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Additional information about Fosferrox: A Biogeochemical Model Extension for Coupled Fe, P and S Dynamics in Response to Changes in Bottom Water O_2 in BALTSEM

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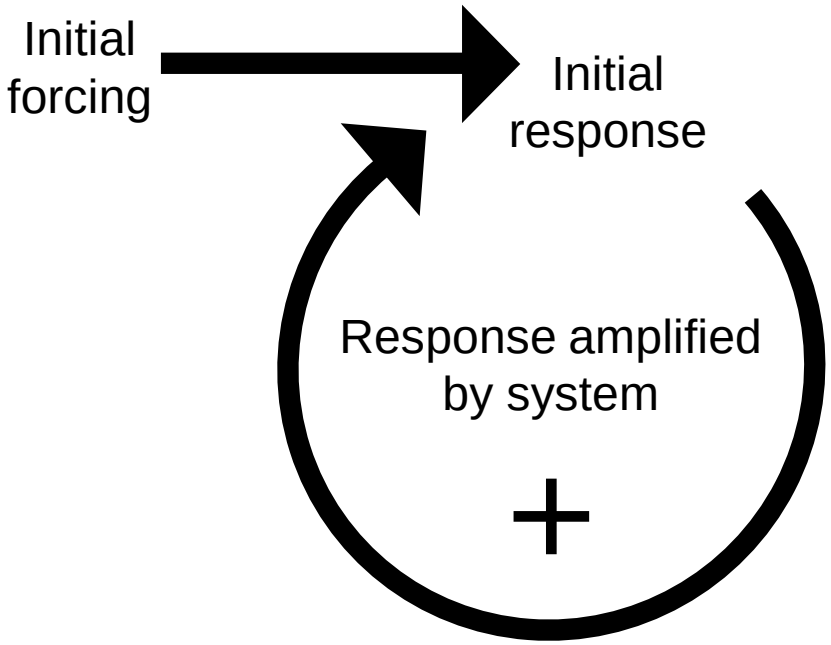
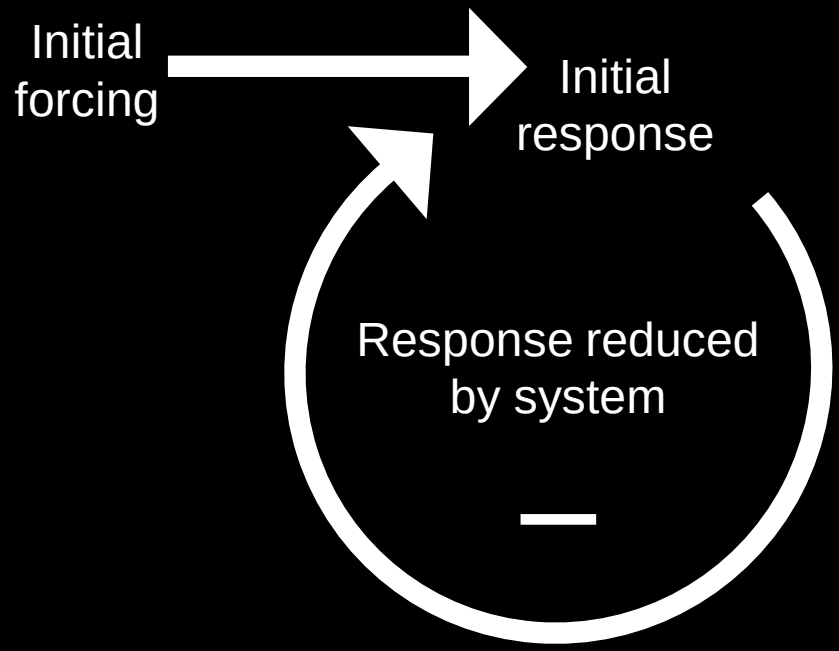
Types of Feedback Mechanisms

Self-reinforcing feedback
(Positive feedback)



Balancing feedback
(Negative feedback)



Types of Feedback Mechanisms

Self-reinforcing feedback
(Positive feedback)

