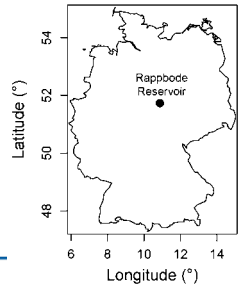
UFZ HELMHOLTZ Zentrum für Umweltforschung

Karsten Rinke

Lake monitoring at various temporal and spatial scales and benefits for process understanding, modelling & predictions

Research activities and knowledge transfer at study site Rappbode Reservoir

- Germany‘s largest drinking water reservoir
- Drinking water for over 1 Mio people
- Max. volume: 113 Mio m^3
- Surface area: 395 ha
- Max. depth: 89 m



Rappbode Reservoir Observatory

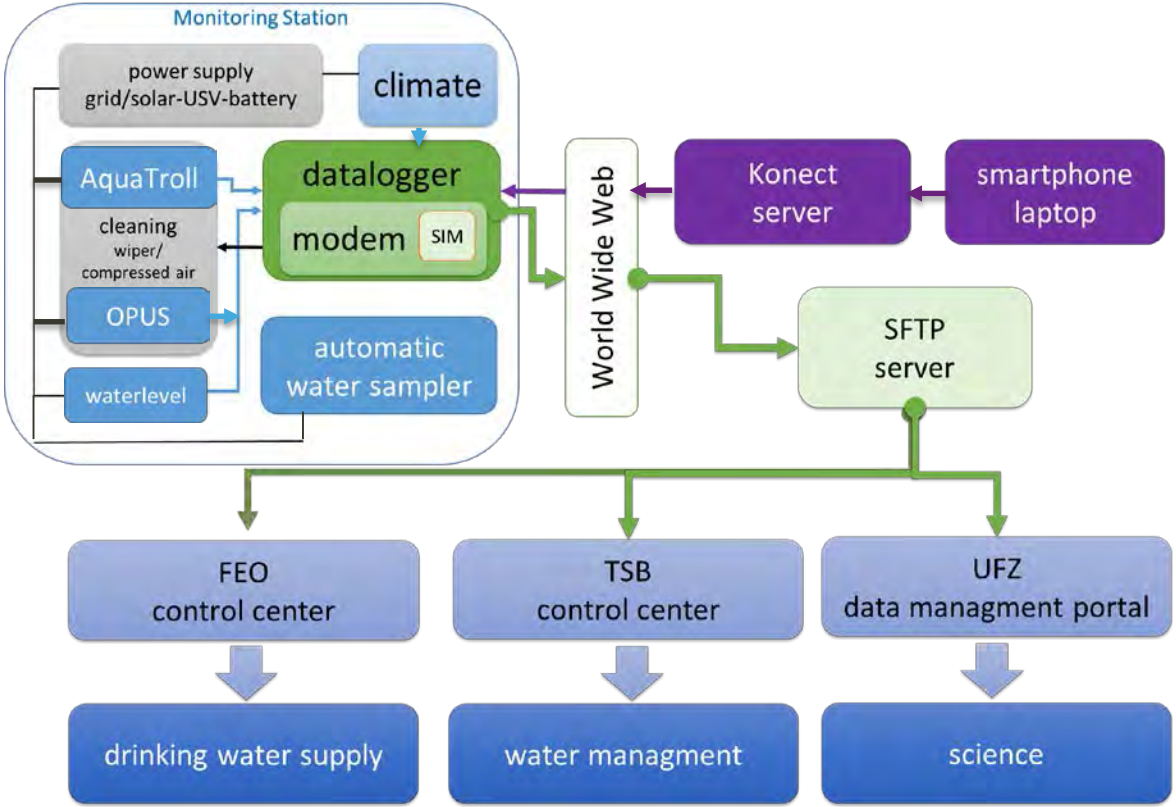
- Real-time monitoring of water quality
- Infrastructure and data sharing with stakeholders (Reservoir authority & Drinking water company)
- Investment of >100T€ into renewal of monitoring hardware by stakeholders
- Co-development of new monitoring products with companies

FEO FERNWASSER ELBAUE-OSTHARZ

Talsperrenbetrieb Sachsen-Anhalt
Anstalt des öffentlichen Rechts

envimo

Data handling and transfer



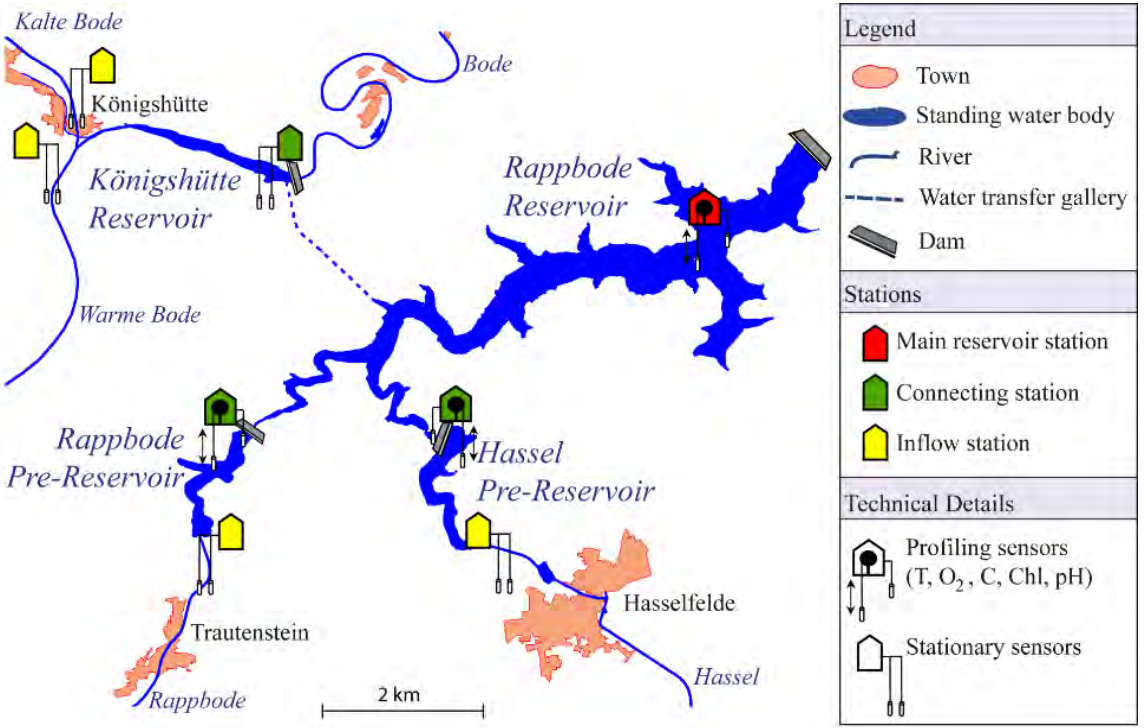
Rappbode Reservoir Observatory (RRO) - sites

Continuously measured parameters

Inflow stations
OPUS-probe: SAC, NO_3, TSS
Aquatroll-probe: T, EC, turbidity

Connecting stations
OPUS-probe: SAC, NO_3, TSS
Aquatroll-probe: T, pH, EC, O_2 (Optode), turbidity / Chl-a, BGA

Main reservoir:
Profiling system for T, EC, O_2, pH, turbidity, Chl-a, BGA



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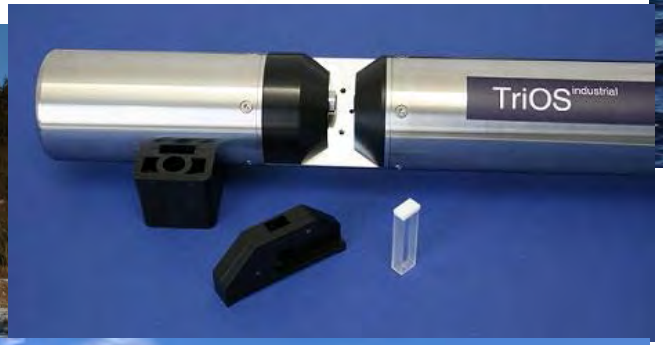
Monitoring technologies



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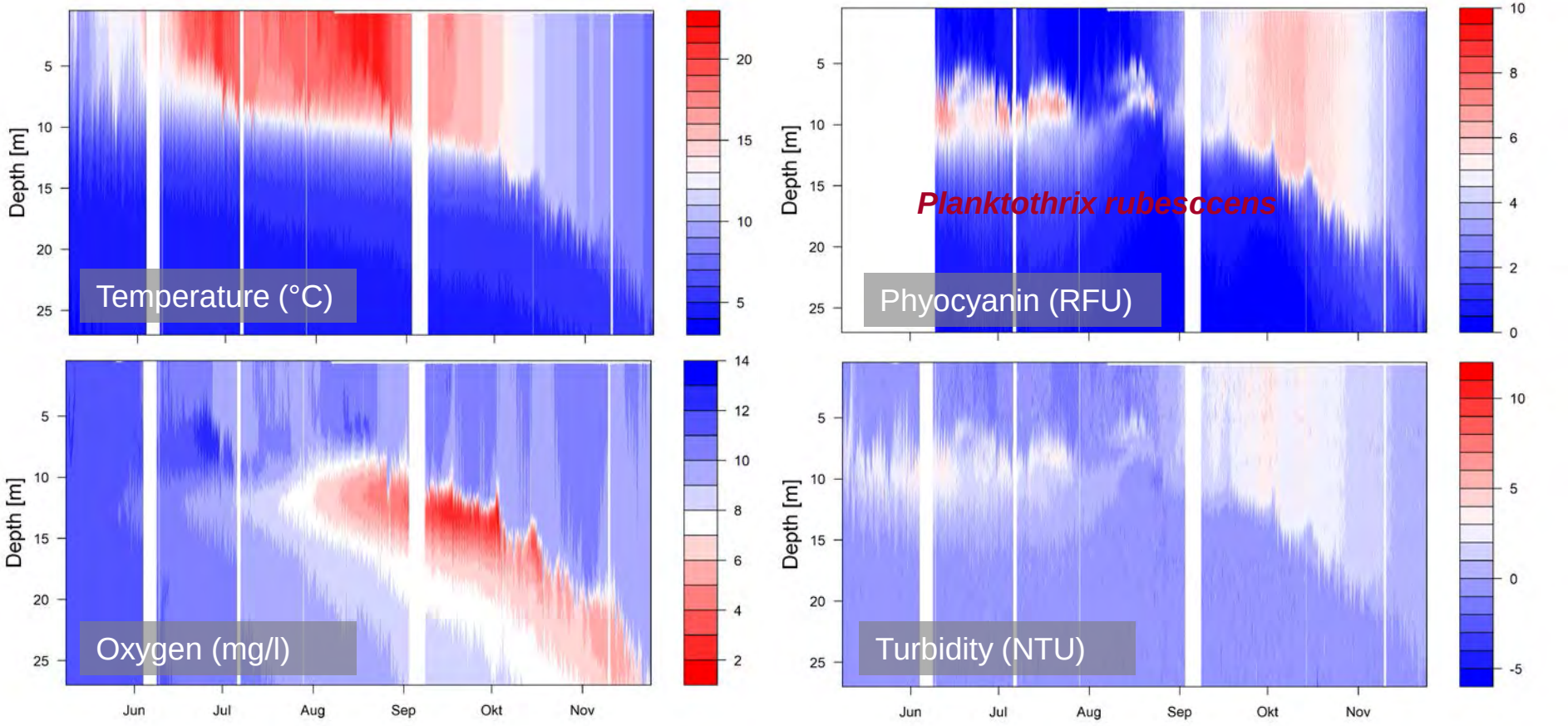
Advanced online monitoring



