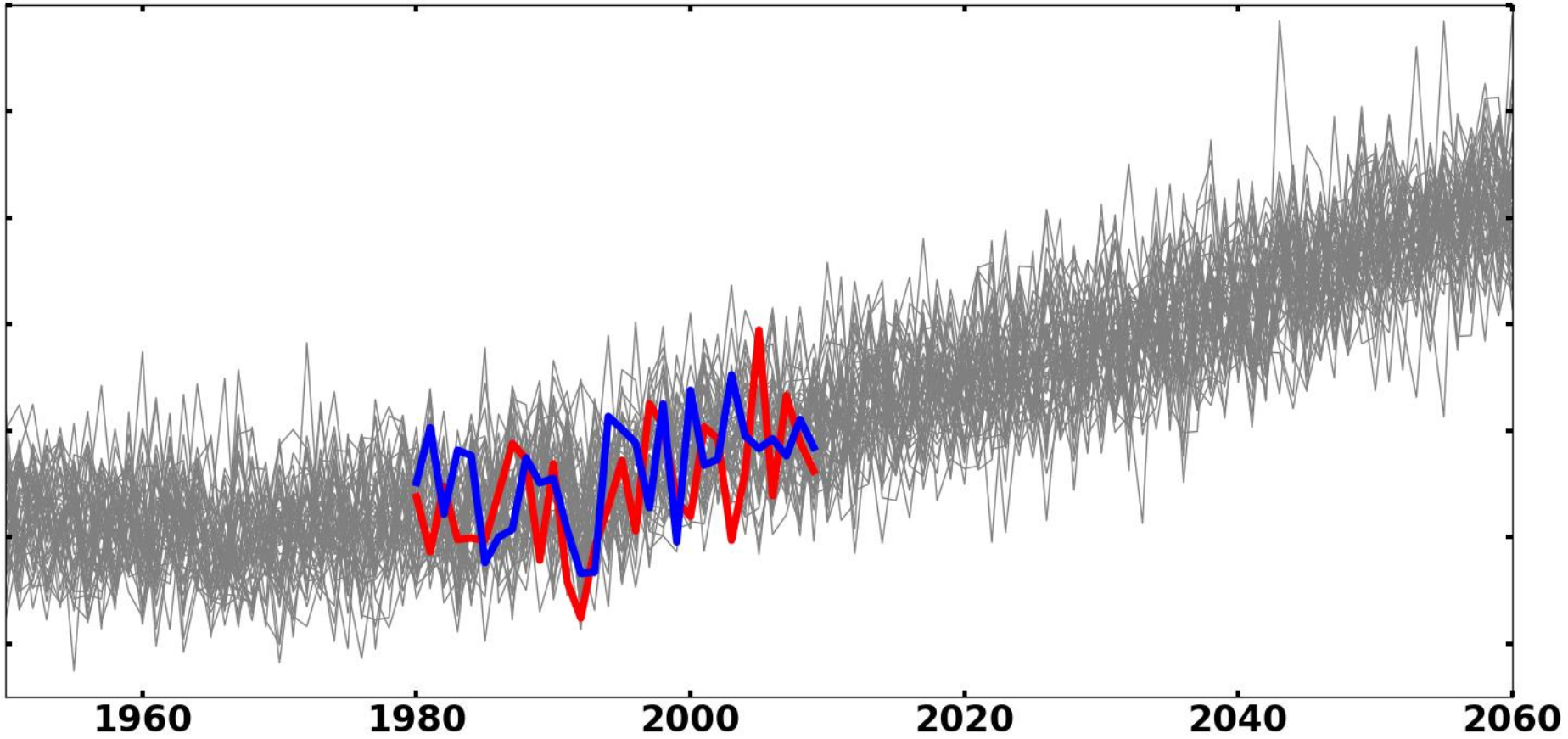
Overview of the ClimEx Large Ensemble - basic characteristics and general results

