MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

BRAZILIAN CONTRIBUTION TO THE LISN PROJECT

(LOW-LATITUDE IONOSPHERIC SENSOR NETWORK)

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Over equatorial and low magnetic latitudes the GPS System is affected by the

- TEC (Total Electron Content)
- ionospheric scintillation.

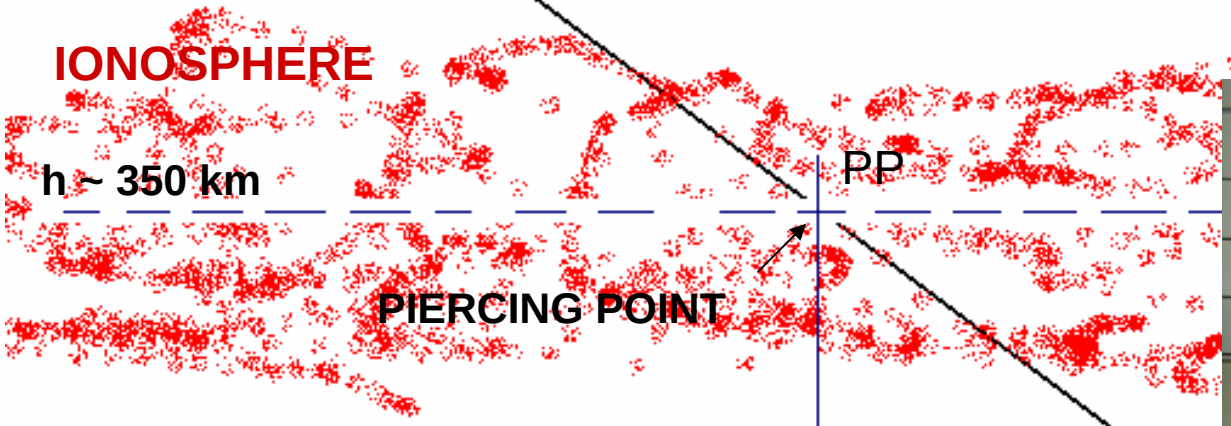
The TEC causes delay in the GPS signal while the scintillations can cause

- loss-of-lock and
- positioning degradation.

GLOBAL POSITIONING SYSTEM (GPS)

24 satellites
20,200 km altitude
12 hour period

L-band
L1 = 1575.42 MHz
L2 = 1227.60 MHz



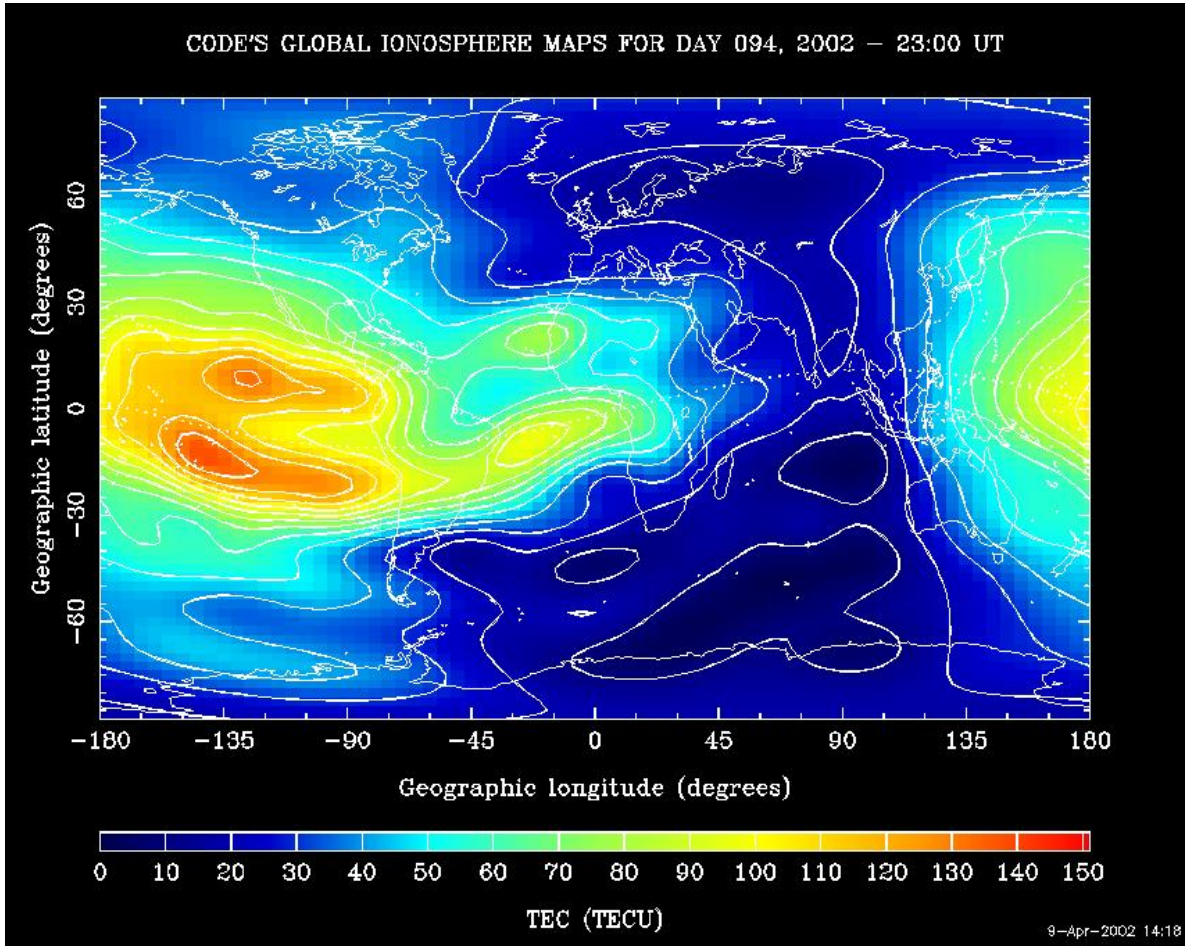
The GPS system main purpose is to
determine the position and velocity
of a fixed or mobile object,
placed over or near the earth surface,
using the signals of 24 satellites on earth's orbit.

