

# Nathalie de Noblet-Ducoudré

[nathalie.de-noblet@lsce.ipsl.fr](mailto:nathalie.de-noblet@lsce.ipsl.fr)

- Who am I today?
- Some snapshots into my main results
- And from now on?

# Who am I today?

- **Scientist at the Laboratoire des Sciences du Climat et de l'Environnement (close to Paris, France)**
- **MERMAID team leader : *'Modelling the Earth Response to Multiple Anthropogenic Interactions and Dynamics'* [~10 scientists with permanent position, + ~20 PhDs and Post-Docs] → Earth System Modelling [foci: Feedbacks between Land, Ocean and Atmospheric Chemistry]**
- **BASC co-coordinator *'Biodiversity, Agrosystems, Society and Climate'* ; Laboratory of excellency [8 years, 5 M€, ~450 scientists, various disciplines: agronomy, ecology, climate, economy, human sciences]**

# Who am I today?

- Scientist at the Laboratoire des Sciences de l'Environnement
- MERMAID team leader  
*Multiple Anthropogenic Forcings on the Response to Climate Change: Role of vegetation dynamics and variability* [~10 scientists]
- **Physicist / Modeller / Land-Atmosphere Interactions / Role of vegetation dynamics on climate changes and variability**  
[~20 PhDs and Post-docs] [foci: Land, Ocean and Atmosphere]
- Co-coordinator '*Biodiversity, Agrosystems, Society and Climate*' ; Laboratory of excellency [8 years, 5 M€, ~450 scientists, various disciplines: agronomy, ecology, climate, economy, human sciences]

**Some snapshots into my main results**

# TIME SCALES

Glacial Inception  
~115000 years ago

Mid-Holocene  
~6000 years ago

pre-industrial  
& present-day

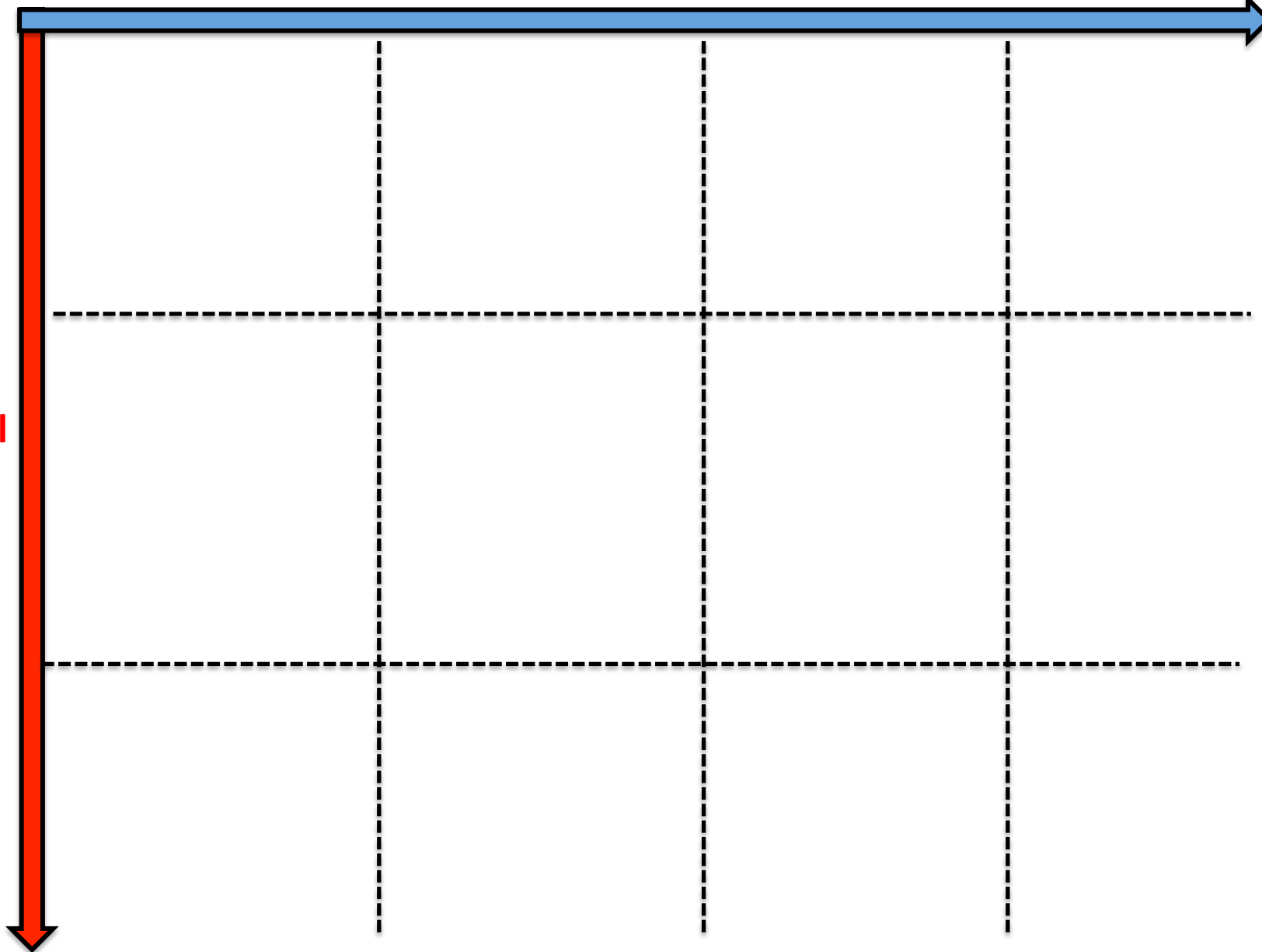
Next Century

# SPATIAL SCALES

Global

Regional

Local



# TIME SCALES

**Glacial Inception**  
~115000 years ago

**Mid-Holocene**  
~6000 years ago

**pre-industrial & present-day**

**Next Century**

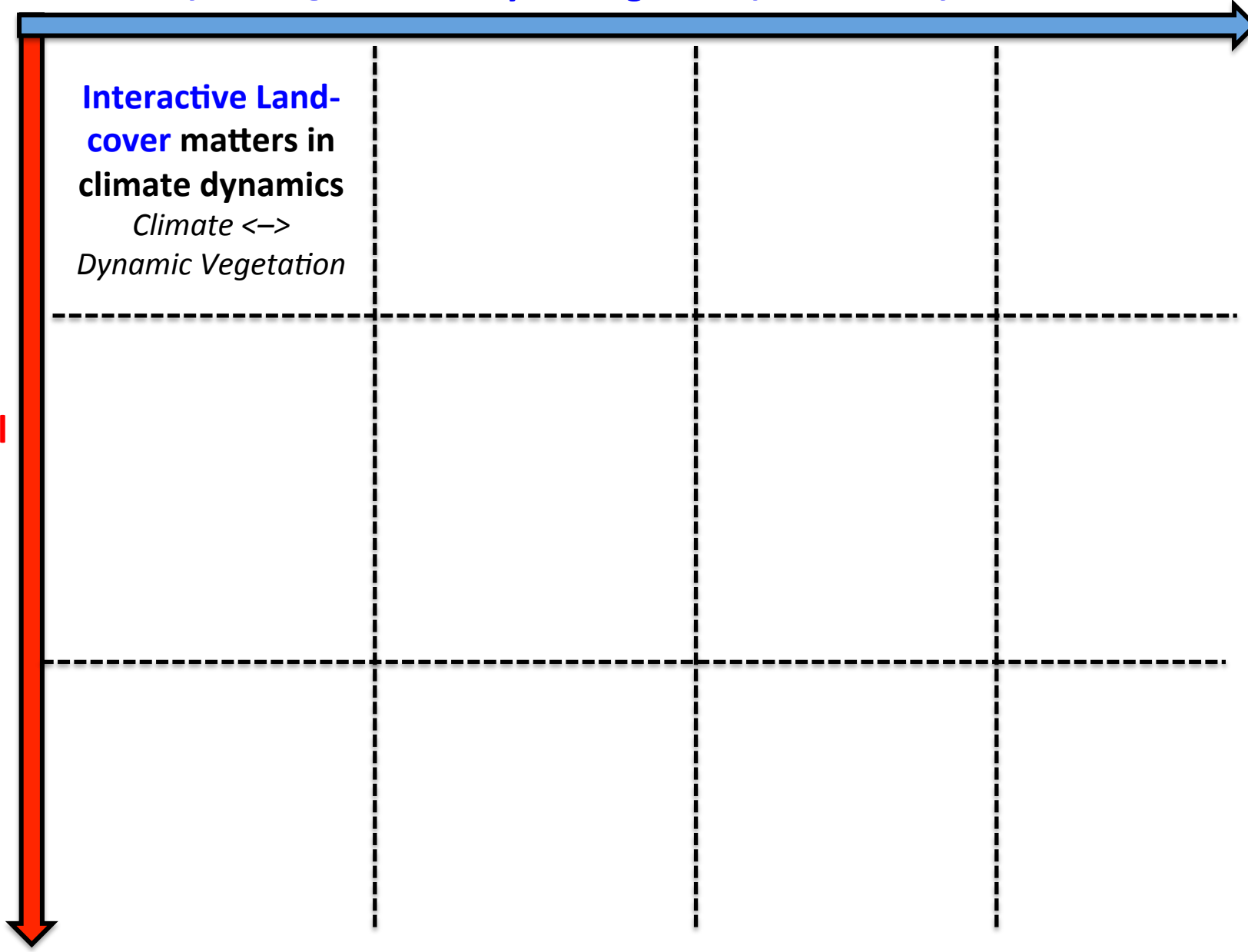
**Global**

**Interactive Land-cover matters in climate dynamics**  
*Climate <-> Dynamic Vegetation*

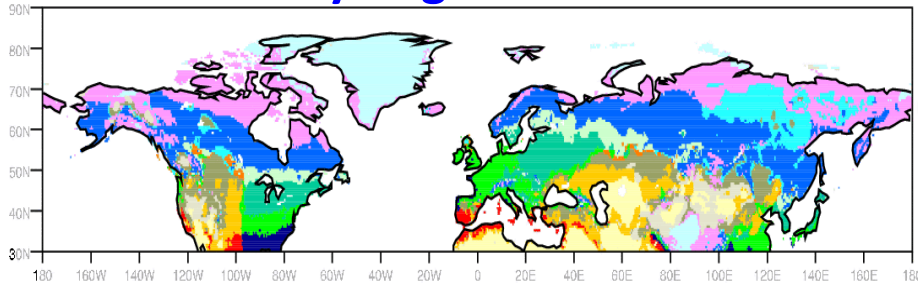
**Regional**

**Local**

**SPATIAL SCALES**



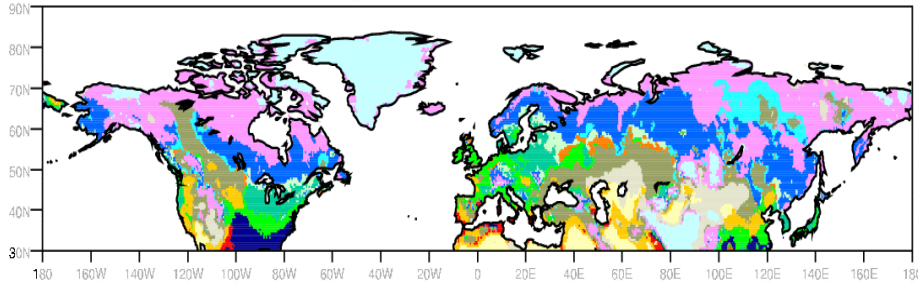
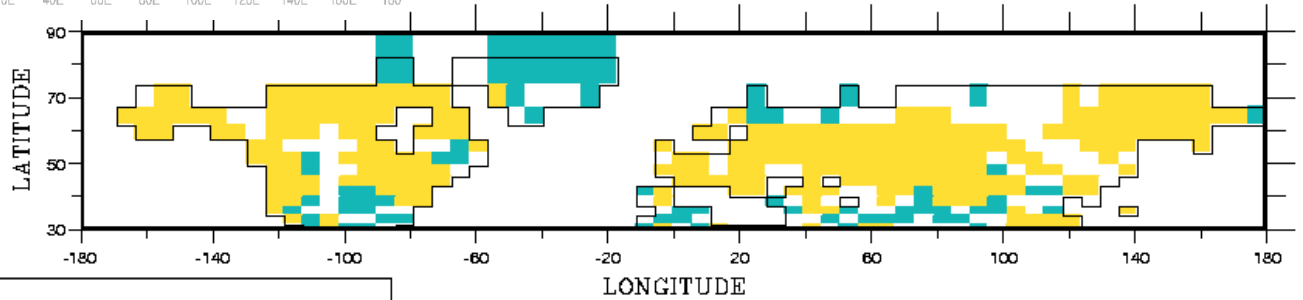
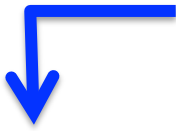
# Present-Day Vegetation Distribution



