

Brief presentation and description of ITRF2014

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INSTITUT NATIONAL
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Key Points

- **Introduction: Reference Frames for science and societal applications**
- **The UN-GGIM Initiative: a great opportunity for global geodesy**
- **ITRF2014:**
 - Some results
 - GNSS Contribution

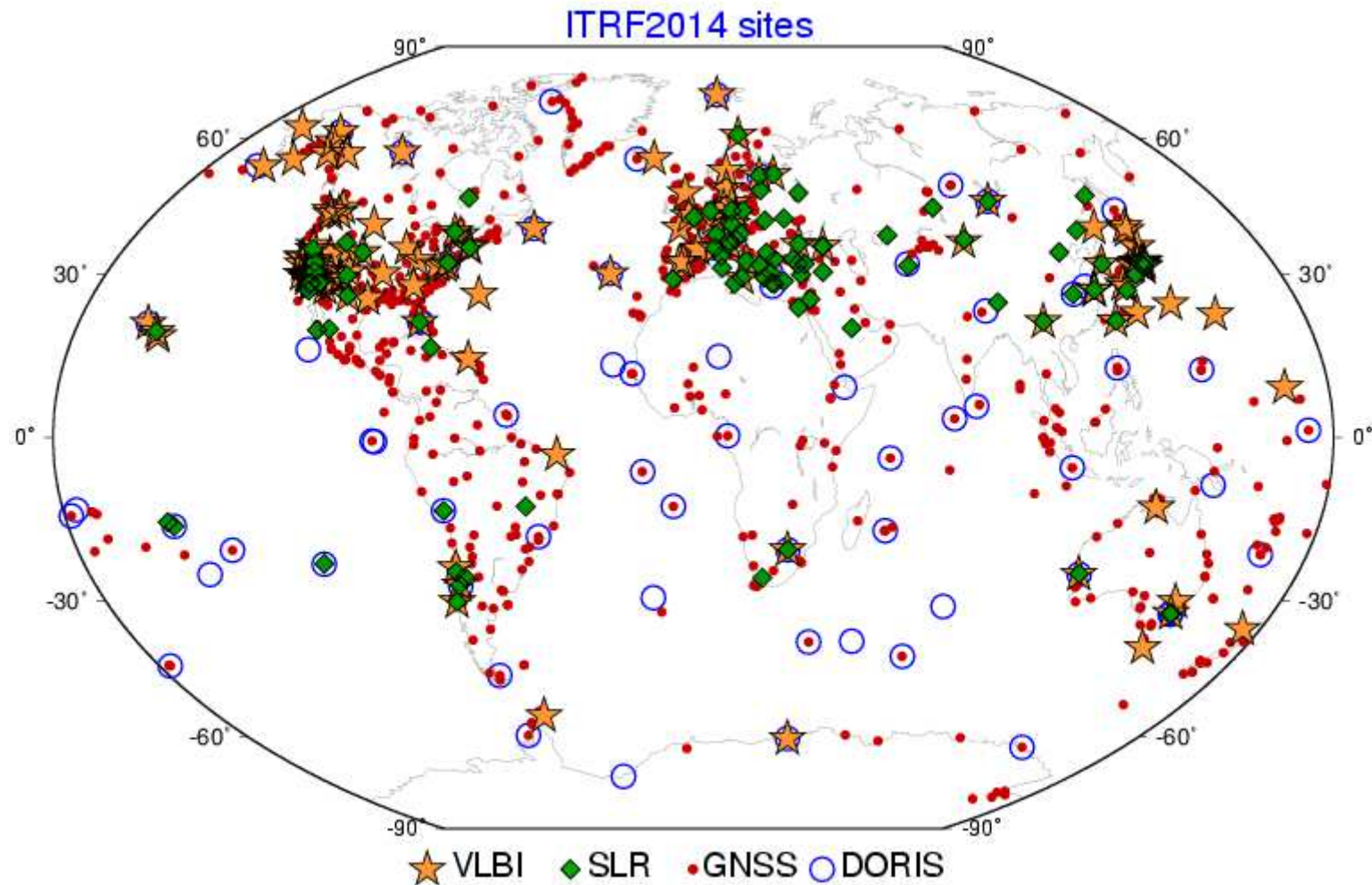
ITRF2014

- Published January, 2016
- Full article with Open Access
- Improved modeling of non-linear station motions
 - All kind of ruptures/discontinuities in the position time series
 - Seasonal signals
 - Modeling of post-seismic deformation
 - GNSS contribution is fundamental to all the above
- All ITRF2014 products are available through ITRF web site:
http://itrf.ign.fr/ITRF_solutions/2014/

