LMDZ Single Column Model

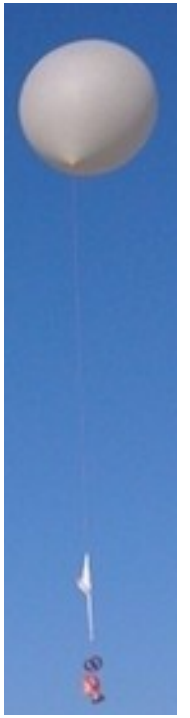
+ what is it ?
+ why is it interesting ?
+ List of 1D cases
+ how to install and run it ?

M-P Lefebvre and LMDZ team

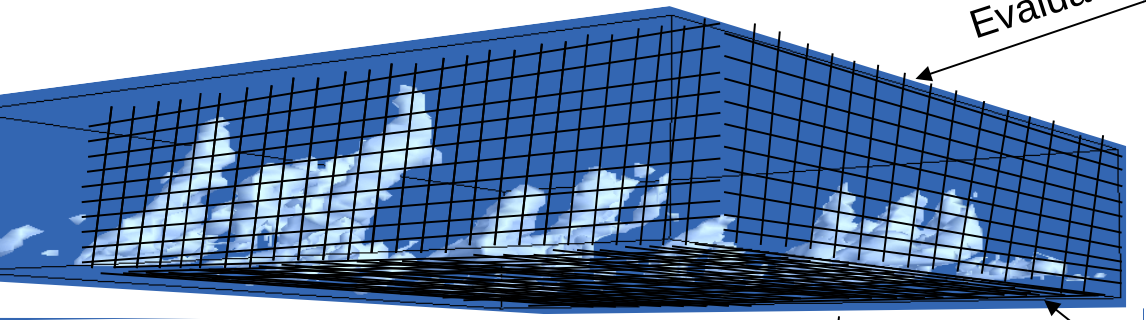
What is it ?

Test case, field campaign experiment

Observation



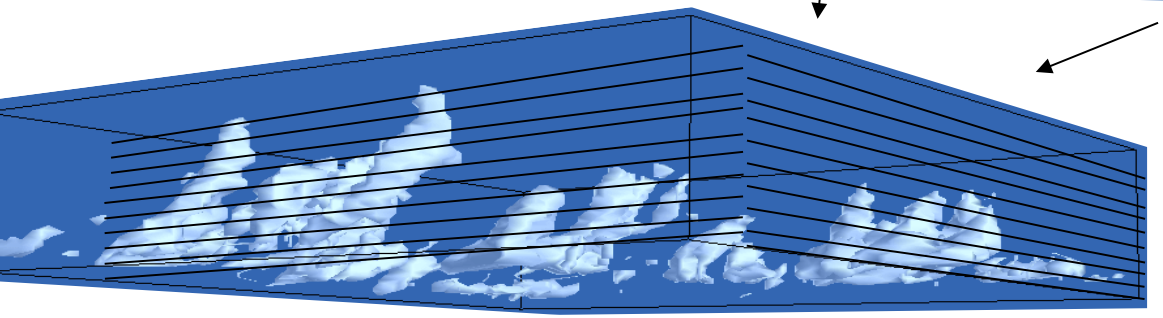
Evaluation



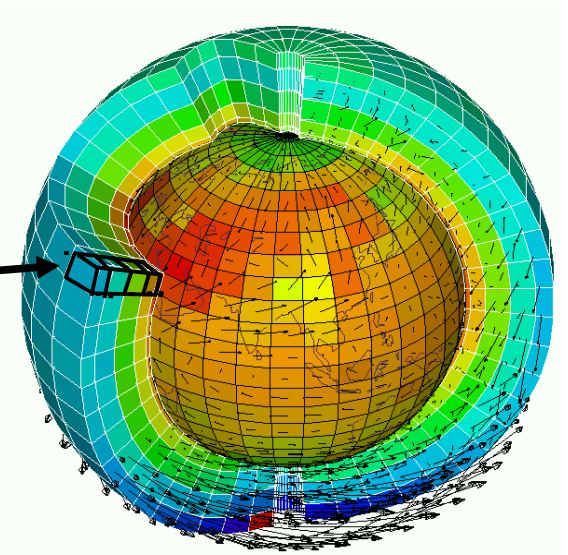
Explicit simulations, Grid cell, 20-100 m

Evaluation

« Large scale » conditions imposed



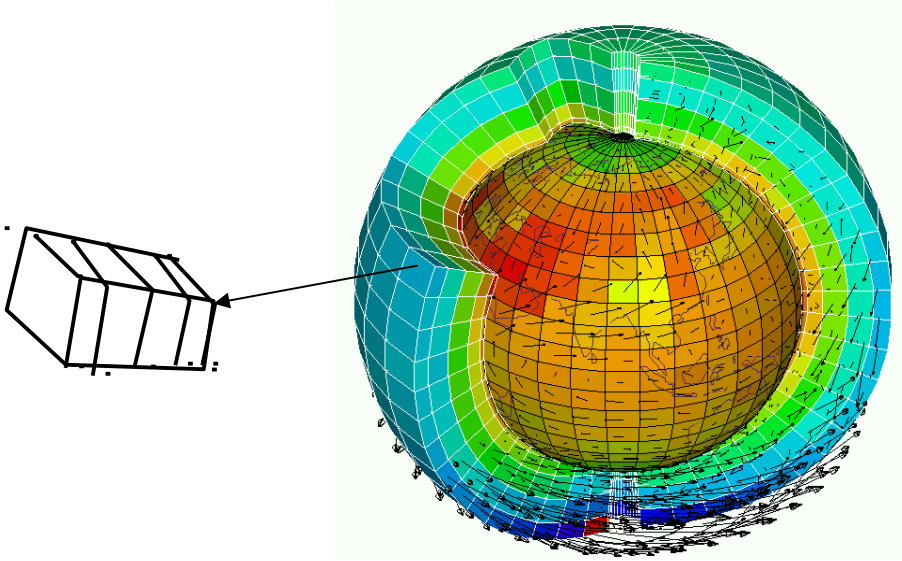
Climate model, parameterizations, « single-column » mode



