

Visualizing JMA High-Resolution GSM Data with GrADS

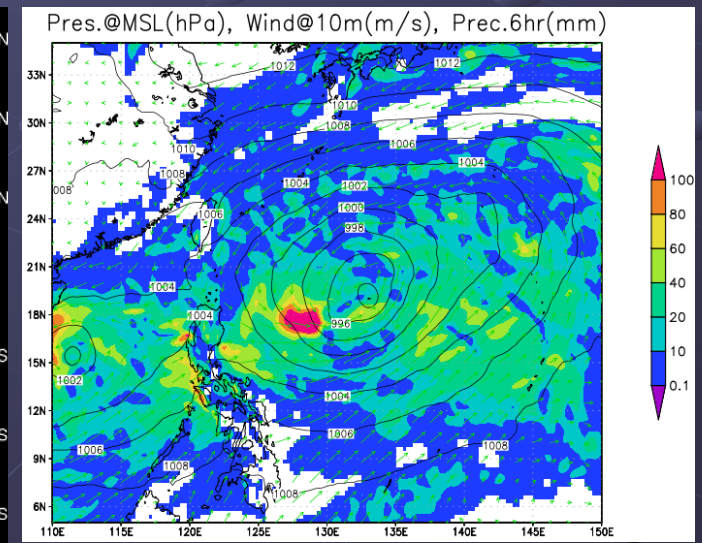
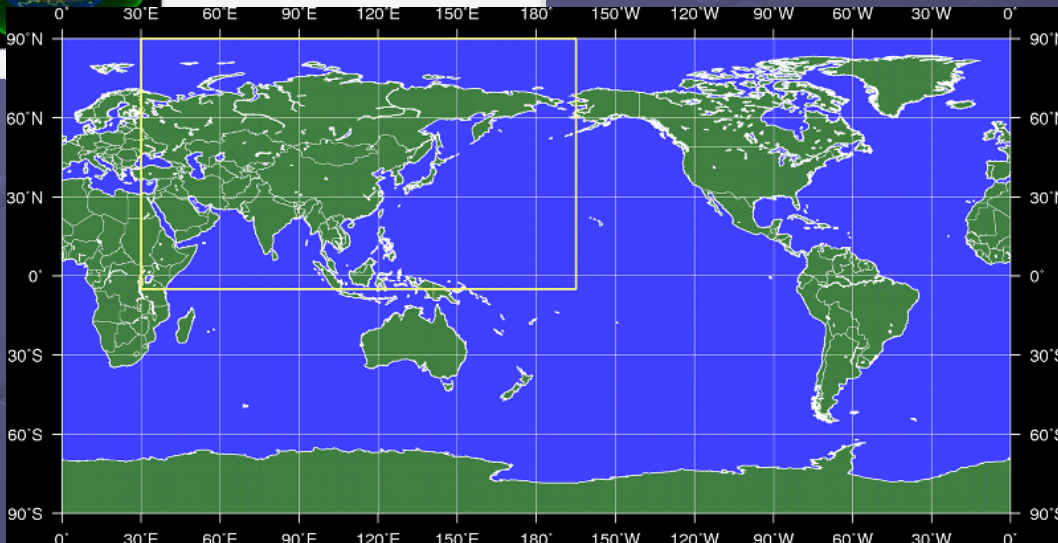
Numerical Prediction Division
Information Infrastructure Department, JMA

Contents

- Getting Meteorological Data
 - JMA High Resolution GSM Data Service
- Preparing for Visualization
- Visualizing Data with GrADS
 - Basic interactive operation
 - Customizing images
 - Converting images
- Scripting with GrADS

JMA High-Resolution GSM Data Service

- Target: NMHSs
 - Mainly in WMO Region II
- Model: GSM(TL959)
- Data Format: GRIB2
- Preservation Term: Latest 14 days



Profile (Global)

	Upper Air	Surface	
Resolution	0.5deg (720 x 361)		0.25deg (1440 x 721)
Region	Lon: 0E – 180 – 0W, Lat: 90S – 90N		
Initial Time	00, 06, 12, 18 UTC (4 times per day)		
Forecast Time	00 to 132 hours by 3 hours (any initials) 132 to 264 hours by 6 hours (00, 12UTC initials)		
Levels	21 (1000, 975, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10 hPa) * All levels in one file	1 (surface)	
Elements	U, V, T, Rh, Z, Omg Stream Function, Velocity Potential (at 850, 250 hPa) Vorticity (at 500 hPa)	U, V, T, Rh, Ps, Psea, Rain, Cloudiness (total, high, middle, low)	
File size	50MB	4MB	17MB

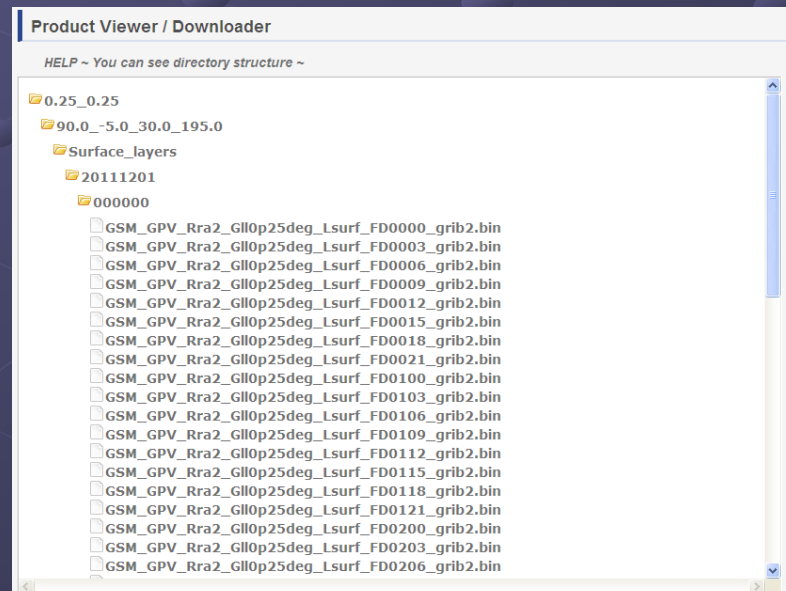
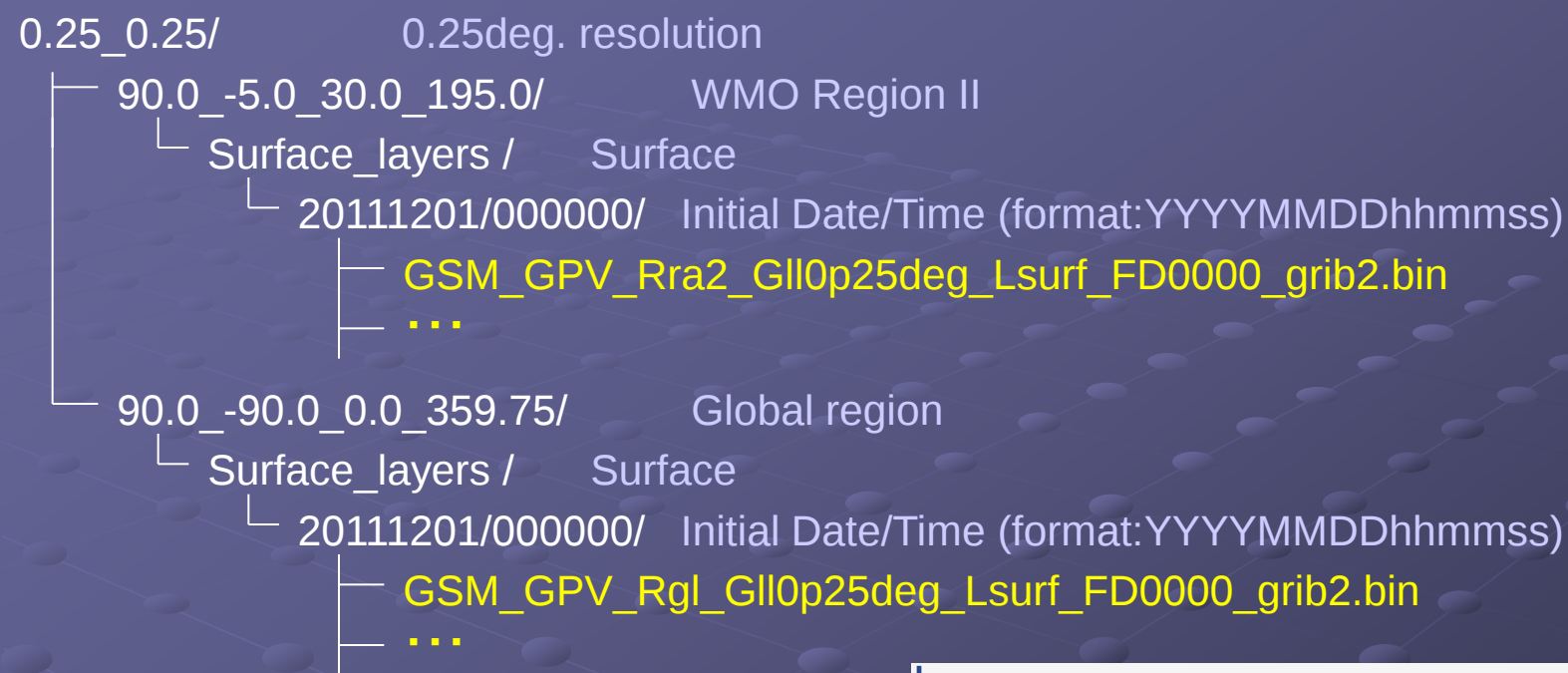
4