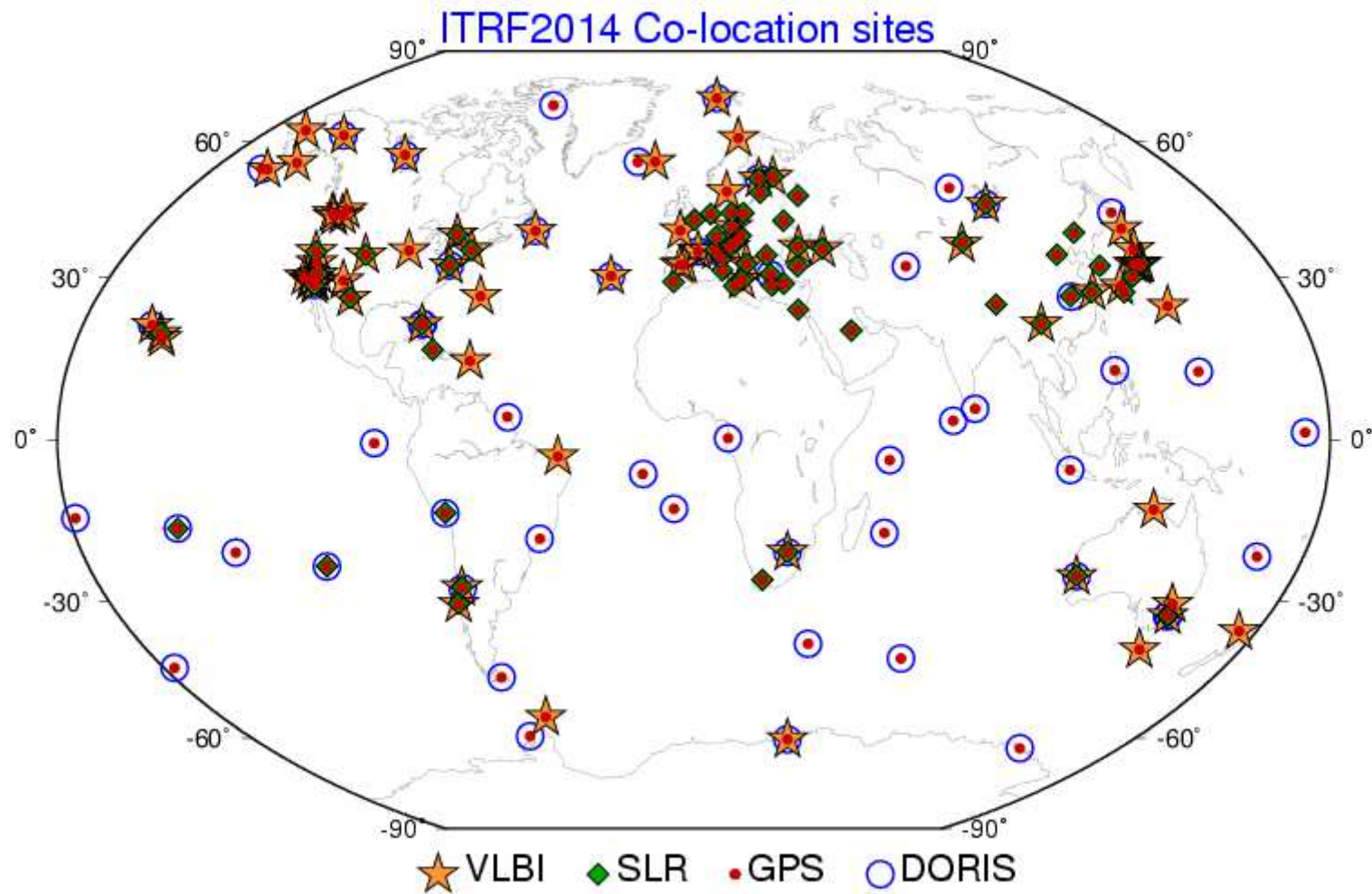
ITRF2014: Input data

Service/Technique	Number of Solutions	Time span
IGS/GNSS/GPS	7714 daily	1994.0 – 2015.1
IVS/VLBI	5328 daily	1980.0 – 2015.0
ILRS/SLR	244 fortnightly	1980.0 – 1993.0
	1147 weekly	1993.0 – 2015.0
IDS/DORIS	1140 weekly	1993.0 – 2015.0

