3.6 ITRS Combination Centres

3.6.1 Deutsches Geodätisches Forschungsinstitut der TU München (DGFI-TUM)

In 2016, the DGFI-TUM ITRS Combination Centre (CC) focused its research activities on the evaluation, interpretation, and further analysis of the DTRF2014 global international terrestrial reference frame (ITRF) realization. Important topics have been the inter-comparison of the three ITRF solutions, the quality assessment of the DORIS contribution to the ITRF, and the geophysical interpretation of station coordinate velocity vectors.

Inter-comparison of the three ITRF solutions

For the most recent ITRS realization, the three IERS ITRS CCs computed three different realizations based on identical input data. The advantage of this redundant computation is, that errors or systematics caused by the combination approach, the analyst, or the software can be identified. Fig. 1 shows exemplarily the height differences between the ITRF solutions for selected SLR stations. Note that the differences outside the ITRF input data interval (after 2015.0) already reach the centimeter-level until 2017.0.

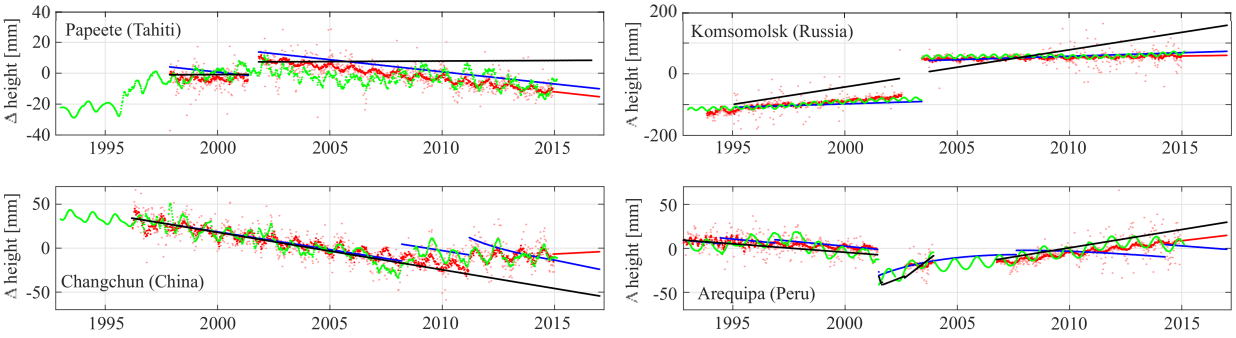

Fig. 1: *Height time series (in mm: common mean subtracted) of the ILRS stations Papeete (Tahiti), Changchun (China), Komsomolsk (Russia), and Arequipa (Peru) between 1993.0 and 2015.0 (within ITRF data interval) and between 2015.0 and 2017.0 (extrapolated data interval) from four different ITRS realizations: most recent SLRF2008 (black), ITRF2014 (blue), DTRF2014+NTL (red), and JTRF2014 (green). In addition, the solution DTRF2014+Res+Ori+NTL (light red) is shown in the background. Note: no seasonal, annual, or semi-annual corrections are applied after 2015.0.*

The main characteristics of each ITRS realization are summarized in Table 2. A special attention was drawn at DGFI-TUM on the investigation of the realized scales in the ITRF2014 and the DTRF2014 solution. Whereas the ITRF2014 comprises an SLR and a VLBI scale which differ by about 1.37 ppb (rate: 0.02 ppb/yr), the DTRF2014 realization

do not show such a large scale discrepancy. Details on this investigation are reported in Bloßfeld et al. (2017).

Solution	ITRF2014	DTRF2014	JTRF2014
Institute	IGN (Paris, France)	DGFI-TUM (Munich, Germany)	JPL (Pasadena, USA)
Software	CATREF	DOGS-CS	CATREF + KALMAN
Combination approach	Solution (parameter) level	Normal equation level	Solution (parameter) level
Station position	Position $\boldsymbol{X}_{ITRF}(t_0)$ + velocity $\dot{\boldsymbol{X}}_{ITRF}(t_0)$ + PSD model (for selected stations) + annual signals (on request)	Position $\boldsymbol{X}_{DTRF}(t_0)$ + velocity $\dot{\boldsymbol{X}}_{DTRF}(t_0)$ + NT-L models + SLR origin + residual station motions	Weekly positions $\tilde{\boldsymbol{X}}_{JTRF}(t_i)$

Fig. 2: *Characteristics of the ITRF2014, DTRF2014, and JTRF2014 solution.*

Quality assessment of the IDS contribution to the ITRF2014

The quality of the IDS contribution to the ITRF2014 was assessed by Bloßfeld et al. (2016). The paper presents the analysis results of the most recent DORIS submission IDS-d09 and evaluates its quality w.r.t. the DTRF2008 (IDS-only) solution. In the most recent version of the analysis, we introduce in total 56 station discontinuities and reduce 15 stations due to a too short time span or too few observations. Time series of weekly IDS solutions are computed and validated w.r.t. DTRF2008. The transformation parameter time series and the station residuals are discussed in detail. Especially the scale parameter time series shows a significant improvement compared to the DTRF2008 input data. The scatter of the x- and y-translation is significantly reduced to 5.7 mm and 7.1 mm compared to 6.6 mm and 8.1 mm for the DTRF2008 (IDS-only) solution. The z-translation time series still shows a high correlation with solar activity. 10 % of all station residuals are significantly affected by spectral peaks at draconitic period harmonics of the altimetry satellites Jason and TOPEX/Poseidon and up to 48 % of all station residual time series contain significantly determined frequencies with a 14 day period. The multi-year IDS solution is validated w.r.t. DTRF2008 and the consistently estimated terrestrial pole coordinates are analyzed and compared to IERS 08 C04. The x-pole spectra comprises prominent peaks at various draconitic frequencies.