1) More gives you more
2) Amplifies a process
3) Enhances change
4) Less associated with stability

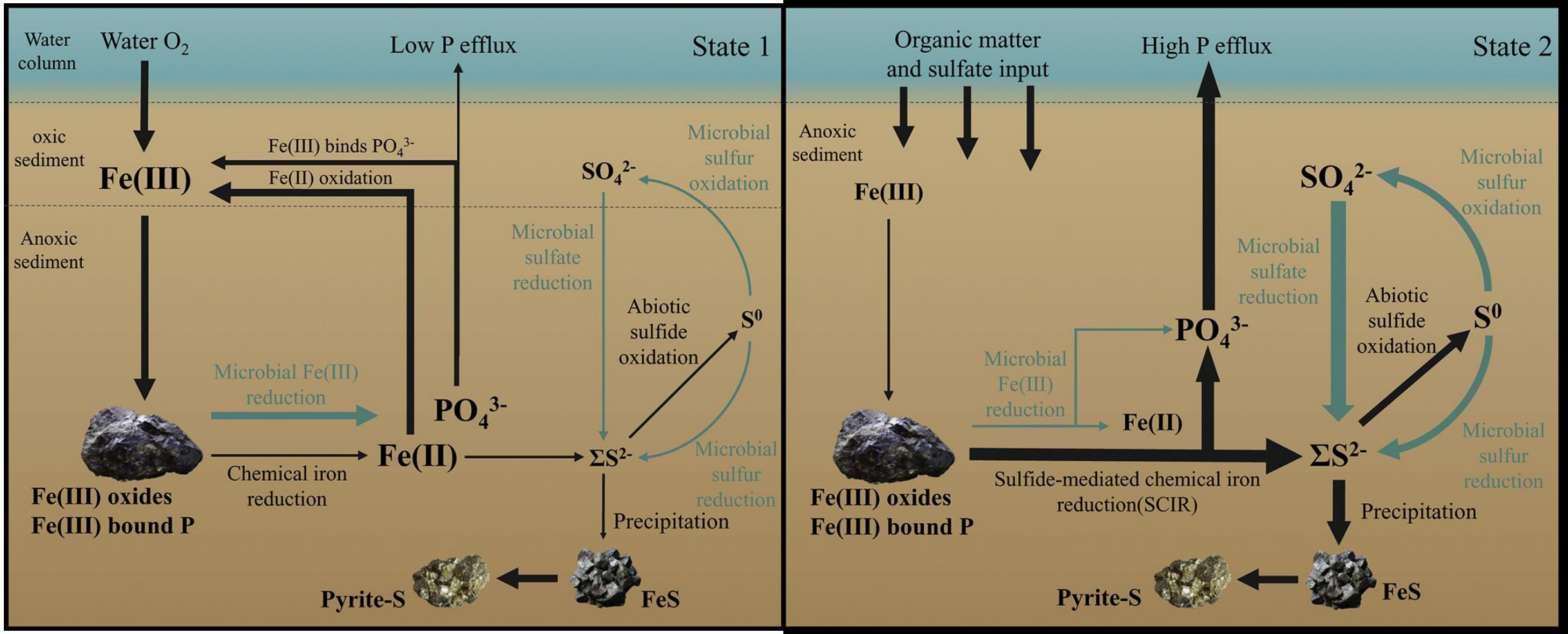
Balancing feedback
(Negative feedback)

1) More gives you less
2) Inhibits or slows down a process
3) Resists change
4) Closely associated with stability

