WRF-Var Namelist

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- This talk is complementary to the “WRF-Var Setup, Run and Diagnostics” talk.

Namelist - WRFVAR1

- Write_increments
  - .false. : Default
  - .true. : Output analysis increment file “analysis_increments” (analysis-background). The file is a binary file, generated every time you run WRF-Var by using a FORTRAN code given in *WRFVAR/da/da_setup_structures/da_write_increments.inc*.

```
-rw-r--r--    1 huishao  ncar    43271476 Jul  7 16:27 analysis_increments
lrwxrwxrwx    1 huishao  ncar          32 Jul  7 16:27 be.dat -> /ptmp/huishao/tutorial/be/be.dat
-rw-r--r--    1 huishao  ncar        1600 Jul  7 16:27 check_max_iv
-rw-r--r--    1 huishao  ncar         313 Jul  7 16:27 cost_fn
```

  - ✓ You could still produce your own analysis increment file by extracting first guess from analysis files (both in netcdf format). The advantage of using this “analysis_increment” is to avoid spurious increments (because it is generated directly from the code without including the first guess).

Namelist - WRFVAR1

- Print_detail_*
  - .false. : Default
  - .true. : Output extra diagnostics

Example: print_detail_grad=.true.

Iteration 0

```
jo_geoamv              0.118917669698E+03
jo%geoamv_u            0.371704152820E+02
jo%geoamv_v            0.817472544158E+02
jo%total               0.120493680229E+03
…
Calculate grad_v(jo) iter=     0
   cv_jb.cv_jb =     0.00000000000000E+00
   cv_je.cv_je =     0.00000000000000E+00
   xhat.xhat =     0.00000000000000E+00
   j_grad.j_grad =     0.93533513206338E+02
Calculate grad_v(j) iter=     0
   cv_jb.cv_jb =     0.00000000000000E+00
    cv_je.cv_je =     0.00000000000000E+00
   xhat_jb.xhat_jb =     0.00000000000000E+00
   xhat_je.xhat_je =     0.00000000000000E+00
   cv_xhat_jp.cv_xhat_jp = 0.00000000000000E+00
   j_grad.j_grad =     0.93533513206338E+02
```

Iteration 19

```
Inner iteration stopped after    19 iterations

   jo_geoamv              0.985110326458E+02
   jo%geoamv_u            0.292654551874E+02
   jo%geoamv_v            0.692455774585E+02
   jo%total               0.100697022398E+03
…
Calculate grad_v(jo) iter=    19
   cv_jb.cv_jb =     0.00000000000000E+00
   cv_je.cv_je =     0.00000000000000E+00
   xhat.xhat =     0.11886920460937E+02
   j_grad.j_grad =     0.12125274158977E+02
Calculate grad_v(j) iter=    19
   cv_jb.cv_jb =     0.00000000000000E+00
    cv_je.cv_je =     0.00000000000000E+00
   xhat_jb.xhat_jb =     0.11886920460937E+02
   xhat_je.xhat_je =     0.00000000000000E+00
   cv_xhat_jp.cv_xhat_jp = 0.00000000000000E+00
   j_grad.j_grad =     0.66566955863646E-02
```

Namelist - WRFVAR2

- Analysis_accu
  - 900 (Sec): Default.

