IDS Contribution to the ITRF2013

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Outline

- ITRF2013: Status of submissions
- ITRF2013:
  - What's new ?
  - Combination strategy
- IDS Contribution to ITRF2013: Preliminary analysis:
  - Origin & scale agreement with ITRF2008
  - Velocity agreement between IDS-V5 & GPS (MIT solution)
  - Tie Discrepancies DORIS-DORIS and GPS(MIT)-DORIS
- ITRF and site non-linear motions: some numerical results:
  - Periodic signals
  - Co- & Post-Seismic deformation
- Conclusion

ITRF2013: Status of submission

- **IDS final/official solution (V5) submitted**
- **ILRS, IGS, IVS still at the combination stage**
- **ILRS submitted the 1993.0 - 2014.0 part**

ITRF2013

- **What's new ?**
  - **Reprocessed solutions from the 4 techniques**
  - **Improving the process of detection of discontinuities in the time series**
  - **Applying NT-ATML (+) corrections to ITRF2013 input data**
  - **Periodic signals (at least annual & semi-annual)**
    - **Estimated per technique at the stacking level**
    - **Expect to provide more precise station velocities**
    - **Will not be equated at co-location sites: up to half of GPS signal is not geophysical**
  - **Co- & Post-seismic deformation (parametric models will be applied) for EQ sites**

ITRF Construction

DORIS
GPS
SLR
VLBI
Time series stacking

Step 1

Long-term Solutions

DORIS
GPS
SLR
VLBI
X V, EOPs

Combination

Step 2

Local ties

Velocity equality

at co-location sites

ITRF
X V, EOPs

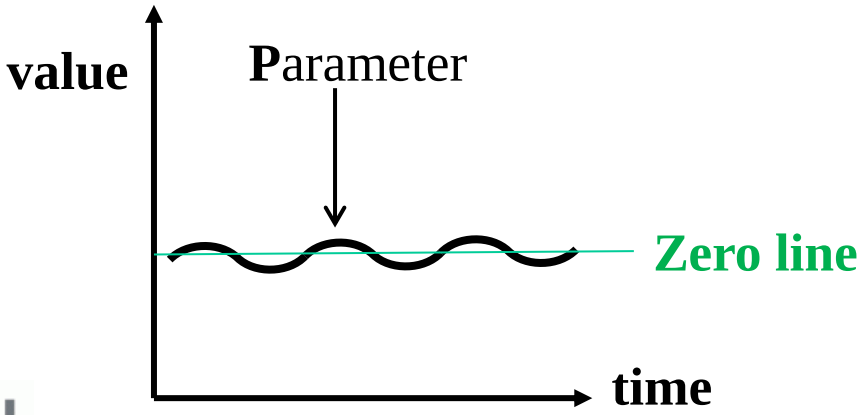
ITRF Specifications:
Origin: SLR
Scale: SLR & VLBI
Orientation: Alignment to previous ITRF

ITRF Combination: Step 1 (1/2)

- **Stacking/accumulating individual time series where the long-term**
  - **origin of SLR (and DORIS)**

  and
  - **scale of VLBI, SLR (and DORIS)**

defined via internal (minimum-type) constraints:



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

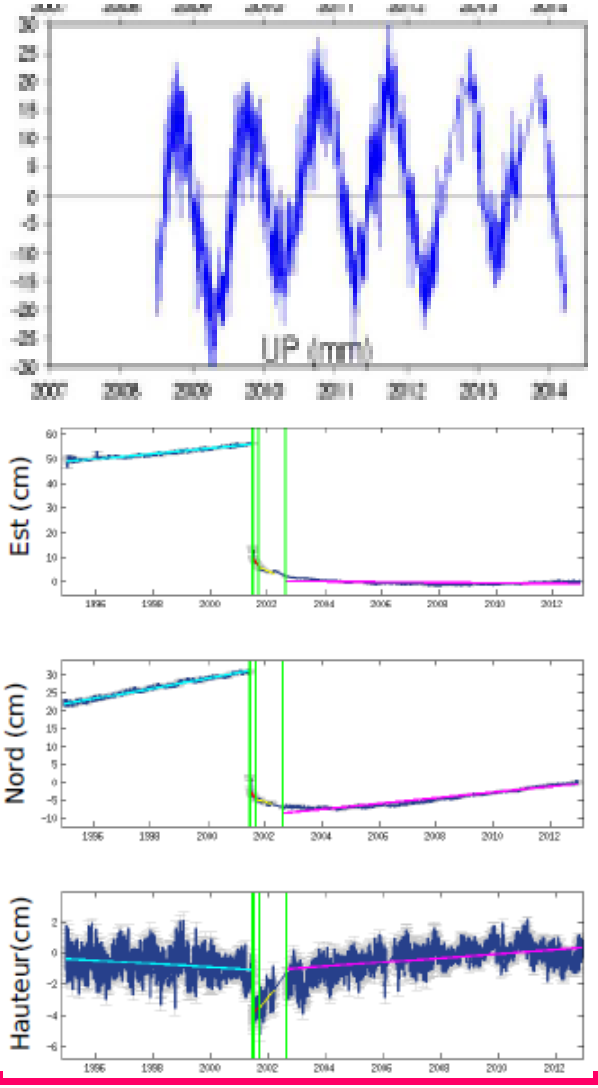
(Altamimi et al., 2007)

ITRF Combination: Step 1 (2/2)

- **Handling of non-linear station motions:**
  - **Periodic signals: using sinusoidal functions:**

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

  - **Post-seismic deformation :**
    - **Piece-Wise Linear (PWL) function**
    - **Parametric models (logarithmic or/and exponential)**



