Response of heavy precipitation and meteorological droughts to increasing CO2 and related global warming

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Q1: Fast v/s Slow response

What are the relative contributions of fast vs. slow processes to changes in precipitation extremes?

> "Regional emergence of the extremes depends on the contributions from these drivers"

Different CFMIP atmospheric-only experiments can be combined to decompose the total response into individual aspects of CO2 forcing and related ocean warming as follows:

Total response = **Uniform SST (slow)** **+ SST pattern** **+ CO2 effect (fast)**

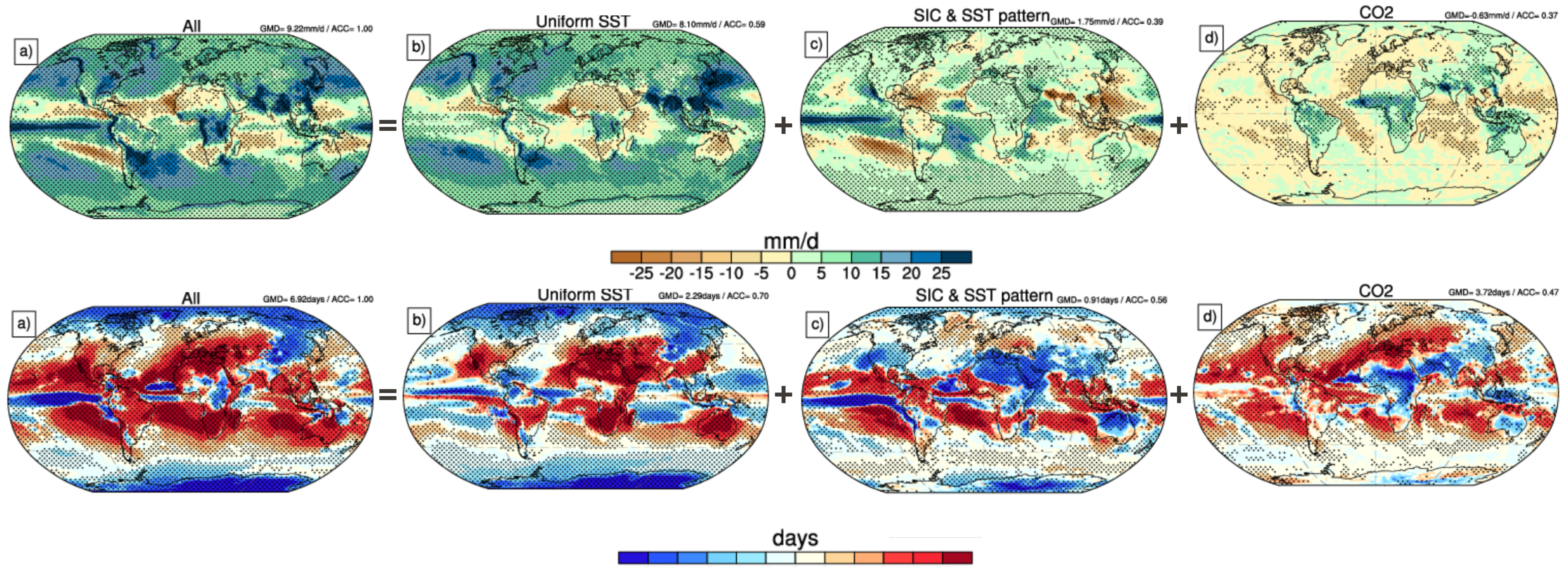


Figure 1
Breakdown of the climatological (Year 111-500) annual RX1DAY (top row) and CDD (bottom row) response (mm/day) to abrupt-4xCO2 in CNRM-CM6-1 using pairs of atmosphere-only timeslice experiments. Here the total AGCM response is the sum of response to uniform SST warming, response to SST and sea-ice anomaly pattern and response to CO2.

