

# Running the WRF Preprocessing System

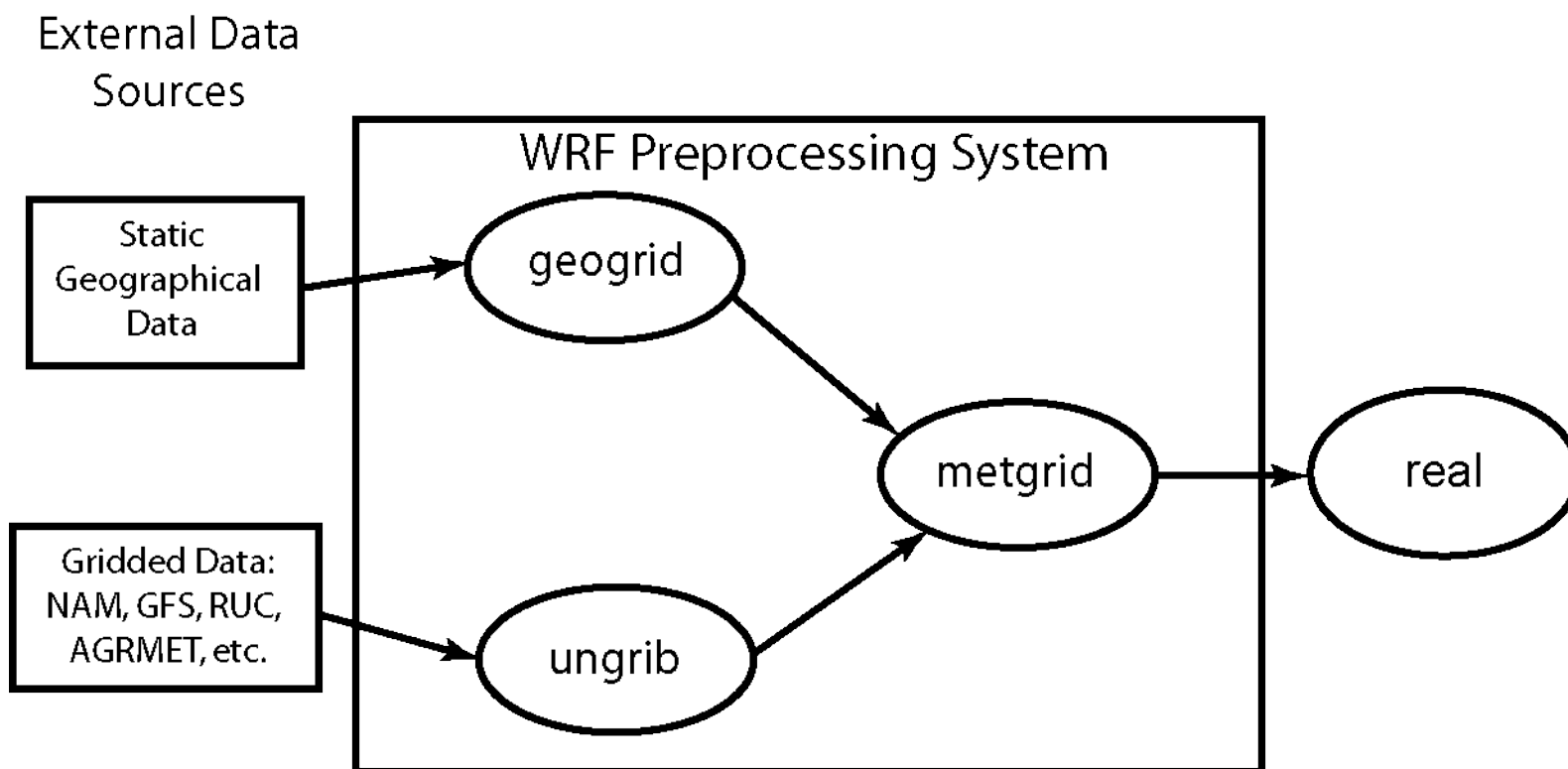
Michael Duda



# Review

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- Briefly recall the programs in the WPS



# Review

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- 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

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- 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

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## **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  
parent?

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

**Static data:** What resolution  
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 data directories (e.g., topo\_30s) located?

