

# Update on the International Terrestrial Reference Frame (ITRF)

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**IGN**

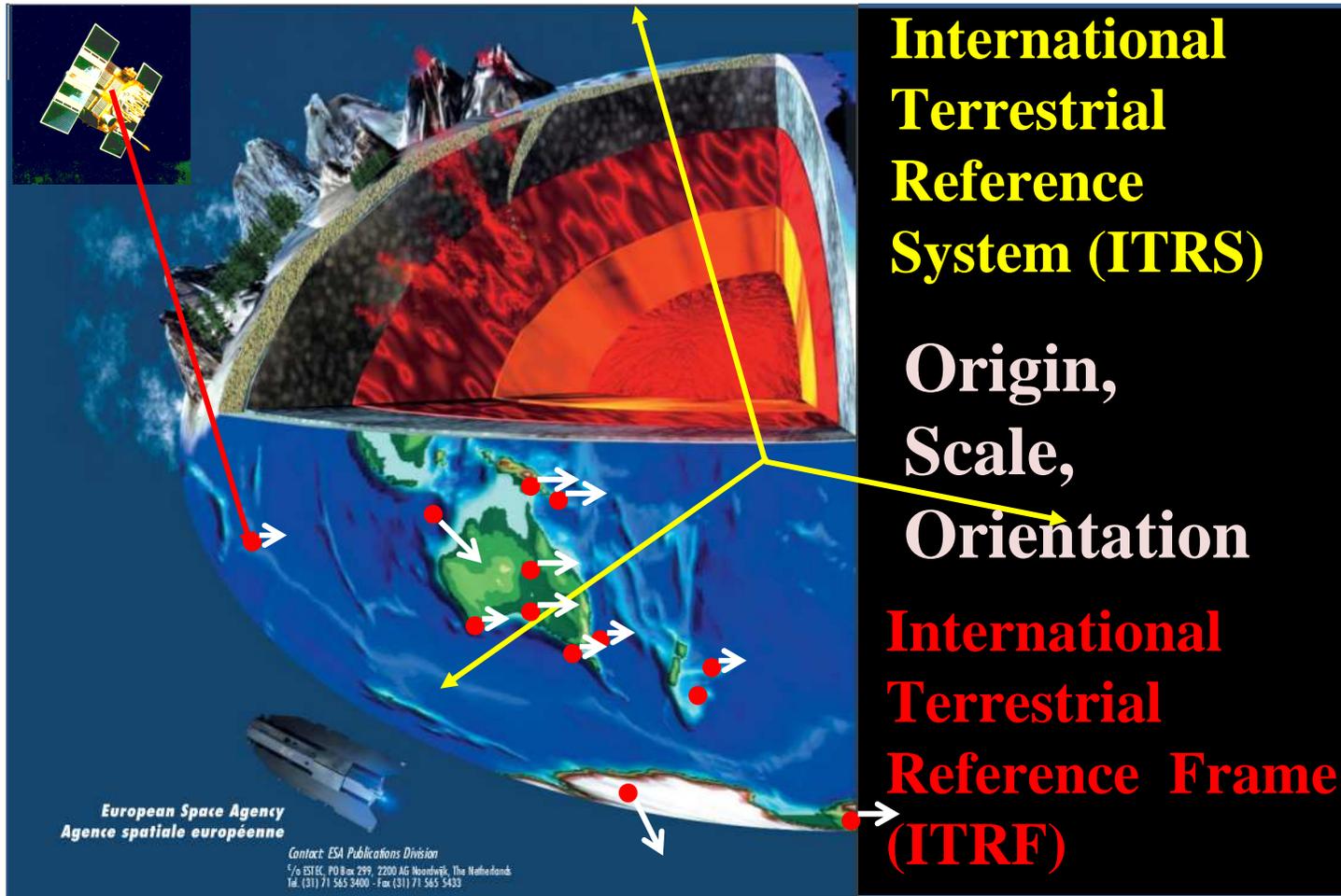
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# Outline

- **Introduction**
- **ITRF Current Status**
- **GNSS and ITRF**
- **Next ITRF Release : ITRF2013**

