Antecedent Precipitation Tool

User Guide

Contents

Antecedent Precipitation Tool Overview

Where can I get it?
Follow the instructions on the LATEST RELEASE PAGE.

What is it?
Automation tool that evaluates three climatological parameters to assist in the making and documenting of various determinations required by policy for the execution of USACE's Regulatory Program.

Scale
The tool can perform its analyses at a single point, for the consideration of wetland hydrology, or it can be configured to run on a watershed scale to help support a typical year analysis.

Usage
Rapidly, accurately, and effortlessly determine whether any of the following problematic circumstances exist for a given Latitude, Longitude, and Date:

- Dry Season
- Drought Conditions
- Lower than normal antecedent precipitation
- Greater than normal antecedent precipitation
- Automatically document the basis of these decisions for the administrative record.

Utility
- **Site Visit:** Determine whether you should use the problematic circumstances portion of the delineation manual and regional supplement
- **Data Sheet Review:** Determine whether the applicant or their agent should have used the problematic circumstances portion of the delineation manual and regional supplement
- **Satellite / Aerial Imagery Interpretation:** Determine whether the seasonality, drought conditions, and antecedent precipitation are appropriate for a given image to be used for:
  - **Hydrology Indicators:** Saturation on aerial imagery, Inundation on aerial imagery
  - **Connectivity:** Continuous saturation or inundation visible between potential WotUS
  - **Apparent differences in vegetation:**
    - Reduced vigor of upland crops in suspected depressions or swales
    - Greener vegetation in suspected depressions or swales compared to dry/yellow surrounding vegetation
    - Location and extent of any other wetland signatures (e.g. vernal pool stratified vegetation rings)

Basic Methodology for each determination

- **Wet/Dry Season Determination**
  - **Protocol:** Based on ERDC instructions for calculating dry season provided in the regional supplements to the 1987 Delineation Manual
  - **Data Source:** WebWIMP (The Web-based, Water-Budget, Interactive, Modeling Program)
- **Drought Conditions:**
  - **Protocol:** Based on ERDC recommendations in the regional supplements to the 1987 Delineation Manual, which suggests using drought indices, specifically the Palmer Drought Severity Index (PDSI) to help inform drought conditions.
  - **Data source:** Climate Division scale PDSI data calculated and hosted by NOAA monthly

- **Antecedent Precipitation Condition**
  - **Protocol:** Combined method of 30-day rolling totals and NRCS Engineering Field Handbook weighting factors (Combined Method) (see Section 4.3, Sprecher and Warne (2000)).
    - Sprecher, S.W. and Andrew G. Warne, A.G., 2000. ***Accessing and Using Meteorological Data to Evaluate Wetland Hydrology***. WRAP Technical Notes Collection, ERDC/EL TR-WRAP-00-1. U.S. Army Engineer Research and Development Center, Vicksburg, MS. (http://el.erdc.usace.army.mil/elpubs/pdf/wrap00-1/wrap00-1.pdf)
    - Natural Resources Conservation Service, 1997. ***Hydrology tools for wetland determination***. Chapter 19, Engineering field handbook. D. E. Woodward, ed. USDA-NRCS, Fort Worth, TX. (http://www.info.usda.gov/CED/ftp/CED/EFH-Ch19.pdf)
  - **WETS Tables were discontinued, so the protocol was amended:** New monthly 30th and 70th percentile data was needed, but since we were generating this data ourselves anyway, we took the opportunity to improve the procedure.
  - **Problems with old monthly procedure**
    - Months vary in length, yet we are comparing monthly totals to 30-day rolling totals.
    - Precipitation varies throughout the month
    - However, the monthly total protocol simply graphs straight lines between the last days of each month.
    - Ex. If it only rains at the end of September in a given area, this method artificially spreads that rain out evenly across each day.
  - **Solution - Compare 30-day rolling totals to 30-day rolling totals**
    - We get 30 years and 1 month of precipitation data, and use it to calculate 30 years of 30-day rolling totals.
    - We then calculate the 30th and 70th percentile values for each day of the year
    - Now, when we compare the current year 30-day rolling total to the 30-year normal, we are directly comparing the same exact type of measurement, at the same resolution.
  - **Station Selection**
    Manual Procedure

- The original method required a PM to manually locate weather station data that they deemed most appropriate to use for their site, with a note that it should be relatively close and at a similar elevation.
- No real parameters were provided for when a station is too far, or how you can be sure there is not a closer station that you have overlooked.
- Most PMs were using only the stations used to create the WETS tables, which are limited to approximately 1 or 2 per county in California.
- If any dates were missing from the record, PMs were having to backfill from the other WETS station in the county, which might be drastically further away.

Problems with the manual method

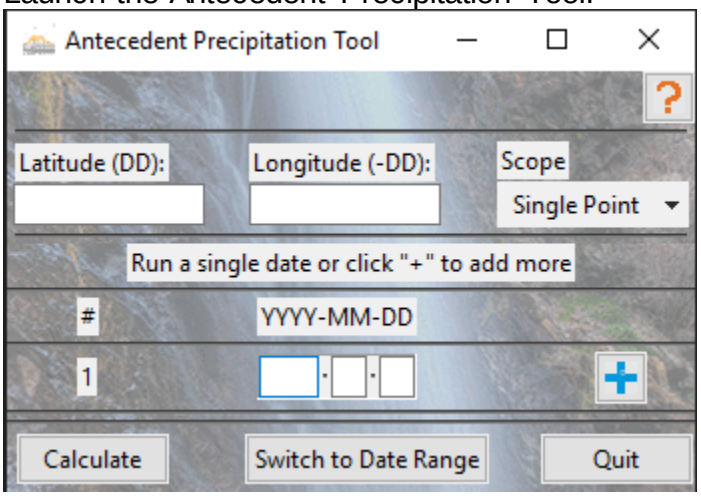
- Weather patterns vary greatly over relatively small lateral distances, especially if those distances are accompanied with large changes in elevation.
- There are typically quite a few stations closer in distance and elevation, but PMs don't know how to find them all, and most people don't know how to calculate distance using geographic coordinates. Even if they did, sorting through all of the available stations based on distance and elevation difference would be extremely time-consuming.
- The completeness of the record needs to be considered, as you can't create a 30-year normal from disparate data sources.
- This would require PMs to download a large number of complete records from every available weather station, do the math on how many of dates from the pertinent range are missing from each dataset, and factor this information into the selection of their primary weather station.

Solution - Automated Querying of NOAA's data by programmatically

- Acquiring a list of every weather station in the U.S.
- Locating those within a specific distance from the observation point
- Sorting the selected stations by a weighted difference value
  - Incorporates both distance and difference in elevation
  - Created experimentally by matching the result to the best professional judgment of contributing PMs around the country.
- For the Primary Station
  - Eliminating stations with insufficient records for the 30 year normal period and the relevant portion of the current year supporting the Antecedent Precipitation calculation
- For the Missing Dates (Secondary Station, etc.)
  - Sorting the remaining station by the weighted difference value
  - Weighted differences are recalculated in relation to the Primary Station's location and elevation, rather than the observation point
  - Attempt to backfill the missing dates from the Primary Station with the resorted stations until there are no missing dates.

Run a Single Point Analysis using the Unique Date Interface

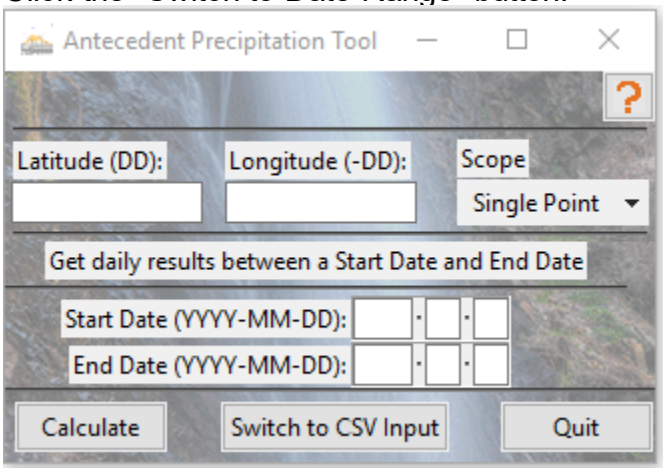
1. Launch the Antecedent Precipitation Tool.



2. Enter a latitude into the “Latitude” field in DD (Decimal Degree) format.
3. Enter a longitude into the “Longitude” field. In DD (Decimal Degree) format.
4. Leave the Scope drop-down menu alone, as the default is already “Single Point.”
5. Enter a date into the multi-part date field in the format “YYYY-MM-DD”
    a. Note: The following date values are not permitted
        i. Years before 1910
        ii. Dates that do not exist, like February 29th 2019, or September 31st of any year.
        iii. Dates occurring less than 2 days prior to the current date. (There is an approximately two-day delay on the upload of weather station data in NOAA’s Global Historic Climatology Network.)
    b. If any of the invalid date entries above are entered, the date field will turn red, and the console will display the issue that must be corrected before you can proceed.
6. If additional dates are desired, click the “+” button to add additional rows.
7. Once satisfied with the entries provided, click the “Calculate” button.

Run a Single Point Analysis using the Date Range Interface

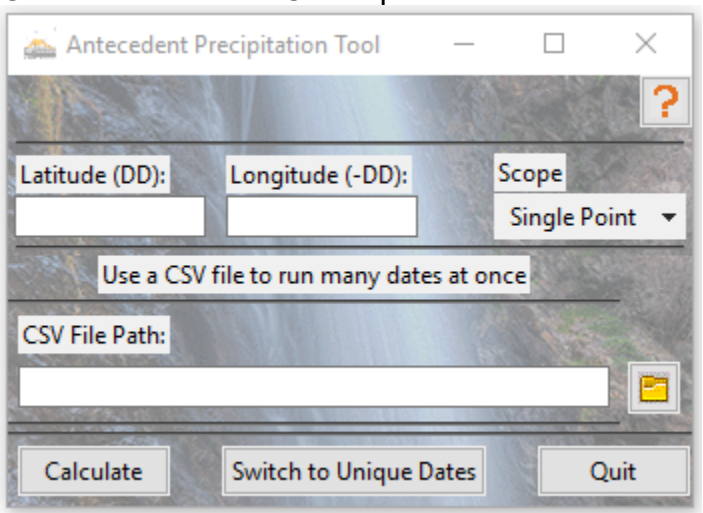
1. Launch the Antecedent Precipitation Tool.
2. Click the “Switch to Date Range” button.



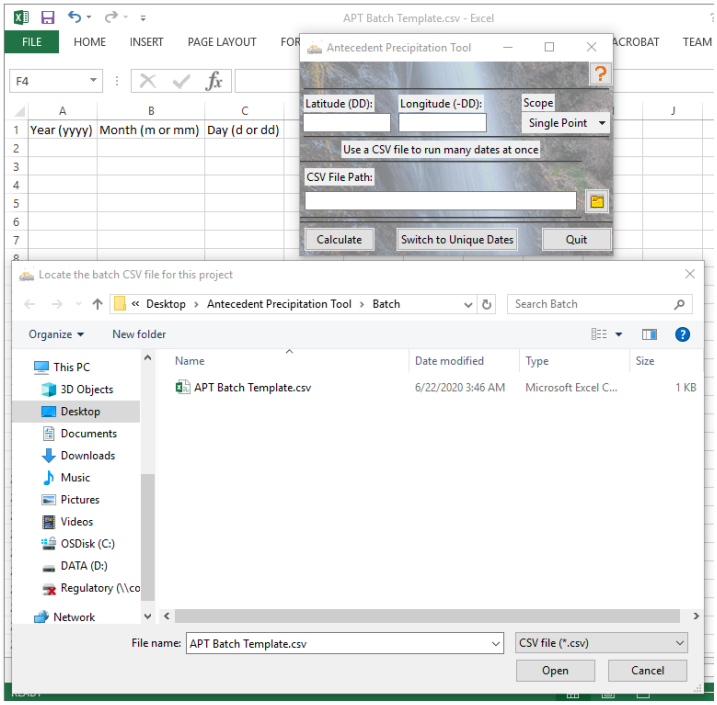
3. Enter a latitude into the “Latitude” field in DD (Decimal Degree) format.
4. Enter a longitude into the “Longitude” field. In DD (Decimal Degree) format.
5. Leave the Scope drop-down menu alone, as the default is already “Single Point.”
6. Enter a Start Date and an End Date into the corresponding multi-part date fields in the format “YYYY-MM-DD”
    a. The tool will run a single point analysis for the Start Date, the End Date, and each day that falls in between them.
    b. Note: The following date values are not permitted
        i. Years before 1910
        ii. Dates that do not exist, like February 29th 2019, or September 31st of any year.
        iii. Dates occurring less than 2 days prior to the current date. (There is an approximately two-day delay on the upload of weather station data in NOAA’s Global Historic Climatology Network.)
    c. If any of the invalid date entries above are entered, the date field will turn red, and the console will display the issue that must be corrected before you can proceed.
7. Once satisfied with the entries provided, click the “Calculate” button.

Run a Single Point Analysis using the CSV Input Interface

1. Launch the Antecedent Precipitation Tool.
2. Click the “Switch to Date Range” button.
3. Click the “Switch to CSV Input” button.



4. Enter a latitude into the “Latitude” field in DD (Decimal Degree) format.
5. Enter a longitude into the “Longitude” field. In DD (Decimal Degree) format.
6. Leave the Scope drop-down menu alone, as the default is already “Single Point.”
7. Click the folder icon to the right of the “CSV File Path” field to select a CSV file.



8. The default “Batch” folder contains a template CSV file to use as a reference.
9. Edit the template or create a new CSV following the same format.
10. Enter a year (yyyy), month (m or mm) and day (d or dd) for as many rows as desired
    a. Note: The following date values are not permitted

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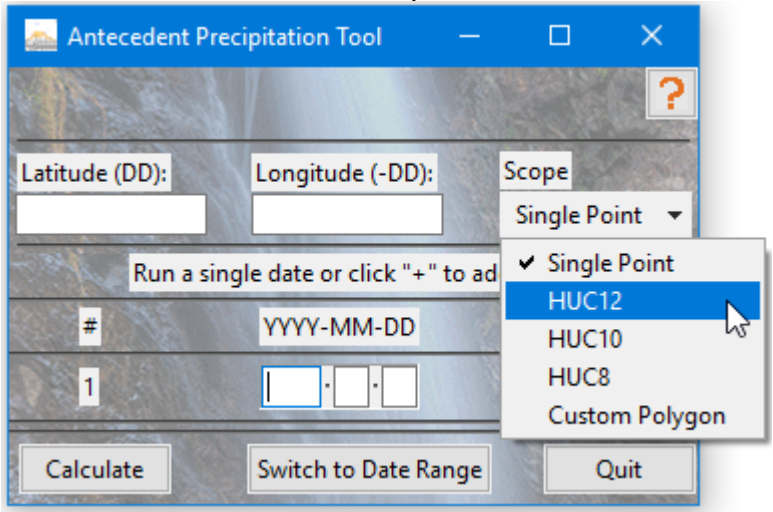
11. Once satisfied with the entries provided, click the "Calculate" button.

