# BLUEGEM

Biosphere and Land Use Exchanges with Groundwater and soils in Earth system Models

**April 3rd, 2024 – Plenary meeting**

**Next one on July 1st, 2024**

# Today's agenda

**1. Short synthesis by all teams (5 min each; with list of achievements, difficulties, and perspectives ; max 1 scientific result)**

- Agnès (BLUEGEM)
- Dan (MSU)
- Sherry (NTU)
- Julie (INRAe)
- Aglaé (IPSL)
- Agnès (IPSL)
- Min Hui (NTU)
- Yadu (NTU)
- Hyungjun (U Tokyo)
- Bertrand (IPSL)

Green: Coordination
Red: Social Sciences
Blue: Earth System Sciences
Purple : Interdisciplinary Sciences

**2. Feedback from stakeholders (5 min each)**

- OFB: Claire
- MRC: to be confirmed

**3. New results: comparison coupled simulations comparaisons (5 min each)**

- Min-Hui over SE Asia
- Pedro at global scale : No → Additionnal plenary meeting in July?

**4. Time for discussion on possible continuation, alone, together or with extended collaborations**

# Group picture

# Effective list of talks

**Short syntheses**
**(5 min each; with list of achievements, difficulties, and perspectives ; max 1 scientific result)**

- Agnès (BLUEGEM)
- Dan (MSU)
- Sherry (NTU)
- Julie (INRAe)
- Aglaé (IPSL)
- Yadu (NTU)
- Hyungjun (U Tokyo)
- Min Hui (NTU): 5-min synthesis + coupled model comparison over SE Asia
- Agnès (IPSL)
- Bertrand (IPSL)
- Claire (OFB)
- Duong Bui (MRC) : oral, no slides

# BLUEGEM in numbers

- **Plenary meetings**: 11 + 1 today
- **Science papers**: 11 published + 1 submitted + 3 in prep
- **International conferences**: 27 communications + 2 organized sessions (IAH/UNESCO 2022; AGU 2023)
- **National conferences**: 8
- **Hired post-docs**: at least 5 (Elodie, Amar, Koichi, Pedro, Peng)
- **PhD theses**: 2 defended (Tamanna & Pedro in 2023); 3 in progress (Tanjila, Julie, Pierre)
- **Master students**: 3 at IPSL + ?
- **Franco-Taiwanese Great Prize** : 1

Please update on:
https://docs.google.com/document/d/1rkwlbirG7P9Rx60uuNVKmfIgAHtIwlYJqNdA23hReKo/edit

# Initial plans…

| Tasks | Domain | Leaders | t1 | t2 | t3 | t4 | t5 | t6 | t7 | t8 | t9 | t10 | t11 | t12 | Gets info from |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **T1** - Project coordination | All | AD | | | | | | | | | | | | | T4F,T4M |
| **T2.1Ga** - ORC Development: soil carbon | Global | BG | DONE | | | | | | | | | | | | |
| **T2.1Gb** - CLM5 Development: water management | Global | MHL,YP | | | | | | | | | | | | | |
| **T2.1F** - ORC-HR: calibration | France | AD,PP | | | | | | | | | | | | | |
| **T2.1M** - CLM5-HR: calibration | Mekong | YP | | | | | | | | | | | | | |
| **T2.2G** - Factorial ESM simulations over 1900-2100 | Global | MHL | | | | | DONE | | | | | | | | T1 |
| **T2.2FM** - Downscaling over France & Mekong | F&M | HK | | | | | | | | | | | | | T2.2G |
| **T2.2Fa** - HR ORC simulations | France | AD,JP | | | | | | | Analysis in progess | | | | | | T2.1M,T2.2FM,T3F,T4F |
| **T2.2M** - HR CLM5 simulations | Mekong | YP | | | | | | | | | | | | | T2.1F*,T2.2FM,T4M |
| **T2.2Fb** - Run-time bias-corrected simulations | France | FC | | | | | | | | Not done | | | | | T1,T2.2FM |
| **T2.3a** - Model benchmarking | All | HK,MHL | | | | | | | | | | | | | T2 |
| **T2.3b** - Trend attribution, land-atmosphere feedbacks | All | MHL,FC,HK | | | | | Analysis in progress | | | | | | | | T2 |
| **T2.3c** - Impact assessment (water, soil C, biosphere) | All | YP,BG,HK | | | | | | | | | | | | | T2 |
| **T3F** - Agro-economic scenarios of LU & irrigation | France | PAJ,AD | | | | | | | In progress | | | | | | T1,T4F,T2.2G,T2.2.Fa,T5a |
| **T3Ma** - Hotspots and bright spots of farmer behavior | Mekong | DK | | | | | | | | | | | | | T2.2M,T2.3c,Other Project |
| **T3Mb** - Farming futures and social-ecological | Mekong | DK,SYK | | | | | | | | | | | | | T2.2M, T2.3c |
| **T4G** - Workshop on GW-irrigation management | Global | AD,AJ | | | | | | | | | To be done | | | | T2.3,T5a,T4FM |
| **T4F** - Plausible storylines of LU-GW management | France | AJ,CM | | | | | | | In progress | | | | | | T2.3,T3Fb,T5a |
| **T4M** - Participatory GIS and cultural mapping | Mekong | DK,YP,SYK | | | | | | | | | | | | | T2.2M,T2.3c,Other Project |
| **T4FM** - Comparison of the two focus areas | F&M | AD,YP | | | | | | | | | | | | Not done | T2.2, T2.3, T3, T4F,T4M, |
| **T5a** - Preparation of selected variables and indicators | All | HK,PP | | | | | | | ?? | | | | | | T2.2,T3F |
| **T5b** - Data storage and exchanges within project | All | HK,MHL | | | | | | | | | | | | | T1,T2.2, T2.3, T3,T4,T5a |

# BLUEGEM Plenary

Daniel Kramer

April 3, 2024

# Achievements

# Achievements

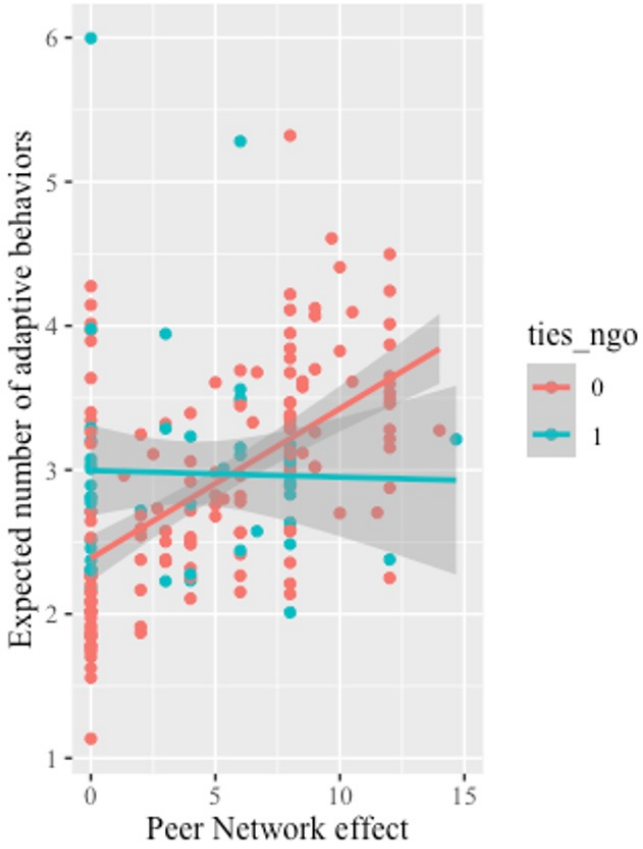
## Papers in Preparation

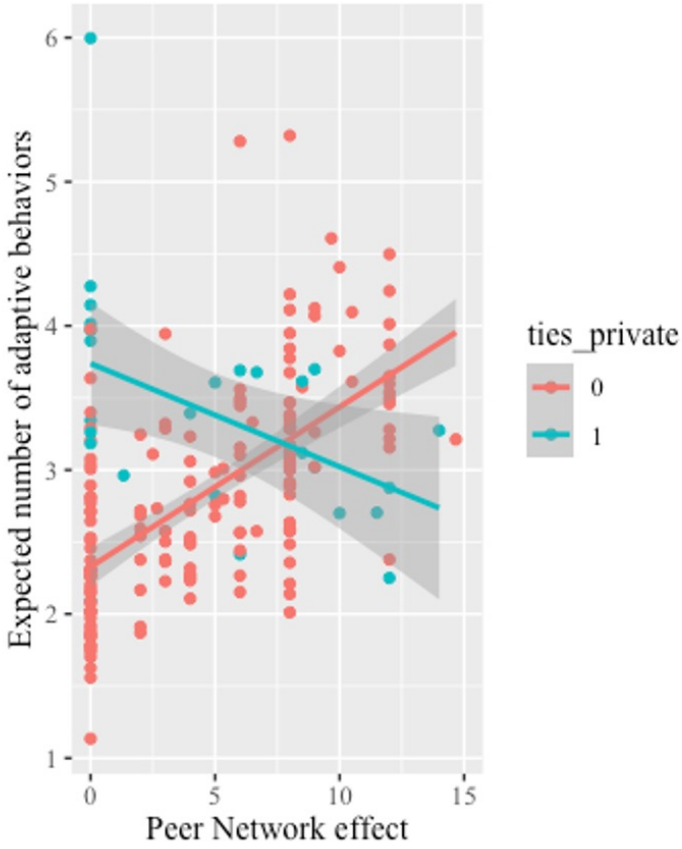
- *A performance comparison of objective versus perception-based resilience measures in Cambodian farming communities* (Graucob & Kramer)
- *A social network analysis of Cambodian farmers' adaptive behaviors to climate risks* (Sainjoo & Kramer)
- *Farmers' assessment of drought risk in irrigated and flood pulse communities in Cambodia* (Sainjoo & Kramer)

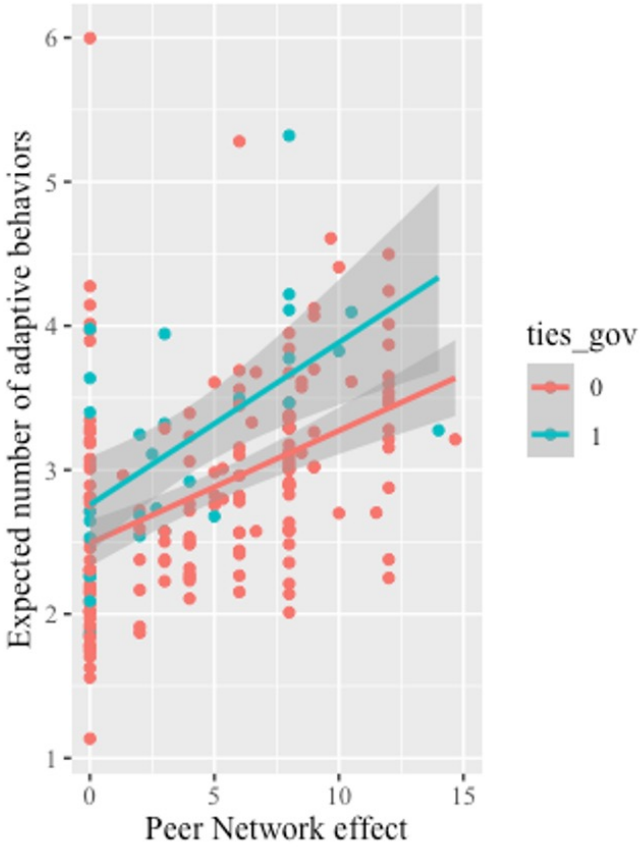
# Challenges

- Fieldwork done under different grant (timelines, data collection choices etc.)
- Data availability
- Data reliability
- Data processing (e.g., transcription) is slow!
- Temporal and spatial scale compatibility issues with hydrological models/data

# Research Result



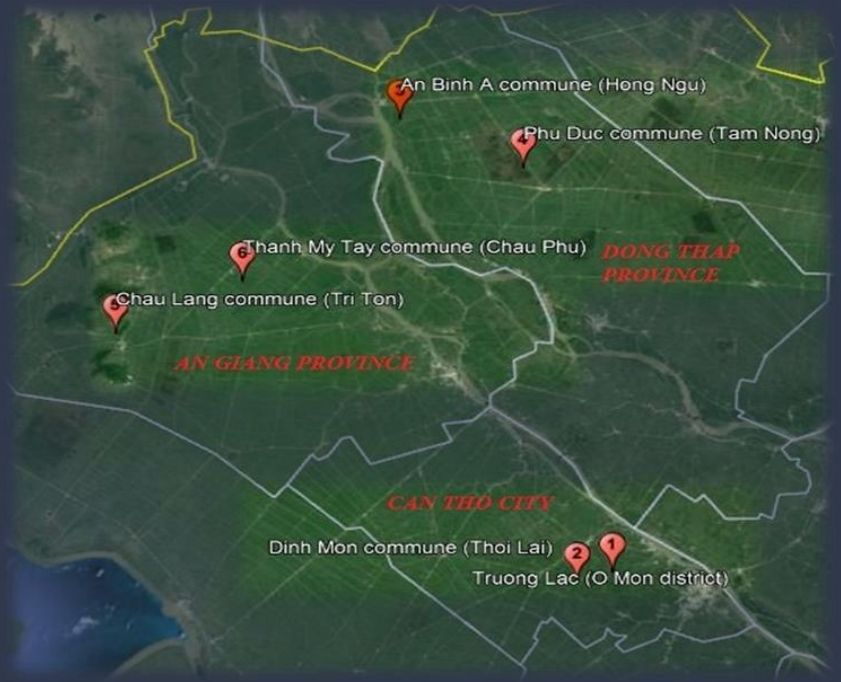
# Mekong Delta Field Study
# Execution Summary Report

- Part I: Climate Change and Drought Perception (Oct. 2023)
- Part II: Agricultural and Irrigation (Apr. 2024)

Minhui Lo, Sherry Kuo
Renjie Wu, Becca Ferguson, Yu-Sheng Yang

National Taiwan University; Academia Sinica
Bluejem Project

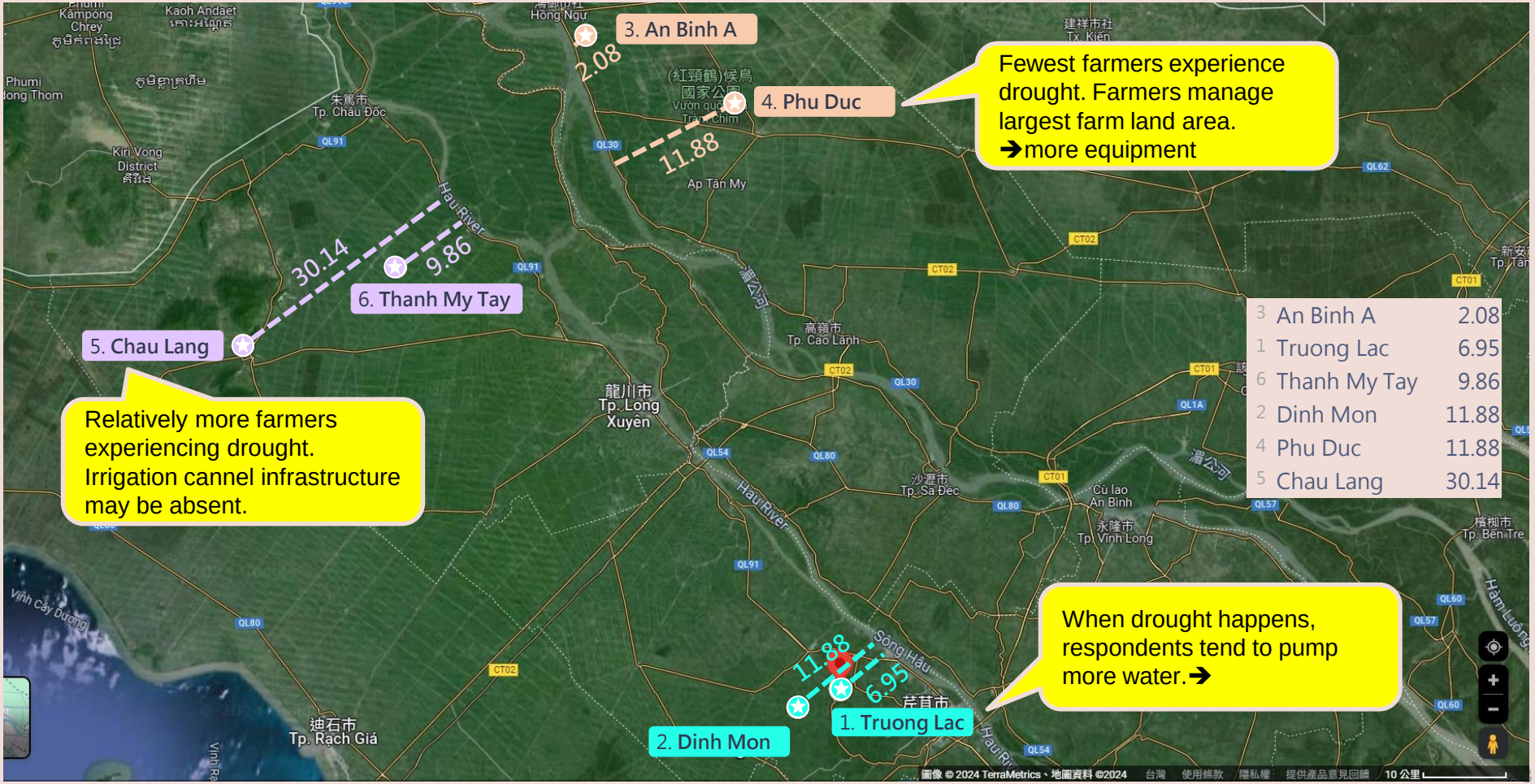
# Field Study Introduction




- **Why?**
  - To investigate local farmers' perspectives regarding climate change/ drought, water resource, irrigation and agriculture behaviors.
    - **Local survey X Model simulation**
- **When?**

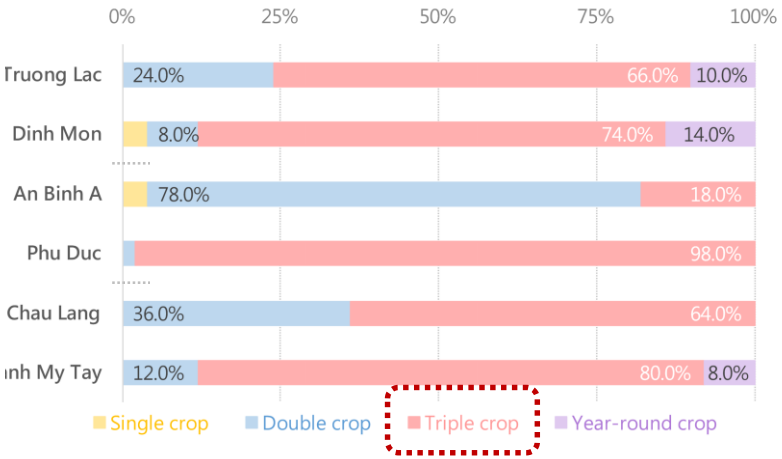
  May 5-May 10, 2023
- **Who?**
  - National Taiwan University.
  - Vietnam National University Ho Chi Minh City University of Science
- **Where?**
  - Mekong River upper delta➔ 3 Province, 6 Commune
- **How?**
  - Face to Face interview
  - Convenience Sampling
  - Household Sampling