TEC contour map of CODE's Global Ionospheric Map
Geographic latitude and longitude. Day 094, 20:02 - 23:00 UT

The Total Electron Content (TEC) is the amount of free electrons along the path of the electromagnetic wave between each satellite and the receiver

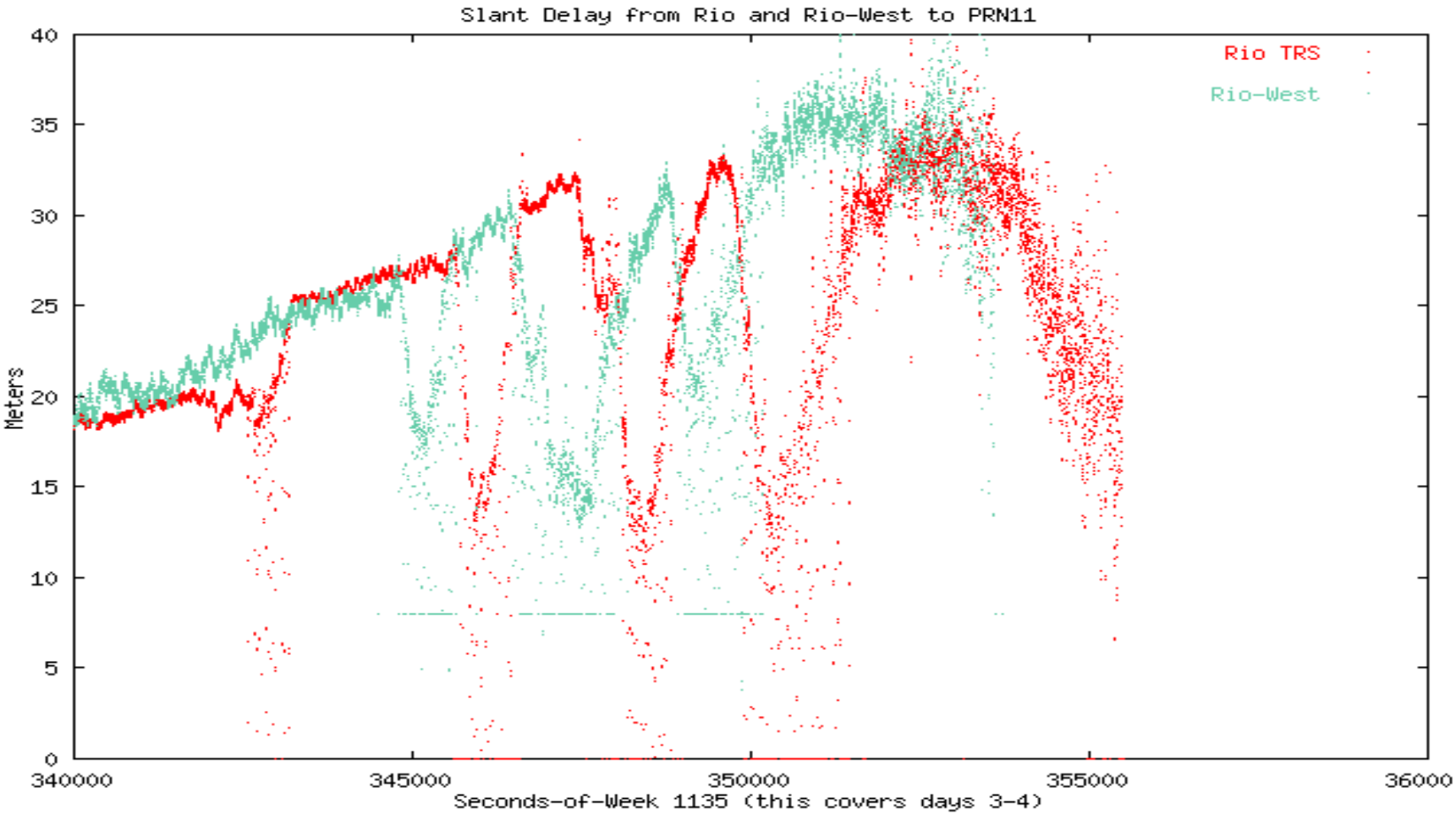
$$TEC = \int_{receiver}^{satellite} N \cdot ds$$

N is the electron density



THE EFFECTS OF IONOSPHERIC IRREGULARITIES OVER TEC

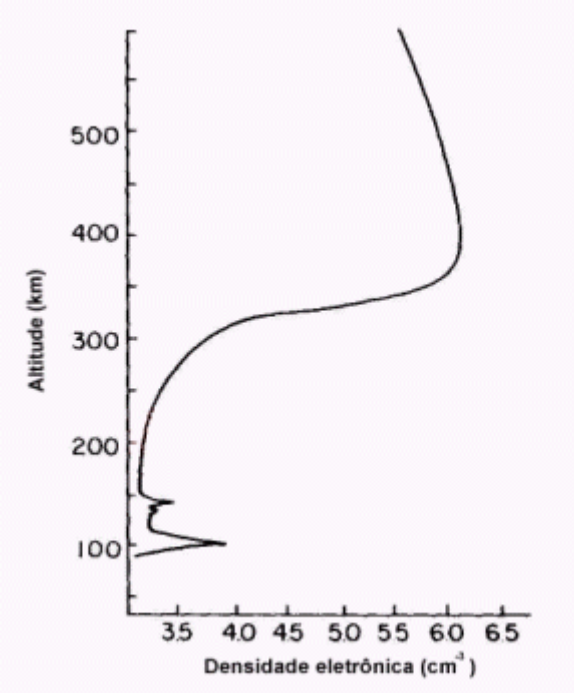
- IONOSPHERIC IRREGULARITIES CAUSE LARGE DEPLETION ON THE TOTAL ELECTRON CONTENT.



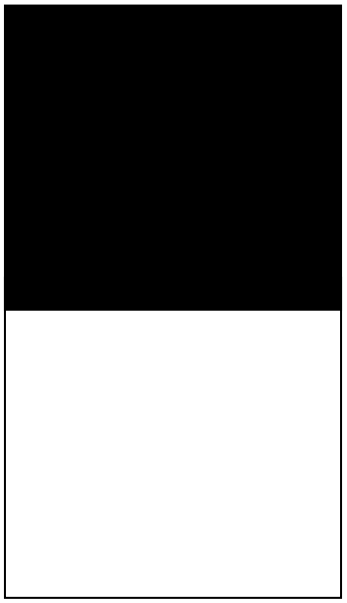
PLOT FROM TOM DEHEL (FAA – FEDERAL AVIATION ADMINISTRATION – USA), 2002

IONOSPHERIC IRREGULARITY GENERATION MECHANISM

Rayleigh - Taylor (RT) instability Dungey (1956)



Kelley (1989, pag. e 122)



