APPLICATION OF ADAPTIVE DYNAMIC REGRESSION MODELING FOR PROCESSING AND THE ANALYSIS OF SOME CHANGES OF DURATION OF TERRESTRIAL AVERAGE DAY

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Introduction: Models of changes of duration of day allow us to predict not only duration of day, but also changes of average speed of rotation of the Earth. Non-uniformity of rotation of the Earth and movement of poles are caused not only by gravitational influences of environmental heavenly bodies, but by processes proceeding on our planet, and depend on features of the structure and physical properties of terrestrial bowels.

For precision treatment and the analysis of time lines in [1] the approach of adaptive dynamic regression modeling (DRM), as a software package - the automated system DRM is offered.

The set of DRM algorithms includes algorithms of designing of approximations, valuation and structural identification; and also procedures of formation of criteria of quality of approximations, analytical and graphic criteria of performance of conditions of application of classical circuits regression analysis - a method of the least squares (MLS) and computing procedures of modeling of time lines [1] are used.

Construction of models and their analysis: As the initial data the given changes of duration of the day, calculated by International Earth Rotation Service (IERS) with step-type behavior 1 day (eopc04) for 1995-2004 (3653 supervision) have been taken.

At the first analysis stage of the data within the framework of the DRM-APPROACH the checked hypothesis about stationarity lines has been rejected with probability of 95 %.

At the second stage construction of harmonious model or allocation of the trend component were supposed to be made.

The model of a square-law trend with the factor of correlation R=0,81, being optimum of 17 constructed dependences is constructed at a significance value 0,05 on F-statistics: $F_{табл}$ = 3,84; $F_{факт}$ = 3470,64; σ_Δ = 0,000604. At each stage of processing the detailed analysis of the rests was carried out. For this purpose modules of check of observance of MLS assumptions and the analysis of quality of the model have been connected with the DRM library, allowing to estimate the degree of adequacy of model to supervision and a degree of suitability of model for approximation in the given selective space.

At the third stage the schedule of autocorrelation was investigated and the factor DW=0,0084 paid off; the conclusion about possible presence of periodic components in the rests was made.

By results of spectral and wavlet analyses of the rests 32 harmonics are allocated. Bearing harmonics with the maximal spectral density appeared to be harmonics with the periods of 365 days; 183; 13,6; 28; 1217; 9,1; 63; 91. Average quadratic deviation (AQD) of the model is equal to 0,00035; AQD on external accuracy σ_Δ = 0,000434.

On the fig. 1 there is a schedule of the rests after allocation of a trend component and the schedule on the model received as a result of application to the line of the rests of the spectral analysis. On a correlation matrix of harmonics with the set periods correlation between harmonics is not found out. The carried out wavelet-analysis allowed to reveal a harmonic with the period 422 days. Inclusion in model of a harmonic with this period reduces AQD up to 0,000345 and AQD on external accuracy (σ_Δ = 0,000392) a little.

Residual fluctuations are smoothed out by autoregression model of the suitable degree, or by methods of martingale approximations (or consecutive application of these two approaches). The model of autoregression of the second degree with AQD 0,00005 is constructed; σ_Δ = 0,000385.

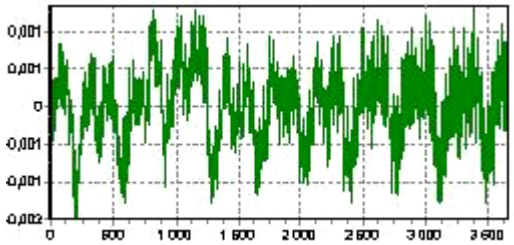

Fig. 1a)

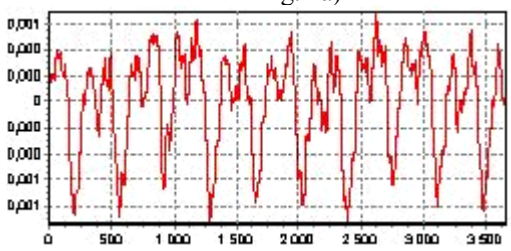

Fig 1b)

Fig. 1. a) the rests from allocation a trend component; b) harmonious model of lines

As a result the time line is submitted by a mathematical model, additively including square-law and periodic trends, and also autoregression. On Fig.2 there is the schedule of complex model of changes of duration of average day for the period since 1995 till 2004.

As a whole for this model the assumption of equality to zero of the mathematical expectation is carried out, model is undetermined, the rests are not allocated under the normal law and homoscedastic, and there is a positive autoregression.

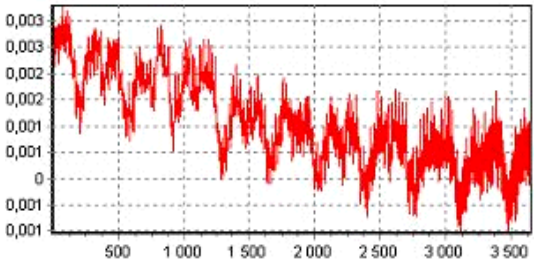

Fig. 2. Complex model of some change of duration of day

On the schedule (Fig.3) dynamics of changes of duration of day separately for 2004 is shown: characteristic fluctuations with the period half year, year, and also month and half-month are allocated.

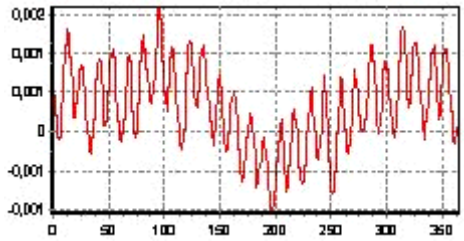

Fig. 3. Dynamics of changes of the duration of day for 2004

It proves to be true the carried out spectral analysis, harmonics with the periods 13,6 are allocated; 28; 9,1; 61 day. Change of duration of day with the period of less then a month is caused by tidal fluctuations [2]. Other allocated harmonics are caused by seasonal changes.

As a result of seasonal changes in speed of rotation of the Earth duration of day within one year can differ from its average duration for a year on ± 0s, 001. Thus the shortest day fall to July - August, and the longest - for March. The most probable reason of periodic changes of speed is seasonal redistributions of air and water weights on the surface of the Earth [3].

The conclusion: As a result of processing of some changes of the duration of day the model describing changes of duration of terrestrial day is allocated optimum by criterion of minimum AQD and σ_Δ. Dynamics of changes of the duration of day for 2004 is analysed.

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References: [1] Valeev S.G. Regression modeling at data treatment. Kazan: the FAN, 2001.296 with. [2] Sidorenkov N.S. Nature of instability of rotations of the Earth // the Nature, 2004. №8.
http://www.ibmh.msk.su/vivovoco/VV/JOURNAL/NATURE/08_04/UNSTABLE.HTM
[3] http://crydee.sai.msu.ru