Recent spatial and seasonal variations of mercury in suspended particulate matter of the legacy contaminated river Elbe (Germany)

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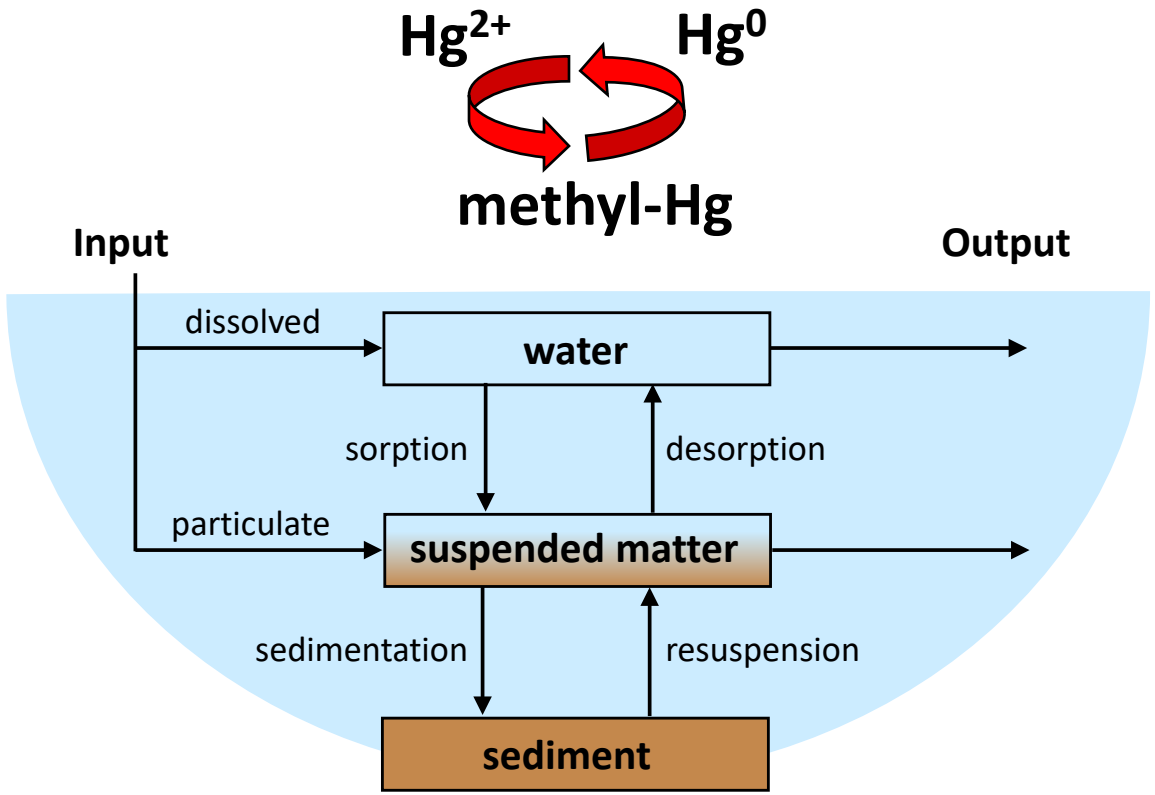
Elbe, VEB Fahlberg-List, 1953 (Bundesarchiv, Roesener)



Elbe near Magdeburg, 2012 (photo: Torsten Maue)

