Impacts of different RCP scenarios on ALADIN-Climate regional climate model projections over Hungary

Beatrix Bán (ban.b@met.hu) and Gabriella Zsebeházi
Regional Climate Modelling Group
Hungarian Meteorological Service (OMSZ), Budapest

EGU 2020: Sharing Geoscience Online
4-8 May 2020

SZÉCHENYI 2020

HUNGARIAN METEOROLOGICAL SERVICE

KLIMADAT

HUNGARIAN GOVERNMENT

European Union
Cohesion Fund

INVESTING IN YOUR FUTURE

OUTLINE

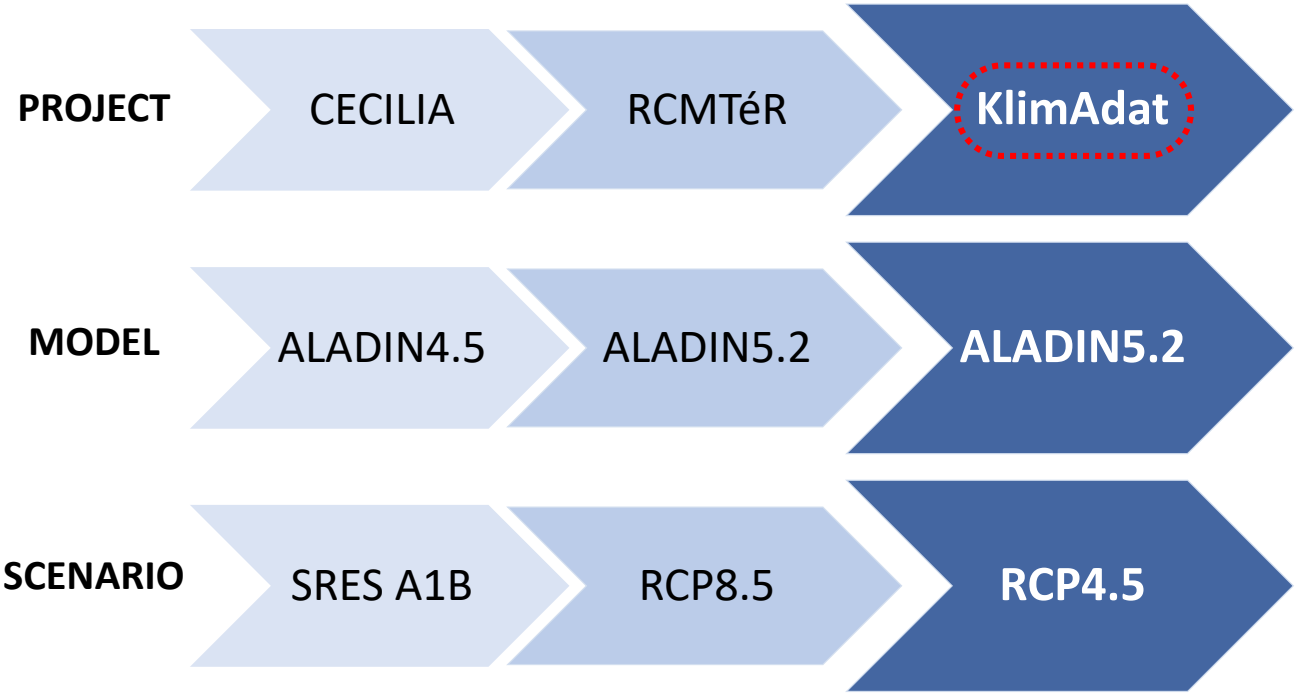
1. History of ALADIN-Climate simulations at OMSZ

2. ALADIN simulations with RCP scenarios:
   a) introduction of the simulations
   b) results of temperature and precipitation change
   c) change in climate indices

