Working with LDAS-Monde on the CNRM infrastructure

original version: Clément Albergel (last update: February 1, 2018)
last version: Bertrand Bonan (April 9, 2018)
current version: Yongjun Zheng

November 7, 2018

This document aims to help you starting working with LDAS-Monde on the CNRM infrastructure. In the first section I explain how to install LDAS-Monde on sxvgo1 and beaufix. Then I explain how to run LDAS-Monde with the help of a test case (1-year expriment over the Iberian peninsula) following six steps.

The original version is created by Clément Albergel. Bertrand Bonan has mainly updated the location of atmospheric forcings and observations and given few more details on each of the six steps. Yongjun Zheng updated the document since he has changed the scripts to improve the efficiency of the LDAS-Monde.

1 How to install LDAS-Monde

To install LDAS-Monde on the CNRM infrastructure (*i.e.* sxvgo1, beaufix and the ftp server hendrix) you first need to:

- Install and Compile SURFEX_V81 on beaufix

- Download LDAS-Chain on sxvgo1

- Setup lftp client for uploading the results from beaufix to hendrix

1.1 Install and compile SURFEX_V81 on beaufix

1. You first need to get a copy of SURFEX_V81. To do so:

   - You first need to be identified by the server. For that, send your SSH public key to `operator@meteo.fr`. This key is available in the directory `$HOME/.ssh`, in the file `id_rsa.pub`. *For indication my $HOME is /home/cnrm_other/ge/mrmi/bonanb*. If this file does not exist, you can create it with the command: `ssh-keygen`

   - Please wait until you got an answered email from the first step. Then, You need to get access granted to SURFEX by administrators. One of them is Marie Minvielle. You can email her at `marie.minvielle@meteo.fr`.

   - When both previous step are done, create a new directory `SURFEX_V81`. You can copy SURFEX in this new directory from a git repository with the command:

     `git clone ssh://reader097@git.umr-cnrm.fr/git/Surfex_Git2.git`

2. Copy the file `compil_master`

   ```
   cp /home/cnrm_other/ge/mrmi/albergelc/SURFEX_V81/Surfex_Git2/src/compil_master
      $HOME/SURFEX_V81/Surfex_Git2/src
   ```

3. Check in `Makefile.SURFEX.mk` if SODA is declared as an option. Line 669 of `Makefile.SURFEX.mk` should be:

```
PROG_LIST += PGD PREP OFFLINE SODA
```

4. To compile SURFEX, you need to load few modules. I find it convenient to load them automatically when I open a new terminal. So I put everything I need in $HOME/.bash_profile, see below:

```
# .bash_profile

# Get the aliases and functions
if [ -f ~/.bashrc ]; then
. ~/.bashrc
fi

# User specific environment and startup programs

PATH=$PATH:$HOME/bin

export PATH\

. ~payart/mesonh/profile_mnhp
# I do not know what is the use of the previous line
# It was in Clement's .bash_profile (so I kept it)

export I_MPI_PMI_LIBRARY=/usr/lib64/libpmi.so

# Module loading
# ---------------------
module load intel ;
module load intelmpi ;
module load netcdf ;
module load grib_api ;
module load python ;
#export GRIBAPI_PATH=/opt/softs/libraries/ICC13.1.4.183/grib_api-1.9.16_libtool
module list
```

In above list, the lines containning "module load" are essential. When you have done the modifications, do not forget to load the new profile by doing

```
source $HOME/.bash_profile
```

5. Compile SURFEX

```
./compile_master
```

When the compilation starts, you should have the following message:

```
Usage:
  master version: ./compil_master
  user version  : ./compil_master name_of_user_version
                  export VER_USER=name_of_user_version ; ./compil_master

Compiling MASTER version
Are you sure? [y]/n
```

Just type y. Then the compilation can start. Be aware that it can take a while.