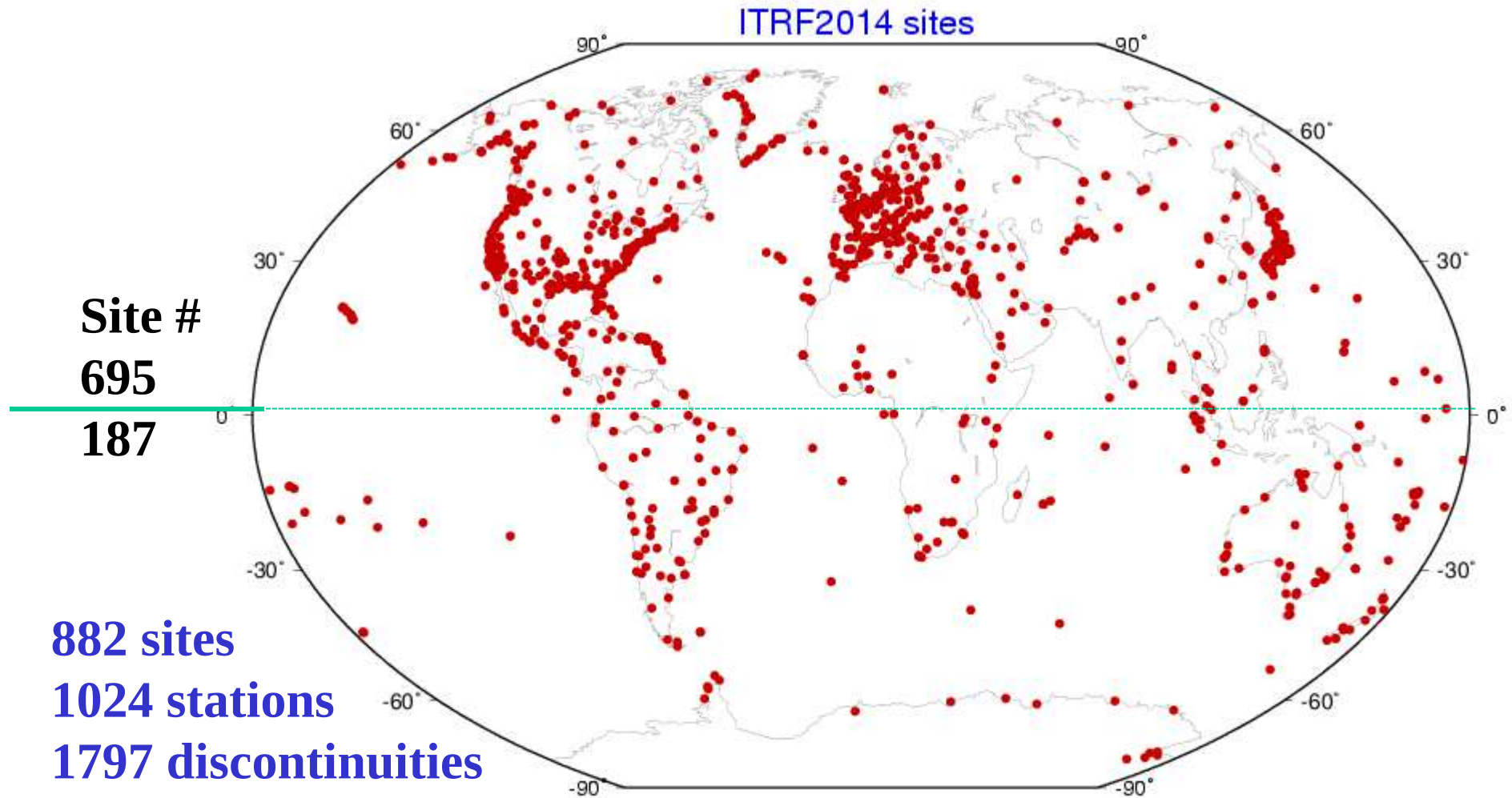
ITRF2014 Network



ITRF2014 Co-locations



ITRF2014: GNSS



Periodic Signals

Annual & semi-annual terms
estimated, using:

$$\Delta X_f = \sum_{i=1}^{n_f} a^i \cos(\omega_i t) + b^i \sin(\omega_i t)$$

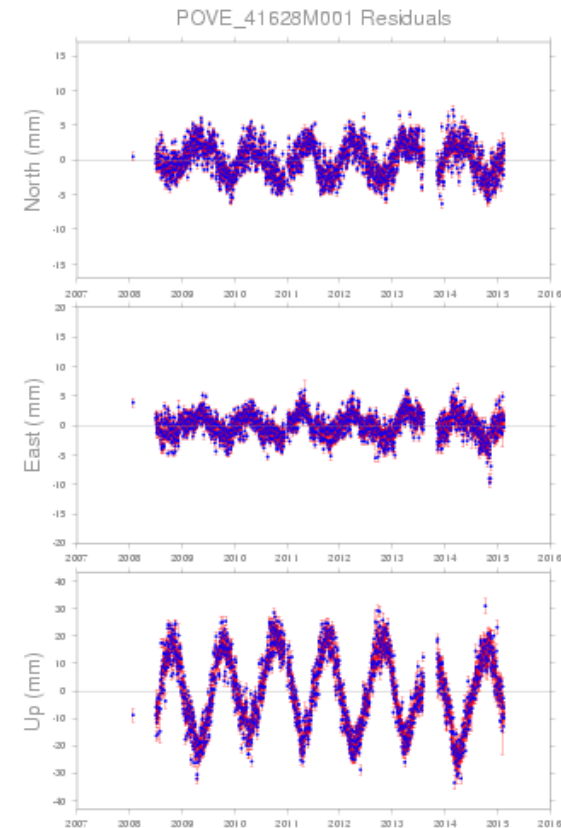
ΔX_f total sum of all frequencies

n_f number of frequencies

$$\omega_i = \frac{2\pi}{\tau_i}$$

τ_i period of the i th frequency

**=> 6 parameters per station & per frequency, i.e. a & b
along each X, Y, Z axis.**



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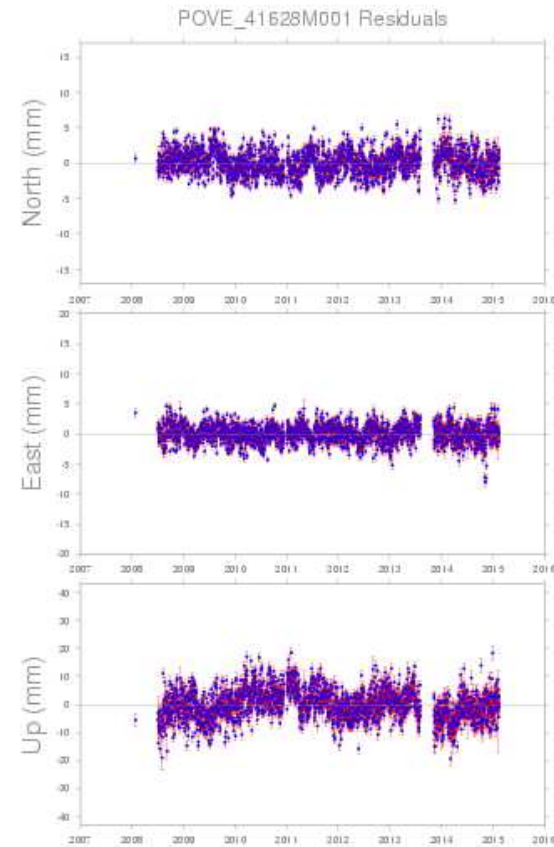
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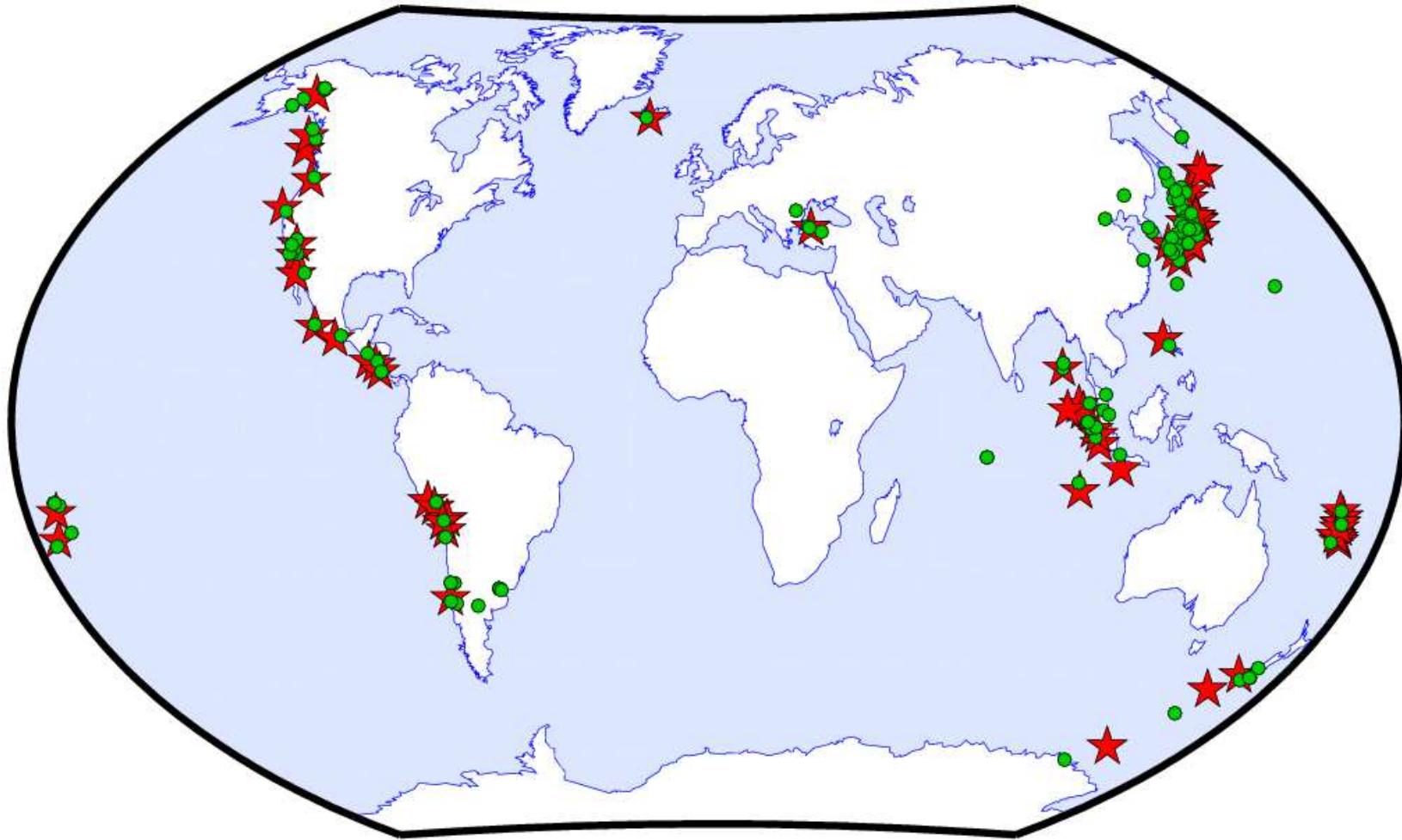
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ITRF2014 Site affected by PSD

