ESTIMATION OF THE ACCURACY OF PREDICTION OF THE EARTH ORIENTATION PARAMETERS AT THE IAA DATA ANALYSIS CENTER

E. SKURIKHINA

IAA RAS - Russia - sea@iaaras.ru

ABSTRACT. The prediction of the Earth's orientation (EOP) parameters is especially important in the tasks of operational determination of the ERP. The Data Analysis Center of IAA RAS uses its own ERP forecast, which was developed and tested for the IAA EOP service in 1996. Since then, only minor changes regarding the nutation forecast (and the coordinates of the celestial pole) were applied. The algorithm is distinguished by high reliability and acceptable forecast quality. The accuracy of the prediction has not been evaluated since its introduction into the ERP service. In this regard, in the light of the increasing requirements for the accuracy of determining the EOP, it has become necessary to estimate the real accuracy of the forecast used. In the work, the accuracy of the prediction of the ERP used in the IAA is estimated.

1. ERP FORECASTING TEHNIQUE AT THE IAA RAS

The Data Analysis Center of IAA RAS (IAA AC) uses its own EOP forecast, which was implemented in the IAA EOP service in 1996. Since then, only minor changes have been made regarding the nutation forecast (and the coordinates of the celestial pole). The algorithm is distinguished by high reliability and acceptable forecast quality. The algorithm is rather reliable and has an acceptable forecast quality. The forecasting method is based on a combination of the deterministic and stochastic component of the EOP series (Malkin and Skurikhina, 1996). The deterministic component consists of polynomial and seasonal parts. To predict the stochastic component, the method of autoregression of the integrated moving average (ARIMA) is used. For each parameter (coordinates of the Earth's Pole, Universal Time, Nutation Parameters), its own order of autoregression and moving average is used, as well as its own length of the reference interval, on which the parameters for further forecasting are determined. The accuracy of the forecast has not been evaluated since its implementation in the EOP Service. In this regard, in the light of increasing requirements for the accuracy of the determination of EOP, it became necessary to evaluate the accuracy of the forecast of EOP. This is the purpose of this work.

2. DATA USED AND COMPARISON WITH IERS RESULTS

Since the IAA AC did not continuously archive the EOP series generated using their own forecasts, it was decided to use the data from the weekly IAA RAS EOP Bulletins, which have been published at the IAA RAS web page since 2005 year (`http://iaaras.ru/dept/lsger/eop`), to evaluate the quality of the prediction. The IAA RAS EOP Bulletins calculates once a week by Thusday.

The bulletin contains one month long EOP time series calculated from VLBI, SLR and GNSS observations and provides a one year long EOP prediction for the rs.dat time series based on SLR data.

It turned out that the forecast step in some of bulletins is different, in most cases the forecast for up to 10 days is given in steps of 1 day, for a number of EOP rs.dat, then up to 75 days the step is 5 days, up to 200 days – 10 days, then – 15 days, in some Bulletins a failure of this order is observed, therefore the number of points for the forecast of one length may differ (Table 1). The

forecast accuracy was determined as the RMS of the differences of the forecast and the real series.