6. You also need ECOCLIMAP and TRIP data:

```
mkdir $HOME/Data
cp -r -f $HOME/../albergelc/Data/ECOCLIMAP $HOME/Data
```

1.2   Download LDAS-Chain on sxvgo1

Create an LDAS folder:

```
mkdir $HOME/LDAS
cd LDAS/
```

Note: We are now working with sxvgo1 so now my $HOME is /cnrm/vegeo/bonanb

Get the latest LDAS pre- and post processing chain:

```
scp beaufix:/home/cnrm_other/ge/mrmi/zhengy/repo/LDAS-v1.3.0-20181107.tgz .
tar zxf LDAS-v1.3.0-20181107.tgz
```

Create a folder (and subfolders) for the test case over the Iberian peninsula

```
mkdir Spain_LDAS Spain_LDAS/sfx-trip Spain_LDAS/sfx-trip/pgd_prep
mkdir Spain_LDAS/sfx-trip/OPTIONS
mkdir Spain_LDAS/forcings Spain_LDAS/observations Spain_LDAS/results
```

Adapt the different working directions in my_options_Spain.py. As an indication I used

```
# -------------------------------
# DIRECTORIES
# -------------------------------

####### Input

# Must contain OPTIONS.nam and TRIP_OPTIONS.nam (if TRIP is used)
options_path = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/sfx-trip/OPTIONS/'
# Must include PGD.nc, PGD_fractown.nc and PREP.nc
mod_pgd_path = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/sfx-trip/pgd_prep/'
# Folder from where the raw forcing data is read
raw_forcing_dir = '/cnrm/vegeo/albergelc/Forcing/ERA5_025/'
# Root folder of all observation files
obs_root_dir = '/cnrm/vegeo/LDAS/OBSERVATIONS/'
# Folder from where openloop output is read in pre- and post-processing steps
openloop_dir = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/results/sfx-trip/ol/'
# Folder from where analysis output is read in post-processing step
analysis_dir = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/results/sfx-trip/'+exp_name+'/'

####### Output

# Folder where NetCDF (as well as intermediate binary) forcing files are written.
forcing_dir  = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/forcings/daily/'
# Folder where processed (CANARI files) observations are written
out_obs_dir  = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/observations/sfx-trip/'
# Folder where PData (when asked) model output data are written
out_mod_dir  = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/results/sfx-trip/ldas_post/ol/'
# Folder where PData (when asked) analysis output data are written
out_ana_dir  = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/results/sfx-trip/ldas_post/'+exp_name+'/'
# Folder from where graphics files are written in the post-processing step.
graphics_dir = '/cnrm/vegeo/bonanb/LDAS/Spain_LDAS/figures/'
```

1.3   Setup lftp client for uploading the results from beaufix to hendrix

Because the LDAS-Monde system uses lftp client to transfer files between beaufix and hendrix, to transfer automatically without asking the username and password for hendrix FTP server, you must add the following line in $HOME/.netrc

```
machine hendrix login usr password pwd
```

where *usr* and *pwd* are your username and password for hendrix FTP server. For security purposes, please execute the following command:

```
chmod og-rwx $HOME/.netrc
```

Every time you change the password of your account, don't forget the change $HOME/.netrc accordingly.

Because the **transfert** nodes do not have the lftp client, I have built a standalone version of lftp client under the directory /home/cnrm_other/ge/mrmi/zhengy/softs/lftp on beaufix. **You can copy this directory to anywhere you want, and add the following line in $HOME/.bash_profile:**

```
export PATH=dir/lftp/bin:$PATH
```

dir is the directory where you put lftp. Finally, do not forget to make it take effect by "source $HOME/.bash_profile" or re-login, and now you can verify the setup by typing "lftp hendrix -e 'ls; quit'" in the commandline. To make sure that you have the right version of lftp, you can type "lftp – version" in the commandline, the first line of the outputs should be "LFTP — Version 4.8.3 — Copyright (c) 1996-2017 Alexander V. Lukyanov".

