Validation results of the completed modell simulations

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OUTLINE

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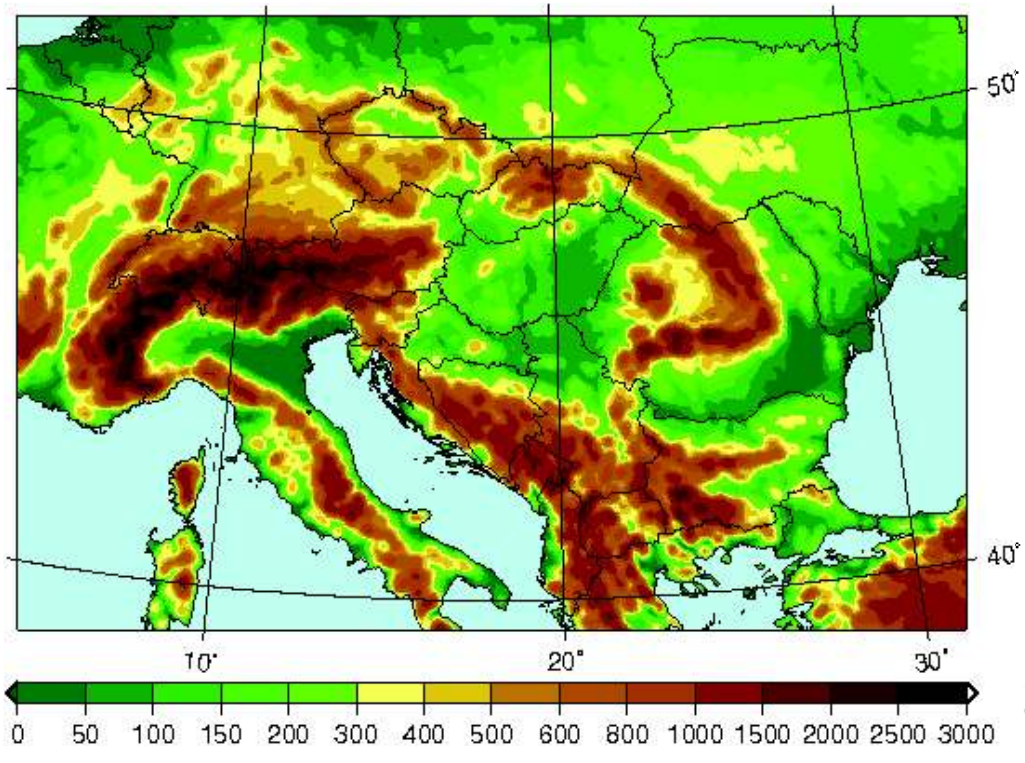
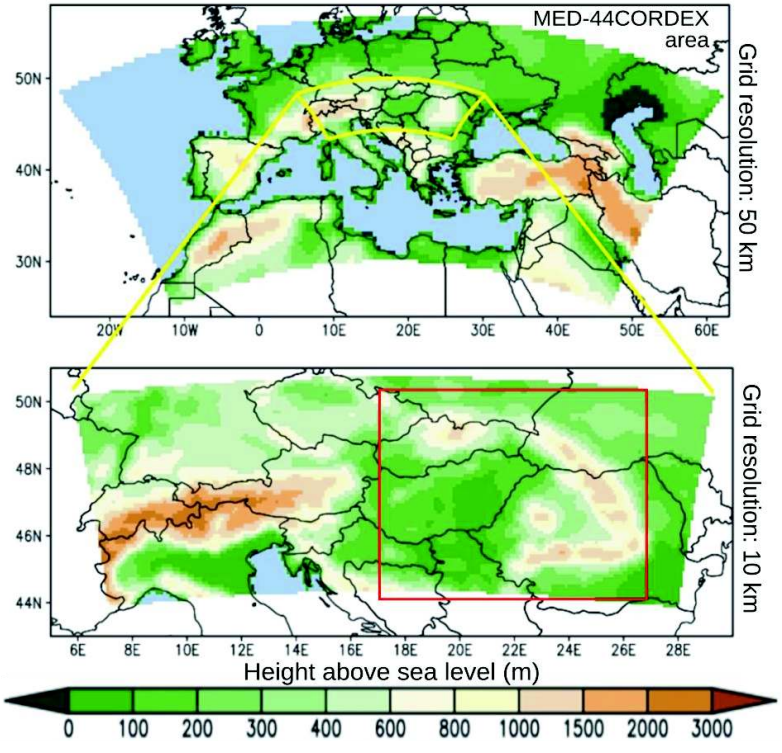
Model simulations – summary

	ALADIN_ERAI	ALADIN_ARP	RegCM_ERAI	RegCM_MED44
ICBC	ERA-Interim	ARPEGE-Climat → ALADIN-Climate	ERA-Interim → RegCM	HadGEM2 → RegCM
Horizontal resolution	10 km	10 km	10 km	10 km
No. of vertical levels	31	31	23	23
Horizontal resolution of ICBCs	80 km	50 km	50 km	50 km
Integration period	1980–2000	1950–2005	1980–2000	1950–2005
Timestep of integration	300 s	300 s	30 s	30 s

