



Reservoirs in the sun

**Biogeochemistry in the Mediterranean to identify patterns
at the global scale**



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Research and Innovation for the sustainable use of water



Research areas

Resources and ecosystems **AI**

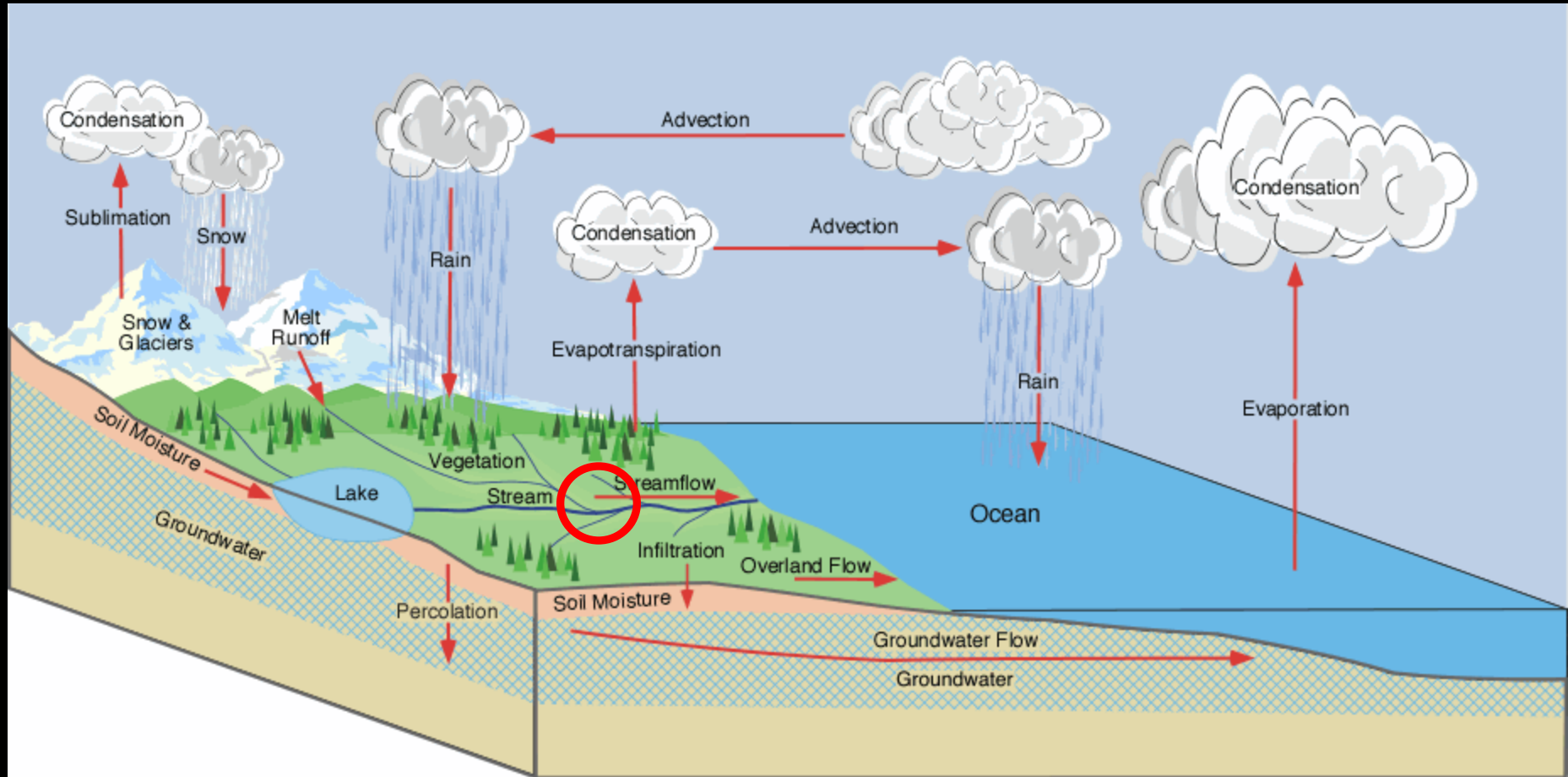
Water quality **AII**

Technologies and evaluation **AIII**

Lines of research

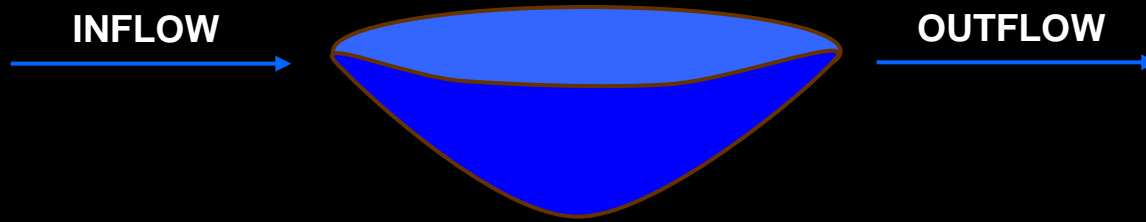
- AI1 Hydrological processes
- AI2 Lacustrine and reservoir systems
- AI3 Fluvial systems
- AI4 Modelling of ecosystems and basins

