

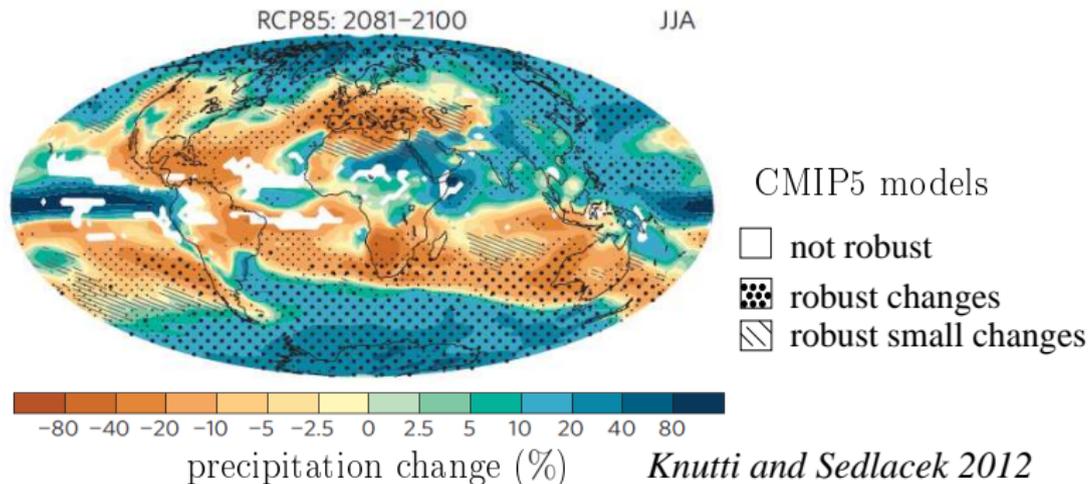
# Combining CMIP5 past, future and idealized simulations and paleo-data to better constrain climate projections

Camille Risi, Sandrine Bony and Françoise Vimeux

LMD/IPSL/CNRS

EGU, 9 April 2013

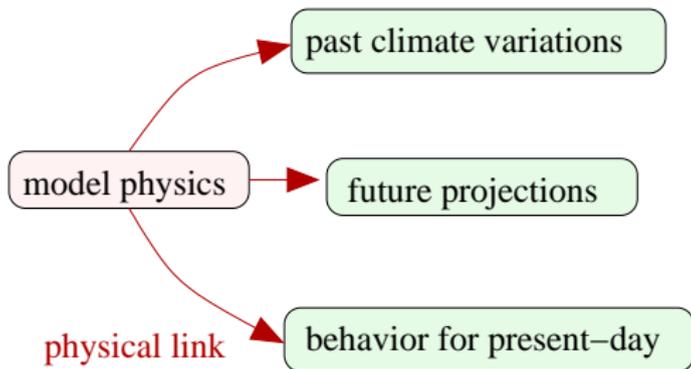
# Spread in projections



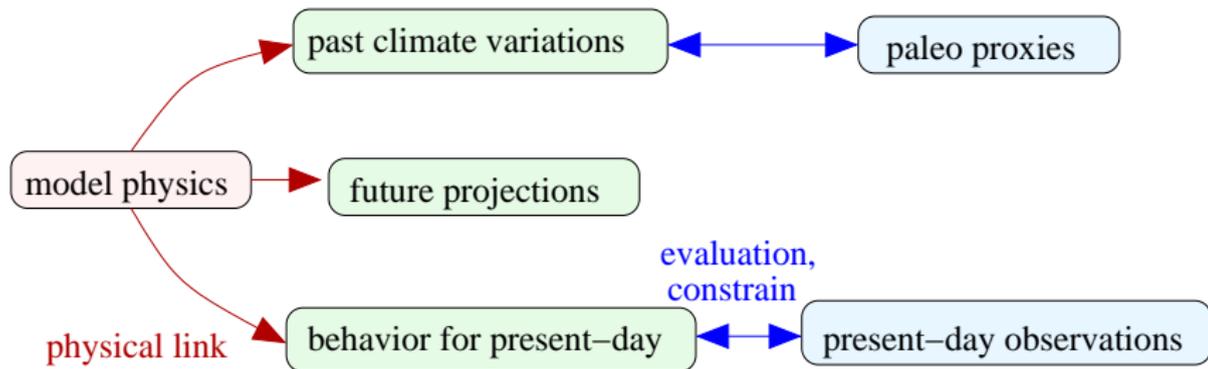
We trust more a projection if

- ▶ we understand the underlying physical mechanisms
- ▶ models are realistic compared to observations for these mechanisms

