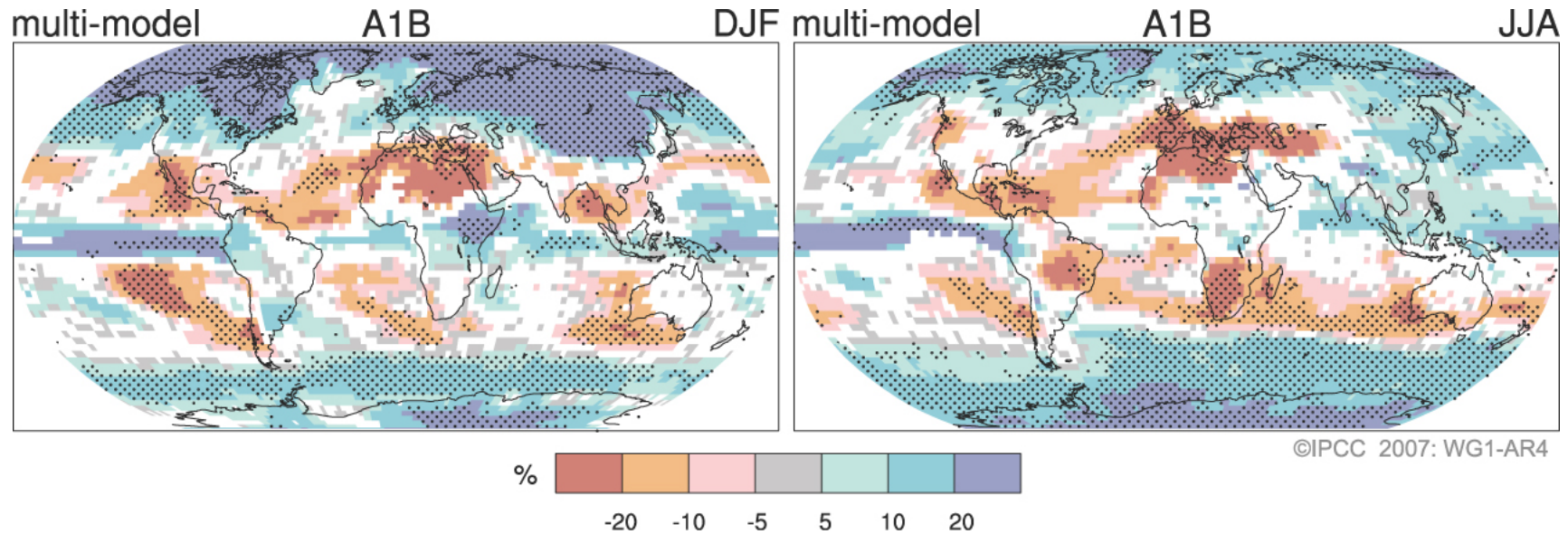


CVC WG Meeting
Boulder, March 15, 2012

Mapping Model Agreement on Future Climate Projections

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Motivation



IPCC AR4 WG1 SPM Figure 7

If less than 66% of models do not agree on the sign of the change **leave blank**.

If more at least 90% of models agree on the sign of the change **stipple**.

But what about **significance** of the change?

- In the framework of multi-model ensembles, what constitutes consensus, or lack of consensus, over future changes?
- **There is a fundamental difference between lack of agreement over the sign of future changes if the signal has not yet emerged from the noise of natural variability and lack of agreement over the sign of an already emerged signal.**
- Natural variability/noise should to be accounted for, before posing the question of agreement over future forced changes.