# Proximity Matters to drought.

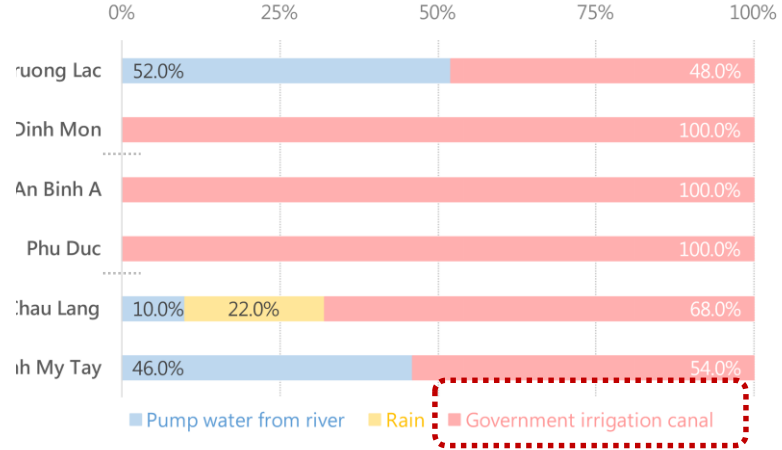


# Farming Practice

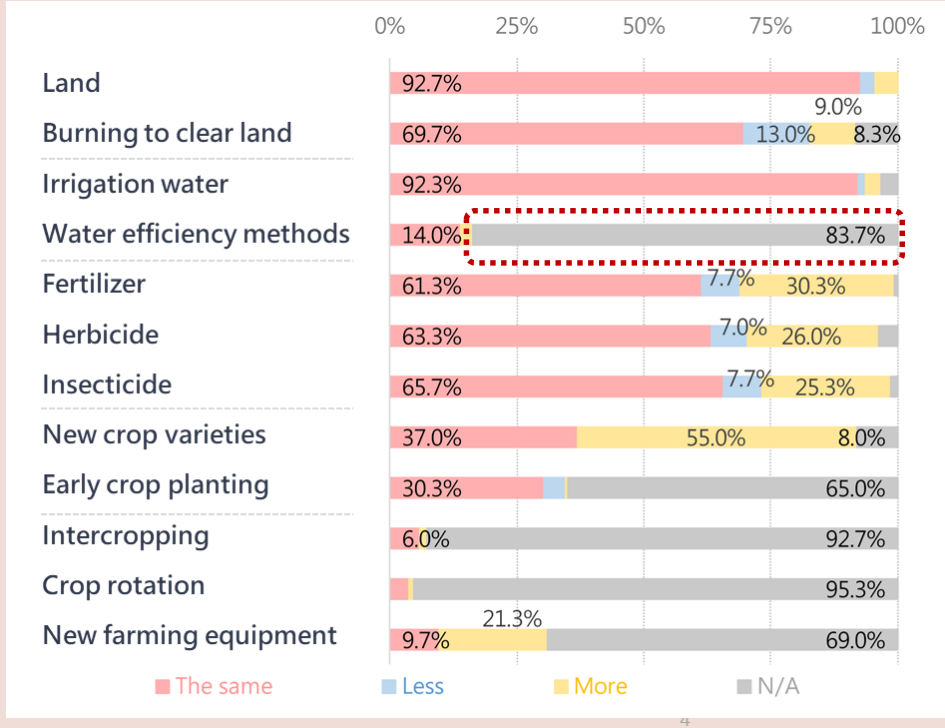
**Crop season**



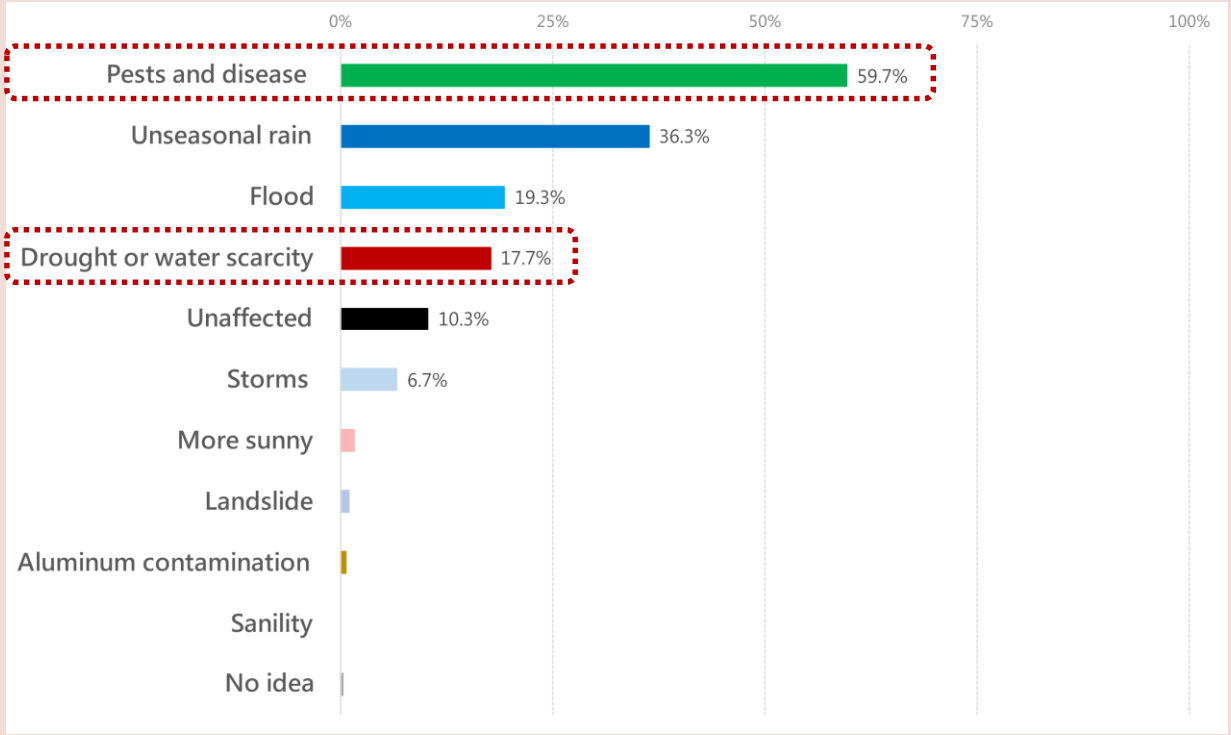

**Irrigation source**




## When compared to your farm practices of a few years ago, do you use more, less, or about the same of the following

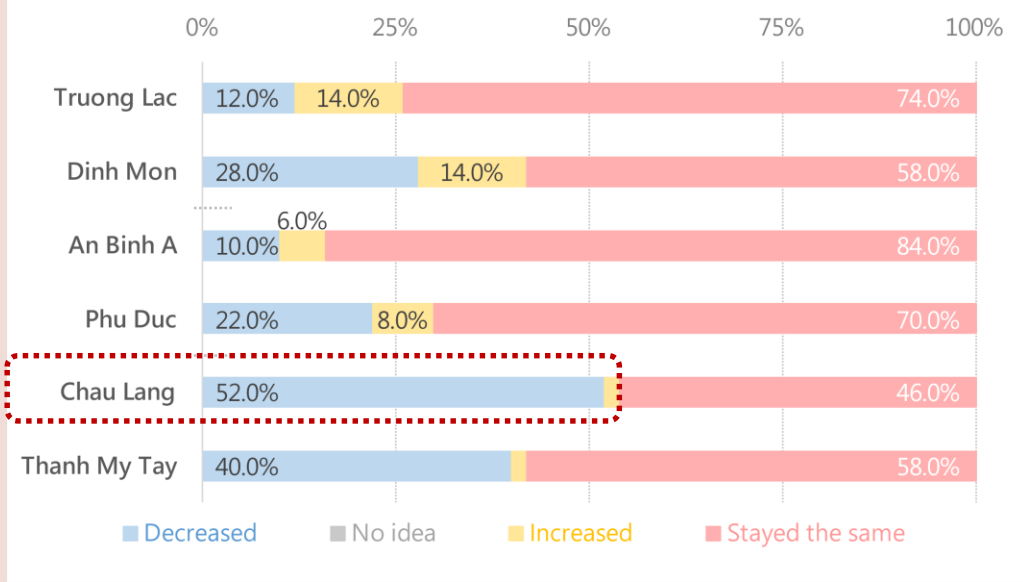


# Which of the following problems have you and your family faced in the past few years? (multiple)

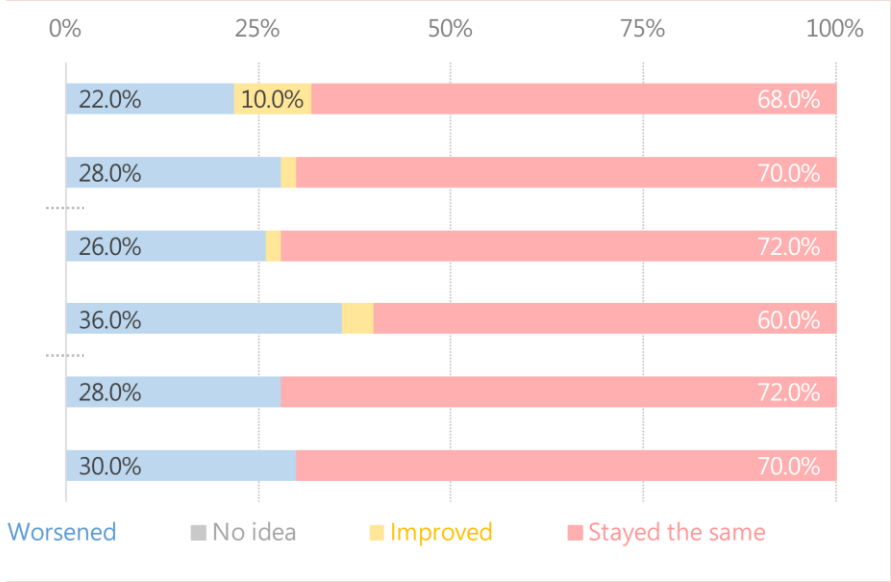



1. Pest and disease >>> unseasonal rain and flood >> drought or water scarcity.
2. Drought is not a common problem…for now, yet some communes already suffered from it (Chau Lang ➔ farthest from the main river).

## How has water availability changed over the past 5 years




## How has water quality changed over the past 5 years




1. Water availability: Chau Lang, Thanh My Tay and Ding Mon felt decreased.
2. Water quality: 22 - 36% participants in each communes felt worsened.

# Age and education vs drought-related attitudes

| | Below primary school<br>Mean ± SD | Secondary school<br>Mean ± SD | Above high school<br>Mean ± SD |
|---|---|---|---|
| Climate change is happening. | 3.8 ± 1.3 [a] | 4.1 ± 1.1 [ab] | 4.3 ± 0.6 [b] |

| | 20-39yr<br>Mean ± SD | 40-49yr<br>Mean ± SD | 50-59yr<br>Mean ± SD | 60-69yr<br>Mean ± SD | ≧70yr<br>Mean ± SD |
|---|---|---|---|---|---|
| How worried are you about the effects of drought on you and your farm in the near future? | 4.0 ± 0.8 [a] | 4.3 ± 0.6 [ab] | 4.2 ± 0.8 [ab] | 4.4 ± 0.5 [b] | 4.3 ± 0.5 [ab] |

1. Farmers with Higher education recognize more on climate change.
2. Older farmers are more worried about the effect of drought.

1. One-way ANOVA and post hoc test: Scheffe's method (p value< .05).
2. Letter a and b: different letter indicated difference of groups reached significance.

# Factors vs drought-related attitudes

| | Not rice farmer | Rice farmer |
|---|---|---|
| | Mean ± SD | Mean ± SD |
| Drought causes reduction in food production. | 3.9 ± .6 a | 4.3 ± .8 b |

| | Not householder | Householder |
|---|---|---|
| | Mean ± SD | Mean ± SD |
| Climate change is happening. | 4.3 ± .8 a | 3.9 ± 1.2 b |

1. Rice Farmers recognize more on drought.
2. Non-householder recognize more on climate change.

1. T-test (p value< .05).
2. Letter a and b: different letter indicated difference of groups reached significance.

# Water availability vs drought-related attitudes

| | How has water availability changed over the past 5 years | | |
|---|---|---|---|
| | Decreased | Stayed the same | Increased |
| | Mean ± SD | Mean ± SD | Mean ± SD |
| How worried are you about the effects of drought on you and your farm in the near future. | 2.5 ± 1.4 a | 2.1 ± 1.1 b | 2.3 ± 1.4 ab |
| How likely is it that you and your farm (cropland and livestock) will experience drought or water shortages in the near future. | 2.7 ± 1.4 a | 2.0 ± 1.3 b | 2.2 ± 1.4 ab |
| If drought or water shortages occur in the near future, how severe will your crop loss be. | 2.1 ± 1.2 a | 1.5 ± 0.9 b | 1.5 ± 1.0 ab |
| Drought causes reduction in household income. | 4.3 ± 0.7 a | 4.2 ± 0.7 ab | 3.9 ± 0.9 b |

1. Farmers with the perception of decreased water availability are more worried on drought.

1. One-way ANOVA and post hoc test: Scheffe's method (p value< .05).
2. Letter a and b: different letter indicated difference of groups reached significance.

# Model Simulation

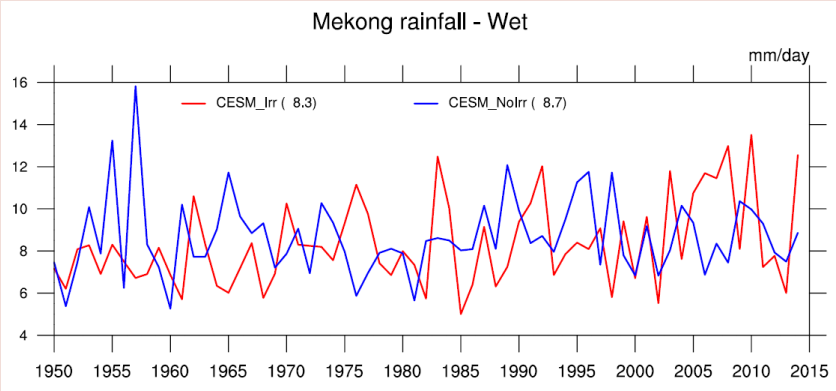
**(0.9 X 1.25 degree)**

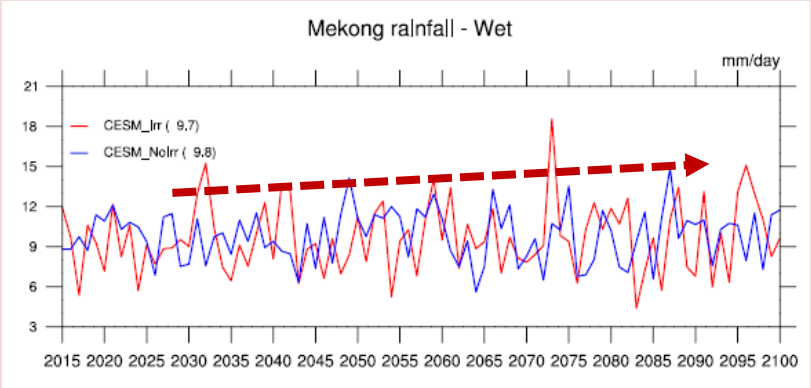
# Seasonal Precipitation

## Historical

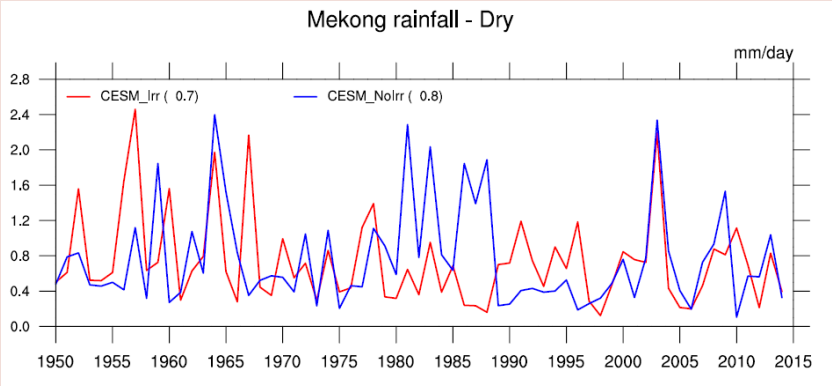
## Future

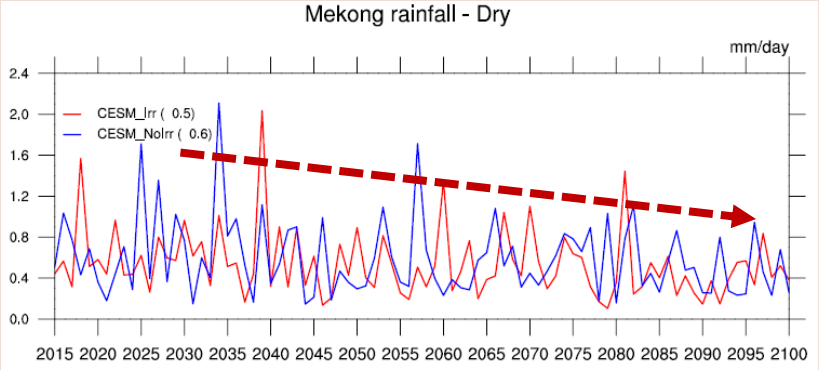
**Wet Season**



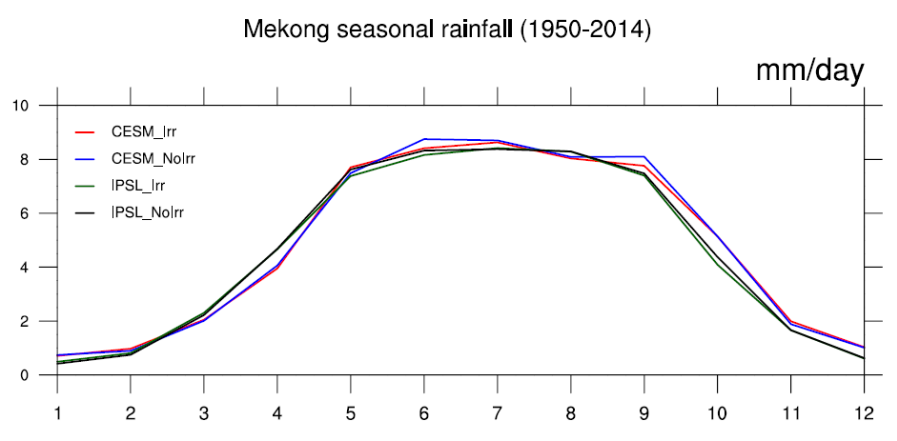



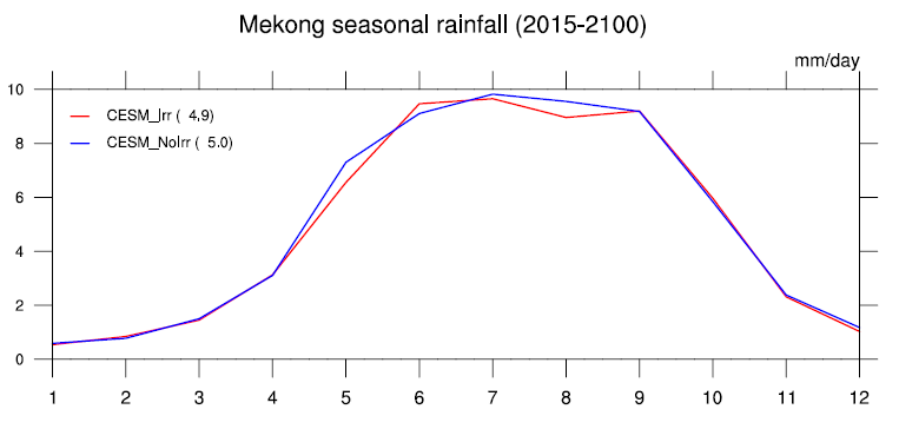

**Dry Season**

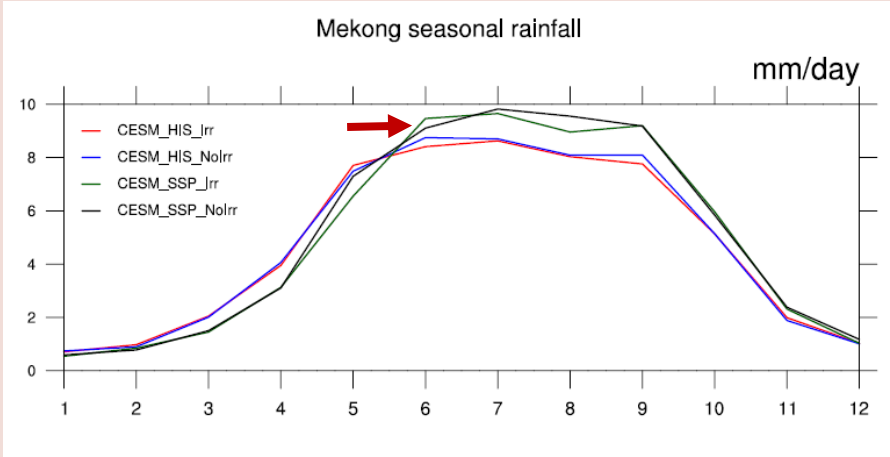


# The Shift of Wet Season?



**Achievement**

- ✓ A Perception Survey Study of the farmers in the Upper Delta.

