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15-17 October, 2013
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ISTF/3 – IP/11
Agenda Item 5
15/10/13

Update on Ionospheric Studies under GAGAN Project

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Overview

- Introduction – GAGAN
- Experimental analysis on Position improvement with GAGAN
- Effect of Scintillation on - Position, Loss of Lock and SBAS Iono model
- Development of Scintillation monitor tool

GAGAN

- GAGAN Signal-In-Space (SIS) is available since Sept-Oct, 2011 with Type 0 message.
- Broadcasts Correction and Integrity information
  - Iono correction by MLDF-Kriging model
- The improvement in position accuracy by using GAGAN corrections is assessed.

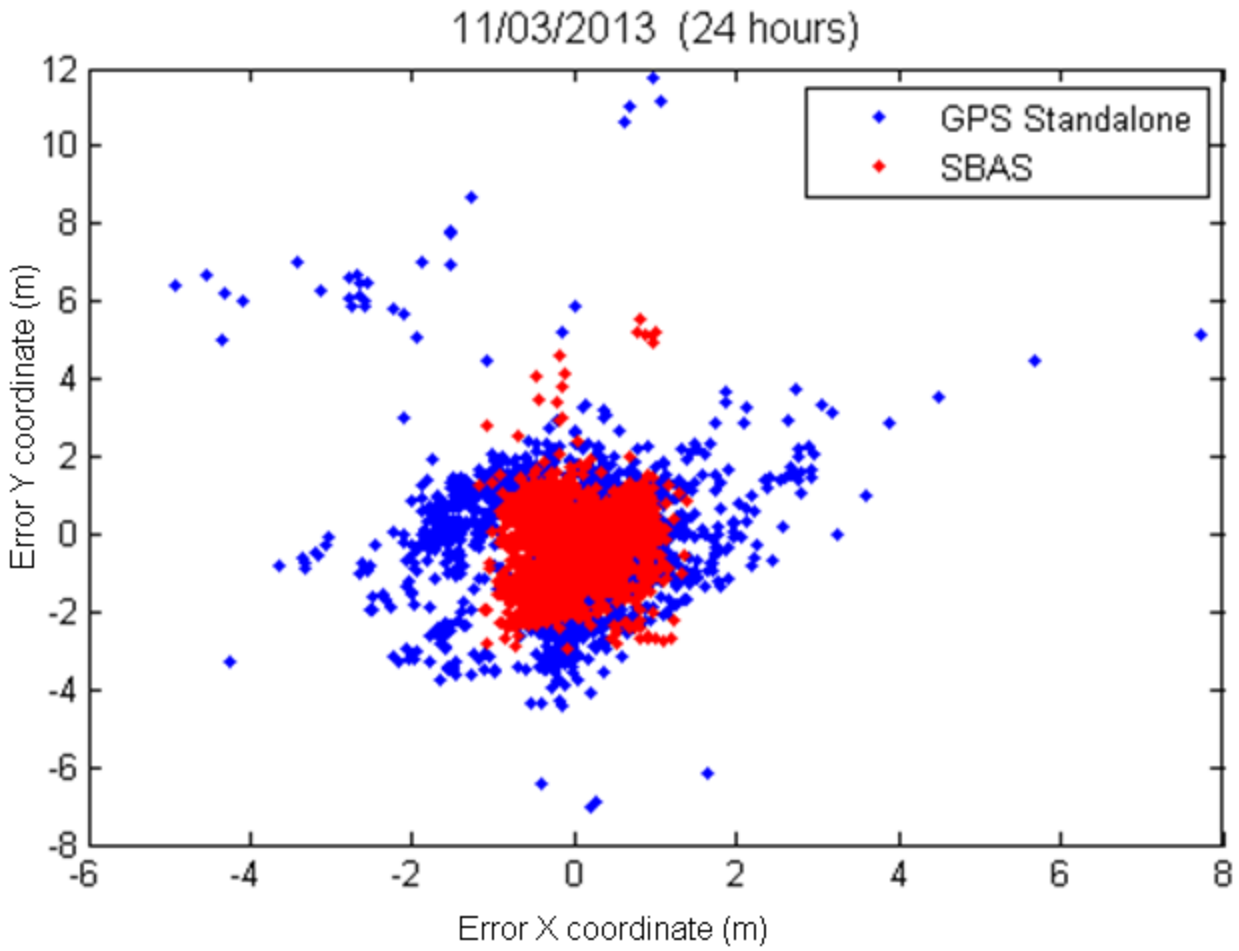
Experimental Set-up

- Two Dual-frequency Novatel's receivers (OEM4-G2 card).
- Antenna of both receivers closely located on roof-top of a building at Ahmedabad.
- One of the receiver configured for SBAS correction to work as SBAS receiver.
- Another receiver acts as GPS standalone.
- Experimental period :February-March 2013

SBAS Configuration

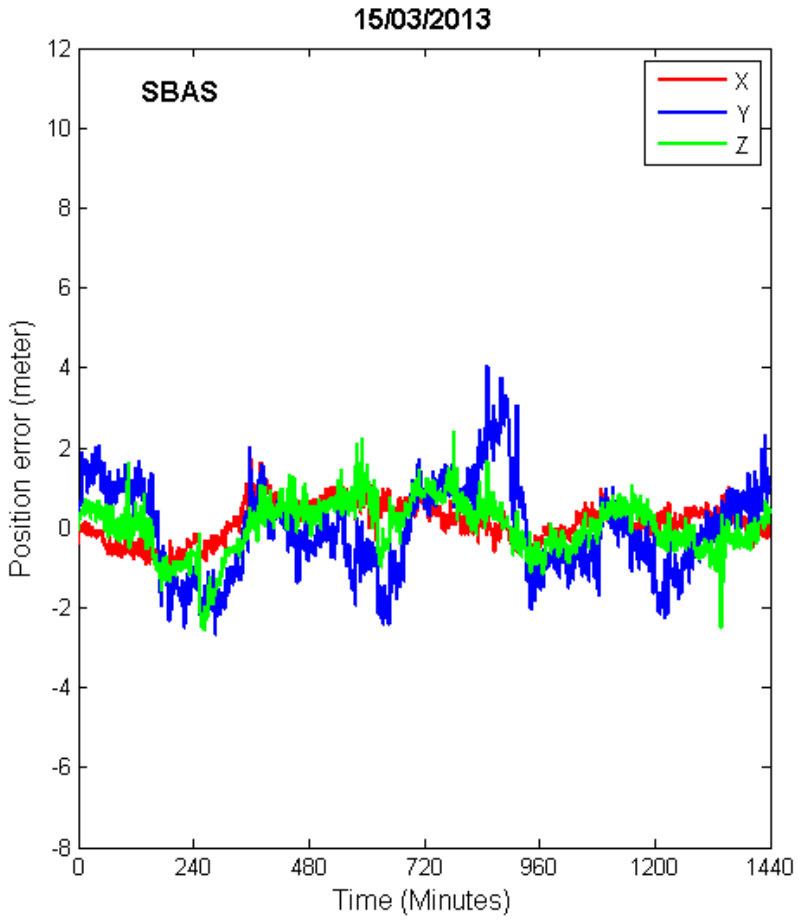
- Out of 3 SBAS channels, two channels are assigned to GSAT-8 (PRN 127) and GSAT-10 (PRN 128).
- Configured to *enable* WAASCORRECTION for position solution.
- GAGAN SIS is broadcast with MT-0 i.e. test mode (*do not use*).
- Hence, Rx configured to ignore this message by using the WAASTESTMODE.

