Brief presentation and description of ITRF2014

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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:**
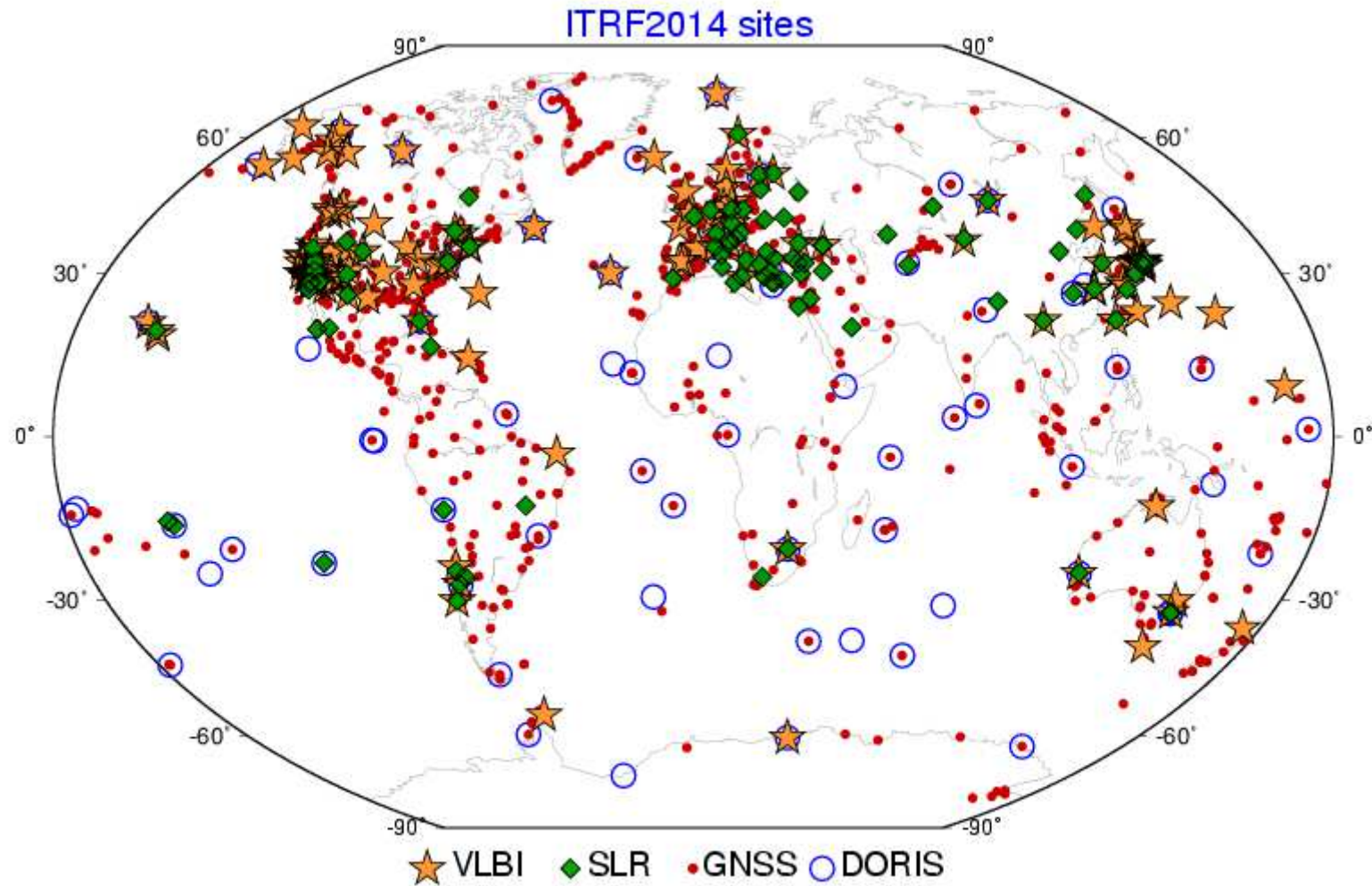 - **Some results**
  - **GNSS Contribution**

