Analysis of the EOPs from Independent Parallel VLBI Sessions

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Abstract. Time series of Earth Orientation Parameters (EOP) have been obtained from independent parallel VLBI networks NEOS-A and CORE-A using OCCAM 5.0 software.

This paper presents the results and their detailed consideration. The EOP time series are approximated by linear functions so offset and rate of the differences NEOS – CORE canbe estimated. It appears that biases between two EOP systems are negligibly small in 1996-1997 years but are increasing in time.

Keywords. Radiointerferometry, Earth Orientation Parameters (EOP)

1 Introduction

VLBI observations provide high-accurate EOPs (both pole components as well as UT1-UTC) for world scientific community. For example, site positions adjusted from space geodetic global or regional networks relate to direction and spin of the Earth axes. Therefore for IERS it is important to distribute as accurate EOP values as possible.

Observations of distant radiosources are performed on independent VLBI networks constructed by different sets of single telescopes. Due to historic reasons the antennas have been involved into international projects in different times. As a result full amount of observations and, consequently, accuracy of position and velocity estimates for each individual radiotelescope are different. Inevitably, resulting accuracy of EOPs provided by different VLBI networks is supposed to be suffer from pure geometry of whole network as well as from hidden errors in coordinates of individual radiotelescopes included into the network. The purpose of the paper is to consider daily EOP estimates from two parallel independent VLBI networks (NEOS-A and CORE-A) to draw a conclusion about agreement of two independent systems of EOP.

Some authors showed that the daily EOP values are not in a good agreement (McMillan and Ma, 2000; Sokolskaya and Skurihina, 2000; Titov, 2001). It appeared that any inadequacies in reduction models are able to cause systematic biases in the daily EOPs. Therefore, the VLBI observations from NEOS-A and CORE-A sessions must be reprocessed in accordance to newest IERS recommendations as well as the most accurate catalogue of radiosources approved by IAU.

OCCAM package has been updated to be compatible to IERS Conventions 2000. New version OCCAM 5.0 proclaimed this year contains additional options that allow more advanced analysis of VLBI observations. The most accurate reduction models have been included into the OCCAM 5.0 version.

Eighty twenty-four hour parallel VLBI sessions have been operated on independent networks (NEOS-A and CORE-A) since January 1997 till April 2000. NEOS-A network includes Wettzell, NRAO20, Kokee, Fortaleza, Ny-Alesund and, before 1998, Algopark. CORE-A network includes Westford, Gilmore Creek, Hartrao, Hobart, Matera, Medicina, and, since 1998, Algopark. Distribution of the VLBI stations for both networks is satisfactory for estimation of EOPs. Unfortunately, composition of the both networks changed from session to session providing additional problems for analysis of daily EOP time series. After preliminary consideration it was decided to include all sessions into the research rather than keeping only the sessions with fixed set of stations. Therefore, all eighty parallel sessions have been processed using OCCAM 5.0 software. The adjustment procedure corresponds to approach for operational IVS service for daily EOP estimation. ICRF 2000 and ITRF 2000 fix celestial a terrestrial reference frames, correspondigly, and only five EOP are estimated routinely. All reduction calculations correspond to

IERS Conventions 2000, only re-instating for permanent tide has not been applied. Kalman filter technique considers clock offset and troposphere delays as stochastic 'random walk' parameters. Troposphere gradients and clock rates are considered as constant parameters usually, exception some sessions when clock rate for any separate station had to be considered as a 'random walk' process due to unstable behaviour of hydrogen maser. Daily values of X-, Y-Pole components as well as UT1–UTC have been estimated following the procedure. We calculated differences NEOS – CORE for more advanced analysis. Statistical analysis of the difference offsets and rates is discussed next section.

2 Solution description

Daily differences have been fitted by linear function using conventional weighted least-squares method. Biases offsets and rates are presented at the Tables 1-2 and Fig. 1-9. If we discuss only offset figures it will be appeared that only X-pole component estimates are in a good agreement. Biases NEOS – CORE for Y-pole component and for UT1–UTC exceeds 3-σ level are pointing out that EOP systems are network-dependent.

Additionally, the same procedure has been made without estimation of troposphere gradients to control a reliability of the results. Biases offsets and rates are presented at the Tables 3-4. We can see that only Y-pole component time series demonstrate satisfied agreement for the variant of solution. It is obvious that adding of troposphere gradients in the list of estimable parameters changes the difference offsets and rates remarkably. Comparison of the Tables 1 and 3 shows that after implementation of troposphere gradients X-pole component offset increased on 72 μas for NEOS-A network and decreased on 27 μas for CORE-A one, Y-pole component offset increased on 26 μas for NEOS-A network and decreased on 98 μas for CORE-A. UT1–UTC offset decreased on 28 μas for NEOS-A network and increased on 98 μas for CORE-A one. Therefore, the resulting X-pole offset in Table 1 looks negligibly small, in contrast to Y-pole component, which is getting significant.

