# ITRF2014 Plate Motion Model

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# Key Points

- **Inversion model, with & without a Translation rate**

- **Site selection**

- **Impact of the network effect on the estimated parameters**

- **Final model**

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# Inversion models

$$\dot{X}_i = \omega_p \times X_i \qquad \qquad \text{(1)}$$

$$\dot{X}_i = \omega_p \times X_i + \dot{T} \qquad \qquad \text{(2)}$$

**Translation Rate: $\dot{T}$**

- **Origin Rate Bias (ORB)**
- **Meaningful when a global inversion of ALL plates is made**
- **= Translational motion between the ITRF2014 origin & the Residual center of surface lateral figure (CL), Blewitt (2003)**
- **Strongly dependent on site selection (network effect)**
- **$T_Z$-rate varies between zero and slightly > 1mm/yr**
- **Hazardous to attribute any geophysical meaning to the estimated ORB**

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# ITRF2014: Horizontal velocity field with σ < 0.2 mm/yr

**829 sites**
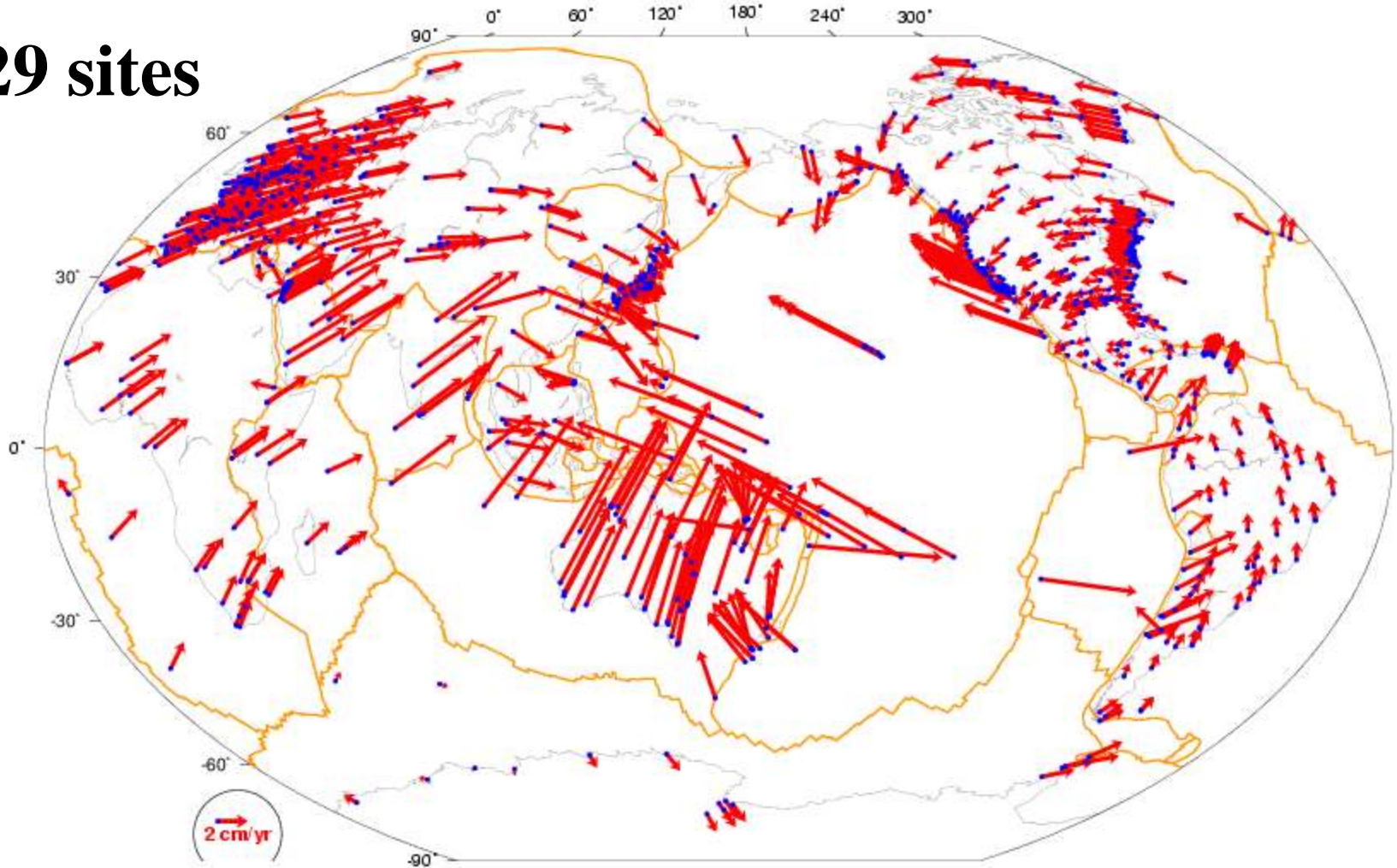
# Selection criteria

**Are excluded from the site selection:**

1. **All sites in deformation zones where the strain rates > 0 in Kreemer's strain map, (Kreemer et al., 2014)**