Coupled Iron, Phosphorus and Sulphur Cycling

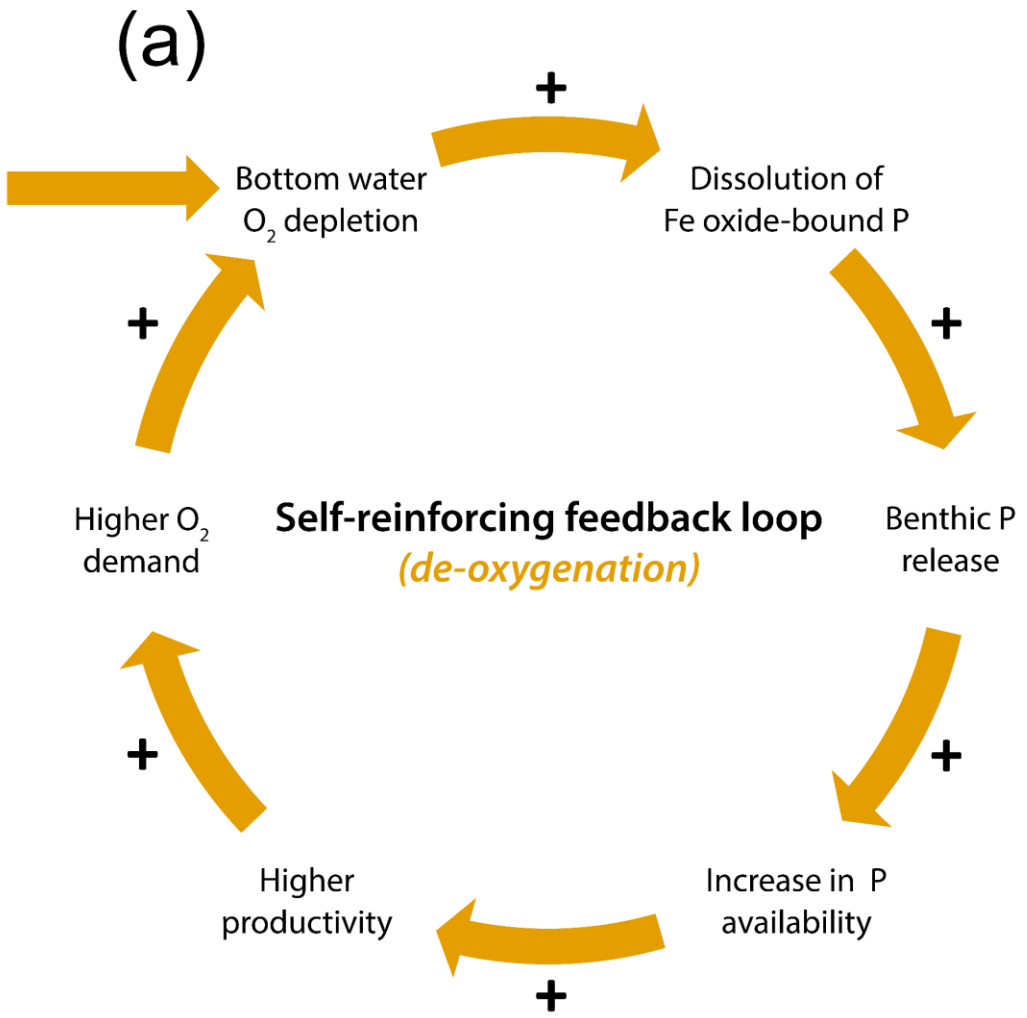
Oxic and oligotrophic conditions

Hypoxic/anoxic and eutrophic conditions



Source: Wu et al. (2019) Sulfur cycling in freshwater sediments: A cryptic driving force of iron deposition and phosphorus mobilization *Science of The Total Environment*, **657**, 1294-1303: https://doi.org/10.1016/j.scitotenv.2018.12.161