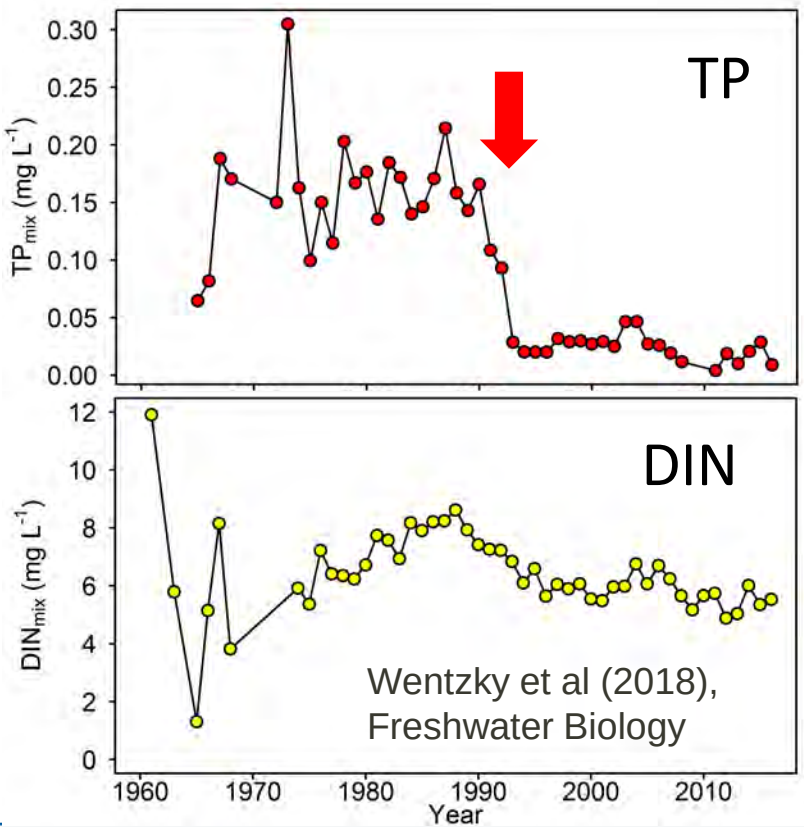
Classical field monitoring

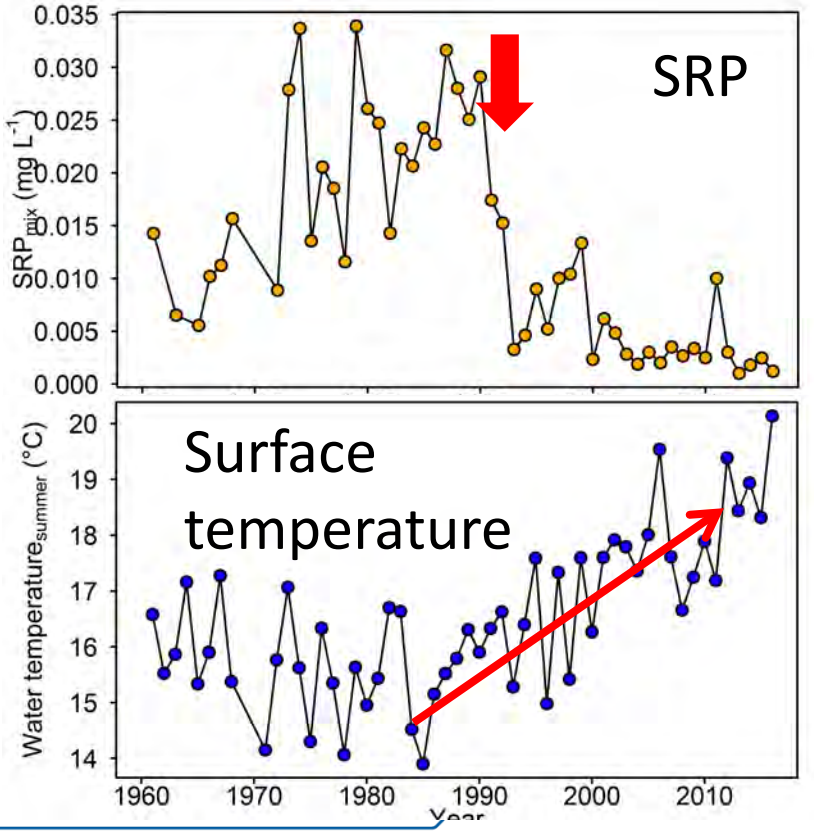
Parameter-group	Parameter	Method
Carbon	DIC, DOC	C-Analyzer
	POC	CN-Analyzer (solid)
Nitrogen	DN, NO3, NH4	CF-Photometry
	PN	CN-Analyzer (solid)
Phosphor	DP, SRP	CF-Photometry
	TP	Photometry (DIN)
Silica	Si	CF-Photometry
Cations / Metals	Na, K, Ca, Mg, Fe, Mn	ICP-OES
Anions	Cl, SO4	IC
Alkalinity	KS 4.3 / KB 8.2	Titration

Bi-weekly water sampling of 7 RRO – stations

since 2011

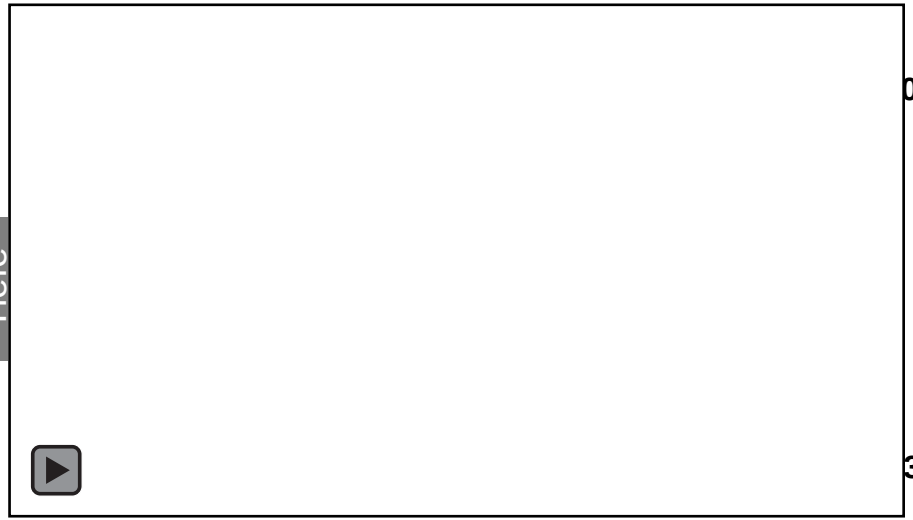
Long-term development of Rappbode Reservoir

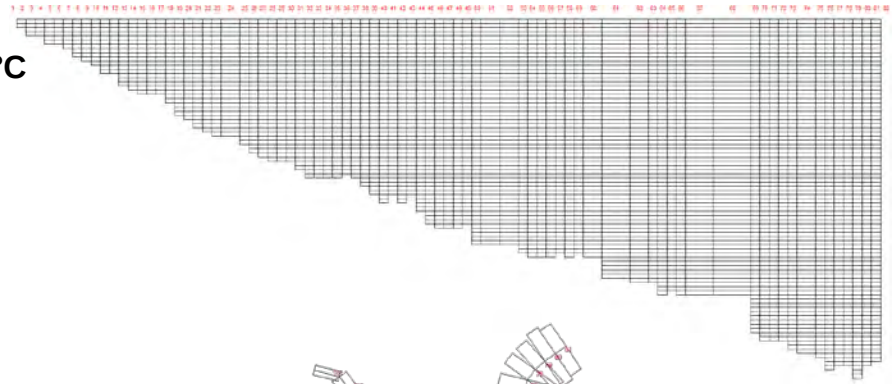


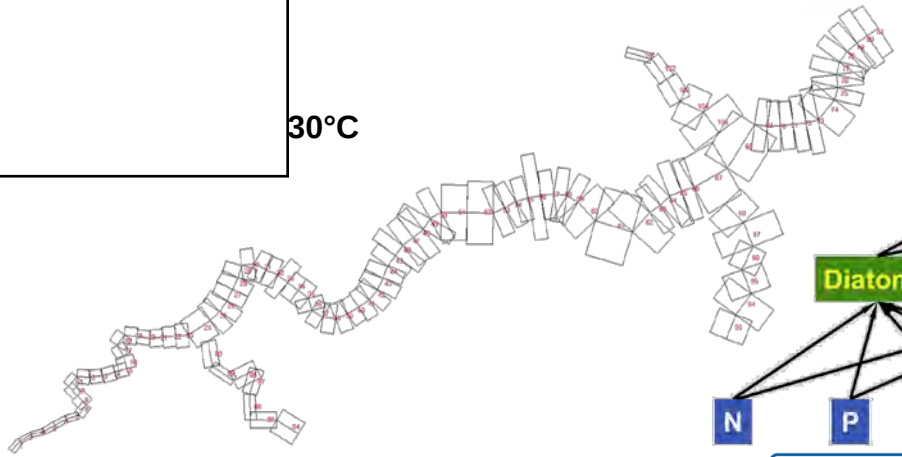


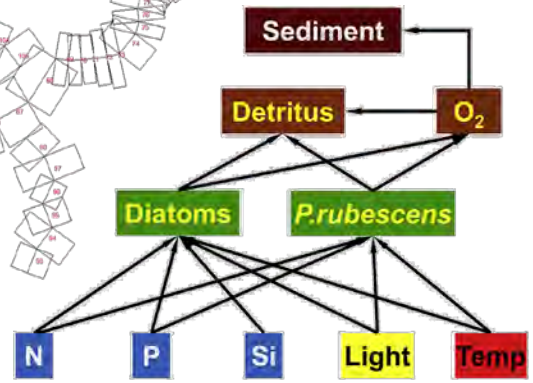
Monitoring-informed reservoir modelling: 2D-Model CEQUAL

Tiefe

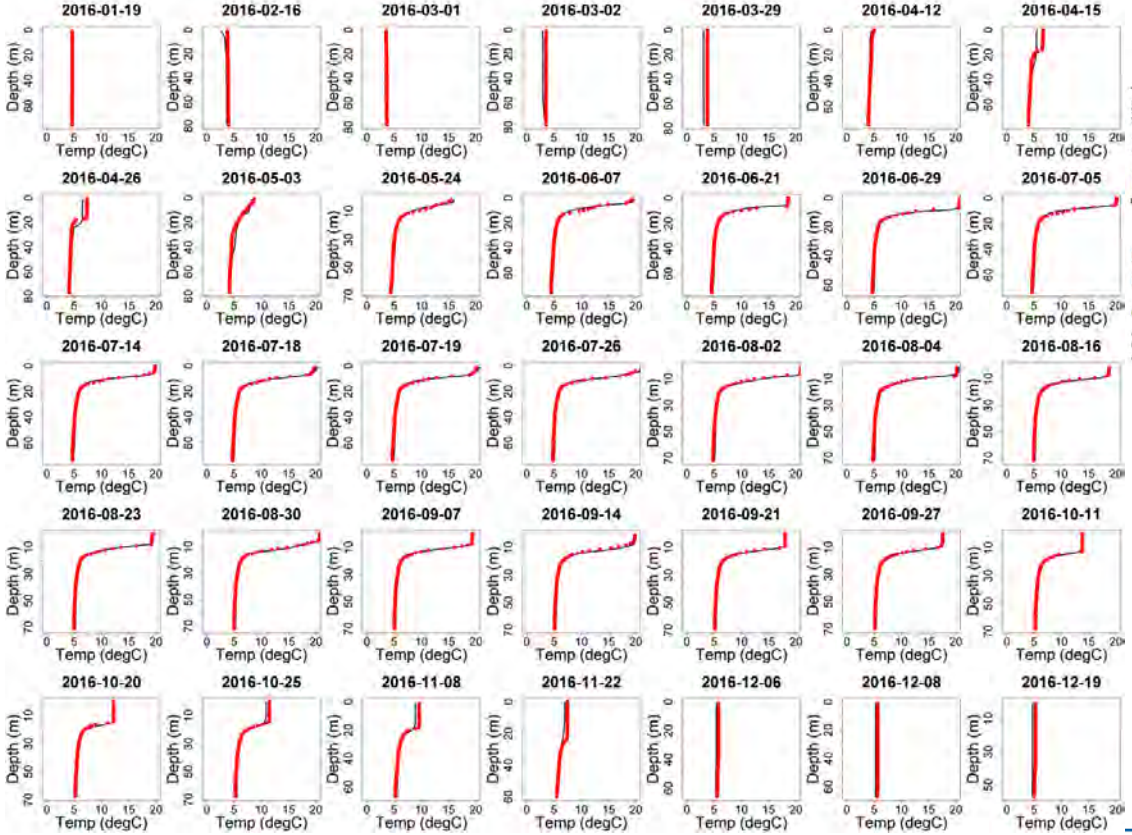








Simulation outputs: Water temperature



Science of the Total Environment 748 (2020) 141366

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Ensemble warming projections in Germany's largest drinking water reservoir and potential adaptation strategies

Chenxi Mi [a,b,*], Tom Shatwell [a], Jun Ma [c], Yaqian Xu [c], Fangli Su [b], Karsten Rinke [a]

[a] Helmholtz Centre for Environmental Research, Department of Lake Research, Magdeburg, Germany
[b] College of Water Conservancy, Shenyang Agricultural University, Shenyang, China
[c] Hubei Key Laboratory of Ecological Restoration of River-Lakes and Algal Utilization, Hubei University of Technology, Wuhan, China

