Instructions for the computation of quasi-instantaneous station positions

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The DTRF2014 computed by the ITRS Combination Centre at DGFI-TUM is the first ITRS realization which considers **non-tidal signals** in station positions induced by **atmospheric and hydrological loading**. This short note explains how **quasi-instantaneous station positions** can be computed using the DTRF2014 product files. A detailed description of the processing strategy and the input data used for the computation is available at `http://www.dgfi.tum.de/en/science-data-products/dtrf2014`.

Data description

The DTRF2014 solution comprises the following files, necessary for the computation of the quasi-instantaneous station positions:

SINEX files (reference epoch 2005.0):

DTRF2014.snx	Estimated station positions and velocities ($\boldsymbol{X}_{\mathrm{DTRF}}$, $\dot{\boldsymbol{X}}_{\mathrm{DTRF}}$) of the space geodetic techniques GNSS, VLBI, SLR and DORIS and the full variance-covariance matrix (12 GB)
DTRF2014_GNSS.snx	Estimated station positions and velocities ($\boldsymbol{X}_{\mathrm{DTRF}}$, $\dot{\boldsymbol{X}}_{\mathrm{DTRF}}$) of the GNSS network and the related full variance-covariance matrix
DTRF2014_VLBI.snx	Estimated station positions and velocities ($\boldsymbol{X}_{\mathrm{DTRF}}$, $\dot{\boldsymbol{X}}_{\mathrm{DTRF}}$) of the VLBI network and the related full variance-covariance matrix
DTRF2014_SLR.snx	Estimated station positions and velocities ($\boldsymbol{X}_{\mathrm{DTRF}}$, $\dot{\boldsymbol{X}}_{\mathrm{DTRF}}$) of the SLR network and the related full variance-covariance matrix
DTRF2014_DORIS.snx	Estimated station positions and velocities ($\boldsymbol{X}_{\mathrm{DTRF}}$, $\dot{\boldsymbol{X}}_{\mathrm{DTRF}}$) of the DORIS network and the related full variance-covariance matrix

Time series:

DTRF2014_SLRorigin.txt	Translation time series of origin. Estimated 15-day/weekly SLR-only network translations ($\boldsymbol{X}_{\mathrm{origin}}$) derived from similarity transformations of SLR-only 15-day/weekly network solutions w.r.t. the DTRF2014 combined solution.
Loading time series	Weekly averaged atmospheric ($\boldsymbol{X}_{\mathrm{NT\text{-}ATML}}$) and hydrological $\boldsymbol{X}_{\mathrm{resid}}$ non-tidal loading corrections applied in DTRF2014 computation for the correction of the respective signals. The data are provided by Tonie van Dam (personal communication) and are based on the atmosphere model NCEP and the hydrology model GLDAS. The station-specific time series are stored in the folders "NT-ATML" and "NT-CWSL", respectively (e.g., "**NT-ATML/IGS/ANDE_19966M001.ntatml**" for the non-tidal atmospheric loading of the GNSS station Andernay in France with the DOMES number 19966M001).
Station position residuals	Transformation residual time series $\boldsymbol{X}_{\mathrm{resid}}$ obtained from similarity transformations of the technique-specific epoch-wise solutions w.r.t. the DTRF2014 combined solution. The temporal resolution of the residual time series depends on the resolution of the space geodetic techniques (daily for GNSS, session-wise for VLBI, weekly for DORIS, and 15-day (1983.0 − 1993.0)/weekly (1993.0 − 2015.0) for SLR). The residual time series do not represent exactly the NEQs accumulated within the DTRF2014 computation since a refined outlier detection was performed

to reduce scatter in order to allow a high-precise interpolation. The station-specific time series are stored in the folder "RESID" (e.g., "**RESID/IGS/ANDE_19966M001_A01.resid**" and "**RESID/ IGS/ANDE_19966M001_A02.resid**" for daily residuals of both station intervals of the GNSS station Andernay in France).

Application of epoch-wise corrections

The station positions and velocities of the DTRF2014 solution only provide a regularized approximation of the instantaneous geocentric station coordinates $\boldsymbol{X}(t_i)$. In order to compute the best possible approximation, regularizations performed within the DTRF2014 computation process can be re-added.

