
Services of the International Association of Geodesy and IGS - Global Geodetic Observing System Links & References

Ruth E. Neilan

Director, IGS Central Bureau; Vice-Chair, GGOS

www.igs.org

www.ggos.org

FIG Rome 2012, Reference Frames in Practice

May 5



Outline

- Some cool historic images – Satellite Geodesy
- IAG, IGS and Global Geodetic Observing System (GGOS) – context
- IGS
 - Organization
 - Products
 - Web surfing and resources
 - Prime Focus:
 - IGS M-GEX – Multi-GNSS Global Experiment
 - IGS Real-Time Project
 - IGS and ICG Activities
 - 10 years - AFREF, example of challenges for regional references
- GGOS & other initiatives
- MEGA – Meta-data Exchange for Geodetic Applications –
 - Nic Donnelly



Positioning, geodesy, surveying,
astronomic observations



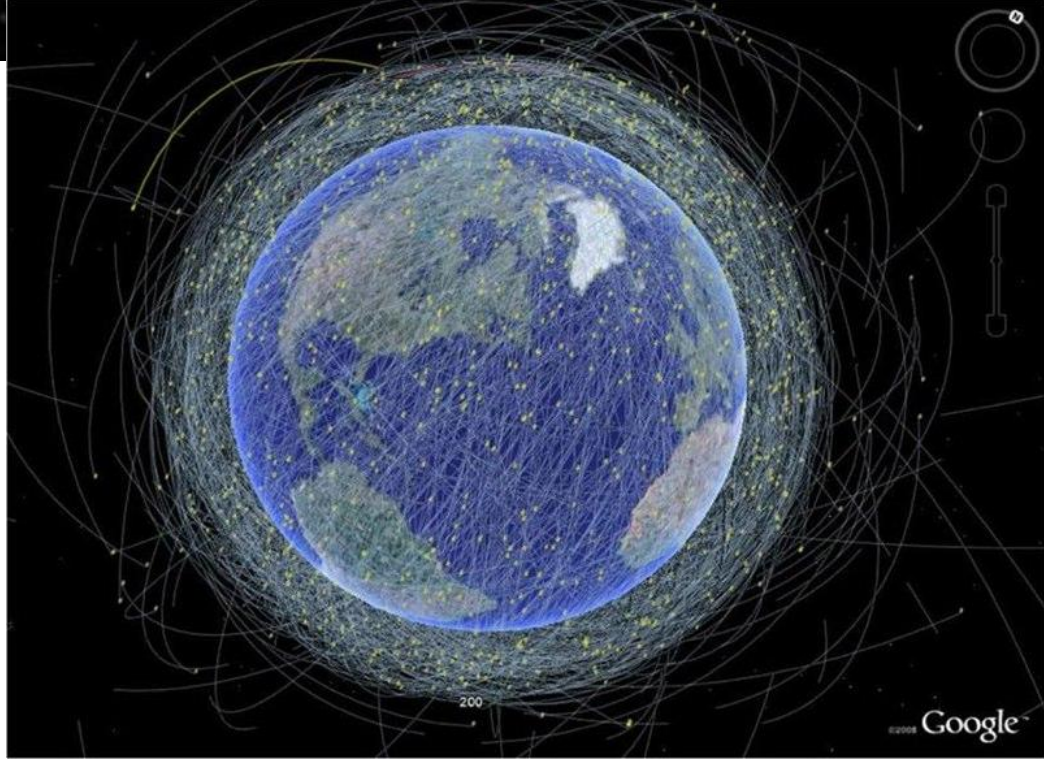
Peter Apian's Geographia, circa 1533

Navigation & Timing



Harrison I, First marine chronometer, ~1700

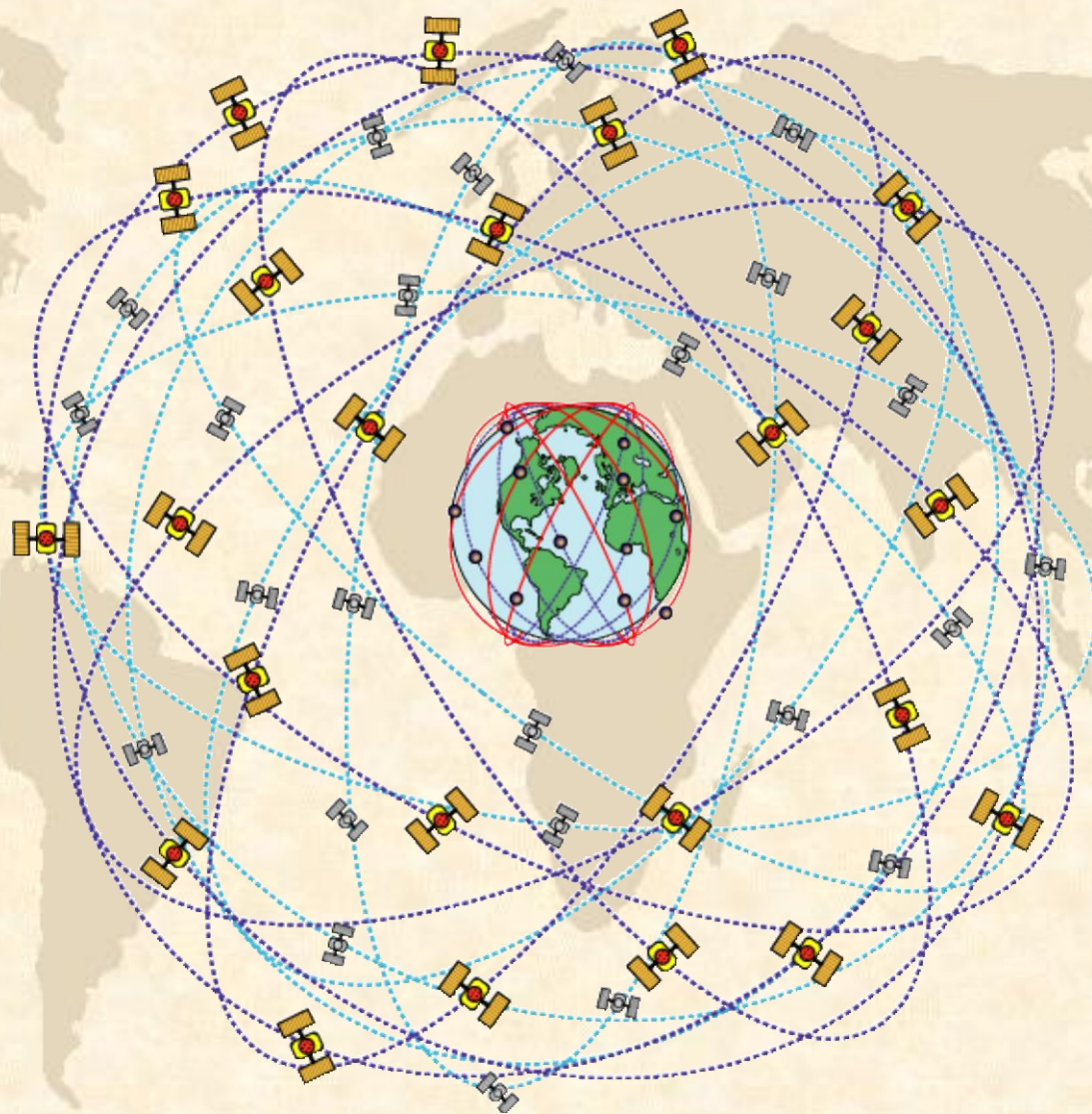
19,000 Satellites in Earth Orbit



All GNSS

Artist view - GPS World





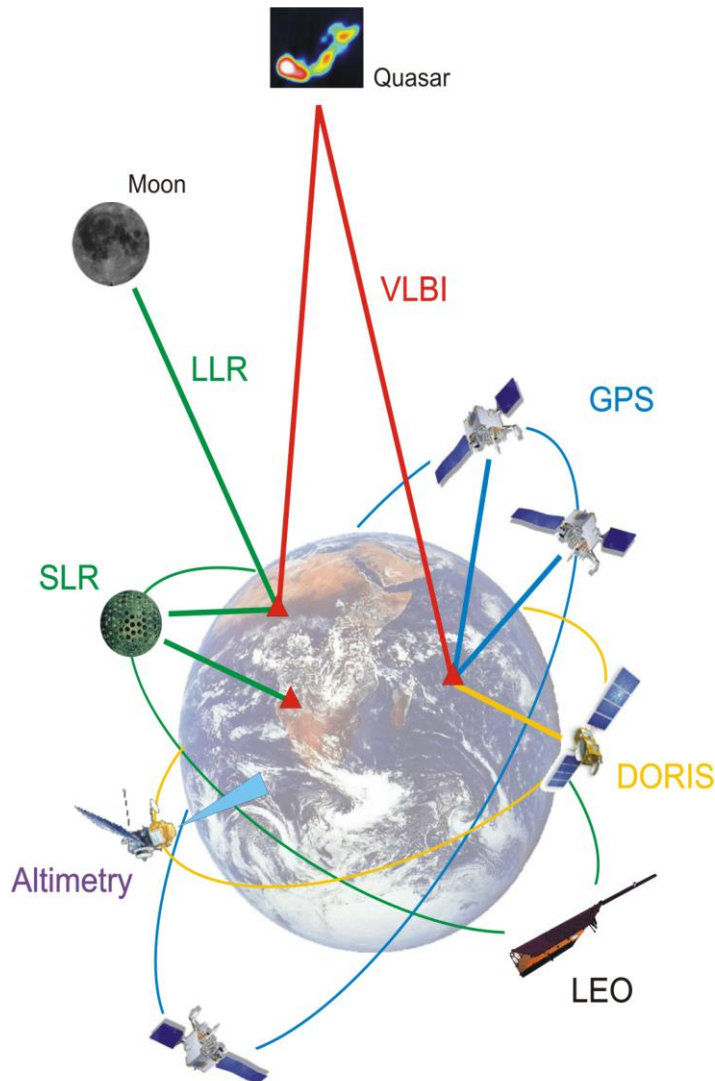
IAG, GGOS & IGS

- 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... **150 years old in 2012**, celebration 2013 (Potsdam)
- 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 100 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



Space Geodesy Today – Observations, Combination and Integration



- Ensure the **consistency** and improve the **accuracy** of the resulting geodetic products
- **Complementary use** of the individual techniques to strengthen the solutions
- Benefits from observing instruments **co-located at the same site/satellite**
- Distinguish **genuine geodetic/geo-physical signals** from **technique-specific systematic biases**
- Crucial to get a **more detailed view** and **understanding** of the complexity of the "System Earth" and its geophysical processes.

International GNSS Service - IGS



Perspective on Our World of Multi-GNSS

GPS, GLONASS, Compass, Galileo, SBAS - “more better”



Early lessons with GPS show that in-depth GPS/GNSS studies in any region require a global infrastructure - this is the perspective that drove the development of an international federation - IGS. (Seeded from CASA-Uno '88 & IAG CSTG)

Driven by understanding our planet

- Science is ‘continent-blind’
- GNSS applications for top-end science & technology in regional areas, must have a global construct, network, a global reference frame
- Improving Earth observing with GNSS can provide early warning for natural disasters and mitigate their effects:
 - Tsunamis, sea level rise, earthquakes, volcanoes
 - Weather, Space weather, climate change,...
 - Real-time responses

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.” **

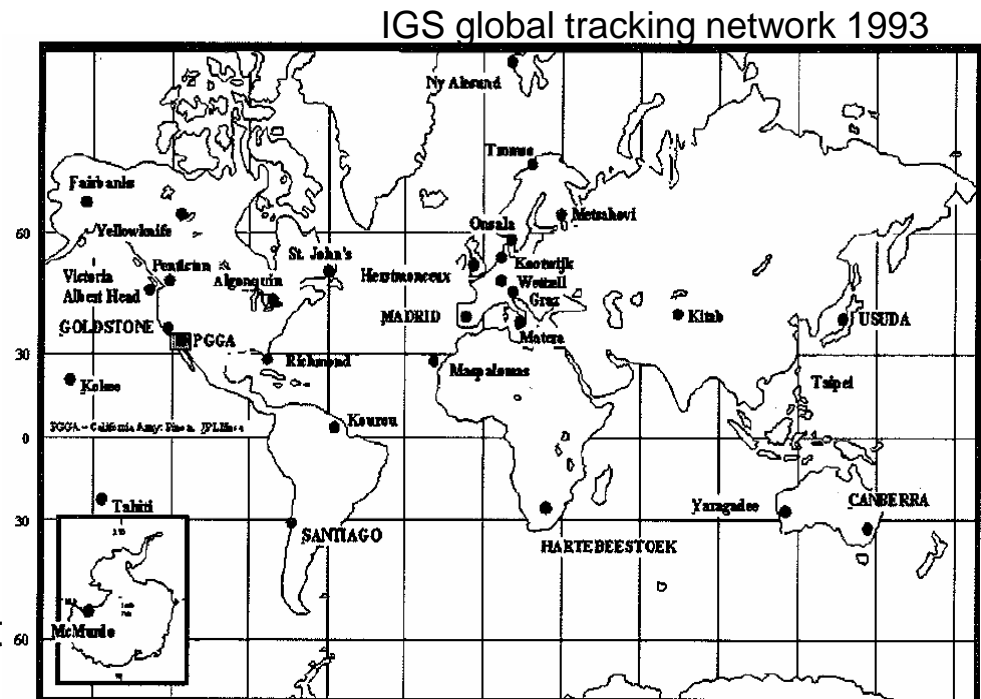
*IGS is a key component of the
Global Geodetic Observing System – GGOS*

