LMDZ Single Column Model

+ what is it ?
+ why is it interesting ?
+ List of 1D cases
+ how to install and run it ?

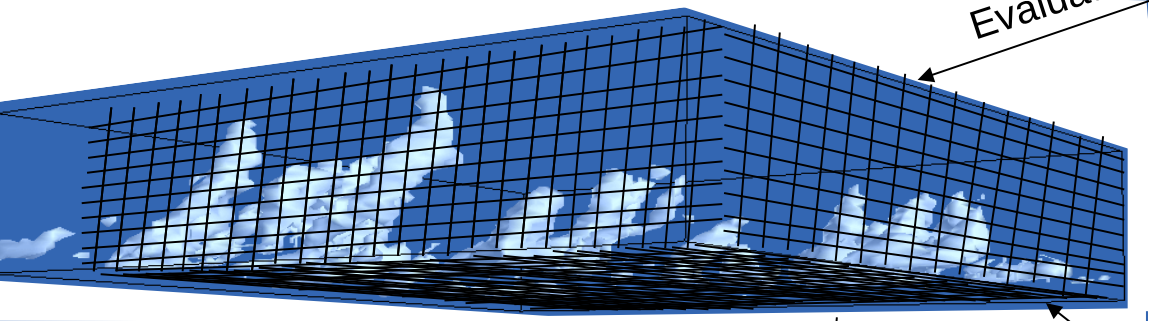
M-P Lefebvre and LMDZ team

Use of 1D cases

Test case, field campaign experiment

Observation

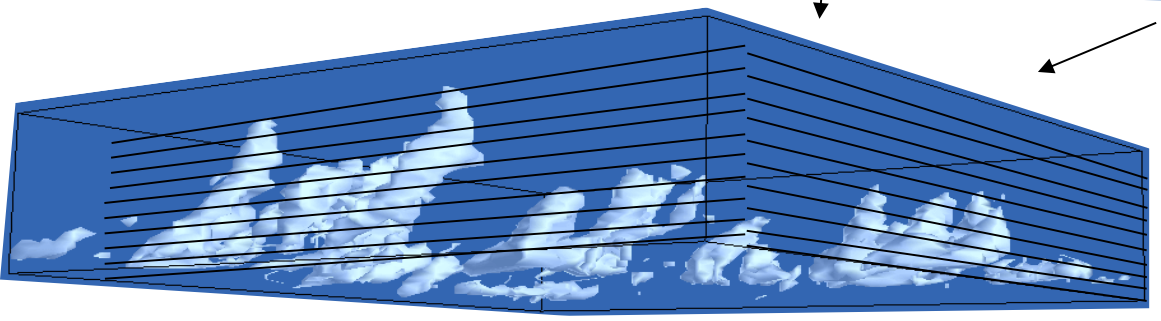
Evaluation



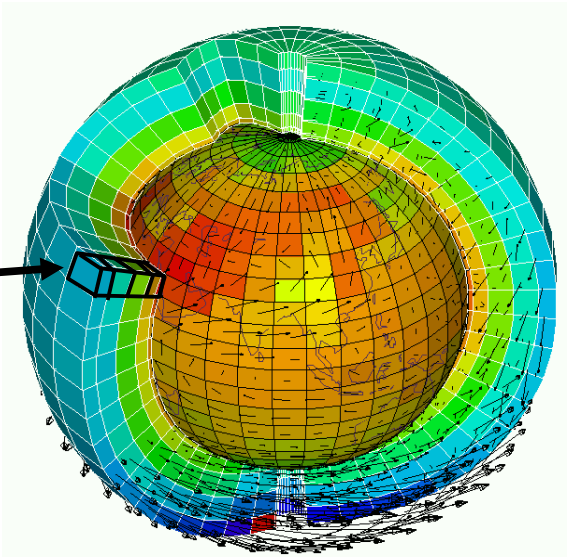
Explicit simulations, Grid cell, 20-100 m

Evaluation

« Large scale » conditions imposed



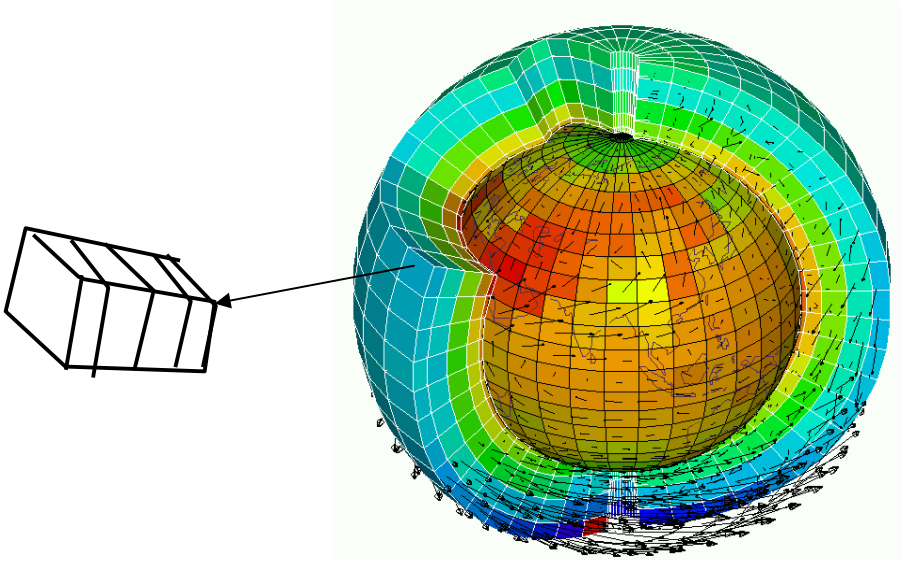
Climate model, parameterizations, « single-column » mode



Courtesy F.Hourdin

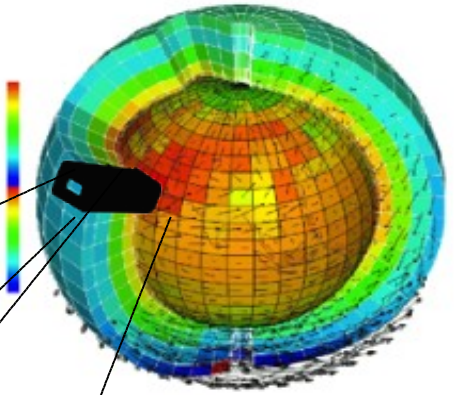
3D is a collection of many “single column models”, covering earth and interaction with each other through a set of rules known as “large scale dynamics”.