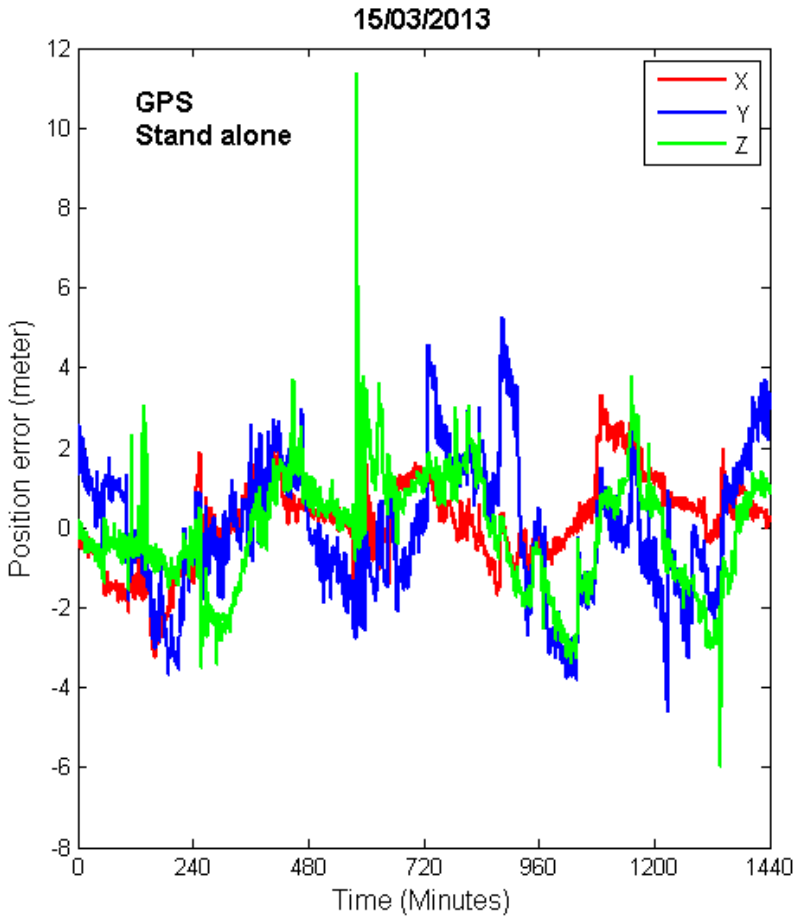
Results- Error Scatter



Results- Position Accuracy *over a day*

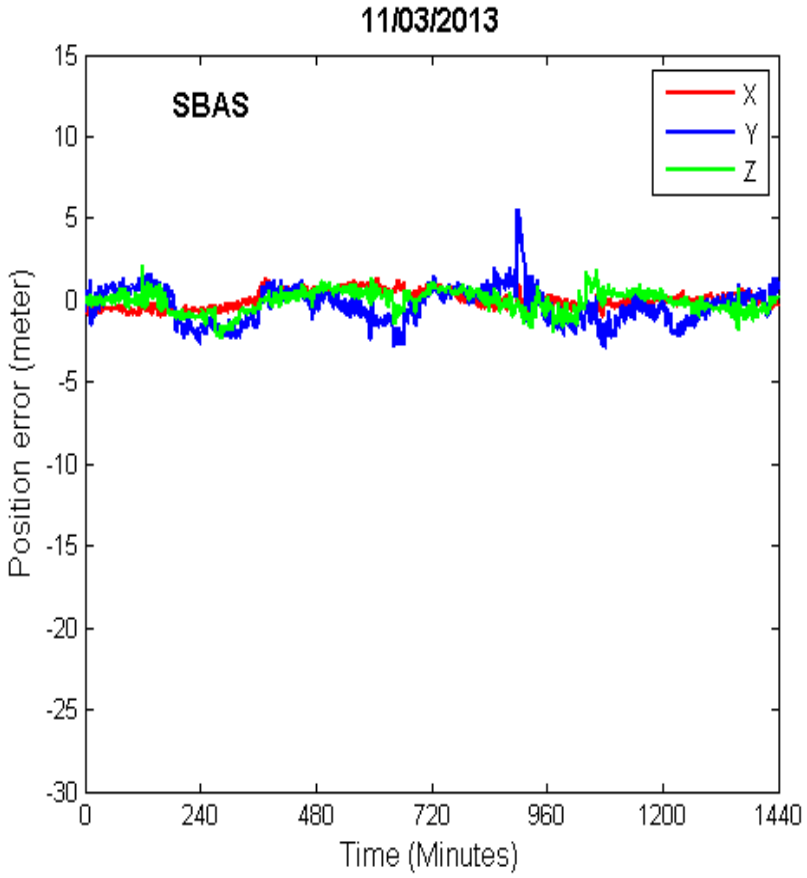
15/03/2013

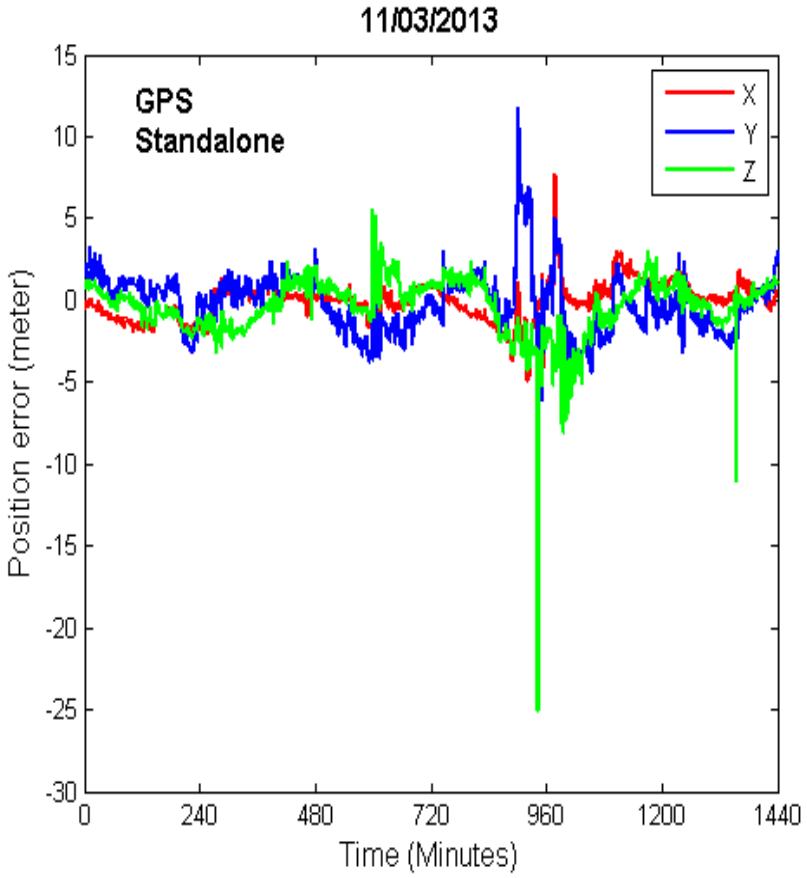