**From IGS Strategic Plan 2008-2012*

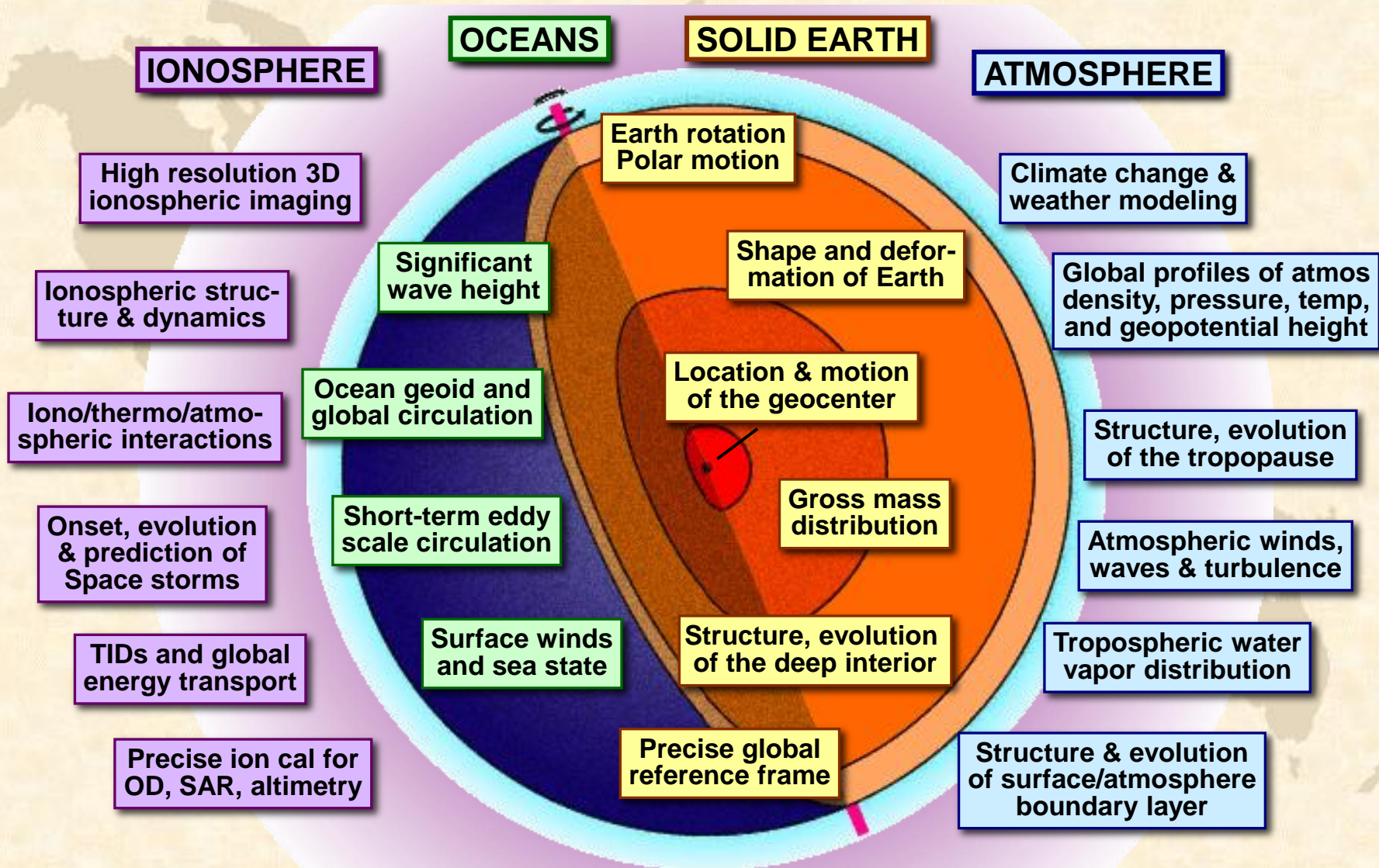


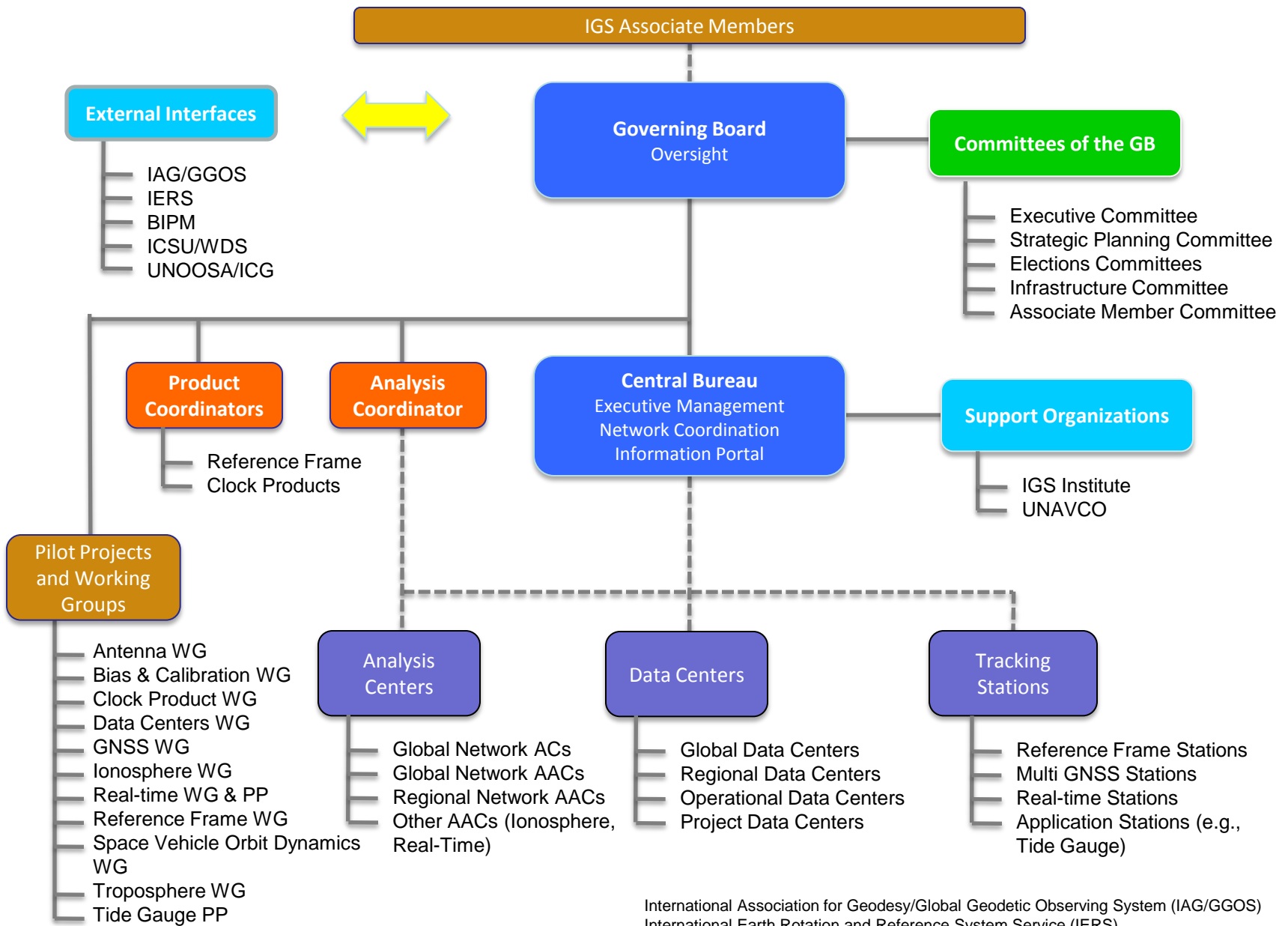
International GNSS Service (IGS)

- Potential of GPS for Geodesy, Surveying and Geodynamics was recognized in the late 1980's.
- Start of IGS Test Campaign in June 1992, *Official IAG Service since 1994.*
- Renamed "International GNSS Service" in March 2005: GPS + GLONASS
- Products:
 - Precise Orbits
 - Clock corrections & timescale
 - Station positions and velocities → ITRF
 - Troposphere parameters
 - Ionosphere maps
 - Earth orientation
- GPS and GLONASS tracking & products.
- New Multi- GNSS Global Experiment



Illuminating the Earth with GPS





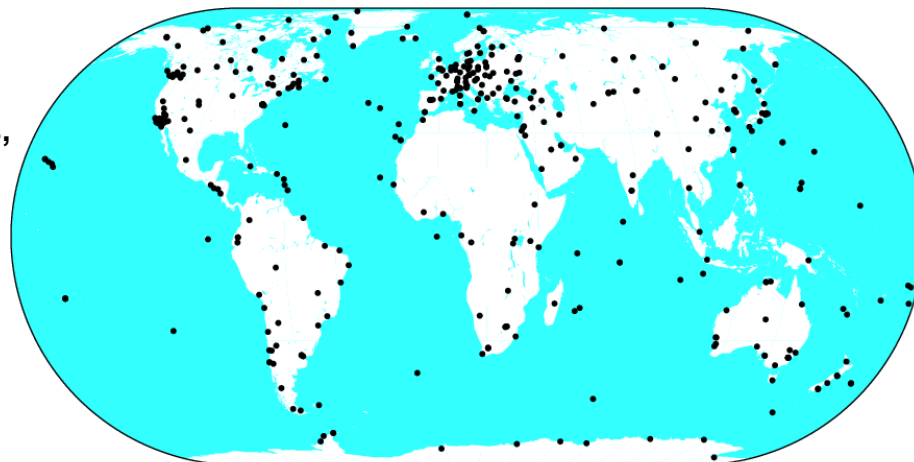
International Association for Geodesy/Global Geodetic Observing System (IAG/GGOS)
 International Earth Rotation and Reference System Service (IERS)
 Bureau International des Poids et Mesures (BIPM)
 International Council for Science/World Data Systems (ICS/WDS)
 United Nations Office for Outer Space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



International GNSS Service *Formerly the **International GPS Service***

The IGS is a voluntary federation of more than 200 worldwide agencies in more than 100 countries that pool resources and permanent GPS station data to generate precise GPS products with open data policy.

Many satellite missions, Earth science missions, multidisciplinary applications, National Mapping Agencies and Universities rely upon the openly-available IGS products, such as ephemerides and coordinate time series.



ISM 2011 May 17 18:48:47

Over 400 permanent tracking stations operated by more than 100 worldwide agencies comprise the IGS network. Currently the IGS supports two GNSS: GPS and the Russian GLONASS. IGS plans to include Galileo, Compass and QZSS once available.

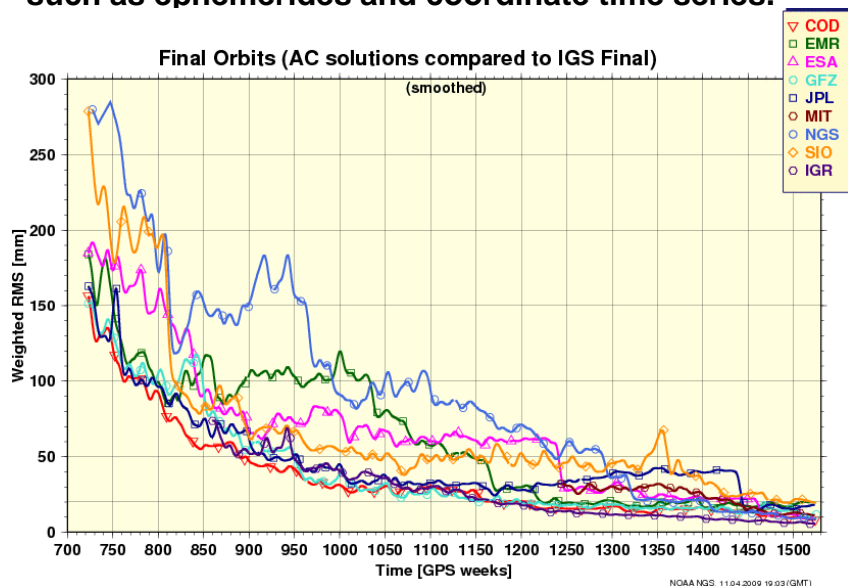
GPS Applications in IGS Projects & Working Groups

IGS Reference Frame
 Timing and Precise Clocks
 Ionosphere WG
 Antenna Calibration WG
 Bias and Calibration WG

Troposphere WG
 Sea Level - TIGA Project
 Real-Time WG & Project
 Data Center WG
 GNSS WG
 Orbit Modeling WG

<http://igs.org>

Final Orbits (AC solutions compared to IGS Final)