Profile (WMO Region II)

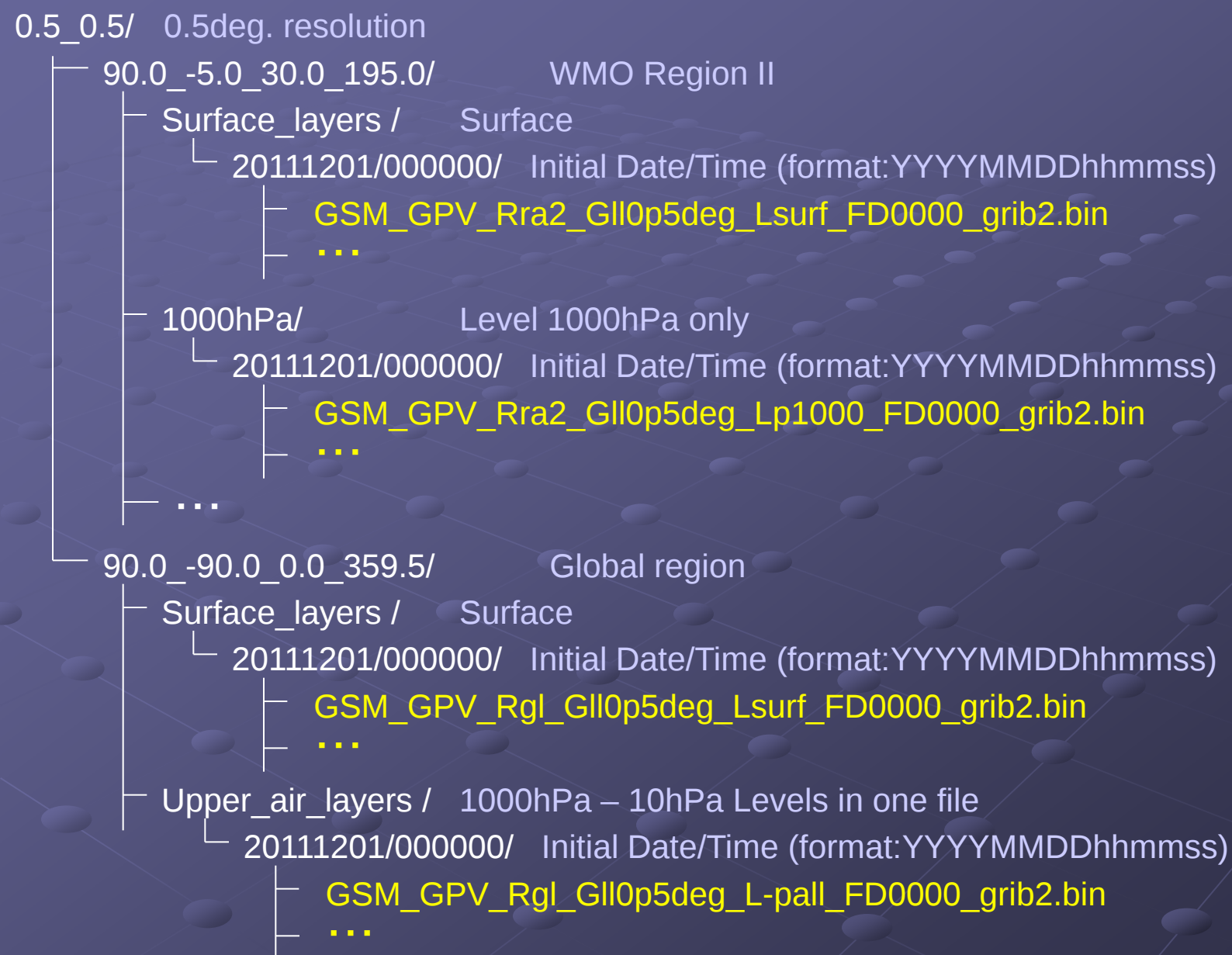
	Upper Air	Surface	
Resolution	0.5deg (331 x 191)		0.25deg (661 x 381)
Region	Lon: 30E – 180 – 165W, Lat: 5S – 90N		
Initial Time	00, 06, 12, 18 UTC (4 times per day)		
Forecast Time	00 to 132 hours by 3 hours (any initials) 132 to 264 hours by 6 hours (00, 12UTC initials)		
Levels	21 (1000, 975, 950, 925, 900, 850, 800, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10 hPa) * Separated 21 files by levels	1 (surface)	
Elements	U, V, T, Rh, Z, Omg Stream Function, Velocity Potential (at 850, 250 hPa) Vorticity (at 500 hPa)	U, V, T, Rh, Ps, Psea, Rain, Cloudiness (total, high, middle, low)	
File size	500 – 700KB	1MB	4MB

5

Directories of Server (1)



Directories of Server (2)



Naming rule of data files

[R]egion:

gl: Global

ra2: WMO RA II

[L]evels

-pall: All upper levels

pLLL: LLL hPa

surf: Surface

GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2.bin

Resolution:

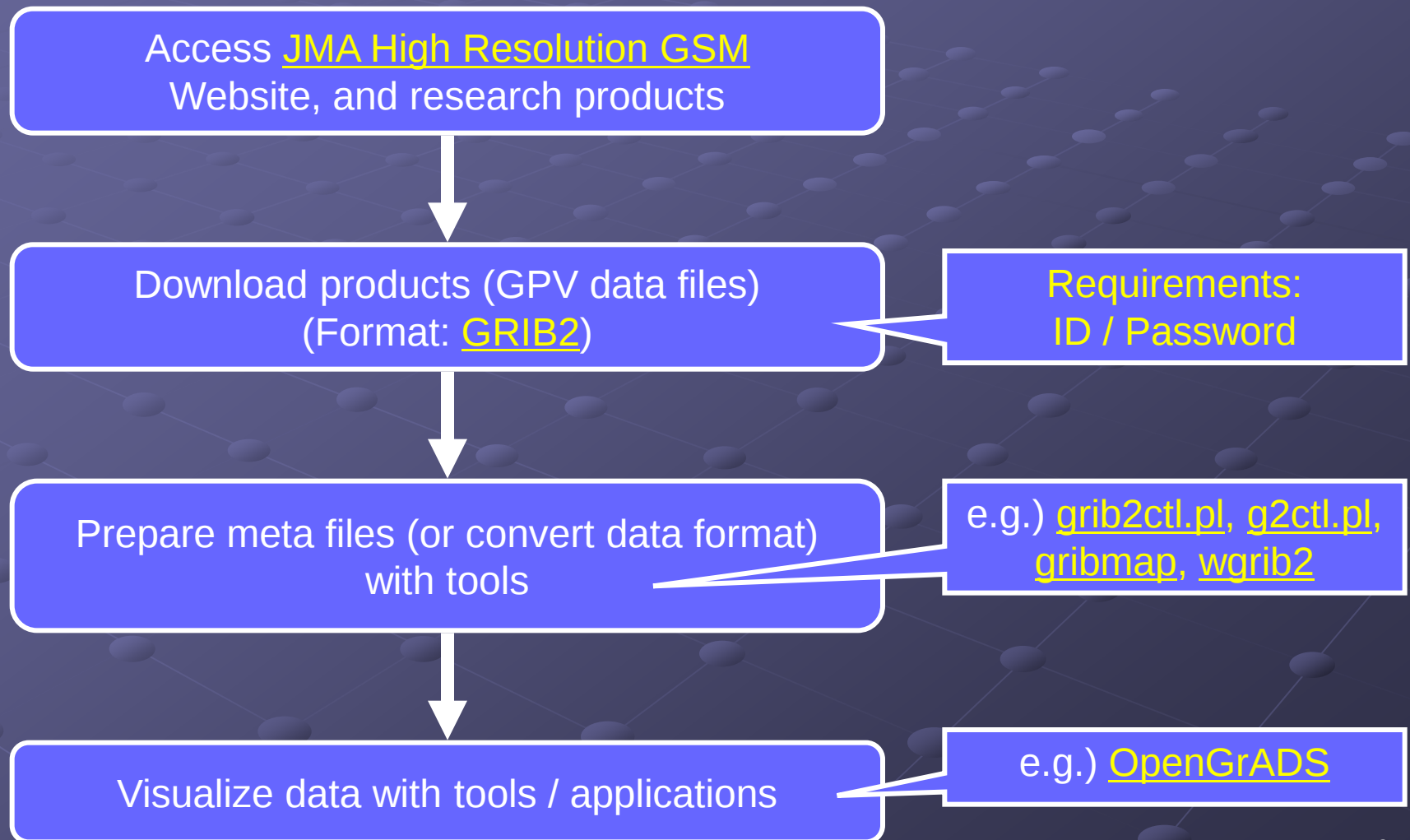
0p5: 0.5 degrees

0p25: 0.25 degrees

FD: Forecast Date/Time

DDhh: DD days, hh hours

Workflow for processing meteorological data



What's GRIB?

- GRIB (GRIdded Binary)

- CBS(Commission for Basic Systems)/WMO Data format
 - Described in WMO Manual on Codes No.306
- For the storage and the exchange of Weather Products in Gridded Binary Form
- Editions:
 - GRIB(GRIB1): Used world-wide for NWP
 - GRIB2: Latest edition (much different in format)

For details: <http://www.wmo.int/pages/prog/www/WMOCodes.html>

Tools for GRIB/GRIB2

● Decoding tools

- **wgrib** : decoding / converting GRIB data file
- **wgrib2** : decoding / converting GRIB2 data file

● Preprocessing tools for GrADS

- **grib2ctl.pl** : making GrADS control file from GRIB data file
- **g2ctl.pl** : making GrADS control file from GRIB2 data file
- **gribmap** : making GrADS index file from GRIB or GRIB2 data file

Note: 'wgrib', 'wgrib2', and 'gribmap' are installed with GrADS ('Windows superpack' edition).