# The ITRF: Combination of 4 techniques :



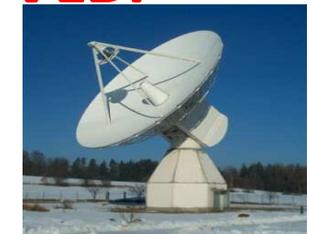
**GNSS**



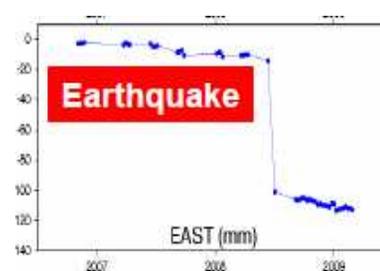
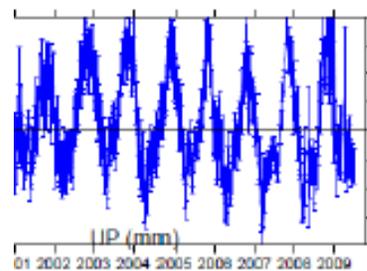
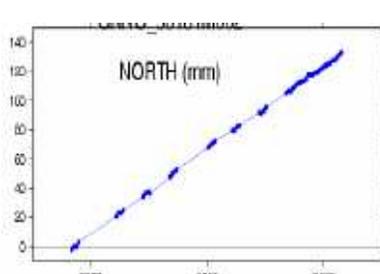
**DORIS**



**VLBI**



**SLR**



# Why is a Reference Frame needed?

- **Precise Orbit Determination for:**
    - **GNSS: Global Navigation Satellite Systems**
    - **Other satellite missions: Altimetry, Oceanography, Gravity**
  - **Earth Science & Societal Applications**
    - Mean sea level variations
    - Hazard mitigation and tsunami warning
    - Plate motion and crustal deformation
    - Glacial Isostatic Adjustment (GIA)
    - ...
  - **Geo-referencing applications : positioning, navigation, surveying...**
- 
- **GNSS is today's tool for all the above and for accessing the ITRF**
- ==> Inter-Operability between GNSS is needed**

# The International Terrestrial Reference Frame (ITRF)

- Established and maintained by the **International Earth Rotation and Reference Systems Service (IERS)**
- Adopted by IAG & IUGG in 1991 & 2007 and by CGPM in 2011 for Earth science & timing applications
- Updated every 3-5 years: ITRF88,...,2000,2005
- Current Version: **ITRF2008**
- **Coming soon by mid 2014: ITRF2013**

