The International GNSS Service
A Component of the
Global Geodetic Observing System

Ruth E. Neilan

www.igs.org

United Nations International Meeting on the Applications of Global Navigation Satellite Systems

Vienna, 12 December 2011
Overview

- IGS Overview
- Global Geodetic Observing System (GGOS)
- IGS M-GEX
- IGS Real–Time
- IGS and ICG Activities

NEWS: GGOS unanimously accepted November 8 as member of Committee on Earth Observation Satellites (CEOS)!
IAG, GGOS & IGS

- The International Association of Geodesy (IAG) represents the geosciences associated with the geometric & gravimetric aspects of the dynamic Earth.
- IAG is part of International Union of Geodesy and Geophysics (IUGG) & International Council for Science (ICSU). IAG is the oldest of the international scientific associations... 150yrs old in 2012.
- IAG’s Global Geodetic Observing System (GGOS) integrates all IAG Services... to coordinate geodetic measurements, analysis and product generation to support science and society.
- The IGS coordinates GNSS tracking, data analysis and product generation to support GGOS and other users
- Key to the IGS approach: sharing investments and operational costs by pooling the resources of many (> 200) organisations in over 90 countries to maintain an independent ground tracking network and generate high accuracy products ... voluntary federation, reliability through redundancy, data & products openly available to all users.

IGS contributes the GNSS global contribution to the International Terrestrial Reference Frame (ITRF) where all regional reference frames are connected
IGS Mission

“The International GNSS Service provides the highest-quality GNSS data, products, and services in support of the Earth observations and research, positioning, navigation and timing, the terrestrial reference frame, Earth rotation, and other applications that benefit society.”

IGS is a key component of the Global Geodetic Observing System - GGOS
Potential of GPS for Geodesy, Surveying and Geodynamics was recognized in the late 1980’s.

Renamed “International GNSS Service” in March 2005: GPS + GLONASS

Products:
- Precise Orbits
- Clock corrections & timescale
- Station positions and velocities "$\rightarrow$ITRF"
- Troposphere parameters
- Ionosphere maps
- Earth orientation parameters

GPS and GLONASS tracking & products.
Central Bureau
Executive Management
Network Coordination
Information Portal

External Interfaces
- IAG/GGOS
- IERS
- BIPM
- ICSU/WDS
- UNOOSA/ICG

Product Coordinators
- Reference Frame
- Clock Products

Analysis Coordinator

Central Bureau
Executive Management
Network Coordination
Information Portal

Analysis Centers
- Global Network ACs
- Regional Network AACs
- Other AACs (Ionosphere, Real-Time)

Data Centers
- Global Data Centers
- Regional Data Centers
- Operational Data Centers
- Project Data Centers

Support Organizations
- IGS Institute
- UNAVCO

Governing Board
Oversight

Committees of the GB
- Executive Committee
- Strategic Planning Committee
- Elections Committees
- Infrastructure Committee
- Associate Member Committee

Pilot Projects and Working Groups
- Antenna WG
- Bias & Calibration WG
- Clock Product WG
- Data Centers WG
- GNSS WG
- Ionosphere WG
- Real-time WG & PP
- Reference Frame WG
- Space Vehicle Orbit Dynamics WG
- Troposphere WG
- Tide Gauge PP

IGS Associate Members

Committees of the GB

Support Organizations

IGS Associate Members

External Interfaces

Product Coordinators

Analysis Coordinator

Central Bureau
Executive Management
Network Coordination
Information Portal

Analysis Centers

Data Centers

Support Organizations

IGS Institute
UNAVCO

Pilot Projects and Working Groups

Antenna WG
Bias & Calibration WG
Clock Product WG
Data Centers WG
GNSS WG
Ionosphere WG
Real-time WG & PP
Reference Frame WG
Space Vehicle Orbit Dynamics WG
Troposphere WG
Tide Gauge PP