2. **All sites that show clear post-seismic deformation (from ITRF2014).**

3. **(Ice melting) all stations in Greenland, in North American extreme North, in South Alaska, in Iceland & Svalbard**

4. **(GIA) all sites located in regions covered by ice sheets during the Last Glacial Maximum (based on ANU or ICE6G models ), with predicted up velocity > 0.75 mm/yr**

5. **Normalized residuals > 3, and raw residual > 1 mm/yr**

# First selection: 318 sites, 11 plates

TX = 0.19 +/- 0.17 mm/yr
TY = 0.20 +/- 0.19
TZ = 0.85 +/- 0.18
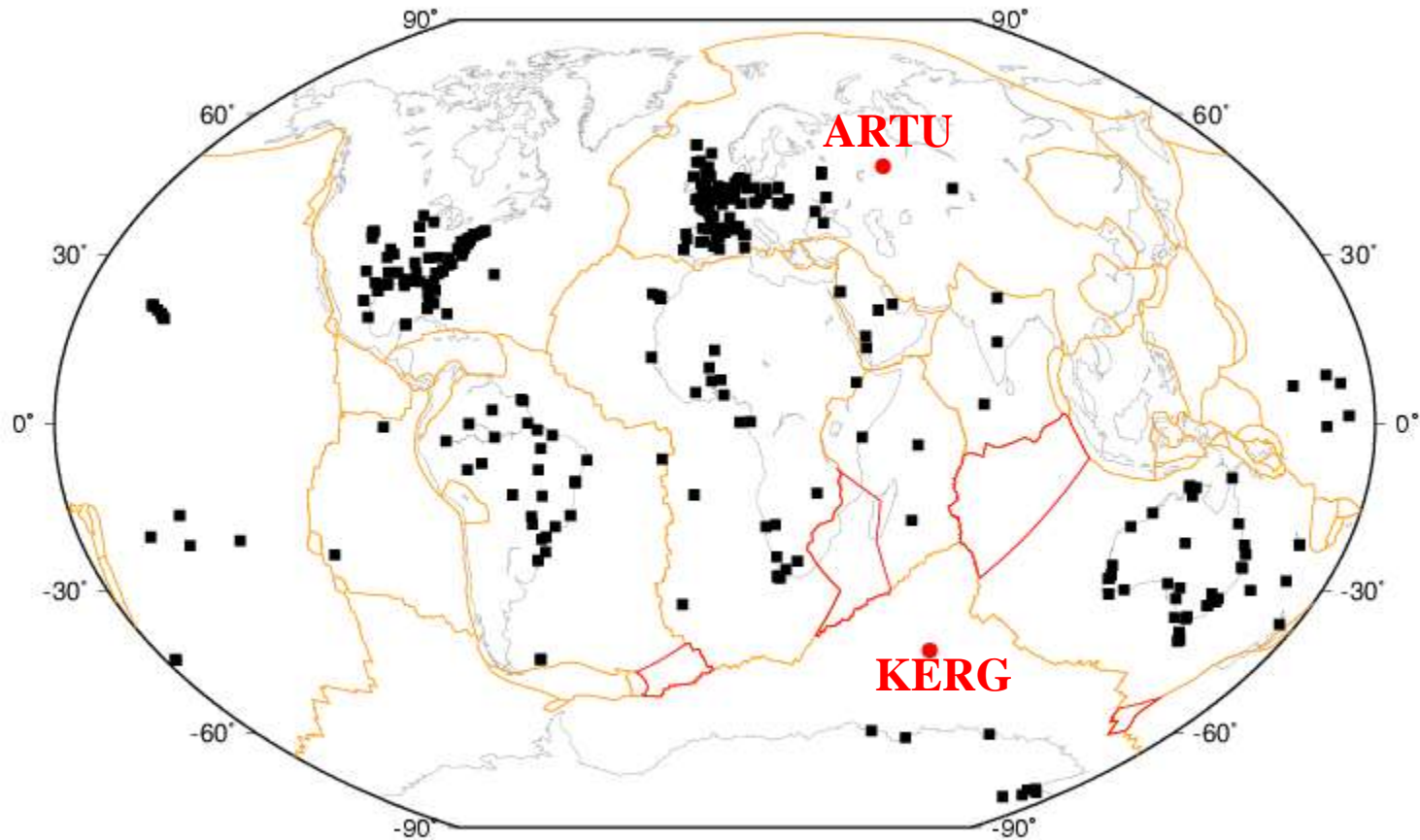


