NASA GPS Applications for Scientific Investigations

Frank H. Bauer[1], Ruth Neilan[2]
NASA Headquarters[1], NASA Jet Propulsion Laboratory[2]

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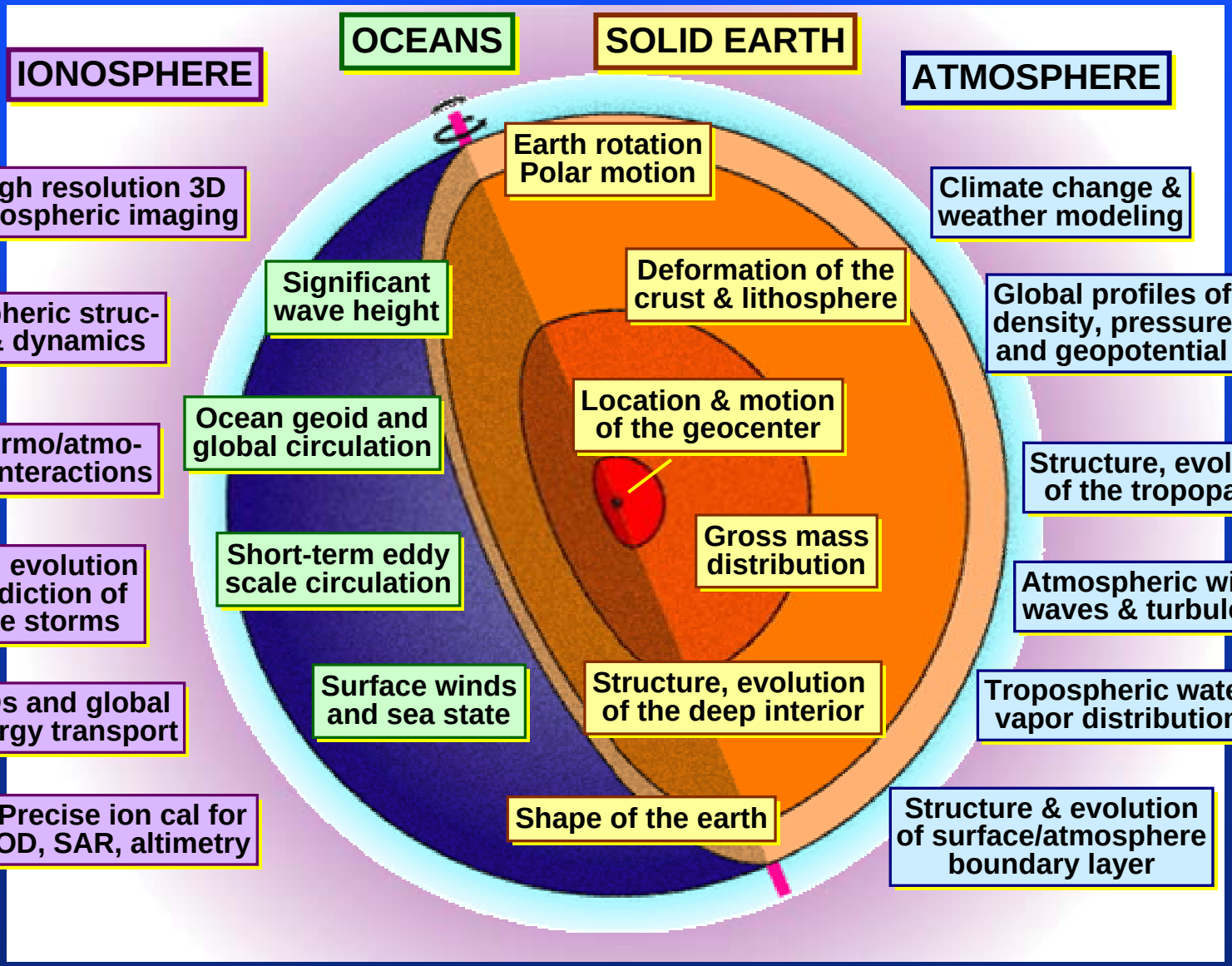
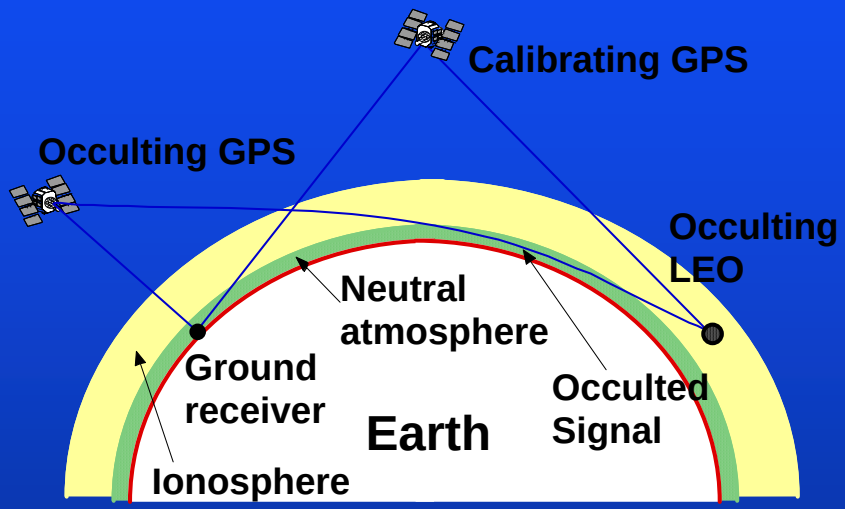
Space Applications of GPS: Probing the Earth



