Researches on predictions of Earth orientation parameters

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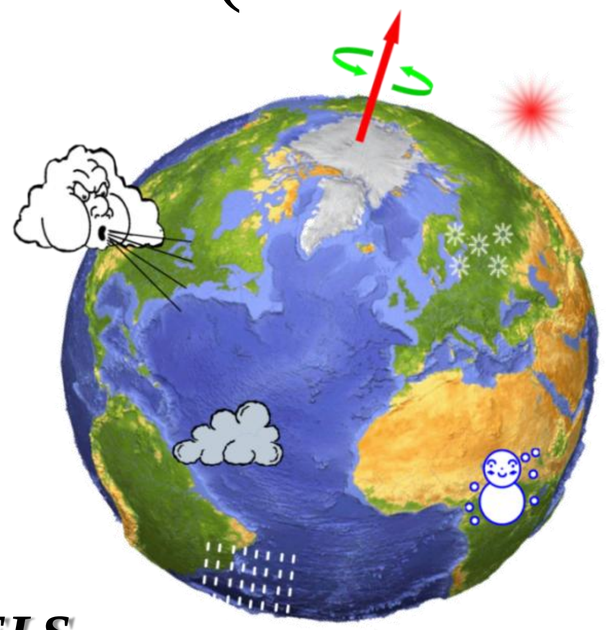
（1） Introduction of EOP prediction

▸Earth's rotation and EOP

- The Earth's rotation characterized the overall state of the Earth motion, and reflects the coupling process between the solid Earth and Various geophysical factors.

- Earth orientation parameters (EOP) mainly contains UT1-UTC, △LOD (Length of day change), PMX and PMY (Polar motion component).



