

Simulation of Slovakia's precipitation and temperature by ERA-Interim driven EURO-CORDEX regional climate models

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Introduction

Information about future climate at regional spatial scales is necessary for climate change adaptation. Numerical global climate models simulate future climate projections under forcing from emission scenarios. Regional climate models downscale lower resolution global climate model output to higher resolutions, which are of interest for regional applications. To assess regional climate models' ability to simulate future climate, they should first be evaluated on how well they represent observations of historical climate. To evaluate regional models' performance separately from the influence of the driving global models, the comparison with observations can be done with regional models driven by a reanalysis instead of a global model.

This work compares historical simulations from 8 ERA-Interim reanalysis driven EURO-CORDEX regional models to gridded observations CARPATCLIM, in order to evaluate their ability to represent precipitation and temperature over Slovakia.

Key findings

The results of the comparison show that all 8 evaluated regional climate models show bias in respect to observations, with no model performing generally better than other models.

Shared model biases include

- smaller precipitation annual cycle amplitude
- higher precipitation maxima
- larger temperature annual cycle amplitudes and annual interquartile range
- higher warm extremes and lower cold extremes of daily temperature averages
- higher maxima and lower means of daily temperature maxima
- more temporally clustered coldest days
- for minima of daily temperature minima, RCMs show large opposing biases

In contrast to observations and all other RCMs, REMO2015 simulates precipitation fields nearly uncorrelated with elevation, RACMO22E significantly underestimates daily temperature averages.

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Regional models (EURO-CORDEX)

resolution 0.11°, driven by ERA-Interim

- ALADIN63 (AL), 1979-2005
- CCLM4-8-17 (CC), 1989-2005
- COSMO-crCLIM-v1-1 (CO), 1979-2005
- HadREM3-GA7-05 (HA), 1983-2005
- HIRHAM5 (HI), 1989-2005
- RACMO22E (RA), 1979-2005
- REMO2015 (RE) 1979-2005
- WRF381P (WR), 1989-2005

Gridded observations

resolution 0.1°, regridded to RCM grid

- CARPATCLIM (OBS), 1979-2005

Compared climatological variables

- daily precipitation (PR)
- daily temperature averages (TAS)
- daily temperature maxima (TASMAX)
- daily temperature minima (TASMIN)

PR	sum	sum Spr	sum Summ	sum Fall	sum Wint	mean Dwp	q90 Dwp	max	iqr Dwp	DWOP
AL	1.14	1.37	0.86	1.21	1.29	1.07	1.10	1.14	1.06	0.97
CC	1.01	1.21	0.69	1.06	1.30	1.01	0.98	1.12	0.98	1.01
CO	0.88	1.03	0.57	0.89	1.26	1.04	1.03	1.08	1.02	1.19
HA	0.99	1.15	0.72	1.03	1.51	0.89	0.90	1.05	0.87	0.76
HI	1.19	1.18	1.03	1.35	1.31	1.17	1.16	1.44	1.10	1.01
RA	0.98	1.02	0.81	0.99	1.23	0.86	0.86	1.05	0.82	0.85
RE	0.92	0.98	0.88	0.85	1.00	0.99	1.00	1.09	1.00	1.09
WR	1.17	1.37	1.04	1.11	1.24	1.02	1.02	0.97	1.05	0.85
avg	1.04	1.16	0.83	1.06	1.27	1.01	1.01	1.12	0.99	0.97

TAS	mean	mean Spr	mean Summ	mean Fall	mean Wint	min	q10	q90	max	iqr
AL	0.7	0.6	2.1	0.7	-0.7	-0.7	-0.4	2.5	4.6	1.8
CC	-0.1	-0.6	1.0	-0.3	-0.6	-0.1	-0.4	0.9	3.0	1.4
CO	0.5	0.6	1.5	0.2	-0.3	0.5	-0.1	1.6	3.5	1.5
HA	-0.5	-0.6	1.1	0.0	-1.0	-3.3	-0.8	0.4	1.5	0.7
HI	-0.1	0.5	0.3	-0.6	-0.8	-0.6	-1.0	0.4	0.6	0.9
RA	-2.0	-2.6	-0.9	-1.6	-2.9	-3.4	-3.2	-1.0	0.1	1.5
RE	0.7	0.9	1.2	0.8	-0.2	0.1	0.0	1.3	2.0	1.3
WR	0.0	-0.4	1.6	-0.6	-0.6	-1.6	-1.0	1.6	2.9	1.9
avg	-0.1	-0.2	1.0	-0.2	-0.9	-1.1	-0.9	1.0	2.3	1.4

