Difficulties in selecting the most appropriate model setup of RegCM for the Pannonian region with a special focus on precipitation

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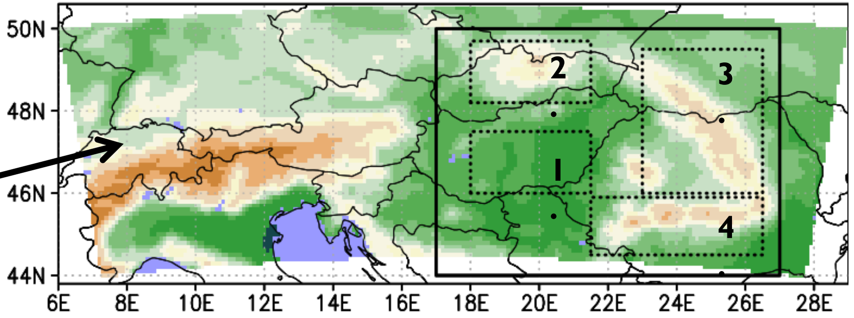
Introduction

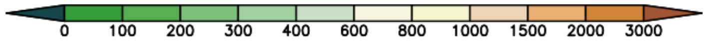
- The Pannonian Basin is surrounded by the Carpathian Mountains and orographic differences are present within the basin itself
- Precipitation is one of the most important climatic variables, it depends on:
  - Cloud microphysics
  - Cumulus convection
  - Large-scale circulation
  - Planetary boundary layer processes
  - Orography
- The main goal is to improve the reconstruction of the historical regional precipitation characteristics for the Pannonian region
- In this study RegCM4.5 and RegCM4.6 are used to compare different approaches (hydrostatic and non-hydrostatic) and parameterizations (SUBEX and NogTom - new microphysics scheme)

Our domain

http://www.cordex.org/domains/region-12-mediterranean/



The topography of the RegCM domain (m)



Validation is shown for the eastern half of the RegCM integration domain covering the CarpatClim domain (indicated by solid black rectangle on the map)

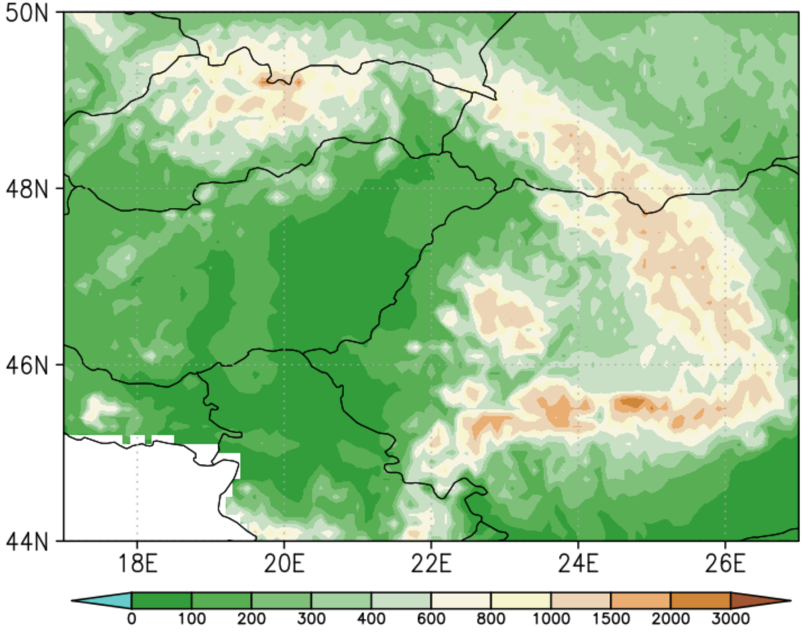
In addition four subregions were selected for more detailed validation:

1. Great Hungarian Plain
2. Tatra mountain
3. North-eastern part of Carpathian region
4. Southern part of Carpathian region

Description of validation data: CarpatClim

- **Timeframe**
  - 1961-2010
- **Spatial range**
  - Gridded climatological datasets cover the area between latitudes 44°N and 50°N, and longitudes 17°E and 27°E
- **Temporal resolution:**
  - 1 day
- **Spatial resolution**
  - 0.1° x 0.1°
- **Data**
  - Precipitation, temperature

