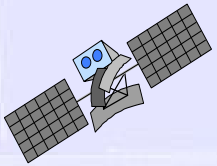
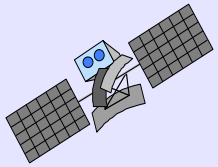
GNSS Interoperability from IGS Perspective & the Multi-GNSS Demonstration Campaign



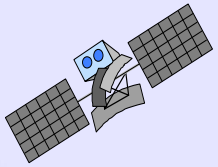
Chris Rizos

School of Surveying & Spatial Information Systems
University of New South Wales, Sydney, Australia

Vice President International Association of Geodesy;
Member of the IGS Governing Board & Executive



Outline …



- The IGS…*today & in the future*
- The IGS as a component of GGOS
- Multi-GNSS & implications for the IGS… *opportunities & challenges*
- The IGS and the Asia-Oceania multi-GNSS campaign & planned activities

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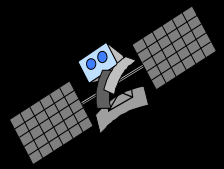

The International GNSS Service underpins PNT applications by virtue of its importance in defining and providing access to the ITRF… which also supports modern geodetic/geoscientific activities

The IGS: IAG's First Operational Service

- By the late 1980's, the potential of GPS for geodesy & geodynamics was realised by many organisations:
  - Announcement of Opportunity 1991: *International GPS Service for Geodynamics* (until 1999, then simply IGS)
  - Start of 3 month Test Campaign 21 June 1992
  - IGS became an official service of the IAG in January 1994
  - Became the **International *GNSS* Service** March 2005
- Key to approach: sharing investments and operational costs by pooling the resources of many (> 200) organisations to establish an independent ground CORS segment and generate high accuracy products … ***"best efforts" basis, reliability through redundancy, freely available to all users***.

http://igs.org

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IAG

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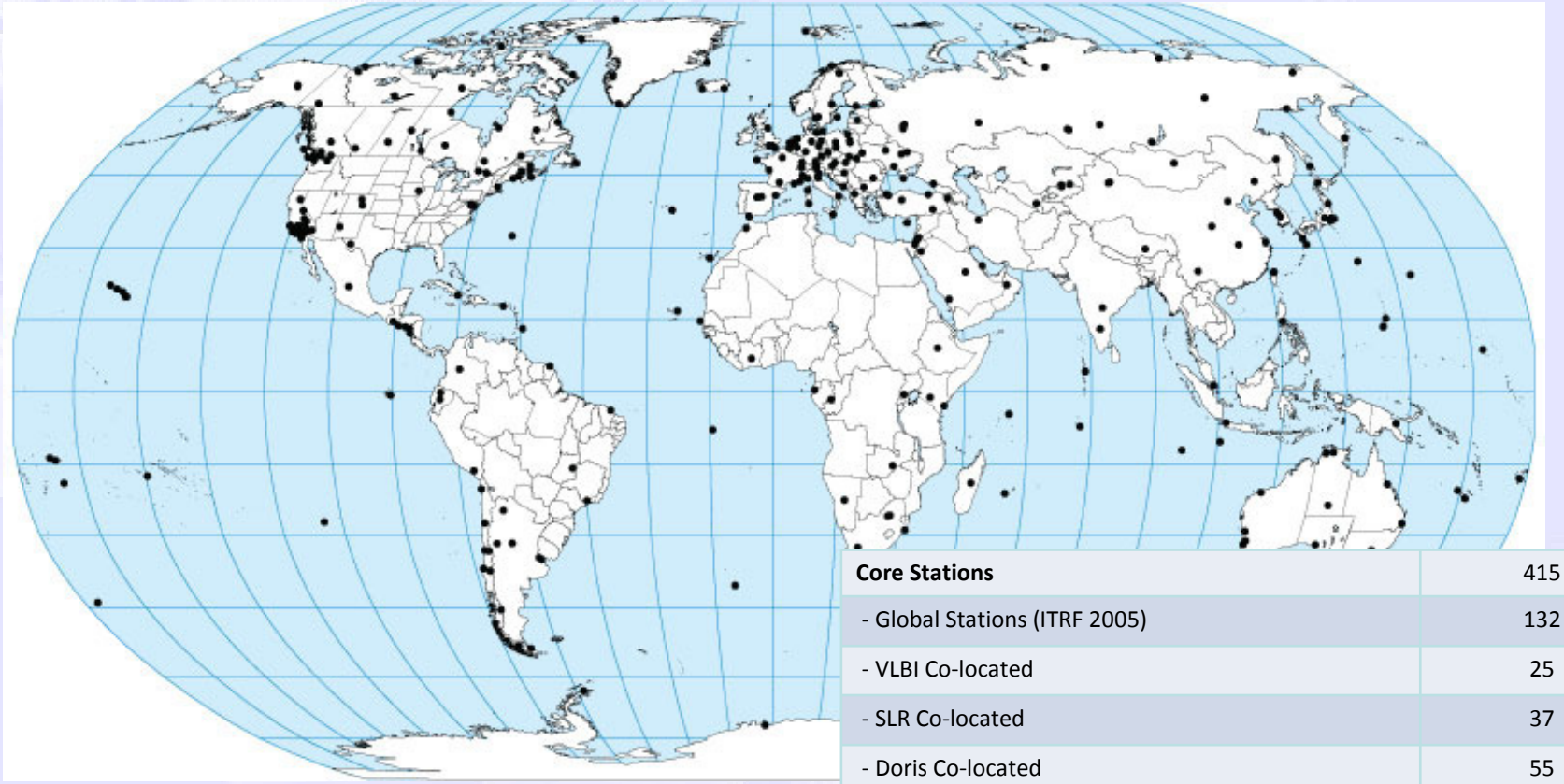
Mission

