AgriMetSoft

IDF Curve Tool — Tutorial

Updated Edition

This tutorial walks you through using the IDF Curve tool to construct rainfall Intensity-Duration-Frequency (IDF) curves from your data. It covers the original workflow and the new capabilities added in the latest update: water-year support, incomplete-year handling, the Generalize Extreme Value (GEV) and Log-Pearson Type III (LP3) distributions, the Goodness-of-Fit table, 90% confidence bands, the IDF Equation dialog with Sherman and Koutsoyiannis fitting, custom return periods, and several smaller refinements.

Each major new feature is marked with a "New in this update" callout so you can scan for the additions if you already know the previous version.

1. License and Installation

Installing the tool is straightforward. Once you purchase a license, you will receive a small utility called "ID Finder." After sending us the ID, you will receive the installer for the registered version. Simply run the installer, and the tool will be installed and ready for use without the need for a key. After installation, you can access the tool either by clicking on the desktop shortcut or by searching for "IDF Curve" in your computer's program list.

2. Input Data

The tool accepts data in two ways:

- Raw rainfall time series (Input Raw Data tab). The tool will compute maxima for each duration and build a Rainfall Intensity Table for you. This is the most common workflow.
- Precomputed Rainfall Intensity Table (Input Data tab). If you already have a table of maximum intensities per duration per year, you can load it directly and skip the maxima computation.

2.1 Loading raw data

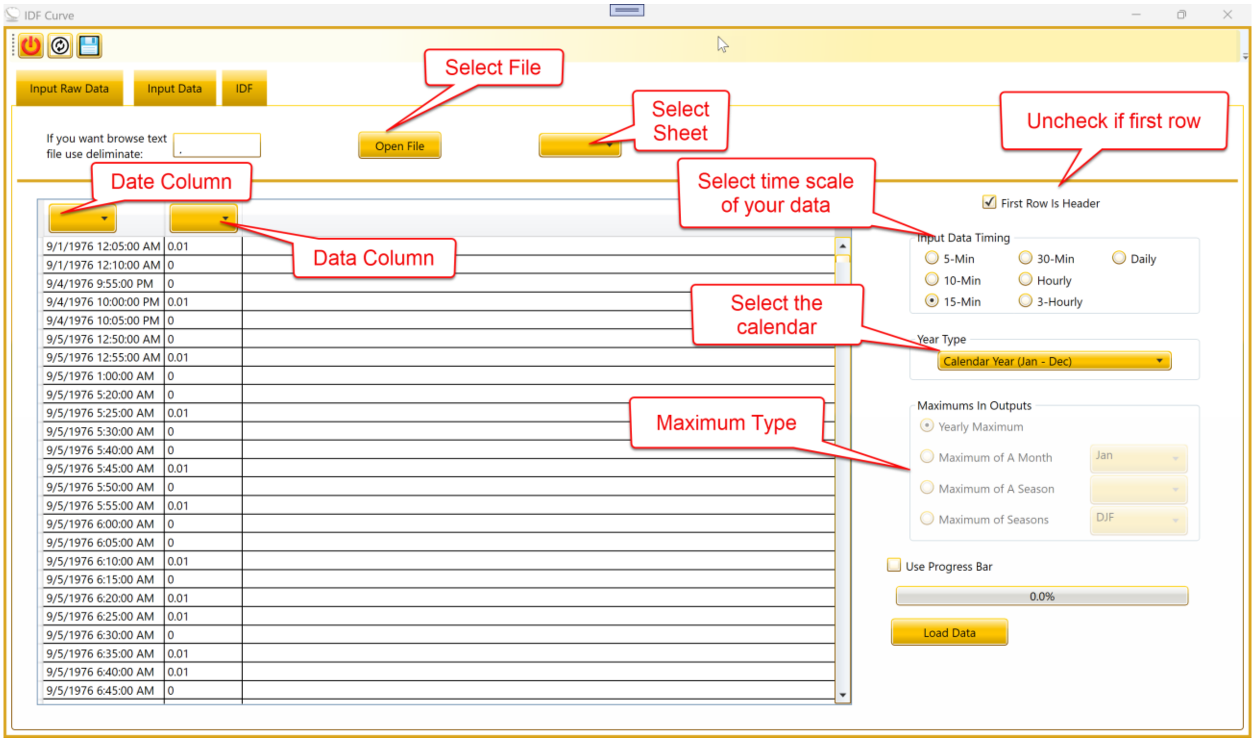
Gather historical rainfall data for the location of interest. You can obtain this data from government meteorological agencies, research institutions, or local weather stations. Online databases and climate archives are valuable resources.

On the Input Raw Data tab:

1. Click Open File and select your Excel workbook.
2. Choose the worksheet that contains the data.
3. Make sure your date column is formatted as Excel Date.

4. Set the time scale of the input data correctly — 5 minute, 10 minute, 15 minute, 30 minute, hourly, etc. Choosing hourly when your data is actually in 3 hour intervals will produce incorrect calculations.
5. Click Load Data.