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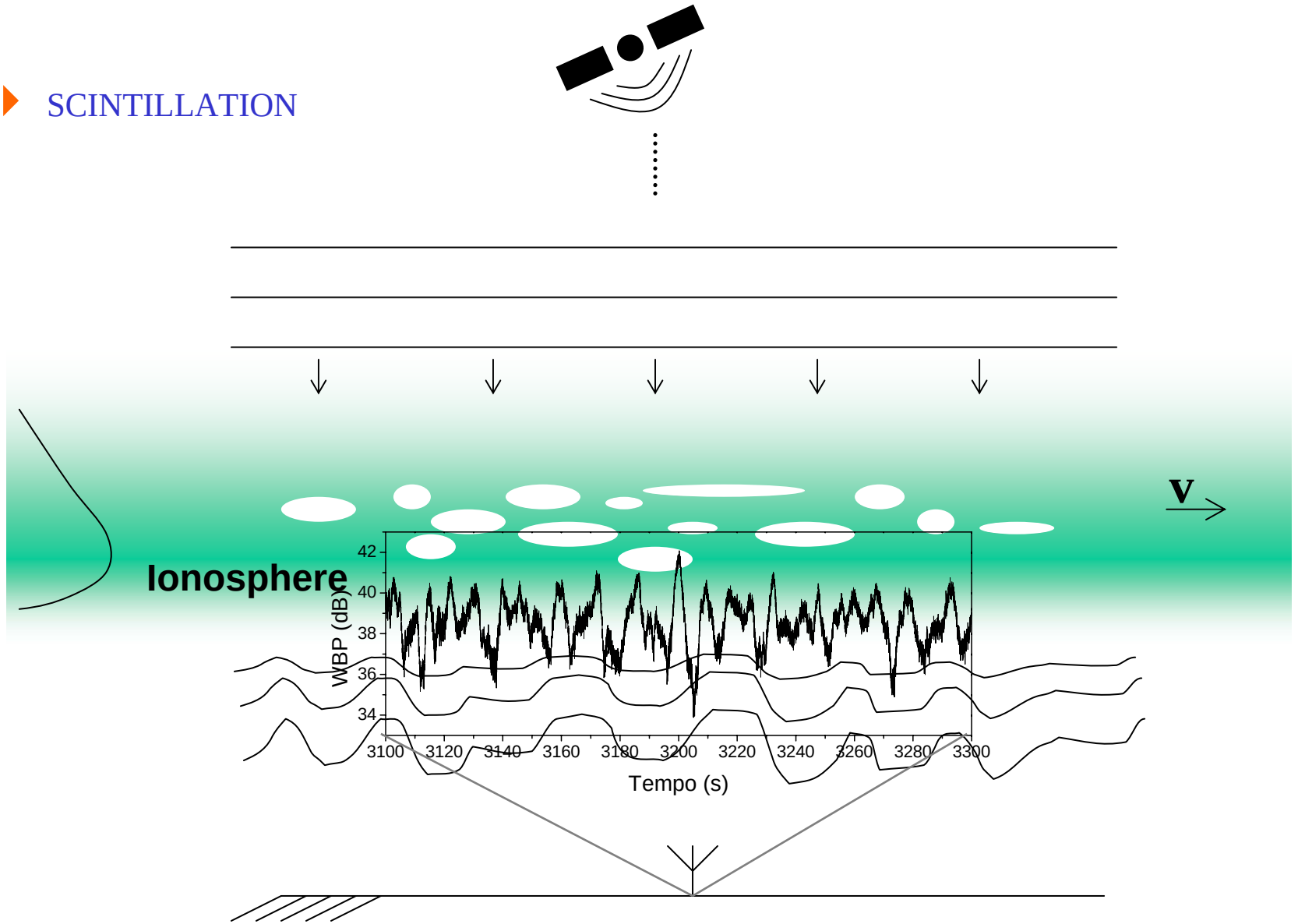
INPE

The Evolution of a Plasma Bubble

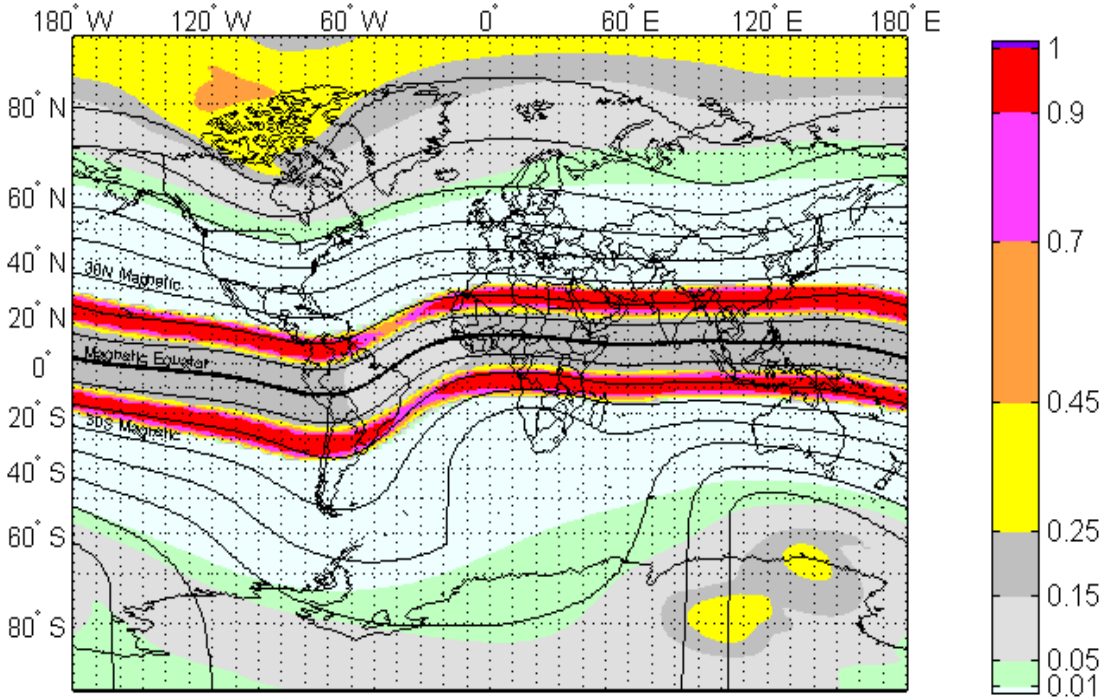
Animação gentilmente cedida
por C. M. Denardini