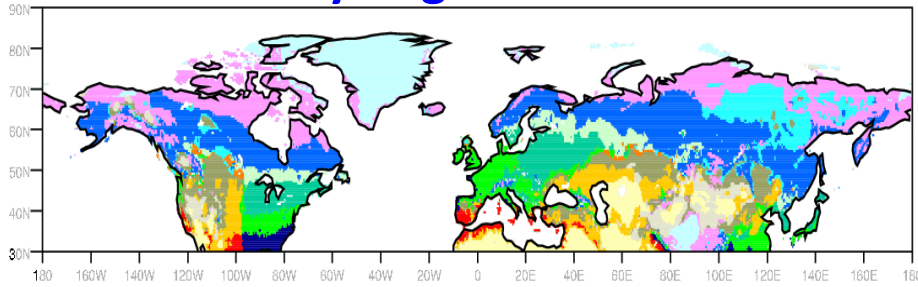
# Glacial Inception ~115000 years ago

Climate forced by orbital configuration → Glaciation sensitive regions [blue ones]

Resulting land-cover Change



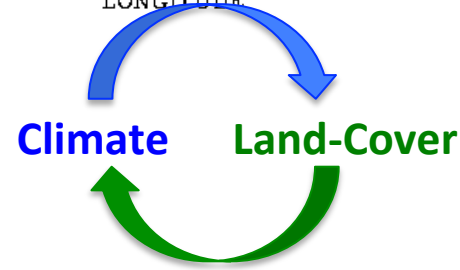
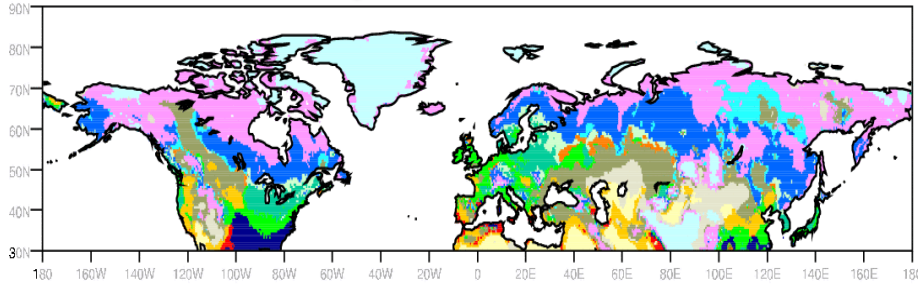
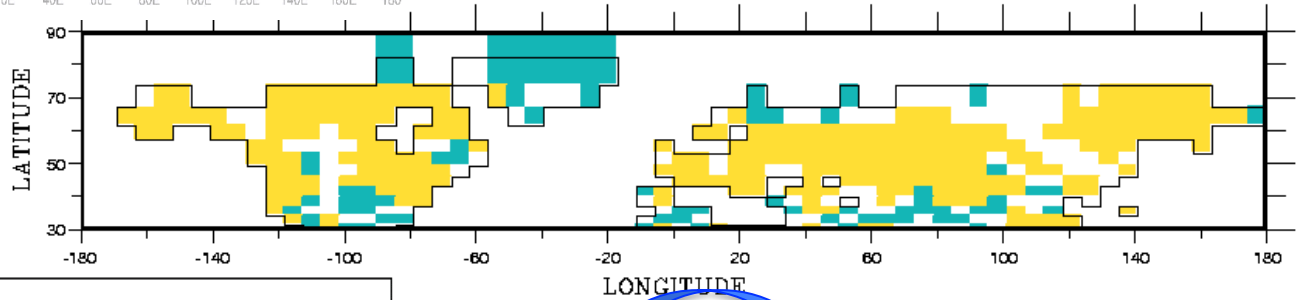
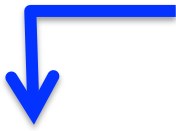
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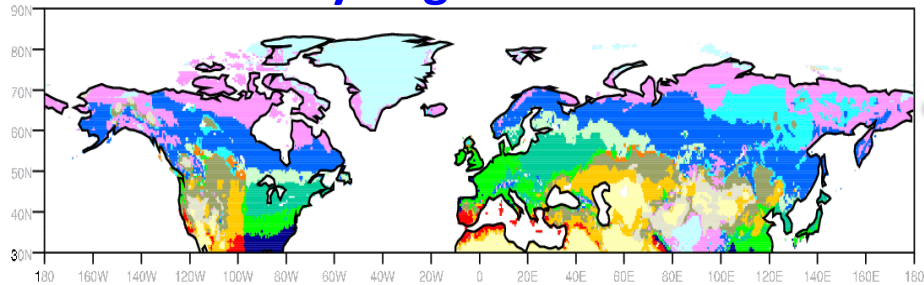
Climate forced by orbital configuration → Glaciation sensitive regions [blue ones]

Resulting land-cover Change





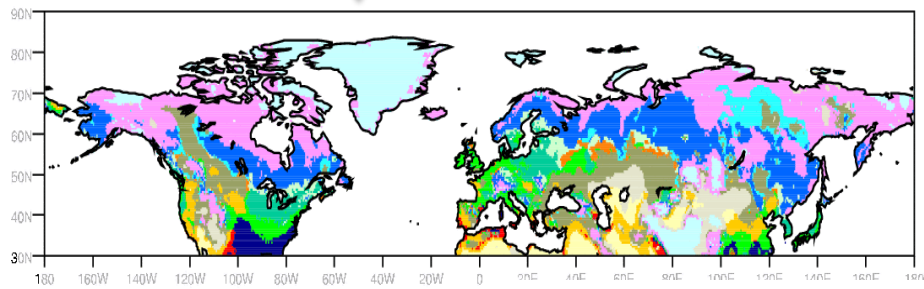
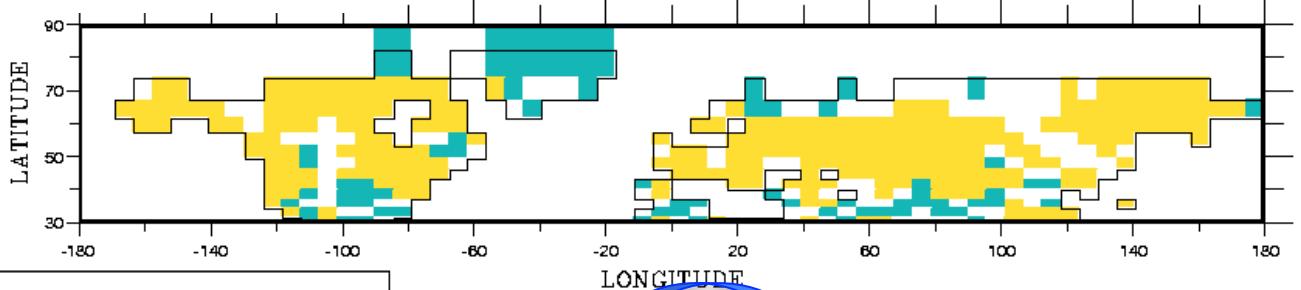
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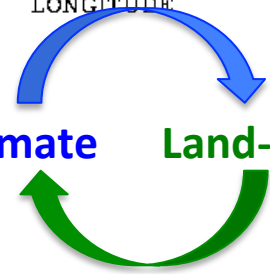
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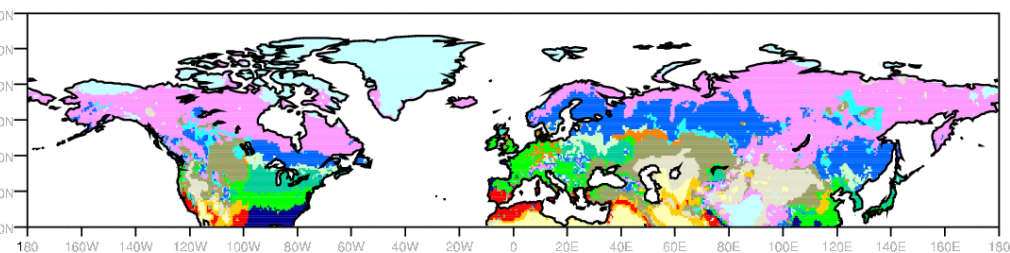
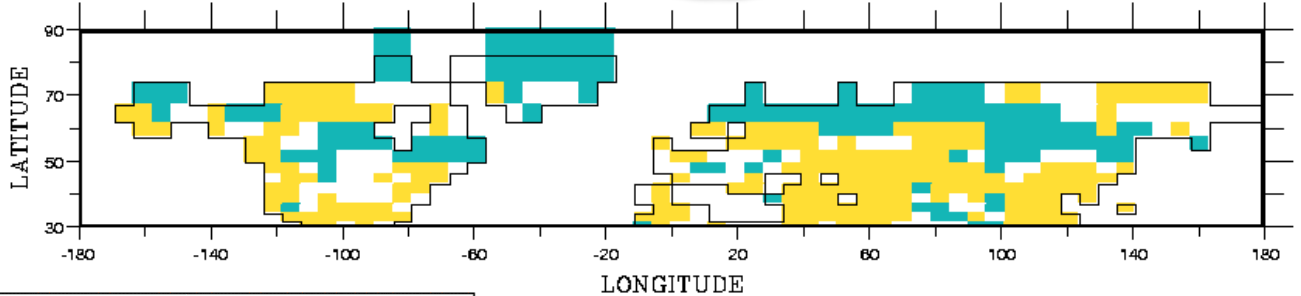
Resulting land-cover Change



