Vienna Contribution to ITRF2014

Sigrid Böhm[1], Hana Krásná[1], Sabine Bachmann[2]

Abstract The next realization of the International Terrestrial Reference System, the ITRF2014, was released in the beginning of 2016. The VLBI input to ITRF2014 was provided by the International VLBI Service for Geodesy and Astrometry (IVS) and consists of a combination of all Analysis Center contributions. One of these single solutions was contributed by the Vienna Special Analysis Center of the Department of Geodesy and Geoinformation at TU Wien. In this paper we describe the characteristics of the Vienna contribution (calculated using the Vienna VLBI Software VieVS) to ITRF2014 and VTRF2014, respectively. We give a documentation of the included sessions and stations as well as some statistical information which shows the performance of the Vienna contribution compared to the other contributions in the IVS combination. In addition to that, a single TRF solution, VieTRF2014a, which is based on the Vienna input to ITRF2014, is presented and compared to previous TRF solutions. By and large the Vienna contribution does not exhibit any outstanding features when compared to the other submissions, except for the Earth rotation component dUT1, which shows large residuals with respect to the combined solution. The reason for this discrepancy is probably the different parameterization of EOP in VieVS as piecewise linear offsets, necessitating a transformation prior to the combination.

Keywords ITRF2014, VieVS, data analysis, global solution

1. TU Wien, Austria
2. BKG, Germany

1 Introduction

The International Terrestrial Reference Frame (ITRF) is re-calculated every few years as a combination of solutions from different space-geodetic techniques. The Very Long Baseline Interferometry (VLBI) solution is provided by the IVS and itself is constituted as a combination of normal equations from a number of analysis centers (ACs). The special AC at TU Wien (VIE) contributed to the IVS combination for the first time with single session normal equations in SINEX format computed using VieVS (Böhm et al., 2009, [1]). In the first part of this paper we give a brief overview of the Vienna contribution and comparative plots focusing on the performance of the VIE solution only. For further information on the combination process, details about other ACs, and a more accurate interpretation of results, we refer to Bachmann et al. (2016) [2]. In the second part we introduce the single TRF solution, VieTRF2014a, calculated using the global solution of VieVS.

2 Vienna Contribution to IVS Combination

A total of 5,708 sessions in SINEX format were submitted to the IVS Combination Center, 4,659 of which were successfully used in the combination process. The submission comprises data from 1979.7–2015.0 and includes 145 VLBI stations.

In contrast to common practice, the EOP (Earth orientation parameters) of AC VIE are parametrized as offsets instead of as an offset and a rate. The SINEX files contain EOP as so-called piecewise linear offsets in 48-hour intervals, which are transformed to an offset and a rate for the combination.

Figure 1 shows the weighted root mean squares (WRMS) of the station position residuals of all ACs with respect to the combined solution. The WRMS of the EOP residuals w.r.t. the combined solution are presented in Figures 2–6. Striking residuals are seen in the VIE dUT1 solution only. This fact can be attributed to the necessary transformation process which needs further investigation.

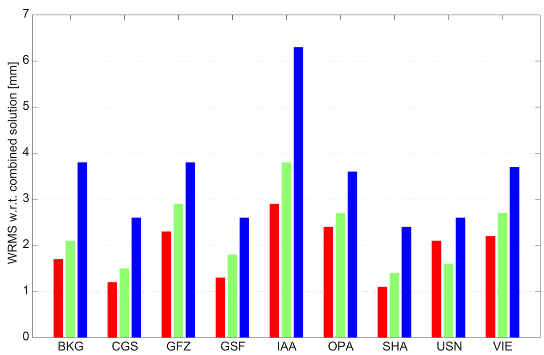

Fig. 1 WRMS of station residuals w.r.t. the combined solution.

