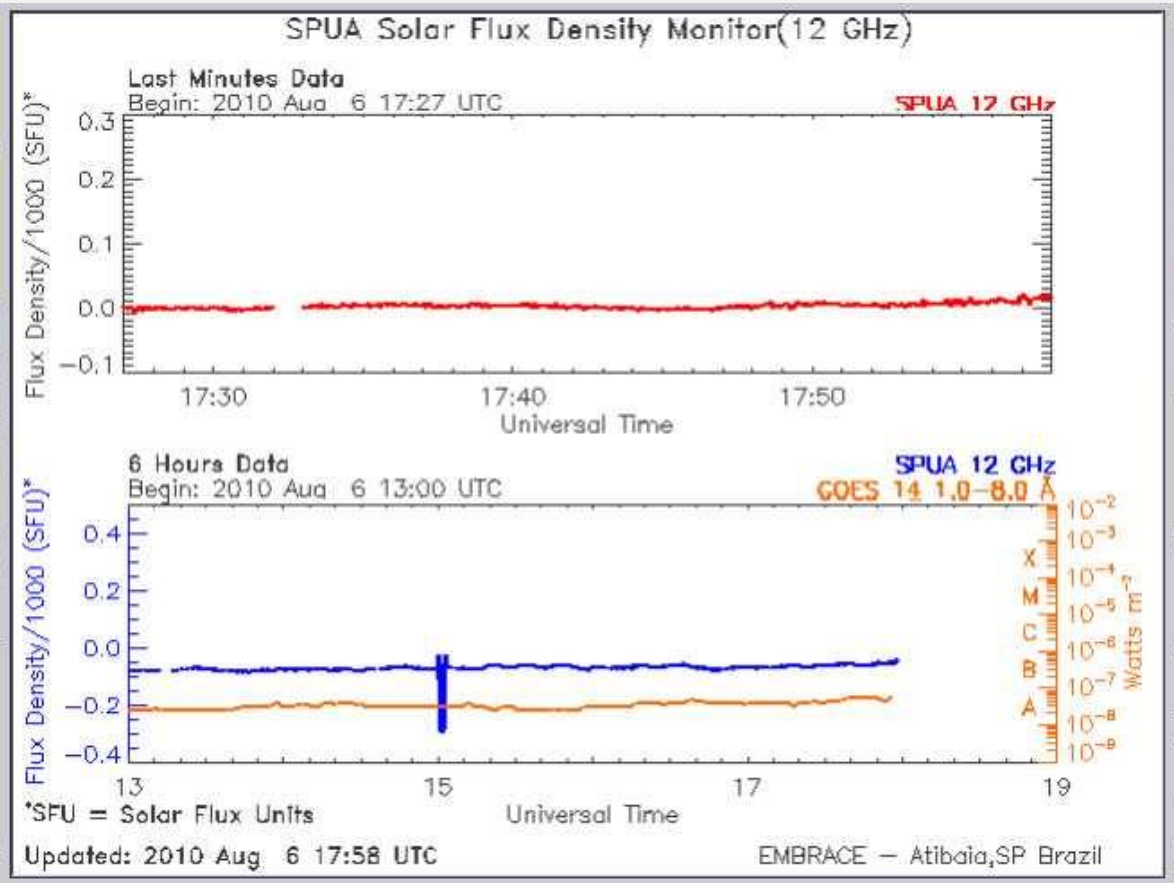
August

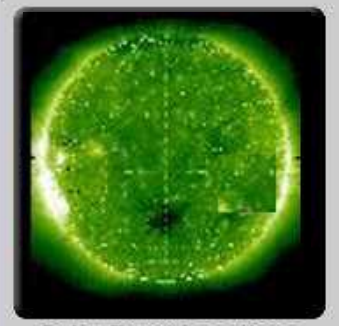
06

2010

Ok

Best View: 1024 x 768 pixels





Solar Burst Locations
(external source maps)

Last Burst
Heliographic Coordinates:

The observed flux density time profile at 12 GHz with **0.1 s** resolution is calibrated in **Solar Flux Units (SFU)** above the solar background.

The observing period is about **11:00 to 20:00 UTC**.

Automatic **calibrations** are done at **12:00, 15:00 and 18:00 UTC**.

Earlier today

This page updates dynamically every minute

Tomorrow

Solar Instrument SPUA

Sun

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EMBRACE

SOLAR MONITORING

ALERT SYSTEM: SPUA

NOW BURSTING

SPUA Operation Mode: Sun Tracking

Solar Patrol Un-phased Array (SPUA)

Search Data:

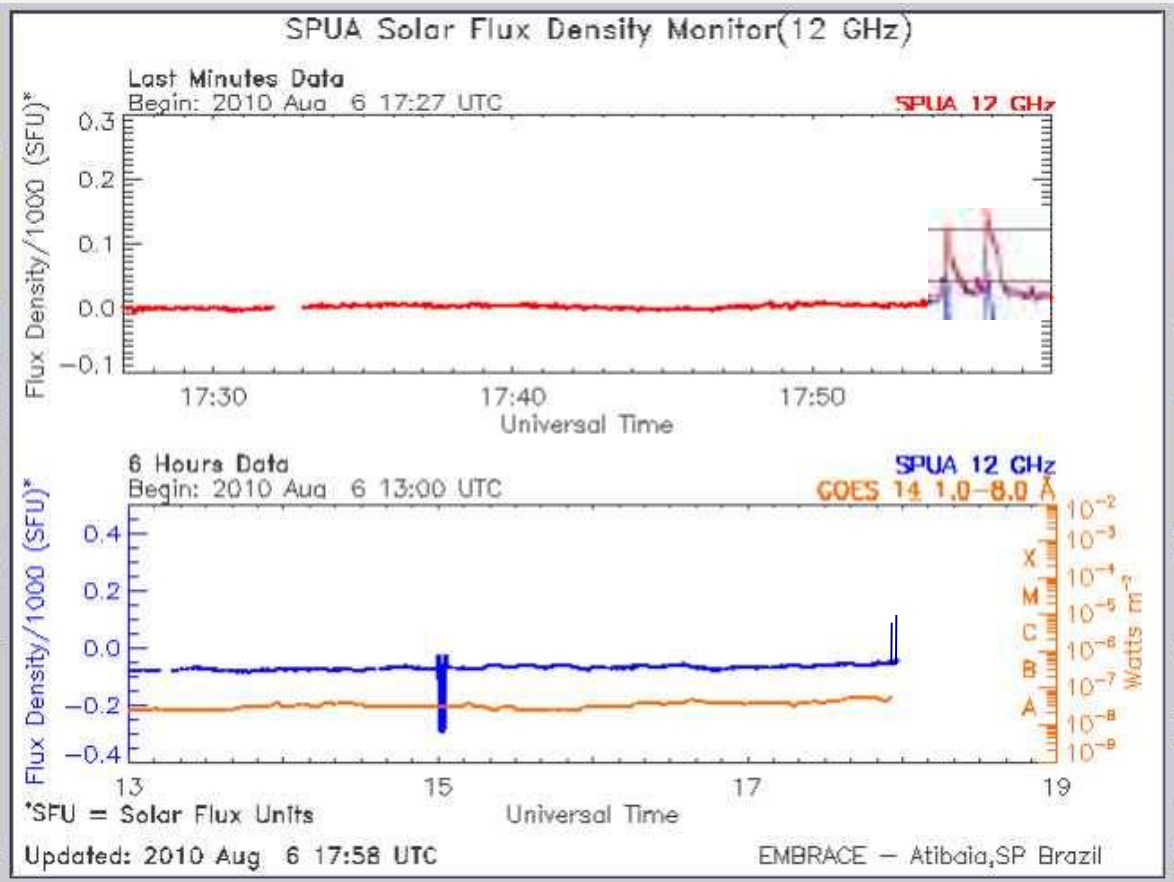
August

06

2010

Ok

Best View: 1024 x 768 pixels



Solar Burst Locations
(external source maps)

Last Burst
Heliographic Coordinates:
S 14 W 40

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Earlier today

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Tomorrow

Solar Instrument CALLISTO

Sun

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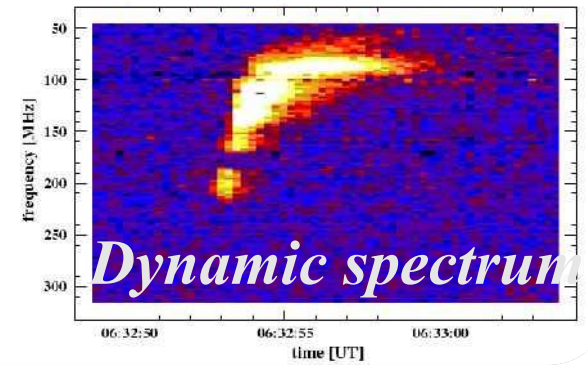
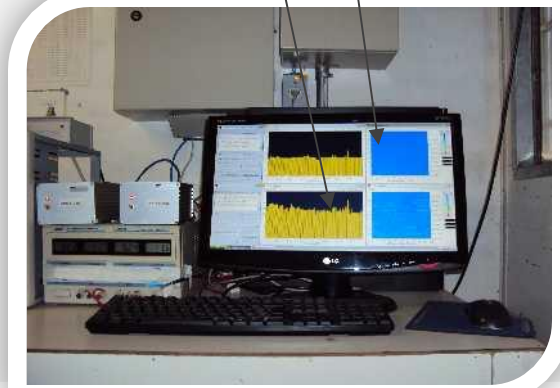
EMBRACE

