A Short Evaluation History of the CLM-Community Models(s)



Klaus Keuler, Nadja Samtleben

BTU Cottbus

Beate Geyer, Ronny Petrik, Burkhardt Rockel

HZ hereon

Astrid Kerkweg

FZ Jülich

and many others …

Evaluation history

Brandenburgische Technische Universität Cottbus - Senftenberg

History of the community model

- First steps in 1999 at PIK based on LM 1.1
- First official CLM release **CLM 1** in 2002 based on LM 2.16
- Switch to COSMO in 2007 results in **CCLM 4** the first unified version
- Now the end is reached with **CCLM 6.0**, probably CCLM 6.0_clm???

Continuous evaluation

- From the first version on a continuously developing evaluation procedure has been established and stepwise improved
- Aiming on updated releases of a recommended new standard version and configuration for regional climate simulations over Europe

Objective of this talk

- What has changed over these years and version?
- Has the model's quality substantially improved?
- Not a full review but over the last 3 generations starting with CCLM 4.8 (the Euro-CORDEX version)

Models and configurations

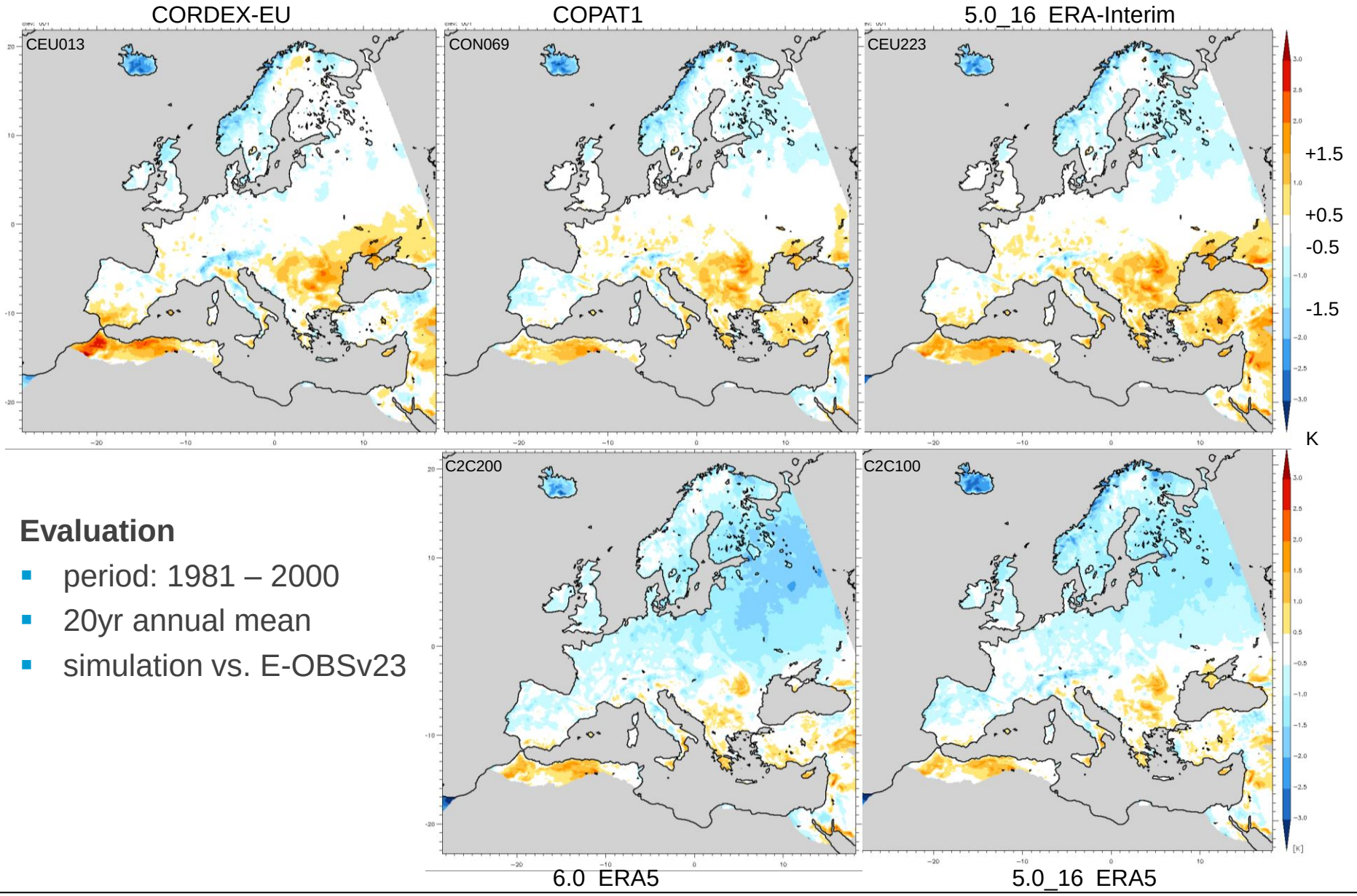
Brandenburgische Technische Universität Cottbus - Senftenberg