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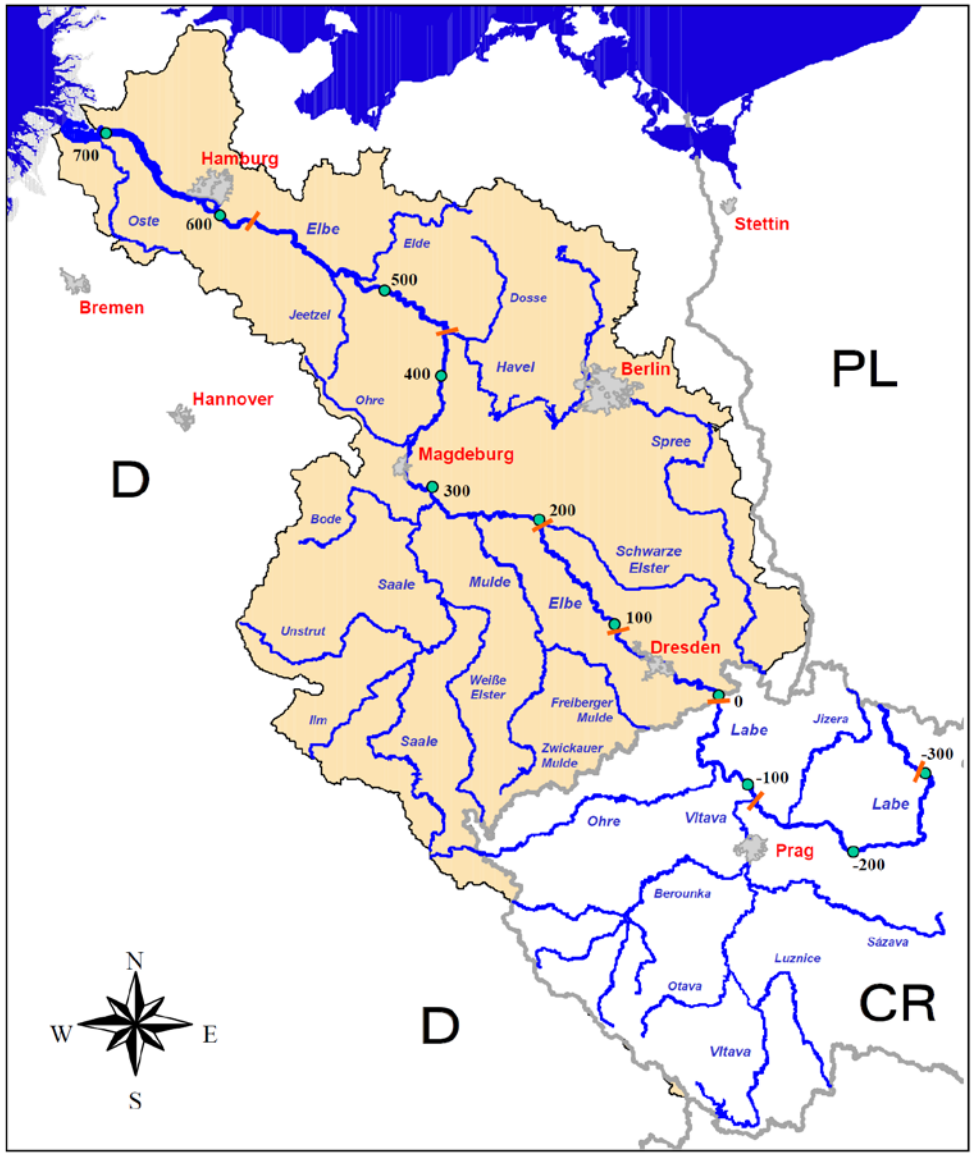
The river Elbe: Slow recovery from severe legacy contamination



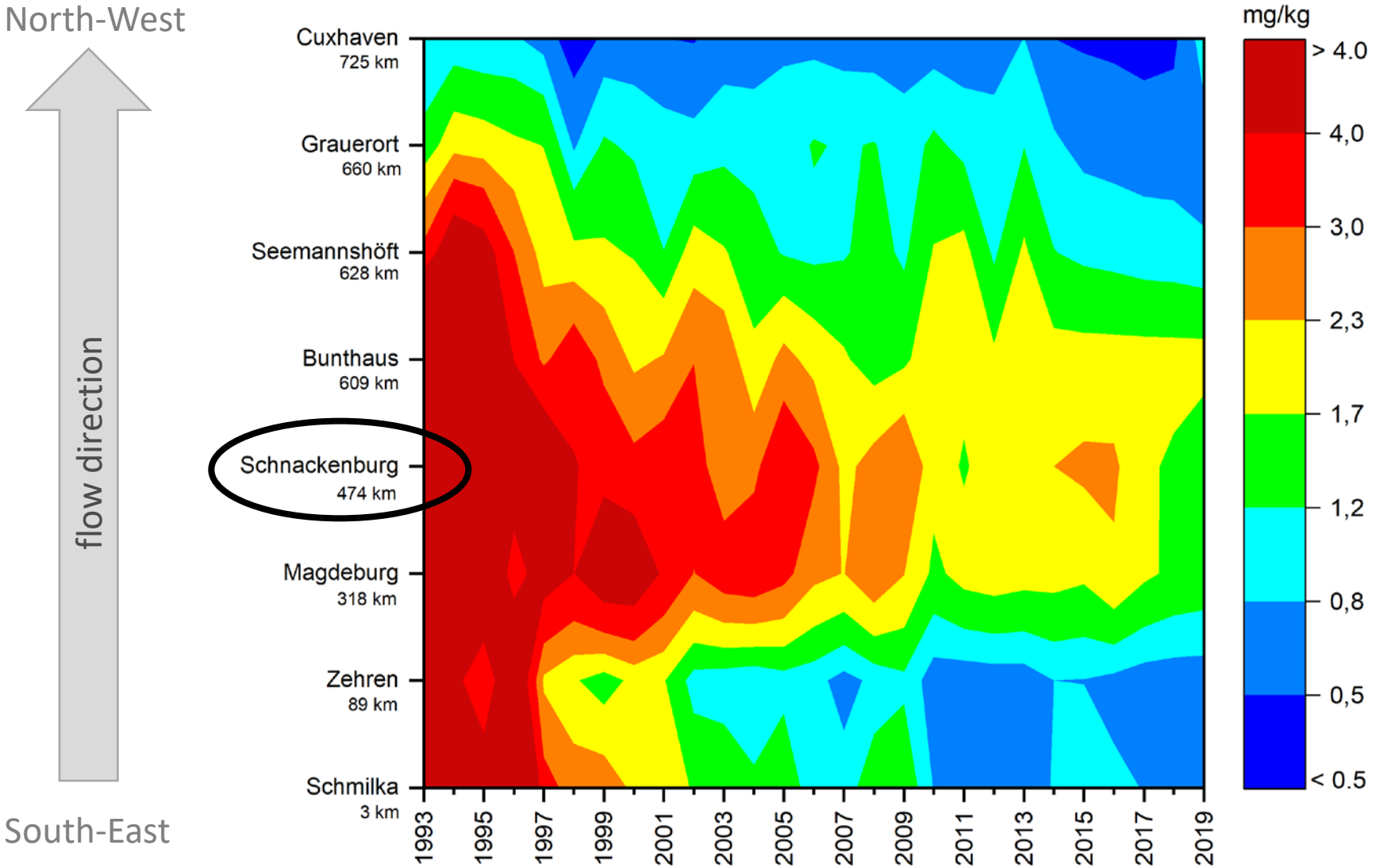
HPA 2005 (map: BfG)