Run a Watershed Analysis using USGS Watershed Boundary Dataset

1. Launch the Antecedent Precipitation Tool.



2. Enter a latitude into the “Latitude” field in DD (Decimal Degree) format.
3. Enter a longitude into the “Longitude” field. In DD (Decimal Degree) format.
4. Click on the “Scope” drop-down menu (You actually click on the default value, “Single Point”).
5. Select HUC8, HUC10, or HUC12, depending on the desired watershed scale.
6. Enter a date into the multi-part date field in the format “YYYY-MM-DD”
    a. Note: The following date values are not permitted
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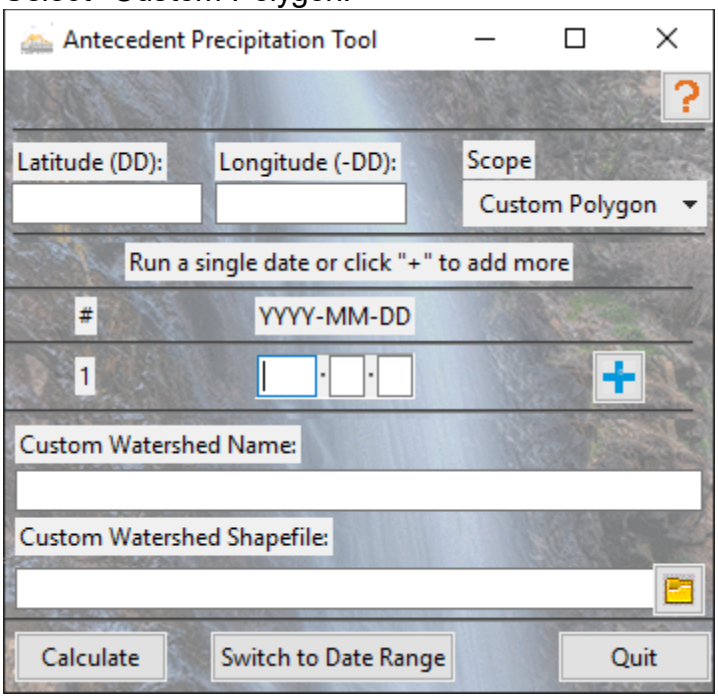
    b. If any of the invalid date entries above are entered, the date field will turn red, and the console will display the issue that must be corrected before you can proceed.
7. If additional dates are desired, click the “+” button to add additional rows.
8. Once satisfied with the entries provided, click the “Calculate” button.

Run a Watershed Analysis using a Custom Watershed Polygon

1. Launch the Antecedent Precipitation Tool.
2. Enter a latitude into the "Latitude" field in DD (Decimal Degree) format.
3. Enter a longitude into the "Longitude" field. In DD (Decimal Degree) format.
4. Click on the "Scope" drop-down menu (You actually click on the default value, "Single Point").
5. Select "Custom Polygon."



6. Enter a date into the multi-part date field in the format "YYYY-MM-DD"
    a. Note: The following date values are not permitted
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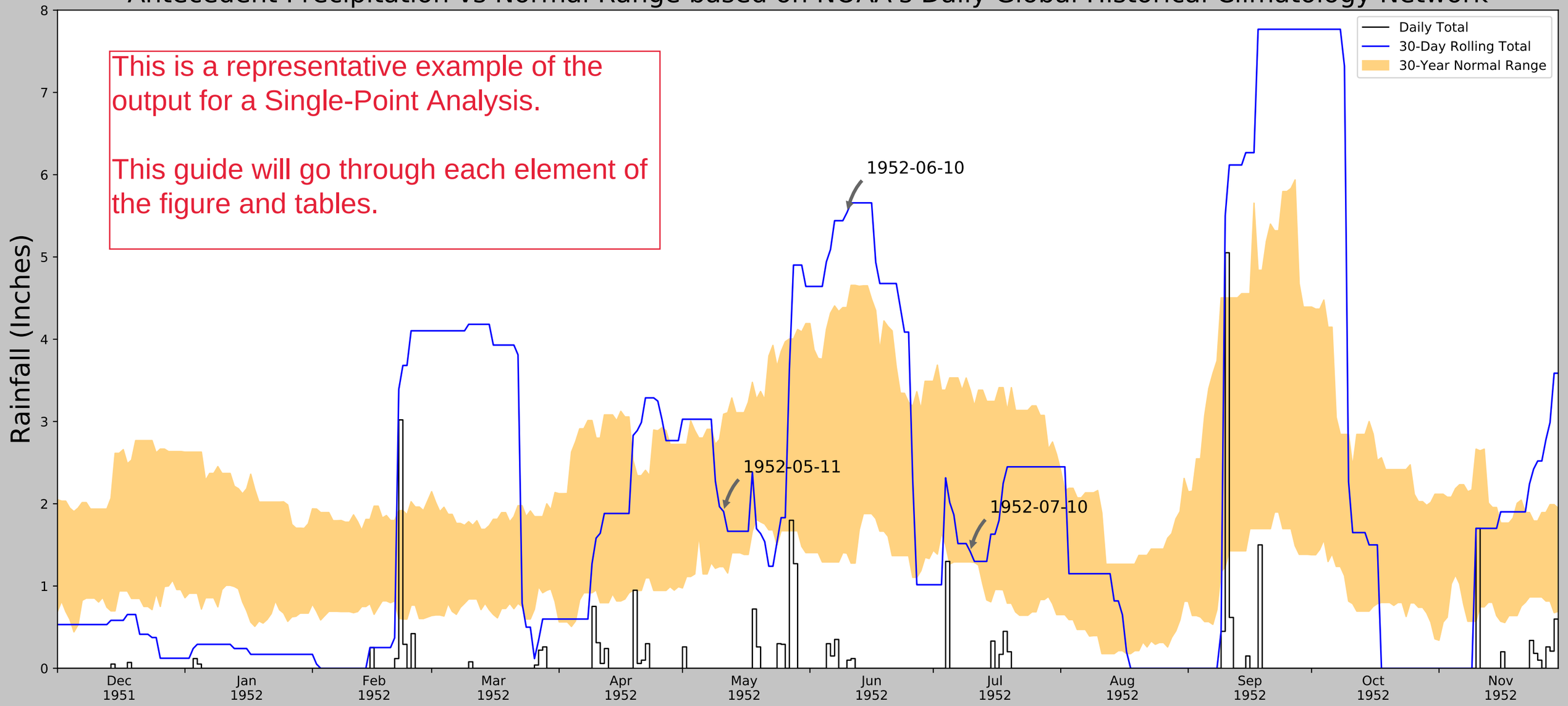
    b. If any of the invalid date entries above are entered, the date field will turn red, and the console will display the issue that must be corrected before you can proceed.
7. In the "Custom Watershed Name" box, enter the name by which you intend to reference this watershed in any documentation within which you may cite this analysis.
8. In the "Custom Watershed Shapefile" box, enter the file path to the shapefile containing your selected custom watershed shapefile. You may also click on the folder icon to browse for said shapefile.
   Note: The intent is to expand the range of file types this tool will accept in the future.
9. Once satisfied with the entries provided, click the "Calculate" button.

How to read the output of a Single Point Analysis

Note: It is recommended that you switch to “Fit One Full Page” viewing mode in to scroll through the following section.

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



Coordinates	28.44571, -98.529303
Observation Date	1952-07-10
Elevation (ft)	248.76
Drought Index (PDSI)	Severe drought
WebWIMP H_2O Balance	Dry Season

30 Days Ending	30th %ile (in)	70th %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
1952-07-10	1.292126	3.381496	1.417323	Normal	2	3	6
1952-06-10	1.399213	4.385433	5.53937	Wet	3	2	6
1952-05-11	1.235039	3.08937	1.905512	Normal	2	1	2
Result							Normal Conditions - 14

Figure and tables made by the **Antecedent Precipitation Tool** Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
WHITSETT 3 SW	28.6333, -98.2667	209.974	20.544	38.786	10.042	11312	90
FOWLERTON	28.5033, -98.8392	299.869	19.238	51.109	9.64	12	0
THREE RIVERS	28.4667, -98.1833	150.919	21.068	97.841	11.542	28	0

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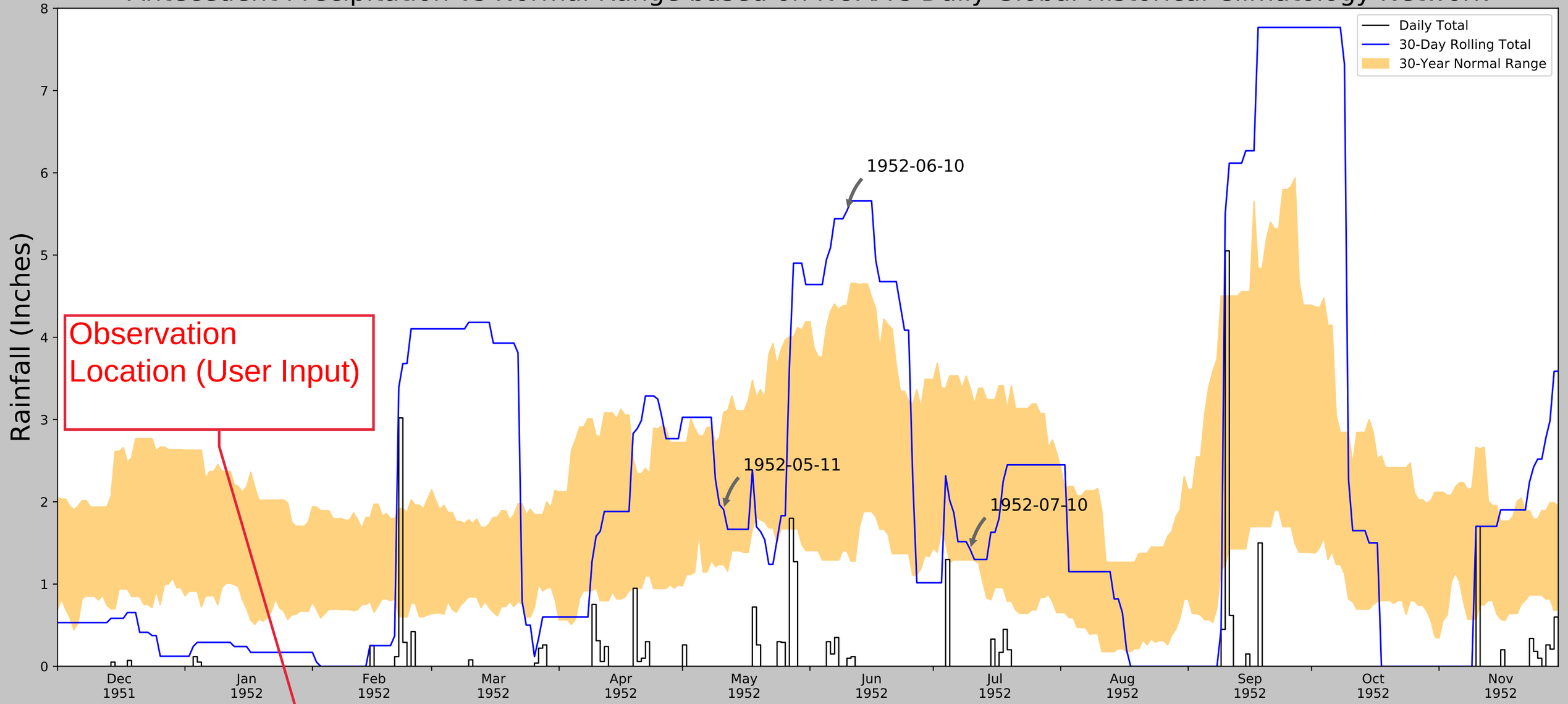

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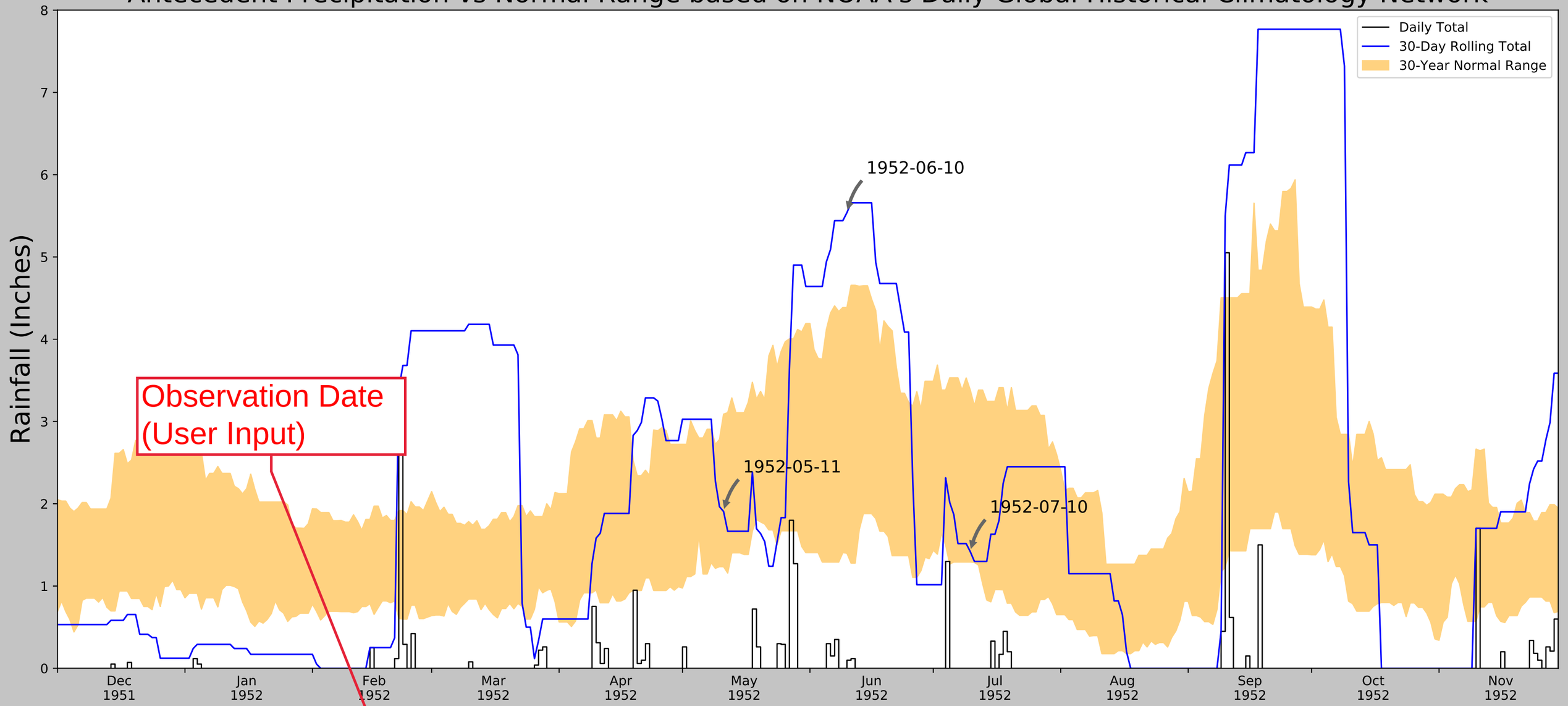

