Norwegian
Meteorological Institute
met.no MSC-W

EMEP model: Data Formats, Manipulation and Visualisation Tools

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Output Data Formats: NetCDF and ASCII

NetCDF:

- self-describing, machine-independent data formats file.nc

To see the content of the data:

- ncdump -h file.nc

```
netcdf Base_fullrun {
dimensions:
        i = 132 ;
        j = 159 ;
        k = 20 ;
        time = UNLIMITED ; // (1 currently)
variables:
        float lon(j, i) ;
                lon:long_name = "longitude" ;
                lon:units = "degrees_east" ;
                lon:standard_name = "longitude" ;
```

Output Data Formats:

```
// global attributes:
                :Conventions = "CF-1.0" ;
                :model = "EMEP_MSC-W" ;
                :created_date = "20130423" ;
                :created_hour = "101920.362" ;
                :projection = "Stereographic" ;
}
```

Ncdump -c file.nc would give extra info: egs.,

```
data:
k = 0.02, 0.06, 0.1, 0.1425, 0.195, 0.2635, 0.347, 0.4365, 0.5215, 0.599,
    0.6695, 0.733, 0.7895, 0.839, 0.8815, 0.917, 0.9455, 0.967, 0.982, 0.994 ;

 time = 40178 ;
}
```

ASCII DATA: In rows and columns

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Post Processing (Data Manipulation tools)

NetCDF Operator (NCO):

http://nco.sourceforge.net/

- *Powerful and free*
- *NCO aids manipulation and analysis of gridded scientific data.*

NCO Examples.

To average along record dimension

- ncra file1.nc file2.nc file3.nc Avg_file.nc

To use *stride* option option to average O3 concentration of march of input files 2005.nc 2006.nc 2007.nc

- ncra -F -d time,3,,12 -v O3 2005.nc 2006.nc 2007.nc 2005-07_03.nc

To select a time period or variable

- ncks -d time/var 3,5/O3,NO2 ifile.nc ofile.nc

NCO Examples.

ncrename – rename a variable or dimension

- ncrename -v PM10,PM ifile.nc

ncatted - editting the attribute (changing the long_name of variable 'T' to 'temperature'

- ncatted -O -a long_name,T,o,c,temperature ifile.nc

ncap2 - Doing arithmetic

- ncap2 -v -s "NO3-25=NO3_1+NO3coar" ifile.nc

NCO Examples.

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- ncra -F -d time,3,,12 -v O3 2005.nc 2006.nc 2007.nc 2005-07_03.nc

To select a time period or variable

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Climate Data Operators (CDO)

www.mpimet.mpg.de/fileadmin/software/cdo/cdo.pdf

for handling netcdf and grib data.

Advantages: Can handle GRIB data. (But who uses it now!?)

- Functions similar to NCO.

Ncview

- Visual Browser for netCDF data.

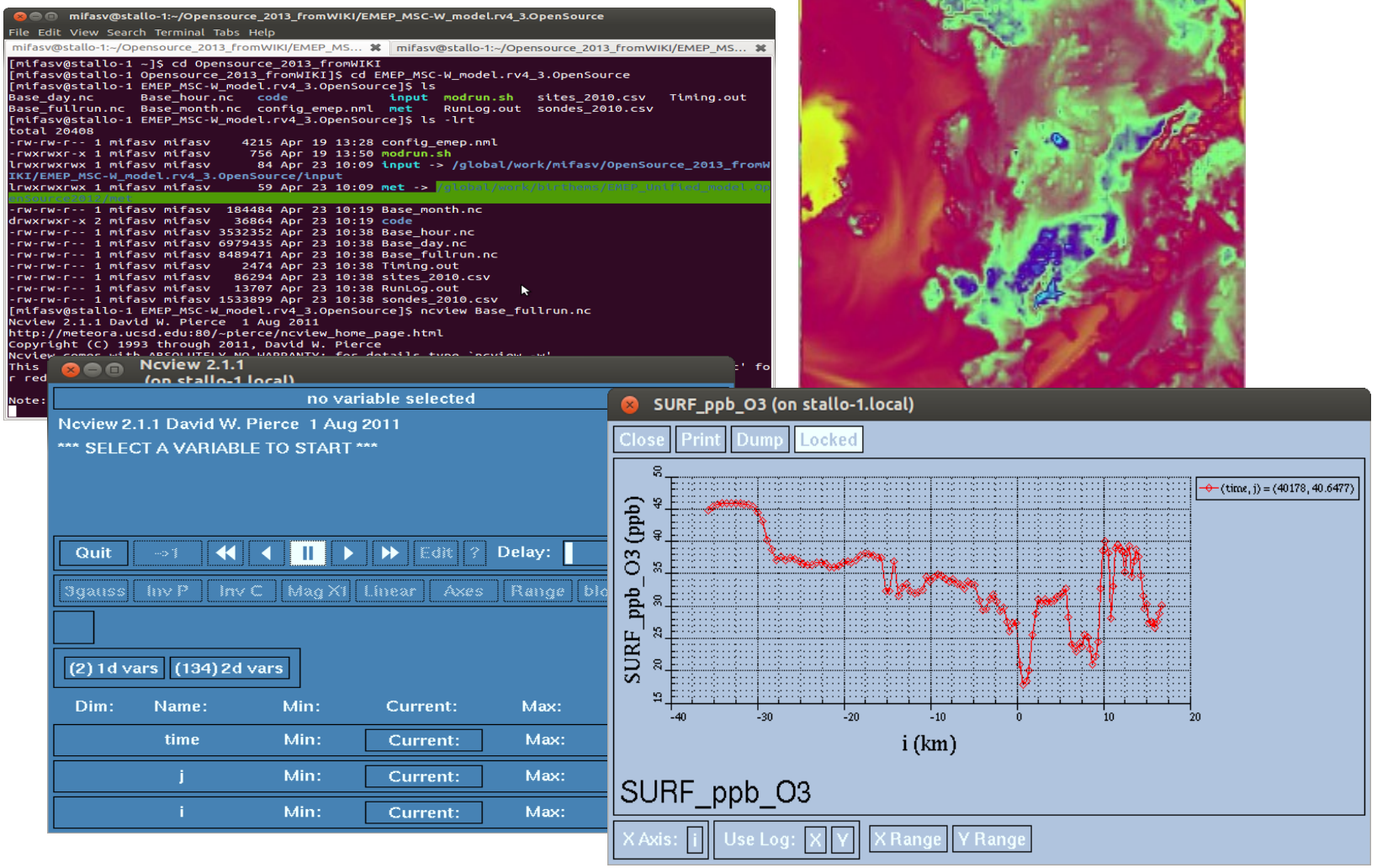
http://meteora.ucsd.edu/~pierce/ncview_home_page.html