Climate Land-Cover



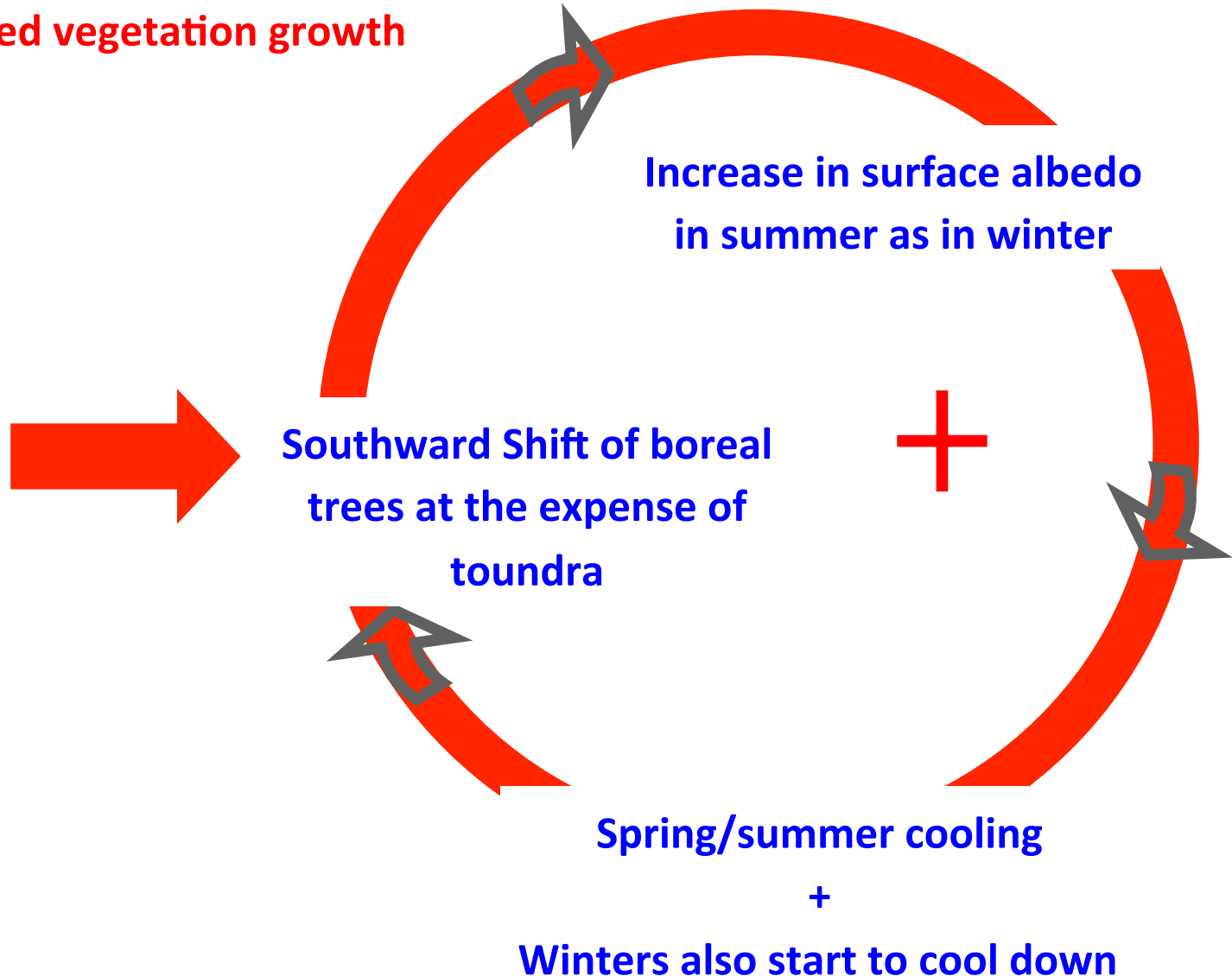
Equilibrium reached between climate & Vegetation



# 115 kyr BP : in summary

**Positive feedback between summer  
Cooling and limited vegetation growth**

Summer cooling  
resulting from  
changes in the  
Earth's orbit



# TIME SCALES

Glacial Inception ~115000 years ago      Mid-Holocene ~6000 years ago      pre-industrial & present-day      Next Century

## SPATIAL SCALES

Global

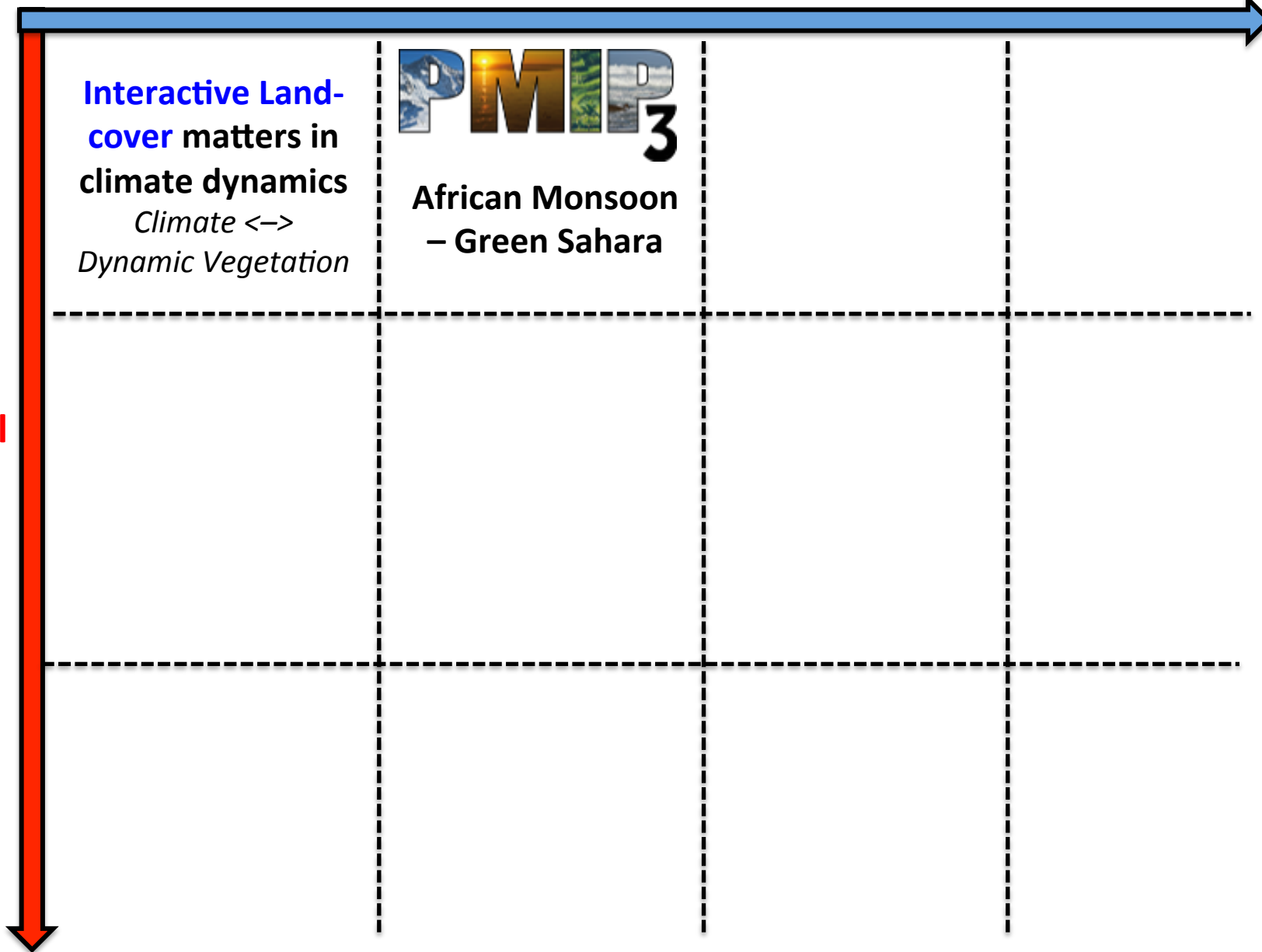
Interactive Land-cover matters in climate dynamics  
*Climate <-> Dynamic Vegetation*



African Monsoon – Green Sahara

Regional

Local



# TIME SCALES

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**Interactive Land-cover matters in climate dynamics**  
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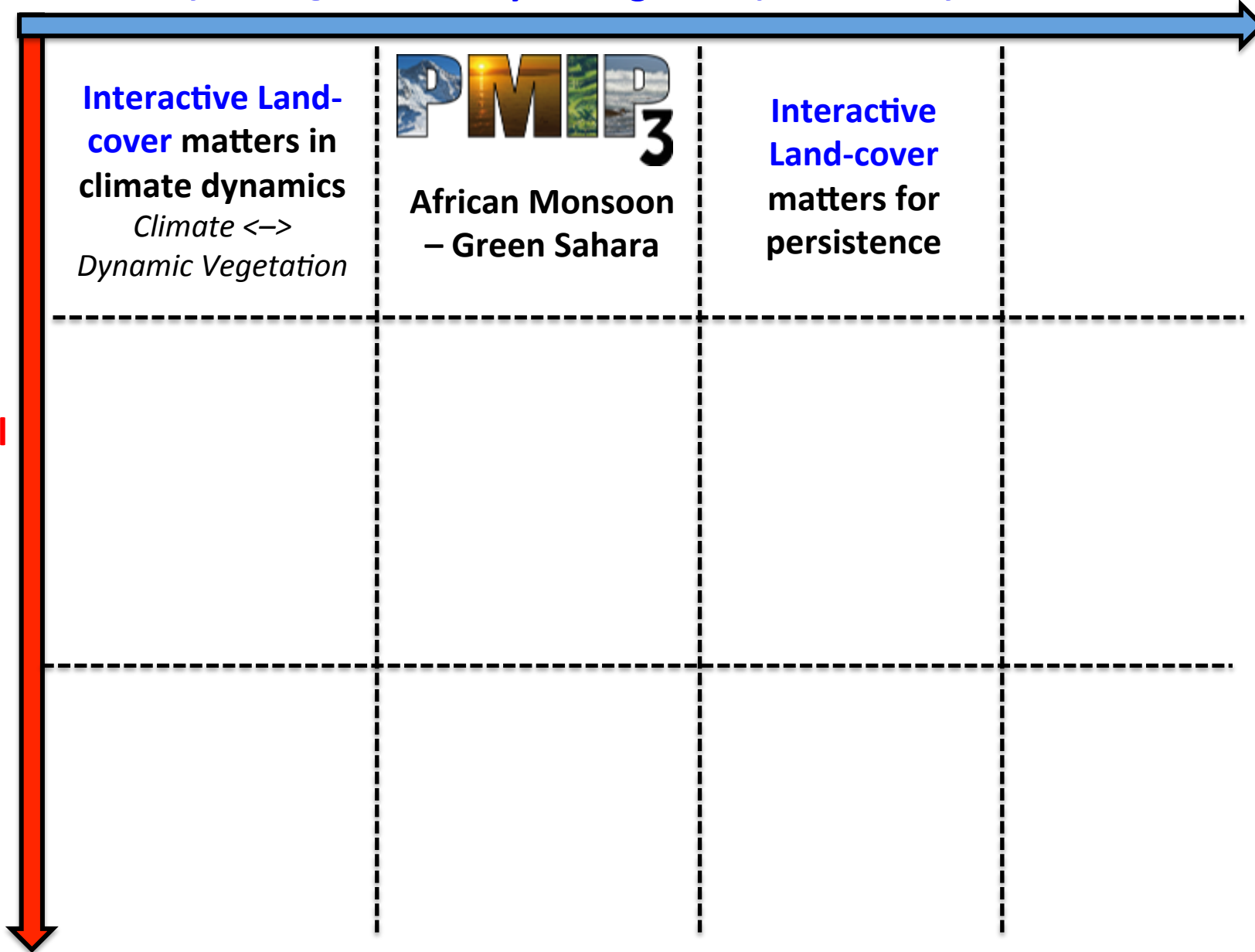
**African Monsoon – Green Sahara**

