Graphics tools
&
Data files processing

Meso-NH Tutorial Class 1-4 December 2025

MesoNH files

NC (Netcdf)

highly recommended format

lfi

historical format

2 types of output files :

- synchronous
- diachronics

with 2 parts :

- .des : descriptive ascii file (namelists used)
- .lfi or .nc : data + metadata

Examples of NetCDF output from a MesoNH simulation

6 hours run with outputs every 2 hours

1 segment (no RESTART)

Synchronous files

```
CTRL0.1.SEG01.001.nc
CTRL0.1.SEG01.002.nc
CTRL0.1.SEG01.003.nc
```

Diachronic file

```
CTRL0.1.SEG01.000.nc
```

3 segments (RESTART)

1st segment

```
CTRL0.1.SEG01.000.nc
CTRL0.1.SEG01.001.nc
```

2nd segment

```
CTRL0.1.SEG02.000.nc
CTRL0.1.SEG02.001.nc
```

3rd segment

```
CTRL0.1.SEG03.000.nc
CTRL0.1.SEG03.001.nc
```

Some useful commands for data printing

All the data

ncdump file.nc

Variables name + metadata

ncdump -h file.nc

Data from specific variables only

ncdump -v var1 var2 file.nc

Data of coordinates/dimensions

ncdump -c file.nc

Example : ncdump -h file.nc

```
netcdf NOADV.1.RUN01.001 {
dimensions:
        ni = 12 ;
        nj = 12 ;
        ni_u = 12 ;
        nj_u = 12 ;
        ni_v = 12 ;
        nj_v = 12 ;
        level = 112 ;
        level_w = 112 ;
        time = UNLIMITED ; // (1 currently)
        size3 = 3 ;
        char16 = 16 ;
        char32 = 32 ;
        size4 = 4 ;
        size2 = 2 ;
        size6 = 6 ;
variables:
        int MNHVERSION(size3) ;
                MNHVERSION:long_name = "MesoNH version" ;
                MNHVERSION:_FillValue = -2147483647 ;
                MNHVERSION:valid_min = -2147483646 ;
                MNHVERSION:valid_max = 2147483647 ;
        int MASDEV ;
                MASDEV:long_name = "MesoNH version (without bugfix)" ;
        int BUGFIX ;
                BUGFIX:long_name = "MesoNH bugfix number" ;
        char BIBUSER(char16) ;
                BIBUSER:long_name = "MesoNH: user binary library" ;
        char PROGRAM(char16) ;
                PROGRAM:long_name = "MesoNH family: used program" ;
        char STORAGE_TYPE(char16) ;
                STORAGE_TYPE:long_name = "STORAGE_TYPE" ;
                STORAGE TYPE:comment = "Storage type for the information written in the FM files" ;
```

Example : ncdump -h file.nc

```
        COUPLING:comment = "Logical for coupling file" ;
double UT(time, level, nj_u, ni_u) ;
        UT:standard_name = "x_wind" ;
        UT:long_name = "UT" ;
        UT:units = "m s-1" ;
        UT:grid = 2 ;
        UT:comment = "X_Y_Z_U component of wind" ;
        UT:_FillValue = 9.969209968386870e+36 ;
        UT:valid_min = -1.e+36 ;
        UT:valid_max = 1.e+36 ;
double VT(time, level, nj_v, ni_v) ;
        VT:standard_name = "y_wind" ;
        VT:long_name = "VT" ;
        VT:units = "m s-1" ;
        VT:grid = 3 ;
        VT:comment = "X_Y_Z_V component of wind" ;
        VT:_FillValue = 9.969209968386870e+36 ;
        VT:valid_min = -1.e+36 ;
        VT:valid_max = 1.e+36 ;
double WT(time, level_w, nj, ni) ;
        WT:standard_name = "upward_air_velocity" ;
        WT:long_name = "WT" ;
        WT:units = "m s-1" ;
        WT:grid = 4 ;
        WT:comment = "X_Y_Z_vertical wind" ;
        WT:_FillValue = 9.969209968386870e+36 ;
        WT:valid_min = -1.e+36 ;
        WT:valid_max = 1.e+36 ;
double THT(time, level, nj, ni) ;
        THT:standard_name = "air_potential_temperature" ;
        THT:long_name = "THT" ;
        THT:units = "K" ;
```

NCO commands

nco.sourceforge.net

- **ncap2** netCDF Arithmetic Processor
- **ncatted** netCDF ATTribute EDitor
- **ncbo** netCDF Binary Operator (addition, multiplication, etc)
- **nces** netCDF Ensemble Statistics
- **ncrcat** netCDF Record Concatenator
- **ncks** netCDF Kitchen Sink
- **ncrename** netCDF RENAMEer
- **ncwa** netCDF Weighted Averager
- **ncpdq** netCDF Permute Dimensions Quickly, Pack Data Quietly

NCO commands : examples

ncbo --op_typ=add file1.nc file2.nc file3.nc

file3 = file1 + file2 (same variables)

ncrcat file1.nc file2.nc file3.nc file4.nc file.nc

concatenate variables from files 1 to 4 in file.nc (add a dimension)

ncks -a -A in.nc out.nc

write all the variables from in.nc in out.nc

NCO commands : examples

ncwa in.nc out.nc

write the mean of the variables (on all the dimensions) from in.nc in out.nc

nces file[1-4].nc out.nc

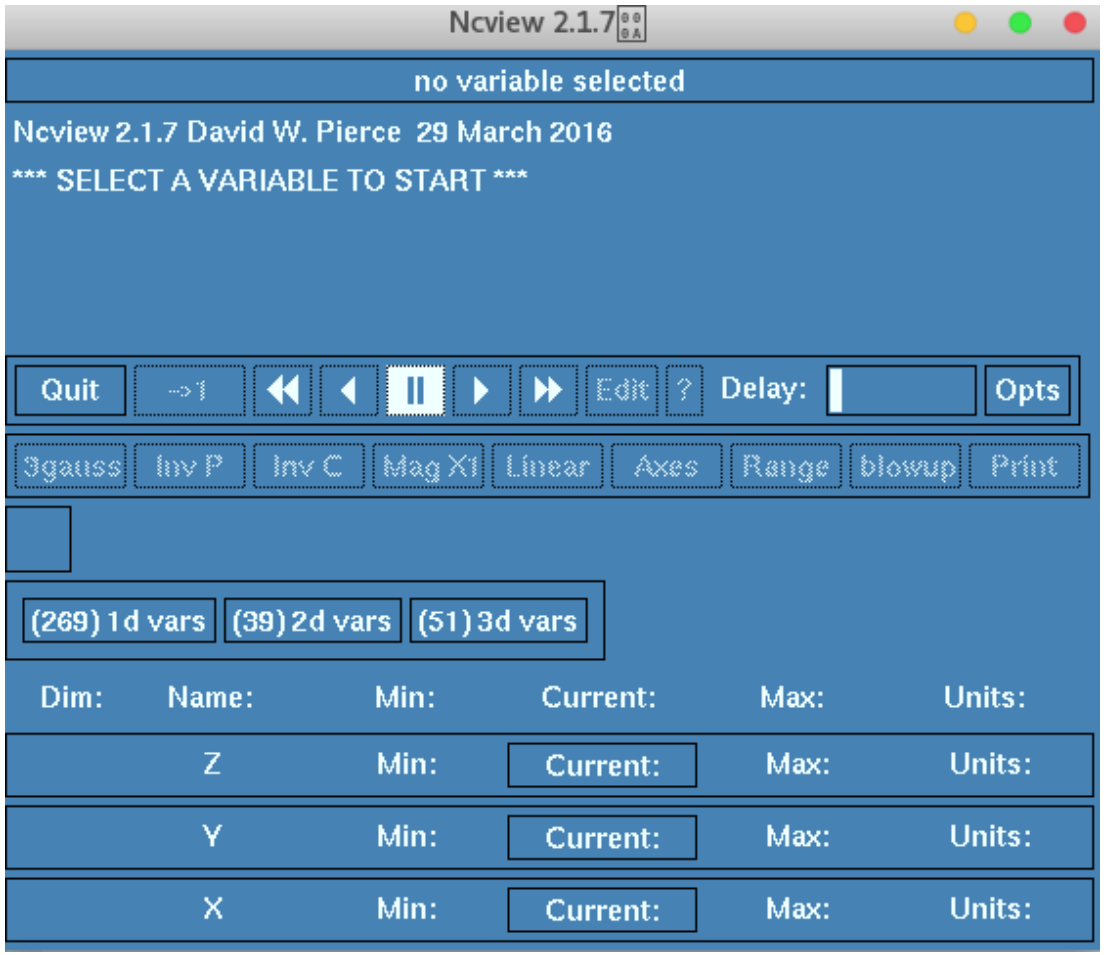
write the mean of the variables of file[1 to 4].nc in out.nc

