



*Norwegian  
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# 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



# Output Data Formats:

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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** - editing 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.

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





# Climate Data Operators (CDO)

[www.mpimet.mpg.de/fileadmin/software/cdo/cdo.pdf](http://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.

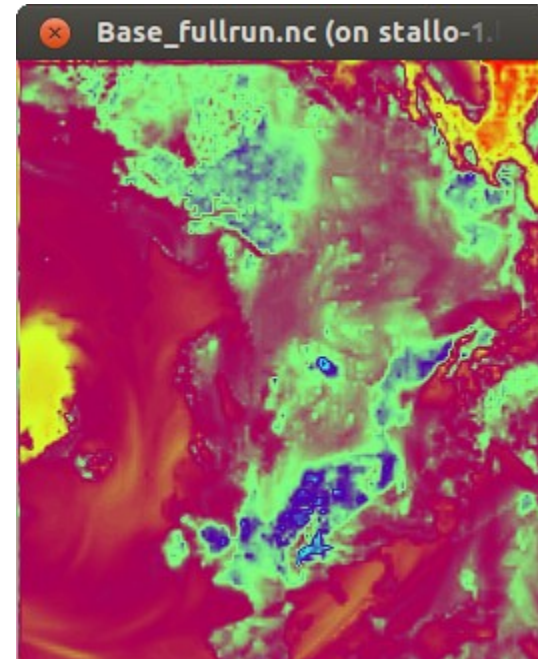
[http://meteora.ucsd.edu/~pierce/ncview\\_home\\_page.html](http://meteora.ucsd.edu/~pierce/ncview_home_page.html)

- 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.



```
mifasv@stallo-1:~/OpenSource_2013_fromWIKI/EMEP_MSC-W_model.rv4_3.OpenSource
File Edit View Search Terminal Tabs Help
mifasv@stallo-1:~/OpenSource_2013_fromWIKI/EMEP_MS... mifasv@stallo-1:~/OpenSource_2013_fromWIKI/EMEP_MS...
[mifasv@stallo-1 ~]$ cd OpenSource_2013_fromWIKI
[mifasv@stallo-1 OpenSource_2013_fromWIKI]$ cd EMEP_MSC-W_model.rv4_3.OpenSource
[mifasv@stallo-1 EMEP_MSC-W_model.rv4_3.OpenSource]$ ls
Base_day.nc Base_hour.nc code input modrun.sh sites_2010.csv Timing.out
Base_fullrun.nc Base_month.nc config_emep_nml met RunLog.out sondes_2010.csv
[mifasv@stallo-1 EMEP_MSC-W_model.rv4_3.OpenSource]$ ls -ltr
total 20408
-rw-rw-r-- 1 mifasv mifasv 4215 Apr 19 13:28 config_emep_nml
-rwxrwxr-x 1 mifasv mifasv 750 Apr 19 13:50 modrun.sh
lrwxrwxrwx 1 mifasv mifasv 84 Apr 23 10:09 input -> /global/work/mifasv/OpenSource_2013_fromWIKI/EMEP_MSC-W_model.rv4_3.OpenSource/input
lrwxrwxrwx 1 mifasv mifasv 59 Apr 23 10:09 met -> /global/work/mifasv/OpenSource_2013_fromWIKI/EMEP_MSC-W_model.rv4_3.OpenSource/met
-rw-rw-r-- 1 mifasv mifasv 184484 Apr 23 10:19 Base_month.nc
drwxrwxr-x 2 mifasv mifasv 36864 Apr 23 10:19 code
-rw-rw-r-- 1 mifasv mifasv 3532352 Apr 23 10:38 Base_hour.nc
-rw-rw-r-- 1 mifasv mifasv 6979435 Apr 23 10:38 Base_day.nc
-rw-rw-r-- 1 mifasv mifasv 8489471 Apr 23 10:38 Base_fullrun.nc
-rw-rw-r-- 1 mifasv mifasv 2474 Apr 23 10:38 Timing.out
-rw-rw-r-- 1 mifasv mifasv 86294 Apr 23 10:38 sites_2010.csv
-rw-rw-r-- 1 mifasv mifasv 13707 Apr 23 10:38 RunLog.out
-rw-rw-r-- 1 mifasv mifasv 1533899 Apr 23 10:38 sondes_2010.csv
[mifasv@stallo-1 EMEP_MSC-W_model.rv4_3.OpenSource]$ ncview Base_fullrun.nc
Ncview 2.1.1 David W. Pierce 1 Aug 2011
http://meteora.ucsd.edu:80/~pierce/ncview_home_page.html
Copyright (C) 1993 through 2011, David W. Pierce
Ncview comes with ABSOLUTELY NO WARRANTY; for details type `ncview -w'.
This is free software; you are free to redistribute and/or modify it under
the terms of the GNU General Public License as published by the
Free Software Foundation; either version 2 of the License, or (at your
option) any later version.
Note: no variable selected
```



