ITRF2014 Plate Motion Model
&
ETRS89 realization

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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

- Discussion on ETRS89 Realizations

Inversion models

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

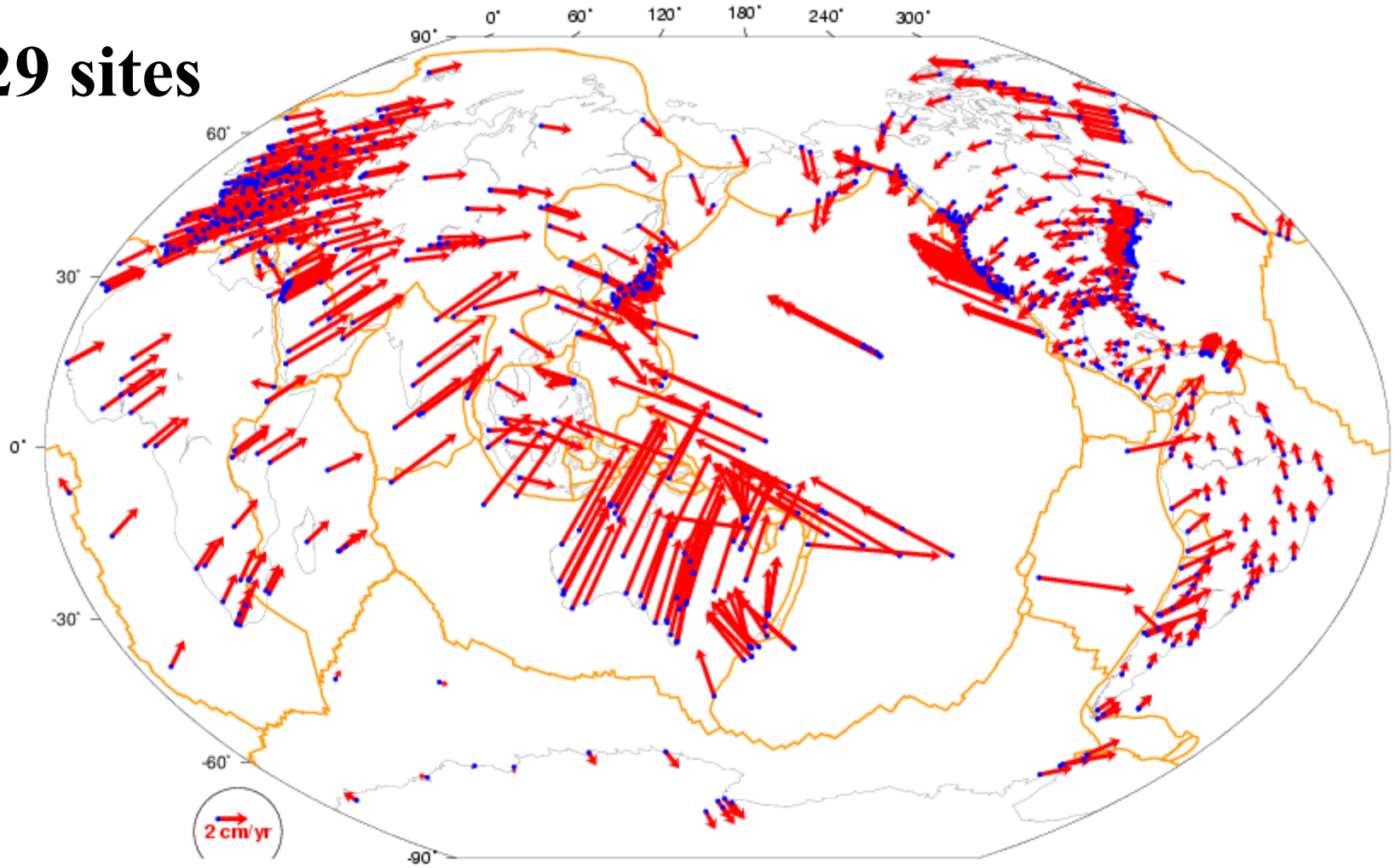
$$\dot{X}_i = \omega_p \times X_i + \dot{T} \quad (2)$$

