The Coordinated Parameter Testing 2 (COPAT2) initiative of the CLM-Community: towards a recommended configuration of COSMO-CLM and ICON-CLM new model versions

Emmanuele Russo[1], Christian Steger[2], Beate Geyer[3], Ronny Petrik[3], Klaus Keuler[4],
Burkhardt Rockel[3], Klaus Goergen[5], Patrick Ludwig[6], Hendrik Feldmann[6], Mauro Sulis[7],
Bijan Fallah[8], HeimoTruhetz[9], Ha Thi Minh Ho-Hagemann[3], Jan-Peter Schulz[2], and Praveen Pothapakula[6]

1 ETH Zurich, Institute for Atmospheric and Climate Science, Zurich, Switzerland
2 Deutscher Wetterdienst (DWD), Offenbach, Germany
3 Helmholtz-Zentrum Hereon, Institute of Coastal Systems-Analysis and Modeling, Geesthacht, Germany
4 Brandenburg University of Technology, Cottbus, Germany
5 Research Centre Jülich (FZJ), Institute of Bio- and Geosciences (Agrosphere, IBG-3), Jülich, Germany
6 Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research, Karlsruhe, Germany
7 Luxembourg Institute of Science and Technology, Environmental Research and Innovation Department, Esch-sur-Alzette, Luxembourg
8 Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany
9 University of Graz, Wegener Center for Climate and Global Change, Graz, Austria

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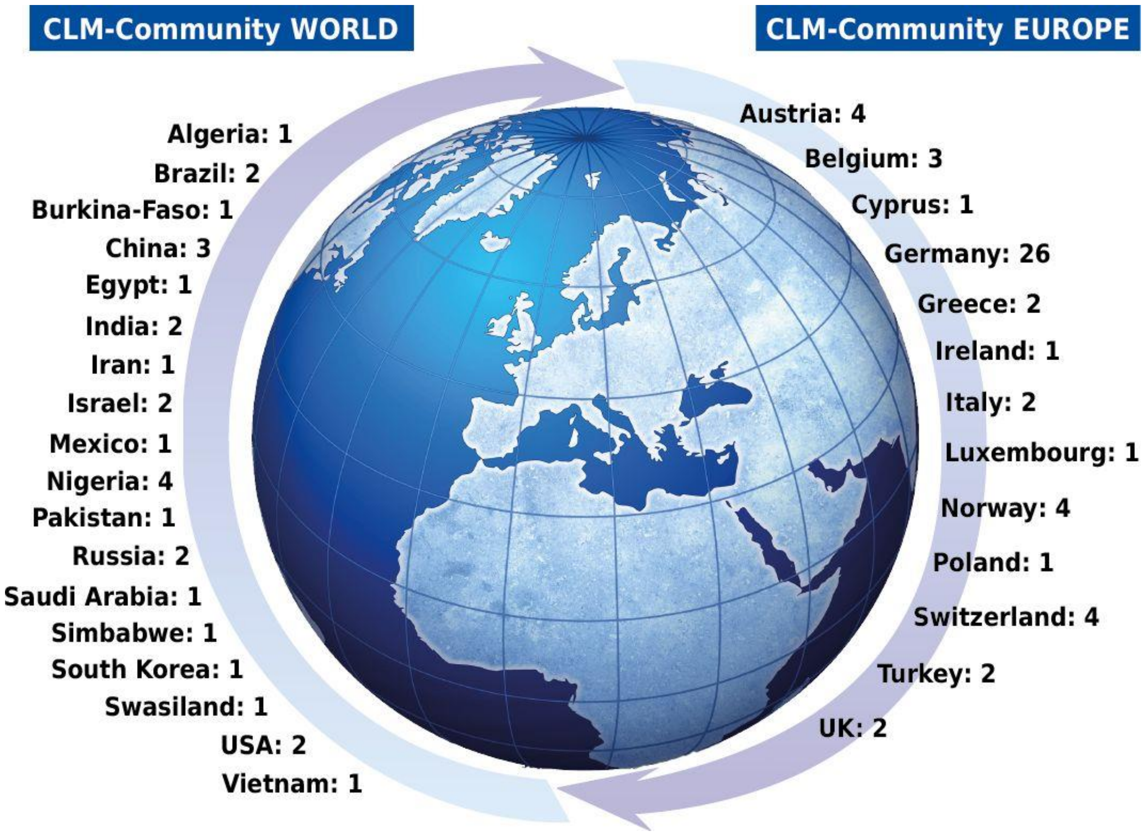
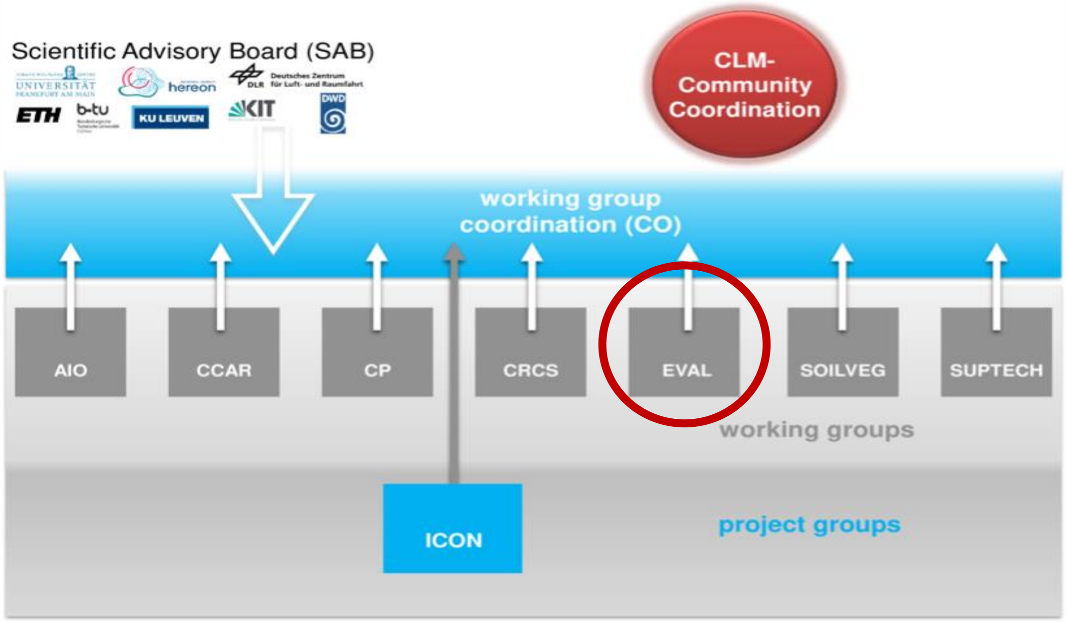
The CLM-Community, EVAL WG and COPAT2