Table 1. Estimates of mean values (μas) of EOPs time series for middle epoch JD = 24450925. Gradients were estimated

Comp.	NEOS	CORE	NEOS – CORE
X	-71 +/- 20	-98 +/- 24	27 +/- 22
Y	268 +/- 17	188 +/- 19	80 +/- 18
UT1-UTC	115 +/- 12	14 +/- 16	101 +/- 14

Table 2. EOP rates estimates (μas/y). Gradients were estimated

Comp.	NEOS	CORE	NEOS – CORE
X	-20 +/- 23	-19 +/- 24	-1 +/- 23
Y	81 +/- 19	59 +/- 20	22 +/- 21
UT1-UTC	16 +/- 11	-16 +/- 16	32 +/- 14

Table 3. Estimates of mean values (μas) of EOPs time series for middle epoch JD = 24450925. No gradients estimated

Comp.	NEOS	CORE	NEOS – CORE
X	-143 +/-21	-71 +/- 20	-72 +/- 21
Y	252 +/- 17	277 +/- 23	-25 +/- 20
UT1-UTC	143 +/- 14	-1 +/- 17	144 +/- 16

Table 4. EOP rates estimates (μas/y). No gradients estimated

Comp.	NEOS	CORE	NEOS – CORE
X	-53 +/- 24	-56 +/- 20	3 +/- 22
Y	39 +/- 17	38 +/- 25	1 +/- 21
UT1-UTC	37 +/- 16	-22 +/- 16	59 +/- 16

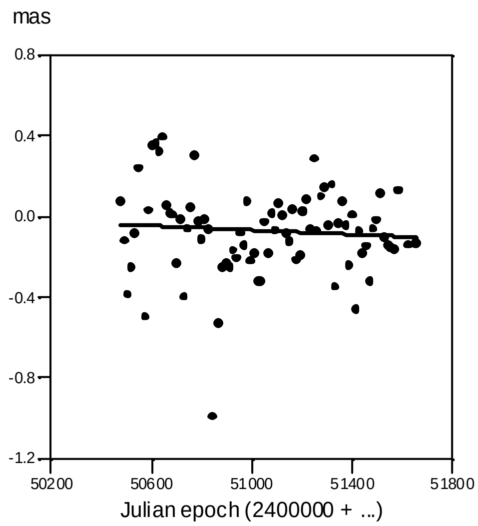

Fig. 1 Variations of X-pole estimates from NEOS.

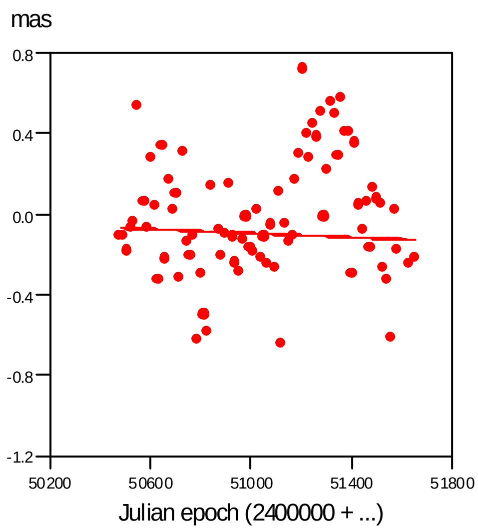

Fig.2 Variations of X-pole coordinates from CORE

However, it is obvious that the significant bias offsets refer to middle epoch JD=24450295.0 are changing in time. Linear extrapolation of the parameters leads us to the fact that both plots (Y-pole and UT1–UTC) are crossing at the resent past, namely, in 1996-1997 years.

Linear increasing of offset from initial epoch near 1997 suggests an idea that the ITRF2000, even perfect on its initial epoch (1997), will becoming worse after due to small errors in velocities of individual site, especially, having short observational history. Indeed, rate difference 32 µas/y for UT1–UTC (Table 1) after 3 years will reach a bias 100 µas which corresponds 3 mm on the Earth surface. It means that disagreement in 1mm/year for ITRF velocity field is able to produce the observed biases in EOPs from independent networks.

