Towards the improvement of EOP prediction:

first results of the 2nd EOP PCC

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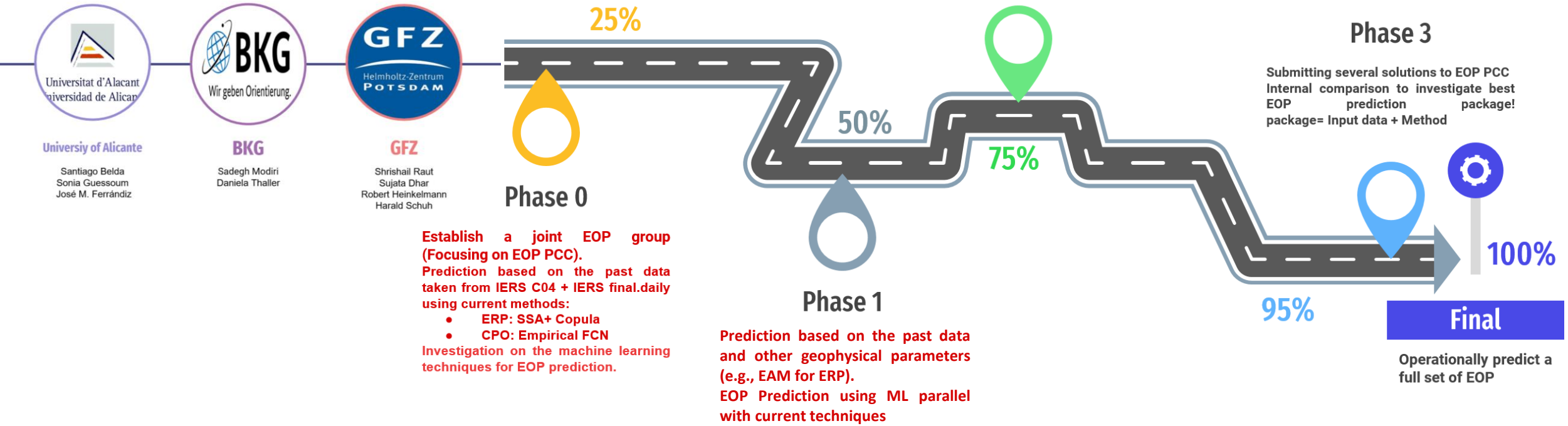
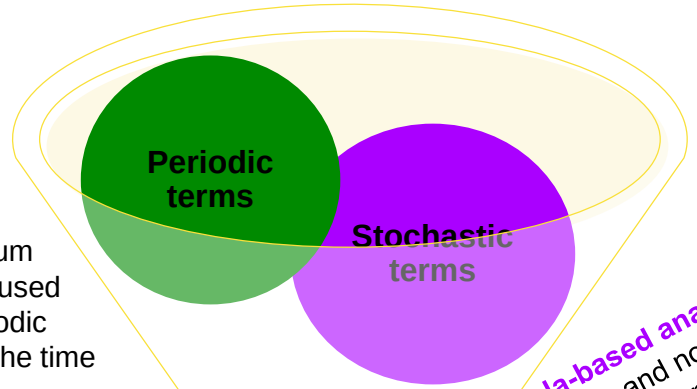
Introduction



Phase 0 – Techniques:

ERP Prediction

- **Combination of SSA + Copula analysis method**



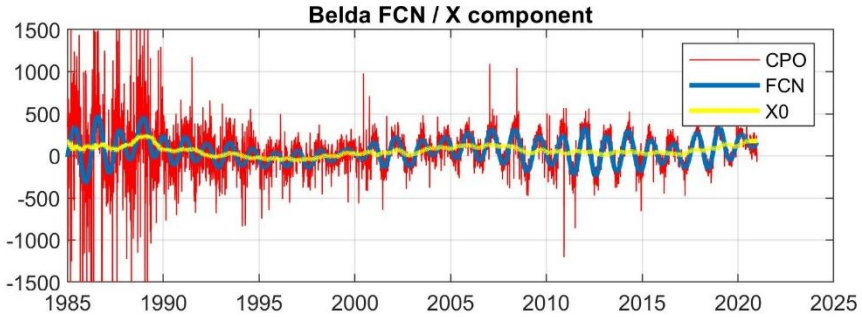
Singular Spectrum Analysis (**SSA**) used for deriving periodic components of the time series.