2 How to run LDAS-Monde

The full LDAS-Chain consists of six different steps (see Figure 1). I will detail what they do using a test case, a 1-year experiment over the Iberian peninsula that I first describe.
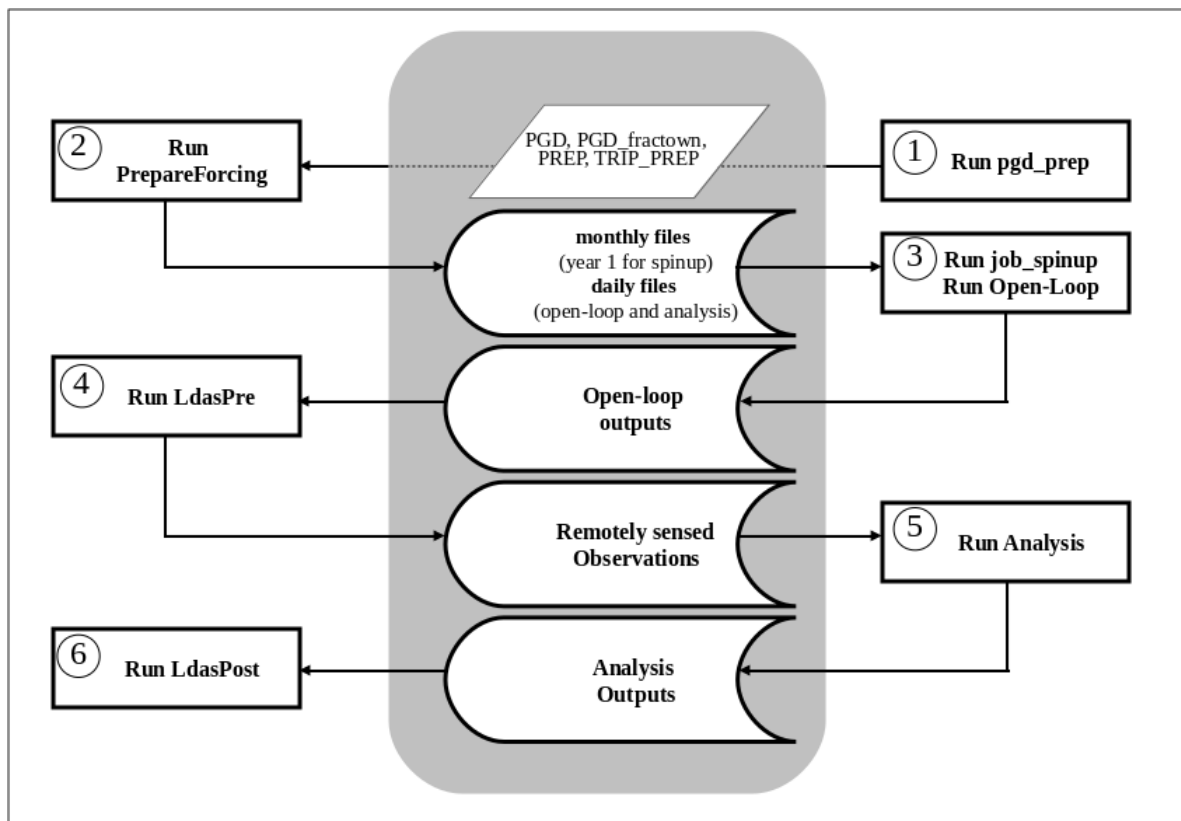

Figure 1: Summary of LDAS-Chain, © Clément Albergel. Steps on the left are performed on sxvgo1 and steps on the right are performed on beaufix.