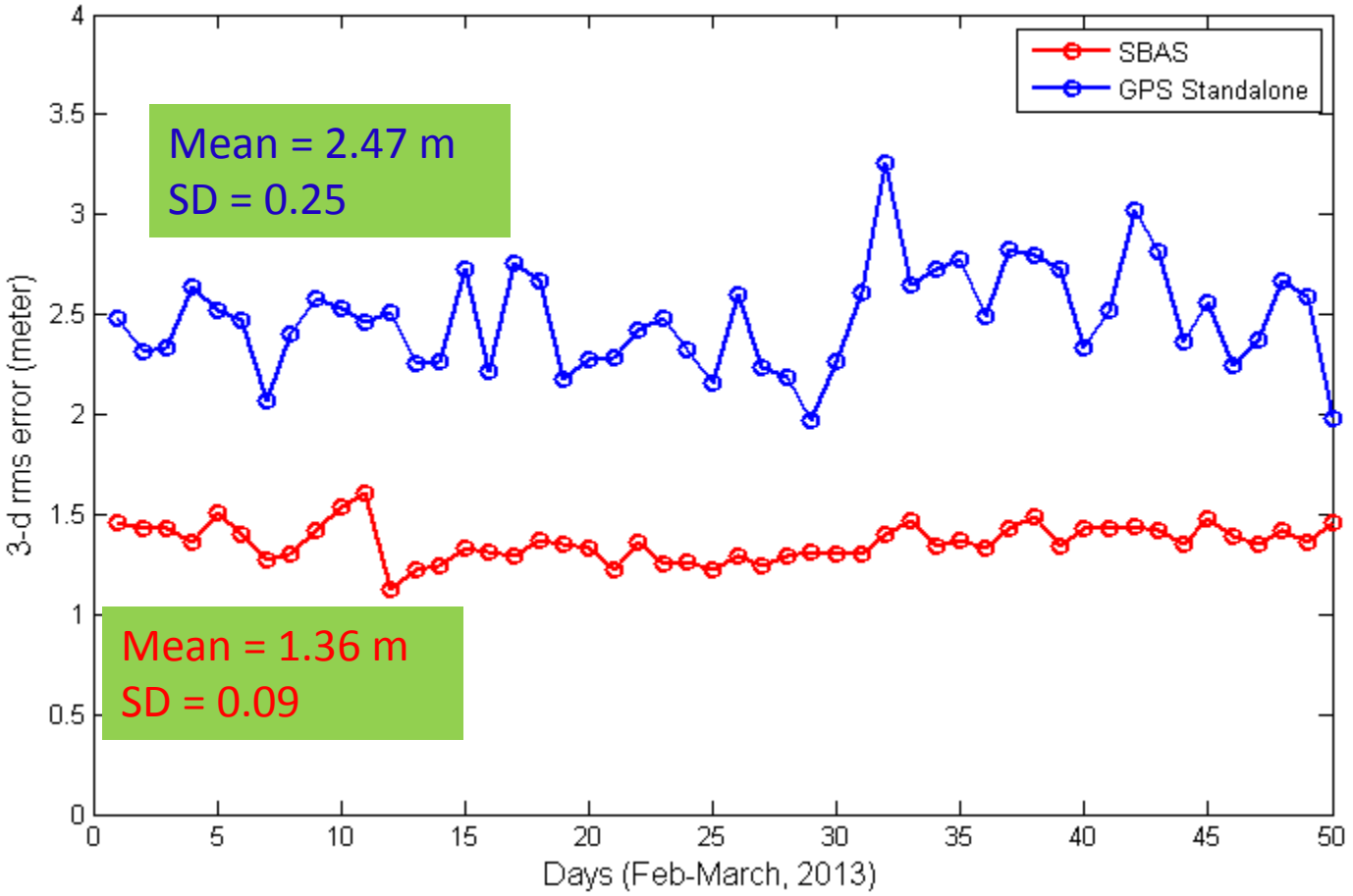
Results- Position Accuracy *over a day*

11/03/2013





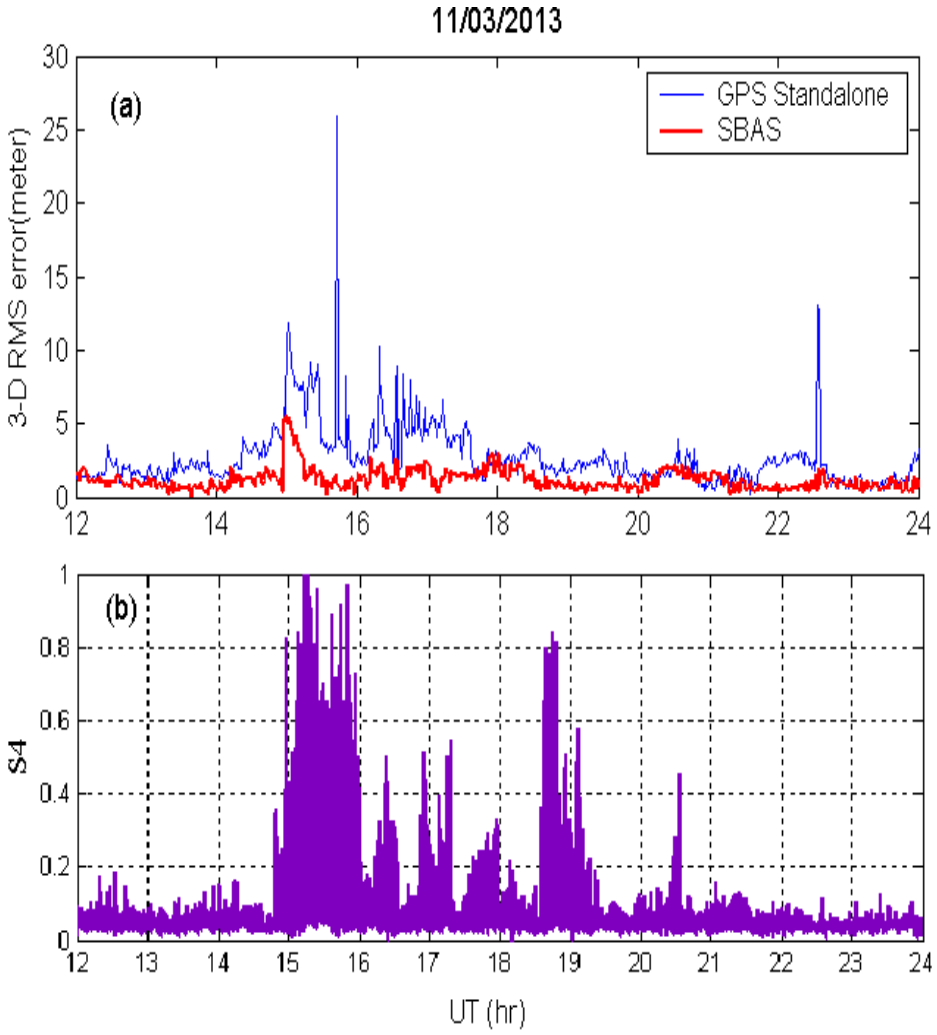
Results:
3-D RMS Error over whole experimental period