- Best for a quick look at the data

> To install ncview you need:

- Install HDF-5, version 1.8.5 or later
- Install netCDF-C library, version 4.1-beta2 or later

Ncview continued.



Grid Analysis and Display System (GrADS):

http://www.iges.org/grads/

Center for Ocean-Land-Atmosphere Studies
Calverton, Maryland

Work with:

Linux, MAC OS X, Windows (requires cygwin)

GrADS Supports the following file formats:

- GRIB Versions 1 and 2
- Griddes data with discription file
- NetCDF
- HDF (4 and 5)
- BUFR (Station data)

Uses 5D data environment (lat,lon,time,lev and an optional 5th dimension mainly used for ensembles

Handles grids: regular, non-linearly spaced, gaussian, or of variable resolution

GrADS Continued.

Features:

- Plots 2D distribution maps, stream lines
- Vertical profiles, wind vectors
- Time series, bar graphs, scatter plots
- Vertical Cross Sections
- 2D Animations

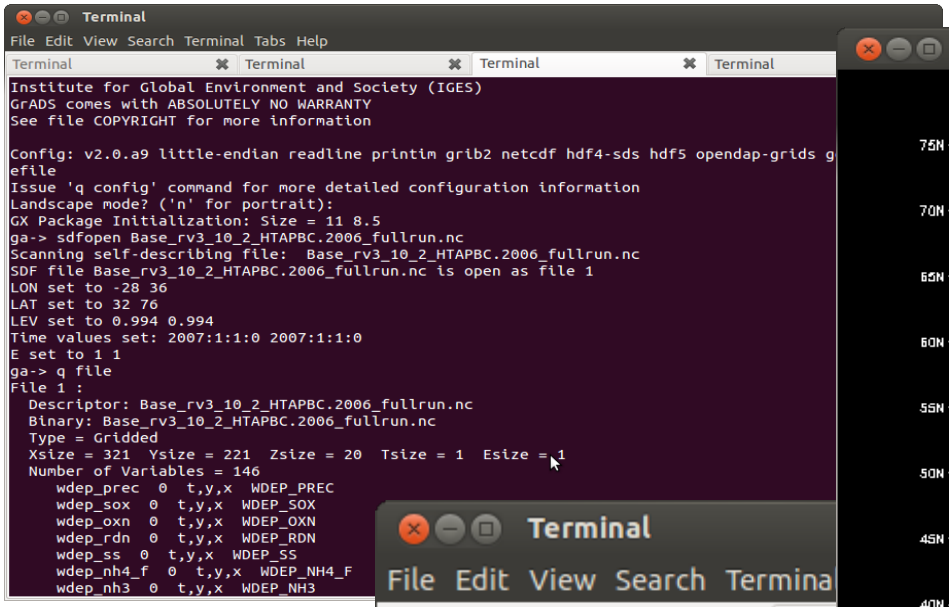
Functions:

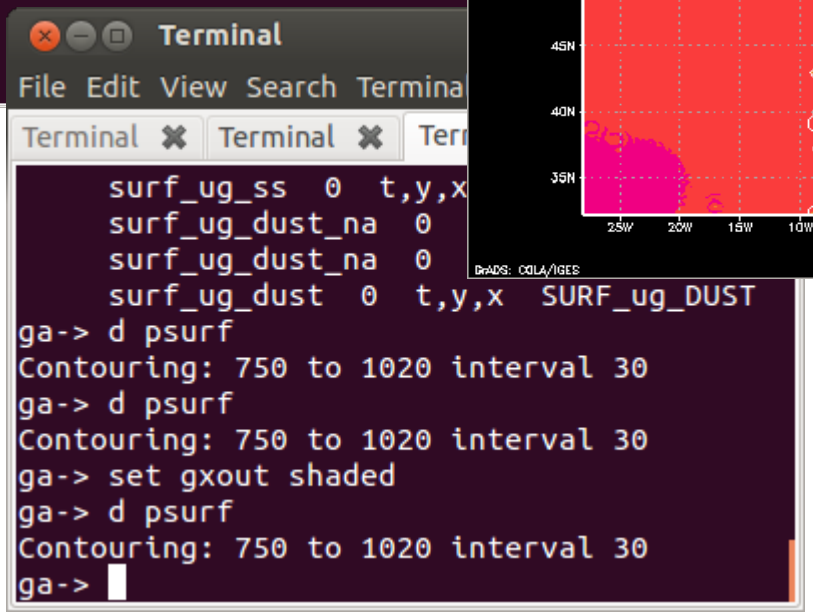
- Area Average
- Time average
- Zonal average
- Meridional average

