STEVE 2.0 USER GUIDE

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1.0 OVERVIEW:

STEVE 2.0 stands for **S**tochastic **T**heory **E**ducation Through **V**isualization **E**nvironment (version 2.0). It is a graphical user interface (GUI) that conveniently visualizes the output of a stochastic theory model against a user-specified set of input conditions and thereby allows easy qualitative comparison of the quantitative magnitude of various stochastic theory concepts. The motivation of STEVE 2.0 is to improve initial learning of difficult-to-grasp stochastic theory concepts which otherwise are limited only through complex theoretical and text-based pedagogical methods at the entry graduate level.

2.0 GENERAL PHILOSOPHY OF STEVE:

STEVE 2.0 can essentially embed any stochastic theory model and visualize its output. Typically, such a stochastic theory model manifests several different concepts (such as spatial statistics, temporal statistics, probability density functions, random fields etc.) wherein the dominance of each concept can be controlled quantitatively through user-defined set of inputs. In STEVE 2.0, a stochastic theory model called 'SREM2D' (Two Dimensional Satellite Rainfall Error Model) developed by Hossain and Anagnostou (see *A Two-Dimensional Satellite Rainfall Error Model, IEEE - Trans. Geosci and Remote Sens.vol. 44(6), pp. 1511-1522 doi: 10.1109/TGRS.2005.863866*). This model employs a code written in fortran 77 which corrupts a time series of rainfall fields in space and time as per user-specified error parameters. Users do not require a background on computing to use STEVE 2.0. The general flowchart for STEVE 2.0 is shown below:

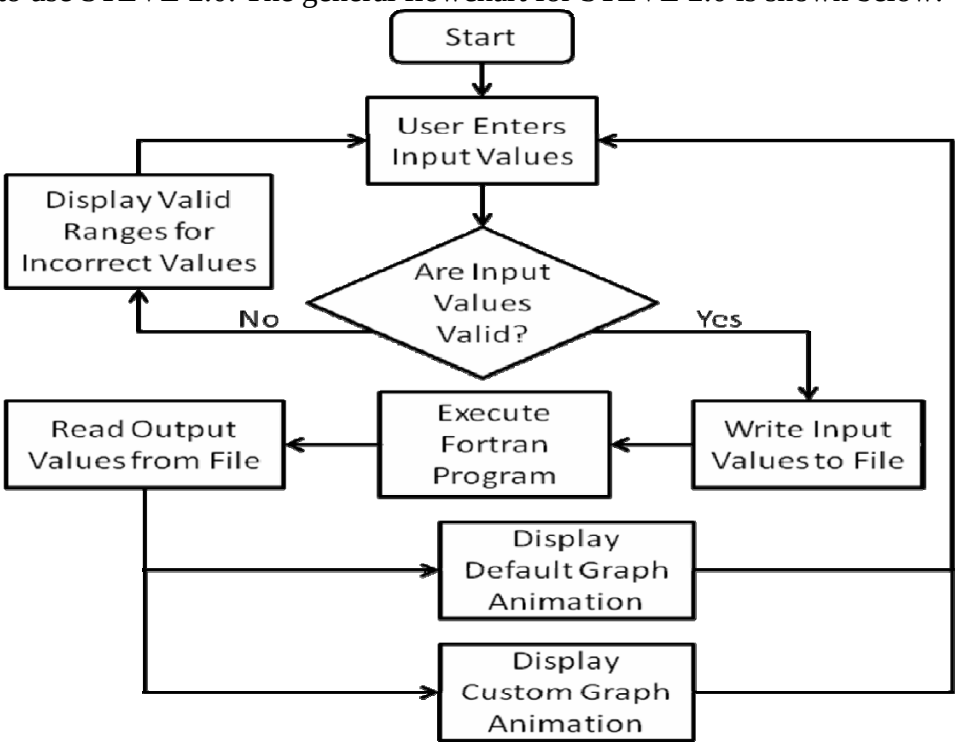

Figure 1. General flow-chart of STEVE 2.0 that visualizes the output of the fortran-coded SREM2D against user-specified input.

