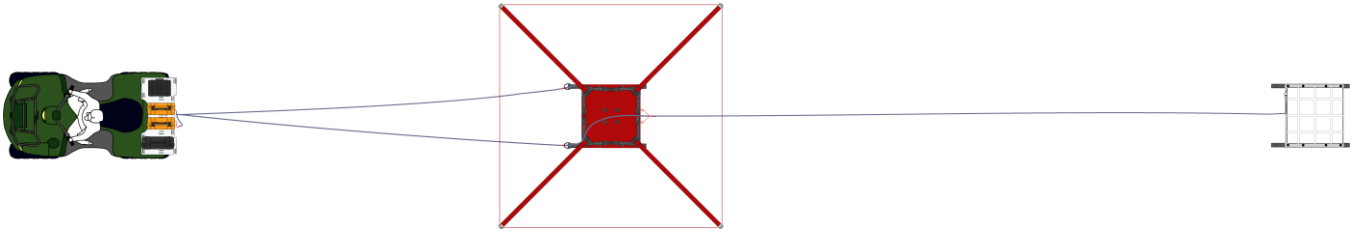


ABEM

ABEM GroundTEM Ralli User Guide




ABEM GroundTEM Ralli


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 **COMING
SOON** To download the **GroundTEM Ralli Controller Software** for Android devices from **Google Play**, scan the QR code on the left

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ABEM GroundTEM Ralli User Manual

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WARNING!

THE ABEM GROUNDTEM SYSTEMS DELIVER HIGH CURRENTS THROUGH THE TRANSMITTER LOOP. CONSIDER ALL CABLES TO CARRY CURRENT, WHETHER CONNECTED DIRECTLY OR INDIRECTLY TO A GROUNDTEM UNIT.

INSPECT CABLES FOR DAMAGE BEFORE USE. STAY AWAY FROM CABLES WHILE THE SYSTEM IS OPERATING. WEAR ELECTRICALLY INSULATING BOOTS AND GLOVES DURING FIELDWORK.

TO AVOID ACCIDENTS, THE OPERATOR MUST ALWAYS KEEP ALL PARTS OF THE EQUIPMENT INCLUDING INSTRUMENT, LOOPS AND COILS UNDER CLOSE SUPERVISION AND BE AWARE OF UNAUTHORIZED PERSONS AND STRAY ANIMALS APPROACHING WHILE THE SYSTEM IS OPERATING.

TO AVOID POTENTIAL INSTRUMENT DAMAGE, ALWAYS FOLLOW THE CORRECT POWER-ON PROCEDURE WHEN OPERATING THE GROUNDTEM RALLI, AS DESCRIBED ON PAGE 4

IMPORTANT POWER-ON PROCEDURE

TX cables of the GroundTEM Ralli **MUST NOT be connected to the instrument when switching it on**

Failure to observe the following power-on procedure could damage the system

1. START

GroundTEM Ralli instrument is in its "off" state.



- No TX coil connected
- No internal / external battery connected
- Lights off

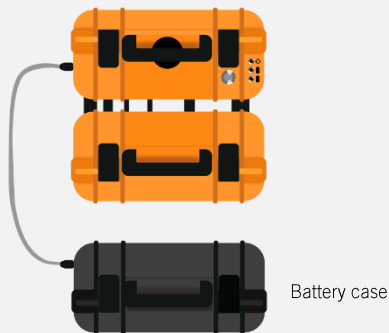
2. STEP 1

Insert the RX battery and wait 5 seconds.



3. STEP 2

Plug in the TX battery



4. STEP 3

Switch on instrument



5. STEP 4

Wait for TX & RX lights to show.



6. CONNECT TX LEAD-IN CABLE

Attach TX coil to instrumentation.

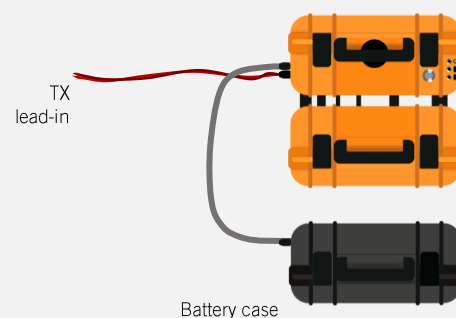


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1. Introduction

1.1 What does the user manual contain?

This user manual contains technical and theoretical specifications for the ABEM GroundTEM Ralli mobile, ground-based TEM system.

It serves the purpose of introducing the GroundTEM Ralli system to the user regarding what needs to be known before, during and after the field survey. It covers:

- the GroundTEM Ralli components;
- the mechanical setup;
- which software to use and how;
- tips for when the user is about to plan a survey;
- the files and parameters being used during a survey;
- and how to proceed with the acquired data, from transfer to processing.



Figure 1. The ABEM GroundTEM Ralli mounted on an ATV with 2 × 2 m transmitter loop and trailing receiver coil

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1.2 The Transient Electromagnetic Method

The measurements are made by transmitting a direct current through the transmitter coil. This results in a static primary magnetic field. The current is shut off abruptly, which induces an electrical field in the surroundings (Figure 2).

In the ground, this electrical field will result in an electrical current which again will result in a magnetic field, the secondary field. As time passes, the resistance in the ground will weaken the current (which is converted to heat), and the current density maximum moves downwards and outwards leaving the current density still weaker. In a conductive ground, the current diffuses more slowly down into the ground compared to a resistive ground where the currents will diffuse and decay fast.

The decaying secondary magnetic field is vertical in the middle of the transmitter coil, and an electro motoric power is induced in the receiver coil - a voltage – and this is the signal, which is measured as a function of time in the receiver.

Just after the current in the transmitter coil is turned off, the current in the ground will be close to the surface, and the measured signal reflects primarily the conductivity of the top layers.

At later times the current will run deeper in the ground, and the measured signal contains information about the conductivity of the lower layers.

Measuring the current in the receiving coil will therefore give information about the conductivity as a function of depth – this is often called a sounding.

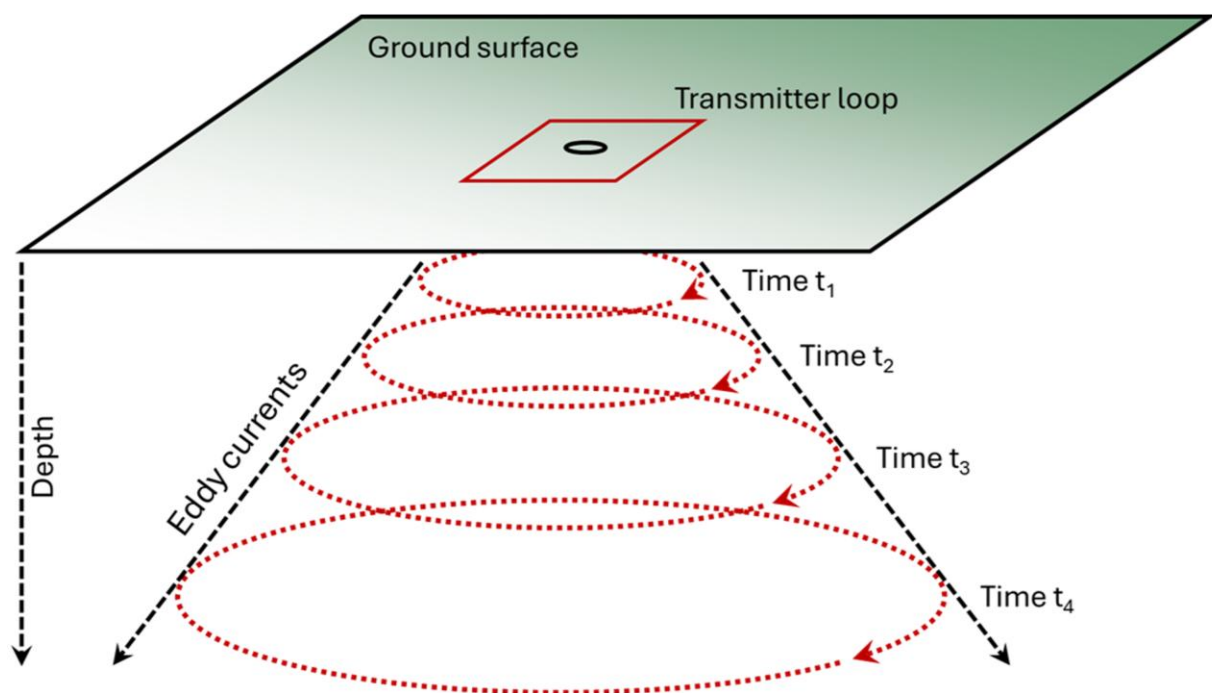


Figure 2. Principal sketch of the TEM method.

2. The GroundTEM Ralli - components

The following list of items is needed to run a GroundTEM Ralli system.

2.1 List of GroundTEM Ralli parts

Type	Name	Amount	Description
Electronics	GroundTEM Ralli instrument	1	Transmitter (Tx) & Receiver (Rx) unit
	RCS20	1	Receiver (Rx) Coil
	Tx Battery	1	Suitcase for 12 V, 100 Ah battery
	Tablet	1	Android tablet with GroundTEM Ralli app
	RRC2054-2	1	Battery for Rx side of the GroundTEM Ralli unit
Cables	Power cable	1	Power cable for power to instrument from battery
	Tx loop / coil*	1	Transmitter loop (single-turn) / coil (3-turn)
	Tx lead in*	1	Lead in cable from instrument to Tx loop / coil
	Receiver cable*	2	Cable from RCS20 to Tx (1 mounted & 1 spare)
	[Coil adapter]	[1]	Adapter for multi-turn (3x3m, 3-turn Tx coil)
Mechanical	Tx Platform	1	Platform for the TX coil
	Rx Platform	1	Platform for the RCS20
	GroundTEM Ralli wings*	4	Wings for Tx platform and for Tx coil
	ATV platform	1	Platform for equipment on ATV

* Wings / transmitter coils need to be compatible. Similarly, TX coil lead-in / receiver cable need to be the same length.

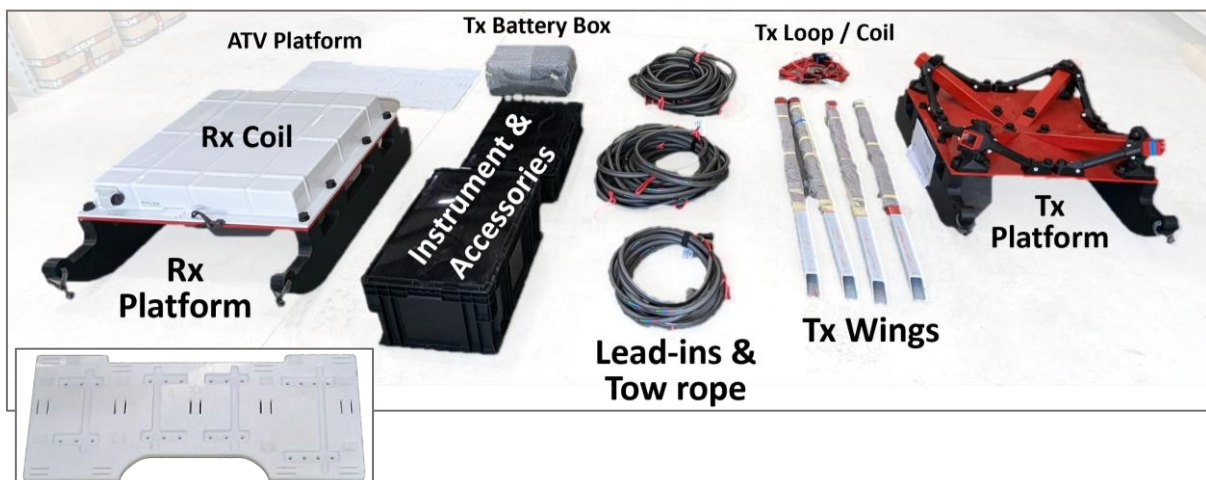


Figure 3 ABEM GroundTEM Ralli delivered system components with detail of ATV platform (inset)

3. GroundTEM Ralli - Mechanical Assembly Guide

The equipment requires some preparation before going to the field for the first time.