- The Elbe catchment contains many large cities and industrial production areas (chemical factories, ore and coal mining, …)
- Large amounts of mercury were released into the Elbe and transported downstream (flux at Inner German border 1990: 25 t/a Hg)

Chemical industry (source: Chemiepark Bitterfeld-Wolfen GmbH)

Effluent from mining area (source: LfULG)

The river Elbe: Historical Hg trends in suspended particulate matter

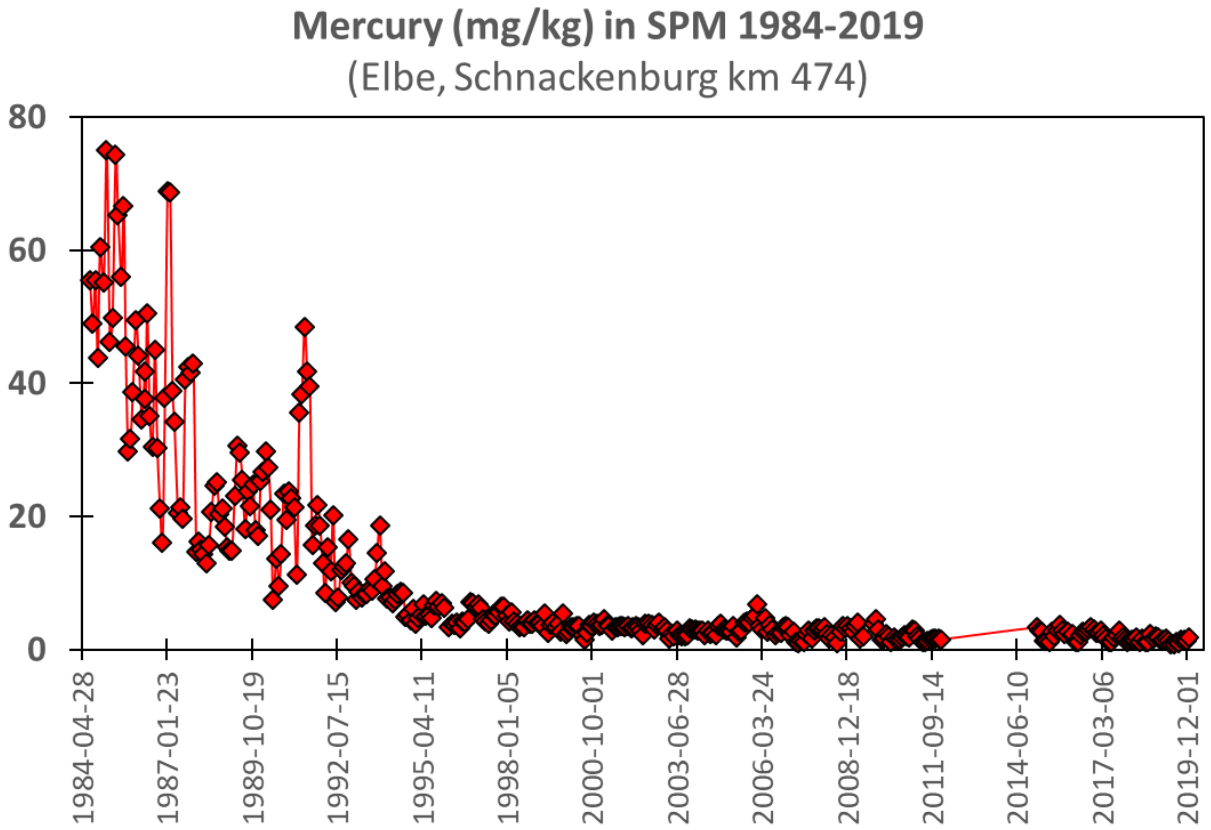


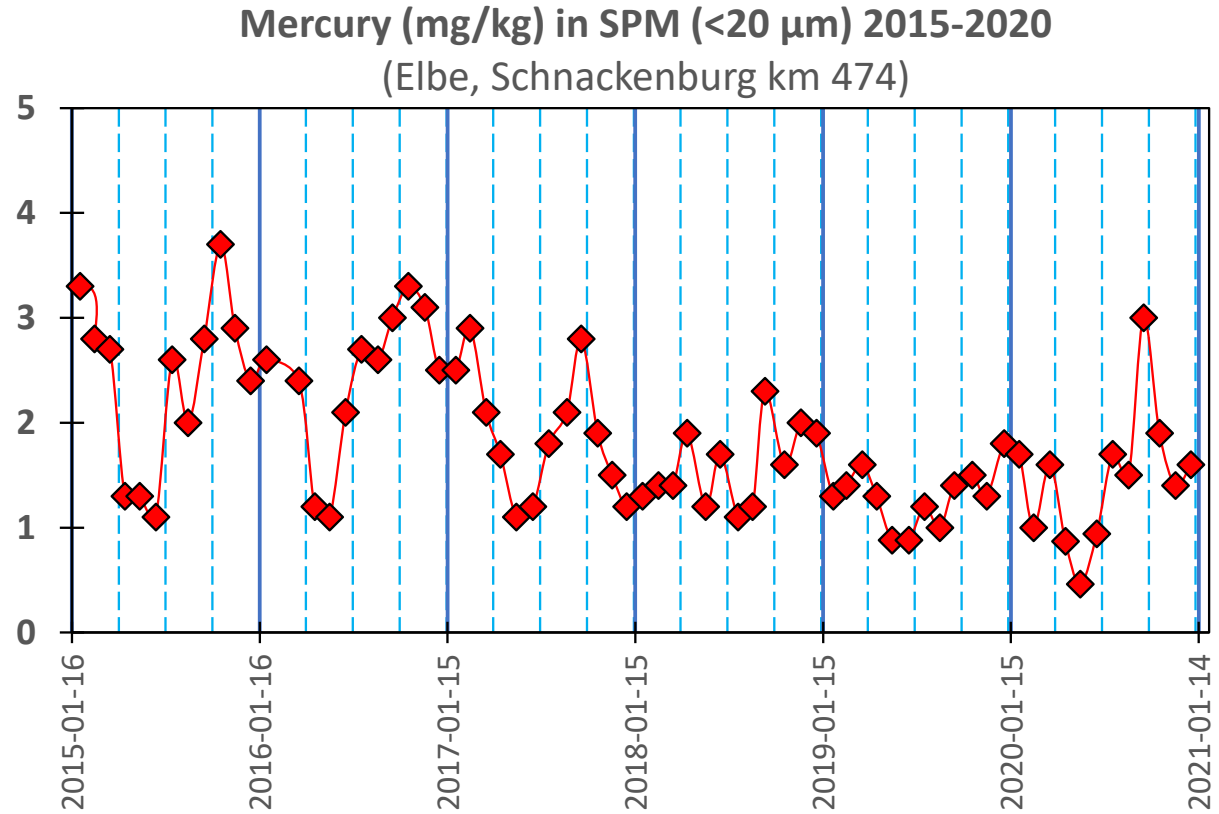
based on >3100 measurements (< 20 µm)
missing datapoints were added by interpolation or extrapolation

natural background: <0.5 mg/kg Hg

data source: federal states FGG-Elbe

Temporal Hg trend at sampling station Schnackenburg (km 474)





