Preliminary results from the Second Earth Orientation Parameters Prediction Comparison Campaign of the IERS

Jolanta Nastula[1], Henryk Dobslaw[2], Justyna Śliwińska[1], Tomasz Kur[1], Małgorzata Wińska[3], Aleksander Partyka[1]

[1]Centrum Badań Kosmicznych Polskiej Akademii Nauk, Warsaw, Poland
[2]GFZ German Research Centre for Geosciences, Potsdam, Germany
[3]Warsaw University of Technology, Faculty of Civil Engineering, Warsaw, Poland

eoppcc@cbk.waw.pl

http://eoppcc.cbk.waw.pl/

EGU General Assembly 2022, 23–27 May 2022, Vienna

Second EOP Prediction Comparison Campaign (2nd EOP PCC)

- Between 2005 and 2008, the **first EOP Prediction Comparison Campaign** (1st EOP PCC; *Kalarus et al., 2010*) provided a comprehensive assessment of the capabilities of different EOP prediction methods in an operational setting.
- In the light of the progress made in recent years in the field of improved geodetic data processing, reduced VLBI latency, and routine availability of model-based forecasts of effective angular momentum functions, a re-assessment of the various EOP prediction capabilities is now pursued in the frame of the **2nd EOP PCC**. The new campaign is carried out under the auspices of the IERS.
- The operational phase of the 2nd EOP PCC began on **September 1, 2022** and will last until **the end of 2022.**
- The aim of the 2nd EOP PCC is re-assessing various EOP prediction capabilities. In particular:
  - collecting and comparing EOP predictions from different institutions over a representative period of time,
  - evaluating the accuracy of final estimates of EOP,
  - identifying both accurate and robust prediction methodologies,
  - assessing the inherent uncertainties in present-day EOP predictions,
  - analysing the impact of various factors (input data used, method applied, reference data, length of prediction etc.) on prediction accuracy.
- The campaign will to some extent repeat the efforts made during the 1st EOP PCC, considering similar evaluation procedures and parameters.
- The EOP PCC Office at CBK PAN is responsible for data collecting, routine visualization and final evaluation of all submitted predictions.

Statistics

Participants and file statistics

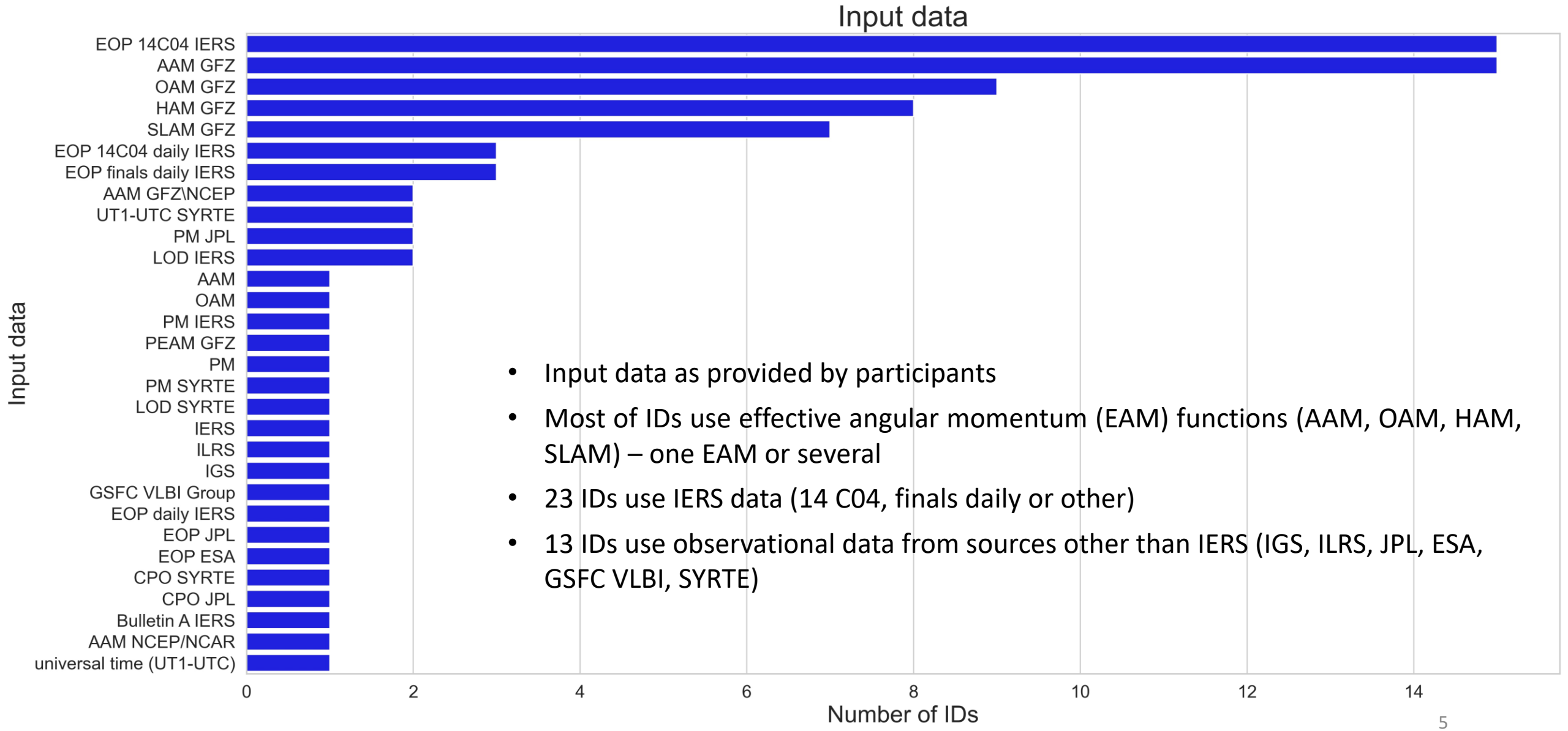
Table 1. Details on the 1st and 2nd EOP PCC participants and methods

