Seasonal dynamics of greenhouse gases in a large river

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Fig. 1: Catchment of River Elbe with sampling sites Magdeburg and Wittenberge, Germany

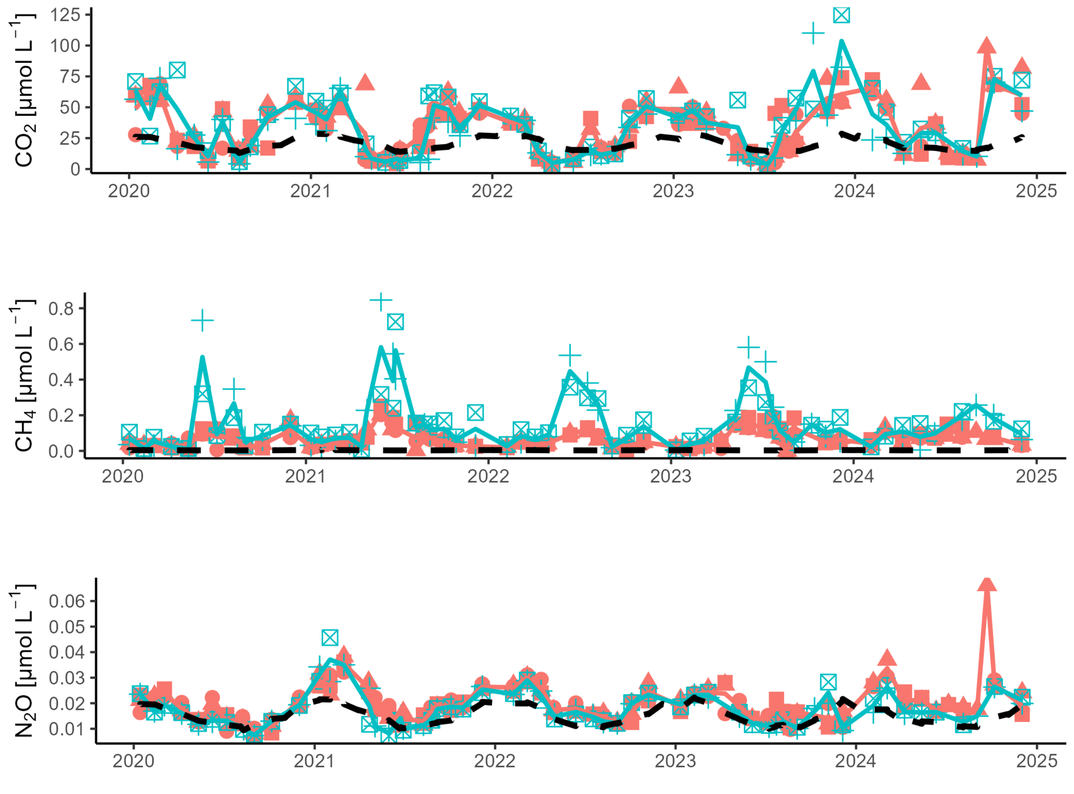

Fig. 2: Time series of GHG concentrations at Magdeburg (orange) and Wittenberge (green). Dotted lines indicate atmospheric equilibrium concentrations.

Material & Methods

- Monthly sampling from bridges, 2020 -2024
- CO_2, CH_4, N_2O with gas chromatography
- Meteorological data from DWD
- Water chemical with standard methods
- Ensemble model Gradient Boosting (GB)