- Martin Leduc, Ouranos -

Possible trajectories of the climate system



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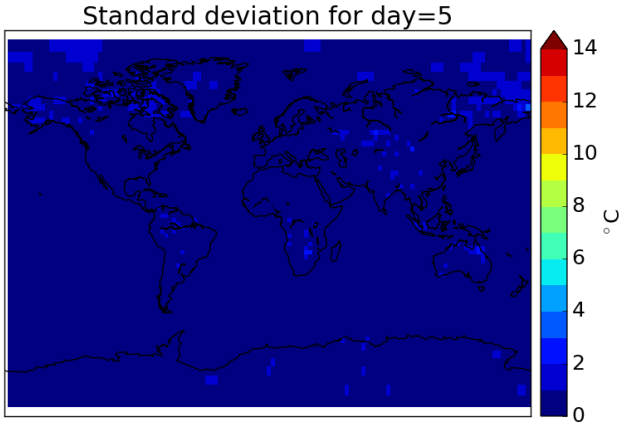
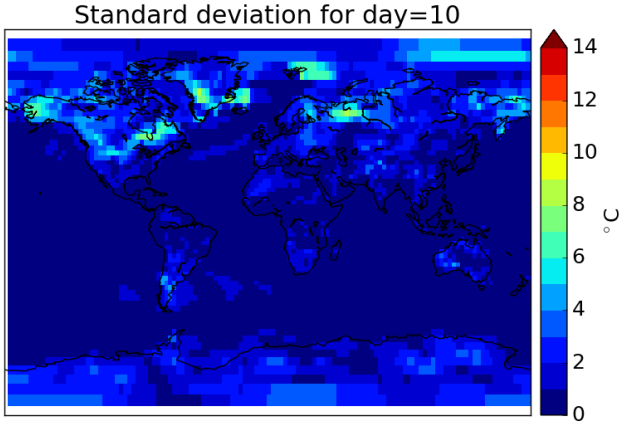
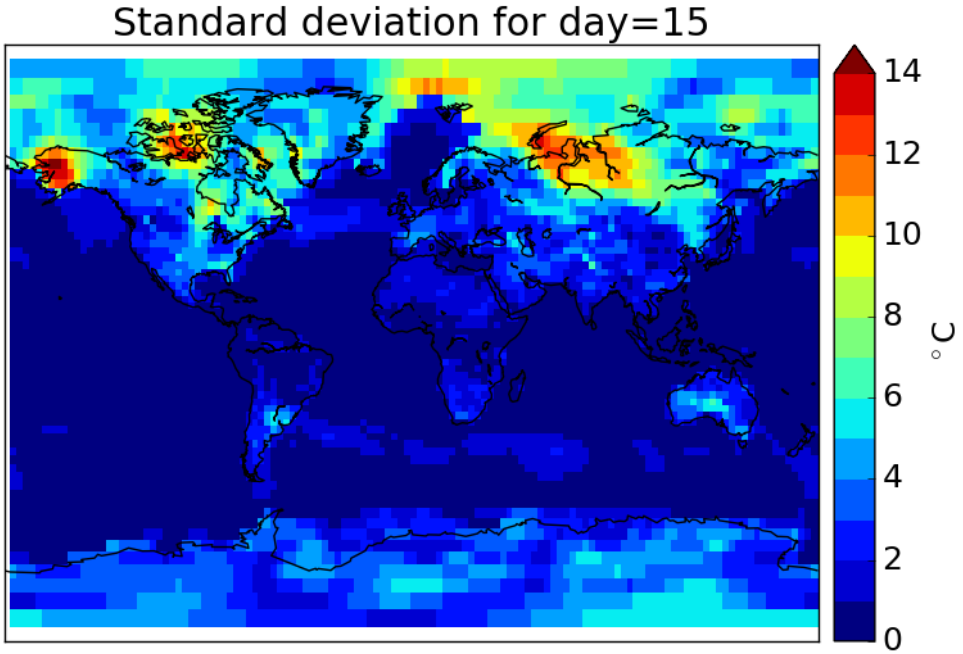
Internal variability in a GCM ensemble