Self-Reinforcing Iron-Phosphorus Feedback: Spatially Finite System

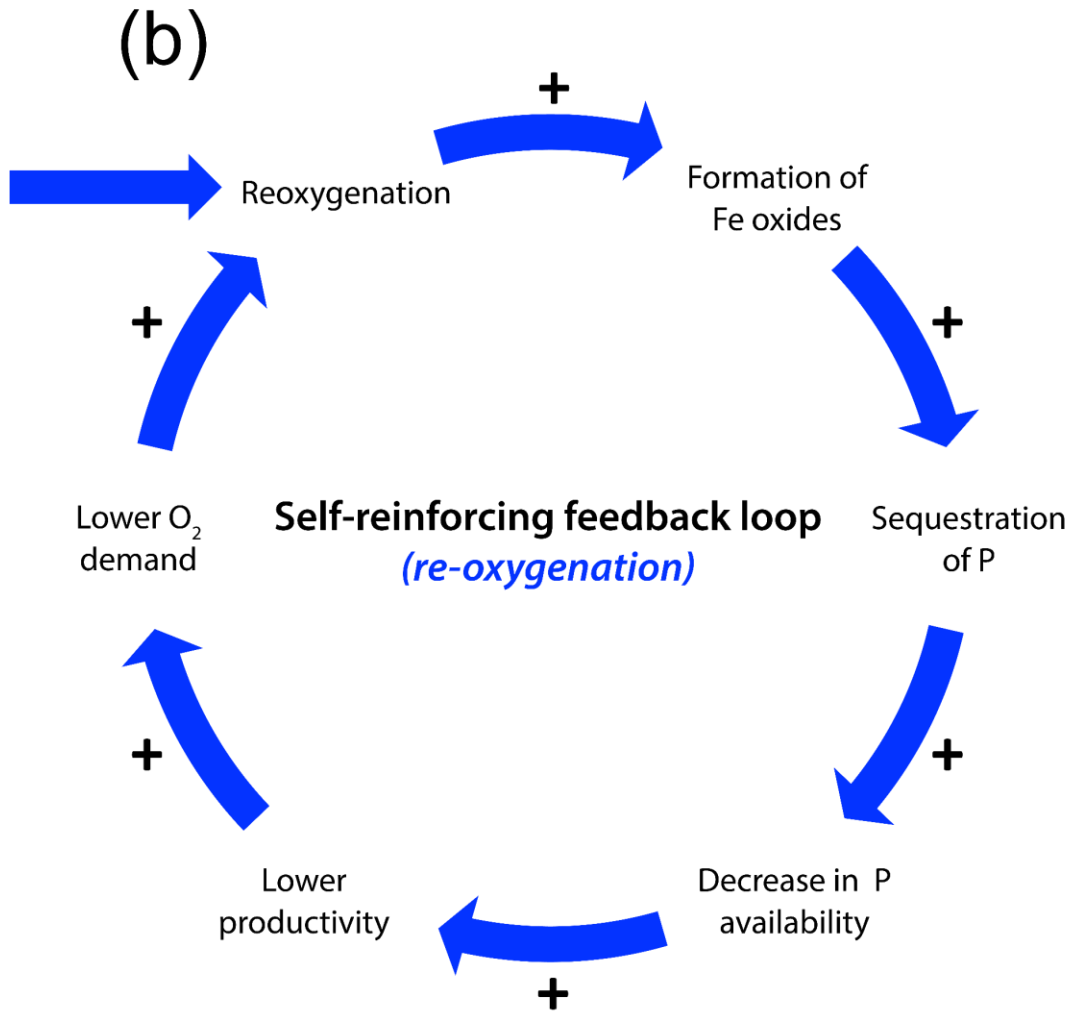


- The self-reinforcing Fe-P feedback cannot proceed indefinitely. Under low bottom water O_2 conditions, the sedimentary Fe oxide-bound P pool rapidly depletes.
- The maximum spatial extent of O_2 depletion is constrained by thermohaline stratification.

Source: Hermans et al. (in prep) A biogeochemical model extension for coupled iron, phosphorus and sulphur dynamics in relation to changes in water column redox conditions in BALTSEM *Geoscientific Model Development*

