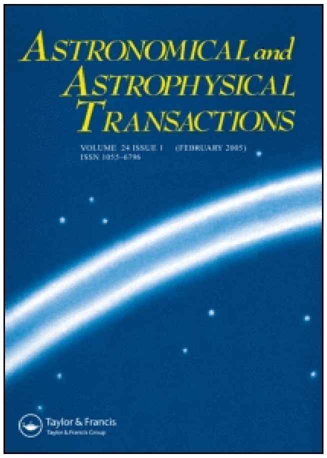

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ESTIMATION OF THE SUBDIURNAL UT1–UTC VARIATIONS BY THE LEAST SQUARES COLLOCATION METHOD

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The result of the two-week VLBI experiment CONT'94 has been processed by the least squares collocation method to calculate the UT1–UTC time series with high temporal resolution (one value every few minutes). It allows us to estimate the influence of tidal variations arising from the world's oceans on the EOP. Time series of UT1–UTC with high temporal resolution is demonstrated. Estimates of the four main tides (M2, S2, K1, O1) are in a good agreement with results of other authors.

KEY WORDS EOP variations, tidal terms

1 INTRODUCTION

The study of subdiurnal EOP variations is of great interest because they allow us to obtain information about different geophysical processes in the Earth's interior. Various natural phenomena are affected by the rotation rate as well as the direction of the rotation axis on the level of $\sim$ 1 cm. Due to the rapidly increasing accuracy of VLBI estimates there is an opportunity to discover these effects from observational data (for example: Eubanks, 1993; Dickey, 1995).

Unfortunately, the conventional procedure of VLBI data analysis provides us which estimates for 24 only time intervals (Ma and Ryan, 1995). Therefore high-frequency EOP variations are not available in spite of the increase in precision.

Nevertheless, some scientists have attempted to move the frequency limit into a higher-frequency range. First Yoder *et al.* (1981) have considered theoretically the periodic variations of the Earth's rotation. The method of calculation was later improved and developed significantly (Brosche, 1982; Baader *et al.*, 1983; Brosche *et al.*, 1989; Seiler, 1991; Gross, 1993).

Brosche *et al.* (1989) have estimated the five partial tides (M2, S2, N2, K1 and O1) from 48 IRIS-A experiments covering about 1 year using the CALC/SOLVE package for VLBI data analysis made at the Goddard Space Flight Center (Ma and Ryan, 1995). They divided the regular 24-hour IRIS-A VLBI experiments into 2-hour bins and obtaining 12 UT1–UTC values from every session. From 576 individual data points the amplitudes and phases of tidal terms have been estimated by the least squares method (LSM).

Other research groups have made use the more expanded observational data set for subdiurnal tide estimation. For example, Sovers *et al.* (1993) have obtained results for eight tidal components using very large amounts of VLBI data: DSN (27 000 delays), CDP (250 000), IRIS (250 000) and NAVNET (60 000). Herring and Dong (1994) have applied a very advanced procedure for the analysis of the nine-year span of VLBI data (610 000 delays) adjustment. They have obtained the power spectrum density with high-frequency resolution across diurnal and semidiurnal bands (±0.1 cpsd about 1 and 2 cpsd). The main tidal components and free-core nutation have also been detected.

Since the work of Brosche *et al.* (1989) a lot of papers on the experimental determination of tidal terms have been published. In addition to the paper mentioned above one can refer to results by Haas *et al.* (1995), Gipson (1996), and Chao *et al.* (1996). These authors usually make use of a large set of observational data over a few years. It seems that the record belongs to Gipson (1996) who considered 2681 IRIS and NEOS experiments from 1979 to 1996 with 1.8 million delays.

But it is possible to solve the problem with a limited observational data set. If the observations are divided into 5–10 minute intervals during the performance of a VLBI experiment there is a good opportunity to estimate the EOP for every time moment and increase the number of values that can be applied for comprehensive analysis.