If your record has gaps, the tool will offer to fill them. You can choose your fill method per gap; the "Do it for all items" option applies the same method to every remaining gap.



2.2 Year Type and Maximums in Output

> The tool now supports any starting month for the year, including water-year conventions used in hydrology.

The default year type is the calendar year (January to December), but you can pick any month as the year start. The most common alternative is the water year, which in the United States Geological Survey convention runs from October to September and is labeled by the year in which it ends. So water year 2025 covers October 2024 through September 2025.

Why this matters: rainfall seasonality often crosses the calendar boundary. A wet season that spans November to March is split into two different calendar years, which weakens the yearly maximum statistics. Using a year type aligned with the local seasonality keeps each season inside a single year.

Under "Maximums in Output," you can choose:

- Yearly Maximum — the annual maximum series (AMS), the most common choice for IDF analysis.

- Maximum for a Specific Month — useful for monsoon studies and other strongly seasonal climates.
- Maximum for a Predefined Season — see the table of twelve seasons in the Reference section below.
- Custom Months — pick any set of months (e.g., February, March, April, June, July).

2.3 Incomplete Years Warning

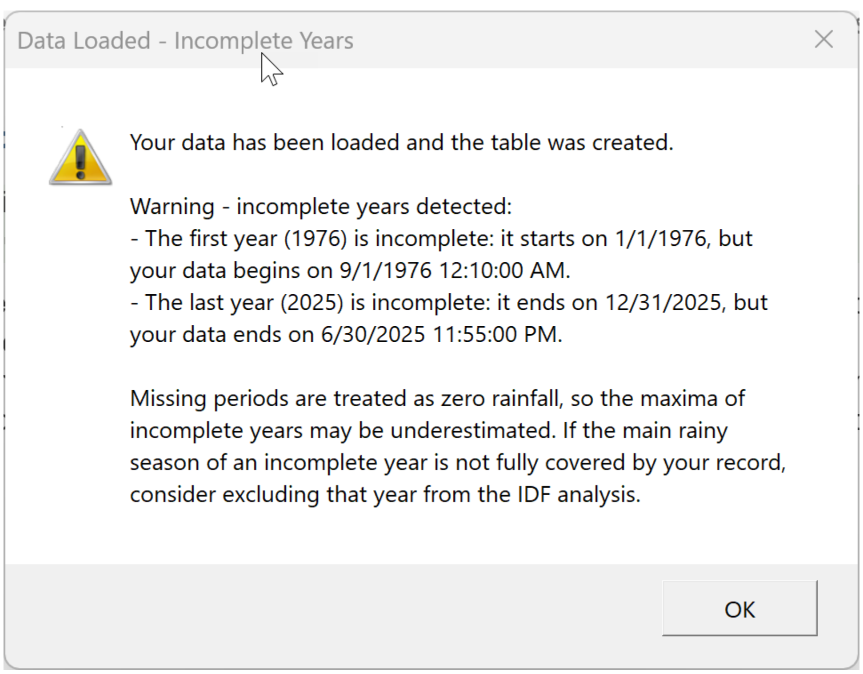
> The tool detects partial first or last years in the record and offers to exclude them from the distribution fit.

After loading raw data, the tool checks whether the first and last years of the record are complete according to the chosen year type. If they are not, a warning dialog lists the partial years.

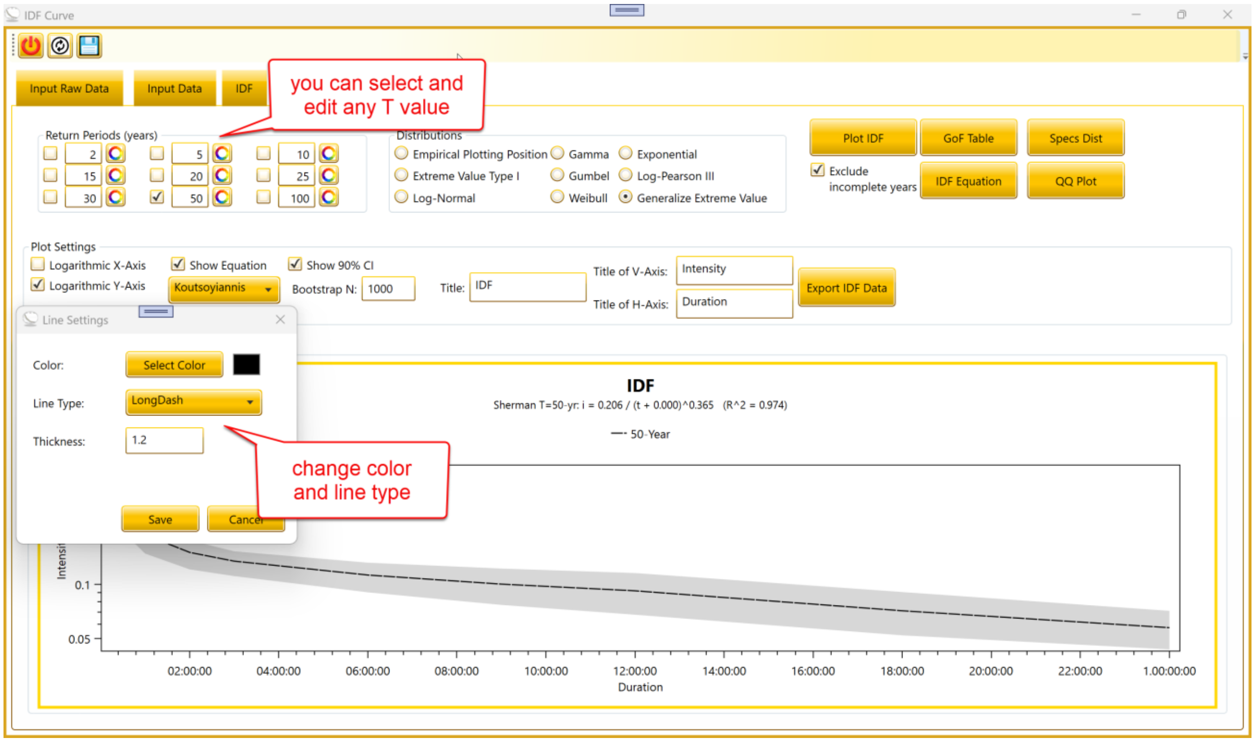
Example: with a water year starting in October and a record from September 1976 to June 2025, both the first water year (1976: October 1975 through September 1976, missing October 1975 to August 1976) and the last water year (2025: October 2024 through September 2025, missing July to September 2025) are incomplete.