ITRF Construction: Step 2

Weighting of LT and Equating Velocities

- **Weighting of Local Ties:**
  - Use of SINEX files
  - Use a variance factor per LT SNX, with 3 mm lower bound sigma
  - Weighting as a function of LT and SG agreement

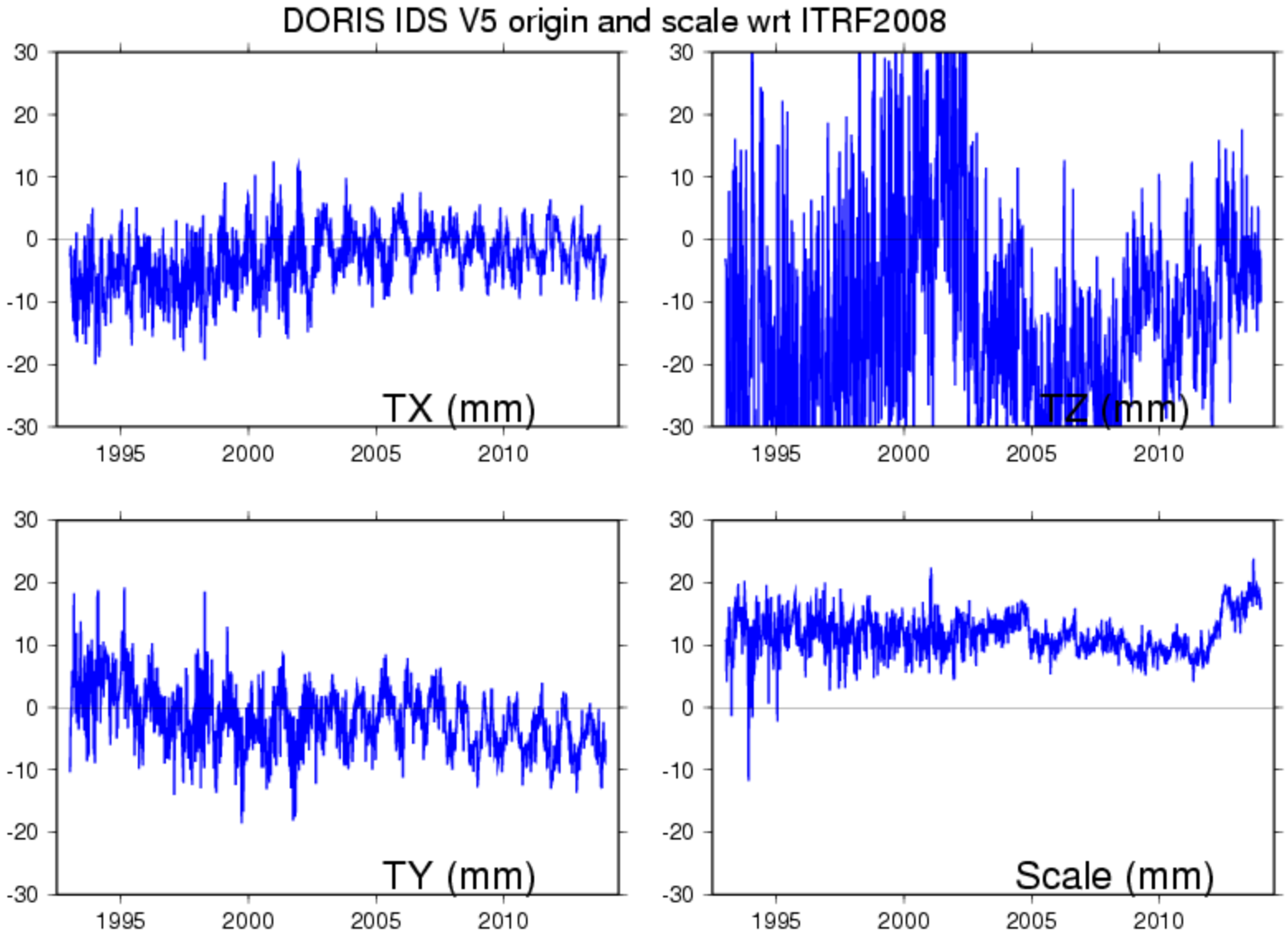
  ==> down-weighting discrepant ties (normalized residual > 3), iteratively