The CLM-Community addresses the challenges of model development, efficient use of resources and answer key questions of regional climate modelling.





COPAT2

Determining optimal model configurations for

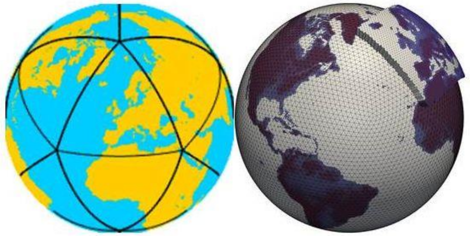
COSMO-CLM 6.0
ICON-CLM

General info on COSMO-CLM 6.0

- COSMO(-CLM) 6.0 released on 14 December 2021: last release of the COSMO model
- The CLM-Community used the COSMO model in **Cl**imate **m**ode (COSMO-CLM) for regional climate modelling over 20 years

- **Main changes between COSMO 5.0 and COSMO 6.0:**
  - Unification with CLM (new diagnostics, new tuning variables, new hydrology scheme, …)
  - Implementation of snow model SNOWPOLINO
  - Modifications of NetCDF I/O (prefetching, asynchronous output, online compression, restart in single precision, …)
  - Modifications for TERRA-URB (urban-canopy land-surface scheme)
  - New diagnostics for soil water budget and fix for computation of subsurface runoff
  - Additional Greenhouse-Gas Emission Scenarios (Shared Socioeconomic Pathways)
  - Changes in Data Assimilation (observation handling, single precision)
  - Implementation of radar forward operator EMVORADO
  - EULAG dynamical core added
  - Revised Cloud Radiation Coupling
  - Unification of Soil and Surface Modules with ICON
  - Implementation of skin temperature formulation in TERRA
  - Running COSMO in single precision