3.1 Coolant in TX unit

When receiving a GroundTEM Ralli system the coolant reservoir in the Tx unit will be empty and must be filled with coolant suited for aluminium before powering up. To fill coolant in the reservoir:

- Power on the Tx unit.
- Use the filler bottle (lab-type plastic squeeze bottle) and fill it with coolant.
- To open the reservoir, unscrew the front bolt in the top of the reservoir (see arrow in Figure 4) using an Umbraco/Hex/Allen type key.
- Fill the reservoir using the filler bottle.
- Run the pump by pushing the bypass button seen in Figure 4. This will circulate coolant and empty the reservoir, allowing you to fill it with coolant again in an iterative approach.



Figure 4: Coolant compartment of TX unit with bypass button indicated in red circle.

Note

- It takes around ½ liter (0.22 gallons) and 2-3 doses before the system and reservoir are full.
- Coolants suited for aluminum are found in every auto parts store.
- If using a coolant concentrate, follow the instructions for dilution ratio.
- The coolant concentrate should be diluted using distilled water.
- If you are in doubt about concentration, a higher dilution is generally better.

3.2 Mounting receiver coil

The Receiver coil is easily mounted on the Rx platform, and then secured to the runners, using the 8 supplied bolts – four on each side (Figure 5 Receiver coil mounted on platform and secured to runners with bolts).



Figure 5 Receiver coil mounted on platform and secured to runners with bolts

3.3 Connecting receiver cable to receiver platform

The receiver cable must be connected through the white plastic bracket shown in Figure 6.



Figure 6: Connecting receiver cable to receiver platform and RCS20

4. GroundTEM Ralli – Field Operation Guide

A field crew of two people is recommended to operate the GroundTEM Ralli system efficiently. The workflow for performing a GroundTEM Ralli survey at one location goes through the following steps:

1. Field assembly (see section 4.1 for detail)
 - a. Setup of GroundTEM Ralli wings
 - b. Setup of GroundTEM Ralli Tx coil
 - c. Setup of GroundTEM Ralli equipment in ATV platform
2. Powering on the instrument, data collection and demobilization (see section 5 for detail)
 - a. Operate the app to collect data
 - b. Run the survey
 - c. De-mobilize the system.

4.1 GroundTEM Ralli field assembly

This section covers the required steps for when the system is in the field and needs to be set up for measuring.

4.1.1. GroundTEM Ralli Wings

- The wings have a “This side up” text on the wingtips.
- The wings should be inserted all the way, until the grey part is no longer visible (Figure 7).

Notes

- *For new systems, some gentle rocking back-and-fore may be necessary to work them in.*
- *All wings are identical.*



Figure 7: Insert GroundTEM Ralli wings into receivers on the Tx Platform

4.1.2. GroundTEM Ralli Tx coil

How the complete setup of the Tx coil and Tx lead-in cable must look like is shown in Figure 8. To set it up follow the steps below:

- Start by rolling out the Tx lead-in. The connector should be placed towards the ATV (OBS! Do NOT connect it yet to the Tx unit. See “Powering on the GroundTEM Ralli unit.”). Attach the soft shackle in the front left runner and put the connectors on top of the wing.
- Start placing the Tx coil. The black box needs to be placed on the front left wing. Attach it to the wing in the way where the sign “UP” it is facing upwards.
- The **blue tape** indicates the Tx coil side that goes after the **front left wing**.
- There is a pair of black heat shrinks on either side of each wing.
- When the Tx coil is correctly setup, tighten it using the black cleat on the front (towards the ATV) of the coil
- Connect the Tx coil to the TX coil lead-in.
- Once mounted, the system should resemble the one shown below.
- If the Tx configuration uses a multiturn coil (e.g. 3 × 3 m, 3-turn) the adapter provided is required to be used. Plug the adapter into the Ralli unit and then the lead-in; secure to minimize oscillation of the adapter cable.

Notes

- When putting the Tx coil on, it is preferable if there are two people helping each other.



Figure 8: Example of GroundTEM Ralli system with 331 Tx coil.



Figure 9 Tx multi-turn coil adapter



Figure 10: How to operate a cleat. Rope is loose (top), Bring rope beneath the black cleat and towards up and tighten it (middle), Lock rope by bringing it downwards to the left side of the black cleat (bottom).

4.1.3. GroundTEM Ralli equipment on ATV platform

Place the equipment in the matching position to the ATV platform (see Figure 11).

- Connect receiver cable to Tx unit.

Notes

- On some ATV platforms the battery position may be rotated.
- Tx coil lead-in needs to have some slack/extra cable between the mounting point of the ATV and the Tx unit.



Figure 11: Back side of ATV platform with equipment

4.2 Powering on the GroundTEM Ralli unit.

To turn on the GroundTEM Ralli unit:

- Insert one RRC 2054 in the GroundTEM Ralli unit (wait 5 seconds before connecting the Tx battery).
- Close the case and place it upright (handles pointing up).
- Connect the GroundTEM Ralli unit to the Tx battery via the power cable.
- Press the power button. The two battery LED indicators should light up.
- When LED lights are lightened up, connect the Tx coil lead-in to the Tx.

The third LED light is GPS lock indicator.

- Blinking if receiving GPS signal.
- Off if not receiving GPS signal.

Notes

- Powering on and getting GPS lock takes a few minutes.
- There is a USB C connector inside, used only for debugging the system and support – it should not be used for anything else

4.3 Operate GroundTEM Ralli controller app to collect data

When field setup is completed, GroundTEM Ralli controller app can be operated to start the survey. Open the app and follow the steps below:

- Make a New Project (or continue an existing one).
- Select a Protocol.
- Add a background map, if available.

For more information on the GroundTEM Ralli controller app, see section 5.

4.4 De-mobilize the system

- Turn-off GroundTEM Ralli PC from the GroundTEM Ralli Controller software and press the power button on the GroundTEM Ralli unit.
- Disconnect cables and put on the protection caps on the plugs.
- Disassemble the GroundTEM Ralli Tx coil, GroundTEM Ralli wings and the equipment from the ATV platform.

To avoid dirt in the plugs, do not drag the plugs over ground.

5. GroundTEM Ralli Controller App

5.1 Installing the GroundTEM Ralli Controller App

The GroundTEM Ralli system is controlled by the GroundTEM Ralli Controller app which is pre-installed on the supplied tablet.

5.2 Connecting to the GroundTEM Ralli unit

- Make sure the GroundTEM Ralli unit is turned on. It needs to run a few minutes to set up the GroundTEM Ralli Wi-Fi.
- From the tablet connect to GroundTEM Ralli Wi-Fi network.
Wi-Fi name: Ralli_0### (ID of the GroundTEM Ralli instrument)
Password: GroundTEM
- Open the GroundTEM Ralli Controller app. If it is properly connected it will display the controller interface as shown in Figure 12.

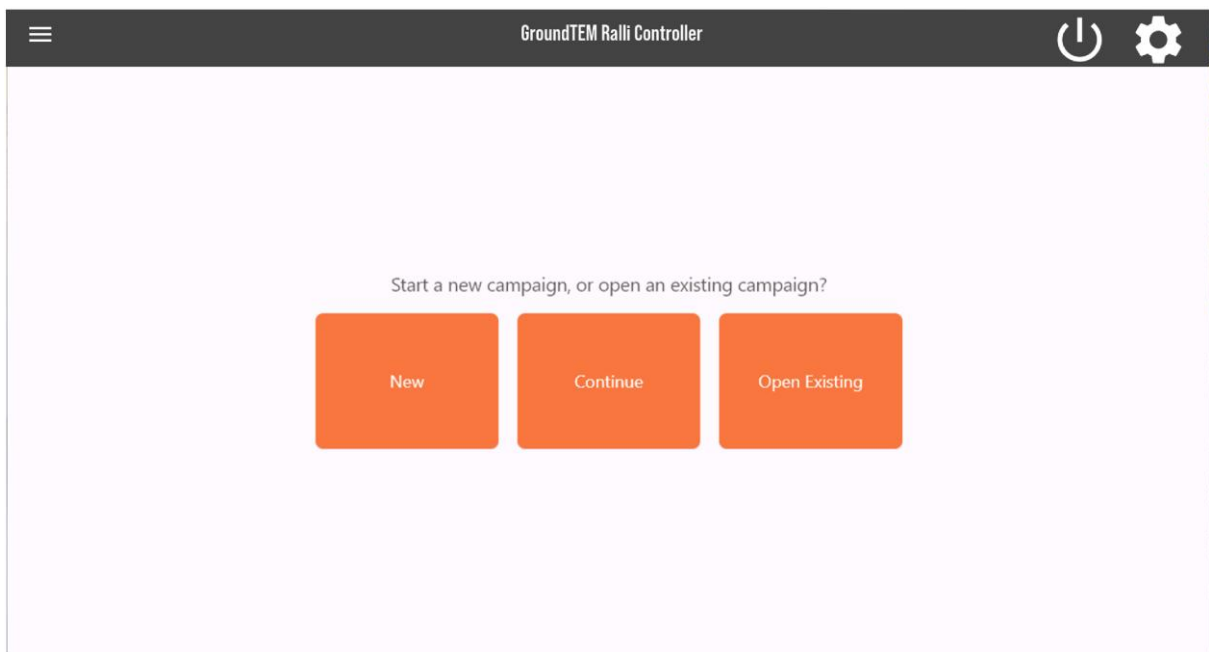


Figure 12: GroundTEM Ralli controller start screen where campaign is chosen. Create a new campaign, continue the last campaign or open an older, existing campaign.

5.3 Project management

5.3.1. Make “New Project”

To start a new project, fill in the fields shown in Figure 13 as explained below:

- Insert “Project Name” (Provide a name for the project (i.e. Aarhus - **mandatory**).
- Insert “Description” (optional).
- Insert “Operator Name” (i.e. name initials of the GroundTEM Ralli user - **mandatory**).
- Select Map (select background map [json, png, png format] - **optional**).
- Select Protocol (select the protocol that matches with the transmitter coil that is being used [e.g. Protocol_GroundTEM Ralli_331_RC20_50Hz.sts] - **mandatory**).

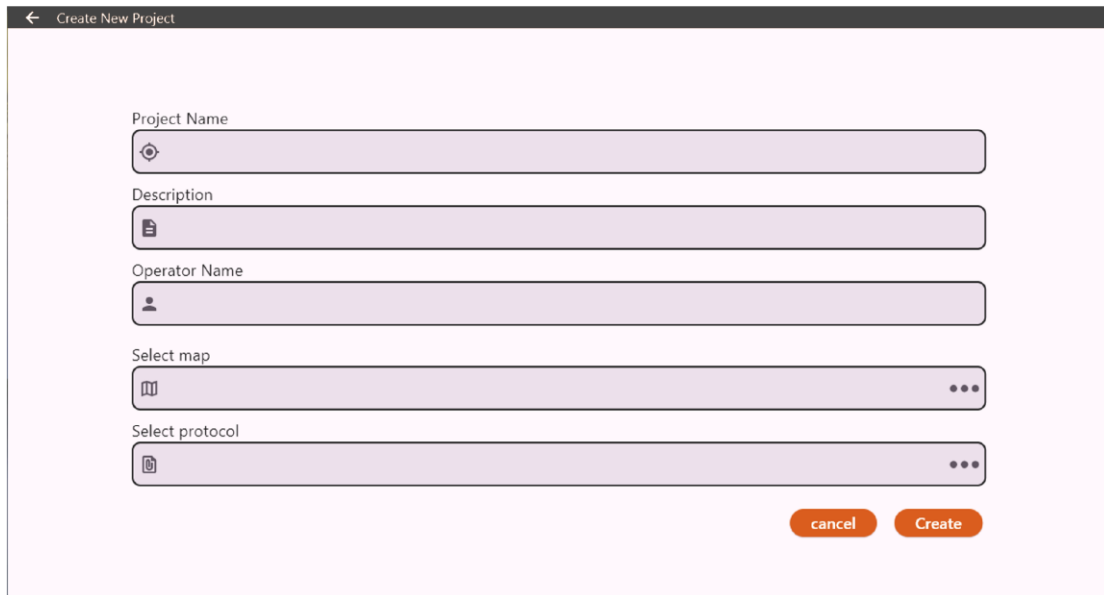


Figure 13: Fill the requested fields to create a new project.