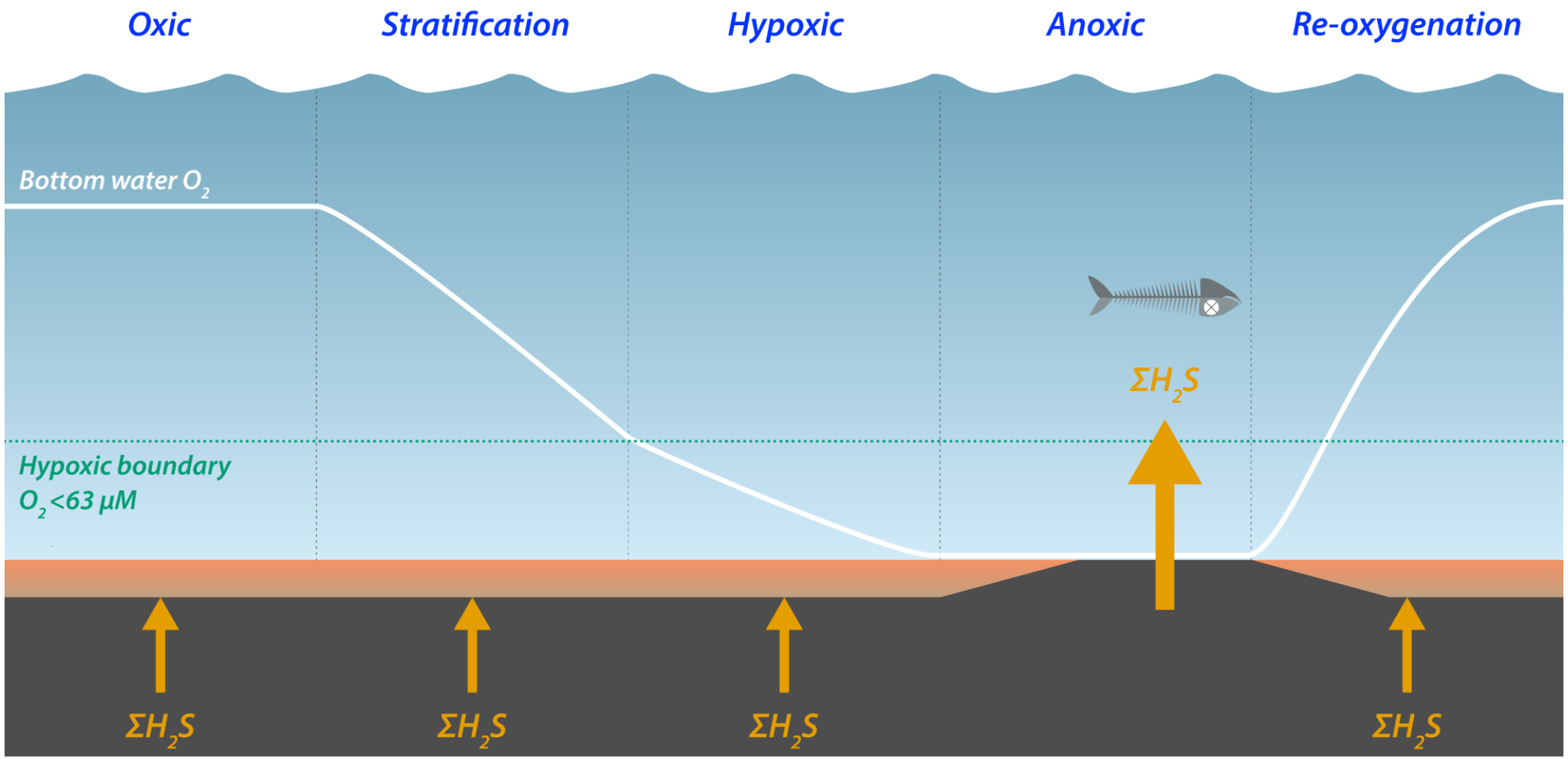
Self-Reinforcing Iron-Phosphorus Feedback: Abatement of Hypoxia/Anoxia

- When external P loads are insufficient to sustain high productivity, a reverse of the self-reinforcing Fe-P feedback might occur.
- Bottom water re-oxygenation can also reverse the self-reinforcing Fe-P feedback.
- The dual directionality of the Fe-P feedback likely plays a key role in multidecadal hypoxic events in the Baltic Sea.