IONOSPHERIC IRREGULARITY EFFECTS OVER THE GPS SIGNAL

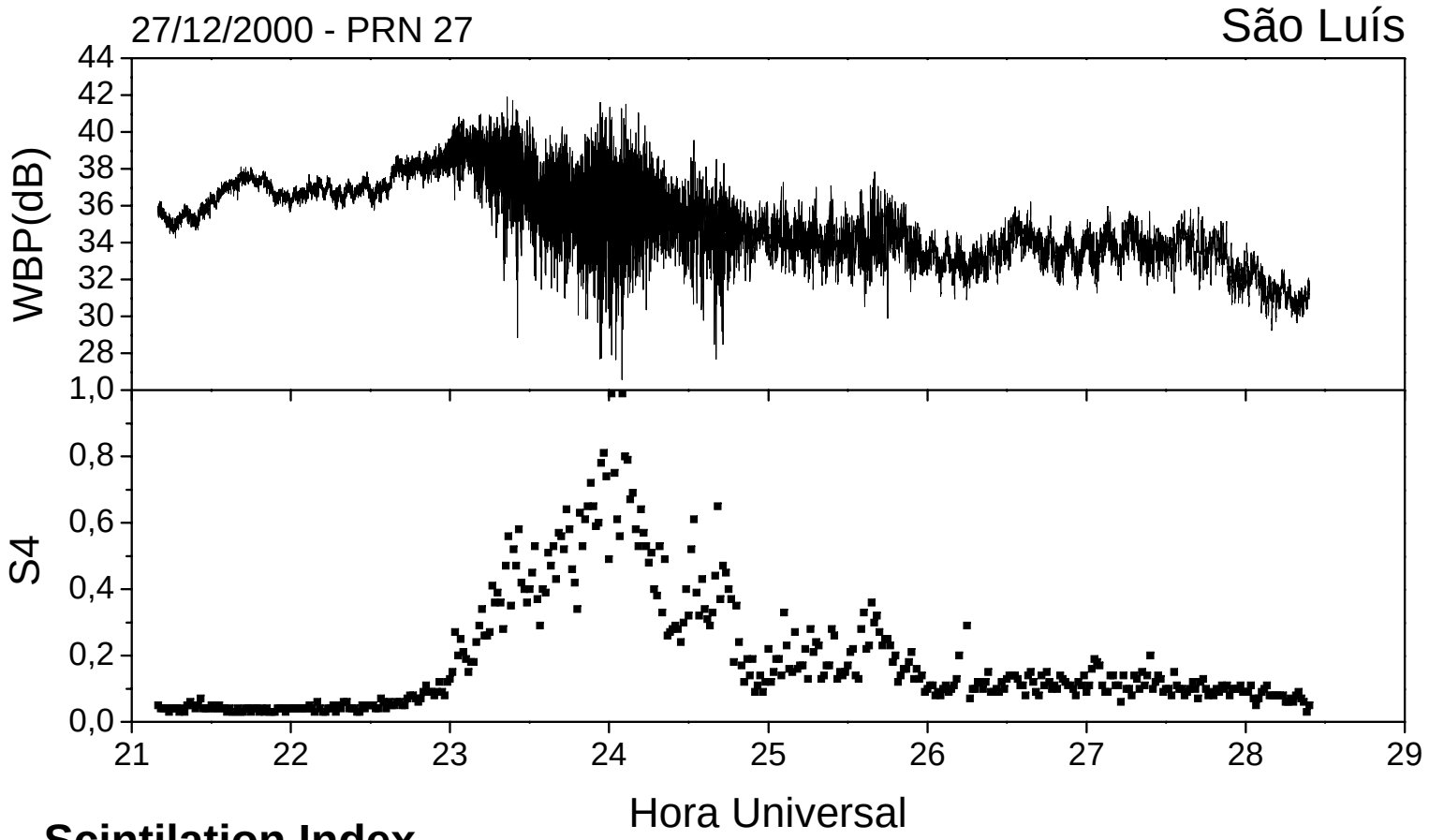
- SCINTILLATION



•THE EFFECTS ARE IN THE TROPICAL REGION ALL OVER THE WORLD WITH LARGEST INCIDENCE OF SCINTILLATIONS OVER BRAZIL (LARGE MAGNETIC DECLINATION).