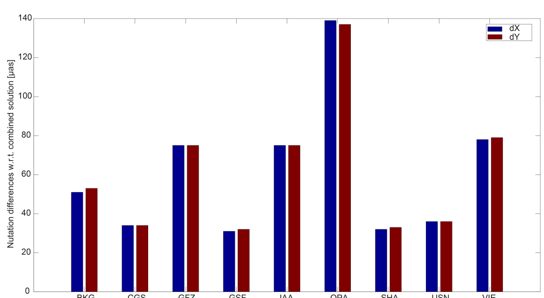

Fig. 2 WRMS of nutation (celestial pole offsets) residuals w.r.t. the combined solution.

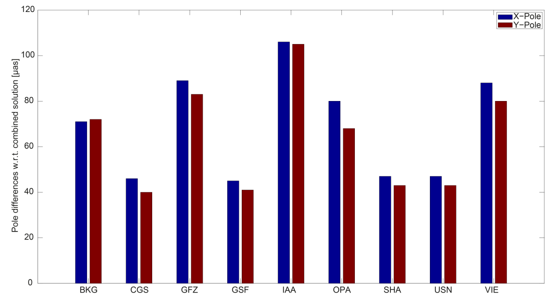

Fig. 3 WRMS of pole residuals w.r.t. the combined solution.

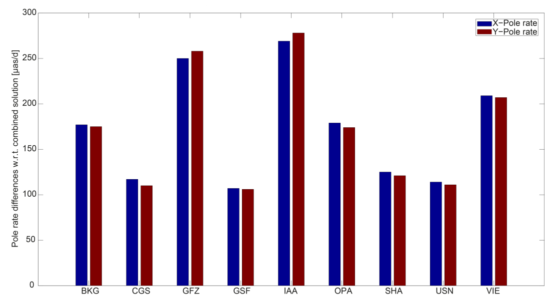

Fig. 4 WRMS of pole rate residuals w.r.t. the combined solution.

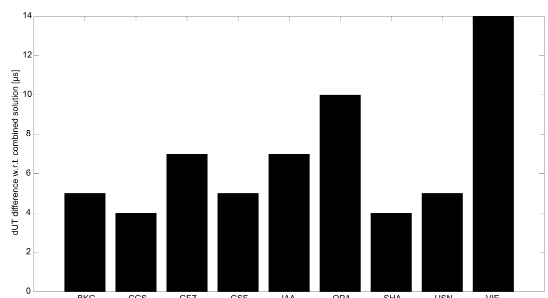

Fig. 5 WRMS of dUT1 residuals w.r.t. the combined solution.

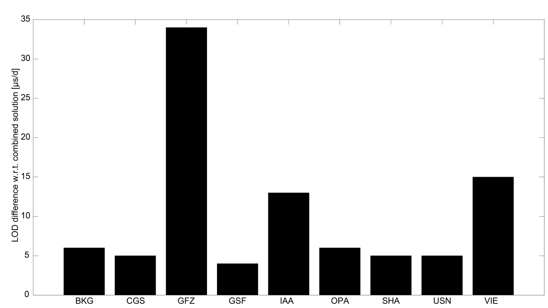

Fig. 6 WRMS of LOD residuals w.r.t. the combined solution.

For the combination, all individual normal equations are rescaled by a variance factor. These weighting factors for the ACs are estimated by means of variance component estimation. As it is illustrated in Figure 7, the factor for VIE AC is closely aligned to the factor for GFZ AC, due to the fact that both use VieVS for data analysis. Both weighting factors feature a clear annual signal, which could be explained by the use of NGS cards as input for VieVS. For more information about this phenomenon and the weighting strategy in general we refer to Bachmann et al. (2016) [2].