Courtesy F.Hourdin

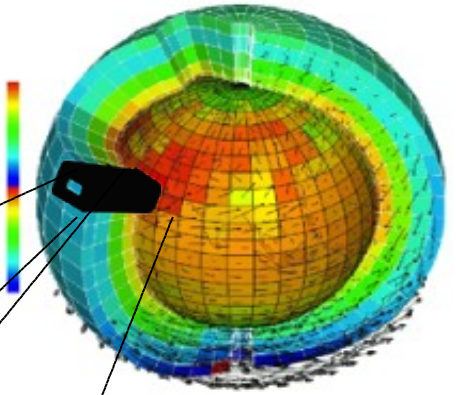
3D is a collection of many “single column models”, covering earth and interaction with each other through a set of rules known as “large scale dynamics”.

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



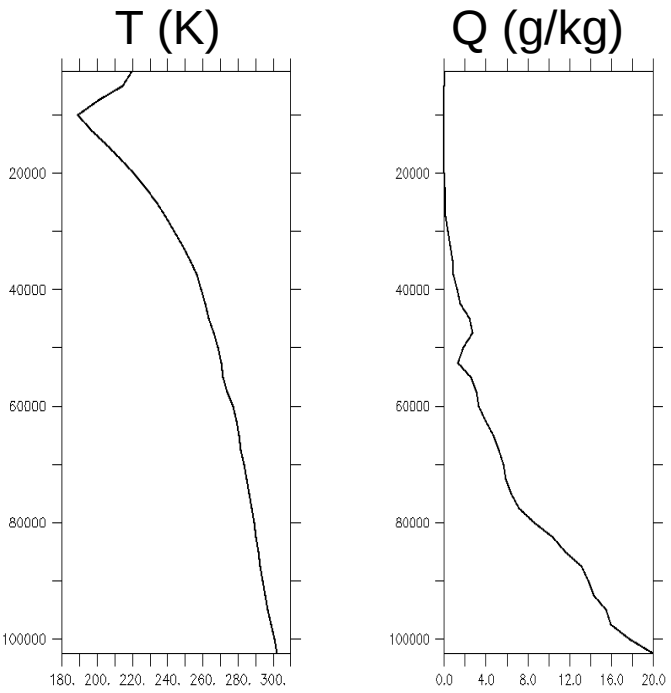
LMDZ model in 1D mode

- 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



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

Surface conditions:
Surface fluxes or
Surface temperature

Δx =
50-300 km

Why is it interesting ?

+ **simple tool**: technical and understanding, usable on any labtop

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

+ we can evaluate behavior of physical parameterizations **comparing results to observations or to explicit simulations** (CRM, LES)

+ then we go back to GCM: test and debug new parameterizations

+ we can anticipate the effect of new development in 3D simulations

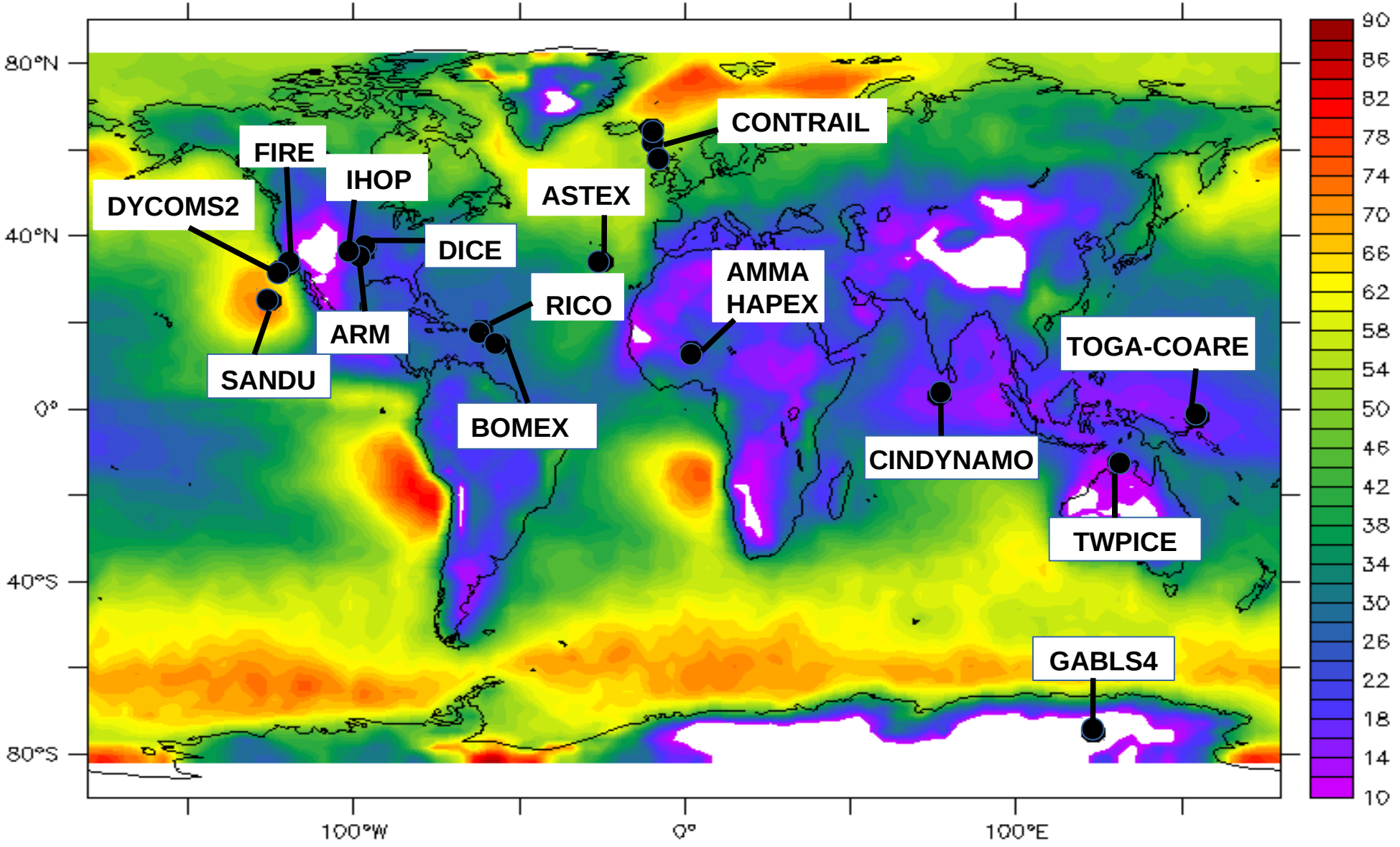
+ we have hierarchy of models: SCM, LAM, AGCM, GCM …