ncrename -v latitude,lat file.nc

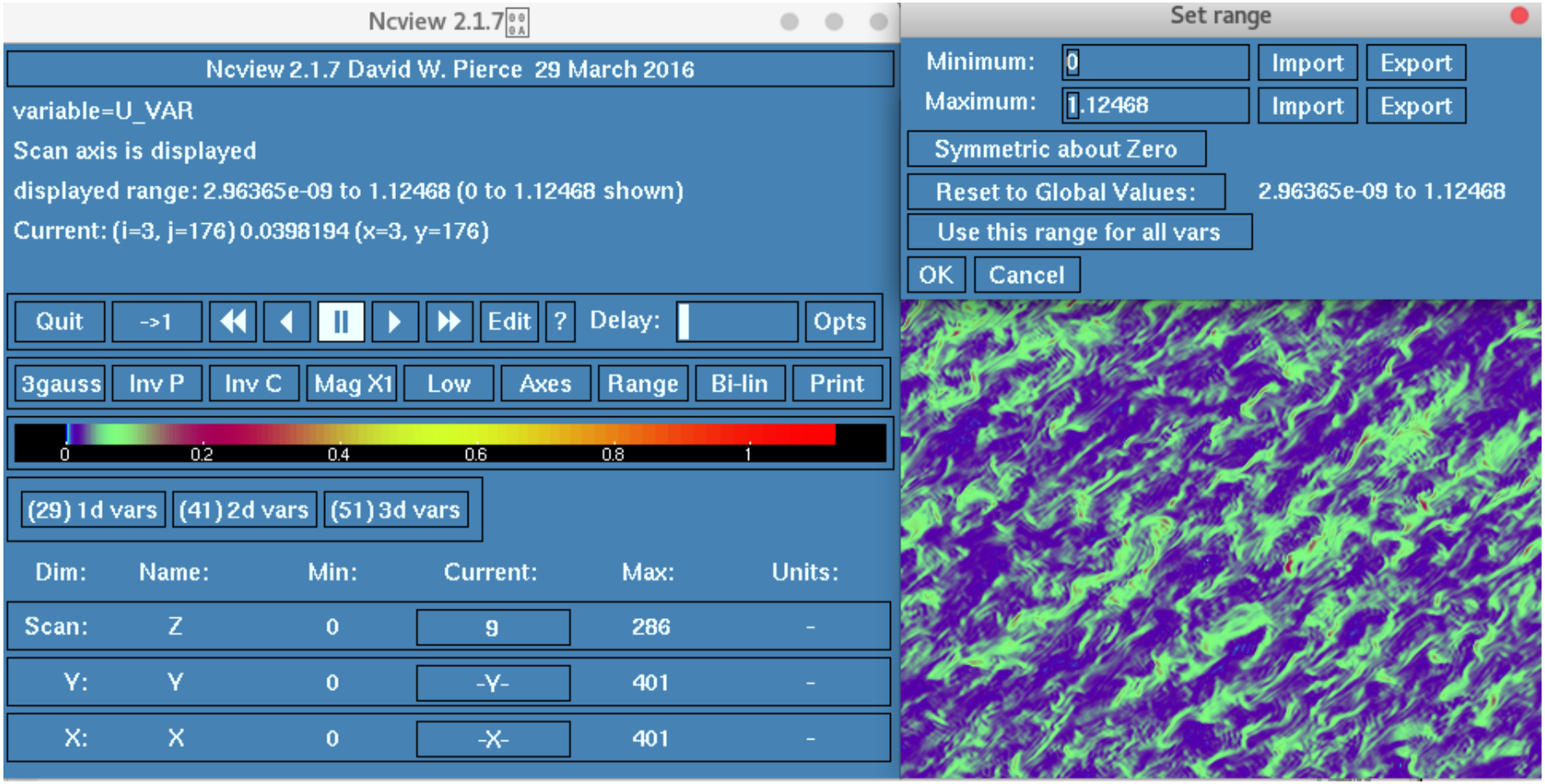
rename the variable latitude to lat in file.nc