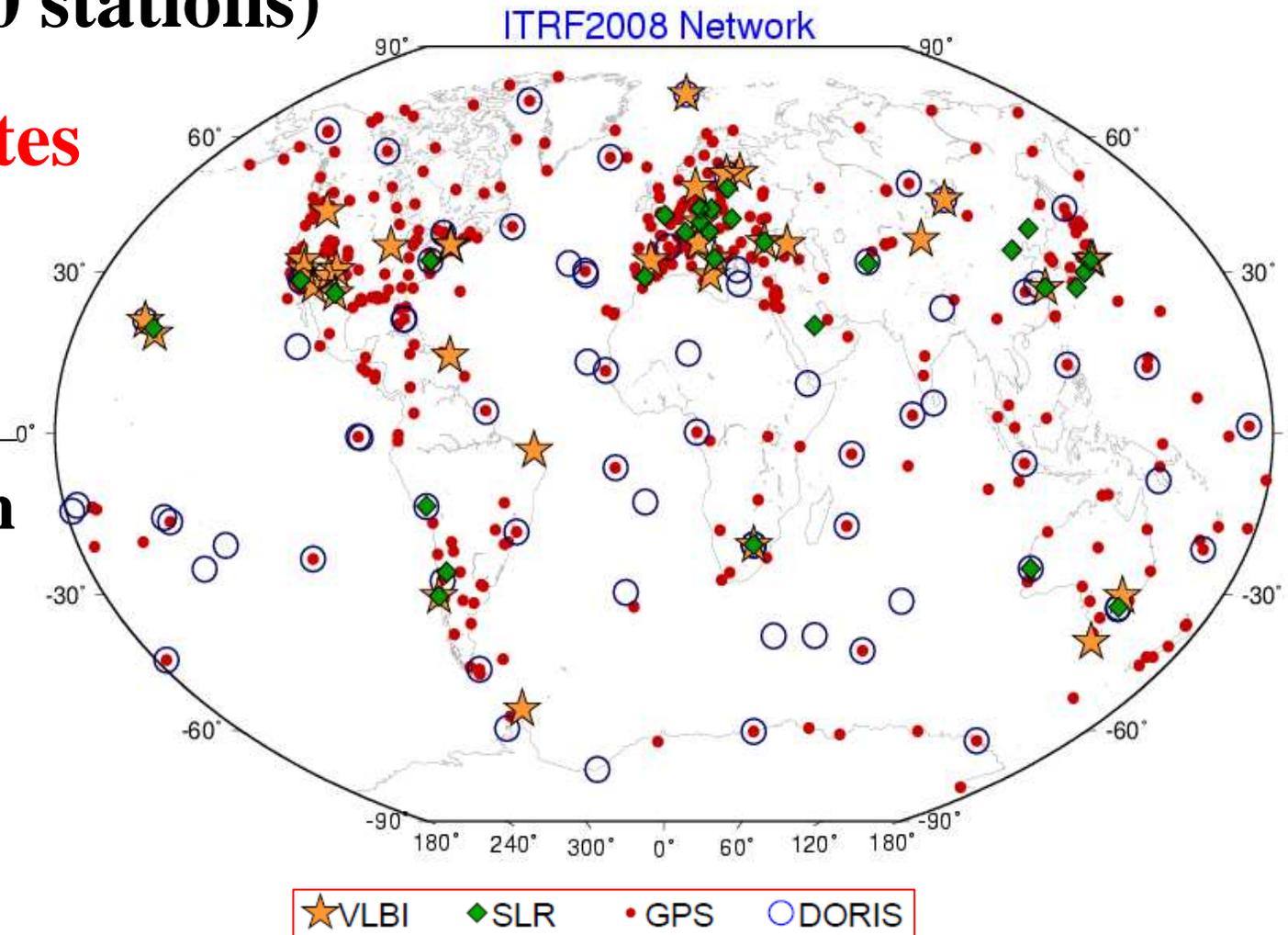
# ITRF2008 Network

580 sites (920 stations)