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:**
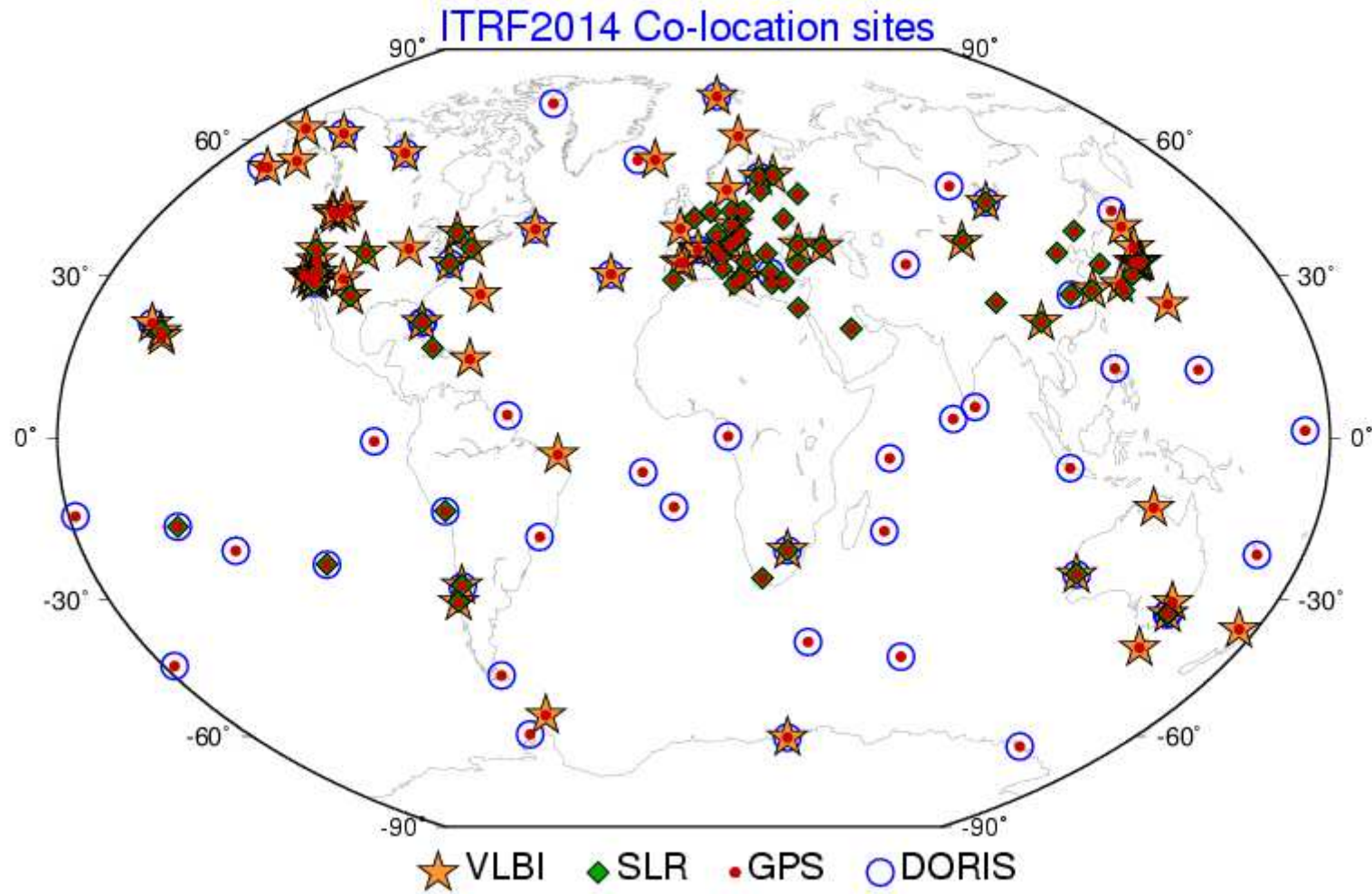 **http://itrf.ign.fr/ITRF_solutions/2014/**