Quick visualization : ncview

ncview file.nc

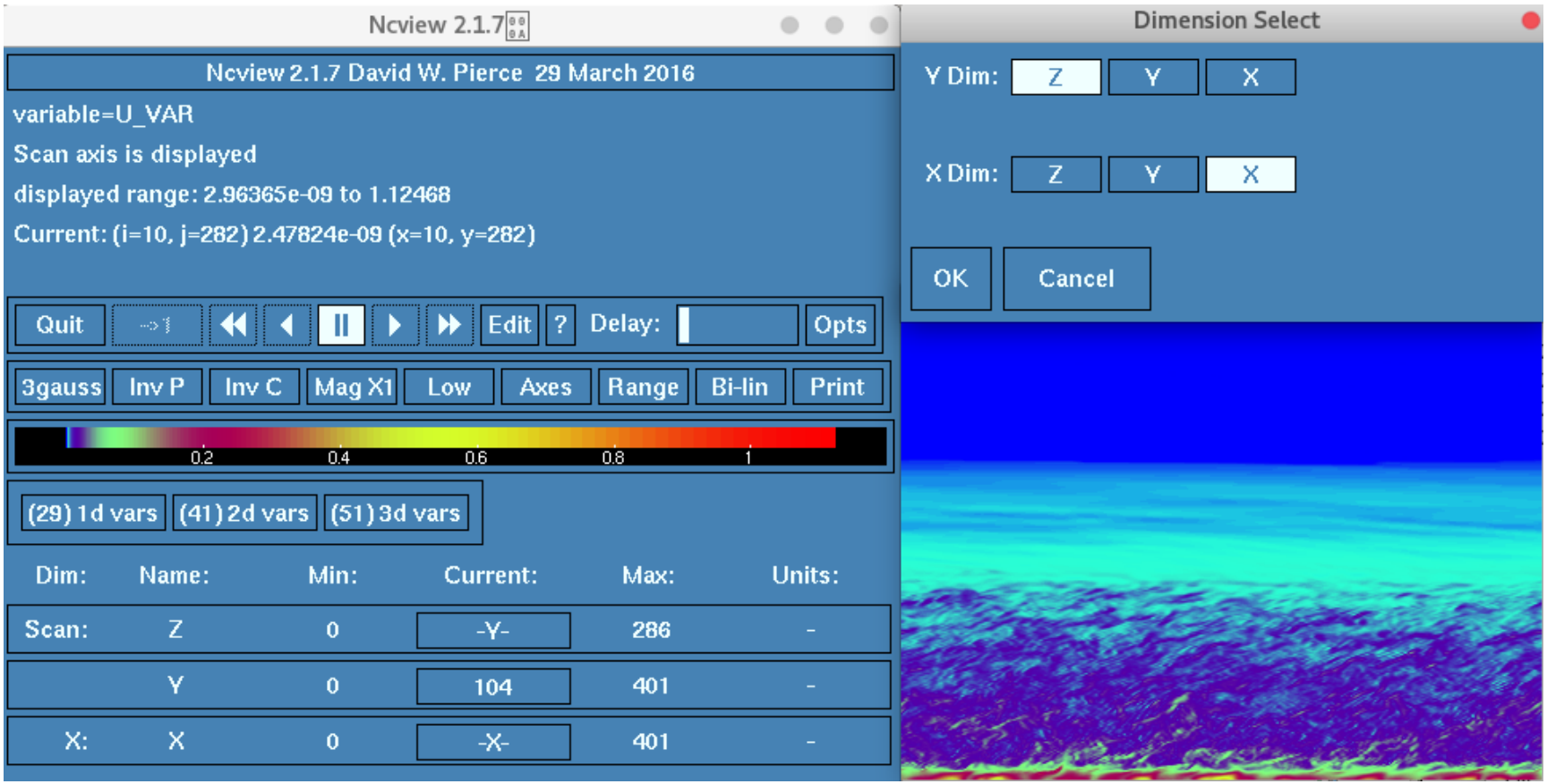


Quick visualization : ncview



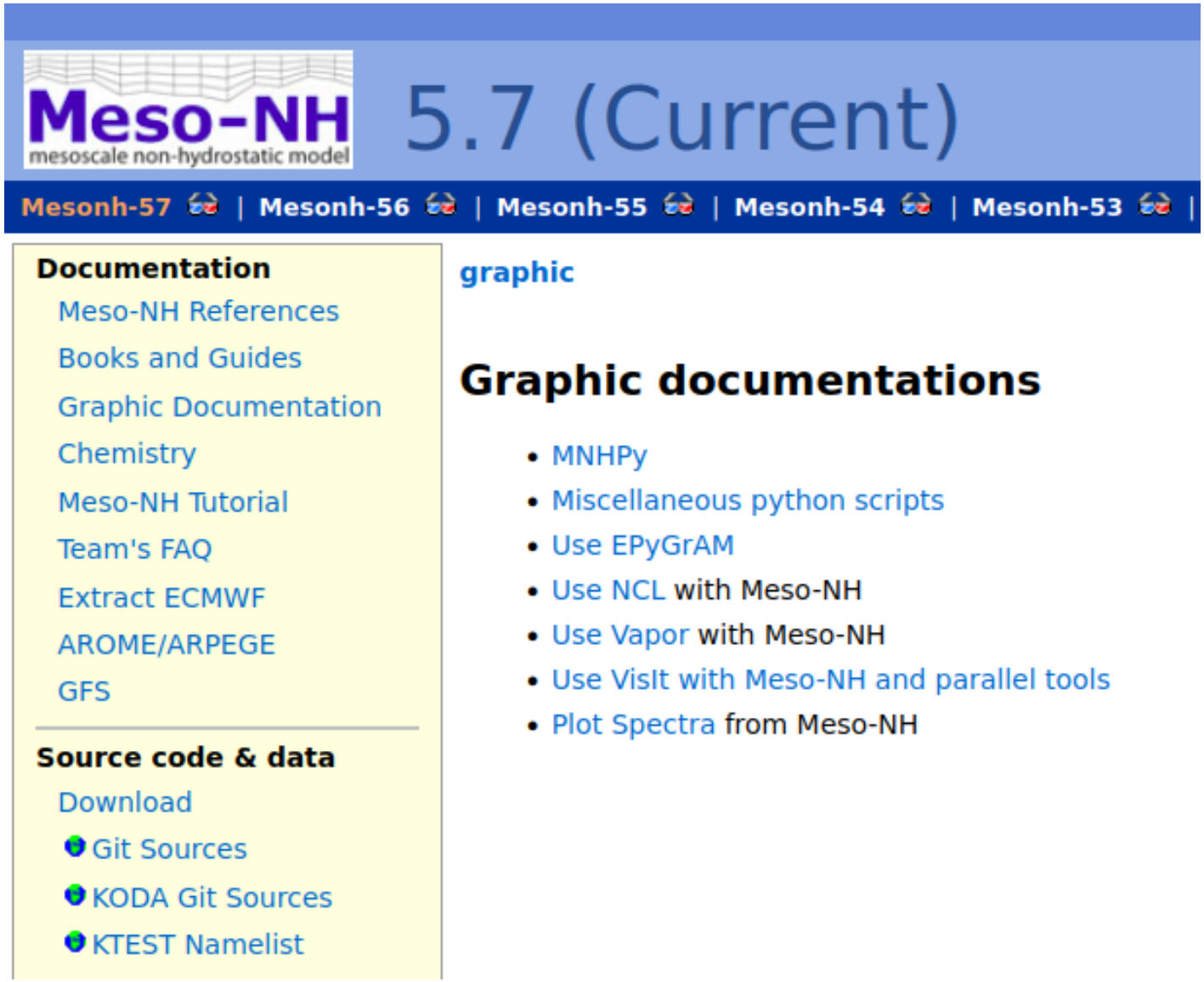
Horizontal cross-section of u'^2 variance