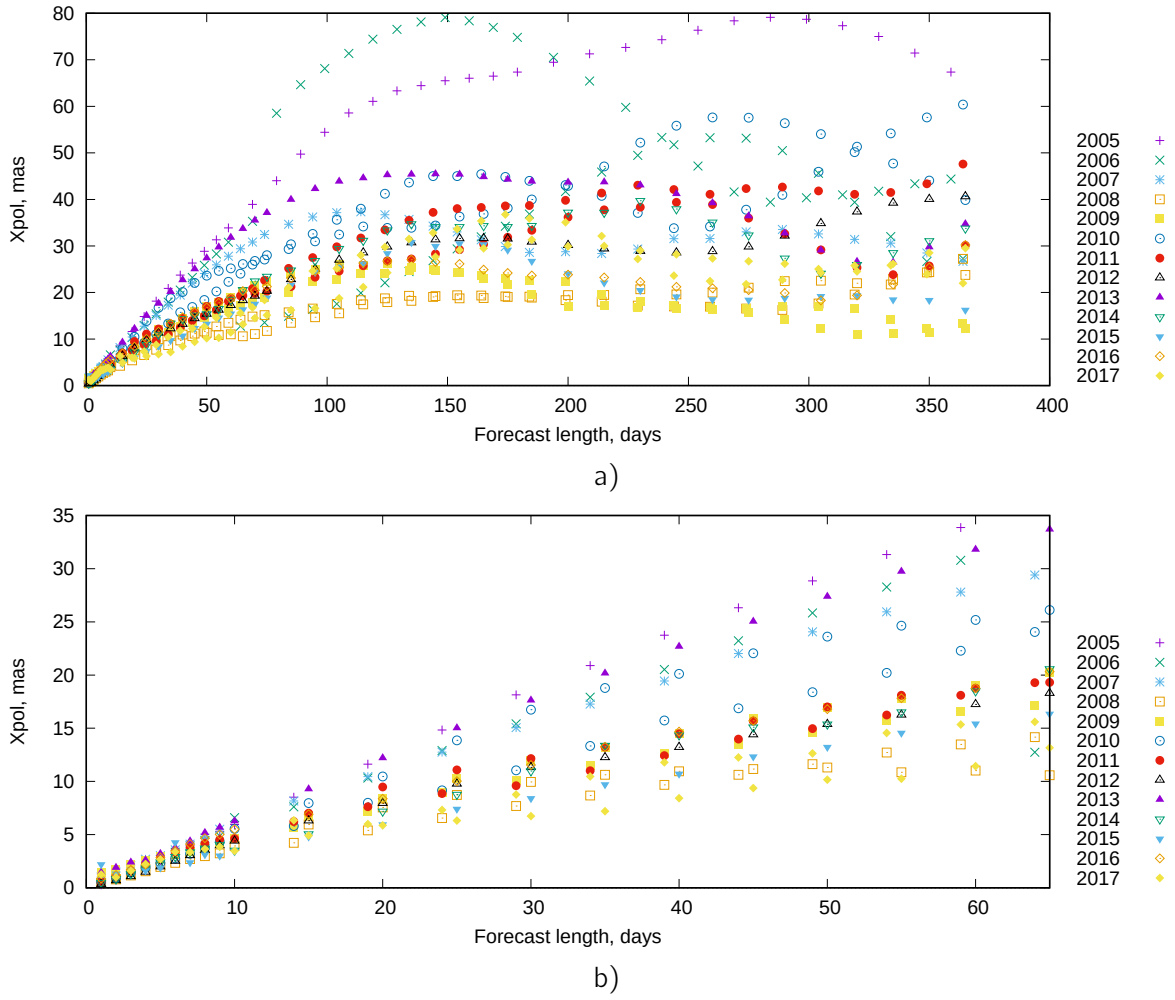
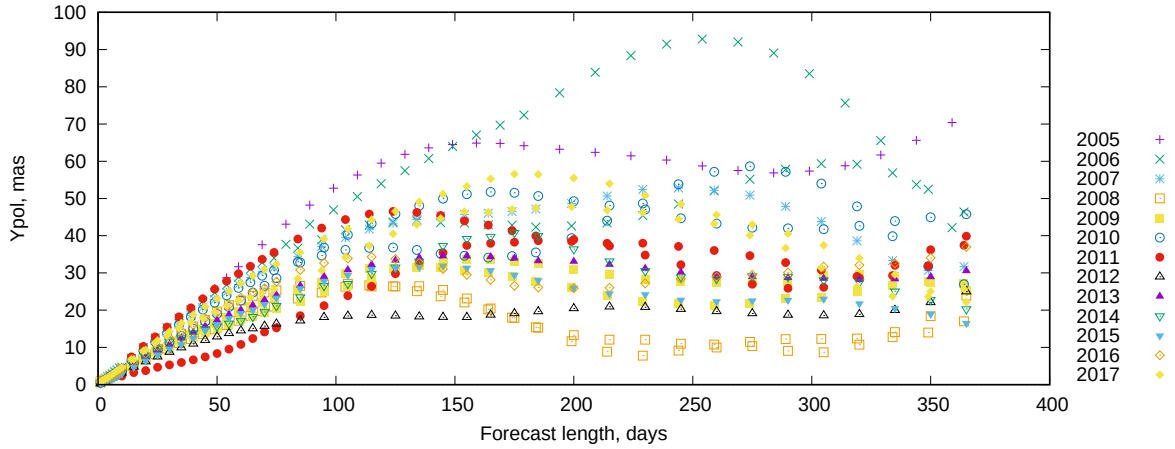


