11th ICG 2016

Update of international GNSS Monitoring and Assessment System(iGMAS)

Wenhai Jiao,Xurong Dong,Hanrong Sun,Shuli Song

China Satellite Navigation Project Center
Shanghai Astronomical Observatory,CAS

Nov 06-12, 2016, Sochi, Russia

Contents

1.Background

- More navigation systems will provide services for users. The multi-GNSS era is coming.

- To ensure the GNSS service quality, realize the interoperation of OS signals, it is desirable to carry out GNSS monitoring and assessment.

- In June 2011, at Vienna ICG conference, the international GNSS Monitoring and Assessment services was proposed.

1.Background

- At 2011 ICG-6 in Tokoyo, the decision was adopted to carry out the GNSS open services monitoring and assessment.

- The subgroup on International GNSS Monitoring and Assessment(IGMA) was formed at ICG-6.

United Nations A/AC.105/1000

General Assembly

Distr.: General
10 November 2011

Original: English

Committee on the Peaceful
Uses of Outer Space

Sixth Meeting of the International Committee on Global Navigation Satellite Systems

Note by the Secretariat

A/AC.105/1000

ICG6, 4-9 September 2011
ICG/REC/2011

Recommendation 4.2 for Committee Decision

Prepared by: Working Group A

Date of Submission: 8 September 2011

Issue Title: International GNSS Monitoring and Assessment

Background/Brief Description of the Issue:

The Providers Forum has agreed to consider the development and discussion of proposals to widely monitor the performance of their open signals and provide timely updates to users regarding critical performance characteristics such as timing accuracy, positioning accuracy and service availability. As stated in its work plan, Working Group A will support this activity by focusing on potential cooperation in the development of the necessary ground infrastructure to monitor signal and service performance for open services.

To ensure the service quality, consistent with common open service performance parameters, and realize the ultimate goal of interoperable GNSS open services signals, it is desirable to carry out monitoring and assessment on GNSS open services. An important approach is to determine if international GNSS Monitoring and Assessment requires a single new system, an architecture created by several national systems or through the use of an existing global network such as the one utilized by the International GNSS Service (IGS).

Discussion/Analyses:

Several multi-GNSS monitoring network activities are underway. For example, Preliminary experience includes BeiDou monitoring and assessment, the long-term successful operation of IGS, and the achievements in GNSS signal monitoring and assessment made by Stanford University, DLR, Information Analysis Center of Roscosmos, and others.

China is developing the International GNSS Monitoring and Assessment System (iGMAS).

Japan has also initiated a project known as Multi-GNSS Demonstration Campaign, which is actively seeking proposals for monitoring sites to host GPS/GLONASS/Galileo/QZSS receivers that have already been procured by JAXA.

Future plans for IGS network upgrades to include multi-GNSS receivers should also be investigated, and the support and participation of all GNSS providers will be very beneficial for global monitoring and assessment

European Union attended the Meeting. Representatives of the following intergovernmental and non-governmental organizations also attended: Civil Global Positioning System Service Interface Committee, Committee on Space Research, European Space Agency, European Position Determination System, International Federation of Surveyors, International Association of Geodesy (IAG) and IAG Reference Frame Sub-Commission for Europe, International Bureau of Weights and Measures, International Earth Rotation and Reference Systems Service and International GNSS Service. Representatives of the Office for Outer Space Affairs of the Secretariat and the International Telecommunication Union also attended. Australia was invited to attend as an observer. The representatives of the Interagency Operations Advisory Group and the Fédération Aéronautique Internationale also attended and were recognized by ICG as a new observer and as an associate member respectively. The representatives of Indonesia, Republic of Korea, Thailand and Viet Nam also participated.

3. ICG recalled that the General Assembly, in its resolution 65/97, welcomed the progress made by ICG towards achieving compatibility and interoperability among global and regional space-based positioning, navigation and timing systems and in the promotion of the use of global navigation satellite systems and their integration into national infrastructure, particularly in developing countries, and noted with satisfaction that ICG had held its fifth meeting in Turin, Italy, from 18 to 22 October 2010, which had been jointly organized by Italy and the European Commission.

4. ICG noted that the working groups focused on the following issues: compatibility and interoperability; enhancement of the performance of GNSS services; information dissemination and capacity-building; and reference frames, timing and applications.

5. ICG further noted that Working Group A on compatibility and interoperability addressed all four areas of its current workplan through an intersessional meeting held in June 2011 at the United Nations Office at Vienna and the two days of presentations and discussions conducted during the Sixth Meeting of ICG. Interference detection and mitigation, and open service provision and performance monitoring by multi-GNSS networks were the major areas of focus, leading to three of the working group's four recommendations. The session on multi-GNSS monitoring and the session on interoperability were held jointly with Working Groups B and D, resulting in constructive dialogue with those working groups and an agreed plan of practical steps, including the establishment of a subgroup to collectively investigate international GNSS monitoring and assessment.

6. Working Group B on enhancement of the performance of GNSS services discussed, among other things, the dissemination of disaster information. It was noted that satellite navigation systems might provide essential contributions, but the service concept still needed further elaboration. Due to the importance of that issue a new work item was introduced in the Working Group's workplan. In addition the existing actions in the current workplan were confirmed and were reflected by the Working Group members in their presentations, and good progress was shown in various areas, including indoor positioning, signal authentication, precise positioning, transportation, maritime

V.11-87033

1.Background

Several GNSS monitoring activities are under way,

- the long-term successful operation of IGS.
- The achievements in GNSS signal monitoring by Stanford University, DLR, IAC, MGA and others.
- Preliminary experience of GSC and future GRC
- For the realization and promotion of IGMA proposal, iGMAS has obtained great achievements led by China.

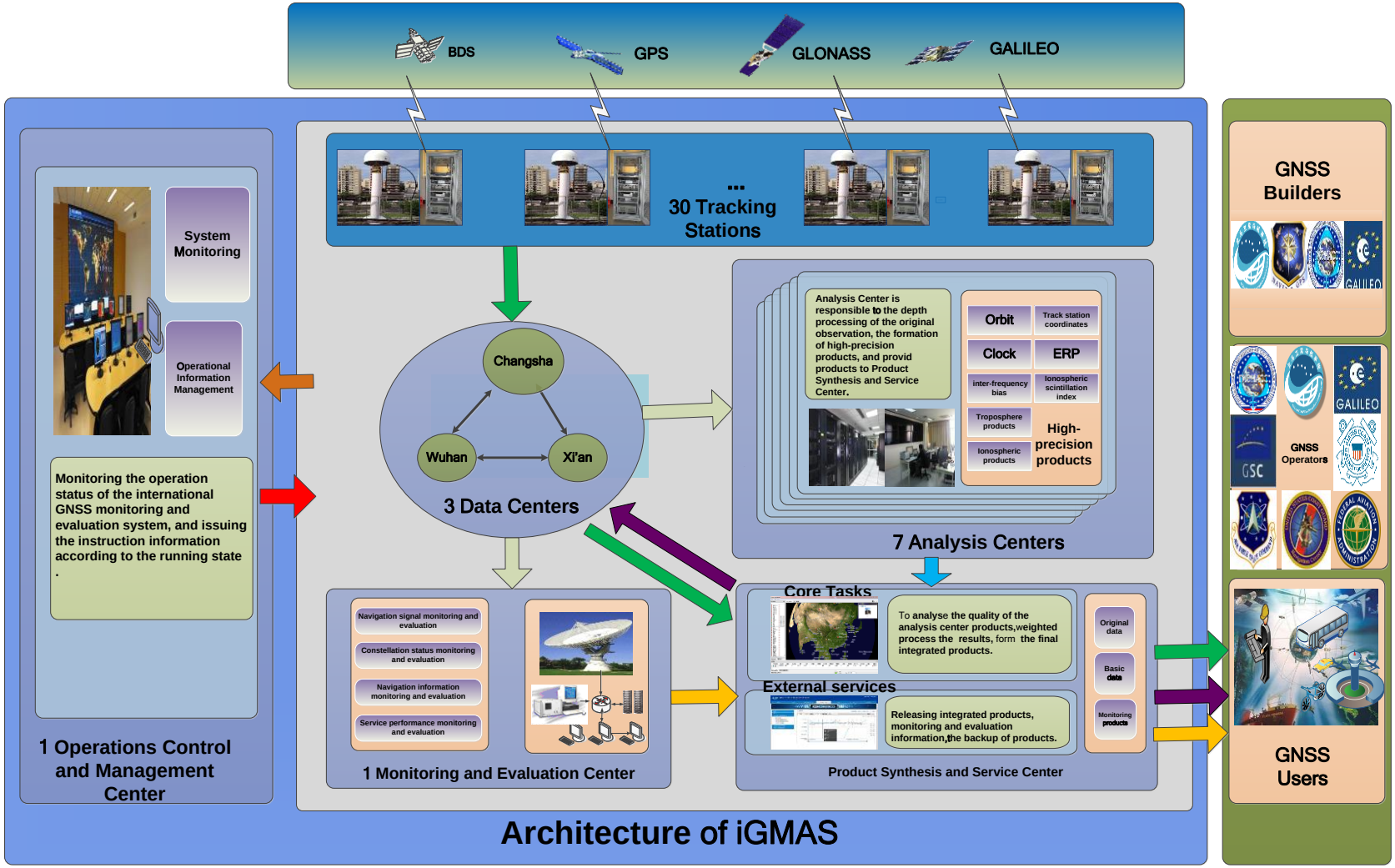
Contents

2.1 Objective of iGMAS

Objective & tasks:

- To **promote** the sharing of global monitoring resource and provide better GNSS service for users.
- To **study** the related standards, the sharing mode of resources.
- To **develop** basic products as well as monitoring and assessment information.
- To **provide** service for monitoring and assessment, scientific research and various applications effectively.

2.2 iGMAS Construction



2.3 iGMAS Construction Roadmap

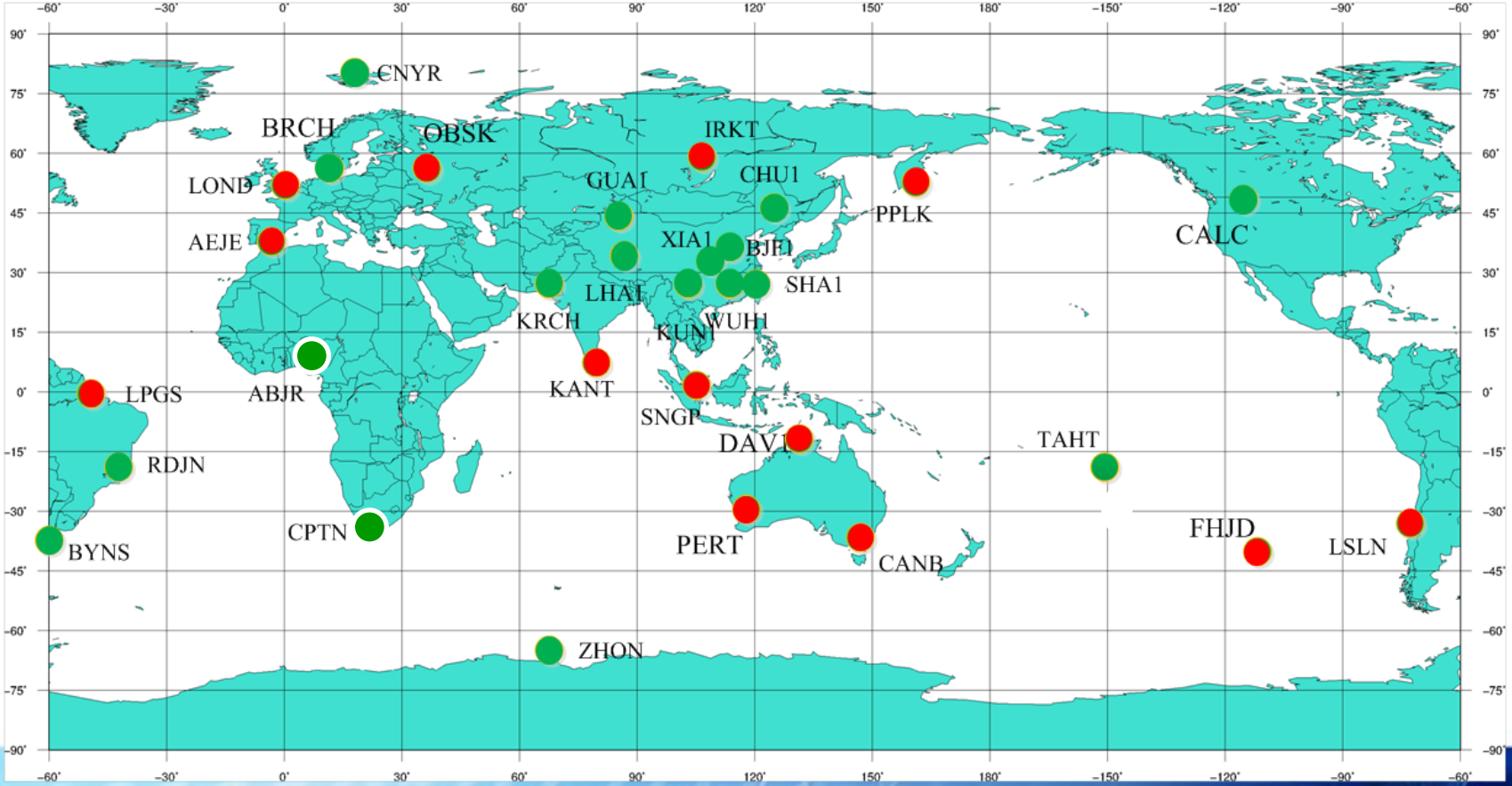
Milestones

- Sep. 2007, idea of iGMAS;
- Aug. 2010, requirements analysis and project approachment;
- Dec. 2012, iGMAS project approval;
- Jul. 2014, start of trial running and service.
- Jul.2016,Most construction has been finished, open routine service started.

