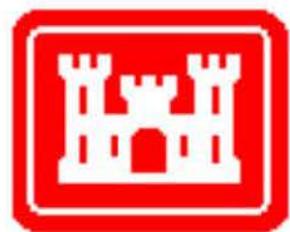


# How to Generate a Watershed Analysis using the USGS Watershed Boundary Dataset



**US Army Corps  
of Engineers®**

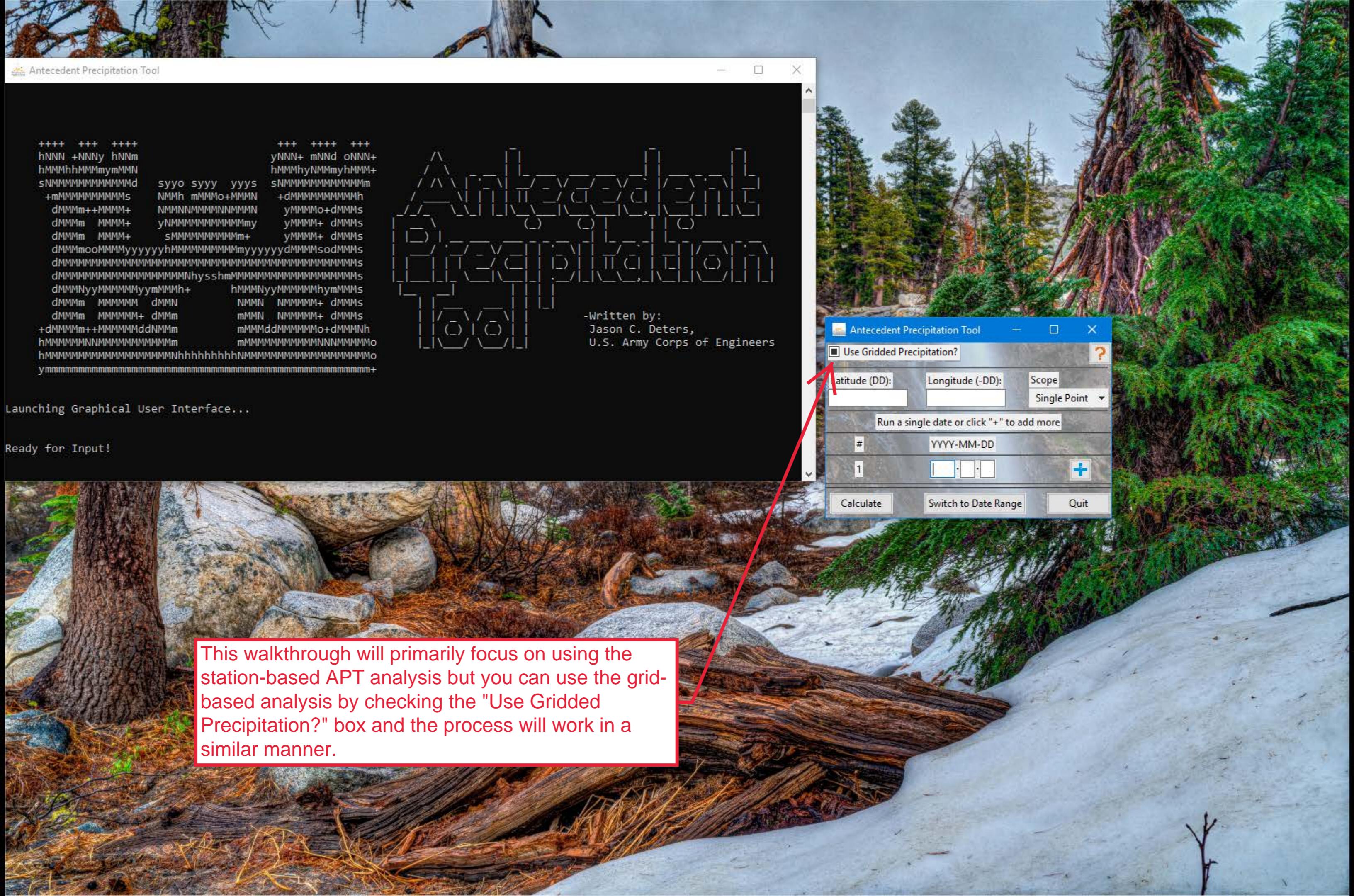


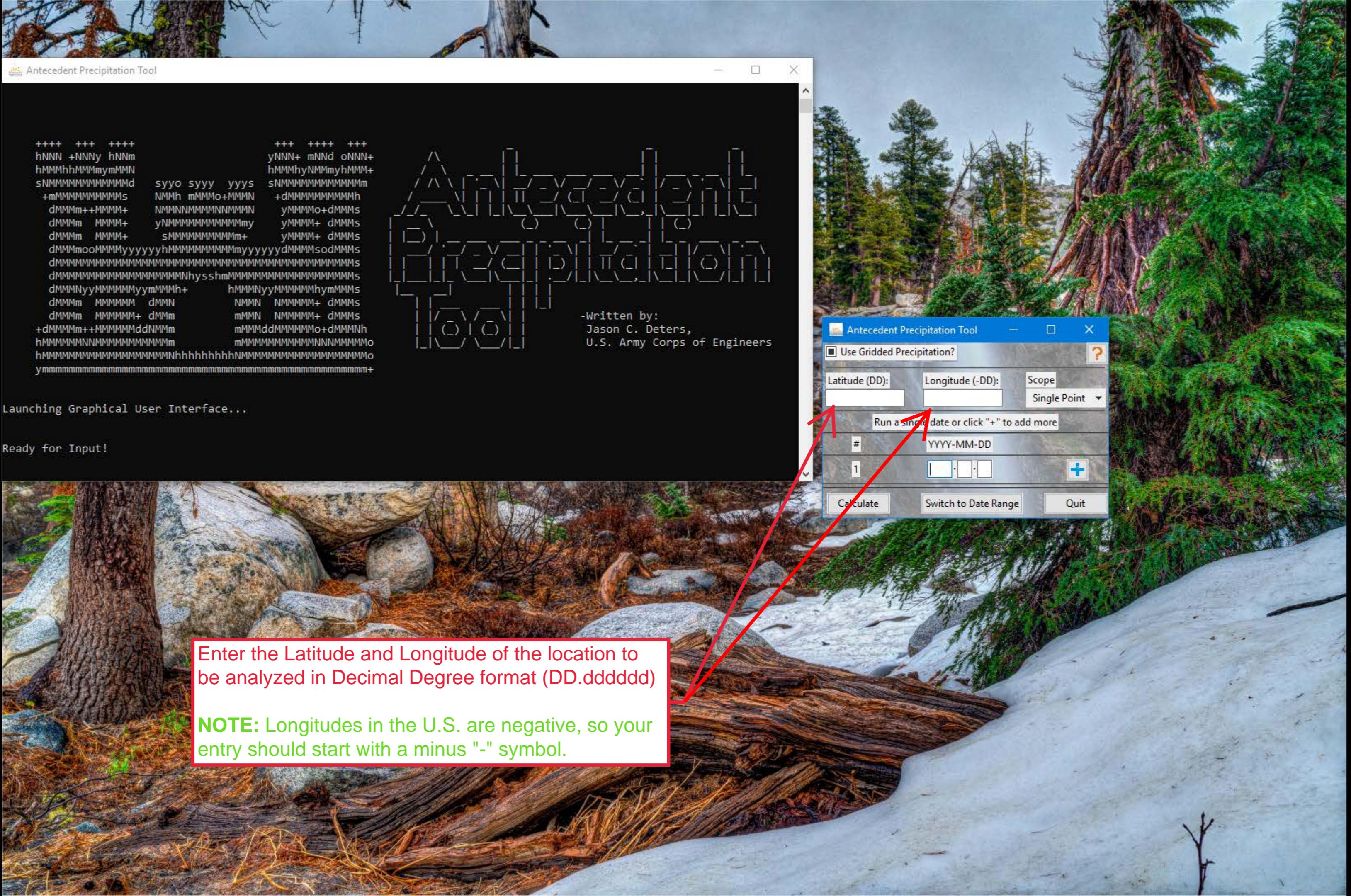
Antecedent Precipitation Tool  
Version 2.0

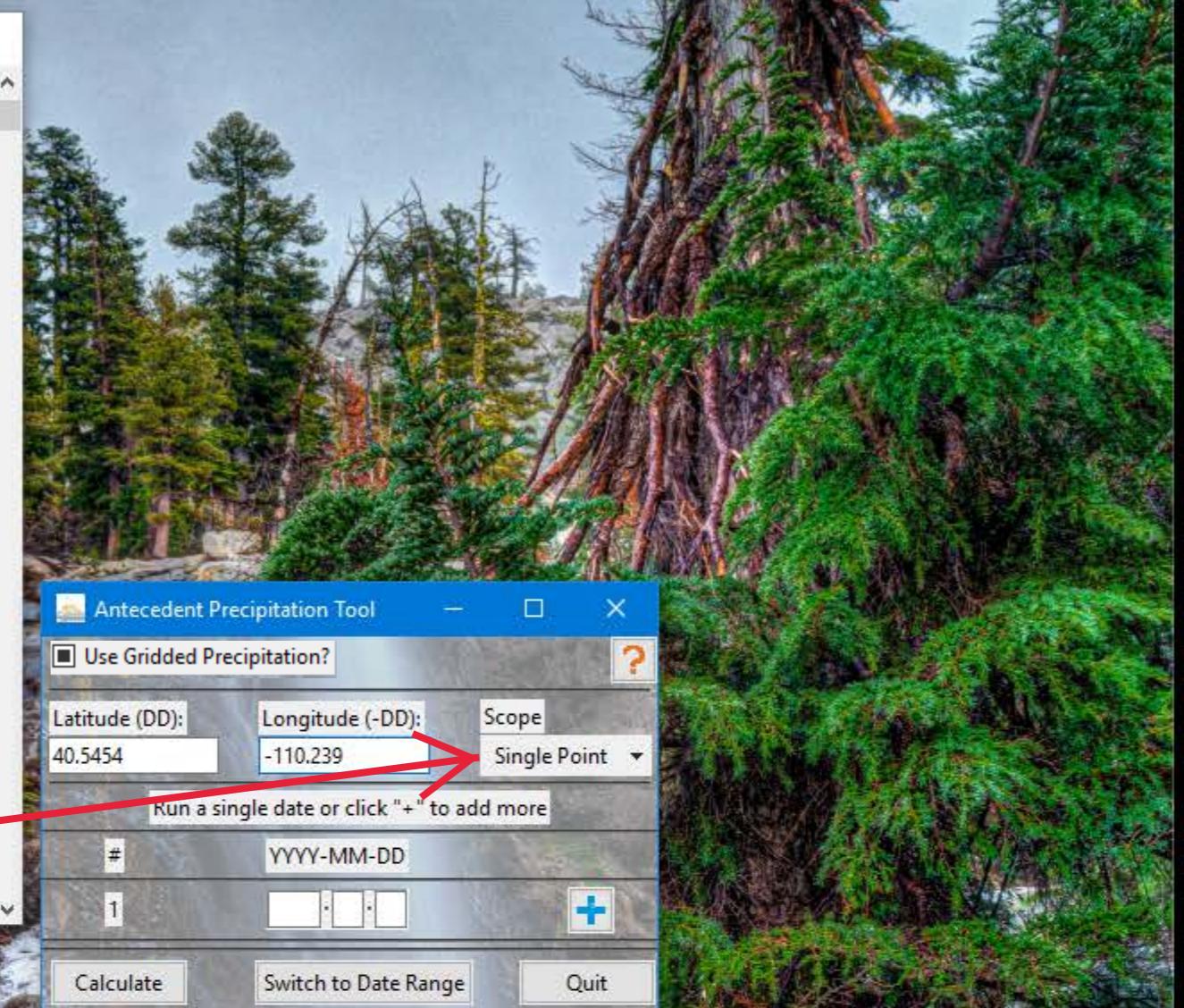
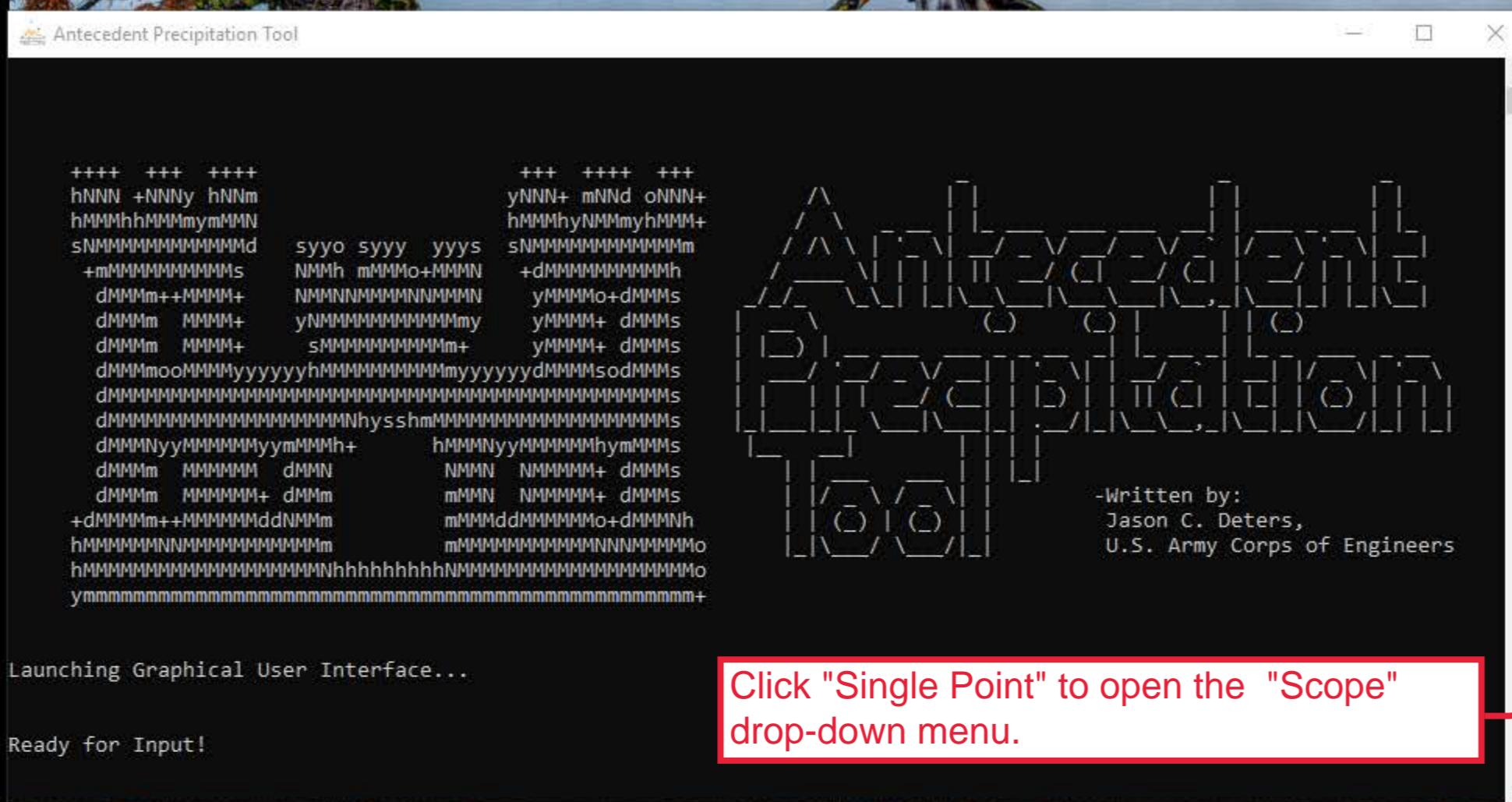
Developed by:  
U.S. Army Corps of Engineers and  
U.S. Army Engineer Research and  
Development Center

