

Graphics tools
&
Data files processing

Meso-NH Tutorial Class 12-15 November 2024

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 title";
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 = 9.96920996838687e+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 = 9.96920996838687e+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 = 9.96920996838687e+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" ;
    THT:grid = 1 ;
```

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

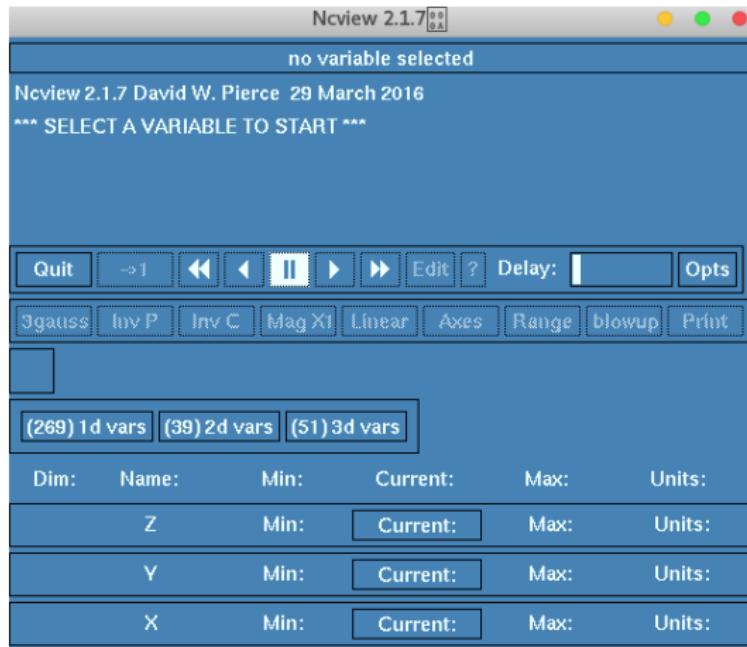
write the mean of the variables of file[1 to 4].nc in out.nc

ncrename -v latitude,lat file.nc

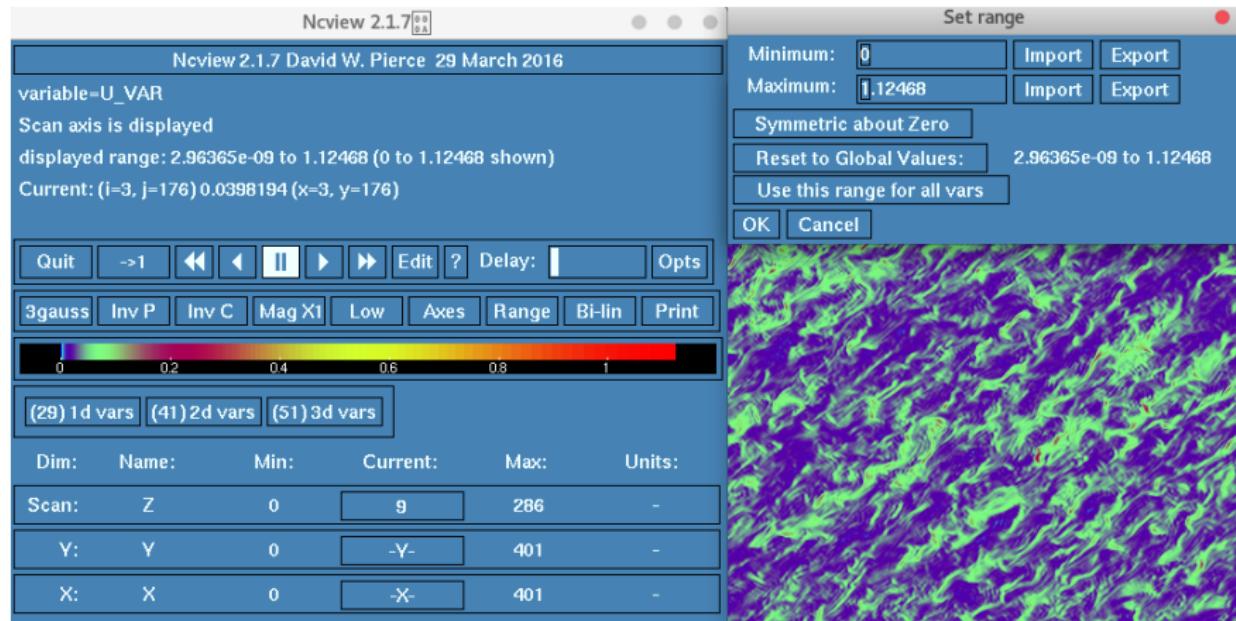
rename the variable latitude to lat in file.nc

Quick visualization : ncview

ncview file.nc

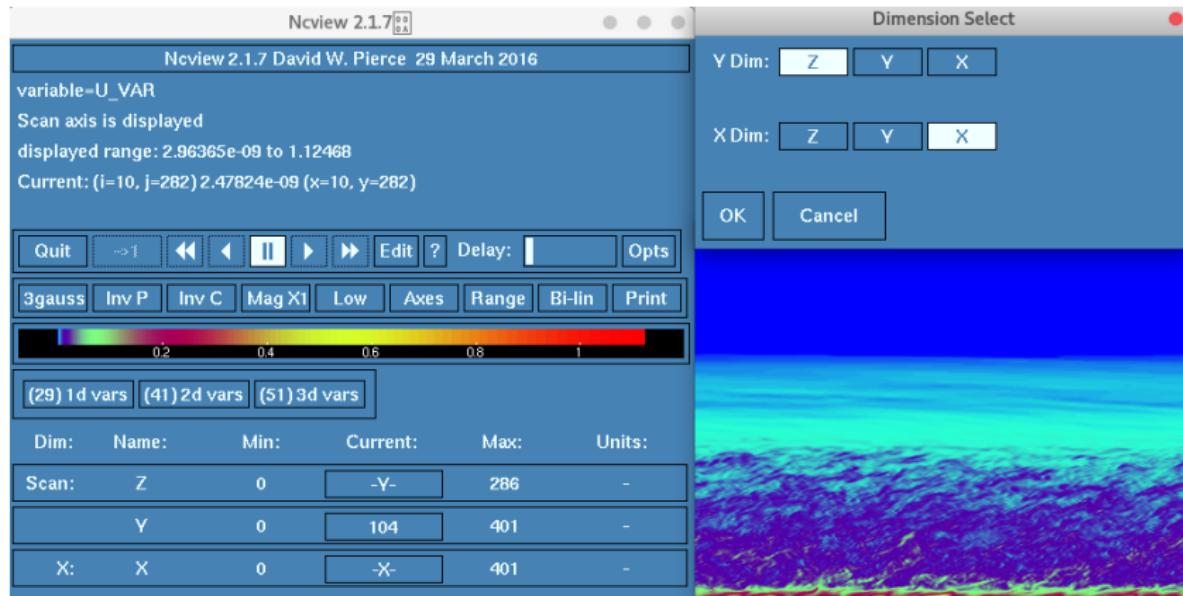