SOLAR MONITORING



40-840MHz



Solar Instrument BSS

Sun

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SOLAR MONITORING

Feed 1-2.5GHz

Control Room

Receiver

Solar Instrument SPECM

Sun

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SOLAR MONITORING

- Ultra High Band under Construction

- feed 1-18GHz

- feed 26-40GHz

Solar Instrument BDA

Sun

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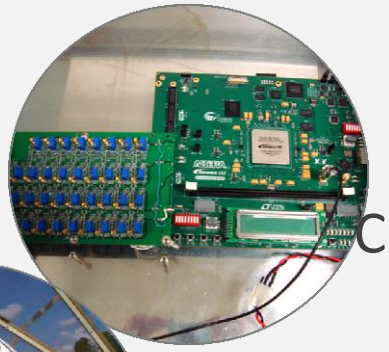
SOLAR MONITORING



Correlator

Feed & Preamp
1.2-1.7GHz

Receivers

Optical connections

Solar
Ground Based
Observatories

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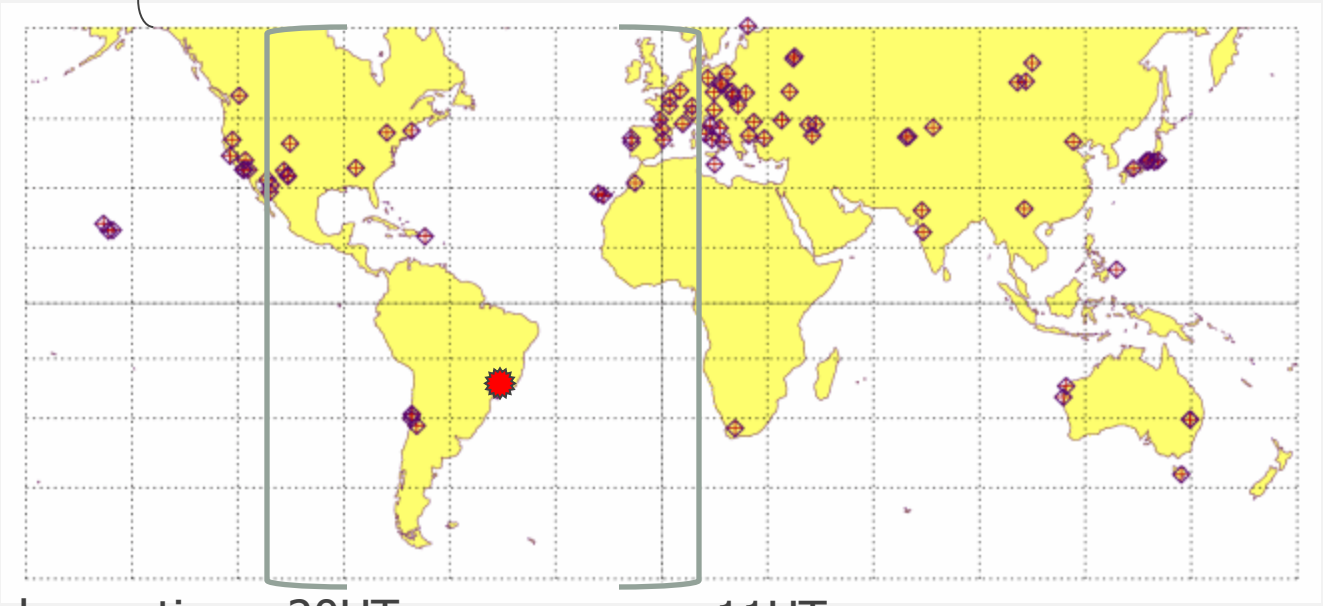
SOLAR MONITORING

- SPECM (1-40 GHz, HPBW:0.6-10º)
- BSS (1-2.7 GHz, HPBW:1.0-1.2º)
- BDA (1-6 GHz , HPBW:0.6-1 arcmin)
- Itapetinga (22, 48 GHz , HPBW: 4, 2 arcmin)

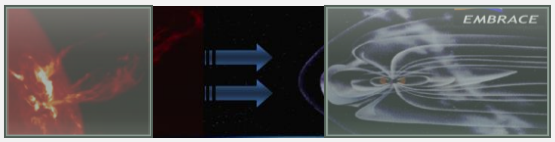


EMBRACE observation ~20UT ← ~11UT

http://www.arcetri.astro.it/~kreardon/EGSO/gbo/

I.M.
Instrument
Muon

I.M.



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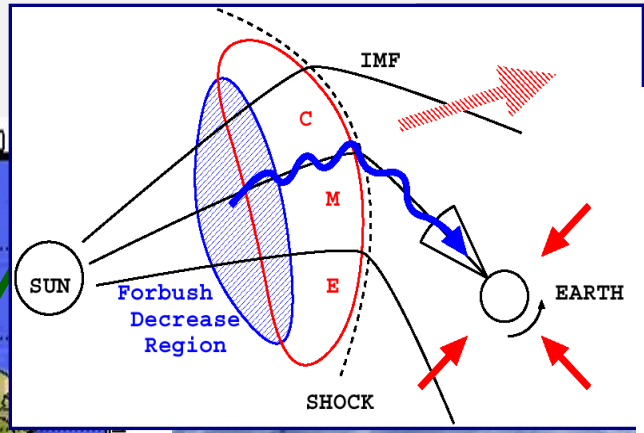
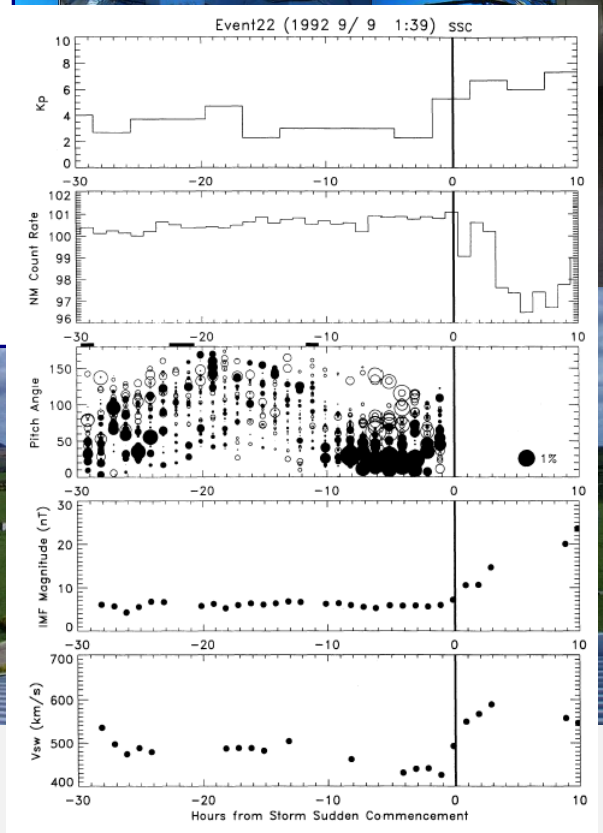
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE

COSMIC RAY MONITORING BY MUON DETECTOR TO PREDICT MAGNETIC STORM IN 6-8 HOURS





Munakata etal, JGR.2000

São Martinho da Serra
Santa Maria *(S29, W53)*

Magnetosphere
Instrument
Magnetormeter

Ionosphere&Earth

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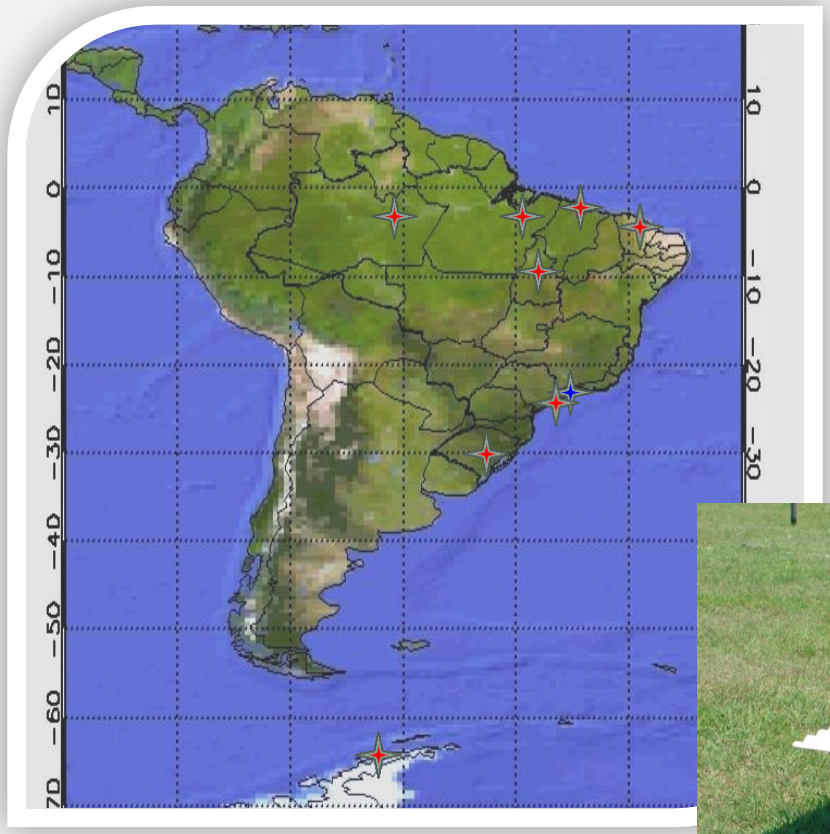
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE

MAGNETOMETERS NETWORK



- BLM (01°26'28" S, 48°26'40" W)
- MAN (02°54'52" S, 59°59'40" W)
- SLZ (02°35'36" S, 44°12'43" W)
- EUS (03°52'48" S, 38°25'28" W)
- PAL (10°17'50" S, 48°21'41" W)
- CXP (22°42'07" S, 45°00'52" W)
- SJC (23°12'38" S, 45°57'23" W)
- SMS (29°26'36" S, 53°49'22" W)
- FRZ (62°05'06" S, 58°24'12" W)

Ionosphere
Instrument
Ionosonde

Ionosphere&Earth

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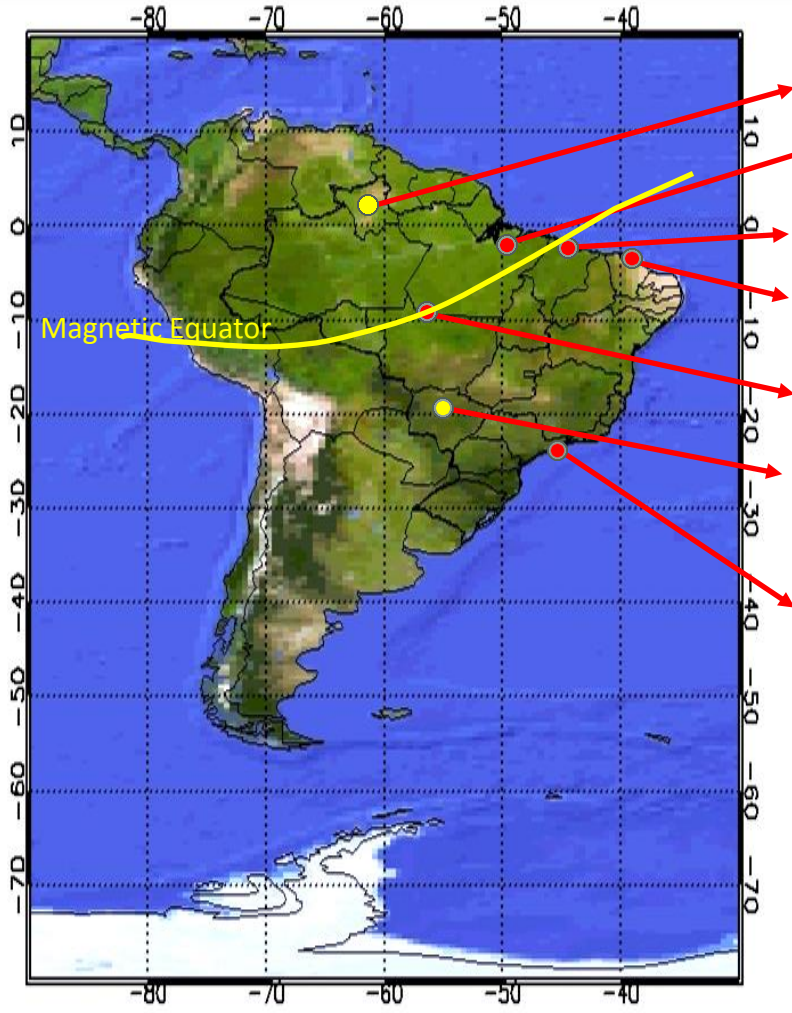
IONOSONDES



- Boa Vista
- Belém
- São Luiz
- Fortaleza
- Alta Floresta
- Campo Grande
- Cachoeira Paulista

Installed & Working

To be installed

Ionosphere
Instrument
Ionosonde

Ionosphere&Earth

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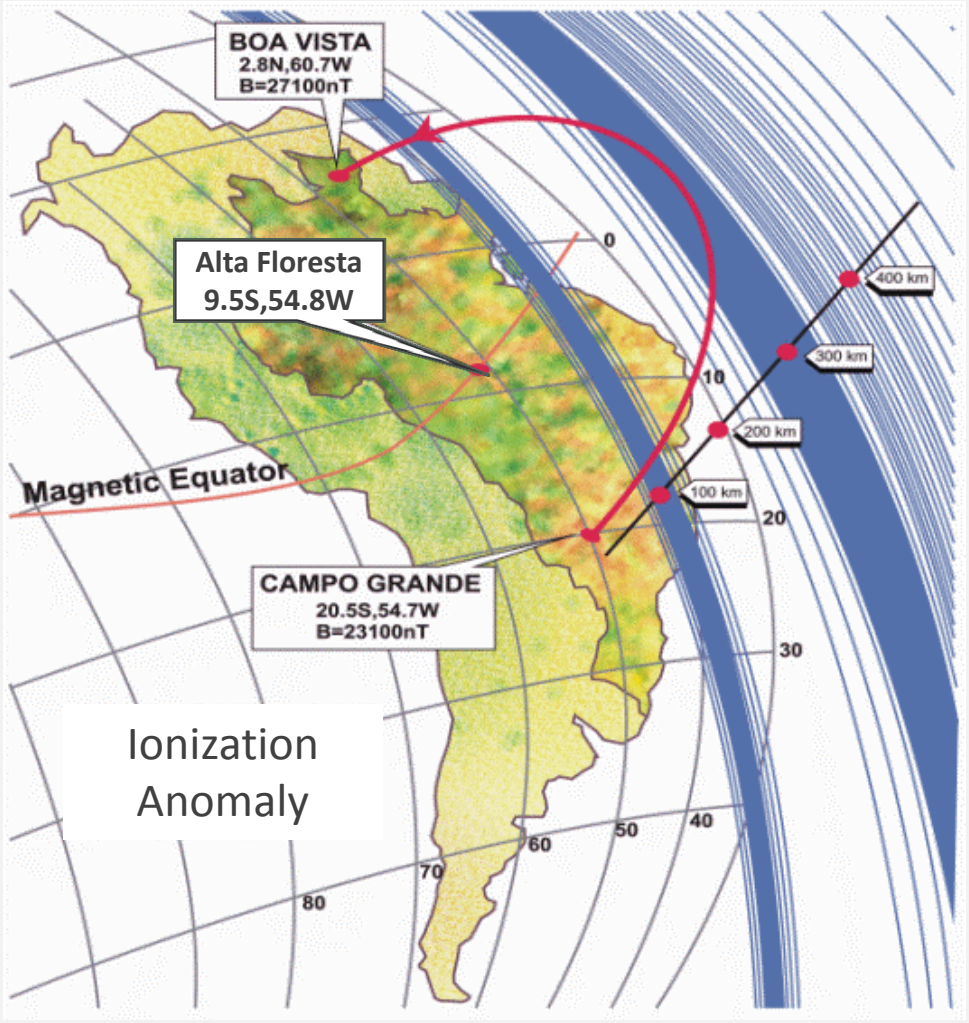
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE

CONJUGATE POINTS



Ionosphere Instrument GPS

Ionosphere&Earth

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GPS RECEIVERS FOR SCINTILLATION MONITORING

LISN / NSF

Alta Floresta-MT
Belo Horizonte-MG
Boa Vista-RR
Brasília-DF
Cuiabá-MT
Dourados-MS
Ilhéus-BA
Imperatriz-MA
Natal-RN
Parintins-AM
Petrolina-PE
Porto Velho-RO
Rio Branco-AC
Santa Maria-RS
São Luís-MA
São José dos Campos-SP
Santarém-PA
Tefé-AM

SCINTEC

Belem-PA
Belo Horizonte-MG
Boa Vista-RR
Brasilia-DF
Cachoeira Paulista-SP
Cuiabá-MT
Manaus-AM
Natal-RN
Palmas-PR
Presidente Prudente-SP
Santa Maria-RS
São João do Cariri-PB
São José dos Campos-SP
São Luís-MA
Tefé-AM

Ionosphere Instrument GPS

Ionosphere&Earth

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INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