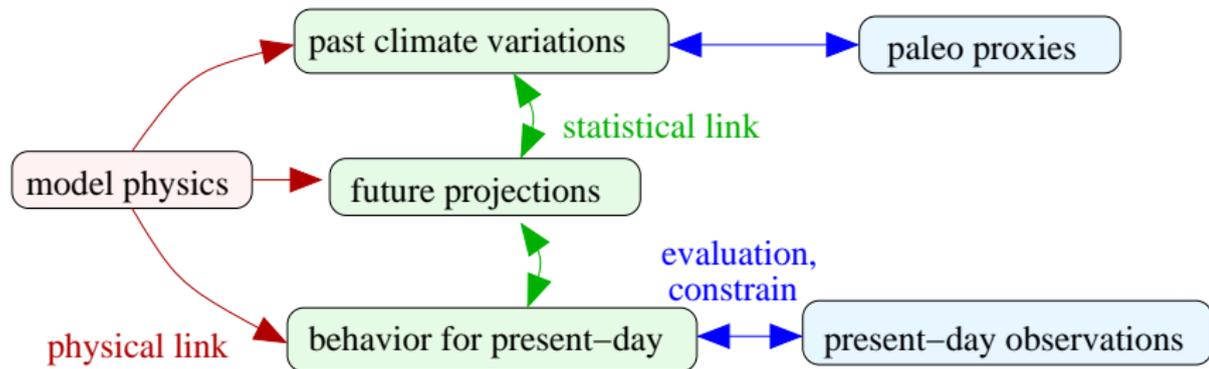
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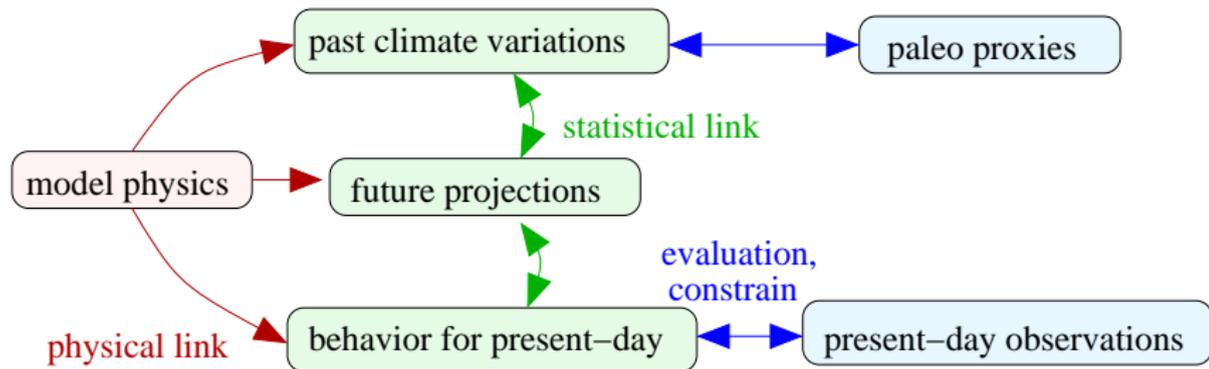
# Observable constraints on projections



⇒ 3 conditions to observationally constrain projections:

1. link between projected behavior and observable behavior

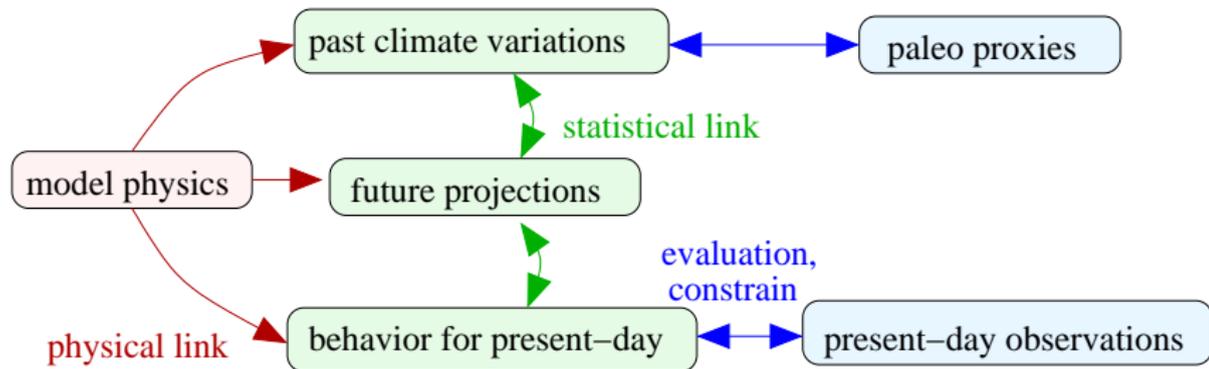
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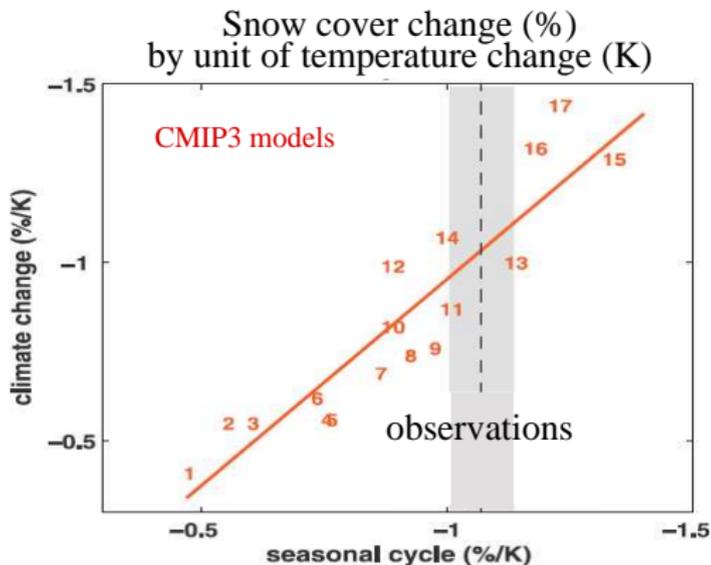


