

ITRF2014: Analyse préliminaire

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Mots Clé

- ITRF et la réalité d'une Terre déformable
- Mouvements linéaires
- Mouvements non linéaires
 - Périodiques: saisonniers et autres (e.g. draconitiques)
 - Déformations post-sismiques

Current/possible Reference Frame Representations

- **"Quasi-Instantaneous" Frame: average of station positions over a "short" time-span:**
 - One day or one week of observations

==> Non-linear motion embedded in time series of quasi-instantaneous reference frames

- **Long-Term Secular Frame: mean station positions at a reference epoch (t_0) and station velocities:**

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

"Motions" of the deformable Earth

- **Nearly linear motion:**
 - **Tectonic motion: mainly horizontal**
 - **Post-Glacial Rebound: Vertical & Horizontal**



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

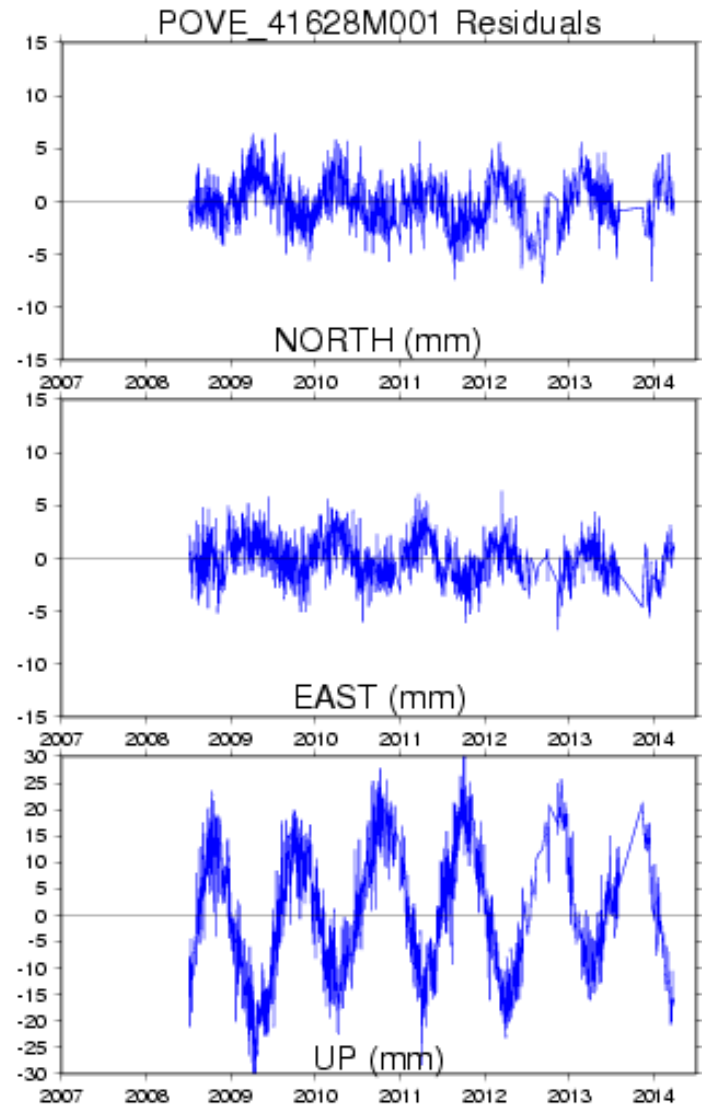
$$X_s^i = X_c^i(t_0) + (t_s - t_0)\dot{X} + T_s + D_s X_c^i + R_s X_c^i$$

"Motions" of the deformable Earth

- **Non-Linear motion:**
 - **Periodic:**
 - Annual, Semi & Inter-Annual
caused by loading effects
(Atmosphere, Oceans,
Hydrology).
 - Other periods, e.g draconitics

==> Apply a geophysical model
or estimate periodic signals by:

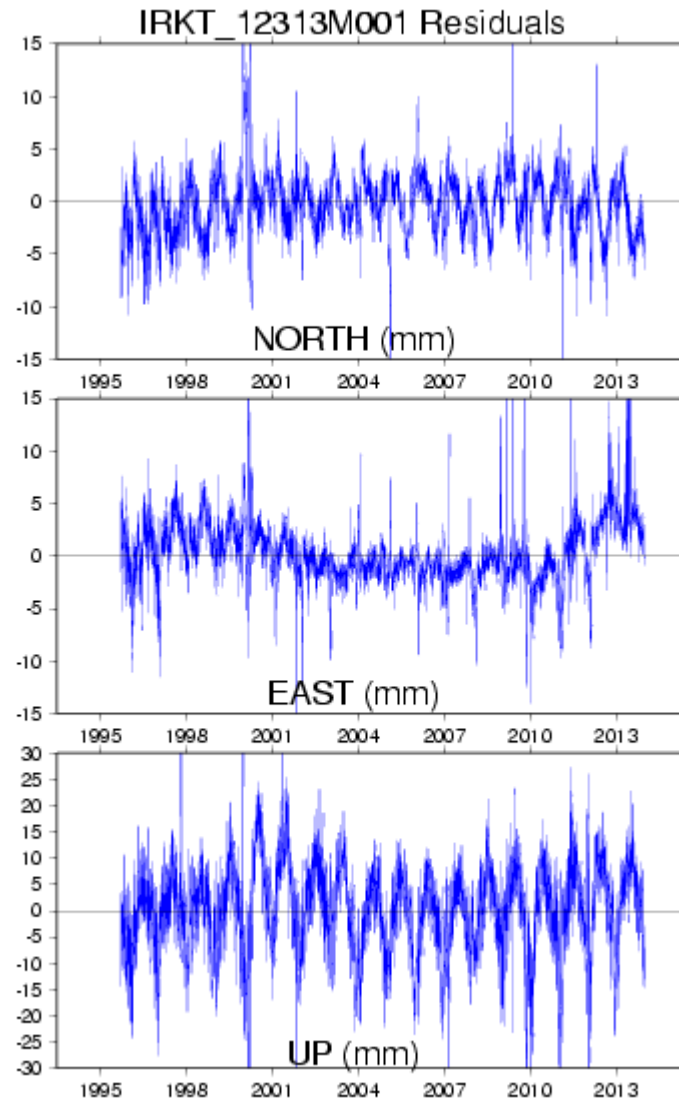
$$\sum a \cos \omega t + b \sin \omega t$$



Surcharge Atmosphérique: Irkutsk



« Irkutsk-Passagirsky » par
Dmitry Afonin — Travail
personnel.