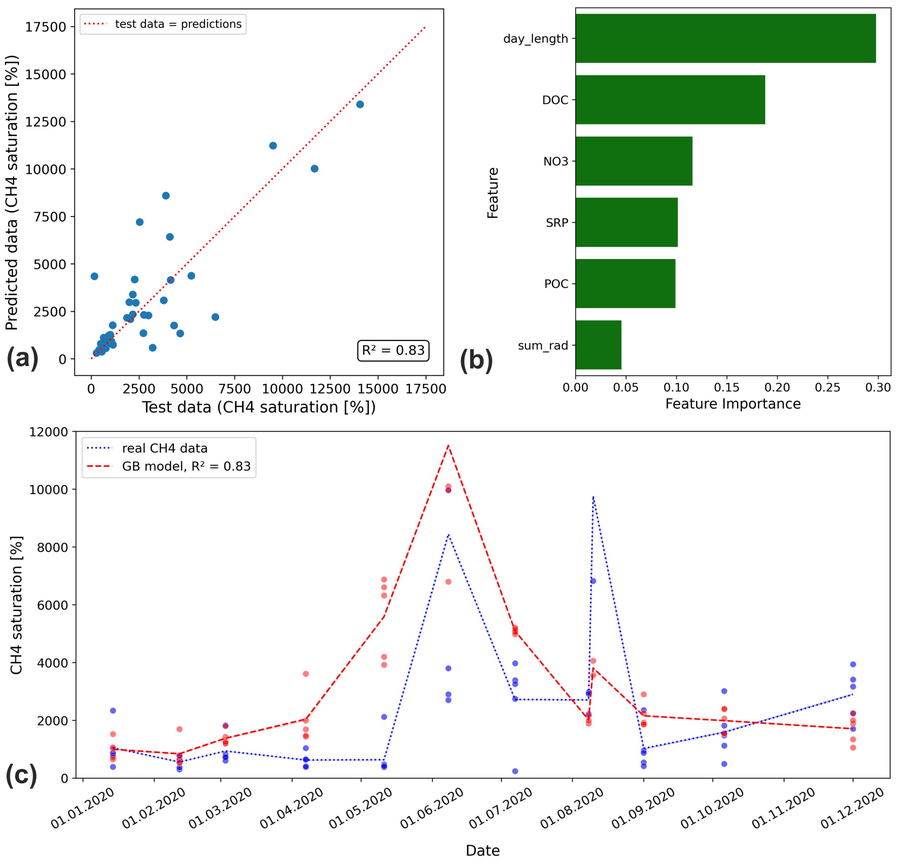

Fig 3: Gradient Boosting ensemble model to predict the CH_4 saturation. (a) Comparison of 2020 test data with predicted data (R^2=0.83). (b) Feature Importance analysis with most important variables for CH_4 prediction: daylight hours, DOC, SRP, NO_3^-, POC and daily radiation sum. (c) Comparison of measured and predicted data in 2020 with $R^2 > 0.83$.

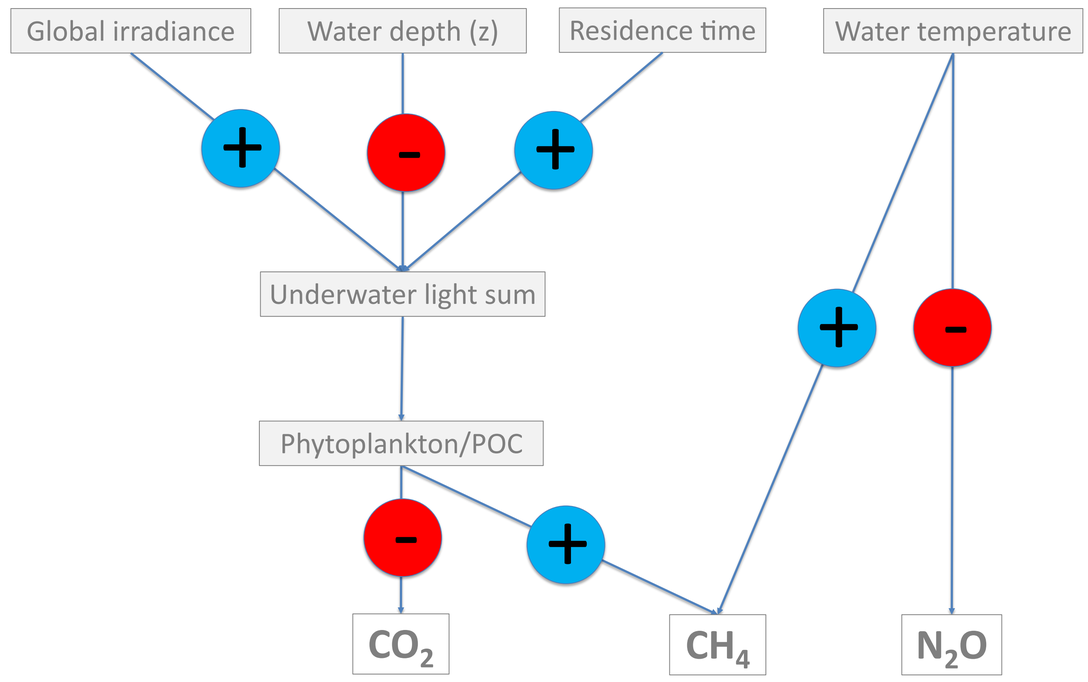

Fig 4: Summary of main correlations

Conclusions

- CO_2 follows a seasonal cycle with a summer minimum controlled by primary production
- CH_4 follows also a seasonal cycle but with a summer maximum controlled by temperature
- N_2O is mainly solubility and temperature driven
- The GB model predicted GHG with high precision
  - => fill data gaps,
  - => reconstruct historical or future emissions
  - => scalable, data-driven approaches for GHG monitoring

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Modular Observation Solutions for Earth Systems