# ATTACHMENT 2

# Methodology for Future Design Storms

**District of Columbia Climate Change and Vulnerability Assessment**

*Prepared by Kleinfelder, June 2015*

The emissions scenarios chosen for the District of Columbia climate assessment include RCP 8.5, a high emissions scenario, and RCP 4.5, a lower emissions scenario. An ensemble of 9 CMIP5 GCMs with daily temperature and precipitation outputs for the RCP 8.5 and 4.5 emissions scenarios were used. Three weather stations were chosen for their proximity to the study area and the length of climate records. These include Dalecarlia Reservoir, National Arboretum, and Reagan International Airport.

- Data gaps were determined through comparison of model output to raw data from the national climatic data center. Model output consistently omitted February 29 for leap years; and various days and, in some instances, whole months of data are missing from the raw station data. It is not clear what effect these data gaps have on the design storm calculations. No data gaps were filled prior to use in training the climate models with the station data.

ATMOS used the Asynchronous Regional Regression Model (ARRM) to downscale global climate output using observed data from the three weather stations. This method was used to downscale temperature and precipitation projections for all three stations for the period 1950-2100. Three 20 year planning horizons were chosen including: 2015-2034 (2020s), 2045-2064 (2050s), and 2075-2094 (2080s). Model output from 1981-2000 (Present) was compared to observed data to determine the accuracy of the models.

Annual maximum rainfall was calculated for each year in the 20-yr averaging period per GCM per scenario, and those maximums were fit to an extreme value distribution (EVD) per GCM per scenario. 1-, 2-, 15-, 25-, 100-, and 200-year 24 hour and 6 hour design storms were determined from EVD per GCM per scenario per horizon. Median values of all GCMs for each design storm per scenario per horizon were calculated, and then means between lower and higher scenarios (RCP 4.5 and 8.5) were determined for each design storm per horizon.

- 24-hr and 6-hr design storms were compared to the Atlas 14 point precipitation frequency estimates (for each of the weather stations used) for the chosen recurrence intervals (1, 2, 15, 100, and 200 years). It was determined that the calculations for present modeled design storms for 2-, 15-, 25-, 100-, and 200-yr recurrence intervals fit well with the Atlas 14 estimates, but the calculations for the 1-yr interval was not a good match. This discrepancy may be attributable to the difference in the record length between Atlas 14 and our methodology. The NOAA Atlas 14 Precipitation-Frequency Atlas of the United States – Volume 2, which includes the District of Columbia, indicates that estimations are based on a range of data of approximately 55 years (1945-2000). Calculations of design storms for our assessment are based on a 20 year interval (1981-2000).
- There are some discrepancies between the 1- and 2-yr design storms calculated by ATMOS and Kleinfelder. The ATMOS team used an empirical approach to determine these design storms and Kleinfelder used a probability based distribution method, consistent with engineering based design criteria. It is recommended that we remove empirically determined design storm

calculations and report only those calculated by probability distribution methods. This course of action is reasonable considering the fact that the Atlas 14 point precipitation frequency estimates are also calculated by probability distribution.

Finally, bar charts were created to allow for the comparison of the 24-hr design storms for each planning horizon..

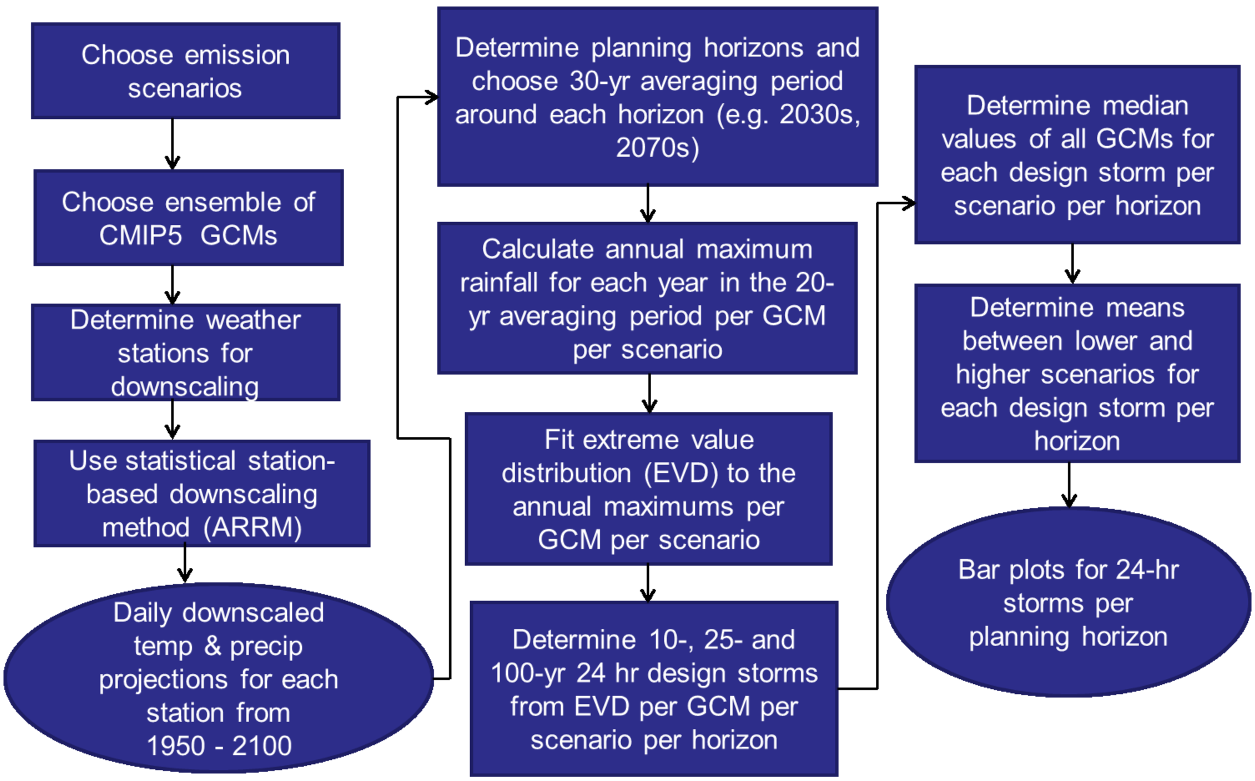


Figure1: Flow Chart illustrating process for developing bar plots