Source: Hermans et al. (in prep) A biogeochemical model extension for coupled iron, phosphorus and sulphur dynamics in relation to changes in water column redox conditions in BALTSEM *Geoscientific Model Development*

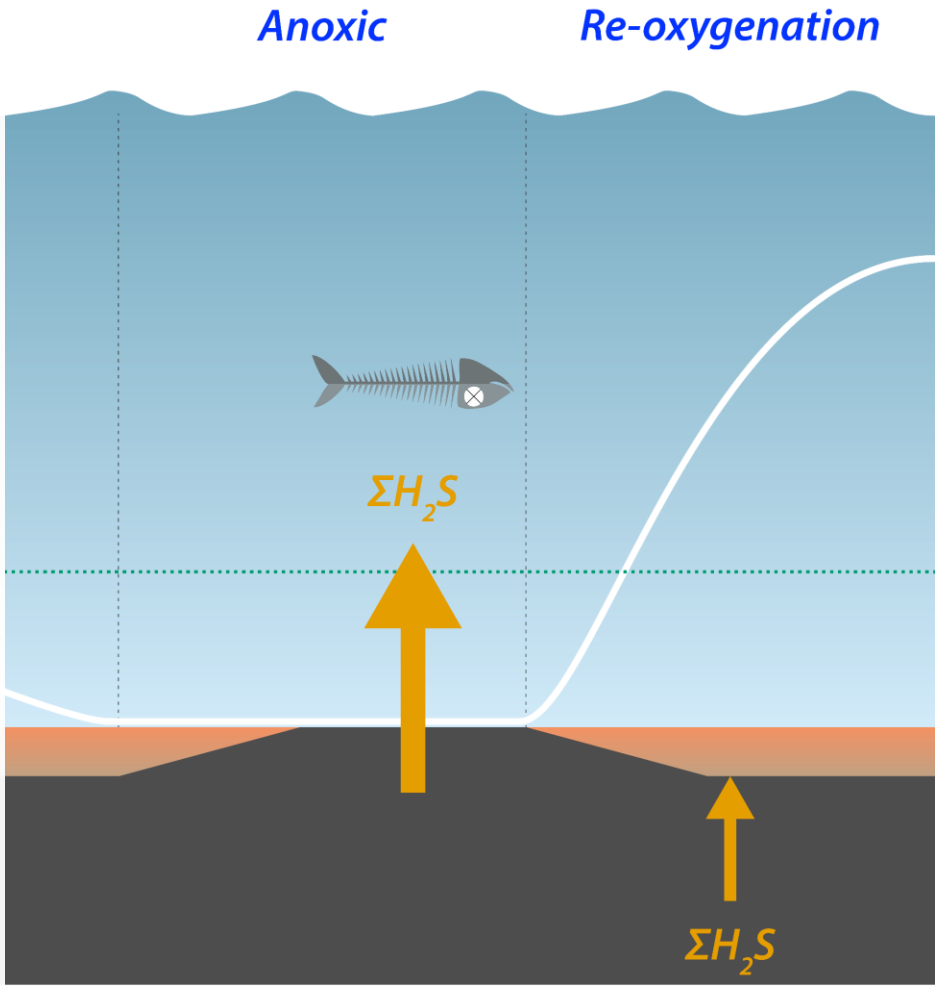
Balancing Iron-Sulphur Feedback: Delays/Prevents Onset of Bottom Water Euxinia



Source: Hermans et al. (in prep) A biogeochemical model extension for coupled iron, phosphorus and sulphur dynamics in relation to changes in water column redox conditions in BALTSEM *Geoscientific Model Development*