Figure 1: x_p forecast accuracy of the rs.dat series up to 60 days (left) and up to 1 year (right)

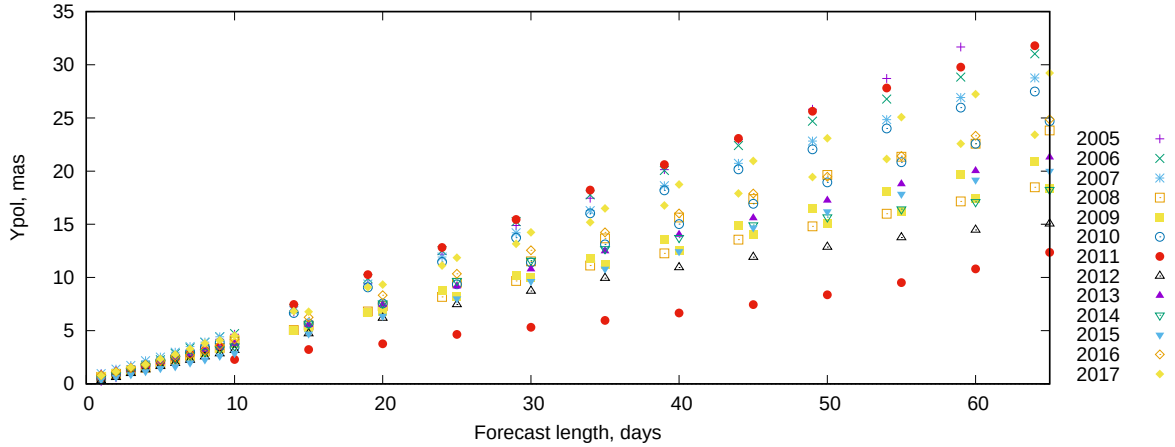
Figures 1–3 shows the estimates of the accuracy of the EOP forecast obtained from the IAA EOP Bulletins based on a comparison with the real series. The figure shows the accuracy estimates by year for all available Bulletins from the 2005 till 2017 year. The figures divided at two parts in agreement with time scale: the estimates of forecast accuracy up to 1 year are presented at the right parts and the estimates of forecast accuracy up to 60 days are presented at the left parts of the Figures. It should be emphasized that the EOP rs.dat series is based on the analysis of SLR observations and its accuracy differs from the accuracy of the IERS EOP series; therefore, this comparison is not entirely correct, but gives some insight about the accuracy of the prediction. It is necessary to evaluate the accuracy of the forecast of IERS EOP time series by another method.

Tables **??**, **??**, **??** compares our estimates of the accuracy of the ERP prediction (for rs.dat EOP time series) and estimates of the ERP forecast of the IERS Rapid Service Prediction Centre (data from annual IERS reports for the years 2005–2018 [1]) for x pole position x_p, y Pole position y_p and Universal Time $UT1 - UTC$ respectively. The Lenght of Prediction is designed as LP.

[1] `https://www.iers.org/IERS/EN/Publications/AnnualReports/AnnualReports.html`.



a)