3. How do the new simulations fit into the in-house and Euro-CORDEX ensembles?

4. Summary and further plans

HISTORY OF ALADIN SIMULATIONS AT OMSZ

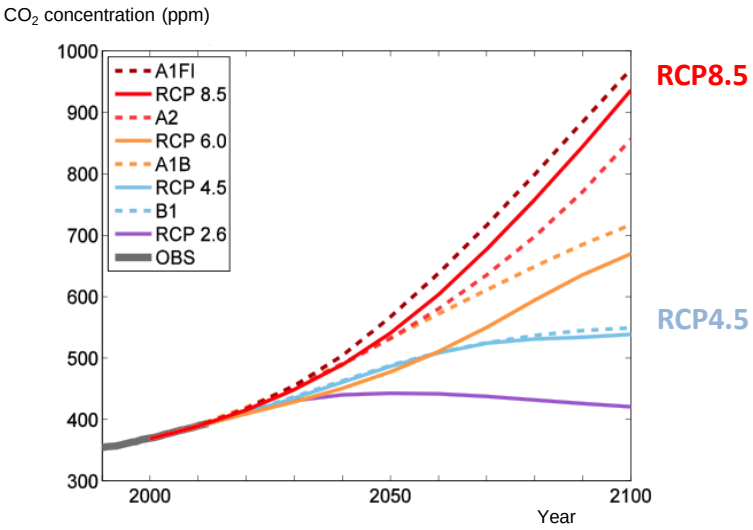


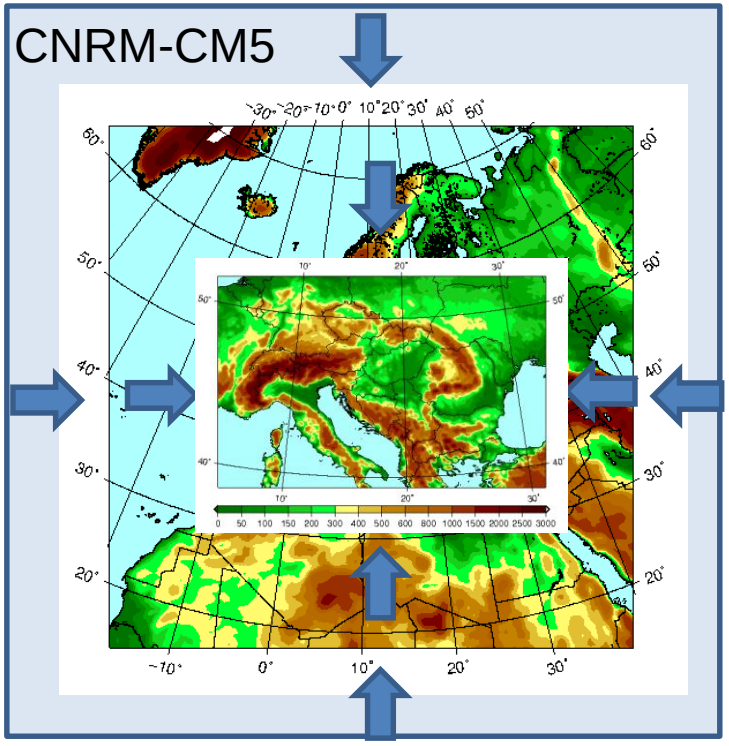
- **KlimAdat:** *Assessment of climate change impacts in Hungary with regional climate model simulations and developments of a representative climate database*
- Project duration: 31 May 2016 – 31 December 2021
- Funded by the Cohesion Fund of the European Union

INTRODUCTION OF THE ALADIN SIMULATIONS

Model	Resolution	LBC	Land surface	Scenario	Integration period
ALADIN5.2	50 km	CNRM-CM5	ISBA scheme	RCP8.5	1951-2100
				RCP4.5	
ALADIN5.2	10 km	ALADIN5.2 50 km	Online coupled SURFEX model	RCP8.5	
				RCP4.5	