3.0 GENERAL FOLDER AND DATA ORGANIZATION OF STEVE

There are three folders, one readme file and one executable (on STEVE GUI). The folders are:

- '**doc**': containing all the necessary help and documentation literature for the user to access when needed from the GUI help menu. The user need not do anything to this folder.
- '**img**': containing iconic images for the STEVE GUI. The user need not do anything to this folder.
- '**simul**': containing the SREM2D fortran code, the SREM2D fortran code executable, user-specified input parameter file, user-specified input parameter range file, input data, and output data. It is basically this folder that the user needs to manipulate for STEVE 2.0 usage.

Starting STEVE 2.0

Click on the executable file STEVE.exe shown as an icon. The GUI will appear as follows:

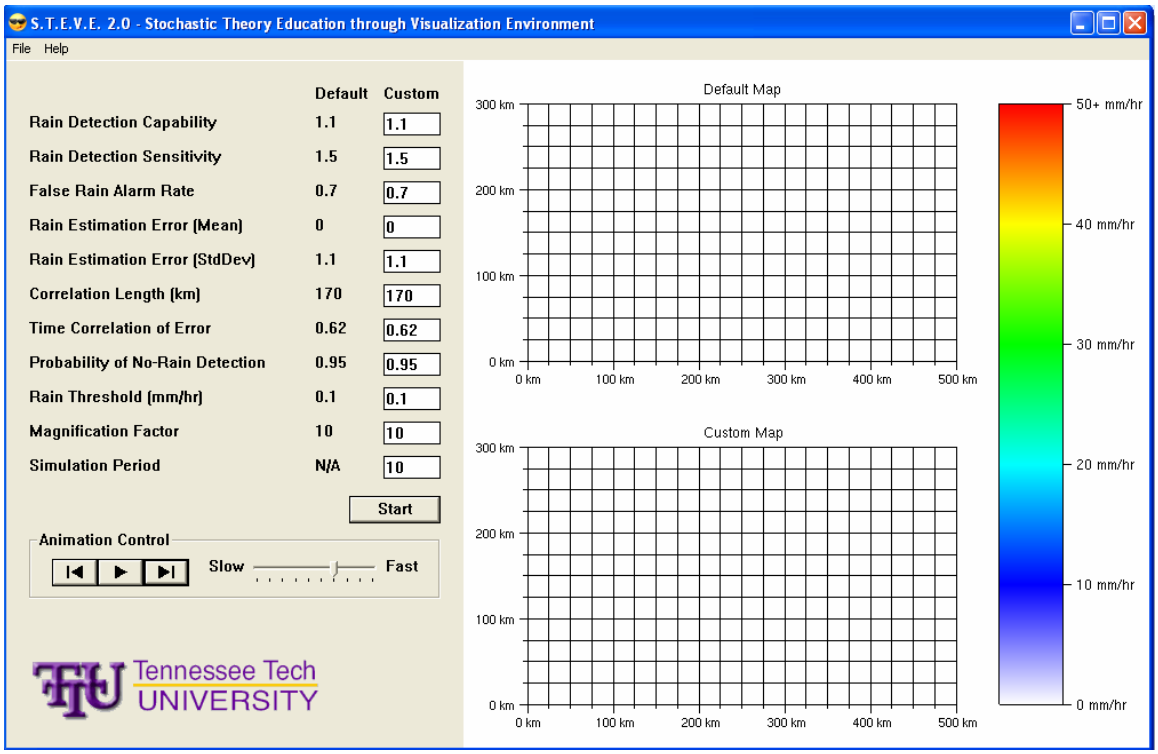

Figure 2. Screen-shot of STEVE 2.0.