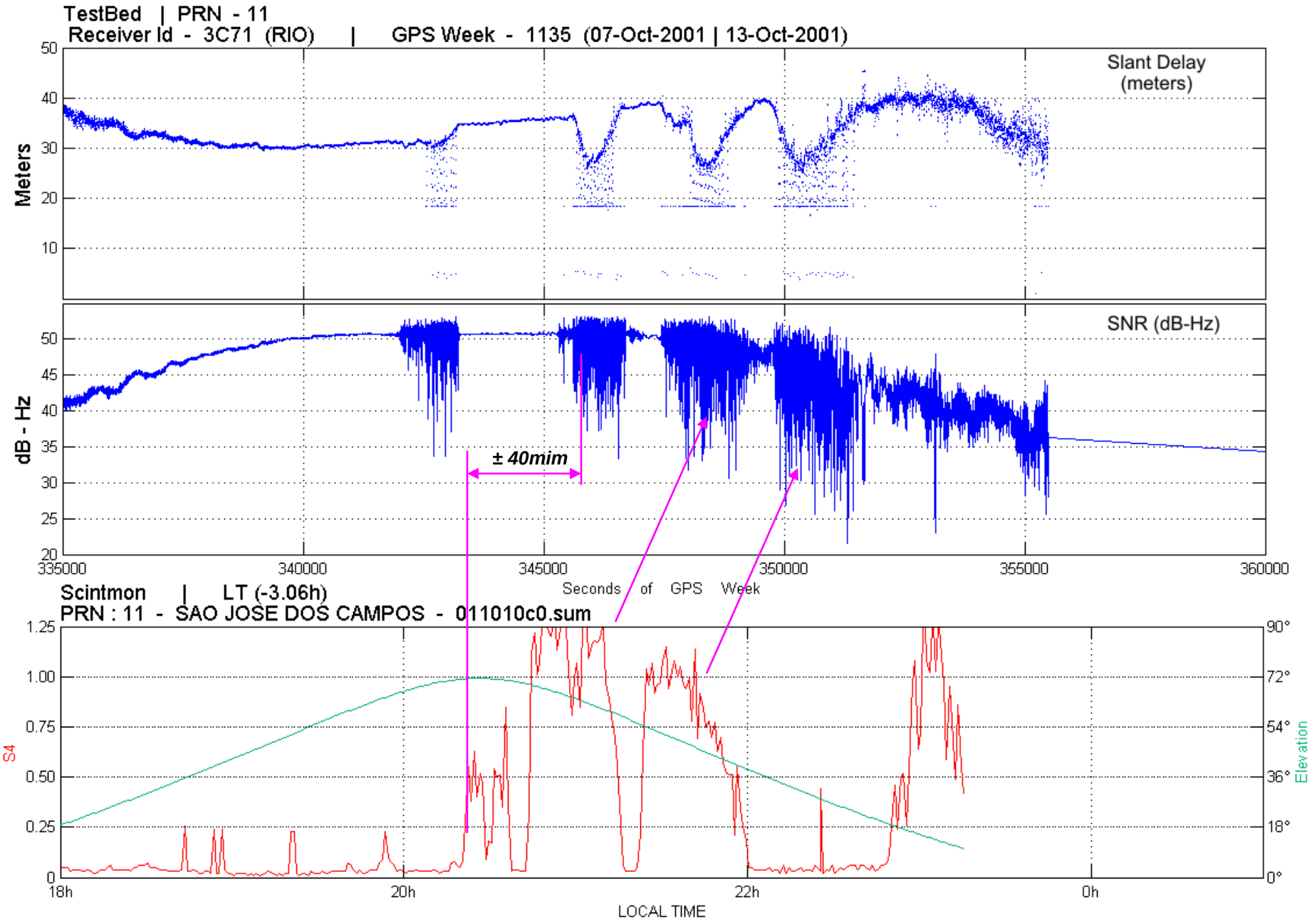
GPS SIGNAL SCINTILLATION



Scintilation Index

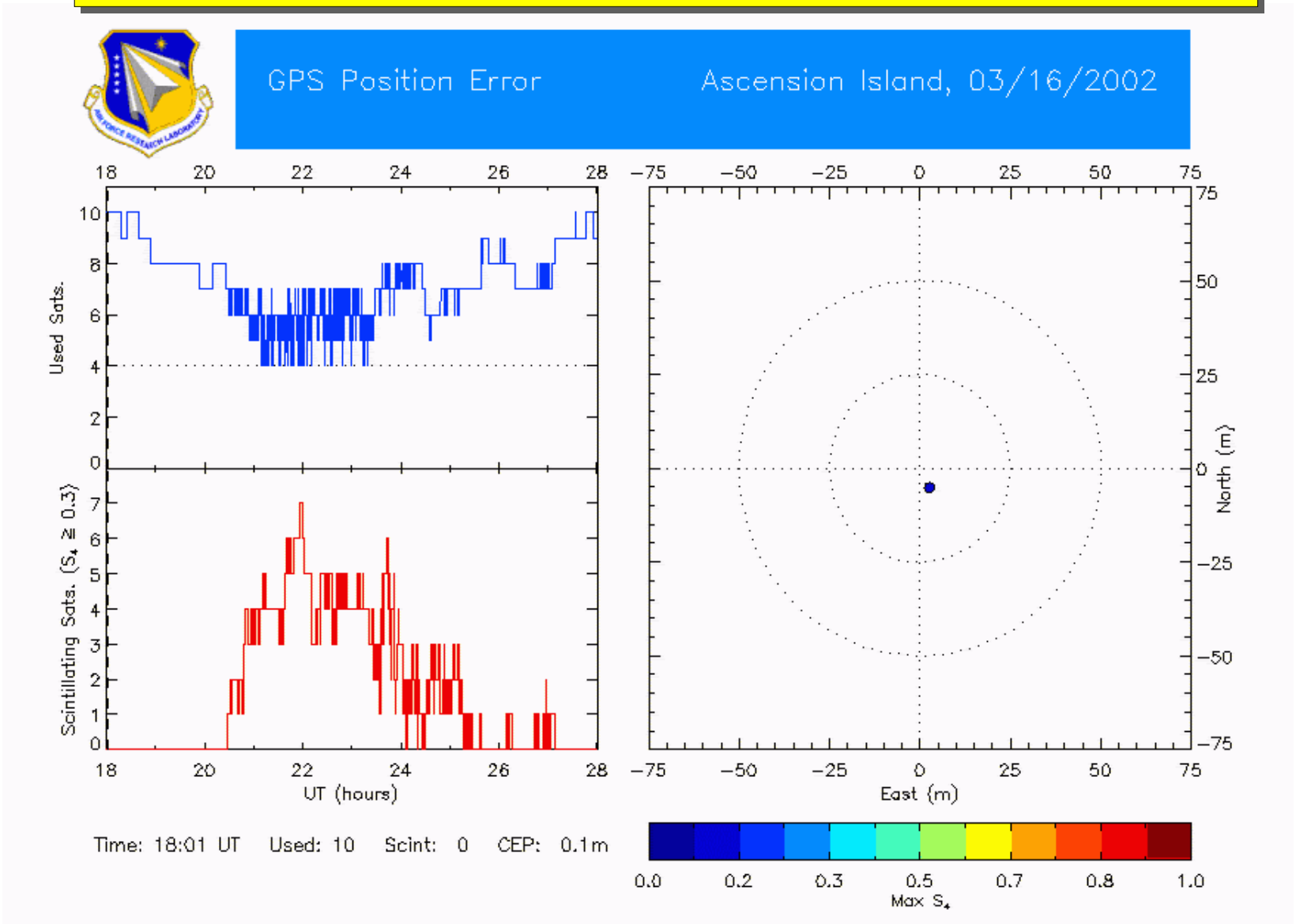
$$S_4^2 = \frac{< I^2 > - < I >^2}{< I >^2}$$

