For the occasion of the
54th Session of the Technical and Scientific Subcommittee of COPUOS
held in Vienna, Austria from January30th to February 11th, 2017.

Space Weather

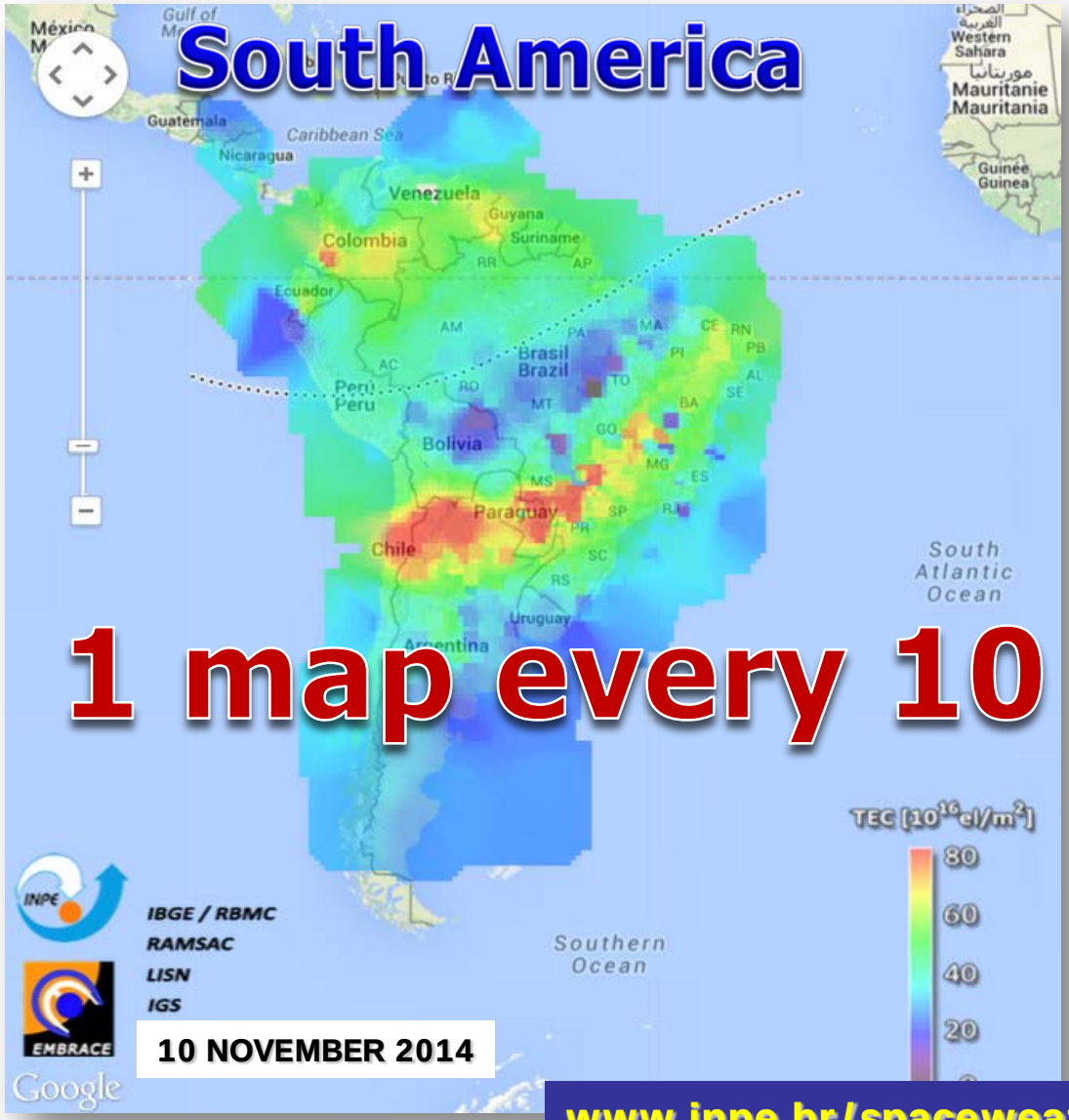
Portfolio Samples

Presented by

Dr. Clezio Marcos De Nardin

Head of the Embrace Space Weather Program (INPE/CEA-LAC-DSS-CPTEC)

Regional TEC Maps

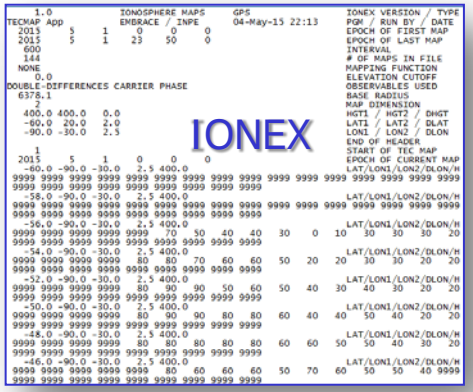


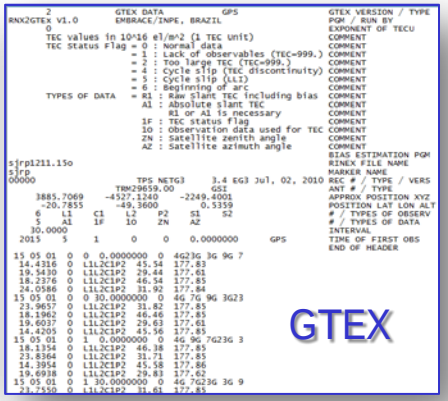
www.inpe.br/spaceweather

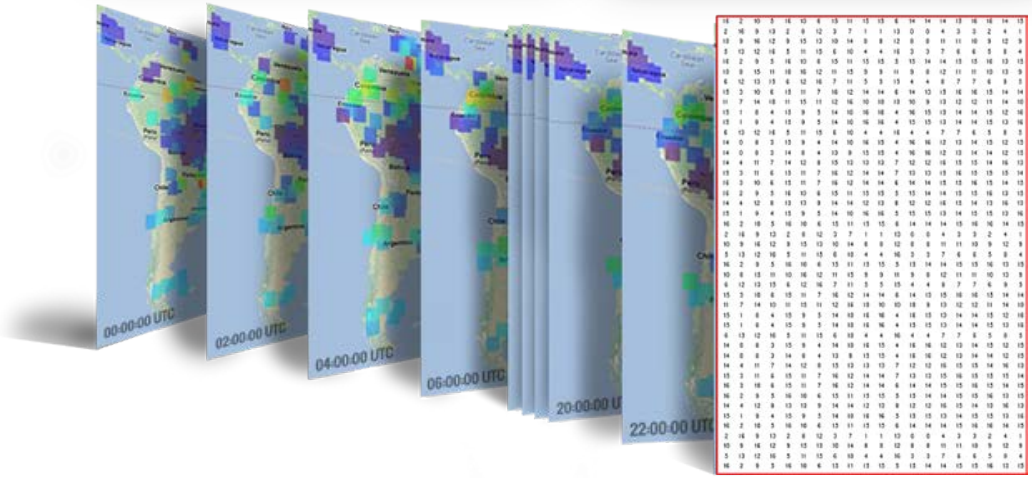
Data Format

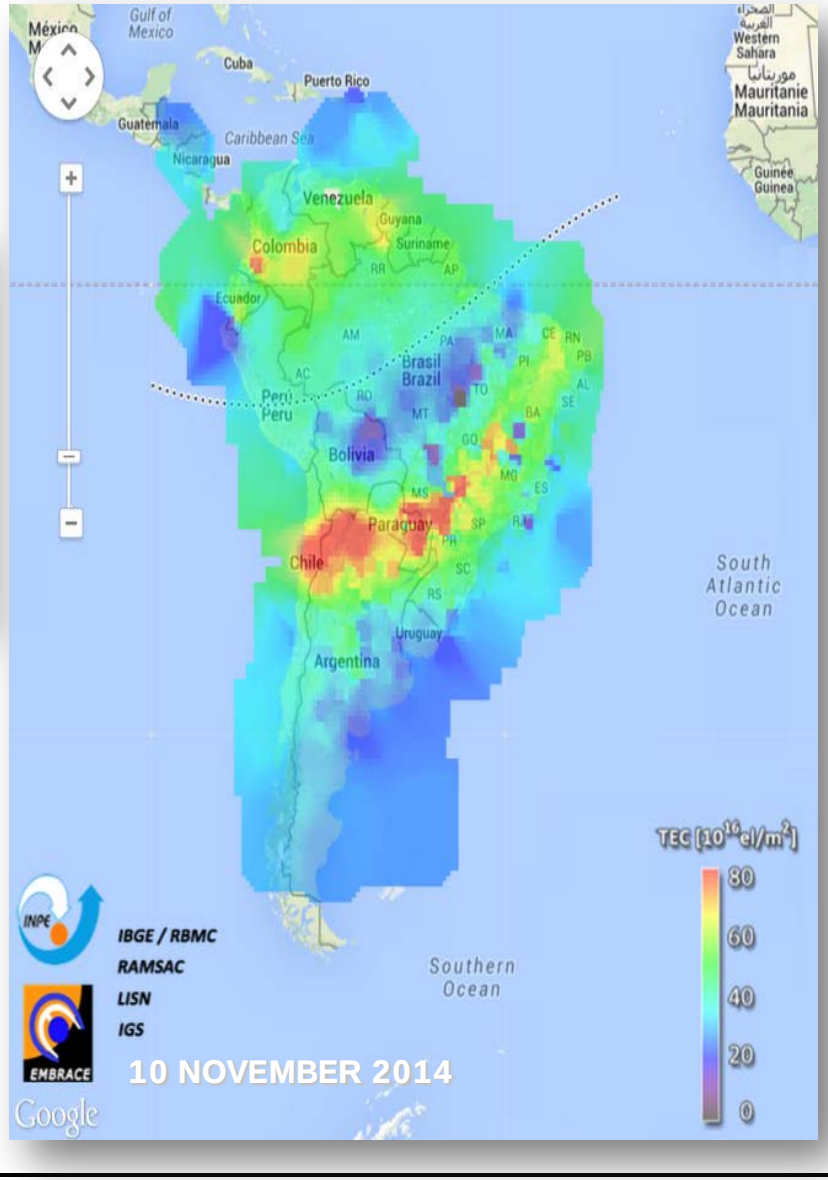
Maps are Google layers that be save as:

- Data Matrices
- Standard File Format (IONEX, GTEX)