⇒ 3 conditions to observationally constrain projections:

1. link between projected behavior and observable behavior
2. common physical processes
3. observations with precision finer than model spread

# School case: Hall and Qu 2006

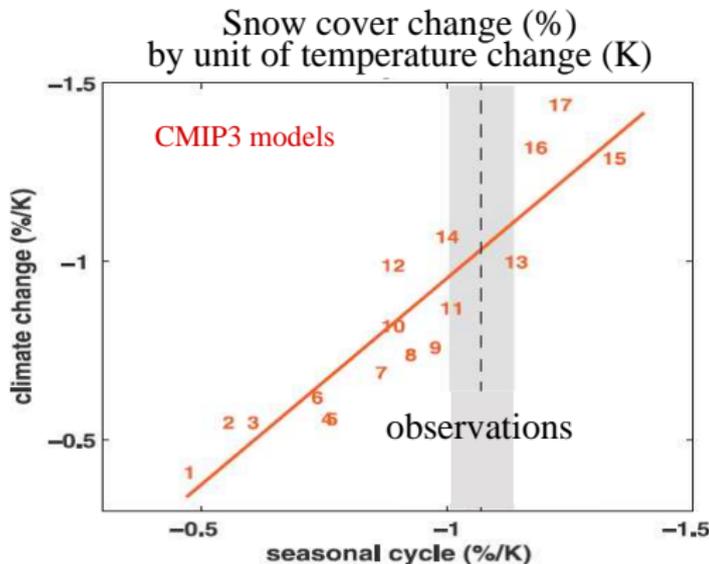
Constrain the snow albedo feedback: the 3 conditions met



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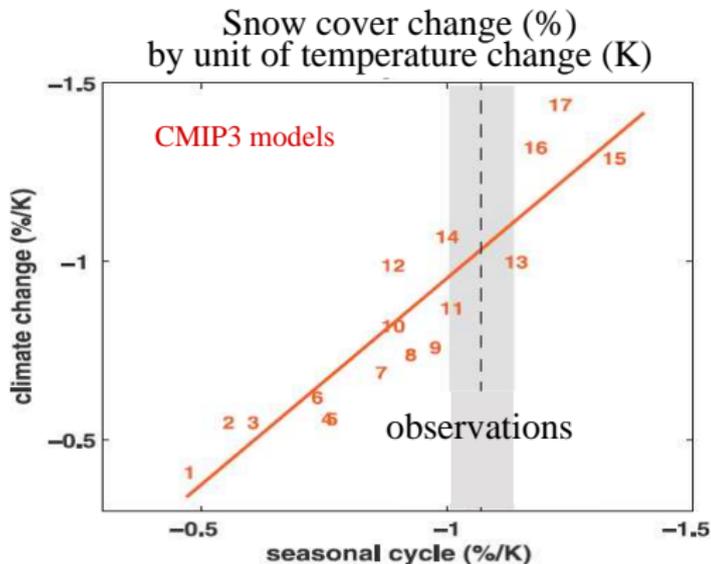
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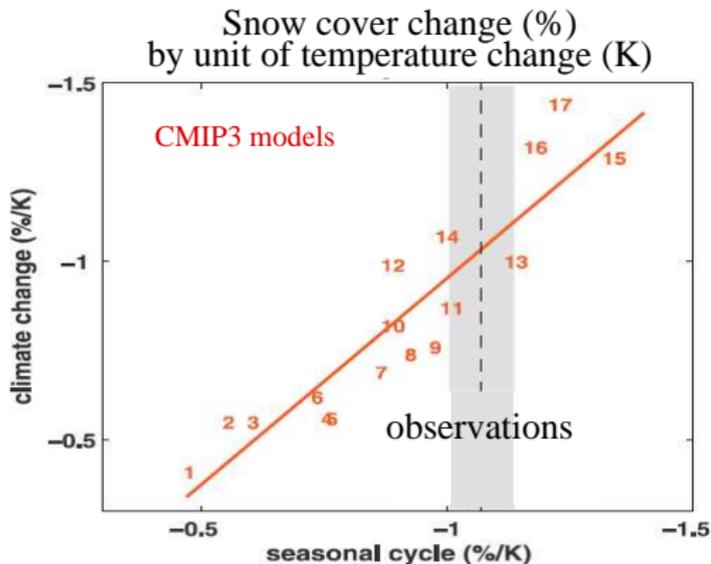
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# Can we apply the same methodology for paleo?

