Reservoir changes pCO_2 of downstream river: Evidences from three reservoirs in the Seine Basin

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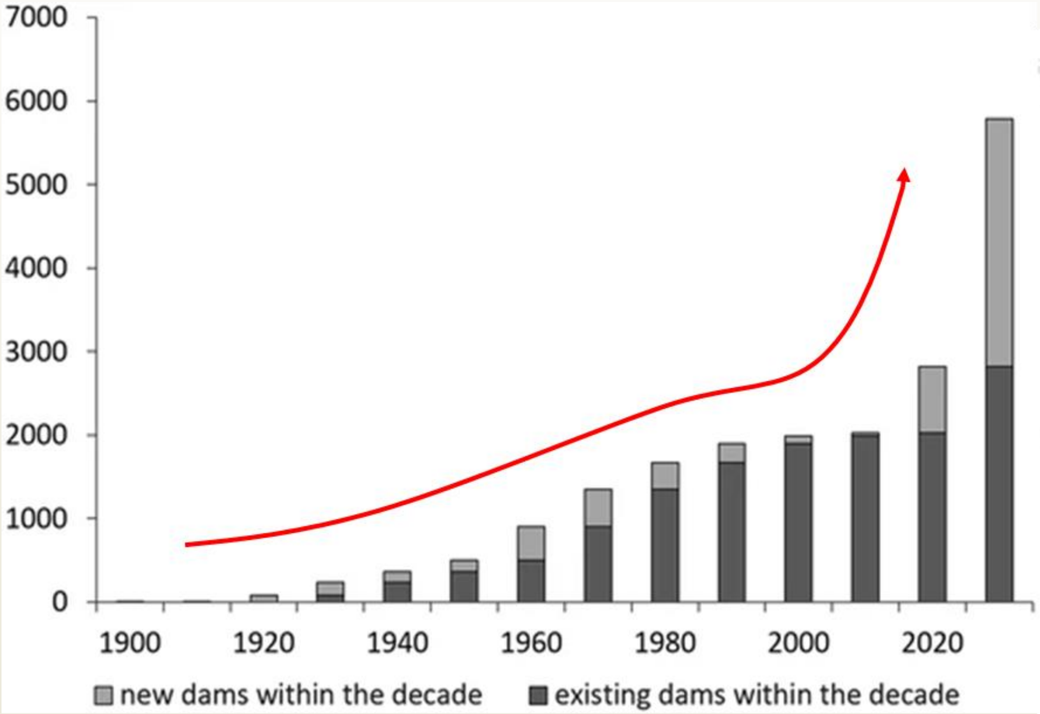
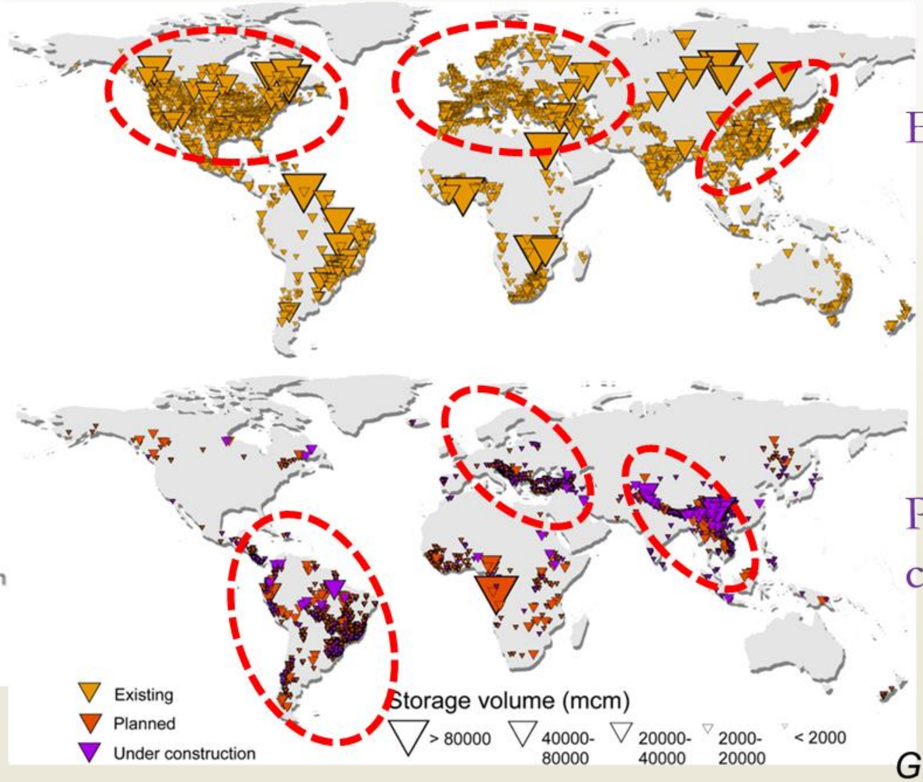
- CO_2 dynamics in three reservoirs of the Seine Basin
- Reservoir changes pCO_2 of downstream river
- Reconstruction of long-term pCO_2 in the three reservoirs
- Conclusions, perspectives and implications