	1st EOP PCC	2nd EOP PCC
Number of registered participants	13	22
Number of institutes	10	28
Number of countries of participants origin	7	9
Total number of all teams members	No data	66
Number of registered prediction methods (IDs)	20 (+1 combined prediction series)	56
Number of active participants	11	18

Table 2. Number of predictions submitted to the with respect to the number of participants and the number of IDs

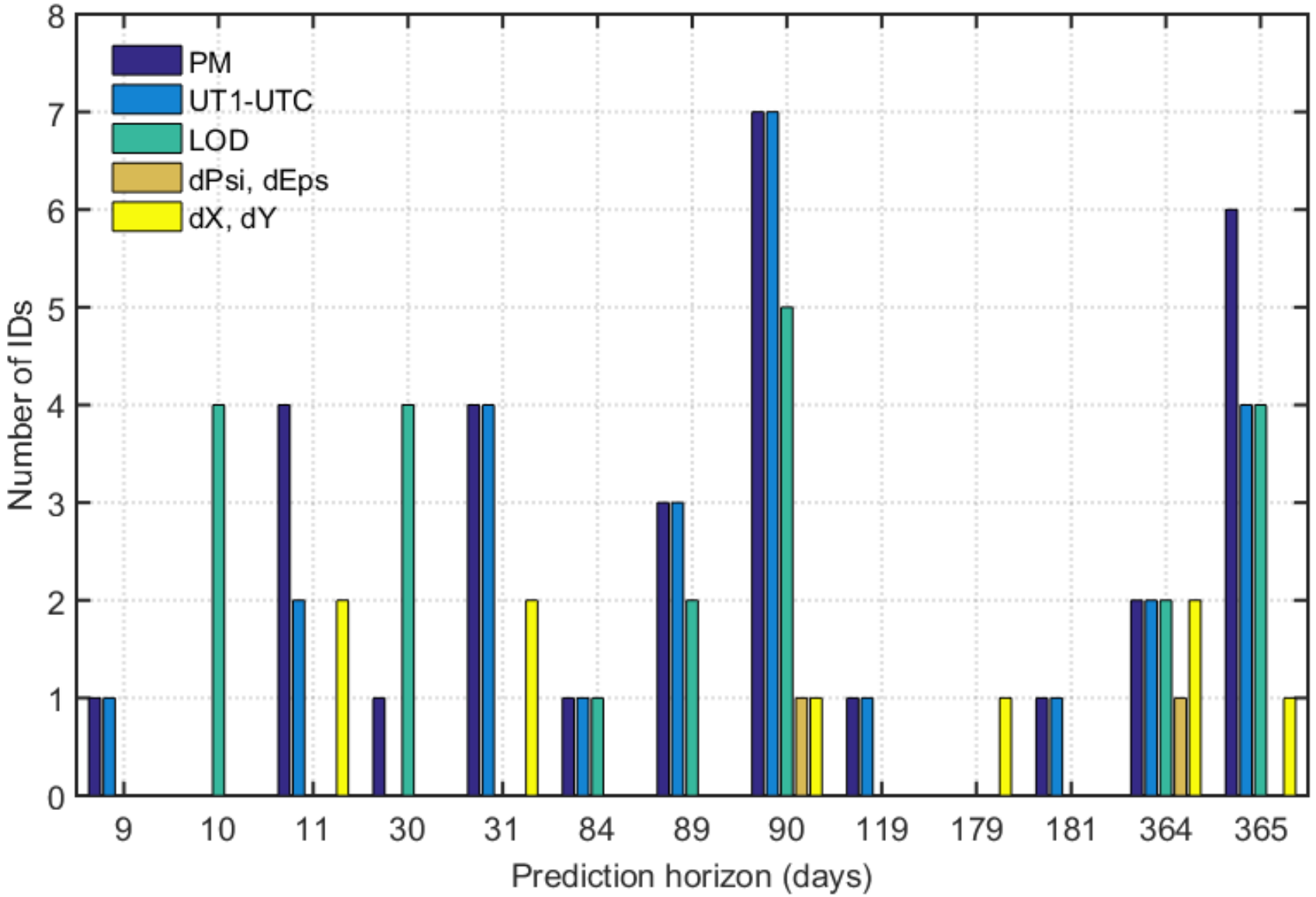
	x pole	y pole	UT1–UTC	LOD	dPsi	dEps	dX	dY	Total
Number of predictions	743	743	648	515	58	58	212	212	**3189**
Number of participants	18	18	16	11	2	2	6	6	**22**
Number of methods (IDs)	31	31	26	22	2	2	9	9	**56**

Input data used by participants to make the predictions



- Input data as provided by participants
- Most of IDs use effective angular momentum (EAM) functions (AAM, OAM, HAM, SLAM) – one EAM or several
- 23 IDs use IERS data (14 C04, finals daily or other)
- 13 IDs use observational data from sources other than IERS (IGS, ILRS, JPL, ESA, GSFC VLBI, SYRTE)

Length of predictions



Most common prediction horizon:

- for PM is 90 days
- for UT1-UTC 90 days
- for LOD is 90 days
- for dPsi, dEps are 90 and 364 days
- for dX, dY are 11, 31 and 364 days

Results

Reference data

Reference EOP	First day of comparison	Last day of comparison
IERS C04**	MJD: **59458** 1.09.2021 (start of the EOP PCC)	MJD: **59681** 12.04.2022 (last final EOP solution used in computation)

Due to the limited time we resigned from showing results for nutation – they can be found in the end of the presentation in section with additional information.