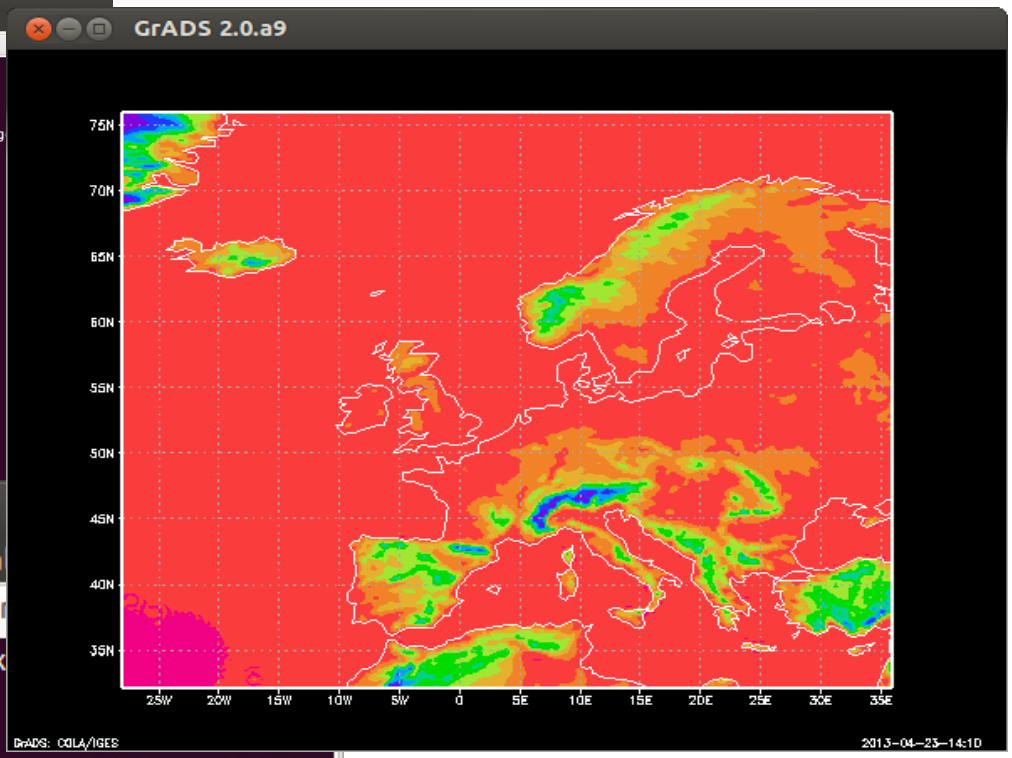
Output: Post Script or Image format

GrADS Continued:

Screen shot of GrADS

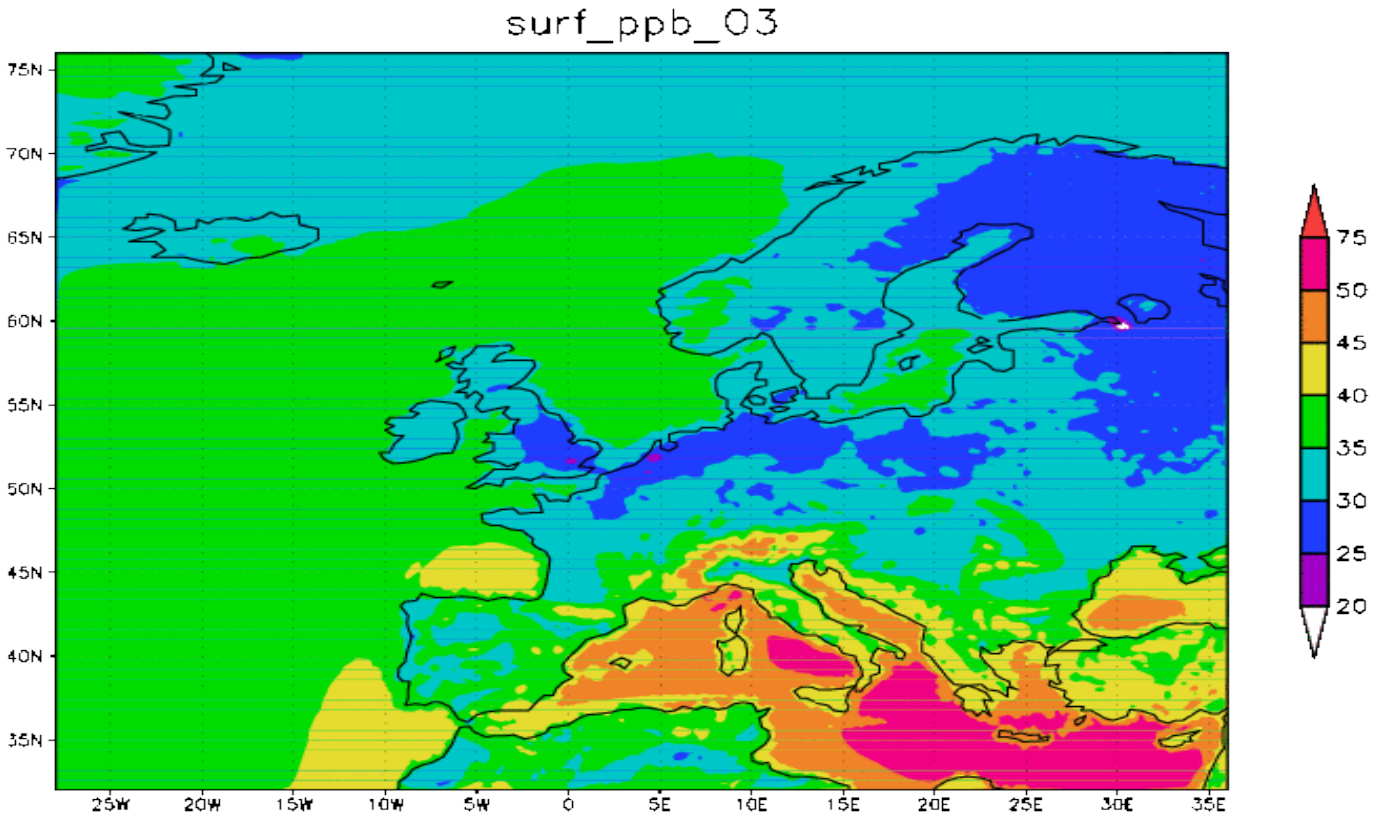




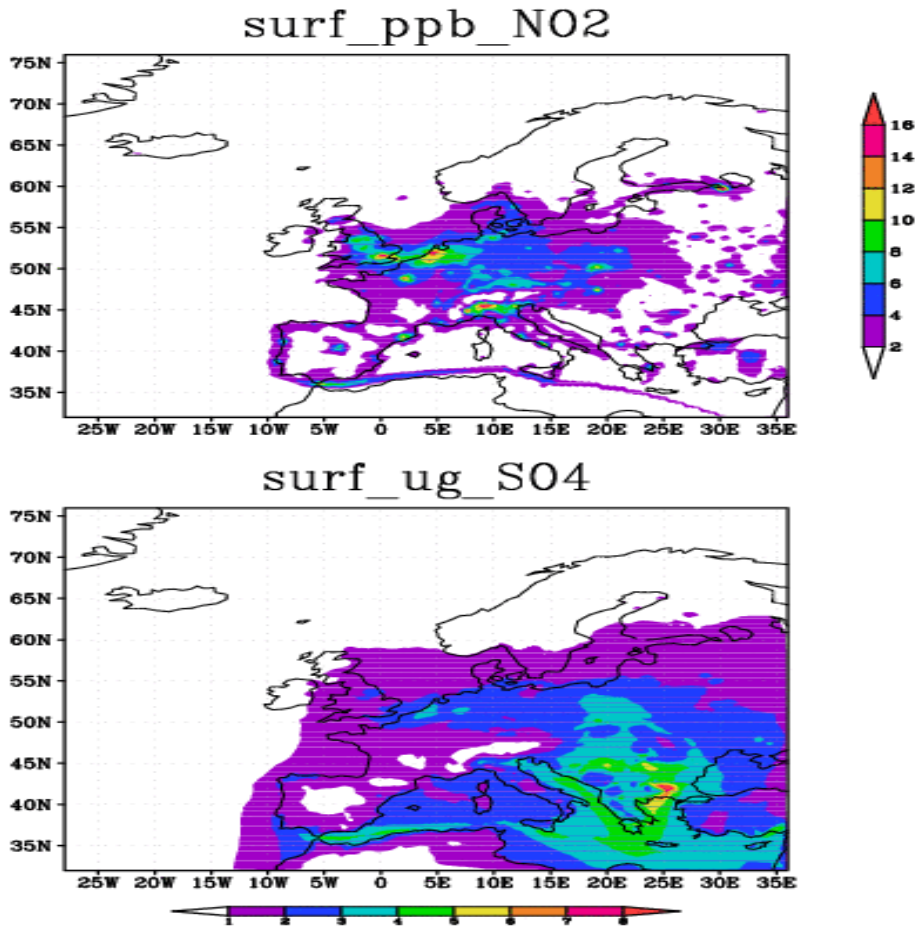


GrADS Continued.

Surface Concentration of O3 in ppb

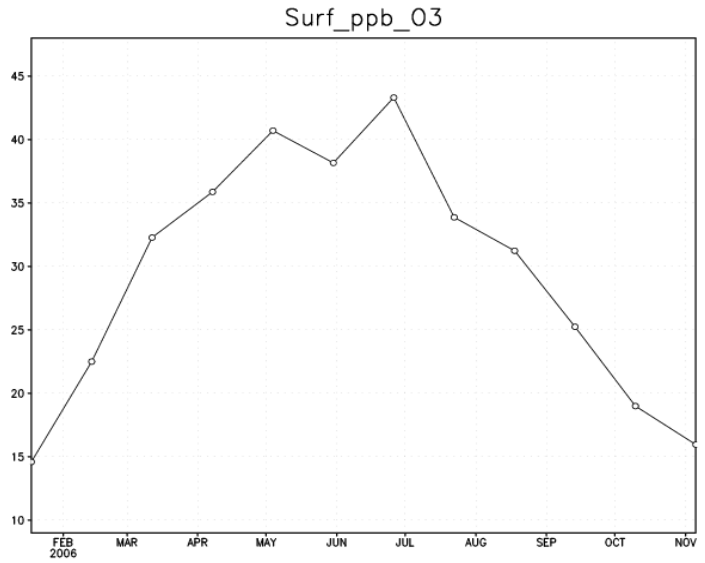


GrADS continued.

