

Simulated Climate Sensitivity Uncertainty: Control Climate Bias vs. Perturbed Physics

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Introduction

In this poster we discuss the structure of simulated climate sensitivity uncertainty. Based on perturbed physics ensemble simulations with a globally resolved energy balance (GREB) model it is illustrated that the uncertainties in the simulated climate sensitivity can be conceptually split into two parts: a direct effect of the perturbed physics on the climate sensitivity independent of the control mean climate and an indirect effect of the perturbed physics by changing the control mean climate, which in turn changes the climate sensitivity, as the climate sensitivity itself is depending on the control climate.

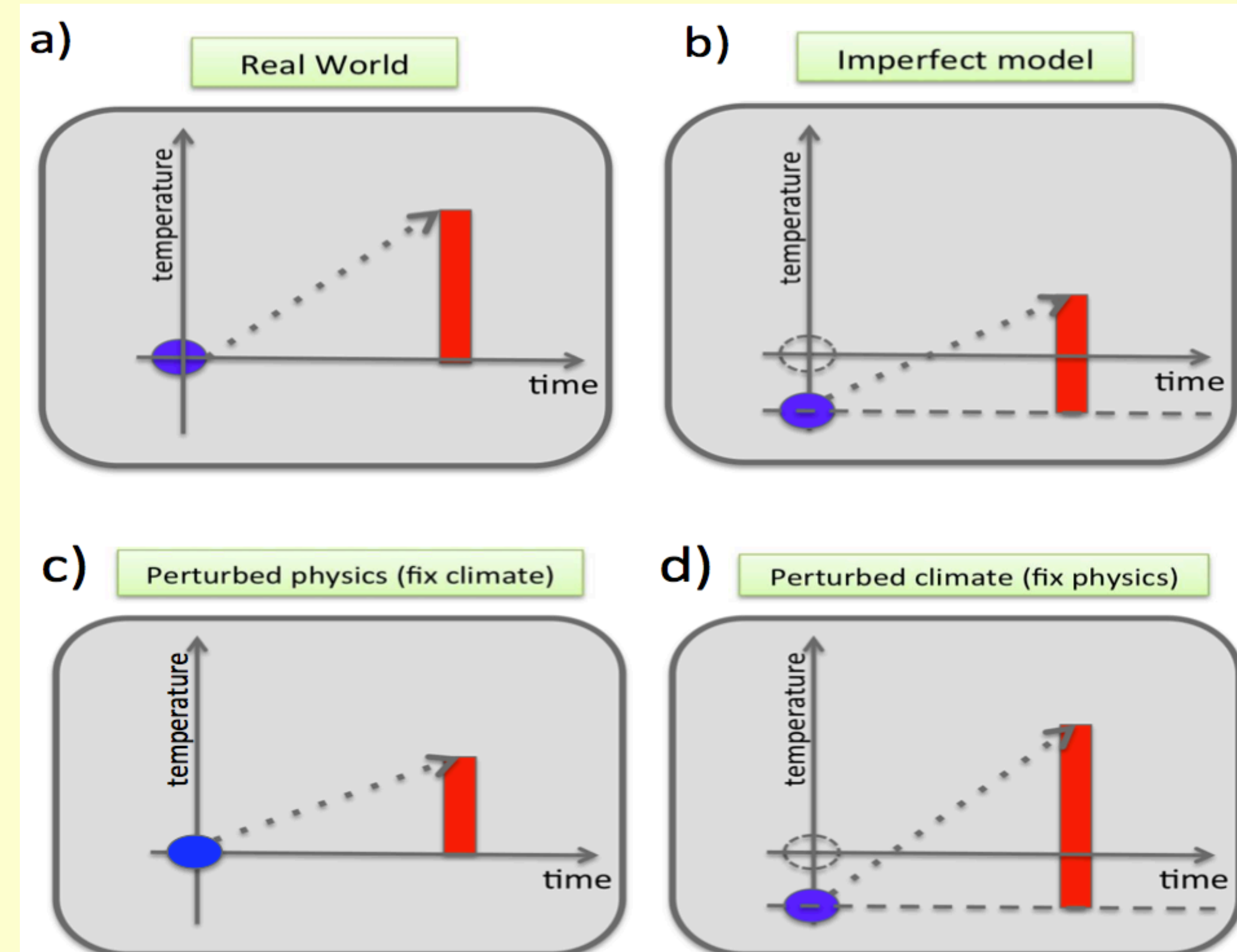


Fig. 1: Illustration of the perturbed mean climate and physics parameters influence on climate sensitivity

Perturbed Responses

✧ We conducted 3 ensembles with 100 members (6 examples shown in Fig.2) of perturbed physics simulations, in which 23 parameters of the GREB model were randomly perturbed. Each is simulating a control and 2xCO₂ simulation. (response diff. to unperturbed model shown in Fig.2).

✧ **Perturbed** (right column): Perturbed physics result into perturbed control climates and perturbed response (sketch Fig.1b).

✧ **Perturbed Physics (fix control)** (left column): Perturbed physics result into perturbed perturbed responses, but control climate is as in the unperturbed model (sketch Fig.1c).

✧ **Perturbed Control (fix physics)** (2. left column): No Perturbed physics, but only perturbed control climate from the 1. ensemble (sketch Fig.1d).