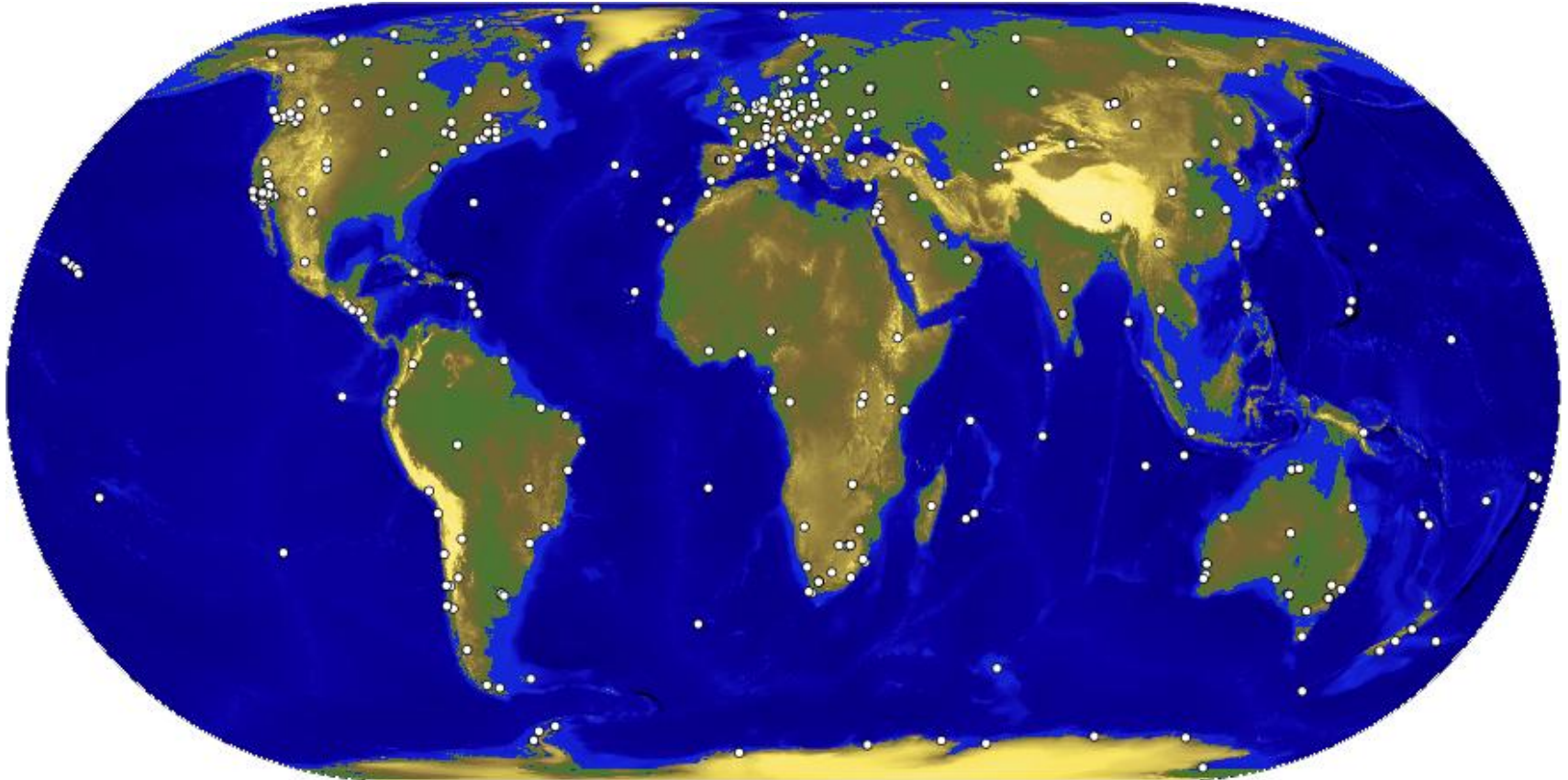


IGS products are formed by combining independent results from each of several Analysis Centers. Improvements in signals and computations have brought the centers' consistency in the Final GPS satellite orbit calculation to ~ 2cm.

Graph courtesy Analysis Coordinator J. Ray, NOAA, NGS

IGS Tracking Network

- Over 380 active global tracking stations



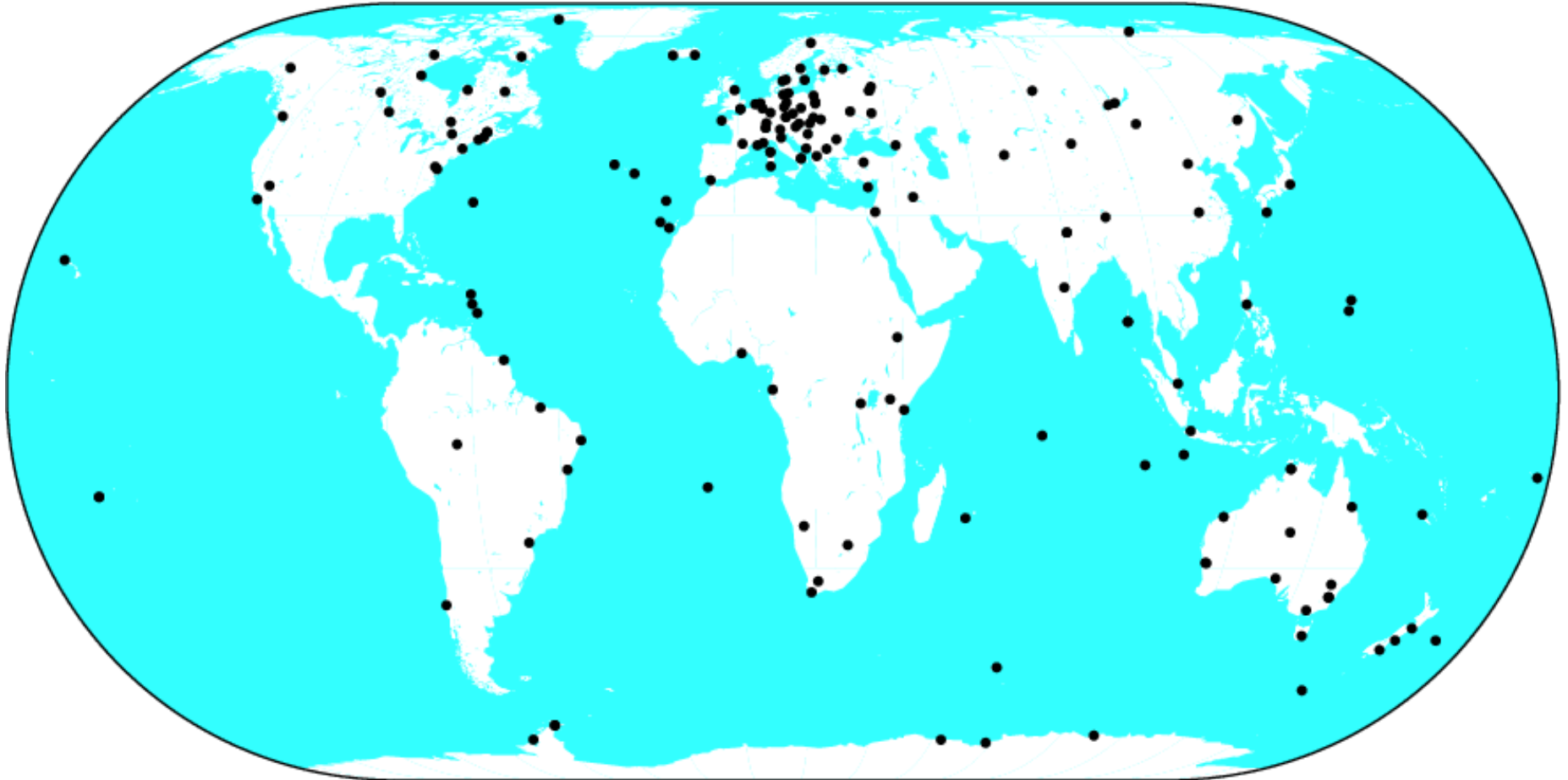
©IM7 2011 Oct 31 16:47:30



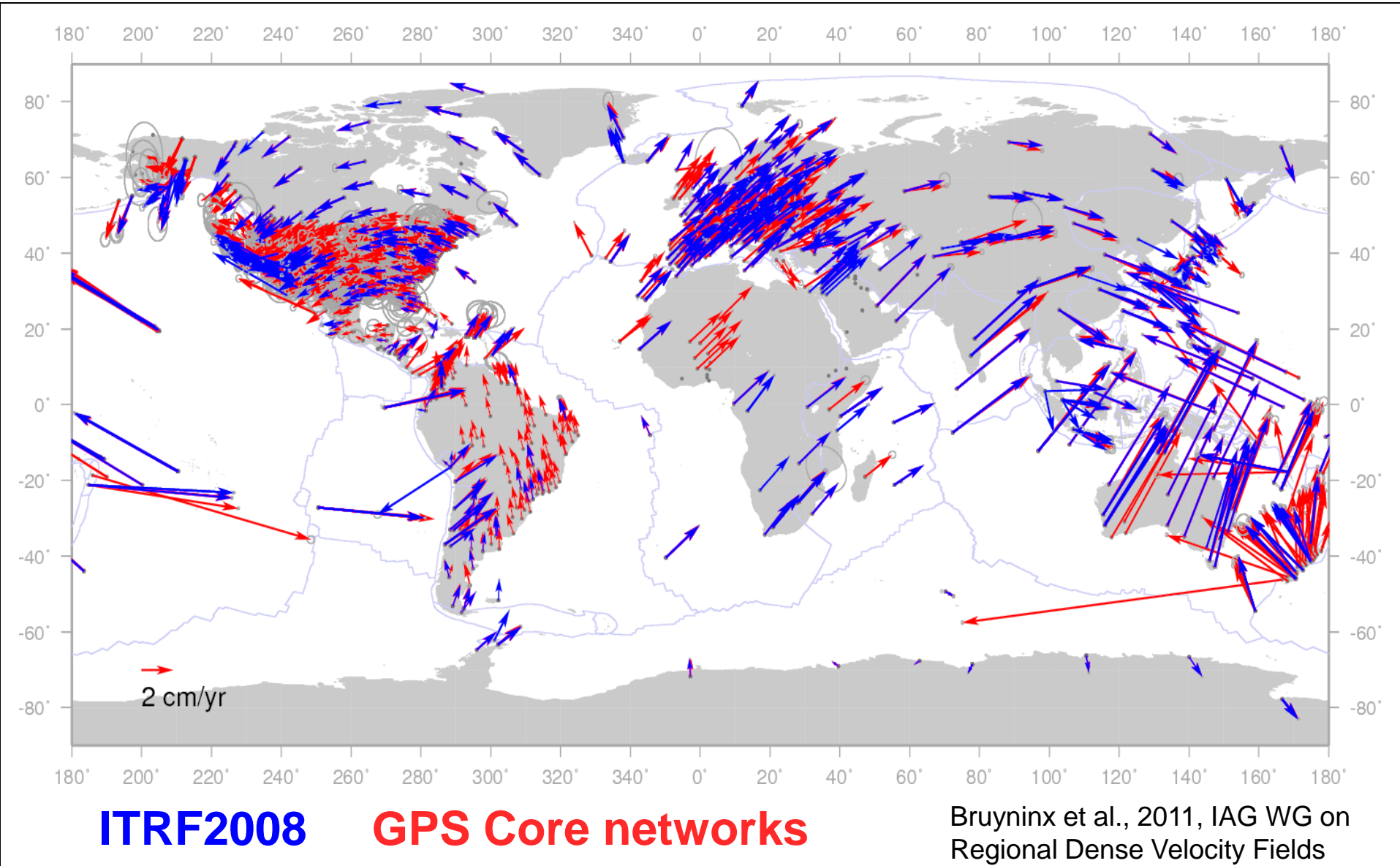
<http://igs.org>



IGS Multi-GNSS Network: GLONASS + GPS



The Global Picture: Global Velocity Field





International GNSS Service

Formerly the International GPS Service

About IGS	Data & Products	Tracking Network	Pilot Projects & Working Groups	Calendar	
MAIL	FAQ	Publications	Organization	FTP	Site Index

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.

- [2012 IGS Workshop](#)
 - [PPP-RTK & Open Standards Symposium and Workshop](#)
 - [IGS M-GEX - Call for Participation - New Information](#)
 - [IGS M-GEX Response Form](#)
-
- [IGS-CB NTRIP Caster](#)
 - [IGS Workshop on GNSS Biases 2012](#)
 - [JAXA M-GEX - Call for Participation](#)
 - [IGS08 Realization adopted](#)
 - [IGS 2010 Workshop Summary Recommendationaions](#)
 - [IGS 2010 Workshop Presentation Videos](#)
 - [IGS Strategic Implementation Plan - 2011](#)

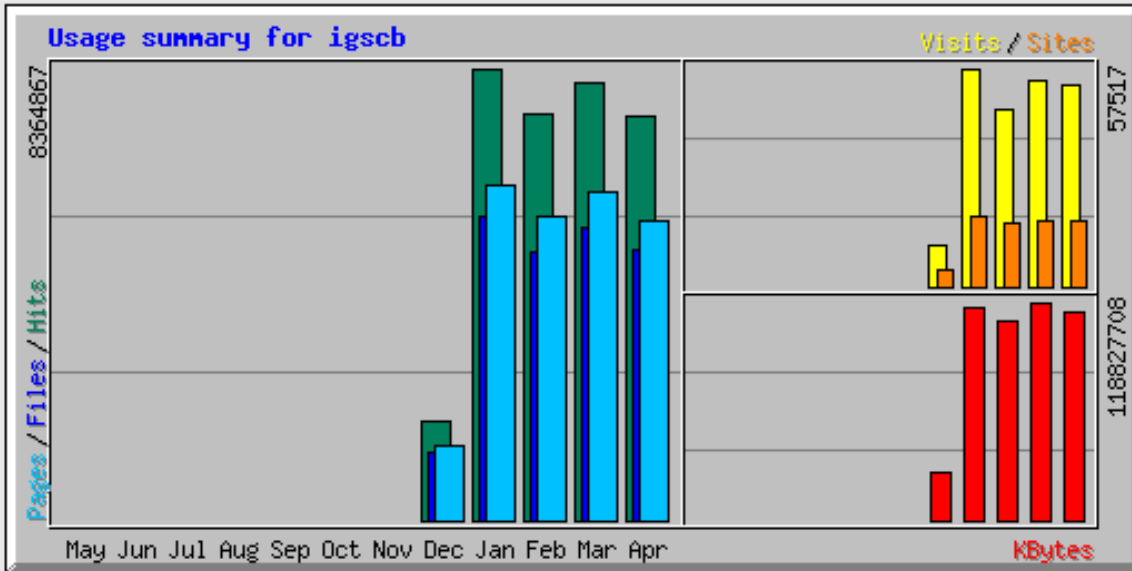
[General GPS/GNSS questions?](#)
Please visit [resource links](#)