492 GNSS sites

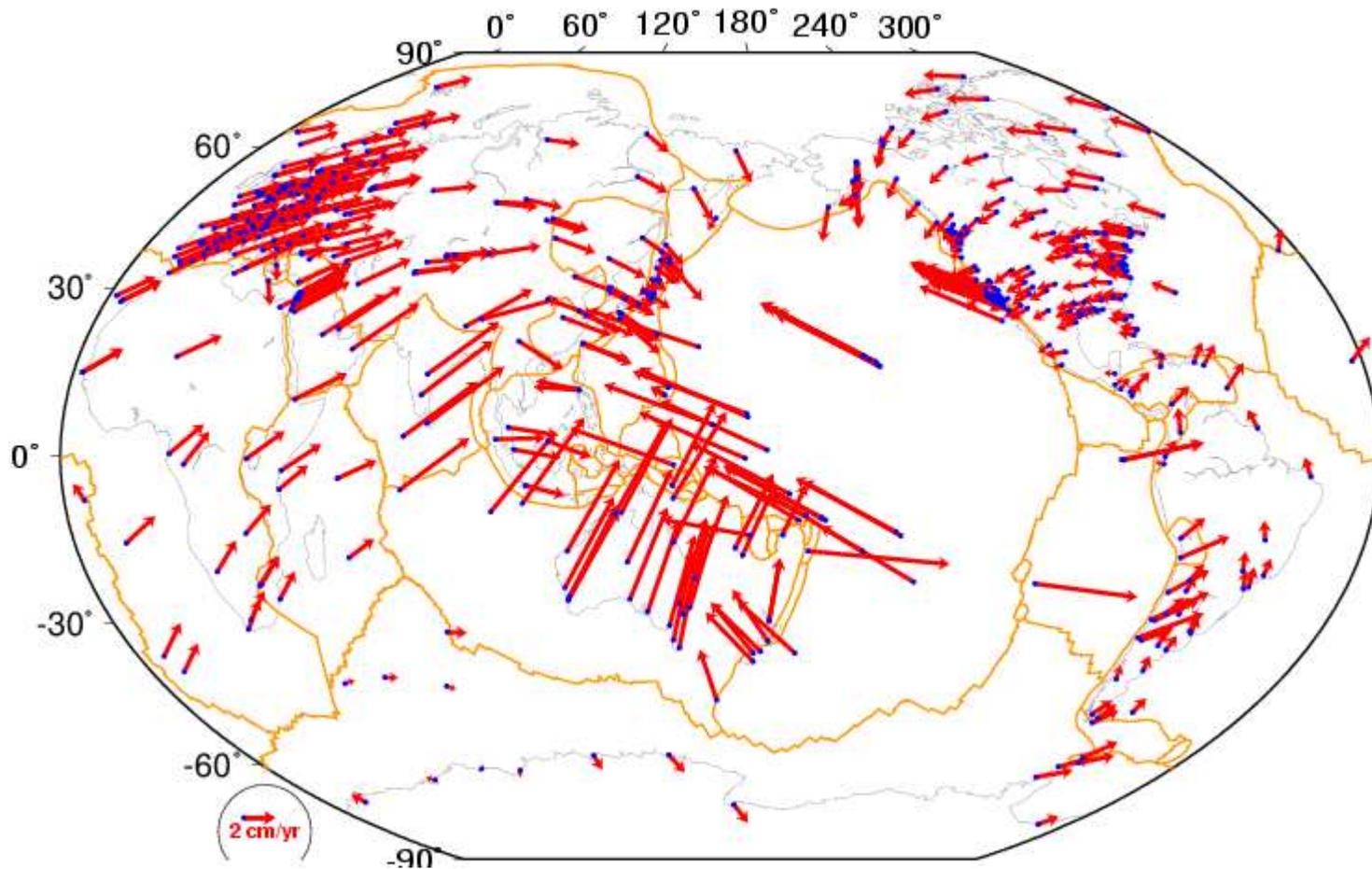
461 Sites North

118 Sites South



# ITRF2008 Site Velocities:

time-span > 3 yrs, ( $\sigma \sim 0.1 - 1$  mm/yr)