Quick visualization : ncview



Horizontal cross-section of u^2 variance

Quick visualization : ncview



Vertical cross-section of u'^2

Graphical tools : online documentation

The screenshot shows the Meso-NH online documentation website. The header features the Meso-NH logo with the text "mesoscale non-hydrostatic model" and the version "5.7 (Current)". Below the header, there is a navigation bar with links to "Mesonh-57", "Mesonh-56", "Mesonh-55", "Mesonh-54", and "Mesonh-53".

The main content area has two columns. The left column, titled "Documentation", contains links to "Meso-NH References", "Books and Guides", "Graphic Documentation" (which is highlighted in blue), "Chemistry", "Meso-NH Tutorial", "Team's FAQ", "Extract ECMWF", "AROME/ARPEGE", and "GFS". The right column, titled "graphic", contains a section titled "Graphic documentations" with a bulleted list:

- MNHPy
- Miscellaneous python scripts
- Use EPyGrAM
- Use NCL with Meso-NH
- Use Vapor with Meso-NH
- Use Visit with Meso-NH and parallel tools
- Plot Spectra from Meso-NH

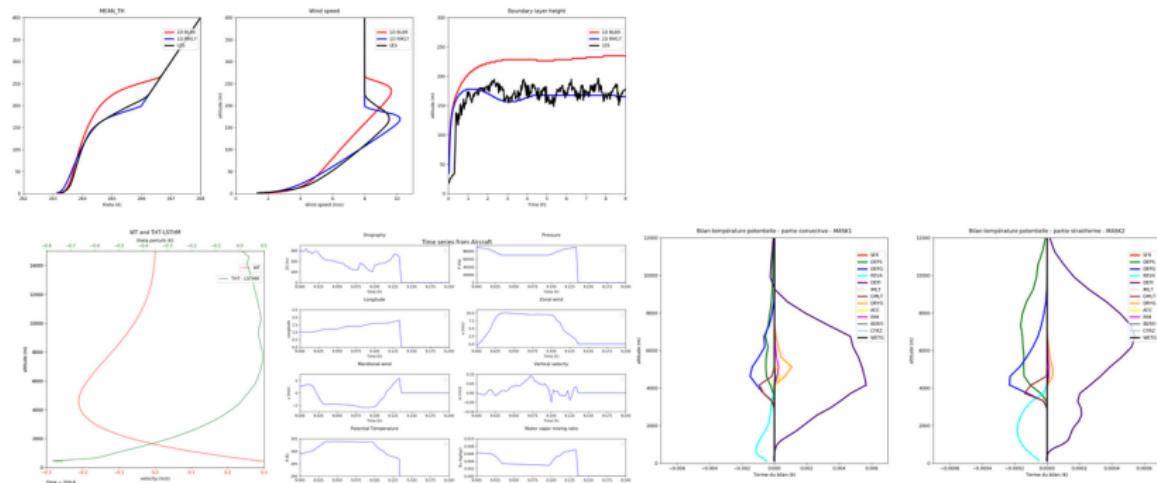
Below the "Documentation" section, there is a "Source code & data" section with links to "Download", "Git Sources", "KODA Git Sources", and "KTEST Namelist".

MNHPy : distributed python library for Meso-NH

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

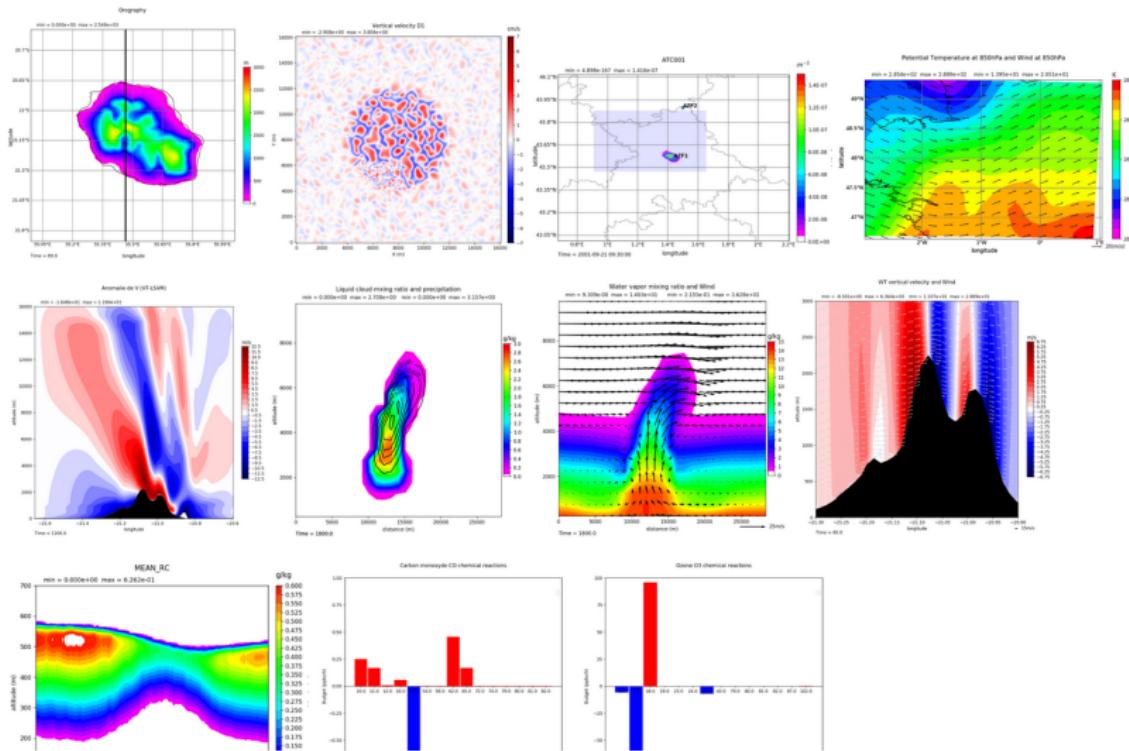
PythonLIB

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

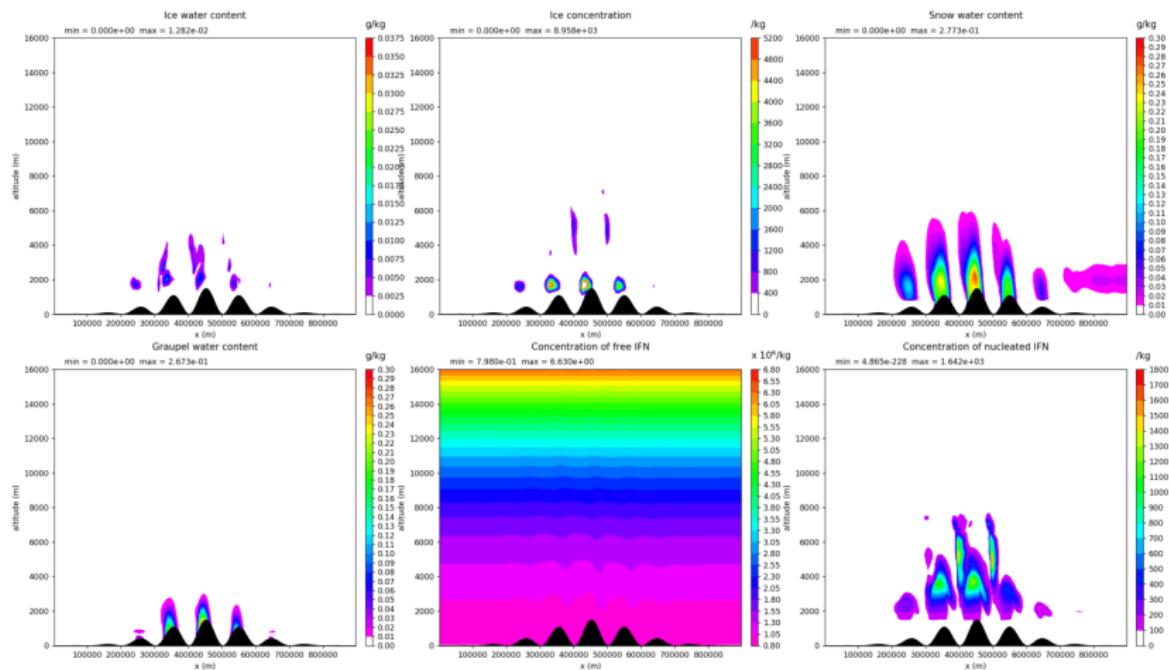
MNHPy



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_GABL51.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

014_LIMA



Example KTEST 014_LIMA