Integration domain of the models



ALADIN



RegCM

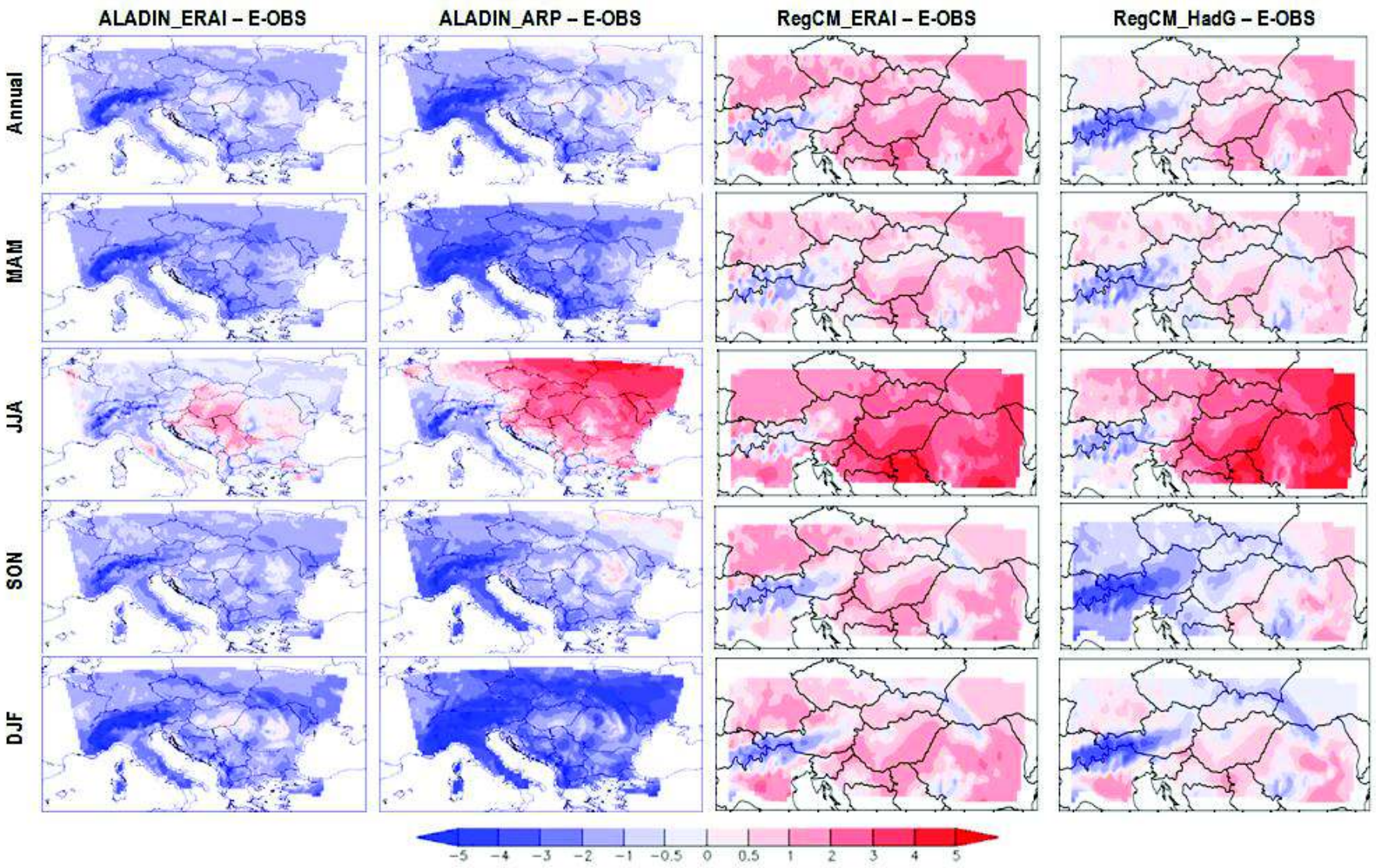
Validation databases

- **Europe** (large-scale climate characteristics): **E-OBS** v10.0 (Haylock et al., 2008; van den Besselaar et al., 2011)
  - 0.25° horizontal resolution
  - Not homogenized
  - Only a few observation station for Hungary
- **Hungary**: extended **CARPATCLIM** (Lakatos et al., 2013)
  - 0.1° horizontal resolution
  - Homogenized
  - Many stations for Hungary

Methods

- Temperature, precipitation – mean, indices
- Reference period: 1981–2000
- Daily, monthly, seasonal, annual values
- Statistical measures (bias, distribution, variability)
  - Systematic error, significance (two-tailed Welch's test)
  - Bias, RMSE
  - Spatial and temporal variance
  - Intra-annual variability
  - Inter-annual variability
  - Box-and-Whisker Plots
  - Taylor diagram
  - Histogram
  - Scatter plot

Results – temperature
annual and seasonal mean bias [°C]



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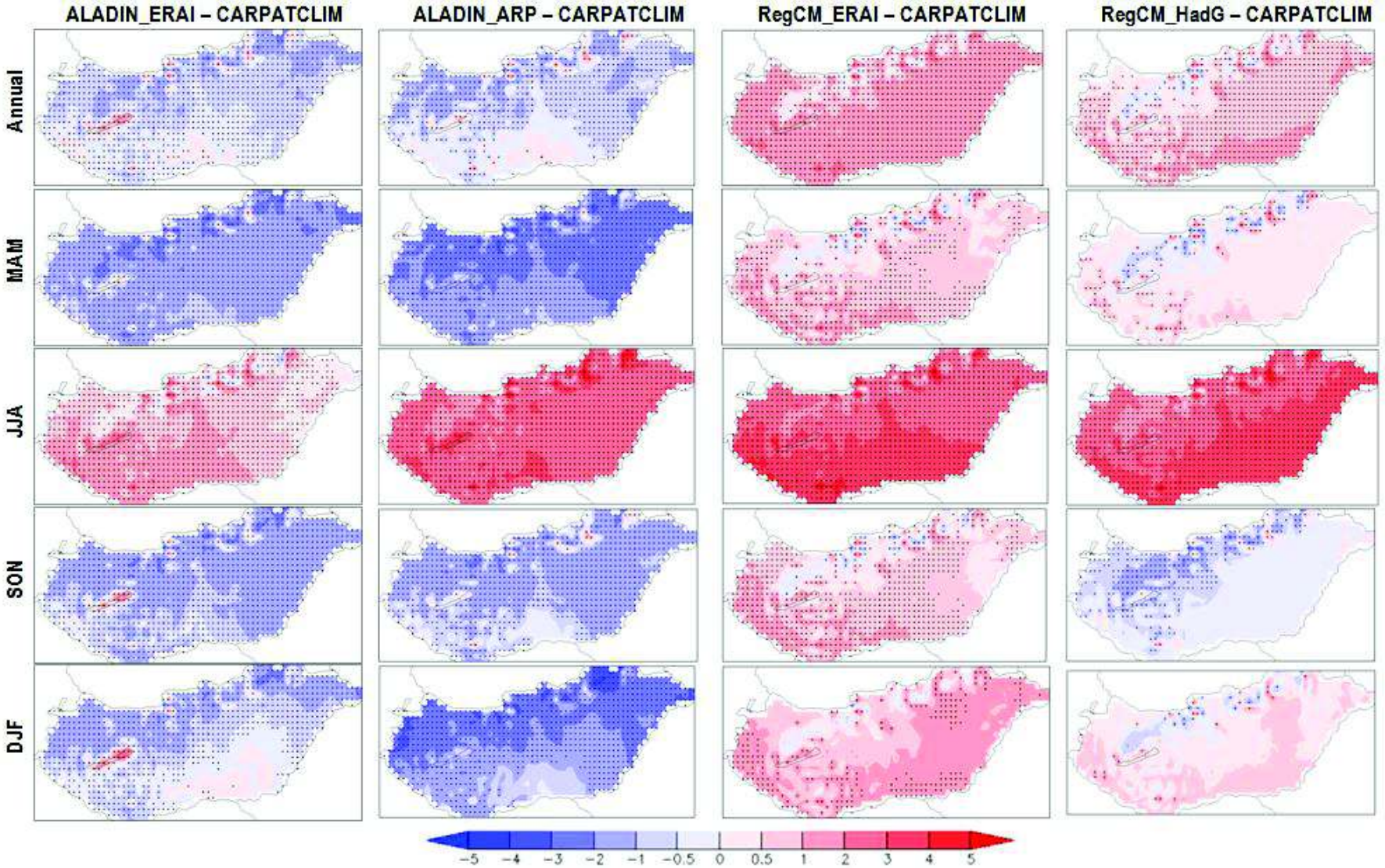

