Documentation of the ECHAM6 standalone radiation code and the PRP feedback analysis in COMBINE

Short description of the radiation standalone program

The source code can be found in the /src directory. The main program is defined in radiation_prog.f90. It reads various input fields, defines the grid, and calls "rrtm_interface" which is the main routine for the calculation of the radiative fluxes. The routine "rrtm_interface" is defined in mo_radiation.f90.

To adapt the grid one has to make obvious changes to radiation_prog.f90, mo_control.f90, and mo_hyb.f90. In mo_hyb.f90 the coefficients for the vertical hybrid coordinate system are explicitly set. They are available from model output files.

Input files for the radiation standalone program are organized in files which contain 6-hourly data, one file for each day, i.e. 4 time steps in each file. One can use the climate data operators (http://www.mpimet.mpg.de/cdo) to generate these files from model output. The files are supposed to be stored in the directory /data. The following variables are read in:
land-sea mask, glacier mask, surface pressure, cloud water, cloud ice, surface geopotential, relative humidity, surface albedo, cloud droplet number concentration, cloud cover, ozone concentration, tropopause height, surface temperature, air temperature, specific humidity
They are supposed to be defined in grid point space (and not spectral). Note that instantaneous fractional cloud cover is read in, not total cloud cover.

There is a namelist that controls some options for the radiation standalone program. The namelist is in the directory /bin and is called "namelist_PRP". The most important one is the definition of the files from which the input variables should be read in. Two filenames can be specified, "infile" and "infilex". For the PRP analysis, "infile" contains the inputs from the control simulation, "infilex" contains the inputs from the perturbed ($2xCO_2$ or $4xCO_2$) simulation. The other input parameters should not be changed for the COMBINE analysis.

Compiling the radiation standalone program

Change to the directory /build and enter

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>make clean
>make programs
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Running the radiation standalone program

Change to the directory /bin. There is a runscript that should be used, it is called "run_PRP.sh". For tests one can use the runscript "run_PRP_test.sh".
In the run script one has to make obvious adaptations of paths and directories. The output of the radiation standalone program is written to the directory /output. Just type

>./run_PRP.sh

PRP analysis in COMBINE

In COMBINE the cmip5 1%CO_2 experiment is supposed to be analyzed. This eperimenst starts on January 1st 1850 from the preindustral control run and ends on December 31st 1989 at a level of 4xCO_2 with respect to the preindustrial period. Experience has shown that for the PRP calculation it is enough to average over a 6 years period to get stable estimates of feedbacks. We therefore choose the years 1850-1855 as the control period, and the years 1984-1989 as the perturbed period.

To read in variables from the control period or perturbed period, respectively, one has to define explicitly in radiation_prog.f90 from which file a variable is read in (either "infile" or "infilex"), and then compile the program again.

The different feedbacks are calculated as follows:

First perform a computation using the radiation standalone code with all the input fields read in from the control period. Then change various input fields according to the different feedbacks as follows:

Water vapor feedback: take specific humidity and relative humidity from perturbed period.
Cloud feedback: take cloud water, cloud ice, and cloud cover from perturbed period.
Albedo feedback: take surface albedo from perturbed period.
Lapse rate feedback: read in temperature and surface temperature for variables "t2" and "tsurf2", respectively, from the perturbed period, and comment in the lines 550-575 in radiation_prog.f90.

To calculate the feedback, determine the difference between the computation with all fields from control and the computation with appropriate fields read in from the perturbed period. The corresponding feedback factor is then calculated as the difference in net TOA radiation (defined as net radiation at the first model layer) divided by the 2-meter temperature difference (mean over the perturbed period minus mean over the control period).