



# Running the WRF Preprocessing System

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The WRF Users' Basic Tutorial  
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## Overview

- How to run through the WPS for a single-domain case
  - Basic steps for running the WPS
    - Geogrid
    - Ungrib
    - Metgrid
- WPS utility programs
- Common WPS mistakes



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## 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 = 1
```

#### `&geogrid`

```
map_proj = 'lambert'  
truelat1 = 45.0  
truelat2 = 30.0  
stand_lon = -105.25  
ref_lat = 40.0  
ref_lon = -105.25  
e_we = 220  
e_sn = 175  
dx = 15000  
dy = 15000  
geog_data_res = 'default'  
geog_data_path = '/data/static/geog/'
```



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## Running geogrid

### STEP 1: Edit `namelist.wps`

#### `&share`

```
wrf_core = 'ARW'  
max_dom = 1
```

Which WRF core?

For ARW, set to 'ARW'

For NMM, set to 'NMM'

Total number of model domains,  
including nests, for ARW.

*See p. 3-8 and 3-37*



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## Running geogrid

### STEP 1: Edit namelist.wps

#### &geogrid

```
...
map_proj   = 'lambert'
truelat1   = 45.0
truelat2   = 30.0
stand_lon  = -105.25
...
```

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

*See p. 3-9 and 3-40*



## Running geogrid

### STEP 1: Edit namelist.wps

#### &geogrid

```
...
ref_lat    = 40.0
ref_lon    = -105.25
```

**Domain location:** Where on Earth is the center of the domain?

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

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

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

**Static data:** What resolution of source data to interpolate from for each domain? Where to find data on the filesystem?  
(See "Extra slides"...)

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



## Running geogrid

### STEP 2: Run geogrid.exe

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

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.

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



## Running geogrid

### STEP 3: Check that geogrid ran successfully

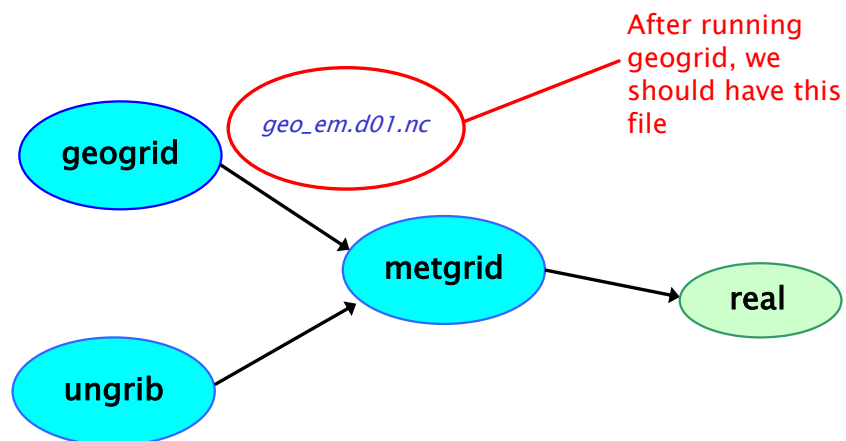
If geogrid ran successfully, this message should be printed:

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
! 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 = 1
start_date = '2006-04-01_00:00:00'
end_date = '2006-04-01_12:00:00'
interval_seconds = 21600
```

#### **&ungrib**

```
prefix = 'GFS'
```



## Running ungrib

### STEP 1: Edit namelist.wps

#### **&share**

```
wrf_core = 'ARW'
max_dom = 1
```

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

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

```
interval_seconds = 21600
```

**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**

```
prefix = 'GFS'
```

**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.



## 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
```



## 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:

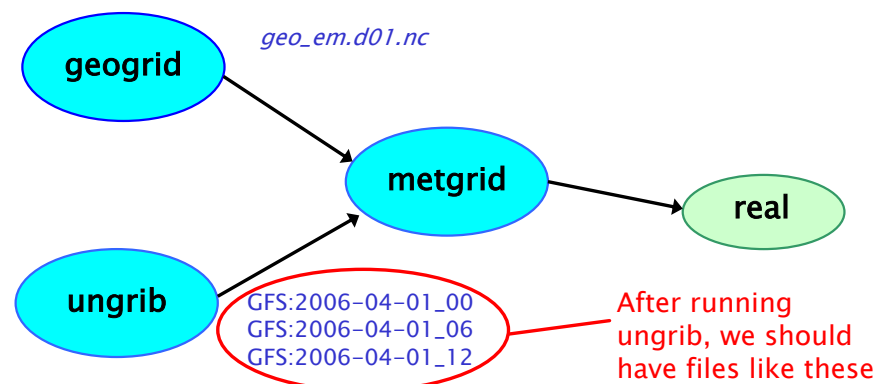
```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
! Successful completion of ungrib.             !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

If there was an error, check for error message in ungrib's printout or in the `ungrib.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 = 1
start_date = '2006-04-01_00:00:00'
end_date = '2006-04-01_12:00:00'
interval_seconds = 21600
```

#### **&metgrid**

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



## Running metgrid

### STEP 1: Edit namelist.wps

#### **&share**

