Content of today

1. Status of local and global simulations.

2. ISIMIP Lake Sector paper writing workshop outcomes.

3. Overview ongoing/planned analyses using ISIMIP data.

    1. How much difference does it make to ISIMIP simulations when we don't calibrate our lake models? (Tom)

    2. The effect of climate change and eutrophication on lake water quality globally (Annette/Maddalena)

    3. Anthropogenic perturbation of organic carbon burial in global lake Sediments – An ISIMIP analysis (Don/Ana)

    4. The footprint of global climate oscillations on surface temperatures across lakes (Daniel)

4. Invitation to Limnoseries.

5. Open questions: discussion and comments from the audience.

Reminder

Local lake data for ISIMIP3 calibration: https://github.com/icra/ISIMIP_Local_Lakes

Input climate data local lakes:
ISIMIP3a: /work/bb0820/ISIMIP/ISIMIP3a/InputData/climate/atmosphere/obsclim/lake-sites/daily/historical
　　　　　/work/bb0820/ISIMIP/ISIMIP3a/InputData/climate/atmosphere/counterclim/lake-sites/daily/historical
ISIMIP3b: /work/bb0820/ISIMIP/ISIMIP3b/InputData/climate/atmosphere/bias-adjusted/lake-sites/daily

Lake morphology for ISIMIP3 global runs: https://github.com/icra/ISIMIP_Lake_Sector

1. Status of local and global simulations.

Model name	Type	Contact person	Run	Status May 2023	Remarks
PCLake	Water quality	Annette Janssen	global	planning	Not started (yet); No coherent nutrient loading data available (to be discussed,)
CLM5	Hydrothermal	Wim Thiery	global	ongoing	Preprocessing ongoing
LAKE	Hydrothermal	Victor Stepanenko	both	ongoing	Planning to start the full-scale runs in the beginning of 2023 (last status on October 2022)
ALBM	Hydrothermal	Zeli Tan	both	ongoing	3a finished, outputs are being processed. Preparing input data for 3b and started a test run
air2water	Hydrothermal	Sebastiano Piccolroaz & Bronwyn Woodward	local	ongoing	Implementing calibration to start running, hope to do it before June 5th
GOTM	Hydrothermal	Daniel Mercado-Bettin	global	ongoing	ISIMIP3a and ISIMIP3b (except picontrol) done
FLake_LER	Hydrothermal	Jorrit Mesman	local	ongoing	Calibration finished, running climate scenarios
GLM_LER	Hydrothermal	Jorrit Mesman	local	ongoing	Calibration finished, running climate scenarios
GOTM_LER	Hydrothermal	Jorrit Mesman	local	ongoing	Calibration finished, running climate scenarios
Simstrat_LER	Hydrothermal	Jorrit Mesman	local	ongoing	Calibration finished, running climate scenarios
VIC-LAKE	Hydrothermal	Annette Janssen	global	ongoing	Runs 3b are almost finished and soon we start post-processing; 3a is still under discusison
Simstrat	Hydrothermal	Martin Schmid	global	ongoing	Implementing calibration to start running
GLM	Hydrothermal	Daniel Mercado-Bettin	global	planning	Waiting to finish GOTM simulations
CE-QUAL-W2	Hydrothermal	Josef Hejzlar	local	planning	Currently planned for one reservoir only
FLake	Hydrothermal	Tom Shatwell & Georgiy Kirillin	local	planning	To start in the next months

Potential models that could run water quality simulation!

CE-QUAL
PCLake
Simstrat
GLM
GOTM
Any other?

2. ISIMIP Lake Sector paper writing workshop outcomes.

PR⊕CLIAS

ISIMIP Lake Sector Writing Paper Workshop 2023

ISIMIP LAKE SECTOR WRITING PAPER WORKSHOP 2023

Building on the ISIMIP Lake Sector Procotol developed in PROCLIAS TG1.5 in the past year, a Paper Writing Workshop was held on March 28th-29th, 2023, at the Catalan Institute for Water Research (ICRA) in Girona, Spain.

by Rafael Marcé and Daniel Mercado

2. ISIMIP Lake Sector paper writing workshop outcomes.

1. EezyPeezyISIOxy: Worldwide impact of eutrophication and climate change on lake hypoxia.

2. What happens to our ISIMIP simulations when we do not calibrate our lake models?

3. The footprint of global climate oscillations on lake temperature.

4. Optimizing water quality management and predicting climate change impacts in a temperate dimictic reservoir using a catchment-reservoir model system.

5. Sensitive time window of selective withdrawal strategies in mitigating climate warming effects on Germany's largest drinking water reservoir.

6. Climatic change in the ice structure of small boreal lakes: implications for ice phenology, temperature regimes and lake ecosystems.

7. Potential and obstacles of simulating climate change impacts on lake ecology.

3. Overview ongoing/planned analyses using ISIMIP data.

What happens to our ISIMIP simulations when we don't calibrate our lake models?

(...and what could we do about it?)

progress update

Tom Lorimer, Fabian Bärenbold, James Runnalls, Damien Bouffard, Martin Schmid
ISIMIP meeting (Lake Sector) 2023, Prague

eawag
aquatic research ooo

Calibration compensates for:

model imperfections
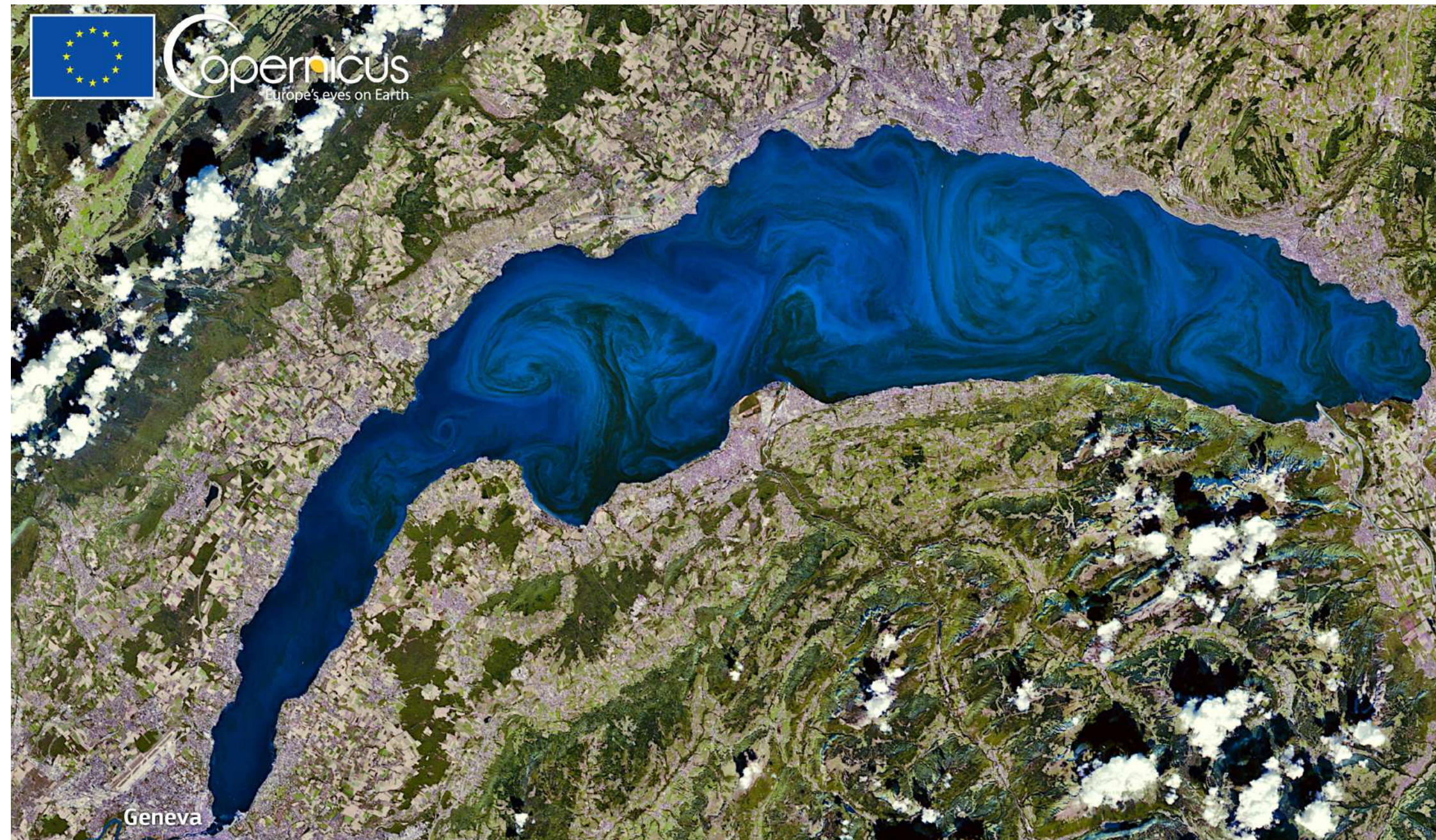
image: Copernicus

forcing imperfections
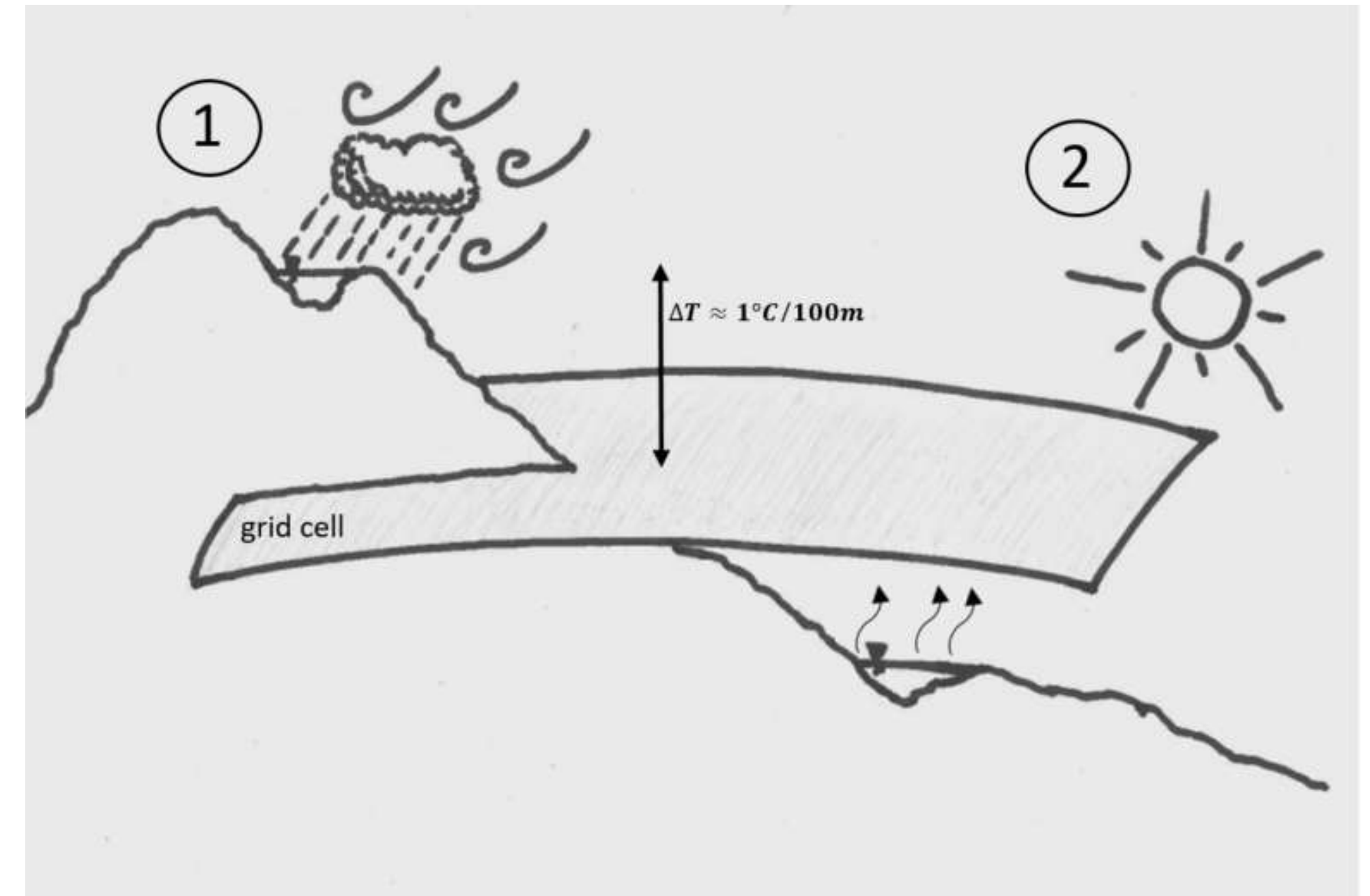
image: Marco Papetti