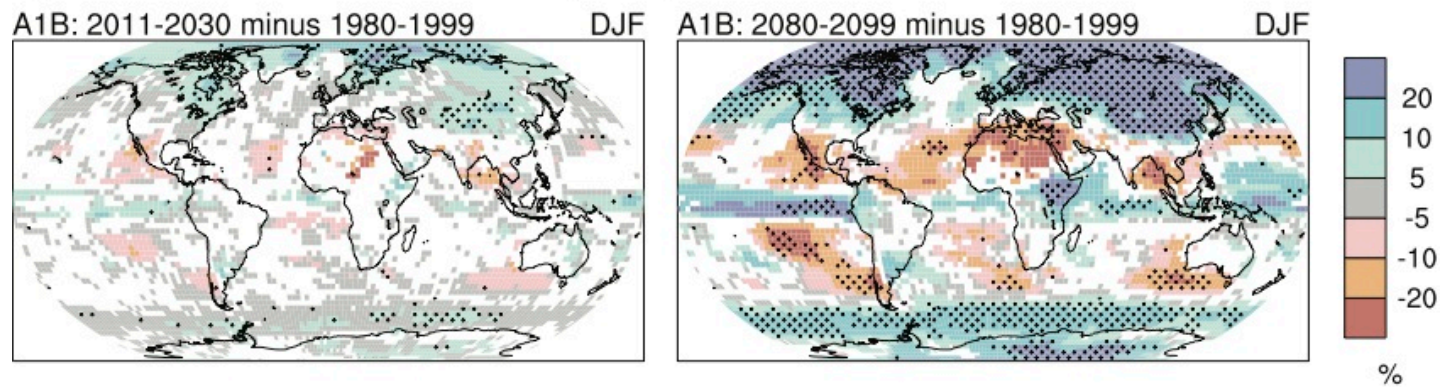
- The distinction becomes increasingly relevant as we focus on smaller and smaller spatial scales and shorter and shorter projection horizons (e.g. decadal prediction, regional analyses).
- Arguably that distinction is very relevant for decision makers using the information provided by multi-model projections: adaptation choices may be very different under the two alternatives.

Our Proposal

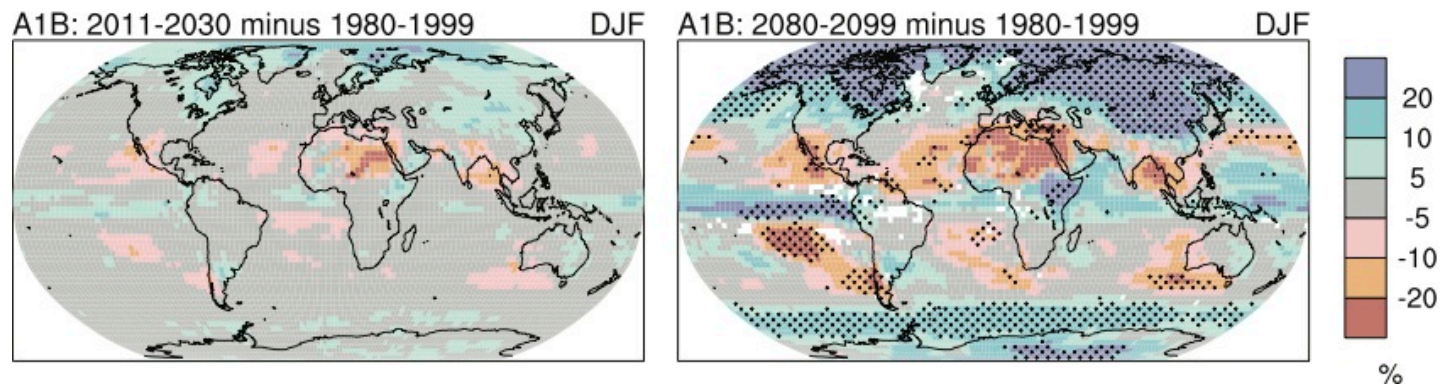
- Consider first for each model and each grid-point the statistical significance of the change.
- If less than 50% of models show a significant change, show the **ensemble mean change in color** (without stippling)
- If at least 50% of models show a significant change then
 - If less than 80% of those models agree in sign, **leave blank**.
 - If at least 80% of those models agree in sign, **color (by the mean change) and stipple**.

