PROJECTED CHANGES OF REGIONAL HEAT WAVES IN CENTRAL/EASTERN EUROPE USING CLIMATE MODEL SIMULATIONS

Rita PONGRÁCZ, Judit BARTHOLY, Enikő Boglár BARTHA, Orsolya TÖRÉK, Ildikó PIECZKA, Csaba TORMA

Department of Meteorology, Eötvös Loránd University, Pázmány st. 1/a, H-1117 Budapest, Hungary. E-mails: prita@nimbus.elte.hu, bari@ludens.elte.hu

SUMMARY OF REGCM

Regional climate model RegCM stems from the National Center for Atmospheric Research/Pennsylvania State University (NCAR/PSU) Mesoscale Model version MM4 (Dickinson et al., 1989; Giorgi, 1989). It is a 3-dimensional, sigma-coordinate, primitive model. It was originally developed by Giorgi et al. (1993a, 1993b) and later modified and improved by Giorgi and Mearns (1999) and Pal et al. (2000). The latest version of this model is RegCM3.1. Currently it is available from the ICTP (International Centre for Theoretical Physics), and detailed information can be found at: http://users.ictp.it/~pubregcm/RegCM3/

Aim: national/regional impacts of climate change (sensitivity analysis, adaptation possibilities)
Installation of RegCM at the Eötvös Loránd University - started in 2008.
Model domain: Central/Eastern Europe, with the center at 47.5°N, 18.5°E, containing 120×100 gridpoints
Target domain: Carpathian basin, SW corner at 45.15°N 13.35°E, NE corner at 49.75° 23.55°E
Applied spatial resolution: 10 km (horizontal)
Number of vertical levels: 18 (14 and 23 also possible)
Applied temporal resolution: 30 second dt
Initial and lateral boundary conditions: ECHAM5 GCM (1.25°) driven RegCM (25 km)
Control run: 1951-1990
Scenario: SRES A1B (estimated CO_2 level by 2050: 532 ppm, by 2100: 717 ppm based on Nakicenovic & Swart, 2000) for 2021-2050 and 2071-2100

Applied model domain and topography (m) for the Central/Eastern European climate simulations
Horizontal resolution: 10 km

SUMMARY OF PRECIS

PRECIS: Providing REgional Climates for Impact Studies. It is applicable for all region of the world. Applied version: 1.8
Aim: national/regional impacts of climate change
Description of PRECIS: Jones et al., 2004; Wilson et al., 2007
Installation of PRECIS at the Eötvös Loránd University - started in 2003
Target region: 123 × 96 gridpoint (Central Europe)
Region of interests: 56 × 30 gridpoint (Carpathian Basin)
Applied spatial resolution: 25 km (horizontal)
Number of vertical levels: 19 (using σ coordinates)
Applied temporal resolution: 5 minutes
Initial and lateral boundary conditions: HadCM3 (UK MetOffice, Gordon et al., 2000)
Control run: 1961-1990
Integration period including the scenario: SRES A1B. for 1951-2100

Applied model domain and topography (m) for the Central/Eastern European climate simulations
Horizontal resolution: 25 km

Region of interest

HEAT WAVES

There is no standardized definition of a heat wave. The existing definitions generally refer to a definite period of time, during which the air temperature is above a threshold. This threshold varies geographically. The WMO-recommended definition is the following: heat wave is considered the period when the daily maximum temperature for more than five consecutive days exceeds the 1961-1990 average daily maximum temperature by 5°C. In 2004, a Heat Health Watch Warning System was developed in Hungary to anticipate heat waves that may result in a large excess of mortality. The system was developed on the basis of a retrospective analysis of mortality and meteorological data (Páldy et al., 2005). In Hungary, three levels of heat wave warning are applied. They are associated to the daily mean temperature values.

HEAT WAVE WARNING LEVELS APPLIED IN HUNGARY

Heat Wave Warning Levels	Criteria	Preventive actions
Level 1 Advisory signal Internal use	The forecasted daily mean temperature (T_{mean}) exceeds 25 °C	The emergency services prepare for the expected increase in patient traffic
Level 2 Warning signal Alert the public	The forecasted daily mean temperature (T_{mean}) exceeds 25 °C on at least 3 consecutive days	– Media Communications (TV, radio), Web site and newsletters, flyers – Telephone emergency service – Water, Fansharing – Air conditioned rooms opening – Water/Electric Works suspend the cut-off of not paying
Level 3 Alarm signal	The forecasted daily mean temperature (T_{mean}) exceeds 27 °C on at least 3 consecutive days	Strict control of the actions taken at Level 2