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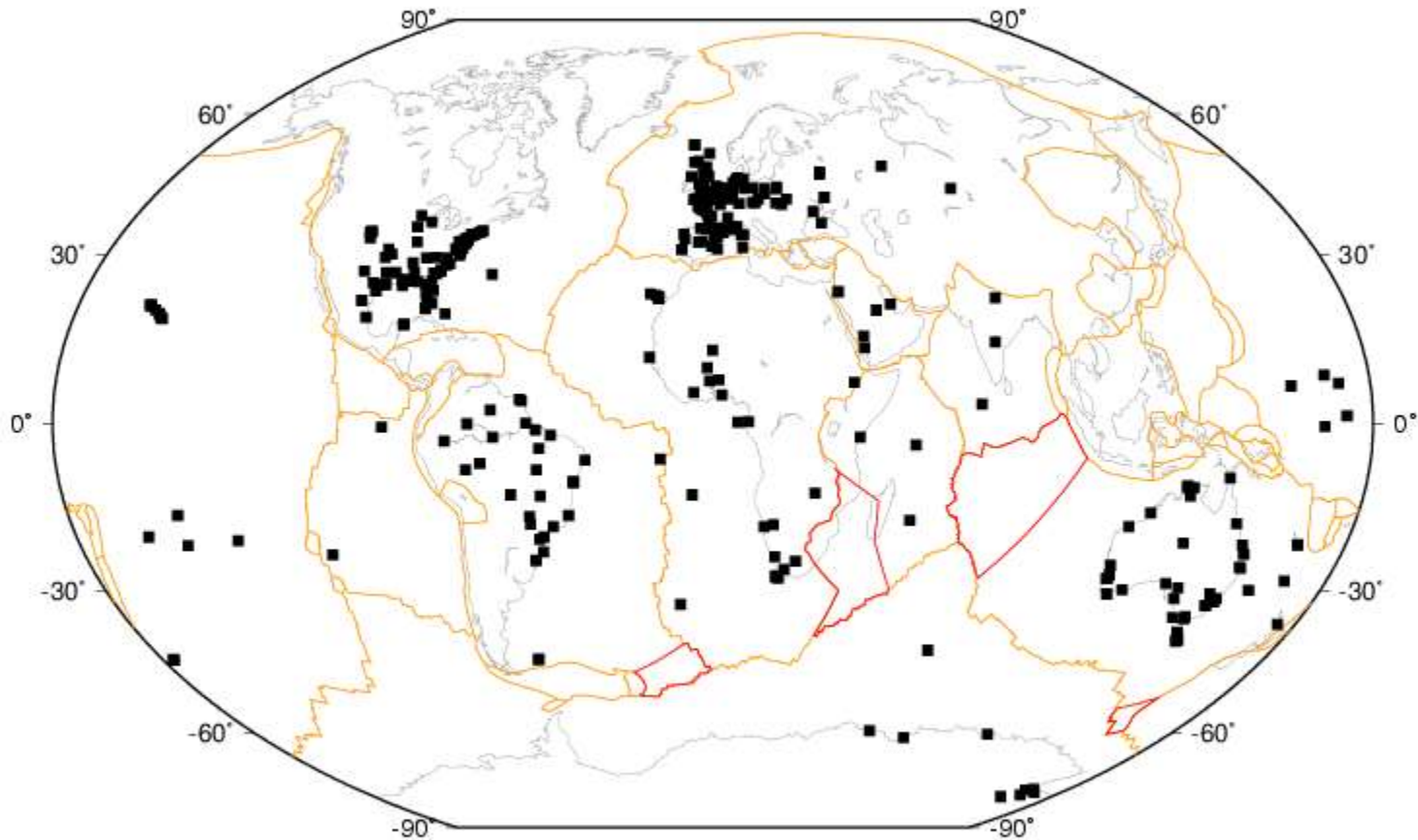
# Evaluation of the network effect (1/2)