**Interactive Land-cover matters for persistence**

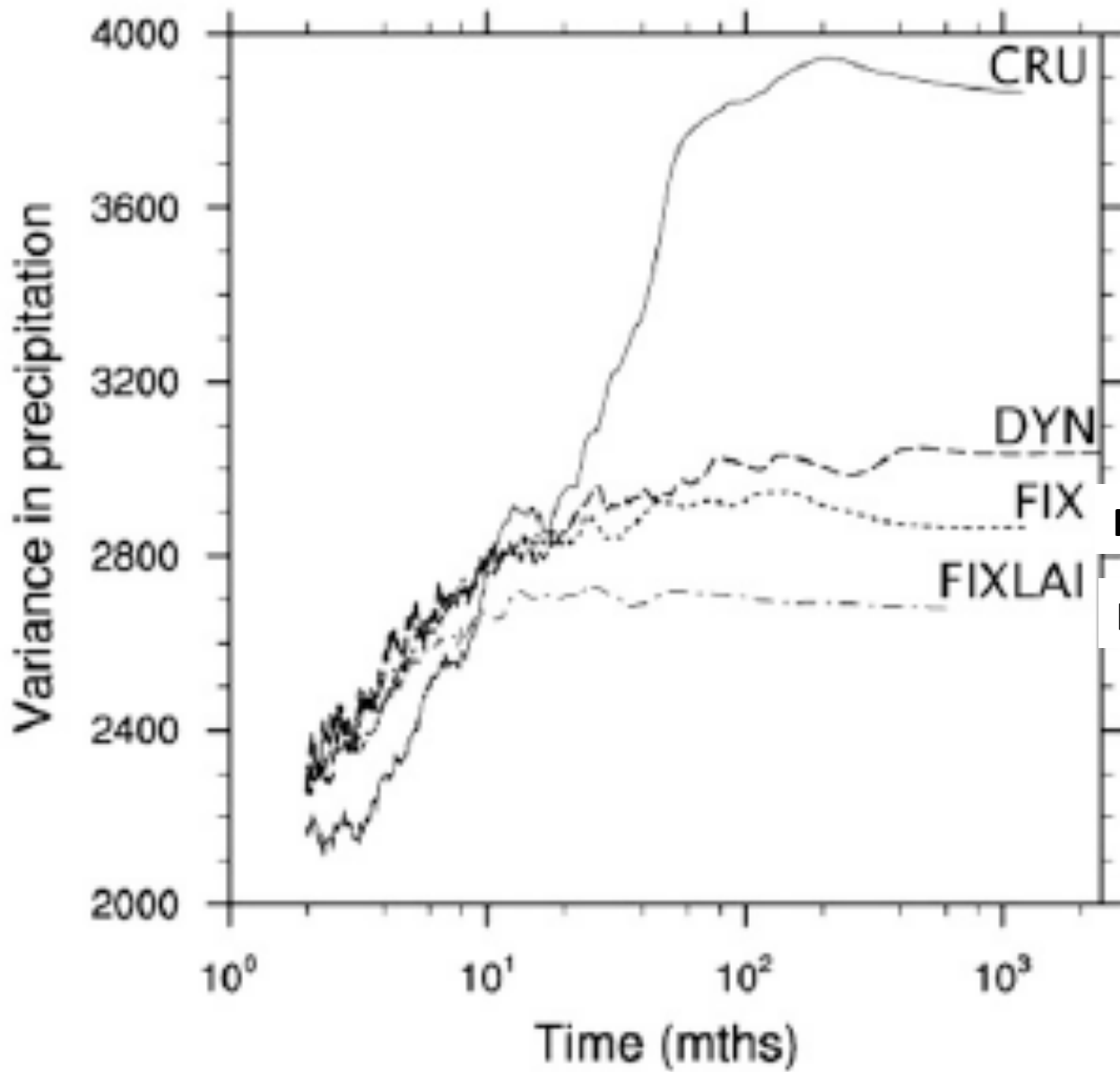
**SPATIAL SCALES**

**Regional**

**Local**



# LMDZ-ORCHIDEE

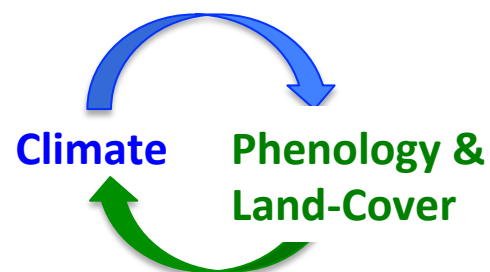


Power Spectrum of monthly precipitation (after removal of seasonal fluctuations)

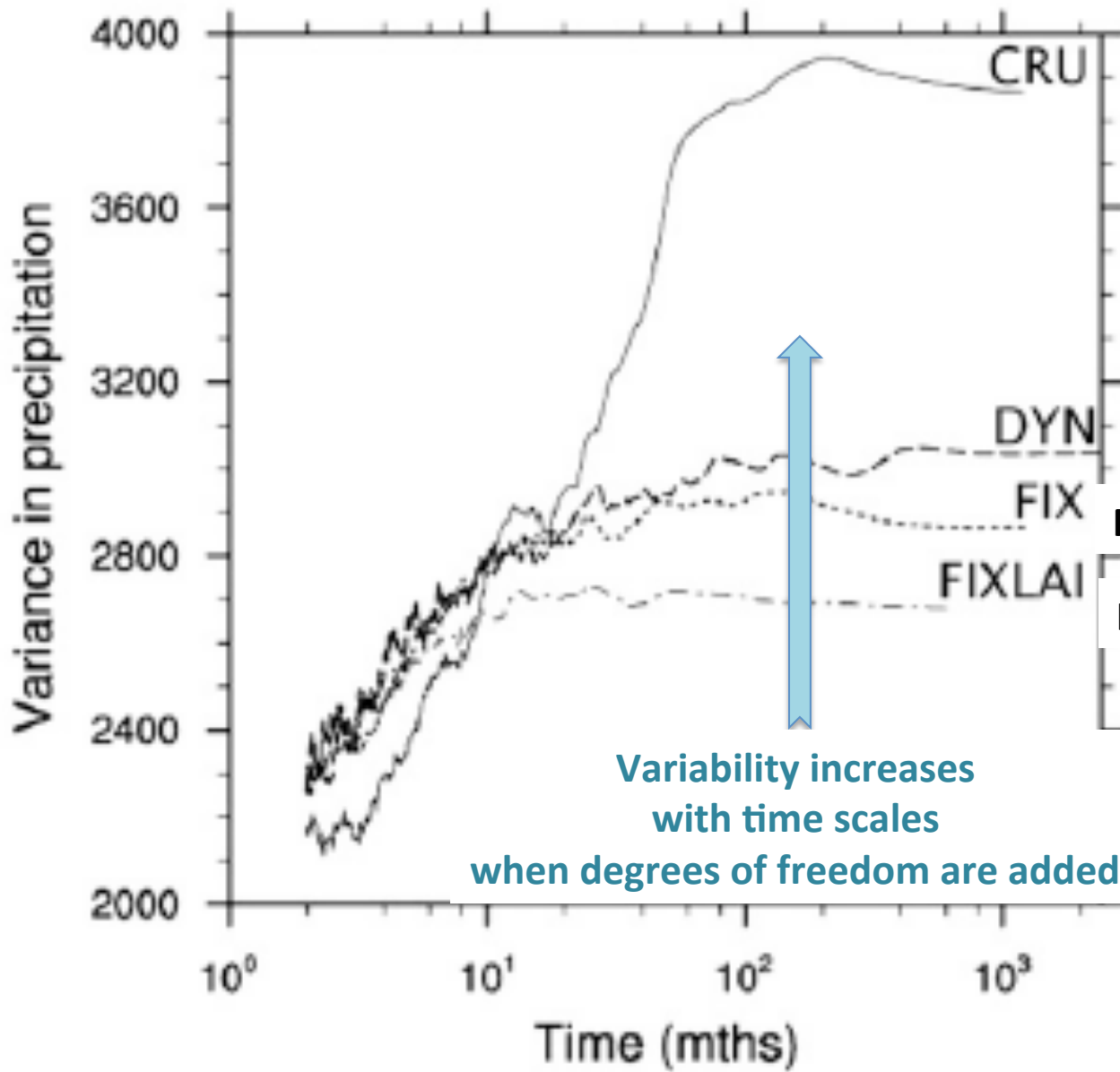
DYN Dynamic Land Cover + LAI

FIX Prognostic seasonal cycle of LAI

FIXLAI Imposed seasonal cycle of LAI



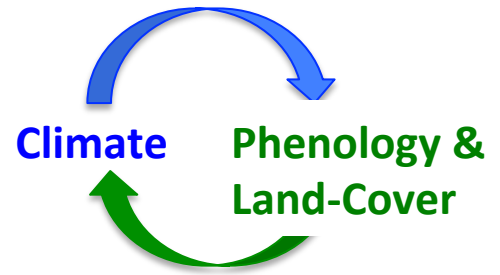
# LMDZ-ORCHIDEE



Variability increases with time scales when degrees of freedom are added

Power Spectrum of monthly precipitation (after removal of seasonal fluctuations)

DYN Dynamic Land Cover + LAI  
FIX Prognostic seasonal cycle of LAI  
FIXLAI Imposed seasonal cycle of LAI