- The IGS provides the highest-quality GNSS data, products, and services in support of
  - the terrestrial reference frame (ITRF)
  - Earth observations and research
  - Positioning, Navigation and Timing
  - and other applications that benefit the scientific community and society

- The IGS provides *the* reference for *all* GNSS applications

IGS Tracking Network



Core Stations	415
- Global Stations (ITRF 2005)	132
- VLBI Co-located	25
- SLR Co-located	37
- Doris Co-located	55
Project Stations or Experimental Capabilities	
- Timing stations	80
- Reprocessing campaign 2003-2007	667
- Tide Gauge Co-located	103
- Multi GNSS	93
- Real-time	120

„The IGS Reference Station Guidelines“, Steven Fisher, FIG Regional Con, Hanoi, Vietnam, 19-22 October 2009

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IGS GPS+GLONASS Activities

- IGS provides GLONASS orbits as one of its core products
- 93 stations contribute to generation of the GLONASS orbit product

„The IGS Reference Station Guidelines“, Steven Fisher, FIG Regional Con, Hanoi, Vietnam, 19-22 October 2009

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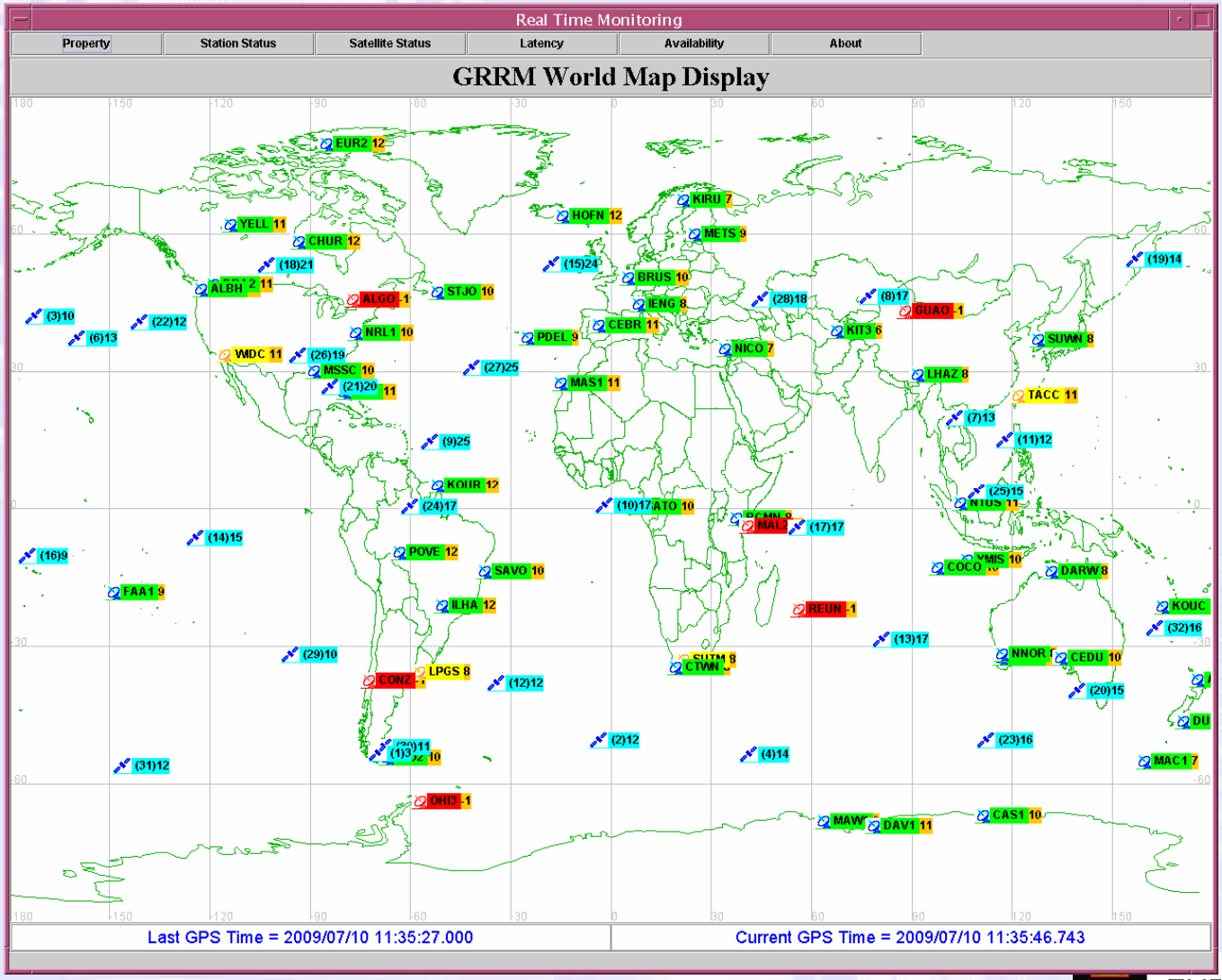
Components & Organisation