➢ Introduction

1.1. Global surges of reservoir construction



Referenced to Zarfl et al., 2015



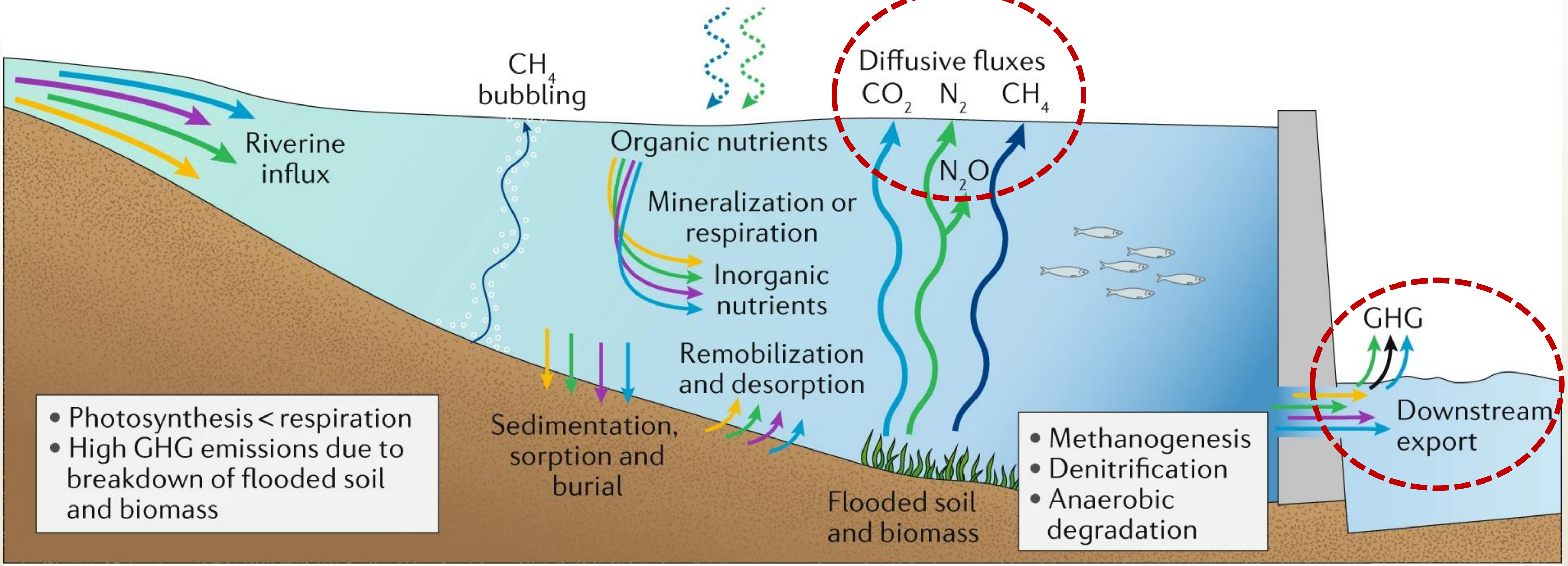
Existing

Planned/Under construction

Grill et al., 2015

➢ Introduction

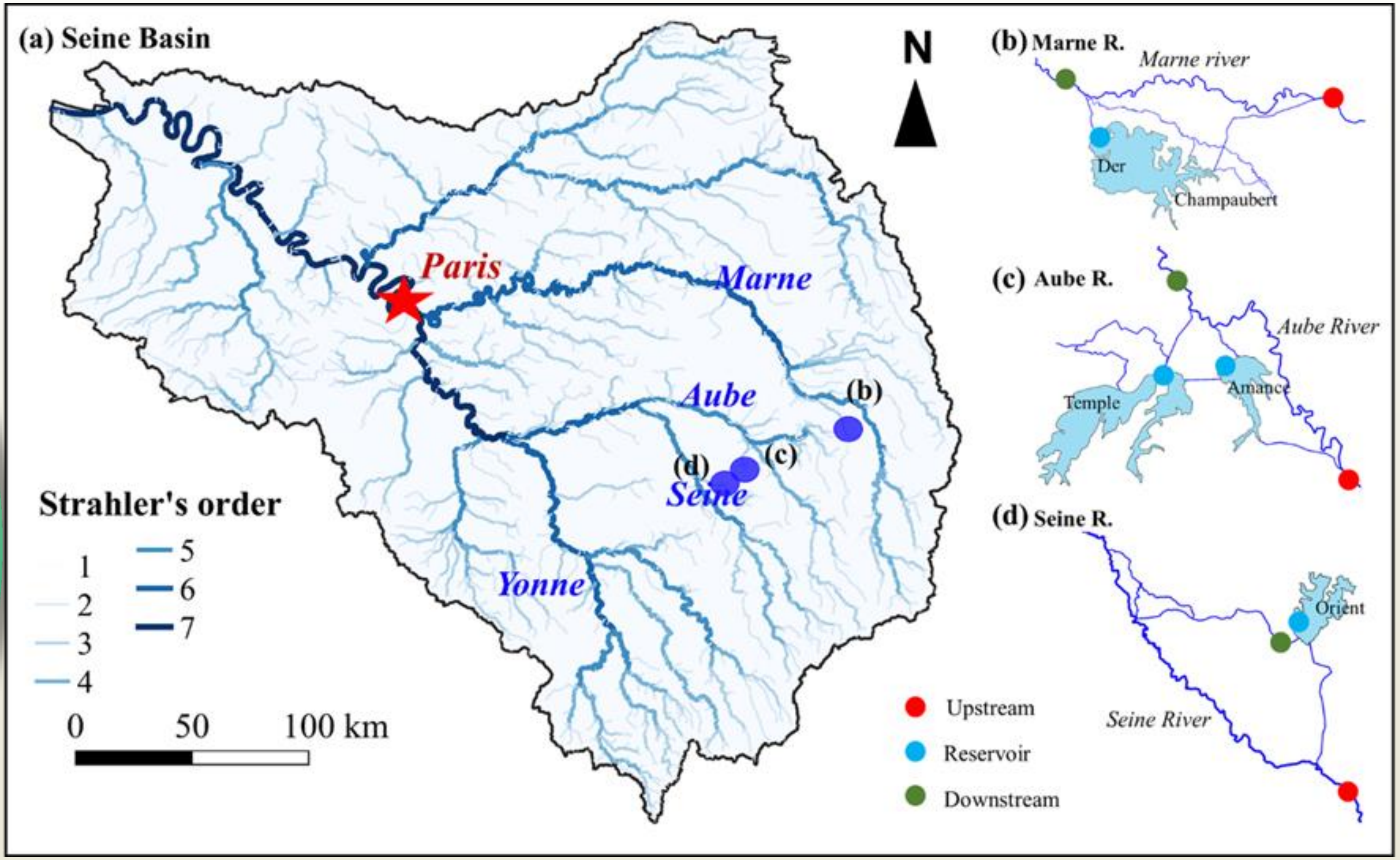
1.2. Reservoir impact on GHG emissions



Maavara et al., 2019

➢ Introduction

1.4. Why the three reservoirs are interesting?



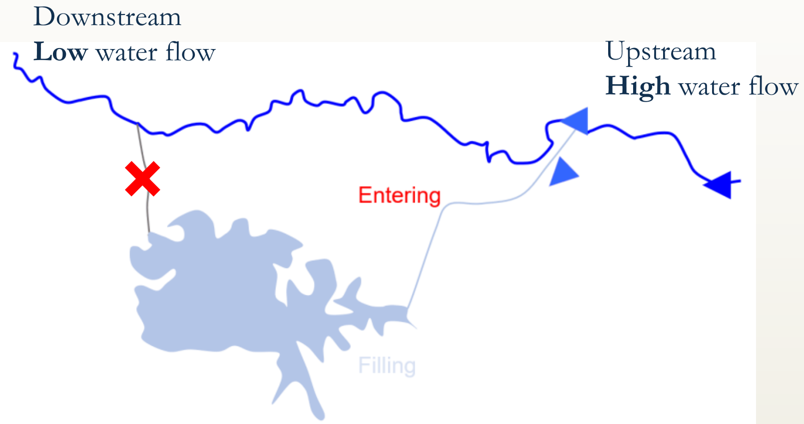
Characteristics:

- ✓ Small surface area (maximus 21~48 km^2)
- ✓ Diverted from their feeding rivers
- ✓ Specific water management strategies

