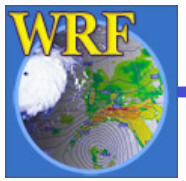
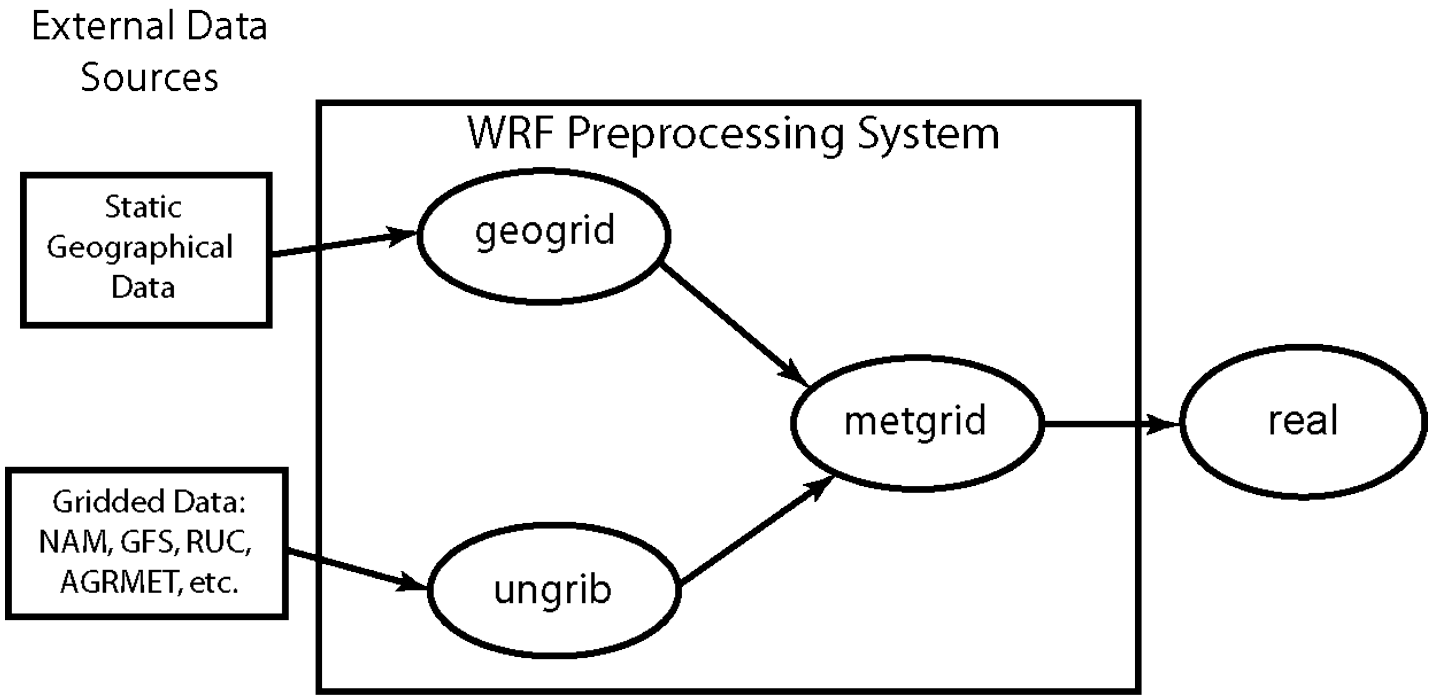
Running the WRF Preprocessing System

Michael Duda



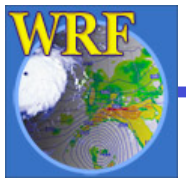
Review

- Briefly recall the programs in the WPS



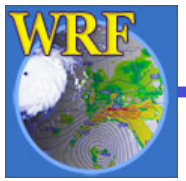
Review

- 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 WPS
    - Geogrid
    - Ungrib
    - Metgrid
- WPS utility programs
- Common WPS mistakes



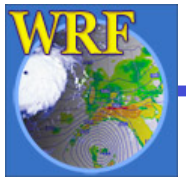
Running geogrid

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`

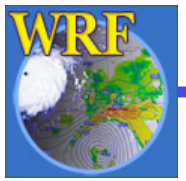
```
&share
   wrf_core = 'ARW',
   max_dom = 2,
   io_form_geogrid = 2,
/
```