- Tracking Network
- Network Coordinator
- Global & Regional Data Centres
- Analysis Centres & Associate Analysis Centres
- Analysis Centre Coordinator
- Reference Frame Coordinator
- Timing Products Coordinator
- Infrastructure Committee
- Working Groups & Pilot Projects
- Central Bureau
- Governing Board

Working Groups & Pilot Projects

- Antenna Working Group
- Bias and Calibration Working Group
- Clock Products Working Group
- Data Centre Working Group
- GNSS Working Group
- Ionosphere Working Group
- Low Earth Orbiters (LEO) Working Group
- Troposphere Working Group
- Reference Frame Working Group
- Tide Gauge Benchmark Monitoring Pilot Project
- Real-Time Pilot Project

IGS Real-Time Network



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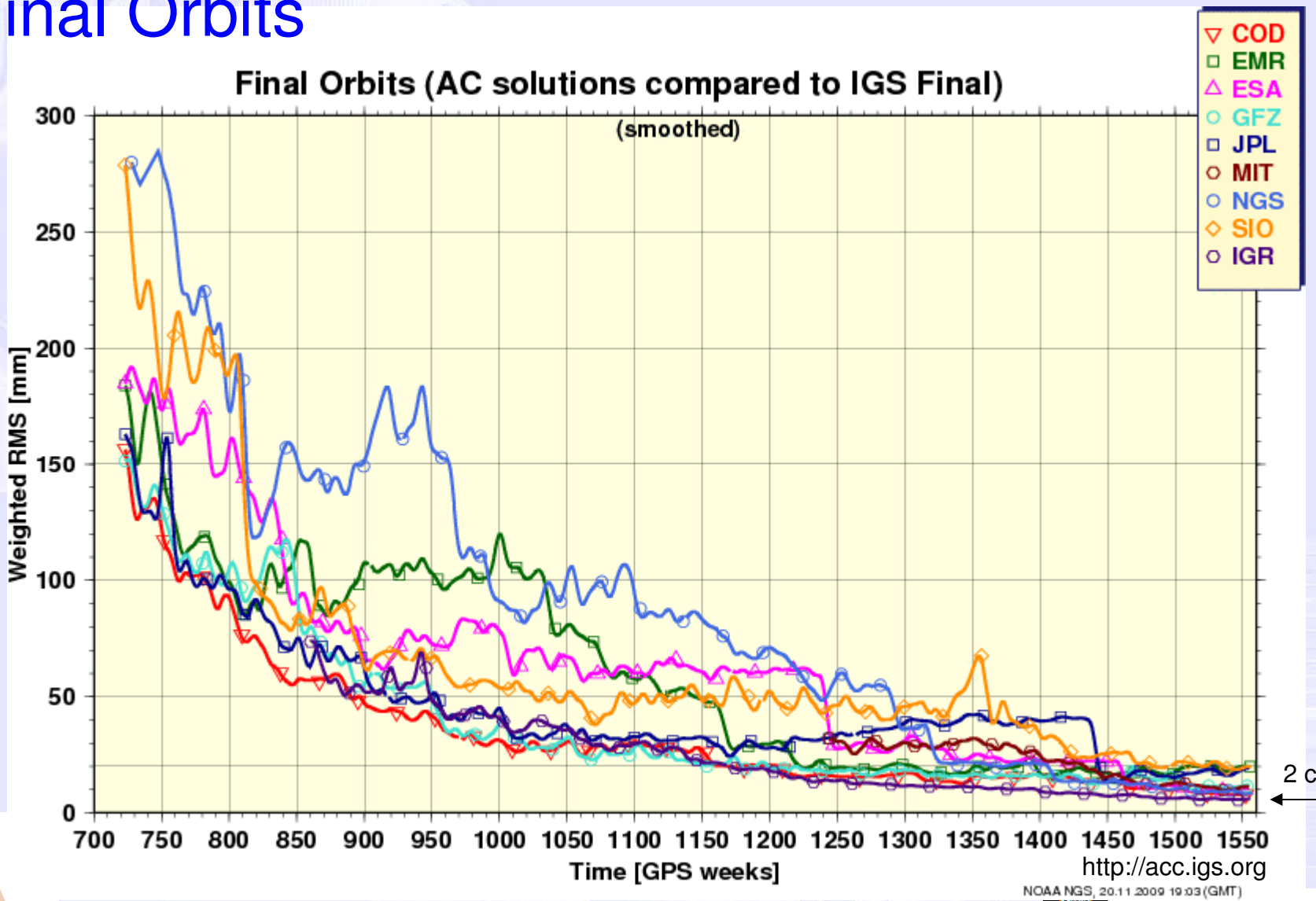
IGS Product Summary

