Project: **1155**

Project title: **COPAT Framework - Coordinated parameter testing for ICON-CLM**

Principal investigator: **Beate Geyer**

Report period: **2025-11-01 to 2026-10-31**

COPAT2 – COSMO6.0

In 2023/2024 we were figuring out the best setup for the COSMO-CLM version 6.0 for Europe with the resources from bg1155. The manuscript “Determining an optimal configuration for the regional climate model COSMO-CLM 6.0 using a novel model evaluation metric” is in the second revision round. Therefore, the storage capacity from that effort is still in use. A link to the preprint version is given (Geyer, Russo, et al., 2026).

COPAT2 – ICON (**ICON-CLM 12 km)**

The optimized setup for the ICON release 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 2024’ Assembly of the CLM-community (22.10.-31.10.24). The optimized setup for the release 2024.07 is already in use for the CMIP6 downscaling by the CLM-community. The paper “Optimisation of ICON-CLM for the EURO-CORDEX domain: developments, sensitivities, tuning” is published (Geyer, Campanale, et al., 2026).

COPAT3 – ICON

The LiMMo version 1.0 was further developed to overcome the problem of the subjective weighting of the variables (mainly introduced to avoid counting temperature multiple times for mean, minimum and maximum). The publication for LiMMo2.0 is almost ready for submission.

The COPAT3 sensitivity tests are finished including new parametrisations and not yet tested parameter for which the model showed sensitivity in the 3 km simulations (Figure 2).

tas	rsds	tasmin	tasmax	pr_amount	psl	hfls_o	hfls_l	ws	clt	Avg
1.9	2.3	1.2	1.9	1.1	1.3	1.8	1.4	1.1	2.1	1.6
1.6	2.2	1.1	1.7	1.1	1.6	1.8	1.3	1.0	2.1	1.6
1.3	1.2	1.0	1.3	1.1	1.4	1.3	1.3	1.1	1.4	1.2
1.5	1.2	1.1	1.5	1.2	1.2	1.6	1.4	1.1	1.1	1.3
1.2	1.2	1.0	1.3	1.4	1.3	1.3	1.3	1.0	1.7	1.3
1.2	1.1	1.0	1.2	1.1	0.7	1.1	1.2	5.1	1.0	1.5
1.2	1.0	1.1	1.4	1.1	0.9	1.0	1.2	1.0	1.1	1.1
1.8	1.1	2.9	1.3	1.1	1.2	2.3	1.3	1.1	2.8	1.7
2.1	2.7	1.4	3.5	1.2	0.8	4.8	1.6	1.7	2.6	2.2
1.2	1.3	1.0	1.2	1.1	0.8	1.1	1.2	1.0	1.3	1.1
1.3	1.1	1.1	1.3	1.1	0.9	1.1	1.3	1.8	1.1	1.2
1.1	1.1	1.0	1.2	1.1	1.0	1.1	1.3	1.1	1.1	1.1
1.1	1.0	0.9	1.1	1.1	0.8	1.3	1.2	1.0	1.1	1.1
1.1	1.0	0.9	1.2	1.1	0.9	1.1	1.2	1.0	1.0	1.1
1.2	1.1	0.9	1.2	1.1	0.8	1.0	1.3	1.0	1.0	1.0
1.2	1.1	1.0	1.3	1.2	1.0	1.7	1.3	1.0	1.1	1.2

