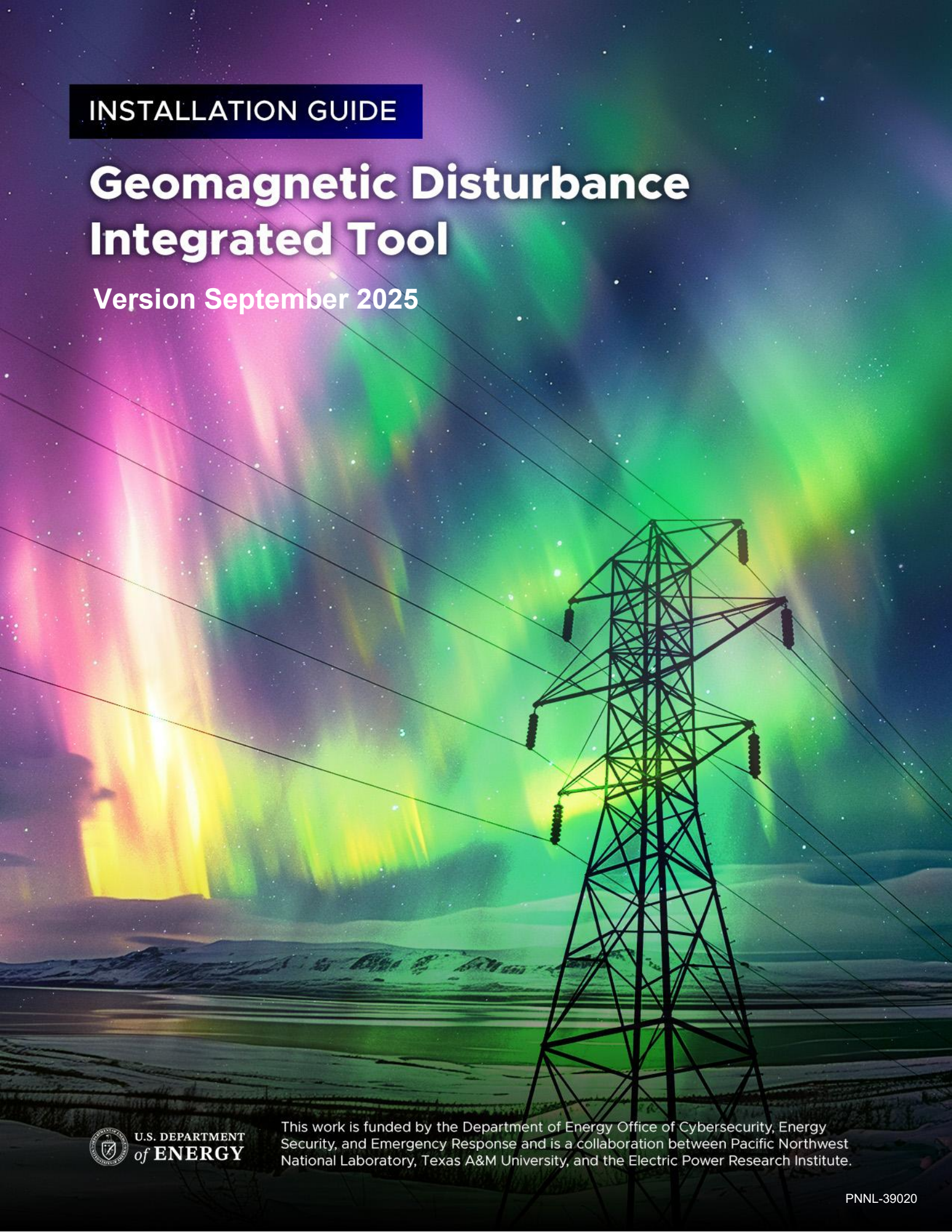
INSTALLATION GUIDE

Geomagnetic Disturbance Integrated Tool

Version September 2025



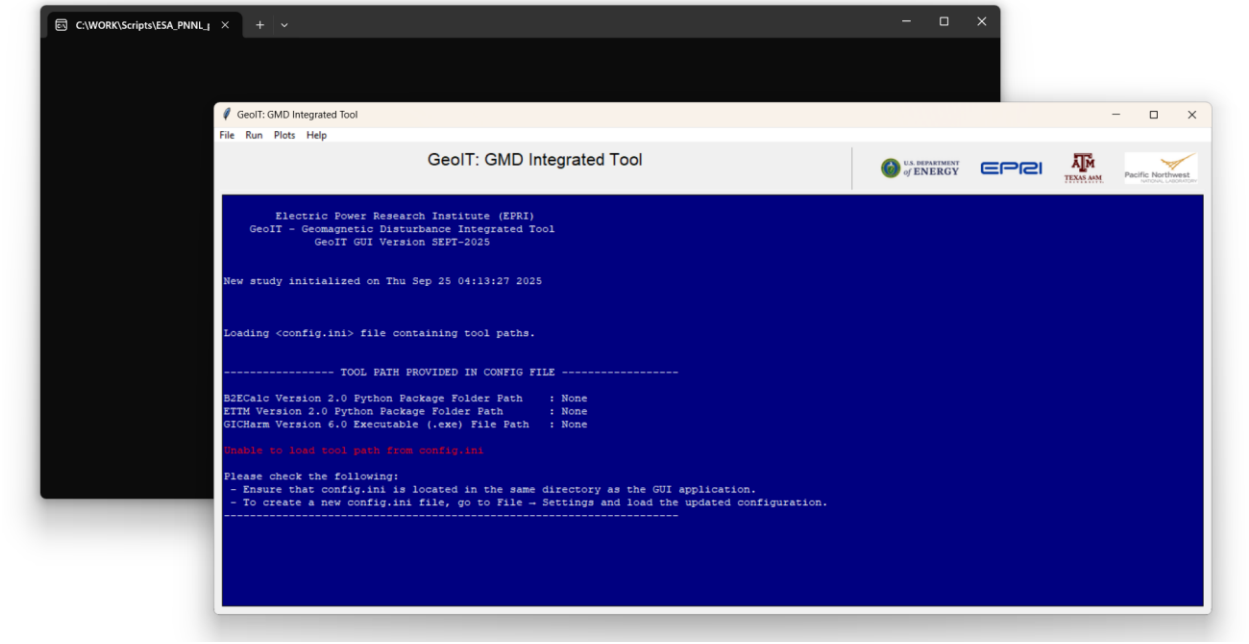
U.S. DEPARTMENT of ENERGY

This work is funded by the Department of Energy Office of Cybersecurity, Energy Security, and Emergency Response and is a collaboration between Pacific Northwest National Laboratory, Texas A&M University, and the Electric Power Research Institute.

PNNL-39020

1.0 Getting Started

- Launching the **Graphical User Interface (GUI)**: To open the Geomagnetic Integrated Tool (GeoIT) GUI, double-click the executable file located in the tool package at:
  - \GeoIT-GUI\GeoIT V-Sept2025.exe
- Interface Overview: This action will launch both the GUI window and a console window.
- While the GUI includes its own log panel for basic activity tracking, the console window provides more detailed logging information that may be useful for troubleshooting or advanced monitoring.



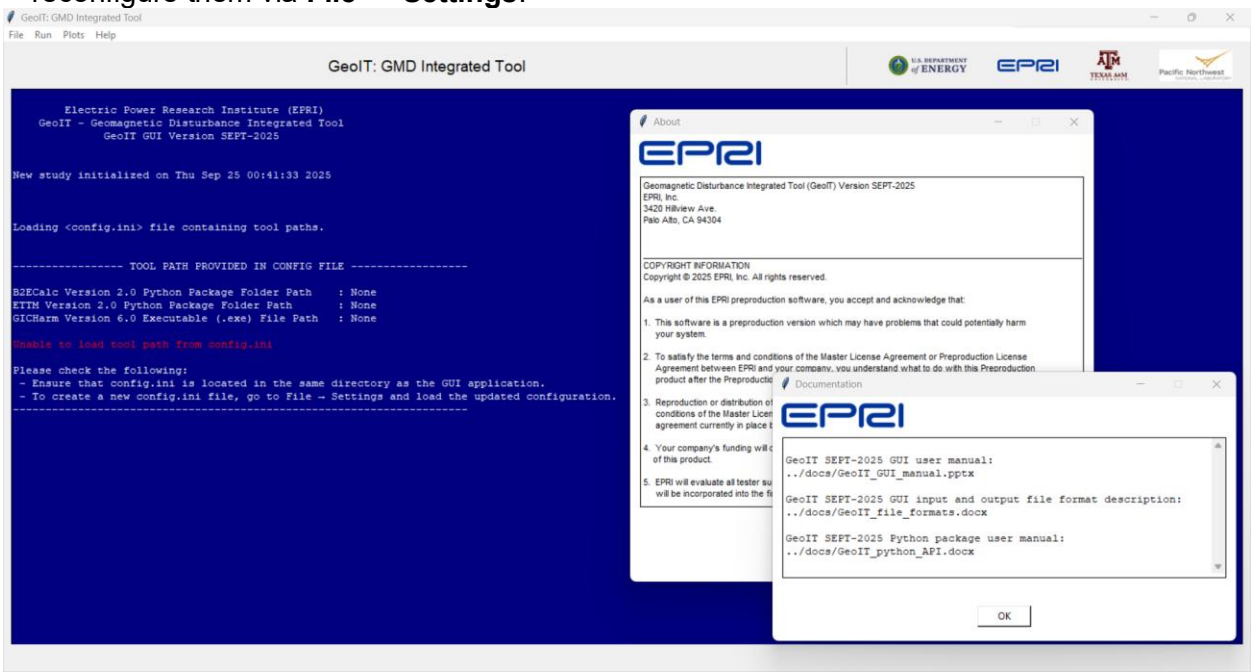
2.0 GeoIT Home Screen

The **GeoIT** GUI base window includes the following components:

- **Execution Log Window**: Displays real-time logs and status messages during tool execution.
- Menu Items:
  - File, Run, Plots, and Help
    - Help **Menu** Options:
      - **About**: Provides essential background information about the GeoIT tool.
      - **Documentation**: Links to all available documentation for the tool.

First-Time Use:

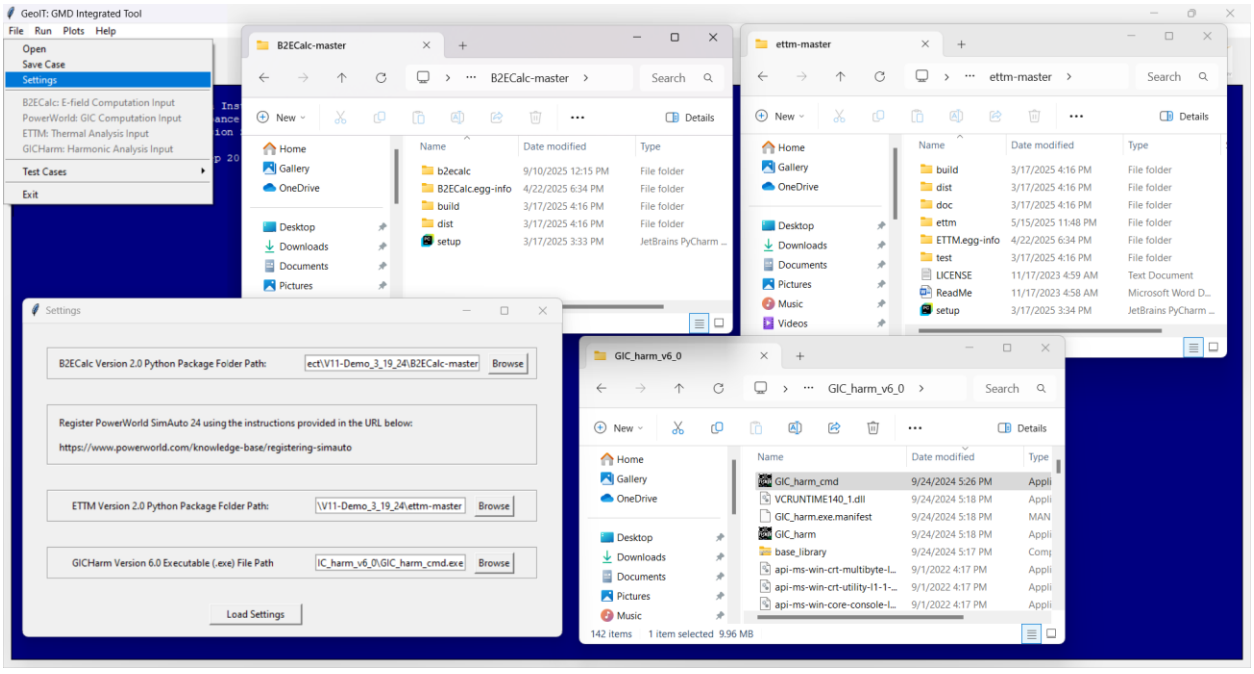
- **Initial Error Message**: When launching the GeoIT GUI for the first time on your computer, the **Execution Log Window** may display the following error: **"Unable to load tool path from config.ini"**
- **Loading Tool Paths**: First-time users must manually load the tool paths by navigating to **File → Settings**. Follow the on-screen instructions to populate the GeoIT configuration file with the available tool paths.
- **Saving Configuration**: Once the settings are loaded, a config.ini file is automatically saved. From this point onward, the GUI will use the saved tool paths unless the user chooses to reconfigure them via **File → Settings**.



3.0 File → Settings

To configure individual tool paths and dependencies, follow these steps:

- Open Settings Window:
  - Click **File** → **Settings** to open the **Settings** window.
- Enter Tool Paths: Provide the paths for the following tool packages or executables. You can either enter the full path manually or click **Browse** to select from your directory.
  - B2ECalc Version 2.0 Python Package Folder Path
    - Path to the B2ECalc Python package. Screenshot shows folder contents.
  - Register PowerWorld SimAuto 24
    - PowerWorld SimAuto Registration Guide: https://www.powerworld.com/knowledge-base/registering-simauto
  - Electric Power Research Institute's Engineering Technical Training Module (ETTM) Version 2.0 Python Package Folder Path
    - Path to the ETTM Python package. Screenshot shows folder contents.
  - GICHarm Version 6.0 Executable (.exe) File Path
    - Path to the GICHarm executable (GIC_harm_cmd.exe). Screenshot shows file location.
    - Note: This step must be completed to enable access to individual tool module options within the GUI.