- **Velocity equalities at co-location sites:**

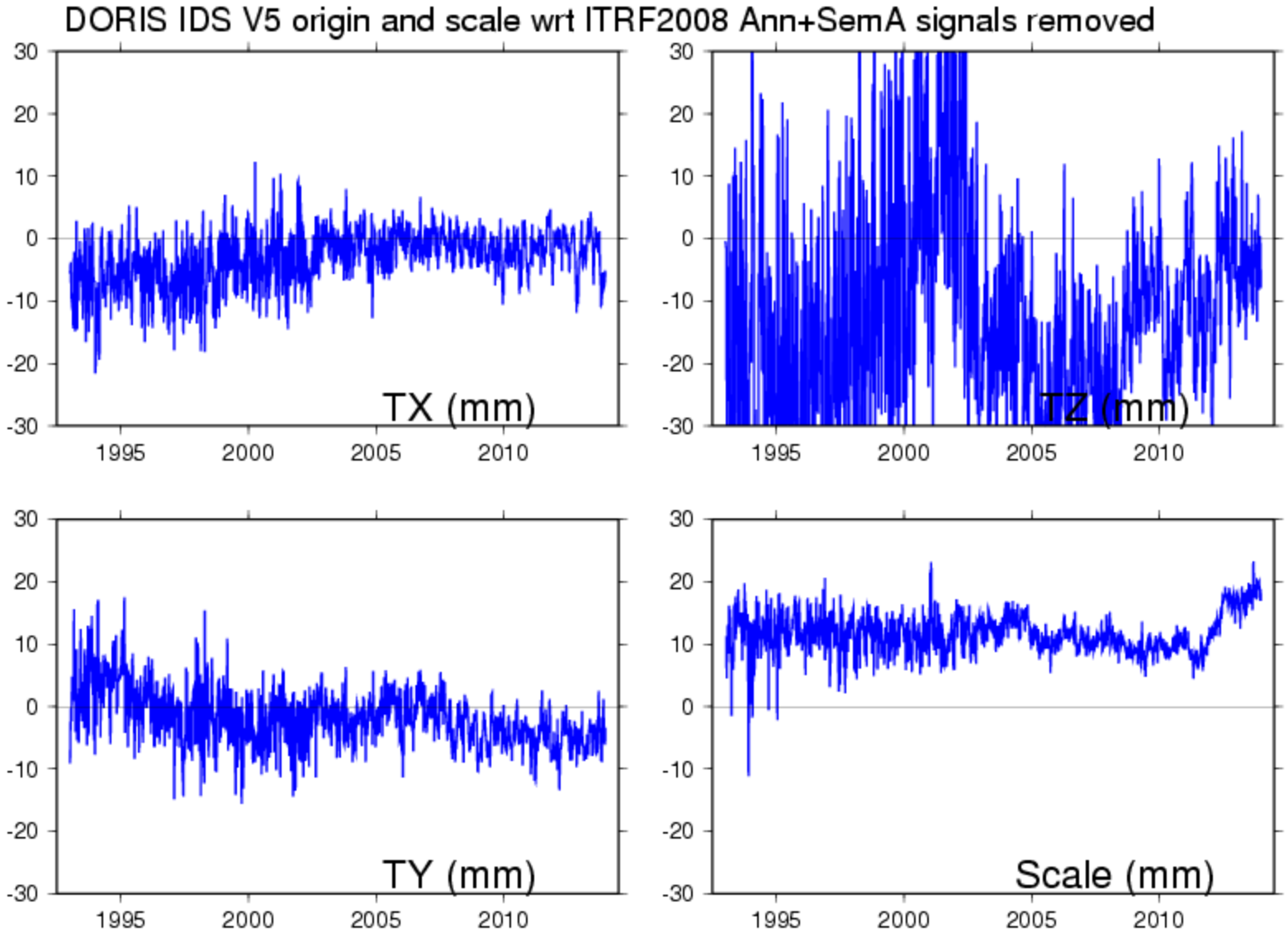
$$\dot{X}_i \quad = \quad \dot{X}_j \qquad (\sigma)$$

  - Increase σ as a function of technique discrepancy, i.e. (normalized residual > 3)

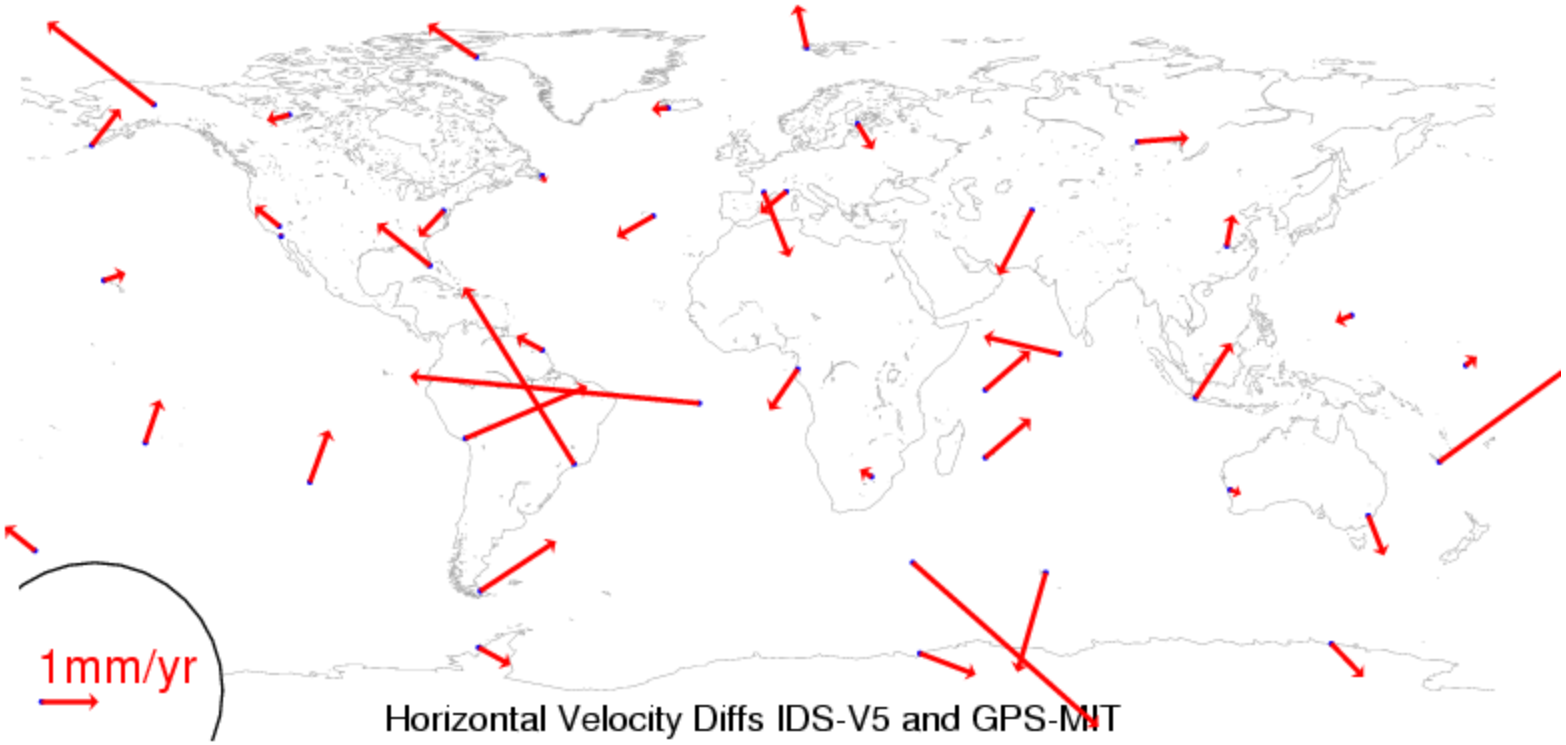
DORIS – IDS V5 Origin & Scale wrt ITRF2008