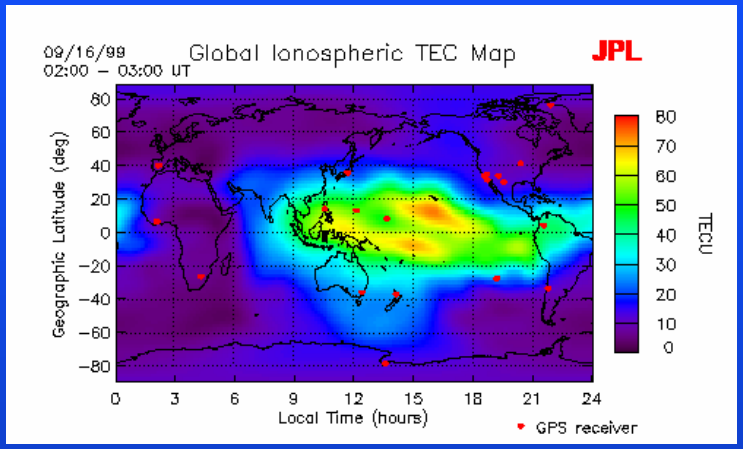
Space Applications of GPS: Atmosphere & Ionosphere Science Investigations

GPS Satellite Occultation Techniques



GPS Occultation Techniques

- GPS Receivers in Low-Earth Orbit
- High-resolution soundings of atmospheric properties (e.g., water vapor, temperature, pressure), new observations important for weather and climate studies
- Ionospheric tomography - structure and irregularities, interest for scientific research and space weather applications



Ionospheric Remote Sensing

- Developed real-time software for GPS orbits, clocks, and ionosphere maps - technology transfer for aviation (US WAAS)
- Enhanced ionosphere capability ⇒ improved safety/availability algorithms and input to advanced space weather models
- Improved space weather research

