Using Restart Files in WRF-Hydro Simulations

What is a Cold vs Warm start?

When you start the model as a 'cold restart' (meaning that it is starting with the default values at the very beginning), it takes time for the model to warm up and reach an equilibrium state. For example, consider simulating streamflow values for a stream which has a base flow of at least 10 cms during the year, and you have a 'cold start'. The default values of the streamflow might be zeros at the start of the modeling. It then takes time for the simulated streamflow within the model to reach the 10 cms. In contrast, a 'warm start' is when the model simulation begins with the simulated values of a given time step (starting time step) from a previous run. This eliminates the processing time the model would take to reach an equilibrium state. Depending on which variable of the model you are looking at, the time required to reach to the warm state may differ. For example, groundwater requires a large time period to reach to equilibrium as it has a longer memory compared to other components of the hydrologic model.

How to Warm start a WRF-Hydro simulation

One way to warm start your simulations is to use the restart files from a simulation that has happened in a separate run for your specific domain. For example, consider you have run WRF-Hydro for a period covering 2009-01-01 to 2010-01-01 (1st run), and want to submit a new run starting from 2010-01-01 (2nd run). In this case, you could use the restart files produced from your first run for your second run, and let the model resume from the state which it was at the end of your first simulation.

What are the WRF-Hydro restart files?

Restart files store the model states at a specified time.
There are two restart files that can be produced and used by WRF-Hydro.
- RESTART.YYYYmmddHH_DOMAIN1 which is the LSM RESTART file (not required if running channel only configuration of WRF-Hydro)
- HYDRO_RST.YYYY-mm-dd_HH:MM_DOMAIN1 which is the Hydro restart file (required if you are using Hydro components of the model)

How to generate restart files

You can set up the frequency of outputting the LSM restart files in the **namelist.hrldas.**
Below is an excerpt from the namelist.hrldas file. Notes and descriptions are in blue and indicated with <<--.

```
RESTART_FREQUENCY_HOURS = -99999 <<-- Timestep for LSM restart files to be generated (in
hours). A value of -99999 will simply output restarts on the start of each month, useful for longer model runs.
Restart files are generally quite large, so be cognizant of storage space and runtime impacts when
specifying.
```

You can set up the frequency and format of outputting the hydro restart files in the **hydro.namelist.**
Below is an excerpt from the hydro.namelist file. Notes and descriptions are in blue and indicated with <<--.

```
! Specify the restart file write frequency...(minutes)
! A value of -99999 will output restarts on the first day of the month
only.
rst_dt = 120  <<-- Specify how often hydro restart files should be generated, in minutes. This should
generally match your LSM restart file frequency (as specified in namelist.hrldas). A value of -99999 will
simply output restarts on the start of each month, useful for longer model runs. Hydro restart files are
generally quite large, so be cognizant of storage space and runtime impacts when specifying.

! Restart file format control
rst_bi_out = 0        !0: use netcdf output restart file (default)
                      !1: use parallel io for outputting multiple restart
files, 1 per core  <<-- Options to specify whether restart files (both read in and output) should be in
binary or netcdf format. Generally recommend using NetCDF format (option 0) for.  -->>
```

How to use the restart files to warm start a simulation

To warm start the LSM part of the model, specify path to the RESTART file in the **namelist.hrldas.** Notes and
descriptions are in blue and indicated with <<--

```
RESTART_FILENAME_REQUESTED = "RESTART.2013090100_DOMAIN1"  <<-- Path to LSM
restart file if using; this contains a "warm" model state from a previous model run. Comment if not a restart
simulation.
```

To warm start the HYDRO part of the model, specify the path to the HYDRO_RST files and the format of it in
the **hydro.namelist.**

```
! Specify the name of the restart file if starting from restart...comment
out with '!' if not...
RESTART_FILE  = 'HYDRO_RST.2013-09-12_00:00_DOMAIN1'  <<-- Path to hydro restart file
if using; this contains a "warm" model state from a previous model run.

! Restart file format control
rst_bi_in = 0         !0: use netcdf input restart file (default)
                      !1: use parallel io for reading multiple restart
files, 1 per core  <<-- Options to specify whether restart files (both read in and output) should be in
binary or NetCDF format. Generally recommend using NetCDF format (option 0) for both.  -->>
```