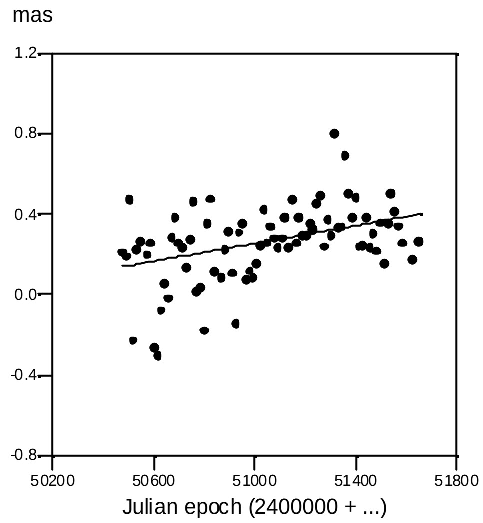

Fig. 3 Variations of Y-pole estimates from NEOS

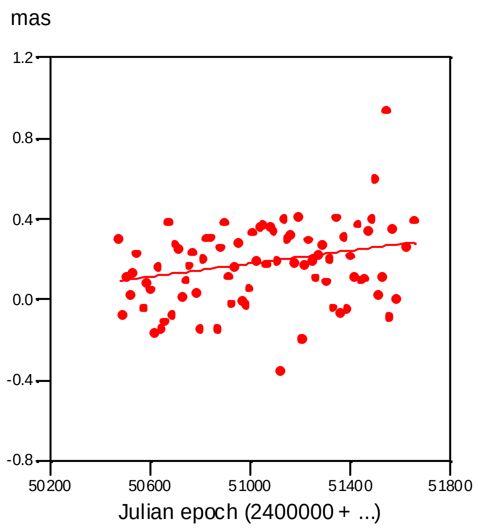

Fig.4 Variations of X-pole coordinates from CORE

3 Conclusion

Analysis of detected biases in EOP differences NEOS – CORE shows that the differences for X-pole, Y-pole components and UT1–UTC were negligibly small in 1996 - 1997 years but later the

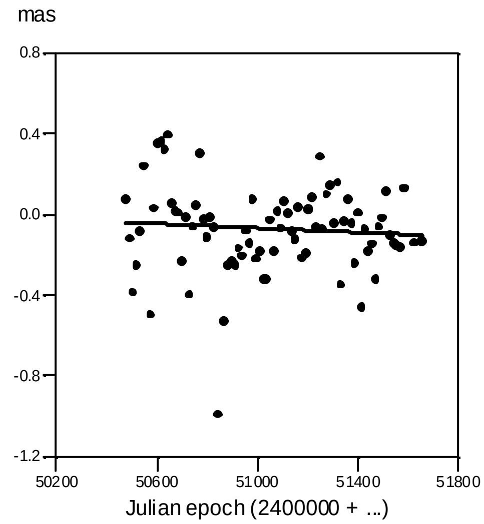

Fig. 5 Variations of UT1–UTC estimates from NEOS.

Y-pole and UT1–UTC differences became significant due to effect of any natural process. The linear increasing can be explained by inaccuracy of accepted velocities of VLBI stations. The velocity inaccuracy might be reasonably small (1mm/year); nonetheless, the cumulative errors after 10 years will reach centimeter-level. As a result, the terrestrial reference frame, perfect at the initial epoch, will lose its self-consistency.

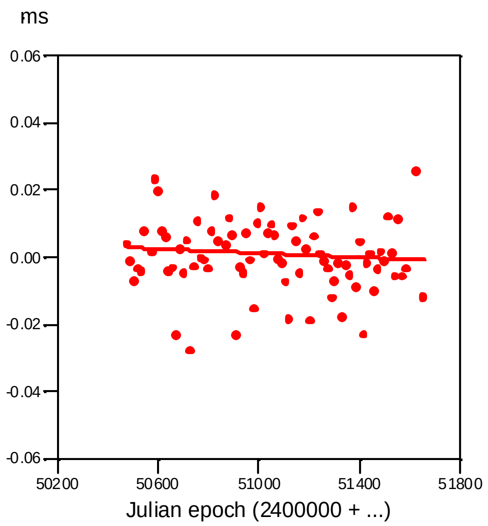

Fig. 6 Variations of UT1–UTC estimates from CORE.

Meanwhile, the conclusion has been drew using too limited amount of observational data – only eighty parallel sessions from two networks – on 3-year time gap. One has to do more detailed research to check the suggestion carefully. Additional networks that were active during long-time period should be considered for the purpose.

Acknowledgments

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