Bolotin (1994) has applied the Kalman filter for EOP estimation with high temporal resolution from the intensive VLBI experiment CONT'94 and has built up a power spectrum density of subdiurnal EOP variations. The author confirmed the existence of diurnal and semidiurnal components. But the frequency resolution of the spectrum was not suitable enough to separate the single tidal terms. The author later estimated the three components of the instantaneous rotation vector of the Earth rather than the five EOP parameters (Bolotin *et al.*, 1995).

In the present paper the least squares collocation method (LSCM) (Gubanov *et al.*, 1994; Titov, 1995; Titov, 1996) has been applied to VLBI data (CONT'94 intensive experiment) analysis to calculate the EOP series with a time resolution which is equal to the rate of performing observations. The time series (5039 points) of UT1–UTC is compared with hourly estimates from the CONT'94 experiment made at the GSFC (Gipson, 1996). It appears that one can estimate the amplitudes of the four tidal components (M2, S2, K1, O1) using a short time span (only 13 days). In this paper the tidal term values from LSCM estimation are presented.

2 METHOD

All reduction calculations were made using OCCAM 3.3 software (Zarraoa *et al.*, 1989) in accordance with IERS 92 standard procedure (McCarthy, 1992). The software predictor – the BVSS package – was created by H. Schuh at Bonn University (Schuh, 1987) during the 1980s. N. Zarraoa developed a Kalman filter technique to take into account the stochastic behaviour of the clock offset as well as tropospheric delay. The mapping function of Davis *et al.* (1985) has been applied for the modelling of the wet delay due to water vapour in the Earth's atmosphere. Observational dispersions for large zenith distance ($Z > 75°$) have been multiplied by $\sec Z$ to reduce errors from modelling the tropospheric delay.

Let us consider a two-parameter model (Moritz, 1980) for VLBI data adjustment; here N is the number of observations and n is the number of determinate vector components:

$$\boldsymbol{A x} + \boldsymbol{B y} + \boldsymbol{w} = \boldsymbol{l}, \tag{1}$$

where A is the matrix of partial derivatives for the determinate parameters ($N \times n$); x is the vector of determinate parameters ($n \times 1$); B is the matrix of partial derivatives for the stochastic parameters ($N \times N$); $\boldsymbol{y}$ is the vector of stochastic parameters ($N \times 1$); $\boldsymbol{w}$ is the vector of random errors (like white noise) ($N \times 1$); and $\boldsymbol{l}$ is the vector of O–C values ($N \times 1$). Expression (1) will be correct if there is only one vector $\boldsymbol{y}$. If there are m vectors $\boldsymbol{y}$ ($\boldsymbol{y}_1, \boldsymbol{y}_2, \dots, \boldsymbol{y}_m$) we should to rewrite (1) as follows

$$\boldsymbol{A x} + \sum_{i=1}^{m} \boldsymbol{B}_i \boldsymbol{y}_i + \boldsymbol{w} = \boldsymbol{l}, \tag{2}$$

but there is an opportunity to consider B and $\boldsymbol{y}$ in (1) as block structures. The expanded form of (2) is:

$$Ax + (B_1, B_2, B_3, \dots, B_m) \begin{pmatrix} \boldsymbol{y}_1 \\ \boldsymbol{y}_2 \\ \boldsymbol{y}_3 \\ \cdots \\ \boldsymbol{y}_m \end{pmatrix} + \boldsymbol{w} = \boldsymbol{l}, \tag{3}$$

where B_i is a diagonal matrix of partial derivatives

$$B_i = \begin{pmatrix} b_i^1 & 0 & 0 & \cdots & 0 \\ 0 & b_i^2 & 0 & \cdots & 0 \\ 0 & 0 & b_i^3 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & 0 & 0 & b_i^N \end{pmatrix} \tag{4}$$

$\boldsymbol{y}_i$ is a vector of parameters under estimation

$$\boldsymbol{y}_i = \begin{pmatrix} y_i^1 \\ y_i^2 \\ y_i^3 \\ \cdots \\ y_i^N \end{pmatrix} \tag{5}$$

