Supporting users to implement uncertainty of climate change information in adaptation studies

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KLIMADAT
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INVESTING IN YOUR FUTURE

OUTLINE

1. Introduction:
   a) Climate models and their uncertainties
   b) Climate model data in action: its use in adaptation and mitigation measures (climate services)

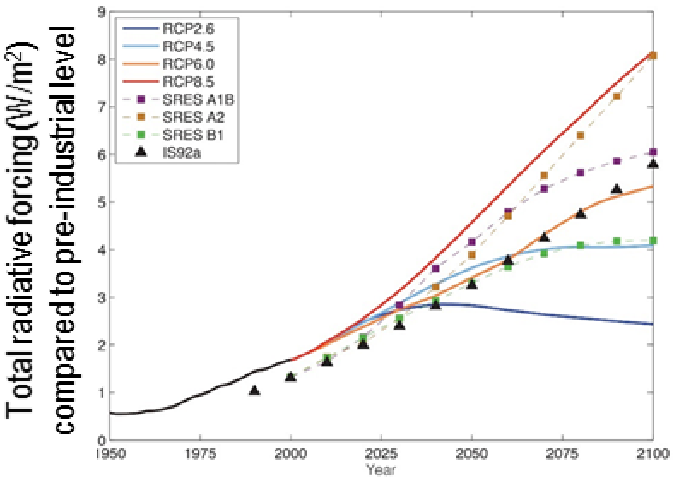
2. The KlimAdat project and its communication and education pillar

3. Guidance on how to use uncertainty information of climate model

4. Summary

THE BASIS OF CLIMATE MODELLING

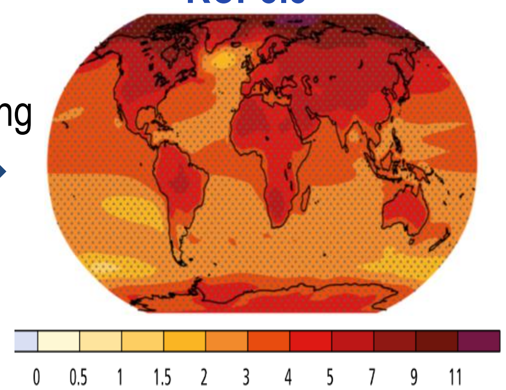
Anthropogenic scenarios



Forcing

GCM projection: Temperature change [°C] by 2100

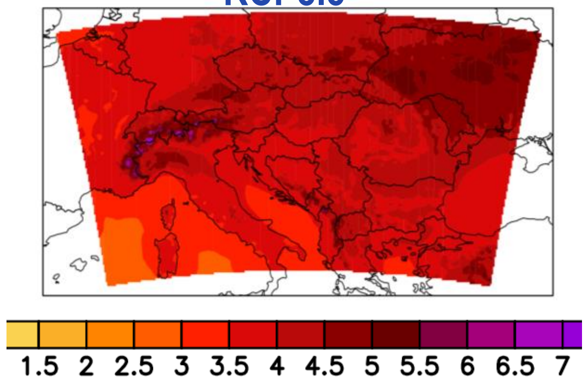
RCP8.5



The behaviour of the Earth system to altered forcing is studied with **global climate models (GCMs).** Their typical horizontal resolution is 100-200 km

RCM projection: Temperature change [°C] by 2100

RCP8.5

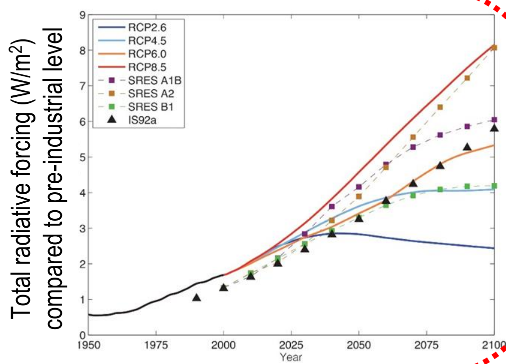


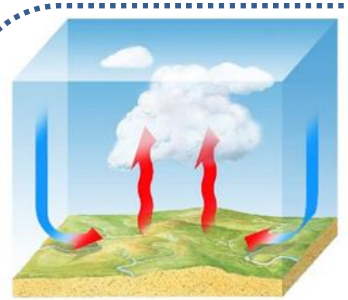
Large scale information (e.g. circulation) is downscaled with **regional climate models**, which are applied on a limited area domain with finer resolution (10-25 km)