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).

igs.org



IGS Website Statistics March 2012



Summary by Month										
Month	Daily Avg				Monthly Totals					
	Hits	Files	Pages	Visits	Sites	KBytes	Visits	Pages	Files	Hits
Apr 2012	257492	172163	190571	1825	17214	113793325	52932	5526566	4992728	7467284
Mar 2012	261723	174279	196276	1753	17507	118827708	54353	6084566	5402677	8113413
Feb 2012	259072	171722	193972	1607	16538	109033941	46616	5625200	4979939	7513099
Jan 2012	269834	181148	200705	1855	18274	115455078	57517	6221870	5615589	8364867
Dec 2011	262350	178046	197881	1581	4114	26600403	11073	1385168	1246326	1836450
Totals						483710455	222491	24843370	22237259	33295113

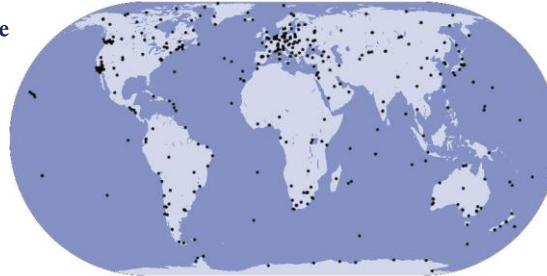


IGS

- ⊙ A *federation* of over 200 *worldwide* national agencies, universities, and research institutions in more than 90 countries
- ⊙ GPS satellite orbits to 3 cm — the *highest precision* in the world
- ⊙ *Precise positions* (5 mm) for 400 worldwide reference stations

⊙ All products mutually *consistent* in the IGS realization of the International Terrestrial Reference Frame

⊙ Continuous development of *new applications* and products in Working Groups and Pilot Projects



The foundation of the International GNSS* Service (IGS) is a global network of over 400 permanent, continuously operating, geodetic-quality GPS and GLONASS tracking sites. The station data are archived at IGS Global Data Centers and four Regional Data Centers. Analysis Centers regularly process the data and contribute products to the Analysis Center coordinator, who produces the official IGS combined products. The Central Bureau is responsible for day-to-day management of the IGS following policies set by the IGS International Governing Board.

*Global Navigation Satellite System

The IGS classic product set — satellite orbits, clocks, Earth rotation parameters, and station positions — is augmented by newer products born from IGS Working Groups and Pilot Projects:

- Troposphere
- Ionosphere
- Real-time
- GLONASS classic products
- Sea Level and Tide Gauges (TIGA)
- GNSS/WG
- Precise Timing and clock products

The IGS reference frame coordinator determines tracking site coordinates and velocities in the International Terrestrial Reference Frame (ITRF), and organizes the IGS contribution to ITRF.

Central Bureau Information System <http://igs.org>
 CDDIS Global Data Center <http://cdis.gsfc.nasa.gov>
 IGN Global Data Center <http://igs.eng.ign.fr>
 SIO Global Data Center <http://sopac.ucsd.edu>
 KASI Global Data Center <http://gdc.kasi.re.kr>

IGS Central Bureau
 Jet Propulsion Laboratory MS 238-540
 Pasadena, CA 91109 USA
 Telephone: (818) 354-2077
 Fax: (818) 354-8545



<http://acc.igs.org/>

(GPS Broadcast Values Included for Comparison)

GPS SATELLITE EPHEMERIDES/ SATELLITE & STATION CLOCKS		ACCURACY	LATENCY	UPDATES	SAMPLE INTERVAL
Broadcast	Orbits	~100 cm	real time		daily
	Sat. clocks	~5 ns			
Ultra-Rapid (predicted half)	Orbits	~5 cm	real time	4x daily	15 min
	Sat. clocks	~3 ns			15 min
Ultra-Rapid (observed half)	Orbits	<3 cm	3 hours	4x daily	15 min
	Sat. clocks	~0.15 ns			15 min
Rapid	Orbits	<2.5 cm	17 hours	daily	15 min
	Sat. & Stn. clocks	75 ps			5 min
Final	Orbits	<2.5 cm	~12 days	weekly	15 min
	Sat. & Stn. clocks	<75 ps			5 min
Real Time Combination	Orbits	~10 cm	25 sec	10 sec	10 sec
	Sat. clocks	<0.3 ns			
Real Time AC Streams	Orbits	~10 cm	8-20 sec	5-10 sec	5-10 sec
	Sat. clocks	~0.3-2 ns			

Note 1: IGS accuracy limits, except for predicted orbits, based on comparisons with independent laser ranging results. The precision is better.

Note 2: The accuracy of all clocks is expressed relative to the IGS timescale, which is linearly aligned to GPS time in one-day segments.

Note 3: Real Time products are provided on an experimental basis. See <http://www.rti.gs.net/index.php> and <http://igs.bkg.bund.de/rtip/orbits>.

Note 4: The methods used by some RT Analysis Centres result in high clock biases for individual satellites. Clock standard deviation, which is the more important metric for Precise Point Positioning, is typically of the order of 0.1 ns.

GLONASS SATELLITE EPHEMERIDES

Final	5 cm	12-18 days	weekly	15 min
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GEOCENTRIC COORDINATES OF IGS
TRACKING STATIONS (>130 SITES)

Final Positions	Horizontal	3 mm	12 days	weekly	weekly
	Vertical	6 mm			
Final Velocities	Horizontal	2 mm/yr	12 days	weekly	weekly
	Vertical	3 mm/yr			

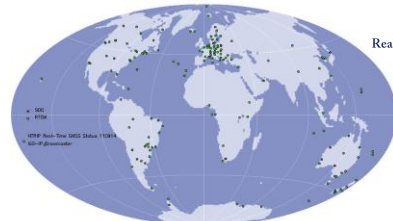
EARTH ROTATION PARAMETERS

Ultra-Rapid (predicted half)	Polar Motion	0.2 mas	real time	4x daily	4x daily
	Polar Motion Rate	0.3 mas/day			
	Length-of-day	0.05 ms			
Ultra-Rapid (observed half)	Polar Motion	0.05 mas	3 hours	twice daily	twice daily (00 & 12 UTC)
	Polar Motion Rate	0.25 mas/day			
	Length-of-day	0.01 ms			
Rapid	Polar Motion	<0.04 mas	17 hours	daily	daily (12 UTC)
	Polar Motion Rate	<0.2 mas/day			
	Length-of-day	0.01 ms			
Final	Polar Motion	0.03 mas	~13 days	weekly	daily (12 UTC)
	Polar Motion Rate	<0.15 mas/day			
	Length-of-day	0.01 ms			

Note: The IGS uses VLBI results from IERS Bulletin A to calibrate for long-term LOD biases.

ATMOSPHERIC PARAMETERS

Final tropospheric zenith path delay	4 mm	<4 weeks	daily	5 min
Ionospheric TEC grid	2-8 TECU	~11 days	weekly	2 hours; 5 deg (lon) x 2.5 deg (lat)



Real Time RT Map



International
Association
of Geodesy



ICSU
WORLD DATA SYSTEM



IGS coordination and outreach activities are organized by the Central Bureau, which is sponsored by the National Aeronautics and Space Administration (NASA) and managed for NASA by the Jet Propulsion Laboratory (JPL) of the California Institute of Technology.

IGS Formats

Here is a collection of the formats currently used by the IGS. More details such as archive locations and file naming conventions are available via the [data center navigation](#) area.

RINEX v. 2.10	GPS and GLONASS observations, meteorological data, and navigation files
RINEX v. 2.11	GPS and GLONASS observations, meteorological data, and navigation files
RINEX v. 2.12	GPS and GLONASS observations, meteorological data, and navigation files - <i>used for GNSS receivers reporting the C2 observable, currently considered experimental by IGS, data accepted on test basis only, contact CDDIS or other data centers.</i>
RINEX v. 3.01	GPS, GLONASS and Galileo observations, meteorological data, and navigation files - <i>used for GNSS receivers reporting the C2 observable, currently considered experimental by IGS, data accepted on test basis only, contact CDDIS or other data centers.</i>
SINEX	station position and velocity solutions
Hatanaka compact RINEX	GPS and GLONASS observations
sp3 version c	GPS and GLONASS orbit solutions
sp3 version a	GPS and GLONASS orbit solutions. <i>Discontinued January 2006</i>
erp	Earth rotation parameter files (self-documented within)
clock RINEX 3.00	station and satellite clock solutions
clock RINEX 3.02	station and satellite clock solutions
IONEX	ionospheric TEC grid products
Tropo SINEX	Zenith path delay products
site log	History of site installation
ANTEX	Antenna calibrations

IGS Mail List Archives

Welcome!

Below is a listing of all the public mailing lists on igs.cb.jpl.nasa.gov. Click on a list name to get more information about the list, or to subscribe, unsubscribe, and change the preferences on your subscription. To visit the general information page for an unadvertised list, open a URL similar to this one, but with a '/' and the list name appended.

List administrators, you can visit [the list admin overview page](#) to find the management interface for your list.

If you are having trouble using the lists, please contact igs.cb@igs.cb.jpl.nasa.gov.

List	Description
AFREF	AFREF
GGOS	GGOS
IGEX	IGEX (Inactive/Archive only)
IGLOS	IGLOS Mail (Inactive/Archive only)
IGS-ACS	IGS Analysis Centers
IGS-AWG	IGS Antenna Working Group
IGS-BCWG	IGS Bias and Calibration Working Group
IGS-DCWG	IGS Data Center Working Group
IGS-Equipment-Files	IGS Equipment Files
IGS-IC	IGS Infrastructure Committee
IGS-MGEX	IGS Multi-GNSS Experiment
IGS-RFWG	IGS Reference Frame Working Group
IGS-RTWG	IGS Real-Time Working Group
IGS-SO	IGS Station Operators
IGS-TIGA	Tide Gauge Benchmark Monitoring
IGS-TWG	IGS Troposphere
IGSCB	IGS Central Bureau
IGSLEO	IGS LEO
IGSMail	IGSMail
IGSREPORT	IGS Analysis Report
IGSSTATION	IGSStation



version 2.1.9



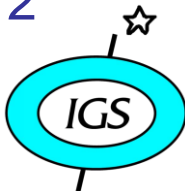
IGS – Multi-GNSS Global Experiment *M-GEX*

- 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 – *also Real-time stations*
- 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](#)



<http://igs.geolinks.org/>



Welcome to IGS Form Submission

Posted on **October 14, 2011**

ARCHIVES

- **October 2011**

The following forms are available:

- [IGS MGEX Call for Participation](#)
 - [Add Additional MGEX Site](#)
- [IGS Associate Members Registration](#)

Presented by IGS.org

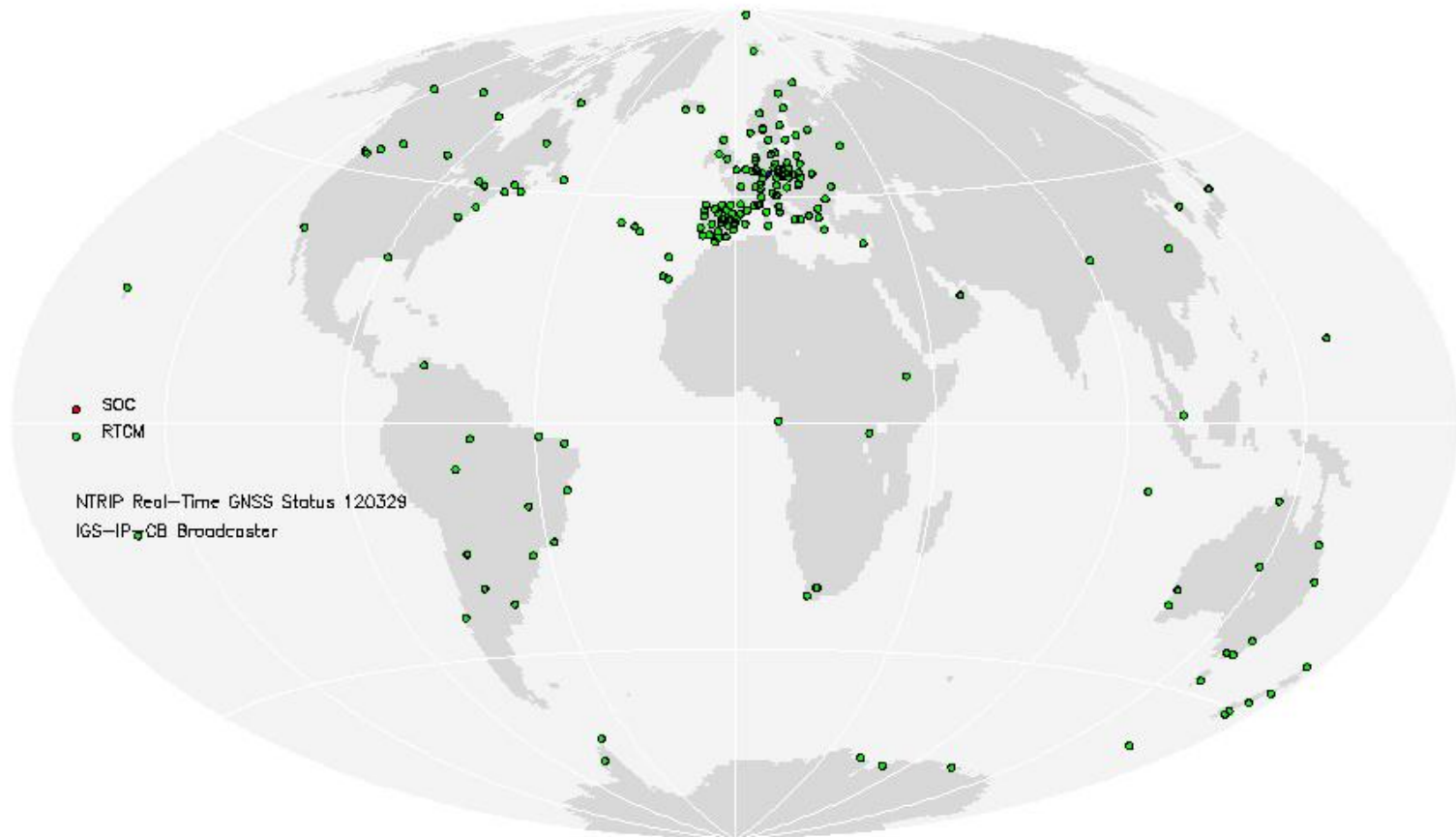


IGS Real-Time Pilot Project

- Real-time product generation is part of IGS Strategic Plan
- Infrastructure
 - More than 120 active real-time stations
 - Close link to RTCM – Joint WG established
 - [The Radio Technical Commission for Maritime Services](http://www.rtcn.org/)
www.rtcn.org/
- 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 Real Time Network – March 2012

