

# **ITRF2014 and the IGS Contribution**

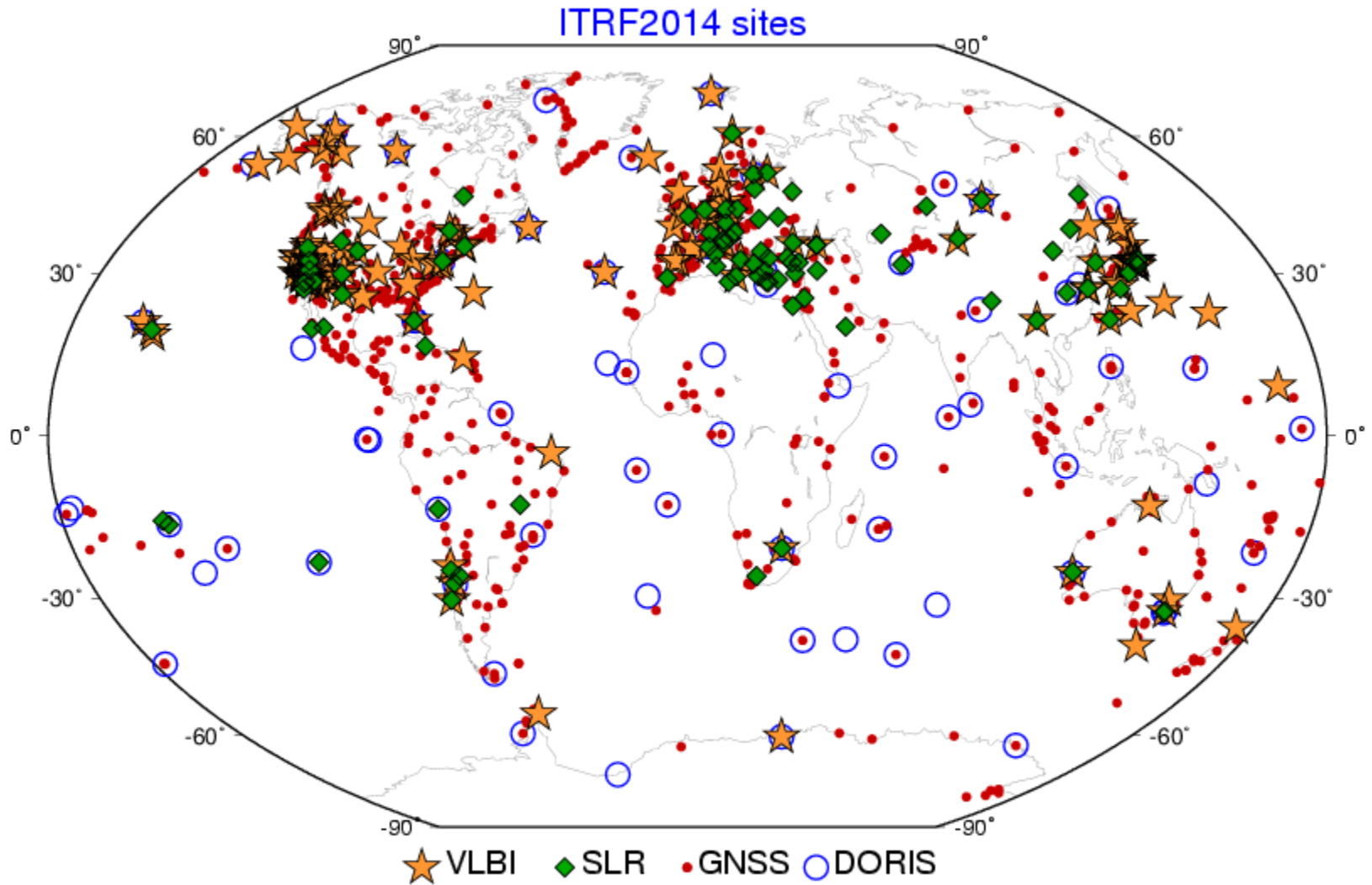
**Zuheir Altamimi,  
Paul Rebischung, Laurent Métivier, Xavier Collilieux**

**E-mail: [zuheir.altamimi@ign.fr](mailto:zuheir.altamimi@ign.fr)**

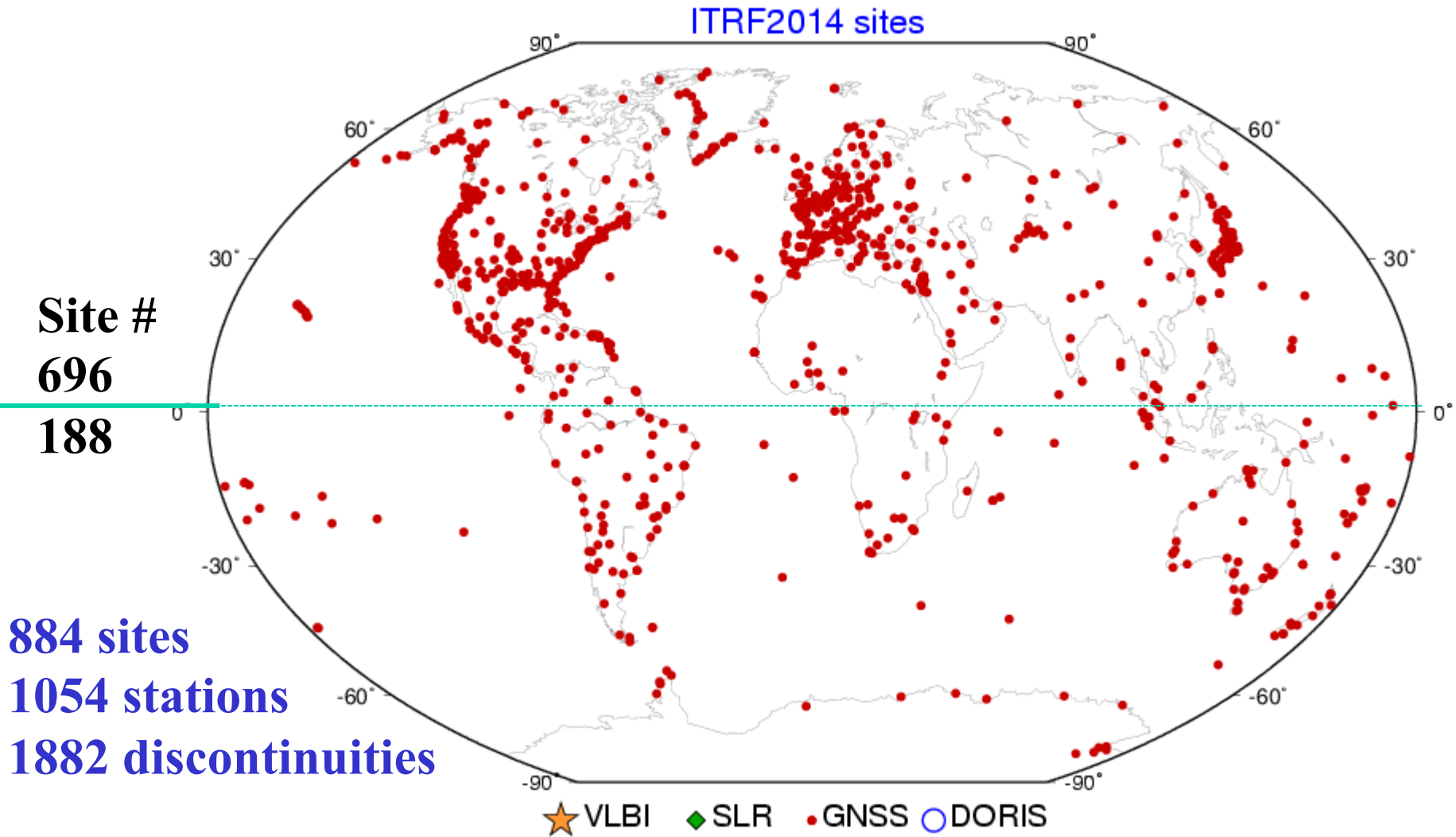
# Key Points

- **ITRF2014 Innovations : modelling of:**
  - **Periodic signals: annual, semi-annual**
  - **Post-Seismic Deformation (PSD)**
- **IGS Contribution**
  - **Fitting the PSD models using IGS data**
  - **Enforcing the link between the 3 other techniques at co-location sites**
- **VLBI & SLR Scale Issue ?**