Comparison between SPM method and our method

c) IPCC AR4 method: CMIP3 precipitation

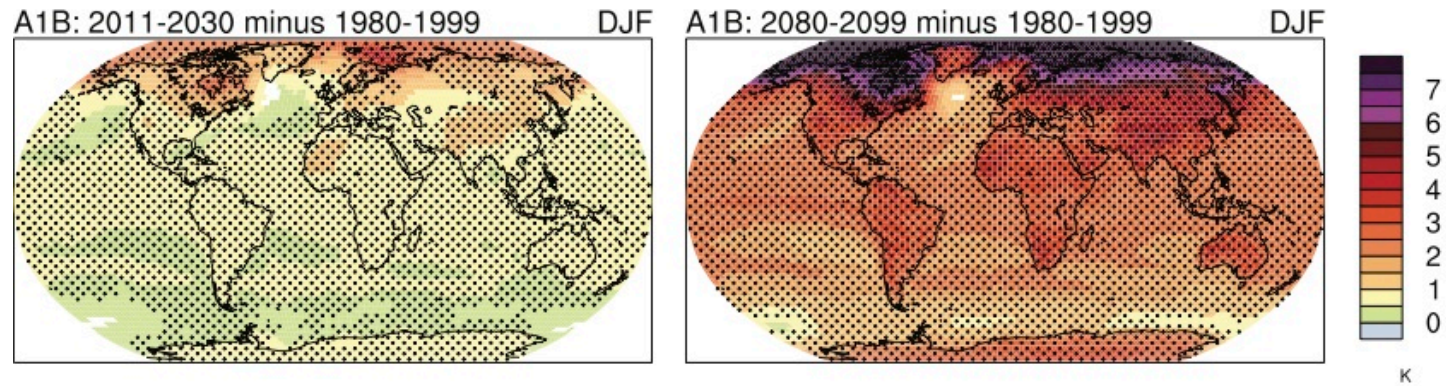


d) New method: CMIP3 precipitation

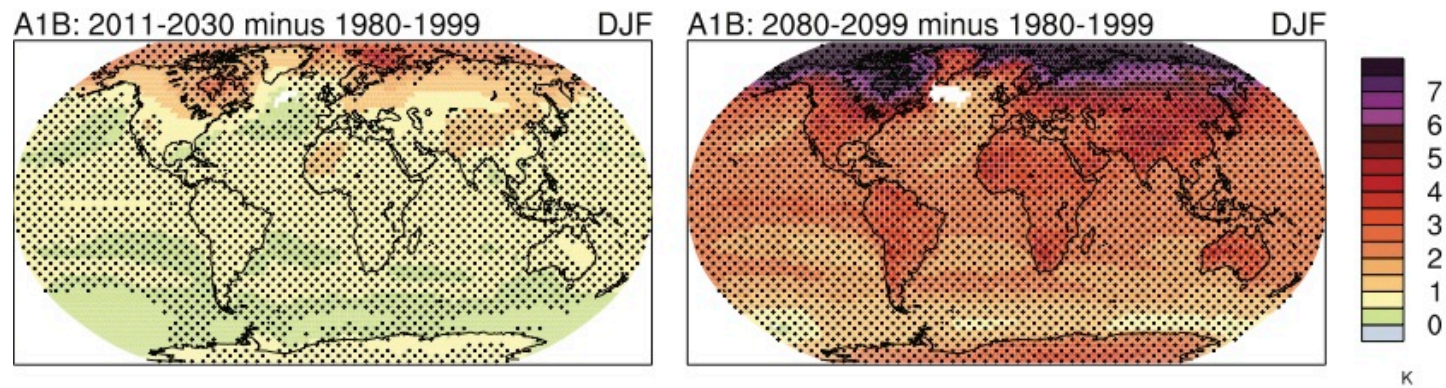


What about temperature?