Note

- To copy the background map to the GroundTEM Ralli unit use the GroundTEM Connect software to upload the files from the local PC to the “Maps folder” using the “Upload” button (Figure 22).
- The file of the map must not exceed 20 Mb. The map needs to be copied to in the GroundTEM Ralli unit before starting the project.
- Maps can be created in free access software (eg. QGIS).
- Imported maps will show up in alphabetically order, first maps and then lines, points.
- If no background map has been selected, a default map from OpenStreetMap will be used.
- When changing the transmitter coil (e.g. from 331 to 333), after setting up the project with the correct protocol, the GroundTEM Ralli computer needs to be restarted to apply the settings. If a project is created with a wrong protocol, e.g. using a 331 coil, but the project is created with a 333 coil, then a new project with the correct protocol must be created by repeating the above step.
- When the GroundTEM Ralli is connected to both GroundTEM Ralli controller App and TEM Data Manager it can be turned off only from the TEM Data Manager. Turn-off button on GroundTEM Ralli controller App is being disabled at that time to prevent mistakenly turning off the instrument and potential failure in the internal hardware.

5.3.2. Continue Project

To continue the same project press “Continue”. Alternatively, if a project was made previously press “Open Existing Project” and a window with all the available projects will be displayed to select the desired project (Figure 14).

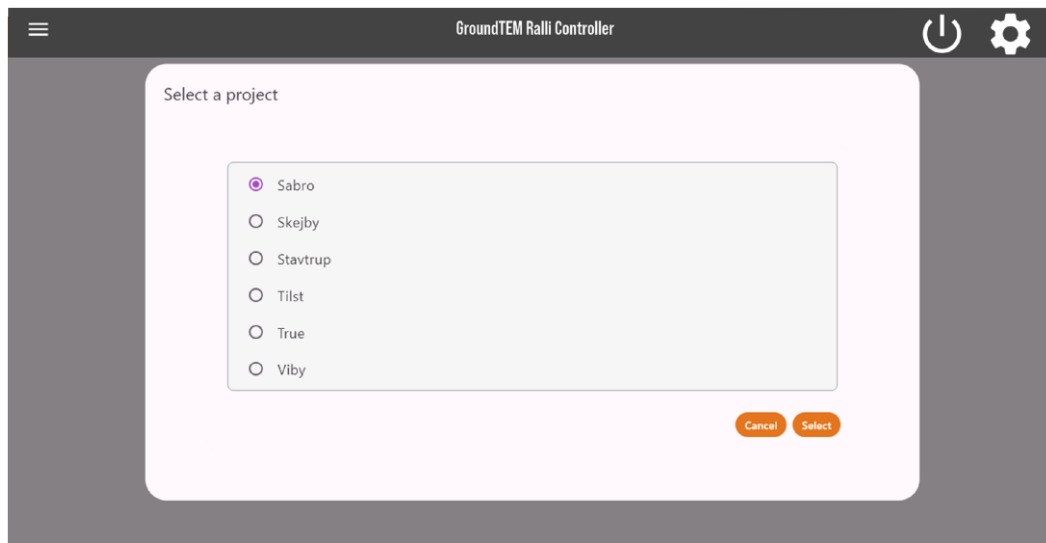


Figure 14: Select an existing project.

5.4 Starting Screen Interface

When the project starts, the following interface will be shown (Figure 15).

- The main view displays a map with your current location marked.

Note

- If the default *OpenStreetMap* does not load, the unit likely needs internet access. Use the Support option in the Main Menu to connect an external Wi-Fi or mobile hotspot.
- Once online, open your project and zoom in/out to prompt the map to load correctly.

- Left panel: Line number, Speed, Data, Temperature, HM current and GPS status indicators to inform the user during the survey.
- Middle panel: Map with driven lines. Imported shapefiles and pictures can be displayed.
- Right panel: Incoming data in tab “Data”. “Map settings” in “GIS” tab. System information in “Info” tab.

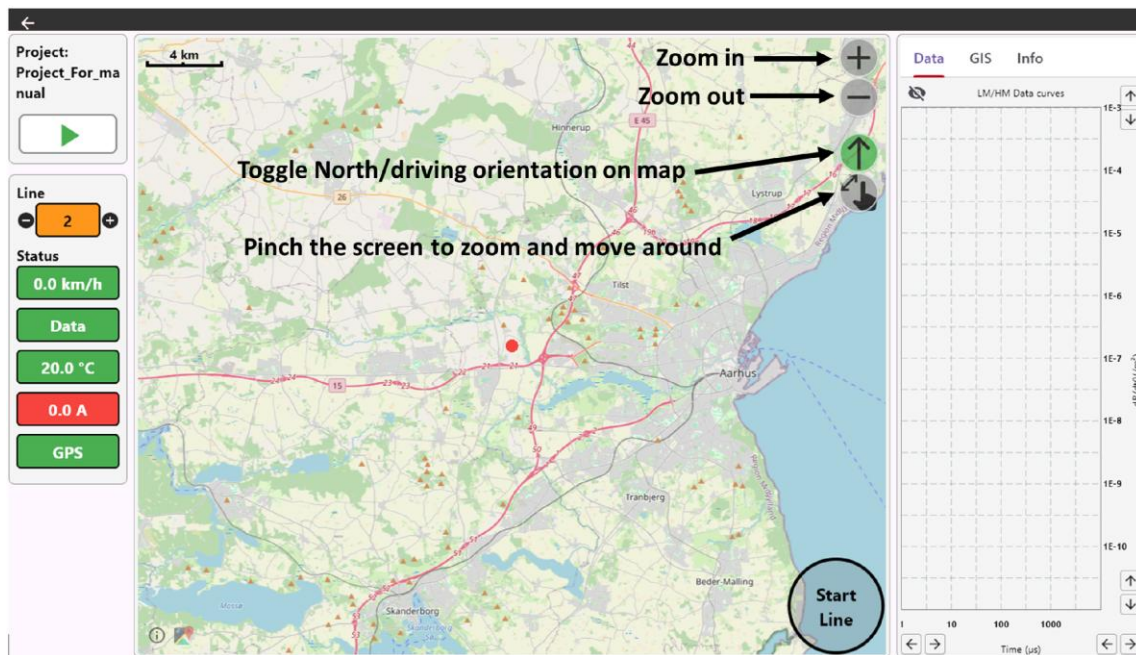


Figure 15: Starting screen interface

5.5 Operating

To start collecting data, press Run (top left corner). Then the transmitter will begin to transmit current.

- Start Line, press when the geometry of the system is straight.
- End Line, press before the geometry of the system is not straight (i.e. before turning).
- Pressing anywhere on the screen will start and end line.

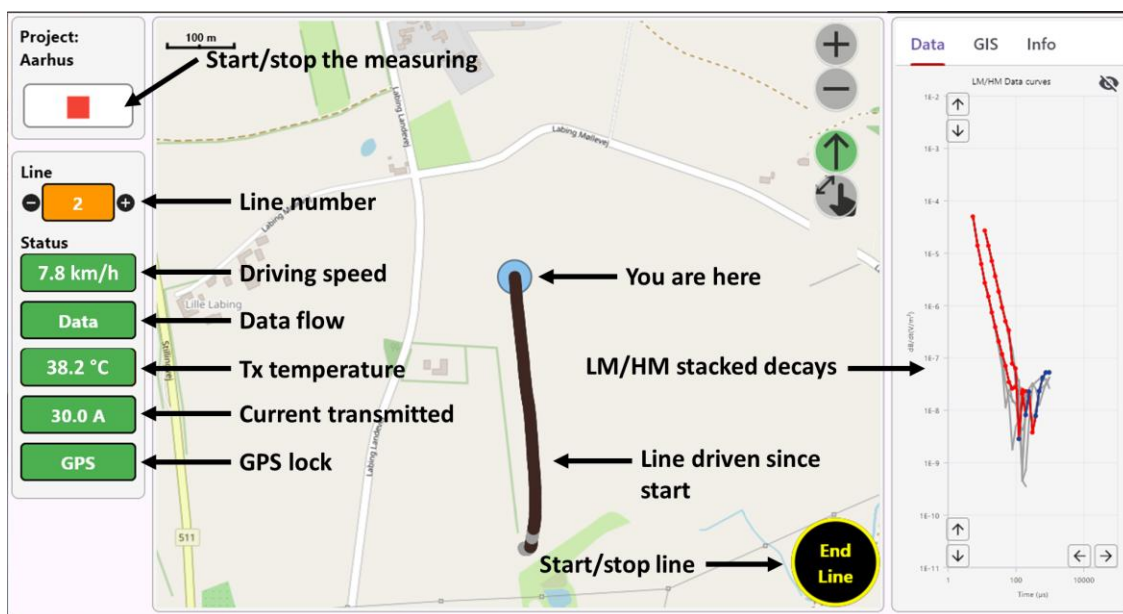


Figure 16: GroundTEM Ralli controller display

5.6 GIS & Info

The “Map settings” (Figure 18) can be changed under GIS tab (Figure 17), as well as the “GIS settings”.

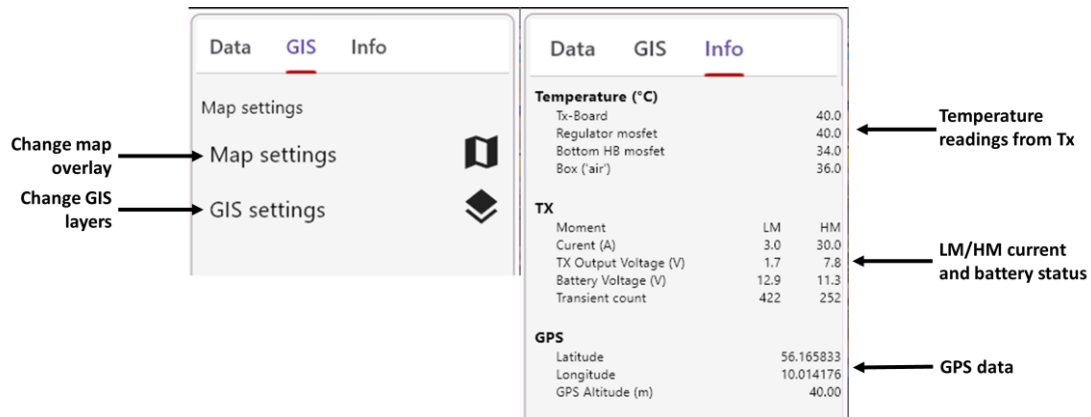


Figure 17: Showing the GIS tab with options.

