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Module 2
Climate Models

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Content

- Specifications of climate models:
  a) Spatial resolution of GCMs and techniques to downscale GCMs
  b) Retrieving climate models from ESGF and COPERNICUS
  c) Understanding the nomenclature of climate models (CORDEX)
  d) Bias correction
  e) Selection of climate models for impact assessments

Downscaling

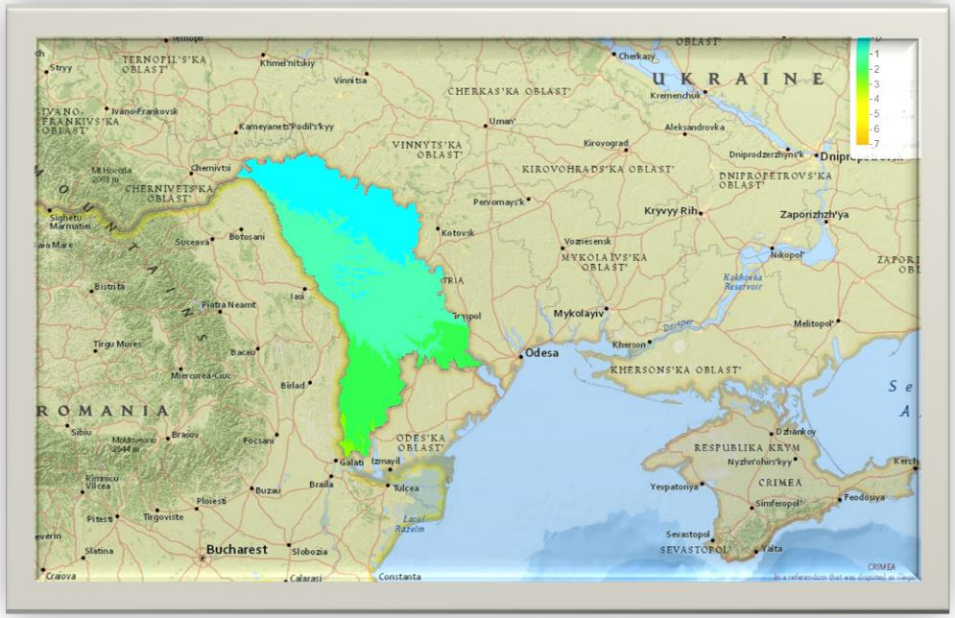
- Most GCMs have a spatial resolution of 100 km or more
- They do not capture well regional dynamics and are often unsuitable for country-level assessments

- GCMs can be downscaled with two main different techniques:
  - Statistical downscaling: creating the linkages between large-scale atmospheric variables and observed data. These statistical relationships are then applied to future projections to tailor climate data to a specific point of interest (stational level information but computationally efficient)
  - Dynamical downscaling: a regional model (RCM) uses boundary conditions driven by the GCM. Computationally intensive (gridded product but need supercomputers)