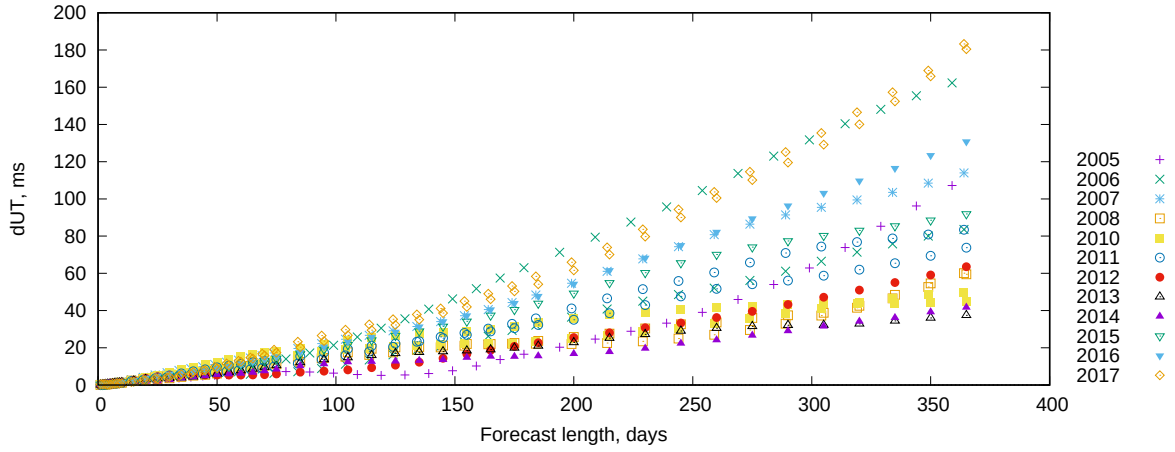


b)

Figure 2: y_p forecast accuracy of the rs.dat series up to 60 days (left) and up to 1 year (right)

3. REFERENCES

Malkin, Z.; Skurikhina, E., 1996, "On Prediction of EOP", Communications of the Institute of Applied Astronomy RAS 93.



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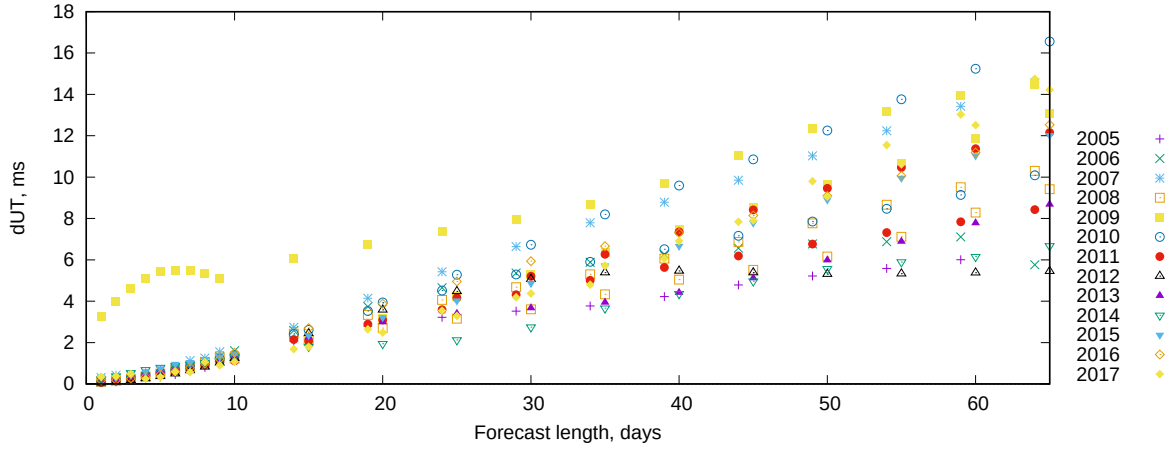

b)

Figure 3: UT1-UTC forecast accuracy of the rs.dat series up to 60 days (left) and up to 1 year (right)

LP	1 day		5 days		10 days		20 days		40 days		90 days	
	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA
2016	0.34	0.85	2.09	2.84	3.52	5.50	6.85	8.36	7.52	14.67	7.94	24.63
2015	0.34	2.19	2.02	1.88	3.42	3.34	5.50	5.94	9.34	10.71	N/A	24.36
2014	0.31	0.49	1.68	2.40	3.14	3.51	5.50	7.19	10.1	14.36	21.7	26.83
2013	0.33	1.43	1.81	3.19	3.46	6.26	6.75	12.20	12.9	22.68	23.8	42.26
2012	0.35	0.35	2.01	1.98	3.92	4.40	7.52	7.94	13.7	13.22	22.1	25.06
2011	0.39	0.54	2.22	2.85	4.01	4.62	6.72	9.48	11.9	14.48	26.6	27.48
2010	0.46	0.53	2.20	2.33	4.49	5.54	8.33	10.46	14.7	20.10	21.0	32.58
2009	0.43	1.41	2.04	2.91	3.49	4.59	5.85	8.43	10.2	14.49	17.6	22.25
2008	0.38	0.48	1.86	1.97	3.38	3.93	5.70	7.56	10.6	10.94	23.4	16.54
2007	0.42	1.01	2.06	3.01	3.75	5.50	6.92	10.45	12.1	19.44	15.3	36.22
2006	0.42	0.42	2.33	2.65	4.44	6.59	8.25	10.32	16.3	20.51	33.5	64.66
2005	0.44	0.28	2.44	2.53	4.13	5.95	6.82	11.64	11.9	23.75	25.2	49.74