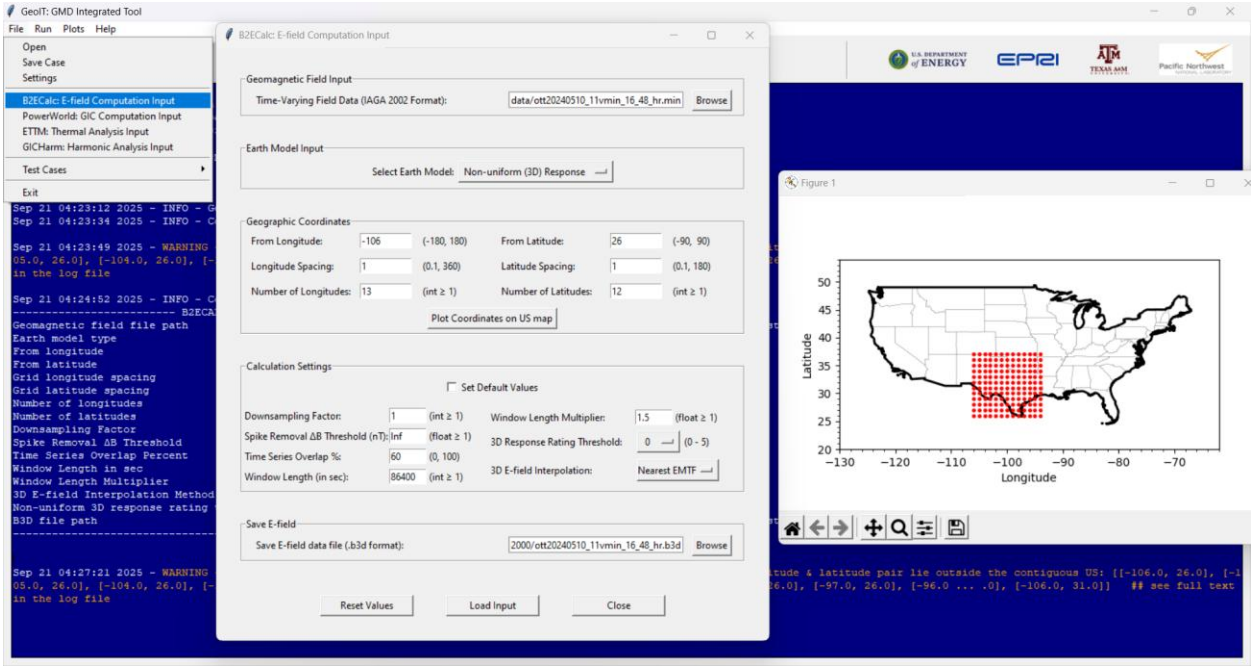
4.0 File → B2ECalc: E-field Computation Input

To open the input window for E-field computation using the B2ECalc module follow the steps below:

- Navigate to File → B2ECalc: E-field Computation Input

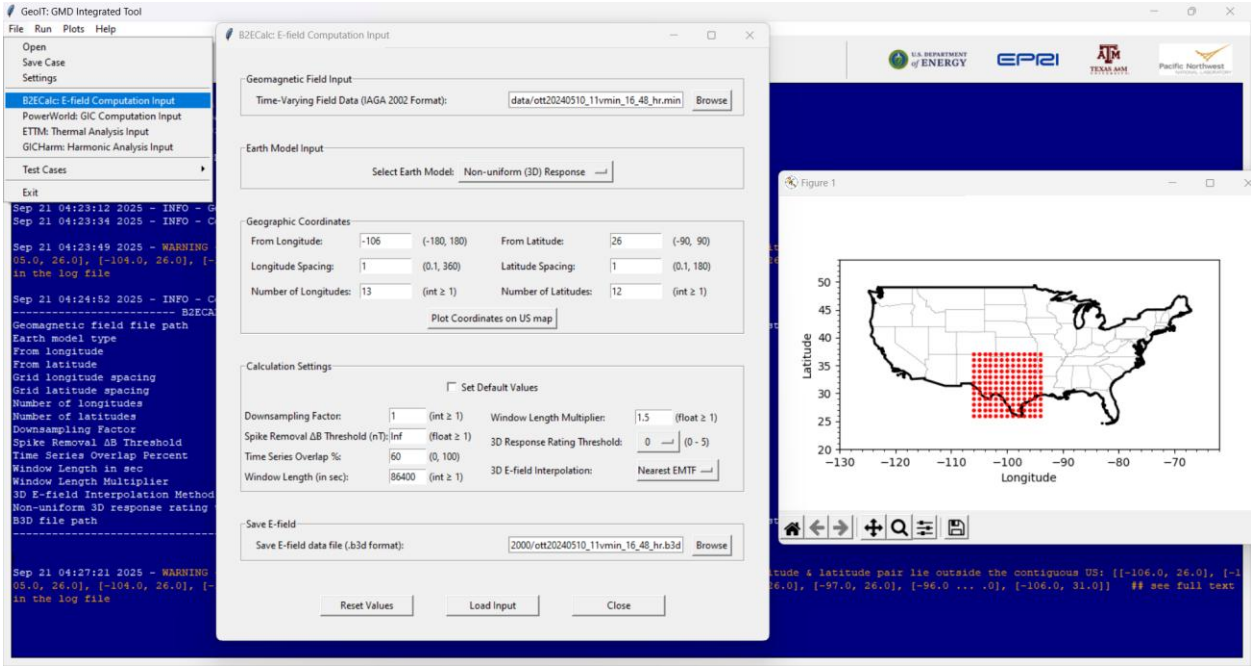
Input Fields:

- **Time-Varying Field Data (IAGA 2002 Format):**
  - Under **Geomagnetic Field Input**, enter the full path of the geomagnetic field data file in IAGA 2002 format, or click **Browse** to select from your directory. Refer to GeoIT_file_formats.docx for details on the file format.
- **Earth Model Input:** Select one of the following surface impedance or transfer function options:
  - Fernberg 1-D conductivity model.
  - Updated 1-D response transfer functions (RTFs).
  - Non-uniform (3-D) response: USArray/USMTArray electromagnetic transfer functions
- **Geographic Coordinates:** To define a uniform grid of geographic coordinates, provide the following values:
  - **From Longitude**: Longitude (in degrees) of the lower-left corner of the grid. Must be between −180 and 180.
  - **From Latitude**: Latitude (in degrees) of the lower-left corner of the grid. Must be between −90 and 90.
  - **Longitude Spacing**: Spacing (in degrees) between longitudes. Must be ≥ 0.1 and ≤ 360.
  - **Latitude Spacing**: Spacing (in degrees) between latitudes. Must be ≥ 0.1 and ≤ 180.
  - **Number of Longitudes**: Total number of longitudes in the grid. Must be a natural number.
  - **Number of Latitudes**: Total number of latitudes in the grid. Must be a natural number.
- Based on the above inputs, clicking **Plot Coordinates on US map** button will display the uniform grid of E-field evaluation coordinates on a map of the US. For more advanced mapping, use **Plots** → **Map Plots** → **E-field Coordinate Map**.


GeoIT: GMD Integrated Tool
File Run Plots Help
Open
Save Case
Settings
B2ECalc: E-field Computation Input
PowerWorld: GIC Computation Input
ETTM: Thermal Analysis Input
GICHarm: Harmonic Analysis Input
Test Cases
Exit
B2ECalc: E-field Computation Input
Geomagnetic Field Input
Time-Varying Field Data (IAGA 2002 Format):
data/ott20240510_11vmin_16_48_hr.min
Browse
Earth Model Input
Select Earth Model:
Non-uniform (3D) Response
Geographic Coordinates
From Longitude:
-106
(-180, 180)
From Latitude:
26
(-90, 90)
Longitude Spacing:
1
(0.1, 360)
Latitude Spacing:
1
(0.1, 180)
Number of Longitudes:
13
(int ≥ 1)
Number of Latitudes:
12
(int ≥ 1)
Plot Coordinates on US map
Calculation Settings
Set Default Values
Downsampling Factor:
1
(int ≥ 1)
Window Length Multiplier:
1.5
(float ≥ 1)
Spike Removal ΔB Threshold (nT):
Inf
(float ≥ 1)
3D Response Rating Threshold:
0
(0 - 5)
Time Series Overlap %:
60
(0, 100)
Window Length (in sec):
86400
(int ≥ 1)
3D E-field Interpolation:
Nearest EMTF
Save E-field
Save E-field data file (.b3d format):
2000/ott20240510_11vmin_16_48_hr.b3d
Browse
Reset Values
Load Input
Close
Figure 1
Latitude
Longitude
50
45
40
35
30
25
20
−130
−120
−110
−100
−90
−80
−70
Sep 21 04:23:12 2025 - INFO - G
Sep 21 04:23:34 2025 - INFO - C
Sep 21 04:23:49 2025 - WARNING
05.0, 26.0], [-104.0, 26.0], [-
in the log file
Sep 21 04:24:52 2025 - INFO - C
---------- B2ECA
Geomagnetic field file path
Earth model type
From longitude
From latitude
Grid longitude spacing
Grid latitude spacing
Number of longitudes
Number of latitudes
Downsampling Factor
Spike Removal ΔB Threshold
Time Series Overlap Percent
Window Length in sec
Window Length Multiplier
3D E-field Interpolation Method
Non-uniform 3D response rating
B3D file path
Sep 21 04:27:21 2025 - WARNING
05.0, 26.0], [-104.0, 26.0], [-
in the log file
itude & latitude pair lie outside the contiguous US: [[-106.0, 26.0], [-1
6.0], [-97.0, 26.0], [-96.0 ... .0], [-106.0, 31.0]] ## see full text

4.0 File → B2ECalc: E-field Computation Input (Continued)

- **Calculation Settings**: These settings allow modification of the computation algorithm parameters:
  - **Set Default Values**: Resets all calculation settings to default.
  - **Downsampling Factor**: Downsamples the input geomagnetic field data. Example: A factor of 2 changes a 1-second time series to 2 seconds. Must be a natural number.
  - **Spike Removal ΔB Threshold (nT):** Removes data points where ΔB (difference between consecutive samples) exceeds the user-defined threshold.
  - **Time Series Overlap (%)**: Percentage overlap between time series segments.
  - **Window Length (sec)**: Length of each time series segment. Must be a natural number and ≤ total input data length.
  - **Window Length Multiplier**: Multiplier for padding time series segments. Must be ≥ 1.
  - **3-D Response Rating Threshold**: Filters electromagnetic transfer function (EMTF) impedances based on quality rating. Only those above the threshold are used for E-field computation.
  - **3-D E-field Interpolation**: Sets the interpolation method for determining the E-field values at each location in the geographic coordinate grid. Applicable only for non-uniform E-fields. Choose one:
    - **Nearest EMTF**: Assigns the E-field value from the nearest magnetotelluric survey station.
    - **IDW Interpolation**: Uses Delaunay triangulation to find three nearby survey stations and applies inverse distance weighted (IDW) interpolation.
- **Save E-field Data File (.b3d format):** Enter the full path to save the E-field output in B3D format, or click **Browse**. Refer to GeoIT_file_formats.docx for format details.
- Control buttons:
  - **Reset Values**: Clears all input fields.
  - **Load Input**: Loads the input into the tool's working memory.
  - **Close**: Closes the input window.


GeoIT: GMD Integrated Tool
File Run Plots Help
Open
Save Case
Settings
B2ECalc: E-field Computation Input
PowerWorld: GIC Computation Input
ETTM: Thermal Analysis Input
GICHarm: Harmonic Analysis Input
Test Cases
Exit
B2ECalc: E-field Computation Input
Geomagnetic Field Input
Time-Varying Field Data (IAGA 2002 Format):
data/ott20240510_11vmin_16_48_hr.min
Browse
Earth Model Input
Select Earth Model:
Non-uniform (3D) Response
Geographic Coordinates
From Longitude:
-106
(-180, 180)
From Latitude:
26
(-90, 90)
Longitude Spacing:
1
(0.1, 360)
Latitude Spacing:
1
(0.1, 180)
Number of Longitudes:
13
(int ≥ 1)
Number of Latitudes:
12
(int ≥ 1)
Plot Coordinates on US map
Calculation Settings
Set Default Values
Downsampling Factor:
1
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Window Length Multiplier:
1.5
(float ≥ 1)
Spike Removal ΔB Threshold (nT):
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(float ≥ 1)
3D Response Rating Threshold:
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(0 - 5)
Time Series Overlap %:
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(0, 100)
Window Length (in sec):
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(int ≥ 1)
3D E-field Interpolation:
Nearest EMTF
Save E-field
Save E-field data file (.b3d format):
2000/ott20240510_11vmin_16_48_hr.b3d
Browse
Reset Values
Load Input
Close
Figure 1
Latitude
Longitude
50
45
40
35
30
25
20
−130
−120
−110
−100
−90
−80
−70
Sep 21 04:23:12 2025 - INFO - G
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05.0, 26.0], [-104.0, 26.0], [-
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---------- B2ECA
Geomagnetic field file path
Earth model type
From longitude
From latitude
Grid longitude spacing
Grid latitude spacing
Number of longitudes
Number of latitudes
Downsampling Factor
Spike Removal ΔB Threshold
Time Series Overlap Percent
Window Length in sec
Window Length Multiplier
3D E-field Interpolation Method
Non-uniform 3D response rating
B3D file path
Sep 21 04:27:21 2025 - WARNING
05.0, 26.0], [-104.0, 26.0], [-
in the log file
itude & latitude pair lie outside the contiguous US: [[-106.0, 26.0], [-1
6.0], [-97.0, 26.0], [-96.0 ... .0], [-106.0, 31.0]] ## see full text

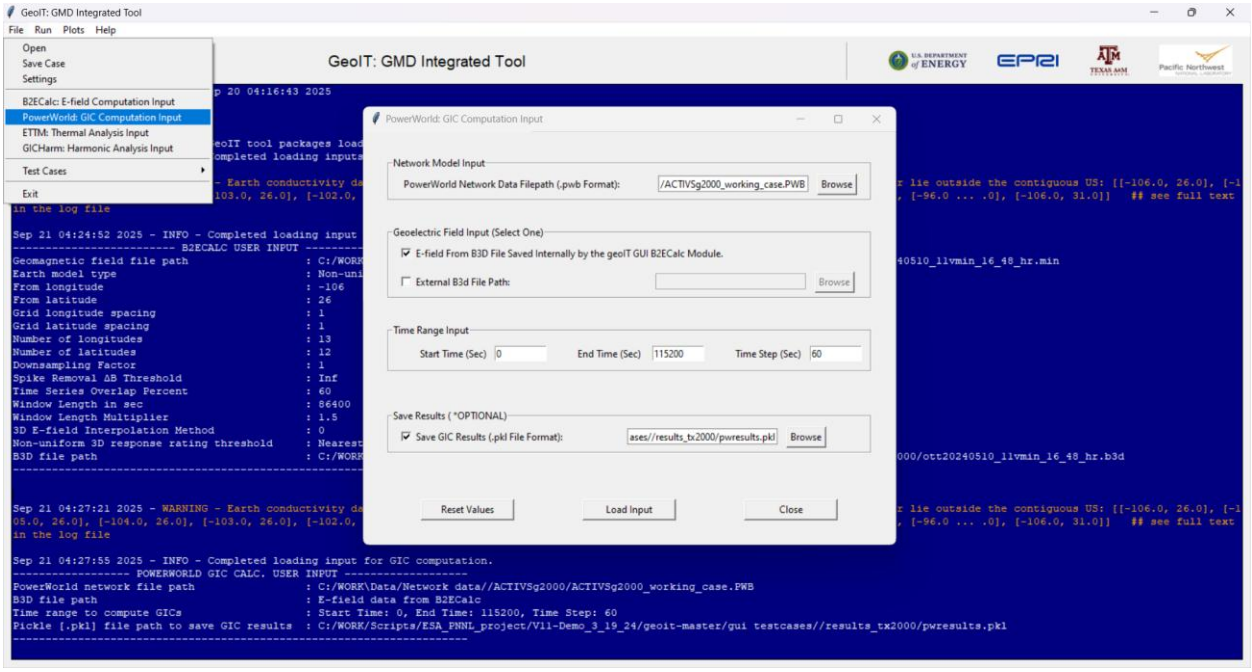
5.0 File → PowerWorld: Geomagnetically Induced Currents (GIC) Computation Input

To configure and run GIC computations using the PowerWorld module follow the steps below:

- Navigate to **File → PowerWorld: GIC Computation Input** to open the input window.