Perturbing the model's initial conditions to emulate the "butterfly effect"

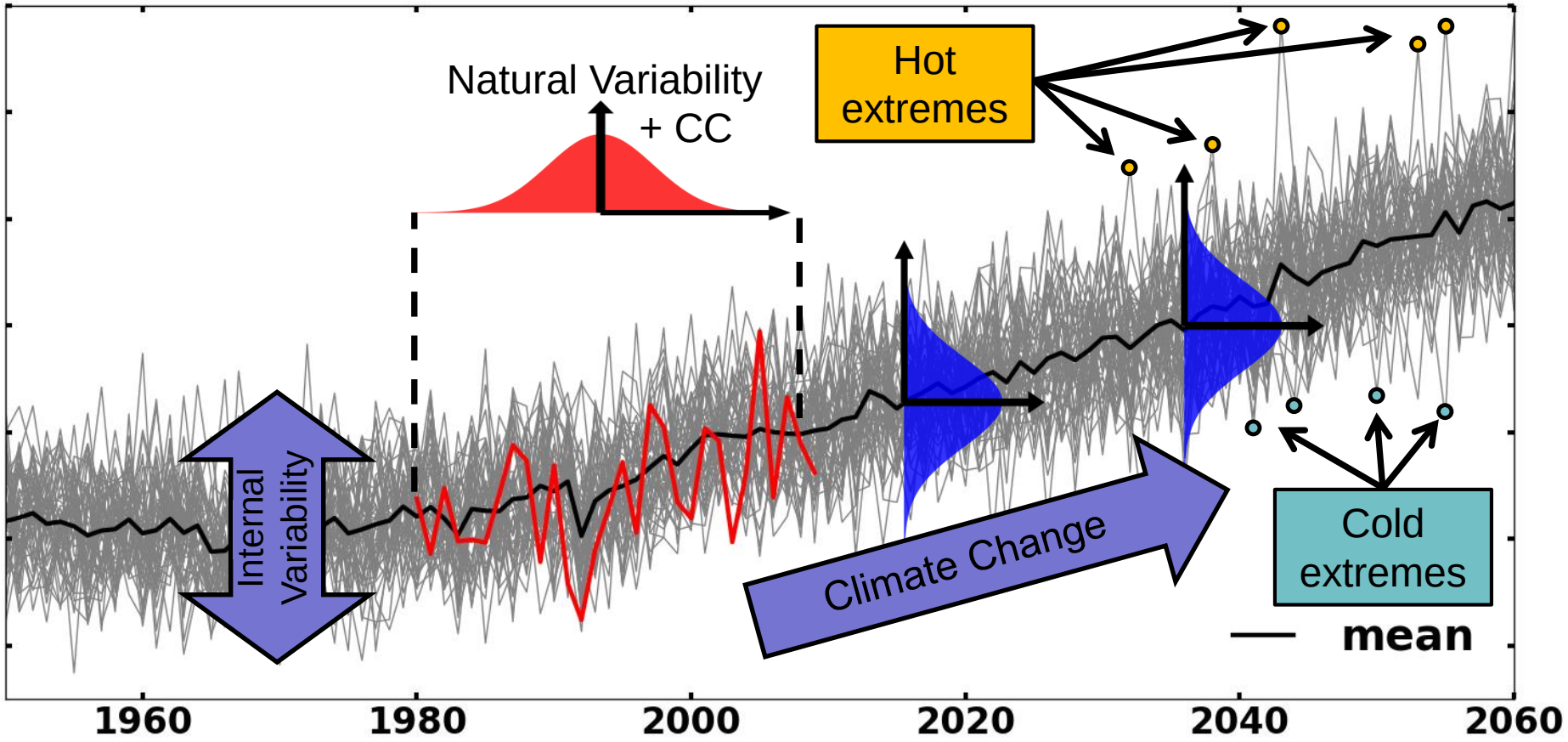






Natural variability and climate change

50 realizations of “reality”