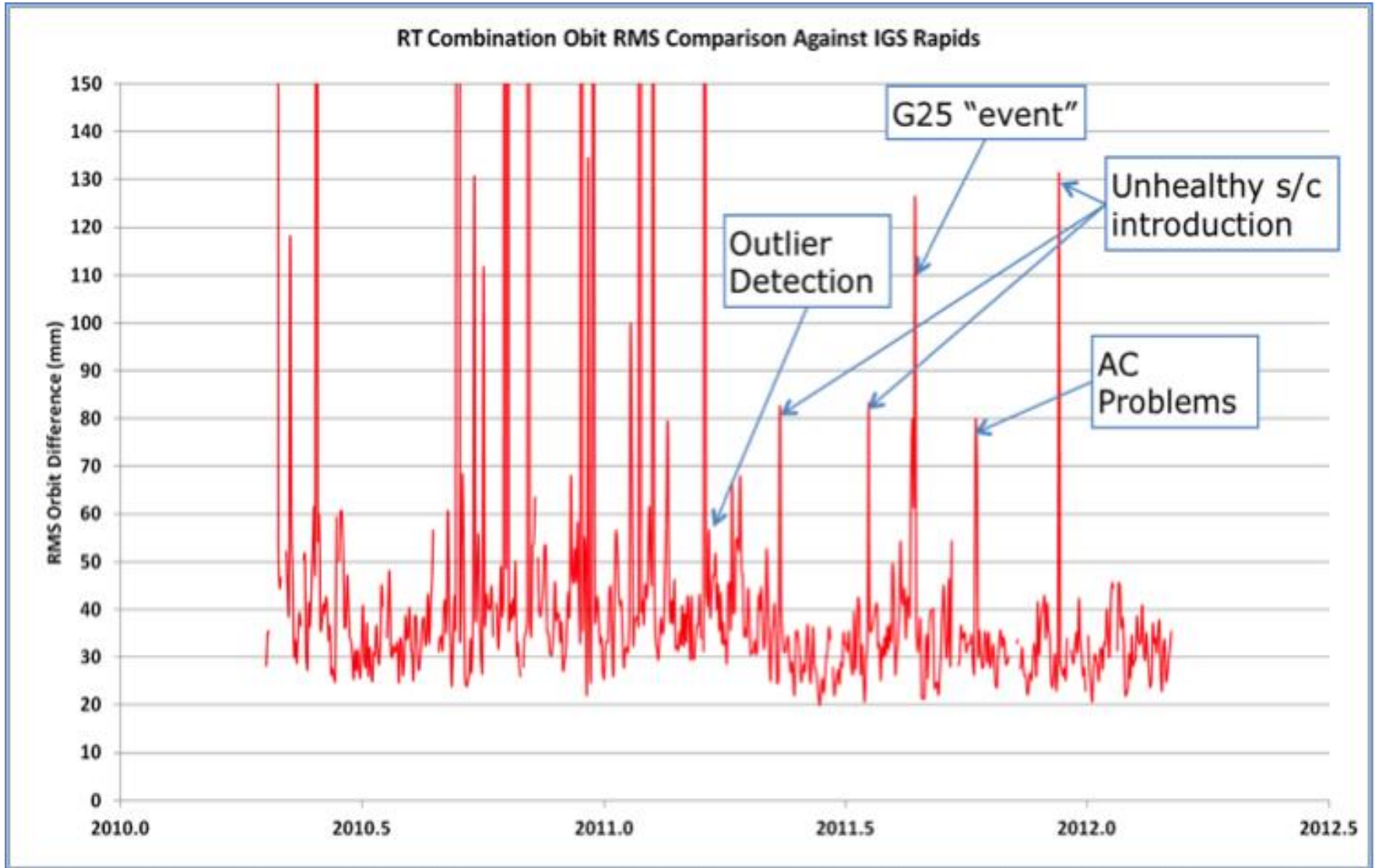


~160 Stations - soon to become openly available!

Real-Time Clock Product Table

AC	Feb 6 2009		June 8 2010		June 15 2011	
	Clock RMS (ns)	Clock Sigma (ns)	Clock RMS (ns)	Clock Sigma (ns)	Clock RMS (ns)	Clock Sigma (ns)
Comb	0.29	0.22	0.16	0.10	0.14	0.07
RTComb	-	-	0.15	0.11	0.18	0.08
BKG	6.72	2.97	0.20	0.12	0.30	0.07
CNES	-	-	-	-	0.30	0.03
DLR	0.38	0.10	0.20	0.12	0.25	0.12
ESOC	0.42	0.38	0.21	0.12	0.17	0.12
GFZ	-	-	-	-	0.33	0.06
NRC	0.67	0.62	0.24	0.10	0.23	0.07
GMV	1.67	1.66	0.28	0.14	0.34	0.10
TUW	-	-	0.70	0.53	0.73	0.53
WUH	-	-	-	-	0.57	0.07

Real-Time Orbit Plot



IGS & International Committee on GNSS - 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) and ITRF:
 - Task Forces established in 2008, ICG-3
 - Reference Frames - Altamimi
 - Timing - Arias
 - 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, Sept 2011

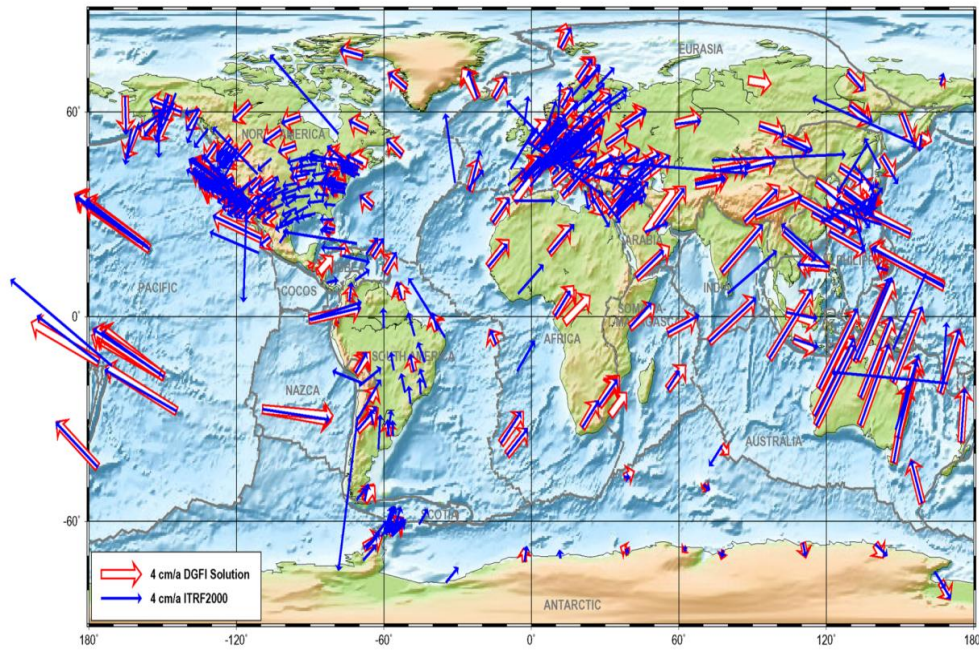


Global Geodetic Observing System

<http://www.ggos.org/>



Processes: Millions of Years \leftrightarrow Fractions of Seconds





Catch the Earth!

GGOS is a program of the International Association of Geodesy (IAG):

- Ensures observations of the three fundamental geodetic observables and their variations: Earth's shape, gravity field and rotational motion
- Integrates different geodetic techniques, models, and approaches to ensure long-term, precise monitoring of observables in agreement with the Integrated Global Observing Strategy (IGOS)
- Is a recognized member of the Global Earth Observing System of Systems (GEOSS)
- Is a powerful tool consisting mainly of high quality IAG/IUGG/IAU services, standards, conventions and references, and of theoretical and observational innovations

GGOS Vision and Mission

Vision

Advancing our understanding of the dynamic Earth system by quantifying our planet's changes in space and time.

Mission

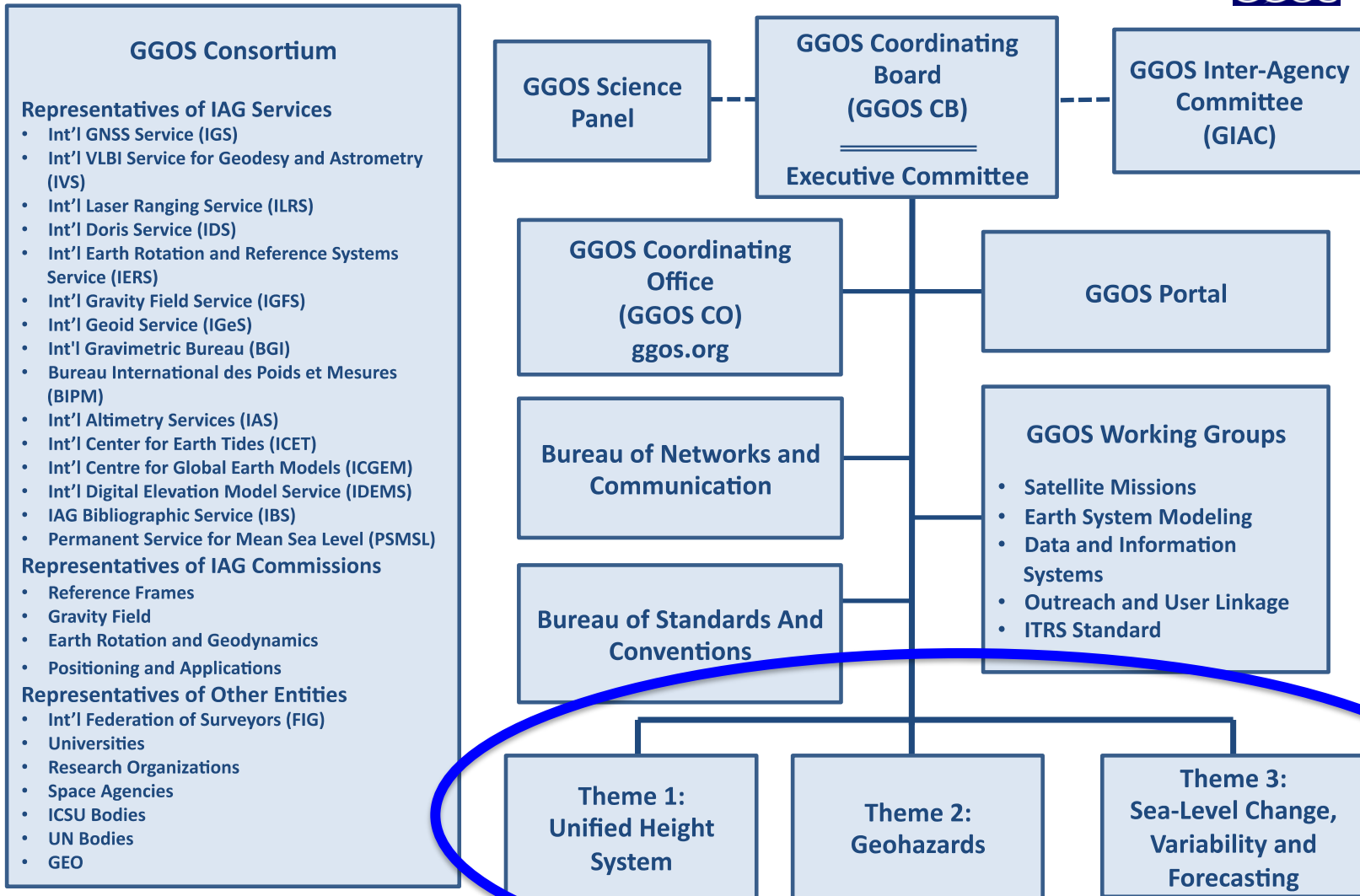
We live on a dynamic planet in constant motion that requires long-term, continuous quantification of its changes in a truly stable frame of reference.