# ITRF2014 Network



# ITRF2014: GNSS

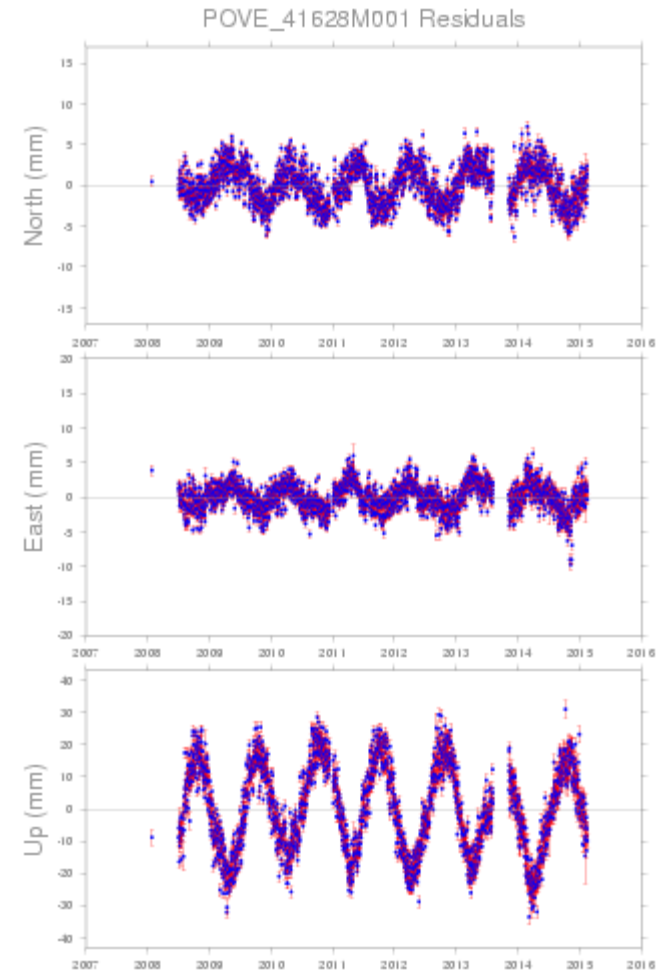


# Periodic Signals

Annual & semi-annual terms estimated, using:

$$\sum_{i=1}^n a \cos \omega t + b \sin \omega t$$

Removing draconitics in addition to annuals and semi-annuals has no impact on site velocities

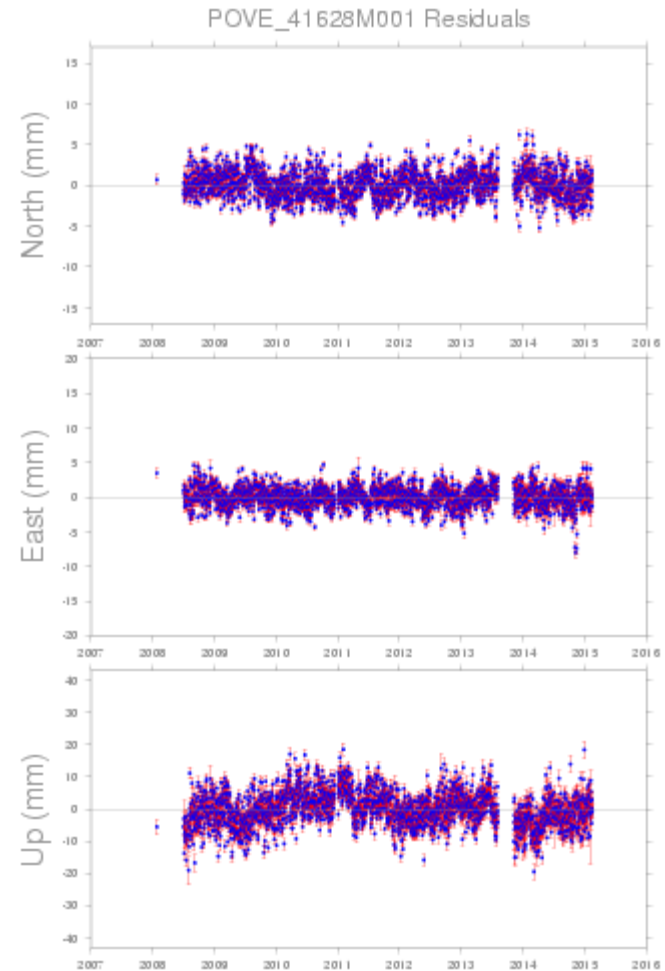


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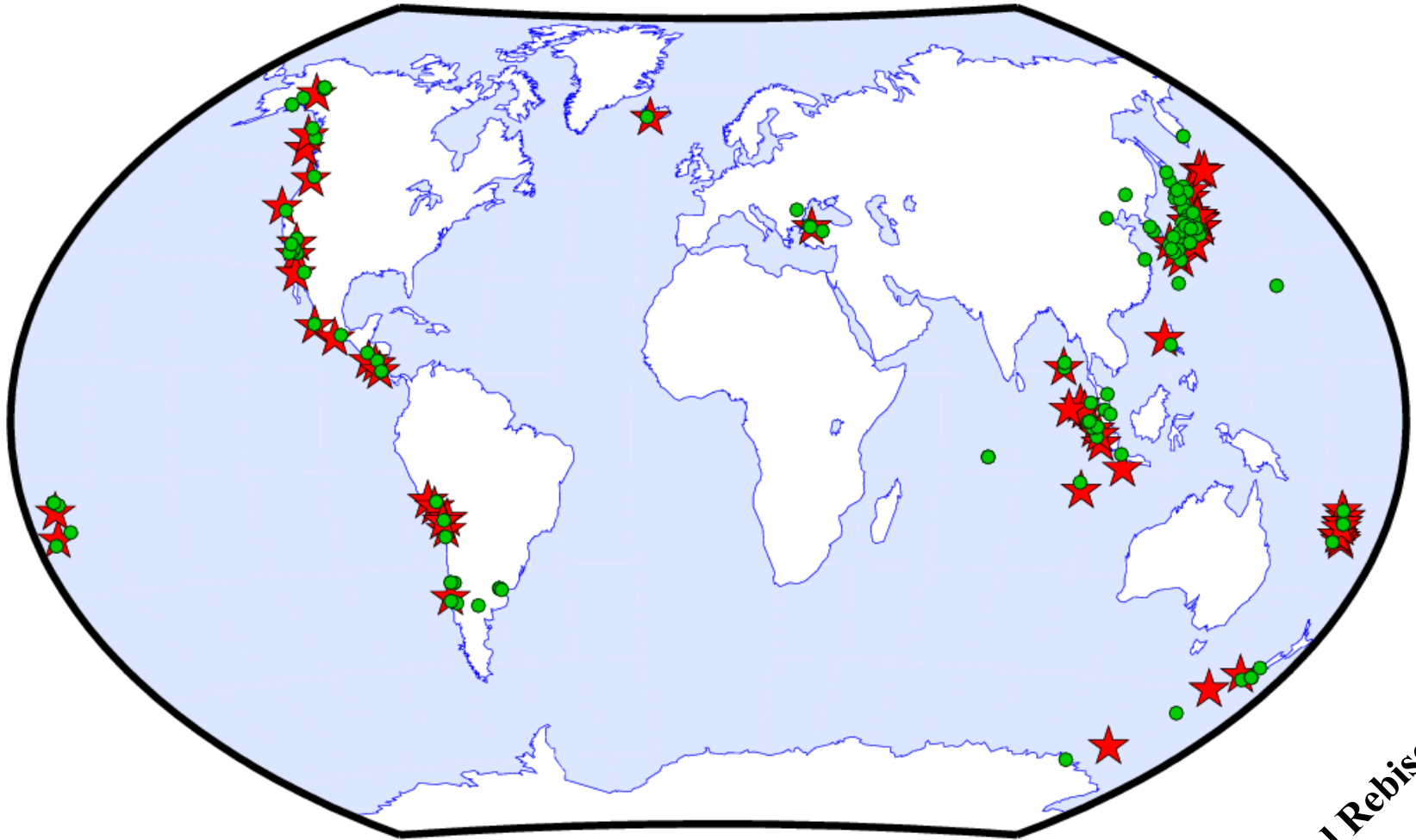
$$\sum_{i=1}^n a \cos \omega t + b \sin \omega t$$