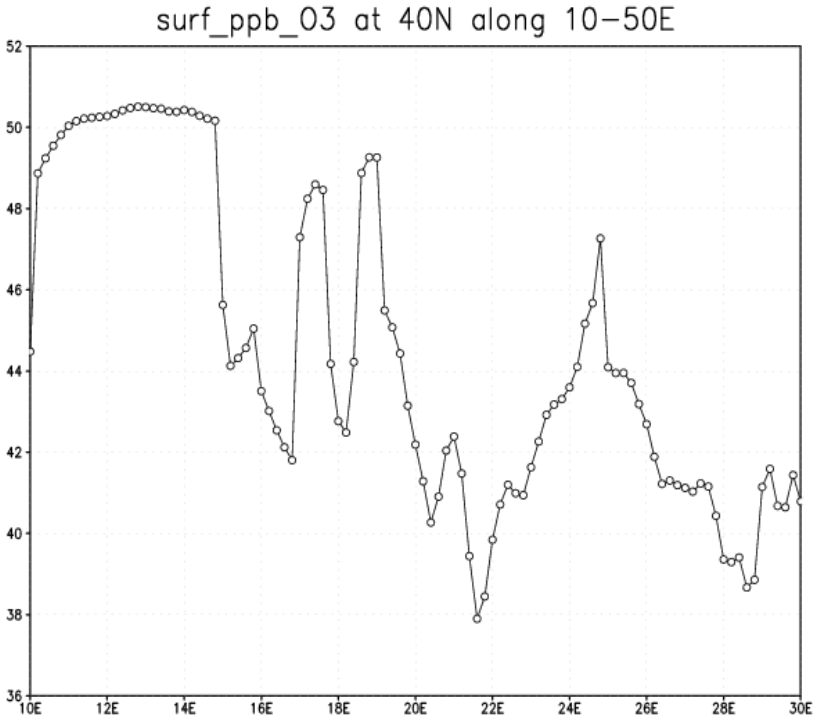


GraDS Continued

Timeseries

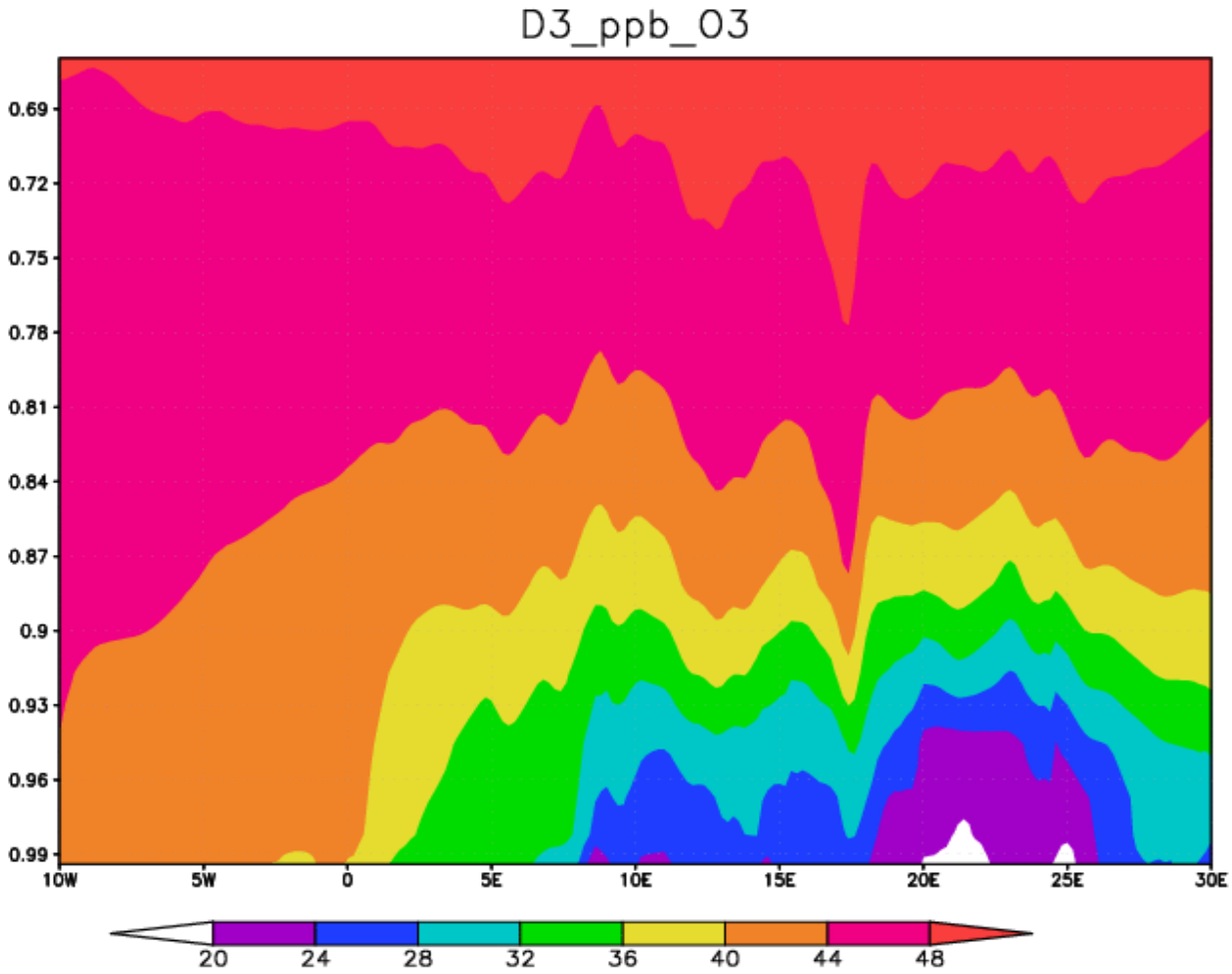


Meridional Mean



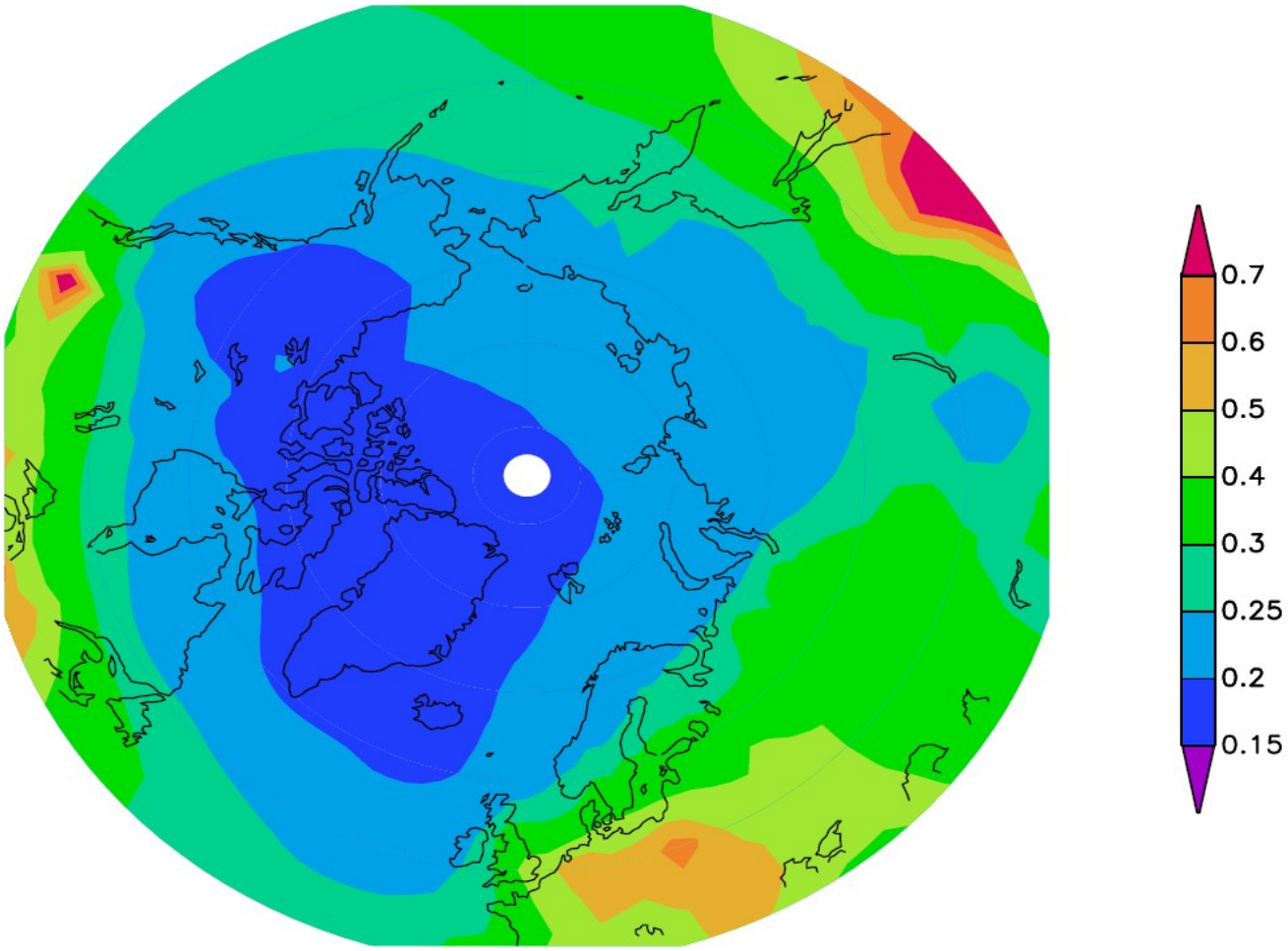
GrADS Continued.

Vertical Cross section (z=1-10) at 50N along 10W-30E

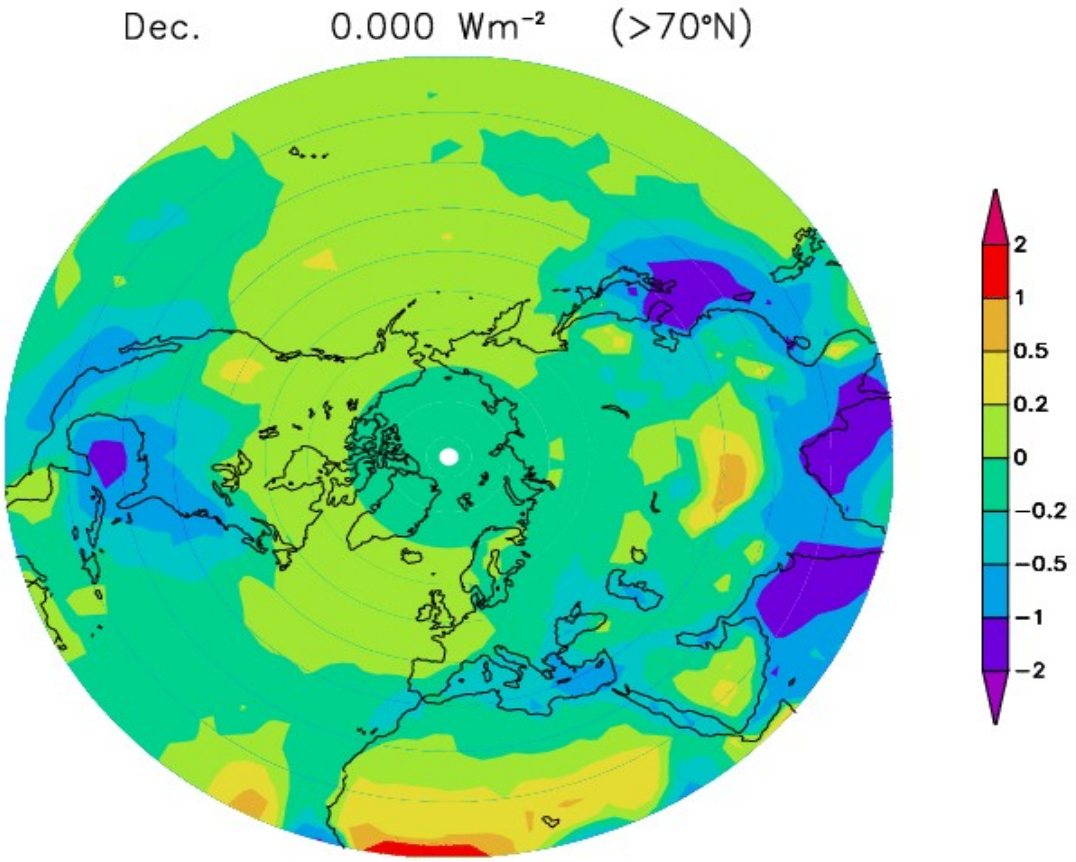


GrADS Continued.

North Polar Stereographic Projection



GrADS Continued.



GrADS Continued.

Correlation and Regression

scorr() Calculates the spatial correlation over an X-Y domain
tcorr() Produces a spatial map of temporal correlation coefficients
sregr() Calculates the linear least-squares regression over an X-Y domain
tregr() Calculates the least-squares regression over the time domain

Grid Operations

cdiff() Performs a centered difference operation
fndlvl() Finds the vertical level at which a given value occurs in a variable
lterp() Performs bi-linear interpolation between two grids
max() Returns the maximum value over a given grid dimension
maxloc() Returns the grid location of the maximum value
min() Returns the minimum value over a given grid dimension
minloc() Returns grid location of the minimum value
skip() Sets alternating data values to missing
smth9() Performs a 9 point smoothing operation on gridded data

GrADS Cintinued.