Quick visualization : ncview



Vertical cross-section of u'^2

Graphical tools : online documentation

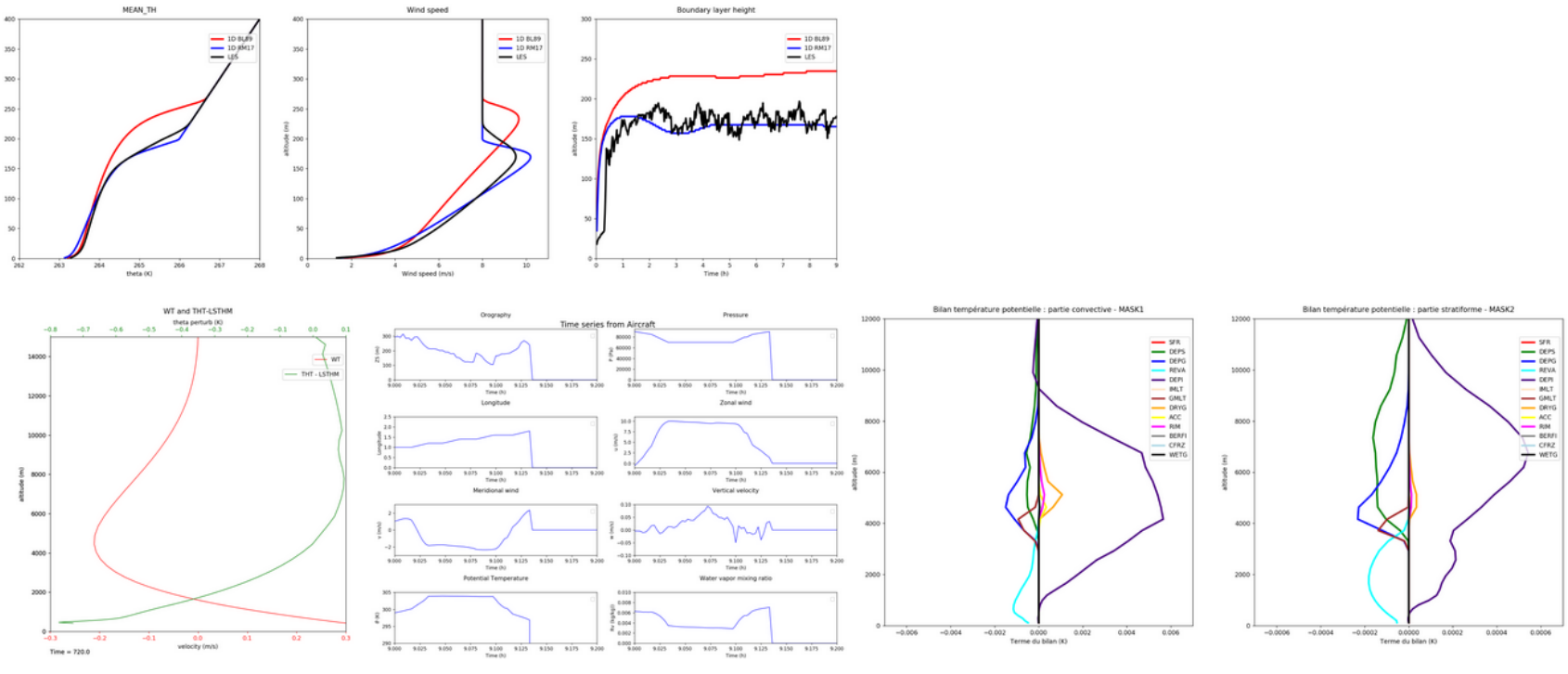


MNHPy : distributed python library for Meso-NH

http ://mesonh.aero.obs-mip.fr/mesonh57/PythonLIB

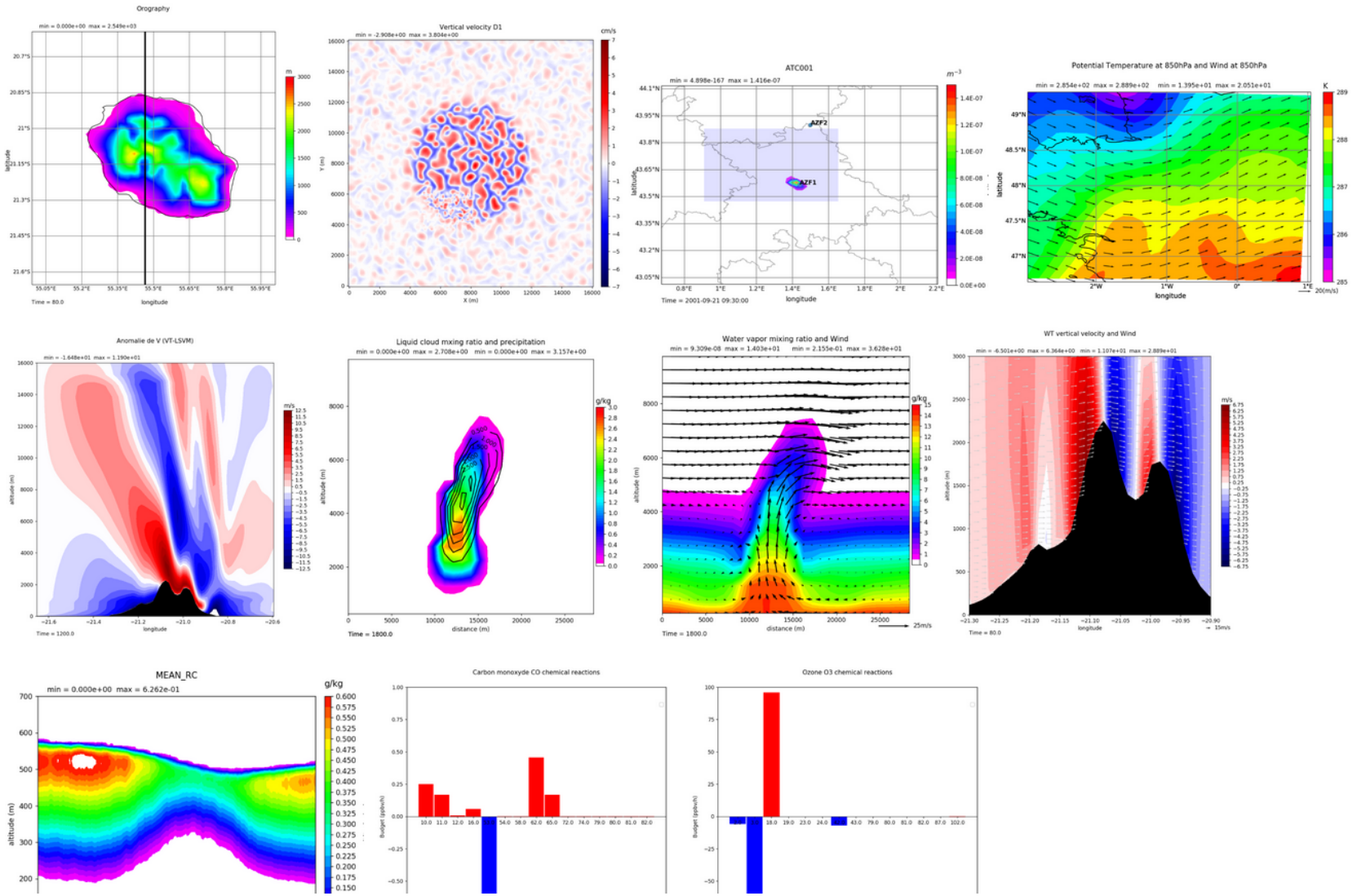
PythonLIB

Here is a gallery and Python scripts examples of what is possible with the Python library package distributed since MNH-V5-X-X in src/LIB/Python. Feel free to contribute (add functions, examples, etc) by c



30+ python scripts are available online

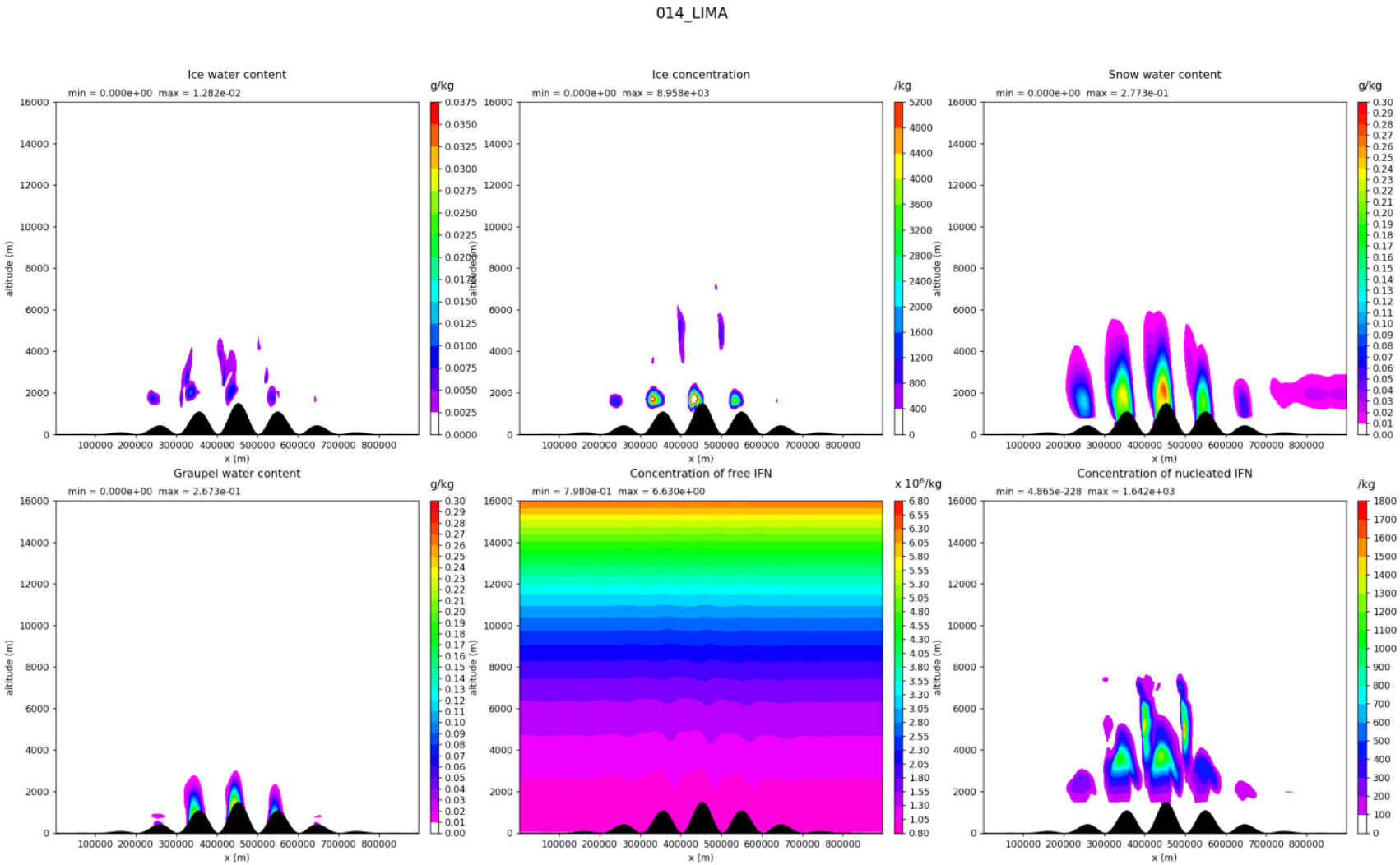
MNHPy


Orography
Vertical velocity D1
ATC001
Potential Temperature at 850hPa and Wind at 850hPa
Anomalie de V (VT-LSVM)
Liquid cloud mxing ratio and precipitation
Water vapor mixing ratio and Wind
WT vertical velocity and Wind
MEAN_RC
Carbon monoxyde CO chemical reactions
Ozone O3 chemical reactions

MNHPy

Type of graphics	Features	Scripts example
XY lines	single line, time-series, panel plot	plot_AZF2M.py
XY lines	multiple lines, time-series, one figure	plot_Reunion.py
XY lines	single line, multi x-axe, (z,val)	plot_001_2DRelief.py
XY lines	multiple lines, (z,val), panel plot	plot_COPT81_MASK.py
XY lines	multiple lines and axes (3D vs 1D files)	plot_GABLS1.py
Horizontal section	conformal coordinate with coastal/regions line and grid iso-contours	plot_004_Reunion.py plot_AZF2M.py plot_007_16janvier.py plot_009_ICARTT.py plot_012_dust.py plot_FANNY_LIMA_CAMS.py plot_FOG_3D_LIMA.py plot_ICE3_LRED_MOENG.py
Horizontal section	cartesian coordinate iso-contours	plot_002_3DRelief.py plot_003_KW78.py plot_OCEAN.py
Horizontal section	iso-contours + overlapping vectors	plot_003_KW78.py plot_007_16janvier.py
Vertical section	cartesian coordinate iso-contours + iso-lines	plot_003_KW78.py plot_011_KW78CHEM.py plot_CYCLONE.py
Vertical section	with vectors and orography	plot_003_KW78.py plot_Reunion.py
Oblique vertical section	with vectors	plot_003_KW78.py
Time series of vertical profiles	iso-contours	plot_004_Reunion.py plot_005_ARM.py plot_014_LIMA.py plot_BOMEX.py plot_FIRE_1D.py plot_FIRE_RKC4_LIMA_ECRAD.py plot_ARM_COND_SAMP.py plot_COPT81_CART.py plot_FOG_1D.py
Histogram		plot_009_ICARTT.py