Then, combining (3)–(5), we will have the fully expanded expression

$$\begin{aligned} Ax + \begin{pmatrix} b_1^1 & 0 & 0 & \cdots & 0 \\ 0 & b_1^2 & 0 & \cdots & 0 \\ 0 & 0 & b_1^3 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & 0 & 0 & b_1^N \end{pmatrix} \begin{pmatrix} y_1^1 \\ y_1^2 \\ y_1^3 \\ \cdots \\ y_1^N \end{pmatrix} + \cdots + \\ \begin{pmatrix} b_m^1 & 0 & 0 & \cdots & 0 \\ 0 & b_m^2 & 0 & \cdots & 0 \\ 0 & 0 & b_m^3 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & 0 & 0 & 0 & b_m^N \end{pmatrix} \begin{pmatrix} y_m^1 \\ y_m^2 \\ y_m^3 \\ \cdots \\ y_m^N \end{pmatrix} + w \;=\; l \end{aligned} \tag{6}$$

for m stochastic parameters from N elements.

It is essential that all N elements of the vector $\boldsymbol{y}_i$ are not equal to each other due to the stochastic nature of the real process under investigation. Otherwise, if $\boldsymbol{y}_i^1 = \boldsymbol{y}_i^2 = \ldots = \boldsymbol{y}_i^N = \boldsymbol{y}$, we have to consider the parameter $\boldsymbol{y}_i$, as a determinate one and move it to the left term of (6).

The conditional probability density of the vector $\boldsymbol{l}$ in relation to the vectors $\boldsymbol{x}$ and $\boldsymbol{y}$ can be written as follows:

$$p(\boldsymbol{l}|\boldsymbol{x}) = \frac{1}{(2\pi)^{N/2}[\det Q_W]^{1/2}} \exp\left[-\frac{1}{2}(\boldsymbol{l} - A\boldsymbol{x} - B\boldsymbol{y})^{\mathsf{T}} Q_W^{-1}(\boldsymbol{l} - A\boldsymbol{x} - B\boldsymbol{y})\right] \tag{7}$$

and under the assumption that the stochastic vectors $\boldsymbol{l}$ and $\boldsymbol{y}$ have a Gaussian distribution (Sage and Melsa, 1972)

$$\begin{aligned} p(\boldsymbol{l}|\boldsymbol{y}) \quad &= \quad \frac{[\det(BQ_yB^{\mathsf{T}} + Q_W)]^{1/2}}{(2\pi)^{N/2}[\det Q_W]^{1/2}[\det Q_y]^{1/2}} \\ &\times \quad \exp\left[-\frac{1}{2}(y - m(\boldsymbol{y}))^{\mathsf{T}}(B^{\mathsf{T}}Q_W^{-1}B + Q_y^{-1})(y - m(\boldsymbol{y}))\right], \end{aligned} \tag{8}$$

where

$$m(\boldsymbol{y}) = (B^{\mathsf{T}}Q_W^{-1}B + Q_y^{-1})^{-1}B^{\mathsf{T}}Q_W^{-1}(\boldsymbol{l} - A\boldsymbol{x}). \tag{9}$$

Following Sage and Melsa (1972), Moritz (1980) and Titov (1996) and using for (9) the compact form like (1), let us write the expressions for the estimates of $\boldsymbol{x}$ as

$$\hat{\boldsymbol{x}} = [A^{\mathsf{T}}(BQ_yB^{\mathsf{T}} + Q_W)^{-1}A]^{-1}A^{\mathsf{T}}(BQ_yB^{\mathsf{T}} + Q_W)^{-1}\boldsymbol{l} \tag{10}$$

and for the y vectors as

$$\hat{y} = Q_y B^{\mathsf{T}} (B Q_y B^{\mathsf{T}} + Q_W)^{-1} (l - A\hat{x}), \tag{11}$$

where Q_y, Q_W are the covariance matrices for the stochastic vectors y and w, respectively. The components of Q_W are calculated by OCCAM, Q_y should be constructed on the basis of stochastic parameter covariance functions.