4.0 BACKGROUND LITERATURE

Although it is not entirely necessary for the user to completely understand the workings of SREM2D, it is recommended that the user first read the following documentation (in order of sequence) by clicking the 'Help' menu of STEVE (Figure 3):

- 'About STEVE'
- 'SREM2D Theory'
- 'General Information About Error Metrics'

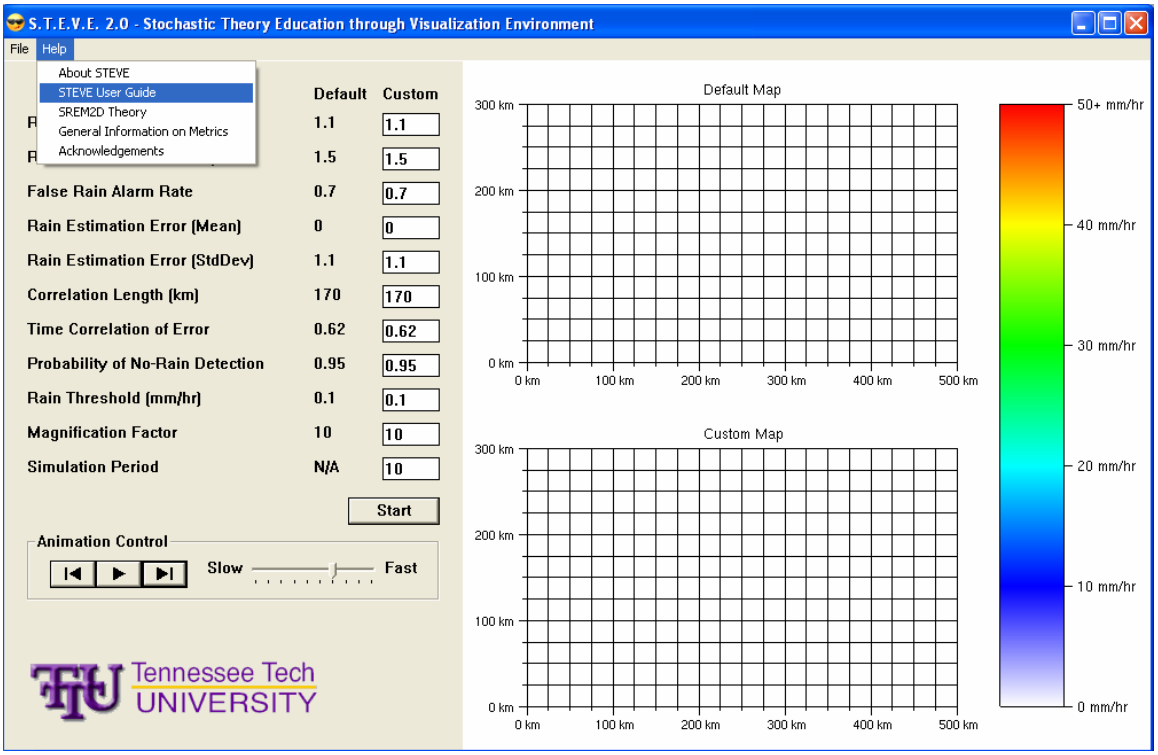

Figure 3. Using the 'Help' menu of STEVE 2.0 for reading background and supporting material.

5.0 ORGANIZATION OF THE 'SIMUL' FOLDER

As mentioned earlier, user needs to understand the contents of the 'simul' folder in order to make good use of STEVE 2.0. The following are the specific file names of the 'simul' folder:

- 'simulation_fast.exe': the executable of the SREM2D code in fortran 77.
- 'software_fast.f': the SREM2D code in fortran 77 (whose executable is 'simulation_fast.exe').
- 'input.dat': the input file (containing rainfall data) that SREM2D uses to corrupt using the space-time stochastic concepts.
- 'output.dat': the output file that is generated once STEVE is executed via SREM2D. Data format is similar to input.dat. This output.dat is visualized as the 'custom map' in STEVE (see Figure 3).
- 'default.dat': the output corrupted rainfall file that was generated using the user-specified set of input parameters. This data is visualized as 'Default Map' in STEVE (see Figure 3).
- 'paramInfo.dat': parameter information file. This file contains specifications on the number of specific aspects of stochastic theory that STEVE can manipulate. In general, the user need not manipulate this file.
- 'params.dat': parameter input file that SREM2D executable reads before generating the output.dat. User need not do anything to this file. The params.dat file is created as soon as the user key in the input values on the STEVE GUI on the left hand side.