UNCERTAINTIES IN CLIMATE INFORMATION

- Climate projection uncertainties are derived from three main sources

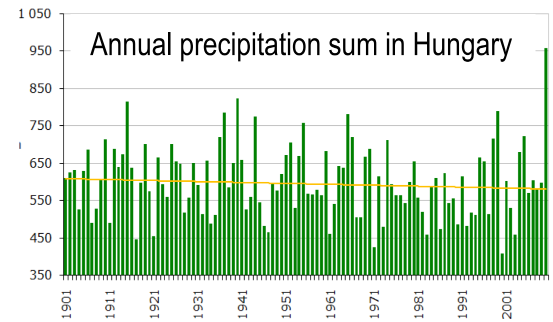
1. Ambiguous political-economical-societal changes → different **scenarios** of radiative forcing





2. Several **models** exist which apply different mathematical and physical approximations (e.g. cloud formation)

3. **Natural variability** of climate system (e.g. consecutive dry and wet years)



<u>Quantifying uncertainties</u>: simulations with different GCM-RCM combinations and with different antropogenic scenarios

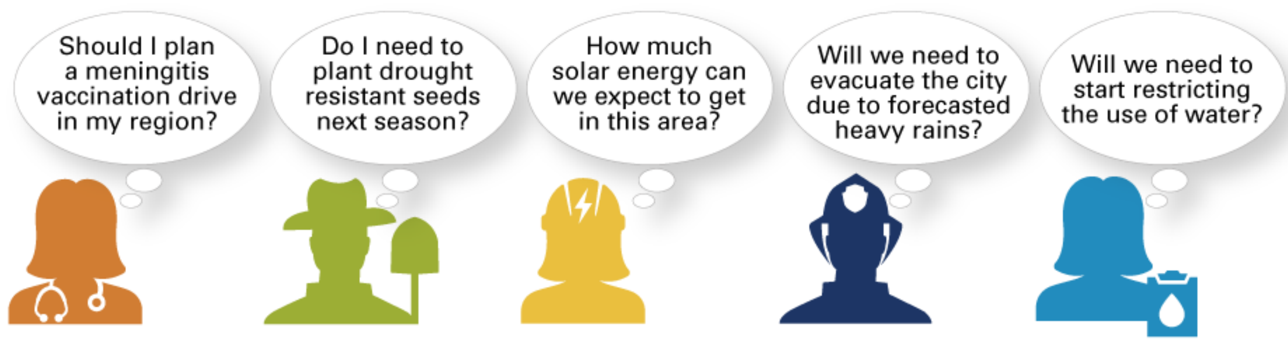
ADAPTATION TO AND MITIGATION OF CLIMATE CHANGE – DATA IN ACTION

- Climate model data is often used as a basis of impact studies and decision making for adaptation and mitigation → cross-disciplinary approach

Observed and projected climate data

Socio-economic information (e.g. agriculture production)

Easily accessible information



Answers based on quantified studies

Grand challenge to inform the users about the nature of climate model data

Image source: https://gfcs.wmo.int/what-are-climate-services

TRAINING AND EDUCATING USERS VIA SEVERAL CHANELS AT OMSZ

Annual workshops: direct information exchange with the users (e.g. on their needs regarding the climate service)

1st topic: How to cope with uncertainties of climate model data?

Brochures and guidance: hands-on information about the proper use of climate model data, tailored to different type of users

Let's see in it!

…in preparation

This work is implemented within the KlimAdat (2016–2021) project

KLIMADAT

A GUIDANCE ON HOW TO USE EFFECTIVELY THE CLIMATE MODEL DATA WITH UNCERTAINTIES

- **Target audience** is grouped:
  1. ***Impact researchers, modellers*** (e.g. a hydrologist who simulates river discharge)
     - Need large amount of data (usually bias adjusted and gridpoint data)

  2. ***Engineers, local planners*** (e.g. an engineer who makes calculations to design a new bridge)
     - Need small amount of data (usually for a given location) in the form of multiyear averages, climate indices, plots, tables, etc.

