



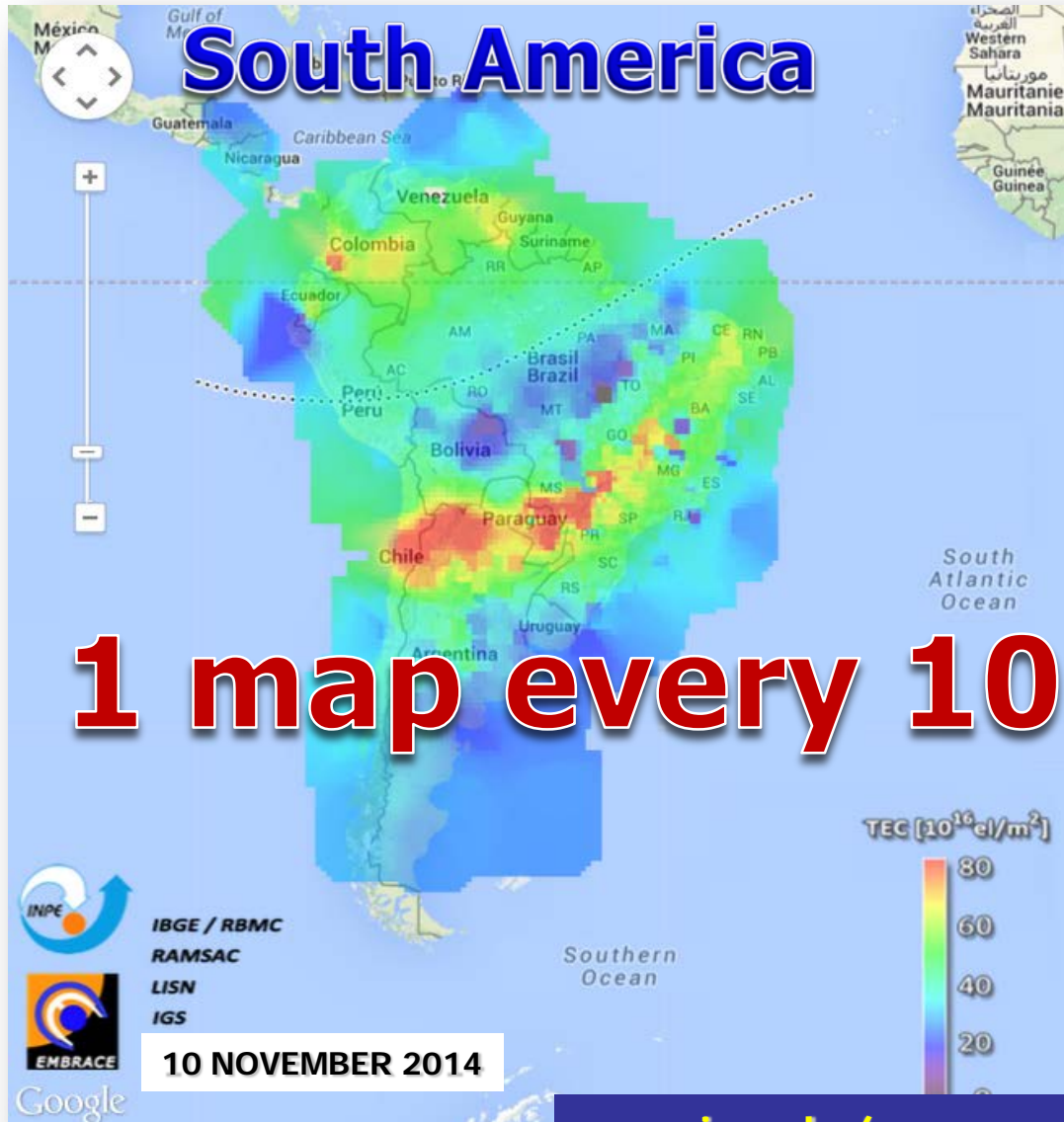
# Space Weather Portfolio Samples

Presented by

**Dr. Clezio Marcos De Nardin**

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

# Regional TEC Maps



**1 map every 10 minutes**

[www.inpe.br/spaceweather](http://www.inpe.br/spaceweather)

Maps are Google layers that be save as:

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

```

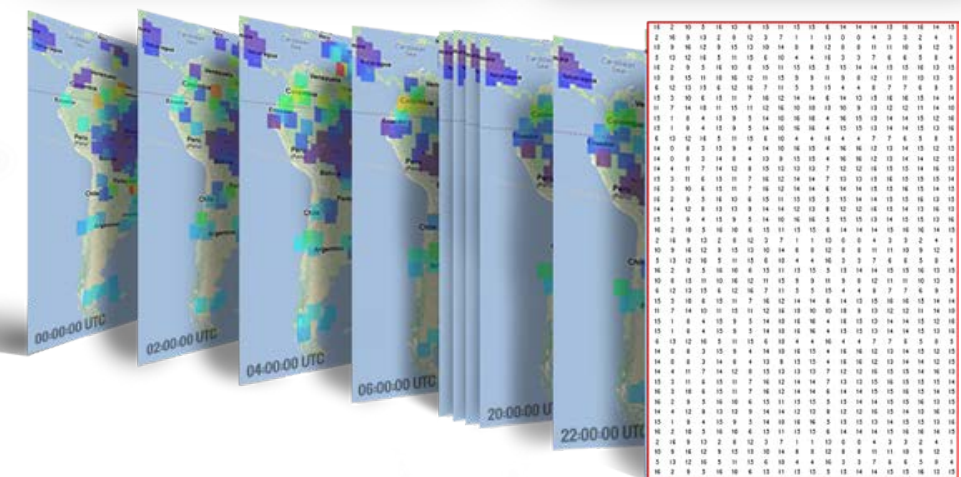
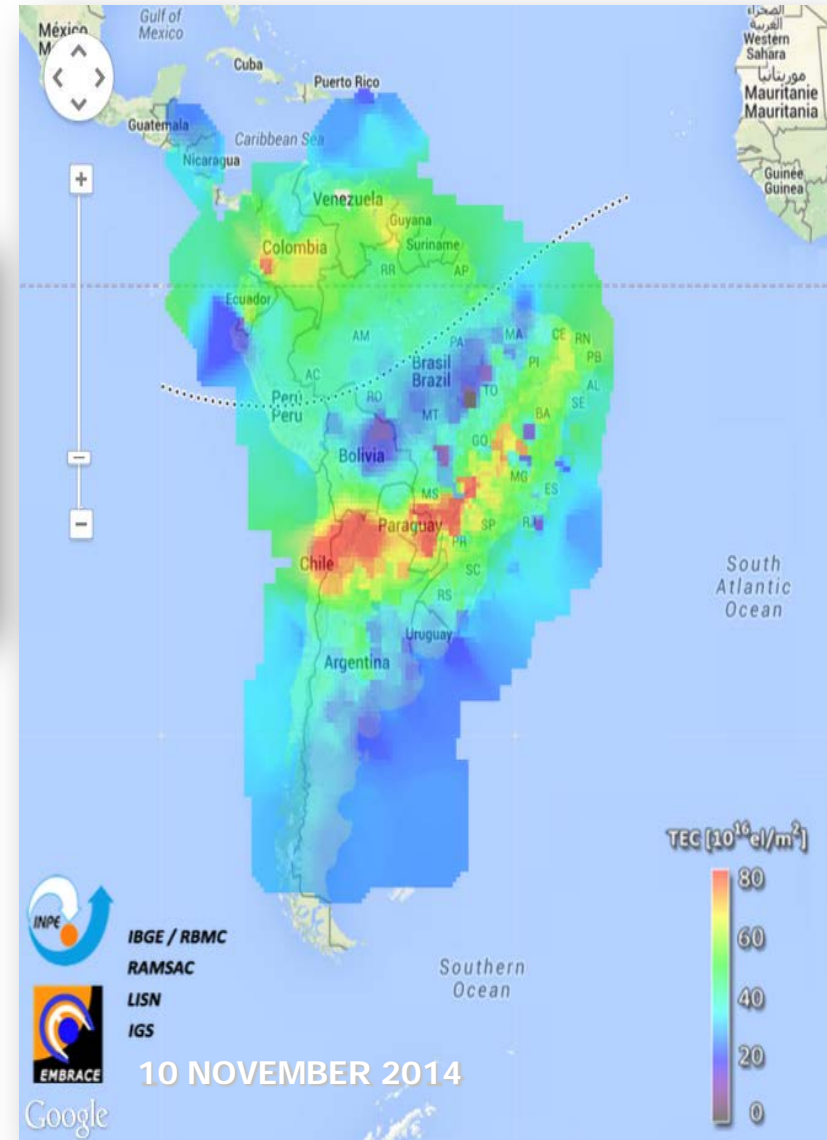
1.0 IONOSPHERE MAPS GPS IONEX VERSION / TYPE
TECMAP App EMBRACE / INPE 04-May-15 22:13 POP / RUN BY / DATE
2015 5 1 23 50 0 EPOCH OF FIRST MAP
600 5 1 23 50 0 EPOCH OF LAST MAP
144 NONE INTERNAL
0.0 # OF MAPS IN FILE
DOUBLE DIFFERENCES CARRIER PHASE 6378.1 MAPPING FUNCTION
ELEVATION CUTOFF OBSERVABLES USED
400.0 400.0 0.0 BASE RADIUS
-80.0 20.0 2.0 MAP DIMENSION
-90.0 -30.0 2.5 400.0 MCTI / MCTJ / DMGT
LAT1 / LAT2 / DLAT LON1 / LON2 / DLON
END OF HEADER
START OF TEC MAP
EPOCH OF CURRNET MAP
51r|p211.150
51r|p 00000
TPS MET03 3.4 663 3u1, 02, 2010 REC # / TYPE / VERS
ANT # / TYPE
APPROX POSITION XYZ
POSITION LAT LON ALT
# / TYPES OF OBSERV
# / TYPES OF DATA
INTERVAL
TIME OF FIRST OBS
END OF HEADER
    
```