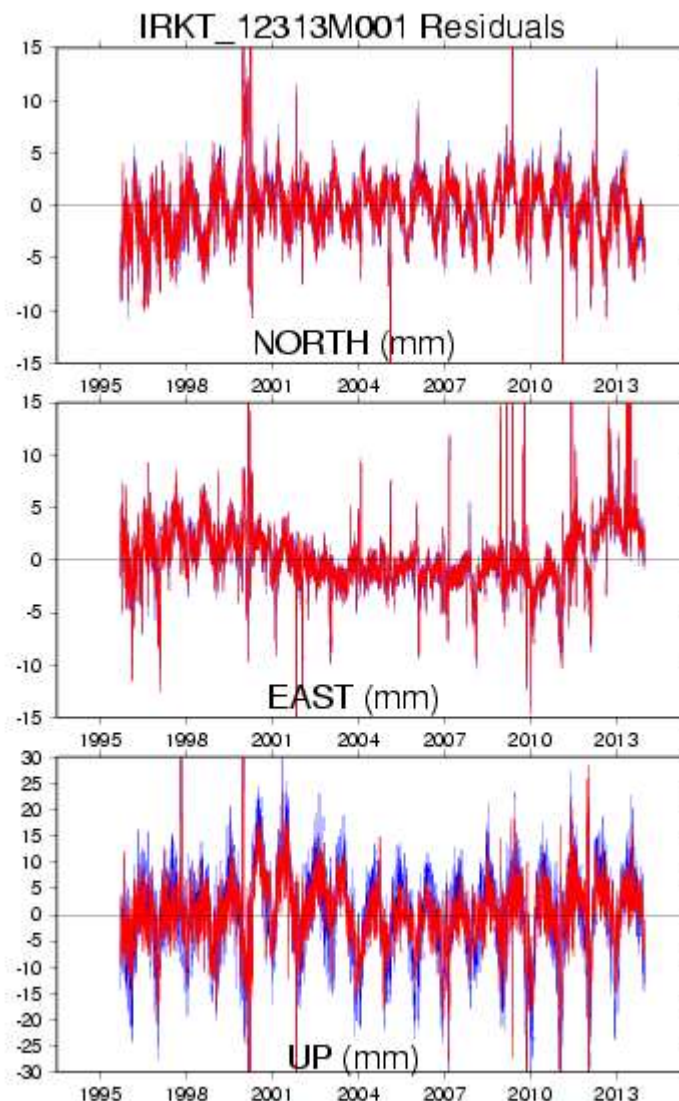
Surcharge Atmosphérique: Irkutsk



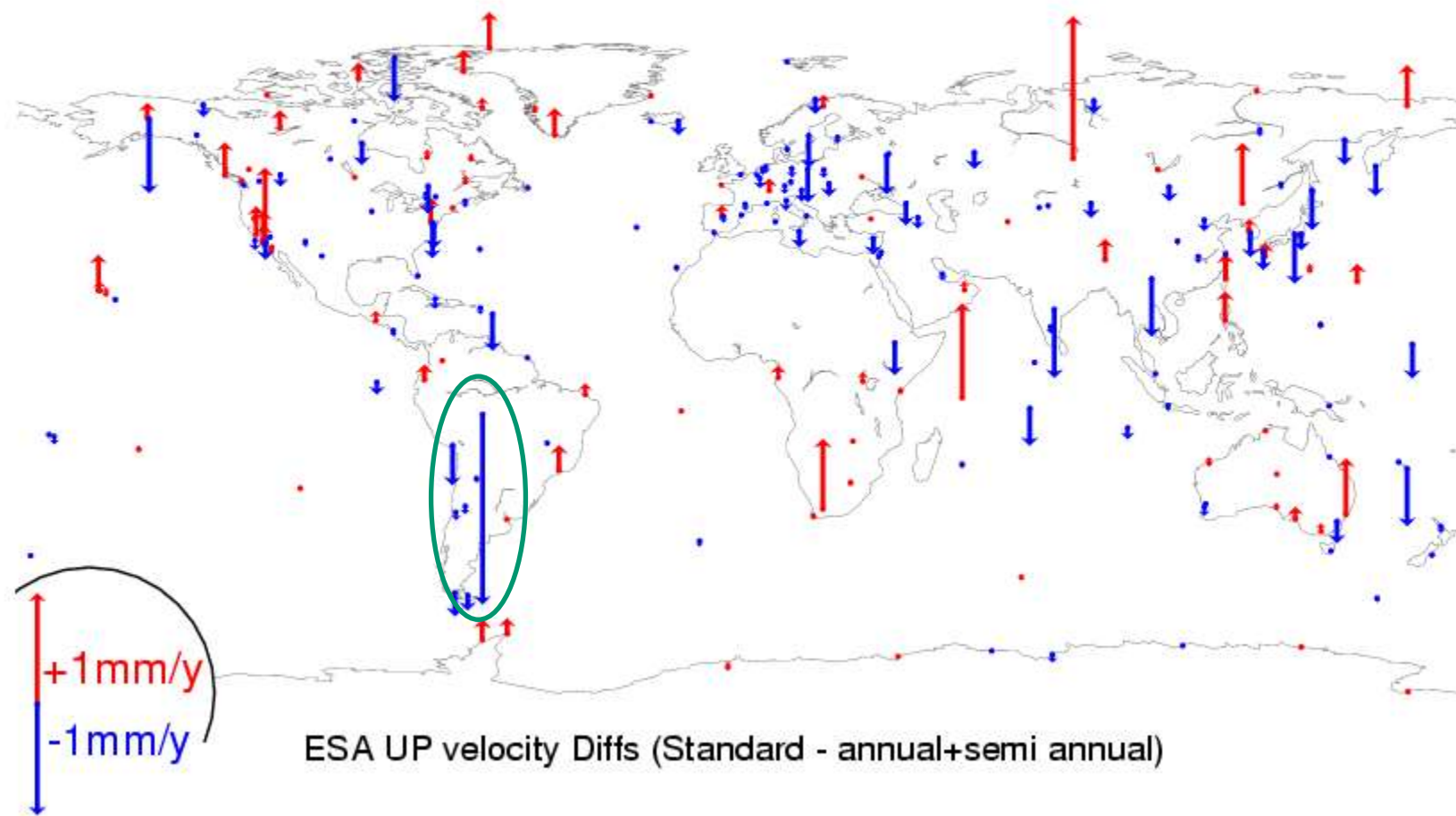
« Irkutsk-Passagirsky » par
Dmitry Afonin — Travail
personnel.

En bleu: Série brute

**En rouge: Série corrigée
de la surcharge atmosphérique,
model fourni par Tonie van
Dam**

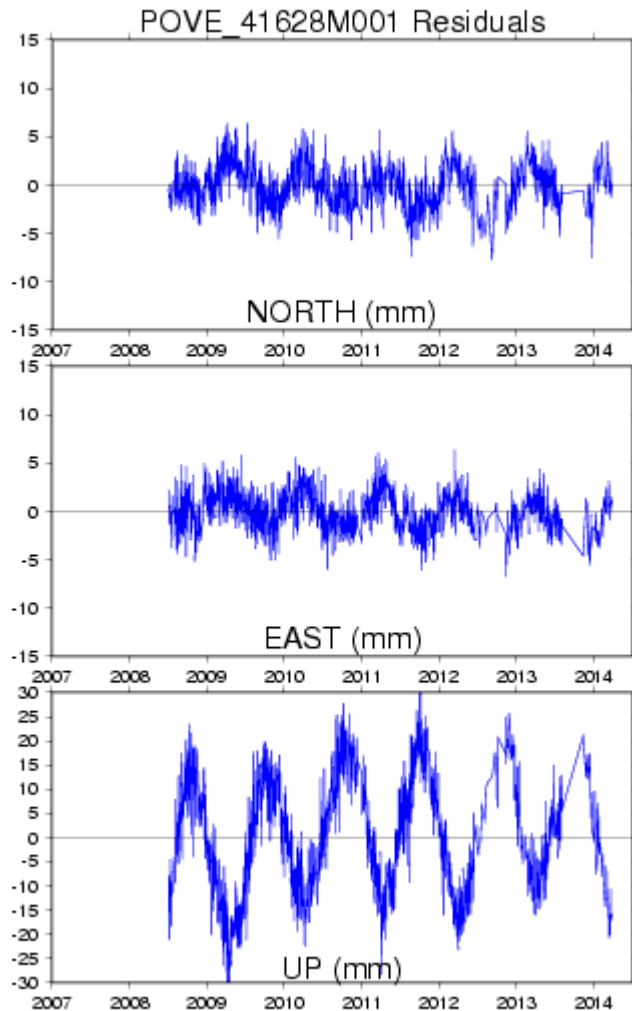


ESA GNSS Repro 2 Vertical velocity differences (Standard – Annual+Semi-Annual)