** https://datacenter.iers.org/products/eop/long-term/c04_14/iau2000/csv/
https://datacenter.iers.org/products/eop/long-term/c04_14/iau1980/csv/

Mean Absolute Error – MAE

$$MAE_i = \frac{1}{n_p}\sum_{j=1}^{n_p}\left|\varepsilon_{i,j}\right|$$

$$\varepsilon_{i,j} = x_i^{obs} - x_{i,j}^{pred}$$

Where:

$\varepsilon_{i,j}$ - differences between the observed EOP data x_i^{obs} and their ith point of jth prediction $x_{i,j}^{pred}$

n_p - number of predictions related to the same ID and the same parameter

$i = 1,2, \dots, I$

I - length of prediction

(*Kalarus et al., 2010*)

MAE for x pole and y pole

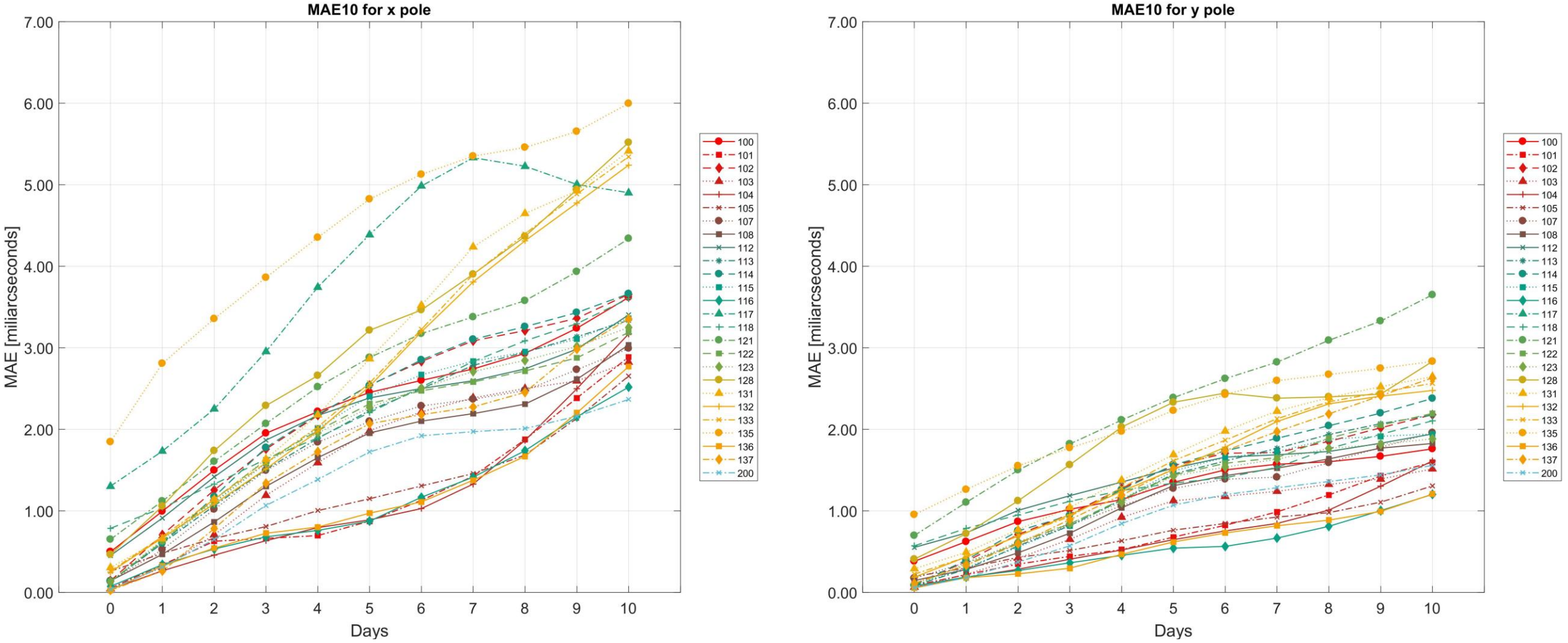
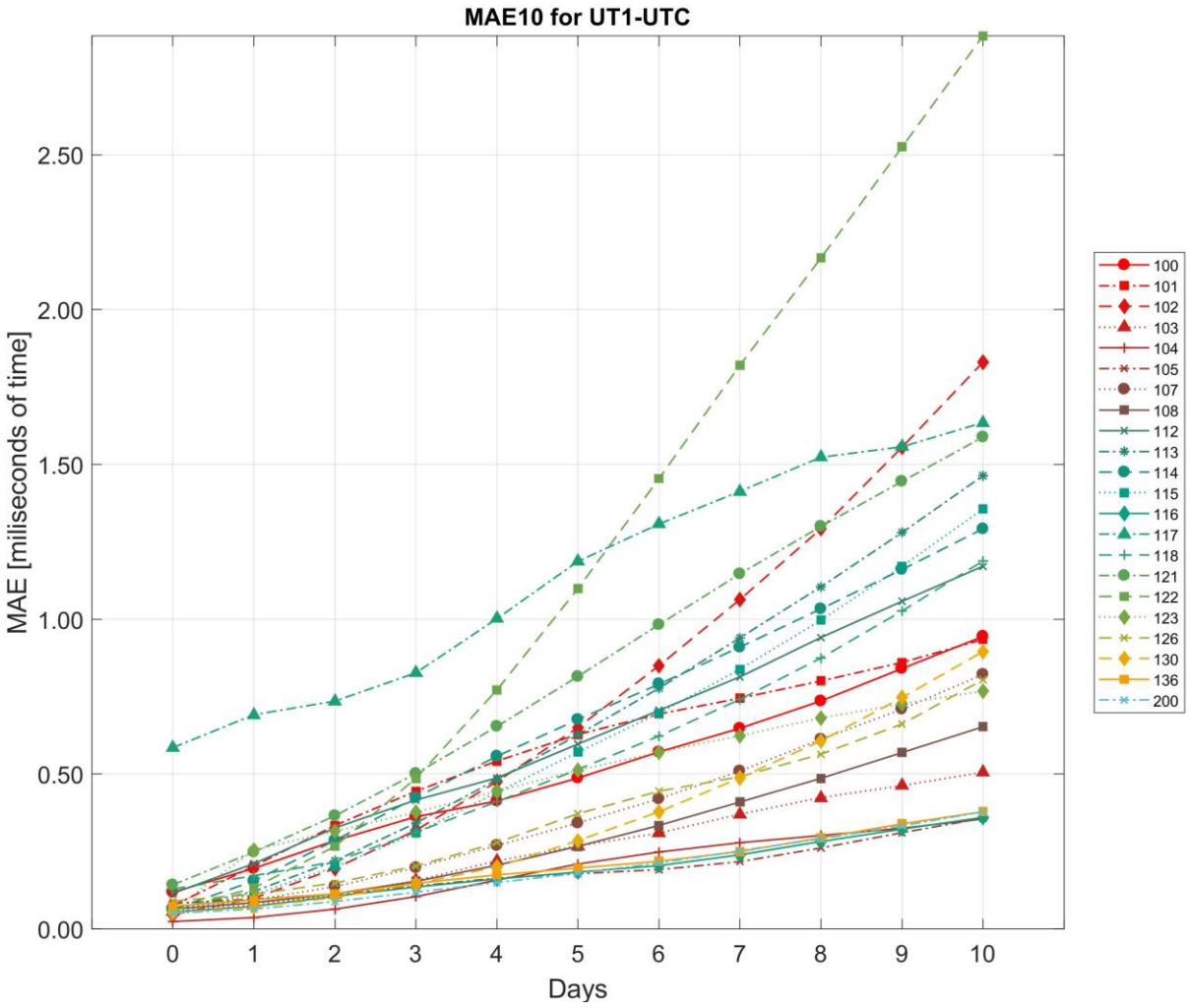