Input Fields:

- **Network Model Input:** Enter the full **PowerWorld Network Data Filepath (.pwb format)**, or click **Browse** to select from your directory. Refer to GeoIT_file_formats.docx for details on the required file format.
- **Geoelectric Field Input (Select One)** Check one of the following options:
  - **E-field From B3D File Saved Internally by the GeoIT GUI B2ECalc Module** uses the B3D file path specified in the Save E-field field of the B2ECalc input window.
  - **External B3D file path**: Allows use of externally computed E-field data.
- **Time Range Input** Specify the time range for which GICs are to be calculated:
  - **Start Time (sec), End Time (sec)** and **Time Step (sec)**
- **Save Results (Optional):** Check the **Save GIC results** box to save the output in pickle (.pkl) format. Enter the full path to the output file or click **Browse** to select a location. Refer to GeoIT_file_formats.docx for details on the output format.
- Controls Buttons:
  - **Reset Values**: Clears all input fields.
  - **Load Input**: Loads the input into the tool's working memory.
  - **Close**: Closes the input window.



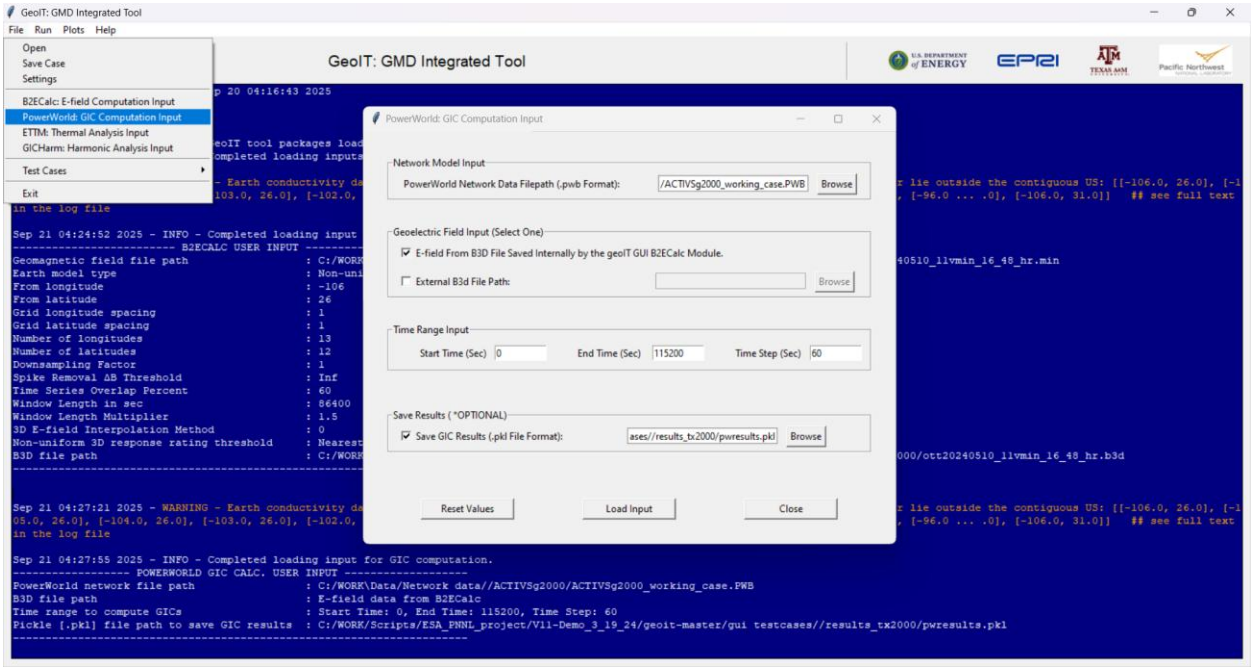
6.0 File → PowerWorld: GIC Computation Input

To configure and run GIC computations using the PowerWorld module follow the steps below:

- Navigate to **File → PowerWorld: GIC Computation Input** to open the input window.

Input Fields:

- **Network Model Input:** Enter the full **PowerWorld Network Data Filepath (.pwb format)**, or click **Browse** to select from your directory. Refer to GeoIT_file_formats.docx for details on the required file format.
- **Geoelectric Field Input (Select One)** Check one of the following options:
  - **E-field From B3D File Saved Internally by the GeoIT GUI B2ECalc Module** uses the B3D file path specified in the Save E-field field of the B2ECalc input window.
  - **External B3D file path**: Allows use of externally computed E-field data.
- **Time Range Input** Specify the time range for which GICs are to be calculated:
  - **Start Time (sec), End Time (sec)** and **Time Step (sec)**
- **Save Results (Optional):** Check the **Save GIC results** box to save the output in pickle (.pkl) format. Enter the full path to the output file or click **Browse** to select a location. Refer to GeoIT_file_formats.docx for details on the output format.
- Controls Buttons:
  - **Reset Values**: Clears all input fields.
  - **Load Input**: Loads the input into the tool's working memory.
  - **Close**: Closes the input window.



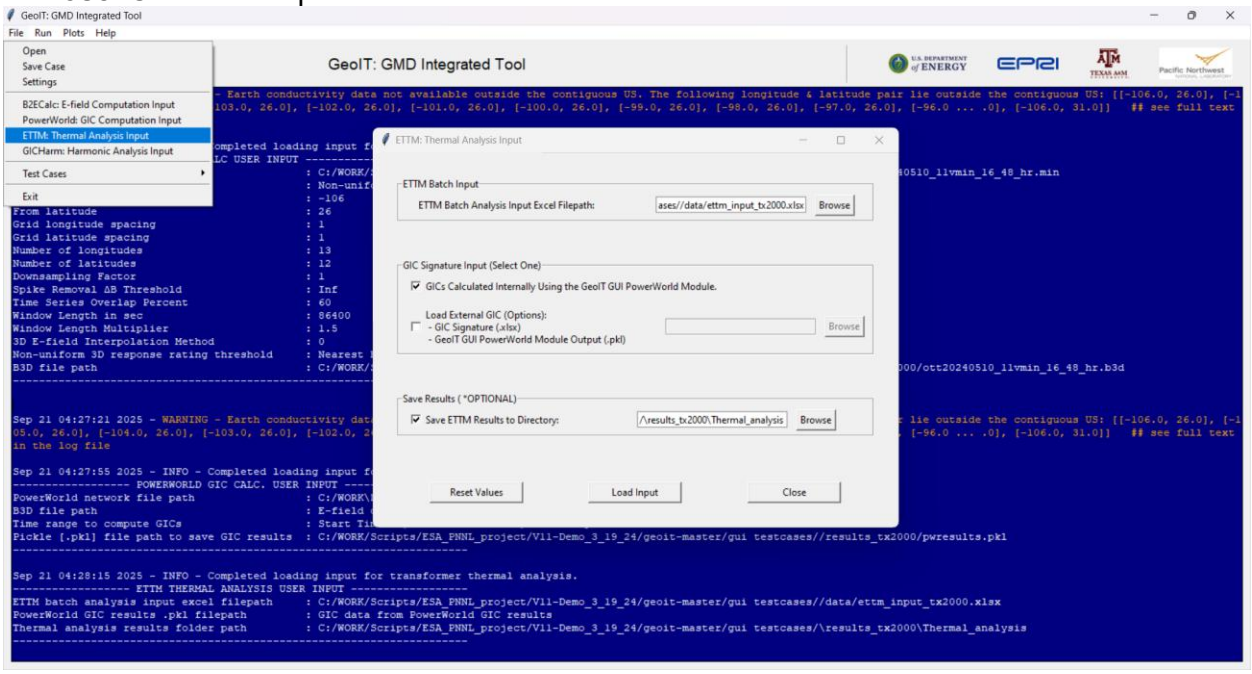
7.0 File → ETTM: Thermal Analysis Input

To configure and run transformer thermal analysis using the ETTM module follow the steps below:

- Navigate to **File → ETTM: Thermal Analysis Input** to open the input window

Input Fields:

- **ETTM Batch Input**: Enter the path to the ETTM batch analysis input Excel file, or click **Browse** to select from your directory. Refer to GeoIT_file_formats.docx for details on the required file format.
- **GIC Signature Input (Select One):** Check one of the following options:
  - **GICs Calculated Internally Using the GeoIT GUI PowerWorld Module** uses GIC data stored in the tool's working memory from the PowerWorld module.
  - **Load External GIC (Options):**
    - **GIC Signature (.xlsx)**: Enter the path to the external GIC signature Excel file or click **Browse**.
    - **GeoIT GUI PowerWorld Module Output (.pkl)**: Enter the path to the previously saved PowerWorld results pickle file or click **Browse**.
- **Save Results (Optional):** Check the **Save ETTM Results to Directory** box to save all output files to a folder. Enter the folder path or click **Browse** to select the destination. Refer to GeoIT_file_formats.docx for details on the output file formats.
- Control buttons:
- **Reset Values**: Clears all input fields.
- **Load Input**: Loads the input into the tool's working memory.
- **Close**: Closes the input window.



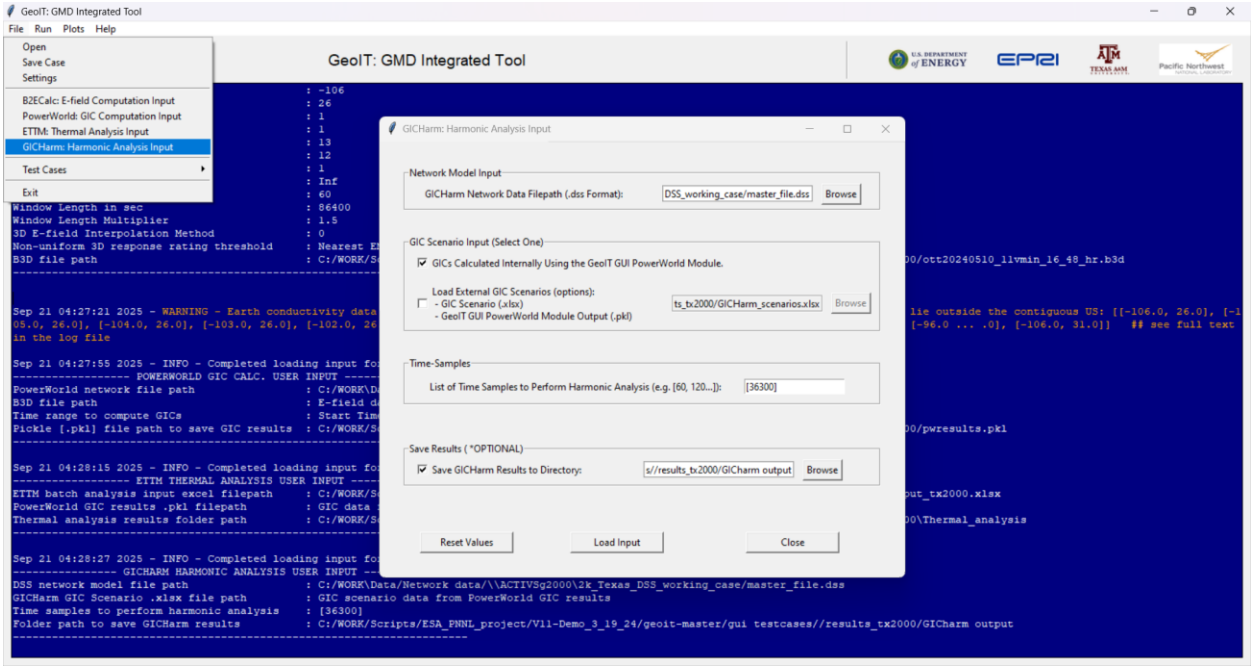
8.0 File → GICHarm: Harmonic Analysis Input

To configure and run harmonic analysis using the GICHarm module follow the steps below:

- Navigate to File → GICHarm: Harmonic Analysis Input to open the input window

Input Fields:

- **Network Model Input**: Enter the path to the network model file in .dss format, or click **Browse** to select from your directory. Refer to GeoIT_file_formats.docx for details on the required file format.
- **GIC Scenario Input (Select One):** Check one of the following options:
  - **GICs Calculated Internally Using the GeoIT GUI PowerWorld Module** uses GIC data stored in the tool's working memory from the PowerWorld module.
  - **Load External GIC (Options):**
    - **GIC Scenario (.xlsx)**: Enter the path to the external GIC scenario Excel file or click **Browse**.
    - **GeoIT GUI PowerWorld Module Output (.pkl)**: Enter the path to the previously saved PowerWorld results pickle file or click **Browse**.
- **Time Samples**: Enter a comma-separated list of time samples for which harmonic analysis is to be performed. This field is not required if a GIC scenario Excel file is selected.
- **Save Results (Optional)**: Check the **Save GICHarm Results to Directory** box to save all output files to a folder. Enter the folder path or click **Browse** to select the destination. Refer to GeoIT_file_formats.docx for details on the output file formats.
- Control buttons:
  - **Reset Values**: Clears all input fields.
  - **Load Input**: Loads the input into the tool's working memory.
  - **Close**: Closes the input window.