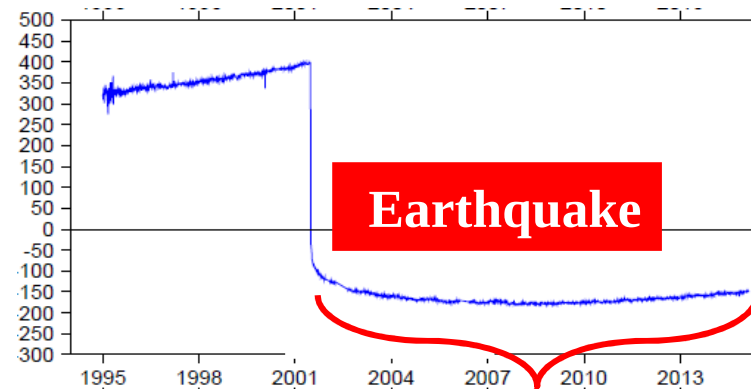


Red Stars: EQ Epicenters

Green circles: ITRF2014 sites

Post-Seismic Deformation (PSD)

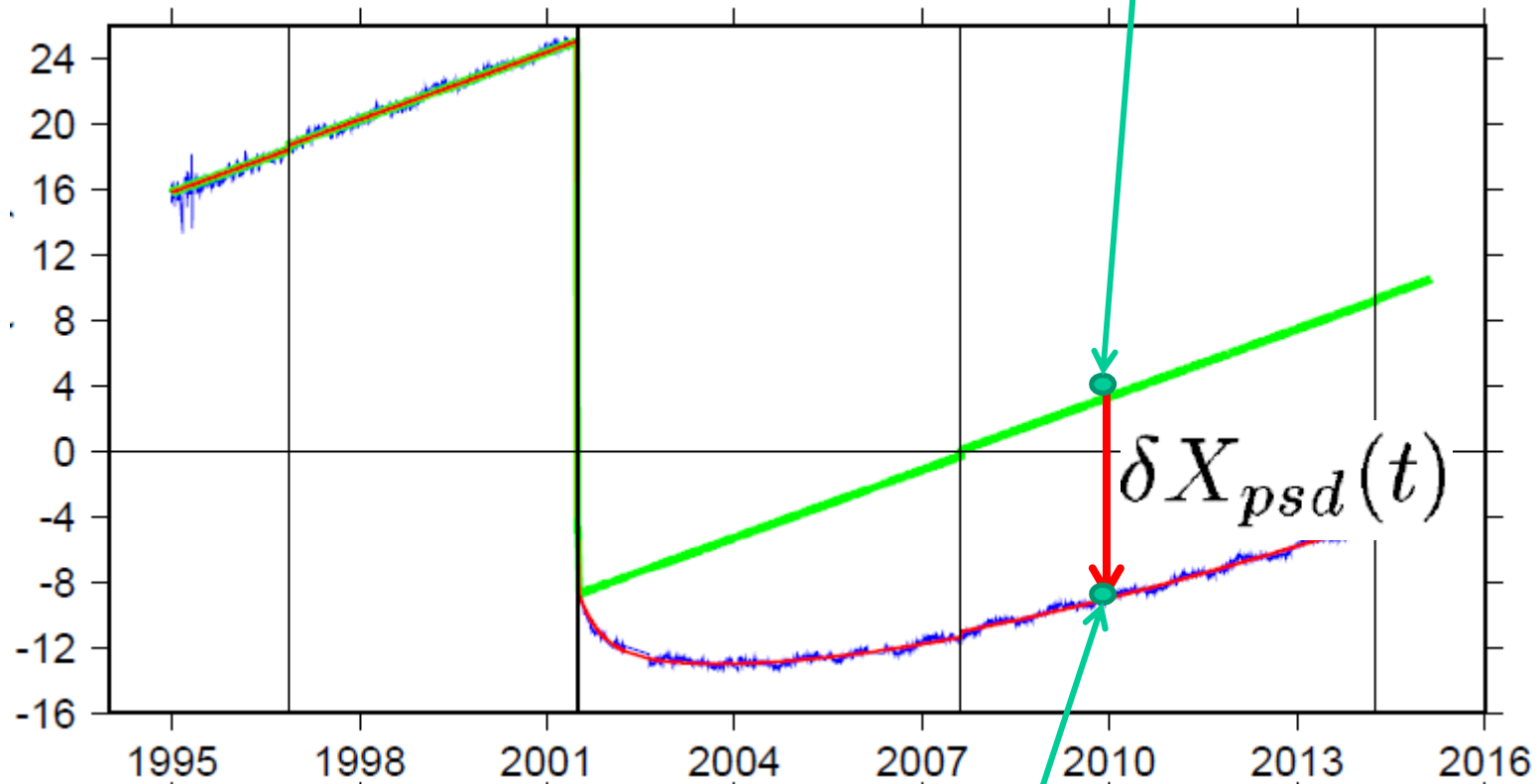
- Fitting parametric models using GNSS/GPS data
 - at major GNSS/GPS Earthquake sites
 - apply these models to the 3 other techniques at co-location EQ sites
- Parametric models:
 - Logarithmic
 - Exponential
 - Log + Exp
 - Two Exp