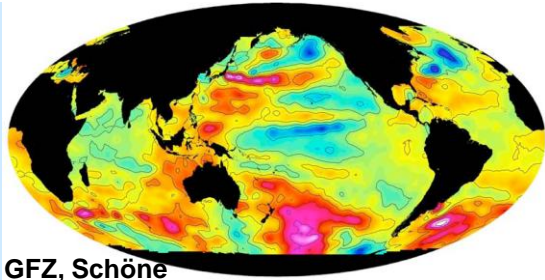
IAG Approved July 2011



Global Geodetic Observing System



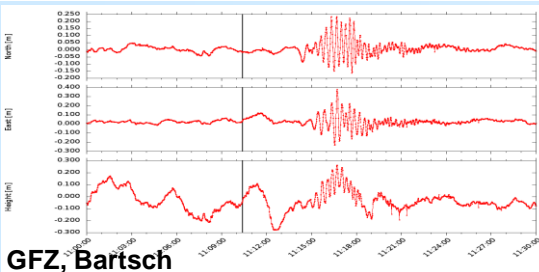
Challenges for Planet Earth Monitoring



GFZ, Schöne

Sea Level: Altimetry

- **Reliable detection of small, long-term trends:** long time series from reprocessing of ground / satellite data

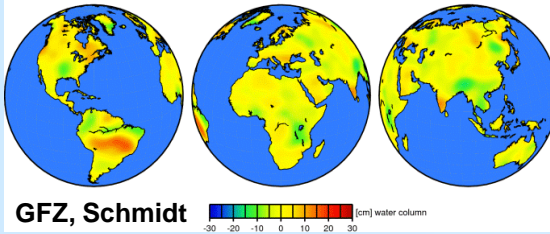


GFZ, Bartsch

Earthquake: GPS, Seismology

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

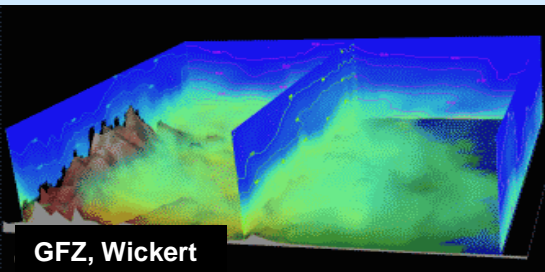
Global Water Cycle from GRACE JAN-2006



GFZ, Schmidt

Water Cycle: GRACE

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



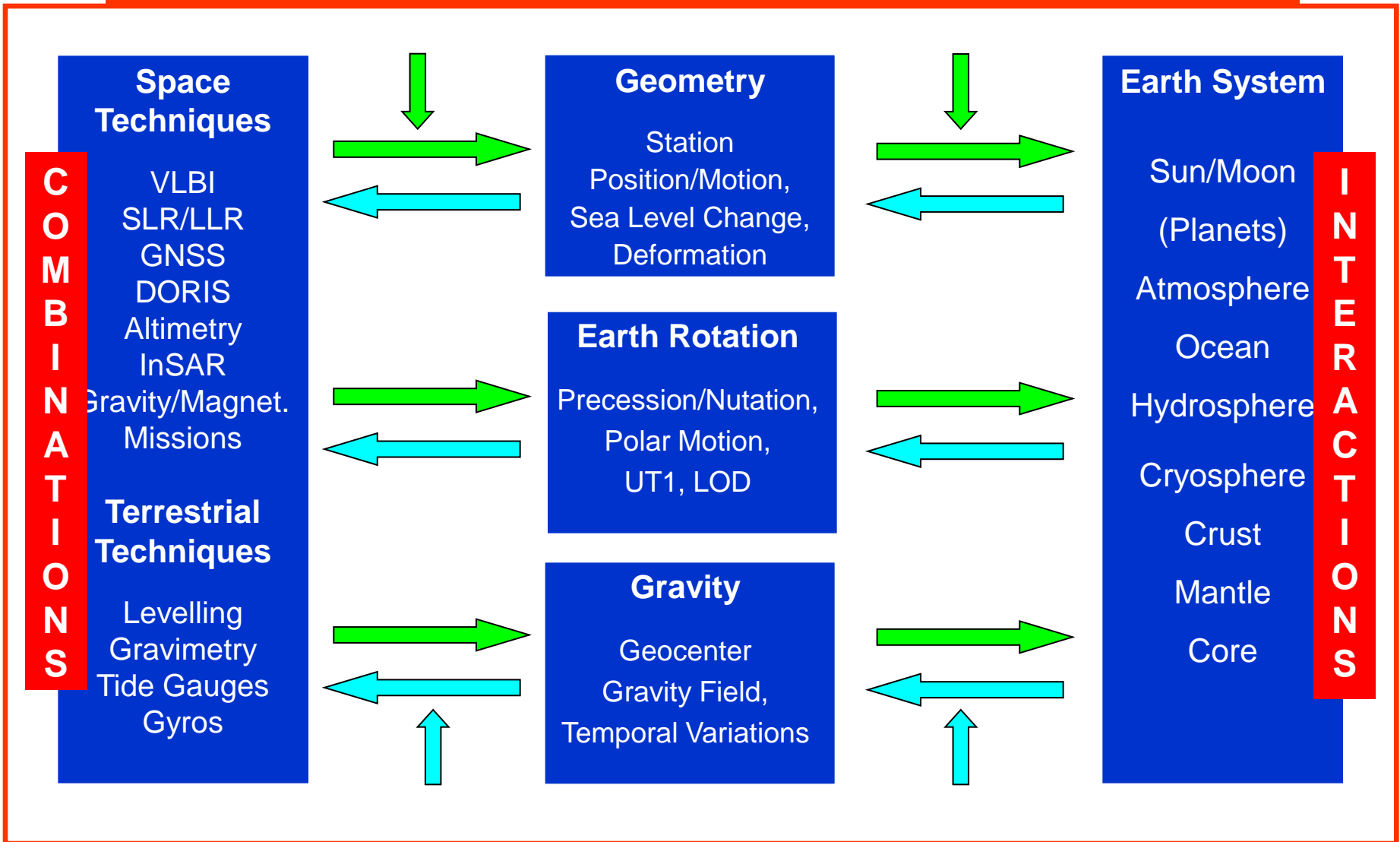
GFZ, Wickert

Water Vapor: GPS / VLBI

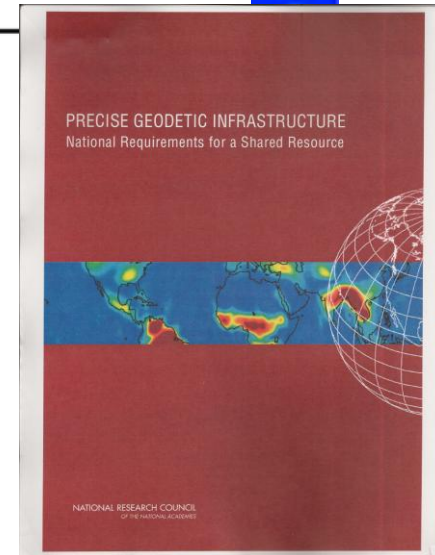
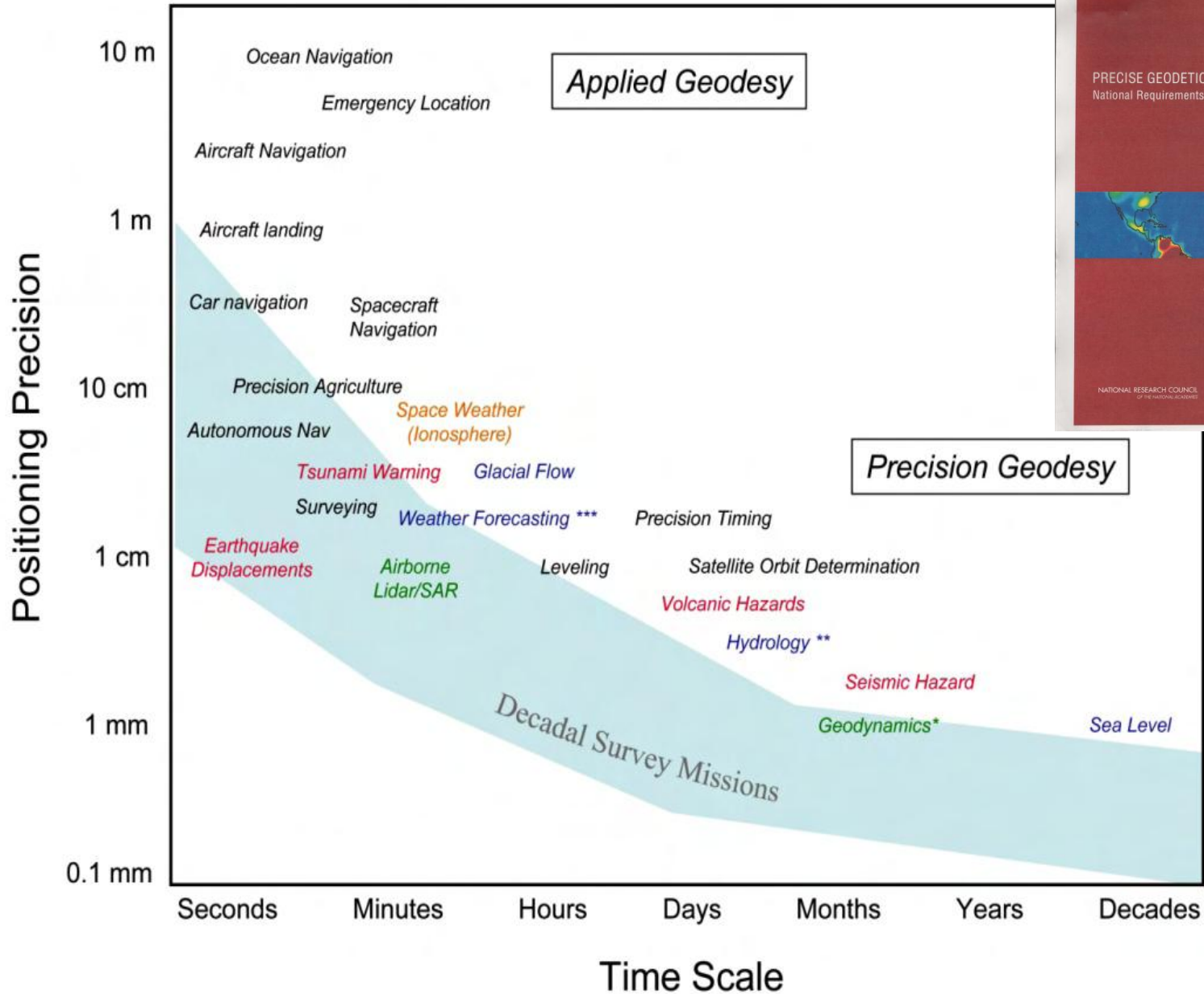
- **Information exploitation:** portals, up-to-date methods of visualization, information/knowledge management

GGOS: Monitoring and Modelling the Earth's System

Reference frames: highest accuracy and long-term stability



Societal Benefits of Precision Geodetic Infrastructure



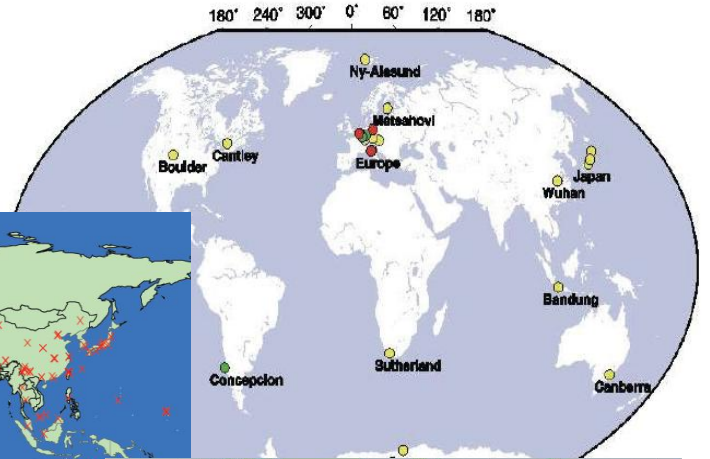
Ground-Based Component of GGOS

VLBI

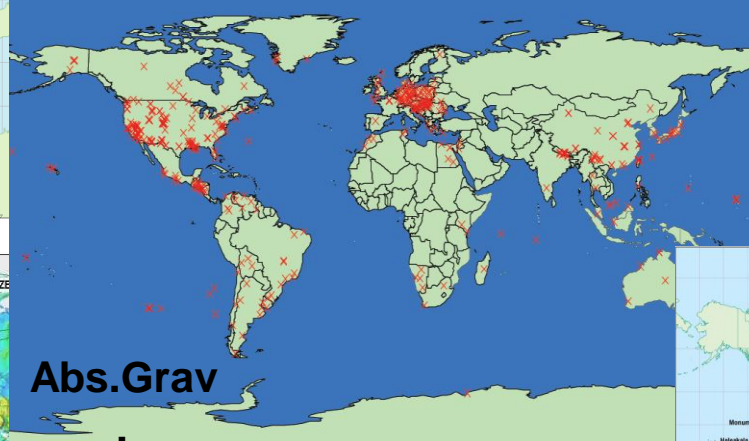
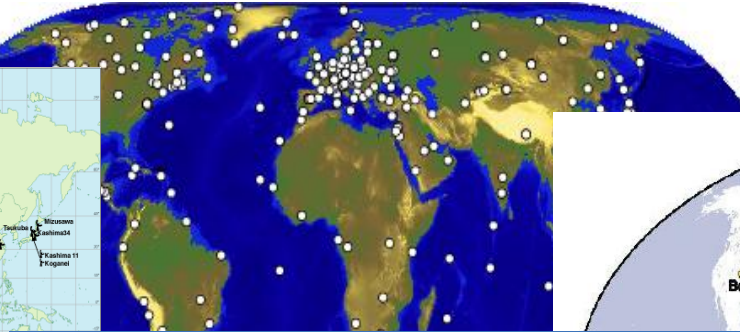


Elevation 12°

GPS



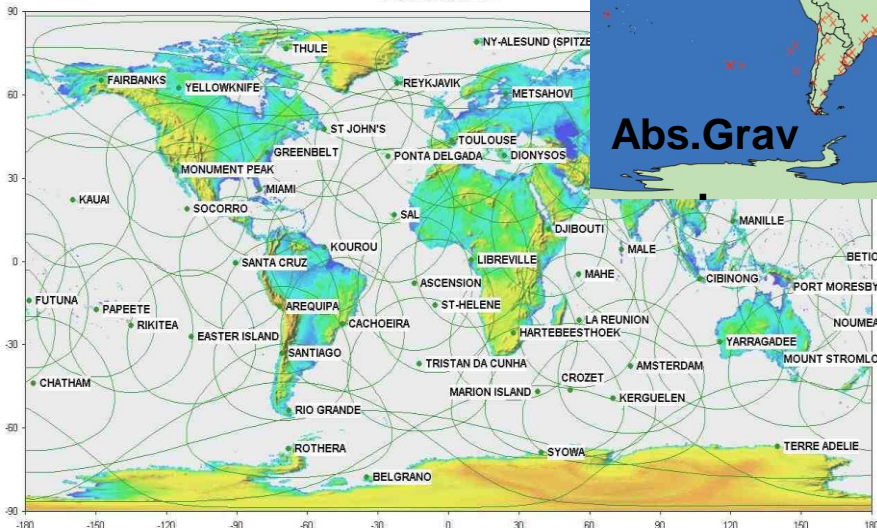
Sup.Grav.