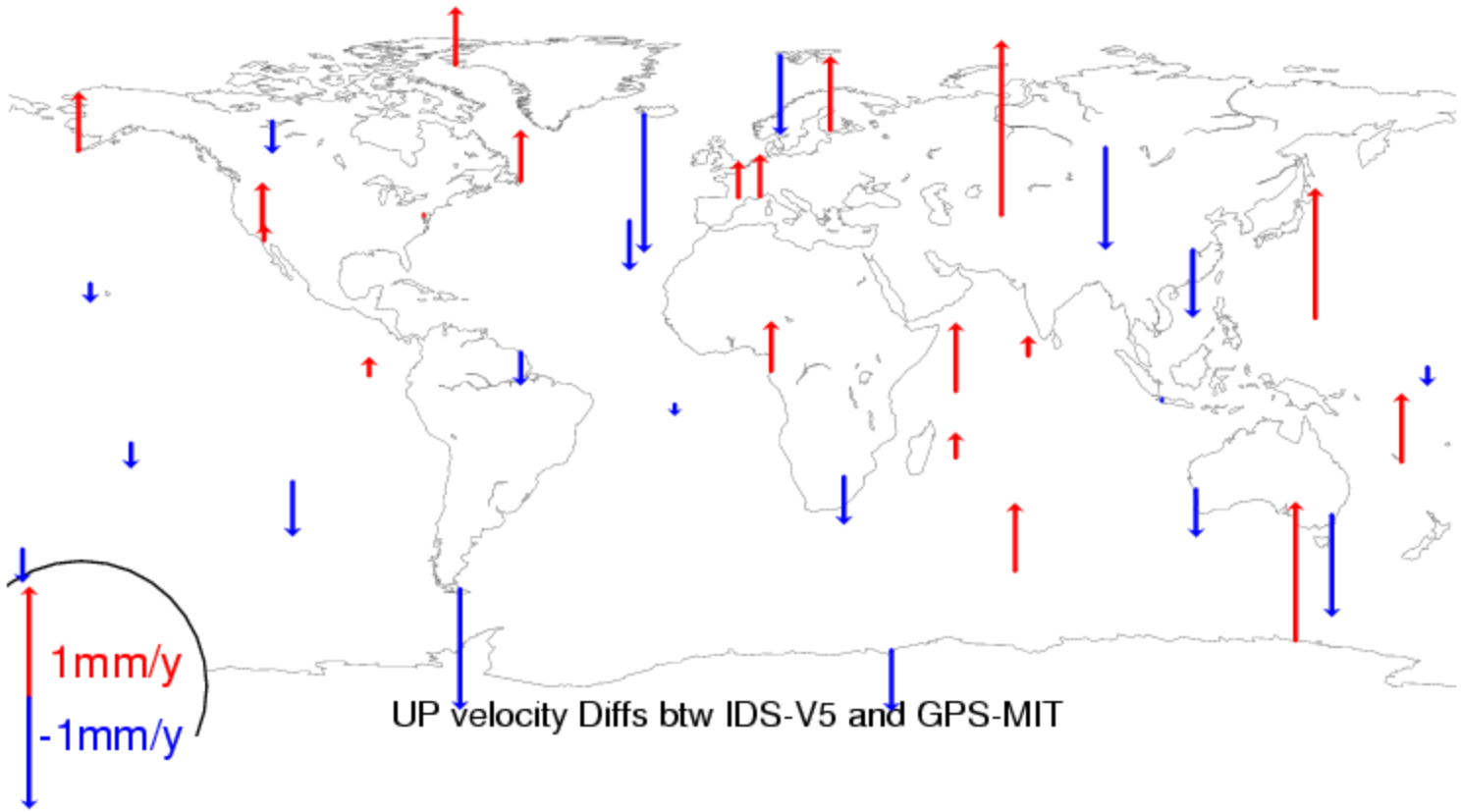
IDS V5 Origin/Scale wrt ITRF2008 (Ann+semA signals removed)