In a 1D model, there is no dynamics. We use observations or model output or idealized forcing to impose forcing at the boundaries of the column.



LMDZ model in 1D mode

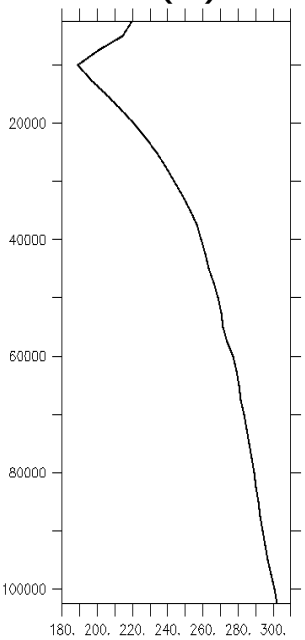
- We impose large scale conditions.
- Duration of the case varies from few hours to few months
- We study parameterizations in a given environment.



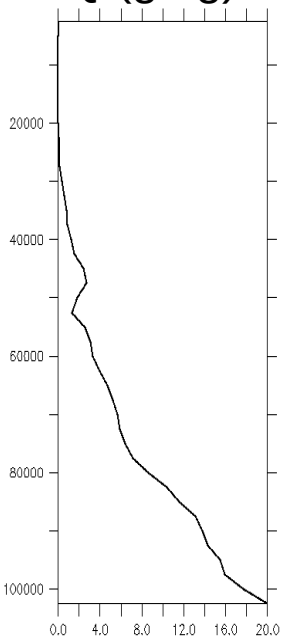
z~20km

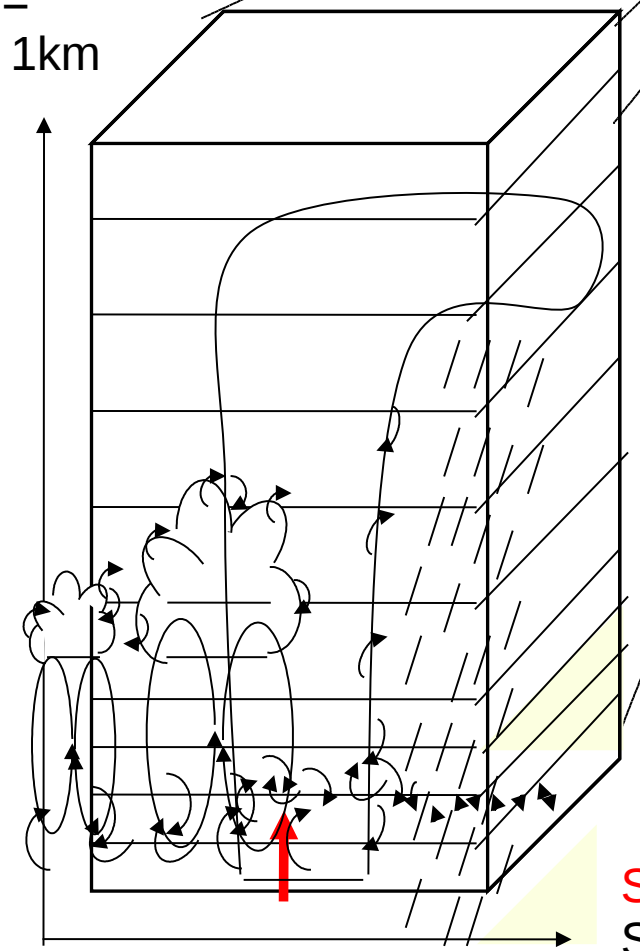
Δz =
30m - 1km

T (K)



Q (g/kg)





Large scale forcings
(constant or not):
Temperature, humidity,
Wind advection

Surface conditions:
Surface fluxes or
Surface temperature

Δx =
50-300 km

Why use SCMs ?

+ **simplicity**: technical and understanding, usable on any laptop

+ it's a useful tool for **parameterization development**: shallow convection, deep convection, transition from stratocumulus to cumulus, stable boundary layer, radiation...

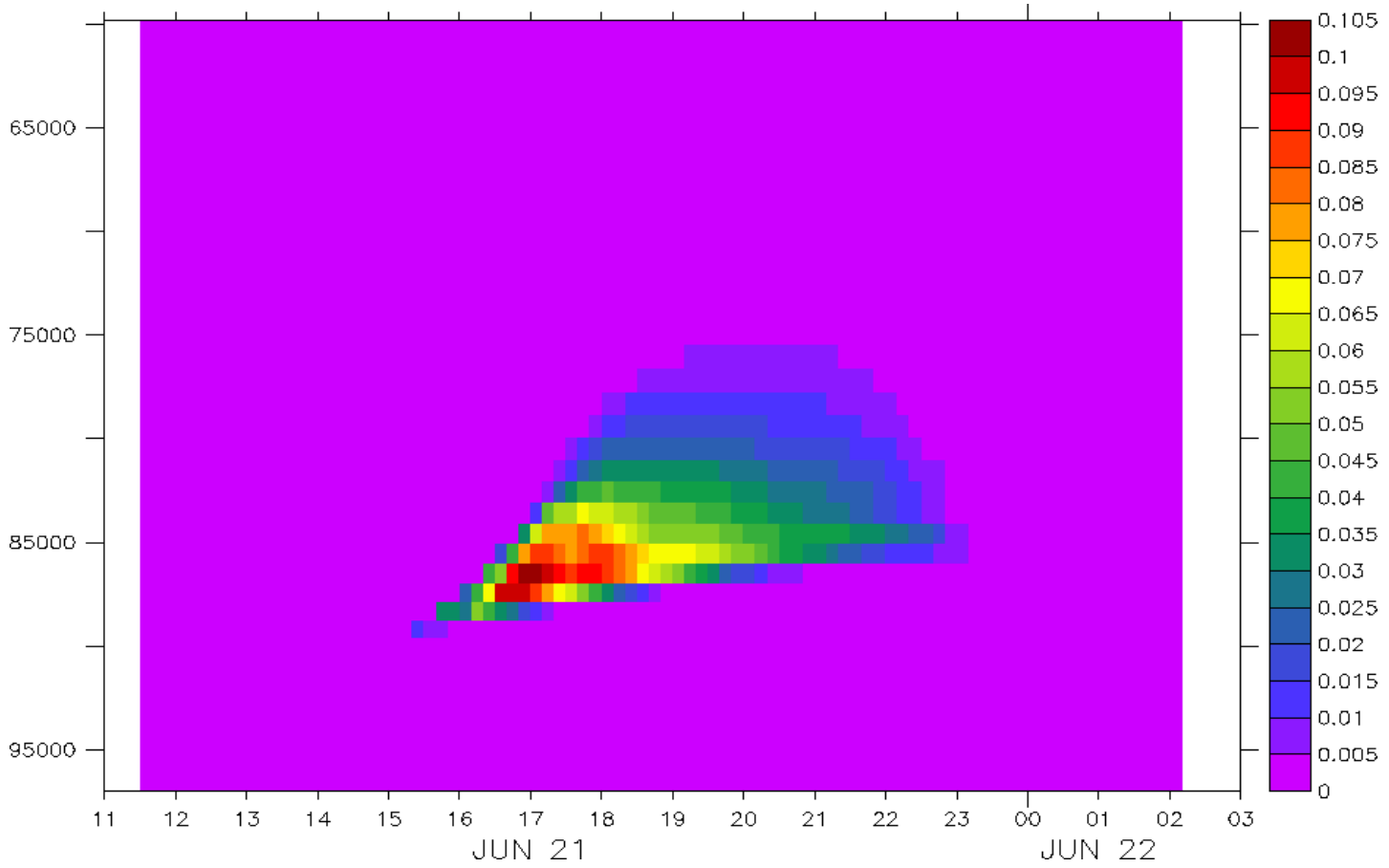
+ we can **compare results to observations or to explicit simulations** (CRM, LES)