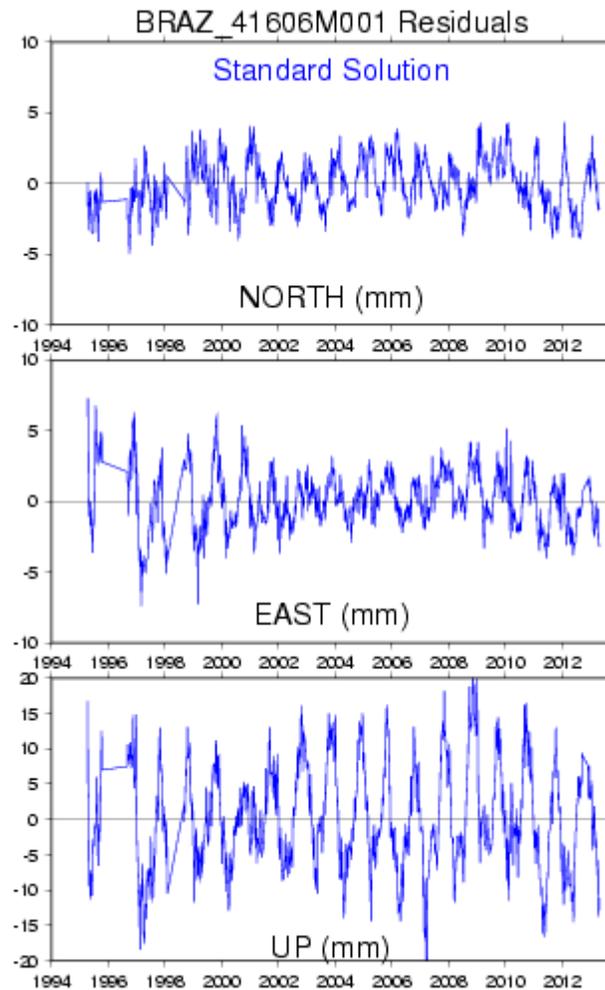


$$X(t) = X(t_0) + \dot{X}(t - t_0)$$

# Next ITRF solution (ITRF2013)

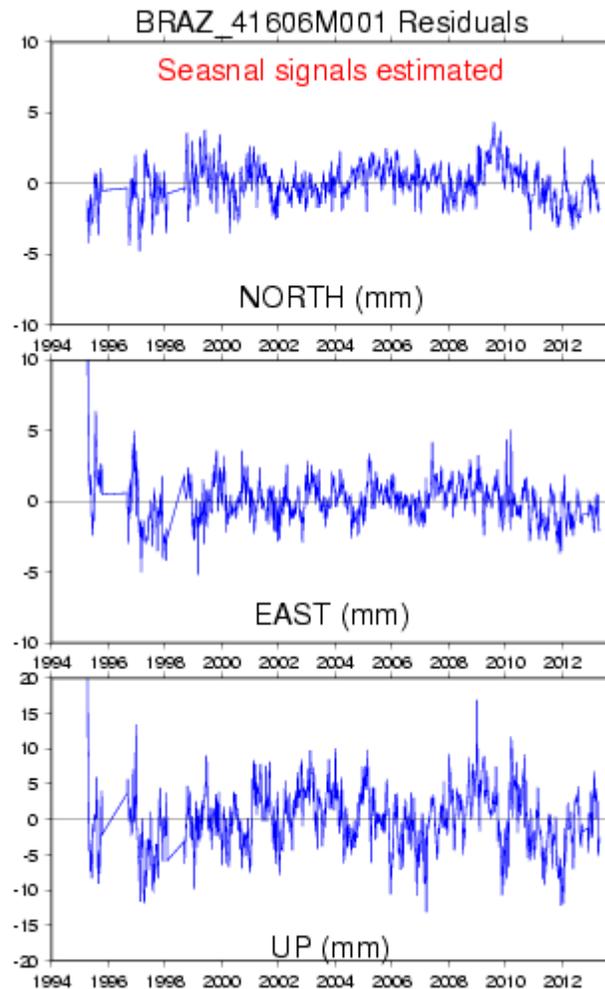
- **To be ready by mid 2014**
- **Expected Improvements & Developments:**
  - **Reprocessed solutions from the 4 techniques ;**
  - **Improved modeling of non-linear station motions**
    - **All kind of ruptures/discontinuities in the position time series**
    - **Seasonal signals**
    - **Modeling of post-seismic deformation**