Prepare the test case over the Iberian peninsula for 2010

To get the test case, just follow:

```
scp /cnrm/vegeo/albergelc/Spain_V81_KTEST_v1.0.tar.gz
      your_login@beaufix:/$HOME/SURFEX_V81/Surfex_Git2/MY_RUN/KTEST
ssh beaufix
cd $HOME/SURFEX_V81/Surfex_Git2/MY_RUN/KTEST
tar xvfz Spain_V81_KTEST_v1.0.tar.gz
mv Spain_V81 Spain
mv Spain_V81_KTEST_v1.0.tar.gz ./Spain
```

You may need to check if the options in the options files are rightly specified.

In `./OPTIONS/OPTIONS.nam`:

- check if NYEAR, NMONTH, NDAY and XTIME in NAM_PREP_SURF_ATM are correctly specified. The experiment should start 1st January 2010, 00:00.

- check if XLONMIN, XLONMAX, XLATMIN, XLATMAX, NLON and NLAT in NAM_LONGLAT_REG are correctly specified. The studied domain is the Iberian peninsula, *i.e.* between -10° and 5° for longitude, between 35.5° and 44° for latitude. We use NLON = 60 and NLAT = 34 in order to have a 0.25° resolution for ISBA. Alternatively you can use NLON = 30 and NLAT = 17 to have a 0.5° resolution over the domain.

- check if LSPLIT_PATCH=F in NAM_WRITE_SURF_ATM. If not, correct or add it.

- remove (if needed) CROUGH from NAM_SSOn

- add CALBEDO = 'CM13' in NAM_ISBA and remove it from NAM_ISBAn

In `./OPTIONS/TRIP_OPTIONS.nam`:

- check if NYEAR, NMONTH, NDAY and XTIME in NAM_START_DATE are correctly specified. The experiment should start 1st January 2010, 00:00.

- check if TLONMIN, TLONMAX, TLATMIN, TLATMAX and TRES in NAM_TRIP_GRID are correctly specified. TLONMIN = $-10°$, TLONMAX = $5°$, TLATMIN = $35.5°$, TLATMAX = $44°$. We specify a 0.5° resolution for TRIP, so TRES = 0.5°.

In `./OPTIONS/namcouple`:

- make sure the dimensions for coupling between SURFEX and TRIP models are consistent with those in `./OPTIONS/OPTIONS.nam` and `./OPTIONS/TRIP_OPTIONS.nam`.

You may also need to check if the options specified in `my_options_Spain.my`, on sxvgo1, are correct. In particular:

- check if `analysis_period` is ['2010-01-01', '2010-12-31'].

- check if `freq_forcing = 1`, the atmospheric forcing we use is ERA 0.25° is available every hour (see in folder `raw_forcing_dir`).

- check if `obs_names = ['SWI','LAI_V1']` and `obs_datasets = ['CGLS','CGLS_20D']`. We use SWI observations from CGLS for the surface soil moisture and LAI from CGLS_20D for leaf area index (see in folder `obs_root_dir`).

- check if `rescale_calib_periods = [ ['2010-01-01', '2010-12-31'],[] ]`. We rescale SWI observations with the model using CDF matching. LAI are not rescaled.

2.1 LDAS-Chain task 0: Update the LDAS scripts

Go to the top directory on beaufix of your test case, for example, for the test case in this document just follow:

```
cd $HOME/SURFEX_V81/Surfex_Git2/MY_RUN/KTEST/Spain
tar zcf scripts_old.tgz *.sh SCRIPTS/*
rm -rf *.sh SCRIPTS/*
tar zxf /home/cnrm_other/ge/mrmi/zhengy/repo/sh-20181107.tgz
```

2.2 LDAS-Chain task 1: job_pgd_prep

Task 1 produces files (`PGD.nc`, `PREP.nc`, `TRIP_PREP.nc` and `PGD_fracdown.nc`) needed to initialize SUR-FEX.