a) IPCC AR4 method: CMIP3 temperature



b) New method: CMIP3 temperature

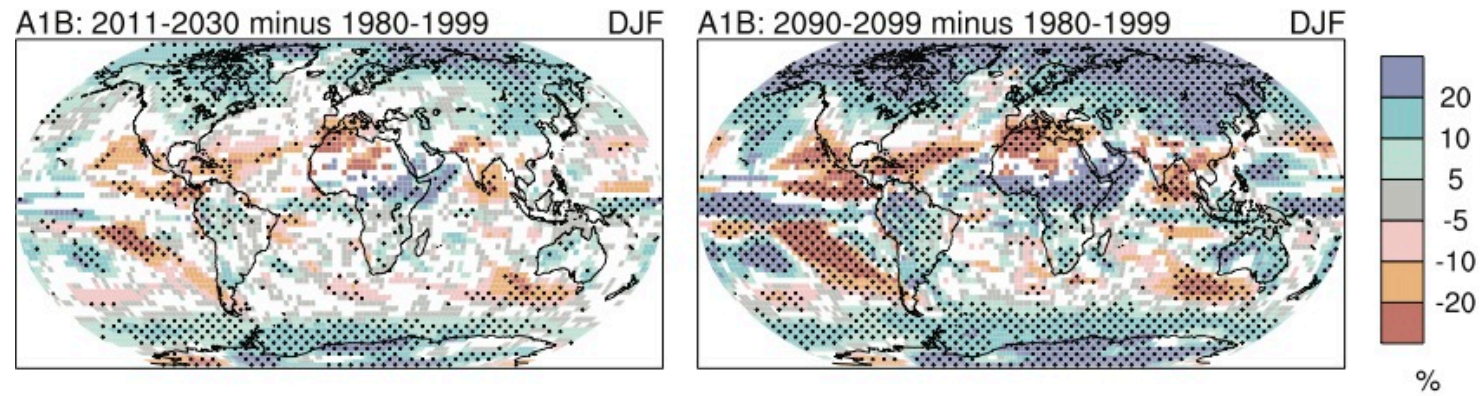


Proof of concept: CCSM ensemble

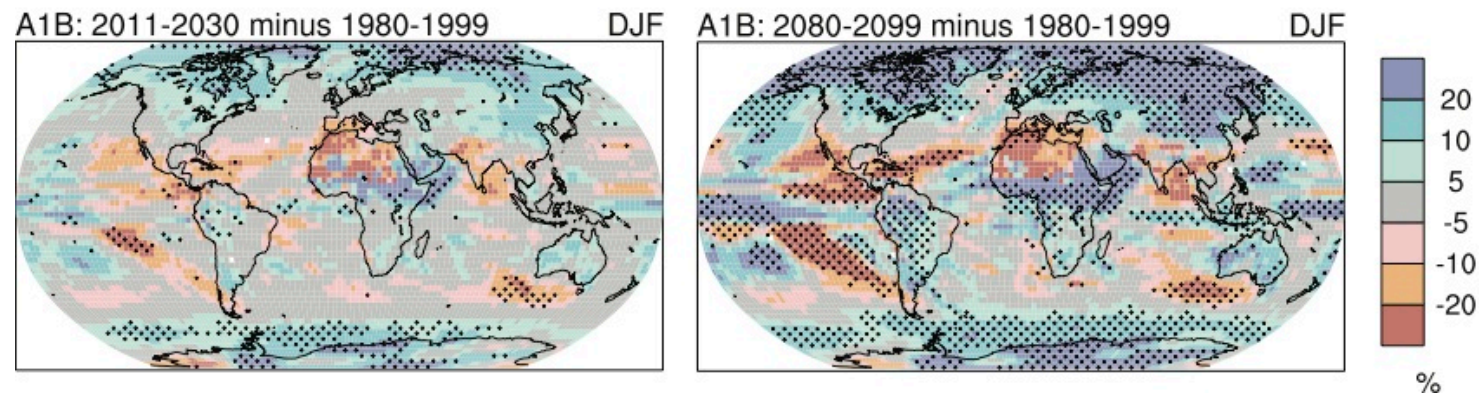
We do not expect white spots at all:
no model disagreement here!

CCSM only

a) IPCC AR4 method: CCSM3 precipitation



b) New method: CCSM3 precipitation



Does the choice of the ensemble member matter?

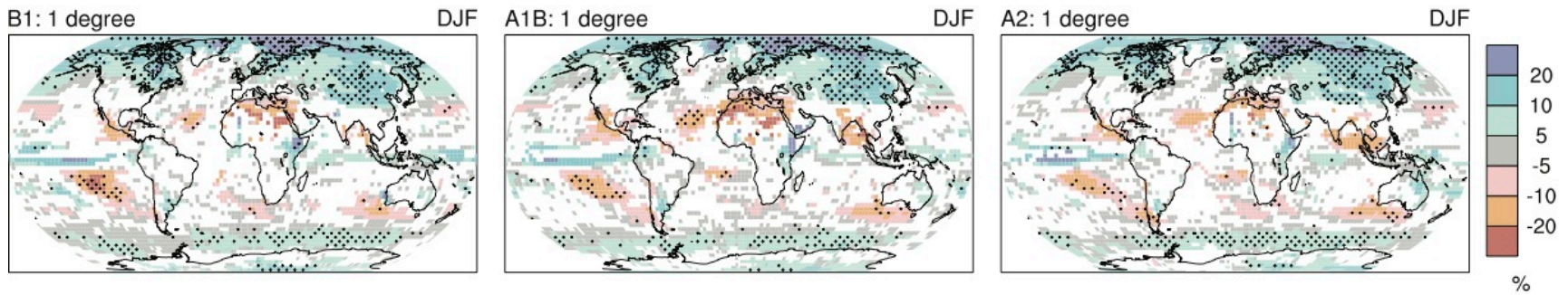
- When performing multi-model analysis in the presence of multiple ensemble members for individual models, we choose a single one.
- Does the choice matter? Hopefully not. We want the measure of natural variability to be robust to the choice of members.