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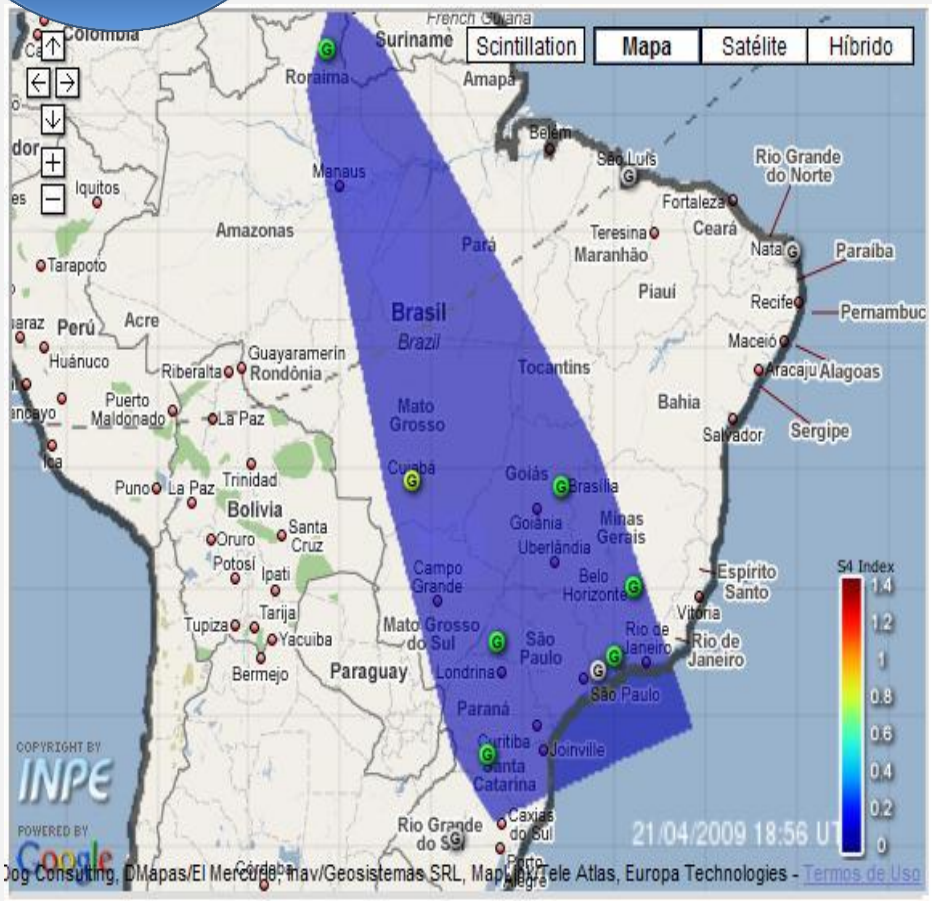
S4 AND POSITIONING ERROR RANGES

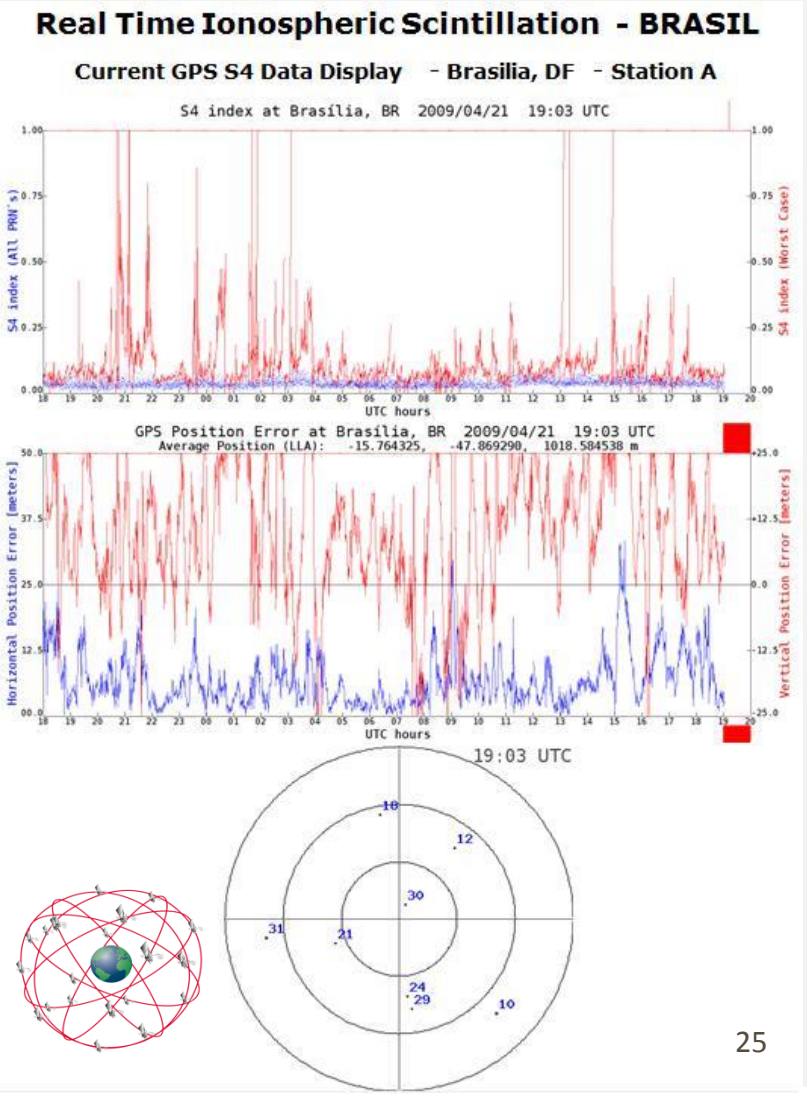


Network Status: 64% | Scintillation Map: On

Larger scintillation: 0.13 in the satellite 10 from Presidente Prudente, BR.

Put the mouse over the stations to get more informations or click to get scintillation plots, errors, azimuth and elevation angle.

CAPTION	
Online	> 3min
> 1min	> 6min
	Offline



Ionosphere Instrument GPS

Ionosphere&Earth

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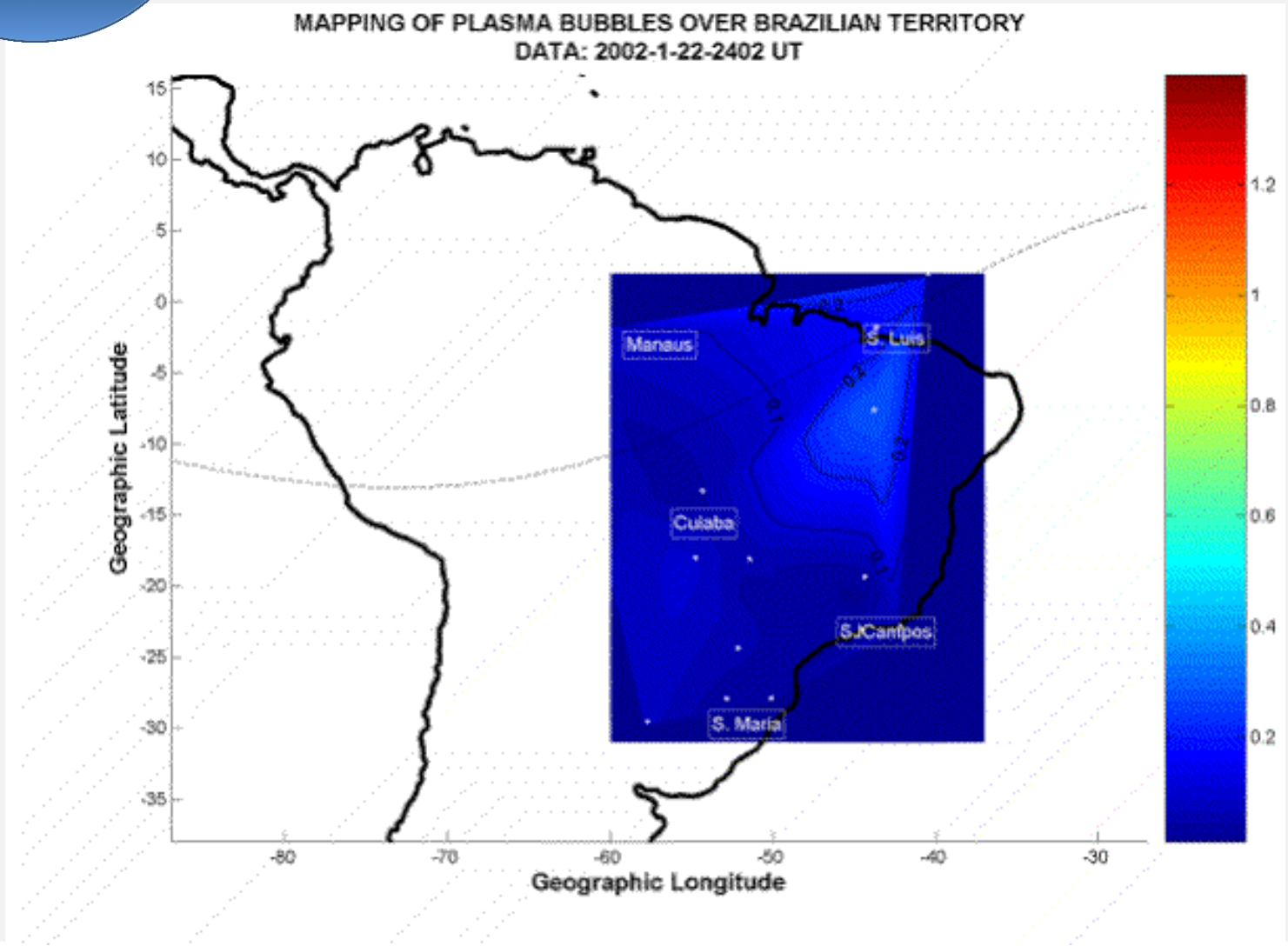
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE

IONOSPHERE SCINTILLATION MAP OVER BRAZIL



Ionosphere Instrument GPS

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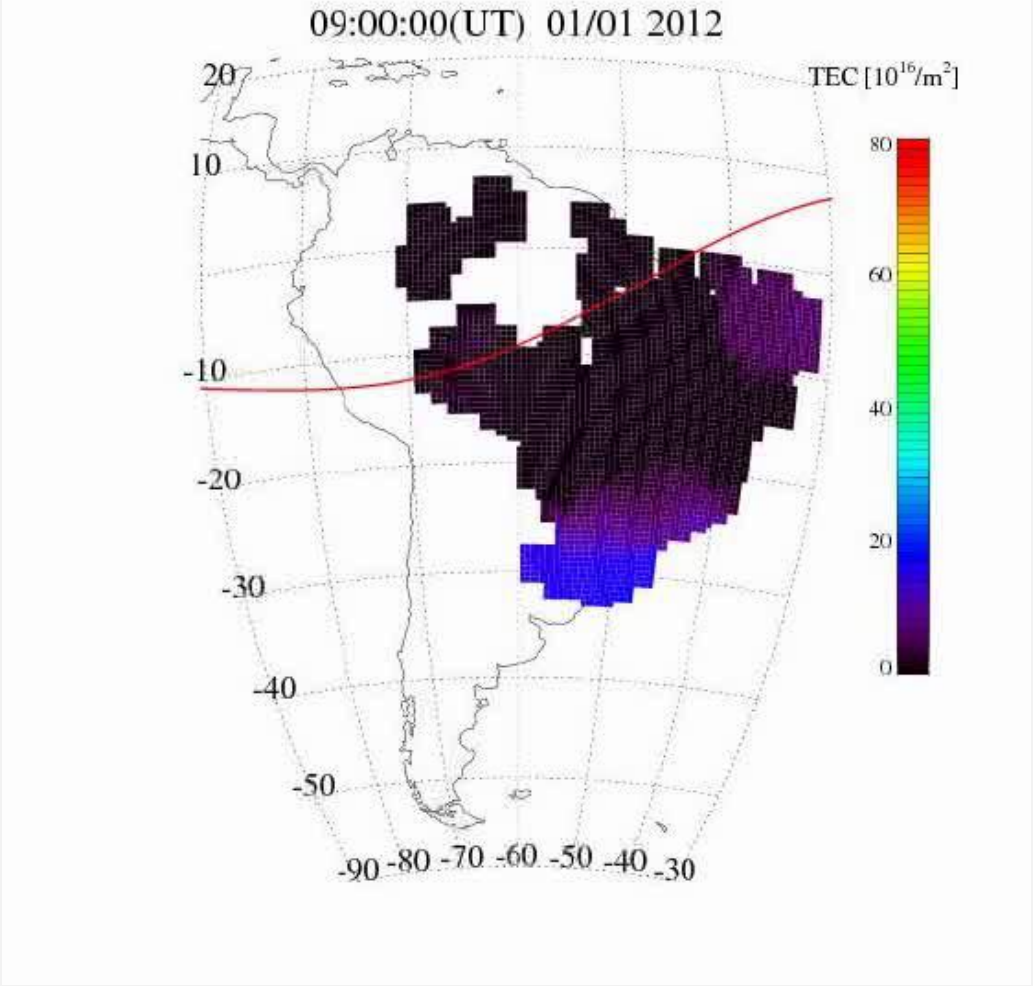
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

EMBRACE

GPSTEC MAPPING: 24 HOURS

2012 January 01, 9:00 – 02, 9:00 UT (24 hours)



IBGE RINEX data file
TEC Mapping code by STEL Nagoya University (Y. Otsuka)

Sheffield Ionosphere Model

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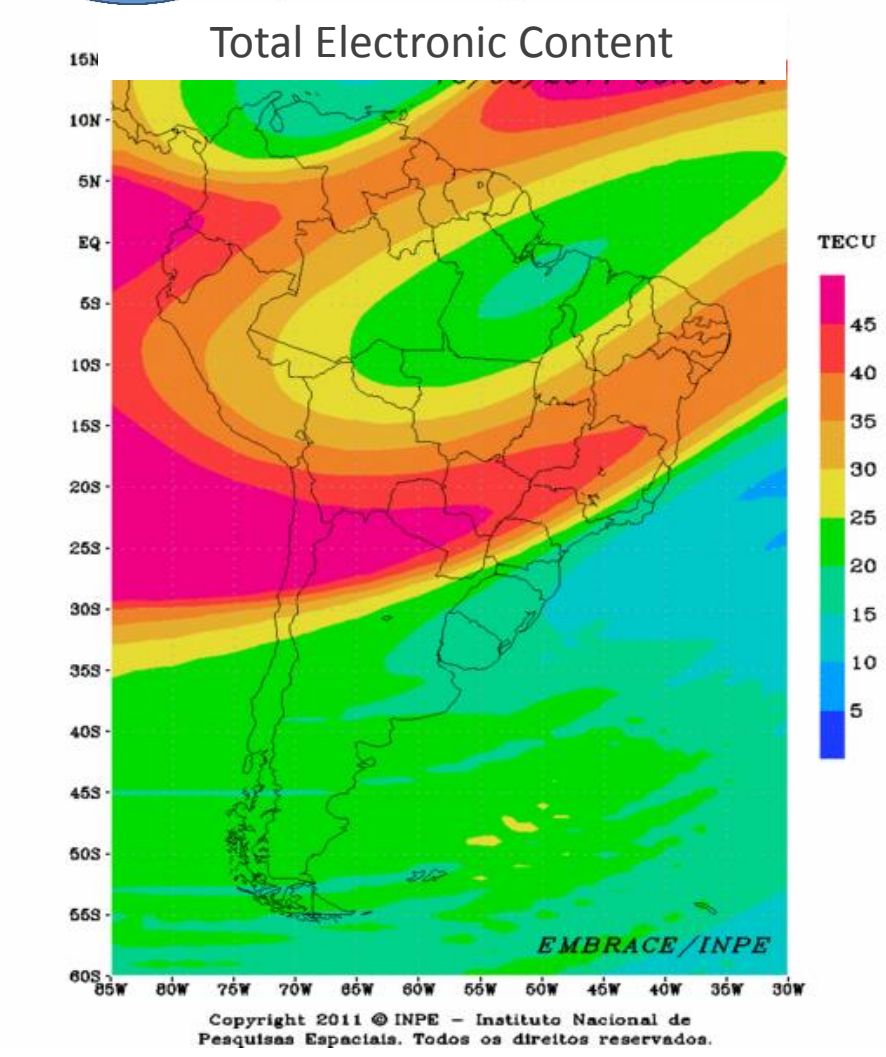
SUPIM – IONOSPHERE MODEL



This simulation were obtained from the SUPIM (Sheffield University Plasmasphere Ionosphere Model), a co-development of the Aeronomy Division of the CEA/INPE with the University of Sheffield and with the computational improvements by the Computer Lab for Space Weather at the SSO/INPE and by the Computer Lab for Mathematical and Science at the ETE/INPE.

Sheffield Ionosphere Model

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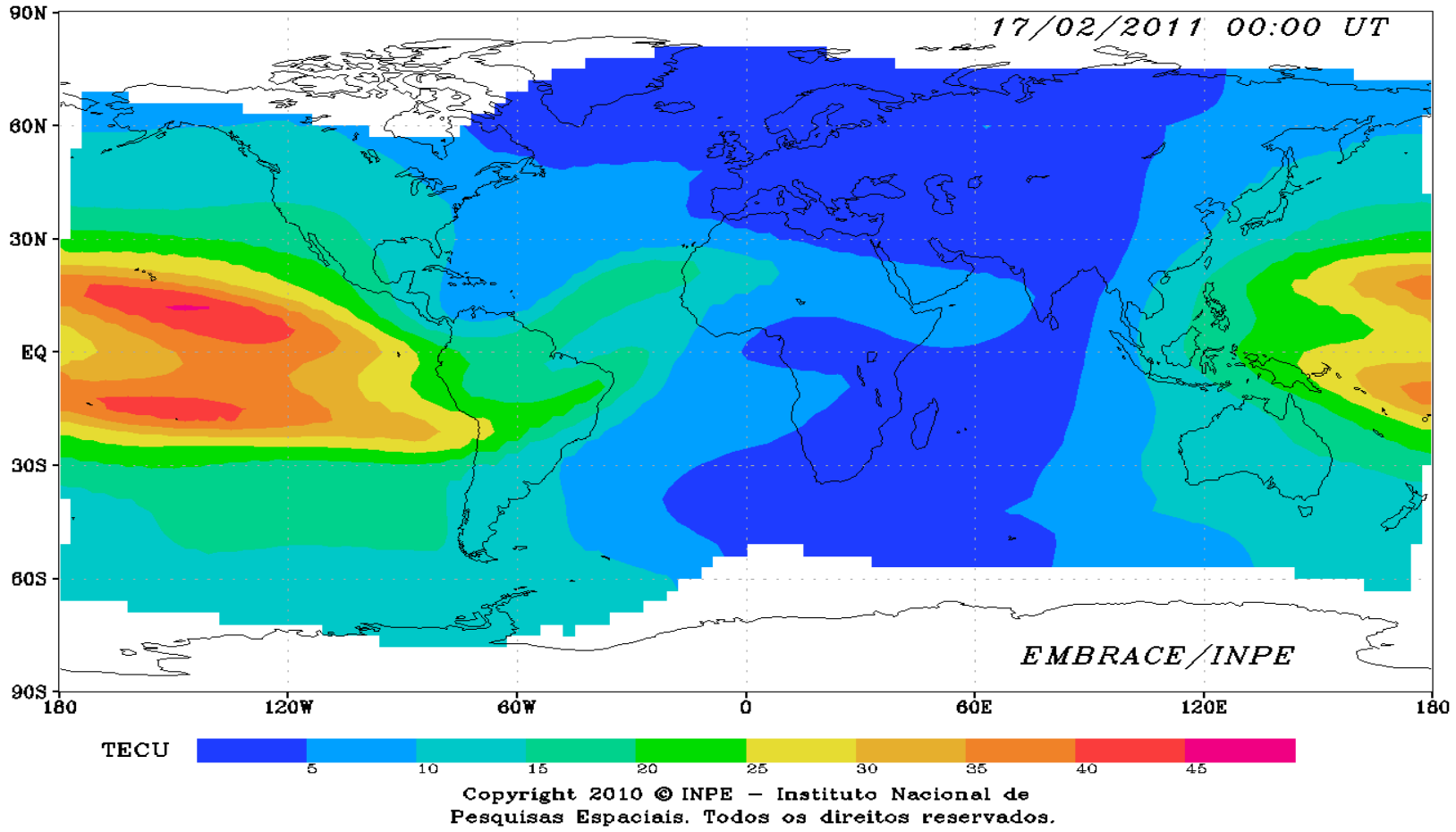
GLOBAL MODEL