Position Residuals of Porto Velho, Brazil

Standard Solution



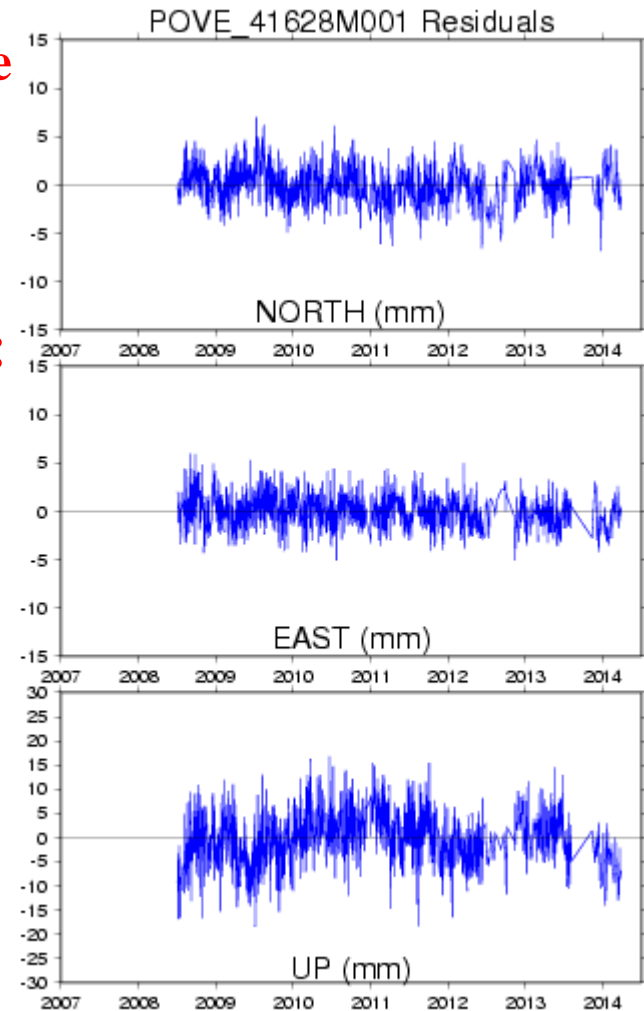
Velocity change



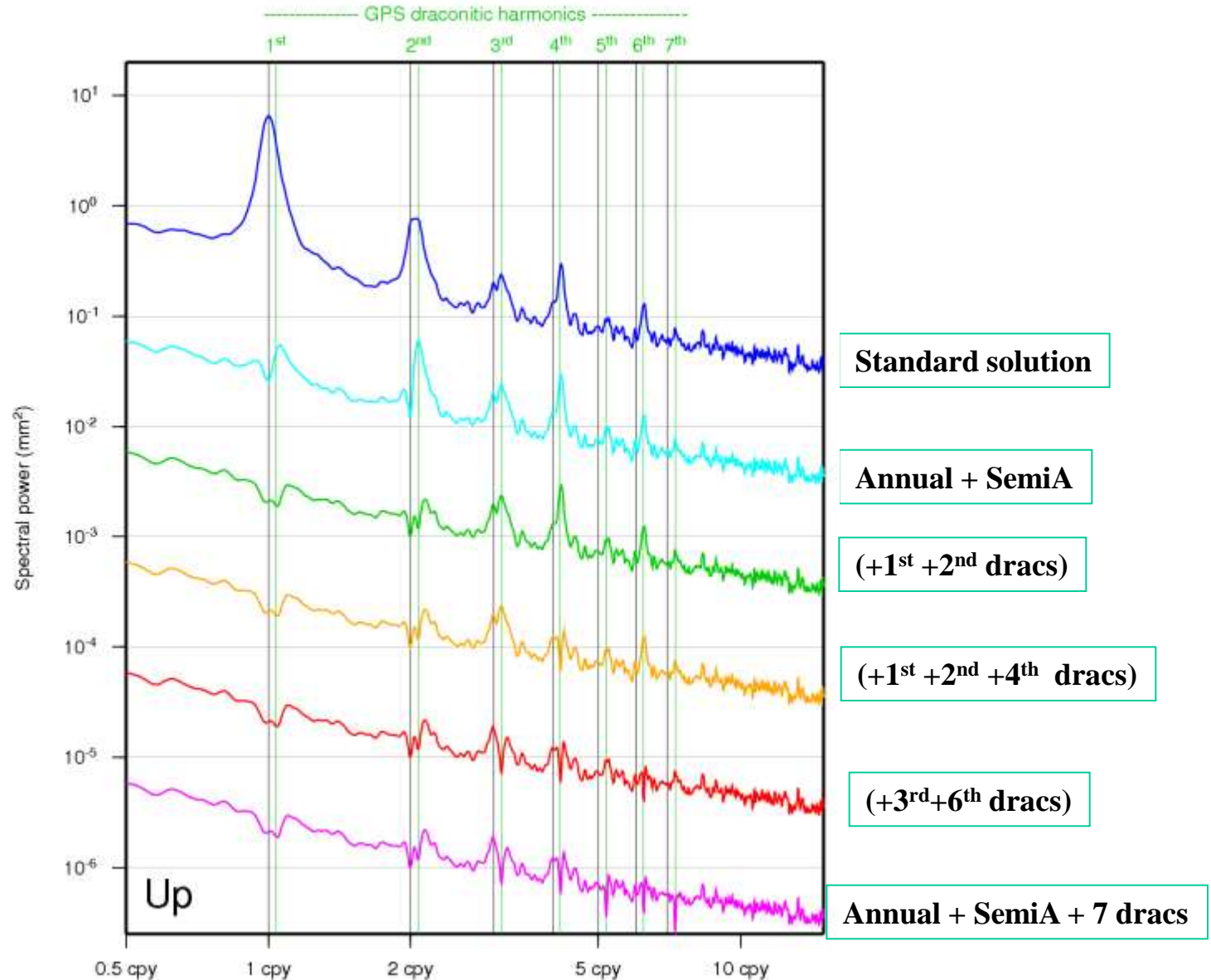
Horizontal:
0.2 mm/yr

Vertical:
1.7 (± 0.15)
mm/yr

Ann+semi-ann removed

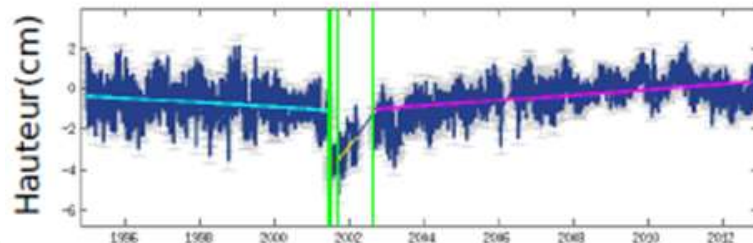
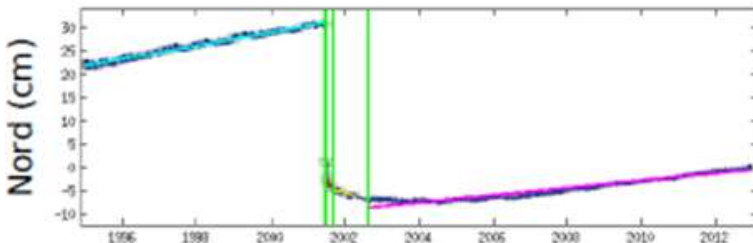
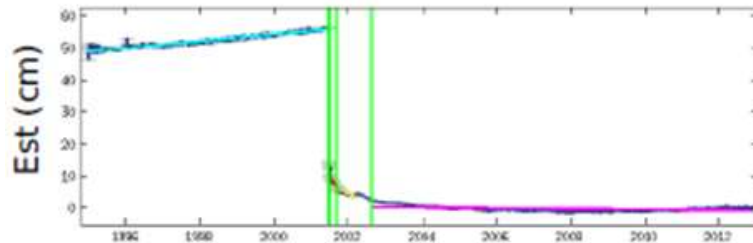


IGS station position Up residuals: stacked periodogram



"Motions" of the deformable Earth

- **Non-Linear motion:**
 - Post seismic deformation



- **Piece-Wise Linear (PWL) function**
- **Parametric models:**
 - **Logarithmic**
 - **Exponential**
 - **Log + Exp**
 - **Two Exp**

Parametric post seismic models

Parametric models for postseismic displacements :

$$\forall i \in \{E, N, U\}, X_i(t) =$$

$$\begin{cases} X_1(t_0) + V_1 \times (t - t_0) & , \quad t < t_{eq} \\ X_2(t_{eq}) + V_2 \times (t - t_{eq}) + D(t - t_{eq}), & t > t_{eq} \end{cases}$$

Parametric postseismic models use logarithmic or exponential functions :

$D(t - t_{eqk})$ with

$$D(t - t_{eqk}) = A \log\left(1 + \frac{t - t_{eqk}}{\tau}\right) \quad (1)$$

or

$$D(t - t_{eqk}) = A \left(1 - e^{-\frac{t - t_{eqk}}{\tau}}\right) \quad (2)$$

[e.g. : Kreemer et al., 2006]

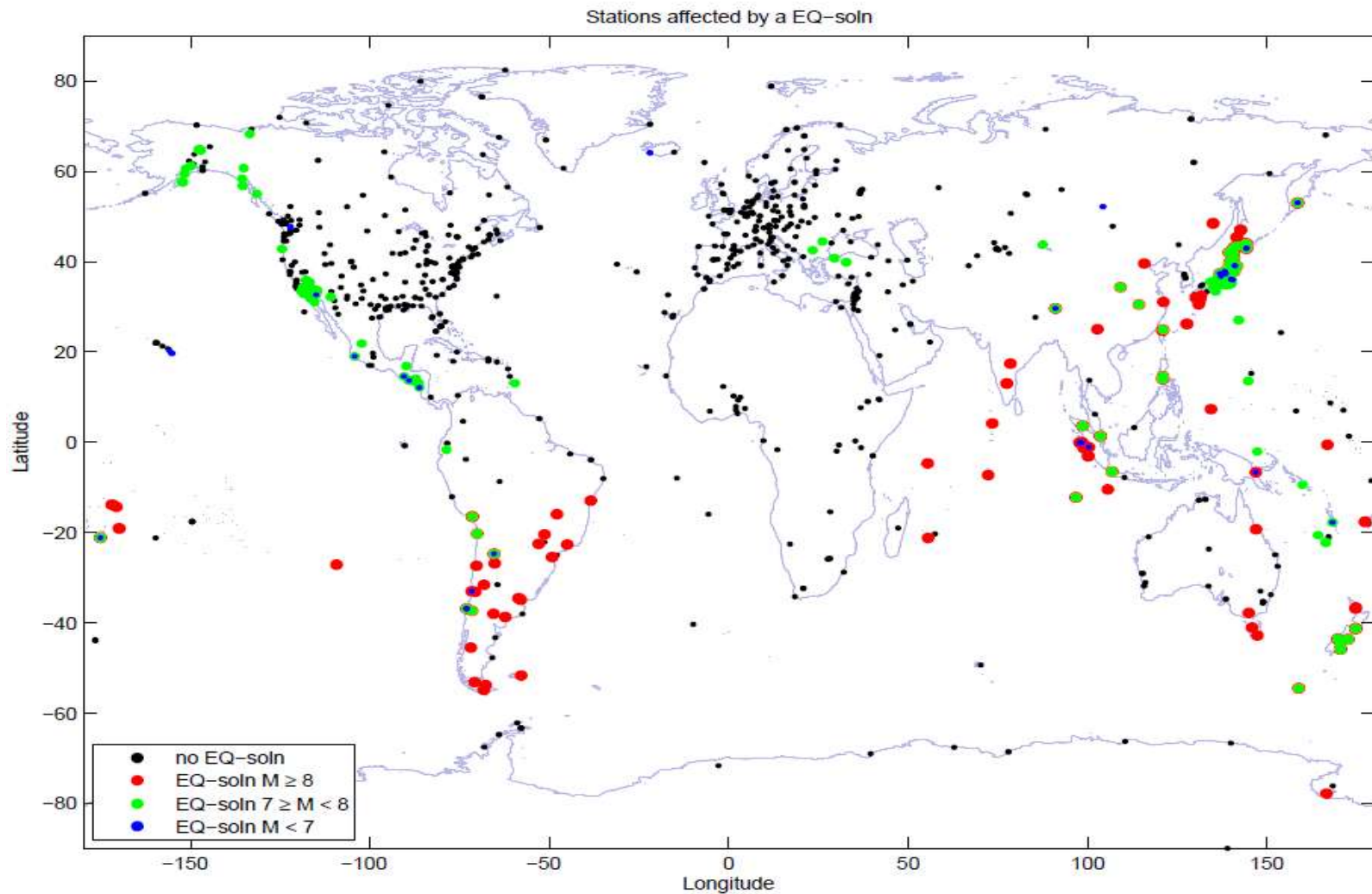
or

$$D(t - t_{eqk}) = A_1 \log\left(1 + \frac{t - t_{eqk}}{\tau_1}\right) + A_2 \left(1 - e^{-\frac{t - t_{eqk}}{\tau_2}}\right) \quad (3)$$