IRREGULARITY EFFECTS OVER SBAS (SPACE BASED AUGMENTATION SYSTEM) -TESTBED



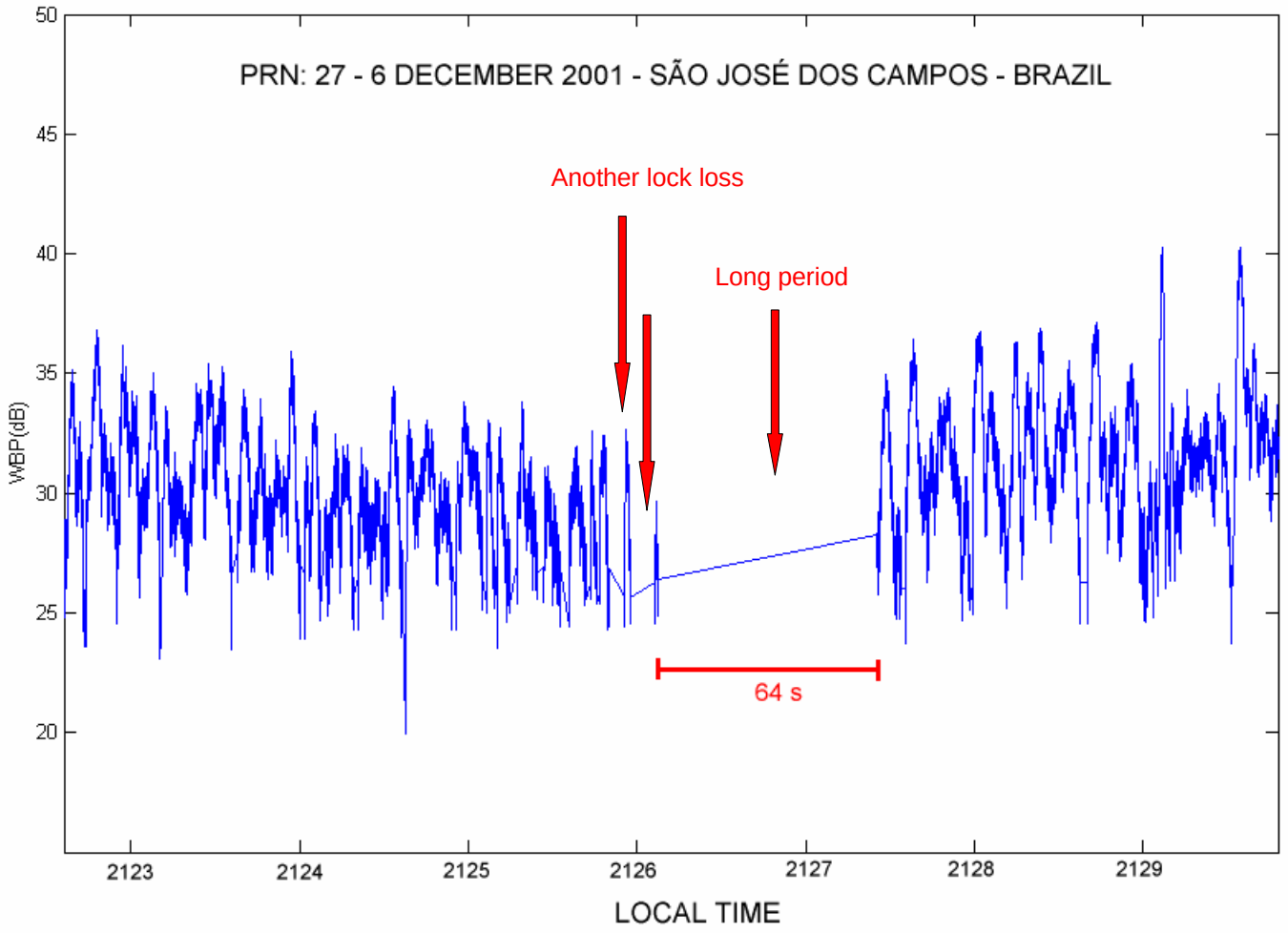
IONOSPHERIC IRREGULARITY EFFECTOVER GPS POSITIONING ERRORS

Scintillation can cause rapid fluctuations in GPS position fix



(Su. Basu et al., GRL, 2005)

IONOSPHERIC IRREGULARITY EFFECTS OVER GPS
LOSS OF LOCK



Summary of GPS Stations in Brazil:

GPS receiving stations in Brazil (INPE, IBGE and LISN/NSF, INCRA)

SINGLE FREQUENCY

LISN/NSF receivers: (C. Valladares) (LISN PROJECT) provide TEC AND S4

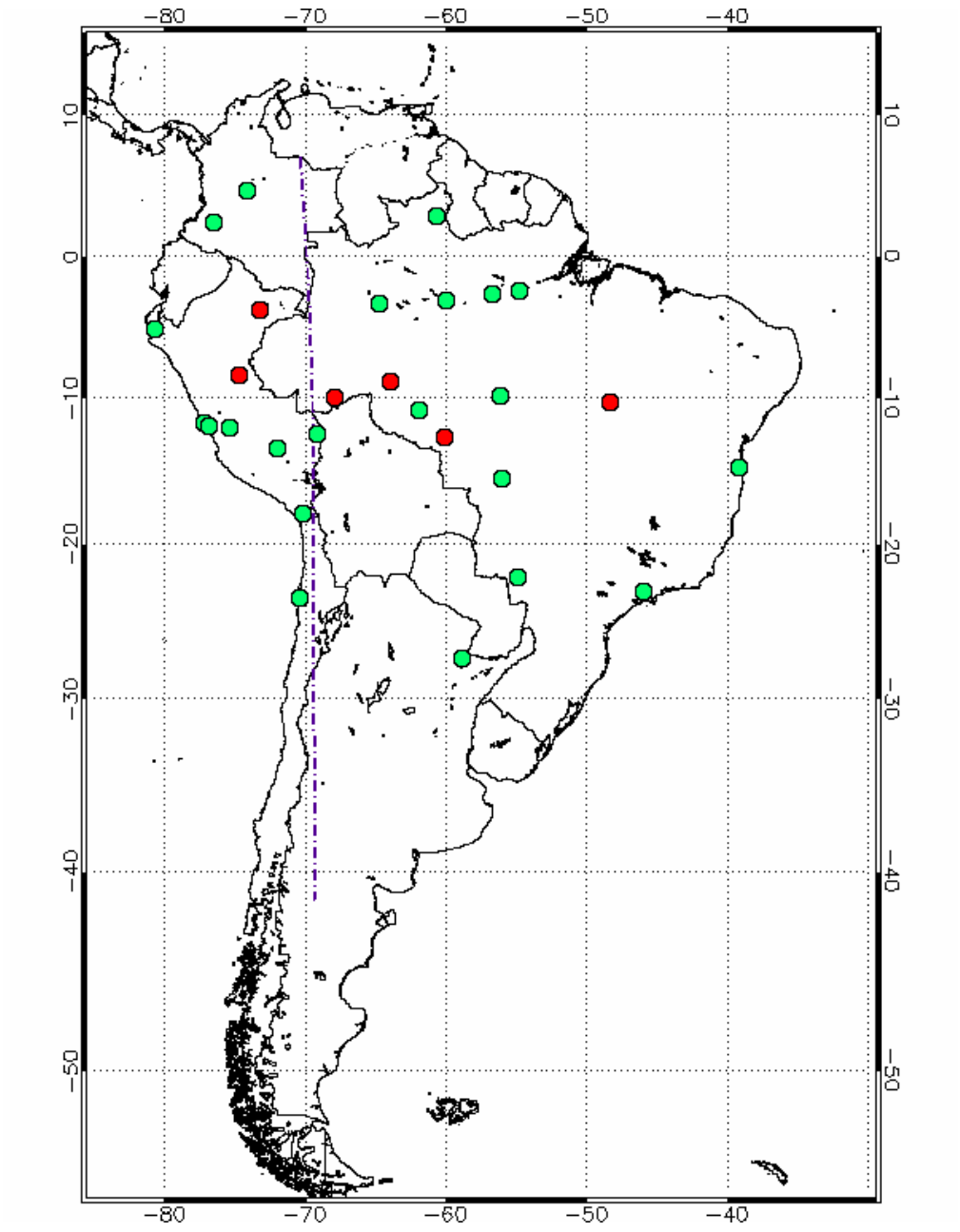
Vilhena
Porto Velho
Rio Branco
Parintins
Tefé
Boa Vista
Dourados
Santarém
Alta Floresta
Ilhéus
Cuiabá
São José dos Campos
Ji-Paraná
Palmas

To study and undestand these ionospheric effects
it is necessary a network of ionospheric observing stations,
like the LISN project,

LISN will provide a nowcast of the state of the
South American Low-latitude ionosphere in terms of

- TEC,
- TEC depletions,
- scintillations,
- bottomside F and E-region densities and a
- short-term regional forecast of the onset os ESF.