+ then we go back to GCM and test new parameterizations ...

+ hierarchy of models: SCM, LAM, AGCM, GCM ...

Dry and shallow convection

- Arm_cu (diurnal cycle of shallow cumulus over land)
- Rico (shallow precipitating cumulus over sea)
- Ayotte (convective boundary layer, sky clear)



Arm_cu case - Cloud fraction

Stratocumulus and transition to cumulus

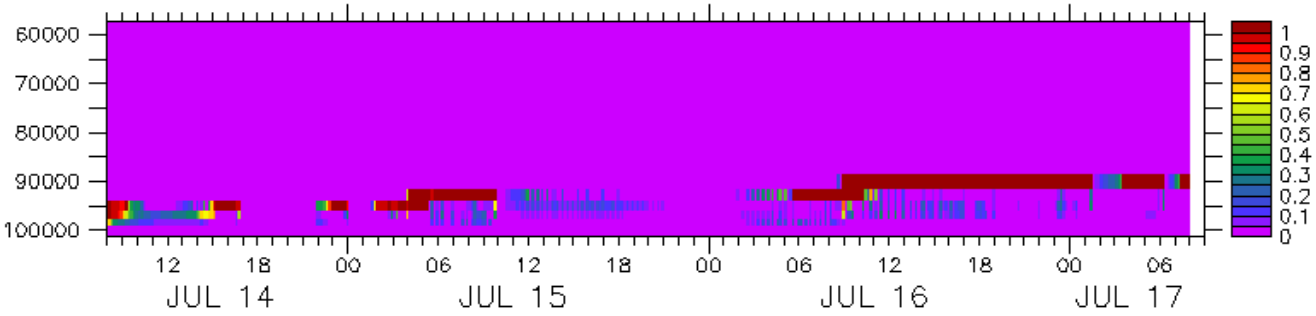
- Sandu (transition case with 3 options according to variation of SST)
- Fire (diurnal cycle of stratocumulus)

Fire case:
Cloud fraction (%)

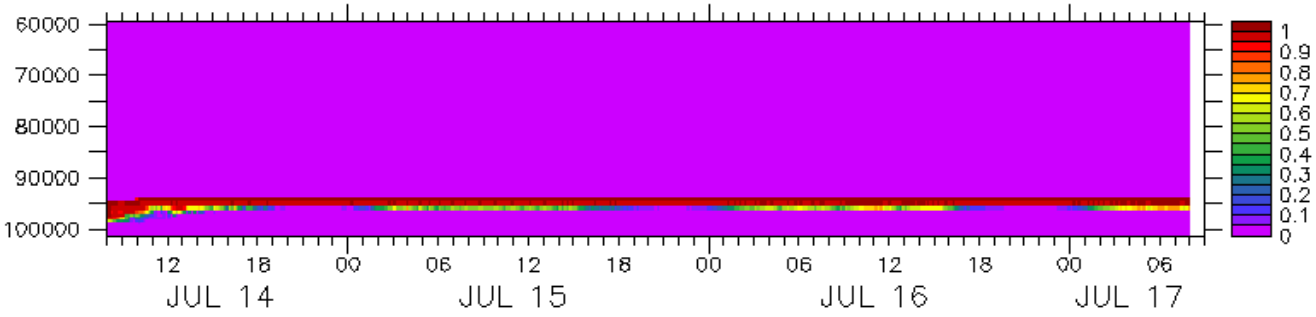
Top: standard version NPv3.2
Bad representation because not
Enough entrainment at the cloud top