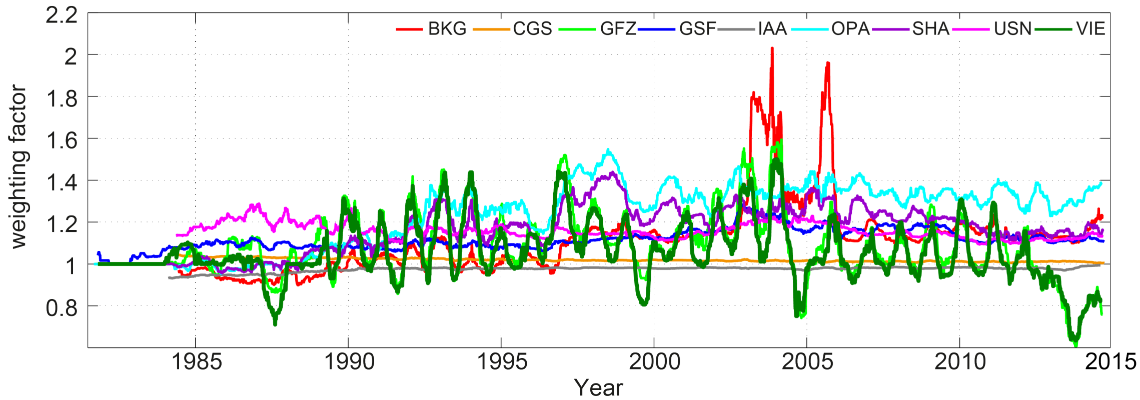

Fig. 7 Session-wise weighting factors for the individual Analysis Centers (ACs).

3 Vienna TRF Solution VieTRF2014a

For the Vienna TRF solution we selected 4,834 sessions spanning the years 1979.7–2015. The solution contains only sessions with more than two stations and more than 200 observations. Sessions for which the single session processing revealed a standard deviation of the unit weight a posteriori of more than 3 or a badly conditioned normal equation matrix were excluded from the global solution. The single sessions were processed using the standard processing settings of VieVS, which are summarized in Table 1.

Table 1 Standard single session processing settings of VieVS.

	Interval (min)	Relative constraints
Clock	60	1.3 cm after 60 min
Zenith wet delay	60	1.5 cm after 60 min
Trop. gradients	360	0.05 cm after 360 min
x-pole, y-pole	1440	0.1 μas after 1 day
dUT1	1440	0.1 μas after 1 day
Cel. pole offsets	1440	0.1 μas after 1 day
Station models	according to IERS Conventions 2010 [3] + non-tidal atmospheric loading (VIENNA)	

The TRF solution called VieTRF2014a contains site positions and velocities of the stations displayed in the global map (Figure 9). Source coordinates were fixed to their ICRF2 positions. Clocks, zenith wet delays, troposphere gradients, and EOP were reduced session-wise. The datum was defined imposing no-net-rotation and no-net-translation conditions on the VTRF2008 (Böckmann et al., 2010, [4]) coordinates of 23 stable long-term observing stations. Antennas which have been observing in fewer than 20 sessions and for less than two years were reduced and their coordinates estimated session-wise. The activity of the antennas included in the TRF is plotted in Figure 10.

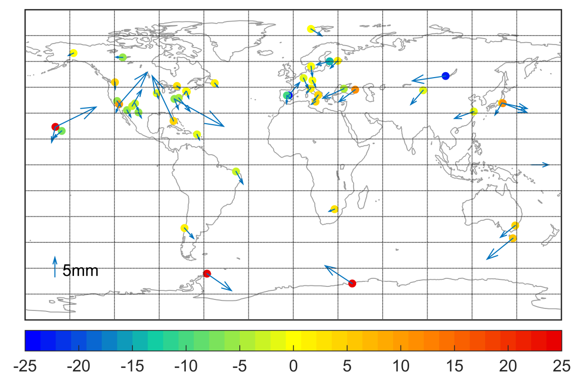

Fig. 8 Position differences between VieTRF2014a and VTRF2008 at epoch 2000.0. Only stations with an RMS of less than 5 mm are shown. The color bar represents the height difference in mm

Table 2 gives the weighted Helmert parameters including formal errors from VieTRF2014a to VTRF2008 at epoch 2000.0 for stations with a position RMS of less than 5 mm and for all stations, respectively. The position differences between VieTRF2014a and VTRF2008 at epoch 2000.0 are shown in Figure 8.

