Climate Modelling

Exercise 02: Climate Downscaling

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Overview: The first part of this exercise will recapitulate a number of important aspects of the lecture "Climate Downscaling". The second part will introduce you to the analysis of regional climate model output and the derivation of climate change signals. That part will make use of the CDO postprocessing and the Panoply visualization tools. We will look at temperature and precipitation climate change signals over Europe as simulated by a regional climate model.

Your specific tasks for which you need to provide a written answer or the respective figure(s) are marked in **red** color. All other points mentioned are necessary processing steps or helpful comments and do not need to be directly answered.

First part:

1. Please explain briefly why climate downscaling is required.

2. Please explain the principle differences between statistical and dynamical downscaling.

3. Please list and briefly explain the two basic methods to transfer climate model results to a climate impact model.

Second part:

Retrieve the following files from the links indicated:

- **File 1:** `model1_tas_monmean_1980-2099_K.nc` from https://polybox.ethz.ch/public.php?service=files&t=cc95a97c2b91a1941bd772f8549aa821. This file contains 2D fields of monthly mean temperature for Europe (parameter name: `tas`) for the period 1980-2099 as simulated by a regional climate model, driven by a GCM, unit: [K].

- **File 2:** `model1_pr_monmean_1980-2099_kgm2s.nc` from https://polybox.ethz.ch/public.php?service=files&t=cc95fe4c0ad4dec09e3b047e2562ef1a. This file contains 2D fields of monthly mean precipitation for Europe (parameter name: `pr`) for the period 1980-2099 as simulated by a regional climate model, driven by a GCM, unit: [kg/m2s].

  File 3: `grid_ens022_cdo.txt` from https://polybox.ethz.ch/public.php?service=files&t=d40e4d136a04c08805524b74e149d84c. This is a supporting grid description files (ASCII) that defines the RCM grid (can be read by the CDOs). You hopefully won't need this file.

Please carry out the following tasks:

1. For both parameters (temperature: `tas`, precipitation: `pr`): select the time slices 1980-2009 and 2070-2099 (two separate result files for each parameter; use `cdo selyear`)
2. Compute the 2d fields of multi-year seasonal means for each time slice (use `cdo yseasmean`)
3. Calculate the 2D fields of the mean seasonal climate change signal for both parameters (2070-2099 with respect to 1980-2009): temperature as absolute change, precipitation as relative change (use `cdo sub`, for precipitation in combination with `cdo div`)
4. **Display the 2D fields of the seasonal mean changes (eight maps in total: four maps for temperature, four maps for precipitation).**
5. Calculate the area averages of the mean seasonal temperature climate change signal (use `cdo fldmean`), export the four numbers to a text file (use `cdo output`), import them into MS Excel and **display them as bars in Excel (please provide this one figure in your solution sheet).**

Hint: In case the display of horizontal patterns in Panoply does not work (region is located over Africa) explicitly set the grid before displaying: `cdo setgrid,grid_ens022_cdo.txt file.nc resultfile.nc`)