GLONASS ORBIT/CLOCK COMBINATION IN VNIIFTRI

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ABSTRACT. An algorithm and a program for GLONASS satellites orbit/clock combination based on daily precise orbits submitted by several Analytic Centers were developed. Some theoretical estimates for combine orbit positions RMS were derived. It was shown that under condition that RMS of satellite orbits provided by the Analytic Centers during a long time interval are commensurable the RMS of combine orbit positions is no greater than RMS of other satellite positions estimated by any of the Analytic Centers.

1. INTRODUCTION

An idea of the weighted average orbit/clock combination for GPS and GLONASS satellite constellations by mathematical processing of calculation results obtained by individual Analytic Centers goes back to Beutler et al. (1995) and Kouba et al. (1995). Since 1993 and to the present IGS issues Sp3-files with official values of coordinates and clock corrections of GPS satellites. Since 2004 up to now the combined orbits and clock corrections of GLONASS satellites are formed under the auspices of IGS by the Data-processing center of National administration of oceanic and atmospheric researches and National geodetic service of the USA (NOAA/NGS).
The purpose of this paper is to demonstrate our own activity in VNIIFTRI in orbit/clock combining and some theoretical results in this scope as well.

2. RESULTS

By now an algorithm and software were developed in VNIIFTRI for production of the combined orbits and clock corrections for GLONASS satellites. Main functions of the software are as follows:
∘ production of combined GLONASS orbits and clock corrections on base of data sets provided by individual Centers;
∘ outliers detection in satellite orbit/clock data sets as they determined by each Center and elimination if needed appropriate epochs for each satellite and for each Center from further combination process;
∘ the detection and elimination of "bad" satellites from combination process;
∘ application orbital dynamics with calculation of long arc (1, 3, 5, 7 days) orbits to obtain some statistical characteristics of combined orbits;
∘ producing report files of two types:
1) SP3-files with combined orbits and clock corrections for GLONASS satellites (daily);
2) Sum-files of reports for the 8th day period with transformation parameters, statistical, accuracy and orbital characteristics for each satellites and each Center (weekly).

Comparison results of GLONASS orbits defined by the Centers with the IGL combined orbits for the period from 2011.01.29 to 2011.02.05 are presented in Fig. 1.

Let us denote:
N_{Cent} – number of Centers, N_{Sat} – number of satellites, N_{Epo} – number of epochs in a day,
$\boldsymbol{x}^j_{i,k,n}$ – position of j-th satellite as it was estimated by i-th Center in k-th day at n-th epoch.
$\Delta\boldsymbol{x}^j_{i,k,n}$ – residual vector: $\Delta\boldsymbol{x}^j_{i,k,n} = \boldsymbol{x}^j_{exect,k,n} - \boldsymbol{x}^j_{i,k,n}$, where $\boldsymbol{x}^j_{exect,k,n}$ is the exact solution (unknown).
Then the main theoretical result of this paper is the following (Bezmenov and Pasynok, 2015):

THEOREM. *Let the following conditions be satisfied*

1. RMS calculated for the period in N days for each of the Centers, asymptotically (at N sufficiently large) are equal to each other.

2. In k-th day and n-th epoch the position vector for combined orbit of j-th satellite represents a weighted average (with weights $W_{i,k}$) of satellite's positions as determined by the Centers:

$\boldsymbol{x}^j_{Comb,k,n} = \sum_{i=1}^{N_{Cent}} W_{i,k} \cdot \boldsymbol{x}^j_{i,k,n}; n = 1, ..., N_{Epo}, j = 1, ..., N_{Sat},$

3. The weights $W_{i,k}$ are related for each k with residual mean squared

$RMS_{i,k} = \left(\frac{1}{3N_{Epo}N_{Sat}} \sum_{j=1}^{N_{Sat}} \sum_{n=1}^{N_{Epo}} \|\boldsymbol{x}^j_{i,k,n}\| \right)^{1/2}$ *by monotonously decreasing dependence.*

Then RMS for the combined orbit calculated for the period in N days is no greater then RMS for each of the Centers.

