Project: **1155**

Project title: **COPAT2 – Coordinated parameter testing of the COSMO6.0 version and ICON-CLM**

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Report period: **2021-11-01 to 2022-10-31**

In the last year the working group EVAL of the CLM community was mainly working on the COSMO-CLM part of the parameter testing initiative COPAT2. In the first phase, changes with respect to a reference simulation in single parameters or combined model parameters and physical options belonging to a specific physical or dynamical implementation were tested. A reference simulation covering the years from 1979 to 2019 and 15 sensitivity tests, each covering the years from 1979 to 1985, were performed in this phase. One of these simulations further needed to be repeated, due to a longer spin-up required by the tested hydrological scheme with a new ground water formulation: the values of soil moisture and soil temperature from a 6-year long simulation were needed for initializing a new simulation over 1979-1985.

An evaluation of the performance of each simulation with respect to the reference run was automatically performed inside each job chain, using the Hereon-Evasuite package. The evaluation is based on different metrics (such as bias, RMSE, linear correlation and several skill scores), variables, temporal aggregation intervals and a domain decomposition consistent with the one of the PRUDENCE project given by the output of the EvaSuite in 2D and time series data and figures. Fig. 1 shows an example of one of the considered metrics, the Advanced (symmetric) Mean Squared Error Skill Score, based on daily values of 5 variables (i.e.: precipitation, mean, maximum and minimum near surface temperature and mean sea-level pressure) and all the 8 PRUDENCE regions. It allows a quick estimate of the potential of a given run to improve over the results of the reference simulation.

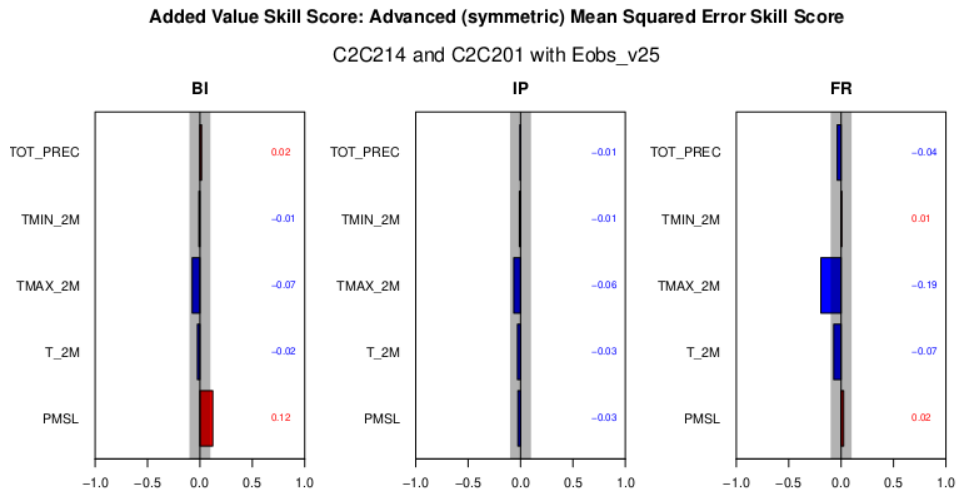

Figure 1: Example for the ad hoc comparison of a simulation with the reference simulation produced automatically at the end of the simulation period (here for British Island, Iberian Island and France)

After a long discussion among different project members, the main metric selected for determining the best performing model simulation compared to observations, is the so-called score points of evidence. It basically estimates the ratio of points for which the considered simulation leads to a significant improvement over a reference experiment, for a given measure of the model deviation from observations. The significance analysis was not only done for the parameters provided by eObs but also for the ERA5 reanalysis data of mean sea level pressure (more reliable than eObs), incoming short-wave radiation at surface, cloud cover and total water content of clouds. An overview of the score points of evidence for all simulations from COPAT2 phase 1 can be seen in Figure 2.

