Erik Neemann

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This document is my attempt to catalog information from my thesis research so that others in the Horel Group can reproduce it, if necessary, or build from it for further research.

This document and most of the files linked below can be found in the following folder:

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/>

Throughout the document, hyperlinks are provided for online files, directories or folder names are in GREEN, and Unix commands or programming code are in Courier New.

**1 - Original, really old Uintah Basin WRF runs are on ‘horel\_data’, found here:**

/uufs/chpc.utah.edu/common/home/horel-group3/horel\_data/eneemann/Uintah\_Basin\_Runs

* These cases include Snow/No Snow runs for a CAP in 2011 and 2013 with the original, exponential snow curve from 12 cm to 1 m (although the “curve” was incorrect and snow depth actually gets to near 2 m before leveling at 1m above 2900 m elevation

**2 - Newer Uintah Basin WRF runs are on ‘horel-group2’, found here:**

/uufs/chpc.utah.edu/common/home/horel-group2/eneemann/Uintah\_Basin\_Runs

This directory contains 3 folders:

**NWP:** WRF data for my NWP class project in Fall 2013

* 4km PBL testing of MYJ, YSU, MYNN, and QNSE schemes
* “Clear” CAP case from 00Z 19 Jan 2013 to 00Z 22 Jan 2013
* Modified snow/albedo like thesis research, did NOT implement modified microphysics

**Uintah\_tests:** Early PBL testing toward thesis research

* 4km testing of GBM, YSU, YSU\_Jiminez, MYJ, ACM, and BP PBL schemes
* Each folder numbered according to namelist option

**WRFv3.5:** Numerous additional testing toward thesis research and CMAQ data files

* Each folder corresponds to different model run and includes: wrfout files, RIP data, and timeseries (TS) files. Some folders also have namelist.input, and restart files
* Model runs in thesis research are in the following folders:

**BASE:** Feb\_2013\_BASE

**FULL:** Feb\_2013\_snow\_TIN12IAU0T

**NONE:** Feb\_2013\_no\_snow\_TIN12IAU0T

**NW:** Feb\_2013\_no\_wrn\_snow\_TIN12IAU0T

The thesis runs all use a linear snow “curve” from 17 cm on basin floor below 2000 m to 1 m above 2900 m. They have VEGPARM.TBL edited for 20 kg m-2 (or 2 cm of SWE) to imply 100% snow cover over “cropland” and “cropland/grassland mosaic” vegetation types. They also have albedo inside the basin/below 2000 m set as 0.82. See thesis for more details.

**CMAQ:** Contains CMAQ output forced from: snow, no snow, and unmodified WRF runs

* 2013\_snow = FULL run for thesis research
* 2013\_no\_snow = NONE run for thesis research
* 2013\_snow\_unmodified = “default” WRF run for Lance to use as comparison to FULL
	+ This is NOT the BASE run used in thesis research, it has different snow characteristics

The rest of the directories in WRFv3.5 are kind of cryptic, but are named based on what modification were made for that particular model run. They include testing Morrison (Morr) and WSM3 (WSM3) microphysics, sedimentation speed of cloud ice (FS, FS0, S20, S), additional albedo edit to 0.82 and VEGPARM edits (A), different percentages of ice autoconversion to snow (IAU0, IAU5, IAU20), different ice nucleation temperatures in degrees below 0 (IN3, IN6, IN12, IN15), turning off diffusion (NOD), different CCN concentrations (100, 1000), and altering RH of input files (RH20, RH40). If you’re having troubling deciphering them, some details for each run can be found in the “Neemann RIP commands” text file, and “WRF 2m Temp Errors” spreadsheet found here:

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/>

- The TS list I used for most simulations can be found here:

<http://home.chpc.utah.edu/~u0818471/4Dec2013_conf_call_3SAQS/tslist>

- My WPS data for the Uintah Basin can be found here:

/uufs/chpc.utah.edu/common/home/horel-group3/horel\_data/eneemann/WRFv3.5/WPS

**3 – Running WRF on Meso3**

For a complete description on how to run WRF (tailored to using meso3), see my WRF workflow doc:

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/Neemann%20WRF_workflow.docx>

Most of my WRF runs were done on the scratch space of meso3 (especially after Aug 2013). This was done on Chris Galli’s recommendation that it might allow for faster processing due to a decrease in communication across the network. It didn’t seem to really speed anything up, but running WRF on 15 nodes on meso3 was good enough for what I needed. In order to get to where I ran them on meso3, you need to navigate to my directories on the scratch space. This can be accomplished by a few steps.