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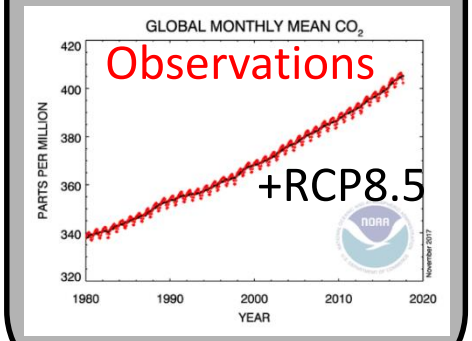
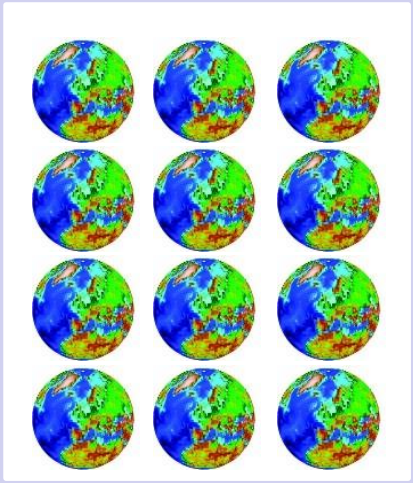
From global climate to local hydrology…

GHG Emissions



Global Climate Model

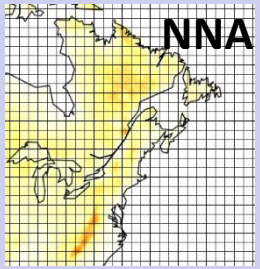
(CanESM2, ΔX ≈ 310 km)

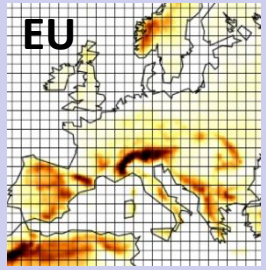


50 realizations
1950-2100

Regional Climate Model

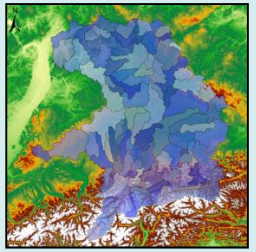
(CRCM5, ΔX ≈ 12 km)