```

8 import matplotlib as mpl
9 mpl.use('Agg')
10 from read_MNHfile import read_ncdf
11 from Panel_Plot import PanelPlot
12 from misc_functions import comp_altitude1DVar
13
14 path = ''
15 LnameFiles = ['XPREF.1.SEG01.000.nc']
16
17 Dvar_input = {'f1':[['RI','AVEF'], ['CICE','AVEF'], ('RS','AVEF'), ('RG','AVEF'), ('CIFNFREE01','AVEF'), ('CIFNNUCL01','AVEF') ]}
18 Dvar_input_coord_budget = {'f1':['cart_level', 'cart_ni']}
19 Dvar_input_coord = {'f1':['ZS', 'ZTOP']}
20
21 # Read the variables in the files
22 Dvar, Dvar_coord_budget, Dvar_coord = {}, {}, {}
23 Dvar = read_ncdf(LnameFiles, Dvar_input, path=path, removeHALO=False)
24 Dvar_coord_budget = read_ncdf(LnameFiles, Dvar_input_coord_budget, path=path, removeHALO=False)
25 Dvar_coord = read_ncdf(LnameFiles, Dvar_input_coord, path=path, removeHALO=True)
26
27 Dvar['f1']['altitude'], Dvar['f1']['ni_2D'] = comp_altitude1DVar(Dvar['f1'][('CIFNFREE01','AVEF')], Dvar_coord['f1']['ZS'], Dvar_coord['f1']['ZTOP'])
28
29 ##### PLOT #####
30 ##### PANEL 1 #####
31
32 Panel1 = PanelPlot(2,3, [25,14], '014_LIMA', titlepad=25, minmaxpad=1.04, timepad=-0.07, colorbarpad=0.03, labelcolorbarpad = 13, colorbaraspect=40)
33
34 Lplot = [Dvar['f1'][('RI','AVEF')], Dvar['f1'][('CICE','AVEF')], Dvar['f1'][('RS','AVEF')],
35 Dvar['f1'][('RG','AVEF')], Dvar['f1'][('CIFNFREE01','AVEF')], Dvar['f1'][('CIFNNUCL01','AVEF')]]
36 LaxeX = [Dvar['f1']['ni_2D']] * len(Lplot)
37 LaxeZ = [Dvar['f1']['altitude']] * len(Lplot)
38 Ltitle = ['Ice water content', 'Ice concentration', 'Snow water content',
39 'Graupel water content', 'Concentration of free IFN', 'Concentration of nucleated IFN']
40 Lcbarlabel = ['g/kg', '/kg', 'g/kg', 'g/kg', 'r' * 10^6$/kg', '/kg']
41 Lxlab = ['x (m)'] * len(Lplot)
42 Lylab = ['altitude (m)'] * len(Lplot)
43 Lylim = [[0, 16000]] * len(Lplot)
44 Lminval = [0, 0, 0, 0, 0.8, 0]
45 Lmaxval = [3.75E-2, 5400, 3E-1, 3E-1, 7, 1800]
46 Lstep = [0.25E-2, 400, 0.01, 0.01, 0.25, 100]
47 Lstepticks = Lstep
48 Lfaccconv = [1000, 1, 1000, 1000, 1E-6, 1]
49 orog = Dvar_coord['f1']['ZS']
50 Lcolormap = ['gist_rainbow_r'] * len(Lplot)
51 LaddWhite = [True, True, True, True, False, True]
52
53 fig1 = Panel1.psectionV(Lxx=LaxeX, Lzz=LaxeZ, Lvar=Lplot, Lxlab=Lxlab, Lylab=Lylabel, Ltitle=Ltitle, Lminval=Lminval, Lmaxval=Lmaxval,
54 Lstep=Lstep, Lstepticks=Lstepticks, Lcolormap=Lcolormap, Lcbarlabel=Lcbarlabel, Lfaccconv=Lfaccconv, Lylim=Lylim,
55 orog=orog, Laddwhite_cmn=LaddWhite)
56 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()