no variable selected

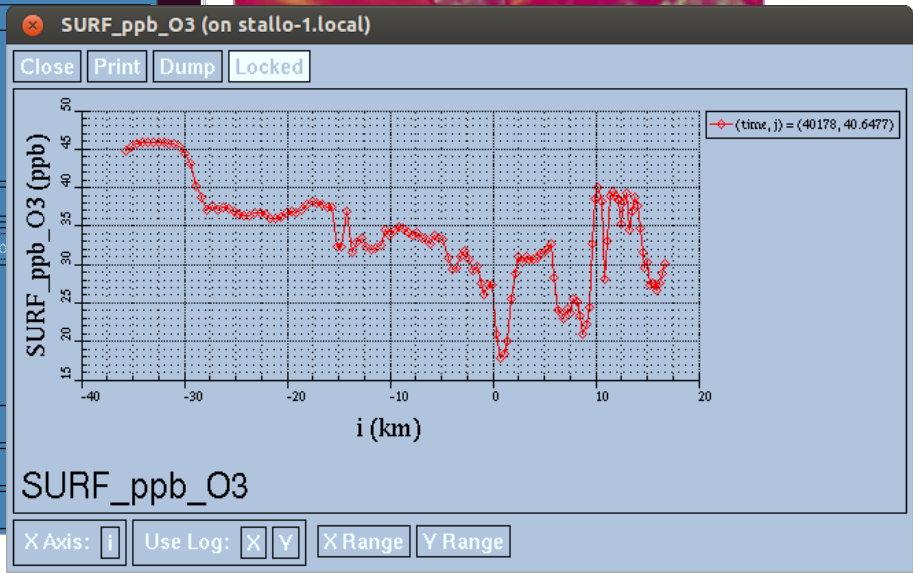
Ncview 2.1.1 David W. Pierce 1 Aug 2011  
\*\*\* SELECT A VARIABLE TO START \*\*\*

Quit →1 ⏪ ⏩ Edit ? Delay: |

ggauss Inv P Inv C Mag X1 Linear Axes Range blo

(2) 1d vars (134) 2d vars

Dim:	Name:	Min:	Current:	Max:
	time	Min:	Current:	Max:
	j	Min:	Current:	Max:
	i	Min:	Current:	Max:





# 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
- Gridded data with description 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