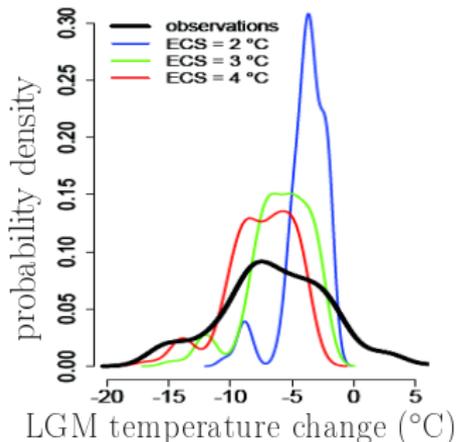
- ▶ CMIP5 great opportunity to extend this approach to paleo
- ▶ CMIP5 target periods: abundant data, relatively well known forcing
  - ▶ LGM  $\implies$  temperature changes
  - ▶ MH  $\implies$  tropical hydrological changes
  - ▶ last millenium  $\implies$  solar, volcanic and natural variability

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- ▶ In this talk, 2 examples to illustrate the 3 conditions:
  - ▶ A: climate sensitivity using LGM data (review)
  - ▶ B: tropical precip changes in South America using MH data (our work)

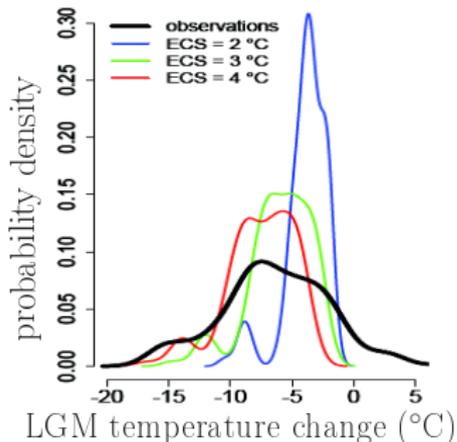
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Example: Schmittner et al 2011: use of LGM data  
PPE with ICM, 2xCO<sub>2</sub> and LGM simulations



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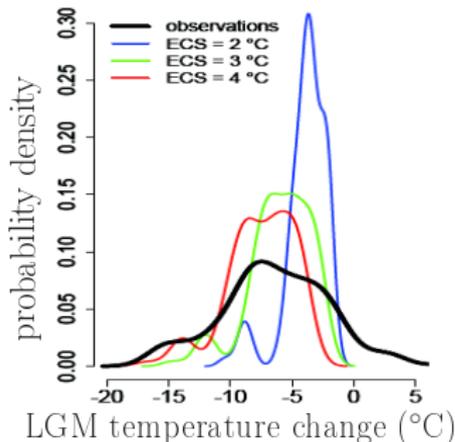
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⇒ Statistical link (condition 1) + data availability (condition 3)

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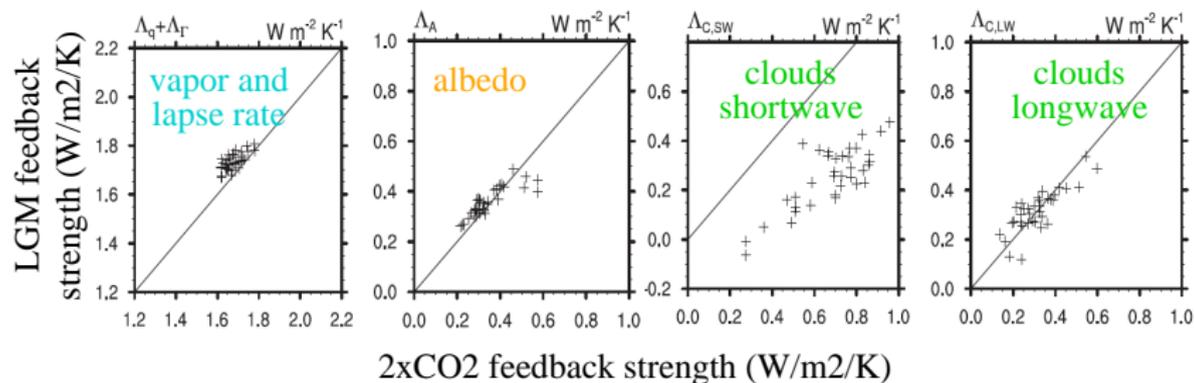
⇒ Statistical link (condition 1) + data availability (condition 3)  
Limitations:

- ▶ PPE vs MME? Do we cover the full range of possible models?
- ▶ is the link physically based? (condition 2)

