First steps with convection-permitting regional climate modelling at the Hungarian Meteorological Service
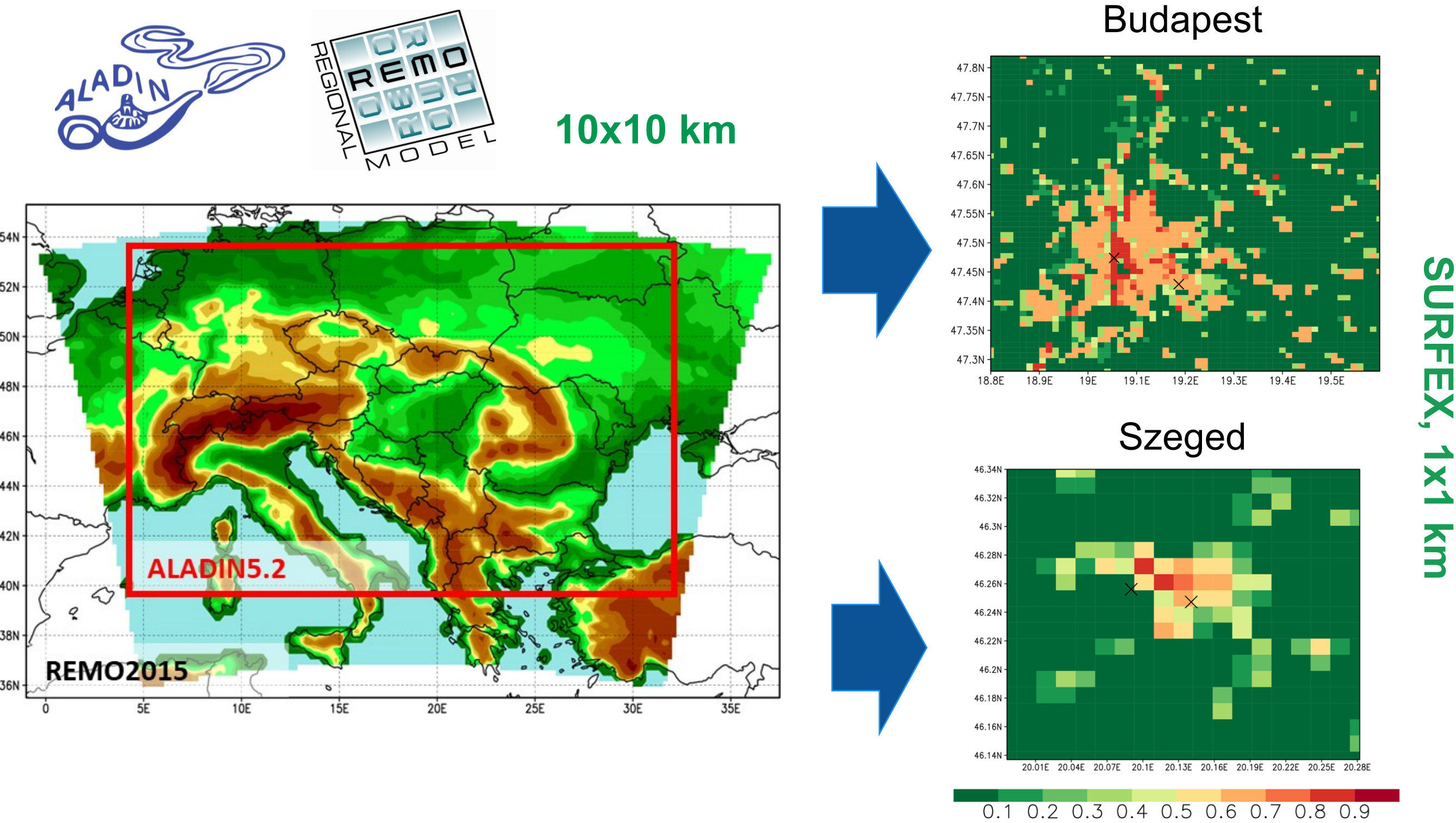
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Activities of the RCM Group

