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On the dominant uncertainty source of climate change projections at the local scale

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Decision makers and stakeholders are usually concerned about climate change projections at local spatial scales and fine temporal resolutions. This contrasts with the reliability of climate models, which is typically higher at the global and regional scales, Therefore, there is a demand for advanced methodologies that offer the capability of transferring predictions of climate models and relative uncertainty to scales commensurate with practical applications and for higher order statistics (e.g., few square kilometres and sub-daily scale).

A stochastic downscaling technique that makes use of an hourly weather generator (AWE-GEN) and of a Bayesian methodology to weight realizations from different climate models is used to generate local scale meteorological time series of plausible “futures”. We computed factors of change from realizations of 32 climate models used in the Coupled Model Intercomparison Project Phase 5 (CMIP5) and for different emission scenarios (RCP 4.5 and RCP 8.5). Future climate projections for several meteorological variables (precipitation, air temperature, relative humidity, shortwave radiation) are simulated at three locations characterized by remarkably different climates, Zurich (Switzlerand), Miami and San Francisco (USA).

The methodology is designed to partition three main sources of uncertainty: uncertainty due to climate models (model epistemic uncertainty), anthropogenic forcings (scenario uncertainty), and internal climate variability (stochastic uncertainty). The three types of uncertainty sources are considered as dependent, implicitly accounting for possible co-variances among the sources. For air temperature, the magnitude of the different uncertainty sources is comparable for mid-of-the-century projections, while scenario uncertainty dominates at large lead-times. The dominant source of uncertainty for changes in precipitation mean and extremes is internal climate variability, which is accounting for more than 80% of the total uncertainty also for end-of-the-century projections. For precipitation, the uncertainty due to historic climate variability is covering a large fraction of the total uncertainty for the projected future. For precipitation statistics, there is a limited room for uncertainty reduction even for end-of-century projections because uncertainty is almost entirely due to internal climate variability. Conversely, projected changes in air temperature and other variables can be largely constrained, even at local scales, if more accurate emission scenarios can be identified.