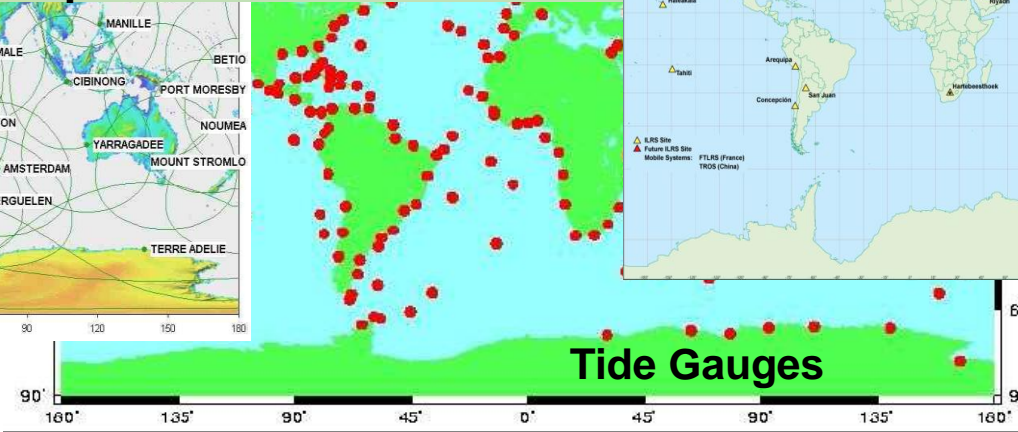
Abs.Grav



SLR/LLR



DORIS



Tide Gauges

GGOS Mission

We live on a dynamic planet in constant motion requiring for its understanding long-term, continuous quantification of its changes in a truly stable frame of reference.

The mission of GGOS is:

to provide the observations needed to monitor, map and understand changes in the Earth's shape, rotation and mass distribution;

to provide the global frame of reference that is the fundamental backbone for measuring and consistently interpreting key global change processes and for many other scientific and societal applications;

to benefit science and society by providing the foundation upon which advances in Earth and planetary system science and applications are built.



Future Core Ground-Based Infrastructure

- **Core Network (~ 40 Stations):**
- **2-3 VLBI telescopes for continuous observations**
- **SLR/LLR telescope for tracking of all major satellites**
- **At least 3 GNSS antennas and receivers (controlled equipment changes)**
- **DORIS beacon of the most recent generation**
- **Ultra-stable oscillator for time and frequency keeping and transfer**
- **Terrestrial survey instruments for permanent/automated local tie monitoring**
- **Superconducting and absolute gravimeter (gravity missions, geocenter)**
- **Meteorological sensors (pressure, temperature, humidity)**
- **Seismometer for combination with deformation from space geodesy and GNSS seismology**
- **Additional sensors: water vapor radiometer, tiltmeters, gyroscopes, ground water sensors, ...**
- **General Characteristics: highly automated, 24-hour/365 days, latest technologies**



GGOS Core Sites

Positive Developments:

- First really new infrastructure since about 15 years:
- IAG Services (e.g., VLBI2010, SLR, IGS M-GEX)
- Argumentation within GGOS

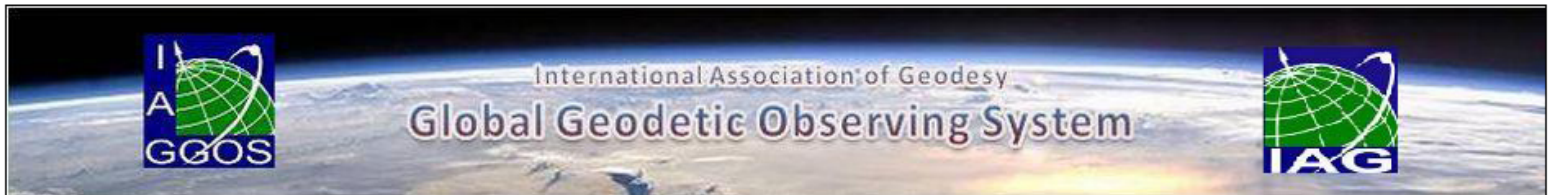


Wettzell: twin telescopes and new SLR

New GGOS Core Sites:

- Australia/New Zealand: 4 new core sites
- Wettzell, Germany: new twin and SLR telescopes
- Spain/Portugal: 4 new VLBI sites funded
- Norway, Finland, Sweden: proposals
- NASA: prototype site; proposal for 10 sites planned
- Russia, China, Korea: several sites planned

GGOS Call for Participation



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NEWS

- The Theme 3: Sea Level is issuing a **Call for Demonstration Projects** which demonstrate the value of geodetic techniques to sea level research and applications. Here you can find also a **Template for the Call**.
- New **Status Report of Theme 3: Understanding and Forecasting Sea-Level Rise and Variability** (April 17th, 2012)
- The **GGOS Bureau for Network and Communications** has published the **Call for Participation for the "Global Geodetic Core Network: Foundation for Monitoring Earth System"**, supported by a **short message** from the BNC director
- New **GGOS Terms Of Reference** (as officially adopted by the IAG Executive Committee at the IUGG XXV General Assembly, Melbourne, Australia, July 2011)
- Redefinition of **GGOS Vision, Mission, Goals and Tasks**
- **22th GGOS Steering Committee Meeting - First Coordinating Board Meeting**
- The **GGOS Bureau for Network and Communications** has developed the first version of the document **GGOS Site Requirements for Fundamental Stations**
- **21th GGOS Steering Committee Meeting**
- **GGOS 2020 Book published**

GGOS Inter-Agency Committee (GIAC)

- **Problem: long-term support and sustainability of the IAG Services and the global GGOS infrastructure**
- **Frankfurt Meeting, November 2-3, 2009 (D. Grünreich, R. Rummel): GGOS Intergovernmental Committee (GIC) with national governments/agencies to support GGOS**
 - Frankfurt Declaration
- **GIAC Establishment, December 2010 at AGU**
- **GIAC Elections April 2011:**
 - Chair: John Labrecque (NASA)
 - Vice-chair: Gary Johnston (Geoscience Australia)
 - Secretariat: Bernd Richter (BKG)



GIAC Members



Australian Government
Geoscience Australia

Geoscience Australia
AUSTRALIA



Natural Resources
Canada

Natural Resources
Canada
CANADA



SHAO

Chinese Academy of
Sciences
CHINA



Finnish Geodetic
Institute
FINLAND



Institut Géographique
National
FRANCE



Federal Agency for
Cartography and Geodesy

Federal Agency for
Cartography and
Geodesy
GERMANY



agenzia spaziale
italiana

Italian Space Agency
(ASI)
ITALY



Toitu te
Land whenua
Information
New Zealand

National Geodesist
Land Information New
Zealand
NEW ZEALAND



NORWEGIAN MAPPING
AND CADASTRE
AUTHORITY

Geodetic Institute
NORWAY



Korea Astronomy and Space
Science Institute (KASI)
REPUBLIC OF KOREA



Institute of Applied
Astronomy (IAA)
RUSSIA



National Research
Foundation Hartbeesthoek Radio
Astronomy Observatory

Hartebeesthoek Radio
Astronomy Observatory
SOUTH AFRICA



MINISTERIO
DE FOMENTO

DIRECCIÓN GENERAL
DEL INSTITUTO
GEOGRÁFICO
NACIONAL

IGN

Instituto Geográfico
Nacional (IGN)
SPAIN



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Office of
Topography swisstopo
SWITZERLAND



National Aeronautics and
Space Administration
(NASA)
USA



NOAA NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

National Geodetic Service
National Oceanic and
Atmospheric Administration
USA

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)



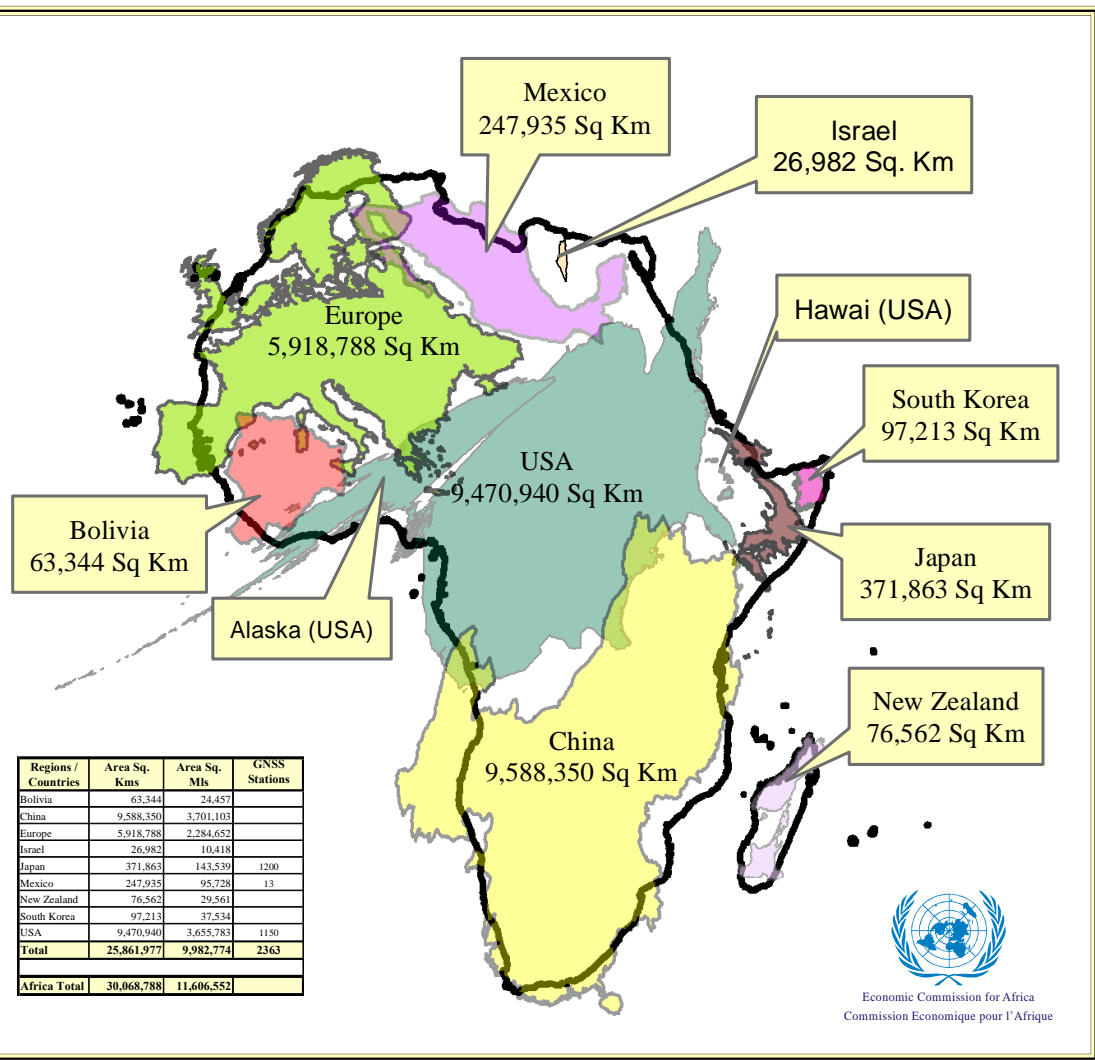
Map of the World with Country Flags



17 Countries in South America – SIRGAS

53 Countries in Africa – AFREF

40 Countries in Europe - EUREF



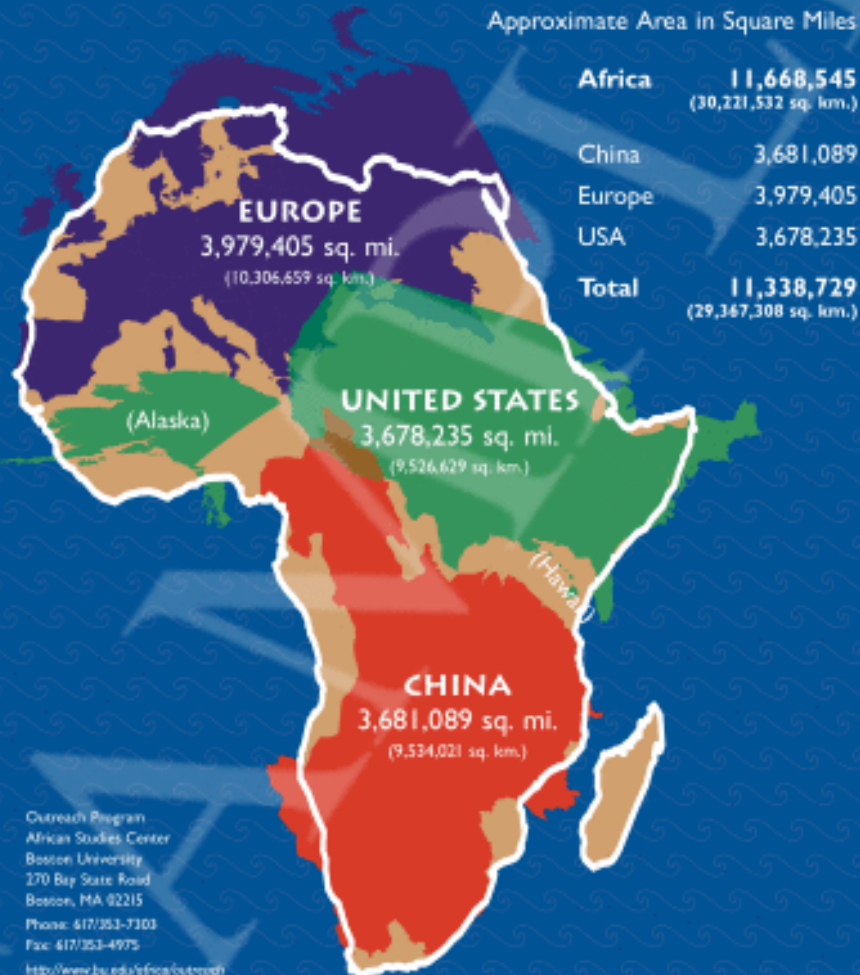
Regions / Countries	Area Sq. Kms	Area Sq. Mls	GNSS Stations
Bolivia	63,344	24,457	
China	9,588,350	3,701,103	
Europe	5,918,788	2,284,652	
Israel	26,982	10,418	
Japan	371,863	143,539	1200
Mexico	247,935	95,728	13
New Zealand	76,562	29,561	
South Korea	97,213	37,534	
USA	9,470,940	3,655,783	1150
Total	25,861,977	9,982,774	2363
Africa Total	30,068,788	11,606,552	



Economic Commission for Africa
Commission Economique pour l'Afrique

HOW BIG IS AFRICA?