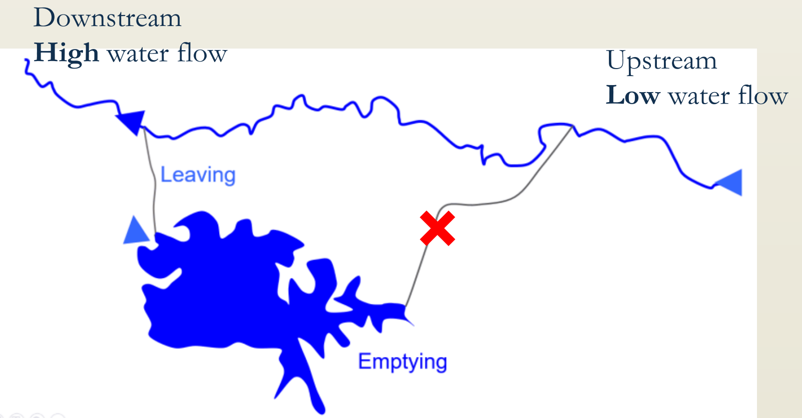
➢ Introduction

1.4. Why the three reservoirs are interesting?

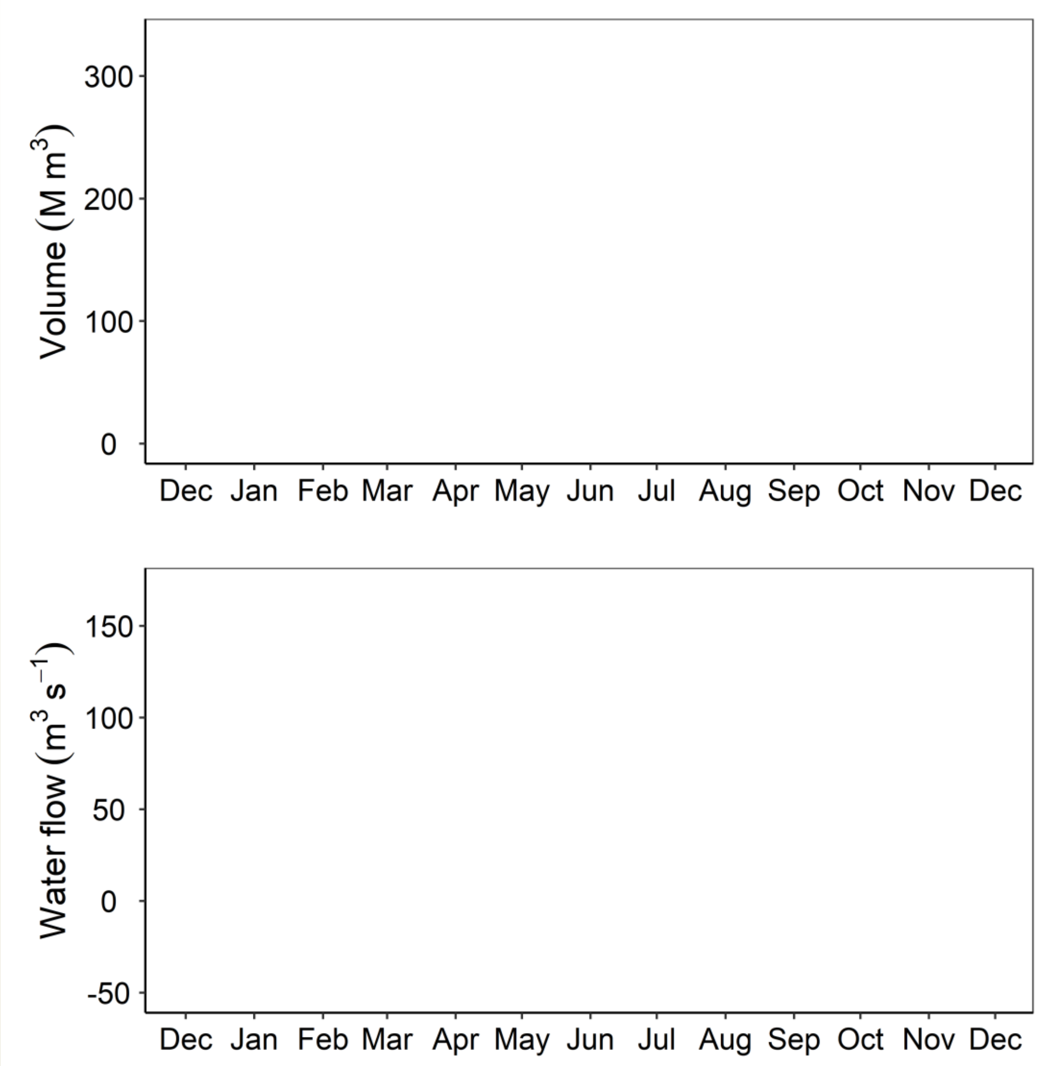
1. Filling period (Dec-Jun)



2. Emptying period (Jul-Nov)

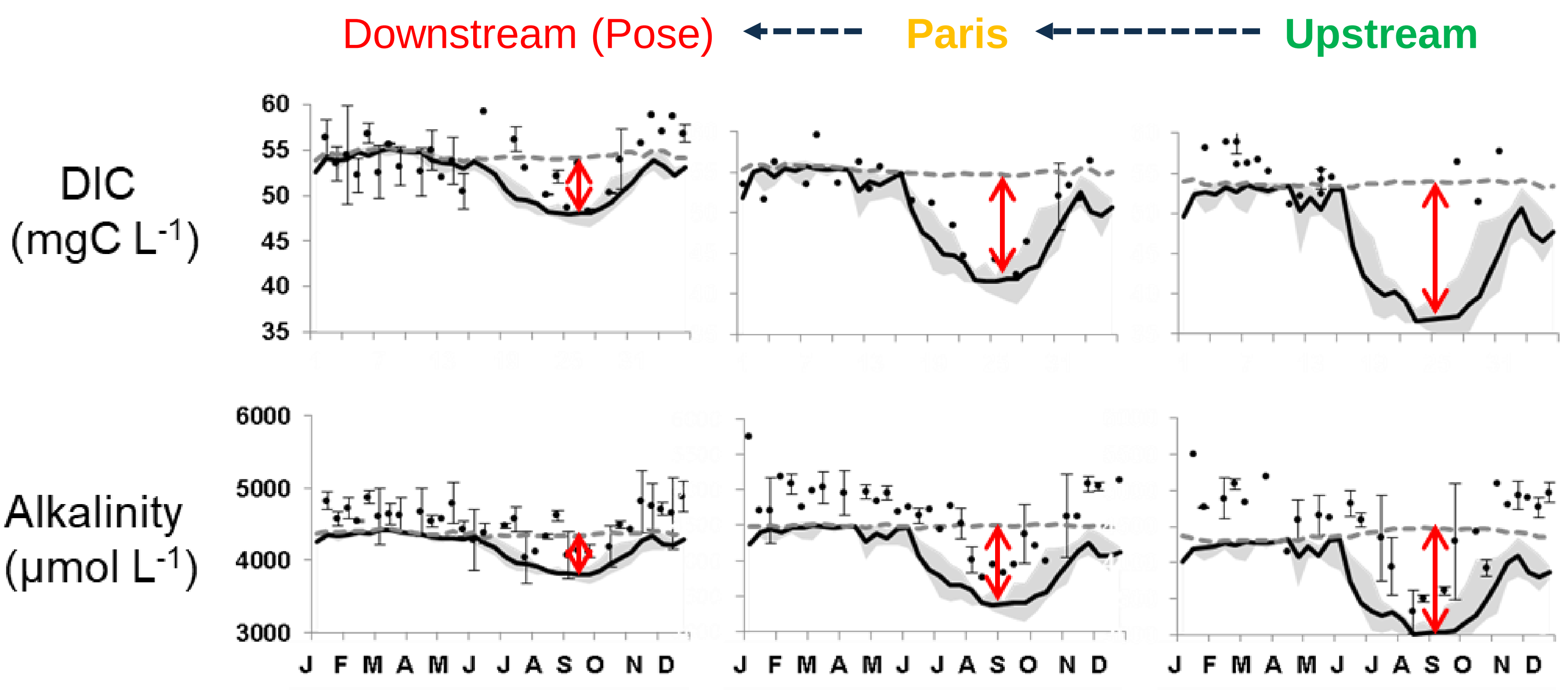


Marne R.
2019-2020



➢ Introduction

Seasonal variations of CO_2 concentrations (2010~2013)