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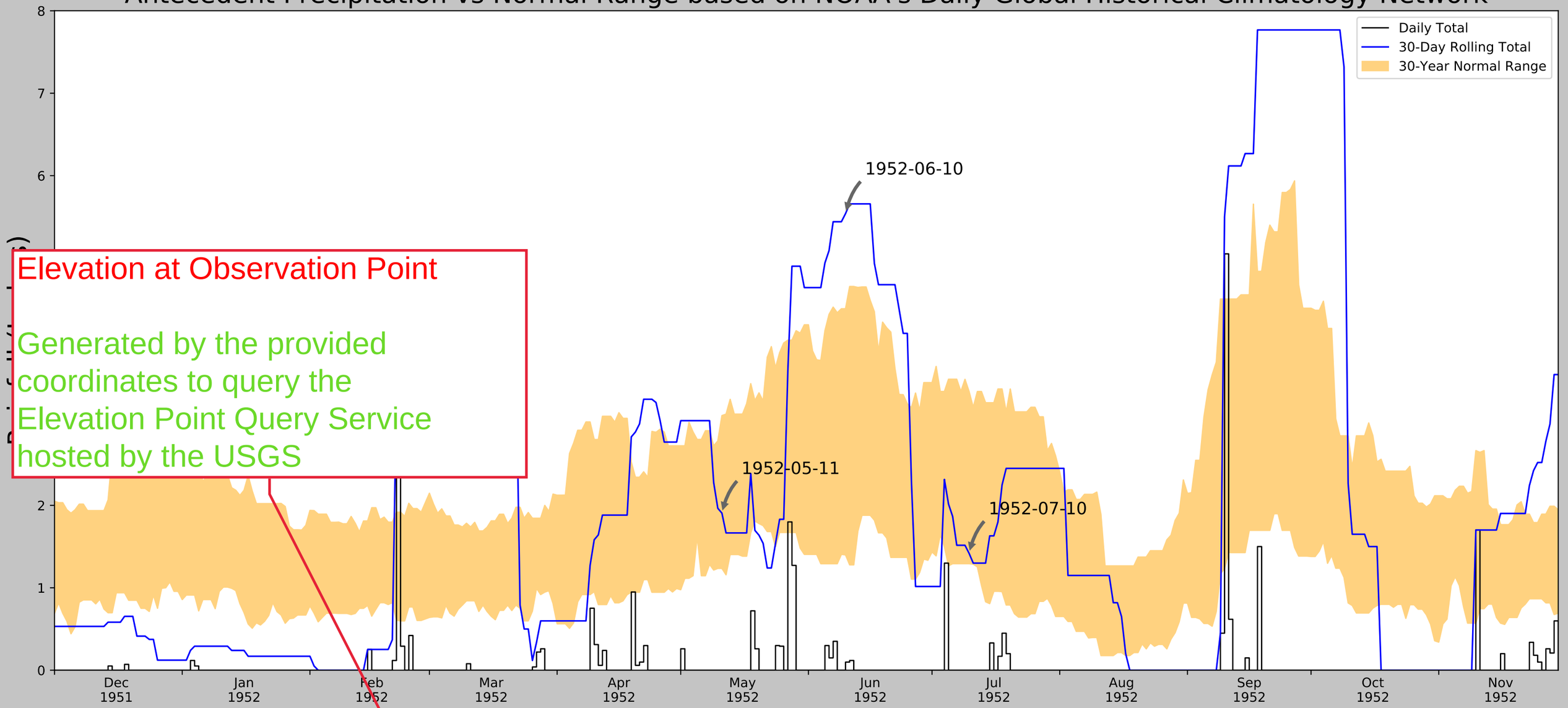

Elevation at Observation Point

Generated by the provided coordinates to query the Elevation Point Query Service hosted by the USGS

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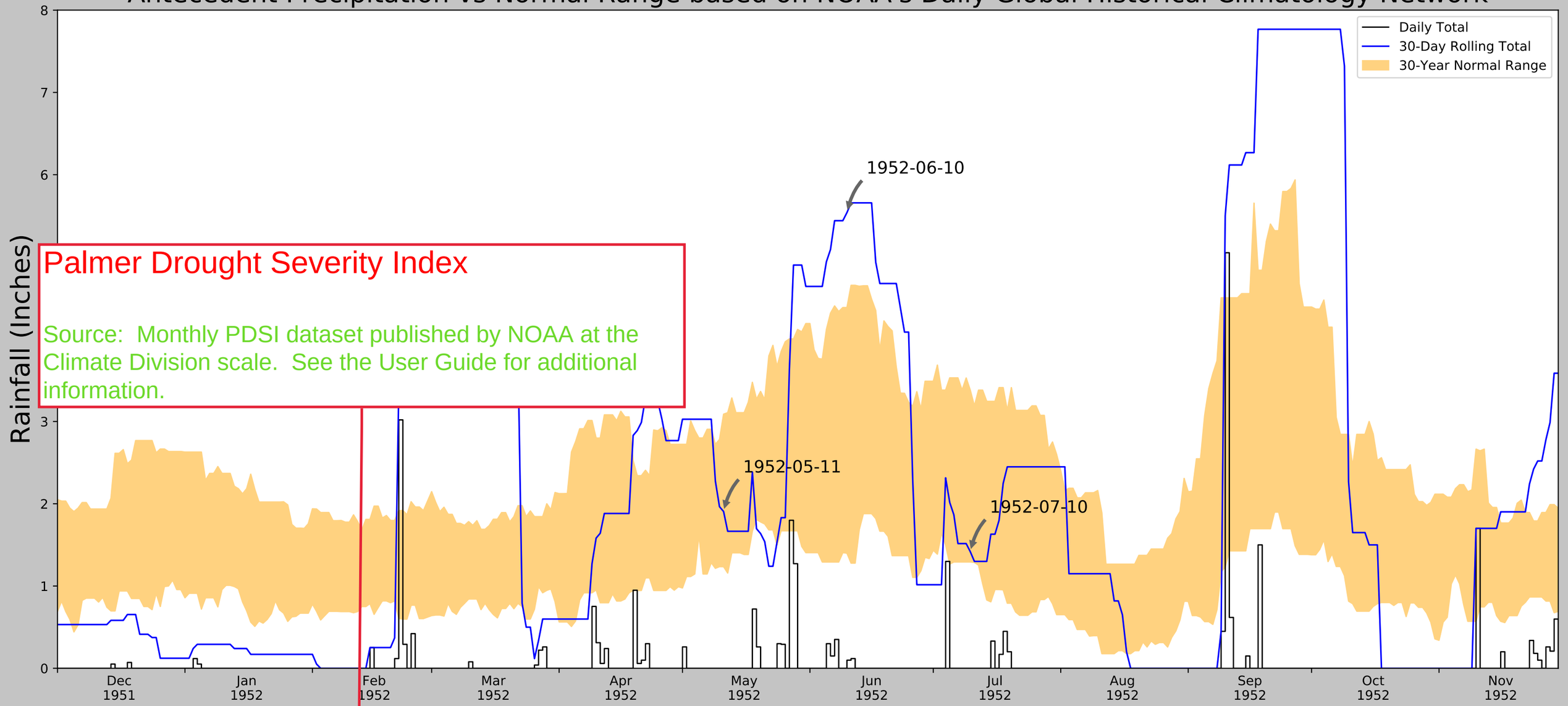

Palmer Drought Severity Index

Source: Monthly PDSI dataset published by NOAA at the Climate Division scale. See the User Guide for additional information.

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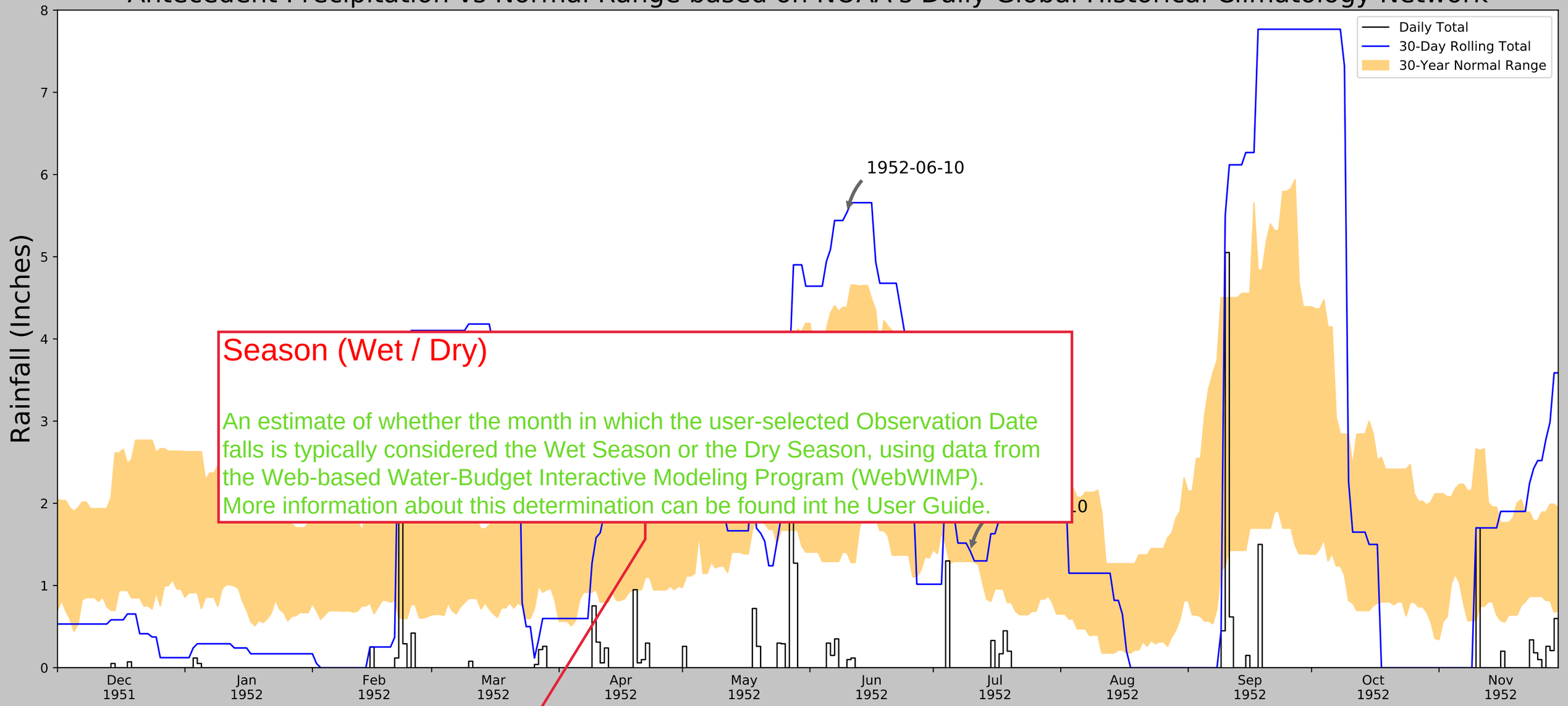

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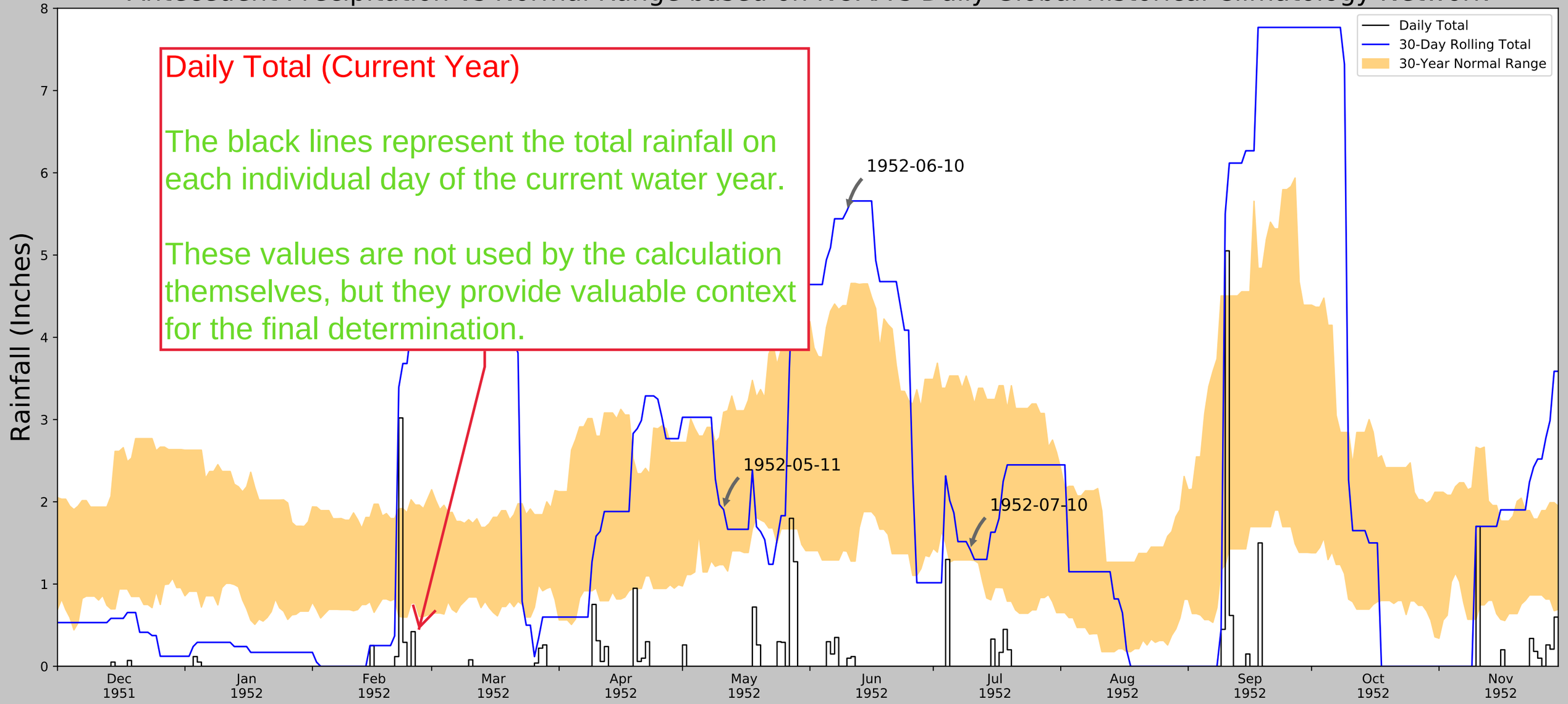

