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Regional paleoclimate in the EMME and the Nile basin based on COSMO-CLM with orbital and volcanic forcing at the different spatial resolution

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The interaction between climate variability, extreme events and societies in the Eastern Mediterranean and the Middle East (EMME) and the Nile river basin is of particular interest in the last 2000 years. Major civilizations and complex pre-modern societies have written the greatest and multifaceted history of the area. However, the influence of climate on the societies is examined only from the proxy records perspective, without the detail of the processes that offer regional climate model simulations. The present and future climate and climate variability of this region are currently studied in the frame of the MENA CORDEX program with different global and regional climate models. For the past climate, exist only global climate or earth system model simulations with a coarse spatial resolution with a minimum of 100 km horizontal resolution. We aim at improving our understanding of past climate in the EMME and the Nile river basin (Nile) at the regional scale and use an adjusted paleoclimate version of the COSMO-CLM. Test simulations have been performed over the study region for the years 2017-2018 to identify the best settings of CCLM with respect to the CORDEX-MENA simulations which are carried out by Bucchignani et al. (2016). Test simulations show the CCLM can correctly simulate large tropical volcanic eruptions, as conditions similar to the Tambora eruption by adapting the stratospheric aerosol optical depth (AOD) mimicking conditions after a Tambora-like volcanic eruption. In agreement with Bucchignani et al. (2016), the albedo and aerosols parameters are found to be most important for the area and may be responsible for larger deviations compared to observational data. Thus, CCLM climate modelling for the present (1979-2019) and selected paleo-periods (525-575 CE and 1220-1290 CE) with intense volcanic activity will be forced by the MPI-ESM-LR ‘past2k’ simulation with the optimized settings which is identified in the test simulations. Orbital, solar and volcanic forcing, together with vegetation, land-use changes and greenhouse gas changes will be addressed step by step in the CCLM with resolutions of 0.44° and 0.11°. The present-day simulations show that the temperature and precipitation are well simulated compare to reanalysis and observational data in general. Additional, CCLM correctly captured convection and cloud cover clearly define the model performance in the greater southern areas of the domain that are affected by the tropical convection. Further, the orography and the land-sea interaction seem to significantly influence the

local climate and may lead to differences compared to observations, which may also be strongly connected with the specific spatial resolution. For example, the Ethiopian Highlands and the East African Plateau have high elevations and have a large impact on the regional climate.

Reference

Bucchignani, E., Cattaneo, L., Panitz, HJ. et al. Sensitivity analysis with the regional climate model COSMO-CLM over the CORDEX-MENA domain. Meteorol Atmos Phys **128,** 73–95 (2016). https://doi.org/10.1007/s00703-015-0403-3