# Example A: constrain climate sensitivity

Example: Yoshimori et al 2009: decompose climate sensitivity into feedbacks

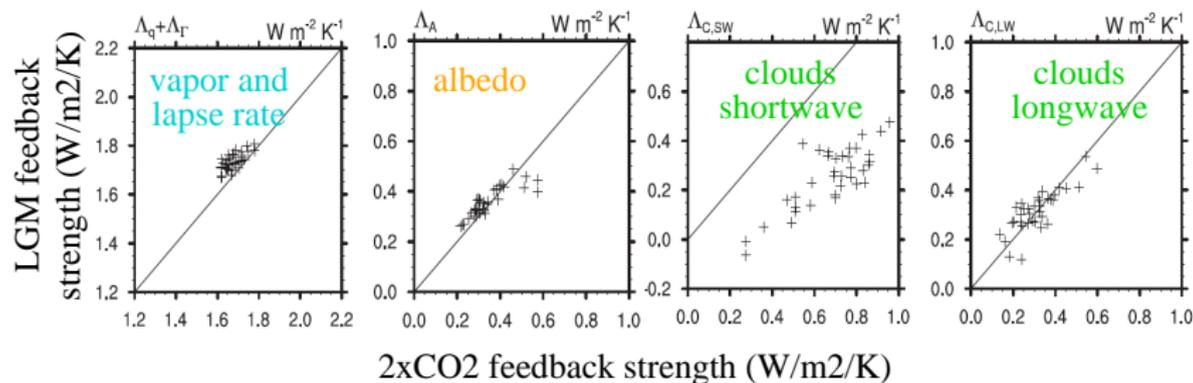
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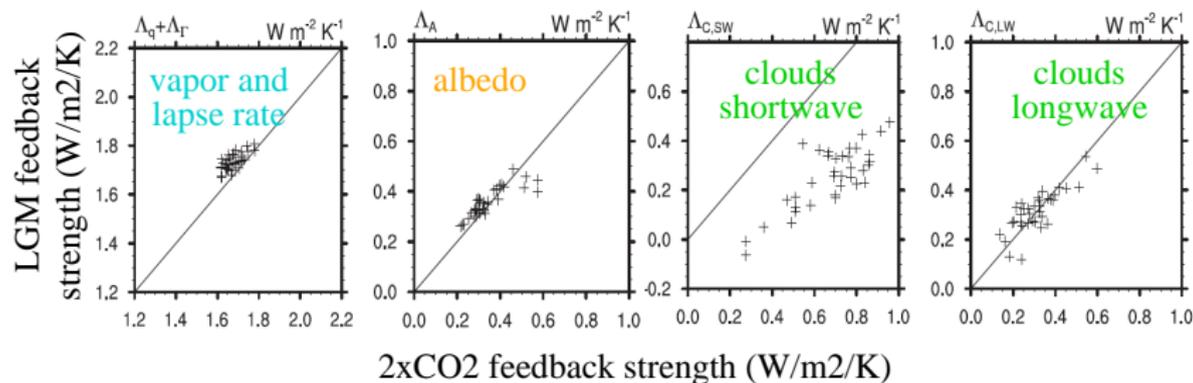


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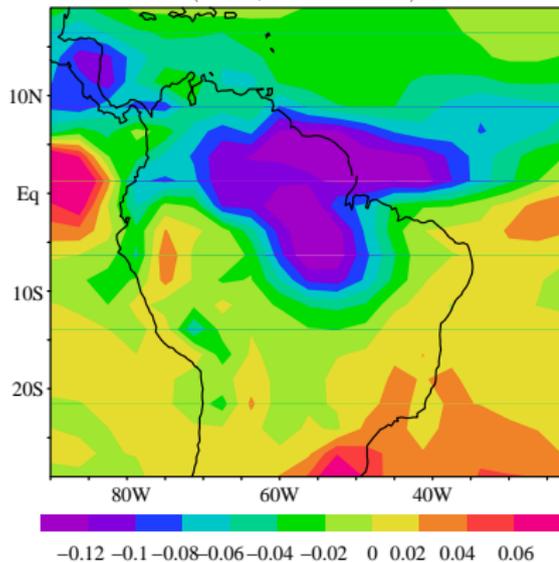
Limitations:

- ▶ PPE vs MME? ⇒ will be addressed with CMIP5
- ▶ Link with observable constraints (condition 3)?