```
wrf_core = 'ARW'
max_dom = 1
```

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

```
interval_seconds = 21600
```

**Data time range:** Time range to process.

Interval between intermediate files created by ungrib

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'
```

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

See p. 3-17, and 3-41



## Running metgrid

### STEP 2: Run metgrid.exe

```
Processing domain 1 of 1
  SST:2006-04-01_00

Processing 2006-04-01_00
  GFS
Processing 2006-04-01_06
  GFS
Processing 2006-04-01_12
  GFS
```

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

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



## Running metgrid

### STEP 3: Check that metgrid ran successfully

If metgrid ran successfully, this message should be printed:

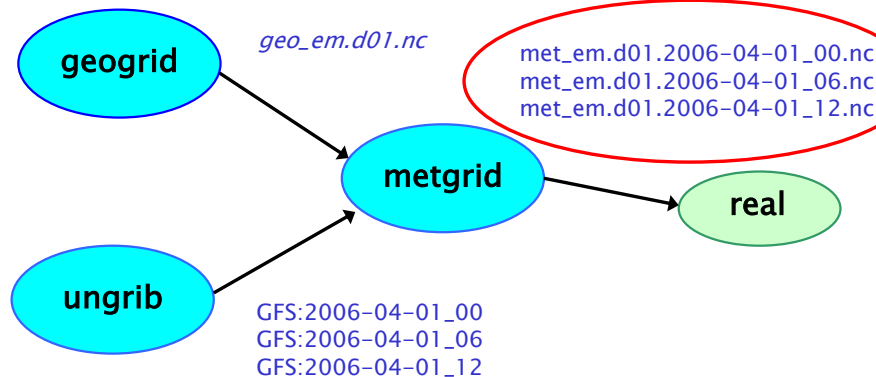
```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
! Successful completion of metgrid. !
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

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

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  - Basic steps for running WPS
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    - 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

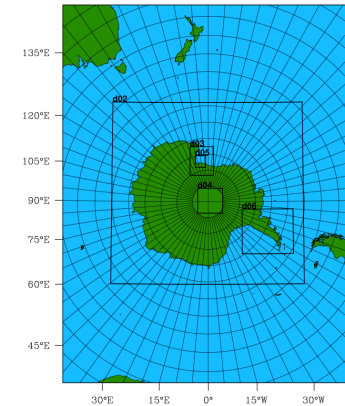
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## Utility: plotgrids.ncl

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!



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## 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
TRUCLAT1 = 25.000002
DATA(1,1)=295.910950
=====
```



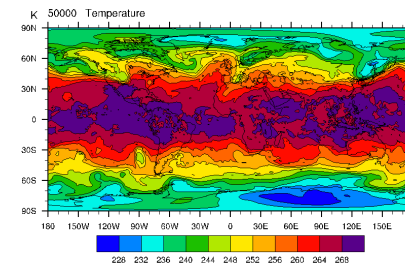
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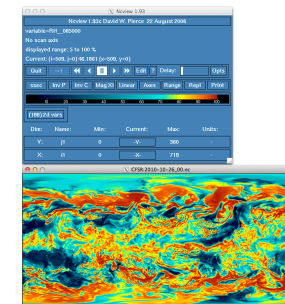
## Utility: int2nc + plotfmt\_nc.ncl

The *int2nc* program converts an ungrib intermediate file to a standard NetCDF file

- Users may then visualize fields with *ncview*, *NCL*, or other graphical packages:



Visualize NetCDF intermediate fields using *plotfmt\_nc.ncl* script



Visualize NetCDF intermediate fields using *ncview*



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## 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  
SPECUMD

calc\_ecmwf\_p.exe

PRES:2009-08-27\_00

PRESSURE  
RH  
GHT

ecmwf\_coeffs

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

See p. 3-28



## Overview

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

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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?



## Extra slides



## Choosing Static Datasets

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WPS v3.9 supports several land cover datasets and two different topography datasets

### Land use:

- USGS 24-class, 30-arc-second resolution
- USGS 24-class + inland water, 30-arc-second resolution
- MODIS 20-class, 30- and 15-arc-second resolution
- MODIS 20-class + inland water, 30-arc-second resolution
- NLCD 2011 40-class, 9-arc-second resolution

### Terrain:

- GTOPO30
- GMTED2010



## Choosing Static Datasets

Selection of alternate static datasets is performed using the `geog_data_res` namelist option in the `&geogrid` record

Prefix the usual `geog_data_res` selection with the name for the land use or topography dataset to be used.