List of 1D cases

The cases are located in different places of the world

and represent various meteorological situations

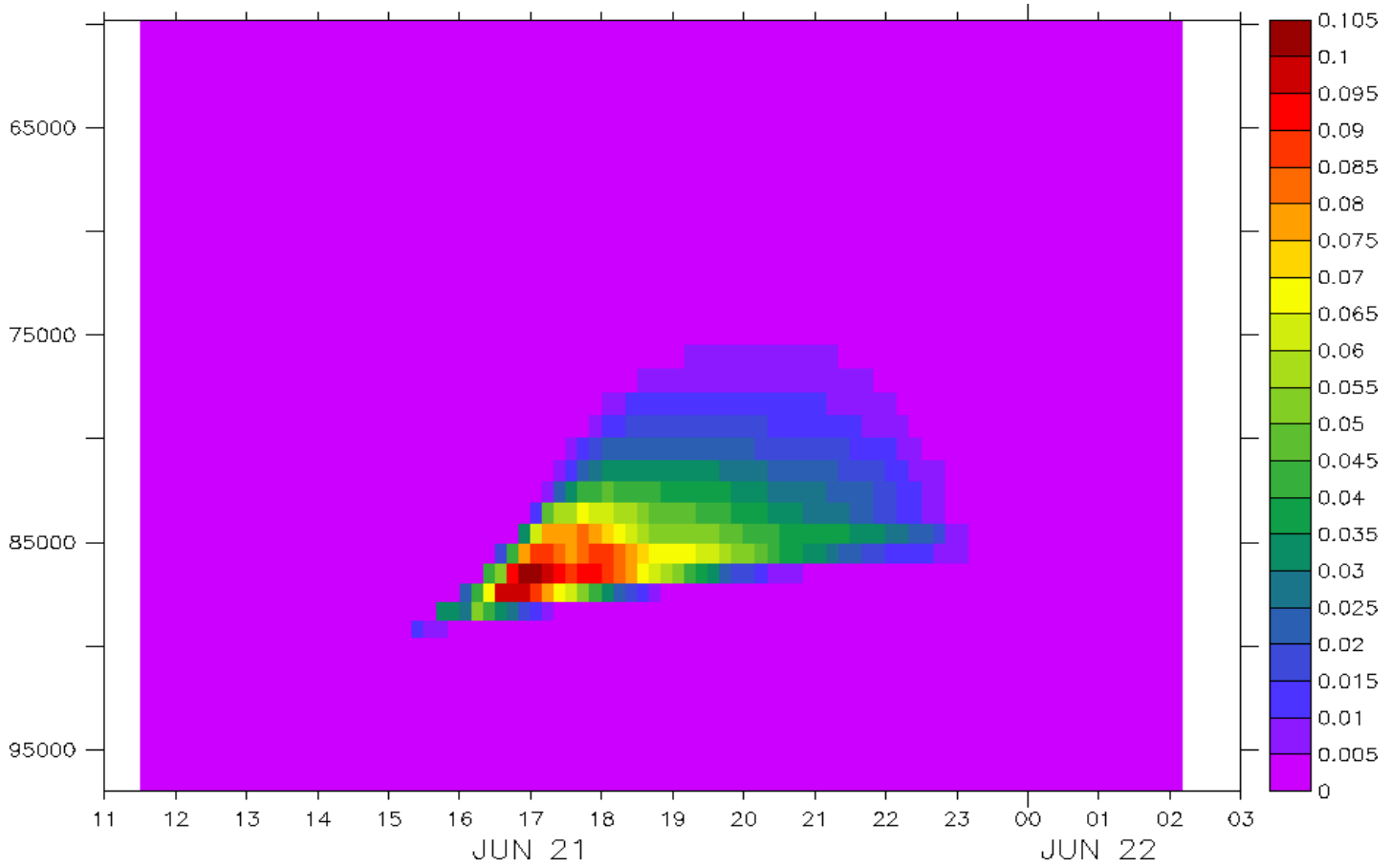
Where are located all these cases ?