2.4 Development of iGMAS

(1)Tracking stations

Up to the Sept.2016,18 tracking stations have been built:8 in China,2 in polar regions,8 abroad stations



2.4 Development of iGMAS

(1)Tracking stations


Beijing


Shanghai


Wuhan


Kunming


Zhongshan station


Pakistan


Brazil


Germany


Xi'an


Lhasa


Changchun


Urumqi


Yellow River station


Canada


Argentina

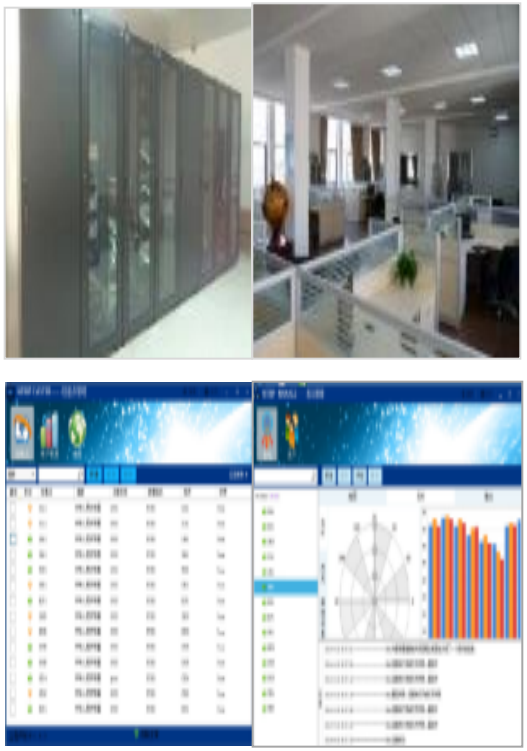

Tahiti


South Africa


Nigeria

2.4 Development of iGMAS

(2)Data Center



NUDT

WHU

NTSC

2.4 Development of iGMAS

(3)Analysis Center

Wuhan University

Shanghai Astronomical Observatory

Xi'an Satellite Control Center

Chang'an University

Space Information Relay and Transmission Technology Research Center

Institute of Geodesy and Geophysics

Chinese Academy of Surveying & Mapping

Information Engineering University
Xian Institute of Surveying and Mapping
China University of Mining and Technology
Beijing Aerospace Control Center
National Time Service Center,CAS
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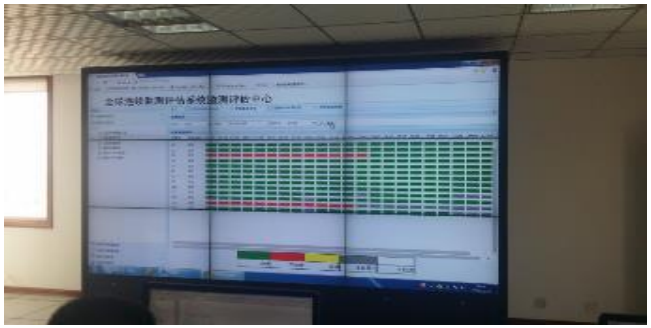
2.4 Development of iGMAS

(4)Monitoring Analysis Center

Xi'an Institute of Surveying and Mapping

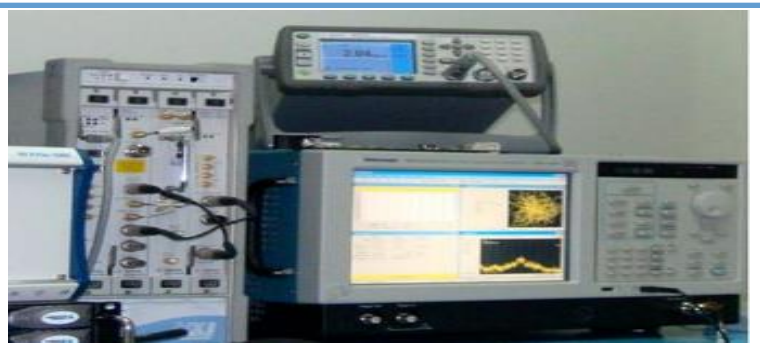


Monitoring Hall

Computer room

National Time Service Center

40 meter Antenna for signal monitoring

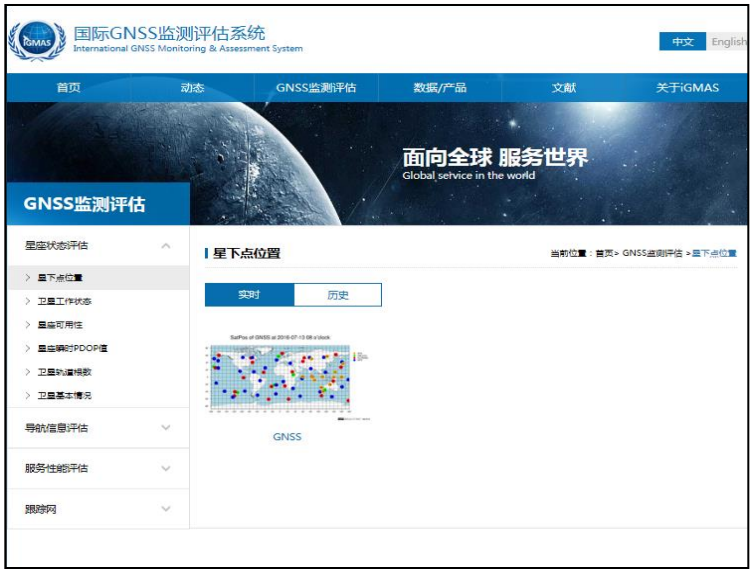


Radio Frequency signal monitoring equipments

2.4 Development of iGMAS

(5) Product Integration and Service Center

Product Integration Process



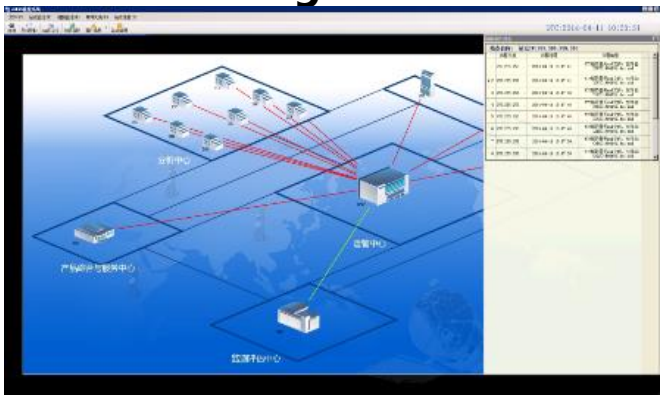
Website

2.4 Development of iGMAS

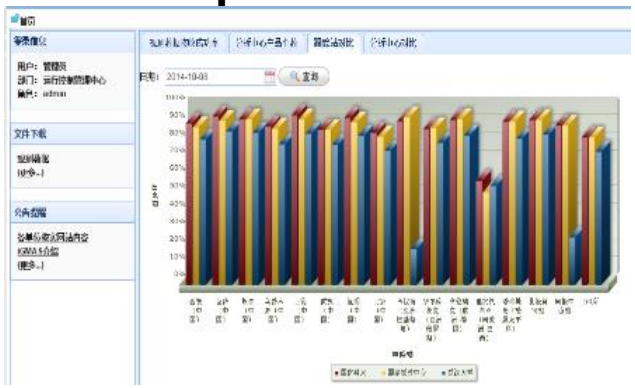
- **(6)Operational Control and Management Center**