The statistical expectation and, sometimes, the linear trends of the stochastic parameters are estimated as determinate ones and included in the vector x. Thus, the LSCM is a two-step procedure; first we obtain estimates of the determinate parameters using (10): secondly, we calculate estimates of the stochastic parameters using (11). In fact the procedure expressed by (11) is a filtration, rather than an adjustment like (10), because the number of components of every vector y_i, is equal to those of the O–C vector l. The filter characteristics depend on the combination of Q_y, Q_W and B. Expression (11) allows us to calculate an estimate of the stochastic parameter (5) for every observational moment without loss of accuracy. It is the most remarkable property of LSCM.

The dispersions of the estimates (10), (11) are given by

$$\hat{Q}_x = [A^{\mathsf{T}} (B Q_y B^{\mathsf{T}} + Q_W)^{-1} A]^{-1} \tag{12}$$

and

$$\hat{Q}_y = Q_y - Q_y B^{\mathsf{T}} (B Q_y B^{\mathsf{T}} + Q_W)^{-1} (E - P) B Q_y, \tag{13}$$

where E is the unit matrix; P is the so-called projective matrix

$$P = A[A^{\mathsf{T}} (B Q_y B^{\mathsf{T}} + Q_W)^{-1} A]^{-1} A^{\mathsf{T}} (B Q_y B^{\mathsf{T}} + Q_W)^{-1}, \tag{14}$$

having the properties

$$\begin{aligned} P \times (E - P) &= 0, \\ P \times P &= P, \\ (E - P) \times (E - P) &= (E - P). \end{aligned} \tag{15}$$

The post-fit residuals

$$\varepsilon = 1 - A\hat{x}, \tag{16}$$

are used for the calculation of the estimate of the random error dispersion (Titov, 1996)

$$\hat{\sigma}_0^2 = \frac{\varepsilon^{\mathsf{T}} (Q_W + B Q_y B^{\mathsf{T}})^{-1} \varepsilon}{N - n}, \tag{17}$$

where N is the number of observations and n is the number of determinate parameters. It is important that the value $\hat{\sigma}_0^2$ does not depend on the number of

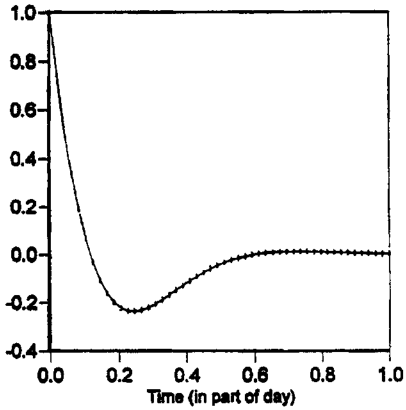

Figure 1

stochastic parameters. Moreover, it has a normalized chi-squared distribution. The mathematical expectation of $\hat{\sigma}_0^2$ is

$$M[\hat{\sigma}_0^2] = 1. \tag{18}$$

This is usually applied to the calculation of the standard deviation:

$$\hat{\sigma}_x = \hat{\sigma}_0[\operatorname{diag}(\hat{Q}_x)]^{1/2}. \tag{19}$$

The following parameters have been estimated by the LSCM briefly described in (1)–(19):

- station coordinates;
- nutation angles;
- EOP;
- three clock parameters (clock offset, first and second derivatives);
- tropospheric delays.

The last three groups of parameters were considered to be stochastic during the estimation by LSCM. In accordance with this approach one has to make use of the corresponding covariance function. For variations of the clock and troposphere parameters the following model for the 24-hour VLBI experiment has been applied:

$$q(t) = \frac{q(0)}{\cos\varphi}\exp(-\alpha t)\cos(\beta t + \varphi), \tag{20}$$

were t is the time shift (in parts of a day) $0 \le t \le 1$; and $q(0)$ is the dispersion.