International Association for Geodesy/Global Geodetic Observing System (IAG/GGOS)
International Earth Rotation and Reference System Service (IERS)
Bureau International des Poids et Mesures (BIPM)
International Council for Science/World Data Systems (ICS/WDS)
United Nations Office for Outer Space Affairs/International Committee on GNSS (UNOOSA/ICG)
Analysis Center (AC)
Associate Analysis Center (AAC)
IGS Tracking Network

- Over 380 active global tracking stations

http://igs.org
IGS Multi-GNSS Network: GLONASS + GPS
Why GGOS?
Processes: Millions of Years ↔ Fractions of Seconds
Challenges for Planet Earth Monitoring

- **Reliable detection of small, long-term trends**: long time series from reprocessing of ground / satellite data
  - **Sea Level**: Altimetry
  - **Water Cycle**: GRACE
  - **Earthquake**: GPS, Seismology
  - **Water Vapor**: GPS / VLBI

- **Fast event detection and quantification**: Real-time processing for early warning systems (tsunami, slides, earthquakes, ...)
  - **Earthquake**: GPS, Seismology

- **Integration and Separation**: Sensor combinations; separation of signals with complementary data
  - **Water Cycle**: GRACE

- **Information exploitation**: portals, up-to-date methods of visualization, information/knowledge management
  - **Water Vapor**: GPS / VLBI
GGOS: Monitoring and Modelling the Earth’s System

Reference frames: highest accuracy and long-term stability

Space Techniques
- VLBI
- SLR/LLR
- GNSS
- DORIS
- Altimetry
- InSAR
- Gravity/Magnet. Missions

Terrestrial Techniques
- Levelling
- Gravimetry
- Tide Gauges
- Gyros

Geometry
- Station Position/Motion,
- Sea Level Change,
- Deformation

Earth Rotation
- Precession/Nutation,
- Polar Motion,
- UT1, LOD

Gravity
- Geocenter
- Gravity Field,
- Temporal Variations

Earth System
- Sun/Moon (Planets)
- Atmosphere
- Ocean
- Hydrosphere
- Cryosphere
- Crust
- Mantle
- Core

Interactions

Combinations

C O M B I N A T I O N S
Ground-Based Component of GGOS

- VLBI
- GPS
- Sup.Grav.
- Abs.Grav.
- DORIS
- SLR/LLR
- Tide Gauges
The Global Picture: Global Velocity Field

ITRF2008 GPS Core networks

Bruyninx et al., 2011, IAG WG on Regional Dense Velocity Fields
IGS & Regional Reference Frames

• IGS contributes the GNSS global contribution to the International Terrestrial Reference Frame (ITRF) since 1990’s, providing the global grid to connect all regional reference frames and GNSS applications – alignment to the ITRF
  • All observations in a common, robust reference frame
  • Currently ITRF08
  • Next ITRF 2013, full reprocessing 1995 to date
• Supporting and cooperating with Unification of African Reference Frames (AFREF) since 1999 –
  • Africa has 50+ national reference frames and datums
  • Continental reference frame allows cross-border, international & intra-Africa development
  • Support development of transformations between GNSS and national datums
• Strong Liaison with International Federation of Surveyors (FIG) working with many National Mapping Agencies (NMA)
  • FIG / IAG / UNOOSA Rome 2012 ‘Technical Seminar on Reference Frames in Practice’ on 4-5 May
IGS – Multi-GNSS Global Experiment *M-GEX*

**Motivation**
- New and modernized systems and signals upcoming or available
- Receivers have multi-GNSS capabilities
- IGS must prepare for incorporation of new GNSS

**Goal**
- Experiment to operate an expanded network of new receivers capable of tracking new signals in addition to GPS & GLONASS
- Support & coordinate with Multi-GNSS Asia (MGA) activities

**Tasks**
- Set-up tracking network of Multi-GNSS equipment
- Make tracking data publicly available
- Experiment with data flow and signals, qualify equipment, signals, ...
- Upgrade IGS network to Multi-GNSS
- Generate Multi-GNSS products
M-GEX

