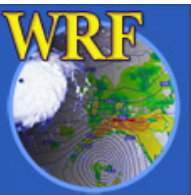




Developmental Testbed Center

Running the WRF Preprocessing System

Michael Duda

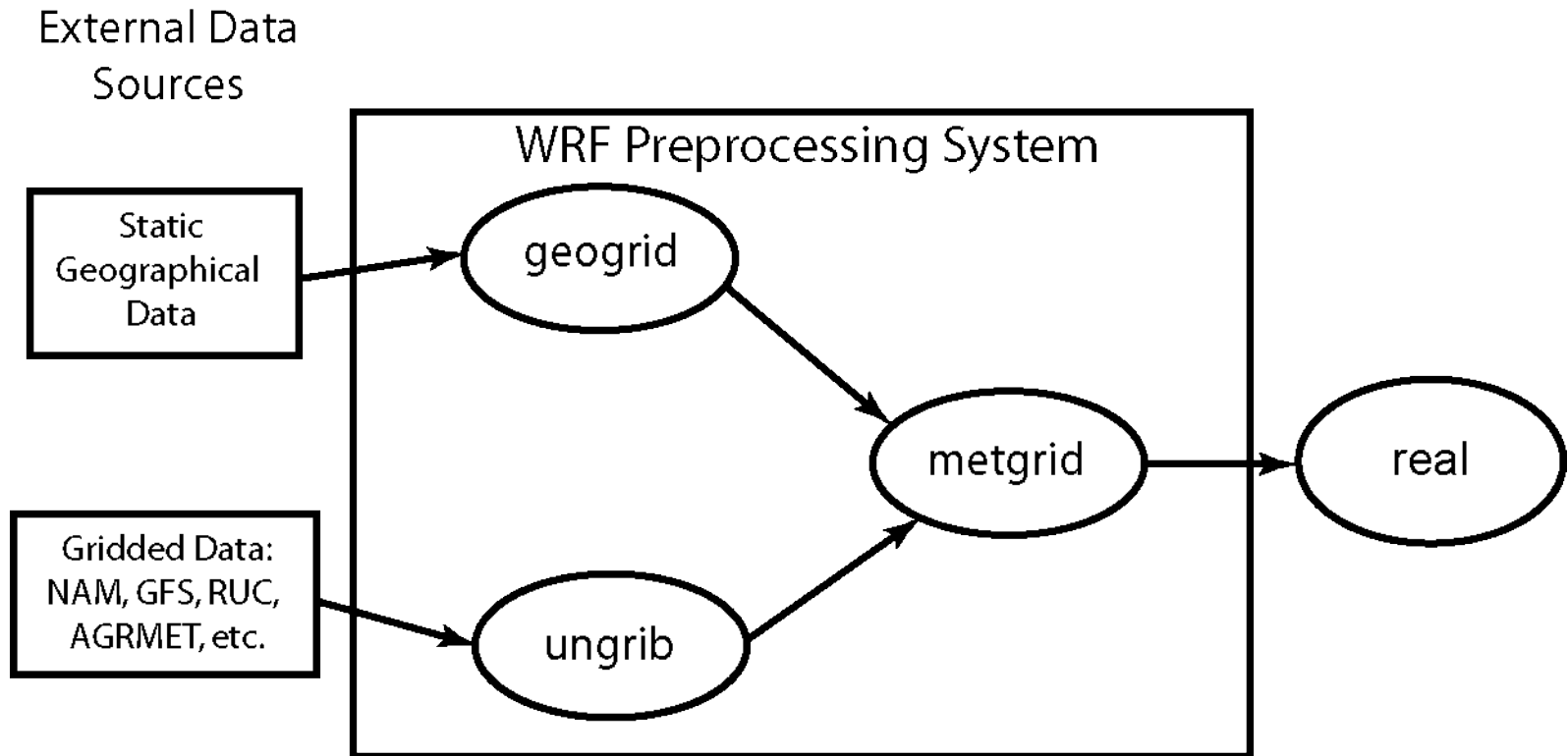


The Basic WRF Users' Tutorial
28 January – 1 February 2013, Boulder, CO

*NCAR is sponsored by the
National Science Foundation

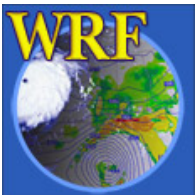
Review

- Briefly recall the programs in the WPS



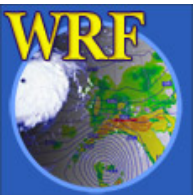
Review

- geogrid (think geographical)
 - ☐ Define size/location of model domains and interpolate static terrestrial fields to simulation grids
- ungrib (think un+grib)
 - ☐ Extract meteorological fields from GRIB files
- metgrid (think meteorological)
 - ☐ Horizontally interpolate meteorological fields (from ungrib) to simulation grids (defined by geogrid)



Overview

- How to run through the WPS for basic cases
 - ☐ Basic steps for running the WPS
 - Geogrid
 - Ungrib
 - Metgrid
- WPS utility programs
- Common WPS mistakes



Running geogrid

STEP 1: Edit `namelist.wps`

For geogrid, only the `&share` and `&geogrid` namelists need to be edited in `namelist.wps`

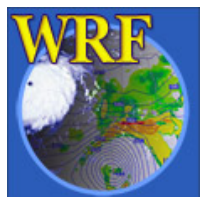
`&share`

```
wrf_core = 'ARW',  
max_dom = 2,  
io_form_geogrid = 2,
```