LISN Web Page
http://jro.igp.gob.pe/subwebs/lisn/



GPS stations in South America

LISN, proposed the installation about 50 stations of GPS, distributed in South America, this stations will be administered by Instituto Geofísico del Perú, located at aprox. 12°S, 75° W, will be having a Central Server. The server have this principal function to monitoring, storage and distribution of information to the different users. At the map, green color, show the active stations and the red color the inactive stations.

In the brazilian territory

15 LISN receivers were installed.

These GPS receivers are providing data

that are being recorded at the main server at

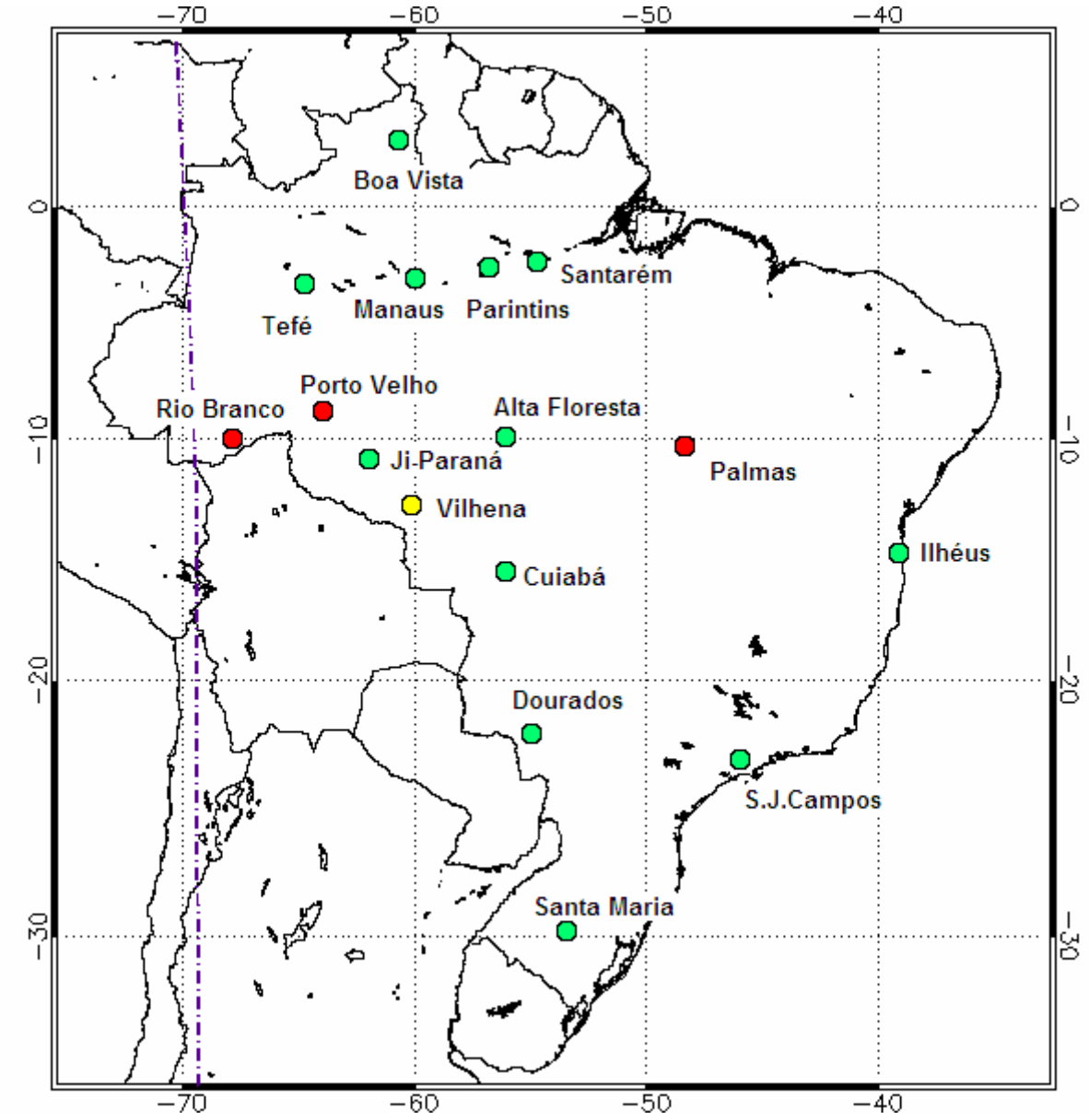
- Boston College and at
- São Jose dos Campos, Brazil.

