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Estimating internal variability from relatively short regional-climate simulations

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Convection permitting regional climate models (CP-RCMs, typical horizontal resolution O(1-3km)) are currently state of the art when it comes to simulating regional climate. Their level of resolved spatial detail and realistic behaviour of for example summer convection is unprecedented. Consequently, impact modelers and even society at large have a strong interest in their products. However, because the computational demands of running such CP-RCMs are still huge, most of the simulations to date are relatively short, typically on the order of 10 years. Future trends are then derived from differences between two single time-slice experiments.

In contrast, conventional regional climate models (RCMs), that operate on typical “CORDEX” resolution (O(10km)), nowadays are relatively cheap to run, making it feasible to generate large ensembles of long transient integrations. These ensembles allow for a better determination of the amplitude of the internal variability and therefore come with higher signal-to-noise ratios. Invariably, it turns out that internal variability on the 10-year time scale (i.e., the typical time scale of the CP-RCM simulations) is considerable, if not very large for climate parameters like mean precipitation and temperature, let alone for climate extremes. This not only holds for the RCM results of course, but also for the CP-RCMs, perhaps even more strongly.

Two questions arise. First, to what extent are the mean trends derived from CP-RCM simulations meaningful given the large amplitude of internal variability at time scales used for the simulation? Second, how can we estimate the amplitude of internal variability at the 10-year time scale in the first place? We examine answers to these two basic questions in the GCM/RCM world where large ensembles are routinely available. The expectation is that some of the lessons learned here will carry over to the CP-RCM world.