THE CONSISTENCY OF THE CURRENT CONVENTIONAL CELESTIAL AND TERRESTRIAL REFERENCE FRAMES AND THE CONVENTIONAL EOP SERIES

R. HEINKELMANN[1], S. BELDA-PALAZÓN[2,1], J.M. FERRÁNDIZ[2], H. SCHUH[1,3]
[1] Helmholtz Centre Potsdam, GFZ German Research Center for Geosciences
Telegrafenberg, 14473 Potsdam, Germany
e-mail: heinkelmann@gfz-potsdam.de
[2] University of Alicante, Departamento de Matematica Aplicada
Road San Vicente del Raspeig, 03690 San Vicente del Raspeig - Alicante, Spain
[3] Institute of Geodesy and Geoinformation Science, Technische Universität Berlin
Straße des 17. Juni 135, 10623 Berlin, Germany

ABSTRACT. For applications in Earth sciences, navigation, and astronomy the celestial (ICRF) and terrestrial (ITRF) reference frames as well as the orientation among them, the Earth orientation parameters (EOP), have to be consistent at the level of 1 mm and 0.1 mm/yr (GGOS recommendations). We assess the effect of unmodeled geophysical signals in the regularized coordinates and the sensitivity with respect to different a priori EOP and celestial reference frames. The EOP are determined using the same VLBI data but with station coordinates fixed on different TRFs. The conclusion is that within the time span of data incorporated into ITRF2008 (Altamimi, et al., 2011) the ITRF2008 and the IERS 08 C04 are consistent. This consistency involves that non-linear station motion such as unmodelled geophysical signals partly affect the IERS 08 C04 EOP. There are small but not negligible inconsistencies between the conventional celestial reference frame, ICRF2 (Fey, et al., 2009), the ITRF2008 and the conventional EOP that are quantified by comparing VTRF2008 (Böckmann, et al., 2010) and ITRF2008.

1. CONSIDERATION OF UNMODELLED GEOPHYSICAL SIGNALS

The regularized coordinate model of ITRF provides for each station a position at the catalogue epoch (for ITRF2008 it is 2005.0) and a linear velocity. As specified by IERS Conventions, most of the known significant station displacements are considered for the reduction of the observations of the space geodetic techniques, but not all. The atmospheric pressure loading is for example disregarded. For our investigations, we have to fix station coordinates on their catalogue values in order to assess the level of inconsistency of the catalogue. The fixation of station coordinates on catalogue values causes shifts and drifts of EOP of which y_{pol} is most significant: shift $\approx 30\mu$as, drift $\approx 3\mu$as/yr . The root mean square (rms) of the pole coordinates and dUT1 (ERP) increases significantly when station coordinates are estimated. The IERS 08 C04 EOP are adjusted together with ITRF2008 station coordinates and are thus consistent with the linear station velocity model. Consequently, if station coordinates are adjusted, the EOP differ from IERS 08 C04 causing larger rms.

2. SENSITIVITY TO A PRIORI EOP AND RADIO SOURCE COORDINATES

Here we assess how much the estimated EOP depend on the a priori information about the EOP and the radio source coordinates. Therefore we test radio source coordinates from ICRF-Ext.2 (Fey, et al., 2004) as an alternative to ICRF2. As an alternative to IERS 08 C04 we introduce EOP from USNO finals or celestial pole offsets from IAU2006/2000A models. Taking coordinates from the various radio source catalogues causes insignificant weighted mean differences of the EOP up to about 14 μas. The rms of EOP w.r.t. ICRF-Ext.2 is generally larger than w.r.t. ICRF2. Significantly different celestial pole offsets can be found, if the a priori values are taken from IAU models that do not contain the free core nutation (FCN) component. If including a FCN model the weighted mean difference drops to 10 μas.