Monitoring Hall

Computer Room



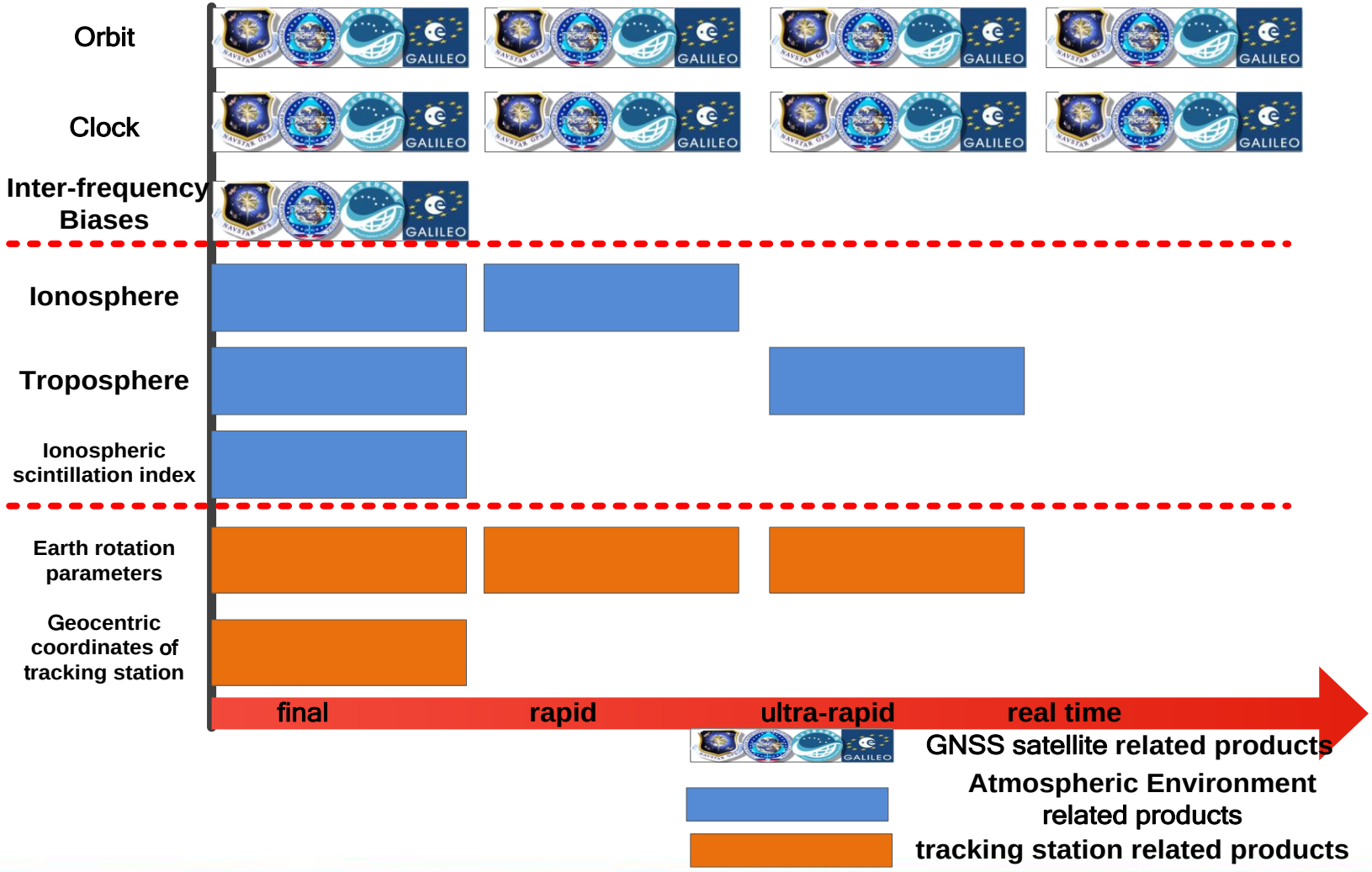
System Monitor software



Operation information management system

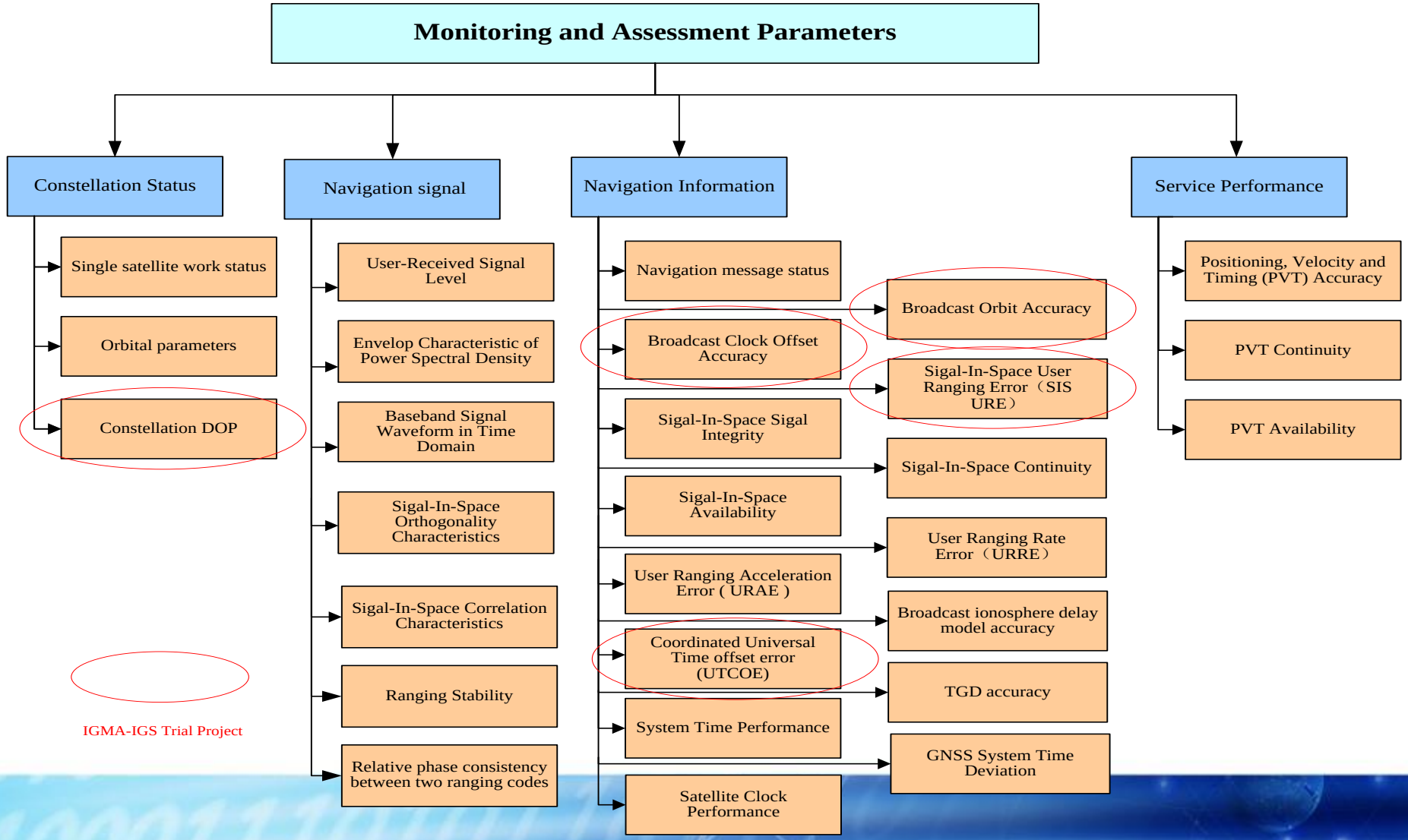
2.5 Basic Service

(1) Original observations and Basic Products



2.5 Basic Service

(2)Monitoring and assessment information



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1. Backround

2. iGMAS

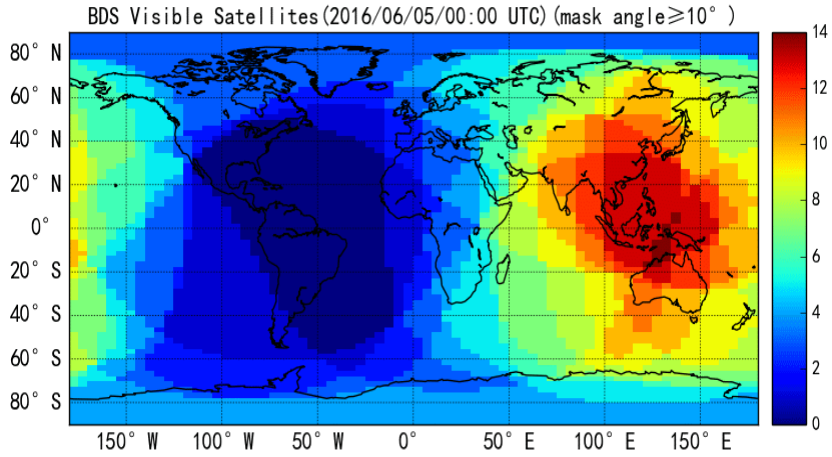
3.Monitoring Results

4. Summary

3.1 Constellation Status

(1)Visible Satellite number

30th June 2016



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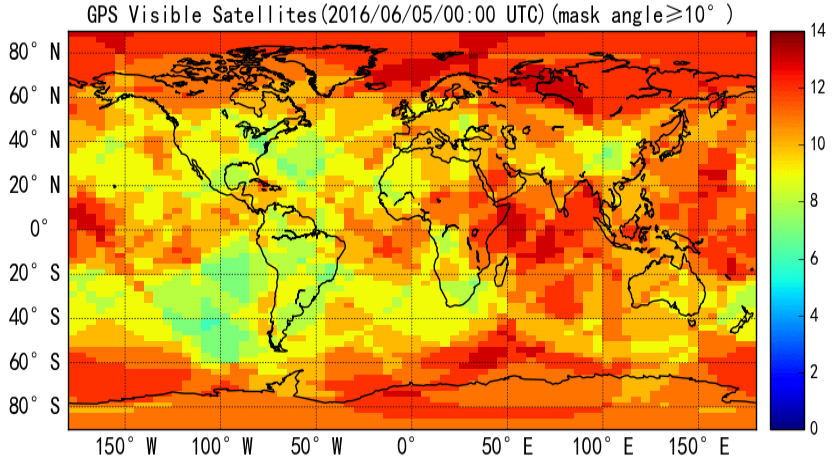
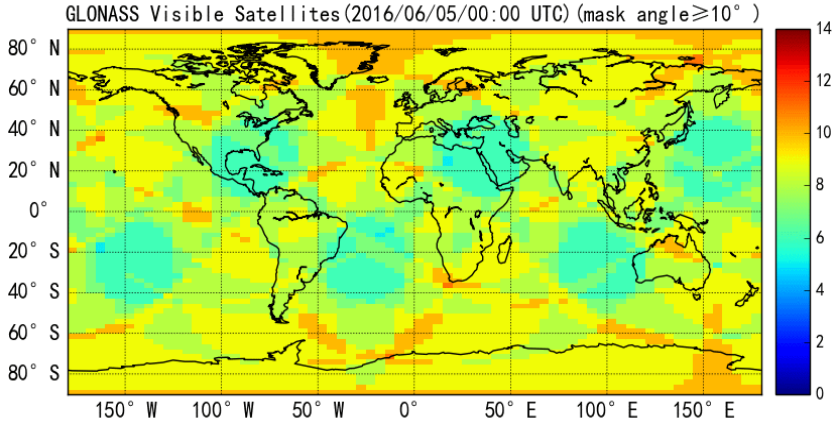
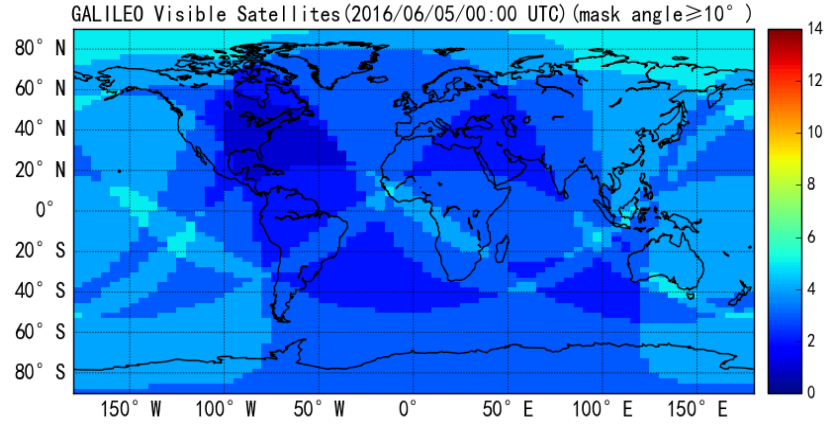


GPS



GLONASS

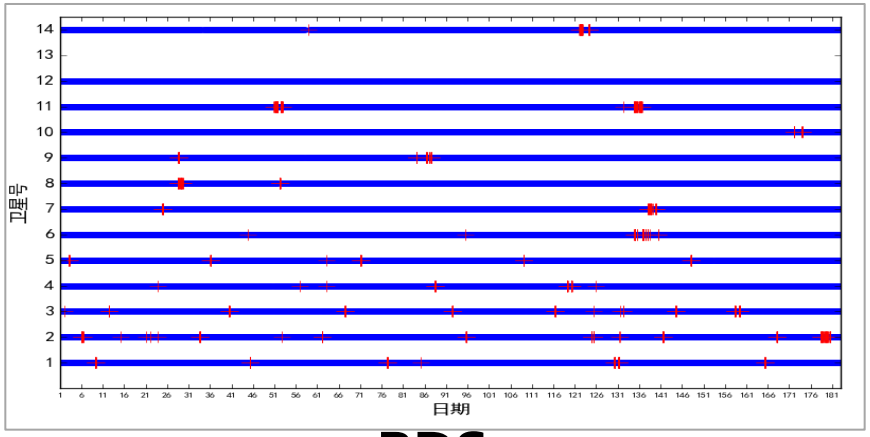


Galileo

3.1 Constellation Status

(2) Healthy of Satellite

(blue:healthy, red:unhealthy, 2016, doy1-181)



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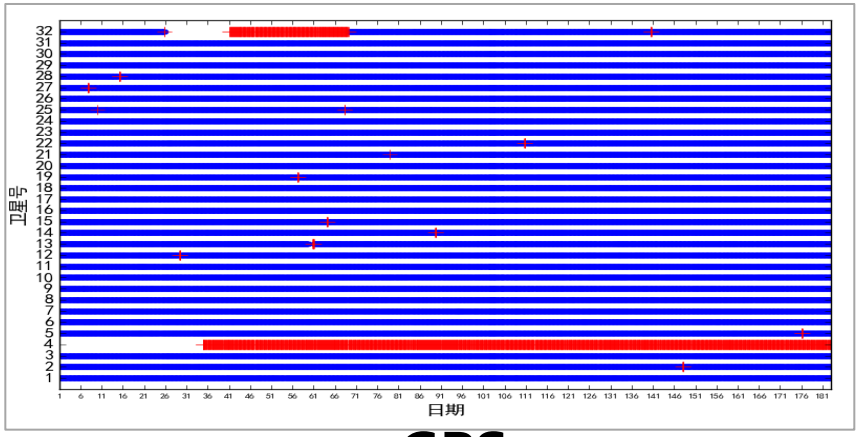
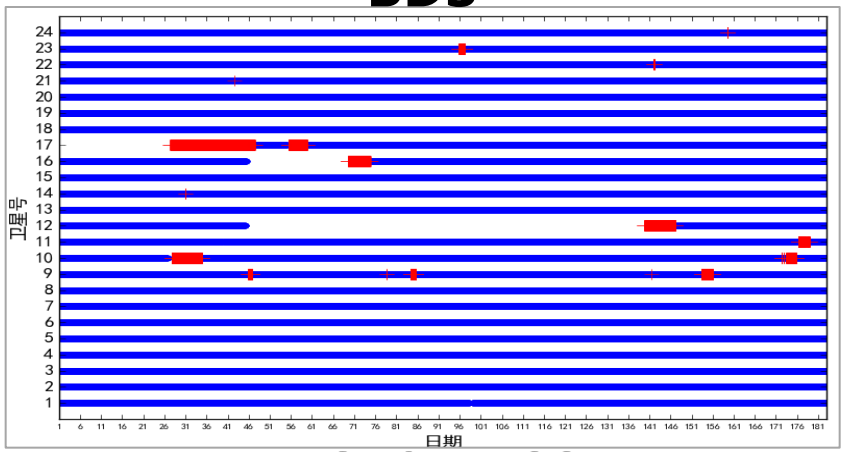
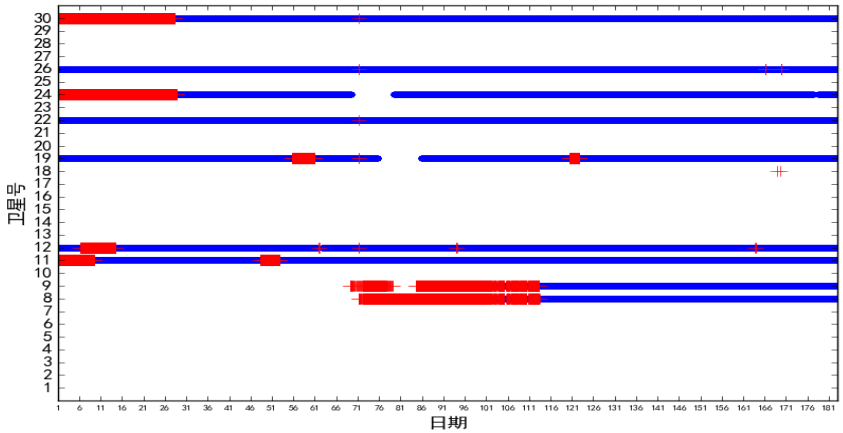