Incomplete years bias the maxima downward, because missing periods are effectively treated as zero rainfall. Including them in the fit can pull the IDF curves below their correct level, especially at long return periods.

On the IDF tab there is a checkbox labeled "Exclude incomplete years." When the tool detects partial years in the record, this checkbox is automatically ticked and the partial years are excluded from the distribution fit. You can untick it if you specifically want to include them, but ticking it is the safer default.



3. The IDF Tab



3.1 Return Periods (editable)

Each return-period checkbox now has an editable number next to it. You can type any T value, including 200, 500, or 1000.

Nine checkboxes select which return periods to include in the plot. Each has an adjacent editable text field with the T value in years. Default values are 2, 5, 10, 15, 20, 25, 30, 50, and 100. You can change any number to a custom value by typing into the textbox. When you click Plot IDF, the tool computes quantiles for whichever T values are currently checked.

A small color/style button next to each row opens the Line Settings dialog. You can choose the line color, dash style, and thickness used to draw that T's curve on the plot.

Extrapolation warning

When you click Plot IDF, if any selected T is greater than 2x the record length (in years), a warning lists the affected return periods. For a 48-year record, asking for 100-year quantiles is reasonable, but asking for 500-year or 1000-year quantiles is heavy extrapolation — the fitted distribution is being asked to predict events far beyond what your data has constrained.

The values are still computed, but they should be interpreted with caution and reviewed before any design use. The Excel export and the IDF Equation CSV both annotate the affected return periods.

3.2 Distributions

> Two new distributions are available: Generalize Extreme Value (GEV) and Log-Pearson Type III (LP3). Both use methods that match international hydrology standards.

The tool supports seven probability distributions for frequency analysis:

Distribution	Parameters	Fit method	Typical use
Empirical Plotting Position (EPP)	0 (non-parametric)	Weibull plotting positions p = i / (n + 1)	Quick visual check; cannot extrapolate beyond ~n years
Extreme Value Type I (Gumbel)	2	Method of moments (mean, std)	Classical extreme-value fit; assumes light upper tail
Gamma	2	Maximum likelihood (Accord)	Common for daily precipitation totals
Exponential	1	Maximum likelihood (Accord)	Simple single-parameter form
Log-Normal	2	Maximum likelihood (Accord)	Empirically good for rain amounts
Weibull	2	Maximum likelihood	Flexible shape for time-to-event data
Generalize Extreme Value (GEV)	3	L-moments (Hosking 1990) + Newton refinement	Recommended for AMS; covers Gumbel as limit
Log-Pearson Type III (LP3)	3	Bulletin 17B (log-skewness + Kite factor)	U.S. standard for flood frequency analysis

The detailed mathematical formulation of each distribution is in the companion Formulas document. The choice of distribution affects every output: the IDF curves, the confidence bands, the IDF Equation coefficients, and the goodness-of-fit ranking.

3.3 Plot Settings

Click Plot IDF to compute and draw the curves. Several plot-settings options affect how the result is displayed:

- Logarithmic X-Axis / Logarithmic Y-Axis — switch each axis to log scale. The logarithmic horizontal axis displays values as log10(time) in seconds.
- Show 90% CI — adds shaded bootstrap confidence bands around each curve. See the next section.
- Bootstrap N — the number of bootstrap resamples used for the bands. 1000 is the standard choice; 500 is faster; 2000 is smoother. Only used when "Show 90% CI" is ticked.