# A telling example: Rejecting two sites only

TX =     0.25  +/-     0.17 mm/yr
TY =     0.02  +/-     0.20
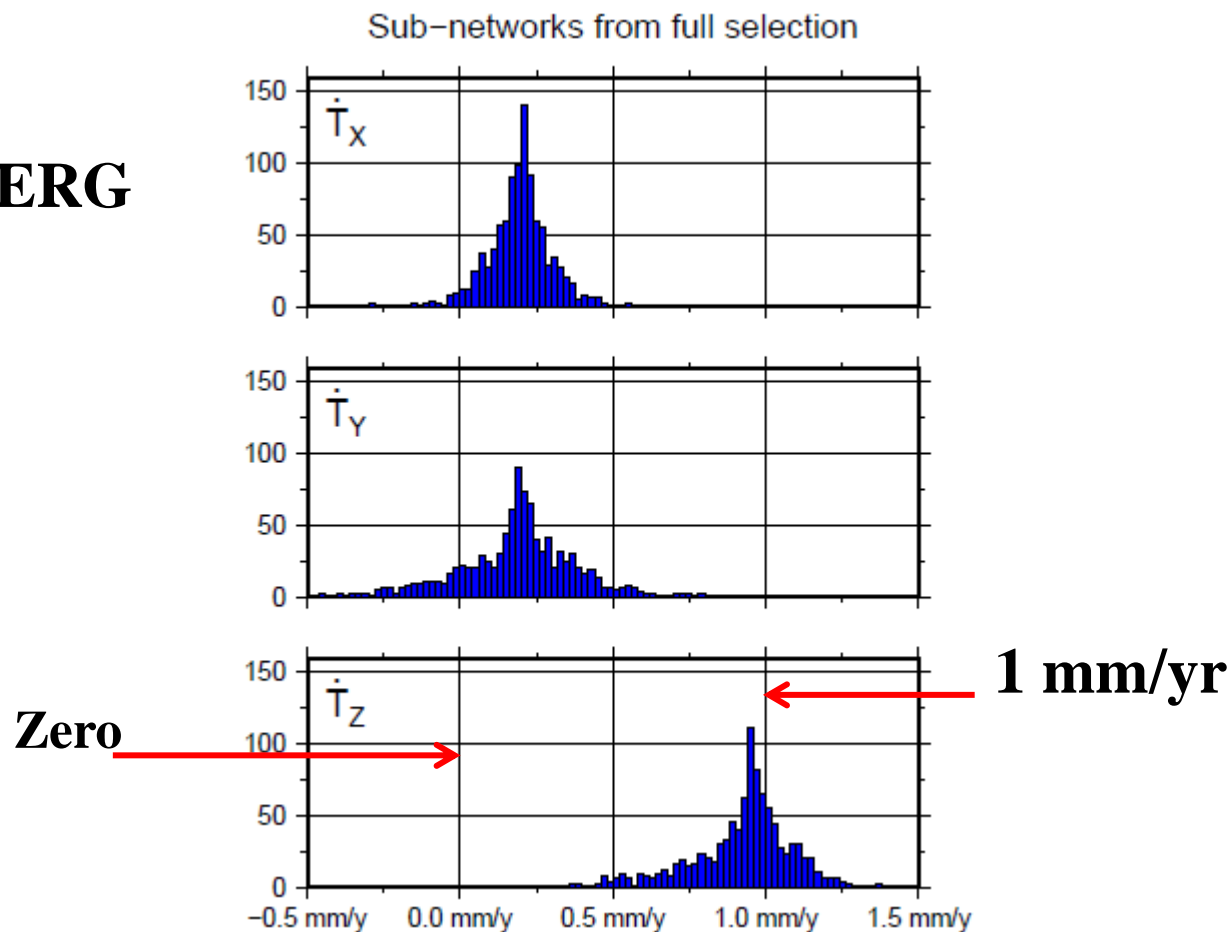TZ =     **0.48**  +/-     0.20



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# Evaluation of the network effect

- **Selection of 1000 random subnetworks, each of which contains randomly between 150 and 318 sites.**

**With ARTU and KERG**



Sub-networks from full selection

$\dot{T}_X$   $\dot{T}_Y$   $\dot{T}_Z$

Zero    1 mm/yr

−0.5 mm/y   0.0 mm/y   0.5 mm/y   1.0 mm/y   1.5 mm/y

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# Evaluation of the network effect

- **Selection of 1000 random subnetworks, each of which contains randomly between 150 and 316 sites.**

