THE RECENT IMPROVEMENT IN NON-RIGOROUS COMBINATION METHOD OF SPACE GEODETIC TECHNIQUES

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ABSTRACT. Nowadays the orientation of the Earth's body in the space is observed mainly by space geodesy techniques. Each technique has analytical centers that produce highly accurate products, primarily, Earth Orientation parameters (EOP) and station coordinates. This article describes recent progress in the method based on idea (Pešek and Kostelecký, 2006) combining station position vectors in the celestial reference frame in order to obtain representative set of EOP and station coordinates. The new improvement of the method consisted in changing the form of basic observation equation in order to be able to compute station coordinate corrections directly. Final results were compared with the solution of the terrestrial reference frame $ITRF2005$.

1. OUTLINE OF THE COMBINATION METHOD

The transformation from $ITRS$ to $GCRS$, i.e. $x_T \longrightarrow x_C$, in the concept of non-rotating origins, reads (Capitaine at al., 2003):

$$x_C = Q(t)R_3(ERA)R_3(-s)R_1(y_p)R_2(x_p)x_T. \tag{1}$$

Then the partial derivatives of (1) with respect to any unknown, U, yield the observation equations of the form:

$$\sum_j^6 \frac{\delta x_C}{\delta U_j} dU_j = x_{C|obs} - x_{C|0} + v, \tag{2}$$

where the "observed" vectors $x_{C|obs}$ are calculated from the respective input data and $x_{C|0}$ are functions of adopted a priori values of the unknowns (x_T, x_P, y_P and ERA) and v is residual. By contrast to the previous version of this method (Štefka et al., 2010) the station position vectors are solved directly instead of obtaining them through computing seven parameters of the seven-parametric transformation for particular technique.

The EOP are calculated for each individual epoch independently of the others. As a consequence, errors in the input data, including station coordinates, are transferred to the EOP and increase their scatter substantially. The effect can be reduced by including constrains, in the form of additional observation equations, which are based on smoothing method (Vondrák, 1977), and have a form of the third derivative of third-order Lagrange polynomial. The constraints were weighted to retain in the solution as much as 99% of the signal with period greater than 5 days.

To remove singularity of the system (2), three types of additional equations have to be introduced: translation, rotation and scale, all are related to Tisserand condition (Dermanis, 2010) and stabilize calculation of the station coordinates.

1. RESULTS AND CONCLUSIONS

The latter method was applied on the the data covering the period $51549 - 54351$ MJD, which were taken from the $IERS$ Combination Pilot Project database and $ILRS$ analysis center for GPS, $VLBI$ and SLR, respectively.

The results (EOP and station coordinates) were compared with ITRF2005 (Altamimi et. al., 2007): the mean value of station differences is at the level of 1 cm and the rms of differences between computed EOP and ITRF2005 are 0.142 mas, 0.131 mas and 0.117 ms for x_P, y_P and $(UT1 - UTC)$, respectively.

The described improvement in computing station coordinate residuals directly brought substantive benefit to this method so that the solution of station coordinates is closer to the official solution ITRF2005 and might be considered as more real.

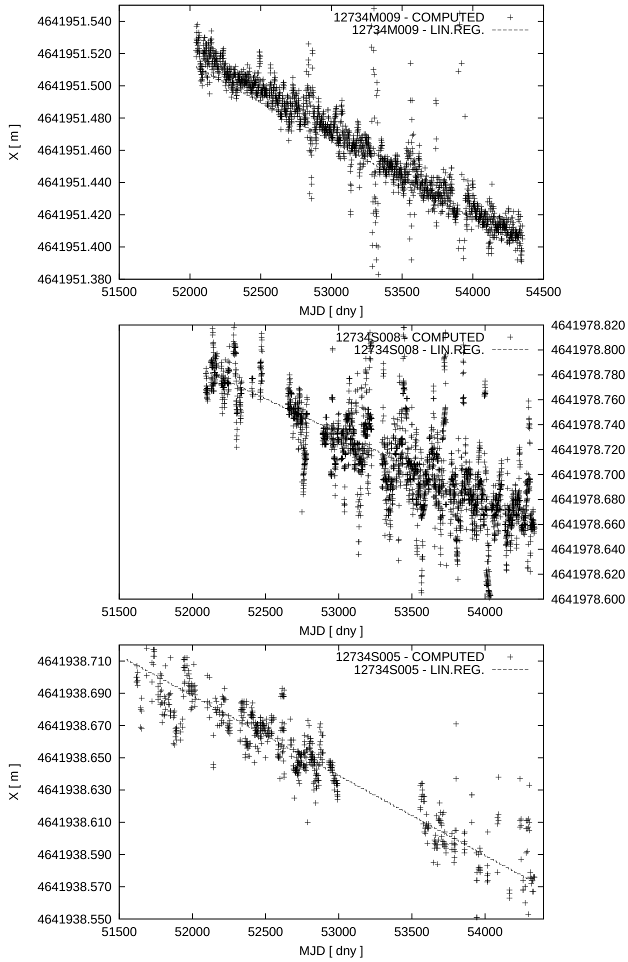

Figure 1: The picture shows corrected station coordinates X as solution of the combination method and lines represent measured data at collocation station 12734, where three geodesy techniques (GPS - top, SLR - center, VLBI - bottom) are present.

3. REFERENCES

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