- Show Equation — adds the fitted IDF equation as a subtitle on the plot. The dropdown next to it picks which form to show: Koutsoyiannis (global) or Sherman (at the median selected T).
- Title, Title of V-Axis, Title of H-Axis — text labels for the plot. These also propagate to the Excel chart on export.

3.4 90% Confidence Bands

Shaded bands around each return-period curve, computed by bootstrap resampling.

When "Show 90% CI" is ticked, the tool computes 90% bootstrap confidence bands around each return-period curve. The bands are obtained by resampling the annual maxima with replacement (Bootstrap N times), refitting the chosen distribution to each resample, and taking the 5th and 95th percentiles of the resulting quantile distribution at each duration.

The bands show the range where the true population quantile likely lies, given the limited sample size. They are not predictive intervals for an individual storm; the actual rainfall in any given year can lie outside the band.

Note: If the fitted line falls outside its own band, that points to either a poor distributional choice or an estimator inconsistency. The latest version of the tool uses a single Gumbel estimator (Accord maximum likelihood) for the line, the band, the GoF Table, and the Specs Dist dialog, so the line should sit inside the band for Gumbel on most records. For non-Gumbel data the line can still be far from the empirical points; that is a fit-quality issue, addressed by switching to GEV or LP3.

3.5 IDF Equation

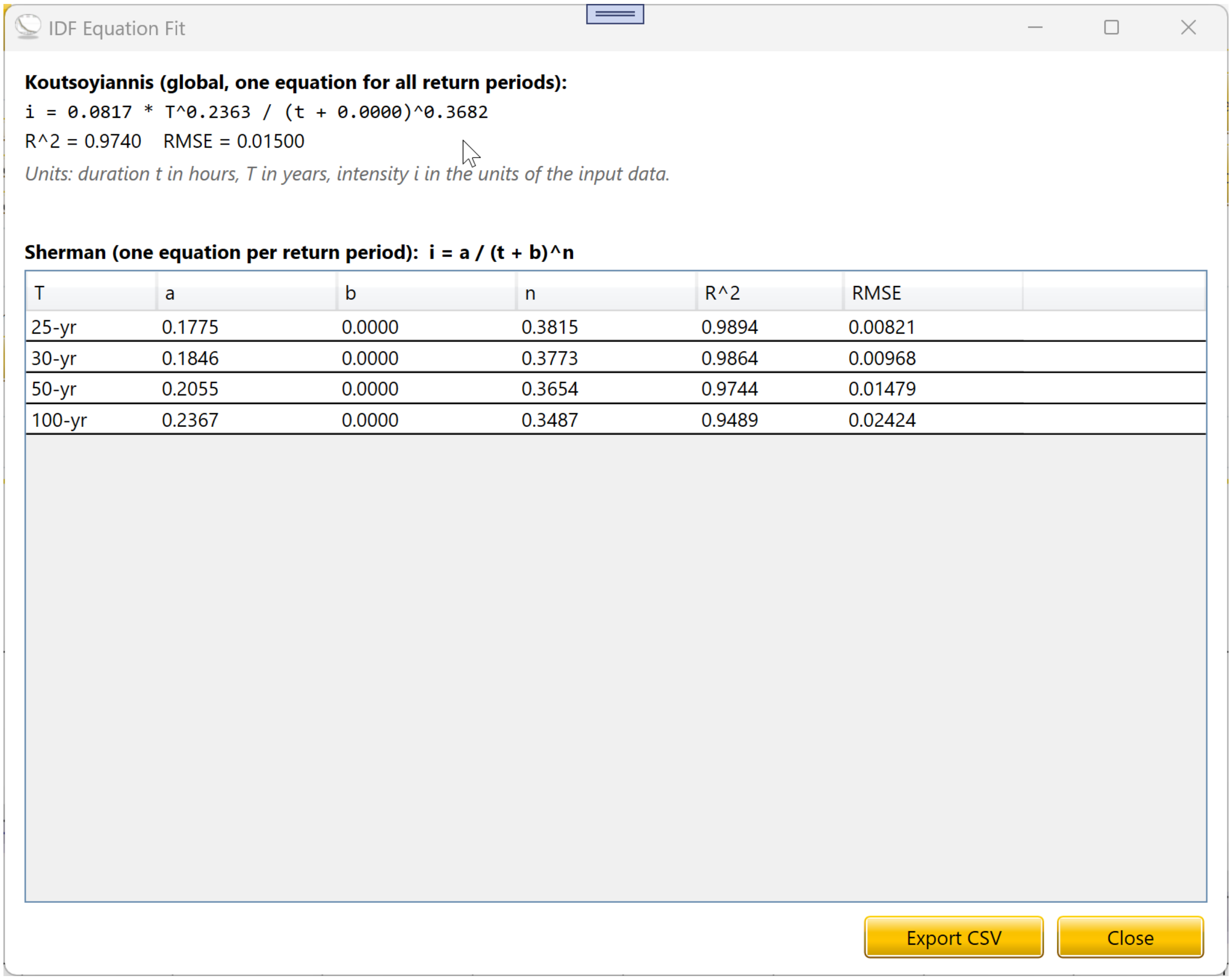
Fit closed-form IDF equations to your curves and export the coefficients to CSV.