Bottom: version developped by A.Jam

NPv3.2



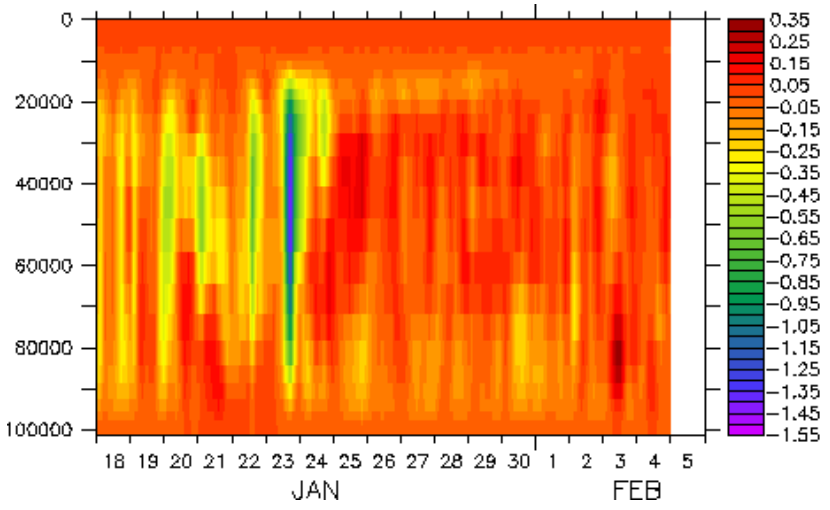
NPv5.17g



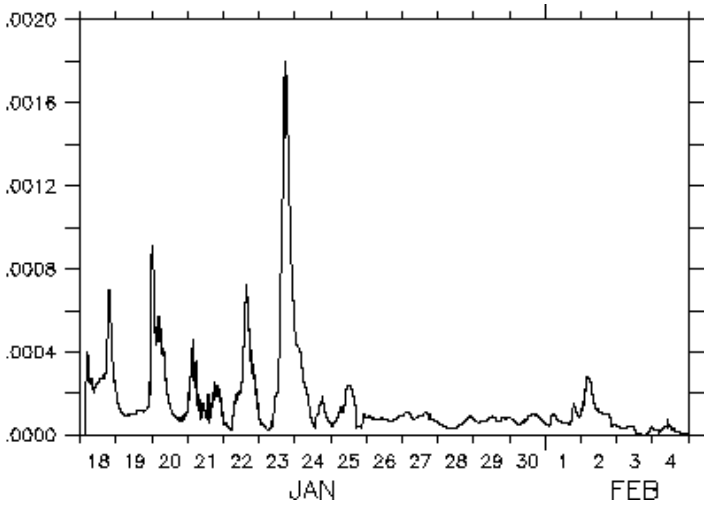
Deep convection over ocean:

- Toga (1 month)
- case_e (part of Toga)
- TWPICE : off the coast of Darwin
- Cindynamo : Madden Julian Oscillation

TWPICE Case (2 weeks)



Vertical speed (m/s)



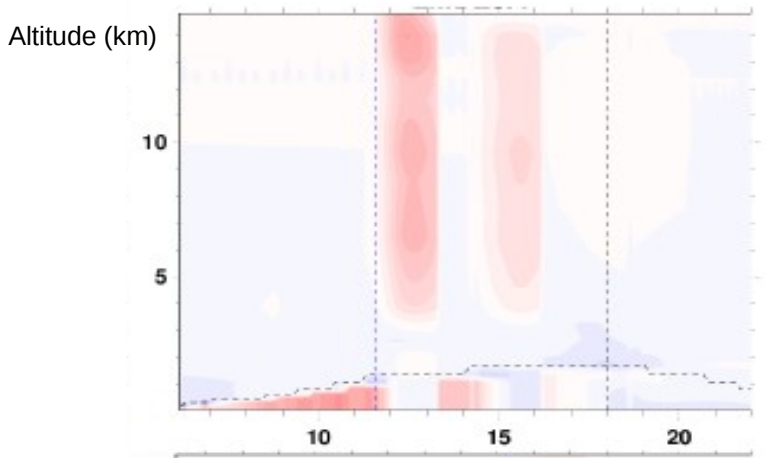
Precipitation (mm/j)

AMMA case : heating rate (K/j)

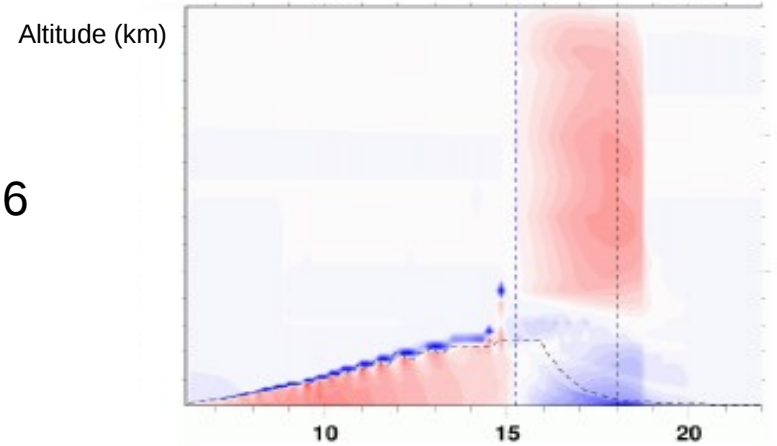
Deep convection over land:

- Hapex
- AMMA
- eq_rad_conv (RCE) : radiative
- and convection scheme active

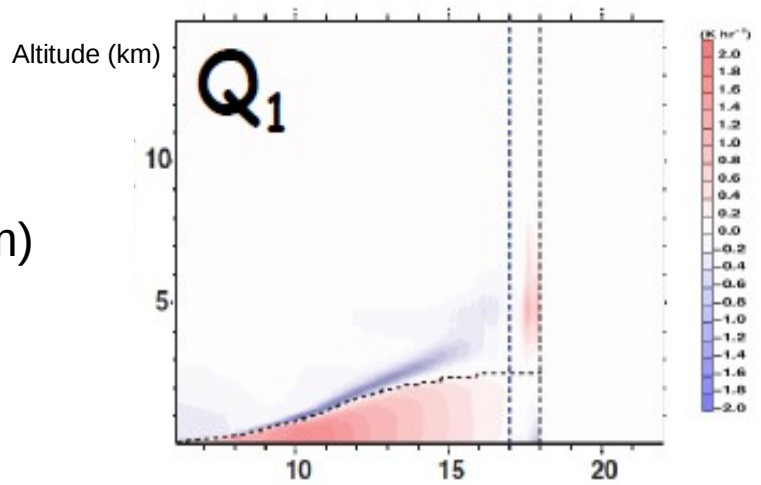
CMIP5



Pre-CMIP6



Meso-NH (Δx=500m)



Stable boundary layer:

- Dice
- GABLS4

We can run these cases with atmosphere forced or coupled with Orchidee model

DICE case : characterize boundary layer
In the site of SGP during 3 days/night

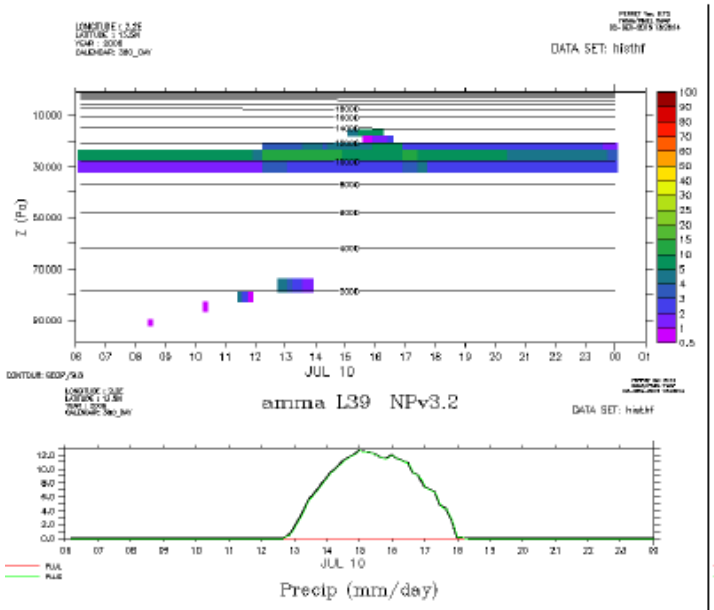
GABLS4 case : interaction of a very stable boundary layer with a snow surface

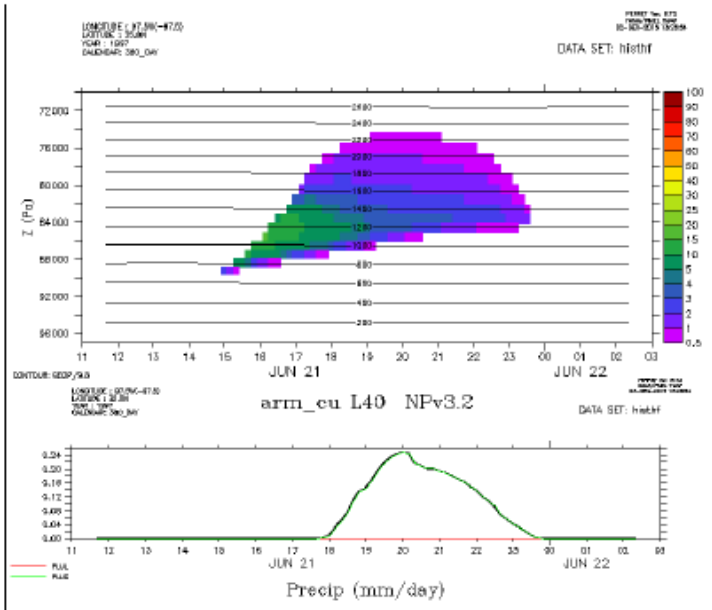
How to proceed ?

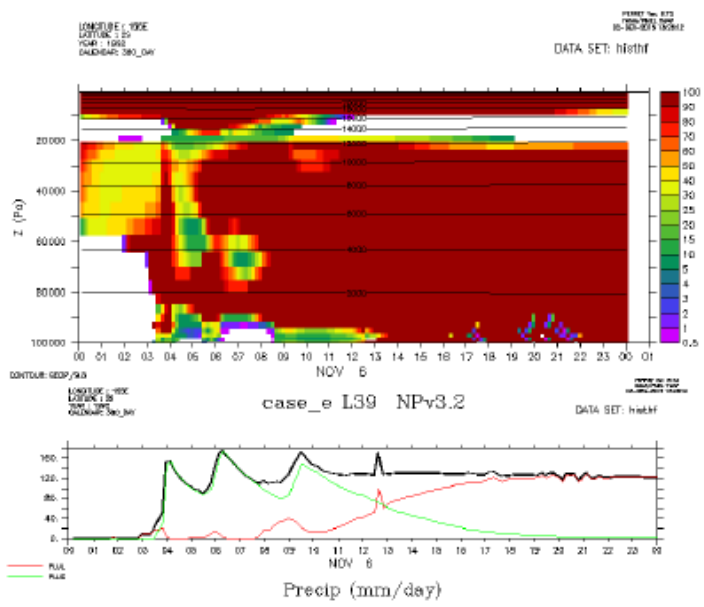
+ install LMDZ 3D with **install.sh** => LMDZ20151130.trunk

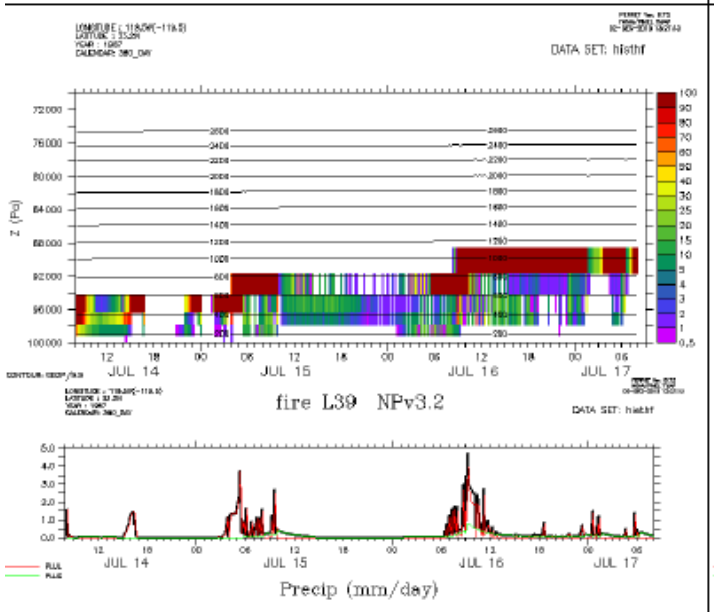
+ install LMDZ 1D :
    * copy 1D in LMDZ20151130.trunk
    * ./run.sh (compiles & executes)
    * runs automatically 10 cases with 2 different physics and show cloud cover + precipitation plot
    * you can modify run.sh to run the case(s) with physical package you are interested in

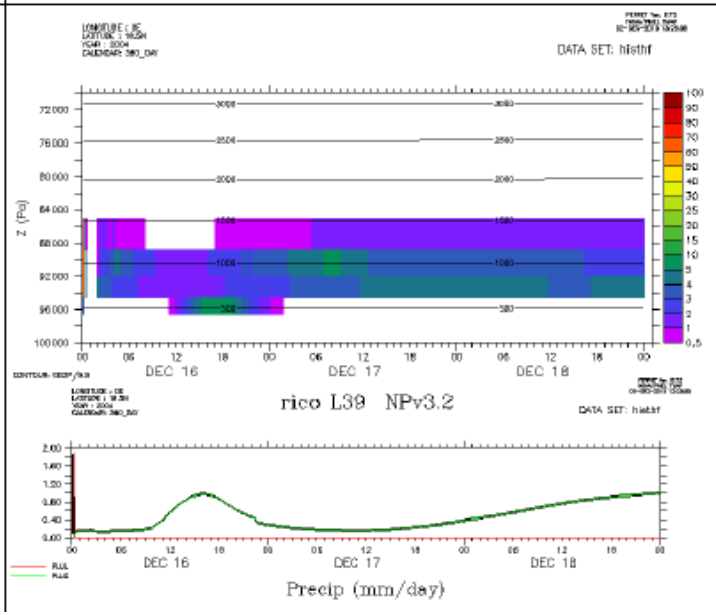
How does the file all.pdf looks like ?

