Tutorial Single Column Model (1D)
LMDZ training course

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 LMDZ model 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 ~LMDZ20211102.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

Now, in ~LMDZ20201109.trunk, you should have:

1D
1D.tar.gz
modipsl
netcdf-4.0.1
netcdf.log

cd 1D

./run.sh

The script should run smoothly without errors. If not, don't hesitate to ask for assistance.
It nonetheless takes a few minutes and you should see all the 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) and with 79 vertical levels.
Note that the run.sh script **recompiles** the model and run the so-called « cases » (simulation type).
Note that after compilation, all the files necessary to the execution of the cases take place in the ~1D/EXEC directory while the
Outputs (history files) of the run.sh command as well as figures are stored in the ~1D/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. At the same place, there is also a special file for each case : ARMCUREF.pdf, RICOREF.pdf and SANDUREF.pdf, for the present example.. This file contains more detailled ouputs for the case.

You can list all the available cases by looking at the content of the
- 1D/CAS folder which contains the ‘new’ cases, i.e. cases that have been built following the so-called ‘DEPHY’ international format)
- 1D/OLDCASES folder which contains the ‘old’ cases

Look now at the different avalaible physics versions: in 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 ~1D/LES.nc files in the LES directory provide Large Eddy Simulation results that can be used as benchmarks for evaluating the simulations.

Test runs and analysis

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/gabls4/NPv6.1L79/ directory, try to change the value of the thermal inertia of the surface snow in physiq.def (inertie_sno parameter). You can for instance make it vary from a typical value for ice (2000 SI) to a typical value for dense snow (300 SI). You can now re-run the model with ./lmdz1d.e. 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). What can you conclude regarding the role of the thermal inertia about the amplitude and phase of the diurnal cycle in temperature ?

2/ 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)
- 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

3/ 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_stochastic.nc (deterministic version)
- modify physiq.def to deactivate stochastic triggering (iflag_trig_bl=0) and save results in histhf_deterministic.nc.
- compare for both simulations cloud fraction, convective precipitation, heating due to thermal plumes, due to convection, same for dqcon and dqthe
- What can you conclude about the structure of these variables between the stochastic version and the deterministic version ?