On beaufix, do:

```
cd $HOME/SURFEX_V81/Surfex_Git2/MY_RUN/KTEST/Spain
sbatch job_pgd_prep.sh
```

Before submitting the job, please modify the following lines in job_pgd_prep.sh. Or simply set ROOT_DIR variable and link the SURFEX root directory (containing exe and src) to SURFEX and link the directory (containing ECOCLIMAP) to Data under ROOT_DIR.

```
ROOT_DIR=/home/$(whoami)/LDAS
SURF_DIR=$ROOT_DIR/SURFEX
DATA_DIR=$ROOT_DIR/Data
```

In some configuration mpirun has to be executed with `./` (*i.e.* `./job_pgd_prep.sh`). Check the log file `pgd_prep.log` to see whether the run succeeded or not.

Upload pgd_prep files from beaufix to sxvgo1 (`PGD.nc`, `PREP.nc`, `TRIP_PREP.nc` and `PGD_fracdown.nc`)

```
cd pgd_prep
scp PGD.nc PGD_fracdown.PC PREP_2010010100.nc TRIP_PREP_2010010100.nc
    login@sxvgo1:/$HOME/LDAS/Spain_LDAS/sfx-trip/pgd_prep
```

Upload options files from beaufix to sxvgo1 (OPTIONS.nam, TRIP_OPTIONS.nam)

```
cd ../OPTIONS/
scp OPTIONS.nam TRIP_OPTIONS.nam login@sxvgo1:/$HOME/LDAS/Spain_LDAS/sfx-trip/OPTIONS
```

On sxvgo1, rename files to remove date information when appropriate, or ladsPre.py can not find these files.

2.3 LDAS-Chain task 2: prepareForcing.py

Task 2 produces monthly and daily atmospheric forcing files. From global monthly files of atmospheric forcing (called raw forcings) it will first crop the specified domain, the iberian peninsula in this case, (files stored in `forcing_dir/raw_monthly`), and then create 24-hour files from d1 at 09:00 to d+1 at 09:00 (files stored in `forcing_dir`).

On sxvgo1 :

```
cd $HOME/LDAS/LDAS_v1.2.3
python prepareForcing.py my_options_Spain.py
```

Before execution, check if you have the right information in `my_options_Spain.py` for the forcings (where raw forcings are stored and where you will store daily forcing files).

Upload **monthly files** of the first year (for spinup) to the ftp server hendrix. On sxvgo1:

```
cd $HOME/LDAS/Spain/forcings/monthly
lftp hendrix
mkdir LDAS/Spain/forcings/monthly
cd LDAS/Spain/forcings/monthly
mput *nc
bye
```

Upload **daily files** to the ftp server hendrix. On sxvgo1:

```
cd $HOME/LDAS/Spain/forcings/daily
lftp hendrix
mkdir LDAS/Spain/forcings/daily
cd LDAS/Spain/forcings/daily
mput *nc
bye
```

For the forcings for deterministic forecasts, you need to upload them with the directory.
You can use the following snippet:

```
for f in 'ls -d FC_*'
do
  lftp hendrix -e "cd $HOME/LDAS/Spain/forcings/daily; mkdir -fp $f; cd $f; mput $f/FORCING_*.nc; qu
done
```

Note that the prepareForcing.py has been updated. Now it can prepare the forcings for both analyses and deterministic forecasts. So you need to set **DAYS_NC=[]** and **FREQ_NC=[]** for analyses in your options*.py. For deterministic forecasts, you also need to set the **raw_forcing_dir** (for example raw_forcing_dir = ['/cnrm/vegeo/albergelc/Forcing/IFS_fc6/', '/cnrm/vegeo/albergelc/Forcing/IFS_fc10/']) besides setting **DAYS_NC=[6,10]** and **FREQ_NC=[3,6]**.

2.4   LDAS-Chain task 3: Spin-up and open loop

LDAS-Chain task 3a: Spin-up

Task 3a fully initialize the model by running the model twenty times over a year with the same atmospheric forcing over the year to produce an initial state that is physical.

