

WRF Model Version 4.6.0

<https://www2.mmm.ucar.edu/wrf/users/>

WRF PUBLIC DOMAIN NOTICE

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This is the main directory for the WRF Version 4 source code release.
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Other README files are located in the WRF/doc directory:

doc/README.cmake_build
doc/README.crtm
doc/README.CTSM
doc/README.cygwin.md
doc/README.DA
doc/README.hybrid_vert_coord
doc/README.hydro
doc/README.io_config
doc/README.irr_diag
doc/README.madwrf
doc/README.NMM
doc/README.rsl_output
doc/README.SSIB
doc/README_test_cases
doc/README.windturbine
doc/README.WRFPLUS

- Beginning with version 4.0, for more information on the releases, visit the WRF GitHub Release Page:
<https://github.com/wrf-model/WRF/releases>

V3.9.1.1 Release Notes (8/28/17):

- Version 3.9.1.1 has only limited bug fixes compared to version 3.9.1. For more information on WRF V3.9.1.1 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>, and <http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

V3.9.1 Release Notes (8/17/17):

- For more information on WRF V3.9.1 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>, and <http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

V3.9 Release Notes (4/17/17):

- For more information on WRF V3.9 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>, and <http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

V3.8.1 Release Notes (8/12/16) (rev 9553):

- For more information on WRF V3.8.1 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>, and read the online User's Guide.

V3.8 Release Notes (4/8/16) (rev 9345):

- For more information on WRF V3.8 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>, and <http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

V3.7.1 Release Notes (8/14/15) (rev 8584):

- For more information on WRF V3.7.1 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>

V3.7 Release Notes (4/17/15) (rev 8345):

- For more information on WRF V3.7 release, visit WRF User's home pages

<http://www2.mmm.ucar.edu/wrf/users/>, and
<http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

V3.6.1 Release Notes (8/14/14) (rev 7630):

- For more information on WRF V3.6.1 release, visit WRF User's home pages
<http://www2.mmm.ucar.edu/wrf/users/>, and
<http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

V3.6 Release Notes (4/18/14) (rev 7412):

- For more information on WRF V3.6 release, visit WRF User's home pages
<http://www2.mmm.ucar.edu/wrf/users/>, and
<http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

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V3.5.1 Release Notes (9/23/13) (rev 6868):

- For more information on WRF V3.5.1 release, visit WRF User's home pages
<http://www2.mmm.ucar.edu/wrf/users/>, and
<http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

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V3.5 Release Notes (4/18/13) (rev 6660):

- For more information on WRF V3.5 release, visit WRF User's home pages
<http://www2.mmm.ucar.edu/wrf/users/>, and
<http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

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V3.4.1 Release Notes (8/16/12) (rev 5930):

This is a bug fix release. The detailed updates for WRF-ARW can be found at
<http://www2.mmm.ucar.edu/wrf/users/wrfv3.4/updates-3.4.1.html>,
and for WRF-NMM at
<http://www.dtcenter.org/wrf-nmm/users/model/wrfv3/updates.php>

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V3.4 Release Notes:

Version 3.4 is released on April 6, 2012 (rev 5745).

- For more information on WRF V3.4 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>, and <http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

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V3.3.1 Release Notes (9/16/11) (rev 5130):

This is a bug fix release. The detailed updates for WRF-ARW can be found at <http://www2.mmm.ucar.edu/wrf/users/wrfv3.3/updates-3.3.1.html>, and for WRF-NMM at <http://www.dtcenter.org/wrf-nmm/users/model/wrfv3/updates.php>

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V3.3 Release Notes:

Version 3.3 is released on April 6, 2011 (rev 4896).

- For more information on WRF V3.3 release, visit WRF User's home pages <http://www2.mmm.ucar.edu/wrf/users/>, and <http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

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V3.2.1 Release Notes (8/18/10):

This is a bug fix release. The detailed updates for WRF-ARW can be found at <http://www2.mmm.ucar.edu/wrf/users/wrfv3.2/updates-3.2.1.html>, and for WRF-NMM at <http://www.dtcenter.org/wrf-nmm/users/model/wrfv3/updates.php>

See online User's Guides for latest information.