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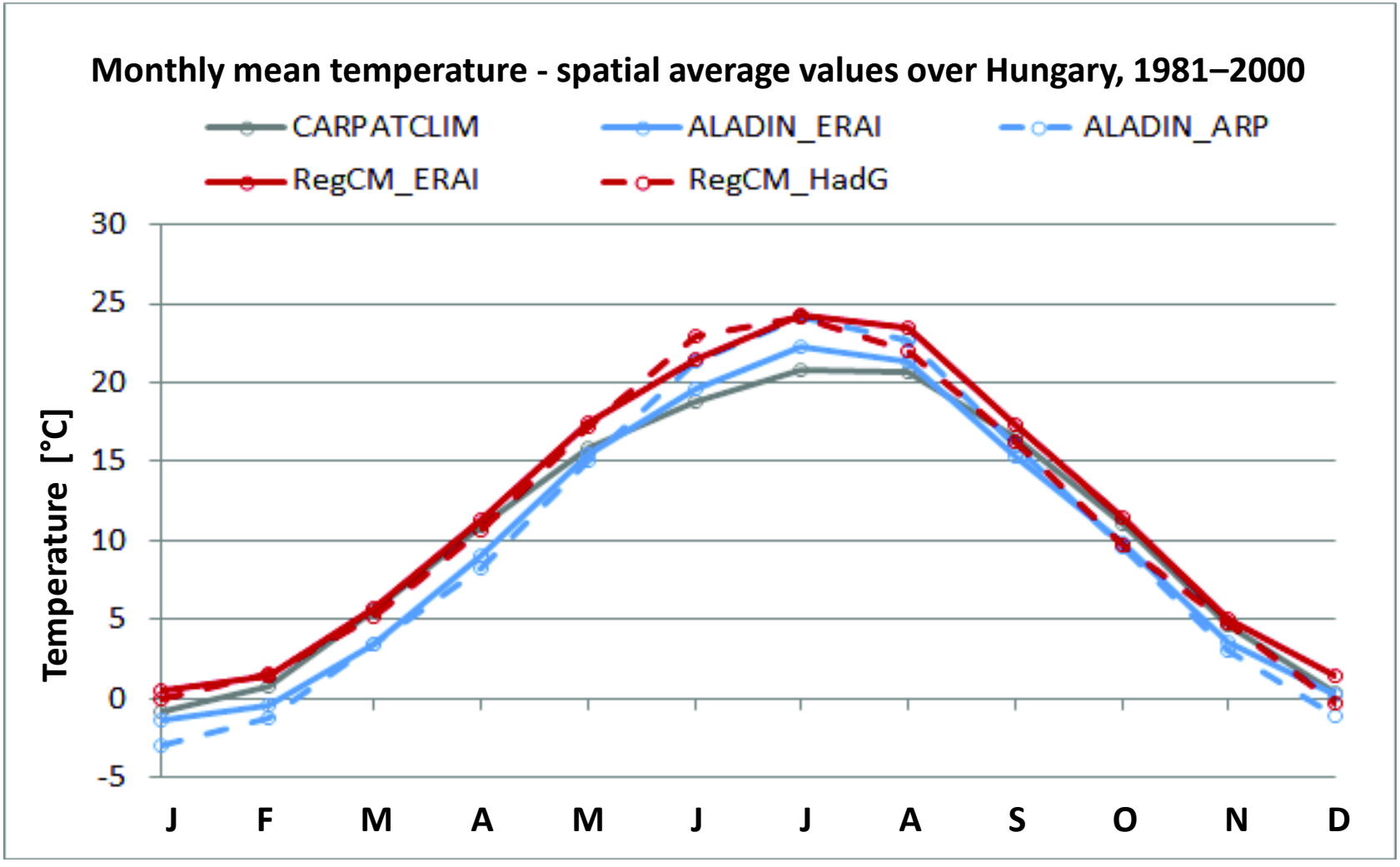
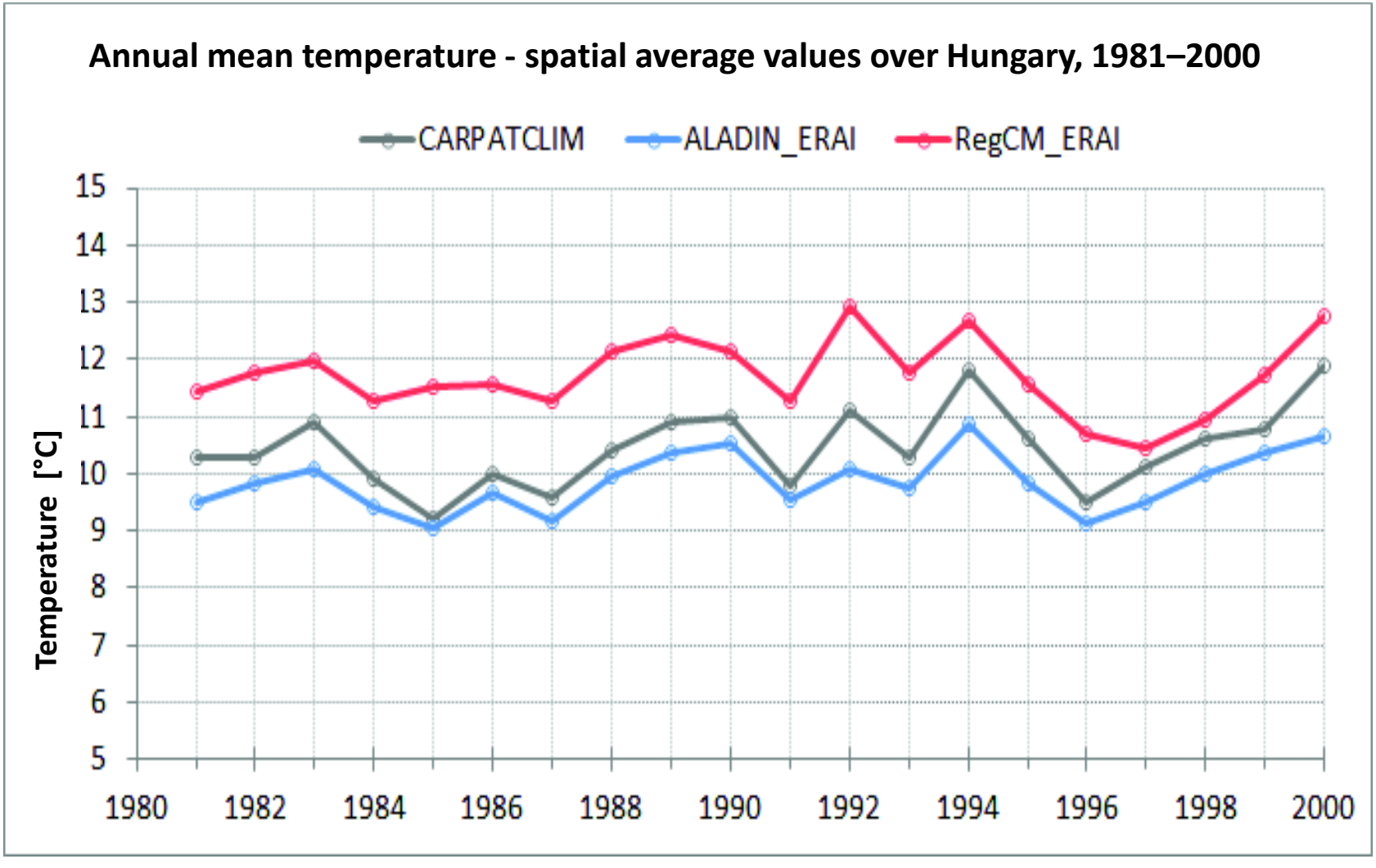
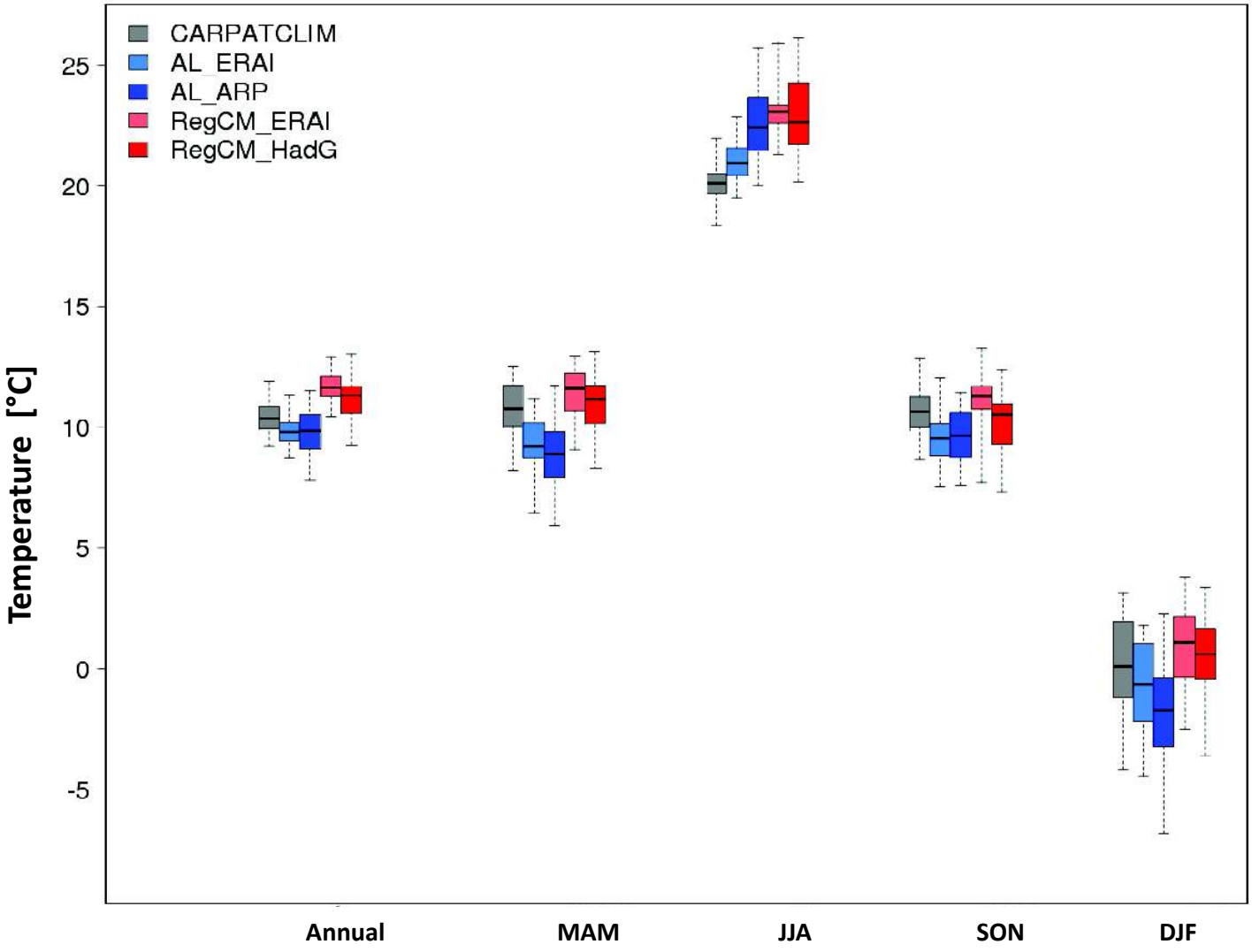