*See p. 3-41*





# Running geogrid

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**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

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## 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

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## **STEP 4**: Check that geogrid ran successfully

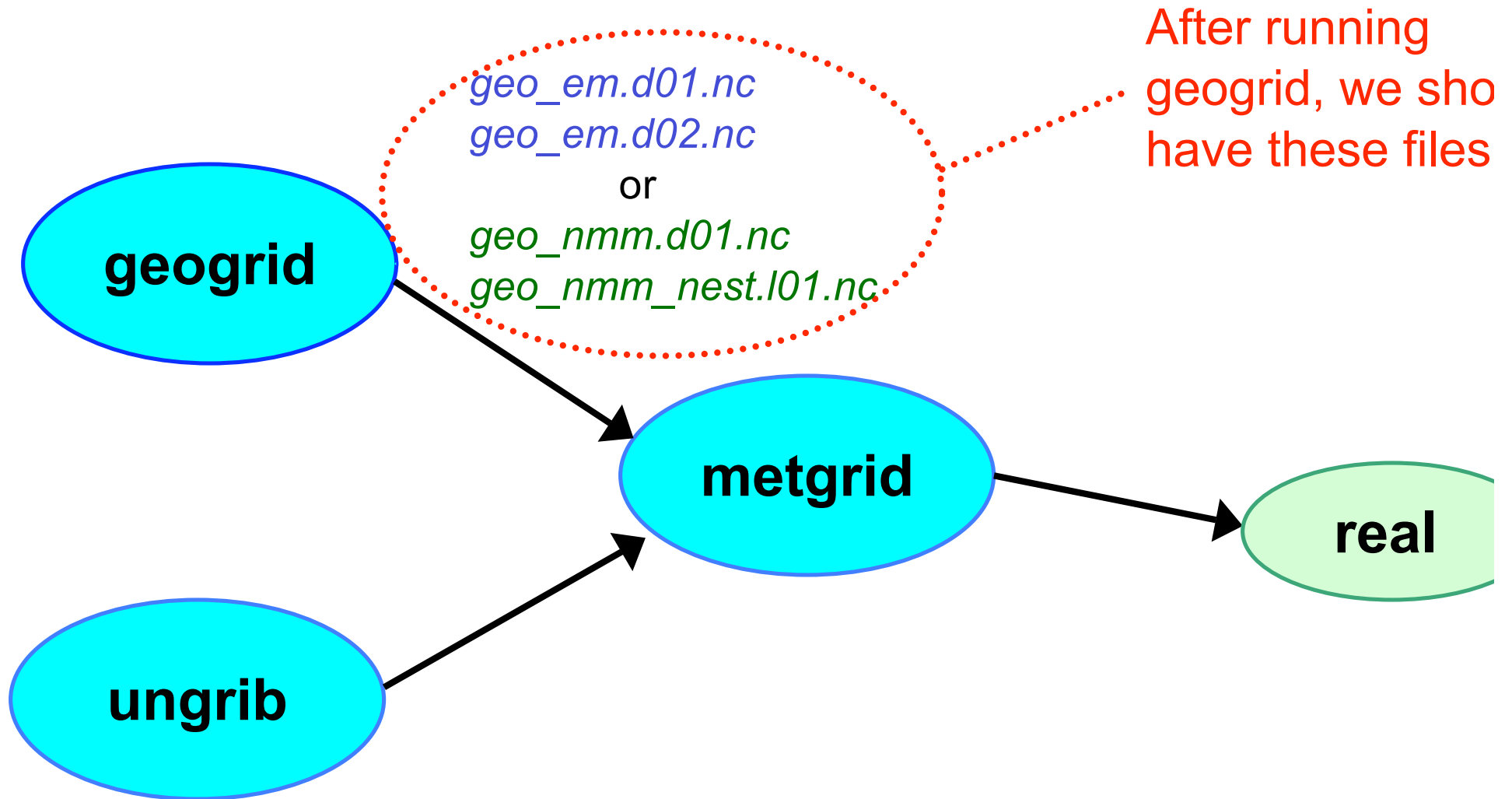
If geogrid ran successfully, this message should be printed:

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

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## **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`

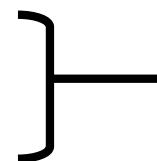
```
wrf_core = 'ARW',  
max_dom = 2,
```

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

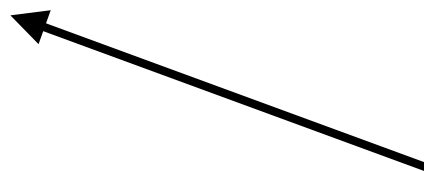
```
interval_seconds = 21600
```

```
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

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## 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 file named `XYZ:yyyy-mm-dd_hh`.

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



# Running ungrib

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

See p. 3-

> In –s ungrib/Variable\_Tables/Vtable.GFS Vtable

> ls Vtable

Vtable -> ungrib/Variable\_Tables/Vtable.GFS





# Running ungrib

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## **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
```