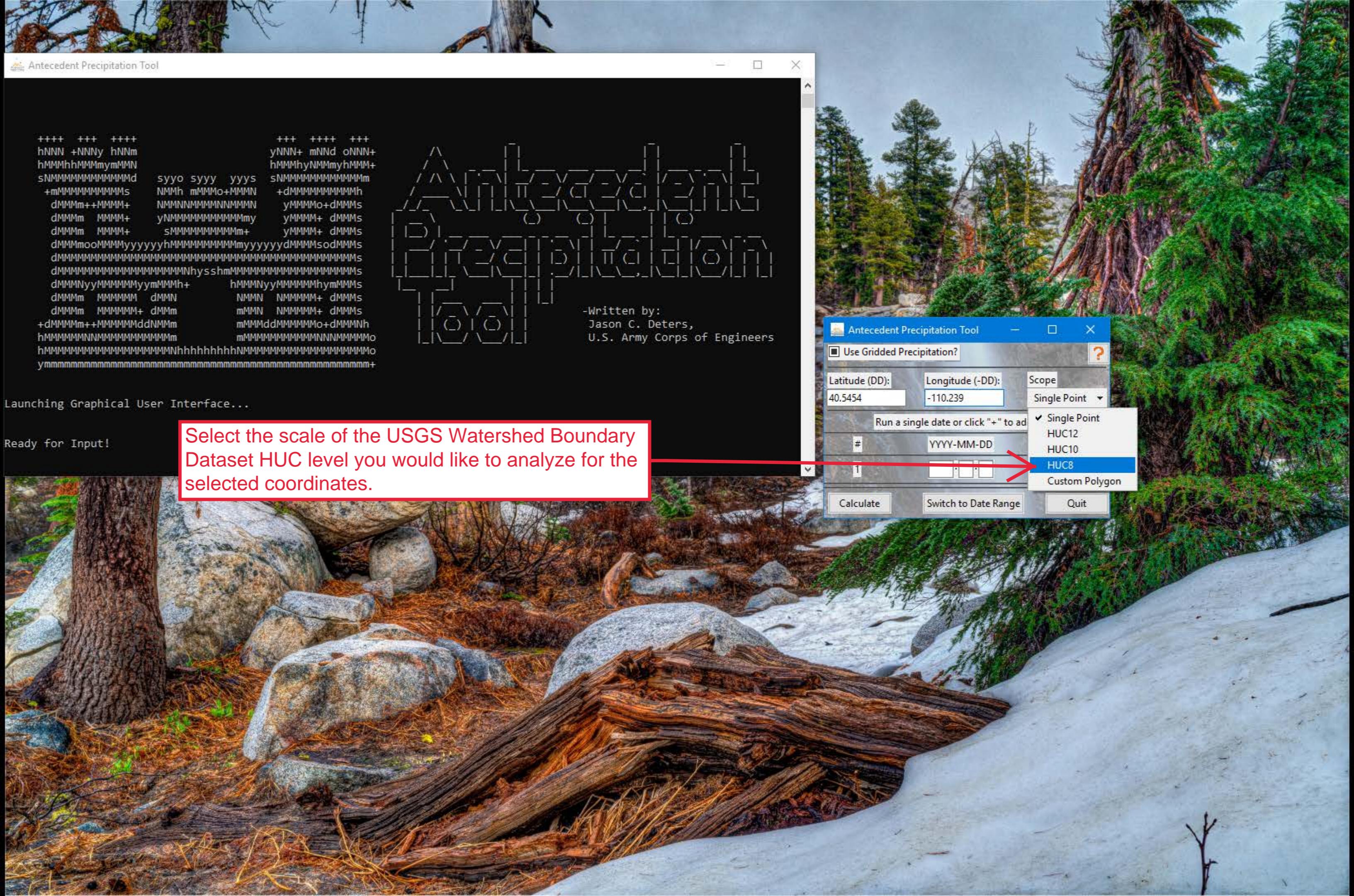
Open the APT

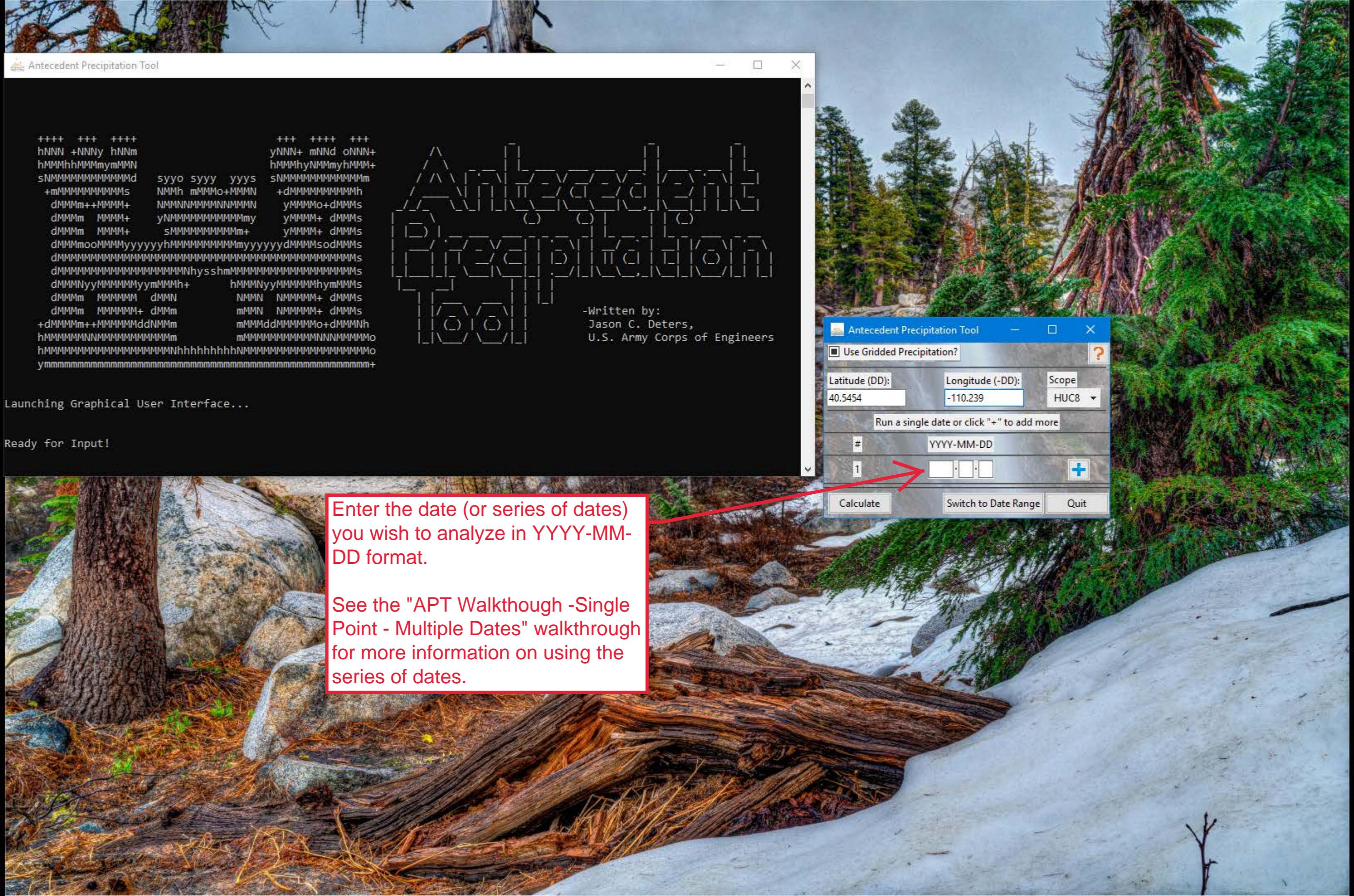






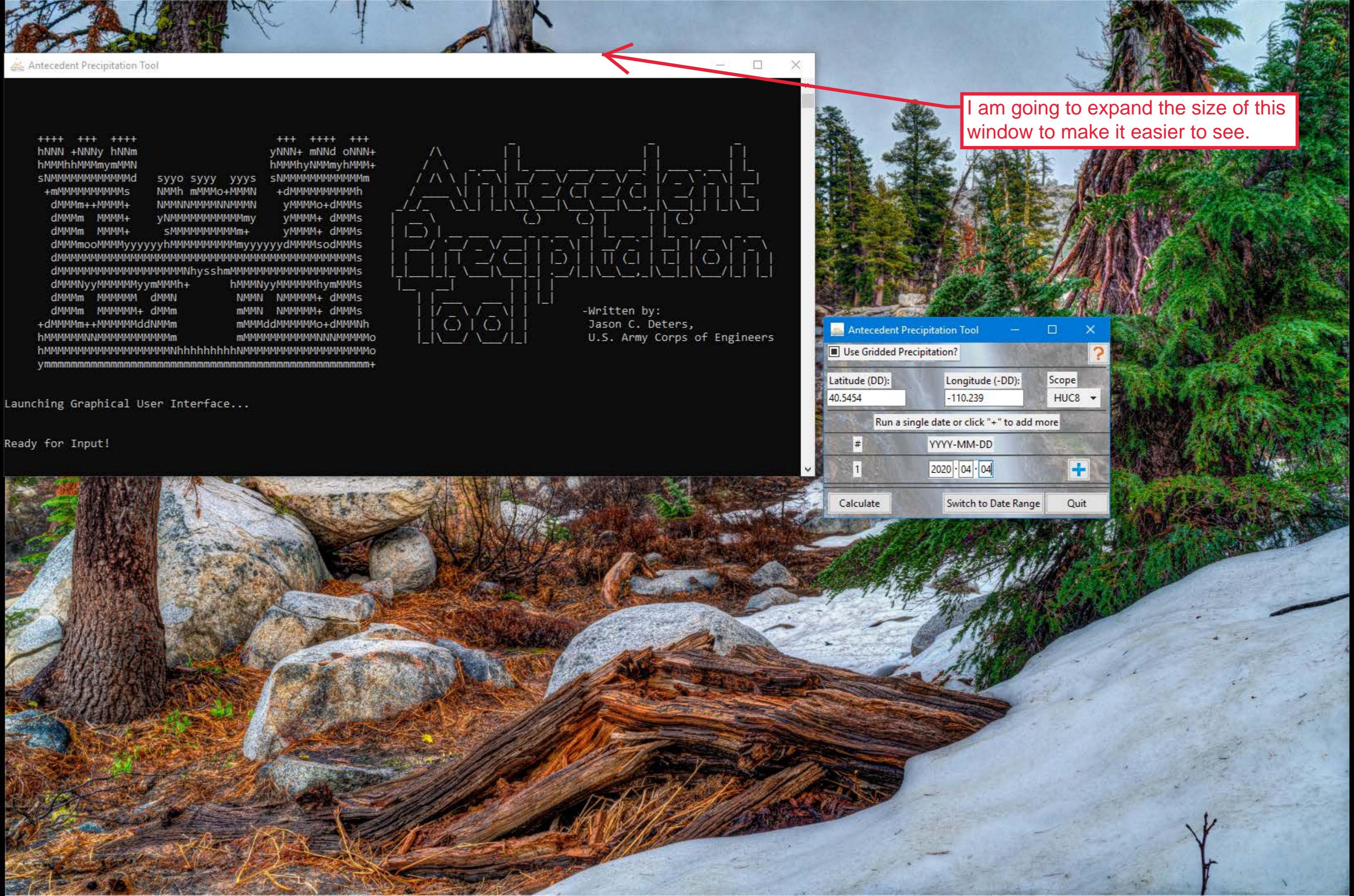


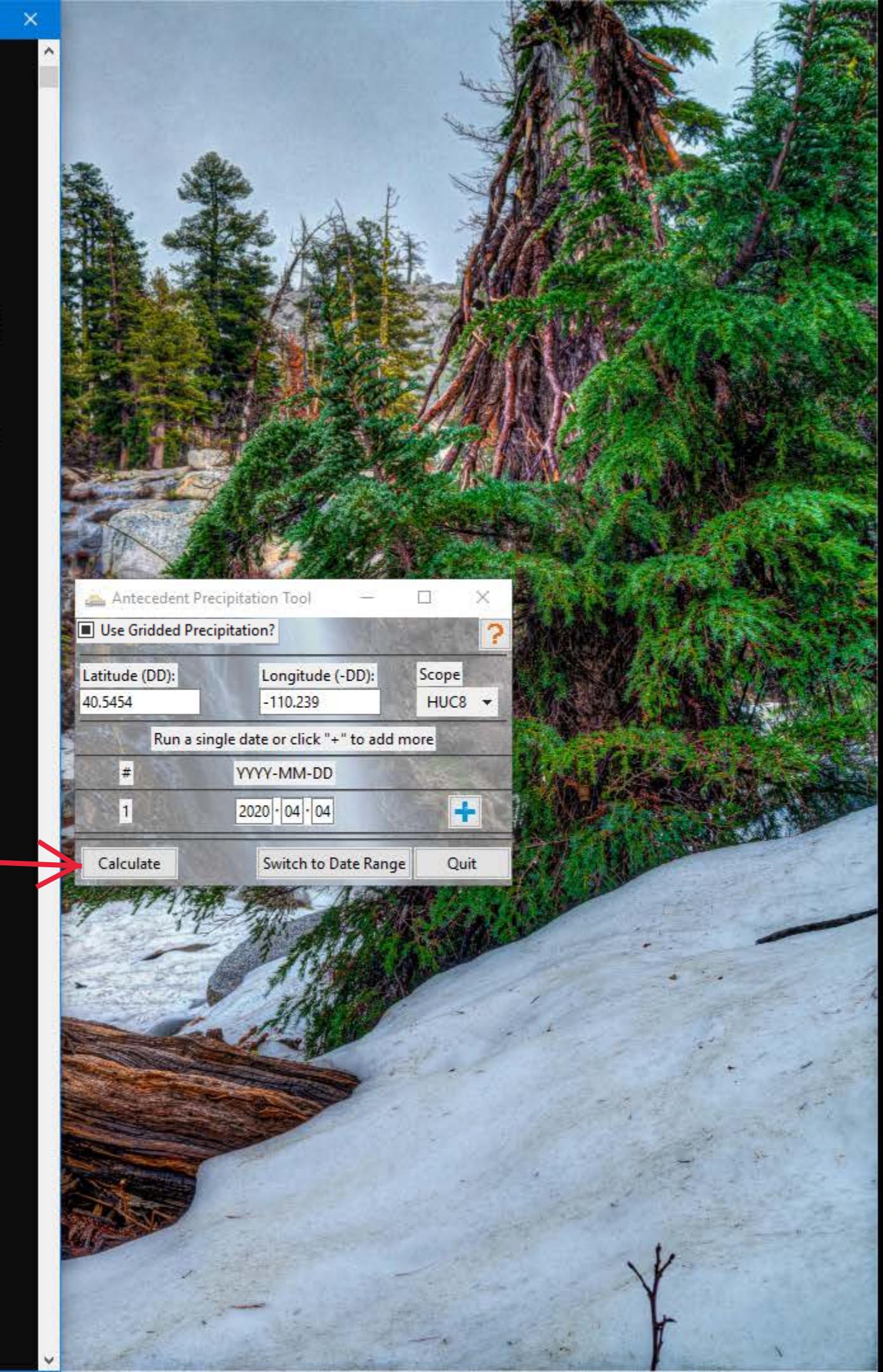
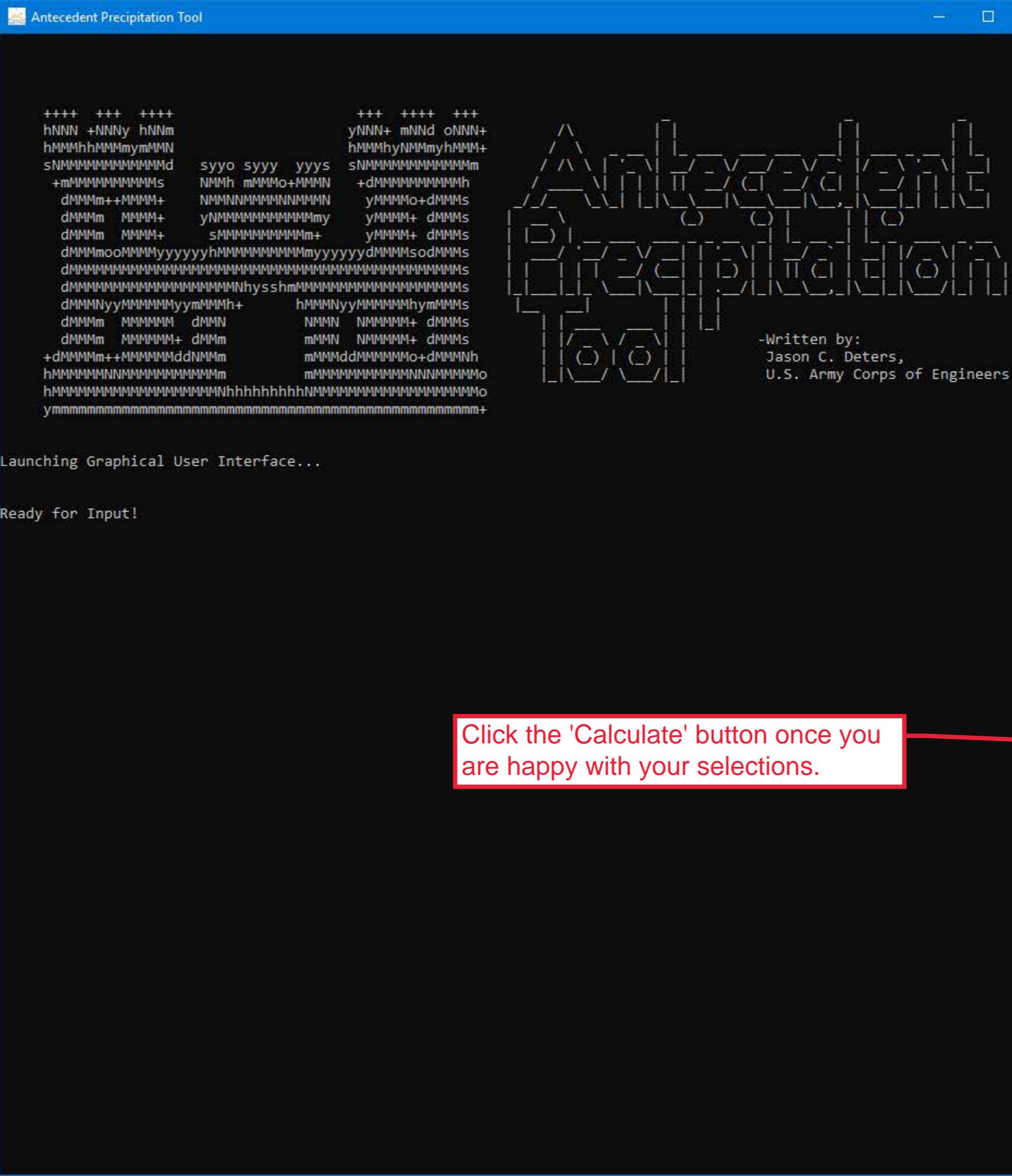






Antecedent  
Precipitati...





Antecedent Precipitation Tool

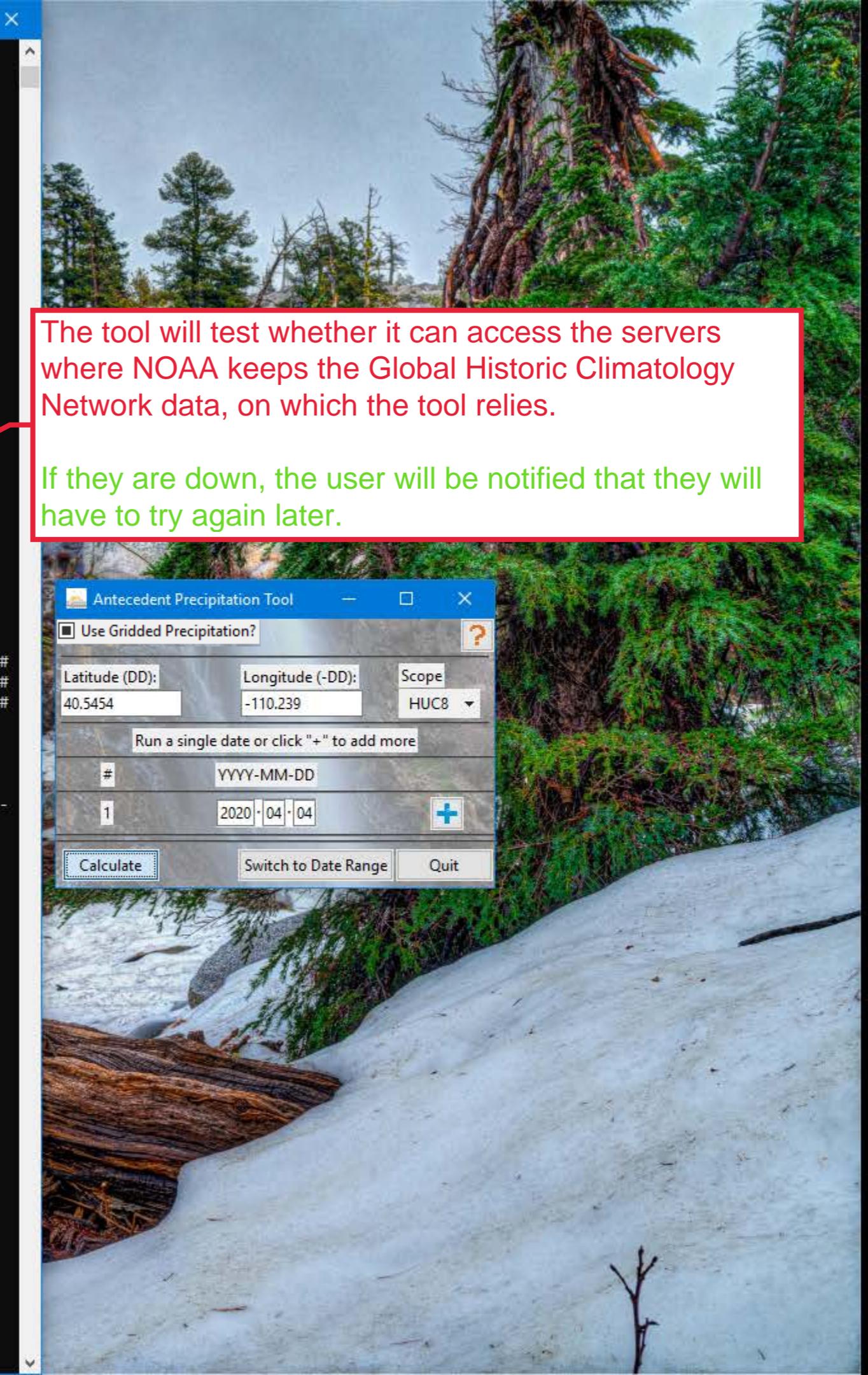
```
++++ +++ +++
hNNN +NNNy hNNm      +++ +++ ++
yNNN+ mNnd oNNN+
hMMhMMmyhMMN      sNNMMMMMMMMMd
+syo syy yyys      yNNN+ mNnd oNNN+
hMMhyNMMmyhMMN+    sNNMMMMMMMMMM
+mMMMMMMMMMs      NMMh mMMy+MMMN
dMMMm++MMMN+      NMMNNMMMNMMMN
dMMm MMM+      yNMmmmmmmmmmy
dMMm MMM+      sMMmmmmmmmm+      yMMMN+ dMMNs
dMMmoMMyyyyyyhMMMMMMMMMMyyyyydMMMsodMMMs
dMMMMMMMMMMMMMMMMMMhysshMmmmmmmmmmmmmmm
dMMNyymmmmmMymMMh+  hMMNyymmmmmhymMMs
dMMm MMMMN dMMN      NMMN NMMMN+ dMMNs
dMMm MMMMN+ dMMn      mMMN NMMMN+ dMMNs
+dMMMN++MMMMMdNNm  mMMddMMMMMo+dMMNh
hMMMMNNMMMMMMMMm  mMMMMMMMMMMNNMMMM
hMMMMMMMMMMMMMMNNhhhhhhhNMMMMMMMMMMMM
ymmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmm
```

-Written by:  
Jason C. Deters,  
U.S. Army Corps of Engineers

Launching Graphical User Interface...

Ready for Input!

```
#####
# NOAA Server Status Check #
#####
Server Base URL = https://www1.ncdc.noaa.gov/pub/data/ghcn/daily
Testing if NOAA's Server is currently accessible...
Attempting to download: https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/readme.txt
NOAA's Servers ONLINE. Proceeding with request...
```

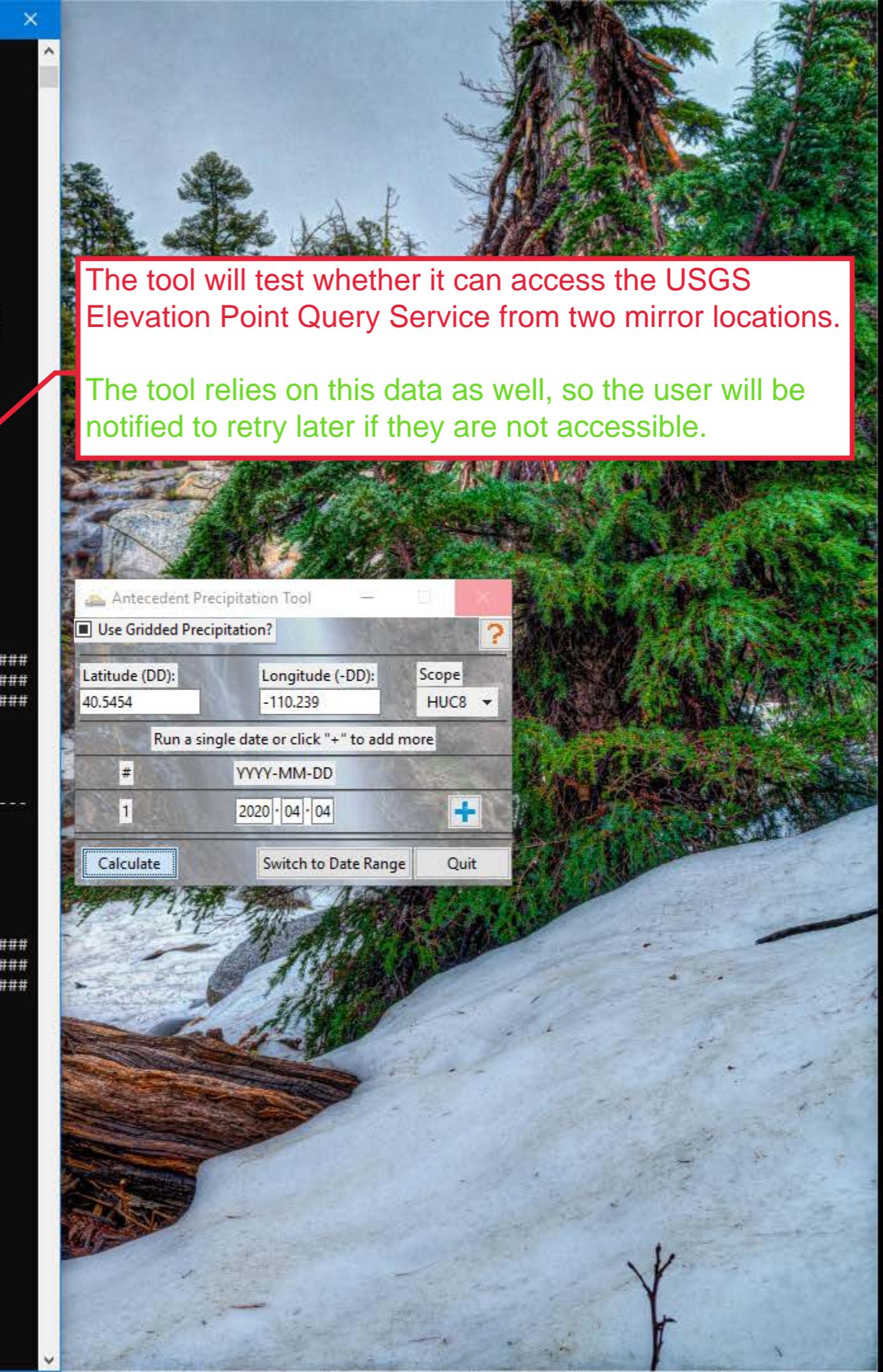
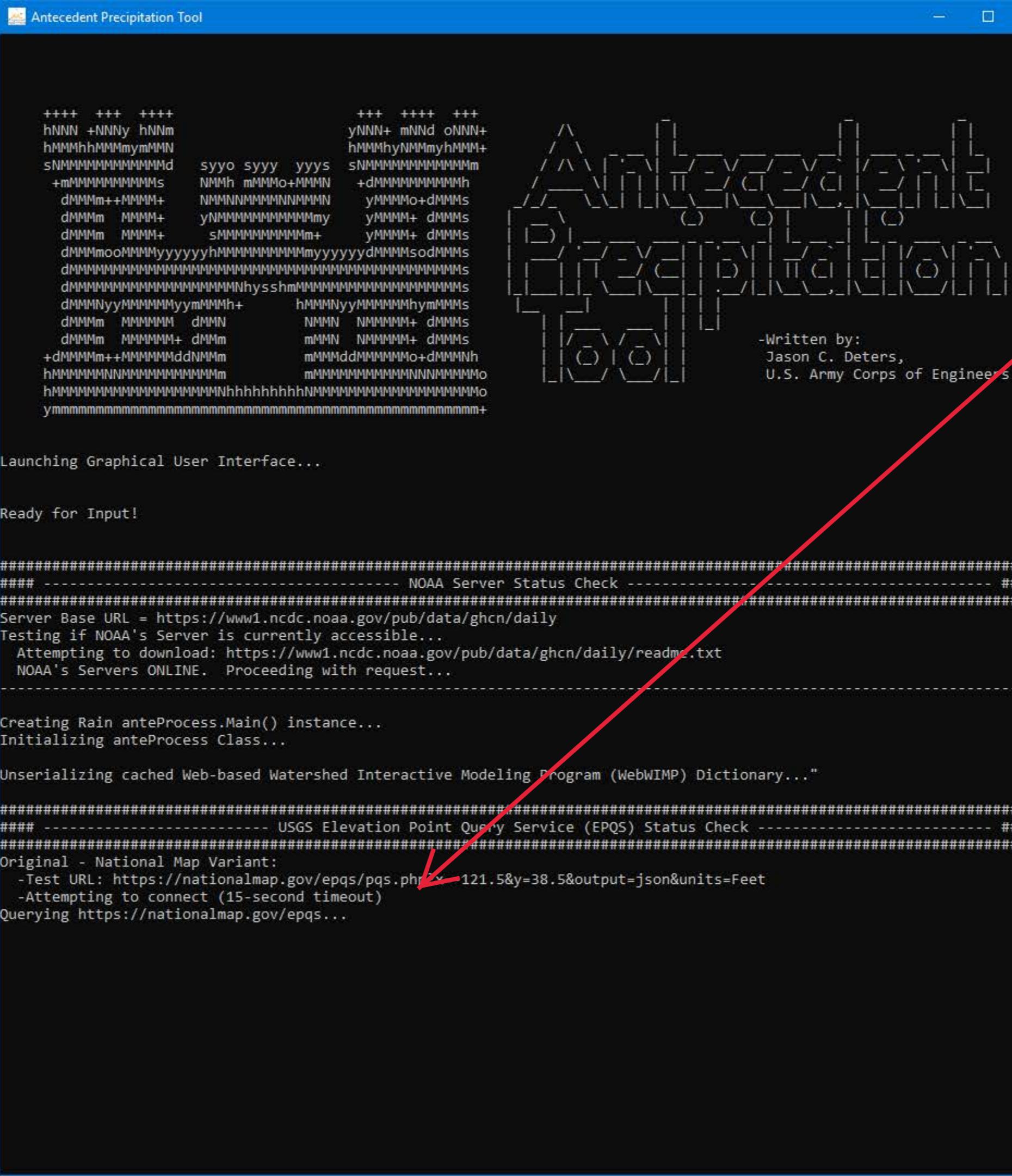


The tool will test whether it can access the servers where NOAA keeps the Global Historic Climatology Network data, on which the tool relies.

If they are down, the user will be notified that they will have to try again later.



Antecedent  
Precipitati...



