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Experiment *hirlake*

The aim of this exercise is to learn how to run a two-dimensional (x-y) SURFEX experiment using external atmospheric forcing from a NWP model. To see the sensitivity of SURFEX to different definition of some input parameters, two different experiments are run. In the following, practical advise for the task is given.

SURFEX experiment "hirlake" is run over the north-eastern part of the lake district of Finland. Most of the surface is here is covered by forest and lakes. In the beginning of December 2006, only the northernmost lakes were frozen, but till the beginning of January 2007 practically all lakes in this area got frozen. During this period, there was already snow on the forests and fields. Air temperature was typically somewhat below zero. Not much solar radiation arrived at the surface even daytime.

Atmospheric forcing data for SURFEX has been prepared based on HIRLAM experiment output. (You can find a presentation about this HIRLAM experiment in **http://netfam.fmi.fi/Lake08**). Ony a short period 5-14.12. is studied in this task. You should run two experiments: one with FLake lake parametrizations, another with the simple Watflux parametrizations and compare the results. FLake and Watflux are two different ways to handle the development of lake surface state (mainly, temperature) and its interactions with the rest of the model.

0. Creating the environment

Give a command 'sfx5 hirlake' in order to create your working environment and enter you working directory $SFX_WD/rundir (defined also as $RUNDIR).

1. Definition of your experiment with a namelist

First you need to edit the namelist OPTIONS.nam to define the schemes and initial values for them. Make two copies of the namelist: OPTIONS.nam_flake and OPTIONS.nam_watflx. First edit the watflx version. Note that the option file contains many different namelists, whose order is not important. Most of them you may leave untouched.

Choose FLake or Waterflux, in the list of PGD schemes:

```
&NAM_PGD_SCHEMES      CNATURE = 'ISBA  '    ,
                      CSEA    = 'SEAFLX'    ,
                      CTOWN   = 'TEB   '    ,
                      CWATER  = 'FLAKE '        or        'WATFLX'
 &END
```

For Waterflux, you only need to define some constant initial water temperature, like this:

```
&NAM_PREP_WATFLUX  XTS_WATER_UNIF = 276.
            NYEAR  = 2006,
            NMONTH = 12,
            NDAY   = 5,
            XTIME  = 0.
 &END
```

Note the definition of the experiment start date 5.12.2006. It is given for each scheme of SURFEX separately, thus repeated five times in OPTIONS.nam. Save your edited file as OPTIONS.nam. Start this experiment as explained below. Then you can continue to definitions for the next experiment editing OPTIONS.nam_flake.

For FLake, you need to define some more basic properties in addition to the choice of CWATER:

```
&NAM_DATA_FLAKE       YWATER_DEPTH = 'DEPLK.txt                ',
                      YWATER_DEPTHFILETYPE='ASCLLV',
                      XUNIF_WATER_FETCH = 100. ,
                     XUNIF_T_BS       = 277. ,
                     XUNIF_DEPTH_BS    = 0.1 ,
                     XUNIF_EXTCOEF_WATER = 6.3
 &END
```

A file DEPLK.txt contains lake depths used by HIRLAM. If you want to use them, leave the above lines unchanged. Instead, you could use some constant depth for all lakes, e.g.: XUNIF_WATER_DEPTH=10., (for ten metres). You can then remove the definition of the filetype, which is not used.

Uniform initial values for some FLake variables are given as below. You may leave these values unchanged.

```
&NAM_PREP_FLAKE    XTS_WATER_UNIF = 276.,
            XUNIF_T_MNW = 276. ,
            XUNIF_T_BOT = 276. ,
            XUNIF_T_B1 = 276. ,
            XUNIF_H_ML = 8. ,
            XUNIF_H_B1 = 0.1
            NYEAR  = 2006,
            NMONTH = 12,
            NDAY   = 5,
            XTIME  = 0.
 &END
```

2. Running the experiment

Now you are ready to start your first experiment in the working directory $SFX_WD. You can write a command: *Runsfx*. This script calls three programs in the needed order: *pgd.exe* for surface description,

prep.exe for initial state and *offline.exe* for the main SURFEX run. Running the whole experiment, which consists of all these components, will take approximately 15-20 minutes. In the end, your results will appear in several netcdf files (moved to a subdirectory *resu* by *Runsfx*). While the experiment is running, you are free to prepare yourselves for the analysis of the results. As soon as your first experiment will be ready, please start the second, with Watflux changed to FLake. Remember to copy your edited OPTIONS.nam_flake to OPTIONS.nam before starting the esecond xperiment! While this experiment will be running, you can draw the maps of the first one.