**Without ARTU and KERG**



Sub−networks without ARTU and KERG

Zero → 1 mm/yr

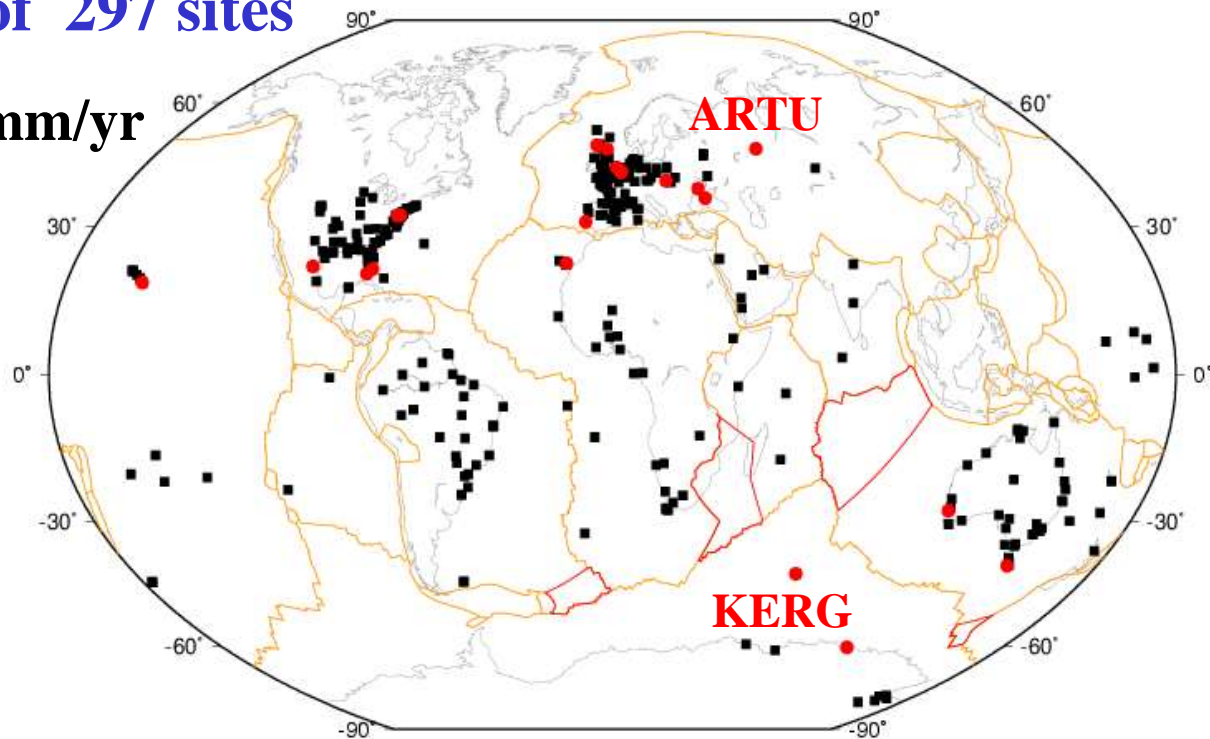**Altamimi et al. FIG 2017, Helsinki**
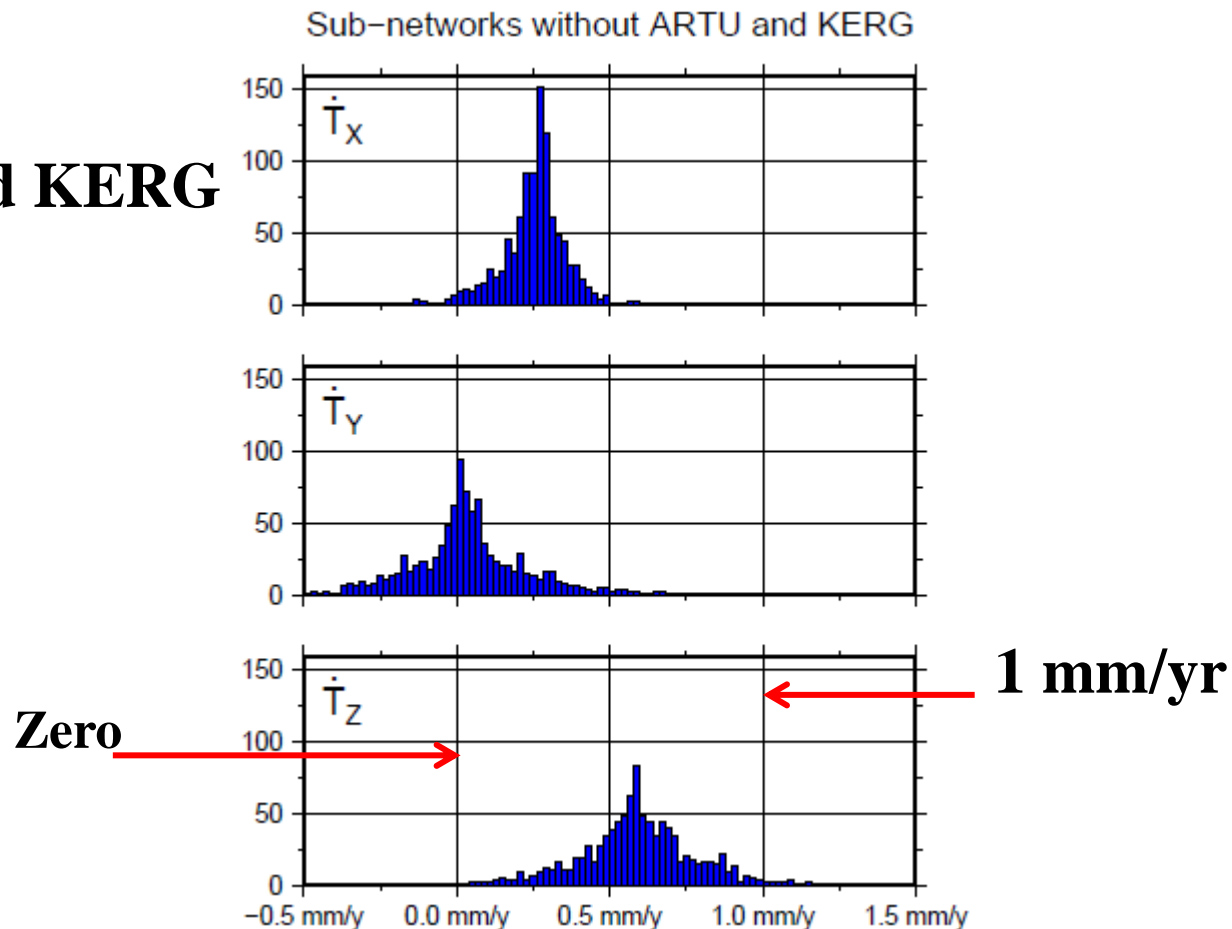
# Evaluation of the network effect (2/2)