The image displays two overlapping windows from a Linux desktop environment. The background window is a terminal titled "Terminal" showing the output of the GrADS configuration process. The foreground window is titled "GrADS 2.0.a9" and shows a map of Europe with a color-coded overlay representing a meteorological variable. The map uses a color scale from red (low values) to blue (high values). The terminal window shows the following configuration details:

```
Institute for Global Environment and Society (IGES)
GrADS comes with ABSOLUTELY NO WARRANTY
See file COPYRIGHT for more information

Config: v2.0.a9 little-endian readline printm grib2 netcdf hdf4-sds hdf5 opendap-grids g
efile
Issue 'q config' command for more detailed configuration information
Landscape mode? ('n' for portrait):
GX Package Initialization: Size = 11 8.5
ga-> sdfopen Base_rv3_10_2_HTAPBC.2006_fullrun.nc
Scanning self-describing file: Base_rv3_10_2_HTAPBC.2006_fullrun.nc
SDF file Base_rv3_10_2_HTAPBC.2006_fullrun.nc is open as file 1
LON set to -28 36
LAT set to 32 76
LEV set to 0.994 0.994
Time values set: 2007:1:1:0 2007:1:1:0
E set to 1 1
ga-> q file
File 1 :
Descriptor: Base_rv3_10_2_HTAPBC.2006_fullrun.nc
Binary: Base_rv3_10_2_HTAPBC.2006_fullrun.nc
Type = Gridded
Xsize = 321 Ysize = 221 Zsize = 20 Tsize = 1 Esize = 1
Number of Variables = 146
wdep_prec 0 t,y,x WDEP_PREC
wdep_sox 0 t,y,x WDEP_SOX
wdep_oxn 0 t,y,x WDEP_OXN
wdep_rdn 0 t,y,x WDEP_RDN
wdep_ss 0 t,y,x WDEP_SS
wdep_nh4_f 0 t,y,x WDEP_NH4_F
wdep_nh3 0 t,y,x WDEP_NH3

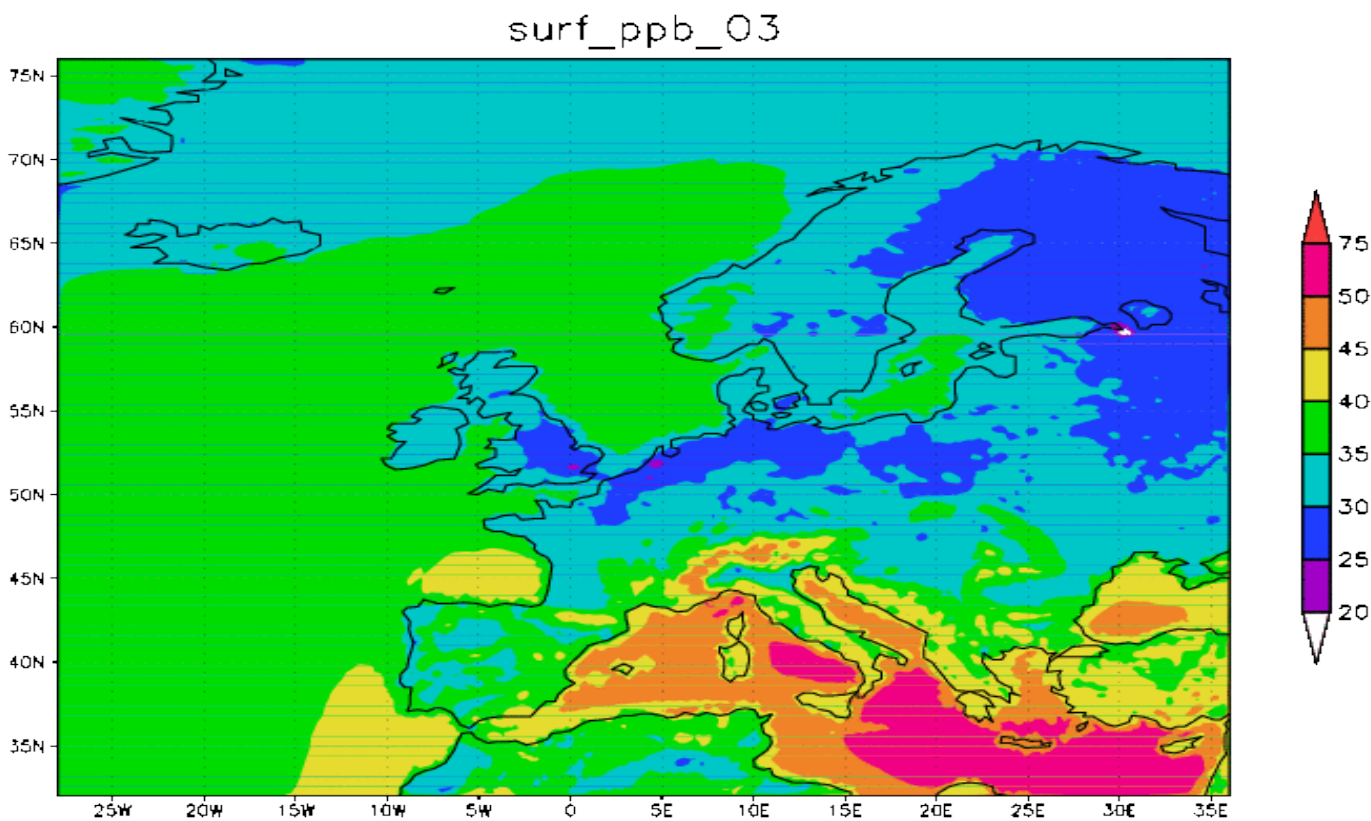
surf_ug_ss 0 t,y,x
surf_ug_dust_na 0
surf_ug_dust_na 0
surf_ug_dust 0 t,y,x SURF_ug_DUST
ga-> d psurf
Contouring: 750 to 1020 interval 30
ga-> d psurf
Contouring: 750 to 1020 interval 30
ga-> set gxout shaded
ga-> d psurf
Contouring: 750 to 1020 interval 30
ga->
```

The map in the GrADS window shows a color-coded overlay over a map of Europe and the surrounding regions. The color scale ranges from red (low values) to blue (high values). The map is titled "GrADS: CGLA/IGES" and includes a date and time stamp "2013-04-23-14:10".



