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# Project: Global Analysis of 1979-2004 VLBI Data

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**Abstract**

New software IAA RAS QUASAR is prepared for the analysis of practically all VLBI observations over the period of 1979-2004. The general purpose is improvement of reference systems ICRF, ITRF and EOP. Main features are explained and some results are demonstrated.

## 1. Introduction

First version of software QUASAR with usage global collocation technique was developed in 1998-2000 by V.S. Gubanov and I.F. Surkis with collaboration by Yu.L. Rusinov. Further development goes on by I.A. Verestchagina and students of SPb State University C.Ya. Shabun and S.L. Kurdubov. At present package QUASAR is a multipurpose system which can make mass processing of VLBI observations in different modes and purposes. It features the opportunity of use of various estimation techniques for the intraday stochastic component of UT1, tropospheric wet-delay and local clock time-scale variations. The following techniques based on parametric, stochastic and dynamic modeling will be used in QUASAR: a) multi-group least-squares (MGLS), b) moving least-squares filter (MLSF), c) global least-squares collocation (GLSC), d) recursive Kalman filter of random walk (KFRW) and e) recursive two-dimension Kalman filter (TDKF). More detail presentation of these techniques is carried out in [1]–[4], but their testing and comparison are continued. For this reason the presented below applications are related to GLSC as a basic technique of software QUASAR.

## 2. Preparation of QUASAR VLBI Database

All available data were sorted by programs and prepared for processing in compact format. The following procedures are executed: a) relative clock trends are reduced to standard quadratic model, b) super-series of programs CONT, VLBA and Bb023 are shared by some sub-series with observation numbers does not exceed 2000 [1]. After this all observations were processed by GLSC techniques, the EOP corrections and all stochastic signals were estimated in reference frames ICRF-Ext.1, ITRF2000 and EOP(IERS)C04.

## 3. Covariance of Signals

Obtained signal estimates were used for auto-covariance function calculations. These functions normalized to dispersion and averaged on 50 most active stations for wet- and clock-signals and on years for UT1-signal are presented in Figs. 1–3. The light gray curves show common average functions. These functions were modeled by positive-definite parametric function. Averaged dispersions of wet- and clock-signals are taking into account independently for every station and season of observation.

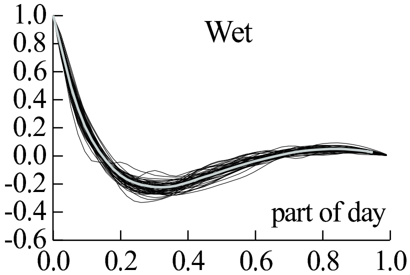

Fig. 1

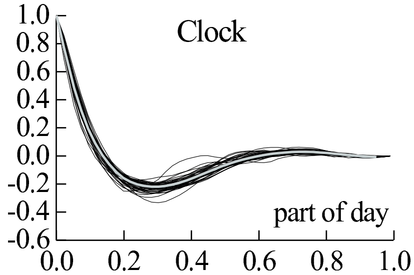

Fig. 2

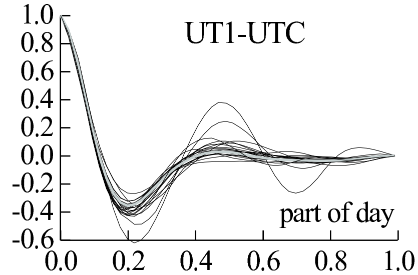

Fig. 3

## 4. Joint Determination of EOP and ITRF Corrections

In processing long series of observations the EOP trends are convenient for representing as polynomial expansions the coefficients of which are common for all series. The random EOP corrections are determined for every series. It is useful to determine stations coordinates for every session in order to investigate their high frequency variations. At Figs. 4–5 and 6–8 results of these determinations using NEOS-A observation data on 2001–2002 are shown.