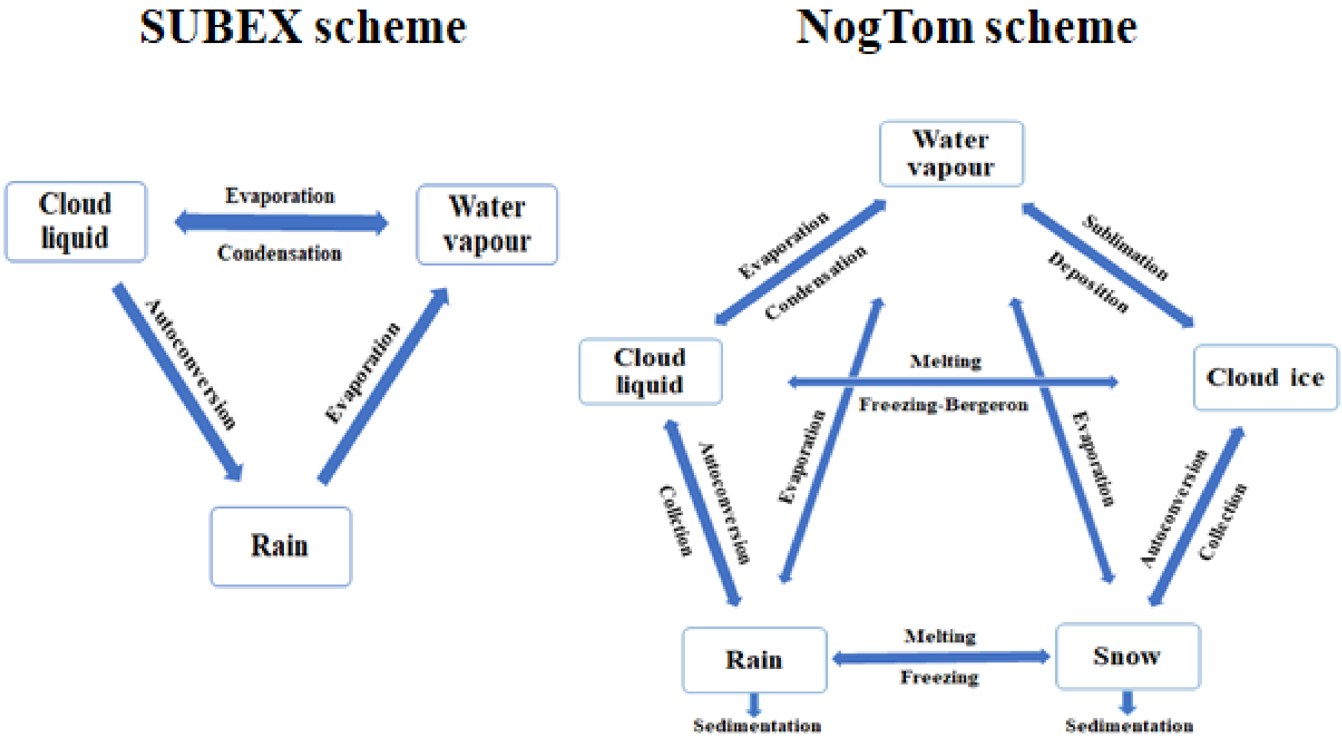
CarpatClim domain



RegCM4.5 and 4.6 simulations

4+4 si

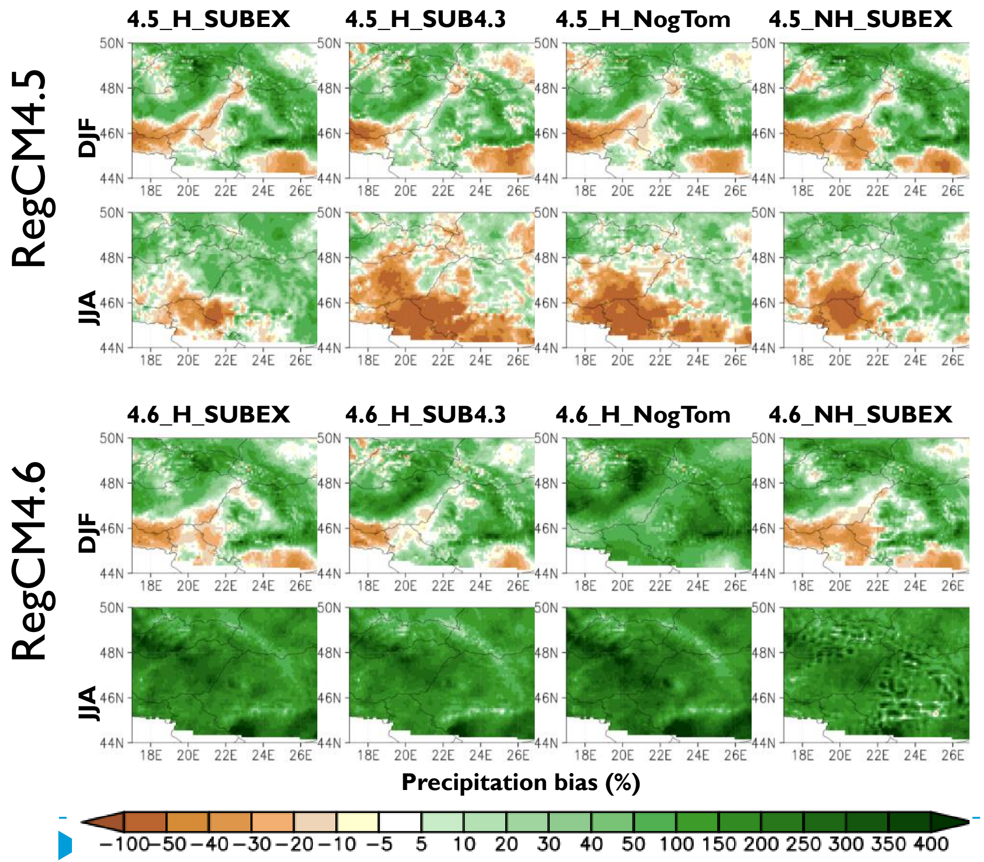
Name	ive n (CP)	Closure
H_SUBEX	/ Grell	FC
H_NogTom	/ Grell	FC
H_SUB4.3	/ Grell	FC
NH_SUBEX	/ Grell	FC



UBEX
0.0005
$\text{g} \cdot \text{m}^{-2} \cdot \text{s}^{-1})^{-1/2} \cdot \text{s}^{-1}$
$^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-1}$

Torma et

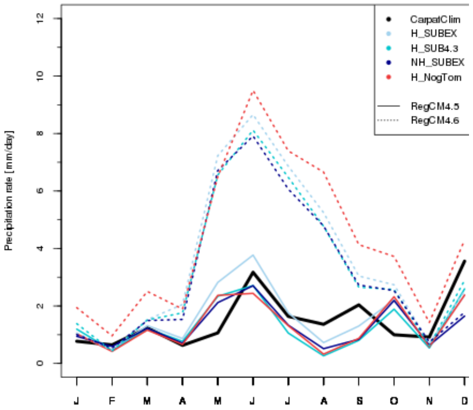
Results – precipitation (1981)