Hydrological Models

Québec

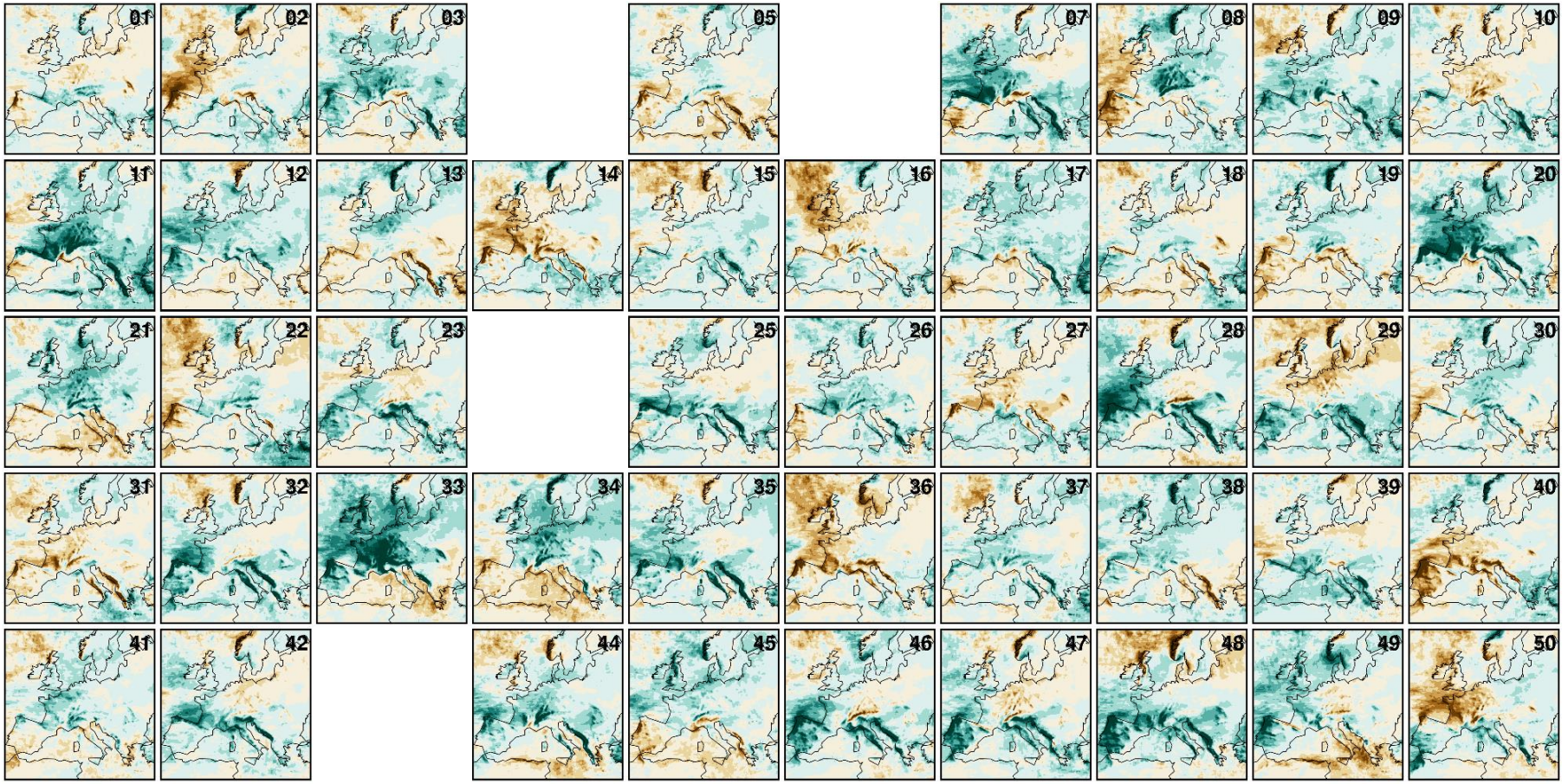


Bavaria

- CanESM2 is developed by the Canadian Centre for climate modelling and analysis
- CRCM5 is developed by Université du Québec à Montréal (UQAM) and ECCC

Short term climate change

Changes in precipitation for December (2020-2039 vs. 2000-2019)