- - - *Without reservoirs*

— *With reservoirs*

• Impact of reservoirs

Marescaux et al., 2020

➢ Introduction

1.5. Main objectives of this study

I. Understanding the seasonal dynamics of pCO_2 in the three reservoirs and their related rivers.

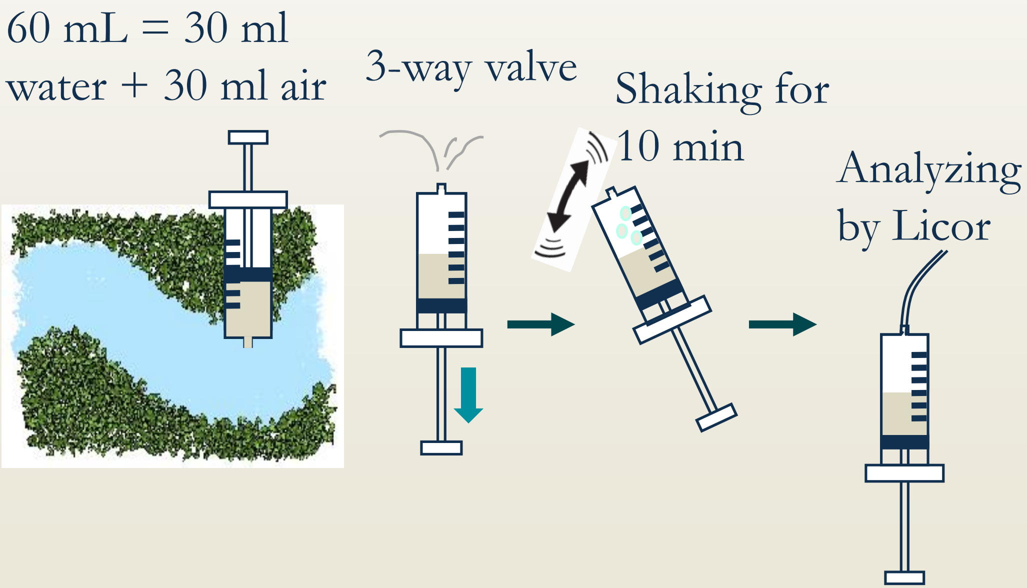
II. Identifying the impacts of reservoirs on pCO_2 of their downstream rivers.

III. Trying to calculate long-term dynamics of pCO_2 in the three reservoir based on observed data.

➢ Introduction

1.6. Methods

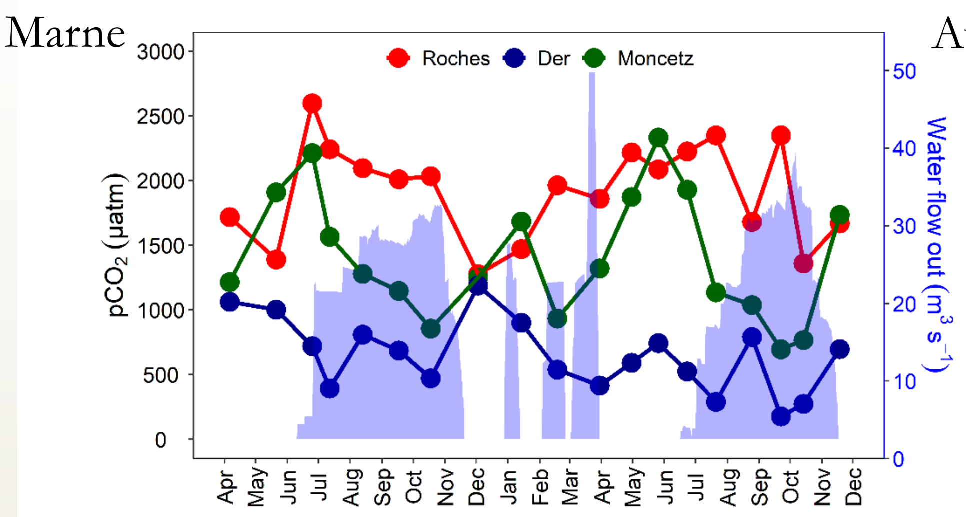
Sampling sites covered reservoir, upstream and downstream of the Marne, Aube and Seine rivers, with the intervals of once a month from 06/04/2019 to 18/11/2020.



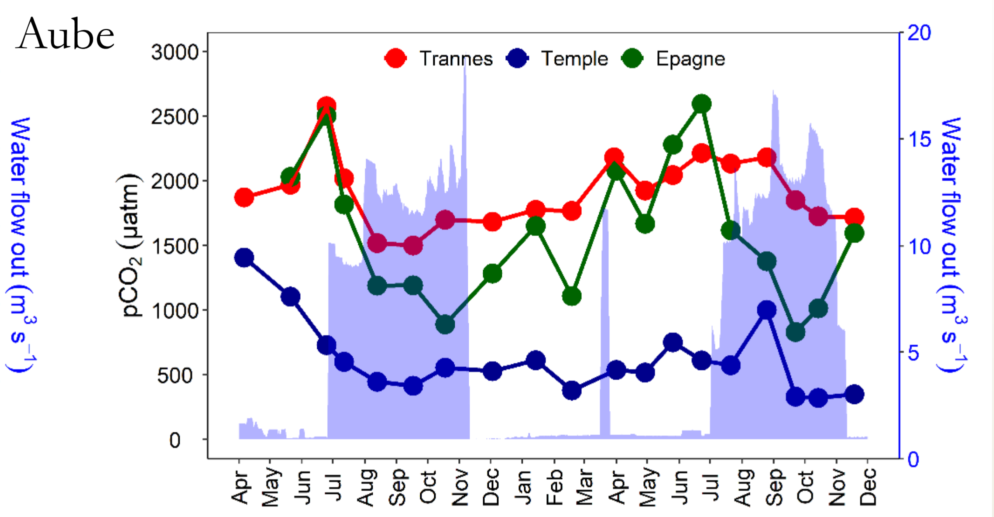
➢ Results

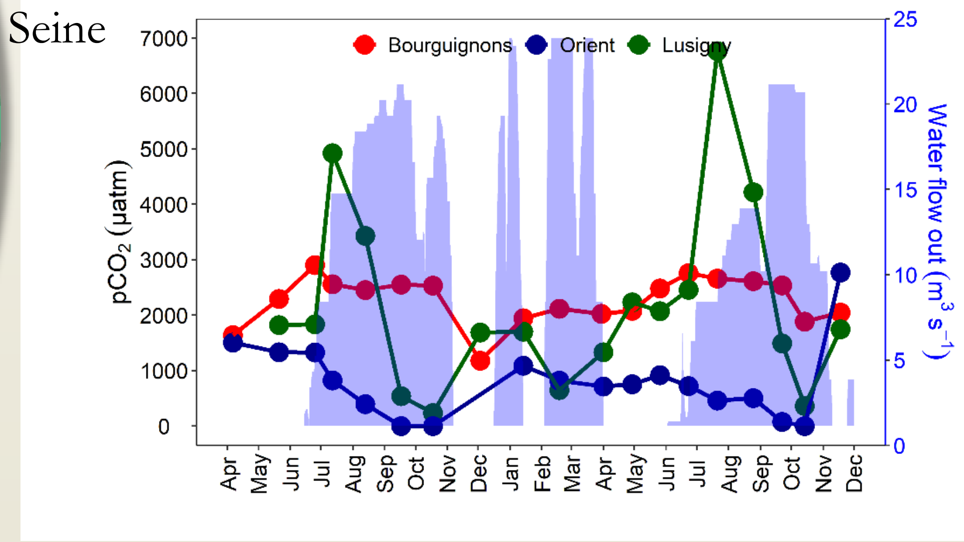
2.1. CO_2 dynamics in three reservoirs and related rivers