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**

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

829 sites



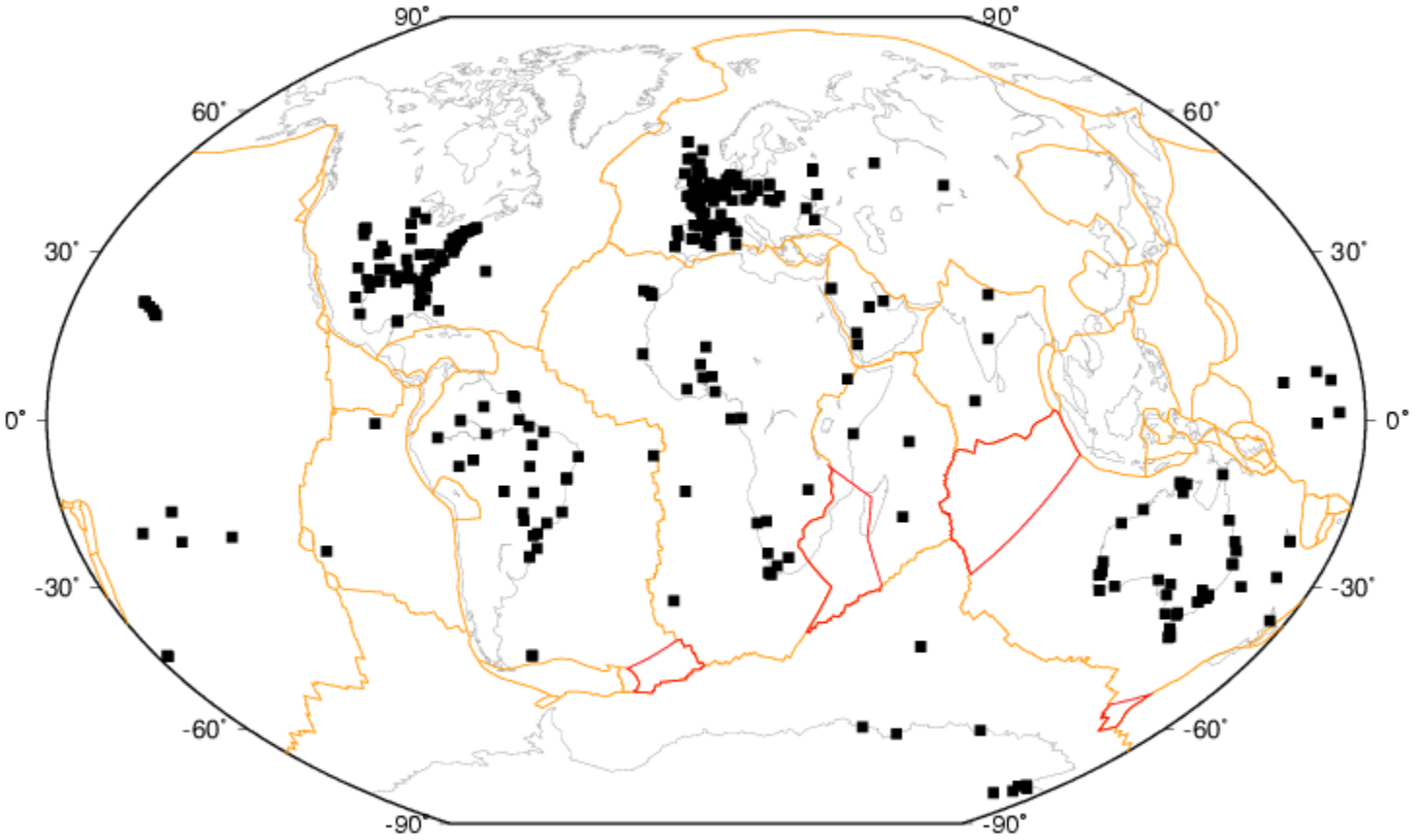