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 1147 weekly	1980.0 – 1993.0 1993.0 – 2015.0
IDS/DORIS	1140 weekly	1993.0 – 2015.0

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ITRF2014 Network

ITRF2014 sites

⭐ VLBI ◆ SLR • GNSS ○ DORIS

ITRF2014 Co-locations

ITRF2014: GNSS

Site #
695
187

882 sites
1024 stations
1797 discontinuities

Periodic Signals

Annual & semi-annual terms estimated, using:

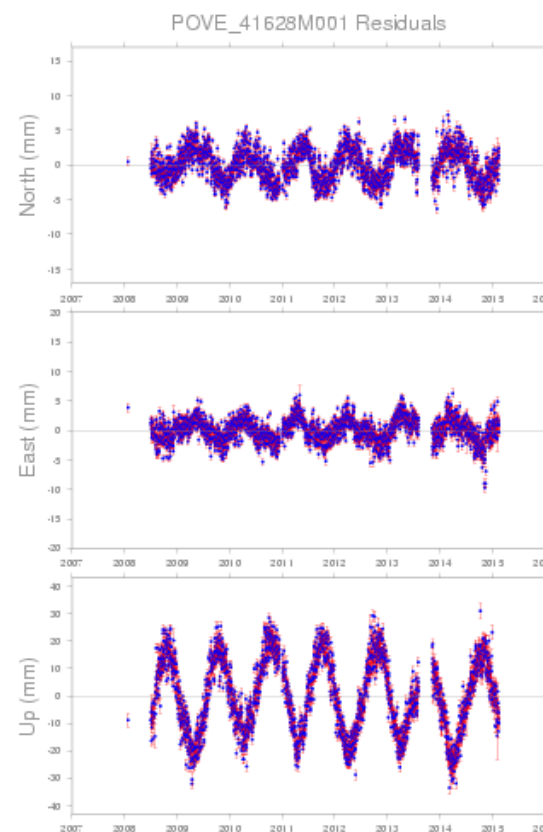$$\Delta X_f = \sum_{i=1}^{n_f} a^i \cos(\omega_i t) + b^i \sin(\omega_i t)$$

ΔX_f total sum of all frequencies

n_f number of frequencies

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

τ_i period of the ith frequency

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

POVE_41628M001 Residuals

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Periodic Signals

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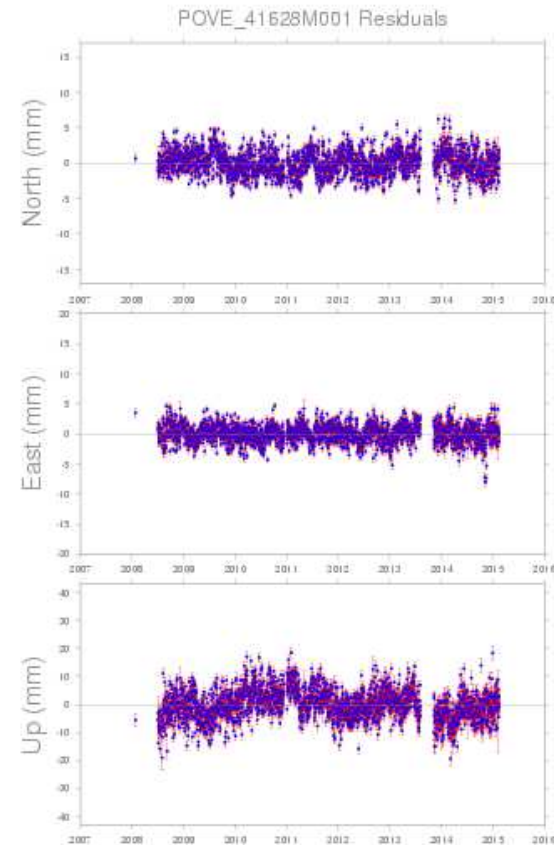$$\Delta X_f = \sum_{i=1}^{n_f} a^i \cos(\omega_i t) + b^i \sin(\omega_i t)$$

