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DTRF2014 products for station coordinates and EOP

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Parametrization of station coordinates

According to the Conventions of the International Earth Rotation and Reference Systems Service (IERS; Petit and Luzum, 2010), the regularized station position $\boldsymbol{X_R}$ at an epoch t_i can be computed by subtracting n conventional models from the instantaneous station position $\boldsymbol{X}(t_i)$. The conventional International Terrestrial Reference Frame (ITRF) as the realization of the International Terrestrial Reference System (ITRS) approximates $\boldsymbol{X_R}(t_i)$ by a position $\boldsymbol{X_{ITRF}}$ estimated at the ITRF reference epoch t_0 and a constant velocity ${}^{d}/_{dt}\,\boldsymbol{X_{ITRF}}$ (Fig. 1).

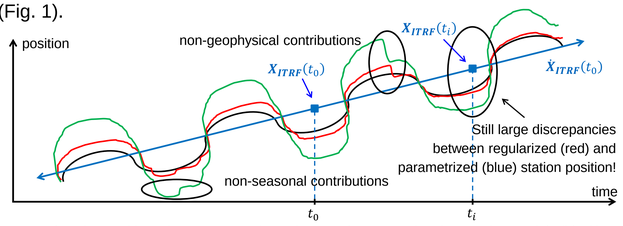

Fig. 1: Different types of station positions: instantaneous (green), sum of n conventional correction models (black), regularized (red), and ITRF (blue).

For the most recent ITRF solutions, the three ITRS Combination Centres of the IERS, namely IGN (Paris, France), DGFI-TUM (Munich, Germany) and JPL (Pasadena, USA), applied different methods to improve the approximation of $\boldsymbol{X_R}(t_i)$:

- **Expansion of the mathematical modeling (IGN; ITRF2014)**
  - ⊕ post-seismic models help to avoid discontinuities
  - ⊖ estimated annual signals contain non-geophysical contributions
- **Improvement of the geophysical modeling (DGFI-TUM; DTRF2014)**
  - ⊕ good approximation of the regularized position by considering non-tidal loading
  - ⊖ global models do not cover regional effects; limited accuracy of the models
- **Estimation of epoch reference frames (JPL; JTRF2014)**
  - ⊕ good approximation of the regularized position
  - ⊖ uncertainty of geodetic datum; difficult extrapolation

The DTRF2014 station positions and velocities roughly approximate the regularized station coordinates $\boldsymbol{X_R}(t_i)$. To improve the approximation, non-tidal loading corrections are applied in the DTRF2014 computation. These corrections together with SLR-derived origin information or residual station motions can be re-added (see Fig. 3) and allow the DTRF2014 user to compute the quasi-instantaneous station position according to:

$$\boldsymbol{X}(t_i) = \underbrace{\boldsymbol{X_{DTRF}}(t_0) + \Delta t \frac{d}{dt}\boldsymbol{X_{DTRF}}(t_0)}_{\text{conventional ITRF model}} + \underbrace{\boldsymbol{X_{origin}}(t_i) + \boldsymbol{X_{NT-L}}(t_i) + \boldsymbol{X_{resid}}(t_i) + \overbrace{\sum_n \boldsymbol{X_n}(t_i)}^{n \text{ conventional correction models}}}_{\text{non-conventional correction models}}$$

with $\boldsymbol{X_{NT-L}}(t_i) = \boldsymbol{X_{NT-ATML}}(t_i) + \boldsymbol{X_{NT-CWSL}}(t_i)$. The first two terms represent the conventional model as provided for previous ITRS realizations (e.g., DTRF2008) whereas the following terms (non-conventional correction models) are made available for the first time. The values for $\boldsymbol{X_{origin}}(t_i)$, $\boldsymbol{X_{NT-L}}(t_i)$, and $\boldsymbol{X_{resid}}(t_i)$ have to be interpolated from the respective time series.

DTRF2014 products

The DTRF2014 solution comprises positions and velocities of more than 1700 globally distributed stations of four space geodetic techniques (GNSS, VLBI, SLR, and DORIS; see Fig. 2) as well as consistently estimated Earth orientation parameters (EOP). For the first time, **non-tidal atmospheric and hydrological loading** was considered for the DTRF2014. The solution comprises the following products:

SINEX files at reference epoch 2005.0 (can be used for extrapolation to any date):

DTRF2014.snx — Estimated station positions and velocities for all techniques and the full variance-covariance matrix (12 GB).

DTRF2014_GNSS.snx
DTRF2014_VLBI.snx
DTRF2014_SLR.snx
DTRF2014_DORIS.snx
— Technique-specific files containing station positions, velocities, and the related variance-covariance matrices.