GPS



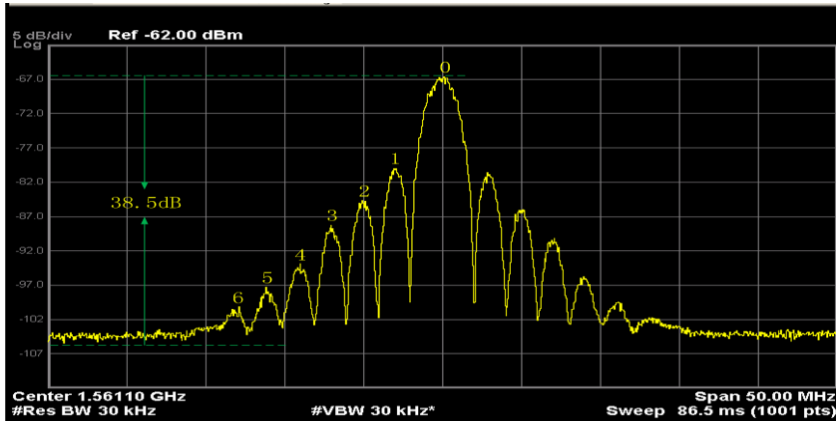
GLONASS



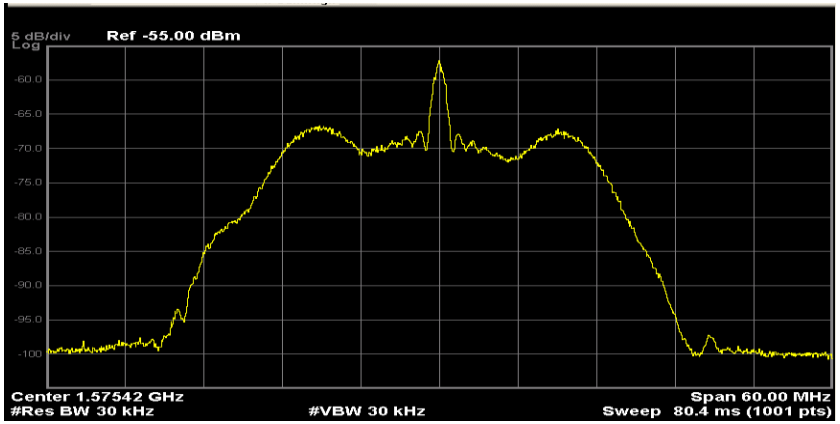
Galileo

3.2 Navigation Signal Quality

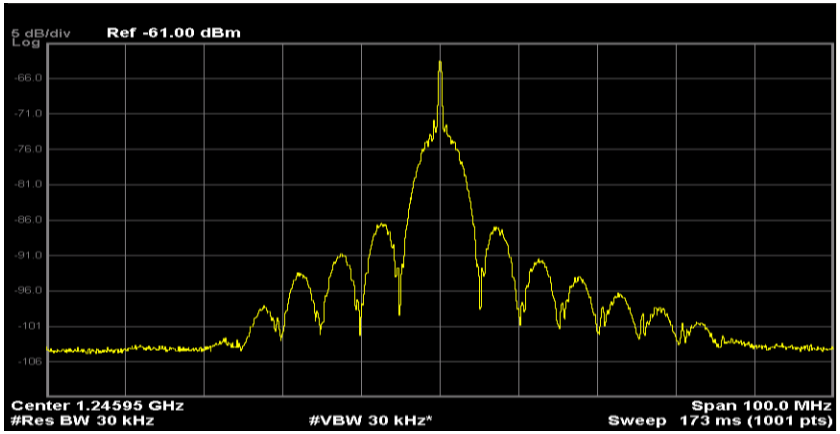
(1)Signal power envelope



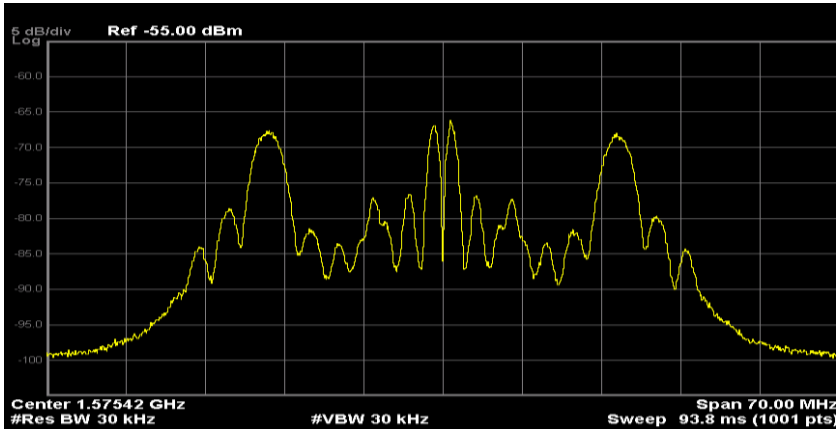
BDS IGSO4-B1(2016-06-24)



GPS BIIRM-1-L1(2016-06-24)



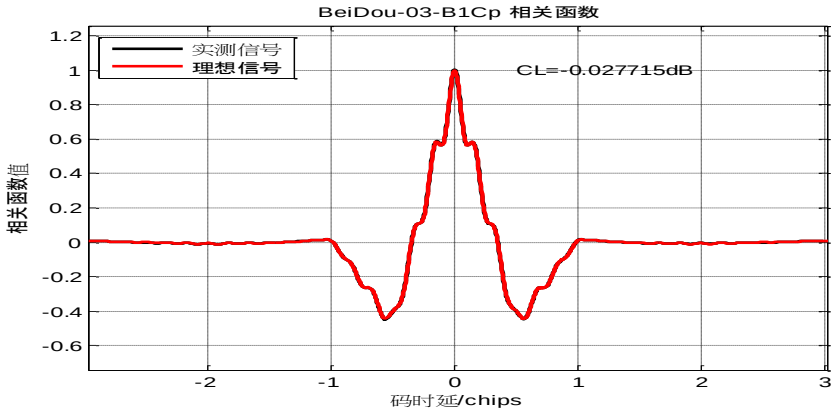
GLONASS COSMOS-G1(2016-06-24)



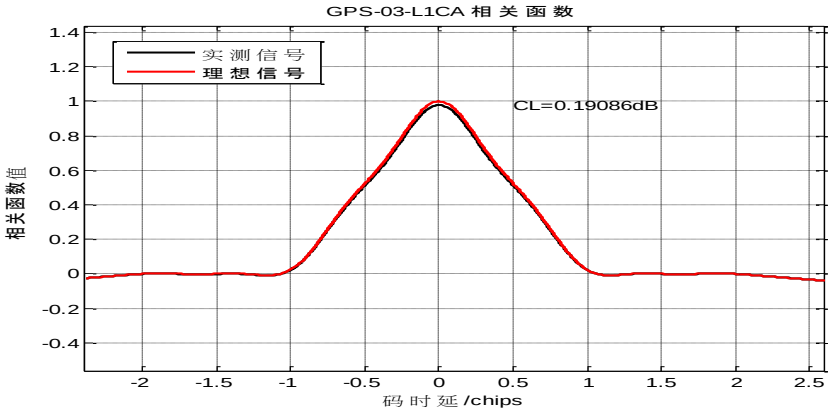
Galileo GSAT0102-E1

3.2 Navigation Signal Quality

(2)Signal Correlation



BDS M1-S-B1(2016-05-10)



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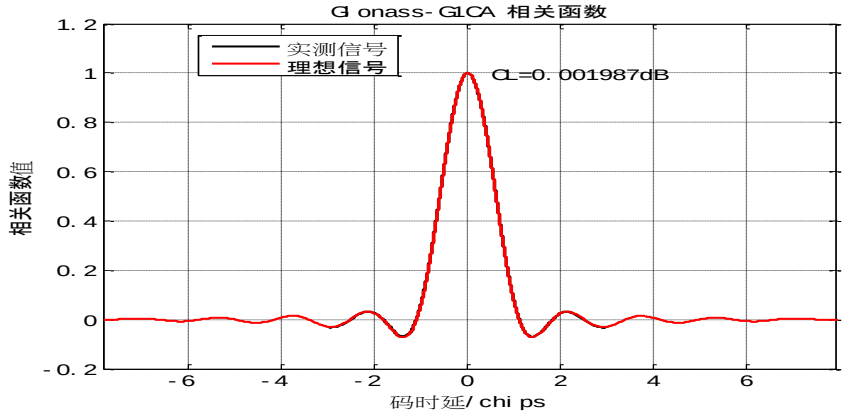

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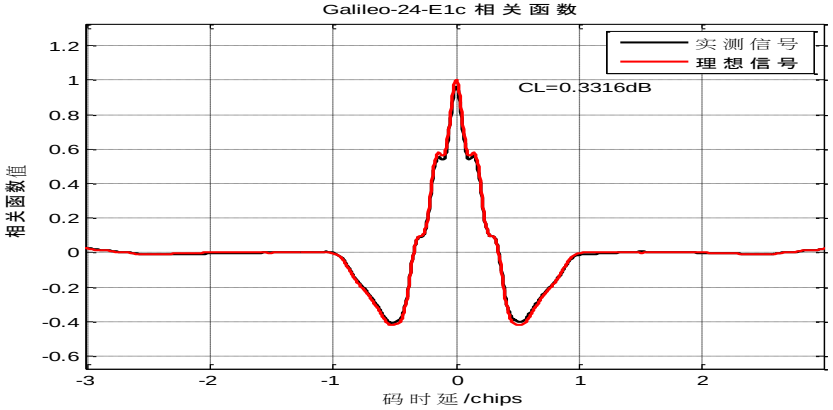
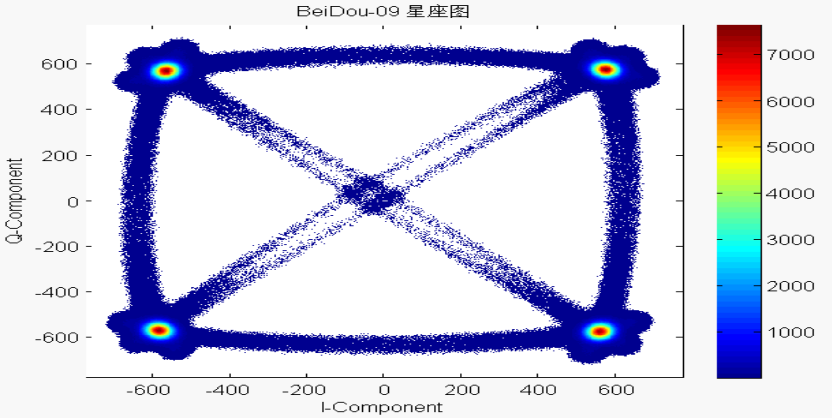


Galileo GSAT0206-E1(2016-06-25)

3.2 Navigation Signal Quality

(3)Signal constellation figure



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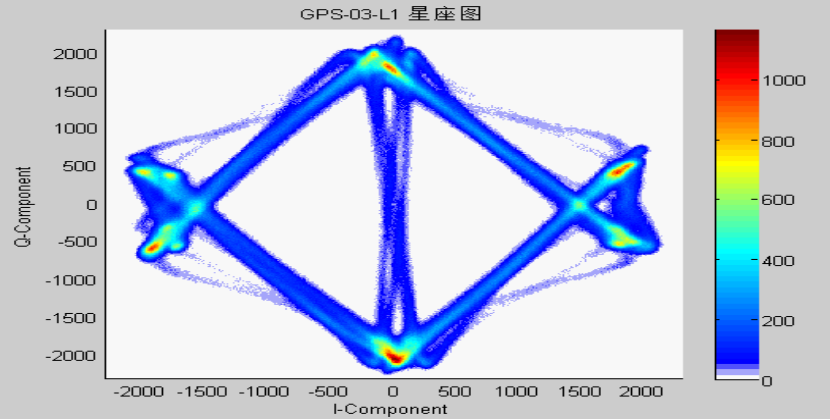

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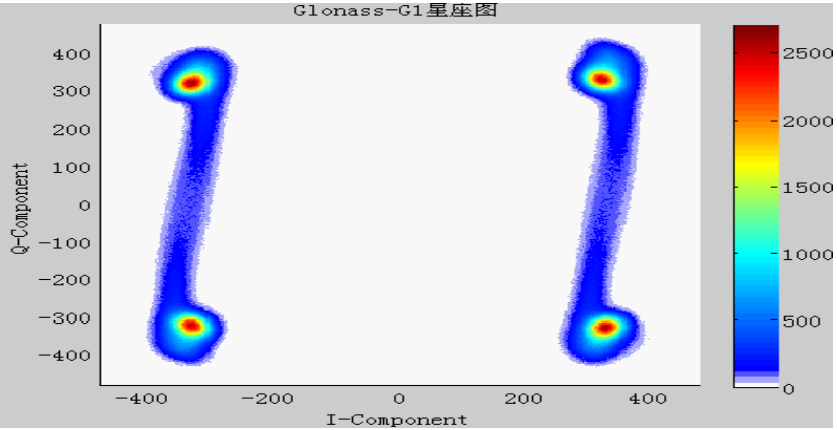

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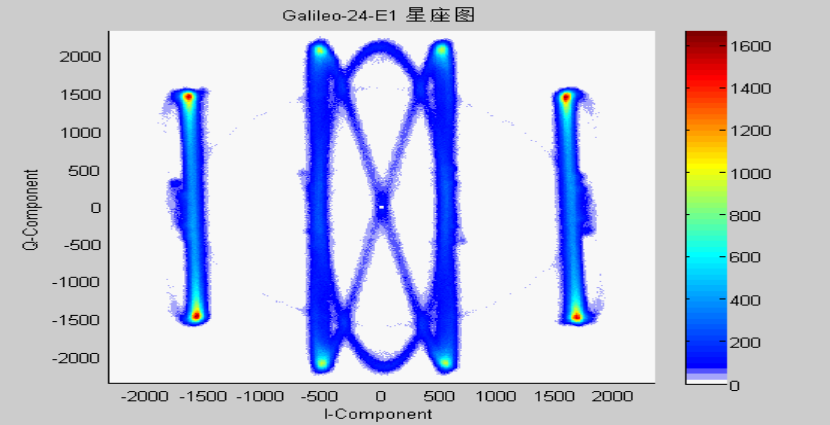
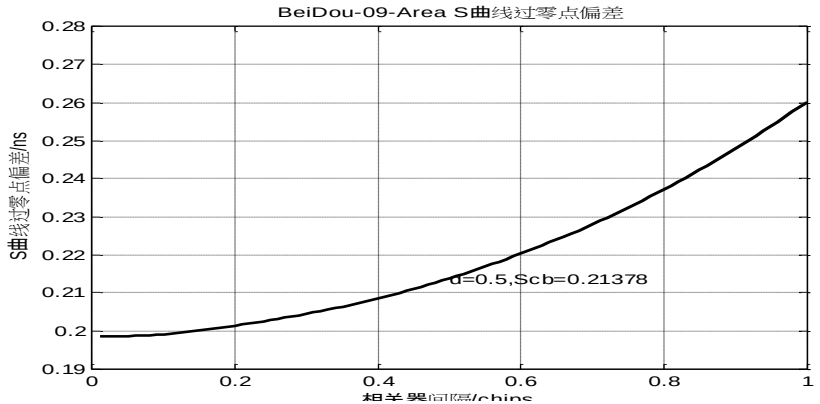


