

CURRENT RESULTS OF THE EARTH ORIENTATION PARAMETERS PREDICTION COMPARISON CAMPAIGN

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ABSTRACT. The precise transformation between the celestial (ICRF) and terrestrial (ITRF) reference frames is needed for many advanced geodetic and astronomical tasks. To perform this transformation for the time moment of observation the precise EOP predictions have to be known. This paper presents the current status of the Earth Orientation Parameters Prediction Comparison Campaign (EOP PCC), which started in October 2005 under the umbrella of the IERS (International Earth rotation and Reference systems Service). The ultra-short term, short term and medium term EOP predictions submitted since then by different groups were evaluated by means of the same statistical analysis. The mean prediction errors of the EOP with respect to IERS C04 data for each proposed algorithm were computed to show the performance in each prediction category. In October 2006 the EOP PCC rules were slightly changed, however all prediction results before this moment were transformed according to the new conventions.

1. OBJECTIVES

The main objective of the EOP PCC is to compare the various methods, models, techniques and strategies which can be applied for EOP predictions. We use the same statistical method for all results, and what is different from many other studies we collect predictions before any EOP observations are available. Our main goal is to investigate the EOP time series as well as other data strongly correlated with the EOP (e.g. AAM and OAM). We also expect the final conclusions to be useful for the operational computation of the EOP.

2. MAIN RULES

The EOP PCC provides three categories of the predictions: ultra short-term (for 10 days), short-term (for 30 days) and medium-term (for 500 days). This is a consequence of our assumption that in general short and long term predictions require different strategies and techniques. In that case each participant can submit any type of the prediction of any EOP except ultra short-term and short-term predictions of dX , dY or $d\psi$, $d\varepsilon$. Various prediction techniques can be applied by the same participant. This allows to provide different and very specific algorithms adjusted to each category. After joining the EOP PCC a participant is asked to submit the specified predictions every Thursday with one day delay. Then all the submissions are being processed and the current results are available on the official EOP PCC website: http://www.cbk.waw.pl/EOP_PCC/.

3. ANALYSES

Thanks to the EOP PCC participants (Tab. 1) we received a few thousands of predictions. Such a valuable collection give us an opportunity to perform many unique statistical analysis. Unfortunately, a reliable comparison of the submissions cannot be performed directly since very often predictions sent by different participants are referred to different prediction epochs. The detailed investigation of predictions also shows that some of them have unexpected high errors mostly caused by human mistake rather than by the applied prediction technique. The substantial reduction of mentioned problems is performed by means of the median absolute prediction error ($MDAE$) computed for all predicted EOP. For i^{th} day in

ID	Participant	Institute/Organization
011 012	Sergey Kumakshev	IPM RAS, Russia
021	Orhan Akyilmaz Hansjoerg Kutterer	ITU, Turkey University of Hannover, Germany
031	Richard Gross	NASA JPL, USA
051 052 053	Wiesław Kosek	Space Research Centre PAS, Poland
061	Maciej Kalarus	Space Research Centre PAS, Poland
071	EOP Product Center	Paris Observatory, France
072 073 074 075	Daniel Gambis	Paris Observatory, France
091 092 093	Leonid Zotov	SAI, Moscow State University, Russia
101	Sergey Pasynok	SAI, Moscow State University, Russia
111	Paulo Jorge Mendes Cerveira	IGG, Vienna University of Technology, Austria
121	Bora Jovanovic	Astronomical Observatory, Belgrade, Serbia

Table 1: List of participants (status as of Dec. 2007)

the future $MDAE$ is defined as follows:

$$MDAE_i = median(|\varepsilon_{i,1}|, |\varepsilon_{i,2}|, \dots, |\varepsilon_{i,P}|), \quad i = 1, 2, \dots, N_p, \quad (1)$$

where $\varepsilon_{i,j}$ is the difference between the EOP data (IERS C04) and its j^{th} prediction for i^{th} day in the future, P is the number of all available predictions of a given EOP and N_p is a prediction length (10, 30 or 500 days). Then, a coefficient β_n is computed (Eq. 2) in order to get the relative quality of each prediction. Finally we exclude predictions with $\beta_n < 0$, while $\alpha = 10$ is deduced empirically to preserve a representative set of data.

$$\beta_n = \sum_{i=1}^{N_p} (\alpha \cdot MDAE_i - |\varepsilon_{i,n}|) \quad (2)$$

In practice we accepted about 98.6% of the predictions and then performed the main statistical analysis based on the Mean Absolute Error (MAE) expressed by equation

$$MAE_i = \frac{1}{N_{Acc}} \sum_{k=1}^{N_{Acc}} |\varepsilon_{i,k}|, \quad i = 1, 2, \dots, N_p, \quad (3)$$

where N_{Acc} is a number of accepted predictions related to the given EOP and prediction technique.