IONEX

```

RNXGTEX v1.0 GTEX DATA GPS GTEX VERSION / TYPE
0 TEC values in 10^16 el/m^2 (1 TEC Unit) POP / RUN BY / DATE
TEC status Flag = 0 : Normal data COMMENT
= 1 : Lack of observables (TEC<999.) COMMENT
= 2 : Too large TEC (TEC>999.) COMMENT
= 3 : Cycle slip (TEC discontinuity) COMMENT
= 4 : Cycle slip (L1/L2) COMMENT
= 5 : Beginning of arc COMMENT
= 6 : Raw Elasic TEC including bias COMMENT
= 7 : Absolute start TEC COMMENT
= 8 : All of All is necessary COMMENT
= 9 : TEC status flag COMMENT
= 10 : Observation data used for TEC COMMENT
= 11 : Satellite zenith angle COMMENT
= 12 : Satellite azimuth angle COMMENT
BIAS ESTIMATION PGM
RINEX FILE NAME
MARKER NAME
REC # / TYPE / VERS
ANT # / TYPE
APPROX POSITION XYZ
POSITION LAT LON ALT
# / TYPES OF OBSERV
# / TYPES OF DATA
INTERVAL
TIME OF FIRST OBS
END OF HEADER
51r|p211.150
51r|p 00000
TPS MET03 3.4 663 3u1, 02, 2010 REC # / TYPE / VERS
ANT # / TYPE
APPROX POSITION XYZ
POSITION LAT LON ALT
# / TYPES OF OBSERV
# / TYPES OF DATA
INTERVAL
TIME OF FIRST OBS
END OF HEADER
    
```

GTEX

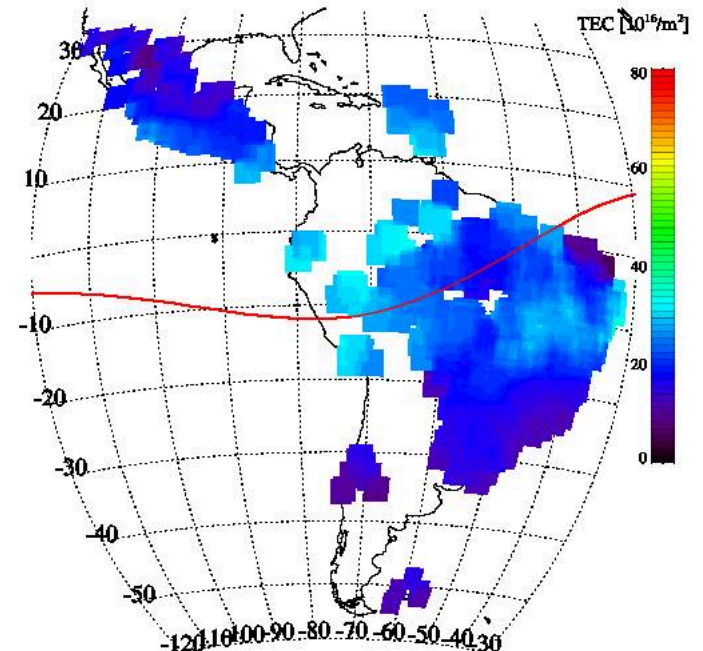
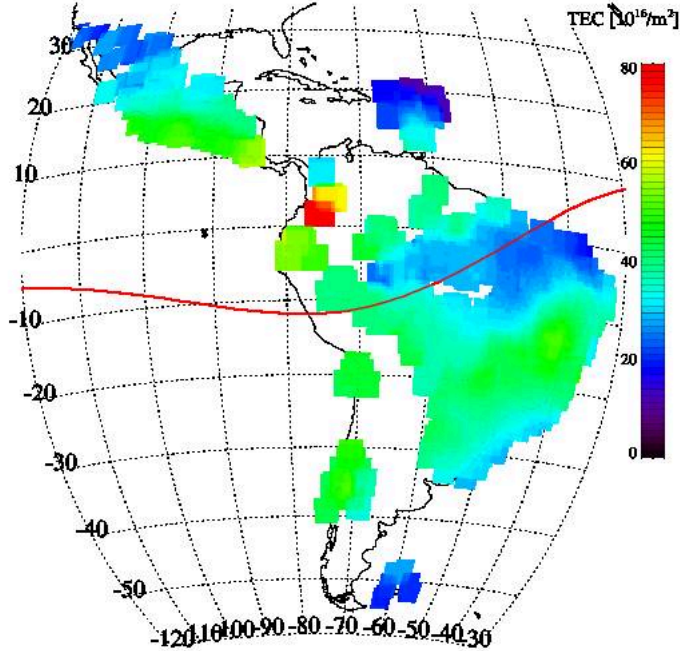


DECEMBER 20, 2015

DECEMBER 21, 2015

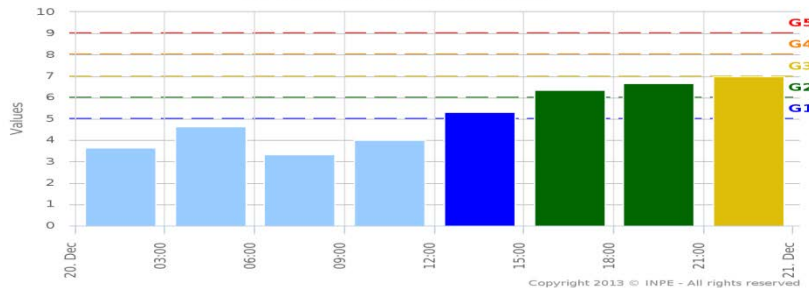
23:00:00(UT) 12/20 2015

23:00:00(UT) 12/21 2015



EMBRACE Magnetometers Network

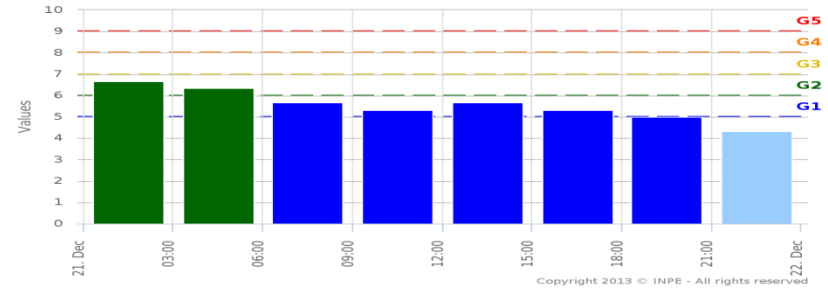
Ksa Index - (12/20/2015 - 12/20/2015)



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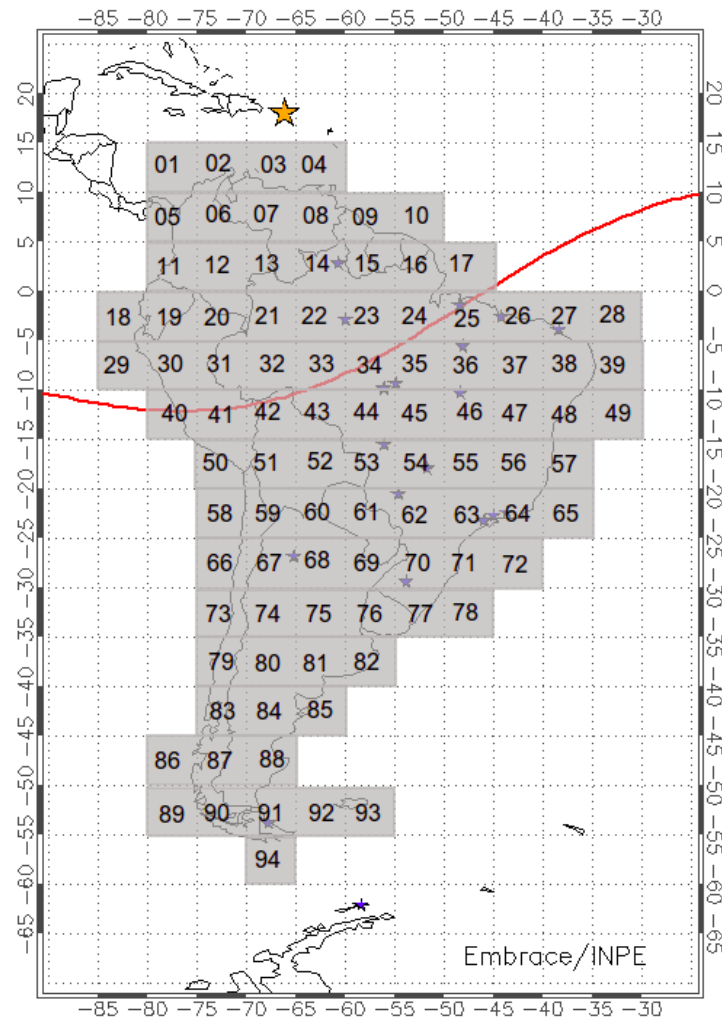
EMBRACE Magnetometers Network

Ksa Index - (12/21/2015 - 12/21/2015)



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Embrace MagNet currently operating stations and observatories