Reference: 1971-2000
Evaluation period: 2021-2050 and 2071-2100





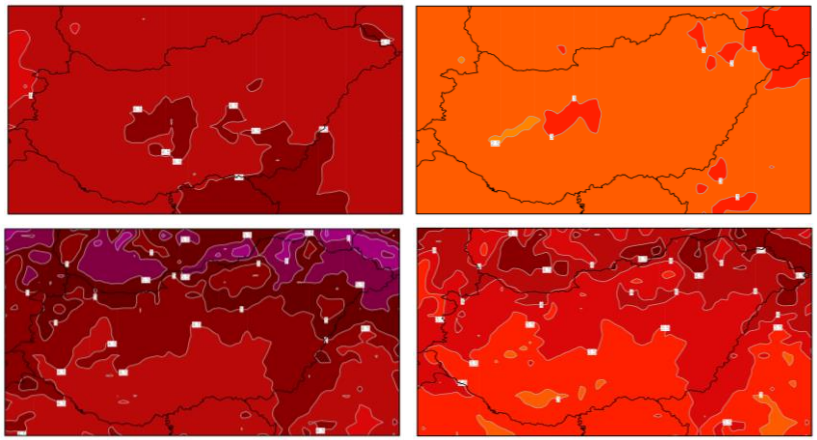
RESULTS – TEMPERATURE CHANGE [°C]

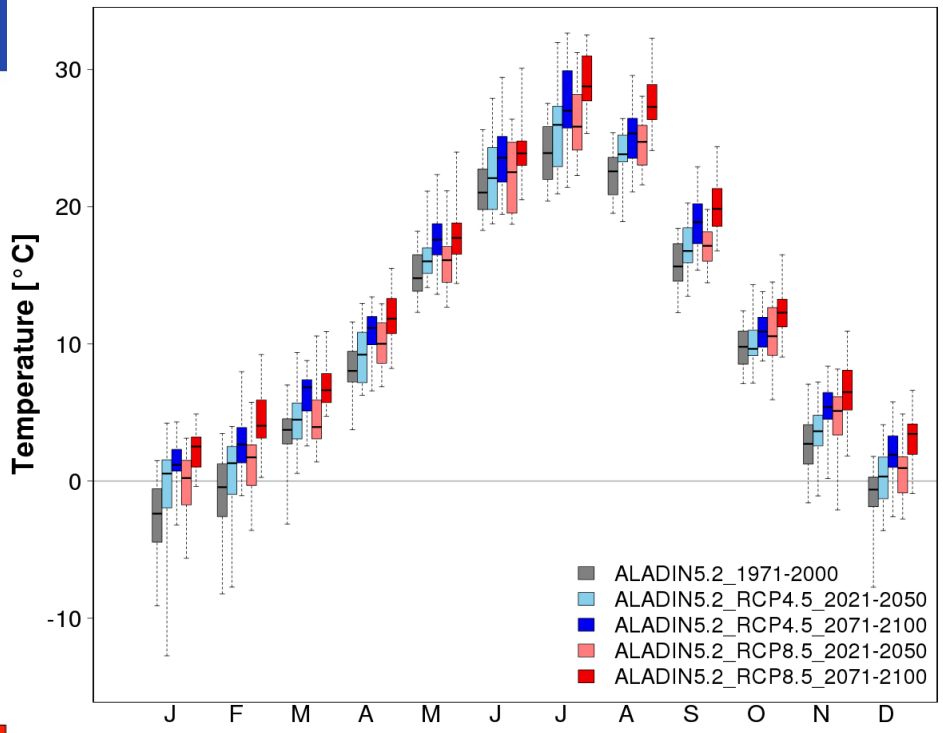
- Larger increase with RCP8.5
- 2071-2100: **3-4 °C** annual mean increase
- Greater change over northern part of Hungary with both scenarios in winter

10 km resolution

ALADIN RCP8.5 **ALADIN RCP4.5**

2071-2100





Based on 30 monthly averages, data are not bias adjusted

- Some extreme cold January and February months with RCP4.5 for 2021-2050 (minimum around -10 °C)
- Large changes in a few months with RCP8.5 by the end of the century (e.g. July, August, September)

RESULTS – PRECIPITATION CHANGE [%]

- 2071-2100: **16-24 %** annual mean increase
- The direction of change is opposite to the two scenarios over the lake Balaton (no explicit lake parametrization)