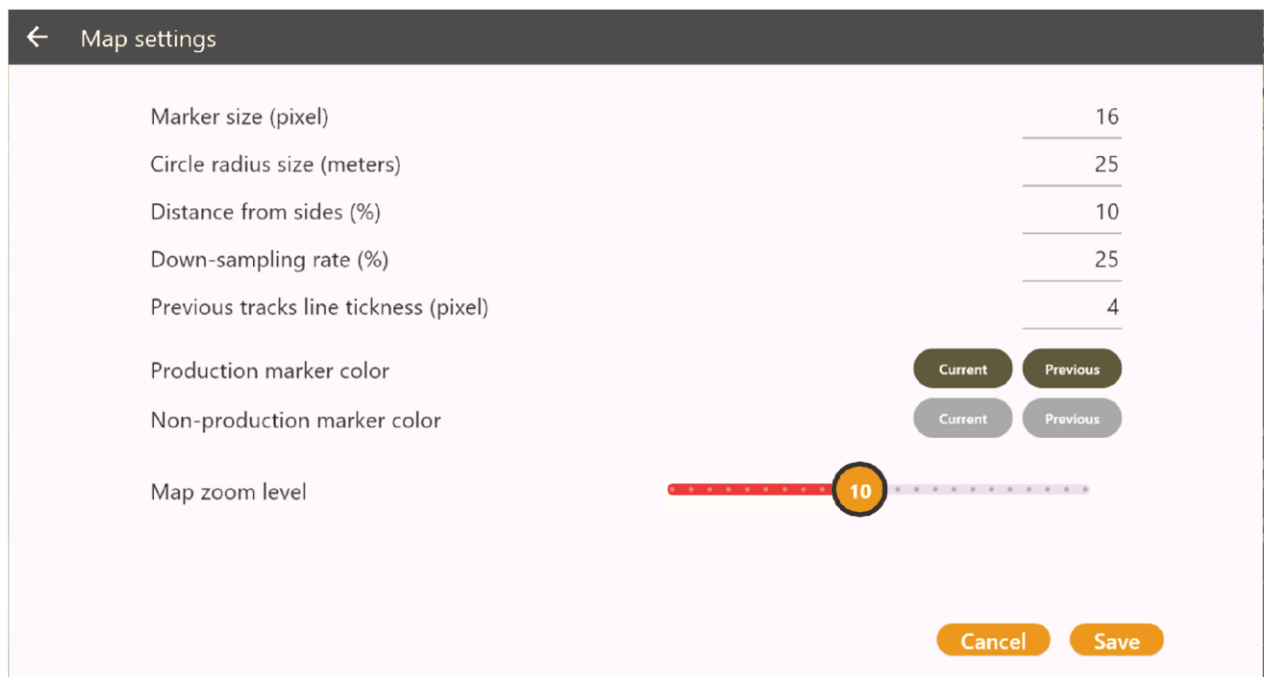


Figure 18: Options for map settings

5.7 Premium features and real-time inversion

If you have access to the Premium features package, you will have access to the real-time inversion option in the tTEM Controller app. It is designed to provide immediate insights into your subsurface data while you're still in the field.

As data is collected, the instrument will automatically perform a preliminary 1D inversion, using a smooth model. When measuring along a line, this will result in the display of pseudo-2D sections by interpolating the individual 1D models, giving you a quick overview of lateral variations. The app provides insight into the depth of investigation (DOI).

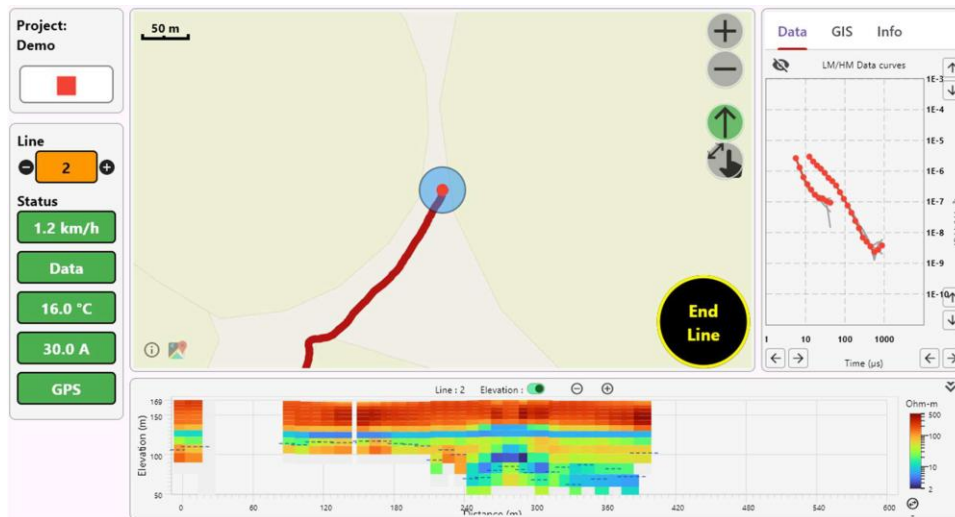


Figure 19 Real-time inversion with pseudo-2D resistivity section made of 1D interpolated models along the survey line

5.7.1. Real-time inversion Troubleshooting

There are two common situations where an inversion model may not appear:

1. A gray model is displayed
 The grey model bar is a dummy bar, that is displayed when the inversion process is running, but the automatic processing rejects too much data for the inversion to be able to run. This usually indicates that the collected data is of poor quality, possibly due to noise, couplings, Induced polarization, 3D effects or something. The relevant log file will display the following message:
Sapi.InversionThread: Lupus inversion returned error (type: ValueError, message: Not enough data points, has 0, expect at least 5)
2. The inversion window is completely blank
 This typically points to a problem with the inversion function itself, rather than the data. This can happen due to the following reasons:
 - a) Inversion is turned off - Go to Settings and make sure inversion is enabled (Figure 20).
 - b) License issue - The instrument does not have a Premium Functionality License, or it has expired. Check the expiry date under the About section.
 Contact support@guidelinegeo.com for information on how to get it renewed.
 - c) Inversion process not running - If the above two are fine, then contact support@guidelinegeo.com for help.

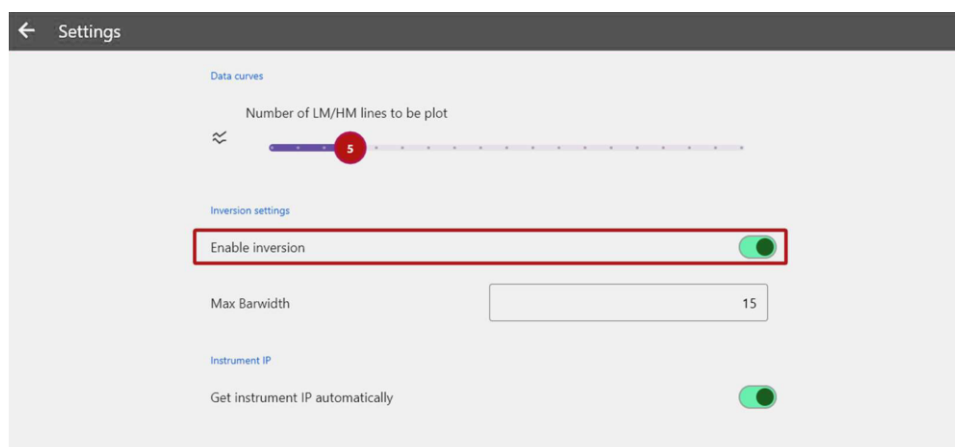


Figure 20 Enable/Disable inversion option in Settings menu

5.8 Export Background Images & Shapes for Ralli Controller App

GroundTEM Ralli Controller app supports commonly used EPSG3857 (WGS 84 / Pseudo-Mercator) and EPSG4326 (WGS 84) Coordinate Reference Systems (used by Google Maps, OpenStreetMap, Bing ArcGIS, ESRI, QGIS etc.).

In EPSG3857 the coordinates are in meters and use Mercator projection while EPSG4326 uses latitude and longitude for coordinates. Both CRSs are based on World Geodetic System 1984.

*The suggested software is QGIS since it is an open-source package.

5.8.1. Background Images

To display satellite images exported from QGIS in GroundTEM Ralli Controller app the world file is required. World files contain georeferenced information for the image and must have the same name as the image file name. Extensions will be .pgw for PNG and .jgw for JPG files (i.e. *image.pgw* & *image.jgw*).

Before export, make sure that the correct CRS (Coordinate Reference System) has been selected. From the menu bar to the top select “Project” then “Import/Export” and “Export Map to Image” to export map as image.

Make it sure that “Append georeferenced information (embedded or via world file)” checkbox has been selected. This is needed to create world file that contains georeferenced information for the created image.

5.8.2. Exporting shapes (points, lines, polygons) from QGIS

To export shapes from QGIS, right click on the shape layer in Layers section of QGIS, select “Export” then “Save Features As...”. In the dialog window, select CRS (“EPSG: 4326 – WGS 84” or “EPSG:3857 – WGS 84 / Pseudo-Mercator”).

If you need to export more layers, you need to do the same for each layer needed so each layer will be in its own file.

5.8.3. Upload Map Files to GroundTEM Ralli instrument

See Download and upload data section and Figure 22 for more information on how to upload the created files.

6. Survey

6.1 General

- Do not connect/disconnect plugs/cable while recording data.
- Do not connect/use damaged plugs or cables. For repair/replace options contact TEMcompany or reseller Minor damage on Tx coil can often be repaired with insulation tape.
- Do not connect plugs if the inside is wet or dirty.
- To clean the equipment, use a wet cloth with soap for the GroundTEM Ralli instrument, the RCS20 and the cables (Tx coil, receiver cable, power cable). Use air pressure (if available) and/or a spatula to remove mud and dirt from the platforms.

6.1.1. Survey Packing

- Create a check list with all the items needed for the field. Use it to make sure you bring everything back when you return.
- Batteries charged (RRC battery, 100 Ah battery and tablet). It is recommended to either have a power bank connected to the tablet or charge the tablet directly from ATV.
- If possible, bring a spare RX-cable. Should you damage the cable, the fieldwork can continue.
- A toolbox might be helpful to do a field-repair while on a survey. Recommended items to include are a 30 mm wrench, a cleaning spray for connectors, screwdrivers with different heads, a multimeter, duct tape and extra zip ties.

6.2 Survey

Before starting up the ATV and driving, there are some pointers and things to be aware of listed below.

- *If something breaks, it is most likely to be a cable.*

This is of course an exaggeration, but true in many cases. When driving, and especially turning, keep an eye on the cables between the ATV and Tx platform (this means the Tx coil lead-in as well as the Rx cable). The cables will be more under tension when turning, and it is very important (especially in the beginning) to learn just how tightly you can make turns.

- *Watch your speed and watch your equipment.*

The GroundTEM Ralli system is, including ATV, almost 20 meters long. Whenever you are driving in tight quarters, around corners etc., look back and keep an eye on the system. Even though it is tempting to open the throttle on the ATV, please do not. The faster you drive (>20 km/h), the more difficult it will be to stop or correct your course. Remember to look at the RCS20 platform as well, as it tends to get tangled in trees, bushes etc. This happens due to inattentiveness and because the system is almost 20 meters long, the turns must be larger than many think.

- *Setup of instruments and cables must be checked*

Check if the cables are coiled or have any loops. Make sure the distances are correct – if there is excess cable there is risk of creating loops and distance might be wrong.

Note

- Do not charge the batteries at ambient temperatures below 0 °C.
- Do not charge the battery if the battery temperature is below 0 °C.
- Each day before driving, a quick tightening of all bolts should be performed.
- Keeping the equipment clean and tidy without mud and dirt helps with its reliability.
- Check all cables and ropes for fraying and excessive wear. This includes the connectors.

6.3 Survey Troubleshooting

Apart from the normal dB/dt decays that someone can see during a survey, there are few cases where their shape changes. The parameters that cause these changes are described below.

