

Validation of different regional climate models over the Carpathian Basin



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Motivation

A couple of years ago research activities had been started on regional climate modelling in Hungary in order to establish the modelling basis for climate dynamics analysis. Four regional climate models were adapted:

(i) the **ALADIN-Climate** model developed by Météo France on the basis of the internationally developed ALADIN modelling system (Spiridonov et al., 2005).

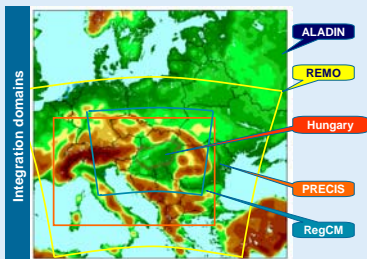
(ii) the **PRECIS** model developed by the Hadley Centre of the UK Met Office (Jones et al., 2004, Wilson et al., 2005).

(iii) the **RegCM** model originally developed at NCAR and available from the International Centre for Theoretical Physics in Trieste (Giorgi et al., 1993a, 1993b), and

(iv) the **REMO** model developed by the Max Planck Institute for Meteorology in Hamburg (Jacob and Podzun, 1997).

It is anticipated in Hungary that these models will be able to give realistic regional climate estimations for the next few decades particularly for the area of the Carpathian Basin (where one of the largest climate projection uncertainties can be found as it was already identified by several large international climate projects such as PRUDENCE for instance).

In order to test our regional climate models, simulations were accomplished covering the three decades of 1961–1990. The model domains include continental Europe with 25 km and 10 km horizontal resolution. The large-scale forcings for the regional model integrations were provided by the ERA40 re-analysis fields. The model results were evaluated with the CRU-dataset (Mitchell et al., 2004) over Europe and Hungary. The poster briefly summarises the first validation results of the four regional climate models.



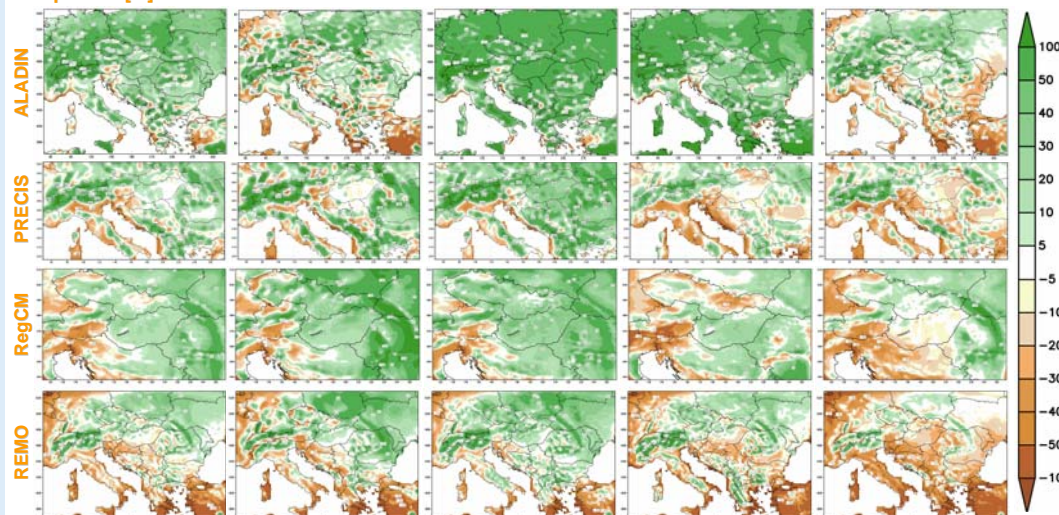
| Characteristics of the applied regional climate models | | | | |
|--|---------------------------------|--------------------------|-----------------------|--------------------------------------|
| Model | ALADIN-Climate V4.5 | PRECIS | RegCM3.1 | REMO5.0 |
| Horizontal derivatives | Spectral | Gridpoint | Gridpoint | Gridpoint |
| Plane geometry | Lambert-projection | Rotated spherical system | Lambert-projection | Rotated spherical system |
| Horizontal grid | Arakawa A | Arakawa B | Arakawa B | Arakawa C |
| Vertical coordinate system | Hybrid | Hybrid | Sigma | Hybrid |
| Hydrostatic assumption | Hydrostatic | Hydrostatic | Hydrostatic | Hydrostatic |
| Prognostic variables | $u, v, T, q_{\text{spec}}, P_s$ | u, v, θ, c_w, P_s | u, v, T, p_s | $u, v, T, q_{\text{spec}}, c_w, P_s$ |
| Temporal scheme | Semi-implicit + semi-Lagrangian | Explicit + Heun's scheme | Split-explicit scheme | Explicit leapfrog + semi-implicit |
| Treatment of LBCs | Davies | Davies | Davies & Turner | Davies |
| Radiation | Fouquart & Bonnel, Morcrette | Edwards & Slingo | Kiehl | Fouquart & Bonnel, Morcrette |
| Soil model | ISBA | MOSES | BATS | Warrilow |
| Number of soil layers | 4 (T_s), 2 (q_s) | 4 | 3 | 5 |
| Large scale precipitation and cloud | Smith, Ricard & Royer | Smith | Pal et al. | Sundquist, Roeckner |
| Convection | Bougeault | Gregory & Rowntree | Grell | Tiedtke, Nordeng |

