

LMDZ tutorial: ORCHIDEE

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December 16th, 2018

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 and #2.

2 Preparing a simulation with Orchidee

- set `veget=1` in the script `init.sh` and replace `SIMU1` by `SIMUORCH` (for instance)
- Run the script :

```
./init.sh
```

The script first compiles the model (`gcm.e`) again and also compiles the program `ce01.e`, which creates initial state and boundary conditions. `init.sh` then downloads new NetCDF files which contain the surface orography, sea-surface temperature, and so on. `init.sh` then runs `ce01.e` which creates files `start.nc`, `startphy.nc` and `limit.nc` in a directory called `INITIAL`. These files are then used to initialize a new simulation in a directory called `SIMUORCH`. You can check that these 3 files have actually been created in the directory `SIMUORCH`. If not, please ask for our help. If you already run `init.sh` in a previous step (without `veget=1`), you already have these files in the directory called `INITIAL`. The script will get the files requested to initialize ORCHIDEE. You will need to run a first simulation to create the ORCHIDEE initial file. To do so:

```
cd SIMU0
edit physiq.def and set ifl_pbltree=0 (the default value is 1 but cannot be activated with the C
./gcm.e > listing0
```

This simulation should create a file called `sechiba_rest_out.nc`. The ORCHIDEE initial file of your simulation, `sechiba_rest_in.nc`, should point to this file (this is done automatically for the `SIMUORCH` experiment when `veget=1`).

- If you have the files `start.nc`, `startphy.nc` and `limit.nc` and `sechiba_rest_in.nc` in your `SIMUORCH` directory, you are almost done.

3 Exploring the sensitivity to the continental surface scheme

3.1 Running with ORCHIDEE 2-layers

in the directory `SIMU0` you already have a start file named `sechiba_rest_in.nc` (`sechiba` is the hydrological part of the soil/vegetation model Orchidee).

In the directory `SIMUORCH` you can 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; -1 means monthly 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

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.

If it's the first time that you do a run with ORCHIDEE in your current working directory (which is the case if you don't have a `sechiba_rest_in.nc` file), the procedure is the same as described in 3.1 for ORCHIDEE 2-layers.

If you have already done a run with ORCHIDEE -2 layers, you need to re-create an initial state file adapted to the multi-layer hydrology:

1. remove the file `sechiba_rest_in.nc` in `SIMU0` directory, and
2. remove `sechiba_rest_out.nc sechiba_out_2.nc sechiba_history.nc` and all `used_*` files
3. relaunch the `gcm`.

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`).

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) = 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 LMZ output files) computed using the different options.

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

go in the directory

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

if you have access to the web you can update the version with "svn update -r 4470 " to use the revision 4470 otherwise cp the file `ORCHIDEE.tar` which is in `LMZ/ORCHIDEE.tar`

```
modips1/modeles/
```

and do `tar -xvf ORCHIDEE.tar` go into `ORCHIDEE` and recompile

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

then go back in

```
modips1/modeles/LMDZ
```

edit the file compile.sh and remove the option:

```
-cpp ORCHIDEE_NOZOH from the ./make_lmdz_fcm
```

line. We need to do that in order 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:

```
./compile.sh
```

if the compilation fails ask for help.

Once the code is successfully compiled, create a new directory for this experiment

```
in modipsl/modeles/LMDZ/TUTORIAL
mkdir SIMUNORCH
cd SIMUNORCH

ln -s ../SIMUNORCH/start.nc .
ln -s ../SIMUNORCH/startphy.nc .
ln -s ../SIMUNORCH/limit.nc .
ln -s ../SIMUO/PFTmap.nc .
ln -s ../SIMUO/cartepente2d_15min.nc .
ln -s ../SIMUO/lai2D.nc .
ln -s ../SIMUO/soils_param.nc .
cp ../SIMUNORCH/*.def .
ln -s ../SIMUNORCH/gcm.e .
```

In order to benefit from the albedo optimized from MODIS you need to use the file alb_bg.nc which is in

```
~/LMDZ/pub/3DInputData/Orchidee
```

You can get it also with the following command:

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

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

```
cp ~/LMDZ/pub/3DInputData/Orchidee/orchidee.def.new orchidee.def
or
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 SIMUNORCH directory.

You need to edit the orchidee.def (new) file and (if not present) add the line: XIOS_ORCHIDEE_OK to n, this prevents the use of XIOS for the outputs. Verify that HYDROL_CWRR is set to y. Set SECHIBA_restart_in.nc to NONE, set SOILTYPE_CLASSIF to zobler, and set SOILCLASS_FILE to soils_param.nc in order to use the zobler texture map. Set ALB_BG_MODIS = y and ALB_BG_FILE = alb_bg.nc to use the background albedo optimized with MODIS. In orchidee.def, the following keys allow to activate various recent options of ORCHIDEE:

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.