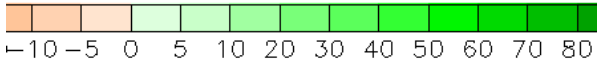
10 km resolution

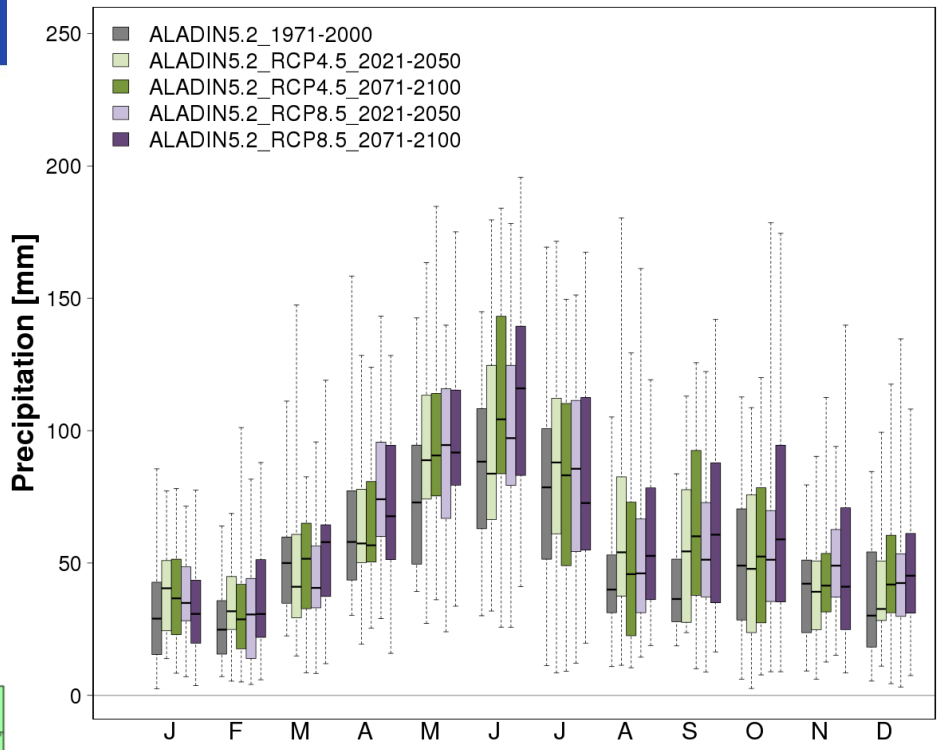
ALADIN RCP8.5 **ALADIN RCP4.5**

2071-2100

summer

winter





Based on 30 monthly averages, data are not bias adjusted

- June (wettest month on average) is even wetter in the later period (2071-2100)
- Large variability in October precipitation according to RCP8.5

RESULTS – IMPACTS OF THE RESOLUTION (2071-2100)

Temperature

- Lower changes with 10 km spatial resolution in spring and autumn
- Greater change in winter with 10 km spatial resolution RCP4.5 scenario simulation

	Resolution	Year	MAM	JJA	SON	DJF
RCP8.5	50 km	4,1	4,1	4,5	3,8	3,9
	10 km	4,0	3,4	4,4	3,5	3,8
RCP4.5	50 km	2,8	3,2	2,9	2,5	2,9
	10 km	2,9	2,7	2,9	2,3	3,6

The weaker temperature rise in 10 km experiments can be caused by wetter conditions

Precipitation

- Except the RCP4.5 summer, always the 10 km simulations show higher precipitation increase

The largest difference (7%) with **RCP8.5 in autumn**

	Resolution	Year	MAM	JJA	SON	DJF
RCP8.5	50 km	18	14	19	26	19
	10 km	24	19	24	33 !	24
RCP4.5	50 km	15	7	18	19	21
	10 km	16	10	16	23	22