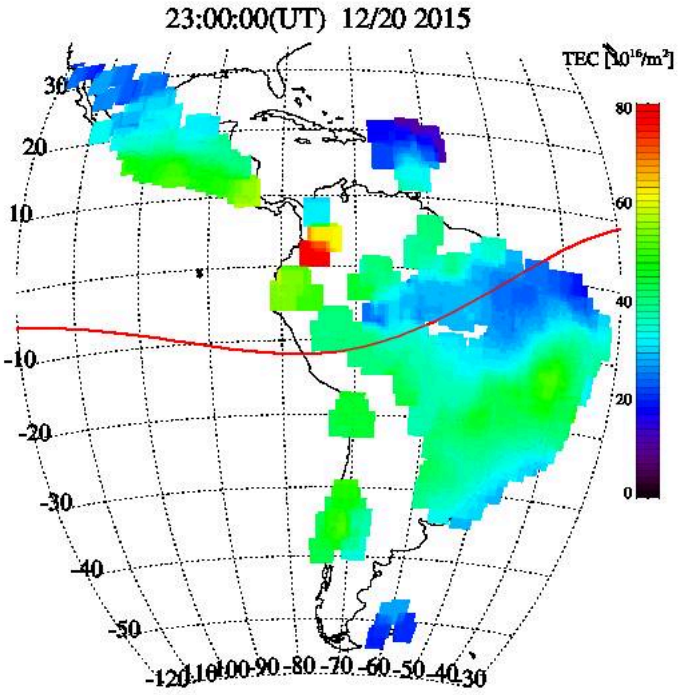


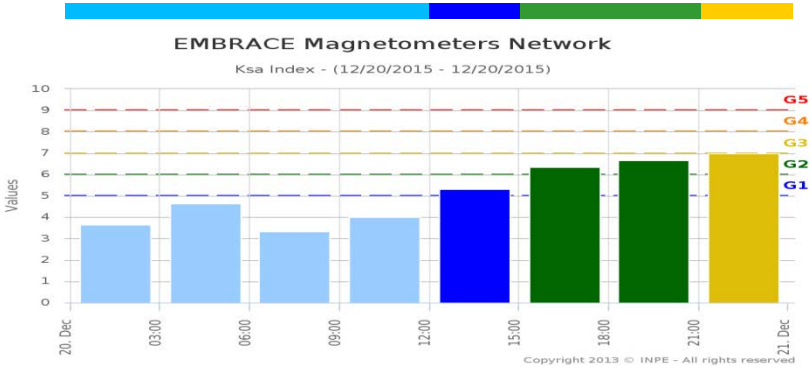




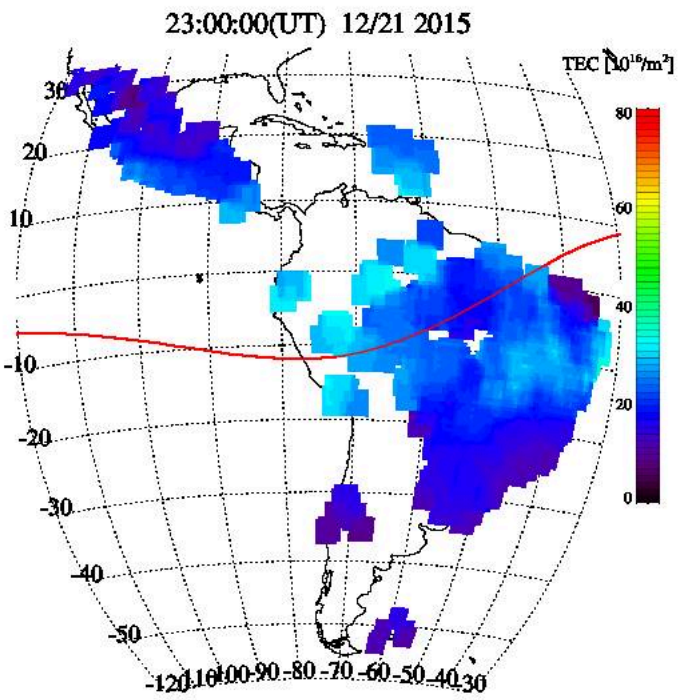
TEC Maps Updates

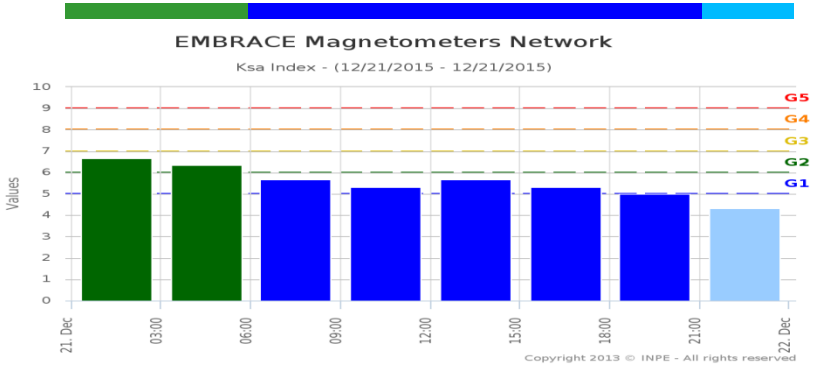
DECEMBER 20, 2015



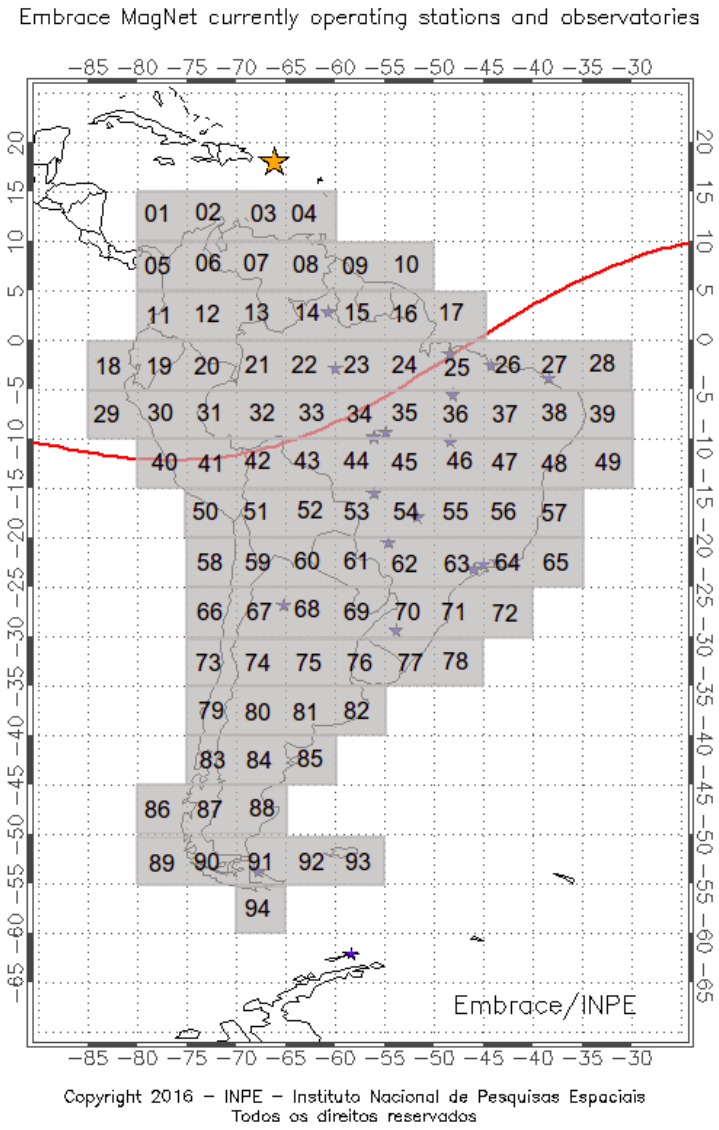


DECEMBER 21, 2015





South American DIX Maps



$$RIDX_r^{med} = \sqrt{\left(\frac{1}{N_{grp}-1}\right)\sum_{k=1}^{N_{grp}}((TEC_k - TEC_k^{med})/TEC_k^{med})^2}$$

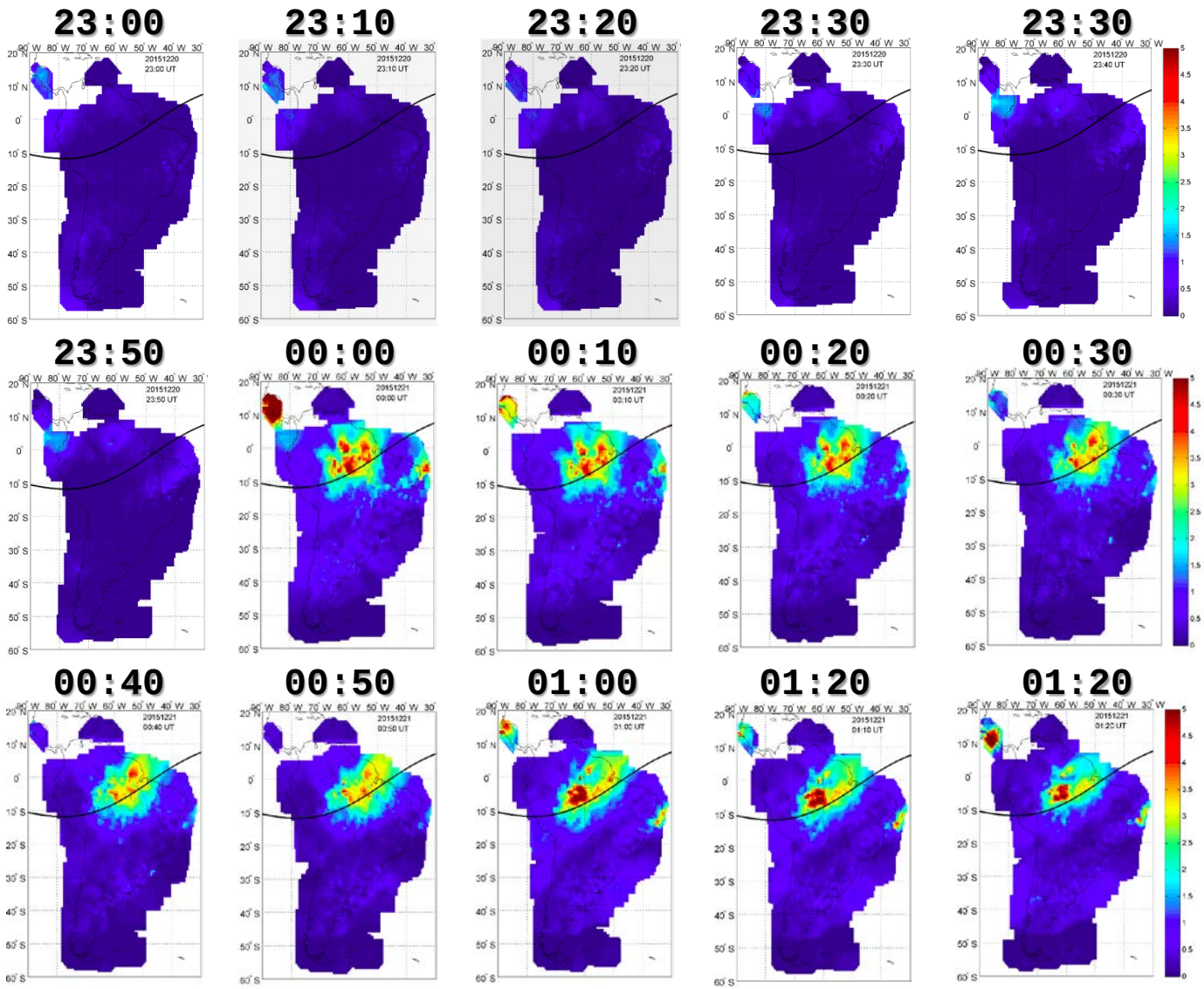
Number of grid points in a given regional map