Selection criteria

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

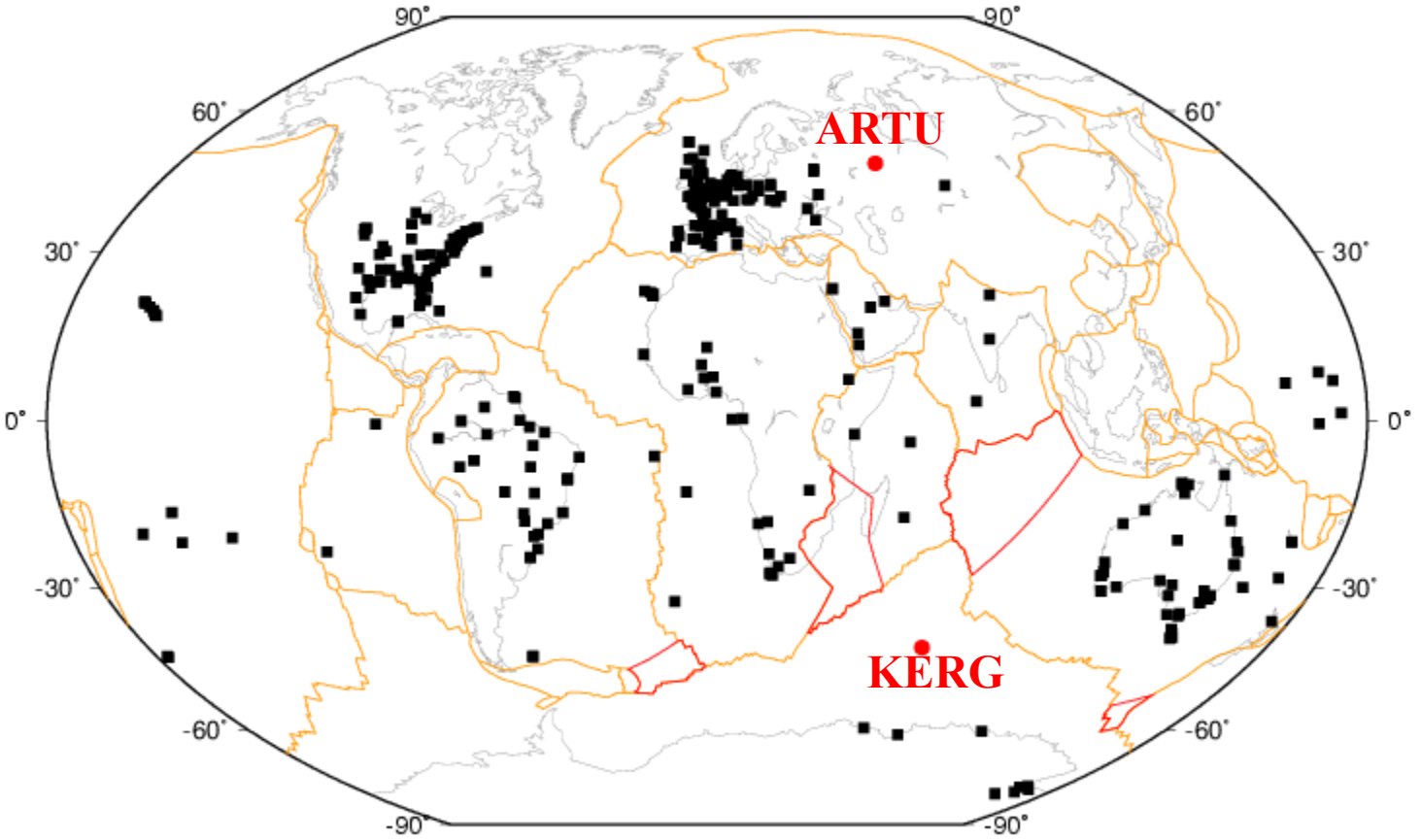
TX = 0.19 +/- 0.17 mm/yr
TY = 0.20 +/- 0.19
TZ = 0.85 +/- 0.18