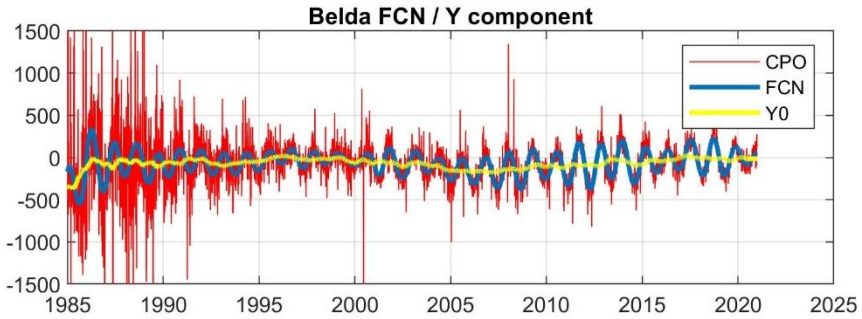
The **Copula-based analysis** performs linear and nonlinear dependency between variables.

Hybrid model: SSA + Copula

CPO Prediction

- **Empirical Free core nutation (FCN)**

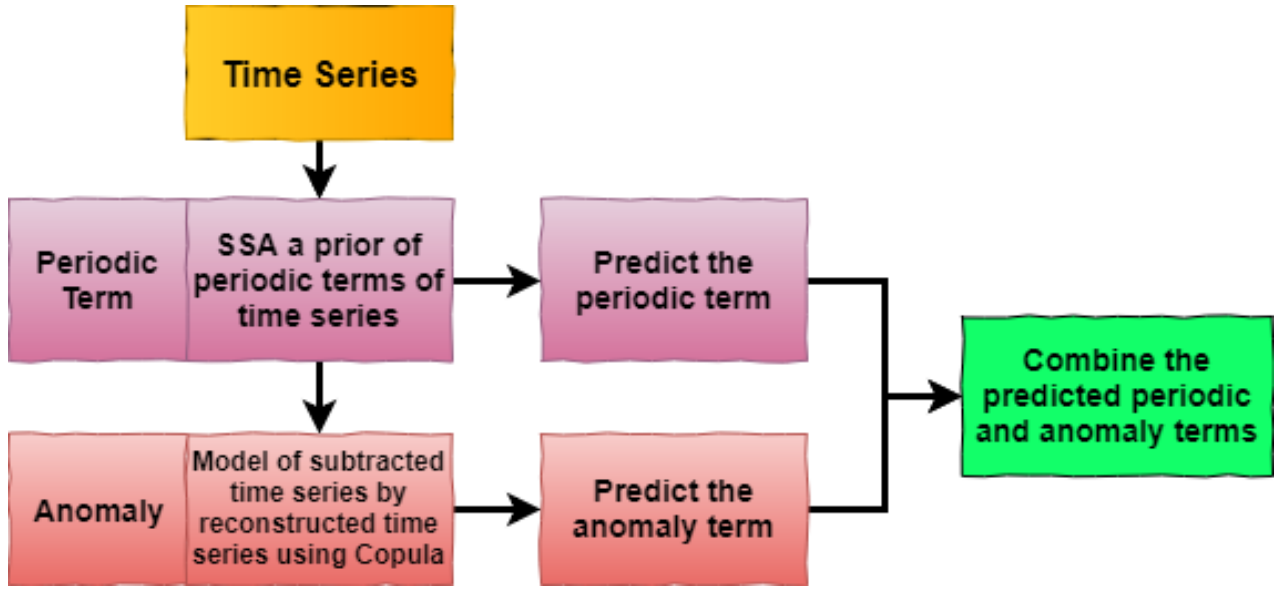




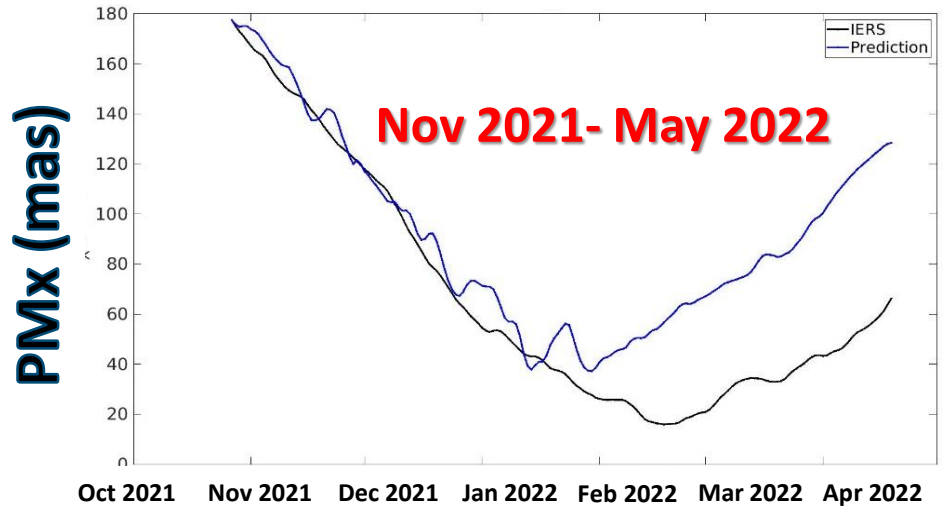
Phase 0 – ERP Prediction

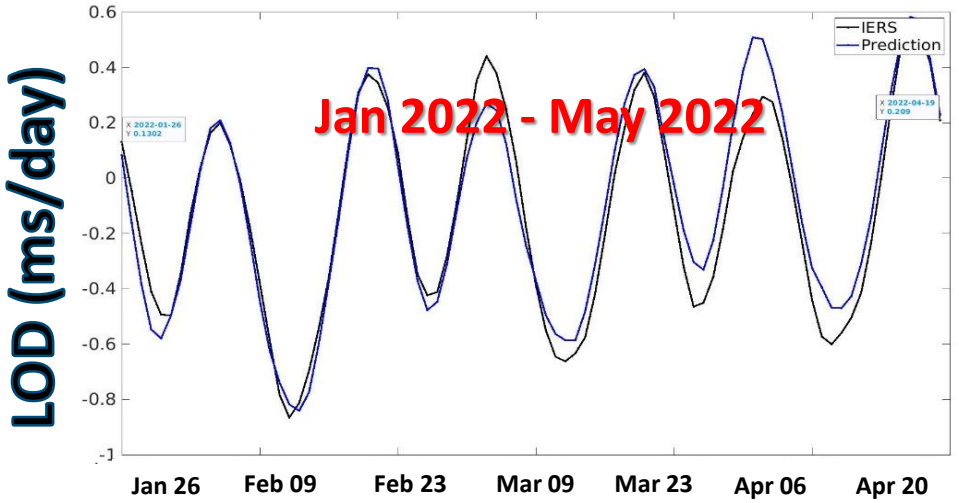
- Singular Spectrum Analysis (SSA)
  - SSA is a general time series analysis method which has been used for a wide range of tasks such as trend detection and extraction, de-noising, forecasting and change-point detection.
  - It is a nonparametric method.

- Copula-based Analysis
  - Copula contains all the information about dependence between random variables,
  - Any multivariate distribution can serve as a Copula,
  - Extension of the common concept of Correlation and Covariance.