Llacs i embassaments...un origen prou diferent

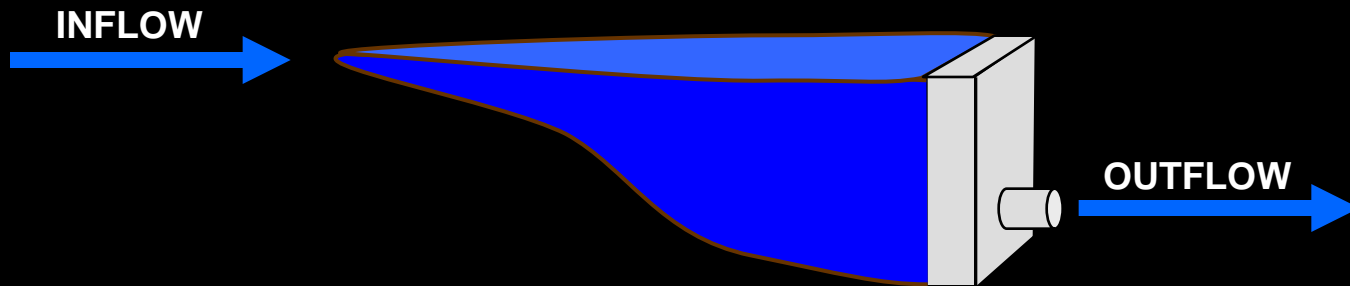


CONSEQUENCES OF LOCATION OF RESERVOIRS IN THE LANDSCAPE

Lakes : low flushing rate

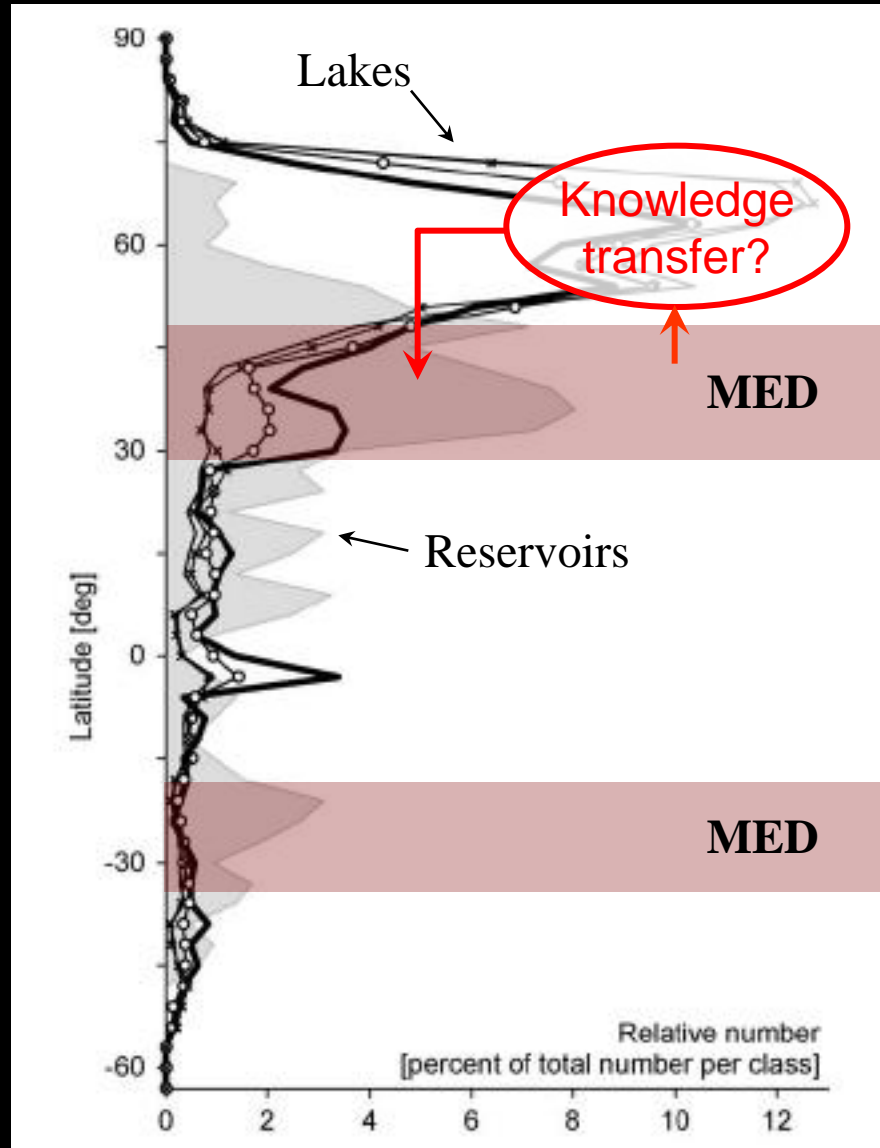


Reservoirs : high flushing rate



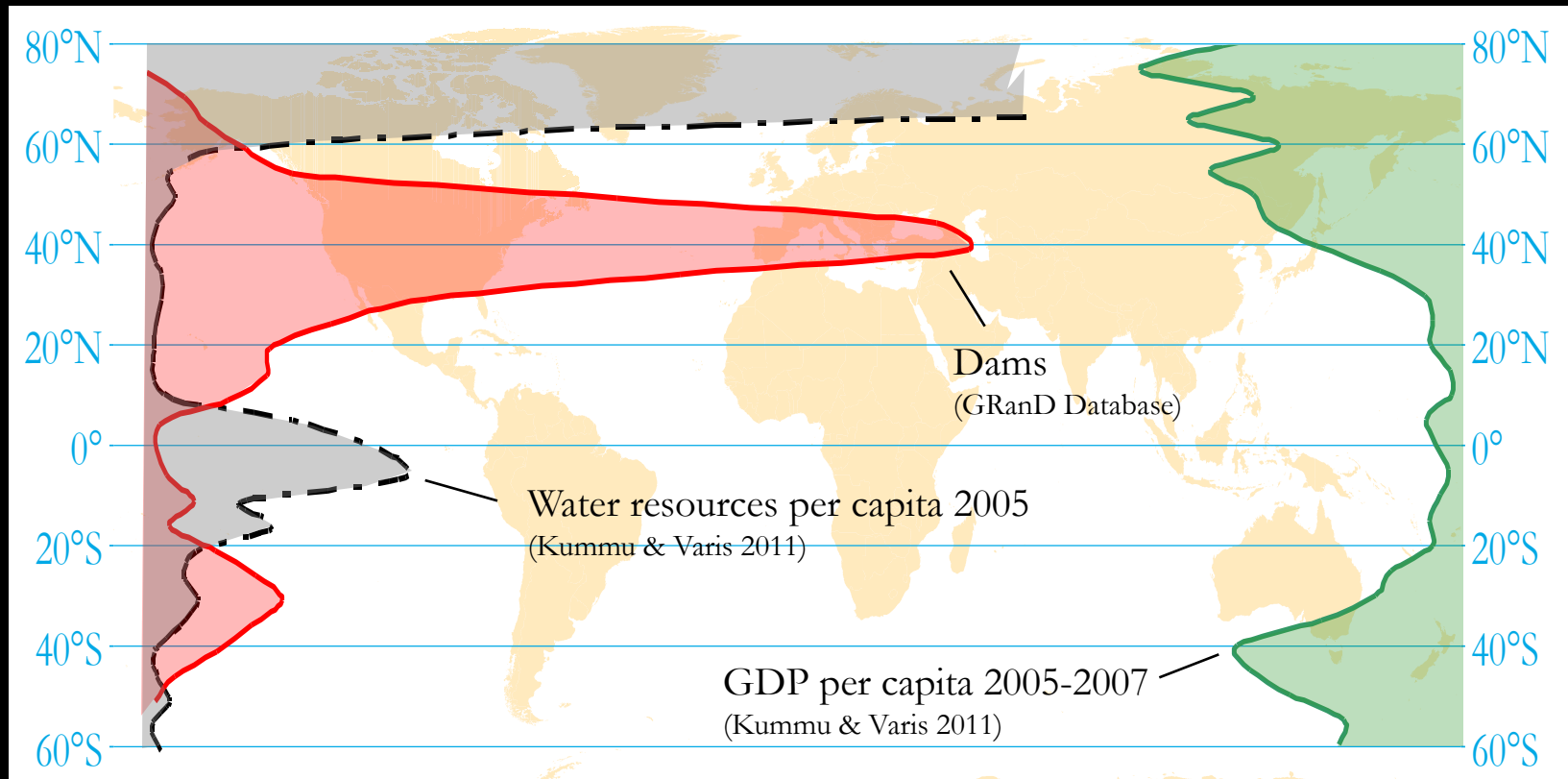
Reservoir global distribution:

a distinctive trait of Mediterranean landscapes



Reservoir global distribution:

a distinctive trait of developed regions under water scarcity



m³ per capita

0 20.000 40.000 60.000 80.000

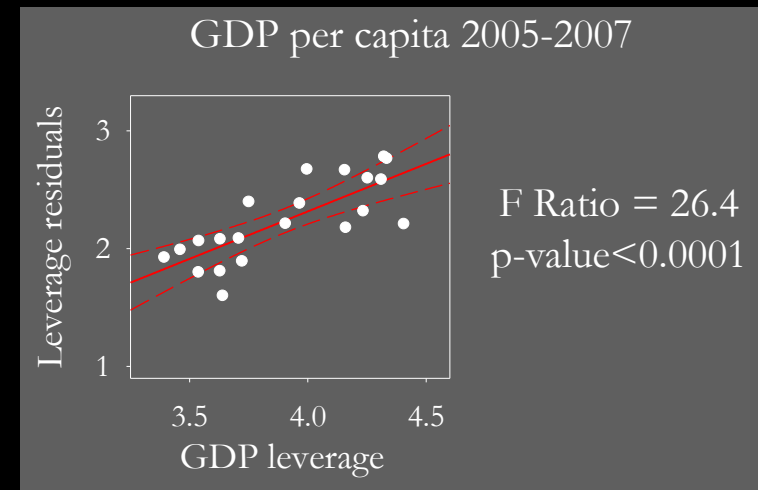
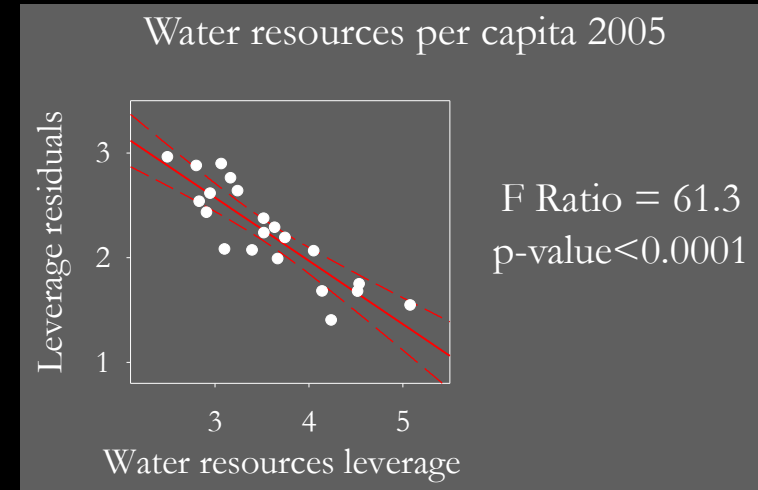
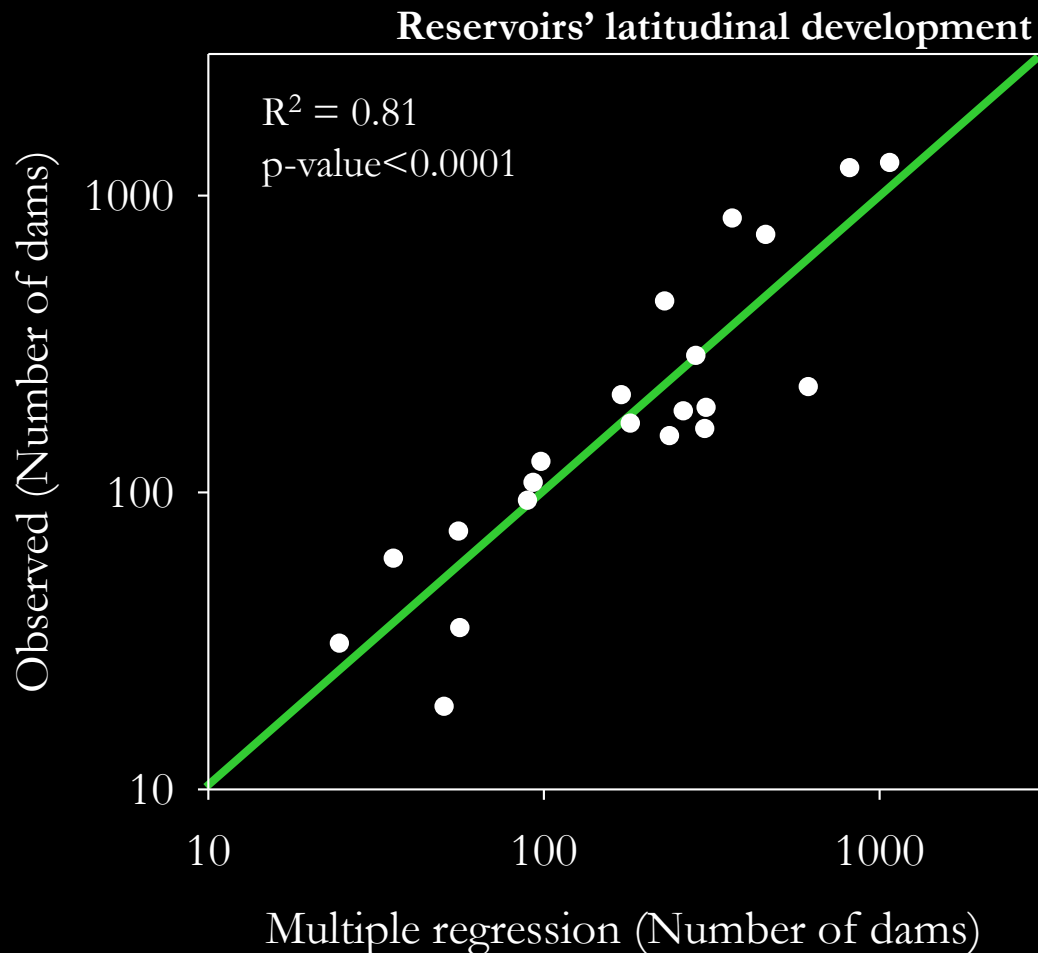
30 15 0

Number
of dams

0 350 700 1050 1400

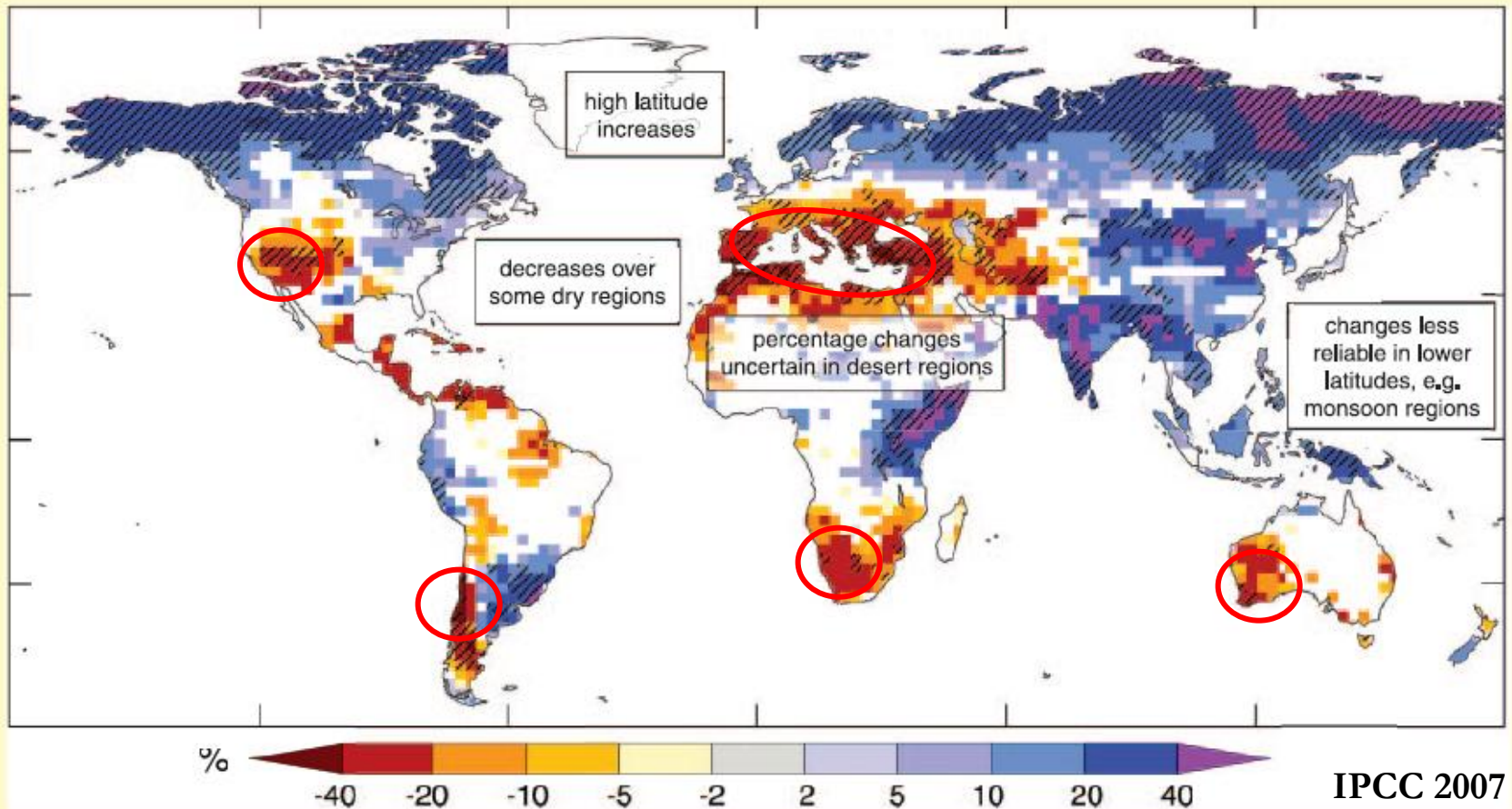
GDP per capita
(10³ US\$)