# GrADS Continued.

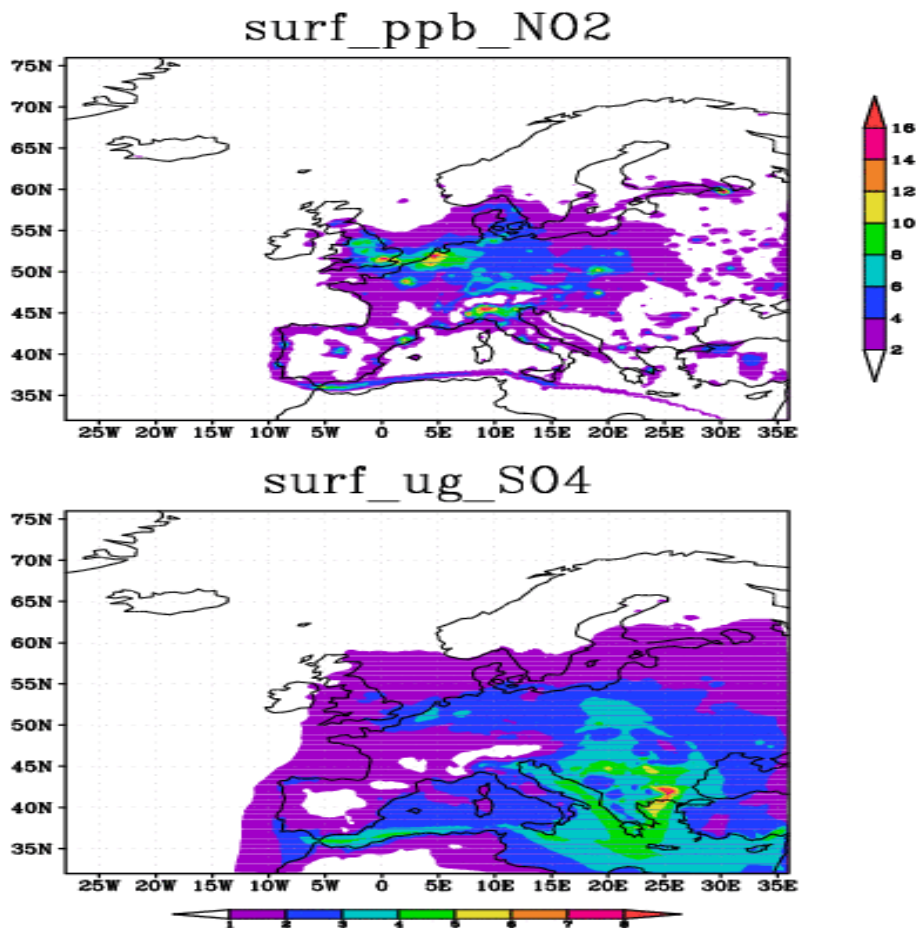
## Surface Concentration of O<sub>3</sub> in ppb







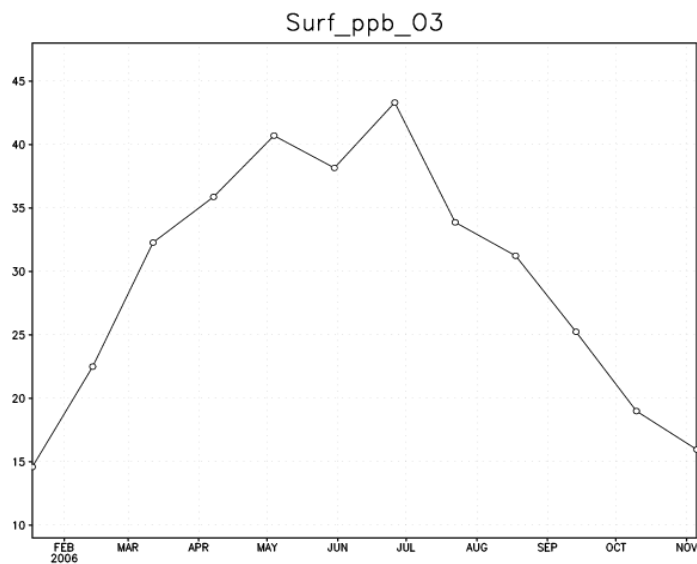
# GrADS continued.