ΔX_f **total sum of all frequencies**

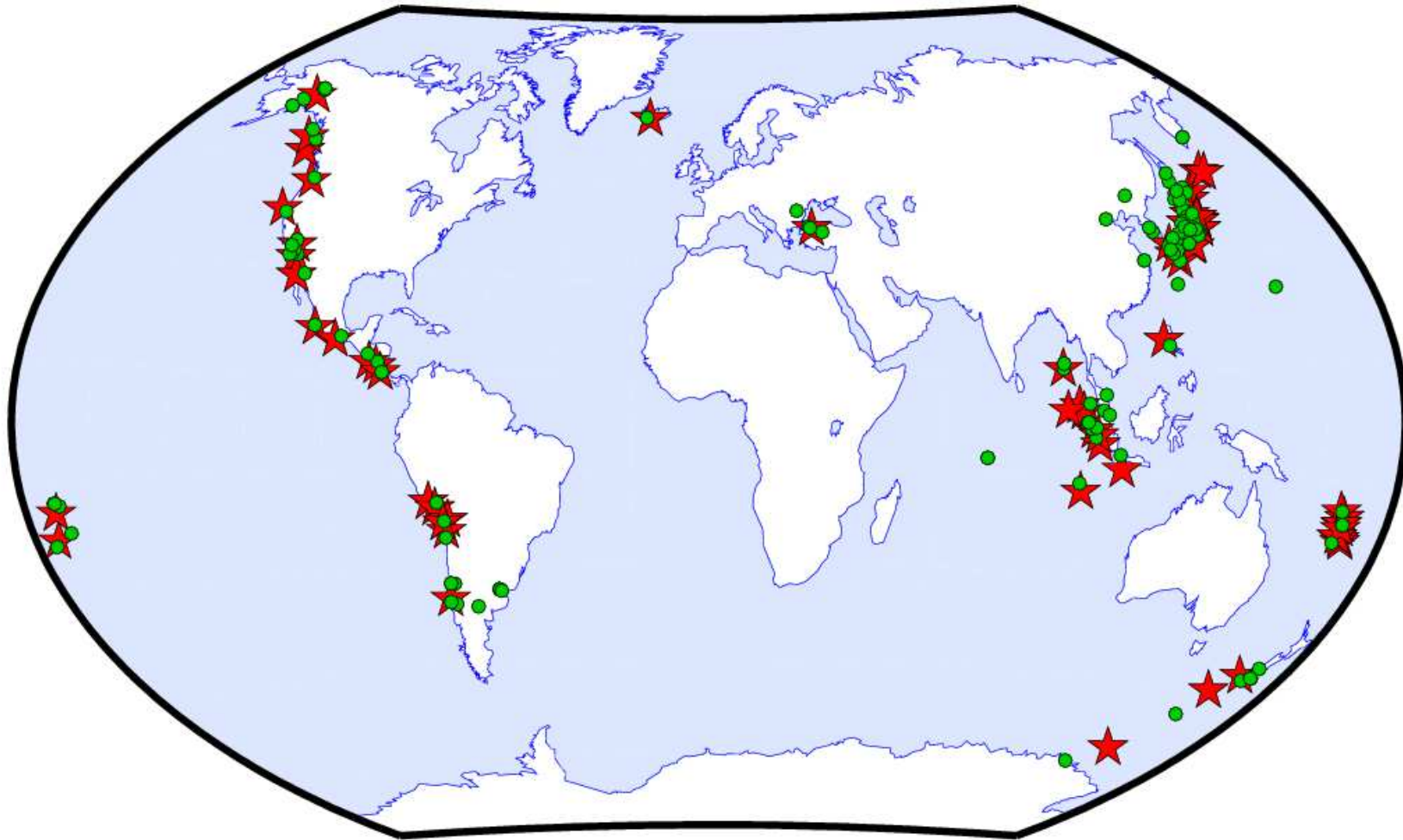n_f **number of frequencies**

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POVE_41628M001 Residuals

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ITRF2014 Site affected by PSD