- **Input:** 12 GCM-RCM combinations of the Euro-CORDEX initiative
  - Period: 1971–2100
  - Anthropogenic scenarios: RCP4.5 (optimistic) and RCP8.5 (pessimistic)
  - 24 simulations were investigated

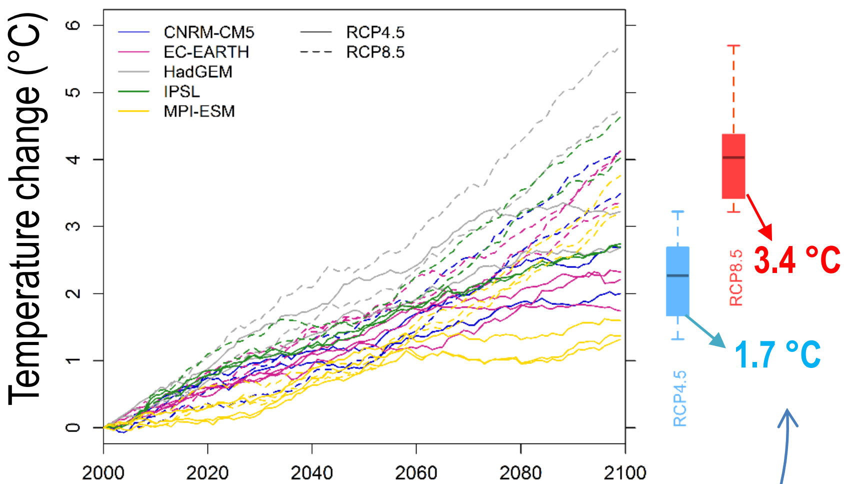
		Regional climate model							
		ALADIN53	RCA4	CCLM-4-8-17	RACMO22E	REMO2009	WRF331	HIRHAM5	Total
Global model	CNRM-CM5	x	x						2
	MPI-ESM-LR		x	x		x			3
	HadGEM2-ES		x		x				2
	IPSL-CM5A		x				x		2
	EC-EARTH		x		x			x	3
Total		1	5	1	2	1	1	1	12

QUESTION 1: HOW MANY CLIMATE MODEL SIMULATIONS SHOULD WE CONSIDER?

Advice for the researcher:

- A **representative subset** of the whole ensemble (but at least two simulations) should be used
- Different simulations can be representative for different variable, season, etc. → **a single subset may not be useful for every tasks**

Temperature change for Hungary (reference: 1971–2000)



Advice for the planner:

- The ensemble should highlight the **different sources of uncertainties**
- **Probabilistic information** can support decision making

e.g.: What is the temperature change level which is exceeded by 75% of the projections (i.e. lower quantile on box-whisker diagram)?

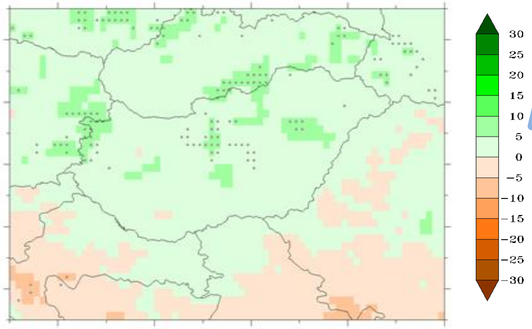
QUESTION 2: CAN WE APPLY THE MUTLIMODEL-MEAN?

Advice for the planner:

- Certain entities maybe sensitive or resilient to climate change (**low and high tails of ensemble distribution** can be important)
- If **positive and negative changes** are possible (e.g. for precipitation), the ensemble average does not contain information about these alternatives

Summary precipitation change (%)

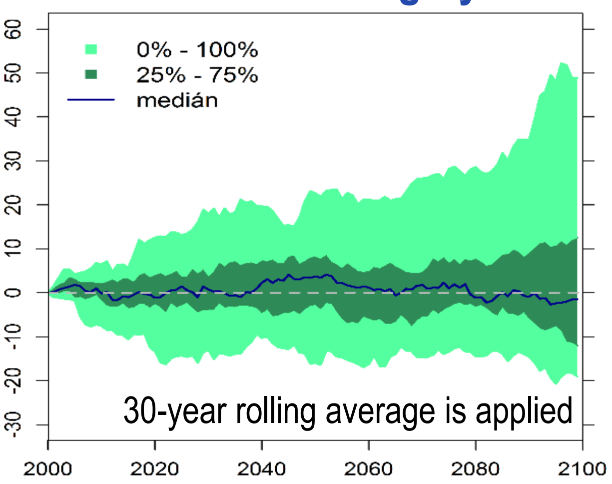
Mean of 24 simulations in 2021–2050



Dots indicate those gridpoints where the 75% of simulations agree on the sign of change