Stippling highlights areas where the differences are significant at the 5% level. GMD denotes the areal averaged global response and ACC is the spatial continental pattern correlation with the total change shown .

Q2: Uncertainy Quantification

How robust are future projections of daily precipitation extremes?

How does the use of local (ΔT) vs. global (ΔGSAT) scaling affect changes in precipitation extremes?

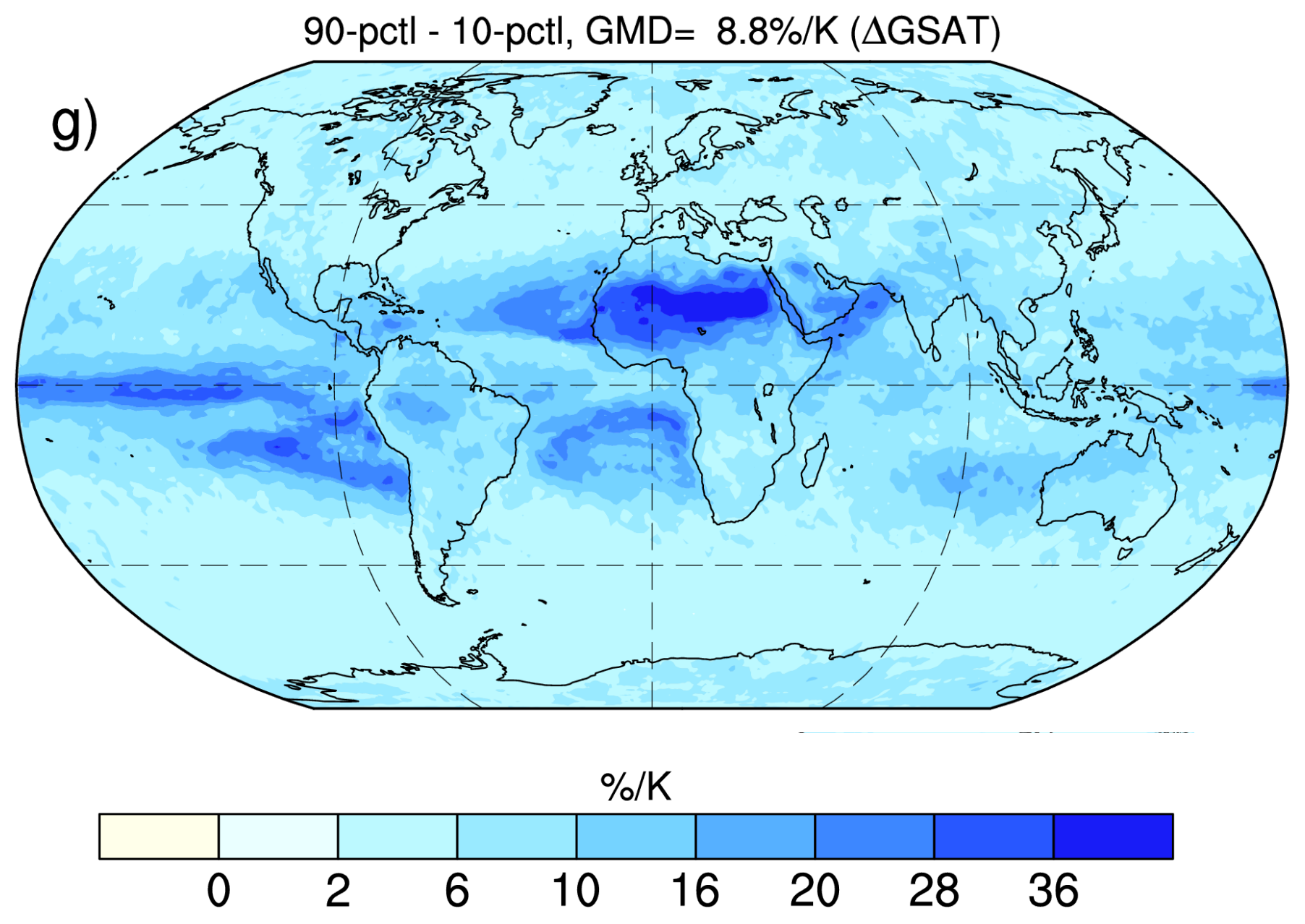


Figure 2
Width of the confidence range of extreme precipitation, computed as the difference between the 90% and 10% quantile maps of extreme precipitation distribution