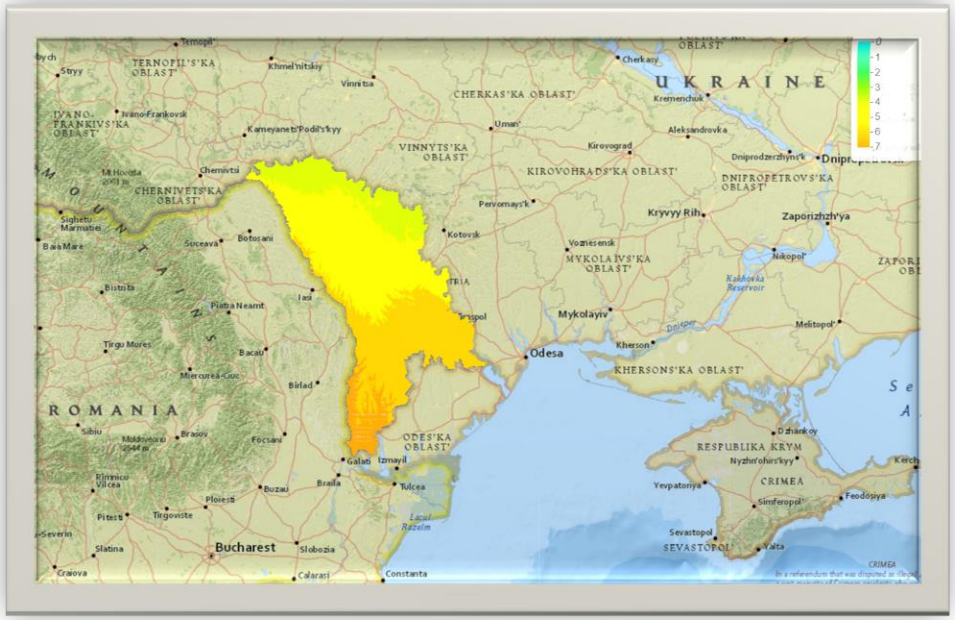
Other approaches-CHELSA

- CHELSA (Climatologies at High resolution for the Earth's Land Surface Areas) downscale climate models at 1 km resolution for temperature and precipitation. It does so considering elevation and wind direction.
- CHELSA provides a high-resolution version of W5E5 and can be applied to GCM and CORDEX models (requires good understanding of programming)

1981-2010



2071-2100



Average maximum temperature in January for W5E5 (left) and RCP8.5 GCM MPI-esm1 (right).

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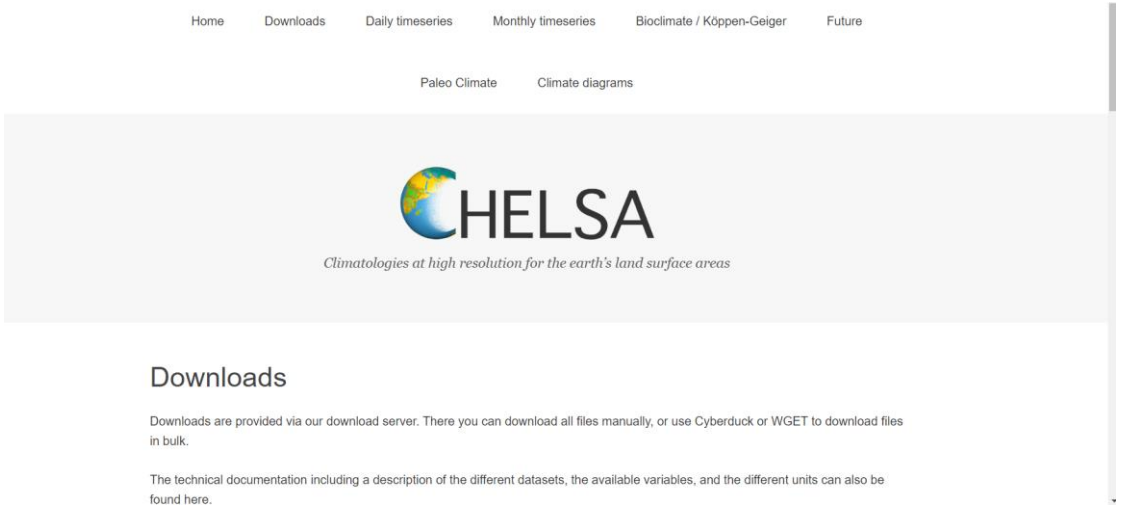
How to access CHELSA data?

CHELSA website (https://chelsa-climate.org/downloads/)

1



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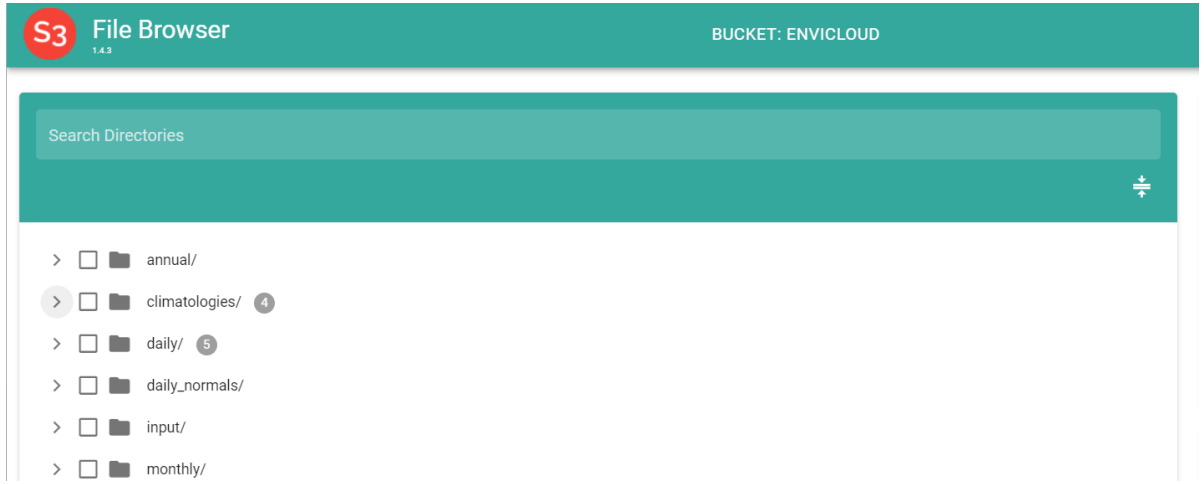