or

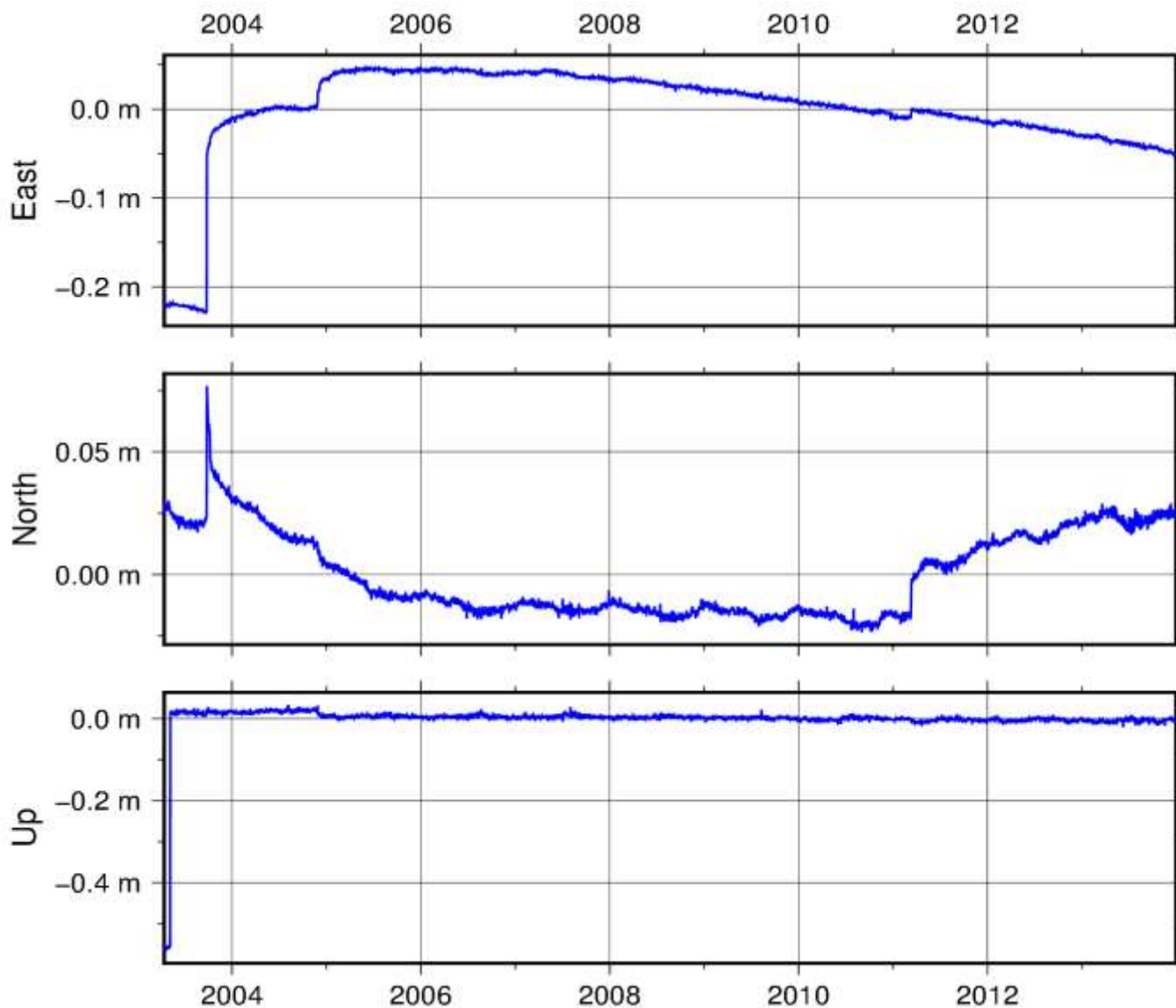
$$D(t - t_{eqk}) = A_1 \left(1 - e^{-\frac{t - t_{eqk}}{\tau_1}}\right) + A_2 \left(1 - e^{-\frac{t - t_{eqk}}{\tau_2}}\right) \quad (4)$$

Sites affected by EQ discontinuities

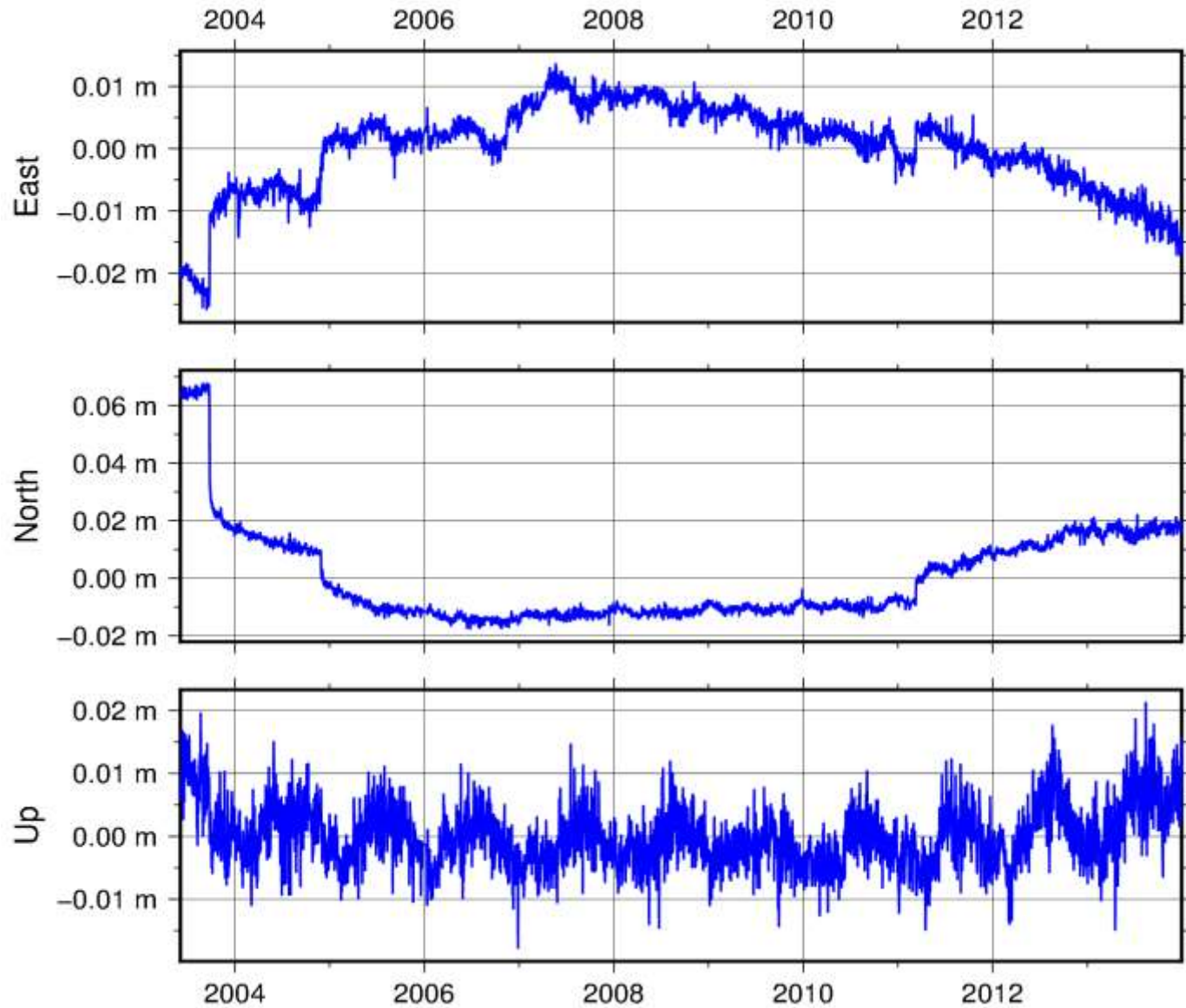


(Métivier et al., 2014)