both of these issues will be present in the ISIMIP Global Lakes simulations...
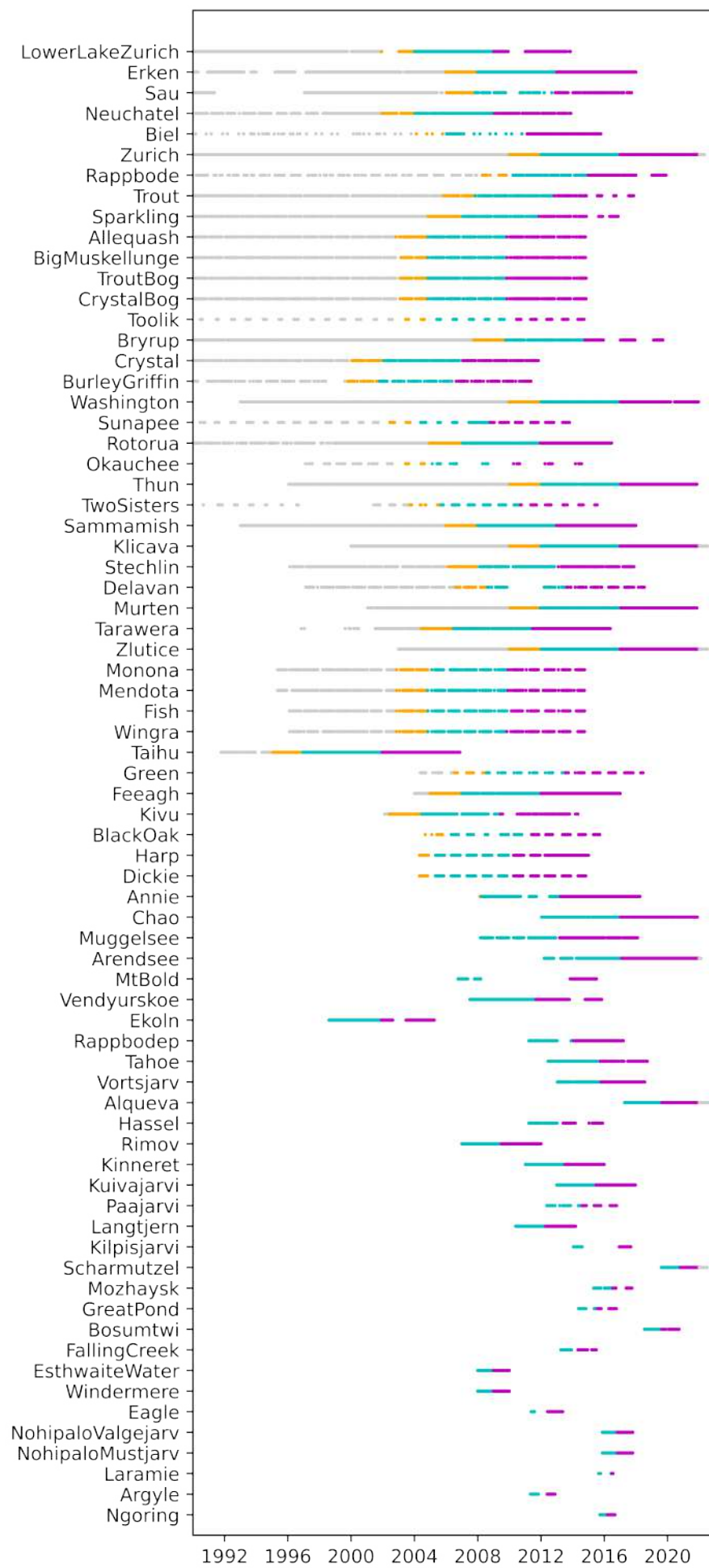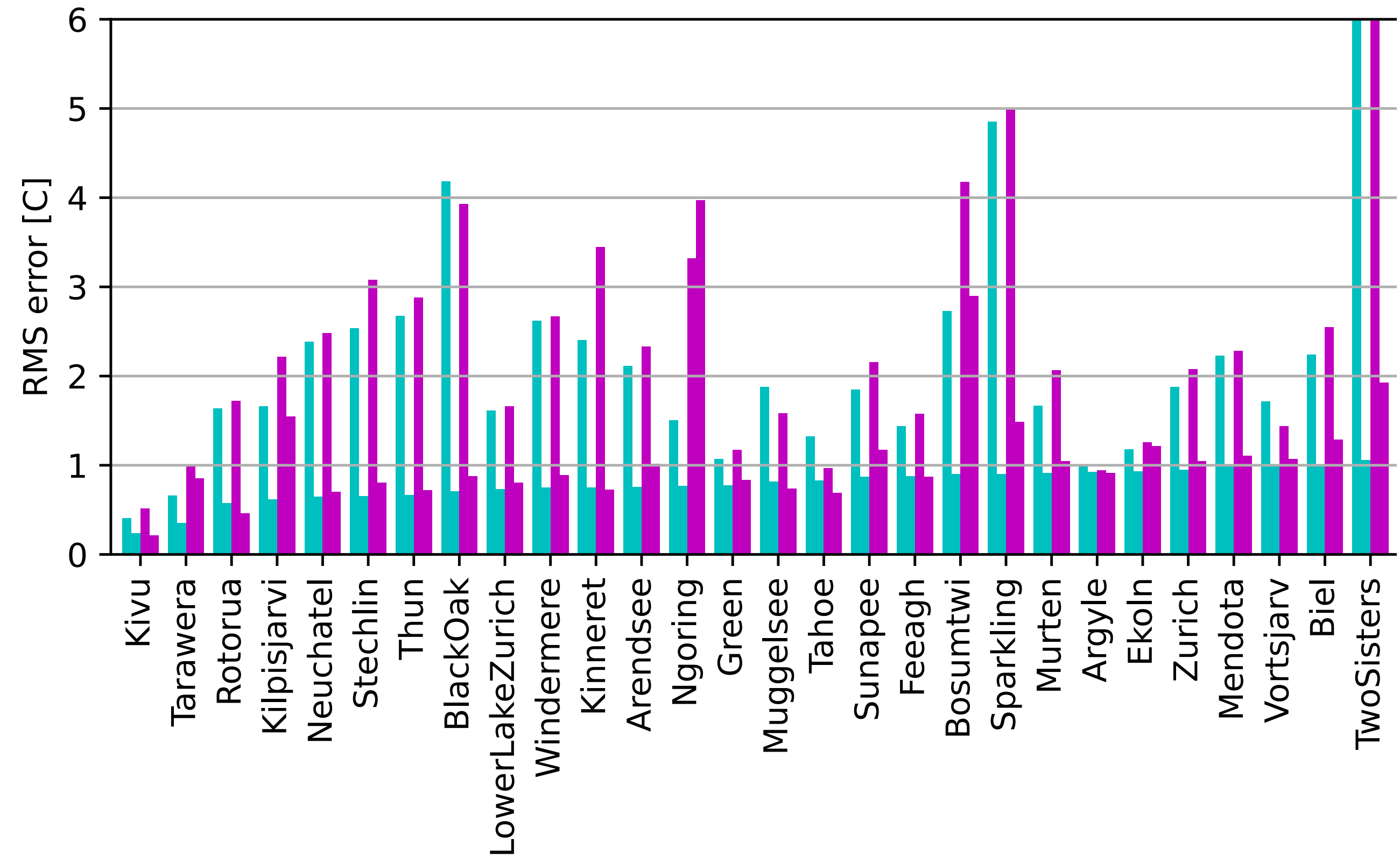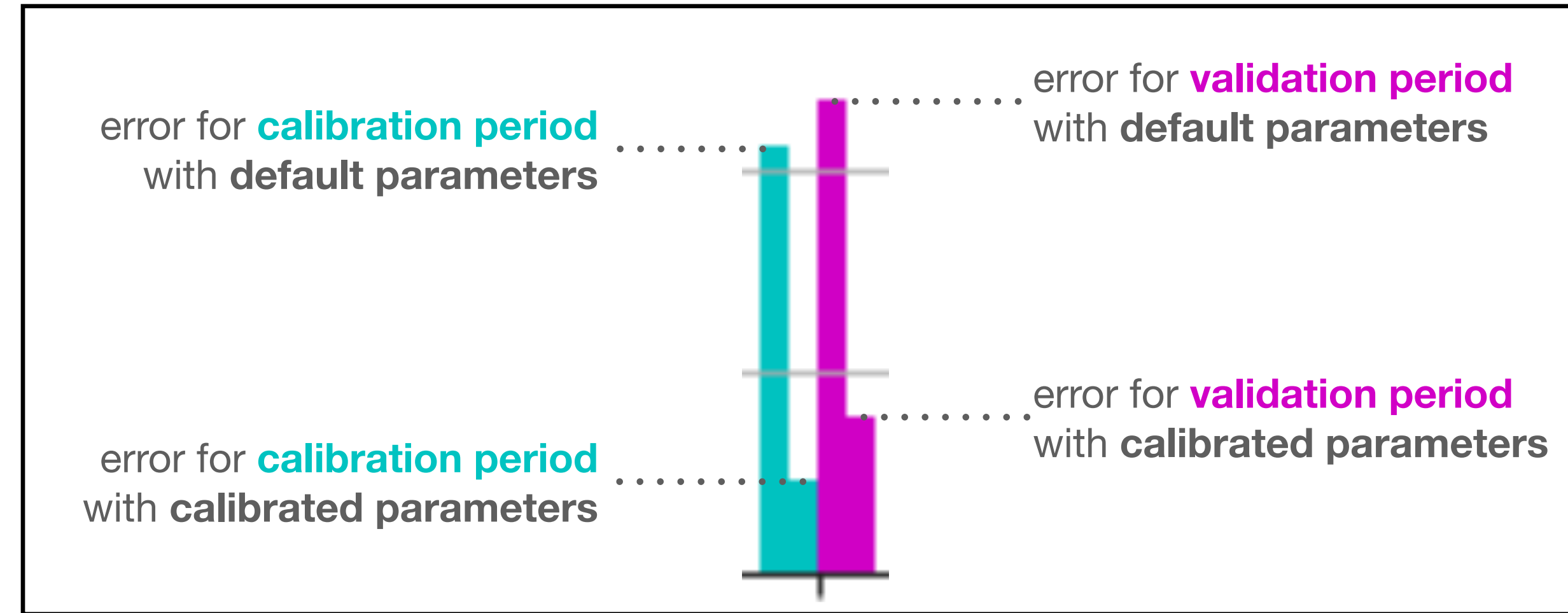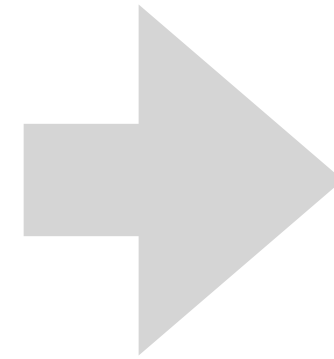...but without in-situ data to calibrate our models

Our plan

...ions

②

ge: Marco Papetti

s...

