

The IGS, the IAG, and the ICG

G. Beutler

*Astronomical Institute, University of Bern
IAG representative on PNT Advisory Board*

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**University Corporation for Atmospheric Research
(UCAR)**

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3080 Center Green Drive
Boulder, Colorado 80301**

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Content

- **The IAG, the IGS, the GGOS, the GIAC, and the ICG**
- **The UN GGRF Working Group and the UN resolution on reference frames, February 26, 2015.**
- **IGS: History and present**
- **Perspectives on science with GNSS**
 - **today**
 - **future**

IAG, IGS, GGOS, GIAC and ICG

IAG, the **International Association of Geodesy** is a scientific organization in the field of geodesy promoting scientific cooperation and research [...] on a global scale [...].

IGS, the **International GNSS Service**, is a scientific service of the IAG, enabling high-accuracy applications, including scientific applications.

GGOS, IAG's **Global Geodetic Observing System**, working with the other IAG components to provide the geodetic infrastructure necessary for monitoring the Earth system and for global change research.

GIAC is the GGOS Inter-Agency Committee (GIAC).

IERS is the **International Earth Rotation and Reference System Service** (of IUGG and IAU) using the IGS products to generate technique-overarching geodetic & astronomical products.

The IGS is an associate member of the **ICG**, the **International Committee on Global Navigation Satellite Systems**.

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UN-GGRF & resolution of reference frames

UN-GGRF (UN-Global Geodetic Reference Frames) is a working group of the UN Committee of Experts on Global Geospatial Information Management (UN GGIM).

Its members are to a large extent members of the aforementioned IAG entities.

On February 26, 2015, **the first UN resolution about global geodetic reference frames** was adopted.

→ The resolution is an **outstanding example** of the **science-driven community and decision makers from politics**, in particular of the **UN working together** to the benefit of society.

The IGS: history

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.**

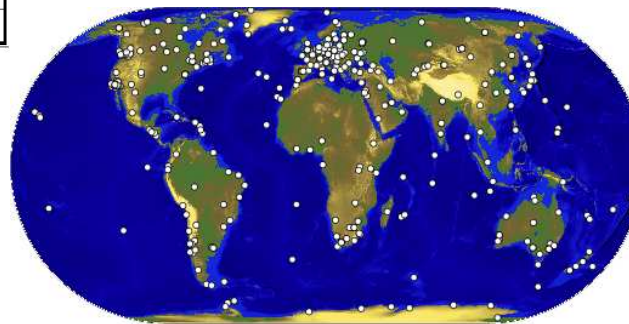
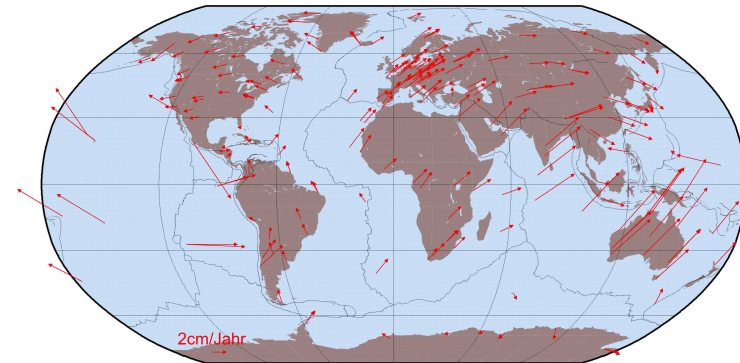
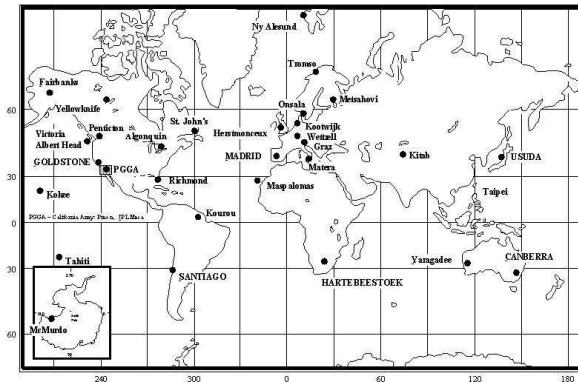
Since its creation the **IGS Central Bureau** is located in the USA with **Ruth Neilan** as director – who stands for **continuity and leadership.**

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The IGS: development

Station Locations for the IGS Pilot Campaign, 1992



IGS Network in 2015

In 1992 the IGS network consisted of about 20 geodetic receivers, 400+ receivers are active and their data retrievable today.