MNHPy


014_LIMA
Ice water content
min = 0.000e+00 max = 1.282e-02
g/kg
Ice concentration
min = 0.000e+00 max = 8.958e+03
/kg
Snow water content
min = 0.000e+00 max = 2.773e-01
g/kg
Graupel water content
min = 0.000e+00 max = 2.673e-01
g/kg
Concentration of free IFN
min = 7.980e-01 max = 6.630e+00
x 10⁶/kg
Concentration of nucleated IFN
min = 4.865e-228 max = 1.642e+03
/kg
altitude (m)
x (m)

Example KTEST 014_LIMA

```
import matplotlib as mpl
mpl.use('Agg')
from read_MNHfile import read_netcdf
from Panel_Plot import PanelPlot
from misc_functions import comp_altitude1DVar

path=""
LnameFiles = ['XPREF.1.SEG01.000.nc' ]

Dvar_input = {'f1':[('RI','AVEF'), ('CICE','AVEF'), ('RS','AVEF'),('RG','AVEF'), ('CIFNFREE01','AVEF'),('CIFNNUCL01','AVEF') ]}
Dvar_input_coord_budget = {'f1':['cart_level', 'cart_ni']}
Dvar_input_coord = {'f1':['ZS','ZTOP']}

#  Read the variables in the files
Dvar, Dvar_coord_budget, Dvar_coord = {}, {}, {}
Dvar = read_netcdf(LnameFiles, Dvar_input, path=path, removeHALO=False)
Dvar_coord_budget = read_netcdf(LnameFiles, Dvar_input_coord_budget, path=path, removeHALO=False)
Dvar_coord = read_netcdf(LnameFiles, Dvar_input_coord, path=path, removeHALO=True)

Dvar['f1']['altitude'], Dvar['f1']['ni_2D'] = comp_altitude1DVar(Dvar['f1'][('CIFNFREE01','AVEF')], Dvar_coord['f1']['ZS'],Dvar_coord['f1']['ZTOP'],

############################################################
#########          PANEL 1
############################################################
Panel1 = PanelPlot(2,3, [25,14],'014_LIMA', titlepad=25, minmaxpad=1.04, timepad=-0.07, colorbarpad=0.03, labelcolorbarpad = 13, colorbaraspect=40)

Lplot = [Dvar['f1'][('RI','AVEF')],Dvar['f1'][('CICE','AVEF')], Dvar['f1'][('RS','AVEF')],
         Dvar['f1'][('RG','AVEF')],Dvar['f1'][('CIFNFREE01','AVEF')], Dvar['f1'][('CIFNNUCL01','AVEF')]]
LaxeX = [Dvar['f1']['ni_2D']]*len(Lplot)
LaxeZ = [Dvar['f1']['altitude']]*len(Lplot)
Ltitle = ['Ice water content', 'Ice concentration', 'Snow water content',
          'Graupel water content', 'Concentration of free IFN', 'Concentration of nucleated IFN']
Lcbarlabel = ['g/kg', '/kg', 'g/kg','g/kg',r'x $10^6$/kg','/kg']
Lxlab = ['x (m)']*len(Lplot)
Lylab = ['altitude (m)']*len(Lplot)
Lylim = [(0,16000)]*len(Lplot)
Lminval = [0, 0, 0, 0, 0.8 ,0]
Lmaxval = [3.75E-2, 5400, 3E-1, 3E-1, 7, 1800]
Lstep = [0.25E-2,400,0.01,0.01,0.25, 100]
Lstepticks = Lstep
Lfacconv = [1000, 1, 1000, 1000, 1E-6, 1]
orog = Dvar_coord['f1']['ZS']
Lcolormap = ['gist_rainbow_r']*len(Lplot)
LaddWhite = [True, True, True, True, False, True]

fig1 = Panel1.psectionV(Lxx=LaxeX, Lzz=LaxeZ, Lvar=Lplot, Lxlab=Lxlab, Lylab=Lylab, Ltitle=Ltitle, Lminval=Lminval, Lmaxval=Lmaxval,
                        Lstep=Lstep, Lstepticks=Lstepticks, Lcolormap=Lcolormap, Lcbarlabel=Lcbarlabel, Lfacconv=Lfacconv,Lylim=Lylim,
                        orog=orog, LaddWhite_cm=LaddWhite)
Panel1.save_graph(1,fig1)
```

Read the variables and coordinates

1 variable = 1 plot

Lists of options
(can be different for each plot)

make the figures

save 1 Panel = 1 png

MNHPy

Read MNH file : see the examples on the website

Graphics available :

- psectionV()
- psectionH()
- pXY_lines()
- pvector()
- pXY_bar()
- pstreamline()

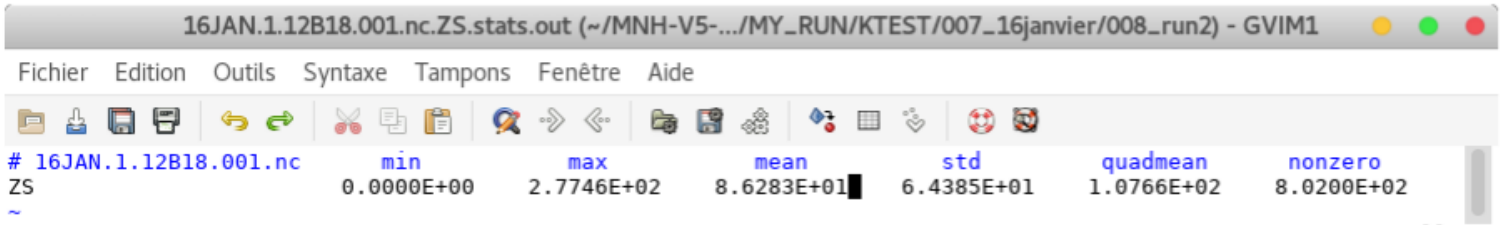
MNHPy

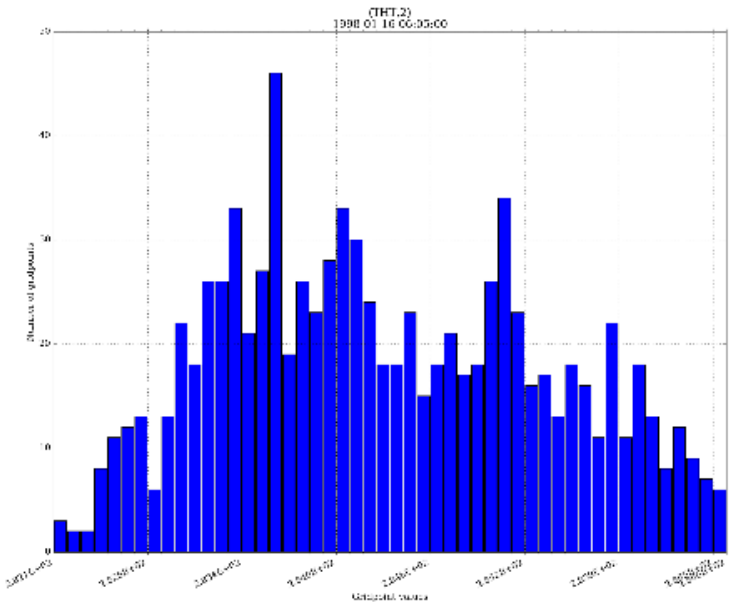
- Contribute : github.com/QuentinRodier/MNHPy
- Jupyter Notebook tutorial : MNHPy/examples/mnhpy.ipynb
- Install : pip install MNHPy

