Real-Time and Ionosphere in the IGS

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Content

- The IGS
- IGS Workshop 2014 in Pasadena, California
- IGS-RTS (Real Time Service)
- IGS ionosphere monitoring & Low Earth Orbiters (LEOs)
The IGS

The creation of the IGS was initiated in 1989 with I.I. Mueller, G. Mader, B. Melbourne, and Ruth Neilan as protagonists.

The IGS became an official IAG service in 1994.

The IGS first was a pure GPS Service, it was renamed as the International GNSS Service in 2004.

Today the IGS is a truly interdisciplinary, multi-GNSS service in support of Earth Sciences and Society.

Since its creation the IGS Central Bureau is located in the USA with Ruth Neilan as director – who stands for continuity and leadership.
In 1992 the IGS was based on about 20 geodetic receivers, 400+ receivers are active and their data retrievable today.
The IGS

In 1992 the IGS started off as an orbit determination service (dm accuracy) for about 15-20 GPS satellites.

Today, the IGS provides ephemerides (accurate to 2-4 cm) for 32 GPS satellites and for 24 GLONASS satellites (accurate to 5-8 cm), i.e., for all currently active GNSS satellites.

In addition, the IGS provides

- archive of all globally relevant GNSS observations since 1991
- satellite and receiver clock corrections (sub-ns accuracy)
- polar motion (PM) and length of day (lod) (cm accuracy)
- coordinates and velocities for 200+ sites (cm / mm/y accuracy)
- atmosphere information, in particular Global Ionosphere Models (GIMs).
- Satellite clock corrections & corresponding orbits are provided in „real time“ based on the IGS Real Time Network of 150+ sites.

All IGS products are accurate, reliable and robust, due to mutual validation and combination of agency-specific products, and they are available in a timely manner.
IGS Workshop 2014

http://kb.igs.org/hc/en-us/articles/204895687-2014-Workshop-Compendium

International Association of Geodesy

12-Jun-15 6
In summary the IGS is …

... the premier source of the highest-quality GNSS data, products, and related standards and conventions

... a scientific Service of the International Association of Geodesy (IAG) since 1994

... a federation of more than 200 institutions and organizations worldwide

... following an open data policy
IGS Real Time Service

International effort of many contributions:

Station operations, Data Centers, Analysis Centers, Combination Centers, Analysis Coordination, NTRIP caster operation, ...

International Association of Geodesy
Development from creation of the Real-time working group to the launch of the service in 2013 and to the performance in 2014/15. Chair Mark Caissy (NR Can), Co-Chair Loukis Agrotis, ESA/ESOC, protagonist Georg Weber (BKG).
IGS Real-time Tracking Network

150+ stations

International Association of Geodesy
IGS RTS Product Performance IGS03

Realtime-FPP Displacements for FFMJ5 using IGS03 - (C) BKG
Presently Combined Fren: CLK11 CLK31 CLK00

Height Displacements, RMS +/-0.073 m
East Displacements, RMS +/-0.068 m
North Displacements, RMS +/-0.035 m
Number of GPS+GLONASS Satellites

RMS
N +/- .04 (m)
E +/- .07 (m)
U +/- .07 (m)

# GPS & GLONASS sats
IGS RTS Users – currently > 500
IGS Ionosphere-related activities

The IGS operates the Ionosphere Working Group with Prof. Andrzej Krankowski from Poland as chair. It generates the IGS Global Ionosphere Maps (GIMs) with a … … temporal & spatial resolution of 2 hours x 5 deg x 2.5 deg (UT x long x lat).

It also generates TEC fluctuation maps, maps of Rate of TEC Index (ROTI) of the arctic region as a pilot project.

Both kinds of maps are based on the so-called single layer model, where it is assumed that all free electrons are contained in a layer of infinitesimal thickness at height H=450km.

Hundreds of IGS stations are contributing to the maps.
IGS Ionosphere-related activities

Mean daily ionosphere content since 1995 (left), associated spectrum (right) from CODE spherical harmonics model.
Main spectral lines (right): @ 27 days (rot of Sun), @ 365.25/i, i=1,2,3, ..., from orbital motion of Earth and Earth orientation in space (seasons).
IGS Ionosphere-related activities

Day-averaged GIM of New Year’s Eve 2015
From CODE’s 25 GIMs based on a spherical harmonics development up to degree and order 15.

Coordinate system: geomagnetic / equatorial, co-rotating with Sun.

Units: TECU, $1 \text{ TECU} = 1 \times 10^{16} \text{ e}^{-/m^2}$. 
IGS Ionosphere-related activities

Fig. 3 The example of ROTI map for the geomagnetic quiet day.

Fig. 4 The example of ROTI map for the geomagnetic disturbed day.

Rate of TEC in TECU/min due to scintillation on a calm (left) and “not so calm” day.
from Krankowski et al. (2013) “IGS Ionosphere Working Group Report, December 2013”.

International Association of Geodesy
IGS Ionosphere-related activities

Low Earth Orbiters (LEOs) scan “in essence” a meridian of the Earth in about 90 minutes.

By combining data from several months, one obtains fantastic complementary information to the IGS GIMs concerning the Earth’s ionosphere – also of scintillation effects.

Ionosphere gradients derived from GRACE-A in first half of 2014. (TECUs/30s)
Combine IGS and LEO-derived GIMs

Ionosphere gradient from 2h-GIMs (red) and from GRACE geometry-free LC (plain difference of L1 and L2 phases in m).

→ GIMs are very useful for LEO data analysis
→ LEOs could/should contribute to IGS GIMs

LEOs scan one complete Earth meridian in 90 minutes at different altitudes!

From GRACE RINEX File of Day 100 of year 2014