Phase 0 – ERP Prediction – Selected Results





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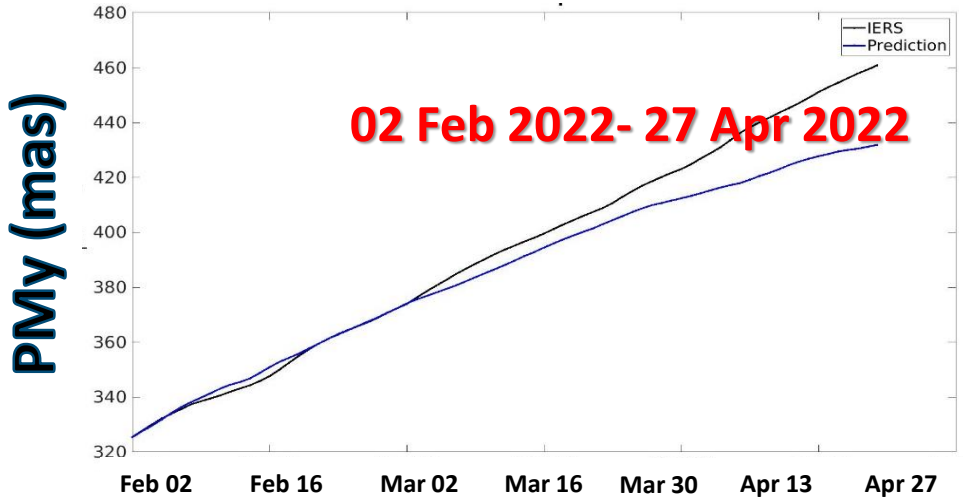
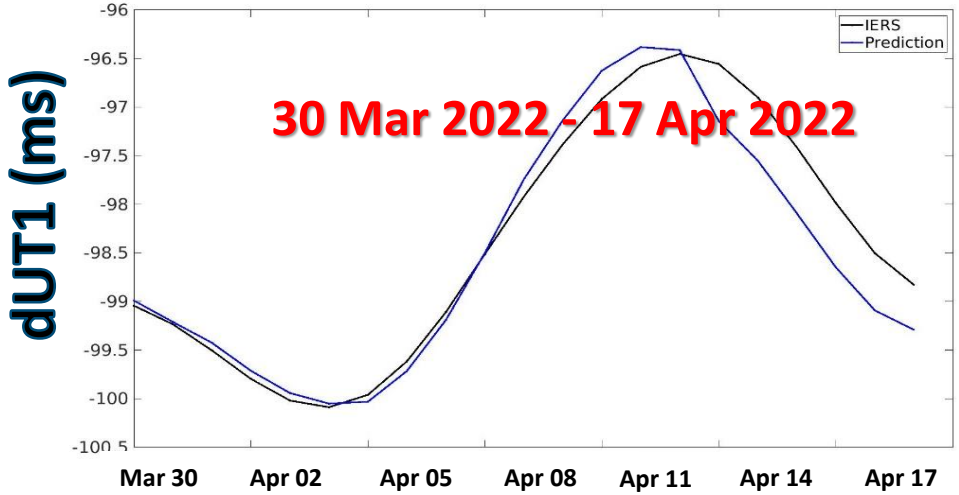
Prediction



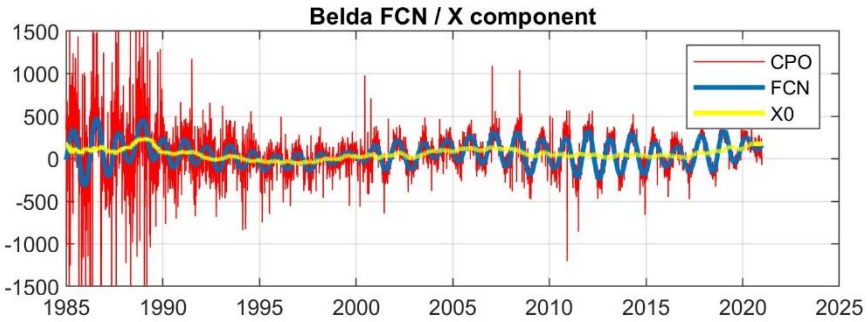


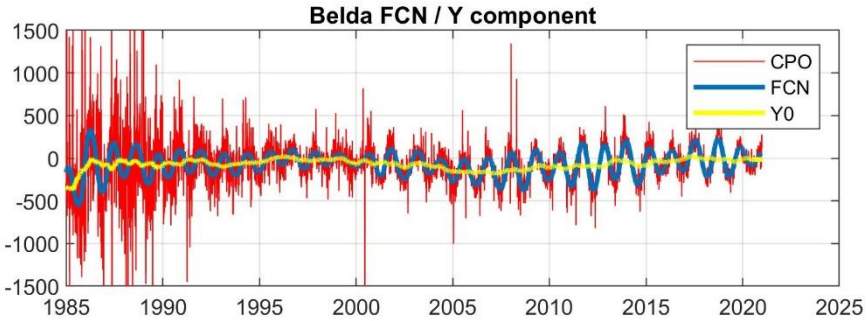
Phase 0 – CPO Prediction

It is believed that FCN cannot be known until it is inferred from observations, but...

