International Civil Aviation Organization

THE SECOND MEETING OF IONOSPHERIC STUDIES TASK FORCE (ISTF/2)

15 – 17 October 2012, Bangkok, Thailand

Agenda Item 4: Review Summary of Data Sources

SUMMARY OF IONOSPHERE DATA SOURCES IDENTIFIED THROUGH A DATA COLLECTION TEMPLATE

(Presented by Japan)

SUMMARY

This paper presents a summary of ionospheric data sources nominated by States/Administrations through a data collection template for ionospheric data collection, analysis, and sharing activities of the ionospheric studies task force.

1. INTRODUCTION

1.1 The first Ionospheric Studies Task Force (ISTF/1) meeting identified five tasks and their sequence was identified. Task 1 is "Data Collection" which is responsible for collection, integration, administration and distribution of data collected from States and Administrations (Ref. WP8, APANPIRG CNS/MET SG-16).

1.2 The Task Details of the Data Collection task includes identifying data sources.

1.3 A template for ionospheric data collection, in coordination with other participating States has been circulated by ICAO APAC Office through State Letter T 8/5.10, T 8/5.11:AP083/11 (CNS) dated 15 June 2011. Two (2) types of ionospheric data, ionospheric delay and scintillation being collected, are required to be treated separately.

1.4 The data collection templates filled up by the States were reviewed by the first (1st) Ionospheric Studies Task Force meeting (ISTF/1) held at Tokyo in February 2012.

2. DISCUSSION

2.1 By the end of March 2012, eight (8) templates were returned to ICAO APAC Office from Australia, India, Hong Kong China, Japan, Philippines, Thailand, Singapore, and USA.

2.2 Summary of the data sources nominated by States and Administrations was reported to the sixteenth (16th) APANPIRG CNS/MET SG meeting as an information paper (IP27, APANPIRG CNS/MET SG-16). The summary is attached to this working paper as **Attachment 1**.

2.3 In summary, thanks to the efforts and contributions by the States/Administrations, 542 data sources for ionospheric delay and 37 data sources for ionospheric scintillation have been identified.

2.4 In the identified data sources, 11 types of receivers from 4 manufacturers are being used for delay measurements, while only two types of receivers are being used for scintillation measurements. Data conversion software and common data format need to be defined.

2.5 About 3/5 (342 stations) of data sources of delay measurements will share the low level data, while another 2/5 (200 stations) of the data sources will share data in the form of delay and delay gradient values. Thus, at least two common data formats need to be defined for delay data. For scintillation data, all stations share scintillation index data and 10 stations share raw scintillation measurements data. Two common data format for both types of data are necessary for scintillation data as well.

2.6 A large number (485) of data sources for ionospheric delay measurements sample data at 1 Hz. This will make it easier for us to analyze data under disturbed conditions. Slower sampling data are definitely useful for background ionosphere characterization. For scintillation measurements, a large number of receivers (27 out of 37) provide scintillation index data every 1 min based on 50 Hz sampling. Some of the stations are providing raw scintillation measurements data at higher sampling rate. Scintillation index data are definitely useful for climatological studies of scintillation. Raw scintillation measurement data at higher sampling rate would allow us to derive more information on scintillation.

2.7 Data from 265 stations from Australian ARGN and SPRGN and from USA will be shared without any restriction. Other data sources will impose restrictions on secondary distribution, out-of-purpose use, or otherwise. For these data with restrictions, the conditions for use of data agreed at ISTF/1 will be useful.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) review the summary of the data sources nominated by States and Administrations;

b) discuss the adequacy of the data sources for the purposes of ISTF; and

c) explore ways to enhance ionospheric data collection and sharing, if necessary.

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ATTACHMENT

Summary of possible data sources identified in Templates

Prepared by Susumu Saito

12 July 2012

1. Background

Following the agreement at the 14th APANPIRG CNS/MET SG meeting at Jakarta in July 2010, a workshop on ionospheric data collection, analysis, and sharing to support GNSS implementation was held in Bangkok in May 2011. At the workshop, it was recommended that States be urged to coordinate with their relevant national organizations for sharing of available GNSS data collected to facilitate characterization of ionosphere to support the implementation of GNSS applications for aviation [1].

Following the workshop outcome, a template for ionospheric data collection in coordination with other States was developed and circulated by ICAO APAC Office through State Letter T 8/5.10, T 8/5.11:AP083/11 (CNS) dated 15 June 2011.

By the end of March 2012, 8 templates were returned to ICAO APAC Office from Australia, India, Hong Kong China, Japan, Philippines, Thailand. Singapore, and USA.

This paper summarizes the contents of the templates to overview the data sets which are currently available to us.

2. Ionospheric delay

2.1 Data sources

542 stations are nominated as data sources of ionospheric delay measurements. Out of these 542 stations, 468 stations belong to certain GNSS observation networks and remaining 74 stations are stand-alone.

2.2 Receiver types

Various kinds of receivers from various receiver manufacturers are used for ionospheric delay measurements. At this moment, 11 types of receivers from 4 manufacturers including GSV(1), Leica(3), NovAtel(6), and Trimble(1) are deployed. The number between the parenthesis indicate number of receiver type(s) corresponding to each manufacturers.

