International Civil Aviation Organization

THE SIXTH MEETING OF IONOSPHERIC STUDIES TASK FORCE (ISTF/6)

Bangkok, Thailand, 19 – 21 January, 2016

Agenda Item 4: Review of deliveries of Tasks and related Action Items

e) Task 5 - Iono Models

PRELIMINARY RESULTS ON IONOSPHERIC GRADIENTS USING LTIAM TOOL AND THE WAY FORWARD

(Presented by India)
(Prepared by Surendra Sunda, Airports Authority of India)

SUMMARY

This paper presents the preliminary results of ionospheric delay gradients derived from the Long Term Ionospheric Anomaly Monitoring (LTIAM) tool.

The Working paper also proposes to include IGS (International GNSS Station) network data in development of GBAS threat model.

1. INTRODUCTION

1.1 India has acquired the Long Term Ionospheric Anomaly Monitoring (LTIAM) tool from FAA through the ISTF for computing the ionospheric delay gradients to develop the GBAS threat model.

1.2 The LTIAM tool was installed in 64-bit Windows Machine and MATLAB R2014 (8.3 version) is used to run the tool. The initial problems faced in running the tool were discussed in webconference and the report is attached to another Working paper.

1.3 Further modifications were carried out in consultation with Republic of Korea (Dr. Jiyun Lee) to bypass the data fetching through Internet (FTP).

2. Discussion

2.1 LTIAM tool requires multiple (at least 2) stations at short baseline to derive the ionospheric delay spatial gradient. Since stations under the GAGAN-TEC network have long baseline, they are not suitable for gradient computation using LTIAM tool.

2.2 AAI and Honeywell have installed 3 dual frequency receivers at Chennai to support the GBAS certification and commissioning. These receivers are suitable candidates for LTIAM tool. The data is available from November 2013 onwards.

2.3 LTIAM tool is being used to process the Chennai data. The Preliminary results are presented in Attachment I to this working paper.

2.4 India has identified other data sources with short baseline to process with LTIAM tool. There are 2 IGS (International GNSS Station) sites in Bangalore with a baseline of 6.2 km and one Station from GAGAN-TEC network. Similarly, there is one IGS station at Hyderabad and Lucknow and one each from GAGAN-TEC network.

2.5 It is proposed to include and combine the IGS network receivers in India with GAGAN-TEC network to create short baseline groups at various latitudes.

2.6 Processing IGS data from Bangalore has already been started with LTIAM tool. The preliminary results are presented in Attachment I to this working paper.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to do the following:

a) note the results obtained so far using LTIAM tool;

b) consider the proposal of including IGS network data in gradient analysis for GBAS threat model; and

c) discuss any relevant matters as appropriate.

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Preliminary results on Ionospheric Gradients using LTIAM Tool and the Way Forward

PRESENTED BY INDIA
(PREPARED BY SURENDRA SUNDA,
AIRPORTS AUTHORITY OF INDIA)

ICAO ISTF/6
19-21 January 2016
Bangkok, Thailand

Introduction

- Long Term Ionosphere Anomaly Tool (LTIAM) was acquired from FAA through ISTF for ionosphere gradient analysis for GBAS/SBAS.
- LTIAM tool has been installed in the 64-bit Windows machine.
- MATLAB *R2014a* (8.3 version) is being used to run the LTIAM tool.

Analysis with Chennai GBAS data

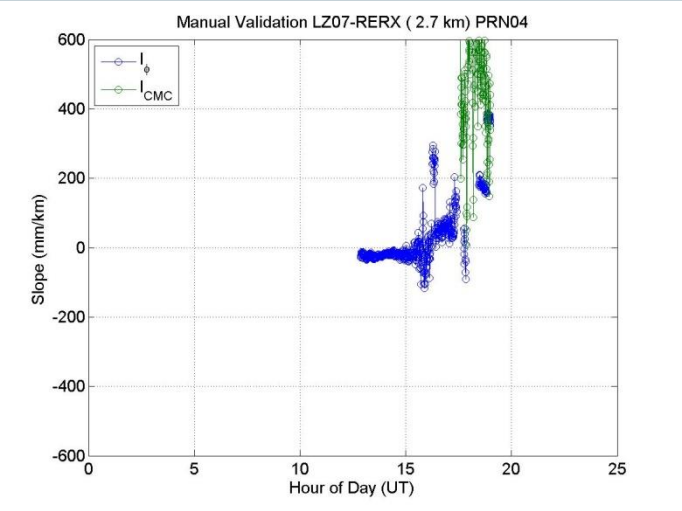
- **Baselines**
  - **1-2:- 2.7km**
  - **2-3:- 2.2km**
  - **1-3:- 4.3km**
- Data collection from November 2013 onwards
- Honeywell has computed the spatial gradients using Bernese software.
- The extreme gradient observed was 311 mm/km on 14 April 2014.

