**Hawaii Weather Research Forecast Model Data Processing Instructions**

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## Getting Started

This workflow requires R and ArcGIS 10.X. R is free, ArcGIS is not. For working with R, I highly recommend using RStudio (<https://posit.co/> now called posit, apparently).

This guide will cover 2D and 3D data products. The 2D data products are available from the USGS via the internet. The 3D data products are on physical hard-drives at the University of Hawaii Manoa. It will require a person to physically access the hard drives to extract any desired data.

All scripts (and this User’s Manual!) are available on GitHub: [www.github.com/akeyel/HI\_WRF](http://www.github.com/akeyel/HI_WRF).

In file names, ok indicates Oahu/Kauai and hm indicates Hawaii Big Island and Maui. Unfortunately the data conventions for the download differ between the two sets of islands, but once they are converted to daily files, the four islands should all use the same processing steps.

## Processing Notes

* January 1 1996 was missing from the present day runs.
  + For rainfall, for Maui and Hawaii this day was interpolated by assigning the rainfall that fell on Jan 1 and Jan 2 over the two day period evenly to the intervening hours.
  + For Oahu and Kauai, it was assumed no rainfall fell during that 24 hour period (due to the missing i\_rain variable). This could be adjusted on the daily aggregates if so desired.
* Data were processed on Hawaii time rather than GMT time.
  + Due to the GMT offset of 10 hours, the last year was missing 10 time steps.
  + These timesteps were filled in using the 364th day of the 2009 run to capture recent synoptic conditions.
* Day 365 for the year 2007 for Maui RCP 4.5 had negative rainfall and corrupted I\_RAIN values. This day’s values were replaced with those from day 364.
* The I\_RAIN variable was missing for Oahu and Kauai. We used the difference in precipitation between each hours. This will underestimate rainfall if more than 100 mm falls in a 1 hour period. (based on Maui data, that heavy of rainfall was a relatively rare event).

## Overview of Scripts

Workflow.R This is the main script for processing the 2D data. It will call other scripts in the required order. It is best run interactively with one section at a time, as sometimes a step will result in error or may take some time for processing, in which case it may need to be re-run or corrected before attempting the next step. See 2D Data below for details on the scripts used by this workflow.

Variables.R: This script provides an overview of the 2D variables in the WRF file available for use.

Workflow\_hlpr.R This script contains the functions used by the other scripts. It is best navigated by searching for the desired function, as the functions are present in no particular order, and I navigate it using the search option.

## 2D Data

To download the precipitation data, the workflow is laid out in Workflow\_ppt.R.

The workflow will need to be run separately for each island.

The workflow consists of the following major tasks:

Load Functions: (Workflow\_hlpr.R), loads functions into memory but does not perform any actions

Load Settings (e.g., 000b\_PrecipSettings.R) Runs a settings file, , which contains instructions on how to run the rest of the processing. This will load variables into the active session.

Make a grid (was only run once, no need to run again) #\*\*# Pull out into a separate script then!

Download the chosen variable(s) for each scenario (0000\_Data\_Downloader.R). Downloads the data for an island. The speed of this script will depend on your internet connection, and may take several hours per island and scenario. The resulting data download may be large (10’s of GB)

#\*\*# DO WE NEED AN ANNUAL HOURLY FILE? #\*\*#

Process the downloaded hourly data into a daily file (001c\_ExtractAnnual\_hm.R, 001c\_ExtractAnnual\_ok.R, note that oahu/Kauai process much slower due to the missing I\_RAIN variable and the need to calculate differences hourly.)

Convert the daily files to .csv format (Daily\_to\_geotif.R)

Convert the .csv format to raster using ArcGIS tool 003c\_CSV\_to\_Rainfall\_Atlas\_Daily.py (add the ArcGIS Toolbox and the script tool should be available)

Process the daily data into aggregates (monthly and annual climatologies) (#\*\*# ProcessAnnual? Needs re-evaluation now that daily files are created differently)

## 3D Data

## Troubleshooting

**How to add an ArcGIS toolbox to ArcGIS and run it?**

Open ArcGIS

Right click on white space on the Toolbox

(if the toolbox is not open, it can be found XXXX)

Select “Add Toolbox”

Navigate to where the XXXX toolbox is stored. (if you did not download it from GitHub, you will need to download it. If you copied all the files from GitHub, it should be wherever you copied them)

Open the toolbox and find the tool that you want to use!

**I have ArcGIS Pro. Will the Toolbox tool still work?**

No. ArcGIS Pro uses Python 3 and ArcGIS 10.X uses Python 2. The Toolbox tool is written in a different version of Python, and would need to be adapted to Python 3 and ArcGIS Pro. Please contact me if this is something that is needed.

**I got this error or something similar while downloading the data:**

**CURL Error: Failure when receiving data from the peer**

**Error in Rsx\_nc4\_get\_vara\_double: NetCDF: DAP failure**

**Var: RAINNC\_rcp85 Ndims: 3 Start: 17579,0,0 Count: 8785,64,82**

**Error in ncvar\_get\_inner(ncid2use, varid2use, nc$var[[li]]$missval, addOffset, :**

**C function R\_nc4\_get\_vara\_double returned error**

Sometimes it has memory issues while downloading. Find the spot where the download script left off and try to resume there (by running the DataDownloader manually with appropriate start/end numbers. Alternatively, you can try downloading everything again in a new session (perhaps reboot the computer to try to free up any memory that may have been tied up, or try running it with fewer other processes at the same time).

**I am running the downloader script, but it is not doing anything.**

Stop the R process, restart R, check your internet connection, and try again. Likely the internet connection was disrupted, the process hung up. If you are careful, you can adjust the start and end points to run for just the remaining files, instead of re-running for everything.

**There are small negative values in the array when I switch from hourly to daily**

This appears to be a rounding error related to the interpolation. This will be corrected at a later step, or one can take the data out of array, replace with 0’s, and then put the data back into an array format to correct it. (this was not done to avoid getting the order wrong, and there may be an easier tool for this!)

## Acknowledgements