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## SPATIAL SCALES

Global

**Interactive Land-cover matters in climate dynamics**  
*Climate <-> Dynamic Vegetation*



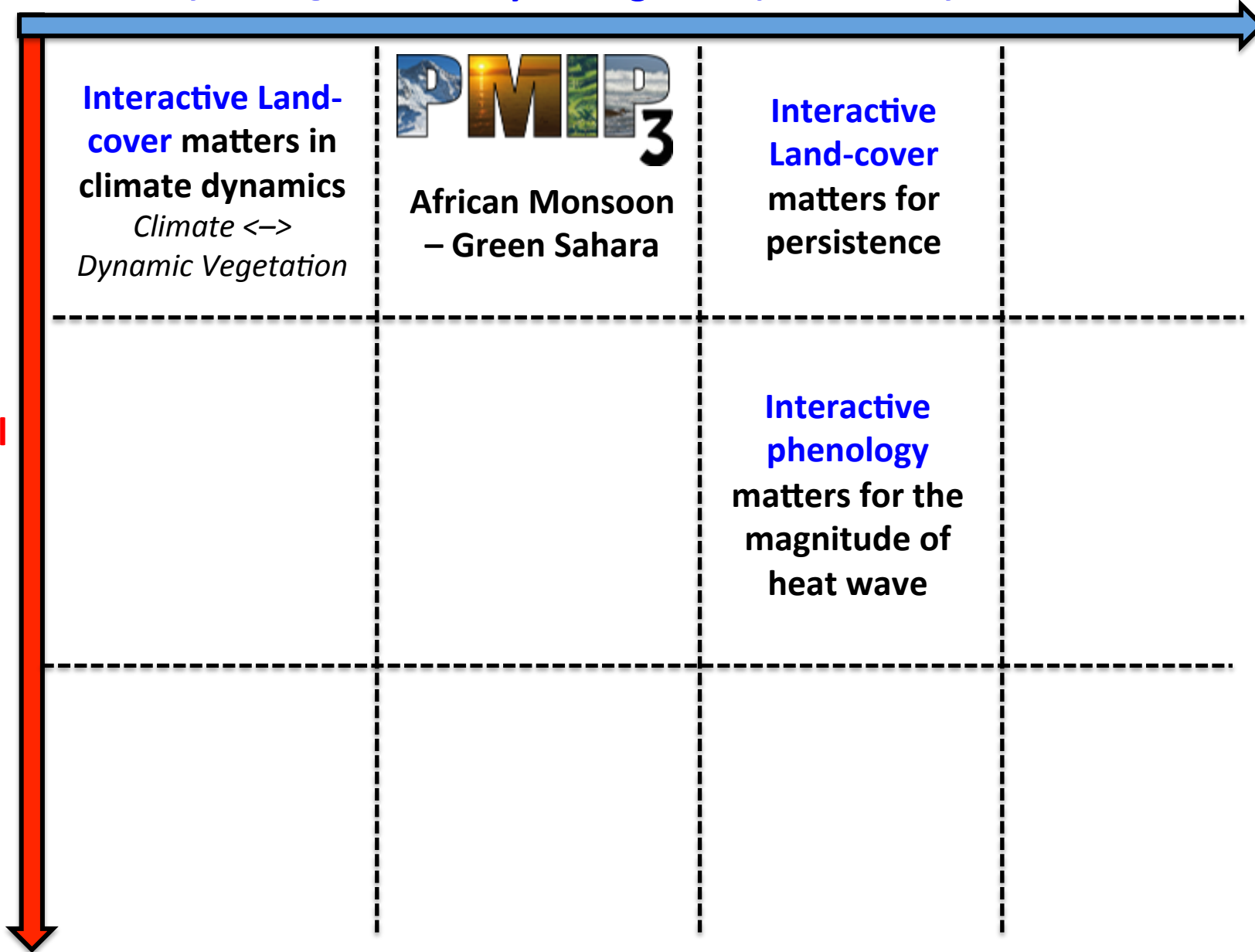
**African Monsoon – Green Sahara**

**Interactive Land-cover matters for persistence**

Regional

**Interactive phenology matters for the magnitude of heat wave**

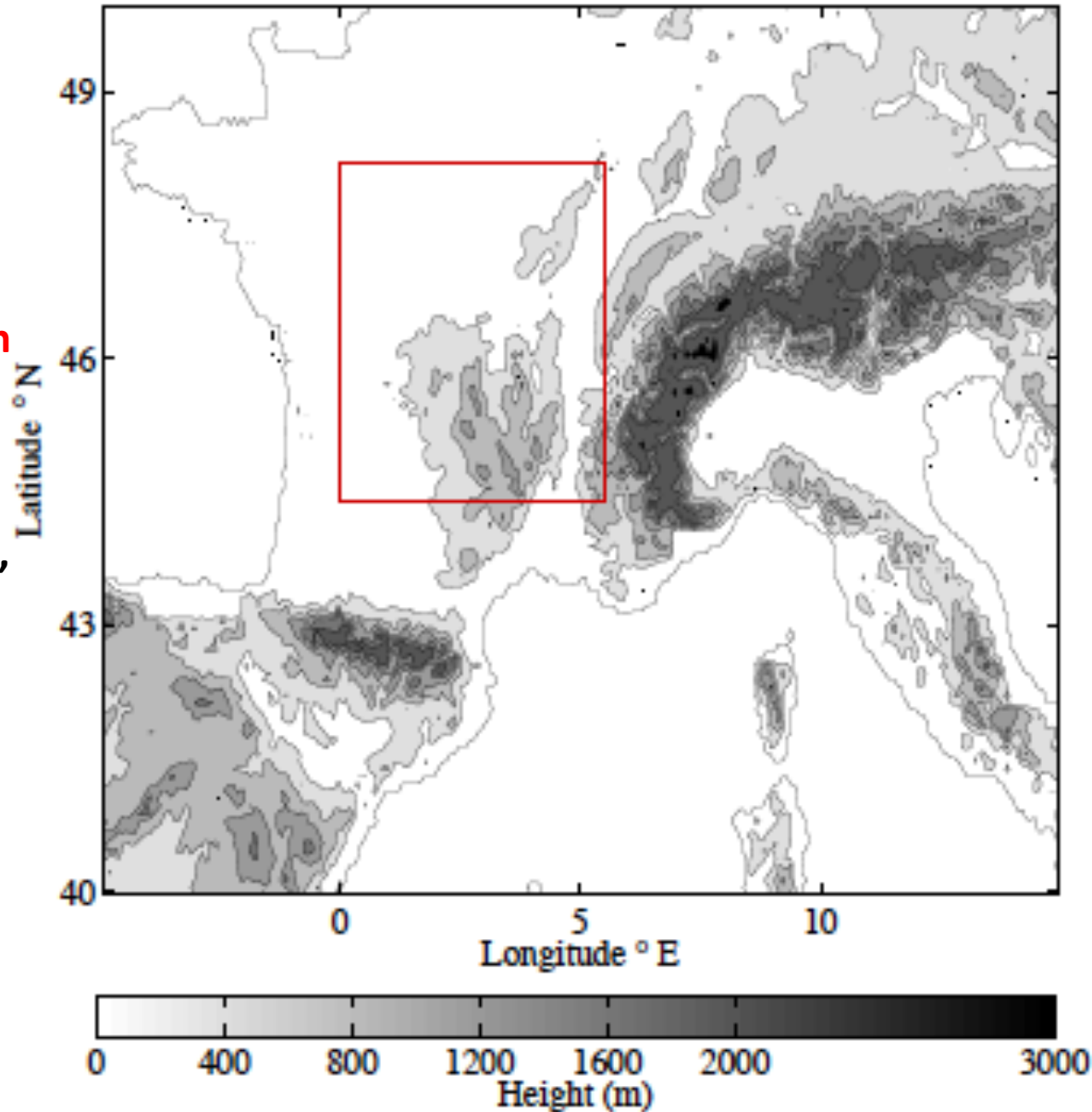
Local



# Role of Interactive Phenology on 2003 Heat Wave

**Regional Climate  
Model: WRF**  
*coupled to*  
**Dynamic Vegetation  
Model: ORCHIDEE**

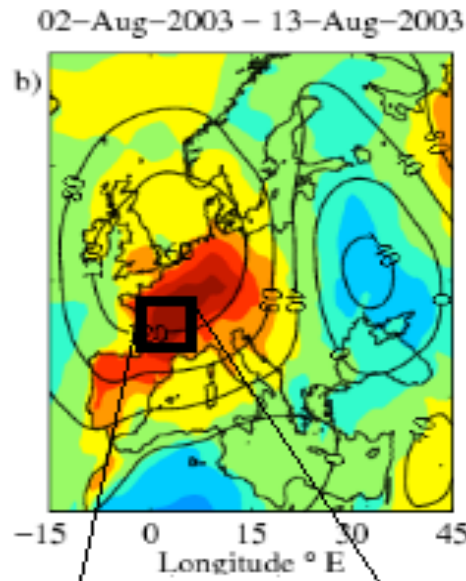
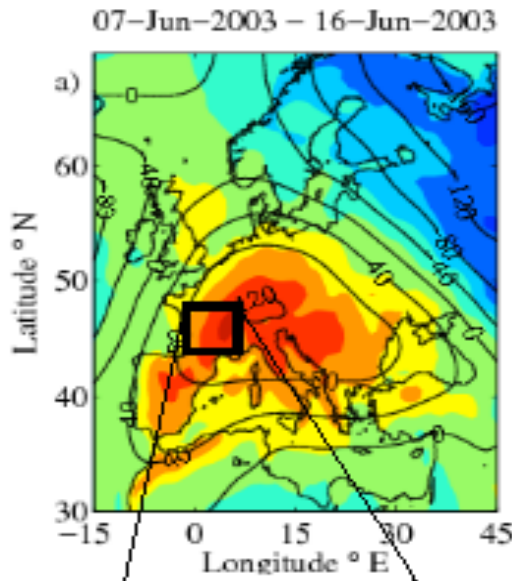
**2 simulations: 1)  
with interactive LAI,  
2) imposing 2002  
LAI**



**Dominant  
Vegetation  
= Crops**

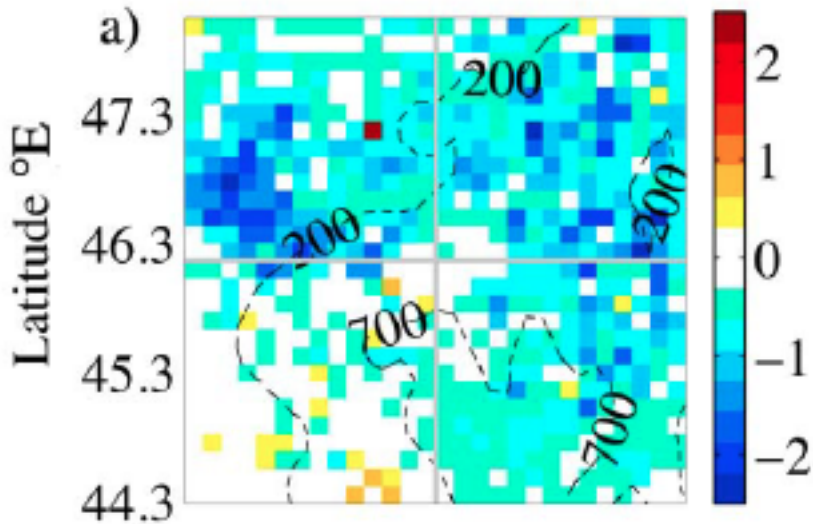


Observed  
June anomaly  
of Surface  
Temperature  
( $\Delta T$ )

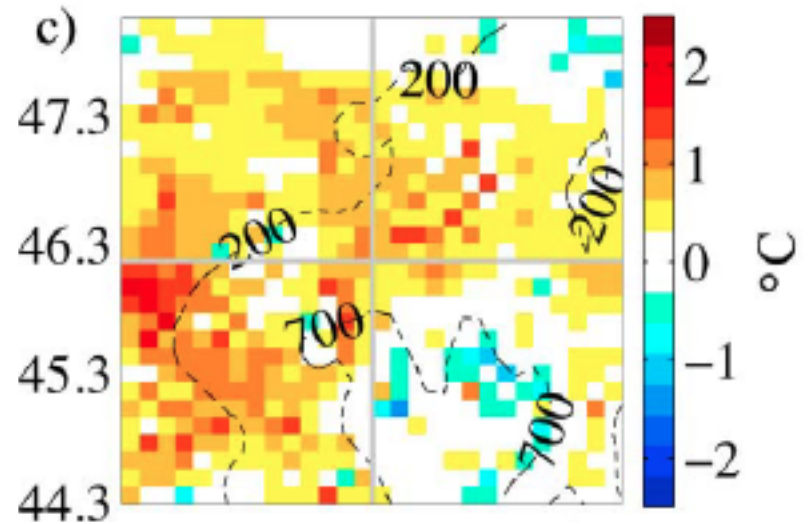


Observed  
August  
anomaly of  
Surface  
Temperature  
( $\Delta T$ )

LAI-induced changes in  $\Delta T$   
[Interactive LAI – LAI imposed to 2002 conditions]