Part A: ISIMIP3 "Local" and effect of calibration

ISIMIP "**Local**" dataset

Simstrat **calibration**

Default parameters

Success?

Calibrated simulation

Uncalibrated simulation

Comparison

Refine?

"Local" Results

Part B: ISIMIP3 "Global" (?)

ISIMIP "**Global**" dataset

Uncalibrated simulation

"Global" Results (?)

Model performance

Lake temperature data split into **calibration** and **validation** sets based on availability

Model bias

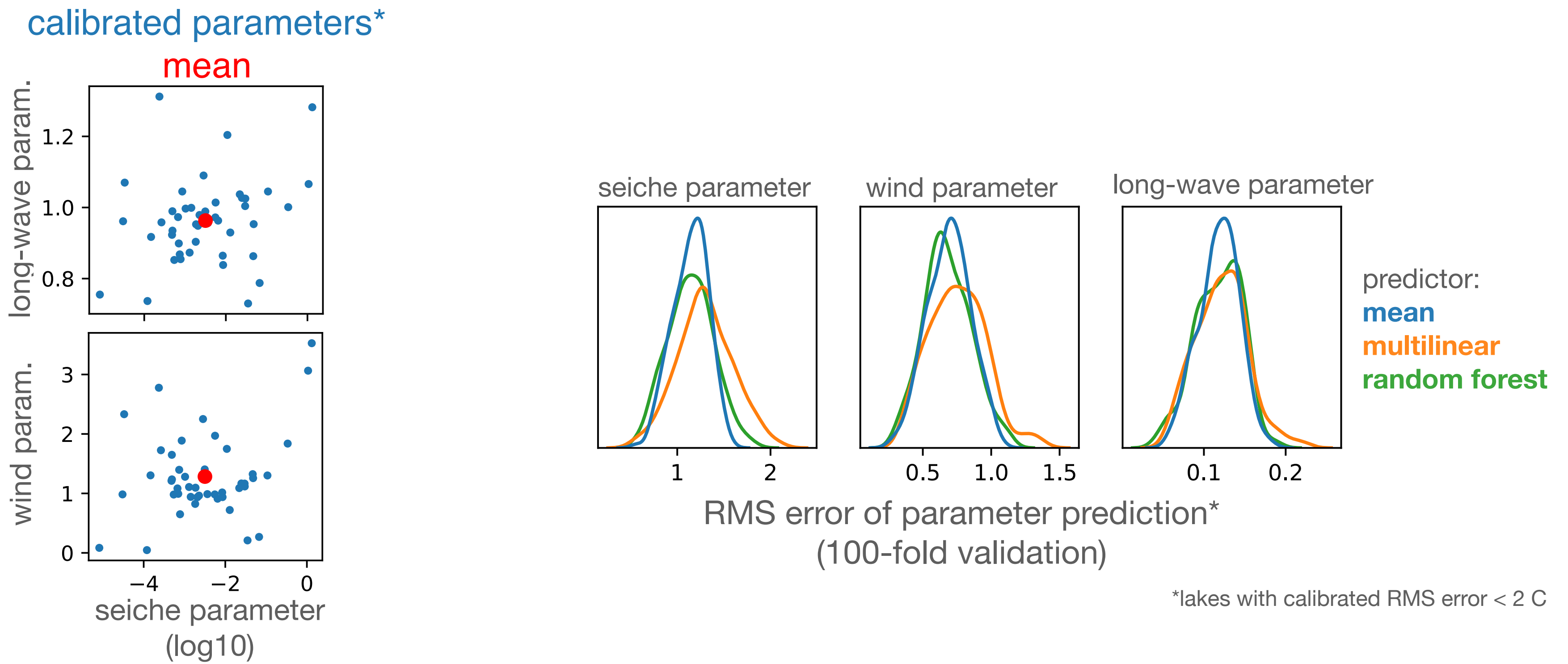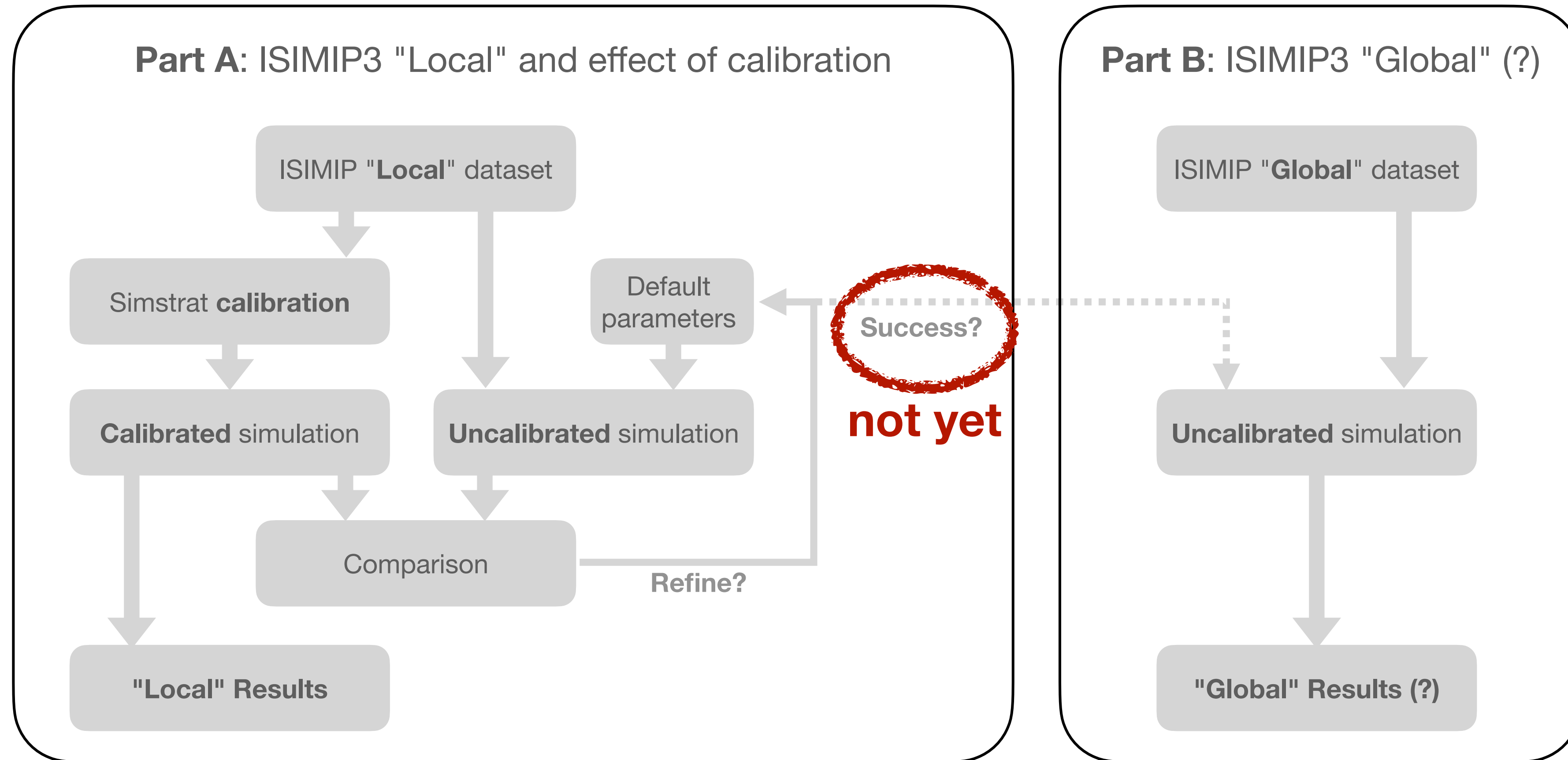Lake names (x-axis): Kivu, Tarawera, Rotorua, Kilpisjarvi, Neuchatel, Stechlin, Thun, BlackOak, LowerLakeZurich, Windermere, Kinneret, Arendsee, Ngoring, Green, Muggelsee, Tahoe, Sunapee, Feeagh, Bosumtwi, Sparkling, Murten, Argyle, Ekoln, Zurich, Mendota, Vortsjarv, Biel, TwoSisters, Erken, Scharmutzel, Rimov, Paajarvi, Wingra, Zlutice, BigMuskellunge, Eagle, Harp, Okauchee, Crystal, Vendyurskoe, Klicava, GreatPond, Toolik, Bryrup, BurleyGriffin, Sau, Allequash, EsthwaiteWater, Trout, Washington, Langtjern, NohipaloValgejarv, NohipaloMustjarv, Dickie, TroutBog, Alqueva

Looking in more detail, we see a systematic bias using default parameters, but this can be somewhat corrected post-hoc by using the mean of the calibrated parameters:

top 1m of lake | bottom 20% of lake

mean temperature error [C]*

— calibrated pars (cal/val)
— default pars (cal/val)
— mean pars (cal/val)

*lakes with calibrated RMS error < 2 C

So far, none of the predictors is better than the mean, but that's good news, because this is how modellers often set up their ISIMIP Global Lakes simulations:

Lake model parameters are

Predicting calibrated parameters

calibrated parameters*

mean

Lake model parameters are highly variable after unconstrained calibration

But perhaps they can be predicted from local properties like wind and LW radiation mean and variance, lake surface area and depth, and latitude?

long-wave param.

1.2

1.0

0.8

log10(a_seiche)

wind param.
f_wind

3

1

0

log10(p_seiche)

seiche parameter
(log10)

seiche parameter
(log10)

So far, none of the predictors is better than the mean, but that's good news, because this is how modellers often set up their ISIMIP Global Lakes simulations.

seiche parameter

wind parameter

long-wave parameter

long-wave

1   2

0.5 1.0 1.5

0.1   0.2

0.1

RMSE

predictor:
mean
multilinear
random forest

RMS error of parameter prediction*
(100-fold validation)

prediction
on)

*lakes with calibrated RMS error < 2 C

eawag
aquatic research

Progress on the original plan

ons

Marco Papetti

..