Post-seismic deformation

PSD Correction

Regularized Position (ITRF2014)



Observed Position

How to use ITRF2014 PSD models ?

Regularized Position (ITRF2014)

$$X_{PSD}(t) = \boxed{X(t_0) + \dot{X}(t - t_0)} + \delta X_{PSD}(t)$$

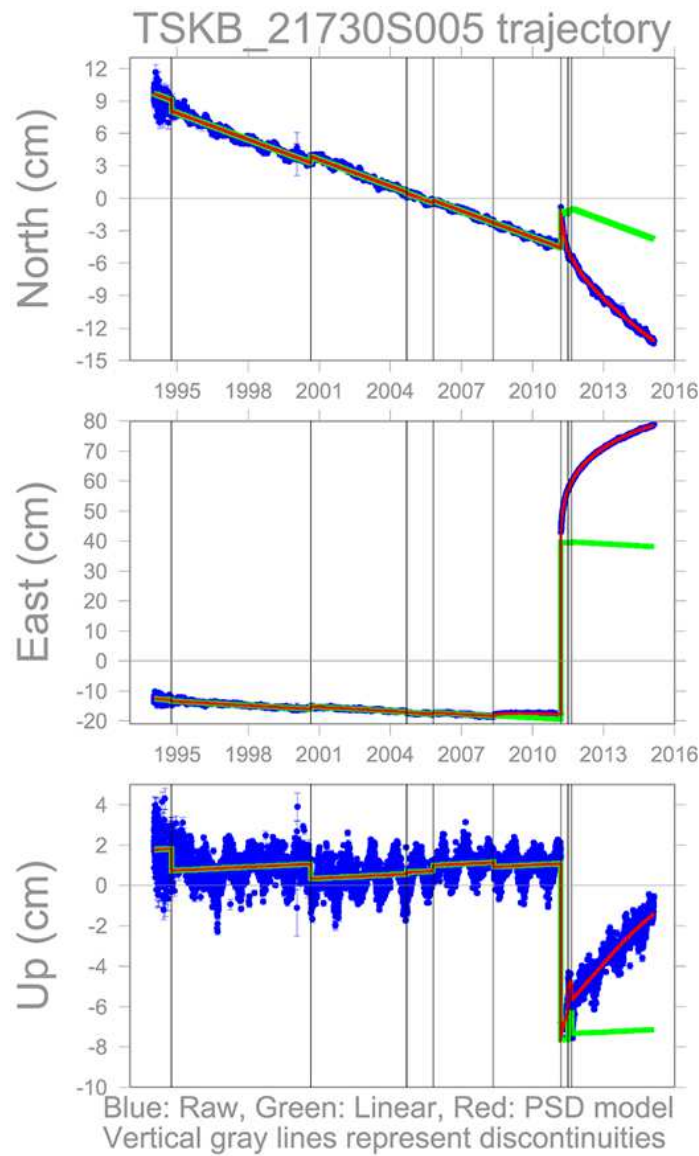
$$\delta L(t) = \sum_{i=1}^{n^l} A_i^l \log\left(1 + \frac{t - t_i^l}{\tau_i^l}\right) + \sum_{i=1}^{n^e} A_i^e \left(1 - e^{-\frac{t - t_i^e}{\tau_i^e}}\right)$$