Models and simulations used in this presentation

1. CCLM 4.8_clm14 on EUR-11 grid, 0.11° resolution, ERA-Interim forcing
   - The first optimized configuration for the Euro-CORDEX evaluation simulation
2. CCLM 5.0_clm6 on standard evaluation grid, 1/6, ERA-Interim forcing
   - Basis for the last recommended standard version (result of COPAT1 initiative)
3. CCLM 5.0_clm16, on EUR-11 grid, 0.11° resolution, ERA-Interim forcing
   - Last 5.0 subversion, using same configuration as 5.0_clm6 (updated Euro-CORDEX evaluation)
4. CCLM 5.0_clm16, as above but with ERA5 forcing
   - Investigates the influence of new (improved) forcing data
5. CCLM 5.09b, configuration adapted to previous versions, ERA5 forcing
   - Not exactly CCLM 6.0 – without snowpolino and TERRA-URB but with bugfix for soil water balance
6. ICON-CLM 2.6.3b, switch to a new model, NWP configuration, ERA5 forcing
   - Our first evaluation of ICON-CLM

Annual mean temperature bias (absolute in K)

Brandenburgische Technische Universität Cottbus - Senftenberg

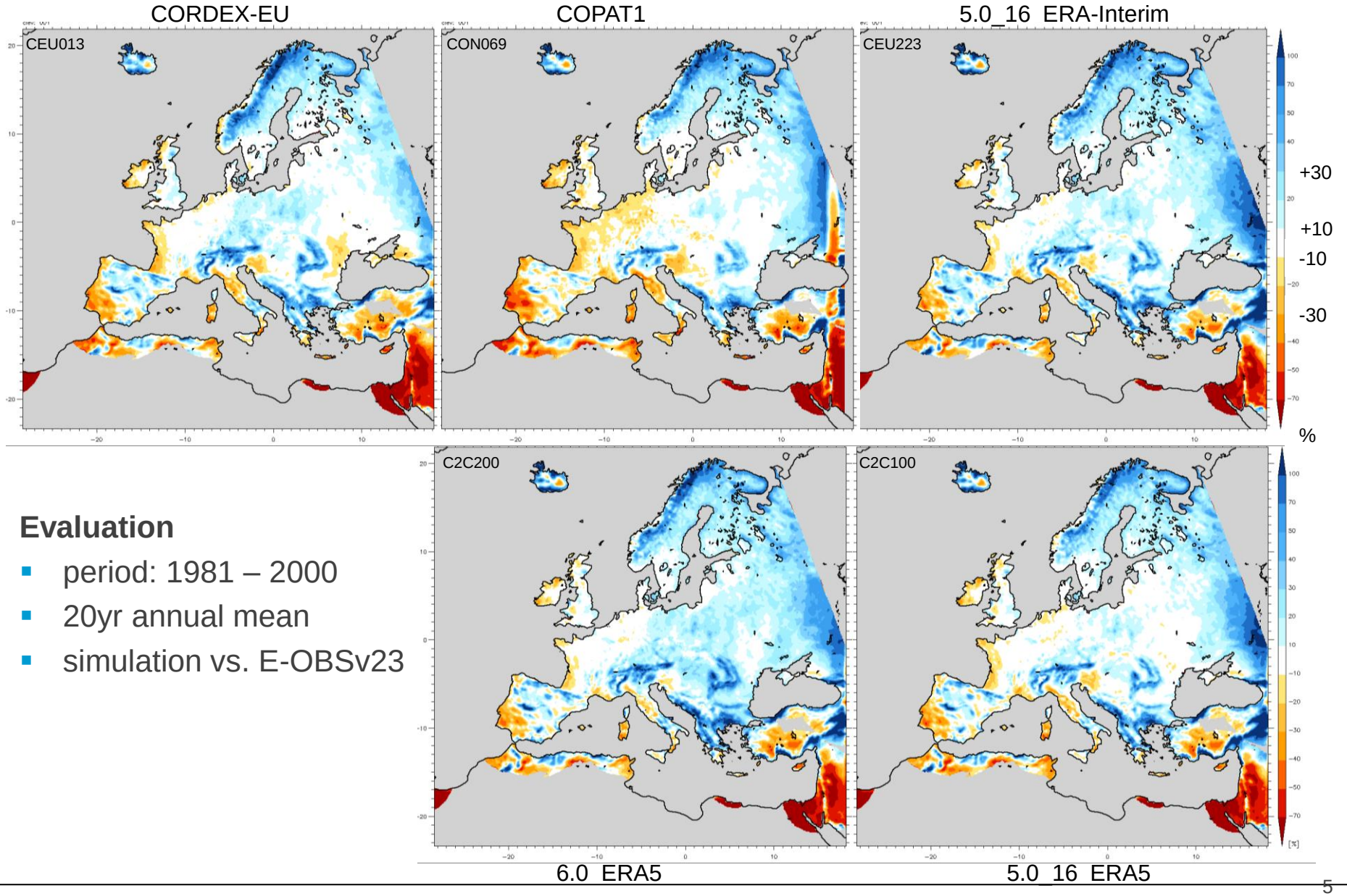


Evaluation

- period: 1981 – 2000
- 20yr annual mean
- simulation vs. E-OBSv23

Annual mean precipitation bias (relative in %)