**Two-step procedure :**

**Step 1: iterative global inversions of ALL plates together using Equation 1 (no ORB) & rejecting outliers (3-sigma ratio) ==> 21 outliers, remain 297 sites**

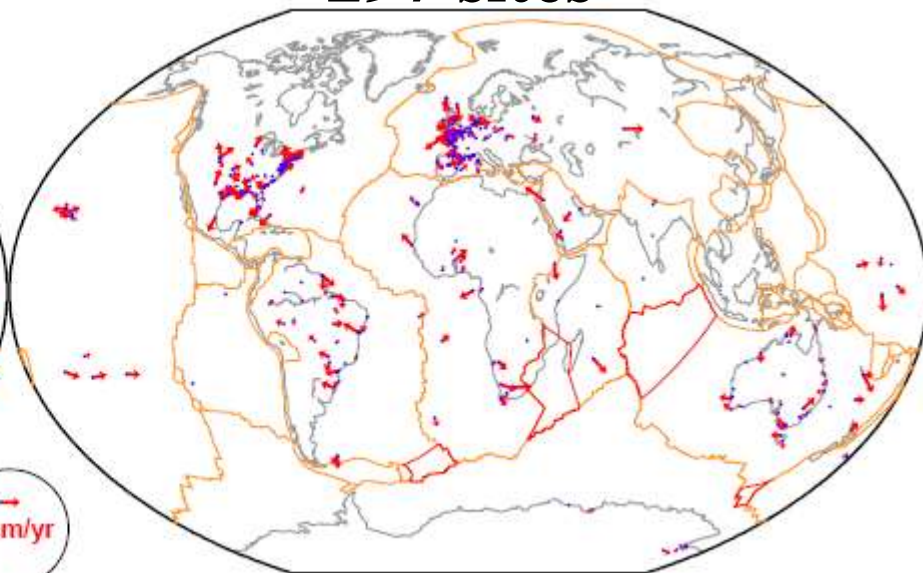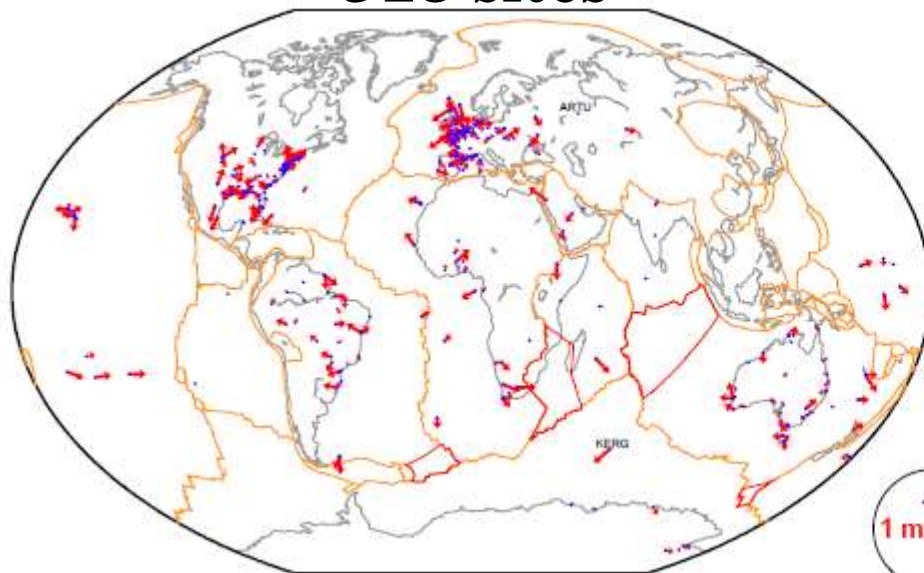**Step 2: use of Equation 2 to estimate the ORB on the remaining network of 297 sites**

