Project: **1155**

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

Principal investigator: **Beate Geyer**

Report period: **2023-11-01 to 2024-10-31**

In the last but one year we, members of the working group EVAL of the CLM community, were working together to figured out the best set up for the COSMO-CLM version 6.0 for Europe. We started based on the recommended setup for version 5.0 with single parameter tests for parameters of new developments for a short period, namely 1979-1985 to test the sensitivity of model. We developed an objective procedure to summarise the results of the variable- and area-specific comparisons with observational data and, where no such data were available, with ERA5 data. The metrics used are bias, RMSE, linear correlation and AMSESS (Advanced (symmetric) Mean Squared Error Skill Score). The measure is named "Score point of evidence", ScoPi, and in detail described in the publication uploaded to accompany this request. The final score for each simulation is the weighted mean for all subregions where the weight can be chosen between distance to the mid of the domain or the size of the subregion. The score point of evince for a single domain is a weighted mean over the scores per variable. Here the weights were defined by the working group, e.g. not to overemphasise the temperature influence on the measure by evaluating 2m temperature itself and maximum and minimum temperature. In the second phase, we combined the most promising namelist switches searching for the best performing combinations. In the next phase, we tested whether our findings are stable when a longer period is analysed and when we shift the period of interest to 2003-2008 where satellite data came into play additionally.

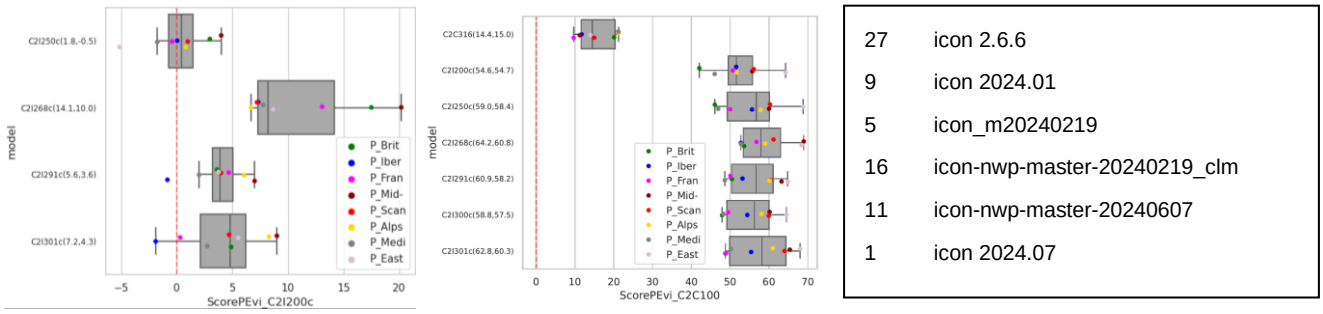
The entire process was finalised by compiling a community internal report of 37 pages, which was published as COSMO Technical Report. A paper publication is pending.

In the last year we went ahead with the parameter testing for ICON-CLM. We started with the same procedure as for the COPAT2 COSMO-CLM. Then after the first phase we figured out that an additional tool, the LinearMetaModel (LiMMo) might help to reduce the needed test simulations to find the best setup.
The best setup for the newest release Icon 2024.07 was defined in July 2024 – and it was agreed on to be the recommended version for simulations over Europe on R13B05 grid at the Assembly of the CLM-community (22.10.-31.10.24).

In COPAT2 ICON-CLM phase 1 we did 27 simulations with version 2.6.6. In phase 2 we did 69 simulations (see Fig 1c).

One challenge was that the final version of the setup was to be used for the production runs of the CMIP6 downscaling (in UDAG project 1364). The adjustments of the model necessary for meaningful climate simulations and other model developments that improve the quality of the simulations therefore had to be taken into account, so that it was necessary to change the model version several times.

A publication summarizing all the activities and parameter settings will follow. To show here, that we used the resources in the sense of the application, we show some of the final plots only.



27	icon 2.6.6
9	icon 2024.01
5	icon_m20240219
16	icon-nwp-master-20240219_clm
11	icon-nwp-master-20240607
1	icon 2024.07

Figure 1: ScoPi plots a) for the basis of decision at the CLM community assembly and b) comparison to the COSMO-CLM final setup.

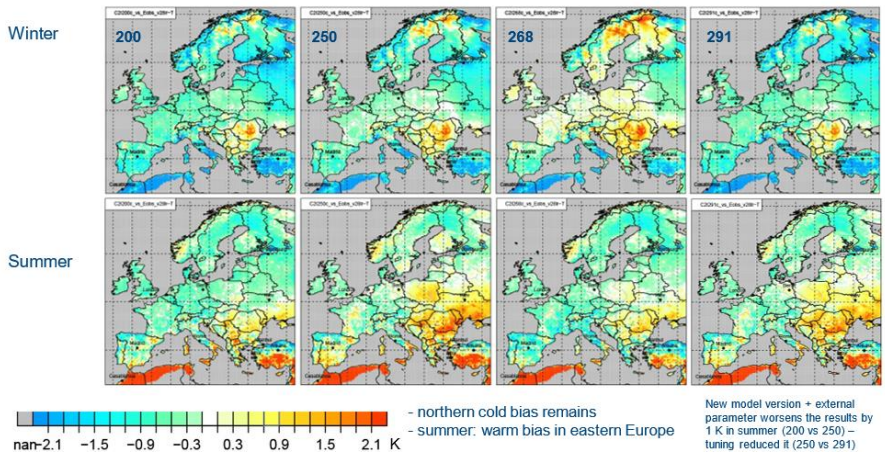


Figure 2: Seasonal mean bias of daily temperature in 2 m height in comparison to eObs v 29 for the period of 2003 – 2007.