'grib2ctl.pl' and 'g2ctl.pl' are Perl scripts. They require Perl.

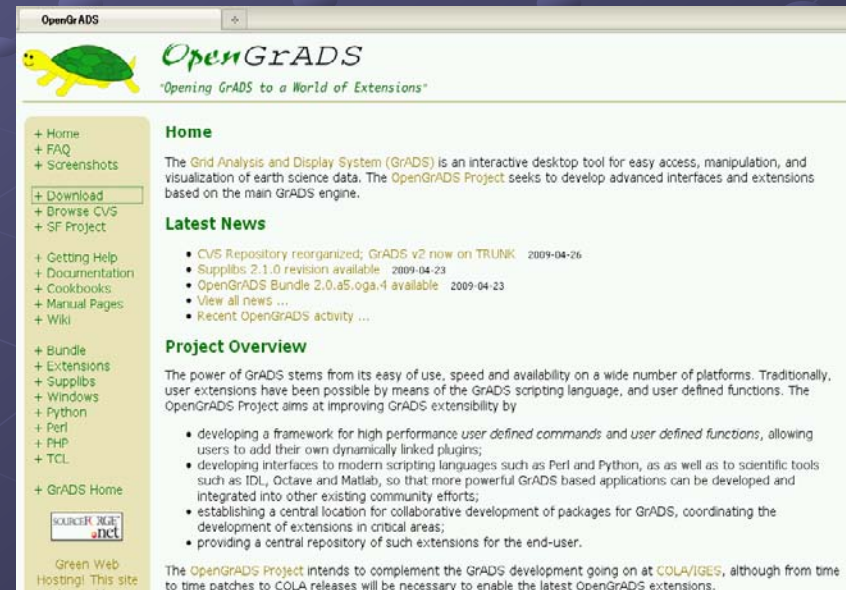
What's GrADS?

● GrADS(The Grid Analysis and Display System)

- **Interactive** desktop tool
- Commonly used for easy access, manipulation, and visualization of earth science data
- **CUI(Character User Interface) / GUI(Graphical User Interface)** Application

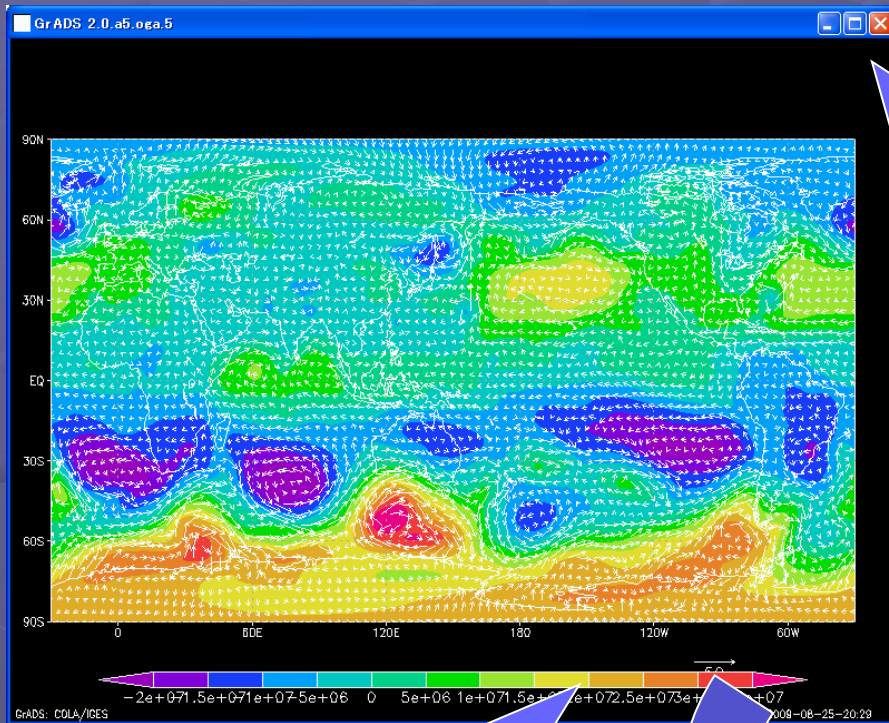
● OpenGrADS

- Based on 'GrADS'
- Open Source
 - Available sources/binaries of several OSs
- Some useful **Extensions** (User Defined Commands/Functions)



What's GrADS?

Display Window



Enter commands, and
Set visualizing properties

```
POSIX Shell (bash)
Error occurred at column 1
DISPLAY error: Invalid expression
Expression = skip(uvelpr,5,5)
ga-> d skip(ugrdpr,5,5);vgrdpr;mag(ugrdpr,vgrdpr)
ga-> c
ga-> set gxout shaded
ga-> d strm850mb
Contouring: -2.5e+07 to 4e+07 interval 5e+06
ga-> d skip(ugrdpr,5,5);vgrdpr;
Syntax Error: Expected operand or '('
Error occurred at column 1
DISPLAY error: Invalid expression
Expression =
ga-> d skip(ugrdpr,5,5);vgrdpr
ga-> c
ga-> d strm850mb
Contouring: -2.5e+07 to 4e+07 interval 5e+06
ga-> d skip(ugrdpr,10,10);vgrdpr
ga-> c
ga-> set lon -30 330
LON set to -30 330
ga-> d strm850mb
Contouring: -2.5e+07 to 4e+07 interval 5e+06
ga-> d skip(ugrdpr,8,8);vgrdpr
ga->
```

Visualize image in
synchronization with
commands

Console Window

Installing grib2ctl.pl, g2ctl.pl

- Download Perl scripts from “CPC/NOAA” website, and allocate them adequately

- grib2ctl.pl

- <http://www.cpc.noaa.gov/products/wesley/grib2ctl.html>

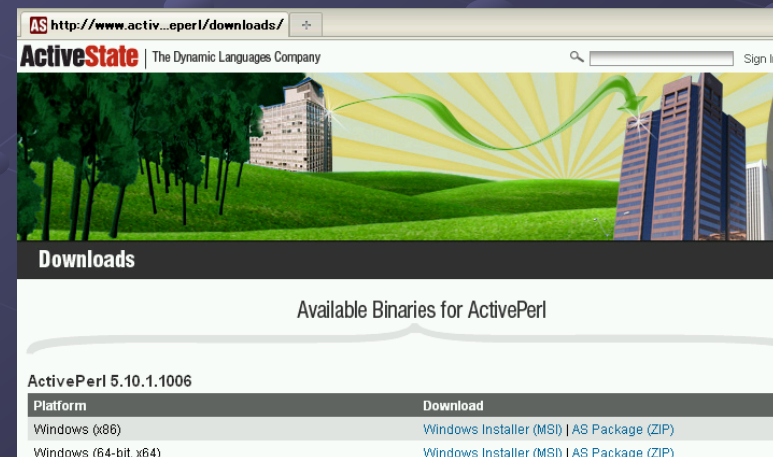
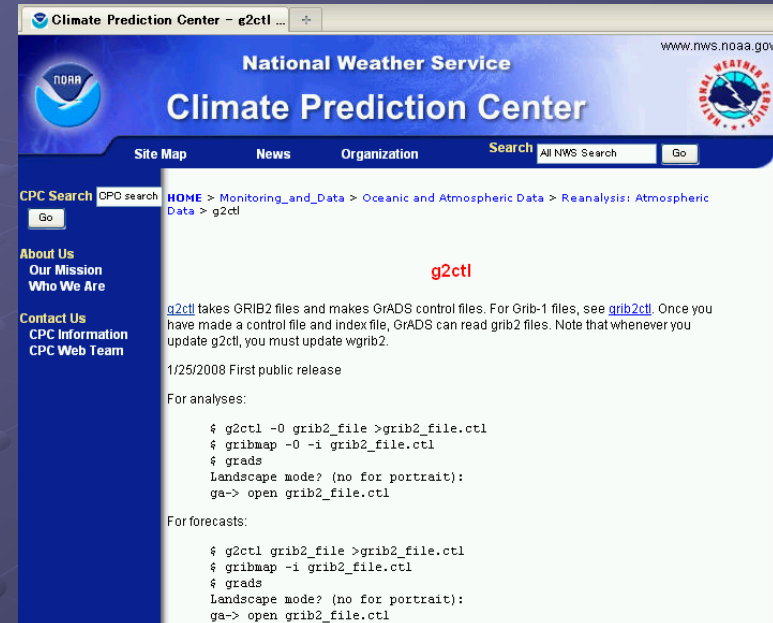
- g2ctl.pl

- <http://www.cpc.noaa.gov/products/wesley/g2ctl.html>

- Download and Install Perl

- ActivePerl (for Windows)

- <http://downloads.activestate.com/ActivePerl/Windows/5.10/ActivePerl-5.10.1.1006-MSWin32-x86-291086.msi>