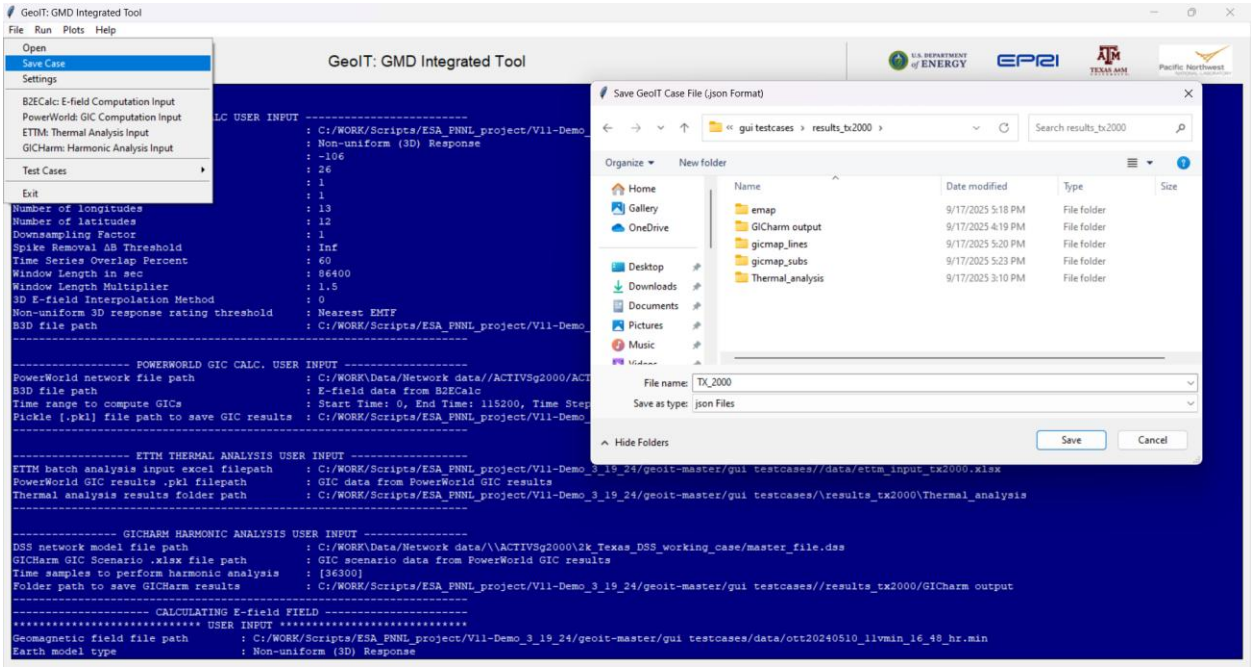

GeoIT: GMD Integrated Tool
File Run Plots Help
Open
Save Case
Settings
B2ECalc: E-field Computation Input
PowerWorld: GIC Computation Input
ETTM: Thermal Analysis Input
GICHarm: Harmonic Analysis Input
Test Cases
Exit
GeoIT: GMD Integrated Tool
GICHarm: Harmonic Analysis Input
Network Model Input
GICHarm Network Data Filepath (.dss Format):
DSS_working_case/master_file.dss
Browse
GIC Scenario Input (Select One)
GICs Calculated Internally Using the GeoIT GUI PowerWorld Module.
Load External GIC Scenarios (options):
- GIC Scenario (.xlsx)
- GeoIT GUI PowerWorld Module Output (.pkl)
ts_tx2000/GICHarm_scenarios.xlsx
Browse
Time-Samples
List of Time Samples to Perform Harmonic Analysis (e.g. [60, 120...]):
[36300]
Save Results (*OPTIONAL)
Save GICHarm Results to Directory:
s//results_tx2000/GICharm output
Browse
Reset Values
Load Input
Close

9.0 File → Save Case

This option allows users to save all input fields from every input window into a single JSON file.

Steps to Save a Case:

- Click **File → Save Case** to open the **Save GeoIT Case File** window. Enter a file name in the entry box.
- Click **Save** to store the case configuration. Refer to GeoIT_file_formats.docx for details on the JSON file format.

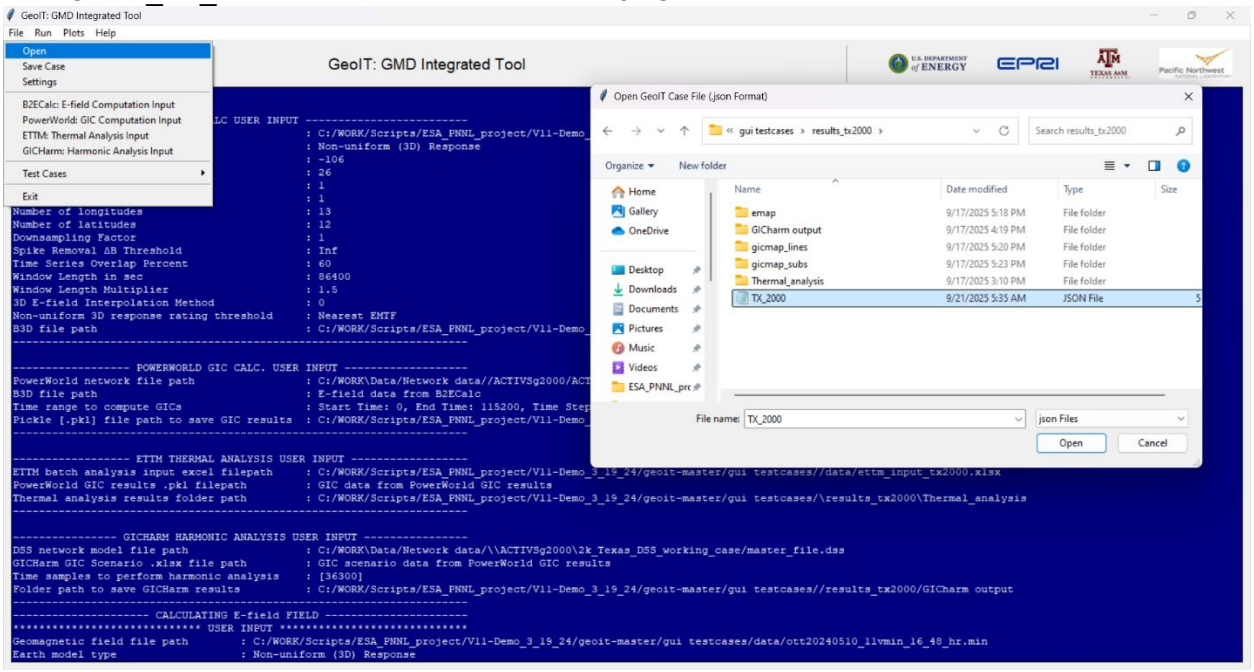


10.0 File → Open Case

This option allows users to load a previously saved JSON file to automatically populate all input fields across the tool input windows.

Steps to Open a Case:

- Click File → Open Case to open the Open GeoIT Case File window.
- Select a previously saved JSON file from your directory.
- Click Open to load the case configuration into all input windows. Refer to GeoIT_file_formats.docx for details on the JSON file format.



11.0 Run → GMD Analysis

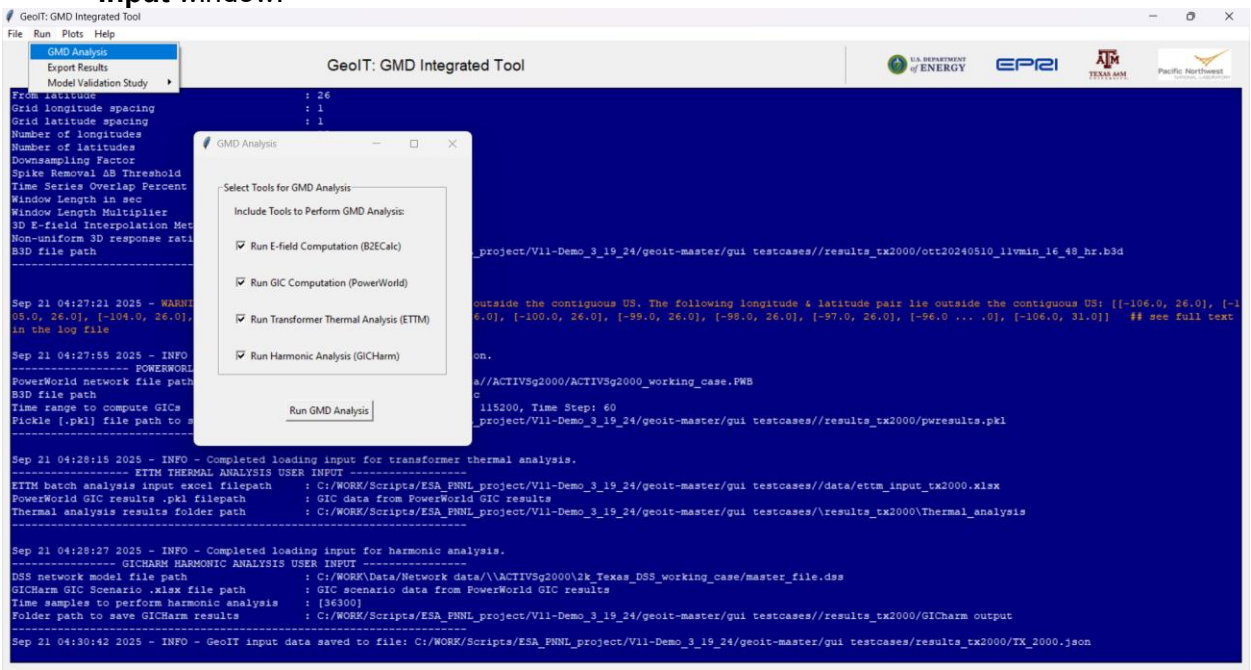
This feature allows users to perform a GMD analysis in sequence by selecting individual tool modules.

Steps to Run GMD Analysis:

- Click **Run → GMD Analysis** to open the GMD Analysis window.
- In the window, check the boxes for the tools you want to include in the analysis:
  - **Run E-field Computation**
  - **Run GIC Computation**
  - **Run Transformer Thermal Analysis**
  - **Run Harmonic Analysis**
- Click **Run GMD Analysis** to begin the computation.

Notes and Dependencies:

- If Run GIC Computation is checked but Run E-field Computation is unchecked:
  - You must provide an external B3D input file in the **PowerWorld: GIC Computation Input** window.
- If Run Transformer Thermal Analysis is checked but Run GIC Computation is unchecked:
  - You must load an external GIC input file in the **ETTM: Thermal Analysis Input** window.
- If Run Harmonic Analysis is checked but Run GIC Computation is unchecked:
  - You must load an external GIC input file in the **GICHarm: Harmonic Analysis Input** window.



12.0 Autosaved Results

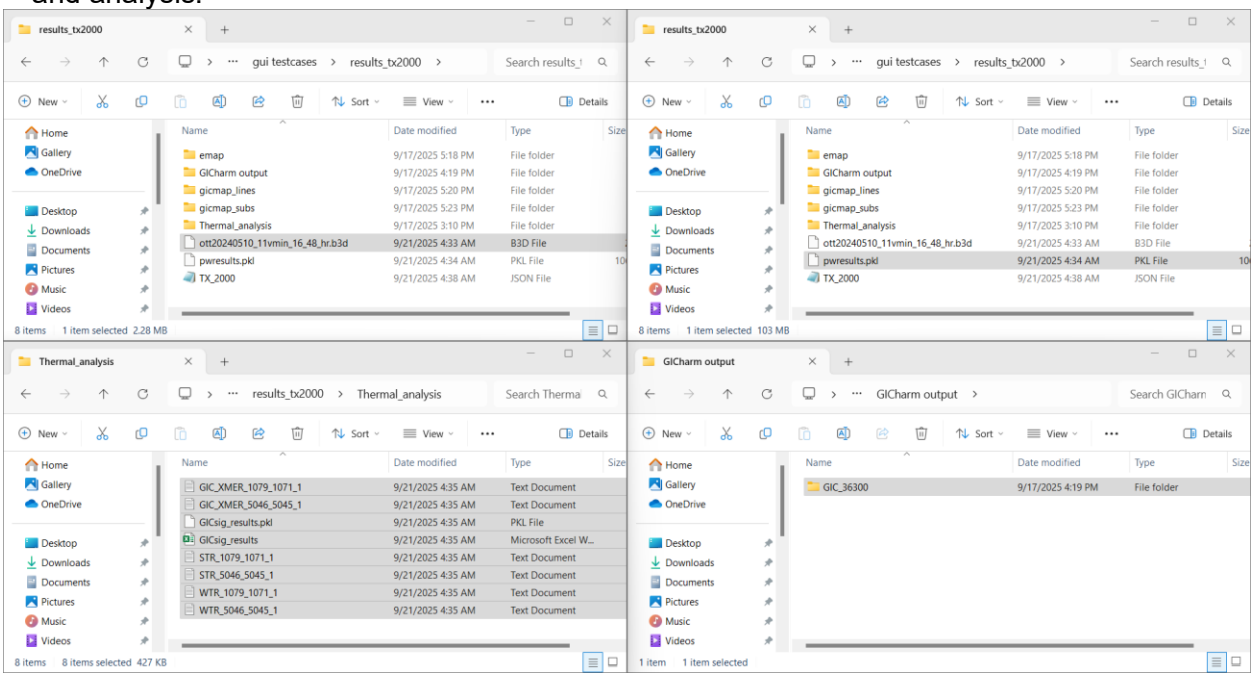
Each tool saves its results in directories specified in their respective input windows.

The screenshot referenced shows the following:

- Top-left: B3D output file generated using the **B2ECalc** module.
- Top-right: Pickle (.pkl) output file generated using the **GeoIT PowerWorld** module.
- Bottom-left: Thermal analysis output files generated using **ETTM**.
- Bottom-right: Harmonic analysis results folder generated using **GICHarm**.

Viewing Results in Excel Format:

- To view results from all tools in Excel format: Use the **Run** → **Export Result** option. The Excel files generated using **Export Result** are intended for viewing only. They cannot be used as input for subsequent tool runs.
- Performance Consideration**:** The file formats autosaved directly by each tool (e.g., B3D, .pkl) are optimized for computation speed. The Excel exports are optimized for human readability and analysis.



13.0 Run → Export Results

This feature allows users to export results from each tool in Excel format for easy viewing and analysis.