- Can we made a reasonably accurate prediction of the FCN signal before observing it with the help of advanced FCN models?

- Can we take advantage of that FCN prediction to improve the CPO predictions?





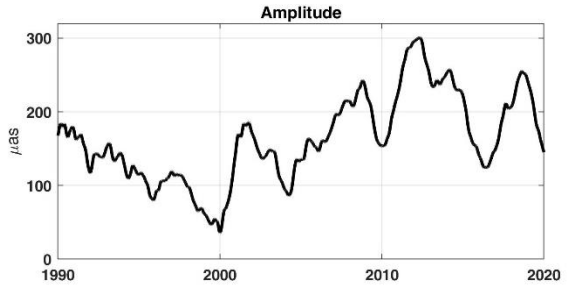
Belda et al. (2016)

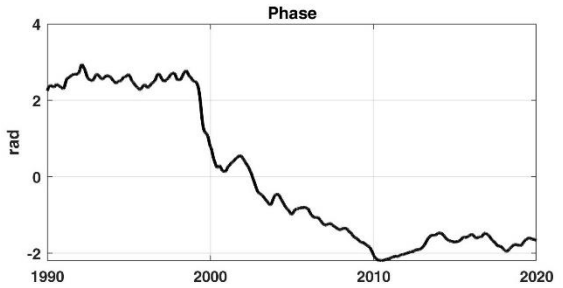
Journal of Geodynamics

$$X_{FCN} = A_C \cos(\sigma_{FCN} t) - A_S \sin(\sigma_{FCN} t) + X_0$$

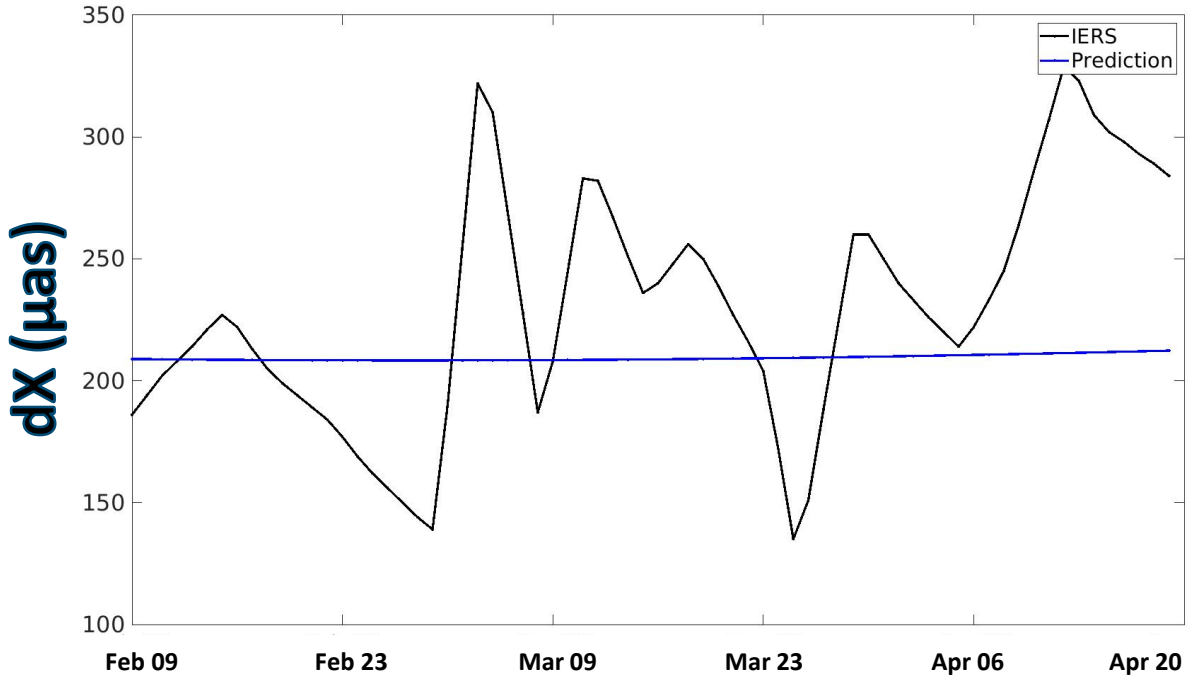
$$Y_{FCN} = A_S \cos(\sigma_{FCN} t) + A_C \sin(\sigma_{FCN} t) + Y_0$$