CHANGE IN CLIMATE INDICES

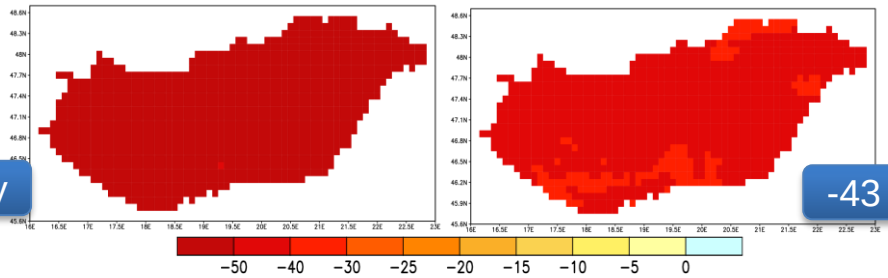
Reference: 1971-2000

10 km resolution

ALADIN RCP8.5 **ALADIN RCP4.5**

2071-2100

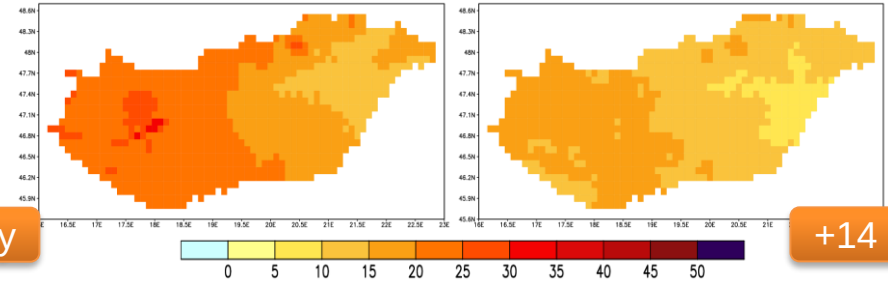
Frost days, annual [day]
T_{min} < 0°C



-58 day

-43 day

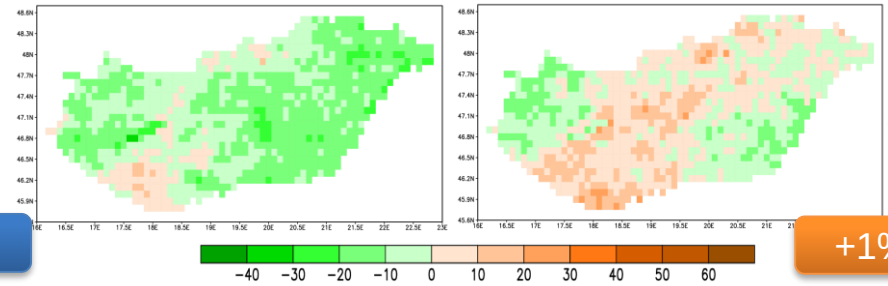
Summer days, annual [day]
T_{max} > 25°C



+20 day

+14 day

Consecutive dry days, summer [%]
R_{day} < 1 mm



-10%

+1%

- Clear and strong annual **decrease in frost days**, and **increase in summer days**, especially with RCP8.5 (pessimistic) scenario
- Summer days show east-west gradient of increase (for both scenarios)

Consecutive dry days (CDD):

- **RCP8.5**: despite the mean 10% decrease, the south-west area of the country shows increase **up to 10-20%**
- **RCP4.5**: except north-western and south-eastern parts of Hungary, **up to 20% longer** CDD is projected (despite the mean precipitation increase)

Mean over Hungary

WHERE THE NEW SIMULATIONS FIT IN THE IN-HOUSE AND EURO-CORDEX ENSEMBLES?

Hungarian Meteorological Service (OMSZ): **4 available simulations** (ALADINs are dominant)

Previous scenarios

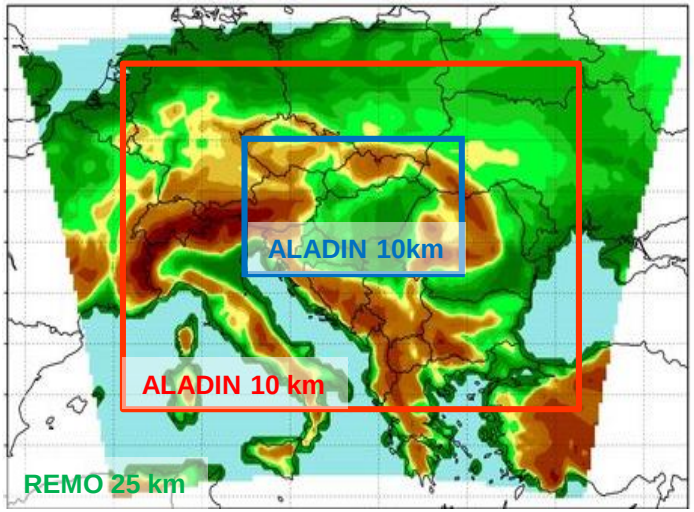
Model	Resolution	Integration period	Scenario
ALADIN4.5	10 km	1961–2100	SRES A1B
REMO	25 km	1951–2100	SRES A1B
ALADIN5.2	10 km	1950–2100	RCP 8.5
ALADIN5.2	10 km	1950–2100	RCP 4.5