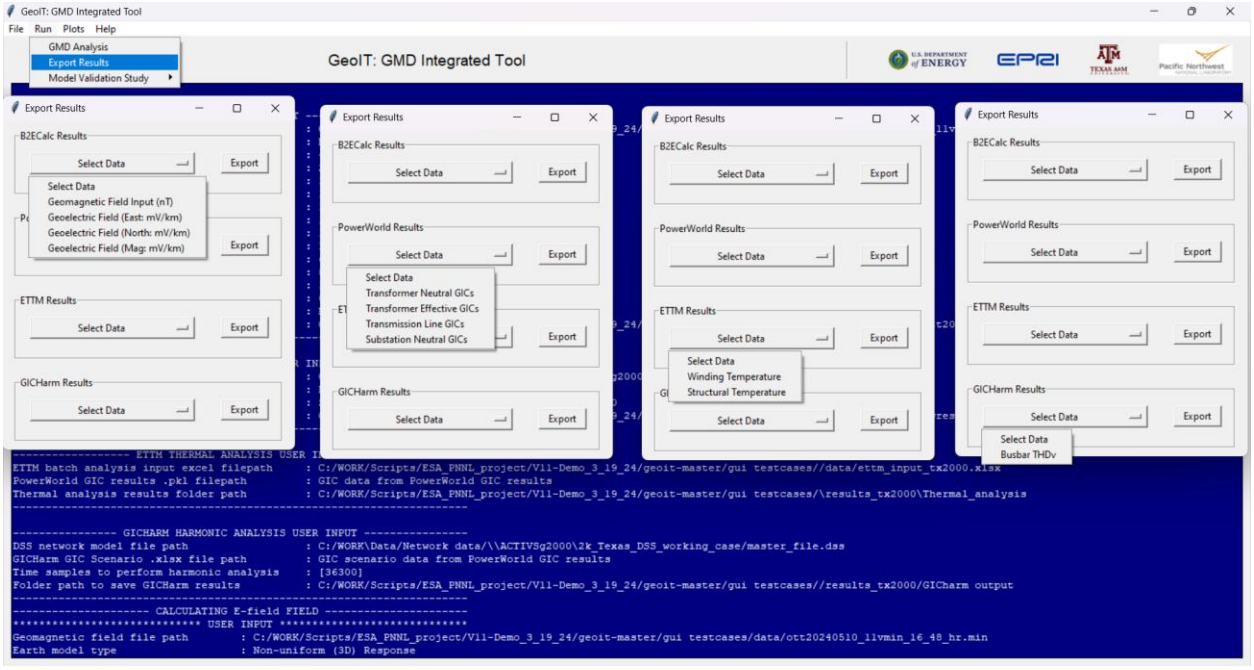
Steps to Export Results:

- Click Run → Export Result to open the Export Result window.
- Select the desired result type from the dropdown menu corresponding to each tool.
- Click Export to generate Excel files.

Available Export Options

- B2ECalc Results
  - **Geomagnetic Field Input (nT)**
  - **Geoelectric Field (East: mV/km)**
  - **Geoelectric Field (North: mV/km)**
  - **Geoelectric Field (Mag: mV/km)**
- PowerWorld Results
  - **Transformer Neutral GICs**
  - **Transformer Effective GICs**
  - **Transmission Line GICs**
  - **Substation Neutral GICs**
- ETTM Results: Winding Temperature and Structural Temperature
- GICHarm Results: Busbar THDv

Note: The Excel results generated here are intended for viewing only. They cannot be used as input for subsequent tool runs. Computation-optimized formats (e.g., B3D, .pkl) are saved automatically in respective directories based on respective tool inputs.

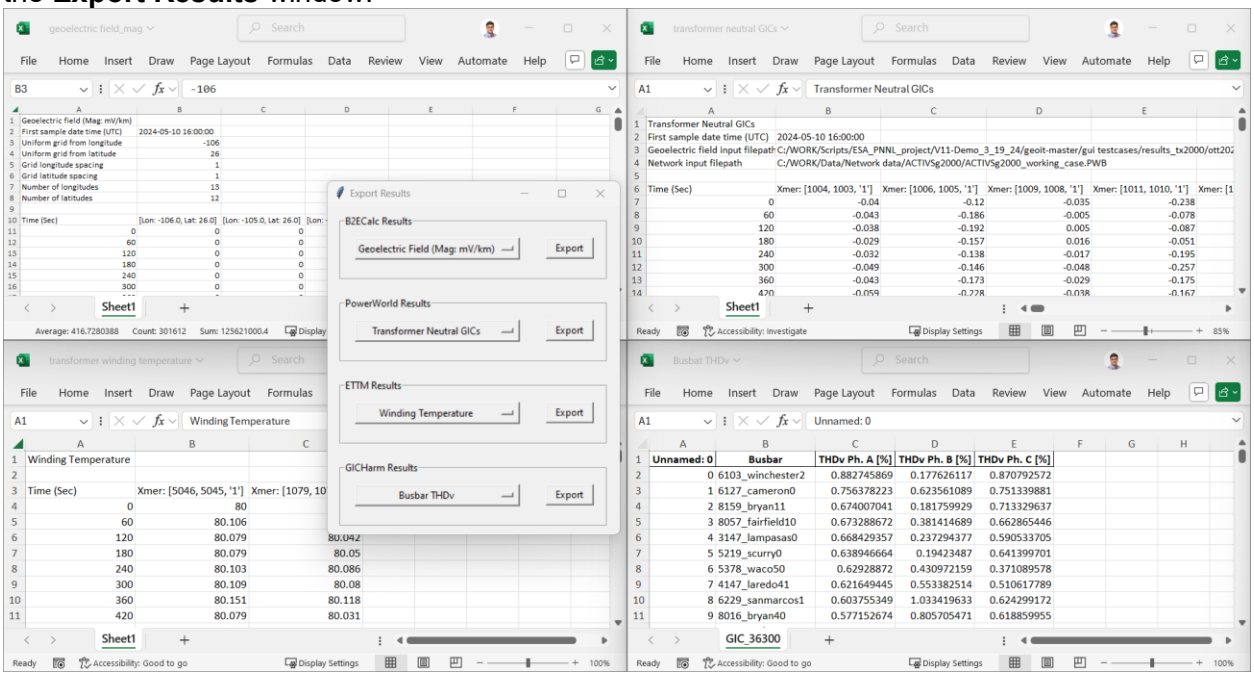

GeoIT: GMD Integrated Tool
File Run Plots Help
GMD Analysis
Export Results
Model Validation Study
GeoIT: GMD Integrated Tool
Export Results
B2ECalc Results
Select Data
Export
Select Data
Geomagnetic Field Input (nT)
Geoelectric Field (East: mV/km)
Geoelectric Field (North: mV/km)
Geoelectric Field (Mag: mV/km)
ETTM Results
GICHarm Results
PowerWorld Results
Transformer Neutral GICs
Transformer Effective GICs
Transmission Line GICs
Substation Neutral GICs
Winding Temperature
Structural Temperature
Busbar THDv
ETTM batch analysis input excel filepath : C:/WORK/Scripts/ESA_PNNL_project/V11-Demo_3_19_24/geoit-master/gui testcases//data/ettm_input_tx2000.xlsx
PowerWorld GIC results .pkl filepath : GIC data from PowerWorld GIC results
Thermal analysis results folder path : C:/WORK/Scripts/ESA_PNNL_project/V11-Demo_3_19_24/geoit-master/gui testcases/\results_tx2000\Thermal_analysis
GICHARM HARMONIC ANALYSIS USER INPUT
DSS network model file path : C:/WORK\Data/Network data/\\ACTIVSg2000\2k_Texas_DSS_working_case/master_file.dss
GICHarm GIC Scenario .xlsx file path : GIC scenario data from PowerWorld GIC results
Time samples to perform harmonic analysis : [36300]
Folder path to save GICHarm results : C:/WORK/Scripts/ESA_PNNL_project/V11-Demo_3_19_24/geoit-master/gui testcases//results_tx2000/GICharm output
CALCULATING E-field FIELD
USER INPUT
Geomagnetic field file path : C:/WORK/Scripts/ESA_PNNL_project/V11-Demo_3_19_24/geoit-master/gui testcases/data/ott20240510_11vmin_16_48_hr.min
Earth model type : Non-uniform (3D) Response

13.0 Run → Export Results (Example)

This section illustrates how to use the Export Results feature with a practical example.
Example Workflow:

- Open the **Export Results** window by clicking **Run** → **Export Result**.
- From the dropdown menus, select one or more result types from any of the available tools.
  Example Selections (as shown in the screenshot):
  - **Geoelectric Field (Mag: mV/km)** — from B2ECalc
  - **Transformer Neutral GICs** — from PowerWorld
  - **Winding Temperature** — from ETTM
  - **Busbar THDv** — from GICHarm
- Click Export to generate the corresponding Excel files.

The screenshot shows the Excel files generated using the above selections displayed behind the **Export Results** window.



14.0 Plots → Time-Series Plots

This feature allows users to generate time-series plots for various output variables from each tool*.

Steps to access are as below:

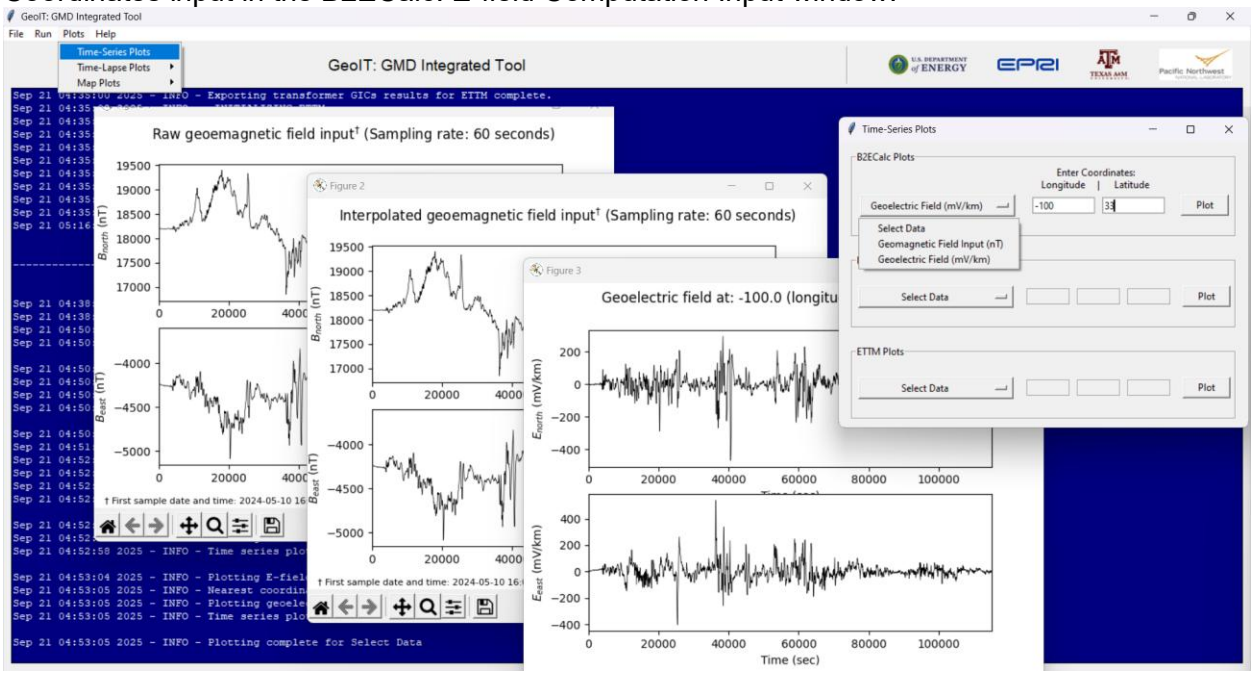
- Click Plots → Time-Series Plots to open the Time-Series Plots input window.

B2ECalc Plots: From the dropdown menu, select one of the following options:

- Geomagnetic Field Input (nT):
  - Click Plot to generate the time-series plot.
- Geoelectric Field (mV/km):
  - Enter the **Longitude** and **Latitude** of the location** for which the E-field must be plotted.
  - Click Plot.

* Exception is GICHarm which does not produce time-series results

** The selected coordinate must lie within the region defined by the Geographic Coordinates input in the B2ECalc: E-field Computation Input window.



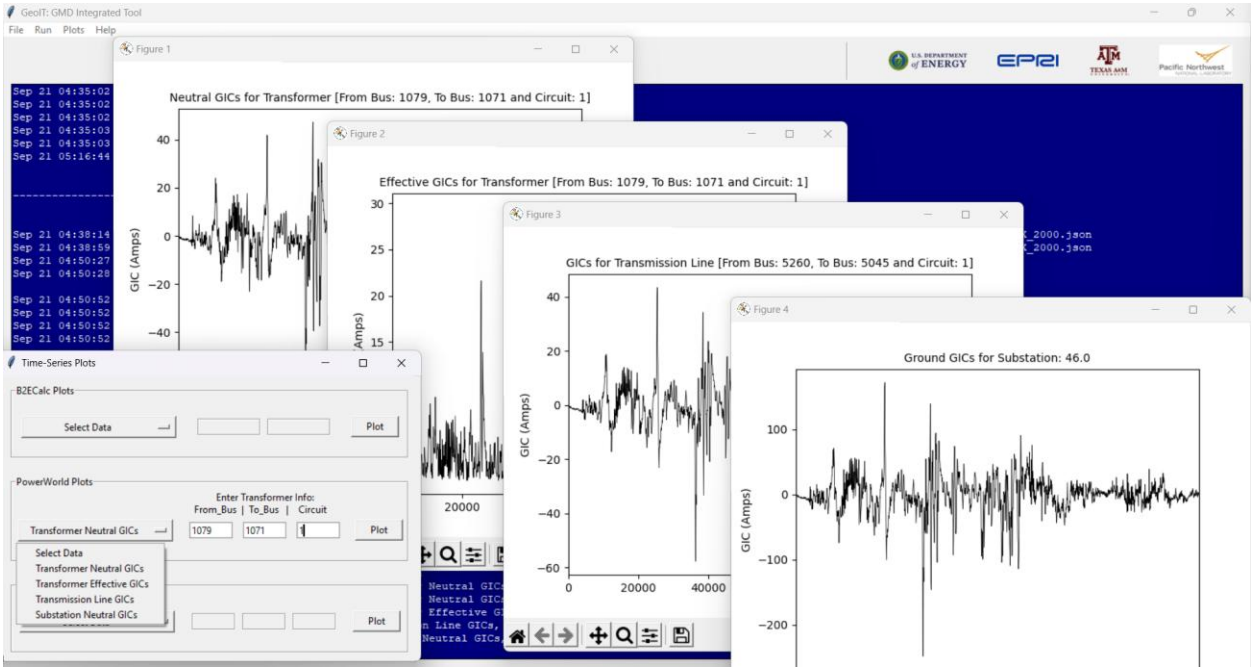
14.0 Plots → Time-Series Plots (Continued)

PowerWorld Plots: From the dropdown menu, select one of the following options:

- **Transformer Neutral GICs:** Enter transformer **From Bus*, To bus*** and **Circuit***
- **Transformer Effective GICs**: Enter transformer From **Bus*, To bus*** and **Circuit***
- **Transmission Line GICs**: Enter line From **Bus*, To bus*** and **Circuit***
- **Substation Neutral GICs**: Enter **Substation Number*.**

Click Plot to generate the time-series visualization.