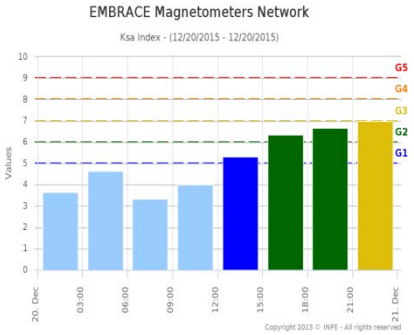
Vertical TEC

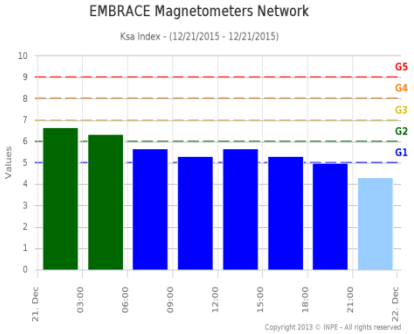
monthly TEC median

- RIDX - Regional Ionosphere Disturbances IndeX (RIDX) – Jakowski DIX first version
- Regional Ionosphere Disturbances IndeX (RIDX) is based on GNSS measurements. The index may be defined on local, regional and global scale depending on user needs [Jakowski et al, 2006].

South American DIX Maps





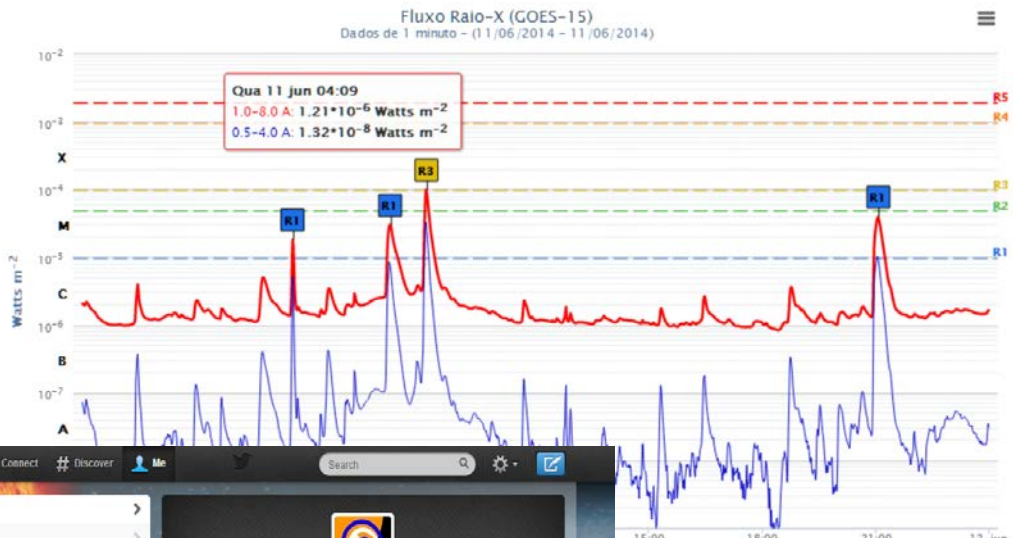


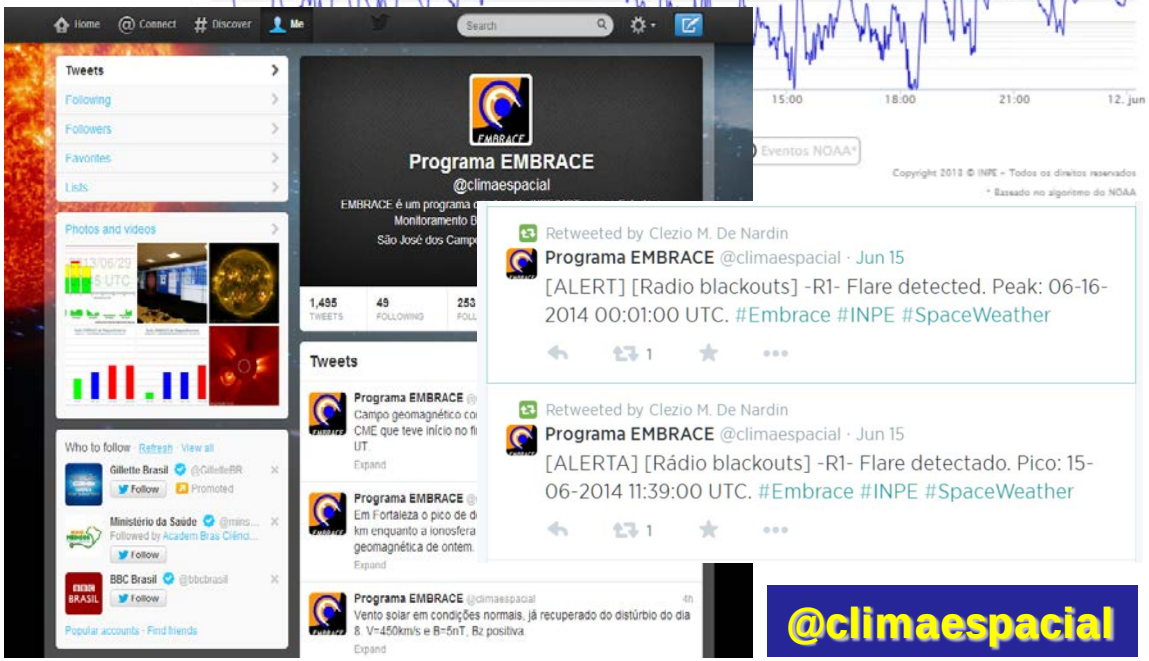
Magnetic Storm on December 20th, 2015

Dst = -155 nT

Kp = 6+

Flare Alerts





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Estudo e Monitoramento Brasileiro do Clima Espacial

CLASS_X

Clezio Marcos De Nardin,

O sistema de monitoramento do EMBRACE detectou um evento CLASS_X através do instrumento GOES.

The monitoring system EMBRACE detected an CLASS_X event through the instrument GOES.

ALERTA RAIO-X GOES

R3

O sistema de detecção de eventos EMBRACE verificou a existência de flare classe X com nível de severidade R3 ocorrido em 11-06-2014 às 09:06:00 UTC.

Efeito de Severidade R3:
HF Radio: Grande área de blackout em comunicação em rádio HF, perda de rádio contatos por aproximadamente uma hora na região iluminada.
Navegação: Navegação em baixa frequência degradada por aproximadamente uma hora.

X-RAY GOES ALERT

R3

The event detection system EMBRACE verified the existence of flare class X with severity level R3 ocurrred in 06-11-2014 at 09:06:00 UTC.

Effect Severity R3
HF Radio: Large area blackout in HF radio communication, loss of radio contact for about an hour in the illuminated region.
Navigation: Navigation in low frequency degraded for about an hour.

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Magnetic Storm

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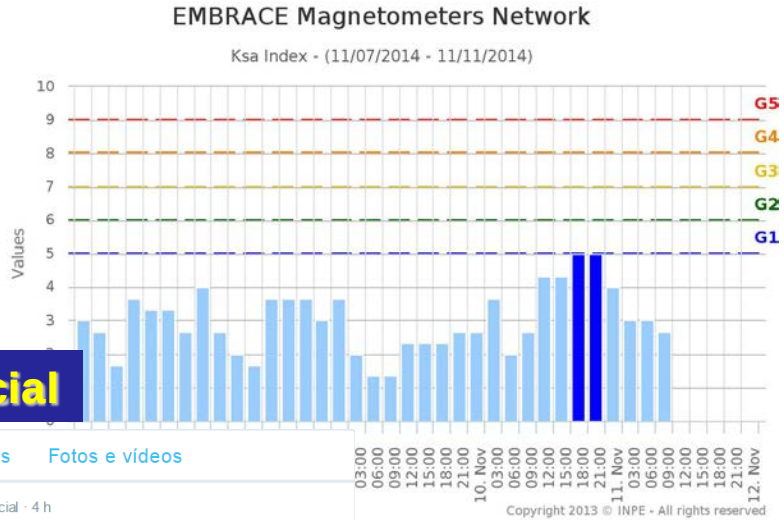

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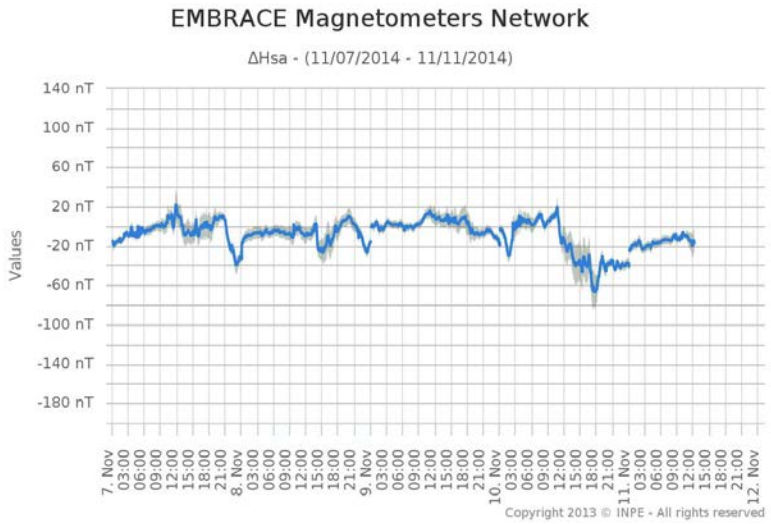
Tweets | Tweets e respostas | Fotos e vídeos

Programa EMBRACE @climaespacial · 4 h
[ALERT] Embrace/INPE detected a G1 level Magnetic Storm using the Ksa index. See details bit.ly/1o2QpUS #INPE #SpaceWeather

Programa EMBRACE @climaespacial · 4 h
[ALERTA] Embrace/INPE detectou tempe
índice Ksa. Detalhes em bit.ly/1v6aOcw.

Programa EMBRACE @climaespacial · 22 h
Subtempestade geomagr
manhã de hoje eleva os
para 4+ e 1000 nT, respe



Ksa - 10-11-2014 18:00:00

Clezio Marcos De Nardin,

O sistema de monitoramento do Embrace/INPE detectou uma tempestade magnética nível G1 no índice de perturbação magnético Sul-americano Ksa. Detalhes em http://bit.ly/1v6aOcw.