Results – temperature



Results – temperature



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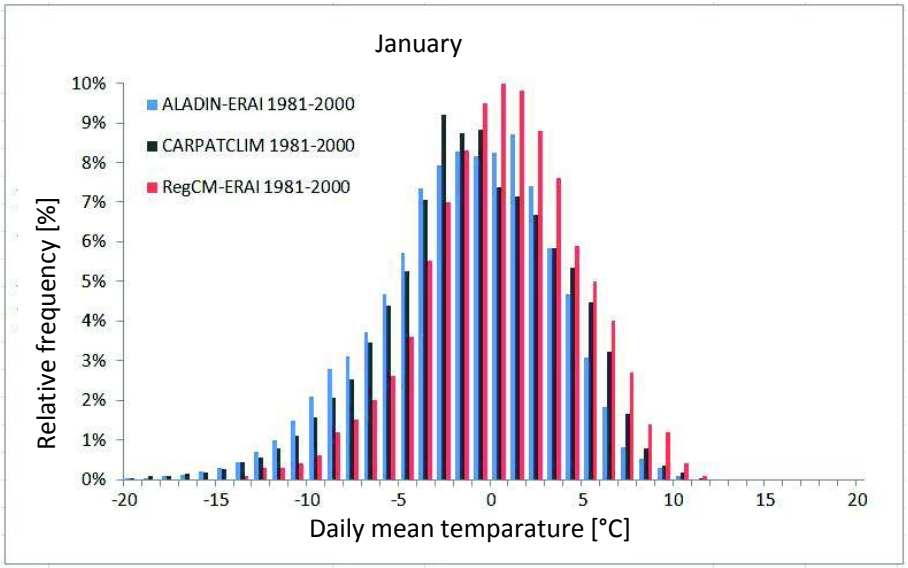
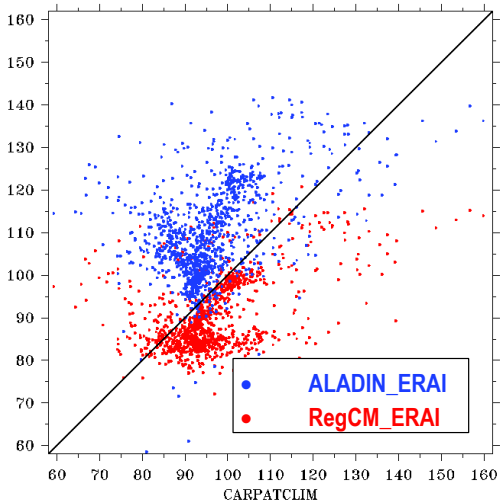
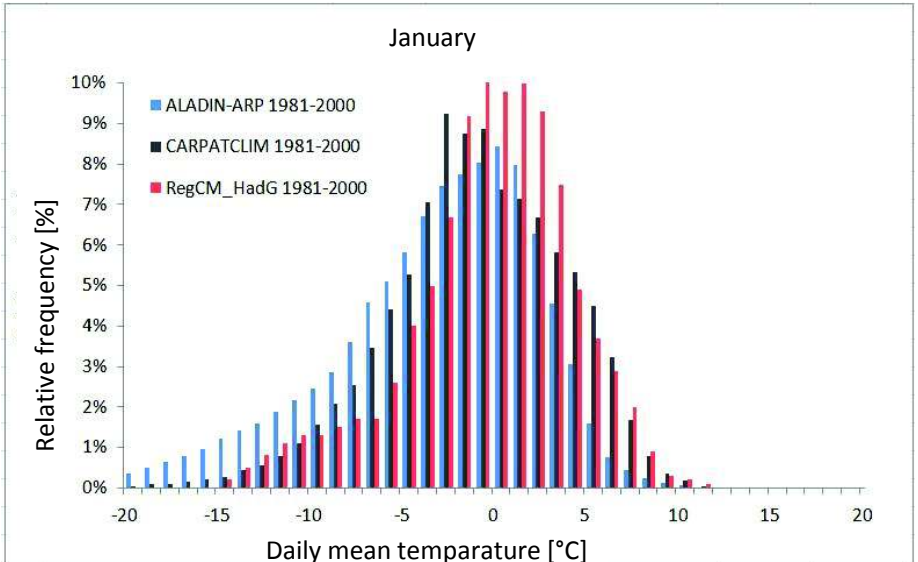
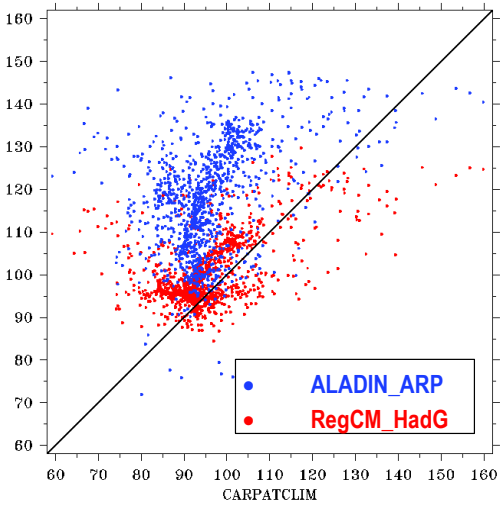