Red Stars: EQ Epicenters
Green circles: ITRF2014 sites

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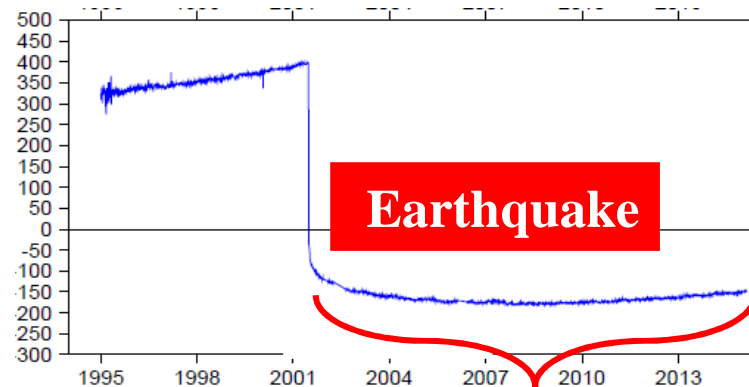ET FORESTIÉRE

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
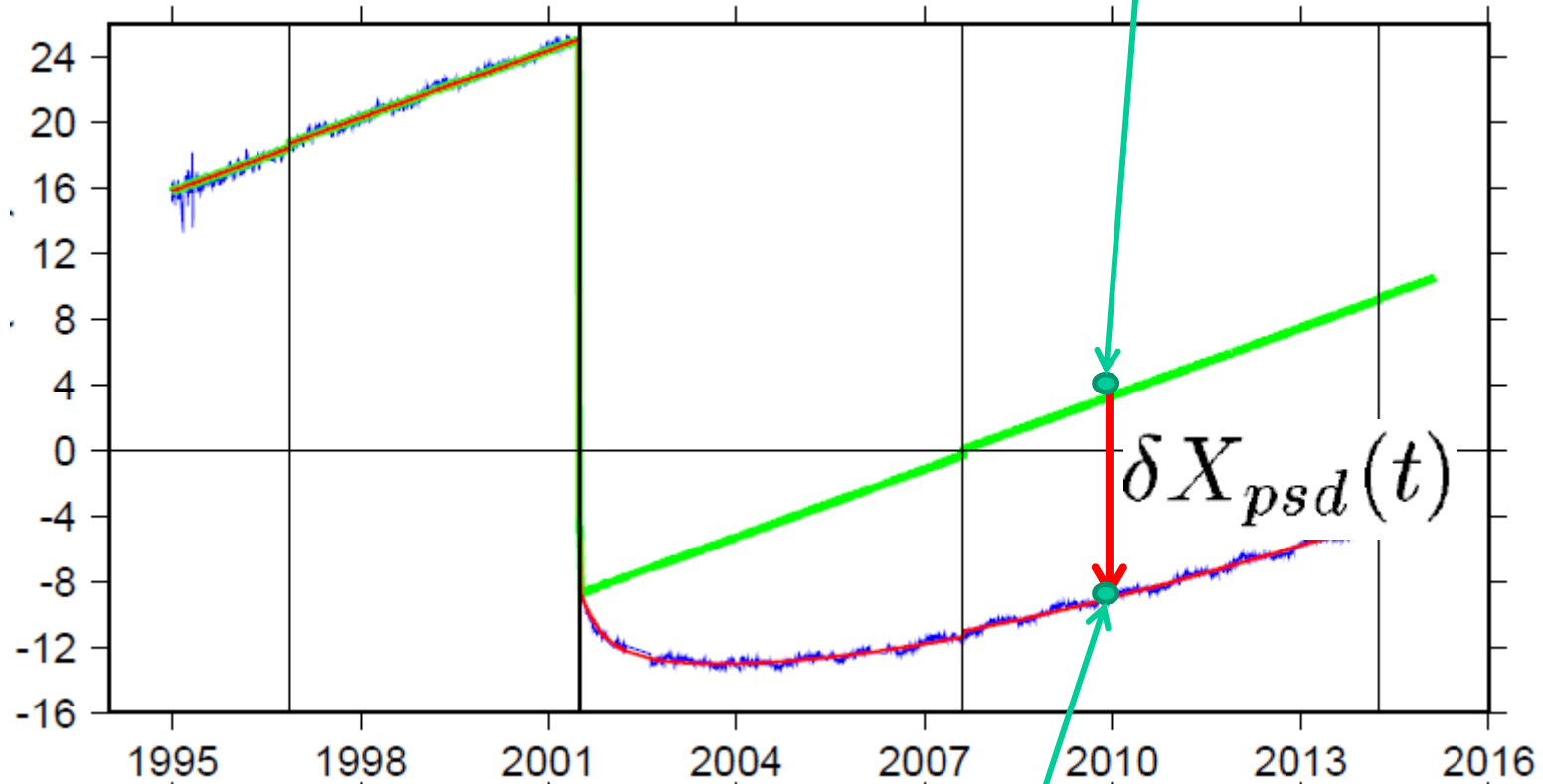
- **Parametric models:**
  - Logarithmic
  - Exponential
  - Log + Exp
  - Two Exp