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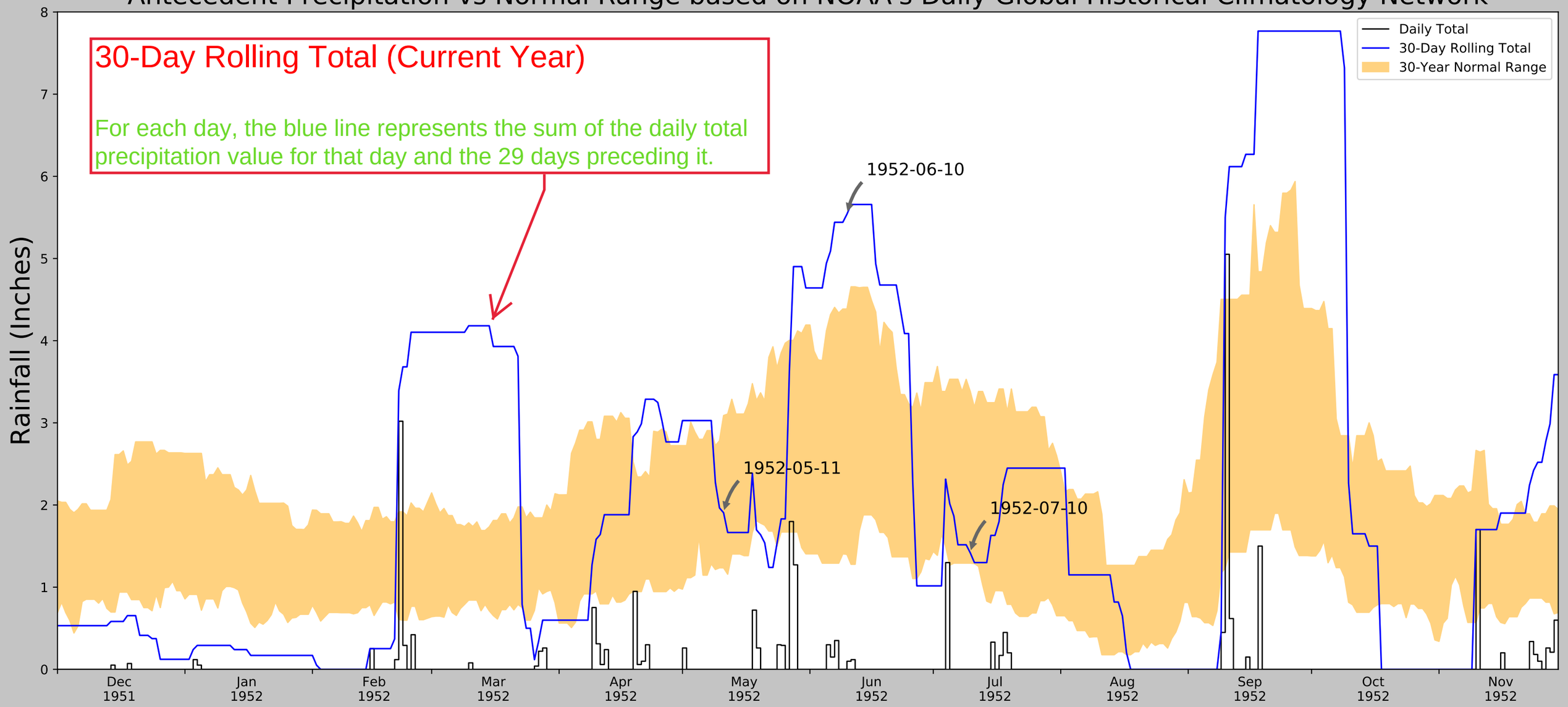

Coordinates	28.44571, -98.529303
Observation Date	1952-07-10
Elevation (ft)	248.76
Drought Index (PDSI)	Severe drought
WebWIMP H_2O Balance	Dry Season

30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
1952-07-10	1.292126	3.381496	1.417323	Normal	2	3	6
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1952-05-11	1.235039	3.08937	1.905512	Normal	2	1	2
Result							Normal Conditions - 14

Figure and tables made by the **Antecedent Precipitation Tool** Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
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FOWLERTON	28.5033, -98.8392	299.869	19.238	51.109	9.64	12	0
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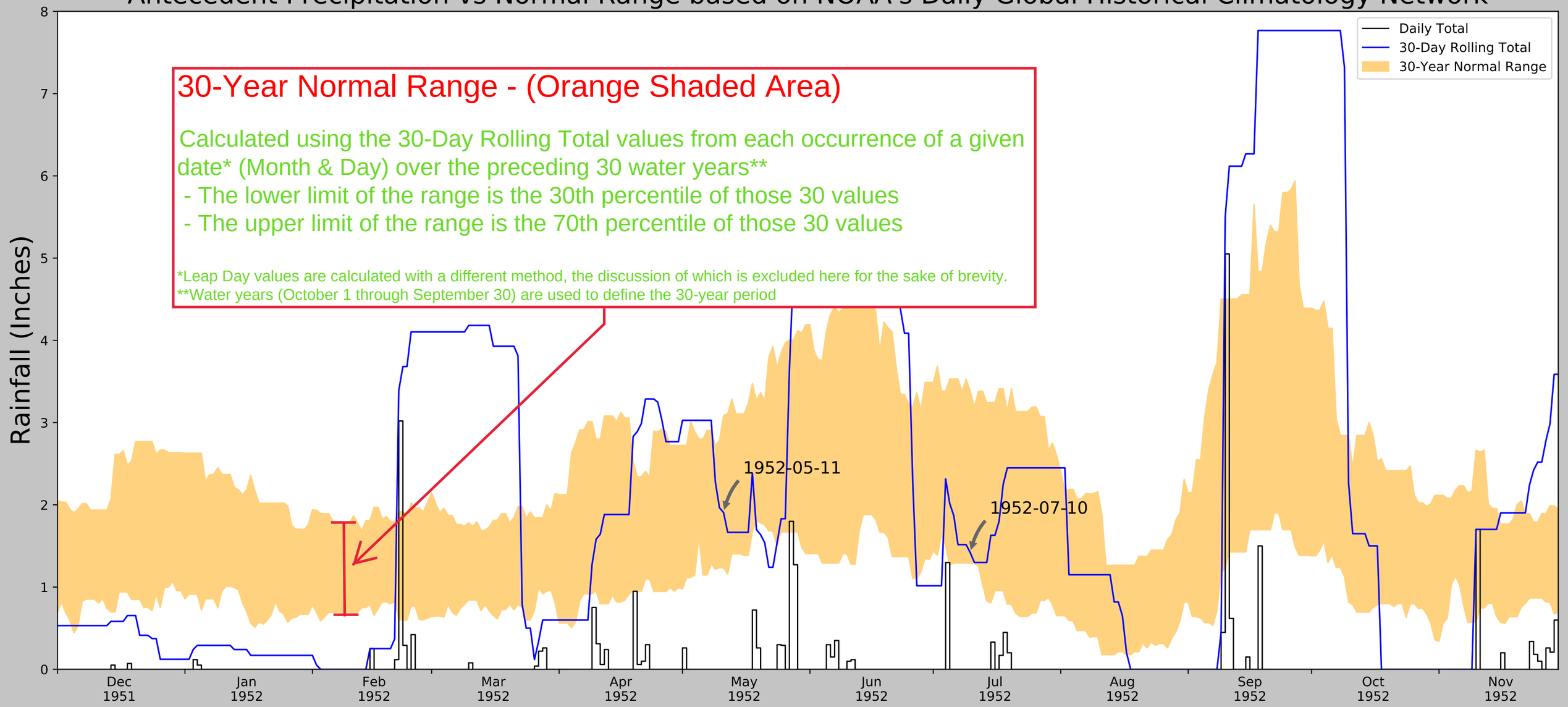

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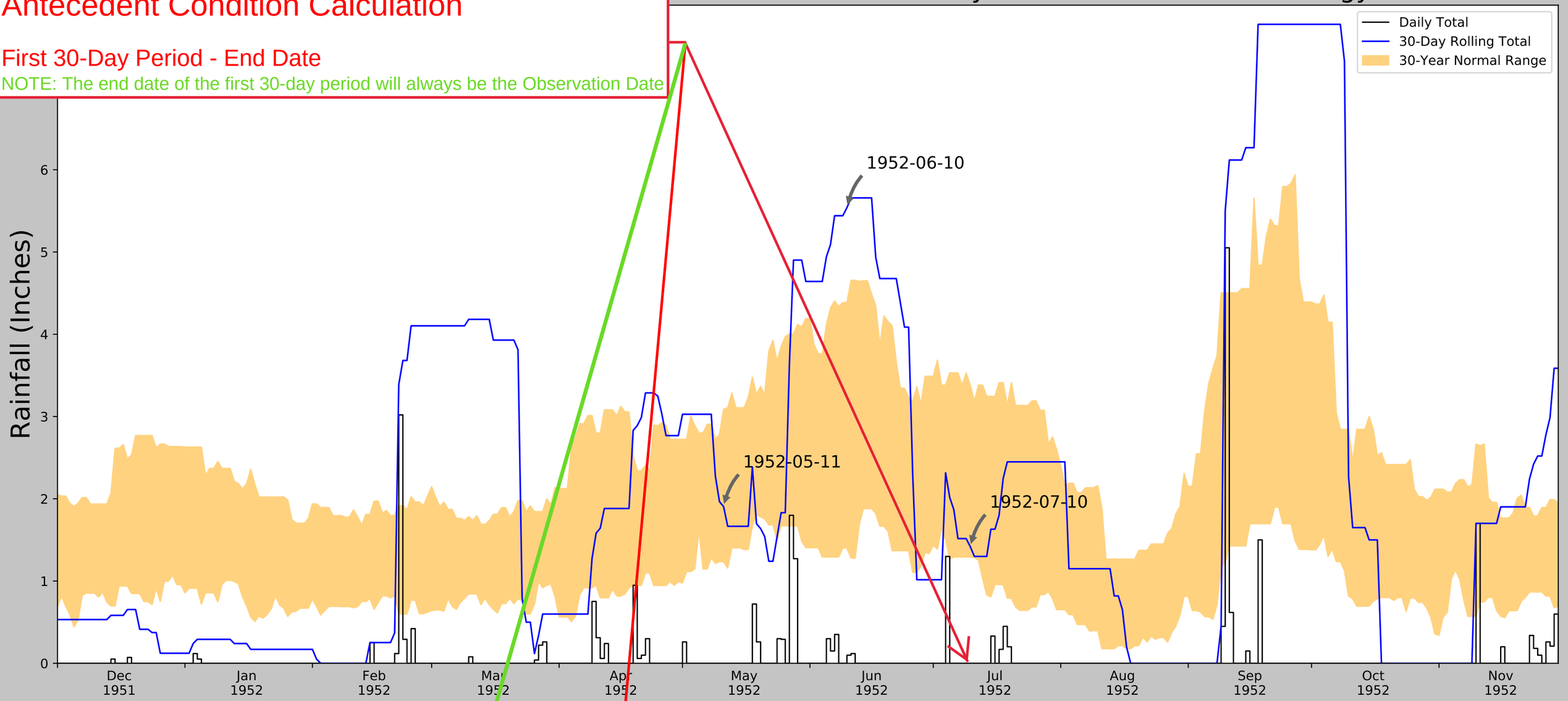
Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network

Antecedent Condition Calculation

First 30-Day Period - End Date

NOTE: The end date of the first 30-day period will always be the Observation Date



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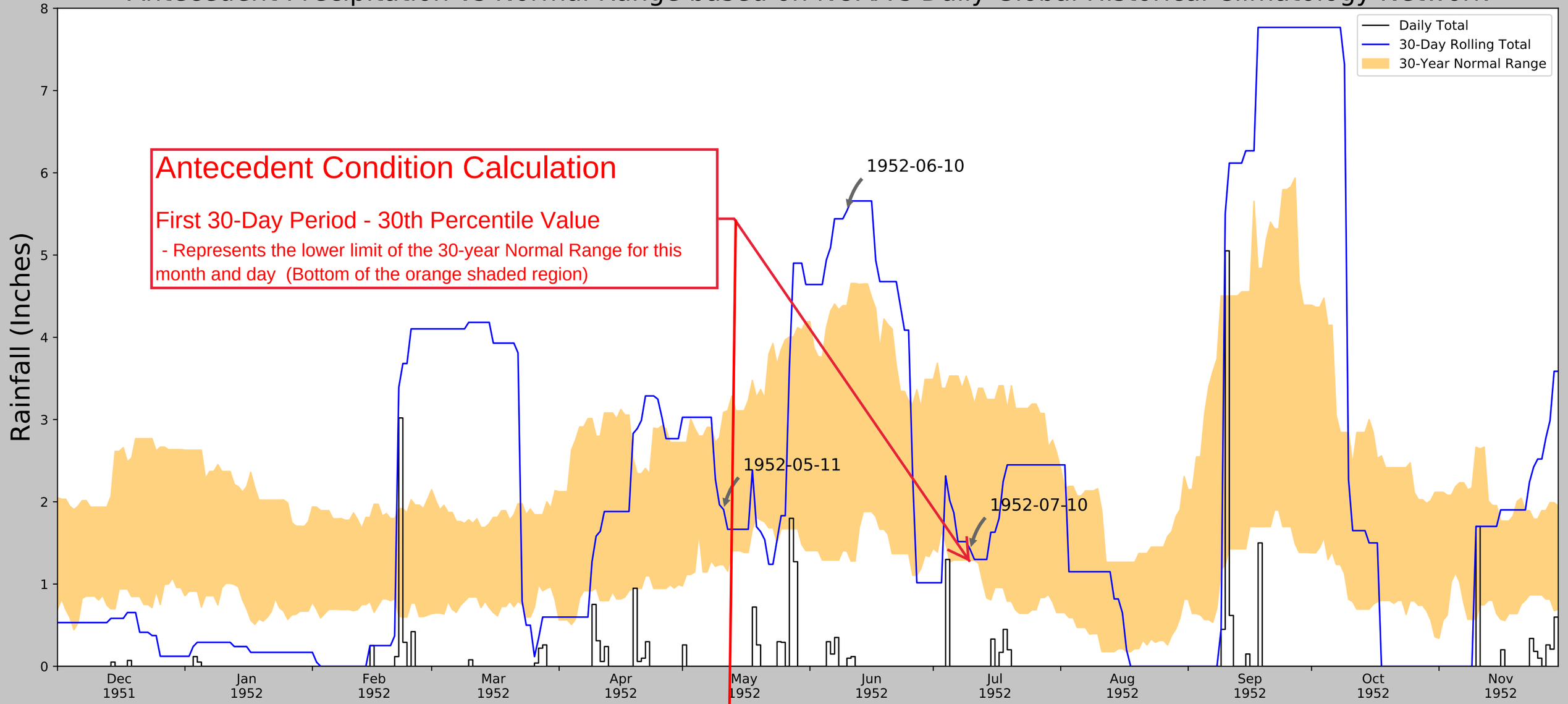