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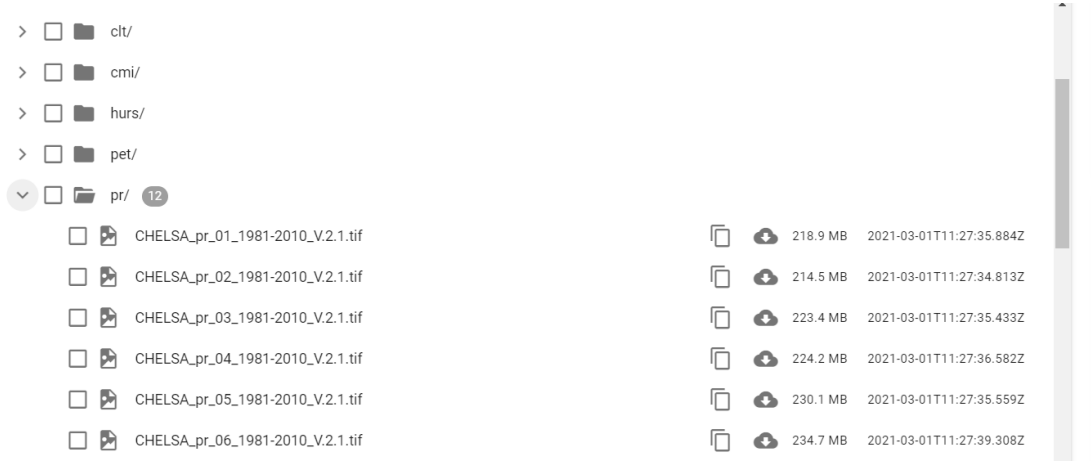

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Accessing CORDEX data from ESGF

- ESGF (Earth System Grid Federation) nodes contain CMIP5, CMIP6, CORDEX, and CORDEX-CORE simulations and others (e.g ISIMIP impact models).
- Very good for downloading a lot of data but not very user friendly.
- No visualization possible
- Excellent tutorial

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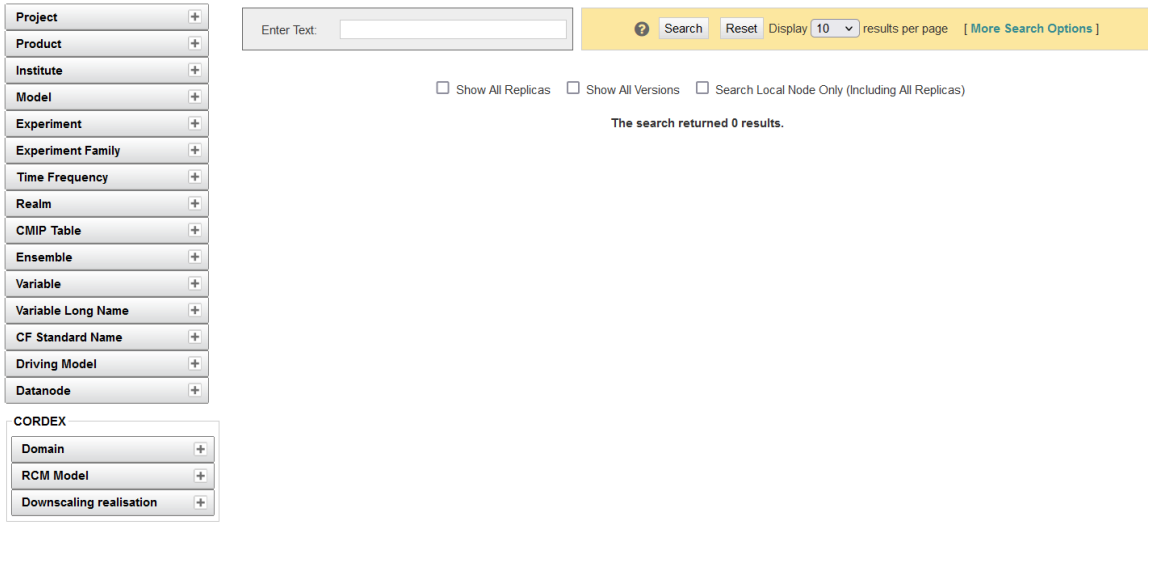
Accessing CORDEX data from ESGF