Geophysical interpretation

The velocity vectors of the DTRF2014 solution can be used to study geophysical phenomena. The left panel of Fig. 3 shows the plate tectonic motions of Greenland and the Scandinavian region. Note also Iceland which is located directly at the mid-Atlantic ridge and shows

different horizontal velocities for the east and the west coast. The right panel of Fig. 3 shows the vertical land motion of Greenland and the Scandinavian region. Both regions are significantly affected by post-glacial rebound motions of up to 14 mm per year.

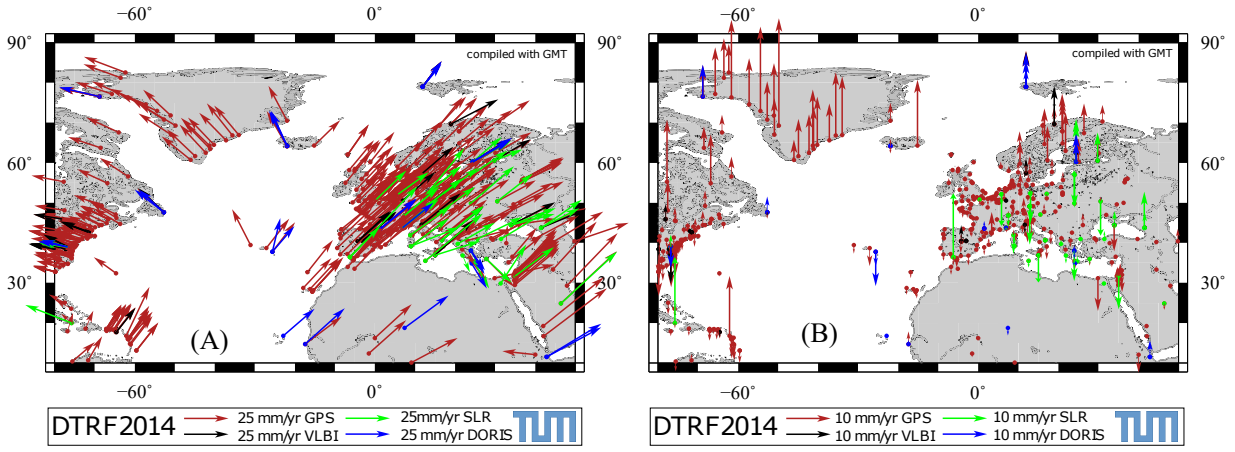

Fig. 3: *Horizontal (A) and vertical (B) station velocities in Greenland (A) and Scandinavia (B) of the DTRF2014 solution.*

Fig. 4 shows differences of the global horizontal station velocity field between the DTRF2008 and the DTRF2014 solution. The vector field clearly indicate the effect of the large Chile-Maule earthquake in Chile on February 27, 2010 and the Tohoku-Oki earthquake in Japan on March 11, 2011 on the station mean motions in the respective regions.

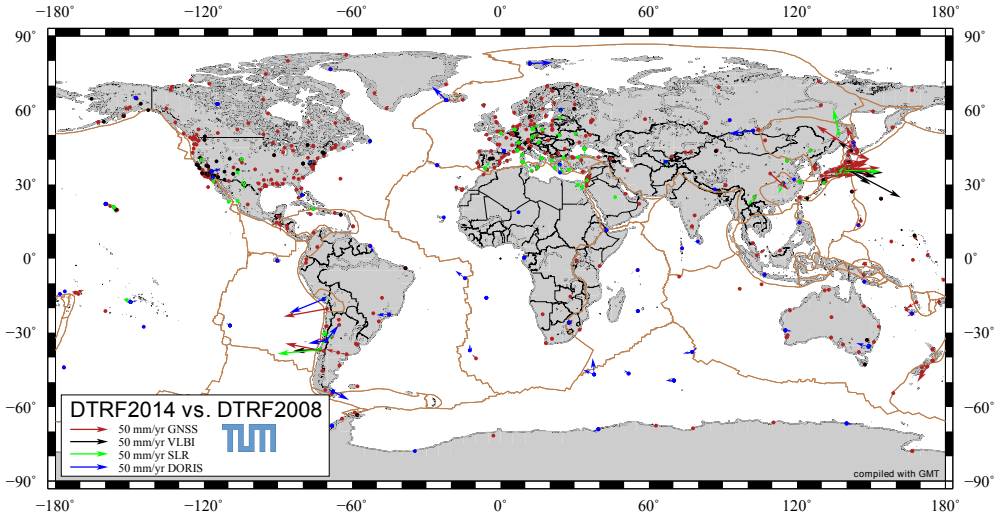

Fig. 4: *Global horizontal velocity differences between the DTRF2014 and the DTRF2008 ITRF solution.*

Publications

Bloßfeld M., Seitz M., Angermann D., Moreaux G.: Quality assessment of IDS contribution to ITRF2014 performed by DGFI-TUM. Advances in Space Research, 58(12), 2505-2519, DOI: 10.1016/j.asr.2015.12.016, 2016.

Bloßfeld M., Angermann D., Seitz M.: DGFI-TUM analysis and scale investigations of the latest terrestrial reference frame realizations. Proceedings of the 2017 IAG/IASPEI meeting, Kobe, Japan, submitted, 2017.

Seitz M., Bloßfeld M., Angermann D., Schmid R., Gerstl M., Seitz F.: The new DGFI-TUM realization of the ITRS: DTRF2014 (data). Deutsches Geodätisches Forschungsinstitut, Munich, DOI: 10.1594/PANGAEA.864046, 2016.

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