TASMAX	mean	q90	max	iqr
AL	0.7	2.1	4.5	1.2
CC	-1.2	-0.4	2.4	1.2
CO	-0.4	0.7	3.2	1.6
HA	-1.1	-0.2	1.8	0.7
HI	-1.3	-1.4	-1.5	-0.1
RA	-1.6	-1.5	-0.2	0.5
RE	0.6	1.5	2.6	1.9
WR	-0.2	0.9	2.6	1.6
avg	-0.6	0.2	1.9	1.1

TASMIN	mean	q10	min	iqr
AL	0.3	-0.5	0.7	1.2
CC	1.1	0.5	2.9	1.5
CO	1.4	0.9	3.3	1.1
HA	-0.3	-1.3	-5.3	0.3
HI	1.1	-0.4	1.7	1.9
RA	-2.6	-4.9	-3.4	2.2
RE	1.3	1.4	-1.1	0.4
WR	-0.1	-0.9	0.3	1.4
avg	0.3	-0.7	-0.1	1.3

PR, TAS, TASMAX, TASMIN statistics: ratio (PR) or difference [°C] (TAS, TASMAX, TASMIN) between RCM and OBS 1979*-2005 SR averages, 'avg' represents the ensemble average

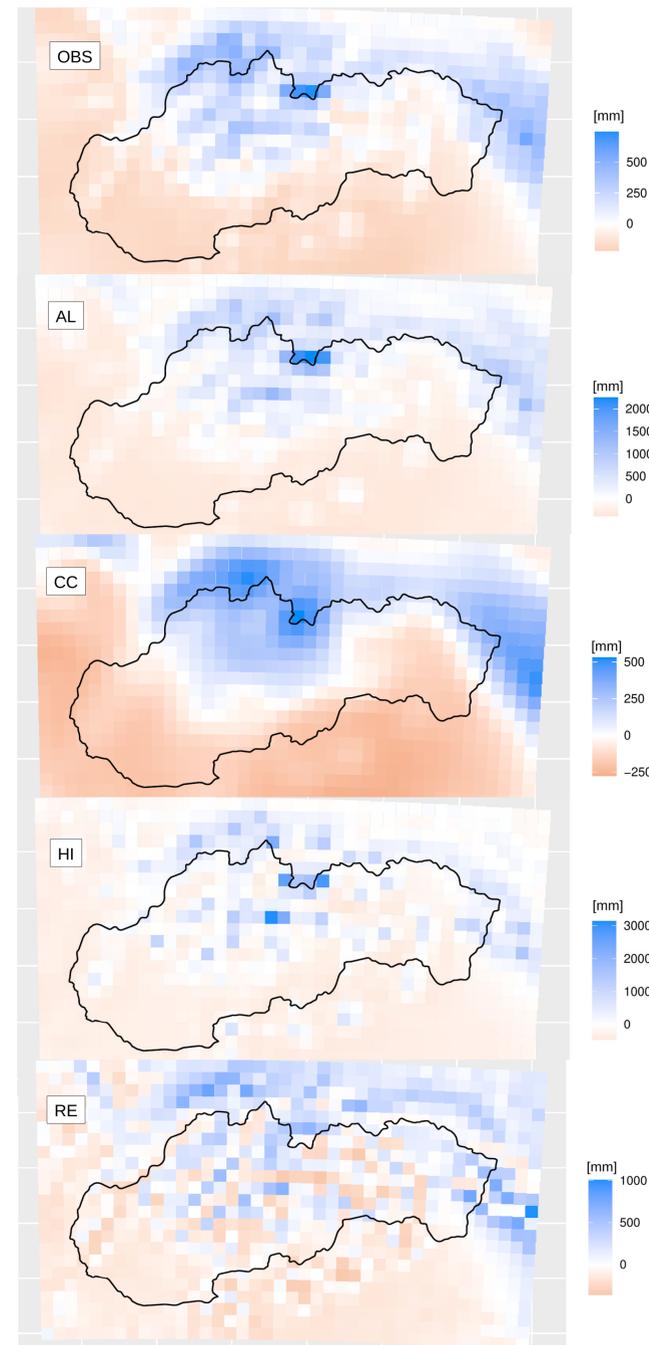
	AL	CC	CO	HA	HI	RA	RE	WR
freq.	0.02	-0.01	-0.09	0.09	0.00	0.07	-0.05	0.07
F>T	0.00	-0.01	-0.06	0.07	0.01	0.04	-0.01	0.06
T>F	-0.02	0.00	0.06	-0.05	0.02	-0.05	0.06	-0.03