| ERA-40 driven experiments | | | | |
|----------------------------------|-----------|-----------|-----------|-----------|
| | ALADIN | PRECIS | RegCM | REMO |
| Integration period | 1958–2000 | 1959–1990 | 1960–1990 | 1957–2000 |
| Horizontal resolution | 25 km | 25 km | 10 km | 25 km |
| Coupling frequency | 6h | 6h | 6h | 6h |
| Number of vertical levels | 31 | 19 | 18 | 20 |
| Time step | 15 min | 5 min | 1.5 min | 2 min |

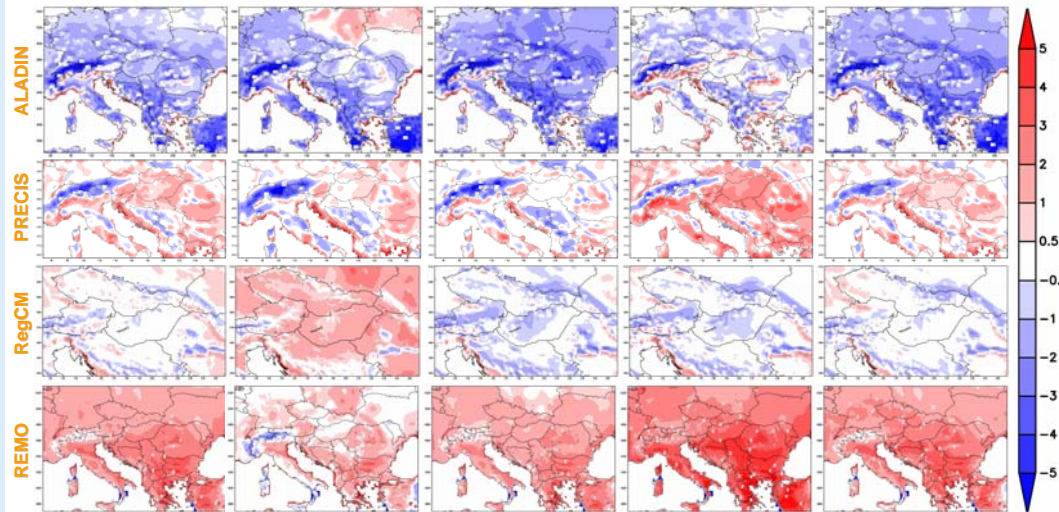
Mean differences with respect to the CRU1.2 dataset, period: 1961–1990

Annual Winter (DJF) Spring (MAM) Summer (JJA) Autumn (SON)

Precipitation [%]



Temperature [°C]



Mean differences: model–obs; reference: CRU1.2
Period: 1961–1990, area: Hungary

| | ALADIN | PRECIS | RegCM | REMO |
|---------------------|--------|--------|-------|------|
| Annual | 31 | 4 | 17 | -2 |
| Winter (DJF) | 12 | 0 | 30 | 9 |
| Spring (MAM) | 68 | 33 | 29 | -13 |
| Summer (JJA) | 33 | -4 | 13 | -8 |
| Autumn (SON) | 8 | -7 | 0 | -18 |
| Annual | -1.1 | 0.9 | 0.1 | 2.0 |
| Winter (DJF) | -0.7 | 0.5 | 1.3 | 0.5 |
| Spring (MAM) | -2.0 | 0.1 | -0.5 | -1.5 |
| Summer (JJA) | -0.3 | 2.2 | -0.4 | -3.4 |
| Autumn (SON) | -1.6 | 0.9 | -0.2 | -2.5 |

Conclusions

Precipitation:

- In general ALADIN and RegCM are too humid, while in fields of PRECIS and REMO a separation line can be noticed (isolating the too humid and too dry regions simulated by the models).

- Over Hungary REMO and PRECIS have the best annual performance (partly due to the compensation of positive errors in winter-spring and negative errors in summer-autumn), while ALADIN and RegCM are too humid in every season with the lowest relative differences in winter.

Temperature:

- In general ALADIN is too cold, while REMO is rather warm over the major part of the domain. RegCM as well as PRECIS underestimate the temperature over the highly elevated regions of Europe, however PRECIS is too warm over the Carpathian Basin.

- Over Hungary the temperature is most realistically simulated by RegCM with a slight positive bias (however its errors are mainly negative with the only exception of winter). ALADIN simulates too cold past climate with the largest differences in the transition seasons. Contrary to that PRECIS and REMO are too warm all over the year with highest errors in summer.

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Acknowledgements

These works were supported by the European Commission's 6th Framework Programme in the framework of CLAVIER project (contract number 037013), CECLIA project (contract number 037005), by the Hungarian National Office for Research and Technology (NKFP, grant No. 3A/052/2004), by the Hungarian National Science Research Foundation under grants T-049824 and the Hungarian Ministry of Environment and Water under the National Climate Strategy Development project.