



EarthScope
Consortium

phoenix2seed Archiving Instructions

1. Introduction and Overview

Congratulations! You have completed your wide-band MT survey using the Phoenix MTU-5C. This document will guide you, step-by-step, through the process of organizing your raw data, validating metadata, converting the data to miniSEED, and creating metadata as a stationXML for your experiment using **phoenix2seed** so that the data can be submitted for permanent archiving.

Unix commands are indicated with bold print. Unix commands and any command line arguments are **highlighted in yellow**. Input files are denoted by *<filename>*. GUI options and menus are **highlighted in gray**. *GUI fields are italicized*.

This guide utilizes both common Unix commands, and custom software resources developed at the Earthscope Primary Instrument Center (EPIC), and distributed in the PASSOFT package, available at the link below:

<https://epic.earthscope.org/content/software-resources>

Additional documentation on the data conversion and archiving process can be found on the EPIC website:

<https://epic.earthscope.org/content/passive-source-seed-archiving-documentation>

2. Create an organized directory structure for your data

Start by creating a main directory for the project. Under this project directory, make a first-level directory named "RAW" for the raw data that was downloaded directly from the Phoenix datalogger. Then create a subdirectory for each station under the RAW directory. Directories can be created from the terminal by using the following commands:

```
mkdir RAW
```

followed by:

```
mkdir RAW/STA1
```

Each datalogger stores the data in a series of directories which are named according to the serial number of the datalogger and the GPS date and time at which data acquisition started, ie: *<SerialNumber_YYYY-MM-DD-HHmmSS>*. Move these directories under the appropriate station directory, and move the *MTU-5C_Credential_Sheet.xlsx* and *MTU-5C_Install_Sheet.xlsx* for each station into the appropriate station directory as well. An example of a fully populated directory structure is shown in Figure 1. Please note that there is some variability in the number of directories and in the presence of some files depending on the equipment used and specifics of your survey. See Section 2.1. for a more detailed explanation.