`&geogrid`

```
parent_id      = 1,      1,  
parent_grid_ratio = 1,      3,  
i_parent_start  = 1,      20,  
j_parent_start  = 1,      17,  
e_we           = 220,    181,  
e_sn           = 175,    181,  
geog_data_res   = '5m',  '2m',  
dx             = 15000,  
dy             = 15000,  
map_proj        = 'lambert',  
ref_lat         = 37.0,  
ref_lon         = -97.0,  
truelat1        = 45.0,  
truelat2        = 30.0,  
stand_lon       = -97.0,  
geog_data_path  = '/data/static/geog/'
```

/



Running geogrid

STEP 1: Edit `namelist.wps`

`&share`

```
wrf_core = 'ARW',  
max_dom = 2,  
io_form_geogrid = 2,  
/
```

Which WRF core?

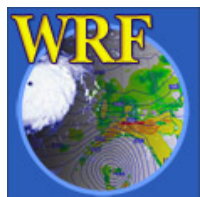
For ARW, set to 'ARW'

For NMM, set to 'NMM'

Total number of model domains, including nests, for ARW; number of nesting levels for NMM.

Format for geogrid output files; 2=netCDF is recommended.

See p. 3-8 and 3-37



Running geogrid

STEP 1: Edit `namelist.wps`

`&geogrid`

```
parent_id      = 1, 1,
parent_grid_ratio = 1, 3,
i_parent_start  = 1, 20,
j_parent_start  = 1, 17,
```

Nesting: Who is the parent?
What is the grid ratio for each nest? Where is it located in its parent?

```
e_we = 220, 181,
e_sn = 175, 181,
dx   = 15000,
dy   = 15000,
```

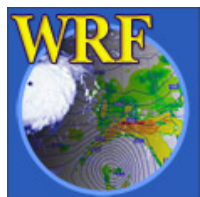
Domain sizes: How many grid points does the domain have? What is the grid spacing?

```
geog_data_res = '5m', '2m',
```

Static data: What resolution of source data to interpolate from for each domain?
'30s', '2m', '5m', or '10m'?

...

See p. 3-9, 3-19, and 3-38



Running geogrid

STEP 1: Edit `namelist.wps`

&geogrid

...

```
map_proj      = 'lambert',  
ref_lat       = 37.0,  
ref_lon       = -97.0,  
truelat1      = 45.0,  
truelat2      = 30.0,  
stand_lon     = -97.0,
```

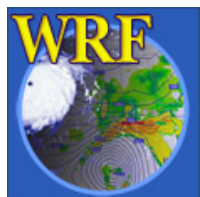
Map projection: What projection to use? What are the parameters of the projection?

See p. 3-9 and 3-40

```
geog_data_path = '/data/static/geog/'
```

Static data: Where are the data directories (e.g., topo_30s) located?

See p. 3-41



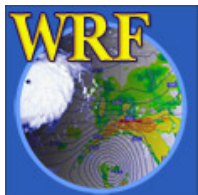
Running geogrid

STEP 2: Make sure GEOGRID.TBL is linked to the correct version of GEOGRID.TBL

- There are multiple GEOGRID.TBL files to support multiple dynamical cores in WRF
- GEOGRID.TBL.ARW must be used for ARW
- GEOGRID.TBL.NMM must be used for NMM

```
> ls geogrid/GEOGRID.TBL
```

```
GEOGRID.TBL -> GEOGRID.TBL.ARW
```



Running geogrid

STEP 3: Run geogrid.exe

```
Parsed 11 entries in GEOGRID.TBL
Processing domain 1 of 2
  Processing XLAT and XLONG
  Processing MAPFAC
  Processing F and E
  Processing ROTANG
  Processing LANDUSEF
  Calculating landmask from LANDUSEF
  Processing HGT_M
```

...

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!   Successful completion of geogrid.                                   !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

Geogrid processes each domain individually. There will be one section of messages for each domain.

As each field is processed, a message will be written to the screen and to the geogrid.log file.



