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 Prerequisits

You should be familiar with setting up simulations, as described in tutorials #1 and #2.

2 Preparing a simulation with Orchidee

You should have completed the tutorial 2, and have a directory SIMU1 in the TUTORIAL directory.

- In the directory `TUTORIAL/DEF`

  edit physiq.def and set `ifl_pbltree=0` (the default value is 1 but cannot be activated with the Orchidee version which is distributed for the training) edit the orchidee.def file and set `XIOS_ORCHIDEE_OK=n` which means that the outputs wont'be produced with XIOS but with IOIPSL. Then in the TUTORIAL directory set `veget=1` in the script init.sh

- Run the script :

  ```
  ./init.sh
  ```

  The script first compiles the model (`gcm.e`) again and will get input files to create the ORCHIDEE initial file. To do so, once the init.sh script is done:

  ```
  cd SIMU0
  ./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 SIMU1 experiment when `veget=1`).

- If you have the files `start.nc`, `startphy.nc` and `limit.nc` and `sechiba_rest_in.nc` in your SIMU1 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 SIMU1 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

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

3.2 Running with ORCHIDEE 11-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,
2. 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. (this is now the recommanded version for the hydrology) and
3. remove sechiba_rest_out.nc sechiba_out_2.nc sechiba_history.nc and all used_* files
4. relaunch gcm.e
5. Then you can copy the directory SIMU1 onto SIMUORC11 for instance (cp -rfp SIMU1 SIMUORC11)
6. in SIMUORC11 edit orchidee.def, set HYDROL_CWRR to y in orchidee.def
7. remove sechiba_rest_out.nc sechiba_out_2.nc sechiba_history.nc and all used_* files (if present)
8. launch gcm.e
9. You can compare the near surface temperature produced when the 2-layer scheme is activated (SIMU1) or when the 11-layer scheme is activated (SIMUORC11)

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 copy the SIMU1 directory onto a SIMUbucket directory, modify the config.def file as indicated above and run the model again

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

1. Go in the directory

   ```
   modipsl/modeles/ORCHIDEE/
   ```

   You can update the version with "svn update -r 4470 " to use the revision 4470

2. `go in modipsl/modele/LMDZ/TUTORIAL`

   edit the file init.sh and remove the option:

   `-cpp ORCHIDEE_NOZOH from the optveget="-v orchidee2.0 -cpp ORCHIDEE_NOZOH"`

   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.

3. Launch ./init.sh if the compilation fails ask for help.

4. You can redo the experiments already done with the older version of ORCHIDEE.

   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

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

   (a) Verify that the file `sechiba_rest_in.nc` is not present in working directory.
   (b) 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.
   (c) Verify that `HYDROL_CWRR` is set to `y`.
   (d) Set `SECHIBA_restart_in.nc` to `NONE`,
   (e) Set `SOILTYPE_CLASSIF` to `zobler`, and
   (f) Set `SOILCLASS_FILE` to `soils_param.nc` in order to use the zobler texture map.
   (g) Set `ALB_BG_MODIS = y`
   (h) Set `ALB_BG_FILE =alb_bg.nc`

   In `orchide.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 explict 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 evporation activated (`DO_RSOIL = y`). You can then compare the latent heat flux: flat.