Brandenburgische Technische Universität Cottbus - Senftenberg

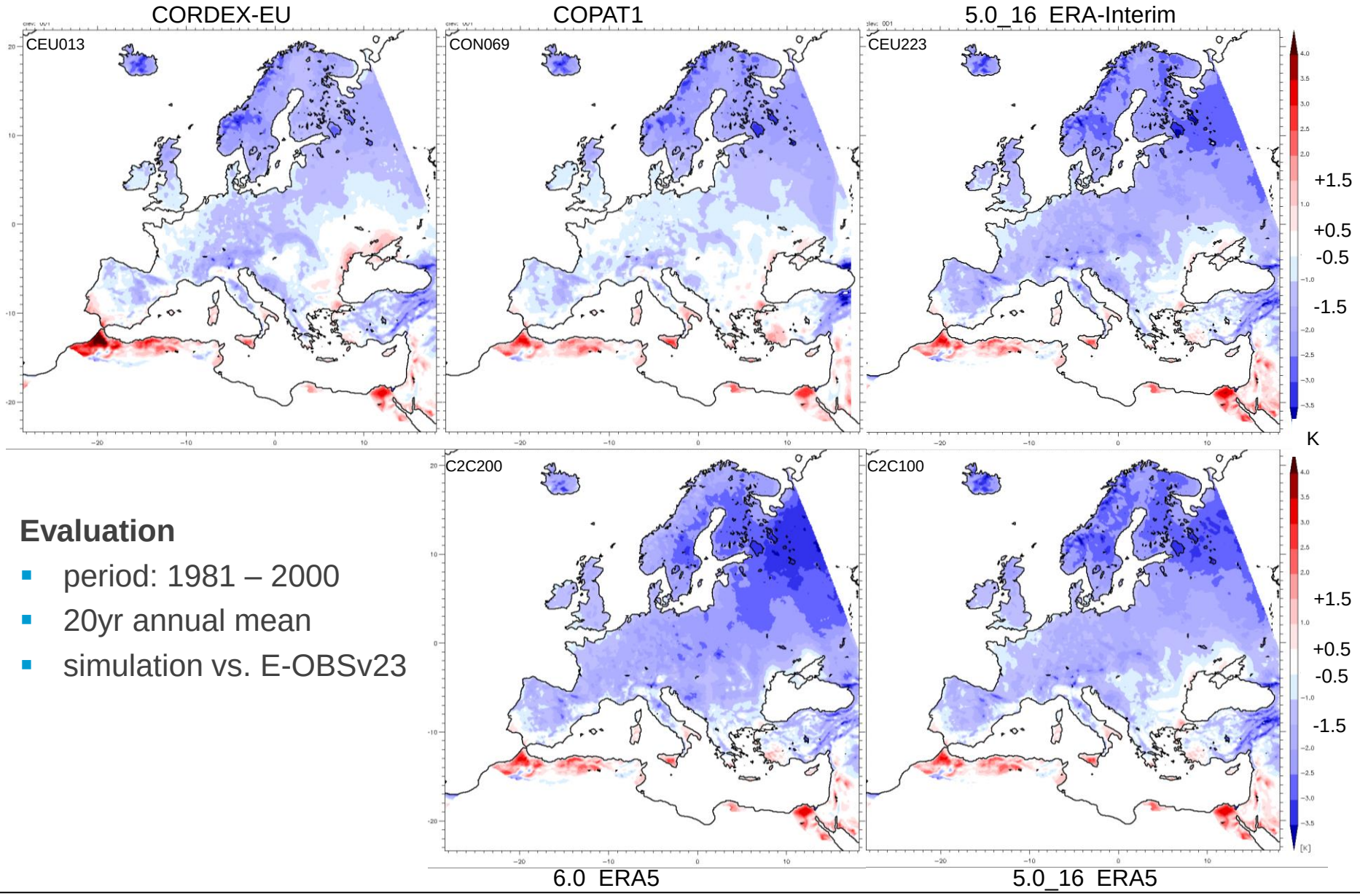


Evaluation

- period: 1981 – 2000
- 20yr annual mean
- simulation vs. E-OBSv23

Annual mean daily maximum temperature bias

Brandenburgische Technische Universität Cottbus - Senftenberg