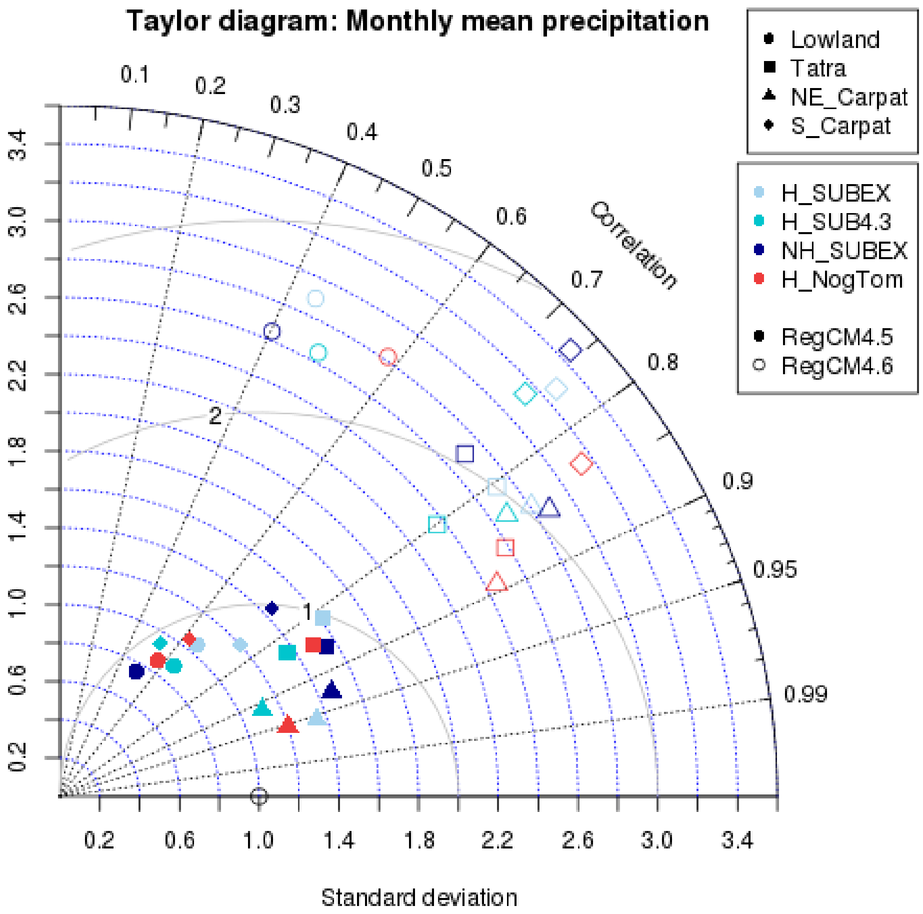


- Seasonal mean errors
- 4.5: precipitation is overestimated over the Carpathians by ~50%
- 4.5: underestimation over lowland in summer
- 4.6: overestimations (~200%)
- 4.6_NH_SUBEX – precipitation pattern

Results – m   n (1981)

Lowland





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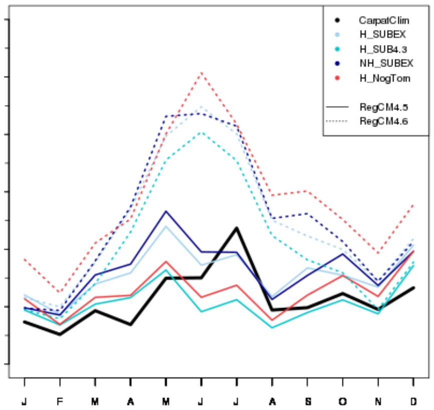
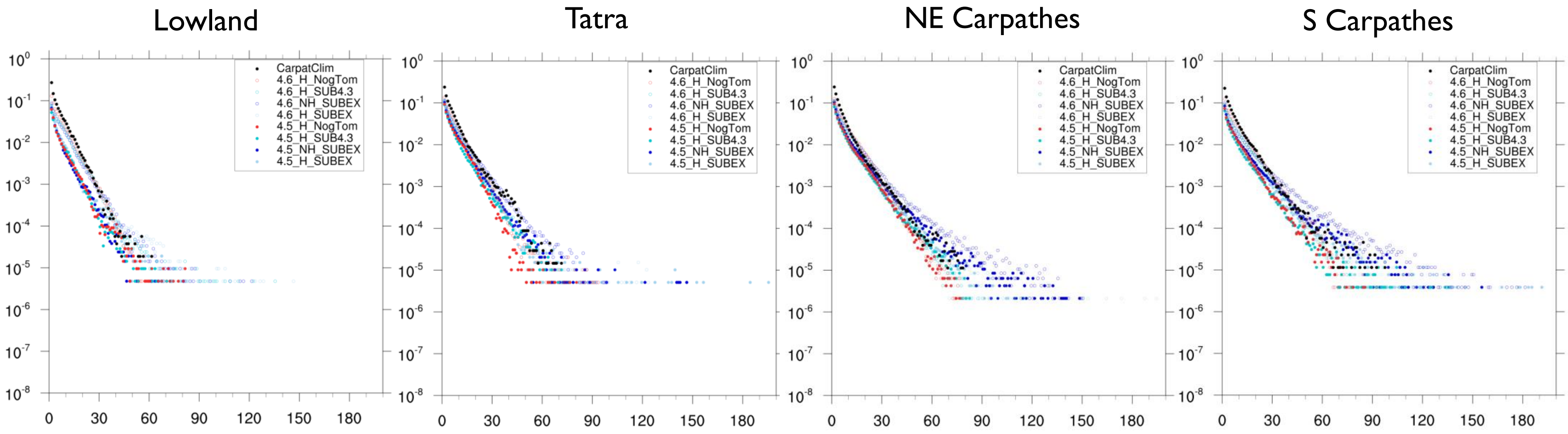


