Project: **1151**

Project title: **Investigating the scale-dependency of COSMO-CLM for Climate Projections**

Principal investigator: **Bijan Fallah**

Additional Investigators**: Emmanuele Russo**

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Due mainly to some erroneous calculation of resources, only part of the initially planned simulations will be performed by the end of the year 2020. These include all the simulations at a spatial resolution of 0.44° and 0.22° for the present-day and for the RCP8.5 scenario. Due to the effective higher cost of simulations performance, double the initially estimated resources, we decided to dismiss the initially planned simulation for the RCP2.6 scenario. This choice can be considered as a good compromise between used resources and the achievement of the general objectives of the project, since this scenario is characterized by rather limited changes in the forcings with respect to RCP8.5. Promising results deriving from a preliminary analysis of the so-far performed experiments supports the validity of the project. At the moment, only a default simulation for present days has been performed for the three spatial resolutions considered in the project, namely 0.44°, 0.22° and 0.11°.A first comparison of these first results is interesting because it allow to see that, for an optimal model configuration, no significant differences in model performances are obtained by an increase in resolution (Fig. 1).

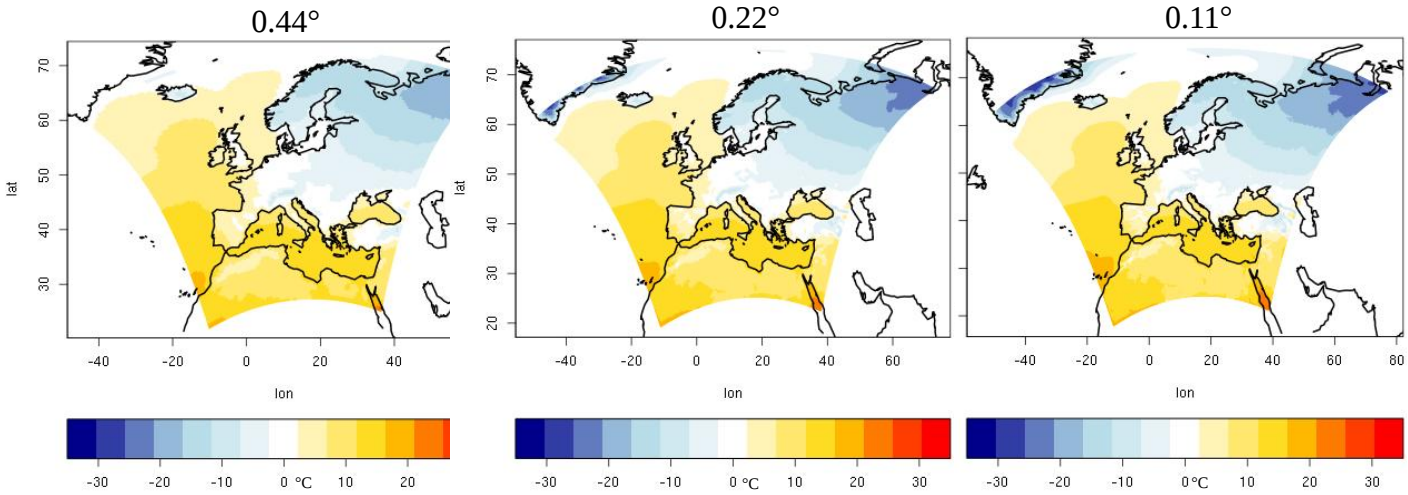

Fig 1: Maps of January mean temperatures as derived from three different model simulations for the present day, performed with a same configuration, at a spatial resolution, respectively from left to right, of 0.44°, 0.22° and 0.11°.

Up to now, additionally, almost all the simulations for the present day and for the RCP 8.5 scenario at 0.22° resolution have been performed (53 simulations). Also in this case, preliminary analyses of the results support the validity of the project. Here though, results for now are not useful for a real assessment of the scale dependency of the model structural uncertainty, but rather to debate the utility of calibration methods and changes in the spread of model results at a given resolution. The results of the Physically Perturbed Ensembles at 0.22° at present and in the period 2090-2099, following the RCP8.5 scenario, show that the spread of the ensembles changes in the different cases over specific seasons (Fig. 2). In particular, changes are remarkable for winter temperatures. What seems to be interesting in this case, is that the spread is more pronounced at present than in the future, over a large part of the domain. This might suggest that other effects, such as the boundaries, might play a more important role in the future, given the considered scenario. Further tests will be planned in the year 2021, for testing the effect of the boundaries on the simulations at 0.22°, considering additional CMIP6 GCM realizations. Concerning the already mentioned validity of the calibration methods for COSMO-CLM, results show that the stationarity assumption on which such calibration methods rely, might not be satisfied given the evinced changes in the model structural behaviour over the different periods. Another interesting behaviour emerging from this analysis is that the spread of the ensemble is more pronounced in winter rather than in summer, for both present and future periods.