Post-seismic deformation

PSD Correction

Regularized Position (ITRF2014)

$$\delta X_{psd}(t)$$

Observed Position

How to use ITRF2014 PSD models ?

Regularized Position (ITRF2014)

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

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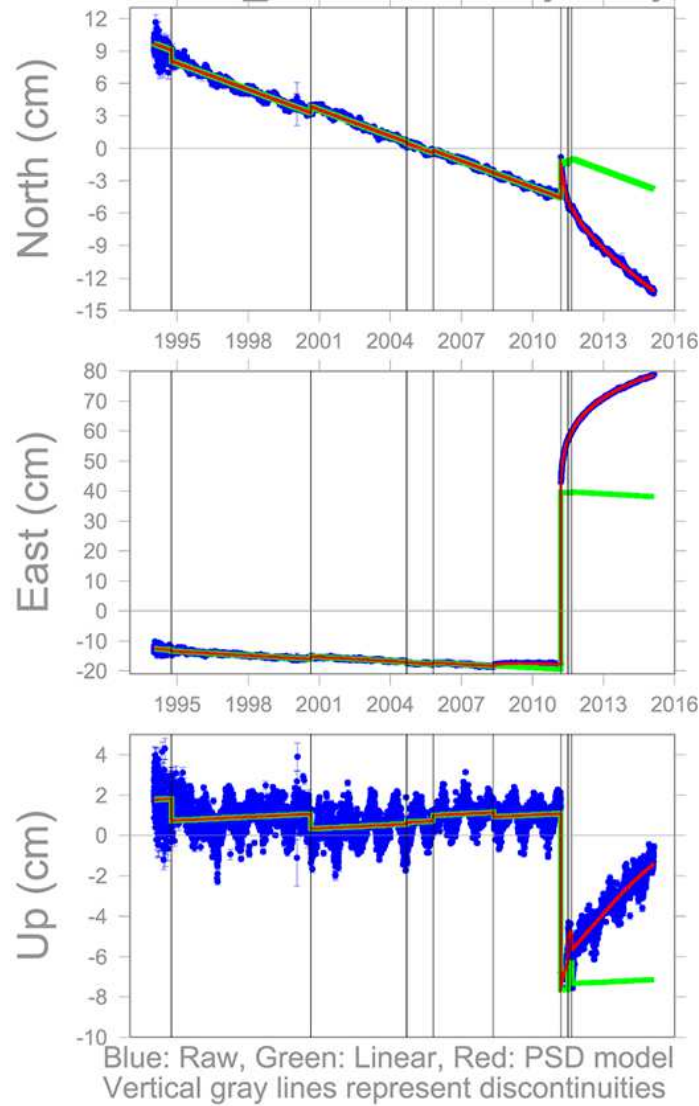
Local Frame