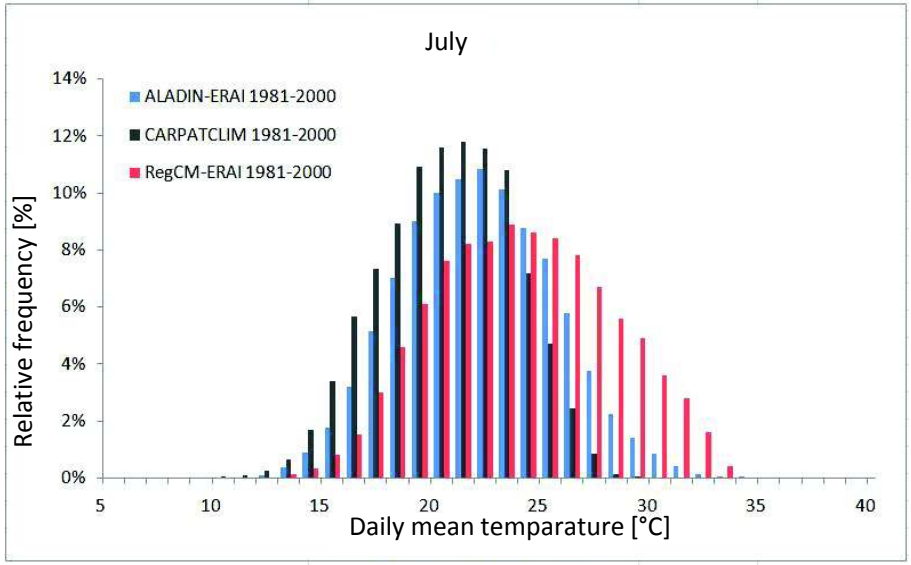


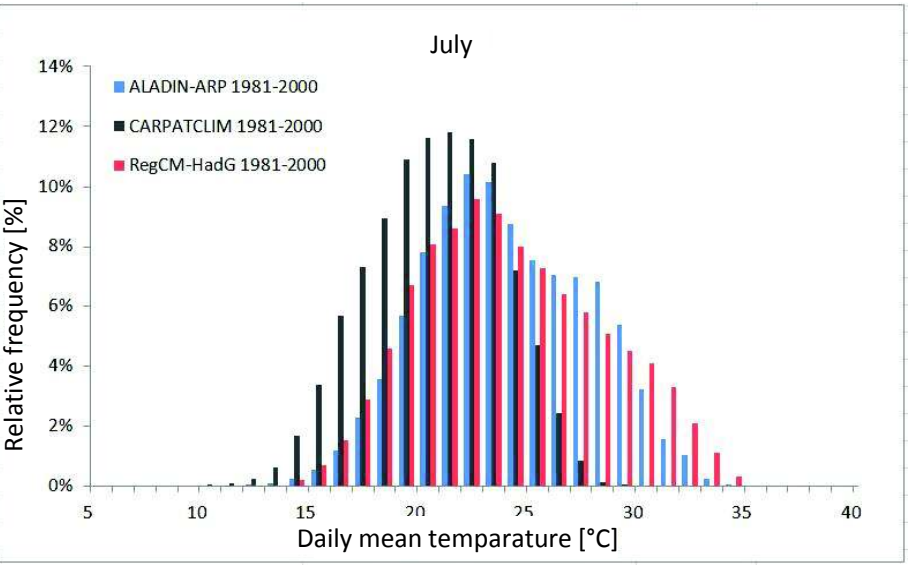
Frost days
$T_{min} < 0$ °C

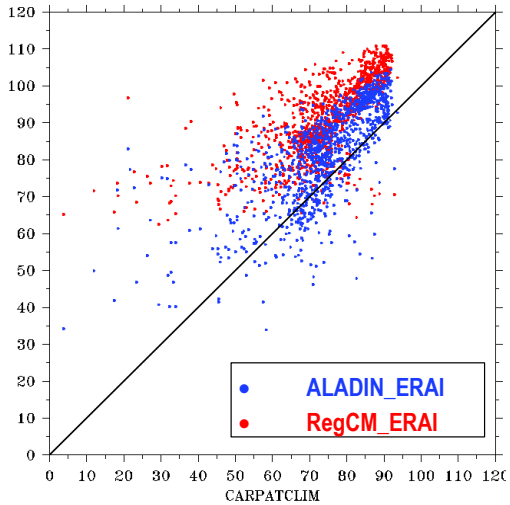




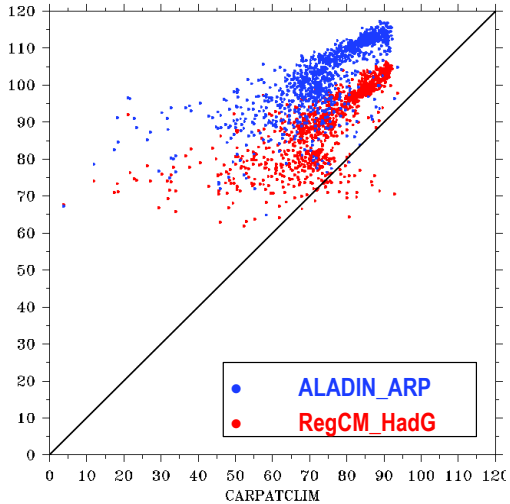
Results – temperature



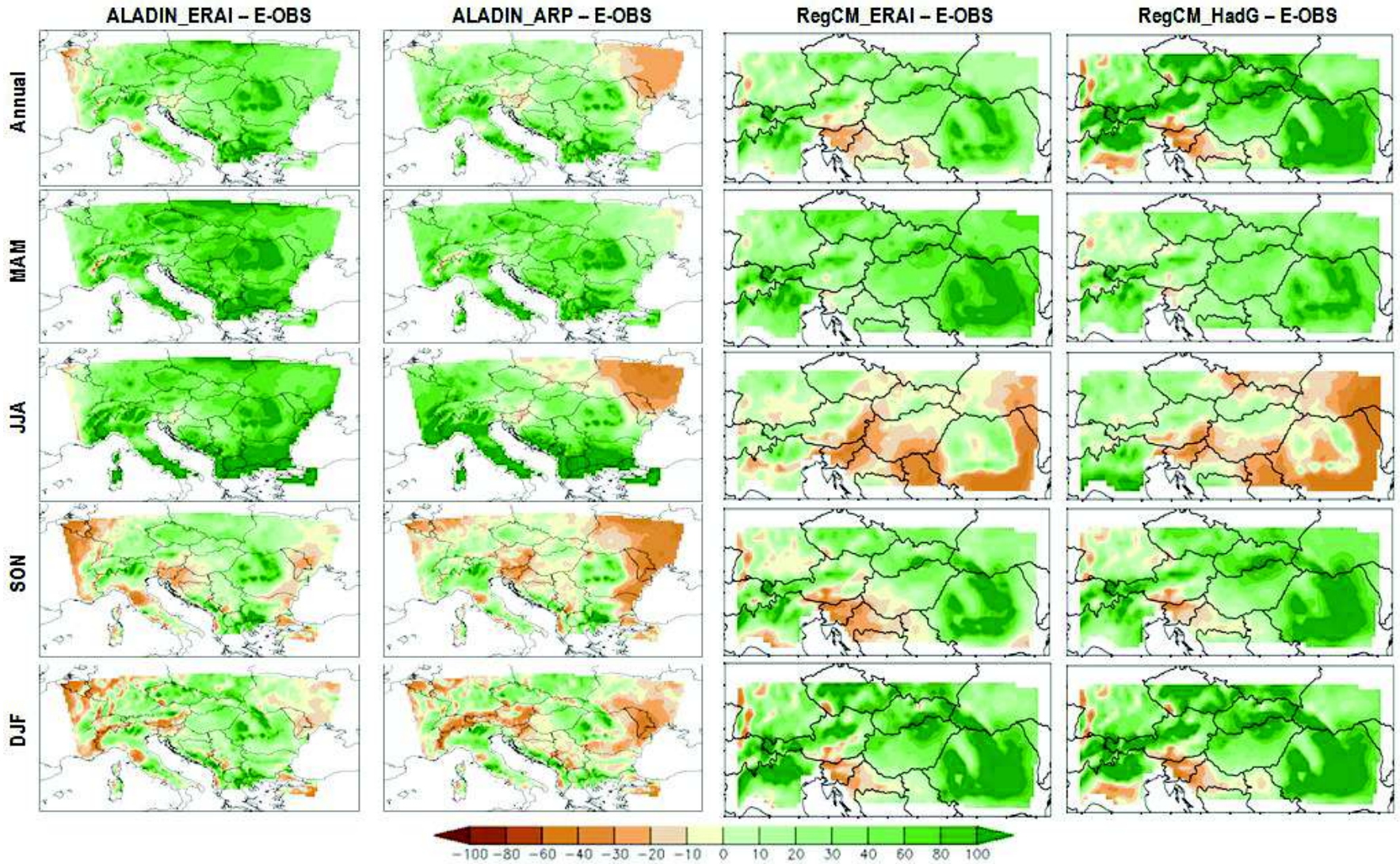




Summer days
T_{max} > 25 °C



Results – precipitation
annual and seasonal mean bias [%]