Part A: ISIMIP3 "Local" and effect of calibration

ISIMIP "**Local**" dataset

Simstrat **calibration**

Default parameters

Success?

not yet

Calibrated simulation

Uncalibrated simulation

Comparison

Refine?

"Local" Results

Part B: ISIMIP3 "Global" (?)

ISIMIP "**Global**" dataset

Uncalibrated simulation

"Global" Results (?)

Open questions

Predict parameters based on model error?

How does this translate to other models?

How does this translate to ISIMIP 3b forcing?

Outlook

Predict parameters based on model error?

> Yes.

How does this translate to other models?

> Joint project with other modellers arising from Girona workshop

How does this translate to ISIMIP 3b forcing?

> ?????
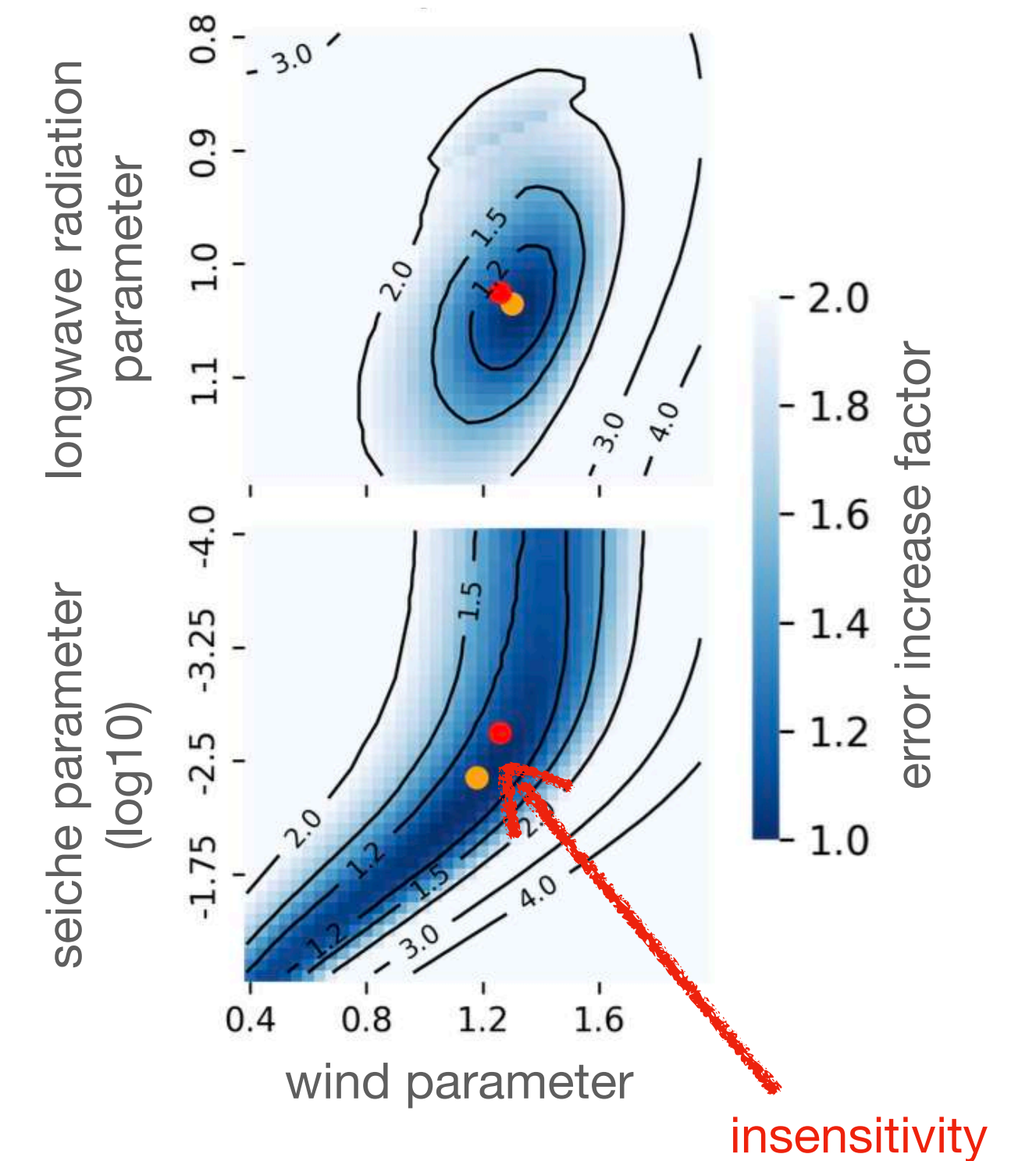
The future of algal blooms in lakes globally is in our hands

Maddalena Tigli, Annette Janssen, Mirjam Bak
others involved: Jan Janse, Maryna Strokal

Problem description

2 future scenarios

RCP2.6

< 2 °C   CLIMATE DIMENSION

SSP1

SOCIO-ECONOMIC DIMENSION

RCP8.5

> 2 °C   CLIMATE DIMENSION

SSP5

SOCIO-ECONOMIC DIMENSION

Baseline (2010)

2050 RCP2.6-SSP1

2050 RCP8.5-SSP5
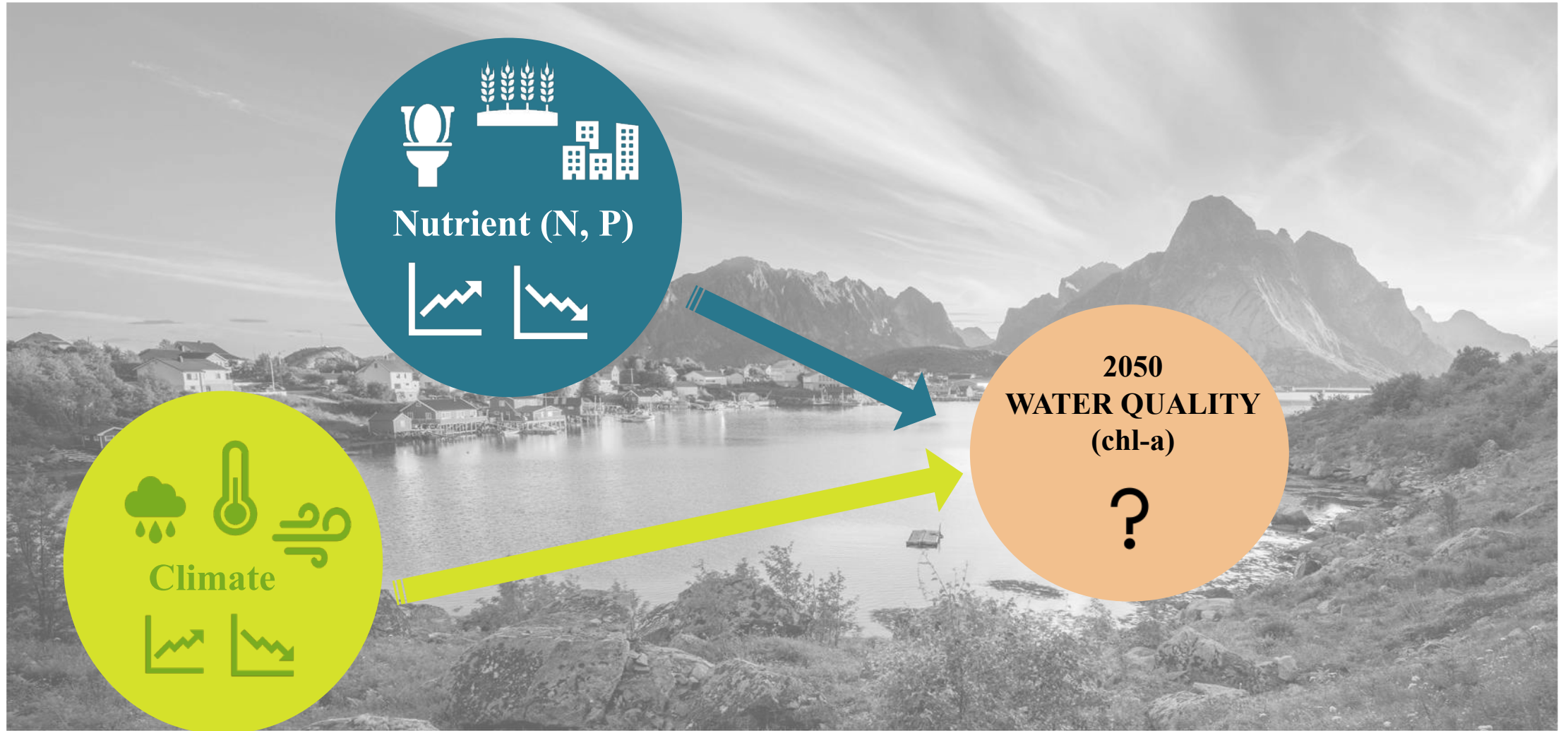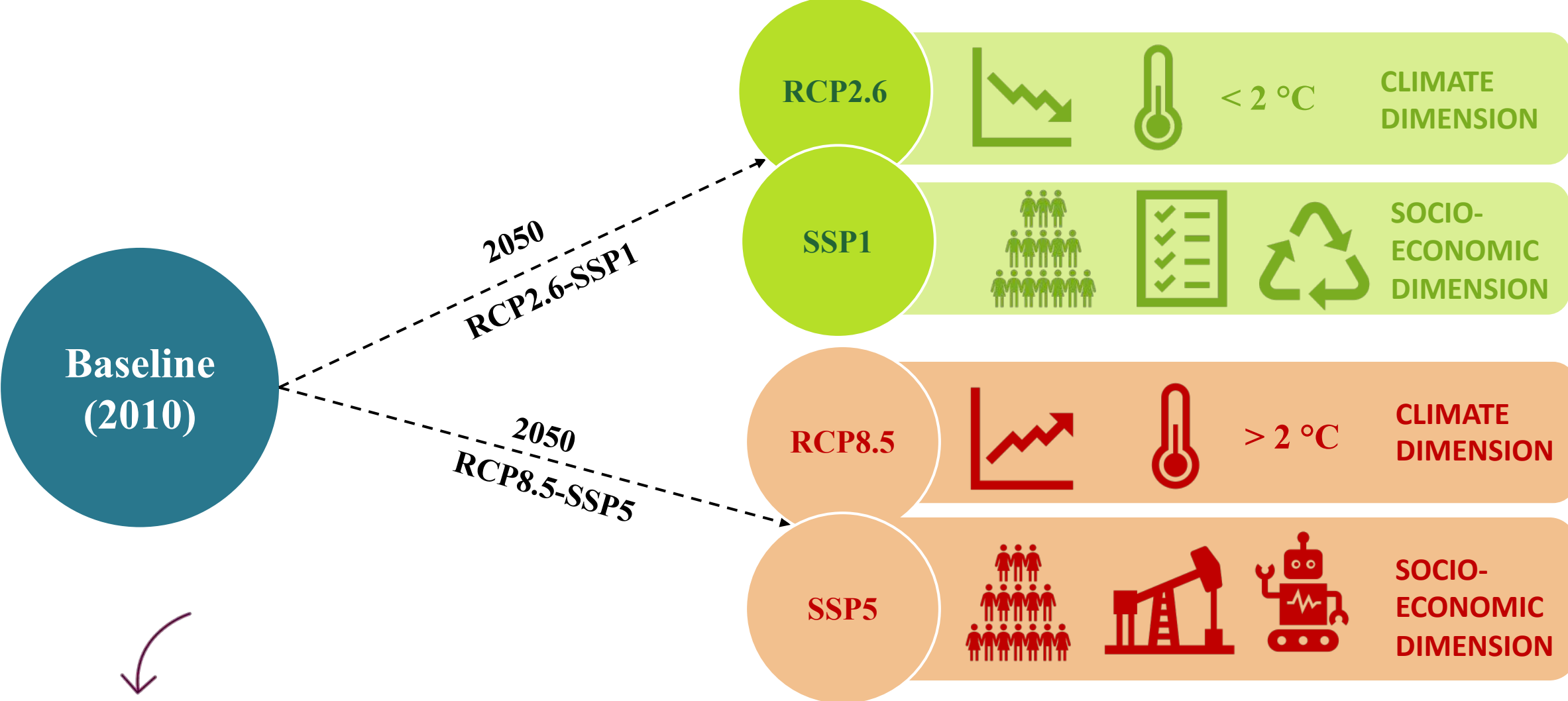
We purposely chose opposite scenarios, rather than "most likely" scenarios