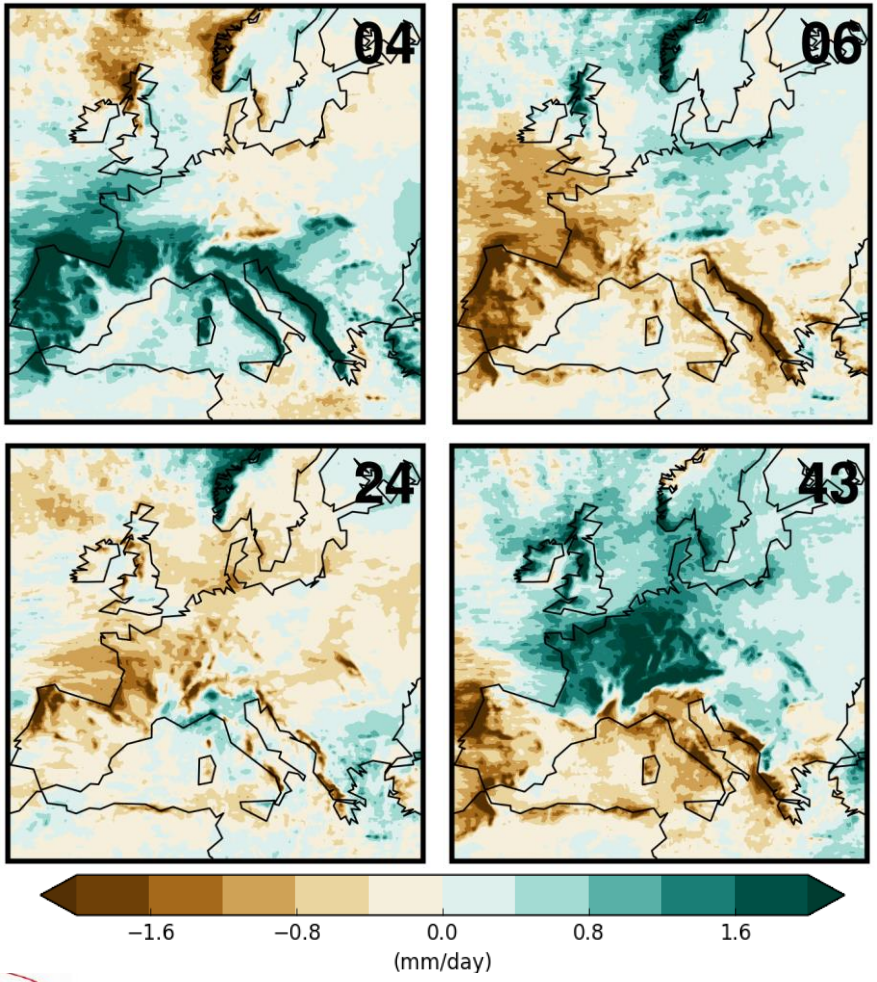


Leduc et al. (2019)

Signal and “climate noise”

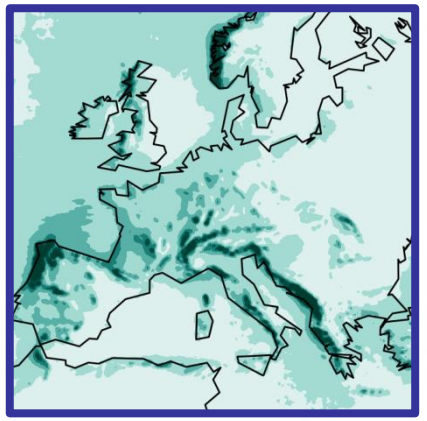
Changes in precipitation for December (2020-2039 vs. 2000-2019)