（1） Introduction of EOP prediction

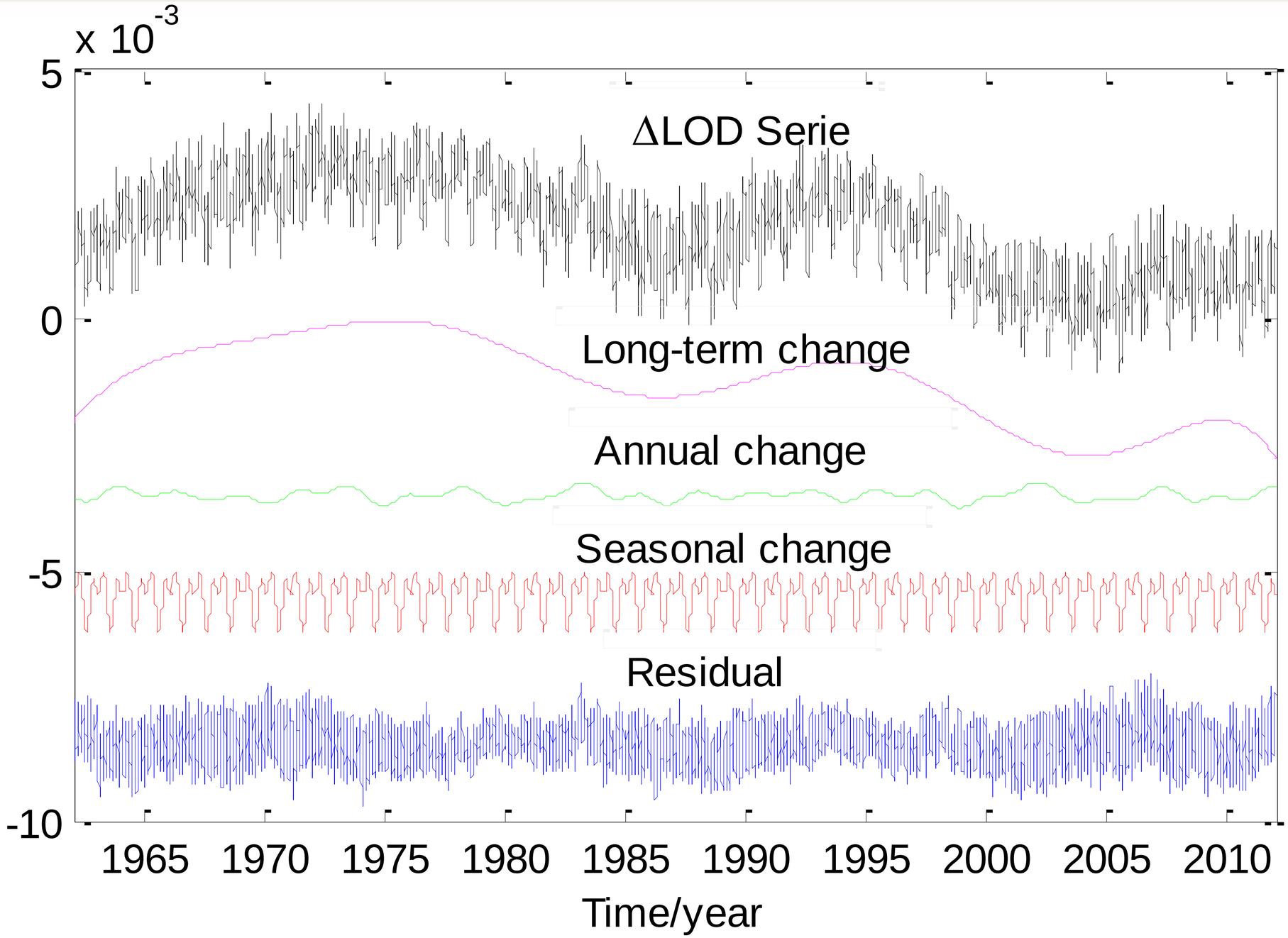


Fig 1. △LOD sequence and multiple time scale changes

（1） Introduction of EOP prediction

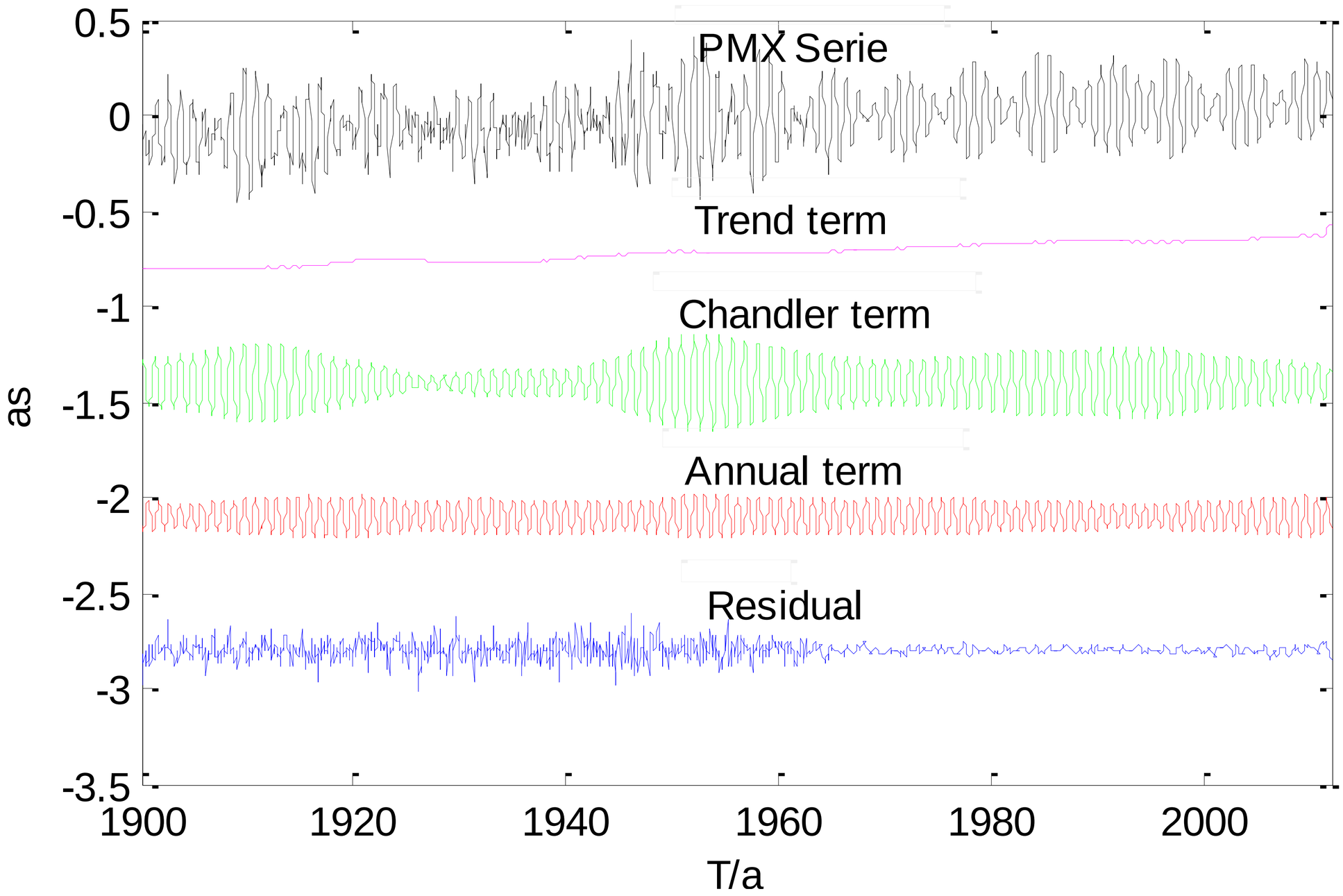


Fig 2. PMX sequence and multiple time scale changes

（1） Introduction of EOP prediction

- Earth orientation parameters (EOP) is essential for **transformation** between the celestial and terrestrial coordinate systems.
- The Earth Orientation Parameters Prediction Comparison Campaign, abbreviated as **EOP PCC**.
- Attracted 11 participants, and collected almost 6500 submissions .
- Estimating the accuracy of the EOP predictions and provoke the improvement.