1985:
≈ 60 mg/kg

1990-1995:
≈ 10 mg/kg

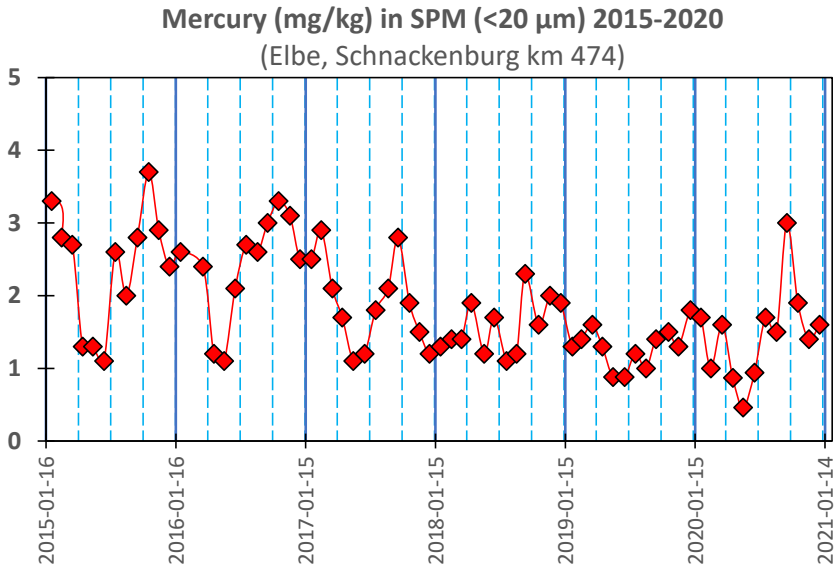
2000:
≈ 3 mg/kg

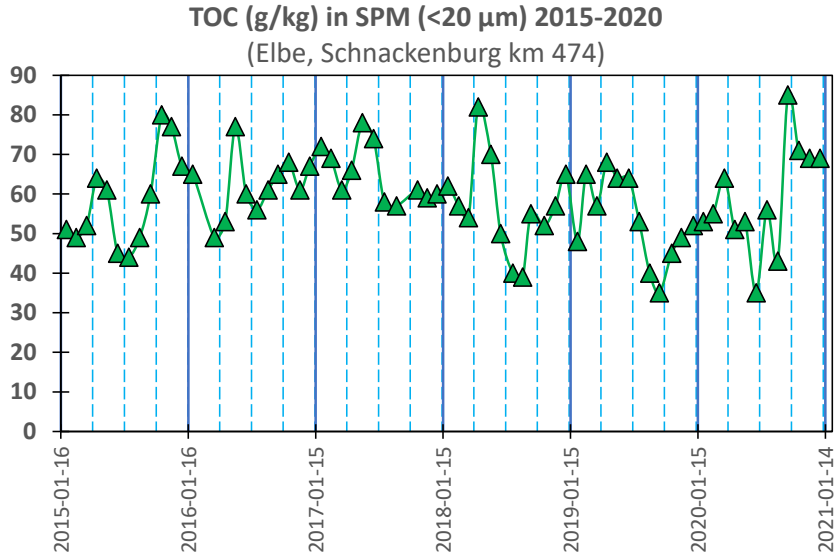
today:
≈ 1-2 mg/kg

data source: federal states FGG-Elbe

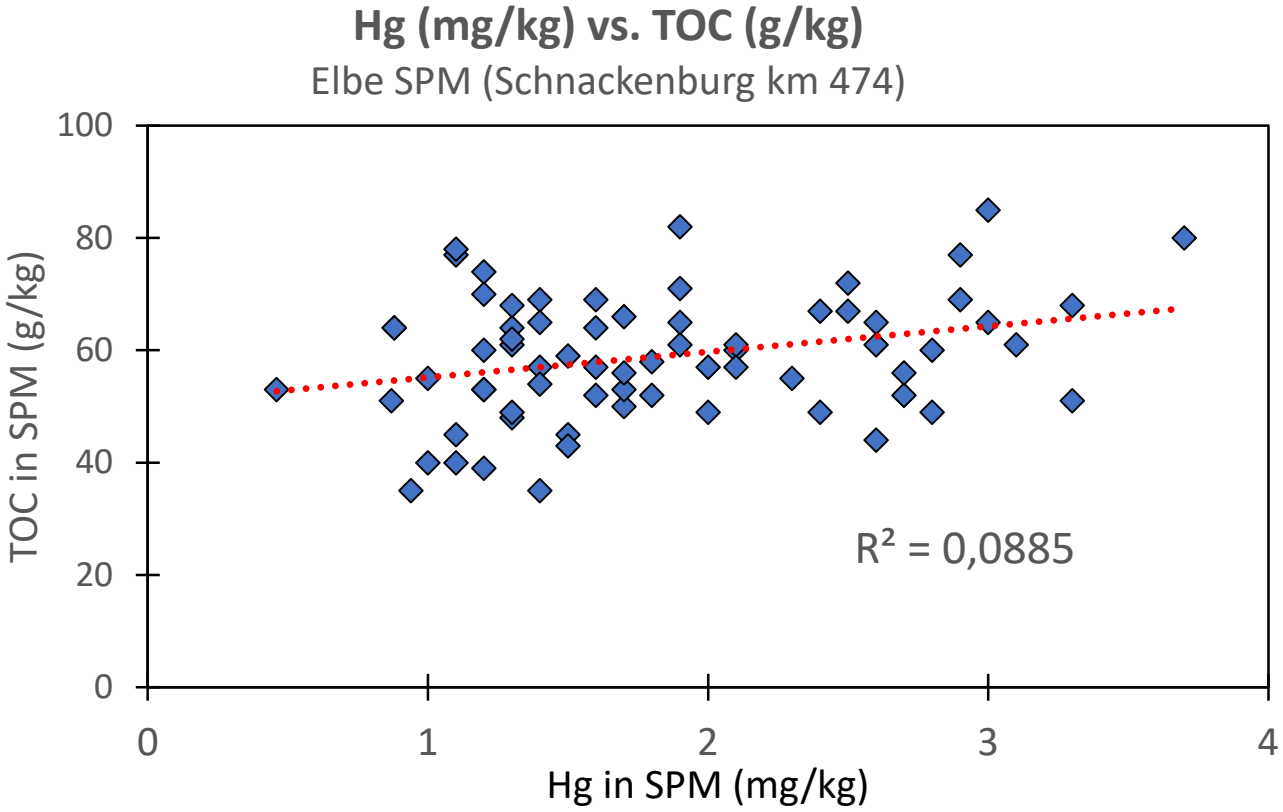
- decreasing trend has slowed down
- strong seasonal variations
  (usually Hg maximum in fall/winter)