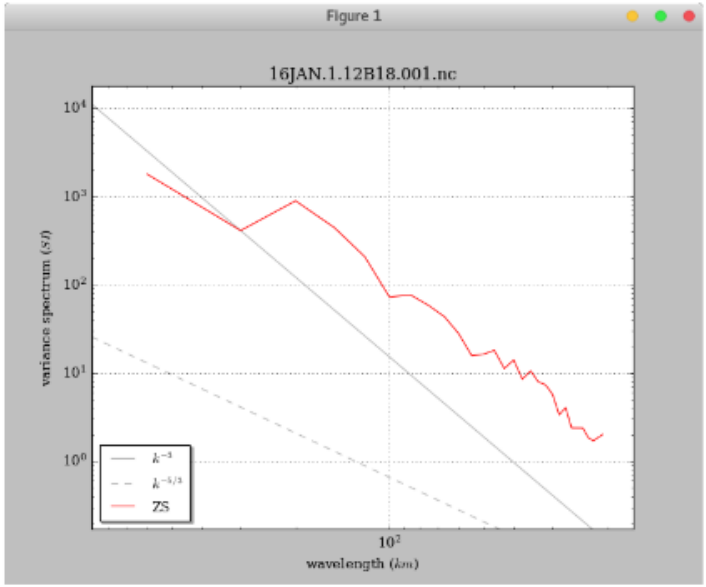
Tool : python library EPyGrAM

- Read/Write multiple formats : FA, LFI, NetCDF, GRIB[1-2]
- Easy to compare multiple files with different formats
- Quick visualization tool
- Advanced graphics (3D...)
- Setup & Overview :
  https ://github.com/UMR-CNRM/EPyGrAM
- not open yet (only MF)

EPyGrAM

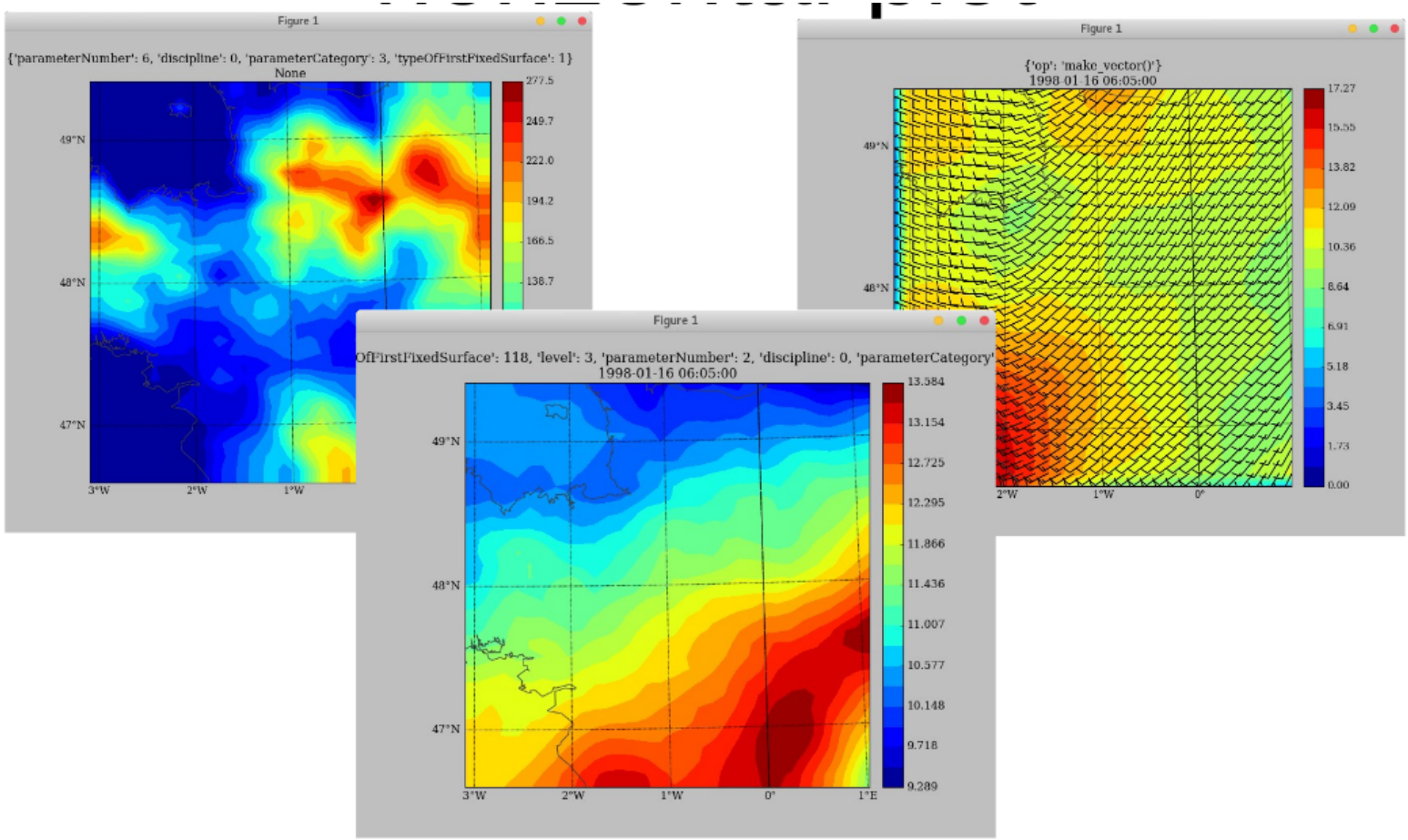






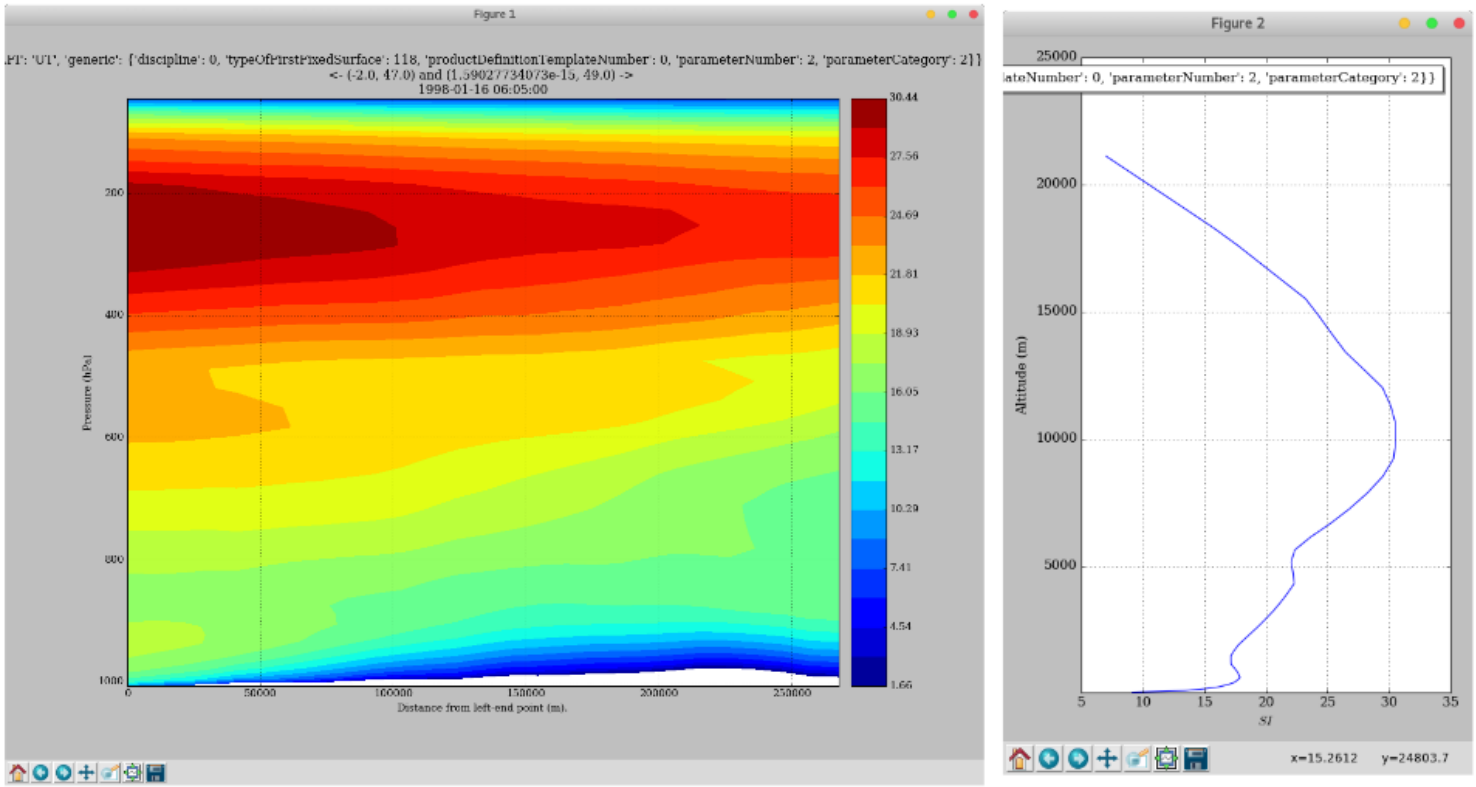
- epy_stats.py -f ZS file.nc
- epy_hist.py -f '(THT,2)' file.lfi
- epy_spectrum -f UT file.nc