**Hypothesized Perspective**

- ✓ Climate projection data shows there is a drying trend in terms of precipitation and river flow in the Mekong River Delta, but the local farmer do not demonstrate sufficient level of problem recognition and preparedness toward drought. Hence, the adaptation strategies have not been addressed properly.

- ◻ Further simulation results with the higher resolution in the future scenarios are needed to support the hypothesized perspective.

# Cross-influence of climate and environmental policies on the development of irrigation in France: towards a regional-scale modeling by coupling agro-economic, biophysical, and hydrogeological constraints.

Julie Reineix

PhD supervised by Agnès Ducharne (dir), Stéphane De Cara (dir) and Pierre-Alain Jayet

April 3, 2024

# Objective and Achievements

**Objective :**

- Studying **changes in agricultural practices** and **land use** in metropolitan France in the face of climate change, while considering a **water withdrawal** that would be **sustainable**.

**Achievements:**

- Integration into AROPAj of the ability to **distribute available water** among farmers **within the same region**, to calculate the **price of water**, and the resulting change in land use based on a certain water availability *(BLUEGEM plenary meeting of July, 5 2023)*.
- Implementation of a **simulation set** with 6 climatic years (2050 to 2100 in 10-year intervals) based on 7 calibration years as outlined below.

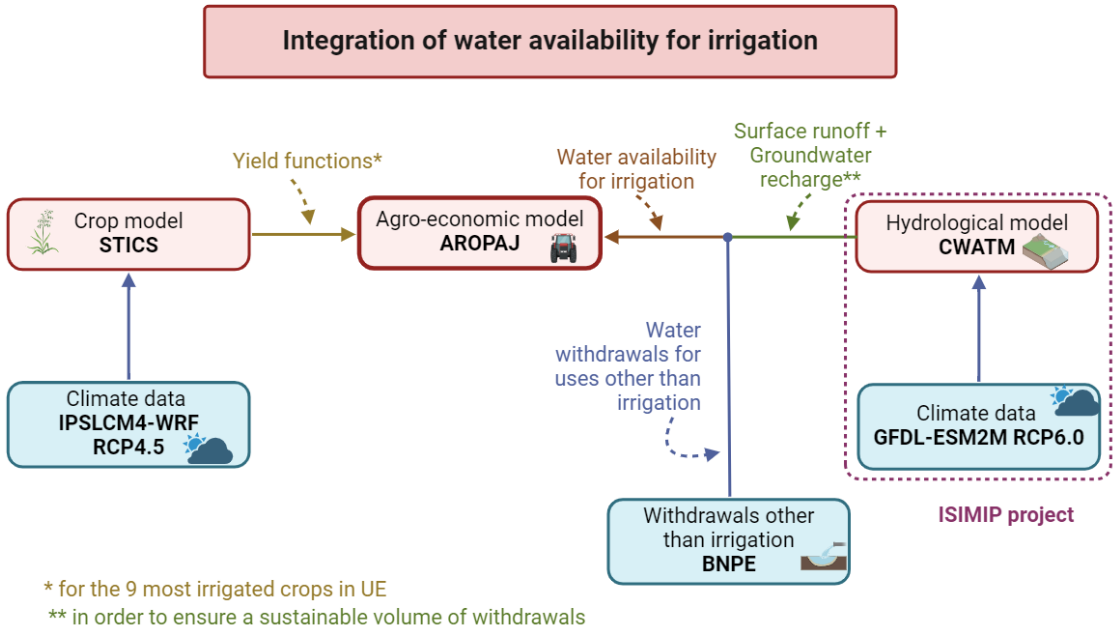
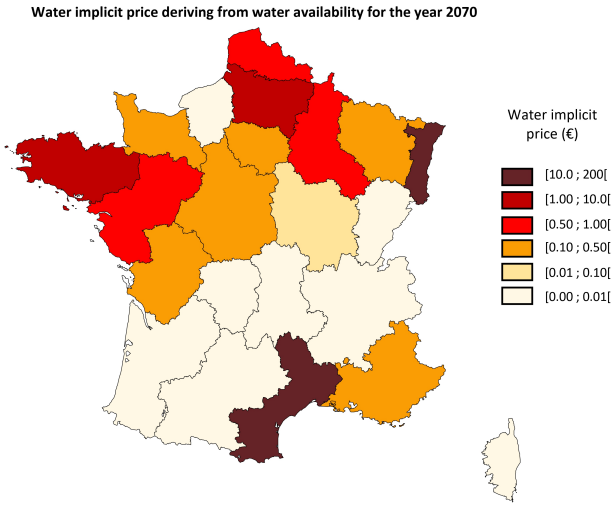



Figure: Methodological approach for integrating water availability, aligned with climate data already incorporated into AROPAj.

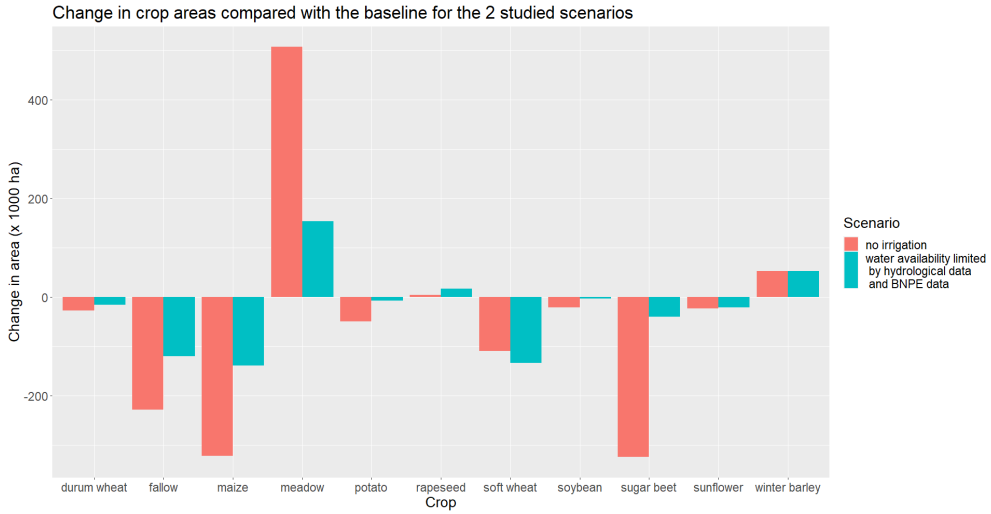
# Results

**Results :**

- Possible scenarios of **agricultural land use**.
- A regional-scale **study of water scarcity** for irrigation, accompanied by a calculation of the implicit **price of water** based on a prescribed irrigation water availability.
- A comparison of 2 scenarios with a baseline (infinite physical availability of water) : (1) a **water availability** corresponding to the hydrological and climate data integrated; (2) an **irrigation ban**.




(a) Regionalized water implicit price in €




(b) Agricultural land use change for the 2 scenarios, compared with a baseline without water constraints (x1000 ha).
In pink : no irrigation allowed; in blue : water availability calculated according to the previous methodology

Figure: Exemples of results for the climatic year 2070 of the IPSLCM4-WRF data. Shown here is the mean of the results obtained for the 7 calibration years.

# Perspectives and difficulties

**Perspectives :**

- Analysis of the results obtained, particularly at the **regional level**, by averaging over the calibration years.
- Examination of the **influence of the calibration year** on the results obtained, particularly on irrigation (presence/quantity), all else being equal.
- Outside of the thesis scope: selecting **different climatic data**, drier and warmer, and **expanding the range of irrigable crops**.

**Difficulties :**

- Trade-off between complexity/computational time and actual needs, particularly regarding the choice of climatic data. Do we want to prioritize **realism** or solely study the **influence of one parameter** (rainfall) on agriculture? In which case, it would suffice to manipulate only that parameter. However, this leads to inconsistency with other climatic variables.
- The agro-economic model is inherently biased (like every model involving human/social components). Crops that can be irrigated correspond to the most irrigated crops currently. It is challenging to incorporate a likely **evolution of prices**, **technologies**, and **societal and political ideas** in general. This implies that our conclusions are likely flawed.
- Difficulties to integrate the **differences in land use** between the models used, and the **water uses** already accounted for.
- Technical difficulties

# Storyline of extreme droughts in France

Aglaé Jézéquel

BLUEGEM – 03/04/2024

# Storylines of extreme droughts in France

Aglaé Jézéquel - LMD

Agnès Ducharne - METIS

Claire Magand - OFB

Nathan Humbert
6 months internship - 2023

Matthieu Belin
6 months internship - 2024

# Storylines of extreme droughts in France

- Interviews with French water management stakeholders

  -> Inspiration for a perspective on attribution of extreme events to different anthropogenic factors

  *Broadening the scope of anthropogenic influence in extreme event attribution – Jézéquel et al. (submitted)*

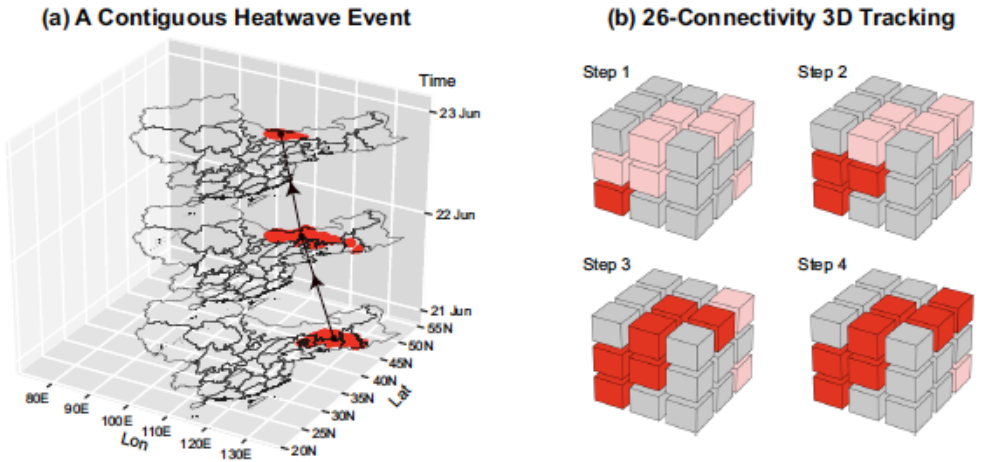
- Analysis of regional climate models with an event perspective

  -> SPI and SPEI-based catalogue of spatio-temporal droughts over France -> Nathan Humbert's internship

  -> Selection of the worst ones in future climate scenarios (RCP 8.5)

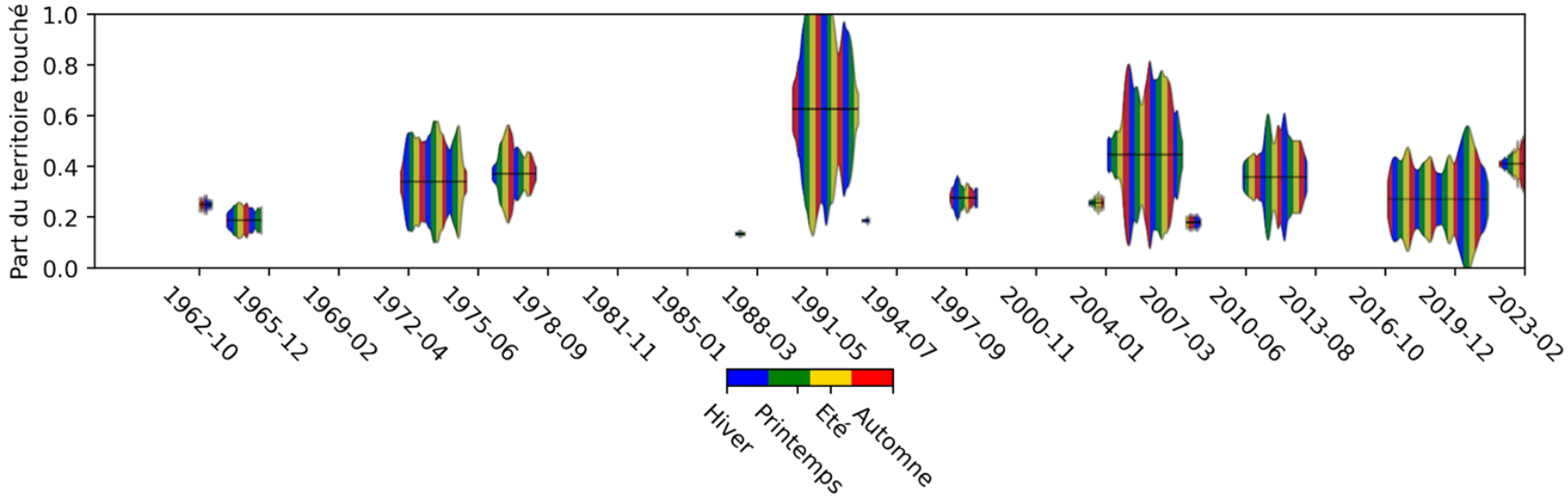
  -> Looking at other variables (SSWI, SRI) -> Matthieu Belin's internship

# Some results – SPI and SPEI-based storylines

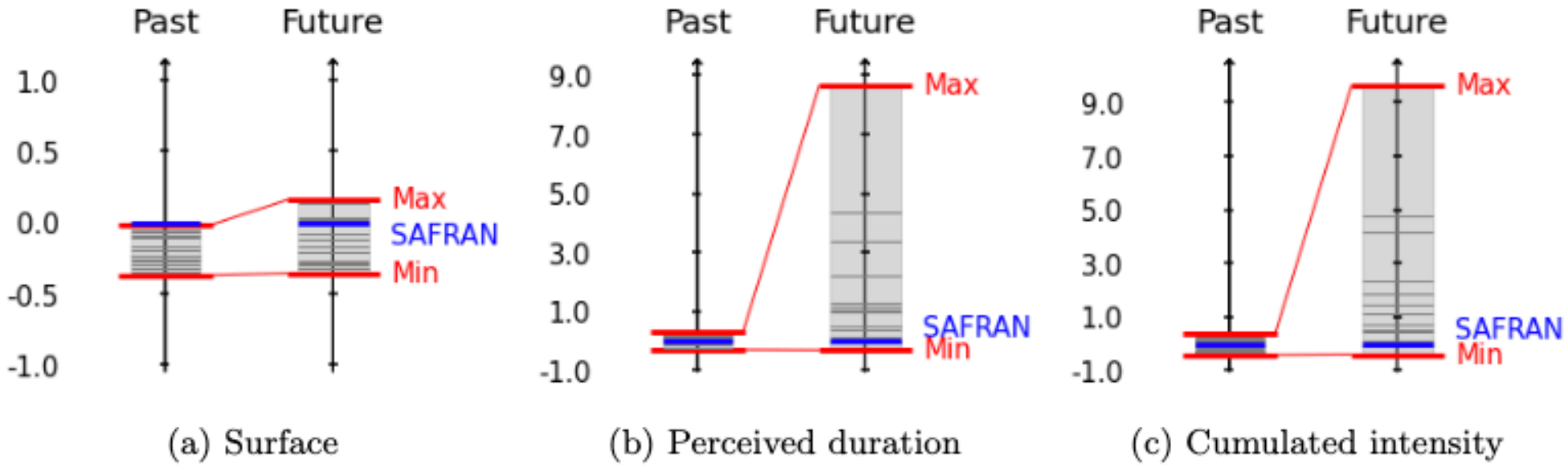



Method – Connected Components 3D applied for dry points over France (SP(E)I<-1)
-> construction of a catalogue of spatio-temporal droughts

-> After some filtering for SPEI 24 for SAFRAN (French reanalysis)



# Some results – SPI and SPEI-based storylines




(a) Surface (b) Perceived duration (c) Cumulated intensity

Worst events for each model and observations (SAFRAN) based on cumulation intensity and calculated with SPEI24

# Perspectives

- Paper on SPI and SPEI-based storylines of extreme droughts in France
- Chaire MACIF in collaboration between geosciences and social sciences
  - PhD grant to better understand the links between meteorological, agricultural and hydrological droughts in the context of storylines
  - Postdoc in social science to work on sharing water ressources during droughts in a changing climate with input from climate and hydrology-based storylines

