

# Completeness Magnitude Estimation user guide

**i** To evaluate the magnitude of completeness  $M_c$ , defined as the lowest magnitude at which all seismic events in a selected space-time volume are recorded by a network.  $M_c$  is an essential prerequisite for most seismicity analyses.

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REFERENCES [Document Repository](#)

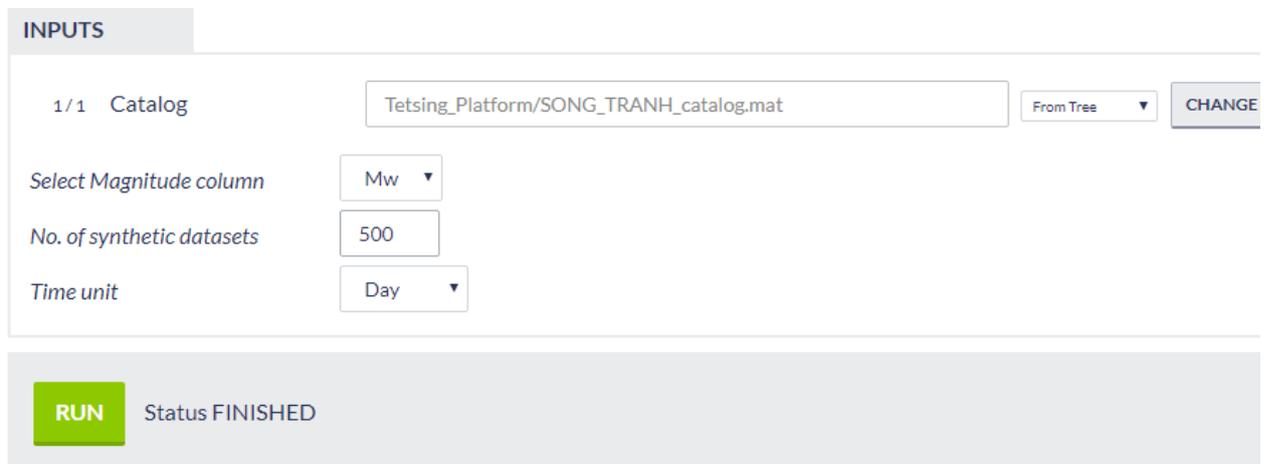
**CATEGORY** Collective Properties of Seismicity

**KEYWORDS** Statistical analysis, Statistical properties of seismicity, Parameter probabilistic distribution

**CITATION** Please acknowledge use of this application in your work: IS-EPOS. (2016). *Completeness Magnitude Estimation* [Web application /Source code]. Retrieved from <https://tcs.ah-epos.eu/>

## Step by Step

1. After the User adds the Application into his/her personal workspace, the following window appear on the screen (Figure 1):