3

Methodology
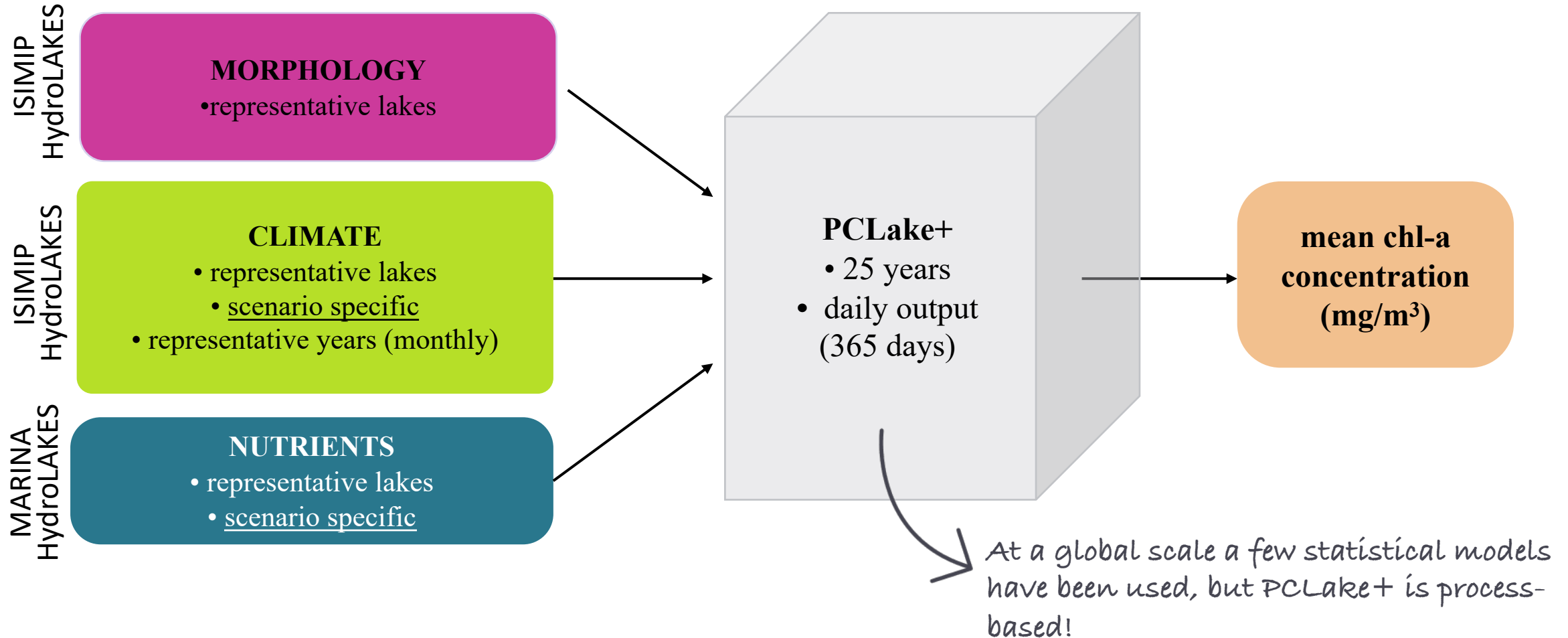
Results

To interpret the chlorophyll-a concentration we used the Trophic State Index (TSI) developed by Carlson (1977):

$9.81 \times \ln(\text{Chl-a}) + 30,6$

TSI	Chl-a (mg/m^3)	Category
<40	< 2.6	oligotrophic
40-50	2.6 – 7.3	mesotrophic
50-70	7.3 – 55.5	eutrophic
>70	> 55.5	hypereutrophic