Individual members



Ensemble mean

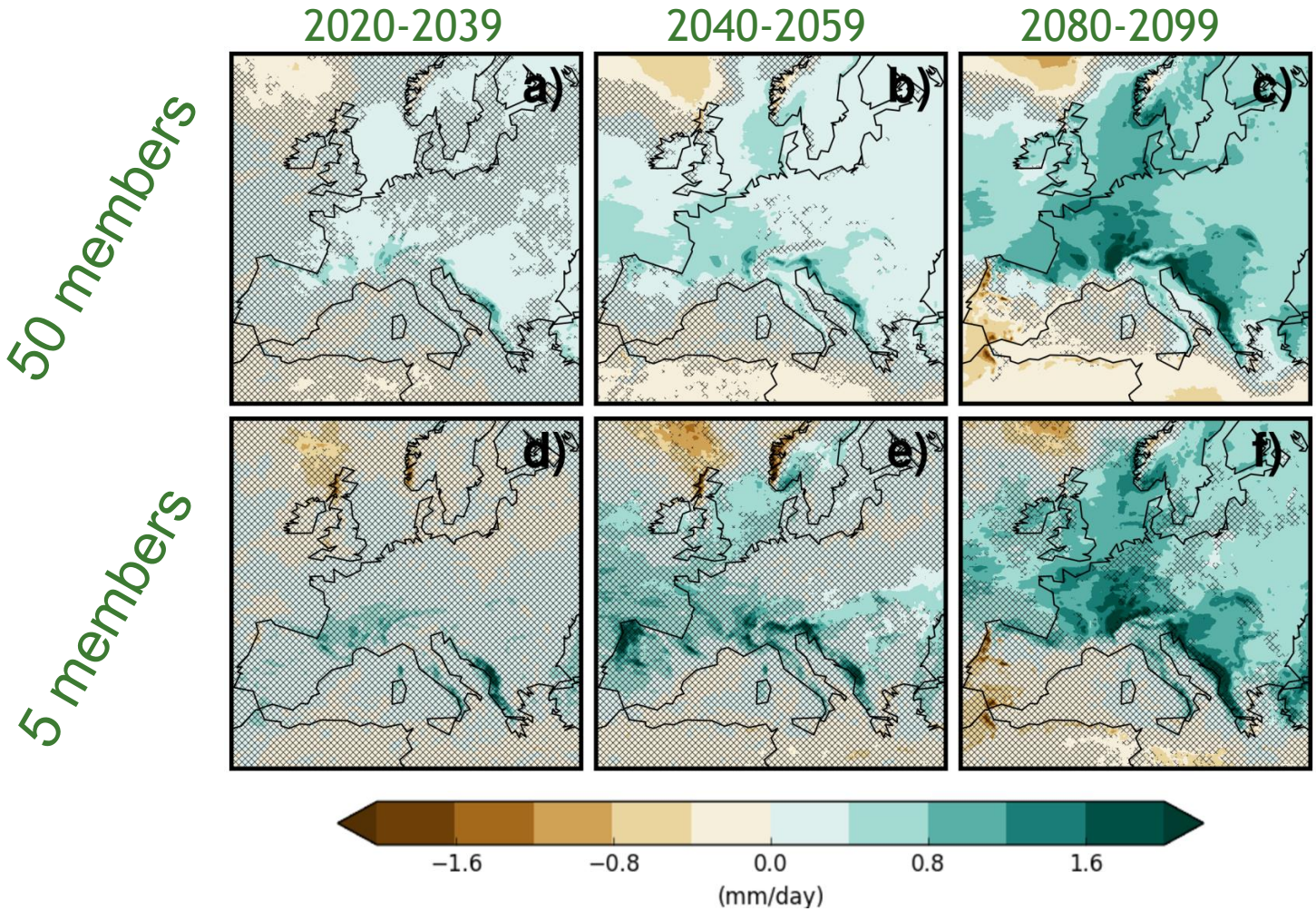
Ensemble STD



Leduc et al. (2019)

Ensemble size vs. temporal horizon

Changes in precipitation for December (ref. 2000-2019)



Leduc et al. (2019)