The Embrace/INPE monitoring system detected a G1 level Magnetic Storm using the South American disturbance index Ksa. See details http://bit.ly/1o2QpUS.

G1 (Fraco) - 5o

G1

Evento ocorrido no período: 10/11/2014 18:00:00 a 10/11/2014 21:00:00

Efeito: Sistema elétrico: flutuações fracas na voltagem podem acontecer. Operação de satélite: possível impacto pequeno nas operações. Outros sistemas: animais migratórios são afetados neste nível e em níveis mais altos.

Medida: Kp = 5

Frequência Amostral: 1700 por ciclo (900 dias por ciclo)

G1 (Minor) - 5o

G1

Event occurred in the period: 11/10/2014 18:00:00 to 11/10/2014 21:00:00

Effect: Power systems: weak power grid fluctuations can occur. Spacecraft operations: minor impact on satellite operations possible. Other systems: migratory animals are affected at this and higher levels.

Measure: Kp = 5

Average Frequency: 1700 per cycle (900 days per cycle)

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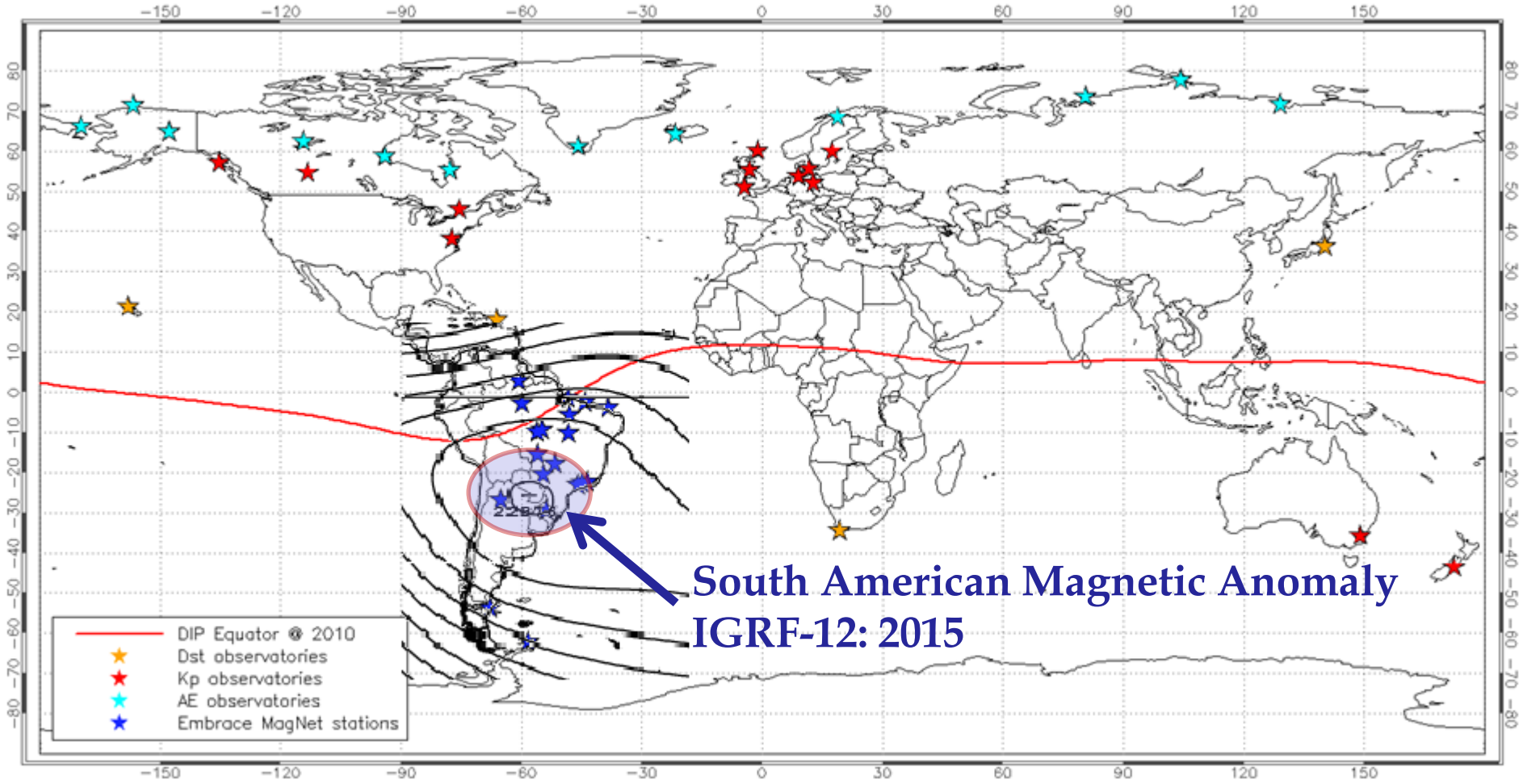
South America Mag Anomaly

Courtesy:
Eng. Sony Su Chen



EMBRACE Magnetometer Network

AFT

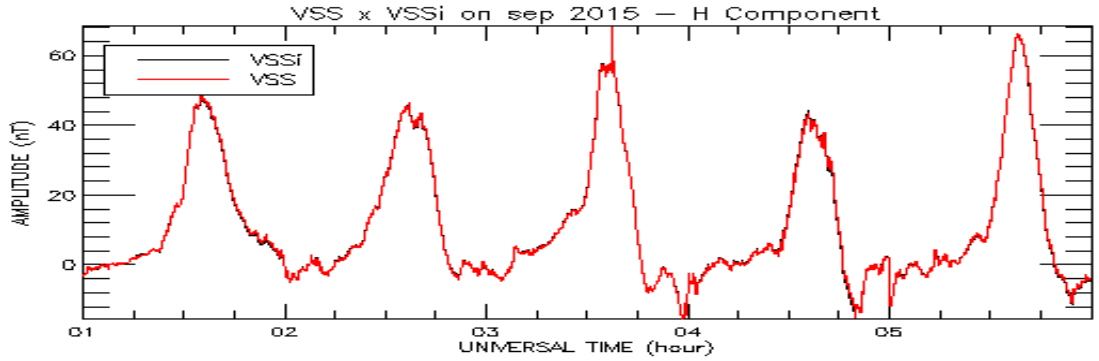
EMBRACE-09 AFT

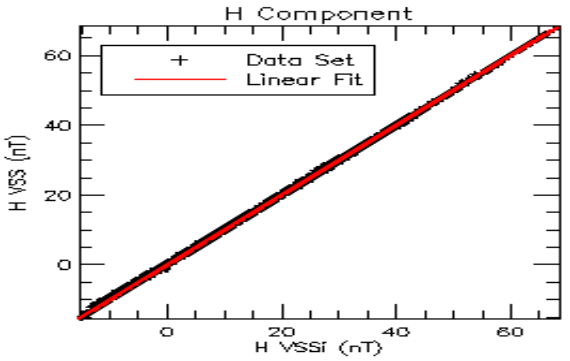
Current Network AVG ERROR

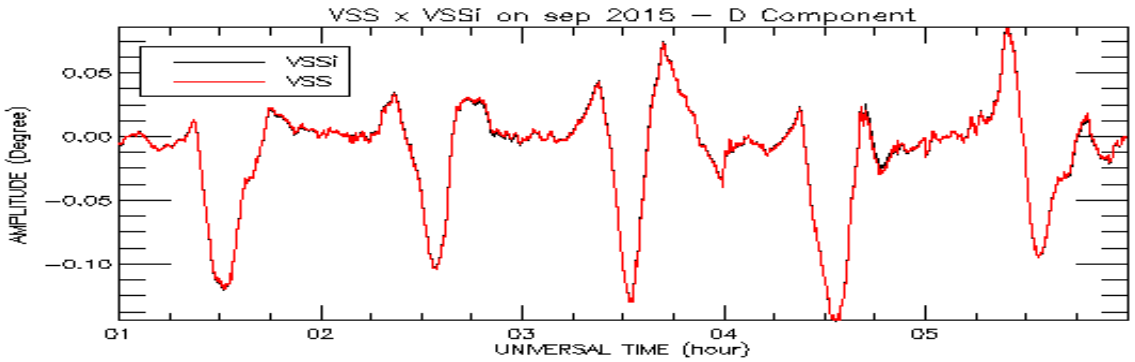
Magnetometer Labels		Maximum error with respect to the reference			
Reference	Under Evaluation	H	D	Z	F
EMBRACE-01	EMBRACE-02	+0.237 %	-0.053 %	+0.112 %	±0.247 %
EMBRACE-01	EMBRACE-03	-0.116 %	+0.001 %	+0.084 %	±0.141 %
EMBRACE-01	EMBRACE-04	-0.252 %	-0.199 %	+0.648 %	±0.637 %
EMBRACE-01	EMBRACE-05	+0.064 %	-0.053 %	+0.088 %	±0.107 %
EMBRACE-05	EMBRACE-06	-0.105 %	-0.015 %	-0.073 %	±0.126 %
EMBRACE-05	EMBRACE-07	-0.028 %	-0.068 %	-0.083 %	±0.078 %
EMBRACE-05	EMBRACE-08	+0.178 %	-0.121 %	-0.103 %	±0.053 %
EMBRACE-05	EMBRACE-09	-0.099 %	+0.089 %	+0.041 %	±0.041 %
EMBRACE-05	UNIVAP-01	-0.863 %	+0.453 %	+0.133 %	±0.705 %
EMBRACE-05	UNIVAP-02	-0.121 %	-0.165 %	-0.141 %	±0.186 %
EMBRACE-05	UNIVAP-03	-0.075 %	-0.002 %	-0.102 %	±0.125 %
Averaged Square Error		**±0.194 %**	**±0.111 %**	**±0.146 %**	**±0.222 %**

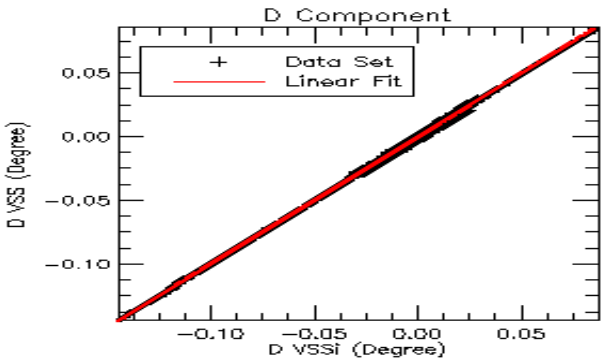
Denardini et al. (2015), Brazilian Journal of Geophysics
"The initial steps for developing the South American k index from the embrace magnetometer network"