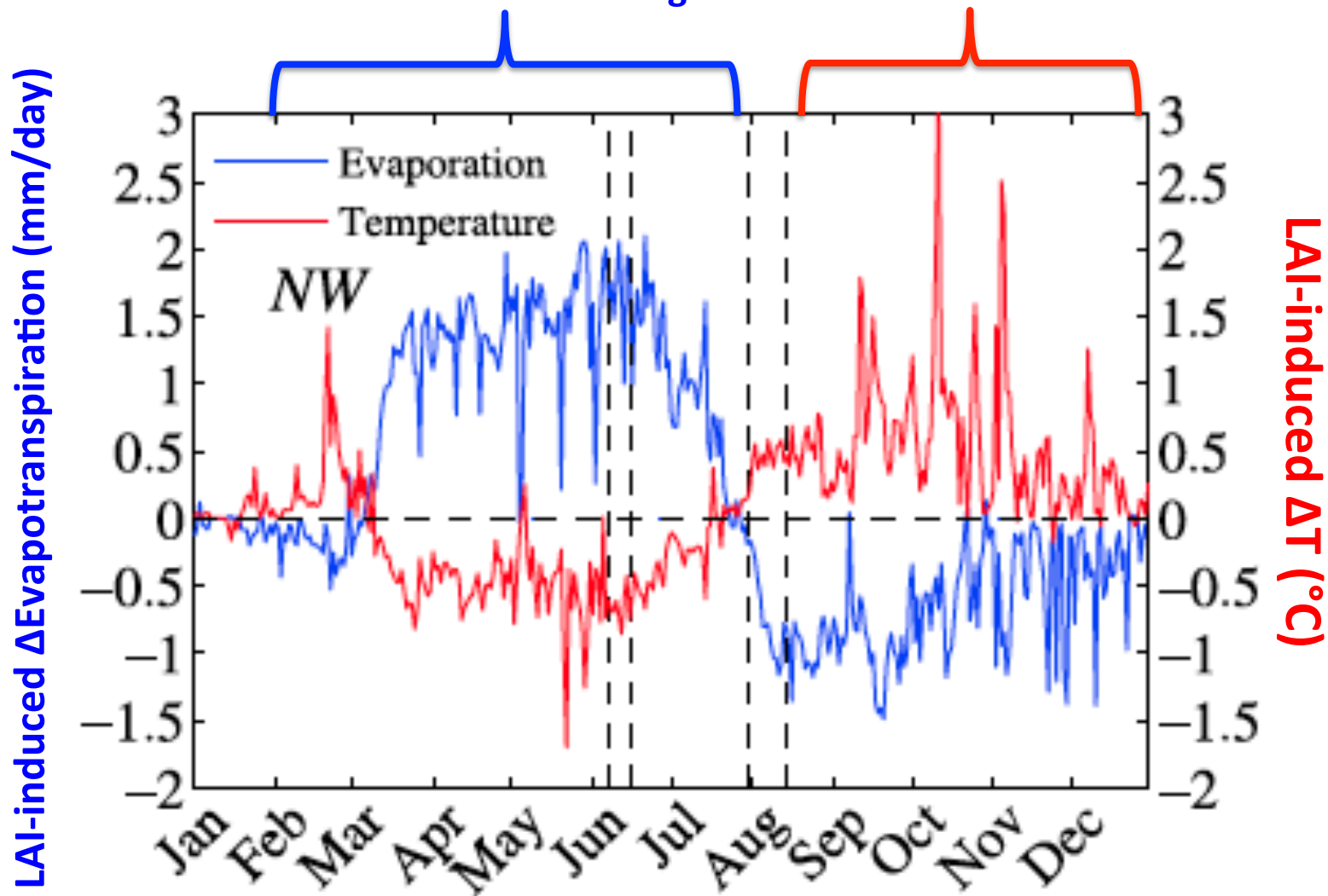
*Dampening*



*Amplification*

Earlier Onset of crops → larger LAI  
in 2003 than in 2002 → more  
evapotranspiration → cooler  
surface → reduced warming

Earlier senescence due to drought  
→ lower LAI in 2003 than in 2002 →  
less evapotranspiration → warmer  
surface → enhanced warming



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Interactive Land-cover matters in climate dynamics  
*Climate <-> Dynamic Vegetation*



African Monsoon – Green Sahara



LUCID Phase 1

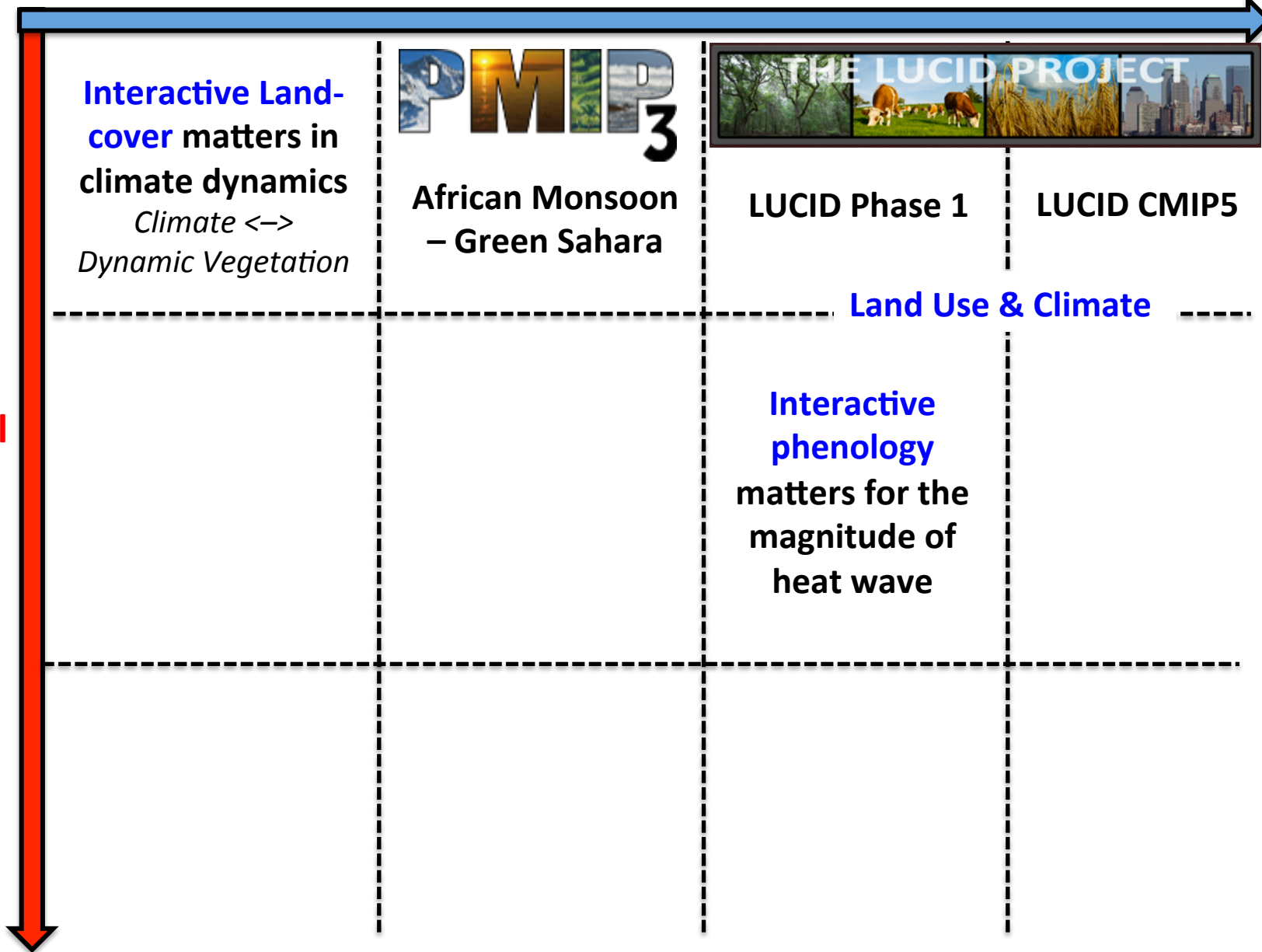
LUCID CMIP5

Regional

Land Use & Climate

Interactive phenology matters for the magnitude of heat wave

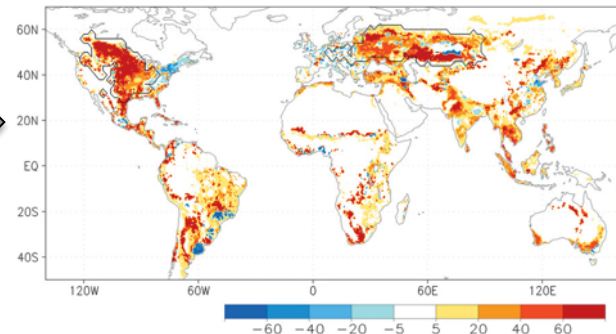
Local



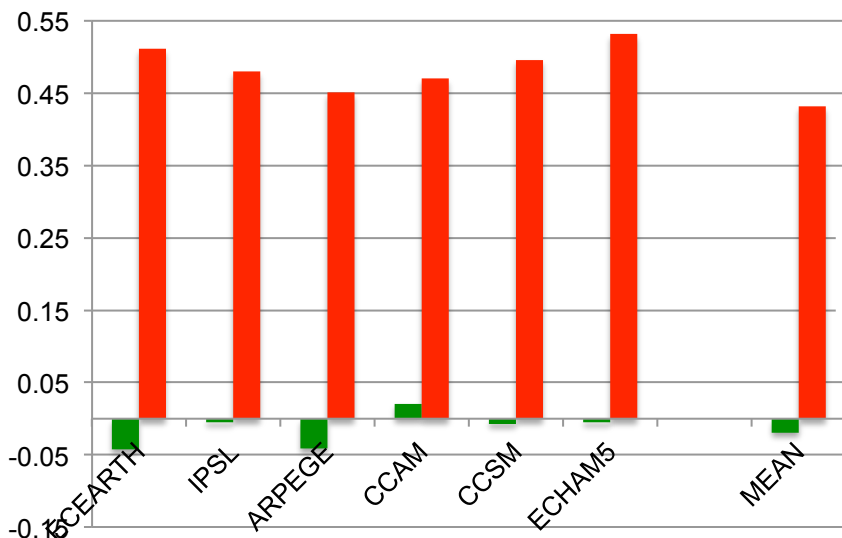


<http://www.lucidproject.org.au/>

**Increased Crop areas since pre-industrial times**  **&**  
**The response of Surface Air Temperature**



No Significant Signal for mean annual global temperature

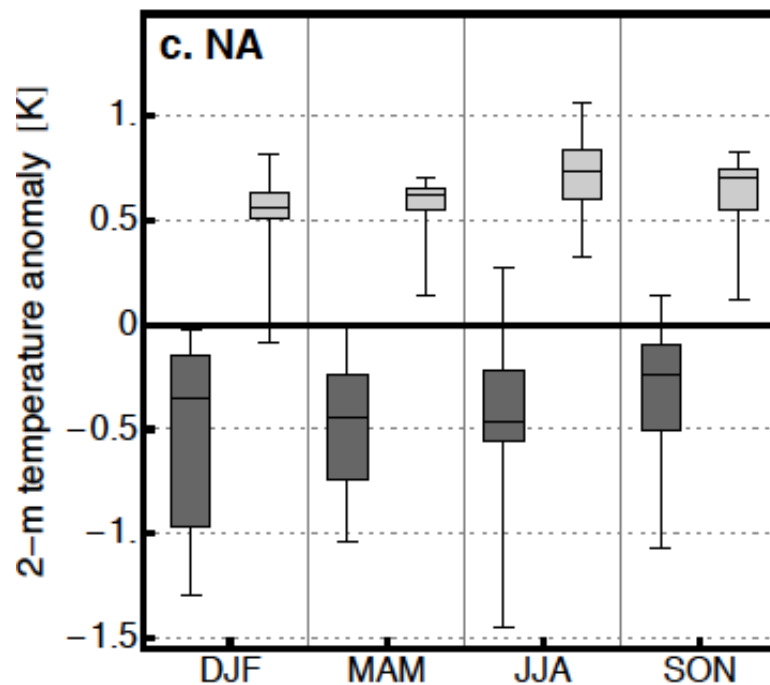


**Response to increasing crop areas**  
**Response to global warming**

*Pitman et al. (2009)*

*de Noblet-Ducoudré et al. (2012)*

However, signal of equivalent magnitude but of opposite sign at the regional level (here North America)