Effect of Scintillation

- Position
- Loss of Lock
- Iono Model

Scintillation Effects on Position



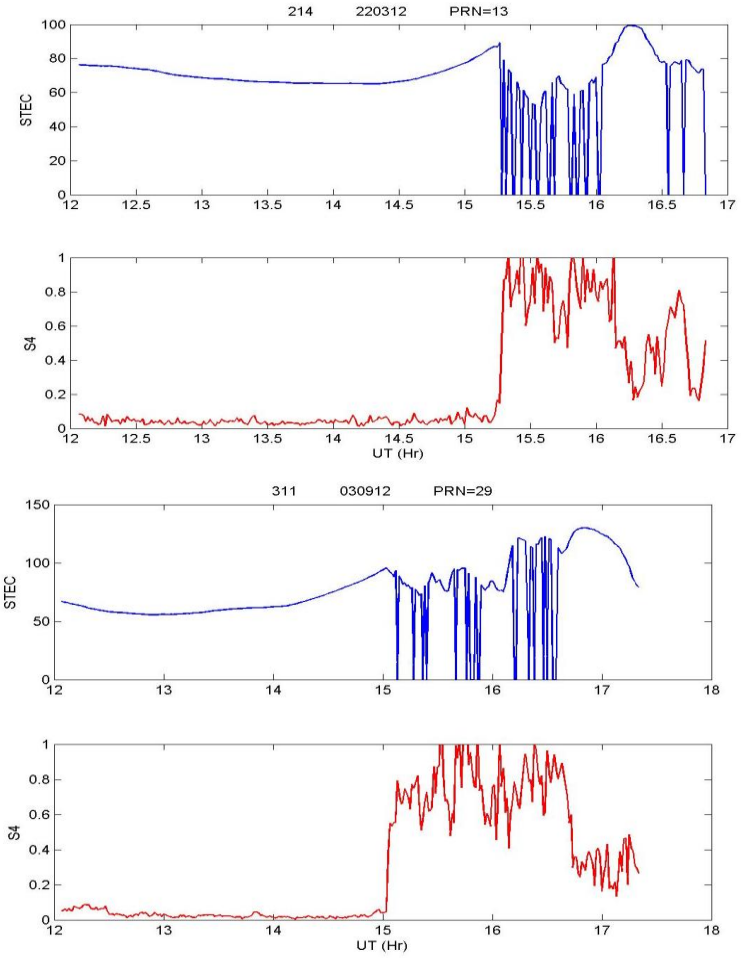
- Both receivers experiences position degradation during severe scintillation event.
- The impact was more severe on GPS standalone receiver, although it was a dual frequency receiver.
- This may be due to loss of lock of either frequency which devoid iono corrections.
- Hence, SBAS iono corrections proved to be better than dual frequency iono corrections by receiver itself.