Baseline (2010)
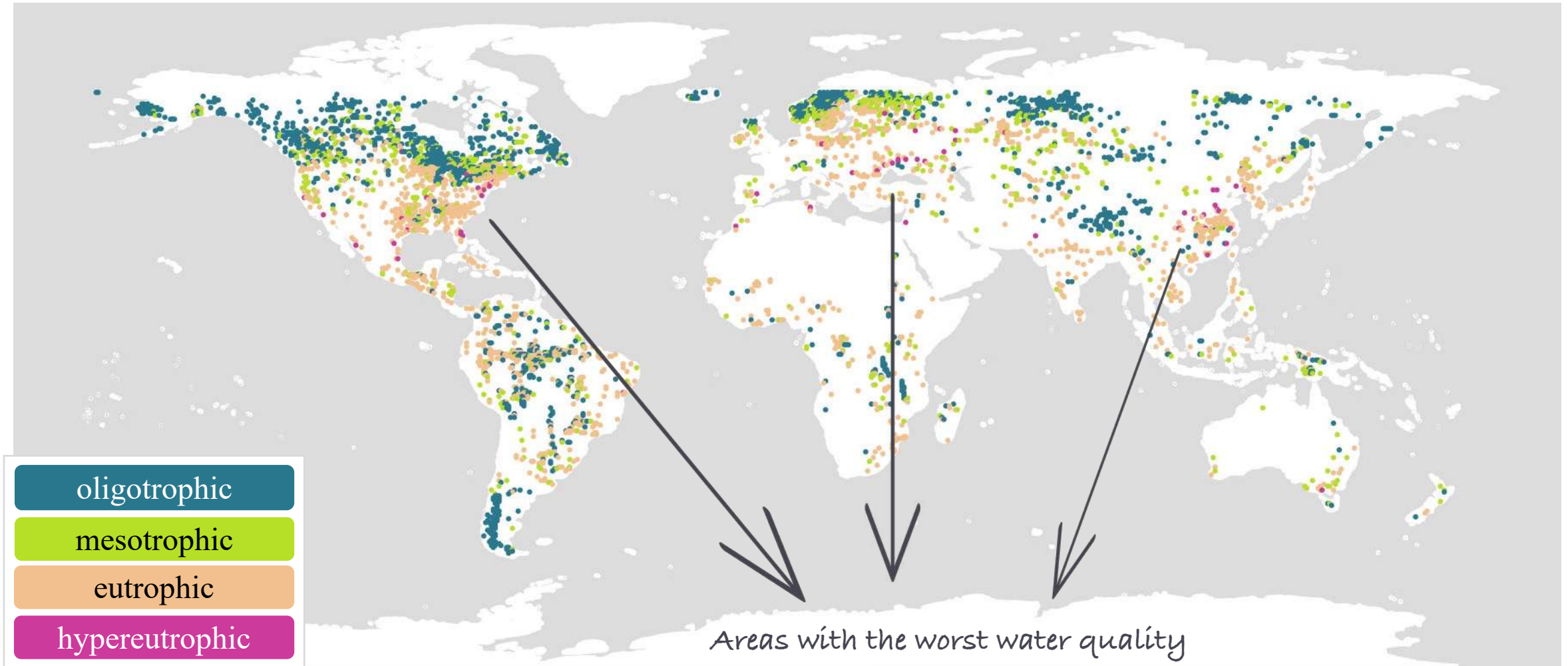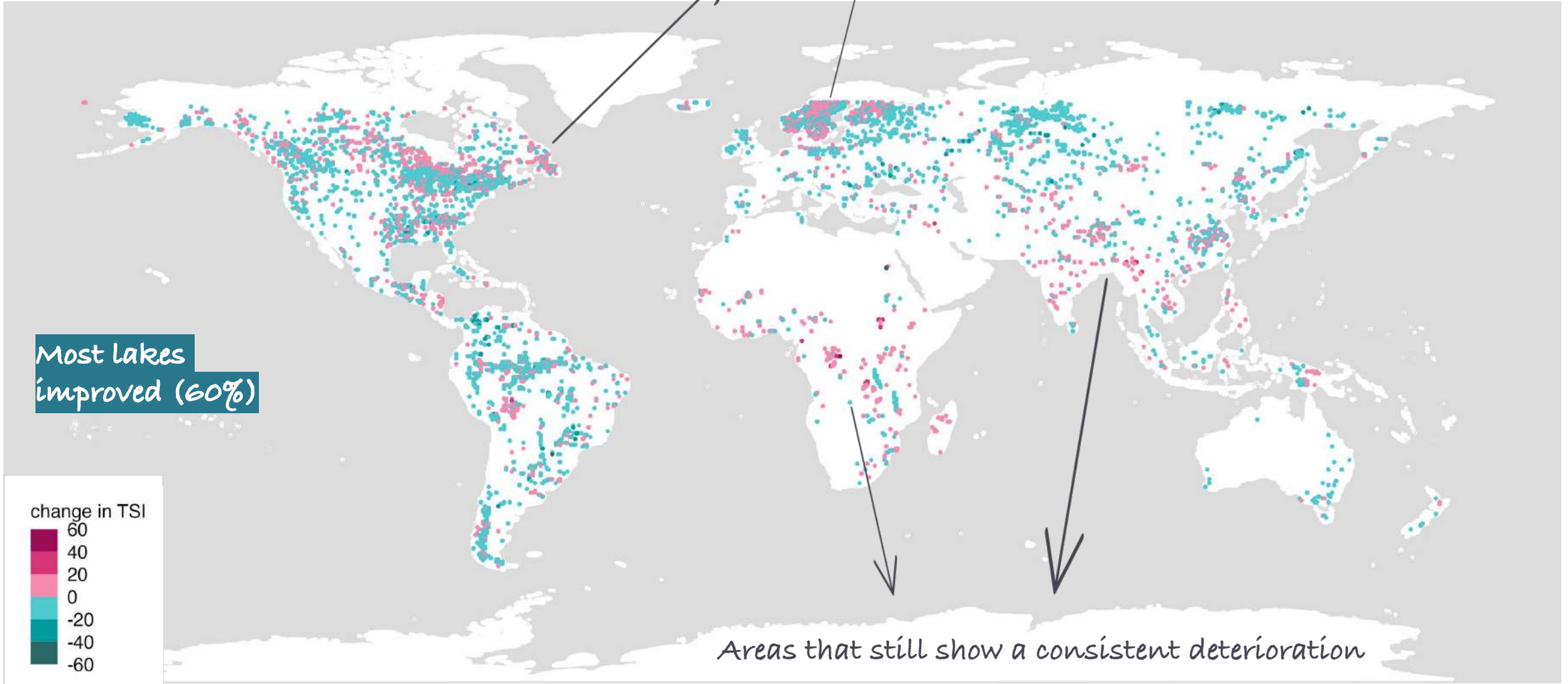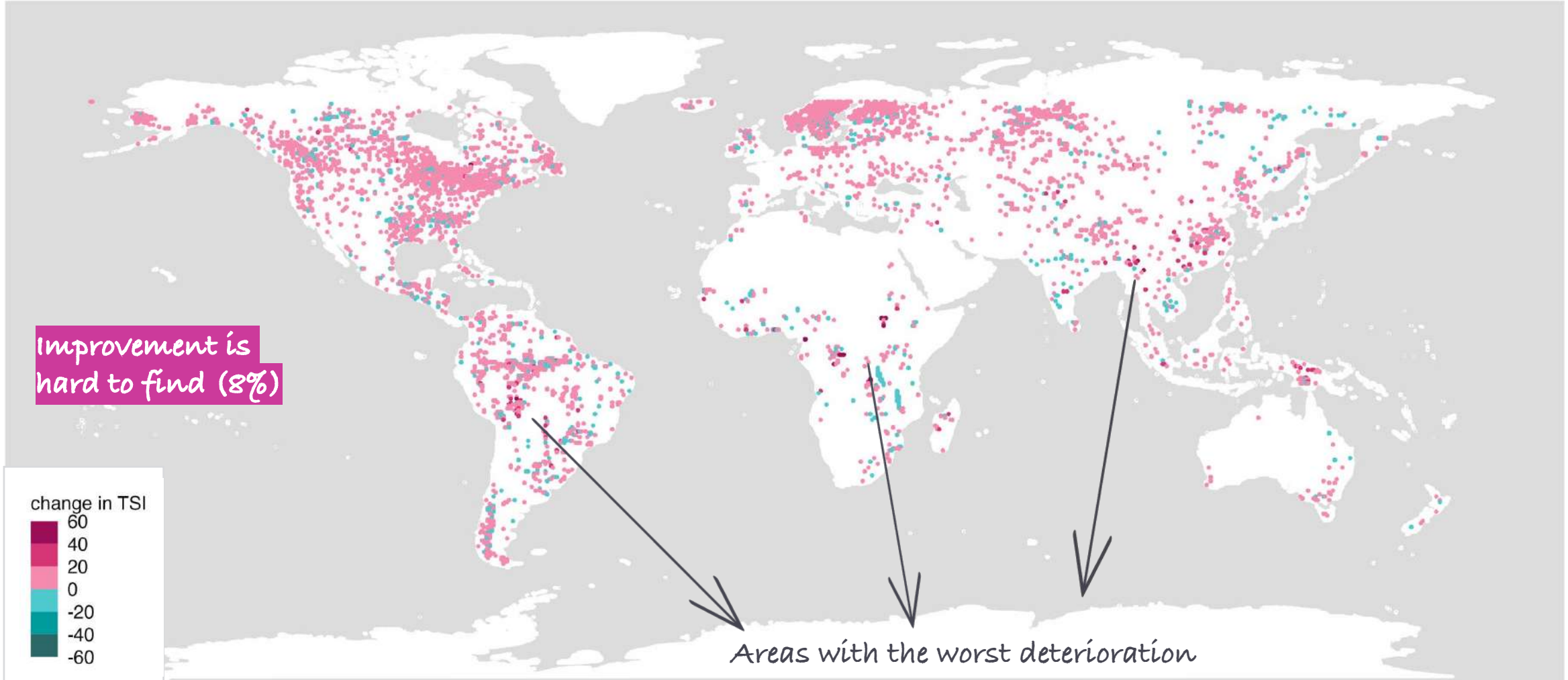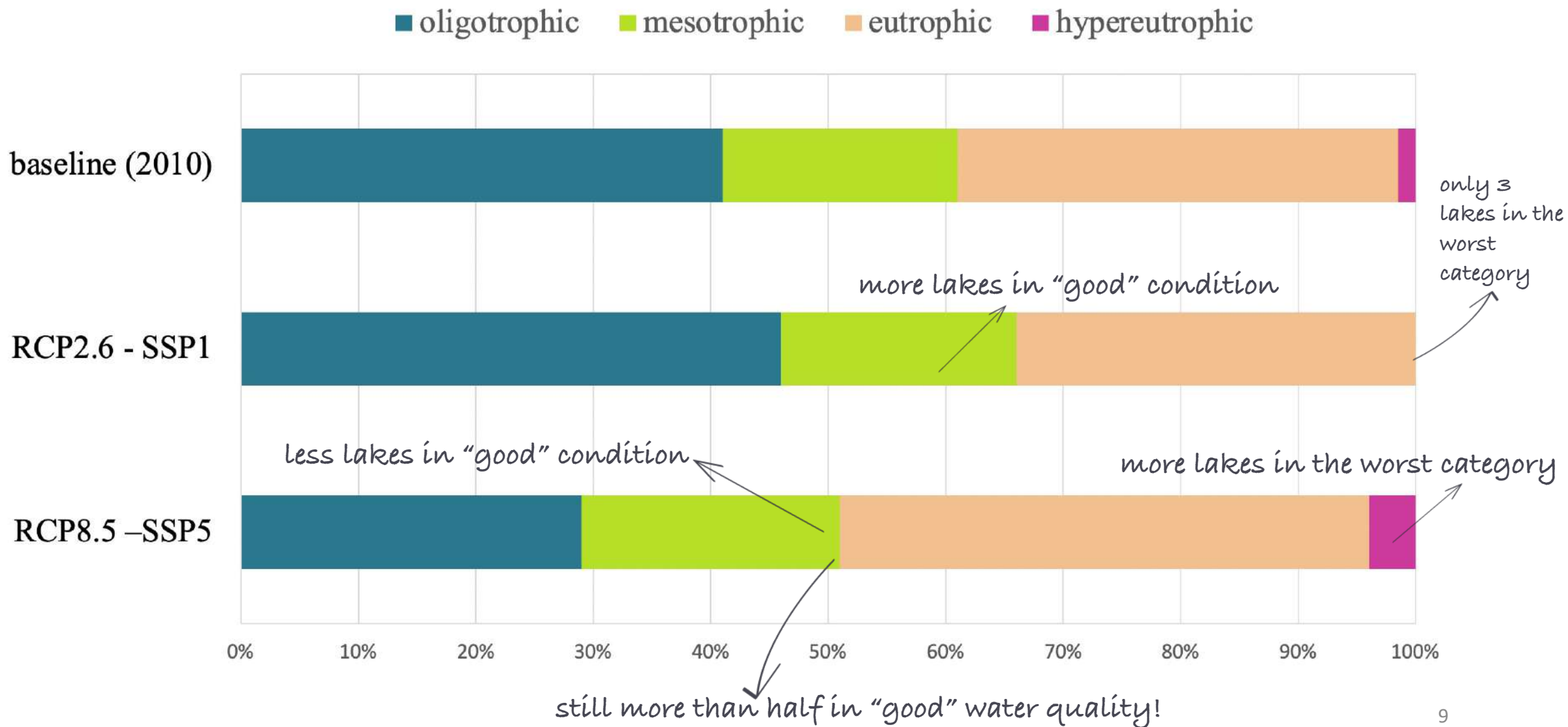
oligotrophic
mesotrophic
eutrophic
hypereutrophic

Areas with the worst water quality

RCP2.6 – SSP1

Areas that still show some deterioration

Most lakes improved (60%)

change in TSI
60
40
20
0
-20
-40
-60

Areas that still show a consistent deterioration

RCP8.5 – SSP5

Improvement is hard to find (8%)

change in TSI
60
40
20
0
-20
-40
-60

Areas with the worst deterioration

8

Long story short
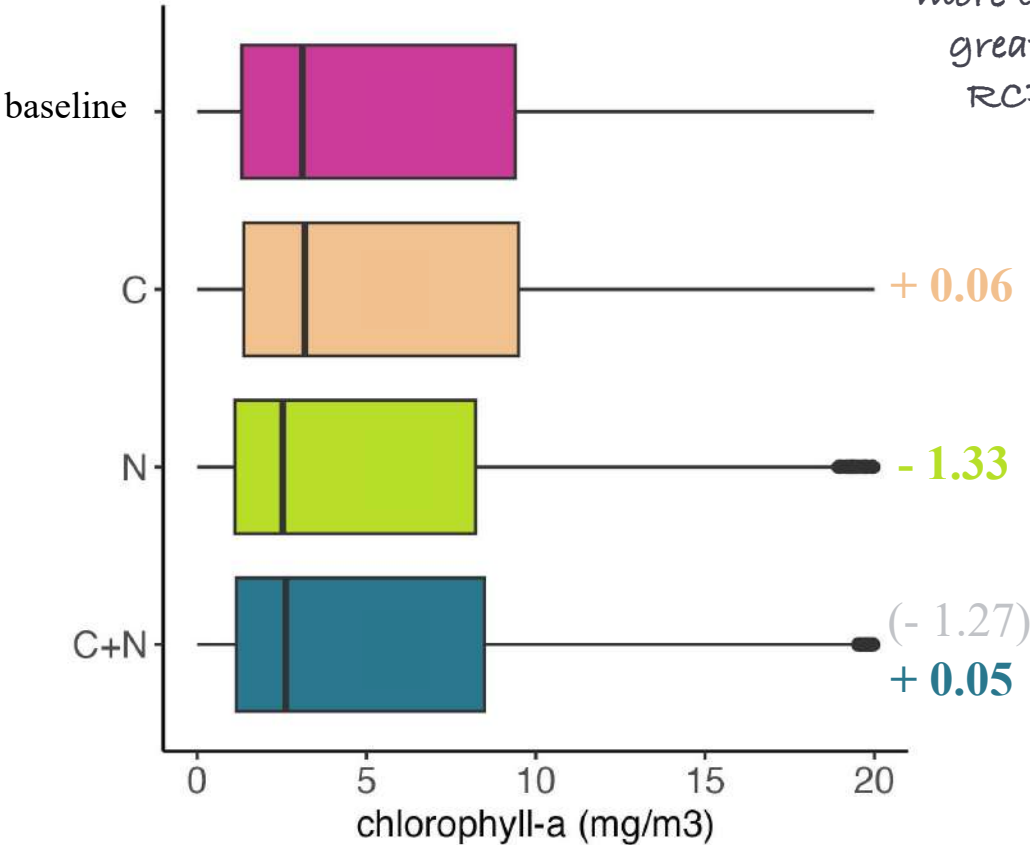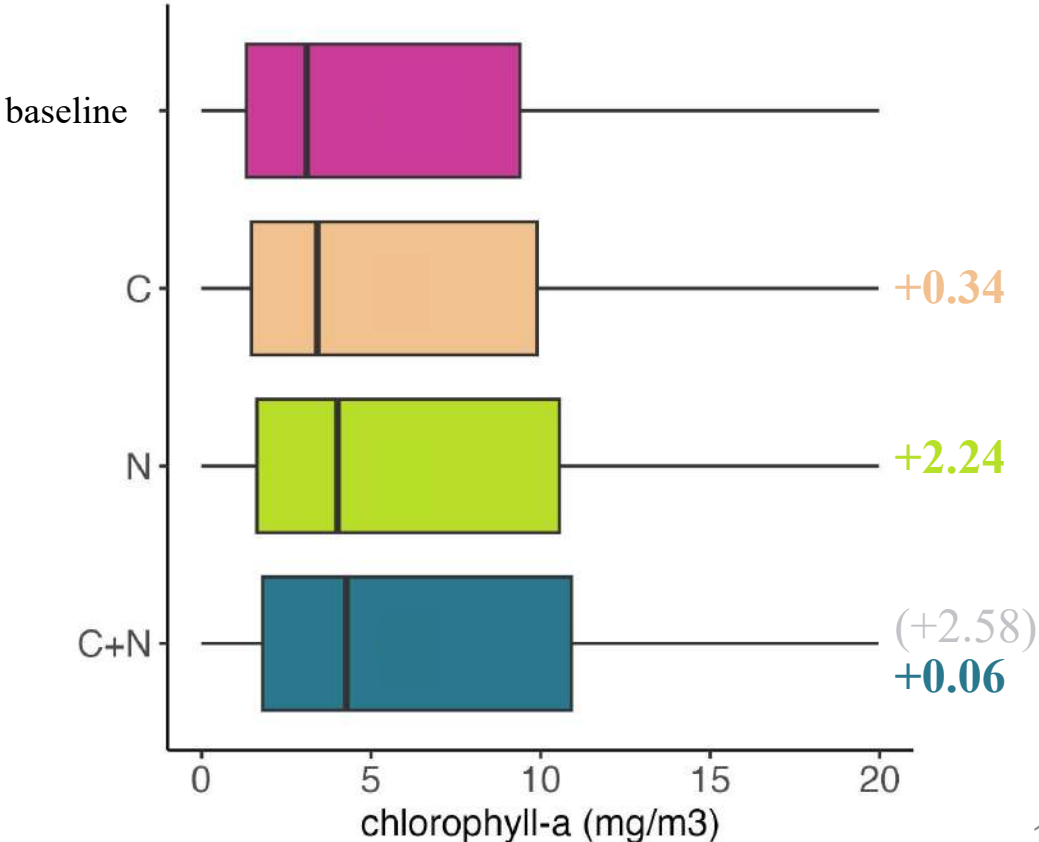
Validation (Satellite data)