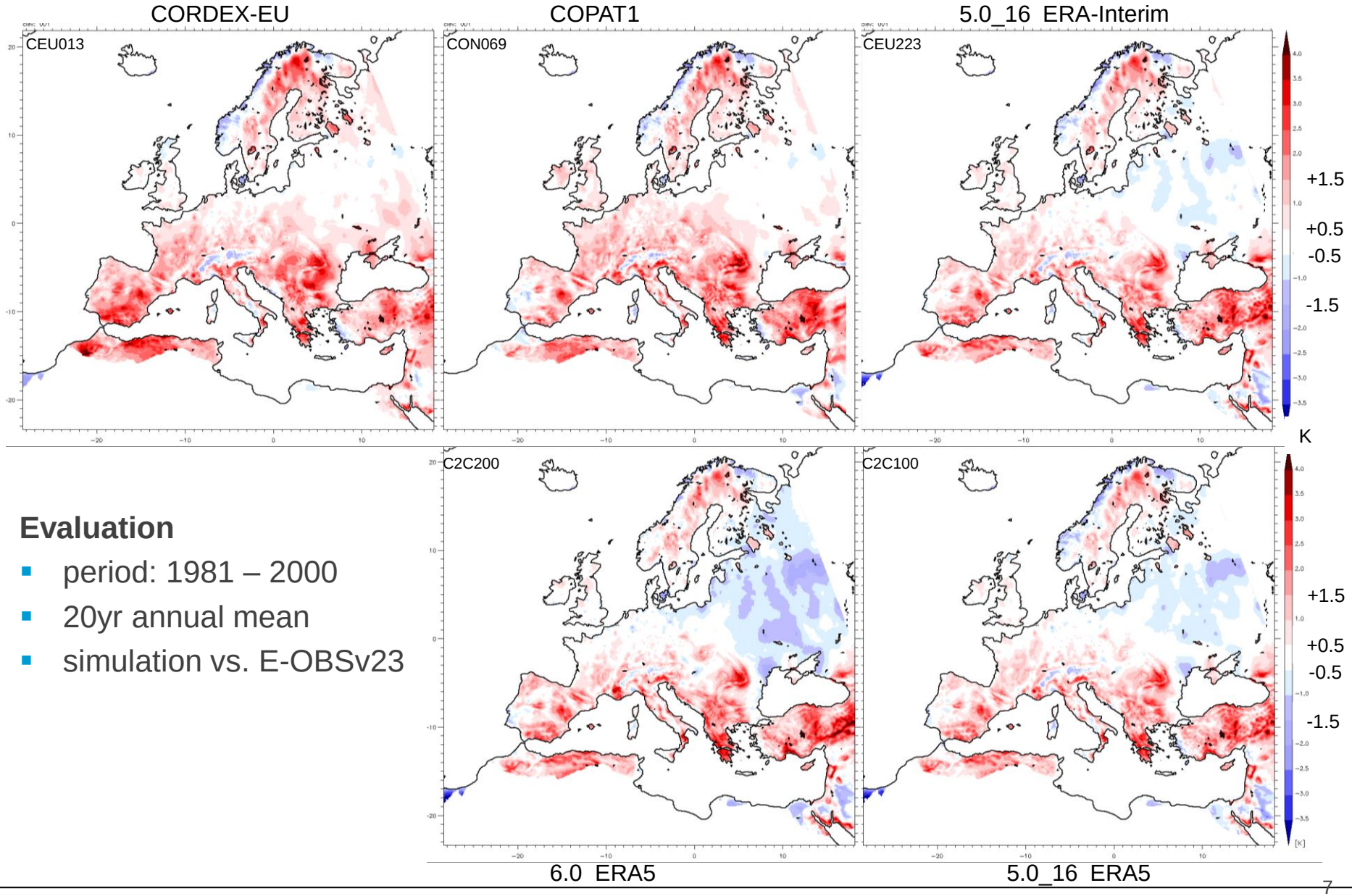


Evaluation

- period: 1981 – 2000
- 20yr annual mean
- simulation vs. E-OBSv23

Annual mean daily minimum temperature bias

Brandenburgische Technische Universität Cottbus - Senftenberg