Running geogrid

STEP 4: Check that geogrid ran successfully

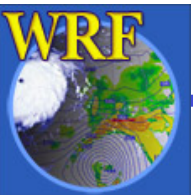
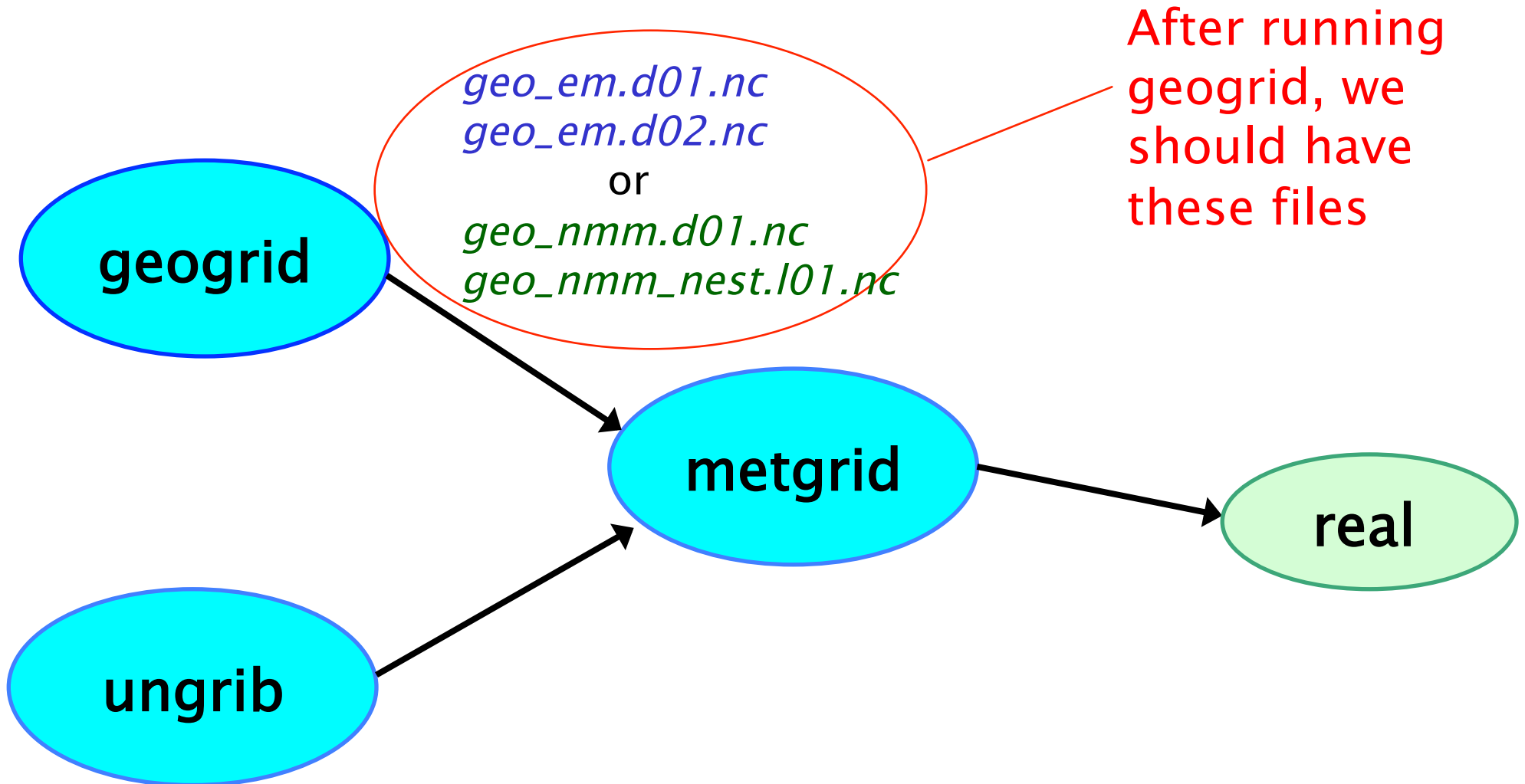
If geogrid ran successfully, this message should be printed:

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!  
!   Successful completion of geogrid.                        !  
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

If there was an error, check for an **ERROR** or **WARNING** message in the `geogrid.log` file, or for a system error, like “Segmentation fault”.



Running geogrid



Running ungrib

STEP 1: Edit `namelist.wps`

For ungrib, only the `&share` and `&ungrib` namelists need to be edited

`&share`

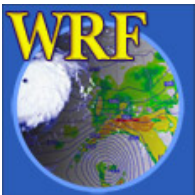
```
wrf_core = 'ARW',  
max_dom = 2,  
start_date = '2006-04-01_00:00:00',  
end_date   = '2006-04-01_12:00:00',  
interval_seconds = 21600  
io_form_geogrid = 2,
```

`&ungrib`

```
out_format = 'WPS',  
prefix = 'GFS',
```

/

/



Running ungrib

STEP 1: Edit `namelist.wps`

&share

```
wrf_core = 'ARW',  
max_dom = 2,
```

```
start_date = '2006-04-01_00:00:00',  
end_date   = '2006-04-01_12:00:00',
```

```
interval_seconds = 21600
```

```
io_form_geogrid = 2,
```

/

Data time range: Between which times should ungrib process GRIB data?

Data frequency: How many seconds between output files for ungrib?
E.g., 10800 s = 3 hrs

See p. 3-14, and 3-38



Running ungrib

STEP 1: Edit `namelist.wps`

`&ungrib`

`out_format = 'WPS',`

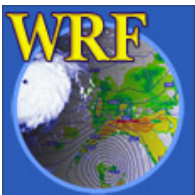
`prefix = 'GFS',`

`/`

Intermediate file format: Which format to use for intermediate files? 'WPS', 'SI', or 'MM5' are possible; 'WPS' is recommended.

Intermediate file names: Gives prefix for intermediate files. Prefix can include a path. E.g., 'XYZ' would give intermediate files named `XYZ:yyyy-mm-dd_hh`.