General info on ICON / ICON-CLM



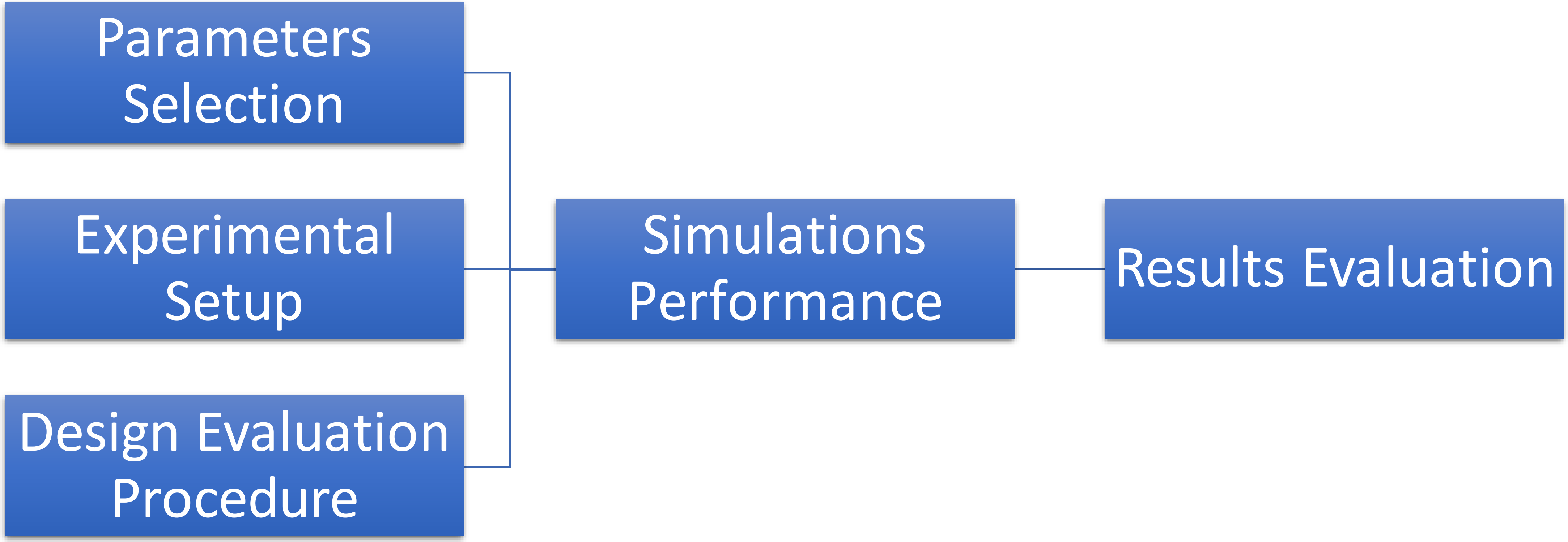
- The ICON modelling framework is a joint project aimed at developing a unified next-generation global numerical weather prediction and climate modelling system

Additional partners

- The Climate Limited-area Mode of ICON (**ICON-CLM**) developed by the CLM-Community.
  It is based on the limited-area mode of ICON, including further developments and adjustments that are necessary for regional climate simulations

- The CLM-Community also provides a runtime environment (SPICE) for regional climate simulations with ICON-CLM, including pre- and postprocessing functionalities

General Strategy COPAT2



Parameters selection

1st Phase **Test single configuration options → determine potential parameters improving model performances**

COSMO-CLM 6.0

Dynamics

e.g.: Bott advection with deformal correction

C202,C203,C204,C205

Physics

e.g.: explicit calculation of skin surface energy budget

C210,C212,C213,C214

Turbulence

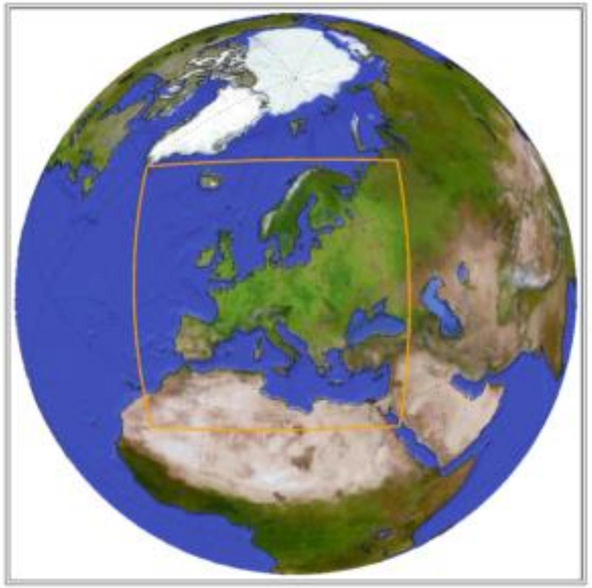
e.g.: new ICON Turbulence scheme

C220,C221,C222,C223, C224, C225

2nd Phase **Test Combined configuration changes**

Experimental Design COSMO-CLM 6.0

- Target domain: CORDEX Europe
- Target resolution: ~12 km
- Reference simulation for period 1979-2000
  with configuration based on NWP configuration
- 1st set of simulation over period 1979-1985
- 2nd set of extended simulations over period 1979-1990
- Additional test simulations for more recent period
- All simulations are performed on the systems of the German Climate Computing Center (DKRZ):
  -- MISTRAL (decommissioned)
  -- LEVANTE