RMSE = 0.61 °C
R^2 = 0.98
Bias = +0.09 K

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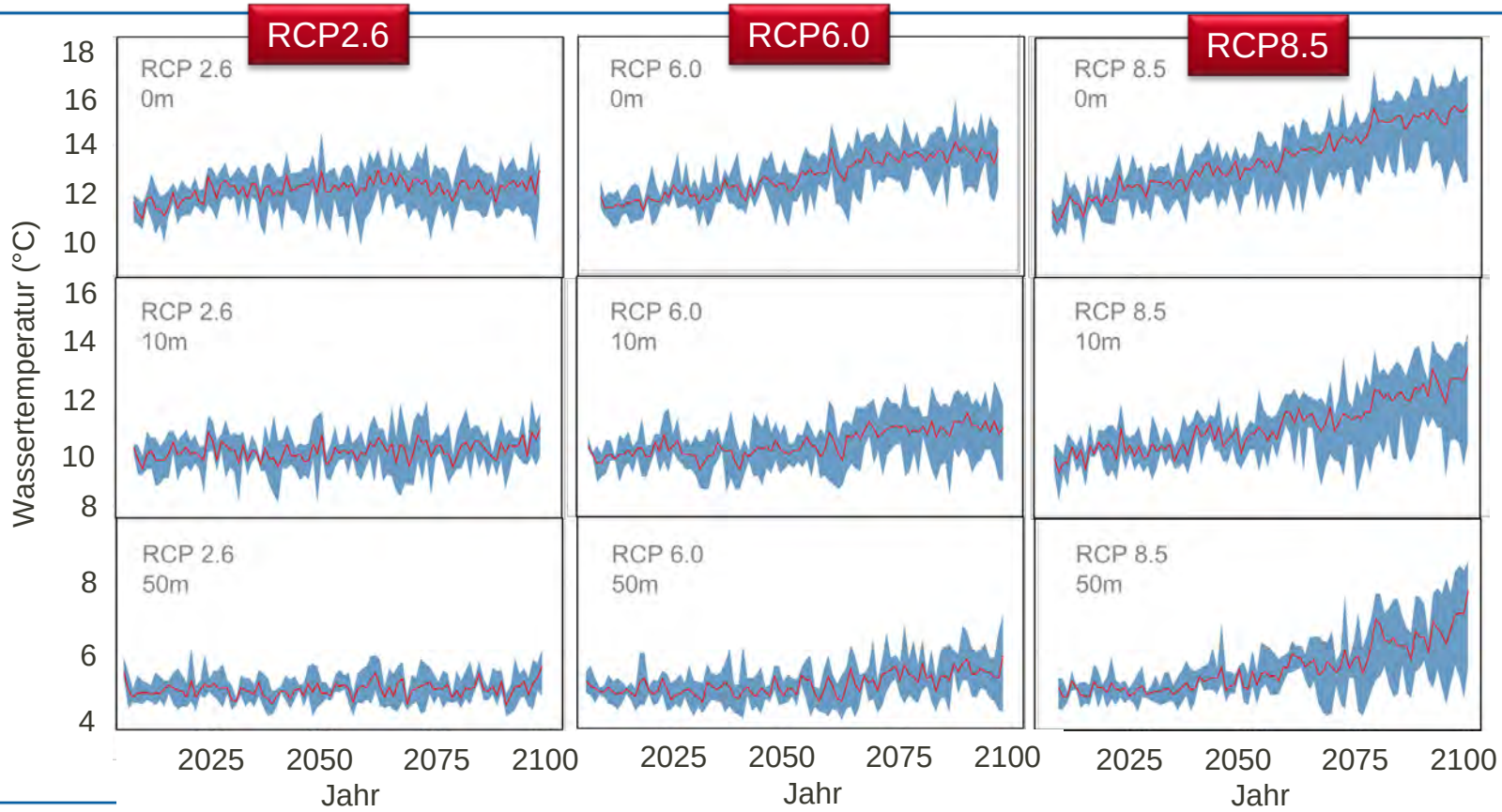
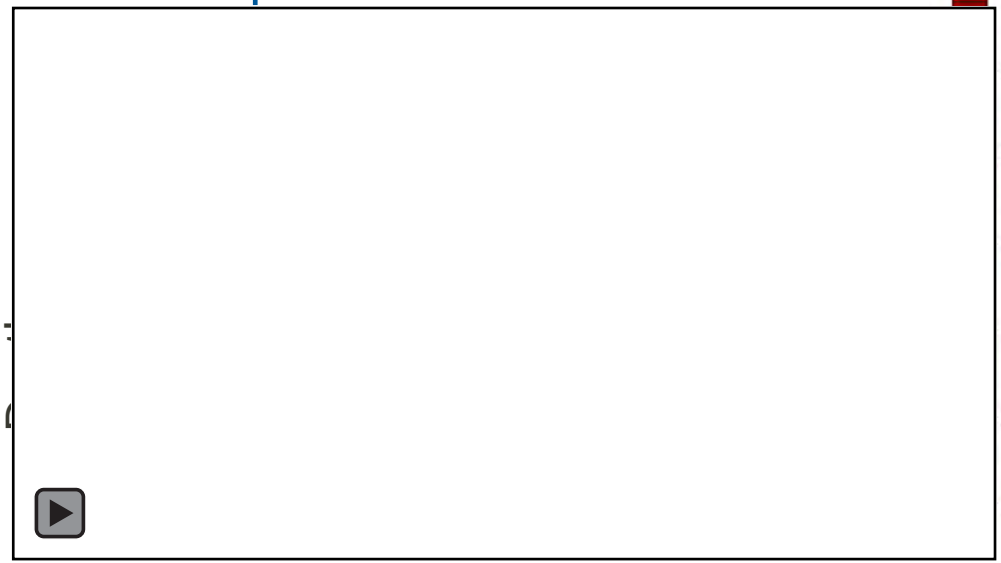
Rappbode-Reservoir in the 21. Century

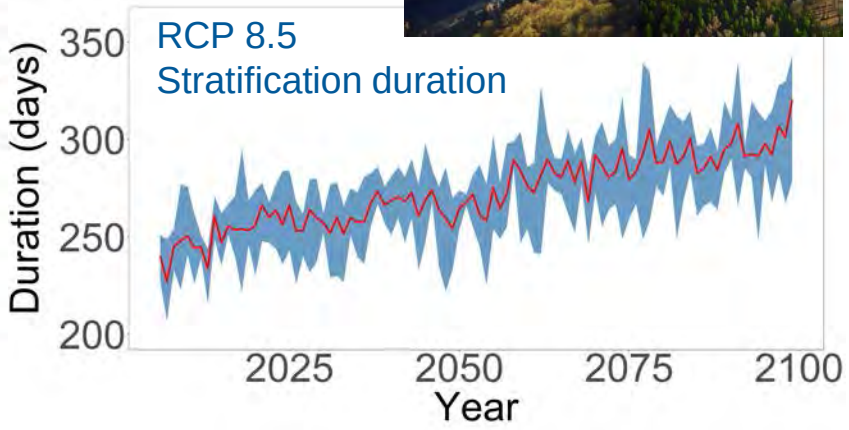
ISIMIP Inter-Sectoral Impact Model Intercomparison Project