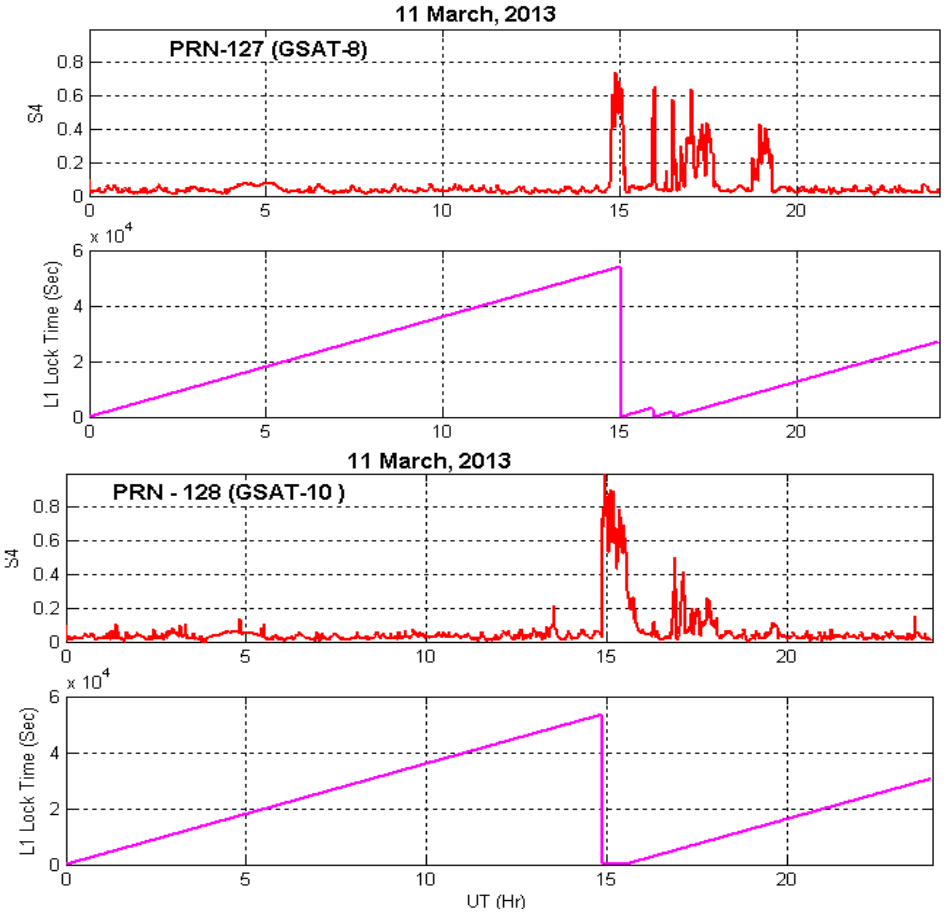
Scintillation effects- Loss of lock

Loss of Lock in GPS

11/03/2013

Loss of Lock in GEO

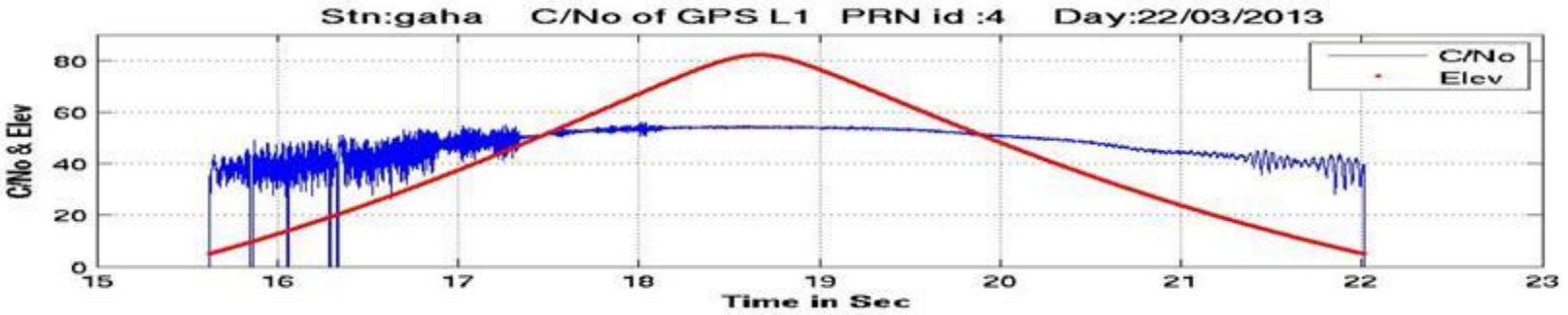


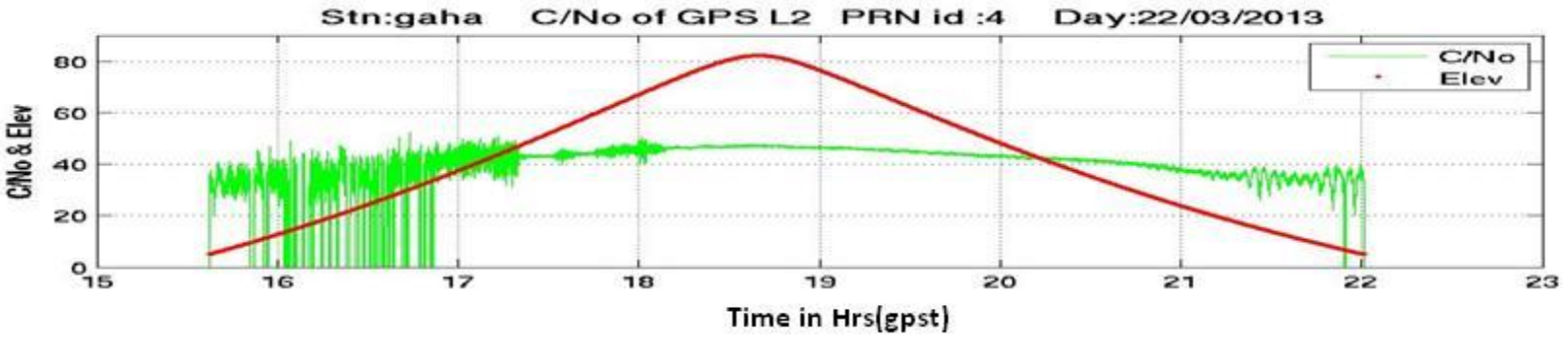


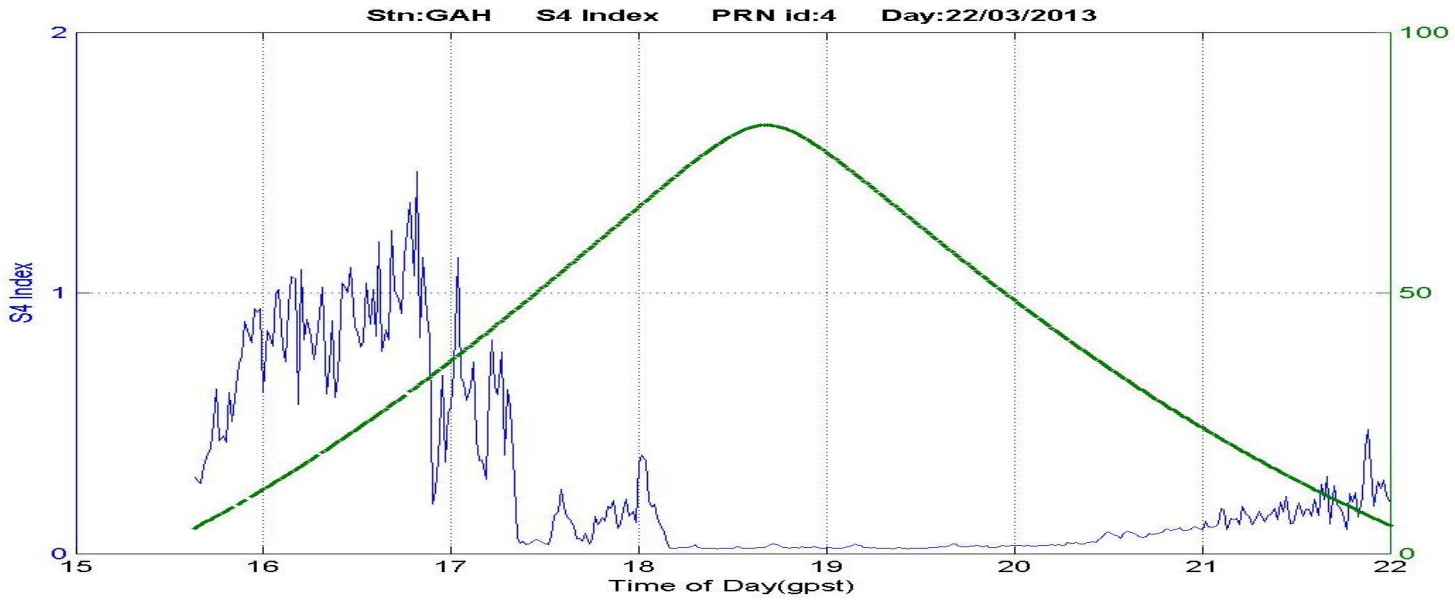
The TEC drops to Zero in case of loss of lock of either frequency. Normally L2 gets unlocked first due to its weak power and is more susceptible to scintillation

Although both GEOs are wide apart, still we have seen simultaneous loss of lock in GEO signals.