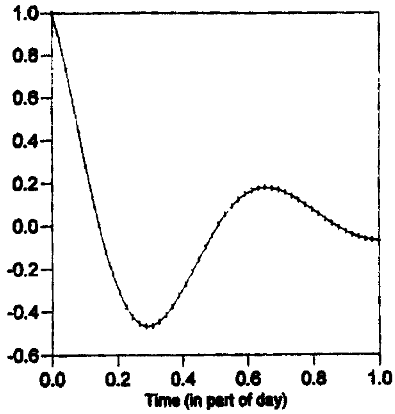

Figure 2

The meaning of the coefficients α, β, φ are:

$\alpha = 2.64\ \text{day}^{-1}$, $\beta = 8.64\ \text{day}^{-1}$, $\varphi = 0.33$ radian – for the clock;

$\alpha = 6.24\ \text{day}^{-1}$, $\beta = 6.48\ \text{day}^{-1}$, $\varphi = 0.82$ radian – for the troposphere.

Pictures of the correlation functions of the clock and tropospheric parameters are given in Figures 1 and 2, respectively.

The *a priori* value of the dispersion of the stochastic parameters is a subject of special consideration. If the dispersion is too small the LSCM estimates will be biased. To check the influence of the *a priori* value on the final result there are solution for two meanings of the dispersions:

– 1 cm^2 for the clock and 2 cm^2 for the troposphere;

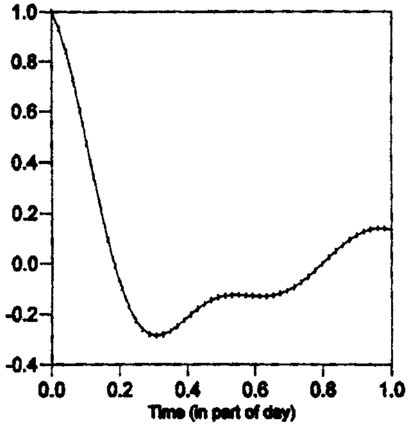

Figure 3

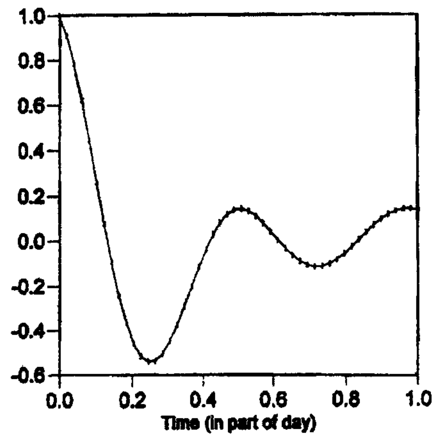

Figure 4

- 16 cm^2 for the clock and 10 cm^2 for the troposphere.

For estimation of the EOP the following expression was used:

$$q(t) = \frac{q(0)}{\cos\varphi + \cos\psi} \exp(-\alpha t)(\beta\cos(2\omega t + \varphi) + \gamma\cos(\omega t + \psi)), \tag{21}$$

where t has the same description as in (20); and ω is the Earth's rotation frequency.

The analytical expression (21) has been chosen because the diurnal and semidiurnal components dominate in the subdiurnal EOP variations. All the coefficients (except for the fixed parameter $\alpha = 2$) of the expression have been calculated from a preliminary LSCM adjustment with a correlation function like a damping exponential. For the X and Y polar coordinates the correlation functions were calculated separately and the average curve is shown in Figure 3. The correlation function for UT1–UTC is shown in Figure 4.

The meanings of the coefficients α, β, γ, φ and ψ are as follows:

$\alpha = 2.0\ \mathrm{day}^{-1}$, $\beta = 0.868$, $\gamma = 0.466$, $\varphi = 0$ rad,
$\psi = 0.59$ rad – for UT1–UTC;
$\alpha = 2.0\ \mathrm{day}^{-1}$, $\beta = 0.285$, $\gamma = 0.598$, $\varphi = 0.05$ rad,
$\psi = 0.09$ rad – for X, Y
(values for average curve).