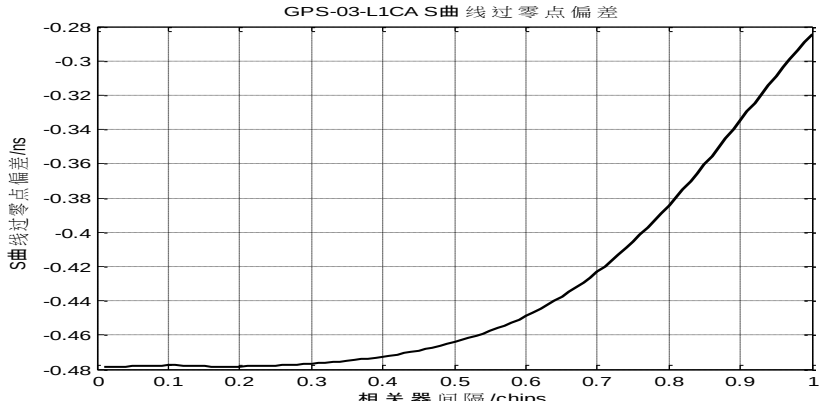
Galileo GSAT0206-E1(2016-06-24)

3.2 Navigation Signal Quality

(4)SCB profile



BDS IGSO4-B1(2016-06-24)



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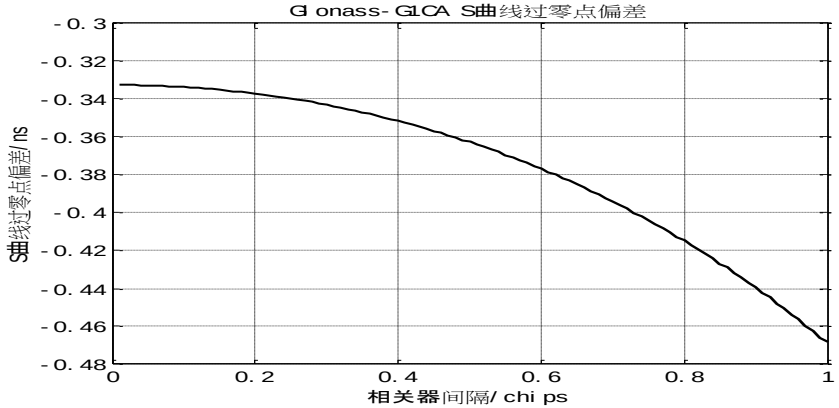

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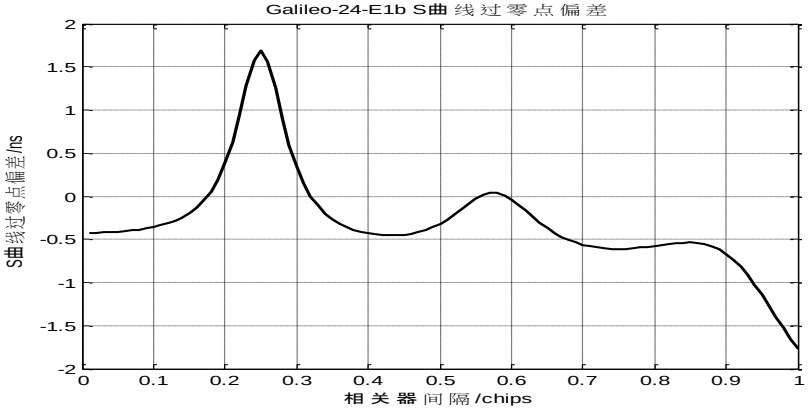
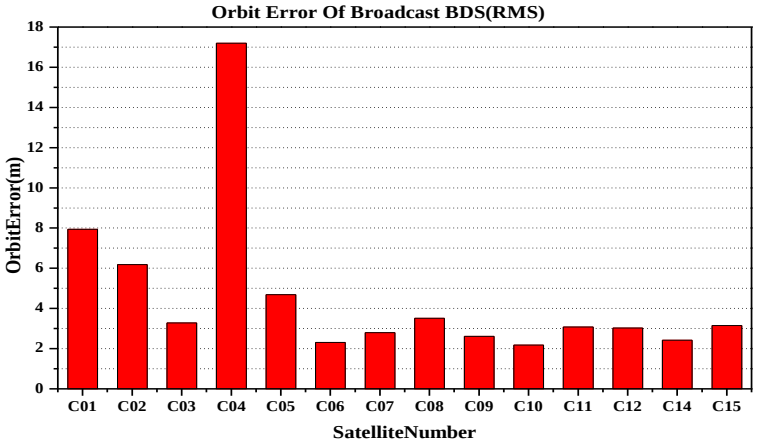


Galileo GSAT0209-E1(2016-06-23)

3.3 Navigation information Accuracy

(1)Accuracy of broadcast orbit



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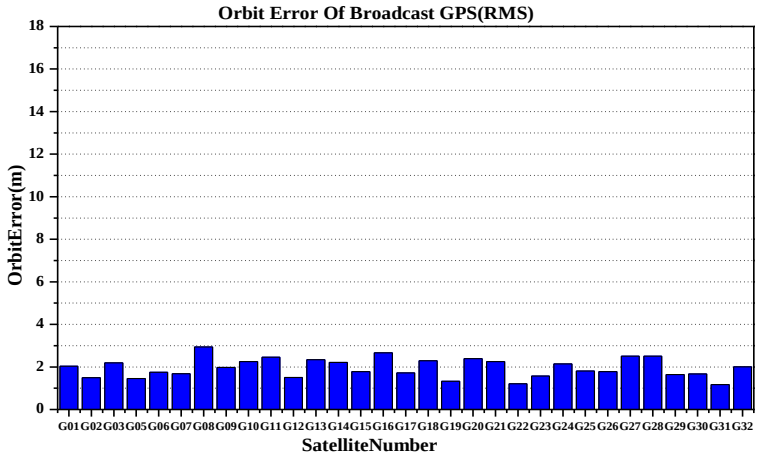
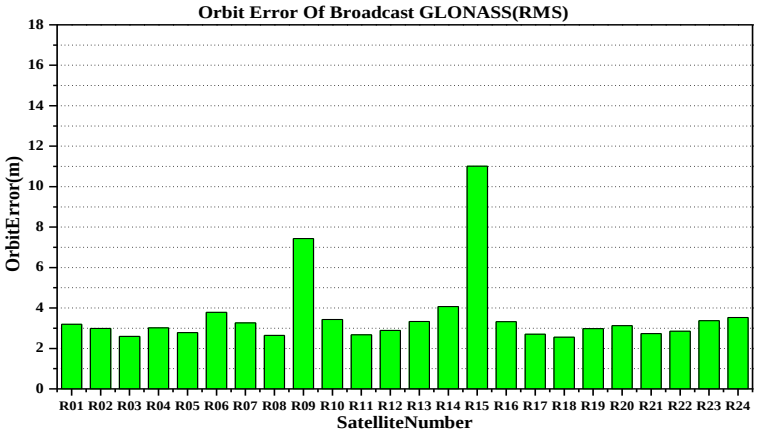
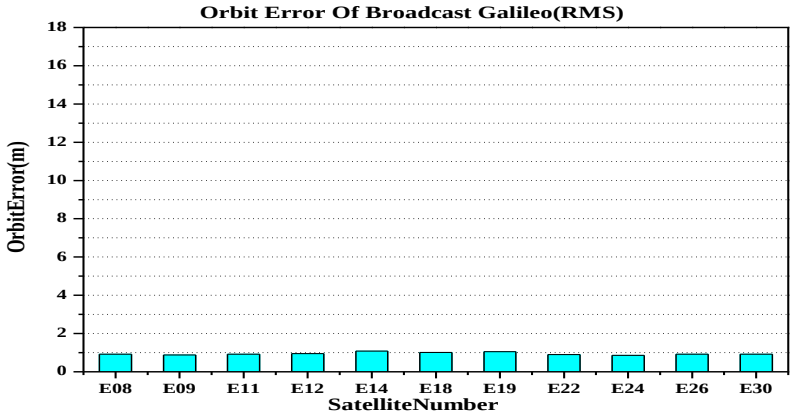


GPS



GLONASS

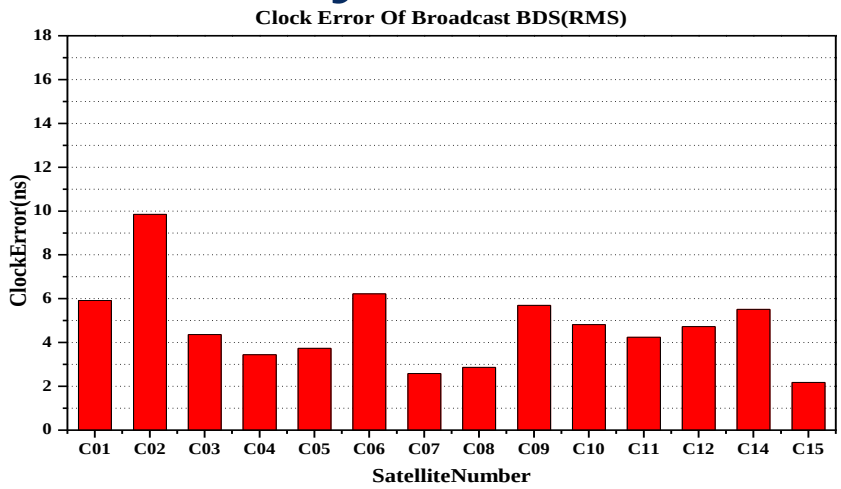


Galileo

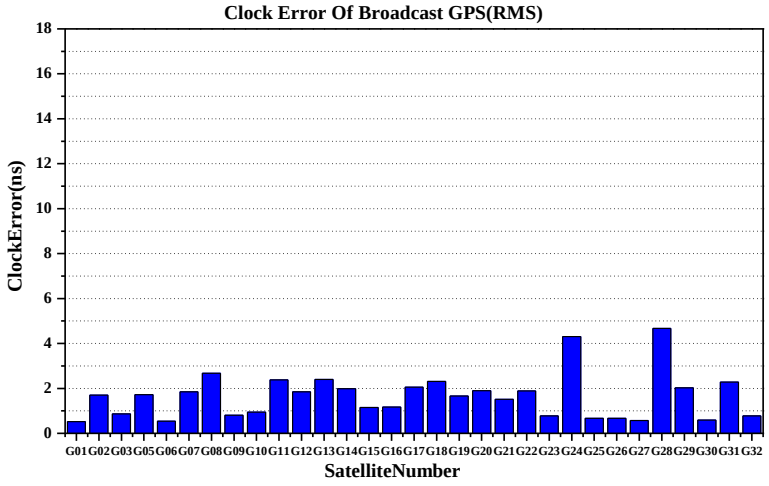
(2016 Jan – Sept)