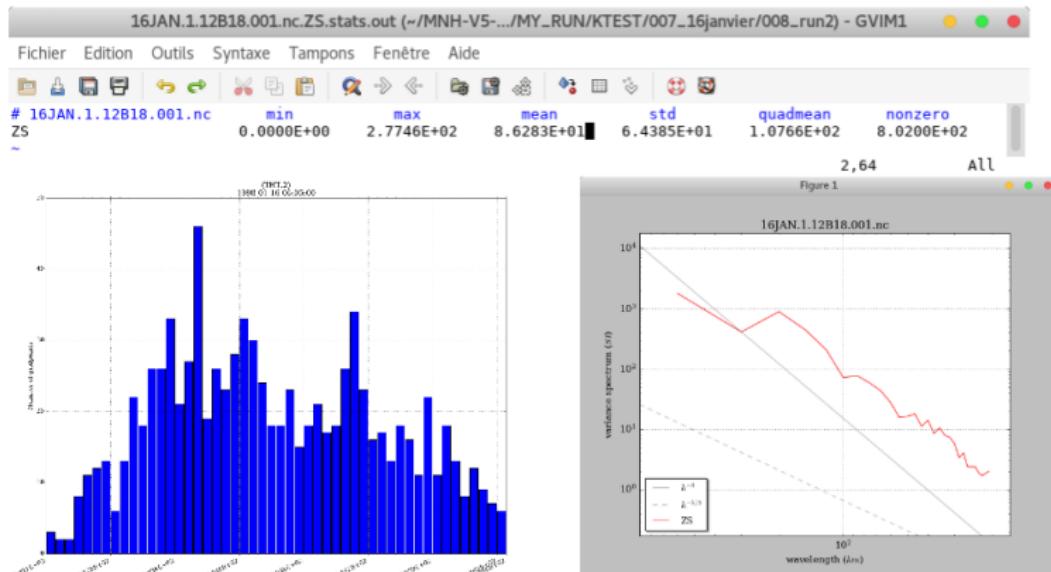
MNHPy

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

Tool : python library EPyGrAM

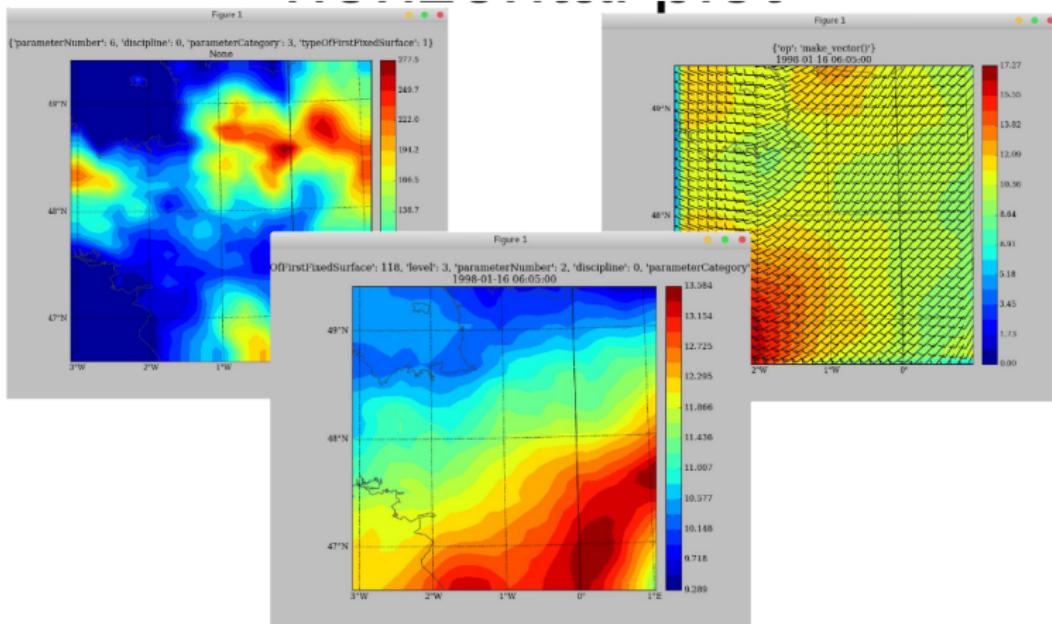
- ▶ Read/Write multiple formats : FA, LFI, NetCDF, GRIB[1-2]
- ▶ Easy to compare multiple files with different formats
- ▶ Quick visualization tool
- ▶ Advanced graphics (3D...)
- ▶ Setup & Overview :
<https://github.com/UMR-CNRM/EPyGrAM>
- ▶ not open yet (only MF)

EPyGrAM



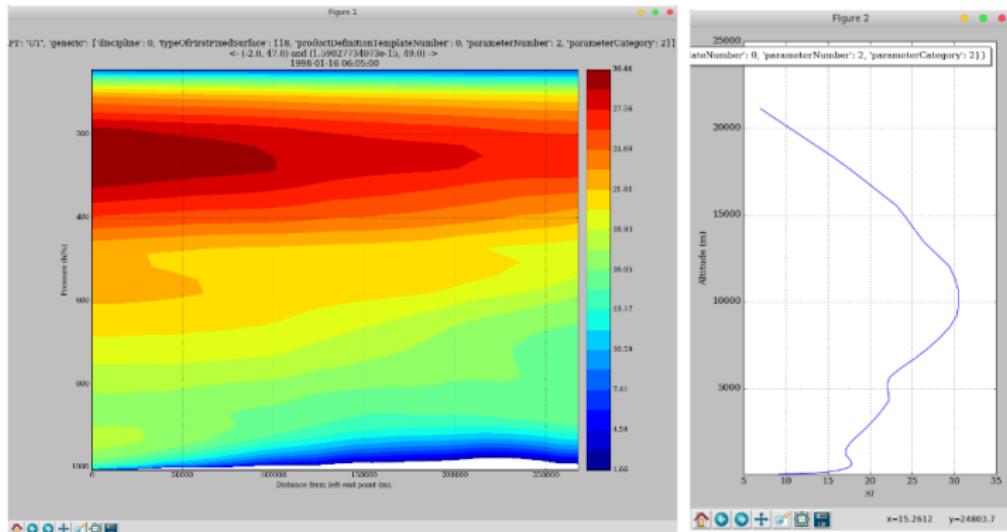
- ▶ epy_stats.py -f ZS file.nc
- ▶ epy_hist.py -f '(THT,2)' file.lfi
- ▶ epy_spectrum -f UT file.nc