TOTAL ELECTRON CONTENT



Sheffield Ionosphere Model

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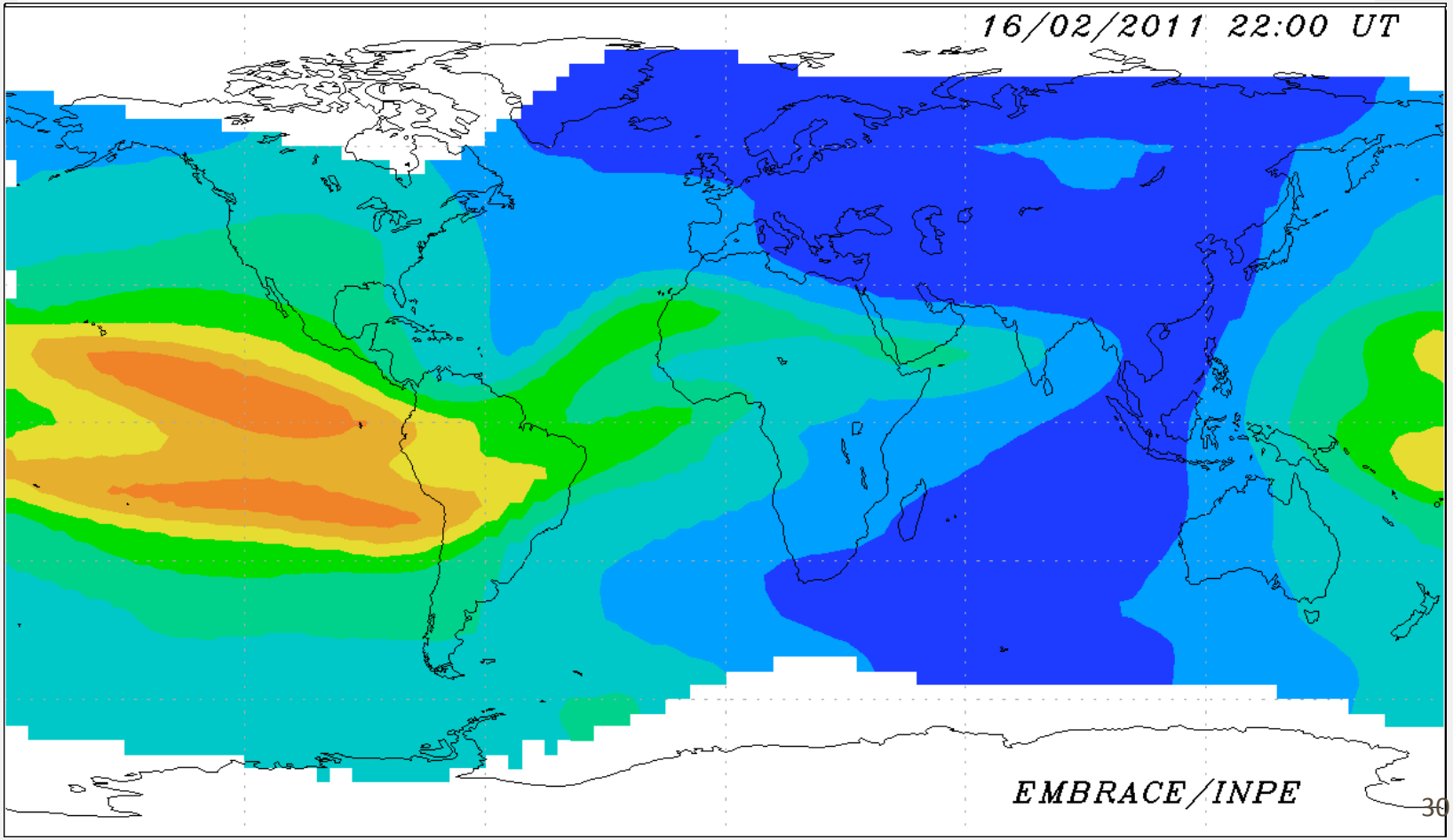
COMPARING MODELS

TOTAL ELECTRON CONTENT



GIC Instrument FURNAS

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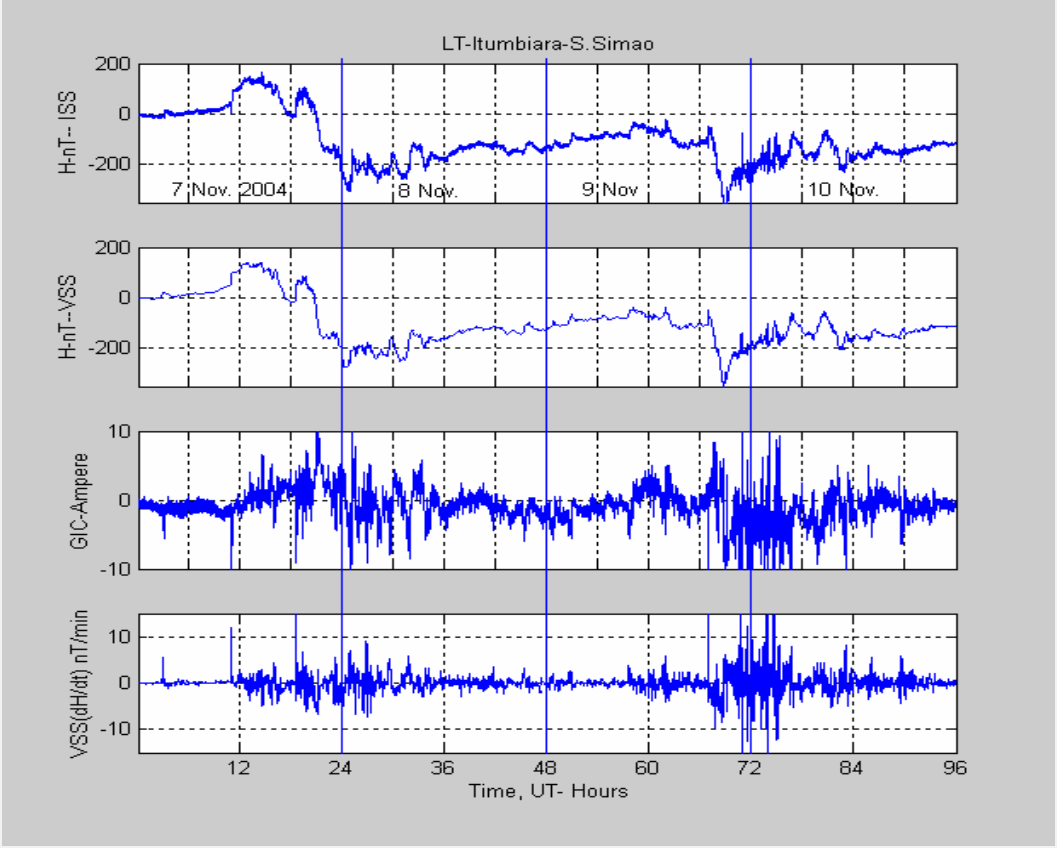
GIC DETECTED IN FURNAS DURING THE GEOMAGNETIC STORM:



- Magnetic variations under the power line similar to the nearest Observatory in Vassouras (RJ)
- GIC measured correlated to the derivative dB/dt em Vassouras (RJ)

EMBRACE Building
CODE:Operation Center Demísio Simões

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INAUGURATION YEAR

www.inpe.br/spaceweather

EMBRACE in WMO

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WMO SPACE WEATHER WEB SITE

From Brazilian Space weather information and prediction center to WMO Space weather center: GPSTEC map and scintilation map over Brazil.