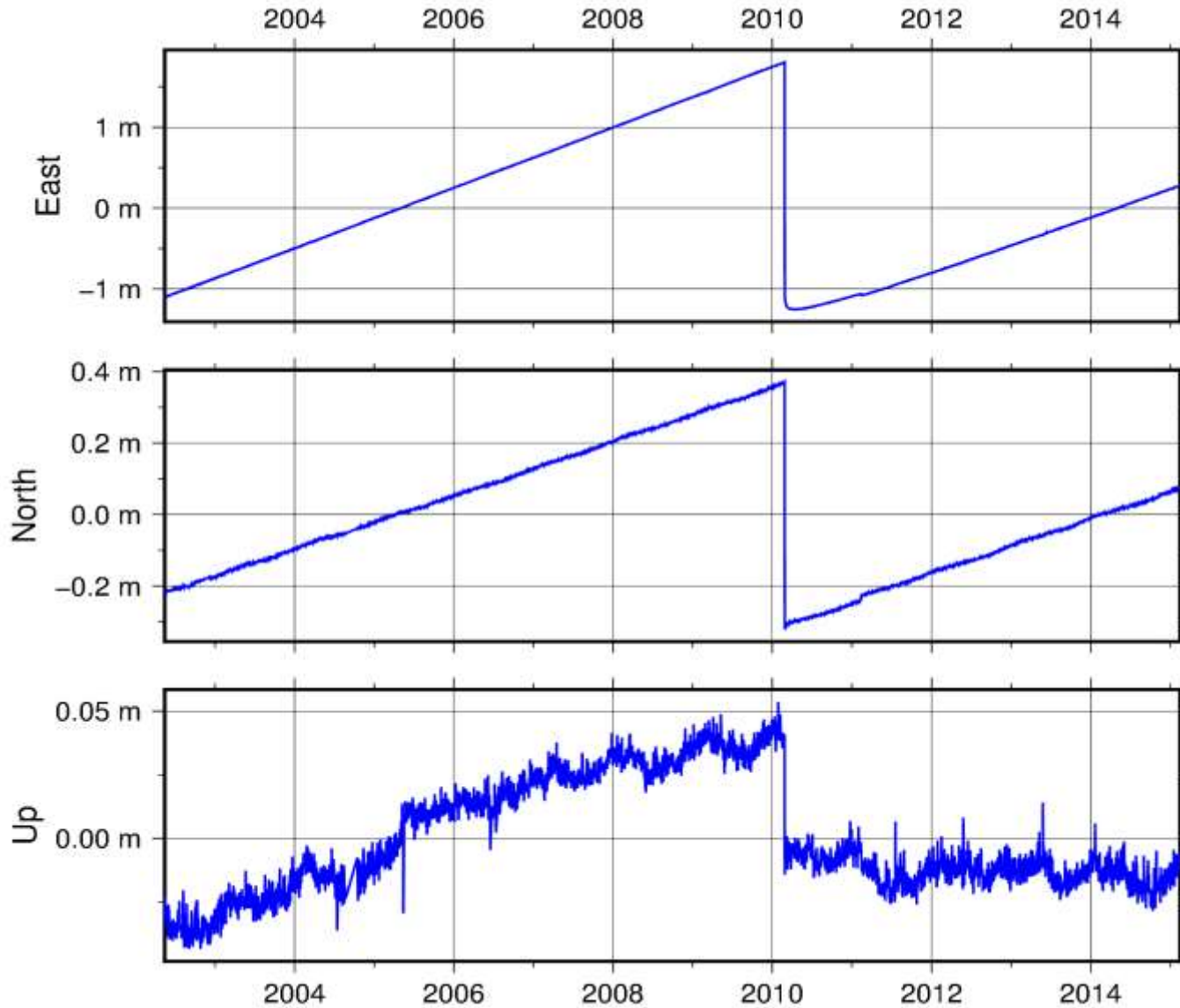
Une station ITRF2014 au Japon



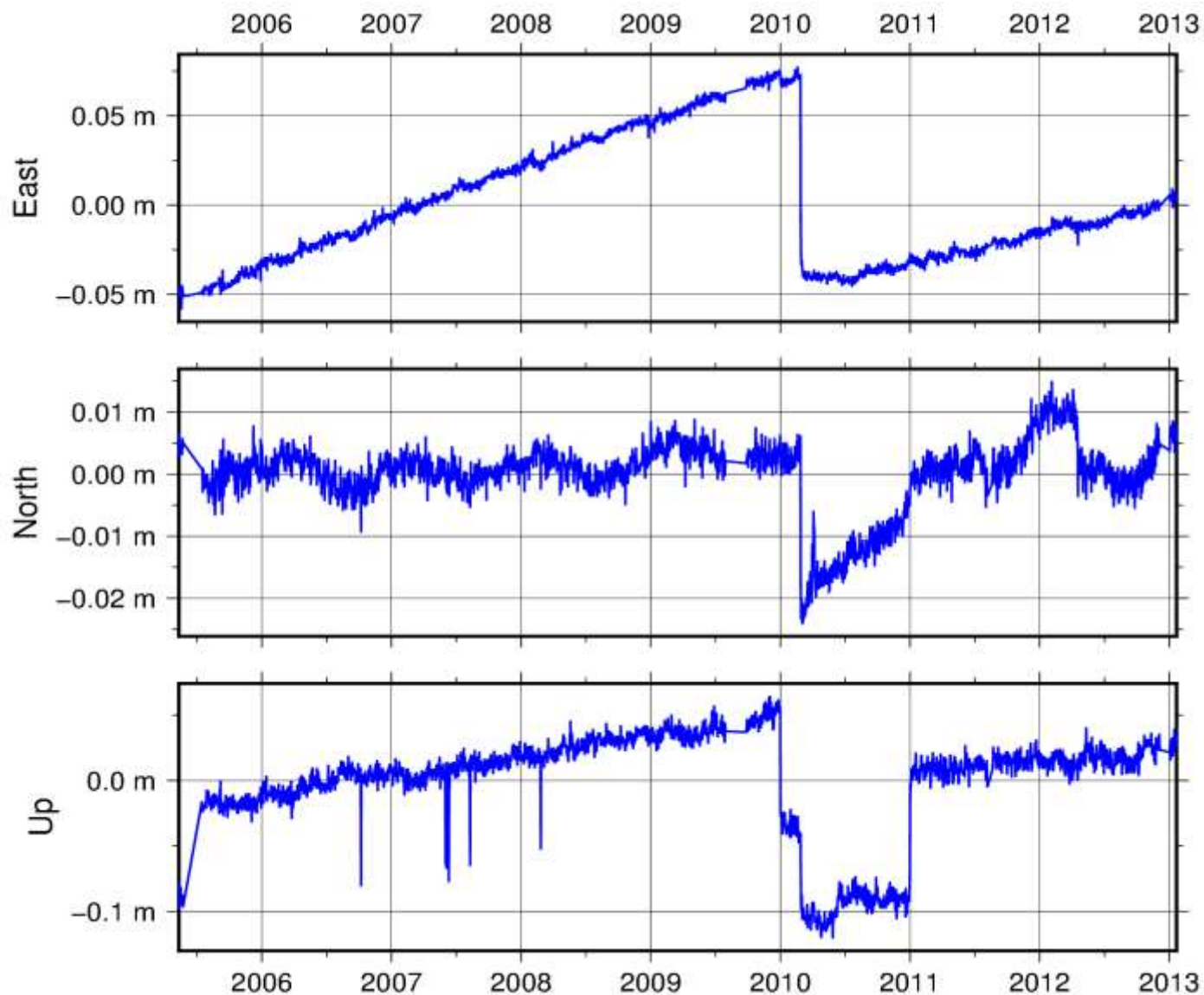
Une station ITRF2014 au Japon



Une station ITRF2014 au Chili



Une station ITRF2014 au Chili

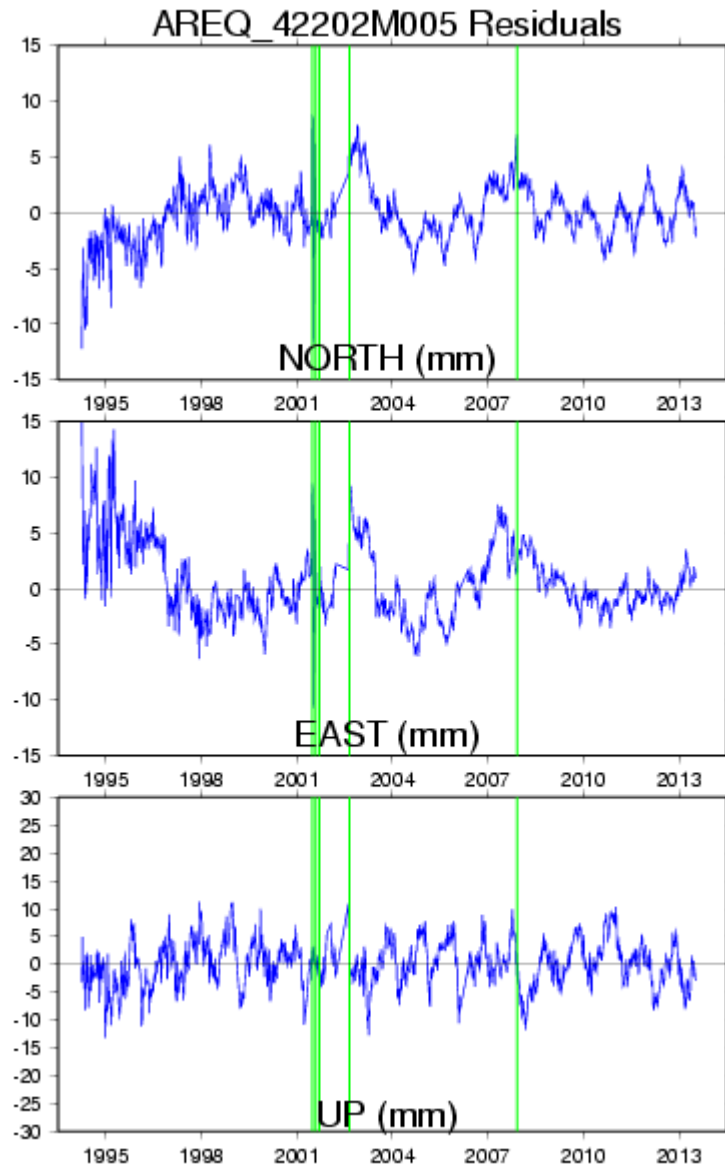


Linear Function

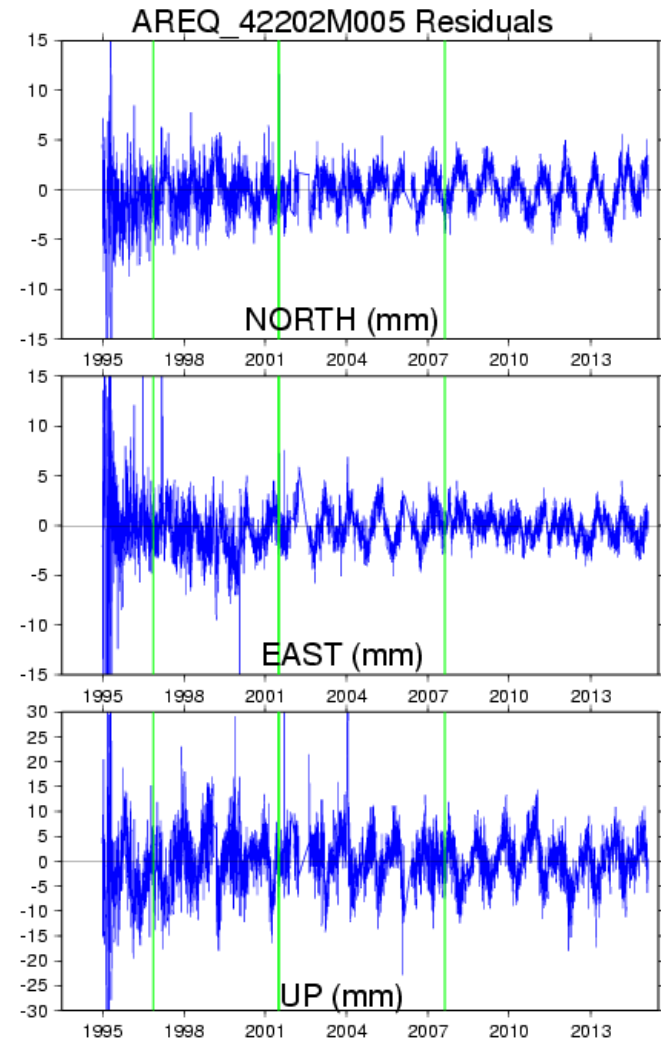
Arequipa

Parametric Model

Multiple velocities estimated



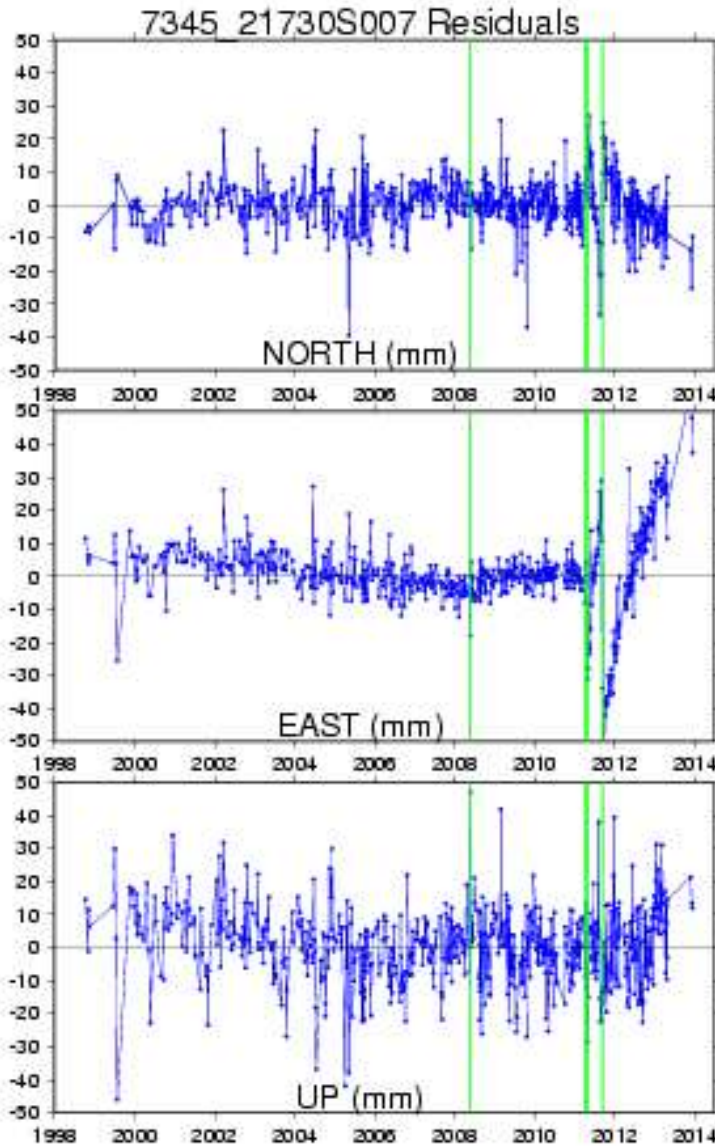