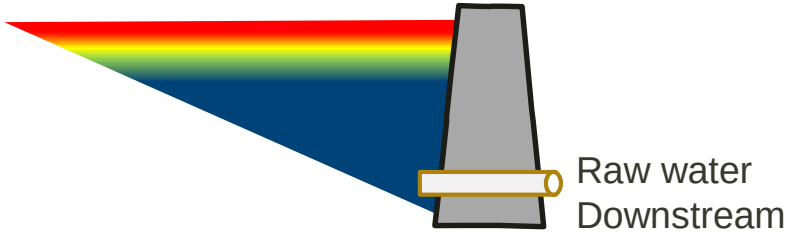
Rappbode-Reservoir in the 21. Century

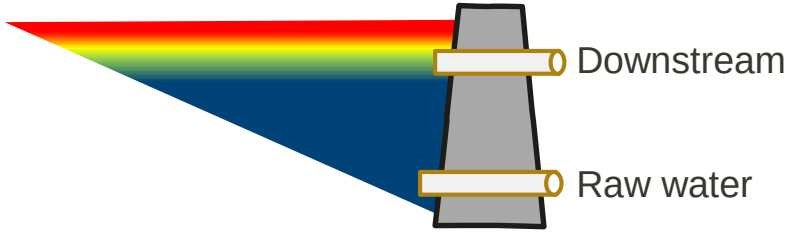
Development from 2000 to 2100

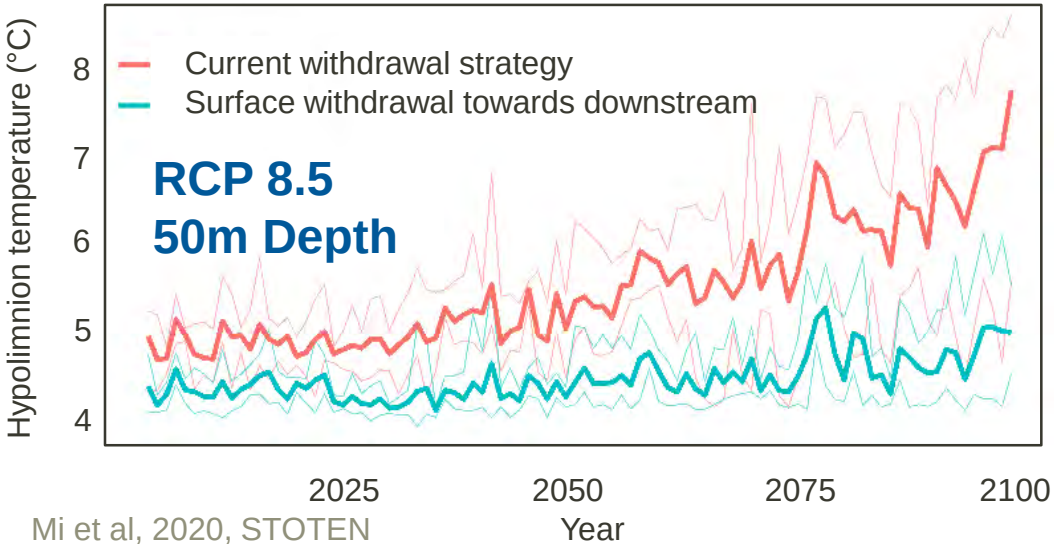




Climate adaptation of reservoir management: Deep water temperature

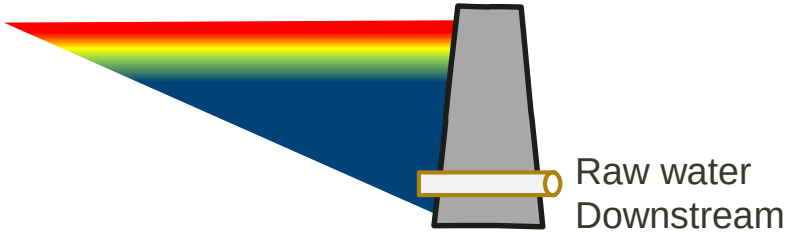


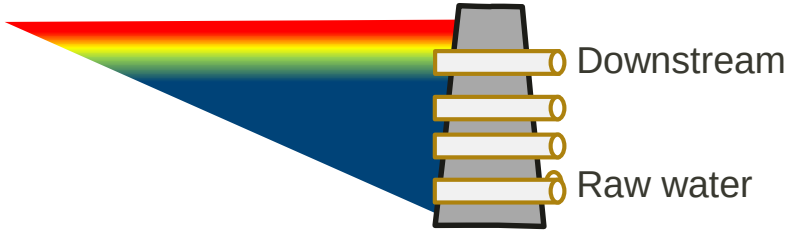




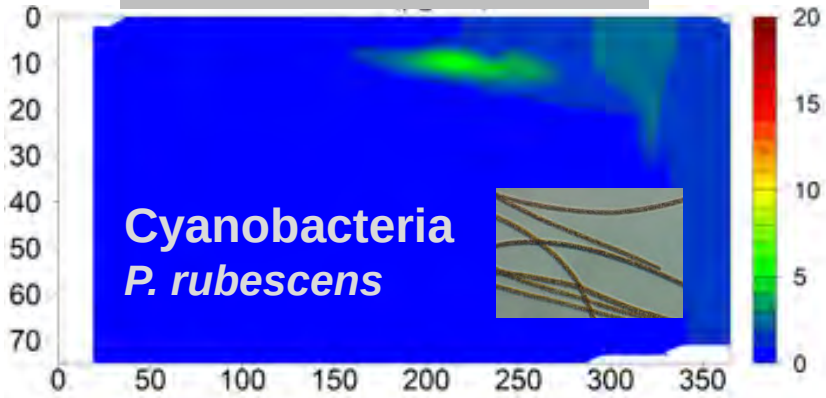
Mi et al, 2020, STOTEN

Climate adaptation of reservoir management: Metalimnetic cyanobacteria

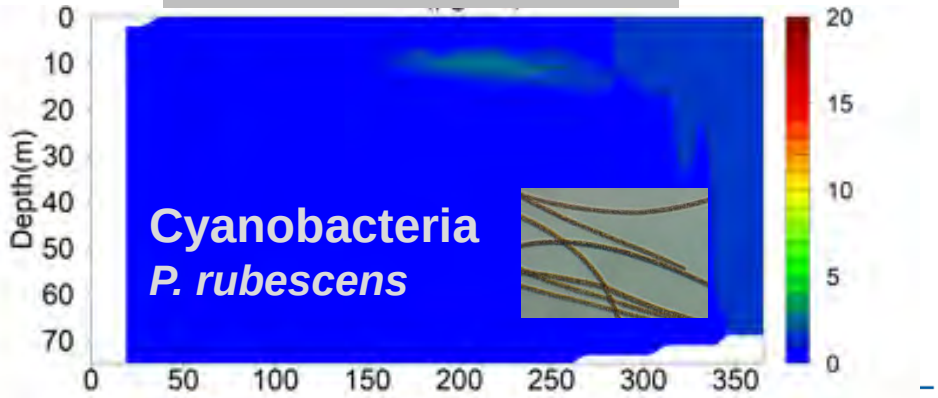




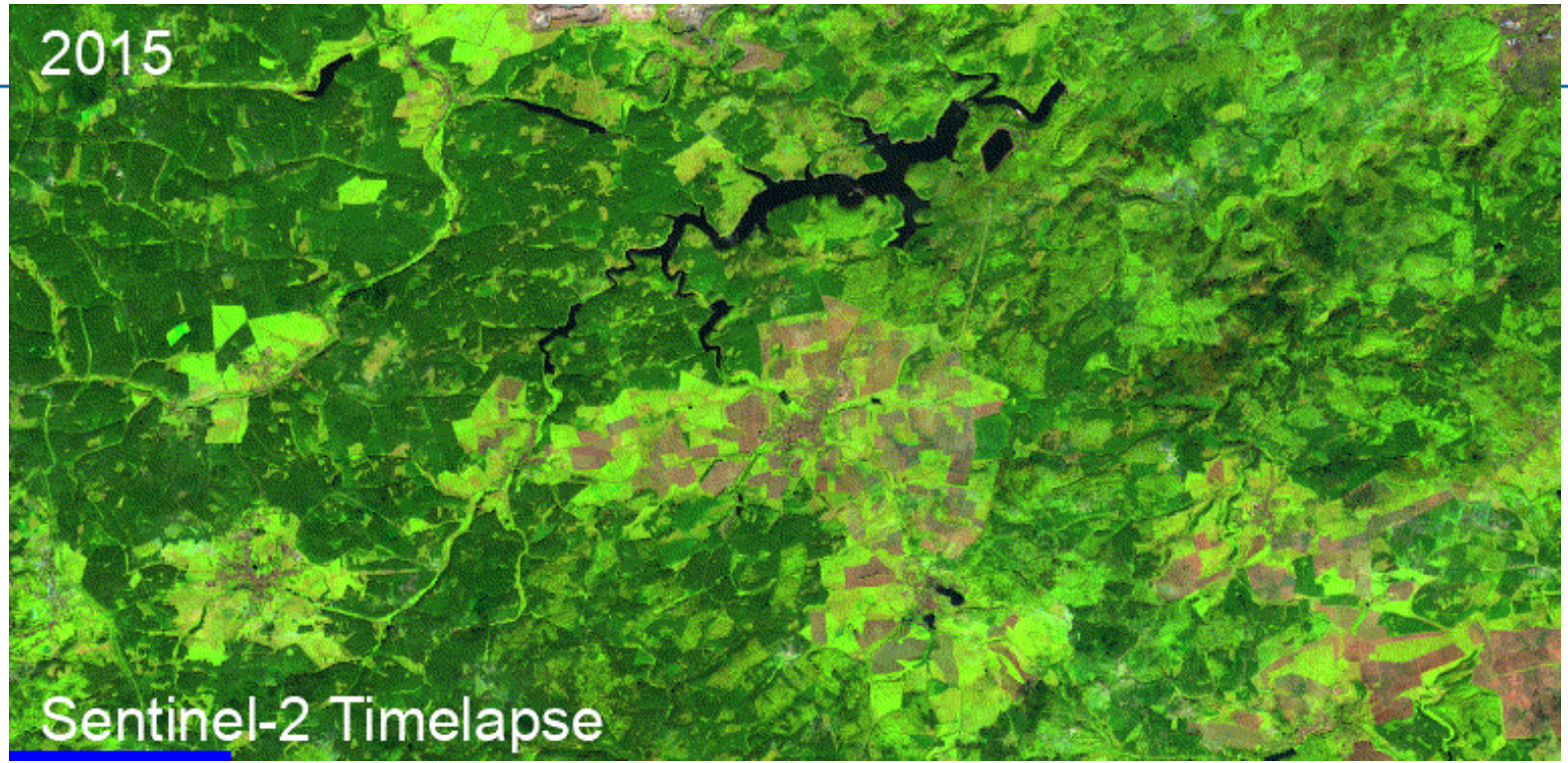
Classical Management



Adapted Management

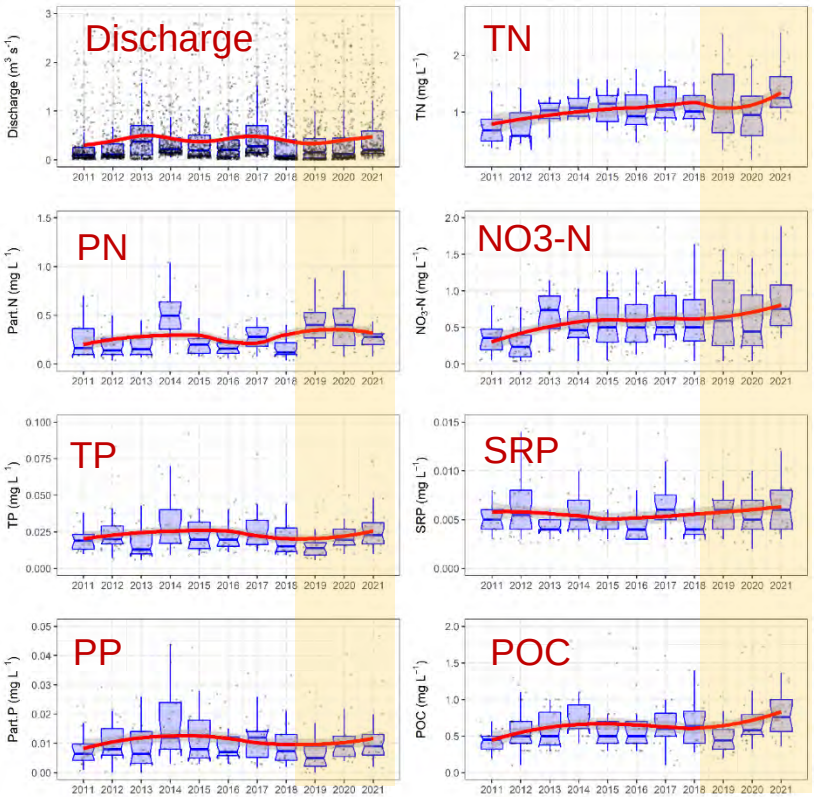


Unexpected cyanobacterial population growth in drinking water reservoirs (2020)


2015
Sentinel-2 Timelapse

Cross ecosystem effects

Rappbode catchment



After deforestation

ELSEVIER
Water Research
Volume 221, 1 August 2022, 118721

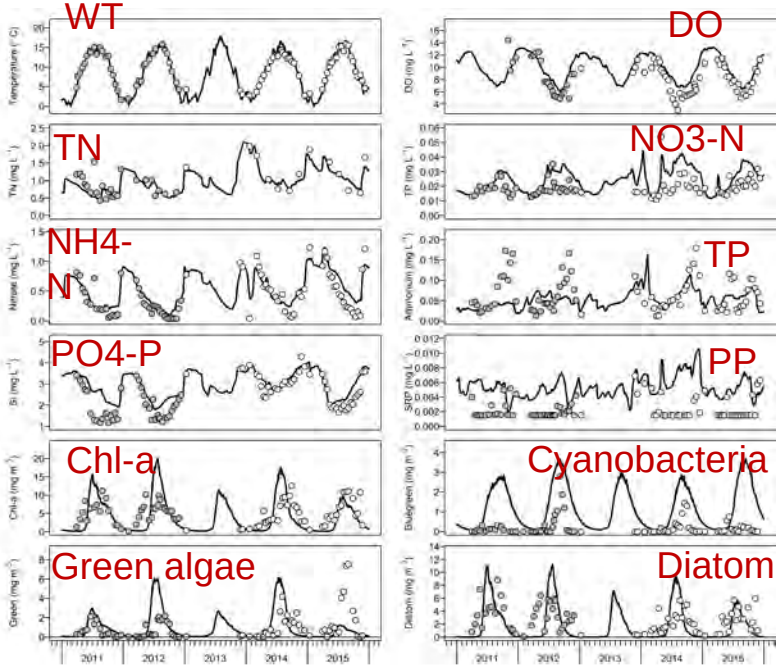
Reservoir water quality deterioration due to deforestation emphasizes the indirect effects of global change

Xiangzhen Kong [a, b], Salman Ghaffar [c, d], Maria Determann [b], Kurt Friese [b], Seifeddine Jomaa [c], Chenxi Mi [b], Tom Shatwell [b], Karsten Rinke [b], Michael Rode [c, e]

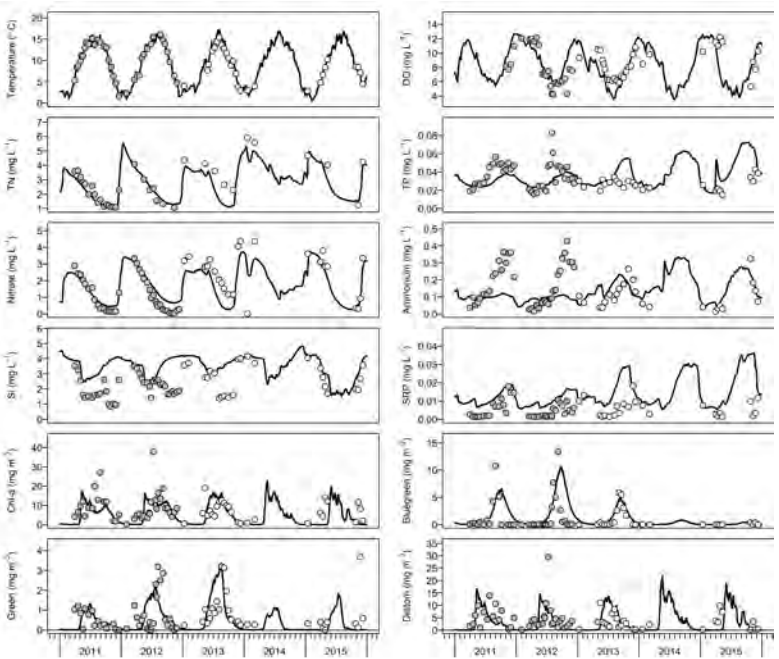
Climate projections → **Catchment model** → **Reservoir model**

GOTM-PCLake (WET) – water quality

Rappbode



Hassel



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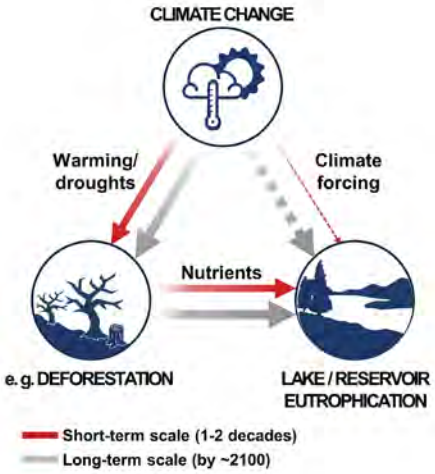
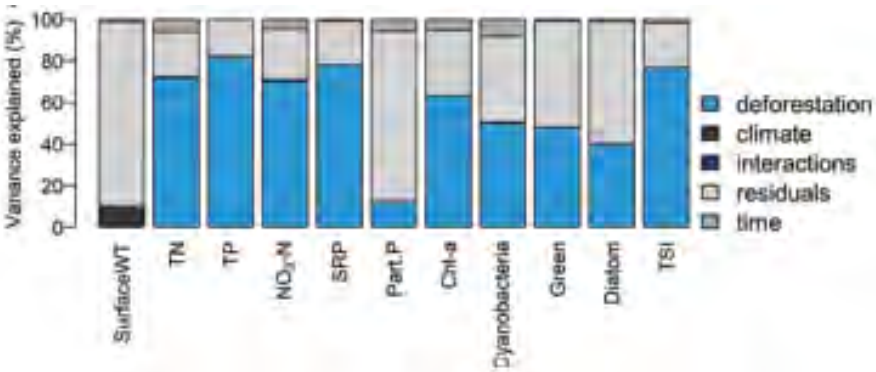
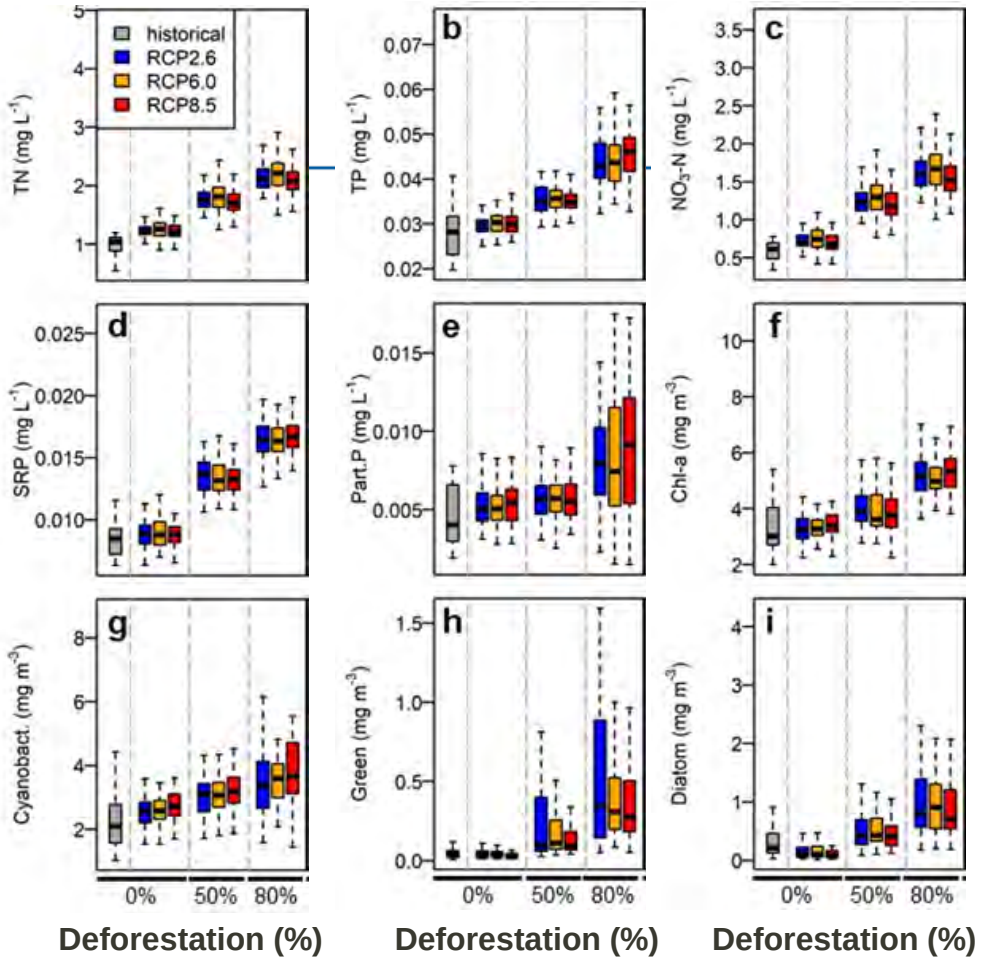