Multimodel mean indicates a small (5%) precipitation increase for Hungary

Mean over Hungary



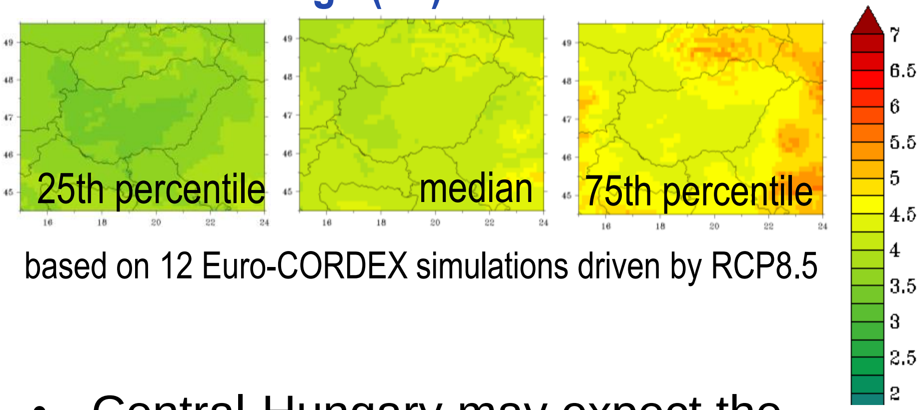
However if we look at the whole ensemble, the change can be between (-15)–20 %

QUESTION 3: HOW TO DISTILL INFORMATION FROM CLIMATE MODEL ENSEMBLE?

- When the spatial distribution of climate change is of interest, we can portray either **gridpoint quantiles** or **probabilistic maps**

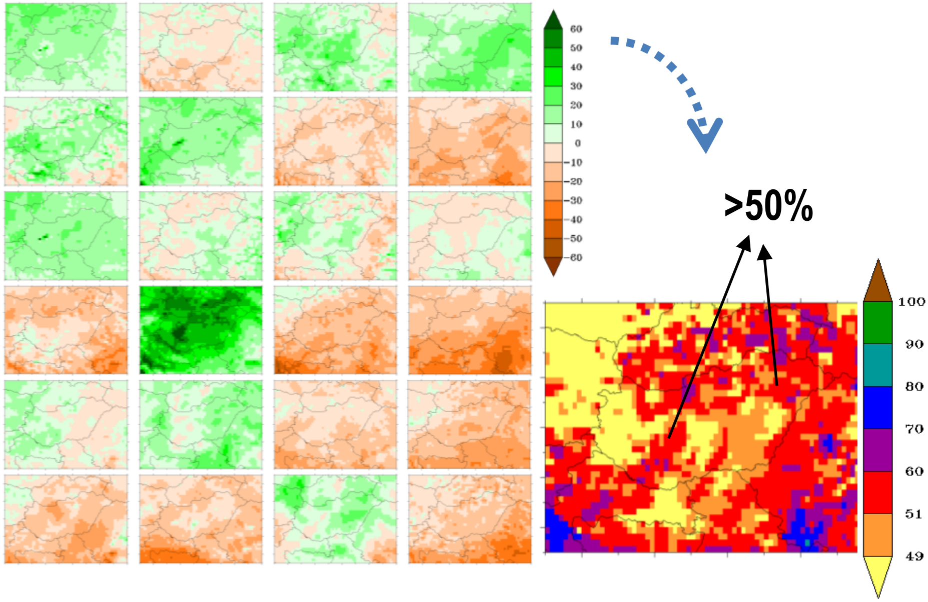
We specify the option (i.e. precipitation decrease) a priori, to quantify its probability

Gridpoint quantiles of temperature change (°C) in 2071–2100



based on 12 Euro-CORDEX simulations driven by RCP8.5

Left: summer precipitation change (%), right: probability (%) of decrease. Period: 2071–2100



- Central-Hungary may expect the smallest changes
- Larger temperature increase in the North-Eastern part of Hungary

TAKE HOME MESSAGES

Simulation uncertainties must be quantified and considered in adaptation and mitigation

Researchers' voice

Synthetized information is needed to make decisions in adaptation and mitigation

Users' voice

synthetized information ≠ simplified information

(we can do better than simply giving the ensemble mean or a yes/no answer)

Users need to learn about the **limitations** of model data and work with **probabilistic** information

Users must be **guided** what to select from a **huge amount of information**

Climate scientists should know every task in detail to provide **the right information**

Database should be **public,** user friendly and flexible to let us pick up our needs

Consultation and consultants are needed between climate researchers and users

Thank you very much for your attention!

The Klimadat project is implemented between 2016 and 2021 and funded by the Cohesion Fund and the European Union

Webpage: klimadat.met.hu/en

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