IVS Analysis Center at Main Astronomical Observatory of National Academy of Sciences of Ukraine

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Abstract

This report summarizes the activities of VLBI Analysis Center at Main Astronomical Observatory of National Academy of Sciences of Ukraine in 2002.

New version of the software *SteelBreeze* has been developed and the comparison of results obtained by using old and new versions was carried out.

The preliminary results of data processing of campaign CONT02 observations are presented. Sub-daily variations of wet zenith delays and Earth's rotation have been estimated in the solution.

1. General information

The VLBI Analysis Center was established in 1994 by Main Astronomical Observatory (MAO) of the National Academy of Sciences of Ukraine as a working group of the Department of Space Geodynamics of MAO. In 1998 it started its IVS membership as an IVS Analysis Center. The AC MAO is located in Central building of the observatory (shown on the left photo on the figure 1) at Golosiiv Wood in Kiev.

Central building of Main Astronomical Observatory at Golosiiv Wood (southern part of City of Kiev).

New computer of the MAO Analysis Center running the software *SteelBreeze* version 2.

Figure 1. Central building of Main Astronomical Observatory and the MAO VLBI Analysis Center's computer.

The primary goal of one activity of the Center was development of the VLBI data processing software for constructing Terrestrial and Celestial Reference Frames and determining Earth Orientation Parameters from the VLBI observations. Now, it is shifting to studying geodynamical and geophysical effects which are influencing the observables.

The development of new version of our VLBI data processing software *SteelBreeze* is approaching its final stage and we are going to resume the submission of TRF, CRF and EOP solutions to IVS on an annual basis.

2. Technical Description

The computer of the AC MAO was upgraded in mid 2002. Now it is a Pentium-4 1.9 GHz CPU box with 256M RAM and a 40 Gb HDD. It is running under Linux/GNU Operating System (OS) and is used for software development and for VLBI data processing. On the right image of figure 1 one can see the upgraded computer.

Main Astronomical Observatory has a 33.6 kbps link for Internet connection. Unfortunately, it is not sufficient for acting as a full analysis center for IVS (e.g., to make a weekly solutions of EOP).

The *SteelBreeze* software is written in the $C++$ programming language and uses Qt widget library for graphic user interface. It is developed under Linux OS and can be executed on different operating systems, such as Linux, FreeBSD, Solaris, etc. *SteelBreeze* makes Least Square estimation of different geodynamical parameters with the Square Root Information Filter (SRIF) algorithm. The SRIF uses Householder's transformation for matrix triangularization which makes it fast and insensitive to computer roundoff. The SRIF also makes it possible to introduce a stochastic model for parameter estimation.

The software analyzes VLBI data (time delay) of single and multiple sets of sessions. The time delay is modeled according to the IERS Conventions 1996 [3], plus additional models (tectonic plate motion, nutation model, wet and hydrostatic zenith delay, mapping function, etc). The software makes estimations of the following parameters: Earth orientation parameters, coordinates and velocities of a selected set of stations, coordinates of a selected set of radio sources, clock function and wet zenith delay.

3. Staff

The VLBI Analysis Center at Main Astronomical Observatory now consists of two members:

Prof. Yaroslav Yatskiv: Head of the Department of Space Geodynamics, performs general coordination and support of activity of the Center.

Ph.D. Sergei Bolotin: Junior research scientist of the Department of Space Geodynamics, responsible for the software development and data processing.

4. Current Status and Activities in 2002

This year activity was focused on software development. As of the end of 2002 *SteelBreeze ver. 2.0.3* became a fully operational system and is able to process a large set of sessions. Comparisons of calculated time delay between new and old versions of the software has been carried out and it was found that the value of the delay agrees at the picosecond level.

As an example of the VLBI data processing we would like to present preliminary results of analysis of the CONT02 campaign. Ten of 14 sessions which are already processed by correlators have been analyzed to estimate (1) the variations of wet zenith delay at each site of observation and (2) subdiurnal polar motion variations.