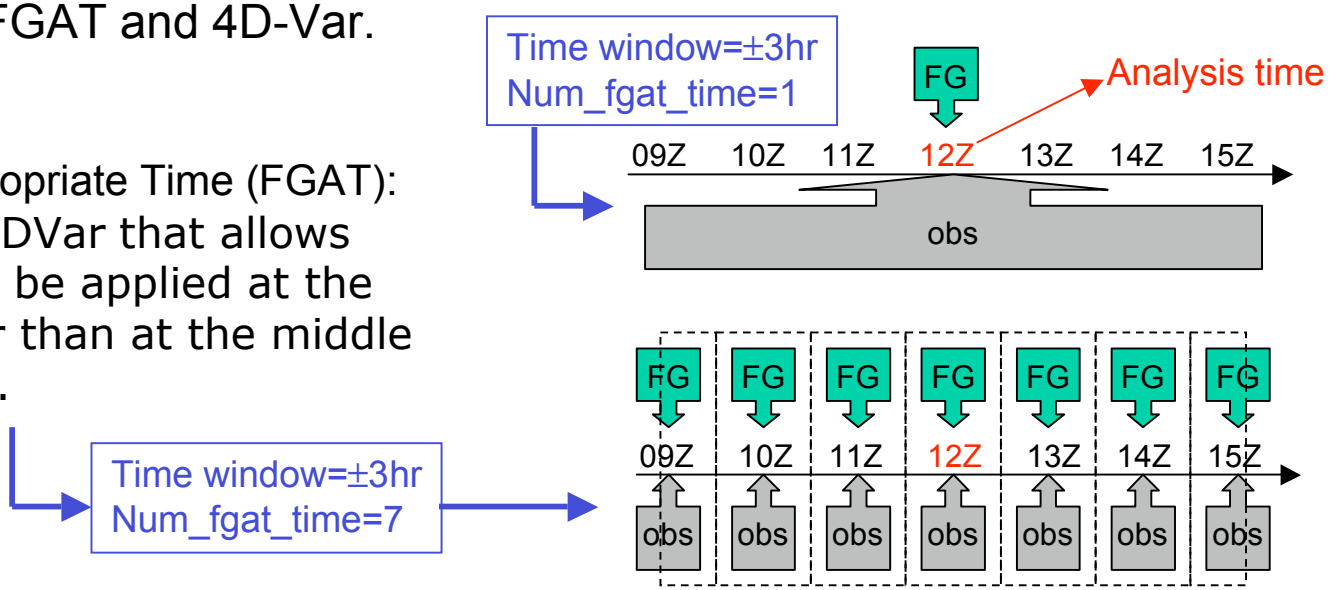
  If |analysis time - first guess time| > Analysis_accu, WRF-Var will give a warning like "*Wrong xb time found???*".
- Write_filtered_obs
  - Not used.
  - Please refer to "analysis_type" for outputting filtered observation by WRF-Var (WRF-Var internal QC procedure).

Namelist - WRFVAR3

- Fg_format: Format of the first guess of WRF-Var.
  - 1 = WRF-ARW: Default (recommended).

- Num_fgat_time: Number of data time windows (slots) used in WRF-Var.
  - 1 = 3DVAR: Default.
  - >1 apply to FGAT and 4D-Var.

✓ First-Guess at Appropriate Time (FGAT): An option in WRF-3DVar that allows the observations to be applied at the correct time, rather than at the middle of the time window.



Namelist - WRFVAR4

- Use_obs_errfac: Option for using tuned observation error.
  - .false. : Default. At this moment, please use this option.
  - .true. : Use tuned observation error statistics (need to produce errfac.dat beforehand created by da_tune_obs_desrozier.f).

Namelist - WRFVAR5

- Put_rand_seed:
- Omb_set_rand:
- Omb_add_noise:

} For observation error tuning.

Namelist - WRFVAR5 (Cont.)

- Obs_qc_pointer:
  - 0 : Default, Good data.
  - ✓ For ASCII observation files generated by OBSPROC, QC flag value ranges from -88 to 88 (please refer to the latest QC flags from OBSPROC).
    - qc = -88 : Missing data
    - qc = 0 : Good data
    - qc = -77 : Outside of horizontal domain
    - qc = -15 : Wind direction <0 or > 360 degrees
    - qc = -14 : Negative wind speed vector norm
    - qc = -13 : Null wind speed vector norm
    - qc = -12 : Spike in the wind profile
    - qc = -11 : Null temperature or dew point
    - qc = -10 : Superadiabatic temperature
    - qc = -9 : Spike in Temperature profile
    - qc = -8 : Height higher than model lid's height
    - qc = -5 : h,p or T from standard atmosphere
    - qc = -4 : h,p or T from background
    - qc = 1 : convective adjustement correction
    - qc = 2 : surface_correction
    - qc = 3 : Height recovery from hydrostaic + OBS
    - qc = 4 : Height recovery from reference + OBS
    - qc = 88 : Any other check
  - ✓ For PREBUFR observation files generated by OBSPROC, qc = 0 indicates the best quality (please refer to the latest QC flags from OBSPROC).

Namelist - WRFVAR5 (Cont.)