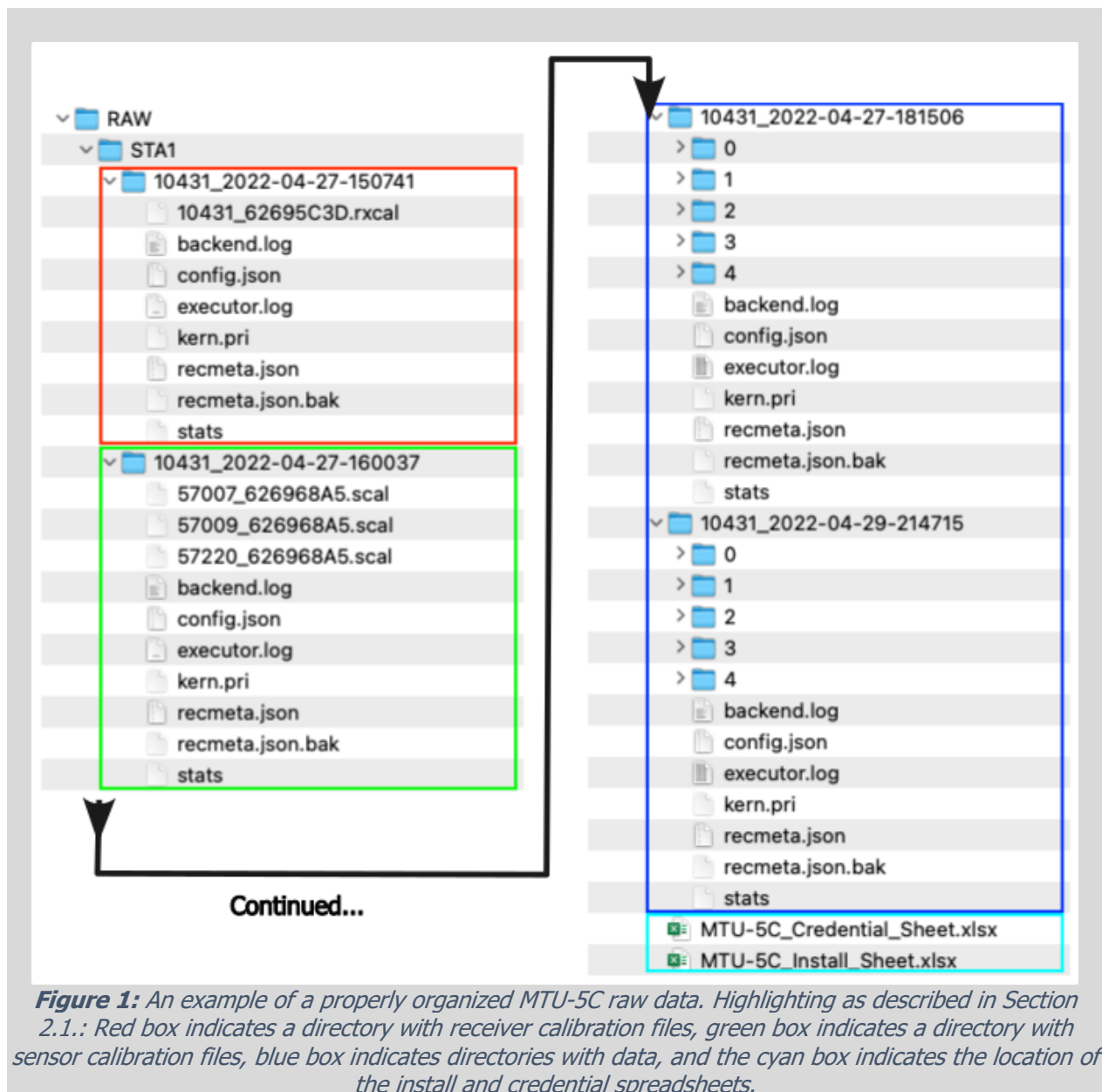


Figure 1: An example of a properly organized MTU-5C raw data. Highlighting as described in Section 2.1.: Red box indicates a directory with receiver calibration files, green box indicates a directory with sensor calibration files, blue box indicates directories with data, and the cyan box indicates the location of the install and credential spreadsheets.

2.1. Notes on files and MTU-5C directories:

- Each station directory should have only one *MTU-5C_Credential_Sheet.xlsx* and only one *MTU-5C_Install_Sheet.xlsx* file belonging to that station. These are highlighted in cyan in Figure 1.
- The number of and contents of the $\{serial\ no\}_{YYYY-MM-DD-HH:mm:ss}$ directories can vary depending on how each survey was undertaken and the equipment used:
 - (At least one) directory(s) containing a receiver calibration file (.rxcal). If you undertook multiple receiver calibrations you may see multiple directories with

receiver calibration files. Directories containing receiver calibration files should not contain any subdirectories. An example of such a directory is highlighted in red in Figure 1.

- If supported by the equipment used in your experiment, you may see directories containing a number of sensor calibration files (.scal) equal to the number of magnetic sensors that were used in your experiment. An example of such a directory is highlighted in green in Figure 1.
 - If you did not perform a sensor calibration or did not use equipment that allows sensor calibration—such as experiments using ZONGE coils—you will not see any directories containing sensor calibration files.
 - A directory for each Run of your sensors with subdirectories numbered 0-4 containing data for the following channels: 0(channel H2), 1(channel E1), 2(channel H1), 3(channel H3), 4(channel E2). Two examples of data directories are highlighted in blue in Figure 1.
- Do not change the naming or content of any of the folders or files.

3. Running phoenix2seed

phoenix2seed runs in three modes: a quality control mode which runs only in the terminal, a GUI-only mode, and a field sheet & GUI mode. The latter two modes both utilize the same GUI. If you are in the field and/or want to quickly convert raw data to miniSEED for inspection or verification, use the quality control mode. For the purposes of archiving data with EarthScope, you must use one of the GUI modes to convert the data to archivable miniSEED files and create a stationXML of your station's metadata.

3.1. Run phoenix2seed in quality control mode

To assess the quality of your data, run **phoenix2seed** in quality control mode. Quality control mode will bypass the handling of the metadata, allowing you to quickly convert your data into miniSEED files suitable for initial inspection and assessment of data quality.

To run **phoenix2seed** in quality control mode, you must use the (-qc) flag to instruct the program to run in quality-control mode, and the (-d) flag to define the path to the raw data directory. An example of a complete terminal command for quality control mode is shown below:

```
phoenix2seed -qc -d RAW/STA1
```

Each run of **phoenix2seed** will convert only the data in the path following the (-d) flag. If your experiment used multiple stations **phoenix2seed** must be run multiple times, once for each station, making sure to update the path following the (-d) flag for each station.