EPyGrAM



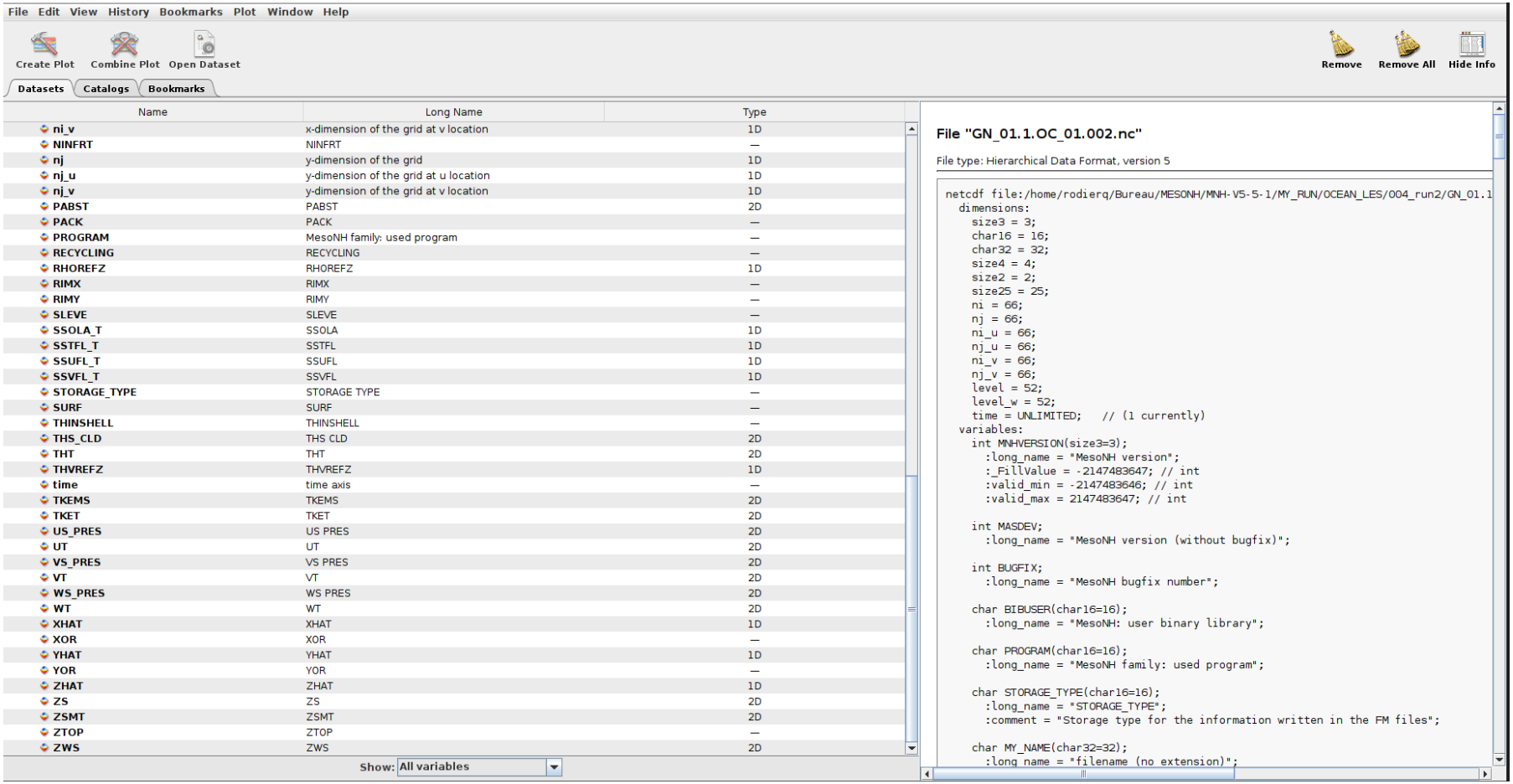
- epy_plot.py -f ZS file

EPyGrAM

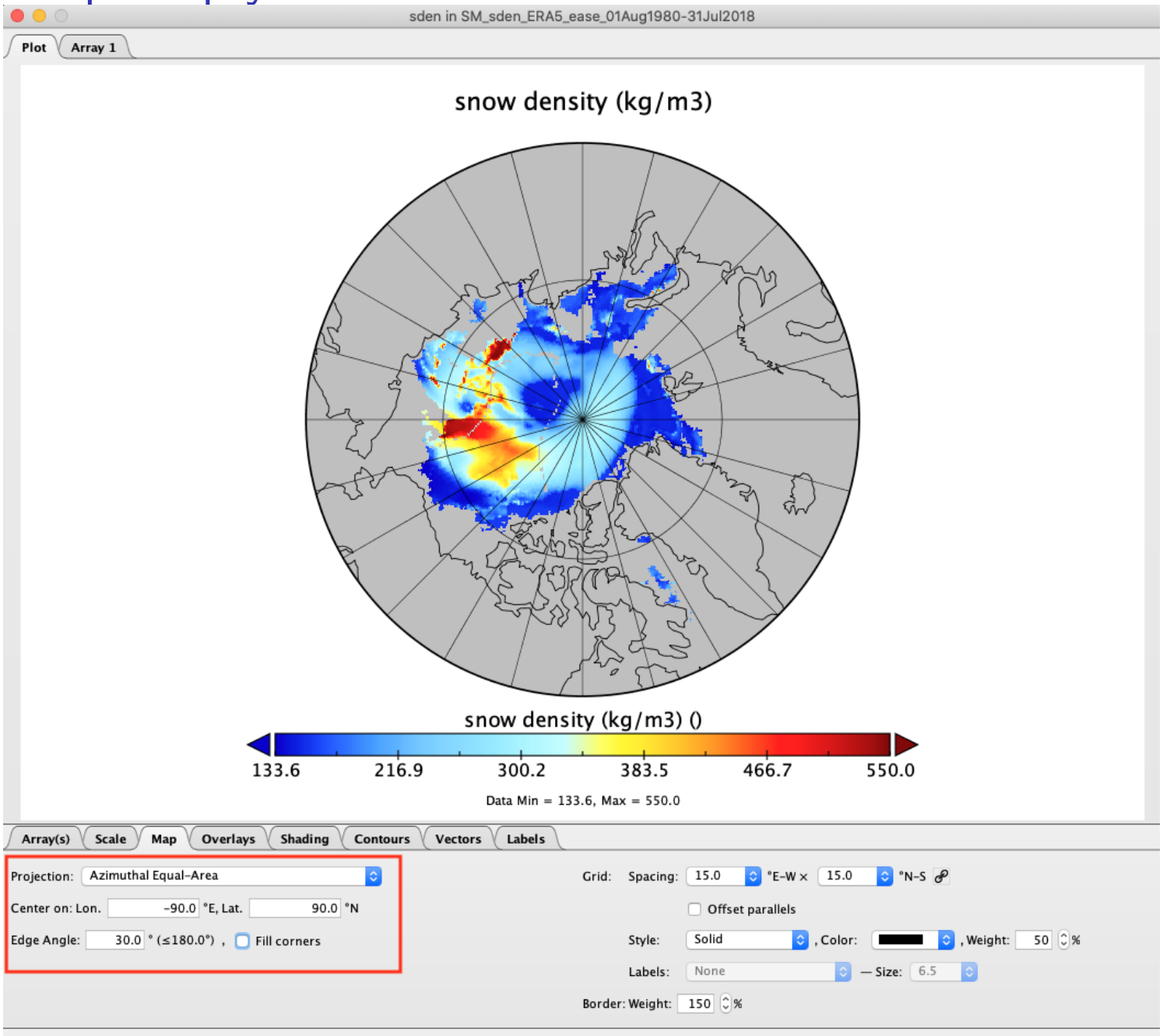


- epy_section.py -f UT -s'-2,47' -e'0,49' file.nc
- epy_profile.py -f '(UT,*)' -c'-2,47' file.lfi