Reservoir global distribution: a distinctive trait of developed regions under water scarcity

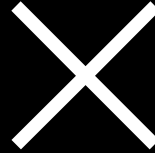
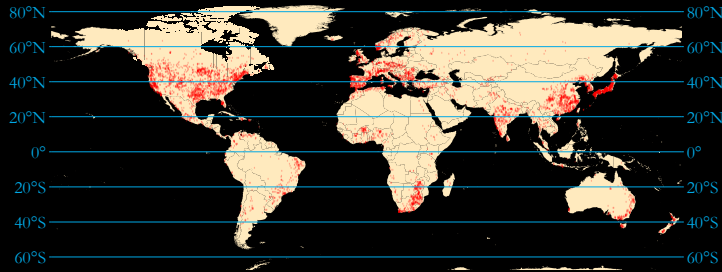


The future drought: a distinctive trait of Mediterranean regions

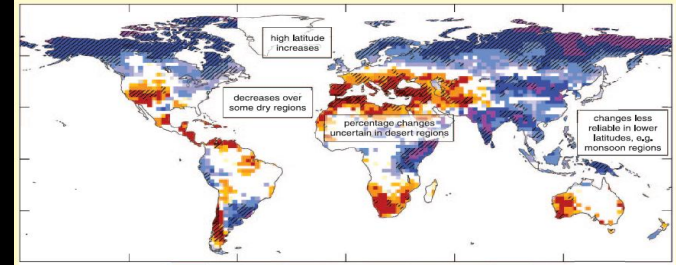
Projections and model consistency of relative changes in runoff by the end of the 21st century



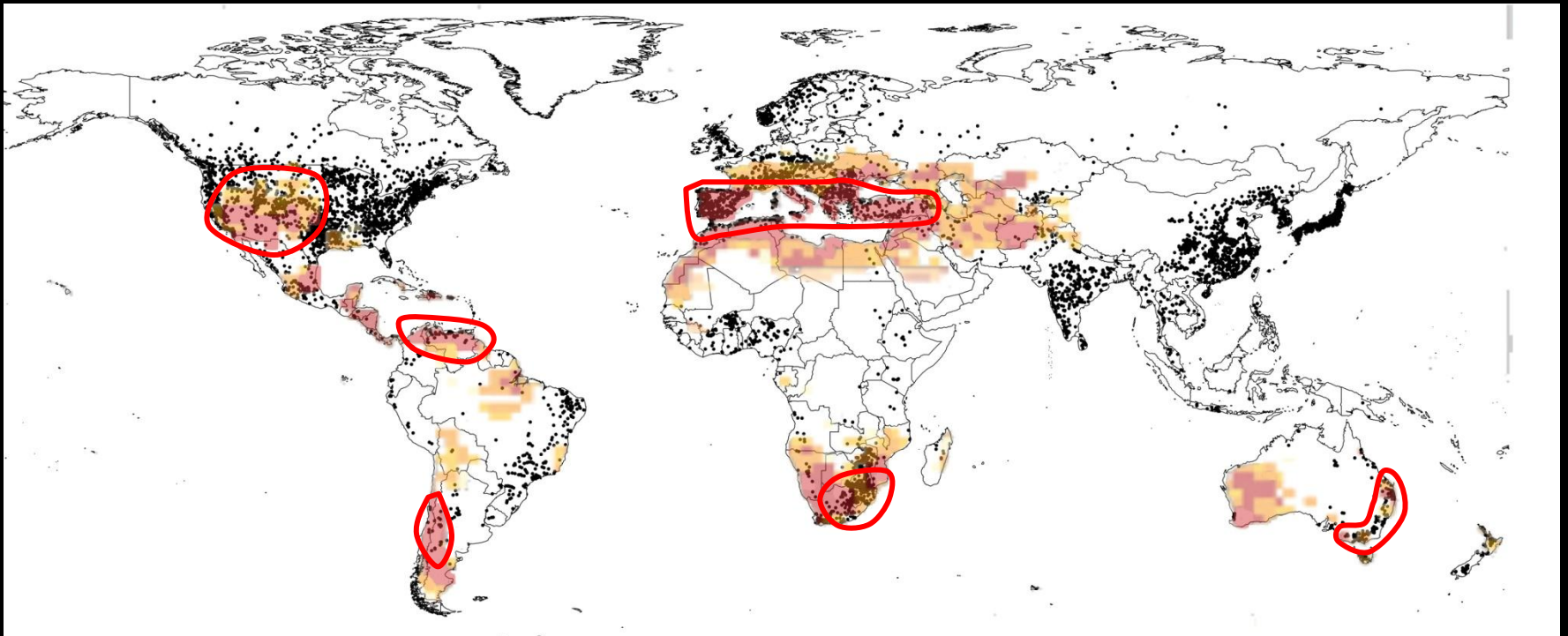
Global distribution



The future drought



Solving the equation ... = **Drought impact on reservoirs**



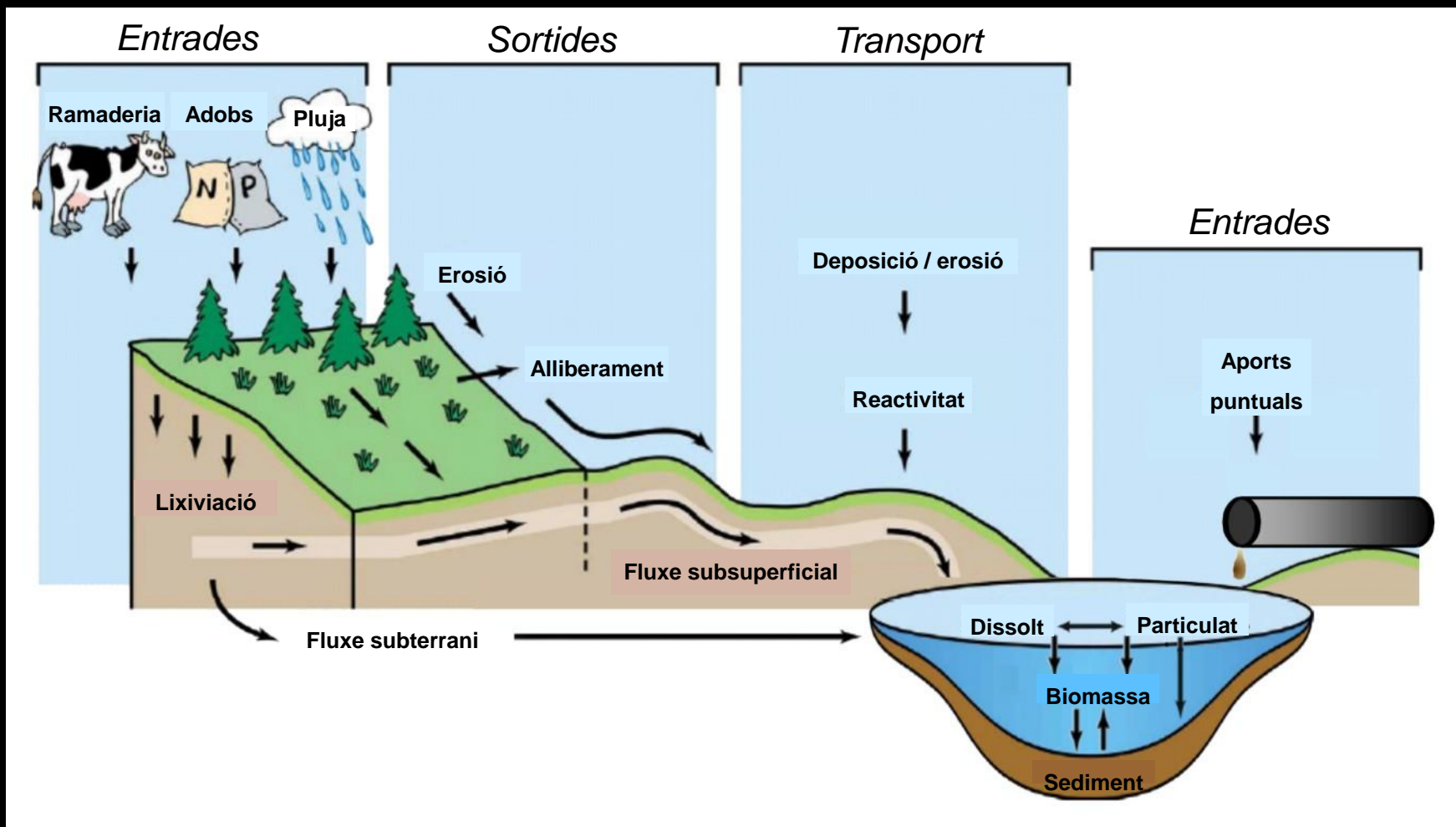
Two questions arise:

- Can we use the “lake tool-kit” to answer questions in arid and semiarid landscapes dominated by reservoirs?
- And the reciprocal...can research in arid and semiarid regions put light on global limnological patterns?