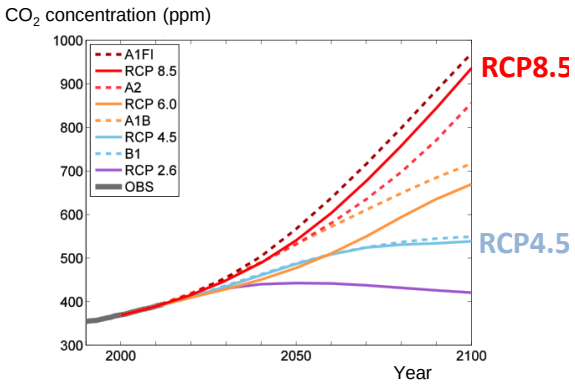
New scenarios

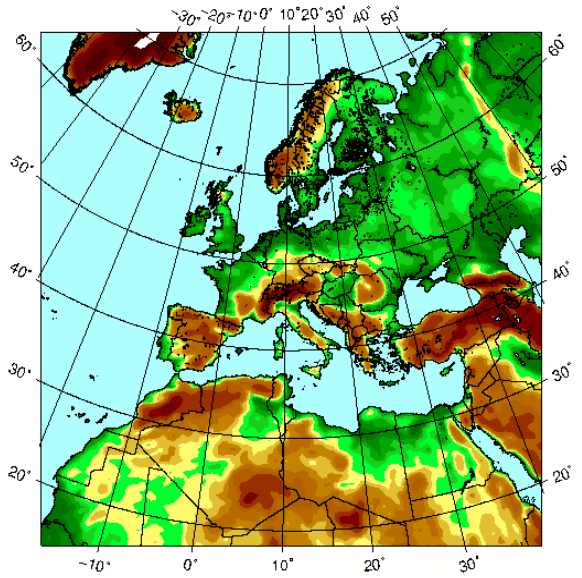
Using a subset of European climate models: **12 Euro-CORDEX simulations**