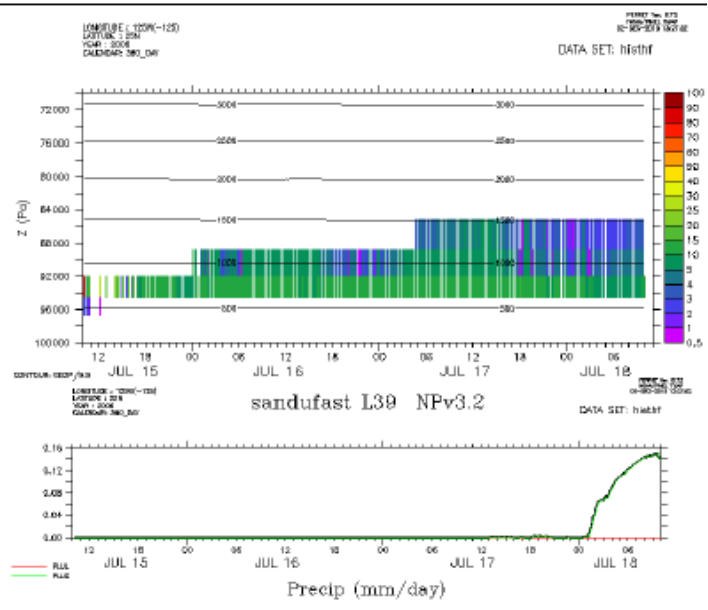






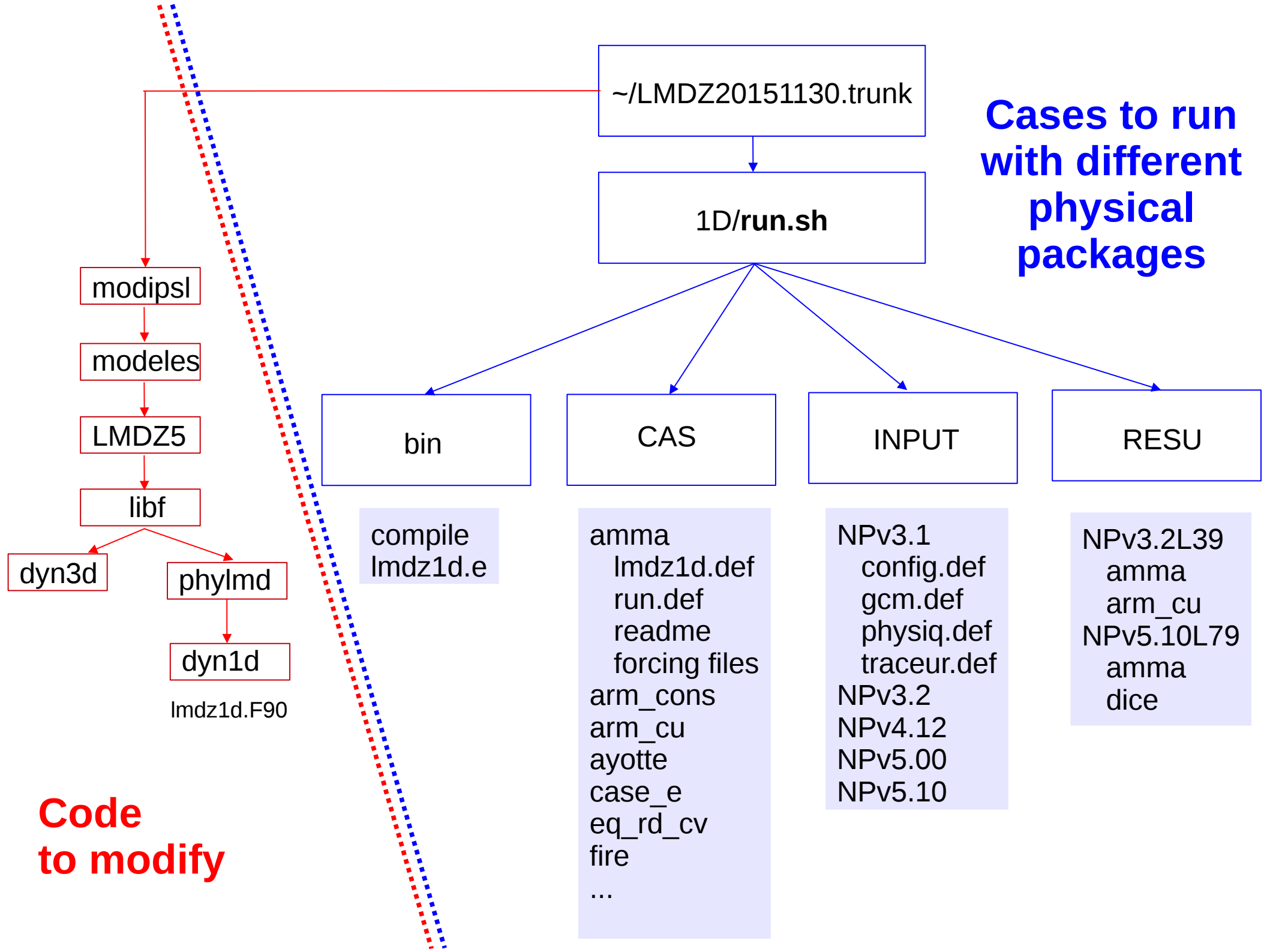






What can you do in each case directory ?