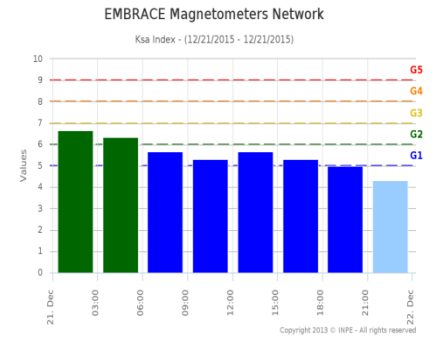
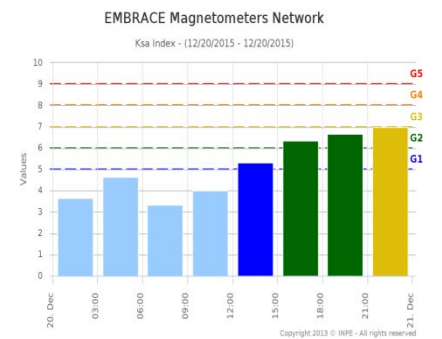
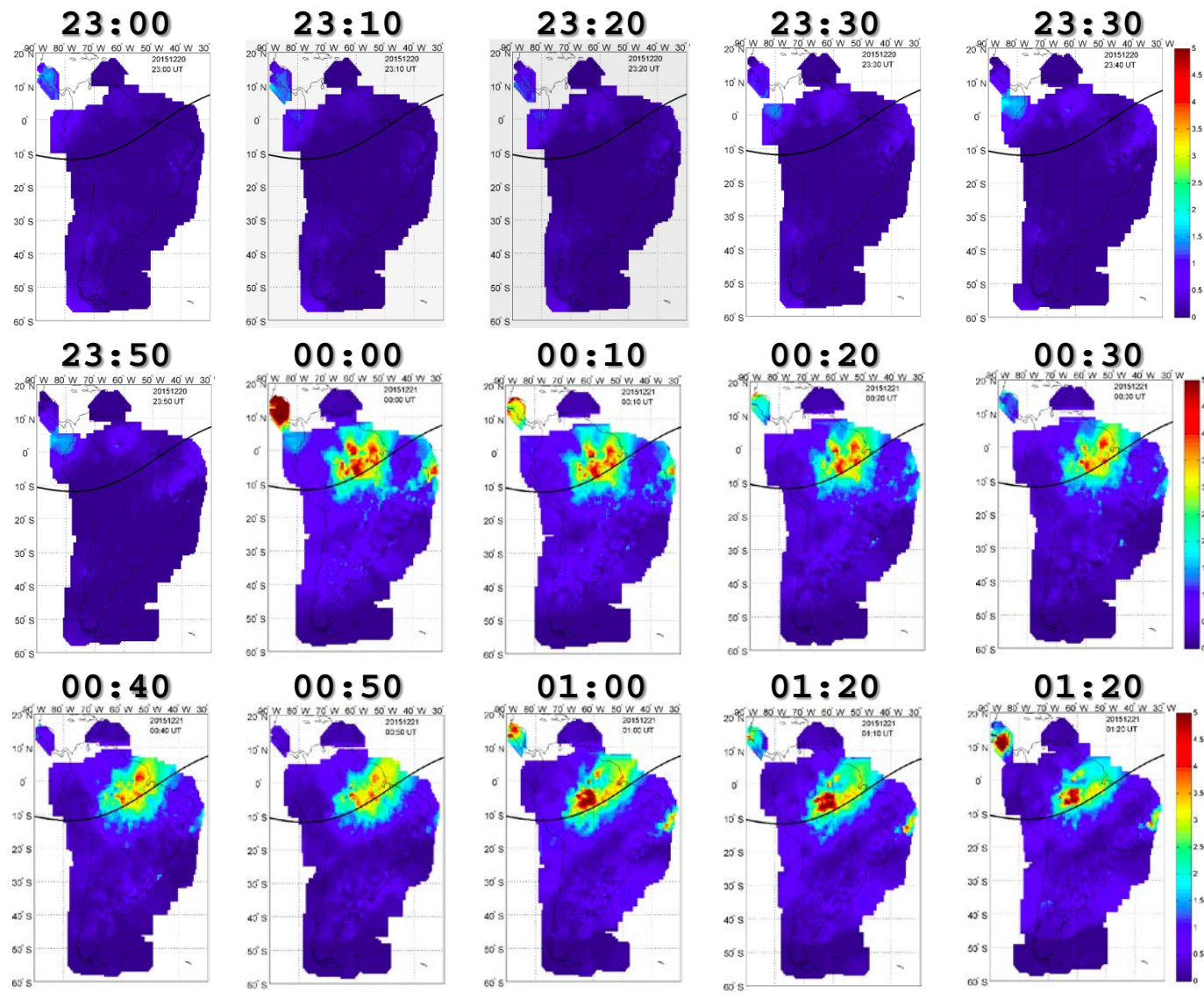
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$$RIDX_r^{med} = \sqrt{\left(\frac{1}{N_{gp} - 1}\right) \sum_{k=1}^{N_{gp}} \left(\frac{TEC_k - TEC_k^{med}}{TEC_k^{med}}\right)^2}$$

↓
↓
↓

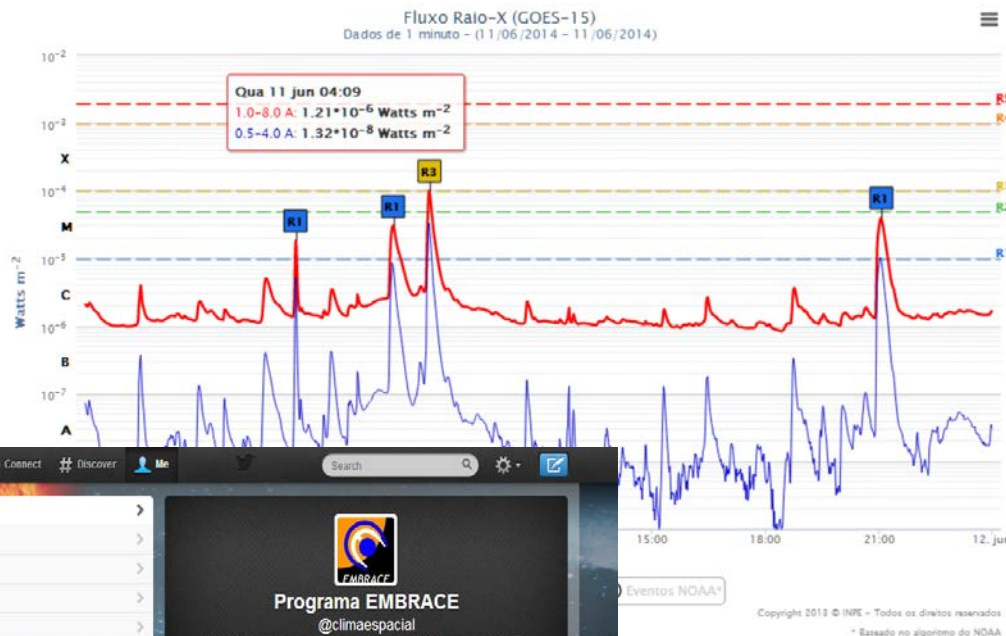

Number of grid points in a given regional map      Vertical TEC      monthly TEC median

- 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].



**Magnetic Storm on December 20<sup>th</sup>, 2015**

**Dst = -155 nT**  
**Kp = 6<sup>+</sup>**

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Retweeted by Clezio M. De Nardin

Programa EMBRACE @climaespacial · Jun 15  
[ALERT] [Radio blackouts] -R1- Flare detected. Peak: 06-16-2014 00:01:00 UTC. #Embrace #INPE #SpaceWeather

Retweeted by Clezio M. De Nardin

Programa EMBRACE @climaespacial · Jun 15  
[ALERTA] [Rádio blackouts] -R1- Flare detectado. Pico: 15-06-2014 11:39:00 UTC. #Embrace #INPE #SpaceWeather

Programa EMBRACE @climaespacial  
EMBRACE é um programa de Monitoramento B São José dos Camp

1,495 TWEETS 49 FOLLOWING 283 FOLL

Tweets

Programa EMBRACE @climaespacial  
EMBRACE é um programa de Monitoramento B São José dos Camp

Programa EMBRACE @climaespacial  
Em Foztaleta o pico de d km enquanto a ionosfera geomagnética de ontem.

Programa EMBRACE @climaespacial  
Vento solar em condições normais, já recuperado do distúrbio do dia 8. V=450km/s e B=5nT. R2 positiva

@climaespacial

## 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 RAIÓ-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 occurred 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.

Esta é uma mensagem automática. Por favor não responda este email. Se precisar contactar-nos envie email para [contato.embrace@inpe.br](mailto:contato.embrace@inpe.br). This is an automated message. Please do not reply to this email. If you need to contact us please send email to [contato.embrace@inpe.br](mailto:contato.embrace@inpe.br).



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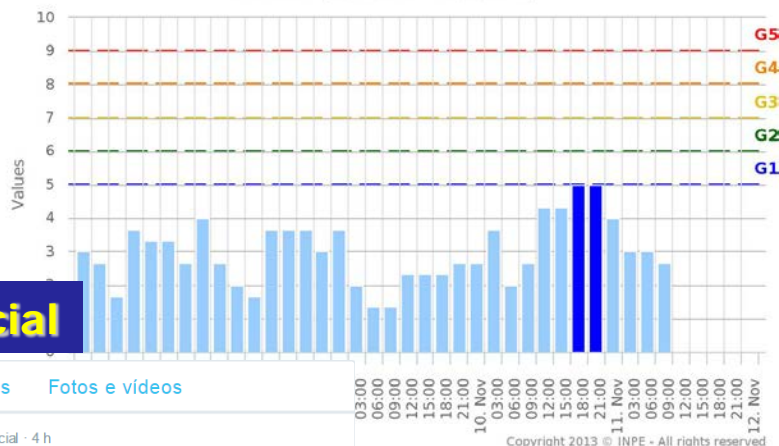


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## EMBRACE Magnetometers Network

Ksa Index - (11/07/2014 - 11/11/2014)



@climaespacial

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](http://bit.ly/1o2QpUS) #INPE #SpaceWeather

Programa EMBRACE @climaespacial · 4 h

[ALERTA] Embrace/INPE detectou tempe índice Ksa. Detalhes em [bit.ly/1v6aOcw](http://bit.ly/1v6aOcw).