Post-fit residuals



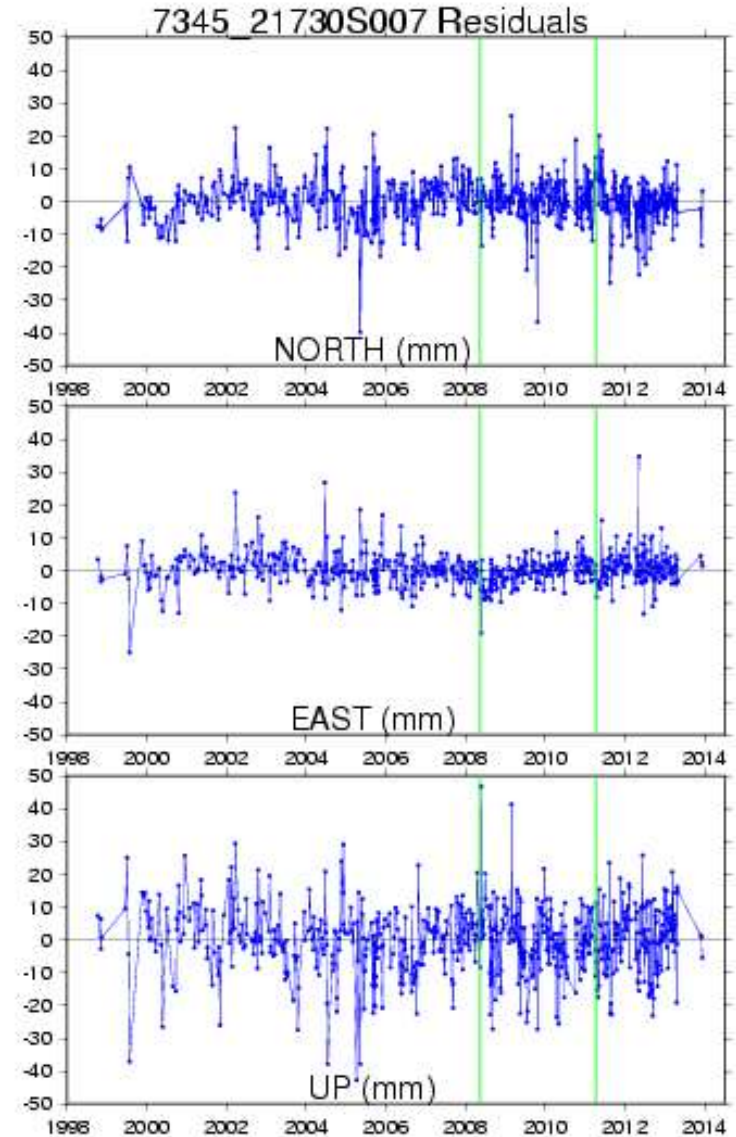
One velocity estimated

Linear Function **Tsukuba VLBI** Parametric Model

Multiple velocities estimated



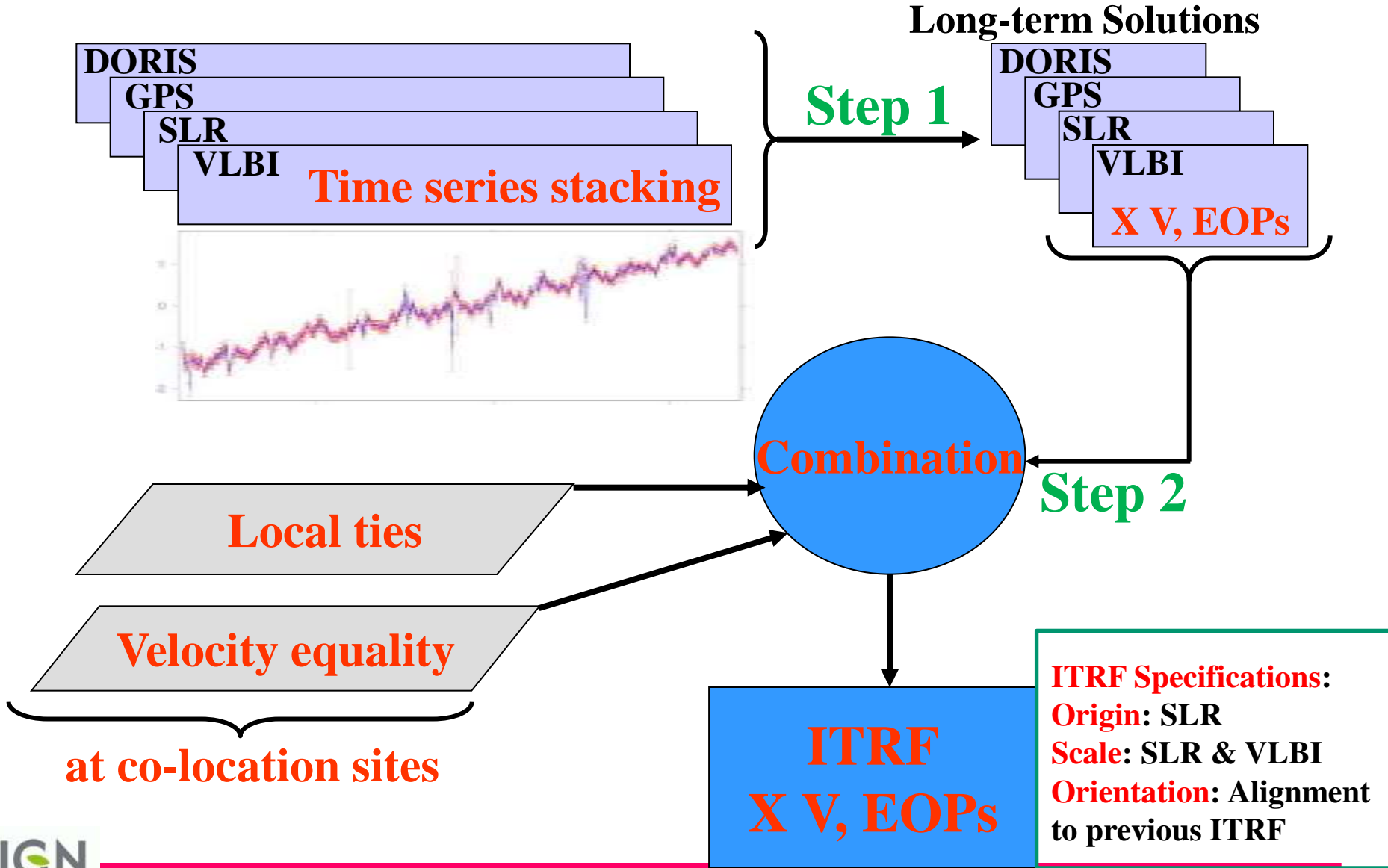
Post-fit residuals



One velocity estimated

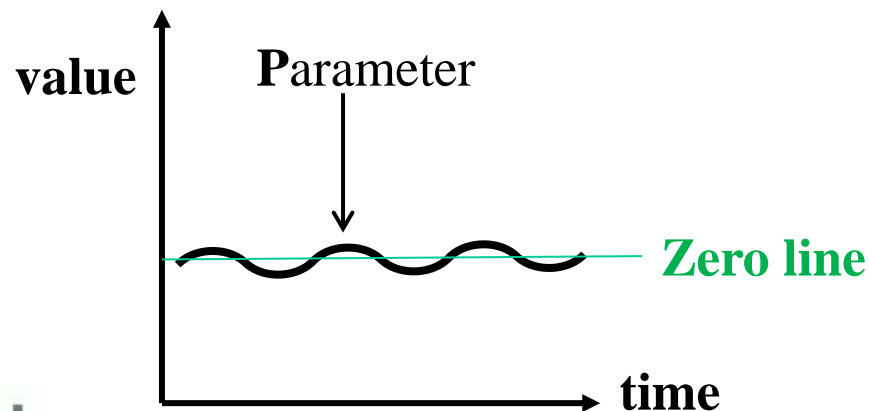
Lercier et al., 2014, submitted

ITRF Construction



