Climate Modelling

Exercise 01: Global Climate Modelling

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Overview: The first part of this exercise will recapitulate a number of important aspects of the lecture "Global Climate Modeling". The second part will introduce you to the analysis of global climate model output. That part will make use of the CDO postprocessing and the Panoply visualization tools.

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 the difference between the terms "climate" and "weather".**
2. **Please list four components (sub-systems) of the global climate system.**
3. **Please briefly explain the snow/ice-albedo-feedback.**
4. **What are physical parameterizations and why are they required in climate models?**
5. **Please briefly explain the meaning of "climate scenario".**

Second part:

Retrieve the file `tas_Amon_MPI-ESM-LR_historical_r1i1p1_196001-200212.nc` from https://polybox.ethz.ch/public.php?service=files&t=48f3d64d845c50f8557501d95cfaf2e6. This file contains monthly mean fields of 2m temperature (parameter name: `tas`) for the period 1960-2002 (one 2D grid for each month) as simulated by the global climate model MPI-ESM-LR. The file was directly retrieved from the CMIP5 archive and represents the typical file name structure in this archive (see lecture slides).

Please carry out the following tasks:

1. Have a look at the file format (use `cdo showformat`)
2. Have a look at the basic contents of the file (use `cdo sinfon`)
3. Have a more detailed look at the contents, including parameter ranges (use `cdo infov`)
4. List the years covered by the file (use `cdo showyear`)

5. Select the years 1961-1990 from the file (use `cdo selyear,year1/year2` for selection of ranges)
6. Compute multi-year seasonal means for the period 1961-1990 (`cdo yseasmean`)
7. Have a quick look at the results files with (`cdo infov`)
8. **Display the maps of the four multi-year seasonal means in Panoply and briefly describe the global temperature pattern for each season** (take care: the units is NOT [°C] but [K]: 0°C = 273.15 K)
9. (optional) In case you'd prefer to display the temperature maps in [°C] instead of [K], convert the data from [K] to [°C] before step 8 (use `cdo subc` for this)

Now, retrieve the file `tas_Amon_MPI-ESM-LR_rcp85_r1i1p1_207001-209912.nc` from https://polybox.ethz.ch/public.php?service=files&t=5087d32f0b223ae5698caaf012b014be. This file contains monthly mean fields of 2m temperature (parameter name: `tas`) for the period 2070-2099 (one 2D grid for each month) as simulated by the global climate model MPI-ESM-LR. It is a climate scenario that assumes the RCP8.5 emission scenario. The file was directly retrieved from the CMIP5 archive, and the years 2070-2099 have already been selected.

10. Calculate the 30-year annual mean temperatures for the period 1961-1990 (historical file) and the period 2070-2099 (rcp85 file) (`cdo timmean`)
11. Compute the climate change signal of mean annual temperature by subtracting the 30-year historical mean from the 30-year RCP8.5 scenario mean (`cdo sub`)
12. **Display the map of the temperature climate change signal between 1961-1990 and 2070-2099 in Panoply and briefly describe and interpret the pattern you see.** Take care to properly adjust the plot title in Panoply.