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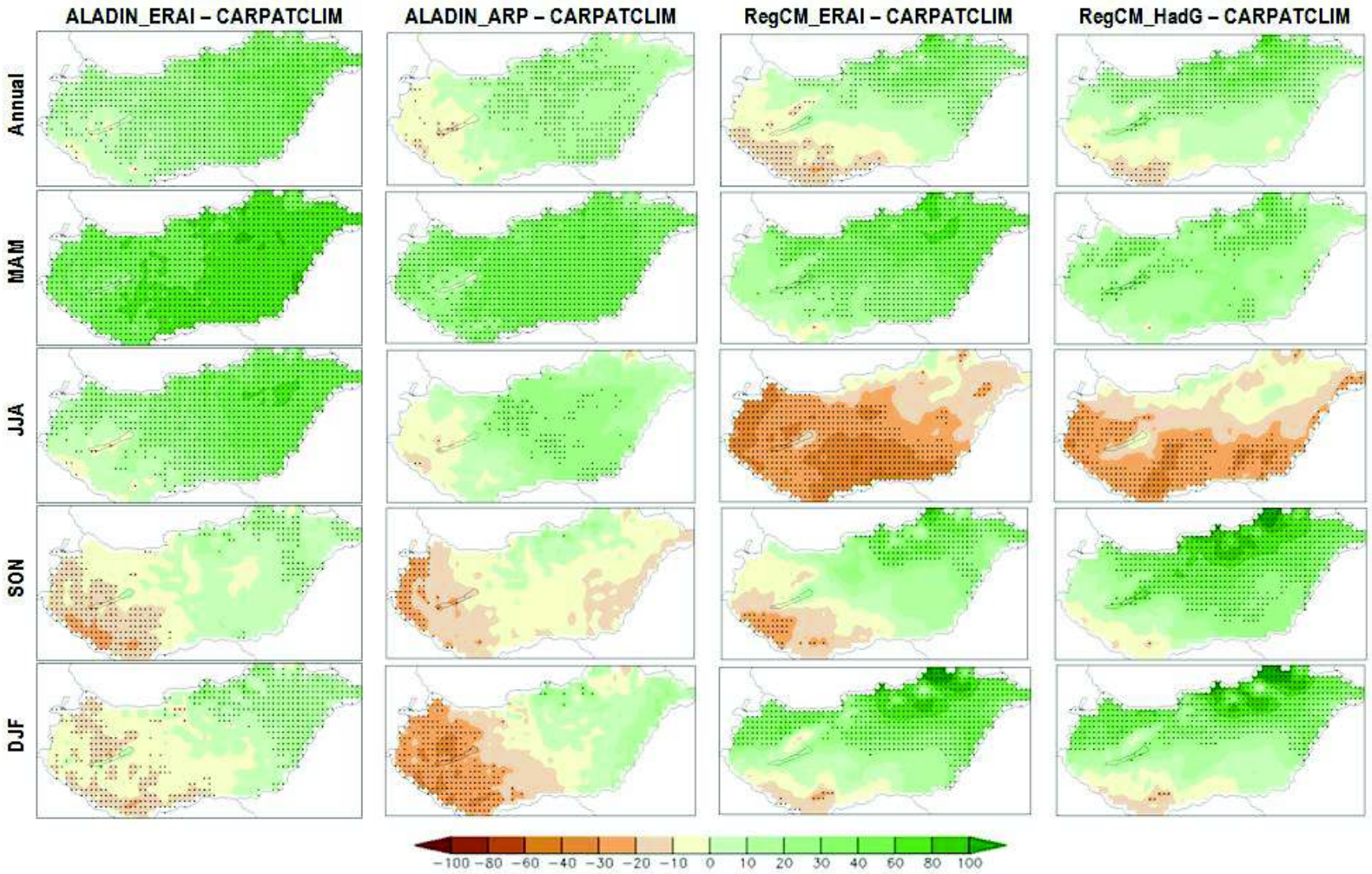

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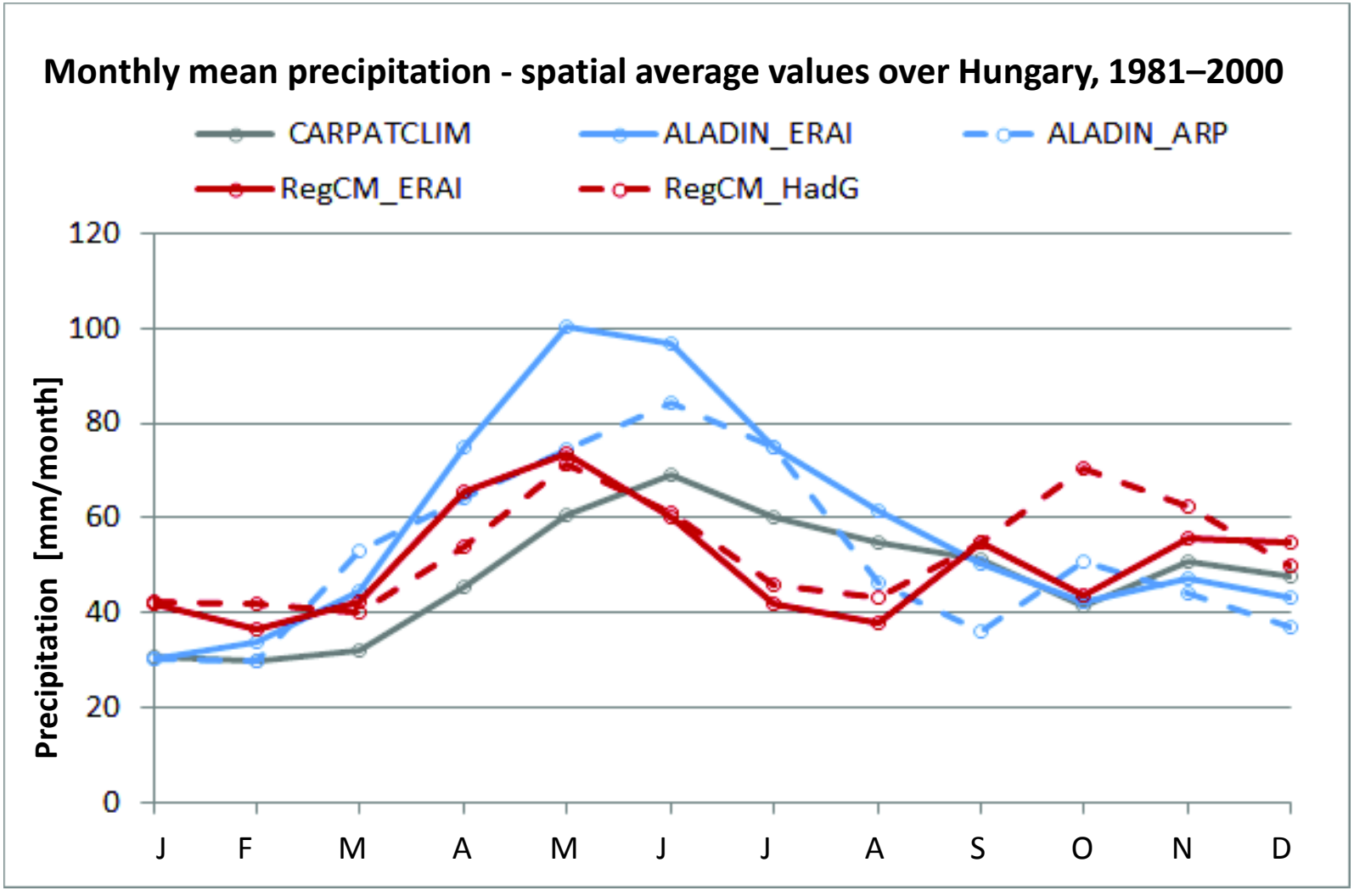
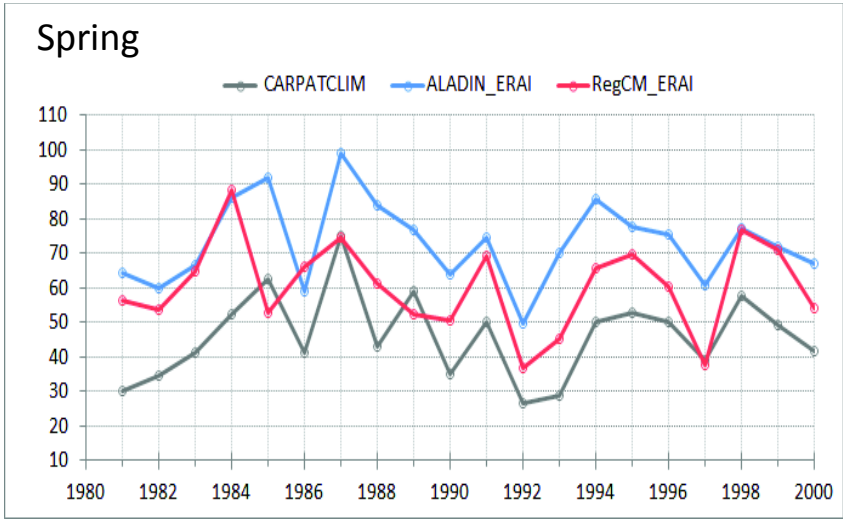