upstream→reservoir→downstream



upstream→reservoir→downstream





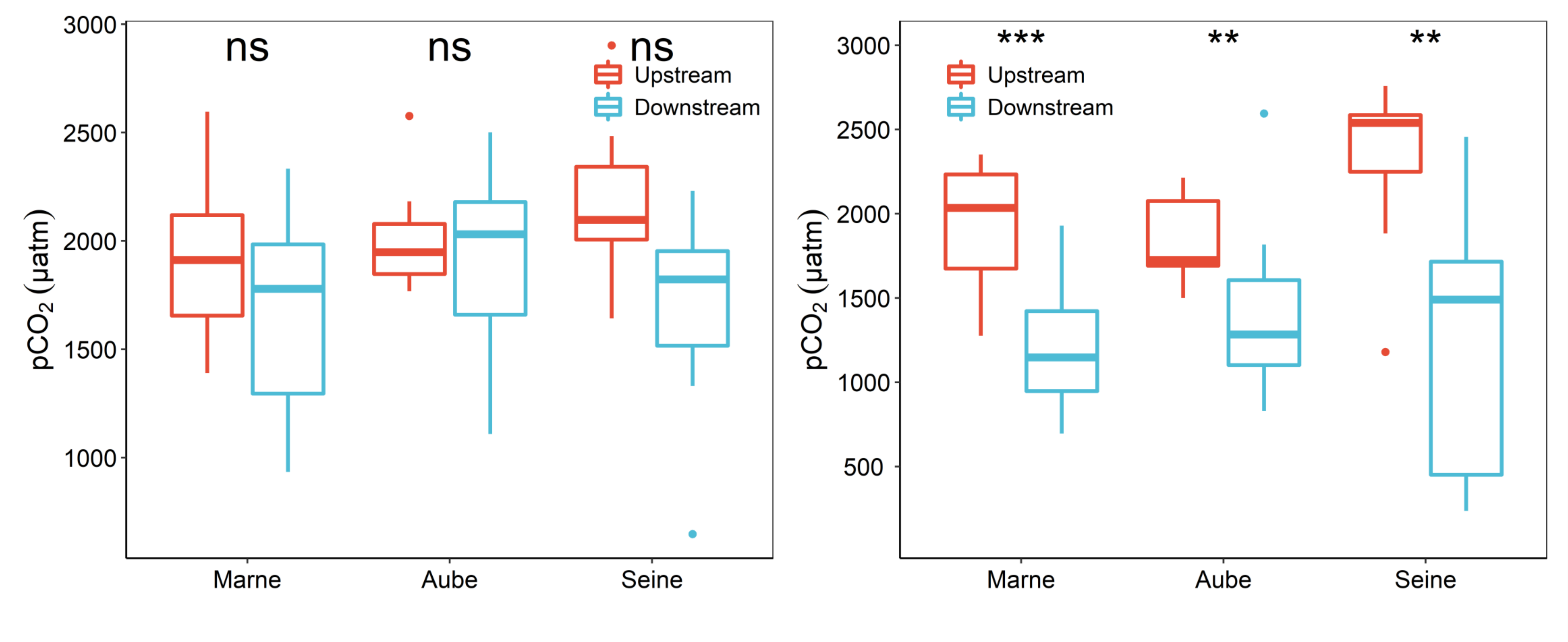
- ✓ Seasonal dynamics of pCO_2 in three reservoirs were similar
- ✓ High pCO_2 were observed in summer in rivers, while in winter and spring in reservoirs
- ✓ Reservoirs lowered pCO_2 in the downstream rivers during emptying period (from July to November)

➢ Results

2.2. Reservoirs lowered pCO_2 in downstream rivers during emptying period

A. Filling period: water entering reservoir

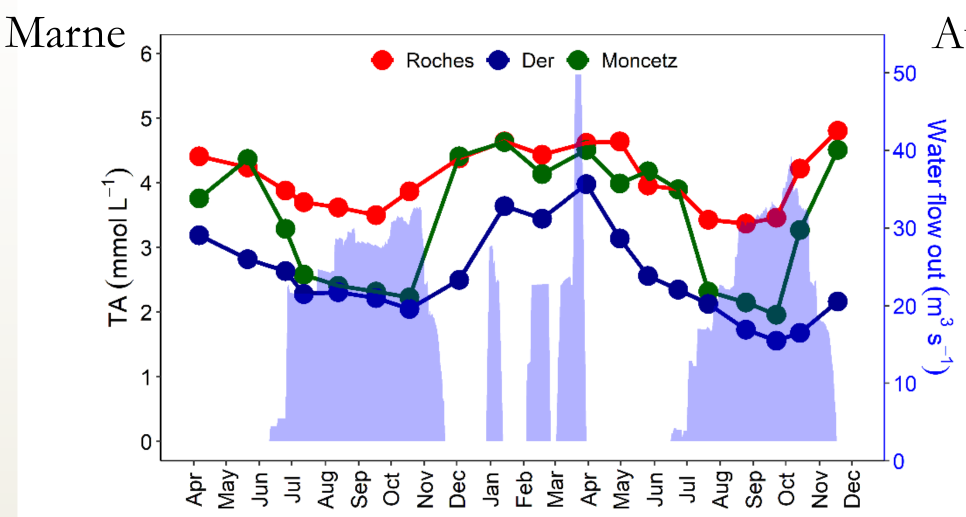
B. Emptying period: water leaving reservoir