> "A robust overall CC-scaling with global warming despite regional exceptions possibly due to dynamical damping of extreme precipitation events."

Global land areas showing inconsistent CC rate of change in extreme precipitation is:

only 17% for ΔGSAT scaling
58% for ΔT scaling

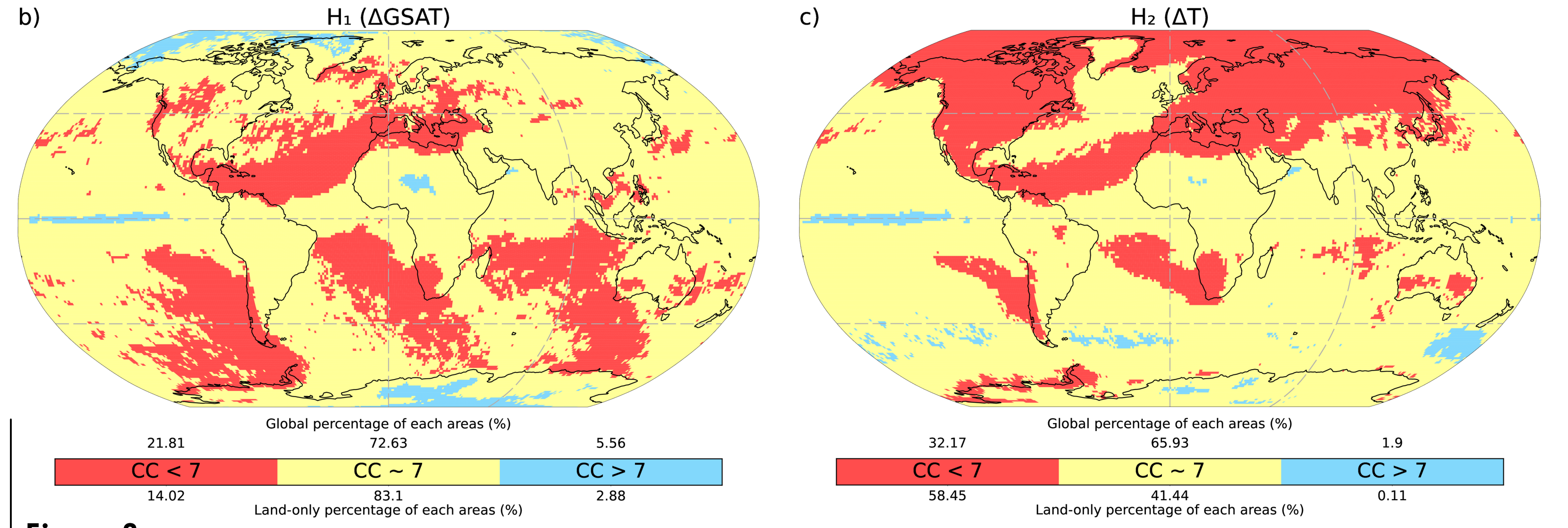
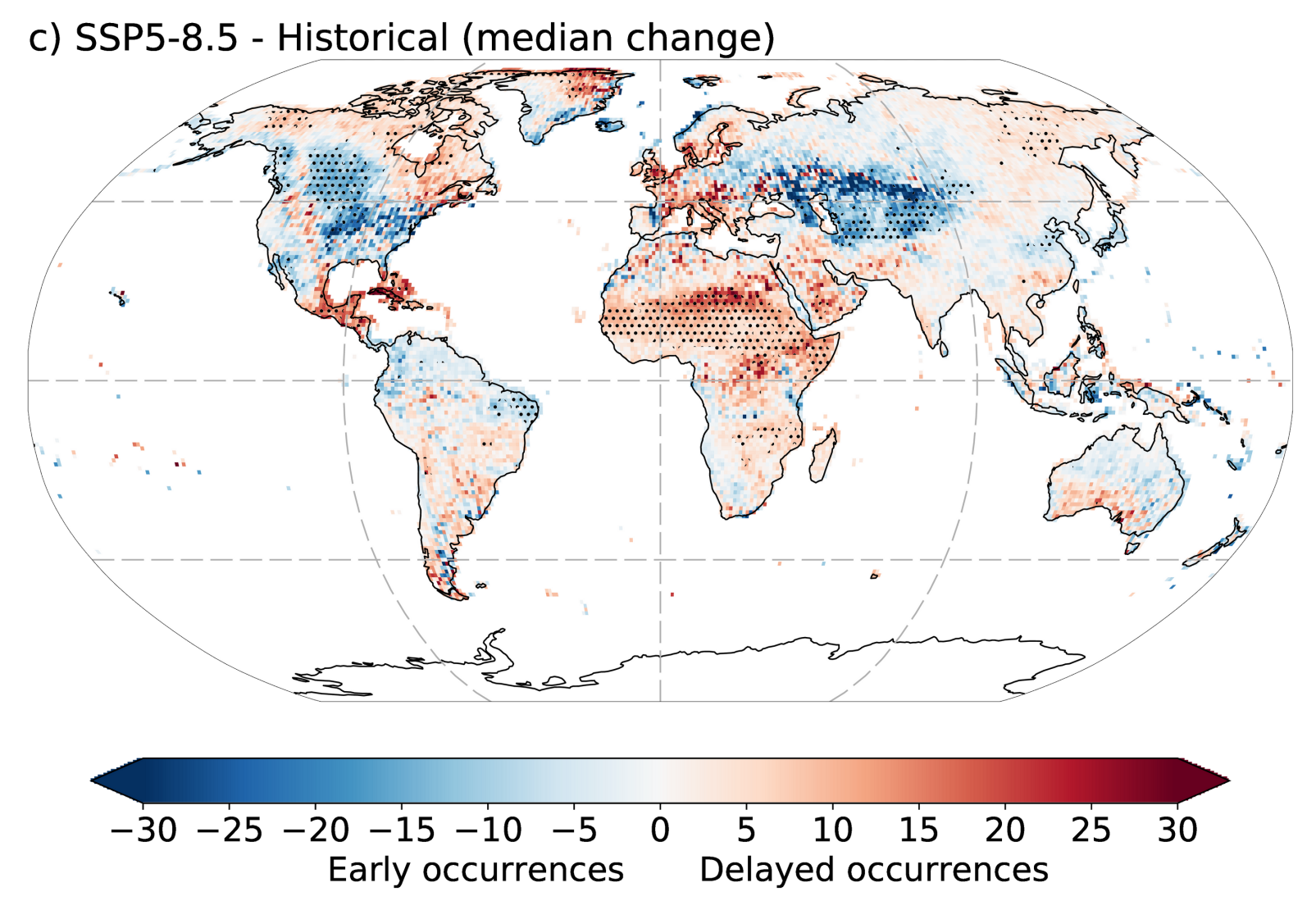


Figure 3
Maps showing the global areas where the rate of changes in extreme precipitation are consistent with the CC rate of ≈7%/K with respect to ΔGSAT and ΔT. The values on top of colourbar show the percentage of each coloured area over the global land surface, while the values at the bottom indicate the same over the total global surface.

Q3: Changing Seasonality



> "The occurrence of wet extremes are projected to shift over regions like Europe, Sahel, ..."