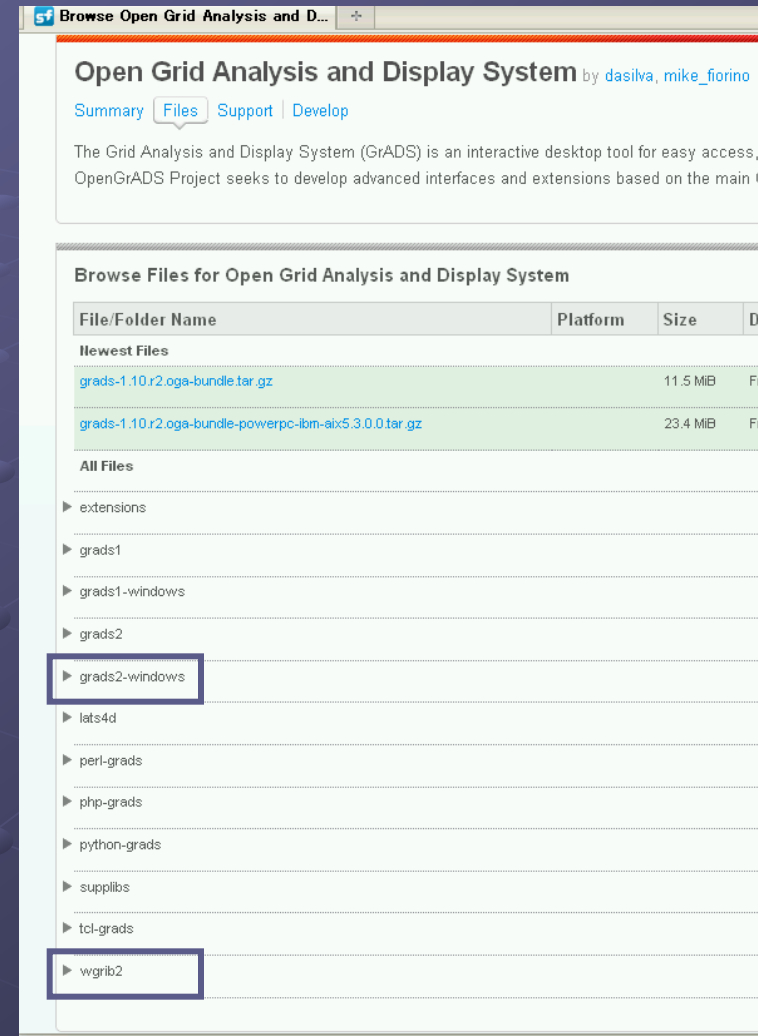


Installing GrADS (Windows)

- Download installation binary (.exe) from “SourceForge” website
 - Filename:
grads-2.0.*-win32_superpack.exe
- Execute the binary
 - Automatic installation
 - Follow installer’s guidance

For details:

[http://opengrads.org/wiki/index.php?title=Installing
_GrADS_v2.0_on_Microsoft_Windows](http://opengrads.org/wiki/index.php?title=Installing_GrADS_v2.0_on_Microsoft_Windows)



Installed GrADS Directories

GrADS_ROOT/

e.g.) C:\OpenGrADS

- Contents/ --- map data bases, GrADS fonts

- Resources/

- SampleDatasets/ --- sample data files

- Documentation/ --- user's guide, references, and so on.

- Scripts/ --- GrADS utility scripts

- SupportData/ --- fonts, coastal data

- Xming/ --- bundled Xming X window server

- Cygwin/ --- programs, DLLs

- Classic/ --- Shortcuts for conventional user.

Requirements for visualizing with GrADS

Data Format	Requirements	
	Data file	Configuration file
32bit IEEE floats	binary data file	control file by yourself
GRIB	GRIB data file 'wgrib' 'grib2ctl.pl'	control file index file 'gribmap'
GRIB2	GRIB2 data file 'wgrib2' 'g2ctl.pl'	control file index file 'gribmap'
NetCDF	NetCDF data file	none

self-describing data formats developed by UCAR

Preparation for GRIB / GRIB2

GRIB2

(1) Create control file
from GRIB2 data file with 'g2ctl.pl'

If the data contain forecast, use '-verf'.
(If analysis, use '-0')

```
$ perl g2ctl.pl -verf data.grib2.bin > data.ct1
```

Data file name

same name

You can name the
control file name.

(2) Create index file
from control file with 'gribmap'

```
$ gribmap -i data.ct1 -e
```

Automatically
creates '.idx' file.

same name

GRIB

(1) Create control file
from GRIB data file with 'grib2ctl.pl'

```
$ perl grib2ctl.pl -verf data.grib.bin > data.ct1
```

Control file (GRIB2): Sample

```
dset ^GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2.bin
index ^GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2.bin.idx
undef 9.999E+20
title GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2.bin
* produced by g2ctl v0.0.4n
* griddef=1.1:0:(720 x 361):grid_template=0:lat-lon grid:(720 x 361) units 1e-006
  input WE:NS output WE:SN res 48 lat 90.0 to -90.0 by 0.5 lon 0.0 to 359.5 by 0.5
  #points=259920:winds(N/S)
dtype grib2
ydef 361 linear -90.000000 0.5
xdef 720 linear 0.000000 0.500000
tdef 1 linear 12Z22aug2009 1mo
* PROFILE hPa
zdef 21 levels 100000 97500 95000 92500 90000 85000 80000 70000 60000 50000 40000 30000
                25000 20000 15000 10000 7000 5000 3000 2000 1000
options pascals
vars 11
HGTprs      21,100  0,3,5  ** (1000 975 950 925.. 50 30 20 10) Geopotential Height [gpm]
RELV500mb   0,100,50000  0,2,12  ** 500 mb Relative Vorticity [1/s]
RHprs       21,100  0,1,1  ** (1000 975 950 925.. 50 30 20 10) Relative Humidity [%]
STRM850mb   0,100,85000  0,2,4  ** 850 mb Stream Function [m^2/s]
STRM200mb   0,100,20000  0,2,4  ** 200 mb Stream Function [m^2/s]
TMPprs      21,100  0,0,0  ** (1000 975 950 925.. 50 30 20 10) Temperature [K]
UGRDprs     21,100  0,2,2  ** (1000 975 950 925.. 50 30 20 10) U-Component of Wind [m/s]
VGRDprs     21,100  0,2,3  ** (1000 975 950 925.. 50 30 20 10) V-Component of Wind [m/s]
VPOT850mb   0,100,85000  0,2,5  ** 850 mb Velocity Potential [m^2/s]
VPOT200mb   0,100,20000  0,2,5  ** 200 mb Velocity Potential [m^2/s]
VVELprs     21,100  0,2,8  ** (1000 975 950 925.. 50 30 20 10) Vertical Velocity (Pressure) [Pa/s]
ENDVARS
```

"^" indicates same directory with control file.

ol file (GRIB2): Sample

```
dset ^GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2.bin
index ^GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2.bin.idx
undef 9.999E+20
title GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2_bin
* produced by g2ctl v0.0.4n
* griddef=1.1:0:(720 x 361):grid_template=0:lat-lon grid.(720 x 361) units 1e-006
input WE:NS output WE:SN res 48 lat 90.0 to -90.0 by 0.5 lon 0.0 to 359
#points=259920:winds(N/S)
dtype grib2
ydef 361 linear -90.000000 0.5
xdef 720 linear 0.000000 0.500000
tdef 1 linear 12Z22aug2009 1mo
* PROFILE hPa
zdef 21 levels 100000 97500 95000 92500 90000 85000 80000 75000
                25000 20000 15000 10000 7000 5000 3000 2000 1000
options pascals
vars 11
HGTprs 21,100 0,2,1 ** (1000 975 950 925.. 50 30 20 10) Geom. Height [m]
REL500mb 0,100,20000 0,2,4 ** 500 mb Relative Vorticity [1/s]
RHprs 21,100 0,2,1 ** (1000 975 950 925.. 50 30 20 10) Relative Humidity [%]
STRM850mb 0,100,85000 0,2,4 ** 850 mb Stream Function [m^2/s]
STRM200mb 0,100,20000 0,2,4 ** 200 mb Stream Function [m^2/s]
TMPprs 21,100 0,0,0 ** (1000 975 950 925.. 50 30 20 10) Temperature [K]
UGRDprs 21,100 0,2,2 ** (1000 975 950 925.. 50 30 20 10) U-Component of Wind [m/s]
VGRDprs 21,100 0,2,3 ** (1000 975 950 925.. 50 30 20 10) V-Component of Wind [m/s]
VPOT850mb 0,100,85000 0,2,5 ** 850 mb Velocity Potential [m^2/s]
VPOT200mb 0,100,20000 0,2,5 ** 200 mb Velocity Potential [m^2/s]
VVELprs 21,100 0,2,8 ** (1000 975 950 925.. 50 30 20 10) Vertical Velocity (Pressure) [Pa/s]
ENDVARS
```

Data file path

Index file path

Definition of 'undefined value' (=No Data)

Title

Comment

Grid definition for Y-axis (grid size, latitude of southern end, interval)

Grid definition for X-axis (grid size, longitude of western end, interval)

Grid definition for Time-axis (size, initial date/time, interval)

Grid definition for Vertical-axis (grid size, levels)

Number and information of elements

Preparation for time-series dataset

- How to treat separated data files by forecast time
 - Concatenate GRIB files by “cat” command **before making Control file**

```
GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0000_grib2.bin  
GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0003_grib2.bin  
GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0006_grib2.bin  
:  
:  
GSM_GPV_Rgl_Gll0p5deg_L-pall_FD0312_grib2.bin
```

Command “cat” :
1) Display contents of file
2) Concatenate files

```
$ cat GSM_GPV_Rgl_Gll0p5deg_L-pall*_grib2.bin  
> GSM_GPV_Rgl_Gll0p5deg_L-pall_grib2.bin
```

```
GSM_GPV_Rgl_Gll0p5deg_L-pall_grib2.bin
```

```
$ g2ctl .....  
$ gribmap .....
```

Visualizing by GrADS CUI

- How to use GrADS -

- Lesson 1 : How to launch GrADS -

(1) Launch Command Prompt (Shell) and GrADS

The screenshot shows the OpenGrADS 2.0 application window. The 'Shells' menu is open, listing various shells. A callout points to this menu with the text 'Launch GrADS command prompt directly.' The 'POSIX Shell (bash)' option is selected. A callout points to this option with the text 'Command prompt which enables using 'bash' for Unix/Linux. (Powered by Cygwin)'. Below the menu, a terminal window is open, showing the command 'grads' entered. A callout points to this command with the text 'Enter 'grads''. The terminal output shows the GrADS startup sequence, including the version '2.0.a5.oga.5' and the configuration 'v2.0.a5.oga.5 little-endian readline printim grib2 netcdf hdf4-sds opendap-grids, stn athena geotiff'. A callout points to the 'yes' response to the 'Landscape mode?' prompt with the text 'Select shape of display: Enter 'yes' or 'no''. Below this, the prompt 'ga->' is visible, with a callout pointing to it with the text 'Enter GrADS commands'.