The IDF Equation button fits closed-form intensity equations to the plotted curves. Two equation forms are produced together:

- Sherman (per return period):   i = a / (t + b)^n. One fit per selected T. The coefficients a, b, n vary with T.
- Koutsoyiannis (global):   i = a · T^m / (t + b)^n. A single fit covering all selected return periods together. The coefficients a, m, b, n are constants across the entire IDF surface.

The dialog shows both fits side by side, including R^2 and RMSE for each. Sherman’s per-T table can be reviewed row by row. The Koutsoyiannis equation is shown in the dialog header in human-readable form.

The Export CSV button saves both fits to a plain-text file. Units are duration t in hours, return period T in years, and intensity i in the units of your input data. If any selected return period was flagged as extrapolation, the CSV includes a warning comment at the top naming the affected T values, so reviewers can see immediately which numbers are heavy extrapolations.



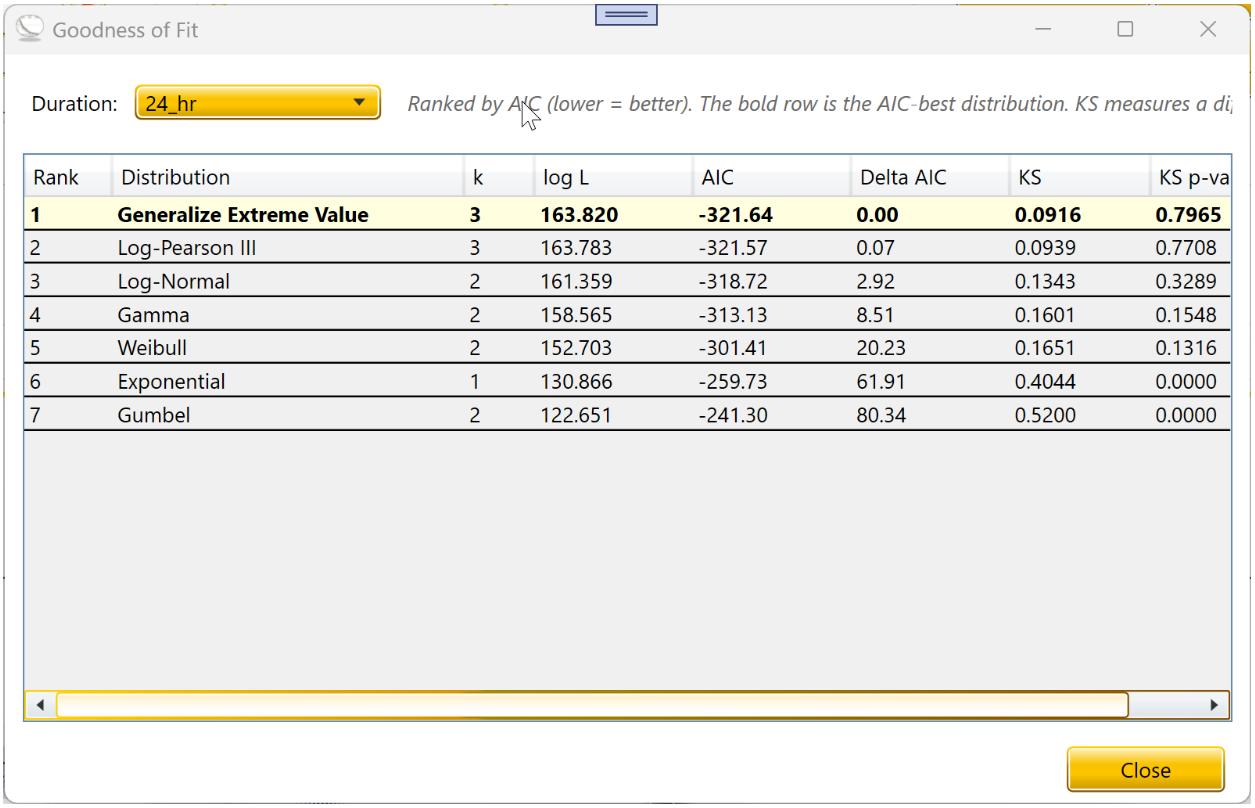
3.6 Goodness-of-Fit Table

> Compare all seven distributions on the data for the selected duration. Ranked by AIC; the AIC-best row is highlighted.

The GoF Table button compares all seven distributions on the data for the selected duration. The table shows, for each distribution:

- k — number of parameters
- log L — log-likelihood (higher is better)
- AIC — Akaike Information Criterion (lower is better; balances fit against complexity)
- Delta AIC — difference from the best distribution’s AIC
- KS — Kolmogorov-Smirnov statistic, the largest gap between fitted and empirical CDF (smaller is better)
- KS p-value — using Stephens (1970) finite-n correction; the same formula Accord’s KolmogorovSmirnovTest uses internally

The table is sorted by AIC, smallest first. The top row is shown in bold with a light-yellow background — this is the AIC-best distribution. KS measures a different aspect of fit (the worst-point gap between fitted and empirical CDFs) and may rank distributions slightly differently from AIC. A common rule of thumb is that Delta AIC < 2 indicates two distributions are essentially tied; Delta AIC > 10 indicates the lower-AIC distribution is clearly preferred.