Fig. 1. Mean absolute error for x pole predictions (left) and y pole predictions (right) for forecast horizon up to 10 days

MAE for UT1-UTC and LoD



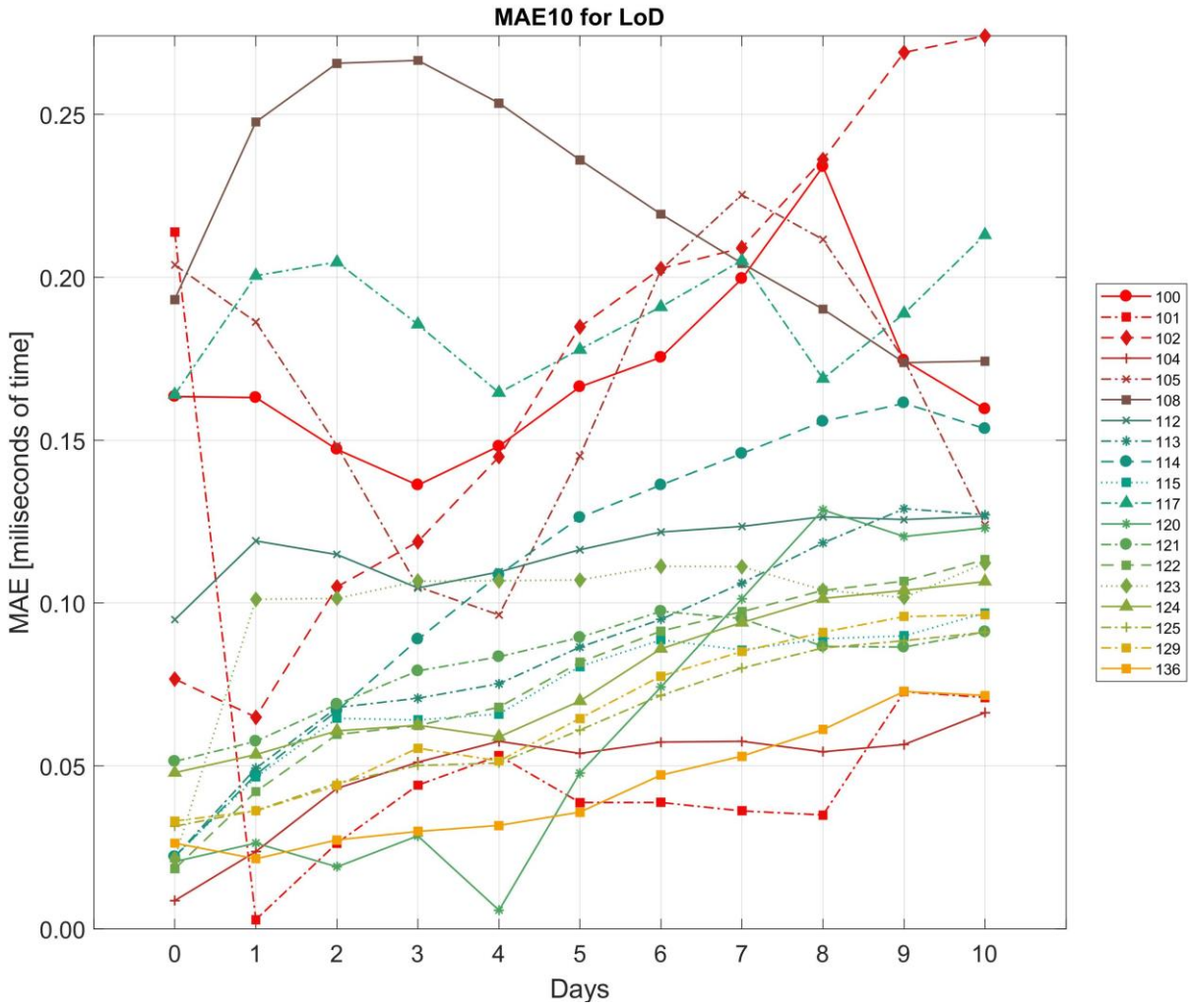


Fig. 2. Mean absolute error for UT1-UTC predictions (left) and LoD predictions (right) for forecast horizon up to 10 days

