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## A Climate Model Structural Behavior Under Different Forcing

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In this study the COSMO-CLM sensitivity to parameters perturbation is investigated under different climate forcings. The main aim is to understand

how the uncertainty of the model propagates in different climate regimes and whether the model presents structural stability when different forcings are considered. For this purpose, two Physically Perturbed Ensembles (PPEs) are produced, each composed of 35 realizations, at two different periods of the past: the Mid-Holocene, 6000 years ago, and the Pre-industrial period. The two periods present significant differences in the seasonal values of incoming insolation due to changes in the Earth's orbital configuration. The effects of these changes on the Earth's radiative balance, at least when considering seasonal values, are of the same magnitude of the changes due to GHGs emissions of the worst case Representative Concentration Pathway scenario (RCP8.5). Two additional ensembles, but with a lower number of components, are produced in order to determine the role of the boundaries with respect to the one of changes in the climate forcings.

Preliminary analyses show that the model presents a structurally stable behavior in the two periods for several variables, in particular when considering climate mean statistics. Some parameters do not produce sensible changes in the model behavior in both periods. This confirms that conducting a calibration of the model only on a restricted set of parameters is a good praxis when willing to simulate future or past climate change. On the other hand, some parameters show remarkable changes with respect to a reference simulation: these differences are maintained in the two different regimes, pointing again to a relatively good model stability, but also to a very similar sensitivity of the model to the different forcings. Finally, when considering the ensembles with the same forcings but different boundaries, the effect of the boundaries seems to play a major role. This is particularly important for climate projections using the COSMO-CLM: a model PPE would probably not be particularly relevant in order to characterize the model uncertainty, but more attention should instead be paid to consider a wide ensemble of independent boundary realizations with different GCMs