Background : low cloud cover from Calipso (Chepfer et al. 2008)

Dry and shallow convection

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



Arm_cu case - Cloud fraction

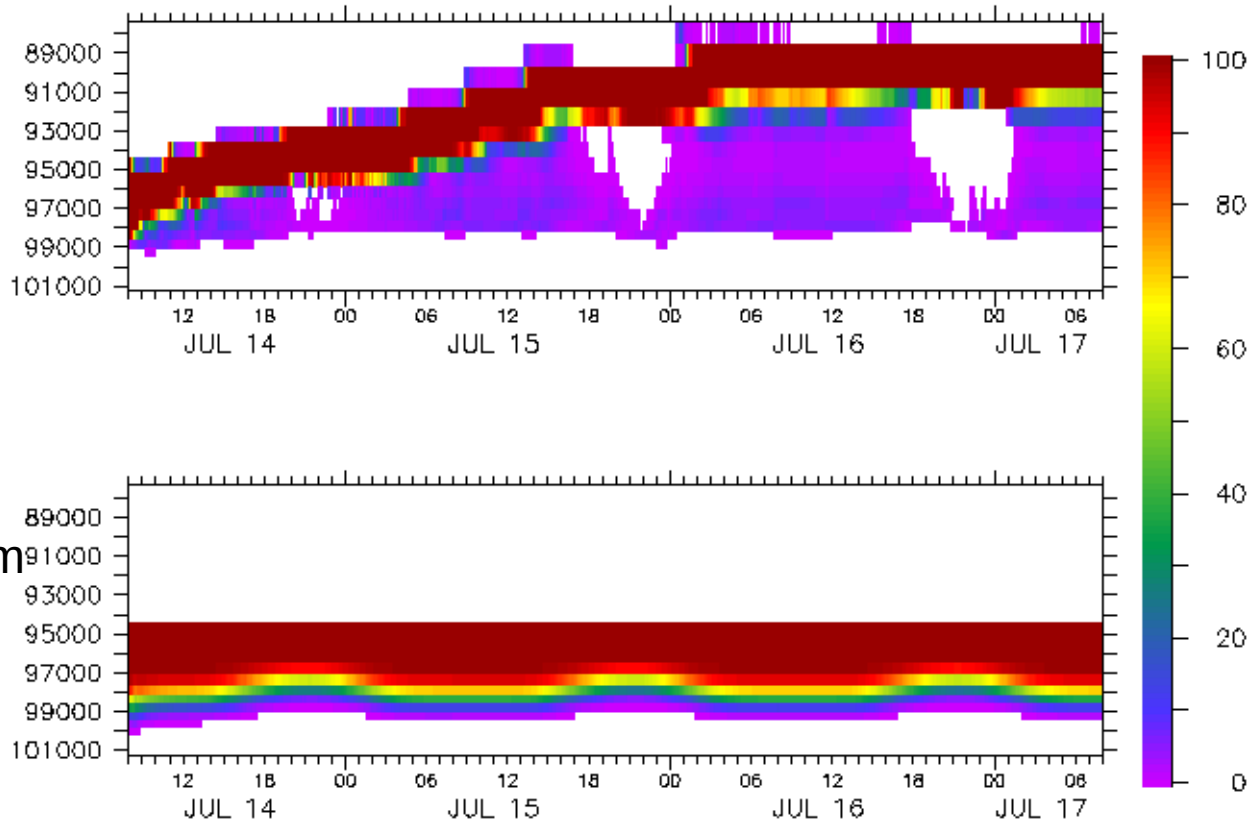
Stratocumulus and transition to cumulus

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

Fire case:
Cloud fraction (%)

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

Bottom: version developped by A.Jam

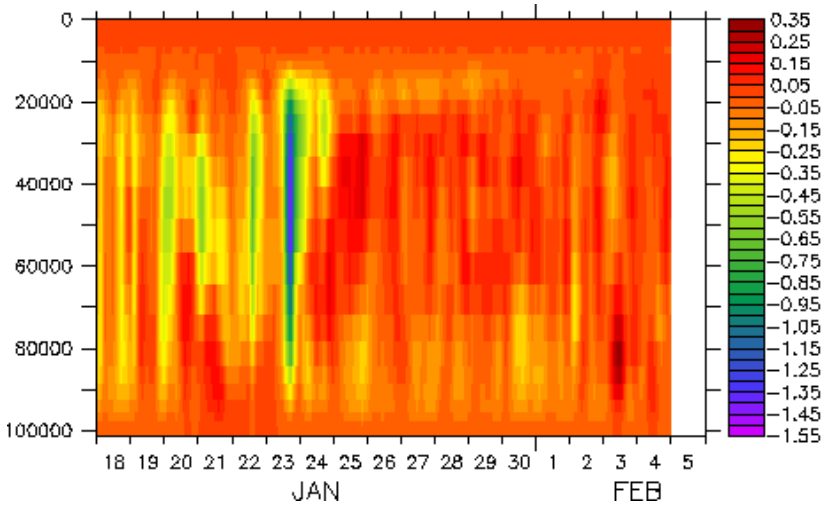


Deep convection:

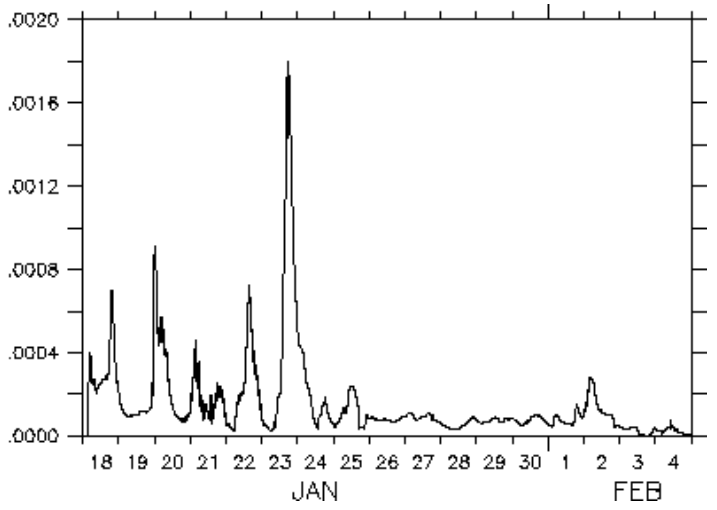
Over ocean:

- **Toga**
- **case_e** (part of Toga)
- **TWPICE** : off the coast of Darwin
- **Cindy Dynamo** : MJO study

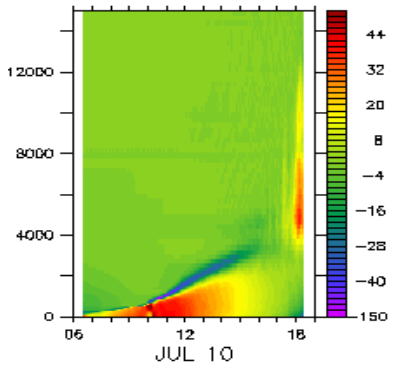
TWPICE Case (2 weeks)



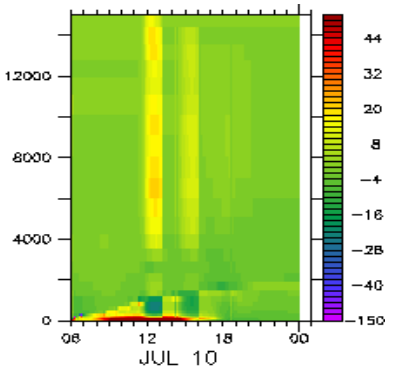
Forcings vertical speed (m/s)



Precipitation (mm/j)



LES from 6h **to 18h**



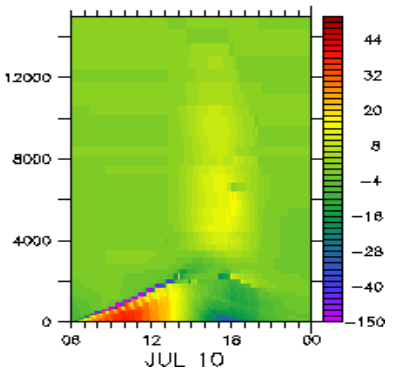
LMDZ_AR4_L39
From 6h **to 00h**

AMMA case (10h july 2006):
Thetal tendencies due to all schemes (K/j)

<u>Deep convection:</u>

<u>Over land:</u>
- **Hapex**
- **AMMA**

<u>Idealized case</u>:
- **eq_rad_conv** (RCE) : radiative and convection scheme active



LMDZ_NP_L70 from 6h **to 00h**

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

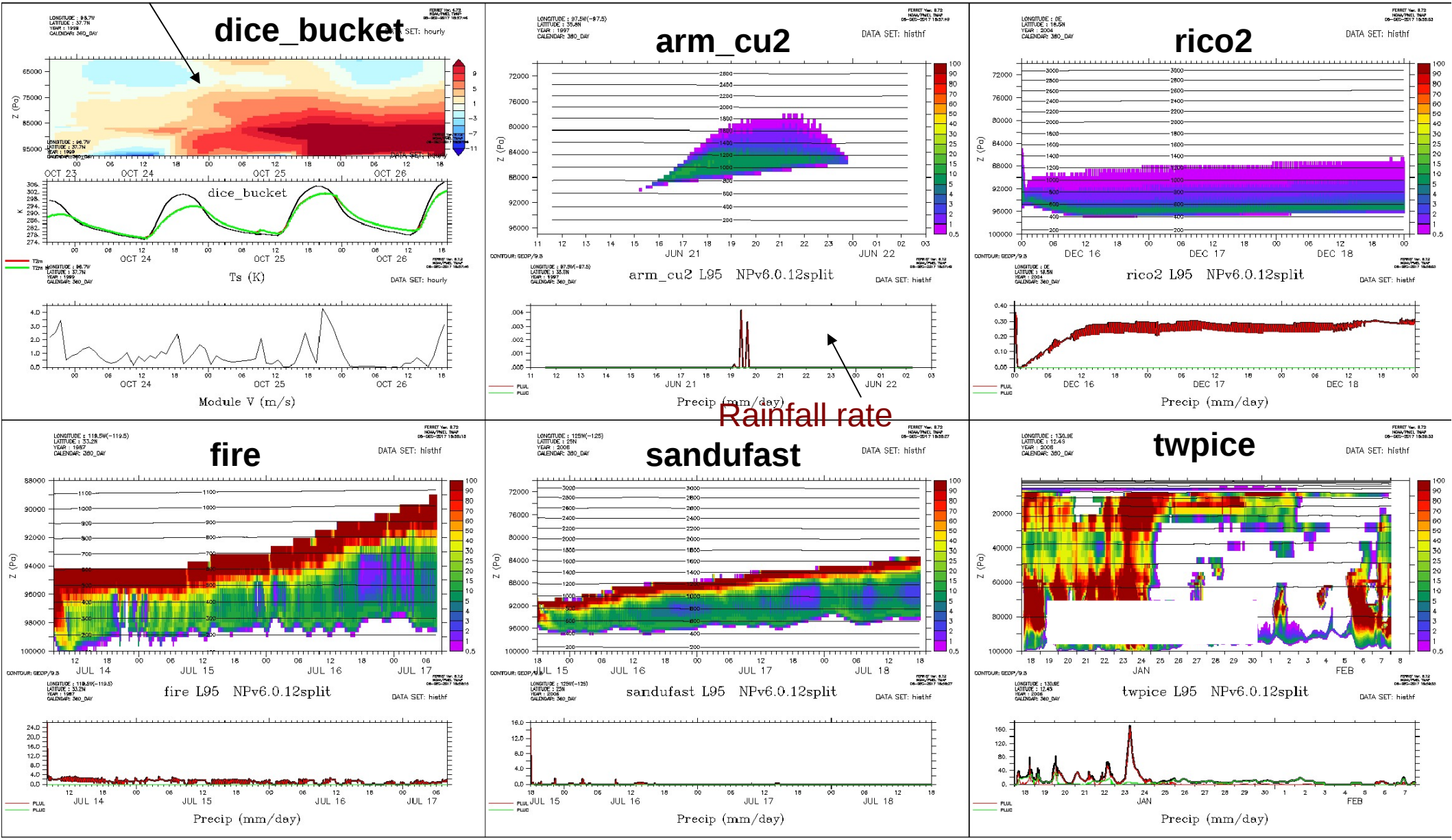
How to install and run it ?