Conclusions and future plans

- Since the start of the 2nd EOP PCC, **22 participants** are registered with a total of **56 prediction methods** used, which is more than in the previous campaign.
- Most often predicted parameters are **PM, UT1-UTC and LOD** and most popular **prediction horizon is 90 days**.
- The results of the campaign are **promising** as there are **several predictions that achieve similar or even better accuracy than forecasts provided by the IERS**.
- Eight months after the start of the 2nd EOP PCC, obtained MAE for the 10th day of prediction was:
  - between 2.5 mas and 6.0 mas for x pole, between 1.2 mas and 3.7 mas for y pole,
  - between 0.4 ms and 2.8 ms for UT1–UTC,
  - between 0.07 ms and 0.27 ms for LoD.

  The corresponding values from the IERS Bulletin A was 4.0 mas for x pole, y pole and 1.4 ms for UT1–UTC.
- During the course of the campaign, we will continue to evaluate the quality of individual predictions also for longer predictions like annual. As soon as sufficiently long series of finally processed EOP are available it will be also possible to investigate in more detail the impact of the rapid EOP on the subsequent predictions.
- The benefit of the campaign is to provide specific feedback to participants about deficits in their products, which may lead to improvement in their computational algorithms.

Thank you

Backup slides

2nd EOP PCC – milestones

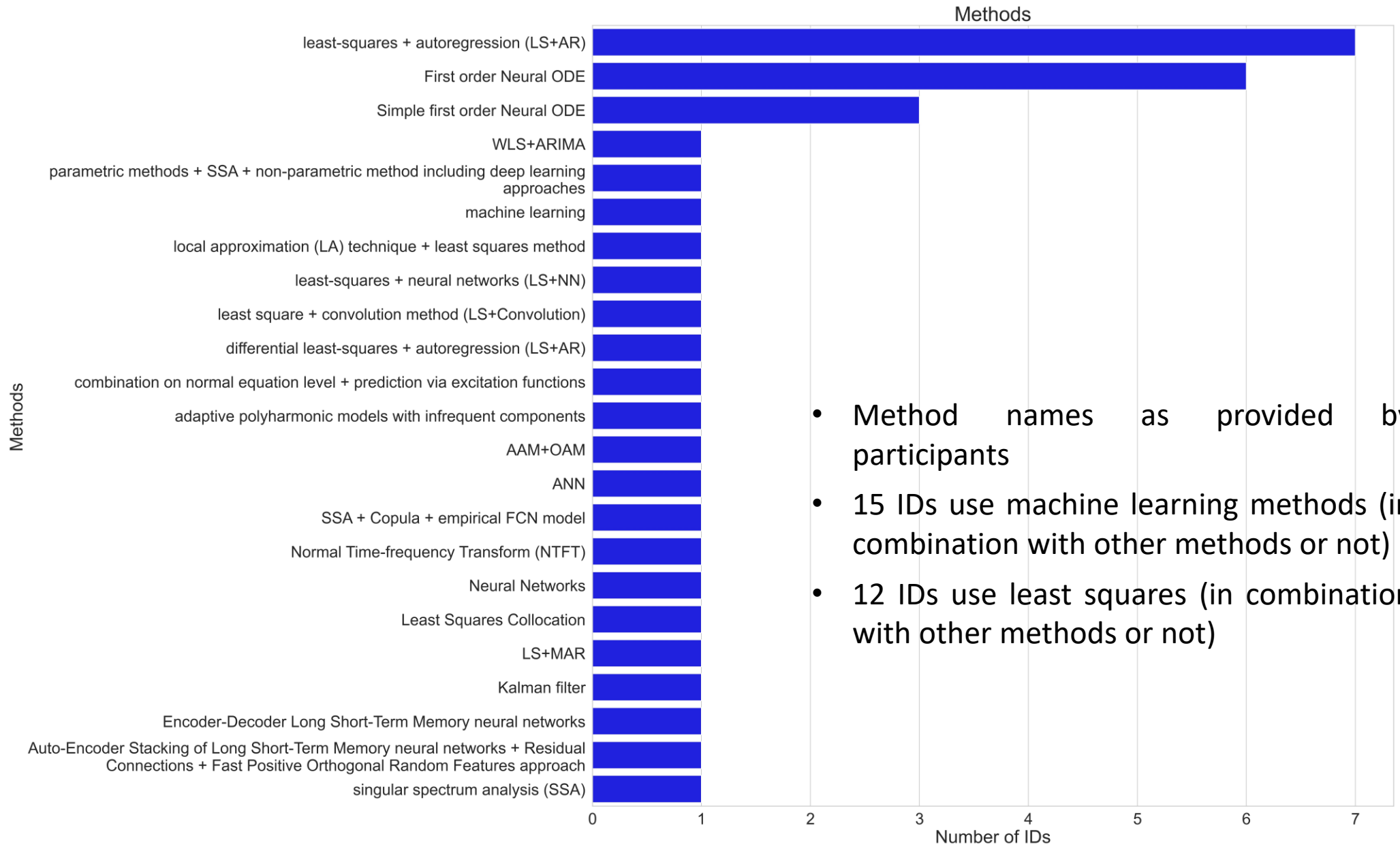
- **Q1 2021:** open call for participation in IERS Working Group on the 2nd EOP PCC (**24 March 2021**)
- **Q2 2021:** first meeting of WG on the 2nd EOP PCC (**6 May 2021**)
- **Q2 2021:** definition of the validation protocol, website of EOP PCC online, technical document summarizing all the rules and requirements (**2 June 2021**)
- **Q2 2021:** open call for participation in pre-operational phase of the 2nd EOP PCC (**3 June 2021**)
- **Q2 2021:** open the server for ID applications and preliminary submissions of predictions for testing purposes (**7 June 2021**)
- **Q2 2021:** first weekly submission of test EOP predictions (**9 June 2021**)
- **Q3 2021:** poster about preparations for the 2nd EOP PCC presented during the IAG Scientific Assembly (**1 July 2021**)
- **Q3 2021:** open call for participation in operational phase of 2nd EOP PCC (**13 July 2021**)
- **Q3 2021:** first weekly submission of EOP predictions (**1 September 2021**)
- **Q4 2021**: preliminary results presented during ICCC JWG C.1 Meeting (**25 November 2021**)
- **Q4 2021**: call for participation in the 2nd EOP PCC Workshop (**10 December 2021**)
- **Q4 2021**: poster with campaign overview and first results presented during AGU Fall Meeting (**16 December 2021**)
- **Q1 2022**: 2nd EOP PCC Workshop (**15-16 February 2022**)