Source: *ht tps://cordex.org/domains/cordex-region-euro-co rdex/*

Details of Evaluation Procedure

Observational Datasets: ERA5, Eobs
Target Variables: T_2M, TOT_PREC, TMAX_2M, TMIN_2M, CLCT, PMSL

Metrics

Need of simplified approach, with single metric for ranking different experiments

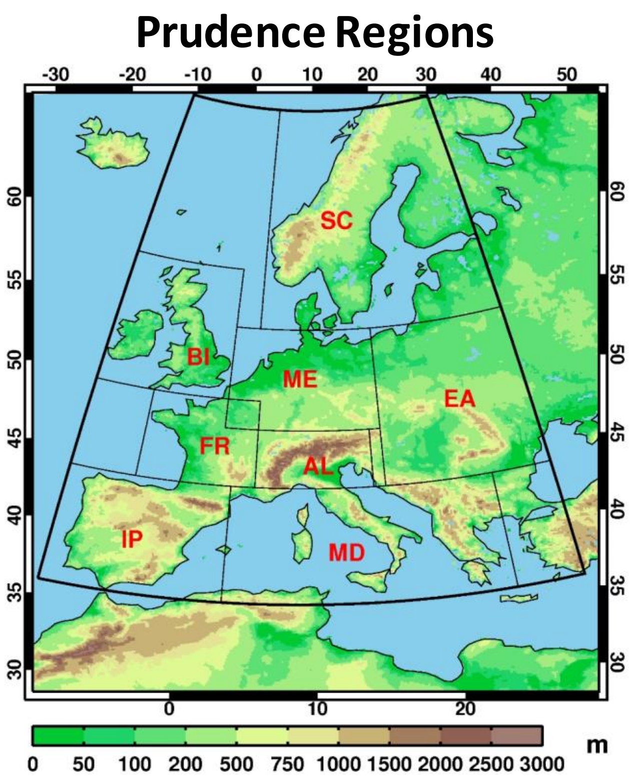
Discussion is still ongoing

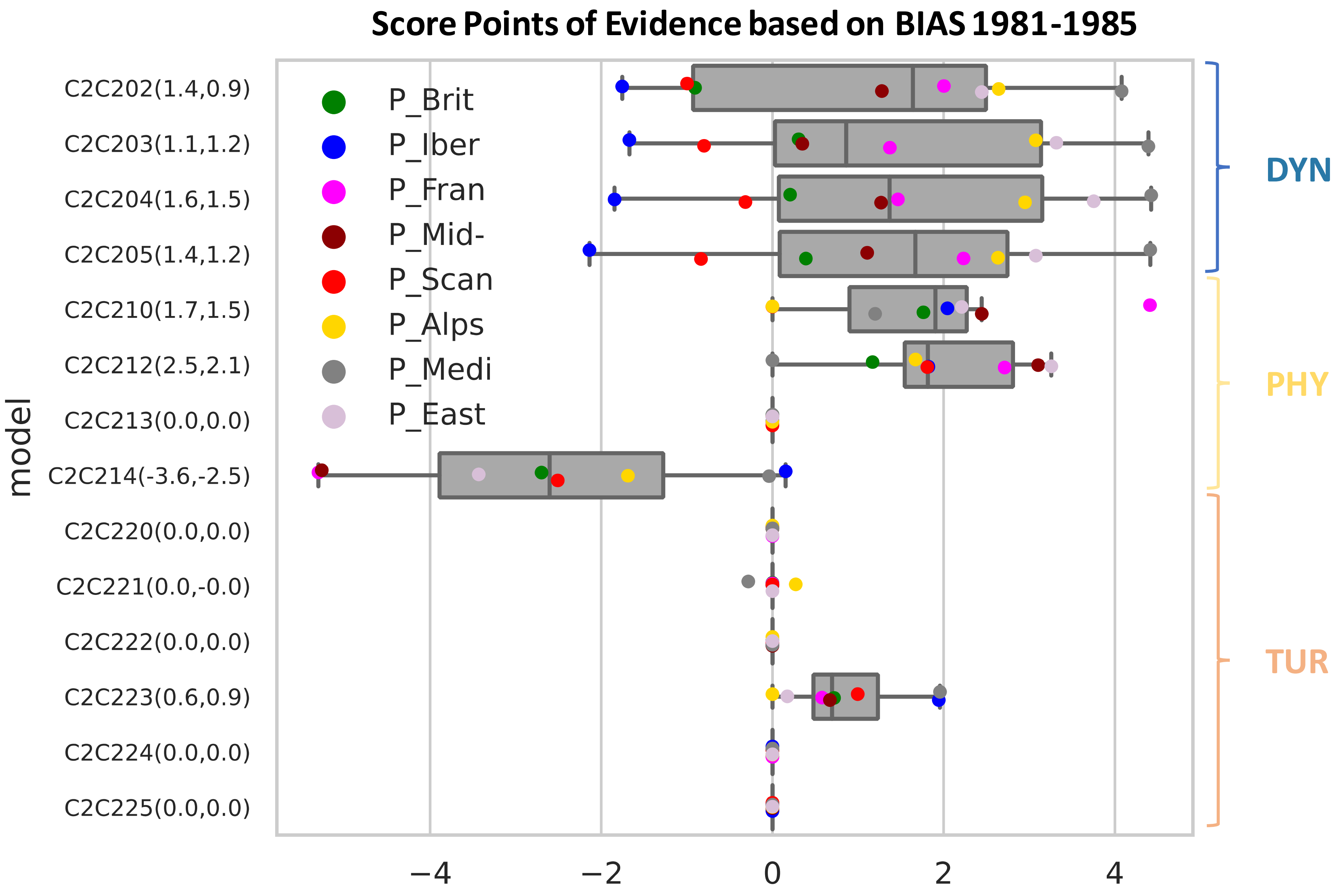
- **Score points of evidence**: for a given metric (e.g. BIAS), ratio of points with significant improvement/worsening
- Consideration of **Standardized RMSE:** averaging first over a set of pre-defined regions:

1- Variables become quasi-gaussians

2- Reduce uncertainty related to chaotic nature of the system

First Evaluation Results





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Conclusions & Outlook

- Designed calibration procedure for COSMO-CLM 6.0 and ICON-CLM
- First set of experiments performed with COSMO-CLM 6.0
- Some parameters of COSMO-CLM 6.0 show potential for additional tests
- Ongoing discussion on evaluation metrics
- Detection of test parameters for ICON-CLM and first experiments performance
- Use of radiosondes measurements for evaluation procedure (Ulrich Voggenberger, University of Vienna)
- Final results will be made publicly available

Thank you for your attention!

General Strategy: Parameters Selection

C2C201	Reference			
C2C202	DYNUM_group	y_scalar_advect = BOTTDC2, itype_fast_waves = 2, l_3D_div_damping = .TRUE., ldyn_bbc = .FALSE., itype_bbc_w = 114, l_diff_Smag = .TRUE.	Bott Advection with deformal correction; improved fast waves stability; fully 3-D Isotropic divergence damping	
C2C203	DYNUM_GROUP + DYNUM_SINGLE	DYNUM_GROUP + lhor_pgrad_Mahrer = .TRUE.	Better geostrophic gradient than in standard discretization	
C2C204	DYNUM_GROUP + DYNUM_SINGLE	DYNUM_GROUP + itype_outflow_qrsg = 2	no relaxation of qr, qs, qg is done at outflow boundary points	
C2C205	DYNUM_GROUP + DYNUM_SINGLE	DYNUM_GROUP + hd_corr_u_bd = 0.75, hd_corr_t_bd = 0.75, hd_corr_p_bd = 0.75	Diffusion in wind components	
C2C210	Physics	itype_canopy=2, cskinc=-1	Explicit calculation of skin surface energy budget (Schulz and Vogel 2017)	
C2C212	Physics	itype_evsl = 4, c_soil=1.25	Improved bare soil evaporation	
C2C213	Physics	itype_hydmod = 1	Ground water formulation allowing ground water build up	
C2C214	Physics	itype_heatcond = 3	Soil Heat conductivity based on vegetation and not on soil moisture	
C2C220	Turbulence	ltkesso = .TRUE.	SSO-wake turbulence production for TKE	
C2C221	Turbulence	ltkeshs = .TRUE.	Consider horizontal shear production for TKE	
C2C222	Turbulence	icldm_turb = 2, icldm_tran = 2	Clouds sub-grid scale condensation considering water clouds	
C2C223	Turbulence ICON	loldtur=.FALSE., itype_vdif = 1	New ICON turbulence scheme	
C2C224	Turbulence ICON	pat_len=750.0, imode_pat_len=2 (turbdata.f90)		
C2C225	Turbulence ICON	ltkeshs=True, a_hshr=2.0, imode_shshear=2 (turbdata.f90)		