When run in quality control mode **phoenix2seed** will first parse the data files in the directory defined by the (-d) flag, and print a large number of messages to the terminal window informing the user of its progress. After it parses all the data files, **phoenix2seed** prompt the user to provide some basic information about the station as

well as which channels should be converted to miniSEED for quality assessment. These prompts will appear as command-line prompts within the terminal window from which the user ran **phoenix2seed** in quality control mode. The program will prompt the user to input the following in the terminal:

- Network Code
- Station Name
- Number of electrode pairs
- Channel for each electrode pair
- Direction for each electrode pair
- Number of coils
- Channel for each coil
- Direction for each coil

After the user provides satisfactory responses to the terminal prompts, **phoenix2seed** will create a directory named "MSEED/{Station Name}/" and create day-long miniSEED files (dayvols) in that newly created directory. Once complete, the program will inform the user via a message in the terminal window. You can verify quality of your data and visualize your miniSEED files using **sqlx** or any other waveform quality control software of your choice. Use **fixhdr** to change miniSEED header values if necessary. For more information on how to use these tools, refer to the appropriate documentation on our website (see link on the first page).

3.2. Run phoenix2seed in GUI-only mode

To create an archivable copy of your data and metadata, you must supply **phoenix2seed** with additional metadata and technical details of your MT survey. This information must be entered and validated using one of **phoenix2seed**'s two GUI modes. While we strongly recommend using the field sheet & GUI mode described in Section 3.3, it is possible to run **phoenix2seed** in GUI only mode. In GUI-only mode the user must enter all of the required information into the GUI manually rather than allowing **phoenix2seed** to read information from the field sheets.

To run **phoenix2seed** in GUI-only mode, you must use the -d flag to define the path to the raw data directory, and the -g flag to instruct **phoenix2seed** to run in GUI-only mode. For example:

```
phoenix2seed -d RAW/STA1 -g
```

The layout of the **phoenix2seed** GUI, the required metadata fields, and the procedure for validating and converting data are identical to those described in Section 3.3.

3.3. Run phoenix2seed in field sheet & GUI mode

To create an archivable copy of your data and metadata, run **phoenix2seed** in field sheet & GUI mode. In this mode **phoenix2seed** ingests metadata information from the completed *MTU-5C_Credential_Sheet.xlsx* and the *MTU-5C_Install_Sheet.xlsx* files, and automatically populates many of the fields in the GUI window that are required to create a complete and valid stationXML metadata file.

To run **phoenix2seed** in field sheet & GUI mode you must use the -m flag to define the path containing the *MTU-5C_Credential_Sheet.xlsx* and *MTU-5C_Install_Sheet.xlsx* files, and the -d flag to define the path to the raw data directory. For example:

```
phoenix2seed -m RAW/STA1 -d RAW/STA1
```

After running **phoenix2seed** with the properly defined data and field-sheet paths, **phoenix2seed** will launch the GUI after parsing the metadata and raw data files and printing a large number of messages to the terminal.

Note: The program will display a number of messages to the terminal with flags *INFO*, *WARNING*, or *ERROR*. Review these messages as you complete the metadata in the GUI, correct any *ERRORS* and confirm that any metadata field that generated a *WARNING* message is indeed correct as entered in the GUI.

The **phoenix2seed** GUI displays a File dropdown menu with options to Load Metadata, Save Metadata, Write MiniSEED, and Write StationXML. The last two appear greyed out initially and will remain so until the metadata is complete and validated (Section 3.3.6). These commands are also available via icons below the menu bar:

-  : Load Metadata
-  : Save Metadata
-  : Write MiniSEED
-  : Write StationXML

The GUI also has four tabs: Network, Station, Electric, and Magnetic. Each tab contains a number of metadata fields, some of which will have been pre-populated with information read from the install and credential spreadsheets. Required fields are denoted by an asterisk (*). The GUI will launch displaying the Network tab as displayed in Figure 2.