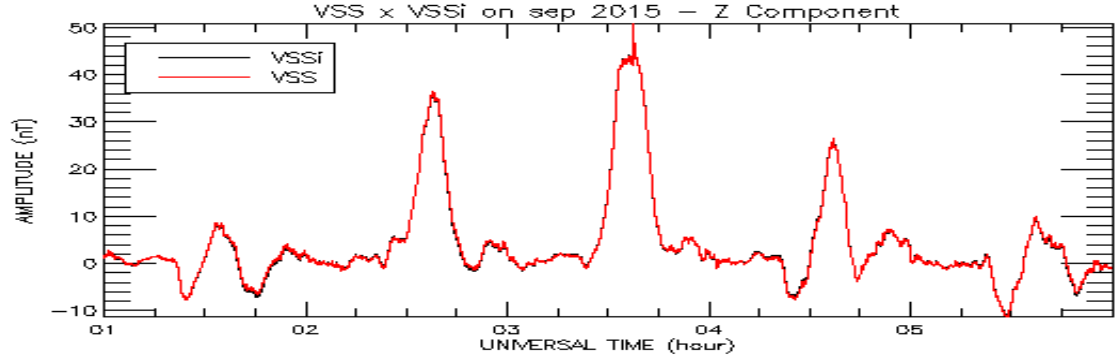
Embrace vs Intermagnet

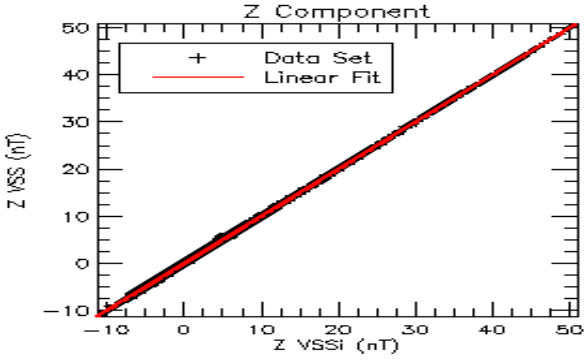




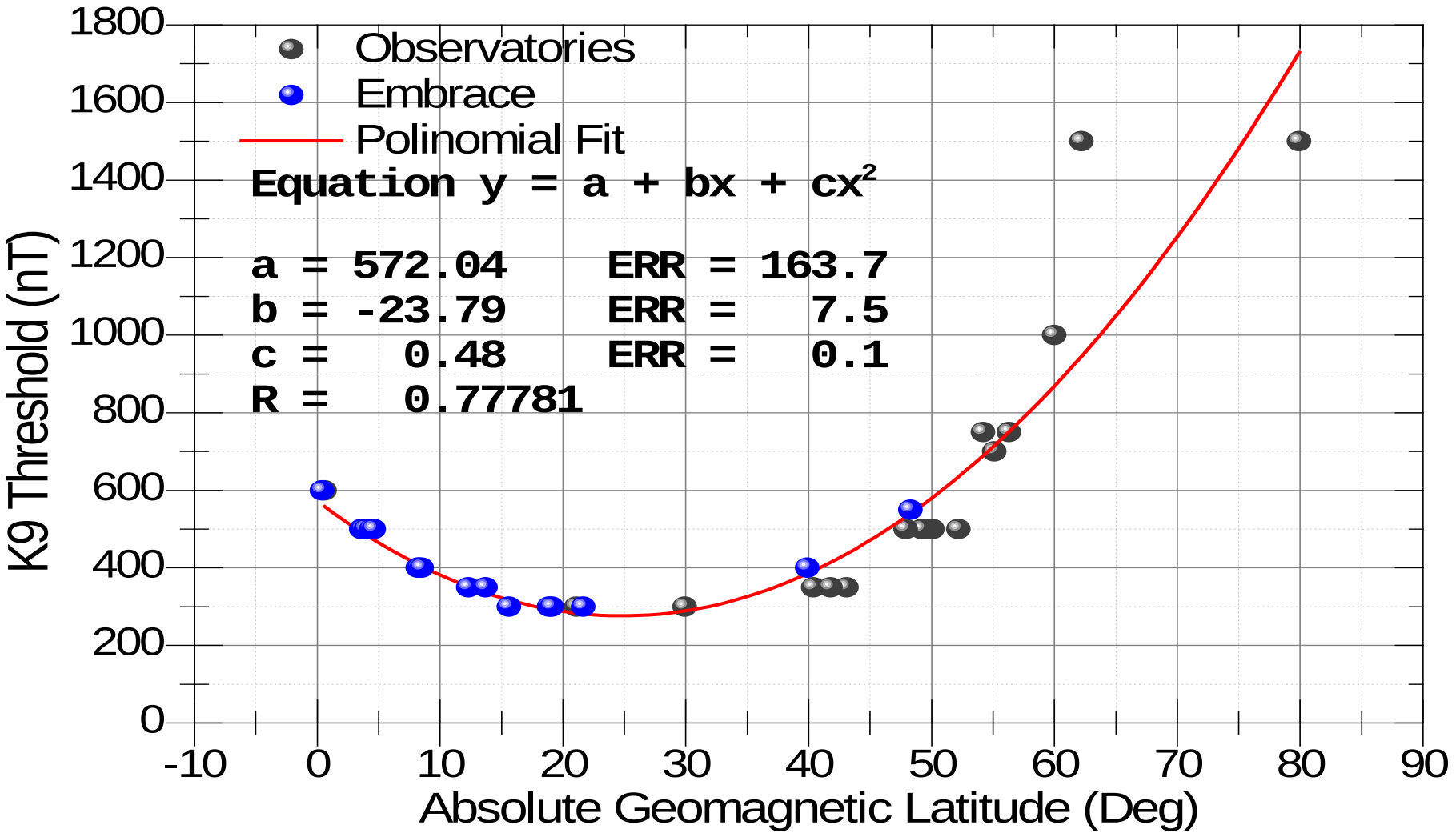








K9 Threshold (our stations)



Denardini et al. (2015), Brazilian Journal of Geophysics
"The initial steps for developing the South American k index from the embrace magnetometer network"

A New Dst Proxy

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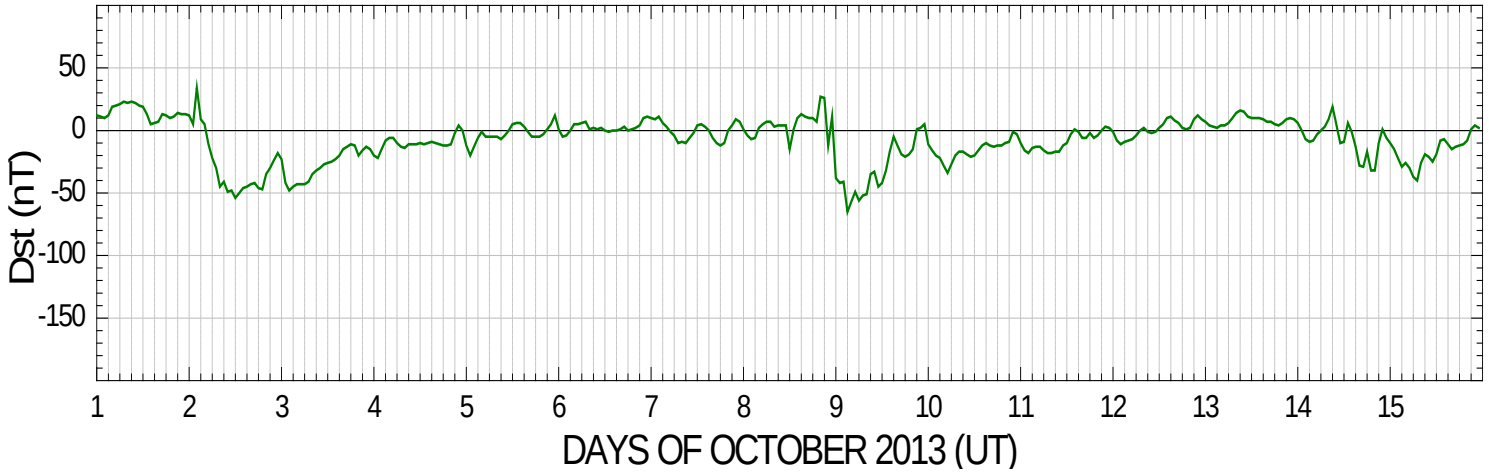
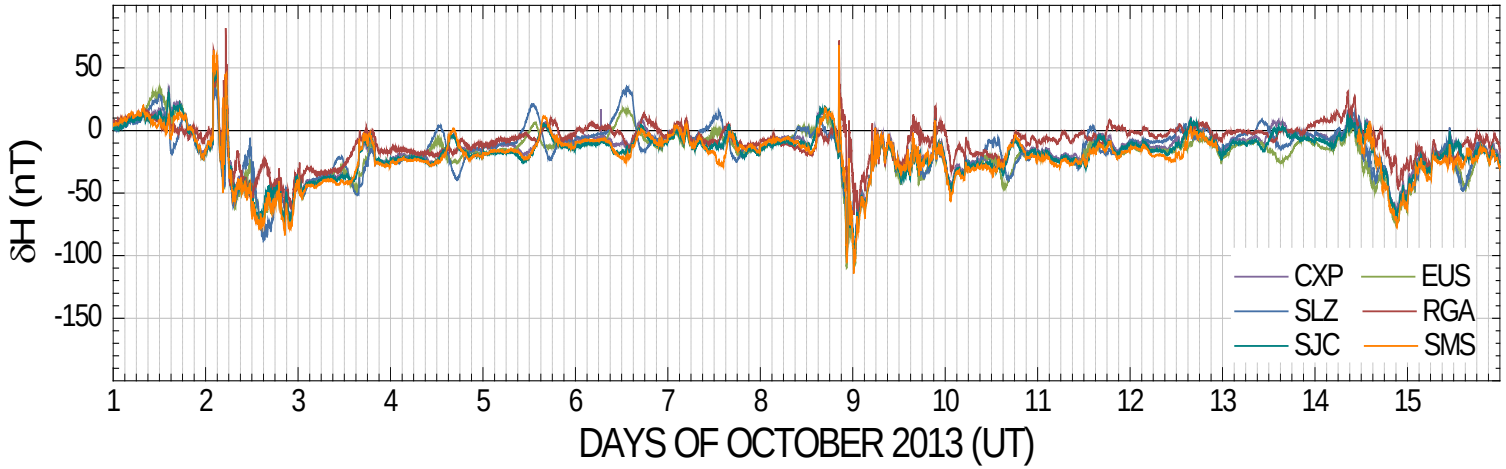
01 to 15 OCT 2013