（1） Introduction of EOP prediction

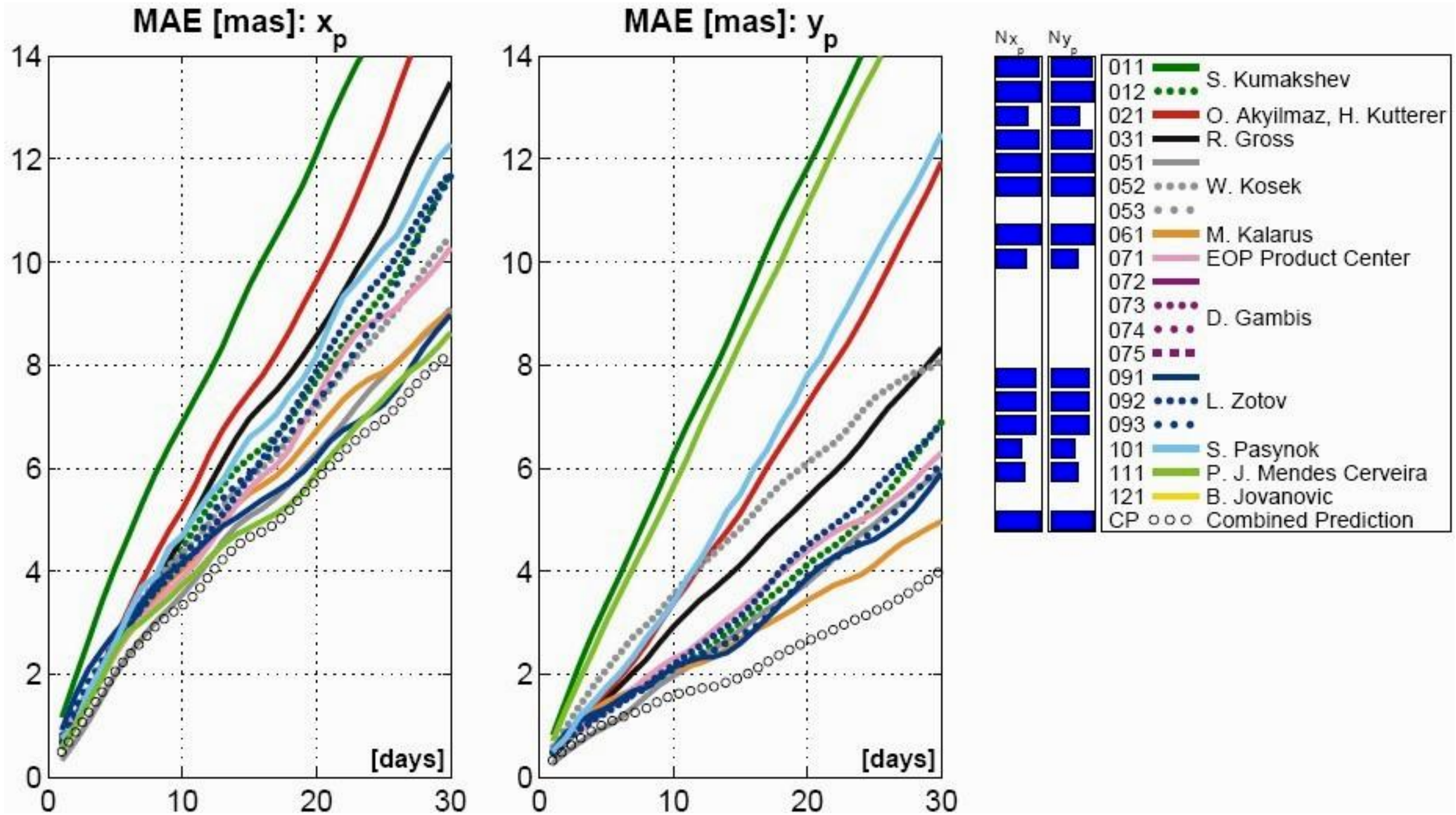


Fig 3. short term prediction accuracy（MAE）of PMX and PMY（Kalarus et al., 2010）

（1） Introduction of EOP prediction

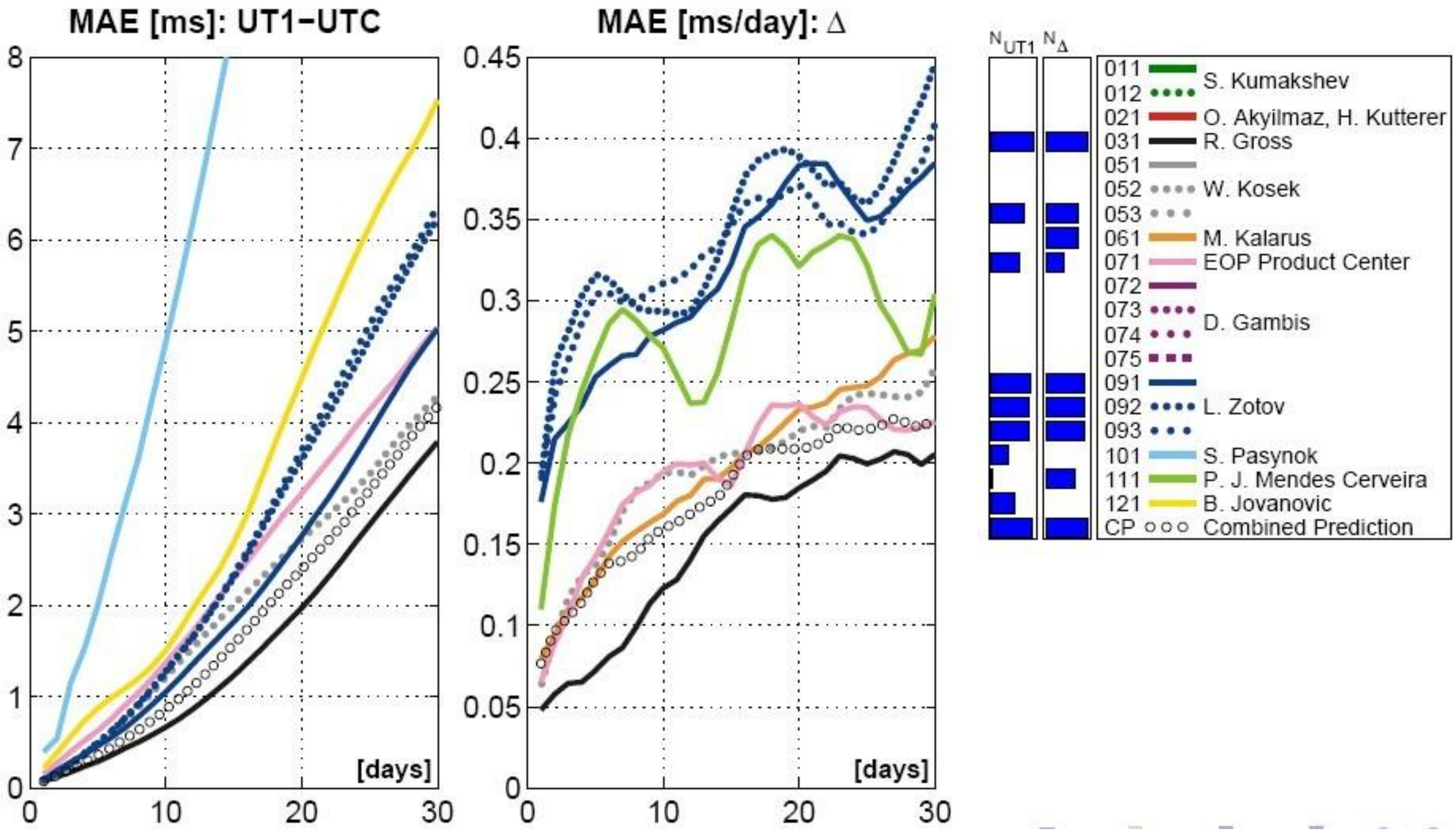


Fig 4. short term prediction accuracy（MAE）of UT1-UTC and △LOD（Kalarus et al., 2010）

（1） Introduction of EOP prediction

- Result shows that **no single forecasting method** works as good for all the parameters and all the time spans （Kalarus et al., 2010； XQ. Xu et al., 2012）.

- Get a **joint solutions** of variety forecasting methods to improve the accuracy and stability of EOP prediction .

（2） Our work about EOP prediction

▸AR+Kalman method

- we employ for the first time a combination of AR model and Kalman filter (**AR+Kalman**) in short-term EOP prediction.
- The combination of AR model and Kalman filter shows a significant improvement in short-term EOP prediction.