Preserving SLR origin and SLR and VLBI scales

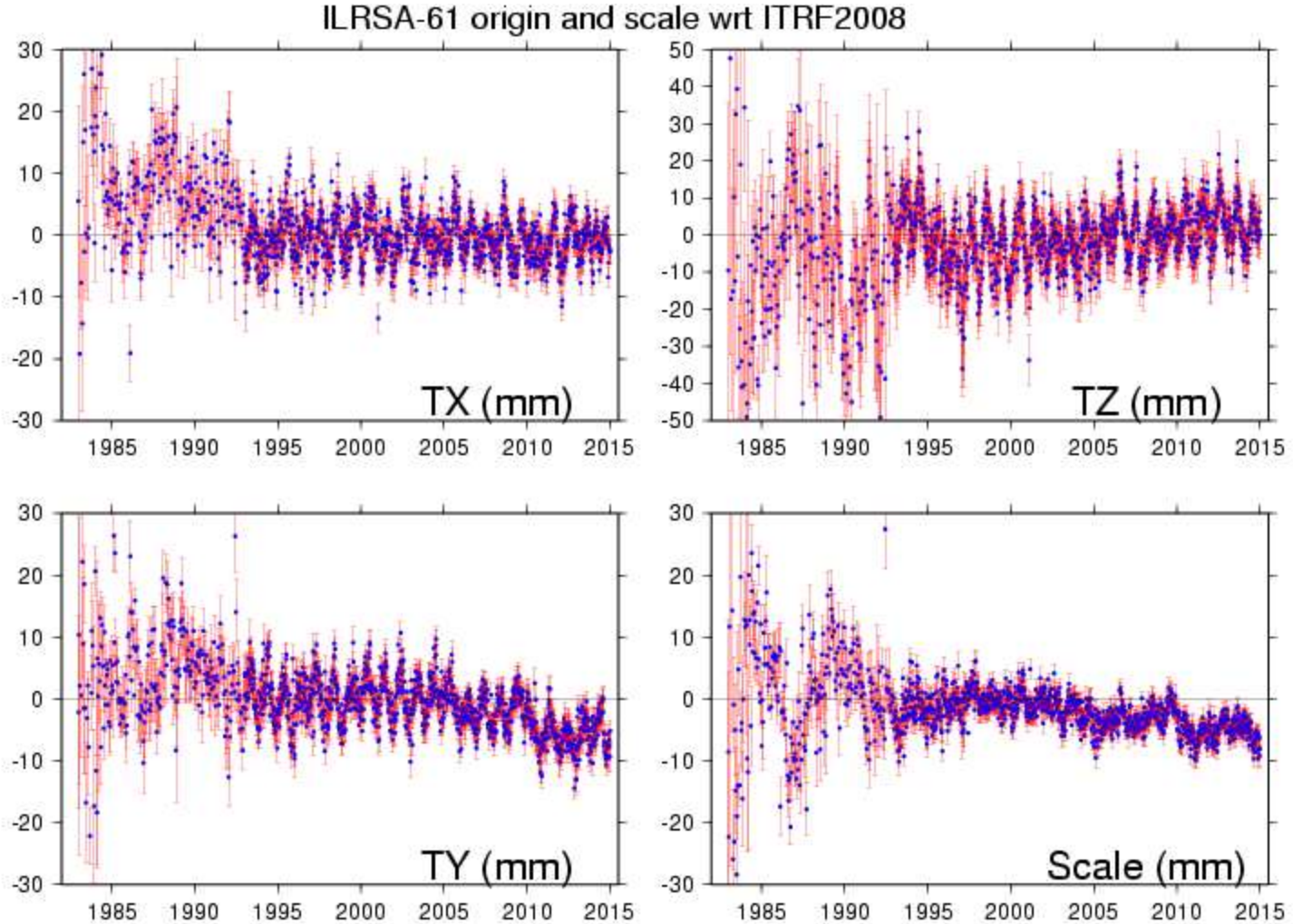
- Stacking/accumulating individual time series where the long-term
 - origin of SLR
 - and
 - scale of VLBI, SLRare defined via internal (minimum-type) constraints:



$$\begin{cases} \sum_{k \in K} P_k & = 0 \\ \sum_{k \in K} (t_k - t_0) P_k & = 0 \end{cases}$$

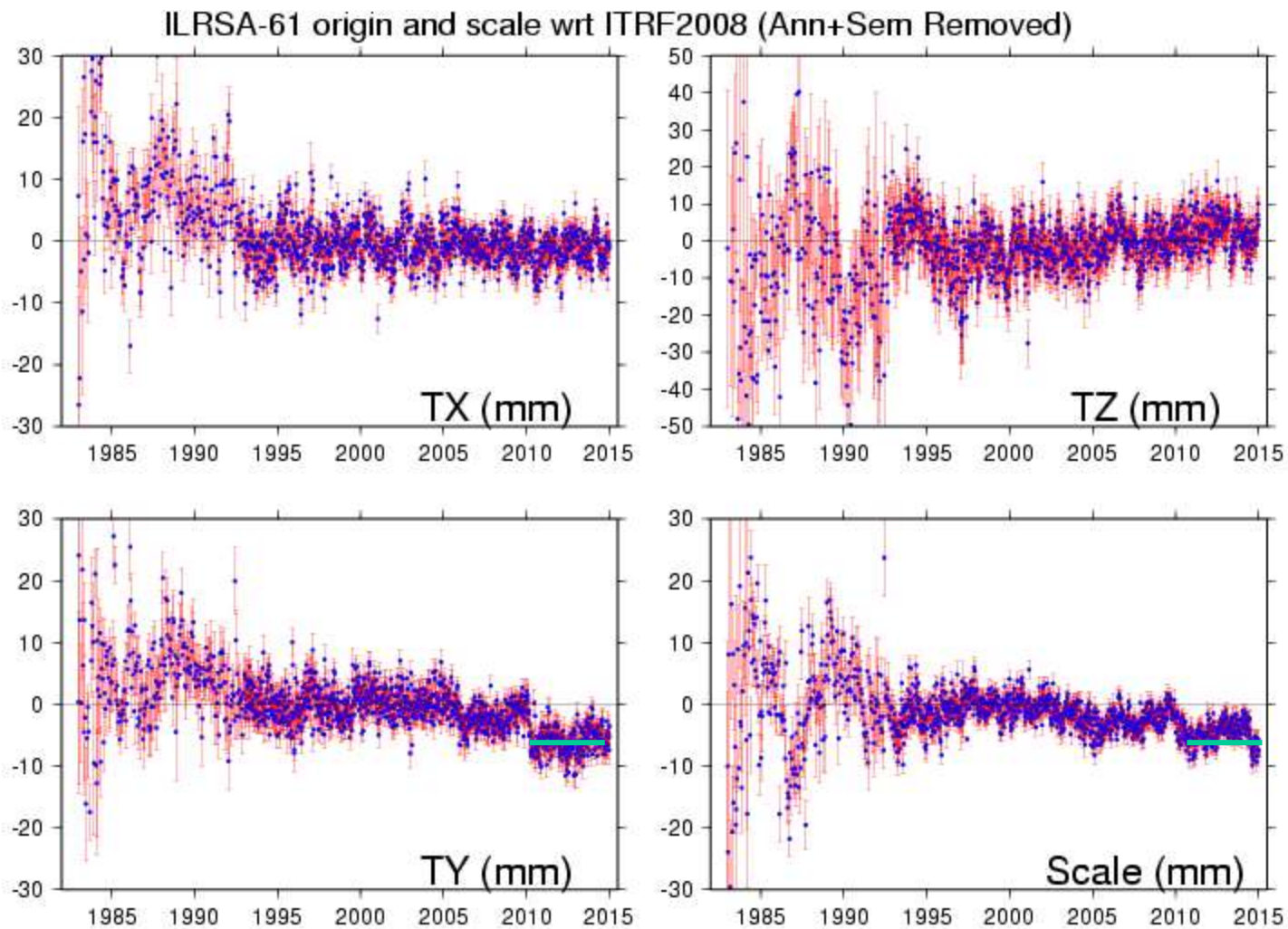
(Altamimi et al., 2007)