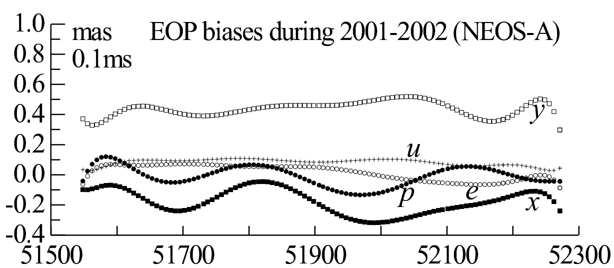

Fig. 4

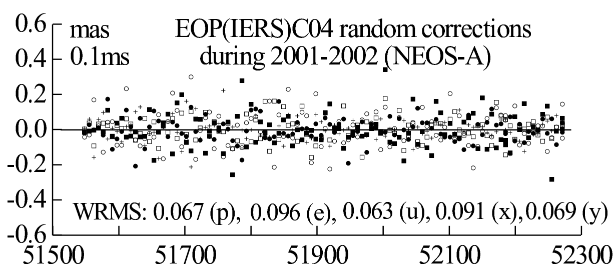

Fig. 5

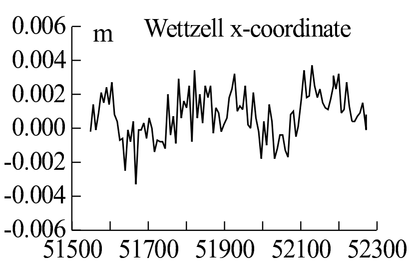

Fig. 6

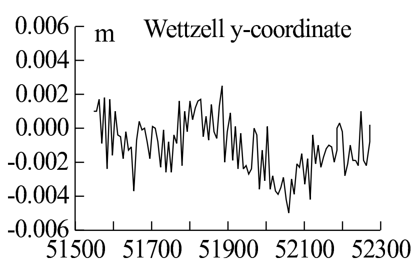

Fig. 7

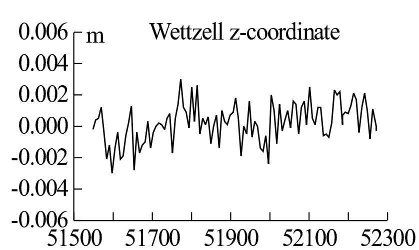

Fig. 8

## 5. Super-Sessions Analysis

Least-squares collocation demands the inverse for every daily series with observation number $N$ one covariance $N \times N$-matrix, and the mass processing of near 5000 daily sessions obtained on 1979-2000 became very difficult because it demands some iterations. For this reason all super-sessions with $N > 2000$ was shared on some sub-sessions with $N < 2000$. The super-sessions with $2000 < N < 4000$ (program CONT etc.) was shared according to "time principle" by two sub-series such as odd moments of observations relates to 1st sub-series and even - to 2nd sub-series (option 1). For example, at Fig. 9 the total wet-component of tropospheric path delay in zenith for station Onsala obtained by GLSC-analysis of 7 super-series 940119-940125 (CONT-94) shared by option 1 is shown with the comparison of synchronous WVR measurements.

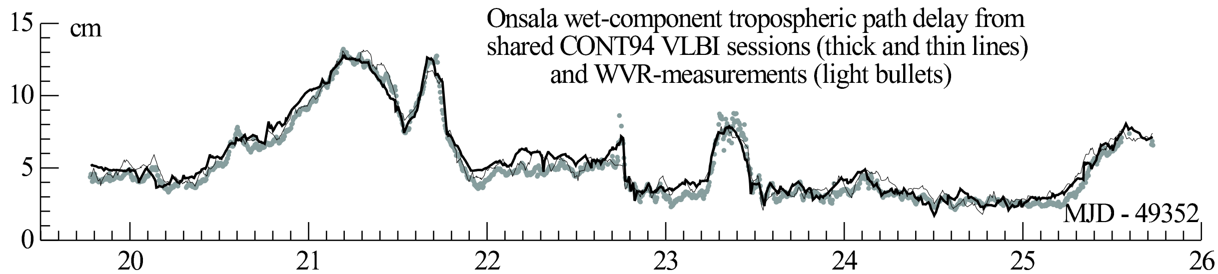


Fig. 9

The more complicated problem is sharing of VLBA and Bb023 super-sessions which contain up to 34000 observations. In this case option 1 cannot be used and sharing according to "base-principle" (option 2) was applied. All set of bases were shared by some subsets, everything of them make independent configuration quite optimal for all parameters and signals. Results of this option application are demonstrated below using example of super-session VLBA-02.03.06 contained more than 21.5 thousands of observations at 18 stations. This session was shared by 17 sub-sessions, which may be processed by GLSC both independent and combined. The results of combined solution of these sub-sessions — corrections of radio-sources coordinates (Fig. 10), coordinates all 18 stations (Fig. 11), and EOP (Fig. 12) — are shown. The radio source and station coordinates corrections was obtained under some constraints that is guarantees their unbias relative to reference systems ICRF-Ext.1 and ITRF2000.

All sub-sessions of 2nd type are independent because they do not contain the same bases, but the same station can be contained in more than one sub-session then some estimates of one signal for this station can be obtained. In the agreement of these estimates among themselves it is possible to conclude about its reliability. For example, at Figs. 13-18 estimations of wet- and clock-signals for three selected stations are shown. These signals obtained from independent processing all sub-sessions of one super-session VLBA-020306. Too excessive noise of clock-signal estimates pays attention to itself, therefore there is additional filtering needed.