Figure 3
The multi-model median change in the median day of the year of extreme daily precipitation between the end of the 21st century (2051-2100) using the SSP5-8.8 scenario and the historical period (1951-2014). Stippling indicates the areas where more than 66% of the models agree on the sign change.

What are the projected changes in heavy precipitation seasonality and what is the role of changes in atmospheric circulation types?

> "Changes over Europe partly explained by a seasonal shift in favourable synoptic circulation types"

Relative fequency change in RX1DAY = **Between Class (BC)** + **Within Class (WC)** + **Residual**

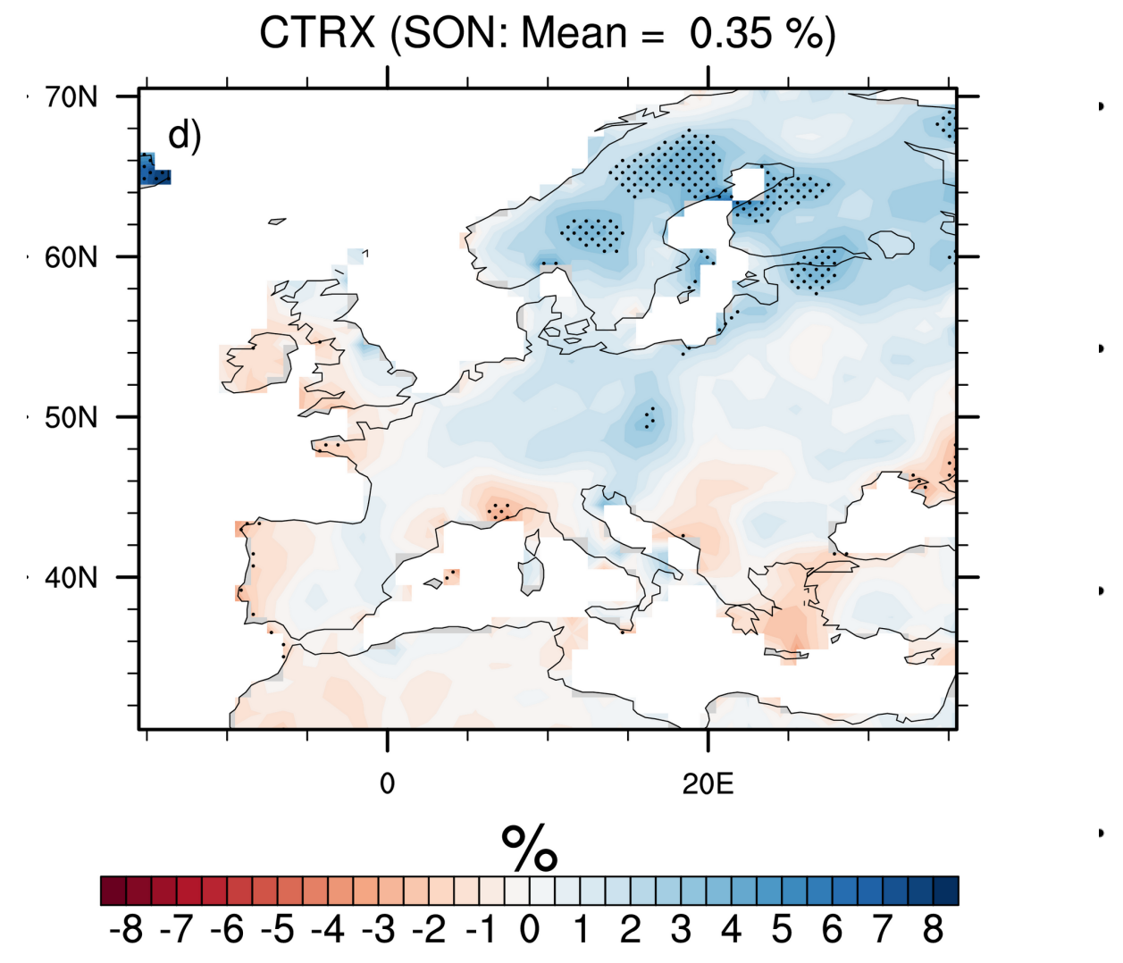
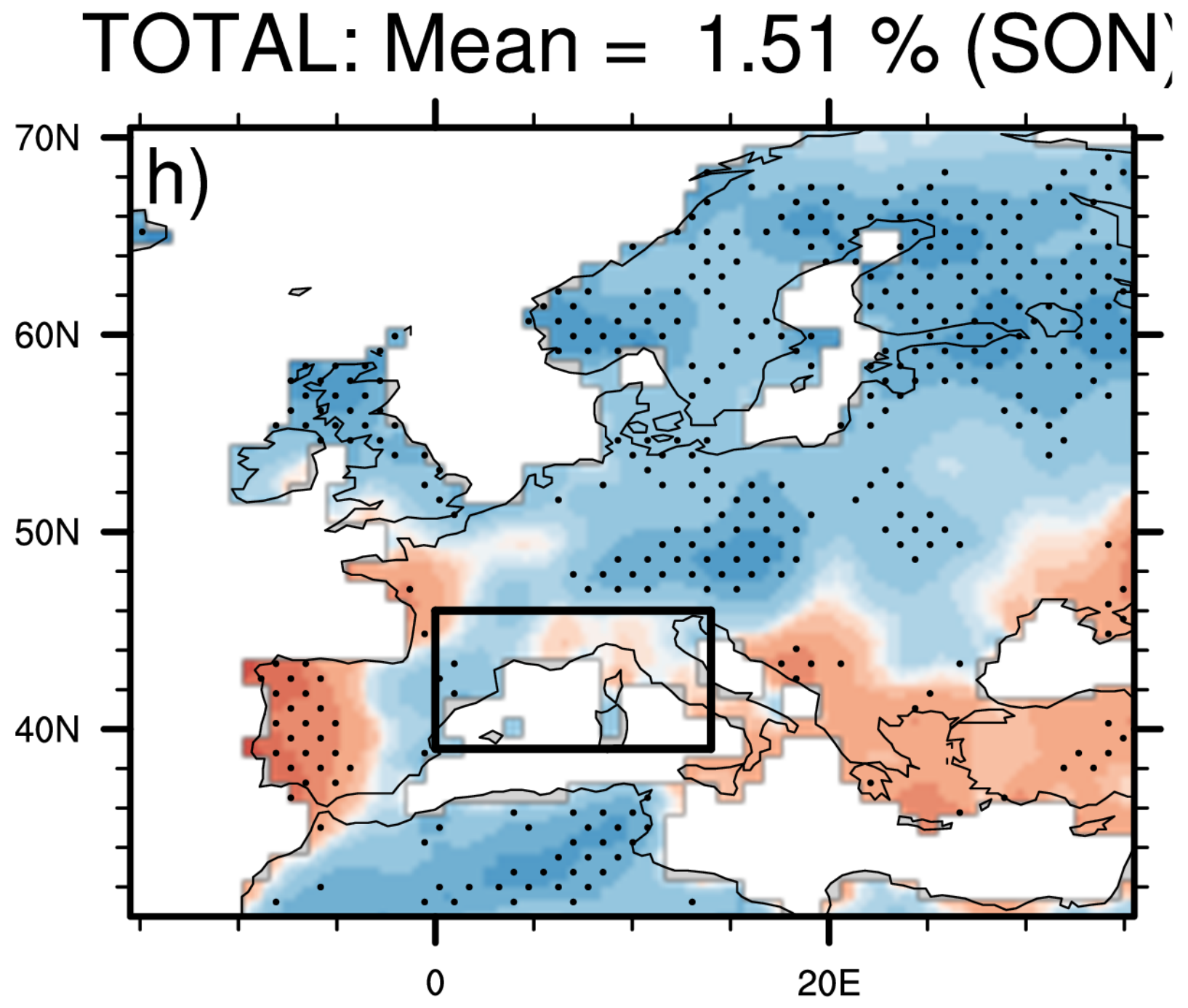