2.3 Data types and shared level

Data are also provided in various data formats depending on receiver types as well as the shared data level. 177 data sources from USA including WAAS, National Satellite Test Bed (NSTB), and stations operated by FAA and in Thailand will share receiver native raw data. 165 data sources will share data in RINEX format. This means that

lower level (raw pseudo-range/carrier phase measurement) data will be available from 342 stations. Data from 200 stations belonging to Japan's GEONET will be provided in the form of slant ionospheric delay and the ionospheric delay gradient values. Therefore, at least two data formats should be prepared, one for the lower level data and the other for the delay value data.

2.4 Sampling intervals (rates)

A large number (485) of data sources sample data at 1 Hz (1 sample per second) or faster. 12 stations sample every 5 sec, 26 stations every 10 sec, and 19 stations every 30 sec. Under disturbed ionospheric conditions where ionospheric delay changes quickly, faster sampling rate is more desirable. Therefore, having 485 stations sampling at 1 Hz is a good news. Slower sampling rate data would also be useful to evaluate the background ionosphere.

2.5 Restrictions

265 data sources from Australia including the Australian Regional GNSS Network (ARGN) and the South Pacific Regional GNSS Network (SPRGN) and from USA including WAAS, National Satellite Test Bed (NSTB), and stations operated by FAA will provide data without any restriction. From 55 stations, data will be provided with the restriction of 'no secondary distribution'. 216 stations data from Hong Kong China and GEONET will provide data for this (ISTF) project only. Restriction for 6 stations data from Singapore is under discussion.

The conditions for use of data of which draft was agreed at the ISTF/1 meeting define that the collected data should be used solely for the ISTF activities. Thus, except for the 173 stations, data which will be provided without any restriction, the common restriction will be applied to the collected data.

3. Ionospheric Scintillation

3.1 Data sources

37 stations are nominated as data sources of ionospheric scintillation measurements. Out of these 37 stations, 23 stations belong to GAGAN-TEC network of India and provide ionospheric delay data as well. 14 stations are stand-alone stations.

3.2 Receiver types

Most of scintillation data are obtained by GSV 4004/4000B receivers (36 stations). Only one station at Kotzebue, Alaska, USA uses a NovAtel G2 receiver.

3.3 Data types Shared data levels

Data from 36 out of 37 stations are provided as GSV binary format data. Data from Kotzebue sites are provided as NovAtel binary format data. Though almost all the station uses GSV 4004/4004B, it would not be a good choice to keep those data in the receiver native binary format, because new stations with different receiver types may be added in the future. It should be noted that the GSV 4004/4004B receivers have been discontinued.

There are two types of data: scintillation index data and raw scintillation measurements data. Though not many (10) data sources provide raw scintillation measurement data at higher sampling rate (as discussed in the next section), another common data format for raw scintillation measurement data may be necessary to benefit from the information contained in them.

Data format conversion should be considered by the data provider or by a data archiving system at the time of data submission.

3.4 Sampling intervals (rates)

27 stations provides scintillation index data every 1 min, 1 station samples data at 1 Hz, and 9 stations provide raw scintillation measurement data at 50 Hz and scintillation index data every 1 min. Although 50 Hz raw data will allow us to analyze scintillation index and even to study the motion of ionospheric irregularities from a pair of closely separated stations, processed scintillation index data at lower sampling rate are definitely useful for climatological studies.

3.5 Restrictions

Secondary distribution is not permitted for 36 stations data out of 37. Only for 1 station data from Kotzebue, USA, no restriction is imposed. The agreed terms of conditions should cover the required restrictions for the 36 stations data.

4. Summary

Thanks to the efforts and contributions by the States/Administrations, 542 data sources for ionospheric delay and 37 data sources for ionospheric scintillation have been identified.

11 types of receivers from 4 manufacturers are used for delay measurements, while only two types of receivers are used for scintillation measurements. Data conversion software and common data format need to be defined.

About 3/5 (342 stations) of data sources of delay measurements will share the low level data, while another 2/5 (200 stations) will share data in the form of delay and delay gradient values. Thus, at least two common data formats need to be defined for delay data. For scintillation data, all stations share scintillation index data and 10 stations share raw scintillation measurements data. Two common data format for both types of data are necessary for scintillation data as well.

A large number (485) of data sources for ionospheric delay measurements sample data at 1 Hz. This will make it easier for us to analyze data under disturbed conditions. Slower sampling data are definitely useful for background ionosphere characterization. For scintillation measurements, a large part of receivers (27 out of 37) provide scintillation index data every 1 min based on 50 Hz sampling. Some of stations provide raw scintillation measurements data at higher sampling rate. Scintillation index data are definitely useful for climatological studies of scintillation. Raw scintillation measurement data at higher sampling rate would allow us to derive more information on scintillation.

Data from 265 stations from Australian ARGN and SPRGN and from USA will be shared without any restriction. Other data sources will impose restrictions on secondary distribution, out-of-purpose use, or else. For these data with restrictions, the conditions for use of data agreed at ISTF/1 will be useful.

5. References

[1] WP 20, Report on the outcome of workshop on ionospheric data collection, analysis and sharing to support GNSS implementation, APANPIRG CNS/MET SG-15, Bangkok, Thailand 2011.

[2] State Letter T 8/5.10, T 8/5.11:AP083/11 (CNS), 15 June 2011.