- ‘last.dat’: parameter file (parameter.dat) that was used in the last simulation. The purpose of this file is to allow the user to re-run the last simulation-based visualization without having to simulate the SREM2D program (this saves time). This file also allows the user to conveniently visualize circectly any other input, default or output file already simulated by skipping the ‘start’ button (discussed more later in section 7.0).

6.0 GENERAL USE OF STEVE 2.0

After clicking on the STEVE.exe icon, the user can key in quantitative values in the input fields on the left-hand side of the GUI. If the values are beyond a realistic range, an error message will appear and the program will not execute. The user can also specify how many time steps the SREM2D code will run (from 1 to 2952 timesteps).

Once all the fields are keyed in, the user hits the start button. The GUI transfers the user-specified parameters to SREM2D for execution and generation of ‘output.dat’. The total simulation time is printed when the execution is complete. Once simulation is complete, STEVE visualizes the output.dat (a space-time field of rainfall shown as ‘Custom Map’) simultaneously with the ‘default.dat’ (shown as ‘Default Map’).

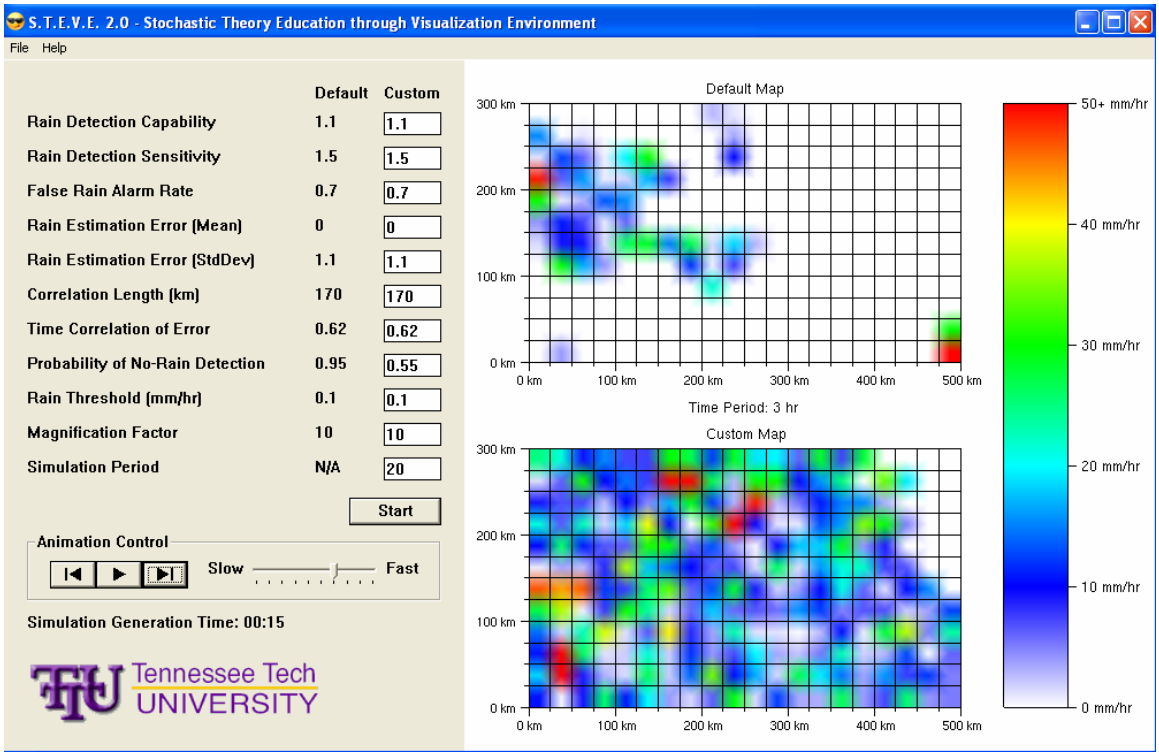

Figure 4. Executing STEVE as per user-specified input and observing the visual nuances between default and custom maps that can connect to a set of stochastic theory concept.