Removing draconitics in addition to annuals and semi-annuals has no impact on site velocities



# Post-Seismic Deformations

# ITRF2014 Sites affected by PSD



**Red Stars: EQ Epicenters**

**Green circles: ITRF2014 sites**

*Artist: Paul Rebischung*

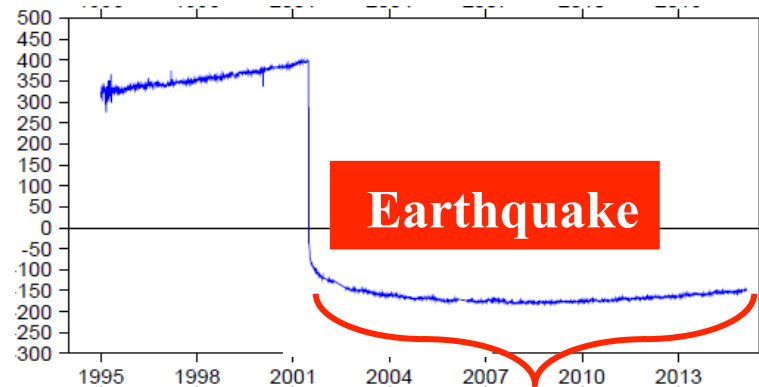


# Post-Seismic Deformations

- 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

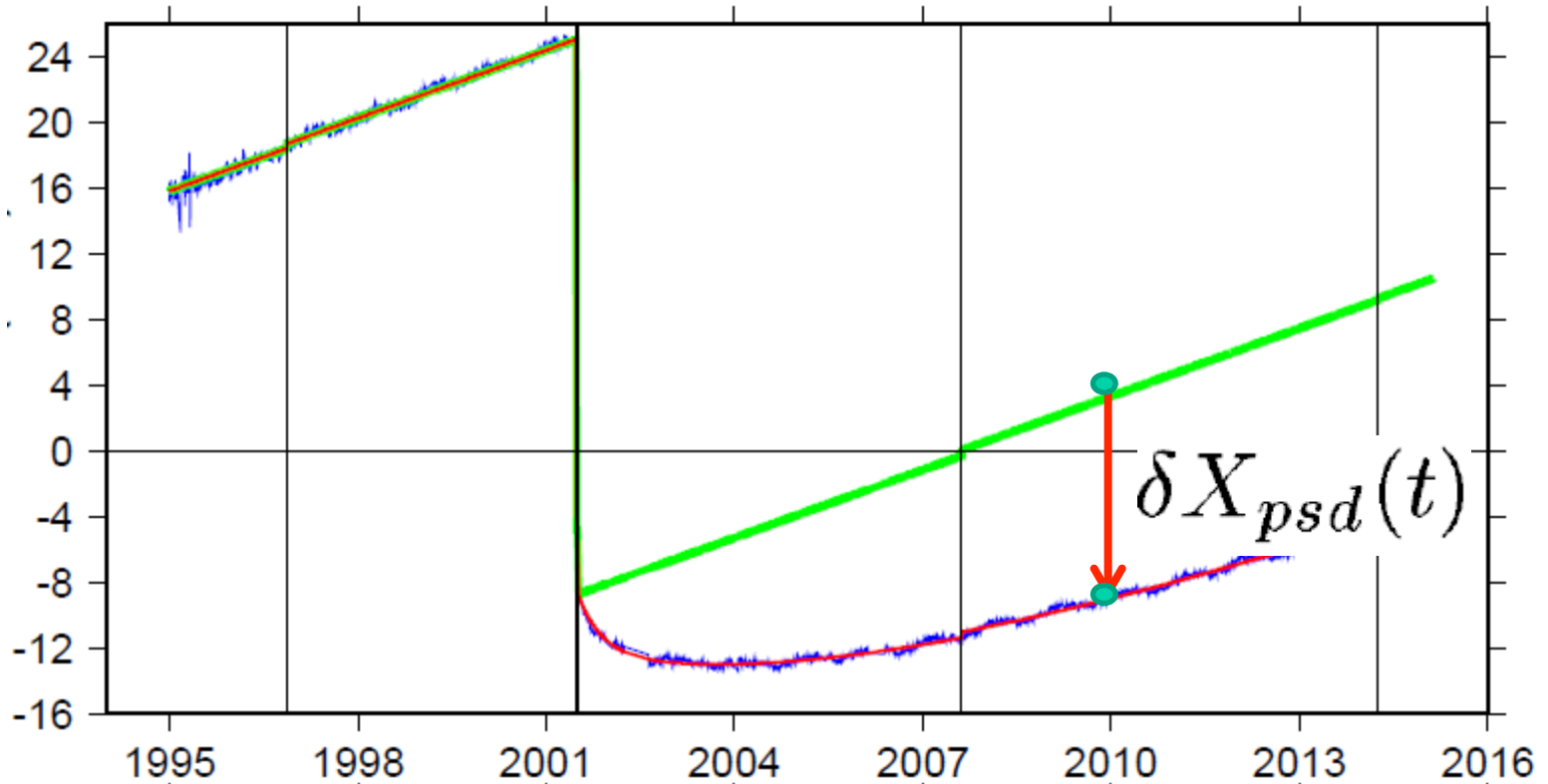
- Parametric models:

- Logarithmic
- Exponential
- Log + Exp
- Two Exp



**Post-seismic deformation**

# PSD Correction



# Post seismic parametric models

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

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

Local Frame

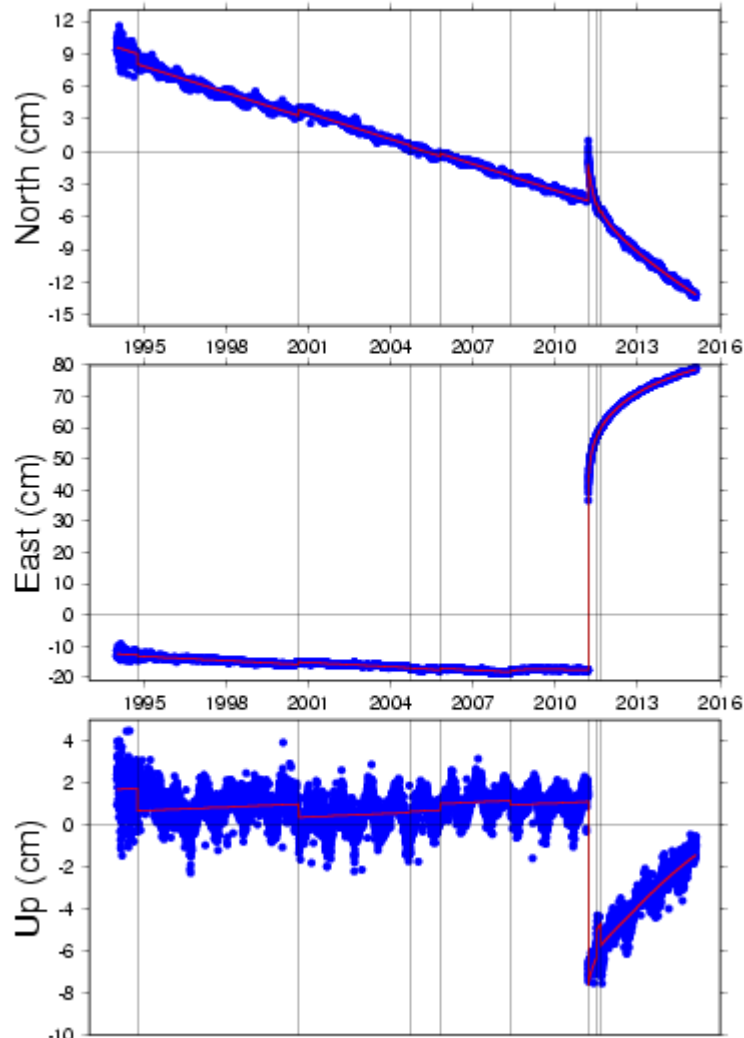
## Applications:

- Propagate ITRF2014 stations positions from  $t_0$  to  $t$ : **Add (+)**
- Apply to a time series before stacking: **Subtract (-)**

# Tsukuba Trajectory

GPS

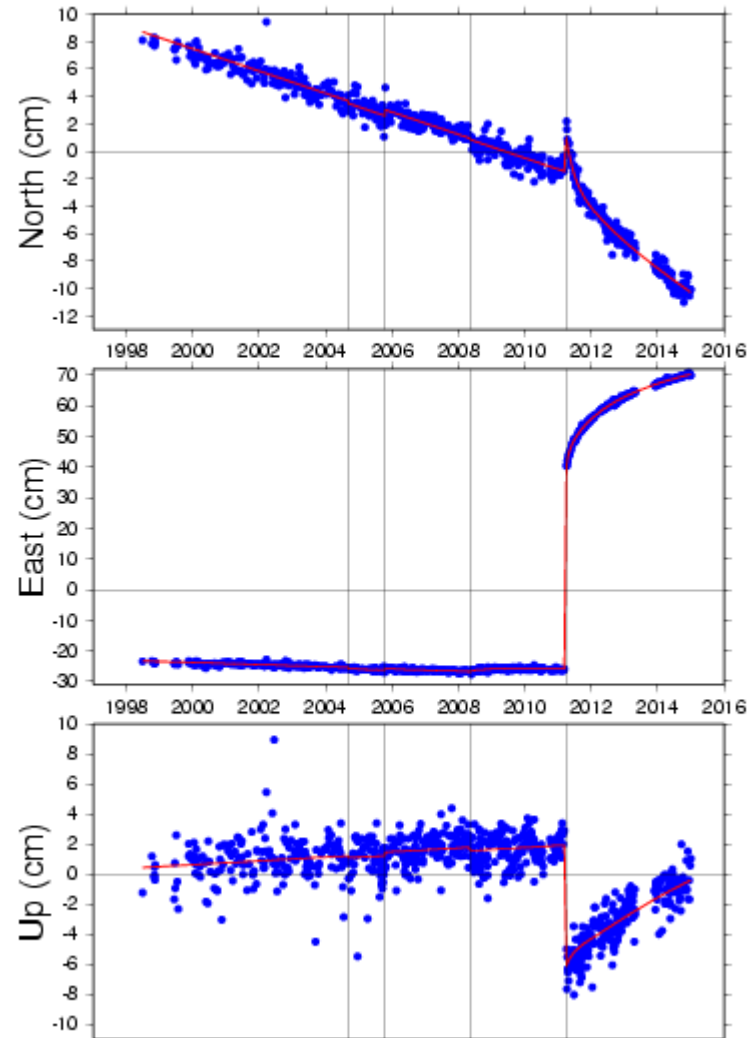
TSKB\_21730S005 trajectory



Trajectory : Blue: Raw, Green: Linear, Red: PSD model  
Vertical gray lines represent discontinuities

VLBI

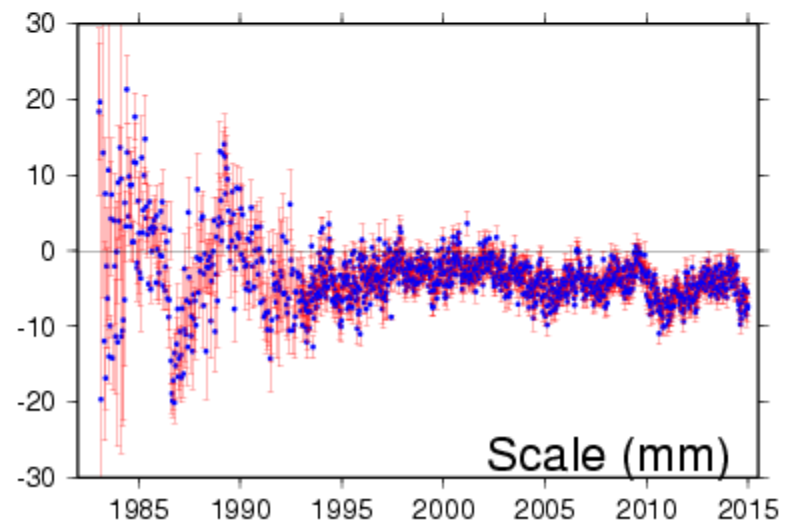
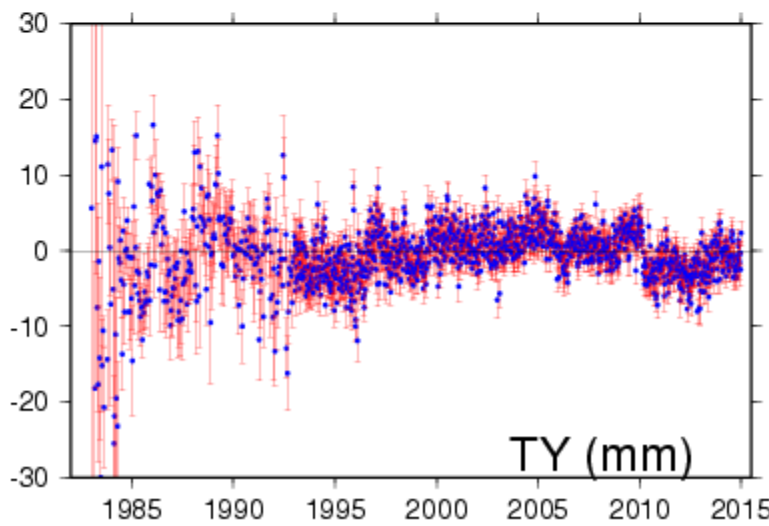
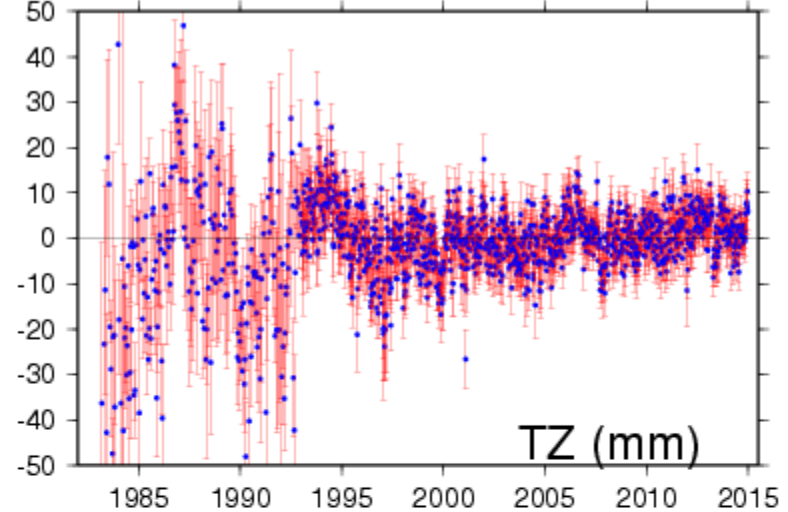
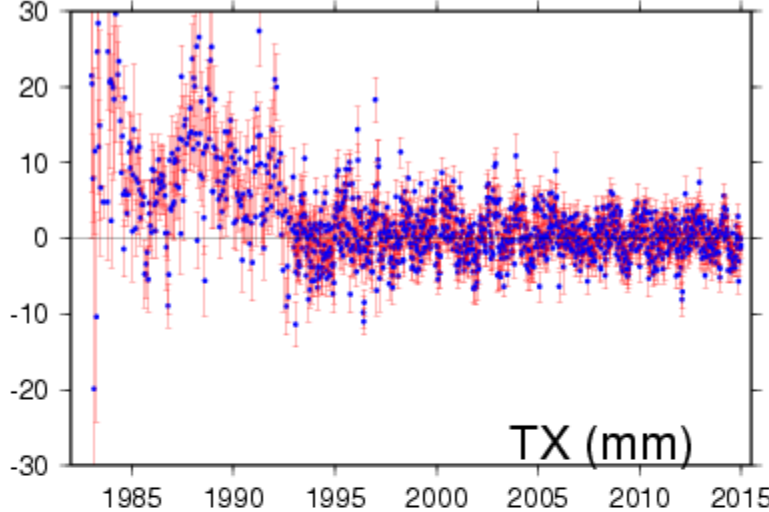
7345\_21730S007 trajectory