1

link



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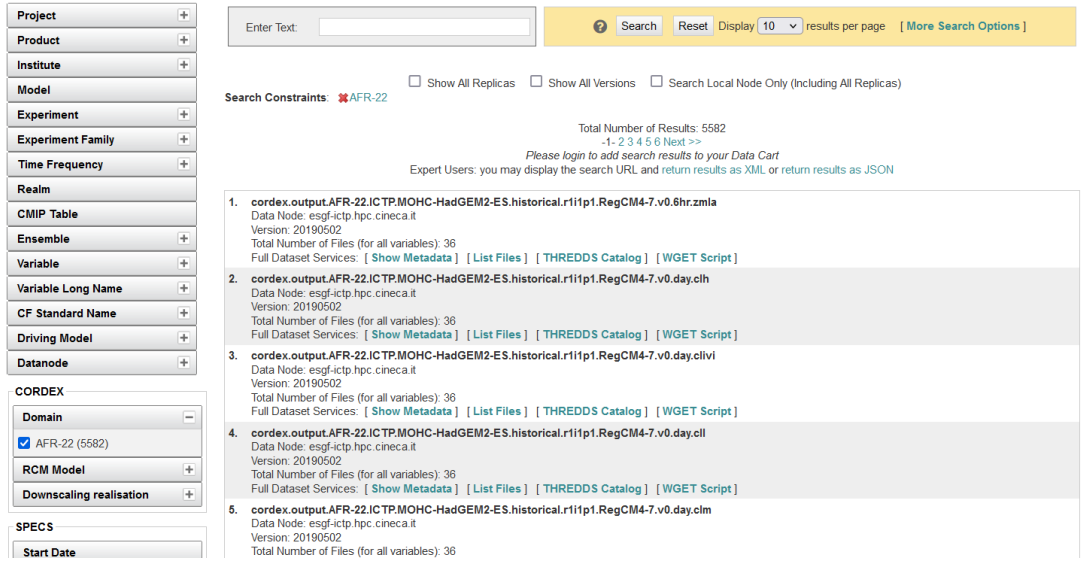

The rest in real-time. Follow this tutorial when needed

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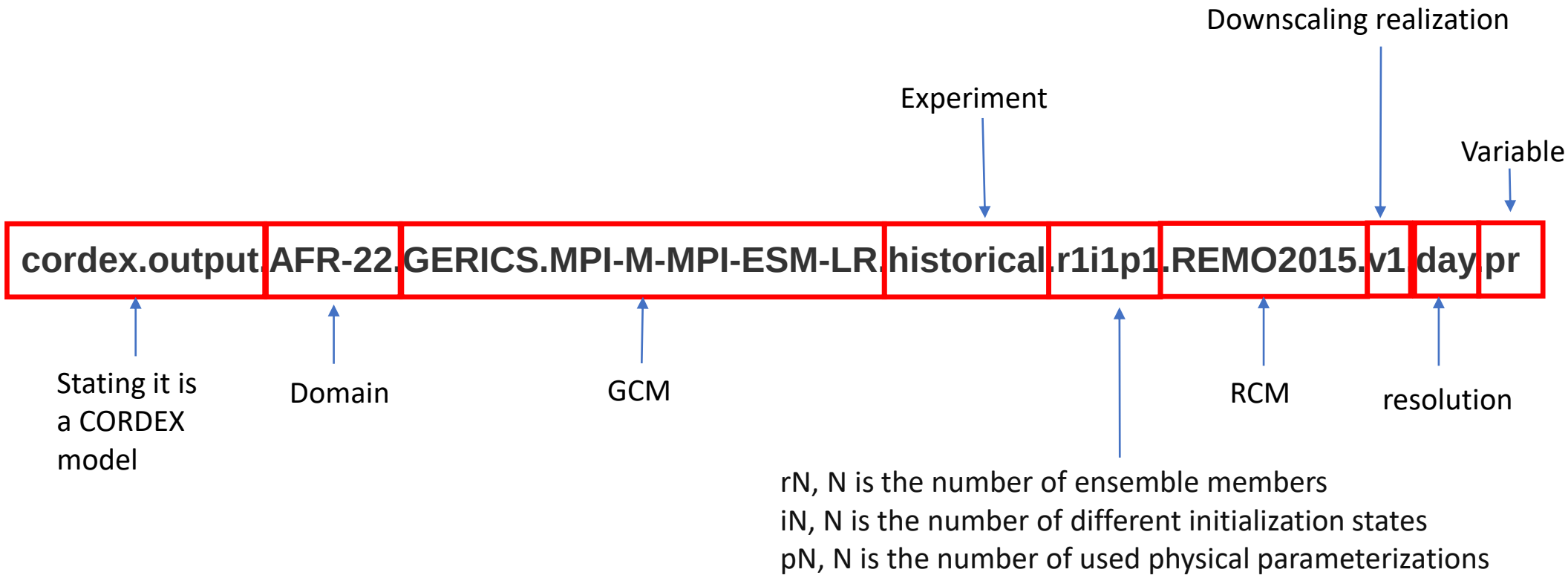
CORDEX models name