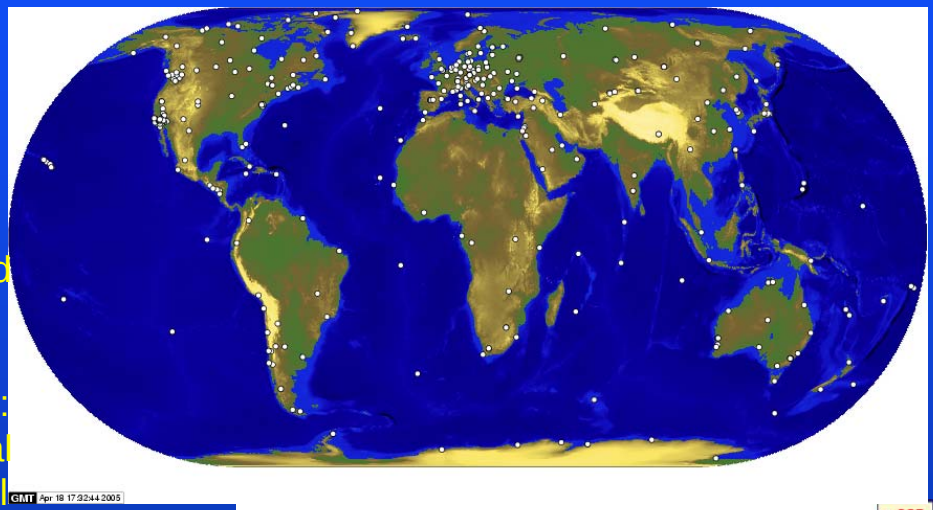
International GNSS Service

Formerly the International GPS Service

GNSS: Global Navigation Satellite System

The IGS is a voluntary federation of more than 200 worldwide agencies that pool resources and permanent GNSS station data to generate precise GNSS products.

Over 350 permanent, geodetic GNSS stations operated by more than 100 worldwide agencies comprise the IGS network. Currently the IGS supports two GNSS: GPS and the Russian GLONASS.



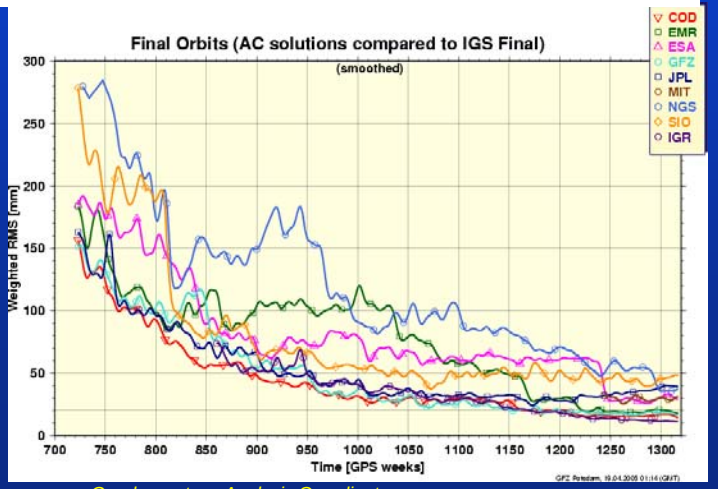
NASA funds two centers, JPL and GSFC, to support IGS: Day-to-day management and coordination by IGS Central Bureau; responsibility and management of NASA's global GPS network that contributes to the IGS Network; an IGS Analysis Center (one of eight) for GPS orbits, clocks, and reference frame products; and an IGS Global Data Center where full access to data and products is provided.

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.

IGS is a key component contributing to the ITRF and enabling its densification. IGS fosters unique application projects and working groups.

IGS Projects & Working Groups

IGS Reference Frame
Precise Time & Frequency Transfer
GLONASS Pilot Service Project
Low Earth Orbiters Project
Ionosphere WG
Atmosphere WG
Sea Level - TIGA Project
Real-Time WG
Data Center WG
GNSS WG

