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Climate Change Projections for Switzerland based on a Bayesian Multi-Model Approach

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Given that future climate projections are necessarily based on a finite number of climate models, it remains one of the key challenges to quantify the uncertainty range of the projections obtained. Ideally, the model projections should sample the whole cascade of uncertainties, ranging from emission uncertainty over uncertainties about physical process understanding and model formulations down to internal variability. However, this goal can at present hardly be achieved due to a range of conceptual and computational limitations (e.g. the quantification of the “unknown unknowns” of the climate system). Any uncertainty estimate obtained is therefore necessarily conditioned on an array of assumptions. To treat this kind of conditional uncertainty, a Bayesian framework is particularly appealing, since it allows decomposing the complex interrelationships between observations, model projections and unavoidable (subjective) prior assumptions in a systematic and transparent way.

In this study, a recently developed Bayesian multi-model combination algorithm is applied to regional climate model simulations from the ENSEMBLES project to generate probabilistic projections for Switzerland. The seasonal temperature and precipitation scenarios are calculated relative to 1980–2009 for three 30-year scenario periods (centred at 2035, 2060, and 2085), three regions, and the A1B emission scenario. Projections for two further emission scenarios are obtained by pattern scaling. Key to the Bayesian algorithm is the determination of prior distributions about climatic parameters. It is shown that the prior choice of model projection uncertainty ultimately determines the uncertainty in the climate change signal. Here, we assume that model uncertainty is fully sampled by the climate models available. We have extended the algorithm such that internal decadal variability is also included in all scenario calculations. The A1B scenarios show a significant rise in temperature increasing from 0.9–1.4 °C by 2035 (depending upon region and season), to 2.0–2.9 °C by 2060, and to 2.7–4.1 °C by 2085. Mean precipitation changes are subject to large uncertainties with median changes close to zero. Significant signals are seen towards the end of the century with a summer drying of 18–24% depending on region, and a likely increase of winter precipitation in Switzerland south of the Alps. The A2 scenario implies a warming of 3.2–4.8 °C, and a summer drying of 21–28% by 2085, while in case of the mitigation scenario RCP3PD, climate change could be stabilized to 1.2–1.8 °C of warming and 8–10% of drying.