# BLUEGEM Summary

**Presenter-**

**Yadu Pokhrel, PhD**

*Associate Professor*

*Department of Civil & Environmental Engineering*

MICHIGAN STATE
UNIVERSITY

# Students / postdoc supported

Amar Deep Tiwari

**Postdoc Scholar**

2022-

Tamanna Kabir

PhD Student

2019-2022

Tanjila Akhter

PhD Student

2021-

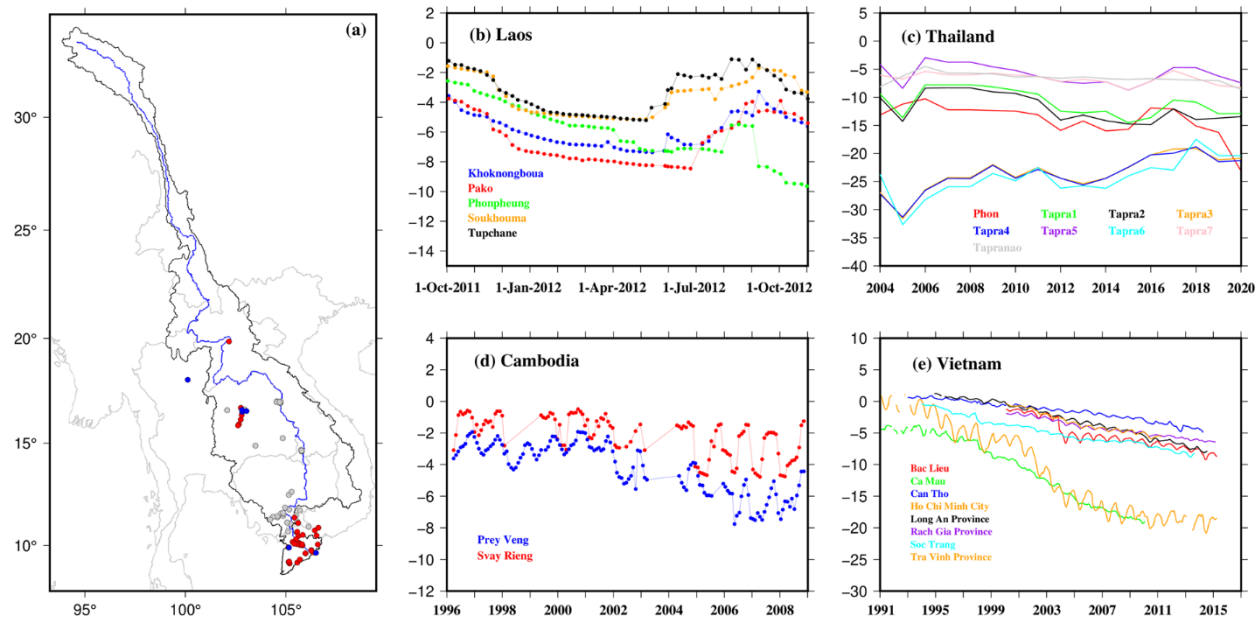
# Overall activities

## Conferences:

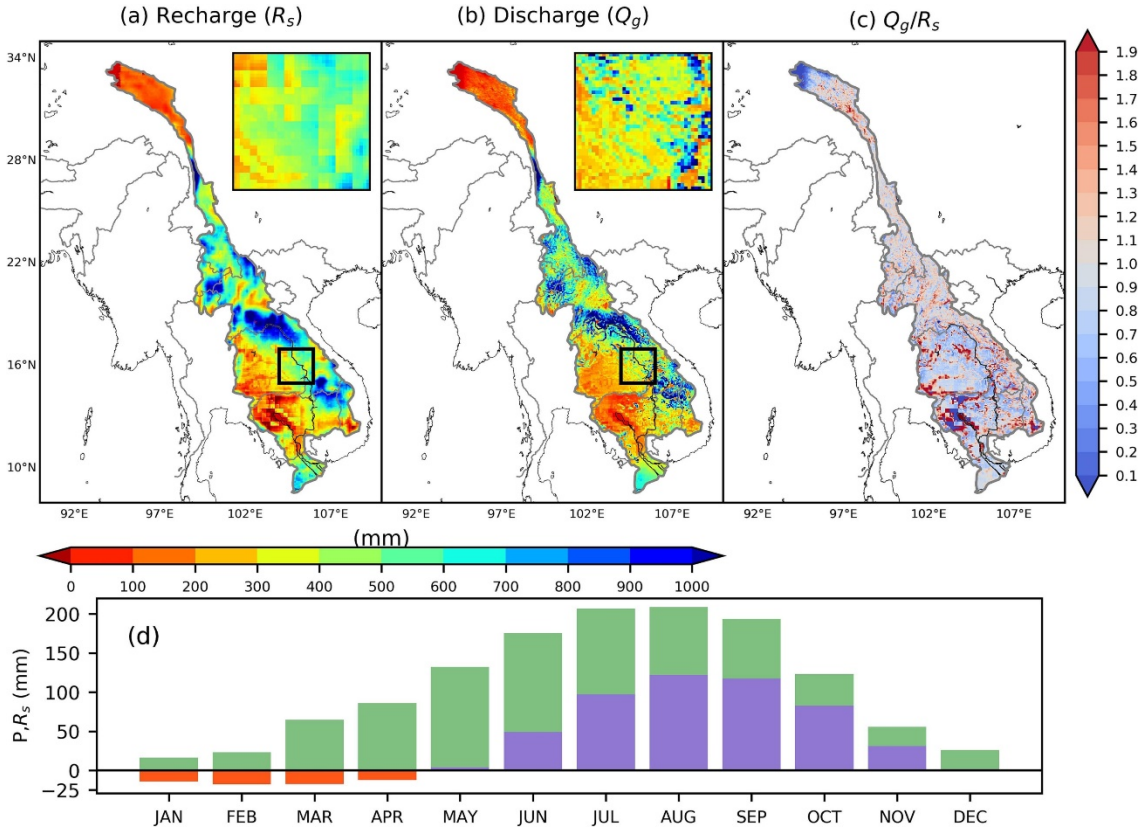
- Tiwari, A. D., Pokhrel, Y., Kramer, D., & Akhter, T. (2022, December). A synthesis of climate, water, food, energy, and ecosystem datasets to advance transdisciplinary research and collaboration in the Mekong River basin. In AGU Fall Meeting Abstracts (Vol. 2022, pp. H45Q-1598).
- Akhter, T., & Pokhrel, Y. (2022, December). Scale-dependency of Lateral Groundwater Flow in Land Surface Models. In AGU Fall Meeting Abstracts (Vol. 2022, pp. H22Q-1075).
- Tiwari, A. D., Pokhrel., Y. (2023, June). Similarities and divergent patterns in hydrologic fluxes and storages simulated by global water models. 2023 Cross-sectoral ISIMIP and PROCLIAS Workshop 05-08 June 2023, Prague, Czech Republic & Online
- Tiwari, A. D., Pokhrel., Y. (2023, June). Interplays between dam construction, climate, hydrology, land use, and ecology in the Mekong River basin, MSU OISS Showcase (poster presentation)
- Tiwari, A. D., & Pokhrel, Y. (2023). Improving irrigation and groundwater representations in the Community Land Model. AGU Fall Meeting Abstracts.

06/27/2023

# Journal Publications

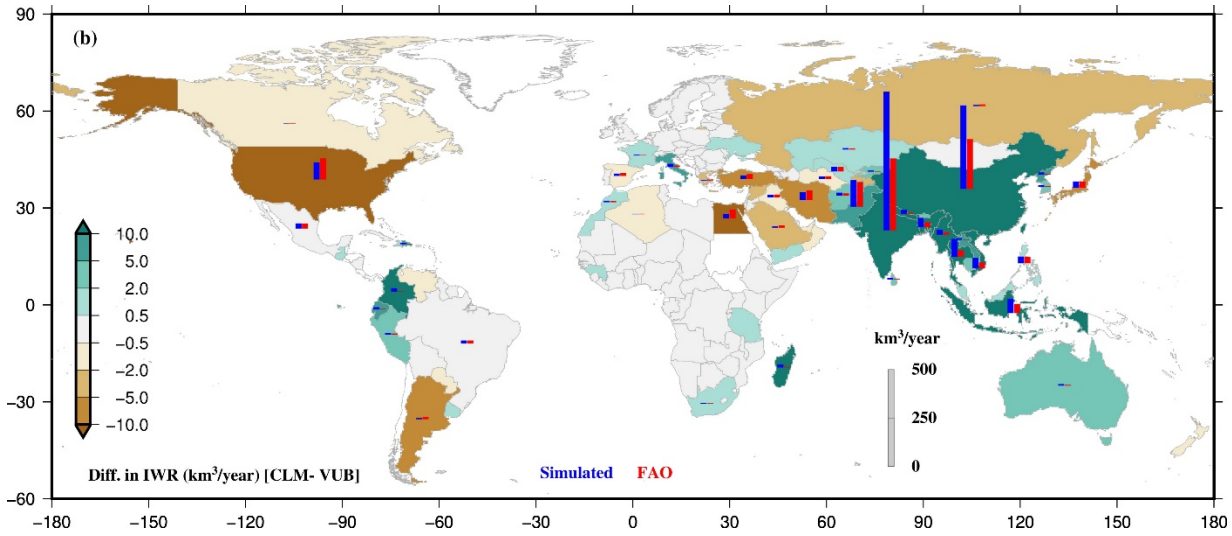



Tiwari, A. D., Pokhrel, Y., Kramer, D., Akhter, T., Tang, Q., Liu, J., Qi, J., Loc, H. H., & Lakshmi, V. (2023). A synthesis of hydroclimatic, ecological, and socioeconomic data for transdisciplinary research in the Mekong. *Scientific Data*, *10*(1), 1-26

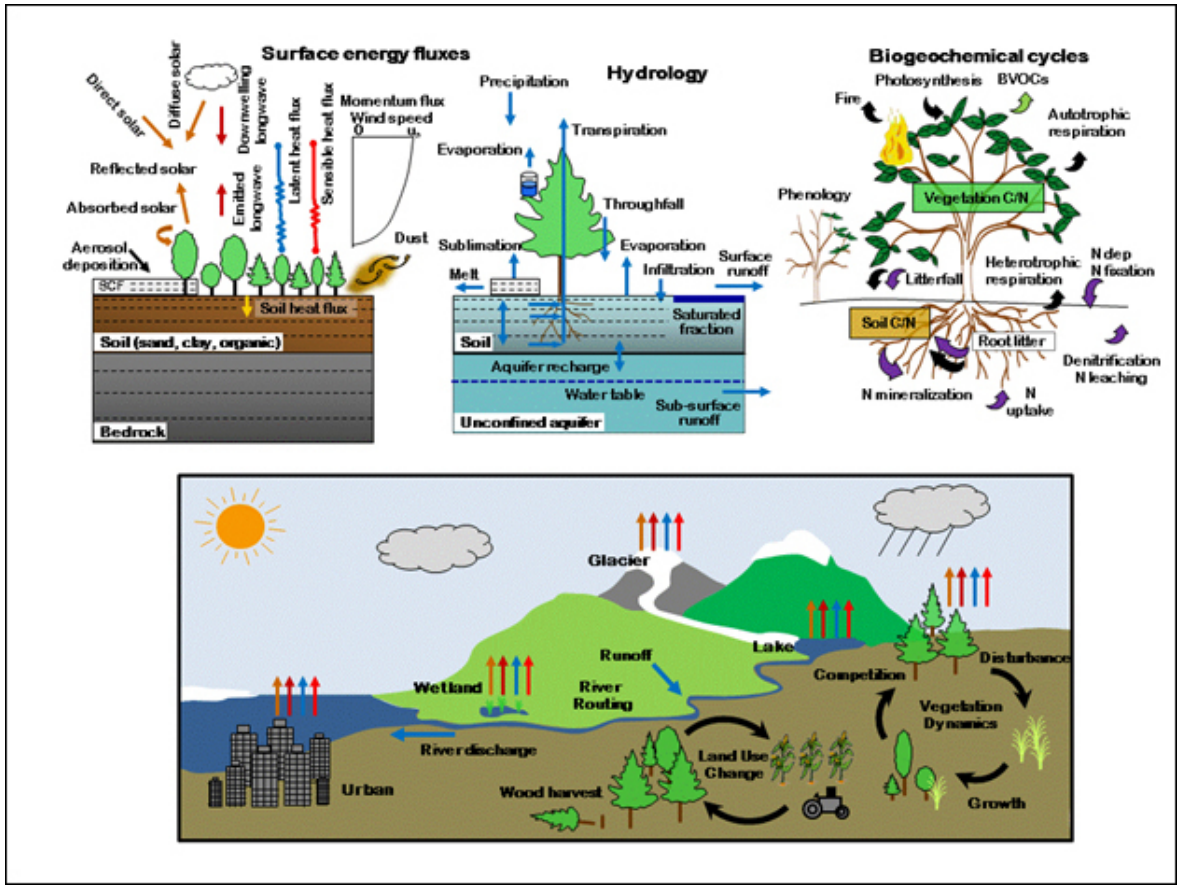



Kabir, T., Pokhrel, Y., & Felfelani, F. (2023). Climatic and anthropogenic controls on groundwater dynamics in the Mekong River Basin. *Journal of Hydrology*, *622*, 129761

# Ongoing activities




Tiwari, A. D., Pokhrel, Y., et al. (2024). Sustainable Solutions for global Groundwater Crisis: Integrating Climate Change, Irrigation Management, and Modeling (in preparation)




Akhter, T., Kabir, T., Pokhrel, Y., et al., (2024). Significance of cell-to-cell groundwater flow and aquifer pumping in the Global Land Surface model. *(in preparation)*

**Report to BLUEGEM @ 2024-04-03**
**Hyungjun Kim**

東京大学
THE UNIVERSITY OF TOKYO

## Achievement

Deliverables:
- Bias-corrected forcing data (ongoing)
- Data management (ongoing)

Hiring:
- Koichi Toyoshima (postdoc)
- Marvin Seow (postdoc)

Papers:
- Kim and Tokuda (2021, 2022), BAMS
- Satoh et al (in prep.)

## Difficulties

Scheduling:
- Inconsistent project period
- Schedule delays

Job switching:
- All members have left from U-Tokyo
- Korea, Japan and Hongkong

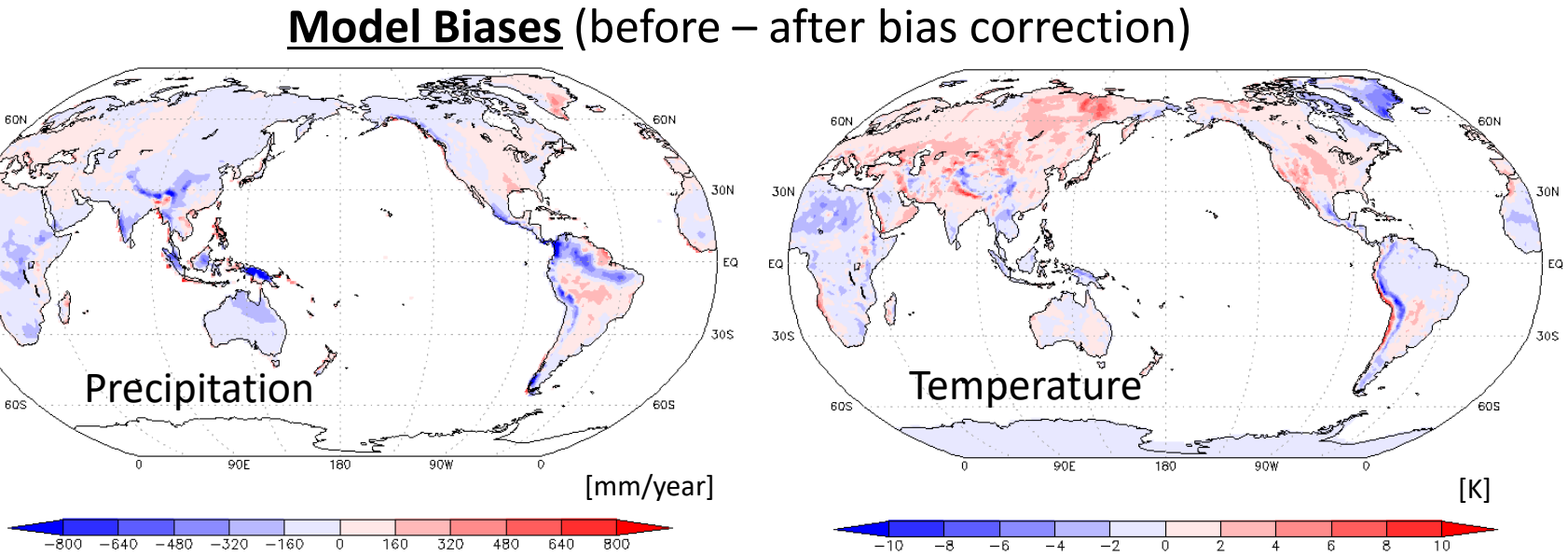
## Perspectives

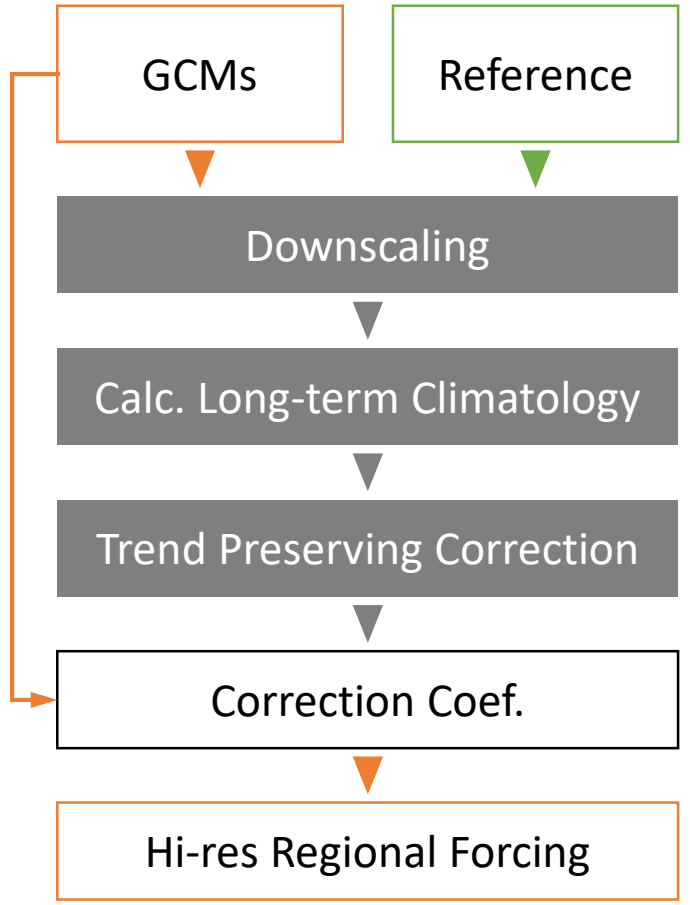
Forcing data:
- Trying to way to keep contributing (hired a student)

Data management:
- Negotiating with DIAS.JP (not easy)
- Plan B @ KISTI.KR (highly probable)
- Dr. Yusuke Satoh will take over this

# Bias correction and Downscaling

- A numerical method for bias-correction and downscaling has been proposed for France and the Mekong focal regions.
- Test has been carried out at the global scale for the period 1901-2010, using GSWP3 data as a reference on the CESM simulation by NTU.
- In general, a large area of north hemisphere shows positive bias in temperature, and a strong positive bias in precipitation has been found over tropics.



# Data management and exchanges among project partners

We have built a virtual machine within DIAS, Japan to prepare a service to archive and disseminate data as project outcomes.

1. Consortium Database
   - DIAS services provided for building a shared database
   - Utilized Virtual Machine with 40TB storage, 50GB RAM, and 24 CPU cores for database creation
   - Enables aggregation and utilization of hosted data
2. Future Collaboration
   - Collaborative team will continue to provide simulation results and survey data.
   - Model benchmarking framework will be prepared incorporating various types of data from the project.

| Data spec | |
|---|---|
| Date | 1901/1/1 to 2014/12/31 |
| Temporal Characteristics | 3hourly |
| region | global |
| row/column | 192/288 (1.25 grid) |
| Data type | netCDF4 |
| all data size | 513 GB |
| variables | precipitation, wind speed, air temperature, humidity, surface pressure, short-/long-wave radiation |

# Report from NTU team

Min-Hui LO; Sherry Kuo; Ren-Jie Wu

# CESM2+MSU GW/IRRI scheme

**Achievement:**

1. **Implementing** MSU GW/IRRI scheme to CESM2
2. **Conducting simulations +** IRRMIP

**CESM2:** Land-Atmosphere couple simulation with observational and AMIP future SST (0.9x1.25 degree)

- Historical (1901-2014) and SSP585 (2015-2100) scenarios
- Each scenario are with 2 experiments: With/without irrigation effect
- Each experiment is with 3 ensemble members: To explore the irrigation effect in coupling model

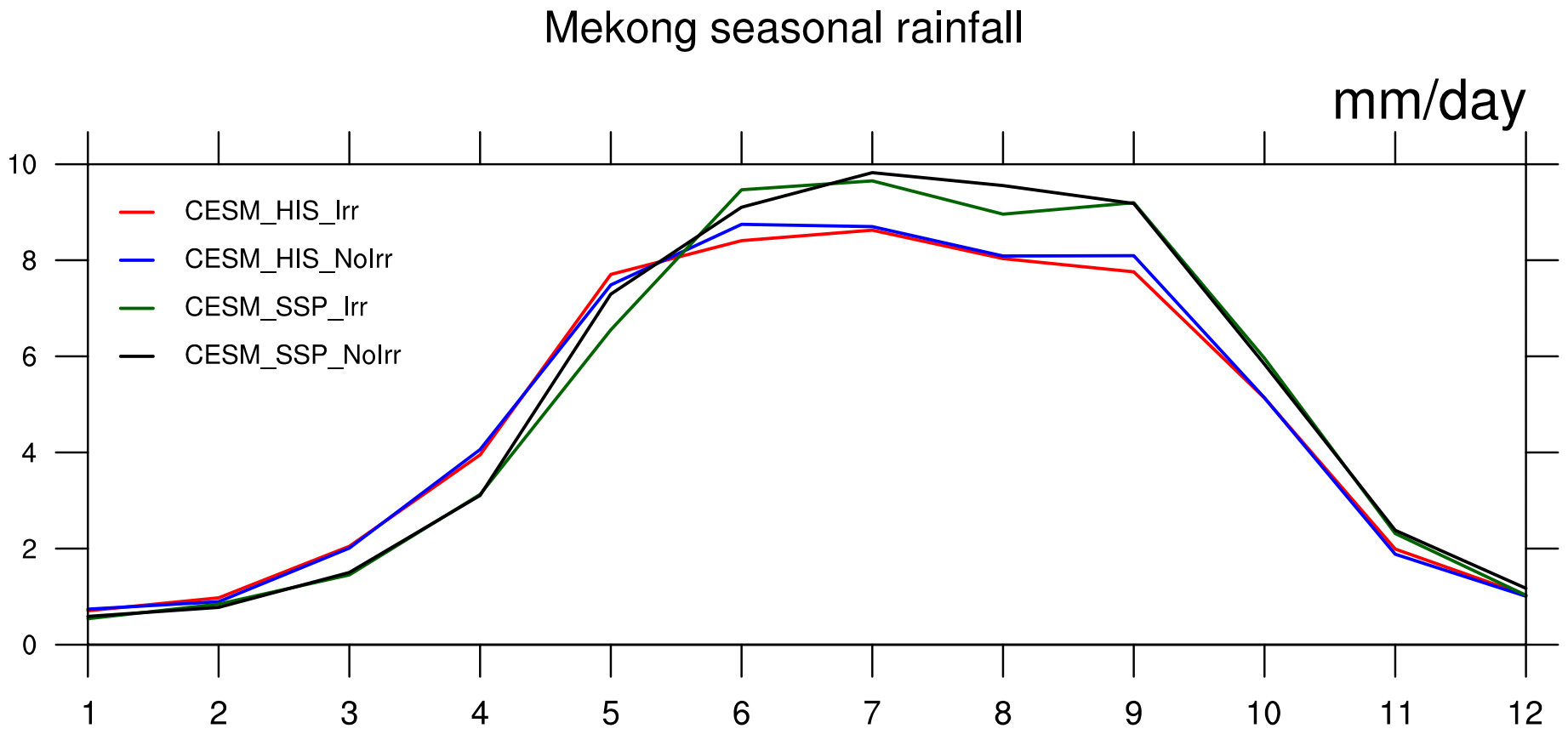
**Challenges (difficulties)**

- The irrigation‘s responses are small in CESM due to less irrigation water compared to IPSL. (New scheme in MSU?)
- Data transfer to the local server; porting the model