How it appears	Cause	Solution/ What to do
Not smooth decays in the noise level (Figure 21, A)	Receiver cable is not connected to the TX	Connect the receiver cable to the TX.
Flatish decays (Figure 21, B)	RCS20 is not connected to the receiver cable	Connect the RCS20 to the receiver cable.
Signal level is low for both LM and HM & sign change can be seen either in both moments or only in HM (Figure 21, C)	High resistive areas are with chargeable layers and may produce this type of response. The system operates properly and there is no need for further action.	In case of doubt, move to a different area with less resistive subsurface or with a known response from previous measurements and check the shape of the decays.
Decays with several fluctuations-spikes (Figure 21, D)	Capacitive coupling. It can be seen when crossing buried cables.	Move further away from the area and check the shape of the decays.
Last gates have very low signal (0 dB/dt) (Figure 21, E)	Defective Receiver cable	Change Receiver cable and test if the shape of the decays remains the same.
Last gates have very low signal (0 dB/dt) (Figure 21, E)	Defective RCS20 lead in	Check the RCS20 lead-in if it has been pulled and if there is any damage in the connection.
First gates in LM exhibit a small “step-like” behaviour (Figure 21, F)	Multiturn Tx coil has been plugged in without the Tx coil adapter	Plug the Tx coil adapter and then the Tx lead-in.

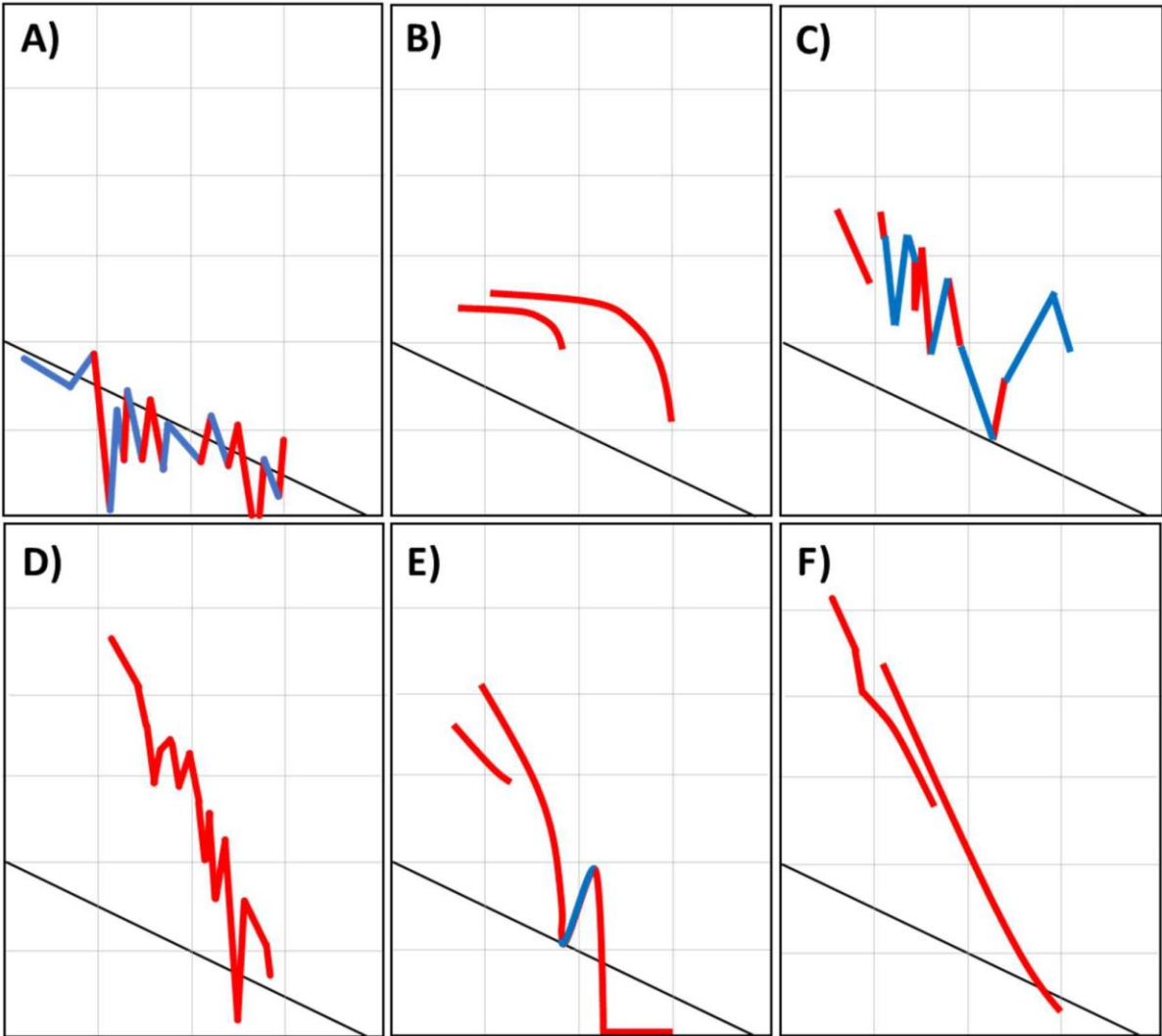


Figure 21: Different decay shapes. A) Only the noise level, B) Flattened decays C) Decays with low signal levels and sign change (only in HM in this example), D) Decays with several fluctuations-spikes, E) Last gates have very low signal (0 dB/dt), F) Stepped appearance to decays.

7. Download and upload data

The recorded data is downloaded/copied from the GroundTEM unit to a PC using the *GroundTEM Connect* program. *GroundTEM Connect* program is available from the Guideline Geo website (www.guidelinegeo.com/help-center/resources). This section is written for version 2025.2.0.7.

7.1 Connecting to GroundTEM Wi-Fi

The first step is connecting the *Local PC* to the Wi-Fi of the unit. To do so:

- Insert the batteries into the GroundTEM unit and turn it on.
- From the *Local PC* connect to GroundTEM Wi-Fi network.

Wi-Fi name: GroundTEM_0###, Password: GroundTEM

7.2 GroundTEM Connect program

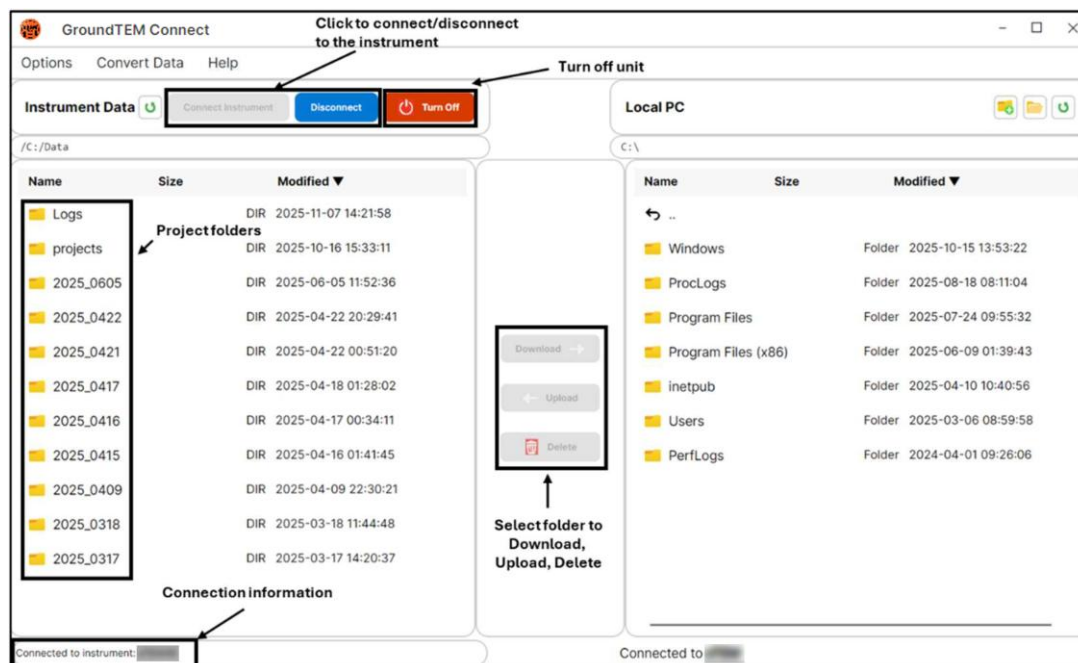


Figure 22: Steps for copying data from unit to Local PC (after connecting to the instrument).

7.2.1. To copy data from Instrument to Local PC

- Press *Connect to Instrument* to display the data folders on the unit
 - The TEM data on the instrument is sorted in main folders named by (yyyy_mmdd)
- Select main- or sub-folder(s) to copy to Local PC and set a target folder on the Local PC.
- Turn off the Instrument PC from the controller app before turning off the unit.

Note

- Folders/files with date/time names are named using UCT-time (GPS date/time).
- Before deleting data from the instrument, verify that data files are copied to your Local PC.

7.2.2. Additional options in GroundTEM Connect

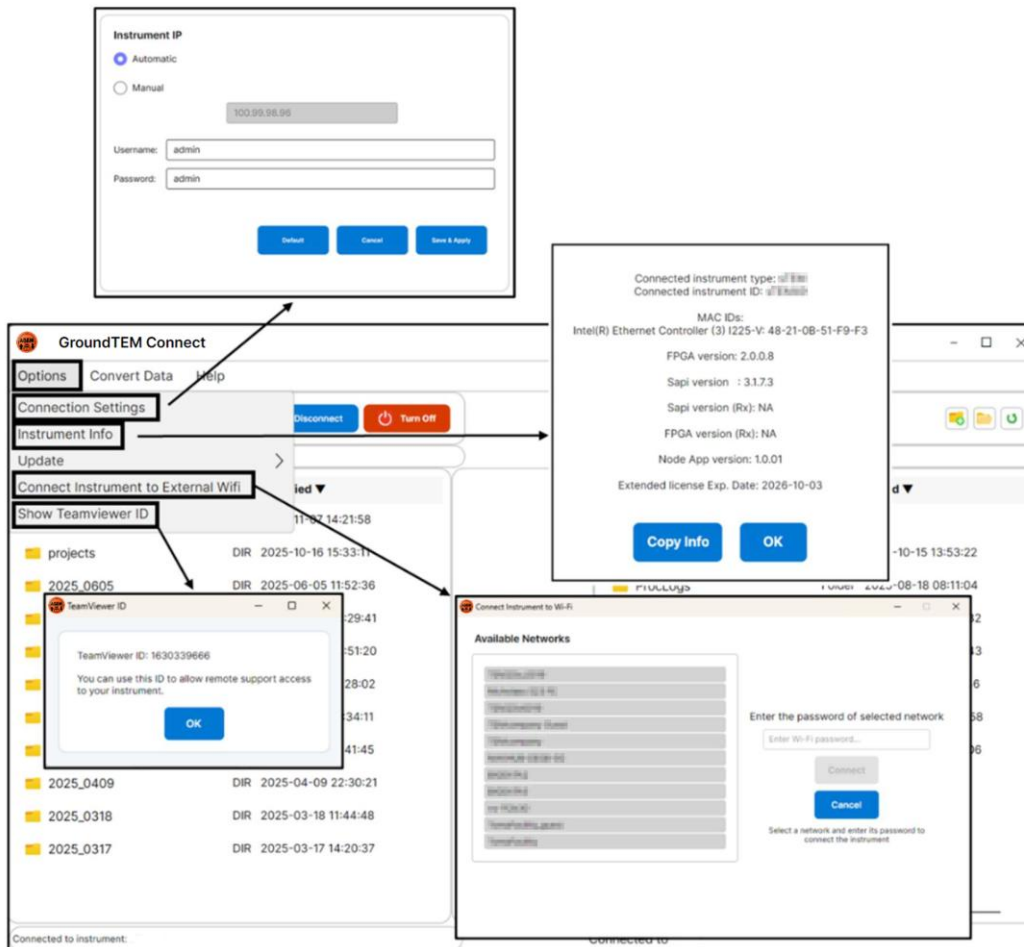


Figure 23: Settings and Options in GroundTEM Connect

Figure 23 illustrates several additional menus available in the TEM Data Manager application:

- **Connection Settings** - The default setting is "Automatic", which connects to the instrument currently paired with your device. This option should not be changed unless specifically advised by support.
- **Instrument Info** - Displays key information about your unit, including the MAC address, firmware/ SAPI/ node versions, and license expiration date. This information is particularly useful when contacting support, as it helps us identify your system.
- **Connect Instrument to External Wi-Fi** and **Show TeamViewer ID** - These two options are primarily used to enable remote support. To allow our support team to access your unit, first connect the instrument to the internet, then share the Teamviewer ID provided in this menu.