Local Frame

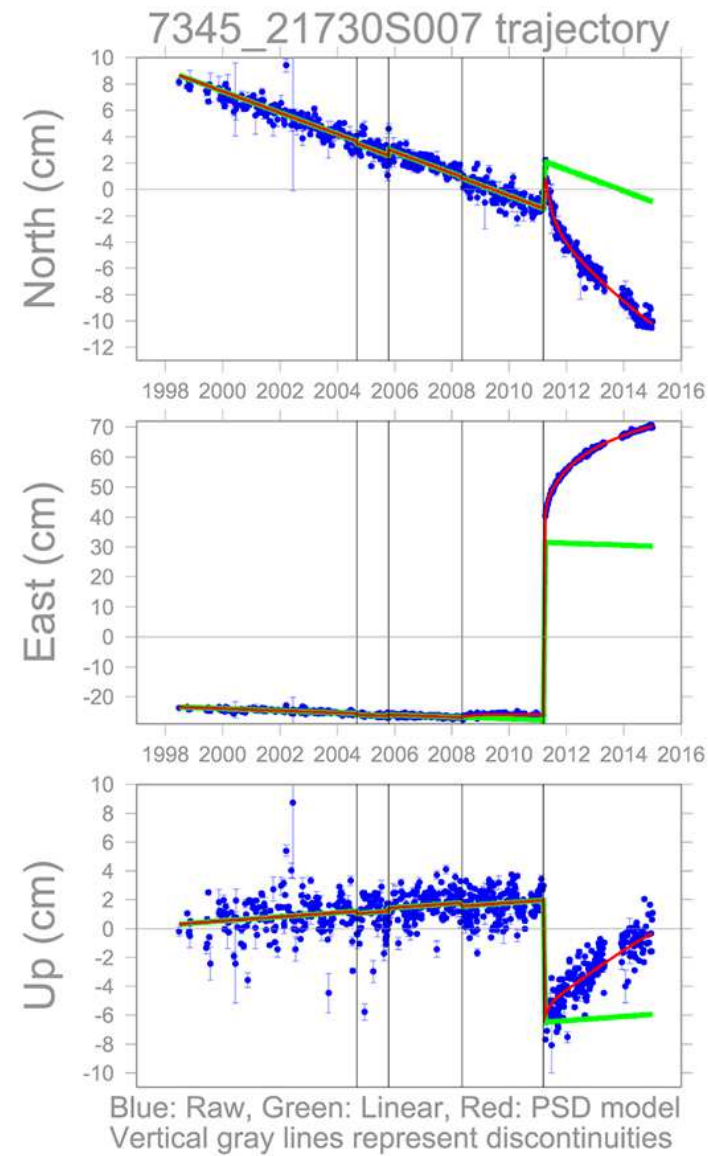
PSD Subroutines available at ITRF2014 Web site:
http://itrf.ign.fr/ITRF_solutions/2014/

