NU-WRF
NASA Unified Weather Research and Forecasting Model
Tutorial – 2 : NU-WRF default

Jossy P. Jacob, Eric Kemp
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NU-WRF website: https://nuwrf.gsfc.nasa.gov
This NU-WRF default workflow uses MERRA/ MERRA2 reanalysis atmospheric initial and lateral boundary conditions, RSS SST (Remote Sensing Sytems SST product) along with LIS land surface model initial conditions and run WRF coupled with LIS land surface model.
How to run NU-WRF Default workflow

1. Download the code
2. Compile
3. Model setup
4. Run components
5. Post processing
Download the code

Tar files are available to NCCS and NAS s0942 group members.

On Discover:
• /discover/nobackup/projects/nu-wrf/releases/stable/nu-wrf_v7lis7-3.5.1-p2.tar.bz2
• /discover/nobackup/projects/nu-wrf/releases/stable/nu-wrf_v7lis7-3.5.1-p2.tgz

On Pleiades:
• /nobackupp8/nuwrf/releases/stable/nu-wrf_v7lis7-3.5.1-p2.tar.bz2
• /nobackupp8/nuwrf/releases/stable/nu-wrf_v7lis7-3.5.1-p2.tgz
• To untar the tar ball:
  >tar –zxvf nu-wrf_v7lis7-3.5.1-p2.tgz

For developers with proper ssh keys, the code can also be checked out of Subversion repository:
>svn co svn+ssh://progressdirect/svn/nu-wrf/code/tags/stable/v7lis7-3.5.1-p2
>svn co svn+ssh://progress.nccs.nasa.gov/svn/nu-wrf/code/tags/stable/v7lis7-3.5.1-p2
Compile NU-WRF

Login to discover-sp3: First login to discover

>ssh –YC username@discover.nccs.nasa.gov

Login to discover-sp3 nodes:

>ssh –YC discover-sp3

Or login to Pleiades (default is sp3 nodes).

cd NUWRFDIR (path/to/v7lis7-3.5.1-p2)

>./build.sh wps lis merra2wrf sst2wrf wrf rip > & log.out & (to compile WPS, LIS, MERRA2WRF, SST2WRF, WRF and RIP in the background) Or

>./build.sh all > & log.out & (to compile WRF and all pre & post processors)

Executables will be created in the directory: $NUWRFDIR/bin/ and $NUWRFDIR/utils/geos2wrf-2/bin/ungrrib.exe, geogrid.exe, metgrid.exe, merra2wrf, sst2wrf, LIS, real.exe, wrf.exe

For more details on build system, user should refer to the NU-WRF user guide section 4.3
Model setup on discover

**NUWRFDIR**: path/to/NUWRF/v7lis7-3.5.1-p2/

```bash
>mkdir RUNDIR: Create path/to/NUWRF/RUNDIR
```

Note: It is preferable to create the RUNDIR outside the NUWRFDIR. This is useful when switching between NU-WRF versions or for updating to new changes.

In CSH shell, you can define environment variable using:

```bash
>setenv NUWRFDIR path/to/NUWRF/v7lis7-3.5.1-p2/
>setenv RUNDIR path/to/NUWRF/RUNDIR
```

In BASH environment, you can define environment variable using:

```bash
>export NUWRFDIR = path/to/NUWRF/v7lis7-3.5.1-p2/
>export RUNDIR = path/to/NUWRF/RUNDIR
```

Copy the following shell scripts from $NUWRFDIR/scripts/discover/ to your $RUNDIR:

```bash
>cp $NUWRFDIR/scripts/discover/config.discover.sh $RUNDIR/
>cp $NUWRFDIR/scripts/discover/run*.sh $RUNDIR/
```
Model setup on discover

Run scripts, configuration files and input files specific for this tutorial are available in the directory:

>set WRF_LIS_DIR = /discover/nobackup/projects/nu-wrf/tutorial/WRF-LIS/

Sample files are also in the directory: $NUWRFDIR/defaults/

Copy the following files from $WRF_LIS_DIR to your $RUNDIR:

>cp $WRF_LIS_DIR/namelist.wps $RUNDIR/.
>cp $WRF_LIS_DIR/namelist.input* $RUNDIR/.
>cp $WRF_LIS_DIR/lis.config* $RUNDIR/.
>cp $WRF_LIS_DIR/ldt.config* $RUNDIR/.
>cp $WRF_LIS_DIR/param_atrribs_modis.txt $RUNDIR/.
>cp $WRF_LIS_DIR/forcing_variables*.txt $RUNDIR/.
>cp $WRF_LIS_DIR/NOAH33_OUTPUT_LIST*.TBL $RUNDIR/.
Model setup on discover (contd...)