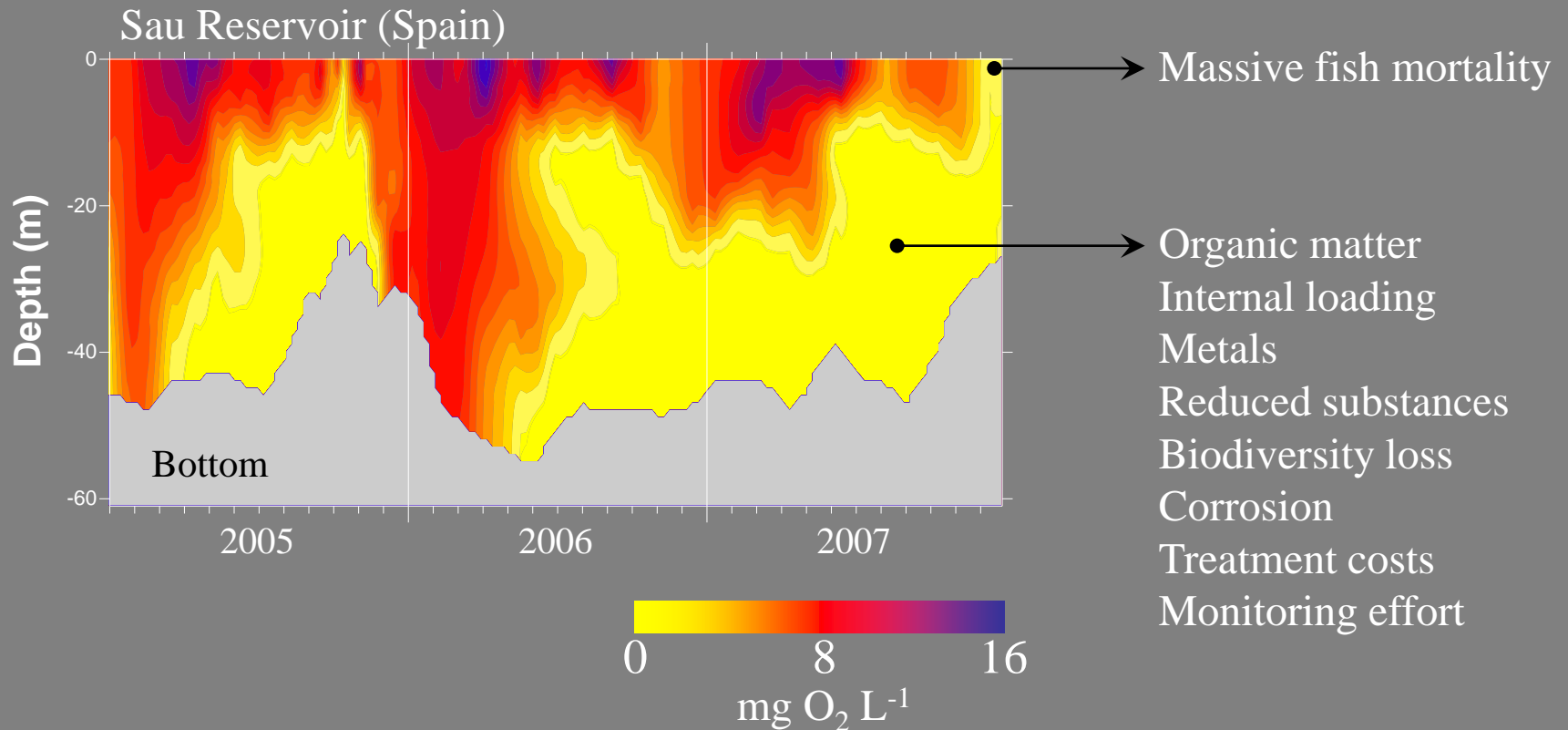
Can we use the “lake tool-kit” to answer questions in arid and semiarid landscapes dominated by reservoirs?

Example 1

Organic matter load, not nutrient load, controls hypolimnetic anoxia in reservoirs

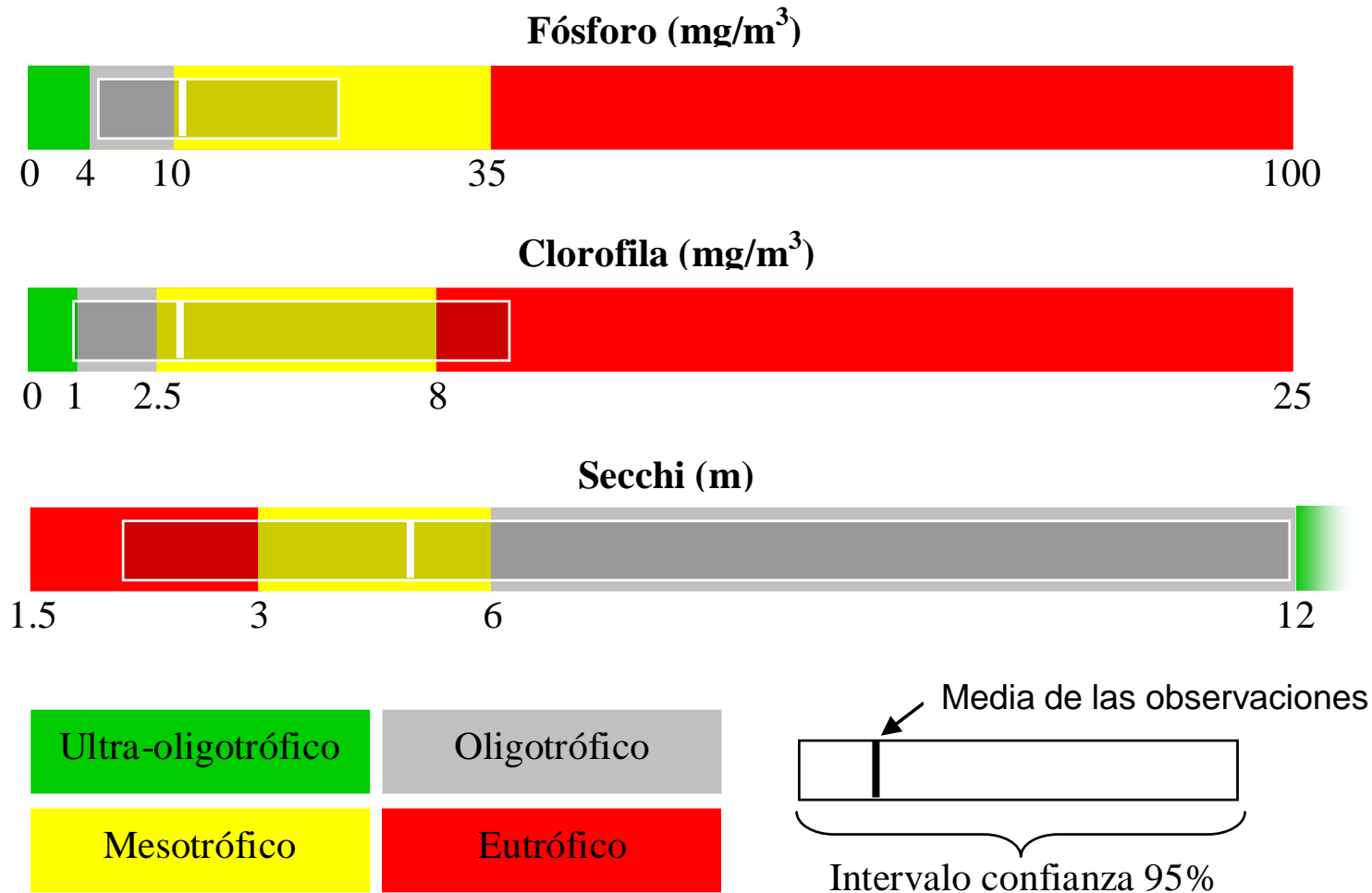


HYPOLIMNETIC ANOXIA AS A PROXY OF WATER QUALITY IN RESERVOIRS

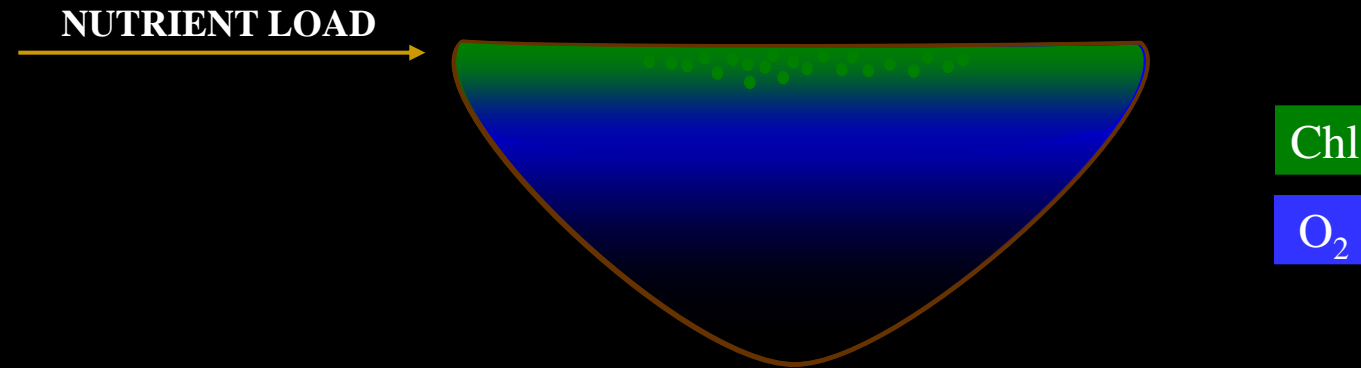


EVALUACIÓN EMPÍRICA DEL RIESGO POTENCIAL DE EUTROFIZACIÓN

Posición del futuro embalse de xxxxx respecto a los umbrales de estados tróficos según la OCDE.



EMPIRICAL MODELS FOR HYPOLIMNETIC OXYGEN: CLASSICAL BACKGROUND



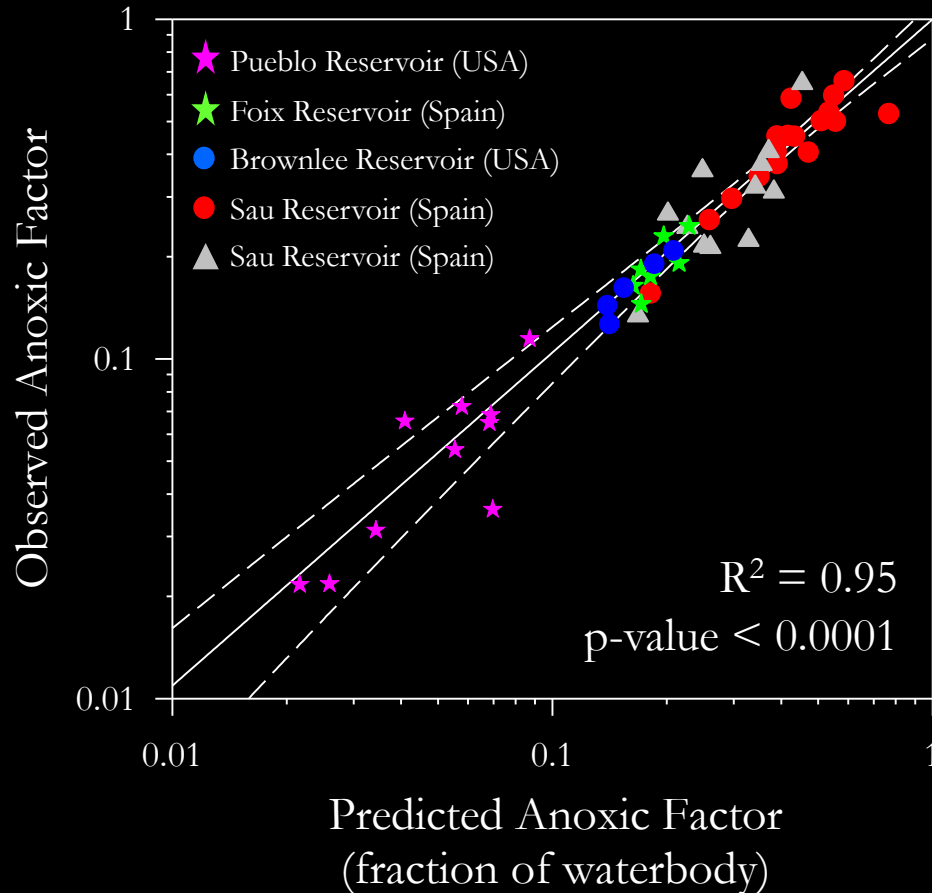
NUTRIENT

LABILE C

STREAM

Reservoir anoxia:

interplay between streamflow and organic carbon effects



$$AF \sim f(\text{Streamflow, labile OC})$$



FOIX



SAU



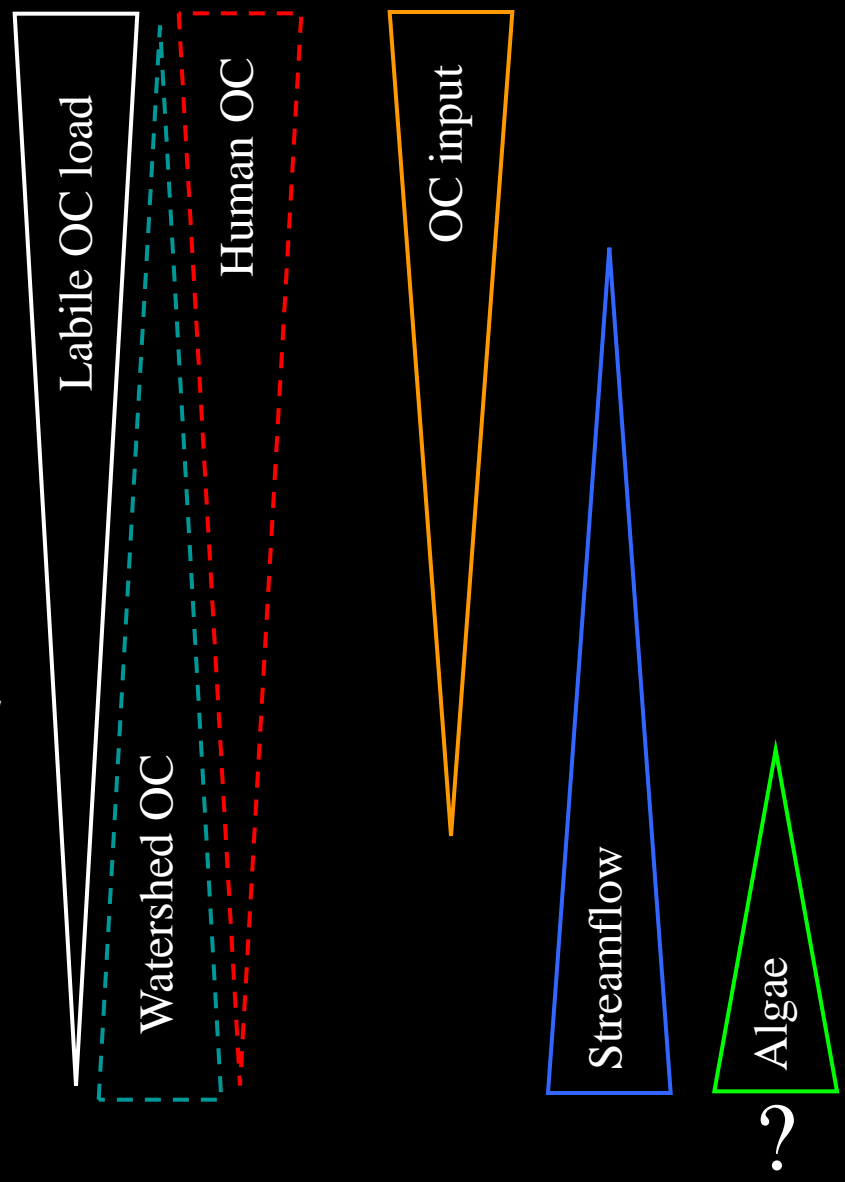
BROWNLEE



PUEBLO

DOC SOURCE

RELEVANCE ON ANOXIC FACTOR PREDICTION

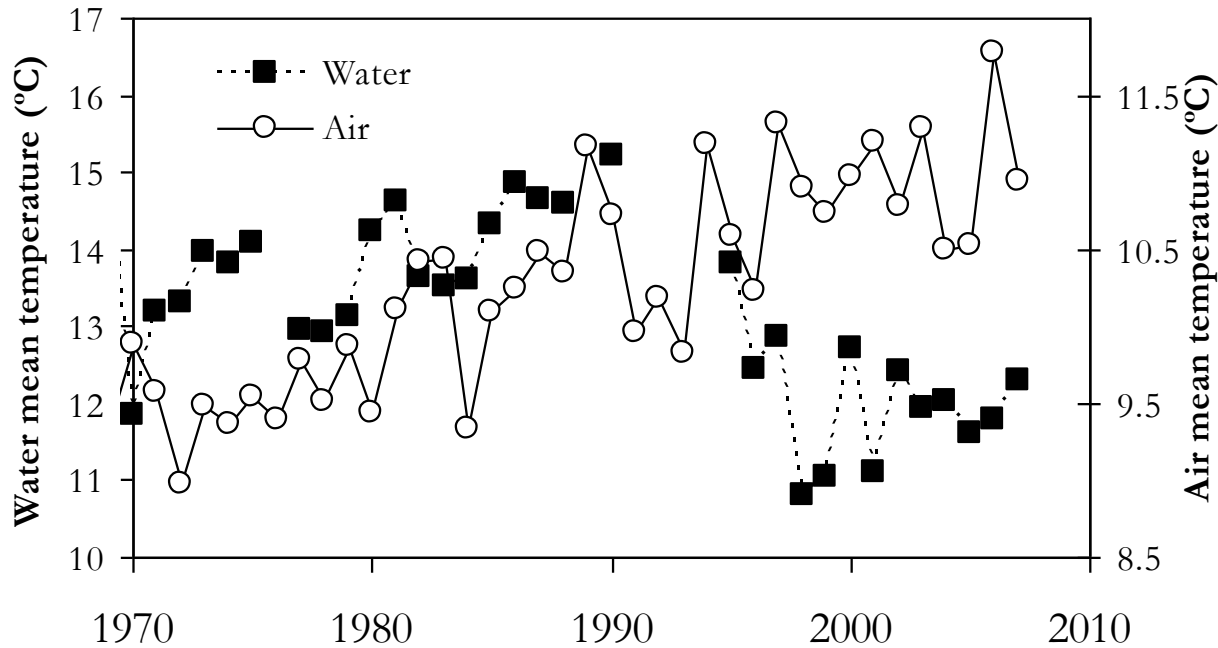


Can research in arid and semiarid regions put light on global limnological patterns?

Example 3

Runoff as a master variable to predict climate change effects on reservoir water quality

Hydraulic management: blurring the effects of climate



Withdrawal from
the bottom

Withdrawal from
the surface





FOIX

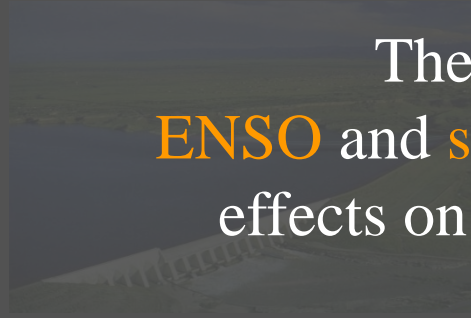
Streamflow control on the hypolimnetic oxygen

SAU

A direct link between climate processes and water quality in reservoirs ?

