

LMDZ tutorial: ORCHIDEE

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This tutorial focuses on the interaction with the continental surface scheme ORCHIDEE in LMDZ. This document can be downloaded as a pdf file:

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/Training/Tutorials/Tutorial_ORCHIDEE.pdf
```

which should ease any copy/paste of command lines to issue.

1 Prerequisites

You should be familiar with setting up simulations, as described in tutorials #1.

2 Preparing a simulation with Orchidee

- go to `LMDZ20191106.trunk/modips1/modeles/LMDZ` and use the file called

```
bench_lmdz_32x32x39.tar.gz
```

to create a new experiment:

```
mv BENCH32x32x39 BENCH32x32x39_old
tar -xf bench_lmdz_32x32x39.tar.gz
cd BENCH32x32x39
```

- make sure that `nday=1` in `run.def`
- to avoid recompiling the code, just create a link to the executable you have already compiled before:

```
ln -s ../BENCH32x32x39_old/gcm.e .
```

- open the `config.def` files and modify the flag `VEGET` that activates ORCHIDEE (if compiled):

```
VEGET=y
```

- open the `physiq.def` files and turn off the parameterization for the drag of induced by vertical obstacles penetrating the boundary layers like trees. It cannot be activated with the version of Orchidee distributed.

```
ifl_pbltree=0
```

3 Exploring the sensitivity to the continental surface scheme

3.1 Running with ORCHIDEE 2-layers

- get the file that describes the vegetation types over the continents

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/PFTmap_IPCC_2000.nc
```

- create a link

```
ln -s PFTmap_IPCC_2000.nc PFTmap.nc
```

- you can now run `gcm.e` to do a simulation with Orchidee activated.

The number of days, set in `run.def`, is `nday=1`. It can be increased and change 1day in 3day in `config.def`, in the line 'phys_out_filetimesteps' (otherwise your output file `histmth.nc` will be empty).

You can play with the `sechiba` output frequency by changing in `orchidee.def` the variable `WRITE_STEP` (in seconds; default: 86400 for daily output); 0 means no `sechiba` output; `N*86400` means output written every N days). A second output file `sechiba_out_2.nc` is for high-frequency output, modulated by `WRITE_STEP2` (default: 10800, for 3 hours)

You can change the complexity level of outputs by playing with the `SECHIBA_HISTLEVEL` variable: higher `SECHIBA_HISTLEVEL` means more variables in output. The variables corresponding to the various output levels are coded in

```
modips1/modeles/ORCHIDEE/src_sechiba/intersurf.f90
```

3.2 Running with ORCHIDEE 11-layers

create a new experiment: Proceed as in section and .

- Set `HYDROL_CWRR` to `y` in `orchidee.def` in order to use the multi-layer (11) hydrology in ORCHIDEE instead of the 2 layers scheme.
- you will need an initial state file for ORCHIDEE adapted to the multi-layer hydrology , you can get with:

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/sechiba_rest_in.11_13PFT.nc \\  
ln -s sechiba_rest_in.11_13PFT.nc sechiba_rest_in.nc
```

or creating it following the procedure "initializing ORCHIDEE-11"

- get file that describes the soil textures

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/soils_param.nc .
```

- you need to proceed as for ORC2 before running `gcm.e`

3.3 Running with the simple bucket scheme

If `VEGET=n` (meaning that the vegetation is not activated) instead of `y` in file `config.def`, the soil scheme is a simple bucket (even if you compiled with `makegcm -v true` as done by `install.sh` when ran with `veget=1`).

You can create a new experiment to test this option

3.4 Running with bucket scheme with imposed soil water content

Same as in 3.3, you should run with `VEGET=n` in `config.def`. Evaporation is computed as the potential evaporation multiplied by the aridity coefficient `vbeta`, which is a function of the soil water content `qsol0`:

$$vbeta(i) = \text{MIN}(2.0 * qsol / mx_eau_sol, 1.0)$$

(here `mx_eau_sol=150mm`). So, if `qsol0` is constant, `vbeta` is constant as well. You can fix `qsol0` to a chosen value `qsol0_val` (in mm), by adding in `physiq.def` the line `qsol0=qsol0_val` ; try for example `qsol0_val=5` or `10`, that result in `vbeta` values typical of summertime.