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`

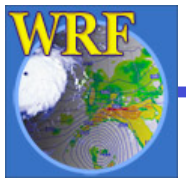
```
&geogrid
   parent_id             =   1,     1,
   parent_grid_ratio     =   1,     3,
   i_parent_start        =   1,     20,
   j_parent_start        =   1,     17,

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

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

    . . .
/
```

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

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

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`

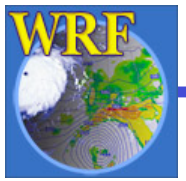
```
&geogrid
   ...

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

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

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

See p. 3-9 and 3-40

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

See p. 3-41

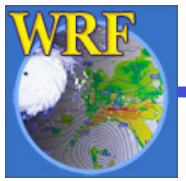


Running geogrid

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
```



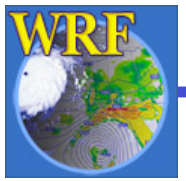
Running geogrid

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.



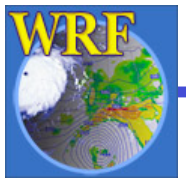
Running geogrid

STEP 4: Check that geogrid ran successfully

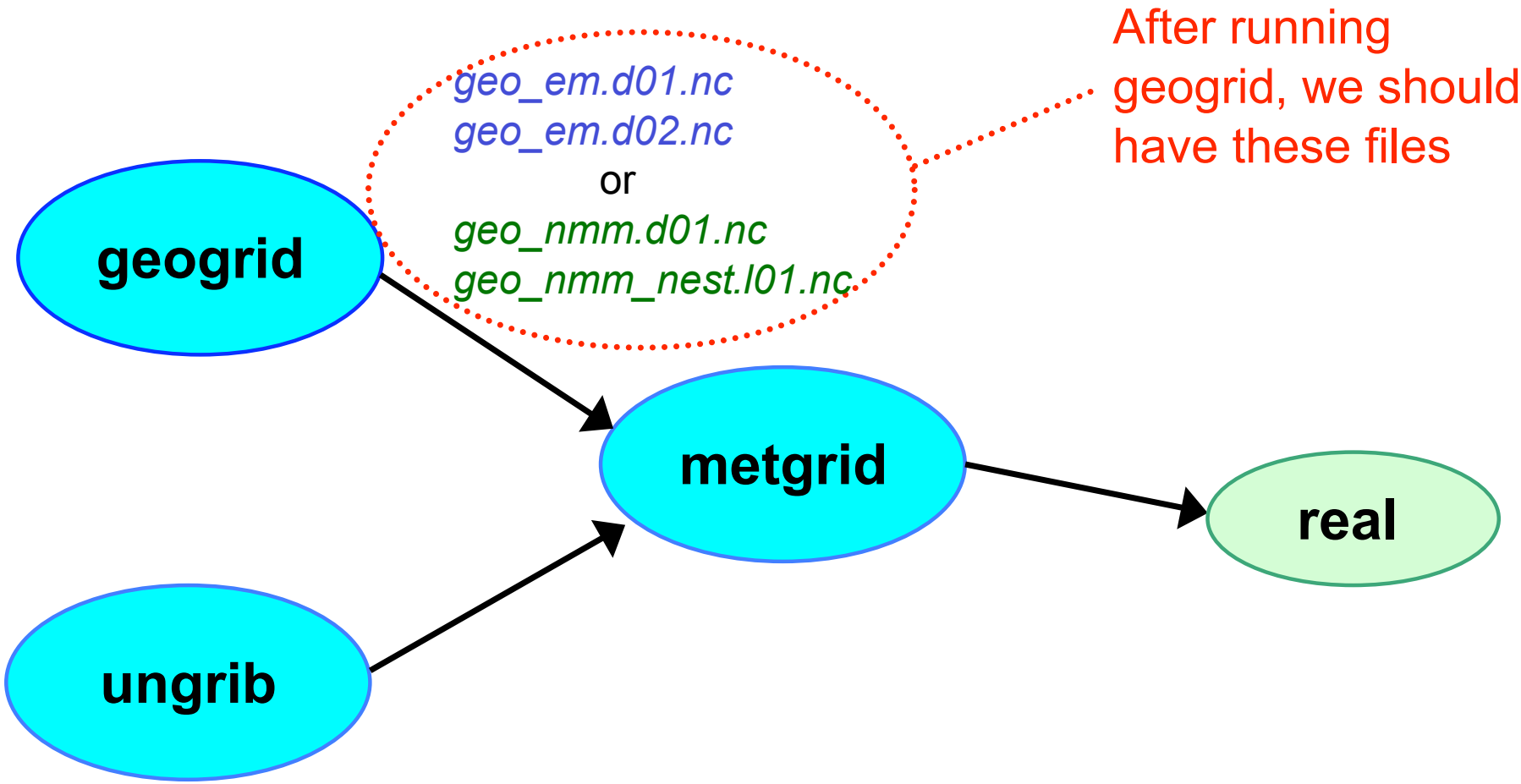
If geogrid ran sucessfully, this message should be printed:

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



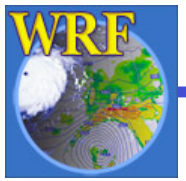
Running ungrib

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

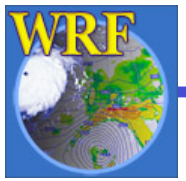
STEP 1: Edit `namelist.wps`

```
&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

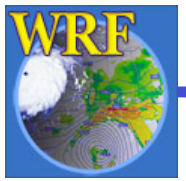
STEP 1: Edit `namelist.wps`

```
&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., 'XZY' would give intermediate files named XYZ:*yyyy-mm-dd_hh.*

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



Running ungrib

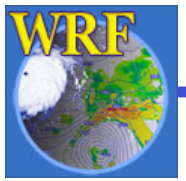
STEP 2: Link the correct Vtable to the file name "Vtable" in the run directory

- 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

```
> ln –s ungrib/Variable_Tables/Vtable.GFS Vtable
> ls Vtable
Vtable -> ungrib/Variable_Tables/Vtable.GFS
```



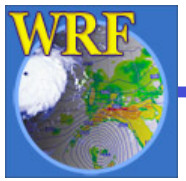
Running ungrib

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

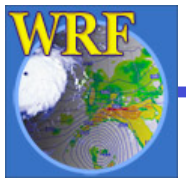
See p. 3-15



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

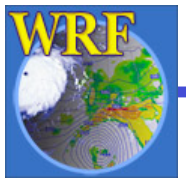
STEP 5: Check that ungrib ran successfully

If ungrib ran successfully, this message should be printed:

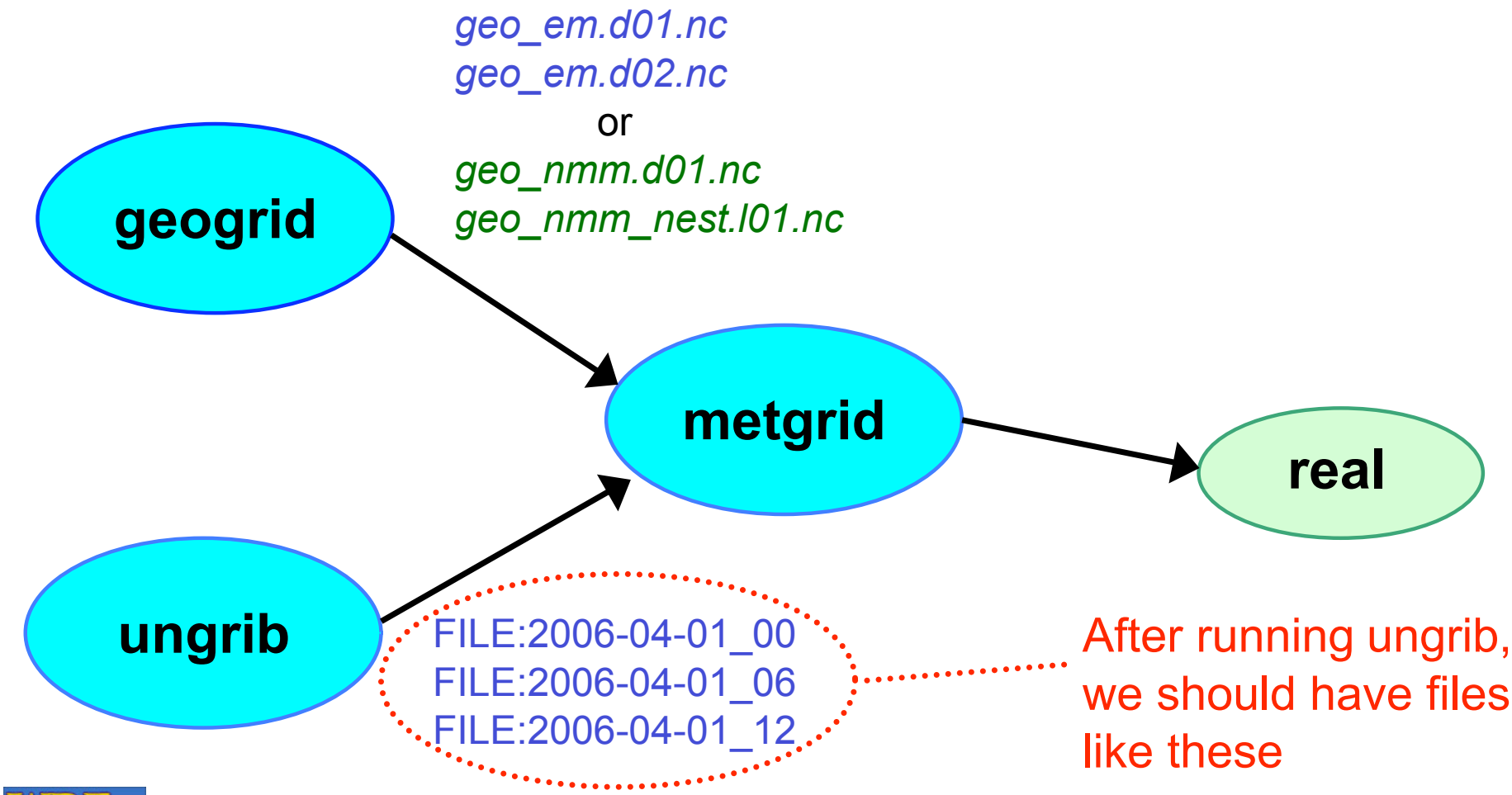
```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!  Successful completion of ungrib.             !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

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



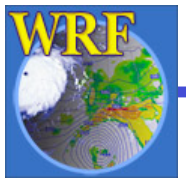
Running metgrid

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,
/
```



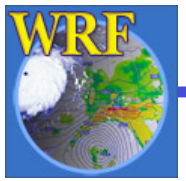
Running metgrid

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. Only coarse domain needed for NMM.

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.

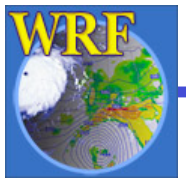
See p. 3-17 and 3-24

```
&metgrid
   fg_name = 'GFS',

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

   io_form_metgrid = 2,
/
```