# Seasonal Signals



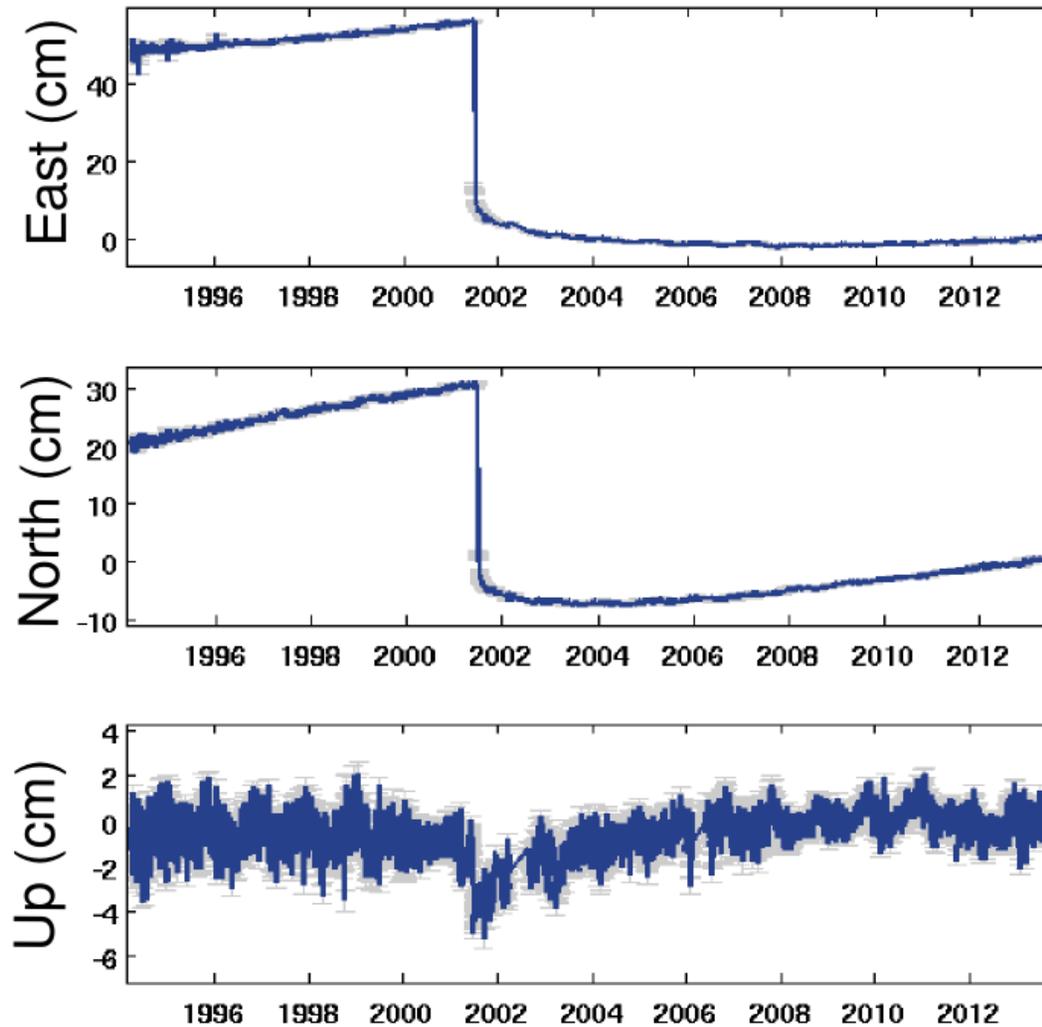
## Brazilia (Brazil)