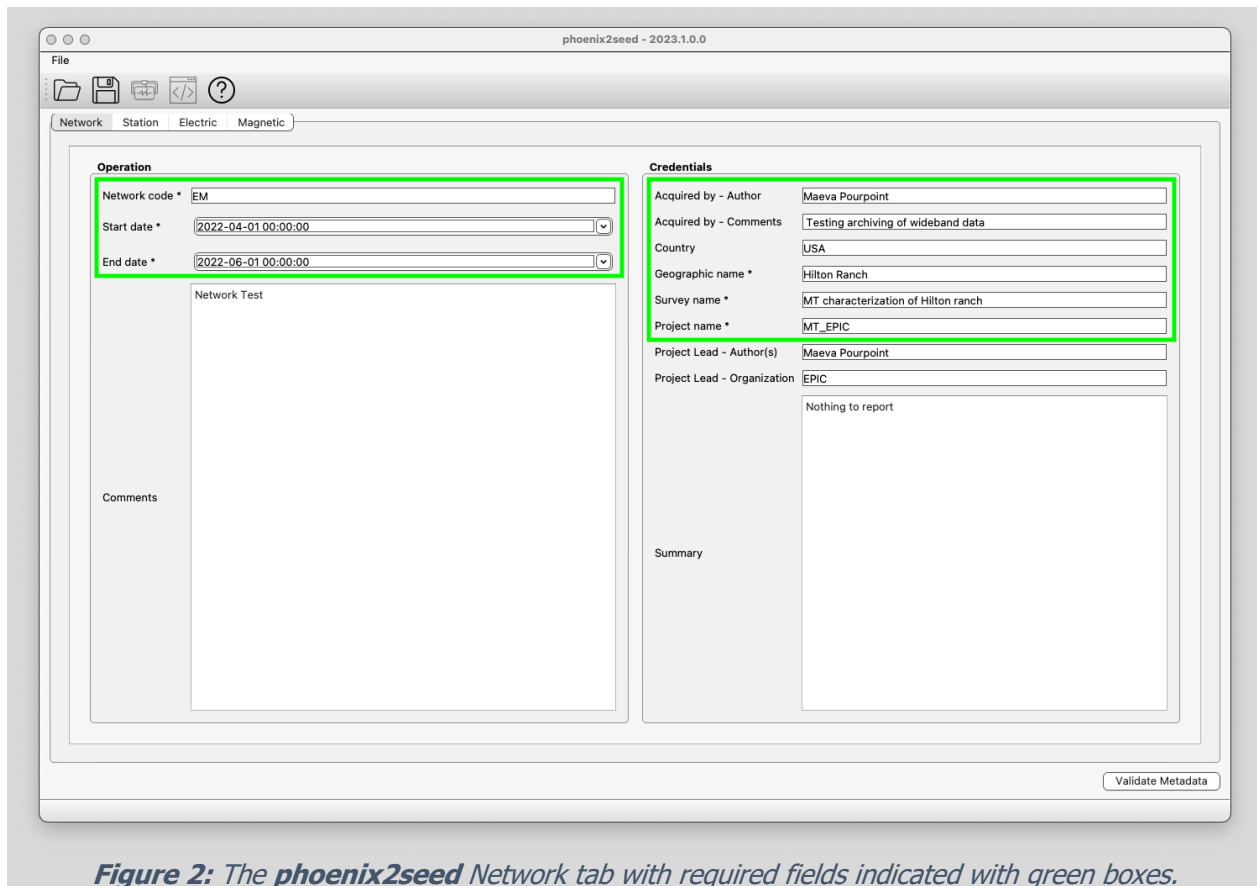


Figure 2: The *phoenix2seed* Network tab with required fields indicated with green boxes.

3.3.1. Load or Save Metadata while work is in-progress

Phoenix2seed allows you to save your metadata before completing the conversion process. Use the **Save Metadata** (or **Load Metadata**) to create (or open) a *.pkl* file at the location of your choosing.



Select the **Save metadata** button or go to **File >> Save metadata** to save an in-progress version of your metadata. This will create a *.pkl* file in the location you specify that can be loaded back into the **phoenix2seed** GUI.



To resume working on your saved *.pkl*, bring up the GUI:

Select the **Load metadata** button or go to **File >> Load metadata** to load a *.pkl* file with an in-progress version of your metadata. This will allow you to continue verifying or editing your metadata without needing to repopulate previously filled metadata fields.

Alternatively, to launch the GUI and your *.pkl* file directly and simultaneously from the command line:

```
phoenix2seed -g -d RAW/STA1 -s sta1_temp.pkl
```

3.3.2. Network Tab: Verify the Network Metadata

The **phoenix2seed** GUI will display the **Network** tab at launch. Many fields will have been pre-populated with information from the credential and install spreadsheets or with information from your previously-saved .pkl file. Review all of the required fields (*), review the *WARNING* and *ERROR* messages printed to the terminal window for troubleshooting and confirm all fields are complete and correct. If fields are blank and/or there are a large number or *ERROR* messages printed to the terminal, ensure you've either loaded a .pkl file properly, or that your credential and install spreadsheets are located at the path defined by (-m).