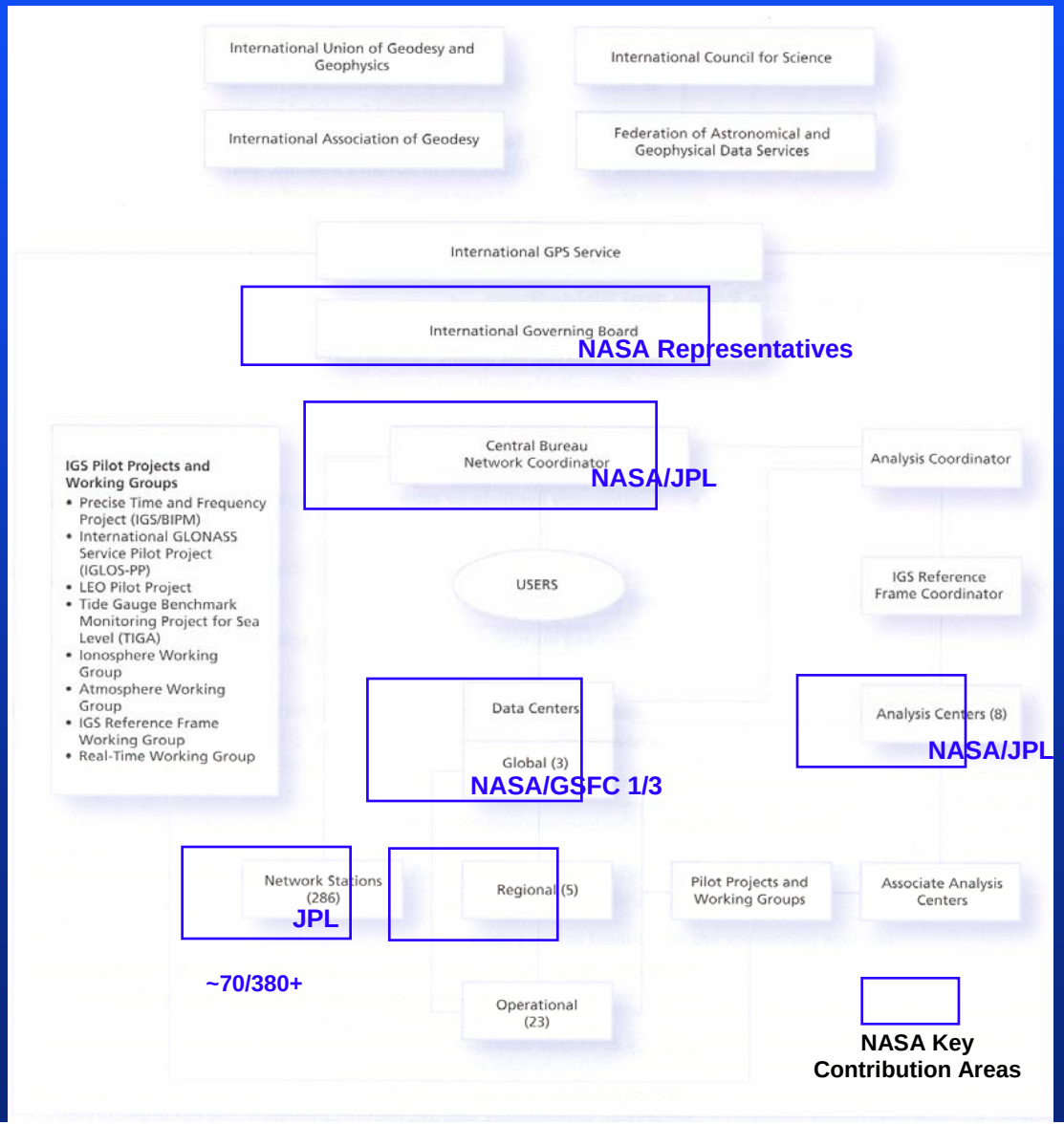


Graph courtesy Analysis Coordinator

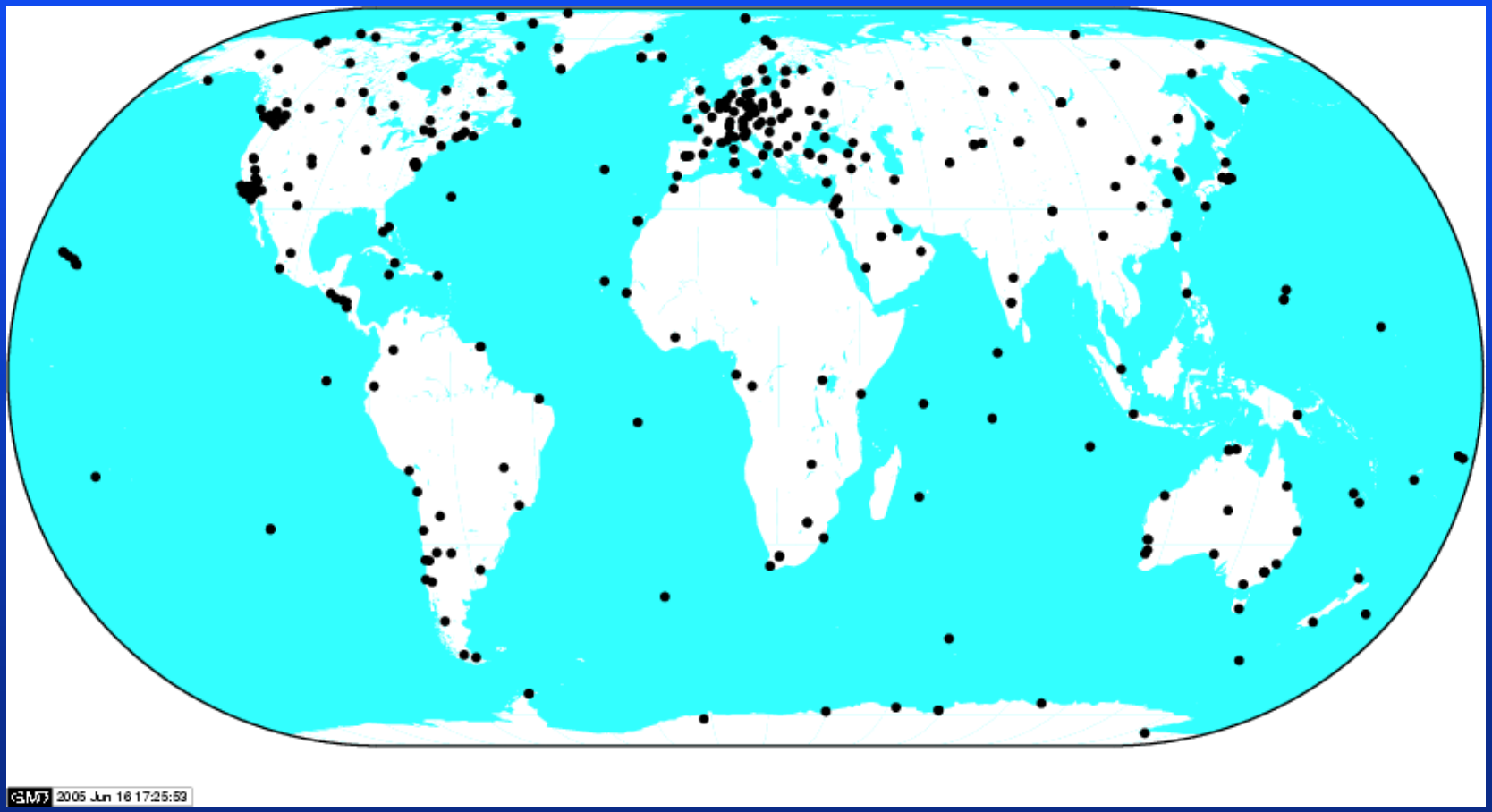
G. Gendt, GFZ Potsdam

NASA Supports the IGS

The IGS is an international science consortium involving over 200 organizations from nearly 100 countries and is strongly supported by NASA since 1992.