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Part I. Summary of RegCM results

HEAT WAVE WARNING – LEVEL 1

(T_{mean} > 25 °C)

• Zonal structure: from North to South the number of heat warning cases is increasing and the projected changes are also increasing
• Simulated changes are larger for 2071-2100 than for 2021-2050

• By the end of the 21st century heat warning level 1 is possible from late-May until early-September, unlike in the reference period (when it occurred from mid-June until mid-August) – thus, the total length of the possible occurrence is likely to extend by about a month.
• Zonal structure can be identified

HEAT WAVE WARNING – LEVEL 2

($T_{mean,3 days}$ > 25 °C)

• Zonal structure: from North to South the number of heat warning cases is increasing and the projected changes are also increasing
• The occurrence simulated in 2071-2100 may be four times larger than in 1961-1990 (especially, in the southern regions)

• The start of the heat wave warning season is simulated to occur 1-1.2 week(s) earlier by 2021-2050 / 2071-2100
• The end of the heat wave warning season is projected to not shift by 2021-2050, and to shift with 2-2.5 weeks by 2071-2100
• Simulated changes are larger for 2071-2100 than for 2021-2050

HEAT WAVE WARNING – LEVEL 3

($T_{mean,3 days}$ > 27 °C)

• Zonal structure: from North to South the number of heat warning cases is increasing and the projected changes are also increasing
• In 1961-1990 heat warnings of level 3 are present only at the southern border of the country, however, by the end of the 21st century they are possible almost all over the country

• Zonal structure can be identified with special distribution in the hilly subregions (in 1961-1990 only 1 case occurred over those regions – at day 178 [the end of June], which affects the geographical distribution)
• Simulated changes are larger for 2071-2100 than for 2021-2050

Summary of the grid point values for the simulation time slices

• 977 grid points are located within Hungary, the table summarizes the main statistical characteristics of the values
• By the end of the 21st century heat warning level 2 has similar frequency as the heat warning level 1 in the reference period
• Simulated changes are much larger for 2071-2100 than for 2021-2050

• By the end of the 21st century the average first occurrence of the heat warning days is simulated to shift earlier, and the average last occurrence later, than in the reference period – thus the length of the heat wave season is projected to become remarkably larger.
• Simulated changes are larger for 2071-2100 than for 2021-2050

Part II. Summary of PRECIS results

HEAT WAVE WARNING – LEVEL 1

(T_{mean} > 25 °C)

• Zonal structure: from North to South the number of heat warning cases is increasing and the projected changes are also increasing
• Simulated changes are larger for 2071-2100 than for 2021-2050

• By the end of the 21st century heat warning level 1 is possible from late-May until late-September, unlike in the reference period (when it occurred from mid-June until mid-August mid-September) – thus, the total length of the possible occurrence is likely to extend by about a month.
• Zonal structure can be identified

HEAT WAVE WARNING – LEVEL 2

($T_{mean,3 days}$ > 25 °C)

• Zonal structure: from North to South the number of heat warning cases is increasing and the projected changes are also increasing
• The occurrence simulated in 2071-2100 may be two times longer than in 1961-1990 (especially, in the southern regions)

• The start of the heat wave warning season is simulated to occur 3 weeks earlier by 2021-2050 and the projected changes are also increasing
• The end of the heat wave warning season is projected to shift with 1 week by 2021-2050, and with 3 weeks by 2071-2100
• Simulated changes are larger for 2071-2100 than for 2021-2050

HEAT WAVE WARNING – LEVEL 3

($T_{mean,3 days}$ > 27 °C)

• Zonal structure: from North to South the number of heat warning cases is increasing and the projected changes are also increasing
• By the end of the 21st century heat waves will be a more common feature of the Central/Eastern European climate than in the 20th century

• The start of the heat wave warning season is simulated to occur 2 and 3.5 week earlier by 2021-2050 and by 2071-2100, respectively
• The end of the heat wave warning season is projected to shift with 1 week by 2021-2050, and with 3 weeks by 2071-2100
• Simulated changes are larger for 2071-2100 than for 2021-2050

Summary of the grid point values for the simulation time slices

• 228 grid points are located within Hungary, the table summarizes the main statistical characteristics of the values
• By the end of the 21st century heat warning level 3 has even larger frequency as the heat warning level 1 in the reference period
• Simulated changes are much larger for 2071-2100 than for 2021-2050

• By the end of the 21st century the average first occurrence of the heat warning days is simulated to shift earlier and the average last occurrence later than in the reference period – thus the length of the heat wave season is projected to become remarkably larger.
• Simulated changes are larger for 2071-2100 than for 2021-2050