3.3 Navigation information Accuracy

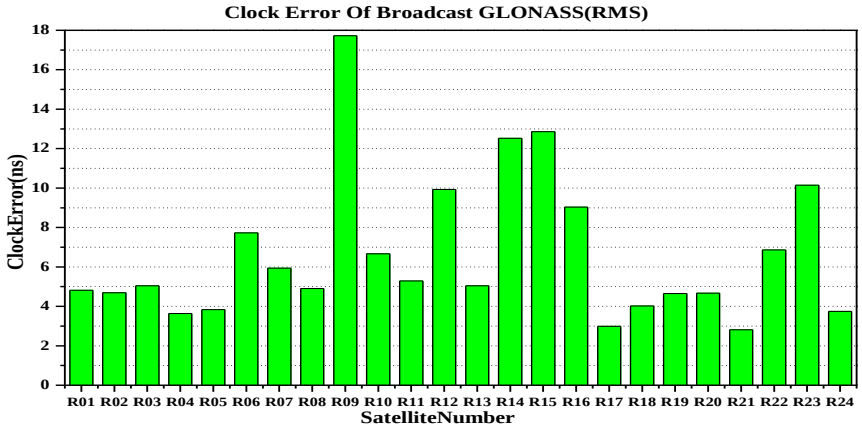
(2)Accuracy of broadcast clock



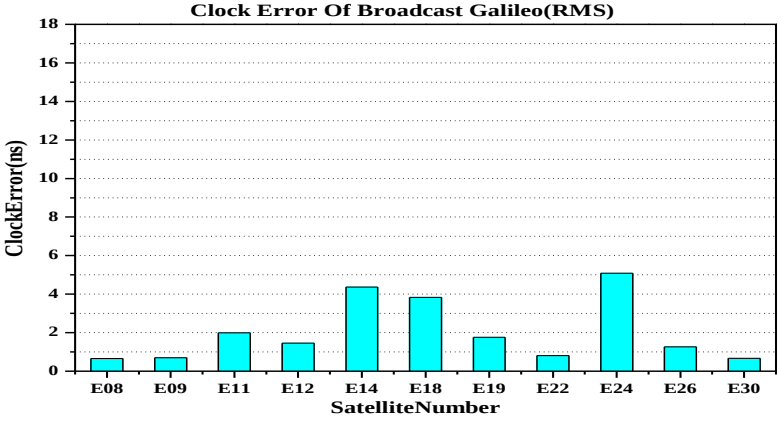
BDS



GPS



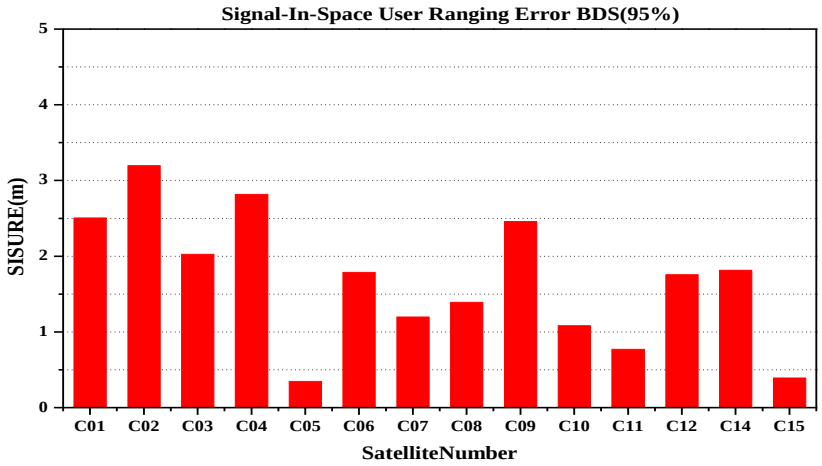
GLONASS



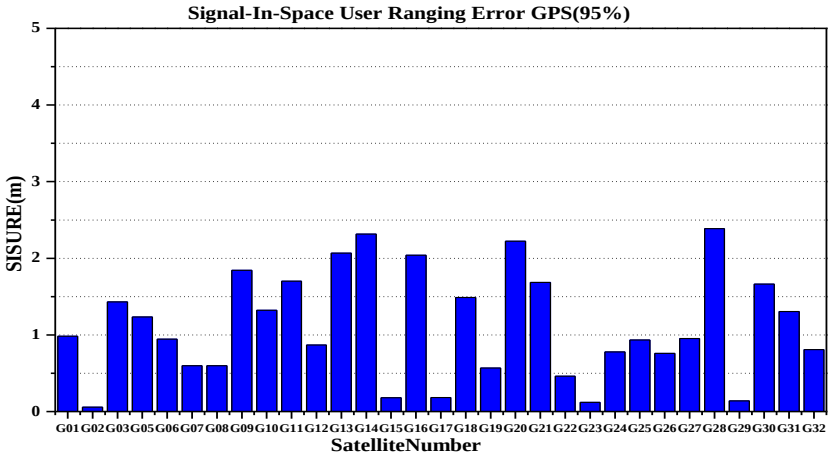
Galileo

3.3 Navigation information Accuracy

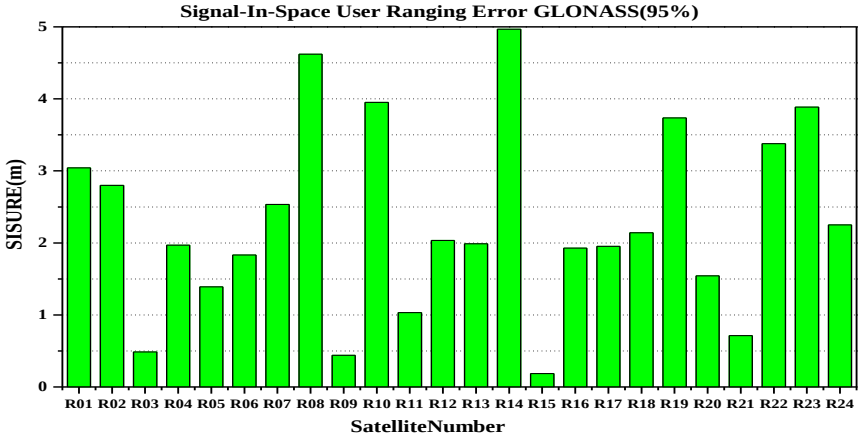
(3)User Range Error of Signal-in Space(SISURE)



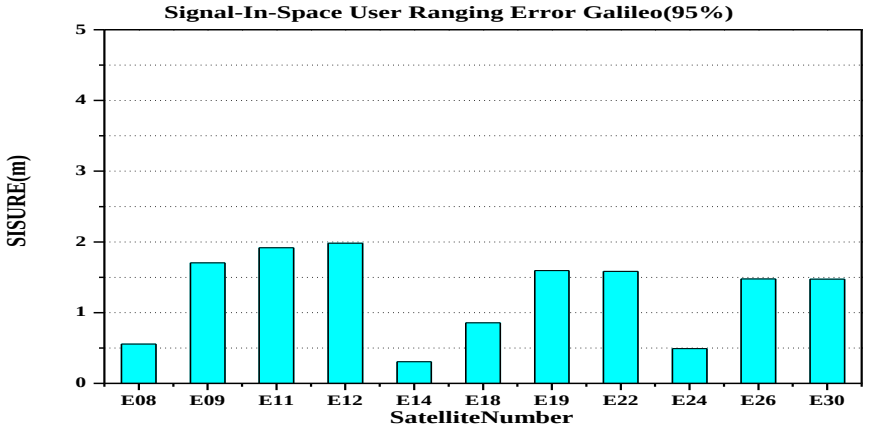
BDS



GPS



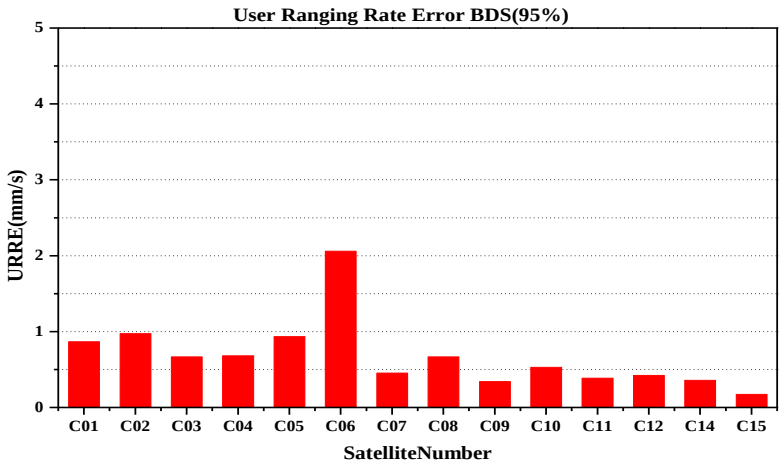
GLONASS



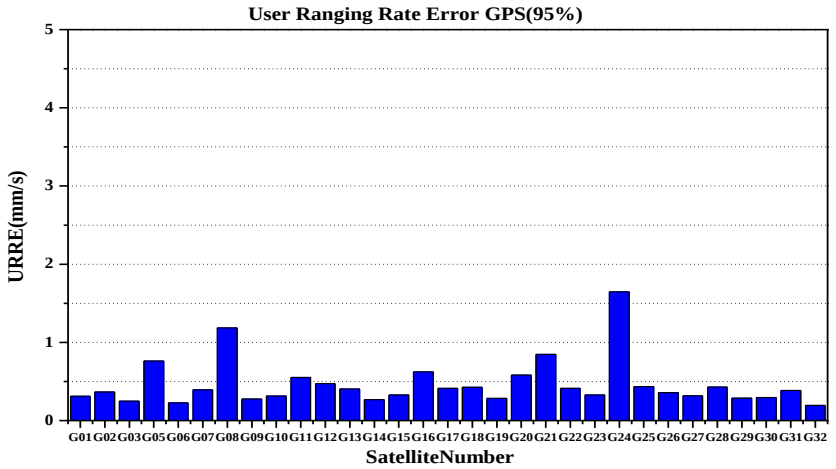
Galileo

3.3 Navigation information Accuracy

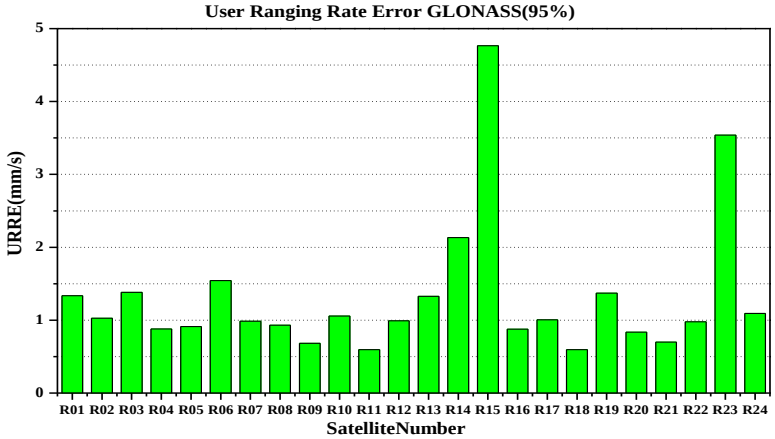
(4)User Range Rate Error of Signal-in Space(SISURRE)



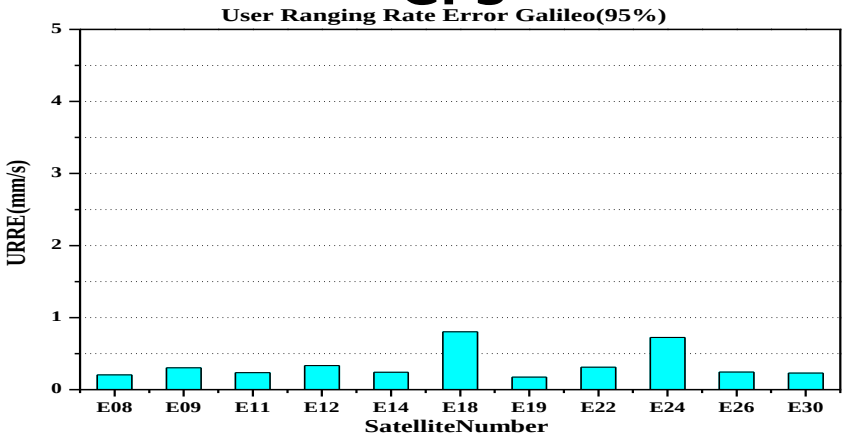
BDS



GPS



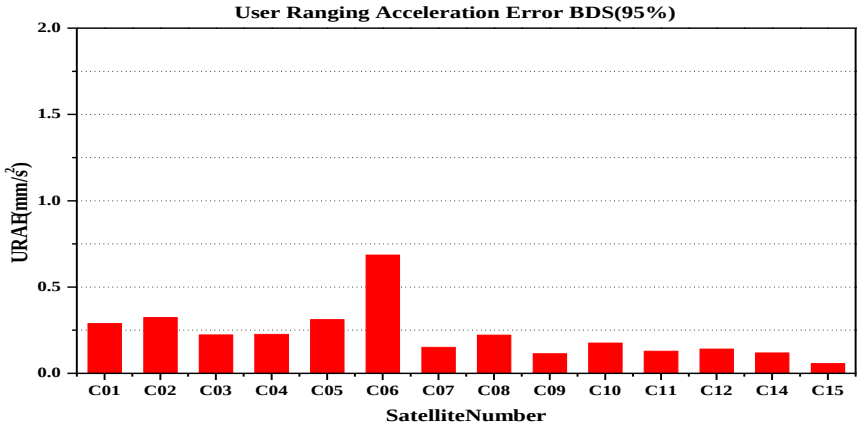
GLONASS



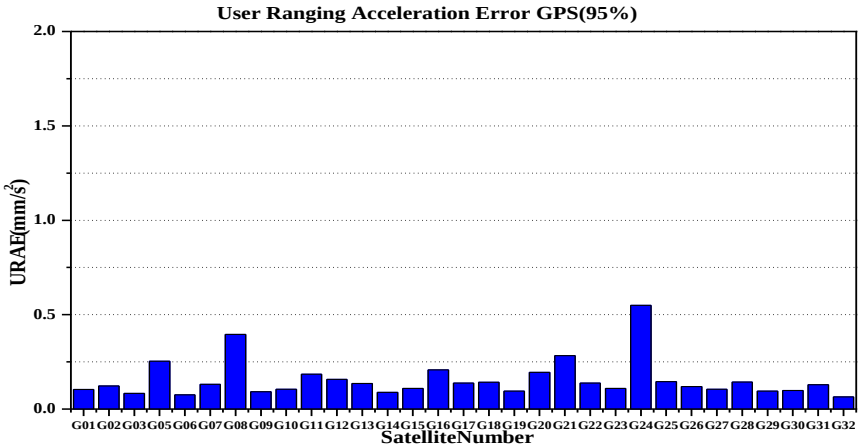
Galileo

3.3 Navigation information Accuracy

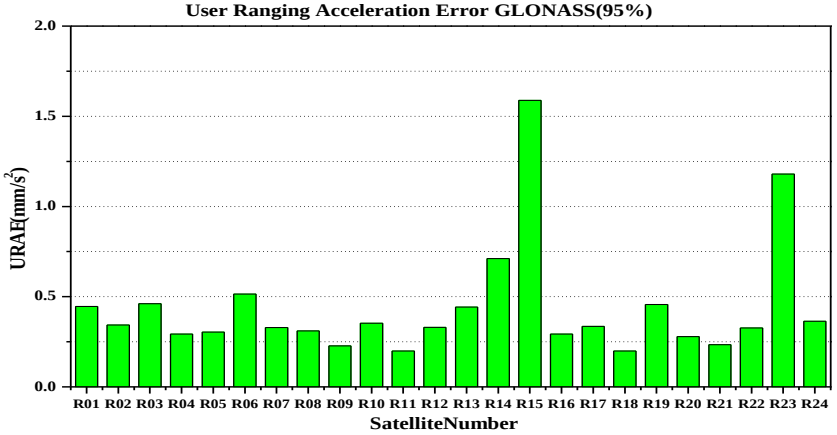
(5)User Range Accelaration Error of Signal-in Space(SISURAE)