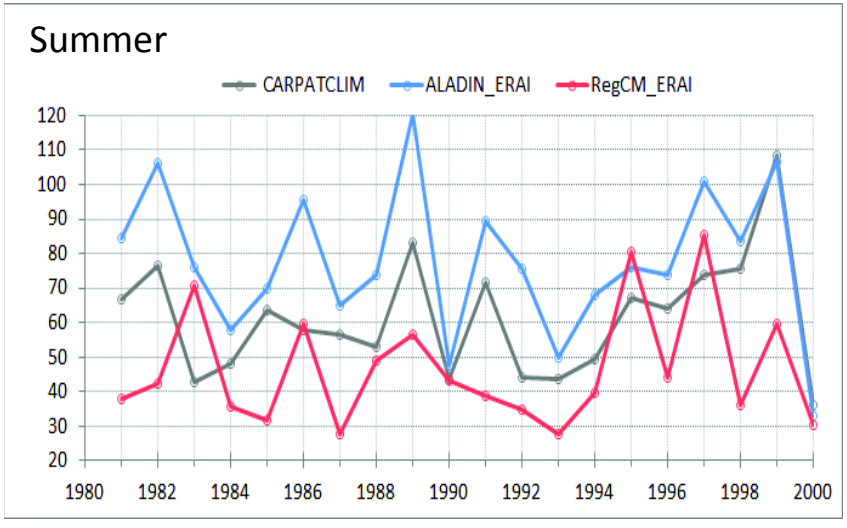
Results – precipitation

Seasonal mean precipitation [mm/month] - spatial average values over Hungary, 1981–2000