# Seasonal Signals



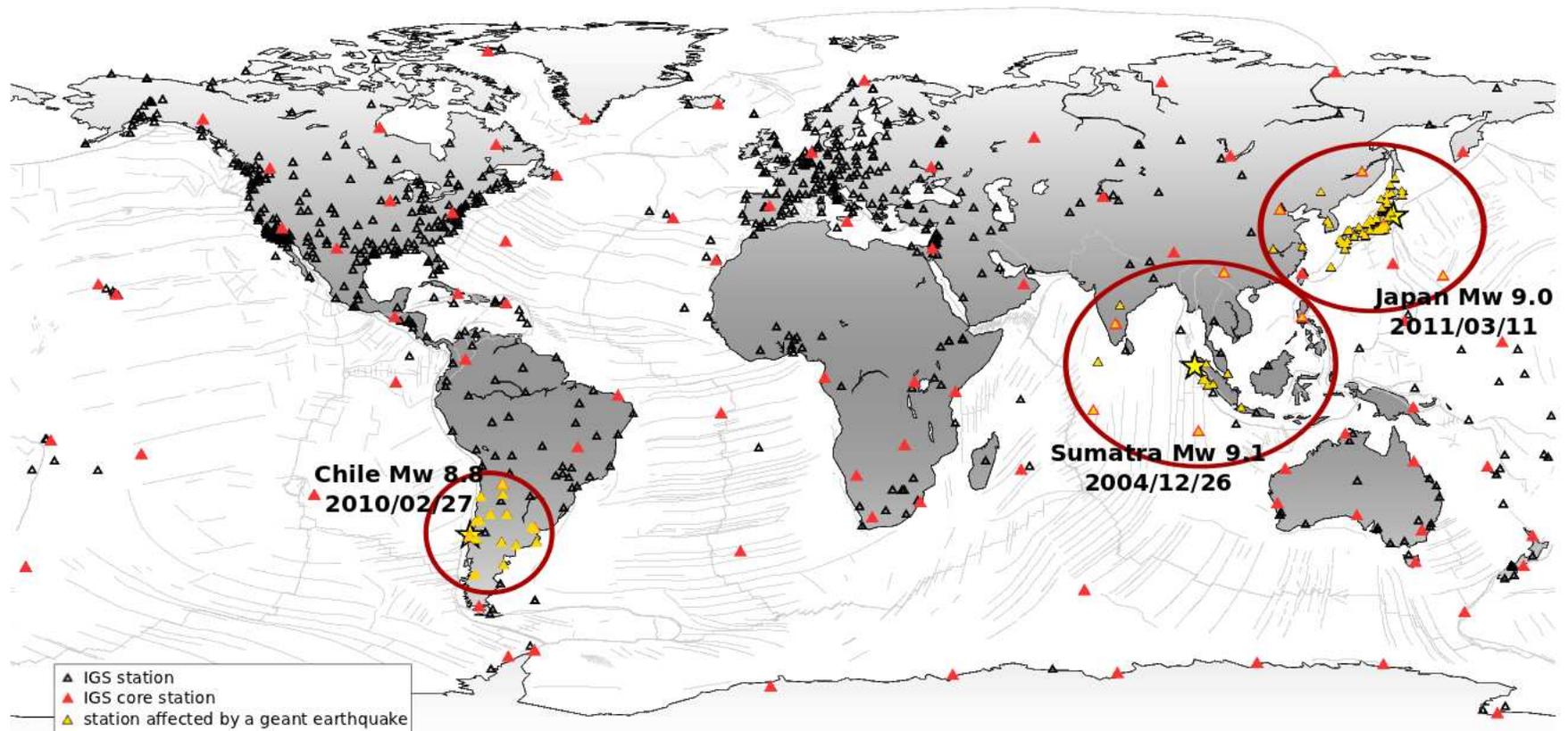
## Brazilia (Brazil)