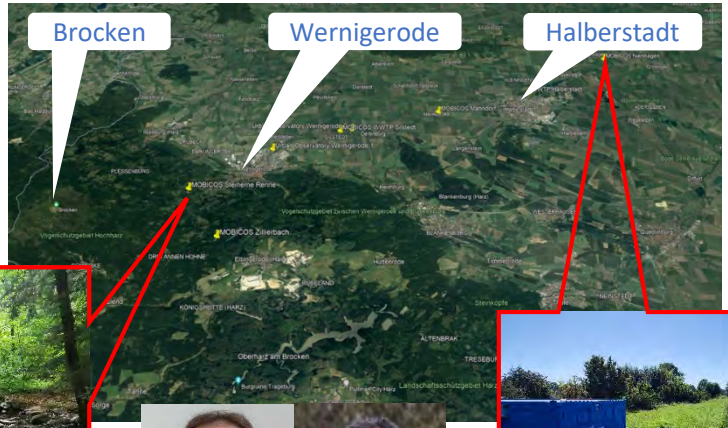
Kong et al., 2022

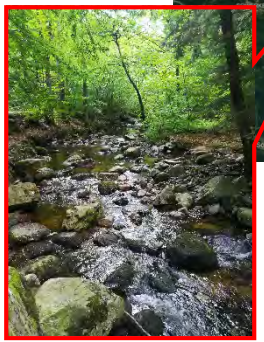




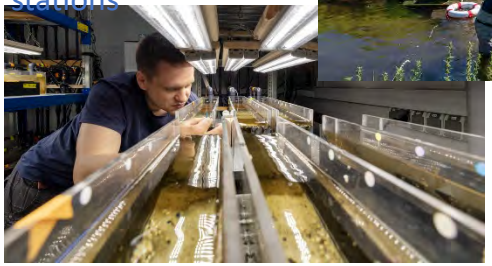
UFZ HELMHOLTZ Centre for Environmental Research

The UFZ research infrastructure MOBIle streamside mesoCOSms (MOBICOS) – expanding an experimental platform into an eLTER monitoring site for stream ecosystems





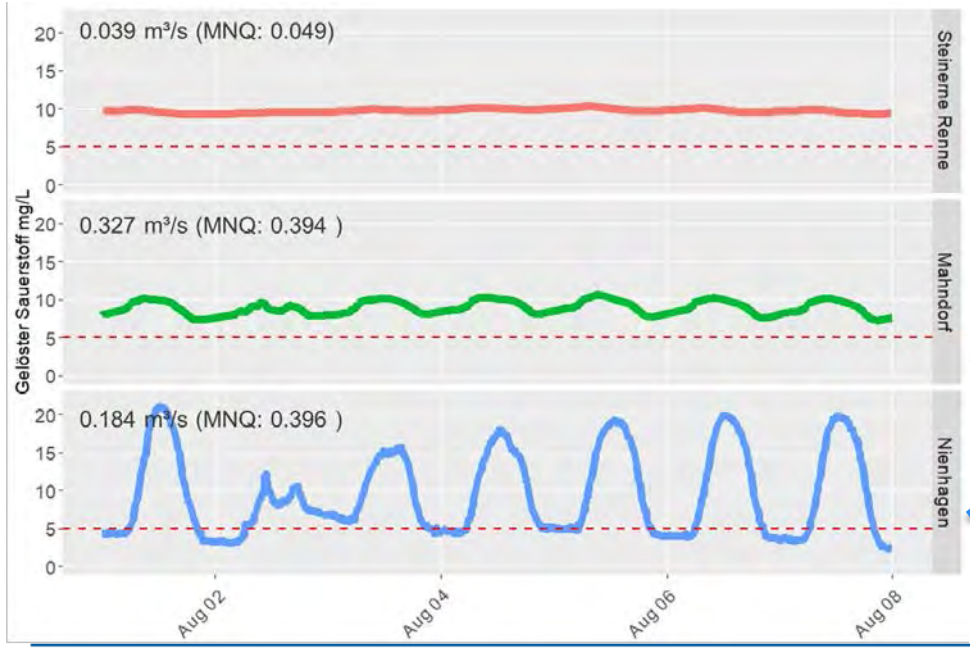
MOBICOS containers: flume experiments and continuous water quality monitoring stations

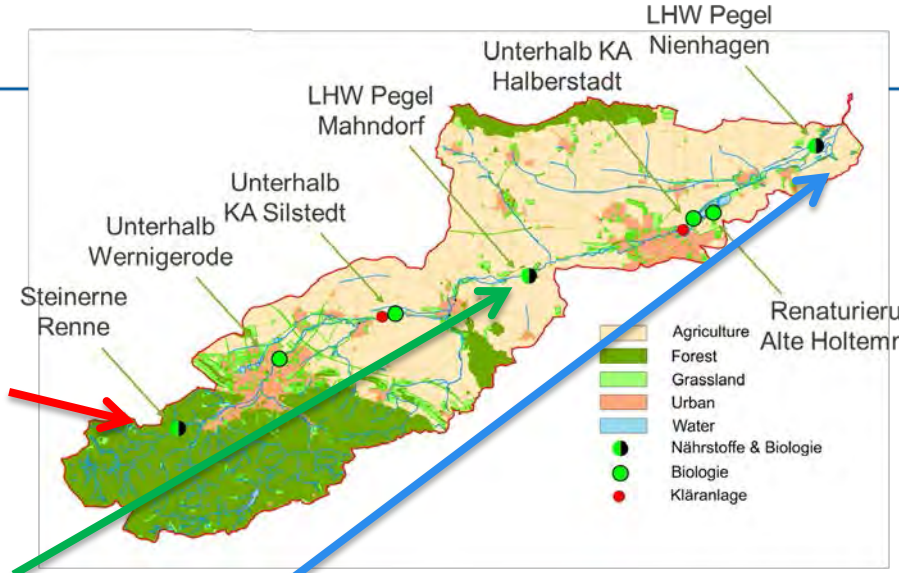


Contacts: Patrick Fink, Mario Brauns

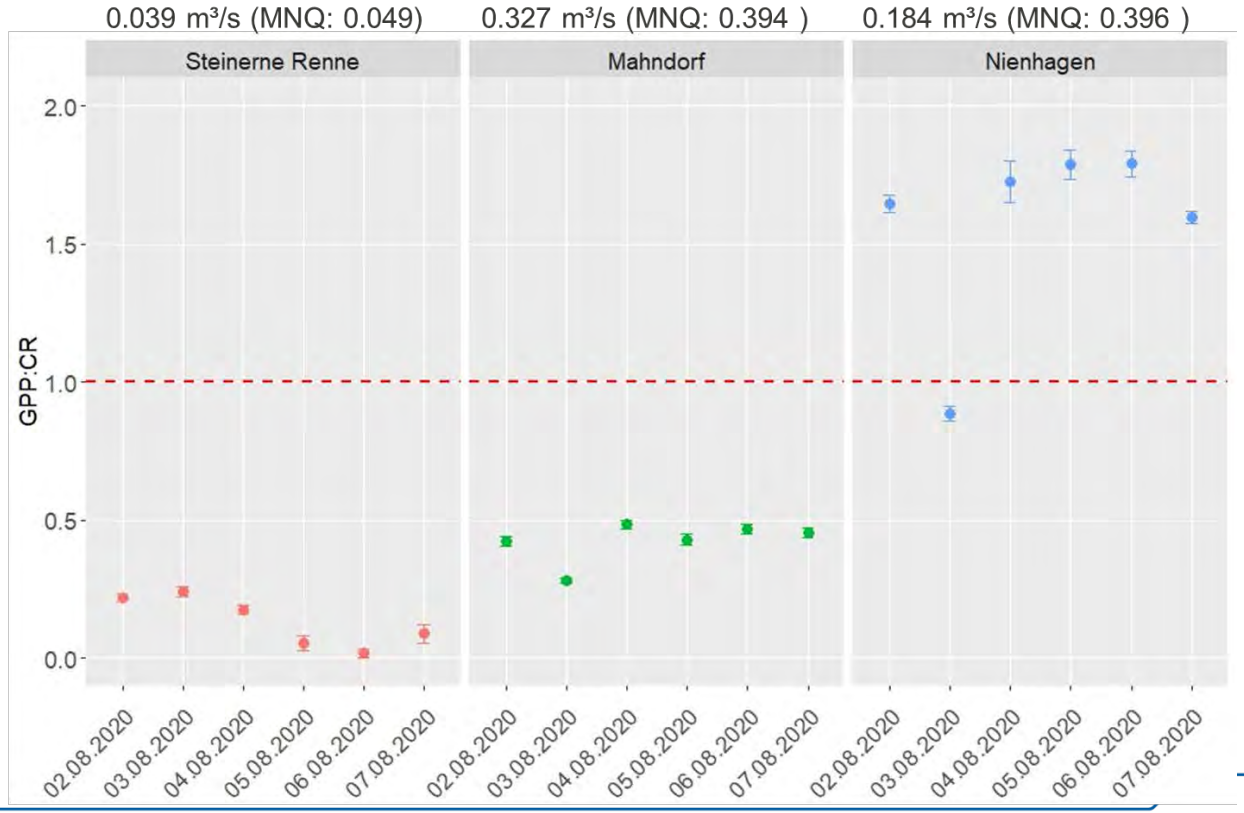
UFZ currently operates 5 MOBICOS containers in the TERENO observatory, plus one at the Elbe River: two of the existing TERENO monitoring sites (at the Holtemme River) will be expanded to category 1 eLTER sites. One at near reference conditions, one at a site with strong anthropogenic modifications (urbanization and agricultural land use).

Stream metabolism measurements





Stream metabolism measurements



Summary

- Structured monitoring programs for lakes and streams, serving as a blueprint for eLTER
- Linking monitoring data with predictive tools enable the identification of climate adaptation strstegies: Example reservoir management
- Translate ecosystem states (e.g. oxygen) into ecosystem functions (e.g. metabolism)
- Strong effects of global change – directly and indirectly

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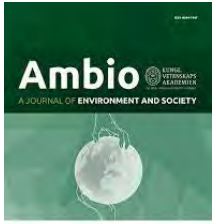
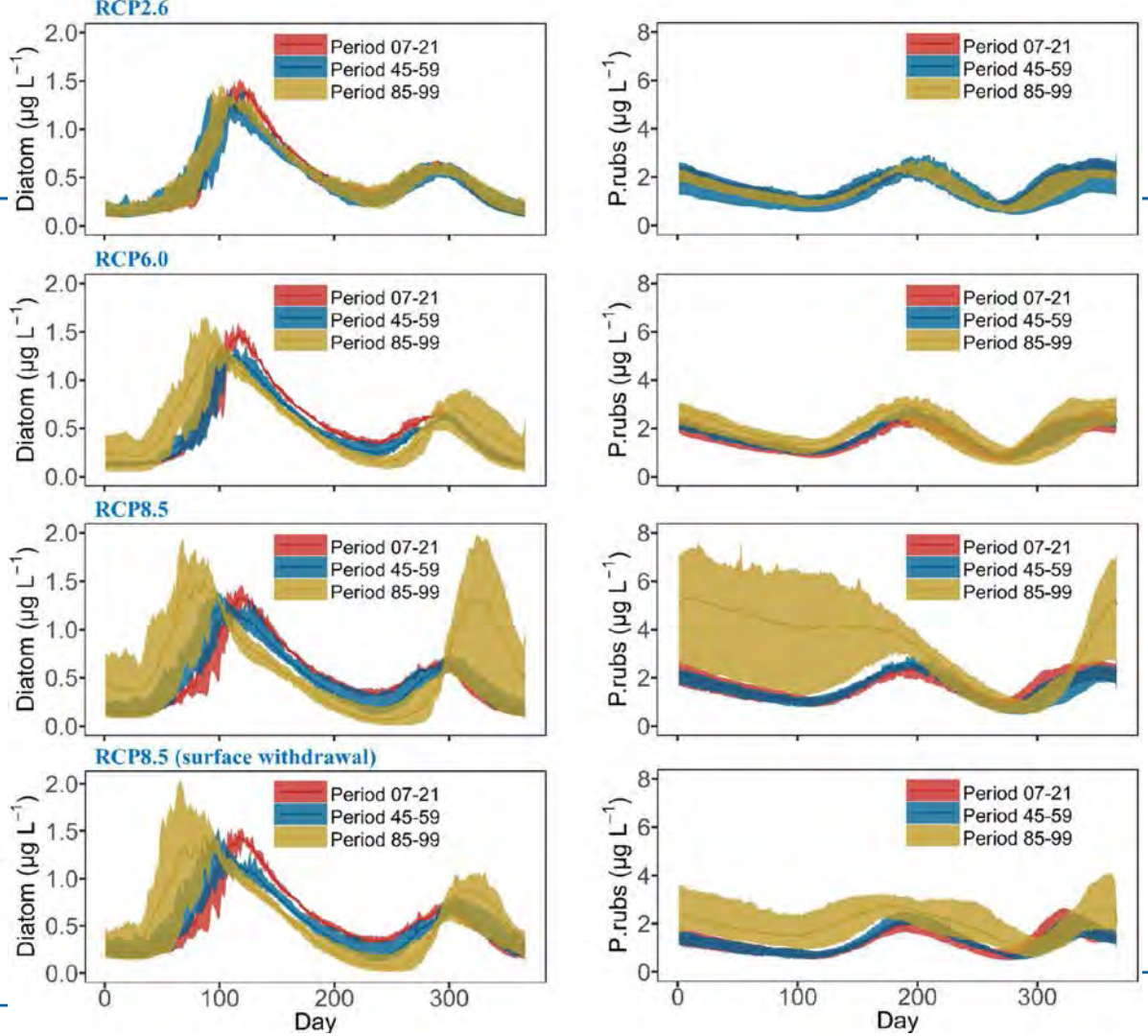
Klimaprognosen zur Dynamik der Algengemeinschaft



