



International Civil Aviation Organization

**FIRST MEETING OF IONOSPHERIC STUDIES
TASK FORCE (ISTF/1)**

27 – 29 February 2012, Tokyo, Japan



Agenda Item 4: Data collection and analysis strategy

IONOSPHERIC DATA COLLECTION AND ANALYSIS- RECENT RESULTS

(Presented by India)

SUMMARY

India had shared the information and activities related to ionospheric studies for GAGAN – an Indian SBAS during the Workshop on Ionospheric Data Collection, Analysis and Sharing in Support of GNSS implementation held at ICAO Regional Office, Bangkok, Thailand from 5 to 6 May 2011. The template of ionospheric data collection was duly filled and submitted providing the information on number of GPS stations and types of data available for sharing among the APAC States. India is committed to provide the full cooperation in Ionospheric Studies Task Force established by Fifteenth Meeting of CNS/MET Sub Group of APANPIRG to pursue its objective of characterization of ionosphere throughout Asia and Pacific Regions for implementation of GNSS service. Scintillation is considered to be major threat in wake of recent results along with ionospheric delay and gradients. India proposed to include scintillation analysis in the agenda of the First Meeting of Ionospheric Studies Task Force. Strategy for the sharing of results was also proposed for discussion in the meeting. This paper provides the steps taken by India to accomplish the objectives of ICAO APANPIRG and discusses some recent results obtained in the year 2011.

1. INTRODUCTION

1.1 The Workshop on Ionospheric Data Collection, Analysis and Sharing held at ICAO Regional Office, Bangkok, Thailand from 5 to 6 May 2011 recognized and discussed the need to characterize the ionosphere over Asia and Pacific region for implementation of GNSS. India had shared the information and experience gained on ionospheric studies for GAGAN.

1.2 As part of the action item of the workshop, India had filled and submitted the Template for Ionospheric Data collection providing the details of data available for sharing among the APAC States. Data from 26 stations comprising equatorial to mid latitude region is available for sharing.

1.3 India is keen to play a major role in Ionospheric Study Task Force established by Fifteenth Meeting of CNS/MET Sub Group of APANPIRG on the recommendation of the Workshop to pursue its objectives.

1.4 The recent results on scintillation during 2011 when solar activity is increasing show the alarming threat to GNSS applications. Hence, India proposed to include the Scintillation also in the analysis strategy along with ionospheric delay and ionospheric gradients.

1.5 Considering the vast amount of ionospheric data and the results thereof, India proposes to discuss the sharing of results along with data sharing strategy. Results of important ionospheric events may be shared in line with the common analysis strategy adopted in First Meeting of Ionospheric Studies Task Force.

2. DATA COLLECTION

2.1 A GPS-TEC network consisting of 18 stations was established in 2004 and later increased to 26 to study and characterize the ionospheric behavior over the Indian region for implementation of SBAS. A GSV4004A/B receiver is deployed at these stations to collect the ionospheric and scintillation data.

2.2 Raw binary data containing ISMR logs are being collected continuously since 2004 from all the GPS-TEC stations. These are converted and processed into standard ISMR format. The raw as well as processed data is archived properly at a central monitoring centre. The data processing involves removal of satellite and receiver biases including bad data filtering. Satellite biases are obtained from the CODE website and receiver bias is estimated using the Kalman filter technique.

2.3 Raw binary data recorded at 10 sec sampling interval can also be converted into RINEX (Receiver INdependent EXchange) format on demand as it is not archived on regular basis.

2.4 India is committed towards sharing of vast ionospheric data collected among APAC States for better utilization and understanding of ionospheric behavior for GNSS implementation.

3. RECENT RESULTS ON SCINTILLATION

3.1 The morphology and characteristics of the scintillation have been studied and understood very well using the continuous scintillation measurements over Indian region since 2004. Recent results of scintillation during peaking solar activity in 2011 exhibit a similar morphology but the strength, percentage occurrence and duration of scintillation patch has increased alarmingly causing a potential major threat to GNSS applications.

3.2 A 900% increase in the number of scintillation epochs ($S_4 > 0.4$) in 2011 is measured compared to 2004 using the combined data from all receivers. The maximum duration of scintillation event/patch (continuous $S_4 > 0.4$) observed in 2004 was of 25 minute whereas it is of 80 min in 2011.

3.3 With increasing solar activity, the latitude range of scintillation occurrence may move further northward (and southward in southern hemisphere) due to lifting of F2 ionospheric layer to greater heights.

3.4 Severe scintillations for close to 2 hours have been observed in measurements of recently launched GSAT-8 satellite (PRN-127) leading to loss of lock and cycle slips several times. This much continuous severe scintillation can greatly impact the accuracy and availability of GNSS service.

3.5 The depth of depletions in the range of 30-80 STEC (5m-13m slant delay) has been observed in 2011. Such deep depletions may cause serious hazard to GNSS service in case of miss-detection. Depletion detector in user receiver is one of option in mitigation techniques as plasma bubbles are the localized phenomena and needs to be detected at user end to mitigate its effects.

3.6 The launch of GSAT-8 satellite has provided new impetus to scintillation and depletion analysis. It would be useful in determining the movement of scintillation and depletion, its drift velocity, size of bubble etc.

4. CONCLUSION

India proposes to support the ionospheric data collection and analysis and share the same among the APAC States for better characterization of ionosphere in the South Asia and Pacific region for implementation of GNSS applications like SBAS and GBAS.

5. ACTION BY THE MEETING

The meeting is invited to note India's continued efforts in ionospheric data collection and analysis and the development of GAGAN for aviation.