+ **compile & run** with run.sh: choose case, physics and level number
+ Look at profils and forcings (ascii files or netcdf files)
+ Modify *def files
+ Read readme file
+ **get results** in netcdf files (hist*.nc)
+ **compare** to LES results if avalaible


~/LMDZ20151130.trunk
1D/run.sh
Cases to run with different physical packages
modipsl
modeles
LMDZ5
libf
dyn3d
phylmd
dyn1d
lmdz1d.F90
bin
CAS
INPUT
RESU
compile
lmdz1d.e
amma
lmdz1d.def
run.def
readme
forcing files
arm_cons
arm_cu
ayotte
case_e
eq_rd_cv
fire
...
NPv3.1
config.def
gcm.def
physiq.def
traceur.def
NPv3.2
NPv4.12
NPv5.00
NPv5.10
NPv3.2L39
amma
arm_cu
NPv5.10L79
amma
dice
Code to modify

How to run a case or compile after modifications : with run.sh

Which case(s) ?

```
listecas="dice ihop arm_cu rico sandufast sanduref sanduslow fire
          toga ayotte twpice case_e amma " # testes
listecas="arm_cu rico sandufast fire twpice amma"
listecas="amma"
```

Which physics ?

```
listedef="SP NPv3.1 NPv3.2 NPv4.12 NPv5.00 NPv5.10"
listedef="NPv5.00 "
listedef="NPv3.2 NPv5.00 "
```

Number of levels ?

```
case $DEF in
   SP|NPV3.1|NPv3.2) L=39 ;;
   NPv4.12) L=59 ;;
   *) L=79
esac
```

Where are the results ?
In LMDZ20151130.trunk/1D/RESU/NPv3.2L39/amma

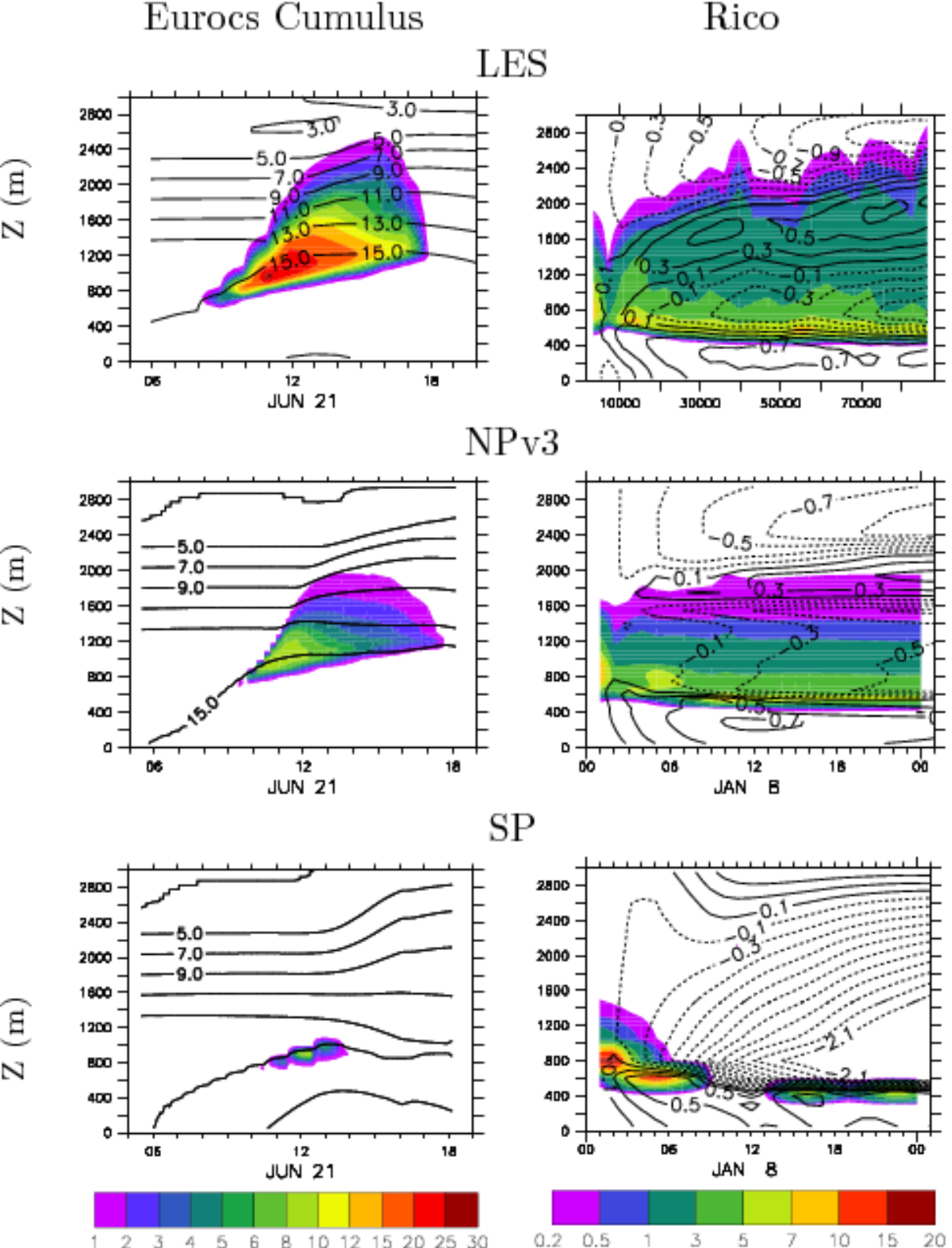
```
lrwxrwxrwx 1 ...     36  3 déc.  11:38 amma.nc
-rw-r--r-- 1 ... 285452  3 déc.  11:38 histhf.nc
-rw-r--r-- 1 ... 279088  3 déc.  11:38 hourly.nc
-rw-r--r-- 1 ...  15292  3 déc.  11:38 limit.nc
-rw-r--r-- 1 ...    652  3 déc.  11:38 lmdz1d.def
-rw-r--r-- 1 ...   4247  3 déc.  11:38 config.def
-rw-r--r-- 1 ...     85  3 déc.  11:38 gcm.def
-rw-r----- 1 ...   3765  3 déc.  11:38 physiq.def
-rwxr-xr-- 1 ...    692  3 déc.  11:38 run.def
-rw-r--r-- 1 ...     42  3 déc.  11:38 traceur.def
-rw-r--r-- 1 ...   7728  3 déc.  11:38 paramLMDZ_phy.nc
-rw-r--r-- 1 ...  16532  3 déc.  11:38 startphy.nc
```

forcings

Result files

***def files**

CAUTION !
Don't modify *def files in ~LMDZ20151130.trunk/1D/RESU directory !!
Here you have only copies of the files.
The « original » files are either under ~LMDZ20151130.trunk/CAS
or ~LMDZ20151130.trunk/INPUT