（2） Our work about EOP prediction

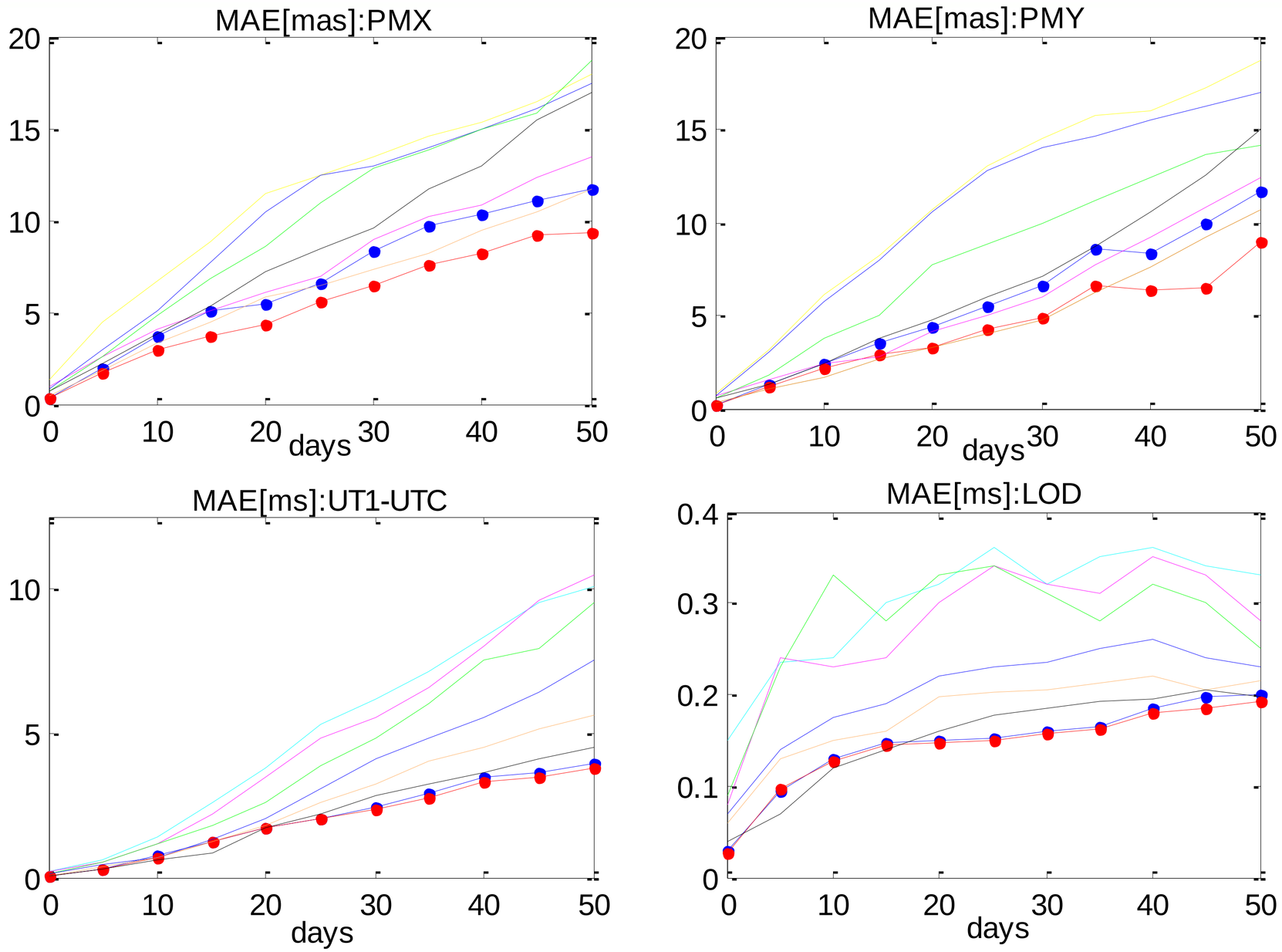


Fig 5. MAE for different prediction intervals for x and y components of polar motion (PMX, PMY),UT1-UTC, △LOD from this study and the EOP prediction comparison campaign (EOP PCC) (Kalarus et al., 2010). Blue curve and dots: this study using AR model; Red curve and dots: this study using AR +Kalman model; others(EOP PCC)(XQ .Xu., et al., 2012; Kalarus et al., 2010).