+ install LMDZ 3D with **install_lmdz.sh**

+ install LMDZ 1D :
    * **wget** http://www.lmd.jussieu.fr/~lmdz/pub/1D/1D.tar.gz
    * **extract** 1D directory → creates 1D directory
    * cd 1D; ./run.sh
    * **runs automatically 6 cases** (dice_bucket arm_cu2 rico2 fire sandufast twpice) with 1 physical package
    * **shows some output**: cloud cover + precipitation plot

NPv6.0.12split physical package, with 95 lev

Cloud cover



What can you do in each case directory ?

+ **compile & run** with run.sh: choose case, physical package and level number

+ Look at **initial profils and forcings** (ascii files or netcdf files)

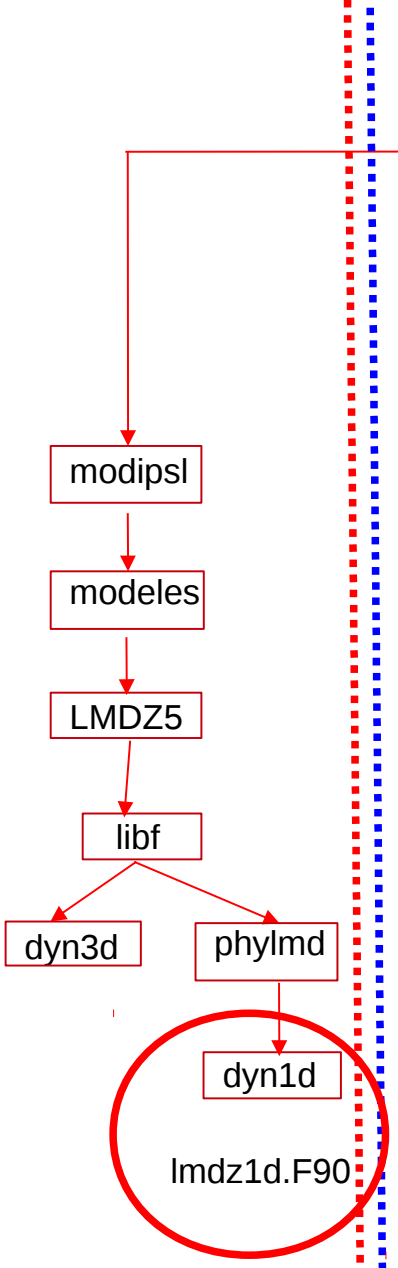
+ Modify ***def files**

+ Read **readme** file

+ **get results** in netcdf files (hist*.nc)

+ **compare** to LES results if avalaible

Where is located 1D ?



Code to modify

~/LMDZ20171130.trunk

1D/**run.sh**

DOC

OUTPUT_COMMUNS

bin

CAS

DIAG

INPUT

RESU

compile
lmdz1d.e

bin contains compile script and different versions of executable file

amma
  lmdz1d.def
  run.def
  readme
  forcing files
arm_cu
  LES.nc
case_e
fire
etc ...

CAS contains .def files specific for each case and LES results to compare with LMDZ outputs

dice_bucket
gabls4

DIAG contains scripts to plot diagnostics

DEF
  config.def
  gcm1d.def
  traceur.def
PHYS
  physiq.def_NPv3.2
  physiq.def_NPv6.0.12
  etc...
VERT
  L79
    L79.def
  L130
    L130.def
  etc...

INPUT contains 3 generic .def files and .def files specific for each physical package, vertical discretization

all.pdf
NPv3.2L39
  amma
  arm_cu
NPv6.0.12L79
  amma
  dice
SAVE5438

RESU directory contains results and is created at the first run

There are two ways to run the model :

- Either in « **operationnal mode** » with ~1D/run.sh (several cases and physical packages)
- Or « **by hand** » in ~/RESU/Np*xxx*/*case*/ with compile.sh then lmdz1d.e

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="NPv6.1 "
```

Number of levels ?

```
case $DEF in
   SP|NPV3.1|NPv3.2) L=39 ;;
   NPv4.12) L=59 ;;
   H2002) L=130
   *) L=79
esac
```

Where are the results ?
In LMDZtesting/1D/RESU/NPv6.1L95/amma
All the files necessary to 1D run are copied + output files