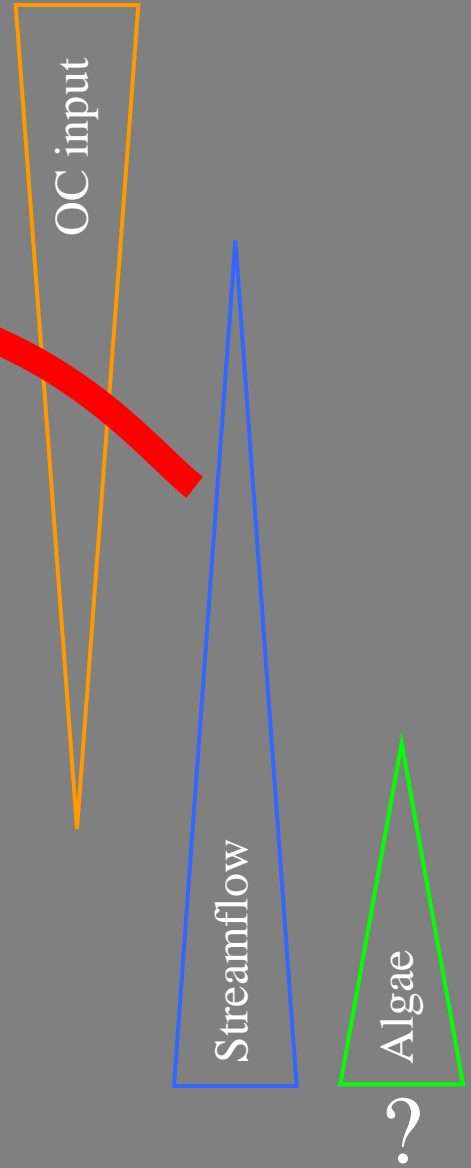
DOWNLEE

The answer: ENSO and streamflow trends effects on Sau Reservoir

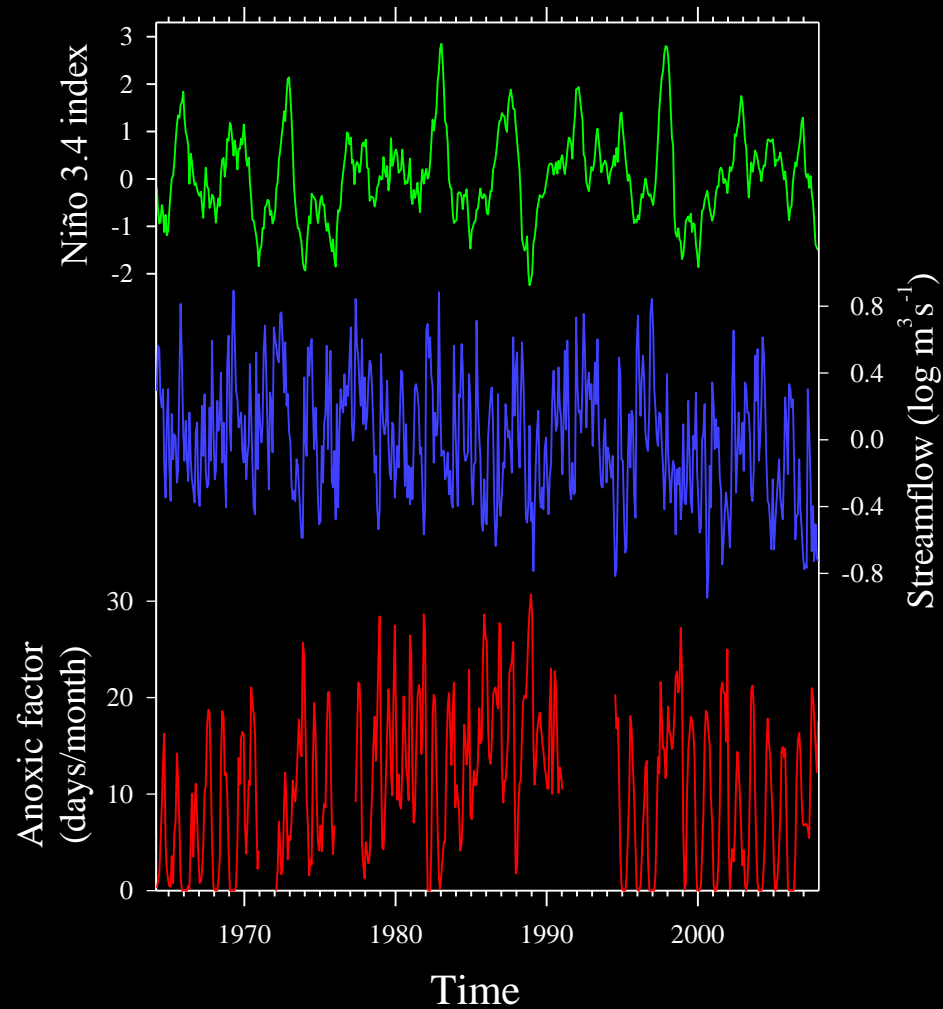


DOC SOURCE

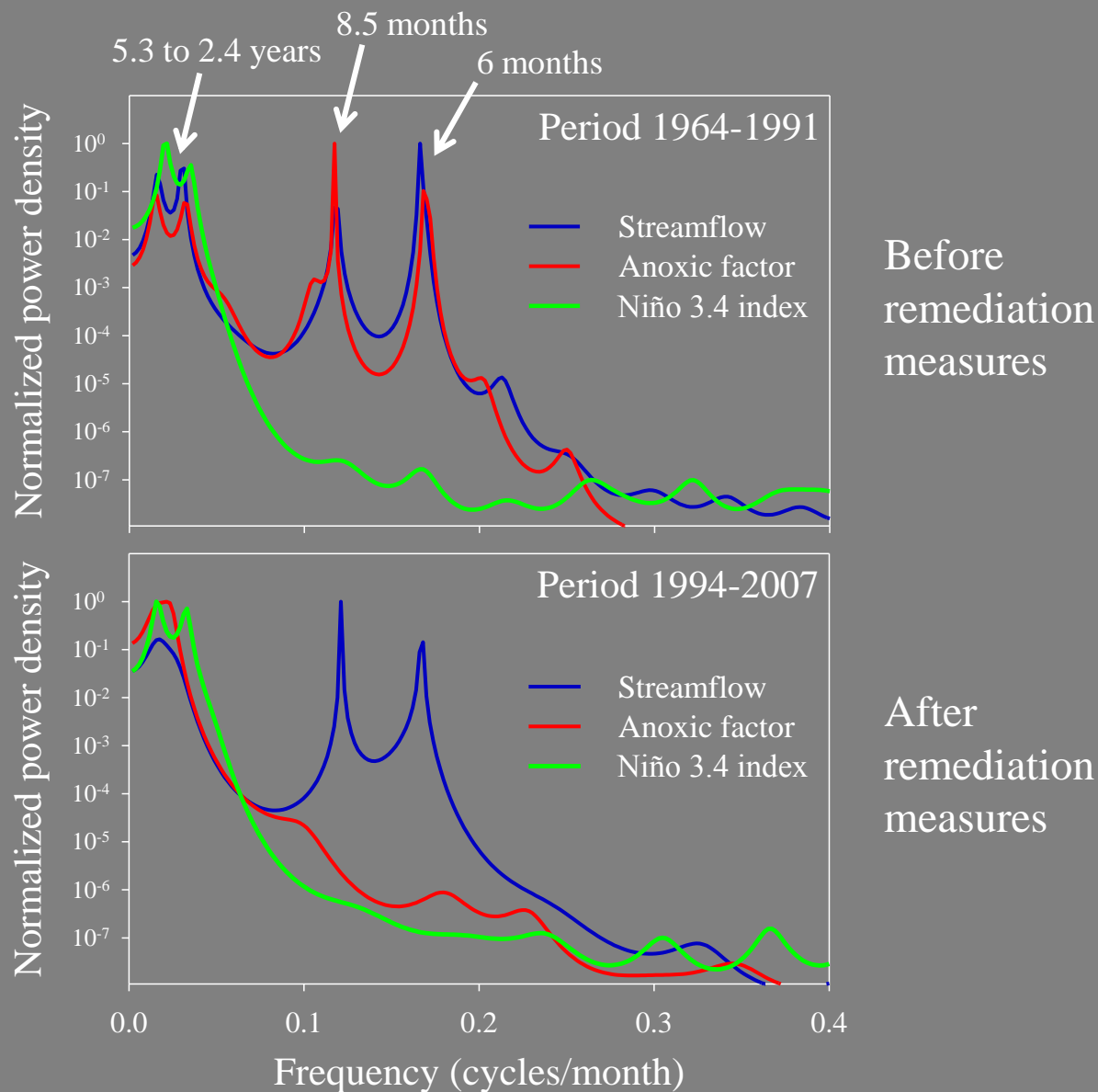
RELEVANCE ON ANOXIC FACTOR PREDICTION



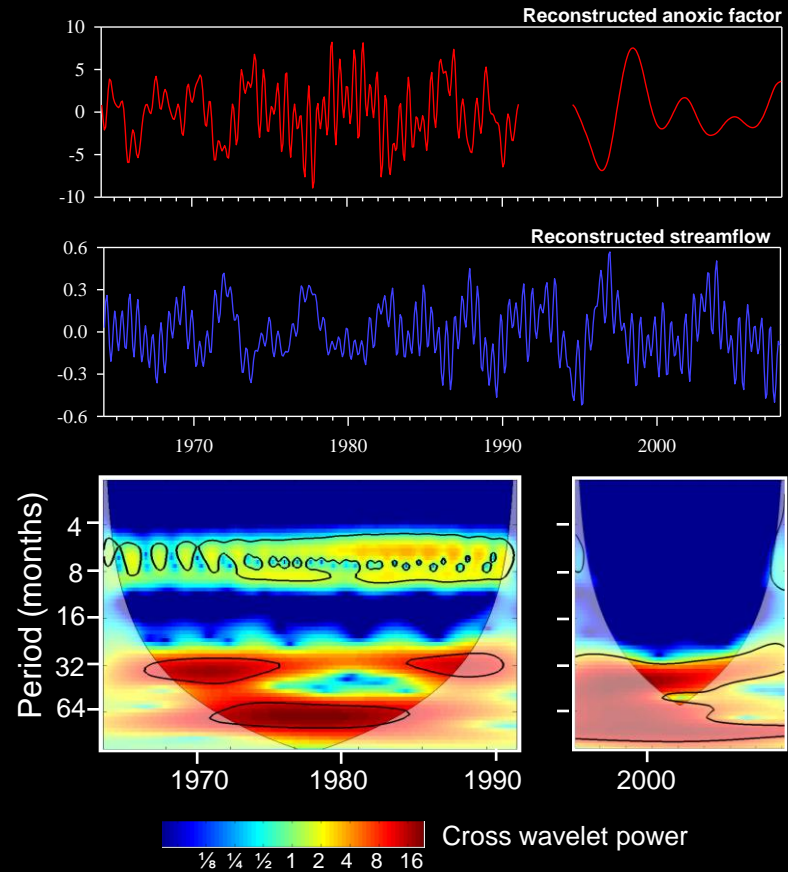
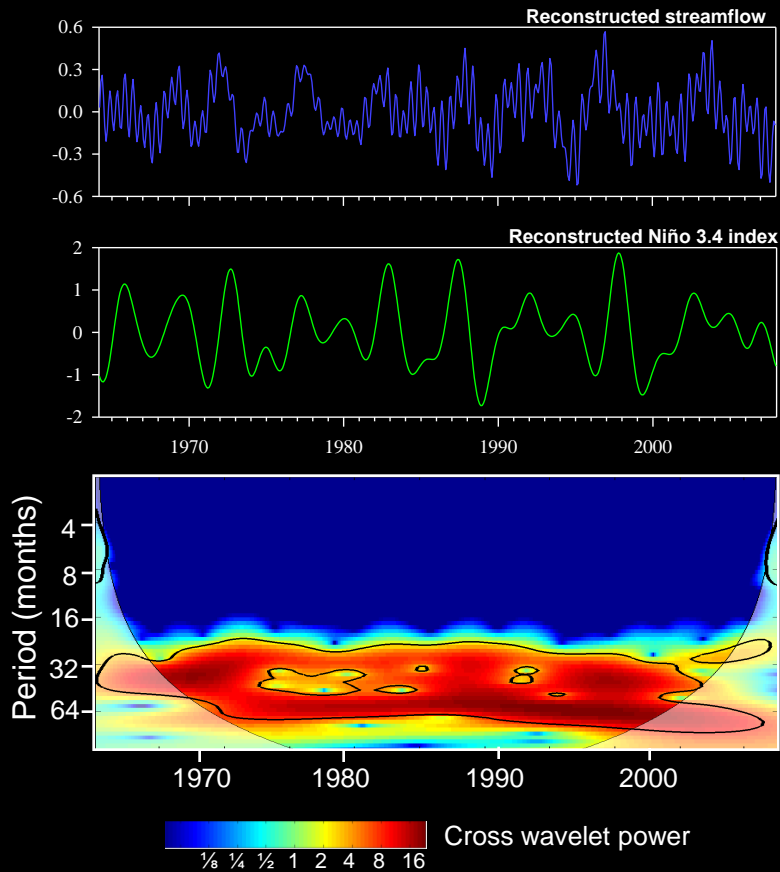
Sau Reservoir hypolimnetic oxygen content and ENSO