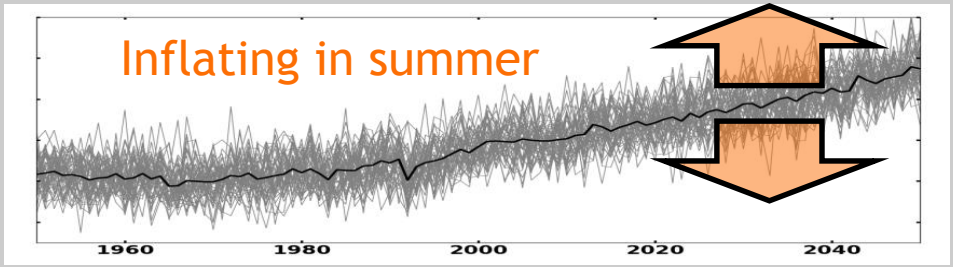
Temperature year-to-year variability

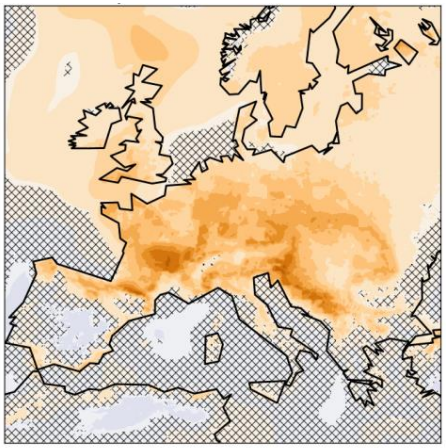
2000-2019

2080-2099

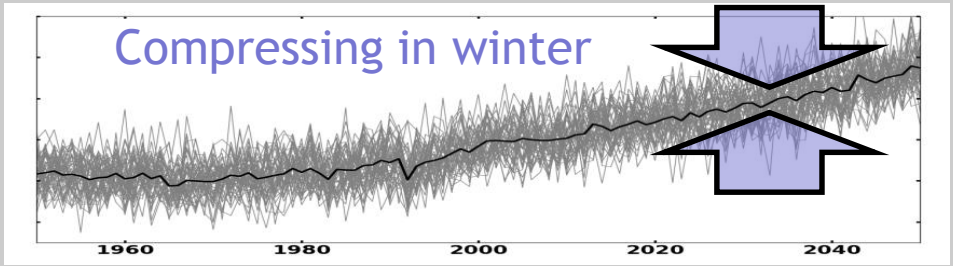
The **envelope of uncertainty** is evolving in time:

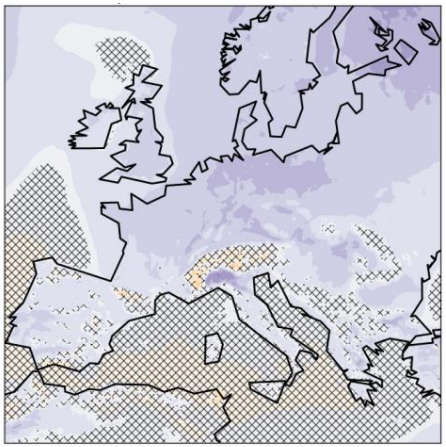
July

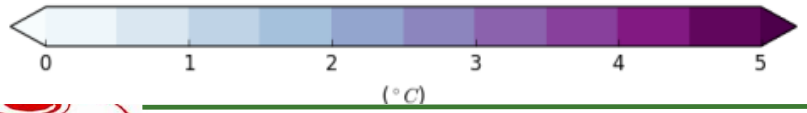


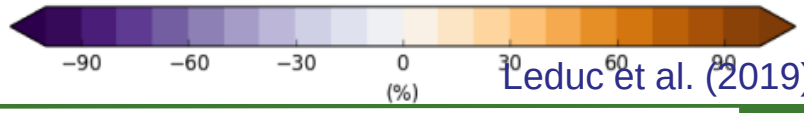


January









Leduc et al. (2019)

Key messages

- Natural climate variability has two components:
  - **Internally generated variability** at every timescales (from seconds to thousands of years)
  - **Externally forced variability** by natural causes (e.g. volcanoes, solar activity)

- Implications of natural variability:
  - Adds **noise** to CC signal – filtered by averaging over several members
  - May **change over time** as part of the CC signal: difficult to assess in the "single reality paradigm"
- From natural variability emerge **extremes…**

Reference:
Leduc, M., A. Mailhot, A. Frigon, J. Martel, R. Ludwig, G.B. Brietzke, M. Giguère, F. Brissette, R. Turcotte, M. Braun, and J. Scinocca, 2019: The ClimEx Project: A 50-Member Ensemble of Climate Change Projections at 12-km Resolution over Europe and Northeastern North America with the Canadian Regional Climate Model (CRCM5). J. Appl. Meteor. Climatol., 58, 663–693, https://doi.org/10.1175/JAMC-D-18-0021.1