Hands on tutorial #2: Setting up a simulation

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November 30th, 2017

This tutorial focuses on the various steps required to set up a 3D simulation, and in particular for a zoomed configuration of LMDZ.

Start by installing the model with the script `install_lmdz.sh`, if you have not already done so in tutorial #1 by using:

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/install_lmdz.sh
chmod +x install_lmdz.sh
./install_lmdz.sh -d 48x36x39
```

1 Setting up a case with a zoomed grid

- Go to the directory `LMDZtrunk/modipsl/modeles/LMDZ`, which contains files `makelmdz_fcm`, `libf`... In this directory, download the following tar file :

  ```
  wget http://www.lmd.jussieu.fr/~lmdz/pub/Training/tutorial.tar
  tar -xf tutorial.tar
  cd TUTORIAL
  ```

- In the directory `TUTORIAL`, take a look at the extracted files and at the DEF directory. In this directory, you should edit the file called `gcm.def` if you want to place the center of the zoom at your preferred location. For that you just have to change the longitude and latitude of the zoom center, `clon` and `clat`.

- If you are interested in coupling LMDZ with the surface scheme Orchidee, edit the `init.sh` file and set option `veget=1`. If not (`veget=0`), the model will be run with a simplified scheme for surface hydrology: the "bucket" scheme.

- Increase the stack memory you can use by typing the following command:

  ```
  ulimit -Ss unlimited
  ```

  or, even better, add this command in you shell start-up file (if you use Bash, your start-up file can be `.profile` or `.bash_profile`).

- Run the script :

  ```
  ./init.sh
  ```

  The script first compiles the model (`gcm.e`) again and also compiles the program `ce0l.e`, which creates initial state and boundary conditions. `init.sh` then downloads new NetCDF files which contain the surface orography, sea-surface temperature, and so on, as well as 3D meteorological files taken from ECMWF analyses at a particular date. `init.sh` then runs `ce0l.e` which creates files `start.nc`, `startphy.nc` and `limit.nc` in a directory called `INITIAL`. These files are then used to initialize a new simulation in a directory called `SIMU1`. You can check that these 3 files have actually been created in the directory `SIMU1`. If not, please ask for our help. If you set `veget=1`, you also need to run a first simulation to create the ORCHIDEE initial file. To do so:

  ```
  cd SIMU0
  ./gcm.e > listing0
  ```

This simulation should create a file called `sechiba_rest_out.nc`. The ORCHIDEE initial file of your simulation, `sechiba_rest_in.nc`, should point to this file (this is done automatically for the SIMU1 experiment when `veget=1`).

- If you have the files `start.nc`, `startphy.nc` and `limit.nc` (and optionally `sechiba_rest_in.nc` for `veget=1`) in your SIMU1 directory, you are almost done. In the file `config.def`, add the line:

  ```
  flag_pres__00003 =           4
  ```

  Thus, the NetCDF variable pres, which contains the pressure at model layers, will be included in the file #3, `histhf.nc`.

- You can now run the model by executing the command `./gcm.e`. The simulation should end with this message "Everything is cool" and the output files `histday.nc`, `histmth.nc` and `histhf.nc` should be present.

2 Optional: Nudging

This section focuses on using the nudging capabilty with LMDZ.

- The program `ce0l.e` (which was run by `init.sh` in the first part of this tutorial) created the file `grilles_gcm.nc` in the `INITIAL` directory. `grilles_gcm.nc` contains the longitudes and latitudes of the model grids (staggered grids for zonal wind, meridional wind and temperature). You can visualize the orography map as seen by the zoomed grid, by opening this file with `ferret`, `ncview` or `grads` and plotting the variable `phis` (which, despite its name, actually contains the surface altitude, in m). You can also easily plot the horizontal resolution of the model as the square root of the grid mesh area (variable `aire`, in m^2).

- We will nudge the model with reanalysis fields. The script `get_era.sh`, in the directory `TUTO`, gets the reanalysis files. Run the script. It will also interpolate the winds on the model grid (by reading the model grid from file `grilles_gcm.nc`). You should end up with a directory called `GUIDAGE` (nudging in french) that contains two files, `u.nc` and `v.nc`. Note that for this tutorial we have given open access to a subset of the ERA-interim wind fields. ERA-interim files are stored at IDRIS, CCRT and Climserv, with restricted access. To access these files at IDRIS or on Climserv, you should contact Sophie Bouffies-Cloché (IPSL). For access at CCRT, contact Anne Cozic (LSCE). `get_era.sh` is a very simplified script for the tutorial, but more general scripts are available on the Subversion server of IGCMG:`http://forge.ipsl.jussieu.fr/igcmg/browser/CONFIG/LMDZOR/branches/LMDZOR_v4/CREATE/SCRIPT`. The file called `era2gcm.ksh` interpolates the ERA data on the GCM grid. This script can be called by another script (see `interp_from_era.ksh` for example) on multiple months, if you want to run long simulations.

- Create a new directory, called for example `SIMU1_nudged`, which contains all the files you need to run a new simulation:

  ```
  mkdir SIMU1_nudged
  cd SIMU1_nudged
  ln -s ../SIMU1/start.nc .
  ln -s ../SIMU1/startphy.nc .
  ln -s ../SIMU1/limit.nc .
  ln -s ../SIMU0/sechiba_rest_out.nc sechiba_rest_in.nc
  cp ../SIMU1/*.def .
  rm -f used_*.def
  ```

  Don't forget to also point to the nudging files:

  ```
  ln -s ../GUIDAGE/u.nc .
  ln -s ../GUIDAGE/v.nc .
  ```

- Take a look at the file `guide.def`. Nudging is activated for variables u and v only (as is often the case). The relaxation time is set to 3 hours inside the zoomed area (`tau_max=0.125` days) and half an hour outside (`tau_min`=0.0208333 days). The smaller the relaxation time, the stronger the nudging. You can change the parameters of this file if you want.

- Add the line:

  `INCLUDEDEF=guide.def`

  in `run.def`.

- Run the model again with nudging:

  `../gcm.e > listing`

- Make sure that the nudged simulation worked by comparing the winds of the outputs with the winds contained in the `u.nc` and `v.nc` files. You should see the same patterns, for the same time and altitude of course (for example look at the first output of the `histhf.nc` file at the 500 hPa level and compare with the first timestep of the `u.nc` and `v.nc` files).

- Compare the results of the simulations with and without nudging.