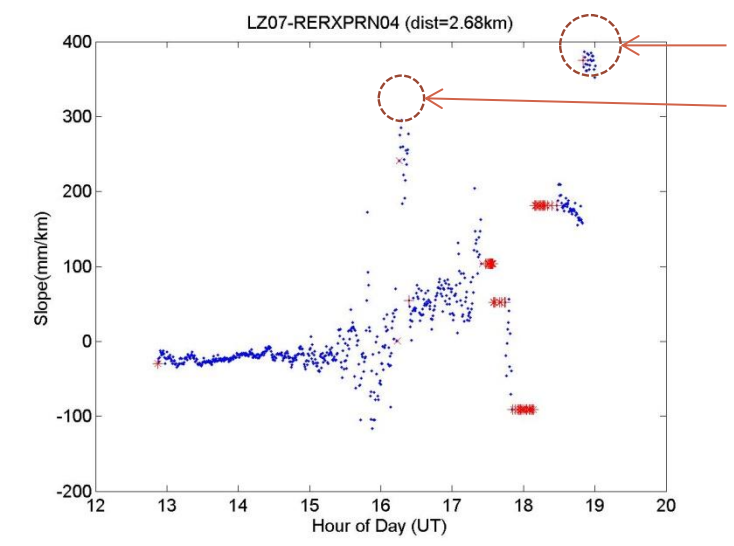
Analysis with Chennai GBAS data

- AAI plans to use LTIAM tool independently to derive the iono gradients.
- Initial data processing – creation of daily RINEX OBS and NAV files as per LTIAM format- has been completed.
- LTIAM tool has been tested successfully with Chennai data.
- Results for 14 April 2014 (extreme gradient day as per Honeywell analysis) are presented.