Rank	Distribution	k	log L	AIC	Delta AIC	KS	KS p-va
1	**Generalize Extreme Value**	**3**	**163.820**	**-321.64**	**0.00**	**0.0916**	**0.7965**
2	Log-Pearson III	3	163.783	-321.57	0.07	0.0939	0.7708
3	Log-Normal	2	161.359	-318.72	2.92	0.1343	0.3289
4	Gamma	2	158.565	-313.13	8.51	0.1601	0.1548
5	Weibull	2	152.703	-301.41	20.23	0.1651	0.1316
6	Exponential	1	130.866	-259.73	61.91	0.4044	0.0000
7	Gumbel	2	122.651	-241.30	80.34	0.5200	0.0000

3.7 Specifications of Distribution

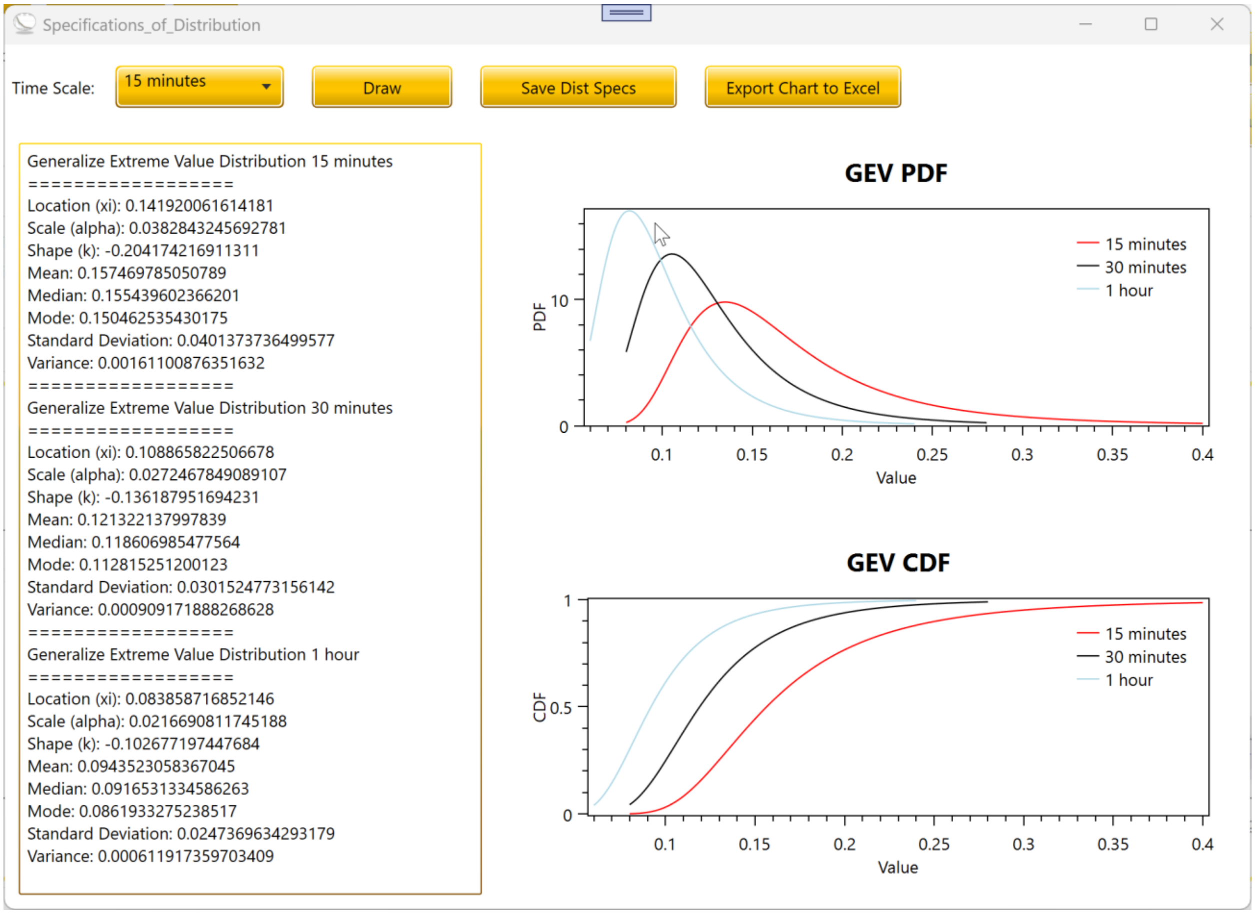
Specs Dist now supports GEV and LP3 in addition to the Accord-backed distributions.