# Example B: tropical precip changes

Example: Schmidt et al 2013: CMIP5

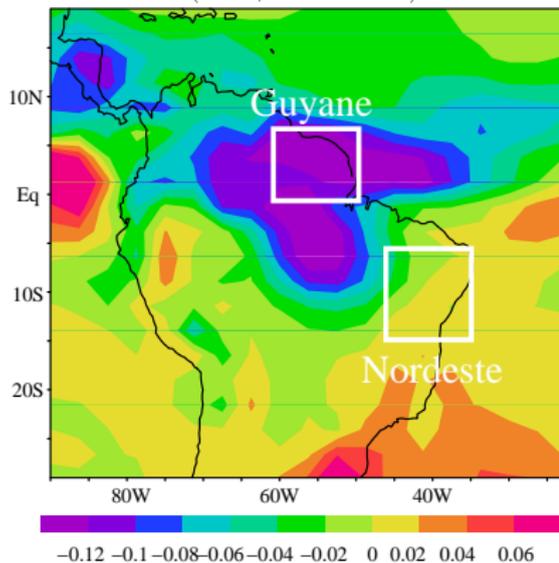
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RCP8.5-PI  
(86%, 16 models)



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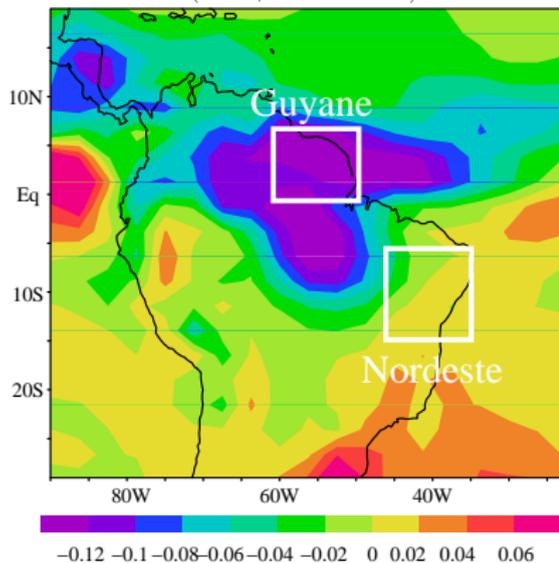
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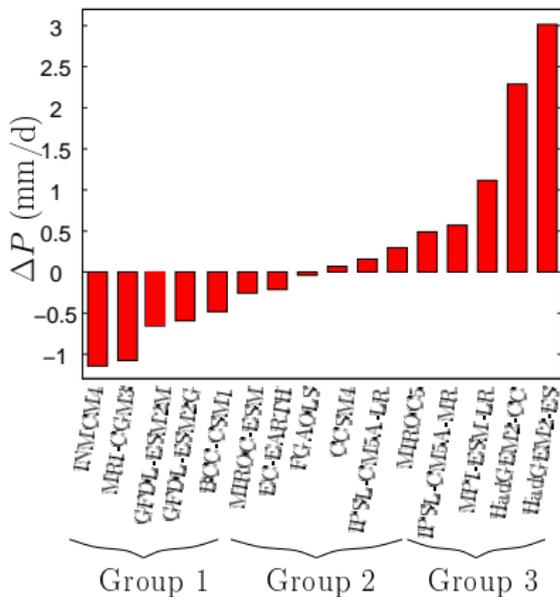
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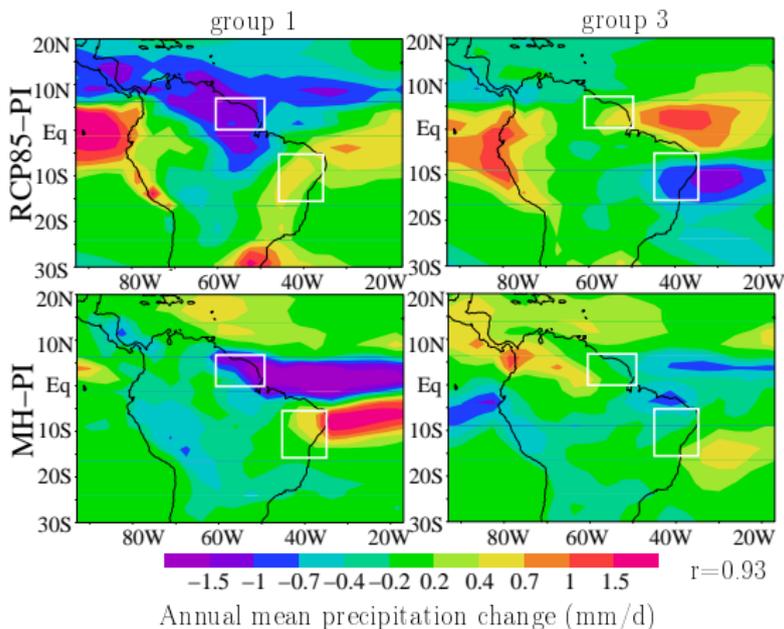
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Guyane-Nordeste  
RCP8.5-PI precip change