The South American K Index

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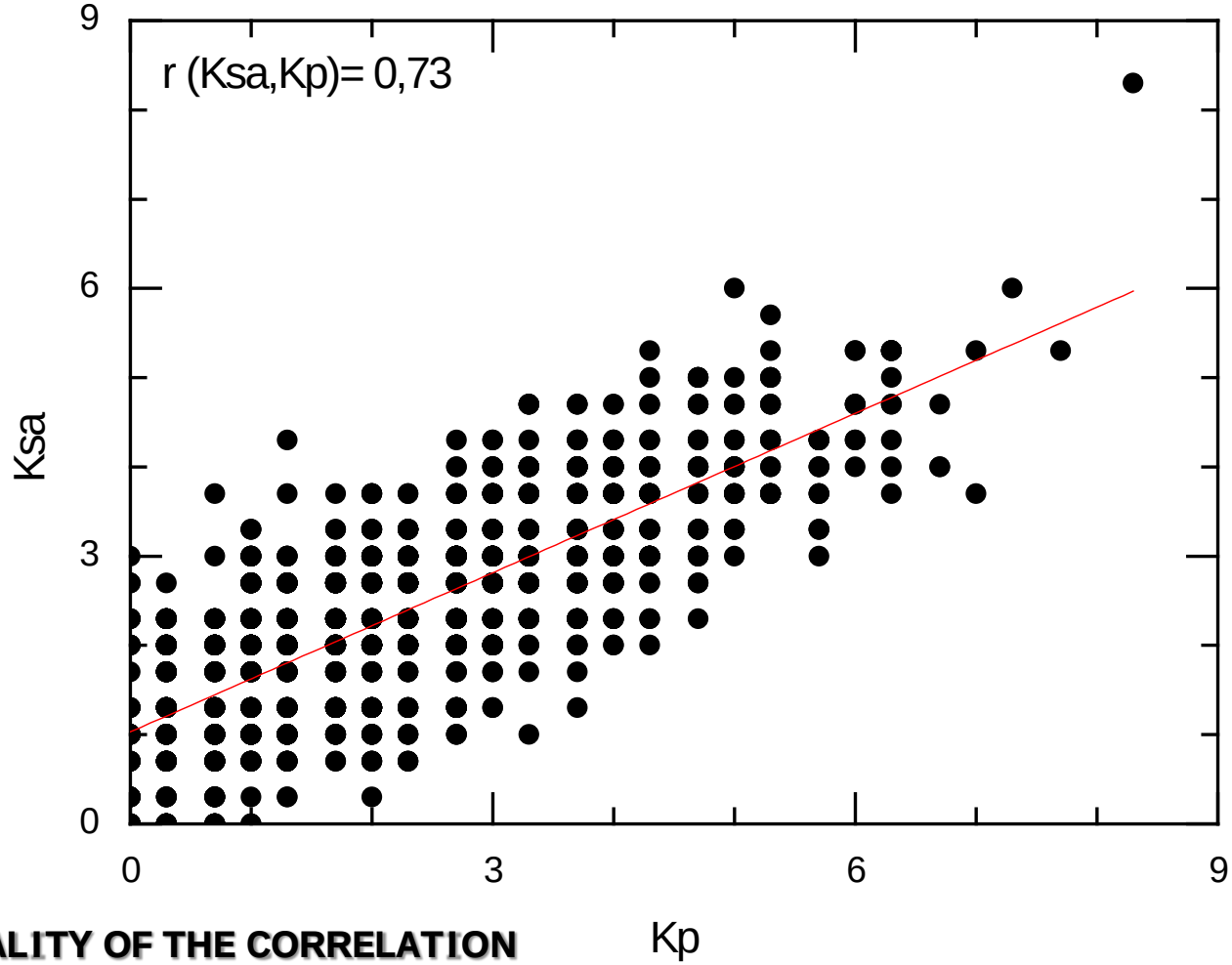
01 June to 31 December de 2015



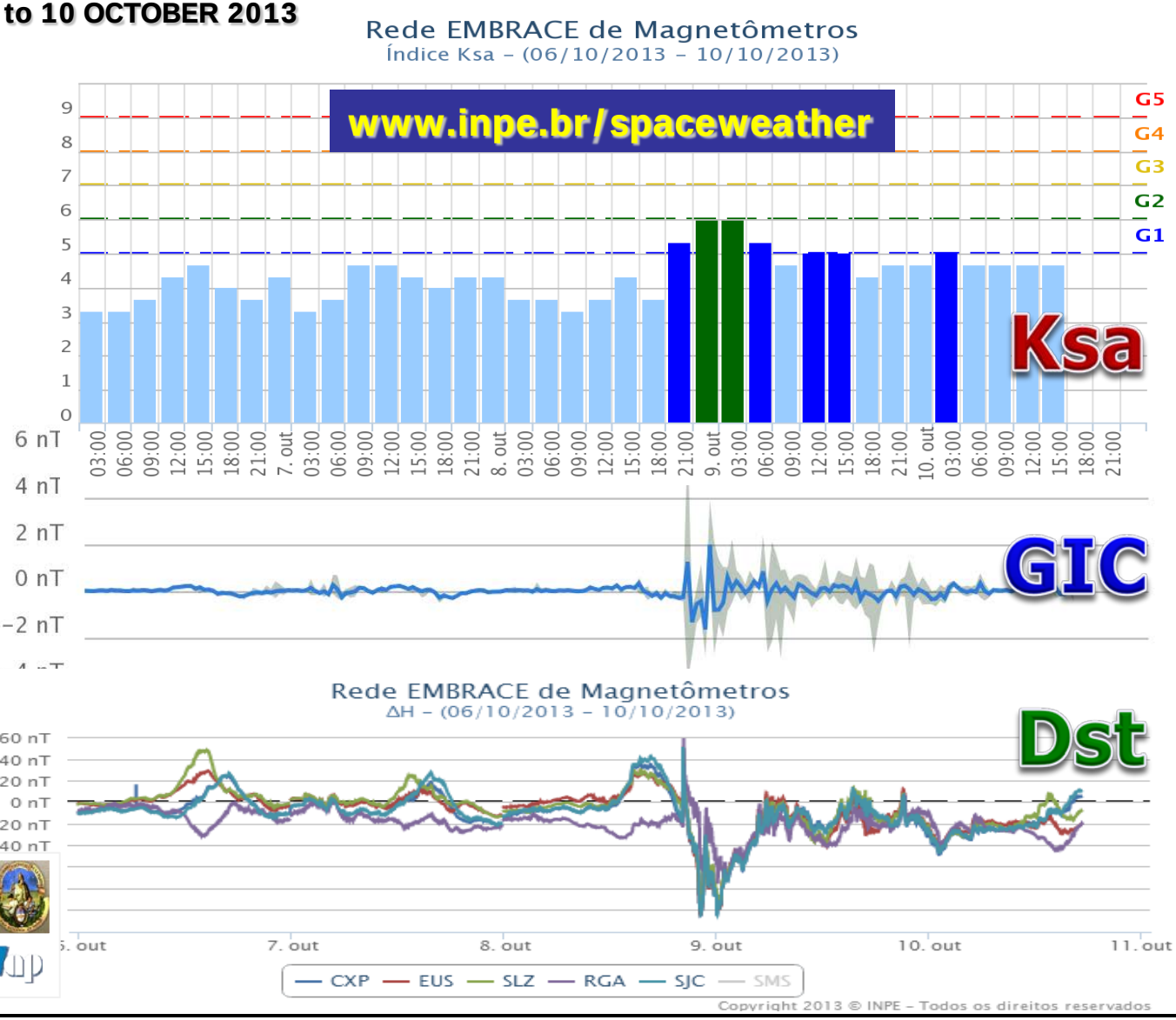
QUALITY OF THE CORRELATION

Weak	0.1	0.4
Moderate	0.4	0.7
Strong	0.7	1.0

DANCEY and REIDY (2006).

Regional Magnetic Indices

06 to 10 OCTOBER 2013



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Brazilian Study and Monitoring of Space Weather Weather 5

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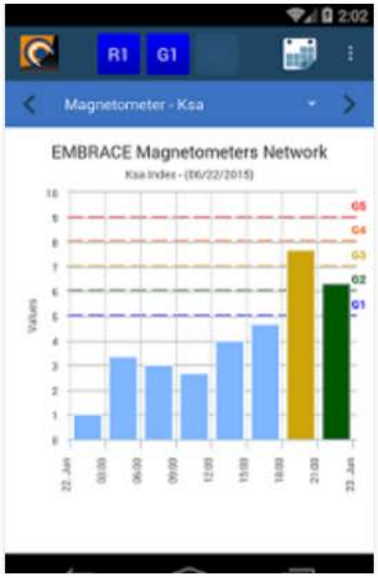
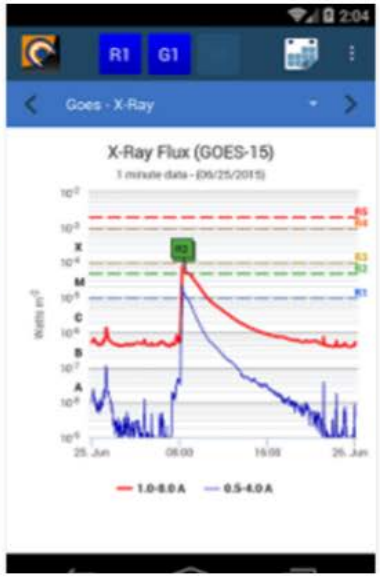
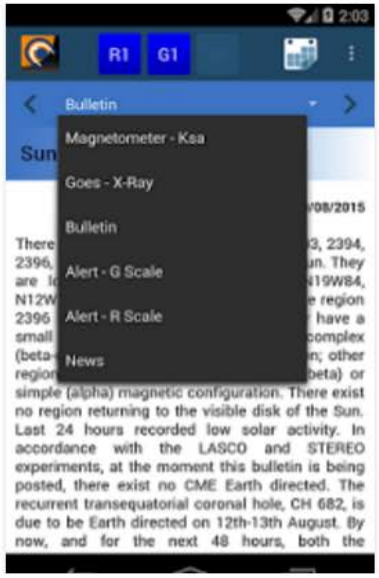




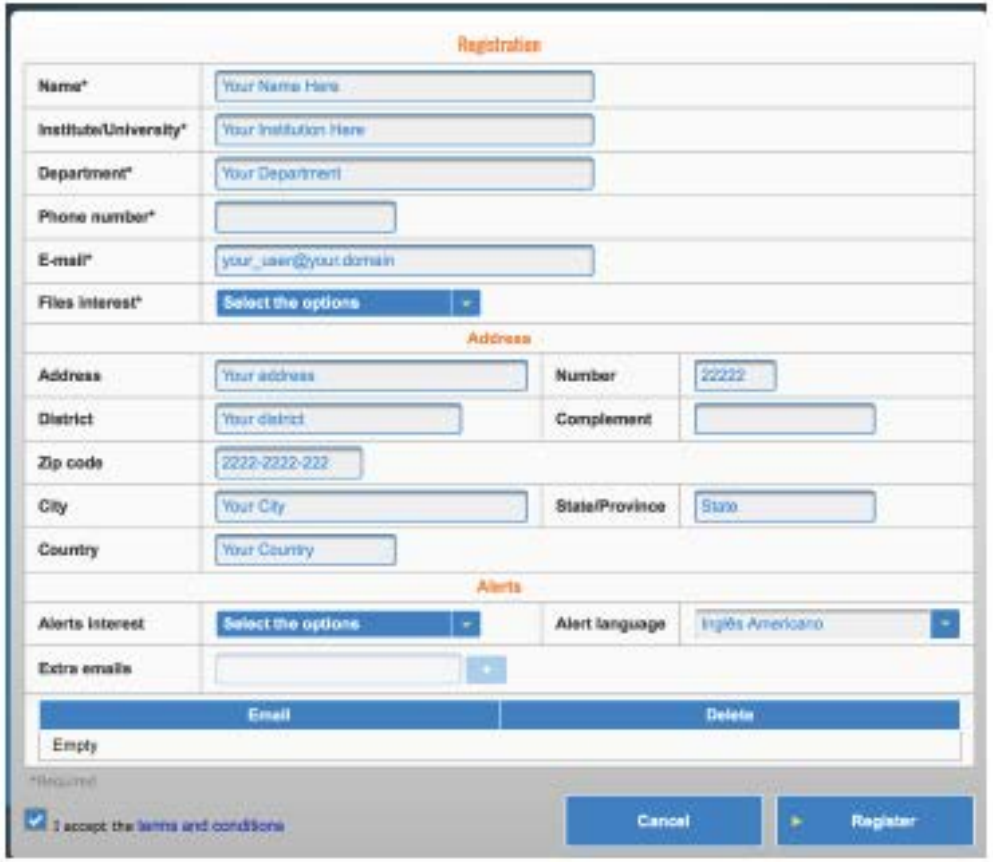


Data Sharing

SINCE JUL 1, 2015

Start here

Register Here



What do you have ?