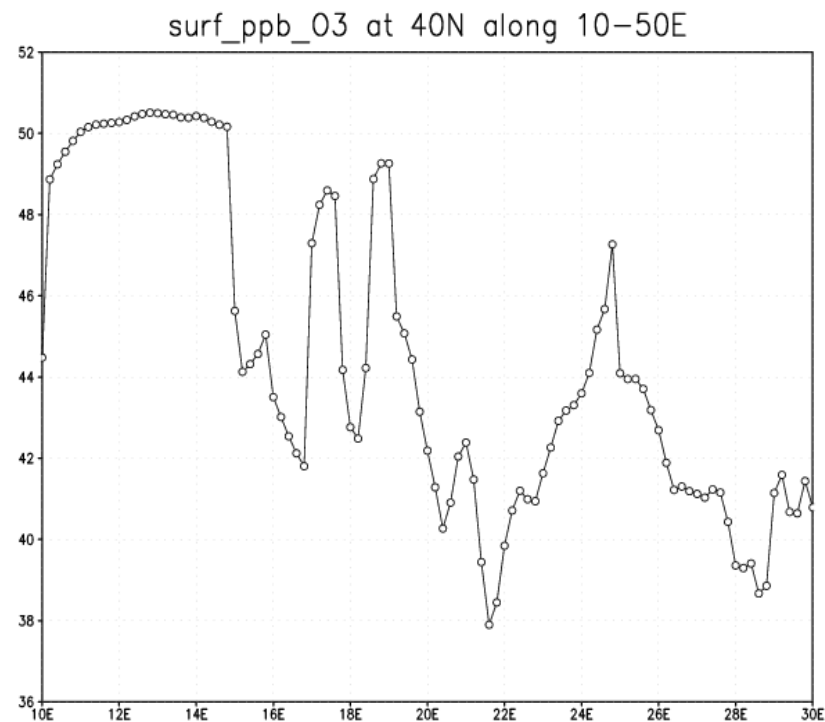


# GraDS Continued

## Timeseries



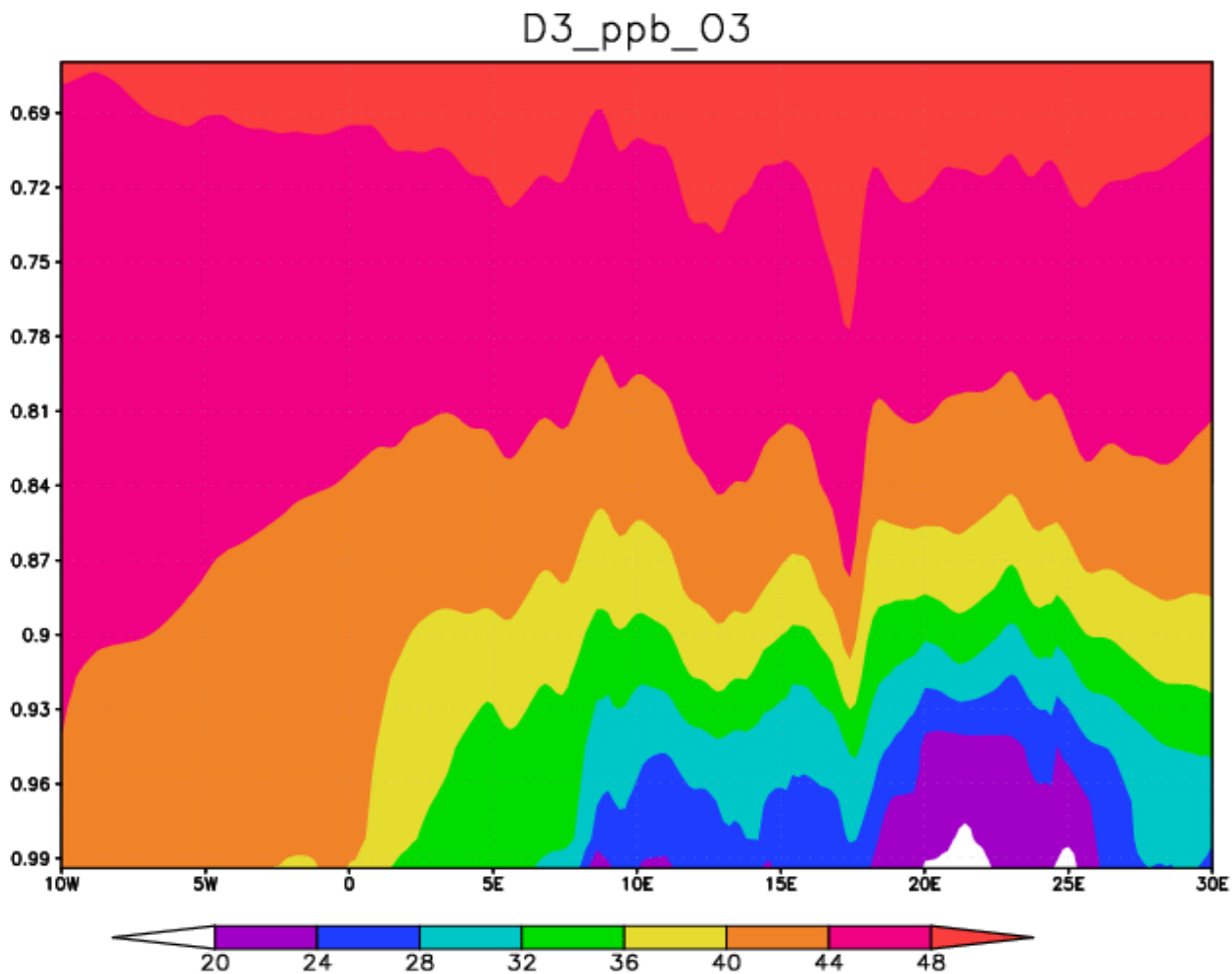