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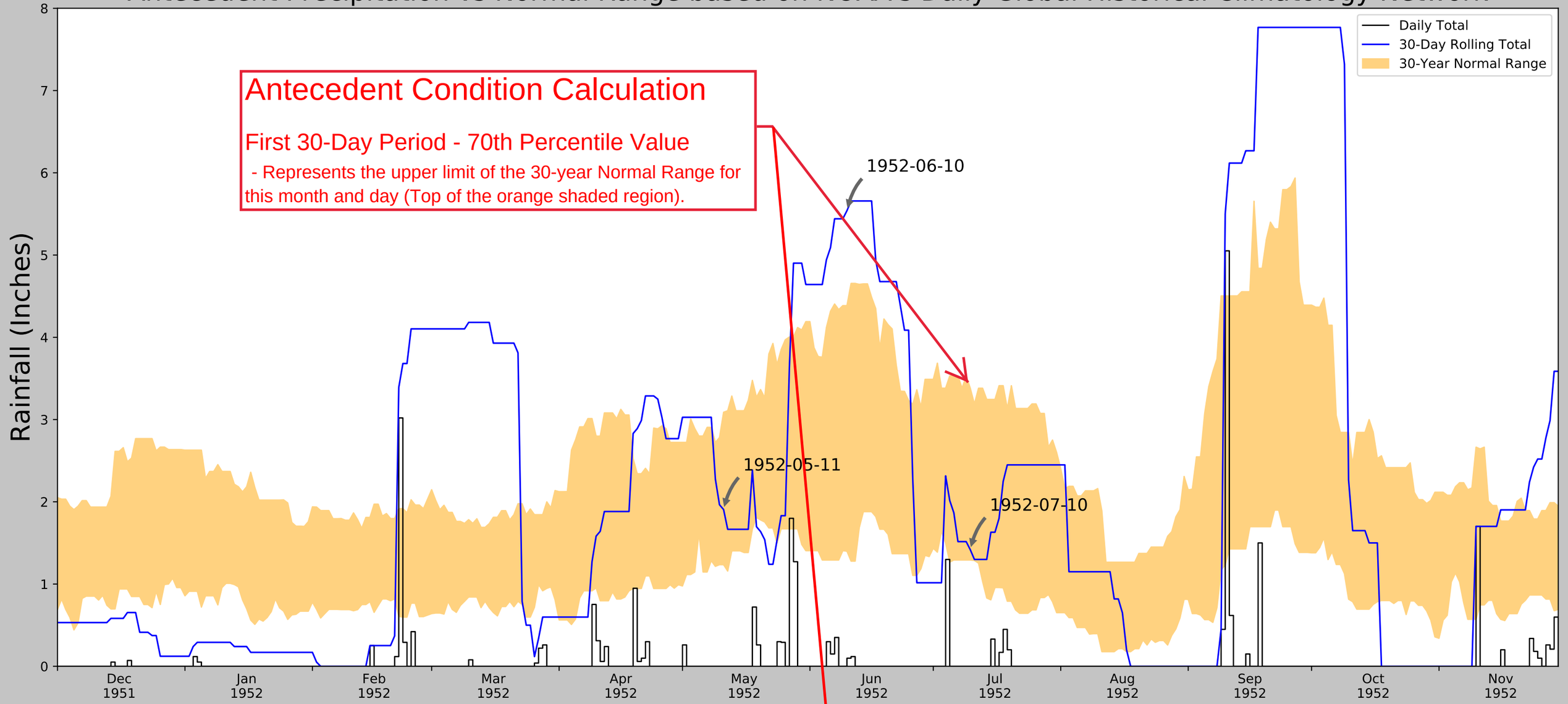

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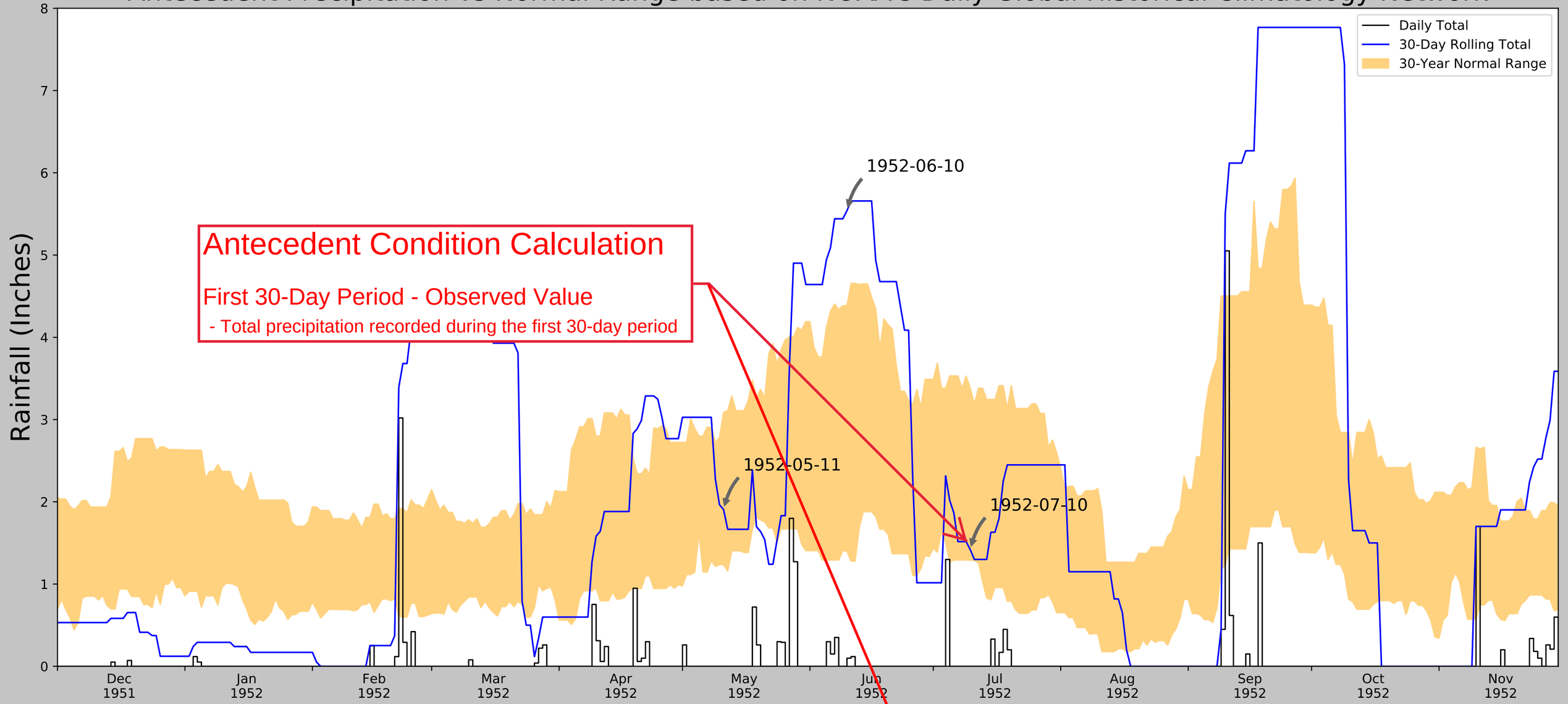

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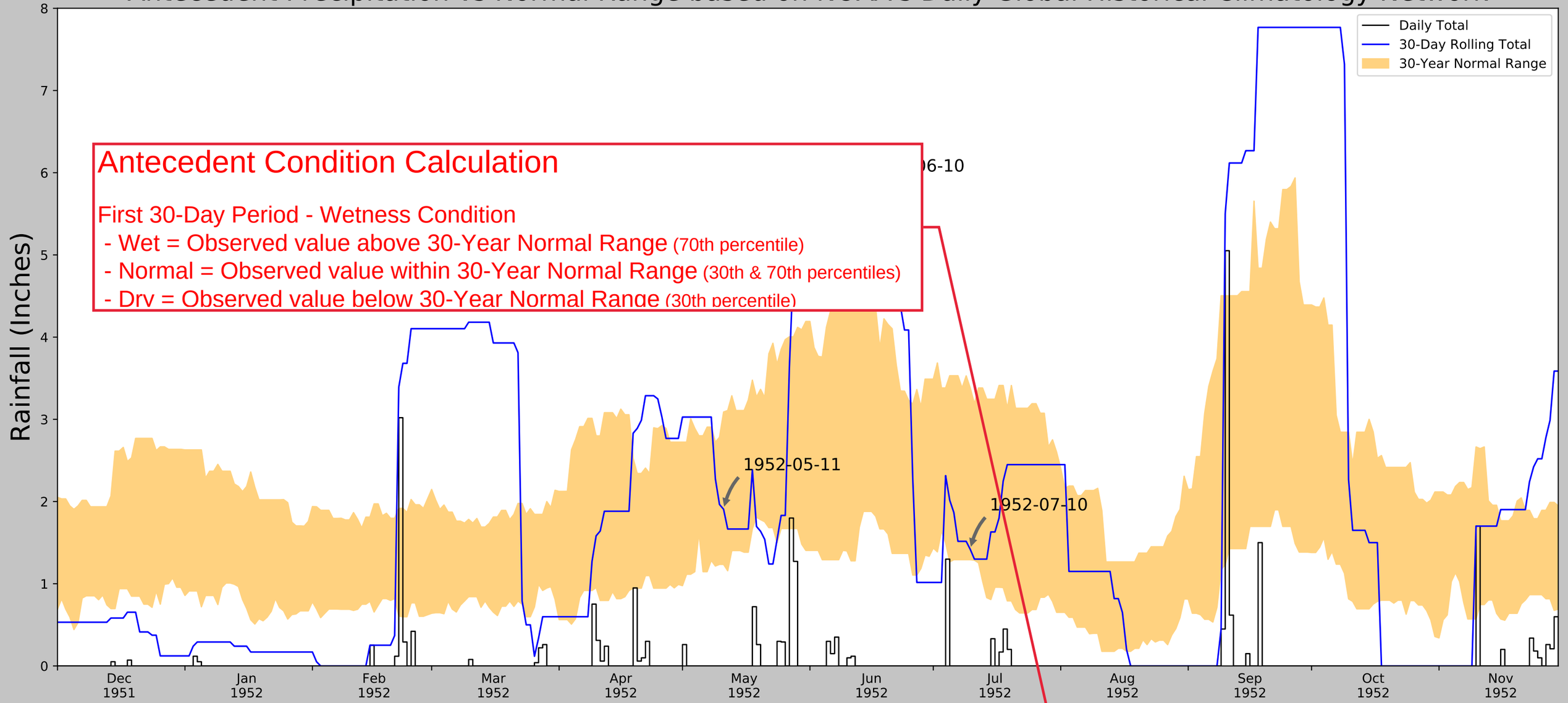

Antecedent Condition Calculation

First 30-Day Period - Wetness Condition
- Wet = Observed value above 30-Year Normal Range (70th percentile)
- Normal = Observed value within 30-Year Normal Range (30th & 70th percentiles)
- Drv = Observed value below 30-Year Normal Range (30th percentile)

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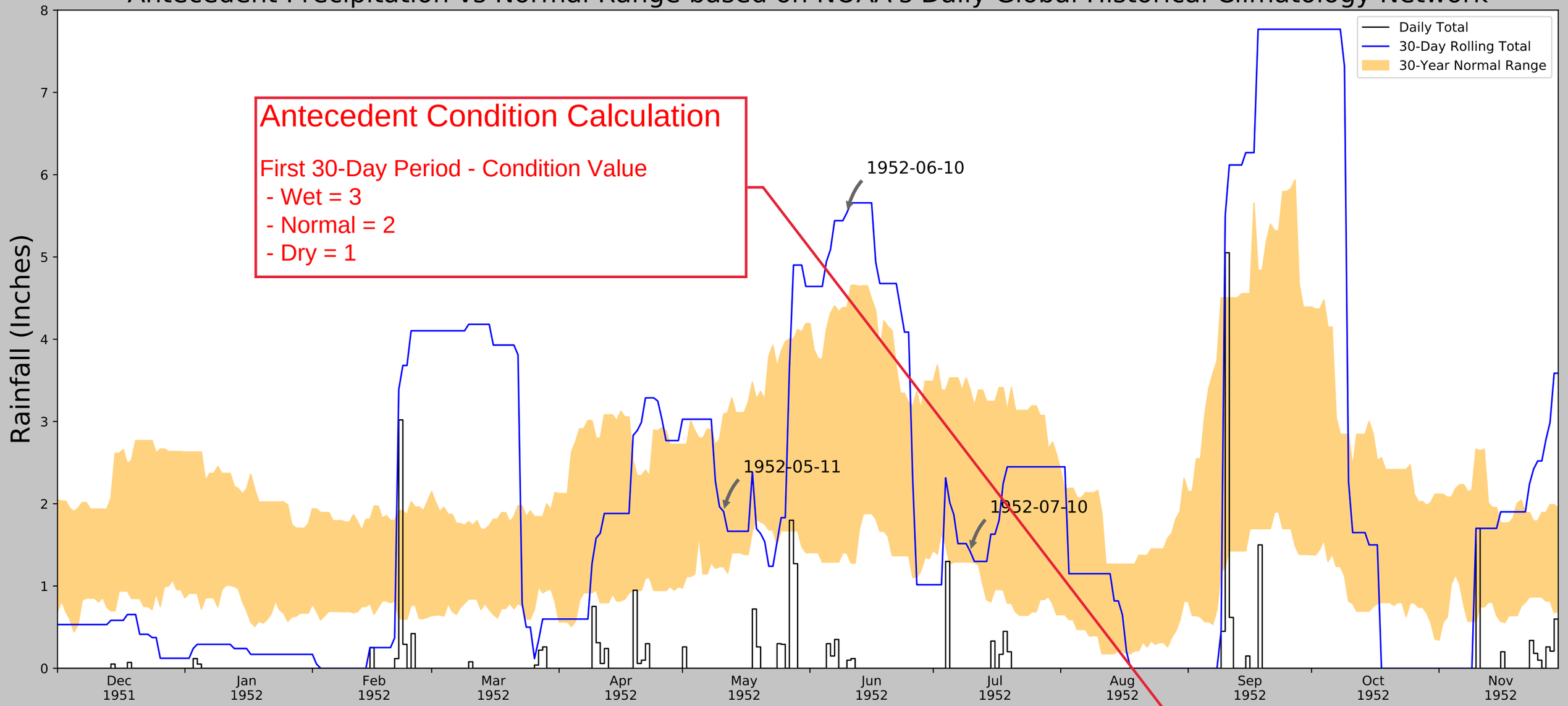

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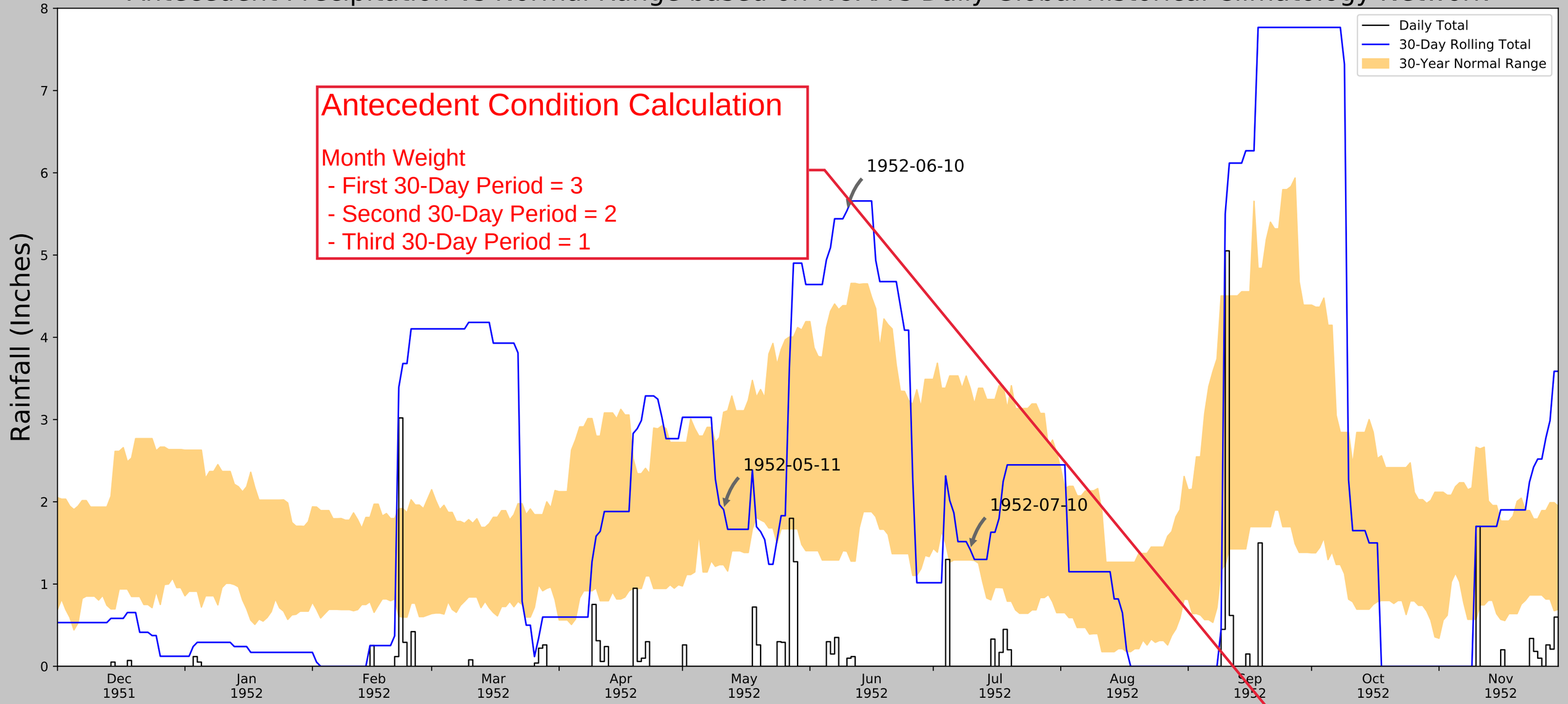