4. COMBINED PREDICTIONS

This part of our work is devoted to the combined solution and its relative quality with respect to the individual solutions provided by the participants. The final combined prediction CP is computed as a weighted mean of all submissions available at a given prediction epoch. The weights W are referred to the global quality factor Q and the number of accepted N_{Acc} submissions of a given prediction technique which can simply be described as follows:

$$W \sim [Q^2 \cdot N_{Acc}], \quad Q = \left(\sum_{i=1}^{N_p} MAE_i \right)^{-1}. \quad (4)$$

In that case small weight (Fig. 1) is caused by low quality factor and/or small number of submitted predictions. On the other hand significant contributions clearly say about good quality factor of the given predictions which can also be seen in the final comparison presented in the next section.

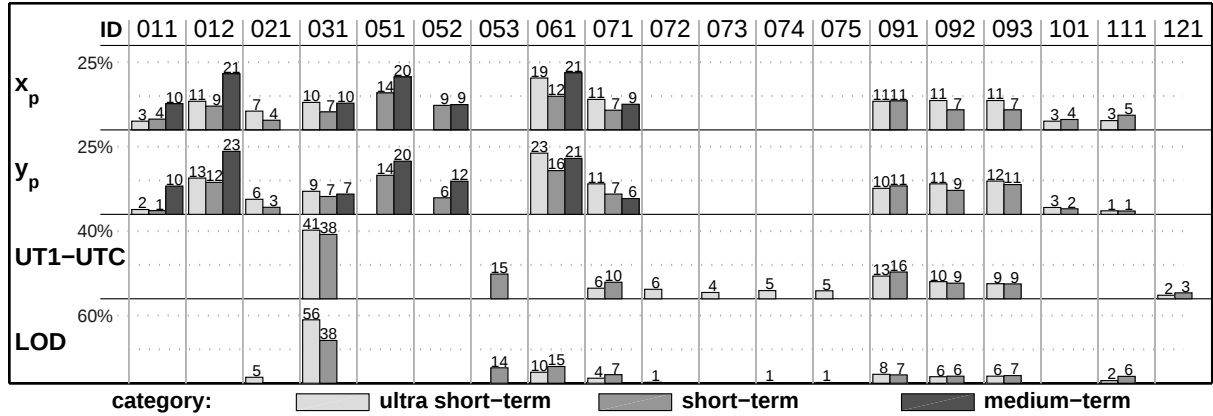


Figure 1: Contributions to the combined solution (weights [%])

5. RESULTS

The most important results of the EOP PCC are presented in Fig. 2 and for more information we refer to the EOP PCC website. Here we would like to underline that a brief comparison of those results can lead to wrong conclusions. In order to express the reliability figures are supplemented by the bar plot related to the number of predictions used to compute MAE. Therefore a small bar means that a given result is less reliable and in fact the direct comparison can be performed between results with maximal or at least significant reliability. The MAE of combined predictions is included as well with the exception of medium-term statistics of $UT1 - UTC$ where too few individual predictions are available. It is also worth to notice that due to lack of the future EOP data the medium-term statistics were computed from 8 submissions only.

6. CONCLUSIONS

Although we did not present the full results of the EOP PCC it is clearly visible that combined predictions are superior to most individual predictions, a fact which can also be seen when combining weather forecast. Nevertheless in order to increase the reliability of the results we need more submissions as well as more observed EOP data especially for medium-term category. It can be noticed that the short-term category of x_p , y_p is the most popular one within our campaign. In this case the combined solution provides the best accuracy.

7. PROSPECTS

The termination of the EOP PCC is foreseen in March 2008, however we hope its achievements will be very useful for the IERS Working Group on Prediction, which is going to find the best prediction algorithm for computing operational predictions of EOP. The first summary of the EOP PCC will be presented at the EGU General Assembly 2008. We plan to compute statistics with respect to different input data used by participants as well as to compare different types of algorithms.