（2） Our work about EOP prediction

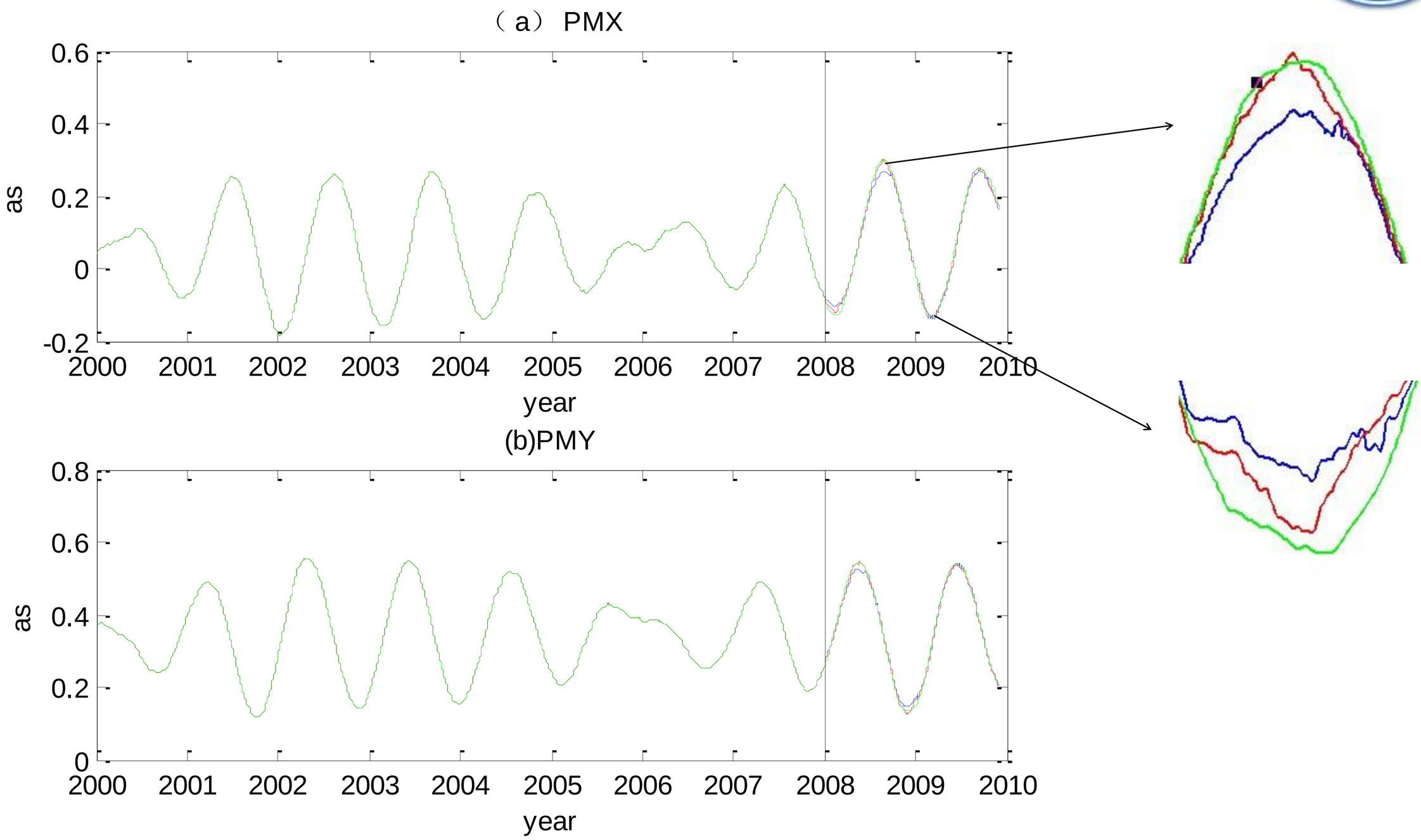
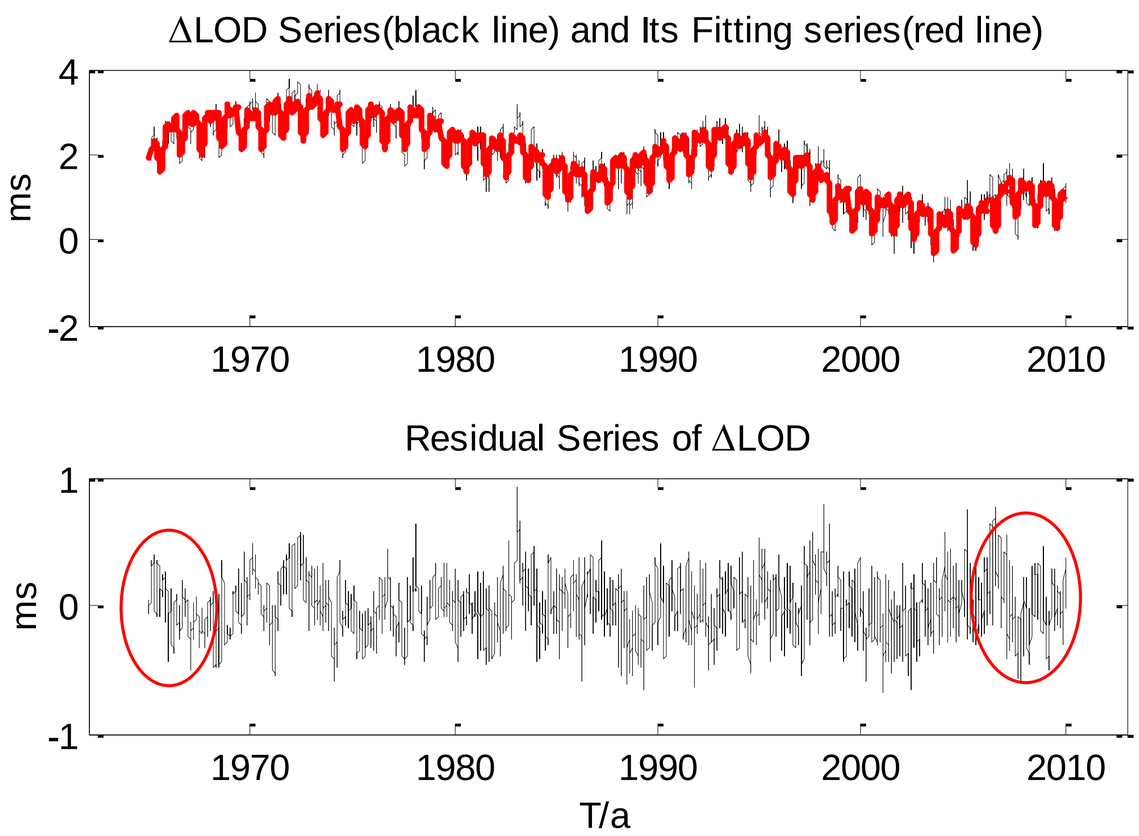


Fig 6. PMX, PMY observations during Jan.1, 2000 ~ Dec. 20, 2009 (green curve), and the 30-day polar motion (PMX, PMY) predictions by means of AR (blue curve) and AR+Kalman (red curve) methods starting from 2008.

（2） Our work about EOP prediction

Edge effect in EOP decomposition series



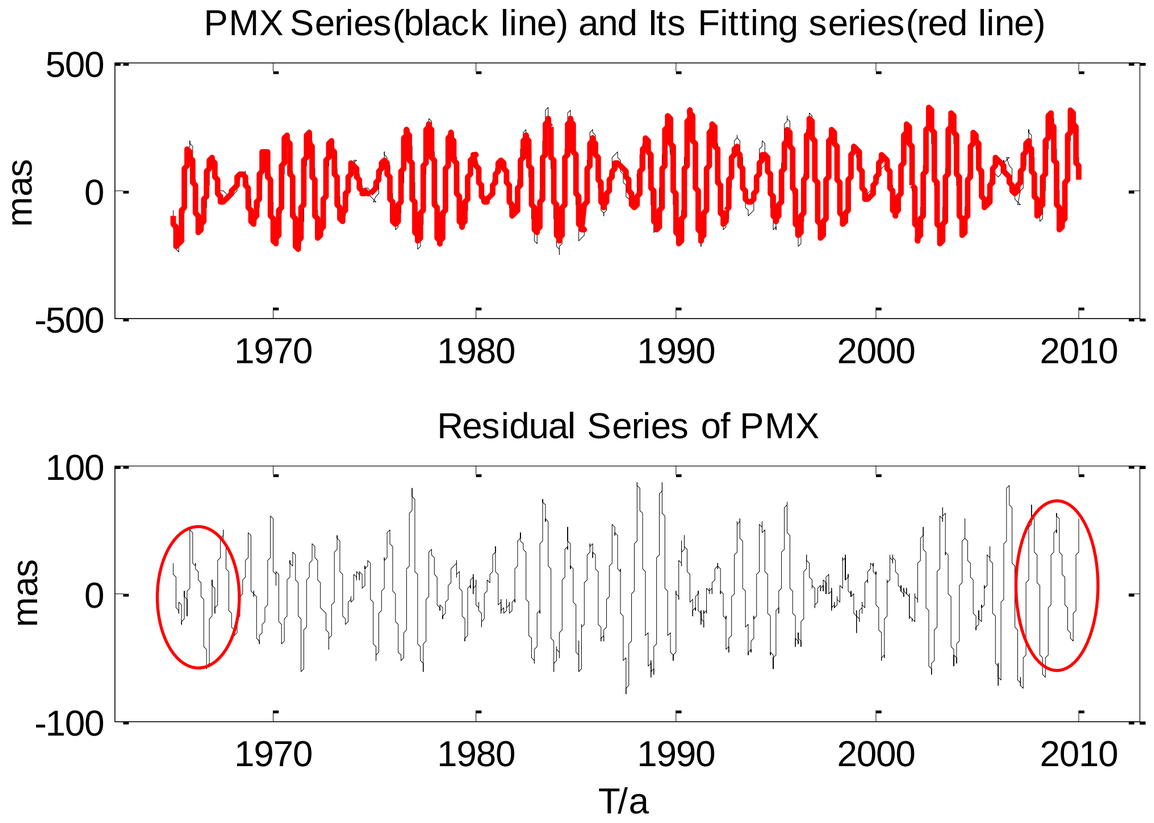


Fig 7. Edge effect in the residual series of △LOD and PMX sequence

（2） Our work about EOP prediction

LSTSA(Leap-Step Time Series Analysis model**)**

$$Z_n = D_n + S_n^{(p)} + E_n \qquad Z_n \in U_p \quad p = 1,2,...,h$$

Dn — Deterministic model, including bias, trend and stable periodic signals.