**Ongoing work:**

1. **Comparing the results from CESM2 and IPSL and focus on the SE – “How does the irrigation affect the future scenario?”**
2. **Focusing on the monsoon and extreme events**

CESM2+MSUGW


Mekong seasonal rainfall
mm/day
CESM_HIS_Irr
CESM_HIS_NoIrr
CESM_SSP_Irr
CESM_SSP_NoIrr
0
2
4
6
8
10
1
2
3
4
5
6
7
8
9
10
11
12

# Effects of Irrigation on the Local and Regional Climate from CESM2 and IPSL models

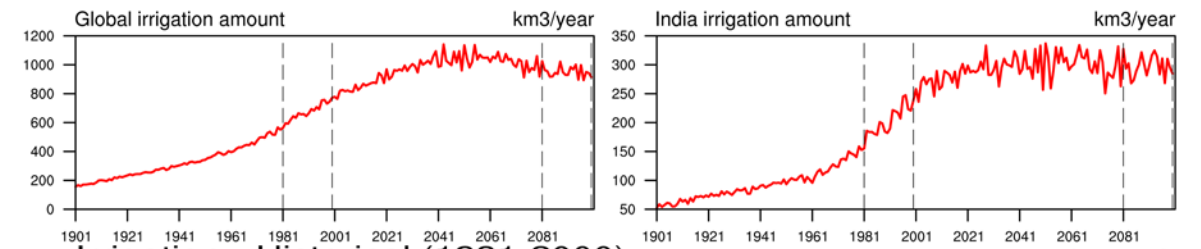
# Motivation

- Current climate (Historical: 1981-2000) with/without IRRI (A-B)
- vs.
- Future Climate (SSP585: 2081-2100) with/without IRRI (C-D)

- **#1. (A-B) -> How does the irrigation affect the local/regional climates**
- **#2. (A-B)-(C-D) -> How does irrigation's effects change under warming simulation?**

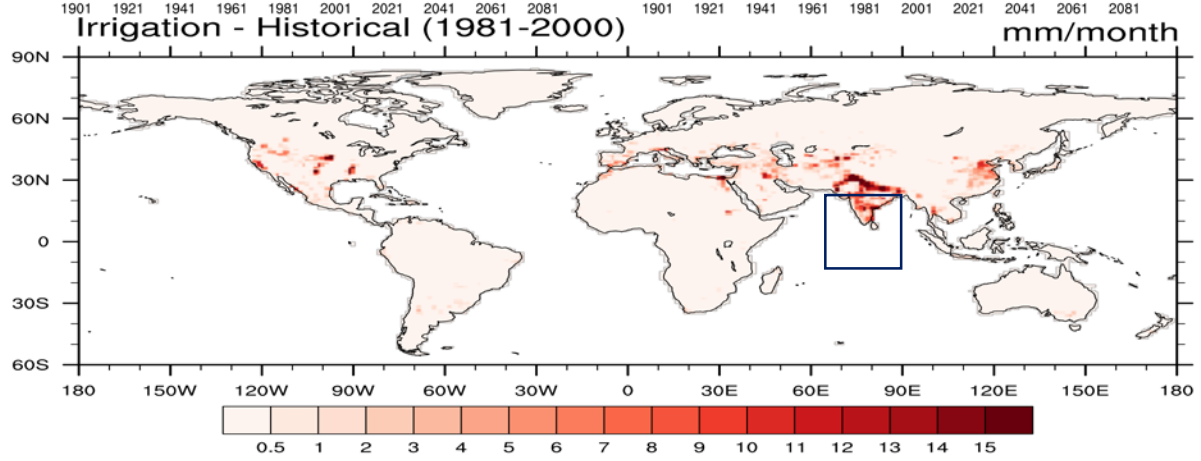
**All the figures are with ensemble mean**

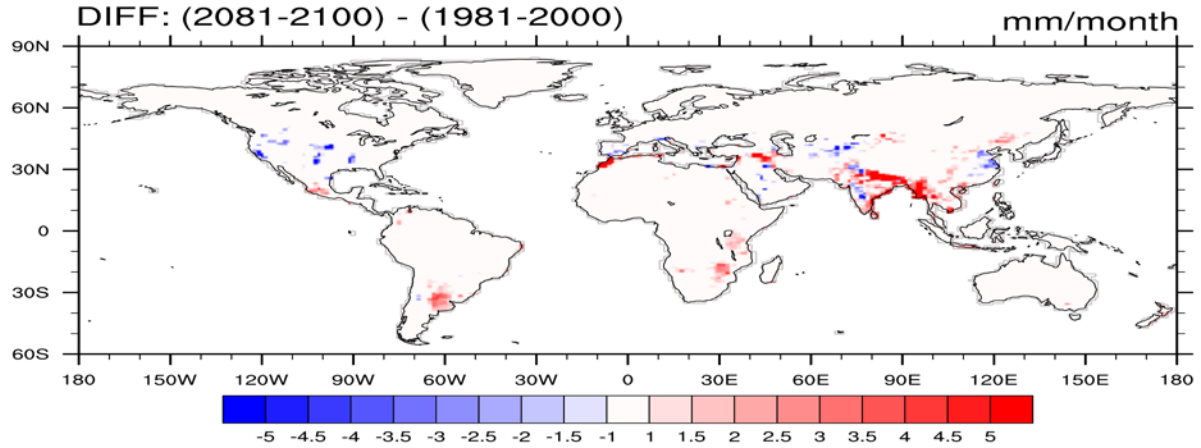
## CESM2



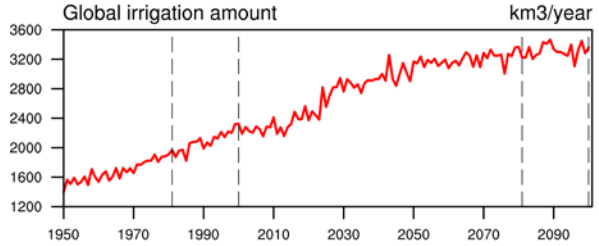


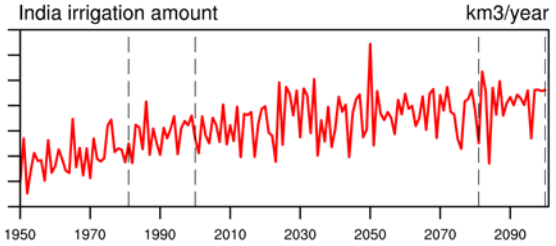


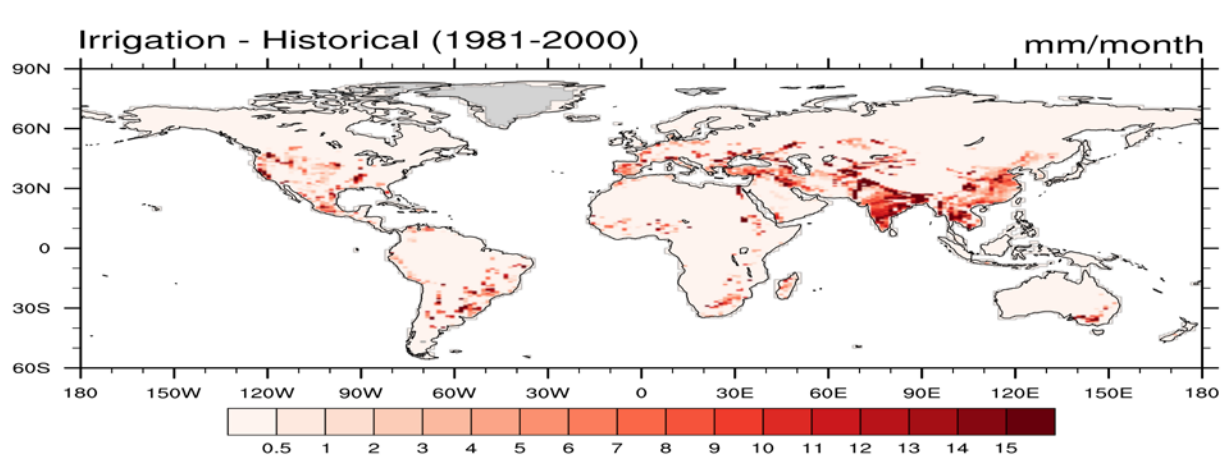


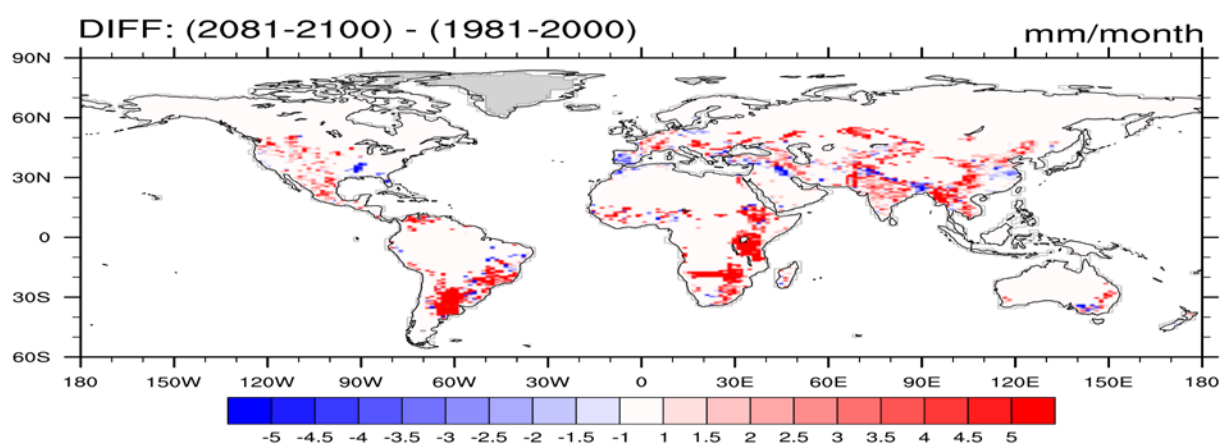




## IPSL



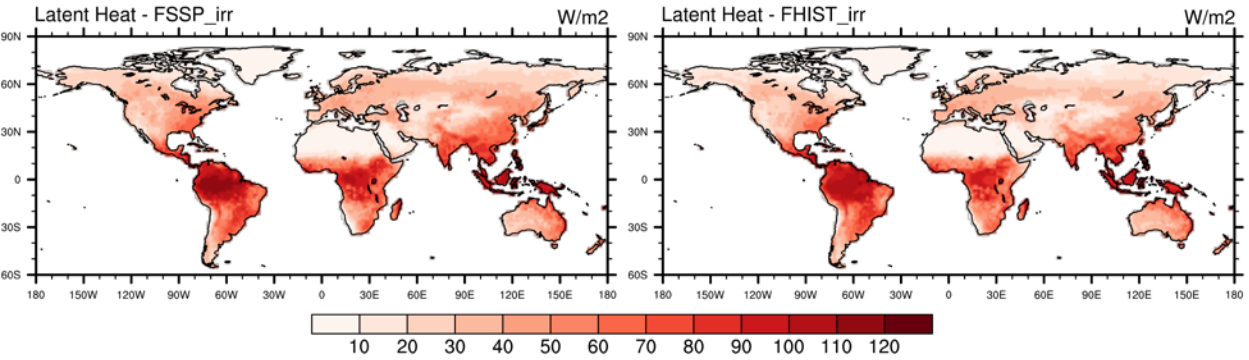



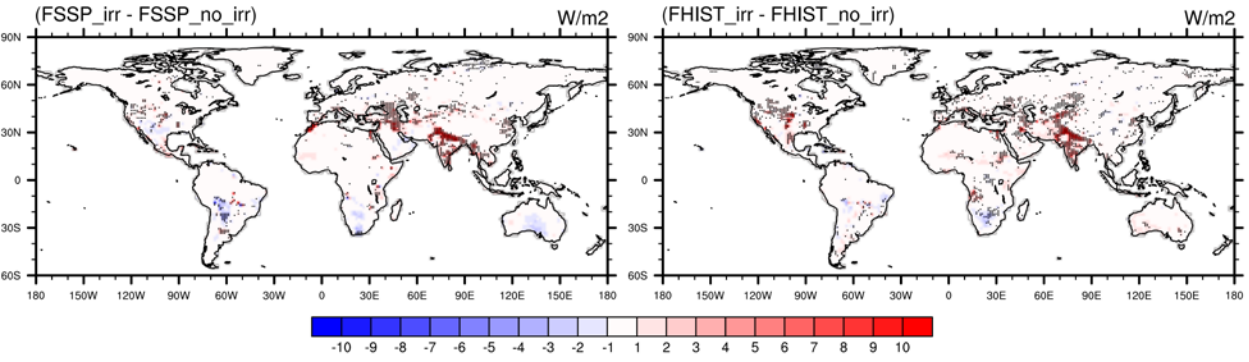



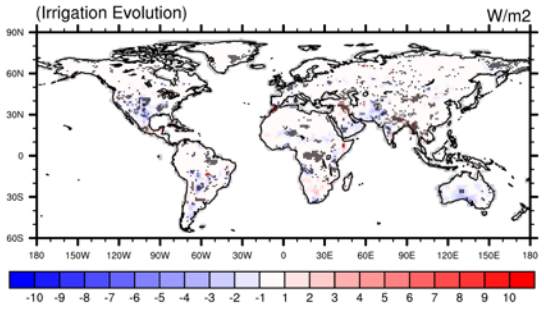




1. Projections suggest that global irrigation will rise by more than 50-60% by the conclusion of the 22nd century, yet the IPSL model indicates a threefold increase in global irrigation compared to CESM.
2. While the anomaly patterns exhibit similarities across regions, notable differences are observed in North America and the Ganges. Nevertheless, India retains its status as the most intensely irrigated region in both models.