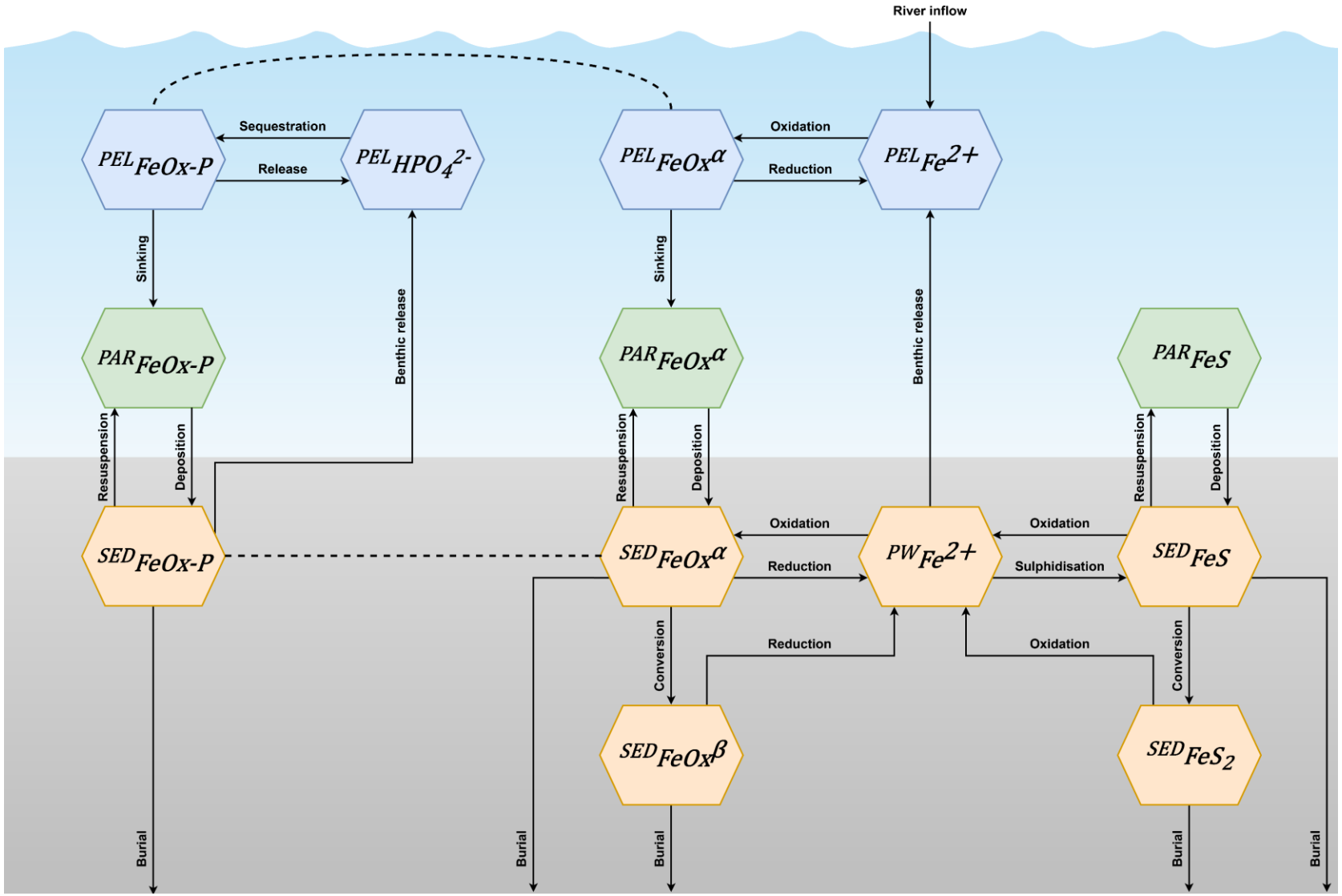
Balancing Iron-Sulphur Feedback: Spatially Finite System

- The balancing Fe-S feedback mechanism can also not proceed indefinitely.
- Sedimentary Fe oxides are gradually converted into Fe monosulphides (FeS) and eventually pyrite (FeS_2).



Source: Hermans et al. (in prep) A biogeochemical model extension for coupled iron, phosphorus and sulphur dynamics in relation to changes in water column redox conditions in BALTSEM *Geoscientific Model Development*

BALTSEM: Fosferrox Extension Complete Flowchart



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Q&A

More information:

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Source: Contains modified Copernicus Sentinel data (2021), processed by ESA