Evaluation of the network effect (1/2)

A telling example: Rejecting two sites only

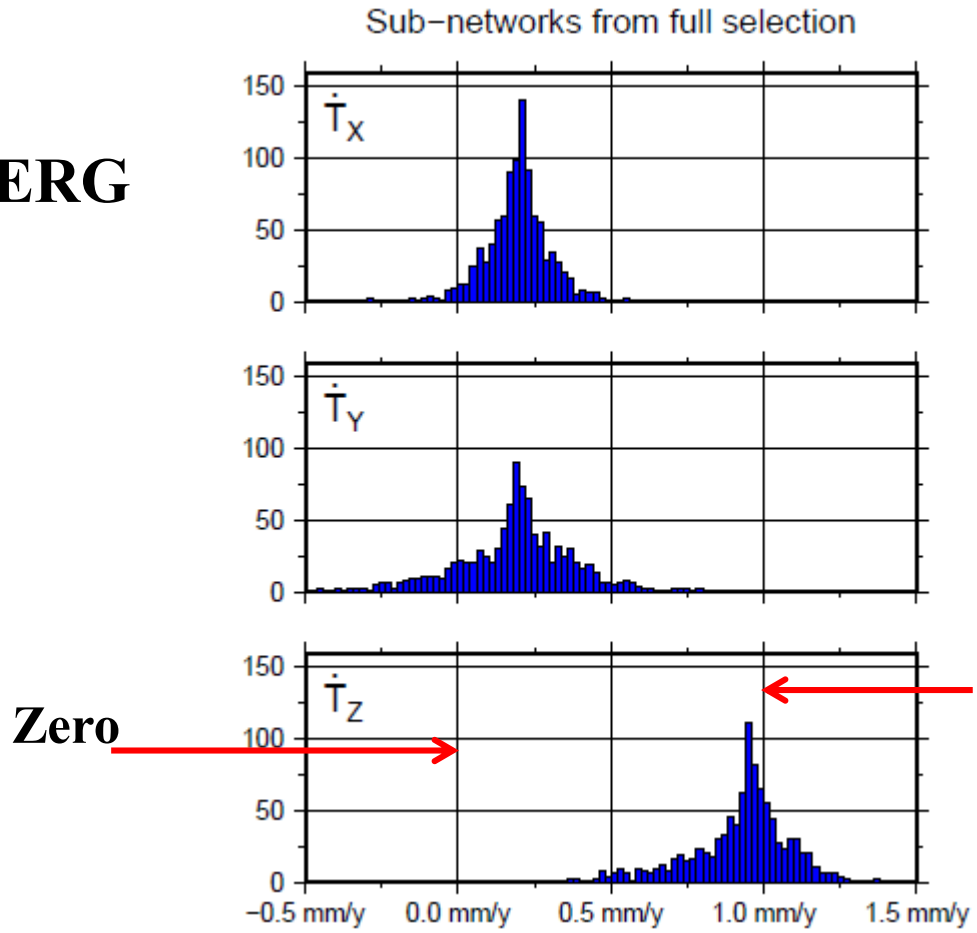
TX = 0.25 +/- 0.17 mm/yr
TY = 0.02 +/- 0.20
TZ = 0.48 +/- 0.20