The required fields for the **Network** tab are:

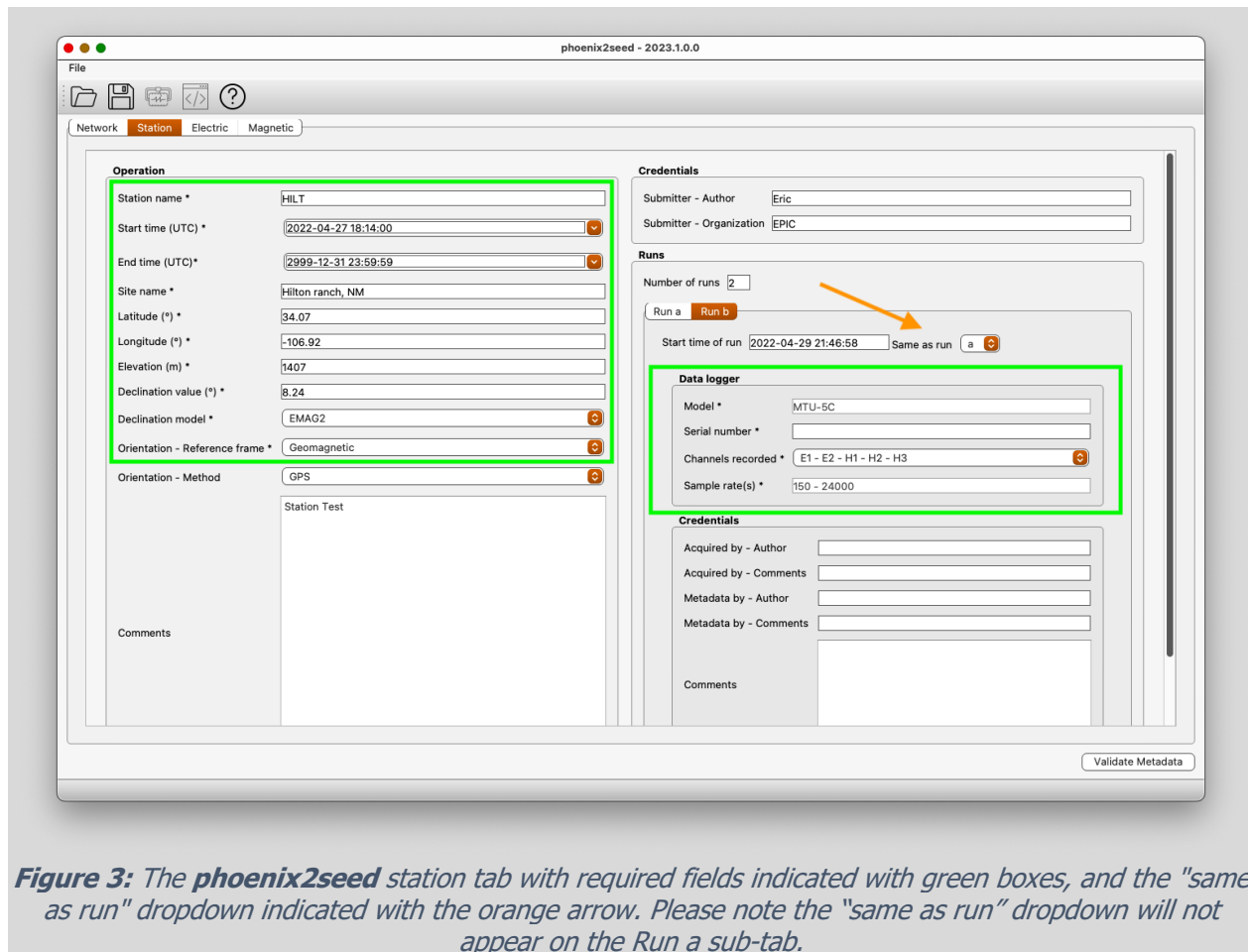
- | | |
|----------------|-------------------|
| * Network code | * Geographic name |
| * Start date | * Survey name |
| * End date | * Project name |