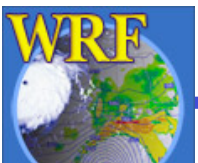
# Running ungrib

## 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

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## **STEP 5**: Check that ungrib ran successfully

If ungrib ran successfully, this message should be printed:

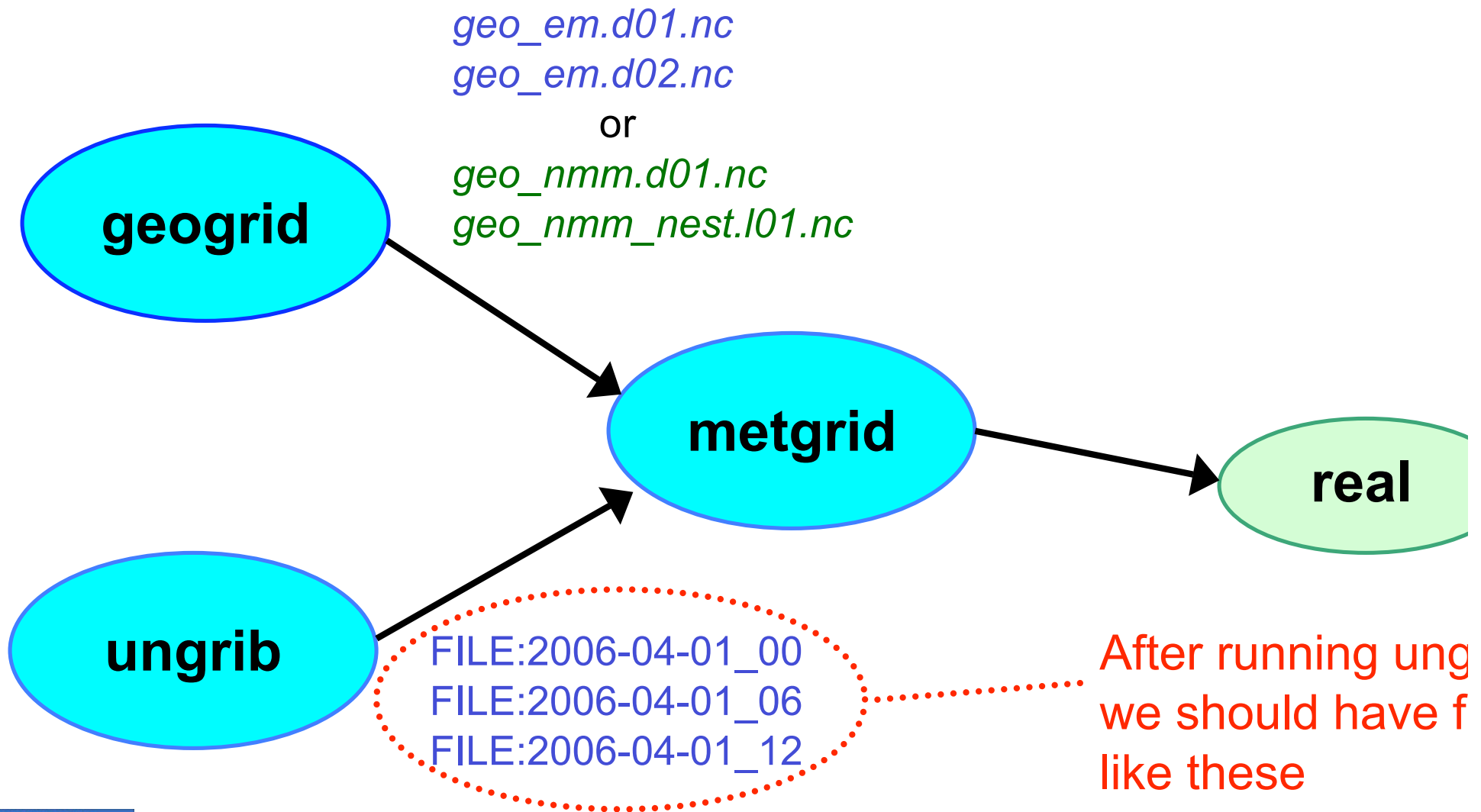
```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!  
!   Successful completion of ungrib.                   !  
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

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

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## **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 3-3



# 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',`

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

`io_form_metgrid = 2,`

`/`

*See p. 3-17 and 3-24*