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

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

GNSS station

VLBI station

Blue: Raw, Green: Linear, Red: PSD model
Vertical gray lines represent discontinuities
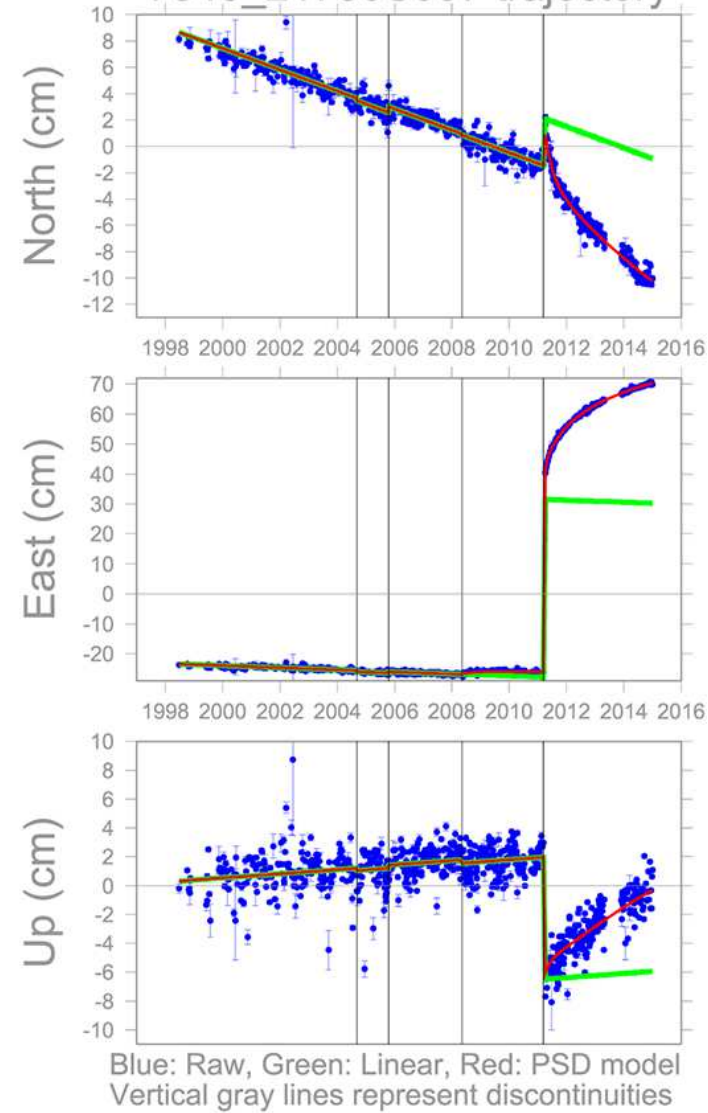
ITRF2014 Site Velocities:
