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
Inversion models

\[ \dot{X}_i = \omega_p \times X_i \]  

\[ \dot{X}_i = \omega_p \times X_i + \dot{T} \]  

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 $\sigma < 0.2$ 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

\[ TX = 0.19 \pm 0.17 \text{ mm/yr} \]

\[ TY = 0.20 \pm 0.19 \]

\[ TZ = 0.85 \pm 0.18 \]

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Evaluation of the network effect (1/2)
A telling example: Rejecting two sites only

\[
\begin{align*}
TX &= 0.25 \pm 0.17 \text{ mm/yr} \\
TY &= 0.02 \pm 0.20 \\
TZ &= 0.48 \pm 0.20
\end{align*}
\]
Evaluation of the network effect

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

With ARTU and KERG

![Graph showing sub-networks from full selection with T_x, T_y, and T_z distributions.](image)
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

- $\hat{T}_X$
- $\hat{T}_Y$
- $\hat{T}_Z$

Zero $\rightarrow$ 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

\[
\begin{align*}
TX &= 0.20 \pm 0.15 \text{ mm/yr} \\
TY &= 0.00 \pm 0.18 \\
TZ &= 0.30 \pm 0.18
\end{align*}
\]
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Residuals

318 sites

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

297 sites

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
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

\[ \Rightarrow \text{The ORB value is not significant} \]

\[ \Rightarrow \text{Final ITRF2014 PMM without ORB} \]
Selection of the final model: Residuals

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

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Differences ITRF2014 –ITRF2008 PMMs
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