```
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
```

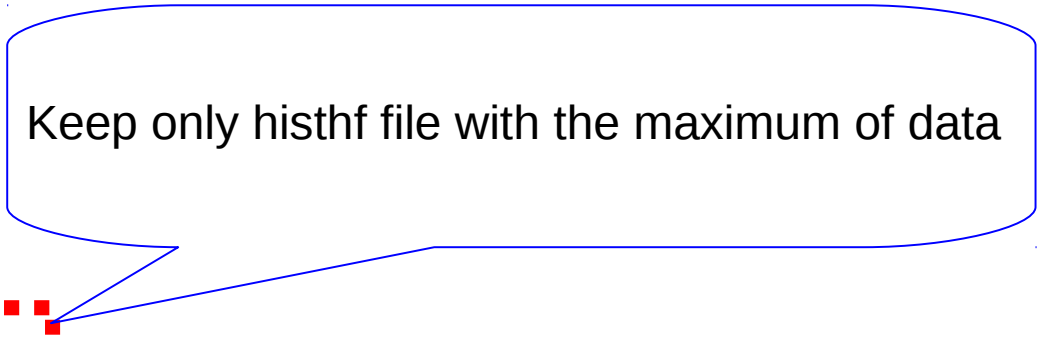
forcings

Result files

***def files**

CAUTION !
You can modify *def files in ~LMDZtesting/1D/RESU and quickly rerun the model because lmdz1d.e is in this directory. **BUT BE CAREFULL**
The « original » files are either under ~LMDZtesting/CAS or ~LMDZtesting/INPUT
And will be replaced at each run of run.sh

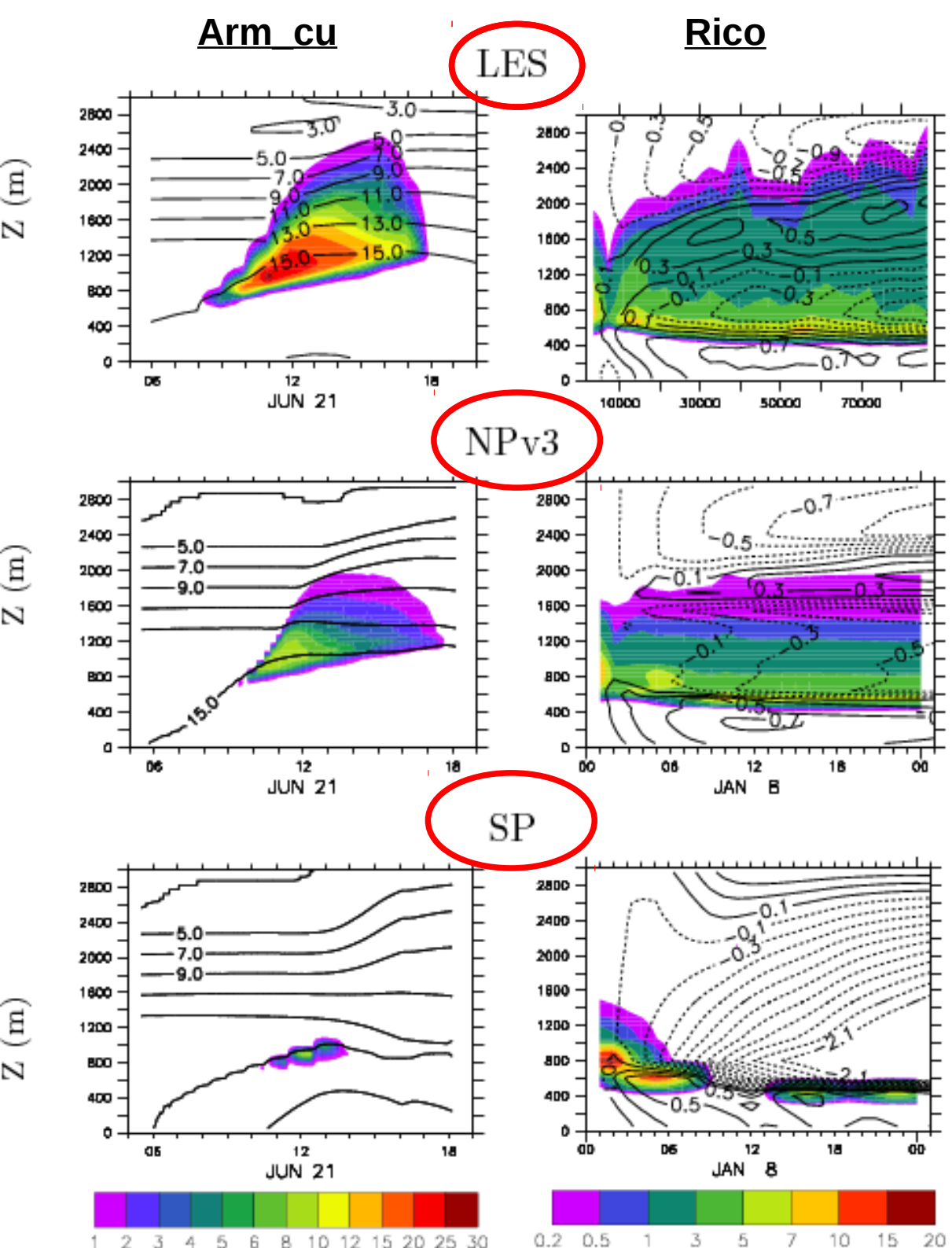
About 1D output files