Seasonal trends at sampling station Schnackenburg (km 474)



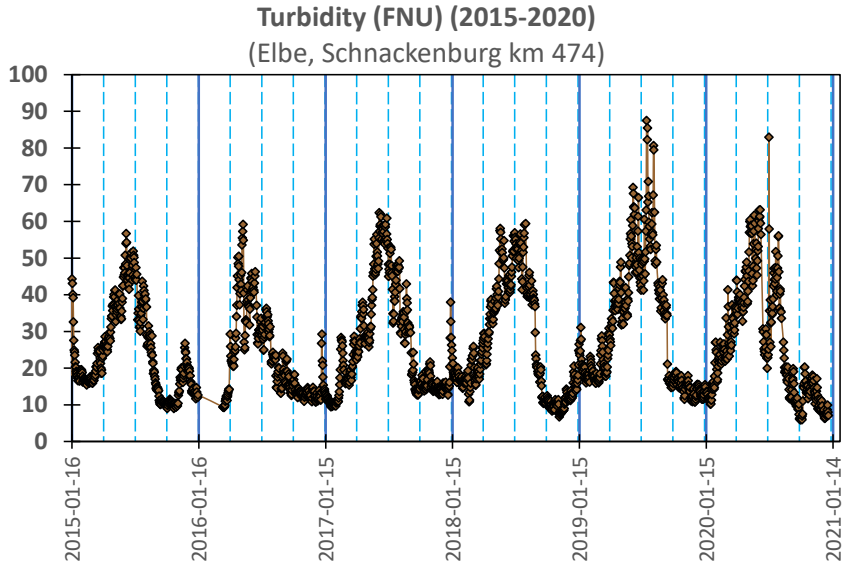


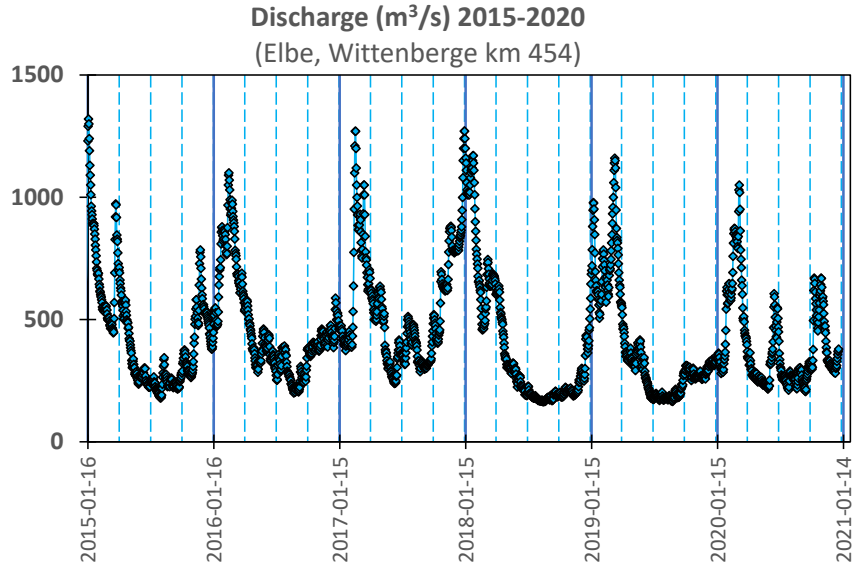
data source: federal states FGG-Elbe

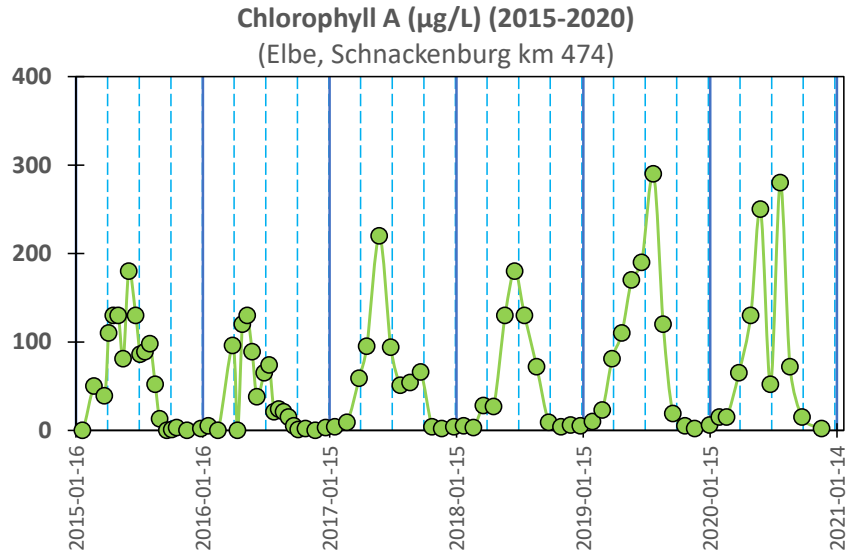


- no correlation between Hg and TOC in SPM
- other parameters must explain seasonal trends

Seasonal trends at sampling station Schnackenburg (km 474)