**Constant fields:** Optional name of an intermediate 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

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**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 (give 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

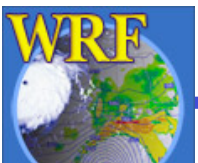
---

## **STEP 4**: Check that metgrid ran successfully

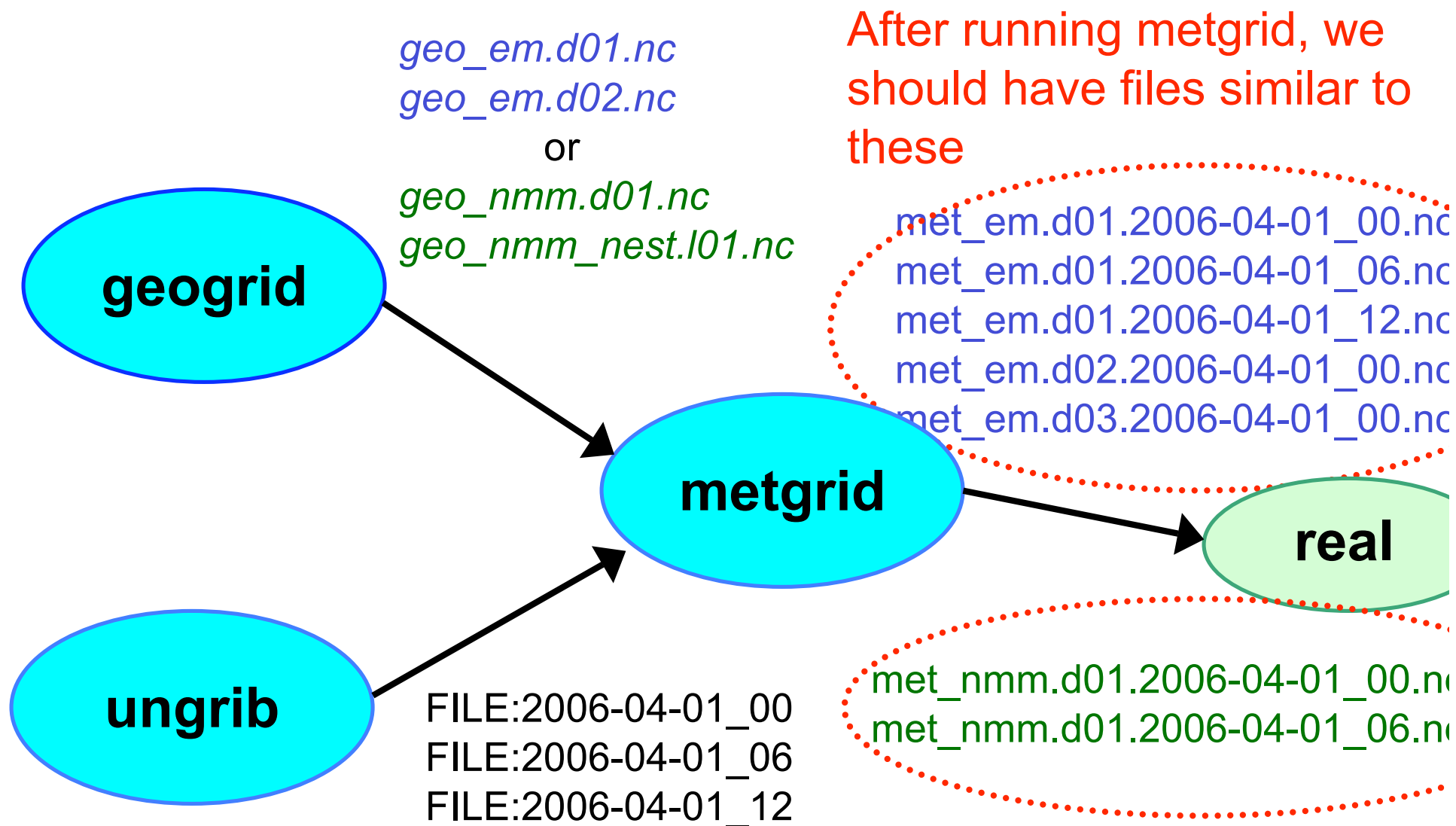
If metgrid ran successfully, this message should be printed:

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

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- 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

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- 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

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