Station Data:

coll2gr()	Creates a grid from a collection of station data
gr2stn()	Grid-to-station interpolator
oabin()	Bins station observations into grid cells
oacres()	Returns a gridded result that represents station data
s2g1d()	Converts a station timeseries to a 1D grid
stnave()	Calculates a time average of station data
stnmin()	Returns the minimum value over a time series of station data
stnmax()	Returns the maximum value over a time series of station data

FERRET

http://ferret.pmel.noaa.gov/Ferret/home

Runs on :

- Most Unix systems
- Windows XP/NT/9x using X windows for display.

Ferret was developed by the Thermal Modeling and Analysis Project (TMAP) at PMEL in Seattle to analyze the outputs of its numerical ocean models and compare them with gridded, observational data.

FERRET Continued.

Similar plotting skills as GrADS

**** Advantage:

Can create netCDF from gridded ascii data

Egs. Prog would look like: (convert2nc.jnl)

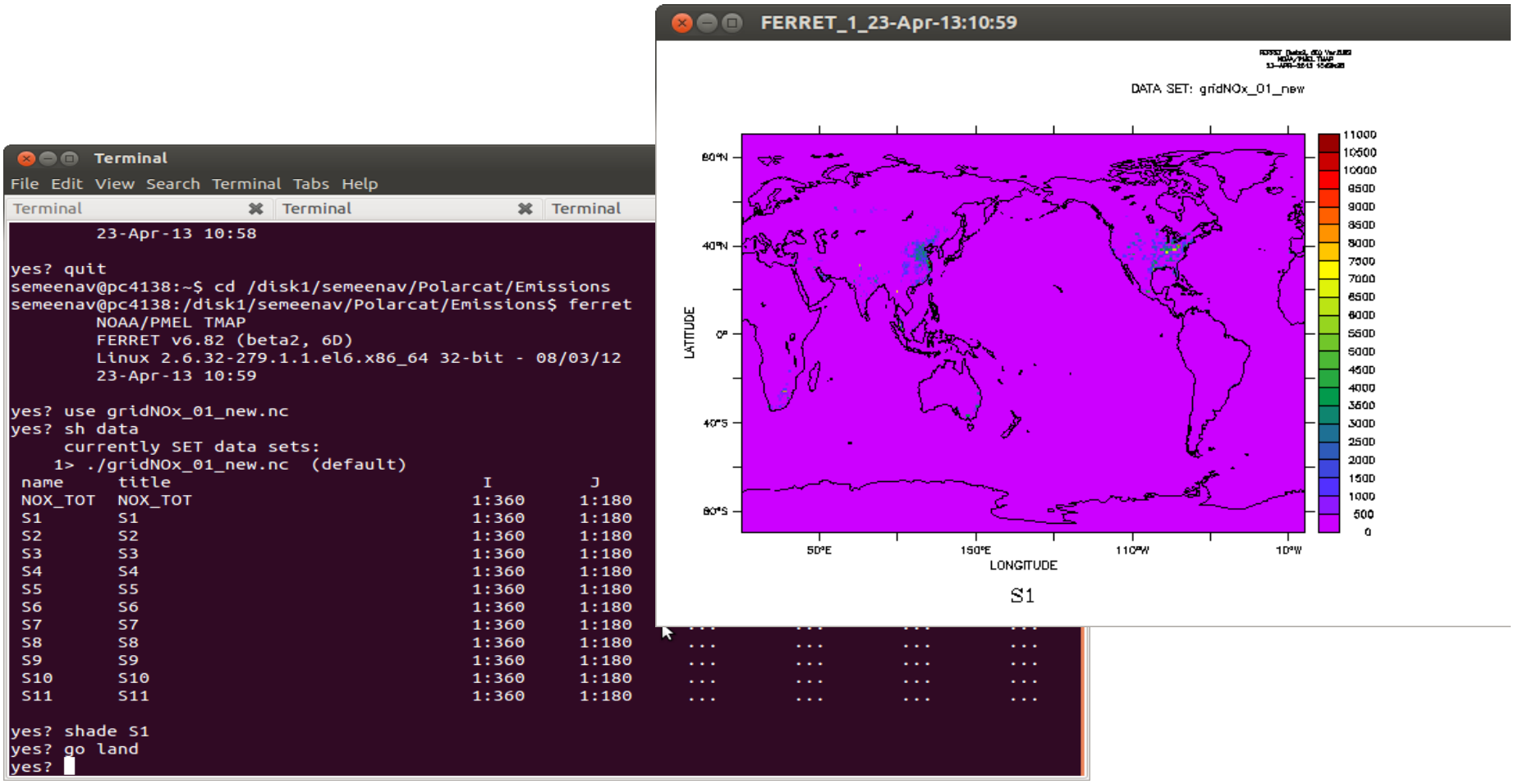
```
define axis/x=1:360:1/units=longitude xax
define axis/y=-89:90:1/units=latitude yax
define grid/x=xax/y=yax gax
file/grid=gax/var="nox_tot,s1,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11"/order=yx gridNOx_lonlat.01
save/file=gridNOx_01_new.nc/append nox_tot,s1,s2,s3,s4,s5,s6,s7,s8,s9,s10,s11
```

Disadvante:

Not good for plotting vertical profiles, since
It is developed for oceanographic purposes.

FERRET Continued.

Screen shot of FERRET



Other tools: IDL, Matplotlib

IDL - Is a commercial tool.