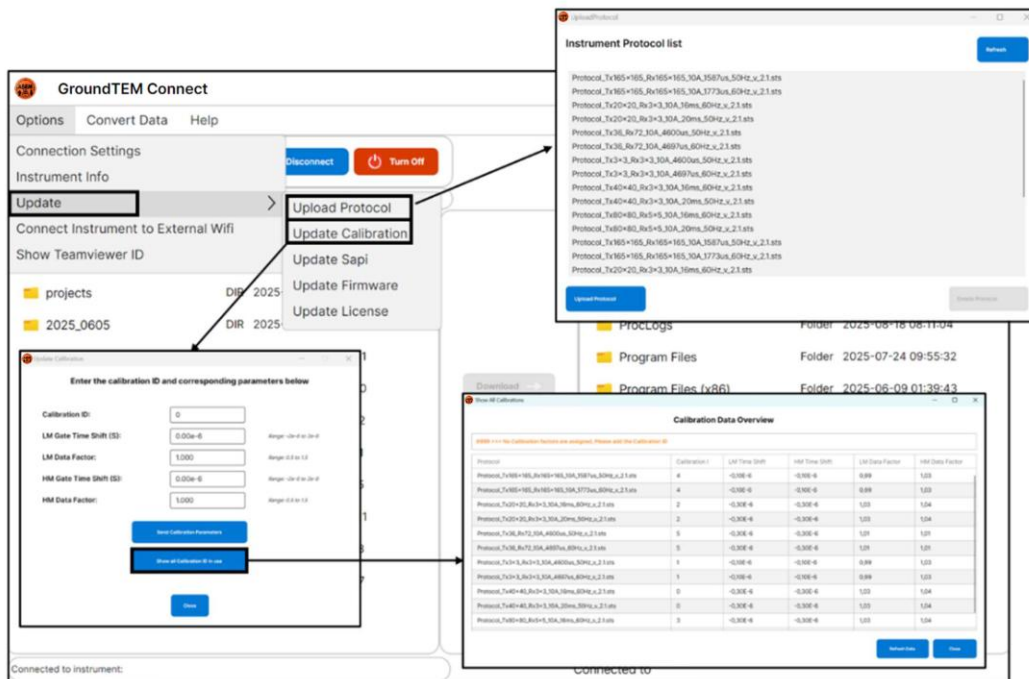


Figure 24: Settings and Options in GroundTEM Connect

Figure 24 illustrates the Update menu which provides several important maintenance and configuration options:

- **Upload Protocol** - Displays a list of all current protocols. From here, you can delete outdated protocols or upload new ones. This action should only be performed if specifically advised by support.
- **Update Calibration** - Each protocol relies on calibration factors that are unique to the system configuration. These values are preset by our team and should not be modified unless instructed to do so by support.
- **Update SAPI / Firmware / License** - These options are used when software updates, firmware upgrades, or license renewals are required. If any of these updates are necessary, our support team will provide detailed instructions and the required files.

Additionally, the program includes a **Convert Data** option (Figure 25), which allows you to convert acquired data into various output formats according to your needs. Supported formats include XYZ files, raw USF files, and formats compatible with TEMImage, AGS Workbench, and SPIA. Data can be converted either upon download (while connected to the unit) or after download (using locally stored data, no active connection required).

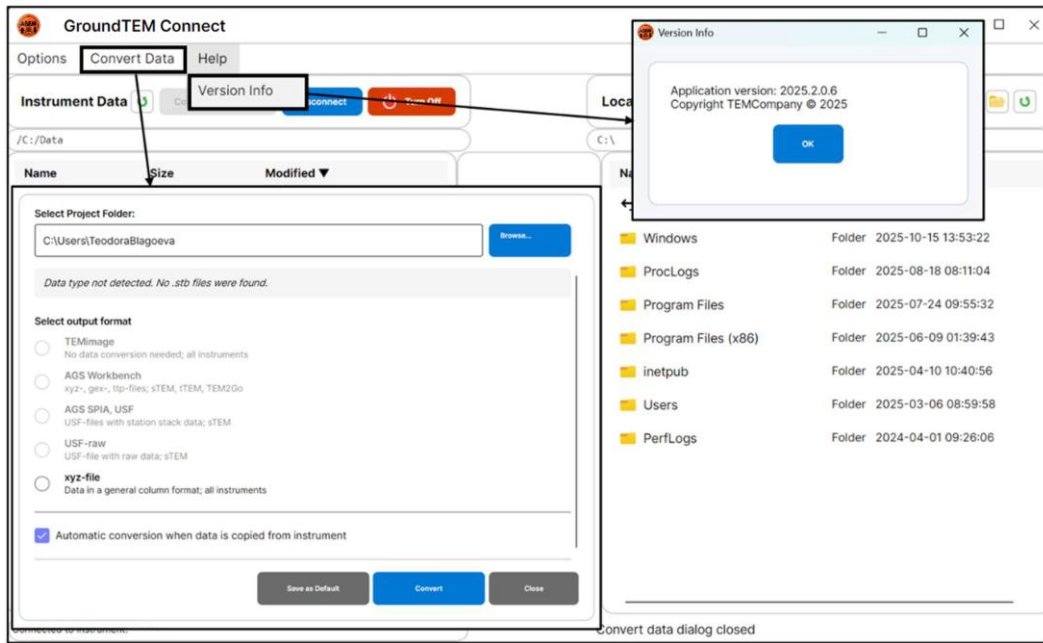


Figure 25: Settings and Options in GroundTEM Connect

Finally, the **Help** menu includes a **Version Info** section, where you can verify whether your application is up to date.

8. GroundTEM Ralli in extreme Temperature

8.1 Cold Weather ($\leq 0\text{ }^{\circ}\text{C}$ / $32\text{ }^{\circ}\text{F}$) – considerations

8.1.1. Water/Coolant

In usual conditions (in ambient temperatures above $0\text{ }^{\circ}\text{C}$ / $32\text{ }^{\circ}\text{F}$), the GroundTEM Ralli system needs to have 25% coolant and 75% water for its cooling system. In some cases, the coolant is already pre-mixed to these proportions, and no further dissolving is needed.

When the system is about to be used in an environment with lower temperatures than that, the coolant needs to be concentrated more than 25%, otherwise the system will freeze. Similarly, the pre-mixed coolants may need to be switched with another coolant that fits the warmer temperature ranges.

Check the coolant's manufacturer information and respect/follow the instructions/limits for each coolant. The most efficient would be to find a coolant for both extreme cold and warm weather. If this is not possible, and the planned survey will take place in extremely different ambient temperature from the previous time, it is highly recommended to change coolant. This is due to the high risks when the concentration is not correct. For example, too high concentration risks severe temperature shutdowns (in ambient temperatures above $30\text{ }^{\circ}\text{C}$ / $86\text{ }^{\circ}\text{F}$) while too low concentrations risk freezing, and breakage of the cooling system (in ambient temperatures below $0\text{ }^{\circ}\text{C}$ / $32\text{ }^{\circ}\text{F}$).

8.1.2. Runners

The runners are made from High Density Polyethylene (PEHD1000) which is known for low friction, anti-stick, abrasion, and its good impact resistance. However, this material can shrink when the temperature is below $0\text{ }^{\circ}\text{C}$, making it difficult to do a field repair/change them in the field in these conditions (see Figure 26).

The recommendation in this case would be to do the repair/changing or the runners indoors or somewhere with room temperature. In this temperature the runners will “expand”, reaching their initial shape, making it easier to attach them back to the system.

In other cases, where no need for field repair arises, it is important to know that the frozen runners have lower endurance range. That creates higher risk for breaking or damaging the runners than usual.



Figure 26. Example of shrank runners in extreme cold weather ($-25\text{ }^{\circ}\text{C}$).

8.1.3. Water hoses

Like all materials, the water hoses that are being used in the GroundTEM Ralli system have a temperature range which is around -5 °C to 60 °C. When a survey needs to be held at a temperature lower than that the ordinary water hose will become brittle and fragile. Then, it will be easier for the hose to break apart and to not provide any more protection to the towing ropes and the cables that are inside them.

An alternative set of Tx coil and Receiver cables, that has been made with a water hose better suited to extreme cold weather can be supplied upon request. In this case, the order needs to be placed a sufficient time before the planned survey, to ensure timely delivery of the cables.

8.2 Warm Weather (≥ 35 °C)

To ensure the best operating conditions, make sure that the fan is not blocked.-If the transmitter gets too hot, shading from the sun may be necessary.

Usually, premixed coolant is sufficient to keep the temperature low, but if the temperature is still rising dilute with distilled water.

If you still have problems with temperature, contact Guideline Geo.

9. Towing vehicle and Distance test

9.1 ATV types

The GroundTEM Ralli is a towed system, which requires a towing vehicle, but not all vehicles are equally suitable. The system is designed and optimized to be towed by an ATV/quad. The large metal frame of larger vehicles will affect the signal and make late time gates unusable. To accommodate larger vehicles, extended transmitter and receiver cables should be used.

9.1.1. Recommended vehicle type:



This kind of “typical” ATV can use standard and extended length cables

9.1.2. Not recommended types:



Larger vehicles and/or those with load-beds, roll-cages, crew cabs, cannot use standard length cables, but the extended length cables will likely be sufficient.

To verify the vehicle does not affect the data, an ATV distance test should be carried out

9.2 ATV distance test

The GroundTEM Ralli frame and sleds are built of non-conductive components to avoid coupling and bias signals. The ATV with the instrumentation is therefore placed approximately 3 meters (10 ft) away from the front of the transmitter frame to minimize interference. The GroundTEM Ralli system has been operating with different brands of ATVs.

If other types of pulling vehicles than an ATV is used, or by any doubt of possible interference from the towing vehicle, we recommend that an ATV distance test is conducted (Figure 27). The ATV distance test should be conducted where the earth signal is low (resistive ground) since minor ATV interference is detectable in this case.

1. Setup the system as normal, but place the instruments, in the normal layout, on the ground or on plastic boxes at the end of the towing rope, instead of on the back of the ATV.
2. Important: Make sure that the transmitter and receiver cables are separated by a minimum of ~40 cm (15¾ inch) as when the instruments are mounted on the ATV.

3. Move the ATV far away (>30 m / 100 feet) and record one minute of data. Make a note of the line number/time interval. This is the Baseline response.
4. Move the ATV as close to the front of the transmitter frame as possible (0 m separation). Change the line number and record for one minute in this position with the ATV engine on.
5. Move the ATV in steps of ~0.5 m (60 inches) away from the transmitter front towards the instrument boxes and record one minute of data at each ATV location and note line number, time, ATV separation at each position. Continue this procedure until the ATV is ~7 m (23 feet) away from the transmitter front. Ensure to make a measurement at the normal ATV position.
6. End the sequence as stated with the ATV far away.
7. Import the data to Aarhus Workbench. Set the stack width to 40 s and turn off filters that eliminate data.
8. Plot the stacked data curve (AVE data) at the center time of the time interval for each ATV distance and compare them with the base line measurements.
9. You should observe that when the ATV is close to the frame the curve is disturbed, compared to the base line response.
10. If no systematic dissimilarities between the response at the normal ATV distance (and longer distances) and the base line response are observed, the ATV - TX-coil distance is sufficient for the specific ATV. You can evaluate the natural fluctuations of the TEM response by comparing the start and end baseline responses. Do not shorten the ATV-transmitter frame distance even if your test results show it is possible.