- Precise GNSS orbits (PP & predicted):
  - GPS (3-5 cm, 3dwrms), predictions (10-20 cm)
  - GLONASS (~10-20 cm, 3dwrms)
- GNSS clock corrections (satellite, ground: sub-ns)
- Earth orientation parameters (polar motion, length of day)
- Ground positioning (sub-cm)
- Consolidated input to ITRF definition/maintenance
- Ionospheric delay mapping
- Tropospheric corrections (integrated water vapour)

→ Quality Control as key driver for IGS product improvement

→ All IGS products are available for free

Final Orbits



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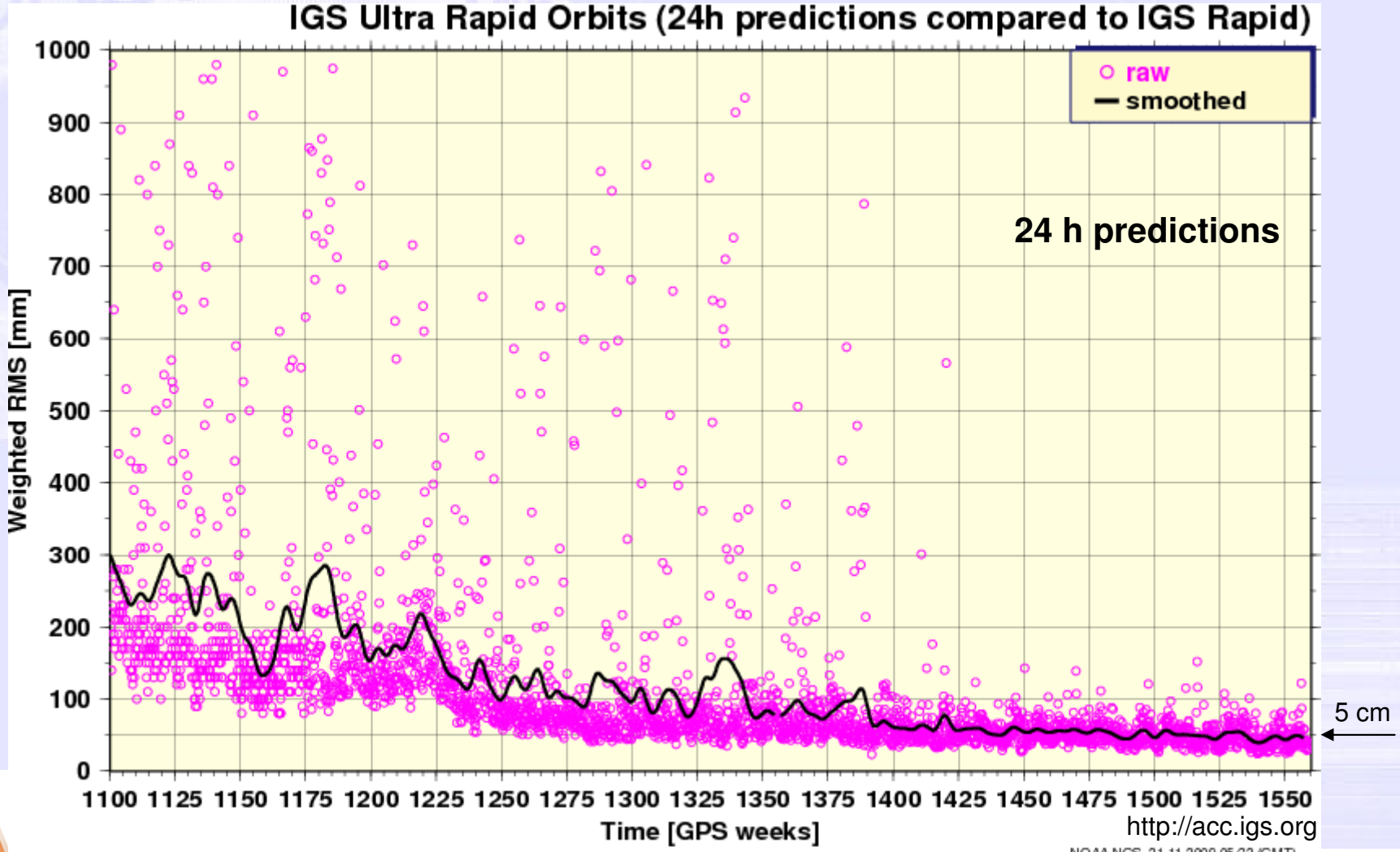
Ultra Rapids