Evaluation of the network effect

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

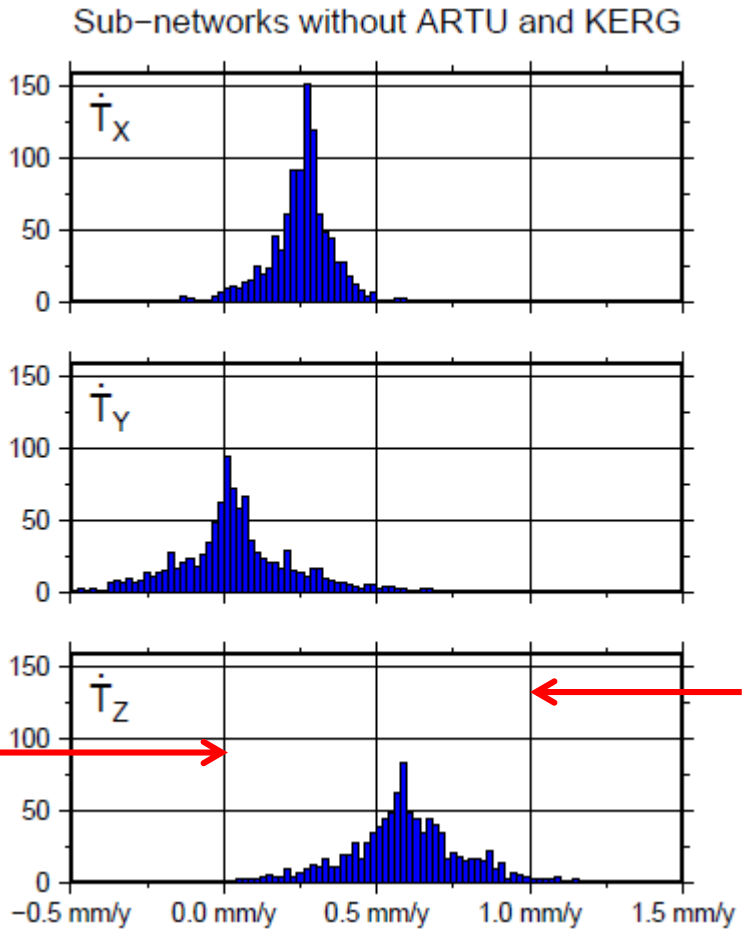
With ARTU and KERG



Evaluation of the network effect

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

Without ARTU and KERG



Zero

1 mm/yr

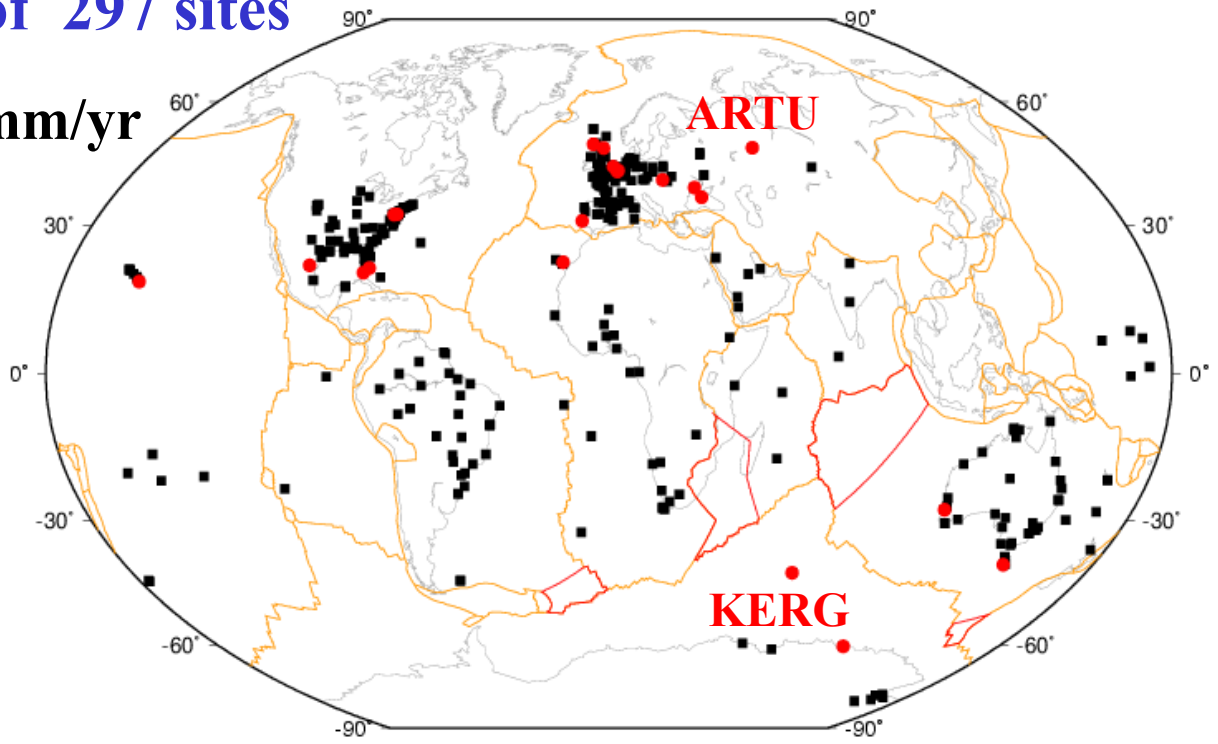
Evaluation of the network effect (2/2)