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V3.2 Release Notes:

Version 3.2 is released on March 31, 2010.

- For more information on WRF V3.2 release, visit WRF User's home pages

<http://www2.mmm.ucar.edu/wrf/users/>, and
<http://www.dtcenter.org/wrf-nmm/users/>, and read the online User's Guide.

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V3.1.1 Release Notes (7/31/09):

This is a bug fix release. The detailed updates for WRF-ARW can be found at
<http://www2.mmm.ucar.edu/wrf/users/wrfv3.1/updates-3.1.1.html>, and for WRF-NMM at
<http://www.dtcenter.org/wrf-nmm/users/model/wrfv3/updates.php>

See online User's Guides for latest information.

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V3.1 Release Notes:

Version 3.1 is released on April 9, 2009.

- For more information on WRF V3.1 release, visit WRF Users home page <http://www2.mmm.ucar.edu/wrf/users/>, and read the online User's Guide.
- WRF V3 executable will work with V3.0 wrfinput/wrfbody (but requires inserting a new namelist variable use_baseparam_fr_nml in &dynamics).
As always, rerunning the new programs is recommended.
- WRF V3.1 has changed a number of namelists. For example, ucmcall has become sf_urban_physics, pd_moist(scalar/tke/chem) has become moist_adv_opt (scalar/tke/chem_adv_opt). Helpful messages will be printed to aid you.

V3.0.1.1 Release Notes:

Version 3.0.1.1 has only limited bug fixes compared to version 3.0.1. The detailed updates for WRF-ARW can be found at
<http://www2.mmm.ucar.edu/wrf/users/wrfv3/updates-3.0.1.1.html>.

V3.0.1 Release Notes:

This is a bug fix release. The detailed updates for WRF-ARW can be found at
<http://www2.mmm.ucar.edu/wrf/users/wrfv3/updates-3.0.1.html>.

Online User's Guides have also been updated.

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V3.0 Release Notes:

- For directions on compiling WRF, see below or Users Web page.
- For more information on WRF V3 release, visit WRF Users home page <http://www2.mmm.ucar.edu/wrf/users/>
- WRF V3 works with WPS, and SI is no longer supported. Please see User' Guide for WPS.
- WRF V3 executable does not work with wrfinput/wrfbdy produced by previous versions.
- WRF V3 has removed one obsolete namelist variable, dyn_opt. Edit with caution.

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WRF update history:

- V2.0.1: May 21, 2004
 - V2.0.2: June 3, 2004
 - V2.0.3: Nov 12, 2004
 - V2.0.3.1: Dec 3, 2004
 - V2.1: August 4, 2005
 - V2.1.1: Nov 8, 2005
 - V2.1.2: Jan 27, 2006
 - V2.2: Dec 21, 2006
 - V2.2.1: Nov 1, 2007
 - V3.0: April 4, 2008
 - V3.0.1: August 5, 2008
 - V3.0.1.1: August 22, 2008
 - V3.1: April 9, 2009
 - V3.1.1: July 31, 2009
 - V3.2: March 31, 2010
 - V3.2.1: August 18, 2010
 - V3.3: April 6, 2011
 - V3.3.1: Sept 16, 2011
 - V3.4: April 6, 2012
 - V3.4.1: Aug 16, 2012
 - V3.5: April 18, 2013
 - V3.5.1: Sept 23, 2013
 - V3.6: April 18, 2014
 - V3.6.1: Aug 14, 2014
 - V3.7: April 20, 2015
 - V3.7.1: Aug 14, 2015
 - V3.8: April 8, 2016
 - V3.8.1: Aug 12, 2016
 - V3.9: Apr 17, 2017
 - V3.9.1: Aug 17, 2017
 - V3.9.1.1: Aug 28, 2017
 - V4.0: June 8, 2018
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How to compile and run?

- In WRF directory, type 'configure' - this will create a configure.wrf file that has appropriate compile options for the supported computers.