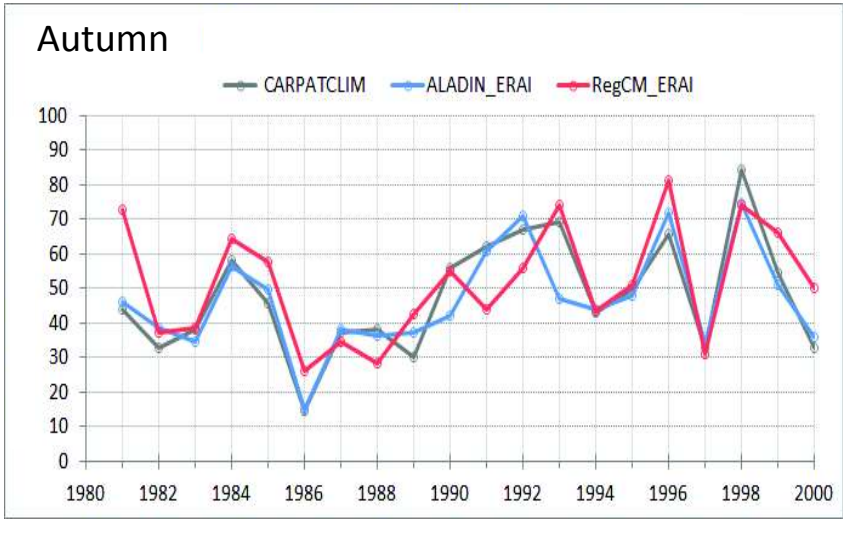
Spring



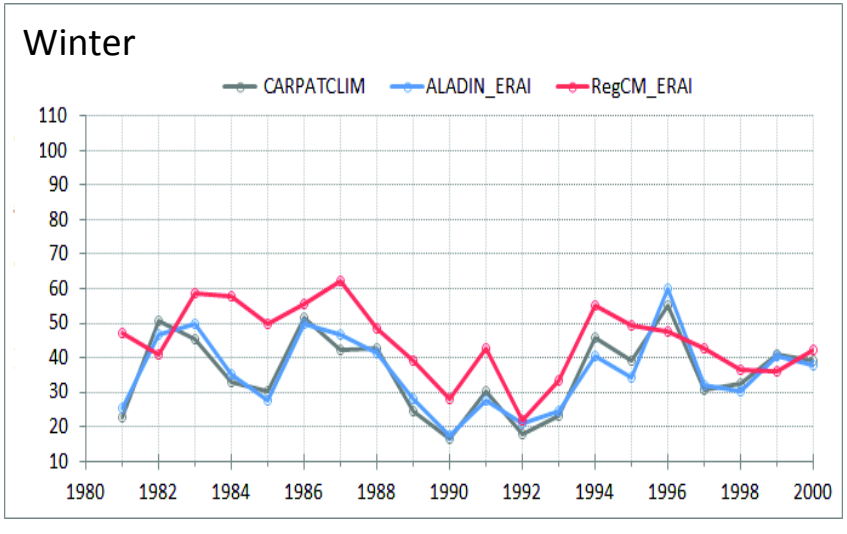
Summer



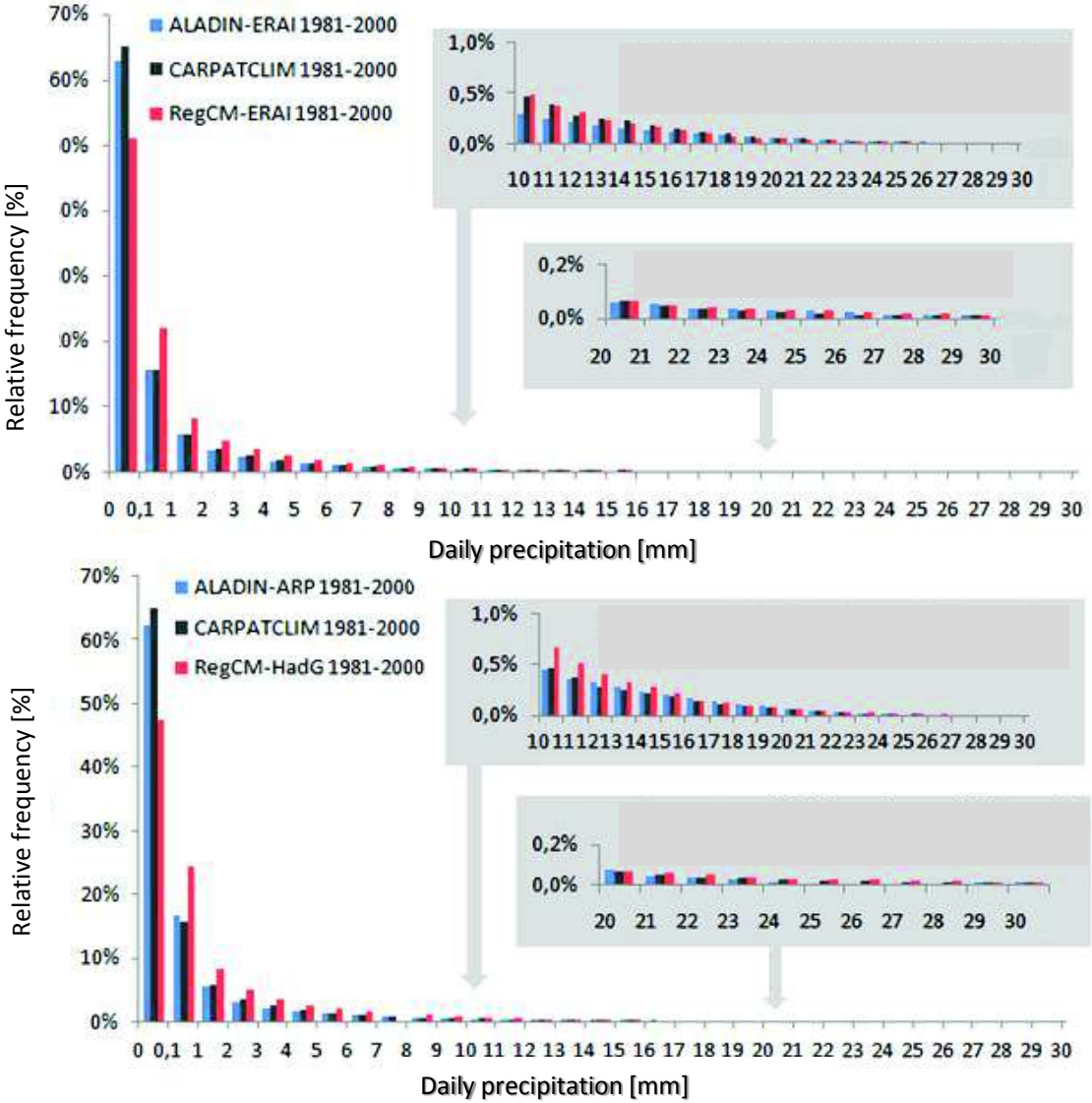
Autumn



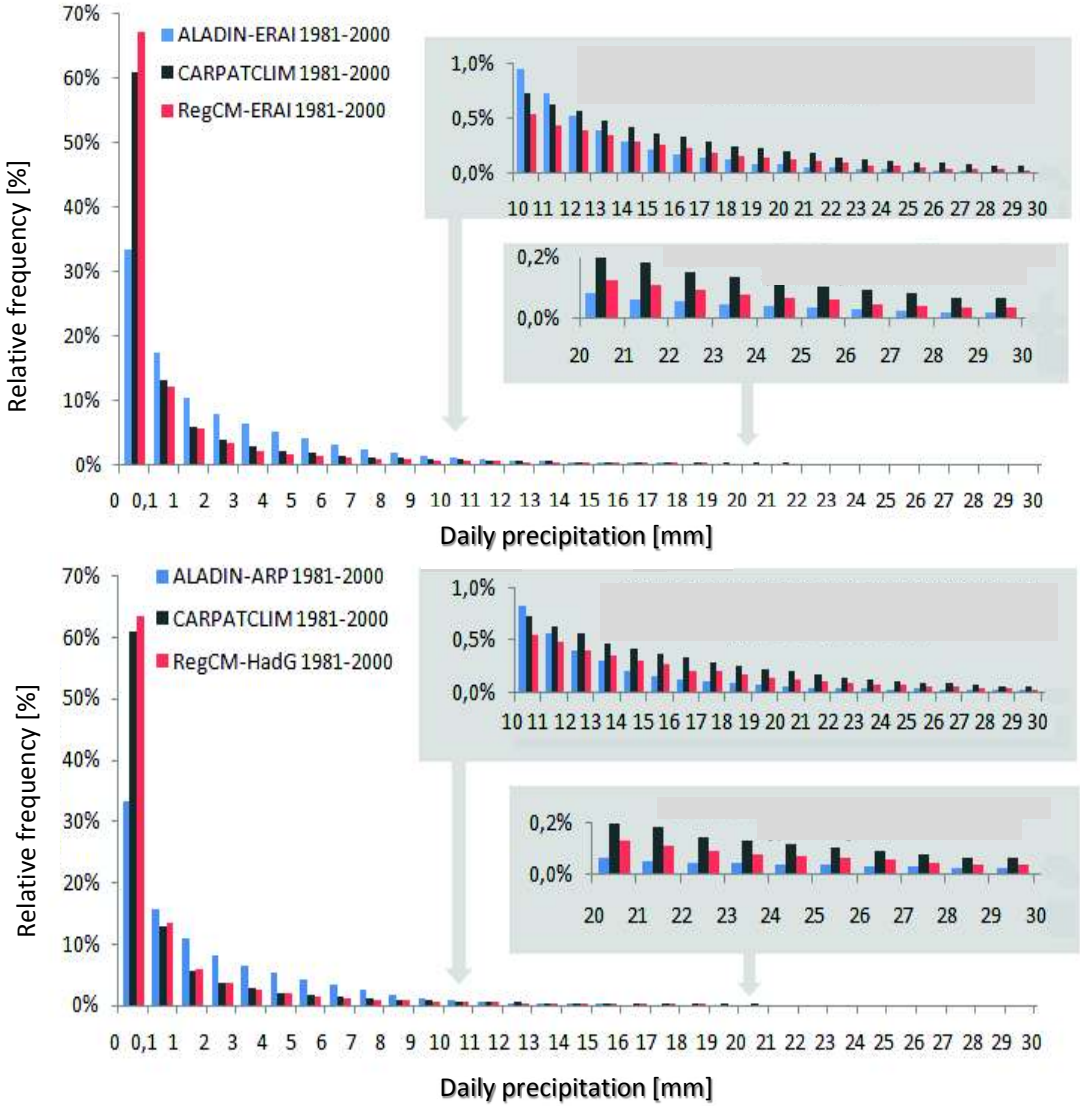
Winter



Results – precipitation (January)



Results – precipitation (July)



Summary

- Temperature:
  - ALADIN-Climate: underestimation (except in summer), 1–2 °C
  - RegCM: overestimation (highest in summer, 3 °C)
- Precipitation:
  - overestimation, except:
    - RegCM: summer
    - ALADIN: autumn, winter, W-Hungary
  - Overestimation not only in mean precipitation, but in the number of wet days and heavy precipitation days (except ALADIN in summer and autumn)
  - Underestimation of CDD
- Improved model performance since the first version of NAGiS
  - Decreased temperature bias (ALADIN, summer)
  - Better representation of intra-annual precipitation (RegCM)