DETERMINATION OF EARTH ROTATION PARAMETERS BY SLR AT MMC SSTF / FSUE VNIIFTRI

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ABSTRACT. At the end of 2014, the MMC SSTF completed the development of a program for determining the Earth Rotation Parameters (ERP) by SLR. Since 2017 a new software based upon neural network models permits to perform regular operational ERP determinations with an accuracy matching the modern requirements. The paper presents the results obtained for pole coordinates.

1. INTRODUCTION

The Federal State Unitary Enterprise (FSUE) "All-Russian Research Institute of physico-technical and radio-technical measurements" (VNIIFTRI) is one of the leading national institutes of metrology in Russia. One of the main divisions of the Institute is the Main Metrological Centre of State Service for Time, Frequency and Earth Rotation Parameters (ERP) evaluation (MMC SSTF). Now the East-Siberian Branch of VNIIFTRI in the city of Irkutsk operates 2 SLR stations, namely "Mendeleevo 1874" and "Irkutsk 1891", displayed in Figure 1, with the followings characteristics:
– Operating wavelength 0.532 micron;
– Frequency 300 Hz;
– Pulse duration of 250 ps;
– Pulse energy 2.5/2.7 mJ;
– Beam divergence 712 arcsec;
– The diameter of the receiving aperture and TV Guide 25 cm. SLR stations produced in Russia in 2011. VNIIFTRI use SLR stations together with:
– Time and frequency state standards in Mendeleevo UTC(SU);
– State standard of length in Mendeleevo;
– Secondary time and frequency standard in Irkutsk city.
Additional equipment:
– Mobile laboratory with mobile TWSTFT station and active H-maser;
– Fixed TWSTFT station in Mendeleevo;
– Standard of comparison: Leica TDA 5005.
The main purposes ofoperating laser ranging at VNIIFTRI are Time and frequency transfer and ERP determination.

2. DETERMINATION OF THE PARAMETERS OF THE EARTH'S ROTATION

The Main Metrological Centre of State Service for Time, Frequency and ERP evaluation was founded based on the Head office of the unified time service and has been actively esimated the ERP based on the combination of the entire measurement data since 1955.
The ERP activities at VNIIFTRI can be grouped in four basic topics:

Figure 1: Stations "Mendeleevo 1874" (left) and SLR station "Irkutsk 1891" (right)

– processing GNSS, SLR , LLR [1,2] and VLBI observation data for ERP evaluation;
– combination of ERP series for evaluation of reference ERP values (on the ERP level and observation level);
– combination of GLONASS/GPS satellites orbit/clock;
– providing GNSS and SLR observations at five metrological sites acting under the auspices of Federal Agency on Technical Regulating of Metrology (ROSSTANDART).

The regular computing of ERP from the Satellite Laser Ranging (SLR) measurements started in the MMC SSTF in 1995. In 2010 the processing of SLR measurements had to be suspended due to technical reasons. The processing of laser measurements in VNIIFTRI has been resumed in 2015.

At this time ILRS Network includes about 40 stations. Thirty of them, listed in Table 1, are dedicated to ERP estimation.

Table 1 List of ILRS station which measurements were used for ERP calculation

Monument	Location Name, Country	Monument	Location Name, Country
1873	Simeiz, Russia	7328	Koganei, Japan
1874	Mendeleevo, Russia	7405	Concepcion, Chile
1879	Altay, Russia	7406	San Juan, Argentina
1884	Riga, Latvia	7501	Hartebeesthoek, South Africa
1891	Irkutsk,Russia	7810	Zimmerwald, Switzerland
1893	Katzively, Ukraine	7821	Shanghai, China
7080	McDonald Observatory, Texas	7824	San Fernando, Spain
7090	Yarragadee, Australia	7825	Mt Stromlo, Australia
7105	Greenbelt, Maryland	7838	Simosato, Japan
7110	Monument Peak, California	7839	Graz, Austria
7119	Haleakala, Hawaii	7840	Herstmonceux, United Kingdom
7124	Tahiti, French Polynesia	7841	Potsdam, Germany
7237	Changchun, China	7845	Grasse, France
7249	Beijing, China	7941	Matera, Italy
7308	Koganei, Japan(CRL)	8834	Wettzell, Germany

3. RESULTS

The pole coordinates x_p and y_p are estimated from the combination of Lageos 1 and Lageos 2 SLR data over the year 2019. Their offsets with respect to the C04 series provided by the International Earth Rotation and Reference System Service (IERS) and presented in Figure 2 (x_p) and Figure 3 (y_p) show standard deviations at 0.08 mas level.