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

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

See p. 3-17, and 3-41

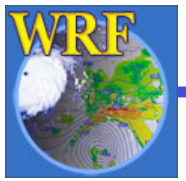


Running metgrid

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
```



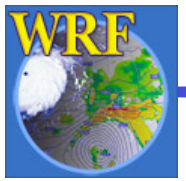
Running metgrid

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



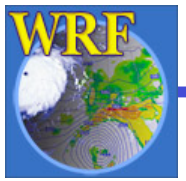
Running metgrid

STEP 4: Check that metgrid ran successfully

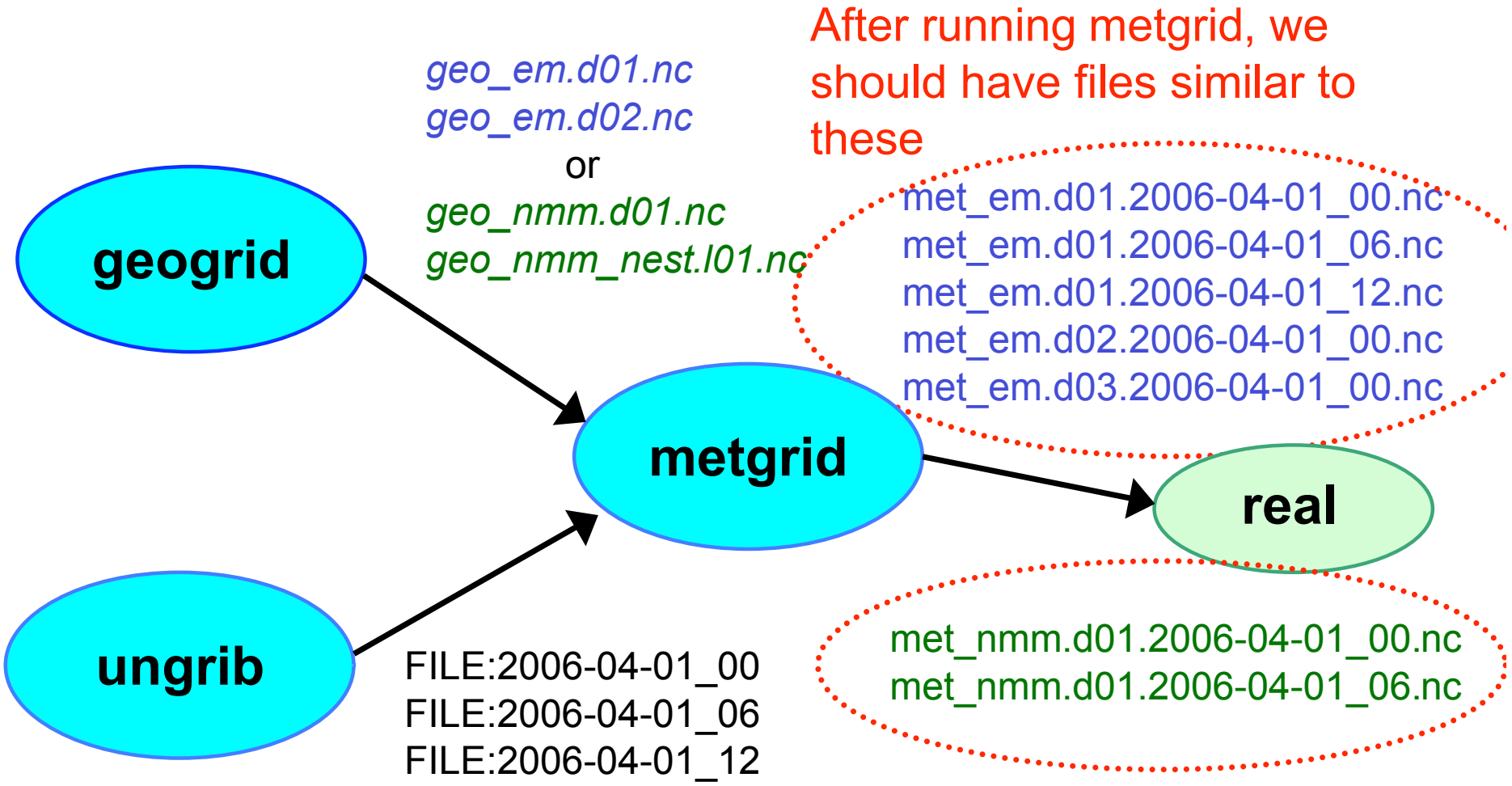
If metgrid ran successfully, this message should be printed:

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!  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".

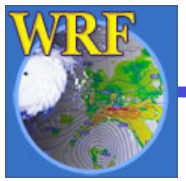


Running metgrid



Overview

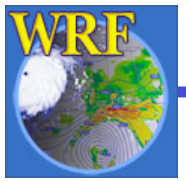
- How to run through the WPS for basic cases
  - Basic steps for running WPS
    - Geogrid
    - Ungrib
    - Metgrid