TX =    0.20  +/-   0.15 mm/yr
TY =    0.00  +/-   0.18
TZ =    0.30  +/-   0.18



ARTU

KERG

**Residuals**

318 sites · 297 sites

1 mm/yr

| | | | |
|---|---|---|---|
| TX = | 0.19 | +/- | 0.17 |
| TY = | 0.20 | +/- | 0.19 |
| TZ = | **0.85** | +/- | 0.18 |

| | | | |
|---|---|---|---|
| TX = | 0.20 | +/- | 0.15 |
| TY = | 0.00 | +/- | 0.18 |
| TZ = | **0.30** | +/- | 0.18 |

**WRMS of fit : E: 0.28 mm/yr**
**N: 0.27**

**E: 0.24 mm/yr**
**N: 0.23**

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# Selection of the final model
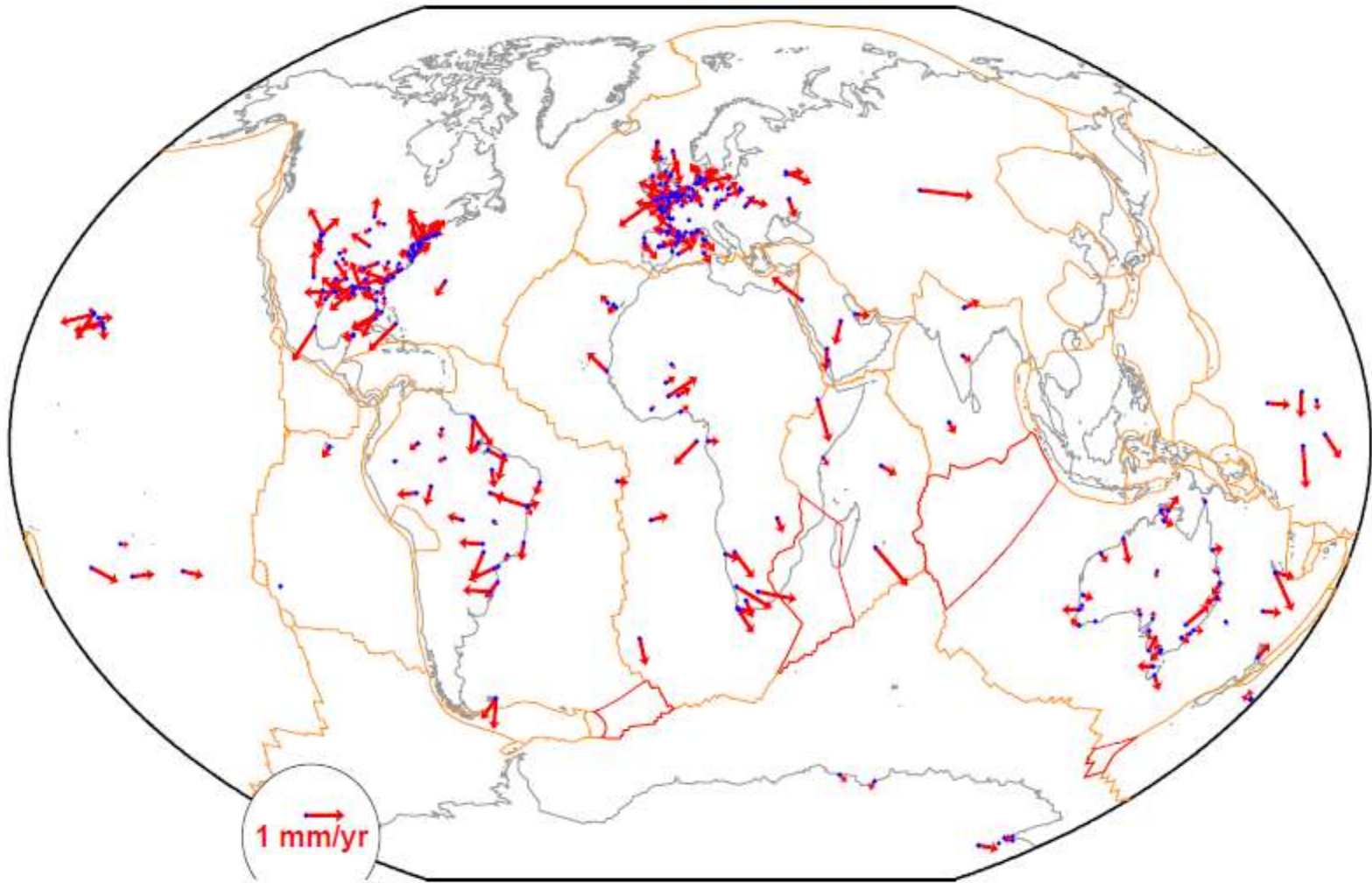
- **Apply the F-ratio test (Nocquet et al. 2001):**