Antecedent Precipitation Tool

```

dMMMd  MMMM+  yNMMMMMMMMMMMy  yMMMM+ dMMMs
dMMMd  MMMM+  sMMMMMMMMMMm+  yMMMM+ dMMMs
dMMMooyyMMyyyyyyhMMMMMMMMMMMyyyyydMMMsodMMMs
dMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMs
dMMMMMMMMMMMMMMhysshMMMMMMMMMMMMMMMMMMMMMMMs
dMMNyymMMMMMyymMMh+  hMMNyymMMMMMyhmMMs
dMMm  MMMMM  dMMN  NMMN  NMMMM+ dMMMs
dMMm  MMMMM+ dMMm  mMMN  NMMMM+ dMMMs
+dMMMMm++MMMMMdNm  mMMMdMMMMMo+dMMNh
hMMMMNNNMNMNMNMNM  mMMMMNMNMNMNMNMNMNMNM
hMMMMNMNMNMNMNMNM  NMNMNMNMNMNMNMNMNMNMNM
yMMMMNMNMNMNMNMNM  NMNMNMNMNMNMNMNMNMNMNM

```

Launching Graphical User Interface...

Ready for Input!

```

#####
##### - NOAA Server Status Check -
#####
Server Base URL = https://www1.ncdc.noaa.gov/pub/data/ghcn/daily
Testing if NOAA's Server is currently accessible...
Attempting to download: https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/readme.txt
NOAA's Servers ONLINE. Proceeding with request...

Creating Rain anteProcess.Main() instance...
Initializing anteProcess Class...
Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary...
#####
##### - USGS Elevation Point Query Service (EPQS) Status Check -
#####
Original - National Map Variant:
-Test URL: https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet
-Attempting to connect (15-second timeout)
Querying https://nationalmap.gov/epqs...

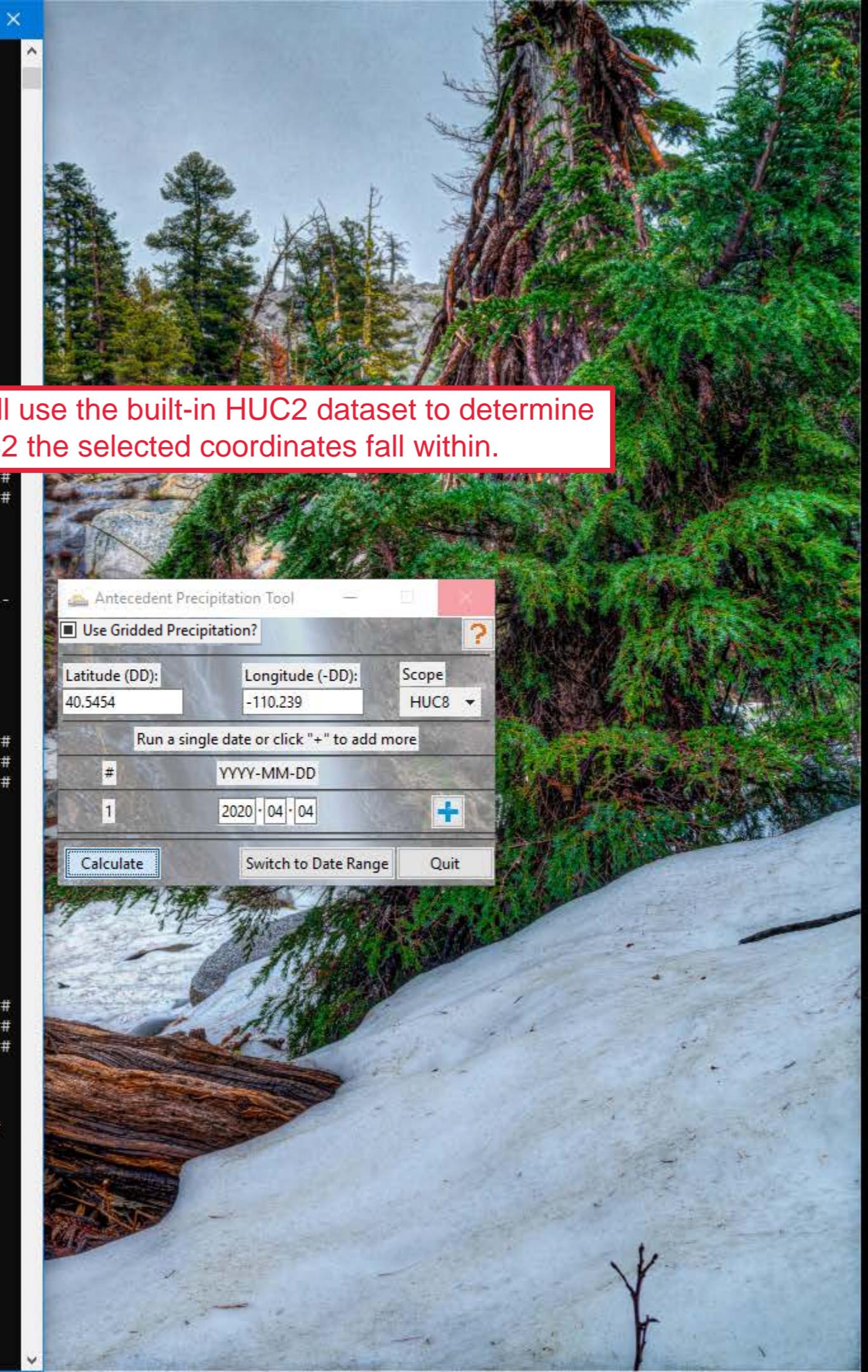
#####
# --- National Map EPQS Server Online ---
#####

#####
##### - WATERSHED IDENTIFICATION AND RANDOM SAMPLING -
#####
Selected Watershed Scale: HUC8
Identifying and sampling watershed...

#####
#----- Watershed (HUC8) Identification Section -----
Identifying HUC2 Watershed
Checking for existing Watershed Boundary Data...
Watershed Boundary Data found
-Reading local HUC2 dataset
-Filtering HUC2 features by spatial overlap with selected coordinates...
HUC2: 14
Area: 113347.01 square miles

Identifying HUC8 Watershed
Checking for existing Watershed Boundary Data...

```



Antecedent Precipitation Tool

```

dMMMd  MMMM+  yNMMMMMMMMMMMy  yMMMM+ dMMMs
dMMMd  MMMM+  sMMMMMMMMMMm+  yMMMM+ dMMMs
dMMMooyyMMyyyyyyhMMMMMMMMMMMyyyyydMMMsodMMMs
dMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMs
dMMMMMMMMMMMMMMhysshMmmMMMMMMMMMMMMMMMMMMMMMs
dMMNyymMMMMMyymMMh+  hMMNyymMMMMMyhmMMs
dMMMd  MMMMM  dMMN  NMMN  NMMMM+ dMMMs
dMMMd  MMMMM+ dMMm  mMMN  NMMMM+ dMMMs
+dMMMd++MMMMMdddNMm  mMMMdMMMMMo+dMMNh
hNNNNNNNNNNNNNNNNNNN  mNNNNNNNNNNNNNNNNNNNNNMo
hNNNNNNNNNNNNNNNNNNNhhhhhhhNNNNNNNNNNNNNNNNNNMo
yNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNMo

```

Launching Graphical User Interface...

Ready for Input!

```

#####
#### - NOAA Server Status Check -
#####
Server Base URL = https://www1.ncdc.noaa.gov/pub/data/ghcn/daily
Testing if NOAA's Server is currently accessible...
Attempting to download: https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/readme.txt
NOAA's Servers ONLINE. Proceeding with request...

Creating Rain anteProcess.Main() instance...
Initializing anteProcess Class...
Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary...

```

```

#####
#### - USGS Elevation Point Query Service (EPQS) Status Check -
#####
Original - National Map Variant:
-Test URL: https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet
-Attempting to connect (15-second timeout)
Querying https://nationalmap.gov/epqs...

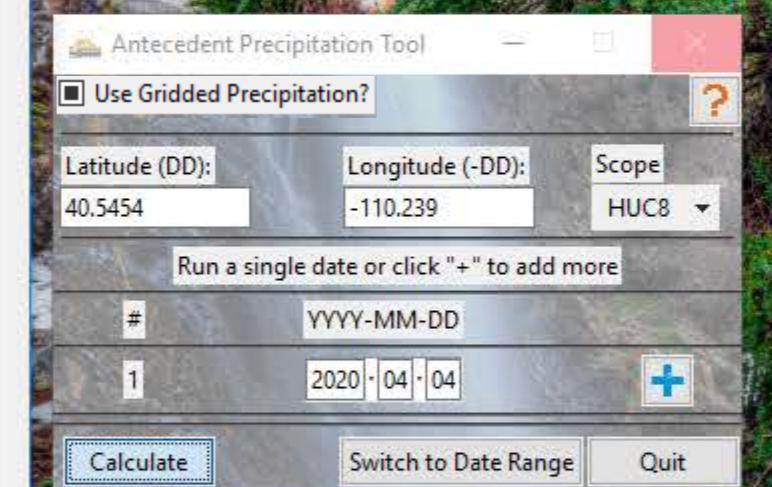
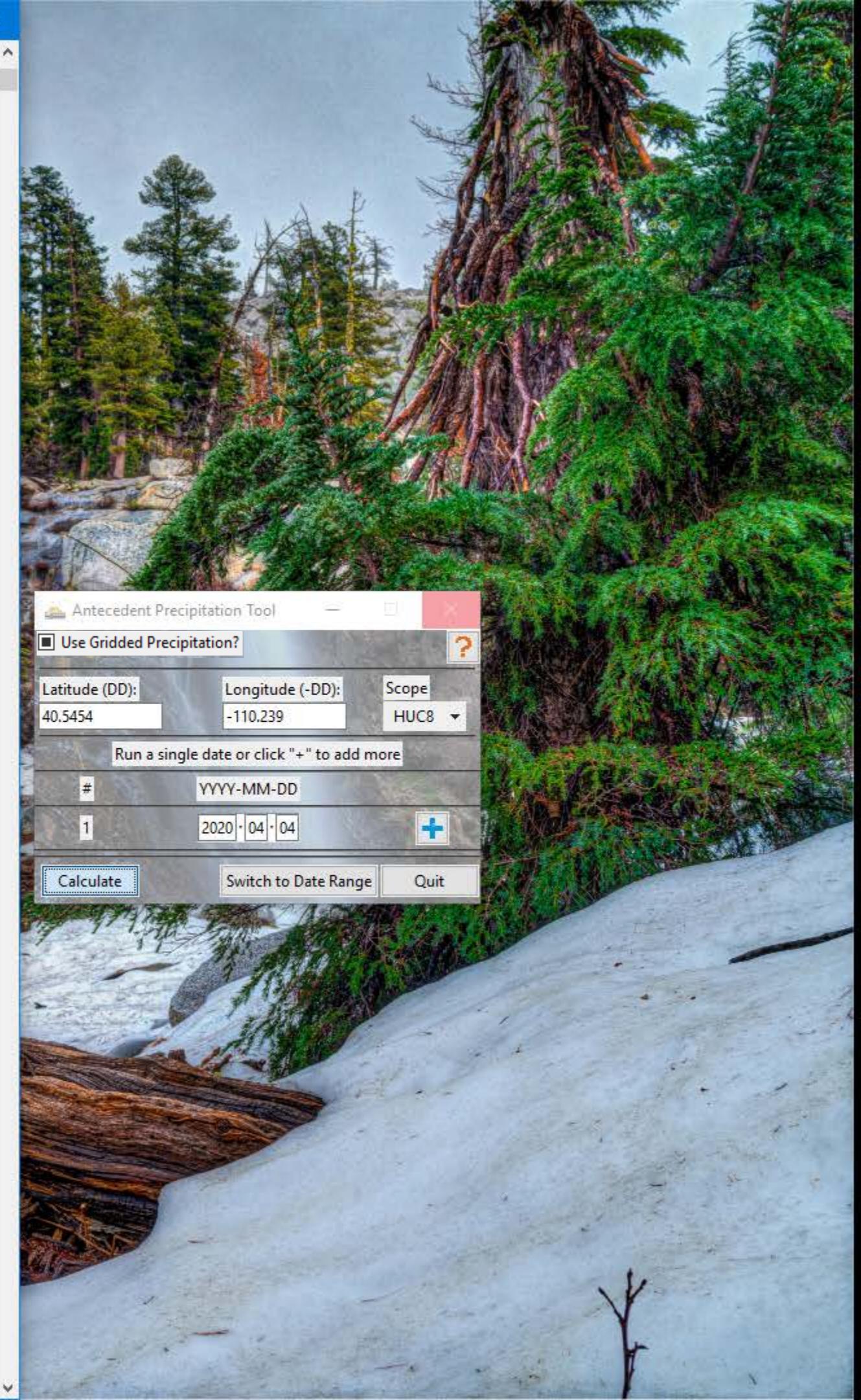
#####
# --- National Map EPQS Server Online --- #
#####

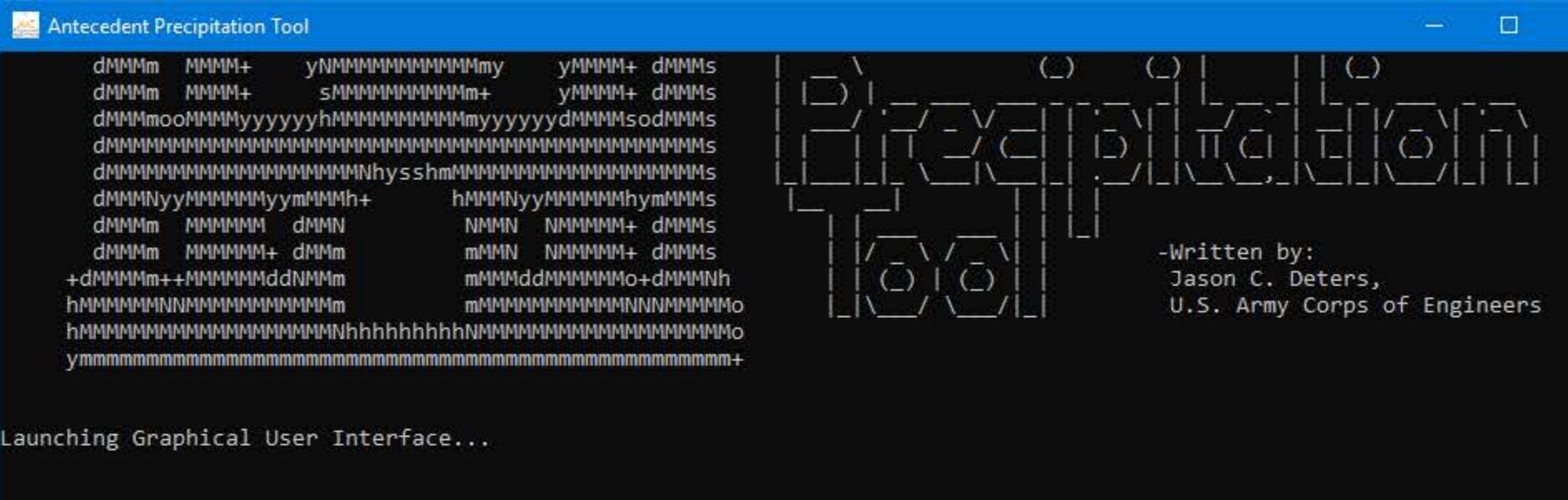
#####
----- WATERSHED IDENTIFICATION AND RANDOM SAMPLING -----
#####
Selected Watershed Scale: HUC8
Identifying and sampling watershed...

----- Watershed (HUC8) Identification Section -----
Identifying HUC2 Watershed
Checking for existing Watershed Boundary Data...
Watershed Boundary Data found
-Reading local HUC2 dataset
-Filtering HUC2 features by spatial overlap with selected coordinates...
HUC2: 14
Area: 113347.01 square miles

Identifying HUC8 Watershed
Checking for existing Watershed Boundary Data...
Downloading WBD_14_HU2_Shape.zip... (416.00 KB)

```





Ready for Input!

```
#####
##### - NOAA Server Status Check -
#####
Server Base URL = https://www1.ncdc.noaa.gov/pub/data/ghcn/daily
Testing if NOAA's Server is currently accessible...
Attempting to download: https://www1.ncdc.noaa.gov/pub/data/ghcn/daily/readme.txt
NOAA's Servers ONLINE. Proceeding with request...

Creating Rain anteProcess.Main() instance...
Initializing anteProcess Class...
Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary...
#####
##### - USGS Elevation Point Query Service (EPQS) Status Check -
#####
Original - National Map Variant:
-Test URL: https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet
-Attempting to connect (15-second timeout)
Querying https://nationalmap.gov/epqs...

#####
# --- National Map EPQS Server Online --- #
#####

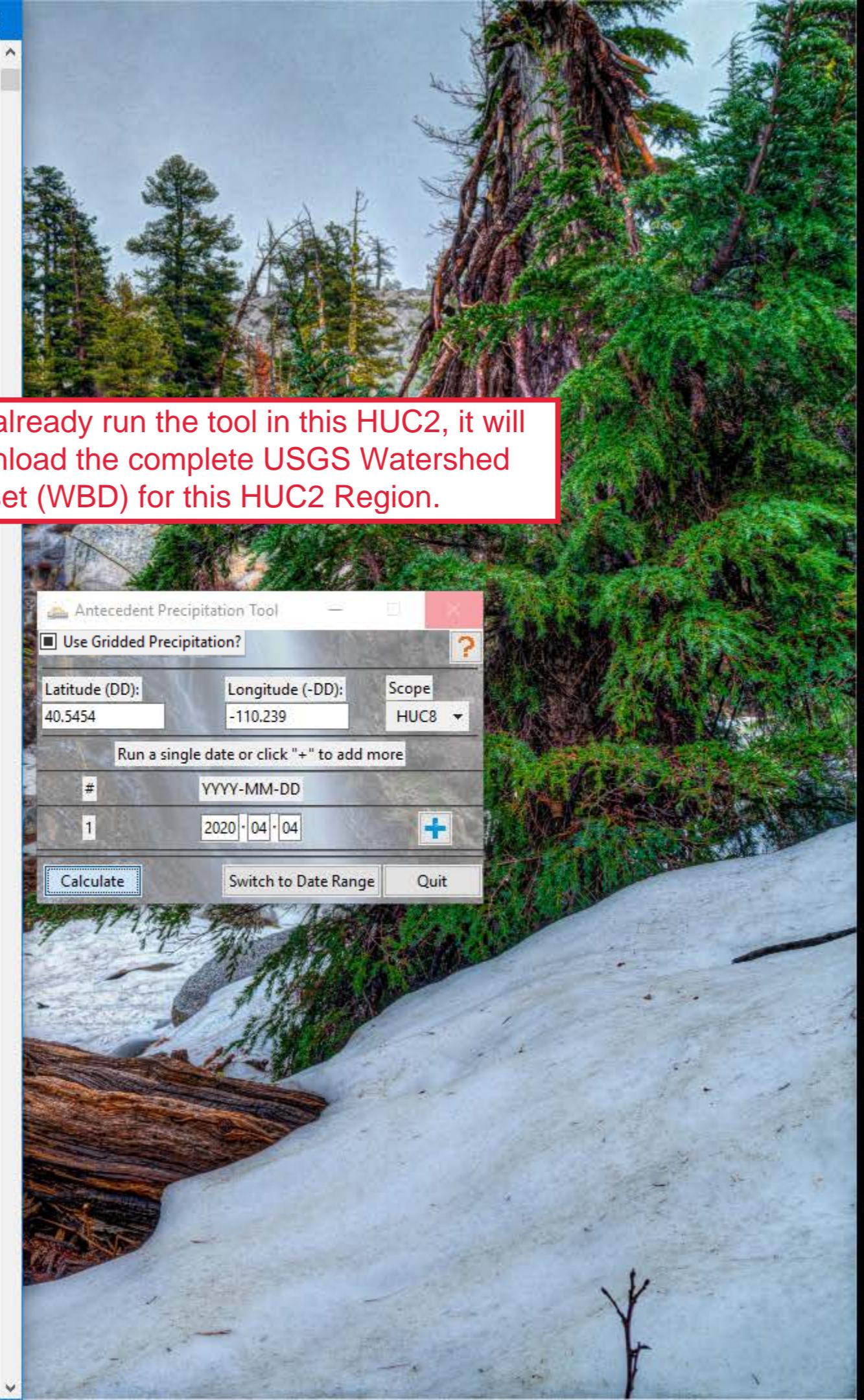
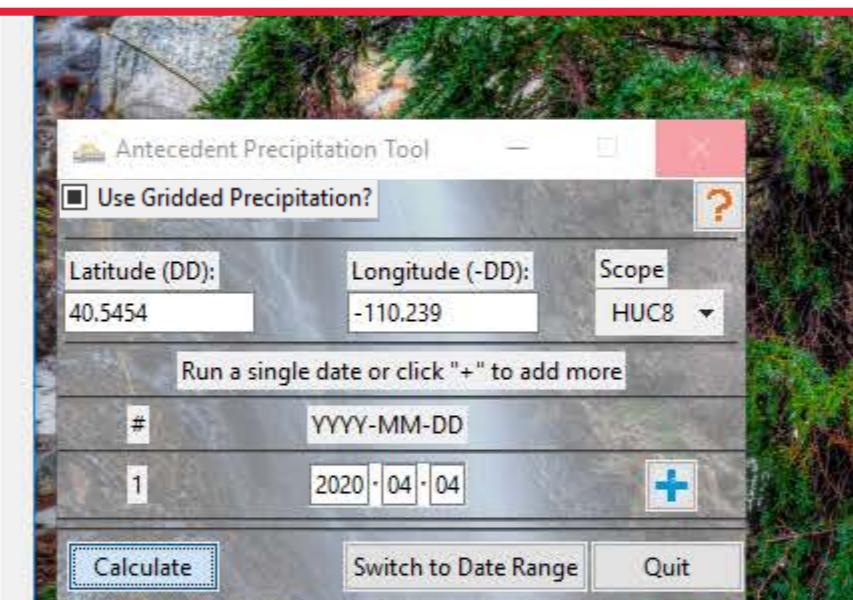
#####
----- WATERSHED IDENTIFICATION AND RANDOM SAMPLING -----
#####
Selected Watershed Scale: HUC8
Identifying and sampling watershed...

----- Watershed (HUC8) Identification Section -----
Identifying HUC2 Watershed
Checking for existing Watershed Boundary Data...
Watershed Boundary Data found
-Reading local HUC2 dataset
-Filtering HUC2 features by spatial overlap with selected coordinates...
HUC2: 14
Area: 113347.01 square miles

Identifying HUC8 Watershed
Checking for existing Watershed Boundary Data...
Downloading WBD_14_HU2_Shape.zip... ( 77.59 MB )
```

-Written by:  
Jason C. Deters,  
U.S. Army Corps of Engineers

If you have not already run the tool in this HUC2, it will proceed to download the complete USGS Watershed Boundary Dataset (WBD) for this HUC2 Region.



```
Creating Rain anteProcess.Main() instance...
Initializing anteProcess Class...

Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary..."
```

##### ----- USGS Elevation Point Query Service (EPQS) Status Check ----- #####

Original - National Map Variant:  
- Test URL: <https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet>  
- Attempting to connect (15-second timeout)

Querying https://nationalmap.gov/epqs...

##### ----- WATERSHED IDENTIFICATION AND RANDOM SAMPLING ----- #####

Selected Watershed Scale: HUC8  
Identifying and sampling watershed...

#----- Watershed (HUC8) Identification Section

Identifying HUC2 Watershed  
Checking for existing Watershed Boundary Data...  
Watershed Boundary Data found  
-Reading local HUC2 dataset  
-Filtering HUC2 features by spatial overlap with selected coordinates...  
HUC2: 14  
Area: 113347.01 square miles

Identifying HUC8 Watershed  
Checking for existing Watershed Boundary Data...  
WBD\_14\_HU2\_Shape.zip Downloaded ( 98.16 MB)  
Extracting package to target directory...  
Extraction complete. Deleting zip file...  
Downloading and Extracting WBD\_14\_HU2\_Shape.zip took 1 minutes and 34 seconds to complete

-Reading local HUC8 dataset  
-Filtering HUC8 features by spatial overlap with selected coordinates...  
HUC8: 14060003  
Area: 2679.13 square miles

#----- Random Sampling Point Generation Section ----- #

Sampling Protocol:  
-Latitudes and Longitudes will be randomly generated watershed polygon extremes:  
HUC8 (14060003) Coordinate Extremes (Converted to Meters for testing):  
Maximum Latitude: 183665.89202728405  
Minimum Latitude: 71826.47903407647  
Maximum Longitude: -1088157.592483701  
Minimum Longitude: -1208099.024459503  
-An OGR point geometry will be created to test each random Latitude and Longitude.  
-The point must fall within the HUC8 (14060003)  
-The point must also be at least 3.75 mile(s) from any previously selected sampling points.  
-If both criteria are met, the point will be added to the list of sampling points.  
-When 3000 consecutive random test points fail these tests, the sampling procedure will be complete.