- WPS utility programs
- Common WPS mistakes



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

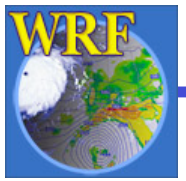


WPS Utility Programs

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

- All utilities are found in the **`WPS/util`** directory

- Users are encouraged to make use of these utilities to examine WPS input and output files

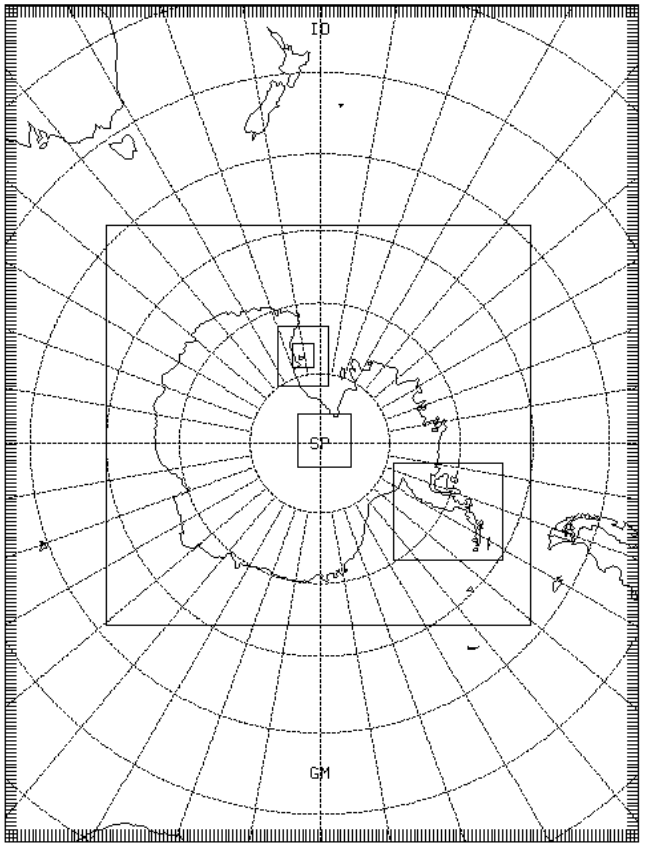


Utility: plotgrids

The *plotgrids* program plots the location of grids defined in *namelist.wps*

- *plotgrids can be used to iteratively refine the locations of grids.*

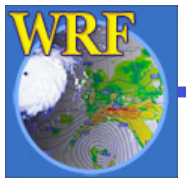
- *plotgrids* uses the namelist.wps file only, so there is no need to run geogrid first!



Utility: rd_intermediate

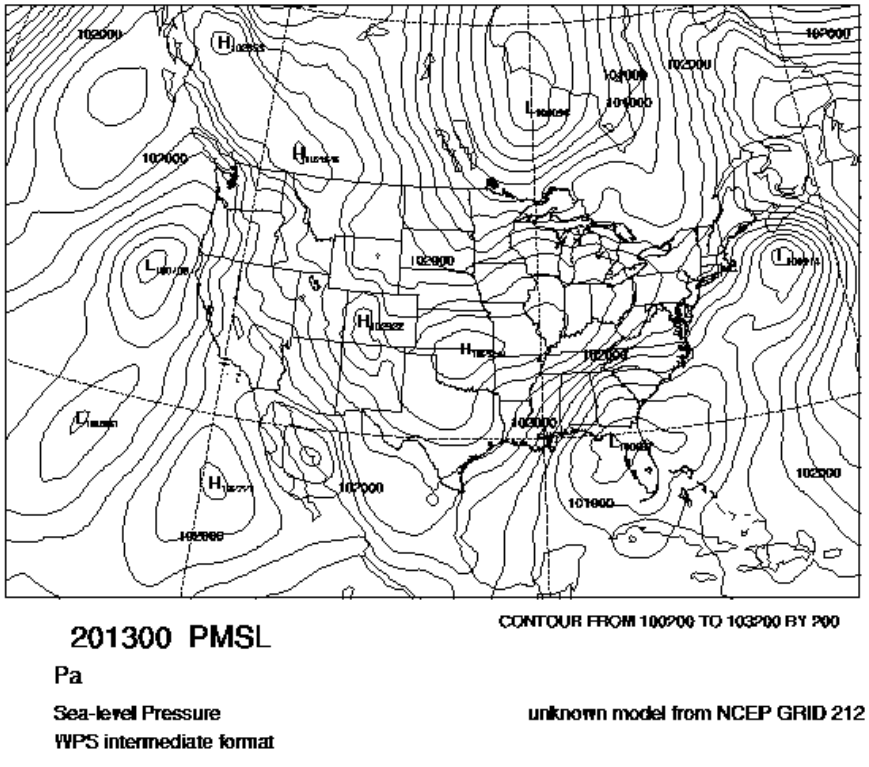
The rd_intermediate lists information about the fields found in an intermediate-format file

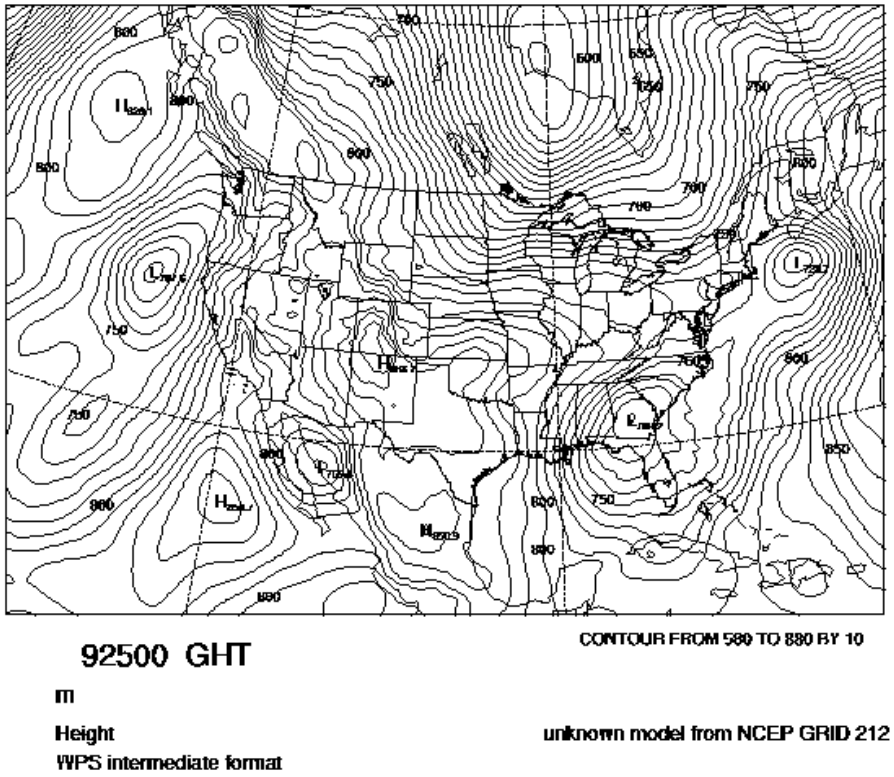
```
==========================================
FIELD = TT
UNITS = K DESCRIPTION = Temperature
DATE = 2000-01-24_12:00:00 FCST = 0.000000
SOURCE = unknown model from NCEP GRID 212
LEVEL = 200100.000000
I,J DIMS = 185, 129
IPROJ = 1
  REF_X, REF_Y = 1.000000, 1.000000
  REF_LAT, REF_LON = 12.190000, -133.459000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

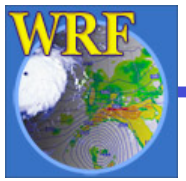




Utility: g1print and g2print

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

calc_ecmwf_p.exe

PRES:2009-08-27_00

PRESSURE
RH
GHT

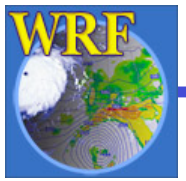
emcwf_coeffs

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

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



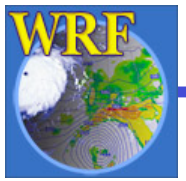
Common WPS Mistakes

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 on which levels



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