The (two-dimensional) results of this experiment will be written into these files:

SURF_ATM.OUT.nc

- this file contains only the fractions: water, sea, nature, town

SURF_ATM_DIAGNOSTICS.OUT.nc

- this file contains these grid-averaged variables (weighted averages over all fractions):

RI 0 99 Averaged_Richardson_Number
RN 0 99 Averaged_Net_Radiation
H 0 99 Averaged_Sensible_Heat_Flux
LE 0 99 Averaged_Latent_Heat_Flux
GFLUX 0 99 Averaged_Ground_Heat_Flux
FMU 0 99 Averaged_Zonal_Wind_Stress
FMV 0 99 Averaged_Merid_Wind_Stress
T2M 0 99 2m_Temperature
Q2M 0 99 2m_Specific_Humidity
HU2M 0 99 2m_Relative_Humidity
ZON10M 0 99 10m_Zonal_wind
MER10M 0 99 2m_Meridian_Wind

You can build the surface energy balance of these values. How to do this? Please write the formula using RN, H, LE and GFLUX! With these four, the energy balance should close, i.e. actually in SURFEX the ground heat flux is calculated as a residual term. (What does it mean over the lakes?) It is also useful to compare the screen-level variables T2M, HU2M and the ten-metre wind components ZON10M and MER10M between the experiments, or the surface energy balance components separately.

The rest of the files contain prognostic or diagnostic variables for water: lakes handled by FLake or Watflux, and nature, handled by ISBA. Note that the results of FLake and Waflux will both be written into files with the name WATFLUX_..., there are no files FLAKE_ ...! There are plenty of interesting variables for you to analyse, but probably too little time to do this during the course exercises...

WATFLUX_PROGNOSTIC.OUT.nc
WATFLUX_DIAGNOSTICS.OUT.nc
ISBA_VEG_EVOLUTION.OUT.nc
ISBA_PROGNOSTIC.OUT.nc
ISBA_DIAGNOSTICS.OUT.nc

Note that to save some time and space, the corresponding output files TEB_... (urban model) and SEAFLUX... (ocean) are not produced at all by the code used in the present exercise.

3. Analysis of the results

You can use GraDS (http://grads.iges.org, available in the workstations or in the MF cluster) to analyse your results. For this it is necessary first to convert the netcdf format output to grads binary and create the corresponding ctl (description) file. You can do this with the script *Sfx_nc_grads2*, by giving a command with the file name as parameter:

./Sfx_nc_grads2 SURF_ATM flake

will create files ./resu_flake/SURF_ATM.OUT.grs and ./resu_flake/SURF_ATM.OUT.ctl . Before giving the command, please edit the script to be sure it suits your experiment definitions! Then process the files SURF_ATM and WATFLUX_DIAGNOSTICS and WATFLUX_PROGNOSTIC for both flake and watflux. Note that this takes a few minutes to complete, because some files are quite large. This is why you should try the rest of the files (SURF_ATM_, ISBA_) only later if you will have enough time!

Now please open a new terminal window and call grads:

grads (or perhaps *gradshdf* or *gradsc*, depenging on the installation in your computer)

Now you are in the command window of grads, where you should say:

open resu_flake/SURF_ATM.OUT.ctl

after this, you could ask what is in the file:

q file 1

In this file, there should be the fractions. You can draw them, first defining the format of drawing:

set gxout grfill

d frac_water (frac_sea, frac_town, frac_nature)

for the colour scale, give the command

cbarn

To get rid of the previous figure, use the command

clear

If you want to save your figure in a file, use the command

printim thenameofmyfigure.png

(It is also possible to save in postscript, but this requires a few commands you can find in grads documentation)

Further, please try to draw surface and two-metre temperatures, components of the surface energy balance etc. from the FLake and Watflux directories. A quick example is given in the file grasfx_example (attached, with a picture of output for one point), which you can call from your grads window like this:

exec grasfx_example

5. GrADS example

grads executable script grasfx_example:

```
reinit
*1
open resu_flake/FORCING.ctl
*2
open resu_watflx/WATFLUX_PROGNOSTIC.OUT.ctl
*3
open resu_flake/WATFLUX_PROGNOSTIC.OUT.ctl
*4
open resu_watflx/WATFLUX_DIAGNOSTICS.OUT.ctl
*5
open resu_flake/WATFLUX_DIAGNOSTICS.OUT.ctl
*6
open resu_flake/SURF_ATM.OUT.ctl
*7
open resu_flake/SURF_ATM_DIAGNOSTICS.OUT.ctl
*8
open resu_watflx/SURF_ATM_DIAGNOSTICS.OUT.ctl

set x 1 80
set y 1 150
set t 1

set gxout grfill

d maskout(ts_water.2,300-ts_water.2)
draw title ts_water watflx
cbarn
clear

d maskout(ts_water.3,300-ts_water.3)
draw title ts_water flake
cbarn
```

```
clear

d maskout(ts_water.3(t=215)-ts_water.3(t=1),frac_water.6(t=1)-0.6)
draw title ts_water difference flake last-first
cbarn
clear

d maskout(t2m_wat.5-t2m_wat.4,frac_water.6(t=1)-0.6)
draw title t2m_water difference watflx-flake
cbarn
clear

set t 1 36
set lat 67.825 67.825
set lon 27.525 27.525

set vrange 260 280
set strsiz 0.2 0.25

set cmark 0
set ccolor 1
d ta.1
set string 1
draw string 6 4 TA FORCING

set cmark 0
set ccolor 2
d maskout(t2m_wat.5,300-ts_water.3)
set string 2
draw string 6 3.7 T2M_WAT FLAKE

set cmark 0
set ccolor 3
d maskout(ts_water.3,300-ts_water.3)
set string 3
draw string 6 3.4 TS_WAT FLAKE

set cmark 0
set ccolor 4
d maskout(ts_water.2,300-ts_water.2)
set string 4
draw string 6 3.1 TS_WAT WATFLX

set cmark 0
set ccolor 5
d maskout(t2m_wat.4,300-ts_water.3)
set string 5
draw string 6 2.8 T2M_WAT WATFLX
```