Programa EMBRACE @climaespacial · 22 h

Subtempestade geomagnética de hoje eleva os índices para 4+ e 1000 nT, respo

## EMBRACE Magnetometers Network

$\Delta H_{sa}$  - (11/07/2014 - 11/11/2014)



## 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**



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**



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)

Esta é uma mensagem automática. Por favor não responda este email. Se precisar contactar-nos envie email para [contato.embrace@inpe.br](mailto:contato.embrace@inpe.br). This is an automated message. Please do not reply to this email. If you need to contact us please send email to [contato.embrace@inpe.br](mailto:contato.embrace@inpe.br).



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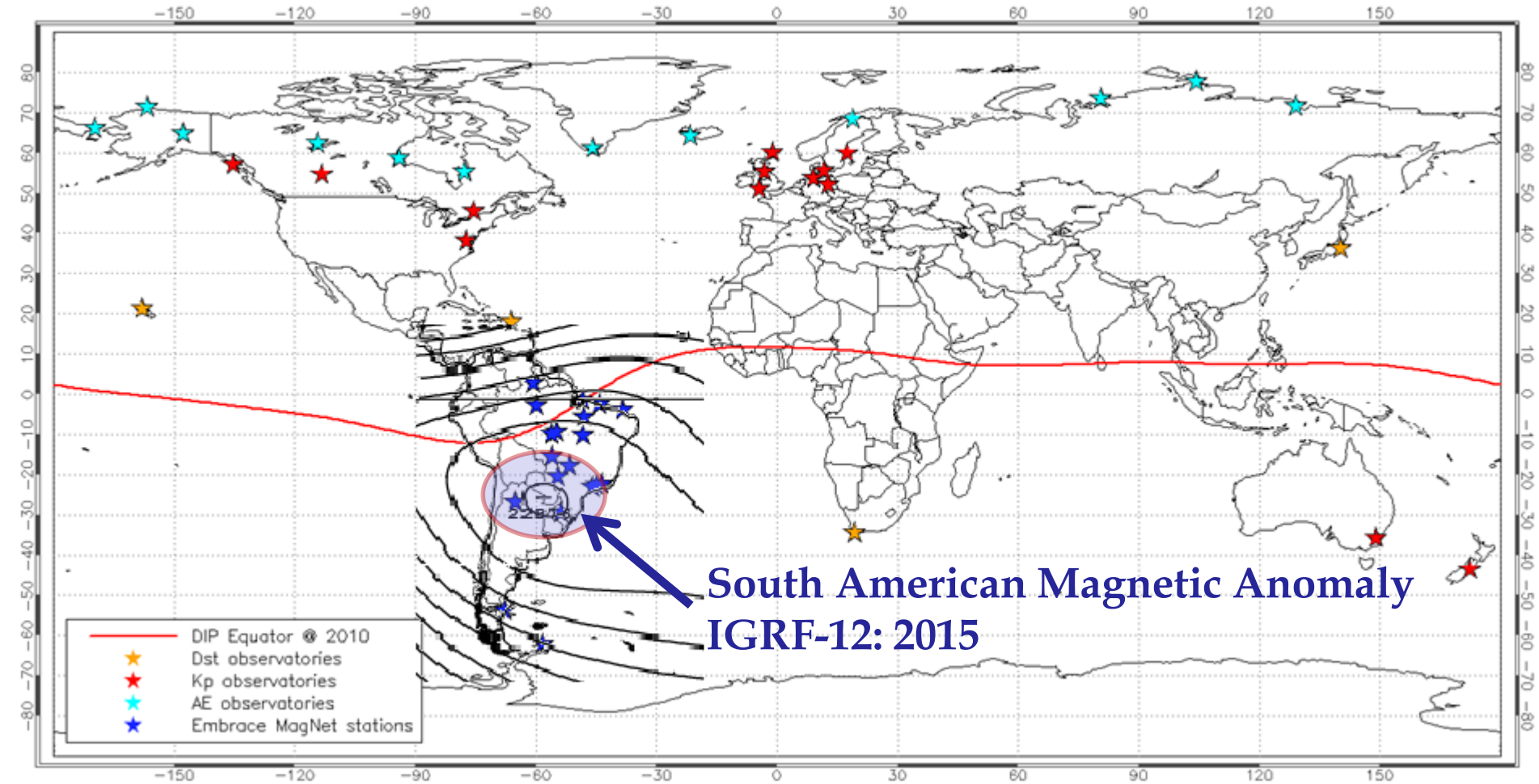


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# South America Mag Anomaly

Courtesy:  
Eng. Sony Su Chen



AFT



## EMBRACE-09 AFT

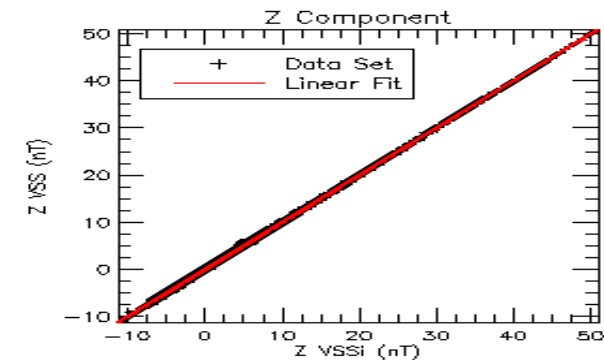
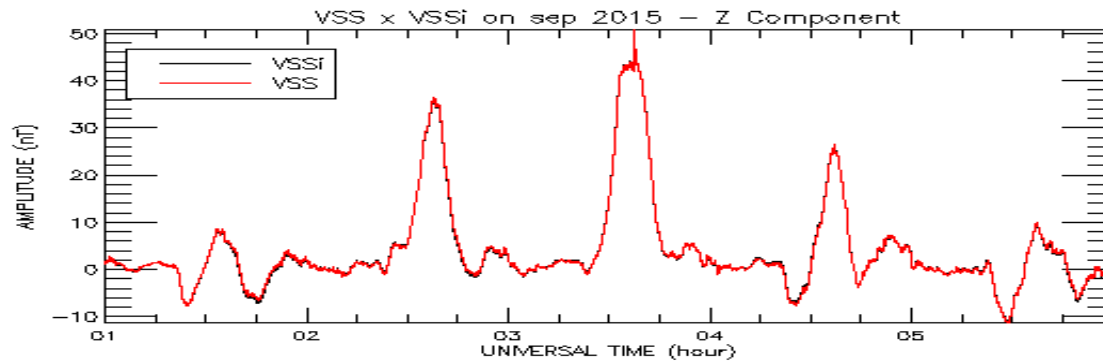
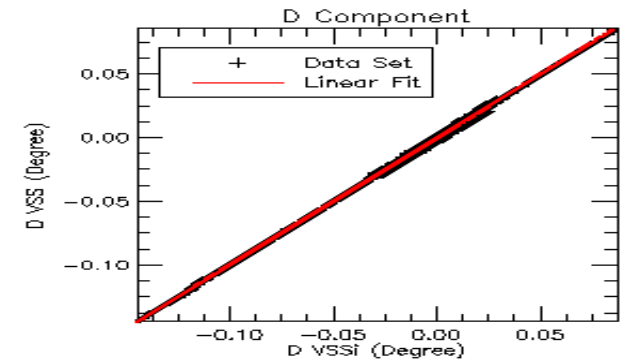
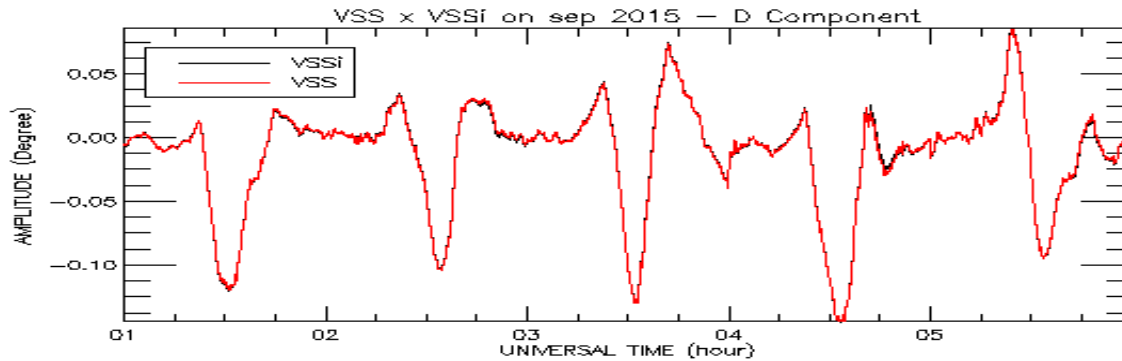
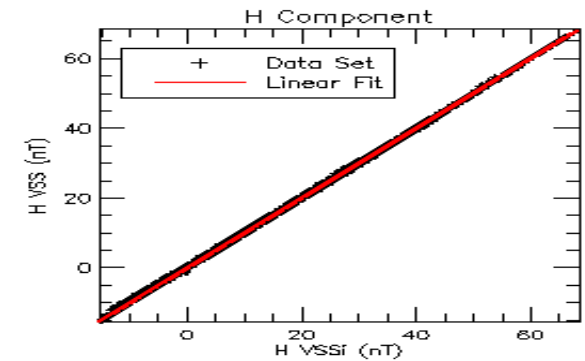
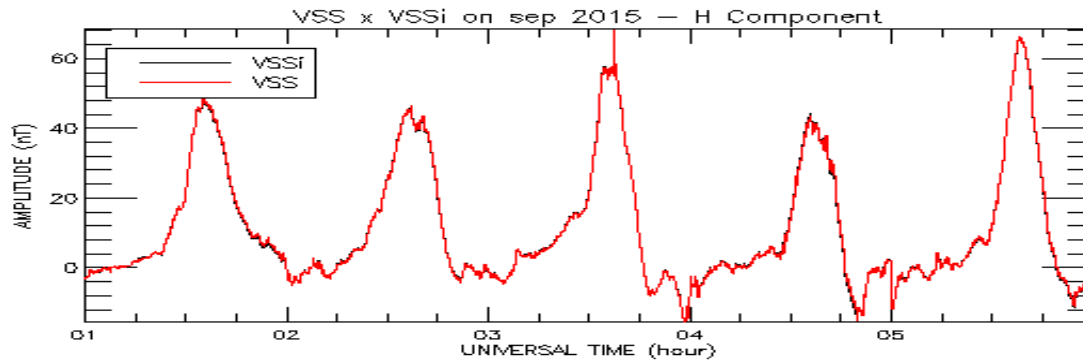