LISN - Low-latitude Ionospheric Sensor Network

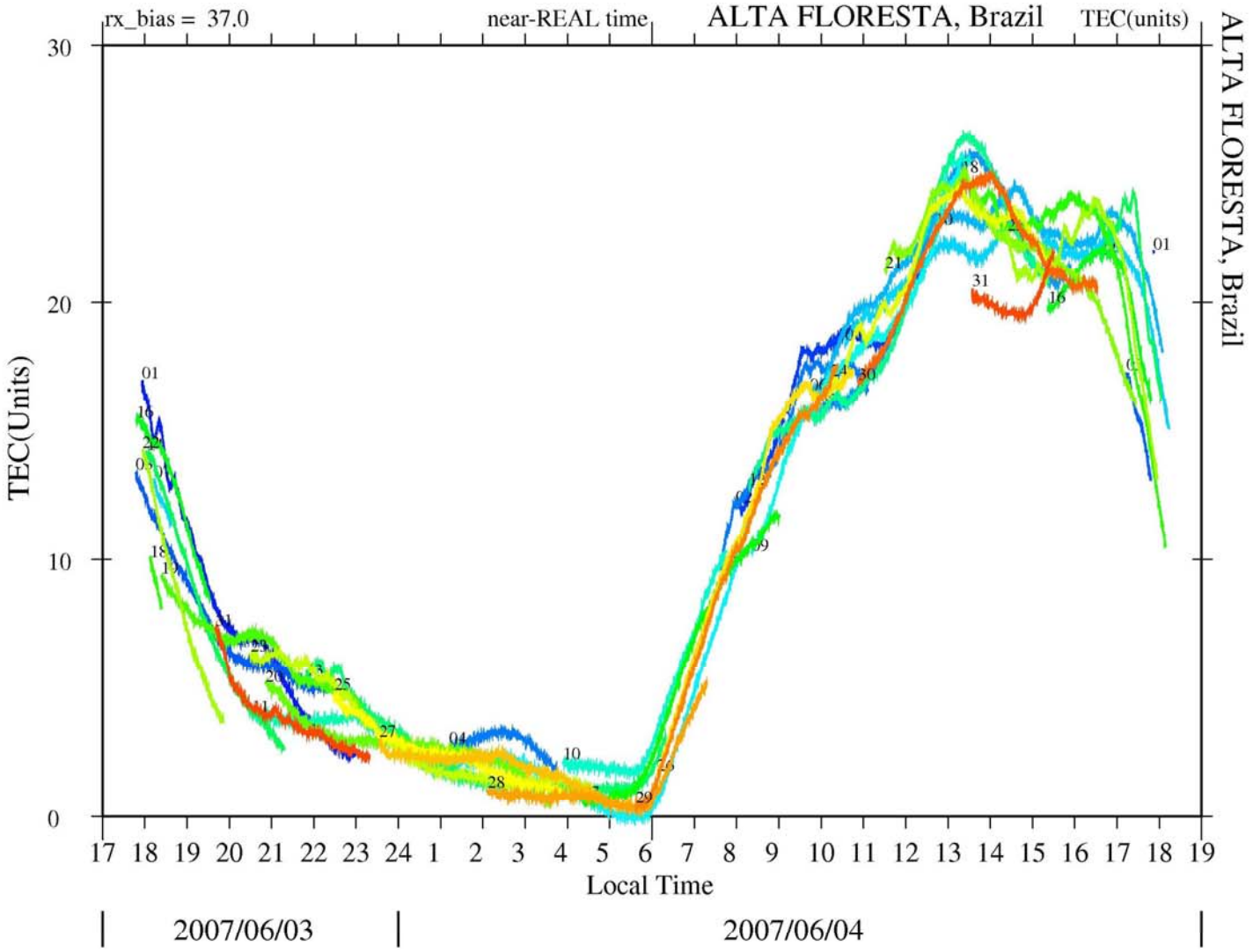
Alta Floresta
Boa Vista
Cuiabá
Dourados
Ilhéus
Ji-Paraná
Manaus
Parintins
S.J.Campos
Santa Maria
Santarém
Tefé

Palmas
Porto Velho
Rio Branco

Vilhena

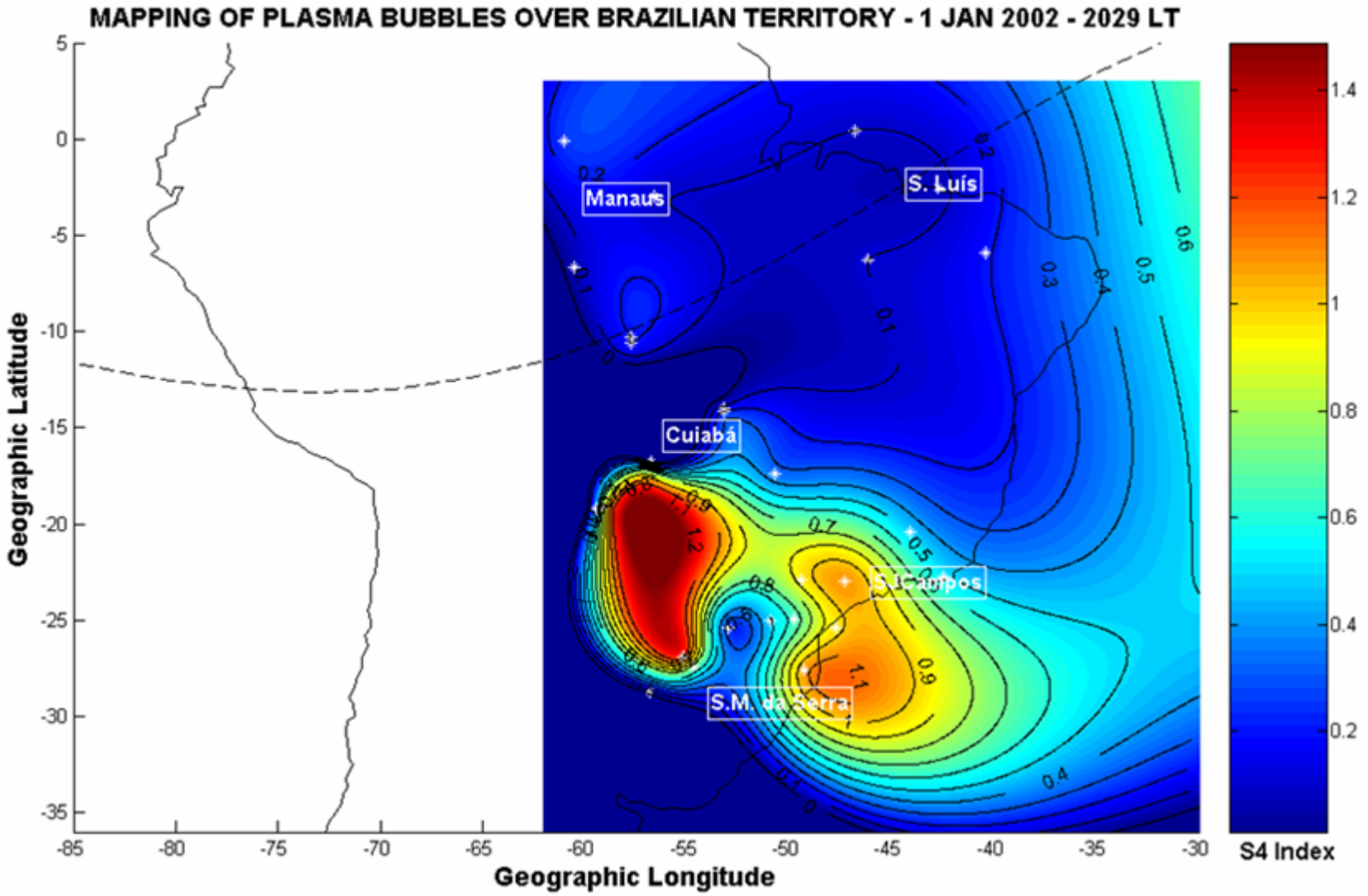


LISN - Low-latitude Ionospheric Sensor Network



The LISN scintillation data,
represented by the S4 scintillation index
is going to complement the
SCINTEC (Scintillation and TEC Monitoring) System
that provides a real time scintillation map over Brazil.

SCINTEC PROJECT http://www.inpe.br/scintec/



SCINTEC PROJECT

Address of the site:

http://www.inpe.br/scintec/

The LISN TEC is going to be used:

to study the low latitude electrodynamics and to develop an ionospheric model which will be used:

- for Scientific Research,
- for Navigation and Positioning and
- Geodetic purposes