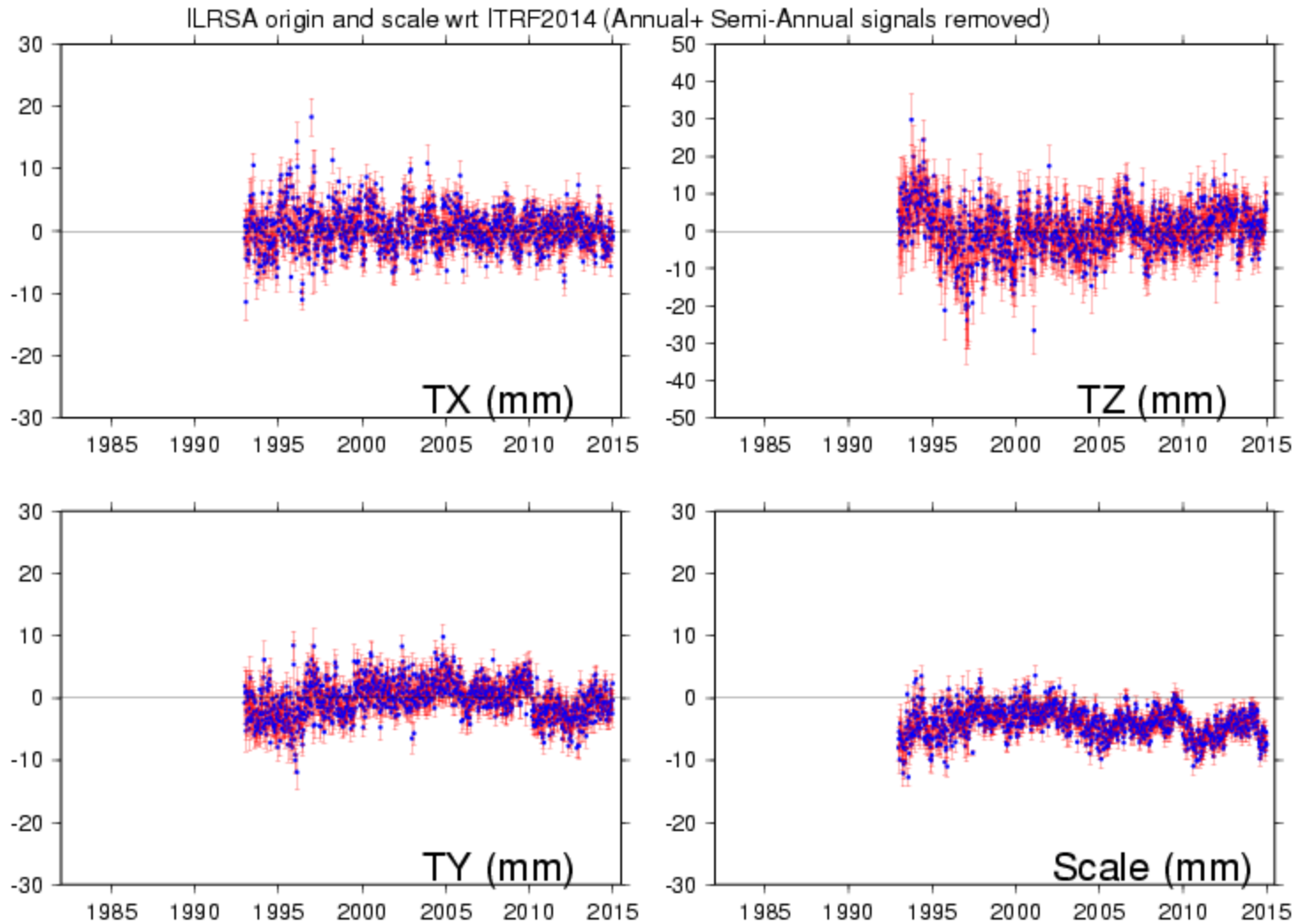
Trajectory : Blue: Raw, Red: PSD model  
Vertical gray lines represent discontinuities

# SLR Origin & Scale WRT ITRF2014

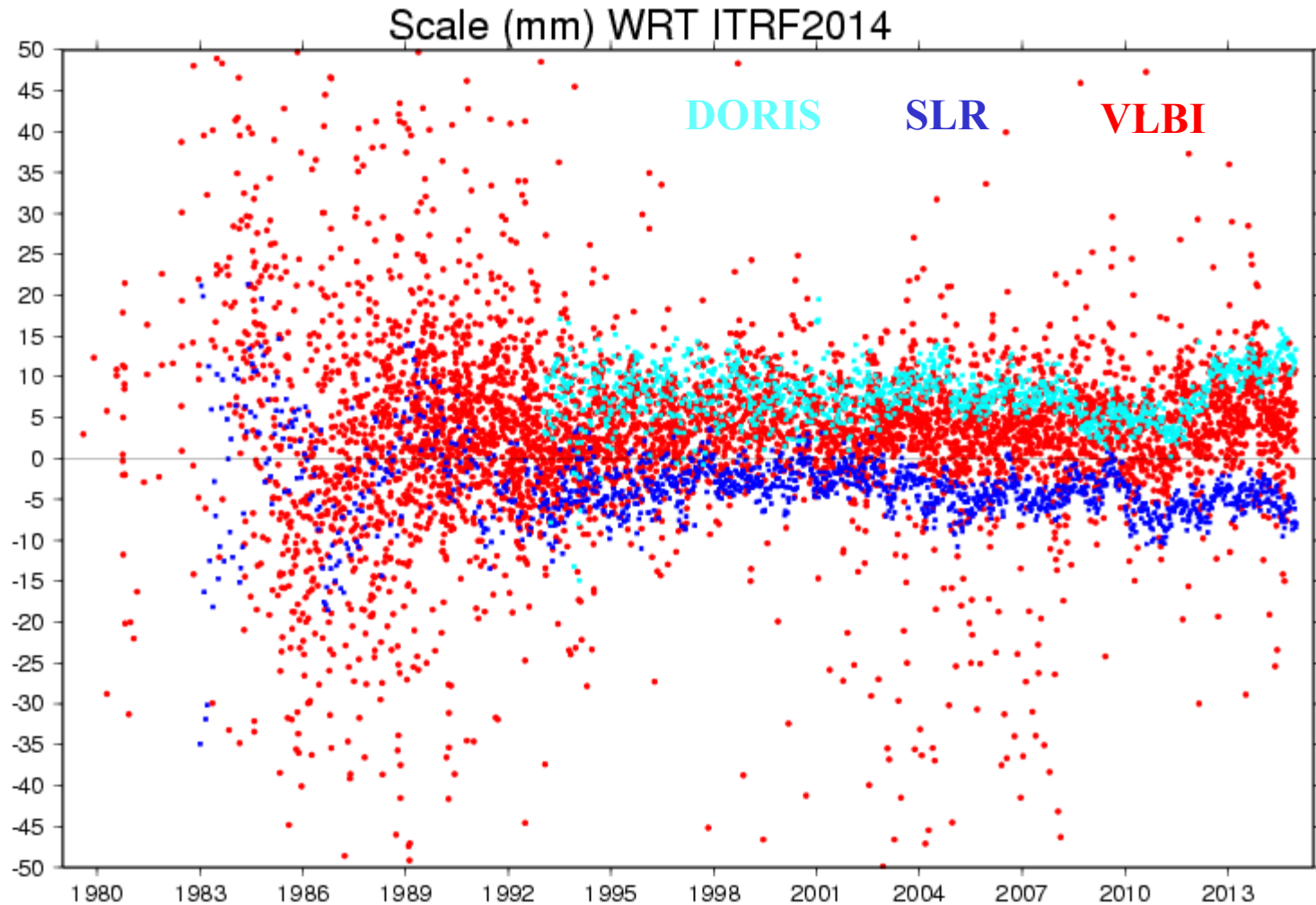
ILRSA origin and scale wrt ITRF2014 (Annual+ Semi-Annual signals removed)