Magnetometer Labels		Maximum error with respect to the reference			
Reference	Under Evaluation	H	D	Z	F
EMBRACE-01	EMBRACE-02	+0.237 %	-0.053 %	+0.112 %	±0.247 %
EMBRACE-01	EMBRACE-03	-0.116 %	+0.001 %	+0.084 %	±0.141 %
EMBRACE-01	EMBRACE-04	-0.252 %	-0.199 %	+0.648 %	±0.637 %
EMBRACE-01	EMBRACE-05	+0.064 %	-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 %
<b>Averaged Square Error</b>		<b>±0.194 %</b>	<b>±0.111 %</b>	<b>±0.146 %</b>	<b>±0.222 %</b>

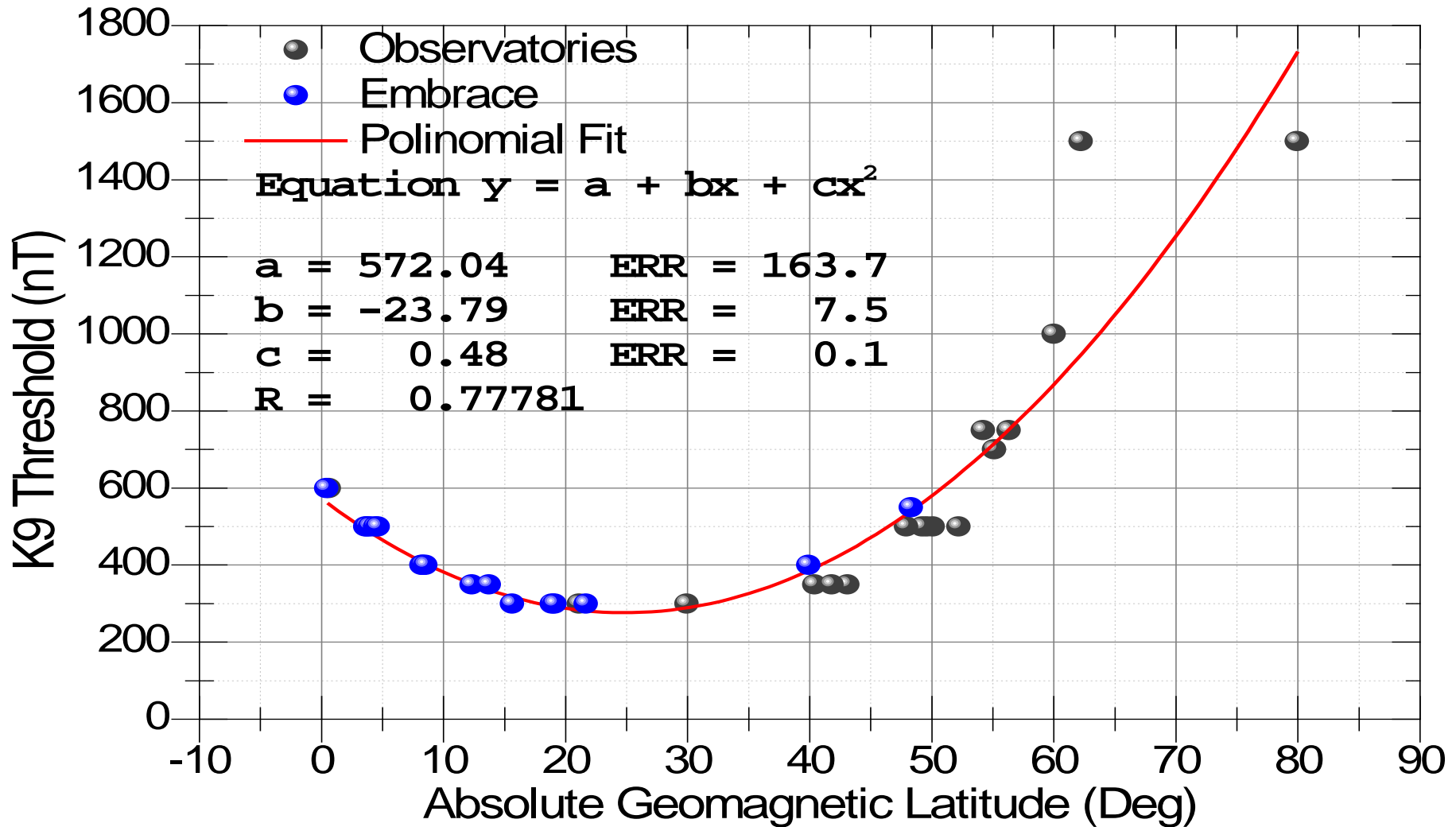


Denardini et al. (2015), Brazilian Journal of Geophysics  
*"The initial steps for developing the South American k index from the embrace magnetometer network"*

# Embrace vs Intermagnet



# K9 Threshold (our stations)

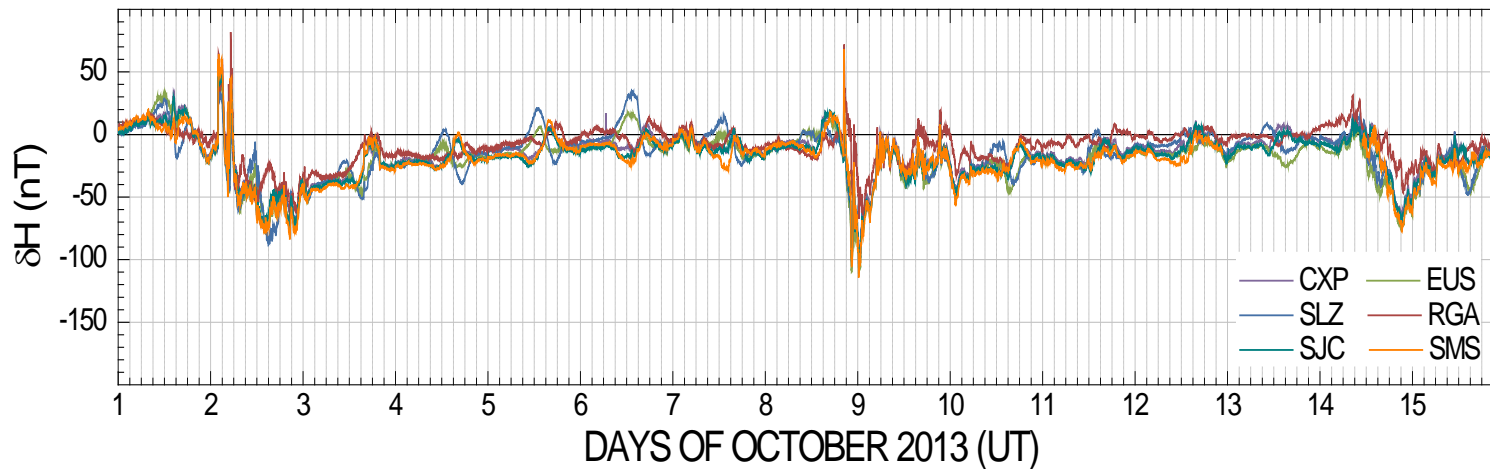
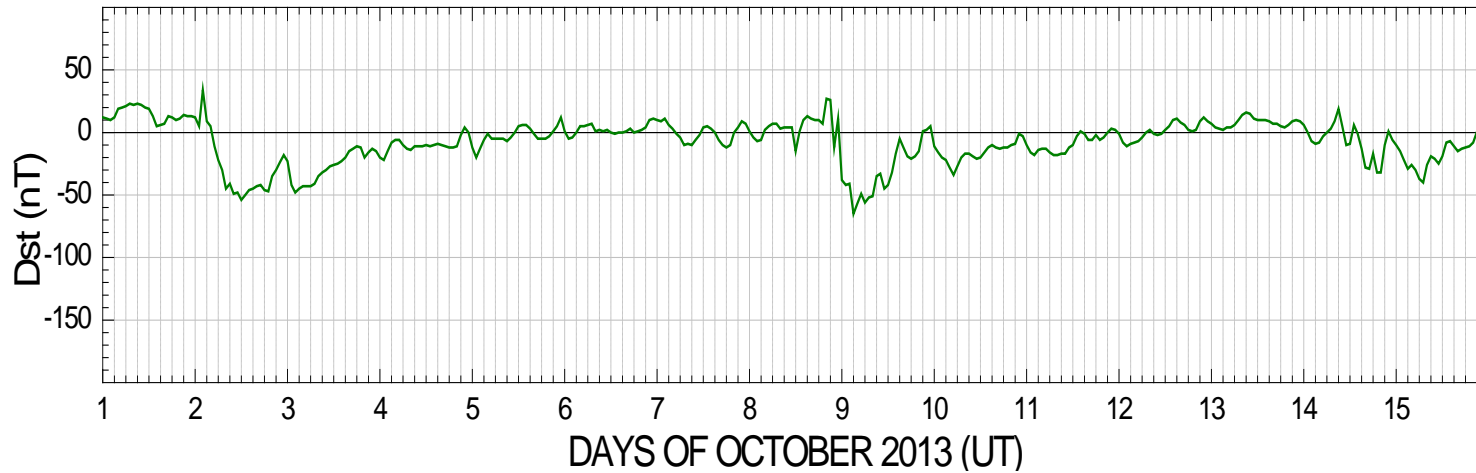


