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USER'S GUIDE FOR THE WRF STATISTICS PACKAGE

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1. Introduction

The WRF statistics package is developed at NOAA ESRL by T. Yamaguchi. This public package is for WRF3.6. Anna Fitch at NCAR updated from WRF3.3.1 to WRF3.6. Please acknowledge her if you use this package. The technical notes is published in JAMES:

Yamaguchi, T., and G. Feingold, 2012: Technical note: Large-eddy simulation of cloudy boundary layer with the Advanced Research WRF model. J. Adv. Model. Earth Syst., 4, M09003.

2. Instllation and compilation

(1) Copy all files in the downloaded LES and statistics packages to your local WRF3.6

(2) /YourPath2WRF/test/em_les/stat

In the **stat** directory, you should have

- **lst**
  Input file which lists all horizontal mean output variables except 1D time series and conditional averages (e.g., cloudy grid average). See the subroutine hbuf_write in module_statistics.F for the 1D time series. See the subroutine hbuf_conditionals_init in module_statistics.F for conditional average output.
- **module_mp_example.F**
  Example codes instructing how to collect microphysical output and pass to module_statistics.F.
- **prm**: Namelist file described below.
- **stat2nc**: Directory containing a conversion program from the binary output file to netCDF format.

(3) . ./configure

Select an appropriate configure option for your platform with "**dmpar**."

(4) Preprocessor flag

Add **-DWRFSTAT** in **ARCHFLAGS** in **configure.wrf**.

(5) Compilation

Do not compile with OpenMP.

3. prm

Parameters in **STAT** has to be set otherwise default value will be used.

- **stat_file_name** (default = 'wrf.stat')
  Output file name, which has to end with "**.stat**." The maximum length of of the **stat_file_name** is **148**.
- **nstat** (default = 1 steps)
  Interval in steps to output statistics. The frequency of saving restart data in steps, (i.e., number of steps converted from **restart_interval** in **nameplist.input**), has to be divisible without remainder by **nstat**.

- **nstatfrq** (default = 1)
  Frequency of computing statistics = number of samples collected over **nstat**. Output statistics will be the mean over the samples. **nstat** has to be divisible without remainder by **nstatfrq**. If one would like to have hourly mean statistics with samples collected every minute for 2 s time step, then **nstat = 1800** and **nstatfrq = 60**.

- **LES** (default = .FALSE.)
  If **TRUE**, then **condensate mixing ratios (qc, qi, qr, qs, qg)** as well as **corresponding droplet number concentrations** are reset to **0** with **q#_threshold** described below before statistics diagnosis. Criteria for conditional averages depends on this flag, too. Search an appropriate part of the codes in **module_statistics.F** for detail.

- **doavgprecflux** (default = .FALSE.)
  If **TRUE**, precipitation rate will be output as time mean over **nstat** with samples collected every time step, in stead of **nstatfrq**.

- **docldconditionals** (default = .FALSE.)
  If **TRUE**, **liquid cloud (qc)** and **ice cloud (qi)** conditional statistics are output.

- **docndconditionals** (default = .FALSE.)
  If **TRUE**, **liquid water condensate (qc+qr)** and **ice water condensate (qi+qs+qg)** conditional statistics are output

- **docoreconditionals** (default = .FALSE.)
  If **TRUE**, **core updraft** and **core downdraft** conditional statistics are output.

- **dosatupdnconditionals** (default = .FALSE.)
  IF **TRUE**, **cloudy updrafts**, **cloudy downdrafts** and **cloud-free environment** conditional statistics are output.

- **doupdnconditionals** (default = .FALSE.)
  IF **TRUE**, **updrafts** and **downdrafts** conditional statistics are output.

- **hrlayers** (default = 10)
  Number of layers between two output levels. This high resolution level is used for the mean profile calculation for flux and moments. If **hrlayers = 1** (not recommended), the output level and high resolution level are same.

- **qc_threshold, qi_threshold, qr_threshold, qs_threshold, qg_threshold** (default = 0 g kg^{-1})
  Minimum threshold for each **condensate mixing ratio**. Each grid value as well as corresponding **droplet number concentration** will be reset to **0** if it is smaller than threshold before statistics diagnosis. This will not affect the WRF **moist** and **scalar** arrays

- **dousednc** (default = .FALSE.)
  IF **TRUE**, each threshold is for each **droplet number concentrations** (mg^{-1}) instead of **condensate mixing ratios**.

4. namelist.input

(1) time_control

restart_interval in steps has to be divisible without remainder by **nstat**.

(2) domains

- Set **e_we** and **e_sn** to **odd number**.

- Set **e_we-1** and **e_sn-1** is divisible without remainder by number of subdomains in each direction. **nproc_x** and **nproc_y** are useful to ensure this requirement.

- Do not use nesting.
- Do not use adaptive time step.

(3) physics

- PBL scheme
  Set **bl_pbl_physics = 0** to output **SGS quantities**.
- Radiation scheme
  In order to output **radiative flux**, use DYCOMS-II RF01 parameterization, CAM or RRTMG scheme.

(4) dynamics

- Advection
  Set **v_mom_adv_order = 3**, **v_sca_adv_order = 3**, **moist_adv_opt = 2**, **scalar_adv_opt = 2**, **tke_adv_opt = 2** to output **resolved scale fluxes**.
- Diffusion
  diff_opt = 2 to output **SGS fluxes**. Set **km_opt = 2** to output the **SGS TKE** and its **tendency**. **km_opt = 3** (Smagorinsky) works but the **SGS TKE** and **tendencies** are not output.

5. module_mp_example.F

In order to output **liquid precipitation rate, ice precipitation rate**, **condensation rate**, **evaporation rate**, **deposition rate**, **sublimation rate**, and **ice fall speed**, the specific codes have to be implemented to the microphysics code to be used for simulations. See **module_mp_example.F** provided in the package. The codes are implemented to the Morrison scheme (**module_mp_morr_two_moment.F**), which is included in the package.

6. Run!

- For the initial run, WRF stops if a file with the same name of the output file (**###.stat**) exists in the **stat** directory in order to avoid overwriting.
- For restart run, the output file with the same name has to exist in the **stat** directory. The output data will be appended.

7. stat2nc

The **stat2nc** directory contains a conversion program (also named as **stat2nc**) to netCDF. Modify **Makefile** for your platform. Type "**stat2nc ###.sta**t" to convert.

8. Heads-up!

- This package is memory intense. If WRF with this package does not run, try increasing stack. For the Intel compiler, using -heap-arrays may help.
- Although most of unit are correct for all microphysics schemes, the units for all schemes have not been checked. Find appropriate units in the subroutines, **wrf_statistics_init**, **wrf_statistics**, and **statistics**.
- Depending on which microphysics, radiation schemes are used, some output variables (e.g., condensation rate, radiative flux, etc.) are not output. Simply because there is no such a variable in the scheme or the necessary codes to collect and pass data to **module_statistics.F** has not been implemented.