Applying the four covariance functions in (10) and (11), estimates of the determined, as well as the stochastic, parameters have been calculated. In this paper I will concentrate on UT1–UTC variations only, in spite of the fact that the estimates of the polar motion are also interesting. It is affected by the fact that there are essential non-tidal contributions in the subdaily polar motion which distort the

Table 1. *A priori* dispersions of stochastic parameters for three variants of estimation (cm^2).

Parameter	*Solution 1*	*Solution 2*
Clock	1	16
Troposphere	2	10
EOP	1	1

tidal term estimates from the limited data set. The non-tidal effect in UT1–UTC is smaller (Chao *et al.*, 1996) and does not prevent us from obtaining reliable estimates.

Two variants of the solution have been calculated to check the influence of the choice of the *a priori* dispersion. Table 1 contains the combinations of the *a priori* estimates. Solution 1 is the basic one, because the *a priori* dispersion values correspond to the modern determination of the accuracy of the stochastic parameters on a 24-hour time span.

Three independent VLBI networks operated during the intensive CONT'94 campaign. Seven stations (WETTZELL, WESTFORD, GILCREEK, ONSALA, KOKEE, FD-VLBA, LA-VLBA) composed the network which was active from 12, January, 1994 till 25, January, 1994 with a one-day break. The WETTZELL–WESTFORD–GILCREEK–KOKEE–FD-VLBA configuration was chosen for estimation by LSCM. The WETTZELL station is the reference station; the height component of WESTFORD, as well as the WETTZELL–GILCREEK direction were fixed to establish a terrestrial reference frame. To establish a celestial reference

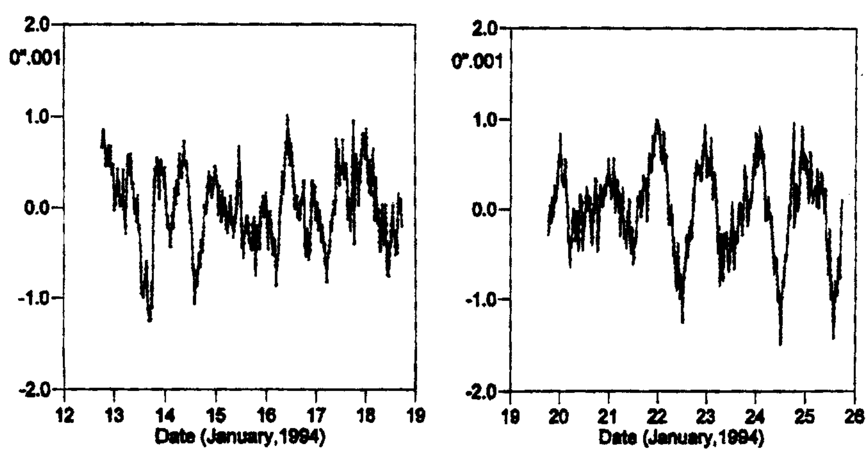

Figure 5

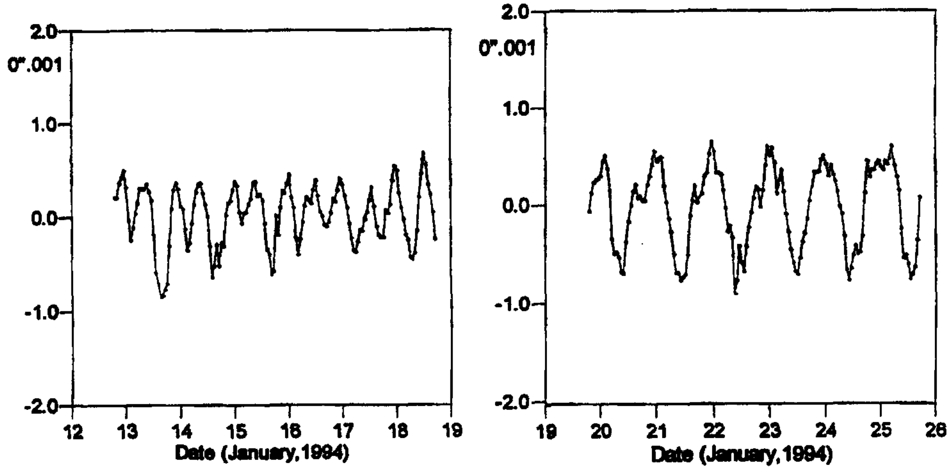

Figure 6

frame the radio-source coordinates are fixed.