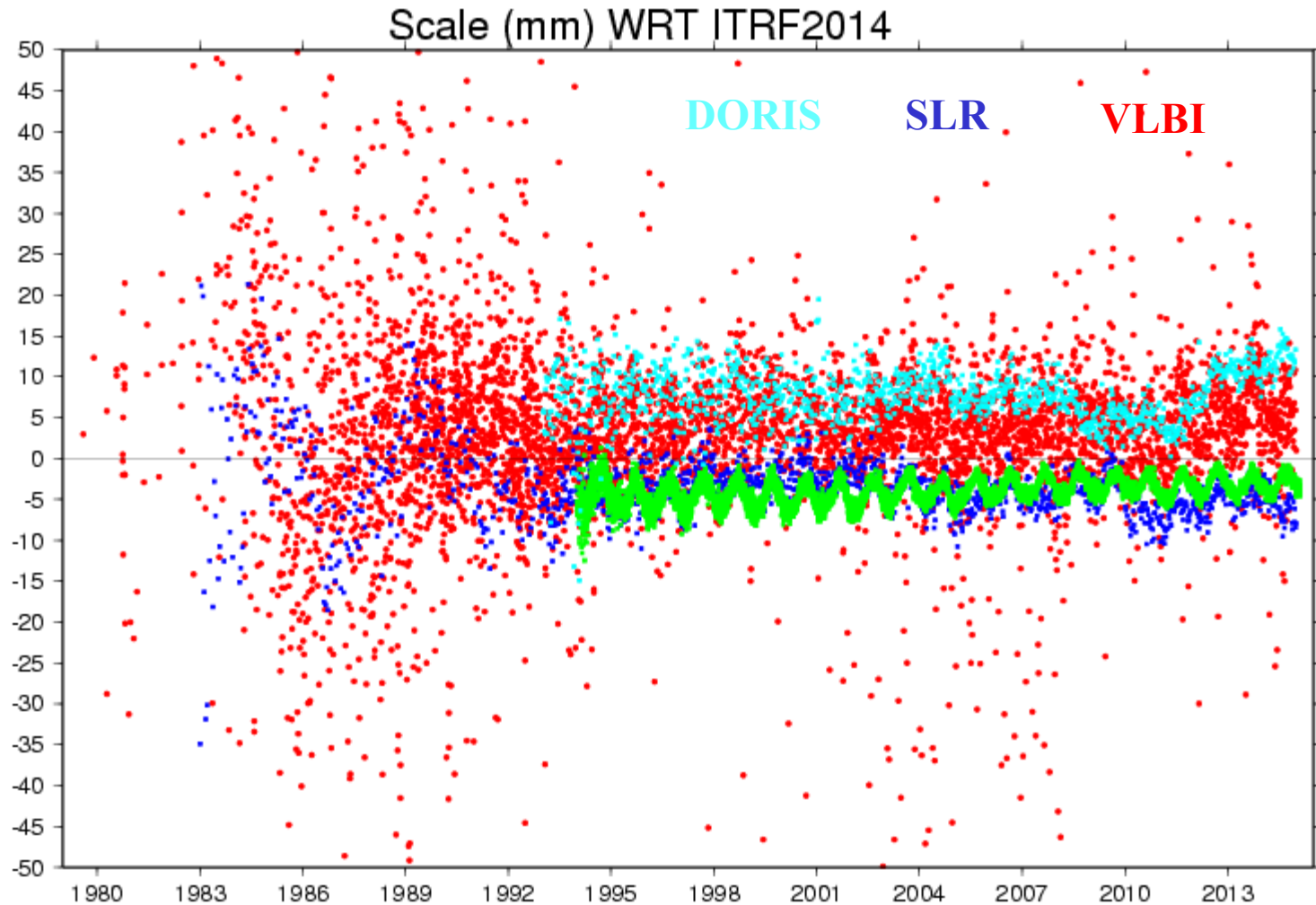
# SLR Origin & Scale WRT ITRF2014



# VLBI, SLR & DORIS Scales wrt ITRF2014

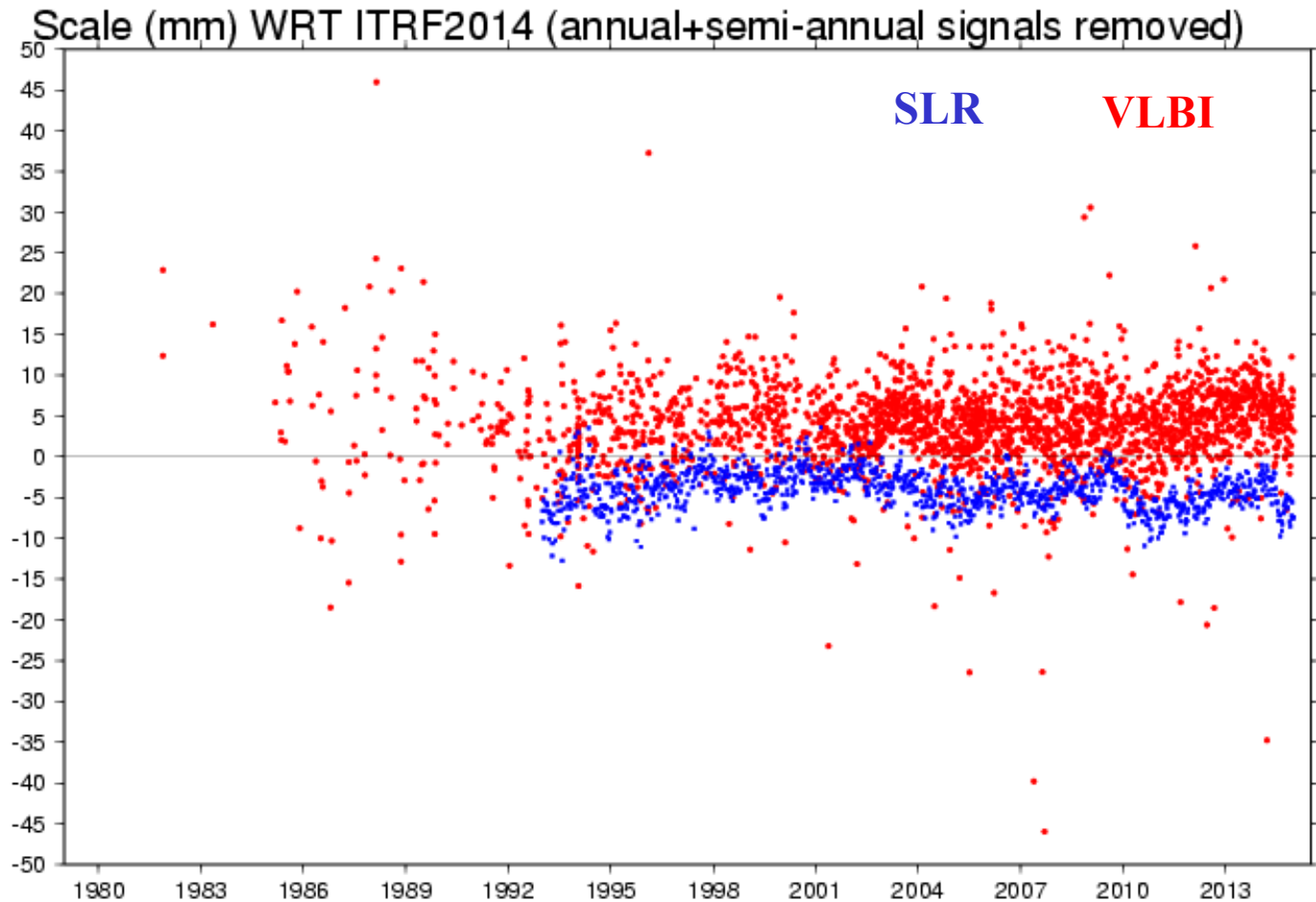


# VLBI, SLR & DORIS Scales wrt ITRF2014





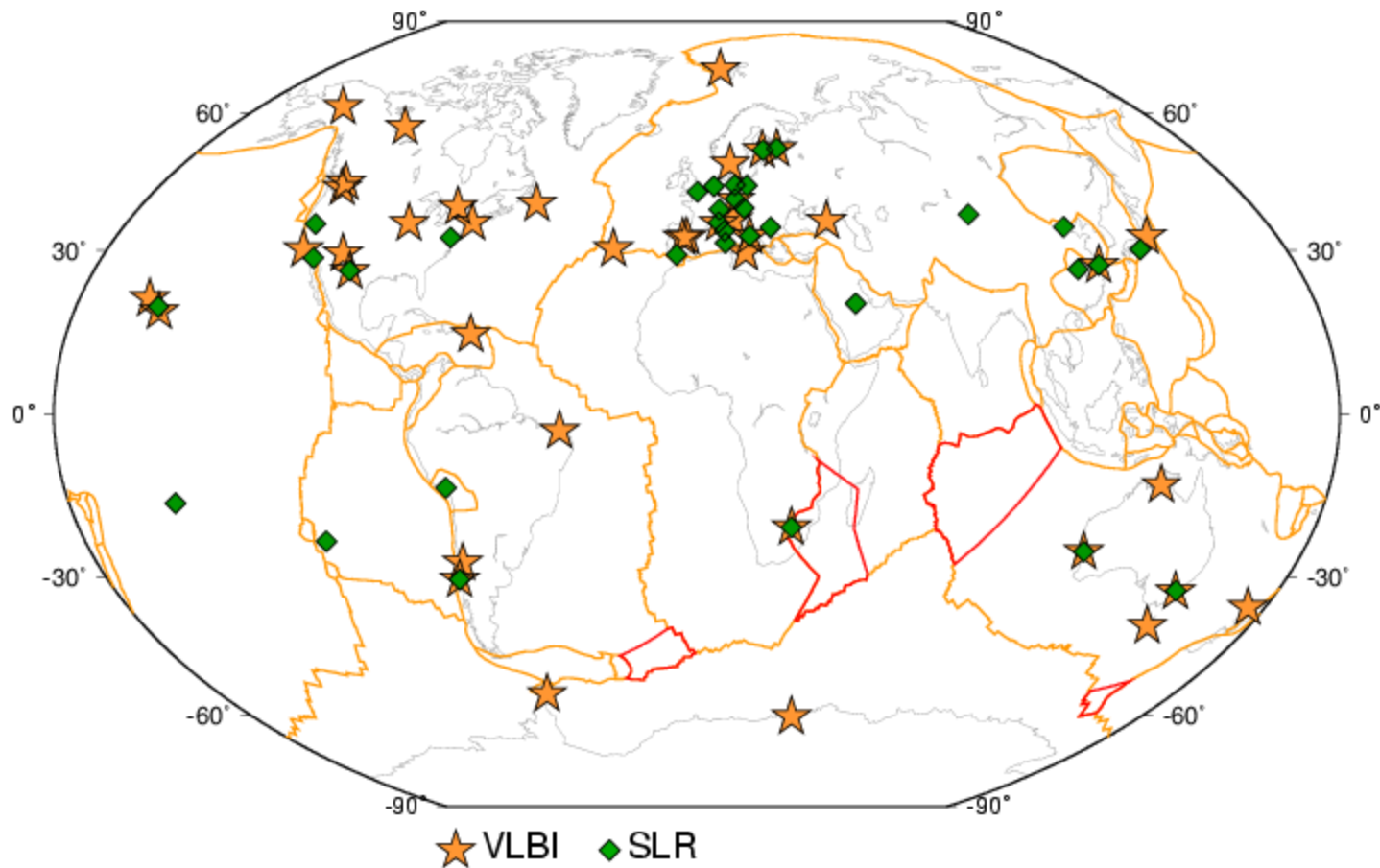
# VLBI, SLR & DORIS Scales wrt ITRF2014



# IGS Contribution

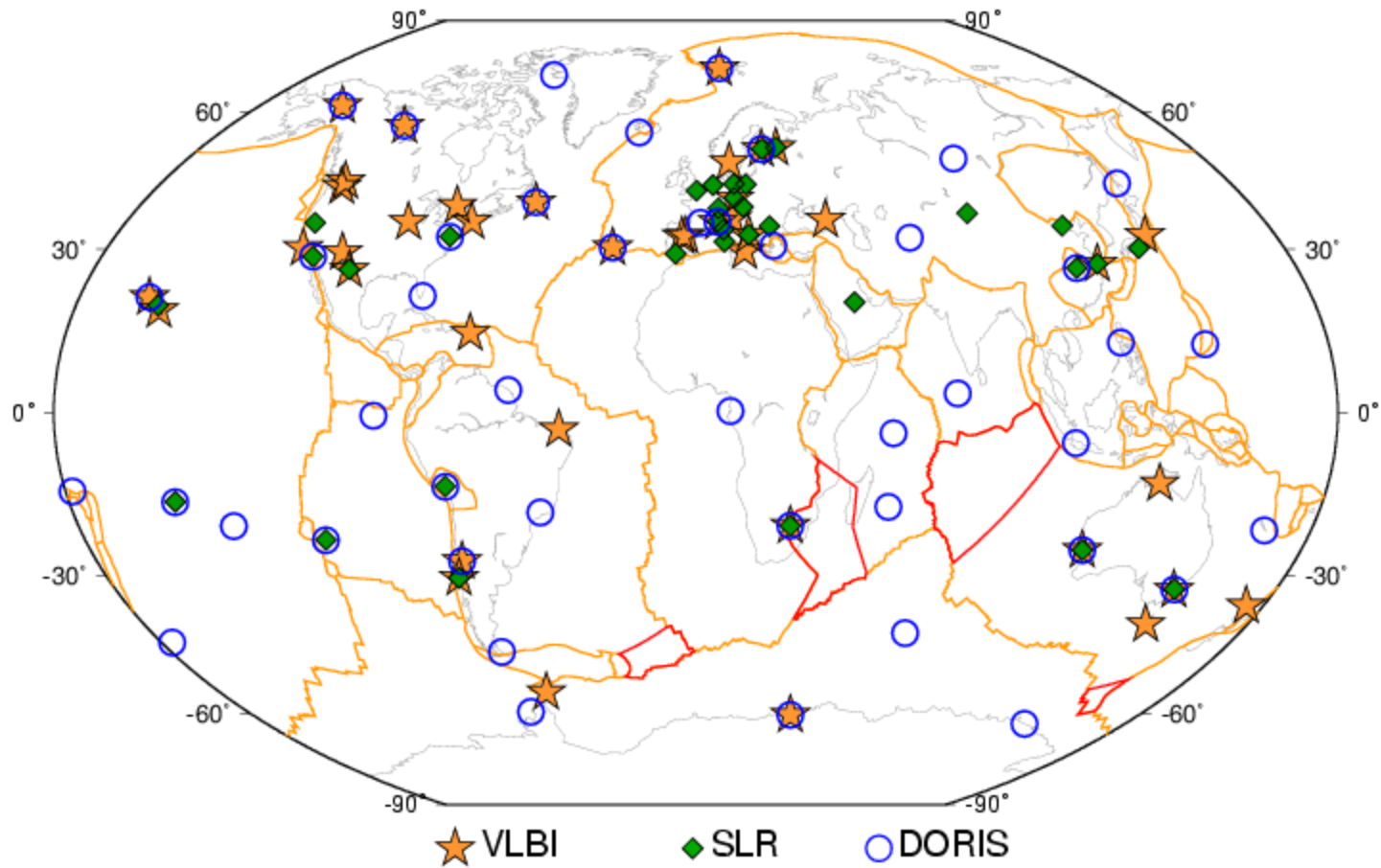
- **Connecting the 3 other techniques**
- **Q: May have any influence on the VLBI & SLR scale agreement/disagreement ?**
  - A: most certainly not, but enforces VLBI & SLR connection**
- **Q: Is there any other alternative for the assessment of the scale between VLBI & SLR ?**
  - A: YES (see next)**