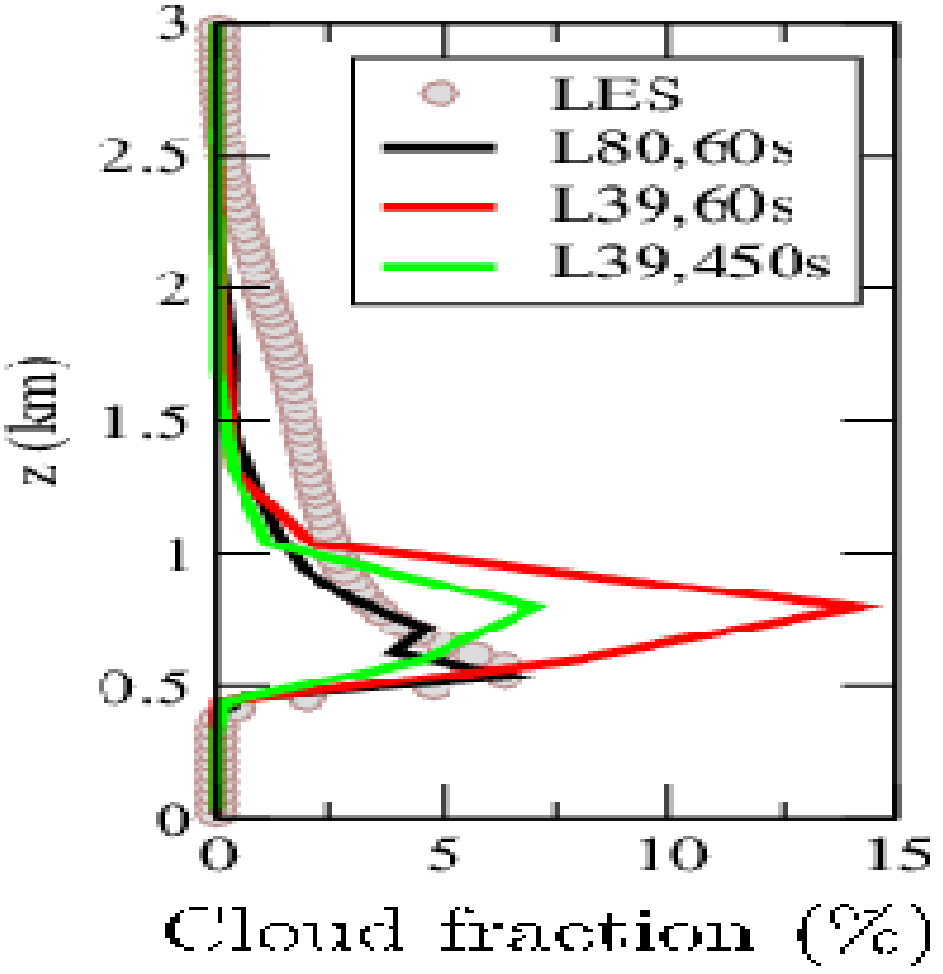
In LMD, we used these cases to develop New Physics version.

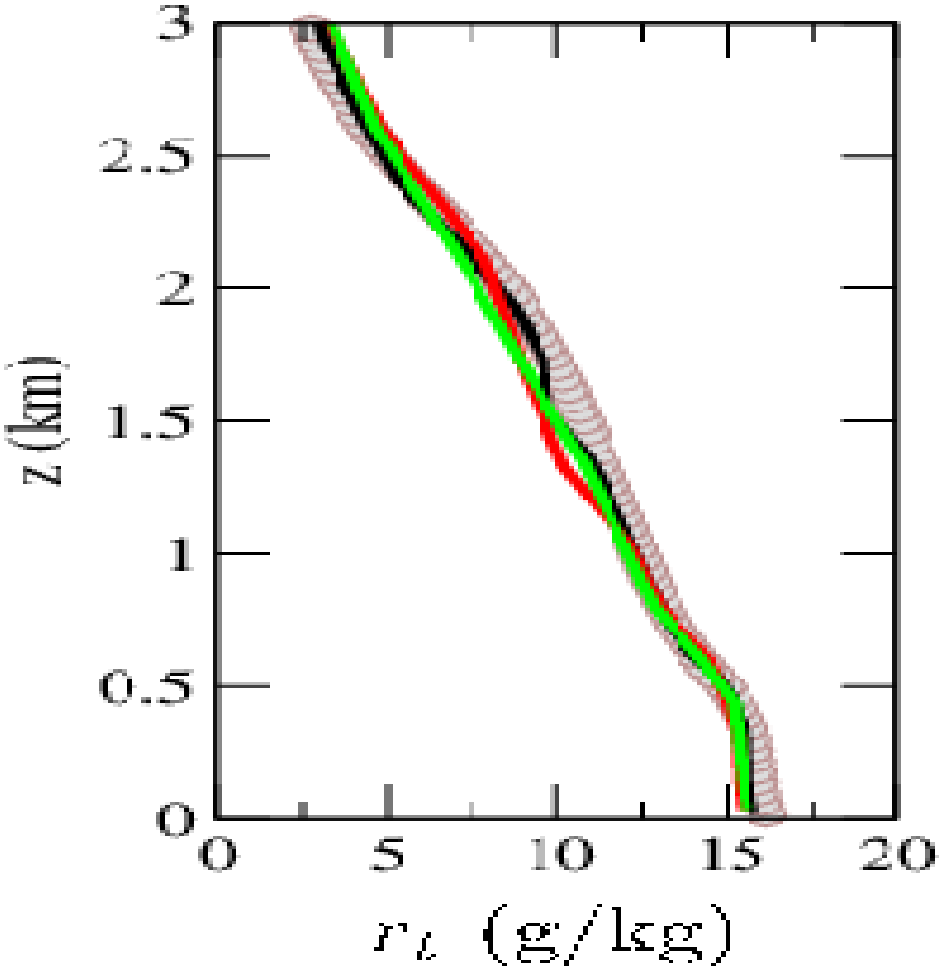
For 2 cases, Arm_cu and Rico, we compare results of « standard physics » (CMIP3), « new physics » (CMIP5) and LES model.

Shade= cloud cover
Contour= specific humidity (g/kg)

Rico case :

Sensitivity Tests to vertical discretization and time step





Thank you !!