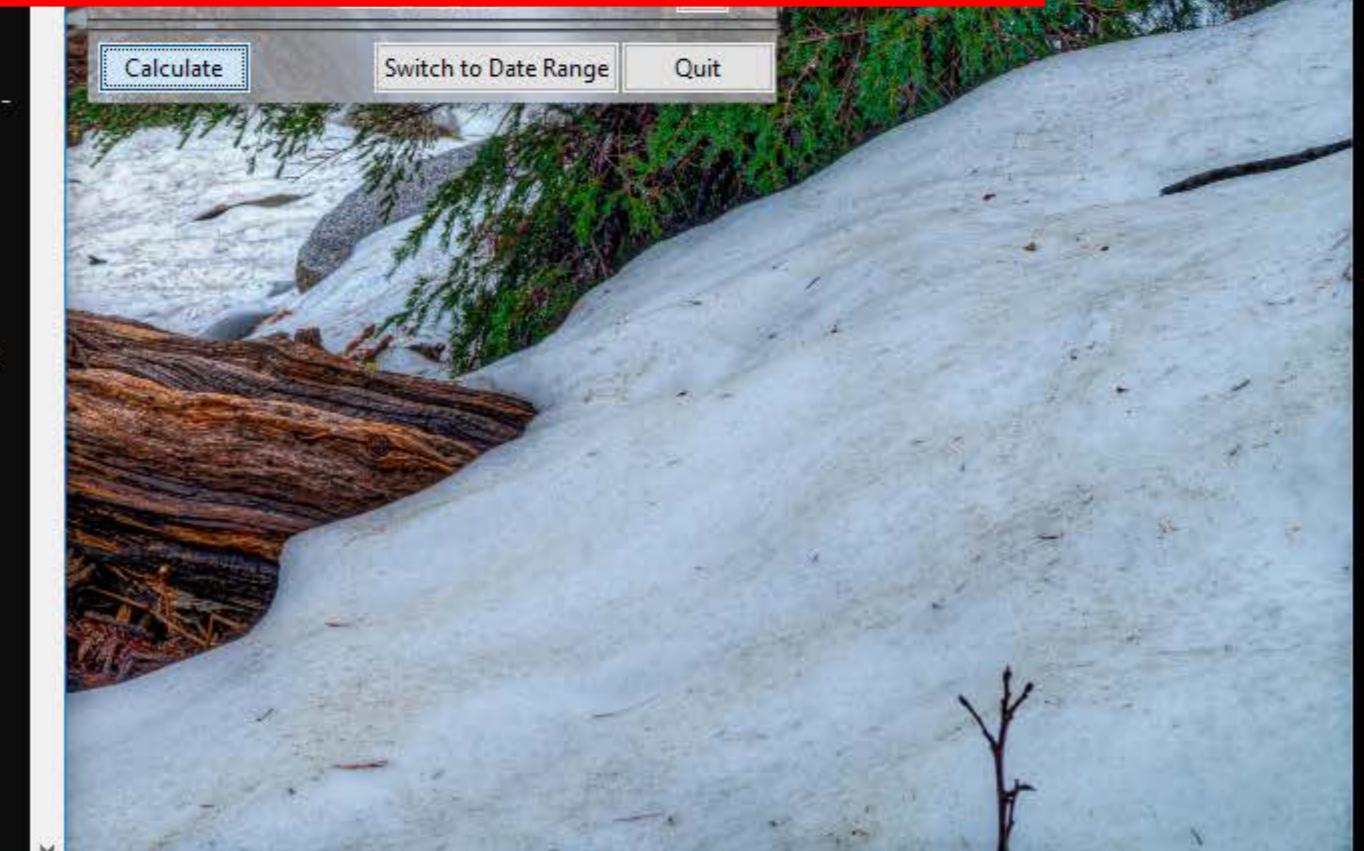
Generating potential sampling points and testing the above conditions...
25 points selected of 50 test candidates generated. Testing (109789.825878, -1193675.543044)

The HUC8 (or other selected WBD scale) will be identified, which will be used to generate the sampling parameters.

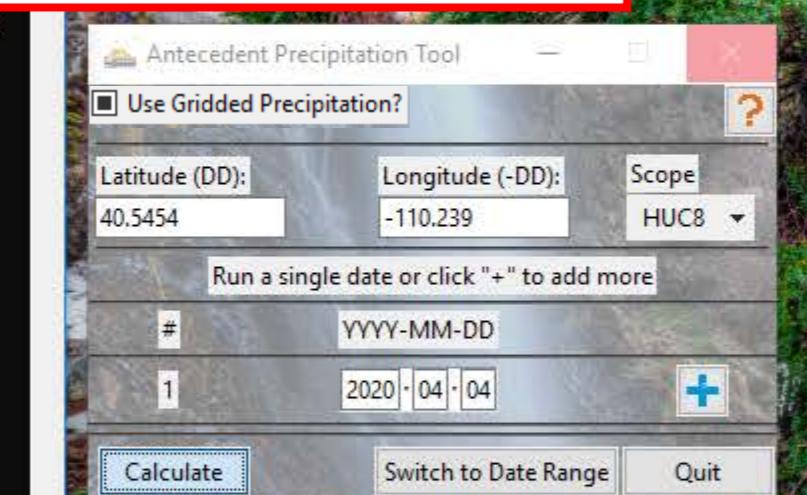
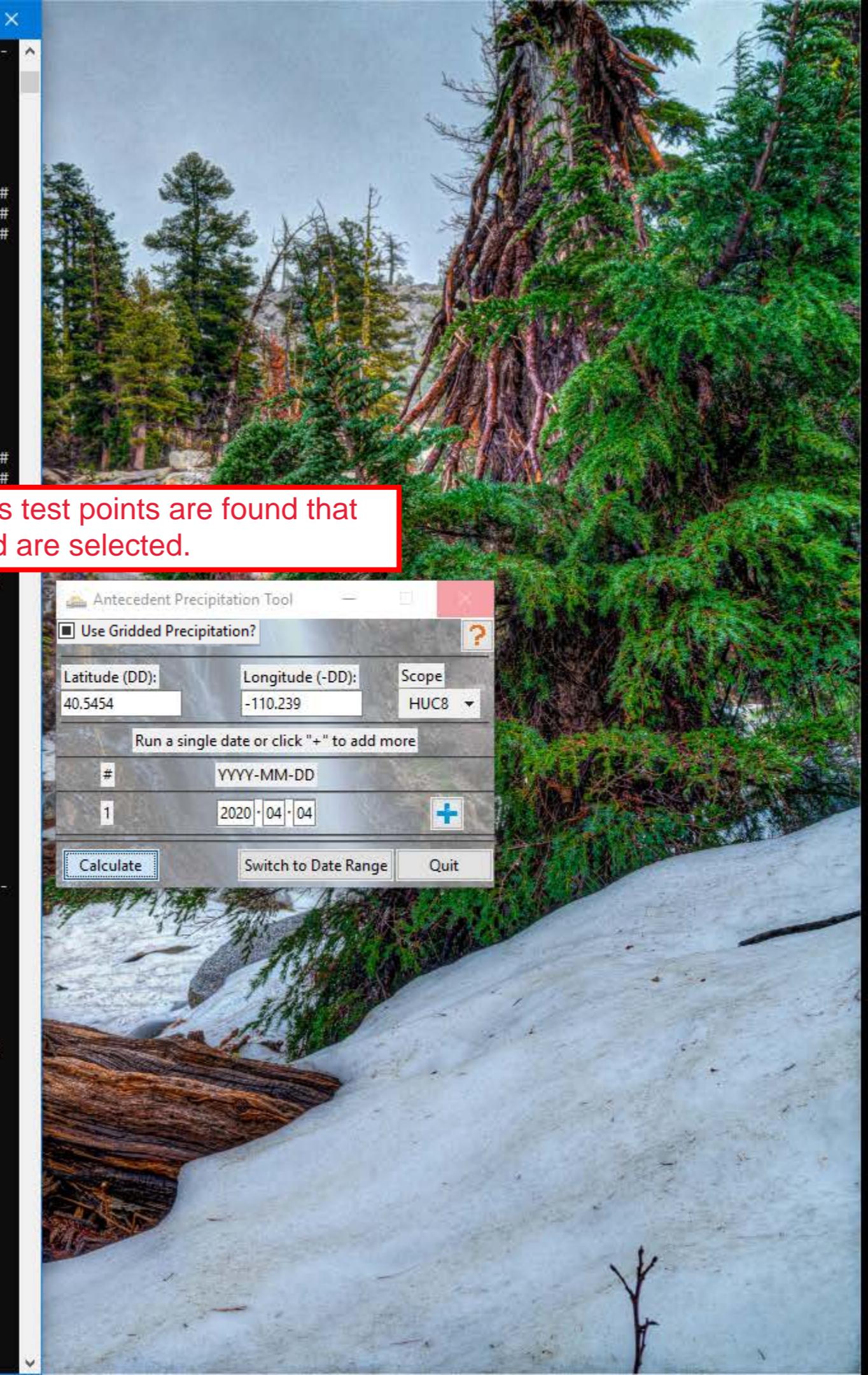
Test points are randomly generated between the minimum and maximum latitude and longitude of the selected HUC8 (or other WBD scale) feature.

For more information on the random point selection process, see the APT - Technical and User Guide available from the [Help Menu](#).

Note: The latitudes and longitudes are in meters here, because we need to be able to measure distance, so the selected feature was transformed into a suitable coordinate system prior to this step.



```
Antecedent Precipitation Tool  
Creating Rain anteProcess.Main() instance...  
Initializing anteProcess Class...  
  
Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary..."  
##### ----- USGS Elevation Point Query Service (EPQS) Status Check ----- #####  
Original - National Map Variant:  
- Test URL: https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet  
- Attempting to connect (15-second timeout)  
Querying https://nationalmap.gov/epqs...  
##### ----- WATERSHED IDENTIFICATION AND RANDOM SAMPLING ----- #####  
Selected Watershed Scale: HUC8  
Identifying and sampling watershed...  
  
#----- Watershed (HUC8) Identification Section -----#  
Identifying HUC2 Watershed  
Checking for existing Watershed Boundary Data...  
Watershed Boundary Data found  
-Reading local HUC2 dataset  
-Filtering HUC2 features by spatial overlap with selected coordinates...  
HUC2: 14  
Area: 113347.01 square miles  
  
Identifying HUC8 Watershed  
Checking for existing Watershed Boundary Data...  
WBD_14_HU2_Shape.zip Downloaded ( 98.16 MB )  
Extracting package to target directory...  
Extraction complete. Deleting zip file...  
Downloading and Extracting WBD_14_HU2_Shape.zip took 1 minutes and 34 seconds to complete  
  
-Reading local HUC8 dataset  
-Filtering HUC8 features by spatial overlap with selected coordinates...  
HUC8: 14060003  
Area: 2679.13 square miles  
  
#----- Random Sampling Point Generation Section -----#  
Sampling Protocol:  
-Latitudes and Longitudes will be randomly generated watershed polygon extremes:  
HUC8 (14060003) Coordinate Extremes (Converted to Meters for testing):  
Maximum Latitude: 18365.89202728405  
Minimum Latitude: 71826.47903407647  
Maximum Longitude: -1088157.592483701  
Minimum Longitude: -1208099.024459503  
-An OGR point geometry will be created to test each random Latitude and Longitude.  
-The point must fall within the HUC8 (14060003)  
-The point must also be at least 3.75 mile(s) from any previously selected sampling points.  
-If both criteria are met, the point will be added to the list of sampling points.  
-When 3000 consecutive random test points fail these tests, the sampling procedure will be complete.  
  
Generating potential sampling points and testing the above conditions...  
84 points selected of 481 test candidates generated. Testing (161273.620664, -1122762.599319)
```



Antecedent Precipitation Tool

```
Creating Rain anteProcess.Main() instance...
Initializing anteProcess Class...

Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary..."
```

##### ----- USGS Elevation Point Query Service (EPQS) Status Check ----- #####

Original - National Map Variant:  
- Test URL: <https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet>  
- Attempting to connect (15-second timeout)

Querying https://nationalmap.gov/epqs...

```
#####
# --- National Map EPQS Server Online --- #
#####

##### ----- WATERSHED IDENTIFICATION AND RANDOM SAMPLING ----- #####
Selected Watershed Scale: HUC8
Identifying and sampling watershed...
```

#----- Watershed (HUC8) Identification Section-----#

Identifying HUC2 Watershed  
Checking for existing Watershed Boundary Data...  
Watershed Boundary Data found  
-Reading local HUC2 dataset  
-Filtering HUC2 features by spatial overlap with selected coordinates...  
HUC2: 14  
Area: 113347.01 square miles

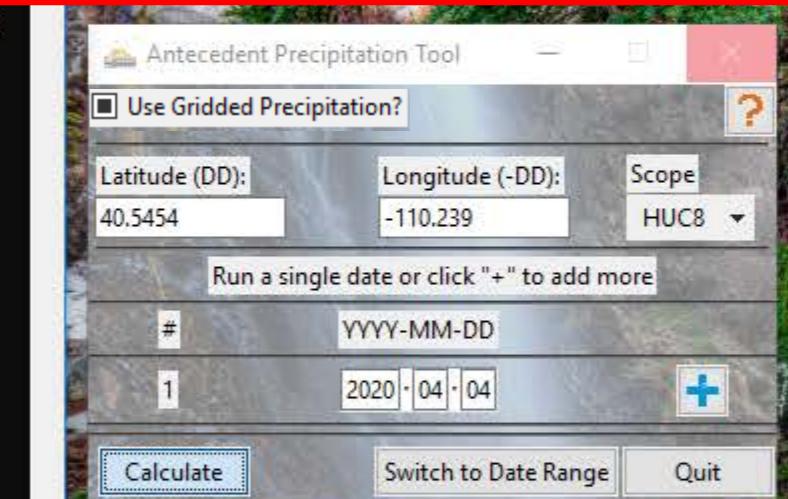
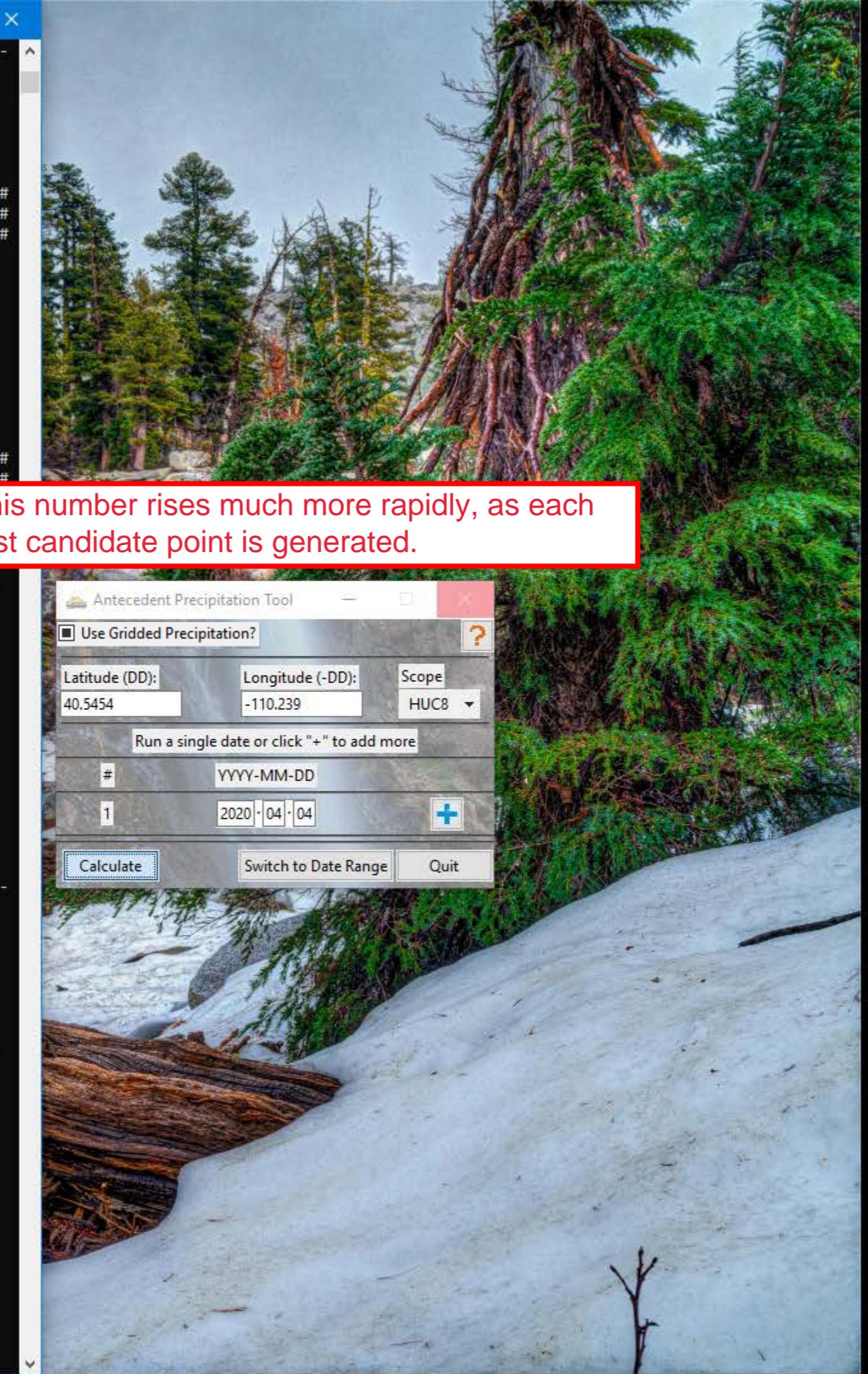
Identifying HUC8 Watershed  
Checking for existing Watershed Boundary Data...  
WBD\_14\_HU2\_Shape.zip Downloaded ( 98.16 MB)  
Extracting package to target directory...  
Extraction complete. Deleting zip file...  
Downloading and Extracting WBD\_14\_HU2\_Shape.zip took 1 minutes and 34 seconds to complete

-Reading local HUC8 dataset  
-Filtering HUC8 features by spatial overlap with selected coordinates...  
HUC8: 14060003  
Area: 2679.13 square miles

#----- Random Sampling Point Generation Section -----#

Sampling Protocol:  
-Latitudes and Longitudes will be randomly generated watershed polygon extremes:  
HUC8 (14060003) Coordinate Extremes (Converted to Meters for testing):  
Maximum Latitude: 183665.89202728405  
Minimum Latitude: 71826.47903407647  
Maximum Longitude: -1088157.592483701  
Minimum Longitude: -1208099.024459503  
-An OGR point geometry will be created to test each random Latitude and Longitude.  
-The point must fall within the HUC8 (14060003)  
-The point must also be at least 3.75 mile(s) from any previously selected sampling points.  
-If both criteria are met, the point will be added to the list of sampling points.  
-When 3000 consecutive random test points fail these tests, the sampling procedure will be complete.

Generating potential sampling points and testing the above conditions...
126 points selected of 3135 test candidates generated. Testing (96237.679876, -1187202.507523)



Antecedent Precipitation Tool

```
Creating Rain anteProcess.Main() instance...
Initializing anteProcess Class...

Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary..."
```

##### ----- USGS Elevation Point Query Service (EPQS) Status Check ----- #####

Original - National Map Variant:  
- Test URL: <https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet>  
- Attempting to connect (15-second timeout)

Querying https://nationalmap.gov/epqs...

```
#####
# --- National Map EPQS Server Online --- #
#####

##### ----- WATERSHED IDENTIFICATION AND RANDOM SAMPLING ----- #####
Selected Watershed Scale: HUC8
Identifying and sampling watershed...
```

#----- Watershed (HUC8) Identification Section

Identifying HUC2 Watershed  
Checking for existing Watershed Boundary Data...  
Watershed Boundary Data found  
-Reading local HUC2 dataset  
-Filtering HUC2 features by spatial overlap with selected coordinates...  
HUC2: 14  
Area: 113347.01 square miles

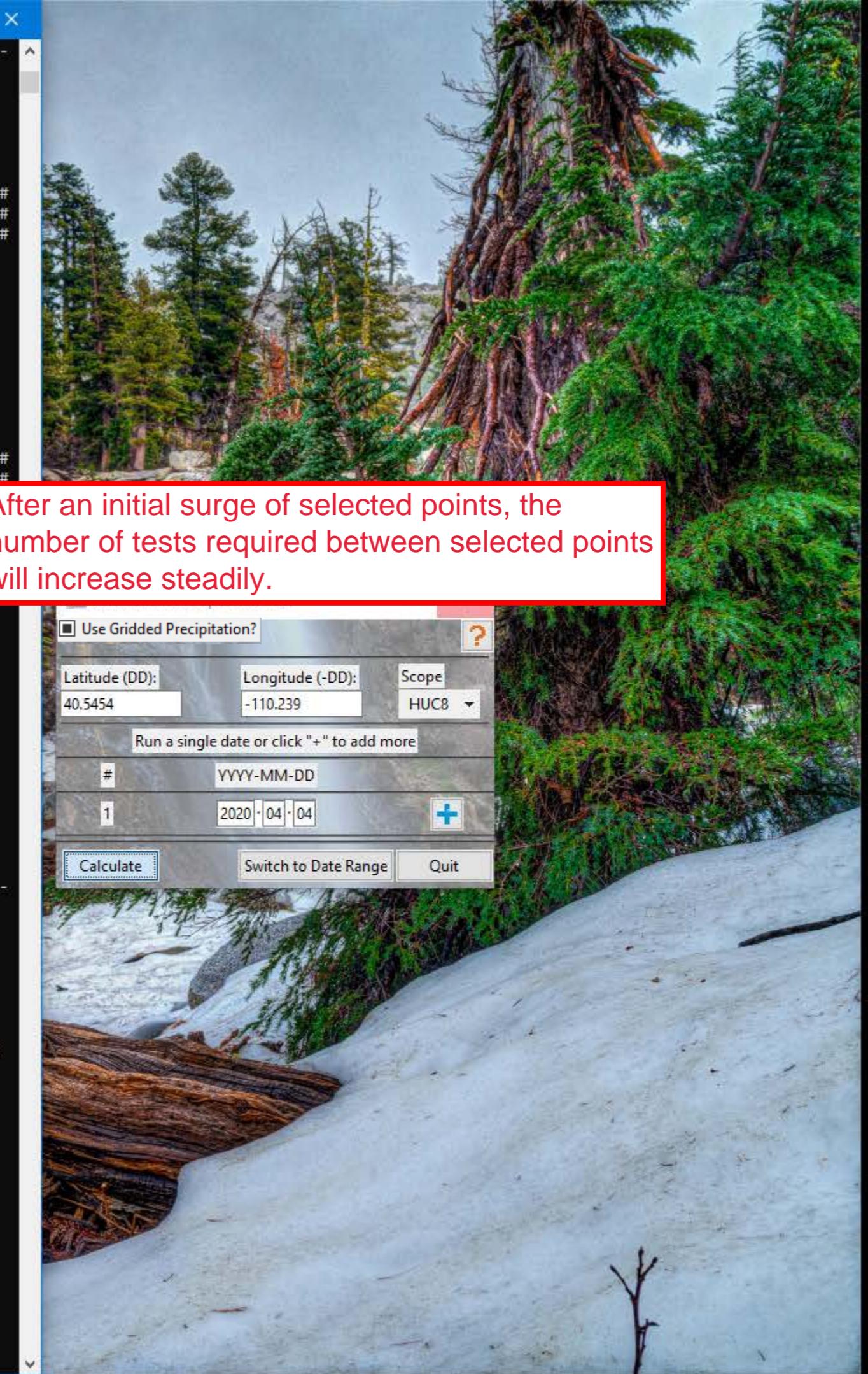
Identifying HUC8 Watershed  
Checking for existing Watershed Boundary Data...  
WBD\_14\_HU2\_Shape.zip Downloaded ( 98.16 MB )
Extracting package to target directory...
Extraction complete. Deleting zip file...
Downloading and Extracting WBD\_14\_HU2\_Shape.zip took 1 minutes and 34 seconds to complete