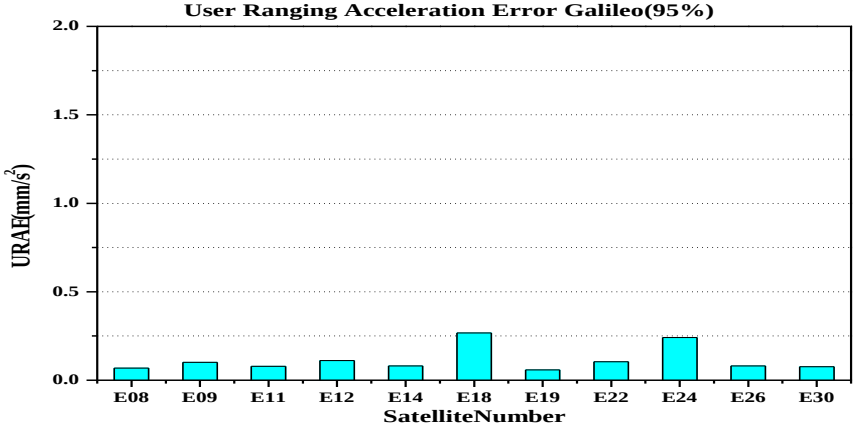
BDS



GPS



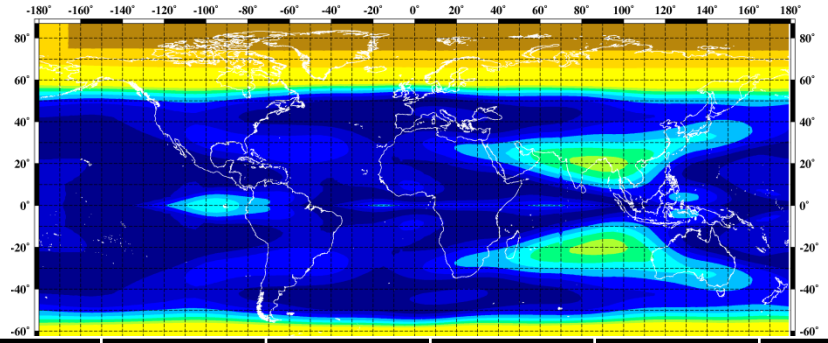
GLONASS

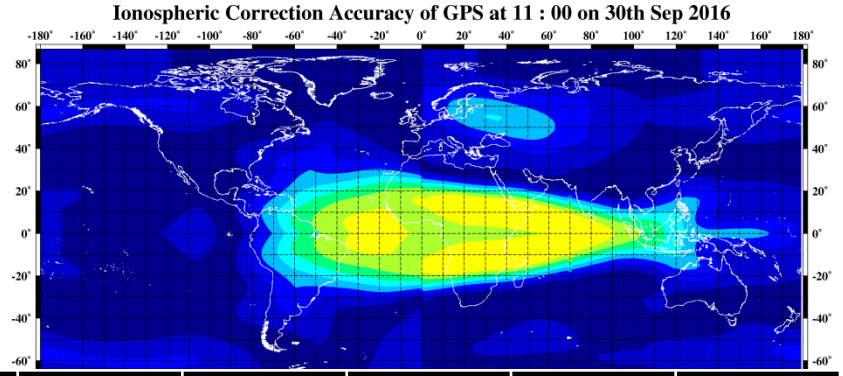


Galileo

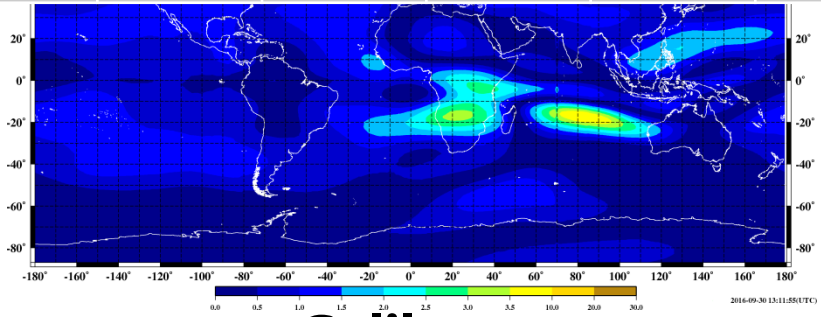
3.3 Navigation information Accuracy

(6) Error of Broadcast Ionospheric model





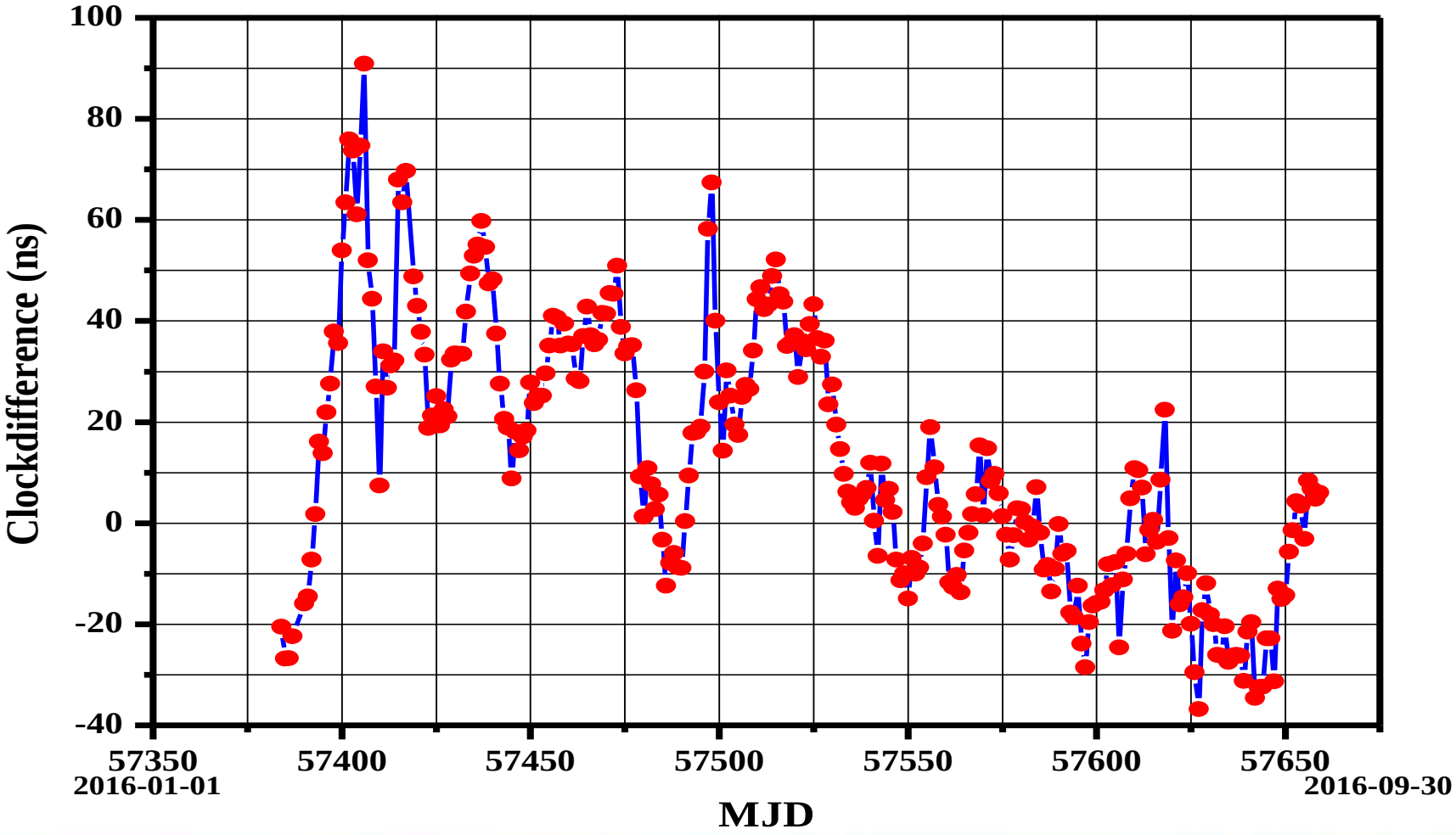
GNSS	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Mean
GPS	1.02	1.00	0.82	0.76	0.70	0.57	0.59	0.68	0.82	0.77
BDS	1.30	1.31	1.28	1.73	1.84	3.09	1.02	1.28	1.49	1.59
GLO	0.77	0.81	0.94	0.72	0.56	0.45	0.58	0.57	0.58	0.66



Galileo

3.3 Navigation information Accuracy

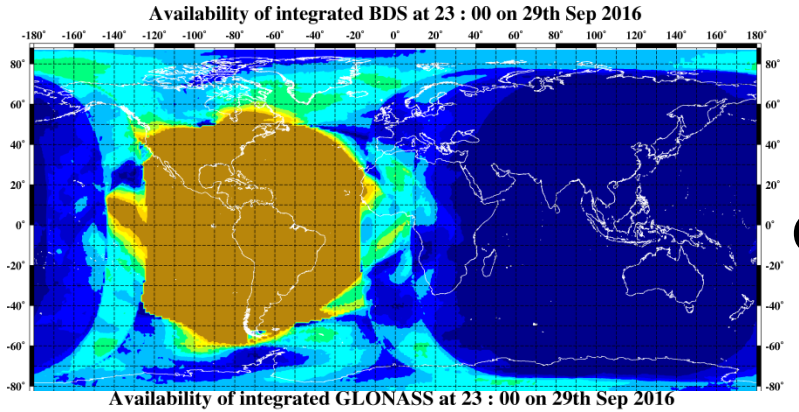
(7)UTC(NTSC)-BDT



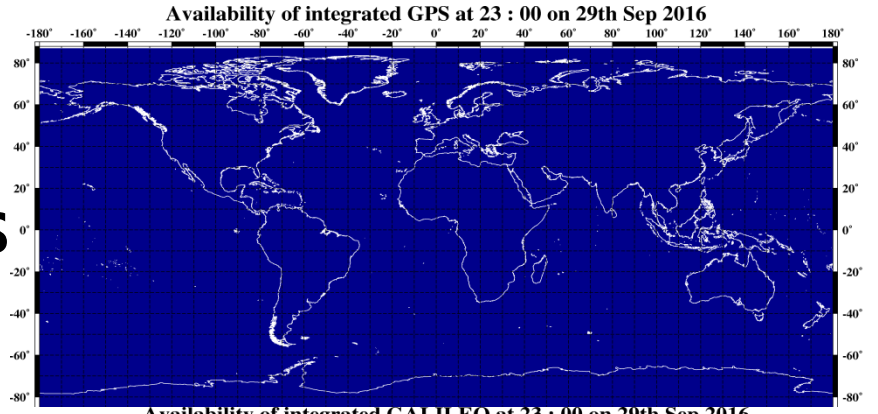
3.3 Navigation information Accuracy

(1)PDOP (≤6)

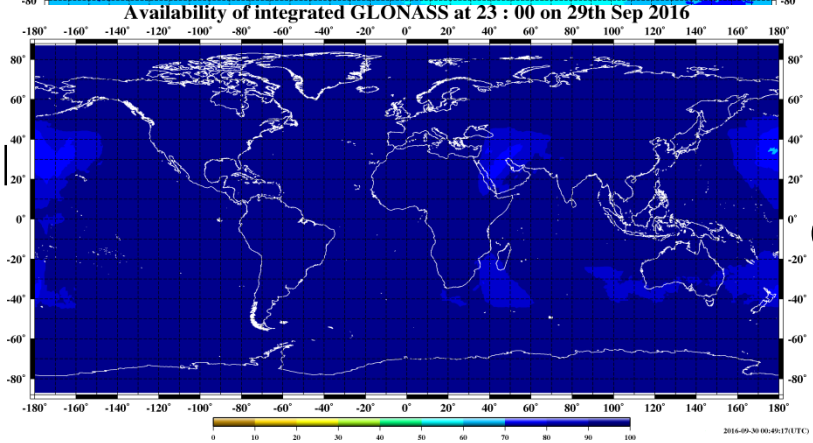
BDS



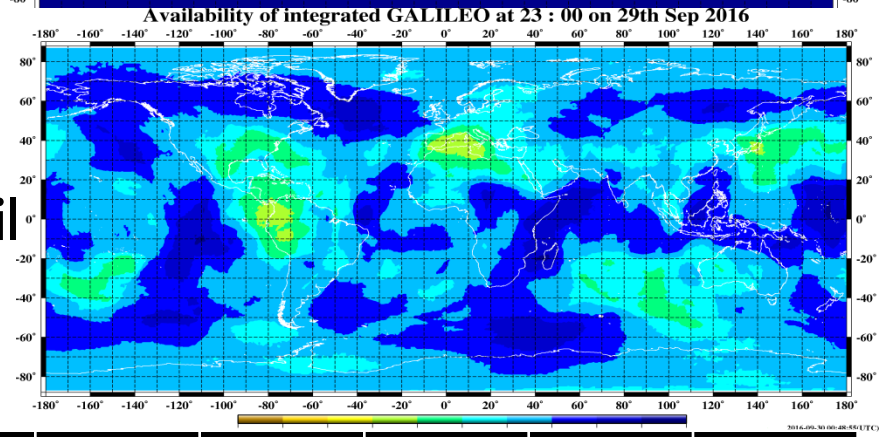
GPS



GLO



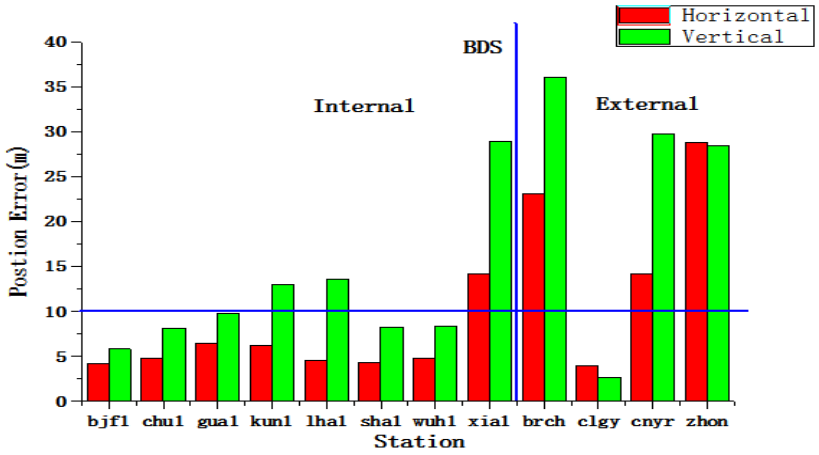
Galil



GNSS	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Mean
GPS	1.60	1.60	1.60	1.72	1.60	1.70	1.60	1.60	1.60	1.62
BDS	2.39	2.36	2.38	2.40	2.41	2.30	2.27	3.04	2.25	2.42
GLO	2.20	2.38	2.64	2.40	2.25	2.35	2.37	2.34	2.23	2.35