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

File Edit View History Bookmarks Plot Window Help

Create Plot Combine Plot Open Dataset

Remove Remove All Hide Info

Datasets Catalog Bookmarks

Name	Long Name	Type
nl_v	x-dimension of the grid at v location	1D
MN1RT	N1BUST	—
nl_x	y-dimension of the grid	1D
nl_u	y-dimension of the grid at u location	1D
nl_v	y-dimension of the grid at v location	1D
PABST	PABST	2D
PACK	PACK	—
PROGRAM	Mesoh4 family: used program	—
RECYCLING	RECYCLING	—
RHOREFZ	RHOREFZ	1D
RIMX	RIMX	—
RIMY	RIMY	—
SURF	SURF	—
SSOLA_T	SSOLA	1D
SSTRL_T	SSTRL	1D
SSUFL_T	SSUFL	1D
SSVFL_T	SSVFL	1D
STORAGE_TYPE	STORAGE TYPE	—
SURF	SURF	—
THINSHELL	THINSHELL	—
THS_CLD	THS CLD	2D
THT	THT	2D
THVREFZ	THVREFZ	1D
THI	time axis	—
THERMS	THERMS	2D
TKET	TKET	2D
US_PRES	US PRES	2D
UT	UT	2D
VS_PRES	VS PRES	2D
VT	VT	2D
WS_PRES	WS PRES	2D
WT	WT	2D
XHAT	XHAT	1D
XOR	XOR	—
YHAT	YHAT	1D
YR	YR	—
ZHAT	ZHAT	1D
ZS	ZS	2D
ZSMT	ZSMT	2D
ZTOP	ZTOP	—
ZWS	ZWS	2D

Show: All variables

File "GN_01.1.OC_01.002.nc"