Configure file:

Edit config.discover.sh to change the following definitions point to the user directory:

- `NUWRFDIR=/discover/nobackup/emkemp/NUWRF/svn/trunk`
- `WORKDIR=/discover/nobackup/emkemp/NUWRF/case13_slurm`

Change to:

- `NUWRFDIR=/discover/nobackup/username/$NUWRFDIR`
- `WORKDIR=/discover/nobackup/username/$RUNDIR`

Make sure that the user has access to this directory:
- `LISDIR=/discover/nobackup/projects/lis`

Run script general changes (for all `run*` files):

Edit all the runscripts for account information changes:

- `#SBATCH --account s0942`
  (Change s0942 to your discover run account)
- `#SBATCH --ntasks=16 --constraint=hasw`
  (Change if you want to change number of nodes, hasw – to run on haswell nodes)
- `#SBATCH --qos=high`  (Change the status high to general depend on user privileges)
- `#Substitute your e-mail here`
- `##SBATCH --mail-user=user@nasa.gov`  (User must partially uncomment lines involving e-mails, remove first #)
Run components - GEOGRID

>cd $RUNDIR

- User should edit run script `run_geogrid.discover.sh` to change the links to `GEOGRID.TBL` depend on the run. Note: 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.

- A sample `namelist.wps` file is available in the directory: `$NUWRFDIR/defaults/namelist.wps`. Copy this file to your `$RUNDIR` and make changes in `namelist.wps` if you need domain changes. User can refer to ARW online tutorial / web for more details on namelist.wps options: [http://www2.mmm.ucar.edu/wrf/users/tutorial/201501/WPS_RUN.pdf](http://www2.mmm.ucar.edu/wrf/users/tutorial/201501/WPS_RUN.pdf)

- Make sure that you have access to the directory: '/discover/nobackup/projects/nu-wrf/cases/geog'

Submit the job with this command:

```
>qsub run_geogrid.discover.sh
Or
>bsub run_geogrid.discover.sh
```

Check this file for successful run completion:

- `geogrid.slurm.out`
- `geogrid.log.<node>` will also be created for tracking run failures/ debugging.
Run components – MERRA2WRF

>cd $RUNDIR

**Case 1 - MERRA** reanalysis for WRF initial and lateral boundary conditions:

>cp $NUWRFDIR/utils/geos2wrf_2/RUN_MERRA/Run_MERRA.csh $RUNDIR/.

For example for start date = 20070119 and end date = 20070120

>./Run_MERRA.csh 20070119 20070120 . $NUWRFDIR

(This program will ftp MERRA data from the website
ftp://goldsmr2.sci.gsfc.nasa.gov/data/s4pa//MERRA_MONTHLY/)

Sample input and output files are given in $WRF_LIS_DIR/MERRA/

Copy the MERRA2WRF output to the $RUNDIR

>cp $RUNDIR/data/merra2wrf/MERRA*.

**Case 2 - MERRA2** reanalysis for WRF initial and lateral boundary conditions:

>cp $NUWRFDIR/utils/geos2wrf-2/RUN_MERRA2/Run_MERRA2.csh $RUNDIR/.

For example for start date = 20070119 and end date = 20070120

>./Run_MERRA2.csh 20070119 20070120 . $NUWRFDIR

(MERRA2 data is staged on discover: /discover/nobackup/projects/gmao/merra2/merra2/scratch/)

Sample input and output files are given in $WRF_LIS_DIR/MERRA2/

Copy the MERRA2WRF output to the $RUNDIR

>cp $RUNDIR/data/merra2wrf/MERRA*.
Run components – SST2WRF

>cd $RUNDIR
>mkdir $RUNDIR/RUN_SST2WRF
>cd $RUNDIR/RUN_SST2WRF
>cp $NUWRFDIR/ufs/sst2wrf/scripts/Run_SST.csh $RUNDIR/RUN_SST2WRF/.