A little trick...

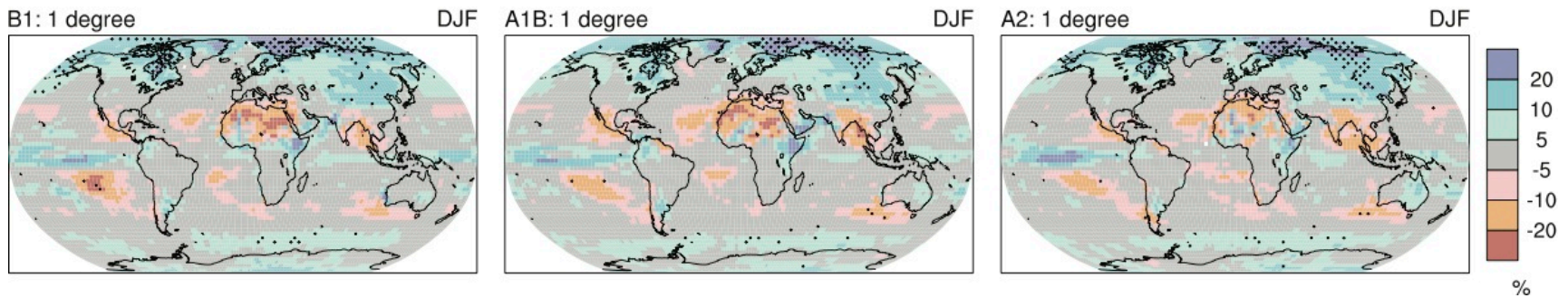
- Only a few models have at least three members available under the same SRES scenario.
- We therefore construct an artificial set of 'IC' ensembles by using the three SRES scenarios available (B1, A1B and A2):
 - We take the subset of models that have run all three and the 20 years of the future simulations under each scenario when the multi-model mean temperature change (globally) is 1 degree C.
 - We use the three runs under the three scenarios for each model as if they were an IC ensemble for that model.
 - We apply our method by choosing in turn run 1 (B1), run 2 (A1B) and run 3 (A2) of each model.

Both methods are robust to the choice of the IC ensemble member

a) IPCC AR4 method: precipitation for different ensemble members



b) New method: precipitation for different ensemble members



Conclusions

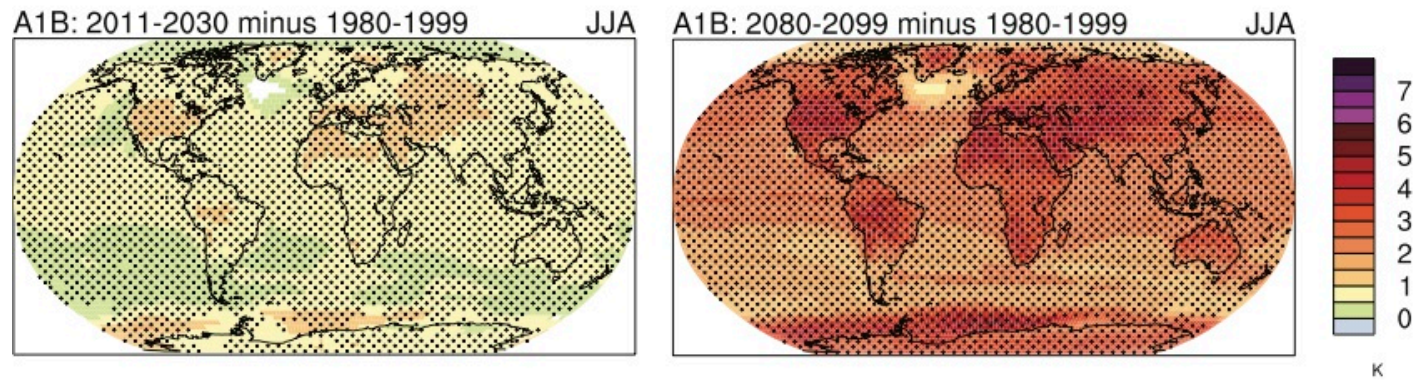
- We have proposed a method for synthesizing the consensus of multi-model projections that distinguishes lack of agreement within the boundaries of natural variability from lack of agreement once the signal has emerged.
- We argue that by so doing the amount of information in the multi-model projections turns out to be larger than thought, for example when considering future precipitation change.
- In particular, many regions continue to experience future changes within the boundaries of their historical natural variability, even in the long-term projection horizon. In these cases the fact that different models project changes of different sign is no longer a big concern: it's all noise anyway, and it's familiar noise.