The Specs Dist button opens a window with the fitted parameters and analytical properties of the currently selected distribution at the chosen duration. For all seven distributions including GEV and Log-Pearson III, it shows:

- The fitted parameters (e.g., for GEV: location xi, scale alpha, shape k; for LP3: log-mean mu, log-std sigma, log-skew g).
- Mean, median, mode, standard deviation, and variance, where these are defined for the fitted parameter values.
- CDF and PDF curves over the data range.

For GEV, certain moments are only defined for certain ranges of the shape parameter: the mean exists when $k < 1$, the variance exists when $k < 0.5$, and the mode exists when $k > -1$. The dialog explicitly flags these as undefined when they cannot be computed for the fitted shape.

For Log-Pearson III, the reported parameters (mu, sigma, g) are on the log10 scale. The median in real space is reported separately, computed using the Kite frequency factor at p = 0.5.

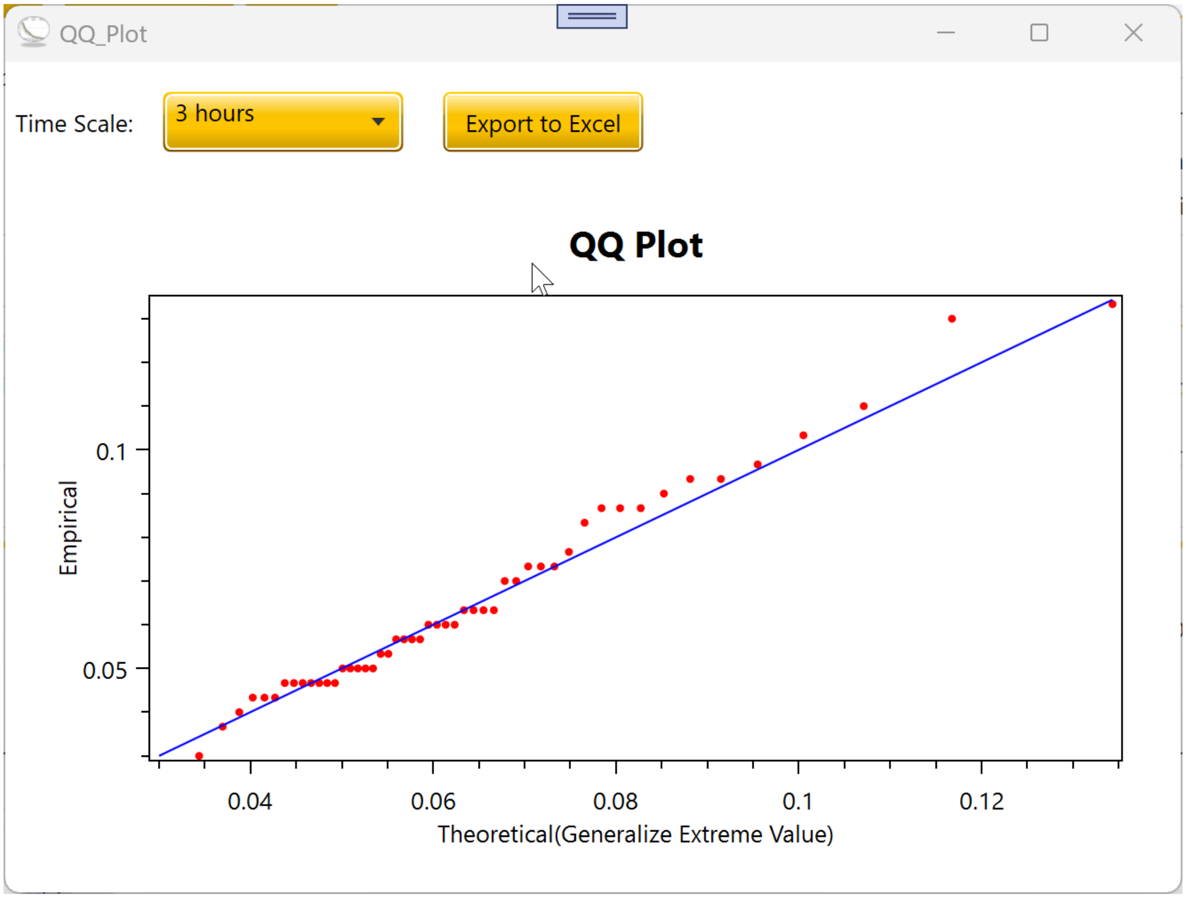


3.8 Q-Q Plot

> Q-Q Plot now supports GEV and Log-Pearson III in addition to Gamma, Log-Normal, Exponential, Weibull, and Gumbel.

The Q-Q Plot button shows a Q-Q diagnostic — theoretical quantiles on the X axis against empirical quantiles on the Y axis. A good fit produces points close to the 1:1 diagonal reference line.

For GEV and LP3, the dialog re-fits the distribution from the same data the IDF curves used, so the Q-Q diagnostic exactly mirrors the fit shown on the plot. Points along the diagonal in the body of the distribution with a small deviation at the highest ranks is normal — that is what a heavy upper tail or an outlier looks like, and it is information about the data, not a tool bug.



3.9 Line Settings

The Line Settings dialog has been rewritten. The previous version could carry over selections between dialog sessions; the new version applies your changes only when you click Save, and a Cancel never modifies the line.