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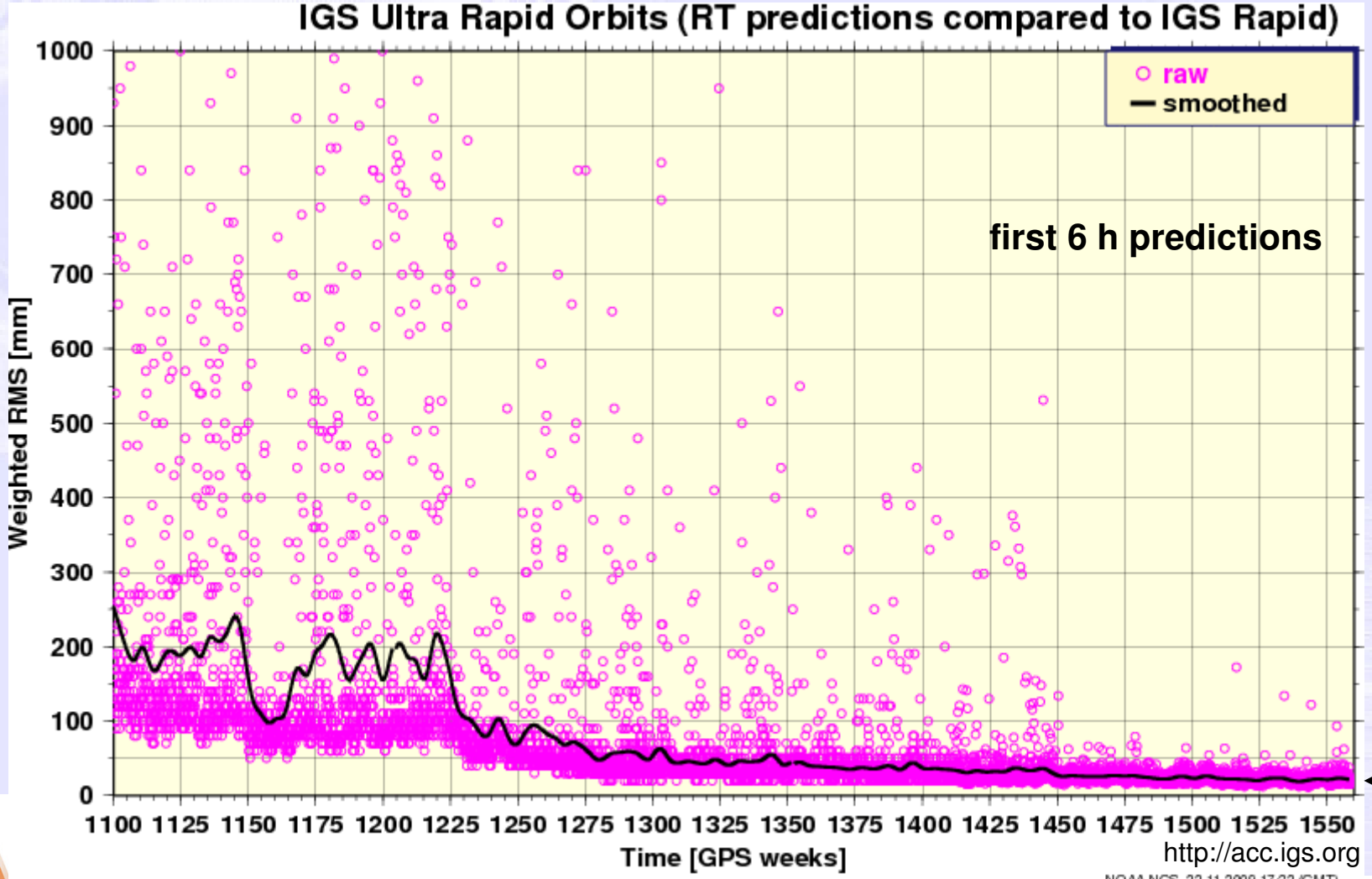
Ultra Rapids