* Use the PowerWorld Simulator **Model Explorer** to obtain all necessary network component information.



14.0 Plots → Time-Series Plots (Continued)

ETTM Plots: From the dropdown menu, select one of the following options:

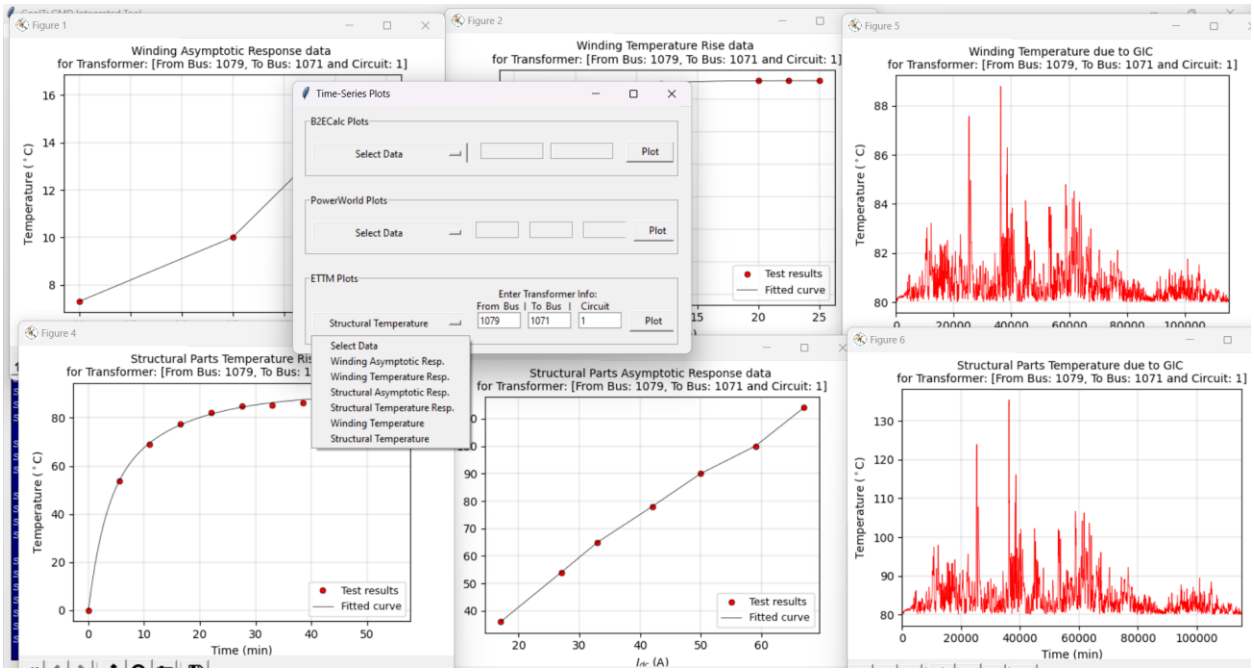
- **Winding Asymptotic Response**
- **Winding Temperature Response**
- **Structural Asymptotic Response**
- **Structural Temperature Response**
- **Winding Temperature**
- **Structural Temperature**

Then enter:

- From Bus*, To Bus*, Circuit*

Click **Plot** to generate the time-series visualization.

* Use the PowerWorld Simulator Model Explorer to obtain transformer identifiers.



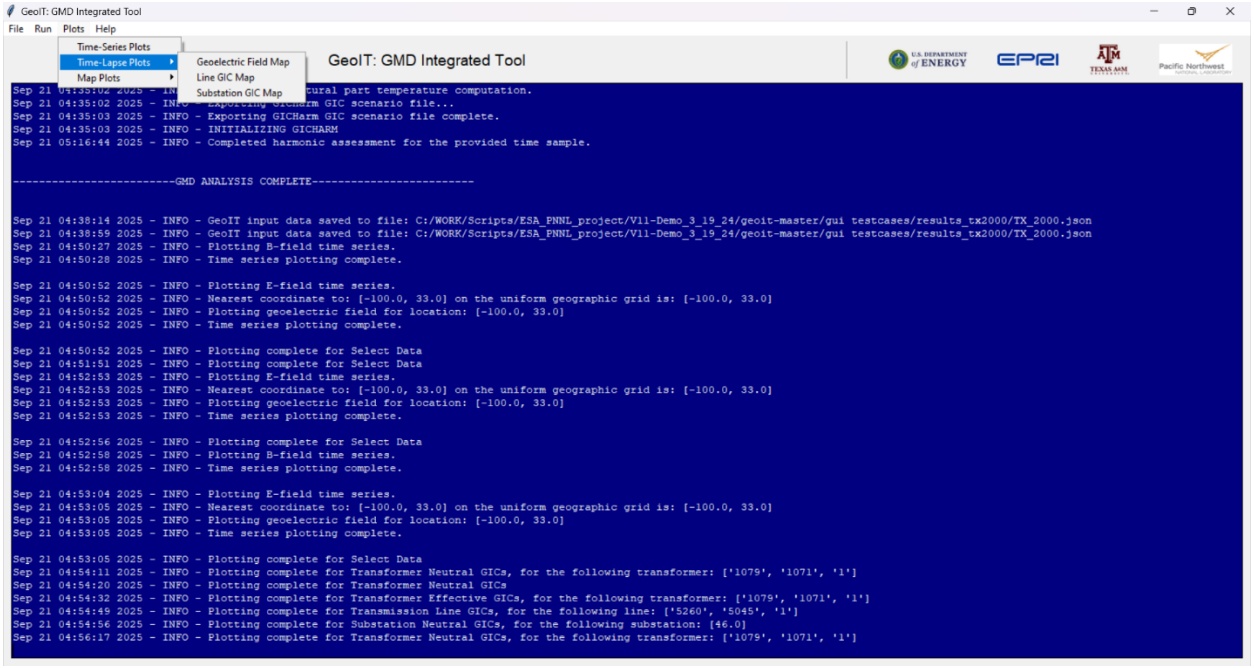
15.0 Plots → Time-Lapse Plots

This feature enables visualization of output variables that change both spatially and temporally across the U.S. map.

Accessing Time-Lapse Plot Options: Click on **Plots** → **Time-Lapse Plots** to view the available options:

- Geoelectric Field Map
- Line GIC Map
- Substation GIC Map

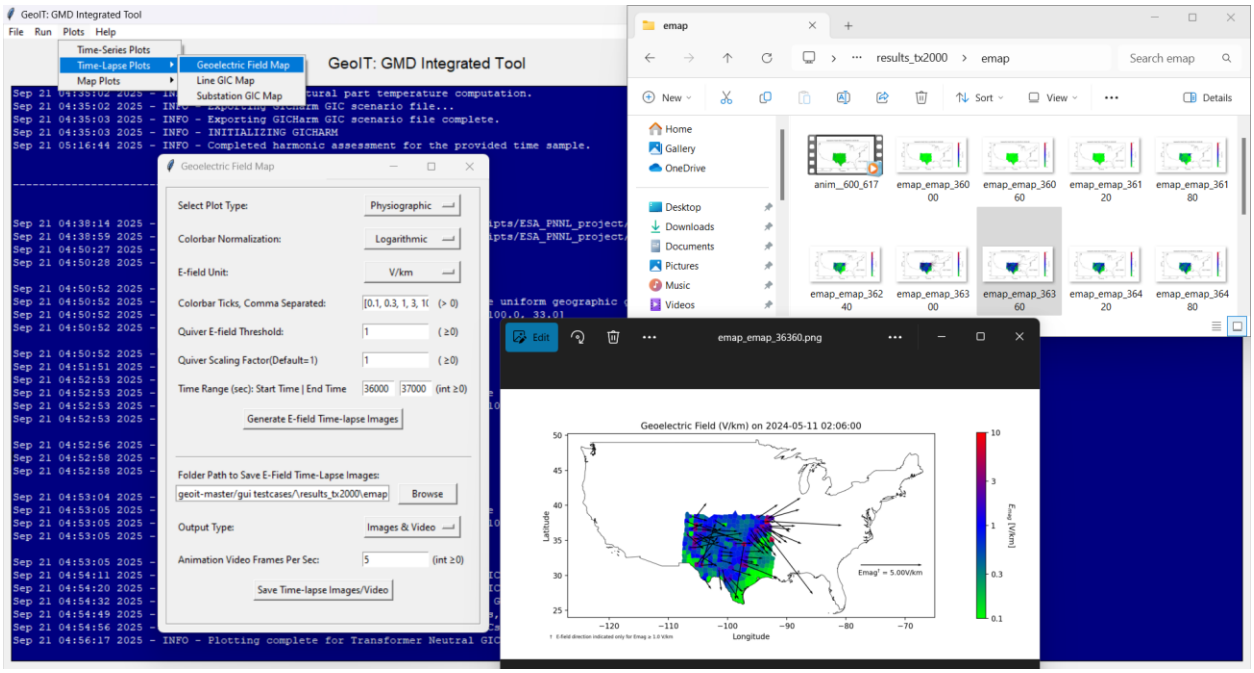
Each of these options opens a dedicated input window with specific configuration settings.

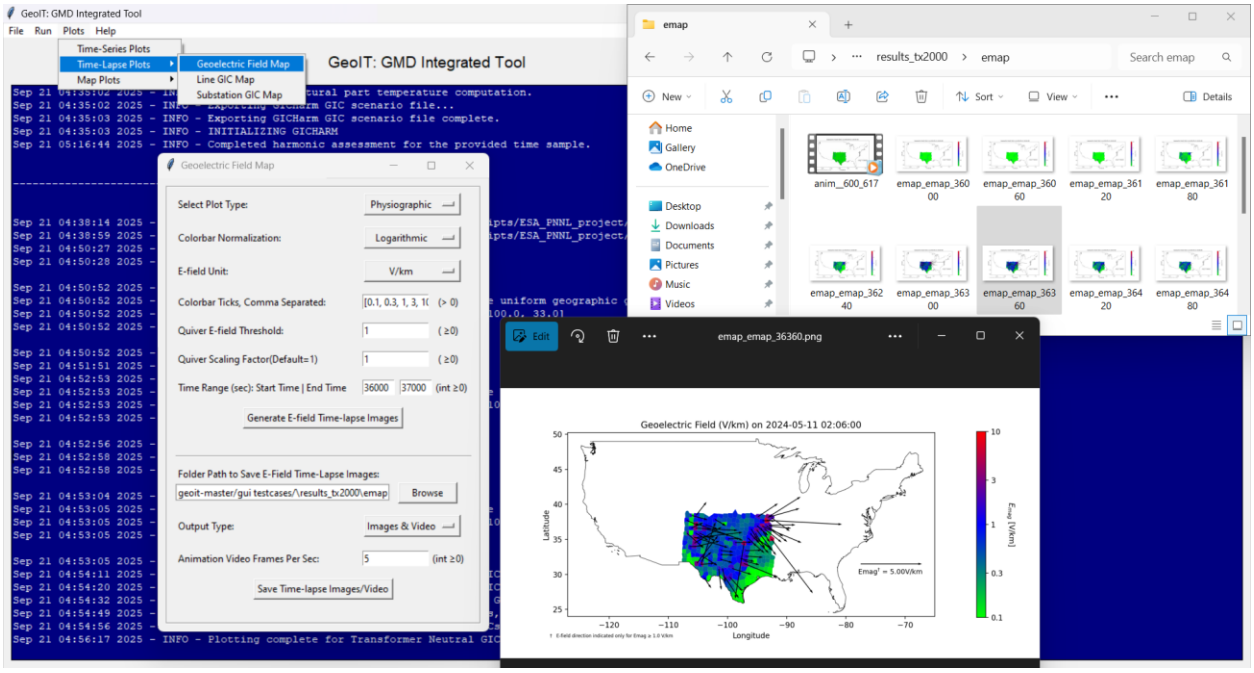


16.0 Plots → Time-Lapse Plots → Geoelectric Field Map

Click on **Plots** → **Time-Lapse Plots** → **Geoelectric Field Map** to open the input window.
In this map plot, each region is color-coded by field magnitude, with quivers indicating field direction.
The input options are described below:

- Select Plot Type:
  - **Physiographic**: Plots the geoelectric field map for each physiographic region.
  - **Uniform Grid**: Plots the geoelectric field map using the E-field values at each uniform grid location.
- Colorbar Normalization:
  - **Logarithmic**: Color changes based on the logarithm of the field value.
  - **Linear**: Color changes linearly with field value.
- **E-field Unit**: Choose between **mV/km** or **V/km**.
- **Colorbar Ticks, Comma separated**: Enter a list of E-field values to define the colorbar ticks.
- **Quiver E-field Threshold**: Minimum field value required to display direction quivers.
- **Quiver Scaling Factor**: Float value to adjust the size of quivers.
- **Time Range, [Start Time, End Time]**: Specify the time window for plotting.
- **Generate E-field Time-lapse Images**: Click to generate the images.
- **Folder Path to Save E-field Time-Lapse Images**: Click **Browse** to select the save location.
- **Output Type**: Choose to generate **Images**, **Video**, or **Both**.
- **Animation Video Frames Per Sec**: Set the frame rate for video animation.
- **Save Time-lapse Images/Video**: Click to save the generated output.