Monitor station positions & motion in „real time“ → contribution to ITRF

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The IGS: current achievements

The IGS provides **ephemerides** (accurate to 2-4 cm) for **~32 GPS satellites** and for **~ 24 GLONASS satellites** (accurate to 5-8 cm), and other GNSS being deployed,

In addition, the IGS archives

- archives of all globally relevant GNSS observations since 1991, generates and provides
 - 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.

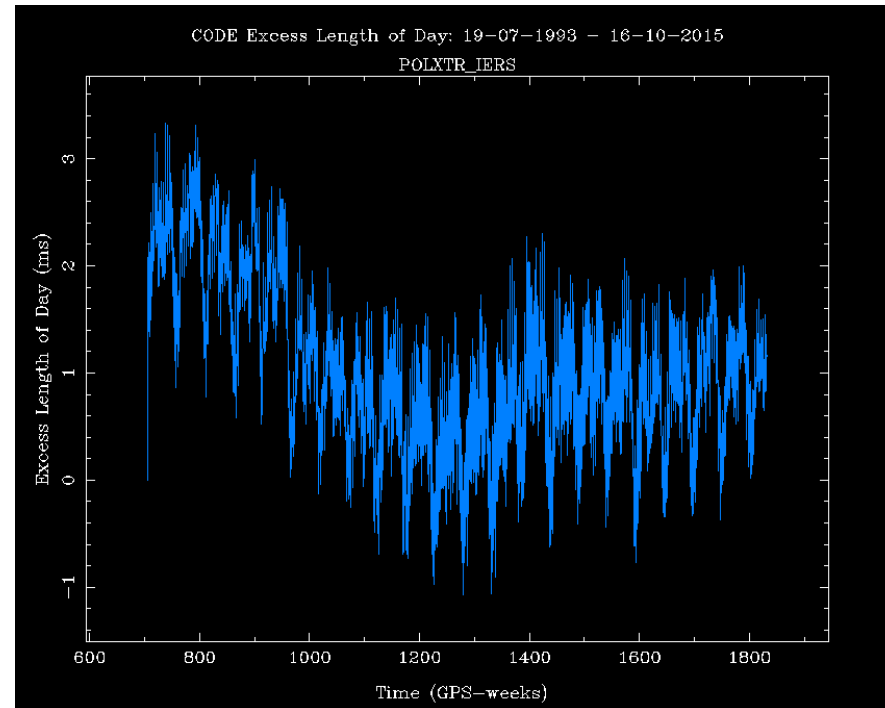
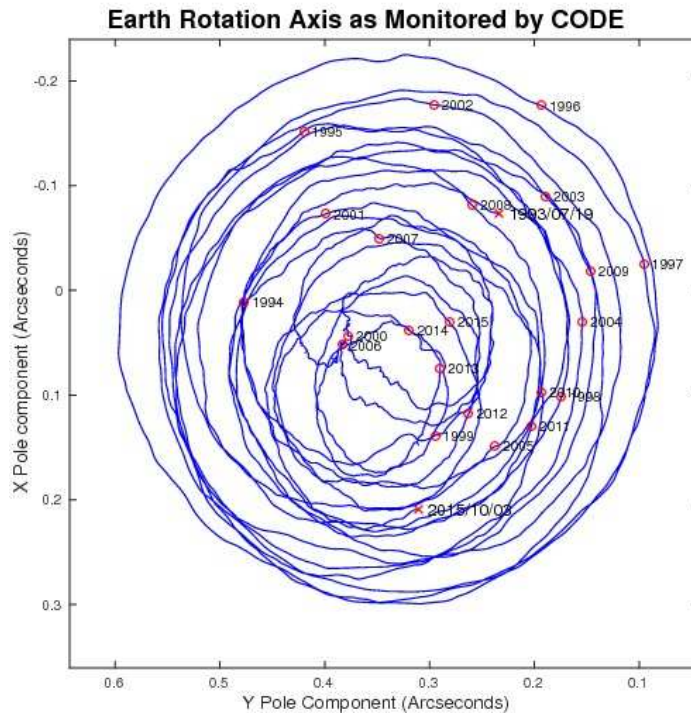
IGS products are **accurate, reliable** and **validated**.