You can compare the turbulent fluxes for the austral summer (variables `flat` and `sens` in the LMDZ output files) computed using the different options.

4 Running with a more recent version for ORCHIDEE-11 (almost CMIP6-version)

- update orchidee version go into

```
modips1/modeles/ORCHIDEE/
```

you can update the version with "svn update -r 5004 " to use the revision 5004. You can need credentials (login : sechiba)

```
./makeorchidee_fcm -j 8 -noxios -prod -parallel none -arch local > orchideelogrev >&1
```

- compile LMDZ

```
in modips1/modeles/LMDZ
```

edit the file compile.sh and remove the option:

```
"-cpp ORCHIDEE_NOZOH" from the ./makelmdz_fcm
```

This is necessary to use the new interface between ORCHIDEE and LMDZ wich allows to compute 2 different roughness lengths for the moment and for the heat. then re-compile the LMDZOR model:

```
rm -rf \verb+bin/gcm.*+  
\verb+./compile.sh+
```

Once the code is successfully compiled, create a new EXPERIMENT as indicated above. Modify config.def in order to activate ORCHIDEE (modify physiq.def). It is recommended to download an updated orchidee.def can get an orchidee.def similar

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/orchidee.def.CMIP6
```

- cp ../bin/gcm_32x32x39_phylmd_seq_orch.e gcm.e
- you can download the file for the initial condition of sechiba
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/sechiba_rest_in.11_15PFT.nc
ln -s sechiba_rest_in.11_15PFT.nc sechiba_rest_in.nc
- download the file describing the vegetation adapted for 15 PFT

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/PFTmap_15PFT.v1_2000.nc\  
ln -s PFTmap_15PFT.v1_2000.nc PFTmap.nc
```

- Description of some keys of ORCHIDEE relevant for the atmosphere land-surface interactions
In orchide.def, the following keys allow to activate various recent options of ORCHIDEE:
Set ALB_BG_MODIS = y and ALB_BG_FILE = alb_bg.nc to use the background albedo optimized with MODIS. ROUGH_DYN : accounts for a dynamic roughness height (if y activation of Su et al. parametrization) OK_FREEZE : if y Activates the complet soil freezing scheme DEPTH_MAX_T=90 : set the maximum depth of the soil thermodynamics to 90m OK_EXPLICITSNOW : if y activates explicit snow scheme DO_RSOIL activates the resistance to bare soil evaporation

You can do a control run (launch the gcm) with DO_RSOIL = n and then run a sensitivity experiment with the resistance to bare soil evaporation activated (DO_RSOIL = y). You can then compare the latent heat flux: flat.

5 Initialisation of Orchidee-11 (CMIP6)

- Create a new experiment.
- Do the modification to activate orchidee
- Download files necessary for the initialization

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/alb_bg.nc
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/cartepente2d_15min.nc
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/lai2D.nc
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/soils_param.nc
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/PFTmap_15PFT.v1_2000.nc
```

you can get an updated file for orchidee.def from the same directory

```
wget http://www.lmd.jussieu.fr/~lmdz/pub/3DInputData/Orchidee/orchidee.def.new
mv orchidee.def.new orchidee.def
```

Verify that the file `sechiba_rest_in.nc` is not present in the working directory directory. You need to edit the `orchidee.def` (new) file and (if not present) add the line: `XIOS_ORCHIDEE_OK=n`, this prevents the use of XIOS for the outputs. Verify that `HYDROL_CWRR` is set to `y`.

You can do a control run (launch the `gcm`) with `DO_RSOIL = n` and then run a sensitivity experiment with the resistance to bare soil evaporation activated (`DO_RSOIL = y`). You can then compare the latent heat flux: flat.

6 Initialisation of Orchidee-11 (CMIP6)

- Create a new experiment.
- Do the modification to activate orchidee
- in `orchidee.def` set `SECHIBA_restart_in.nc` to `NONE` and remove the file `sechiba_rest_in.nc` from the working directory