Clicking the small color button next to a return-period checkbox opens the Line Settings dialog. You can pick:

- Color, via the standard Windows color picker.
- Line type, including Solid, Dash, Dot, DashDot, and several other patterns.
- Thickness, as a decimal number (default 1.2).

A small swatch next to the Select Color button shows the chosen color before saving. The Save and Cancel buttons respond to Enter and Escape respectively.

4. Exports

4.1 PNG image

The save icon in the top bar saves the current IDF plot as a PNG image at the on-screen resolution.

4.2 Excel IDF Data

> When the 90% CI is enabled, the Excel export now includes Low / Mid / High columns for each return period.

The Export IDF Data button in Plot Settings opens Excel with the full IDF table and a default chart. The first column is Duration; each selected return period gets its own column. If "Show 90% CI" was ticked when you last clicked Plot IDF, each return period gets three columns labeled (Lo), main value, and (Hi), so the band data travels with the table.

The Excel chart plots the main lines only by default; the band columns are present in the spreadsheet so you can add them to the chart yourself if you want a visual band. The chart axis titles match the "Title of V-Axis" and "Title of H-Axis" fields from Plot Settings.

4.3 CSV Equation Coefficients

> Coefficients export from the IDF Equation dialog.

In the IDF Equation dialog, the Export CSV button saves both the Koutsoyiannis and Sherman fits to a comma-separated file. The format includes commented header lines (starting with #) explaining units. The file is plain text and works in any spreadsheet program or analysis script.

Units in the file: duration t is in hours, return period T is in years, and intensity i is in the units of your input data. The CSV also includes a warning block at the top if any selected T was flagged as extrapolation.

5. Warnings and Limitations

This section consolidates the cautions noted earlier so they are easy to find.

5.1 Empirical Plotting Position cannot extrapolate

> **Warning:** EPP is a non-parametric method. It estimates quantiles at empirical plotting positions, which means it cannot produce a value for any return period larger than approximately the sample size.

If you select EPP and a return period that is too large (for example, T = 200 years with a 48-year record), the tool returns invalid values for those columns and a specific warning will appear. The IDF Equation dialog automatically skips those rows. For T values beyond the sample size, you must use a parametric distribution such as GEV, LP3, or Gumbel.

5.2 Extrapolation when T exceeds 2x the record length

> **Warning:** For parametric distributions, quantiles for T values larger than approximately 2x your record length are heavy extrapolations of the fitted distribution.

The numbers are mathematically defined but their accuracy depends entirely on whether the fitted distribution correctly describes the upper tail — something a short record cannot verify.

Use these values with caution, and prefer GEV or LP3 over Gumbel for upper-tail estimates. The Excel export and the IDF Equation CSV both annotate the affected return periods so reviewers are alerted.

5.3 Confidence bands are statistical, not predictive

Warning: The 90% bootstrap bands describe uncertainty in the fitted quantile due to limited sample size; they do not predict the range of actual rainfall amounts.

An individual year's rainfall can lie well outside the band even when the fit is correct. For predictive intervals on a specific storm, a different methodology is required.

5.4 Incomplete years bias maxima downward

Warning: A partial year contains fewer rainfall observations than a complete year, so its maximum is on average smaller. Including partial years in the AMS pulls the fitted distribution downward.

The "Exclude Incomplete Years" checkbox handles this; we recommend leaving it ticked when the tool has detected partial years. Untick it only when you have verified that the partial year does in fact contain the annual maximum.

5.5 Goodness-of-Fit p-values are for ranking

Warning: When the distribution is fitted from the same sample being tested, the Kolmogorov-Smirnov p-value is conservatively high — it does not penalize the fact that the parameters were estimated from the data. This is a known property of the test, not specific to this tool.

The values shown in the GoF Table are appropriate for ranking distributions against one another, which is what the table is designed for. For formal hypothesis testing on a specific distribution, use Anderson-Darling or a bootstrap KS test instead.

6. Reference: Twelve Predefined Seasons

The seasonal maxima option groups months into rolling three-month windows. Each season is labeled by the initials of its three months.

Code	Months (Description)
DJF	December, January, February (Winter)
JFM	January, February, March (Winter to Spring transition)
FMA	February, March, April (Early Spring)
MAM	March, April, May (Spring)
AMJ	April, May, June (Late Spring)
MJJ	May, June, July (Early Summer)

Code	Months (Description)
JJA	June, July, August (Summer)
JAS	July, August, September (Summer to Autumn transition)
ASO	August, September, October (Early Autumn)
SON	September, October, November (Autumn)
OND	October, November, December (Late Autumn)
NDJ	November, December, January (Autumn to Winter transition)

7. Further Resources

Tool website: https://agrimetsoft.com/idf_curve

Tutorial videos and channel: http://www.youtube.com/AgriMetSoft

For the mathematical details of each distribution, the bootstrap procedure, the goodness-of-fit metrics, and the IDF equation fitting algorithm, see the companion document "Formulas.docx".