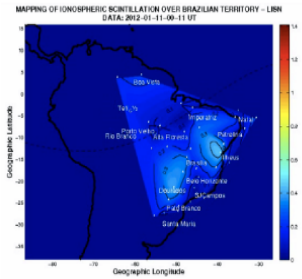
1. Ionospheric total electron content over Brazil: http://www.inpe.br/climaespacial/wmo/iTec.php

2. Ionospheric scintillation map over Brazil: http://www.inpe.br/climaespacial/wmo/iLisn.php

INPE EMBRACE Space Weather Information and Prediction Center

Ionospheric Scintillation S4 Index Products

Scintillation S4 Index over Brazil



Product Desciption:

GNSS signal scintillation monitored by ground-based receivers (LISN network). The map displays location of the receivers, near realtime S4 index. The movie shows 2-D plot of ionospheric scintillation during the evening to night time period of the previous day, represented by the S4 index, that impact telecommunication systems and GNSS signal availability.

Target Users:

Key product users include industries relying on high-accuracy GNSS positioning: surface and air navigation systems, agriculture, surveying, construction, drilling, and scientific users

Link to Map of Scintillation S4 Index over Brazil
Link to Video of Scintillation S4 Index over Brazil

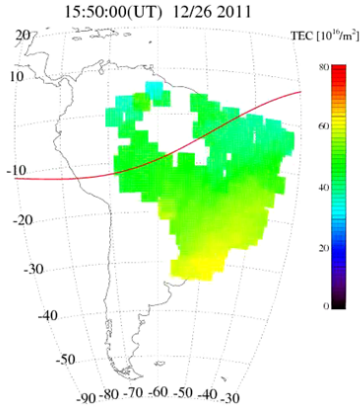
Cadence: 10 min.

Data Source: Ground-based GPS receivers

INPE EMBRACE Space Weather Information and Prediction Center

Ionospheric Total Electron Content Products

Total Electron Content over Brazil



Product Desciption:

This ionospheric product provides a measurement of the ionospheric total electron content (TEC) over Brazil. It is designed to estimate the signal delay for single and dual frequency GNSS applications. The map over South America displays TEC in color shade. The movie shows temporal variation of TEC from 00:00 UT to 24:00 UT of the previous day with the time interval of 10 minutes.It was produced under collaboration of STEL (Nagoya University), Kyoto University, NICT, Japan, and IBGE, Brazil.

Target Users:

Key product users include industries relying on high-accuracy GNSS positioning: agriculture, surveying, construction, drilling, and scientific users.

Link to Video of Total Electron Content over Brazil

Public Outreach

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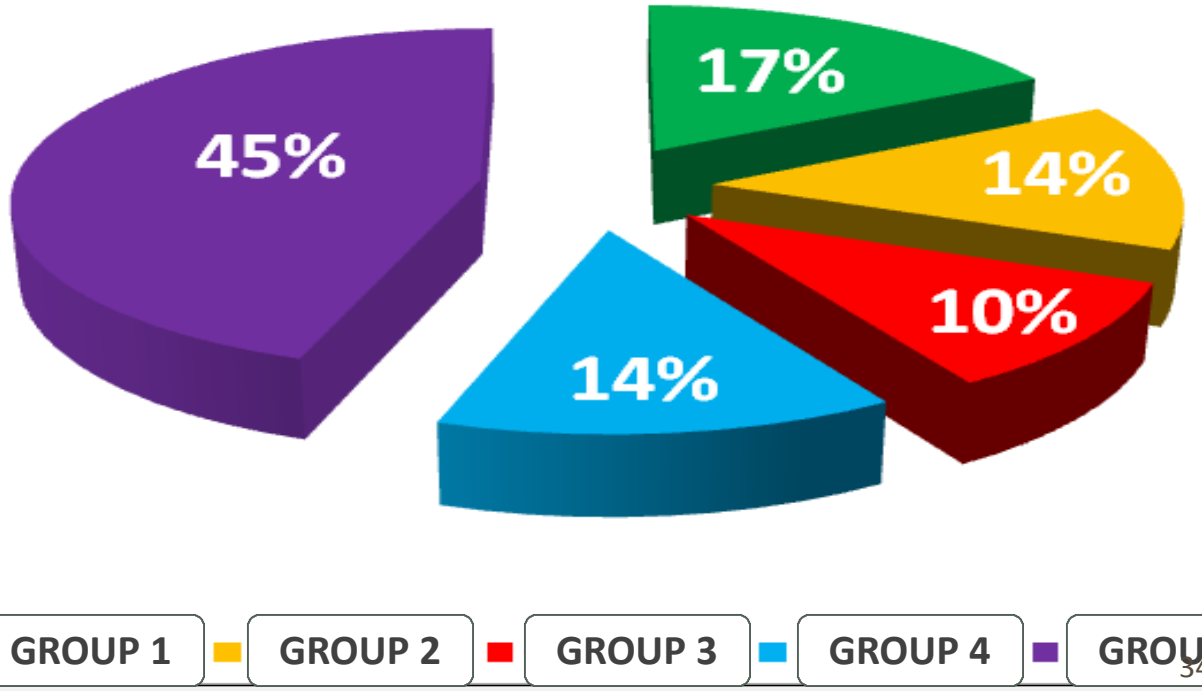
EMBRACE WORKSHOP PARTICIPANTS

GROUP	AREA/ENTERPRISE
Group 1	GNSS USERS
Group 2	TELECOMMUNICATIONS
Group 3	SURFACE TECHNOLOGY
Group 4	SATELLITE OPERATIONS
Group 5	SCIENCE



Public Outreach

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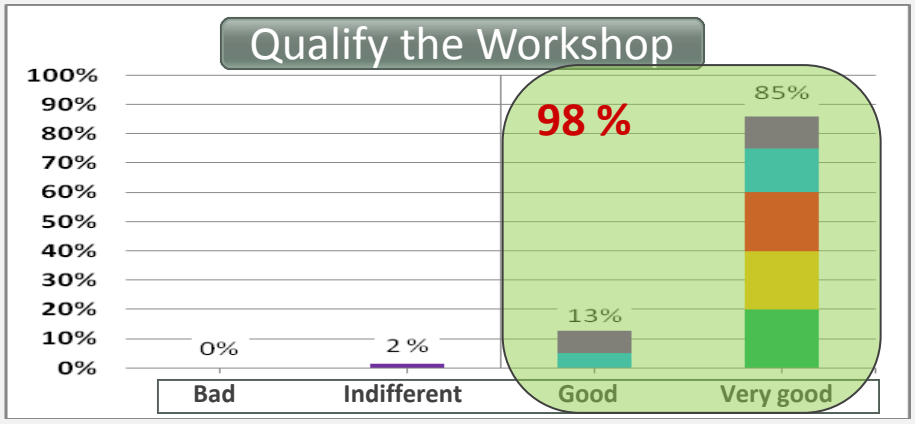
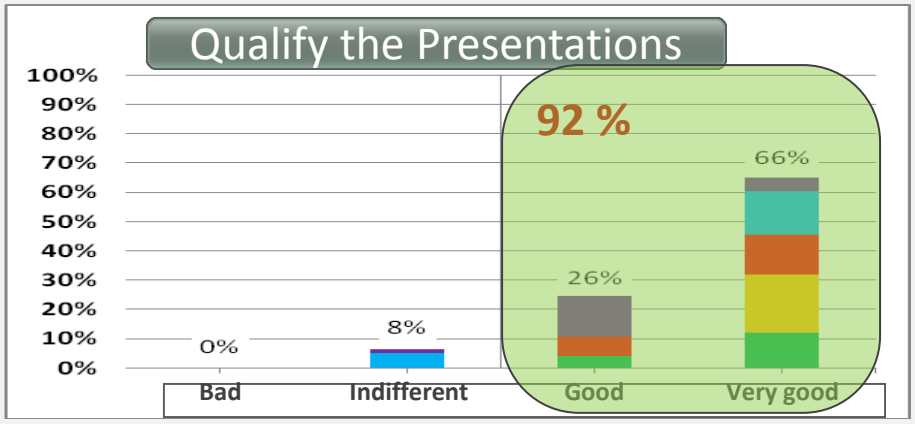
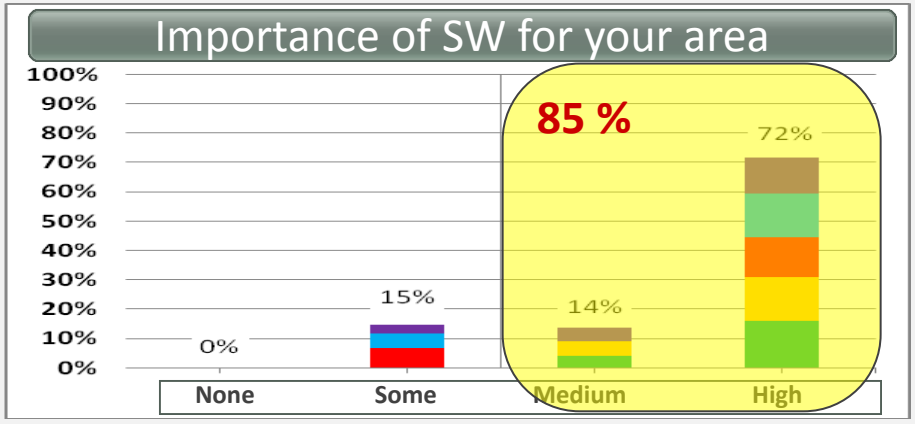
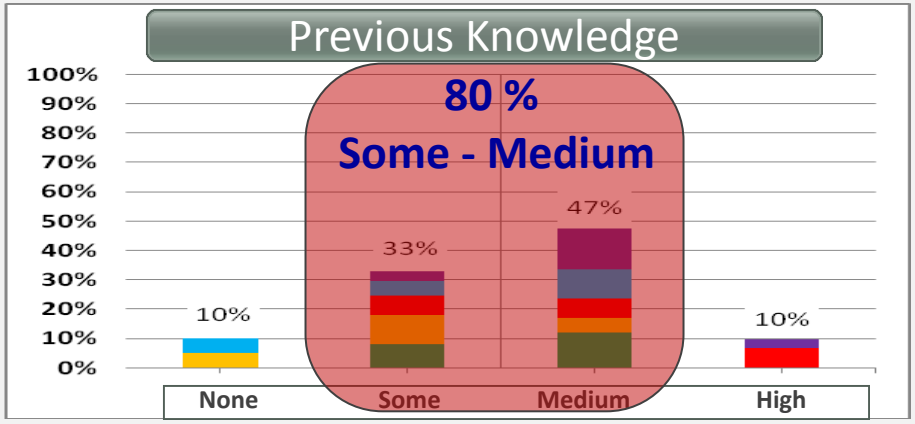
Courtesy:
Dr. Clezio DeNardin