- Both versions overesti
precipitation over mou
- Differences between m
versions are larger ove
lowland than over mou
areas

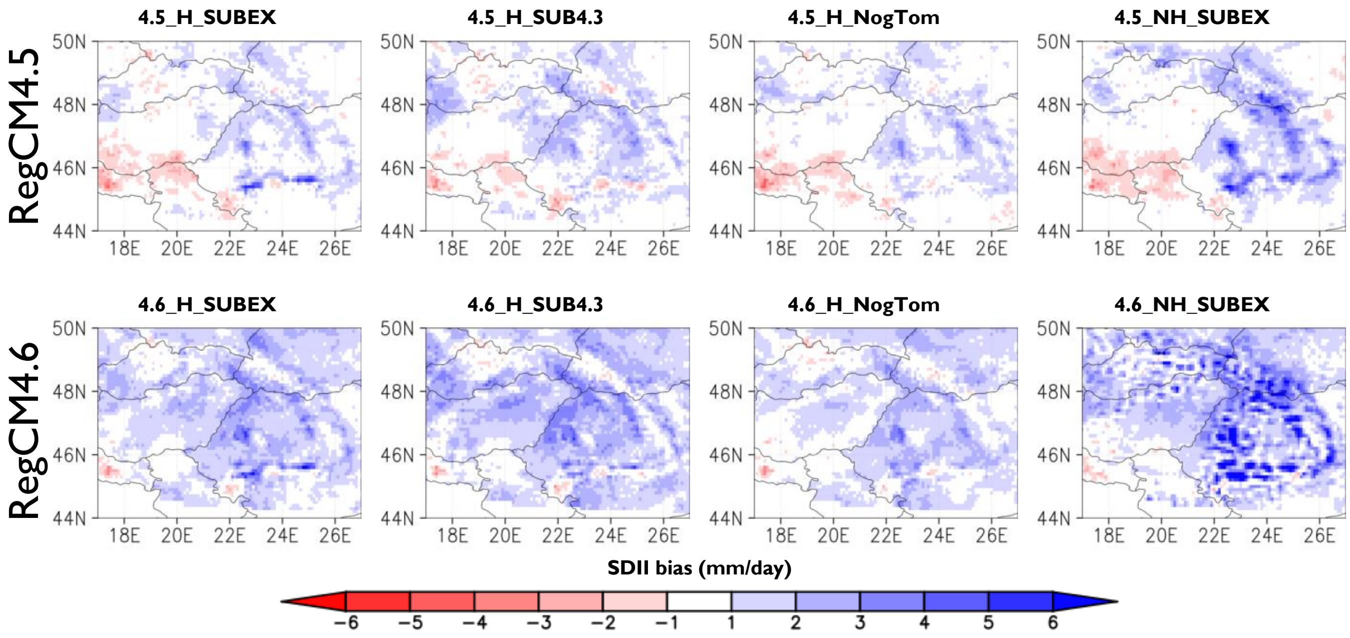
6: large overestimation
summer
6: H_SUB4.3 seems to
„the best"

Daily precipitation intensity: empirical probability distribution functions (PDFs)



- Frequency versus intensity of daily precipitation events (1981)
- 4.5_H_NogTom underestimates the intensity
- RegCM4.6 simulations capture better the occurrence of light events
- But they overestimate the medium and the high-intensity events

Results – Simple daily intensity index bias (1981)