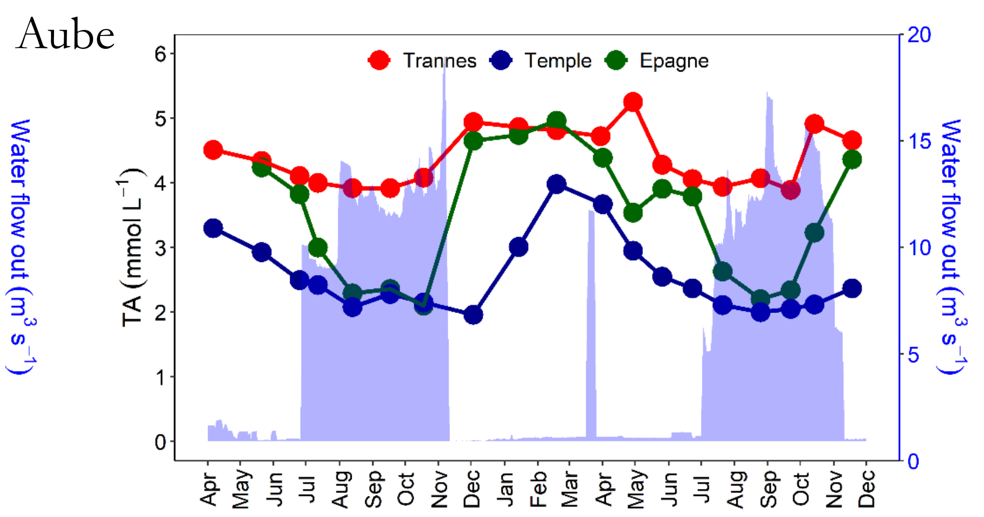
Results

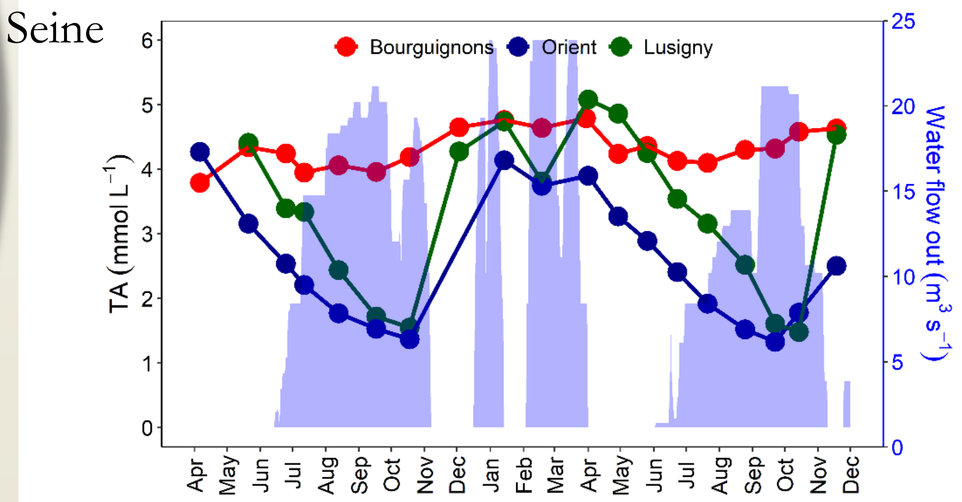
2.3. Reservoir changed water quality in downstream rivers

upstream→reservoir→downstream



upstream→reservoir→downstream



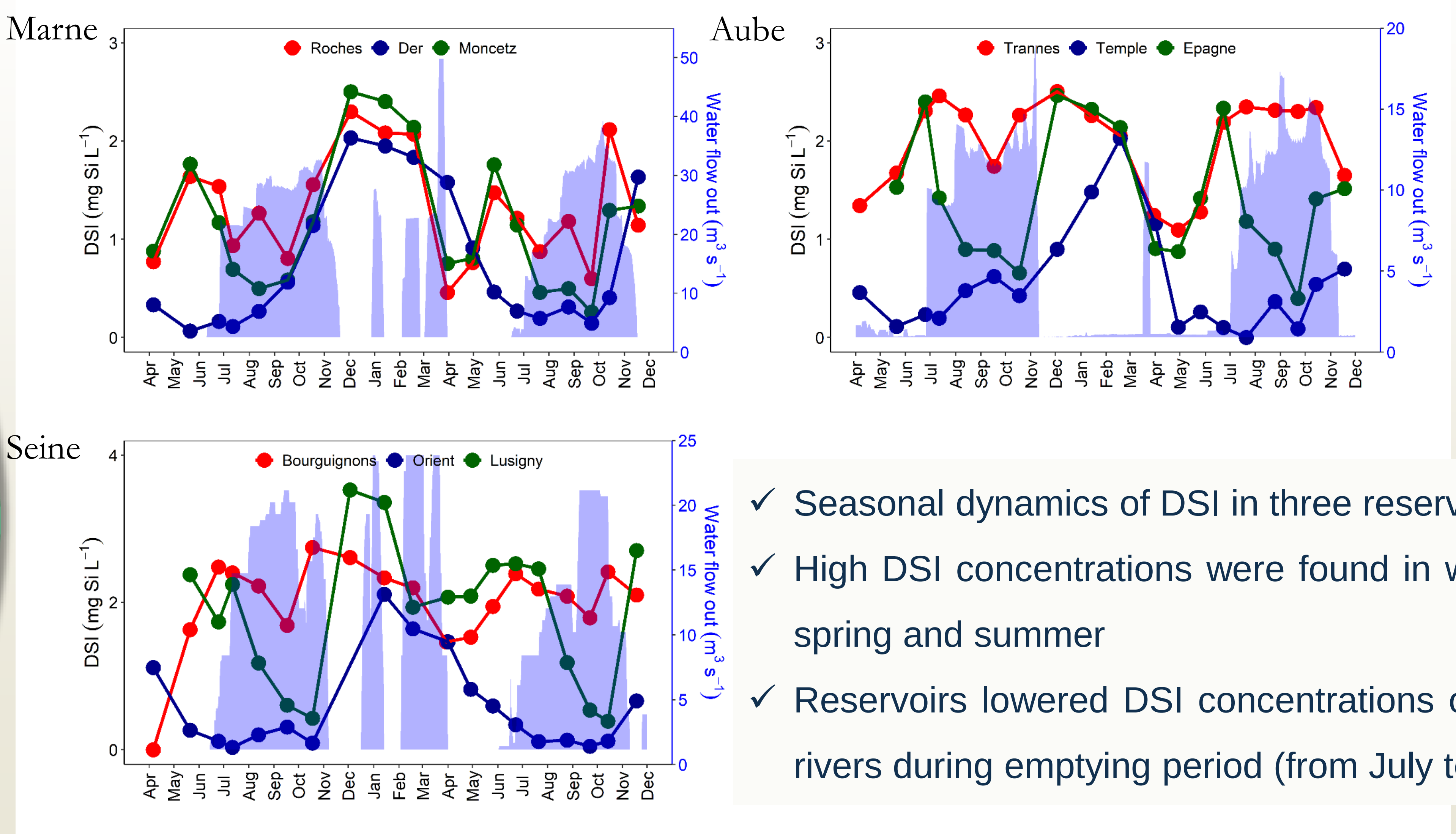


- ✓ Seasonal dynamics of TA in three reservoirs were similar
- ✓ High TA were found in winter, while low in summer
- ✓ Reservoirs lowered TA in the downstream rivers during emptying period (from July to November)

➢ Results

2.3. Reservoir changed water quality in downstream rivers

upstream→reservoir→downstream upstream→reservoir→downstream

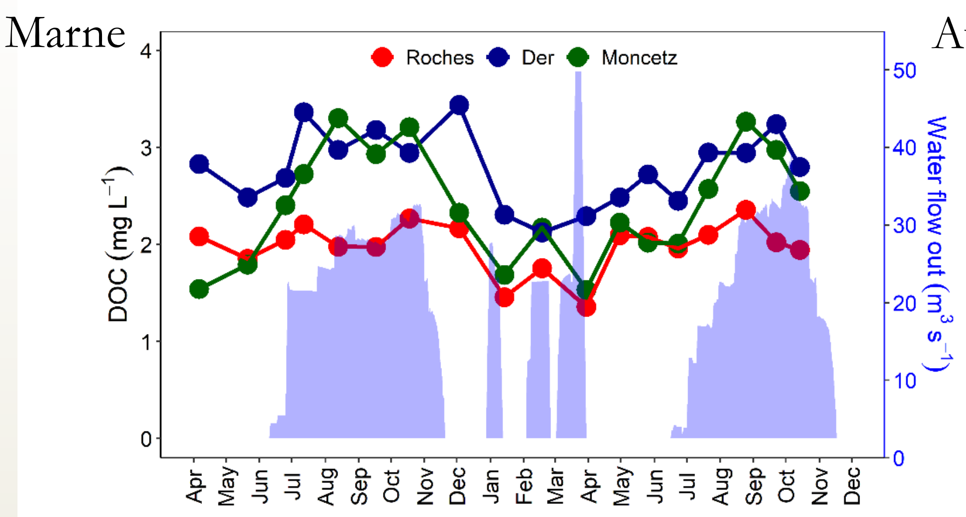


- ✓ Seasonal dynamics of DSI in three reservoirs were similar
- ✓ High DSI concentrations were found in winter, while low in spring and summer
- ✓ Reservoirs lowered DSI concentrations of the downstream rivers during emptying period (from July to November)