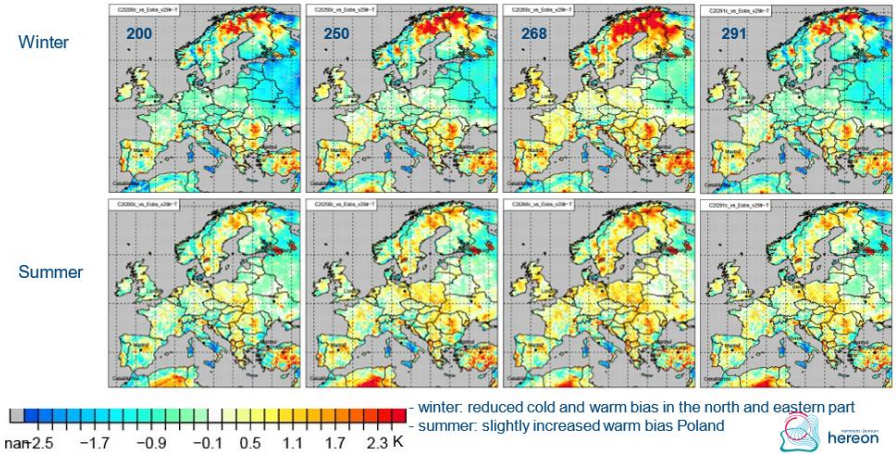


Figure 3: Seasonal mean bias of daily minimum 2m temperature in comparison to eObs v 29 for the period of 2003 – 2007.

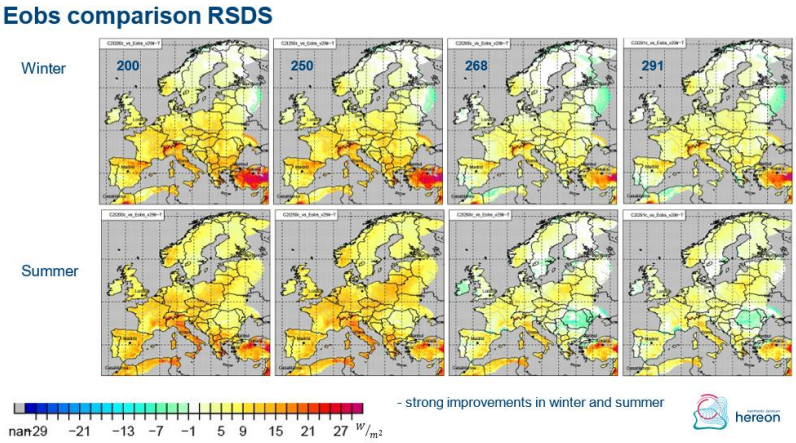


Figure 4: Seasonal mean bias of incoming solar radiation in comparison to eObs v 29 for the period of 2003 – 2007.

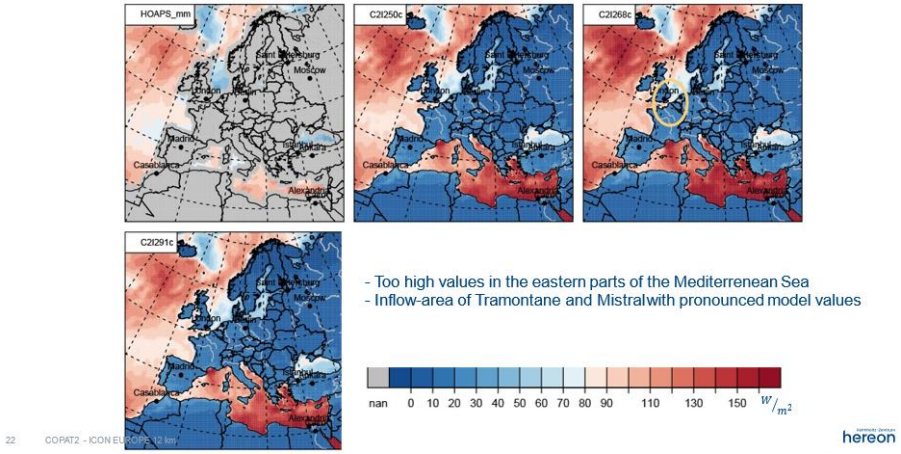


Figure 5: Monthly mean latent heat flux for January for the period of 2003 – 2007 for the satellite product HOAPS and selected ICON simulations.

The parameter rlam_heat (6.25) which led to the best ScoPi Scores led to the overestimation of the latent heat flux over the mediterrean – latent heat flux was not part of the ScoPi-analysis. Therefore the decision was taken as an conservative compromise not to use the setup C2I268c.

The Figures 6 to 9 show that the tackled problems were solved as follows

- The solar incoming radiation bias with too high values over land (station based analysis + eObs-data) is overall reduced by 30%
- For T_2M, TMAX_2M we do not achieve remarkable improvements for Mid-Europa, slightly stronger negative winter bias for Scandinavia. But we see a reduced positive summer bias over Africa
- For TMIN_2M we found slight improvements for cold and warm winter biases for eastern and northern Europe

Additionally, TOT_PREC, Latent and sensible heat flux and others stay nearly unchanged. The windspeed 10m is improved due to the corrected orography at 12 km resolution (MERIT orography)

For now, the optimal configuration is defined for Europe 12 km, the 3 km setup is following and the next ICON version (ICON 2024.10) is already published and has to be tested.

To compare the previous tests with the next one and to write the publication we need the results of the COPAT2 process for the next year.