The regularizations can be considered as follows:

$$\boldsymbol{X}(t_i) = \boldsymbol{X}_{\mathrm{DTRF}}(t_0) + \dot{\boldsymbol{X}}_{\mathrm{DTRF}}(t_0) \cdot (t_i - t_0) + \boldsymbol{X}_{\mathrm{origin}}(t_i) + \boldsymbol{X}_{\mathrm{NT\text{-}L}}(t_i) + \boldsymbol{X}_{\mathrm{resid}}(t_i) \tag{1}$$

with $\boldsymbol{X}_{\mathrm{NT\text{-}L}}(t_i) = \boldsymbol{X}_{\mathrm{NT\text{-}CWSL}}(t_i) + \boldsymbol{X}_{\mathrm{NT\text{-}ATML}}(t_i)$. In Eq. (1), the first two terms represent the conventional model like it was provided in previous ITRS realizations such as the DTRF2008 whereas the later three terms are new for the DTRF2014 solution. The values for $\boldsymbol{X}_{\mathrm{origin}}(t_i)$, $\boldsymbol{X}_{\mathrm{NT\text{-}L}}(t_i)$ and $\boldsymbol{X}_{\mathrm{resid}}(t_i)$ have to be interpolated from the respective time series to the epoch t_i. For example, Figure 1 shows the regularized and quasi-instantaneous Z-components of DTRF2014 for both solution numbers A01 and A02 (time interval for each solution number is defined in the SOLUTION/EPOCH block of the respective SINEX file) and all corresponding correction terms. For the extrapolation of station coordinates, the user should be aware that the non-tidal loading models and the SLR-only origin time series only cover the time span between 1983.0 and 2015.0. This means, for extrapolating the station coordinates outside this interval, only the linear station velocities can be used (conventional approach) or the SLR-only origin time series and the non-tidal loading models might be extrapolated using an annual + semi-annual fit.

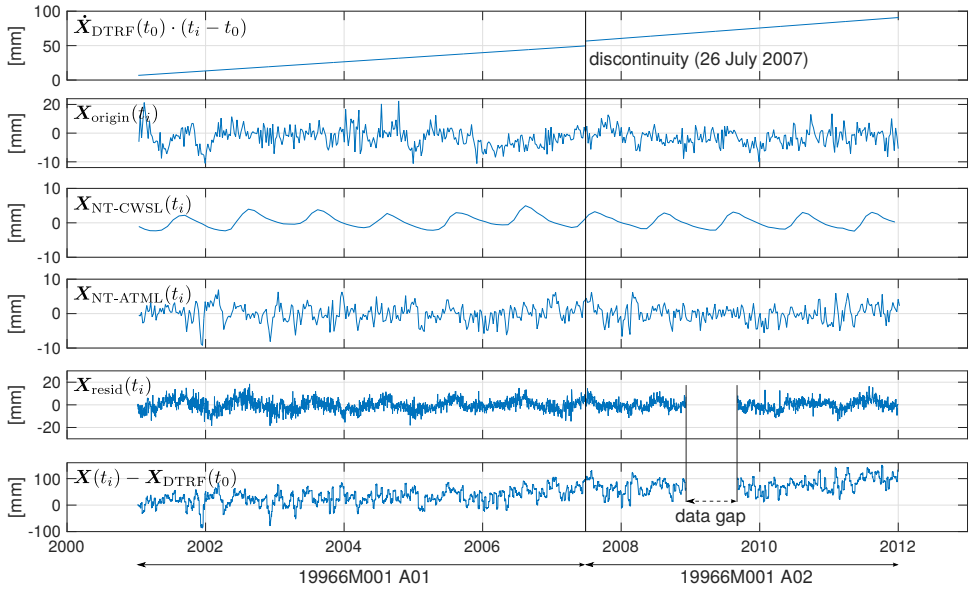

Figure 1: Z-components of the IGS station ANDE (19966M001 A01/A02, Andernay, France). The top panel shows the regularized station coordinates extrapolated from the refrence epoch t_0 using the DTRF2014 station velocities of A01 and A02. The middle panels show the different correction models to be added to the regularized station coordinates. The bottom panel shows the best possible approximation of the instantaneous geocentric station coordinates. Please note the different scales!

Please note: The commonly estimated EOP are only consistent with the regularized station positions and velocities provided within the DTRF2014 solution.

If you have further questions about the computation of quasi-instantaneous station coordinates using the DTRF2014 products, don't hesitate to contact `mathis.blossfeld@tum.de` or `manuela.seitz@tum.de`.