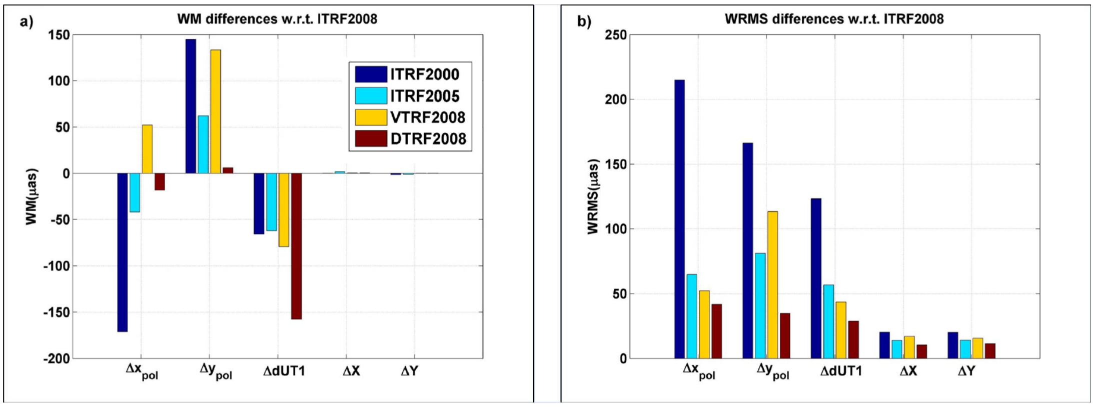

Figure 1: EOP differences caused by the TRF.

3. EOP DIFFERENCES USING DIFFERENT TRF

The predecessors of ITRF2008, ITRF2000 (Altamimi, et al., 2002) and ITRF2005 (Altamimi, et al., 2007) have been used to conserve the orientation of ITRF using no net rotation conditions (NNR): ITRF2005 was NNR constrained to ITRF2000, and ITRF2008 to ITRF2005. If the NNR would work perfectly, we could expect almost no change of the orientation of those frames and consequently no change of the attached EOP even if just the VLBI subset of stations was used. The weighted mean differences of ERP are at the level of about 50 μas and weighted rms are about 60-80 μas comparing ITRF2008 with ITRF2005 (Fig. 1).

The VLBI contribution to ITRF2008, VTRF2008, has been used as the terrestrial reference frame for the creation of the conventional celestial reference frame, ICRF2. During creation of the ITRF2008 and the conventional EOP, the IERS 08 C04, no explicit care has been taken for consistency with ICRF2. It is thus possible to assess the consistency of ICRF2, IERS 08 C04, and ITRF2008 by comparing VTRF2008 and ITRF2008. Fixing coordinates on the VLBI-only frame results in large shifts and drifts of the ERP, in particular of $y_{pol} \approx -38.8\mu$as and $\dot{y}_{pol} \approx -18.6\mu$as/yr.

DTRF2008 (Seitz, et al., 2012) is based on the same input data as ITRF2008 but presents an alternative combination approach. Thus, we would expect very small differences to ITRF2008. Comparing the EOP, however, we find a large shift of $dUT1 \approx -170\mu$as.

Acknowledgements. We thank the Spanish MINECO by partially supporting SB and JMF through grant AYA2010-22039-C02-01. S. Belda-Palazón has been visiting GFZ during creation of the paper.

4. REFERENCES

Altamimi, Z., Sillard, P., Boucher, C., 2002, “ITRF2000: A new release of the International Terrestrial Reference Frame for earth science applications”, J. Geophys. Res., 107(B10), 2214, doi: 10.1029/2001JB000561.

Altamimi, Z., Collilieux, X., Legrand, J., Garayt, B., Boucher, C., 2007, “ITRF2005: A new release of the International Terrestrial Reference Frame based on time series of station positions and Earth Orientation Parameters”, J. Geophys. Res., 112(B9), 401, doi: 10.1029/2007JB004949.

Altamimi, Z., Collilieux, X., Métivier, L., 2011, “ITRF2008: an improved solution of the international terrestrial reference frame”, J. Geod., 85, pp. 457–473.

Böckmann, S., Artz, T., Nothnagel, A., 2010, “VLBI terrestrial reference frame contributions to ITRF2008”, J. Geod., 84, pp. 201–219.

Fey, A.L., Ma, C., Arias, E.F., Charlot, P., Feissel-Vernier, M., Gontier, A.-M., Jacobs, C.S., Li, J., MacMillan, D.S., 2004, “The second extension of the International Celestial Reference Frame”, AJ, 127, pp. 3587–3608.

Fey, A.L., Gordon, D., Jacobs, C.S. (eds.), 2009, “The second realization of the International Celestial Reference Frame by Very Long Baseline Interferometry”, IERS Technical Note 35, Verlag des Bundesamts für Kartographie und Geodäsie, Frankfurt am Main.

Seitz, M., Angermann, D., Bloßfeld, M., Drewes, H., Gerstl, M., 2012, “The 2008 DGFI realization of the ITRS: DTRF2008”, J. Geod., 86, pp. 1097–1123.