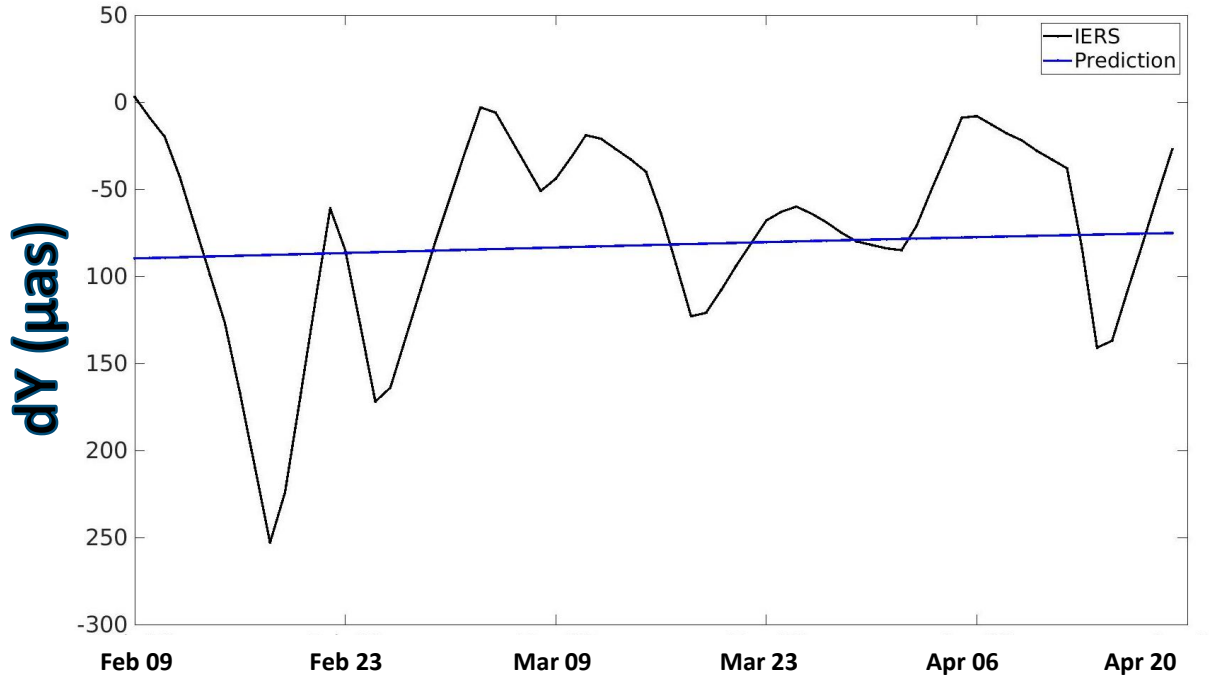
Amplitude coefficients were estimated by using a sliding window with a width of 400 days