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IGS Strategic Plan

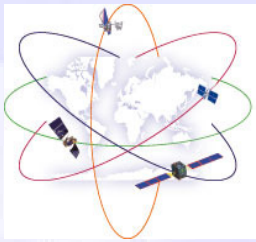
- Deliver world-standard quality GNSS data and products to all users globally with leading-edge expertise and resources.
- Develop, integrate, and participate with new and changing GNSS systems, and understand user needs to continuously improve the IGS to provide value to a broad range of users.
- Continuously improve the effectiveness of the IGS governance and management to support growth of the service.

http://igscb.jpl.nasa.gov/overview/pubs.html

What's ahead for the IGS?

- **IGS performance must improve, more products will be produced, and IGS will continue to be the most critical component of GGOS**
- A subnetwork to support generation of real-time products is being be established under IGS – *expected to move from pilot phase to operational over next few years*
- Stations that support multi-GNSS are sought:
  - GLONASS – *need more stations to support GLONASS orbit products right now*
  - COMPASS, Galileo, IRNSS, QZSS – coming, *IGS will produce products*
  - Stability of reference frame as core stations are upgraded is a key issue
  - IGS cooperating in Asia-Oceania multi-GNSS experiment

„The IGS Reference Station Guidelines", Steven Fisher, FIG Regional Con, Hanoi, Vietnam, 19-22 October 2009



ICG International Committee on Global Navigation Satellite Systems

- ICG established since 2006 to coordinate system providers and facilitate international use of GNSS
- United Nations - Office of Outer Space Affairs is the Secretariat of ICG
- IGS is an Associate Member of ICG
- IGS, FIG and IAG co-chair ICG Working Group D, '*Interactions with National/Regional Authorities & International Organizations in Monitoring, Networks, & Reference Frames*'
- 5th ICG meeting, Turin, Italy, Oct 2010; 4th ICG meeting, St. Petersburg, Russia, Sept 2009; 3rd ICG meeting Pasadena, USA, Dec 2008

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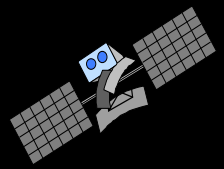
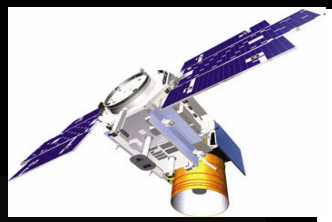