Altogether, 30374 time delays with quality code zero acquired by eight VLBI stations have been analyzed in both solutions. Because of gaps in observations (not all sessions were available for processing) stochastic parameters on different sessions were considered as independent and untied ones (i.e., it is possible to get breaks in continuity of parameter behavior at session boundaries).

To estimate the wet zenith delay variations the observations have been processed in the following way. Time delays were modeled according to IERS Conventions 1996 [3]. The hydrostatic zenith delay was calculated with the model of Saastamoinen [4, 1]. The wet zenith delay was not modeled and was estimated from the observations. Hydrostatic and wet mapping functions of Ifadis [2] have been used for calculating time delay due to troposphere along a signal path.

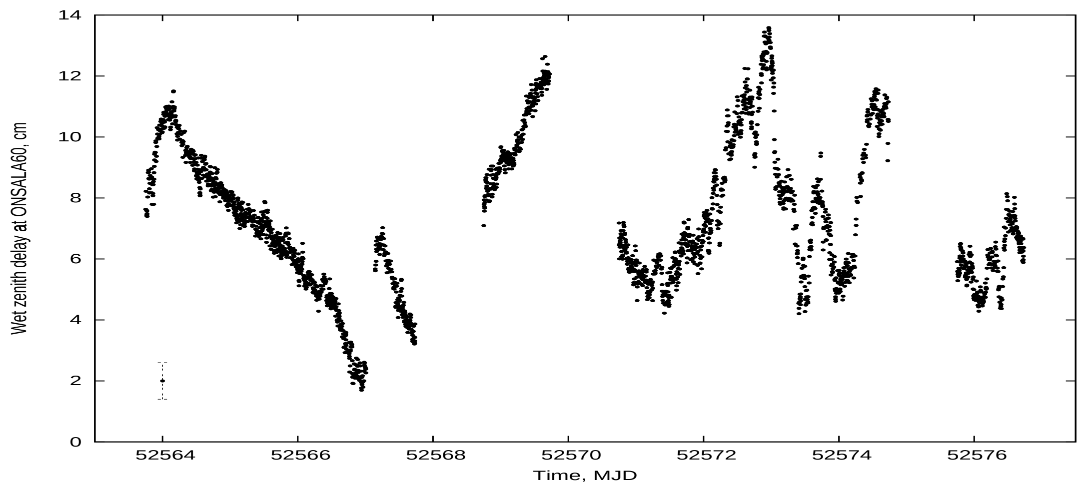

Figure 2. Estimation of wet zenith delay for the station ONSALA60 in the VLBI campaign CONT02, data acquired in interval from 16 October till 29 October 2002.

In the analysis, the coordinates of stations and radio sources have been estimated as global parameters, Earth orientation parameters have been estimated as local ones. The clock function and wet zenith delay at each station have been estimated as stochastic parameters with the random walk model. The value for power spectral density of ruled white noise $(0.18)^2$ ps^2/hr was used for modeling clock functions and the value of PSD $(1.0)^2$ cm^2/hr was used for troposphere.

The variations of estimated wet zenith delay for station ONSALA60 are shown in figure 2.

The estimations of the subdiurnal variations in polar motion and UT1 have been done in the same way, except that the wet zenith delay was modeled according to Saastamoinen [4], diurnal and semidiurnal tidal variations in Earth's rotation were not applied, the angles of nutation were estimated as local parameters and $d(UT1 - UTC)$, dX_p, and dY_p were treated as stochastic parameters (with $(0.012)^2$ ms^2/hr PSD for $UT1$ and $(0.16)^2$ mas^2/hr PSD for polar motion).

Estimated variations of Earth's rotation with respect to IERS(EOP) C 04 solution are shown in figure 3, the corresponding values of Ray's model [3] are presented on the plots for comparing reason. The estimations of polar motion are presented in the top plots of the figure, variations in $UT1$ are shown in the left bottom plot. These values have subdaily variations and biases, the $UT1$ variations after removing long periods trend are presented in the right bottom plot.

