Tutorial 1D model
LMDZ training course
14-18 December 2020

Prerequisite :

The automatic post-processing of LMDZ-1D outputs requires the installation of the ncdump command through netcdf libraries (at the very least, you should have one exectutable in LMDZ/netcfd-4.0.1/ncdump from which you can create an alias in your .bashrc file) as well as the nco software (http://nco.sourceforge.net) that can be easily installed through 'sudo apt-get install nco' on recent ubuntu systems.
For Ubuntu users, note that you might get issues in the image processing (and production of the all.pdf file) due to the setting of the convert (imagemagick) command. In case, check out this page : https://askubuntu.com/questions/1081895/trouble-with-batch-conversion-of-png-to-pdf-using-convert

The primary aim of this tutorial is the installation and use of the 1D model that is associated with LMDZ and its concurrent use with the 3D model. Installing the model itself is done in a similar way than for the 3D model except that ***you have to install the 3D model before installing the 1D one.***

How to install the 1D model ?

cd ~LMDZ20201109.trunk
First step is to get the file 1D.tar.gz either with
wget http://www.lmd.jussieu.fr/~lmdz/Distrib/1D/1D.tar.gz

tar xvzf 1D.tar.gz
cd 1D
./run.sh

Now, in ~LMDZ20201109.trunk, you have:
  1D
  1D.tar.gz

modipsl
  netcdf-4.0.1
  netcdf.log

The script should run smoothly without errors. If not, don't hesitate to ask for assistance.
While runinng the script, which may take a few minutes, you'll see messages corresponding to the download of various elements or information messages from the compiler.
The script ends with the execution of 3 test simulations: **ARMCU/REF , RICO/REF and SANDU/REF** with one version of the physics : **NPv6.1 with 79 levels.**

Note that the run.sh script recompiles the model and run the cases.
Note that after compilation, the execution of the cases takes place in the EXEC directory while the

outputs (history files) of the run.sh command as well as figures are stored in the OUTPUT directory. After each run.sh execution, a all.pdf file is created with the results (rneb, large scale precipitation and convective precipitation) for all cases. You can visualize it with "**evince OUTPUT/all.pdf** " and have a look at the results.
Look at the different physics versions: in ~LMDZ20201109.trunk/1D/INPUT/PHYS, you have a Readme file with the names of different physical packages and their specific features.
To visualize differencies between 2 physical packages, you can do for instance:

vi -d -O physiq.def_NPv3.2 physiq.def_NPv6.0.12split
or diff physiq.def_NPv3.2 physiq.def_NPv6.0.12split

For some cases LES.nc files in the LES directory provide Large Eddy Simulation results that can be used as benchmarks for evaluating the simulations.

<u>Test runs and analysis</u>

To make quick sensitivity tests, you can first run a case through the run.sh commands and go to the execution directory (in EXEC/) in which you will have access to all forcing files and .def files and from which you can re-run the case (without re-compiling) through the execution of ./lmdz1d.e .

1/ Effect of the snow thermal inertia on the amplitude of the diurnal cycle amplitude over the Antarctic Plateau

In run.sh choose to run the 'gabls4' case (typical diurnal cycle of the atmospheric boundary layer over the Antarctic Plateau consisting in the alternation of a diurnal convective boundary layer with a nocturnal stable boundary layer and a new diurnal convective boundary layer) with the NPv6.1 physical package.

Then in the ~EXEC/NPv6.1L79/gabls4 directory, try to change the value of the thermal inertia of the surface snow in physiq.def (inertie_sno parameter). At the end of each model execution, save the history files with different names so that the new execution does not overwrite your results. Then comment the effect of the surface thermal inertia of the amplitude of the diurnal cycle (you can compare the time evolution of the surface temperature tsol).

2/ Make sensitivity tests about triggering of the deep convection scheme and switch from deterministic to stochastic approach:

- in run.sh choose eq_rd_cv case (radiative-convective equilibrium) with NPv6.0.12split physics
- modify config.def to get only histhf.nc file
- modify run.def to run the case during 15 days
- modify lmdz1d.def to impose a dry soil (qsol0=5.)
- run the case and save the results in histhf_norandom.nc (deterministic version)
- modify physiq.def to activate stochastic triggering (iflag_trig_bl=1) and save results in eq_rd_cv_random
- compare for both simulations cloud fraction, convective precipitation, heating due to thermal plumes, due to convection, same for dqcon and dqthe
- Note that the structures of these variables are less regular in stochastic version than in the

deterministic version

3/ **Stratocumulus and transition to cumulus:**

- in run.sh, choose 3 cases: ARMCU/REF RICO/REF SANDU/REF with NPv6.1 physics
- Choose also to run with 95 vertical levels (LLM key in run.sh)
- Set also day_step=288 (temporal time step=5minutes)
- in ~1D/run.sh (line 171) modify "gzip listing" into "gzip -f listing"

We will then assess the sensitivity to the fac_thermals_ed_dz parameter.

z * (1+fact_thermals_ed_dz) is the reference altitude at which the cloud top detrainement is calculated (the idea is to make the detrainment aware of the environmental conditions at a level above cloud top). See section 3.2 of Hourdin et al. 2019 (https://doi.org/10.1029/2019MS001666) for details.

- In ~1D/INPUT/PHYS: duplicate physiq.def.NPv6.1 and create physiq.def_NPv6.1split0 (with fact_thermals_ed_dz=0.), physiq.def_NPv6.1split0.1 (with fact_thermals_ed_dz=0.1), physiq.def_NPv6.1split0.2 (with fact_thermals_ed_dz=0.2),
- modify run.sh to run these 3 new physical packages
- run ./run.sh
- have a look at ~OUTPUT/all.pdf and try to explain the differences between results