On beaufix,

```
cd $HOME/SURFEX_V81/Surfex_Git2/MY_RUN/KTEST/Spain/pgd_prep
cp PREP_2010010100.nc  PREP_2010010100_INIT.nc
cp TRIP_PREP_2010010100.nc  TRIP_PREP_2010010100_INIT.nc
cp lsm_2010010100.nc  lsm_2010010100_INIT.nc
cp trip_2010010100.nc  trip_2010010100_INIT.nc
cd ..
nohup job_spinup.sh Spain 2 &
```

Before running, please modify the following lines in job_spinup.sh. Or simply set ROOT_DIR variable and link the SURFEX root directory (containing exe and src) to SURFEX and link the directory (containing ECOCLIMAP) to Data under ROOT_DIR.

```
FORCINGDIR=/home/$(whoami)/LDAS/$DOM/forcings/monthly #on hendrix
ROOT_DIR=/home/$(whoami)/LDAS
SURF_DIR=$ROOT_DIR/SURFEX
DATA_DIR=$ROOT_DIR/Data
```

This step will take a while since it runs 20 times the integration of the year 2010. Check the log file `spinup.log`, it indicates if the spinup is working correctly or not.

Spinup ran from 00:00 to 00:00 so a small adjustment is required to go from 00:00 to 09:00 (the normal

run starts at 09:00). This is performed with `script_ldas.sh`.

First, please modify the following lines in script_ldas.sh. Or simply set ROOT_DIR variable and link the SURFEX root directory (containing exe and src) to SURFEX and link the directory (containing ECOCLIMAP) to Data under ROOT_DIR.

```
ROOT_DIR=/home/$(whoami)/LDAS
SURF_DIR=$ROOT_DIR/SURFEX
DATA_DIR=$ROOT_DIR/Data
```

Also, please adjust the following variable in script_ldas.sh:

- SCRATCHDIR=/scratch/work/$(whoami)/LDAS/$DOM/$EXP #on beaufix where the intermediate files are stored during running

- FORCINGDIR=/home/$(whoami)/LDAS/$DOM/forcings/daily #on hendrix where the forcings are stored

- OBSDIR=/home/$(whoami)/LDAS/$DOM/observations/CANARI #on hendrix where the observations are stored

- RESDIR=/home/$(whoami)/LDAS/$DOM/$EXP #on hendrix where the results are stored

It is worth noting that this modification of script_ldas.sh is done once and the script_ldas.sh can be used for open loop and soda. The usage of script_ldas.sh is easy:

```
script_ldas.sh TYP[:NJOB:days_FC] DOM:EXP YYYYMMDDHH_beg[:YYYYMMDDHH_end] days_per_job[:days_per_ftp
               num_nodes[:tasks_per_node] [job_time_limit] [VERSION]


TYP              = ENKF if run the ensemble of SURFEX then an Ensemble Kalman filter (closed-loop)
                 = EKF if run the perturbations of SURFEX then an Extended Kalman filter (closed-loop)
                 = OL if run the offline SURFEX without assimilations (open-loop)
                 = ENOL if run the ensemble offline SURFEX without assimilations (open-loop)
NJOB             = the number of jobs submited at the same time for the ensemble or perturbations
days_FC          = the days of a deterministic forecast, zero if no deterministic forecsts
DOM              = the name of a domain
EXP              = the name of an experiment
job_time_limit   = hh:mm:ss
VERSION          = not specified if the standard version is used
                 = MYSRC_EnSRF for example, if the user verion is used
```

where the term in a square brace is optional.

Thus, to integrate from 20100101 00:00 to 20100101 09:00, please execute the following command by adjusting the num_nodes and the job_time_limit accouding to the size of your domain:

```
script_ldas.sh OL Spain:ol 2010010100:2010010109 1 2 00:02:00
```

After the job executed sucessfully, execute `./copy_restart.sh ol` to get the new restart files.

LDAS-Chain task 3b: Open loop

Task 3b runs the model over a year (open loop, *i.e.* no data assimilation).