 1: ssh meso3.chpc.utah.edu

 2: cd / (this will put you into meso3’s local directories)

 3: cd /compute1/scratch/eneemann/WRFV3 (puts you in my WRF directory)

Once in the proper directory, WRF can be compiled and run with the following commands:

source /uufs/chpc.utah.edu/sys/pkg/pgi/std\_rh6/etc/pgi.csh
source /uufs/chpc.utah.edu/sys/pkg/mpich2/std\_pgi\_rh6/etc/mpich2.csh
setenv NETCDF /uufs/chpc.utah.edu/sys/pkg/netcdf/4.0pg
setenv WRF\_EM\_CORE 1
setenv WRFIO\_NCD\_LARGE\_FILE\_SUPPORT 1

./configure

select configuration option 7
1 for nesting

./compile em\_real >& out.txt

setenv OMP\_NUM\_THREADS 8
mpirun -np 15 ./wrf.exe

**4 – UINTAH BASIN DATA**

I have a spreadsheet that I used to help place WRF TS output locations based on MesoWest stations in the UB. It can be found at the link below:

[http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/TS%20locations%20&%20setup%20verification.xlsx](http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/TS%20locations%20%26%20setup%20verification.xlsx)

In addition to TS/MesoWest station information on the first tab, I have a lot of snow depth data on the second tab, some soil data and albedo data (at Roosevelt) on the other tabs. The snow tab has a lot of observational data and sources that I used to calculate how much snow I wanted to put on the basin floor during the 1-6 Feb 2013 period. A little more explanation of WRF snow variables and where I collected data to calculate my snow curve can be found here:

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/Neemann%20WRF%20snow%20info.pdf>

**4 – MATLAB**

My working directory for MATLAB can be found here:

/uufs/chpc.utah.edu/common/home/horel-group2/eneemann/matlab/matlab

There are a ton of MATLAB scripts in this directory that were used to produce various graphics and they have widely varying quality when it comes to comments. Some might be easy to decipher, while others may have been copied and built from other bits of code and the accompanying comments may not be applicable. Most of my code is organized into sections, so I can run certain parts or pause the scripts to see what errors pop up during execution.

There are also a handful of .csv files with trimmed observational data and NetCDF files of WRF output scatted throughout the directory.

**5 – RIP**

RIP is a program that can used for plotting WRF output. I pretty much used RIP for all of my plotting unless I needed to do time-averaging, vertical profiles, or time series plots. RIP is great at quickly producing plots that can be output in a pdf and stepped through hour-by-hour, it does cross sections very easily, and can be used to produce skew-Ts.

If you aren’t familiar with RIP, I recommend spending a day to read through the RIP User’s Guide (<http://www2.mmm.ucar.edu/wrf/users/docs/ripug.htm>) and play around with building scripts and viewing the output.

My working RIP directory is here:

/uufs/chpc.utah.edu/common/home/u0818471/RIP5/RIP4

Before running RIP, you need to run the following environment command:

setenv RIP\_ROOT /uufs/chpc.utah.edu/common/home/u0818471/RIP5/RIP4

* The directory refers to where you will be running RIP

RIP is run in a 2 phases. Both phases involve building a namelist “.in” file that contains the details for that particular step. First, you must run RIPDP (./ripdp command), which takes the WRF output and builds the variables and intermediate files that RIP uses to create plots. You’ll want to create a folder in your WRF output directory to hold these intermediate RIP files. Second, you run RIP (./rip commands), which uses your chosen “.in” file to specify what variables to plot, what times to plot, etc.

As I was running RIP, I saved the commands for each model run in a text file, which is found at the link below. You can also use this as an example for how to use/run RIP if you’re having trouble.

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/Neemann%20RIP%20commands.txt>

Typically, if you only care about the inner domain only run RIPDP on the inner domain. Most of my thesis research data was from domain 3, but I did a lot of testing with PBL and microphysics schemes that only used 2 domains. For this reason a lot of my RIP commands are only for domain 2.