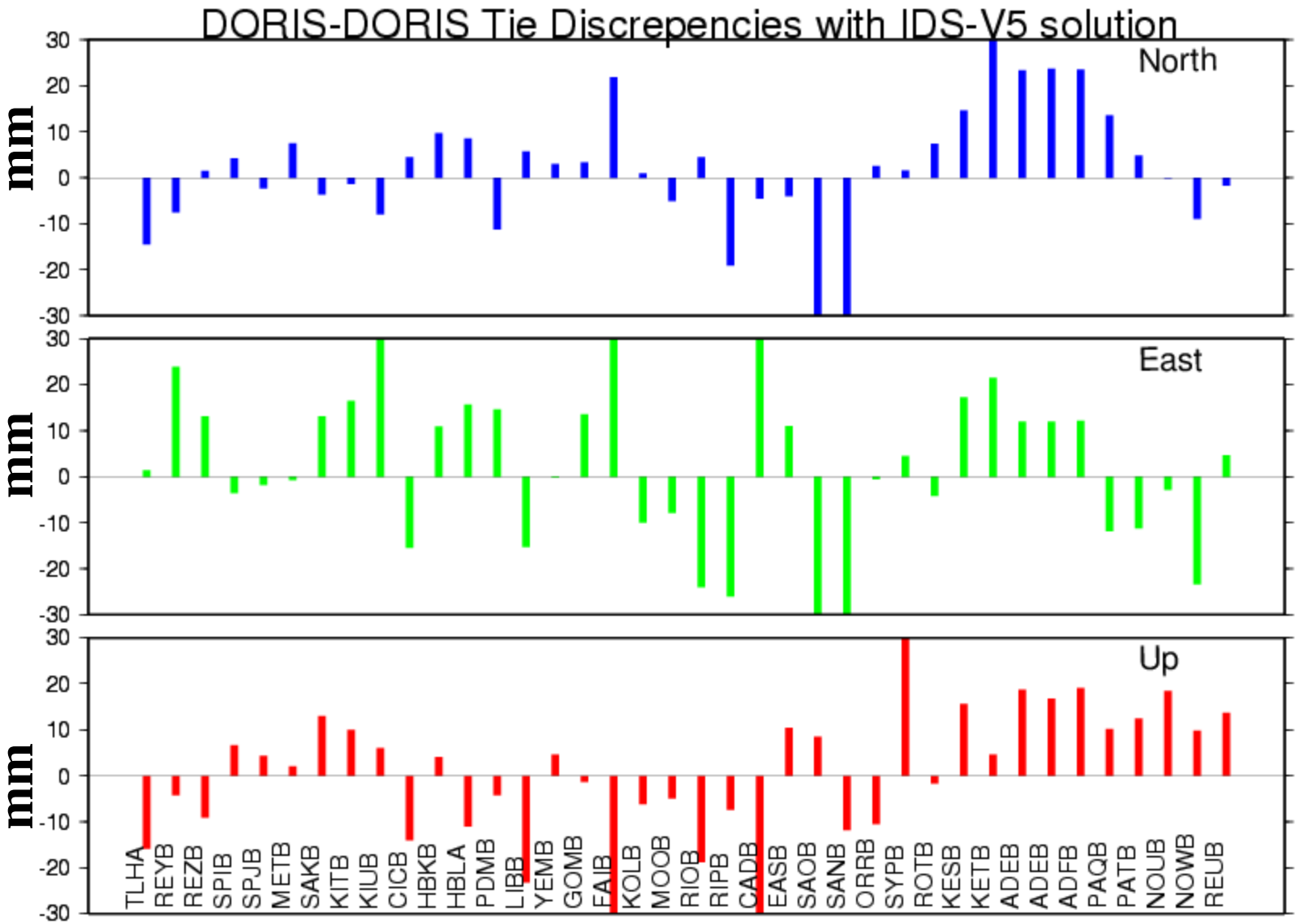
Horizontal velocity differences bwt IDS-V5 and GPS-MIT



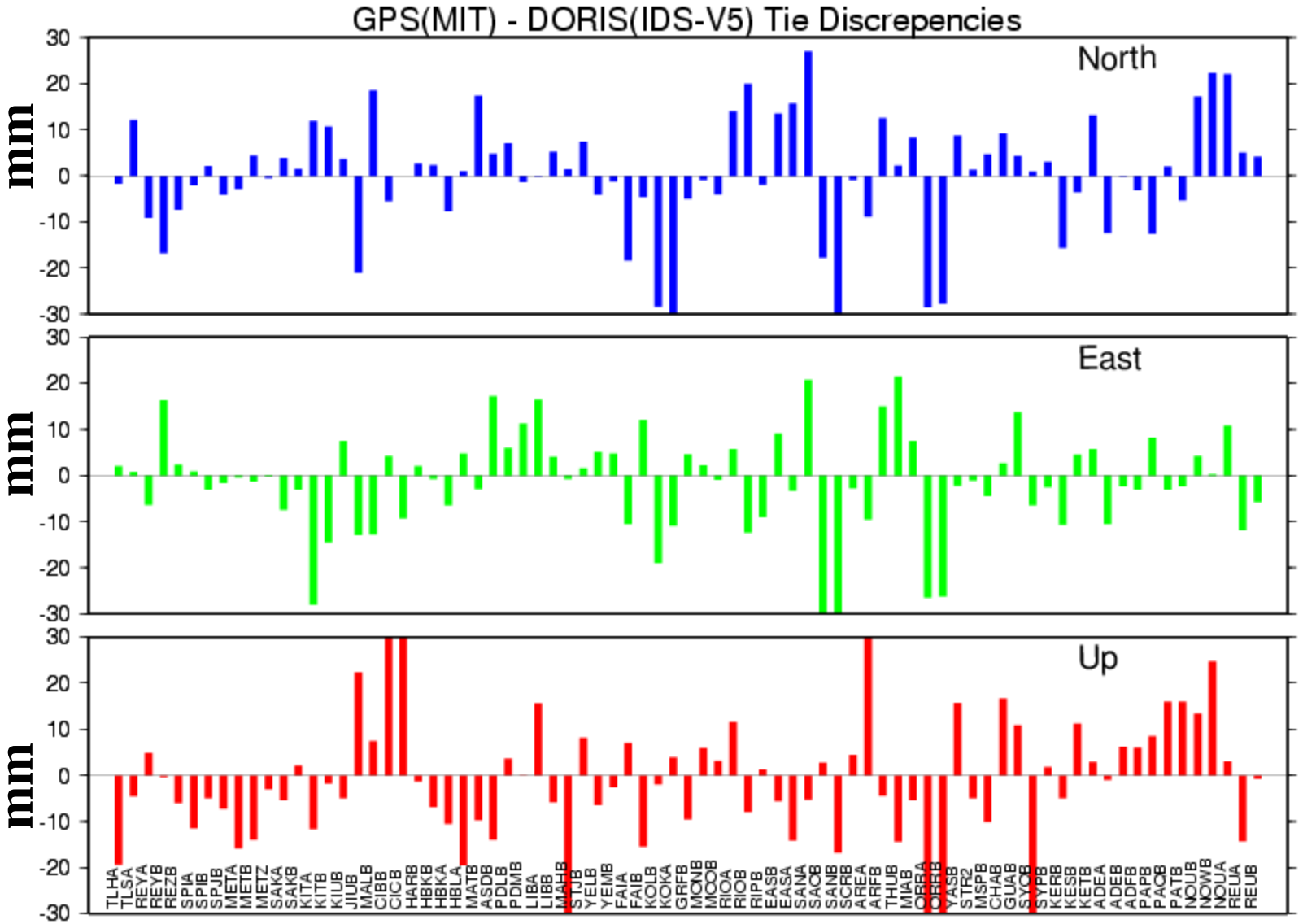
Vertical velocity differences bwt IDS-V5 and GPS-MIT