If you have adjusted the script_ldas.sh correctly, the execution of an open loop is simple. On beaufix, execute the following command by adjusting the num_nodes and the job_time_limit accouding to the size of your domain:

```
nohup script_ldas.sh OL Spain:ol 2010010109:2010123109 30 2 00:20:00 >& ol.log &
```

You can monitor the job by using the command `topq`. By default `topq` is not installed on beaufix, you can get it by doing:

```
cp $HOME/../albergelc/bin/topq $HOME/bin
```

You can also use `tail -f ol.log`. This gives you the last lines of `ol.log` and show live new lines written in the file.

Every days_per_ftp days, the results are archived and transfered to hendrix.

If the job runs out of time, the script_ldas.sh will restart the running from the stop date automatically (now you don't need to do it manually). If restarting too often that means the time limit is too small, you can kill the script_ldas.sh, enlarge the commandline argument job_time_limit, and execute the script_ldas.sh again.

If the job fails on one date, you should check the setting, the model, and the data, then fix the problem and execute the script_ldas.sh again. Automatically restarting only works for TIMEOUT job not for FAILED job because FAILED job means something wrong that you have to figure out and fix. Even sometimes the cluster (beaufix) or the ftp server (hendrix) has a problem. In short, the script_ldas.sh doesn't try to restart the FAILED job.

2.5 LDAS-Chain task 4: Run ldasPre.py

Task 4 pre-processes the observations used in the data assimilation system and store them in daily files used during task 5.

First, on sxvgo1 get open-loop data from hendrix:

```
cd $HOME/LDAS/Spain_LDAS/results/sfx-trip/ol
ftp hendrix
cd Spain_LDAS/ol
prompt
mget ISBA*
mget TRIP*
bye
(for i in *gz ; do tar xvfz $i ; done)
```

Now we create the observation files using the python script `ldasPre.py`:

```
cd $HOME/LDAS/LDAS_v1.2.3
python ldasPre.py my_options_Spain.py
```

This script creates yearly observations files in $HOME/LDAS/Spain_LDAS/observations/sfx-trip under PData format such as LAI_V1_2010-01-01_2010-12-31.PData, raw_SWI_2010-01-01_2010-12-31.PData or SWI_2010-01-01_2010-12-31.PData. Before moving to task 5, check if observations files are not empty. You can do it by reading the PData files. Just open `ipython2` and use the following commands:

```
import pandas as pd
t = pd.read_pickle('....PData')
t
t.mean(axis=1)
```

If the array is entirely full of `NaN` then there is a problem, otherwise things should be ok.

`ldasPre.py` also creates daily files in $HOME/LDAS/Spain_LDAS/observations/sfx-trip/CANARI. Check if those files are full of 999 or not (no need to check every files), if there is only 999 in a file, there is a problem (meaning there is no observations in the daily file). Daily files have to be stored on hendrix:

```
cd $HOME/LDAS/Spain_LDAS/observations/sfx-trip/CANARI
ftp hendrix
cd  Spain_LDAS
mkdir Observations
cd Observations
```

```
prompt
mput *
bye
```

2.6   LDAS-Chain task 5: Run Extended Kalman Filters

Task 5 runs the model over a year but this time with assimilation.

The execution of an extended Kalman filter is almost the same as that of an open loop. On beaufix, execute the following command by adjusting the days_per_job, the num_nodes, and the job_time_limit accouding to the size of your domain:

`nohup script_ldas.sh EKF:8 Spain:ekf 2010010109:2010123109 10:30 2 00:30:00 >& ekf.log &`

This normally takes a while. You can also use `tail -f ekf.log`. This gives you the last lines of `ekf.log` and show live new lines written in the file.

Every days_per_ftp days, the results are archived and transfered to hendrix.

If the job runs out of time, the script_ldas.sh will restart the running from the stop date automatically (now you don't need to do it manually). If restarting too often that means the time limit is too small, you can kill the script_ldas.sh, enlarge the commandline argument job_time_limit, and execute the script_ldas.sh again.