Parameter	Description	Parameter Value
TKHMIN & TKMMIN	minimal diffusion coefficients for heat & minimal diffusion coefficients for momentum	(0,0.4,1,2) (0,0.4,1,2)
RLAM_HEAT	scaling factor of the laminar boundary layer for heat	(0.1,1,3,5,10)
RAT_SEA	ratio of laminar scaling factors for heat over sea and land	(1,10,20,50,100)
E_SURF	exponent to get the effective surface area	(0.1,1,10)
FAC_ROOTDP2	Uniform factor for the root depth field	(0.5,1,1.5)
RADFAC	fraction of cloud water/ice used in radiation scheme	(0.3,0.5,0.9)
UC1	parameter for computing amount of cloud cover in saturated conditions	(0.2,0.5,0.625,0.8)
TUR_LEN	maximal turbulent length scale	(100,500,1000)
SOILHYD	multipl. factor for hydraulic conductivity and diffusivity	(1,1.62,6)
D_MOM	factor for turbulent momentum dissipation	(12,15,16.6)

Tab 1: List of tested parameters values. For the parameters TUR_LEN and D_MOM, highlighted in yellow, not all the RCP85 simulations have been accomplished yet. The values of the default model configuration are highlighted in red.

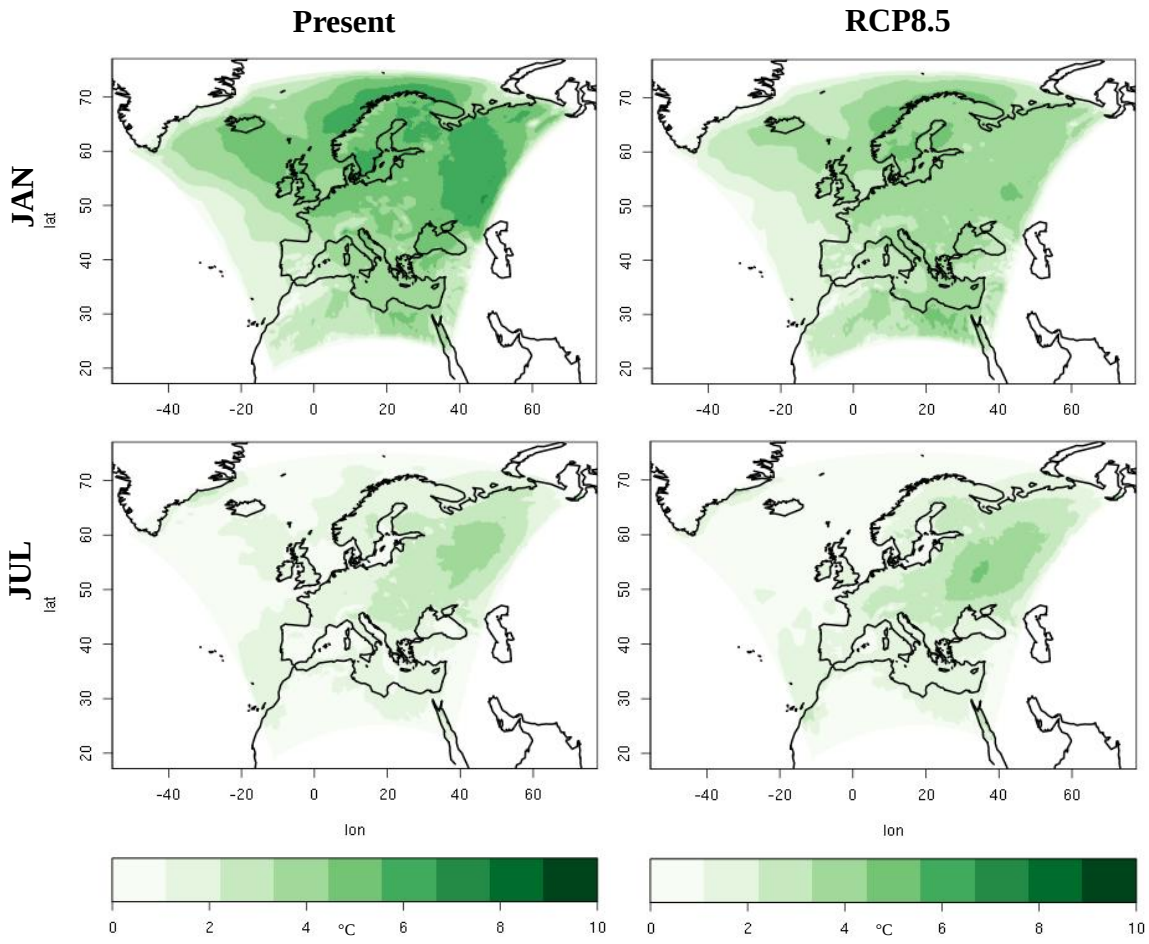

Fig 2: Spread of mean temperatures calculated for January (upper row) and July (lower row) , from the Physically Perturbed Ensembles at present (left) and for the period 2090-2099, following the RCP 8.5 scenario. The values of tested parameters for the realization of the given ensembles are reported in Tab. 1, for a total of 25 members.