Note: WRF requires netCDF library. If your netCDF library is installed in

some odd directory, set environment variable NETCDF before you type

'configure'. For example,

```
setenv NETCDF /usr/local/netcdf-pgi
```

- Type 'compile case_name' where you can find the case_names by simply typing

compile. The following are available:

```
compile em_b_wave
compile em_grav2d_x
compile em_heldsuarez
compile em_hill2d_x
compile em_les
compile em_quarter_ss
compile em_real
compile em_seabreeze2d_x
compile em_convrad
compile em_squall2d_x
compile em_squall2d_y
compile em_scm_xy
compile em_tropical_cyclone
```

Notes: 1. If you are going to create model output file that is more than 2Gb,

you should consider using netCDF large file support function. To activate

this, one must set the environment variable WRFIO_NCD_LARGE_FILE_SUPPORT.

In c-shell environment, do

```
setenv WRFIO_NCD_LARGE_FILE_SUPPORT 1
```

This becomes default since V3.9.

2. Since V3.2, we support using multiple processors for compilation. The

default number of processors used is 2. But if you have any problem with

compilation, please try using one processor to compile. To do this, set

the following environment variable before compile:

```
setenv J "-j 1"
```

- If successful, this will create either real.exe or ideal.exe and wrf.exe in directory main/, and the appropriate executables will be linked into the test directories under test/case_name, or run/.

- cd to the appropriate test or run directory to run ideal/real/wrf.

- If it is one of the idealized cases (b_wave, hill2d_x, grav2d_x, quarter_ss, squall2d_x, squall2d_y, em_les or em_heldsuarez), cd to the appropriate directory, type

```
./ideal.exe
```

to produce wrfinput_d01 file for wrf model. Then type

```
./wrf.exe
```

to run.

- If it is real-data case (real), place files from WPS (met_em.*) in the appropriate directory, type

```
./real.exe
```

to produce wrfbdy_d01 and wrfinput_d01. Then type

```
./wrf.exe
```

to run.

- If you use mpich, type

```
mpirun -np number-of-processors wrf.exe
```

- For information on how to make nested runs, visit <http://www2.mmm.ucar.edu/wrf/users/>

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What is in WRF V4?

- Advanced Research WRF (ARW) solver: Eulerian mass, hydrostatic and non-hydrostatic

- * Arakawa C-grid staggering
- * Runge-Kutta 2nd and 3rd order timestep options
- * scalar-conserving flux form for prognostic variables
- * 2nd to 6th order advection options (horizontal and vertical)
- * time-split small step for acoustic modes
- * small step horizontally explicit, vertically implicit
- * divergence damping option and vertical time off-centering
- * external-mode filtering option for mass model
- * hydrostatic option via namelist option

- * positive-definite and monotonic advection for moisture, scalar, tke and chemical tracers
- * global modeling capability on latitude-longitude grid
- * digital filter initialization
- * WENO advection options
- * Hybrid sigma-pressure vertical coordinate (since V3.9)

- Two-way nesting:

- * multiple domains and multiple nest levels
- * supports integer nest grid ratio
- * feedback option for both odd and even nest grid ratios
- * smoothing options

- One-way nesting

- Moving nest

- * Specified move
- * Automatic move using a mid-level vortex-following algorithm

- Physics options:

- * microphysics (Kessler/ WRF Single Moment 3, 5 and 6 classes / Lin et al./ Mibrandt 2-moment / Eta Ferrier / Thompson / Goddard / 2-moment Morrison / WRF Double Moment 5 and 6 classes / SBU-Lin 5-classes / NSSL 2-moment and 1-moment / CAM 5.1) / Thompson aerosol-aware / HUJI full and fast SBM / P3 / 2-moment Morrison with CESM aerosol
- * cumulus parameterization (Kain-Fritsch with shallow convection / Betts-Miller-Janjic / Grell-Devenyi ensemble / Grell 3D (with shallow convection option) / Grell-Freitas ensemble / Tiedtke (with shallow conv and momentum transport) / NSAS (with shallow conv and momentum transport) / SAS (with shallow conv for ARW) / Zhang-McFarlane (with momentum transport)) / New Tiedtke (with shallow conv and momentum transport) / Multi-scale KF (with shallow convection) / Kain-Fritsch Cumulus Potential (with shallow convection)
- * UW shallow convection / GRIMS shallow convection
- * planetary boundary layer (Yosei University / Mellor-Yamada-Janjic / ACM2 / QNSE-EDMF / MYNN / BouLac / UW / TEMF / Grenier-Bretherton-McCaa) / Shin-Hong
- * slab soil model (5-layer thermal diffusion / Noah land-surface model (4 levels) / RUC LSM (6 levels) / Pleim-Xu (2 levels / Noah-MP (4 levels) / SSiB (3 levels) / CLM4 (10 levels))
- * Urban canopy model, BEP multi-layer and BEM (works with Noah LSM, BEP and BEM also requires MYJ or BouLac)
- * longwave radiation (RRTM / CAM / RRTMG / new Goddard / FLG)
- * shortwave radiation (Dudhia / old Goddard / CAM / RRTMG / new Goddard / FLG),
terrain slope and shading effect

- * sub-grid turbulence (constant K diffusion/ 2-D Smagorinsky/ predicted TKE / 2-D, 6th order diffusion / Nonlinear Backscatter Anisotropic (NBA) sub-grid turbulence stress for LES)
 - * Rayleigh damping for w at the upper boundary layer
 - * gravity wave drag (including flow blocking)
 - * land-use categories determine surface properties; support for 24 category USGS and 20 category MODIS
 - * Options for modifying SST, sea ice, vegetation fraction, albedo, and deep soil temp for long simulations
 - * fractional sea ice option for polar regions; modified snow/ice physics
 - * single-column ocean mixed layer model / 3D Price-Weller-Pinkel (PWP) ocean model
 - * drag and enthalpy flux formulation for hurricane applications
 - * CLM lake model
 - * windfarm drag

- Nudging:

- * three-dimensional, surface analysis nudging, and flux-adjusting surface data nudging
- * observation nudging
- * spectral nudging
- * flux-adjusting surface data nudging

- Software

- * Hierarchical software architecture that insulates scientific code (Model Layer) from computer architecture (Driver Layer)
- * Multi-level parallelism supporting shared-memory (OpenMP), distributed-memory (MPI), and hybrid share/distributed modes of execution
- * Active data registry: defines and manages model state fields, I/O, nesting, configuration, and numerous other aspects of WRF through a single file, called the Registry
- * Two-way nesting:
 - Easy to extend: forcing and feedback of new fields specified by editing a single table in the Registry
 - Efficient: 5-8% overhead on 64 processes of IBM Moving nests.
- * Enhanced I/O options:
 - NetCDF and Parallel HDF5 formats
 - Nine auxiliary input and history output streams separately controllable through the namelist
 - Special input streams for analysis and observation nudging
 - Output file names and time-stamps specifiable through namelist
 - Special output stream for 3DVAR
- * Efficient execution on a range of computing platforms:
 - IBM SP systems, (e.g. NCAR "bluevista", "blueice", "bluefire" Power5-based system)
 - IBM Blue Gene

SGI Origin and Altix

Linux/Intel

IA64 MPP (HP Superdome, SGI Altix, NCSA Teragrid systems)

IA64 SMP

x86_64 (e.g. TACC's "Ranger", NOAA/GSD "wJet")

PGI, Intel, Pathscale, gfortran, g95 compilers supported

Sun Solaris (single threaded and SMP)

Cray X1, X1e (vector), XT3/4 (Opteron)

Mac Intel/ppc, PGI/ifort/g95

NEC SX/8

HP-UX

Fujitsu VPP 5000, FX10

Intel MIC

* RSL_LITE: communication layer, scalable to very large domains, supports nesting.

* I/O: NetCDF, parallel NetCDF (Argonne), HDF5, GRIB, raw binary, Quilting (asynchronous I/O), MCEL (coupling)

* ESMF Time Management, including exact arithmetic for fractional time steps (no drift).

* ESMF integration - WRF can be run as an ESMF component.

* Improved documentation, both on-line (web based browsing tools) and in-line