The simultaneous visualization allows the user to observe visually the impact in space and time of the quantitative difference in parameter value between the default setting and the custom (user-specified) setting (see Figure 4).

User can stop the animation and observe one snapshot at a time for closer inspection. User may also rewind, forward one snap shot at a time and also manipulate the animation speed.

Using the 'File' menu of STEVE, user may also save the settings on input parameters. To save the 'output.dat' with a particular filename so that user can identify it in future against the input setting and/or perform statistical analysis, the user needs to use the usual file renaming using 'Explorer' or 'My Computer'.

For convenience of the user, there exists a sub-folder named 'standard' under 'simul'. In this sub-folder, there are three files:

- 'inputstd.dat': this file contains the input time series of rainfall fields. The user should treat this as a backup version of the 'input.dat' that is in the main 'simul' folder. If the 'input.dat' file is accidentally deleted, then the user should copy this 'inputstd.dat' file to the 'simul' folder and rename it 'input.dat'.
- 'inputstd_magnified10.dat': this file contains the 'input.dat' with values magnified by a factor of 10. This file can be used to visualize the input.dat in STEVE. The user needs to copy this file to 'simul' folder and rename it as 'default.dat'.
- 'default_magnified10.dat': same as 'input_magnified10.dat' except that it is the output file generated with default SREM2D parameters magnified by a factor of 10.

7.0 DIRECT VISUALIZATION (SKIPPING SREM2D SIMULATION)

STEVE has an option that allows user to re-visualize the output of the last program run without having to simulate the time-consuming SREM2D simulation program again. Under 'file menu' the user needs to click on 'Run last simulation'. This will then begin visualization of the last 'output.dat' and 'default.dat' files skipping the SREM2D simulation program.

The direct visualization option ('Run last simulation') also allows the user to visualize any other simulation output/input/default files without having to use the simulation program. For this, the user needs to rename the files he wishes to visualize (assuming they are of the 20X12 grid format – see the Design Documentation SDS.doc for more) as 'output.dat' (will appear in the lower panel – Custom Map) and 'default.dat' (will appear in the upper panel – Default Map). The user should then open the 'last.dat' file under 'simul' folder and make sure that the simulation time period is consistent with the size of the files to be visualized. Finally, the 'Run last simulation' needs to be clicked once all the files have been renamed and modified.

8.0 IMPROVING INITIAL UNDERSTANDING OF STOCHASTIC THEORY CONCEPTS

The following stochastic theory concepts can be played with in STEVE 2.0:

1) Logistic Regression: Rain Detection Capability and Rain Detection Sensitivity.

2) Probability density function: False alarm rain rates.
3) First and Second-order moments: Mean and Standard Deviation.
4) Geostatistics, random fields and variograms: Correlation length
5) Autocorrelation: Temporal Correlation.
6) Bernoulli Trials: Probability of No-rain detection.

The user should either increase or decrease each parameter value from the default value and then compare the visualized output with the custom map. Subsequently, the user should try to reconcile the observed differences with the theory or initial understanding of the specific stochastic theory concept. For example, an increase in correlation length can mean that the rainfall structure may look 'stretched' more. Similarly, if the probability of no-rain detection is reduced (from 0.95 to 0.25), this means that 25% Bernoulli trials would be unsuccessful in detecting no-rain and hence, these events would then be subjected to false alarm rain rates (which can also be played with).

It is up to the user how he/she wants to use STEVE based on instruction provided by the instructor. It is recommended that the instructor provides some guidance and suggestions for setting up various hypothesis construction experiments using STEVE 2.0. Understanding of the significance of each of these stochastic concepts are better appreciated if the general concept of SREM2D error corruption is understood first. The instructor is recommended that he/she first explains the SREM2D concept (or any other stochastic model in general) through an introductory workshop prior to STEVE2.0 usage.