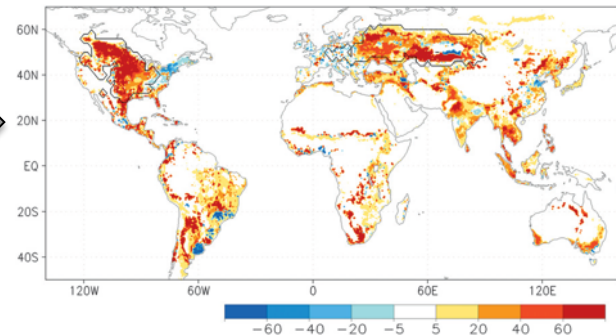


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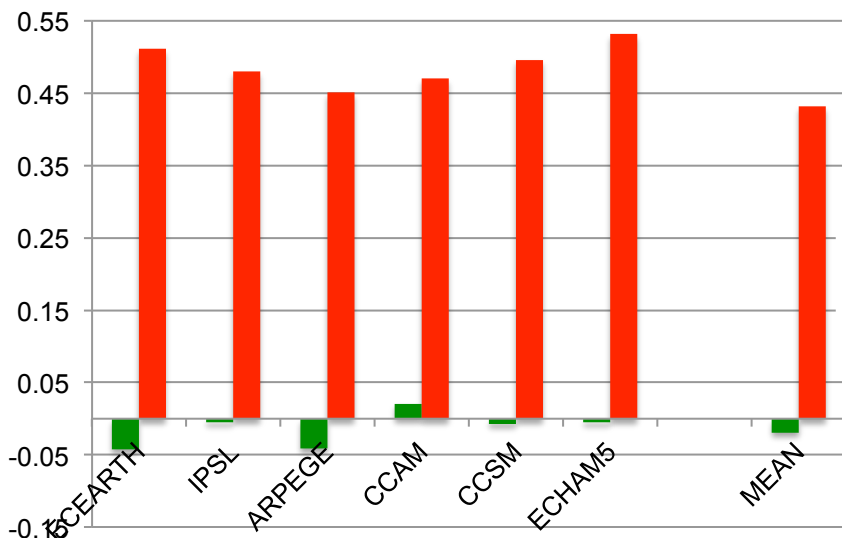


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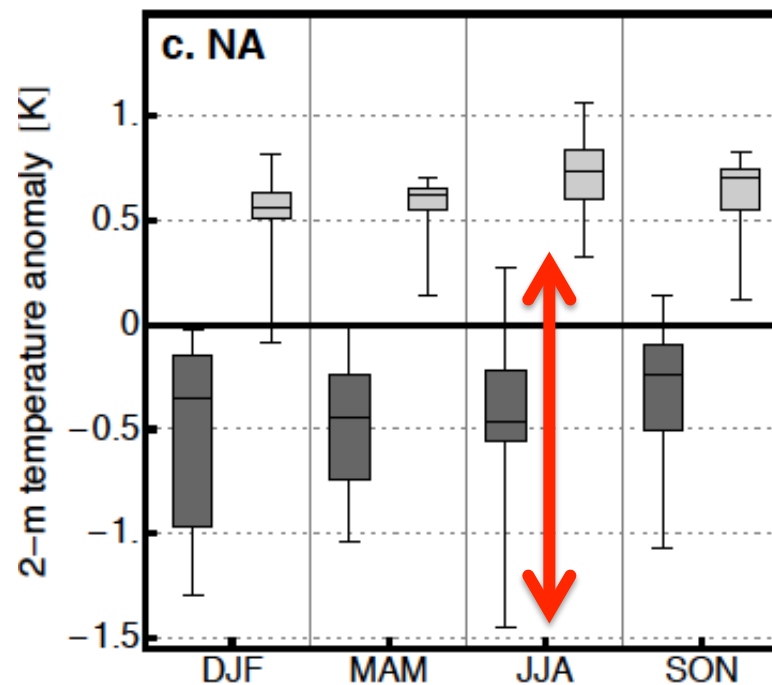


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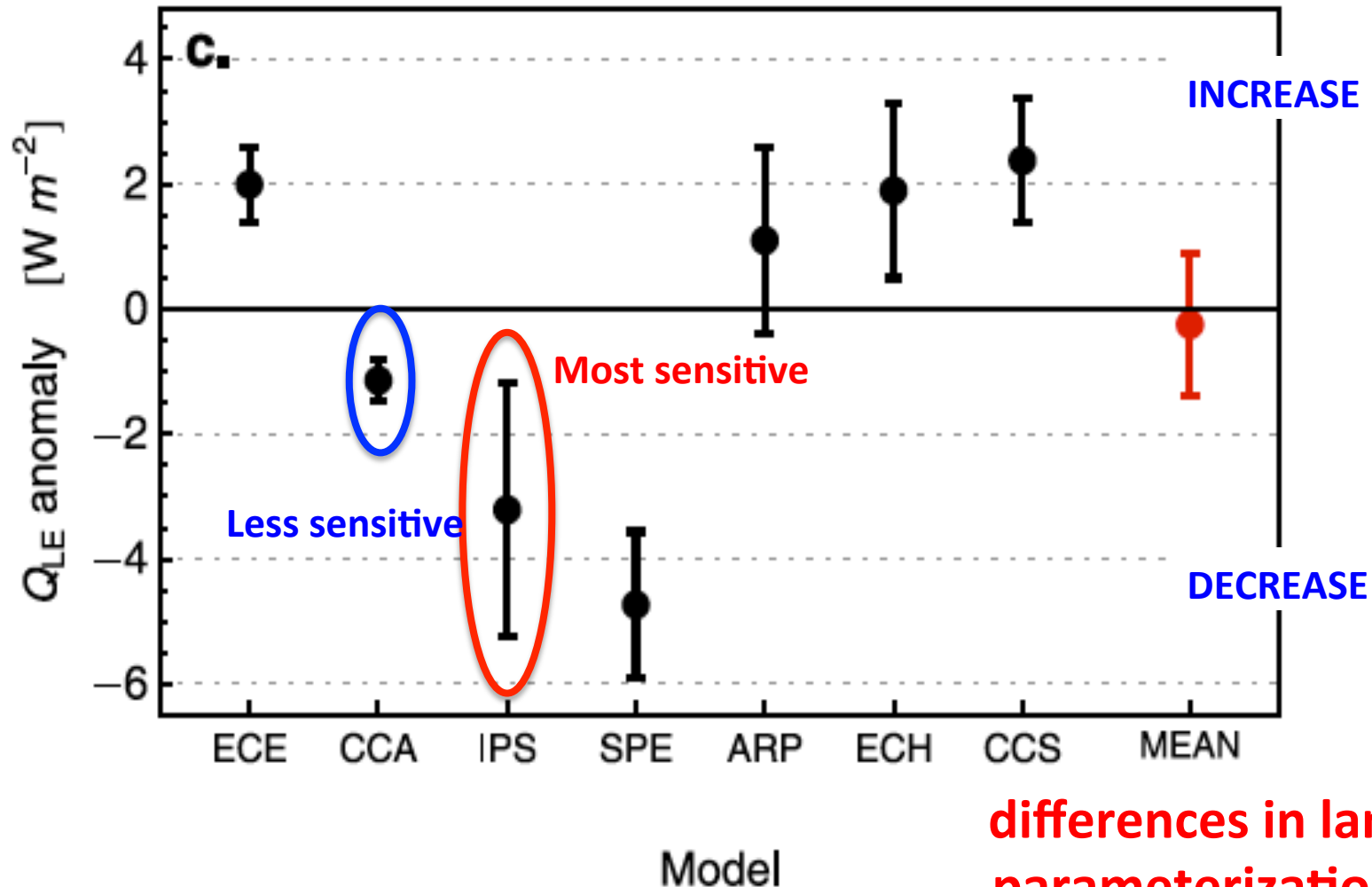
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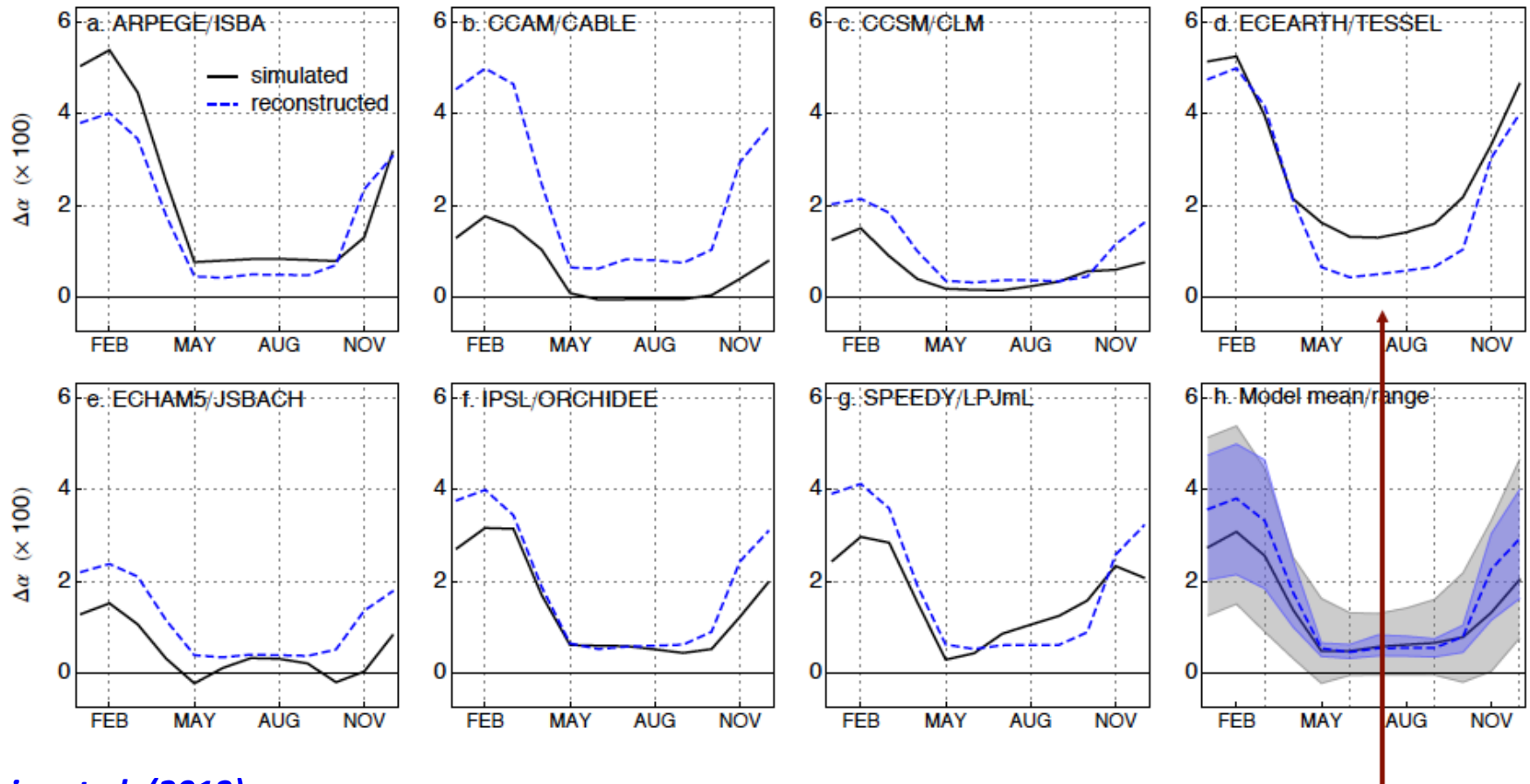
Sensitivity of each DGVM's simulated  
Latent Heat Flux to the magnitude of LULCC



differences in land-surface  
parameterizations explain  
~2/3<sup>rd</sup> of differences  
between climatic responses

# Historical impacts of LULCC estimated from present-day satellite observations

*Surface albedo changes in the northern temperate regions*



*Boisier et al. (2013)*

Large differences between the simulated and diagnosed albedo changes, despite the fact the LULCC is consistent in each case.