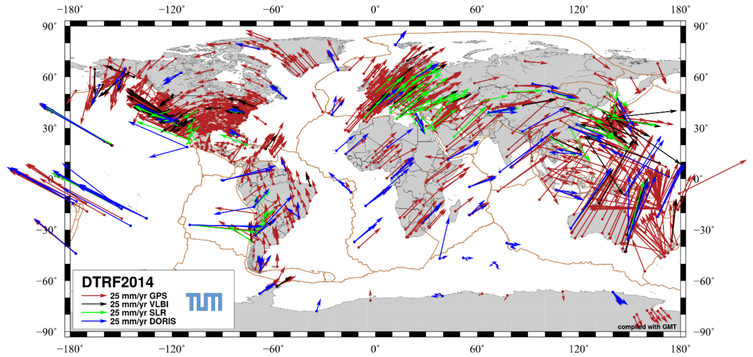

Fig. 2: Positions and horizontal velocities of globally distributed geodetic observing stations.

Non-conventional correction time series (can be used between 1983.0 and 2015.0):

DTRF2014_SLRorigin.txt — Estimated SLR-only network translations ($\boldsymbol{X_{origin}}$) derived from similarity transformations of SLR-only 15-day/weekly network solutions w.r.t. the DTRF2014 combined solution.

Loading time series — Averaged weekly non-tidal loading corrections ($\boldsymbol{X_{NT-L}}$) applied for the DTRF2014 computation. The data were provided by Tonie van Dam (IERS GGFC) and are based on the atmosphere model NCEP ($\boldsymbol{X_{NT-ATML}}$) and the hydrology model GLDAS ($\boldsymbol{X_{NT-CWSL}}$).

Residual station motions — Transformation residual time series ($\boldsymbol{X_{resid}}$) obtained from similarity transformations of the technique-specific epoch-wise solutions w.r.t. the DTRF2014 combined solution.

Earth orientation parameters (EOP):

DTRF2014_EOP-F2.DAT — Commonly estimated EOP which are only consistent with the conventional DTRF2014 station positions and velocities provided in SINEX files.

How to apply the DTRF2014 products

The application of the DTRF2014 products is shown exemplarily for the IGS station Andernay (France).

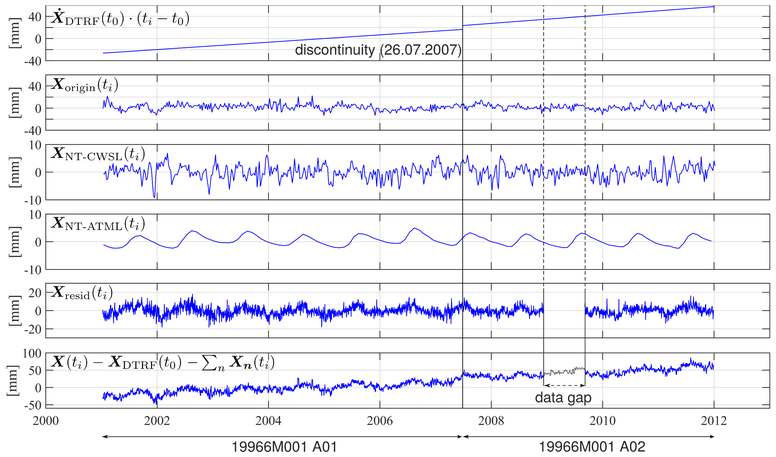

Fig. 3: Z-components of the IGS station ANDE (19966M001 A01/A02, Andernay, France).

The top panel of Fig. 3 shows the conventional station coordinates extrapolated from the reference epoch t_0 using the DTRF2014 station velocity for the two solution intervals A01 and A02. The middle panels show different correction models which can be added to the conventional station coordinates whereas the bottom panel shows the best possible approximation of $\boldsymbol{X_R}(t_i)$. Please note the different scales!

With the DTRF2014 solution, all station coordinates (including those of stations affected by post-seismic deformations) can be extrapolated with the conventional (linear) station velocities. **It is up to the user to decide if additional non-conventional correction models should be re-added** to get an adequate approximation.

Nevertheless, it has to be mentioned that the non-tidal loading models and the SLR-derived origin time series are only available between 1983.0 and 2015.0. Moreover, residual station motions are only available for stations that actually observed. Therefore, interpolation and extrapolation is only possible by applying approximation methods.

ITRS Combination Center at DGFI-TUM

http://www.dgfi.tum.de/en/international-services/itrs-combination-centre/

DTRF2014 data

DTRF2014 data can be accessed via
http://www.dgfi.tum.de/en/science-data-products/dtrf2014/

Citation

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