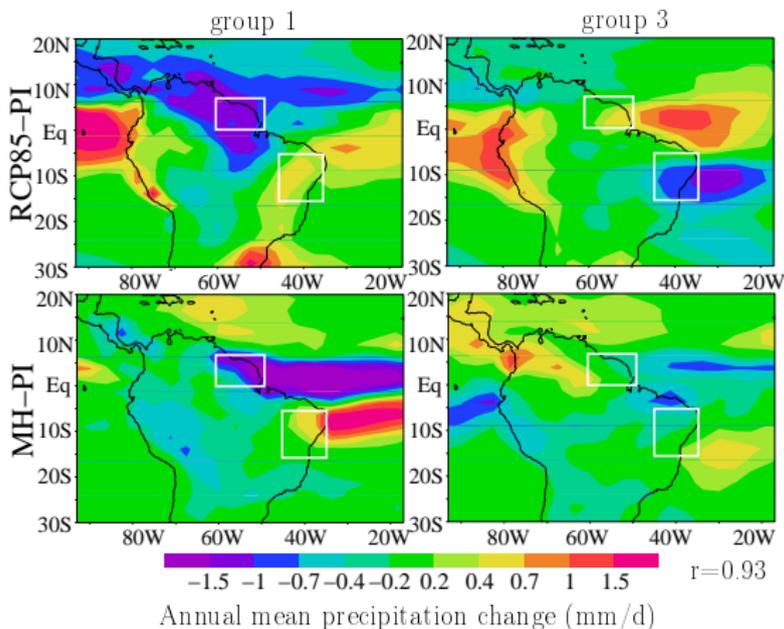


## Example B: tropical precip changes



⇒ In models where precip decreases in Guyane and increases in Nordeste in RCP8.5, similar precipitation dipole in MH ( $r=0.93$ )

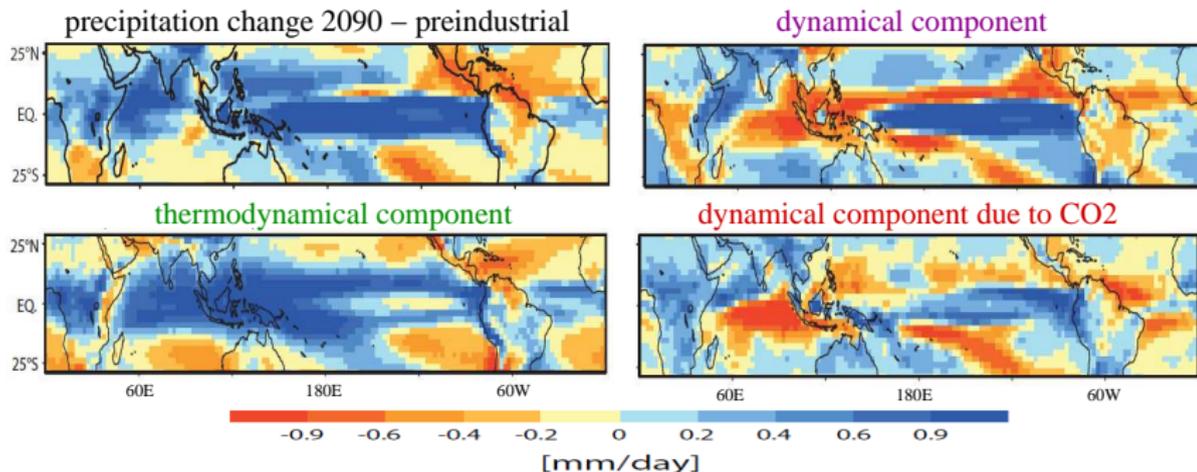
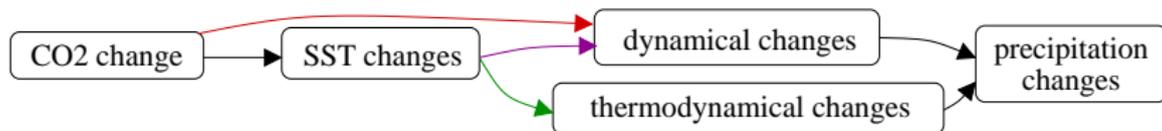
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⇒ statistical link (condition 1); common processes (condition 2)?