Analysis with Chennai GBAS data 14 April 2014

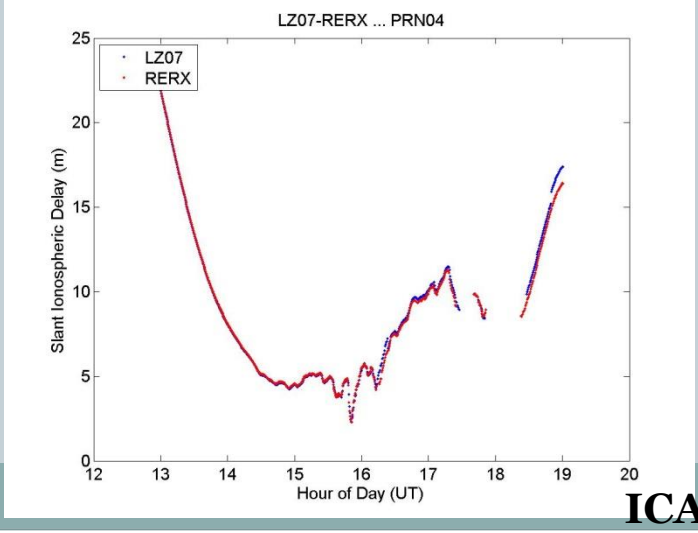
Station pair: 1-2, PRN 4

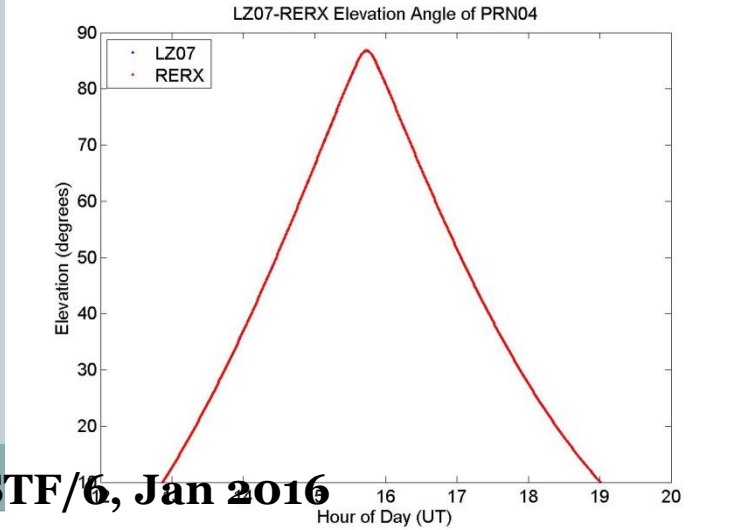




~400 mm/km

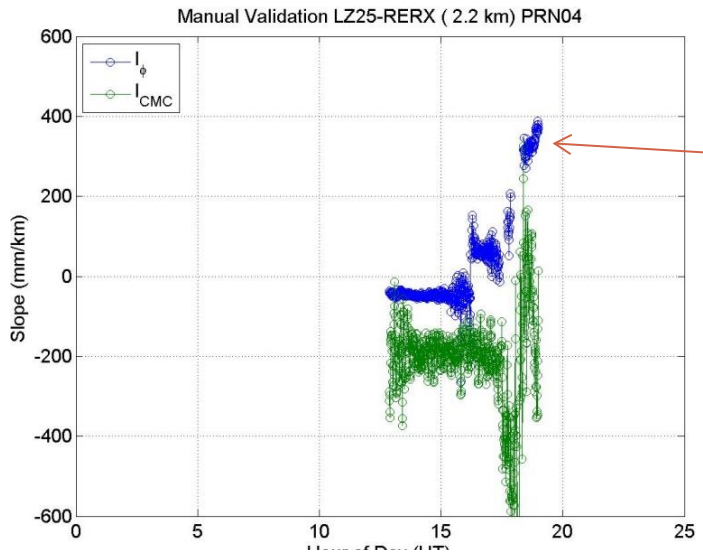
~300

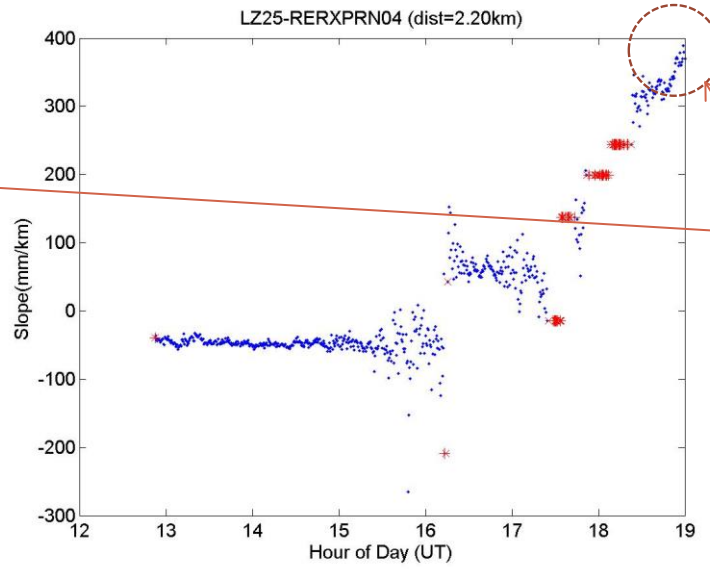




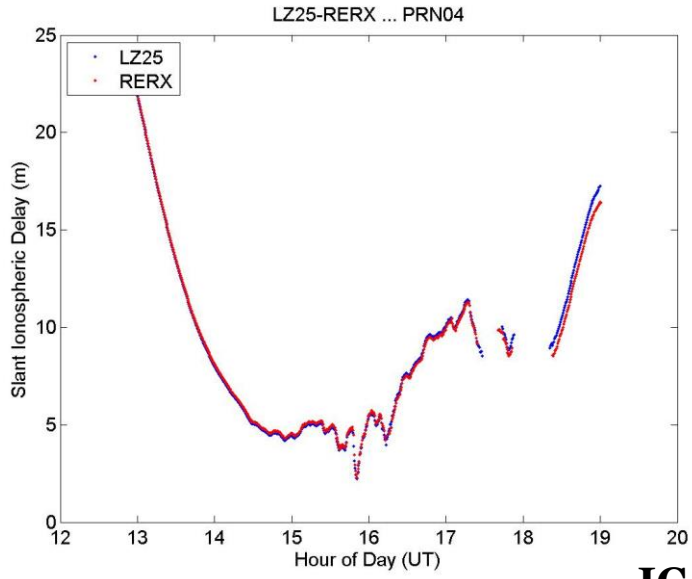
14 April 2014

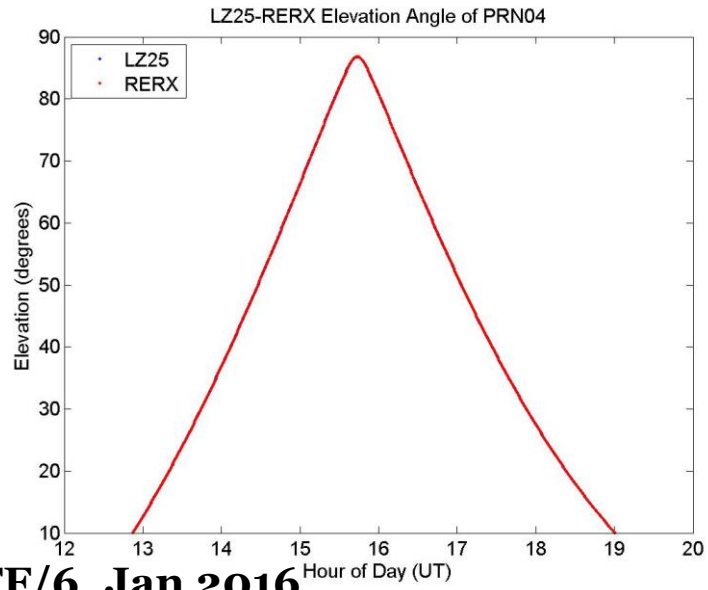
Station 3-2, PRN 4





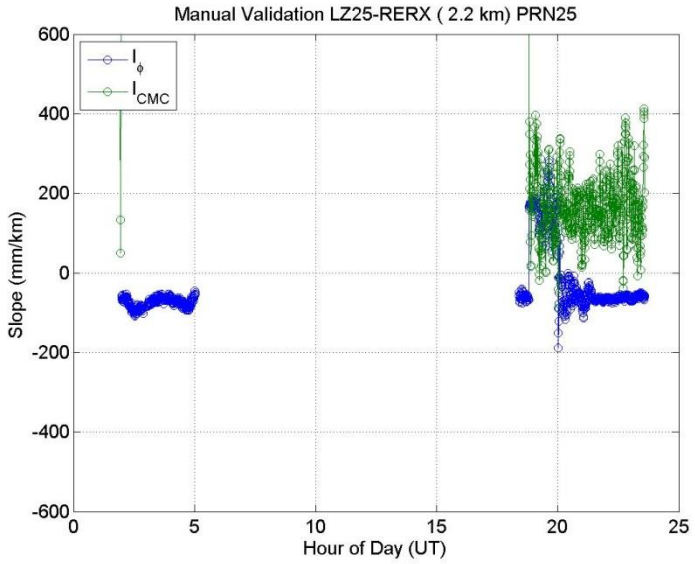
~400

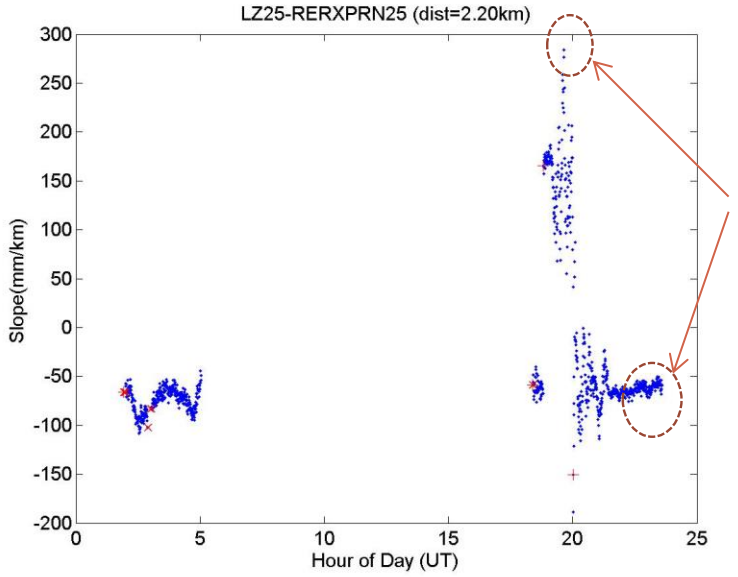




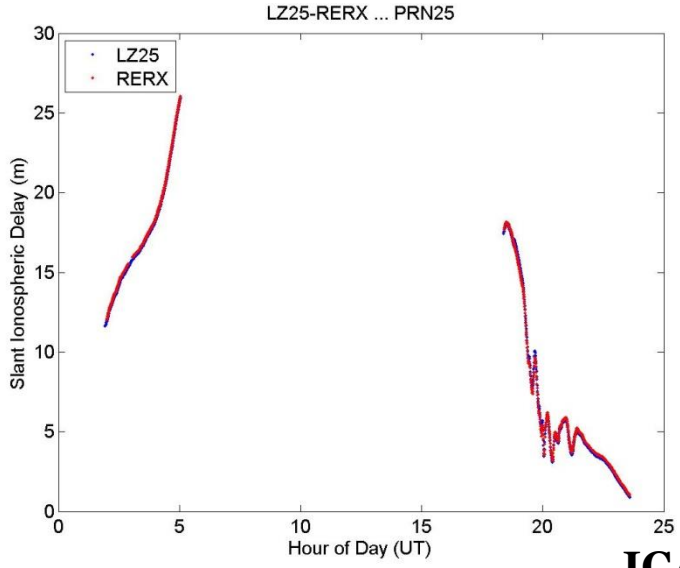
14 April 2014