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DATA

Find the product to download

How about DPS-4 data ?

SINCE JUL 1, 2008

IONOSONDE

The ionosonde is a type of radar that emits pulses of electromagnetic energy at frequencies varying between 1 and 30 MHz. The ionospheric probe consists of a transmission of a vertical pulse at a radio frequency, which is reflected back by the ionosphere at the time when the frequency of the wave equals the plasma frequency of the medium. The time between transmission and reception of the signal is converted into height and a radio frequency vs height graphic (ionogram) is generated. Thus one can obtain the vertical electron density profile of the layers E and F of the ionosphere, since the electron density at the time the wave was reflected is proportional to the square of the frequency of the wave. The digisonde used by INPE consist of: a set of transmitter and receivers, computers and software processing of data in real time; transmitting antenna type cross-delta; four receiving antennas, which enable measurement of the drift taken from doppler shift of the ionospheric plasma irregularities.

Status of Ionosonde Sensors

Ionosonde - Download Files

Station: Cachoeira Paulista Date: 08/01/2015 Search

- Cachoeira Paulista
- Fortaleza
- São Luís
- Boa Vista
- Campo Grande

Cachoeira Paulista

1

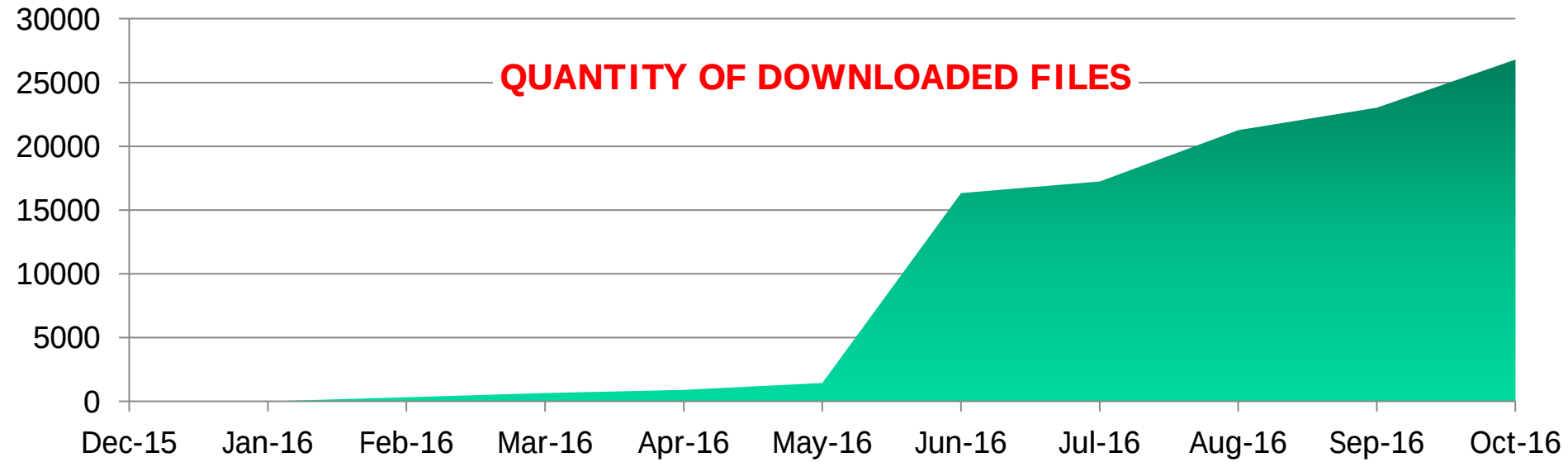
	Type	Modified Date	
	SAO	02/08/2015	Download
CAJ2M_20150801.SAOC	SAOC	11/09/2015	Download
CAJ2M_20150801.GRM	GRM	02/08/2015	Download

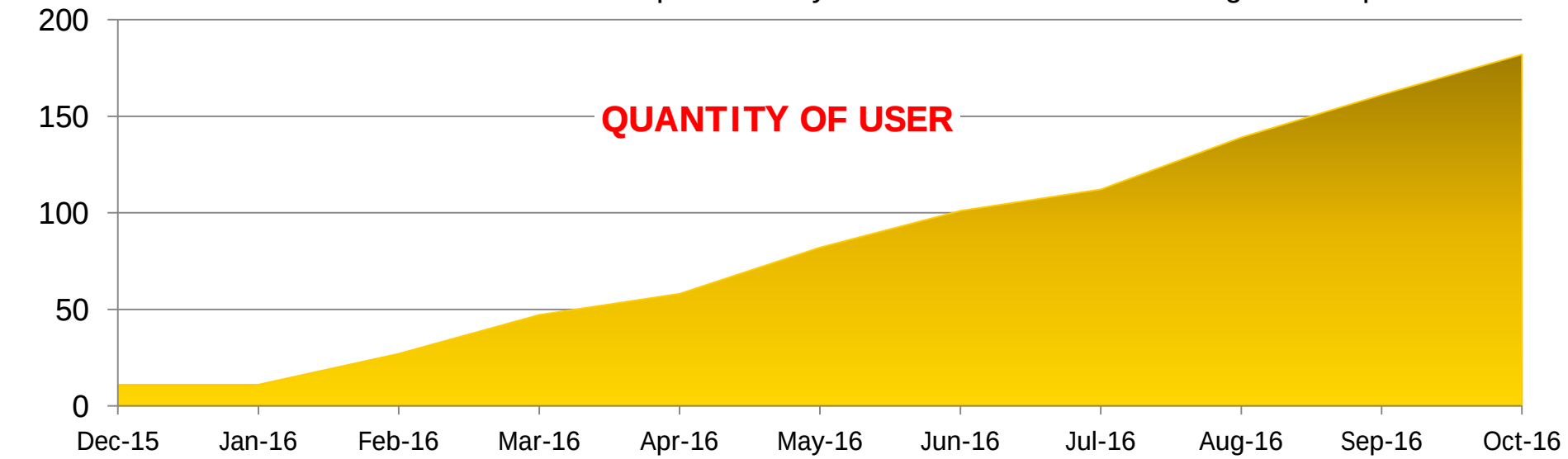
Data Dissemination

QUANTITY OF FILES DOWNLOADED												
MONTH-YEAR		Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16
TOTAL		21	21	308	645	891	1433	16325	17234	21265	23012	26792
INSTRUMENTS	Callisto	2	2	2	3	4	4	4	5	6	6	7
	X-Ray flow	3	3	17	17	17	17	19	26	2560	2561	2562
	Magnetometer	1	1	248	455	671	1104	15867	16684	17236	18874	18940
	GNSS IONEX only	6	6	6	7	9	42	47	47	55	83	3289
	GNSS GTEX only	1	1	1	1	1	5	9	9	15	15	20
	GNSS Wather Vapor	1	1	1	3	3	3	3	3	3	5	5
	GNSS Scintilation	2	2	4	5	7	7	8	8	8	8	9
	Ionosonde	3	3	27	152	177	219	336	415	1333	1397	1412
	All-sky Imager	2	2	2	2	2	32	32	37	49	63	548

QUANTITY OF USER												
MONTH-YEAR		Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16
TOTAL		11	11	27	47	58	82	101	112	139	161	182
INSTRUMENTS	Callisto	1	1	1	2	3	3	3	4	5	5	6
	X-Ray flow	2	2	4	4	4	4	6	7	10	11	12
	Magnetometer	1	1	9	23	27	35	41	43	52	58	63
	GNSS IONEX only	2	2	2	3	4	7	10	10	12	16	20
	GNSS GTEX only	1	1	1	1	1	4	7	7	9	9	13
	GNSS Wather Vapor	1	1	1	3	3	3	3	3	3	5	5
	GNSS Scintilation	1	1	3	4	6	6	7	7	7	7	8
	Ionosonde	1	1	5	6	9	14	18	23	29	36	39
	All-sky Imager	1	1	1	1	1	6	6	8	12	14	16