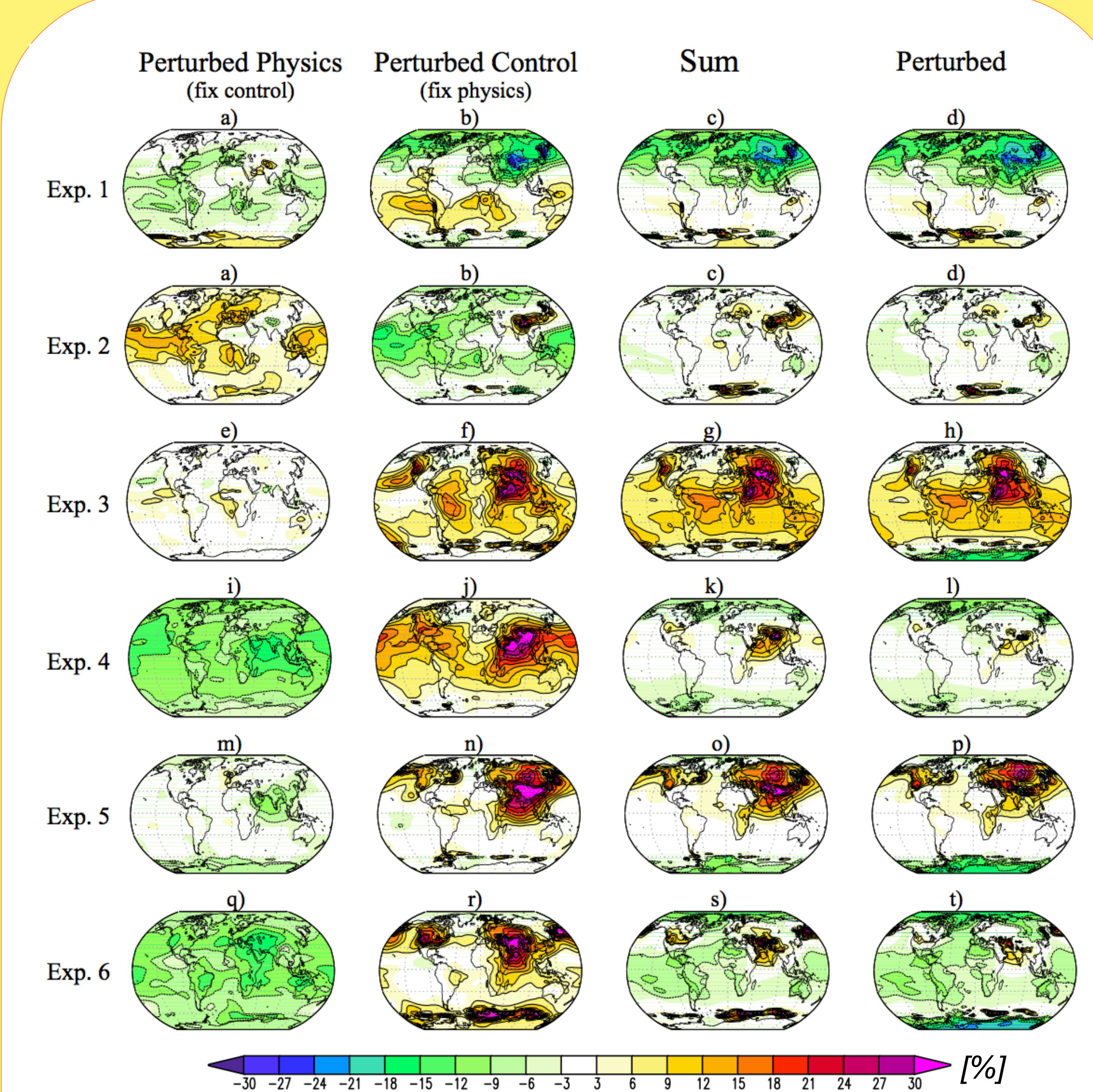


Fig. 2: T_{surf} response variations for 6 different ensemble member simulations with the Perturbed Physics ensembles. Sum in 3. column is the sum of column 1 and 2.