- **Combined products** are formed by **Coordinators** and made publicly available in a **timely** manner.

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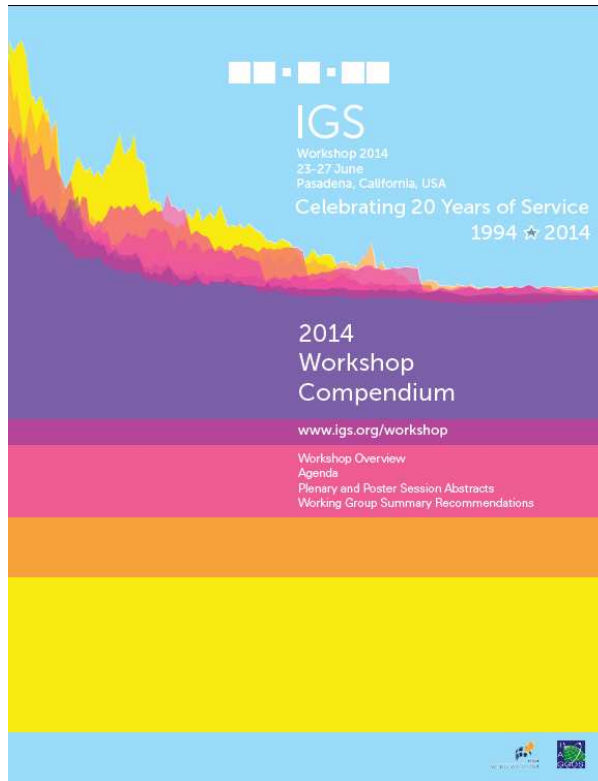
IGS products: Earth Rotation



Left: Polar motion since 1993, Right: Excess Length of Day since 1993. Time resolution of IGS time series: 1 day. “millimetric” accuracy on Earth’s surface

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IGS Workshop 2014: 20th Anniversary



<http://kb.igs.org/hc/en-us/articles/20481>

Compendium. The IGS is regularly questioning and improving its performance and products.

Message from the Director of the IGS Central Bureau

Dear Workshop Attendee,

Thank you for participating in the IGS Workshop 2014, held on the campus of the California Institute of Technology (Caltech) in Pasadena, California, USA. This special twentieth anniversary workshop was hosted by the IGS Central Bureau, with support from the NASA Jet Propulsion Laboratory (JPL) and Caltech.

The week-long workshop featured plenary presentations and posters presented by our colleagues from around the world – illustrating how the IGS is truly an international organization serving science, engineering, and society in general.

The local organizing committee was led by Ruth Neilan (JPL) and Steve Fisher (JPL), with support from members of the IGS Central Bureau. The scientific program committee was led by Rolf Dach (AIUB), Shailen Desai (JPL), and Andrzej Krankowski (UWM).

In addition to plenary and poster presentations, we were able to celebrate twenty years of service with a special Anniversary Colloquium. This event featured many of our colleagues reflecting on various points in IGS history, as well as their own thoughts on the future of the IGS and geodesy.

All plenary session presentations were videorecorded, and are available to view on the "Presents" section of the IGS website: www.igs.org/presents. All presentations and posters are available in PDF format for download from the IGS website, as well.

Thank you for attending, and we look forward to seeing you again in 2016!

Ruth Neilan
IGS Central Bureau Director
Head of the Local Organizing Committee

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Today's perspective: the IGS is ...

- ... the **premier source** of the highest-quality GNSS data, products, and related standards and conventions
- ... a **federation** of more than 200 institutions and organizations worldwide **without central funding**
- ... following an open **data policy**
- ... generating the time series, which are then used
 - ... by the **International Terrestrial Reference Frame (IERS)**, to generate, together with the products of the other IAG Services,
 - The **International Terrestrial Reference Frame (ITRF)**
 - The **IERS series of Earth Rotation Parameters**, in the particular polar motion coordinates x and y , and Length of Day (LOD)
 - ... to derive GNSS-derived **Global Ionosphere Models (GIMs)** and models of the ionosphere's stochastic properties.