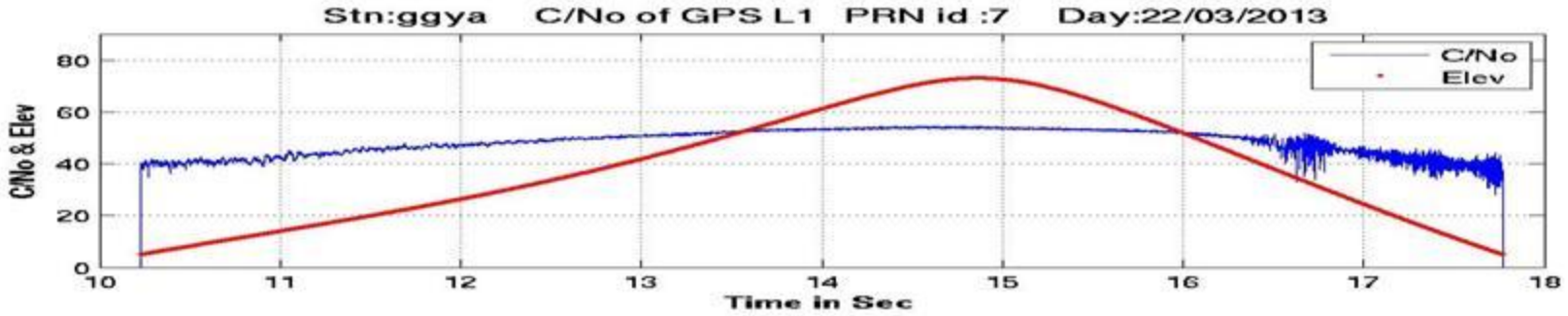
Observations from INRES receiver

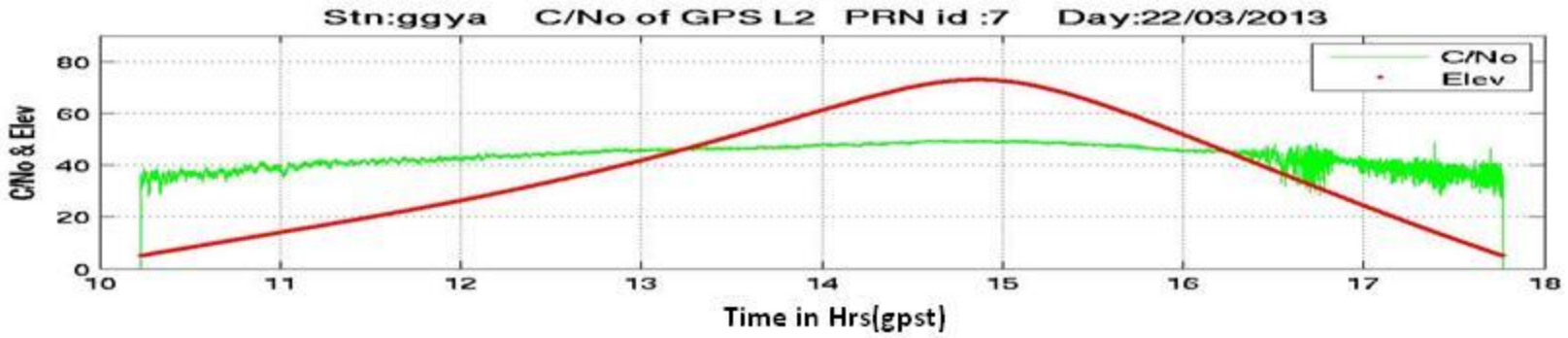


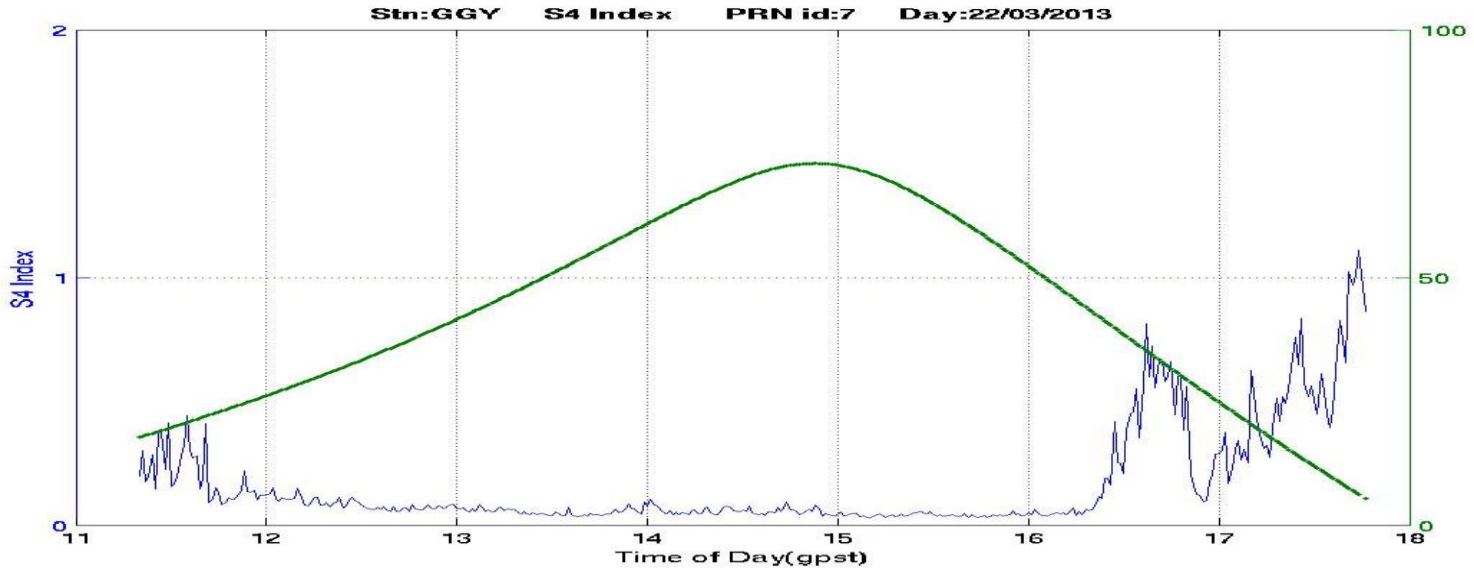




Observations from INRES receiver



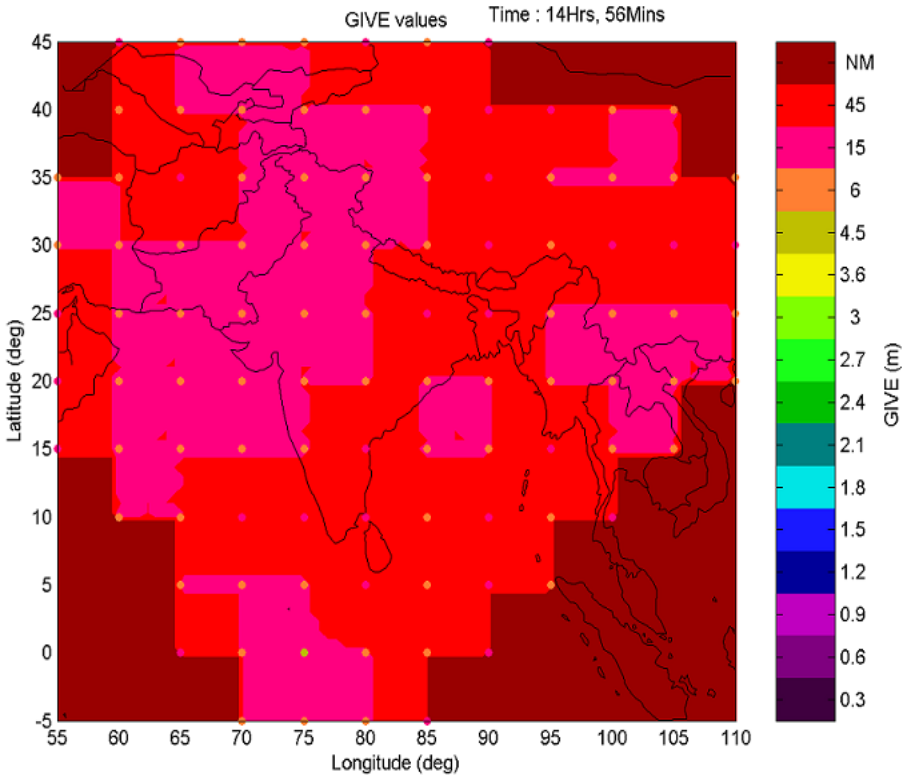




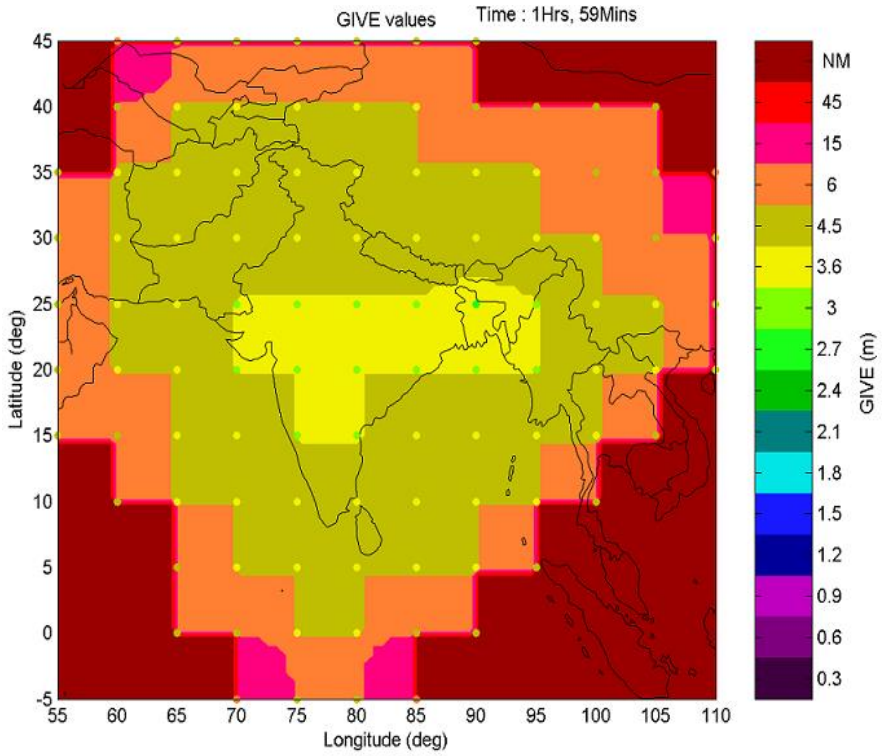
Scintillation effect- Iono model

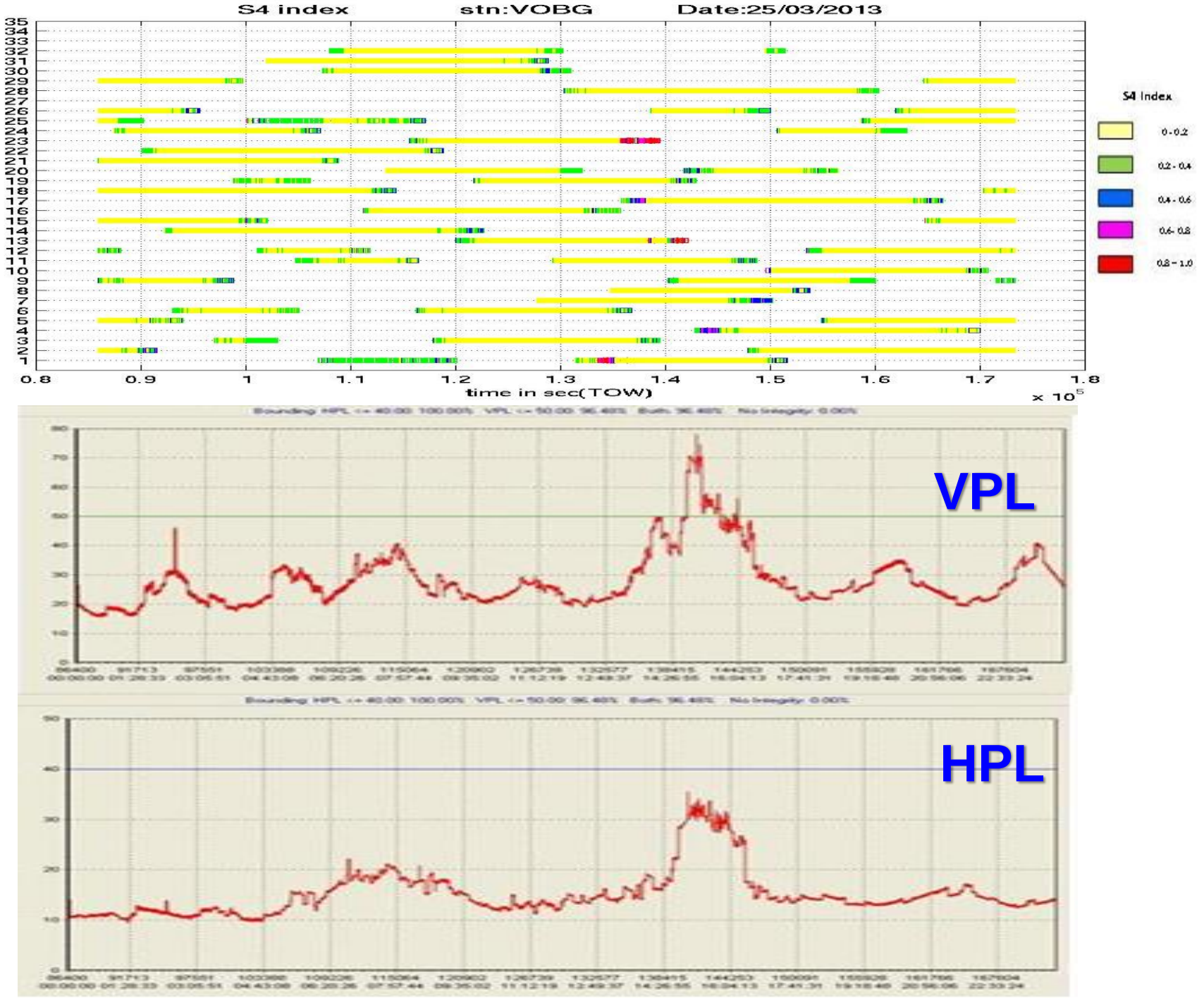
11/03/2013

During Scintillation time



During quiet time

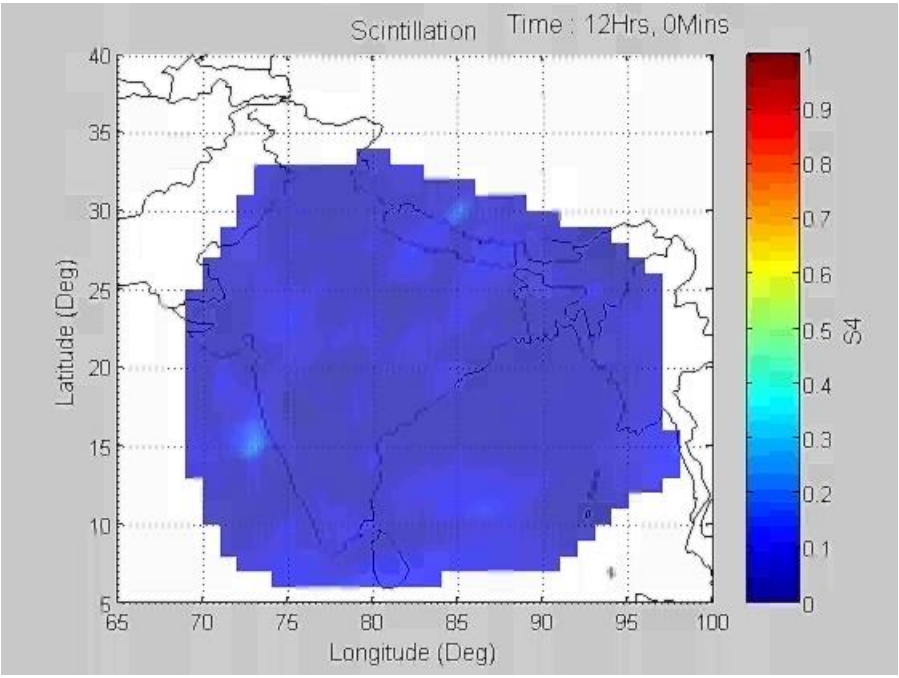



S4 index
stn:VOBG
Date:25/03/2013
time in sec(TOW)
x 10^5
S4 Index
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0
VPL
HPL

Scintillation Monitor Tool

Scintillation Monitor Tool

Scintillation Map 29 Sept 2012

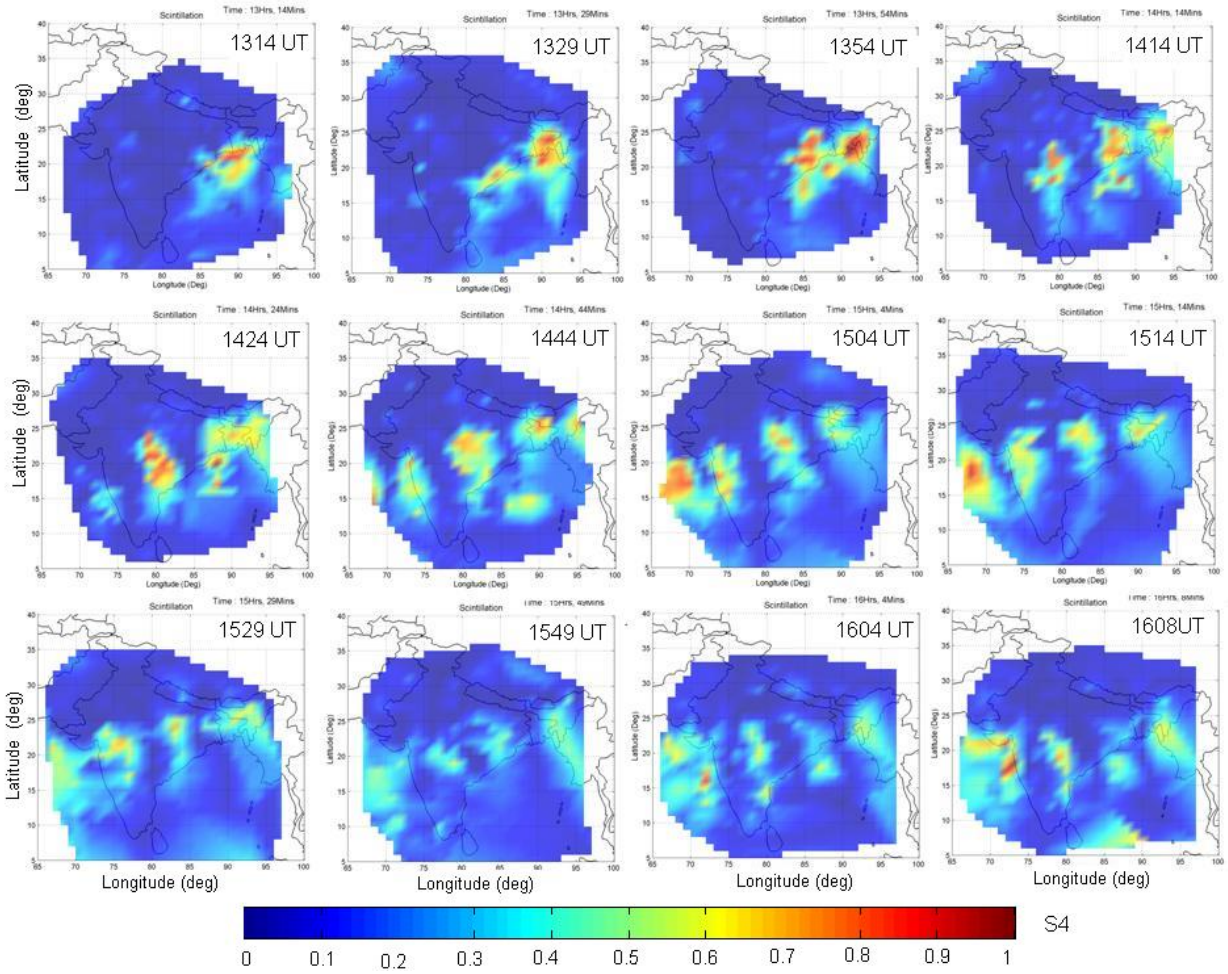