4 Summary and Conclusions

The present paper provides basic information about the contribution of the special AC VIE to the IVS combina-

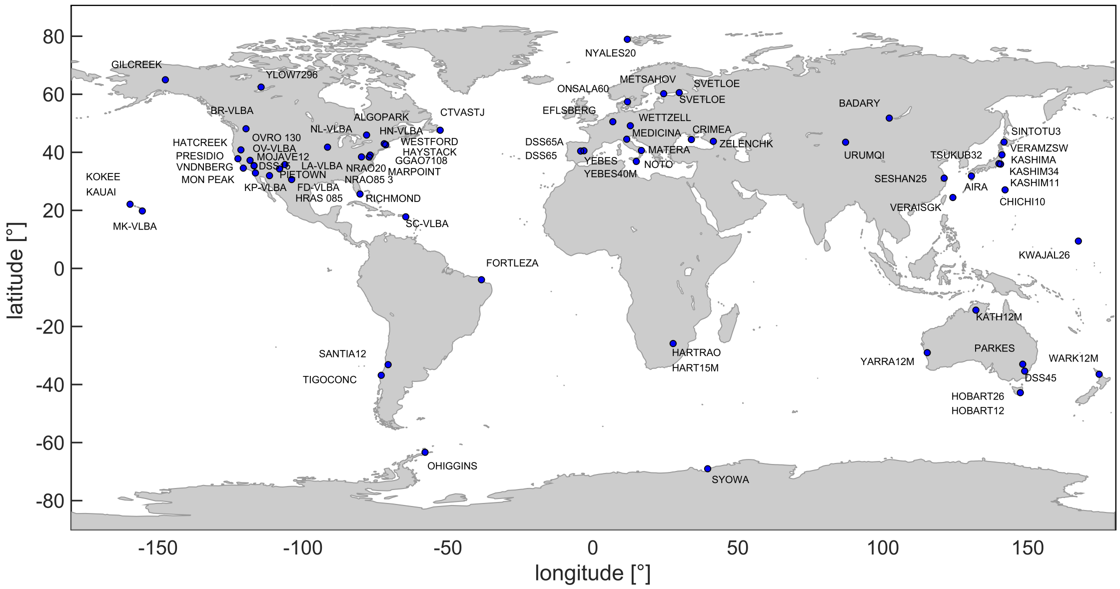

Fig. 9 Stations included in the VieTRF2014a solution. Stations which were reduced session-wise are not shown.