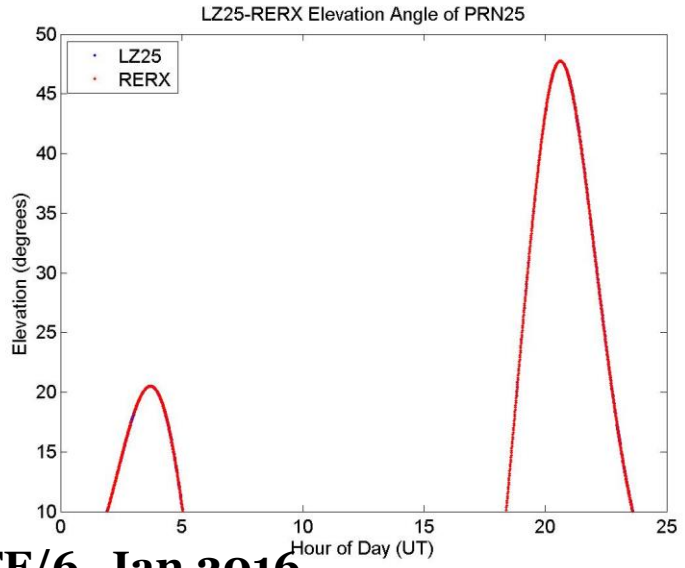
Station 3-2, PRN 25





~350





Other data sources

- Bangalore (12.95°N, 77.68°E, Geomag lat- 4.14°N)
  - 2 IGS stations at Bangalore separated by 6.2 km.
  - 1 GAGAN-TEC station at Bangalore
  - Form a group of 3 stations with short baseline at equatorial latitudes
- Hyderabad (17.45°N,78.47°E, Geomag lat- 8.48°N)
  - 1 IGS station and 1 GAGAN-TEC Station
  - Group at Low latitude
- Lucknow (26.76°N,80.88°E, Geomag lat-17.63°N)
  - 1 IGS station and 1 GAGAN-TEC Station
  - Group at mid low-latitude