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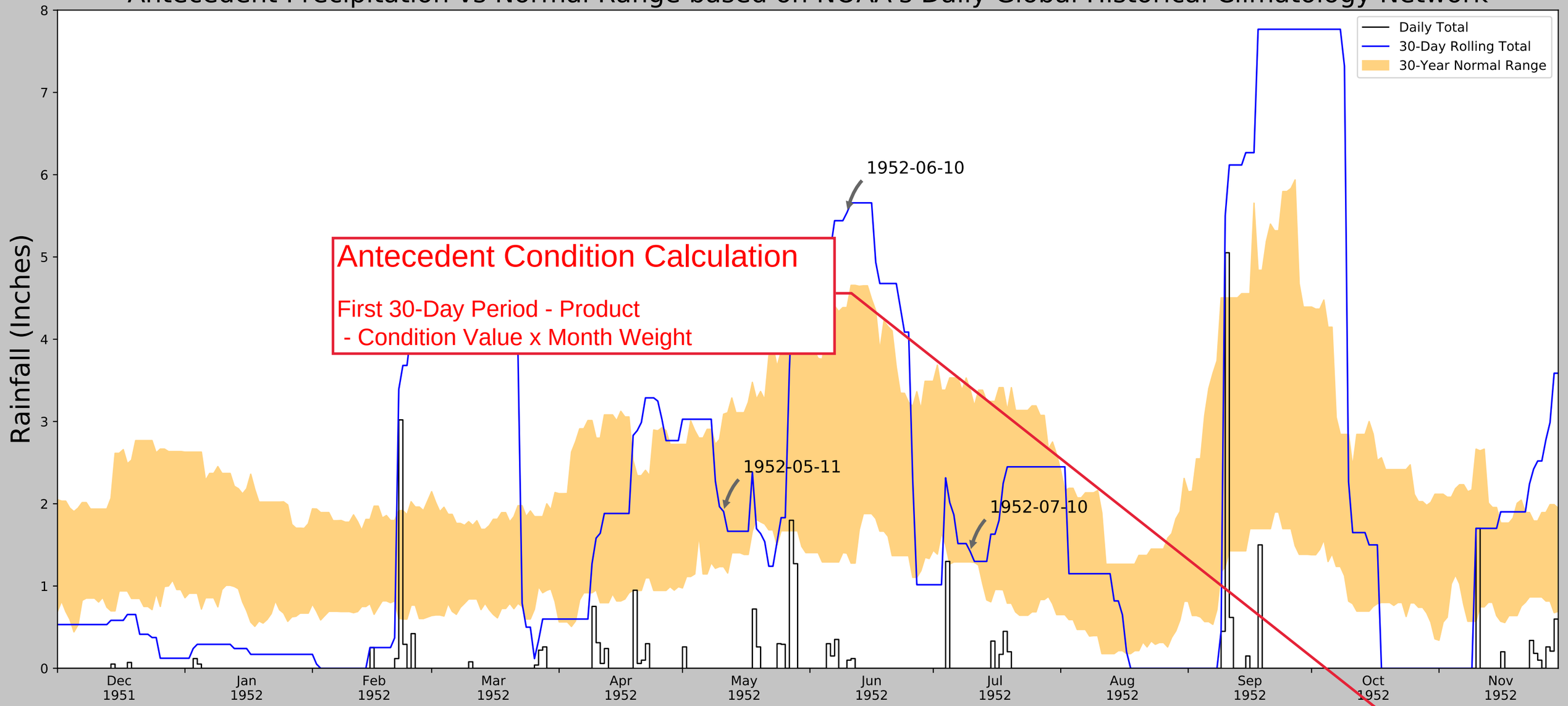

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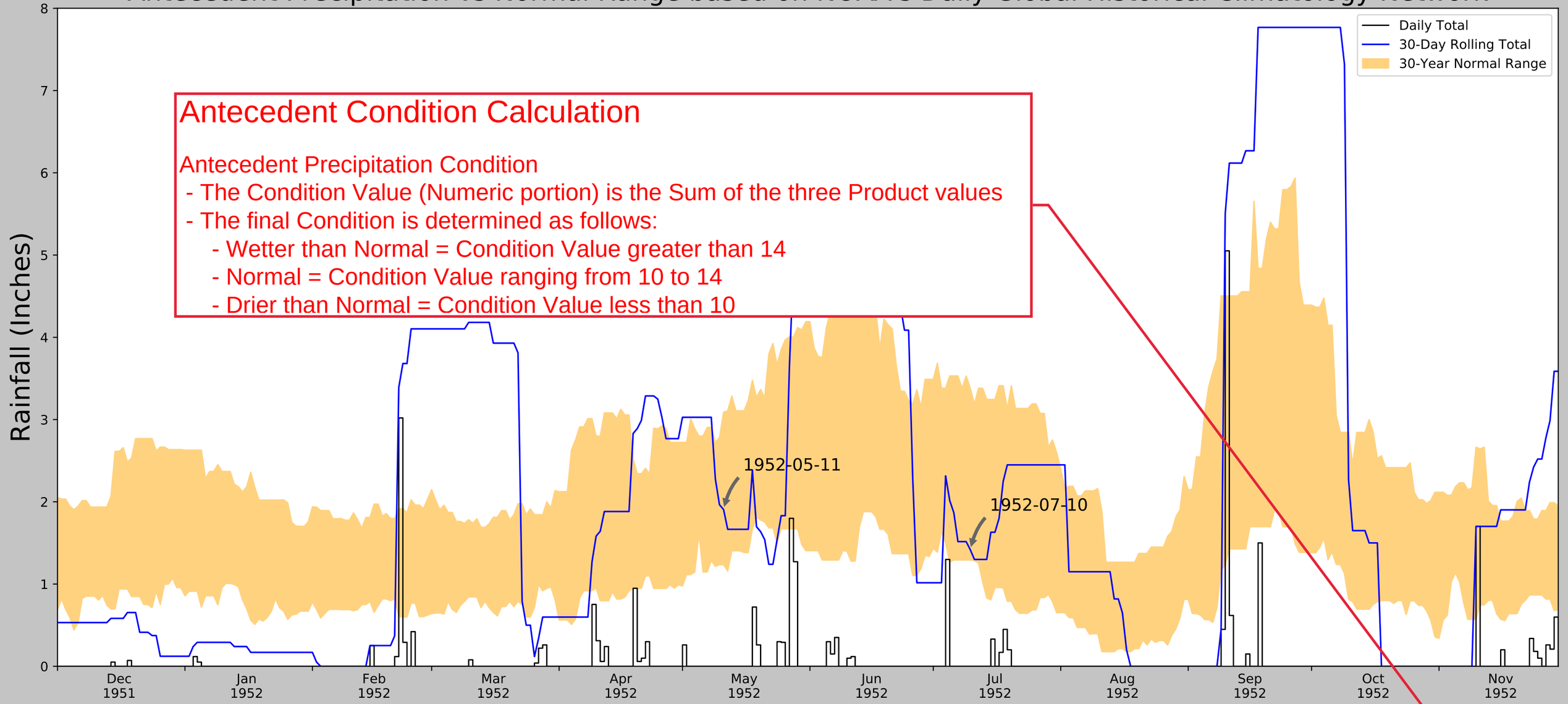

Antecedent Condition Calculation

Antecedent Precipitation Condition
- The Condition Value (Numeric portion) is the Sum of the three Product values
- The final Condition is determined as follows:
  - Wetter than Normal = Condition Value greater than 14
  - Normal = Condition Value ranging from 10 to 14
  - Drier than Normal = Condition Value less than 10

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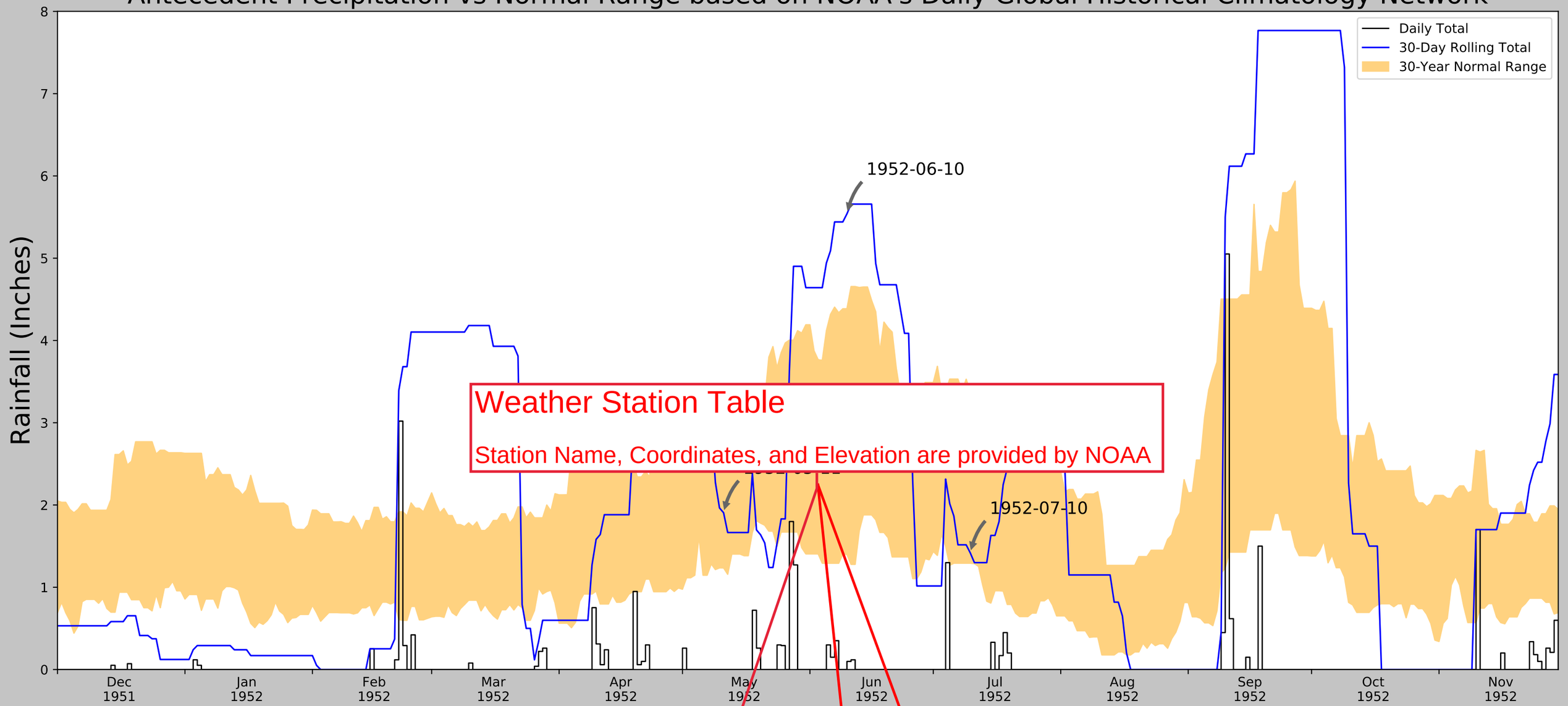

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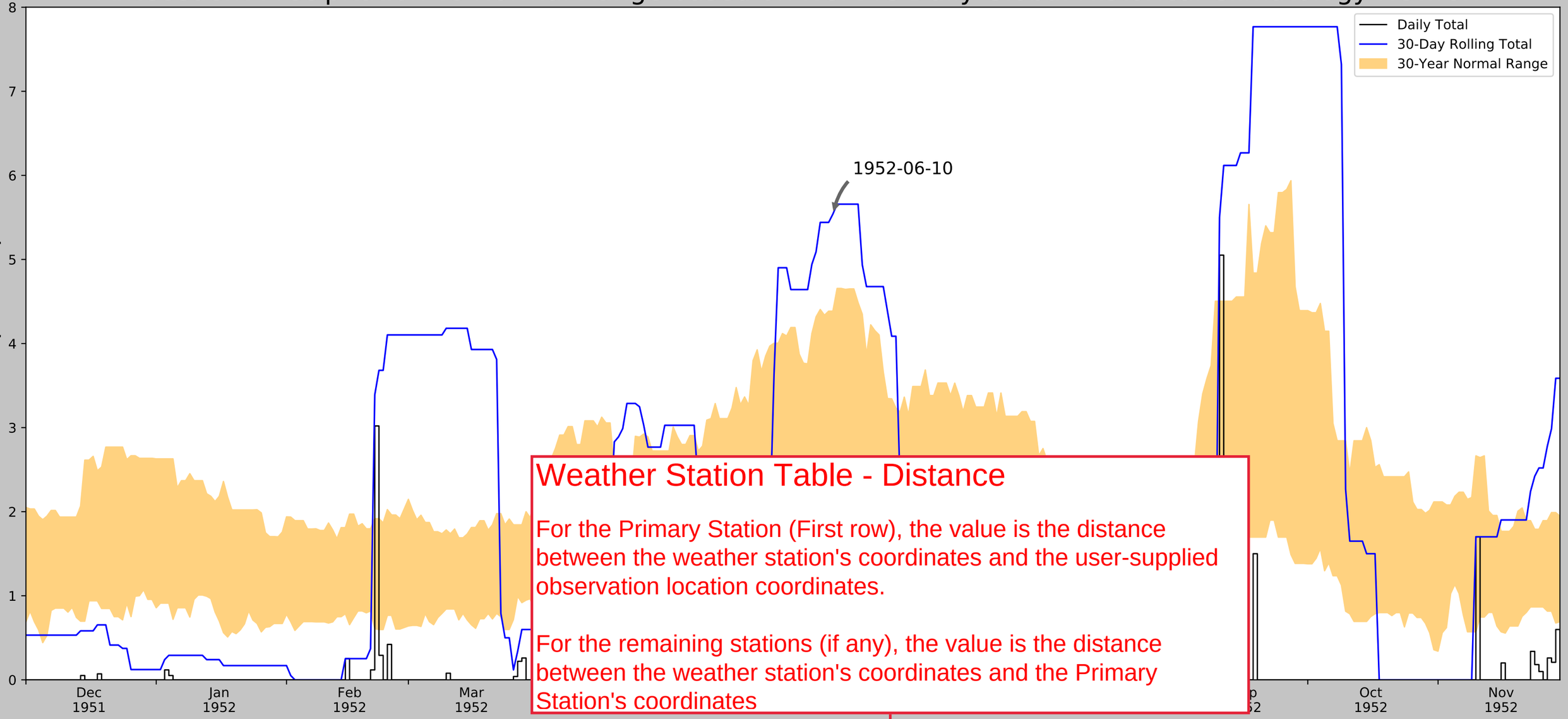

Weather Station Table - Distance

For the Primary Station (First row), the value is the distance between the weather station's coordinates and the user-supplied observation location coordinates.