3.3.3. Station Tab: Verify the Station Metadata

Navigate to the **Station** tab in the **phoenix2seed** GUI and confirm that all of the required (*) fields are correct and complete. If your experiment had more than one Run, you will find a tab for each run (Run a, Run b, etc.) on the right of the GUI. Fill and verify all of the fields for **Run a**, then navigate to the **Run b** tab and use the **Same as run** dropdown to select Run a and copy all of the metadata information (except timing) from Run a to Run b. If you have additional runs, follow the same procedure to populate the fields of those runs with information from an earlier run (Note that the **Same as run** box will not appear on Run a). Alternatively, if your settings or specifications were different for different runs, manually fill the required fields accordingly. In either case, verify that all fields are complete and correct before proceeding to the next run. As with the **Network** tab, terminal messages may highlight potential problems with pre-populated metadata fields. The required fields, run tabs, and **Same as run** dropdown are highlighted in Figure 3.

The required fields for the **Station** tab are:

- | | |
|--------------------|--|
| * Station Name | * Declination value (°) |
| * Start time (UTC) | * Declination model |
| * End time (UTC) | * Orientation – Reference frame |
| * Site name | * Data logger model (for each run) |
| * Latitude (°) | * Data logger serial number (for each run) |
| * Longitude (°) | * Channels recorded (for each run) |
| * Elevation (m) | * Sample rate(s) (for each run) |



3.3.4. Electric Tab: Verify Electrode-Pair Metadata

Navigate to the **Electric** tab in the **phoenix2seed** GUI. If your experiment had more than one Run you will see tabs for each Run (Run a, Run b, etc.) at the top of the **Electric** tab window, and for each run a column of fields for each electrode pair. Confirm that all of the required (*) fields are correct and complete—checking the terminal window for relevant *WARNINGS* and *ERRORS*. As with the **Station** tab, copy the metadata from the first Run to another Run by utilizing the **Same as run** dropdown. Figure 4 highlights these fields.

The required fields for each electrode pair and Run in the **Electric** tab are:

- * Channel port
- * Azimuth (°)
- * Tilt (°)
- * Dipole length (m)
- * Electrode – Specs
- * Direction for each Electrode
- * Serial Number for each Electrode

Caution: If the dipole length entered in the GUI does not match the value in the configuration file, **phoenix2seed** will generate a *WARNING* message in the terminal. A mismatch between the value entered in the GUI and the value contained in the configuration file will not prevent metadata validation and conversion of the data to miniSEED. However, this value does affect the response of the instrument and the conversion of the data from raw data to archivable miniSEED files. Please take extra care to ensure that the values entered into the dipole length (m) fields of the GUI match the specifications of the deployment in the field.

Note: You may see *INFO* or *WARNING* messages in the terminal about the contact resistance and/or DC voltage fields. These fields are not required, and should be viewed as a measure of the quality of the electrode deployment and, correspondingly, the quality of the telluric data. Changes in these values will not affect the conversion of the raw data or response of the recorded data.

The screenshot shows the 'phoenix2seed - 2023.1.0.0' application window with the 'Electric' tab selected. The interface is divided into two main sections: 'Run a' and 'Run b'. The 'Run b' section is active, showing configuration for two electrode pairs. At the top, 'Number of electrode pairs' is set to 0, and 'Same as run' is set to 'a'. An orange arrow points to the 'Same as run' dropdown. Below this, 'Electrode pair 1' and 'Electrode pair 2' are configured. For each pair, the following fields are highlighted with green boxes: 'Channel port', 'Azimuth', 'Tilt', 'Dipole length', 'Electrode - Specs', 'Contact Resistance' (Start, End, DC Voltage), 'Positive Electrode' (Direction, Serial Number), and 'Negative Electrode' (Direction, Serial Number). The 'Validate Metadata' button is at the bottom right.

Figure 4: The *phoenix2seed* Electric tab with required fields indicated with green boxes, and the "same as run" dropdown indicated with the orange arrow. Note that the "same as run" dropdown will not appear on the Run a sub-tab.

3.3.5. Magnetic Tab: Verify Fluxgate Metadata

Navigate to the **Magnetic** tab in the **phoenix2seed** GUI. If your experiment had more than one Run you will see tabs for each Run (Run a, Run b, etc.) at the top of the Magnetic-tab window, and for each Run a column of fields for each magnetic coil. Confirm that all of the required (*) fields are correct and complete—checking the terminal window for relevant *WARNINGS* and *ERRORS*. As with the **Station** and **Electric** tabs, use the **Same as run** dropdown to copy the metadata from the first run to another run (Figure 5).