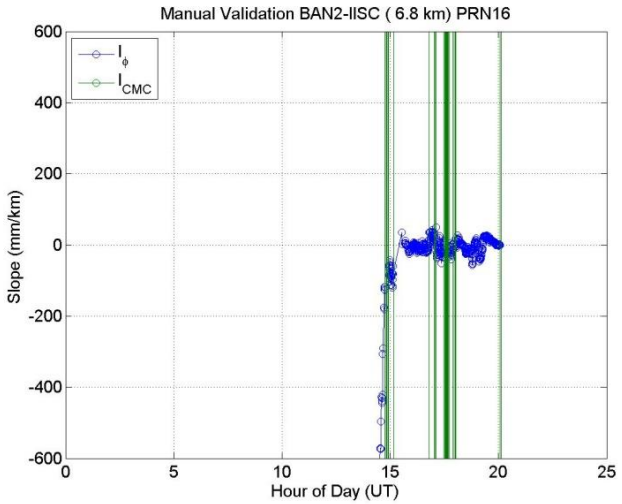
Way forward

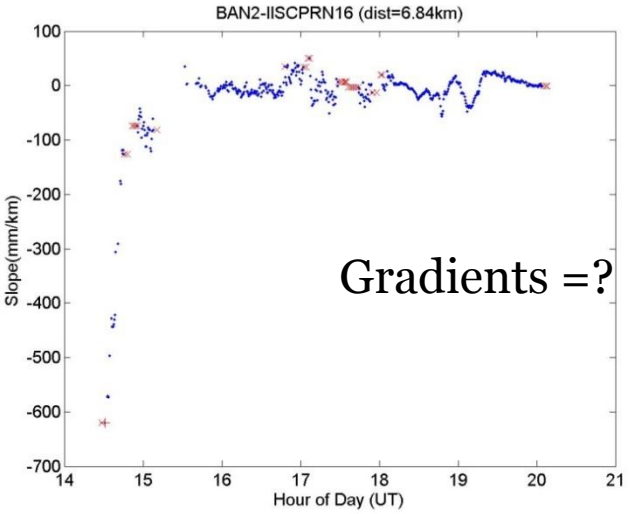
- It is proposed to include and combine the IGS network receivers in India with GAGAN-TEC network to create short baseline groups at various latitudes.
- Analysis to be carried out with LTIAM tool at these groups.
- Some of the dates have already been identified. For example- AATR results
- The LTIAM derived spatial gradients may be verified with gradients derived from Time Step Method.

Analysis with IGS data Bangalore

- Data (RINEX and Satellite bias) for selected days of year 2004(identified using Time Step method from GAGAN-TEC station of Bangalore) has been downloaded.
- LTIAM tool has been tested successfully for IGS station data.
- Further testing with IGS and GAGAN-TEC Receiver data is required.
- Some of the preliminary results of IGS are presented.

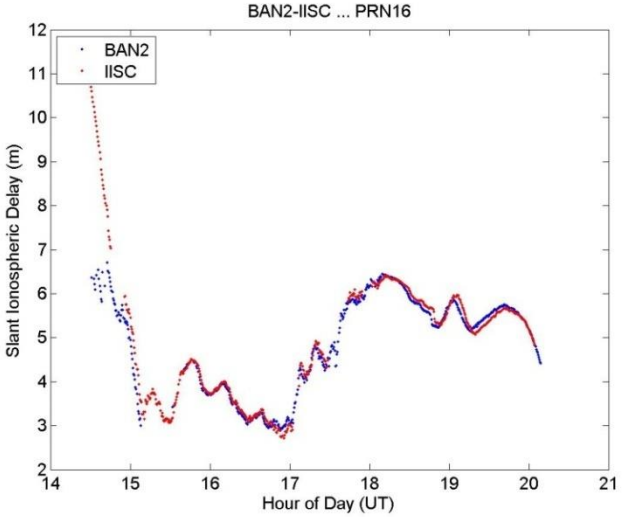
29 March 2004- Bangalore IGS

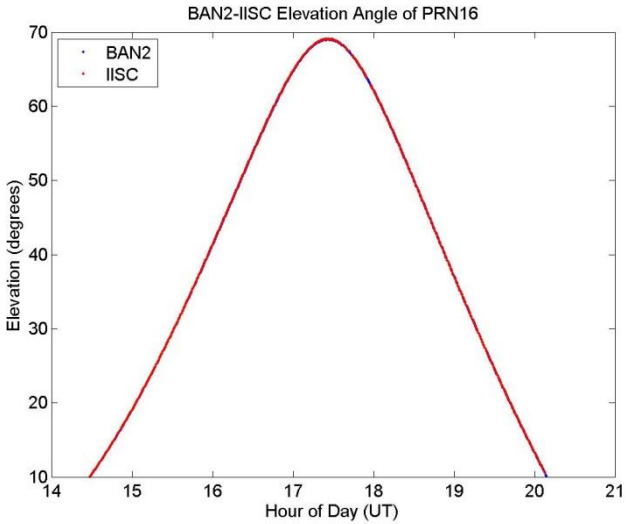




PRN 16

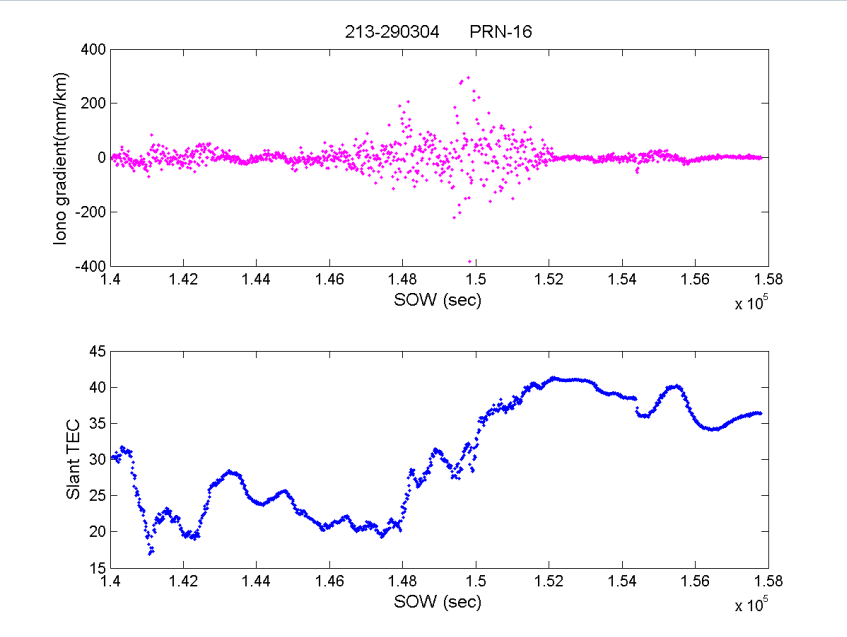
Gradients =?