Sn — Stochastic model such as an autoregressive (AR), autoregressive moving average(ARMA), or nonlinear model.

En — Additive white noise.

Up — The pth leap-step domain of time series Zn .

（2） Our work about EOP prediction

Extension EOP sequence from both ends by LSTSA

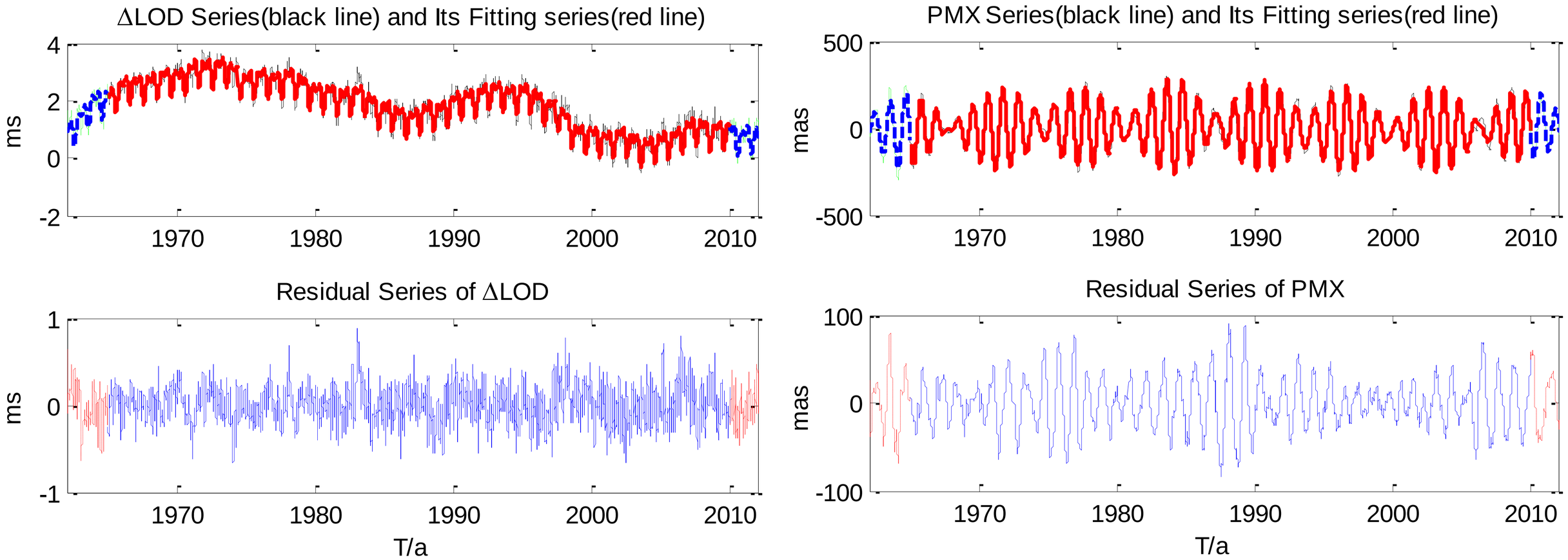


Fig 8. Extension series of △LOD and PMX sequence by LSTSA model

（2） Our work about EOP prediction

Improvement of edge effect by LSTSA

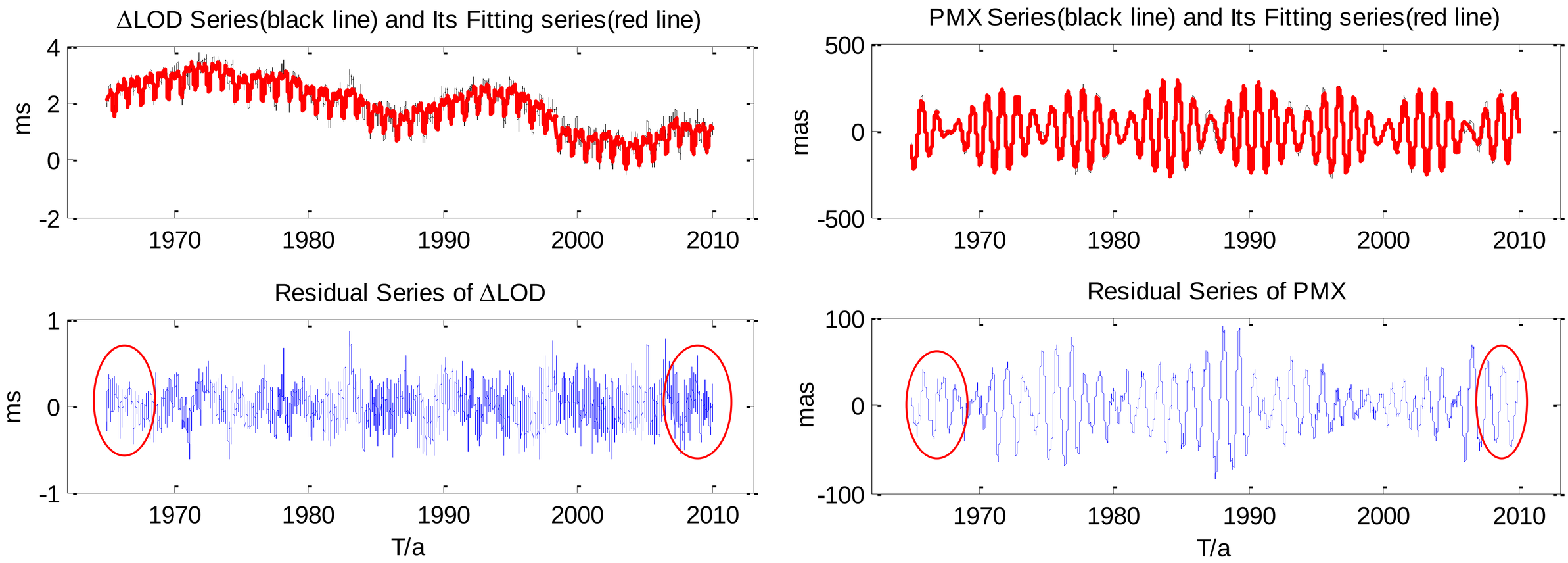


Fig 9. Improvement of edge effect in △LOD and PMX residual sequence by LSTSA model