Extended RX cables and Tx coil lead in can be ordered at any time for existing systems.

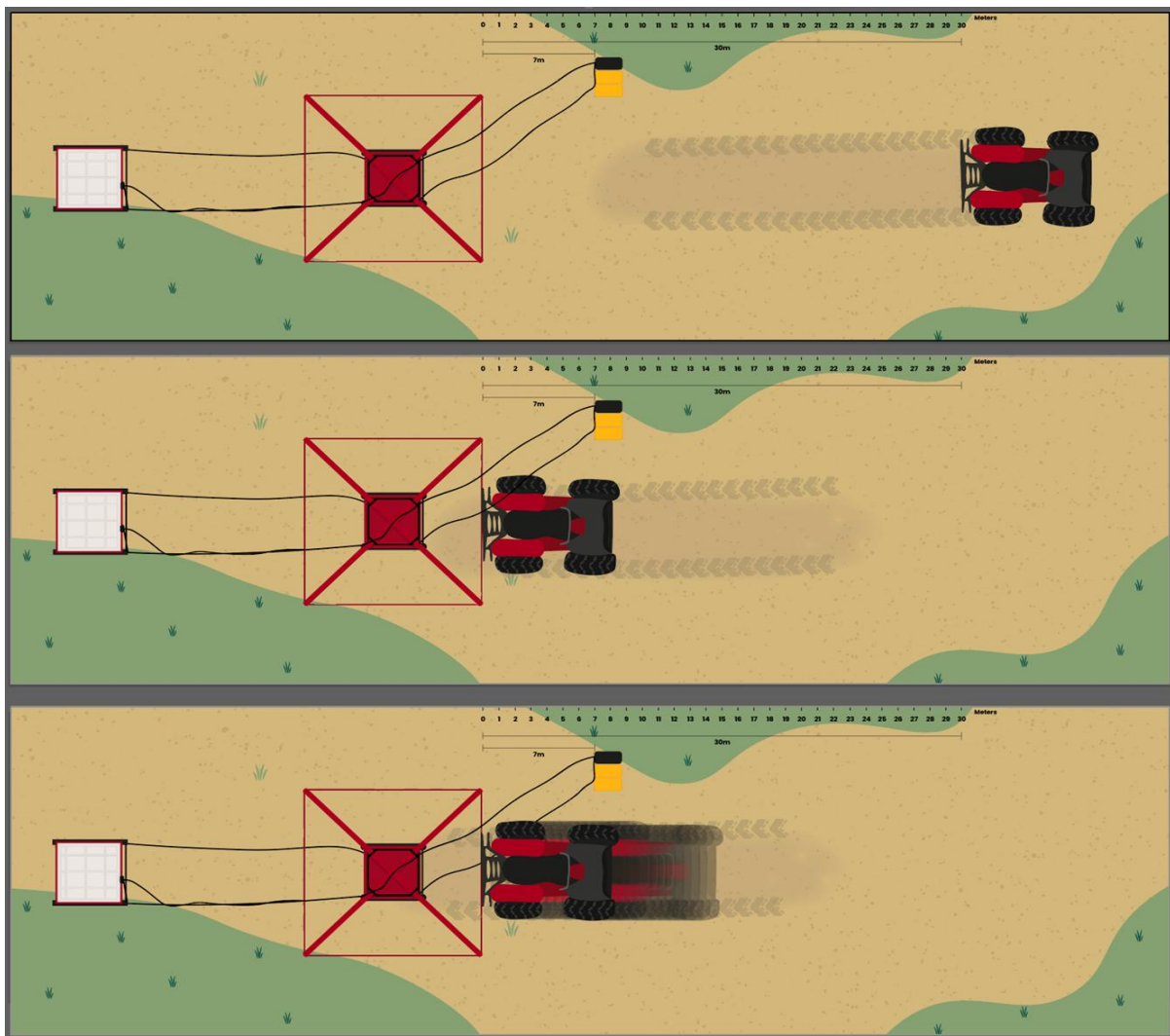


Figure 27 Performing a distance test with the proposed tow vehicle

10. Remote support

If there is a need for remote support, the GroundTEM Ralli needs to be put online and TeamViewer ID needs to be passed on to TEMcompany support.

In some instances, support might also ask for a Sapi log to go though, all the above information can be found in the GroundTEM Ralli Controller app under options → support tab, Figure 28.

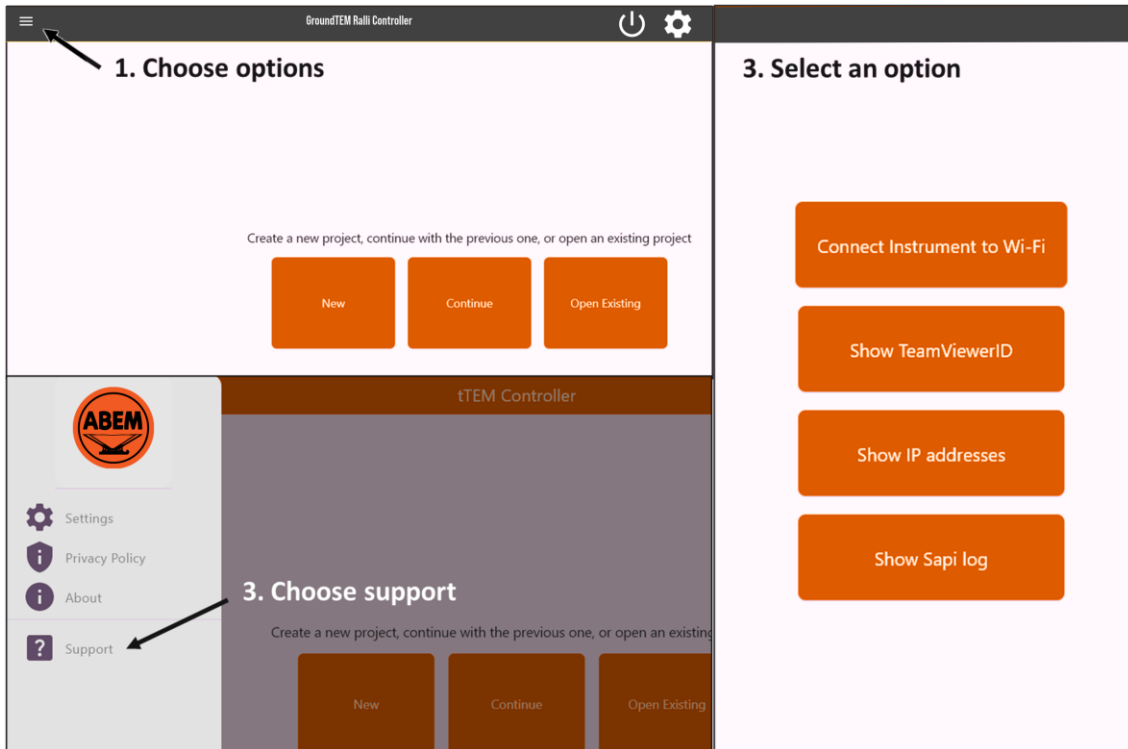


Figure 28 How to access information and get GroundTEM Ralli ready for support.

Appendix I: Components

Electronics



Tx unit



Battery Suitcase



Receiver Coil RS20



RC-2054-2 TiB battery



Power cable



Tx coil



Receiver cable



Tablet

Mechanical



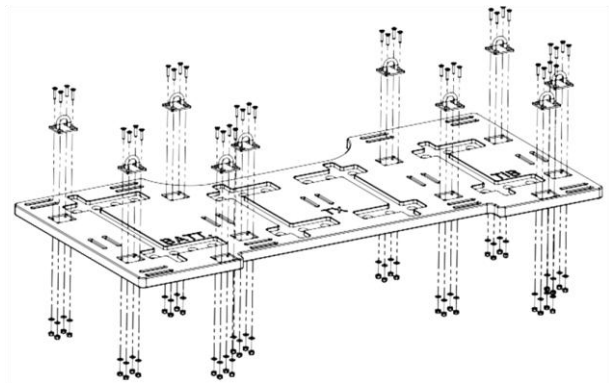
Tx platform



Rx platform



GroundTEM Ralli wings



ATV platform

Miscellaneous



RRC charger



ATV platform Mounting Kit



12 V Victron Battery Charger

Note

Switch off the Victron Battery Charger and then plug in the battery and set power to the charger to make sure it runs an analysis before charging. Be aware that depending on battery depletion it might take 6-8 hours to fully charge a 100 Ah battery.

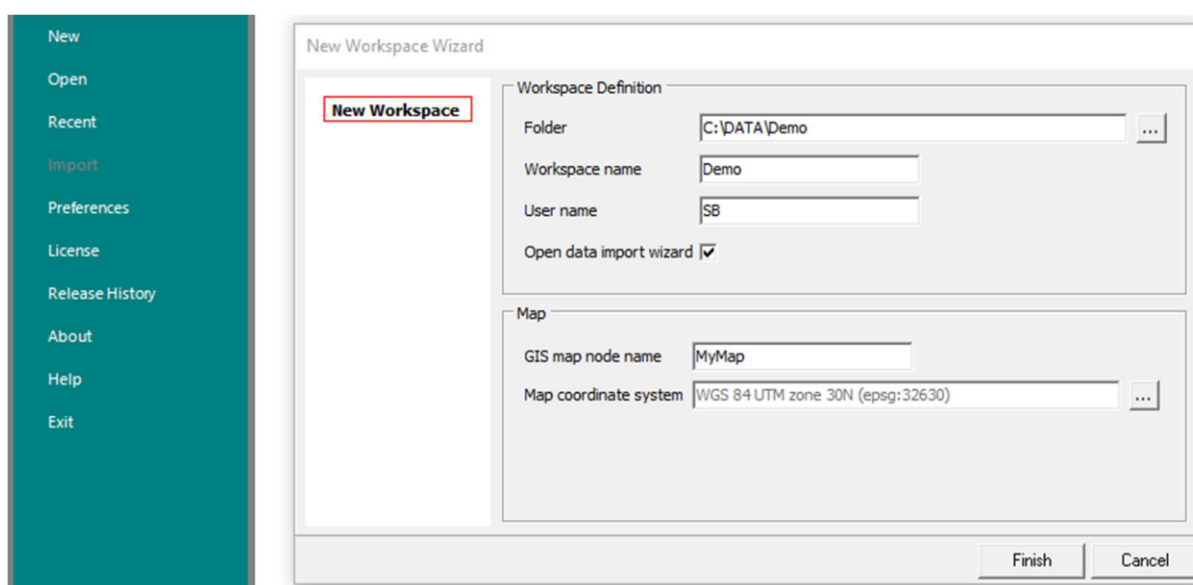
Appendix II: Ralli data - Aarhus Workbench

After a successful survey is completed, the user should follow the steps mentioned in the guide below to import, process, visualize and report the collected data. The present guide consists of a brief walk through for that. However, the abilities of the software extend further, and it is not the subject of the present guide to cover it to that extent.