```
phys_out_filekeys=           n     y     n       n       n
phys_out_filenames=      hourly histhf day  histins histLES    filehf
phys_out_filelevels=         5    10    10      10      10        0
phys_out_filetypes=      ave(X) inst(X)  ave(X) inst(X) inst(X)  inst(X)
phys_out_filetimesteps=  1hr    1ts    1day    1hr     6hr     1ts
```

To get all variables names :
ncdump -h histhf.nc|grep long_name|sort

To get the names of all temperature tendencies :
ncdump -h histhf.nc|grep long_name|grep dt



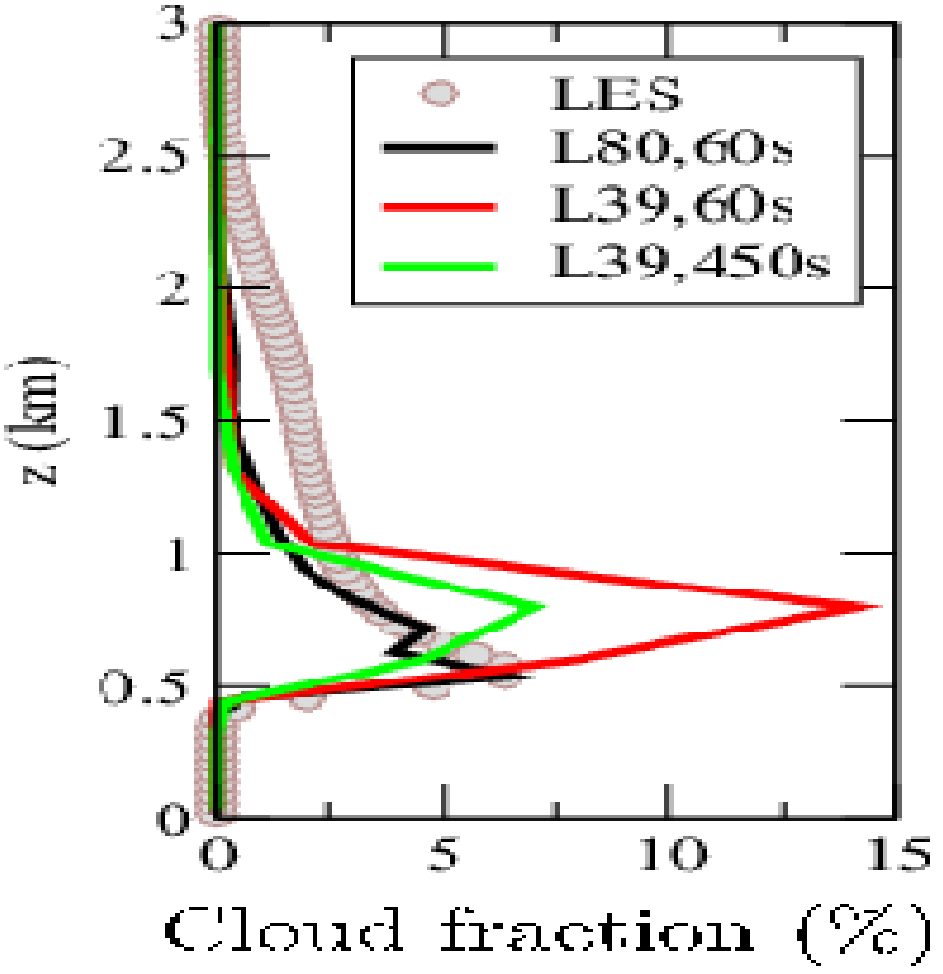
In LMD, we used these cases to develop New Physics version.

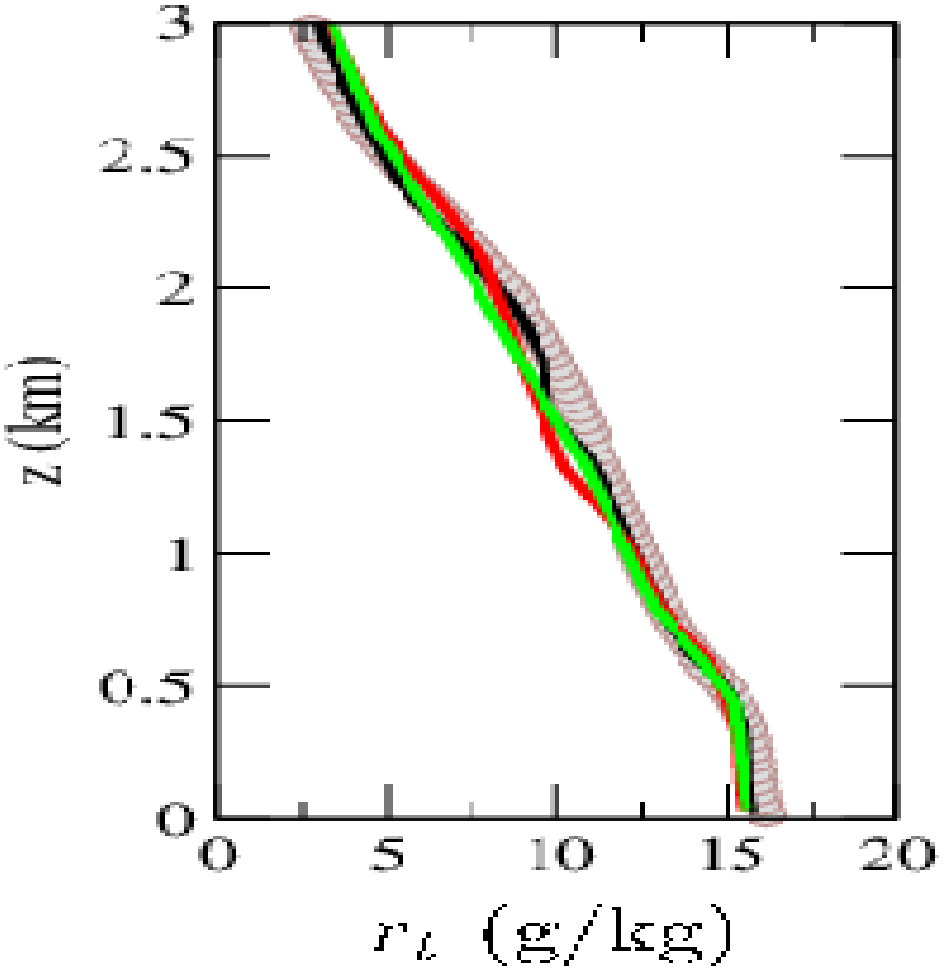
For 2 cases, Arm_cu and Rico, we compare results of « standard physics » (CMIP3), « new physics » (CMIP5) and LES model.

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

Rico case :

Sensitivity Tests to vertical discretization and time step





Thank you !!