Worth mentioning:

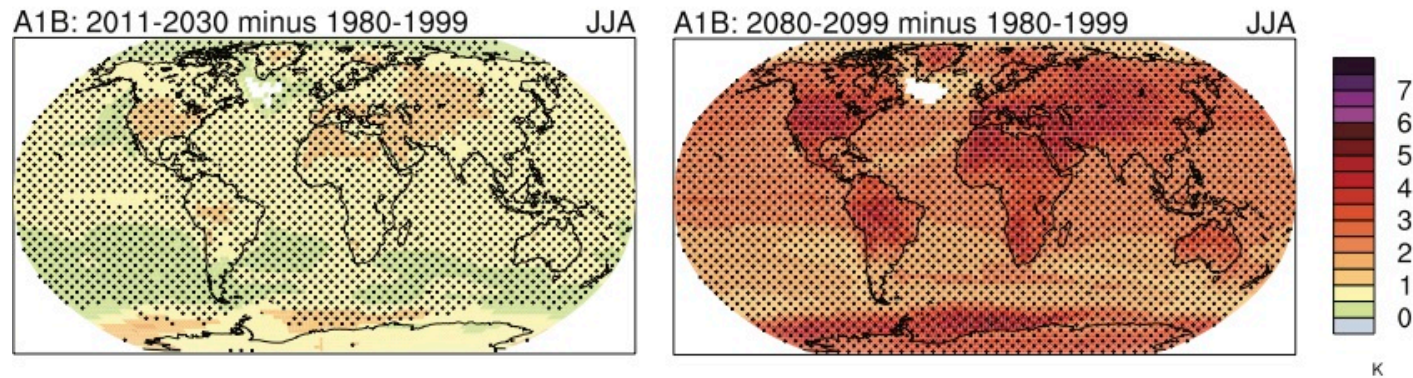
- The methodology for testing significance may be enhanced for example by considering the spatial nature of the field, and by using control runs or large ensembles to better characterize the range of natural variability.
- The choice of the level of agreement (50% or 66%? 80% or 90%?) is arbitrary. One could apply some more formal criteria (independent coin tosses as a null hypothesis?) or one could use subjective choices in the face of specific applications.
- The detailed results will be always dependent on the model resolution/spatial scale of choice.

