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Implementation of Climate Forcings (volcanic, orbital, solar, LUC, GHG) for Paleoclimate Simulations (500BCE-2000CE) in the COSMO-CLM

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The climate of the last 2500 years is documented in natural (speleothems, tree rings, sediments and pollen) and human-historical archives. Proxy records and subsequent climate reconstructions can be subject to a considerable amount of uncertainty, as the proxies can only capture a fraction of the entire variability. Climate model simulations can contribute to the interpretation of variations observed in the paleoclimate data and better understanding of dynamics, mechanisms and procedures. The state-of-the-art simulations following the CMIP6-protocol are highly resolved in time but still present a rather coarse horizontal resolution (200 km or more) to adequately address regional paleoclimate questions/hypotheses. Dynamical downscaling can close the gap between the regional archives and the coarsely resolved Earth System Models (ESMs). Using regional climate models to downscale ESM output requires a consistent implementation of the climate forcings in the regional model used also for the driving ESM. State-of-the-art and CMIP6 compliant reconstructions of volcanic (stratospheric aerosol optical depth), orbital (eccentricity, obliquity, precession), solar (irradiance), land-use and greenhouse-gas changes used for the MPI-ESM are therefore implemented in the regional climate model COSMO-CLM (CCLM, COSMO 5.0 clm16). The functionality of each implemented forcing is tested separately and in combination for the period (1255-1265) that covers the Samalas volcanic eruption of 1257. The orbital forcing is found to have the largest impact in general and the volcanic forcing has a strong but short-lasting effect after the eruption. The other climate forcings only show very small impact in the chosen period. At the moment, a transient CCLM simulation with all forcings implemented with a horizontal resolution of 50 km is running for the last 2500 years in the Eastern Mediterranean, the Middle East and the Nile River basin.