Some cases reveal clear discrepancies in snow-free albedo parametrizations

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## SPATIAL SCALES

Global

**Interactive Land-cover** matters in climate dynamics  
*Climate <-> Dynamic Vegetation*



African Monsoon – Green Sahara



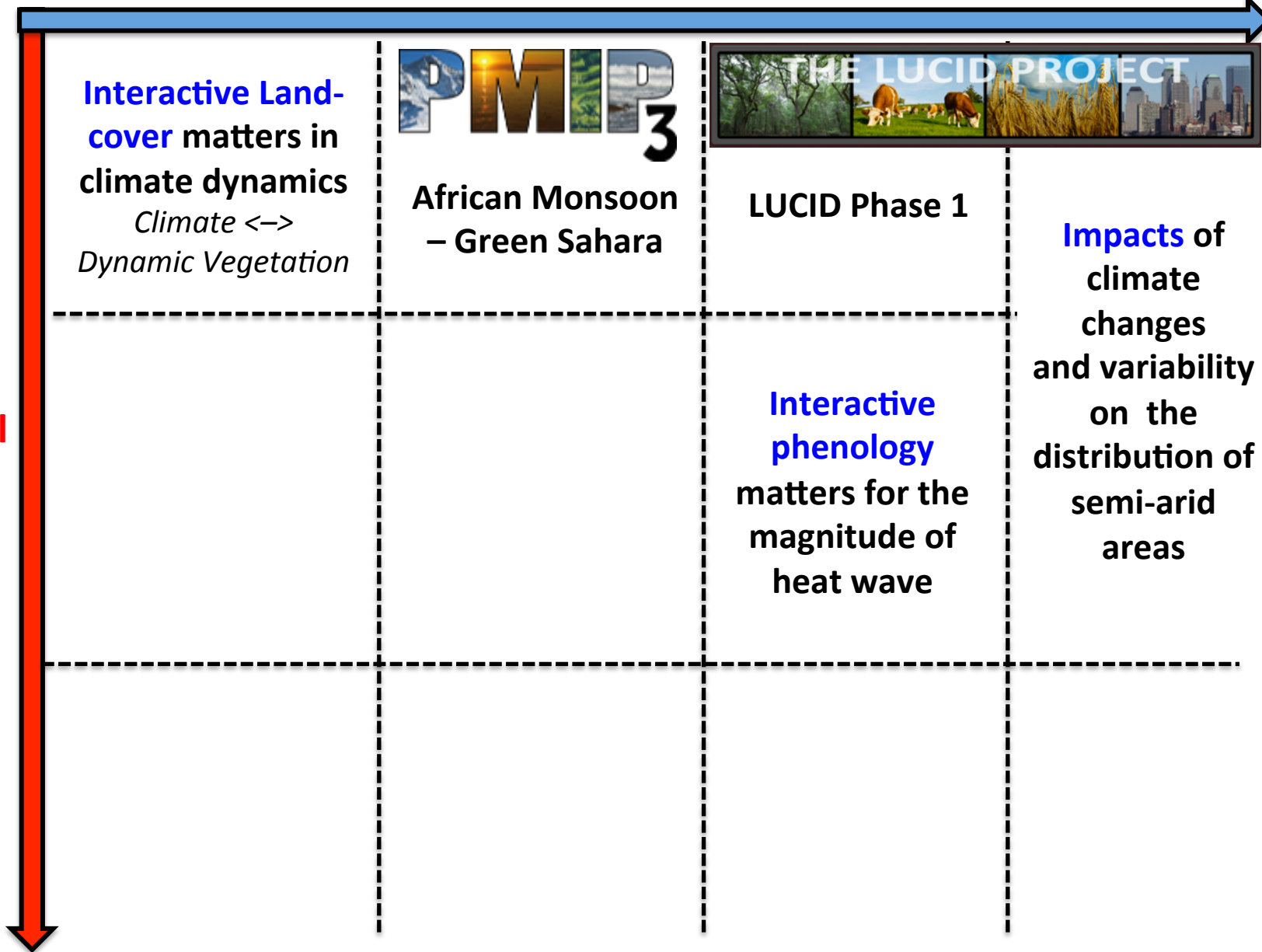
LUCID Phase 1

**Interactive phenology** matters for the magnitude of heat wave

**Impacts of climate changes and variability on the distribution of semi-arid areas**

Regional

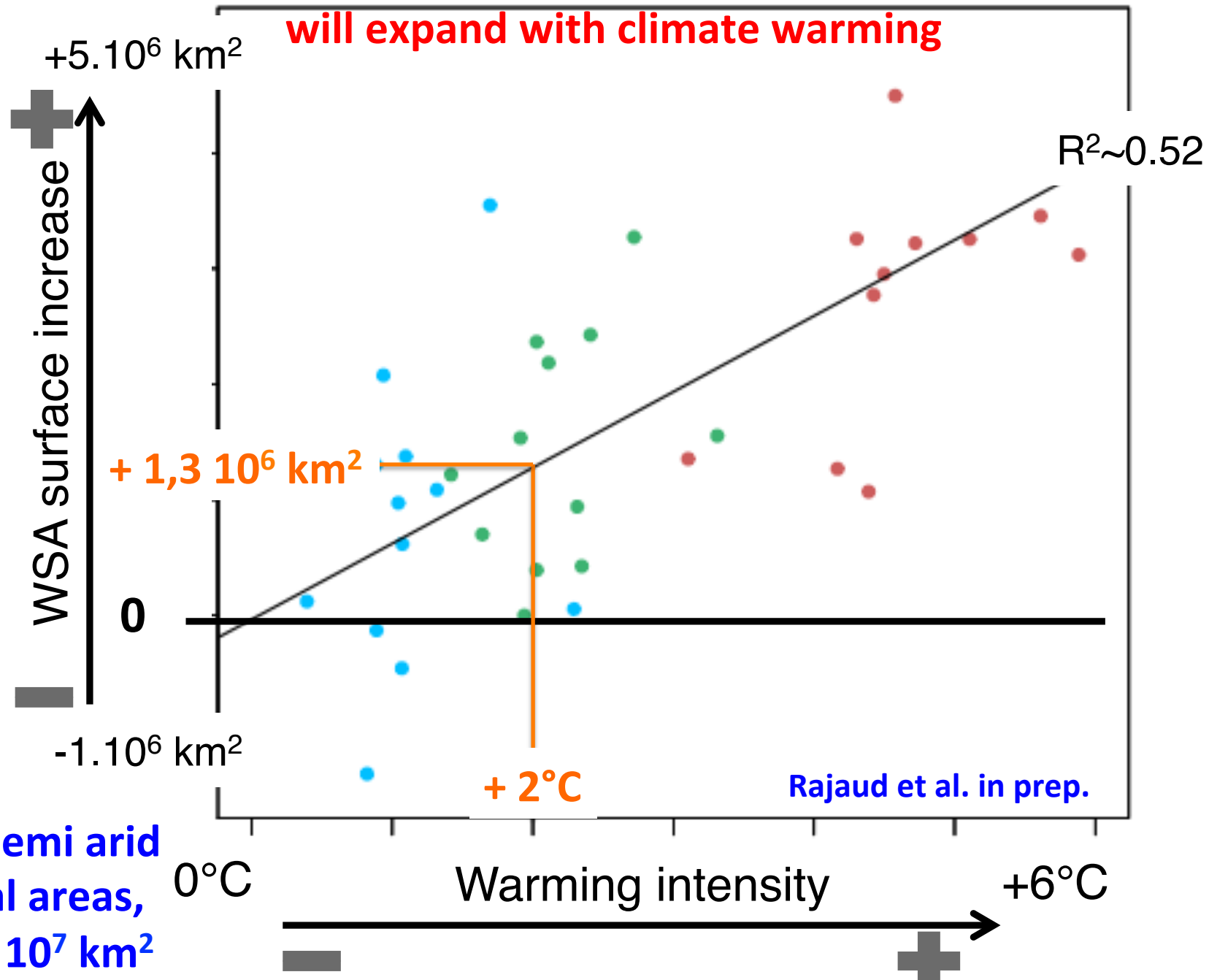
Local





# Warm Semi-Arid Regions (derived from Köppen classification)

will expand with climate warming



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African Monsoon  
- Green Sahara



LUCID Phase 1

Impacts of climate changes and variability on the distribution of semi-arid areas

Regional

Interactive phenology matters for the magnitude of heat wave



Impacts of climate changes and variability on managed ecosystems in France

Local

SPATIAL SCALES

**And from now on?**

**+**

**My questions to GEWEX**

# TIME SCALES

pre-industrial  
& present-day

Next Century

Global

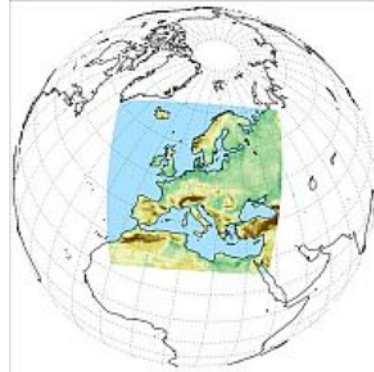


LUMIP

Land Use & Climate

SPATIAL SCALES

Regional



EURO-CORDEX +  
LUCID  
*(in prep.)*

**Impacts** of climate changes  
and variability on  
managed ecosystems

Interactions with local  
stakeholders / Co-construction of  
useful indicators of change

Local

## Main scientific questions/interest for the near future

- What are the relative contributions, on regional climate change of i) global climate change, ii) local land use & land cover changes (LULCC)?
- What errors do we make in impact studies if the simulated regional climate does not include LULCC?
- Are LULCC triggering remote impacts? Where? How? [Quesada et al. subm.]
- How do cities combine with climate change to impact peri-urban and urban ecosystem productivity ?
- ....

## My questions to GEWEX

- What is GEWEX doing with respect to climate services?  
[interactions with Future Earth?]
- How does GEWEX approach decadal time scales?



Thank You