1. Climate **modelling** using 2 adapted RCMs + surface model

10x10 km

Budapest

Szeged

SURFEX, 1x1 km

ALADIN5.2

REMO2015

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

2. **Data and information services** based on national and European RCM results

Selected results of ALADIN, REMO and SURFEX are available in the **KLIMADAT** GIS database

https://klimadat.met.hu/

- open access
- homogenized observations + projections
- 1-10 km resolution gridpoint data, NUTS3 and LAU1 level
- maps, graphs and data for 1971–2100
- bias-adjustment
- representation of uncertainties

3. **User engagements** and outreach activities

Tailored data provision from **EURO-CORDEX**	HadGEM2-ES	EC-EARTH
CCLM-4-8-17	x	x
RACMO 22E	x	x
RCA4	x	x

x 2 RCP scenarios (RCP4.5, RCP8.5)
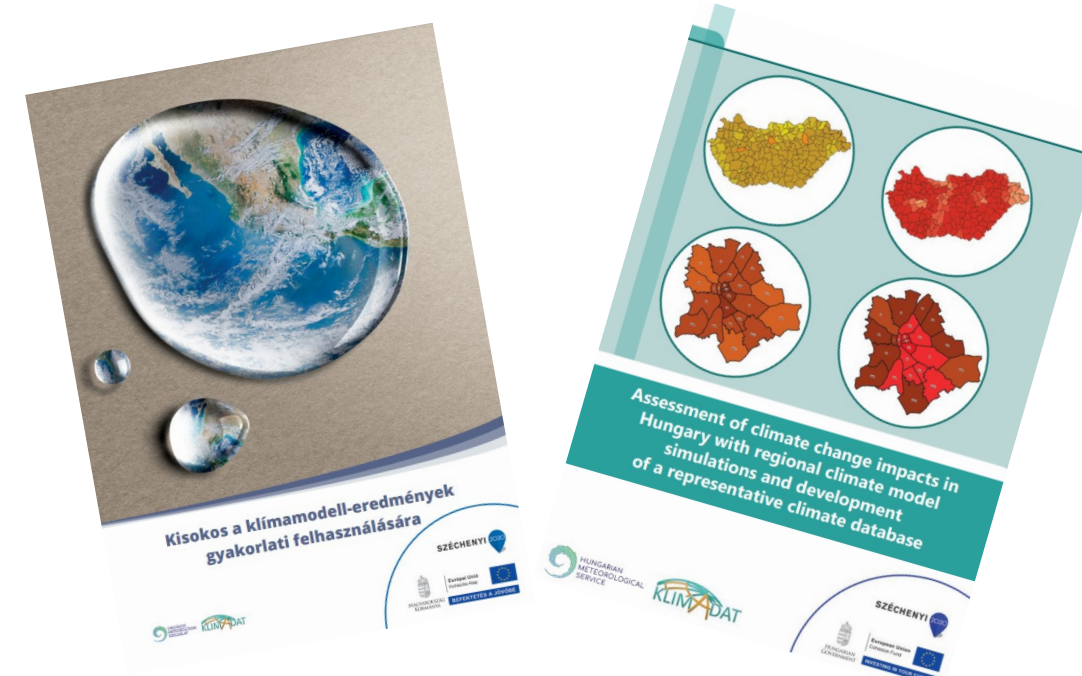
Motivation

10 km horizontal resolution regional climate model outputs **do not provide** proper **information about the sub-daily and local** precipitation characteristics, which is important for certain impact assessments, such as urban planning and infrastructure development.

To address these needs, we have started to adapt a non-hydrostatic, **convection-permitting** climate model.

The Harmonie-Climate (**HCLIM**) regional climate model has RCM (HCLIM-ALADIN → hydrostatic) and **CP-RCM** (HCLIM-AROME → non-hydrostatic) configurations

Using the configuration HCLIM-AROME, it is possible to run climate simulations with a horizontal resolution of a few km and to describe sub-daily and local precipitation patterns in more detail.