If the job fails on one date, you should check the setting, the model or the Kalman filter, and the data, then fix the problem and execute the script_ldas.sh again. Automatically restarting only works for TIMEOUT job not for FAILED job because FAILED job means something wrong that you have to figure out and fix. Even sometimes the cluster (beaufix) or the ftp server (hendrix) has a problem. In short, the script_ldas.sh doesn't try to restart the FAILED job.

2.7   LDAS-Chain task 6: Run ldasPost.py

Task 6 post-processes the results and compare the analysis with the observations and the open loop. It creates figures stored in `$HOME/LDAS/Spain_LDAS/figures`.

First you need to get analysis data from hendrix:

```
cd $HOME/LDAS/Spain_LDAS/results/sfx-trip/ekf
ftp hendrix
cd Spain_LDAS/ekf
prompt
mget ISBA*
mget TRIP*
bye
(for i in *gz ; do tar xvfz $i ; done)
```

Now we create the figures using the python script `ldasPost.py`:

```
cd $HOME/LDAS/LDAS_v1.2.3
python ldasPost.my my_options_Spain.py
```

You can play with the options in `my_options_Spain.py` to get more (or less) figures, change the frequency of figures, etc.

2.8   LDAS-Chain task 7: Ensemble Kalman Filters and Ensemble Forecasts

Now, the LDAS scripts can carry out ensemble forecasts if you can generate member initial conditions, for example, the initial conditions can be the analysis members of an ensemble Kalman filter (ENKF).

The execution of an ENKF is almost the same as that of an open loop (Section 2.4). On beaufix, execute the following command by adjusting the days_per_job, the num_nodes, and the job_time_limit accouding to the size of your domain:

```
nohup script_ldas.sh ENKF:20 Spain:enkf 2010010109:2010123109 \
                     10:30 2 02:00:00 MYSRC_EnSRF >& enkf.log &
```

where the days_per_job and days_per_ftp are 10 and 30, respectively.

It is worth noting that the restart files are archived and transfered to hendrix ftp server every **days_per_ftp** days, that is, the restart files are only availabe every **days_per_ftp** days. More specially, you can use these restart files as the initial conditions for an ensemble forecast whose cycle period is **days_per_ftp** days, that it, the ensemble forecast automatically restarts with the restart files of ENKF every **days_per_ftp**. **Please adjust days_per_ftp according to your needs.**

After the finish of the ENKF, first set the variable **INIDIR_ENOL** in script_ldas.sh to the directory where the restart files of ENKF are on hendrix server, then issue the following command for an ensemble forecast:

```
nohup script_ldas.sh ENOL:20 Spain:enol 2010010109:2010123109 \
                     10:30 2 02:00:00 MYSRC_EnSRF >& enol.log &
```

The LDAS scripts are versatile. The LDAS scripts can be used for **pure ensemble forecasts** without the ENKF if you can generate a good initial members using the methods such as singular vectors or breeding vectors methods.

2.9   LDAS-Chain task 8: Deteministic Forecasts

The LDAS scripts has a new feature: it can run a deterministic forecast, which uses the analysis as the initial condition, at the end of each assimilation cycle.

Since a deterministic forecast is run at the end of each assimilation cycle, so there is no standalone way to run a deterministic forecast. To run deterministic forecasts, you just run an EKF (see 2.6 for details to an EKF) with an extra commandline argument as following:

```
nohup script_ldas.sh EKF:8:9 Spain:ekf 2010010109:2010123109 10:30 2 00:30:00 >& ekf.log &
```

The different between the above commandline and that in Section 2.6 is **EKF:8:9**, that is, we add **:9** to tell the script to run a deterministic forecast of 9 days at the end of each assimilation cycle.

Of course, you need to prepare the forcings for deterministic forecasts and upload the forcings to hendrix ftp server (see Section 2.3 for details).