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



Selection of the final model

- **Apply the F-ratio test (Nocquet et al. 2001):**

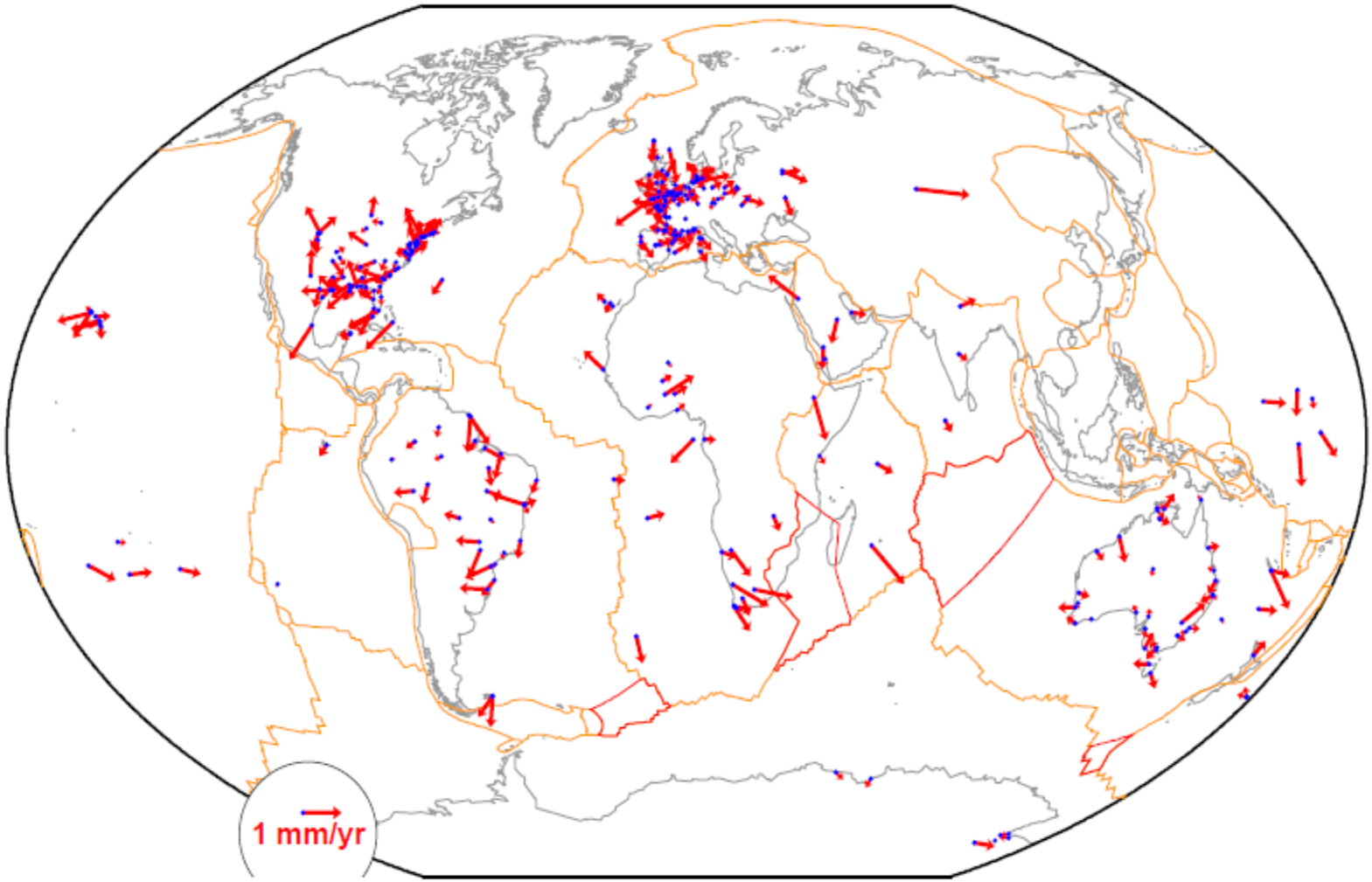
$$F = \frac{[\chi^2(p1) - \chi^2(p2)]/(p1 - p2)}{\chi^2(p2)/p2}$$