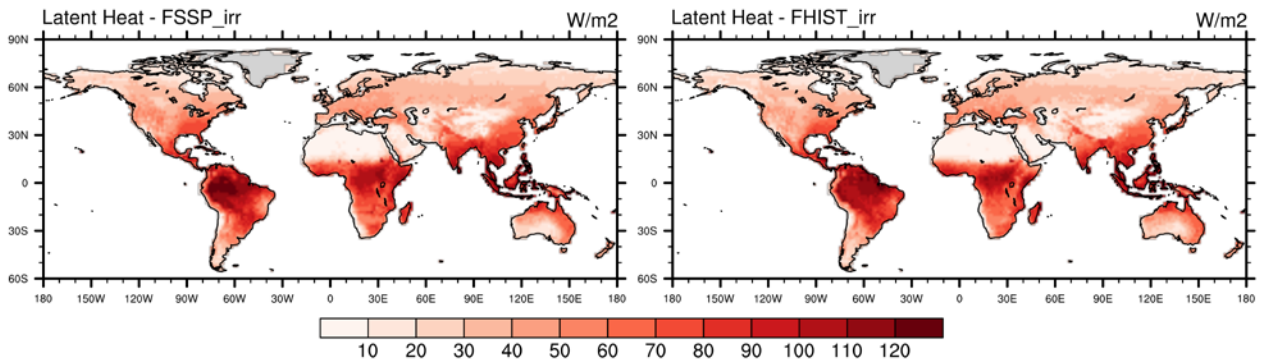
**CESM2**

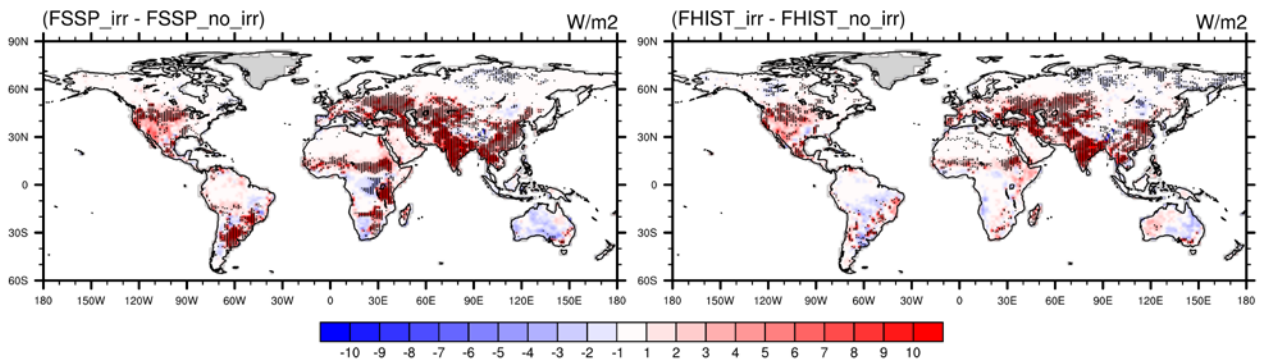


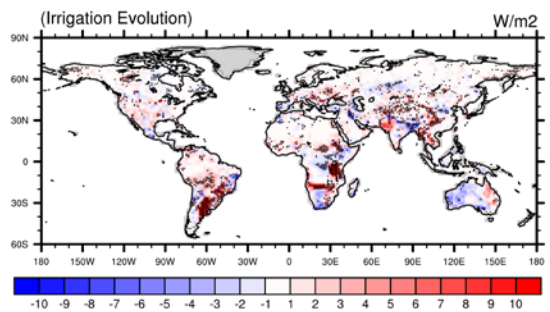




**IPSL**



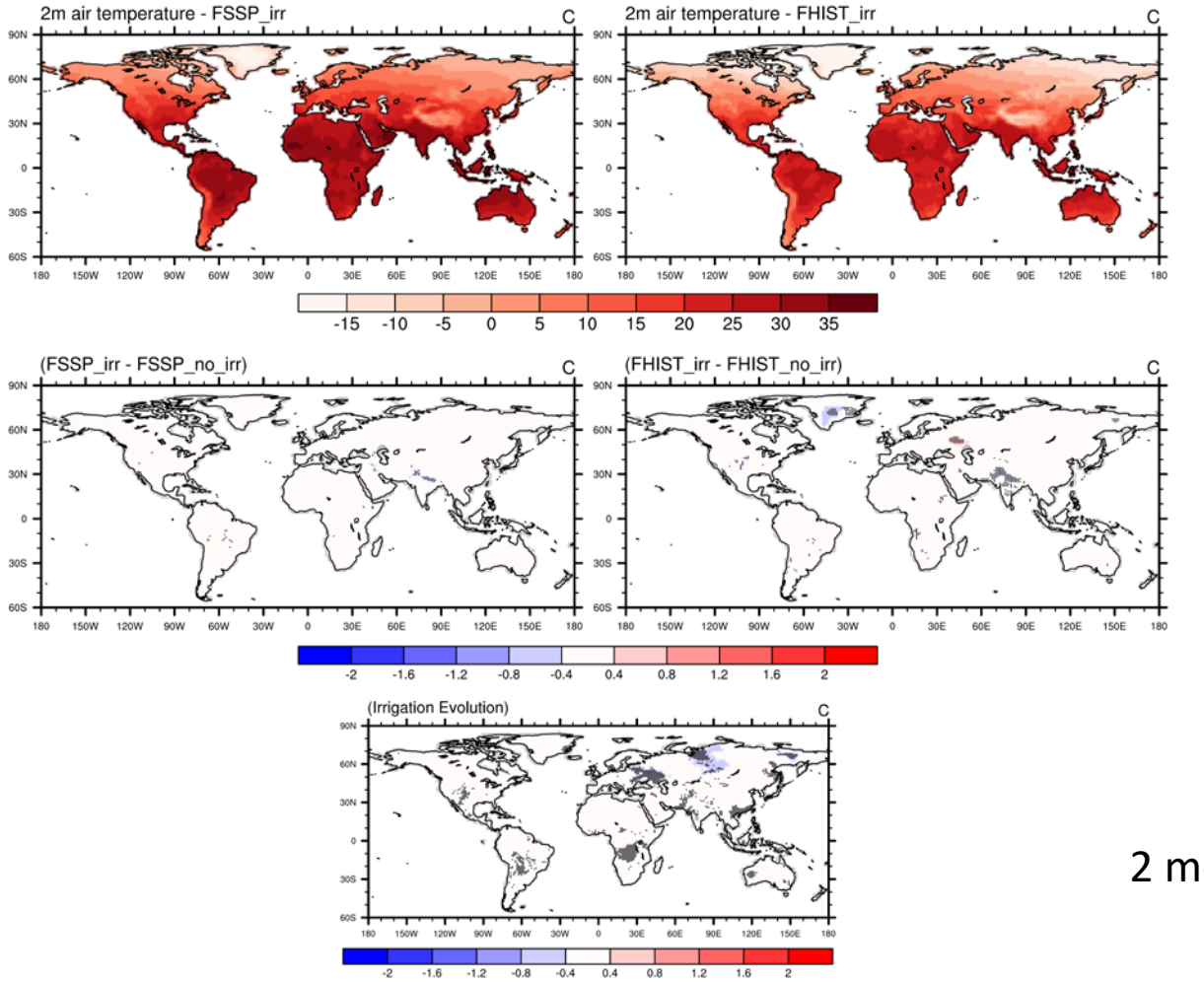



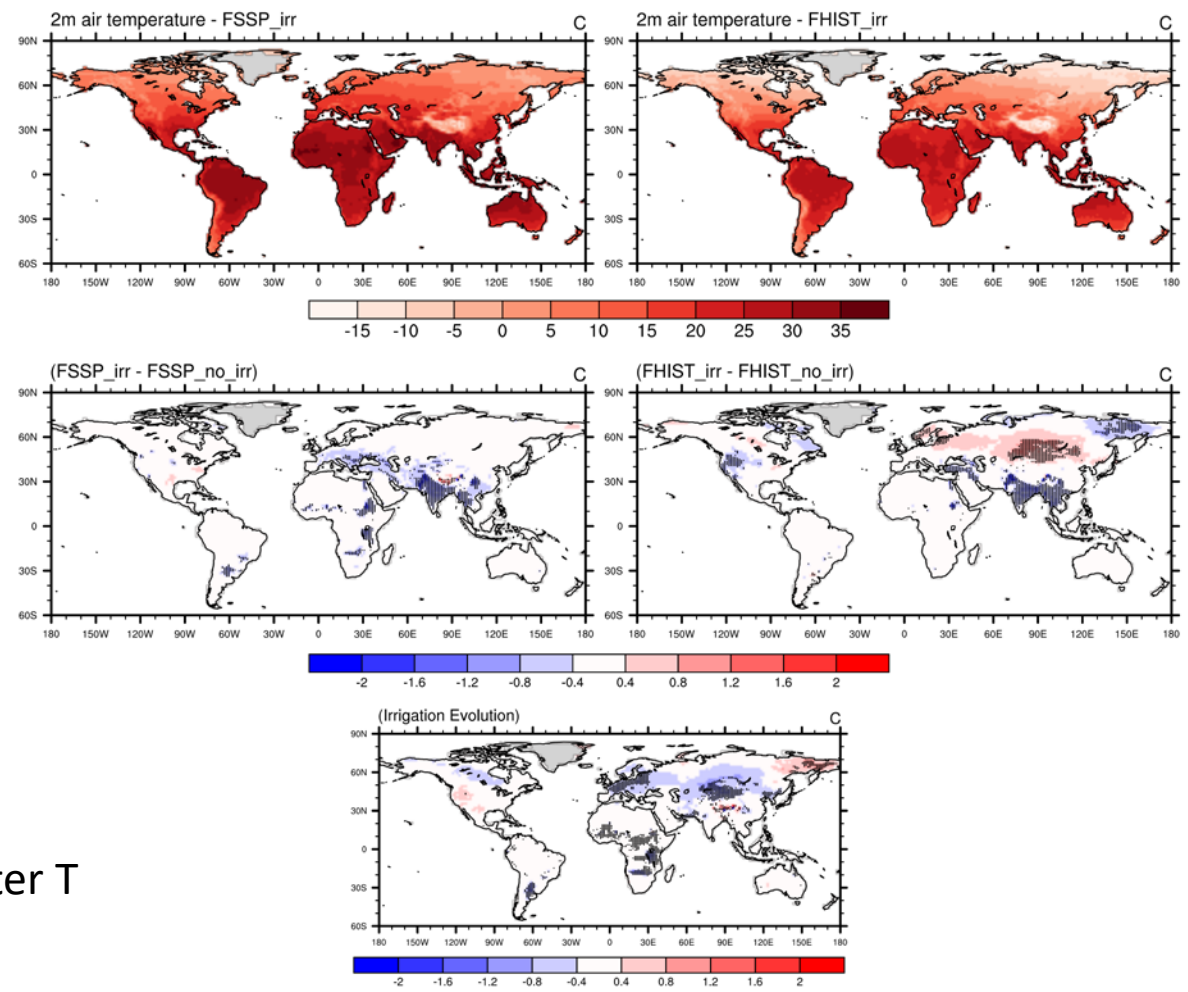

Surface latent heat fluxes

1. The irrigation-induced moistening effect is particularly notable in North India, with CESM emphasizing the Ganges region, whereas in IPSL, the anomaly domain extends further into extratropical regions

**CESM2**



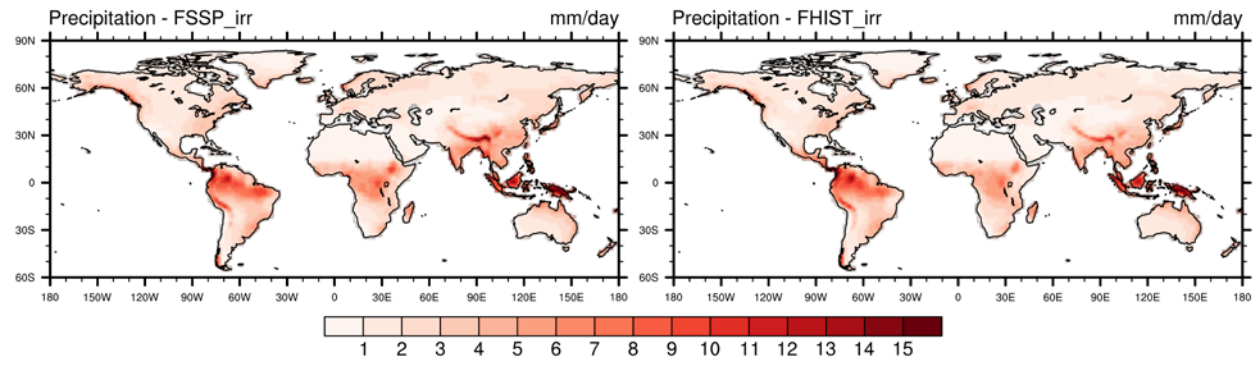

**IPSL**

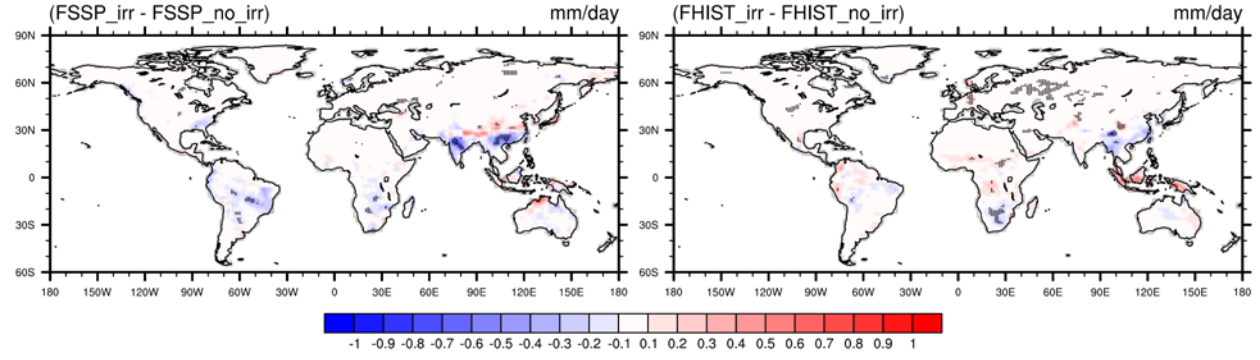


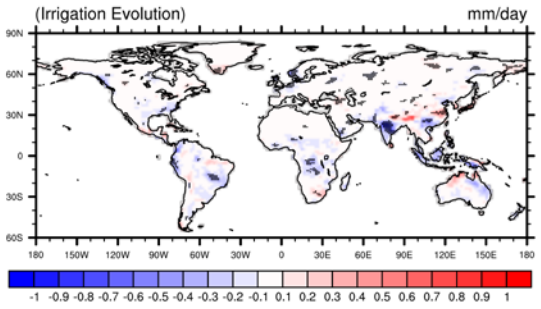

2 meter T

1. In contrast to CESM, IPSL demonstrates a clear cooling effect resulting from increased irrigation in the future.
2. Within IPSL, the irrigation evolution shows an increase in irrigation across Africa but a decrease in the Ganges region, a pattern that corresponds to the T2m anomaly.

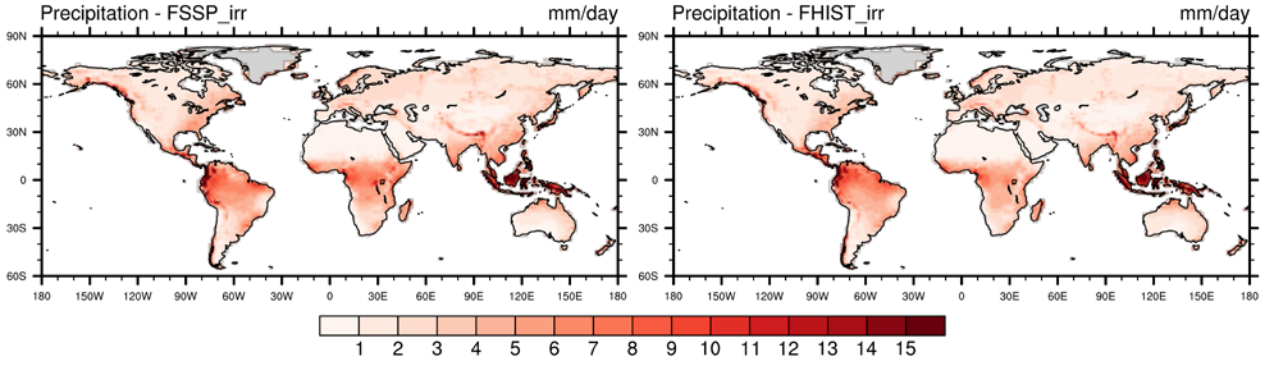
**CESM2**

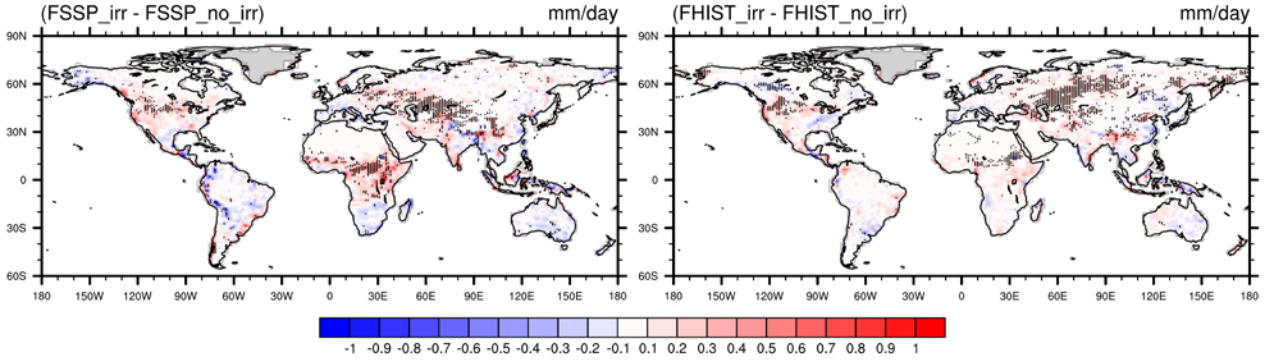


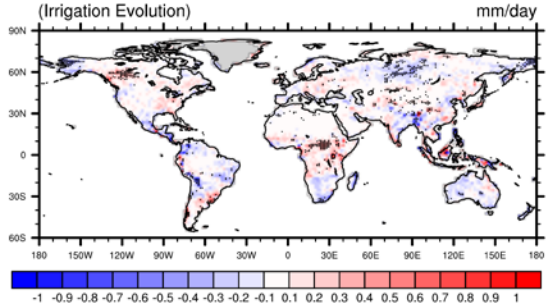




**IPSL**




rainfall

1. There is no direct correlation between areas of intense irrigation and the response of rainfall. Two models exhibit contrasting rainfall anomalies in Southeast Asia in the SSP scenario.
2. Projections indicate an increase in mean rainfall over India in the future.

# Conclusion and Discussion

- 1. The total global irrigation volume in IPSL exceeds that of CESM by threefold.
- 2. In both models, irrigation contributes to an increase in India, although the cooling anomaly is expected to diminish in CESM under future warming scenarios.
- 3. Rainfall anomalies resulting from irrigation effects in CESM exhibit significant variation between two distinct time periods across East and South Asia, with dynamic factors appearing to play a pivotal role.
- 4. IPSL displays a more pronounced response in T2m, LH, and SH compared to CESM.

# IPSL @ METIS, LMD, LSCE

**Staff**

→ Permanent (5) : Agnès Ducharne, Frédérique Cheruy, Josefine Ghattas, Jan Polcher, Philippe Ciais

→ Non permanent (6): Pedro Arboleda (PhD then postdoc), Lucia Rinchiuso and Peng Huang (post-doc), Vladislav Bastrikov (IT support), Pierre Tiengou (PhD), Luiza Vargas (Master)

**Modelling work for ORCHIDEE / IPSL-CM6**

→ Development of a realistic irrigation scheme (Arboleda et al., GMD, 2024)

**French focus area, offline, linked with French project Explore2**

→ Calibration of ORCHIDEE in France at high resolution (Huang et al., HESSD, 2024)

→ Projection of future hydrology according to 51 future forcing (≠ GCMs, ≠ RCMs, ≠ RCPs)

→ Impact of CO2 biophysical effect (strong) and irrigation (weak)

**Global climate simulations with IPSL-CM6**

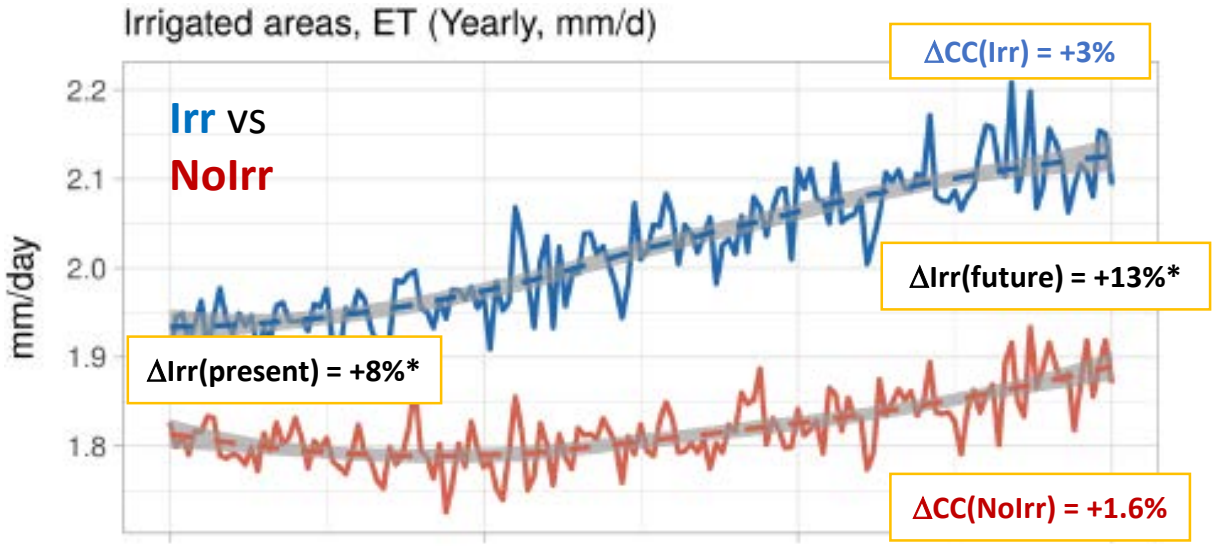
→ Impact of groundwater and hillslope flow on future climate change (Arboleda et al., Earth's Future, 2022)

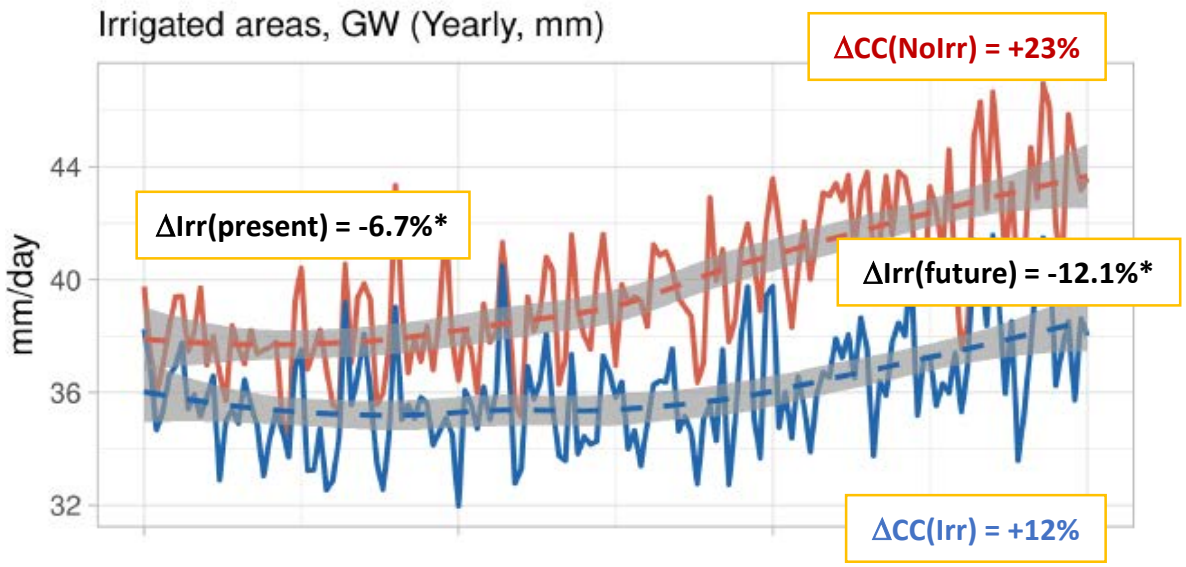
→ Impact of irrigation on historical climate in CMIP6 models (Al-Yaari et al., Earth's Future, 2022)

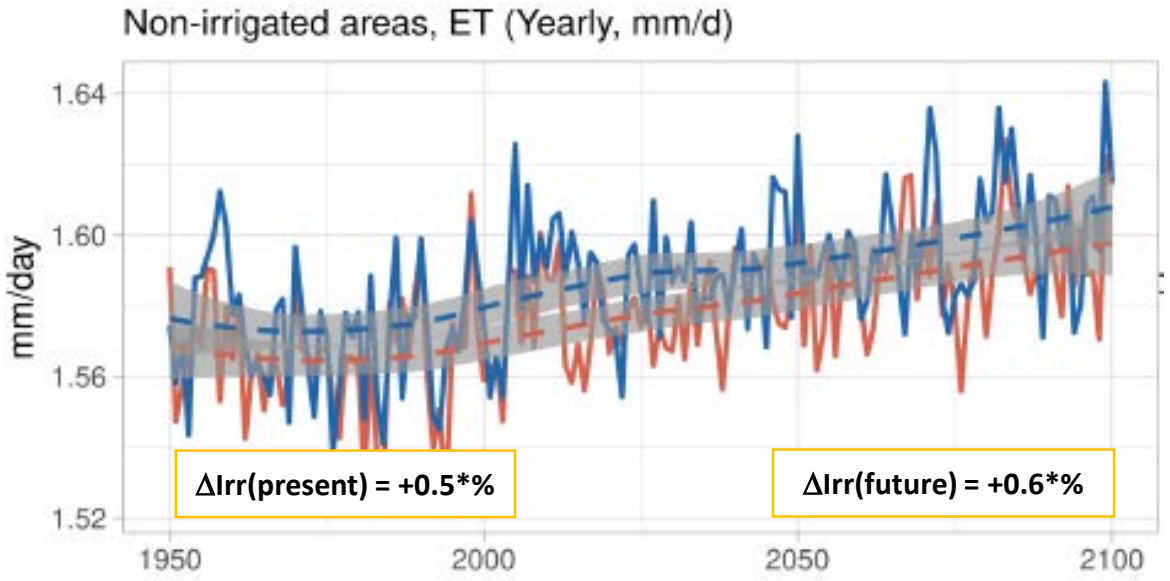
→ Participation to IRRMIP (model benchmarking over historical period)