See p. 3-14, 3-23, and 3-41



Running ungrib

STEP 2: Link the correct Vtable to the file name “Vtable” in the run directory

- Some Vtables are provided with WPS in the **WPS/ungrib/Variable_Tables** directory

☒ E.g., Vtable.GFS, Vtable.SST, Vtable.ECMWF

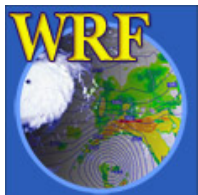
See p. 3–15

- Ungrib always expects to find a file named **vtable** in the run directory

> In -s ungrib/Variable_Tables/Vtable.GFS Vtable

> ls Vtable

Vtable -> ungrib/Variable_Tables/Vtable.GFS



Running ungrib

STEP 3: Link GRIB files to the correct file names in the run directory

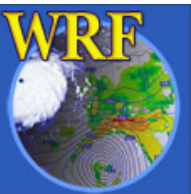
- Ungrib always expects GRIB files to be named GRIBFILE.AAA, GRIBFILE.AAB, GRIBFILE.AAC, etc., in the run directory
- The `link_grib.csh` script can be used to link GRIB files to these file names:

```
> link_grib.csh /data/GRIB/GFS/gfs*
```

See p. 3–15

```
> ls GRIBFILE.*
```

```
GRIBFILE.AAA -> /data/GRIB/GFS/gfs_060401_00_00
```



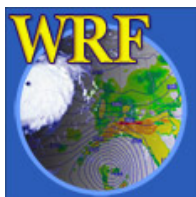
Running ungrib

STEP 4: Run ungrib.exe

```
*** Starting program ungrib.exe ***
Start_date = 2006-08-16_12:00:00 ,      End_date = 2006-08-16_12:00:00
output format is WPS
Path to intermediate files is ./
ungrib - grib edition num                2
```

```
#####
Inventory for date = 2006-08-16 12:00:00
```

PRES	TT	UU	VV	RH	HGT	
2013.0	O	O	O	O	O	O
2001.0	X	X	X	X	O	X
1000.0	X	X	X	X	X	
975.0	X	X	X	X	X	
950.0	X	X	X	X	X	
925.0	X	X	X	X	X	
900.0	X	X	X	X	X	



Running ungrib

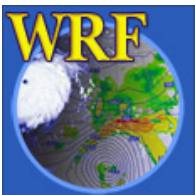
STEP 5: Check that ungrib ran successfully

If ungrib ran successfully, this message should be printed:

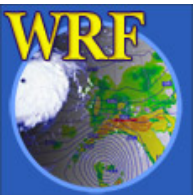
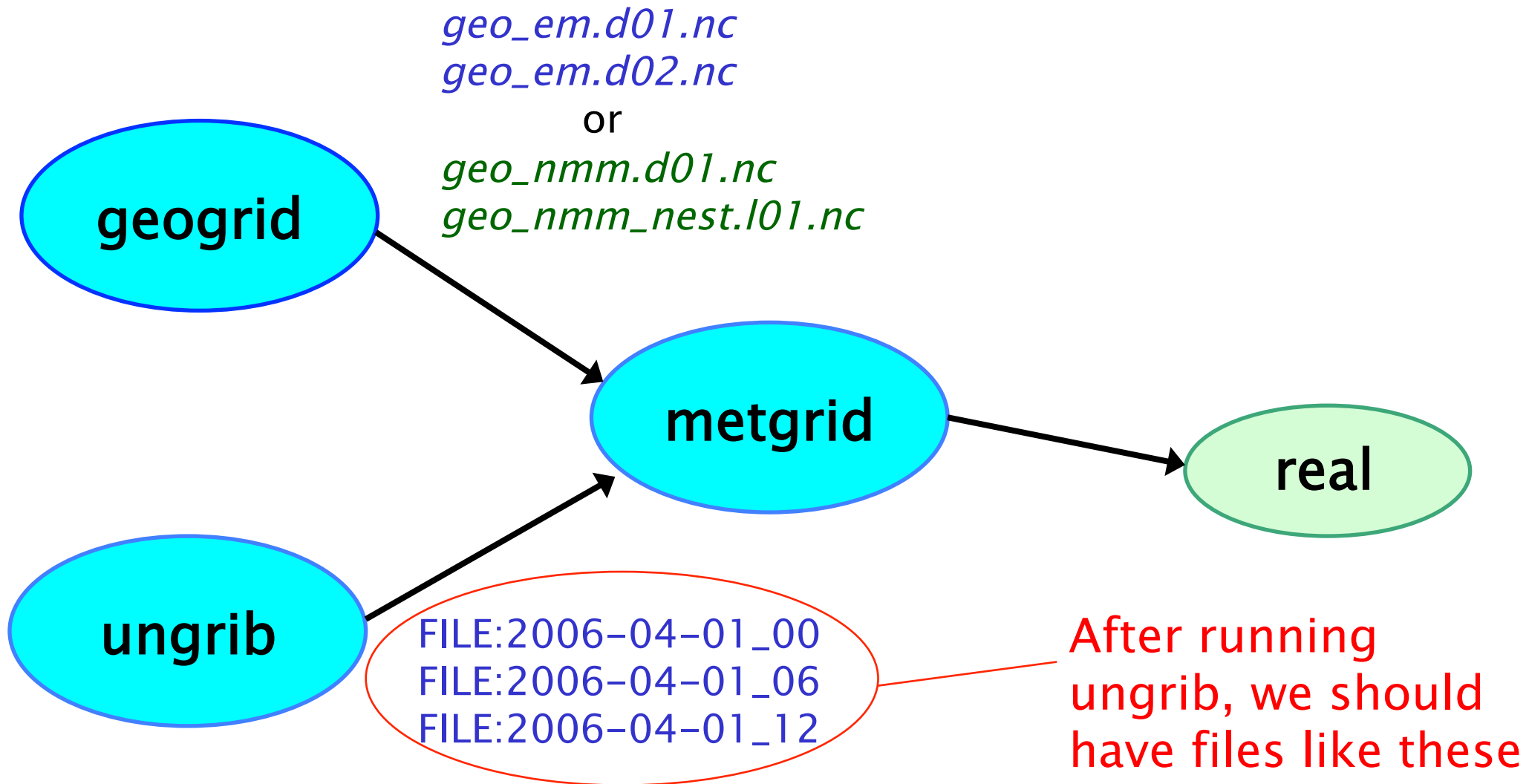
```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!  
!   Successful completion of ungrib.                        !  
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

If there was an error, check for error message in ungrib's printout or in the `ungrid.log` file.

Common errors are related to incorrect date specifications in the `&share` namelist, or because GRIB2 data was used with a version of WPS compiled without GRIB2 libraries.



Running ungrib



Running metgrid

STEP 1: Edit `namelist.wps`

For metgrid, only the `&share` and `&metgrid` namelists need to be edited

`&share`

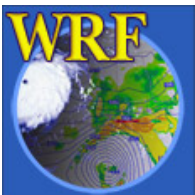
```
wrf_core = 'ARW',  
max_dom = 2,  
start_date = '2006-04-01_00:00:00', '2006-04-01_00:00:00',  
end_date   = '2006-04-01_12:00:00', '2006-04-01_00:00:00',  
interval_seconds = 21600  
io_form_geogrid = 2,
```

/

`&metgrid`

