RAPID EOP CALCULATION USING VIEVS SOFTWARE

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ABSTRACT. For many years the Main Metrological Center of Russian Time, Frequencies and Earth Rotation Service has carried out rapid EOP processing based on GNSS, VLBI, and SLR observations. In 2011 we began a new processing with the production of VLBI EOP series using VieVS (Vienna VLBI Software) developed at the Institute of Geodesy and Geophysics (IGG), Vienna University of Technology. According to requirements of rapid calculations (quick automatic processing without participation of operator), the special control program *eop_start.m* was written. No changes were made in VieVS blocks when developing the control program. Its task is receiving, processing and sending data without manual interaction. The structure and advantages of the control program, and results of EOP calculations are shown.

1. INTRODUCTION

State Time, Frequency and Earth Rotation Service (RTE) is a permanently functioning system. Many Russian facilities and organizations are incorporated and/or related to this common scientific, technical and metrological activity, which includes continuous reproduction, keeping and dissemination of the national time scale and also the determination of Earth's orientation parameters (EOP).

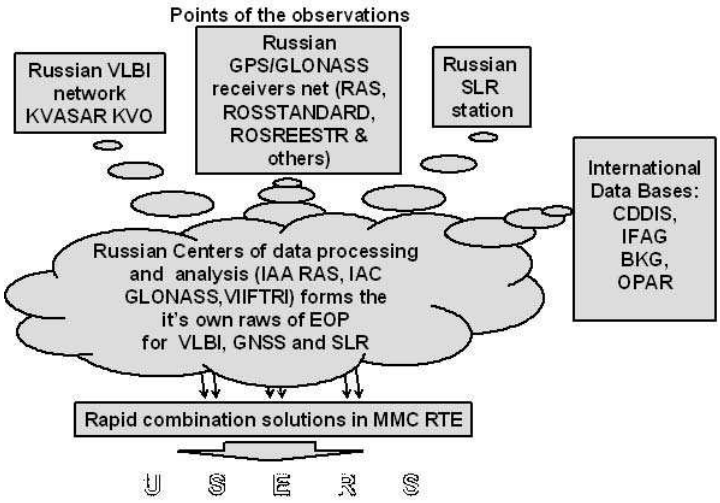

Figure 1: The information streams at RTE

The Main Metrological Center (MMC) of the Service is located at the National Research Institute for Physical and Radio-technical Measurements (VNIIFTRI). The information streams in RTE are represented in Figure 1. For many years, MMC has carried out operational EOP evaluation by combination and processing of the VLBI, GNSS and SLR observations (Kaufman M., Pasynok S., 2010). VLBI observations processing has been started at MMC in 2004 using the software package OCCAM5.0. The actual MMC processing program of EOP evaluations from VLBI observations is now obsolete and requires replacement with more modern and precise programs. There are some modern packages of VLBI

data processing: CALC/SOLVE, MODEST, OCCAM, GLORIA, SteelBreeze, GEOSAT, VieVS, c5 ++, ARIADNA, and others. After careful analysis we have chosen program VieVS developed at the Institute of the Geodesy and Geophysics (IGG) of the Vienna Technical University (Boehm J. et al.,2009). Why did we choose this program? Because it has the following attractive properties.
Firstly, VieVS - the multisystem program, can practically work in any operation system. Secondly, it was written in Matlab language. This program language makes it easy to describe the most complicated mathematical operations and allows to make changes into an initial code of the program if necessary. Besides MMC researchers have a long-term experience with Matlab programming. Thirdly, in the program the graphic representation of results is provided, which considerably facilitates the analysis of results in case of problems with VLBI session processing.

2. MOTIVATION

For operational EOP estimation it was necessary to automate the following operations: collecting new VLBI observations files, detecting VLBI session type and setting processing parameters, launching the VieVS program, analysis of intermediate results, detecting outliers and bad stations, and starting of repeated calculations if necessary, converting results into standard IVS format and saving on the ftp server.
As result, the special managing program *eop_start.m* has been developed at VNIIFTRI. This program executes the operations mentioned above. No changes were made in VieVS blocks when developing the managing program.