- **Estimated value of *F*: 1.368**
- **Expected value of Fisher Snedecor's distribution: 2.621**

==> The ORB value is not significant

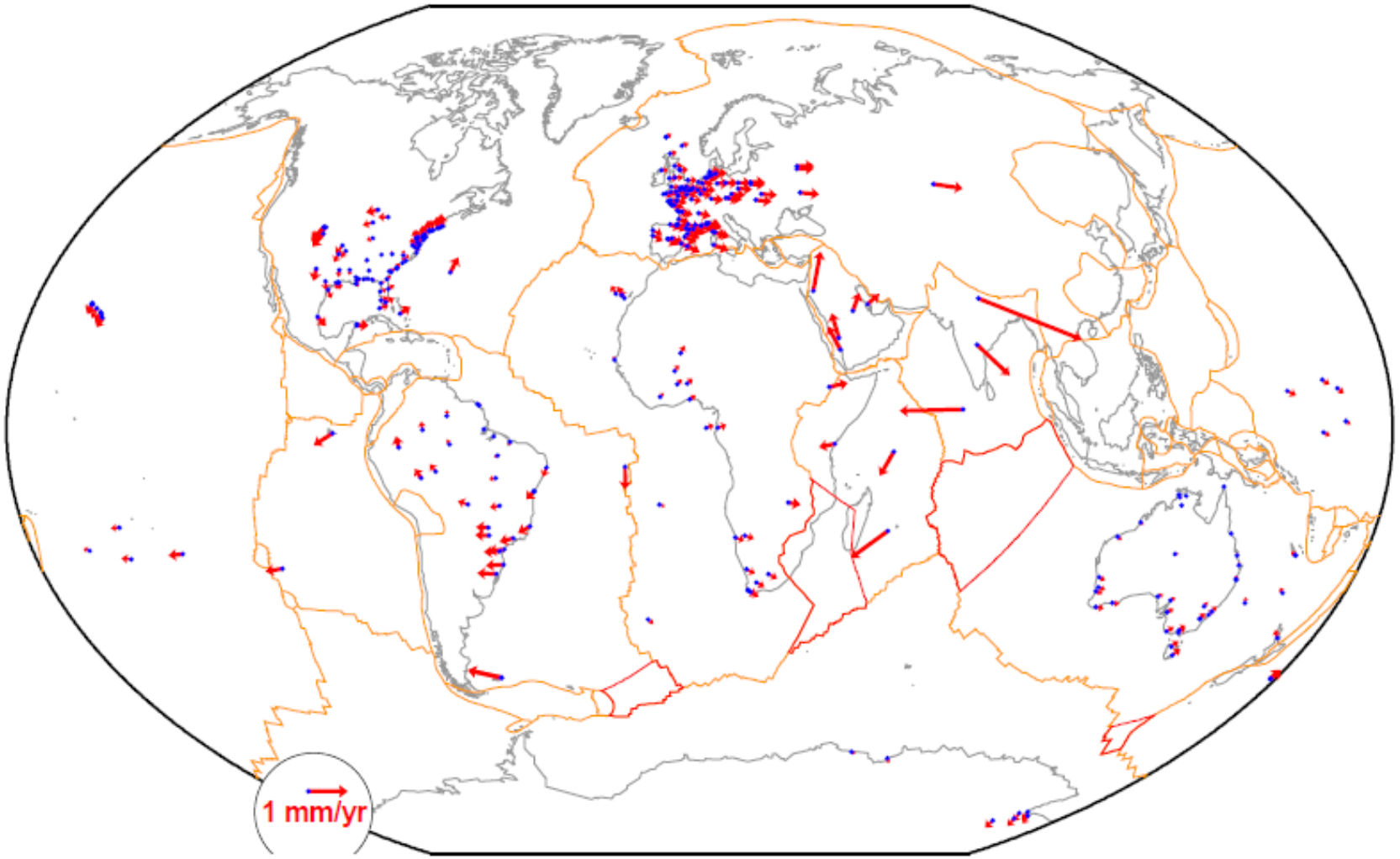
==> Final ITRF2014 PMM without ORB

Selection of the final model : Residuals



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

Differences ITRF2014 –ITRF2008 PMMs



ETRS89 realizations: Remarks

- ETRS89 was designed for practical/geo-referencing applications ==> centimetric "accuracy"
- Inspire Directive: use ETRS89, not a particular ETRFyy
- Max offsets between ETRFyy: less than 7 cm
- Do we really need better precision/accuracy across Europe?
  - If yes, use the ITRF
- Should listen to the countries & understand their needs
- Offer/propose the best and let each country decides
  - The ITRF2000 (ETRF2000) is now 15 years old
  - Origin & Scale btw ITRF2014 & ITRF2008 are small < 3mm
    ==> improved ITRF origin and scale accuracy & stability
  - ITRF2014 (ETRF2014) more precise and accurate than ITRF2000 (ETRF2000), especially for the vertical velocities
- Think and prepare the future: Fully kinematic RF

Resolution xx (ETRS89…) **DRAFT**

The IAG Reference Frame Sub-commission for Europe (EUREF)

Referring to the EUREF 2016 Resolution number X related to the ETRS89 questionnaire 2017

recognising the diverse policies, regulations and concerns among the European countries regarding the national implementation of ETRS89

noting the improved accuracy and stability of the origin and scale parameters of the ITRF2014

considering the significance of an improved ETRS89 realisation based on the ITRF2014

expresses its deep thanks to the countries who responded to the questionnaire for their valuable feedbacks

respects the country decisions on adopting their preferred ETRS89 realisations, including the previously recommended ETRF2000

urges the TWG to make available all the defining parameters of the ETRF2014 with an origin coinciding with that of ITRF2014 and to provide the full series of transformation parameters between ITRF and ETRF versions in an updated technical memo.

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

- ETRS89 realizations:
  - Propose/offer the best ETRF RF
  - Let the countries decide/use their preferred ETRF RF
- Prepare the future:
  - Fully kinematic RF, tied to the ITRF
  - Implies outreach and education programmes