The number of independent observational epochs changes from 370 to 445. This means that the average time density of the EOP series is approximately 15–18 estimates per hour or 1 estimate in 4 minutes. It allows us to move the Nyquist frequency of the spectrum of the EOP variations up to 10 minutes.

Figure 5 shows the UT1–UTC variations in two six-day time spans in January, 1994 (from 12.01.94 till 18.01.94 and from 19.01.94 till 25.01.94). Every 24-hour VLBI experiment has been analysed separately using OCCAM/LSCM code; after that all daily time series were combined together. The full uneven time series for the EOP contain 5039 points. For comparison Figure 6 shows the hourly EOP estimates obtained by Gipson (1996) using CALC/SOLVE code. The GSFC time series contain 284 points.

3 ESTIMATION OF UT1–UTC TIDAL TERMS

Both the CALC/SOLVE and OCCAM/LSCM time series of UT1–UTC variations are in good agreement, exception for the day 18 January, when there is an obvious discrepancy. The time series have been used for the estimation of the four main tidal components (M2, S2, K1, O1). The parametrical model for the analysis was taken from the paper by Herring and Dong (1994) :

$$\delta(\mathrm{UT1} - \mathrm{UTC}) = \sum_{i=1}^{N} (u_i^c \cos\varphi_i + u_i^s \sin\varphi_i), \tag{22}$$

Table 2. Estimates of tidal component amplitudes and their standard deviations (in μsec).

Tide *(period, hours)*		*M2* *12.42*	*S2* *12.00*	*K1* *23.93*	*O1* *25.82*	σ
Solution 1	cos	−10.1	−2.0	1.3	−13.3	0.5
	sin	14.6	5.7	22.6	−13.2	
Solution 2	cos	−9.3	−2.3	1.3	−13.7	0.3
	sin	15.2	4.8	19.1	−14.3	
CALC/SOLVE	cos	−10.1	2.9	8.4	−12.8	0.9
	sin	12.9	4.2	18.4	−12.7	
SteelBreeze	cos	−9.8	2.5	2.7	−9.5	0.5/0.3
	sin	13.7	6.0	15.0	−6.4	

where $\delta(\mathrm{UT1}-\mathrm{UTC})$ is variation in the Earth's rotation calculated using (11); N is the number of tidal terms ($N = 4$ in this paper; u_i^c, u_i^s are the tidal cosine and sine terms; and φ is the general tidal argument written as follows

$$\varphi_i = a_i l + b_i l' + c_i F + d_i D + e_i \Omega + f_i(\theta + \pi). \tag{23}$$

In (23) a_i, b_i, c_i, d_i, e_i, f_i are integer constants multiplied by time-dependent arguments of the motion of the Sun and Moon:

- l is the mean anomaly of the Moon;
- l' is the mean anomaly of the Sun;
- F is the argument of the Moon's latitude;
- D is the elongation of the Moon from the Sun;
- Ω is the longitude of the ascending lunar node;
- Ω is the argument of sidereal time calculated using the expression

$$\theta = \mathrm{GMST}_{0\mathrm{hr}} + R \times \mathrm{UT1} + \Delta\psi \cos\varepsilon, \tag{24}$$

where $\mathrm{GMST}_{0\mathrm{hr}}$ is the Greenwich mean sidereal time in 0 hours of the observational date; R is the ratio of sidereal time to universal time; and $\Delta\psi \cos\varepsilon$ is the term for the motion of the Equinox (McCarthy, 1992).