Data Dissemination

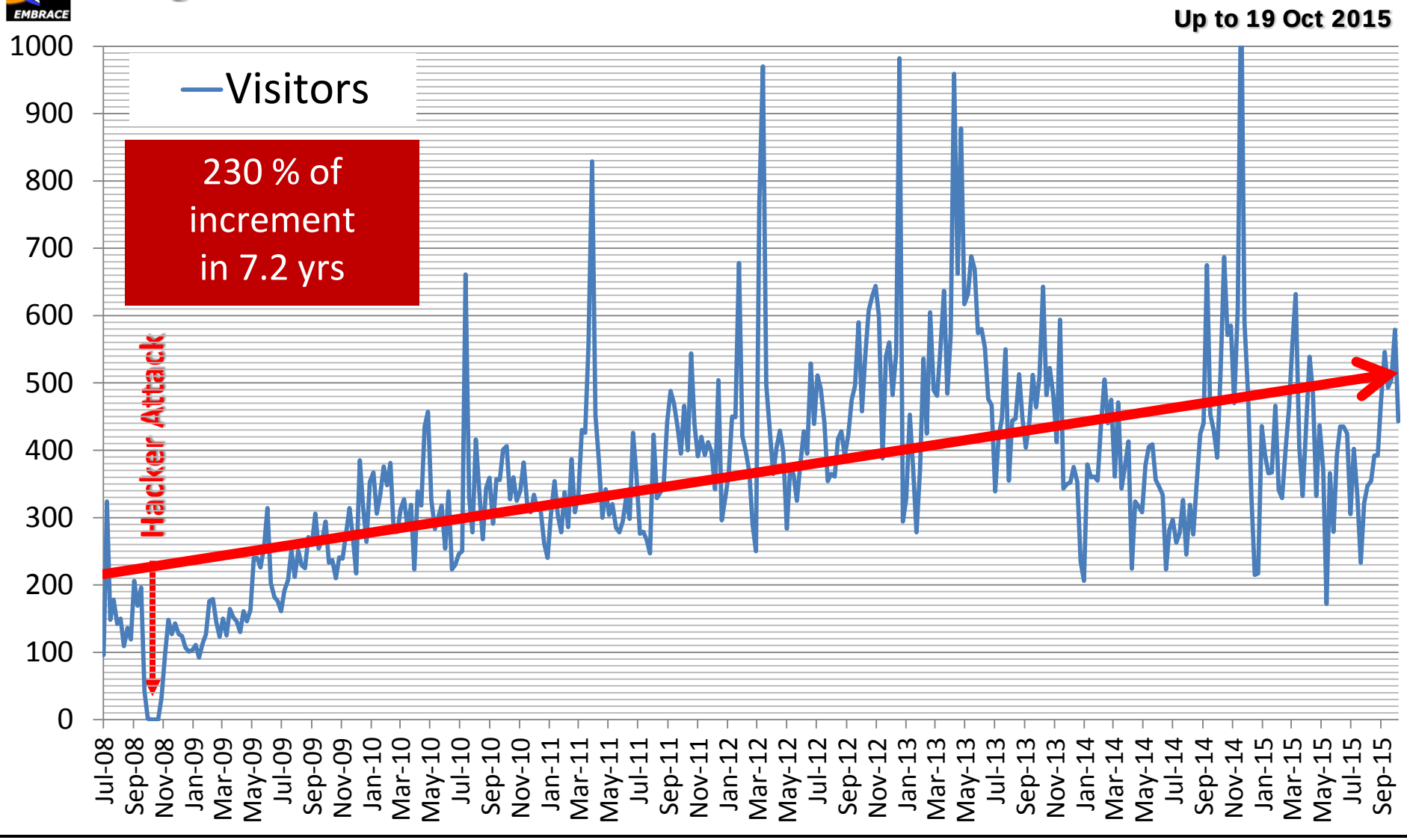




Growing Number of Visitor

www.inpe.br/spaceweather

Google Analytics



Countries that Embraced Us

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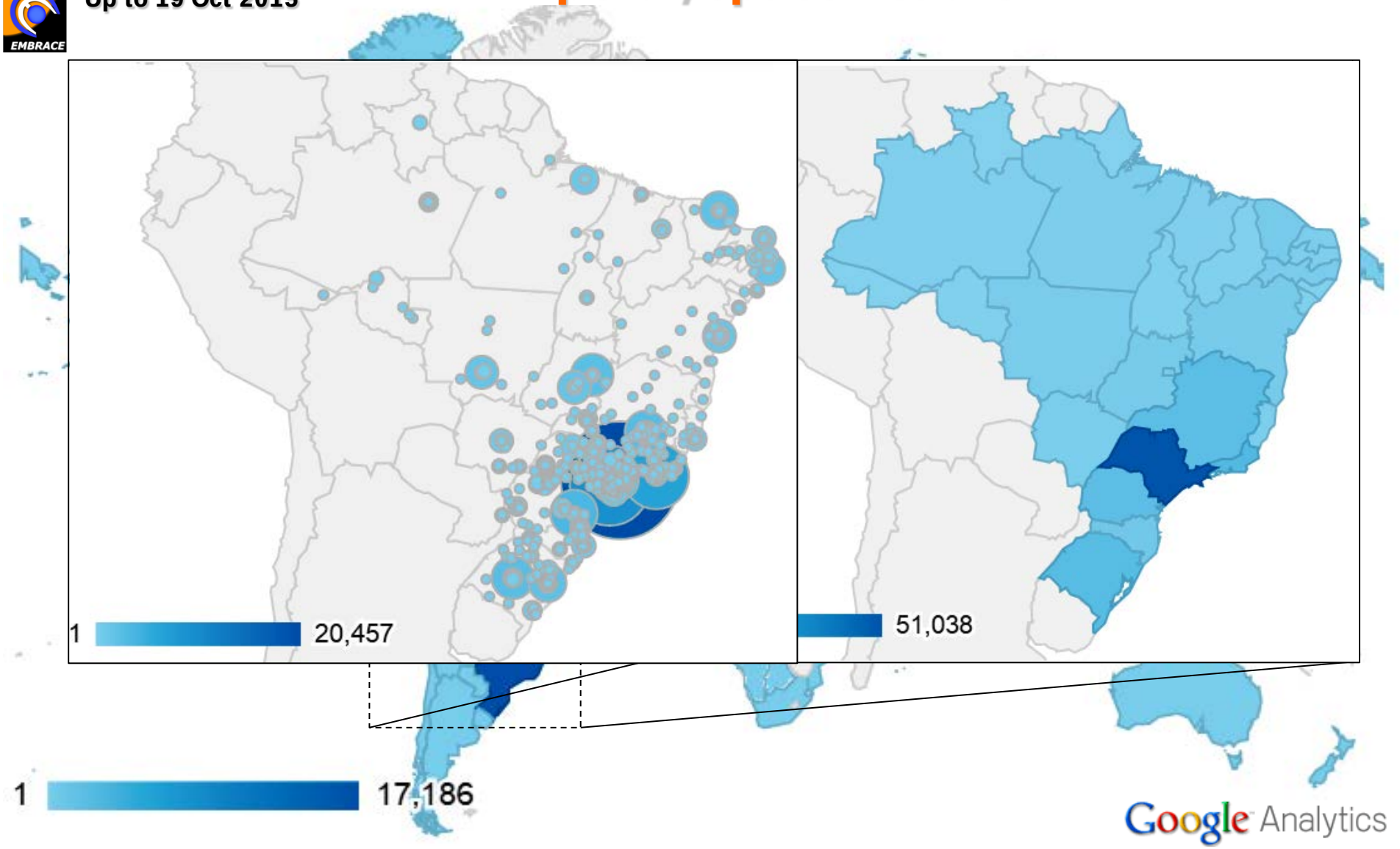
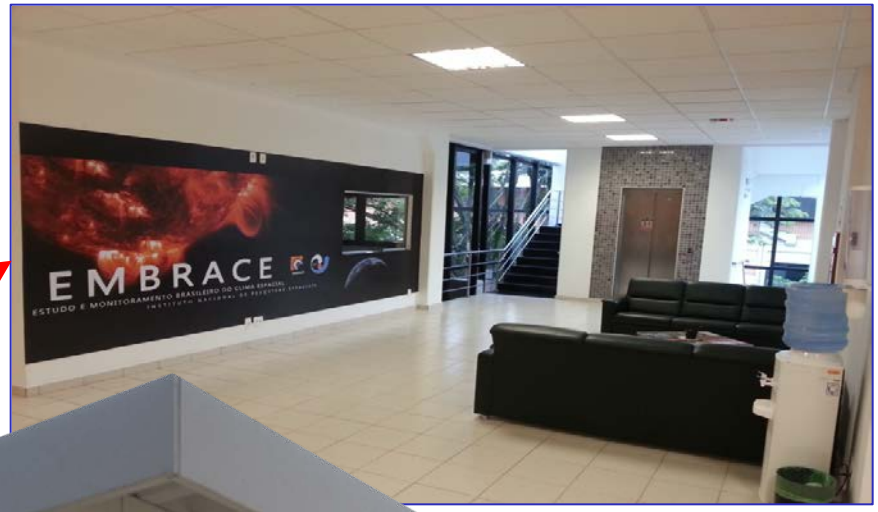
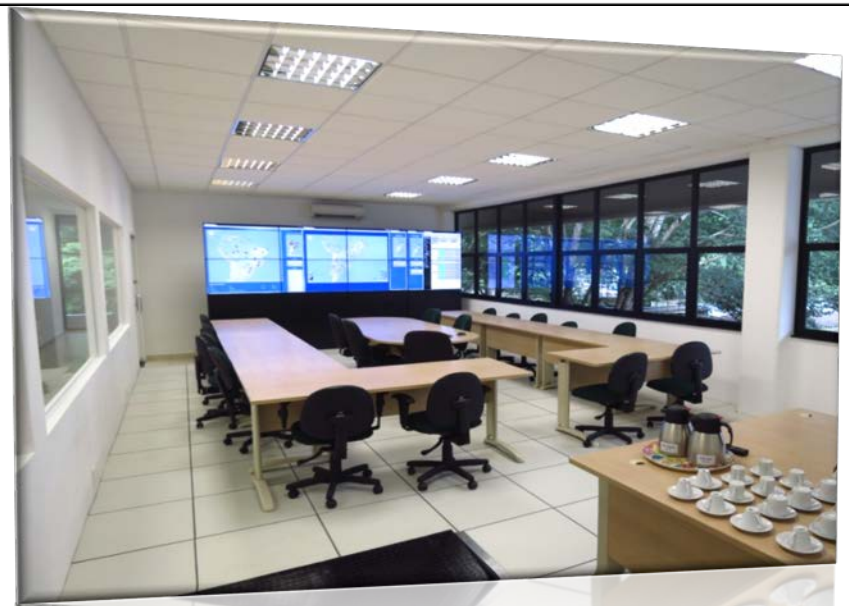
Up to 19 Oct 2015



Location of the Embrace



Embrace Headquarter



PROGRAM FOR

ESTUDO E MONITORAMENTO BRASILEIRO DO CLIMA ESPACIAL

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OBRIGADO


рахмат
danke
謝謝
ngiyabonga
teşekkür ederim
Баярлалаа
mersi
kia ora
barka
welalin
tack
spas
mahalo
tapadh leat
спасибо
faafetai lava
vinaka
спасибі
blagodaram
dank je
misaotra
matondo
paldies
grazzi
хвала
thank you
gracias
asante
manana
obrigada
tenki
kiitos
dankie
nanni
nandri
dhanyavad
mauruuru
köszönöm
hvala
gracie
bayarlalaa
bedankt
enkosi
akun
dankon
aciú
djiere dieuf
tau
mochchakkeram
murakoze
chokrane
дякую
mamnun
dziękuję
chnorakaloutioun
gratias ago
gracies
sulpáy
taiku
go raibh maith agat
sobodi
dėkuji
obrigado
mèsi
didi madloba
sagolun
sukriya
kop khun krap
arigatô
takk
dakujem
trugarez
najis tuke
ありがとう
tanemirt
rahmet
grazie
ευχαριστώ
diolch
dhanyavadagalu
shukriya
merce
мерси
kam sah hamnida
rahmat
terima kasih
감사합니다
xièxie
merci