-Reading local HUC8 dataset  
-Filtering HUC8 features by spatial overlap with selected coordinates...  
HUC8: 14060003  
Area: 2679.13 square miles

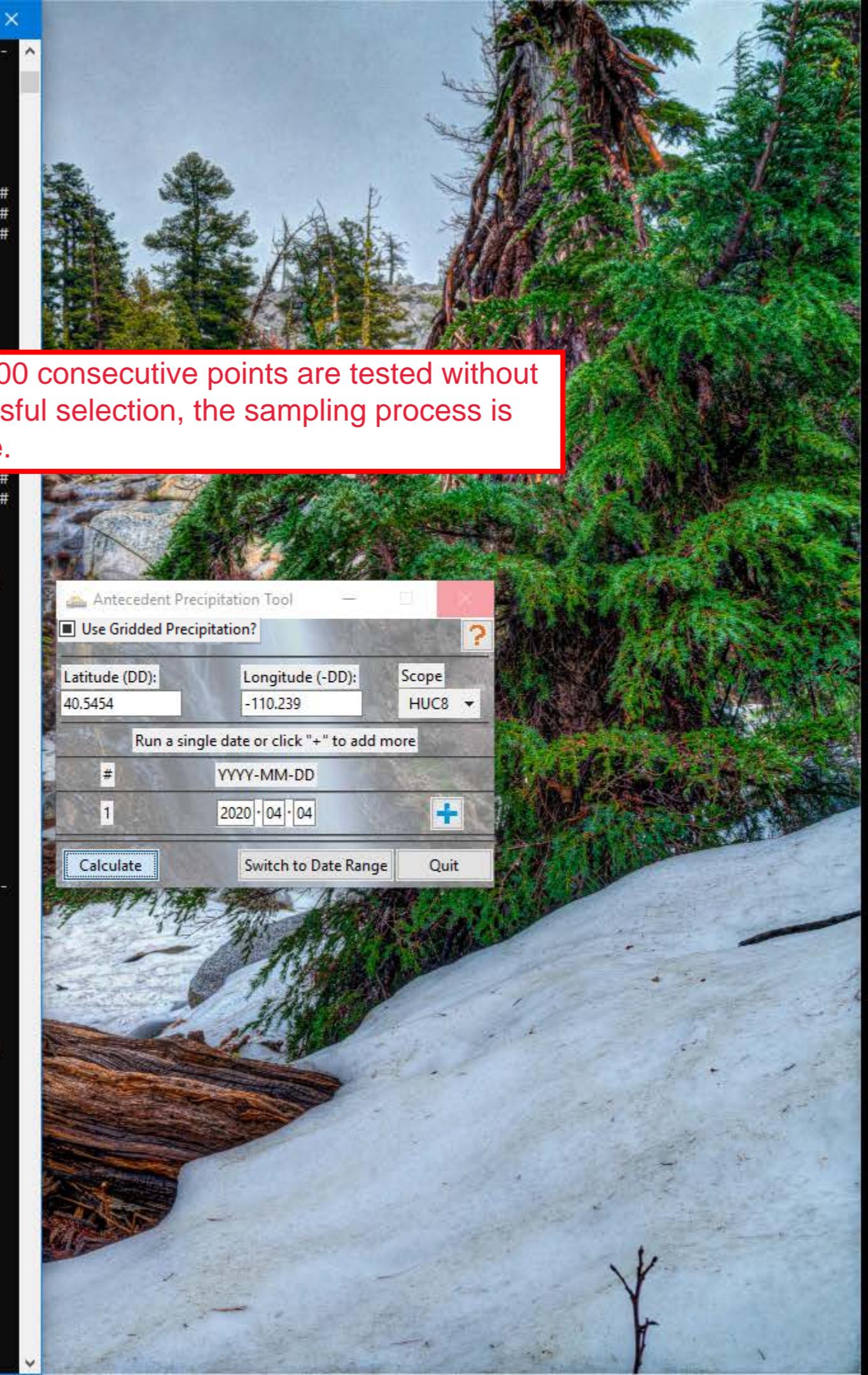
#----- Random Sampling Point Generation Section ----- #

Sampling Protocol:  
-Latitudes and Longitudes will be randomly generated watershed polygon extremes:  
HUC8 (14060003) Coordinate Extremes (Converted to meters for testing):  
Maximum Latitude: 183665.89202728405  
Minimum Latitude: 71826.47903407647  
Maximum Longitude: -1088157.592483701  
Minimum Longitude: -1208099.024459503  
-An OGR point geometry will be created to test each random Latitude and Longitude.  
-The point must fall within the HUC8 (14060003)  
-The point must also be at least 3.75 mile(s) from any previously selected sampling points.  
-If both criteria are met, the point will be added to the list of sampling points.  
-When 3000 consecutive random test points fail these tests, the sampling procedure will be complete.

Generating potential sampling points and testing the above conditions...
140 points selected of 7640 test candidates generated. Testing (139133.780106, -1098613.620815)



```
Antecedent Precipitation Tool  
Creating Rain anteProcess.Main() instance...  
Initializing anteProcess Class...  
  
Unserializing cached Web-based Watershed Interactive Modeling Program (WebWIMP) Dictionary..."  
##### ----- USGS Elevation Point Query Service (EPQS) Status Check ----- #####  
Original - National Map Variant:  
-Test URL: https://nationalmap.gov/epqs/pqs.php?x=-121.5&y=38.5&output=json&units=Feet  
-Attempting to connect (15-second timeout)  
Querying https://nationalmap.gov/epqs...  
##### ----- WATERSHED IDENTIFICATION AND RANDOM SAMPLING ----- #####  
Selected Watershed Scale: HUC8  
Identifying and sampling watershed...  
  
#----- Watershed (HUC8) Identification Section -----#  
Identifying HUC2 Watershed  
Checking for existing Watershed Boundary Data...  
Watershed Boundary Data found  
-Reading local HUC2 dataset  
-Filtering HUC2 features by spatial overlap with selected coordinates...  
HUC2: 14  
Area: 113347.01 square miles  
  
Identifying HUC8 Watershed  
Checking for existing Watershed Boundary Data...  
WBD_14_HU2_Shape.zip Downloaded ( 98.16 MB )  
Extracting package to target directory...  
Extraction complete. Deleting zip file...  
Downloading and Extracting WBD_14_HU2_Shape.zip took 1 minutes and 3+ seconds to complete  
  
-Reading local HUC8 dataset  
-Filtering HUC8 features by spatial overlap with selected coordinates...  
HUC8: 14060003  
Area: 2679.13 square miles  
  
#----- Random Sampling Point Generation Section -----#  
Sampling Protocol:  
-Latitudes and Longitudes will be randomly generated watershed polygon extremes:  
HUC8 (14060003) Coordinate Extremes (Converted to Meters for testing):  
Maximum Latitude: 183665.89202728405  
Minimum Latitude: 71826.47903407647  
Maximum Longitude: -1088157.592483701  
Minimum Longitude: -1208099.024459503  
-An OGR point geometry will be created to test each random Latitude and Longitude.  
-The point must fall within the HUC8 (14060003)  
-The point must also be at least 3.75 mile(s) from any previously selected sampling points.  
-If both criteria are met, the point will be added to the list of sampling points.  
-When 3000 consecutive random test points fail these tests, the sampling procedure will be complete.  
  
Generating potential sampling points and testing the above conditions...  
145 points selected of 12546 test candidates generated. Testing (94060.942804, -1202645.452116)
```



Once 3000 consecutive points are tested without a successful selection, the sampling process is complete.

```

Sampling Point 113 - ['PRCP', 40.5454, -110.239, 2020, '04', '04', None, None]
Sampling Point 114 -
Sampling Point 115 -
Sampling Point 116 -
Sampling Point 117 -
Sampling Point 118 -
Sampling Point 119 -
Sampling Point 120 -
Sampling Point 121 -
Sampling Point 122 -
Sampling Point 123 -
Sampling Point 124 -
Sampling Point 125 -
Sampling Point 126 -
Sampling Point 127 -
Sampling Point 128 -
Sampling Point 129 -
Sampling Point 130 -
Sampling Point 131 -
Sampling Point 132 -
Sampling Point 133 -
Sampling Point 134 -
Sampling Point 135 -
Sampling Point 136 -
Sampling Point 137 -
Sampling Point 138 -
Sampling Point 139 -
Sampling Point 140 -
Sampling Point 141 -
Sampling Point 142 -
Sampling Point 143 -
Sampling Point 144 -
Sampling Point 145 -
Sampling Point 146 -

```

All selected sampling points are then enqueued into a Watershed Batch Process, and the normal process of the tool appears to begin normally. Each sampling point result will in fact be identical to a single-point run, but several modifications were made for efficiency.

The first difference is that, when the tool says it is "Searching for weather stations within 30 miles," it is locating stations within 30 miles of ANY of the sampling points.

This allows us to use a single multiprocessing pool to acquire all of the data we will need at once, rather than restarting the process for each point.

Each starting of a multiprocessing pool and search for stations takes between 5 and 15 seconds, so by doing this all at once we save 12-36 minutes on a high end laptop, and drastically more on lower-powered machines.

```

#####
##### ----- HUC8 WATERSHED ANALYSIS - SAMPLING POINT 1 of 146 -----
#####
Running: ['PRCP', 40.5454, -110.239, 2020, '04', '04', None, None, 'C:\\Temp\\Antecedent Precipitation
Calculator\\Outputs', '0']

Checking for previously cached NCDC GHCN Weather Station Records...
Querying Elevation at Observation Point (40.5454, -110.239)...
Request URL: https://nationalmap.gov/epqs/pqs.php?x=-110.239&y=40.5454&output=json&units=Feet

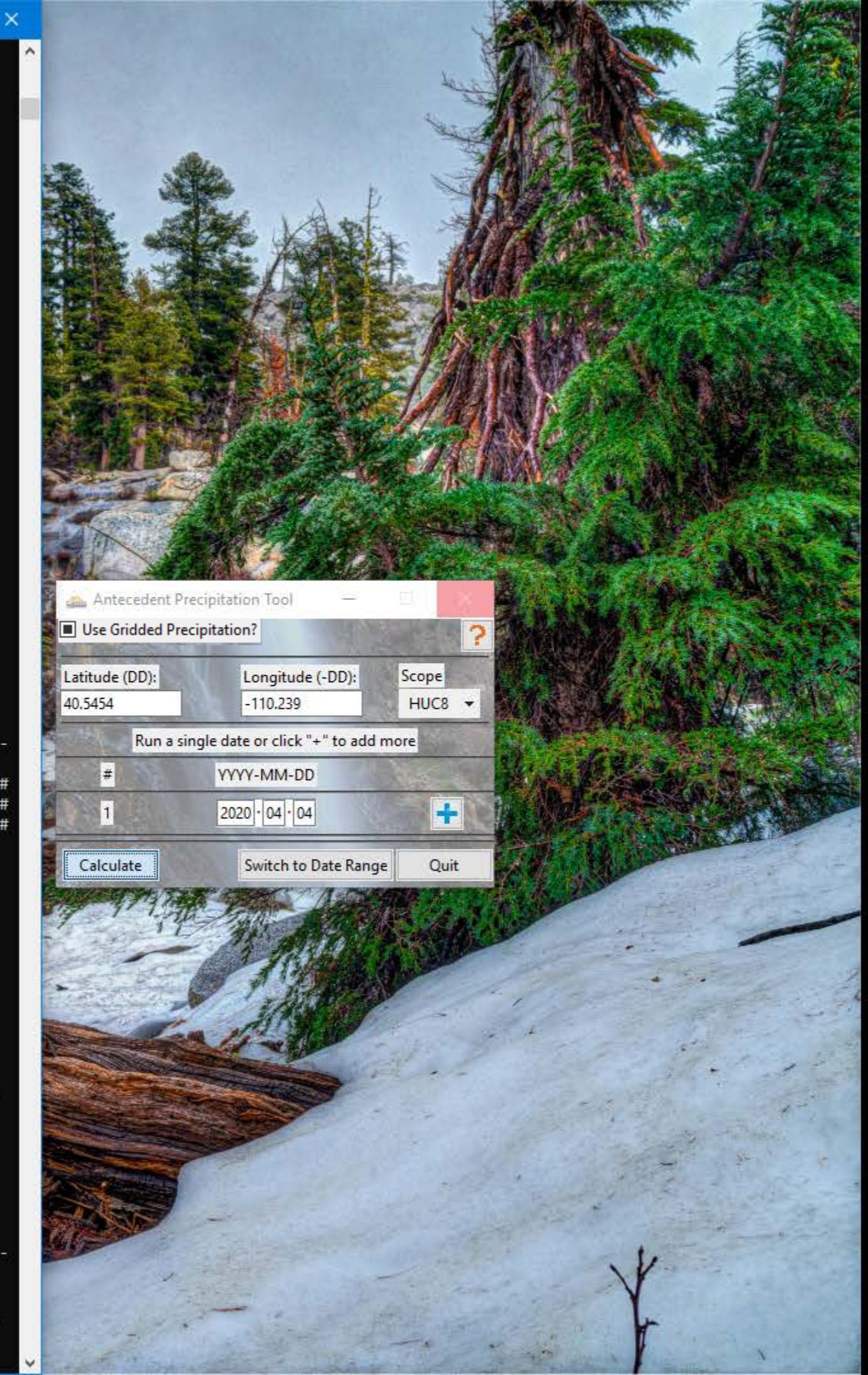
Elevation = 8053.79 Feet

Unserializing previously cached NCDC GHCN daily weather stations...

#----- MULTIPROCESSING START -----
Preparing to use sub-processes to accelerate data acquisition...
Establishing Communication Queues...
Creating 4 sub-processes...
Sub-process 1 started
Sub-process 2 started
Sub-process 3 started
Sub-process 4 started

#----- ENQUEUEING STATION DATA DOWNLOADS -----
Searching for weather stations within 30 miles...

```



531578187/3880

```

Station 149 - Timpanogos Divide
Station 150 - Hobble Creek
Station 151 - Daniels-Strawberry
Station 152 - Currant Creek
Station 153 - Snowbird
Station 154 - Beaver Divide
Station 155 - Smith & Morehouse
Station 156 - Thaynes Canyon
Station 157 - Brighton
Station 158 - Cascade Mountain
Station 159 - PROVO 22 E
Station 160 - MIDWAY 3 NE
Station 161 - PRICE 3 E
Station 162 - PRICE CARBON CO AP
Station 163 - VERNAL MUNICIPAL AP
Station 164 - VERNAL 23 SSE
Station 165 - MANILA 18 ESE

#----- PDSI - Palmer Drought Severity Index -----
Querying the Palmer Drought Severity Index...
Checking for this month's PDSI file on local drive...
This month's PDSI file not found on local drive
Querying the name and date of the latest PDSI file...
Latest file = climdiv-pdsidv-v1.0.0-20200706
Checking for PDSI file on local drive...
Local PDSI file found. Testing file...
Test passed.
Searching for extraneous PDSI files on local drive...
Opening PDSI file to collect monthly values...
PDSI Value = -1.33 - Mild drought

#----- Web WIMP - Web-based Water-Budget Interactive Modeling Program -----
Scraping WebWIMP at 40.5,-110.2...

Terms:
DIFF is the rainfall and estimated snowmelt minus the adjusted potential evapotranspiration (mm/month).
DST is the estimated change in soil moisture from the end of the previous month to the end of the current month (mm/month).
DEF is the estimated deficit or unmet atmospheric demand for moisture (mm/month).



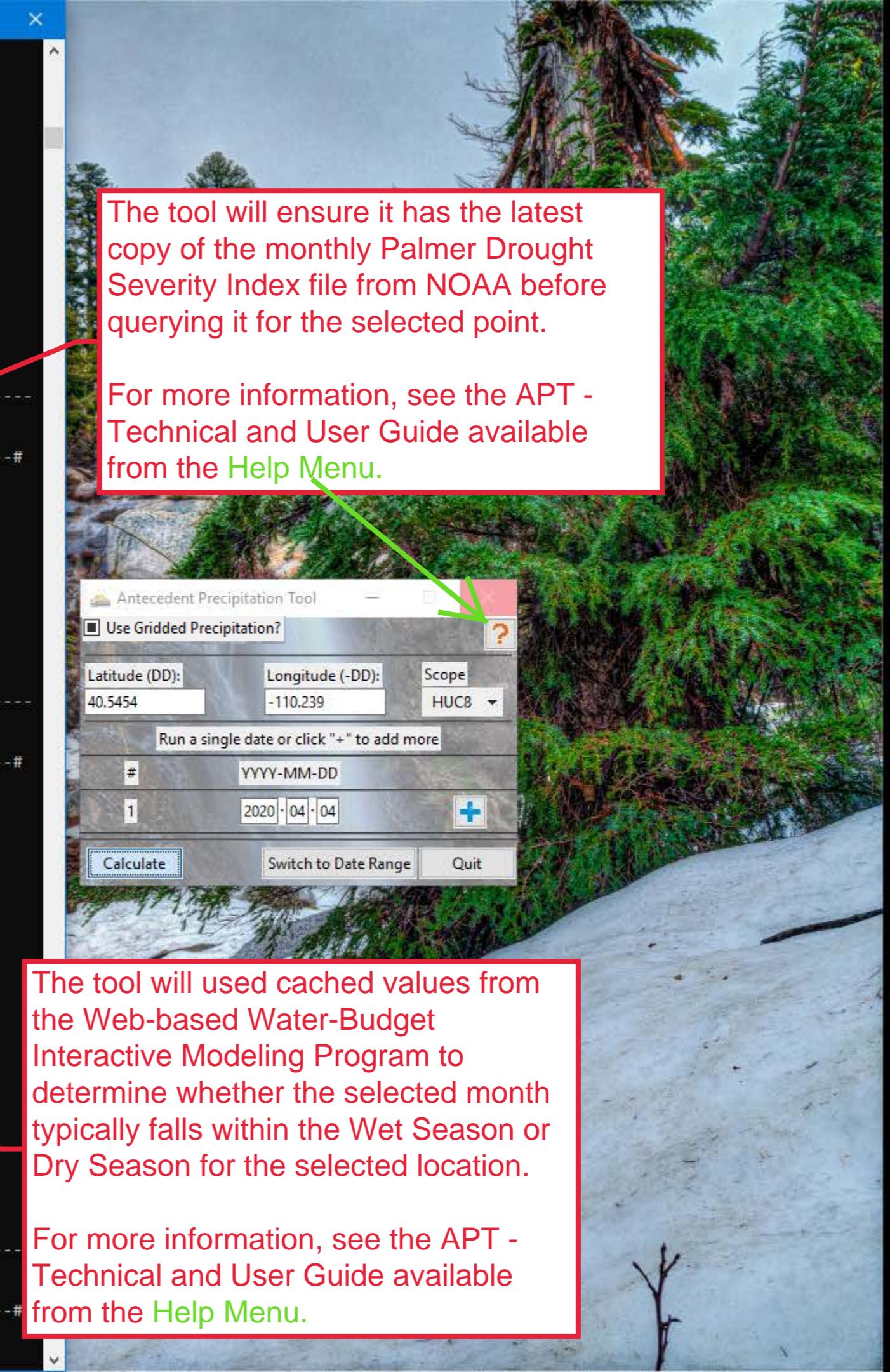
| Mon | DIFF | DST | DEF | Conclusion |
|-----|------|-----|-----|------------|
| Jan | 0    | 0   | 0   | Wet Season |
| Feb | -1   | 0   | 0   | Wet Season |
| Mar | 47   | 47  | 0   | Wet Season |
| Apr | -19  | -8  | 10  | Dry Season |
| May | -57  | -20 | 38  | Dry Season |
| Jun | -93  | -16 | 77  | Dry Season |
| Jul | -126 | -8  | 118 | Dry Season |
| Aug | -99  | -2  | 97  | Dry Season |
| Sep | -55  | 0   | 54  | Dry Season |
| Oct | -16  | 0   | 16  | Dry Season |
| Nov | 6    | 7   | 0   | Wet Season |
| Dec | 1    | 0   | 0   | Wet Season |



#----- Querying USGS Elevation Service for each Watershed Sampling Point -----
Watershed Sampling Point 1 - (40.5454, -110.239) - Elevation = 8053.79 Feet
Querying https://nationalmap.gov/epqs...

```

For many HUC8 features, the number of stations found will be well over 300, So the tool takes this opportunity to do some other work while the stations download.



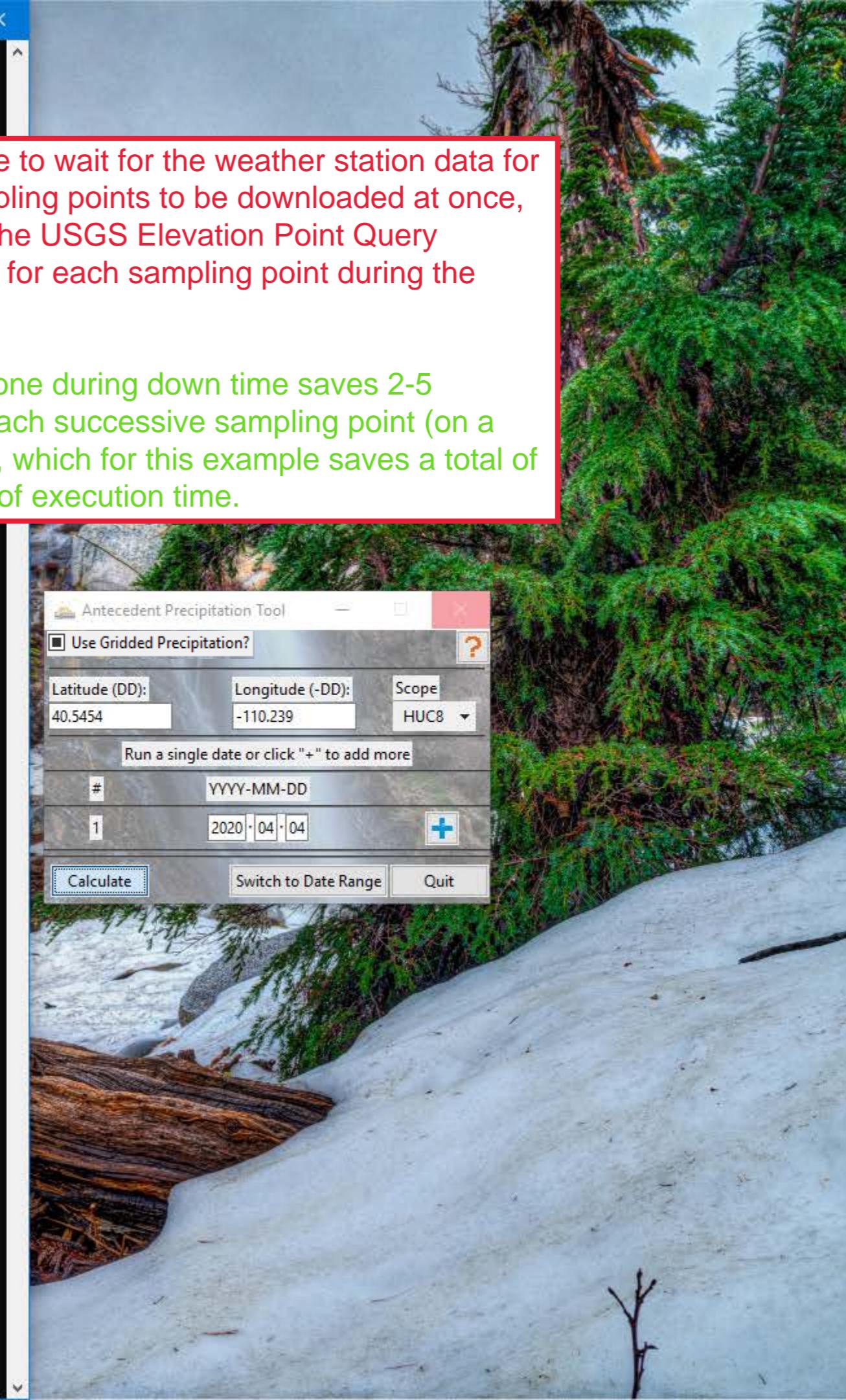
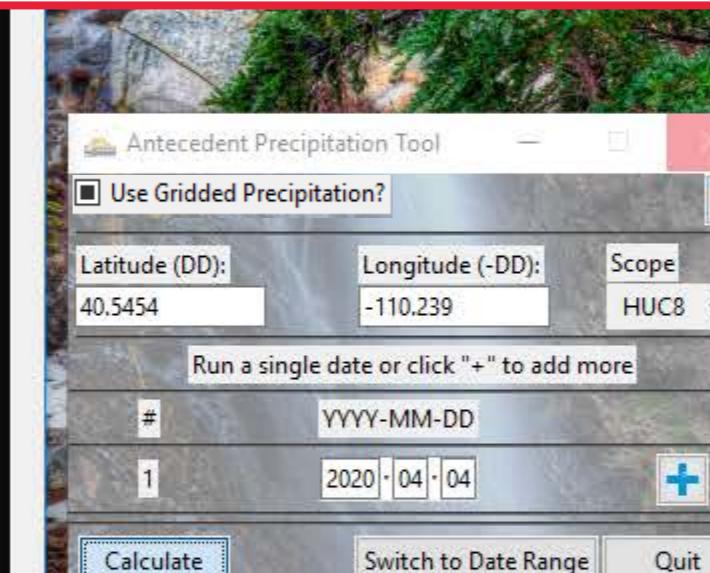
The tool will used cached values from the Web-based Water-Budget Interactive Modeling Program to determine whether the selected month typically falls within the Wet Season or Dry Season for the selected location.