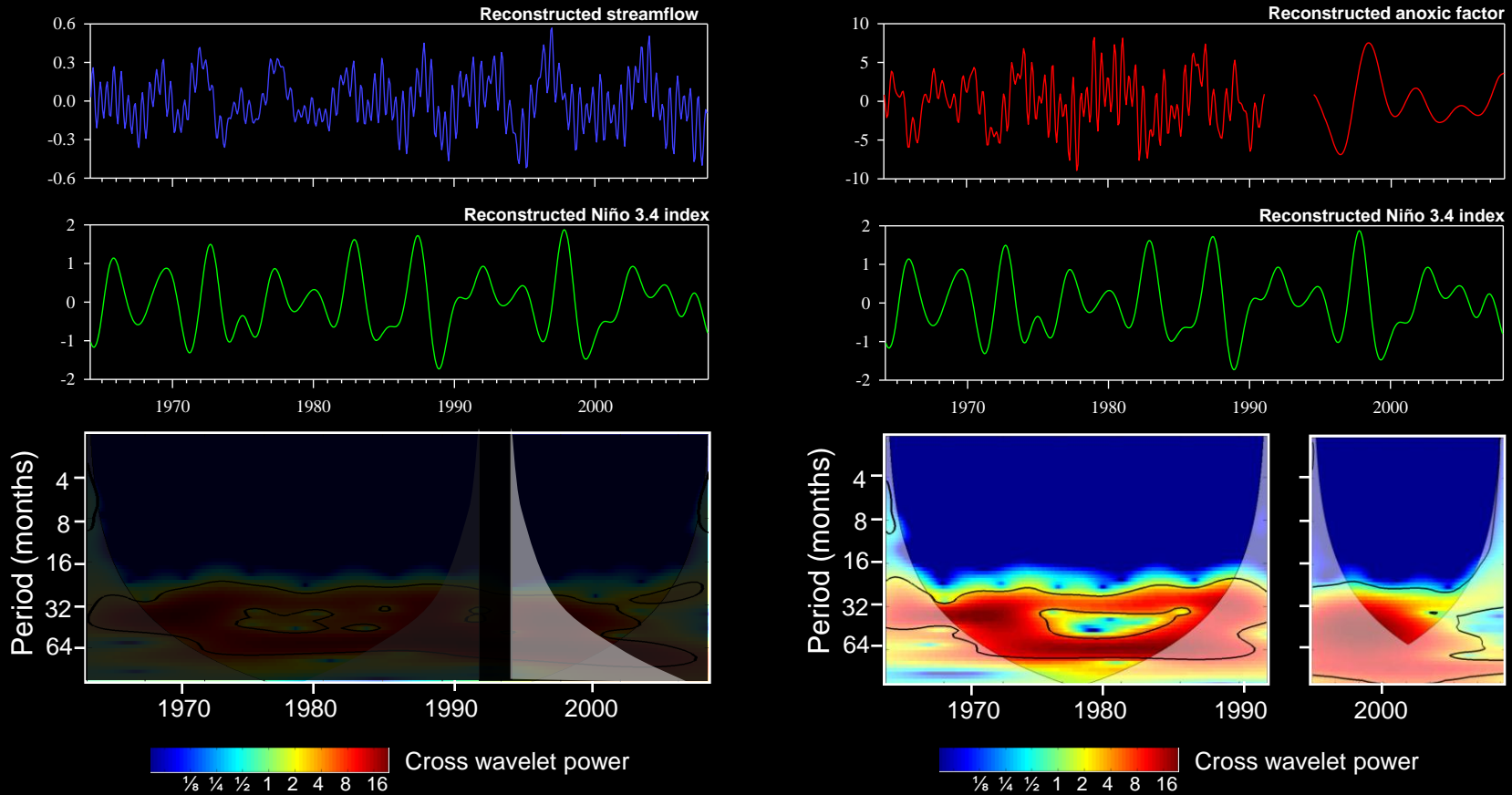
Spectral analysis for reconstructed series



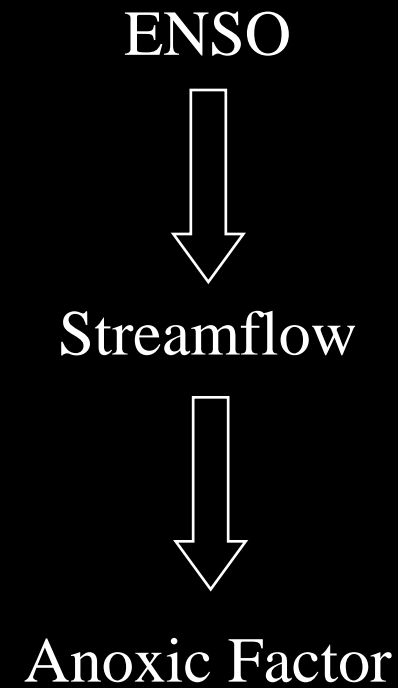
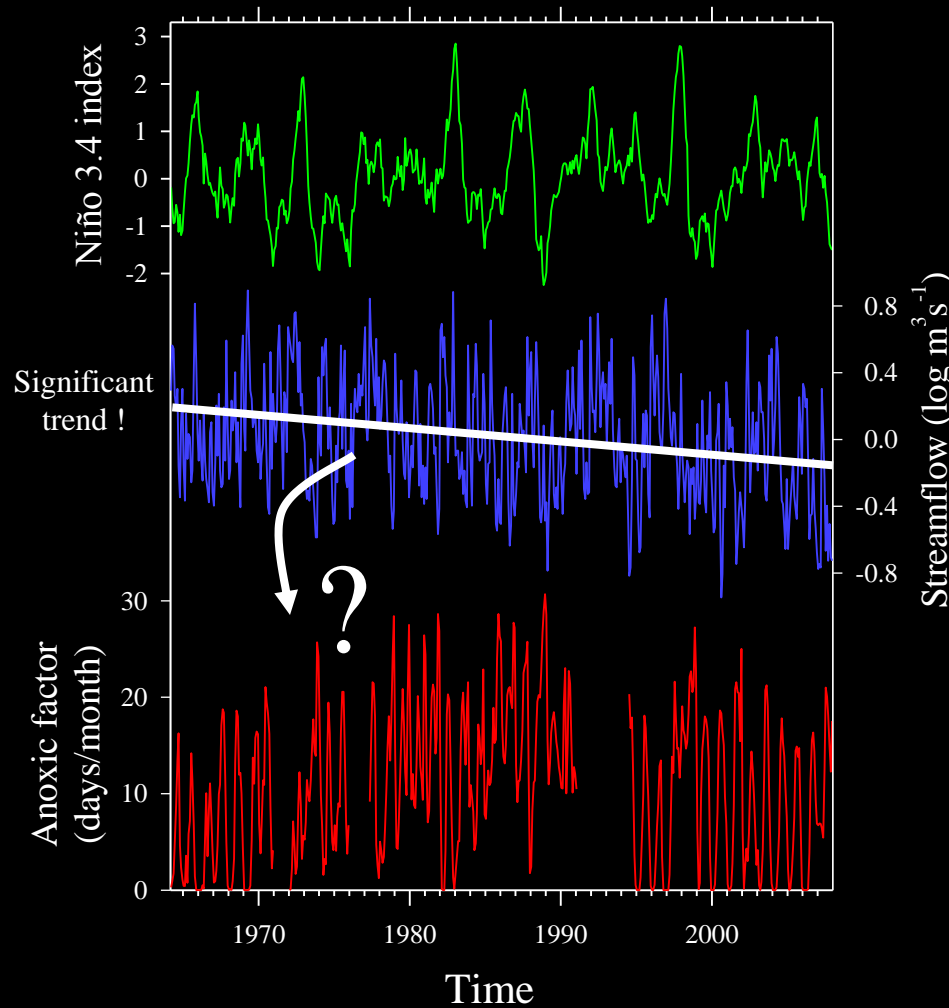
Cross-wavelet analysis for reconstructed series



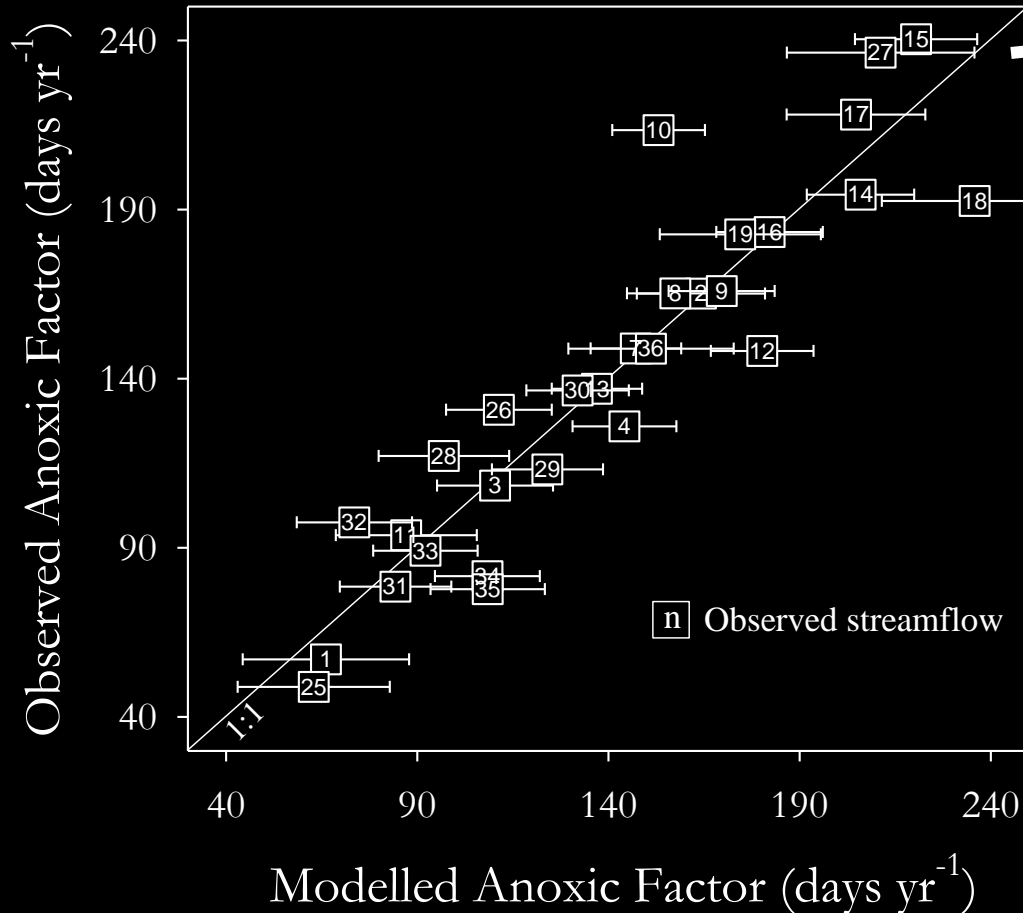
Cross-wavelet analysis for reconstructed series