Frequency, false-true and true-false transition probabilities of days with precipitation, difference between RCM and OBS

F>T, T>F	AL	CC	CO	HA	HI	RA	RE	WR
hottest d.	0.89	1.00	0.92	0.96	1.12	1.02	1.04	0.89
coldest d.	0.82	0.89	0.88	0.89	0.94	0.97	0.95	0.92

False-true and true-false transition probabilities of 'hottest' and 'coldest' days, ratio between RCM and OBS

1979*-2005 spatial fields: precipitation annual sums (individual grid point differences from the 1979*-2005 SR average) for OBS, AL, CC, HI, RE



PR	month	AL	CC	CO	HA	HI	RA	RE	WR
1	1.29	1.31	1.22	1.46	1.21	1.31	1.01	1.18	
2	1.36	1.51	1.37	1.64	1.32	1.17	0.99	1.31	
3	1.44	1.43	1.22	1.37	1.16	1.17	0.98	1.23	
4	1.57	1.33	1.08	1.10	1.29	0.97	0.90	1.55	
5	1.18	0.98	0.88	1.03	1.11	0.98	1.03	1.31	
6	0.97	0.88	0.67	0.77	0.99	0.81	0.87	1.09	
7	0.88	0.64	0.54	0.79	1.07	0.75	0.97	1.02	
8	0.73	0.52	0.51	0.59	1.05	0.89	0.78	1.01	
9	1.04	0.86	0.72	0.87	1.15	0.90	0.71	0.96	
10	1.47	1.21	0.91	1.02	1.57	1.02	0.94	1.14	
11	1.22	1.17	1.07	1.21	1.39	1.07	0.93	1.26	
12	1.25	1.20	1.23	1.31	1.44	1.22	1.00	1.22	
ampl.	0.68	0.53	0.46	0.50	0.79	0.67	0.90	0.86	

TAS	month	AL	CC	CO	HA	HI	RA	RE	WR
1	-0.9	-0.1	-0.3	-0.9	-0.7	-2.8	0.0	0.0	
2	-1.2	-0.7	-0.5	-1.4	-0.5	-3.8	-0.3	-1.2	
3	0.0	-1.1	-0.1	-1.2	0.2	-4.1	0.7	-1.1	
4	0.9	-0.5	0.7	-0.4	0.5	-2.1	1.4	0.0	
5	0.7	-0.1	1.2	-0.1	0.7	-1.4	0.8	0.1	
6	1.4	0.2	1.2	0.3	0.4	-1.1	1.2	1.1	
7	2.1	1.2	1.5	1.4	0.2	-0.8	1.1	1.9	
8	2.5	1.4	1.5	1.4	0.3	-1.0	1.4	1.7	
9	1.3	0.2	1.2	0.4	-0.6	-1.2	1.2	-0.1	
10	0.5	-0.5	0.0	0.0	-0.5	-1.6	0.9	-0.5	
11	0.0	-0.6	-0.5	-0.6	-0.8	-2.2	0.1	-1.3	
12	-0.2	-1.1	-0.1	-1.1	-1.4	-2.2	-0.3	-0.9	
ampl.	2.7	1.6	1.7	2.2	1.2	2.0	1.4	2.2	

TASMAX	month	AL	CC	CO	HA	HI	RA	RE	WR
1	-0.6	-1.2	-1.4	-1.2	-1.3	-1.9	-0.9	-0.4	
2	-0.8	-2.0	-1.7	-2.1	-1.2	-2.6	-1.0	-1.7	
3	0.2	-2.2	-1.0	-2.0	-0.4	-2.8	0.9	-1.3	
4	0.4	-1.6	-0.3	-1.4	-0.7	-1.2	1.6	-0.4	
5	-0.1	-1.4	-0.1	-1.3	-0.9	-1.8	0.7	-0.7	
6	0.8	-1.0	0.2	-0.5	-1.1	-1.7	1.2	0.5	
7	1.6	0.1	0.7	0.9	-1.5	-1.2	1.2	1.4	
8	2.3	0.5	1.0	1.4	-1.5	-1.3	1.8	1.5	
9	1.6	-0.7	0.7	0.3	-2.1	-1.1	1.9	0.1	
10	0.9	-1.8	-0.8	-0.5	-1.9	-0.8	1.5	-0.3	
11	0.6	-1.6	-1.2	-1.2	-1.7	-1.3	0.0	-1.1	
12	-0.1	-2.0	-1.1	-1.3	-2.0	-1.5	-1.1	-0.9	
ampl.	2.1	1.6	2.0	2.1	0.2	0.6	2.4	2.2	