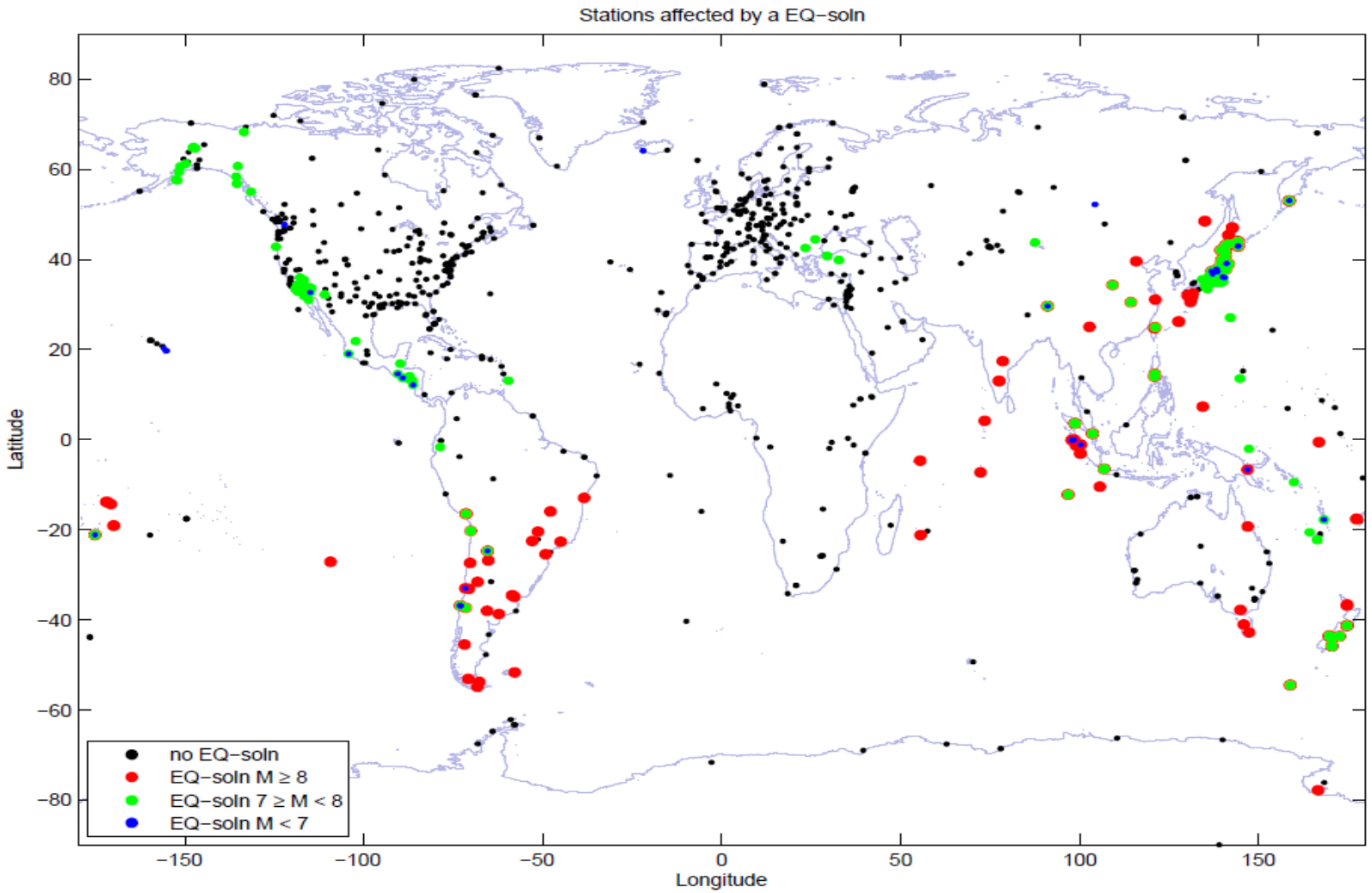
DORIS-DORIS Tie Discrepancies with IDS-V5 solution