Trajectory of Tsukuba (Japan) before and after the 2011 Tohoku earthquake

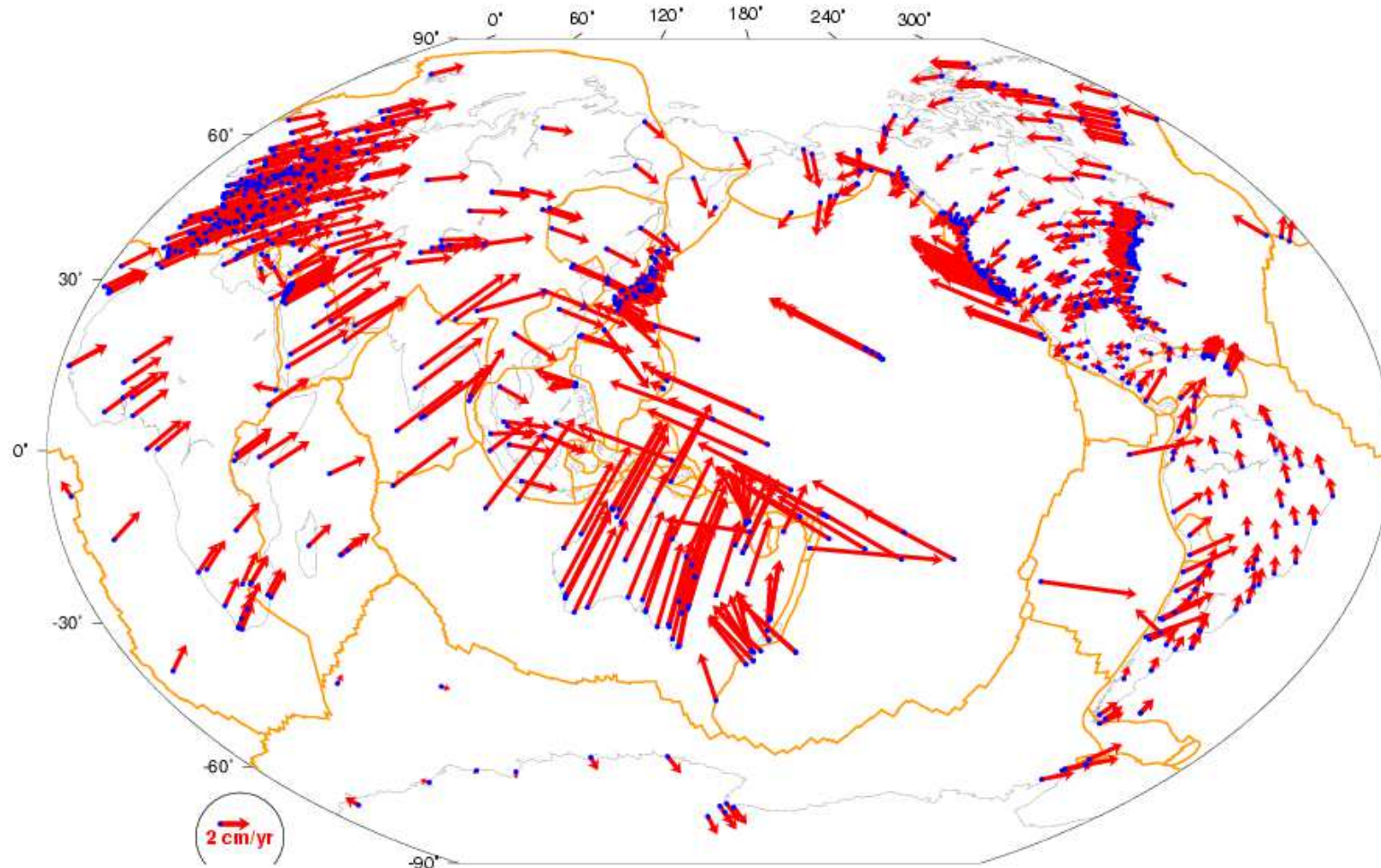
GNSS station



VLBI station



ITRF2014 Site Velocities:

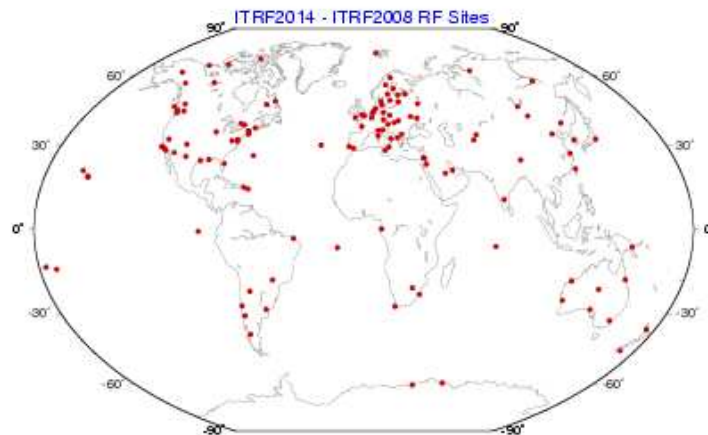


$$X(t) = X(t_0) + \dot{X}(t - t_0)$$

From ITRF2014 to ITRF2008

Using 127 stations

	TX(mm)	TY(mm)	TZ(mm)	Scale (ppb)	Epoch
Offset ±	1.6 ±0.2	1.9 ±0.1	2.4 ±0.1	-0.01 ±0.02	2010.0
Rate ±	0.1 ±0.2	0.0 ±0.1	-0.1 ±0.1	0.03 ±0.02	-



Conclusions

- **ITRF2014 innovation: modelling of non-linear station motions: periodic signal and post-seismic deformation (PSD)**
- **PSD models are part of the ITRF2014 products**
- **Transformation parameters between ITRF2014 & ITRF2008 are small**
- **GNSS data/products are fundamental to the ITRF, through the IGS contribution:**
 - **Connect the 3 other techniques;**
 - **Determine Post-seismic deformations at EQ Sites**

Thank you