Guidelines to generate WRF ensemble ICs and BCs using WRF VAR

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This document describes how to generate ensemble initial conditions and boundary conditions using WRF 3DVAR. The outline of this method is:

1. Use WRF Standard Initialization (SI) to generate ICs (WRF_INPUT files at all available analysis times) and BCs (WRF_BDY files). These ICs and BCs are then treated as the ensemble mean ICs and BCs;

2. Use WRF VAR to perturb the ensemble mean ICs (analysis-type=randomcv, cv-option=3);

3. Use pert_wrf_bdy to update the ensemble mean BCs to generate perturbed BCs for each ensemble member;

We assume you have the following directory structures:

WRFV2	WRF root directory
WRFV2/CASE	directory for running a real case with WRF
WRFV2/WRFSI	WRFSI directory
WRFVAR	WRF-VAR root directory
WRFVAR/ICBC	Directory where the IC/BC files are created.

1. Setup WRF and WRFSI

Download and compile WRF and WRFSI code from http://www.mmm.ucar.edu/wrf/users/

You should be able to run real.exe and wrf.exe under WRFV2/CASE.

2. Setup WRF-VAR

a) Download WRF-VAR (version 2.1), unzip the package and do the following modifications:

In WRFVAR/da_3dvar/src/da_solve_v3d/da_solve_v3d.F, add

if (analysis_type == 'randomcv' .or. analysis_type == 'RANDOMCV') then

print,'call da_set_randomcv'*

call da_set_randomcv (cv_size, xhat%array)

endif

just before

call da_transform_vtox(....)

b) Compile WRF-VAR code following the instructions available at

http://www.mmm.ucar.edu/wrf/WG4/wrfvar/wrfvar-setup.htm

3. Prepare files for generating ensemble ICs and BCs

The additional files needed to generate ensemble ICs and BCs, can be downloaded from here util.tar Under WRFVAR/ICBC, extract util.tar using the following command

tar -xvf util.tar

It contains the following files:

mkmf
mkmf.template
mkmf_convertdate
mkmf_pert_wrf_bc
path_names_convertdate
path_names_pert_wrf_bc
input.nml
WRF_BC/README
WRF_BC/module_couple_uv.f90
WRF_BC/module_netcdf_interface.f90
WRF_BC/module_timediff.f90
WRF_BC/pert_wrf_bc.f90
Utilities/convertdate.f90
Utilities/time_managet_mod.f90
Utilities/types_mod.f90
Utilities/utilities_mod.f90

mkmf.template is customized to run on NSSL's SGI system. You need to edit

mkmf.template so that it runs on your system.

Compile the following:

mkmf_convertdate

make

mkmf_pert_wrf_bc

make

You will have convertdate and pert_wrf_bc executable created in the same directory.

Copy the following files into WRFVAR/ICBC directory:

be.cv_3	from WRFVAR (also available in util.tar)
be	ln -s be.cv_3 be
wrfvar.exe	from WRFVAR/main
namelist.3dvar.template	from WRFVAR/run/namelist.3dvar, rename it

LANDUSE.TBL	from WRF/CASE
namelist.input	from WRF/CASE
prepare_ICBC.csh	available in util.tar
3dvar_Member_ICBC.csh	available in util.tar

Modify the namelist.3dvar.template file as follows:

In **&record3** add

Set

Num_fgat_time = 1,

In **&record4** add

Replace

Use_SatobObs = .TRUE.,

with

Use_GeoAMVObs = .TRUE.,

Set

put_rand_seed = .TRUE.,

Make sure namelist files are set properly. Don't worry about the settings for model times, it will be updated by the scripts.

4. Generate ensemble ICs and BCs

a) Create WRFSI files in WRF/CASE.

b) Copy input.nml from WRFVAR/ICBC to WRF/CASE.

c) Edit and run *prepare_ICBC.csh*. This will run real.exe in WRF/CASE to generate

ICs and BCs, and copy them back to the current directory as ensemble mean. Then it calls *3dvar_Member_ICBC.csh* that launches parallel jobs to generate perturbed ICs and BCs for each ensemble member. This will create temporary directory for each ensemble member (3dvar_tempdir#member).

At the end, you should get the following files at each of 3dvar_tempdir#member directory:

wrfinput_d01_mean_*day_secon*d	ensemble mean IC
wrfbdy_d01_mean_*day_secon*d	ensemble mean BC
wrfinput_d01_*day_second_nu*m	IC for member *nu*m
wrfbdy_*day_second_nu*m	BC for member *nu*m

To run wrf.exe, rename wrfinput_d01_*day_second_nu*m as wrfinput_d01 and concatenate the wrfbdy_*day_second_num* (where num is #member) files into one boundary condition file (wrfbdy_d01) that contains boundary conditions for all analysis time all in one file.

To do this execute the following command (you need to have NCO installed):

ncrcat wrfbdy_day_second_* wrfbdy_d01

Note 1: Since WRF-VAR uses double precision, the perturbed ICs are about twice large as the mean ICs.

Note 2: WRF-VAR also adds a few new fields in the perturbed ICs.