OpenGrADS 2.0

Documentation

Shells

GrADS GUI

GrADS Metafile Viewer

GrADS Prompt

MERRA Browser

NOMADS Browser

Uninstall OpenGrADS

Command Prompt

C-Shell (tcsh)

POSIX Shell (bash)

Rxvt Terminal (bash)

POSIX Shell (bash)

sh-3.2\$ grads

Starting X server under d:\OPENGR~1\Contents\Resources\Xming

Server mode mounting d:\OPENGR~1\Contents as / and d:\OPENGR~1\Contents\Cygwin\Ver

on#20A50G~1.5%i686 as /bin ... done!

Starting grads under d:\OPENGR~1\Contents\Cygwin\Versions\20A50G~1.5%i686 ...

Grid Analysis and Display System (GrADS) Version 2.0.a5.oga.5

Copyright (c) 1988-2008 by Brian Doty and the

Institute for Global Environment and Society (IGES)

GrADS comes with ABSOLUTELY NO WARRANTY

See file COPYRIGHT for more information

Config: v2.0.a5.oga.5 little-endian readline printim grib2 netcdf hdf4-sds opend

ap-grids, stn athena geotiff

Issue 'q config' command for more information.

Loading User Defined Extensions table </cygdrive/d/OPENGR~1/Contents/Cygwin/Vers

ions/20A50G~1.5/i686/gex/udxt> ... ok

Landscape mode? ('n' for portrait): yes

GX Package Initialization: Size = 11 8.5

ga->

ga->

ga->

Launch GrADS command prompt directly.

Command prompt which enables using 'bash' for Unix/Linux. (Powered by Cygwin)

Enter 'grads'

Select shape of display: Enter 'yes' or 'no'

Enter GrADS commands

Visualizing by GrADS CUI

- Lesson 2 : How to open data and visualize them -

(2) Open control file. (“ga->” means GrADS command prompt)

```
ga-> open data.ctl
```

Control file name that was
created by g2ctl.pl

(3) Check available elements.

```
ga-> q ctlinfo (query ctlinfo)
```

Italic words depend
on your
environment / setting

(4) Visualize for an element (e.g. Surf. Pres.).

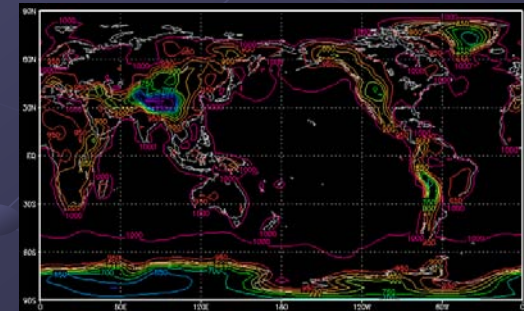
```
ga-> d pressfc (display pressfc)
```

Element name is shown
in results of ‘q ctlinfo’.

(5) Clear screen.

```
ga-> c (clear)
```

To reset settings,
use ‘reinit’.



Visualizing by GrADS CUI

- Lesson 3 : How to draw by various rendering methods -

(6) Use 'contour' option (default).

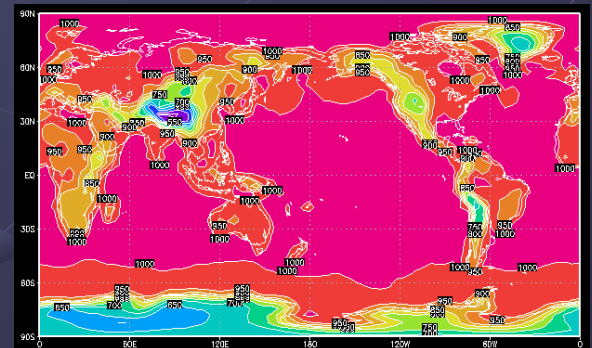
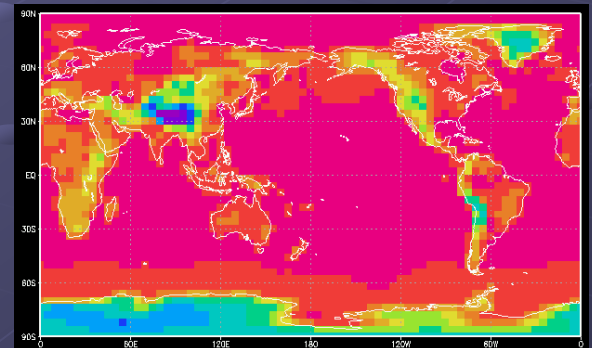
```
ga-> set gxout contour  
ga-> d pressfc
```

(7) Use 'grid-fill' option.

```
ga-> set gxout grfill  
ga-> d pressfc
```

(8) Overlay 'shaded' and 'contour' images.

```
ga-> set gxout shaded  
ga-> d pressfc  
ga-> set gxout contour  
ga-> d pressfc
```



Visualizing by GrADS CUI

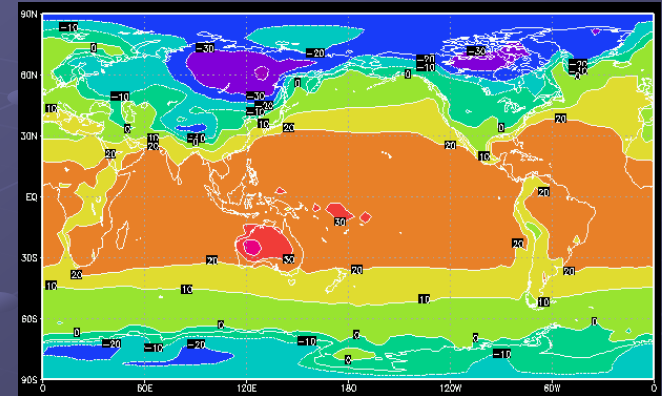
- How to use GrADS -

- Lesson 4 : How to change latitude and longitude -

(6) Set latitude range

```
ga-> set LAT -15 25
```

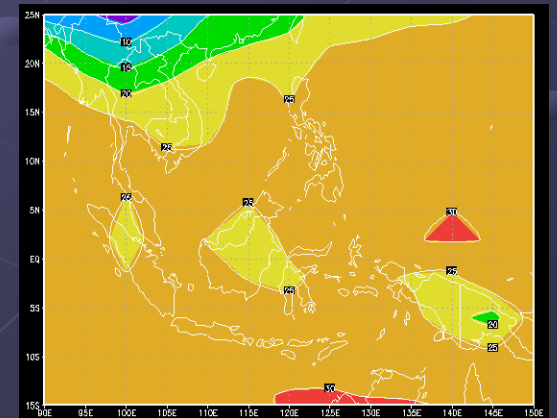
Latitude Range (South North)
(South Latitude: negative value)



(7) Set longitude range

```
ga-> set LON 90 150
```

Longitude Range (West East)
(West Longitude: negative value)



Visualizing by GrADS CUI

- How to use GrADS -

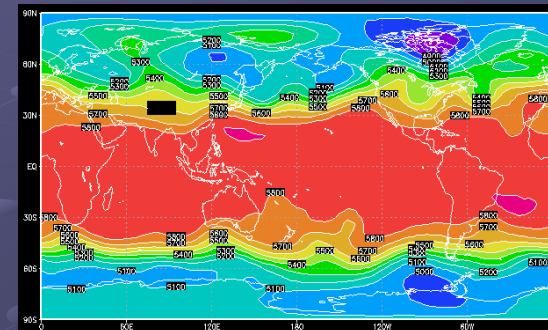
- Lesson 5 : How to change level -

(8) Change level.

```
ga-> set LEV 500
```

(9) Visualize data (e.g. Geopotential height)

```
ga-> d hgtprs # Draw Z at 500hPa
```



- Lesson 6 : How to change target time -

(10) Change target time.

```
ga-> set t 2 (set time 00Z02oct2009)
```

(11) Visualize data (e.g. Geopotential height)

```
ga-> d hgtprs
```

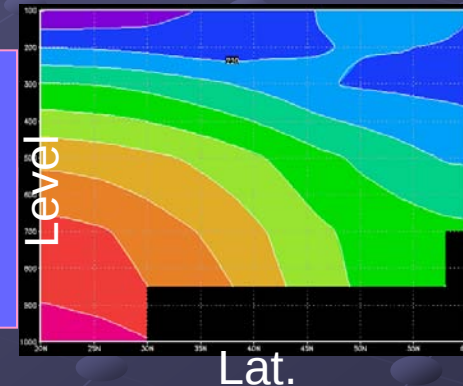
Visualizing by GrADS CUI

- Lesson 7 : How to visualize section -

GrADS treats 4 dimensions (latitude and longitude, level and time). If you set these to range value or single value, you can draw many kinds of figures.