## Meridional Mean





# GrADS Continued.

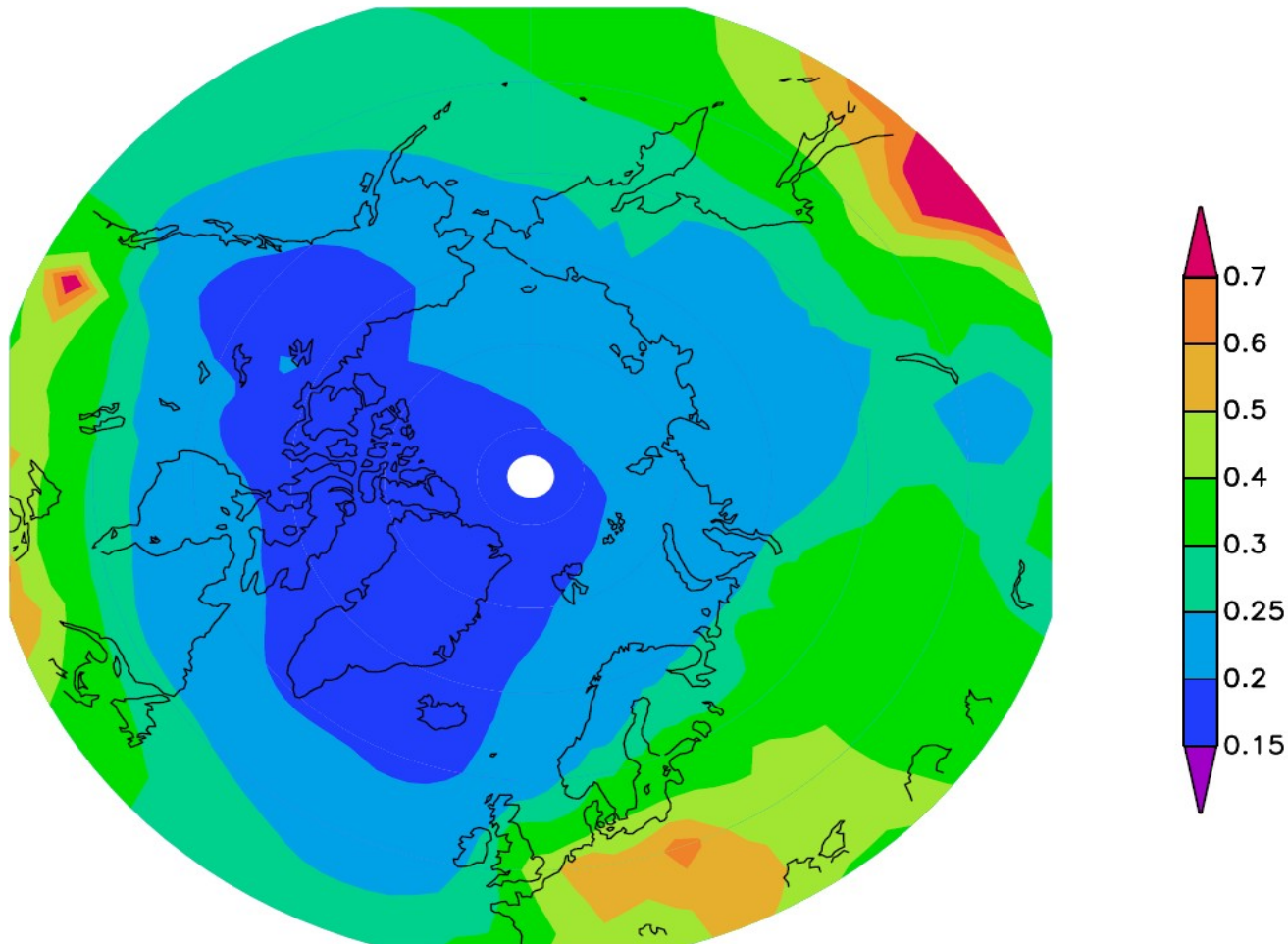
Vertical Cross section (z=1-10) at 50N along 10W-30E