preparations

test phase

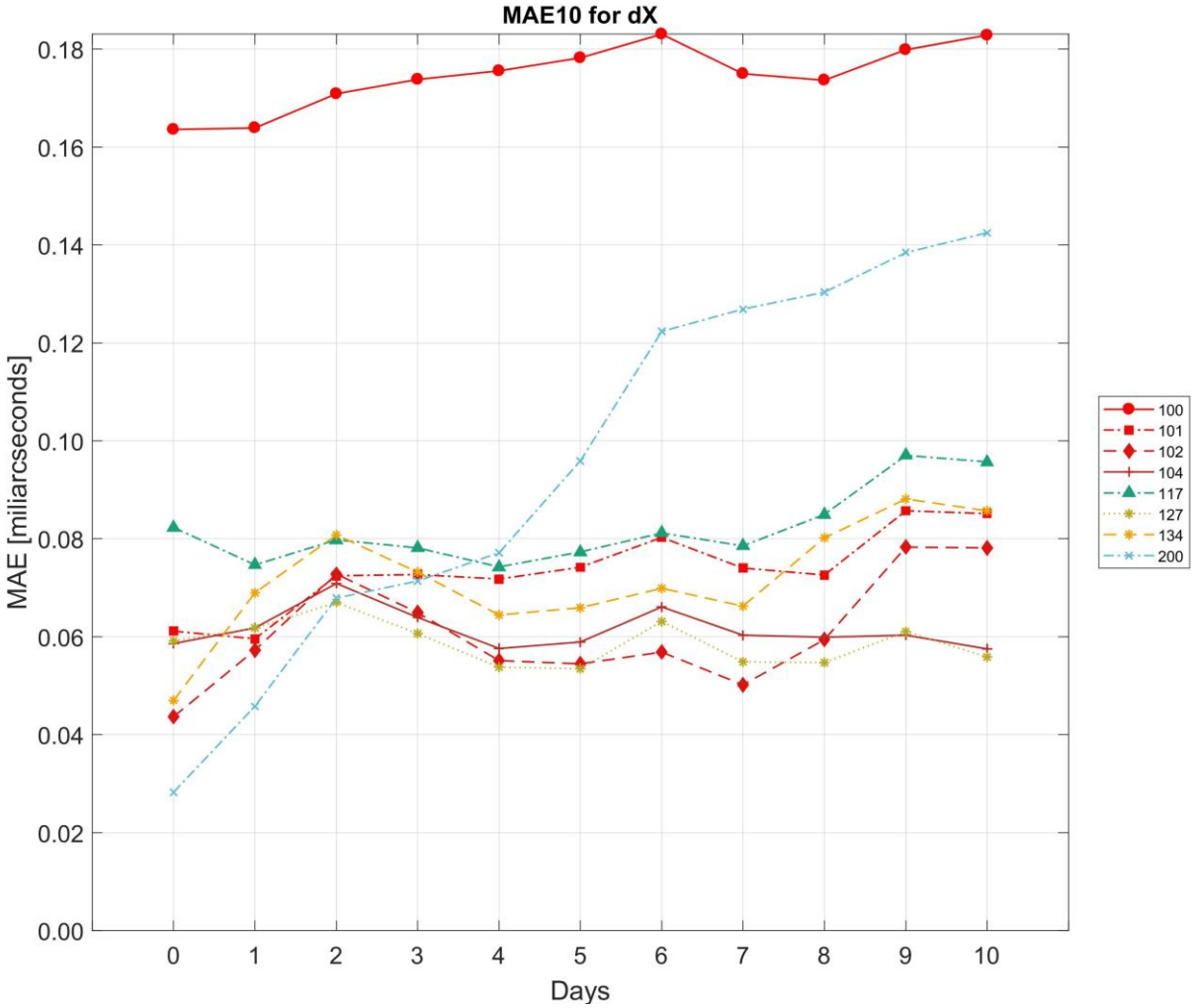
operational phase

Methods used by participants to make the predictions



- Method names as provided by participants
- 15 IDs use machine learning methods (in combination with other methods or not)
- 12 IDs use least squares (in combination with other methods or not)