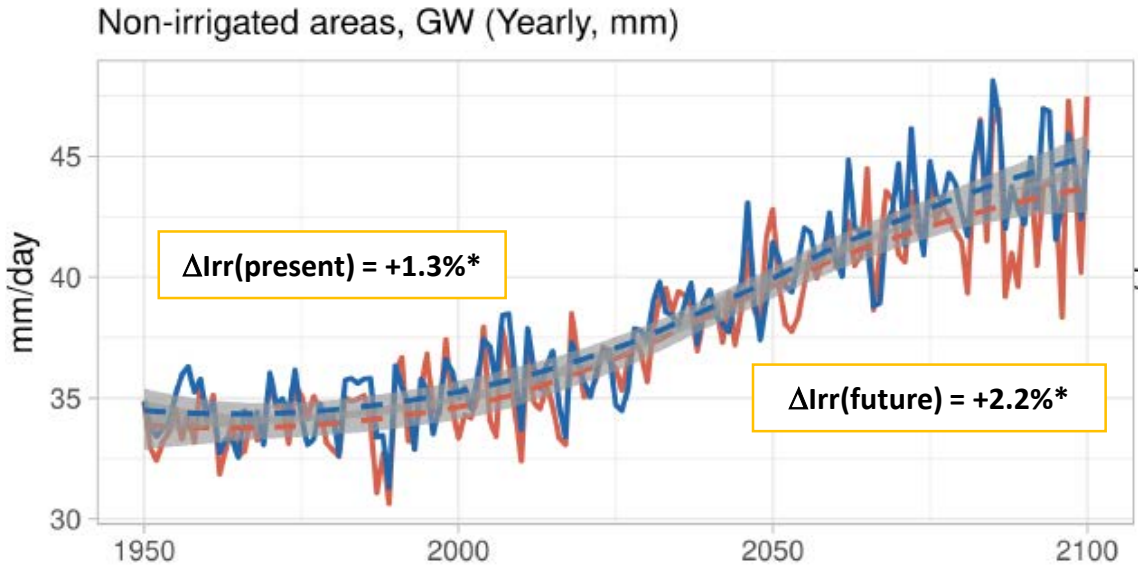
→ Impact of irrigation on future climate and water resources (BLUEGEM simulations, analysis in progress, foreseen comparison to CESM2 simulations)

# Impact of irrigation on future hydrology with IPSL-CM6 over 150 yrs



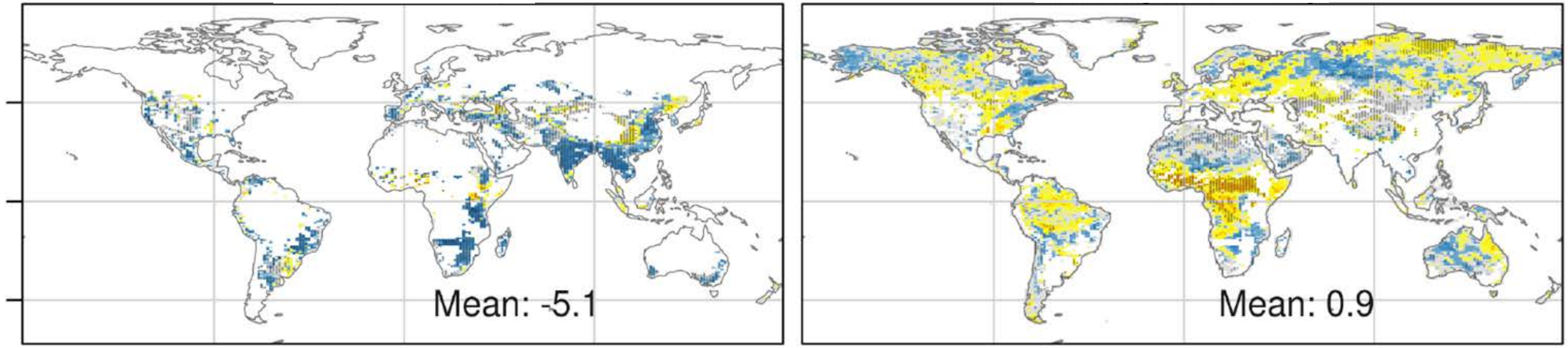



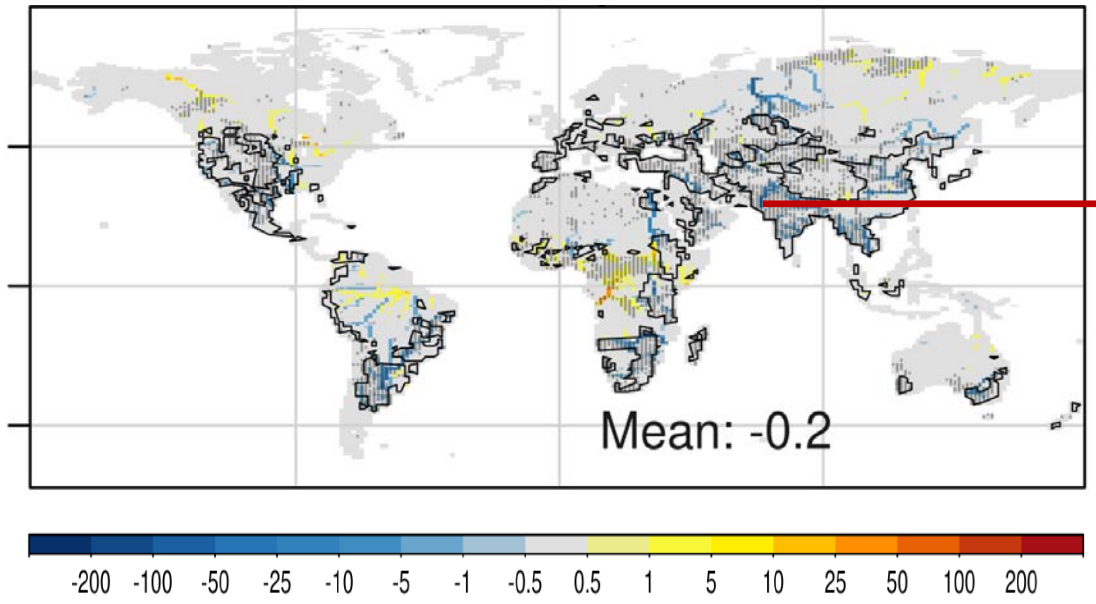



# Impact of irrigation on future hydrology with IPSL-CM6 over 150 yrs

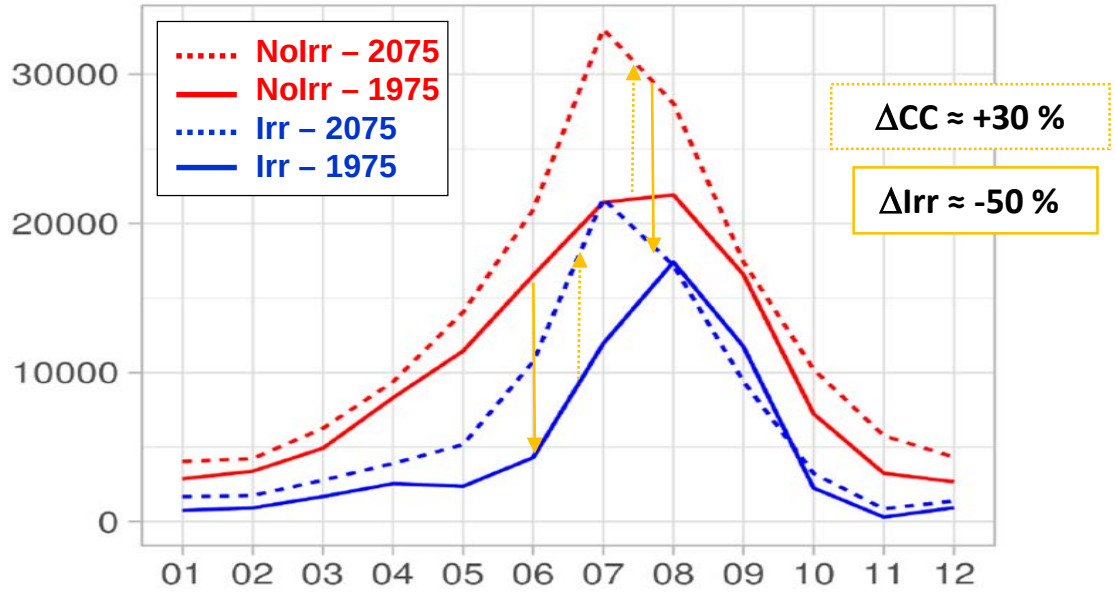
**ΔIrr(future) : GW storage (mm)**




**ΔIrr(future) : Stream storage (mm)**




Indus: river discharge at outlet (m3/s)



# IPSL @ METIS, LMD, LSCE

**Difficulties:** it's always longer than expected when selling the project

- Coupled simulations recently obtained → impact on UTokyo & comparison with CESM2
- No run-time bias corrected climate simulations
- No comparison of the two focus areas
- No CRA coordination work yet (workshop irrigation and water management)

**Perspectives:**

- Workshop on irrigation and water management: eventually in 2024-2025?
- Many foreseen analyses with NTU, MSU, and Explore2
- Pierre's PhD on irrigation impact with a limited area coupled model (LAM) over Spain
- Need to account for human decision in water management :
  - New develoments in ORCHIDEE with Jan Polcher (reservoirs, water needs for hydropower, etc.)
  - Study in progress on « mega-bassines »

# What is a « mega-bassine » ?





**Demonstration against the « mega-bassine » in construction at Sainte Soline on 25/03/2023**

Credits : Joanie Lemercier

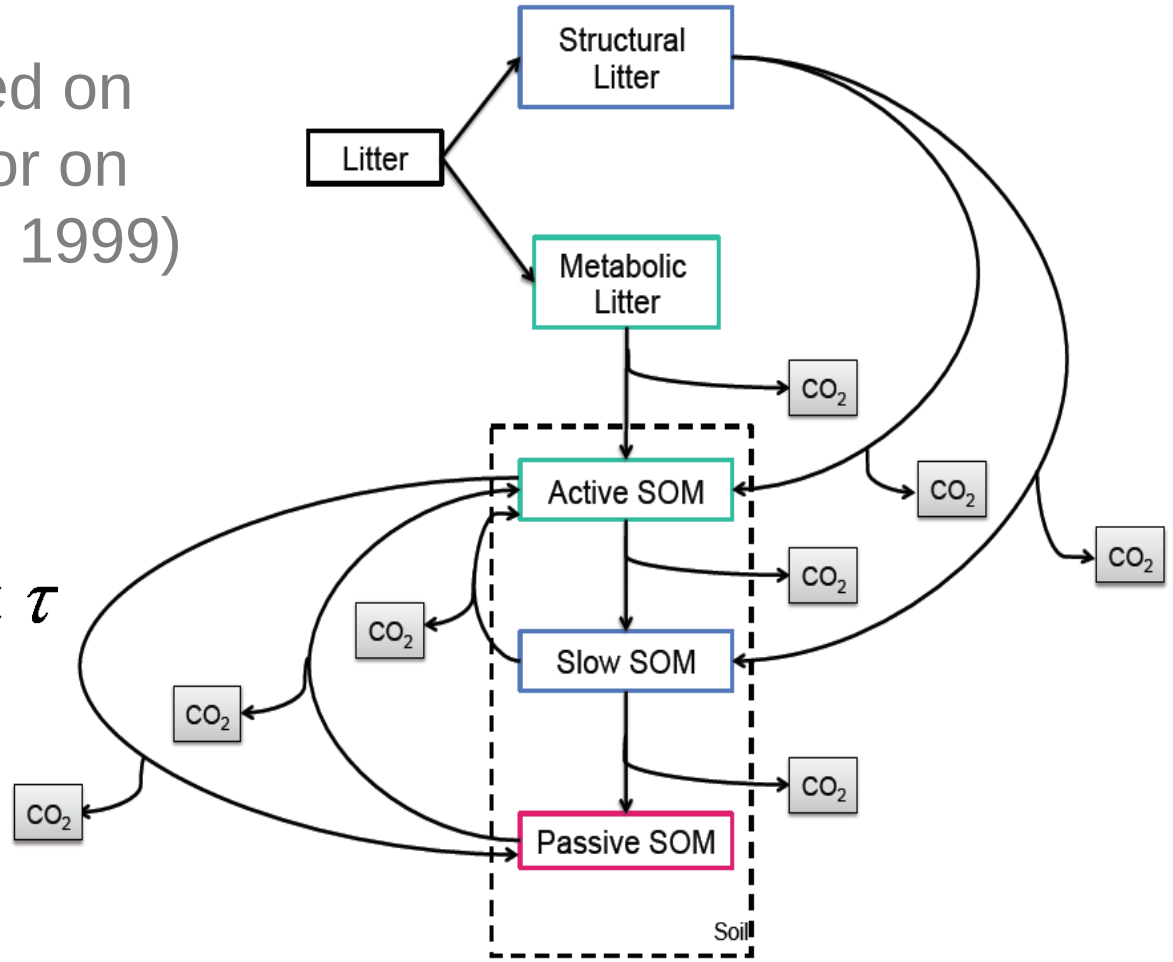
# The effect of soil moisture on soil organic carbon decomposition in ORCHIDEE.

GUENET Bertrand, SALMON Elodie

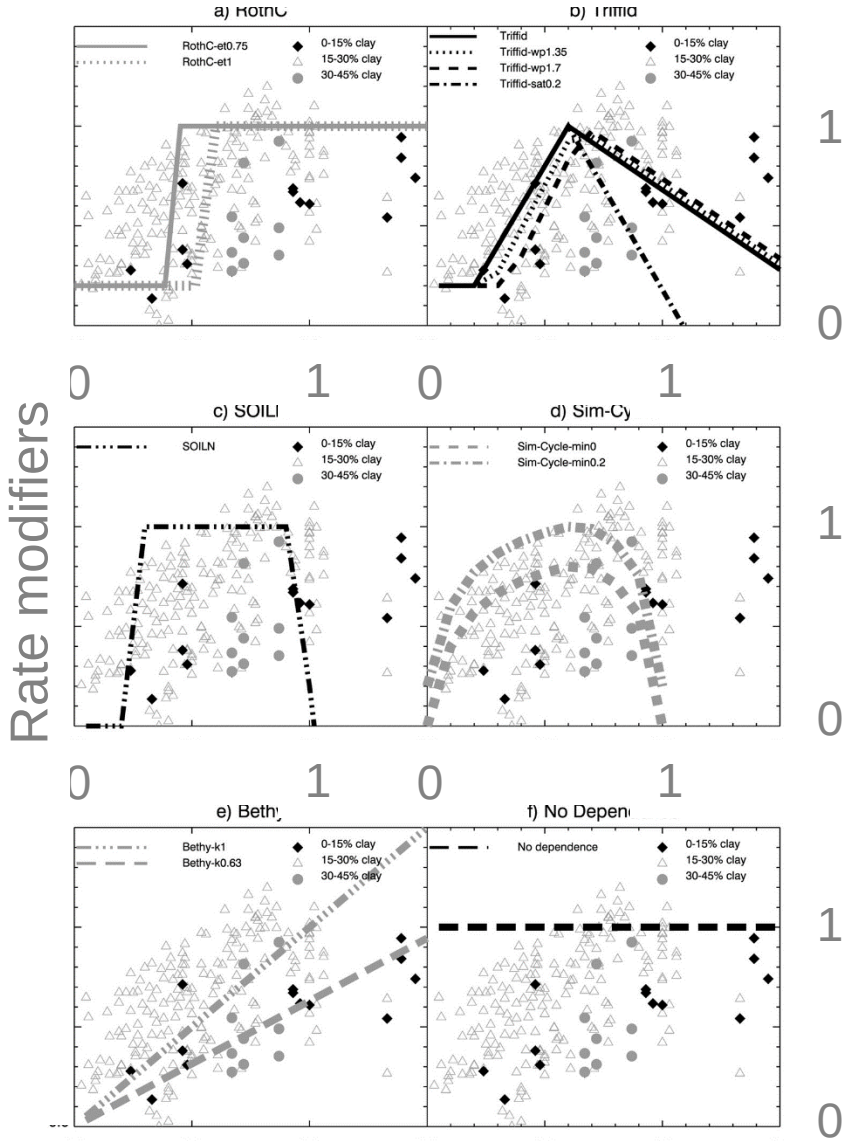
# THE SOIL C IN THE LAND SURFACE MODELS

- Soil representation mainly based on CENTURY (Parton et al., 1987) or on RothC (Coleman and Jenkinson, 1999)

$$\frac{\partial SOC}{\partial t} = I - k \times SOC \times \theta \times \tau$$



# WATER AVAILABILITY

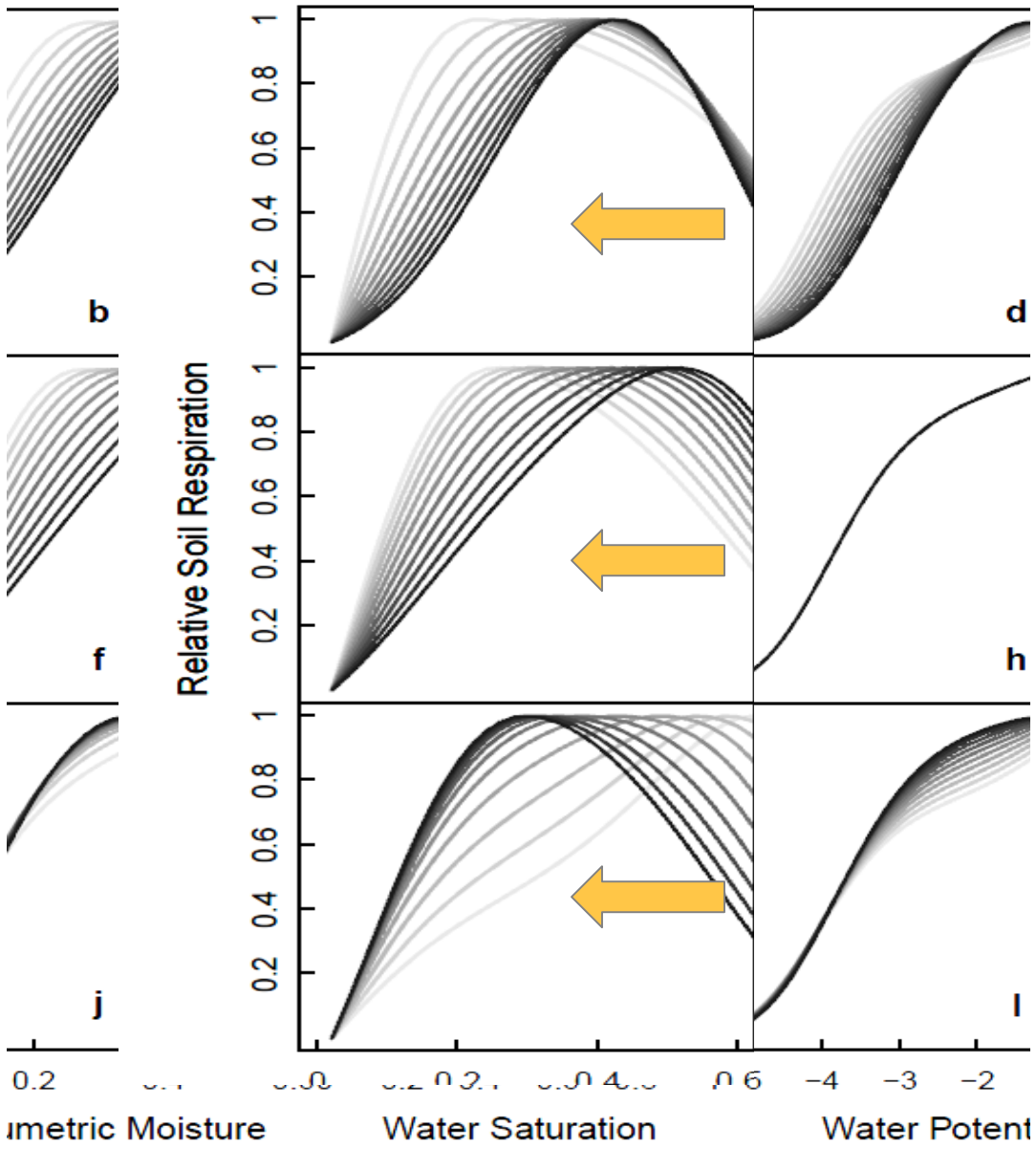



$$\frac{\partial SOC}{\partial t} = I - k \times SOC \times \theta \times \tau$$

$\theta$ is a rate modifier ($0<\theta<1$)