Table 1: x_p forecast accuracy (mas)

LP	1 day		5 days		10 days		20 days		40 days		90 days	
	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA
2016	0.25	0.83	1.38	2.16	2.49	4.18	4.50	8.33	8.16	16.02	15.2	24.42
2015	0.24	0.41	1.18	1.46	2.01	2.88	3.09	6.48	4.69	12.44	N/A	27.78
2014	0.23	0.54	1.18	2.00	2.00	3.53	3.34	7.58	5.32	13.74	12.1	26.54
2013	0.23	0.91	1.22	2.10	1.94	3.77	2.66	7.44	4.12	14.03	16.5	29.00
2012	0.25	0.29	1.35	1.65	2.76	3.16	5.66	6.19	11.3	10.93	24.4	18.07
2011	0.28	0.55	1.37	1.99	2.49	2.28	4.71	3.75	9.13	16.65	17.7	42.04
2010	0.29	0.47	1.35	2.18	2.33	3.44	4.26	7.56	9.11	15.02	23.3	34.57
2009	0.29	0.72	1.26	2.02	2.34	3.76	4.16	6.83	7.00	12.51	13.9	27.41
2008	0.31	0.66	1.38	1.91	2.42	4.09	4.27	7.30	6.94	15.64	7.81	24.74
2007	0.33	0.96	1.33	2.51	2.27	4.42	4.26	9.39	8.47	18.62	17.7	37.10
2006	0.36	0.43	1.51	2.26	2.55	4.71	4.72	9.89	9.14	20.05	18.7	43.10
2005	0.37	0.23	1.70	2.04	2.77	4.65	4.56	9.43	8.32	20.14	18.9	48.23

Table 2: y_p forecast accuracy (mas)

LP	1 day		5 days		10 days		20 days		40 days		90 days	
	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA	IERS	IAA
2016	0.131	0.171	0.223	0.463	0.663	1.508	2.00	3.88	4.52	7.30	9.13	20.63
2015	0.073	0.317	0.207	0.745	0.567	1.147	2.32	3.21	5.90	6.67	17.25	19.19
2014	0.058	0.234	0.204	0.792	0.481	1.342	1.61	1.94	4.51	4.36	14.3	11.29
2013	0.058	0.132	0.214	0.628	0.525	1.350	1.88	2.99	2.82	4.42	8.49	13.68
2012	0.063	0.060	0.256	0.368	0.662	1.235	2.22	3.38	5.77	5.46	10.8	7.48
2011	0.054	0.077	0.305	0.484	0.776	1.120	1.99	3.09	3.62	7.35	13.6	13.7
2010	0.075	0.094	0.308	0.548	0.718	1.391	2.17	3.94	5.09	9.59	7.90	18.00
2009	0.112	0.327	0.366	0.541	0.757	1.172	1.72	3.15	5.61	7.47	17.4	17.57
2008	0.126	0.110	0.375	0.501	0.718	1.216	2.08	2.70	5.63	5.04	N/A	14.36
2007	0.141	0.312	0.452	0.642	0.921	1.556	3.29	4.14	7.77	8.78	13.4	22.27
2006	0.147	0.083	0.518	0.480	1.060	1.603	3.11	3.74	6.88	6.27	22.1	17.21
2005	0.127	0.064	0.380	0.337	0.935	1.222	3.30	2.80	5.98	4.22	7.61	7.02

Table 3: $UT1 - UTC$ forecast accuracy (ms)