For the remaining stations (if any), the value is the distance between the weather station's coordinates and the Primary Station's coordinates

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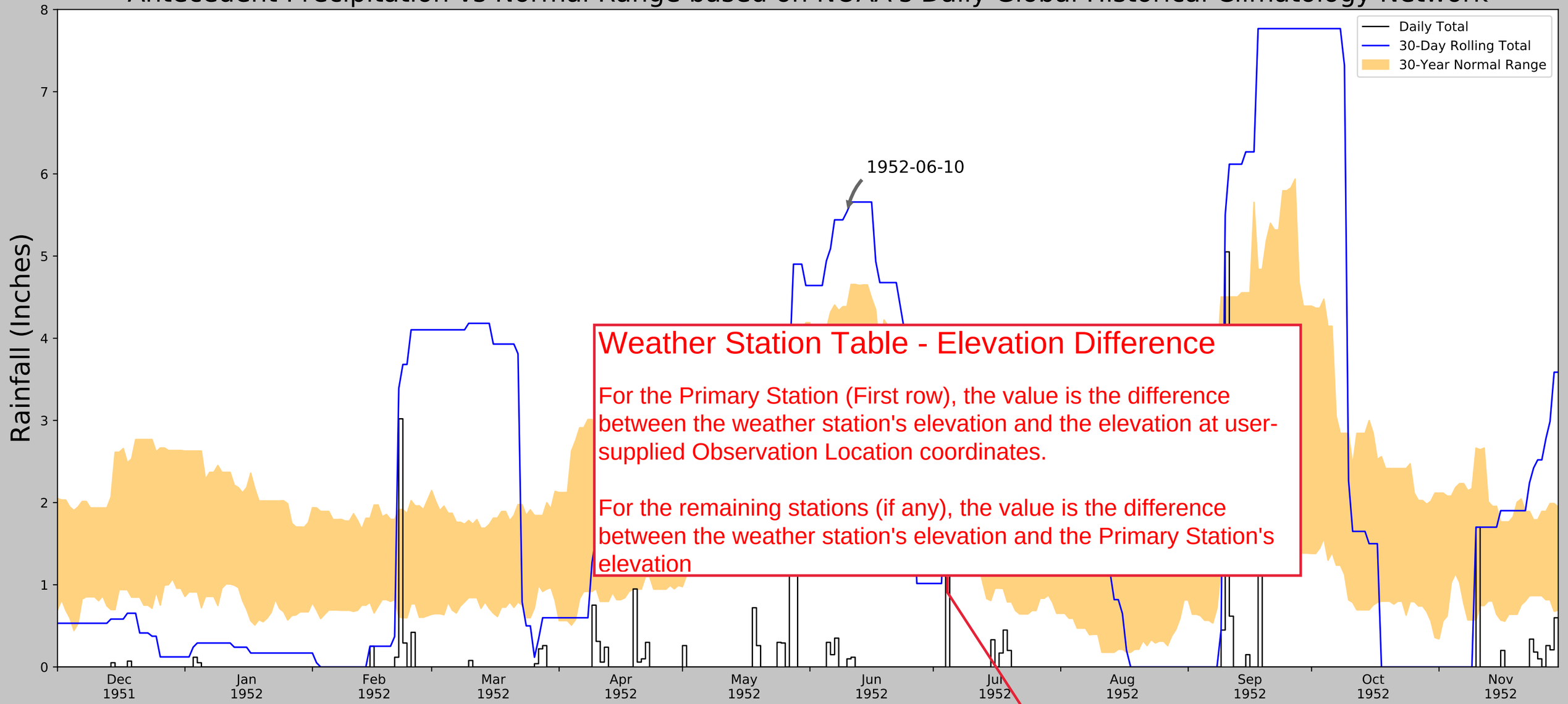

Weather Station Table - Elevation Difference

For the Primary Station (First row), the value is the difference between the weather station's elevation and the elevation at user-supplied Observation Location coordinates.

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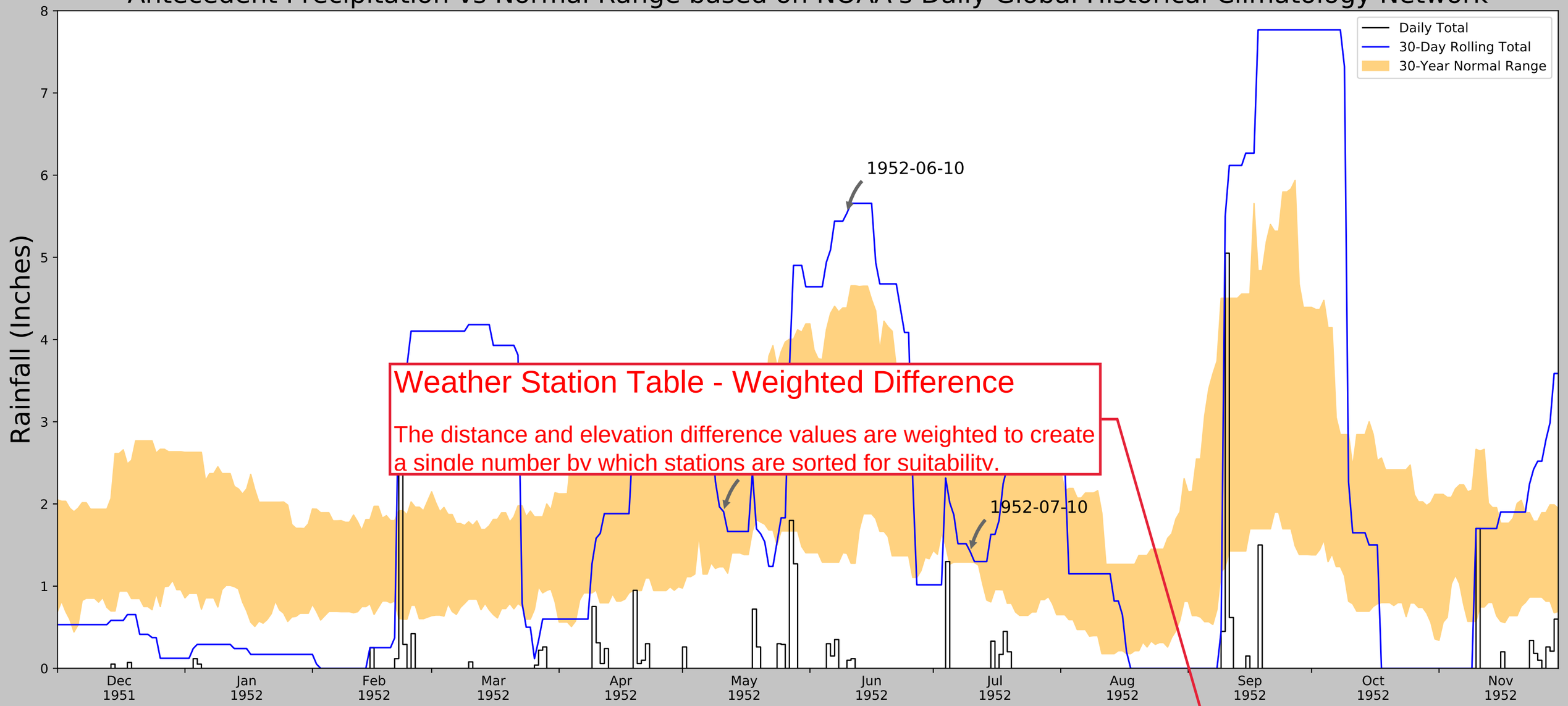
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
WHITSETT 3 SW	28.6333, -98.2667	209.974	20.544	38.786	10.042	11312	90
FOWLERTON	28.5033, -98.8392	299.869	19.238	51.109	9.64	12	0
THREE RIVERS	28.4667, -98.1833	150.919	21.068	97.841	11.542	28	0

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



Weather Station Table - Weighted Difference

The distance and elevation difference values are weighted to create a single number by which stations are sorted for suitability.

Coordinates	28.44571, -98.529303
Observation Date	1952-07-10
Elevation (ft)	248.76
Drought Index (PDSI)	Severe drought
WebWIMP H_2O Balance	Dry Season

30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
1952-07-10	1.292126	3.381496	1.417323	Normal	2	3	6
1952-06-10	1.399213	4.385433	5.53937	Wet	3	2	6
1952-05-11	1.235039	3.08937	1.905512	Normal	2	1	2
Result							Normal Conditions - 14

Figure and tables made by the **Antecedent Precipitation Tool** Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
WHITSETT 3 SW	28.6333, -98.2667	209.974	20.544	38.786	10.042	11312	90
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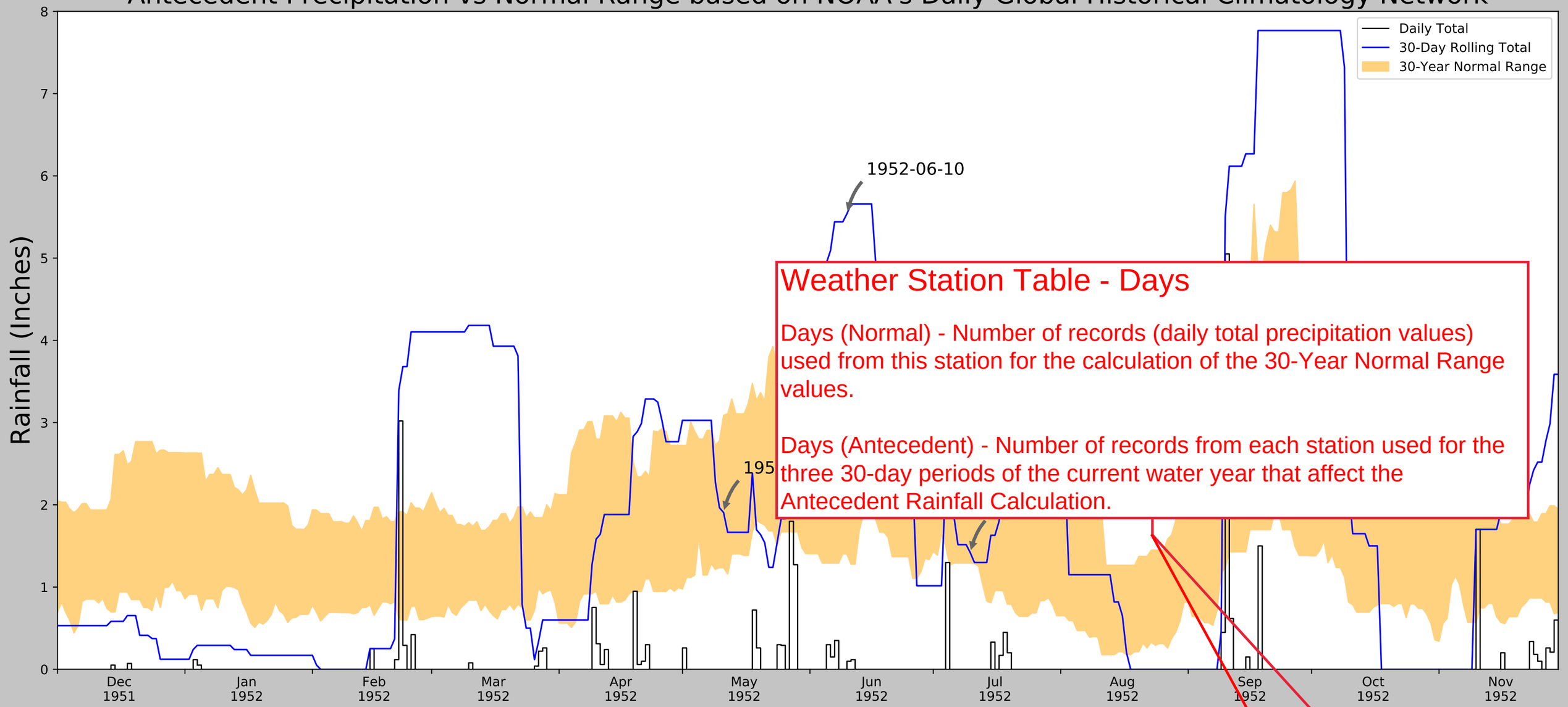

Weather Station Table - Days

Days (Normal) - Number of records (daily total precipitation values) used from this station for the calculation of the 30-Year Normal Range values.

Days (Antecedent) - Number of records from each station used for the three 30-day periods of the current water year that affect the Antecedent Rainfall Calculation.

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Observation Date	1952-07-10
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WebWIMP H_2O Balance	Dry Season

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How to read the output of a Watershed Analysis

Note: It is recommended that you switch to “Fit One Full Page” viewing mode in to scroll through the following section.

Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

Coordinates of the Observation Location (Source: User Input)

User Inputs

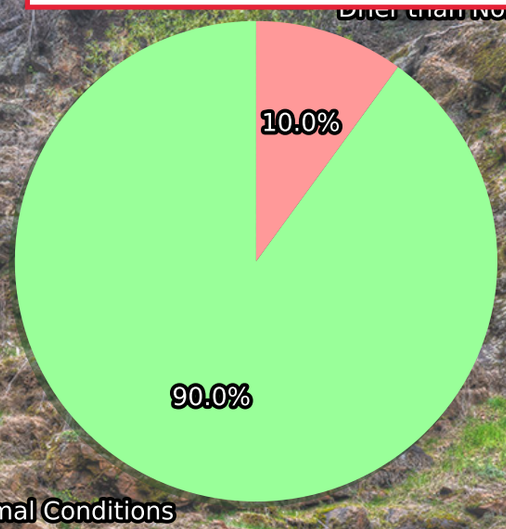
Coordinates	28.523933, -98.843927
Date	1952-07-10
Geographic Scope	HUC8

Intermediate Data

Hydrologic Unit Code	12110108
Watershed Size	1221.06 mi^2
# Random Sampling Points	68

Preliminary Result

Average Antecedent Precipitation Score	10.6
Preliminary Determination	Normal Conditions



Sampling Point Breakdown

Antecedent Precipitation Score	Antecedent Precipitation Condition	WebWIMP H_2O Balance	Drought Index (PDSI)	# of Points
14	Normal Conditions	Dry Season	Severe drought	8
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Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

Observation Date
(Source: User Input)

User Inputs

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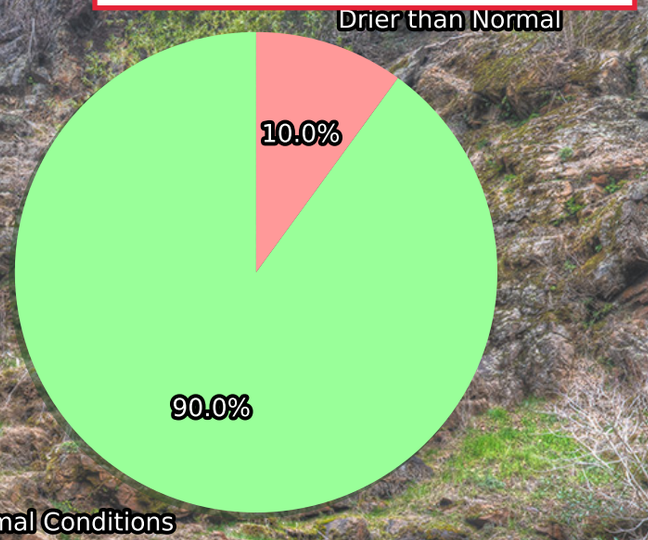

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Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

User Inputs

Coordinates	28.523933, -98.843927
Date	1952-07-10
Geographic Scope	HUC8

Geographic Scope
-Single Point
-HUC8, HUC10, HUC12
-Custom Watershed

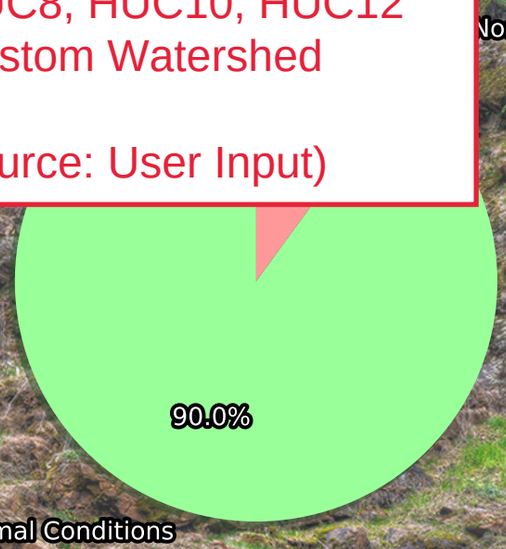
(Source: User Input)

Intermediate Data

Hydrologic Unit Code	12110108
Watershed Size	1221.06 mi^2
# Random Sampling Points	68

Preliminary Result

Average Antecedent Precipitation Score	10.6
Preliminary Determination	Normal Conditions



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Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

User Inputs

Coordinates	28.523933, -98.843927
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Preliminary Result

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Preliminary Determination	Normal Conditions

Normal Conditions

Hydrologic Unit Code (HUC)

The specific identification code of the watershed feature within which the Observation Location falls.

If Custom Polygon is selected, this will be the name given by the user for the Custom Watershed Polygon (E.g. EPA MyWaters Drainage Area)

Sampling Point Breakdown

Antecedent Precipitation Score	Antecedent Precipitation Condition	WebWIMP H_2O Balance	Drought Index (PDSI)	# of Points
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Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

User Inputs

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Geographic Scope	HUC8

Intermediate Data

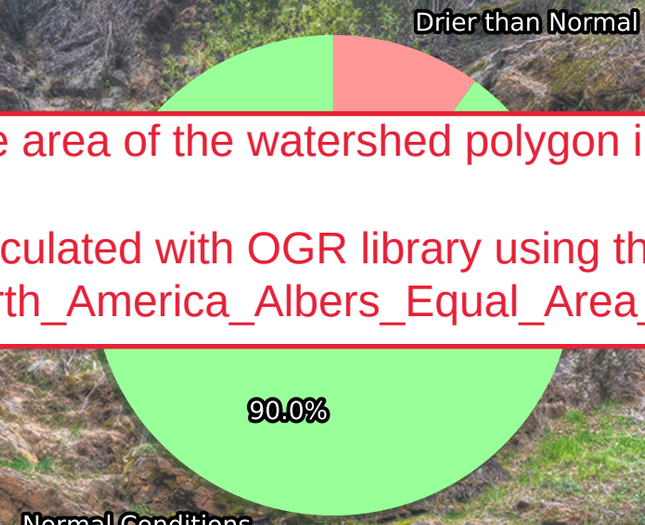
Hydrologic Unit Code	12110108
Watershed Size	1221.06 mi^2
# Random Sampling Points	68

The area of the watershed polygon in square miles.

Calculated with OGR library using the the projection: North_America_Albers_Equal_Area_Conic

Preliminary Result

Average Antecedent Precipitation Score	10.6
Preliminary Determination	Normal Conditions



Sampling Point Breakdown

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Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

User Inputs

Coordinates	28.523933, -98.843927
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Watershed Size	1221.06 mi^2
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Preliminary Result

Average Antecedent Precipitation Score	10.6
Preliminary Determination	Normal Conditions

Sampling Point Breakdow

Antecedent Precipitation Score	Antecedent Precipitation Condition	WebWIM
14	Normal Conditions	Dr
11	Normal Conditions	Dr
10	Normal Conditions	Dr
9	Drier than Normal	Dr
8	Drier than Normal	Dr

Number of Random Sampling Points

Points = Watershed Size / 18

-Minimum of 3 for small HUC12s

-Denominator arrived at through iterative analysis of randomly selected HUC8, HUC10, and HUC12 watersheds, followed by a visual examination in ArcGIS Pro to ensure all major regions of each watershed were being sampled. Early versions took hours to run, so it was deemed important to try to get this number as low as possible without omitting significant portions of watersheds.

Sampling methodology:

-Generate random latitudes and longitudes between the minimum and maximum values of each for a given watershed polygon.

-Drop any points falling outside the watershed polygon.

-Drop any points falling within the minimum point spacing, created to reduce the workload required to cover sample the entire polygon.

-Continue until required number met.

Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

User Inputs

Coordinates	28.523933, -98.843927
Date	1952-07-10
Geographic Scope	HUC8

Interme

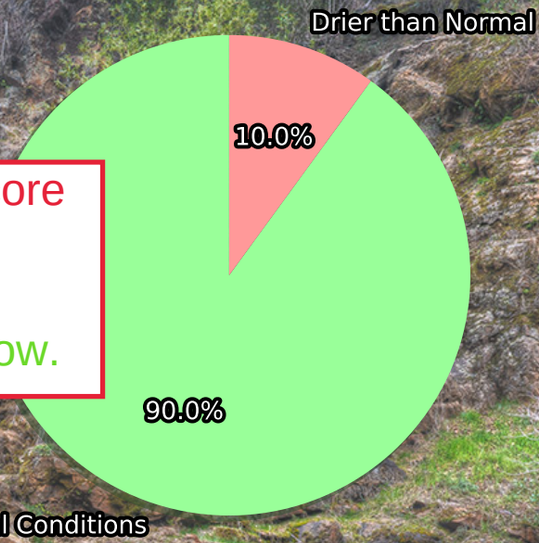
Hydrologic Unit C	
Watershed Siz	
# Random Sampling	

Average Antecedent Precipitation Score

The source numbers are listed in the Sampling Point Breakdown table below.

Preliminary Result

Average Antecedent Precipitation Score	10.6
Preliminary Determination	Normal Conditions



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Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

Preliminary Determination

By preliminary, this means that it is not considering any factors outside of the average Antecedent Precipitation Score.

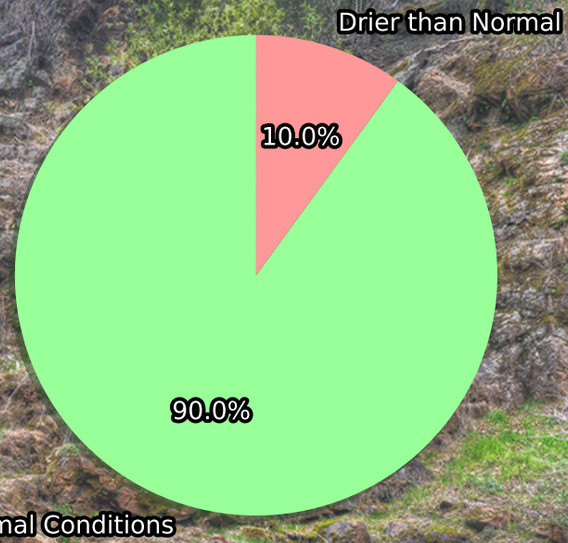
Drier than Normal: Avg. Score < 10
Normal Conditions: Avg. Score >10 and <15
Wetter than Normal: Avg. Score >15

	8.843927
	7-10
	8

	11.0108
	21.06 mi^2
	68

Preliminary Result

Average Antecedent Precipitation Score	10.6
Preliminary Determination	Normal Conditions



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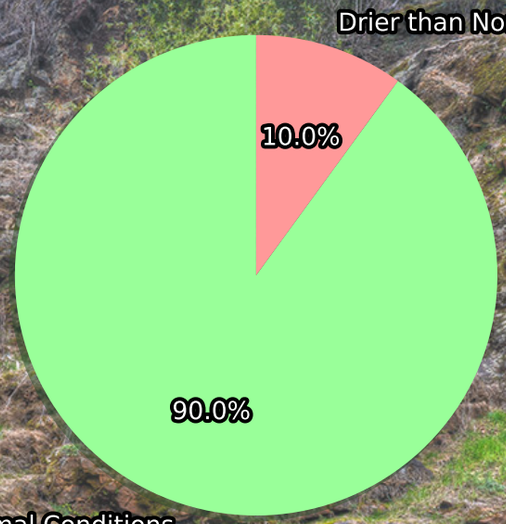
Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

Things to consider in addition to the Average Score:

1. The distribution of the individual scores. Was the average brought up or down by outliers?

Sampling Point Breakdown Table Column 1 provides each unique Antecedent Precipitation Score, and Column 5 provides the frequency that each of those scores occurred in the among the Sampling Points.



Preliminary Result

Average Antecedent Precipitation Score	10.6
Preliminary Determination	Normal Conditions

Sampling Point Breakdown

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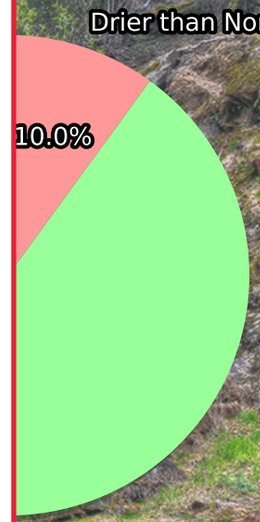
Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

Things to consider in addition to the Average Score:

2. Whether the Observation Date is typically considered to fall within the Wet Season or the Dry Season for the Observation Location (Based on the Web-based Watershed Interactive Modeling Program WebWIMP, and the definitions of Wet Season and Dry Season found in the Regional Supplements to the Corps of Engineers Wetland Delineation Manual.)

If we are looking for indicators of greater than ephemeral flow for a given feature, and we determine we are in the dry season, we may not want to give as much weight to the absence of compelling field indicators as we would in the et Season.



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Antecedent Precipitation Tool v.1.0 - Watershed Sampling Summary

Generated on 2020-06-22

Things to consider in addition to the Average Score:

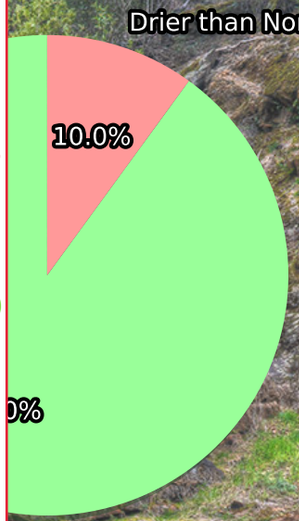
3. The primary contributing source of flowing water:
In the Arid West, a stream may be fed primarily by precipitation during the wet season, but for most of the dry season that same stream may receive the vast majority of its water from snow melt.

For a stream that is mostly fed by snow melt in the dry season, one seeking to determine whether a dry season observation date fell in a typical year might have less interest in the normalcy of rainfall over the past 90 days, and more interest in the normalcy of snow telemetry (SNOTEL) data recorded over the preceding winter season by the NRCS National Water and Climate Center.

Even in a case like the above, one cannot ignore rainfall altogether, as the most damaging floods in Sierra Nevada (California) rivers happened during warm storms when rain fell on snow-covered catchments. (Kattelmann, 1997)

This is why it is so important to review the actual figures that follow the Watershed Sampling Summary. If you look at how much snow the watershed received compared to normal, and check for any potential rain-on-snow events taking place around the Observation Date, you will be getting much closer to a complete picture.

Flooding from rain-on-snow events in the Sierra Nevada, Richard Kattelmann, 1997



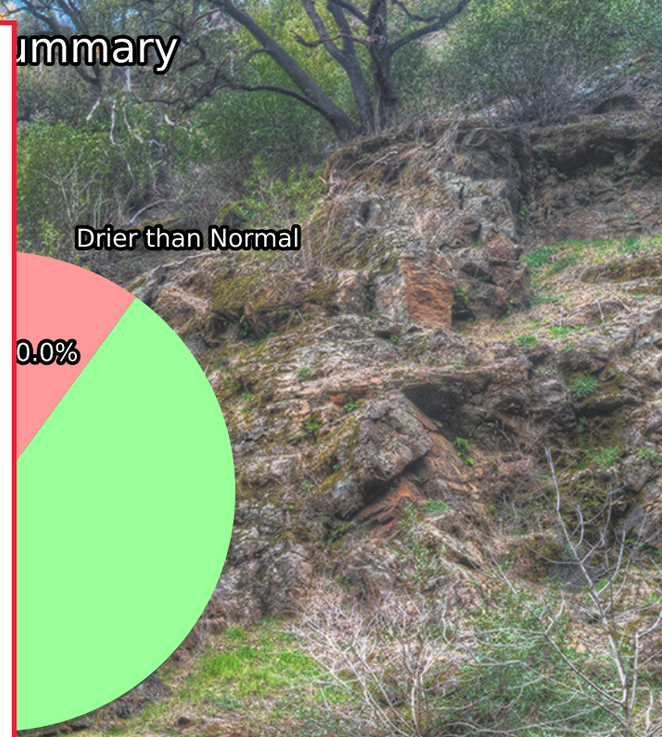
rought Index (PDSI)	# of Points
Severe drought	8
Severe drought	19
Severe drought	34
Severe drought	4
Severe drought	3

Things to consider in addition to the Average Score:

4. Drought Indices:
From Palmer Drought Severity Index: attempts to measure the duration and intensity of the long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during the current month is dependent on the current weather patterns plus the cumulative patterns of previous months. Since weather patterns can change almost literally overnight from a long-term drought pattern to a long-term wet pattern, the PDSI can respond fairly rapidly.

https://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/overview

NOTE: PDSI is not the only drought index. It happens to be the drought index for which I was able to locate a reliable data source (Hosted by NOAA) for the entire United States, which is why it was incorporated into the APT. Additional indices may be added to the APT as options at a later date, but until that time users are encouraged to consult whicher index they deem most appropriate for their region.



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