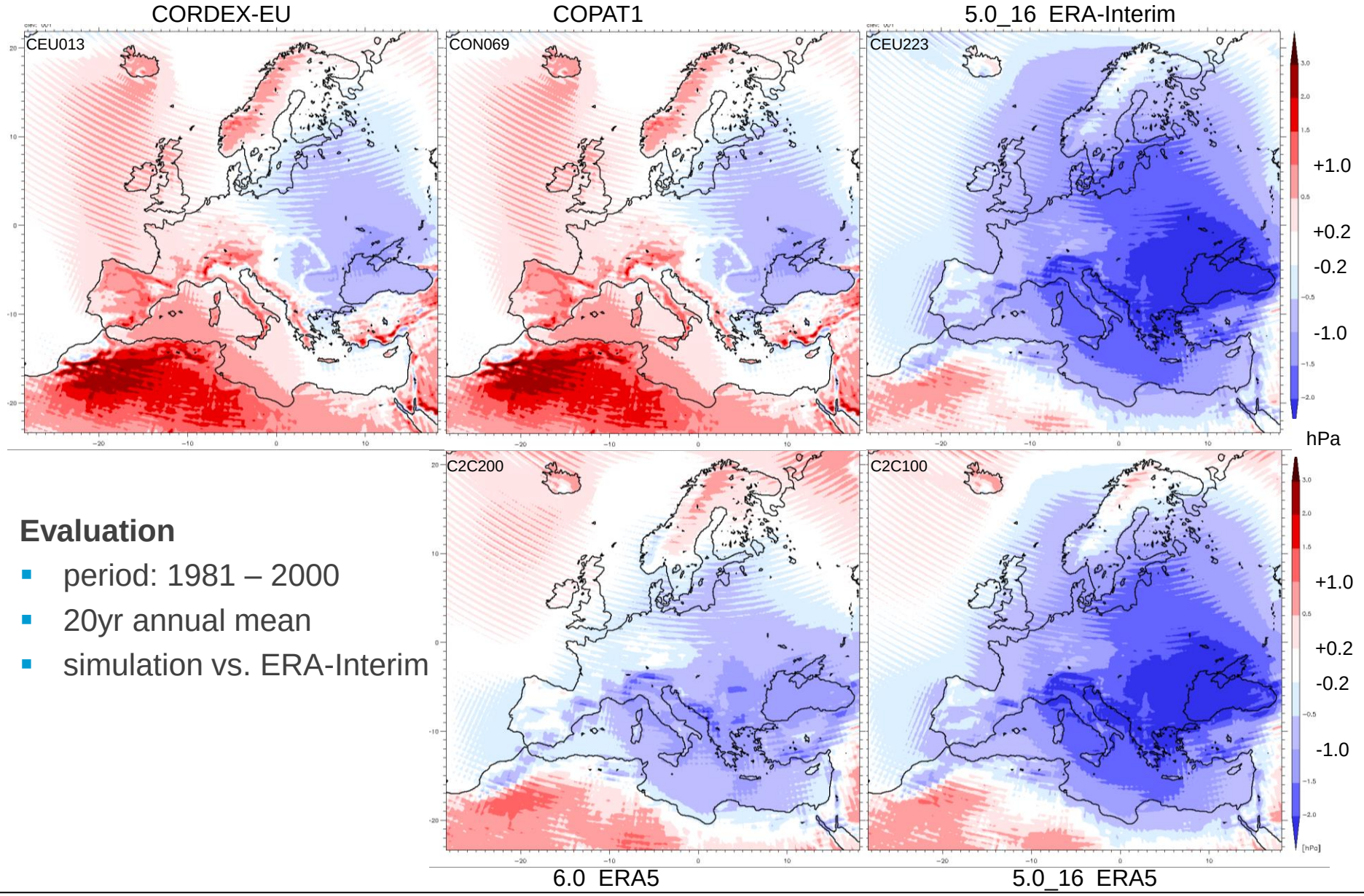


Evaluation

- period: 1981 – 2000
- 20yr annual mean
- simulation vs. E-OBSv23

Annual mean sea level pressure bias

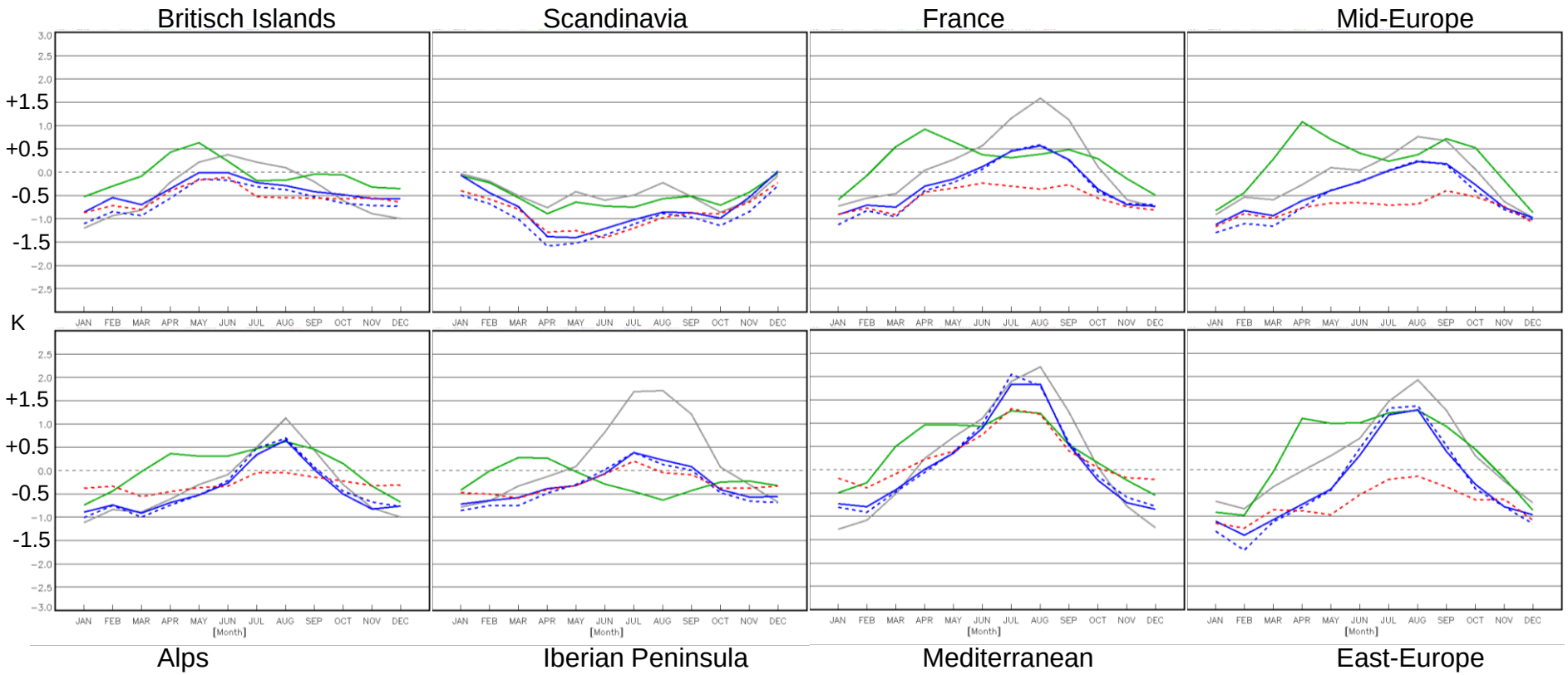
Brandenburgische Technische Universität Cottbus - Senftenberg