For more information, see the APT - Technical and User Guide available from the Help Menu.

```
----- Querying USGS Elevation Service for each Watershed Sampling Point -----
Watershed Sampling Point 1 - (40.5454, -110.239) - Elevation = 8053.79 Feet
Watershed Sampling Point 2 - (40.395216, -110.283535) - Elevation = 6589.29 Feet
Watershed Sampling Point 3 - (40.379759, -109.94296) - Elevation = 5474.97 Feet
Watershed Sampling Point 4 - (40.320737, -110.423526) - Elevation = 6864.17 Feet
Watershed Sampling Point 5 - (39.911014, -110.33837) - Elevation = 7347.92 Feet
Watershed Sampling Point 6 - (40.000356, -110.308569) - Elevation = 6655.61 Feet
Watershed Sampling Point 7 - (40.387893, -110.389964) - Elevation = 6892.69 Feet
Watershed Sampling Point 8 - (40.266369, -110.586335) - Elevation = 7455.42 Feet
Watershed Sampling Point 9 - (40.532673, -110.832899) - Elevation = 9305.01 Feet
Watershed Sampling Point 10 - (40.707013, -110.239489) - Elevation = 10760.83 Feet
Watershed Sampling Point 11 - (40.442707, -110.768303) - Elevation = 7690.54 Feet
Watershed Sampling Point 12 - (40.193677, -110.076811) - Elevation = 5103.76 Feet
Watershed Sampling Point 13 - (40.34305, -110.072901) - Elevation = 5363.5 Feet
Watershed Sampling Point 14 - (40.66888, -110.326014) - Elevation = 11476.42 Feet
Watershed Sampling Point 15 - (40.546831, -110.349804) - Elevation = 8104.17 Feet
Watershed Sampling Point 16 - (40.519732, -110.634445) - Elevation = 9036.93 Feet
Watershed Sampling Point 17 - (40.542364, -110.151827) - Elevation = 7716.58 Feet
Watershed Sampling Point 18 - (40.255522, -110.412434) - Elevation = 5797.36 Feet
Watershed Sampling Point 19 - (40.660498, -110.071679) - Elevation = 10471.72 Feet
Watershed Sampling Point 20 - (40.571057, -110.775677) - Elevation = 10564.73 Feet
Watershed Sampling Point 21 - (40.681713, -109.918315) - Elevation = 10261.97 Feet
Watershed Sampling Point 22 - (40.460083, -110.590945) - Elevation = 8611.39 Feet
Watershed Sampling Point 23 - (40.529453, -110.913487) - Elevation = 9599.86 Feet
Watershed Sampling Point 24 - (40.316255, -109.882398) - Elevation = 5225.3 Feet
Watershed Sampling Point 25 - (40.189783, -110.332474) - Elevation = 5584.28 Feet
Watershed Sampling Point 26 - (39.908622, -110.608196) - Elevation = 8232.69 Feet
Watershed Sampling Point 27 - (40.765899, -110.289319) - Elevation = 12033.4 Feet
Watershed Sampling Point 28 - (40.72395, -110.499938) - Elevation = 11863.07 Feet
Watershed Sampling Point 29 - (40.456025, -110.196235) - Elevation = 7044.73 Feet
Watershed Sampling Point 30 - (40.576147, -110.092292) - Elevation = 7441.14 Feet
Watershed Sampling Point 31 - (40.29008, -110.00597) - Elevation = 5162.91 Feet
Watershed Sampling Point 32 - (40.524208, -110.277698) - Elevation = 8127.05 Feet
Watershed Sampling Point 33 - (40.600943, -110.491106) - Elevation = 10273.47 Feet
Watershed Sampling Point 34 - (40.572681, -110.559632) - Elevation = 10724.21 Feet
Watershed Sampling Point 35 - (40.61292, -110.272711) - Elevation = 10332.06 Feet
Watershed Sampling Point 36 - (40.149935, -109.823739) - Elevation = 5158.89 Feet
Watershed Sampling Point 37 - (40.52691, -110.508838) - Elevation = 9392.04 Feet
Watershed Sampling Point 38 - (40.430201, -111.152835) - Elevation = 9206.72 Feet
Watershed Sampling Point 39 - (40.307074, -110.65837) - Elevation = 6729.96 Feet
Watershed Sampling Point 40 - (40.494682, -109.987326) - Elevation = 6346.86 Feet
Watershed Sampling Point 41 - (40.134999, -109.729005) - Elevation = 4673.49 Feet
Watershed Sampling Point 42 - (40.532783, -109.792114) - Elevation = 6736.85 Feet
Watershed Sampling Point 43 - (40.374859, -110.200182) - Elevation = 6238.73 Feet
Watershed Sampling Point 44 - (40.231762, -109.835926) - Elevation = 4852.96 Feet
Watershed Sampling Point 45 - (40.69884, -110.678996) - Elevation = 10604.03 Feet
Watershed Sampling Point 46 - (40.349346, -110.766856) - Elevation = 8600.65 Feet
Watershed Sampling Point 47 - (40.319749, -110.54024) - Elevation = 7085.37 Feet
Watershed Sampling Point 48 - (40.682438, -110.772317) - Elevation = 11327.7 Feet
Watershed Sampling Point 49 - (40.29741, -110.120985) - Elevation = 5655.59 Feet
Watershed Sampling Point 50 - (40.4807, -109.811327) - Elevation = 6392.48 Feet
Watershed Sampling Point 51 - (40.151265, -109.917329) - Elevation = 5228.61 Feet
Watershed Sampling Point 52 - (40.580452, -110.887133) - Elevation = 7680.24 Feet
Watershed Sampling Point 53 - (40.409263, -110.042216) - Elevation = 5847.11 Feet
Watershed Sampling Point 54 - (40.740725, -110.407557) - Elevation = 10536.04 Feet
Watershed Sampling Point 55 - (40.240349, -110.147103) - Elevation = 5552.08 Feet
Watershed Sampling Point 56 - (40.149915, -110.137202) - Elevation = 5392.08 Feet
Watershed Sampling Point 57 - (40.005571, -110.493962) - Elevation = 7894.45 Feet
Watershed Sampling Point 58 - (40.437215, -109.761789) - Elevation = 6036.72 Feet
Watershed Sampling Point 59 - (40.666663, -110.618457) - Elevation = 10779.51 Feet
Watershed Sampling Point 60 - (40.35505, -109.826471) - Elevation = 5270.56 Feet
Watershed Sampling Point 61 - (40.061537, -110.464969) - Elevation = 7043.69 Feet
Watershed Sampling Point 62 - (40.439165, -109.861664) - Elevation = 5556.68 Feet
Watershed Sampling Point 63 - (40.697356, -110.851976) - Elevation = 9842.68 Feet
Querying https://nationalmap.gov/epqs...
```

Since we have to wait for the weather station data for all of the sampling points to be downloaded at once, the tool runs the USGS Elevation Point Query Service query for each sampling point during the down time.

Getting this done during down time saves 2-5 seconds for each successive sampling point (on a fast machine), which for this example saves a total of 5-12 minutes of execution time.



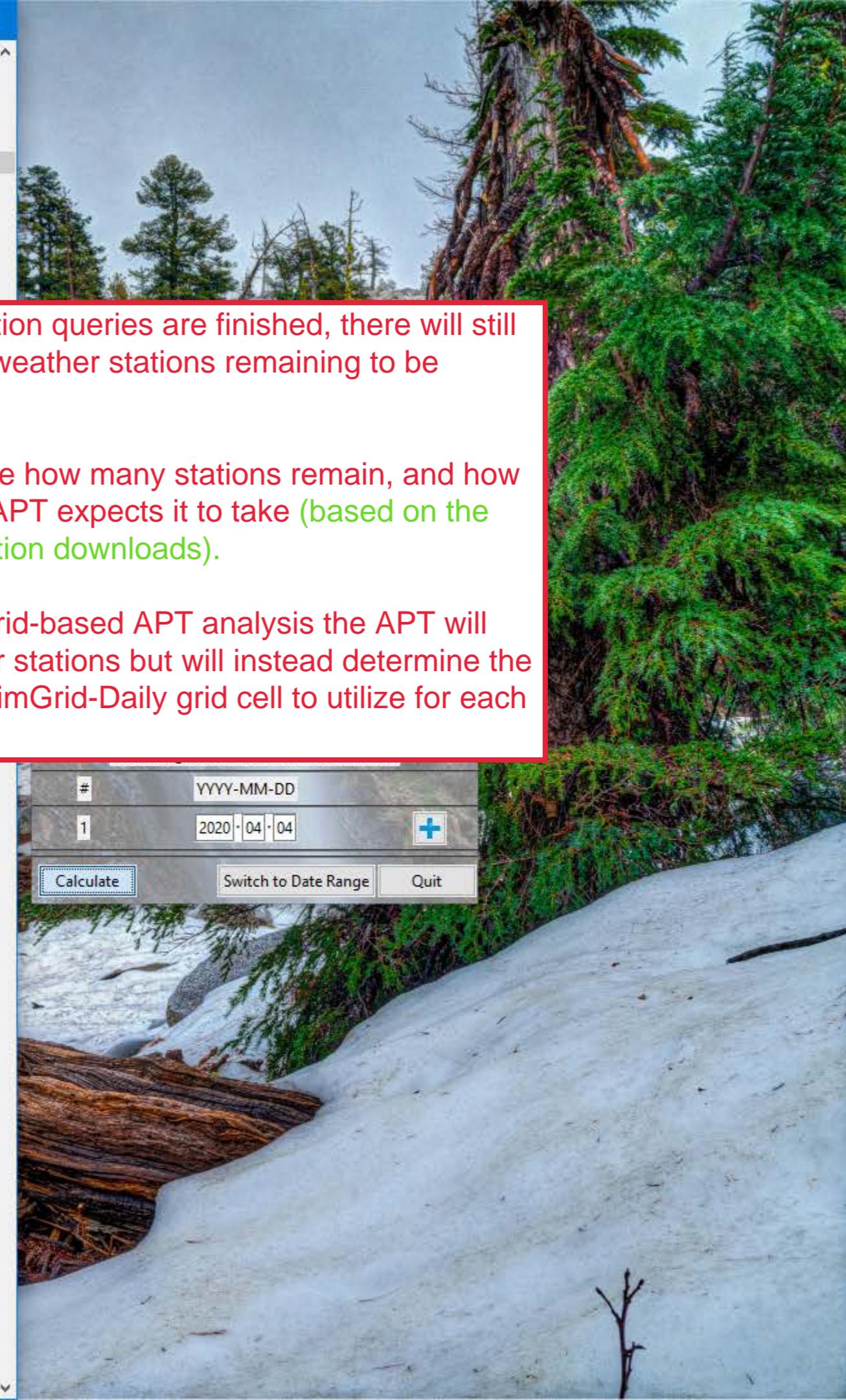
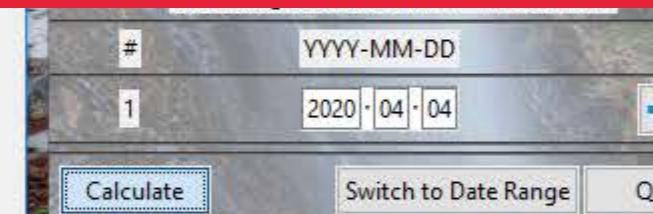
```
Watershed Sampling Point 87 - (40.571668, -110.977536) - Elevation = 10262.45 Feet  
Watershed Sampling Point 88 - (40.747184, -109.982202) - Elevation = 10446.73 Feet  
Watershed Sampling Point 89 - (40.099199, -110.213146) - Elevation = 5708.09 Feet  
Watershed Sampling Point 90 - (40.146847, -110.397044) - Elevation = 6006.14 Feet  
Watershed Sampling Point 91 - (40.81614, -110.195648) - Elevation = 11808.95 Feet  
Watershed Sampling Point 92 - (40.404817, -110.826113) - Elevation = 7836.95 Feet  
Watershed Sampling Point 93 - (40.538735, -109.700179) - Elevation = 8585.89 Feet  
Watershed Sampling Point 94 - (40.488673, -110.980791) - Elevation = 9201.33 Feet  
Watershed Sampling Point 95 - (40.27666, -109.793054) - Elevation = 5038.94 Feet  
Watershed Sampling Point 96 - (40.404173, -110.918765) - Elevation = 7958.13 Feet  
Watershed Sampling Point 97 - (40.085675, -109.693676) - Elevation = 4808.41 Feet  
Watershed Sampling Point 98 - (40.718142, -110.57835) - Elevation = 10137.57 Feet  
Watershed Sampling Point 99 - (40.476902, -110.693751) - Elevation = 8654.4 Feet  
Watershed Sampling Point 100 - (40.666422, -110.509009) - Elevation = 11818.25 Feet  
Watershed Sampling Point 101 - (40.07008, -110.36377) - Elevation = 6424.59 Feet  
Watershed Sampling Point 102 - (40.496326, -110.764477) - Elevation = 9942.93 Feet  
Watershed Sampling Point 103 - (40.463196, -110.883656) - Elevation = 7907.2 Feet  
Watershed Sampling Point 104 - (40.209146, -109.711005) - Elevation = 4859.55 Feet  
Watershed Sampling Point 105 - (40.465461, -110.334433) - Elevation = 7445.77 Feet  
Watershed Sampling Point 106 - (40.496078, -109.897672) - Elevation = 6333.22 Feet  
Watershed Sampling Point 107 - (39.88628, -110.405118) - Elevation = 8607.93 Feet  
Watershed Sampling Point 108 - (40.761746, -110.621754) - Elevation = 11471.05 Feet  
Watershed Sampling Point 109 - (40.324686, -110.265026) - Elevation = 6137.34 Feet  
Watershed Sampling Point 110 - (40.62947, -109.894978) - Elevation = 9772.81 Feet  
Watershed Sampling Point 111 - (40.258325, -110.511528) - Elevation = 6863.58 Feet  
Watershed Sampling Point 112 - (40.744684, -110.724309) - Elevation = 12035.85 Feet  
Watershed Sampling Point 113 - (40.416099, -110.671049) - Elevation = 7677.73 Feet  
Watershed Sampling Point 114 - (40.746403, -110.180397) - Elevation = 11332.15 Feet  
Watershed Sampling Point 115 - (40.358921, -110.608932) - Elevation = 7739.4 Feet  
Watershed Sampling Point 116 - (40.133438, -110.282532) - Elevation = 5695.81 Feet  
Watershed Sampling Point 117 - (40.685774, -110.405654) - Elevation = 10750.43 Feet  
Watershed Sampling Point 118 - (40.799285, -110.352935) - Elevation = 12310.84 Feet  
Watershed Sampling Point 119 - (39.904729, -110.499896) - Elevation = 8886.59 Feet  
Watershed Sampling Point 120 - (40.43243, -109.958849) - Elevation = 5842.72 Feet  
Watershed Sampling Point 121 - (40.635862, -110.852188) - Elevation = 10240.99 Feet  
Watershed Sampling Point 122 - (40.373345, -110.483435) - Elevation = 7086.73 Feet  
Watershed Sampling Point 123 - (40.787408, -110.123051) - Elevation = 11460.27 Feet  
Watershed Sampling Point 124 - (40.58042, -110.20901) - Elevation = 9684.26 Feet  
Watershed Sampling Point 125 - (40.647035, -110.210411) - Elevation = 10496.86 Feet  
Watershed Sampling Point 126 - (40.686402, -110.156109) - Elevation = 11209.4 Feet  
Watershed Sampling Point 127 - (40.268814, -109.714948) - Elevation = 5145.73 Feet  
Watershed Sampling Point 128 - (40.822892, -110.27477) - Elevation = 12217.83 Feet  
Watershed Sampling Point 129 - (40.28405, -110.194789) - Elevation = 5674.44 Feet  
Watershed Sampling Point 130 - (40.789716, -109.925047) - Elevation = 11481.72 Feet  
Watershed Sampling Point 131 - (40.562322, -110.441411) - Elevation = 9649.21 Feet  
Watershed Sampling Point 132 - (40.241319, -110.339416) - Elevation = 6071.07 Feet  
Watershed Sampling Point 133 - (40.157366, -109.996015) - Elevation = 5149.51 Feet  
Watershed Sampling Point 134 - (40.271657, -109.919583) - Elevation = 4986.59 Feet  
Watershed Sampling Point 135 - (40.428717, -110.49035) - Elevation = 7406.07 Feet  
Watershed Sampling Point 136 - (40.525614, -110.05537) - Elevation = 6916.47 Feet  
Watershed Sampling Point 137 - (40.53863, -110.714096) - Elevation = 9969.69 Feet  
Watershed Sampling Point 138 - (40.204023, -109.906176) - Elevation = 4901.44 Feet  
Watershed Sampling Point 139 - (40.72342, -110.335003) - Elevation = 12559.84 Feet  
Watershed Sampling Point 140 - (40.321244, -109.755663) - Elevation = 5365.11 Feet  
Watershed Sampling Point 141 - (40.682528, -109.996552) - Elevation = 10486.71 Feet  
Watershed Sampling Point 142 - (40.781285, -110.457564) - Elevation = 12461.34 Feet  
Watershed Sampling Point 143 - (40.201731, -110.42119) - Elevation = 5790.32 Feet  
Watershed Sampling Point 144 - (40.255436, -110.066199) - Elevation = 5216.92 Feet  
Watershed Sampling Point 145 - (40.628007, -110.559992) - Elevation = 9712.48 Feet  
Watershed Sampling Point 146 - (40.354225, -110.689804) - Elevation = 6697.32 Feet
```

```
#----- MULTIPROCESSING FINISH -----  
Waiting for sub-processes to download stations:  
21 stations left. Approximately 12 seconds remaining.
```

Once the elevation queries are finished, there will still likely be some weather stations remaining to be downloaded.

Look here to see how many stations remain, and how much time the APT expects it to take (based on the previous 20 station downloads).