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8. REFERENCES

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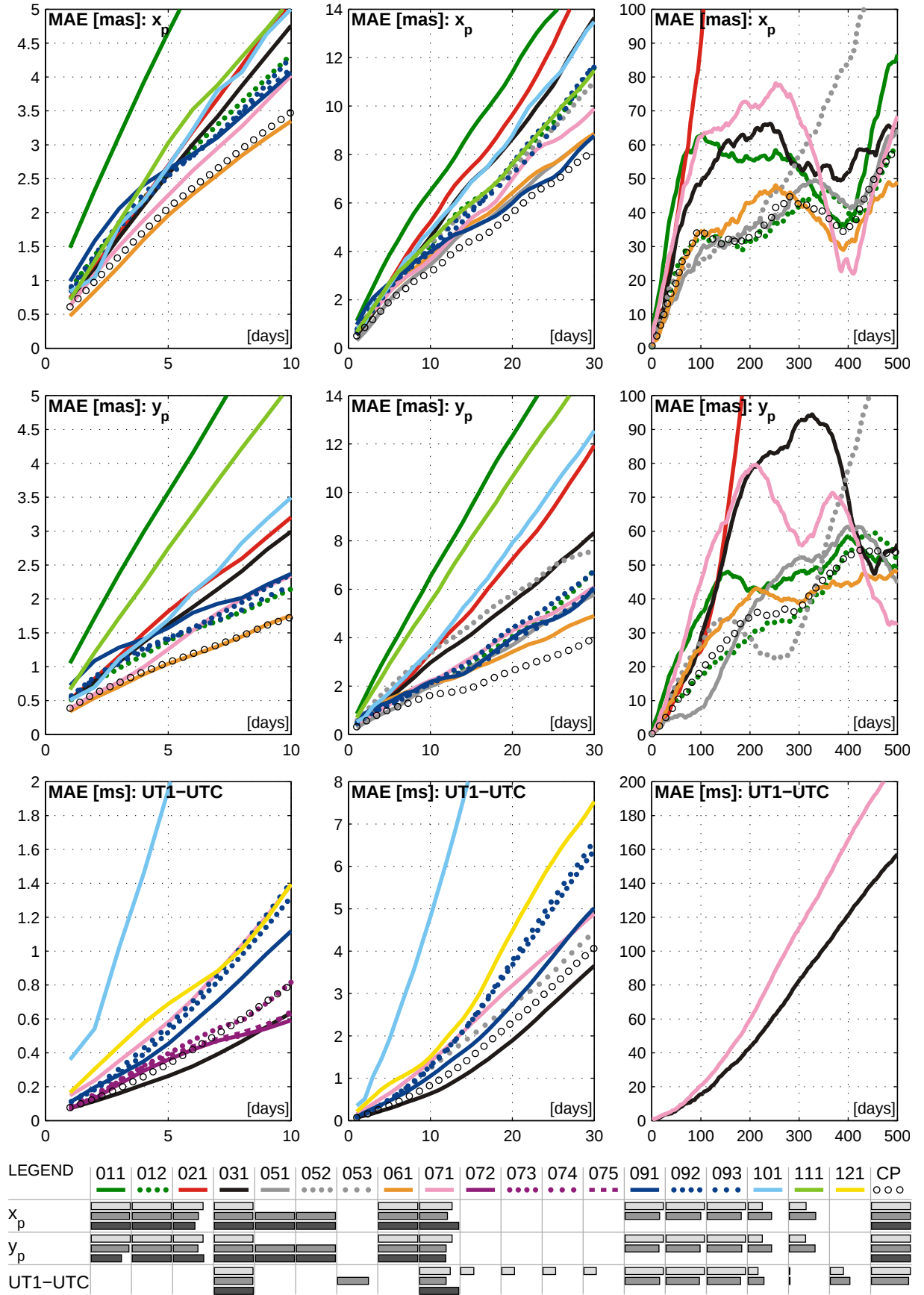


Figure 2: Mean Absolute Prediction Errors of x_p , y_p , and $UT1-UTC$ computed for all categories. Colors of the bars are related to different categories (like in Fig. 1)