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Simultaneous Estimation of a TRF, the EOP and a CRF

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Abstract

The paper presents first results of a DGFI VLBI solution with simultaneous estimation of station positions and velocities, celestial coordinates of the radio sources and Earth orientation parameters. The datum is realised by NNT and NNR conditions for the terrestrial (ITRF2000) and NNR for the celestial reference (ICRF-Ext1) frame. Using minimum datum conditions, biases can be avoided which are due to fixed reference frames or other relevant parameters of the observation equations.

1. Solution Description

For 2211 sessions between 1984 and 2001, normal equations were set up with the VLBI software OCCAM 6.0 ([6] and [7]), including a total of 47 telescopes observing 589 sources. The auxiliary parameters (for troposphere and clocks) were reduced for each session. All normal equations were accumulated to one equation system with the DGFI software DOGS-CS (as described in [5]). The datum of the solution was realised by NNT and NNR conditions for 26 telescope positions and velocities w.r.t. ITRF2000 ([1]) and NNR of 549 sources w.r.t. ICRF-Ext1 ([2] and [3]).

2. Estimated Source Coordinates

The estimated source coordinates agree well with the ICRF-Ext1: for 549 sources, the quadratic mean of the deviations is smaller than 2 mas (Fig. 1 and 3). There are almost no significant biases w.r.t. ICRF-Ext1 (Fig. 2). Although some weakly determined parameters are highly correlated, no large correlations were found between TRF and CRF related parameters.

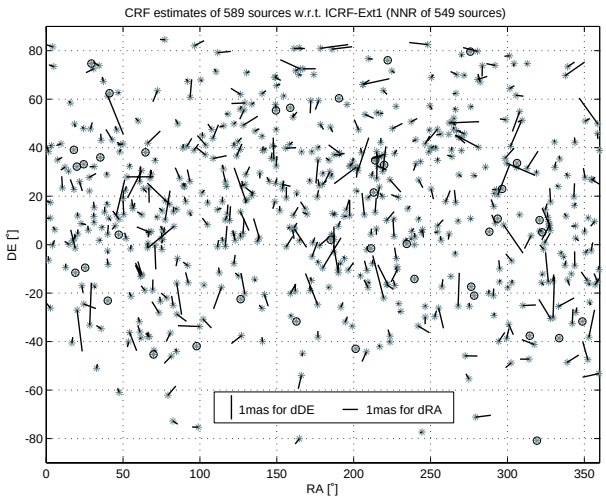

Figure 1: Estimates dDE, dRA of the solution (in black, units see legend). Only estimates for the 549 sources with sqrt(dDE^2+dRA^2) < 2mas are shown. They were used as identical points for the NNR conditions w.r.t. ICRF-Ext1. The 40 sources not used for the datum realisation are surrounded by circles.

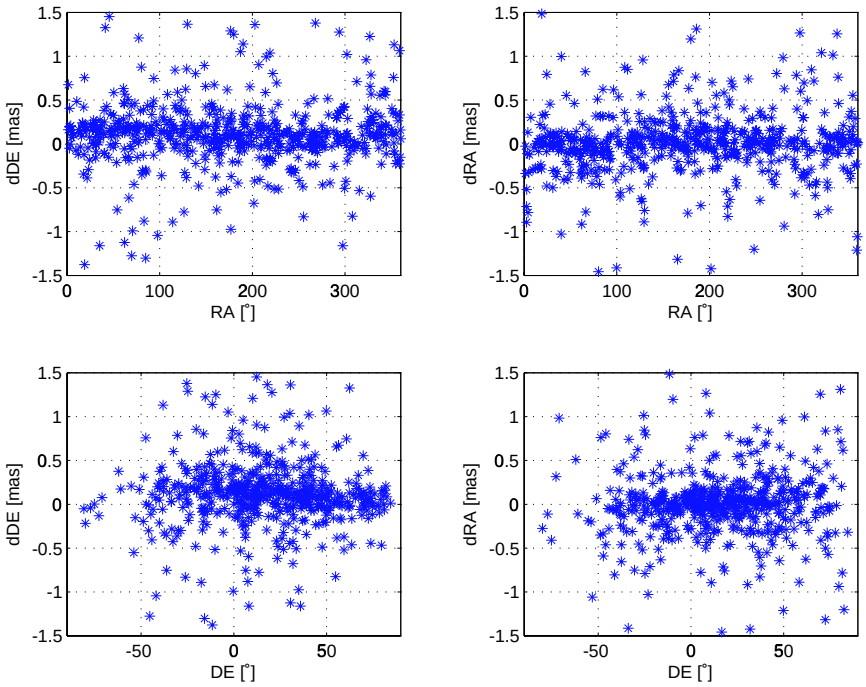

Figure 2: Estimates dDE and dRA of the source positions w.r.t. ICRF-Ext1, plotted vs. the a priori values of right ascension (RA) and declination (DE). No significant biases were found except small systematics for dDE vs. DE.