$$F = \frac{[\chi^2(p1) - \chi^2(p2)]/(p1 - p2)}{\chi^2(p2)/p2}$$

- **Estimated value of $F$:     1.368**
- **Expected value of Fisher  Snedecor's distribution: 2.621**
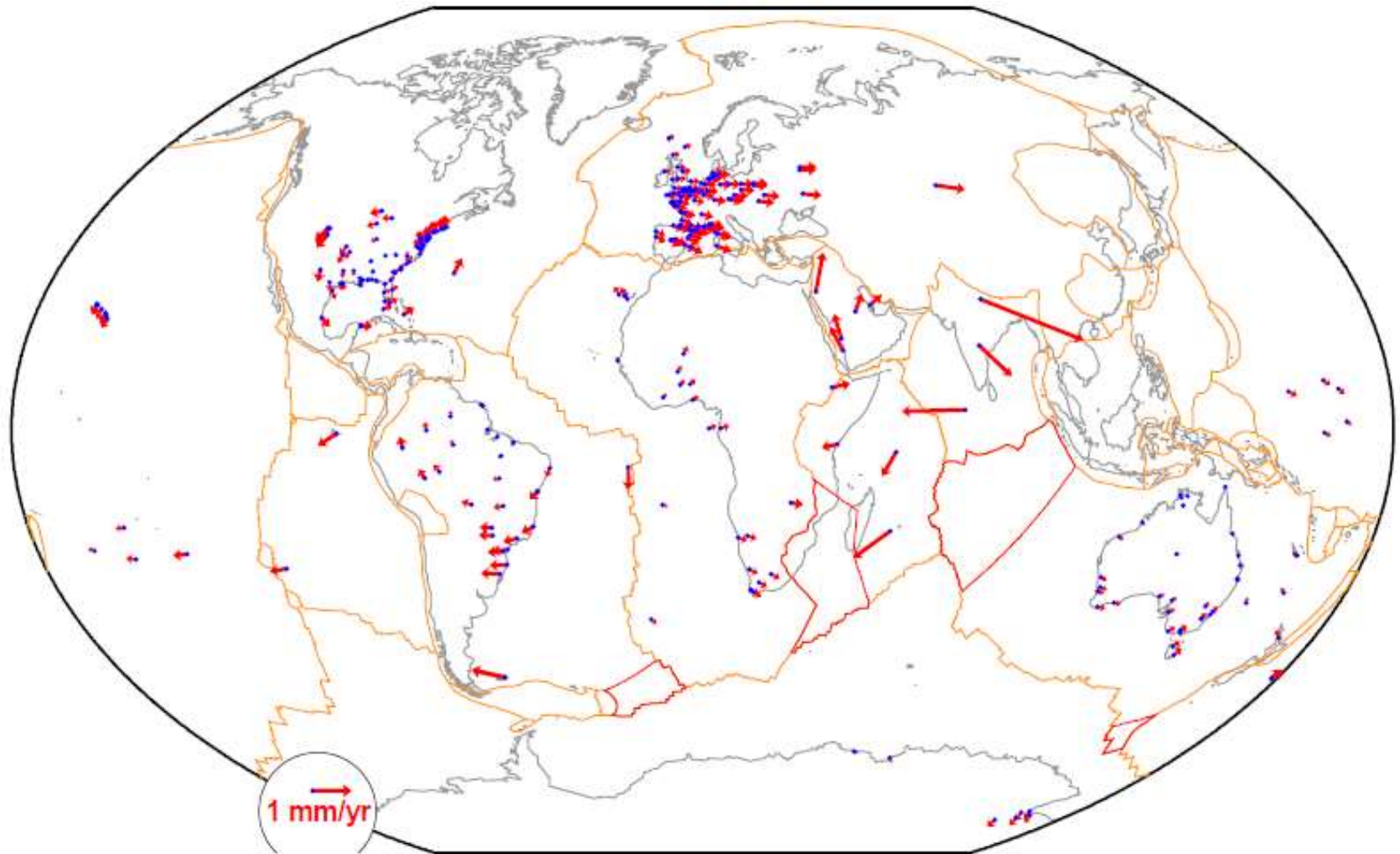
**==> The ORB value is not significant**

**==> Final ITRF2014 PMM without ORB**

# Selection of the final model : Residuals



1 mm/yr

**WRMS of fit : E: 0.26 mm/yr**
**N: 0.26**

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# Differences **ITRF2014 –ITRF2008 PMMs**



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# Conclusions

- **The volatility of the estimated ORB prevents any geophysical interpretation of its estimated value**


- **Final ITRF2014-PMM :**

  - **11 plate rotation poles, with no ORB**

  - **ORB (0.3 mm/yr in Z) is not significant (F-ratio test)**

  - **Overall WRMS fit: 0.26 mm/yr**

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