3.6 ITRS Combination Centres

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

In 2019, the ITRS Combination Centre at DGFI-TUM focused on the development and testing of a new version of the DOGS-CS software and the preparation of the reference paper for the DTRF2014 solution. A further important research task was to investigate and compare the consideration of non-tidal loading corrections at different levels of the Gauss-Markov model.

DOGS-CS software development

The software package DOGS (DGFI Orbit and Geodetic parameter estimation Software) is a geodetic analysis and combination software developed at DGFI-TUM. It provides the options of SLR and DORIS observation analysis and orbit computation (DOGS-OC), VLBI observation analysis (DOGS-RI) as well as the combination of any space geodetic techniques (DOGS-CS). The combination package of DOGS includes a large number of modular matrix manipulation tools which can be used very flexibly. The development of the new software version 501 comprises (i) the extention of the internal data formats. The new format allows for more precise parameter time-tags and thus for a higher resolution of parameters as well as for more precise parameter transformations. (ii) Furthermore, most of the meta data given in observation or SINEX files can now be handled by the new format. This guaranties a lossless transfer of meta data information from input data through the analysis / combination process to the final solution output (SINEX file). (iii) And finally the homogenization of all software parts w.r.t. the mentioned implementations and in general w.r.t. the usage of models and parameterizations is an important task. The programming process is still ongoing but a large part was finished in 2019 and software tests are performed to ensure the smooth running of the DTRF2020 computation.

The correction of non-tidal loading on different levels of Gauss-Markov model

In the DTRF2014 solution non-tidal loading (NTL) induced by atmospherical and hydrological mass load changes are considered. For the ITRS 2014 realization, the input data of the space geodetic techniques provided by the Technique Centres (TC) of the individual Technique Services did not include NTL corrections, as agreed between the ITRS Centre and the TC. Therefore, in DTRF2014, the NTL corrections are applied as daily or weekly mean values (depending on the temporal resolution of the input data series). In accordance to the DTRF computation strategy which is based on the combination of normal equation systems (NEQ), the NTL corrections were applied by a reduction of the right hand side of the normal equations. This corresponds to a reduction of all observations of one station in one session-wise, daily or weekly solution by a mean loading correction. Comparing this approach with a correction of the observations right in the observation analysis, the largest impact on the solutions results from the difference in the temporal resolutions of the applied corrections. A further approach for considering NTL, applied by some groups performing analysis of time series, is the a posteriori correction of estimated station positions for NTL. Like the correction of the NEQ, this approch allows only for a limited temporal resolution of the NTL corrections. Beside this, the approach has to be used carefully, because the already finished parameter adjustment might have led – in the sense of residual minimization – to a partial distribution of observation residuals (including NTL effects) within the station network. At DGFI-TUM we investigated the impact of NTL on the DTRF2014 in detail. A further detailed study was performed by the IVS AC at DGFI-TUM for single VLBI sessions comparing the differences between the application of NTL at observation, normal equation and solution level. The results are presented in Glomsda et al. (2020). VLBI sessions are very suitable for these studies as they provide the lowest network densities of all techniques and the most changing network geometries. Both aspects make the VLBI solutions sensitive to the NTL correction approach.

Effects of NTL correction on DTRF2014 results

In order to investigate the impact of NTL corrections on the DTRF2014 we analysed time series of station positions as well as datum parameters. Figure 1 displays the change in the WRMS of station position residual time series when NTL corrections are applied. A significant decrease of the WRMS was achieved for the up-component of GNSS stations. The results might be explained by the facts that (i) the up component is naturally more affected by NTL than the horizontal components and (ii) GNSS shows a generally smaller scatter of station position time series compared to the other techniques, which leads to a larger effect of the applied corrections on the time series.