3 RCM x 2 GCM x 2 RCP scenario

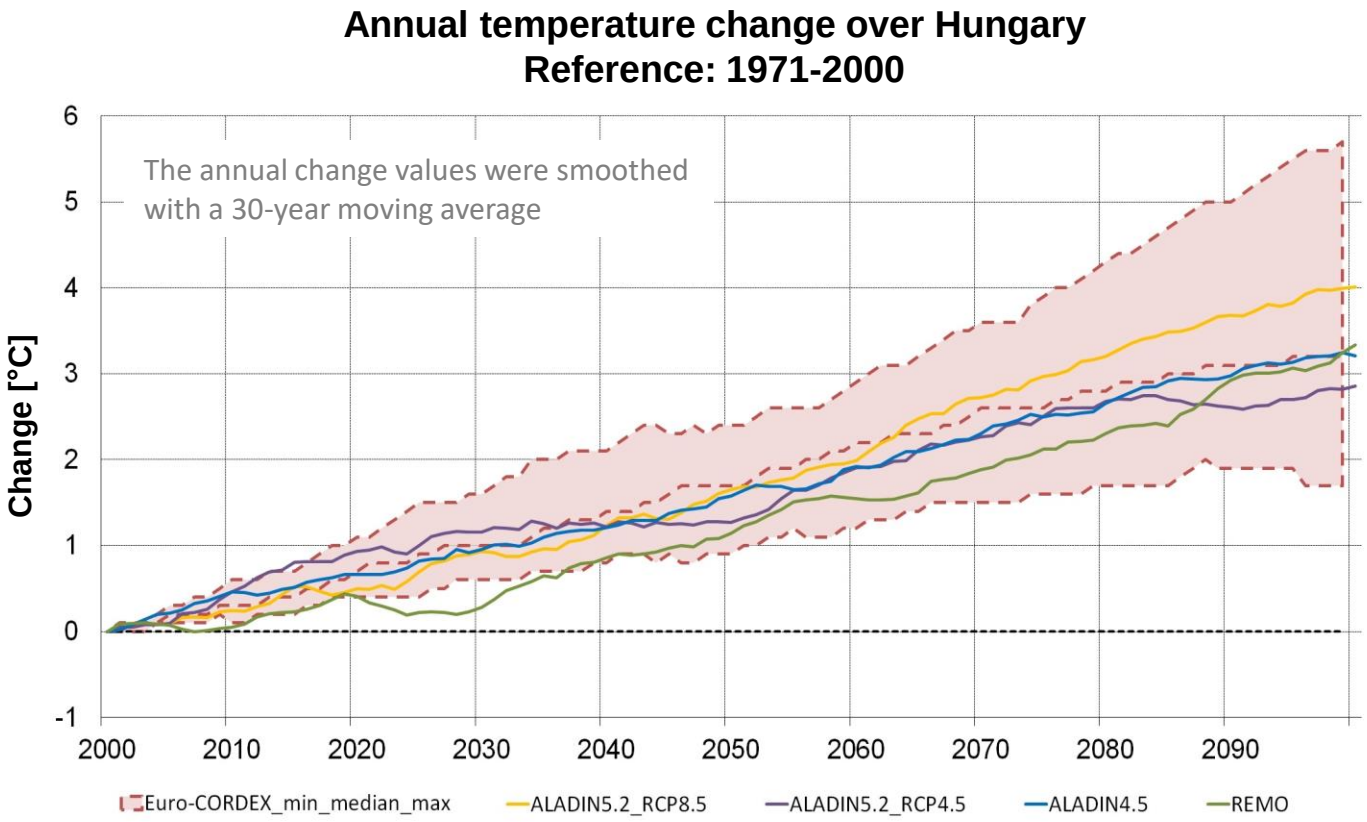
- **CCLM4-8-17**
  RACMO22E
  RCA4
- **EC-EARTH**
  HadGEM2-ES
- **RCP4.5**
  RCP8.5