（2） Our work about EOP prediction

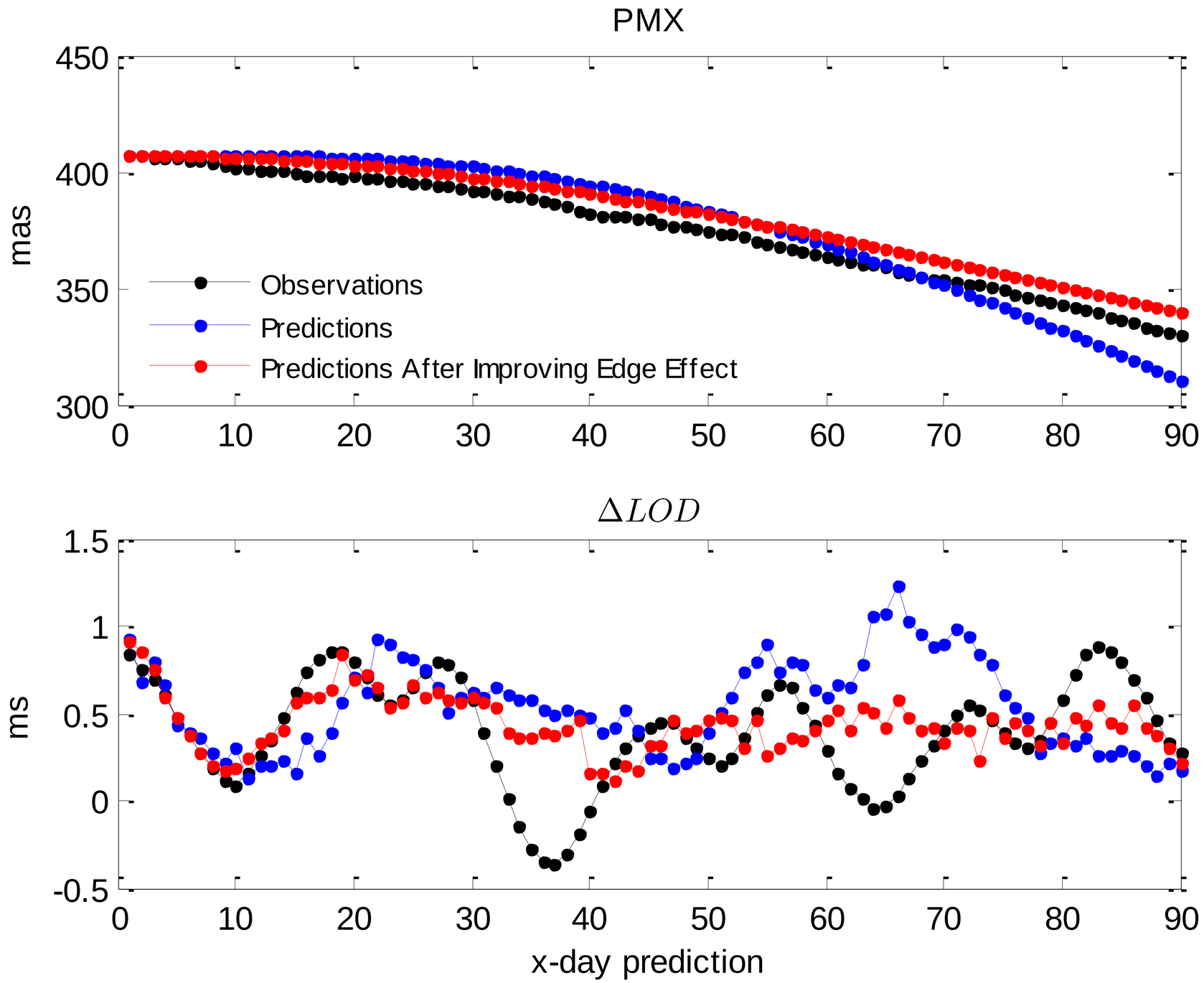


Fig 10. PMX and △LOD observations and predictions before and after improvement of edge effect

（3） Participation of EOPC PPP

▸EOPC PPP

- Earth Orientation Parameter Combination of Prediction Pilot Project，abbreviated as **EOPC PPP**.

- China participate in the activities for the first time .