- More than 100 GNSS satellites will be available in the near future
- Not only more satellites, but also more and better signals, better clocks
- Heterogeneous system of satellite systems and heterogeneous user equipment – interoperability, compatibility, interchangeability
- IGS is preparing for incorporation of new systems and signals into routine operations
- M-GEX Call for Participation – Experiment from February through August 2012, continuing observations encouraged:
  - Seeking groups for tracking, archiving, analyzing of new signals
  - Interested groups can join at anytime
- First results at IGS Workshop in Olsztyn, Poland, 23–27 July 2012
IGS Real-Time Pilot Project

• Real-time product generation is part of IGS Strategic Plan
• Infrastructure
  – More than 120 active real-time stations
  – Data streaming using NTRIP
  – Close link to RTCM
• Analysis
  – 6 real-time analysis centers
  – Real time clock combination
• Future
  – Include new systems and signals – M-GEX
  – Real-time service – To be announced soon
  – Satellite clock corrections, orbits, ionosphere corrections
  – Zero-difference Ambiguity resolution
IGS & ICG Activities

- IGS & IAG members of the GNSS Action Team since 2001; Associate Member of ICG since its establishment
- IGS and IAG and the International Federation of Surveyors (FIG) Co-chairs the ICG working group on Reference frame, Timing and Applications, with Bureau of Weights and Measures (BIPM):
  - Task Forces established in 2008, ICG-3
    - Reference Frames
    - Timing
  - To facilitate GNSS providers experts to engage with the international community represented by IGS, IAG, FIG and others, with a goal of improved inter-operability, and common understanding of these fundamental elements of GNSS – Reference Frame and Timing
- IGS M-GEX endorsed by ICG at ICG-6 in Tokyo
Thank-you
The International GNSS Service (IGS), formerly the International GPS Service, is a voluntary federation of more than 200 worldwide agencies that pool resources and permanent GPS & GLONASS station data to generate precise GPS & GLONASS products. The IGS is committed to providing the highest quality data and products as the standard for Global Navigation Satellite Systems (GNSS) in support of Earth science research, multidisciplinary applications, and education. Currently the IGS includes two GNSS, GPS and the Russian GLONASS, and intends to incorporate future GNSS. You can think of the IGS as the highest-precision international civilian GPS community.

Whenever your use of IGS data or products results in a publication, please include a citation.

**What's new:** Updated: October, 2011.
- IGS M-GEX - Call for Participation - New Information
- IGS M-GEX Response Form
- IGS-CB NTRIP Caster
- IGS Workshop on GNSS Biases 2012
- 2012 IGS Workshop
- JAXA M-GEX - Call for Participation
- IGS08 Realization adopted
- IGS 2010 Workshop Summary Recommendations
- IGS 2010 Workshop Presentation Videos
- IGS Strategic Implementation Plan - 2011

This web site is part of the IGS Central Bureau Information System (CBIS), providing both IGS member organizations and the public with information about the IGS organization, the IGS network of stations, and IGS data & data products (such as precise ephemerides).
Extra Slides
Activities & Concept

- Support to new GGOS structure and new Chair
  - Acting Vice-Chair of GGOS (Neilan)
  - Lead of GGOS Science Panel (Gross)
- Facilitated GGOS strategic retreat for developing mission, vision, goals and objectives
- Led significant revision of the GGOS Terms of Reference and reorganization adopted by IAG during IUGG, July 2010
- Supporting GGOS visibility at the GEO Plenary, Istanbul this month
  - Official delegate of IAG GGOS
  - Exhibit material and handouts
- Planning meeting with other entities especially ILRS and IVS
- Embrace & support the GGOS Network and Communications Bureau activities to a greater extent
  - Very relevant to SGP and developing partners for NASA
  - Promoting common standards, configurations and approach with GGOS partners
Welcome to IGS Form Submission
Posted on October 14, 2011

The following forms are available:

- IGS MGEX Call for Participation
  - Add Additional MGEX Site
- IGS Associate Members Registration

Presented by IGS.org