The required fields for each coil and run in the **Magnetic** tab are:

- * Number of coils
- * Channel port
- * Azimuth (°)
- * Tilt (°)
- * Specs
- * Direction
- * Serial Number

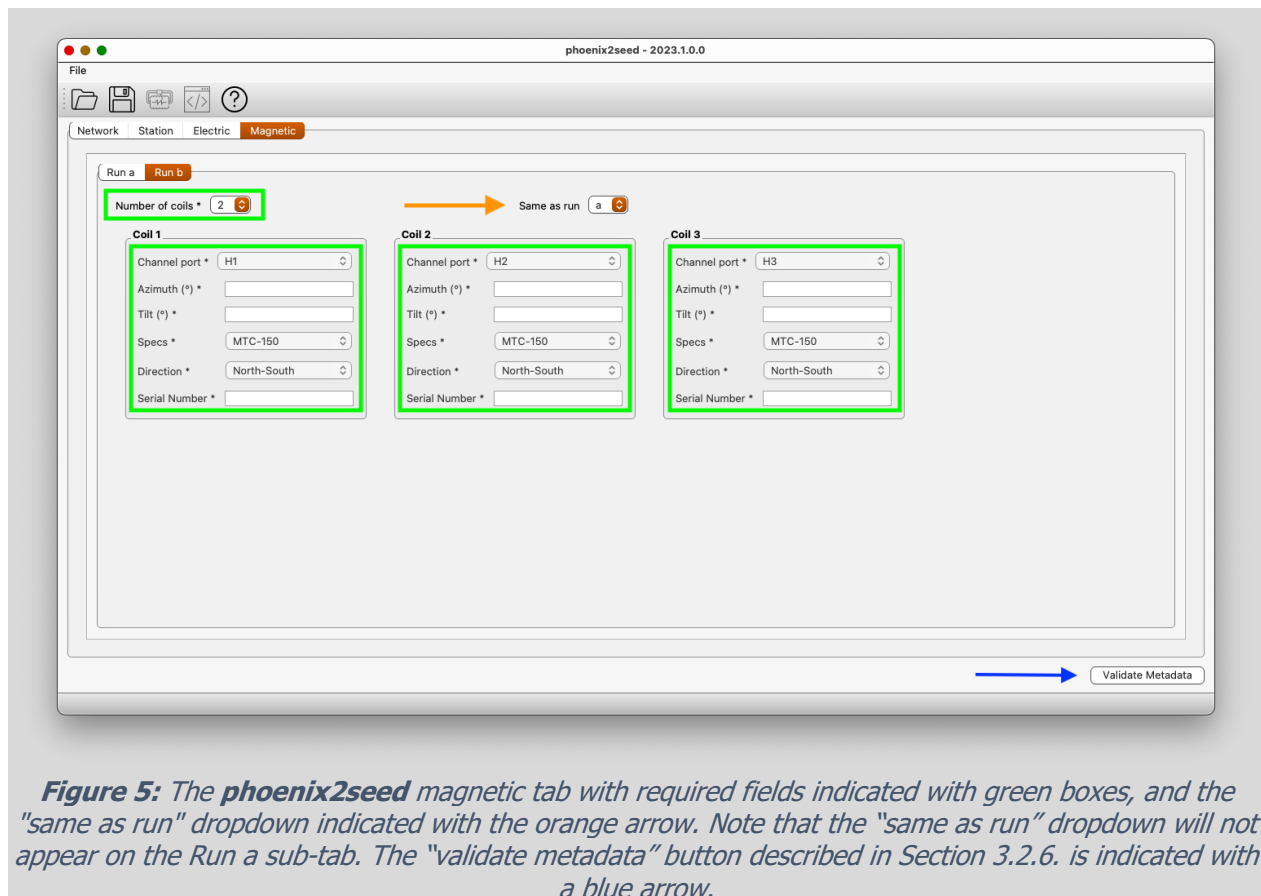


Figure 5: The **phoenix2seed** magnetic tab with required fields indicated with green boxes, and the "same as run" dropdown indicated with the orange arrow. Note that the "same as run" dropdown will not appear on the Run a sub-tab. The "validate metadata" button described in Section 3.2.6. is indicated with a blue arrow.