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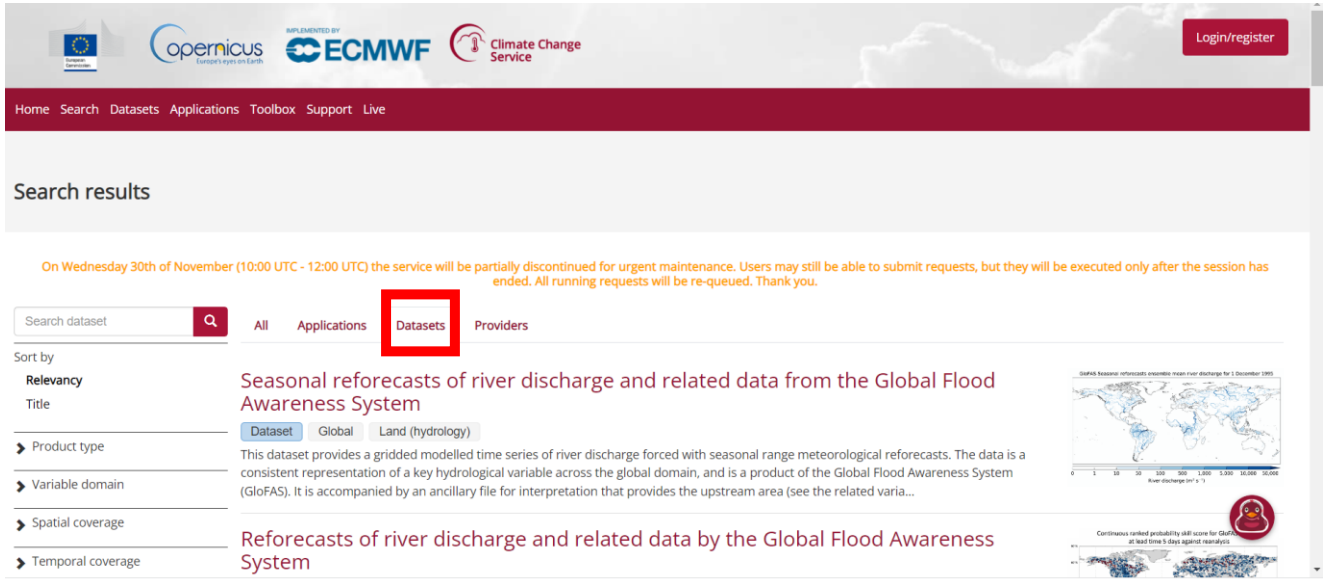
Accessing CORDEX data from COPERNICUS

- COPERNICUS is more user-friendly than ESGF.
- It contains tools to visualize climate and ocean data.
- Very well documented.
- Not all simulations are available.
- Excellent repository for satellite-based observations.
- For large volume of downloads, basic experience in programming is required.
- Link to user friendly applications