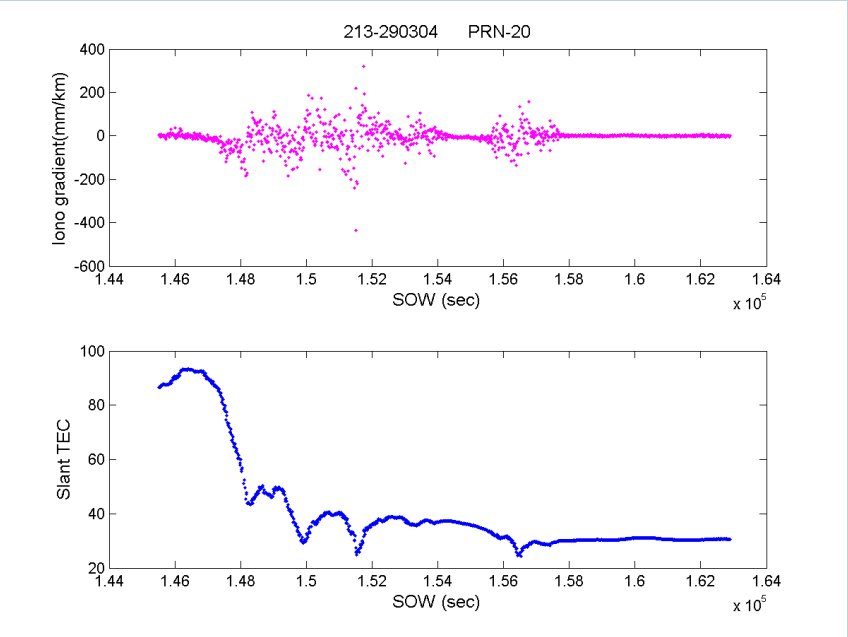




29 March 2004
Bangalore TEC Receiver

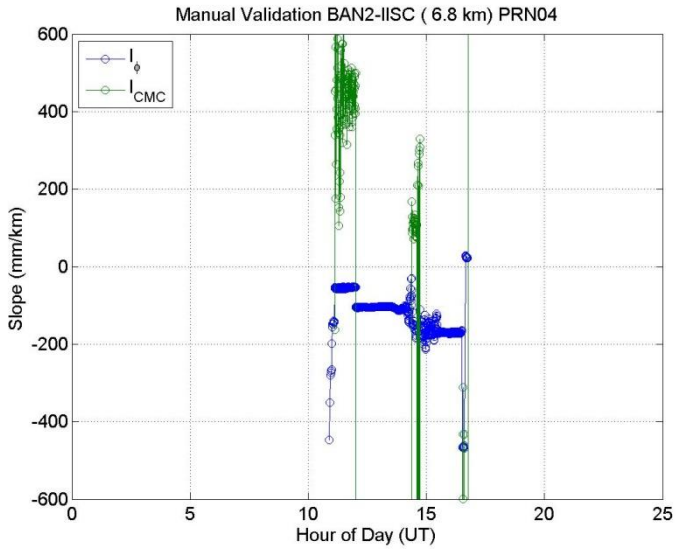
PRN 16 Time Step Method **PRN 20**



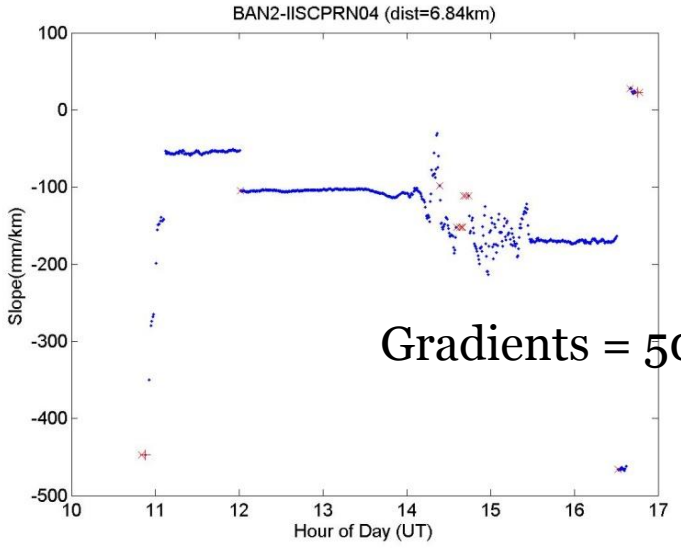