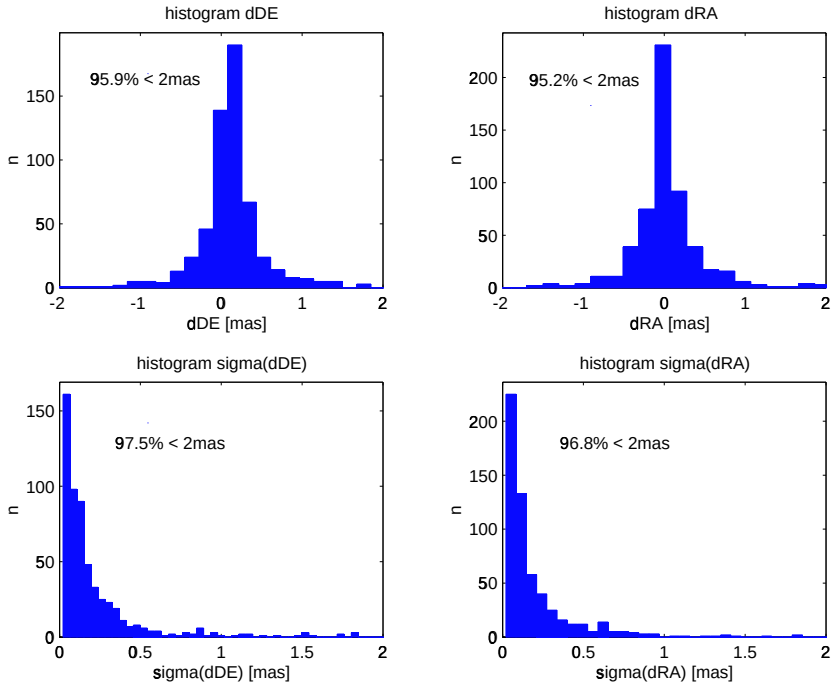

Figure 3: Histograms of the estimates dDE and dRA and the corresponding formal errors for all 589 sources. More than 95% of the estimates are smaller than 2 mas.

3. Influence of Fixing the CRF to ICRF-Ext1 on an Estimated TRF

As shown in figure 4, the estimated station positions of a TRF depend on the handling of the source coordinates in the solution: Two solutions were computed, one estimating the source positions simultaneously (solution setup 1) and another fixing the CRF on the values given in ICRF-Ext1 (solution setup 2). This change affects the coordinates of the telescopes very slightly (almost always < 2 mm) but apparently in a systematic way. One reason for such a bias might be that no horizontal atmospheric gradients were estimated for the determination of the ICRF (e.g., as seen by [4]). Furthermore, the inhomogeneous distribution of the stations and/or the sources could have a significant influence. But, as the estimated source positions are not correlated (< 0.2) with the station positions, this remains unexplained so far and needs to be further investigated.

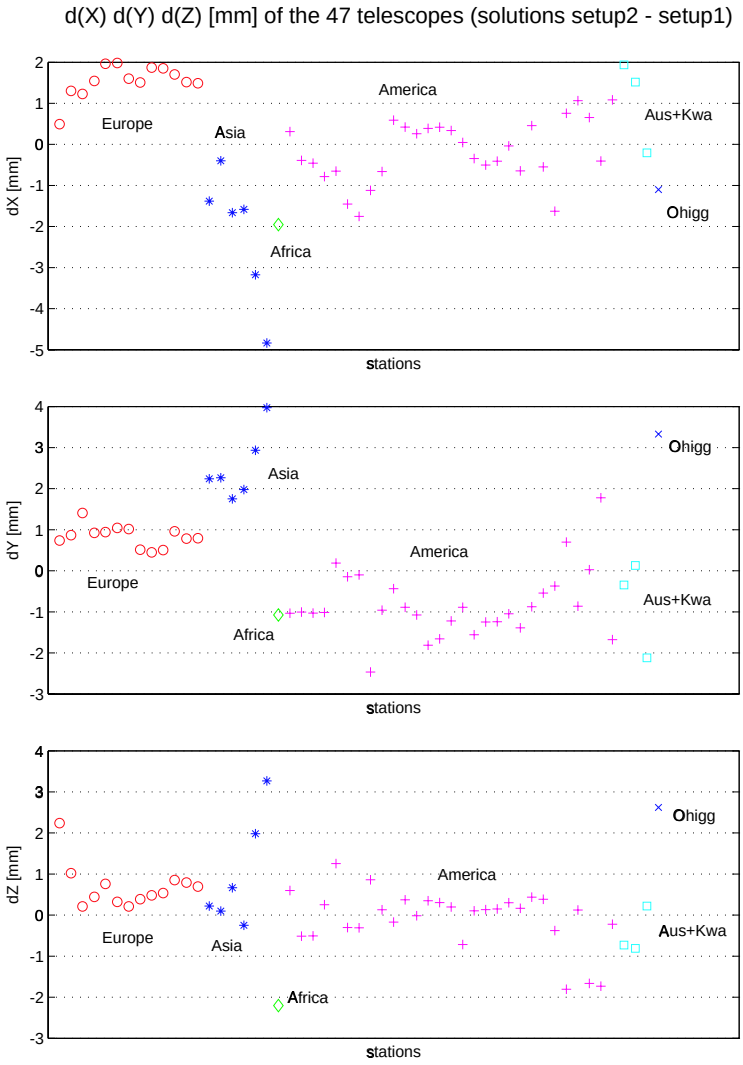

Figure 4: Differences between the cartesian components dX, dY and dZ, of the station positions, estimated with two different solution setups:

- setup 1 TRF and CRF estimated,
- setup 2 TRF estimated with CRF fixed to ICRF-Ext1.

4. Conclusions

At DGFI, a VLBI solution with a TRF, the EOP and a CRF being estimated simultaneously can very well be established applying a non-biasing NNR and NNT datum for the TRF and NNR for the CRF. In these first results, small effects in the TRF estimates due to fixing the ICRF-Ext1, as well as a small but maybe systematic deviation of the declination source coordinate estimates (dDE) is found, depending on the declination (DE) itself. This will be studied in more detail.

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