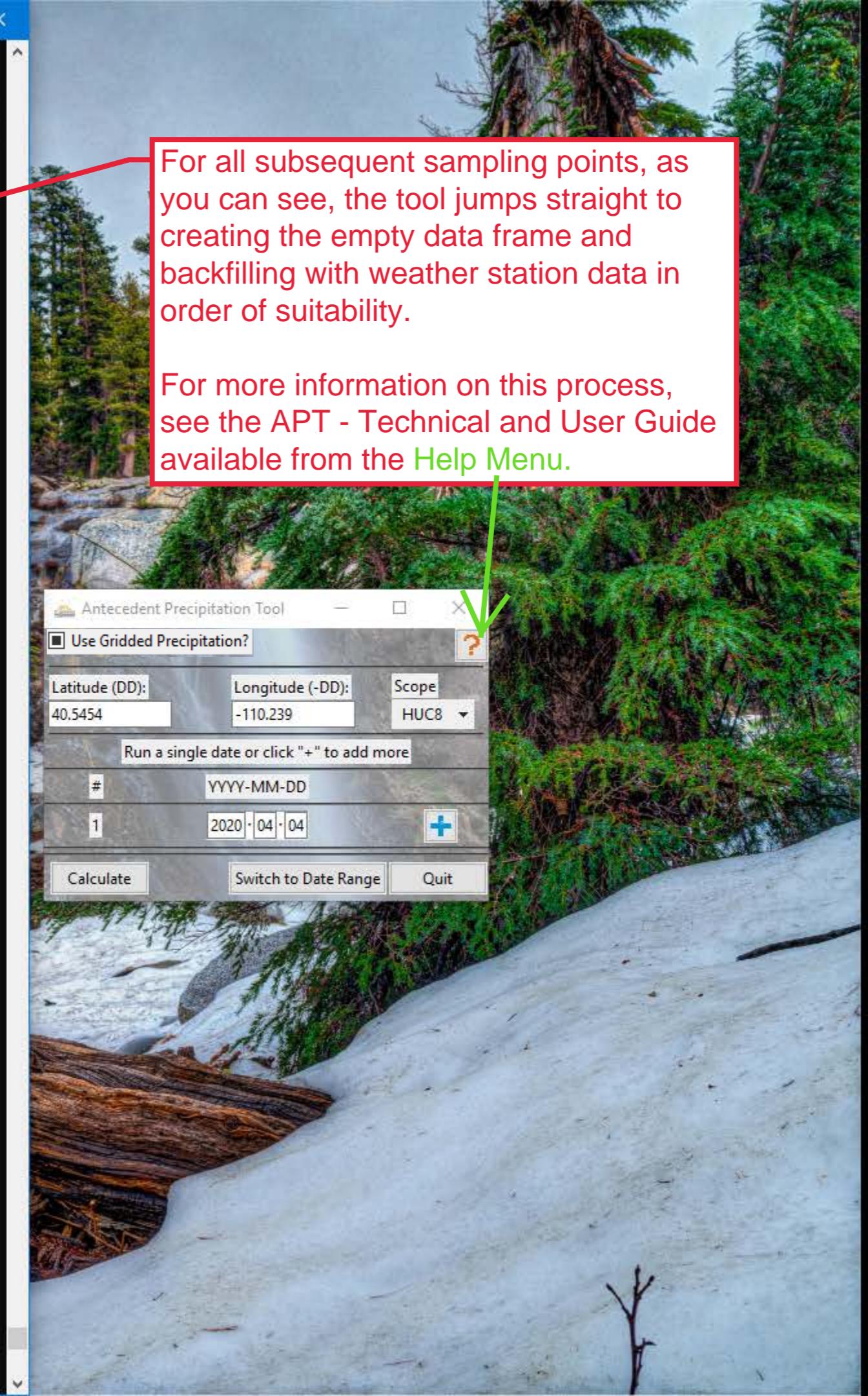
Note that in a grid-based APT analysis the APT will not use weather stations but will instead determine the appropriate nClimGrid-Daily grid cell to utilize for each sampling point.



```
#####
##### ----- HUC8 WATERSHED ANALYSIS - SAMPLING POINT 146 of 146 -----
#####
Running: ['PRCP', 40.354225, -110.689804, 2020, '04', '04', None, None, 'C:\\Temp\\Antecedent Precipitation Calculator\\Outputs', '0']

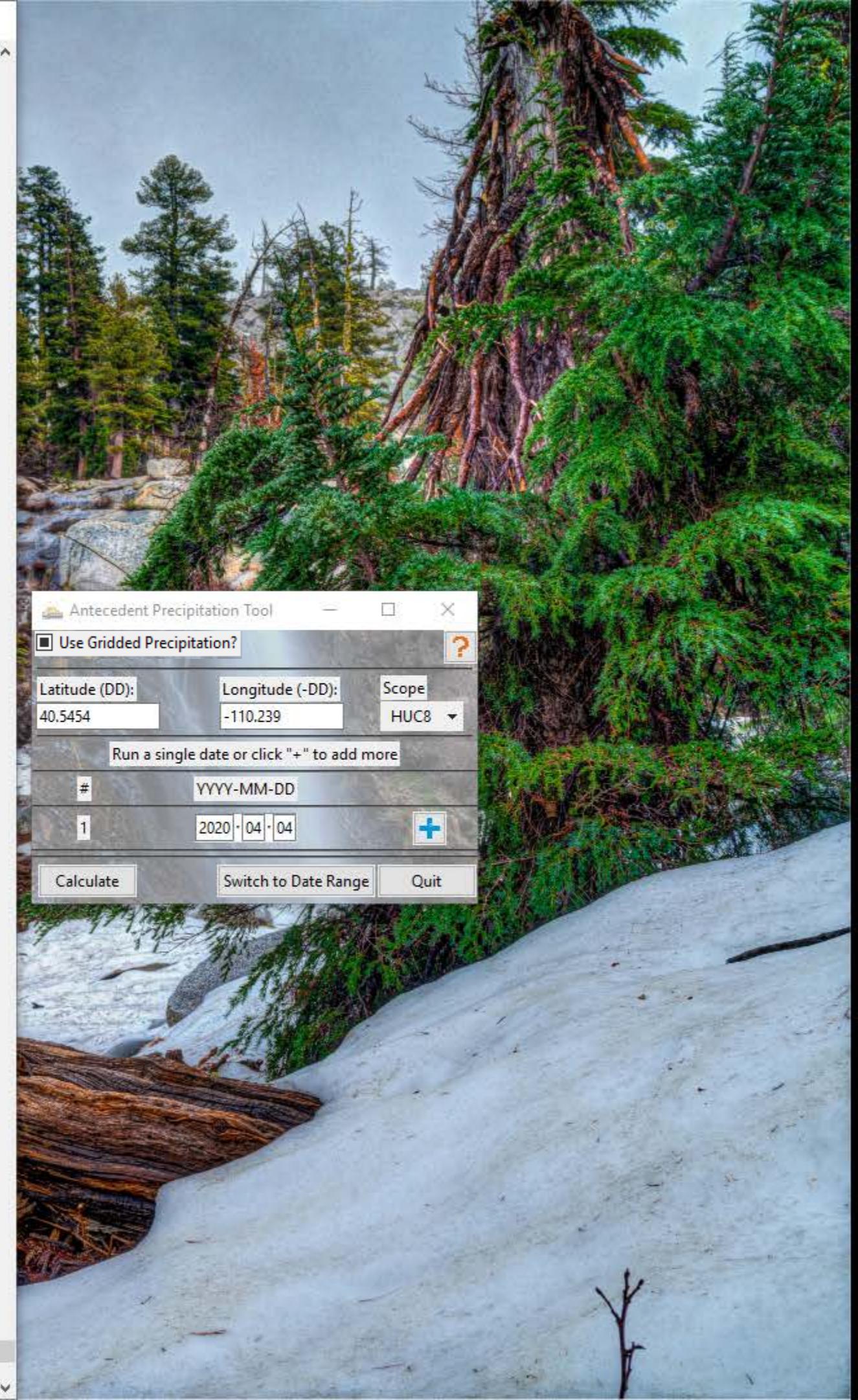
Continuing Watershed Analysis - Keeping recent stations list.
Creating output directory (C:\\Temp\\Antecedent Precipitation Calculator\\Outputs\\v1_0_14\\40.354225, -110.689804)...
Creating stationData output directory (C:\\Temp\\Antecedent Precipitation Calculator\\Outputs\\v1_0_14\\40.354225, -110.689804\\Station Data)...

Creating an empty dataframe from 1988-09-01 to 2020-07-07 to populate with weather station data...
11633 null values.
Searching for primary station...
Attempting to replace null values with values from ALTAMONT...
875 null values remaining.
Saving station data to CSV in output folder...
Attempting to replace null values with values from TABIONA 1 SE...
875 null values remaining.
Attempting to replace null values with values from HANNA...
874 null values remaining.
Saving station data to CSV in output folder...
Attempting to replace null values with values from FRUITLAND...
874 null values remaining.
Attempting to replace null values with values from FRUITLAND 1 ENE...
874 null values remaining.
Attempting to replace null values with values from Currant Creek JUNCTION...
841 null values remaining.
Saving station data to CSV in output folder...
Attempting to replace null values with values from MOUNTAIN HOME...
841 null values remaining.
Attempting to replace null values with values from BONETA...
841 null values remaining.
Attempting to replace null values with values from MT EMMONS...
841 null values remaining.
Attempting to replace null values with values from WOODLAND 4 SE...
841 null values remaining.
Attempting to replace null values with values from Rock Creek...
27 null values remaining.
Saving station data to CSV in output folder...
Attempting to replace null values with values from ELKHORN ASHLEY Rngr ST...
27 null values remaining.
Attempting to replace null values with values from KAMAS 0.1 ESE...
27 null values remaining.
Attempting to replace null values with values from PARK CITY MEADOWS...
27 null values remaining.
Attempting to replace null values with values from SUNDANCE...
27 null values remaining.
Attempting to replace null values with values from KAMAS...
17 null values remaining.
Saving station data to CSV in output folder...
Attempting to replace null values with values from DUCHESNE AP...
17 null values remaining.
Attempting to replace null values with values from HEBER CITY 7.2 E...
17 null values remaining.
Attempting to replace null values with values from MARION...
17 null values remaining.
Attempting to replace null values with values from OAKLEY 1.0 SW...
17 null values remaining.
Attempting to replace null values with values from SOLDIER CREEK...
17 null values remaining.
Attempting to replace null values with values from COALVILLE 13 E...
```



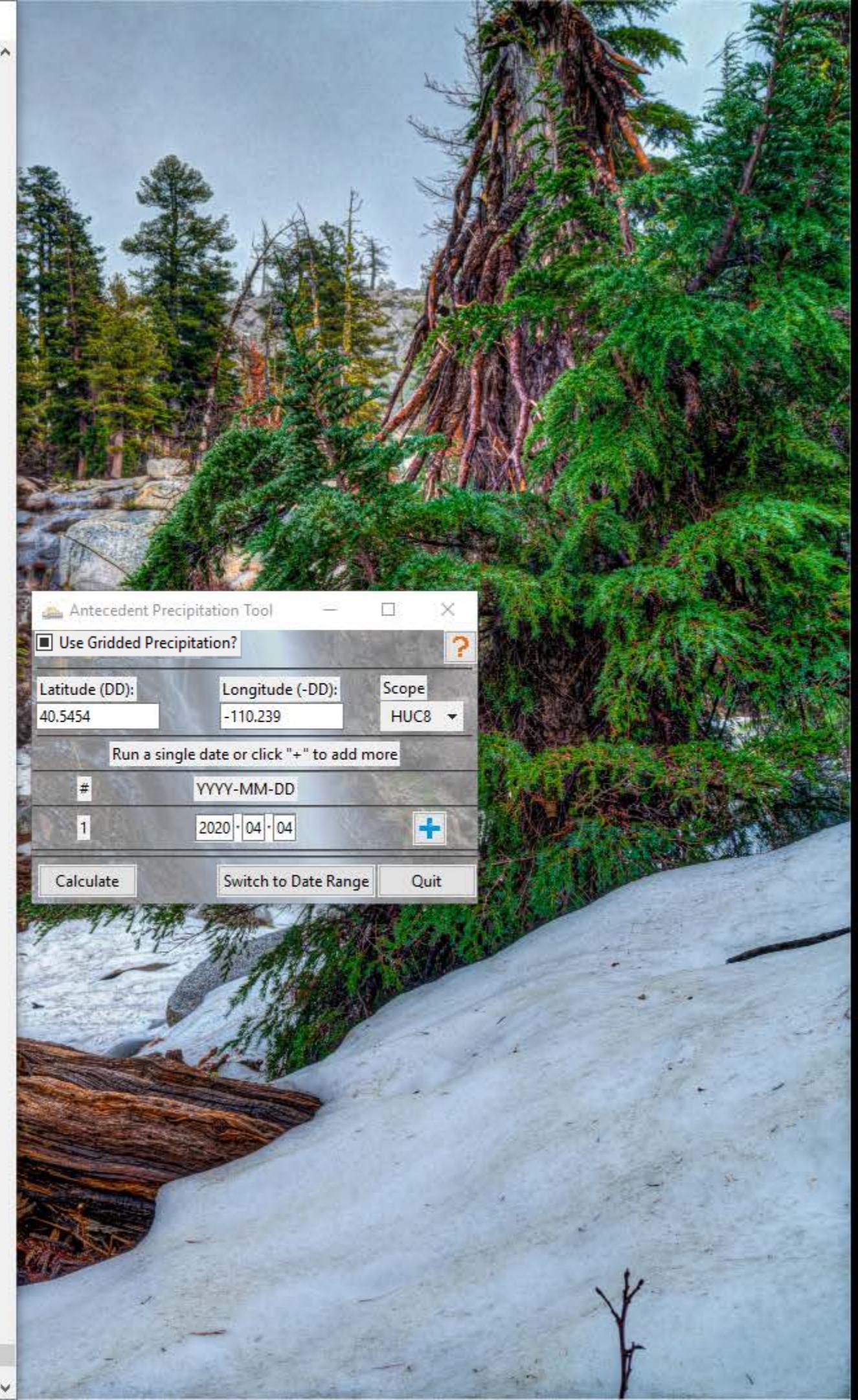
531578187/3880

```
17 null values remaining.  
Attempting to replace null values with values from MARION...  
17 null values remaining.  
Attempting to replace null values with values from OAKLEY 1.0 SW...  
17 null values remaining.  
Attempting to replace null values with values from SOLDIER CREEK...  
17 null values remaining.  
Attempting to replace null values with values from COALVILLE 13 E...  
9 null values remaining.  
Saving station data to CSV in output folder...  
Attempting to replace null values with values from PEOA 0.7 N...  
9 null values remaining.  
Attempting to replace null values with values from SUNNYSIDE...  
9 null values remaining.  
Attempting to replace null values with values from PARK CITY G.C....  
9 null values remaining.  
Attempting to replace null values with values from PARK CITY 5.5 NNE...  
9 null values remaining.  
Attempting to replace null values with values from BEAVER CREEK NURSERY...  
9 null values remaining.  
Attempting to replace null values with values from DUCHESNE...  
3 null values remaining.  
Saving station data to CSV in output folder...  
Attempting to replace null values with values from PARK CITY...  
2 null values remaining.  
Attempting to replace null values with values from YELLOWSTONE G S...  
2 null values remaining.  
Attempting to replace null values with values from MOON LAKE...  
2 null values remaining.  
Attempting to replace null values with values from SNYDERVILLE...  
2 null values remaining.  
Attempting to replace null values with values from PARK CITY 4 NW...  
2 null values remaining.  
Attempting to replace null values with values from SUNNYSIDE CITY CTR...  
2 null values remaining.  
Attempting to replace null values with values from STRAWBERRY HWY STN...  
2 null values remaining.  
Attempting to replace null values with values from STRAWBERRY HWY STN...  
2 null values remaining.  
Attempting to replace null values with values from SUNNYSIDE CITY...  
2 null values remaining.  
Attempting to replace null values with values from STRAWBERRY HWY STN...  
2 null values remaining.  
Attempting to replace null values with values from STRAWBERRY HWY STN...  
2 null values remaining.  
Attempting to replace null values with values from Currant Creek...  
2 null values remaining.  
Attempting to replace null values with values from PINVIEW...  
2 null values remaining.  
Attempting to replace null values with values from MAESER 9NW...  
2 null values remaining.  
Attempting to replace null values with values from VERNAL 9.8 NW...  
2 null values remaining.  
Attempting to replace null values with values from EAST PORTAL...  
2 null values remaining.  
Attempting to replace null values with values from STRAWBERRY RSVR EAST P...  
2 null values remaining.  
Attempting to replace null values with values from NEOLA...  
2 null values remaining.  
Attempting to replace null values with values from STRAWBERRY TUNNEL WEST...  
2 null values remaining.  
Attempting to replace null values with values from Hobble Creek...  
1 null values remaining.  
Attempting to replace null values with values from DRY GULCH RS...  
1 null values remaining.
```



531578187/3880

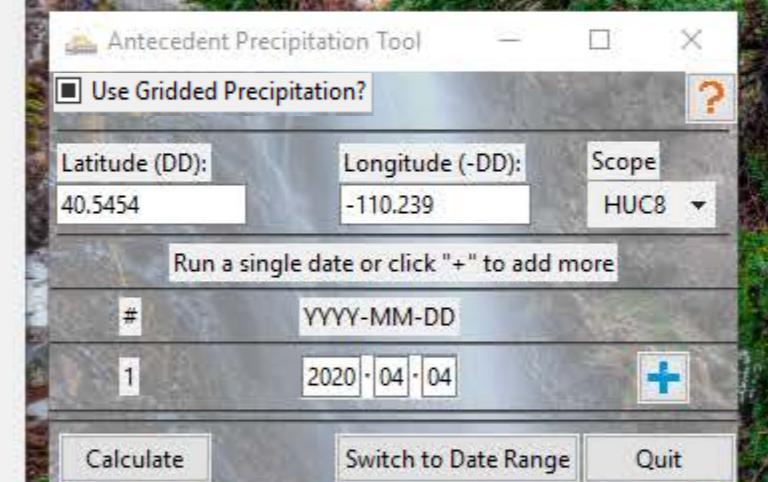
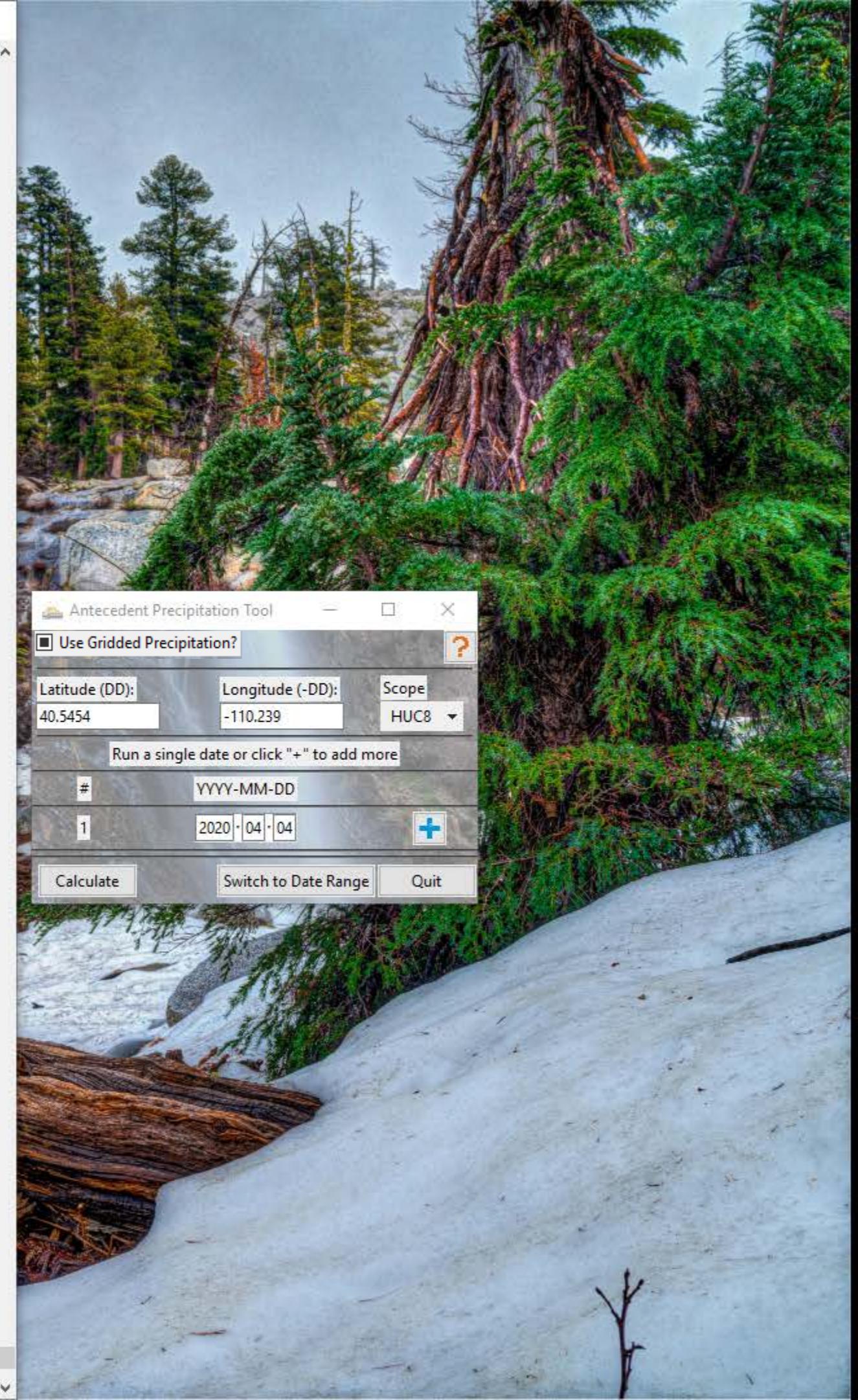
```
Attempting to replace null values with values from SUNNYSIDE CITY CTR...
2 null values remaining.
Attempting to replace null values with values from STRAWBERRY HWY STN...
2 null values remaining.
Attempting to replace null values with values from STRAWBERRY HWY STN...
2 null values remaining.
Attempting to replace null values with values from SUNNYSIDE CITY...
2 null values remaining.
Attempting to replace null values with values from STRAWBERRY HWY STN...
2 null values remaining.
Attempting to replace null values with values from STRAWBERRY HWY STN...
2 null values remaining.
Attempting to replace null values with values from Currant Creek...
2 null values remaining.
Attempting to replace null values with values from PINEVIEW...
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Attempting to replace null values with values from MAESER 9NW...
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Attempting to replace null values with values from VERNAL 9.8 NW...
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Attempting to replace null values with values from EAST PORTAL...
2 null values remaining.
Attempting to replace null values with values from STRAWBERRY RSVR EAST P...
2 null values remaining.
Attempting to replace null values with values from NEOLA...
2 null values remaining.
Attempting to replace null values with values from STRAWBERRY TUNNEL WEST...
2 null values remaining.
Attempting to replace null values with values from Hobble Creek...
1 null values remaining.
Attempting to replace null values with values from DRY GULCH RS...
1 null values remaining.
Attempting to replace null values with values from SOLDIER SUMMIT...
1 null values remaining.
Attempting to replace null values with values from PROVO 22 E...
1 null values remaining.
Attempting to replace null values with values from HELPER-CARBON PLT...
1 null values remaining.
Attempting to replace null values with values from HAYDEN...
1 null values remaining.
Attempting to replace null values with values from MANILA 18 ESE...
1 null values remaining.
Attempting to replace null values with values from MURDOCK POWERHOUSE...
1 null values remaining.
Attempting to replace null values with values from Lakefork #3...
1 null values remaining.
Attempting to replace null values with values from MANILA...
1 null values remaining.
Attempting to replace null values with values from Smith & Morehouse...
1 null values remaining.
Attempting to replace null values with values from SNAKE CREEK POWERHOUSE...
1 null values remaining.
Attempting to replace null values with values from PARK CITY 1.3 E...
1 null values remaining.
Attempting to replace null values with values from WHITE ROCKS...
1 null values remaining.
Attempting to replace null values with values from CASTLE GATE...
1 null values remaining.
Attempting to replace null values with values from STRAWBERRY DANIELS SUM...
1 null values remaining.
Attempting to replace null values with values from HEBER CITY 2.4 SSE...
0 null values remaining.
No null values within self.finalDF
```



531578187/3880

```
2 null values remaining.  
Attempting to replace null values with values from Currant Creek...  
2 null values remaining.  
Attempting to replace null values with values from PINEVIEW...  
2 null values remaining.  
Attempting to replace null values with values from MAESER 9NW...  
2 null values remaining.  
Attempting to replace null values with values from VERNAL 9.8 NW...  
2 null values remaining.  
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Attempting to replace null values with values from STRAWBERRY RSVR EAST P...  
2 null values remaining.  
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1 null values remaining.  
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1 null values remaining.  
Attempting to replace null values with values from WHITE ROCKS...  
1 null values remaining.  
Attempting to replace null values with values from CASTLE GATE...  
1 null values remaining.  
Attempting to replace null values with values from STRAWBERRY DANIELS SUM...  
1 null values remaining.  
Attempting to replace null values with values from HEBER CITY 2.4 SSE...  
0 null values remaining.  
No null values within self.finalDF
```

```
Saving "merged_stations.csv" data to output folder...  
Converting PRCP values to inches...  
self.finalDF conversion complete.  
Saving "merged_stations_converted_to_mm.csv" data to output folder...  
  
calculating 30-day rolling totals...  
Collecting all rolling totals for each day of the year...  
Calculating Normal High and Normal Low values for each day of the year...  
Evaluating sample points...  
Determining relationship between sample points and the normal range...
```



```
1 null values remaining.
Attempting to replace null values with values from Smith & Morehouse...
1 null values remaining.
Attempting to replace null values with values from SNAKE CREEK POWERHOUSE...
1 null values remaining.
Attempting to replace null values with values from PARK CITY 1.3 E...
1 null values remaining.
Attempting to replace null values with values from WHITE ROCKS...
1 null values remaining.
Attempting to replace null values with values from CASTLE GATE...
1 null values remaining.
Attempting to replace null values with values from STRAWBERRY DANIELS SUM...
1 null values remaining.
Attempting to replace null values with values from HEBER CITY 2.4 SSE...
0 null values remaining.
No null values within self.finalDF
```

```
Saving "merged_stations.csv" data to output folder...
Converting PRCP values to inches...
self.finalDF conversion complete.
Saving "merged_stations_converted_to_mm.csv" data to output folder...
```

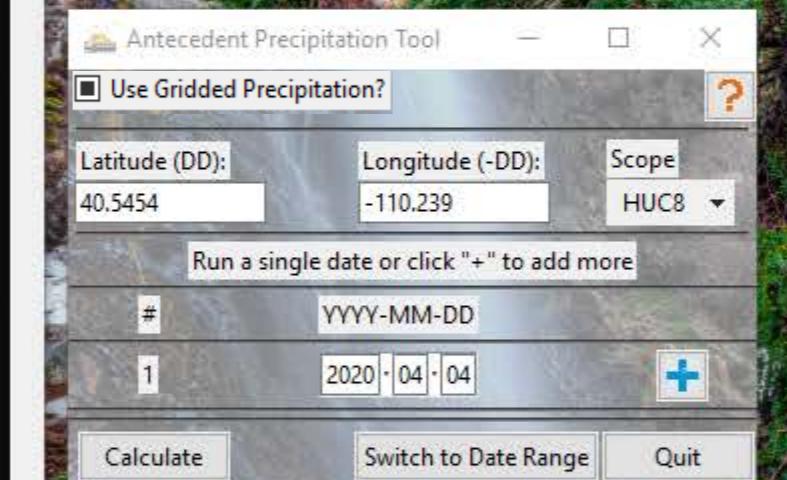
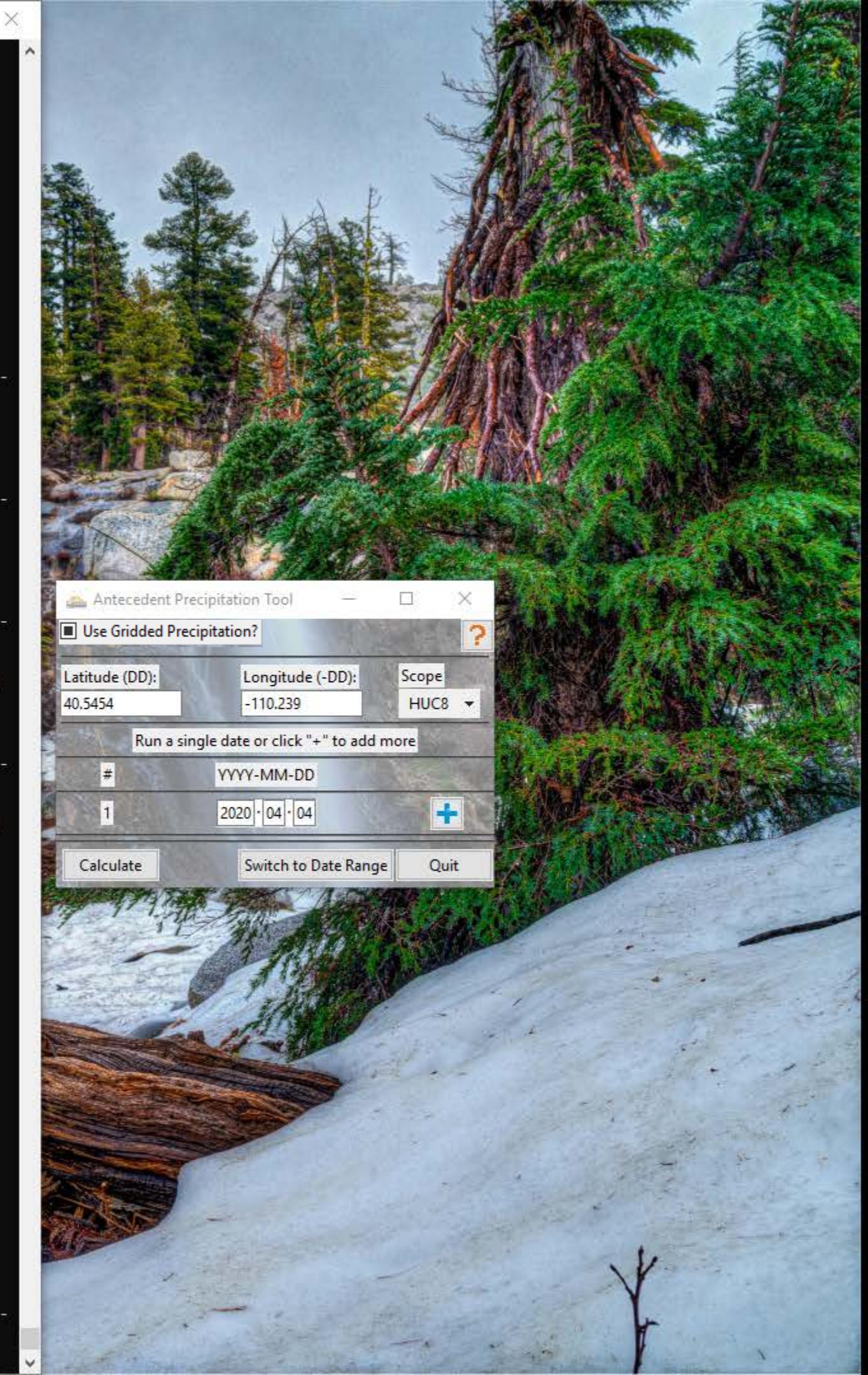
```
calculating 30-day rolling totals...
Collecting all rolling totals for each day of the year...
Calculating Normal High and Normal Low values for each day of the year...
Evaluating sample points...
Determining relationship between sample points and the normal range...
```

```
#----- PDSI - Palmer Drought Severity Index -----
Querying the Palmer Drought Severity Index...
Opening PDSI file to collect monthly values...
PDSI Value = -1.33 - Mild drought
```

```
#----- Web WIMP - Web-based Water-Budget Interactive Modeling Program -----
Scraping WebWIMP at 40.4,-110.7...
```

Terms:  
 DIFF is the rainfall and estimated snowmelt minus the adjusted potential evapotranspiration (mm/month).  
 DST is the estimated change in soil moisture from the end of the previous month to the end of the current month (mm/month).  
 DEF is the estimated deficit or unmet atmospheric demand for moisture (mm/month).