Temperature results for JJA

a) IPCC AR4 method: CMIP3 temperature

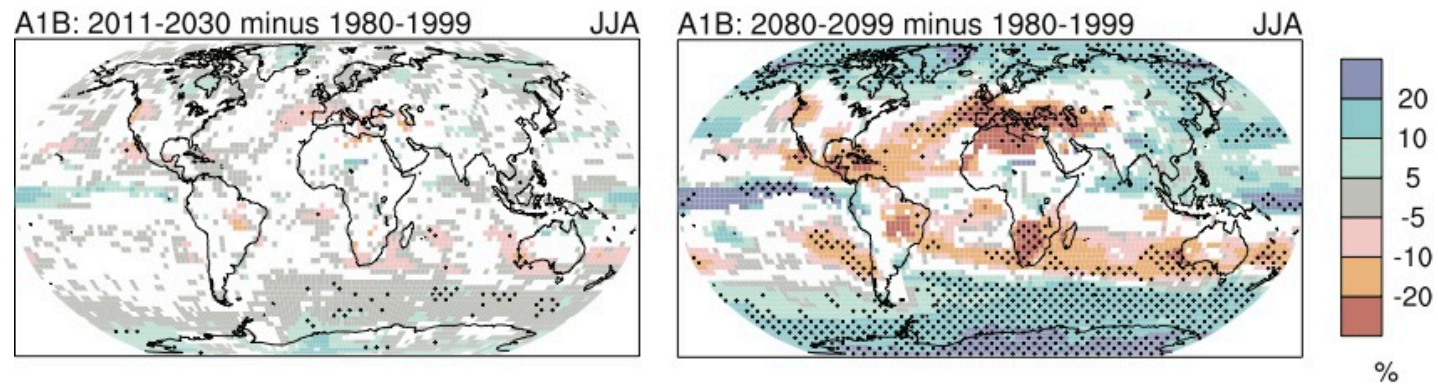


b) New method: CMIP3 temperature

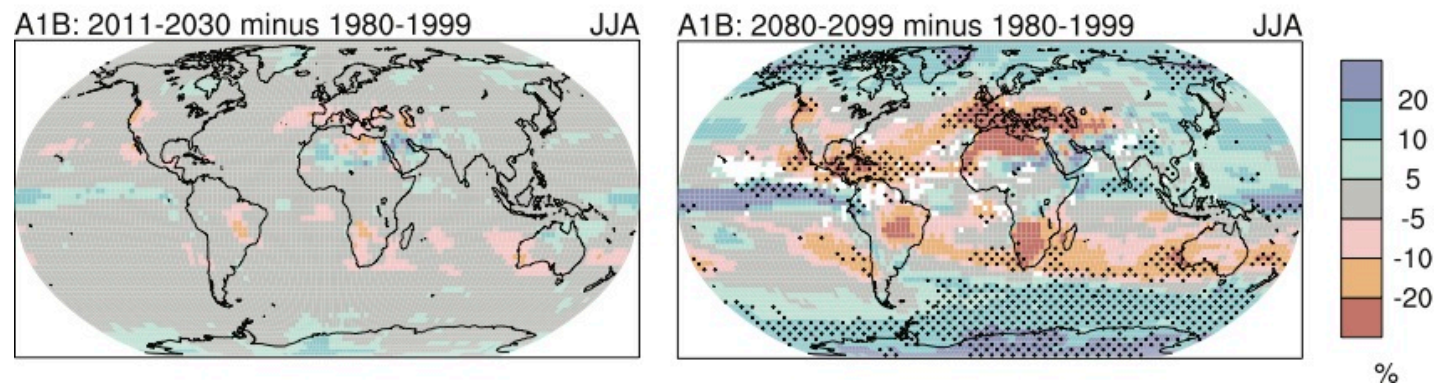


Precipitation results for JJA

c) IPCC AR4 method: CMIP3 precipitation

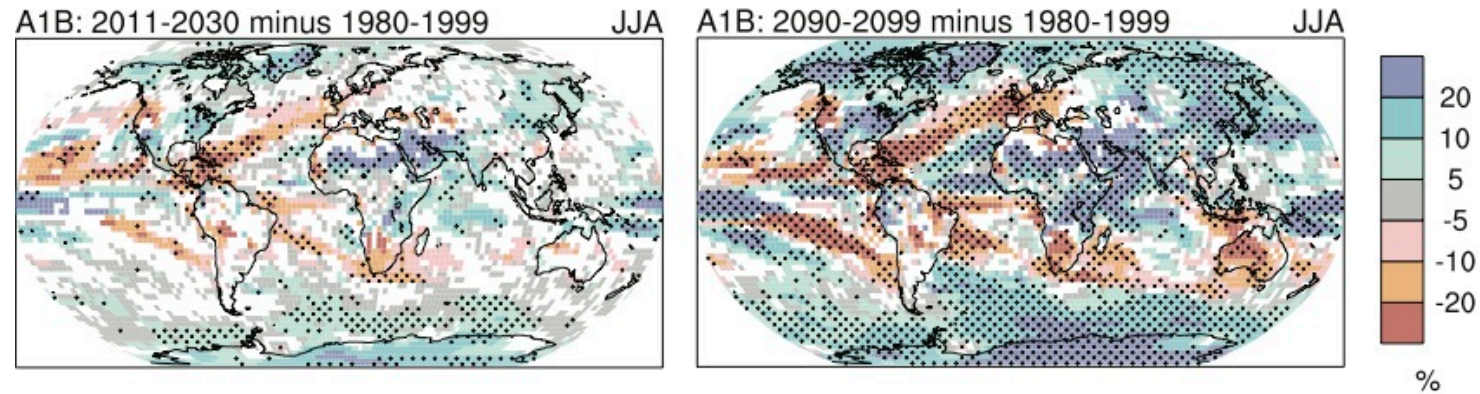


d) New method: CMIP3 precipitation