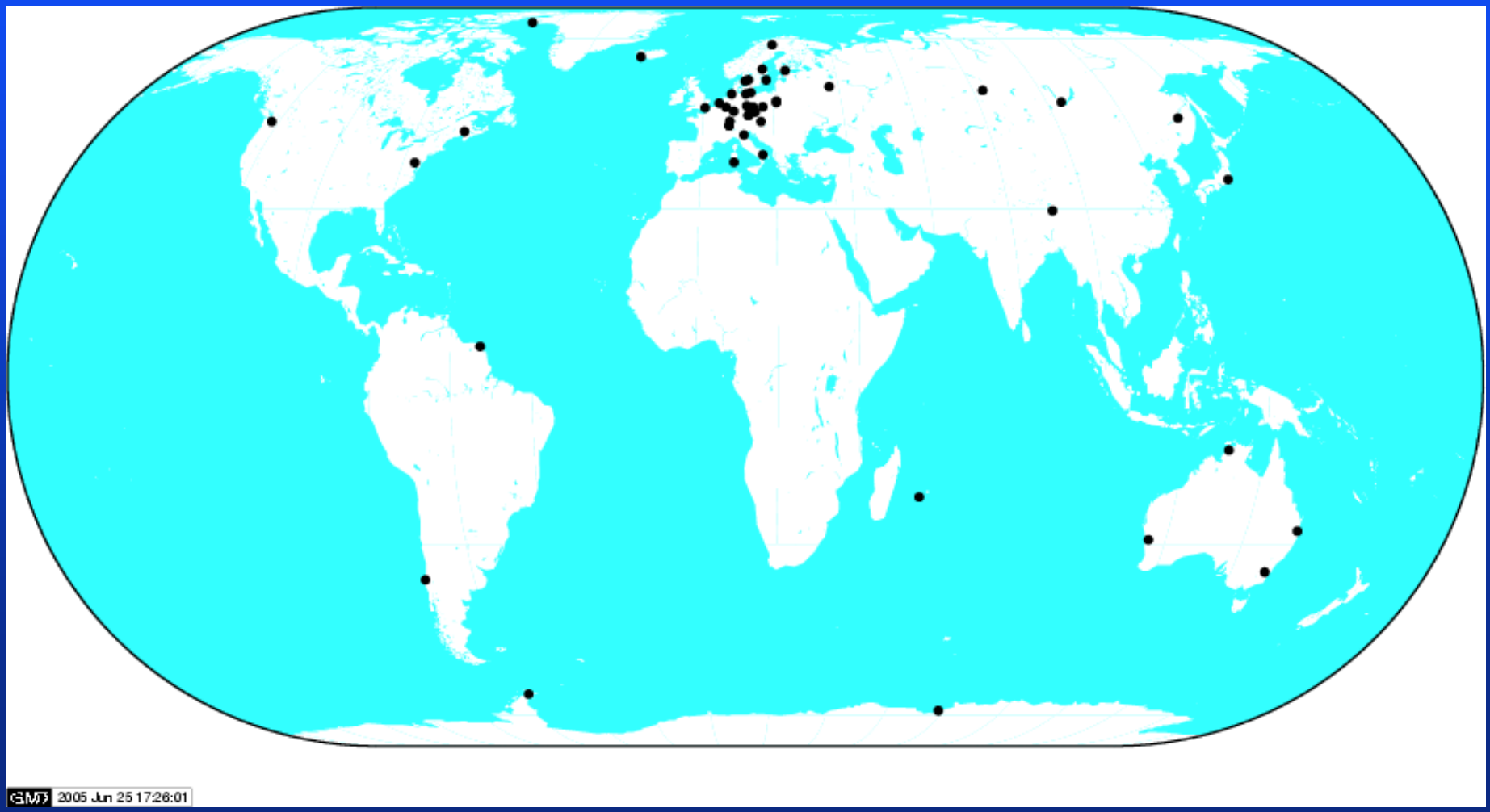


IGS Tracking Network 2005
(GPS + GLONASS)



http://igscb.jpl.nasa.gov/network/netindex.html

GLONASS Network
(GLONASS/GPS Receivers)

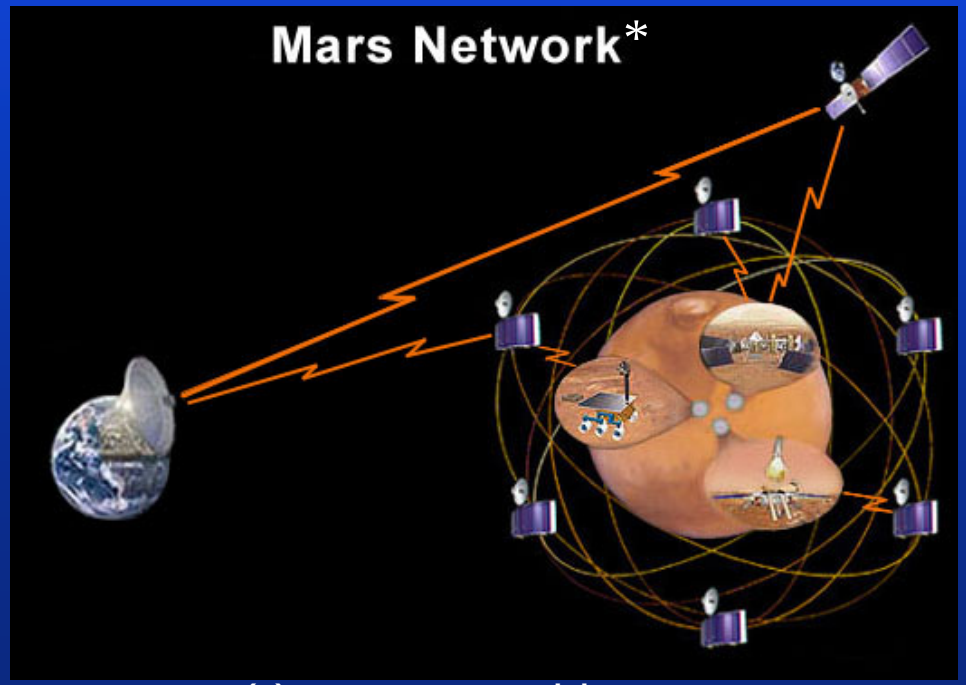


NASA's Vision for Space Exploration
Supporting Infrastructure: Extend GPS?