	tas	rsds	tasmin	tasmax	pr_amount	psl	hfls_o	hfls_l	ws	clt	Avg
allow_overcast	1.2	3.1	1.3	1.3	1.3	1.0	1.8	1.7	1.1	3.5	1.7
tune_box_liq	0.8	1.8	0.9	0.8	1.1	0.8	1.1	0.9	0.9	1.9	1.1
tune_box_liq_asy	0.7	1.1	0.8	0.7	1.1	1.0	1.0	0.8	0.9	1.3	0.9
cwimax_ml	0.6	0.9	0.7	2.8	1.1	0.7	0.9	0.9	0.9	3.2	1.3
tune_eiscrit	0.9	1.1	0.9	2.4	1.9	1.0	1.2	0.9	3.4	3.2	1.7
c_diff	0.7	1.0	1.4	1.5	1.1	0.8	1.0	0.9	4.2	1.0	1.4
itune_albedo	0.7	0.9	0.9	1.1	1.1	0.7	0.9	0.8	0.9	0.9	0.9
tkhmin	1.8	1.4	2.1	1.5	1.1	1.0	0.9	0.9	1.0	2.3	1.4
tur_len	2.0	2.5	2.0	1.8	1.3	1.2	5.2	2.2	2.0	2.9	2.3
tune_rdepths	0.8	1.1	0.9	0.8	1.2	0.9	1.2	0.9	0.9	1.1	1.0
tune_gkwake	0.7	0.9	0.8	0.6	1.1	0.9	1.0	0.9	2.6	1.0	1.1
tune_gfrcrit	0.7	1.0	0.8	0.7	1.1	0.7	0.9	0.9	1.6	1.0	0.9
hdiff_w_efdt_ratio	0.8	0.9	0.8	0.8	1.1	1.1	1.0	0.8	0.9	1.0	0.9
hdiff_efdt_ratio	0.7	0.9	0.8	0.6	1.1	0.8	1.0	0.8	1.0	1.0	0.9
hdiff_smag_fac	0.7	0.9	0.8	0.6	1.1	0.8	0.9	0.8	0.9	1.0	0.9
alpha1	1.1	1.0	1.1	1.0	1.2	1.4	1.1	1.0	1.0	1.1	1.1

Figure 1: Sensitivities of ICON 2025.10 on surface variables for the tested parameters in COPAT3 for summer (top table) and winter (bottom table); Parameter explanations are given in Namelist_overview.pdf.

The main advantage of LiMMo2.0 is that it prevents some variables from being improved at the expense of others, even when the improvement in those variables would be substantial. Figure 3 shows the LiMMo results for each optimised variable and summer and winter season for different optimisation strategies. Our interest is not to improve the latent heat flux over ocean at the expense of temperature and precipitation.

