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Regional climate simulations with COSMO-CLM over MENA-CORDEX domain

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In the frame of WCRP Coordinated Regional Downscaling Experiment (CORDEX), a set of common Regional Climate Downscaling (RCD) domains has been defined, as a prerequisite for the development of model evaluation and climate projection frameworks. CORDEX domains encompass the majority of land areas of the world. In this work, climate simulations have been performed over MENA-CORDEX domain, which includes North-Africa, southern Europe and the whole Arabian peninsula. The non-hydrostatic regional climate model COSMO-CLM has been used. At CMCC, regional climate modelling is a part of an integrated simulation system and it has been used in different European and African projects to provide qualitative and quantitative evaluation of the hydrogeological and public health risks.

A series of simulations has been conducted over the MENA-CORDEX area at spatial resolution of 0.44°. A sensitivity analysis was conducted to adjust the model configuration to better reproduce the observed climate data. The numerical simulations were driven by ERA-Interim reanalysis (horizontal resolution of 0.703°) for the period 1979-1984; the first year, was considered as a spin up period. The validation was performed by using several data sets: CRU data set was used to validate temperature, precipitation and cloud cover; MERRA data set was used to validate temperature and precipitation and GPCP for precipitation.

The model sensitivity to the external parameters was tested considering two different configurations for the surface albedo. In the first one, albedo is only function of soil-type whereas in the second configuration it is prescribed by two external fields for dry and saturated soil based on MODIS data. Moreover, we tested two aerosol distributions as well, namely the default Tanre aerosol distribution and aerosol maps according to Tegen (NASA/GISS). We found, as expected, a significant sensitivity, in particular on the African region. We also varied tuning and physical parameters, such as the scaling factor for the thickness of the laminar boundary layer for heat, which defines the layer with non-turbulent characteristics, mean entrainment rate for shallow convection, cloud ice threshold for autoconversion, radiation and clouds. We choose such parameters following several literature works, which showed that these parameters mostly affect the fields simulated by the model. However, it is known that the sensitivity of a RCM with respect to parameter variations depends, in general, on the model domain, the temporal and spatial scales and the model variables considered.

We made a first set of simulations varying one parameter at a time, using Taylor's diagrams, as well as seasonal cycles and bias maps to take tracking changes in the model performance. Successively, we run a second set of simulations in which we varied two or three parameters at a time to get an optimal configuration. The selected configuration is being used to carry out simulations on a 30-years past period, starting from 1979, for three horizontal resolutions, namely 0.44°, 0.22° and 0.11°.