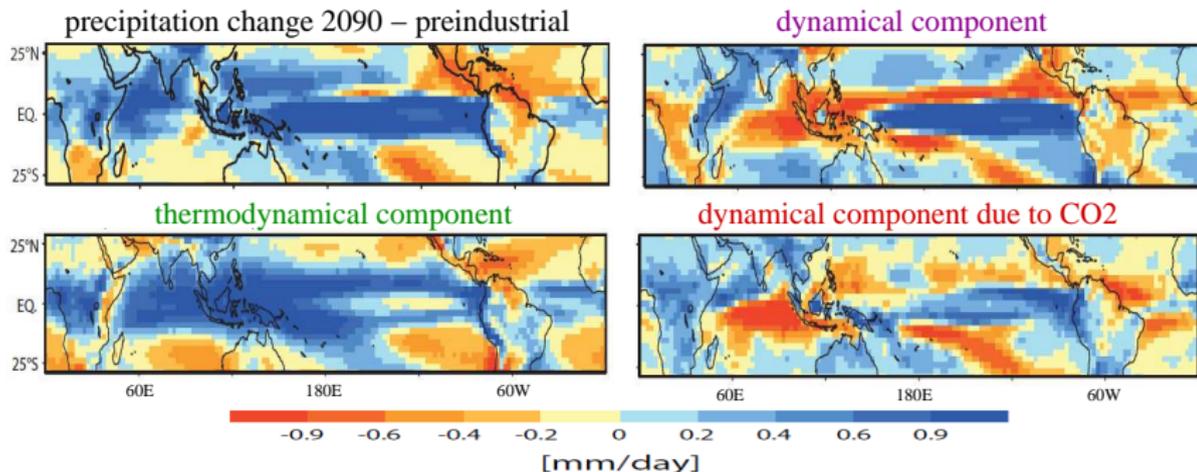
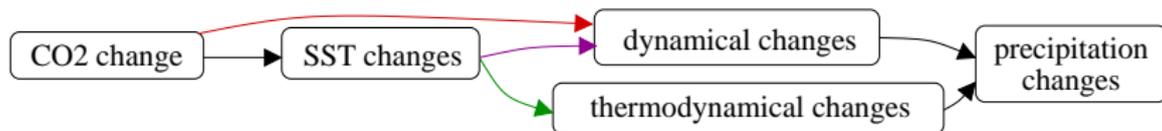
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Example: Bony et al 2013: decomposition of future precip changes



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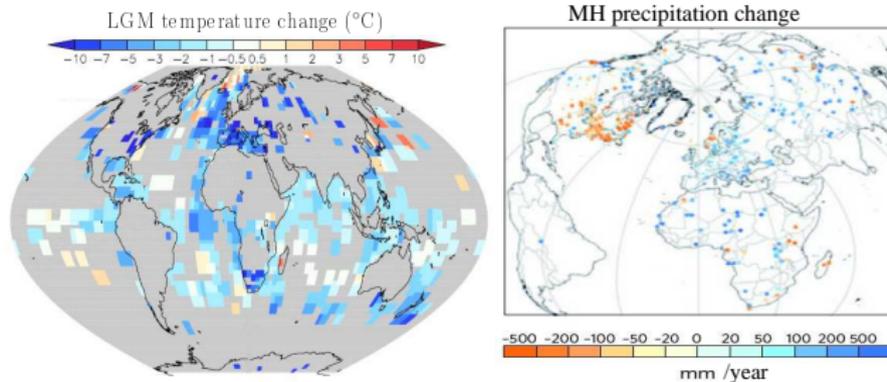


⇒ ongoing: apply this decomposition to past changes

⇒ importance of idealized experiments

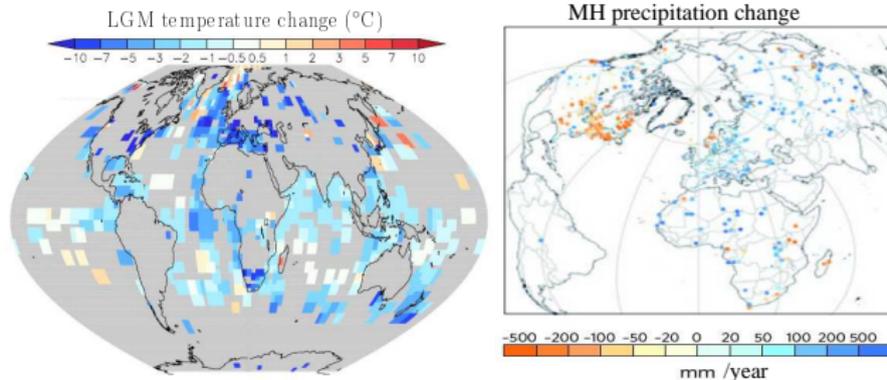
# Condition 3: precise data availability

Data syntheses: MARGO project members 2009, Bartlein et al 2011



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- ▶ enhance data synthesis effort
- ▶ extend types of proxies: e.g. water isotopes.
- ▶ improve model-data comparison: forward proxy modelling for paleo proxies  $\longleftrightarrow$  cloud simulators for satellite observations
- ▶ understand model-data mismatches (Hargreaves et al 2012): simulated climate, forcing, local effects?

# Conclusion

- ▶ CMIP5 is a great opportunity to
  - ▶ investigate past/future links
  - ▶ understand processes using idealized experiments
- ⇒ encourage all groups to run all experiments
- ▶ CMIP5 needs to be complemented with:
  - ▶ enhanced data synthesis
  - ▶ forward modeling development. e.g. PMIP-iso?
  - ▶ detailed process analysis and sensitivity tests with individual models to better understand processes
  - ▶ development of interpretative framework applicable for all models: e.g. feedback decomposition of climate sensitivity, decomposition of tropical precip changes.
- ▶ Close the gap between the 3 conditions
  - ▶ combine statistical analyses with process understanding
  - ▶ combine process understanding with identification of relevant observational constraints