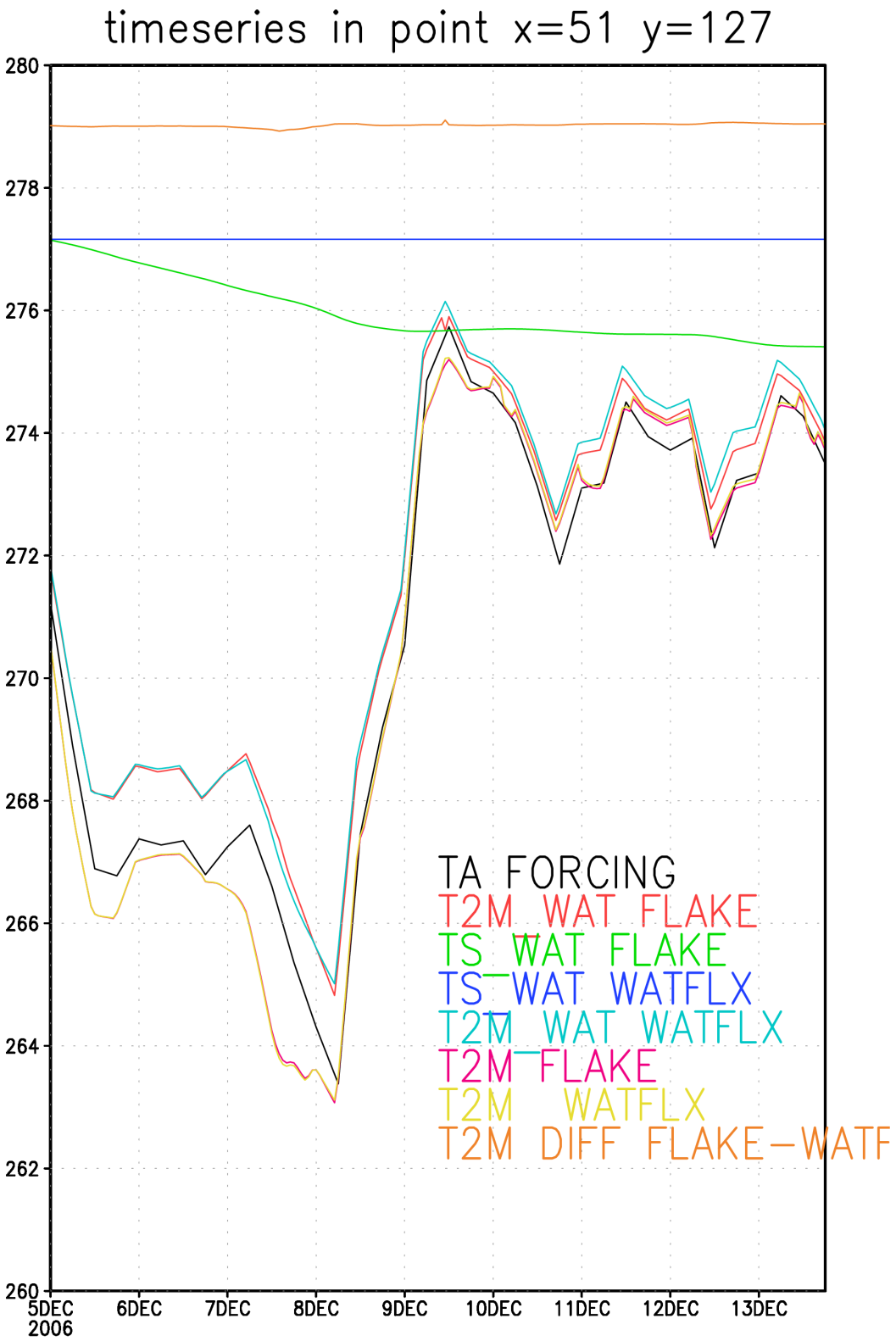
```
set cmark 0
set ccolor 6
d maskout(t2m.7,300-ts_water.3)
set string 6
draw string 6 2.5 T2M FLAKE

set cmark 0
set ccolor 7
d maskout(t2m.8,300-ts_water.3)
set string 7
draw string 6 2.2 T2M  WATFLX

set cmark 0
set ccolor 8
d maskout(t2m.8-t2m.7,300-ts_water.3)+279
set string 8
draw string 6 1.9 T2M DIFF FLAKE-WATFLX+279

draw title timeseries in point x=51 y=127
printim grasfx_example.png
```

You can find some advise for the usage of grads (among other useful for SURFEX things, too) at the University of Helsinki NUMLAB page:
http://www.atm.helsinki.fi/~jaraisan/numlab2009/NumLab09.html



GrADS: COLA/IGES

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