MAE for dX and dY



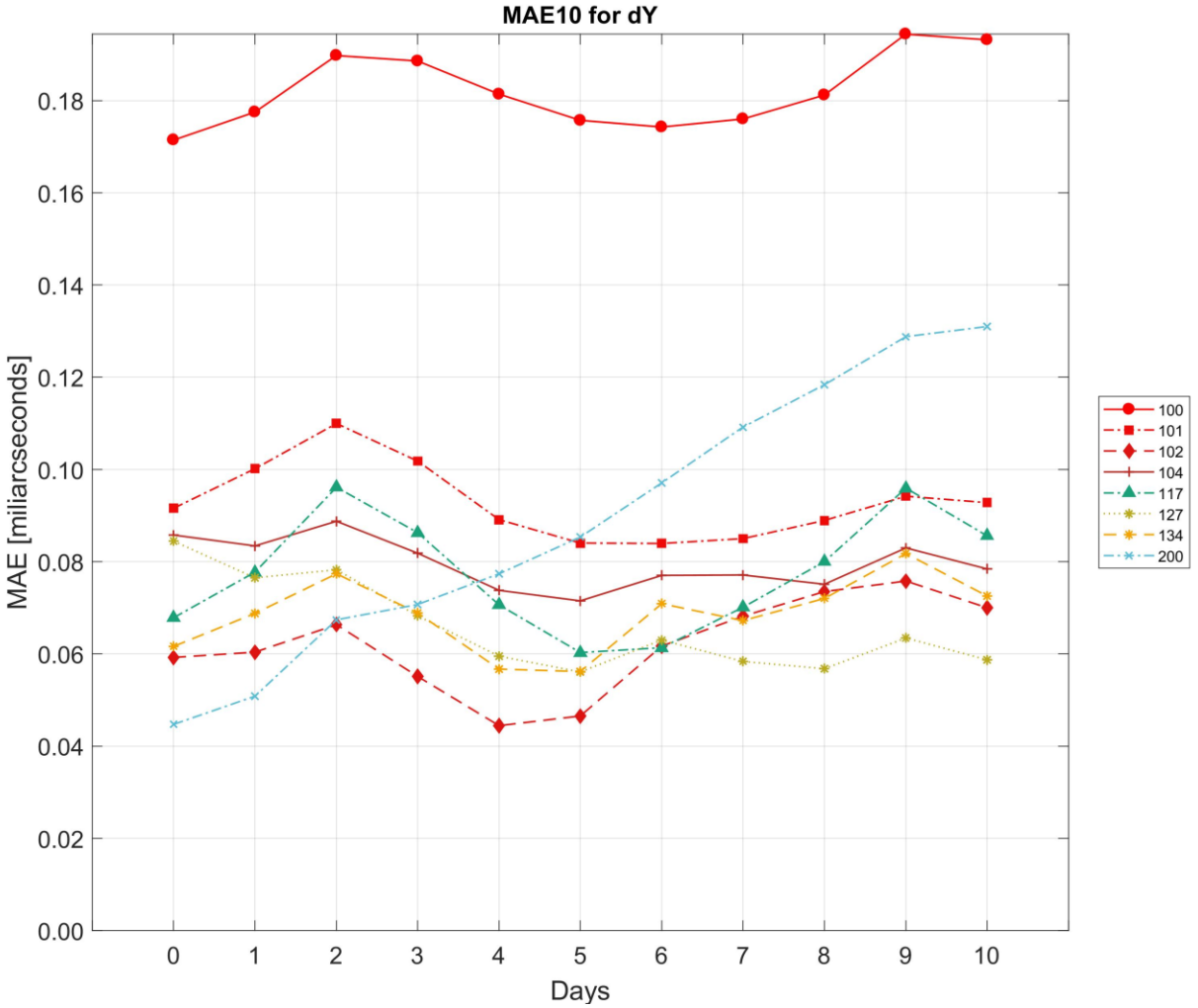
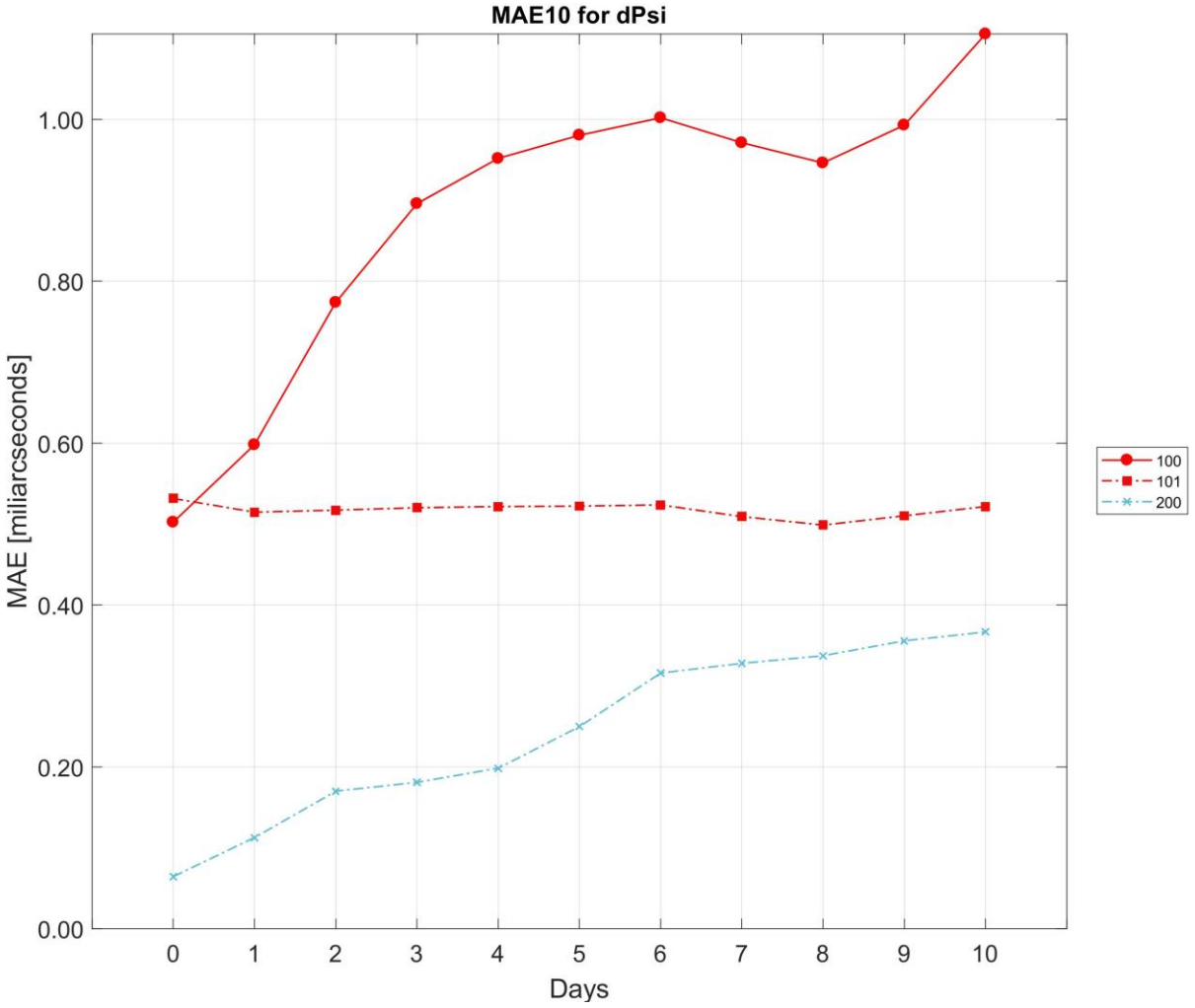