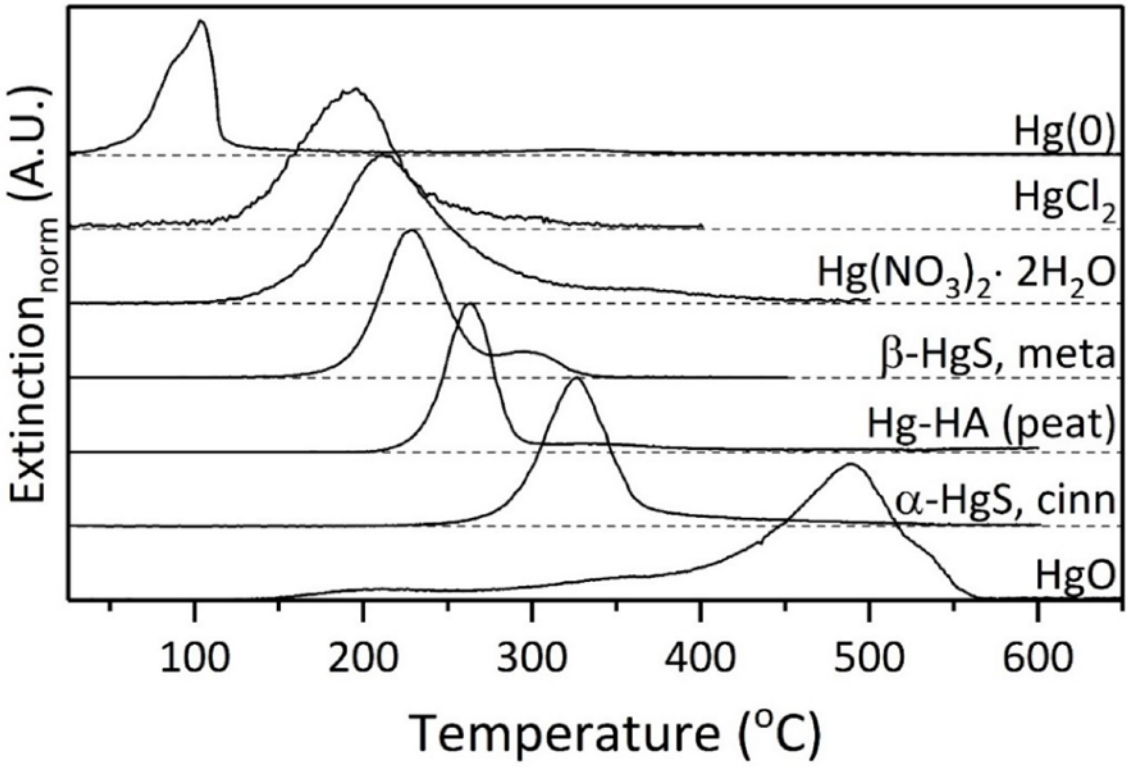


data source: federal states FGG-Elbe

- Rivers are very dynamic systems and seasonal changes are overprinted by hydrology
- Hg in SPM controlled by various factors:
  - „dilution“ with more organic matter in summer
  - increased input from soil erosion and sediment remobilization during high flow events (but: mixture of contaminated and non-contaminated particles)