Phase 0 – CPO Prediction – Selected Results





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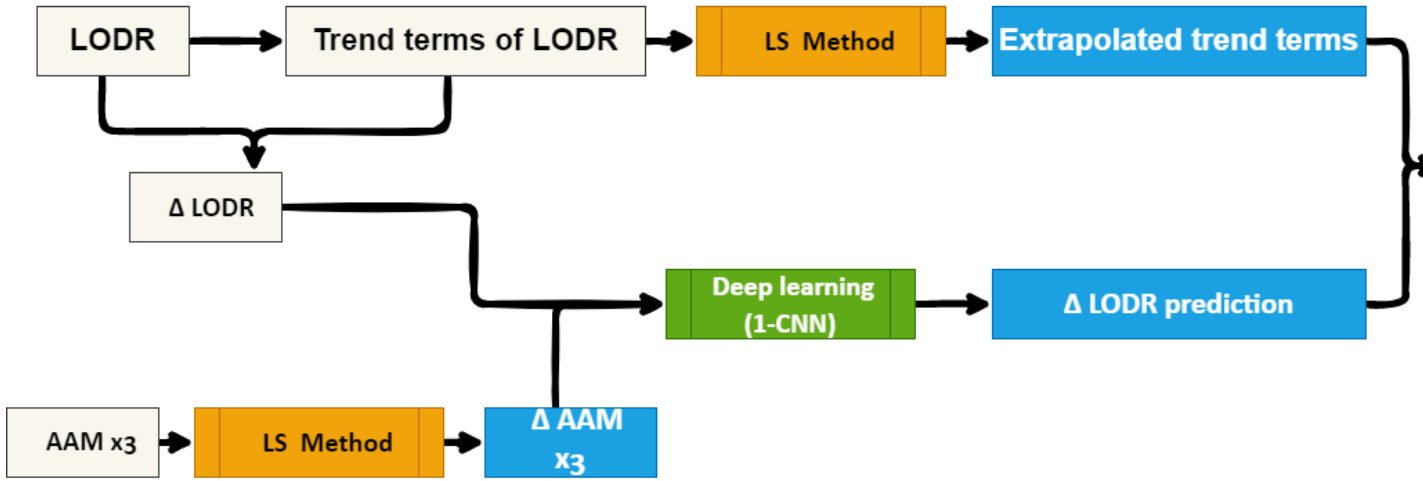
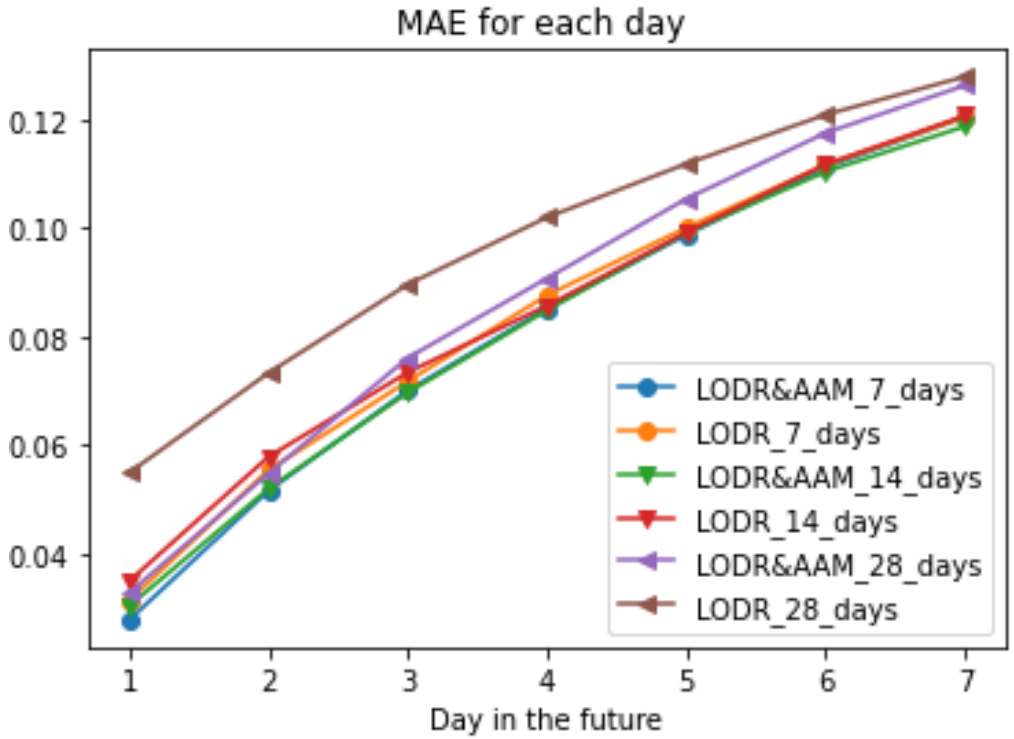
Prediction