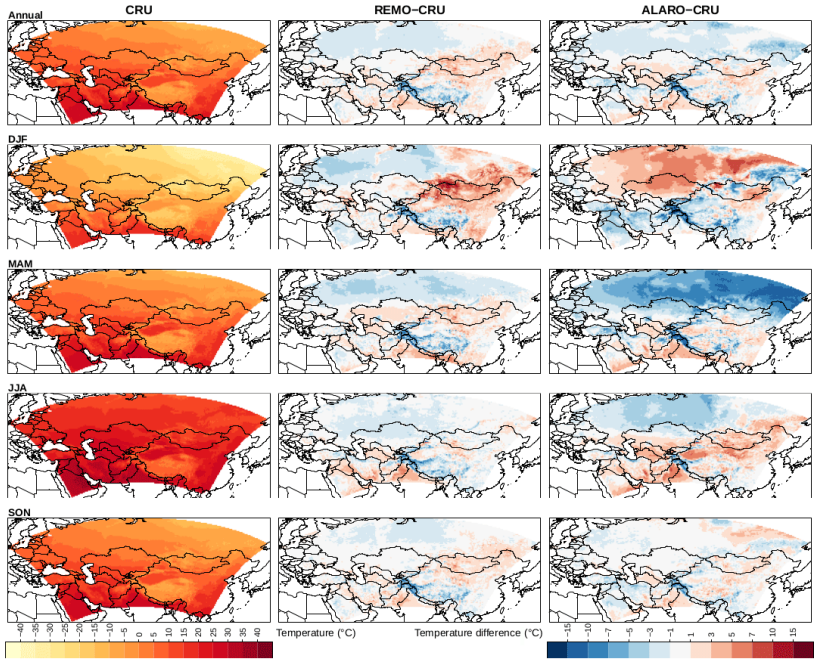
Accessing CORDEX data from COPERNICUS



- Same link as before but instead of applications we look at dataset
- The rest in real time

Bias correction

- Usually climate models are not perfect representation of the reality
- Often, needs bias adjustment. Bias correction is performed by learning the difference between the historical simulation run of the models and observational dataset. The “difference” is applied to the projections to correct the model.



Left column: mean air temperature (°C) at 2 m height over the CAS-CORDEX domain based on the observational CRU dataset for the 1980–2017 period on an annual level and for winter (DJF), spring (MAM), summer (JJA), and autumn (SON). Middle columns: difference in mean temperature between models and CRU. Top et al., 2021

How many models?

- Debated topic, many different ways for selecting climate models.
- When using CORDEX-CORE, we are limited to the number of models available (6 simulations but three GCMs)
- If we are conducting an impact assessment on a large scale (continental level), we can follow the envelope approach.

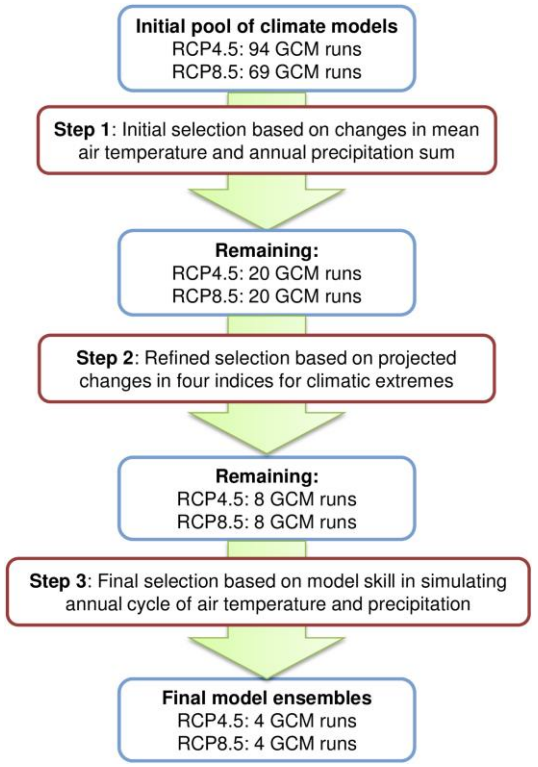


Diagram of the advanced envelope-based approach. Lutz et al., 2016

Take home messages

- Many different portals for accessing climate models. ESGF is the most comprehensive one
- Prons and cons of data portals (accessibility, visualizations apps, etc)
- For impact assessments, use more than one model. For small scales assessments, prioritize high spatial resolution climate models first

Thank you!

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