GeoIT: GMD Integrated Tool
File Run Plots Help
Time-Series Plots
Time-Lapse Plots
Map Plots
Geoelectric Field Map
Line GIC Map
Substation GIC Map
GeoIT: GMD Integrated Tool
Geoelectric Field Map
Select Plot Type:
Physiographic
Colorbar Normalization:
Logarithmic
E-field Unit:
V/km
Colorbar Ticks, Comma Separated:
[0.1, 0.3, 1, 3, 1(
(> 0)
Quiver E-field Threshold:
1
(≥0)
Quiver Scaling Factor(Default=1)
1
(≥0)
Time Range (sec): Start Time | End Time
36000
37000
(int ≥0)
Generate E-field Time-lapse Images
Folder Path to Save E-Field Time-Lapse Images:
geoit-master/gui testcases/\results_tx2000\emap
Browse
Output Type:
Images & Video
Animation Video Frames Per Sec:
5
(int ≥0)
Save Time-lapse Images/Video
Sep 21 04:35:02 2025 - INFO - Exporting GICHarm GIC scenario file...
Sep 21 04:35:03 2025 - INFO - Exporting GICHarm GIC scenario file complete.
Sep 21 04:35:03 2025 - INFO - INITIALIZING GICHARM
Sep 21 05:16:44 2025 - INFO - Completed harmonic assessment for the provided time sample.
Sep 21 04:56:17 2025 - INFO - Plotting complete for Transformer Neutral GIC
emap
results_tx2000 › emap
Search emap
New
Sort
View
Details
Home
Gallery
OneDrive
Desktop
Downloads
Documents
Pictures
Music
Videos
anim__600_617
emap_emap_36000
emap_emap_36060
emap_emap_36120
emap_emap_36180
emap_emap_36240
emap_emap_36300
emap_emap_36360
emap_emap_36420
emap_emap_36480
Edit
emap_emap_36360.png
Geoelectric Field (V/km) on 2024-05-11 02:06:00
Latitude
Longitude
Emag = 5.00V/km
Emag [V/km]


GeoIT: GMD Integrated Tool
File Run Plots Help
Time-Series Plots
Time-Lapse Plots
Map Plots
Geoelectric Field Map
Line GIC Map
Substation GIC Map
GeoIT: GMD Integrated Tool
Geoelectric Field Map
Select Plot Type:
Physiographic
Colorbar Normalization:
Logarithmic
E-field Unit:
V/km
Colorbar Ticks, Comma Separated:
[0.1, 0.3, 1, 3, 1(
(> 0)
Quiver E-field Threshold:
1
(≥0)
Quiver Scaling Factor(Default=1)
1
(≥0)
Time Range (sec): Start Time | End Time
36000
37000
(int ≥0)
Generate E-field Time-lapse Images
Folder Path to Save E-Field Time-Lapse Images:
geoit-master/gui testcases/\results_tx2000\emap
Browse
Output Type:
Images & Video
Animation Video Frames Per Sec:
5
(int ≥0)
Save Time-lapse Images/Video
Sep 21 04:35:02 2025 - INFO - Exporting GICHarm GIC scenario file...
Sep 21 04:35:03 2025 - INFO - Exporting GICHarm GIC scenario file complete.
Sep 21 04:35:03 2025 - INFO - INITIALIZING GICHARM
Sep 21 05:16:44 2025 - INFO - Completed harmonic assessment for the provided time sample.
Sep 21 04:56:17 2025 - INFO - Plotting complete for Transformer Neutral GIC
emap
results_tx2000 › emap
Search emap
New
Sort
View
Details
Home
Gallery
OneDrive
Desktop
Downloads
Documents
Pictures
Music
Videos
anim__600_617
emap_emap_36000
emap_emap_36060
emap_emap_36120
emap_emap_36180
emap_emap_36240
emap_emap_36300
emap_emap_36360
emap_emap_36420
emap_emap_36480
Edit
emap_emap_36360.png
Geoelectric Field (V/km) on 2024-05-11 02:06:00
Latitude
Longitude
Emag = 5.00V/km
Emag [V/km]

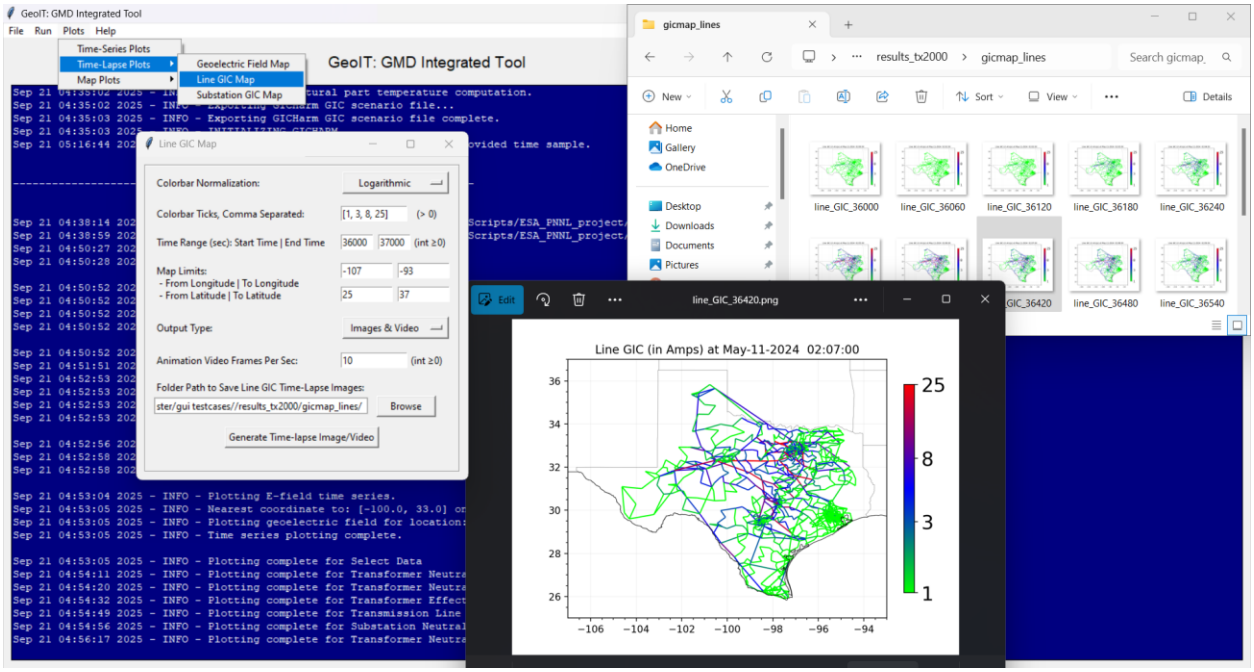
17.0 Plots → Time-Lapse Plots → Line GIC Map

Click on Plots → Time-Lapse Plots → Line GIC Map to open the input window.

This feature visualizes the magnitude of GICs (Geomagnetically Induced Currents) in transmission lines over time using a color-coded map.

Input Options:

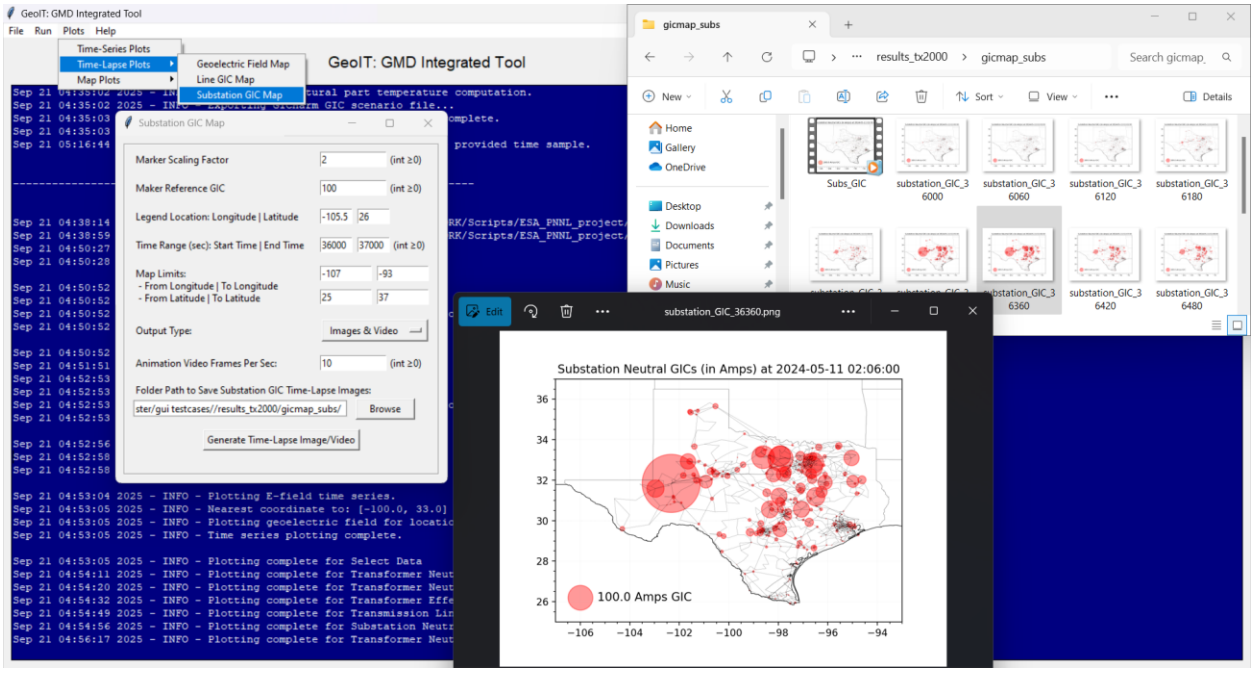
- Colorbar Normalization:
  - **Logarithmic**: Colors change based on the logarithm of the GIC value.
  - **Linear**: Colors change linearly with GIC magnitude.
- **Colorbar Ticks, Comma Separated**: Enter a list of comma-separated GIC values to define the tick marks on the colorbar.
- **Time Range [Start Time, End Time]**: Specify the time window for which the map should be plotted.
- **Map Limits**: Define the plotting window on the US map by entering: **From Longitude, To Longitude, From Latitude** and **To Latitude**
- **Output Type**: Choose to generate **Images**, **Video**, or **Both**.
- **Animation Video Frames Per Sec**: Set the frame rate for video animation.
- **Folder Path to Save Line GIC Time-Lapse Images**: Click **Browse** to select the folder where the time-lapse images or video will be saved.
- **Generate Time-lapse Images/Video**: Click to save the generated output.



Plots → Time-Lapse Plots → Substation GIC Map

Click on **Plots** → **Time-Lapse Plots** → **Substation GIC Map** to open the input window.
This feature visualizes the magnitude of GICs at substations over time using red circle markers. The size of each circle represents the GIC magnitude.
Input Options:

- **Marker Scaling Factor:** A multiplier to scale the size of all circle markers in the plot.
- **Marker Reference GIC:** A reference GIC value used to define the legend marker size.
- **Legend Location:** Enter the **Longitude** and **Latitude** of the location where the legend should be displayed on the map.
- **Time Range [Start Time, End Time]:** Specify the time window for which the substation GIC map is to be plotted.
- **Map Limits**: Define the plotting window on the US map by entering: **From Longitude, To Longitude, From Latitude** and **To Latitude**
- **Output Type**: Choose to generate **Images**, **Video**, or **Both**.
- **Animation Video Frames Per Sec:** Set the frame rate for the video animation.
- **Folder Path to Save Substation GIC Time-Lapse Images:** Click **Browse** to select the folder where the time-lapse images or video will be saved.
- **Generate Time-lapse Images/Video:** Click to save the generated output.



18.0 Plots → Map Plots → E-field Coordinate Map

Click on Plots → Map Plots → E-field Coordinate Map to open the input window.

Plot Feature Options:

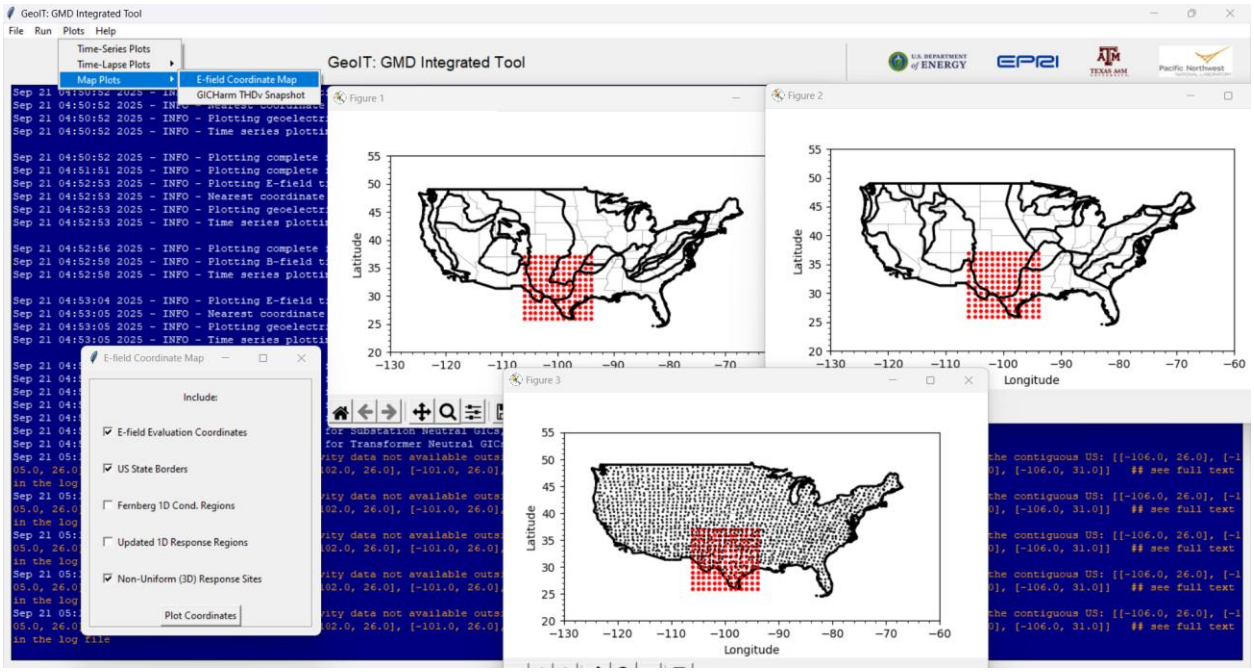
- This feature allows users to visualize the uniform grid of E-field evaluation coordinates on a map of the United States, along with optional overlays for geological and survey data.

Check the boxes to include the following features in the map plot:

- **E-field Evaluation Coordinates:** Plots the uniform grid of coordinates based on inputs provided in the **Geographic Coordinates** section of the **B2ECalc: E-field Computation Input** window.
- **U.S. State Borders:** Adds State boundary lines to the map for geographic context.
- **Fernberg 1-D Conductivity Regions:** Overlays the physiographic regions defined by the Fernberg 1D conductivity model.
- **Updated 1-D Response Regions:** Adds the updated 1-D ground response model physiographic regions to the map.
- **Non-uniform (3-D) Response Sites:** Displays all magnetotelluric survey station locations from the USArray, United States Magnetotelluric Array (USMTArray), and USMTArray-Conterminous United States (USMTArray-CONUS) projects. (updated April 2024).

Plotting the Map:

- After selecting the desired features, click the **Plot Coordinates** button to generate the map showing the uniform grid and overlays.