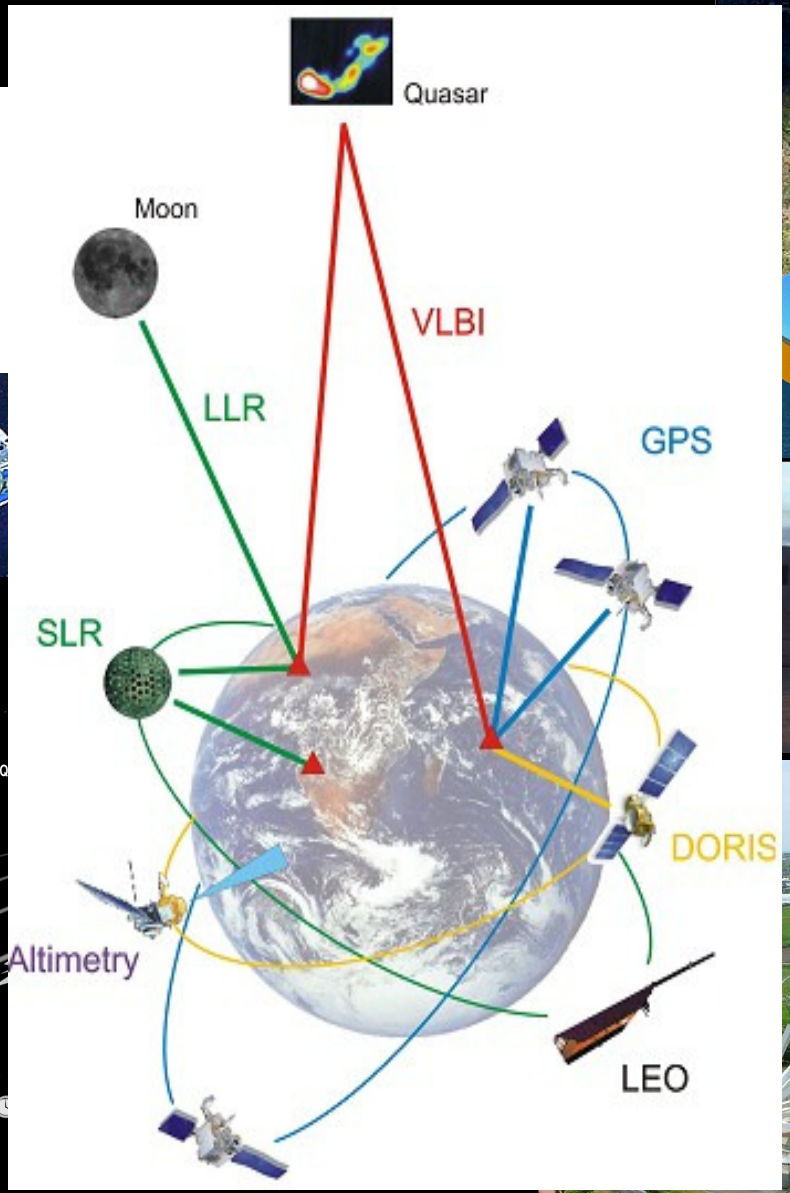
GNSS/IGS is fundamental to geodesy's future role as a high-accuracy global earth monitoring system…

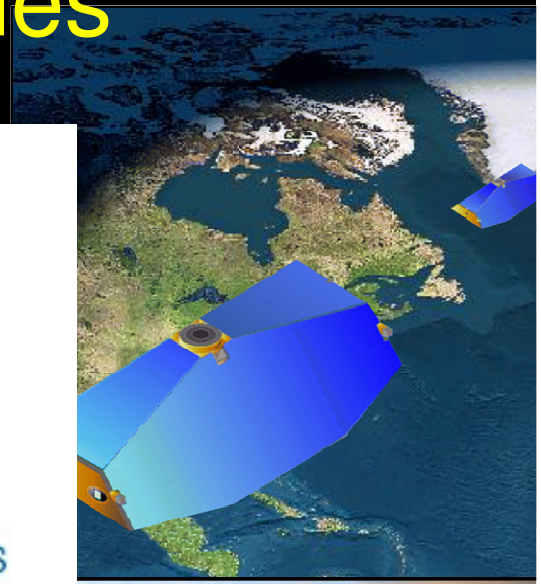
GNSS/IGS is core to the IAG's Global Geodetic Observing System