For a start date = 20070119 and end date of 20070120:
>./Run SST.csh 20070119 20070120 mw_ir . $NUWRFDIR

SSTRSS:* files will be created, and these files should be copied to the RUNDIR before running METGRID component.

>cp $RUNDIR/RUN_SST2WRF/sstdata/mw_ir/SSTRSS* $RUNDIR/.

For more details on the options and data types supported user can refer to NU-WRF userguide section 5.8

Sample input and output files are given in $WRF_LIS_DIR/sst2wrf/
Run components – METGRID

>cd RUNDIR

Edit run script run_metgrid.discover.sh

• User should change the link to METGRID.TBL. There are multiple METGRID.TBL files to support multiple dynamical cores in WRF. For example: METGRID.TBL.ARW should be used for ARW.

```bash
ln -fs $NUWRFDIR/WPS/metgrid/METGRID.TBL.ARW metgrid/METGRID.TBL
```

Make sure you have namelist.wps file in your $RUNDIR.

• Metgrid block in the namelist.wps would look like this to utilize MERRA and SSTRSS data.

```bash
&metgrid
    fg_name = 'MERRA', 'SSTRSS',
    io_form_metgrid = 2,
/
```

Submit the job with this command:

>`qsub run_metgrid.discover.sh (or sbatch can be used)

Check this file for run completion: metgrid.slurm.out
metgrid.log.<node> also will also be created for debugging purposes.
LISCONFIG is an optional utility to change the LIS, LDT config files to same WRF domain. If you use the lis.config and ldt.config files from the $WRF_LIS_DIR directory you don’t have to use this utility.

> cd $RUNDIR
> cp $NUWRFDIR/utils/lisconfig/scripts/lisWrfDomain.py $RUNDIR/.
> ln –sf lis.config LISCONFIG
> ln –sf ldt.config LDTCONFIG
> ln –sf $RUNDIR WPSDIR
> ln –sf $NUWRFDIR/utils/lisconfig/src/lisWrfDomain DOMAINDPROG
> lisWrfDomain.py DOMAINDPROG LISCONFIG LDTCONFIG WPSDIR

Input:
lis.config, ldt.config
namelist.wps,
geo_em.d03.nc

Output:
lis.config
ldt.config

This utility is used to change the configuration files used for LIS to WRF grid
Run components – LDT prelis

LDT – prelis

>cd $RUNDIR
>cp ldt.config.modis.prelis ldt.config
>qsub run_ldt_prelis.discover.sh

(make sure to have config.discover.sh, param_attribs_modis.txt files in $RUNDIR)

Check this file for successful run completion: ldt_prelis.slurm.out

Input
ldt.config
param_attribs_modis.txt

LDT Pre-LIS

Output (for 3 domains):
lis_input_1km.modis.nc
lis_input_3km.modis.nc
lis_input_9km.modis.nc

Process data inputs for different surface models

For more information, user should refer to documentation http://lis.gsfc.nasa.gov/LDT/
Run components – LIS spinup

>cd $RUNDIR

LIS spin up can be run from cold start or from a restart.
Starting from coldstart: Use lis.config.coldstart

>cp lis.config.coldstart lis.config

(Make sure that you have the following files in your $RUNDIR:
forcing_variables_v2.txt,
NOAH33_OUTPUT_LIST_SPINUP.TBL or the user specified files in lis.config)

>qsub run_lis.discover.sh

Check this file for successful run completion: lis.slurm.out
lislog.<node> will also be created for tracking run failures/ debugging.