```
fg_name = 'GFS',  
constants_name = 'SST:2006-04-01_00',  
io_form_metgrid = 2,
```

/



Running metgrid

STEP 1: Edit `namelist.wps`

&share

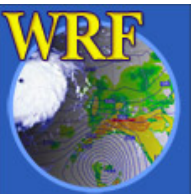
```
wrf_core = 'ARW',  
max_dom = 2,
```

```
start_date = '2006-04-01_00:00:00', '2006-04-01_00:00:00',  
end_date   = '2006-04-01_12:00:00', '2006-04-01_00:00:00',
```

```
interval_seconds = 21600  
io_form_geogrid = 2,
```

Data time range: Time range
to process *for each domain*.
Usually, only the initial time is
needed for ARW nested
domains.

See p. 3-17 and 3-37



Running metgrid

STEP 1: Edit `namelist.wps`

Intermediate file prefixes: Prefix (or prefixes) of intermediate files to interpolate to model domain. Should match prefix given to ungrib.

&metgrid

`fg_name = 'GFS',`

See p. 3-17 and 3-24

`constants_name = 'SST:2006-04-01_00',`

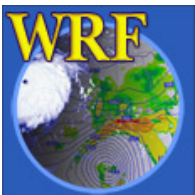
Constant fields: Optional name of an intermediate file with fields to be used for every time period.

`io_form_metgrid = 2,`

Metgrid I/O format: Which I/O format to use for metgrid output? 2=netCDF is recommended.

See p. 3-17, and 3-41

/



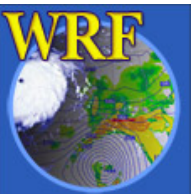
Running metgrid

STEP 2: Make sure METGRID.TBL is linked to the correct version of METGRID.TBL

- There are multiple METGRID.TBL files to support multiple dynamical cores in WRF
- METGRID.TBL.ARW should be used for ARW
- METGRID.TBL.NMM should be used for NMM

```
> ls metgrid/METGRID.TBL
```

```
METGRID.TBL -> METGRID.TBL.ARW
```



Running metgrid

STEP 3: Run metgrid.exe