Denardini et al. (2015), Brazilian Journal of Geophysics  
*"The initial steps for developing the South American k index from the embrace magnetometer network"*

# A New Dst Proxy

[www.inpe.br/spaceweather](http://www.inpe.br/spaceweather)

01 to 15 OCT 2013

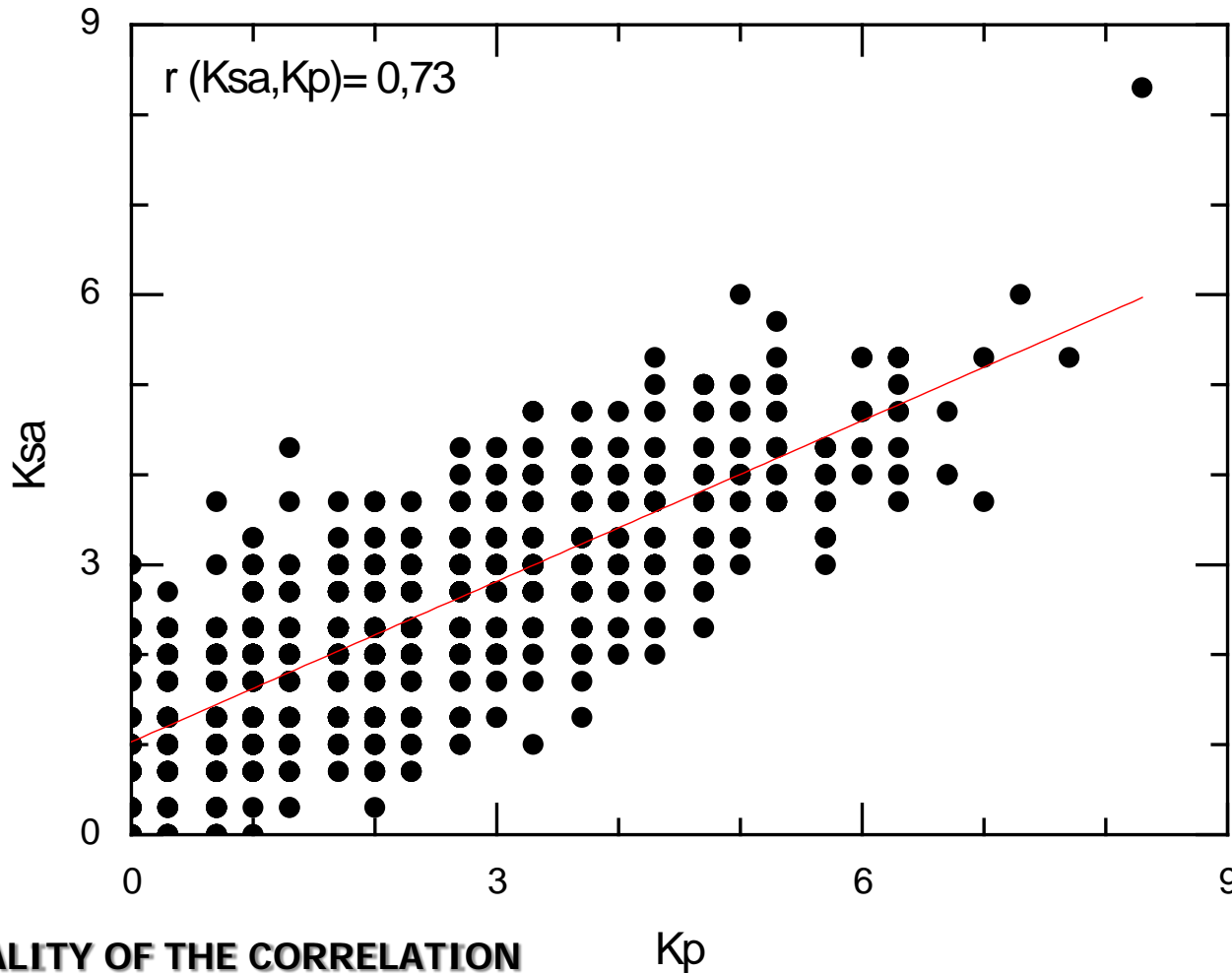


**Localização dos Magnetômetros**

**Listagem**

- ▶ Cuiabá, CBA
- ▶ Alta Floresta, AFT
- ▶ Cachoeira Paulista, CXP
- ▶ Eusébio, EUS
- ▶ São Luís, SLZ
- ▶ Rio Grande - Argentina, RGA
- ▶ São José dos Campos, SJC
- ▶ São Martinho da Serra, SMS





**Localização dos Magnetômetros**

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**QUALITY OF THE CORRELATION**

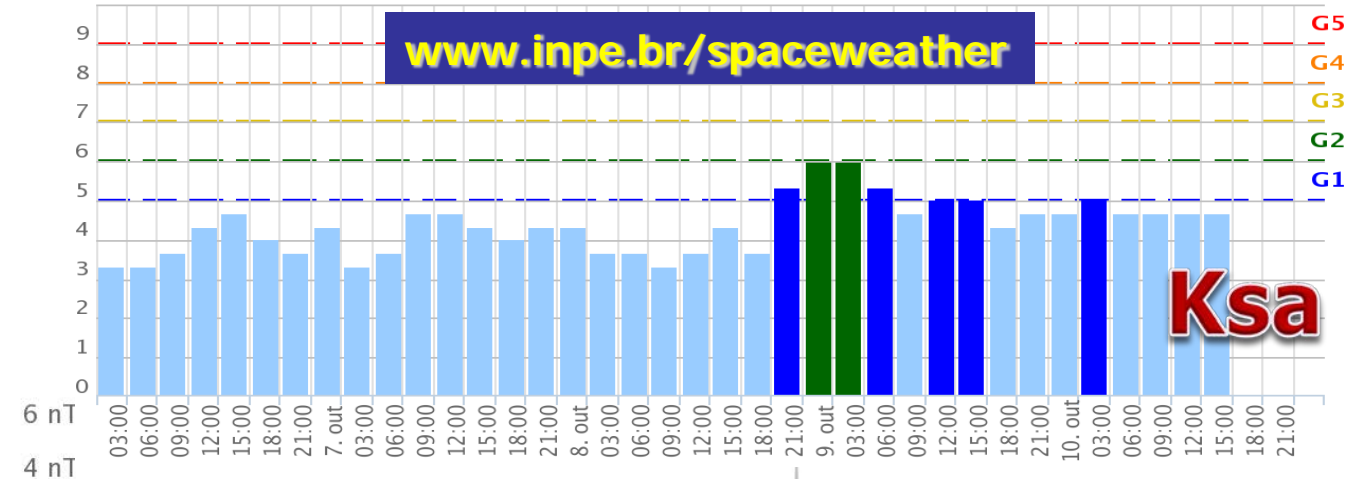
Weak	0.1	0.4	
Moderate	0.4	0.7	
Strong	0.7	1.0	DANCEY and REIDY (2006).



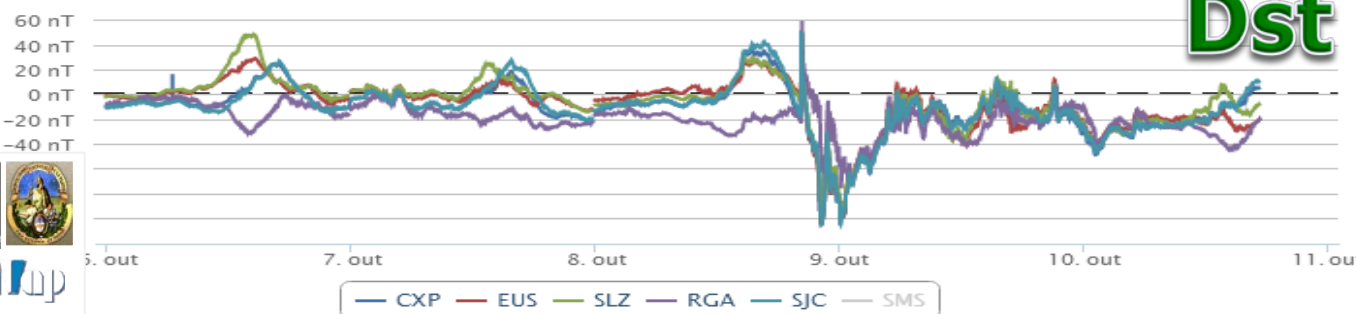
# Regional Magnetic Indices

06 to 10 OCTOBER 2013


Rede EMBRACE de Magnetômetros  
 Índice Ksa - (06/10/2013 - 10/10/2013)