GPS(MIT) – DORIS(IDS-V5) Tie Discrepancies



Sites affected by EQ discontinuities



(Métivier et al., 2014 under review)

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

$$D(t - t_{eqk}) = A \; log(1 + \frac{t - t_{eqk}}{\tau}) \tag{1}$$

or

$$D(t - t_{eqk}) = A \; (1 - e^{-\frac{t - t_{eqk}}{\tau}}) \tag{2}$$

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

or

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

or

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

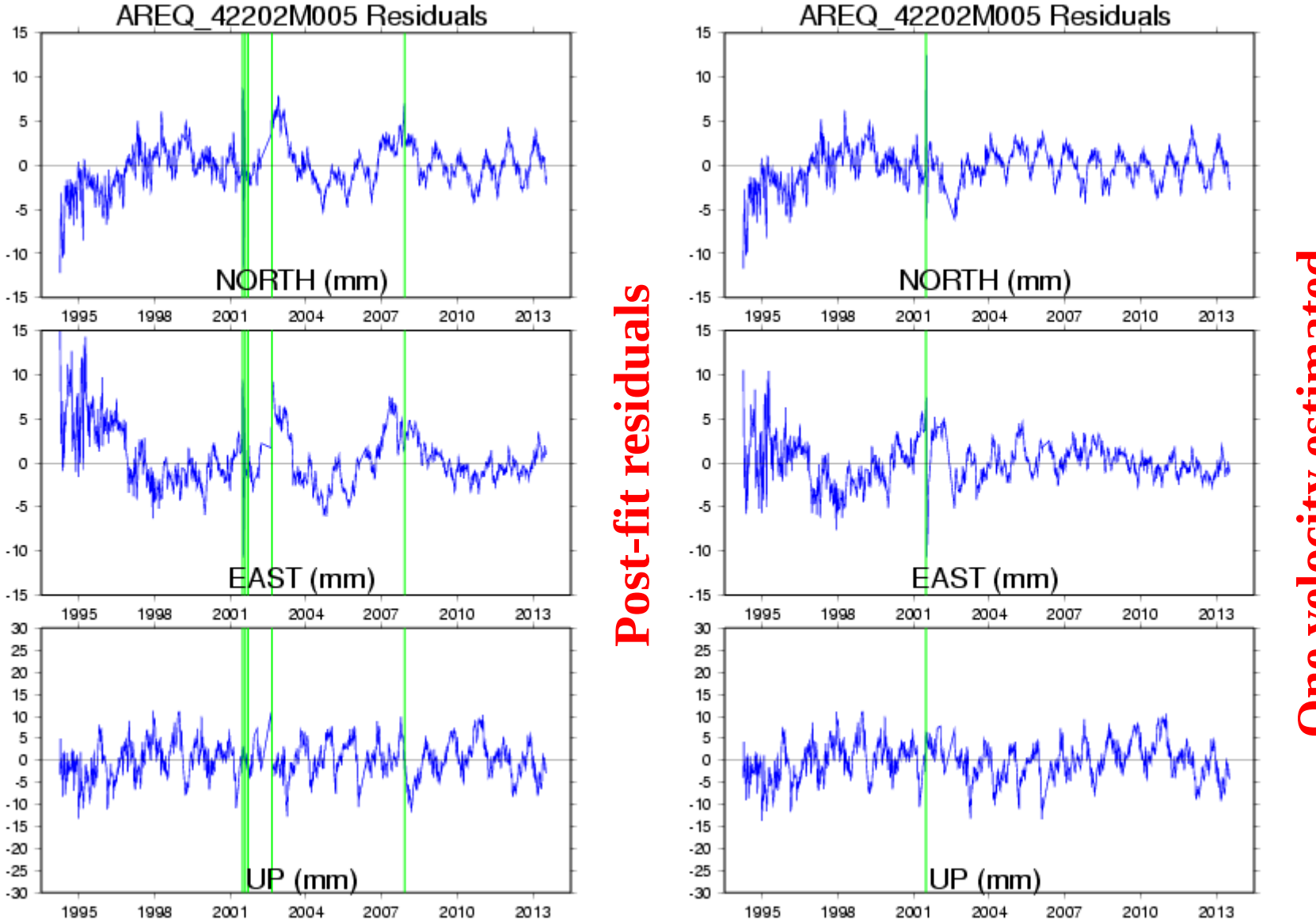
Arequipa

Linear Function | **Parametric Model**

Multiple velocities estimated

Post-fit residuals

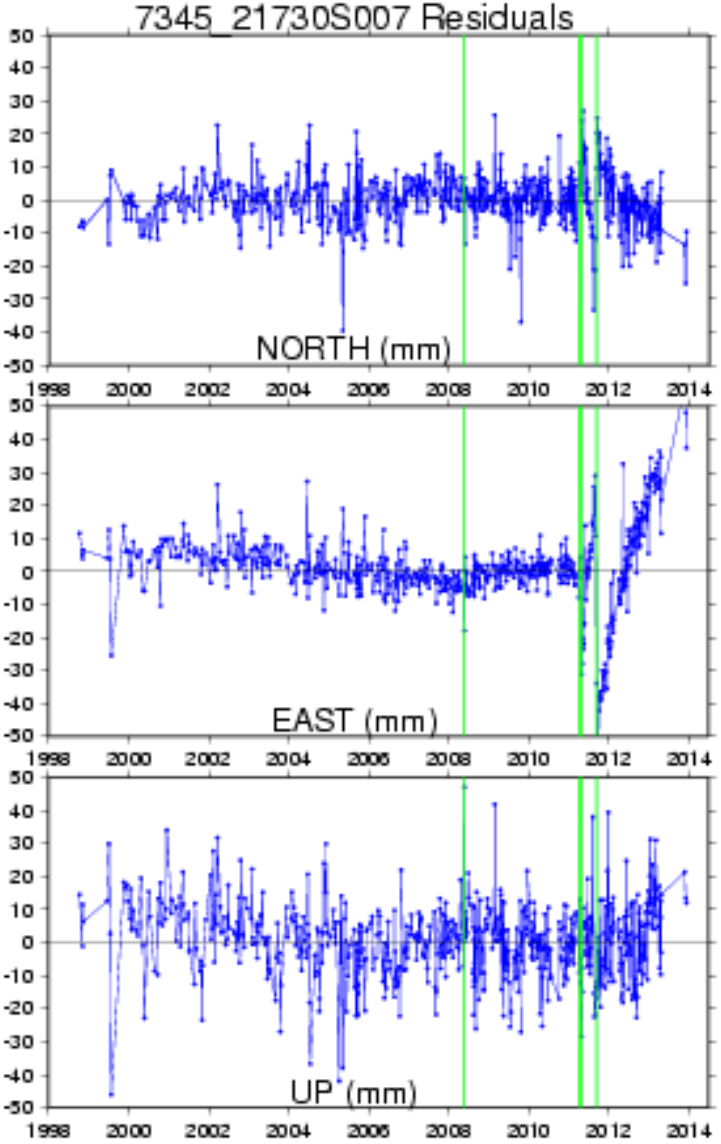
One velocity estimated



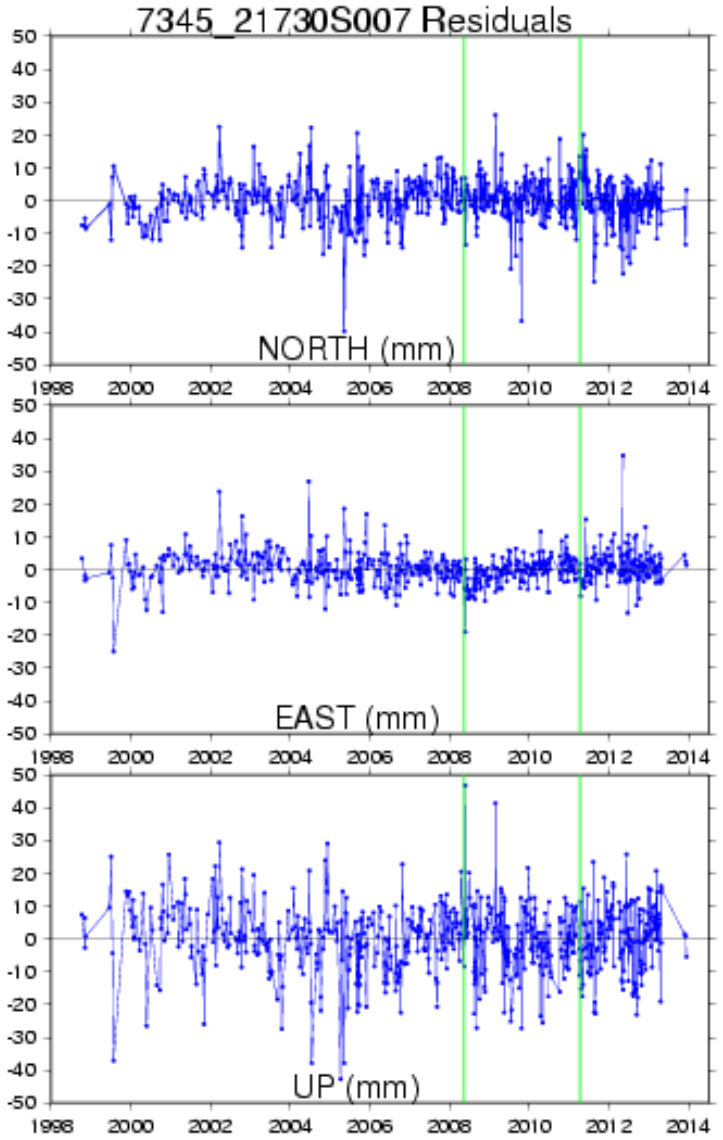
Lercier et al., 2014, submitted

Linear Function Tsukuba VLBI Parametric Model

Multiple velocities estimated



Post-fit residuals



One velocity estimated

Lercier et al., 2014, submitted

ITRF2013 Products

- **The usual products:**
  - Station positions, velocities and residuals;
  - EOPs

- **Additional/new products**
  - Geocenter motion model (amplitude & phase per component: X, Y, Z), probably from SLR only
  - Parametric models (amplitude A & relaxation time τ) Necessary to propagate coordinates at any epoch
  - On request: periodic signals (amplitudes & phases), per technique

Conclusion

- **Preliminary analysis of IDS-V5 solution:**
  - **Scale mean offset wrt ITRF2008 of about 1.8 ppb**
  - **Velocity agreement with GPS-MIT between 0.5 & 1 mm/yr in both horizontal and vertical components**
  - **DORIS-DORIS tie agreement with IDS-V5: ~1 cm WRMS**
  - **GPS(MIT) – IDS-V5 tie agreement : ~1 cm WRMS**
  - **Discontinuities still need to be refined**