Input:
lis.config
NOAH33_OUTPUT_LIST_SPINUP.TBL
forcing_variables_v2.txt

LIS Spin up

Output:
$RUNDIR/OUTPUT/SURFACEMODEL/
2002/20020131/
LIS_RST_NOAH33_200201312330.d01.nc
LIS_RST_NOAH33_200201312330.d02.nc
LIS_RST_NOAH33_200201312330.d03.nc
(monthly restart files)
Run components – LIS spinup

>cd $RUNDIR
LIS spin up from a restart (Sample restart files provided in $WRF_LIS_DIR)
(If the user choose to spinup from coldstart, skip this slide.)
>cp lis.config.restart lis.config
>cp $WRF_LIS_DIR/LIS_restarts/LIS* $RUNDIR/.
(or user defined restart files. Restart files should match the
NOAH33_OUTPUT_LIST_SPINUP.TBL for variables)
>qsub run_lis.discover.sh

Check this file for successful run completion: lis.slurm.out
lislog.<node> will also be created for tracking run failures/ debugging.

Input:
lis.config
NOAH33_OUTPUT_LIST_SPINUP.TBL
forcing_variables_v2.txt
LIS_RST_NOAH33_200612312330.d01.nc
LIS_RST_NOAH33_200612312330.d02.nc
LIS_RST_NOAH33_200612312330.d03.nc

Output:
$RUNDIR/OUTPUT/SURFACEMODEL/
2007/20070119/
LIS_RST_NOAH33_20070119.d01.nc
LIS_RST_NOAH33_200201312330.d02.nc
LIS_RST_NOAH33_200201312330.d03.nc
(monthly restart files)
Run components – LDT postlis

> cd $RUNDIR
> cp ldt.config.modis.postlis ldt.config
> qsub run_ldt_postlis.discover.sh

Input
ldt.config
LIS_HIST* files

LDT Post-LIS

Output:
lis4real_input_1km.modis.nc
lis4real_input_3km.modis.nc
lis4real_input_9km.modis.nc

Process data inputs for different surface models

For more information, user should refer to documentation http://lis.gsfc.nasa.gov/LDT/
Run components – REAL

>cd RUNDIR
The option in the number of land cover
>cp namelist.input.real namelist.input

Copy the LIS Restart files created in LIS Spinup.
Submit the job with this command:
>qsub run_real.discover.sh (or sbatch can be used)

Check this file for run completion: real.slurm.out
real.rsl.out.<node> and real.rsl.error.<node> also will also be created.

Vertically interpolate data fields from metgrid into model grid, create initial conditions and lateral boundary conditions.

Input:
met_em* files
geo_em* files
namelist.input
lis4real* fiiles

Output for 3 domains:
wrfinput_d01
wrfinput_d02
wrfinput_d03
wrfbdy_d01

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Run components – WRF-LIS coupled

>cd RUNDIR
Copy the LIS Restart files created in LIS Spinup.

Edit namelist.input file if the user need any option changes.
Refer userguide for namelist.input options for different workflows.
Sample namelist.input is available in NUWRFDIR/defaults/ directory and in
$WRF_LIS_DIR/ for this tutorial.

>cp namelist.input.wrf namelist.input
>cp lis.config.modis.coupled lis.config

Submit the job with this command:
>qsub run_wrf.discover.sh (or sbatch can be used instead of qsub)
Run components – WRF-LIS coupled

Input:
- wrfinput_d01
- wrfinput_d02
- wrfinput_d03
- wrfbdy_d01
- namelist.input
- LIS_RST*
- lis.config

WRF-LIS coupled

Numerical Weather prediction model WRF coupled with LIS

Output for WRF:
- wrfout_d01*
- wrfout_d02*
- wrfout_d03*
- wrfrst.d01*
- wrfrst_d02*
- wrfrst_d03*

LIST output:
$RUNDIR/OUTPUT/SURFACEMODEL/

Check this file for run completion: wrf.slurm.out
wrf.rsl.out.<node> and wrf.rsl.error.<node> also will also be created for debugging/track failures.
POST PROCESSING

• NCVIEW
WRF output files (NETCDF4) and intermediate files in can be viewed using ncview.
On discover:
> /usr/local/other/SLES11/ncview/2.1.1/bin/ncview filename

• RIP
> cd $RUNDIR/
> qsub run_rip.discover.sh

Other software packages can be used are G_SDSU, RIP4, ARWPOST, UPP, MET, and LVT.