Sau Reservoir hypolimnetic oxygen content and ENSO



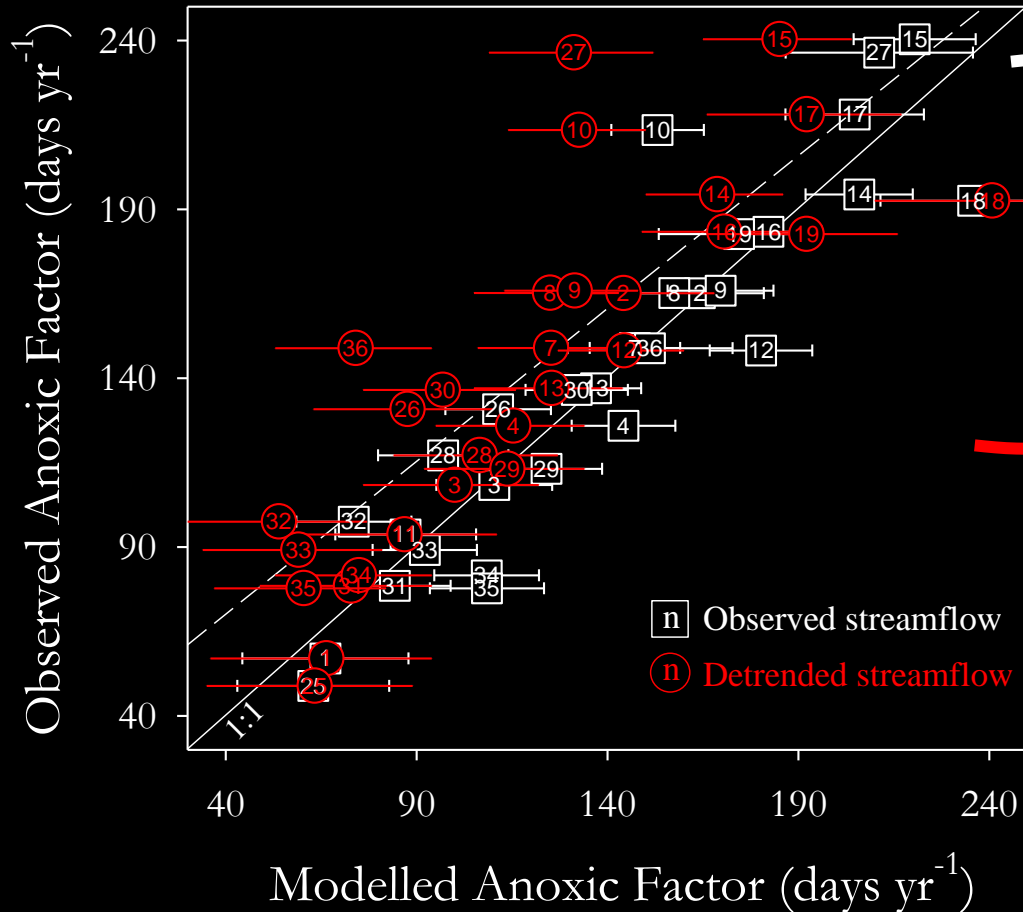
Sau Reservoir long-term hypolimnetic oxygen model



AF ~ f (labile OC, Streamflow)

$R^2 = 0.85$ $p < 0.0001$

Sau Reservoir long-term hypolimnetic oxygen model



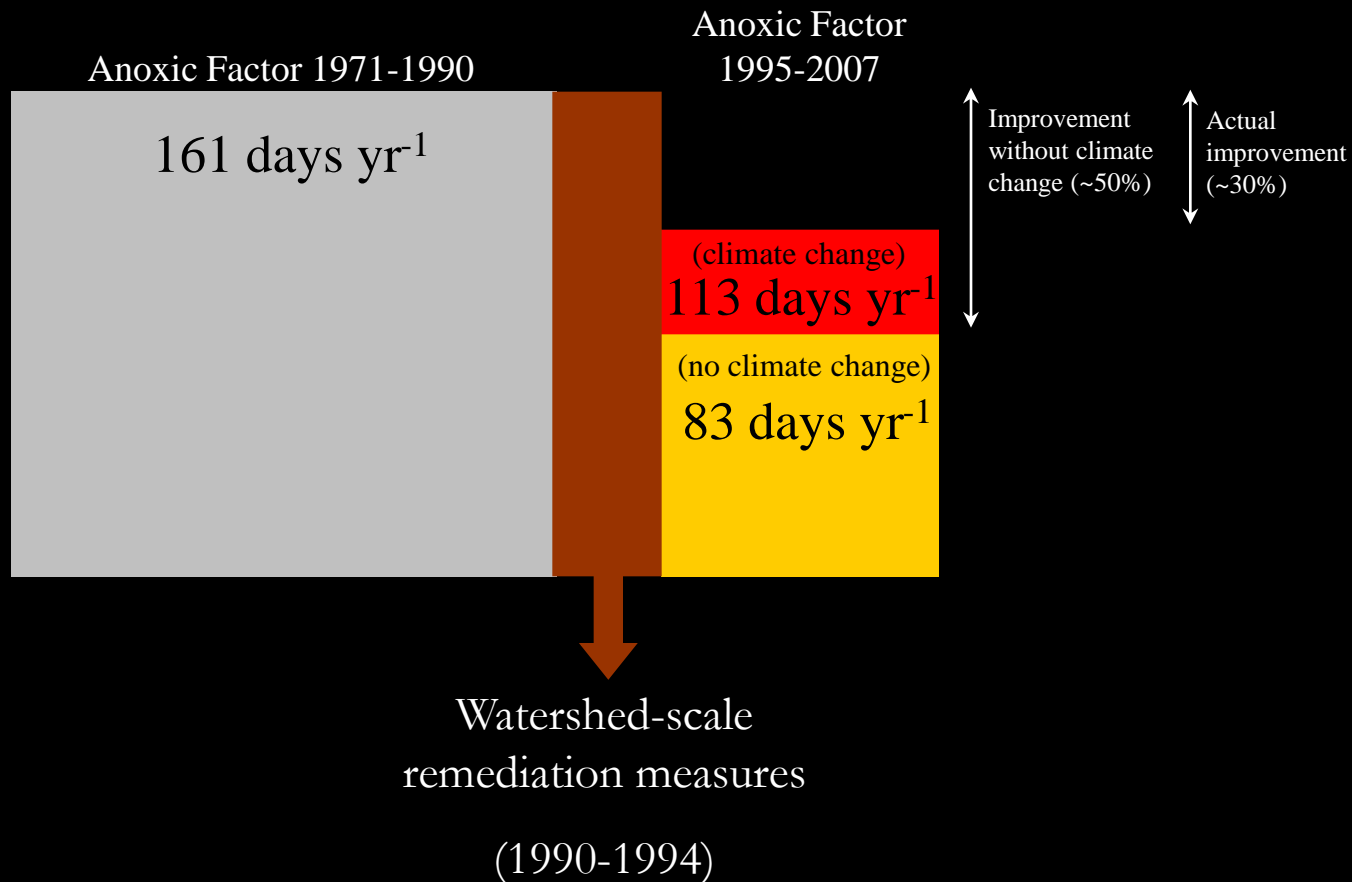
AF ~ f (labile DOC, Streamflow)

$R^2 = 0.85$ $p < 0.0001$

The same model solved using a detrended streamflow series

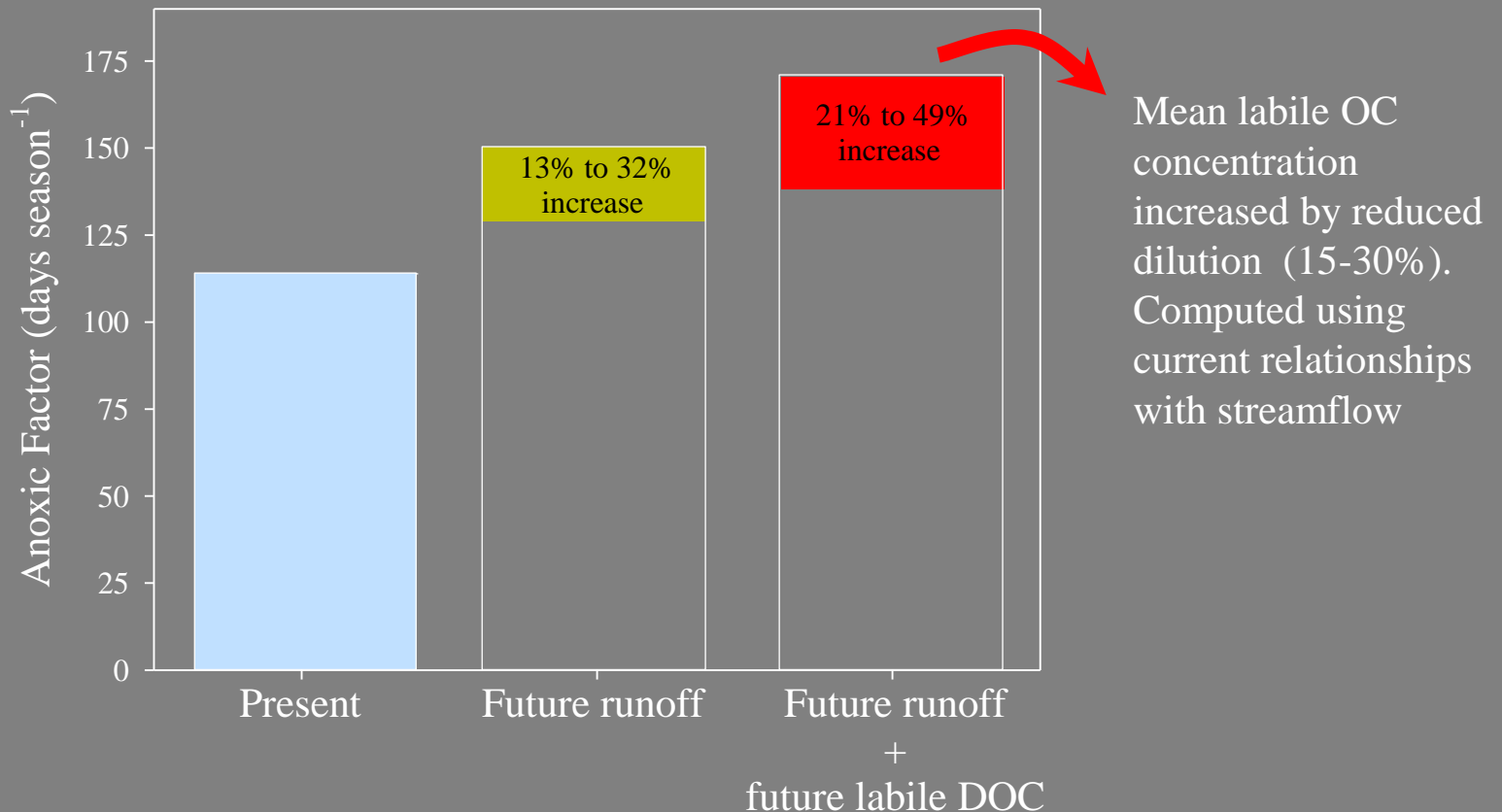
(mean increase = 23%)

From a management perspective, this has enormous implications...



A crude prediction for Sau Reservoir in the 21st century

Assuming decreasing mean streamflow by 20-40% (IPCC, 2007) and the validity of equations:



A conceptual framework for climate change impact research in Mediterranean reservoirs