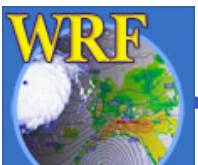
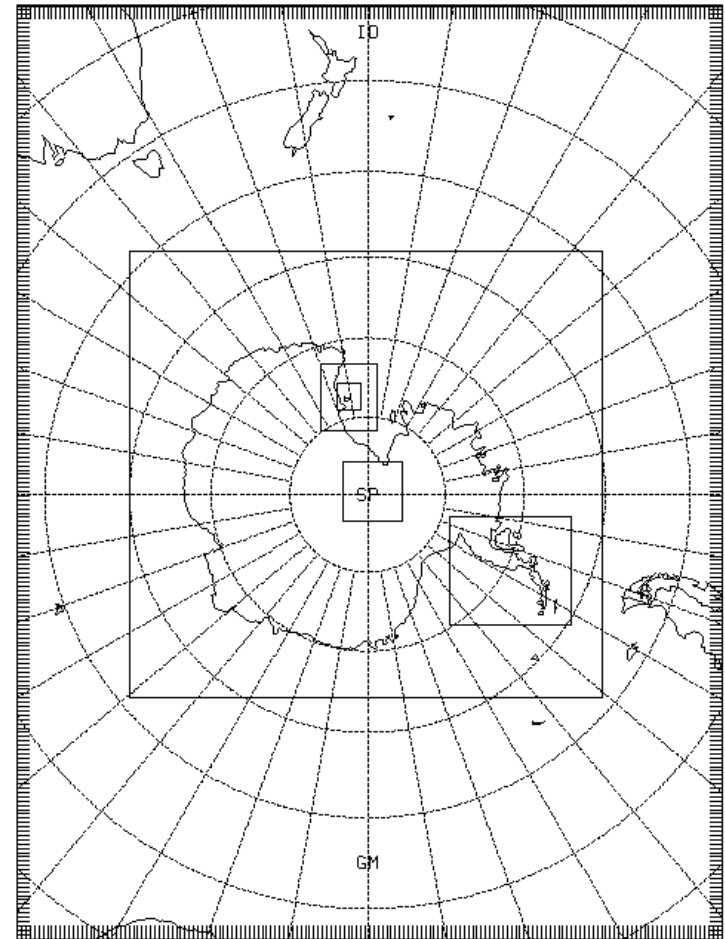
- All utilities are found in the **WPS/utl** directory
- Users are encouraged to make use of these utilities examine WPS input and output files



# 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

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The rd\_intermediate lists information about the fields found in an intermediate-format file

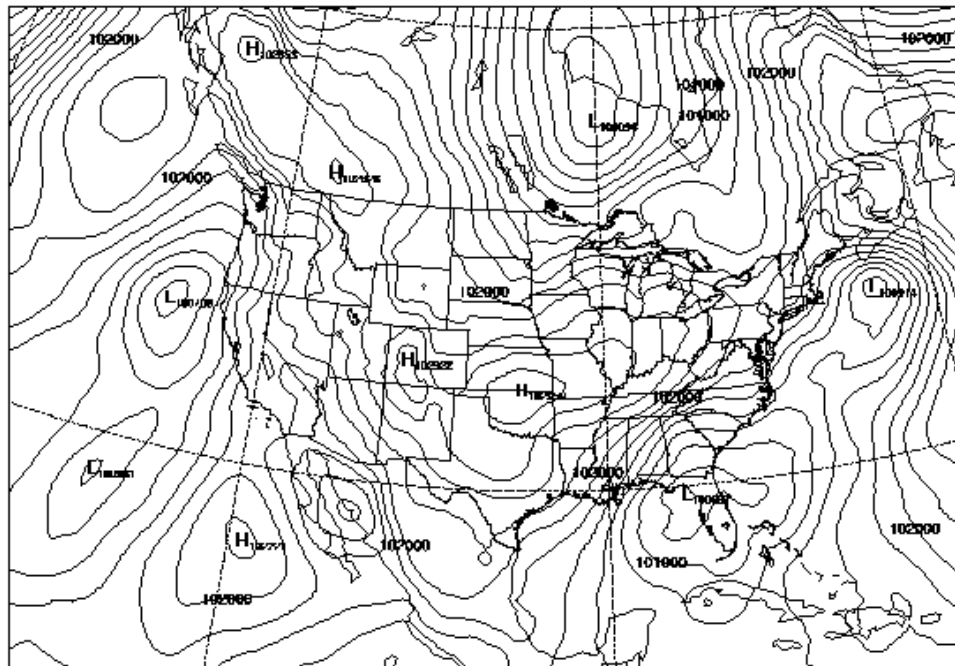
```
=====
FIELD = TT
UNITS = K DESCRIPTION = Temperature
DATE = 2000-01-24_12:00:00 FCST = 0.000000
SOURCE = unknown model from NCEP GRID 212
LEVEL = 200100.000000
I,J DIMS = 185, 129
IPROJ = 1
  REF_X, REF_Y = 1.000000, 1.000000
  REF_LAT, REF_LON = 12.190000, -133.459000
  DX, DY = 40.635250, 40.635250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