Rede EMBRACE de Magnetômetros  
 $\Delta H$  - (06/10/2013 - 10/10/2013)



**Localização dos Magnetômetros**



Venezuela  
 Colombia  
 Peru (Peru)  
 Brasil (Brazil)  
 Bolivia  
 Chile  
 Argentina

Google  
 Termos de Uso

**Listagem**

- ▶ Cuiabá, CBA
- ▶ Alta Floresta, AFT
- ▶ Cachoeira Paulista, CXP
- ▶ Eusébio, EUS
- ▶ São Luís, SLZ
- ▶ Rio Grande - Argentina, RGA
- ▶ São José dos Campos, SJC
- ▶ São Martinho da Serra, SMS



## Embrace Mobile

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- Games
- Family
- Parent Guide
- Editors' Choice

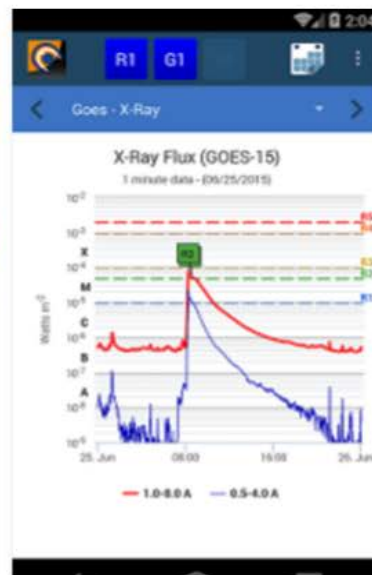
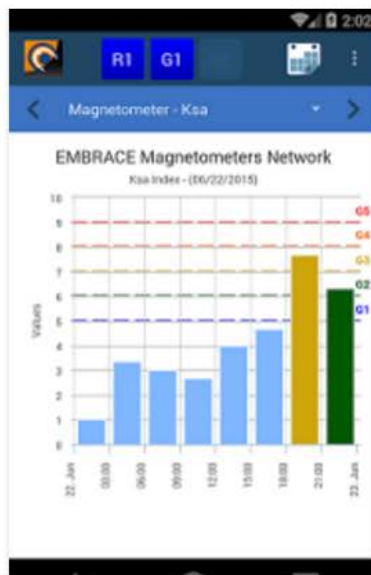
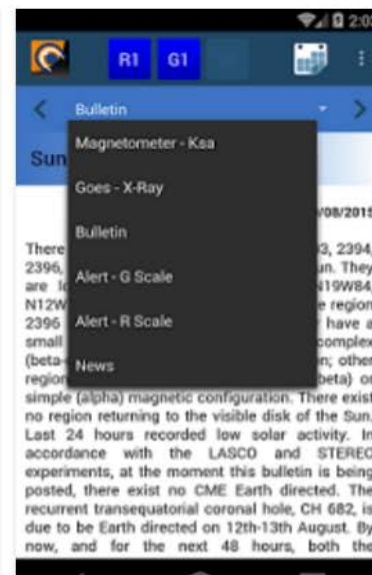


### Embrace Mobile

Brazilian Study and Monitoring of Space Weather Weather ★★★★★ 5

L This app is compatible with all of your devices.

Installed

**Bulletin**  
Magnetometer - Ksa  
Goes - X-Ray  
Sun  
08/2015

There is a small coronal hole (beta) or simple (alpha) magnetic configuration. There exist no region returning to the visible disk of the Sun. Last 24 hours recorded low solar activity. In accordance with the LASCO and STEREO experiments, at the moment this bulletin is being posted, there exist no CME Earth directed. The recurrent transequatorial coronal hole, CH 682, is due to be Earth directed on 12th-13th August. By now, and for the next 48 hours, both the

## Start here



### Registration

Name*	<input type="text" value="Your Name Here"/>		
Institute/University*	<input type="text" value="Your Institution Here"/>		
Department*	<input type="text" value="Your Department"/>		
Phone number*	<input type="text"/>		
E-mail*	<input type="text" value="your_user@your.domain"/>		
Files interest*	<input type="button" value="Select the options"/>		

### Address

Address	<input type="text" value="Your address"/>	Number	<input type="text" value="22222"/>
District	<input type="text" value="Your district"/>	Complement	<input type="text"/>
Zip code	<input type="text" value="2222-2222-222"/>		
City	<input type="text" value="Your City"/>	State/Province	<input type="text" value="State"/>
Country	<input type="text" value="Your Country"/>		

### Alerts

Alerts interest	<input type="button" value="Select the options"/>	Alert language	<input type="text" value="Inglês Americano"/>
Extra emails	<input type="text"/>		

Email	Delete
Empty	

\*Required

I accept the terms and conditions

## DATA Find the product to download



The screenshot shows the EMBRACE data portal interface. At the top, there is a navigation bar with the text "BRASIL Acesso à informação" and links for "Participa", "Serviços", "Legislação", and "Canais". The main content area is divided into two sections: "MANAGEMENT" and "INSTRUMENTS".

**MANAGEMENT** section includes:

- Gravação (represented by a double asterisk icon)
- Atualização (represented by a circular refresh icon)
- Logout (represented by a yellow square with a black 'X' icon)

**INSTRUMENTS** section is organized into two rows:

**Row 1:**

- Calor:** FTS (represented by a sun icon)
- Solatividade:** DIT (represented by a blue square icon)
- Magnetosfera:** DIT (represented by a globe with magnetic field lines icon)
- Ionosfera:** GM no SMO (represented by a graph icon)

**Row 2:**

- Tiempo:** Dione (represented by a rainbow icon)
- IONEX no AMAP:** IONEX (represented by a rainbow icon)
- GTEX:** GTEX (represented by a rainbow icon)
- Índice:** TIT (represented by a blue circle icon)
- Gris:** DIT (represented by a globe icon)
- IBV:** IWI, MET, ZHO, no ZHO (represented by a water drop icon)

At the bottom, there is a footer with the EMBRACE logo, the text "EMBRACE Brazilian Study and Monitoring of Space Weather (INPE/MCT)", and navigation links for "Home", "FAQ", "NSAFI", "Contact", and "About". A copyright notice reads "Copyright 2011 © INPE - National Institute for Space Research. All rights reserved."

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

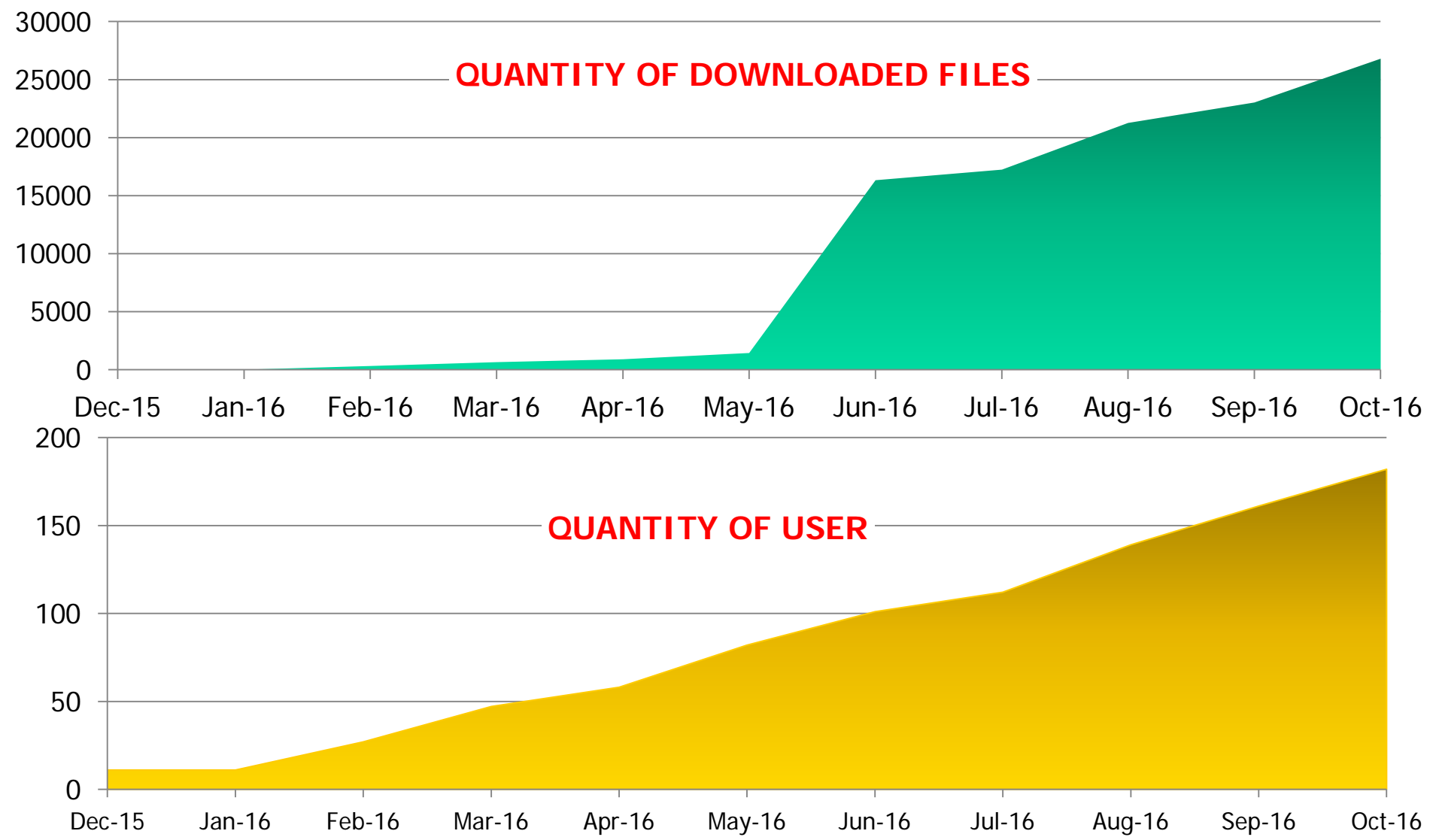
**Cachoeira Paulista**

1

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

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	
<b>TOTAL</b>	<b>21</b>	<b>21</b>	<b>308</b>	<b>645</b>	<b>891</b>	<b>1433</b>	<b>16325</b>	<b>17234</b>	<b>21265</b>	<b>23012</b>	<b>26792</b>	
INSTRUMENTS	Callisto	2	2	2	3	4	4	4	5	6	7	
	X-Ray flow	3	3	17	17	17	17	19	26	2560	2561	
	Magnetometer	1	1	248	455	671	1104	15867	16684	17236	18874	
	GNSS	IONEX only	6	6	6	7	9	42	47	47	55	83
		GTEX only	1	1	1	1	1	5	9	9	15	15
		Wather Vapor	1	1	1	3	3	3	3	3	3	5
		Scintillation	2	2	4	5	7	7	8	8	8	8
	Ionosonde	3	3	27	152	177	219	336	415	1333	1397	
	All-sky Imager	2	2	2	2	2	32	32	37	49	63	