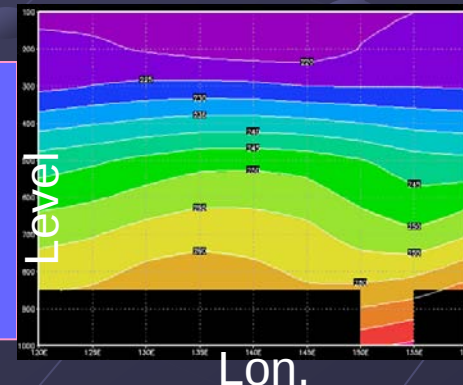
(12) Visualize with longitude fixed

```
ga-> set LON 140      # Fix as 140E
ga-> set LAT 20 60     # 20N - 60N
ga-> set LEV 1000 100  # 1000hPa - 100hPa
ga-> d tmpprs         # Valuable: Lat., Level
```



(13) Visualize with latitude fixed

```
ga-> set LON 120 160  # 120E - 160E
ga-> set LAT 40       # Fix as 40N
ga-> set LEV 1000 100  # 1000hPa - 100hPa
ga-> d tmpprs         # Valuable: Lon., Level
```



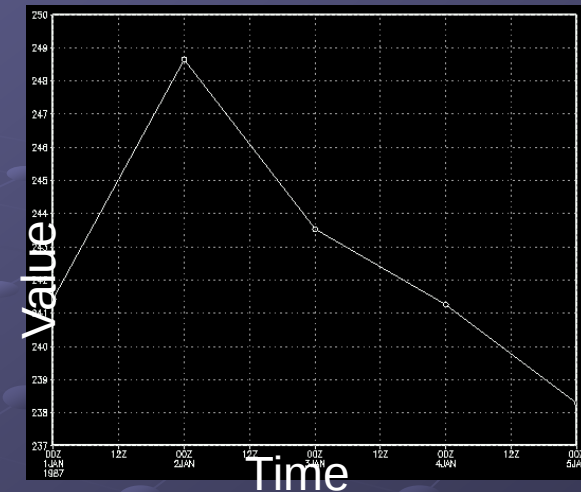
Visualizing by GrADS CUI

- Lesson 8 : How to visualize time graph -

(14) Visualize time-series graph

```
ga-> set LON 140
ga-> set LAT 40
ga-> set LEV 500
ga-> set t 1 5
ga-> d tmpprs
      # Valuable: 1 dimension(Time)
```

Fix as Single value



- Lesson 9 : How to visualize plane map -

(15) Visualize plane map

```
ga-> set LON 20 60
ga-> set LAT 120 160
ga-> set LEV 500
ga-> set t 1
ga-> d tmpprs
      # Valuable: 2 dimensions(Lon.,Lat.)
```

Fix as Single value

Visualizing by GrADS CUI

- Lesson 10 : How to visualize wind -

(16) Visualize
wind strength

Zonal
Component

Meridional
Component

```
ga-> d mag(ugrdprs, vgrdprs) # Wind Magnitude
```

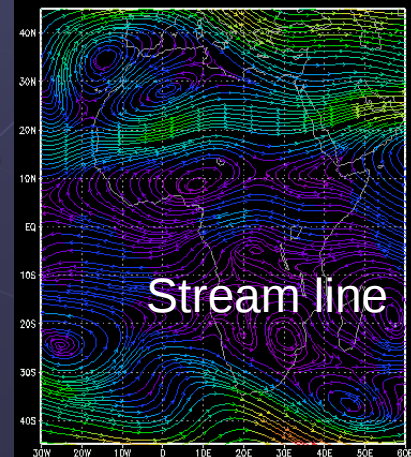
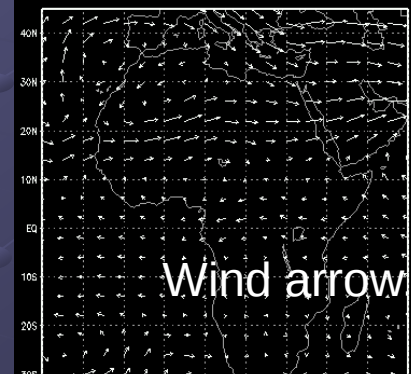
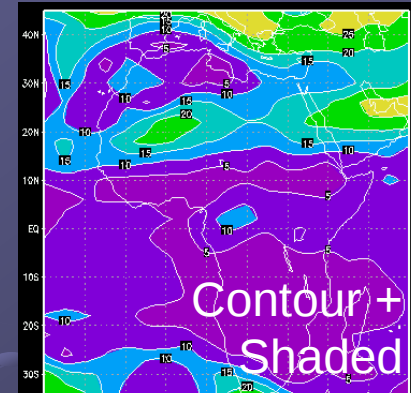
Note: $\text{mag}(\text{ugrdprs}, \text{vgrdprs}) = \sqrt{\text{ugrdprs} * \text{ugrdprs} + \text{vgrdprs} * \text{vgrdprs}}$

(17) Visualize wind arrow (as vector)

```
ga-> set gxout vector  
ga-> d ugrdprs; vgrdprs
```

(18) Visualize stream line
(color indicates wind strength)

```
ga-> set gxout stream  
ga-> d ugrdprs; vgrdprs; mag(ugrdprs, vgrdprs)
```



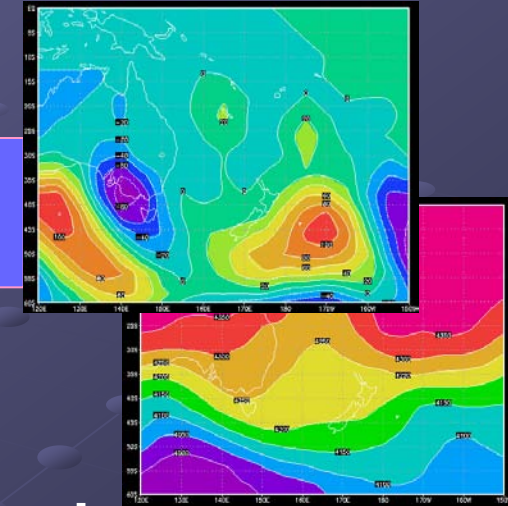
Visualizing by GrADS CUI

- How to use GrADS -

- Lesson 11 : How to calculate / visualize the differences -

(19) Calculate and visualize the differences

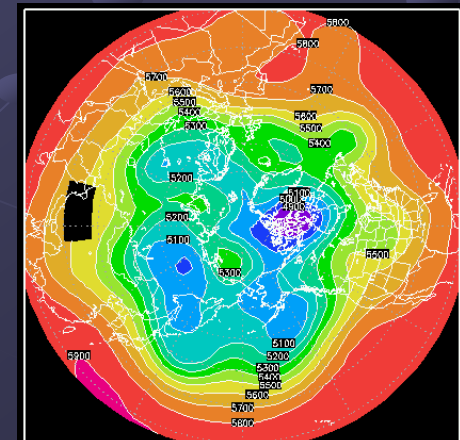
```
ga-> d hgtprs(t=2)-hgtprs(t=1)
ga-> d hgtprs(lev=500)-hgtprs(lev=850)
```



- Lesson 12 : How to use various map projections -

(20) Visualize by using Northern Hemisphere Polar Stereo projection

```
ga-> set mproj nps          # Projection
ga-> set mpdset mres        # Resolution
ga-> set lat 20 90          # Region
ga-> d hgtprs
```



Export images by GrADS CUI

- How to use GrADS -

- Lesson 13 : How to export into image file -

(21) Export as GrADS metafile,
and Convert into image (e.g. format: PNG)

```
ga-> enable print image.gm
ga-> print
ga-> disable print
ga-> !gxyat -o image.png image.gm
      (or exit GrADS, and type
      $ gxyat -o image.png image.gm)
```

The suffixes “.gm” or “.gmf” are typical for GrADS metafile.
Format of image file: PNG, PostScript, PDF, SVG (Scalable Vector Graphics)

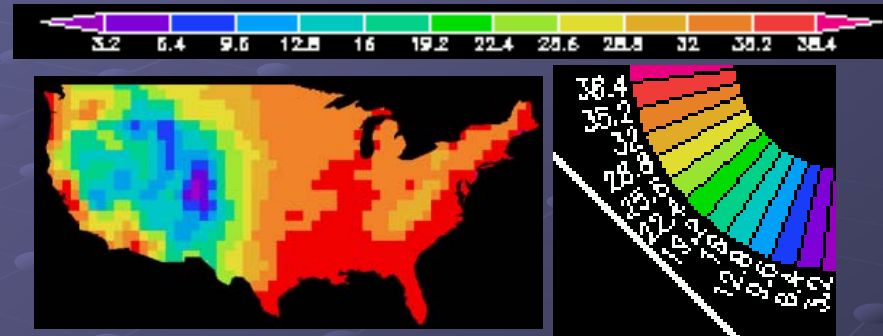
GrADS Script Library

Useful GrADS Utilities

- cbarn.gs, cbarc.gs, ...
 - Draw legends
- map.gs
 - Automates settings for a variety of useful map projections
- basemap.gs
 - Overlays a land or ocean mask that exactly fits the coastal outlines

For details:

<http://www.iges.org/grads/ga/doc/library.html>



GrADS Script Library	
base.gs	Overlays a land or ocean mask that exactly fits the coastal outlines. Requires the following supplemental data files: lpolym_jones.asc and lpolym_mars.asc and lpolym_hires.asc and lpolym_jones.asc and lpolym_mars.asc and lpolym_hires.asc . See instructions in script header for using lpolym_US.asc to mask out non-US areas.
cbarn.gs and cbarc.gs	Scripts to draw a long rectangular color legend next to shaded plots. cbarn has more features -- e.g. it draws outlines and triangular endpoints.
cbarc.gs	Draws a small fan-shaped color legend in the corner of shaded plots.
char.gs	Scripts to draw a legend for line graphs.
char_line1.gs	
char_line2.gs	
cmmap.gs	Creates a color table. See additional documentation .
connect_the_dots.gs	Draws a line connecting user's mouse clicks.
define_colors.gs	Defines a variety of colors using the <code>set_color</code> command.
demo_demo.gs	Illustrates the use of <code>set_color</code> and <code>set_color</code> commands.
font.gs	Displays all the characters in a font set.
isurf.gs	Displays a field interpolated to a specified isentropic level.
latlon.gs	Writes NetCDF, HDF-SDS or GRIB files from GrADS. See additional documentation .
makebg.gs	Creates a background map image that shows topographic texture. It requires a DCOS-enabled version of GrADS and also uses the external ImageMagick utility "convert".
map.gs	Automates settings for a variety of useful map projections.
moconv.gs	Calculates moisture convergence.
metogram_aqa.gs	
metogram_gfs.gs	
metogram_grib.gs	
panels.gs and panels_demo.gs	Scripts to create global variables that contain the 'set vpage' commands for a multipanel plot. These also illustrate the dynamic loading of script functions .
script_math_demo.gs	Illustrates the use of the scripting language math functions.
surfmap.gs	Displays a field interpolated to a specified pressure level.
plotskew.gs	Draws a SkewTLogP Diagram.
stack.gs	Delays display while command sequence is entered by user, then executes all at once.
string.gs	Draws a string located at position of user's mouse click.
sweat_index.gs	Calculates the SWEAT Index given relative humidity, temperature, and wind components.
traj.gs	Draws forward and backward trajectories in the horizontal plane.
use.gs	Similar to open , except it checks the list of current files to see if the specified file has already been opened. If it has been opened, it changes the default file number to the previously opened file instead of opening the same data file again.
weasym.gs	Displays available weather symbols.
zoom.gs	Controls an animated display.
zinterp.gs	Displays a field interpolated to a specified height level.
zoom.gs	A simple way to zoom into a plot.

GrADS Scripting Language

● User facility to program GrADS operations

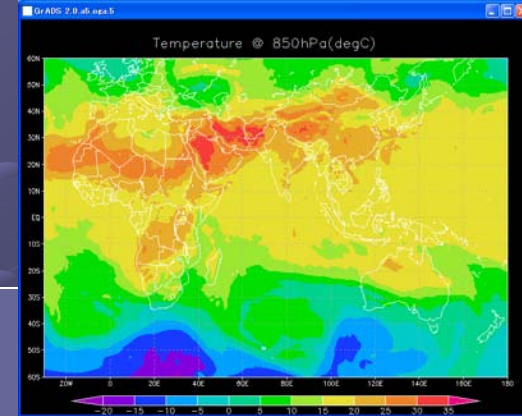
- Automatic production
- Saving procedures

Run by GrADS

```
ga-> run script.gs  
or  
$ grads -c script.gs
```

For details:

<http://www.iges.org/grads/ga/doc/script.html>



*GrADS script sample 1:

```
'open ./t1959_p-all_0p5.ct1'
```

```
'set lon -30 180'
```

```
'set lat -60 60'
```

```
'set lev 850'
```

```
'set mpdset mres'
```

```
'set gxout shaded'
```

```
'set grads off'
```

```
'set strsiz 0.2'
```

```
'set string 1 c 3'
```

```
'draw string 5.25 8 Temperature @ 850hPa(degC)'
```

```
'd tmpprs - 273.15'
```

```
'run cbarn.gs'
```

* ... : Comments

‘...’: GrADS statements

Exchange (K) to (degC)

Call GrADS library

Sample: Overlay data and print image

* GrADS script sample 2:

```
'open ./t1959_surf_0p25.ct1'
```

```
'set lon 110 150'
```

```
'set lat 5 35'
```

```
'set mpdset hires'
```

```
'set gxout shaded'
```

```
'set clevs 0.1 10 20 40 60 80 100'
```

```
'set cmin 0.1'
```

```
'd maskout(apcpsfc, apcpsfc - 0.1)'
```

```
'cbarn'
```

```
'set gxout contour'
```

```
'd prmslmsl / 100'
```

```
'set gxout vector'
```

```
'd skip(ugrd10m, 5, 5);vgrd10m'
```

```
'draw title Pres.@MSL(hPa), Wind@10m(m/s), Prec.6hr(mm)'
```

```
'enable print tmp.gm'
```

```
'print'
```

```
'disable print'
```

```
'!gxyat -i tmp.gm -o output_sample2.png'
```

Use high-resolution coastal map dataset

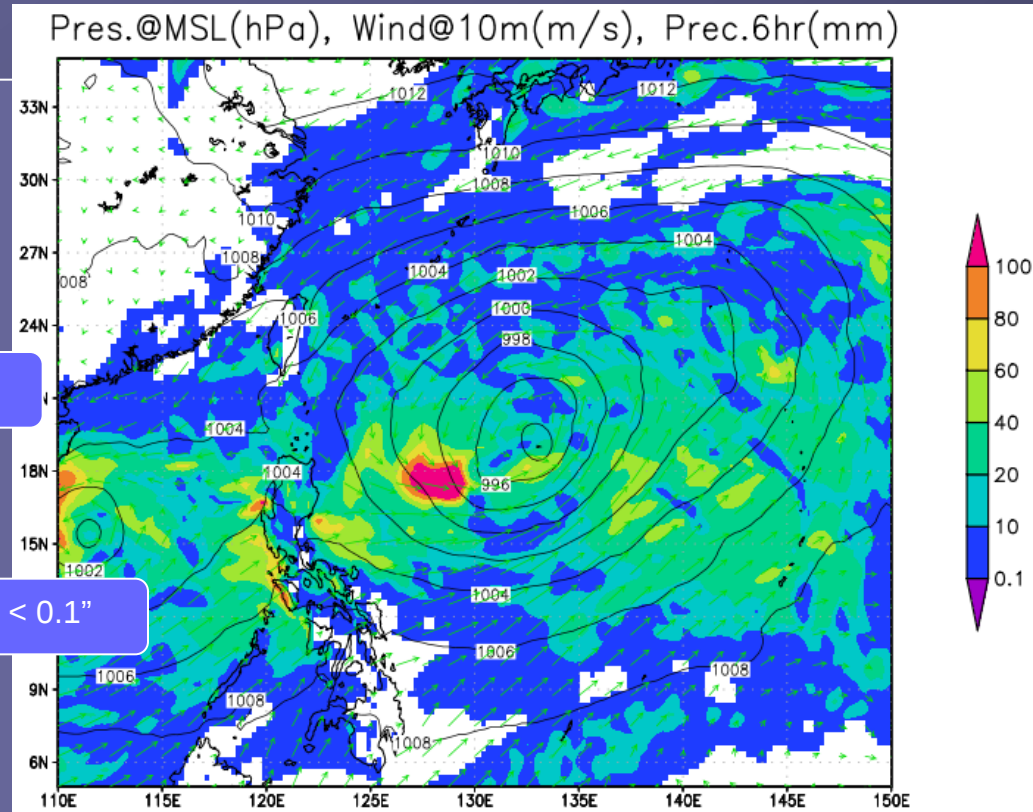
Change intervals of contour

Not draw if "apcpsfc < 0.1"

Alias of 'run cbarn.gs'

Export as GrADS meta image

Convert image into PNG format image



Sample: Using arguments, prompts

* GrADS script sample 3:

Arguments

```
function main(args)
  ctl_file = "./tl1959_p-all_0p5.ctl"
```

```
  if subwrđ(args, 1) != ""
    level = subwrđ(args, 1)
  else
    prompt "Enter Level : "
    pull level
  endif
```

If you run script by
"run sample3.gs 850",
level will be automatically set
as "level = 850".

```
'open 'ctl_file
'set lon 30 210'
'set lat -60 60'
'set lev 'level
'set gxout shaded'
'd hgtprs'
```

If you don't set arguments, you
can enter level manually.

```
'set gxout vector'
'd skip(ugrdprs,5,5);vgrdprs'
```