Table 2 demonstrates the results of estimation for both solutions from Table 1 using model (22) by the conventional least squares method, for CALC/SOLVE as well as the SteelBreeze solutions. The standard deviation of the tidal amplitudes from the CALC/SOLVE solution (one estimate per hour) is greate than from solutions when UT1 variations were estimated for every observational moment.

Table 3. Estimates of tidal component amplitudes, from theoretical consideration (Gross, 1993) as well as VLBI data analysis.

Tide (period, hours)		*M2 12.42*	*S2 12.00*	*K1 23.93*	*O1 25.82*
(Wünsch and Busshoff, 1992)	cos	−10.0	3.6	7.8	−16.2
	sin	20.3	9.0	9.8	−14.2
(Gross, 1993)	cos	−22.7	−3.1	14.7	−13.1
	sin	27.0	17.8	11.5	−32.7
(Herring and Dong, 1994)	cos	−10.8	−0.1	6.5	−17.3
	sin	14.3	8.6	17.8	−16.1
(Sovers *et al.*, 1993)	cos	−10.4	−0.4	3.5	−13.5
	sin	−14.9	5.2	15.1	−16.6
(Gipson, 1996) 'constrained solution'	cos	−10.1	−0.8	9.2	−13.7
	sin	15.3	7.8	16.1	−17.9
(Haas *et al.*, 1995)	cos	−8.4	0.4	3.7	−11.6
	sin	13.3	9.3	17.1	−13.4

Table 3 shows the estimates of the same tidal component amplitudes obtained by other authors. As a whole the results in Tables 2 and 3 are similar. For example, the amplitudes of the basic solution 1 for the M2 term are closer to the results of Herring and Dong (1994) and Gipson (1996), for the K1 and O1 terms to Haas *et al.* (1995), and for the S2 term to Sovers *et al.* (1993) ones. One should note that in comparison with observational information there is not such close agreement with the theoretical estimates by Gross (1993). By the way it was specified earlier, the estimates of the tidal components from VLBI data analysis differ from the theoretical ones. Various missing systematic effects like solid Earth tides, thermal antenna deformations or radio-source structure are capable of distorting our estimates (Haas *et al.*, 1996). Therefore, one can conclude that the LSCM results in Table 2 are of good quality.

It should be noted that OCCAM/LSCM and CALC/SOLVE obtained from the same VLBI data subset are in better agreement with each other in comparison with values from Table 3. This means that results on tidal UT1–UTC variations depend on the original data which have been chosen for analysis. The discrepancy can be explained by both the difference in the amount of observational information, as well as the approach to information adjustment. Moreover, making use of a two-week data subset it is impossible to divide other tidal components at the diurnal and subdiurnal frequency bands (Seiler and Wünsch, 1995). Therefore the results in the Table 2 could be biased due to correlation with other tidal terms.

In spite of the good agreement of the estimates from Table 3 one has to state that the results depend on the choice of the *a priori* covariance (20) and (21). Figures 3 and 4 show the analytical approximation of EOP correlation functions constructed on limited observational data. The plots could be affected by the season of experiment, the latitude and longitude of the VLBI stations, antenna effects, etc.

Therefore it is necessary to improve the correlation functions in future using more observations.

4 CONCLUSIONS

The present paper is a first attempt to apply the LSCM for subdiurnal EOP estimation. Special code has been prepared and added to the OCCAM V3.3 system. The new method results are in good agreement with those obtained by both alternative algorithms and software. This means that LSCM is suitable for solving an important scientific problem. Unfortunately, the results presented here might be biased by local geophysical phenomena at the VLBI sites, as well as seasonal effects characterized by the epoch of observations (winter). Therefore to reach a more rigorous conclusion, one has to analyse a longer continuous experiment.

It is important that the IERS Conventions of 1996 recommend taking into account both the diurnal and semidiurnal effects during reductional calculations immediately. Using this approach we obtain small quasi-noise EOP time variations after LSCM adjustment rather than large tidal waves. This offers an opportunity to study other interesting natural phenomena in a period ranging from 10 minutes to a few days.

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