# GrADS Continued.

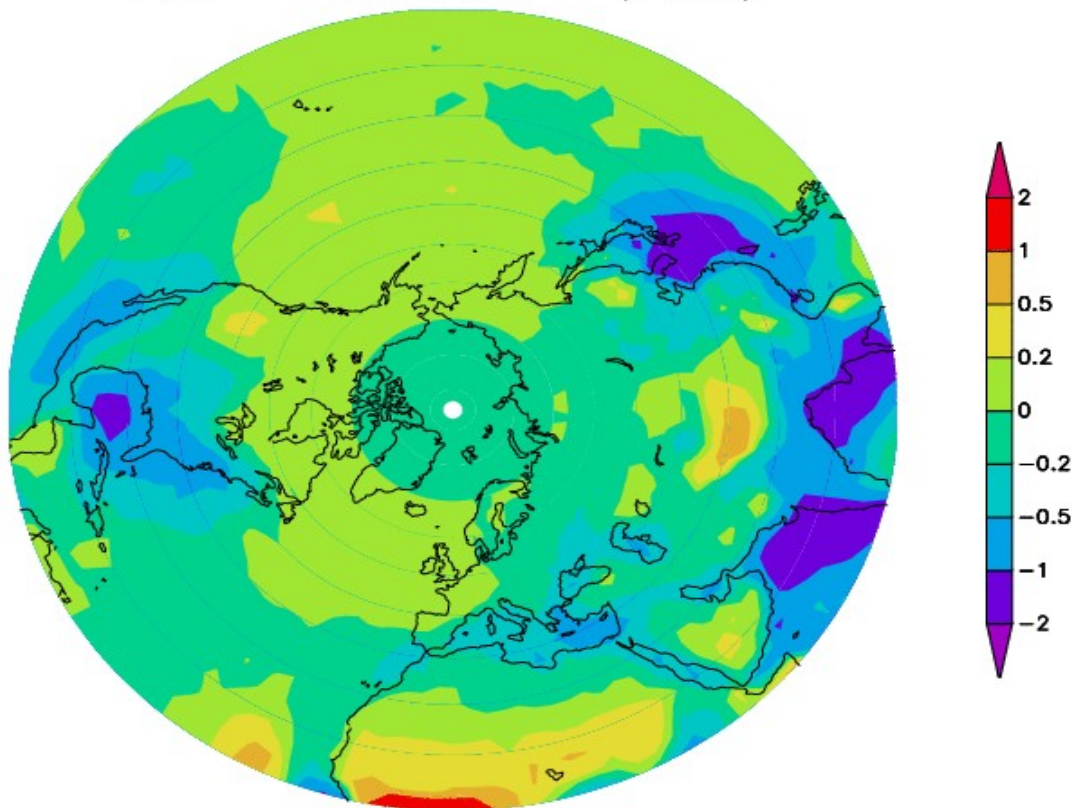
North Polar Stereographic Projection





# GrADS Continued.

Dec. 0.000 Wm<sup>-2</sup> (>70°N)





# 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
- `linterp()` 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:

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

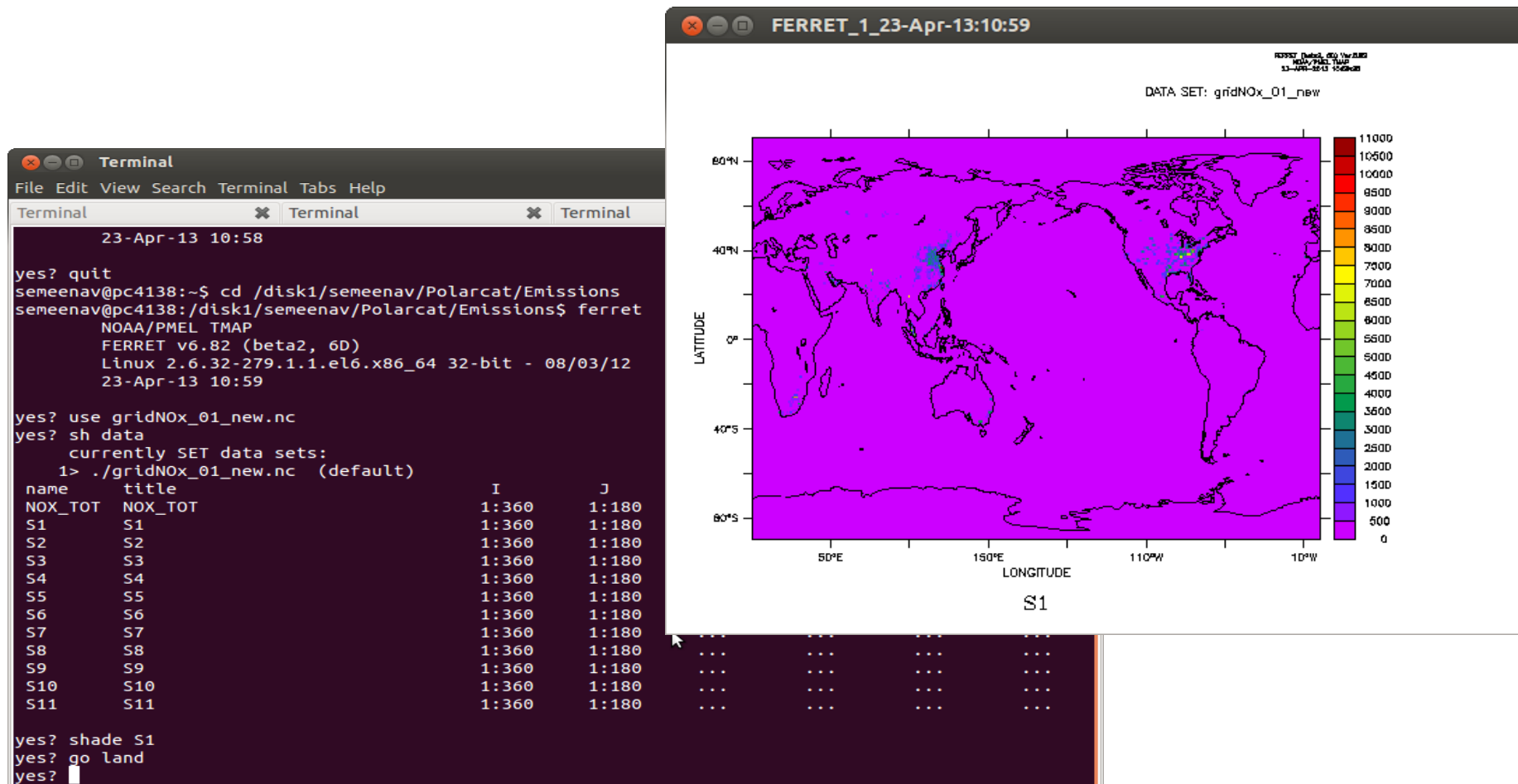
Disadvante:

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.