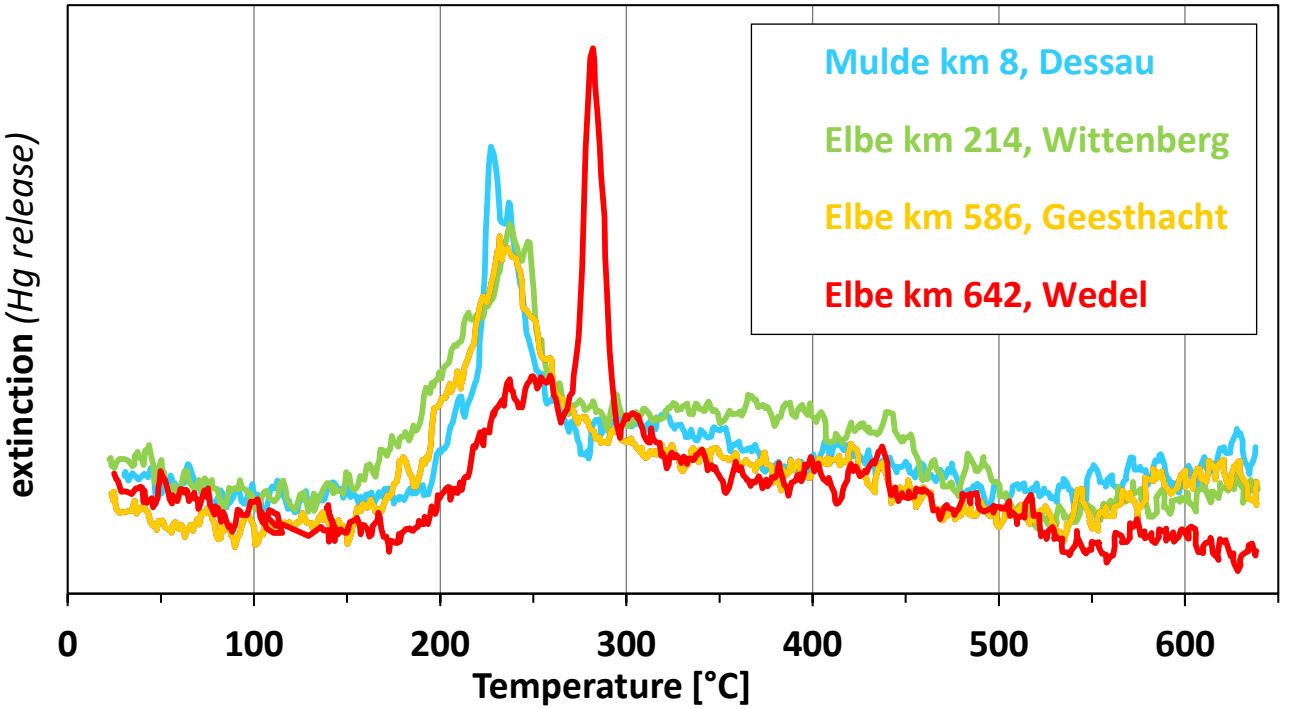
Determination of Hg binding forms by pyrolytic thermodesorption

thermodesorption curves of Hg reference compounds:



source of figure: Gilli et al., 2019, doi: 10.3390/soilsystems2030044

Release curves of selected riverine SPM samples



- Hg in SPM is dominated by Hg(II) bound to organic matter/mineral surfaces and/or β-HgS

Next steps and future research plans

- Comparison of SPM collected by flow-through centrifuge vs. sedimentation boxes
- Further validation of sampling and sample preparation procedures
- Investigation of variations of Hg species (binding forms) in SPM and sediments
- Determination of biogeochemical conditions controlling Hg species dynamics
- Analysis of Methyl-Hg in river water, SPM, and sediments
- Characterization of microbial communities in „methylation hotspots“
- Laboratory experiments investigating Hg dynamics at sediment-water interface and the influence of disturbance events (e.g., dredging in managed water ways)

→ **Recently started reseach project QUISS (2022-2024)**

Acknowledgements

We thank for their help and support:

- Lee Seyeon and Petra Schmidt for PTD analyses at TU Braunschweig
- Rolf Hartmann, Ulf Köppe, Sascha Koch (field staff UPB)
- Field and lab staff at BfG (radiological monitoring and Elbe campaigns)
- FGG-Elbe
- UBA / Environmental Specimen Bank (UPB)
- German Federal Ministry for Digital and Transport (BMDV)

bfg Bundesanstalt für Gewässerkunde

Technische Universität Braunschweig