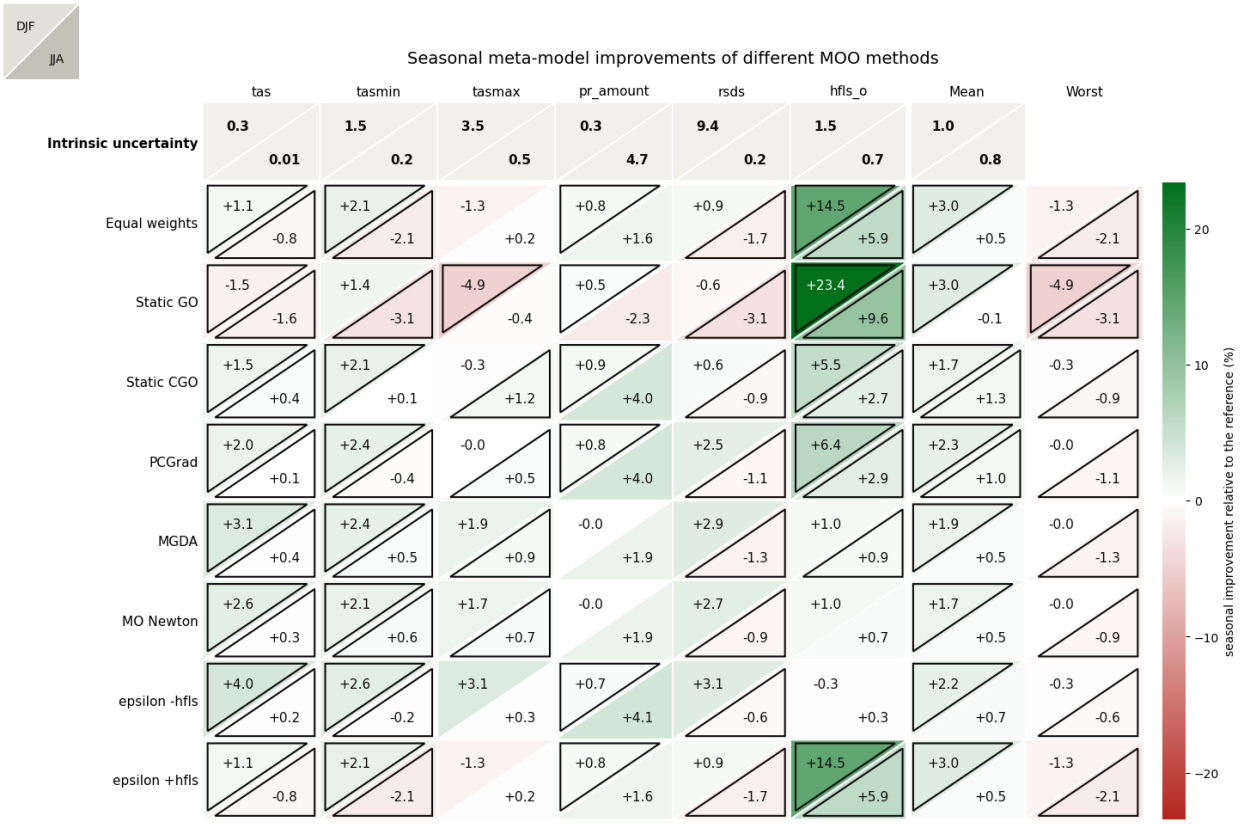


Figure 2: LiMMo2.0 results for different optimisation strategies.

'PCGrad' and 'epsilon −hfls' were chosen because they improve all variables without strongly degrading tasmax and rsds. C3I124 is simulated with 'PC Grad' optimisation and C3I125 with 'epsilon -hfls'. C2I301c was produced with the final COPAT2 configuration. A criticism on this configuration was the annual cycle of the parameter allow_overcast, which we do not accept in the new configuration at the cost of only a very small loss in quality. C2I100 is the new reference simulation with the configuration of C2I301c with ICON 2025.10. The report is in progress.

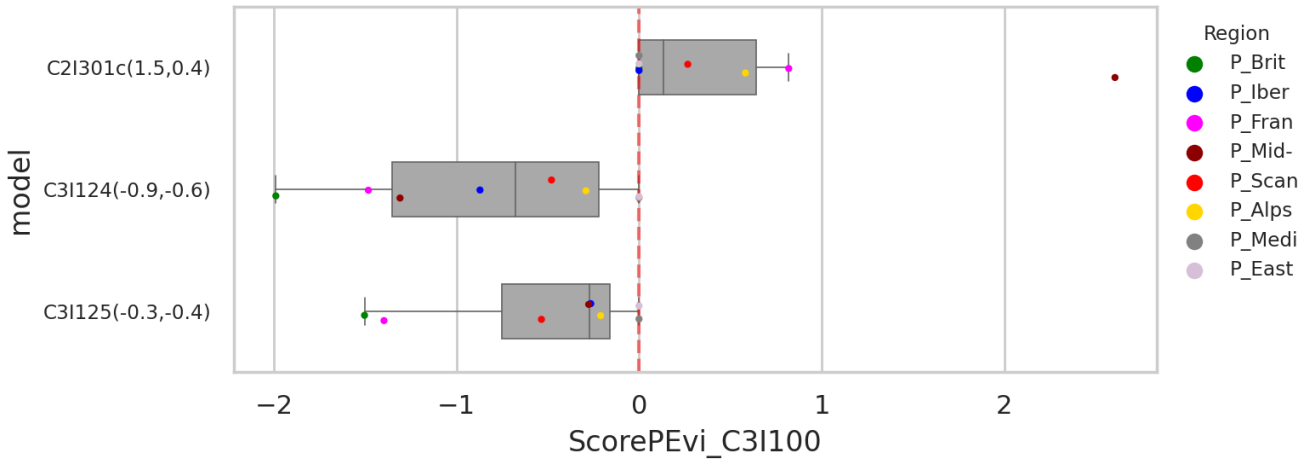


Figure 3: Preliminary ScoPi scores.

ICON-CLM 3 km

For the ICON release 2024.07 the setup was fixed to the usage of the one-moment scheme of micro-physics (Doms, 2011) due to limited resources for production runs, which wouldn't allow for the two-moment overhead. We did the test simulations for many involved parameters with the two-moment scheme but have not yet finished the work because of heavy work load for the finalization of the UDAG project.