Space Geodetic Techniques

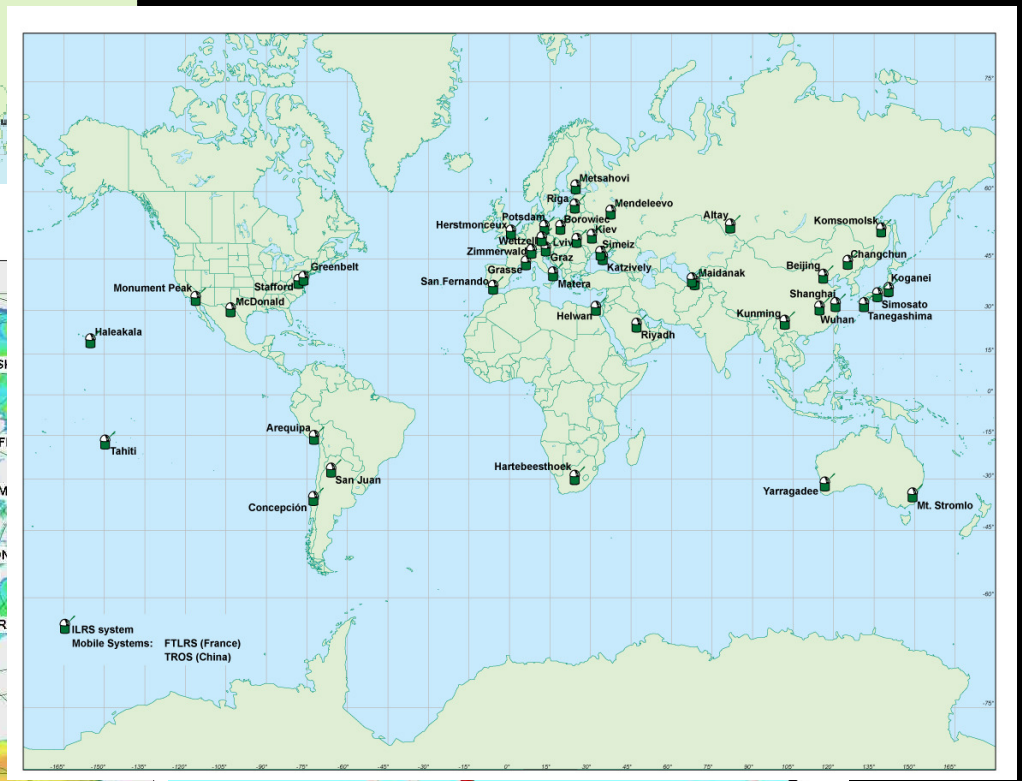
a large toolkit…



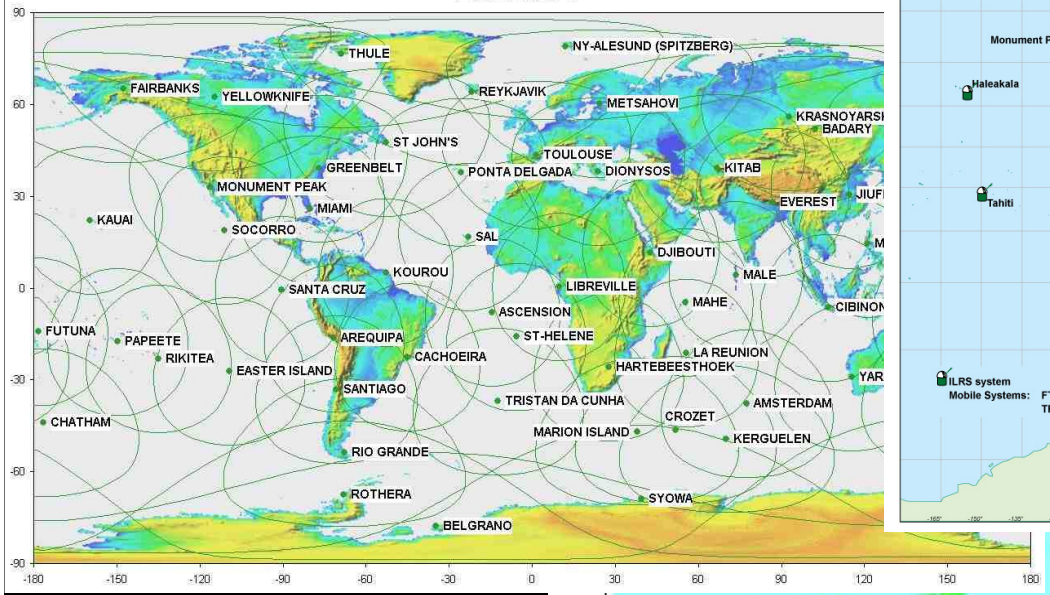


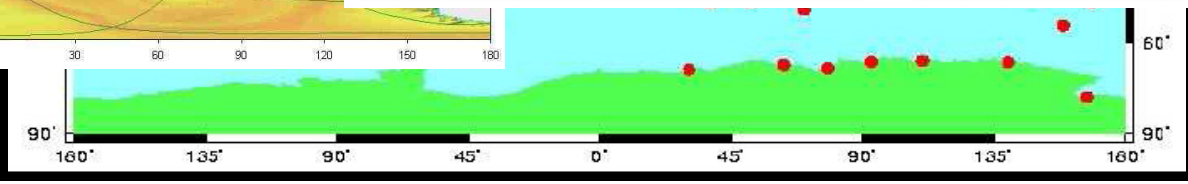


Hydrogen maser clock
(accuracy 1 sec in
1 million years)



Jason-1 DORIS stations visibilities
Elevation 12°





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