Evaluation

- period: 1981 – 2000
- 20yr annual mean
- simulation vs. ERA-Interim

Mean annual cycle of temperature bias



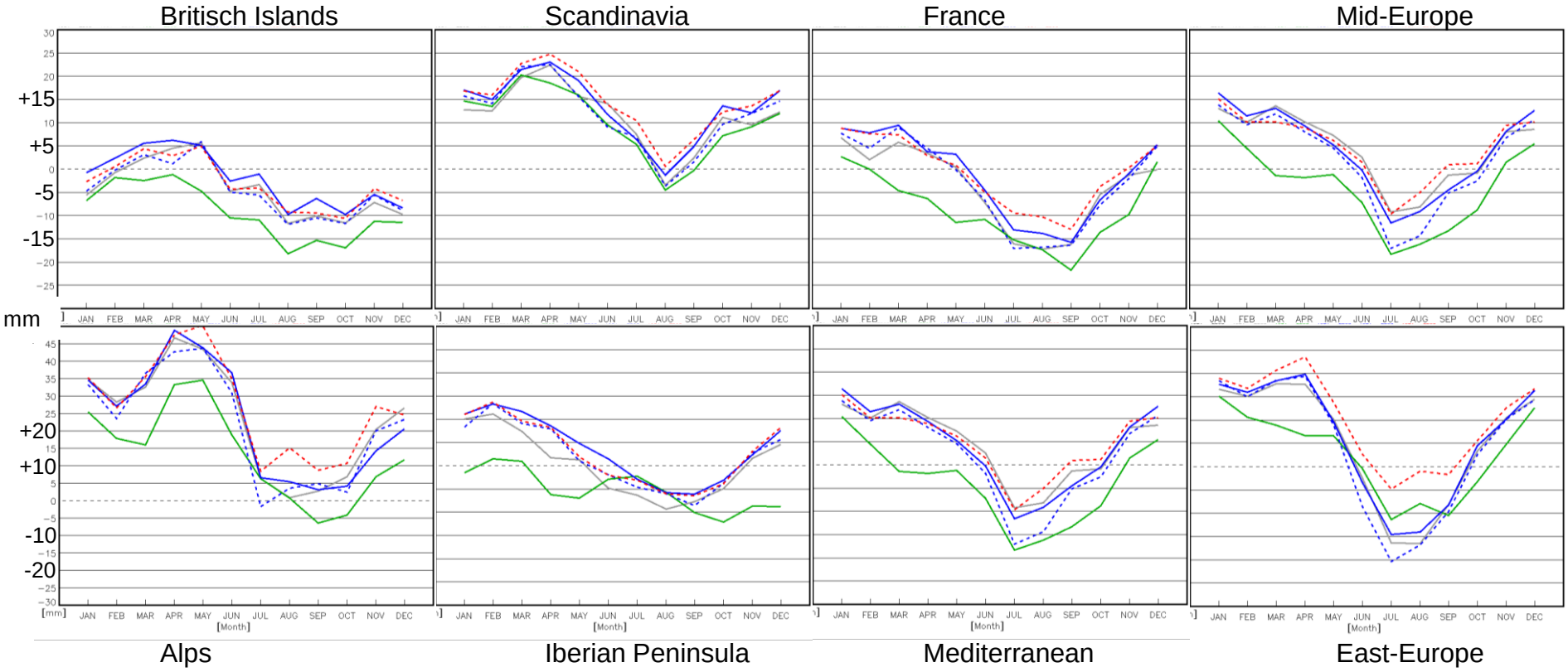
Evaluation

- period: 1981 – 2000
- 20yr monthly mean
- simulation vs. E-OBSv23
- Prudence regions