Mon	DIFF	DST	DEF	Conclusion
Jan	1	0	0	Wet Season
Feb	0	0	0	Wet Season
Mar	96	96	0	Wet Season
Apr	-5	-5	0	Dry Season
May	-42	-36	6	Dry Season
Jun	-74	-39	36	Dry Season
Jul	-92	-22	70	Dry Season
Aug	-76	-8	68	Dry Season
Sep	-35	-2	33	Dry Season
Oct	-2	4	5	Dry Season
Nov	12	12	0	Wet Season
Dec	-1	0	0	Wet Season



Saving "merged\_stations\_converted\_to\_mm.csv" data to output folder...  
 calculating 30-day rolling totals...  
 Collecting all rolling totals for each day of the year...  
 Calculating Normal High and Normal Low values for each day of the year...  
 Evaluating sample points...  
 Determining relationship between sample points and the normal range...

```
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Querying the Palmer Drought Severity Index...
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#----- Web WIMP - Web-based Water-Budget Interactive Modeling Program -----#
Scraping WebWIMP at 40.4,-110.7...
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Mon	DIFF	DST	DEF	Conclusion
Jan	1	0	0	Wet Season
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Aug	-76	-8	68	Dry Season
Sep	-35	-2	33	Dry Season
Oct	-2	4	5	Dry Season
Nov	12	12	0	Wet Season
Dec	-1	0	0	Wet Season

<--Selected Month

```
#----- GRAPH & TABLE GENERATION -----#
Constructing graph, plotting data, and configuring tables...
Generating figure with graph and tables...
```

Saving C:\Temp\Antecedent Precipitation Calculator\Outputs\v1\_0\_14\40.354225, -110.689804\2020-04-04.pdf  
 Closing figure...

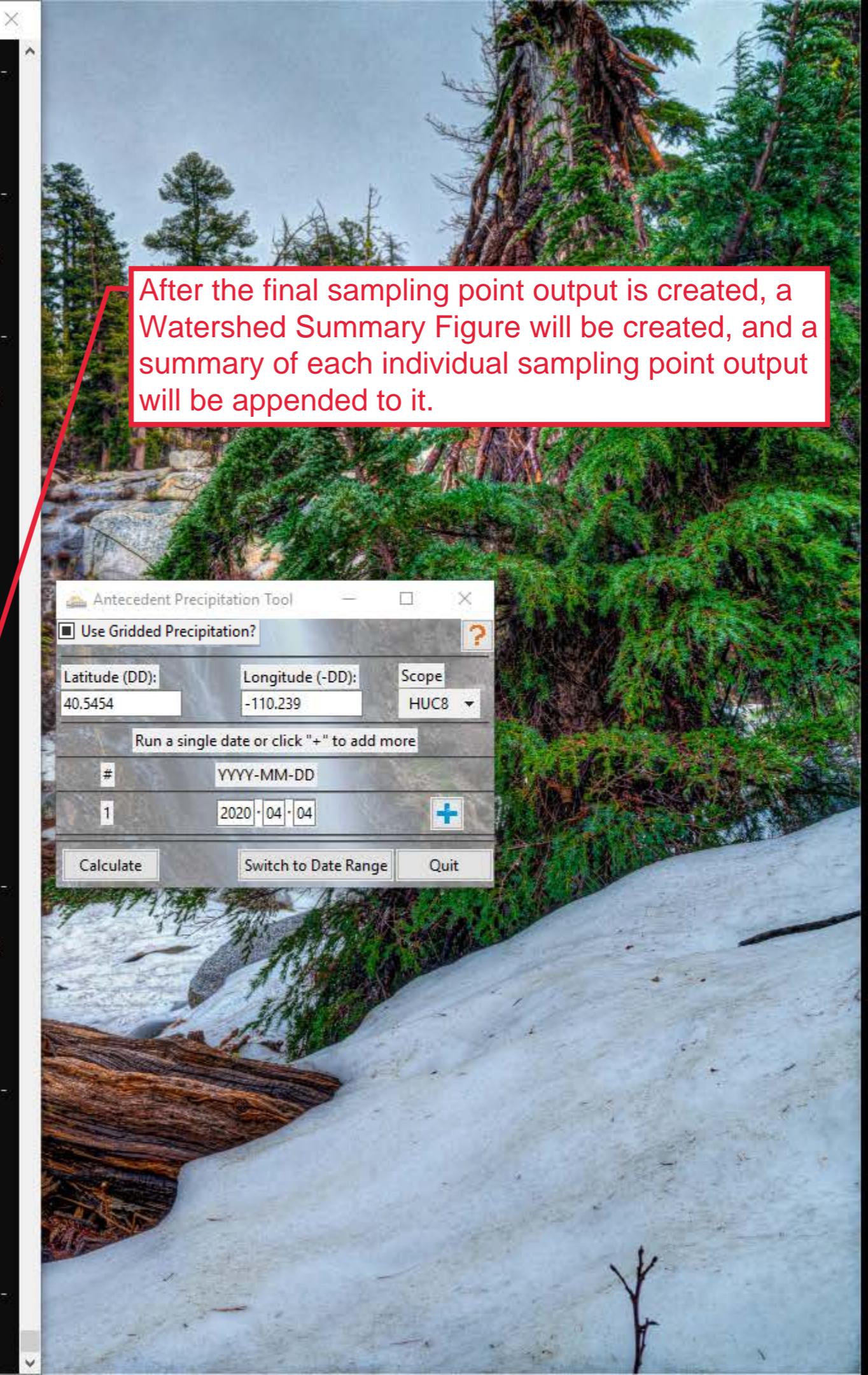
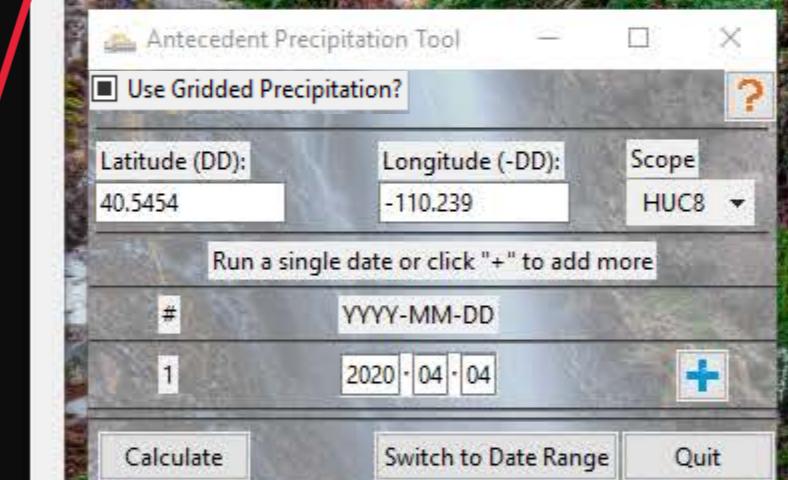
Saving Watershed Summary figure...  
 Closing figure...

Opening Batch Results CSV in new process...
 Opening finalPDF in new process...
 Attempting to delete temporary files...

All tasks took 18 minutes and 42 seconds to complete

Ready for new input.

After the final sampling point output is created, a Watershed Summary Figure will be created, and a summary of each individual sampling point output will be appended to it.



531578187/3880

Saving "merged\_stations\_converted\_to\_mm.csv" data to output folder...

calculating 30-day rolling totals...

Collecting all rolling totals for each day of the year...

Calculating Normal High and Normal Low values for each day of the year...

Evaluat

Determin

#- Queryin

Openin

PDSI

#- Scrapin

Terms

DIFF

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2 items

Opening batch Results CSV in new process...

Opening finalPDF in new process...

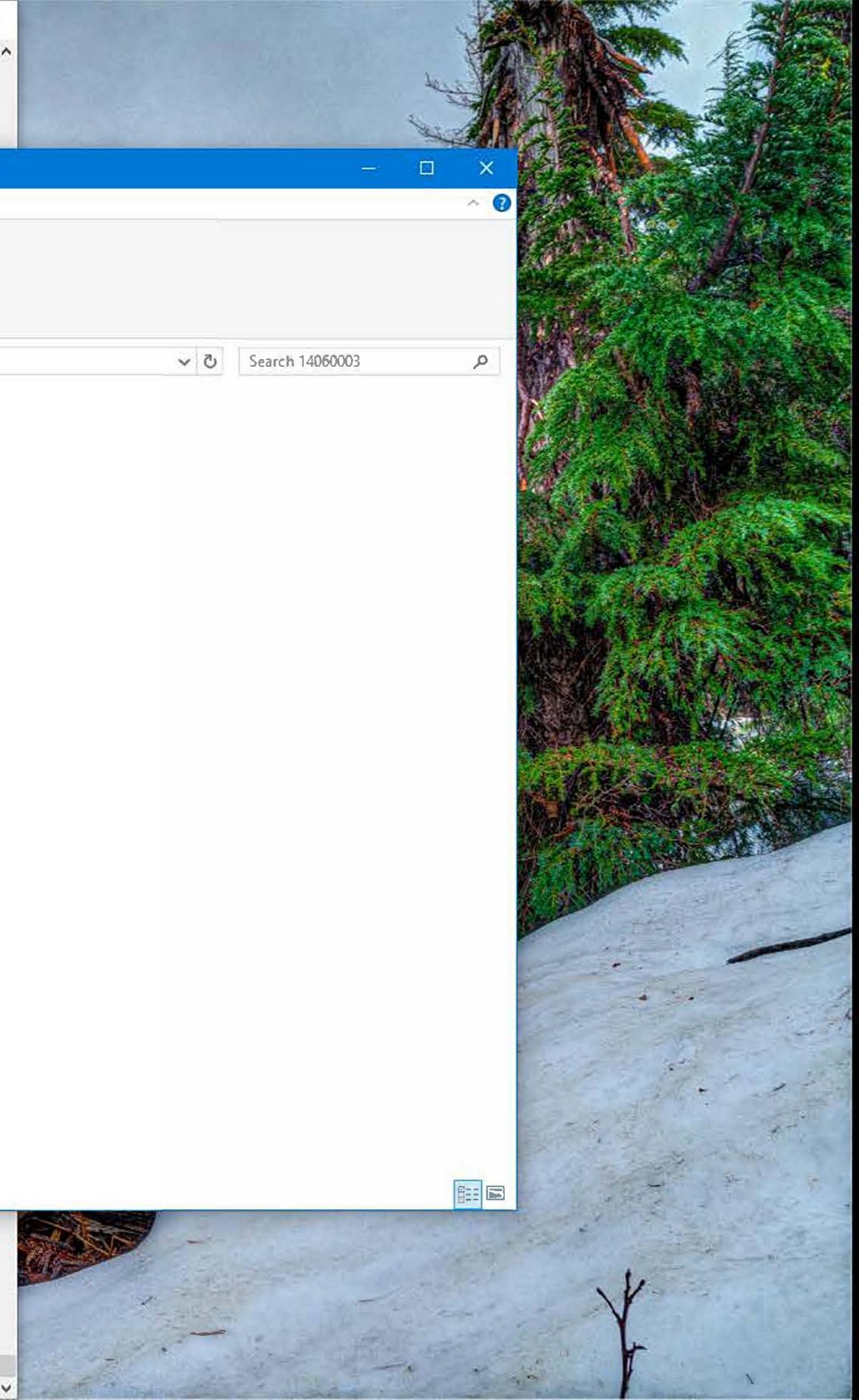
Attempting to delete temporary files...

All tasks took 18 minutes and 42 seconds to complete

Ready for new input.

The tool first opens the output folder, to ensure the user knows where their data was saved.

Results from each sampling point are also saved in the output folder, organized by the sampling points latitude and longitude.



Saving "merged\_stations converted to mm.csv" data to output folder...

2020-04-04 - 14060003 - Sampling Results.csv - Excel

Deters, Jason C CIV USARMY CESPK (USA)

Antecedent  
Precipitati...

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW PROJECTWISE ACROBAT TEAM

K9

Formula Bar

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Latitude	Longitude	Date	PDSI Value	PDSI Class	Season	ARC Score	Antecedent Precip Condition								
2	40.5454	-110.239	4/4/2020	-1.33	Mild drought	Dry Season	9	Drier than Normal								
3	40.395216	-110.283535	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
4	40.379759	-109.94296	4/4/2020	-1.47	Mild drought	Dry Season	12	Normal Conditions								
5	40.320737	-110.423526	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
6	39.911014	-110.33837	4/4/2020	-1.47	Mild drought	Dry Season	10	Normal Conditions								
7	40.000356	-110.308569	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
8	40.387893	-110.389964	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
9	40.266369	-110.586335	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
10	40.532673	-110.832899	4/4/2020	-1.33	Mild drought	Dry Season	15	Wetter than Normal								
11	40.707013	-110.239489	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
12	40.442707	-110.768303	4/4/2020	-1.33	Mild drought	Dry Season	15	Wetter than Normal								
13	40.193677	-110.076811	4/4/2020	-1.47	Mild drought	Dry Season	10	Normal Conditions								
14	40.34305	-110.072901	4/4/2020	-1.47	Mild drought	Dry Season	12	Normal Conditions								
15	40.66888	-110.326014	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
16	40.546831	-110.349804	4/4/2020	-1.33	Mild drought	Dry Season	15	Wetter than Normal								
17	40.519732	-110.634445	4/4/2020	-1.33	Mild drought	Dry Season	13	Normal Conditions								
18	40.542364	-110.151827	4/4/2020	-1.33	Mild drought	Dry Season	12	Normal Conditions								
19	40.255522	-110.412434	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
20	40.660498	-110.071679	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
21	40.571057	-110.775677	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
22	40.681713	-109.918315	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
23	40.460083	-110.590945	4/4/2020	-1.33	Mild drought	Dry Season	13	Normal Conditions								
24	40.529453	-110.913487	4/4/2020	-1.33	Mild drought	Dry Season	15	Wetter than Normal								
25	40.316255	-109.882398	4/4/2020	-1.47	Mild drought	Dry Season	12	Normal Conditions								
26	40.189783	-110.332474	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
27	39.908622	-110.608196	4/4/2020	-1.33	Mild drought	Wet Season	15	Wetter than Normal								
28	40.765899	-110.289319	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
29	40.72395	-110.499938	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
30	40.456025	-110.196235	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
31	40.576147	-110.092292	4/4/2020	-1.33	Mild drought	Wet Season	12	Normal Conditions								
32	40.29008	-110.00597	4/4/2020	-1.47	Mild drought	Dry Season	12	Normal Conditions								
33	40.524208	-110.277698	4/4/2020	-1.33	Mild drought	Dry Season	9	Drier than Normal								
34	40.600943	-110.491106	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
35	40.572681	-110.559632	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
36	40.61292	-110.272711	4/4/2020	-1.33	Mild drought	Wet Season	13	Normal Conditions								
37	40.149935	-109.823739	4/4/2020	-1.47	Mild drought	Dry Season	12	Normal Conditions								
38	40.52691	-110.508838	4/4/2020	-1.33	Mild drought	Dry Season	13	Normal Conditions								
39	40.430201	-111.152835	4/4/2020	-1.33	Mild drought	Wet Season	15	Wetter than Normal								
40	40.307074	-110.65837	4/4/2020	-1.47	Mild drought	Dry Season	9	Drier than Normal								
41	40.494682	-109.987326	4/4/2020	-1.47	Mild drought	Dry Season	12	Normal Conditions								
42	40.124000	-100.720000	4/4/2020	-1.47	Mild drought	Dry Season	10	Normal Conditions								

2020-04-04 - 14060003 - Sampling Results.csv

READY

Ready for New Import



# Antecedent Precipitation Tool v.2.0 - Watershed Sampling Summary

Generated on 2022-11-29

## User Inputs

Coordinates	40.5454, -110.239
Date	2020-04-04
Geographic Scope	HUC8
Used Gridded Precipitation	False

## Intermediate Data

Hydrologic Unit Code	14060003
Watershed Size	2679.13 mi <sup>2</sup>
# Random Sampling Points	140

## Preliminary Result

Average Antecedent Precipitation Score	11.81
Preliminary Determination	Normal Conditions

Wetter than Normal

Drier than Normal

6.0%

21.0%

73.0

Normal Conditions

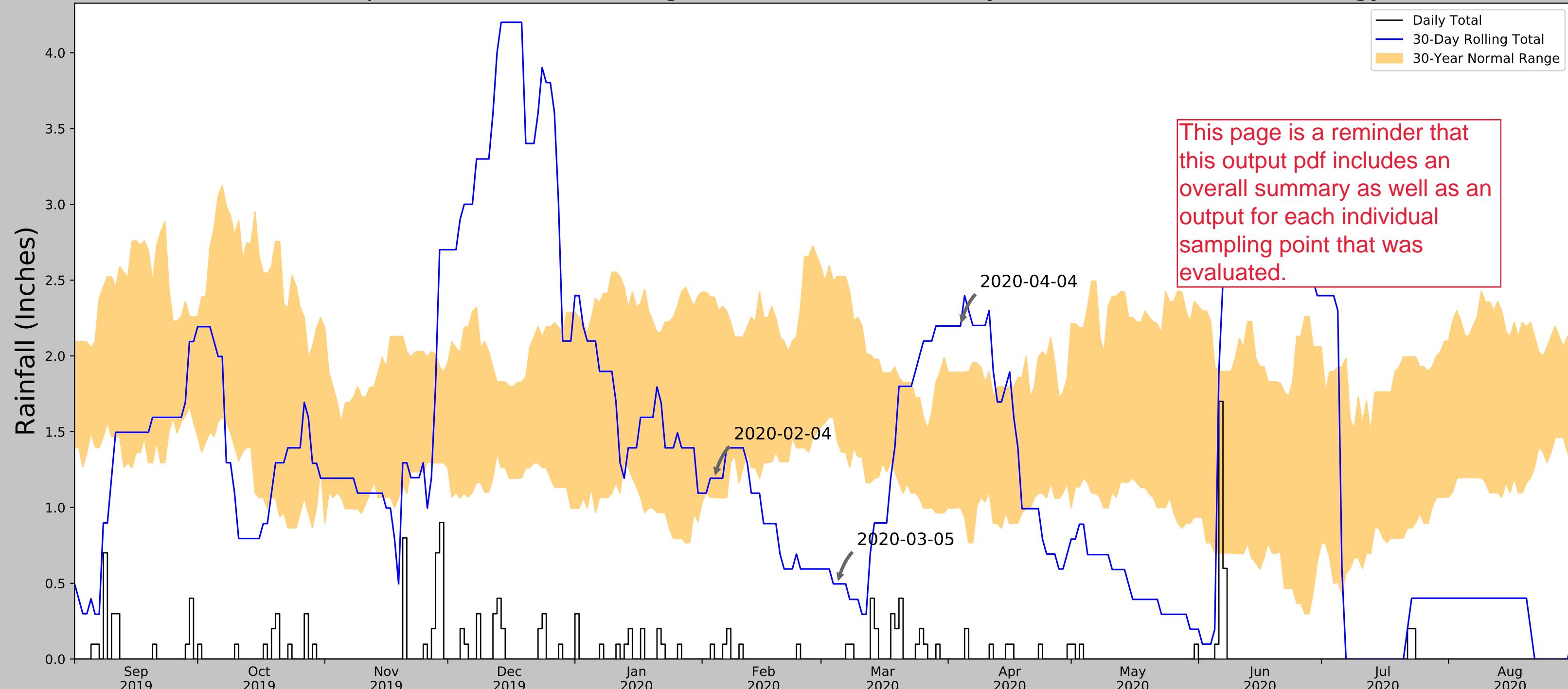
Finally, the tool opens the Watershed Batch Result PDF

Information about this output can be found on the Help Page  
(The orange question mark button on the tool's main interface)

## Sampling Point Breakdown

Antecedent Precipitation Score	Antecedent Precipitation Condition	WebWIMP H <sub>2</sub> O Balance	Drought Index (PDSI)	# of Points
15	Wetter than Normal	Dry Season	Mild drought	3
15	Wetter than Normal	Wet Season	Mild drought	5
13	Normal Conditions	Wet Season	Mild drought	30
13	Normal Conditions	Dry Season	Mild drought	22
12	Normal Conditions	Wet Season	Mild drought	14
12	Normal Conditions	Dry Season	Mild drought	30
10	Normal Conditions	Dry Season	Mild drought	6
9	Drier than Normal	Dry Season	Mild drought	30

# Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



Coordinates	40.5454, -110.239
Observation Date	2020-04-04
Elevation (ft)	8053.79
Drought Index (PDSI)	Mild drought
WebWIMP H <sub>2</sub> O Balance	Dry Season

30 Days Ending	30 <sup>th</sup> %ile (in)	70 <sup>th</sup> %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2020-04-04	0.998819	1.890945	2.19685	Wet	3	3	9
2020-03-05	1.433071	2.524016	0.496063	Dry	1	2	2
2020-02-04	1.066142	2.388189	1.192913	Normal	2	1	2
Result							Normal Conditions - 13



Figures and tables made by the  
Antecedent Precipitation Tool  
Version 2.0

Developed by:  
U.S. Army Corps of Engineers and  
U.S. Army Engineer Research and  
Development Center

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days Normal	Days Antecedent
Rock Creek	40.55, -110.69	7889.108	23.68	164.682	14.556	11352	90