**6 – CMAQ data**

The CMAQ (air quality model) files that Lance Avey from Utah DAQ sent me are different than the standard wrfout files, but they are still NetCDF files that I read and created plots with in MATLAB. First, there are separate files for the domain, meteorology, and air chemistry data. Since the domain file is same for my runs, I kept it in the “CMAQ” folder described in Section 2. I don’t use the meteorology data from CMAQ, but an example of this file is also in the “CMAQ” folder. It is basically a dumbed down version of wrfout with fewer variables, and I only use it to get model heights. Finally, the air chemistry files are in the folders for the corresponding CMAQ run, as described in Section2.

The domain used in CMAQ is different than my WRF domain (the 4km domain). It is a little smaller horizontally, and has only 19 vertical levels. The CMAQ domain keeps the bottom 8 or so vertical levels in WRF, then it starts skipping 1-2 levels above the bottom 8, so they are more spaced out. This is accomplished by the Meteorological-Chemistry Interface Preprocessor (MCIP) as part of the CMAQ system. MCIP produces both the domain and meteorology files.

 It will probably help to do an “ncdisp” command on the each file type so you can get an idea for what exactly is on them. Here’s a basic explanation

* **Domain file (“GRIDCRO2D\_13\_32\_38\_DM2\_1”)** – Contains lat/lon, terrain height, etc. that my code (ex: ACP\_fig15ab\_CMAQ\_ozone.m) uses for plotting. This file is 153x156x1x1 and only contains 1 vertical layer and 1 time, so the data is static.
* **Air chemistry files (“CCTM.13\_32\_38\_DM2\_12.CONC.032”)** – Contains a huge number of variables for different chemical compounds and tracks their concentrations. I really only used ozone (‘O3’ variable). Two numbers in the filename refer to model run and time. The number before ‘CONC’ is the different for each model run (12 = the snow case, for this example), but I already keep them in different directories to avoid confusion. The number at the end refers to the Julian day, so each folder has files \*.032 thru \*.037 referring to 1 Feb through 7 Feb (from 2013). I’m not sure what the other numbers mean, but could be related to the year (13) and start/end Julian dates of the model run, but they aren’t important. The air quality files are 153x156x19x25, meaning they have 19 vertical levels and 25 times. The times are hourly, but for some reason include 00Z for both the start and end of the Julian day. This duplicate of data on the endpoints is annoying, but I accounted for it when creating time series and time averages in my MATLAB code dealing with CMAQ.
* **Meteorology file (“METCRO3D\_13\_32\_38\_DM2\_1”)** – Contains a handful of meteorological variables (temp, press, density, wv, and microphysics, etc). This file is 153x153x19x145, meaning it has 19 vertical levels and contains all 6 days of data (145 hours) in one file. The only variable I actually use from this file is “ZF” which is the “full-layer height above ground”. When I create the ozone cross-sections, I plot them based on the average of this full-layer model height. (I only received the one meteorology file from DAQ in order to get the model height data, and it may be a little sloppy to use the same file to plot data to an average model height for all three simulations.)

**7 – Modified Code Sections**

The WRF code modifications I made can be found here:

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/WRF_modified_code/>

The snow cover and albedo modifications were made to the “module\_initialize\_real.F” files, the vegetation parameter tables edits were made in the file “VEGPARM.TBL\_EMN\_SNUPedits”, and the microphysics edits were made in “module\_mp\_thompson\_Oct2013\_bot15IAUoff\_EMN.F“. I also have the “namelist.input” and “namelist.wps” files in this directory for the 1-6 Feb 2013 CAP. The specific edits I made in most bits of code can be found by searching for my initials “EMN” to see where edits start/end and read comments about the edits.

The modifications used for running tracers in WRF is in the “Tracer\_edits” folder. An explanation for these edits can be found in more detail in the email chain here:

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/WRF_modified_code/Tracer_edits/Tracer_steps_email_chain.docx>

**8 - ACP Figures**

The document explaining which scripts (RIP & MATLAB) were used to produce the figures in our UBWOS paper submitted to ACP can be found here:

<http://home.chpc.utah.edu/~u0818471/Documents/2014/Continuity/ACP%20Figure%20Explanations.docx>