WORKSHOP ANALYSIS









Public Outreach

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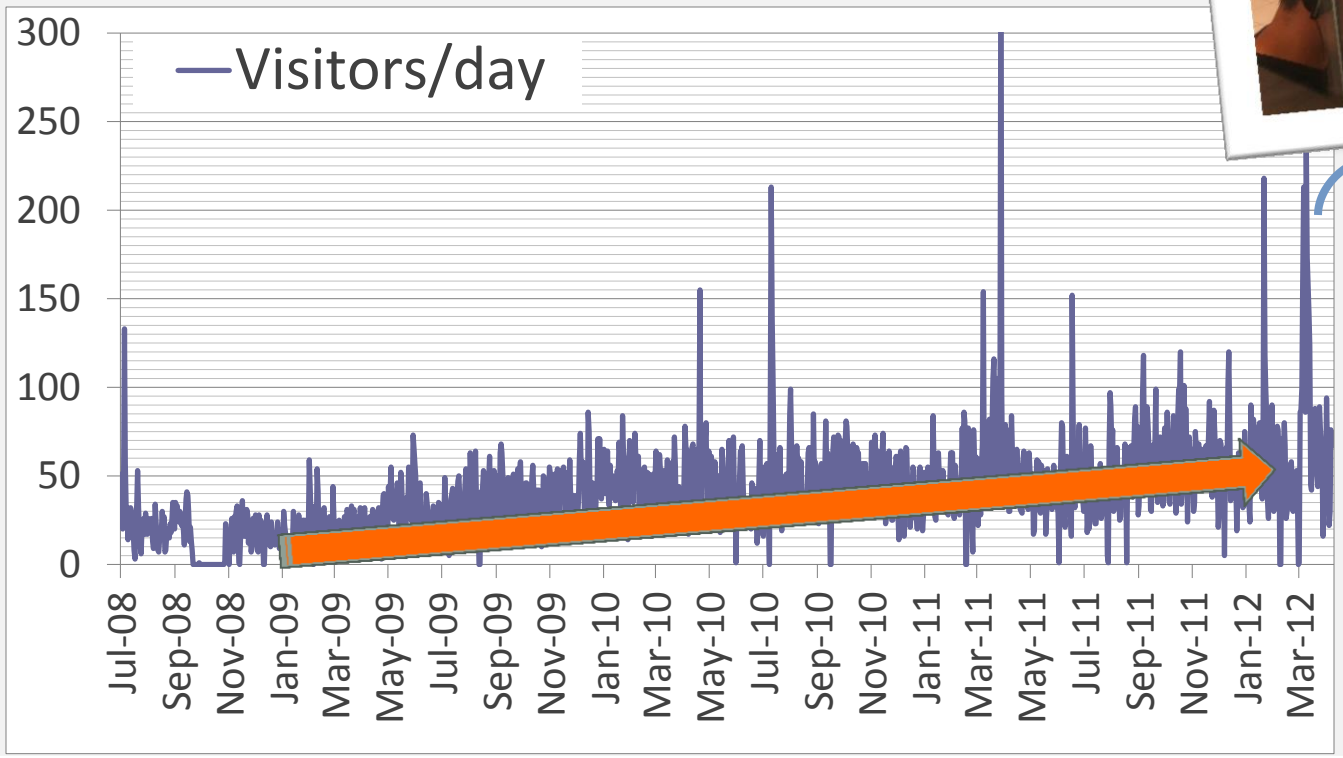
EMBRACE'S VISIBILITY



Public Outreach

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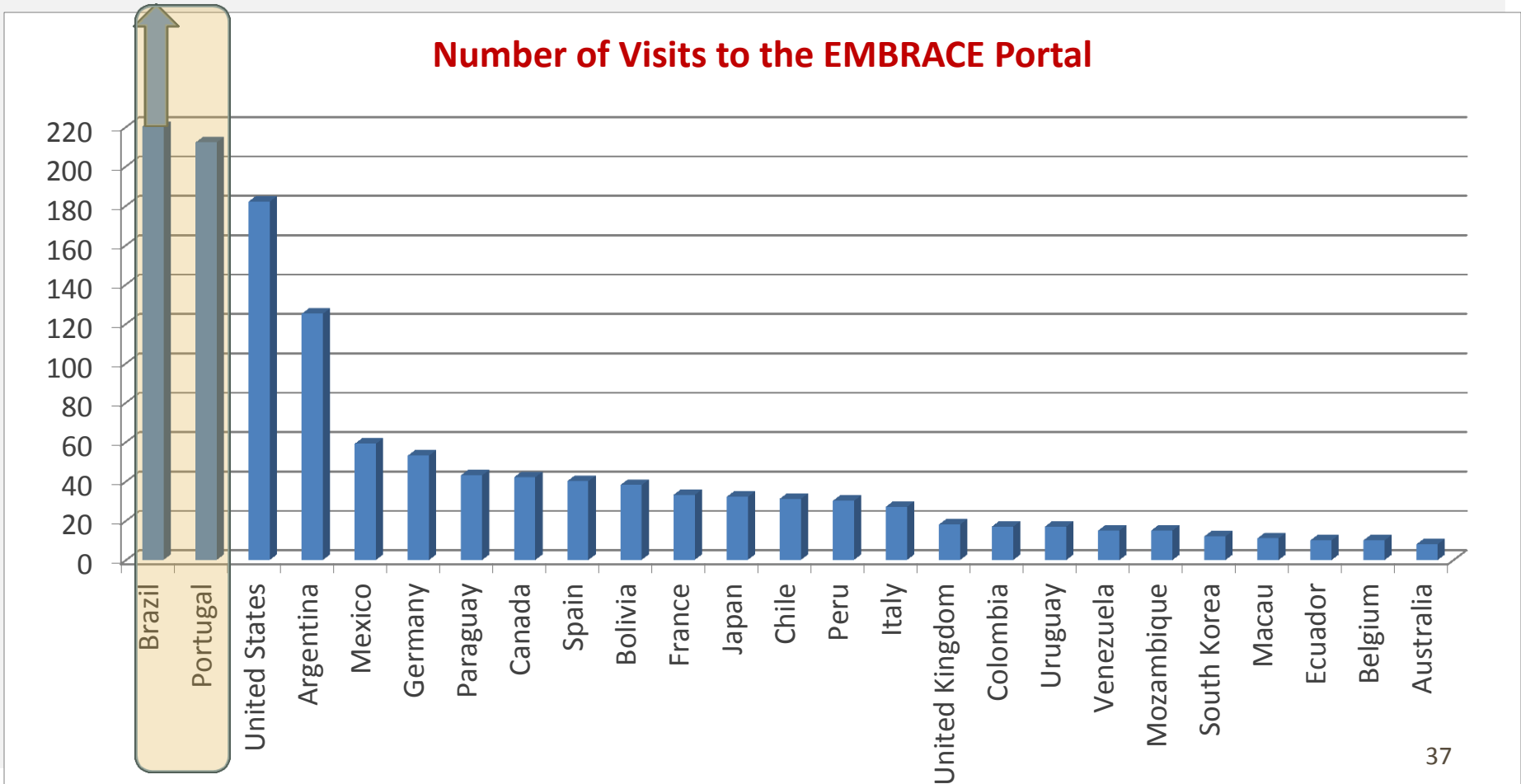
EMBRACE'S VISIBILITY BY COUNTRIES

18,143



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CONTACT US – THANK YOU

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