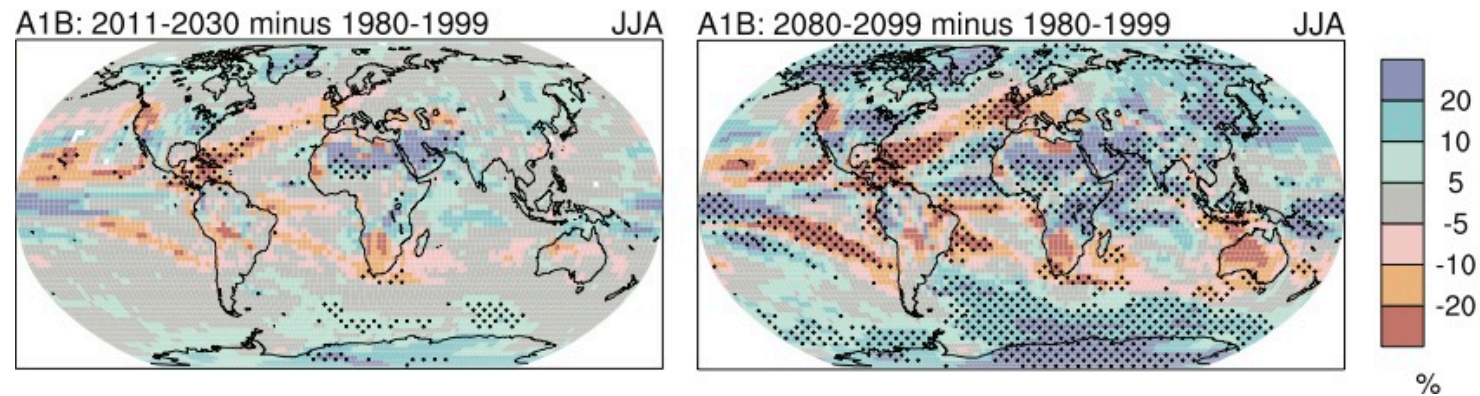


CCSM only for JJA precipitation

a) IPCC AR4 method: CCSM3 precipitation

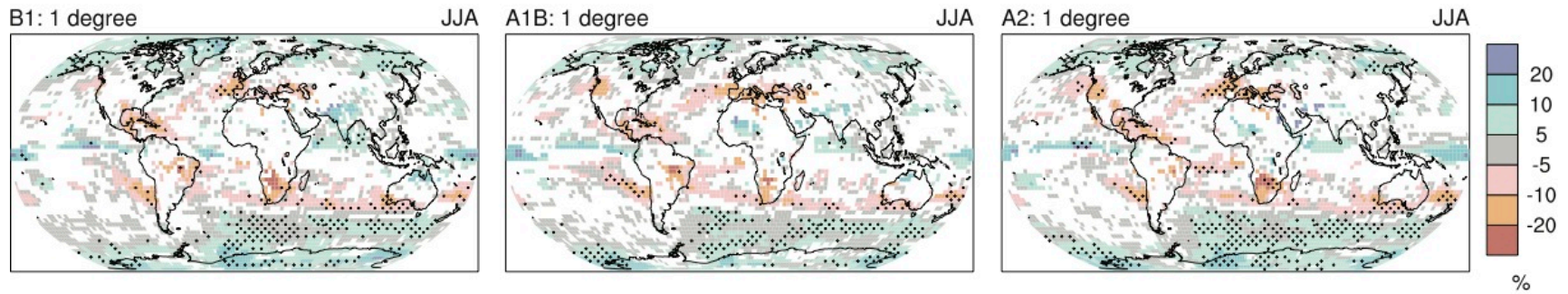


b) New method: CCSM3 precipitation



Robustness to IC for JJA

a) IPCC AR4 method: precipitation for different ensemble members



b) New method: precipitation for different ensemble members