- Aeroicom project's plotting tools are based on IDL

*<http://aeroicom.met.no/Welcome.html>*

Matplotlib - Python based library

- *<http://matplotlib.org/>*



# Plotting ascii output

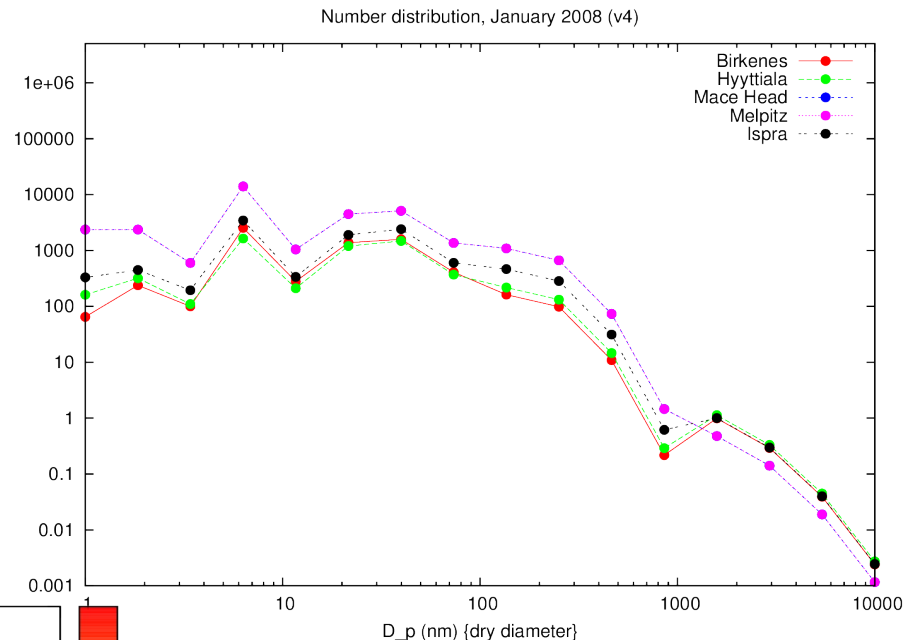
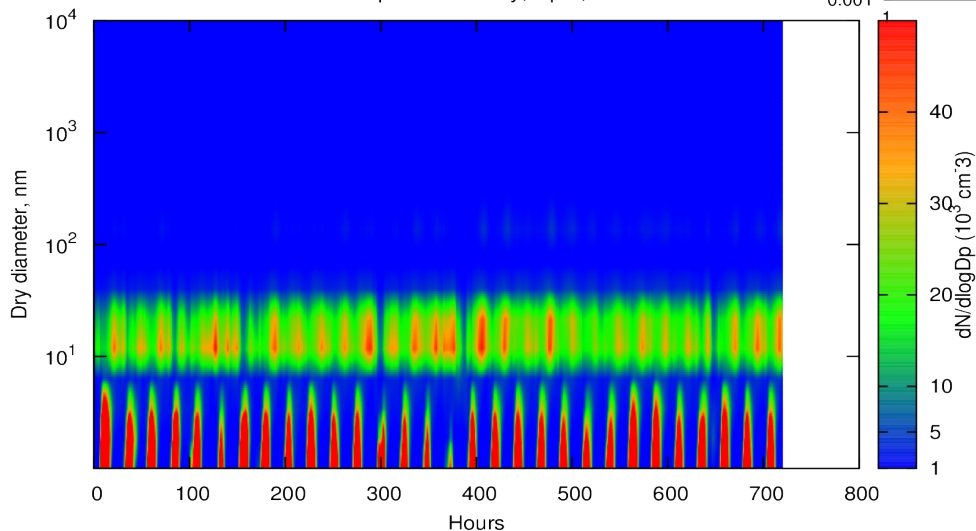
NCL, GrADS, FERRET, Matlab, Matplotlib, gnuplot etc. can be used to plot station data. These tools, **except NCL**, need data in certain format and you need to reformat the default EMEP ascii outputs (sites.csv and sondes.csv). EMEP provide a fortran code to convert this data into several formats. The 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  
 Evolution of particle density; Ispra, June 2008



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.