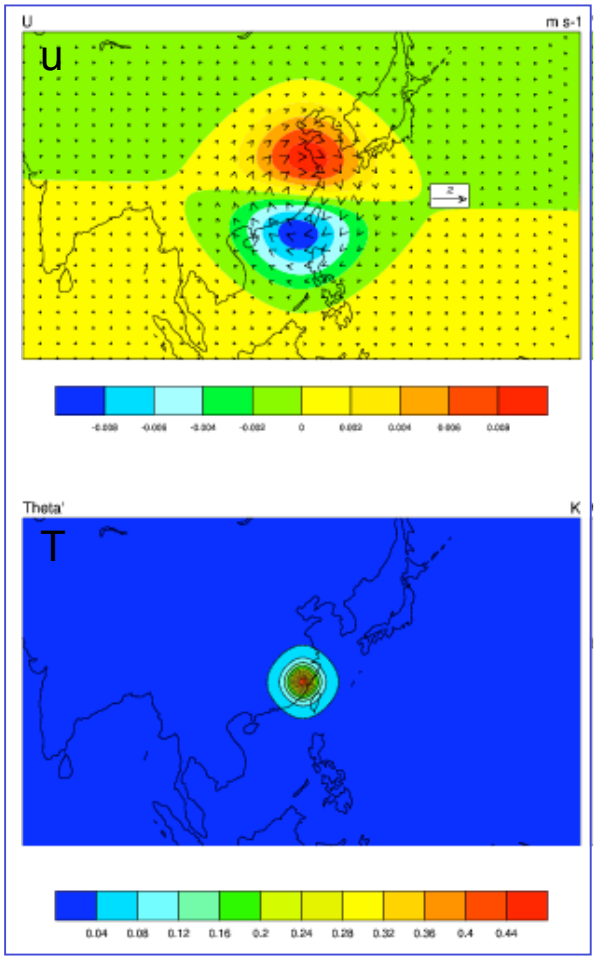
- Max_obstype_input: Set to restrict the maximum number of observations used in each type.
  - The restriction is applied when the observations are read, and applies to the total number of observations across all processors before quality control.
  - E.g., max_sound_input=5000: the maximum number of radiosondes is 5000.

Namelist - WRFVAR7

- Rf_passes: number of passes of recursive filter used in WRF-Var to define the horizontal correlation shape of background errors.

- Var_scaling1(2,…5): The tuning factor of background error covariance for control variables.
  - ✓ Control variables:
    - — 1: stream function
    - — 2: unbalanced velocity potential
    - — 3: unbalanced temperature
    - — 4: Relative humidity
    - — 5: Unbalanced surface pressure

- Len_scaling1(2,…5): The tuning factor of scale-length for control variables.



An example of a pseudo single observation test (PSOT)

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Namelist - WRFVAR8

- Used for debugging purposes.

Namelist - WRFVAR9

- Stdout : 6 (default). Unit number for standard output.
- Stderr : 0 (default). Unit number for error output.
- Warnings_are_fatal: .false.(default). If true, warning messages that would normally allow the program to continue are treated as fatal errors.

Namelist - WRFVAR9 (Cont.)

The following namelist variables are for tracing:

Tracing gives additional diagnostics about program runs. It does not change results, but does slow the program down, so should be disabled in production environments.

- Trace_use: .true. (default). Use tracing function in WRF-Var if true.
- Trace_unit : Unit number for tracing output.
  - Units 9 and 10 are reserved for reading and writing namelist.input and namelist.output.
- Trace_pe : 0 (default). Currently, statistics are always calculated for all processors, and output by processor 0.
- Trace_all_pes: .false. (default). Trace is output for all pes. As above, this does not change processor statistics.

Trace Output

* Calling Tree
* Local routine timings
* Overall routine timings
* Memory usage

Namelist - WRFVAR9 (Cont.)

- Trace_repeat_head & trace_repeat_body: 10 (default). The number of times any trace statement will produce output for any particular routine.
  - ✓This stops the trace output being overwhelmed when a routine is called multiple times. Once this limit is reached a 'going quiet' message is written to the trace file, and no more output is produced from the routine, though statistics are still gathered.
- Trace_max_depth: Define the deepest level to which tracing writes output.
  - 30 : Default, which means effectively unlimited.
- Trace_memory: .true. (default). If true, calculate allocated memory using a mallinfo call.
  - ✓On some platforms (Cray and Mac), mallinfo is not available and no memory monitoring can be done.
- Trace_csv: .true. (default). The tracing statistics are written to a xxxx.csv file in CSV format.
- Use_html: .true. (default). If true, the tracing and error reporting routines will use HTML tags.