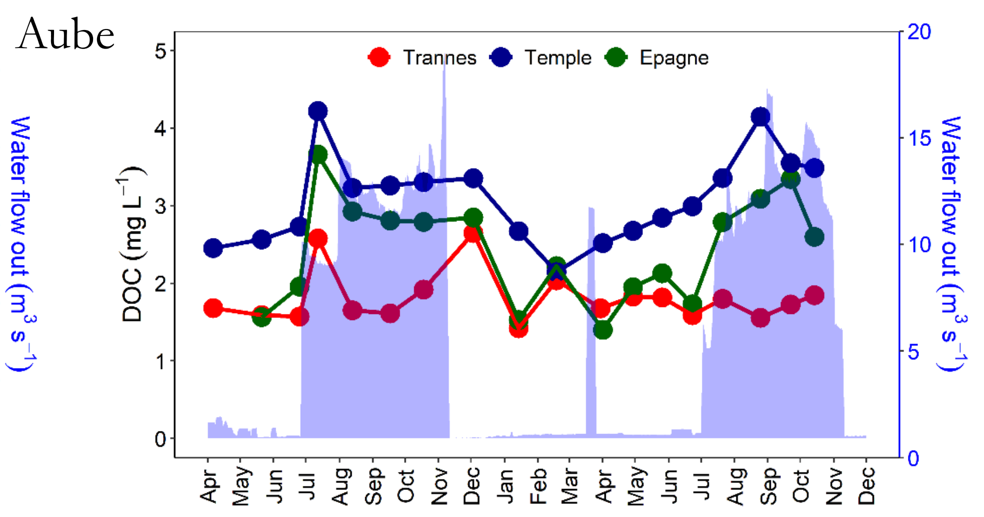
➢ Results

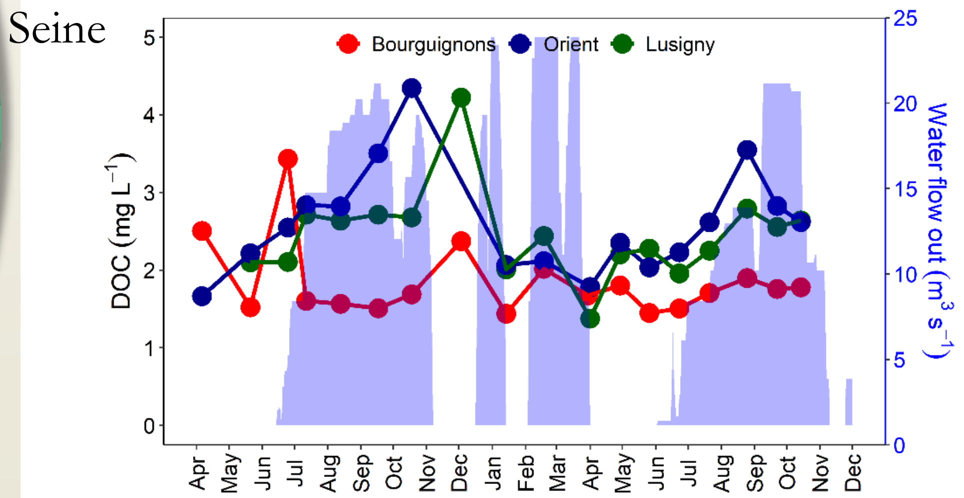
2.3. Reservoir changed water quality in downstream rivers

upstream→reservoir→downstream



upstream→reservoir→downstream



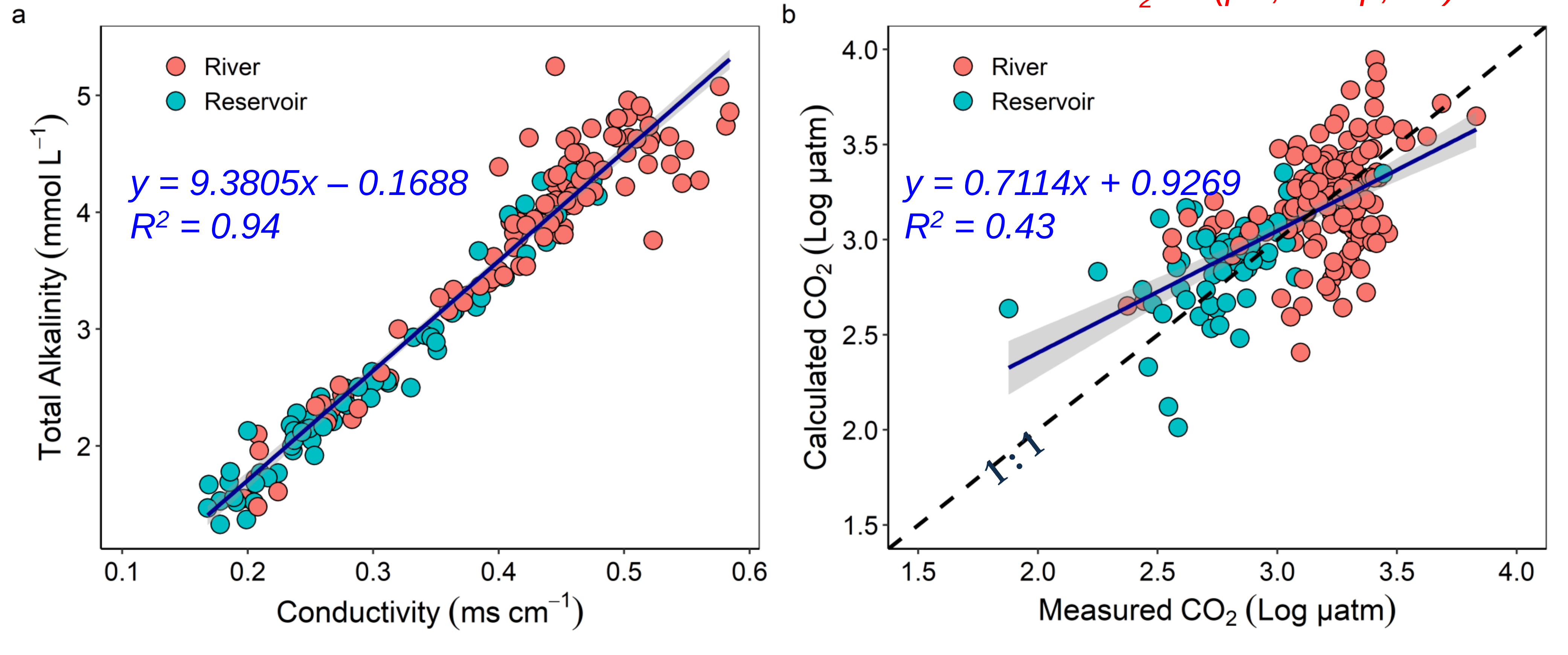


- ✓ Seasonal dynamics of DOC in three reservoirs were similar
- ✓ High DOC concentrations were found in summer, while low in winter
- ✓ Reservoirs increased DOC concentrations of the downstream rivers during emptying period (from July to November)