E.g.,

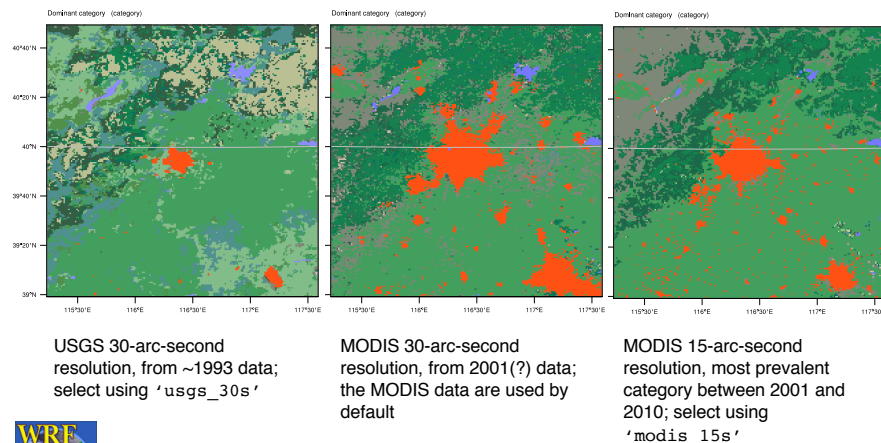
```
geog_data_res = 'nlcd2011_9s+default'
```

to use **NLCD 2011 9-arc-second land cover**, and default resolution for other static fields.



## Global Land Cover Datasets

Consider an example 1-km domain centered over Beijing:



## Identifying Inland Water Bodies

Two land cover datasets also provide a special category to identify “inland water bodies”, which can sometimes require special treatment, e.g., when initializing SST field or running the lake model in WRF.

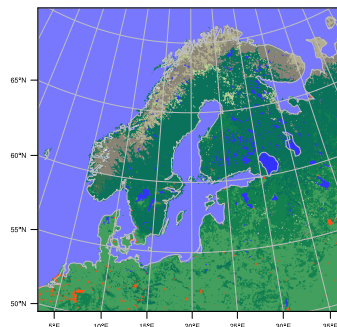
MODIS 30-arc-second:

- Selected using `'modis_lakes'`

USGS 30-arc-second:

- Selected using `'usgs_lakes'`

We'll discuss the use of lake categories for initializing the SST field in the “WPS Advanced Features” talk on Thursday.



A domain over Scandinavia using MODIS 21-class land cover; lake category shown in dark blue.



## NLCD Land Use (Continental U.S. Only)

For the WRF domains over the Continental U.S., one can use high-resolution land cover from the National Land Cover Database (NLCD).

NLCD 2011 9-arc-second:

- Selected using `'nlcd2011_9s'`

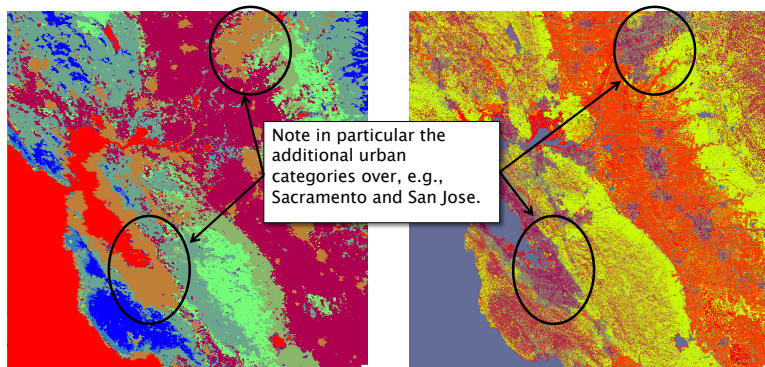
Besides high spatial resolution, the NLCD data provides four new urban categories:

1. Developed Open Space
2. Developed Low Intensity
3. Developed Medium Intensity
4. Developed High Intensity



## NLCD Land Use (Continental U.S. Only)

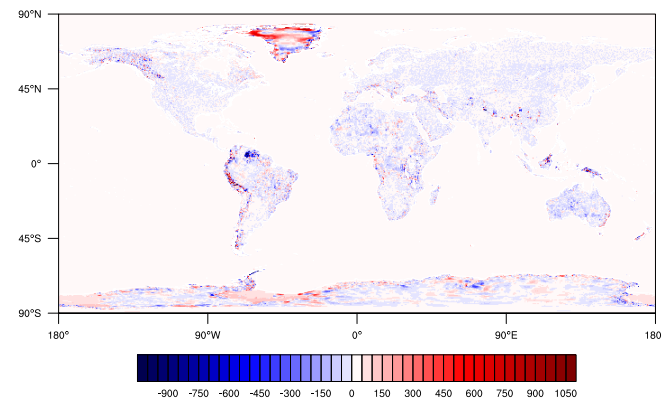
For the WRF domains over the Continental U.S., one can use high-resolution land cover from the National Land Cover Database (NLCD).



Above: (left) A 250-m WRF domain covering San Francisco Bay using MODIS 15-arc-second land cover data; (right) the same domain using NLCD 2011 9-arc-second data.

## GMTED2010 Terrain

WPS v3.8 and newer replace the GTOPO30 dataset with a newer, more accurate terrain dataset from the USGS: GMTED2010\*.



\*<https://lta.cr.usgs.gov/GMTED2010>