Springer

Cascading climate effects in deep reservoirs: Full assessment of physical and biogeochemical dynamics under ensemble climate projections and ways towards adaptation

Chenxi Mi, Tom Shatwell, Xiangzhen Kong, Karsten Rinke



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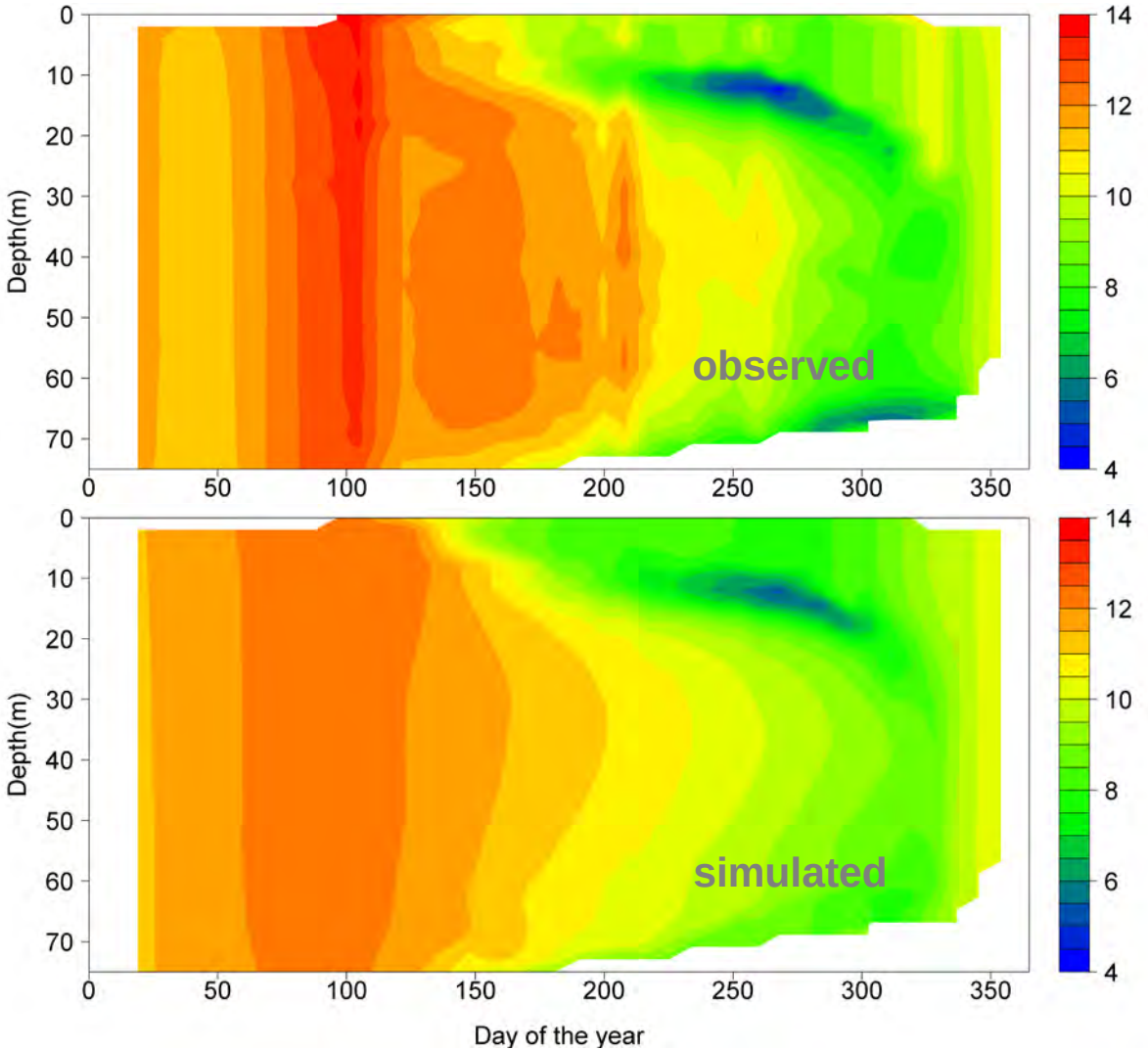
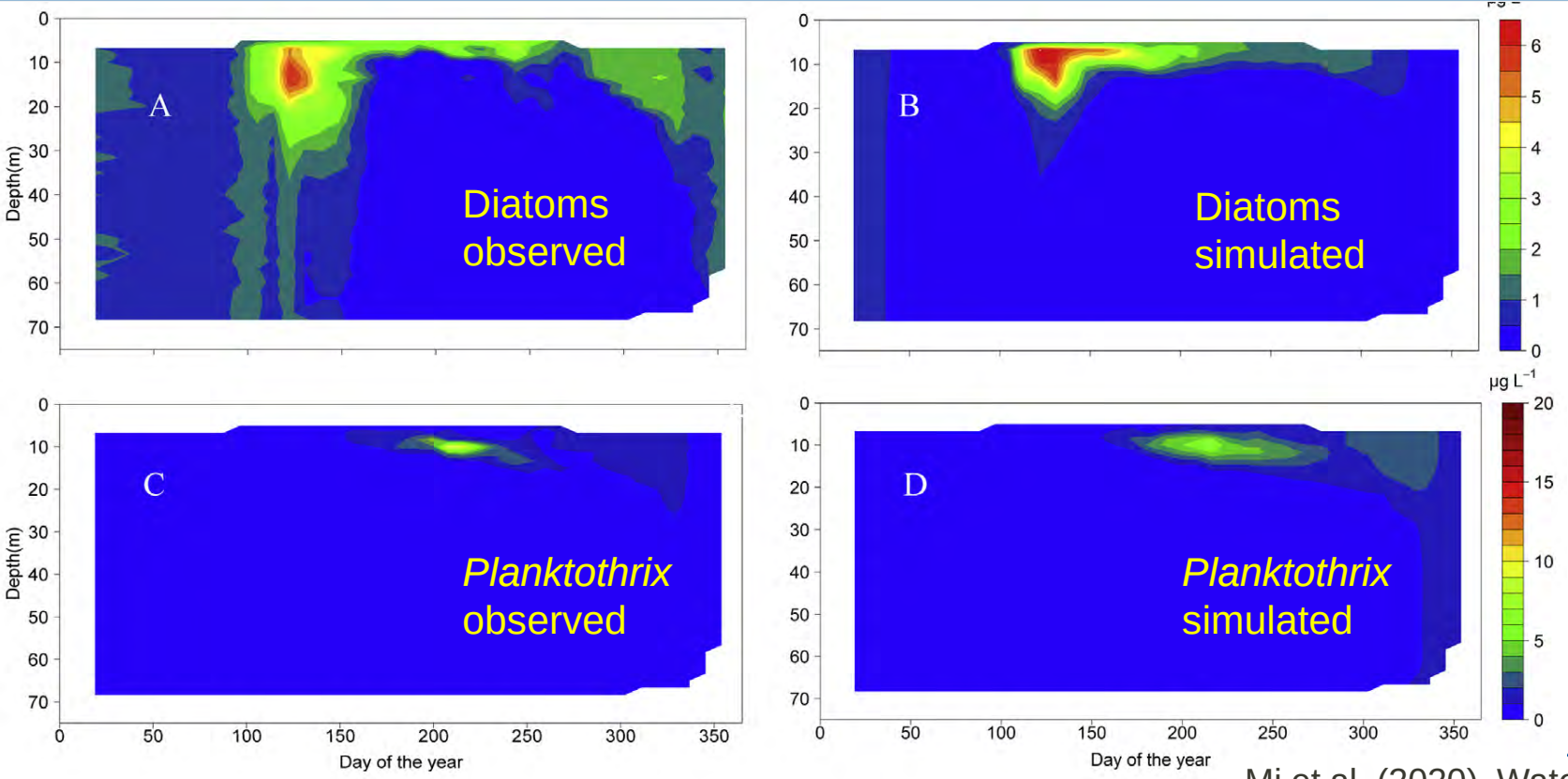
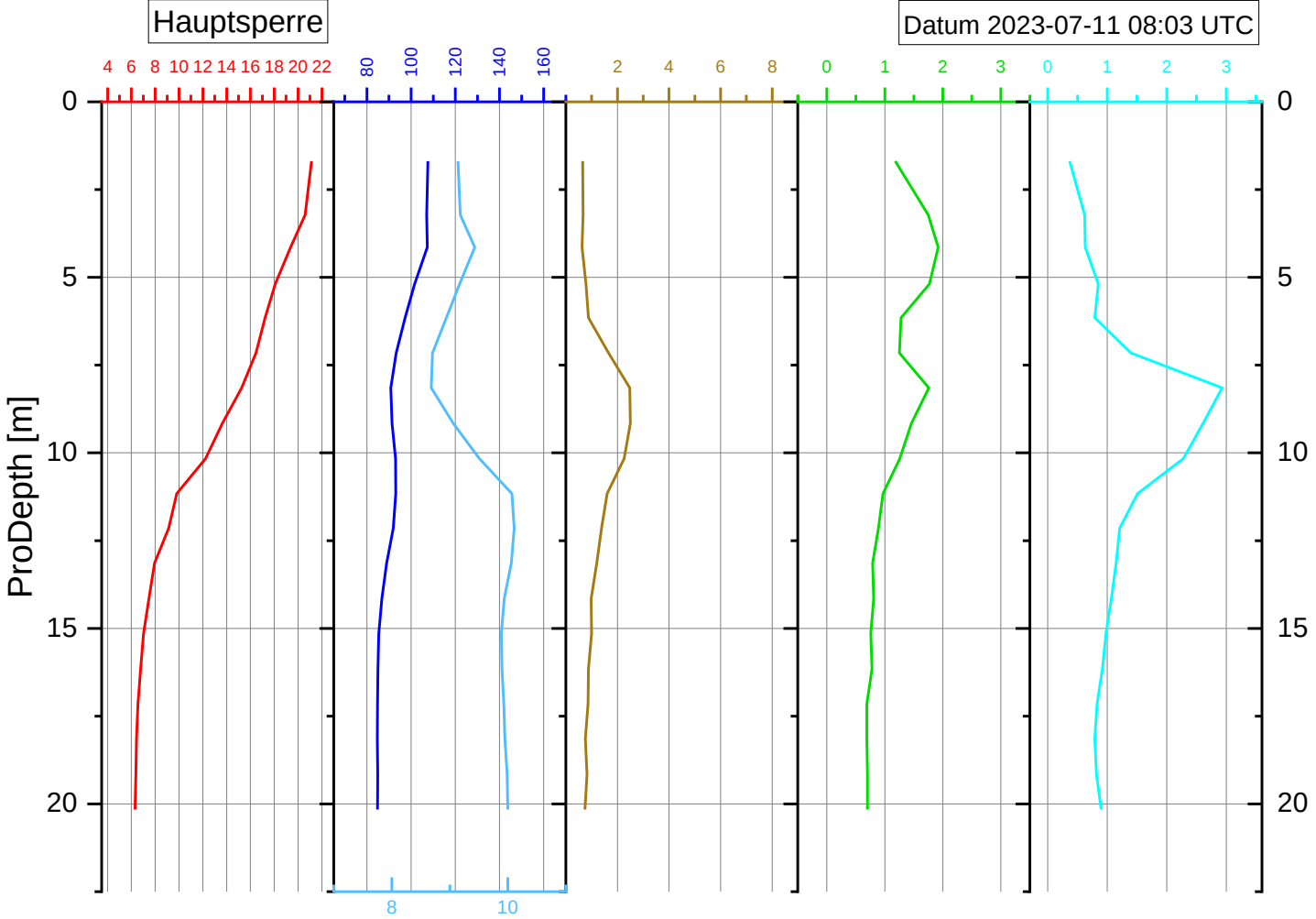
Dissolved oxygen