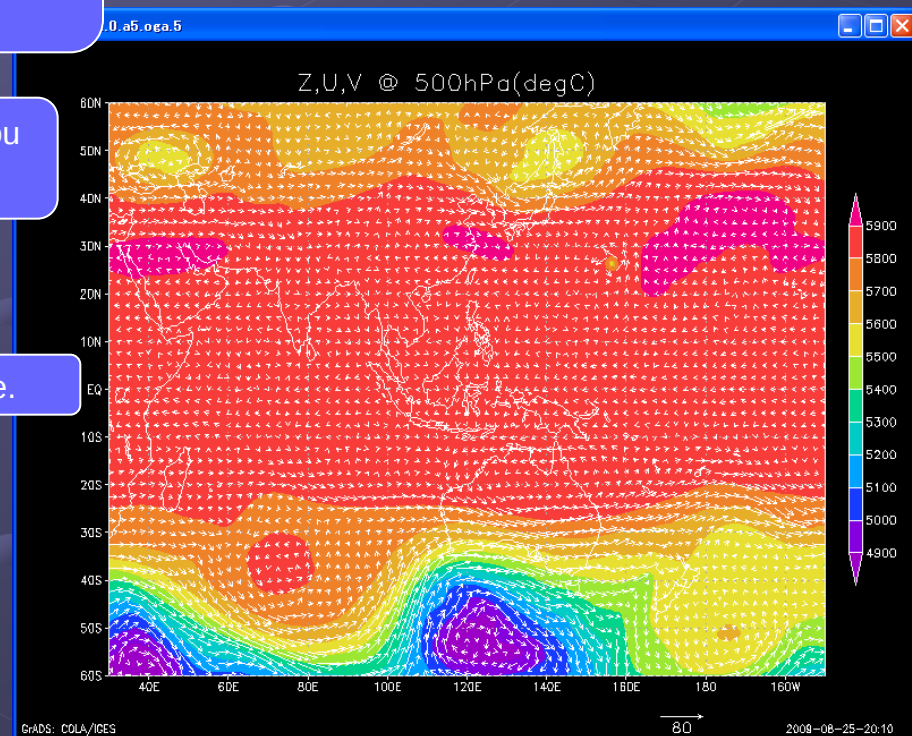
Config and draw title.

```
'set strsz 0.2'; 'set string 1 c 3'
'draw string 5.25 8 Z,U,V @ 'level'hPa(degC)'
'run cbarn.gs 0.8 1 10.25 4.25'
```

```
prompt "Press any key to quit."
pull answer
```

```
'quit'
return
```

```
ga-> run sample3.gs
Enter Level : 500
Press any key to quit.
```



Sample: Extracting values at 1 grid point

* GrADS script sample 4:

```
function main()
```

```
  ctl_file = "./tl959_p-all_0p5.ctl"
```

```
  out_file = "./output_sample4.txt"
```

```
  say "Geopotential Height (gpm)"
```

```
  output = write(out_file, "Geopotential Height (gpm)")
```

```
  'open 'ctl_file'
```

```
  'set lon 140'
```

```
  'set lat 36'
```

```
  'set t 1'
```

```
  'set gxout value'
```

Write data to out_file

```
  Z = 1
```

Loop 21 times
(Z=1, 2, 3, ... ,21)

```
  while(Z<=21)
```

```
    'set z 'Z
```

```
    zlev = subwrd(result, 4)
```

```
    'd hgtps'
```

```
    height = subwrd(result, 4)
```

```
    say zlev' 'height
```

```
    output = write(out_file, zlev' 'height, append)
```

```
    Z = Z + 1
```

```
  endwhile
```

```
  'quit'
```

```
return
```

Geopotential Height (gpm)

1000 28.7195

975 252.417

950 480.678

925 713.9

:

output_sample4.txt

POSIX Shell (bash)

ga-> run sample3.gs

Geopotential Height (gpm)

1000 28.7195

975 252.417

950 480.678

925 713.9

900 952.657

850 1447.85

800 1987.55

700 3093.19

600 4364.55

500 5828.22

400 7560.92

300 9693.23

250 10975.8

200 12470.6

150 14300

100 16753.6

70 18878.9

50 20956.2

30 24201.3

20 26830.5

10 31470.1

No hardcopy metafile open

GX package terminated

Sample: Extracting values at 1 grid point

* GrADS script sample 5:

* GrADS script sample 5:

```
function main()
```

```
  ctl_file = "/tl959_p-all_0p5.ctl"
```

```
  out_file = "/output_sample5.txt"
```

```
  say "Geopotential Height (gpm)"
```

```
  output = write(out_file, "Geopotential Height (gpm)")
```

```
  'open 'ctl_file'
```

```
  'set lon 140'
```

```
  'set lat 36'
```

```
  'set t 1'
```

```
  'set z 1 21'
```

```
  'set gxout print'
```

```
  'set prnopts %10.2f 1 1'
```

```
  'd hgtprs'
```

```
  output = write(out_file, result)
```

```
  output = close(out_file)
```

```
  'quit'
```

```
return
```

Output single value

Format outputs

Output at once without
'while' loop

Geopotential Height (gpm)

28.71

252.41

480.67

713.90

:

:

output_sample5.txt

POSIX Shell (bash)

Geopotential Height (gpm)

Printing Grid -- 21 Values -- Undef = 9.999e+20

28.72

252.42

480.68

713.90

952.66

1447.85

1967.55

3093.19

4364.55

5828.22

7560.92

9693.23

10975.77

12470.55

14300.04

16753.58

18878.86

20956.16

24201.27

26830.52

31470.05

sh-3.2\$

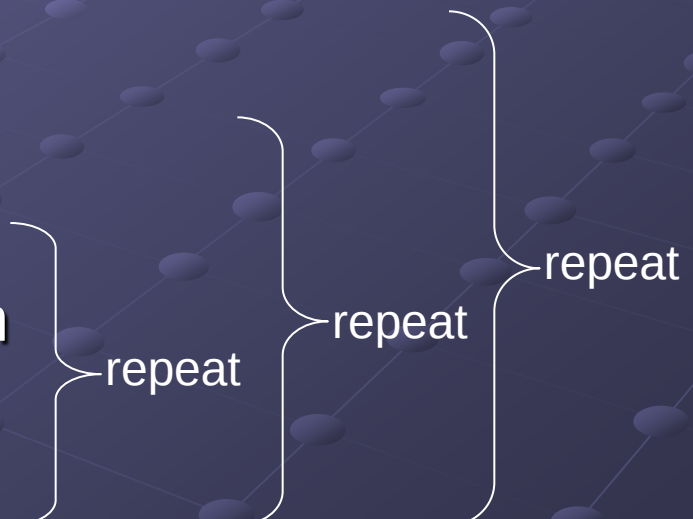
Reference: GRIB(GRIB Edition 1)

● Format

- SECTION0: Indicator (the first 4byte is the ASCII 'GRIB')
- SECTION1: Product definition
- SECTION2: Grid description
- SECTION3: Bitmap
- SECTION4: Binary data
- SECTION5: End (the last 4byte is the ASCII '7777')

Reference: GRIB2(GRIB Edition 2)

● Format

- SECTION0: Indicator (the first 4byte is the ASCII 'GRIB')
 - SECTION1: Identification
 - SECTION2: (Local use section)
 - SECTION3: Grid definition
 - SECTION4: Product definition
 - SECTION5: Data Representation
 - SECTION6: Bitmap
 - SECTION7: Data
 - SECTION8: End (the last 4byte is the ASCII '7777')
- 

References: Preparation for time-series dataset (Analysis)

- How to treat many initials by one Control file (Analysis)
 - Edit Control file, and apply template for “dset” **before making Index file**

Example:

```
Data/Anal/Hist/Daily/20090930.grib2
Data/Anal/Hist/Daily/20091001.grib2
Data/Anal/Hist/Daily/20091002.grib2
Anal_Hist_Daily.ct1
```

%y4 : year 4 digits
%m2 : month 2 digits
%d2 : date 2 digits
%h2 : hour 2 digits

```
dset ^Data/Anal/Hist/Daily/%y4%m2%d2.grib2
index .....
:
options pascals template
:
```

Contents of “Anal_Hist_Daily.ct1”

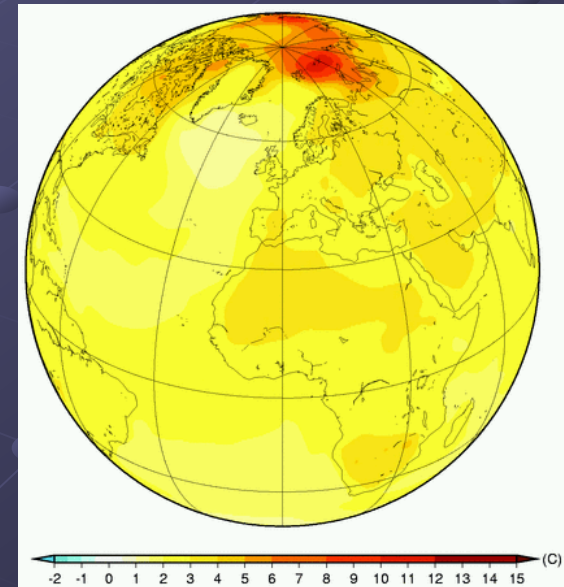
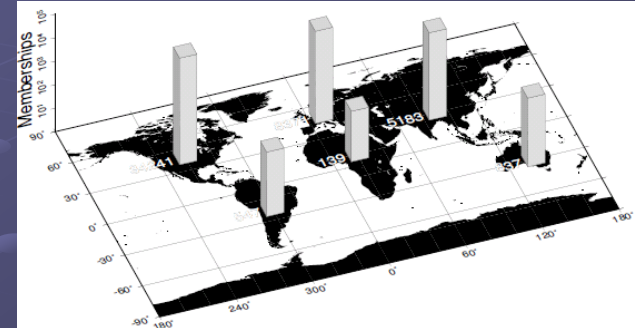
Reference: GMT

● GMT (Generic Mapping Tool)

- Software package for reading script (batch) files, generating fine PostScript images
- Easier than GrADS when visualizing Station-Data
- Interactive operation is not supported.
 - 'iGMT' would be enable interactive operation?
- GRIB/GRIB2 are not supported.

For details:

<http://gmt.soest.hawaii.edu/>



Reference: NCARG / PyNGL

● NCARG(NCAR Graphics)

- Software package for scientific visualization
- NCAR Command Language (NCL; Fortran/C library)
- Difficult to master than GrADS/GMT

● PyNGL

- Python wrapper for NCL
- Easier than using NCL directly
- Interactive operation is not supported by NCARG and PyNGL
- Binary is available for only Linux, Solaris and Macintosh.

For details:

<http://www.ncarg.ucar.edu/>

<http://www.pyngl.ucar.edu/>