Phase 1: Ongoing investigation - ERP – Deep learning technique investigation- Example

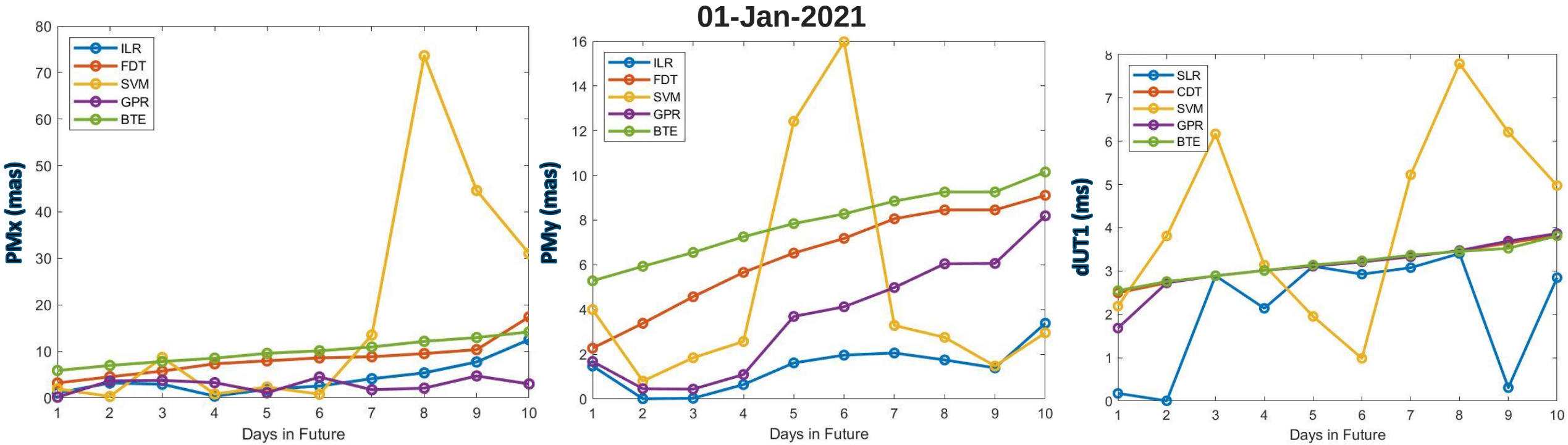


Flow chart of introducing AAM to LODR prediction by Deep learning

The short-term prediction of LOD introducing atmospheric angular momentum by 1D-Convolutional Neural Networks (1D-CNN)
Guessoum et al 2022, EGU G3.5



Phase 1: Ongoing investigation - ERP – ML technique investigation- Example



Interactions Linear Regression (ILR)

Fine Decision Tree (FDT)

Cubic Support Vector Machine (SVM)

Matern 5/2 Gaussian Process Regression (GPR)

Bagged Tree Esemble (BTE)

Prediction of UT1-UTC by machine learning techniques
Dhar et al 2022, EGU G3.5

Summary

- EOP PCC 2 was an excellent reason for establishing our collaborative EOP group focusing on EOP prediction. We will be open to share our idea and develop new research topics.
- Our team continuously works on the source codes and investigates different possibilities to improve EOP prediction at different time intervals.
- We will arrange an internal comparison to assess different input data and techniques.

We acknowledge the EOP PCC 2 organizers team for their fascinating work.

References

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Modiri, S., Belda, S., Heinkelmann, R., Hoseini, M., Ferrándiz, J. M., & Schuh, H. (2018). Polar motion prediction using the combination of SSA and Copula-based analysis. *Earth, planets and space*, *70*(1), 1-18.

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Federal Agency for Cartography and Geodesy

BKG
Wir geben Orientierung.

Thank you for your kind attention!

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