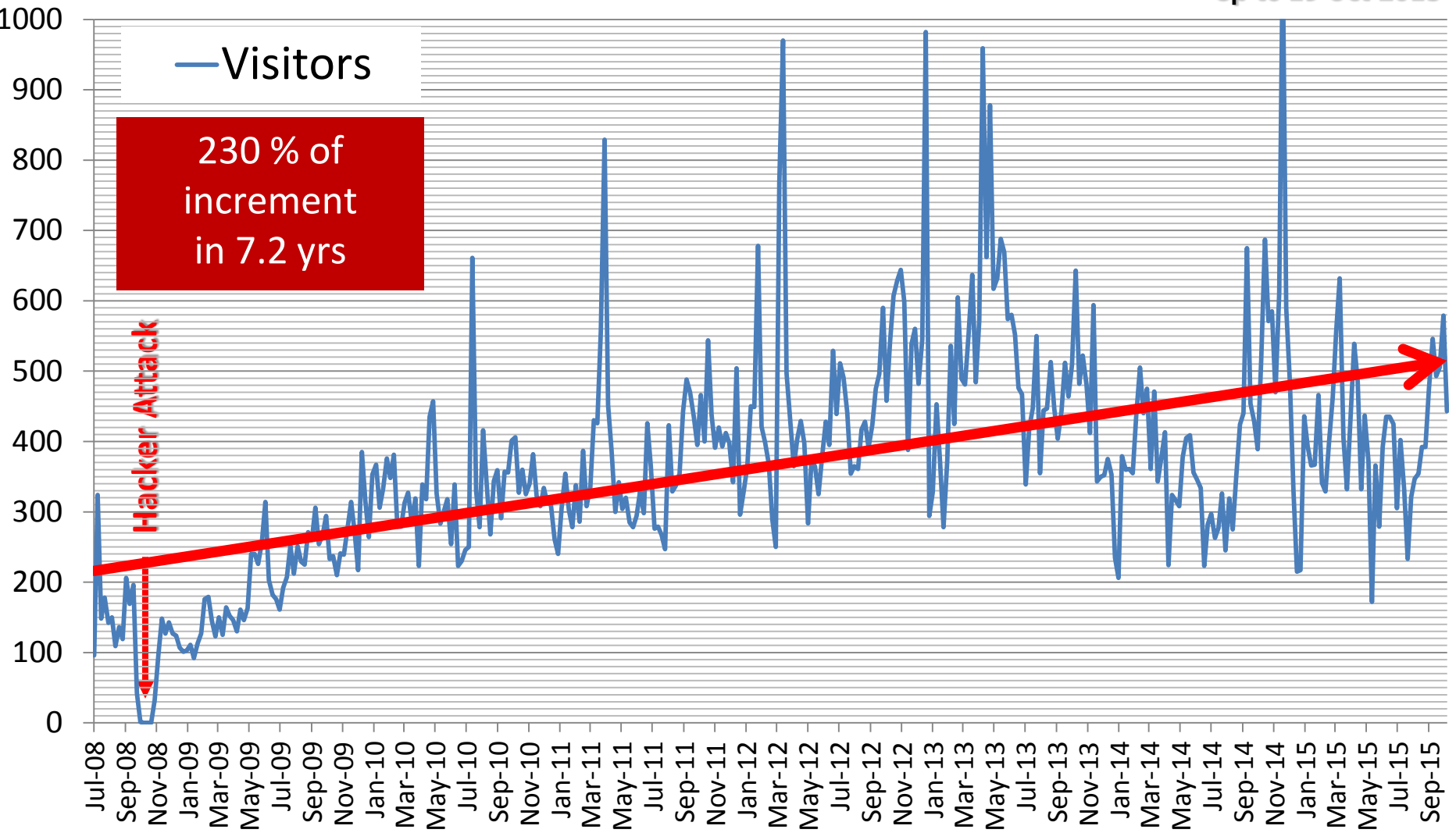
QUANTITY OF USER												
MONTH-YEAR	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	
<b>TOTAL</b>	<b>11</b>	<b>11</b>	<b>27</b>	<b>47</b>	<b>58</b>	<b>82</b>	<b>101</b>	<b>112</b>	<b>139</b>	<b>161</b>	<b>182</b>	
INSTRUMENTS	Callisto	1	1	1	2	3	3	3	4	5	6	
	X-Ray flow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



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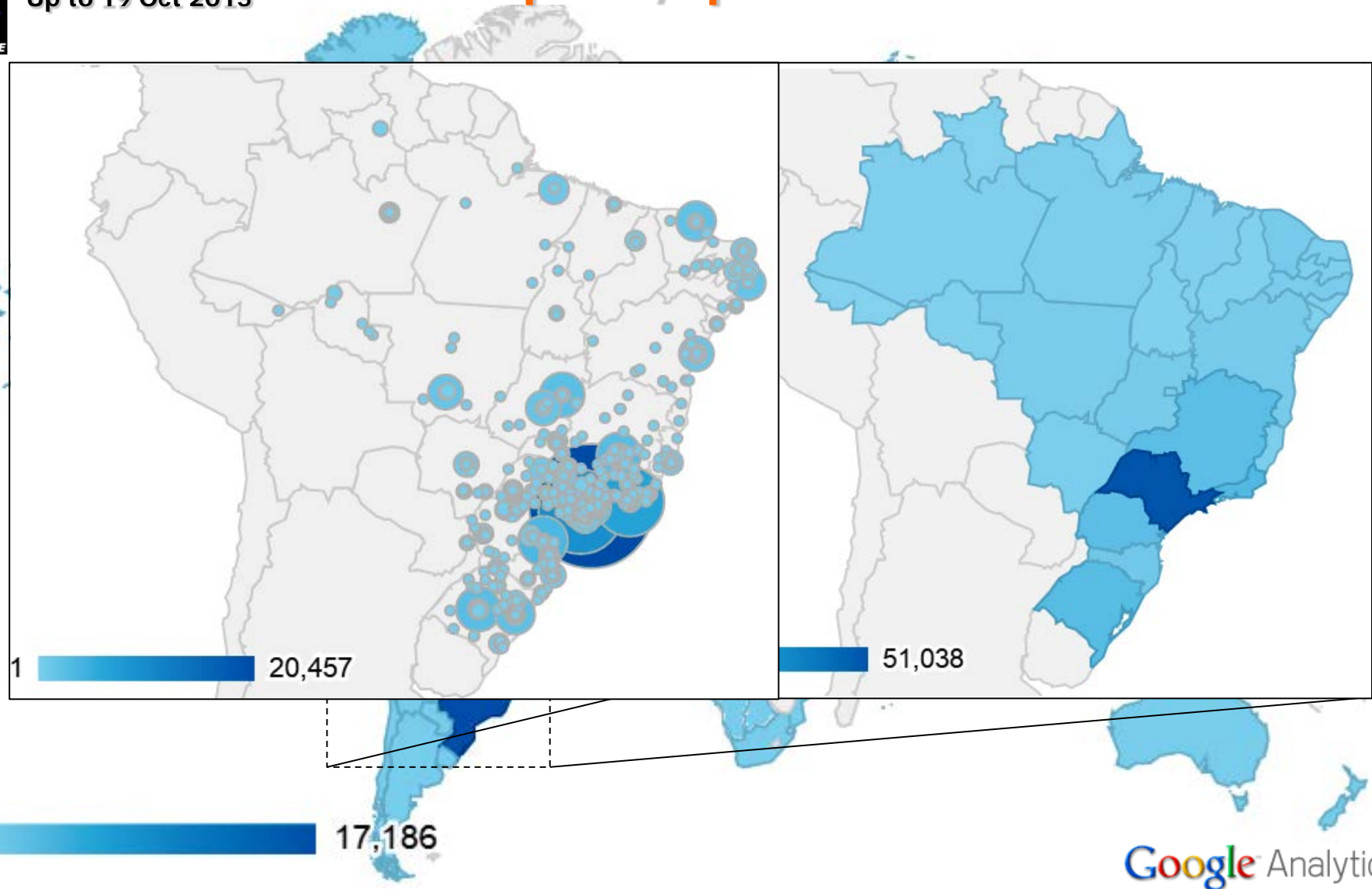
Up to 19 Oct 2015



# Countries that Embraced Us

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Up to 19 Oct 2015





# Location of the Embrace





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**C**LIMA  
**E**SPACIAL



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