In 2017, the development of a new software module for determining ERP from SLR, LLR as well as GNSS measurements by using neural network models has been completed. This software module made it possible to increase the accuracy of ERP determination from SLR and GNSS data by 12-20%. Tests were carried out in the frame of the VNIIFTRI, IAA (Institute of Applied Astronomy) and IAC (Information and Analytical Center of the Russian Space Agency). In order to integrate the programme into the service activity the only thing left to do is to overcome a series of technical issues.

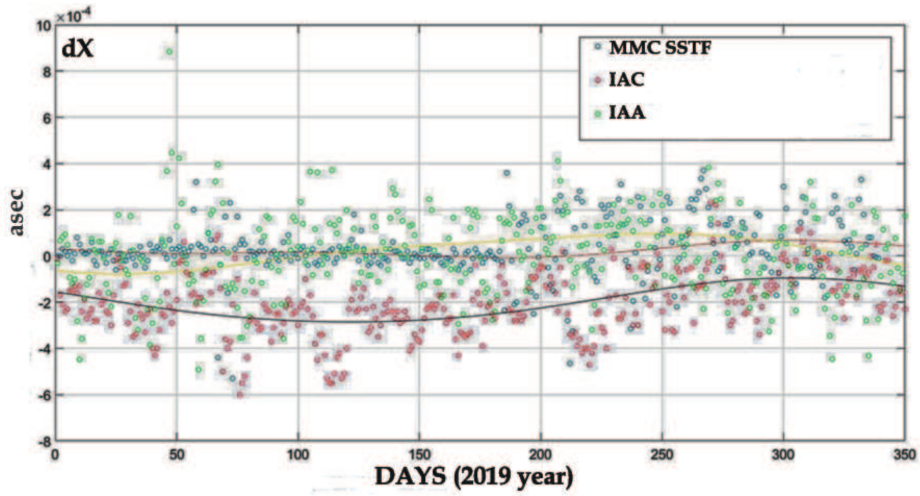

Figure 2: Offsets between calculated x_p pole coordinates and IERS C04 values.

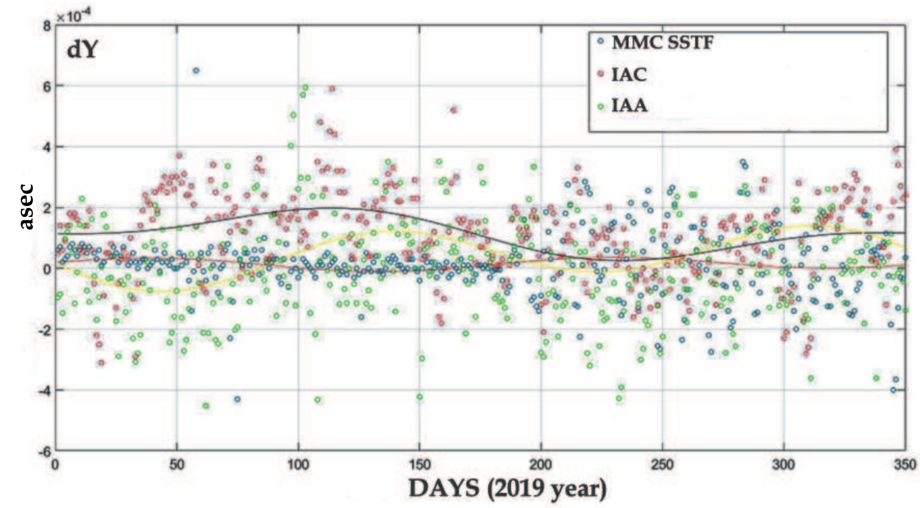

Figure 3: Offsets between calculated y_p pole coordinates and IERS C04 values.

4. CONCLUSIONS

A new programme for determining the Earth Rotation Parameters (ERP) from SLR, LLR and GNSS measurements has been developed. Neural network models can increase the accuracy of ERP by an average of 12-20%. Now, the pole coordinates obtained fromh SLR data have an accuracy approaching the one of the reference series of the IERS.

5. REFERENCES

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