Approximate Area in Square Miles



Outreach Program
African Studies Center
Boston University
270 Bay State Road
Boston, MA 02215
Phone: 617/353-7303
Fax: 617/353-4975
<http://www.bu.edu/africa/outreach>

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2004-2005

Mollweide Equal Area Projection

lgs.org

Mail lists archived:

afref@igscb.jpl.nasa.gov

The AFREF February 2012 Archive by thread

http://igscb.jpl.nasa.gov/pipermail/afref/2012-February/thread.html

February 2012 Archives by thread

- Messages sorted by: [\[subject \]](#) [\[author \]](#) [\[date \]](#)
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Starting: *Thu Feb 2 22:34:52 PST 2012*

Ending: *Wed Feb 8 23:51:29 PST 2012*

Messages: 9

- [\[AFREF-38\] Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *Ivan Farayi Muzondo*
 - [\[AFREF-39\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *stephen at ghana.com*
 - [\[AFREF-41\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *Collins Fosu*
 - [\[AFREF-42\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *Joel.VanCranenbroeck at leica-geosystems.com*
- [\[AFREF-40\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *Nacho Romero*
- [\[AFREF-43\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *olaide onabajo*
 - [\[AFREF-45\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *stephen at ghana.com*
- [\[AFREF-44\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *olaide onabajo*
- [\[AFREF-46\] Re: Which Countries in Africa are Actively Participating in the AFREF Agenda?](#) *olaide onabajo*

Last message date: *Wed Feb 8 23:51:29 PST 2012*

Archived on: *Wed Feb 8 23:51:53 PST 2012*

- Messages sorted by: [\[subject \]](#) [\[author \]](#) [\[date \]](#)
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Summary of Initiatives

- IAG developing strong links with FIG since 2003
- Active working within International Committee on GNSS (ICG) - IAG/IGS/FIG/IERS-ITRF/BIPM
 - lead working group on Reference Frames, Timing and Applications
- GGOS represents IAG in the Group on Earth Observations (GEO) and *System of Systems* (GEOSS)
- IAG Service represented on new International Council of Science – World Data System (ICSU-WDS)
 - WDS Scientific Committee <http://www.icsu-wds.org/>
- RTCM
- New Meta-data Exchange Format for Geodetic Applications (MEGA)
 - Nic Donnelly, LINZ – up next

Extra Slides



Background

- There is no group looking broadly at geodetic metadata across the techniques: from terrestrial surveys to space geodesy
- Metadata frequently needs to be exchanged, but often there are not any accepted, open formats (for example, geodetic adjustment data)
- The standards which exist tend not to follow modern data exchange or format principles (for example, custom text formats)
- Individual organizations may have done work on standards, but discovery is difficult

Proposed solution

- Set up a joint FIG/IAG working group to cover
- Members representing the various techniques
- Mail list or online forum to discuss metadata issues
- Website to provide information about geodetic metadata standards

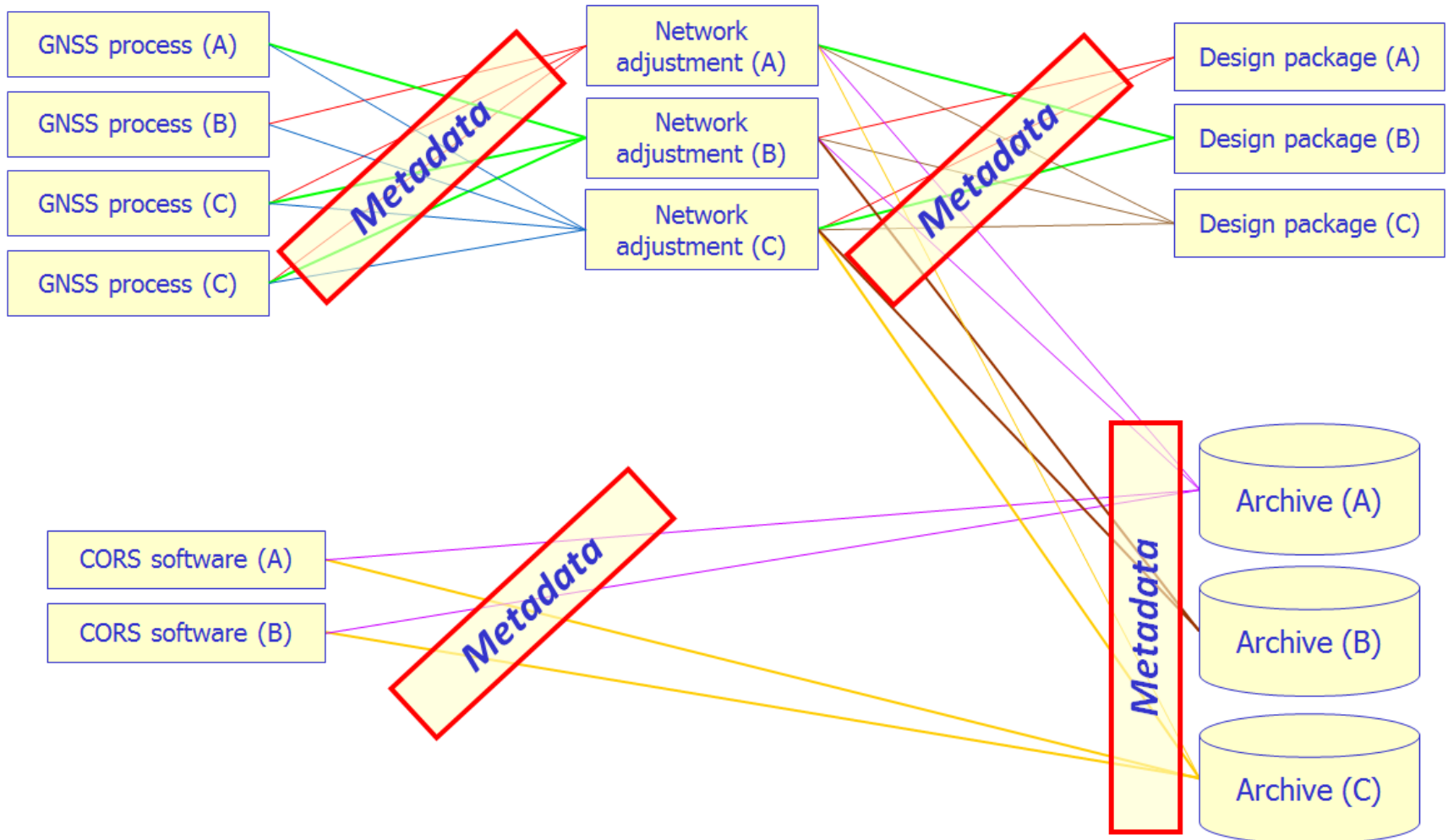
Objectives

- Develop a high level framework for geodetic metadata exchange standards
- Coordinate metadata standards development among geodetic disciplines
- Provide a forum for discussion of matters relating to metadata exchange
- Provide a centralized mechanism for discovery of metadata exchange initiatives in the geodetic community

Scope

- Metadata across all geodetic techniques
 - GNSS, VLBI, SLR, Terrestrial (angles and distances)
etc
- As well as “data about data”, includes consideration of data structures
- Include metadata relating to geodetic products (eg adjustments, orbits, site velocities)

Metadata and Data Exchange



Goals

The goals of GGOS are:

1. to be the primary source for all global geodetic information and expertise serving society and Earth system science;
2. to actively promote, sustain, improve and evolve the global geodetic infrastructure needed to meet Earth science and societal requirements;
3. to coordinate the international geodetic Services that are the main source of key parameters needed to realize a stable global frame of reference and to observe and study changes in the dynamic Earth system;
4. to communicate and advocate the benefits of GGOS to user communities, policy makers, funding organizations, and society.



Tasks of Goal 1

to be the primary source for all global geodetic information and expertise serving society and Earth system science

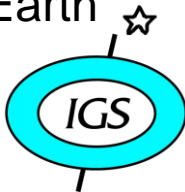
- a. Identify the components and themes of GGOS needed to plan and meet evolving user requirements and to provide crucial data and information to the user.
- b. Define and implement internal and external interfaces needed for technical and organizational efficiency.
- c. Evaluate and review the current GGOS organization and structure.
- d. Develop mechanisms for regular review of GGOS quality and performance, including that of its data and products.
- e. Expand and broaden user communities by conducting impact studies and organizing joint workshops and symposia.
- f. Provide a unique point of access to the user community by creating and maintaining the GGOS portal.



Tasks of Goal 2

to actively promote, sustain, improve & evolve the global geodetic infrastructure needed to meet Earth science & societal requirements

- a. Provide the scientific basis for the necessary global geodetic infrastructure, including establishing requirements for station distribution and data quality.
- b. Provide a forum for inter-Service communication and exchange of information about current activities, infrastructure performance and future plans.
- c. Identify major infrastructure deficiencies and propose remedies to the geodetic and user communities and appropriate entities including the GIAC.
- d. Support requests of stations, agencies and other organizations for resources.
- e. Advocate for the establishment of geodetic fundamental stations with potential sponsors.
- f. Advocate for relevant space-based components including operational chains of geodetic missions like gravity, altimetry, and SAR missions to provide spatial and temporal coverage of continuous and episodic changes in the dynamic Earth system.



Tasks of Goal 3

to coordinate the international geodetic Services that are the main source of key parameters needed to realize a stable global frame of reference and to observe and study changes in the dynamic Earth system

- a. Improve the interaction and communication amongst GGOS, the IAG Services and Commissions by defining appropriate linkages, organizing inter-Service workshops and, when appropriate, holding joint or co-located GGOS EC and Service GB/DB meetings.
- b. Reform the GGOS governance structure in order to facilitate the execution of the Science Themes, manage the relationships between the IAG Executive, GGOS EC, the Services and the Commissions, fulfill GGOS's role in outreach, represent GGOS at forums such as GEO, and other activities as may be tasked.
- c. Identify data and product gaps, integrated products, additional Service and Commission components and, if necessary, new Services and Commissions that are needed to fully address the requirements of the GGOS Science Themes.



Tasks of Goal 3, (con't.)

to coordinate the international geodetic Services that are the main source of key parameters needed to realize a stable global frame of reference and to observe and study changes in the dynamic Earth system

- d. Establish and promote the use of reference frames, common standards and models, open data access, geodetic expertise and information, and even methodologies where appropriate, so as to ensure reliable, consistent and high-quality data and products for the geoscientific community.
- e. Promote combination analyses and integrated product generation across Services and Commissions, especially from co-located geodetic sites, in order to address the requirements of the GGOS Science Themes.
- f. Promote a culture of continuous quality improvement of the geodetic infrastructure, analysis center operations, effectiveness of the GGOS structural components, and of the generated GGOS data and products.



Tasks of Goal 4

to communicate and advocate the benefits of GGOS to user communities, policy makers, funding organizations, and society

- a. Organize meetings about GGOS activities and participate in GEO meetings, user community events, conferences, workshops, symposia, etc.
- b. Identify GGOS requirements in terms of infrastructure and workforce and interact with funding authorities, national and international organizations and space agencies to advocate the importance of meeting these requirements.
- c. Promote the development and submittal to funding agencies of proposals that advance the goals of GGOS.
- d. Involve young scientists by means of GGOS scholarships and grants through national and international projects.
- e. Foster geodetic educational programs within universities, schools and research organizations.



Tasks of Goal 4 (con't)

to communicate and advocate the benefits of GGOS to user communities, policy makers, funding organizations, and society

- f. Strengthen outreach capabilities demonstrating GGOS benefits by means of case studies and success stories; realise a short GGOS movie to be presented and distributed for educational purposes.
- g. Review the respective roles of GGOS and the GIAC.
- h. Improve the recognition and visibility of GGOS within GEO, ICSU, COPUOS, CEOS, COSPAR and other organizations.