Gradients > 450mm/km

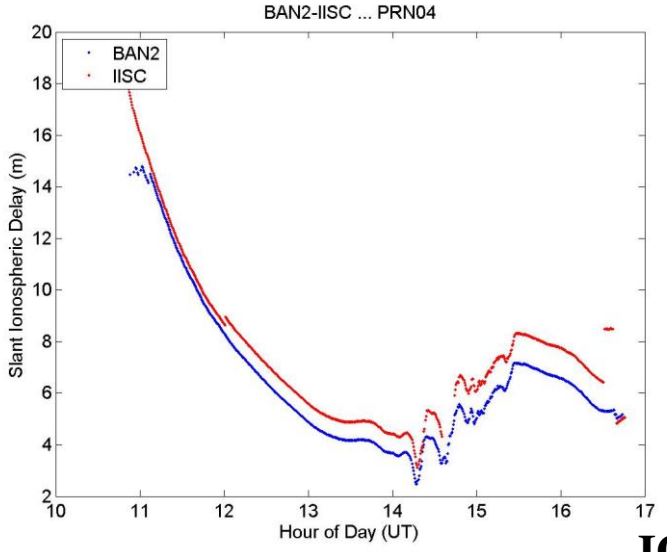
3 October 2004- Bangalore IGS

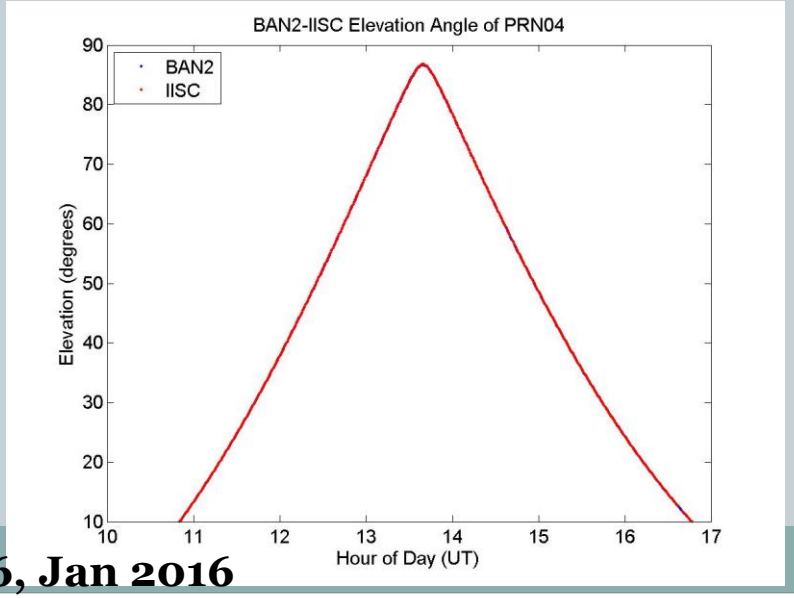


PRN 4



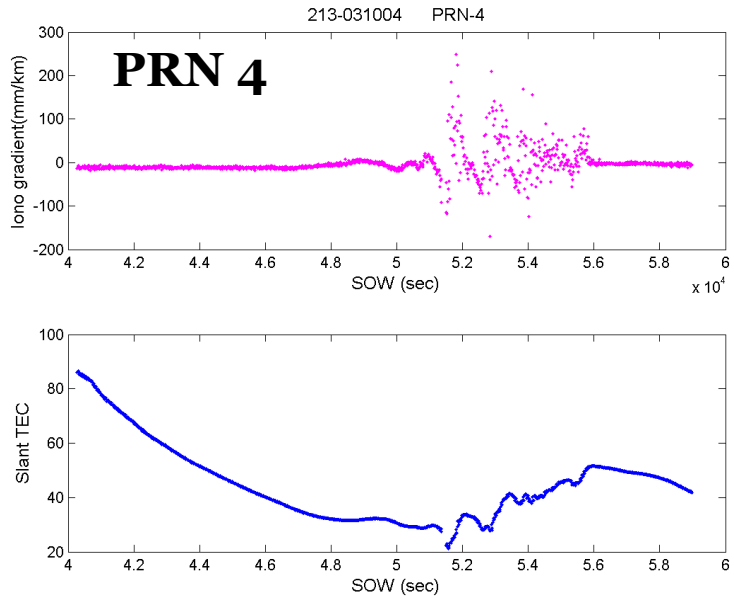
Gradients = 50mm/km?