Log10 CEDA (mgChla/m^3)

Log10 PCLake+ (mgChla/m^3)

lakes characteristics

- regular lakes
- very deep lakes
- very large lakes
- very deep & very large lakes
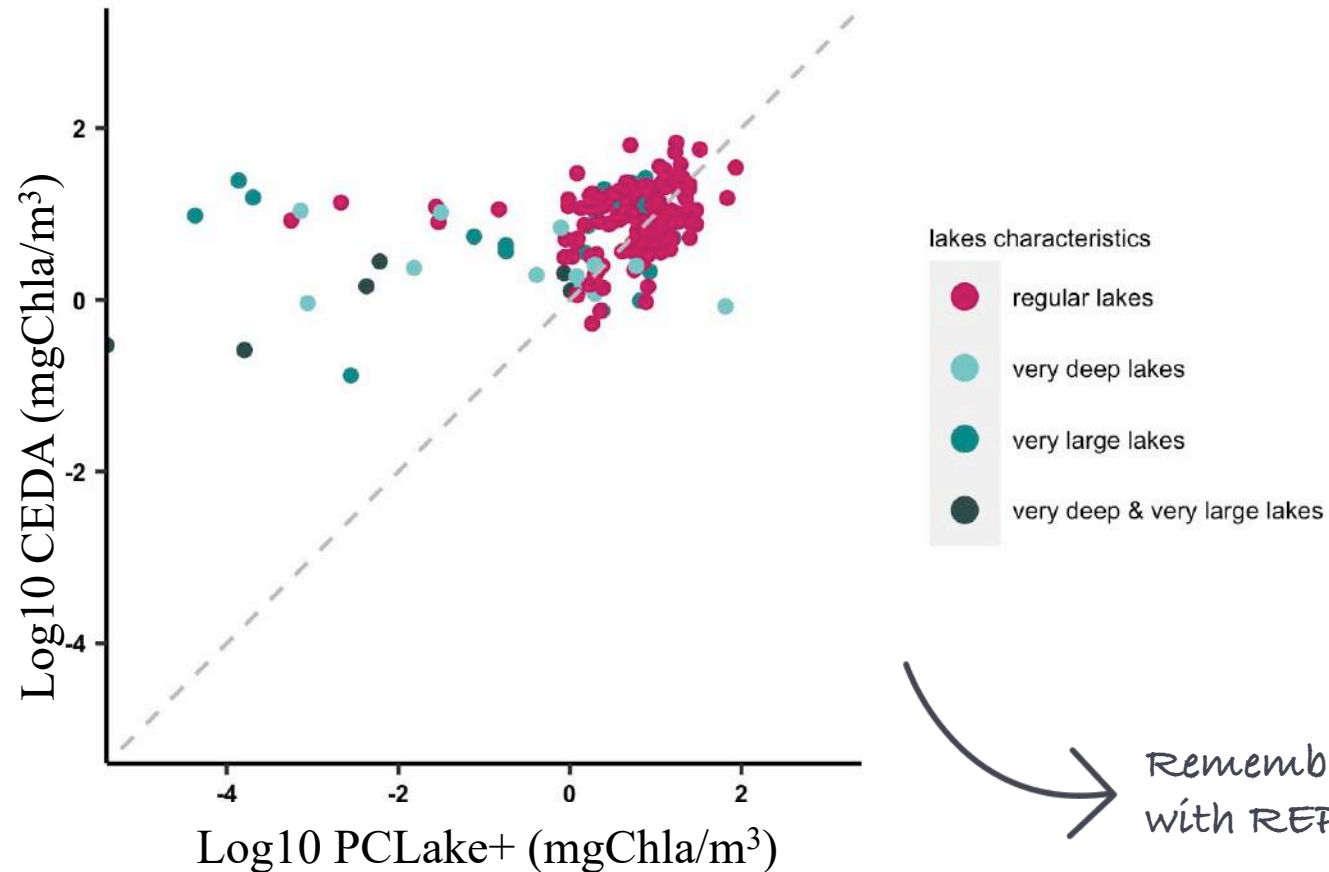
- The model performed better with "regular lakes".

- When we excluded the "very deep" and "very large" lakes. *the narrative remained unvaried*.

Remember that this compares REAL lakes with REPRESENTATIVE lakes

Discussions
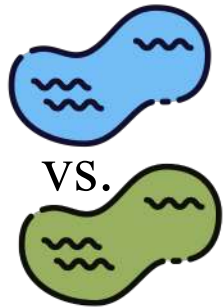
RCP2.6-SSP1 is preferred

Janssen *et al.*, 2020

The effect of climate: RCP8.5-SSP5 > RCP2.6-SSP1

Paerl & Huisman, 2008
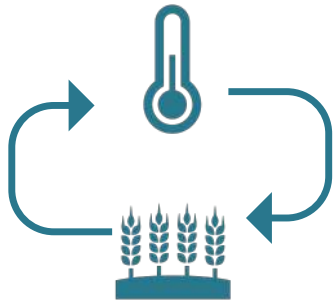
The combined effect was "+"

Moss *et al.*, (2011)

The effect of climate might be bigger in the future

Vuuren *et al.*, 2014

Conclusions

- RCP2.6 – SSP1 resulted in an overall improvement in water quality. But it is not "evenly distributed".
- RCP8.5 –SSP5 resulted in further deterioration of the water quality.

*We can **impact** the state of lakes **significantly**, even in a relatively short period of time (i.e., 40 years). This should serve as motivation to **promote responsible climate and socio-economic policies.***

Opportunities for ISIMIP3?

ISIMIP 2b (this study)	ISIMIP 3 (Disney scenario)
Representative lakes	Real lakes
Basic water balance - *4000 (36.000 lakes of ISIMIP 2b were water balance limited by HydroLAKES)* - *Independent on scenario*	Water balance - *All lakes of ISIMIP 3* - *Scenario dependent*, daily or yearly* - *Ideally from the global water sector*
Nutrient balance - *Specific years (2010,2050)* - *Based on MARINA model*	Nutrient balance - *Based on various models* - *Yearly from 1661-2100* - *Scenario dependent**
Run with PCLake	Run with multiple WQ models

* scenarios
- Pre industrial (1860 soc, pi-control)
- Historical (2005soc, historic, historical, pi-control)
- Projections (2005 soc, rcp 8.5, rcp 6.0, rcp 6.0 with ewembi, rcp 2.6, pi-control)
- (extended projections)

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Making a realistic shopping *list* for ISIMIP3

ISIMIP 3 (Disney scenario)	ISIMIP 3 (realistic list)
Real lakes	An 'offline' dataset for real lakes
Water balance - *All lakes of ISIMIP 3* - *Scenario dependent*, daily or yearly* - *Ideally from the global water sector*	How to get from grid to lake scale? - HydroLAKES = first-order estimate ~ 1950-2000 - Scale with gridded data global water sector? - Validation?
Nutrient balance - *Based on various models* - *Yearly from 1661-2100* - *Scenario dependent**	How to get from grid to lake scale? - Use nutrient input from the Water Quality Sector? - Use method Maddalena et al
Run with multiple WQ models	- What else do WQ models need?

General:
Who might be interested to join this effort?

Question to Global Water Sector:
What would be your suggestions to the lake sector to make this work?

Question to Water Quality Sector:
Which scenarios are available for which model and on what temporal scale to the lake sector?

Question to Lake Sector:
Is an 'offline' dataset with a water and nutrient balance sufficient to run your model?

Contact

- How do we want to get into contact?

Madda: maddalena.tigli3@gmai.com

Annette: annette.janssen@wur.nl

Mirjam: mirjam.bak@wur.nl

Anthropogenic perturbation of organic carbon burial in global lake Sediments – An ISIMIP analysis

Key Goals:
- Global Evaluation of carbon sequestration in lake sediments
- Develop a methodology for simple cross sectorial data sets

Method:
Develop a simple model that links data from
- ISIMP Scenario forcing data (Blue)
- ISIMIP Lake Sector (Red)
- ISIMIP Global Hydrology Sector (Green)
- ISIMIP Water Quality Sector?