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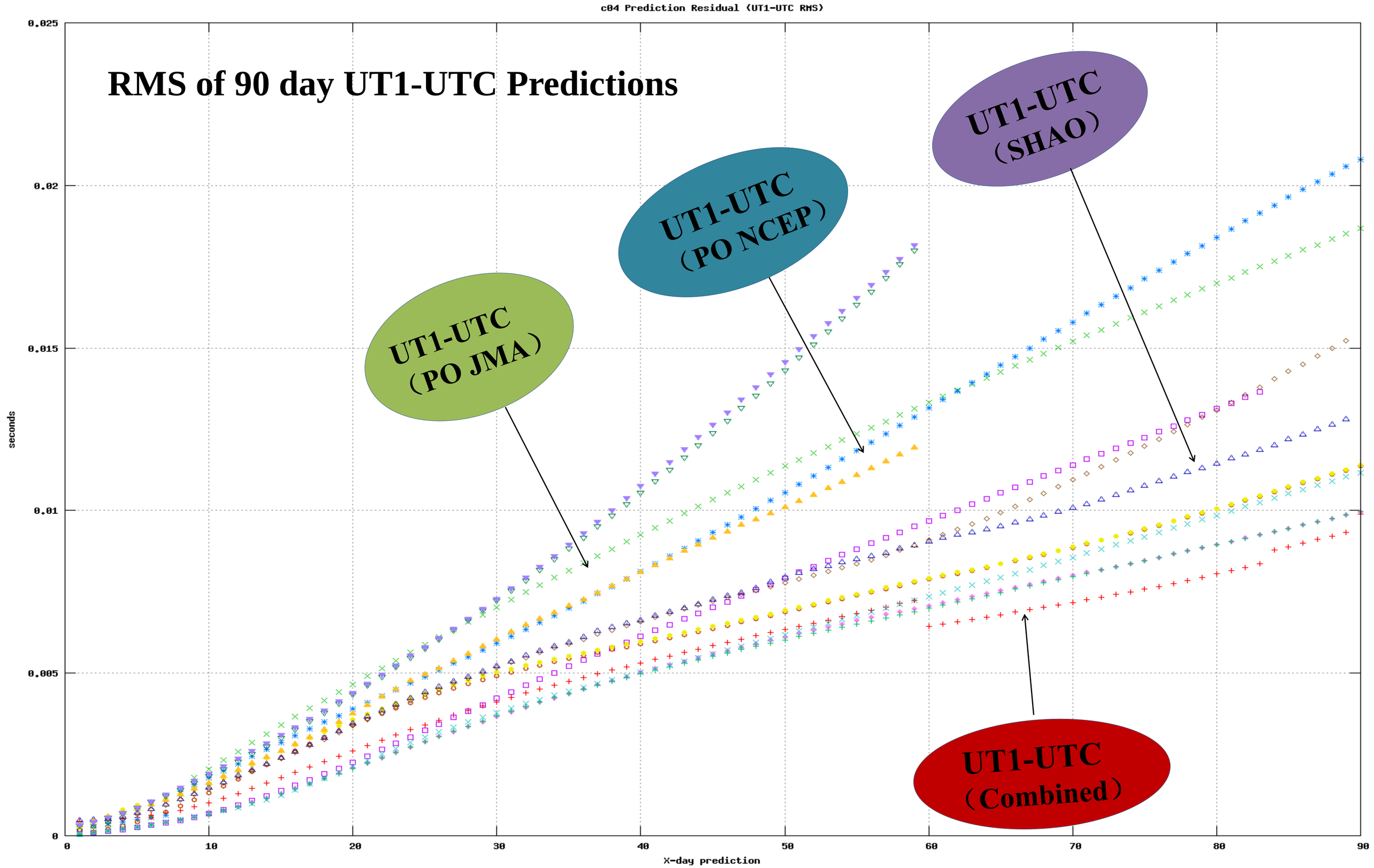
EOP Predictions	■ http://202.127.29.4/xxg/ ■ USNO mirror
Explanation/Methodology	■ The EOP data are pre-processed to remove known effects such as leap seconds and solid Earth tides, differenced, and then least-squares extrapolation and autoregressive (LS+AR) methods are applied to the data.

（3） Participation of EOPC PPP



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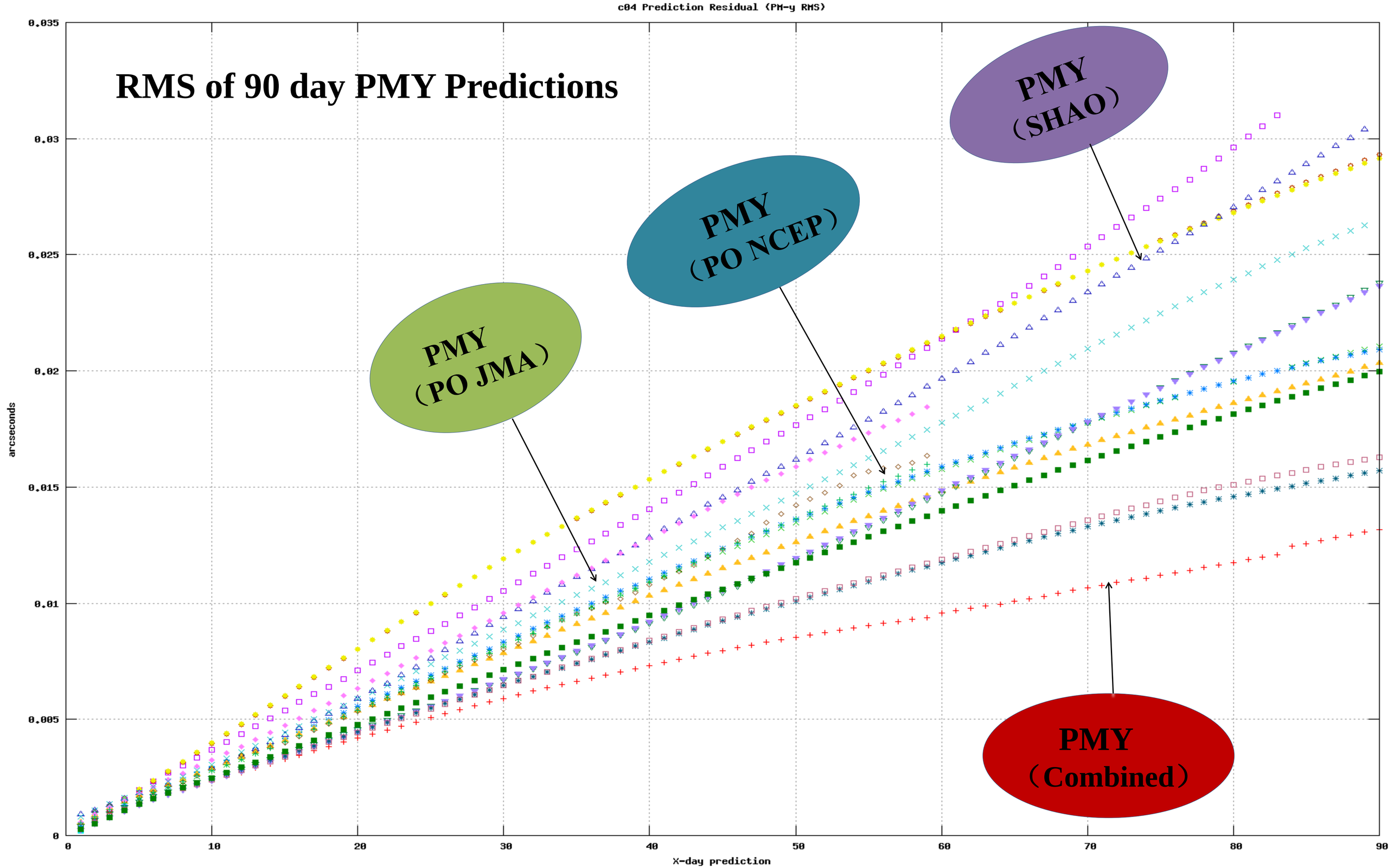

summary

- **AR+Kalman** is an effective method for EOP Prediction.
- **LSTSA model** can improve edge effect in EOP decomposition series and enhance prediction accuracy significantly.
- Higher precision EOP prediction needs more **cooperation**.

Thanks for your attention!