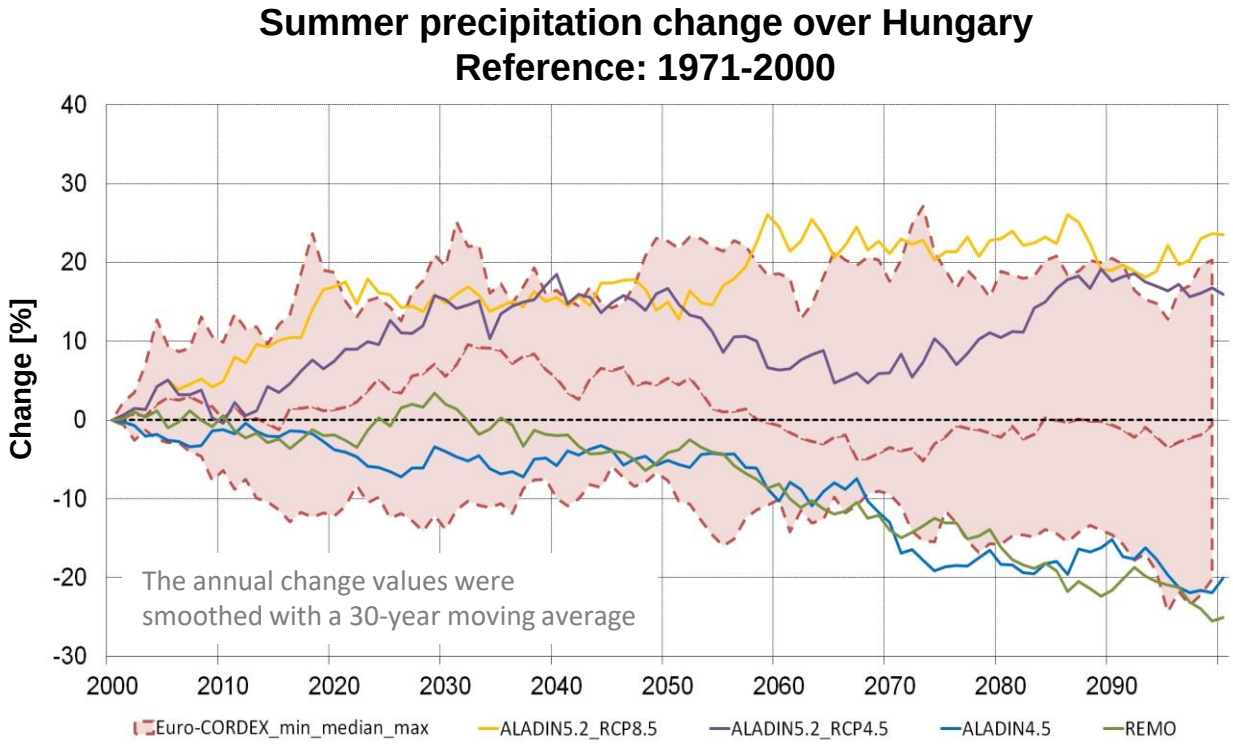
PLACE OF THE NEW SIMULATION - TEMPERATURE



- Continuous rise in trend
- Variance of the in-house simulations are much less, than of the Euro-CORDEX experiments

- End of the century:
  - Our new ALADIN simulations driven with RCP scenarios embrace previous simulations (ALADIN4.5 and REMO, driven with SRES A1B) that fall close to the median of the Euro-CORDEX ensemble

PLACE OF THE NEW SIMULATION - PRECIPITATION



By the end of the century:

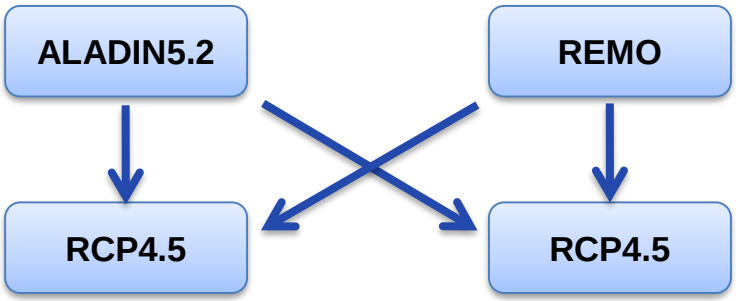
- The new ALADINs show a positive change
- The decreasing simulations were driven with the SRES scenarios (A1B), and in case of ALADIN version 4.5 a different boundary condition was applied

- Spread of the Euro-CORDEX ensemble represented well with in-house simulations
- Not each experiment shows a monotonous trend, e.g. ALADIN RCP4.5 (purple curve)
- The middle of the ensemble is not covered

Representative ensemble: new in-house simulations + EURO-CORDEX

SUMMARY AND FURTHER PLANS

- By the end of the century, lower GHG concentration driven simulations project less temperature change. Precipitation is not sensitive to scenario selection.
- The reason for differences in results between 50 km and 10 km resolution simulations could be the more accurate representation of the orography, and the SURFEX model coupled to the 10 km ALADIN simulations.
- To create a representative ensemble, new simulations with REMO (adapted in OMSZ) and a careful selection of Euro-CORDEX members will be made in the KlimAdat project



4 new RCP scenario driven **in-house simulations**

Thank you very much for your attention!

The Klimadat project is implemented between 2016 and 2021 and funded by the Cohesion Fund and the European Union

Webpage: klimadat.met.hu/en

HUNGARIAN METEOROLOGICAL SERVICE

KLIMADAT

SZÉCHENYI 2020

HUNGARIAN GOVERNMENT

European Union
Cohesion Fund

INVESTING IN YOUR FUTURE