5. Plans for 2003

The development of *SteelBreeze* will be continued next year and new models and algorithms will be implemented. We are also planning to make a data analysis of VLBI observations and to send obtained solutions of TRS, CRS and EOP to IVS.

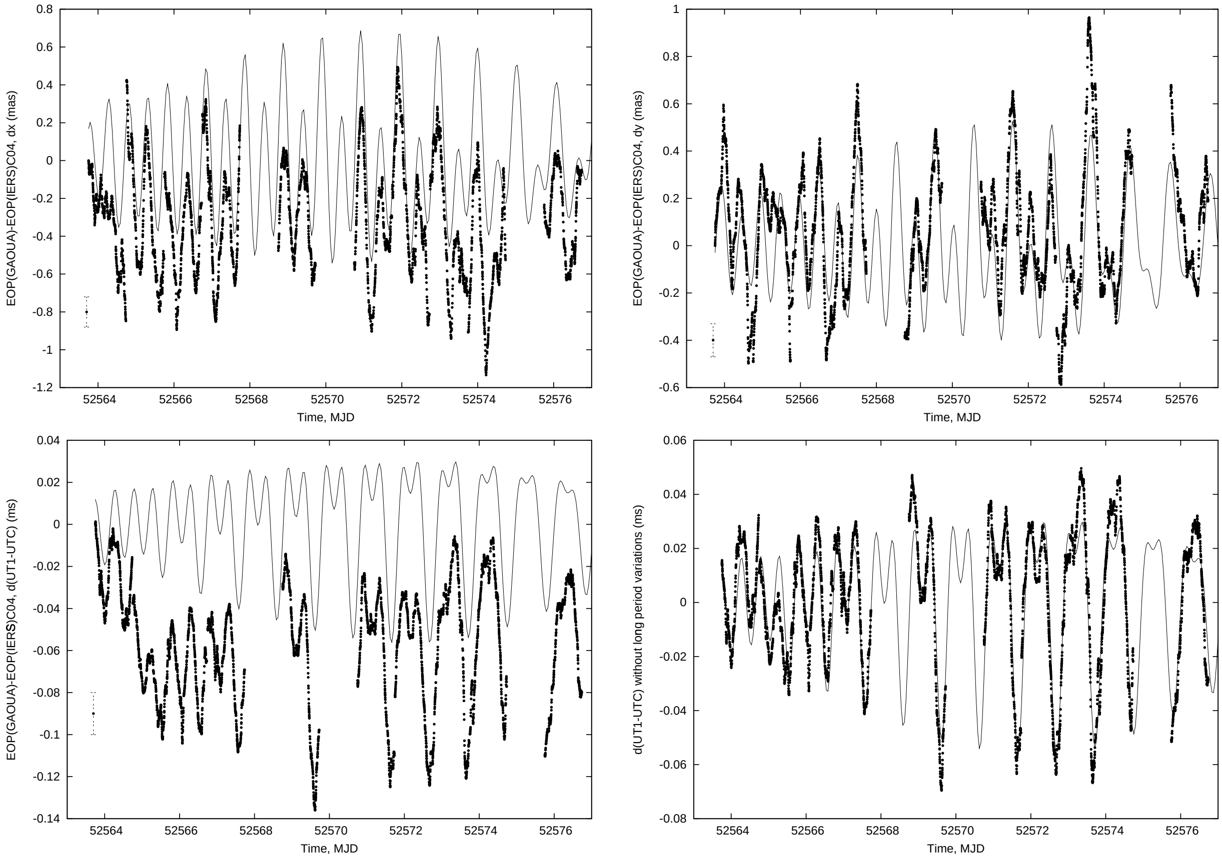

Figure 3. Subdiurnal tidal variations in Earth's rotation derived from analysis of VLBI campaign CONT-02 (points) and their theoretical values according to Ray, [3] (lines).

Acknowledgments

The work of our Analysis Center would be impossible without activities of other components of IVS. We are grateful to all contributors of the Service, especially personnel at Network Stations and Correlators, for their hard work.

References

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