```
Processing domain 1 of 2
```

```
SST:2006-04-01_00
```

```
Processing 2006-04-01_00
```

```
GFS
```

```
Processing 2006-04-01_06
```

```
GFS
```

```
Processing 2006-04-01_12
```

```
GFS
```

```
Processing domain 2 of 2
```

```
SST:2006-04-01_00
```

```
Processing 2006-04-01_00
```

```
GFS
```

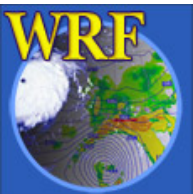
```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
! Successful completion of metgrid. !
```

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

Fields from constant files
(given using `constants_name`)
are processed before any time
varying fields.

Metgrid processes all time
period for one domain before
processing for the next
domain



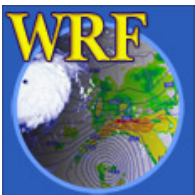
Running metgrid

STEP 4: Check that metgrid ran successfully

If metgrid ran successfully, this message should be printed:

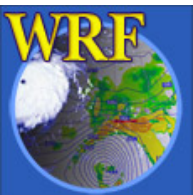
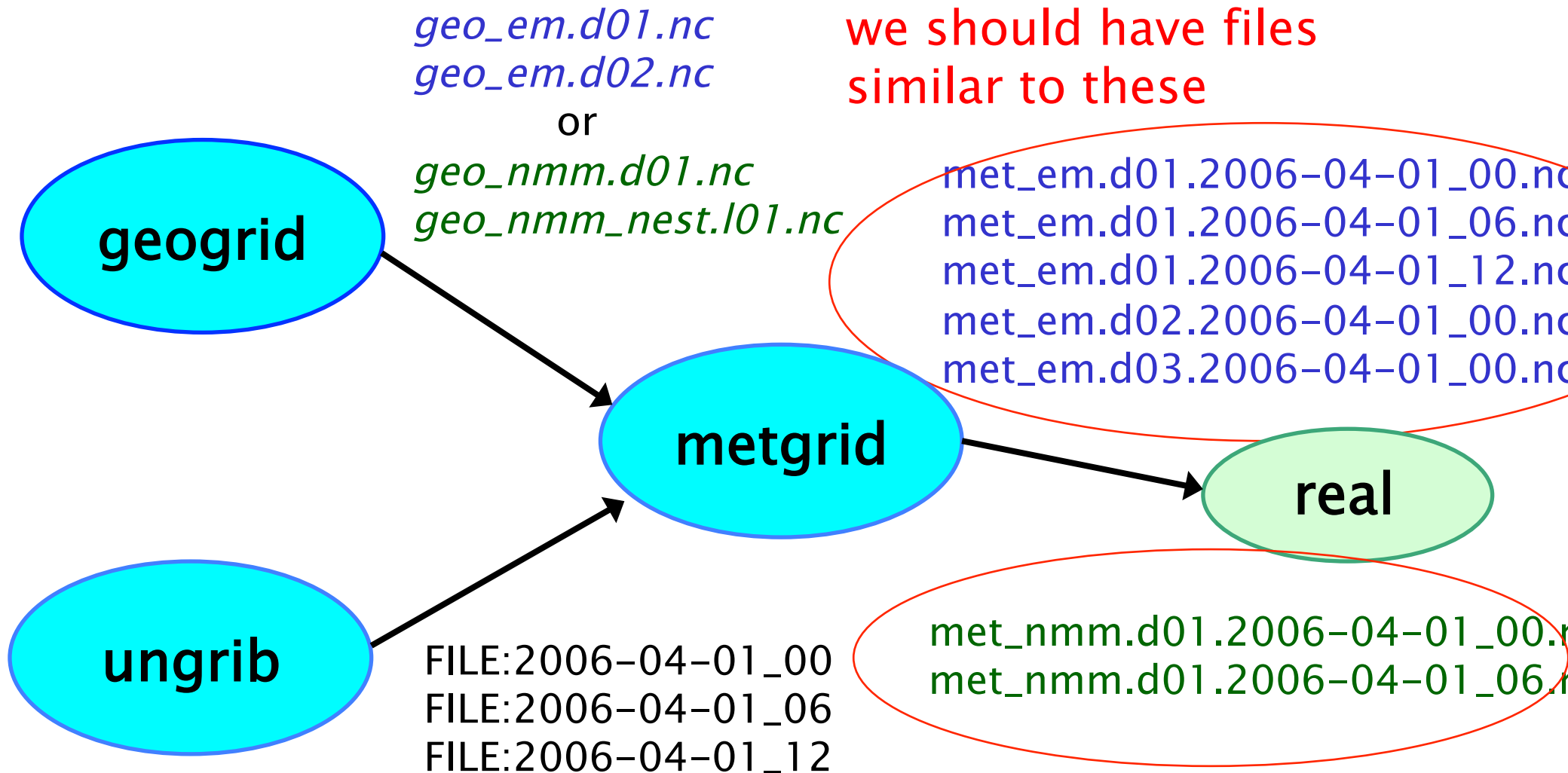
```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!  
!   Successful completion of metgrid.                        !  
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

If there was an error, check for an **ERROR** or **WARNING** message in the `metgrid.log` file, or for a system error, like “Segmentation fault”.



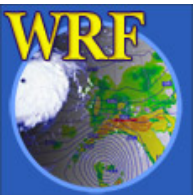
Running metgrid

After running metgrid,
we should have files
similar to these



Overview

- How to run through the WPS for basic cases
 - ☐ Basic steps for running WPS
 - Geogrid
 - Ungrib
 - Metgrid
- WPS utility programs
- Common WPS mistakes



WPS Utility Programs

- Besides geogrid, ungrib, and metgrid, some simple utility programs are distributed with WPS:
 - ☒ For checking contents of intermediate format files
 - ☒ For listing contents of GRIB1 & GRIB2 files
 - ☒ To assist in locating domains
 - ☒ For computing 3d pressure field for ECMWF data
- Some programs use NCAR Graphics libraries for plotting
 - ☒ For these utilities, *NCAR Graphics must be installed*

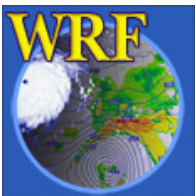
See p. 3-27



WPS Utility Programs

The utility programs that come with WPS can be helpful when diagnosing problems with WPS output