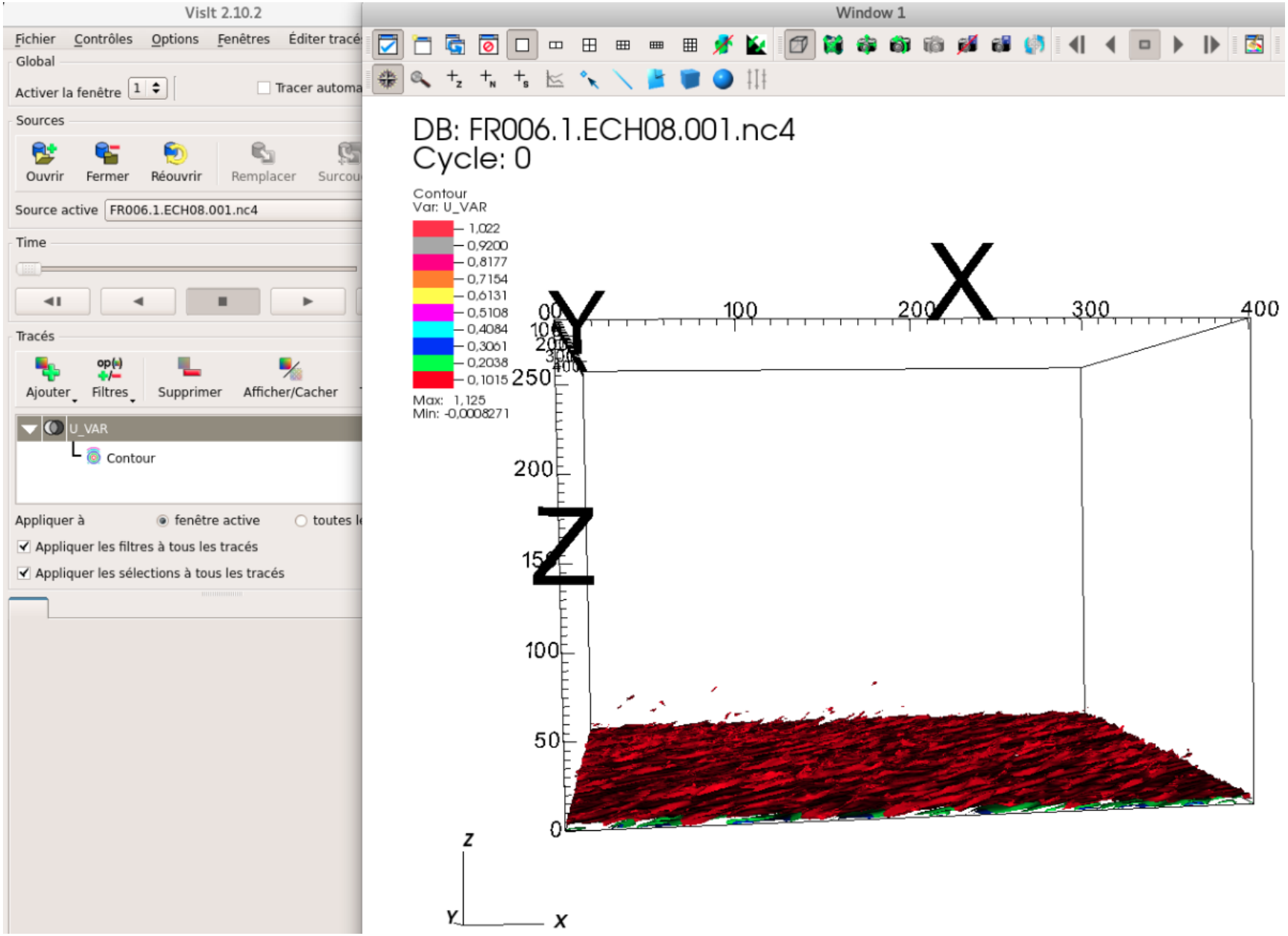
Tool : panoply



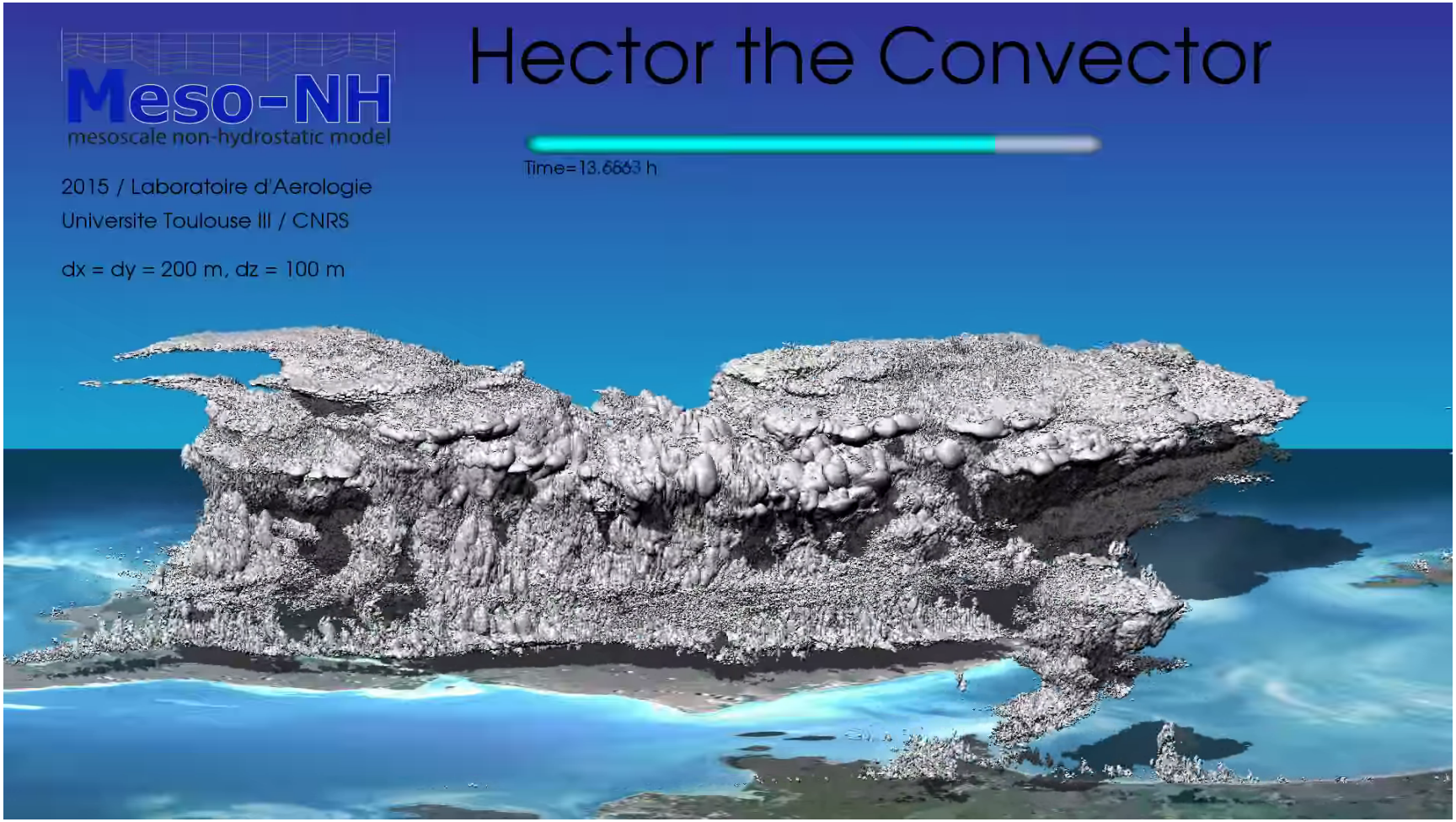
Tool : panoply



Tool : visit


VisIt 2.10.2
Fichier
Contrôles
Options
Fenêtres
Éditer tracé
Global
Activer la fenêtre
Tracer automa
Sources
Ouvrir
Fermer
Réouvrir
Remplacer
Source active
FR006.1.ECH08.001.nc4
Time
Tracés
Ajouter
Filtres
Supprimer
Afficher/Cacher
U_VAR
Contour
Appliquer à
fenêtre active
Appliquer les filtres à tous les tracés
Appliquer les sélections à tous les tracés
Window 1
DB: FR006.1.ECH08.001.nc4
Cycle: 0
Contour
Var: U_VAR
1,022
0,9200
0,8177
0,7154
0,6131
0,5108
0,4084
0,3061
0,2038
0,1015
Max: 1,125
Min: -0,0008271
X
Y
Z
0
100
200
300
400
250
200
150
100
50
0
Z
Y
X

Tool : visit


Meso-NH
mesoscale non-hydrostatic model
Hector the Convector
Time=13.6663 h
2015 / Laboratoire d'Aerologie
Universite Toulouse III / CNRS
dx = dy = 200 m, dz = 100 m