Global mean and Pattern Response Uncertainties

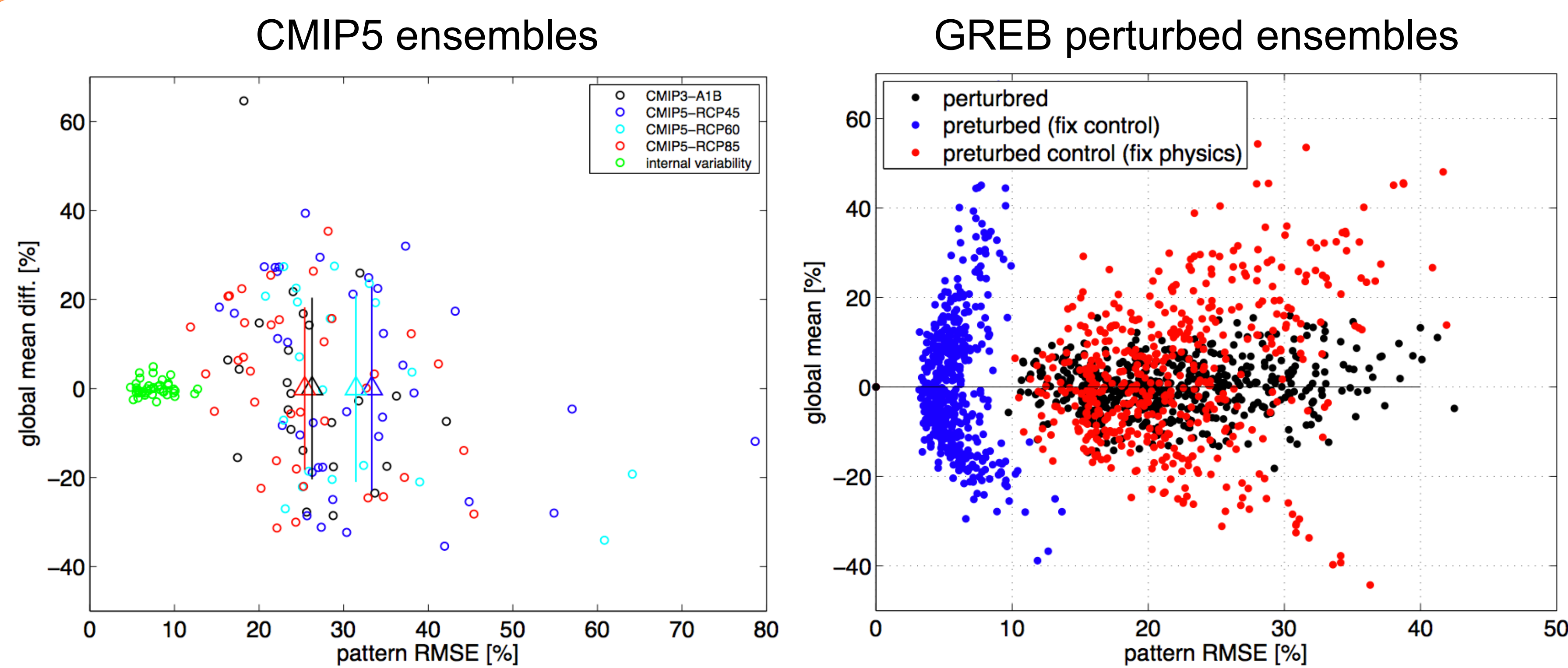


Fig.4: Global mean (y-axis) and pattern (x-axis) uncertainties in the T_{surf} response to CO₂ forcings.

Conclusions

- ✧ The climate sensitivity uncertainty has two parts: a direct effect of the perturbed physics and an indirect effect by changing the control mean climate.
- ✧ The two effects are opposing each other.
- ✧ Biases in the control climate are negatively correlated with the climate sensitivity (colder climates have larger sensitivities).