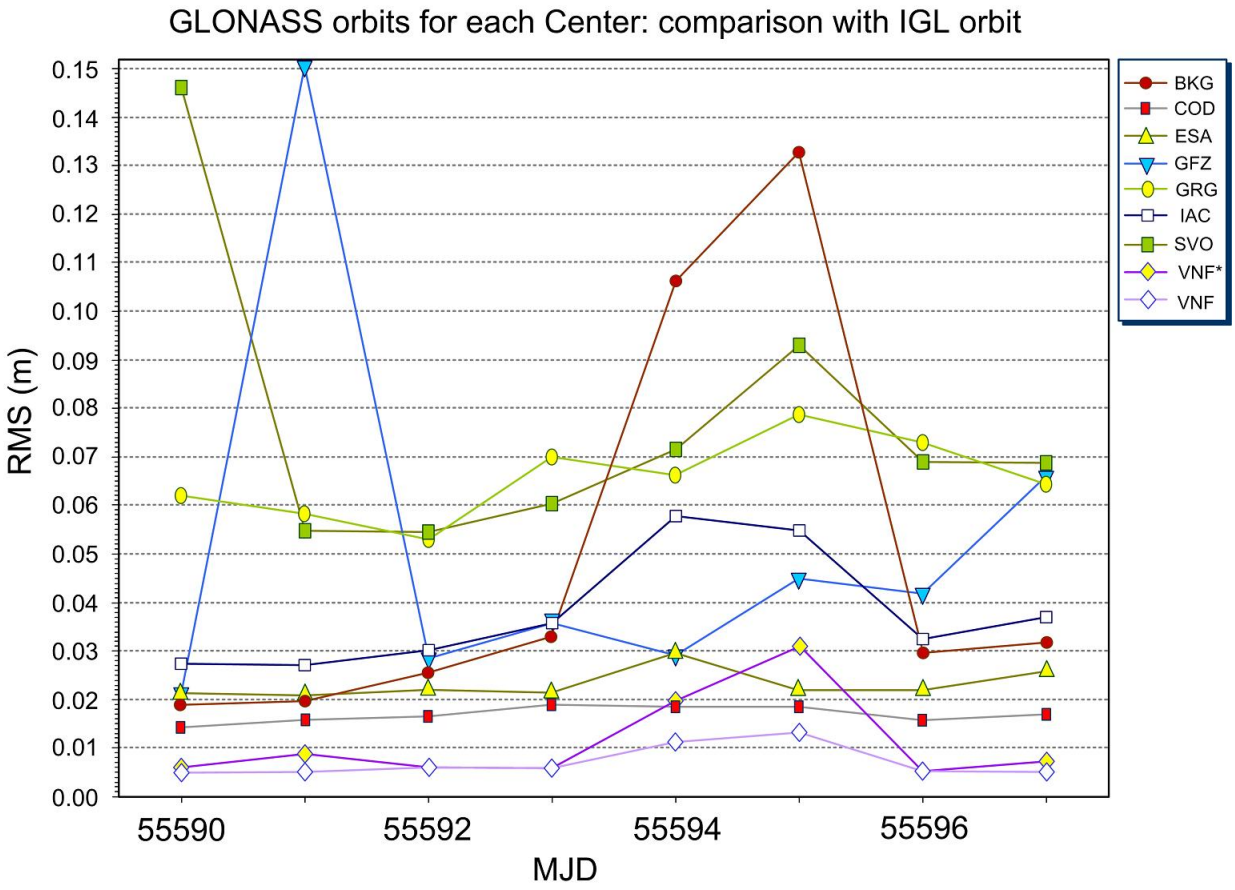

Figure 1: The abbreviation (excepting VNF, SVO) is commonly-accepted in IGS. VNF – final combined orbits of VNIIFTRI; VNF* – preliminary combined orbits of VNIIFTRI (before elimination of "bad" satellites); SVO – abbreviation of High-precision ephemeris and time correction estimation system (HETCES/SVOEVP), RF.

3. REFERENCES

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