File type: Hierarchical Data Format; version 5

```
netcdf file:/home/rodriguez/Bureau/MESOH4/MN1-V5-1/MY_RUN/OCEANLES/004_run2/GN_01.1.OC_01.002.nc {
    dimensions:
        size3 = 3;
        char16 = 16;
        char32 = 32;
        size4 = 4;
        size2x = 2;
        size25 = 25;
        ni = 66;
        nj = 66;
        ni_u = 66;
        nj_u = 66;
        ni_v = 66;
        nj_v = 66;
        level = 52;
        level_w = 52;
        level_w_UNLIMITED; // [1 currently]
    variables:
        int MAJVERS0(size3=3);
        :long_name = "Mesoh4 version";
        :_FillValue = -2147483647; // int
        :valid_min = -2147483646; // int
        :valid_max = 2147483647; // int

        int MASDEV;
        :long_name = "Mesoh4 version (without bugfix)";

        int BUFINX;
        :long_name = "Mesoh4 bugfix number";

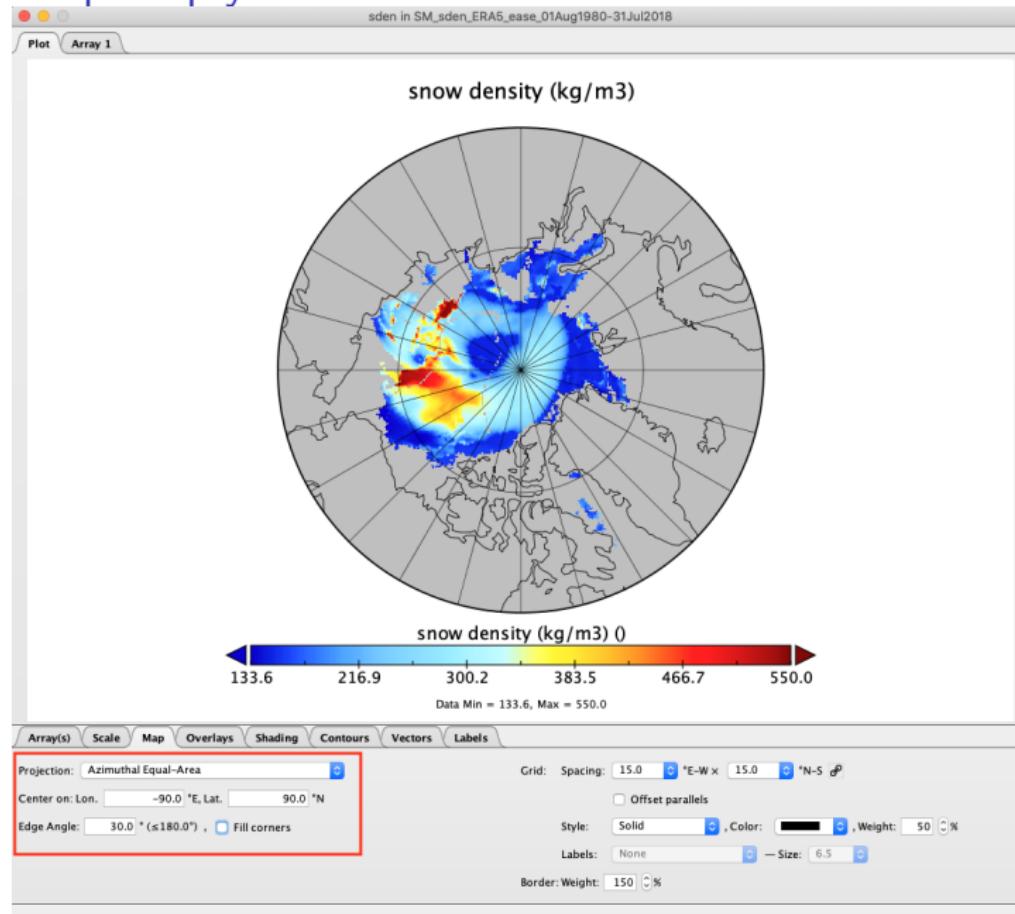
        char BDBUSER(char16=16);
        :long_name = "Mesoh4 user binary library";

        char PROGRAM(char16=16);
        :long_name = "Mesoh4 family: used program";

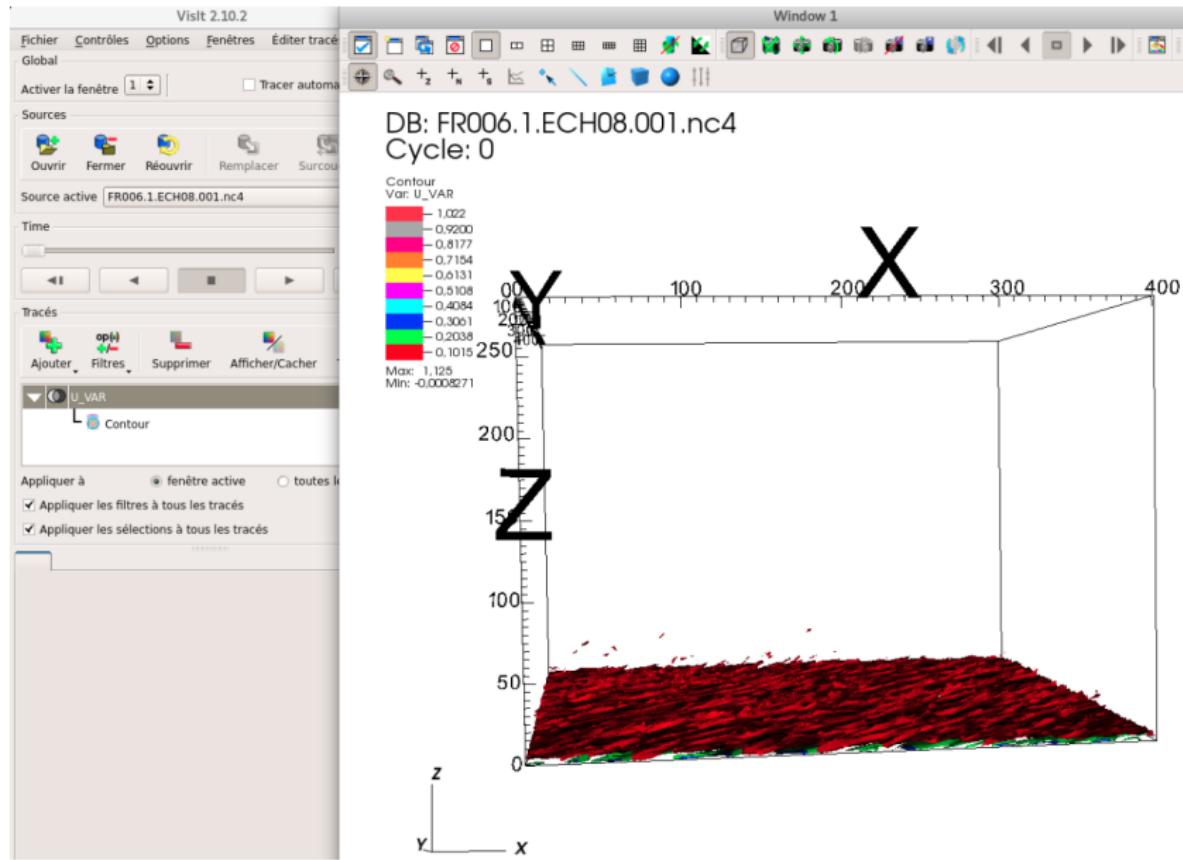
        char STORAGE_TYPE(char16=16);
        :long_name = "STORAGE_TYPE";
        :comment = "Storage type for the information written in the FM files";

        char MY_NAME(char32=32);
        :long_name = "filename (no extension)";
}
```

Tool : panoply



Tool : visit



Tool : visit