Falloon et al., 2011

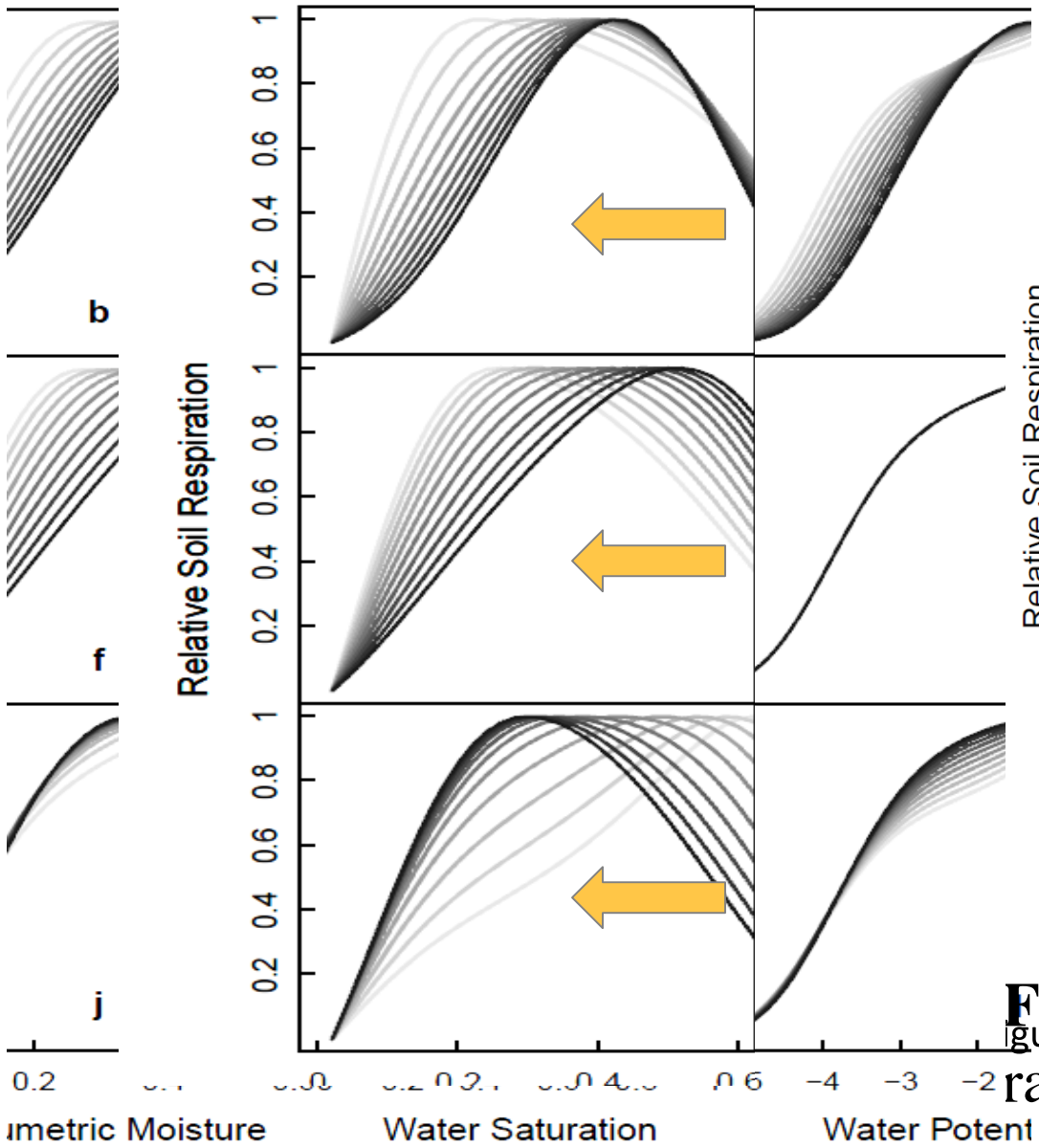
# WATER AVAILABILITY




Moyano et al., 2012

# WATER AVAILABILITY

$\varepsilon, \rho, \mathrm{cm}^3\ \mathrm{H_2O}\ \mathrm{cm}^{-3}$ (**b**, **f**, **j**), $\mathrm{cm}^3\ \mathrm{cm}^{-3}$ and $-\log_{10}|\psi|_{\mathrm{kPa}}$ (**d**, **f**, **l**).



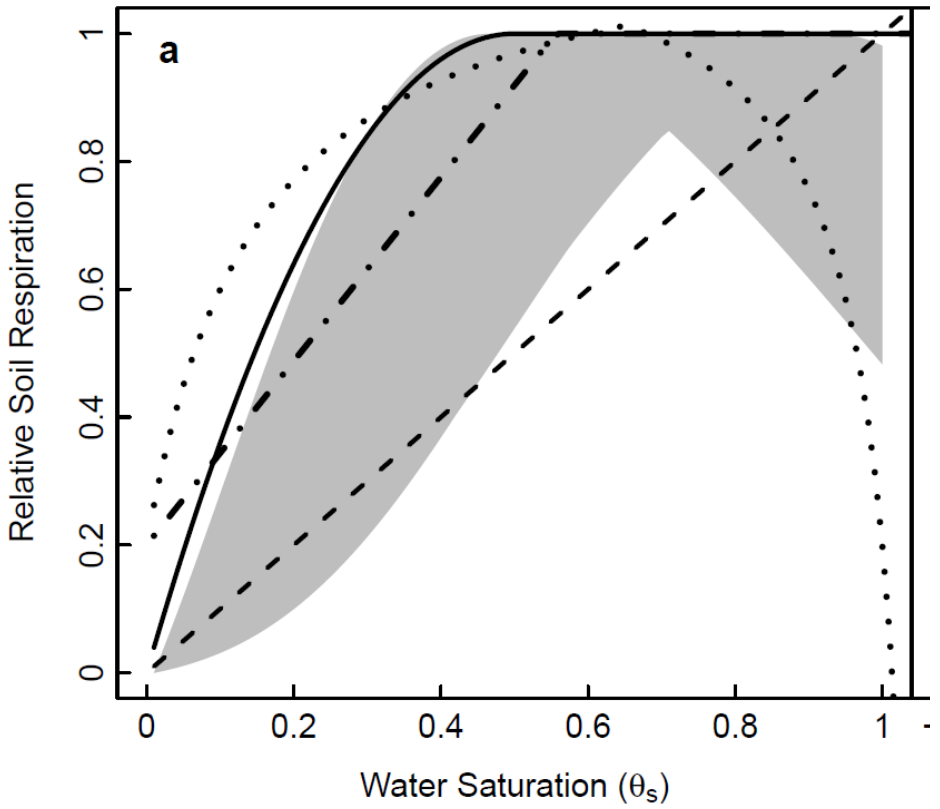



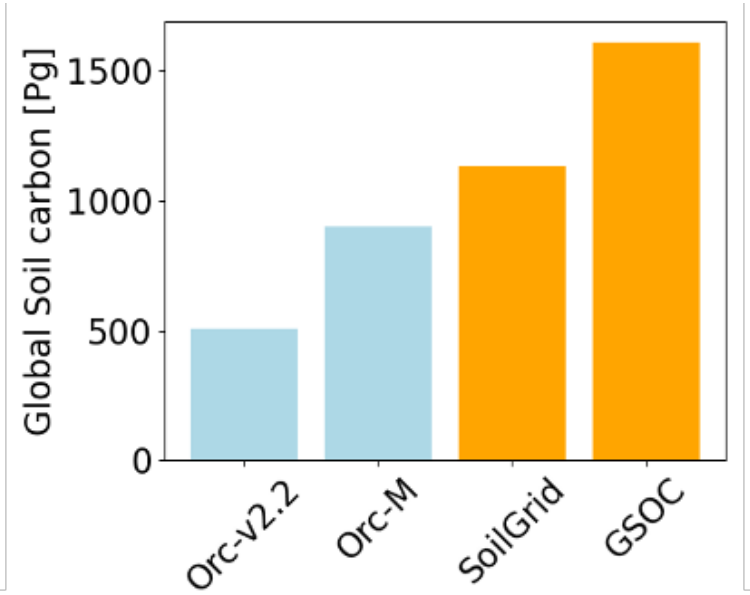

**Fig. 4.** Comparison of predicted re
igure 4: Comparison of predicted relative soil heterotr
ration as a function of soil moisture

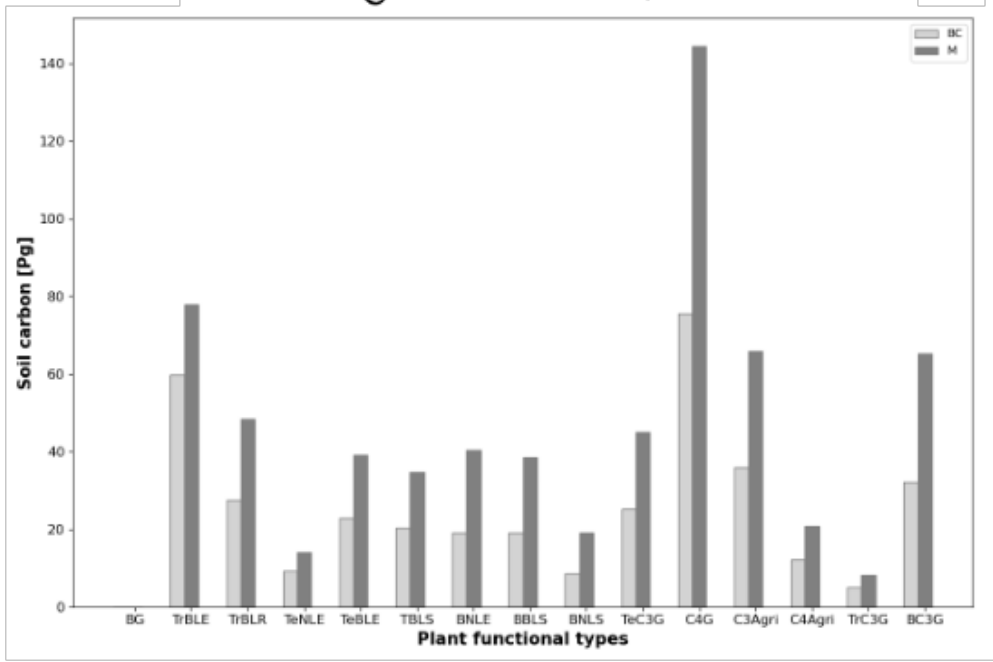
Moyano et al., 2012

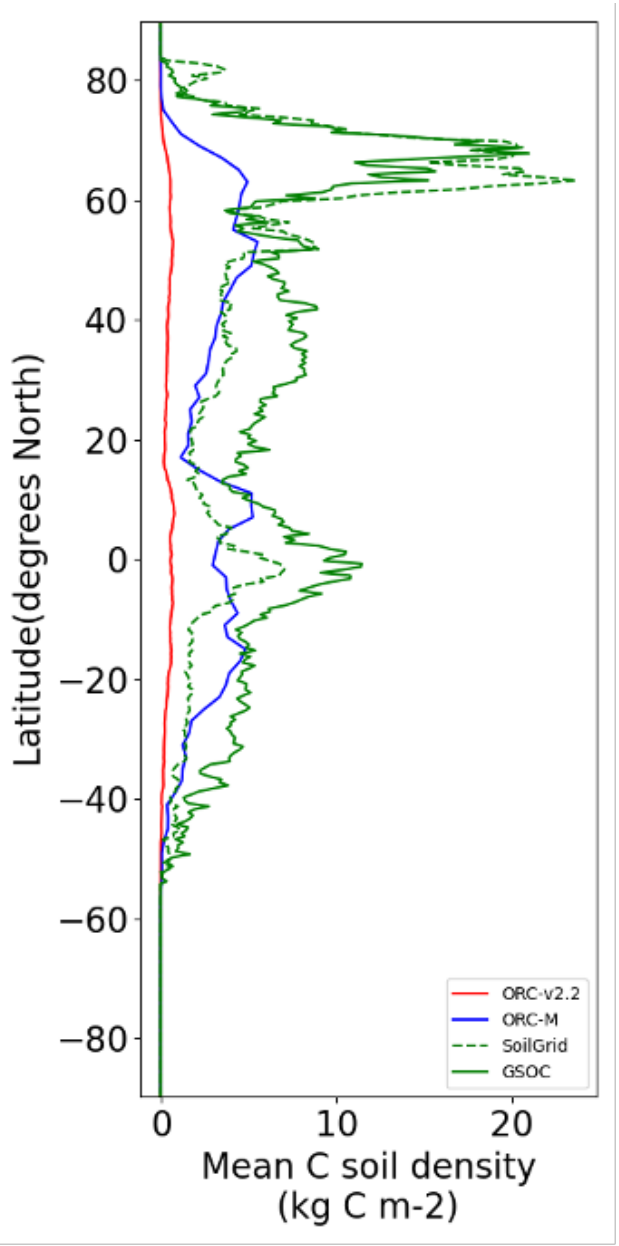
# IMPLEMENTATION INTO ORCHIDEE

- The default soil moisture function was replaced by the Moyano et al. (2012)
- A new feedback between soil C and the response to soil moisture.
- Historical simulations at 0.5° at global scale with both versions

# IMPLEMENTATION INTO ORCHIDEE



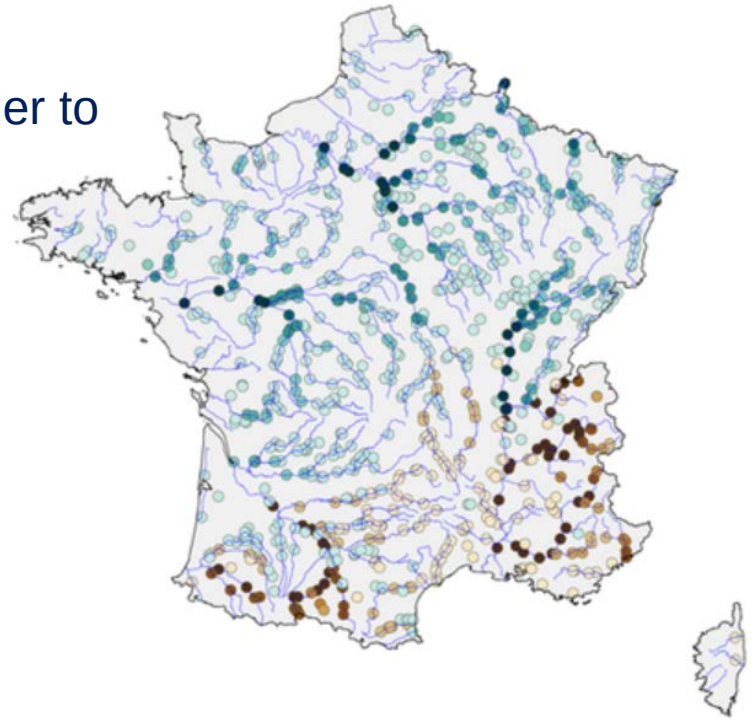



# BLUEGEM – OFB feedback

# Achievements

- **Providing high resolution simulations –**

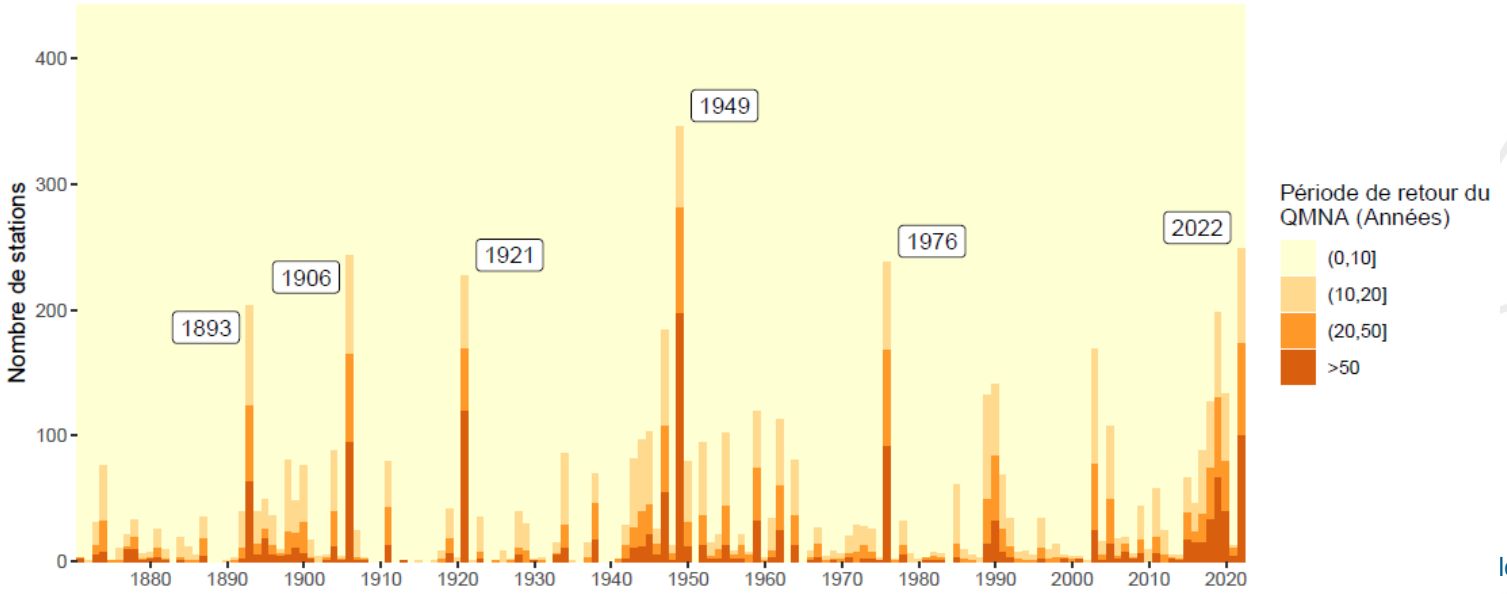
Discharge projections will be used by local water stakeholder to plan sustainable water resources management



DRIAS les futurs de l'eau

ACCUEIL ACCOMPAGNEMENT DÉCOUVERTE DONNÉES ET PRODUITS

- **Analysis of 2022 historical drought**




Contribution to a national conference (March 8-9 2023)

# To be continued

- **Co-construction of storylines with local water stakeholders**
  - > Interviews were carried on
  - > Synthesis of key messages was presented in a precedent BLUEGEM meeting

⇒ **How to integrate local scenarios in simulations?**

- ➢ Sometimes discussed solutions are at a very fine scale (hedges and wetlands restoration, irrigation efficiency…)
- ➢ Strong heterogeneities among scenarios between nearby catchments

⇒ **What kind of feedback can we bring them ?**

- ➢ Explaining uncertainties, helping them to deal with uncertainties
- ➢ Focus on droughts can help (-> Matthieu Belin?)

# Perspectives

- **Relation between meterological variability and water abstractions**
  - > Political objective of water use reduction of 10 %
  - > Water abstraction monitoring is needed first

- **Impacts on different types of water storage on water resources but also on local socio-economic context**

- **Recycling ratios between precipitation and evapotranspiration**
  - > Active debate on the role of forests and irrigation on precipitation
  - > Need scientific explanations and figures