- ✧ In the GREB model the biases in the control climate are the more important effect for the regional climate sensitivity uncertainties than the perturbed physics itself.

Response Correlations

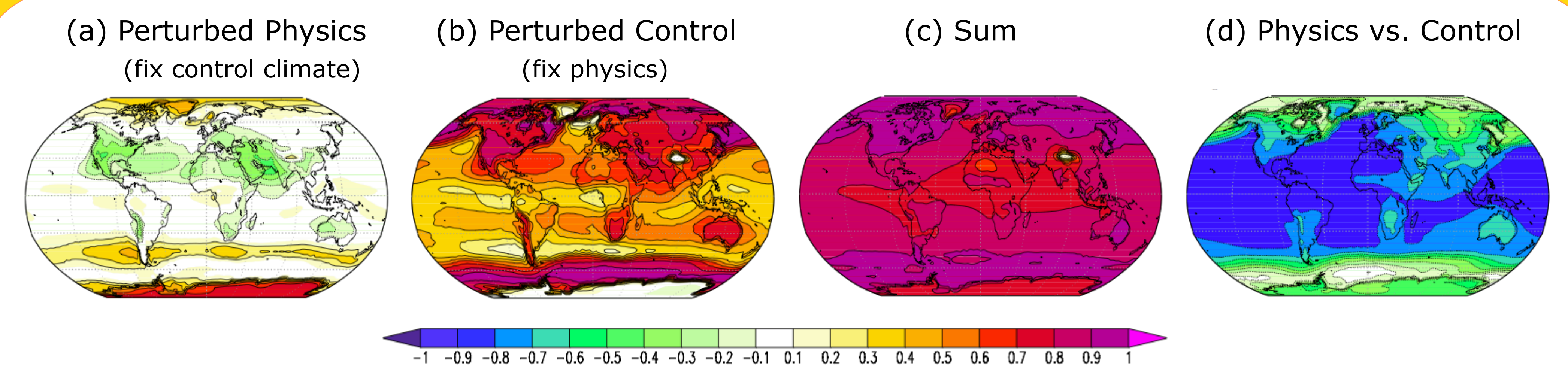


Fig. 3: Correlation of the T_{surf} response variations for different simulations with the Perturbed Physics ensemble.

- ✧ The perturbed physics alone (a) does not relate strongly to the total perturbed physics ensemble T_{surf} response variation, but the perturbed control (b) does.
- ✧ The linear superposition (c) of perturbed physics and perturbed control is highly correlated.
- ✧ The effects of perturbed physics and perturbed control are opposing each other (d).