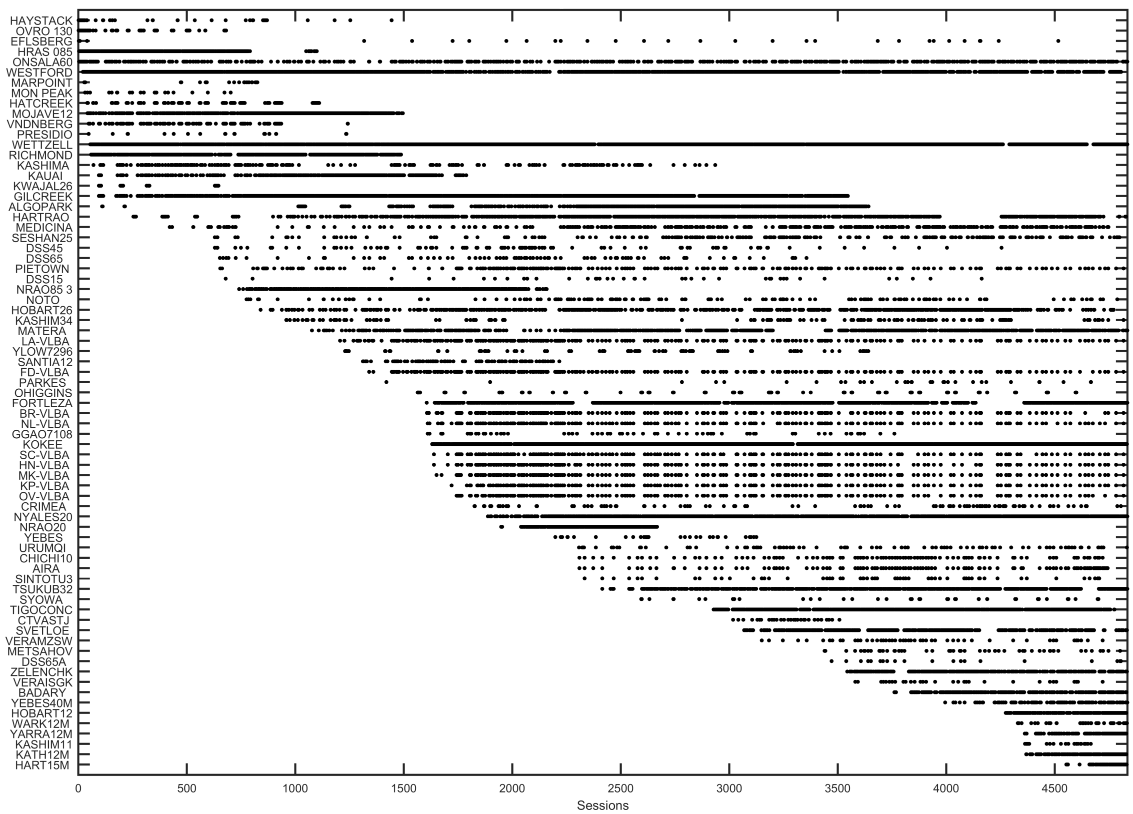

Fig. 10 Activity of the antennas (observing in at least 20 sessions).

Table 2 Weighted Helmert parameters from VieTRF2014a to VTRF2008 (epoch 2000.0).

Tx [mm] *dTx* [mm/yr]	*Ty* [mm] *dTy* [mm/yr]	*Tz* [mm] *dTz* [mm/yr]	*Rx* [mas] *dRx* [μas/yr]	*Ry* [mas] *dRy* [μas/yr]	*Rz* [mas] *dRz* [μas/yr]	Scale [ppb] Scale rate [ppb/yr]
Stations with position RMS < 5 mm						
2.28 ±0.72	1.60 ±0.70	-2.72 ±0.67	-0.03 ±0.03	0.04 ±0.03	0.02 ±0.02	0.26 ±0.10
-0.18 ±0.24	0.01 ±0.24	-0.26 ±0.23	0.49 ±9.35	-2.73 ±9.52	-5.66 ±7.28	0.01 ±0.03
All stations						
2.16 ±2.91	1.06 ±2.83	-3.17 ±2.70	-0.01 ±0.11	0.04 ±0.11	0.01 ±0.09	0.29 ±0.40
-0.13 ±0.99	-0.09 ±0.96	-0.31 ±0.94	3.96 ±37.87	-1.57 ±38.59	-5.02 ±29.54	0.01 ±0.14

tion solution for ITRF2014. In general, the VIE input does not show any distinctive features w.r.t. the other ACs or the combined solution, except for large WRMS of the dUT1 residuals. The EOP submitted by VIE are represented as piecewise linear offsets and have to be transformed to offset and rate to be consistent with the parametrization of the other ACs. The transformation prior to the combination is presumably responsible for this deviation (see also Bachmann et al. (2016), [2]).

A Vienna TRF solution, VieTRF2014a, was presented in the second part of the paper. This TRF is a preliminary solution and will be refined in terms of datum definition and handling of stations where earthquakes occurred. At present the software is not able to reduce a station only for a certain period of time (for example after a break due to an earthquake). It is also planned to estimate future TRF solutions consistently and therefore simultaneously to the Vienna celestial reference frame solution (refer to the paper, "Vienna Contribution to the ICRF3" by Mayer et al. in this volume).

References

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