# Post-Seismic Deformation



## Arequipa (Peru)

# Giant Earthquakes



**Quantify impact of giant Earthquakes on ITRF stability**

# Strengths of GNSS

- GNSS/IGS **IS** the link between DORIS, SLR and VLBI networks in the ITRF combination
- Most precise and accurate polar motion
- Geographic density
  - Covering most tectonic plates
  - Allows maintaining the same orientation and its time evolution between successive ITRF solutions
- Real, near real time and universal access to ITRF **using IGS products**

# Access to the ITRF and the IGS role

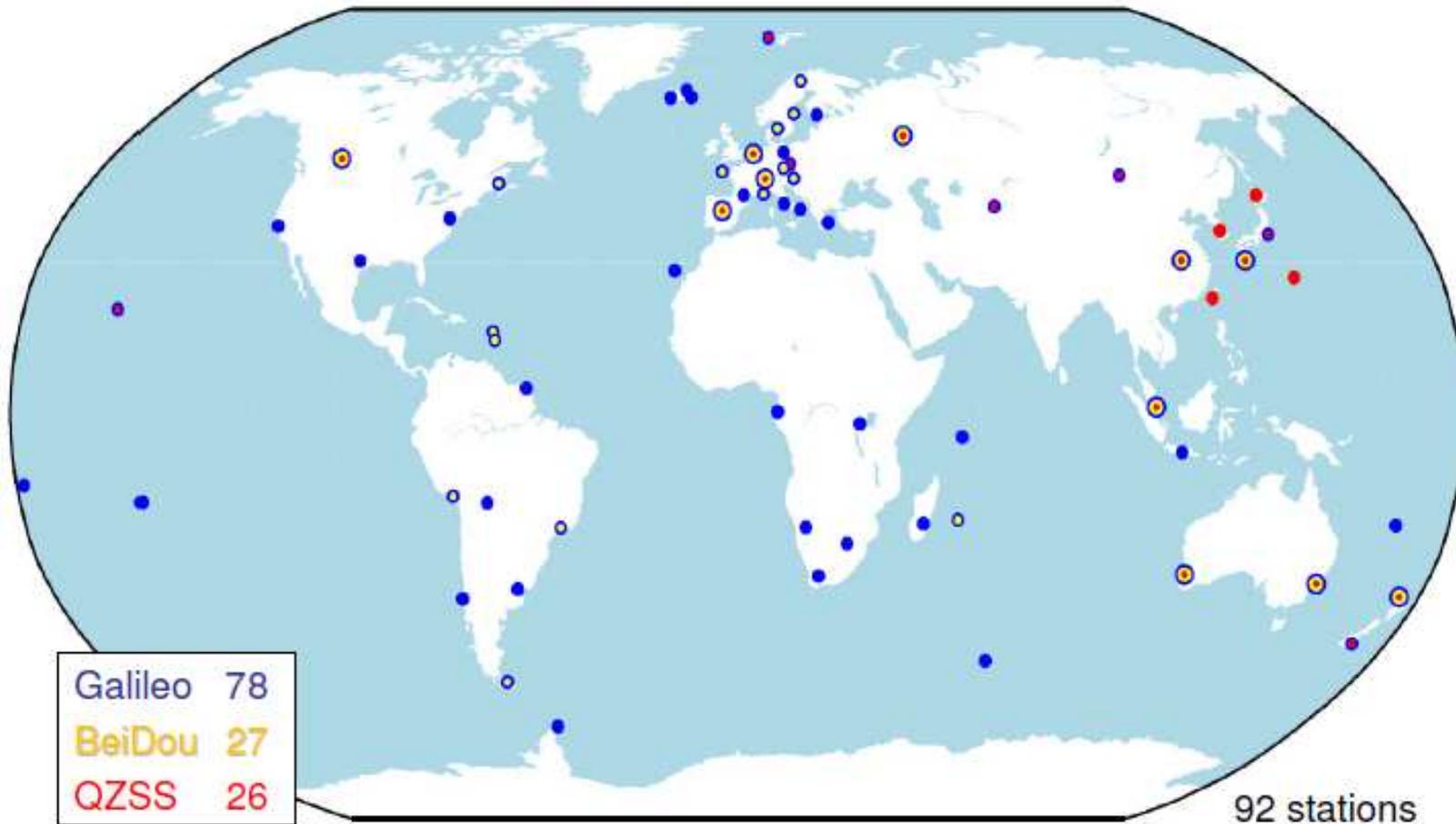
- Any GNSS network can easily be expressed in the ITRF using IGS products (orbit, clocks, ERP: all expressed in the ITRF)
- Publicly available:
  - IGS/GNSS observations (RINEX files) & Products
  - Geodetic/mathematical procedure to express a GNSS network in the ITRF is
  - Scientific software packages

# GNSS and their associated reference systems

<u>GNSS</u>	<u>Ref. System/Frame</u>
• GPS (precise IGS orbits)	ITRS/ITRF
• GPS (broadcast orbits)	WGS84
• GLONASS	PZ-90
• GALILEO	GTRF $\approx$ ITRF
• BeiDou	CGCS 2000
• QZSS	JGS
• All are now aligned to the ITRF2008	
• Assessment of agreement with the ITRF (IGMA)?	
• $\sigma$ -Position using broadcast ephemerides = 150 cm ?	

# IGS MGEX

## IGS MGEX Network



# Conclusion: Key Points

- **GNSS provides high accuracy for positioning applications**
- **IAG/IERS provides the International Terrestrial Reference Frame (ITRF), **the most accurate global RF available today;****
- **All GNSS positioning services rely on the ITRF availability, through IGS products;**
- **Implementation of GNSS-based Global, Regional & National reference frames depend & rely on the availability of the ITRF;**
  
- **ICG WG-D notes the progress of the alignment of GNSS associated reference frames to the ITRF**
- **ICG to acknowledge/support UN-GGIM initiative: need for UN mandate for the GGRF and its infrastructure**

# Geodetic Community Wishes Toward GNSS Providers

- **Satellite antennas to be calibrated before launch**  
==> Ensure/improve the **scale** stability of the GNSS RF
- **Add an accelerometer & ultra-stable clock to each GNSS satellite**  
==> Improve the **geocenter** determination by GNSS
- **Provide data of subset of GNSS control stations to IGS for inclusion in the ITRF (cf. ICG-6 WG-D Recommendation)**  
==> **(1) facilitate GNSS RF alignment to ITRF & (2) ensure interoperability between GNSS RFs**

# Thank you