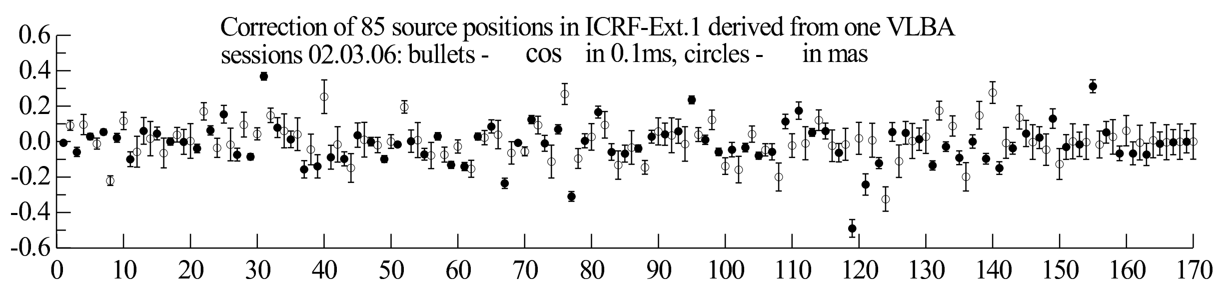


Fig. 10

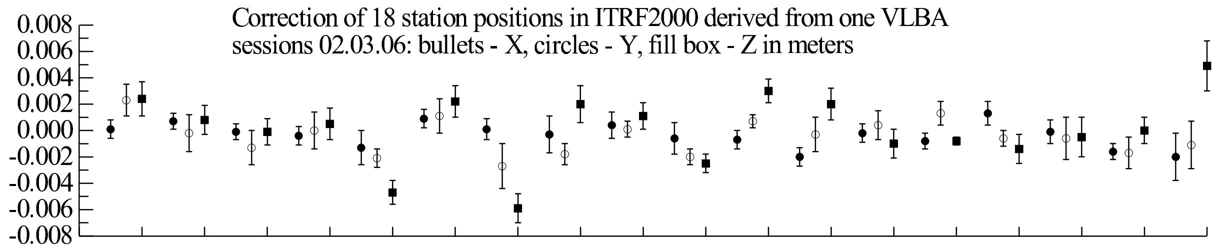


Fig. 11

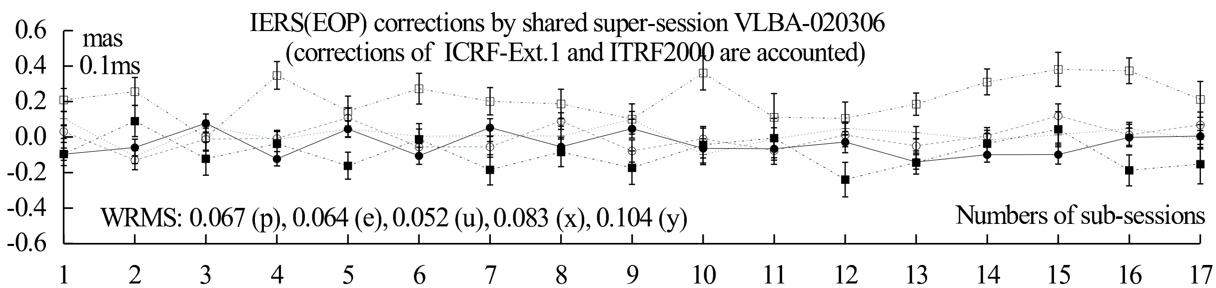


Fig. 12

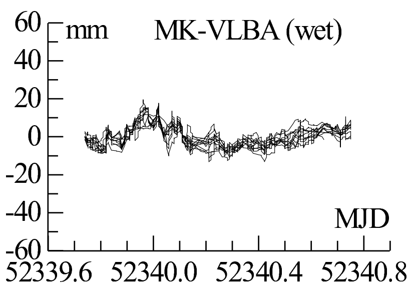


Fig. 13

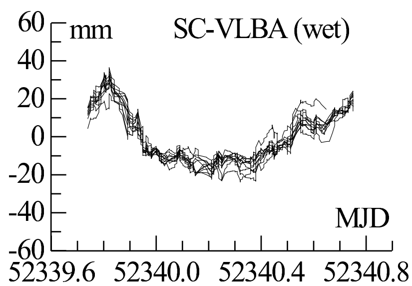


Fig. 14

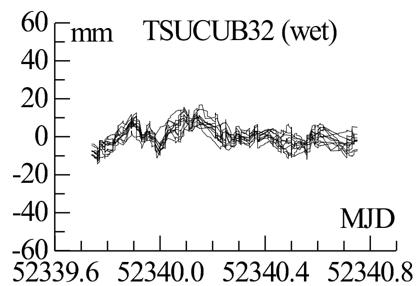


Fig. 15

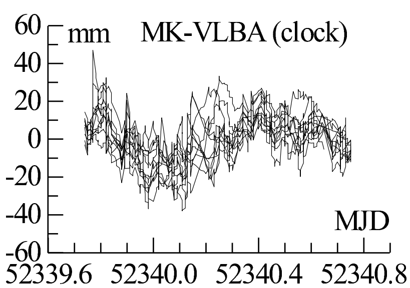


Fig. 16

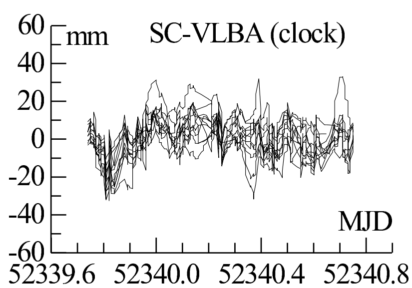


Fig. 17

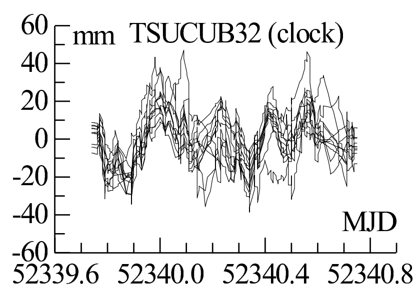


Fig. 18

At Fig. 19 the residuals of the one VLBA-020306 sub-session are shown. Its RMS is 3 mm, that more less than summary RMS of geometric and ionospheric delays errors. In the result for the majority of sessions $\chi^2$-criterion is less than 1. This is the fact that the estimates of clock-signals and errors of observations has 100 percent correlation and the latter penetrates into clock-signals as white noise. This noise has to be filtered in order that $\chi^2$-criterion was valid. After solution of this problem GLSC-technique will be ready for mass processing of VLBI observations with serious scientific purposes.

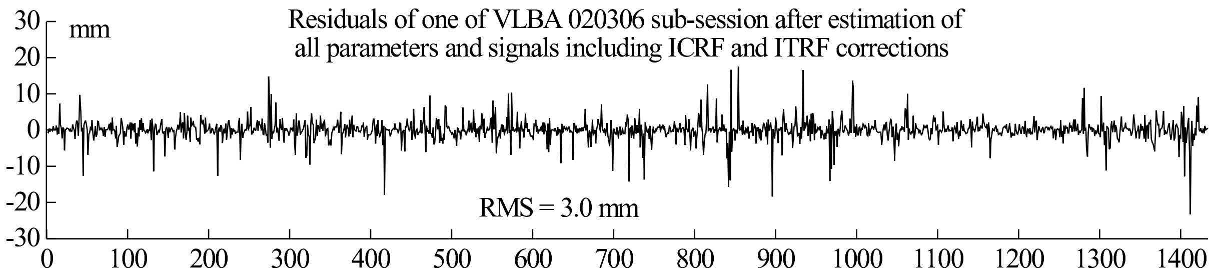


Fig. 19

## 6. Conclusion

At present there is full confidence that in first half of 2004 software QUASAR will be ready for mass processing of VLBI observations during 1979–2003 by least squares collocation and up to the end of year first results will be obtained. Up to this time at least one alternative technique of stochastic analysis mentioned in introduction will be verified and entered into practice.

## 7. Acknowledgements

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## References

[1] Gubanov V.S., Project: Global Analysis of 1979-2004 VLBI Data, Proc. of Journées-2003, St.-Petersburg, 24–27 Sept., 2003. SPb, IAA RAS, 2004 (in press).

[2] Gubanov V.S., Generalized Least-Squares. Theory and Application in Astrometry. SPb, Science, 1997 (in Russian).

[3] Gubanov V.S., Advanced Methods of Astrometrical Data Analysis. Proc. of IAA RAS, No. 6, "Astrometry and Celestial Mechanics". SPb, IAA RAS, 2001, pp.102–113 (in Russian).

[4] Gubanov V.S., Kozlova I.A. and Surkis I.F., Processing of VLBI Observations: Software QUASAR. II. The Data Analysis Techniques. Communications of IAA RAS, No. 142. SPb, IAA RAS, 2002, pp.1–36 (in Russian).