Seamless reference and timing based on GPS technology, from the Earth to the Moon and beyond

Example: Mars Network -

- Integrated Navigation and Telecommunications
- Develop an in situ navigation capability to enable more precise targeting and location information on approach and at Mars - GPS-like system at Mars



(*) concept architecture

Backups

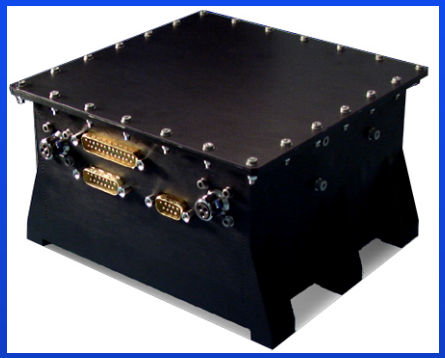
The Vision for Space Exploration : Mandate

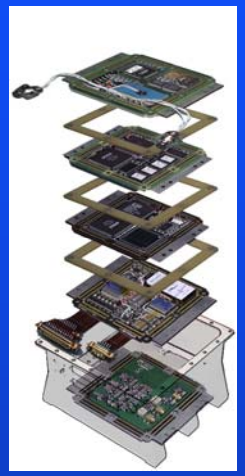
- **On January 14 2004, the US President announced a new vision for NASA**
  - **Implement a sustained and affordable human and robotic program to explore the solar system and beyond;**
  - **Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations;**
  - **Develop the innovative technologies, knowledge, and infrastructures both to explore and to support decisions about the destinations for human exploration; and**
  - **Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests.**

NASA GPS Space Receivers – Overview

Unprecedented Accuracy & Vehicle Security for NASA's Demanding Space Missions

Blackjack Family (JPL)





Ultra-precise: 2-cm orbit accuracy
10-psec relative timing

MAGR-S / SIGI (JSC)

Secure Capability for Shuttle

Attitude & Navigation for ISS

Pivot / Navigator & Low Power Transceiver (GSFC)

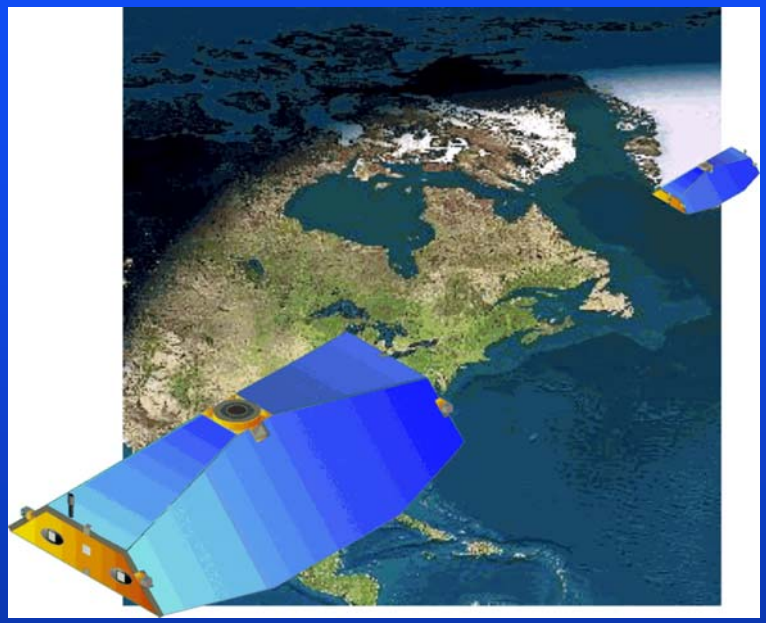
Weak Signal Detection & Fast Acquisition for High Earth Orbits

Reconfigurable Software Defined Receiver

Space Applications of GPS: Geodesy & Oceanography Science Investigations

Gravity Field Measurements

- GRACE dual-satellite mission
- JPL GPS Receiver with integrated camera and K-band spacecraft to spacecraft tracking
- 1-micron accuracy measurement
- Improve knowledge of the Earth's gravity field by several orders of magnitude



Bi-Static Ocean Reflectrometry

- Using reflected GPS signals, measure sea-surface height and winds
- Macro (Global) view of Ocean dynamics through spaceborne techniques expected to improve weather prediction and provide Tsunami detection