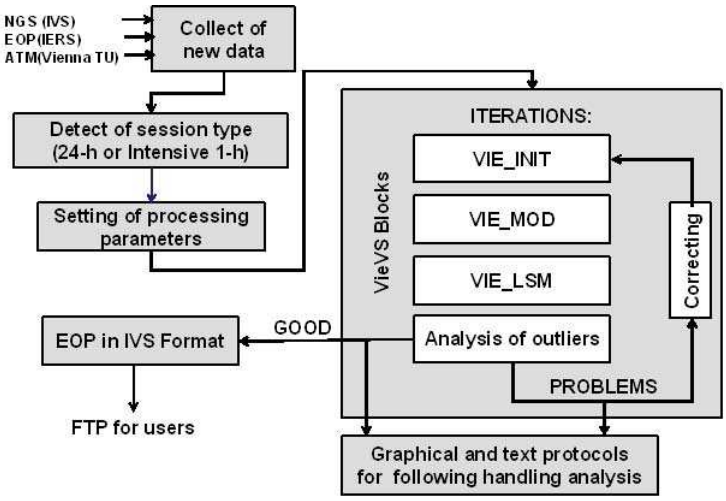

Figure 2: Algorithm of the managing program *eop_start.m*

3. ALGORITHM OF THE MANAGING PROGRAM

Schematically the algorithm of the managing program *eop_start.m* is represented in Figure 2. As a whole, it consists of consecutive operations listed in section 2. The explanations are following with some details.
For 1-hour sessions, UT1-UTC and zenith wet delay parameters are estimated. For daily 24-hour sessions all 5 EOP and also parameters of the troposphere are estimated. Outliers are identified if $O - C > 5\ \sigma_0$. However, we do not use the RMS as σ_0, but the inter quartile range (IQR). For the data containing the big outliers, IQR is more representative than RMS. Problematic stations are found with the following simple condition. The station is considered as problematic if less then 10 % from an average of all observations for given stations are remaining after rejection of outliers for the given station. The information about outliers and problematic stations is kept in OUTLIERS and OPT files of the program VieVS. Results of processing of each session are interpolated for a mean epoch of observations and the string of results in IVS EOP format is formed. This string contains modified Julian date (MJD), Earth's orientation parameters ($x, y, UT1, dX, dY$) and their uncertainties; weighed root-mean-square errors (WRMS) of divergences in

delays in picoseconds, correlation coefficients: $k(x,y); k(x,UT1); k(y,UT1); k(dX/dY)$, velocities of EOP changes and their uncertainty, and also other data (IVS-code of stations, etc.). Strings are inserted into result files in the chronological order. Later, the operator carries out analysis of results of automatic processing mode. He might process observations again in standard interactive mode if it is needed.

4. RESULTS

For experimental tests we carried out EOP evaluations for the time span from January 2010 to September 2011. The EOP discrepancies between evaluated values and EOPC04 series are represented in Figure 3. RMS are 19 and 11 microseconds for 1-hour and daily sessions, respectively. Using the VieVS program with our module for operative EOP evaluations from VLBI observations will start on January 2012.

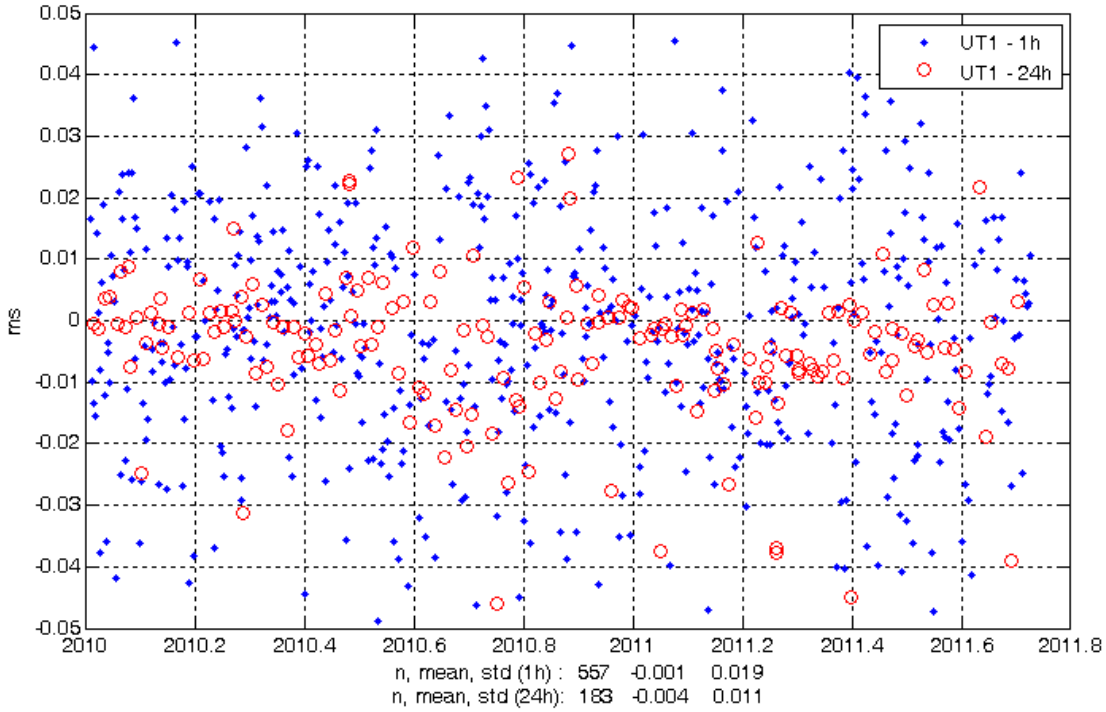

Figure 3: Results (the discrepancies between observables and EOP_C04) of UT1-UTC with VieVS and the managing program for automatic processing *eop_start.m*

5. REFERENCES

Kaufman, M., Pasynok, S., 2010, "Russian state time and Earth rotation service: observation, EOP series, prediction", Artificial Satellites, Vol. 45, No. 2, pp. 81-86.

Boehm, J.,Spicakova, H., Plank, L., Teke, K., Pany, A., Wresnik, J., Englich, S., Nilsson, T., Schuh, H., Hobiger, T., Ichikawa, R., Koyama, Y., Gotoh, T., Kubooka, T., Otsubo, T., "Plans for the Vienna VLBI Software VieVS $http : \backslash\backslash www.u-bordeaux1.fr/vlbi2009/proceedgs/36\_Boehm.pdf >$", Proceedings of the 19th European VLBI for Geodesy and Astrometry Working Meeting, 24-25 March 2009, Bordeaux, edited by G. Bourda, P. Charlot, and A. Collioud, 2009.