About HCLIM

- Harmonie is a non-hydrostatic, convection permitting LAM NWP model
  - Developed by the HIRLAM and ACCORD NWP consortia
- **HCLIM: Harmonie for climate applications** → similar to NWP HARMONIE, but:
  - Long, continuous runs
  - No data assimilation
  - Update SST/SIC
  - Multiple lateral boundary conditions
  - Some modified or new parameterisations
  - GRIB, NetCDF outputs
- HCLIM is developed by the HCLIM consortium
- ecFlow workflow manager is used
- OMSZ has joined in 2022

Steps of running HCLIM

1. Get the code
- From Github
- Download inputs for **climate file generation**
- Download GHG and irradiance files
- Download ERA5 data as LBC from MARS catalogue

Climate input files
- Climate and physiography data for atmospheric climate generation (E923)
- Physiography data for SURFEX (PGD)
- Digital elevation model from UGS: GMTED2010
- Soil type data from SOILGRIDS
- ECOCLIMAP second generation (SG)

2. Setup
- Compilation with MAKEUP system in stand-alone fashion
- Configure the environment, tailor it to our **local machine**

Local computer system
- HPE Apollo 6000 server
- 10 nodes x 2 CPU x 20 cores
- 2.2 GHz Intel XeonE5-2698 processors
- 128 GB RAM/node

**3. Configure experiment**

Model version: cy43hc2 (HCLIM43)

Main settings:
- LBC and coupling interval: ERA5, 3h
- Vertical levels: 65
- Surface: SURFEX v8.1
- Land surface parameters: ECOCLIMAP2.5_plus
- Lake parameterisation: FLAKE
- Orography: GMTED2010
- Soil type database: SOILGRID
- Tegen aerosol climatology
- GHG climatology (based on IFS Cycle 47R1)

HMS_HCLIM_10
- Horizontal resolution: 10 km
- Dynamics: hydrostatic
- Physics: ALADIN

HMS_HCLIM_2.5
- Horizontal resolution: 2.5 km
- Dynamics: non-hydrostatic
- Physics: AROME