Second, it is very interesting to study the impact of NTL corrections on the time series of the datum parameters (origin and scale). Figure 2 shows the power spectra of VLBI scale parameter time series derived from an analysis by separately applying atmospheric, hydrological and oceanic NTL corrections as well as all components together. It comes out very clearly that in particular the application of hydrological NTL leads to a significant decrease of the annual signal in VLBI scale time series. Furthermore, the figure allows for a comparison of the results derived from the application of NTL at observation and at NEQ level. The results are very similar and underline the aforementioned result, that the reduction of NTL at NEQ level corresponds to the reduction at observation level, except for the loss in temporal resolution. The latter affects the parameters with subdaily resolution like EOP rates, clock and tropospheric parameters more than station positions (see also Glomsda et al. (2020)).

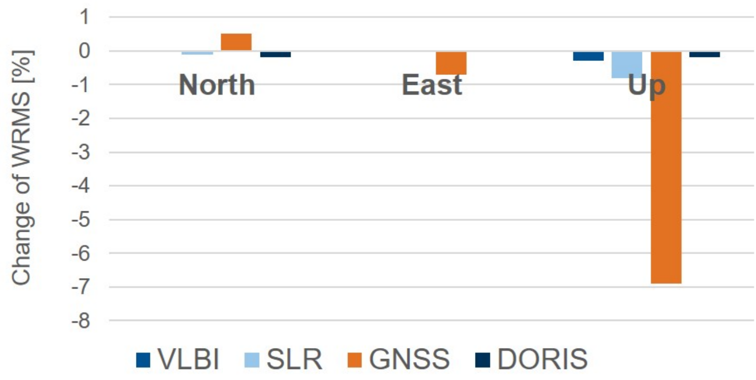

Fig. 1: *Change of WRMS of station position time series due to the consideration of NTL corrections in DTRF2014 computation.*

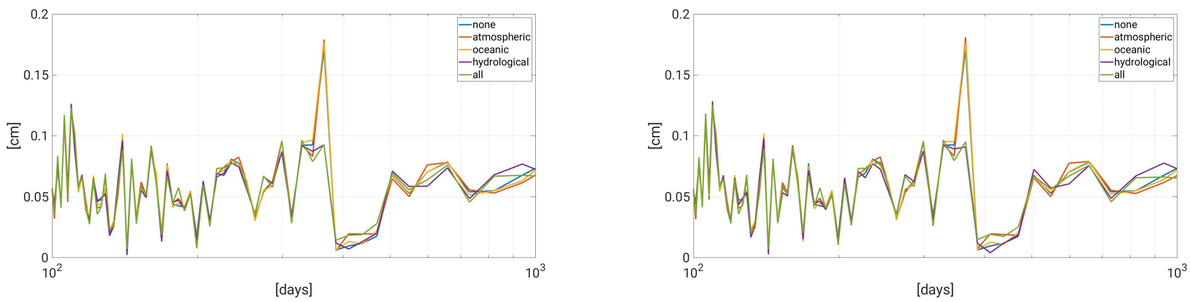

Fig. 2: *Amplitude spectra of scale parameter time series derived from VLBI analysis with and without reducing atmospheric, hydrological and oceanic NTL at observation level (left panel) and NEQ level (right panel).*

Consistent realization of ITRS and ICRS

For ITRF2020 it is planned for the first time, that the provided IVS input series contain besides station positions and EOP also positions of radio sources. This allows for a consistent determination of ITRF2020 and a celestial radio reference frame. The character of this first consistent solution, planned to be computed in addition to the ITRF2020 realization, is an experimental one. It will allow to formulate concrete scientific questions related to the common realization of ITRF and ICRS as well as to refine approaches for this new type of realization resulting from previous research, e.g., presented by Kwak et al. (2018). The importance of this scientific topic is underlined by the Resolution No. 3 of the International Union of Geodesy and Geophysics (IUGG) adopted by the General Assembly in 2011, wherein the IUGG urged “that highest consistency between the ICRF, the ITRF, and the EOP as observed and realized by the IAG and its components such as the IERS should be a primary goal in all future realizations of the ICRS". An according resolution was adopted by the IAG (in 2019). As a consequence, an IAU/IAG/IERS Joint Working Group (JWG) on the Consistent Realization of TRF, CRF, and EOP was installed in 2020, in which the ITRS CC at DGFI-TUM is involved. More information about the JWG can be found on the IERS website https://www.iers.org/IERS/WGConsistentRealization.

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