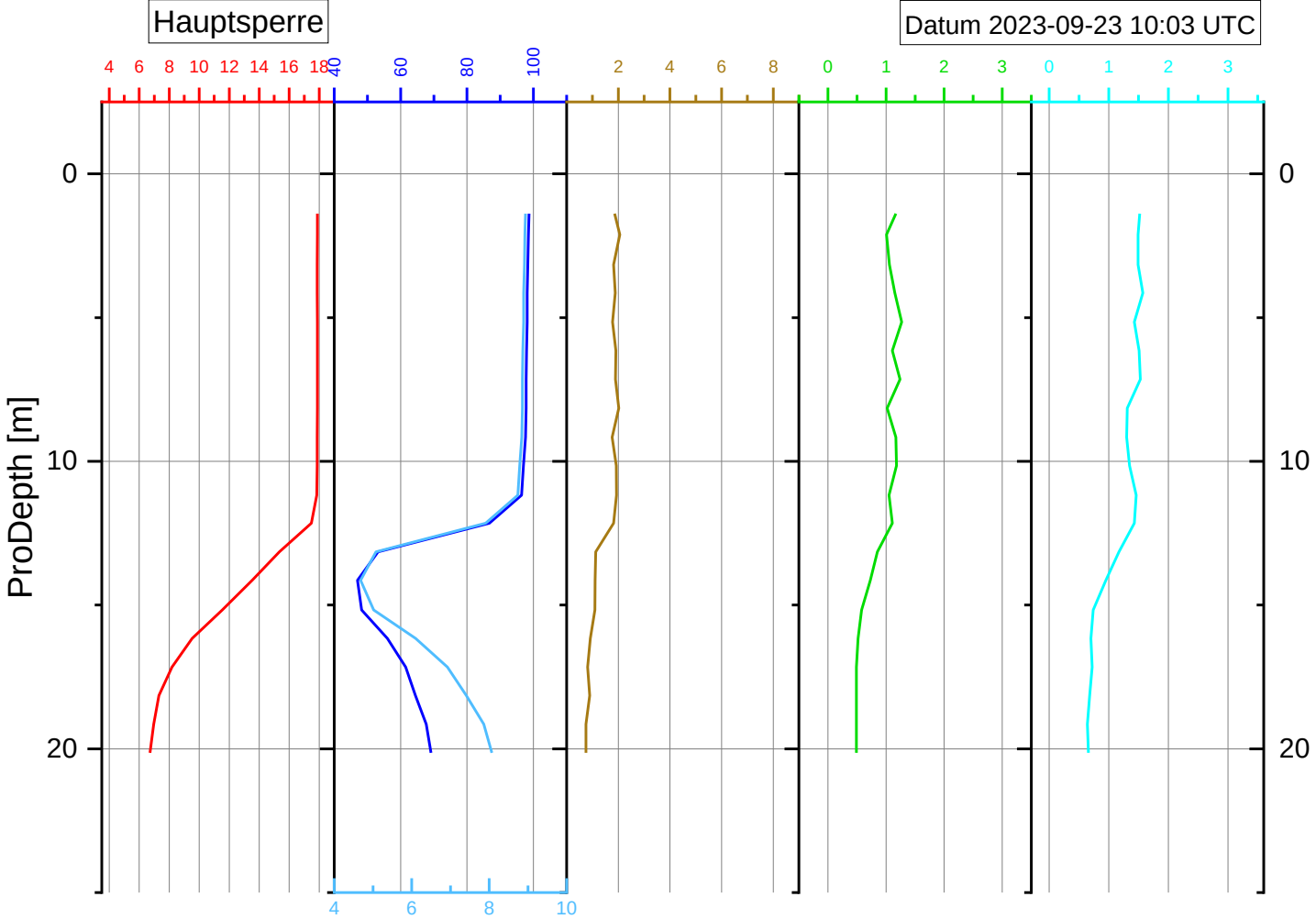


Diatoms and *Planktothrix rubescens*



Mi et al. (2020), Water Research


Hauptsperre
Datum 2023-07-11 08:03 UTC
4 6 8 10 12 14 16 18 20 22
80 100 120 140 160
2 4 6 8
0 1 2 3
0 1 2 3
0
5
10
15
20
ProDepth [m]
8 10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2 4 6 8
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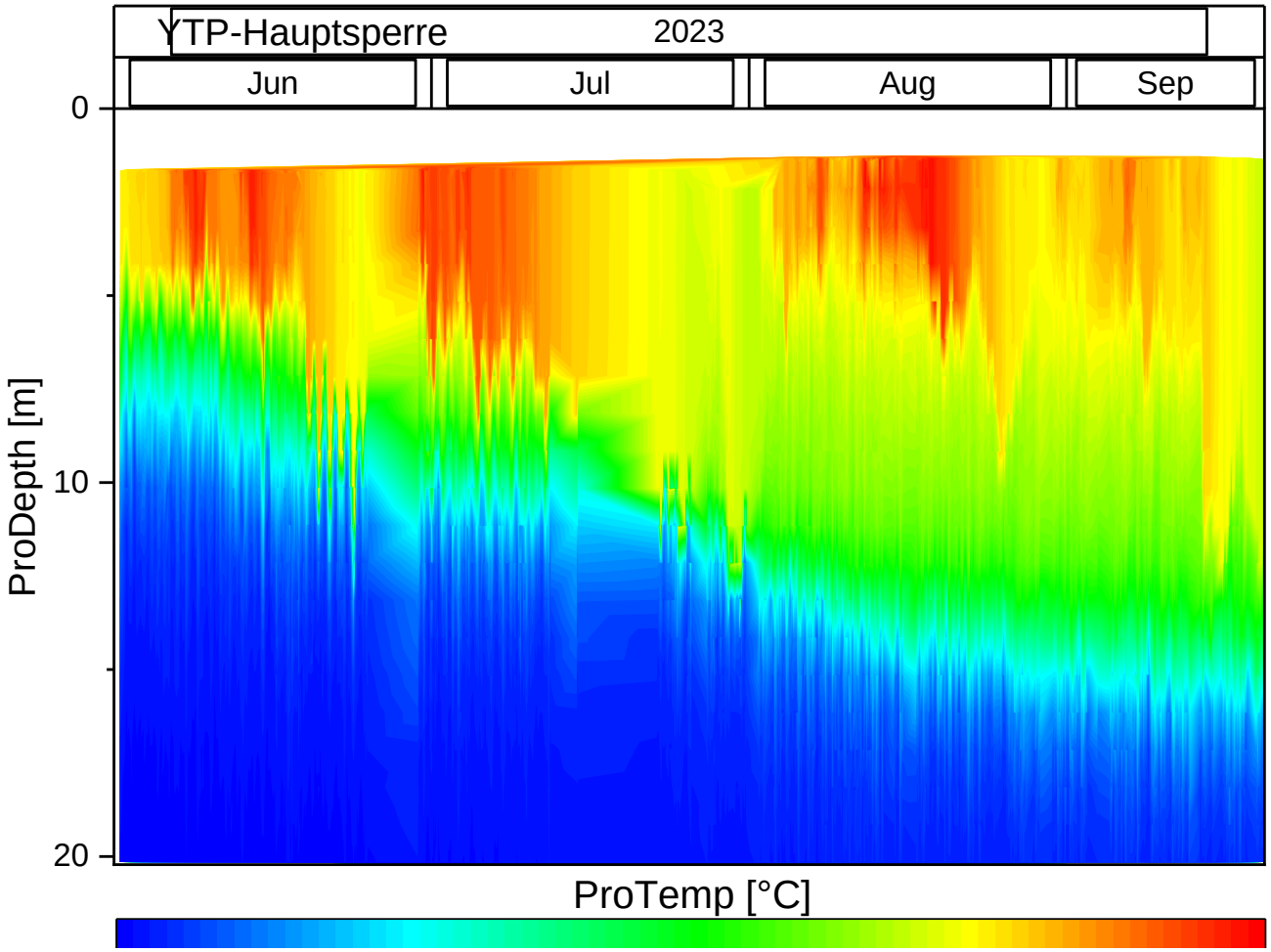
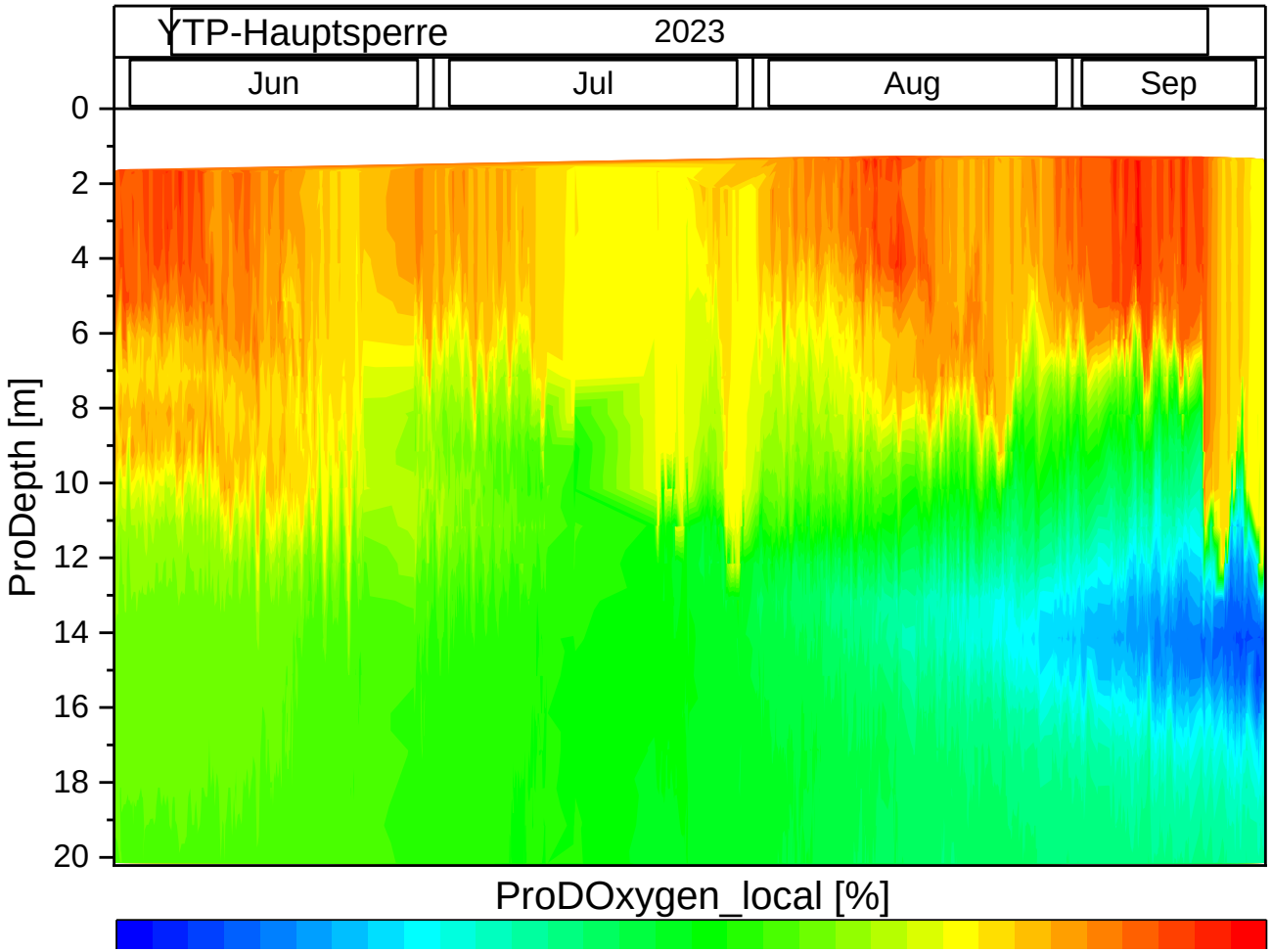
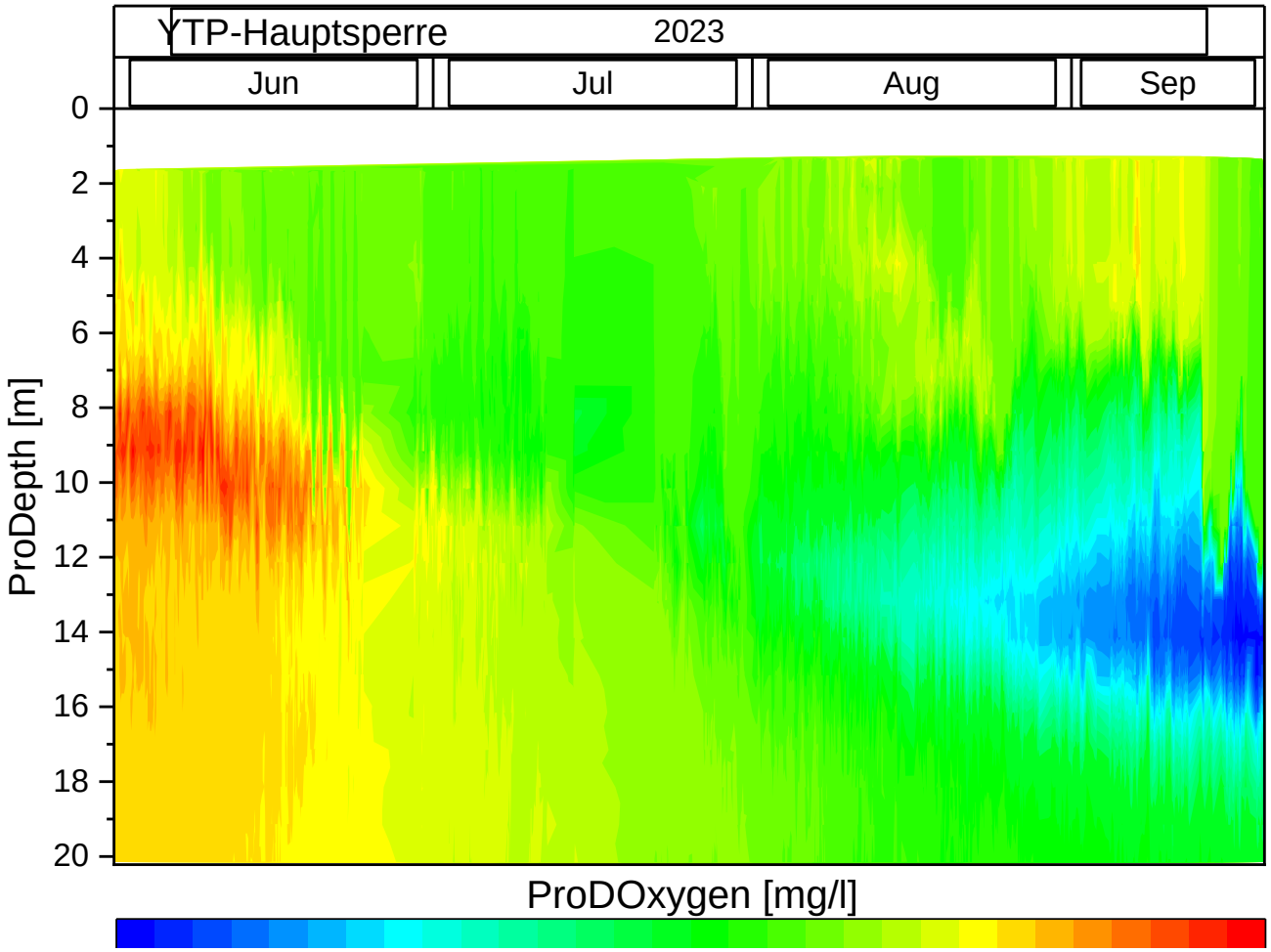
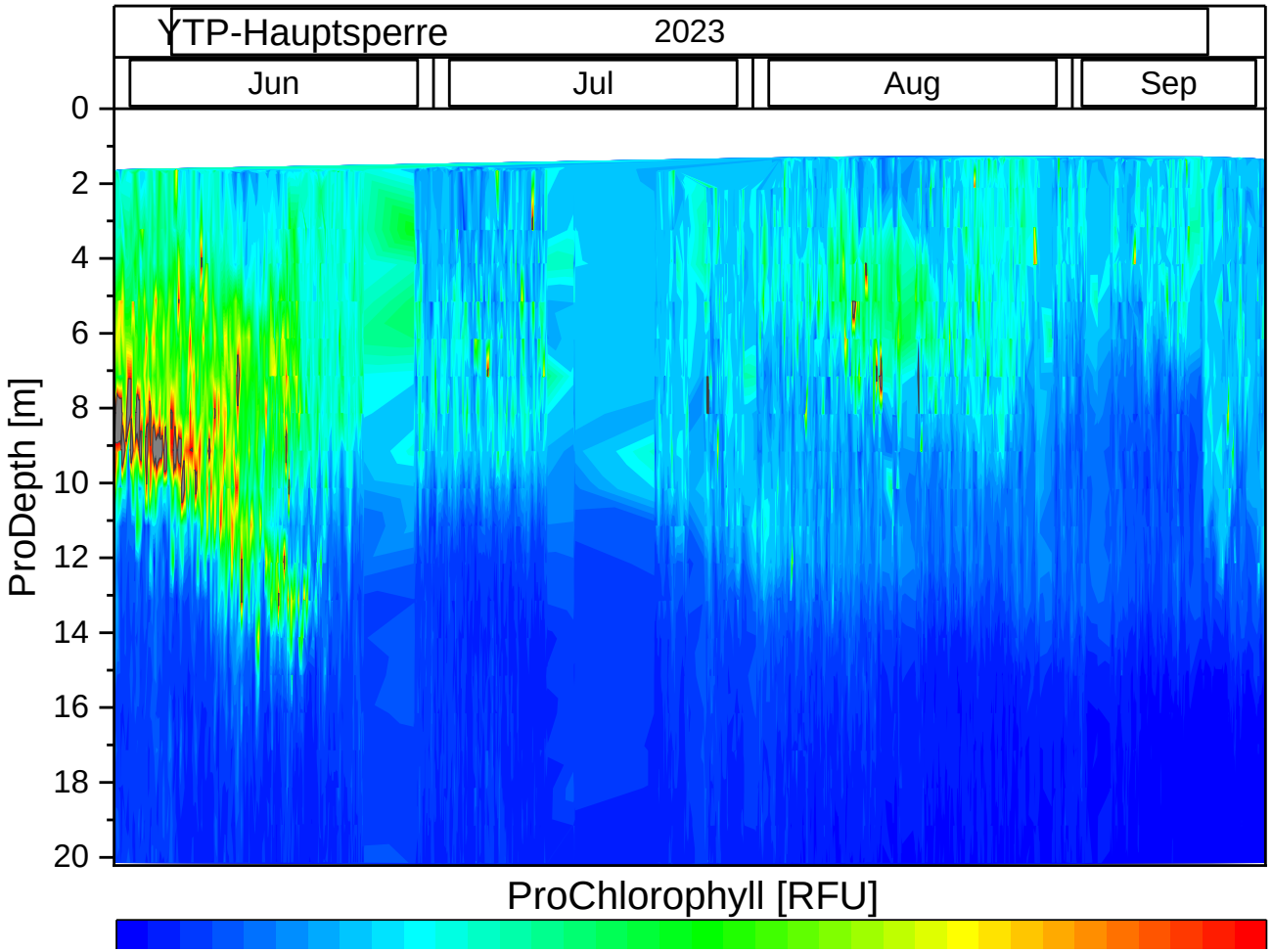
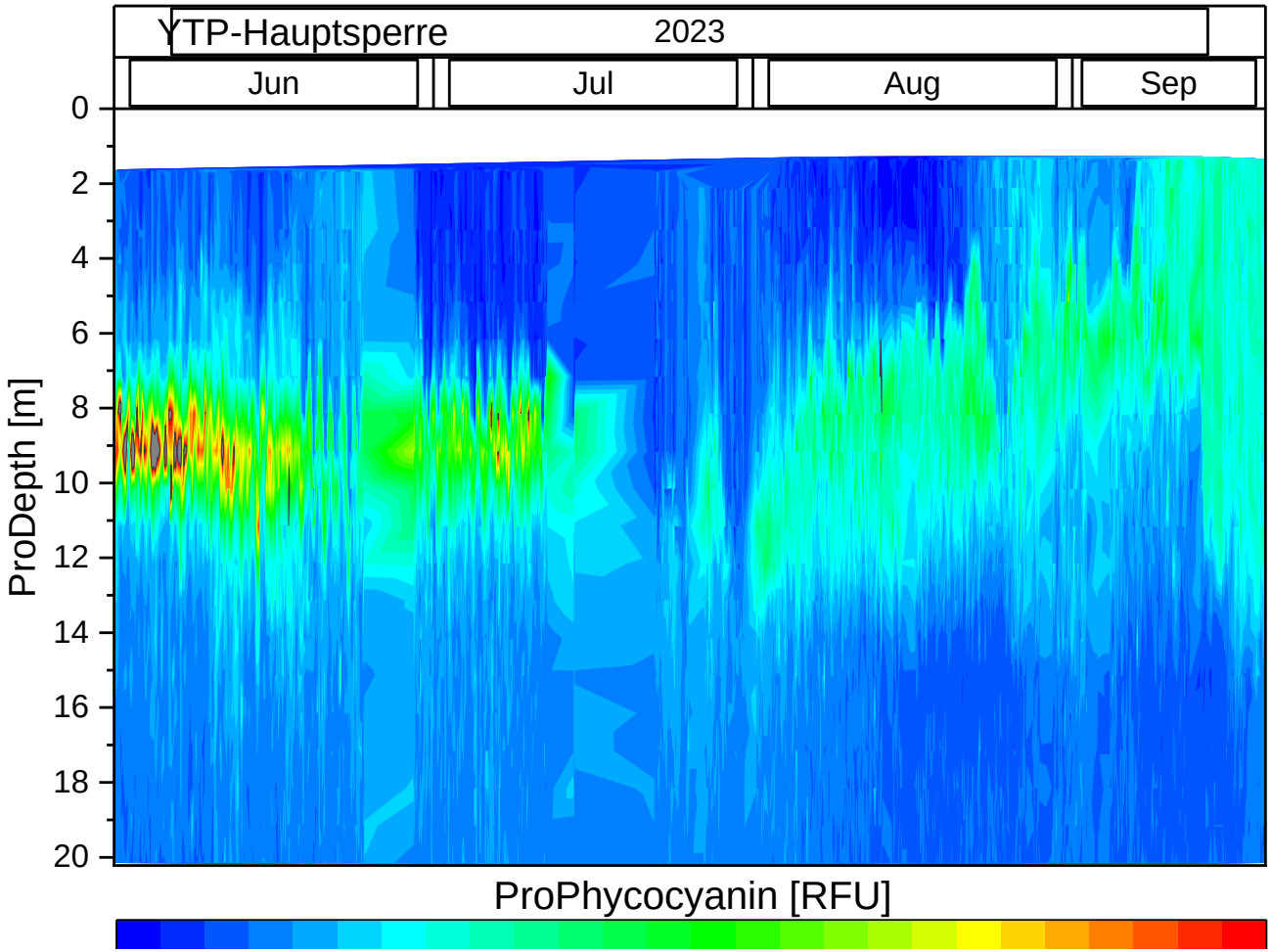
4 6 8 10