- CORDEX_EU
- COPAT1
- 5.0_16 ERA-Interim
- 5.0_16 ERA5
- 6.0 ERA5

Mean annual cycle of precipitation bias

Brandenburgische Technische Universität Cottbus - Senftenberg

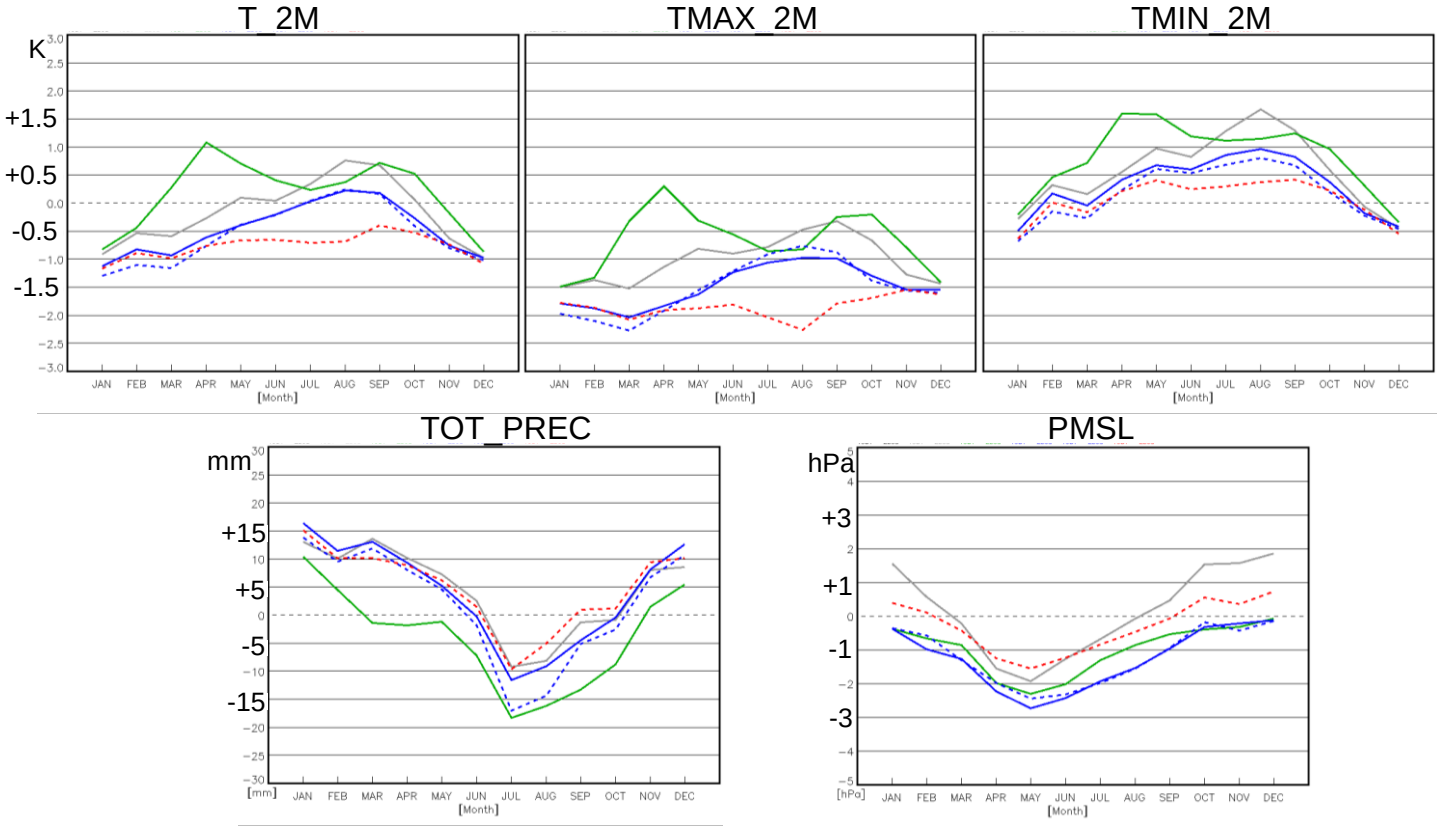


Evaluation

- period: 1981 – 2000
- 20yr mean monthly sum
- simulation vs. E-OBSv23
- Prudence regions

- CORDEX_EU
- COPAT1
- 5.0_16 ERA-Interim
- 5.0_16 ERA5
- 6.0 ERA5

Mean annual cycles of Mid-Europe biases



Evaluation

- period: 1981 – 2000
- 20yr mean monthly means
- simulation vs. E-OBSv23 and ERA-Interim (PMSL)
- Prudence region Mid-Europe

- CORDEX_EU
- COPAT1
- 5.0_16 ERA-Interim
- 5.0_16 ERA5
- 6.0 ERA5

Quantitative measures of climatological annual means for Mid-Europe

Brandenburgische Technische Universität Cottbus - Senftenberg

Bias

Simulation	PP [mm/yr]	T_2M [K]	TMIN [K]	TMAX [K]	PMSL [hPa]
CORDEX-EU	+54	-0.16	+0.57	-1.02	+0.15
COPAT1	-46	+0.17	+0.82	-0.67	-0.98
5.0_16 ERAI	+50	-0.47	+0.31	-1.48	-1.26
5.0_16 ERA5	+24	-0.56	+0.16	-1.51	-1.19
6.0_ERA5	+59	-0.77	+0.06	-1.85	-0.31

Spatial RMSE

Simulation	PP [mm/yr]	T_2M [K]	TMIN [K]	TMAX [K]	PMSL [hPa]
CORDEX-EU	104	0.32	0.76	1.76	0.28
COPAT1	98	0.31	0.95	0.73	0.99
5.0_16 ERAI	99	0.53	0.94	1.52	1.28
5.0_16 ERA5	85	0.61	0.49	1.54	1.21
6.0_ERA5	108	0.82	0.50	1.89	0.34

Quantitative measures of (climatological) annual cycles for Mid-Europe

Brandenburgische Technische Universität Cottbus - Senftenberg

Ratio of temporal variance of monthly area means

Simulation	PP	T_2M	TMIN	TMAX	PMSL
CORDEX-EU	1.04	1.16	1.21	1.08	1.40
COPAT1	0.97	1.13	1.16	1.07	1.20
5.0_16 ERAI	1.12	1.13	1.17	1.07	1.32
5.0_16 ERA5	1.06	1.16	1.17	1.10	1.31
6.0_ERA5	1.05	1.05	1.11	0.97	1.25

Mean absolute difference of climatological monthly area means

Simulation	PP [mm/mon]	T_2M [K]	TMIN [K]	TMAX [K]	PMSL [hPa]
CORDEX-EU	7.7	0.49	0.71	1.02	1.11
COPAT1	7.5	0.56	0.91	0.72	0.98
5.0_16 ERAI	8.5	0.54	0.50	1.48	1.26
5.0_16 ERA5	8.9	0.63	0.46	1.51	1.19
6.0_ERA5	7.4	0.77	0.31	1.86	0.66