Fig. A1. Mean absolute error for dX predictions (left) and dY predictions (right) for forecast horizon up to 10 days

MAE for dPsi and dEpsilon



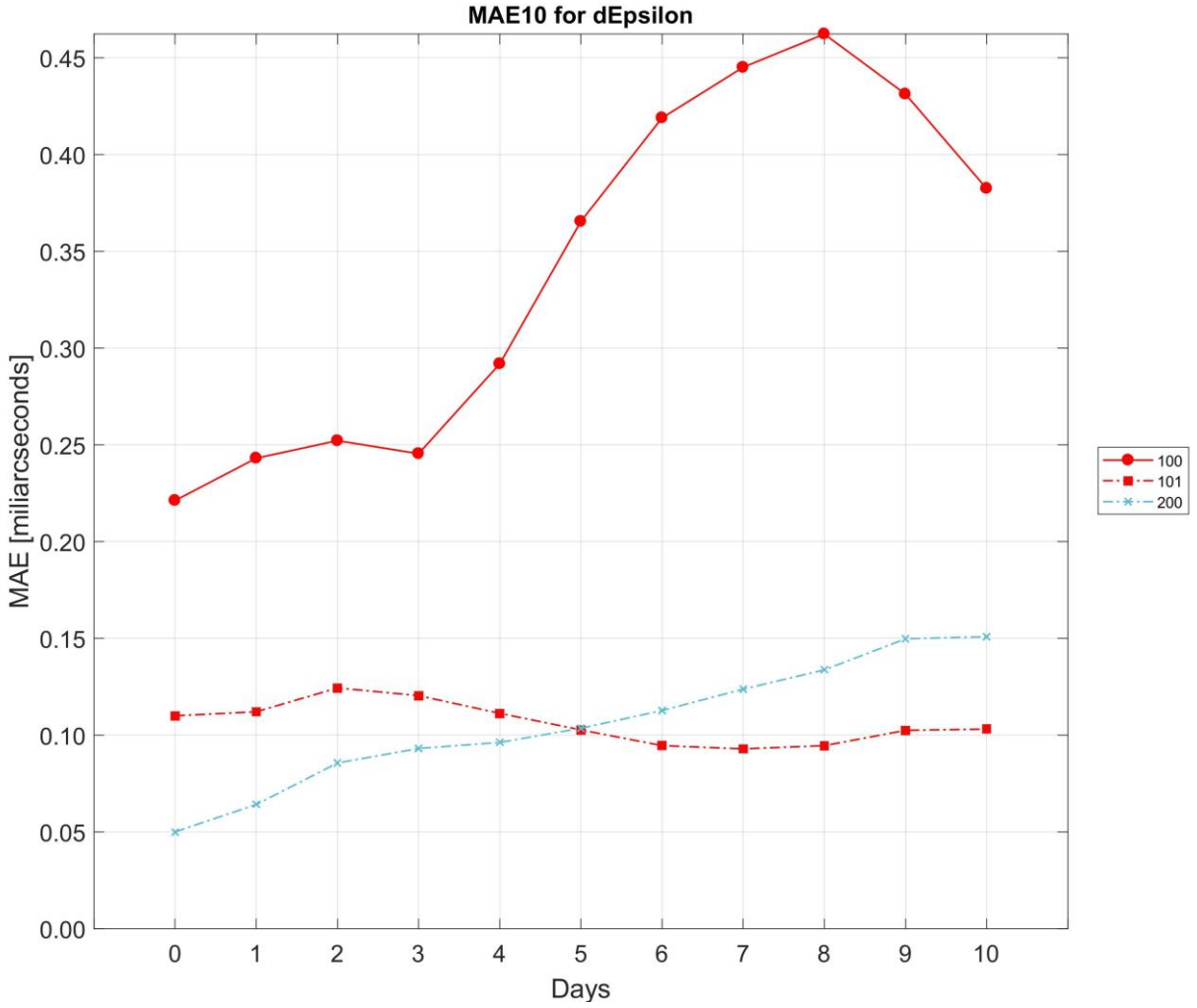


Fig. A2. Mean absolute error for dPsi predictions (left) and dEpsilon predictions (right) for forecast horizon up to 10 days