TASMIN	month	AL	CC	CO	HA	HI	RA	RE	WR
1	-1.0	0.9	0.6	-1.3	-0.1	-3.8	0.6	0.3	
2	-1.2	0.6	0.9	-1.6	0.3	-5.0	0.6	-0.8	
3	-0.3	0.4	1.0	-0.8	1.0	-5.4	1.5	-0.9	
4	0.6	0.9	1.9	0.2	1.8	-3.3	1.9	0.2	
5	0.3	1.2	2.4	0.3	2.1	-1.8	1.3	0.1	
6	0.7	1.3	2.0	0.3	1.7	-1.5	1.4	0.7	
7	1.4	2.3	2.1	1.2	1.8	-1.1	1.5	1.5	
8	1.8	2.5	2.2	0.9	2.2	-1.0	1.8	1.5	
9	0.7	1.5	1.9	0.5	1.3	-1.4	1.5	-0.2	
10	0.4	1.1	1.3	0.6	1.3	-1.8	1.6	-0.2	
11	-0.1	0.4	0.4	-0.3	0.1	-2.7	0.8	-1.3	
12	-0.3	-0.3	0.7	-1.4	-0.8	-3.1	0.3	-0.8	
ampl.	2.1	1.6	1.3	2.3	2.1	2.7	1.0	1.7	

PR	sum	sum Spr	sum Summ	sum Fall	sum Wint	mean Dwp	q90 Dwp	max	iqr Dwp	DWOP
OBS	0.85	0.89	0.85	0.77	0.62	0.78	0.78	0.76	-0.75	0.73
AL	0.89	0.92	0.87	0.89	0.8	0.91	0.86	0.87	-0.9	0.84
CC	0.89	0.94	0.79	0.9	0.81	0.64	0.79	0.73	-0.86	0.77
CO	0.86	0.91	0.83	0.84	0.73	0.68	0.67	0.65	-0.87	0.57
HA	0.71	0.79	0.76	0.72	0.38	0.45	0.53	0.49	-0.82	0.54
HI	0.71	0.71	0.74	0.69	0.58	0.67	0.6	0.57	-0.82	0.57
RA	0.71	0.76	0.82	0.7	0.38	0.59	0.46	0.38	-0.81	0.4
RE	-0.05	-0.11	0.09	-0.18	-0.11	0.07	-0.16	-0.16	-0.16	-0.19

TASMAX	Mean	Max	Q90	IQR
OBS	-0.97	-0.98	-0.98	-0.91
AL	-0.98	-0.99	-0.98	-0.91
CC	-0.97	-0.96	-0.96	-0.77
CO	-0.97	-0.96	-0.96	-0.82
HA	-0.97	-0.98	-0.98	-0.74
HI	-0.97	-0.98	-0.99	-0.83
RA	-0.92	-0.94	-0.94	-0.87
RE	-0.93	-0.95	-0.94	-0.09
WR	NA	NA	NA	NA

TASMIN	Mean	Min	Q10	IQR
OBS	-0.95	-0.63	-0.9	-0.53
AL	-0.97	-0.94	-0.92	-0.72
CC	-0.98	-0.9	-0.94	-0.74
CO	-0.97	-0.94	-0.95	-0.68
HA	-0.98	-0.91	-0.96	0.23
HI	-0.97	-0.87	-0.87	-0.63
RA	-0.9	-0.81	-0.81	-0.67
RE	-0.95	-0.71	-0.87	-0.86
WR	NA	NA	NA	NA

Annual cycle of PR, TAS, TASMAX, TASMIN represented by monthly sums (PR) / means (TAS, TASMAX, TASMIN) and annual cycle amplitude; ratio (PR) or difference [°C] (TAS, TASMAX, TASMIN) between RCMs and OBS

Correlation