Figure 5
Mean change in the relative frequency of the cy
circulation type for the SON season. Stippling inc
66% of model agreement



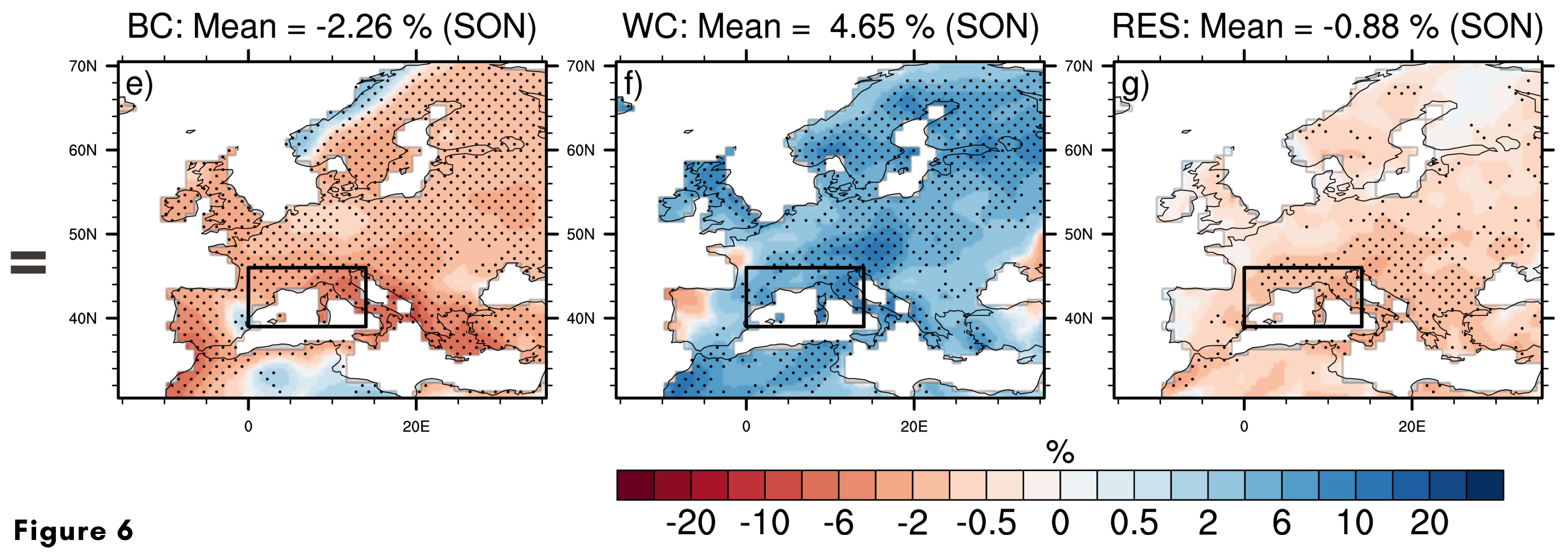


Figure 6
Maps illustrating individual contributions from three decomposed classes; within (WC), between (BC) and residual (RES); to the total extreme precipitation changes for SON season. The stippling indicates areas where 66% of the models agree on the sign change of the multi-model mean. Panels d and h show the sum of the three classes.

Prospects

Study the underlying mechanisms of the extreme precipitation changes

- *by coding the process-oriented diagnostics like CAPE, CIN*

Isolating and quantifying the GHG response in past extreme precipitation constrain future projections

Thesis

Publications

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Climate Advanced Forecasting of sub-seasonal Extremes

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