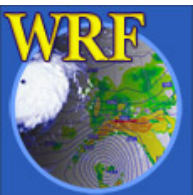
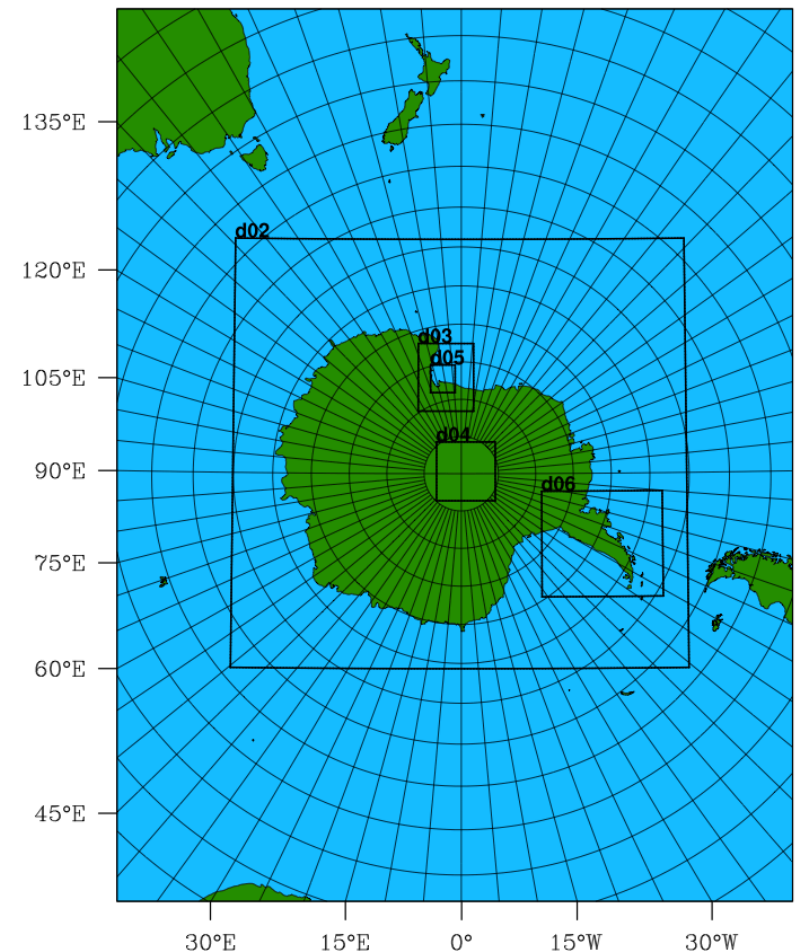
- All utilities are found in the `WPS/uti1` directory
- Users are encouraged to make use of these utilities to examine WPS input and output files



Utility: `plotgrids.ncl`

The *plotgrids.ncl* script plots the locations of grids defined in *namelist.wps*

- *plotgrids* can be used to iteratively refine the locations of grids.
- *plotgrids.ncl* uses the *namelist.wps* file only, so there is no need to run *geogrid* first!



Utility: rd_intermediate

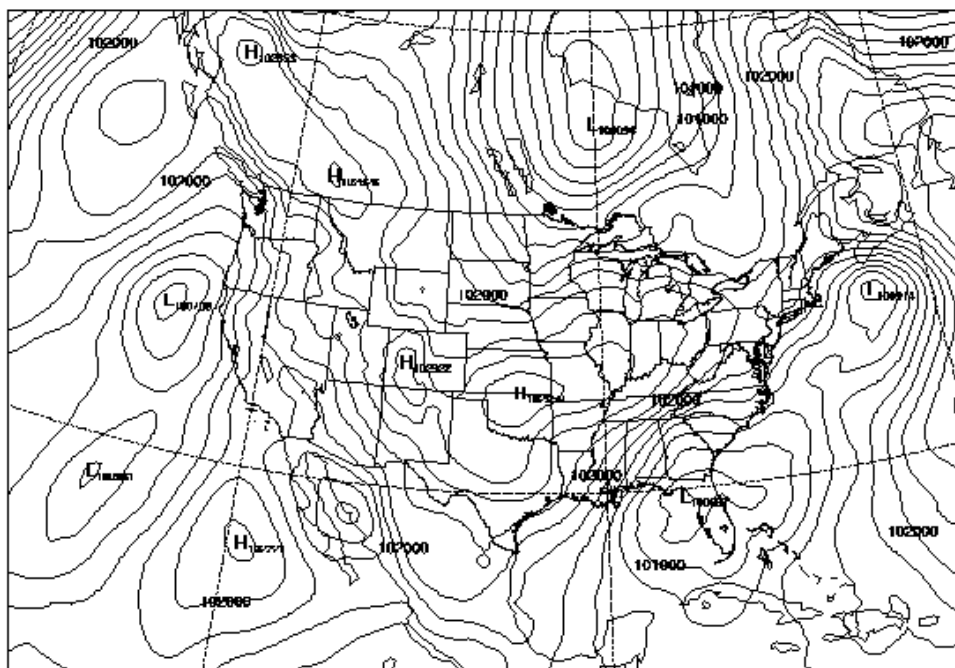
The rd_intermediate lists information about the fields found in an intermediate-format file

```
=====
FIELD = TT
UNITS = K DESCRIPTION = Temperature
DATE = 2000-01-24_12:00:00 FCST = 0.000000
SOURCE = unknown model from NCEP GRID 212
LEVEL = 200100.000000
I,J DIMS = 185, 129
IPROJ = 1
  REF_X, REF_Y = 1.000000, 1.000000
  REF_LAT, REF_LON = 12.190000, -133.459000
  DX, DY = 40.635250, 40.635250
  TRUELAT1 = 25.000002
DATA(1,1)=295.910950
=====
```