- An efficient tool was developed to study/monitor the scintillation occurrences over the whole Indian Sub-continent.
- It generates 3-dimensional scintillation maps using the data from all GAGAN-TEC stations.
- It helps in detecting the scintillation efficiently as handling the huge volume of data is very challenging.

Occurrence pattern of Scintillation

Snapshots of the scintillation map

3 October, 2012



Conclusion/Remarks

- Significant Improvement in position accuracy by using GAGAN (SBAS) corrections.
- The worst-case error over 2 months of experiment is 5.5 meter in SBAS whereas it is 25 meter in GPS.
- Scintillation remains the major threat for SBAS as well as in dual frequency receiver in absence of any mitigation technique.
- An efficient tool for scintillation monitoring was developed.
- Scintillation effects on position accuracy, Loss of lock in GPS and GEO satellites and consequently in Iono model have been observed.
- Preliminary analysis indicate that GAGAN INRES receivers show resilience to withstand loss of lock for scintillations of S4 index up to 0.7

Conclusion/ Remarks

- India has provided the required details of GAGAN-TEC network for data sharing in ISTF.
- India is continuously sharing the results of iono analysis in ISTF.
- Since GAGAN-TEC data is managed by AAI and ISRO both, a formal communication from ICAO/ISTF is required for sharing the data.