For more informationvisit our poster:
- Future projections of anthropogenic perturbation of organic carbon burial in global lake sediments by Ana I. Ayala
- Poster Session 1 and Welcome reception Today
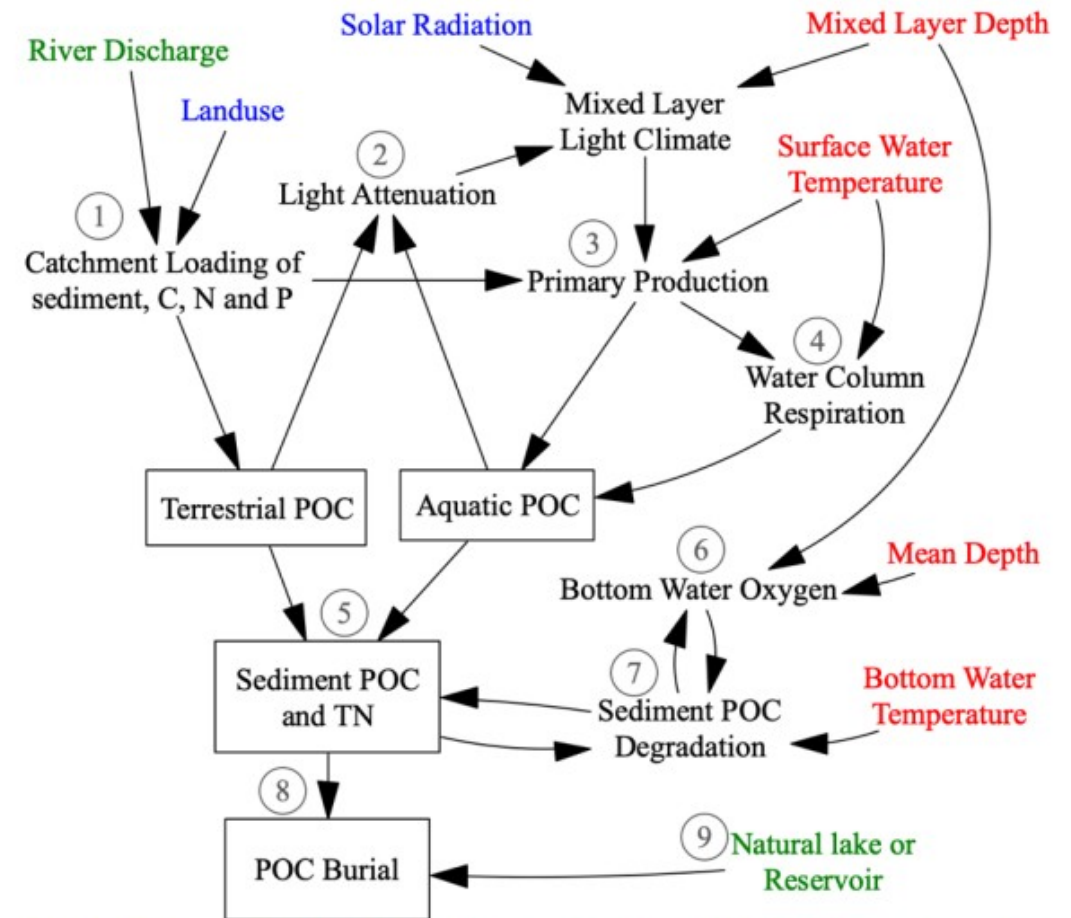
ISIMIP Primary Data *ISIMIP Lake Sector Data* *ISIMIP Global Water Sector Data*

Fig.3. Conceptual model of POC burial in lakes and reservoirs. The numbers denote major steps of calculation (see text).

The footprint of global climate oscillations on temperature across lakes

Daniel Mercado-Bettín, Rafael Marcé

Context

Climate oscillations are expected to influence any ecosystem around the world. But, there is no global evaluation of the relation between these oscillations and water temperature in lakes.

Hence, the annual average of surface and bottom water temperature in 41449 lakes were related to climate oscillation indexes.

Data used

ISIMIP3a GOTM simulations

41449 lakes

ONLY ISIMIP3a data, ensemble mean of the 4 models: GSWP3-W5E5, 20CRv3-W5E5, 20CRv3-ERA5, 20CRv3

Yealy average, to avoid seasonality patterns

Time series between 1901-2021

Current How?

1. Hierarchical Clustering was applied to surface water temperature to separate by region
2. Principal component analysis was applied for all the pixels contained in each cluster
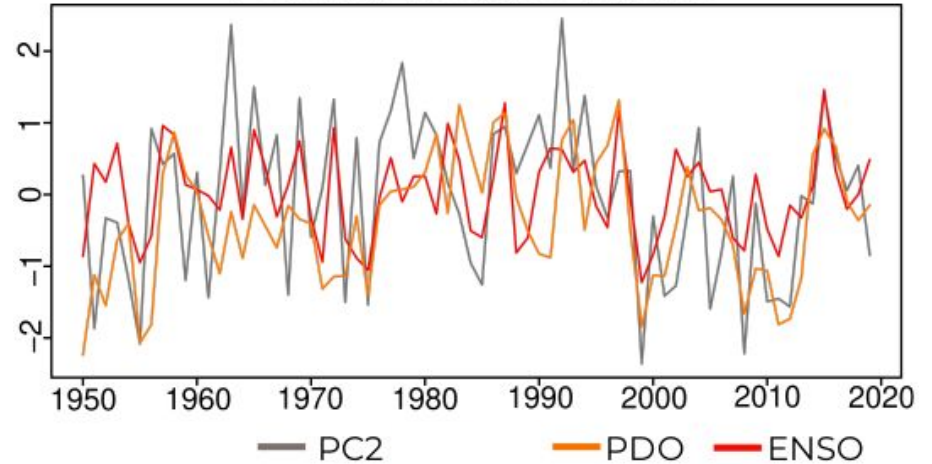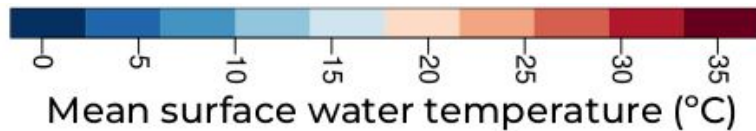3. Cross-correlation between PCs and climate indexes
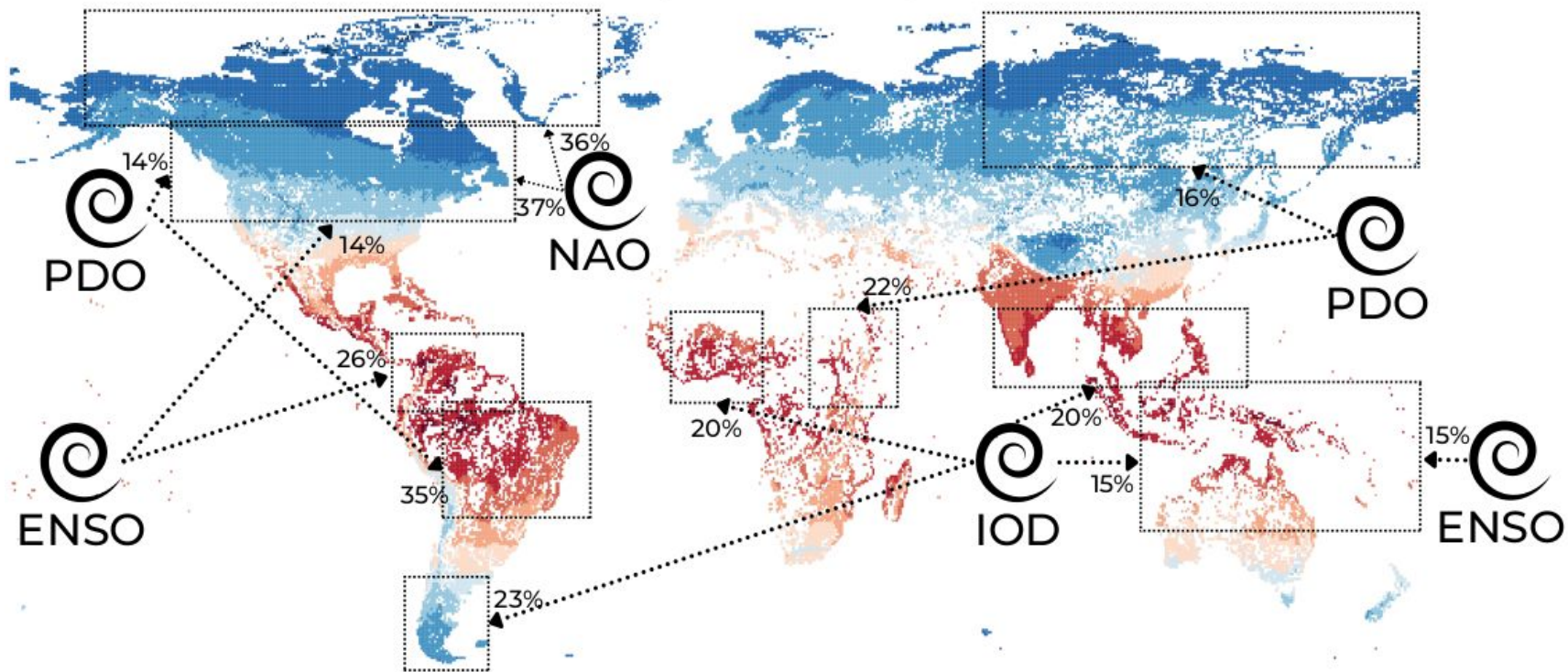

Loadings of PC in North America
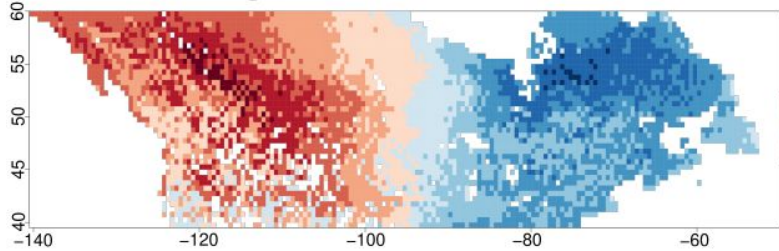
Cross-correlation between PC and ENSO/PD

Correlation PC2 – ENSO

Correlation PC2 – PDO
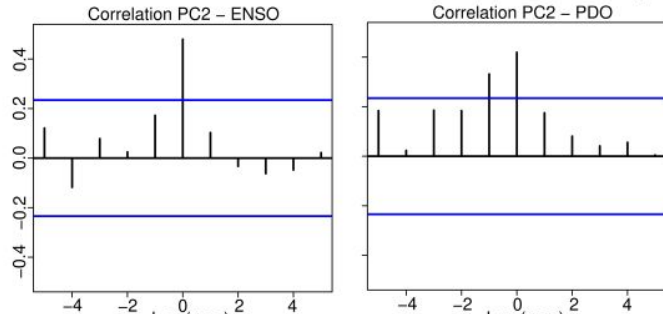
Significant correlation between
PC2 and ENSO/PDO indexes

— PC2 — PDO — ENSO

Mean surface water temperature (°C)

GLEON GSA Limnoseries:
Workshops and Lectures 2023

We are looking for speakers!

Have you produced/used ISIMIP Lake sector data?

Interested to share your research with other lake enthusiasts?

If you are interested please contact:

Sofia La Fuente (ruthsofia.lafuentepillco@dkit.ie)

Daniel Mercado-Bettín (dmercado@icra.cat)

https://gleon.org/

Great opportunity to involve Early-Stage Researchers!

Looking for 4-6 presenters (10 min)

5. Open questions: discussion and comments from the audience.

1. Which scientific aspect of the lake sector you think needs improvements?

2. How can we boost the simulations of water quality variables in the lake sector?

3. Considering the status of the sector, the limitation of the available models and input data, which water quality output variables can be realistically produced by the modellers for ISIMIP3?

4. How can we establish connections between the lake sector and other sectors of ISIMIP (water quality, water global, water regional)?

THANK YOU!