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Future in GNSS: the science perspective

Until about 2007/08 GNSS was synonymous to GPS + minor contributions from other systems.

Today, we have two fully operational systems, namely GPS and GLONASS, which are both capable of generating geodetic products.

A combined analysis results in better products for science and for the wider user community.

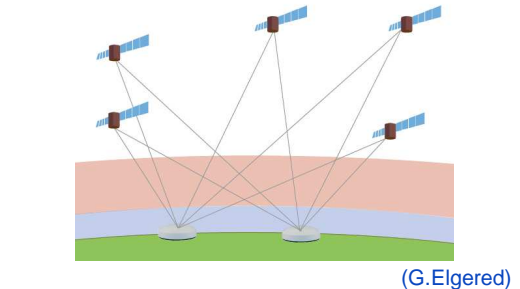
>2018 there will be 3+ fully operational systems.

The future has already begun in the IGS with the **MGEX (Multi-GNSS Experiment)**

MGEX: Why Multi-GNSS?

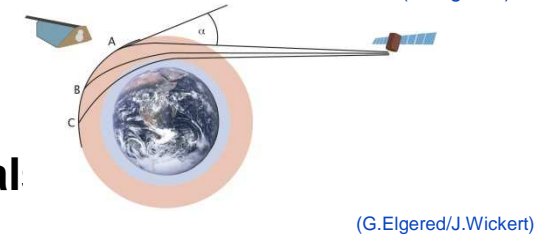
More Satellites

- Improved PPP convergence
- More pierce points for atmospheric sounding
- Decorrelation of height, clock, troposphere



Improved Signals

- Less multipath
- Increased robustness (scintillation, weak signal)



Stable clocks

- Improved Real-time PPP
- Orbit improvement / prediction









Diversity

- Different orbital periods and commensurabilities
- Decorrelation of estimated parameters (orbits, Earth rotation)



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MGEX: Today's „System of Systems”

System		Blocks	Signals	Sats ^{*)}
GPS		IIA	L1 C/A, L1/L2 P(Y)	3
		IIR	L1 C/A, L1/L2 P(Y)	12
		IIR-M	+L2C	7
		IIF	+L5	9
GLONASS		M	L1/L2 C/A+P	23
		M+	L1/L2 C/A+P, L3 (CDMA)	1
		K1	L1/L2 C/A+P, L3 (CDMA)	(2)
BeiDou		GEO	B1, B2, B3	5
		IGSO	B1, B2, B3	5
		MEO	B1, B2, B3	3
		3 rd generation	(B1,B3)	(1)
Galileo		IOV	E1, (E6), E5a/b/ab	3+(1)
		FOC	E1, (E6), E5a/b/ab	(2)+(2)
QZSS		IGSO	L1 C/A, L1C, SAIF L2C, E6 LEX, L5	1
IRNSS		IGSO	L5, S	4

*) Status June 2015; brackets indicate satellites not declared healthy/operational

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IGS-MGEX Products

Post-processed

Precise orbits and clocks

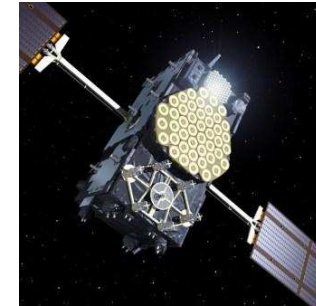
Broadcast ephemerides

Differential code biases

Real-time

Broadcast ephemerides

Orbit and clock corrections (Galileo)



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Desparately needed ...

The IGS is only capable of generating integrated and highest quality GNSS products, **provided the information on**

- satellite properties,
- Attitude maintenance,
- Individual GNSS reference frames
- Satellite clocks

is available from system providers.

ICG is the ideal platform to make this information available.

- The **ICG needs the IGS** to play its coordinating role.
- The **IGS needs ICG** recognition for the continuation of its work.

Acknowledgement

The slides on MGEX stem from Oliver Montenbruck's presentation on the occasion of the 15th PNT Advisory Board Meeting





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28-Oct-15

17



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Panel of Experts, ICG-10

November 2, 2015

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