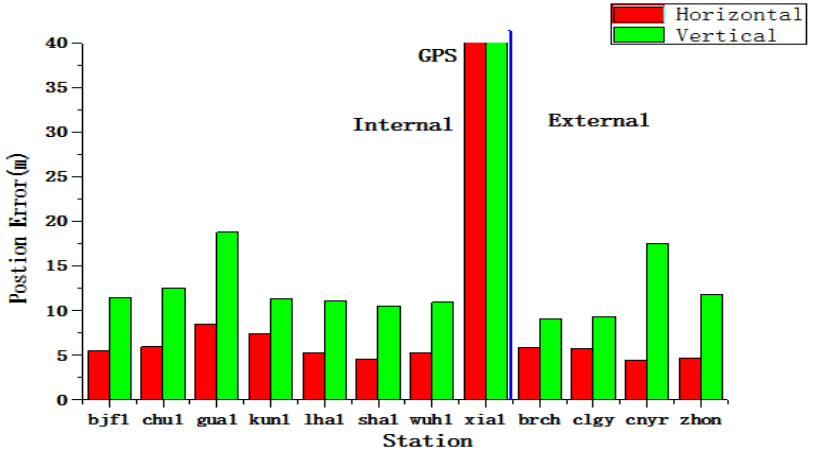
3.4 Service Performance

(2)Positioning Accuracy

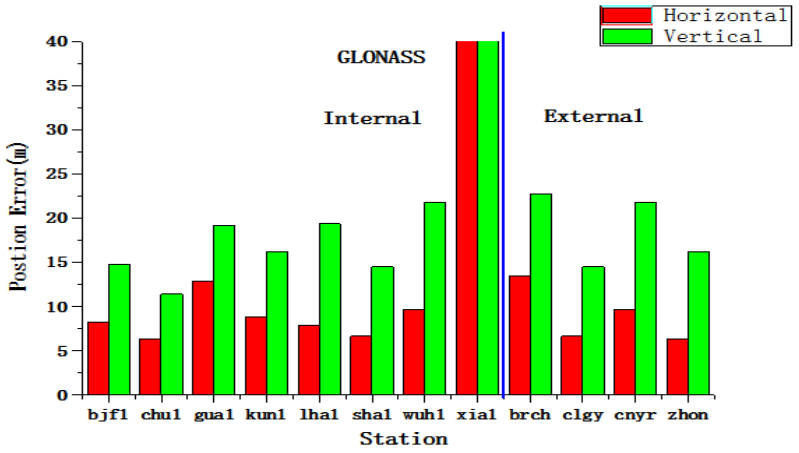


BDS

Station	BDS		GPS		GLONASS	
bjf1	4.21	5.81	5.49	11.46	8.21	14.76
chu1	4.82	8.14	5.96	12.5	6.35	11.4
gua1	6.43	9.78	8.46	18.77	12.85	19.21
kun1	6.19	12.97	7.42	11.31	8.8	16.23
lha1	4.51	13.59	5.3	11.06	7.85	19.33
sha1	4.33	8.25	4.58	10.52	6.65	14.5
wuh1	4.81	8.32	5.24	10.9	9.67	21.75
xia1	14.14	28.89	74.2	55.9	90.15	52.76
brch	23.06	36.01	5.83	9.03	13.44	22.7



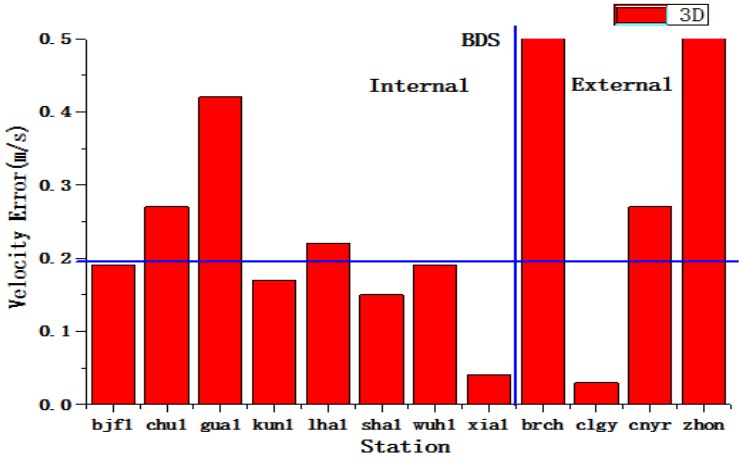
GPS



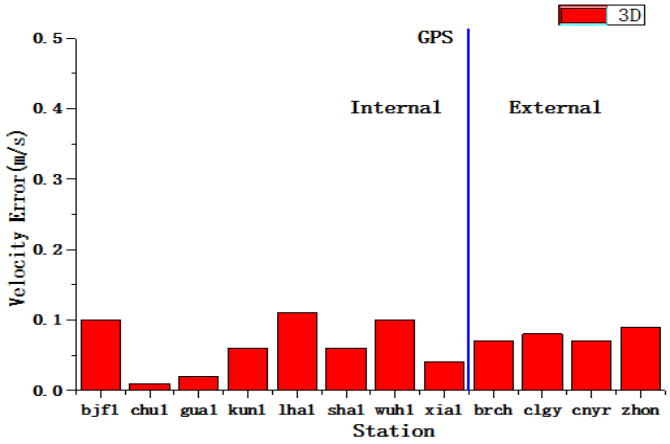
GLONASS

3.4 Service Performance

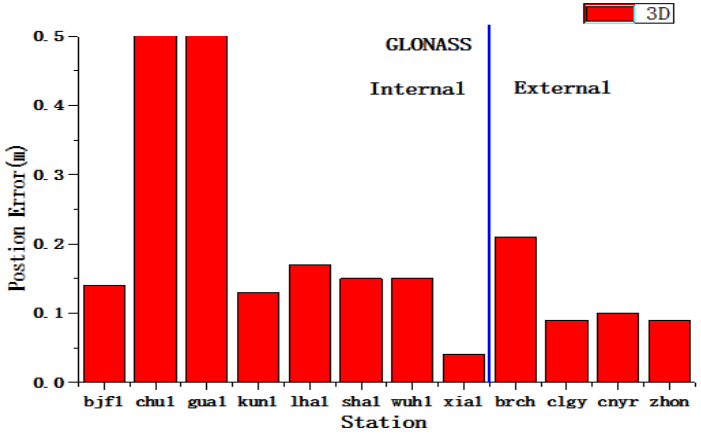
(3)Velocity Accuracy



BDS



GPS

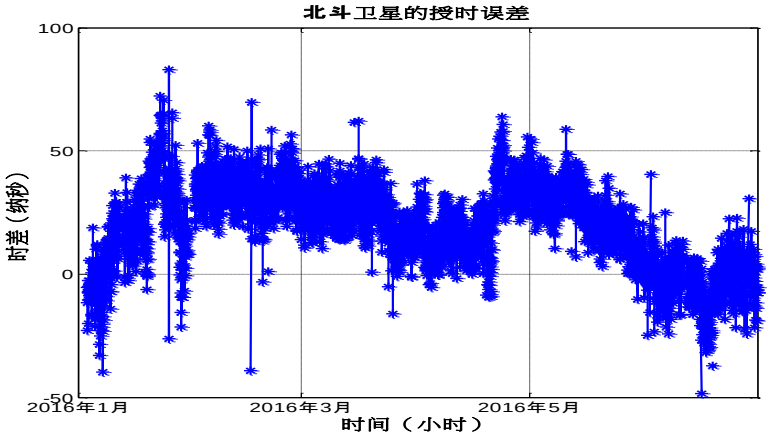


GLONASS

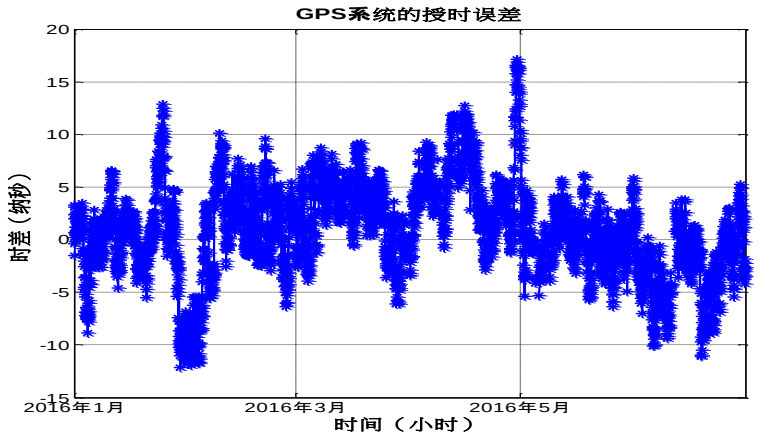
Station	BDS	GPS	GLONASS
bjf1	0.19	0.1	0.14
chu1	0.27	0.01	0.68
gua1	0.42	0.02	0.78
kun1	0.17	0.06	0.13
lha1	0.22	0.11	0.17
sha1	0.15	0.06	0.15
wuh1	0.19	0.1	0.15
xia1	0.04	0.04	0.04
brch	1.82	0.07	0.21
clgy	0.03	0.08	0.09
cnyr	0.27	0.07	0.1
zhon	1.46	0.09	0.09

3.4 Service Performance

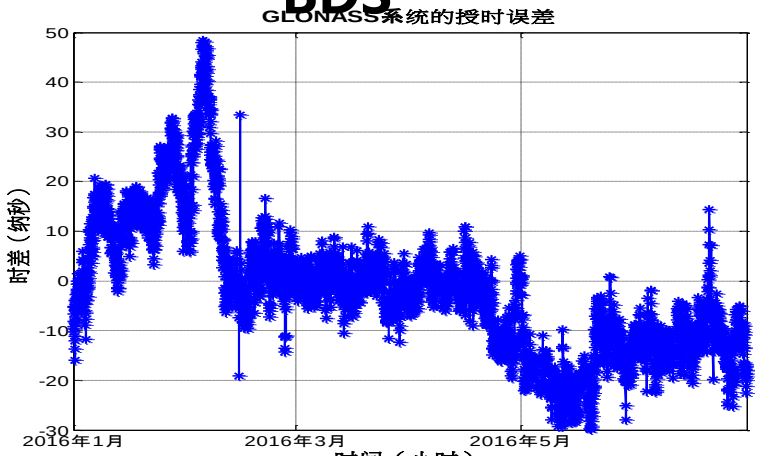
(4)Time Service Accuracy



BDS



GPS



GLONASS

GNSS	Jan	Feb	Mar	April	May	June
BDS	18.7	33.7	24.6	21.7	23.4	-3.0
GPS	-0.14	0.56	2.74	5.08	0.08	-2.8
GLO	12.3	9.6	-0.2	-3.2	-17.2	-11.8

3.5 Result Distribution

The GNSS monitoring and assessment results are distributed through the website and mobile terminals

- Website
- Mobile Terminal (APP)

3.5 APP

The APP of Mobile Terminal can publish the results of iGMAS Monitoring and Assessment, include four types: Constellation Status、Signal Quality 、 Signal Accuracy 、 Service Performance.

- Display in English and Chinese
- Facilitate users anytime and anywhere.

Contents

Summary

- It has been an international consensous to develop a GNSS monitoring and assessment system with resource sharing and open service.
- iGMAS is promoted smoothly and started service in July 2014.It has provided various observations, basic products, monitoring and assessment information.
- iGMAS was designed with an open architecture. Tracking stations and analysis centers worldwide are welcomed to take part in the system.
- Products from other systems or projects are also welcomed to be compared with these from iGMAS.

Thanks !

Welcome to the Website:
http://124.205.50.178/