Utility: plotfmt

The plotfmt program plots the fields in the ungrib intermediate-formatted files



201300 PMSL

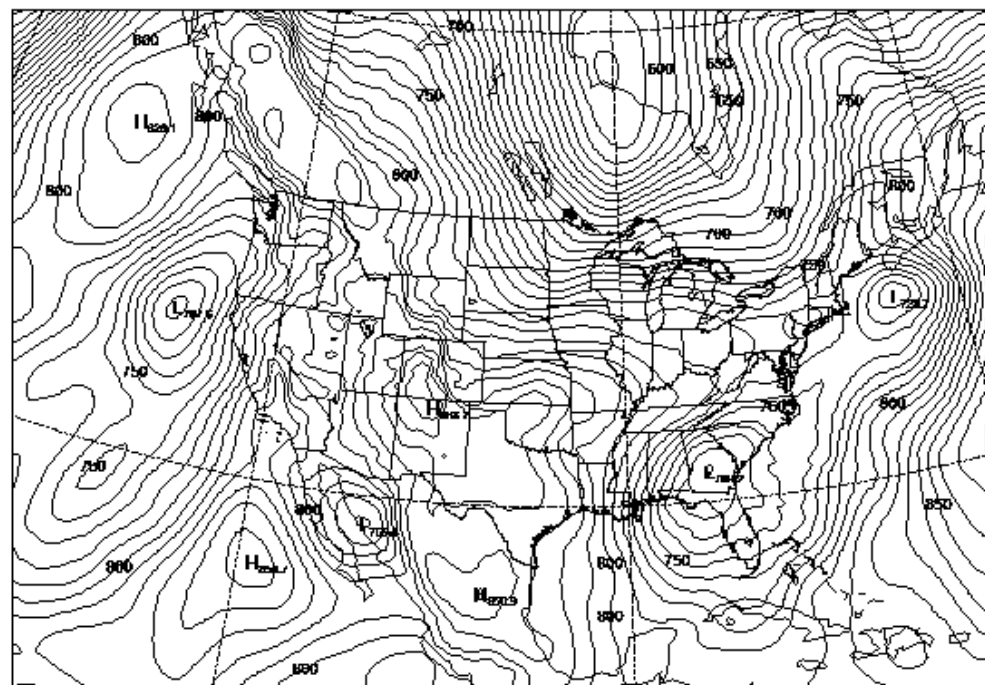
Pa

Sea-level Pressure

WPS intermediate format

CONTOUR FROM 100900 TO 103200 BY 200

unknown model from NCEP GRID 212



92500 GHT

m

Height

WPS intermediate format

CONTOUR FROM 500 TO 880 BY 10

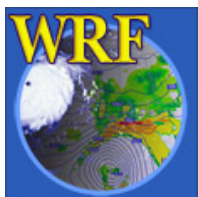
unknown model from NCEP GRID 212



Utility: g1 print and g2print

The *g1print* and *g2print* programs list the contents of a GRIB1 or GRIB2 file:

rec num	Prod Disc	Cat	Param num	Lvl code	Lvl one	Lvl two	Name	Time	Fcst hour
1	0	3	5	100	100000	0	HGT	2006-08-16_12:00:00	00
2	0	3	5	100	97500	0	HGT	2006-08-16_12:00:00	00
3	0	3	5	100	95000	0	HGT	2006-08-16_12:00:00	00
4	0	3	5	100	92500	0	HGT	2006-08-16_12:00:00	00
5	0	3	5	100	90000	0	HGT	2006-08-16_12:00:00	00
6	0	3	5	100	85000	0	HGT	2006-08-16_12:00:00	00
7	0	3	5	100	80000	0	HGT	2006-08-16_12:00:00	00
8	0	3	5	100	75000	0	HGT	2006-08-16_12:00:00	00
9	0	3	5	100	70000	0	HGT	2006-08-16_12:00:00	00
10	0	3	5	100	65000	0	HGT	2006-08-16_12:00:00	00



Utility: calc_ecmwf_p

The *calc_ecmwf_p* utility creates intermediate files with a pressure (and possibly GHT and RH) field

FILE:2009-08-27_00

PSFC / LOGSFP
SOILHGT / SOILGEO
TT
SPECHUMD

emcwf_coeffs

0	0.000000	0.000000	0.0000	
1	2.000040	0.000000	0.0200	0.0100
2	3.980832	0.000000	0.0398	0.0299
3	7.387186	0.000000	0.0739	0.0568
4	12.908319	0.000000	0.1291	0.1015
5	21.413612	0.000000	0.2141	0.1716
6	33.952858	0.000000	0.3395	0.2768
7	51.746601	0.000000	0.5175	0.4285
8	76.167656	0.000000	0.7617	0.6396
9	108.715561	0.000000	1.0872	0.9244

calc_ecmwf_p.exe

PRES:2009-08-27_00

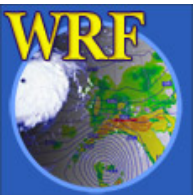
PRESSURE
RH
GHT

See p. 3-28



Overview

- How to run through the WPS for basic cases
 - ☐ Basic steps for running WPS
 - Geogrid
 - Ungrib
 - Metgrid
- WPS utility programs
- Common WPS mistakes

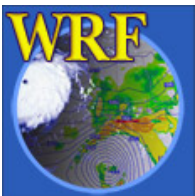


Common WPS Mistakes

- 1) All 3-d fields must have same number of levels in metgrid

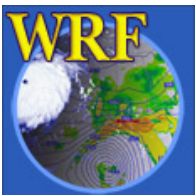
```
WRF_DEBUG: Warning DIM              4 , NAME
num_metgrid_levels REDIFINED  by var GHT              27
26 in wrf_io.F90 line          2347
ERROR: Error in ext_pkg_write_field
```

- This is usually corrected by ensuring that all 3-d meteorological fields have surface level data
- Try setting debug_level=1000 in &share namelist, and checking metgrid.log for a table showing which fields are available at each level



Common WPS Mistakes

- 2) When using a regional data set (e.g., NAM), ensure that model domain is completely covered by the data
 - The metgrid program will stop if the model domain has grid points that are not covered by data
- 3) For native vertical coordinate data sets (e.g., RUCb, ECMWF), ensure that both pressure and geopotential height fields are available



Questions?