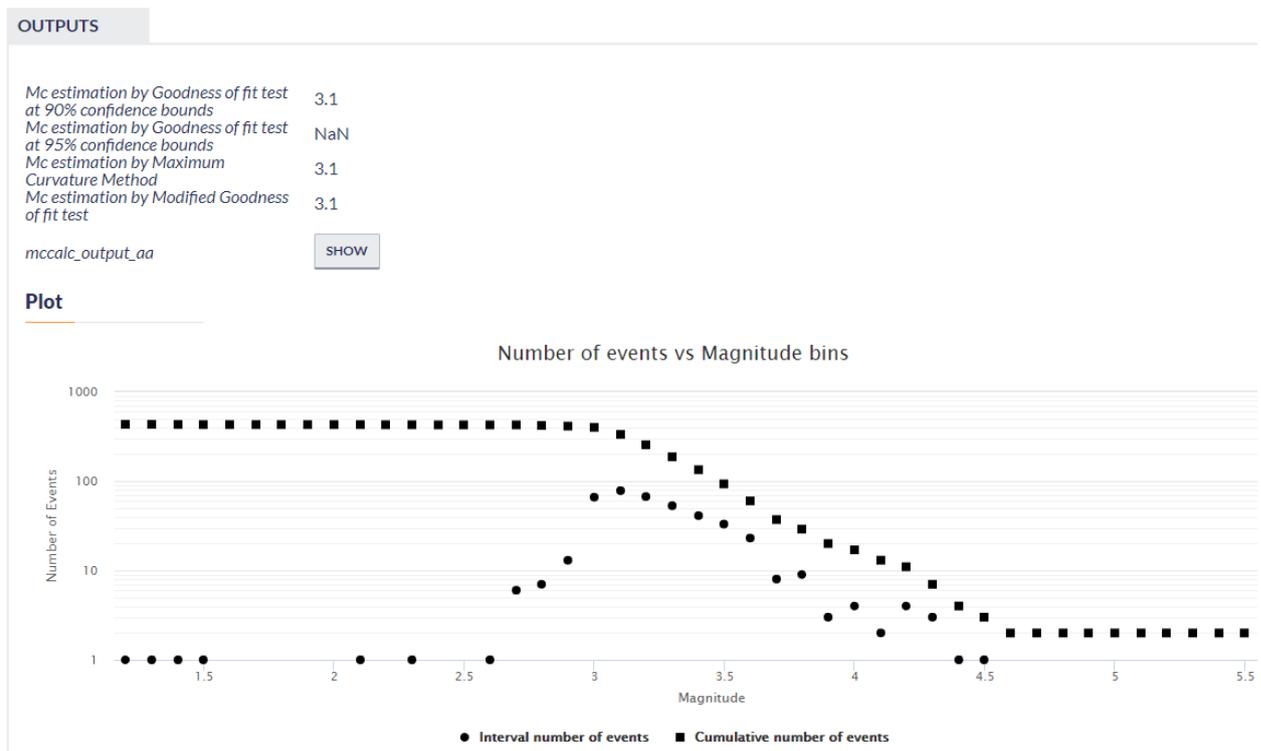


**Figure 1. Input window of CME application.**

The user is now requested to fill the fields shown above:

- *Use Seismic catalog* - The user may click on "change input" button in order to use a seismic catalog data among the ones that are already uploaded in his/her personal workspace.
- *Select Magnitude Scale* - The user may chose among different magnitude scales (e.g  $M_L$ ,  $M_W$ ), in the Episodes where these scales are available.
- *Time Unit* - The user can here select a time unit among 'Day', 'Month' and 'Year'.
- *Number of synthetic datasets* - The user inserts the number of synthetic datasets in the empty box which should be an integer between 10 and 10,000 (default value is 500).

3. After defining the aforementioned parameters, the user shall click on the  button and the calculations are performed. The Status changes from 'CREATED' through 'SENT\_TO\_SERVER', 'RUNNING' and finally 'FINISHED' and the output is created and plotted in the main window. The Analysis Results table appear on the screen after clicking on the 'Show' button (top left corner in Figure 2), next to 'mccalc\_output\_aa'. These results are:



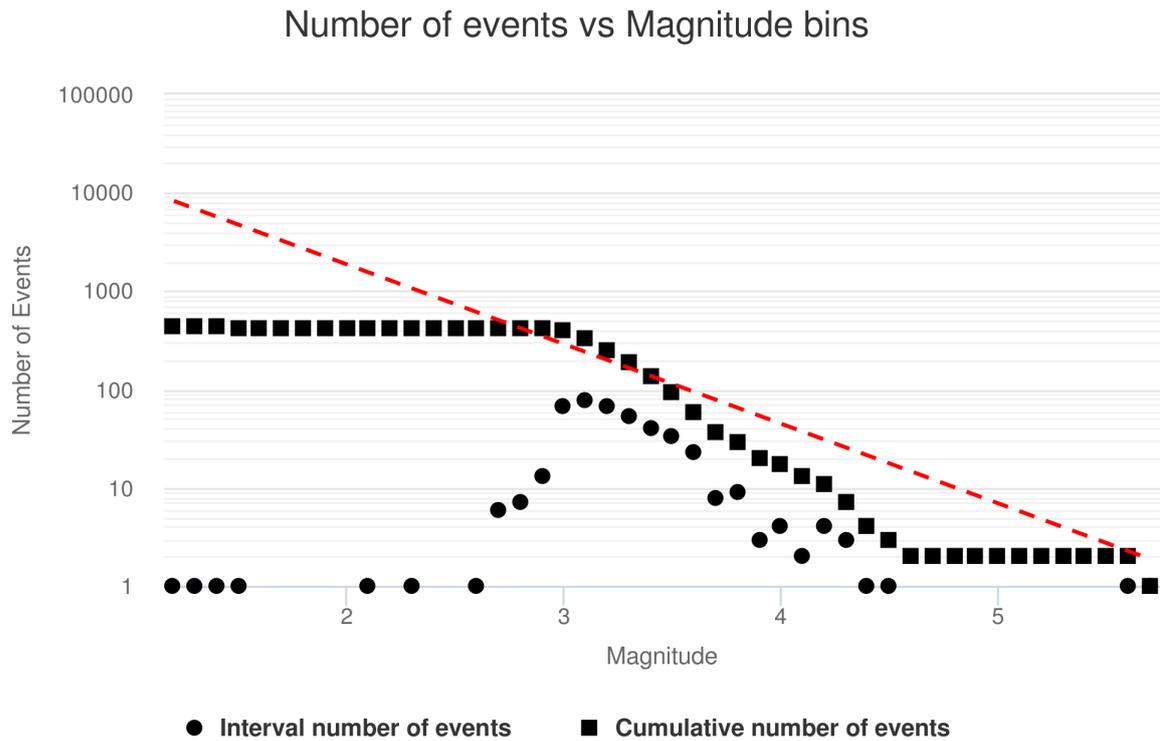
**Figure 2. Number of events vs Magnitude bins plot for CME analysis.**

