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Development of probability distributions for regional climate change from uncertain global mean warming and an uncertain scaling relationship

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Abstract. To produce probability distributions for regional climate change in surface temperature and precipitation, a probability distribution for global mean temperature increase has been combined with the probability distributions for the appropriate scaling variables, i.e. the changes in regional temperature/precipitation per degree global mean warming. Each scaling variable is assumed to be normally distributed. The uncertainty of the scaling relationship arises from systematic differences between the regional changes from global and regional climate model simulations and from natural variability. The contributions of these sources of uncertainty to the total variance of the scaling variable are estimated from simulated temperature and precipitation data in a suite of regional climate model experiments conducted within the framework of the EU-funded project PRUDENCE, using an Analysis Of Variance (ANOVA). For the area covered in the 2001–2004 EU-funded project SWURVE, five case study regions (CSRs) are considered: NW England, the Rhine basin, Iberia, Jura lakes (Switzerland) and Mauvoisin dam (Switzerland). The resulting regional climate changes for 2070–2099 vary quite significantly between CSRs, between seasons and between meteorological variables. For all CSRs, the expected warming in summer is higher than that expected for the other seasons. This summer warming is accompanied by a large decrease in precipitation. The uncertainty of the scaling ratios for temperature and precipitation is relatively large in summer because of the differences between regional climate models. Differences between the spatial climate-change patterns of global climate model simulations make significant contributions to the uncertainty of the scaling ratio for temperature. However, no meaningful contribution could be found for the scaling ratio for precipitation due to the small number of global climate models in the PRUDENCE project and natural variability, which is often the largest source of uncertainty. In contrast, for temperature, the contribution of natural variability to the total variance of the scaling ratio is small, in particular for the annual mean values. Simulation from the probability distributions of global mean warming and the scaling ratio results in a wider range of regional temperature change than that in the regional climate model experiments. For the regional change in precipitation, however, a large proportion of the simulations (about 90%) is within the range of the regional climate model simulations.

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