- Aerocom project's plotting tools are based on IDL

  http://aerocom.met.no/Welcome.html

Matplotlib – Python based library

- *http://matplotlib.org/*

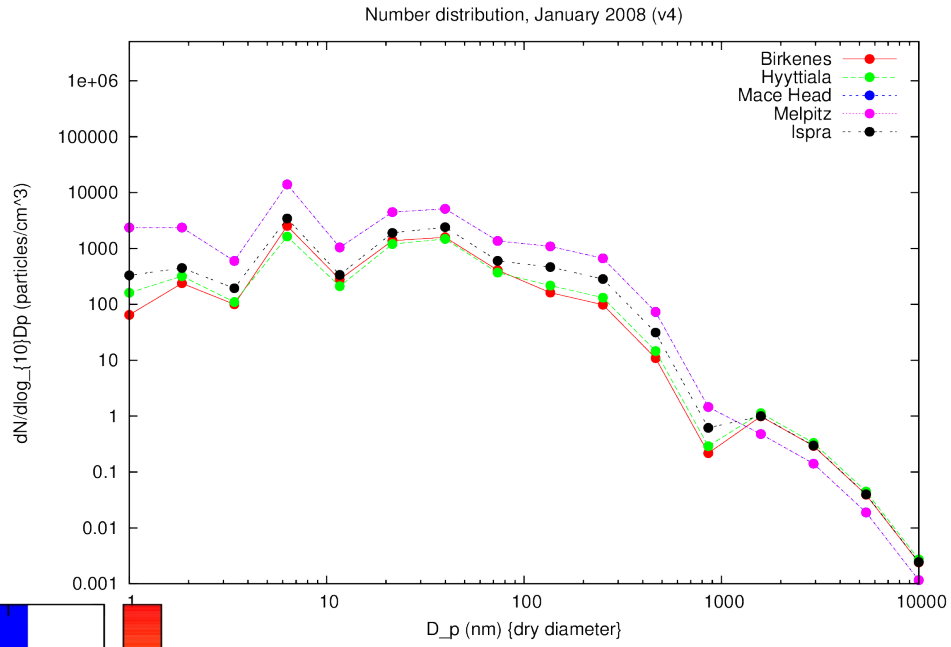
Plotting ascii output

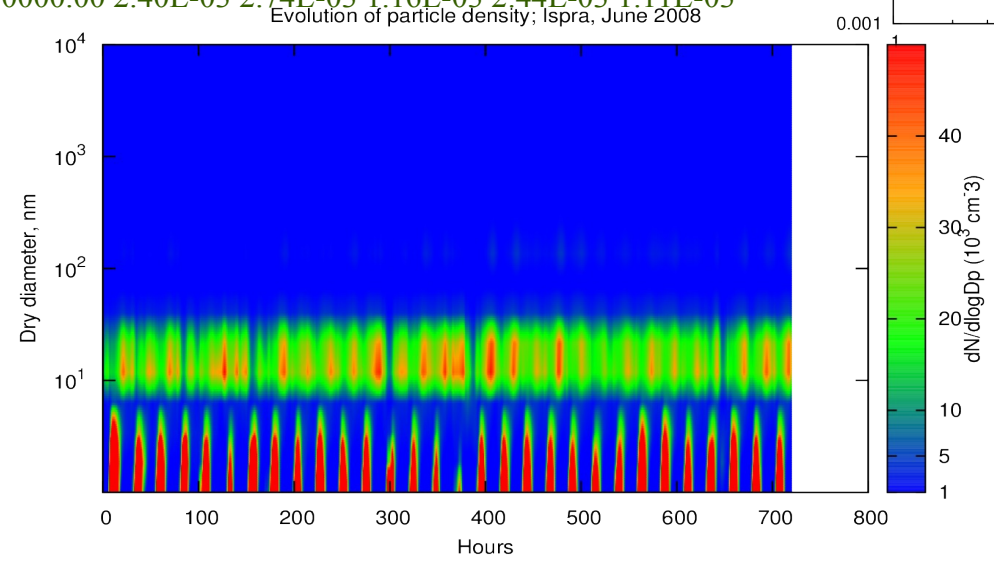
NCL, GrADS, FERRET, Matlab, Matplotlib, gnuplot etc. can be used to plot station data. These tools, except NCL, need data in certain format and you need to reformat the default EMEP ascii outputs (sites.csv and sondes.csv). EMEP provide a fortran code to convert this data into several formats. The progs called 'Rd_csvsites.f90' and 'Rd_csvsondes.f90' are provided by EMEP to convert these data into several desirable formats and they are uploaded at Opensource WIKI page.

- Here each of us use any of the above according to our convenience

Example plots from sites.dat

1.00	6.47E+01	1.61E+02	2.37E+03	3.30E+02	3.81E+02
1.85	2.38E+02	3.19E+02	2.36E+03	4.47E+02	5.13E+02
3.41	1.00E+02	1.10E+02	5.98E+02	1.94E+02	1.49E+02
6.31	2.54E+03	1.63E+03	1.40E+04	3.44E+03	2.54E+03
11.66	2.79E+02	2.10E+02	1.04E+03	3.36E+02	2.46E+02
21.54	1.38E+03	1.20E+03	4.48E+03	1.90E+03	1.30E+03
39.81	1.58E+03	1.48E+03	5.11E+03	2.40E+03	1.62E+03
73.56	4.09E+02	3.69E+02	1.36E+03	6.02E+02	4.12E+02
135.94	1.62E+02	2.17E+02	1.09E+03	4.65E+02	2.47E+02
251.19	9.84E+01	1.32E+02	6.64E+02	2.83E+02	1.50E+02
464.16	1.09E+01	1.46E+01	7.32E+01	3.12E+01	1.66E+01
857.70	2.17E-01	2.90E-01	1.45E+00	6.18E-01	3.29E-01
1584.89	9.87E-01	1.13E+00	4.77E-01	1.00E+00	4.57E-01
2928.64	2.91E-01	3.32E-01	1.41E-01	2.96E-01	1.35E-01
5411.70	3.91E-02	4.47E-02	1.89E-02	3.98E-02	1.81E-02
10000.00	2.40E-03	2.74E-03	1.16E-03	2.44E-03	1.11E-03





Thanks to Svetlana

Note: size resolved aerosol
Is not in standard model

NOTE:

Each tool has its advantages and disadvantages. Please choose the one of your convenience.