# Utility: plotfmt

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



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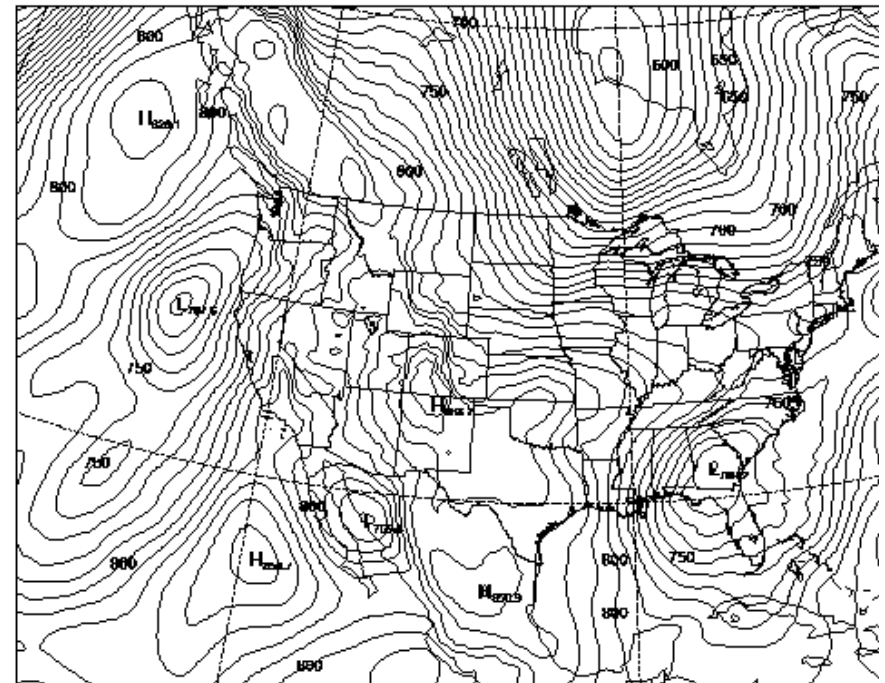
Pa

Sea-level Pressure

WPS intermediate format

CONTOUR FROM 100700 TO 103200 BY 200

unknown model from NCEP GRID 212



92500 GHT

m

Height

WPS intermediate format

CONTOUR FROM 500 TO

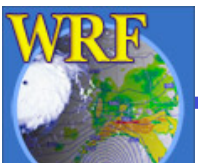
unknown model from NCE



# 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	Fcs hou
1	0	3	5	100	100000	0	HGT	2006-08-16_12:00:00	0
2	0	3	5	100	97500	0	HGT	2006-08-16_12:00:00	0
3	0	3	5	100	95000	0	HGT	2006-08-16_12:00:00	0
4	0	3	5	100	92500	0	HGT	2006-08-16_12:00:00	0
5	0	3	5	100	90000	0	HGT	2006-08-16_12:00:00	0
6	0	3	5	100	85000	0	HGT	2006-08-16_12:00:00	0
7	0	3	5	100	80000	0	HGT	2006-08-16_12:00:00	0
8	0	3	5	100	75000	0	HGT	2006-08-16_12:00:00	0
9	0	3	5	100	70000	0	HGT	2006-08-16_12:00:00	0
10	0	3	5	100	65000	0	HGT	2006-08-16_12:00:00	0



# Utility: calc\_ecmwf\_p

The *calc\_ecmwf\_p* utility creates intermediate files with  $\alpha$  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

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- How to run through the WPS for basic cases
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# Common WPS Mistakes

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

```
WRF_DEBUG: Warning DIM              4 , NAME
num_metgrid_levels REDefined 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

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- 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?