Szintai, B.
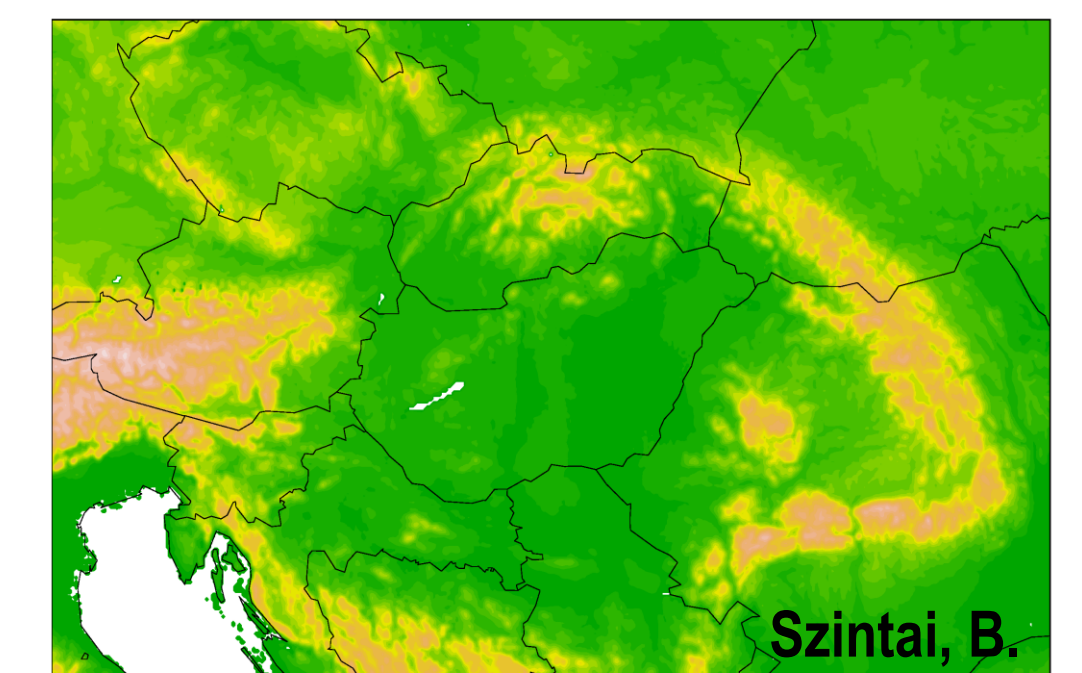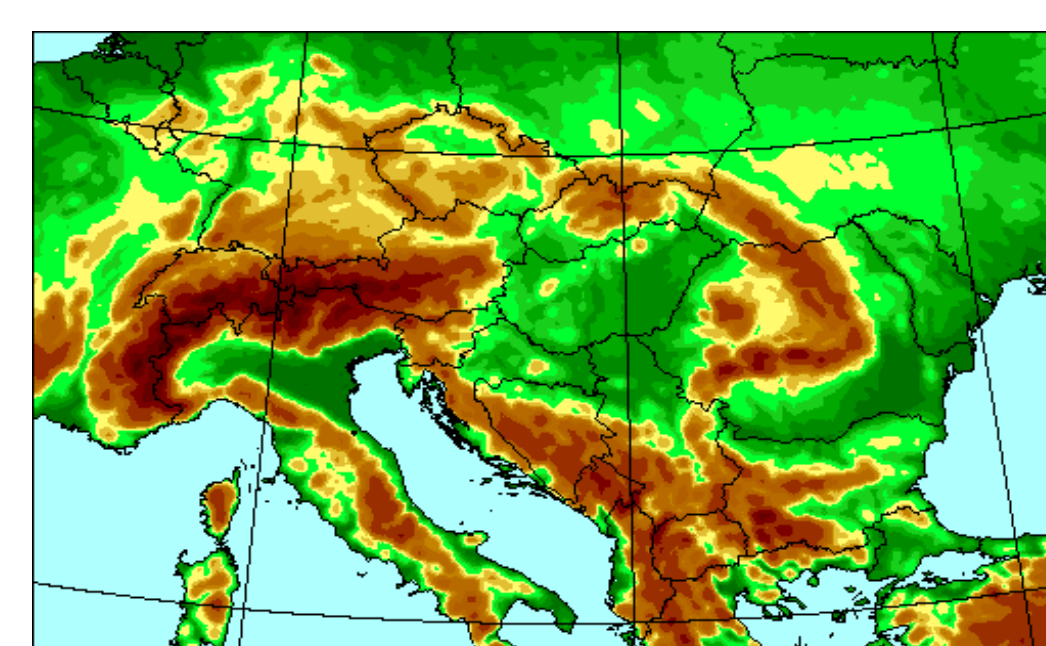
4. Start HCLIM

Test the compiled binaries and the environmental setting
- Monthly climate and SURFEX physiography file generation is included in the running process → Climate family
- Many errors occurred in Climate family which have already been fixed → local climate file generation is possible
- Error in the Boundaries family with our ERA5 files downloaded by MARS request over Europe → fixed, local LBC forcing file generation is possible
- Integration aborted

Plans

- After fixing any installation-related errors, the model results are planned to be **tested first over two past periods**:
  - HMS_HCLIM_10 for 1999: compare with our own ALADIN5.2 results driven by ERA-Interim
  - HMS_HCLIM_2.5 for 1999: study the impact of physics and resolution
  - HMS_HCLIM_2.5 for 2019: compare with test results provided by HCLIM colleagues
- The 2.5 km domain marked for CP modelling is the domain of the operational OMSZ AROME NWP. This will be tested as a first step, but **other domains may be considered** depending on computational capacity and results → **sensitivity study**
- **Evaluation for a longer** (5-10 years) **historical period** with focus on Hungary and precipitation.
- Long-term plan: produce CP **projection** simulations.
- The results will contribute to the Evaluation of HCLIM43 task of the HCLIM consortium.

Acknowledgements