SDII

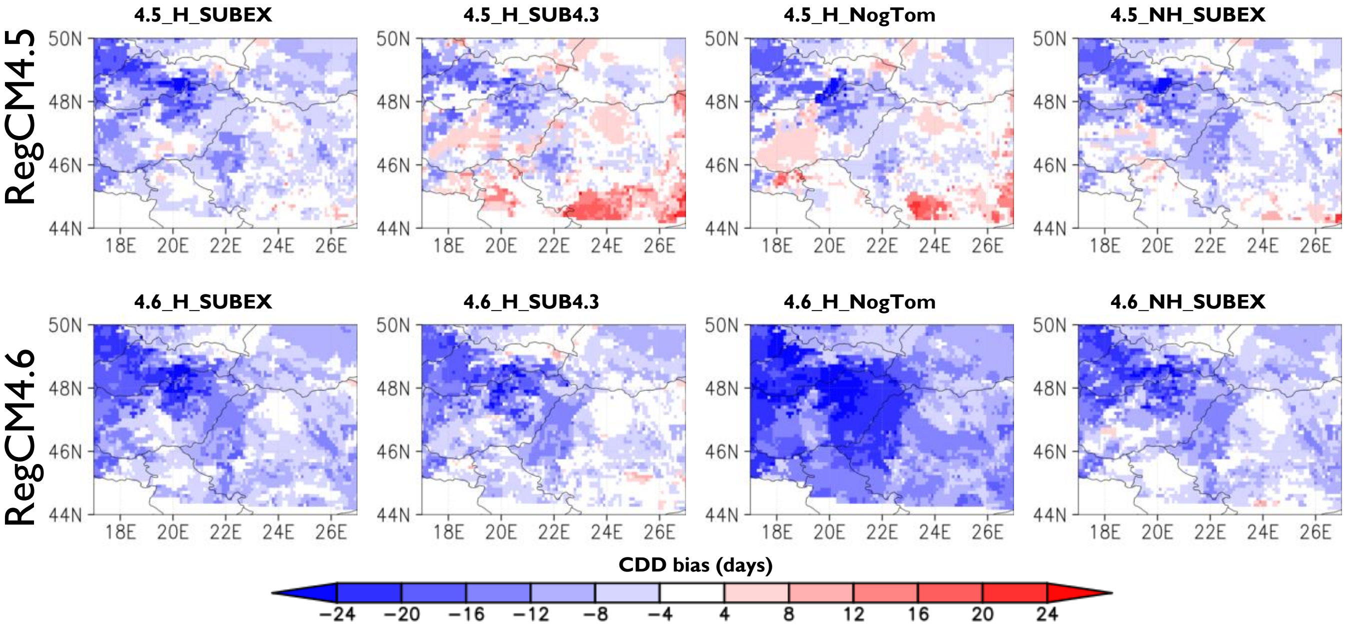
- *Simple daily intensity index (mm/wet day)*

Let RR_{wj} be the daily precipitation amount for wet day w ($RR \geq 1.0$ mm) of period j. Then the mean precipitation amount at wet days is given by:

$$SDII_j = \sum_{w=1}^{W} RR_{wj} \Big/ W$$

- RegCM4.5: negative values in the SW region
- RegCM4.6: higher positive biases occur
- NH dynamic produces higher intensity over Carpathian Mountains

Results – Consecutive dry days bias (1981)



CDD

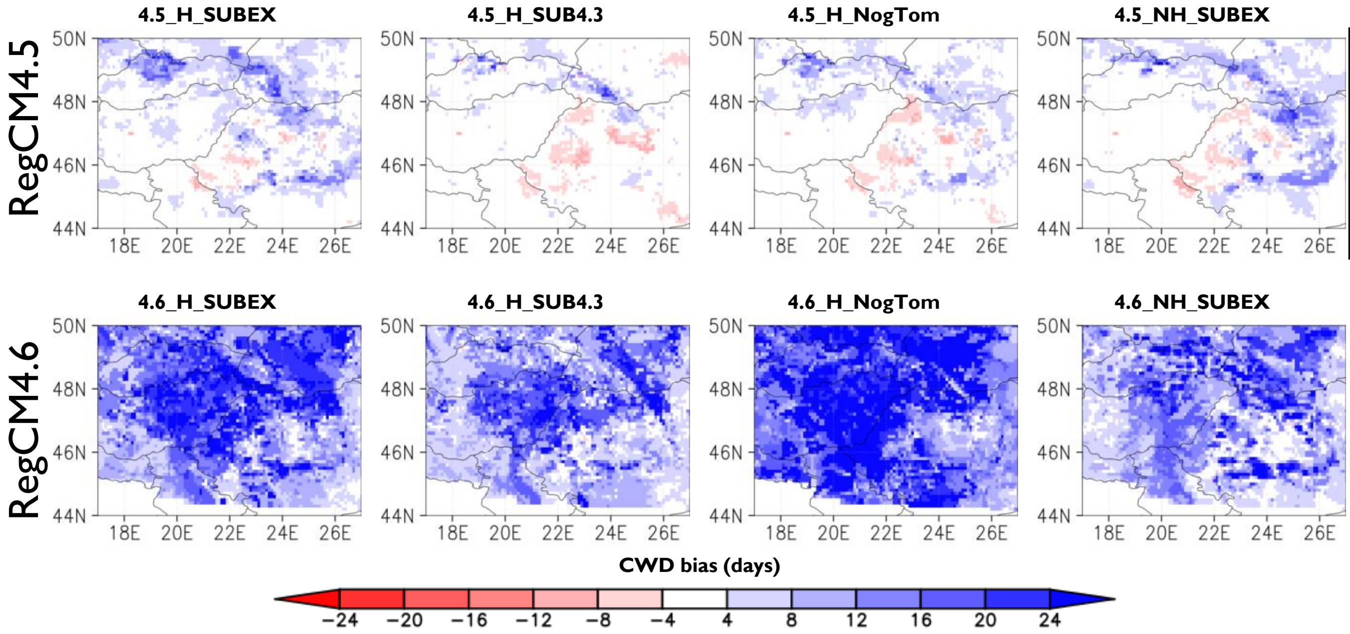
- *Maximum no of consecutive dry days (RR < 1 mm) (days)*