Trace Output

* Calling Tree
* Local routine timings
* Overall routine timings
* Memory usage

Maximum memory usage for routines

Routine	Max in any PE (kbytes)	Overall (kbytes)	Average per PE (kbytes)
da_transfer_xatoanalysis	508076	15803513	493859
da_transfer_xatowrf	508076	15803513	493859
da_write_increments	508076	15803513	493859
da_deallocate_observations	506698	15761784	492555
da_deallocate_y	506392	15756018	492375

Namelist - WRFVAR10

- Test_transforms:
  - .false. (default): Run data assimilation.
  - .true.: Perform adjoint check for the code debugging.

Namelist - WRFVAR11

- Cv_options_hum:
  - 1 (default): Please do not change.

- Check_rh:
  - 0 : No supersaturation check after minimization.
  - 1: With the supersaturation (rh> 100%) and minimum rh (rh<10%) check, and make the local adjustment of q.
  - 2 (default): With the supersaturation (rh> 95%) and minimum rh (rh<11%) check, and make the multi-level q adjustment under the constraint of integrated water vapor in column conserved.

Namelist - WRFVAR11 (Cont.)

- Set_omb_rand_fac
- Seed_array1
- Seed_array2

} For ensemble perturbation purposes.

The following namelist variables are related to Background Error (BE) computation and should be consistent to those in BE file (be.dat) computed from GEN_BE.

Namelist - WRFVAR11 (Cont.)

- Lat_stats_option: .False. (default). Only set true when be.dat is computed with i-dependence (approximately latitude-dependence) .

Namelist - WRFVAR13

- Vert_corr: 2 (default). Please do not change at this moment.
- Vert_evalue: 1 (default). Please do not change at this moment.
- Max_vert_var1(2,…5): Maximum truncation value (percentage) used in the vertical eigenvector decomposition in BE calculation.

Namelist - WRFVAR14

- Namelist options for radiance data assimilation (not supported).

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Namelist - WRFVAR15

- **num_pseudo** = 0 (default). Set the number of pseudo observations. Currently only the value of 1 is allowed, i.e. num_pseudo = 1 --- the SINGLE-OBS test.
- **pseudo_x** = 1.0 (default). Set the x-position (J) of the OBS in units of grid-point.
- **pseudo_y** = 1.0 (default). Set the y-position (I) of the OBS in units of grid-point.
- **pseudo_z** = 1.0 (default). Set the z-position (ZK) of OBS with the vertical level index. In MM5, the top level has z=1, and bottom level, z=kx.
- **pseudo_val** = 1.0 (default). Set the innovation of the OBS variable: u/v at m/s, p at Pa, t at degree, and q at kg/kg.
- **pseudo_err** = 1.0 (default). Set the OBS error of the OBS variable.

Namelist - WRFVAR19

- **pseudo_var** = 't' (default)
  Set the name of the OBS variable:
  'u' = X-direction component of wind,
  'v' = Y-direction component of wind,
  't' = Temperature,
  'p' = Pressure,
  'q' = Specific humidity,
  'pw' = Total precipitable water,
  'ztd' = Zenith tropospheric delay,
  'ref' = Refractivity

The namelist variables here are for pseudo single-observation tests (PSOTs).

Please refer to “WRF-Var Background Error Estimation” talk.

Namelist - WRFVAR16

- For hybrid WRF-Var/Ensemble data assimilation namelist option (Please refer to “Hybrid Data Assimilation System” talk).

Namelist - WRFVAR21/22

- Time_window_min(max): Specify the lower (upper) time values of the assimilation time window.
  - These two values do not have any impact on the observation data (GTS) processed through OBSPROC, since OBSPROC already conducts time check and bundles the observation data within same time window into one file.
  - The radiance data do not go through OBSPROC currently and require the setting of these two variables.

Namelist - WRFVAR23

- Namelist variables related to the 4D-Var penalty term option, which controls the high-frequency gravity waves using a digital filter (Not supported).