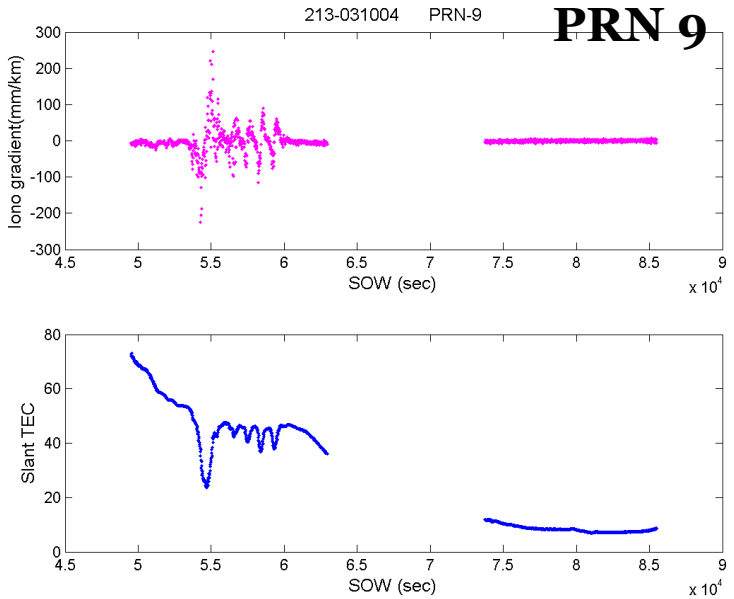


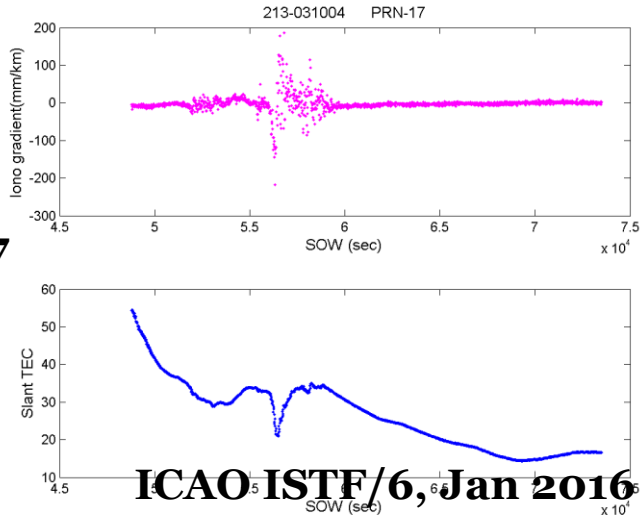


3 October 2004- GAGAN TEC Rx

Time Step Method

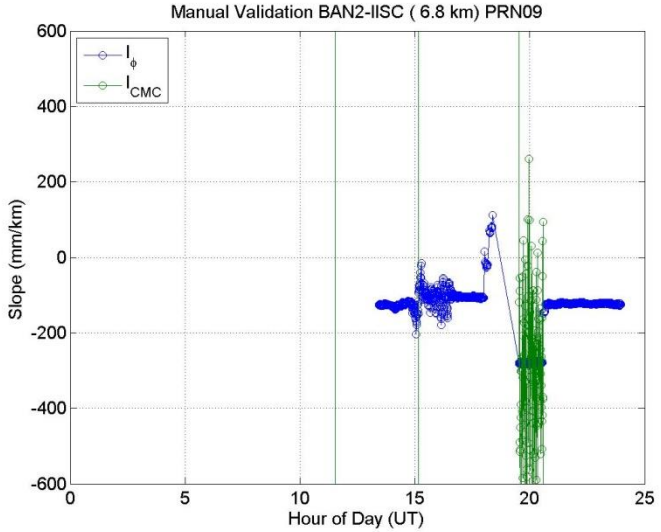




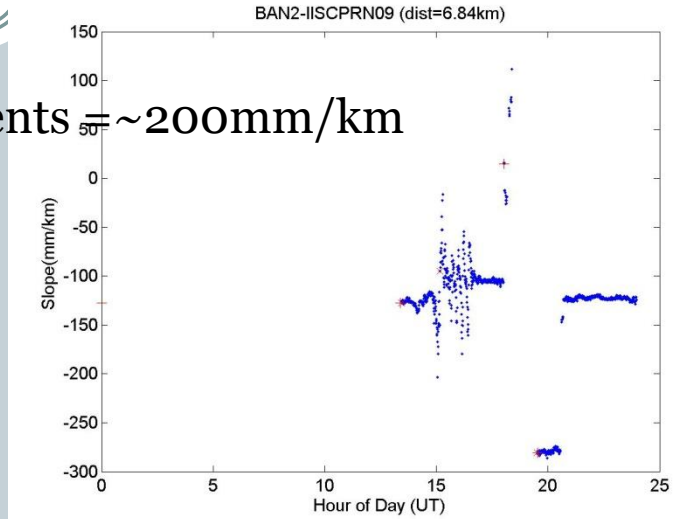


Gradients =~250mm/km

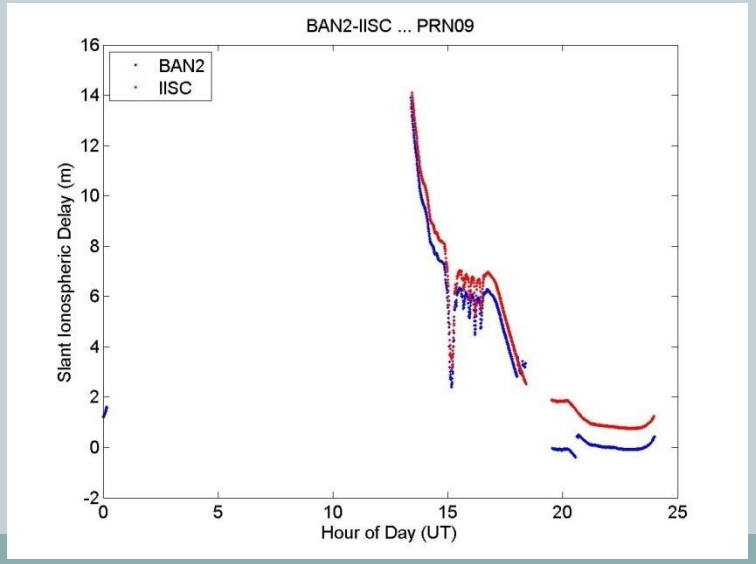
3 October 2004- Bangalore IGS

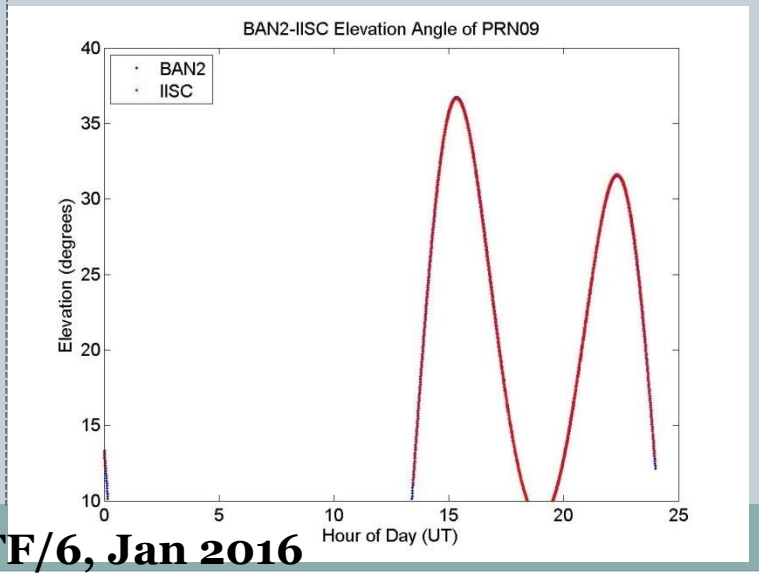


Gradients =~200mm/km



PRN 9





Conclusions

- Issues in verification of gradients needs to be sorted out.
- Preliminary results indicate mismatch of gradients between LTIAM (Station-pair) and Time step method.
- Further understanding is required to validate the results from LTIAM.
- False gradients at low elevation angles are mostly due to cycle slips.

Thank you