Analysis results: A table including information on the obtained results, as a function of minimum magnitude, available after clicking on the 'Show' button (Figure 2). The columns of the table correspond to:

- **Magnitude:** minimum magnitude,  $M$
- **N:** number of events with magnitude  $\geq M$
- **n:** number of events with magnitude  $=M$
- **b-value:** b-value of the Gutenberg-Richter law
- **berr:** b-value standard error
- **a-value:** a-value of the Gutenberg-Richter law
- **a-value normalized:** a-value normalized per unit time as was selected by the user
- **Rs[%]:** Residual between observed data and power law
- **Rf[%]:** Average residual between synthetic catalogs and power law

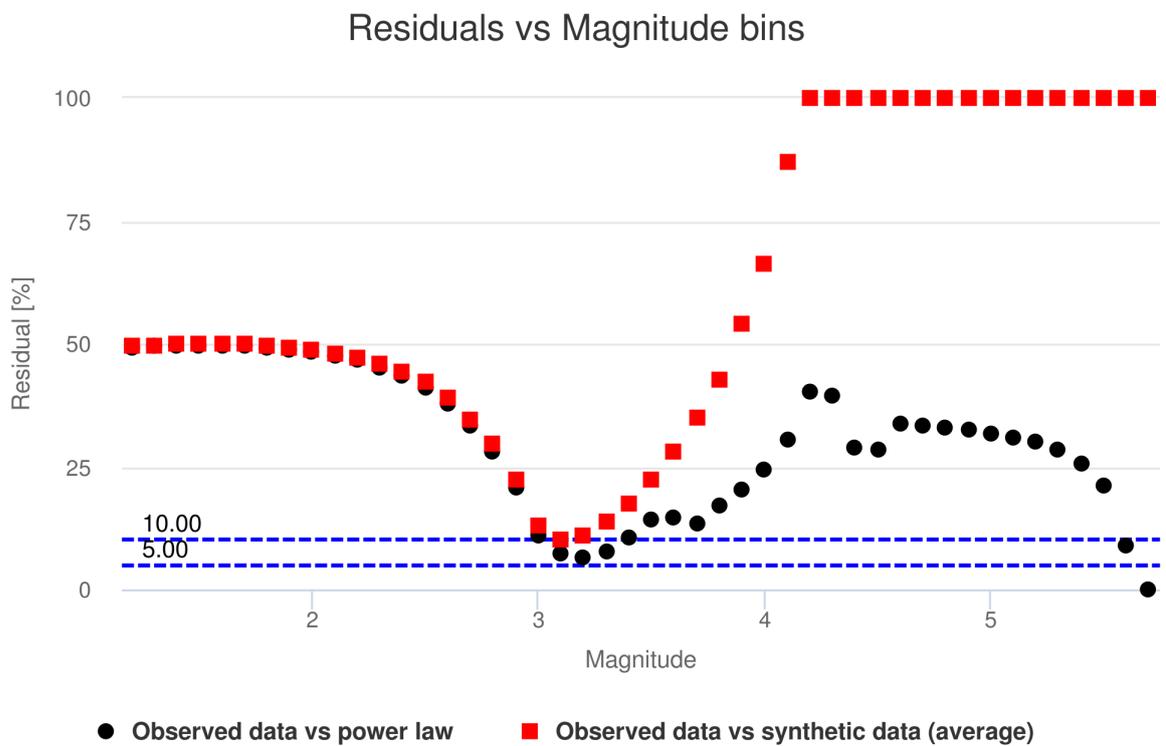
A table with Completeness Magnitude,  $M_C$ , as it was estimated by four different approaches, 90% and 95% Goodness of Fit Tests, Maximum Curvature and Modified Goodness of Fit Test (Figure 2).