3.3.6. Validate Metadata

Once you have confirmed that all of the required (*) fields in the **Network**, **Station**, **Electric**, and **Magnetic** tabs are complete and accurate, click the **Validate Metadata** button

in lower-right corner of the **phoenix2seed** GUI as indicated in Figure 5 with a blue arrow. The program will scan the metadata you entered in the previous steps and provide feedback both in the form of terminal messages and—if all required data is satisfactory—in the form of a pop-up message informing the user that “All required metadata are properly filled out...”.

If you do not see the pop-up described above, check the terminal for *ERROR* messages and correct those errors as needed. Upon an unsuccessful validation, tabs and fields which generated errors will be highlighted in the GUI. Review the *ERROR* messages and correct or complete the highlighted fields in the GUI and click the **Validate Metadata** button again. Once you have successfully validated the metadata, proceed to converting your data to archivable miniSEED files and metadata to a stationXML file (Section 3.3.7).

We recommend using the **Save Metadata** option to save a final copy of your metadata (ie {Station Name}_final_{date}.pkl) in case you encounter any issues during the conversion process.

Note: Even if your data passes validation and you receive see the pop-up message described above, you may still see *WARNING* and/or *INFO* messages in the terminal. Certain fields—such as the dipole length field discussed in section 3.3.4.—may generate *WARNING* messages, but will not prevent validation and conversion of your data. Please confirm that any values in the GUI which generated warning messages are correct.

3.3.7. Convert the Data and Generate stationXML

After your metadata has been successfully validated, proceed to converting your data into archivable day-long miniSEED files and writing your metadata as a stationXML file. The **File** menu options and tool bar icons (see Section 3.3.) to **Write MiniSEED** and **Write StationXML** should now be available.

Note: If you previously converted data using the quality-control (-qc) mode of **phoenix2seed** (Section 3.1) either delete the miniSEED files output by that operation, or move them to a different location in the directory structure than path “MSEED/{Station_Name}”. The presence of quality-control-mode miniSEED files in the path where **phoenix2seed** will write final, archivable miniSEED files will interfere with this operation. Similarly, if you previously generated miniSEED files using the full metadata, but needed to make changes to that metadata and re-convert the data, make sure to delete or move any previously existing data from the path.

To convert your data to archivable miniSEED day volumes, select the **Write MiniSEED** option from the **File** menu or click on the appropriate toolbar icon. This will start the process of converting your data and will output day-long miniSEED files into a folder named “MSEED/{Station Name}” as a subdirectory within the path where you ran

phoenix2seed. The output will be organized by station name, so data from different stations will be output into different subdirectories of the “MSEED” directory. Once data conversion has been completed, a pop-up window with the message “Data Conversion Complete!” will appear. The archivable miniSEED files will be written with the standard naming convention of *{Station}.{Network}..{Channel}.{YYYY}.{JJJ}*.

To write your station metadata in stationXML format, select the **Write StationXML** option from the file menu or click on the appropriate toolbar icon. The stationXML file will be named *{Network Code}.{Station Name}.MT_EPIC.{YYYYJJJ}.{HHmmSS}.xml*. This operation should be nearly instantaneous, and will generate a small number of terminal messages informing the user of the program’s progress. Successful writing of the stationXML file will generate a pop-up window with the message “Metadata Conversion Complete.” Unlike with the data-conversion process, previously existing stationXML files within the “STATIONXML” directory will not affect the writing of subsequent stationXML files, as date and time portions of the stationXML file name will be unique for each writing.

4. Send miniSEED and stationXML files to EPIC

First, send a note with your project name and PIC project number in the subject line and attach your stationXML file(s) to epic.data.group@earthscope.org informing the EPIC data group of your intention to send us data.

Once you have received confirmation from someone in the EPIC data group, you may proceed with sending us data using the tool **data2passcal**. This tool is included with the PASSOFT package described in the introduction (Section 1) of this document. When running **data2passcal** you should provide the program with the path to the “MSEED” directory containing the archivable miniSEED files you generated in Section 3.3.7. The program will scan this directory and its subdirectories for miniSEED files matching standard naming conventions. If the transfer is interrupted, the program should resume where it left off if run from the same path and directed towards the same data. To run **data2passcal** run the following command in the terminal (filling in the information in the brackets with the correct path for your experiment and system):

```
data2passcal {path to your experiment directory}/MSEED/
```

After **data2passcal** has finished sending data, look at the end of the terminal output or at the end of the file *data2passcal.log* to find the number of files sent. Send this number to your contact in the EPIC data group and we will confirm the number of files received matches the number sent.

Congratulations! You’ve submitted your archivable data!