Let RR_{ij} be the daily precipitation amount for day i of period j. Then counted is the largest no of consecutive days where:

$$RR_{ij} < 1\ mm$$

- RegCM4.5 simulations: higher positive biases of CDD are over lowland and SE region
- RegCM4.6: underestimations (biggest with the new microphysics scheme)

Results – Consecutive wet days bias (1981)



CWD

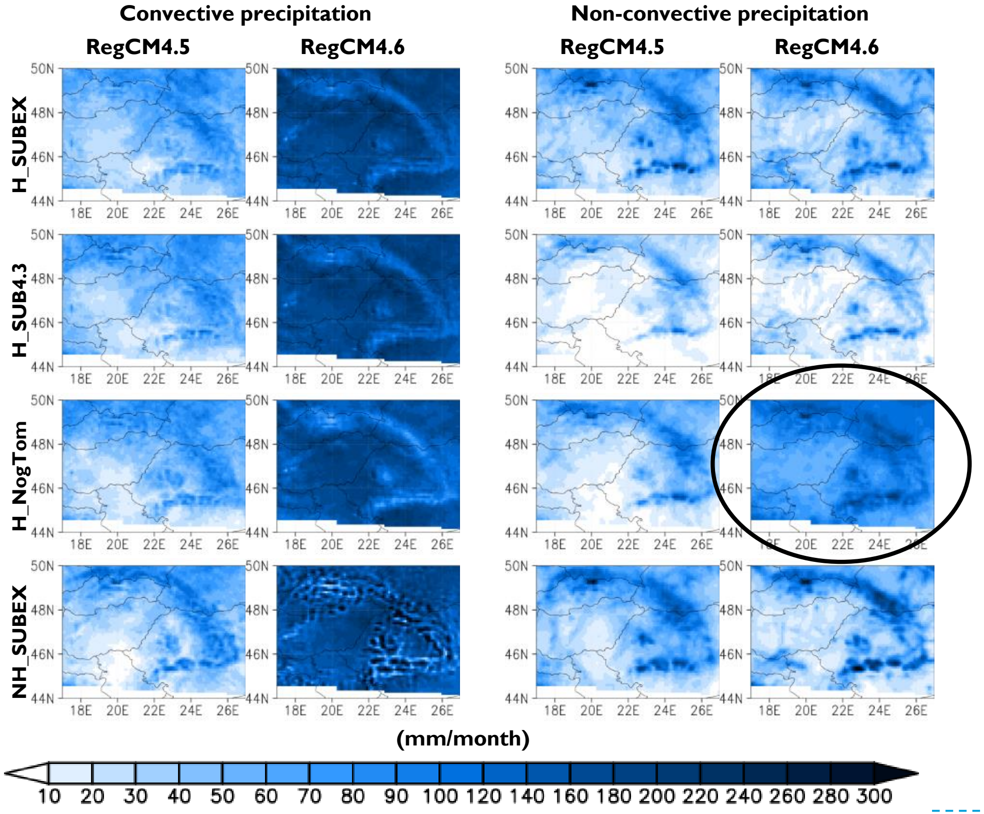
- *Maximum no of consecutive wet days (RR ≥ 1 mm) (days)*

Let RR_{ij} be the daily precipitation amount for day *i* of period *j*. Then counted is the largest no of consecutive days where:

$RR_{ij} \geq 1\ mm$

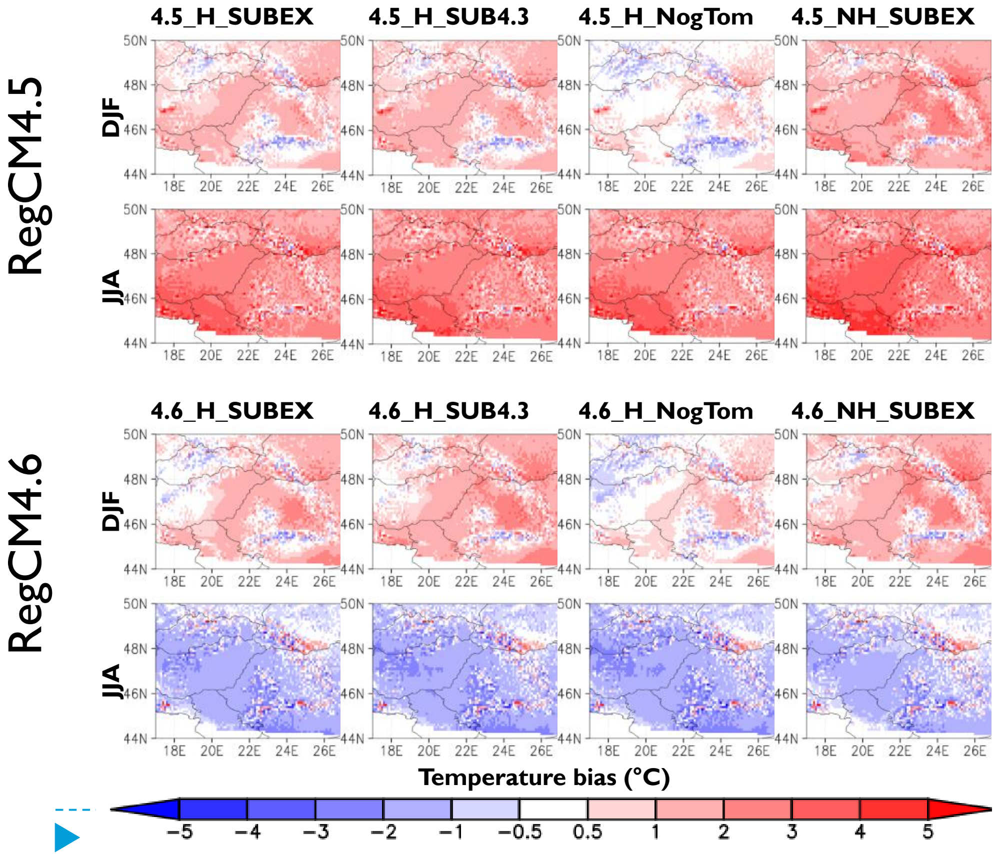
- 4.5: overestimation over the Carpathian Mountain (8-12 days)
- 4.6: substantial overestimation of CWD (more than 20 days)

Convective and non-convective precipitation - JJA



- Convective precipitation
  - more convective precipitation with RegCM4.6
  - 4.5: higher values over mountainous areas
  - 4.6: higher values over lowlands
- Non-convective precipitation
  - the differences between the model versions are bigger with the new microphysics scheme

Results – temperature (1981)



- 4.5: Lake Balaton appears in winter
- 4.5: temperature bias for summer is around 3 °C
- Seasonal mean errors change within short distances in mountains
- 4.5: H_NogTom reproduces the average temperature better in winter
- 4.6: negative bias could be related to the overestimation of precipitation

Summary

- High-resolution (10 km) experiments of the RegCM4.5 and RegCM4.6 for 1981 over the Pannonian region
- Precipitation
  - Positive precipitation biases over the Carpathian Mountains
  - Negative biases appear over the lower elevated regions with RegCM4.5
  - SDII: the highest overestimation with NH core (dynamic + conv. parametrization)
  - CWD: the highest bias with 4.6_H_NogTom
  - Convective precipitation values are high in RegCM4.6
- Temperature
  - RegCM4.6 underestimates the temperature in summer (due to the overestimation of precipitation)
- RegCM4.6 produces wetter and cooler climate than RegCM4.5

Future plans

- Understanding the interactions bet
  parameterization schem
- Tuning – find ... gion
  - (e.g. Tiedtke)
  - Land Model)
  - permitting simulations
- Newer versions: RegCM4.7

Thank you for your attention!

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