# ITRF2014 Co-locations (VLBI & SLR, Co-located with GNSS)

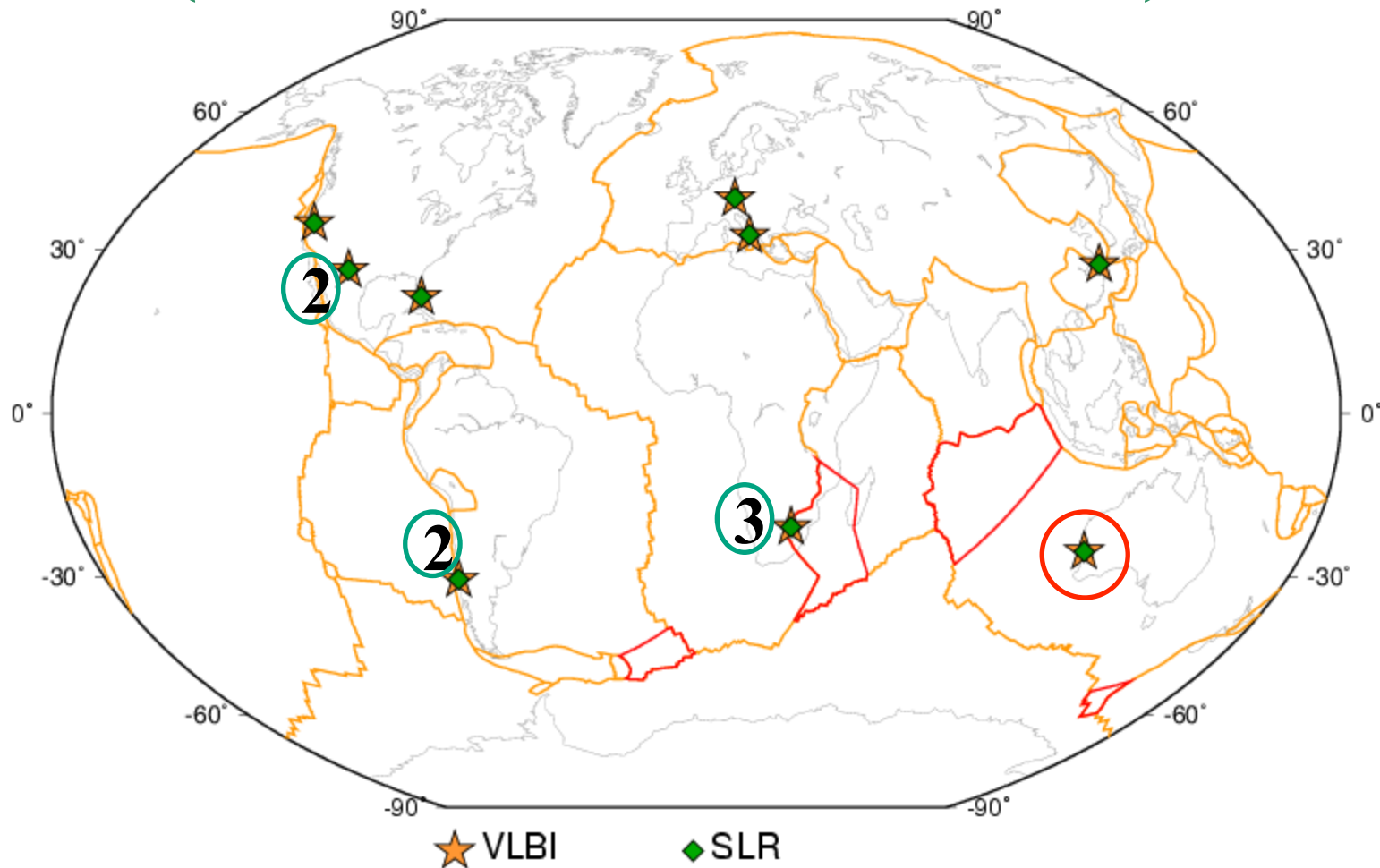


# ITRF2014 Co-locations

(VLBI, SLR & DORIS, Co-located with GNSS)



# ITRF2014 Co-locations (VLBI & SLR co-locations)



Ⓝ : number of tie vectors if  $> 1$

# VLBI vs SLR Scale Difference

Solution	Scale at 2010.0 ppb	Comments
ITRF2014	<b>1.37 ± 0.10</b>	All Tie SNX files properly weighted

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ITRF2014	<b>1.37 ± 0.10</b>	All Tie SNX files properly weighted
Using “best” ties: Residuals < 5 mm	<b>1.49 ± 0.26</b>	32 LT vectors, properly weighted
Using “best” ties: Residuals < 5 mm	<b>1.54 ± 0.22</b>	32 LT vectors, equally weighted <b>3mm</b> per component
Using “best” ties:	<b>1.68 ± 0.14</b>	32 LT vectors, equally weighted <b>1mm</b> per component ( <b>not reliable</b> <b>==&gt; large residuals for some sites</b> )

# VLBI vs SLR Scale Difference

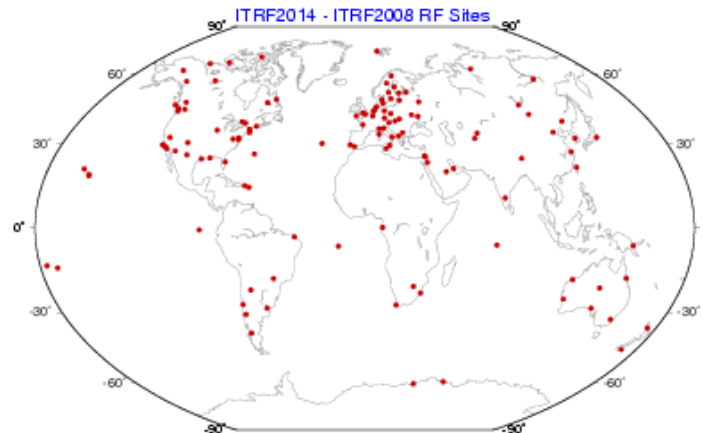
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VLBI & SLR co- locations, No GPS	<b>1.37 ± 0.26</b>	9 sites (good distribution): 13 LT vectors, properly weighted



# From ITRF2014 to ITRF2008

## Using 127 stations

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



# Conclusion

- **ITRF2014 Innovation:**
  - **modelling of station non-linear motions**
- **The IGS contribution is fundamental for:**
  - **The ITRF construction**
  - **The ITRF dissemination**
- **Transformation parameters between ITRF2014 & ITRF2008 are small**