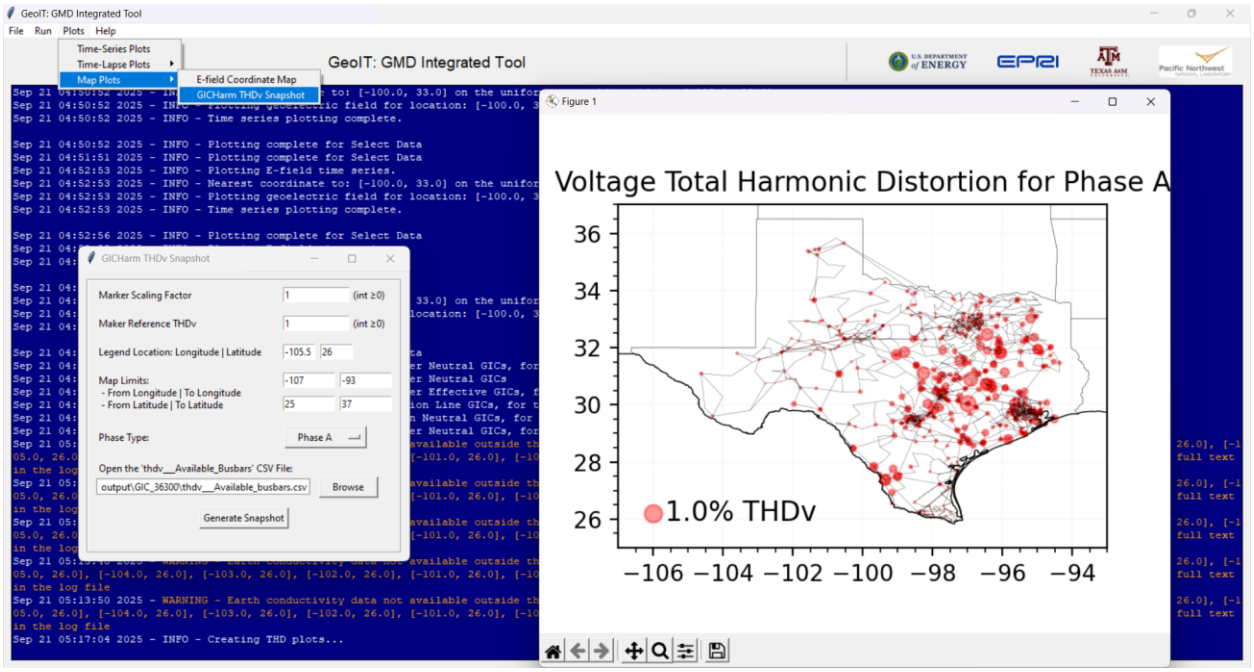
19.0 Plots → Map Plots → GICHarm THDv Snapshot

Click on **Plots** → **Map Plots** → **GICHarm THDv Snapshot** to open the input window.

This feature visualizes the Total Harmonic Distortion Voltage (THDv) at busbars using red circle markers. The size of each marker represents the magnitude of THDv.

Input Options:

- **Marker Scaling Factor:** A multiplier to scale the size of all circle markers in the plot.
- **Marker Reference THDv:** A reference THDv value used to define the legend marker size.
- Legend **Location:** Enter the **Longitude** and **Latitude** of the location where the legend should be displayed on the map.
- **Map Limits:** Define the plotting window on the US map by entering: **From Longitude, To Longitude, From Latitude** and **To Latitude**
- **Phase Type:** Select the phase (**A**, **B**, or **C**) for which the THDv is to be plotted.
- **Open the thdv___Available_Busbars.csv File:** Click **Browse** to select the CSV file containing THDv data for available busbars.
- **Generate Snapshot:** Click this button to display the THDv snapshot plot.



20.0 Plots → Model Validation Study → GIC Comparison

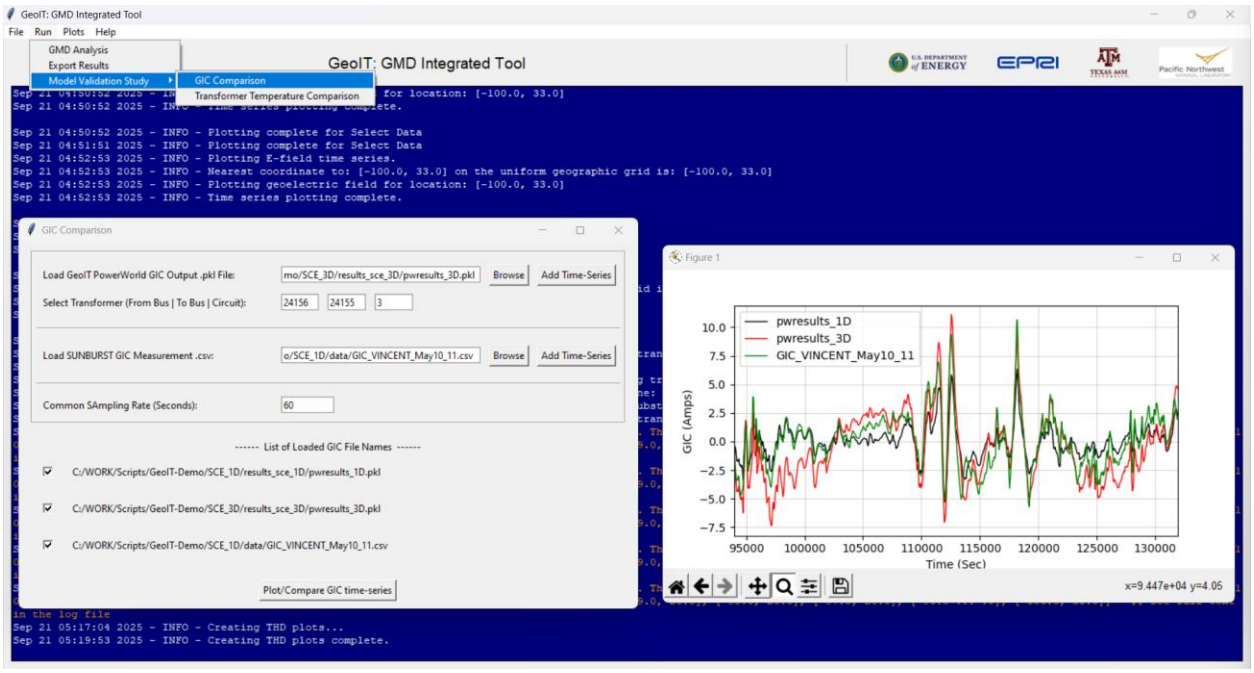
To open the input window, navigate to **Plots** → **Model Validation Study** → **GIC Comparison**.

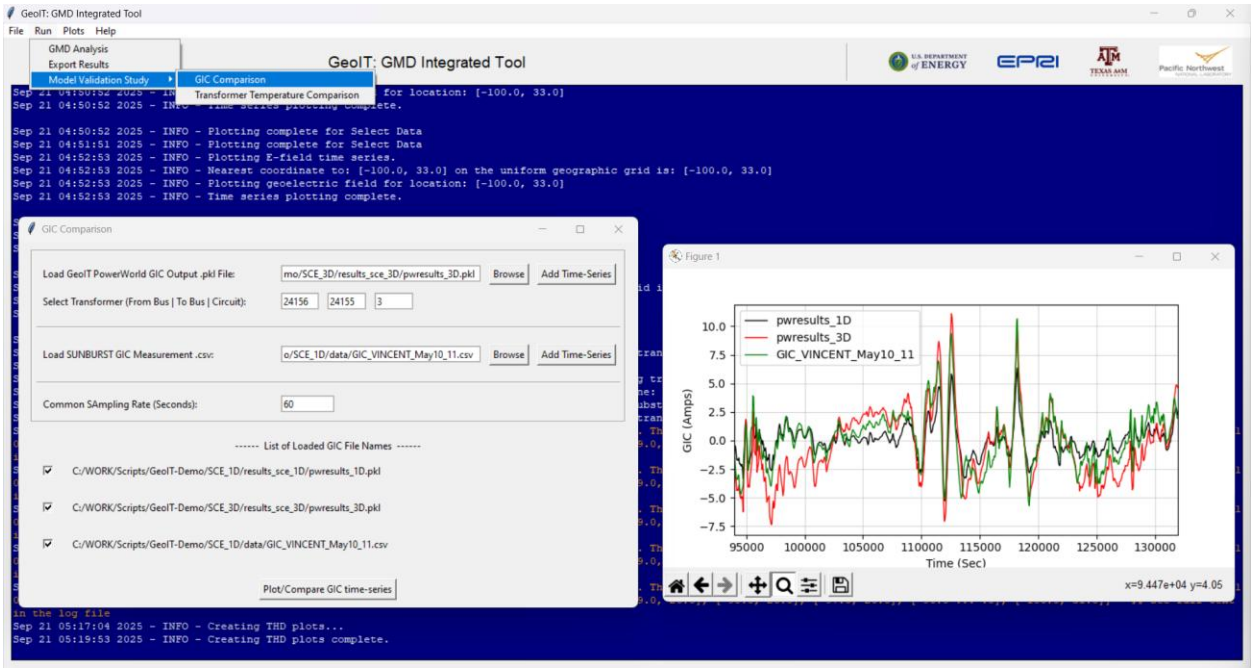
This feature allows users to compare calculated GICs with observed GIC data from the SUNBURST network.

Input Options:

- Load Calculated Transformer Neutral GICs:
  - **Browse for GeoIT PowerWorld GIC Output (.pkl)**: Click **Browse** to select the .pkl file containing GIC data generated by the PowerWorld module.
  - **Specify Transformer**: Enter the transformer identifiers: From Bus*, To Bus*, Circuit*.
  - **Add Time-Series**: Click this button to load the selected time series into the tool's working memory.
- Load Observed Transformer Neutral GICs:
  - **Load SUNBURST GIC Measurement .csv**: Click **Browse** to select the .csv file containing observed GIC data. Only the SUNBURST CSV format is supported. Data can be downloaded from: https://sunburst.epri.com/
  - **Add Time-Series**: Click this button to load the selected time series into the tool's working memory.
- Load multiple time-series by repeating above steps to load additional time-series data.
- Manage Loaded Time-Series: Use the **List of Loaded GIC File Names** at the bottom of the window to select or deselect time-series for comparison.
- Set **Common Sampling Rate (Seconds):** Enter a value to downsample all time-series to a common rate before comparison.
- **Plot/Compare GIC Time-Series:** Click this button to generate the comparison plot.

***** Use the PowerWorld Simulator Model Explorer to obtain transformer identifiers.


GeoIT: GMD Integrated Tool
File Run Plots Help
GMD Analysis
Export Results
Model Validation Study
GIC Comparison
Transformer Temperature Comparison
GeoIT: GMD Integrated Tool
Sep 21 04:50:52 2025 - INFO - Plotting complete for Select Data
Sep 21 04:51:51 2025 - INFO - Plotting complete for Select Data
Sep 21 04:52:53 2025 - INFO - Plotting E-field time series.
Sep 21 04:52:53 2025 - INFO - Nearest coordinate to: [-100.0, 33.0] on the uniform geographic grid is: [-100.0, 33.0]
Sep 21 04:52:53 2025 - INFO - Plotting geoelectric field for location: [-100.0, 33.0]
Sep 21 04:52:53 2025 - INFO - Time series plotting complete.
GIC Comparison
Load GeoIT PowerWorld GIC Output .pkl File:
mo/SCE_3D/results_sce_3D/pwresults_3D.pkl
Browse
Add Time-Series
Select Transformer (From Bus | To Bus | Circuit):
24156
24155
3
Load SUNBURST GIC Measurement .csv:
o/SCE_1D/data/GIC_VINCENT_May10_11.csv
Browse
Add Time-Series
Common SAmpling Rate (Seconds):
60
------ List of Loaded GIC File Names ------
C:/WORK/Scripts/GeoIT-Demo/SCE_1D/results_sce_1D/pwresults_1D.pkl
C:/WORK/Scripts/GeoIT-Demo/SCE_3D/results_sce_3D/pwresults_3D.pkl
C:/WORK/Scripts/GeoIT-Demo/SCE_1D/data/GIC_VINCENT_May10_11.csv
Plot/Compare GIC time-series
Figure 1
pwresults_1D
pwresults_3D
GIC_VINCENT_May10_11
GIC (Amps)
Time (Sec)
x=9.447e+04 y=4.05
Sep 21 05:17:04 2025 - INFO - Creating THD plots...
Sep 21 05:19:53 2025 - INFO - Creating THD plots complete.


GeoIT: GMD Integrated Tool
File Run Plots Help
GMD Analysis
Export Results
Model Validation Study
GIC Comparison
Transformer Temperature Comparison
GeoIT: GMD Integrated Tool
Sep 21 04:50:52 2025 - INFO - Plotting complete for Select Data
Sep 21 04:51:51 2025 - INFO - Plotting complete for Select Data
Sep 21 04:52:53 2025 - INFO - Plotting E-field time series.
Sep 21 04:52:53 2025 - INFO - Nearest coordinate to: [-100.0, 33.0] on the uniform geographic grid is: [-100.0, 33.0]
Sep 21 04:52:53 2025 - INFO - Plotting geoelectric field for location: [-100.0, 33.0]
Sep 21 04:52:53 2025 - INFO - Time series plotting complete.
GIC Comparison
Load GeoIT PowerWorld GIC Output .pkl File:
mo/SCE_3D/results_sce_3D/pwresults_3D.pkl
Browse
Add Time-Series
Select Transformer (From Bus | To Bus | Circuit):
24156
24155
3
Load SUNBURST GIC Measurement .csv:
o/SCE_1D/data/GIC_VINCENT_May10_11.csv
Browse
Add Time-Series
Common SAmpling Rate (Seconds):
60
------ List of Loaded GIC File Names ------
C:/WORK/Scripts/GeoIT-Demo/SCE_1D/results_sce_1D/pwresults_1D.pkl
C:/WORK/Scripts/GeoIT-Demo/SCE_3D/results_sce_3D/pwresults_3D.pkl
C:/WORK/Scripts/GeoIT-Demo/SCE_1D/data/GIC_VINCENT_May10_11.csv
Plot/Compare GIC time-series
Figure 1
pwresults_1D
pwresults_3D
GIC_VINCENT_May10_11
GIC (Amps)
Time (Sec)
x=9.447e+04 y=4.05
Sep 21 05:17:04 2025 - INFO - Creating THD plots...
Sep 21 05:19:53 2025 - INFO - Creating THD plots complete.

21.0 Plots → Model Validation Study → Transformer Thermal Comparison

To open the input window, navigate to **Plots → Model Validation Study → Transformer Thermal Comparison**.

This feature compares multiple transformer temperature rise time-series.

Input Options:

- Load Transformer Temperature Rise Time-Series:
  - **Load Temperature Rise Time-Series .txt File**: Click **Browse** to select the .txt file generated by the ETTM module.
  - **Add Time-Series**: Click this button to load the selected time series into the tool's working memory.
- Load Multiple Time-Series**:** Repeat above step to load additional time-series data.
- Manage Loaded Time-Series: Use the **List of Loaded Temperature Rise File Names** at the bottom of the window to select or deselect time-series for comparison.
- **Set Common Sampling Rate (Seconds):** Enter a value to downsample all time-series to a common rate before comparison.
- **Plot/Compare Temperature Rise Time-Series:** Click this button to generate the comparison plot.