A plot of the number of events (interval,  $n$ , and cumulative,  $N$ ) as a function of minimum magnitude, shown on logarithmic Y-axis (Figure 2 and Figure 3). The user can click on a certain point of the plot to draw the power law fitting curve corresponding to this minimum magnitude (red dashed line, Figure 3). The interval, cumulative and the theoretical number of events for each magnitude bin is shown in the screen as well, by moving the cursor on the circles, squares, or along the fitting curve, respectively (Figure 3). The plotting points can be shown/hidden after clicking on the parameters shown in the legend of the figure.



Highcharts.com

Figure 3. Number of events vs Magnitude bins with the fitting curve plot for CME analysis.



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Figure 4. Residuals vs Magnitude bins with plot for CME analysis.

Residual Plot: This option provides to the user the opportunity to evaluate the Goodness-of-Fit results as a function of magnitude by examining the residuals between real and modeled data. The modeled data corresponds to power law of the frequency magnitude distribution (black dots) and to the synthetic datasets following this power law (red squares). The horizontal dashed lines indicate the residual values of 10% (upper line) and 5% (lower line), which correspond to the commonly used in literature recommended levels (Figure 4).

Plot of b-values with errorbars: This final option shows the b-value fluctuation as a function of magnitude (Figure 5). The errorbars which indicate  $\pm$  one standard deviation are shown as well. In such way the user may consider the accuracy of calculations and the stability of the b-value as the magnitude changes. The dashed horizontal line denotes  $b=1.0$ , which is a value that often characterizes seismic activity in several scales.

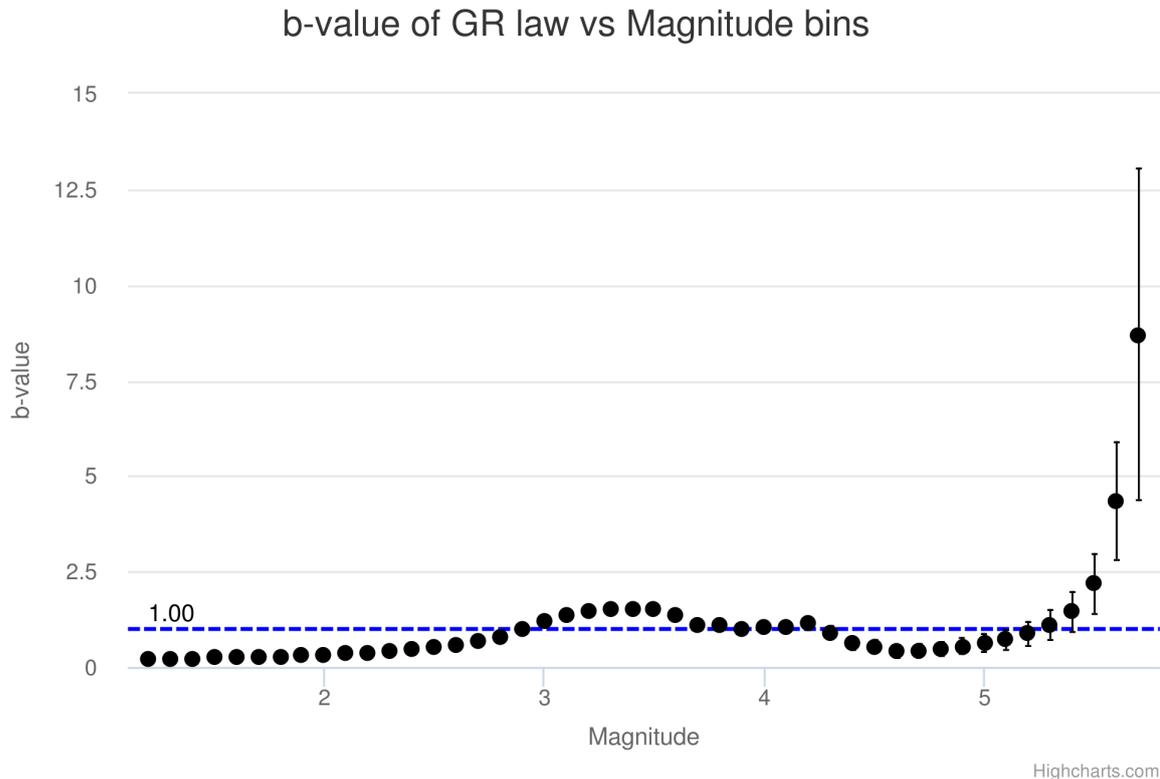


Figure 5. b-value of GR law vs Magnitude bins with plot for CME analysis.

Note that zooming option is enabled for all of the aforementioned plots (see information [i](#) tips at the low part of Figures 3, 4 and 5). (For more details about the available figure options, see section Plot properties" in "Visualization" chapter).

[Back to top](#)

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