YTP-Hauptsperre
2023
Jun
Jul
Aug
Sep
0
10
20
ProDepth [m]
ProTemp [°C]


YTP-Hauptsperre
2023
Jun
Jul
Aug
Sep
0
2
4
6
8
10
12
14
16
18
20
ProDepth [m]
ProDOxygen_local [%]


YTP-Hauptsperre
2023
Jun
Jul
Aug
Sep
0
2
4
6
8
10
12
14
16
18
20
ProDepth [m]
ProDOxygen [mg/l]


YTP-Hauptsperre
2023
Jun
Jul
Aug
Sep
0
2
4
6
8
10
12
14
16
18
20
ProDepth [m]
ProChlorophyll [RFU]


YTP-Hauptsperre
2023
Jun
Jul
Aug
Sep
0
2
4
6
8
10
12
14
16
18
20
ProDepth [m]
ProPhycocyanin [RFU]

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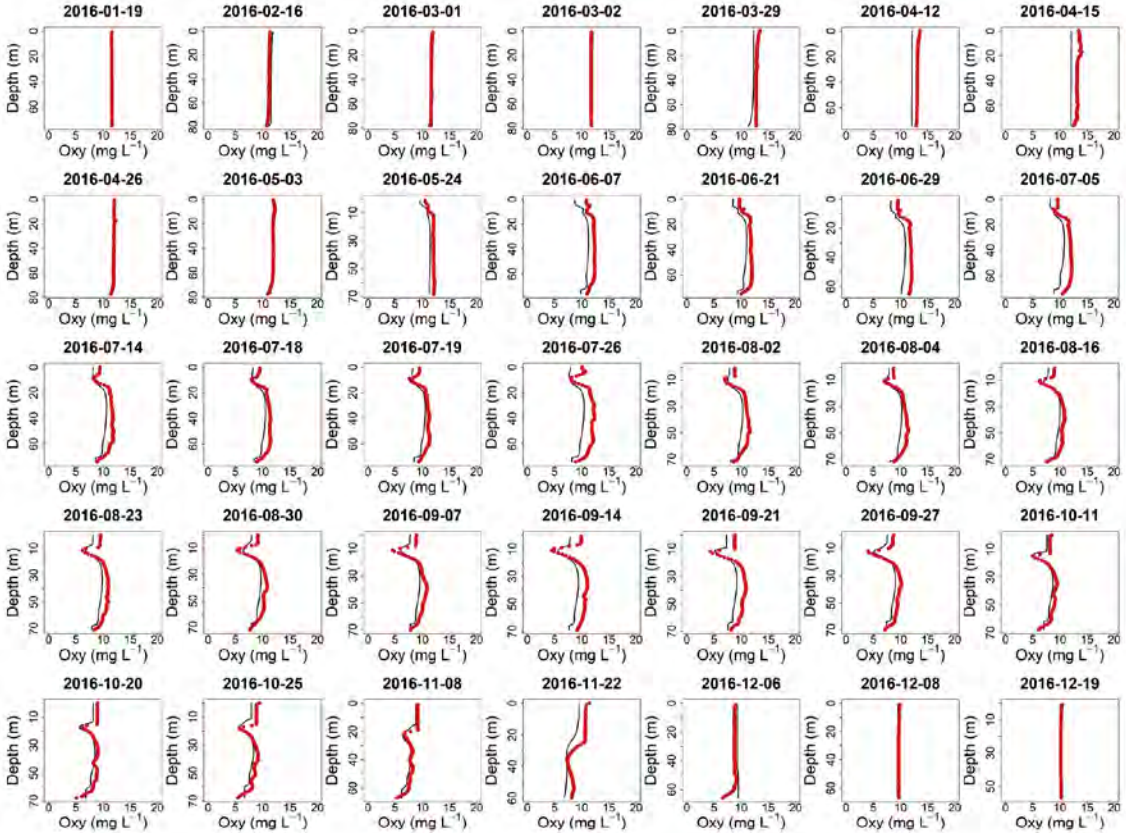
Climate adaptation by reservoir operation

Simulation outputs: Oxygen



RMSE = 0.95 mg l^{-1}
R^2 = 0.84

Water Research 175 (2020) 115700

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

The formation of a metalimnetic oxygen minimum exemplifies how ecosystem dynamics shape biogeochemical processes: A modelling study

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Mi et al. (2020), Water Research