SLR/ILRS Origin & Scale WRT ITRF2008

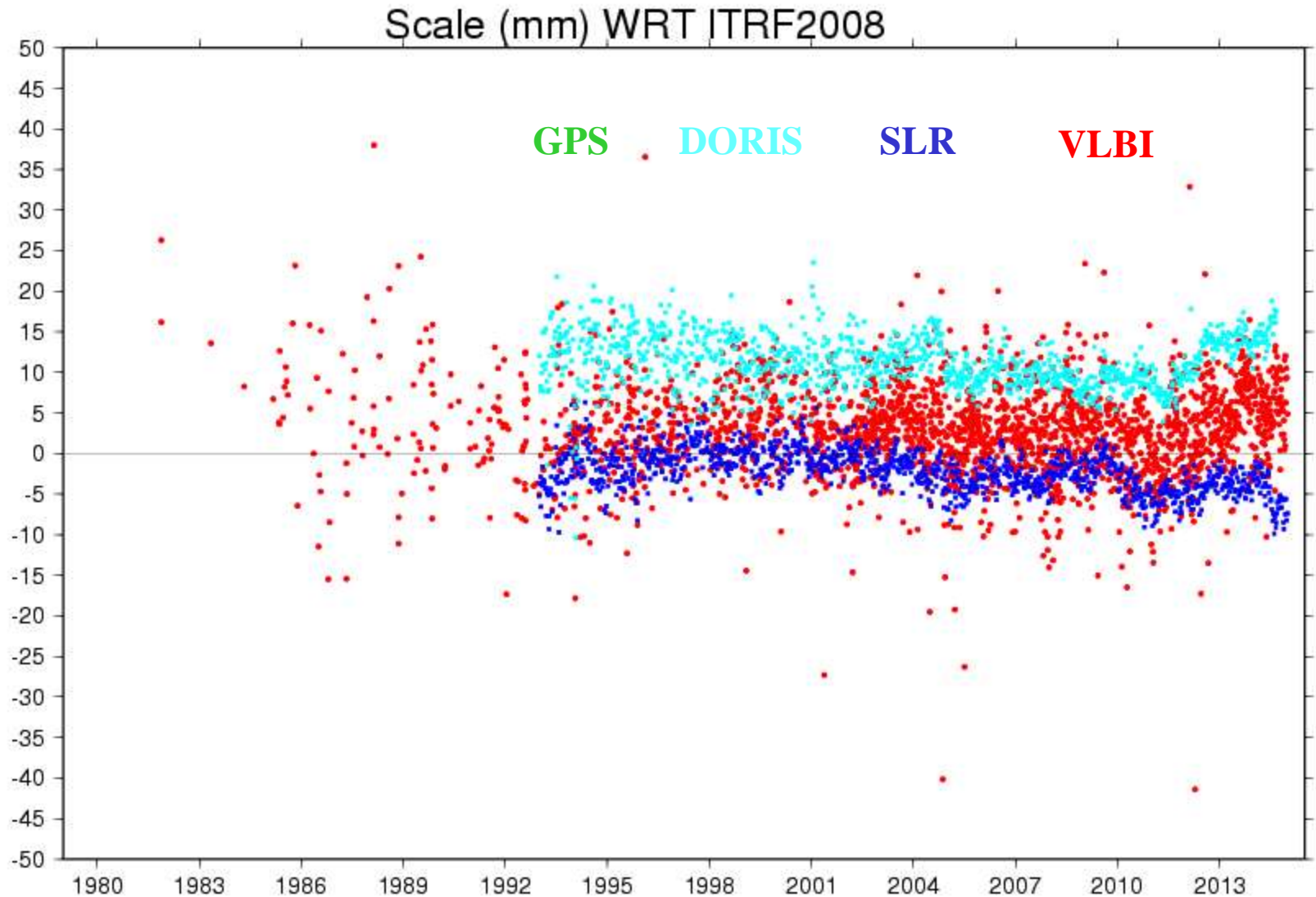


SLR/ILRS Origin & Scale WRT ITRF2008

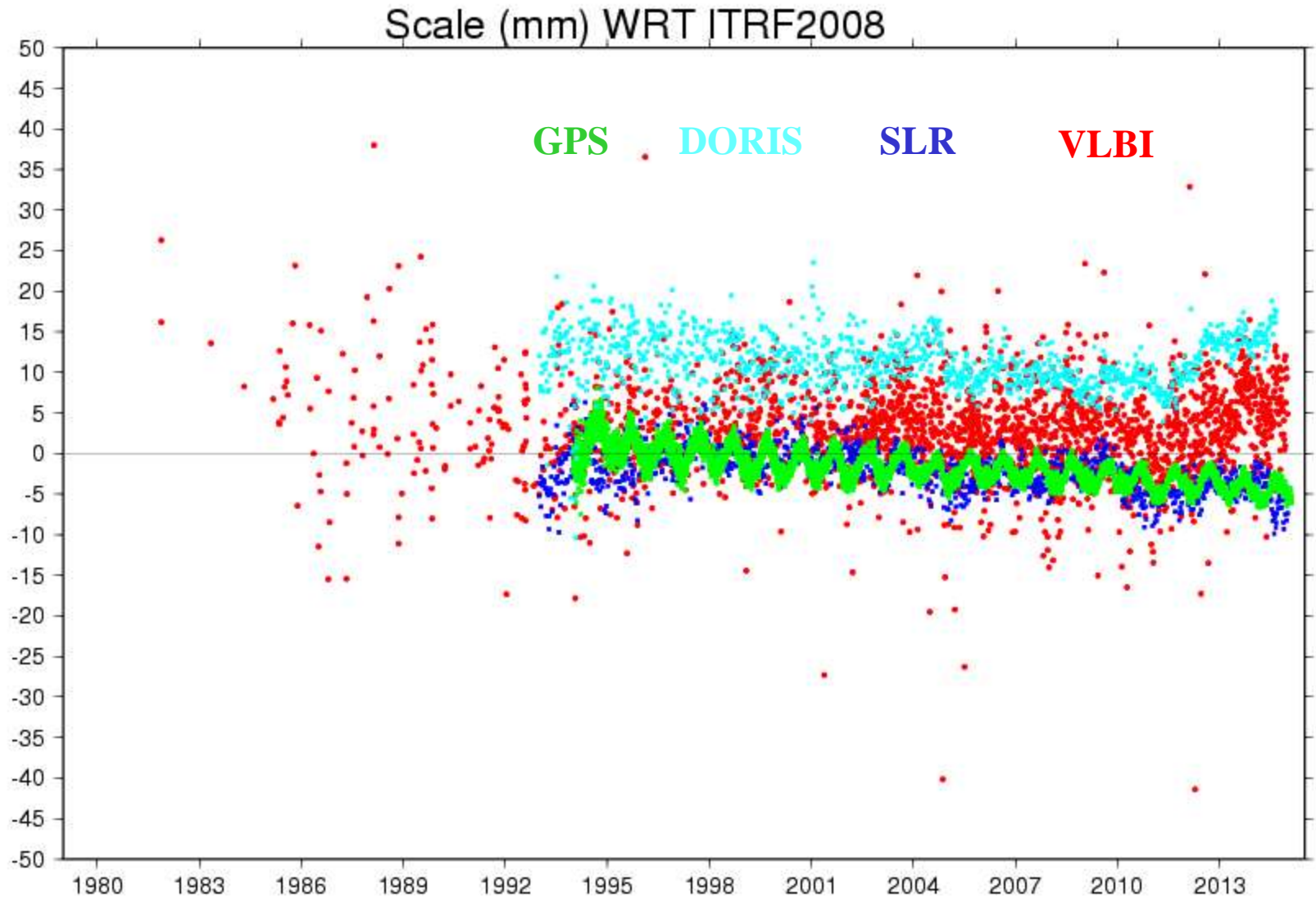
Annual and Semi-Annual signals + PSD removed



VLBI, SLR, DORIS & GPS Scales wrt ITRF2008



VLBI, SLR, DORIS & GPS Scales wrt ITRF2008



Conclusion

- **ITRF2014: Quoi de neuf ?**
 - Application d'un model de surcharge atmosphérique
 - Estimation des termes saisonniers, au moins annuels et semi-annuels
 - Application de modèles paramétriques pour modéliser les déformations sismiques
- **ITRF2014: C'est pour quand ?**
 - On l'espère avant l'été