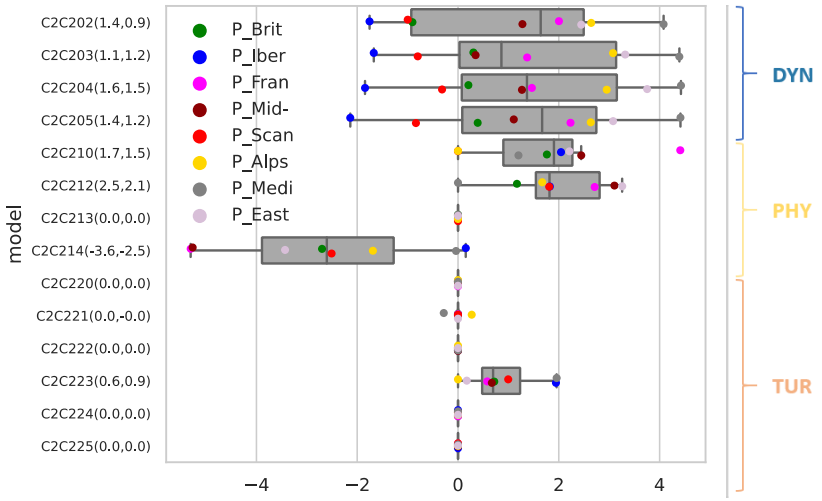

Figure 2: Score Points of Evidence based on the BIAS calculated, for several variables such as mean sea level pressure, short-wave radiation at surface, cloud cover and total water content of clouds, between the different model runs of phase 1 of the project and observations and the reference simulation C2C201, for the years 1981-1985. (R. Petrik).

After an intense discussion on the results of COPAT2 phase 1, the second phase of the project for COSMO-CLM was started. All phase 2 simulations were produced on Levante, as the reference simulation C2C201 was done on Mistral the reference simulation was repeated as C2C301 on Levante.

The transition to Levante resulted in a delay of the project due to the frequent disruptions of the job chains due to various problems.

In this second phase, 8 simulations were performed testing combinations of the parameters that showed the most promising results during phase 1. To get a get a bit more information compared the overview given in Figure 2, it is analysed which of each evaluation variable shows significant improvement / worsening over the reference. The Score board developed by R. Petrik (see Figure 3) separates information between variables, seasons, regions and considered metrics.

Score board with Eobs-v25lr_and_ERA5, model: C2C305,refmod: C2C301, region: P_France

season metric	Summer BIASsk	Winter BIASsk	Spring BIASsk	Autumn BIASsk
tas				
tasmin	▲		△	
tasmax	▲	▲	▲	▲
dtr	▲	▲	▲	▲
psl_eobs	▲	▼	▲	▽
rsds_eobs				
psl_era5	▲	▼	▲	▼
rsds_era5				
clt				
prw				

Figure 3: Example for a new developed score board, based on the performance of the considered simulation with respect to the reference in terms of several variables, here: bias for the PRUDENCE region 'France'. For mean sea level pressure (psl) and radiation (rsds) two sources of 'reference' data are used. Most of the variables were compared with eObs_v25, but cloud cover and vertical integrated cloud water was compared with ERA5 only. (R. Petrik)

The results from the second phase of COPAT2 need to be extended in order to examine the model performance also for a more recent climate. Doing so, we can also consider remote sensing data for the evaluation. The plan is to extend simulations for the years 2005-2011 for the most promising simulations (2-3) of phase 2. The plan is to accomplish such simulations by the end of the year 2022. The final evaluation of the different simulations will be complemented by a comparison against radiosondes data, currently on-going. For the period in the 80s it will be done by explicit calculation of radiosonde shift. For the recent day climate the GPS information of the radiosondes will be used for tracking and matching with the model.

Concerning the ICON-CLM planned simulations, in the year 2022 a reference run for the years 1979 to 2019 was also performed on MISTRAL. Then, a simulation using the same model setup was performed also on LEVANTE, covering the years from 1979 to 1985. A comparison of these 2 simulations over the corresponding periods did not show significant differences originated by the use of different machines.

At the end of 2022, sensitivity tests also for ICON-CLM will be performed. The work will be based on the experiences from the NUKLEUS project and sensitivity parameters that have been already identified during the current year.