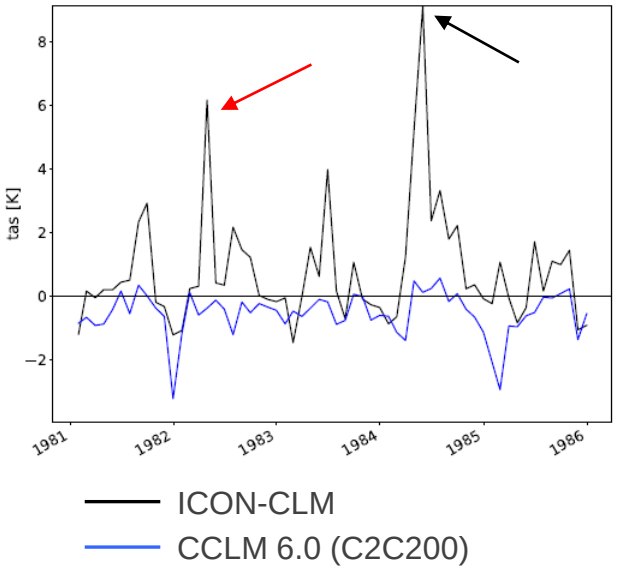
The new model: ICON-CLM

Brandenburgische Technische Universität Cottbus - Senftenberg

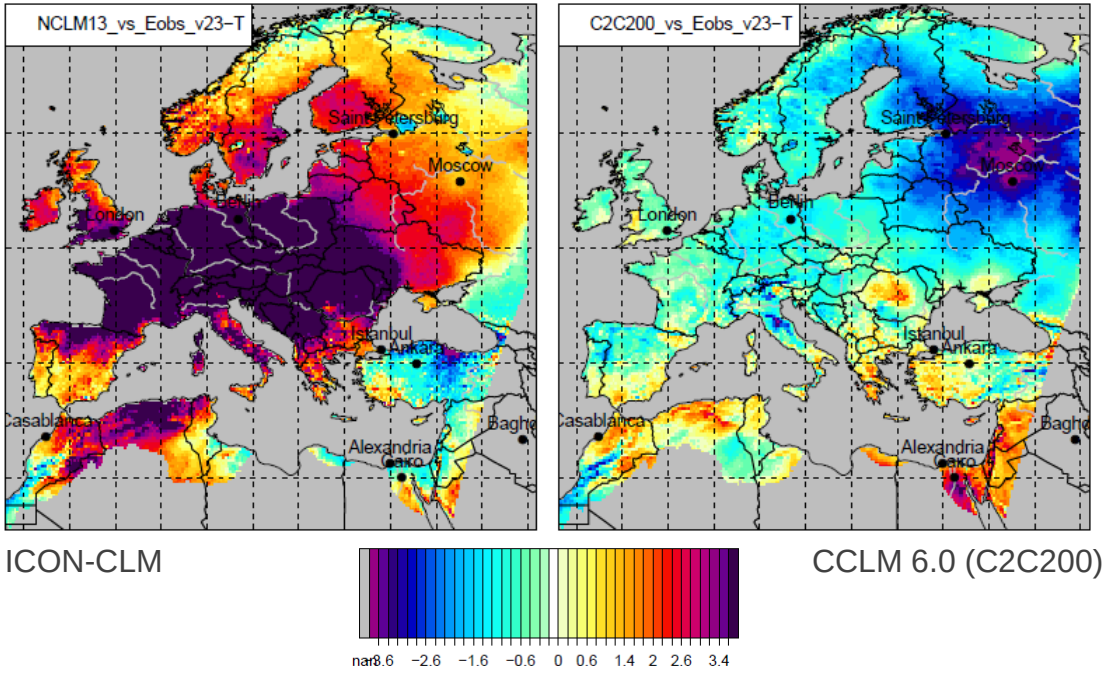
Configuration for evaluation of version 2.6.3b (with bugfix for soil moisture)

- Grid R13B05 (≈12 km)
- 1979 – 1986 with ERA5 forcing
- NWP configuration (recommended by DWD)

T_2M bias, monthly area mean, France



T_2M bias, monthly mean, April 1982



Summary

Brandenburgische Technische Universität Cottbus - Senftenberg

CCLM results

- Simulation quality for Central Europe is quite good
- Spatial structure of bias fields has not changed between simulations
  - weak modification of mean level (up and down)
- General higher monthly temporal variability than in E-OBS
- Shape of bias curves of mean annual cycles are mostly very similar
  - COPAT1 simulations shows significant deviations
- Change from ERA-Interim to ERA5 has no significant effect
  - weak tendency to lower winter/spring temperatures and lower summer precipitation in some regions
- Corrections/Modifications form 5.0_clm6 to _clm16 destroy the tuning effects
- New CCLM version 6.0 shows weak modifications in some regions (FR, ME, EA)
  - reduced summer temperatures and increased summer precipitation
- Main deficits of CCLM-performance over Europe have survived all developments
  - spatial structure of biases
  - underestimation (overestimation) of daily maximum (minimum) temperature
- Current configuration of ICON-CLM not suitable for an evaluation simulation over Europe



Thank you for your attention !