

# LDMZ tutorial: Nudging

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This tutorial focuses on using the nudging capability with LMDZ.

This document can be downloaded as a pdf file (so you could copy/paste command lines from it):

```
wget https://lmdz.lmd.jussieu.fr/pub/Training/Tutorials/Tutorial_Nudging.pdf
```

## 1 Prerequisites

You should have installed the model as described in Tutorial #1, and executed Tutorial #2.

Here you will work in the TUTORIAL folder :

```
cd /your path to/LMDZTraining/LMDZseq/modips1/modeles/LMDZ/TUTORIAL
```

## 2 Experimenting with nudging

- The program `ce01.e` (which was run by `init.sh` in Tutorial2) 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.

A figure of the grid, named `grid.pdf` should have been already produced by `init.sh` in TUTORIAL/INITIAL. You can visualise it with the command `evince` (if `grid.pdf` is not there, try `tmp.ps`).

You can open `grilles_gcm.nc` with `ferret`, `ncview` or `grads` and visualize the grid by plotting the variable `grille_s`.

You can visualize the orography as seen by the zoomed grid by plotting the variable `phis` (which, despite its name, actually contains the surface altitude, in m).

You can also get an idea about the horizontal resolution of the model by plotting the square root of the grid mesh area (variable `aire`, in  $m^2$ ).

- You will nudge the model with wind fields (u and v components) from the ERA-Interim reanalysis. These files must be retrieved from a repository, and interpolated on the model grid. For that, in the directory TUTORIAL, run the script `get_era.sh` :

```
./get_era.sh
```

You should end up with a directory called `GUIDAGE` ("nudging" in French) that contains the the ERAI files (`GLOBAL_075`), and the interpolated ones, `u.nc` and `v.nc`.

**Note 1:** For this tutorial, we have given open access to ERA-Interim wind fields for January 2011. Different reanalysis datasets (ERA-Interim, ERA5...) are stored at IDRIS, CCRT and Climserv, with restricted access. To access these files at IDRIS or on Climserv, you should contact Sophie Bouffies-Cloch e (IPSL; Sophie.Bouffies-Cloche@ipsl.fr). For access at TGCC, contact Anne Cozic (LSCE; anne.cozic@lsce.ipsl.fr).

**Note 2:** `get_era.sh` is a simplified script for use with the tutorial. More general scripts are available on the Subversion server of IGCMG, as explained in LMDZPedia (<https://lmdz-forge.lmd.jussieu.fr/mediawiki/LMDZPedia/index.php/Accueil> ; search for "Guidage") For example, if you want to run long simulations, you can use the script `era2gcm.ksh` which interpolates the ERA data on the GCM grid, called on multiple months by another script (see `interp_from_era.ksh` for example)

- In the directory TUTORIAL, create a new directory, called for example SIMU1\_nudged, and gather in it all the (links to) 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 .
cp ../SIMU1/*.def .
rm -f used_*.def
```

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.
- In `run.def` add the line:

```
INCLUDEDEF=guide.def
```

- Run the model again with nudging:

```
../gcm.e > listing
```

- Make sure that the nudged simulation worked, by comparing the 6-hourly winds in the `hsthf.nc` output file to those in the `u.nc` and `v.nc` files. For a given time and pressure level, you should see the same patterns of `u` and `v` wind components.

For example compare the first timestep of the `u.nc` and `v.nc` files at 500 hPa level (`k=22` in Ferret) with the first timestep of the `u` and `v` variables in the `hsthf.nc` output file at about the same level (`k=28` in Ferret). (Note that the pressure levels on the nudging files are in millibars, while in the LMDZ output they are in Pa.)

- Compare the results of the simulations with and without nudging. You may start by comparing the wind components `u` and `v` in the 2 simulations ; also compare them with the nudging files `u.nc` et `v.nc` located in TUTORIAL/GUIDE.