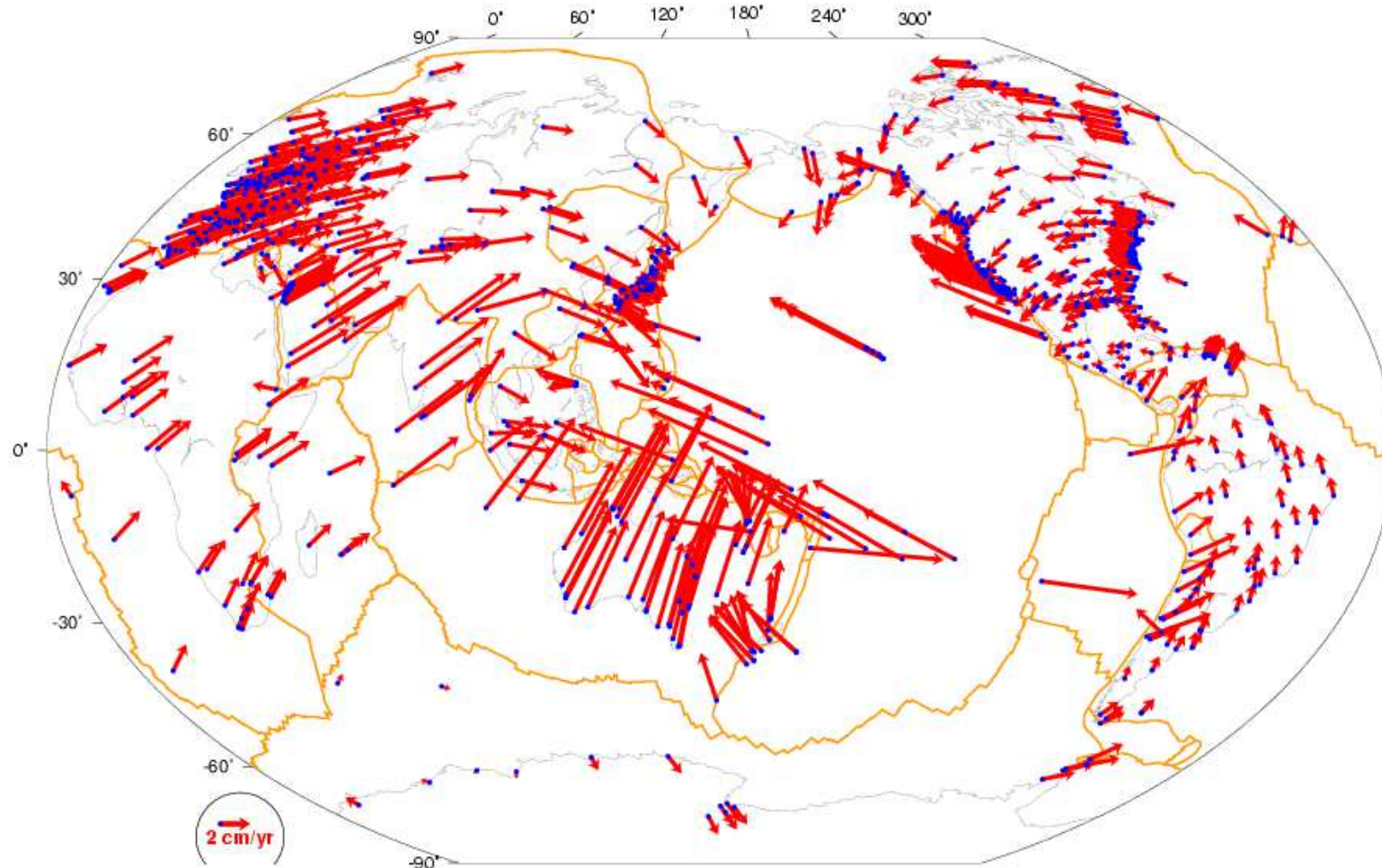
$$X(t) = X(t_0) + \dot{X}(t - t_0)$$

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	-

ITRF2014 - ITRF2008 RF Sites
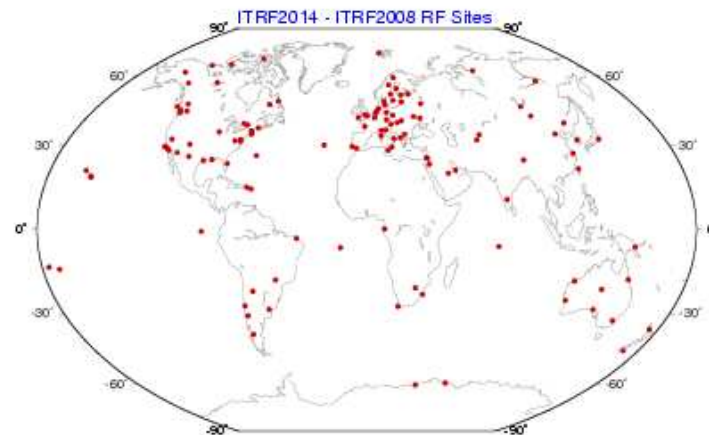
Conclusions

- **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