➢ Results

2.4. Feasibility of calculating long-term pCO_2 in three reservoirs

Calculated CO_2 = f (pH, Temp, TA)



Long-term water quality data

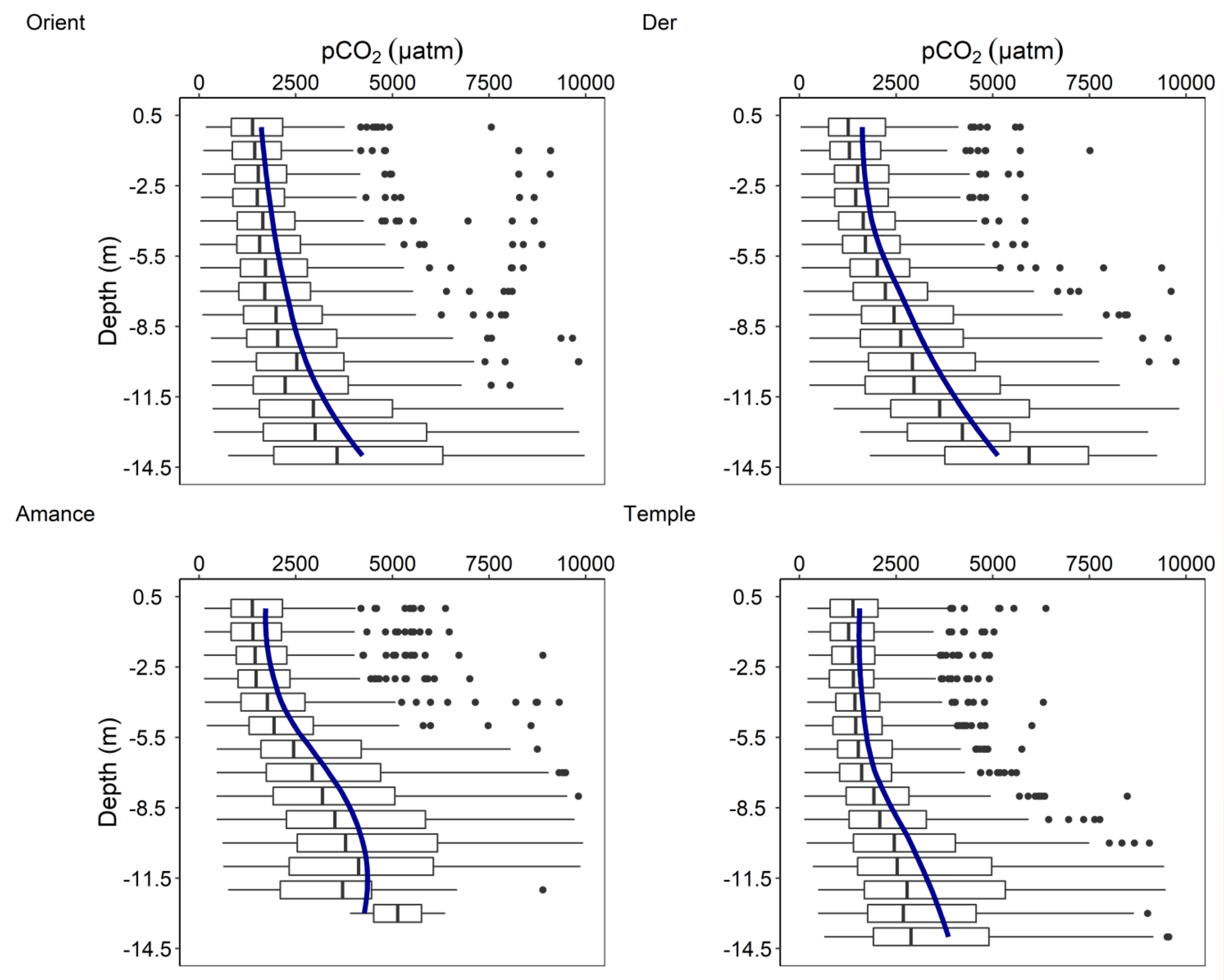
pH, EC, Temp…

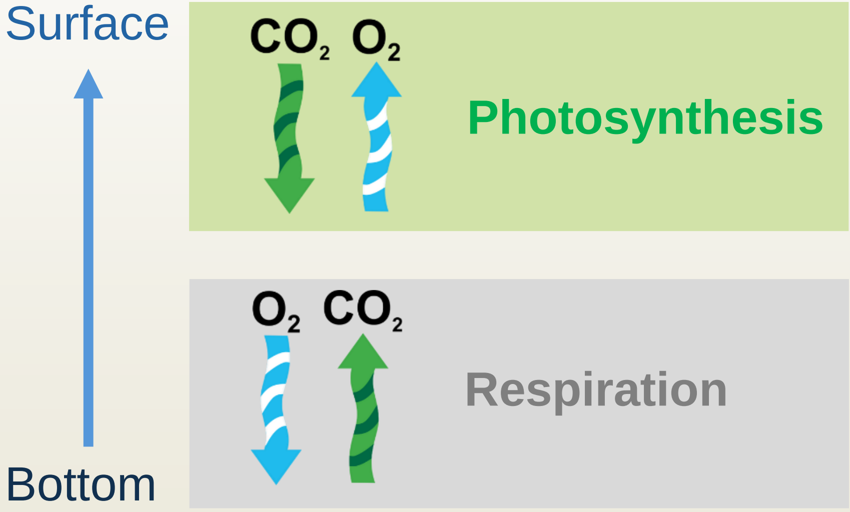
Calculate pCO_2

ç'est super !

➢ Results

2.5. Vertical patterns of pCO_2 in three reservoirs





Results

2.5. Vertical patterns of pCO_2 in three reservoirs

	Surface	Bottom
Date	Temple Lake (μatm)	Temple output (μatm)
2019-08-13	447	1062
2019-09-17	415	1182
2019-10-18	556	507
2020-07-21	573	2530
2020-08-25	1002	1486
2020-09-22	332	602
2020-10-14	323	424

CO_2 degassing in the release canal is also an important component of CO_2 emission from reservoir!

➢ Conclusions, perspectives and implications

Conclusions:

I. Similar seasonal dynamics of pCO_2 were observed in the Marne, Aube and Seine reservoirs and their related rivers during April 2019 to November 2020. Riverine pCO_2 were generally high in summer, which were contrast to reservoirs.

II. Three diverted reservoirs in the Seine Basin significantly lowered pCO_2 in downstream rivers during emptying period, and also changes water quality in the downstream rivers.

III. pCO_2 increased with increasing water depth, highlights importance of CO_2 degassing in the release canal of reservoirs.

IV. The potential impacts of precipitation changes in France under future climate change should be also evaluated by modelling approach, especially the hydrological changes and biogeochemical impacts of these reservoirs on their downstream rivers.

Je vous remercie pour votre attention !

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