Import Ralli Data

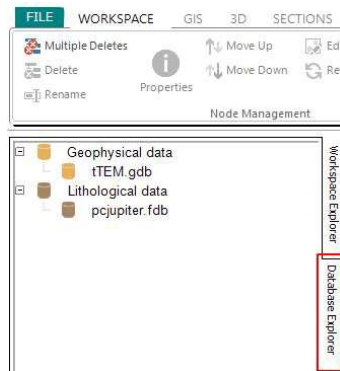
"New Workspace Wizard"

Start "New Workspace Wizard". Select folder where the workspace (ws) will be saved. Provide a name and remember to check which coordinate system you should choose. Press finish and continue.



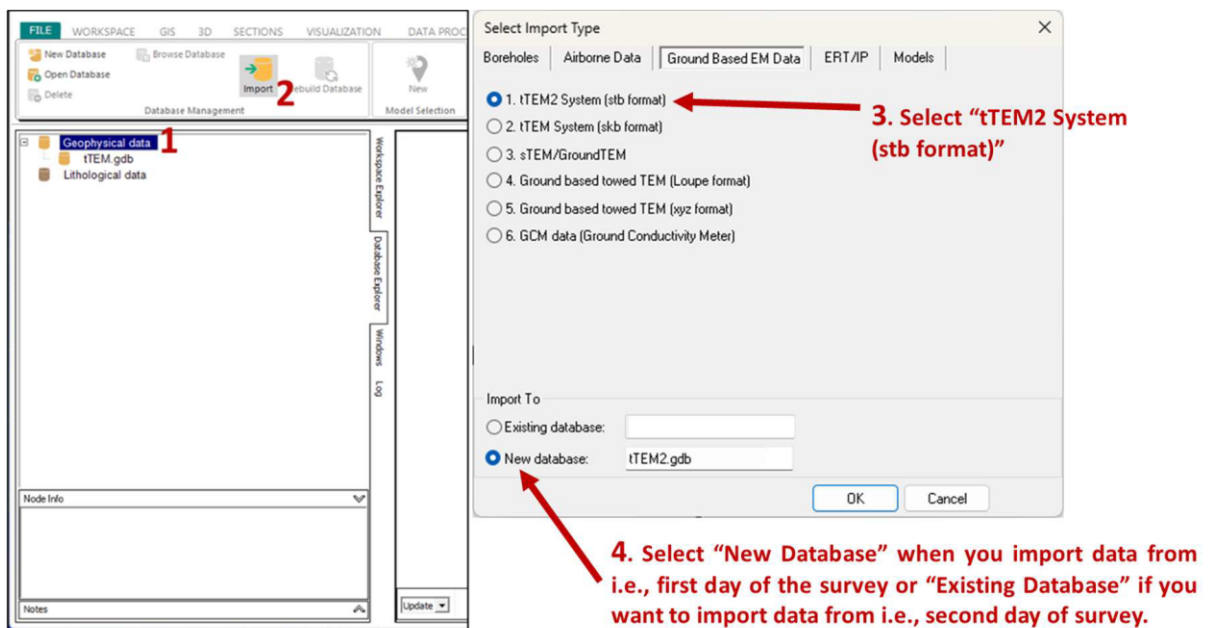
Database explorer

In the new WS, go to "Database Explorer" and select "Geophysical Database". Geophysical database is a file on the hard disk that contains the Ralli dataset(s) (all raw data). Later, if log data are available, one can import them to the Borehole Database which creates a file on the hard disk containing boreholes info (press F1 for more info about the type of log files that can be imported).



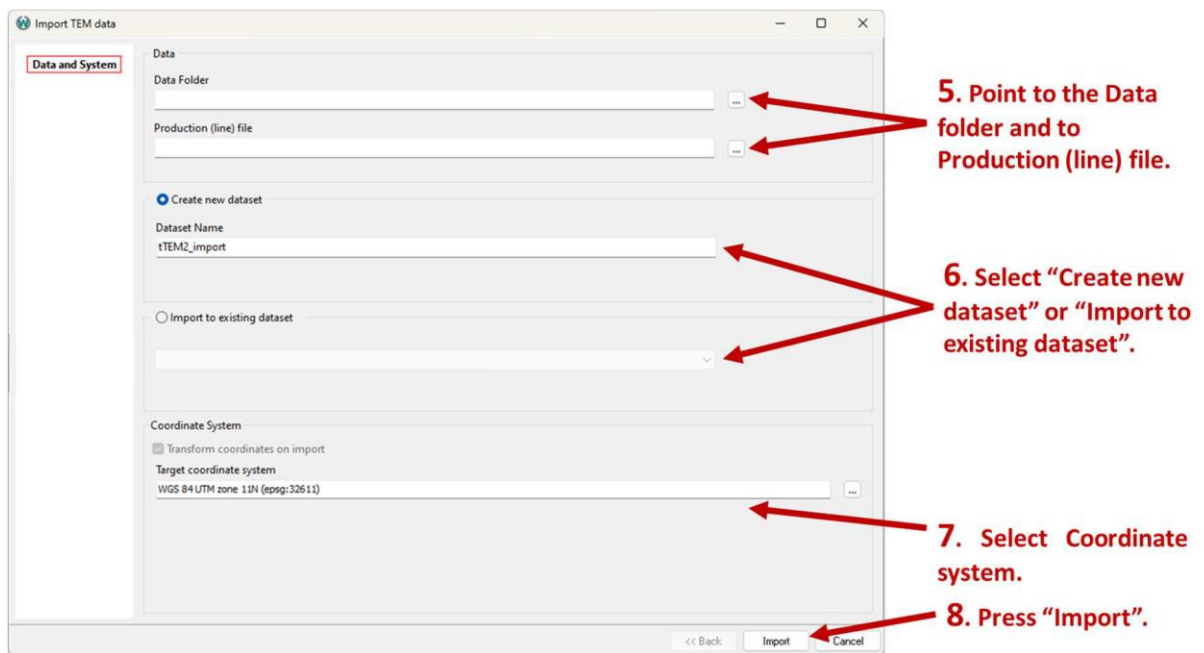
Select import type

To import Ralli data, select "Geophysical data" (1) and then "Import" (2). The "Select Import Type" will open, where the Ralli system (stb format) needs to be selected (3) and then the user selects either "Existing database" or "New database" (4). "New database" corresponds for when data from the first day of a survey are being imported, while "Existing database" corresponds when the second day of a survey is completed etc.



Ralli data import - define Ralli system setup

In the next window point to the Data folder and to the Production (line) file (5) and then select "Create new dataset" or "Import to existing dataset" (6). After these steps select coordinate system (7) and then press "Import" (8).

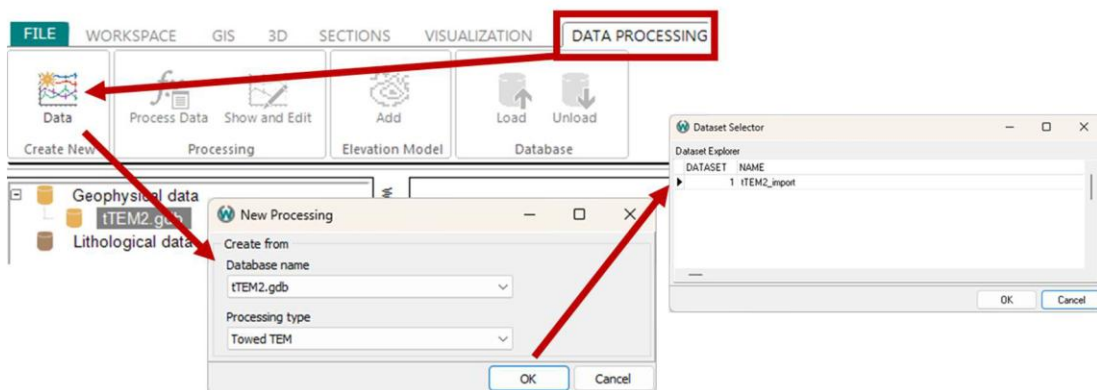


Processing of Ralli Data

Two steps are required before starting the processing of tTEM data. Step 1 is to make a processing node and step 2 is to apply the desired processing settings.

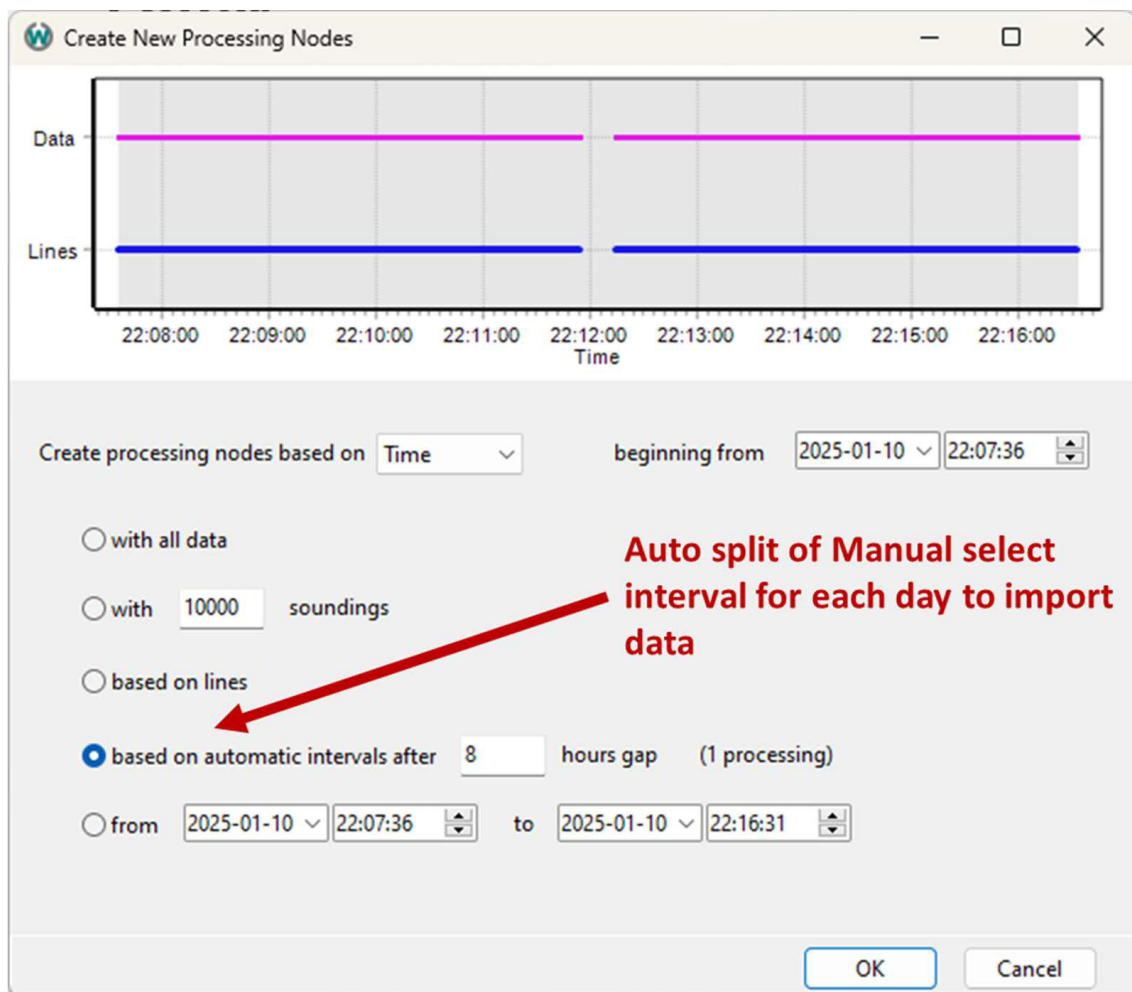
Processing Setup

This step is for how to make a processing node. The user needs to select "Data Processing" tab and then on "Data" on the top left corner of the screen. When the "New Processing" tab opens, select Database name and processing type as "Towed TEM". Select the desired dataset on the next window and press "OK".



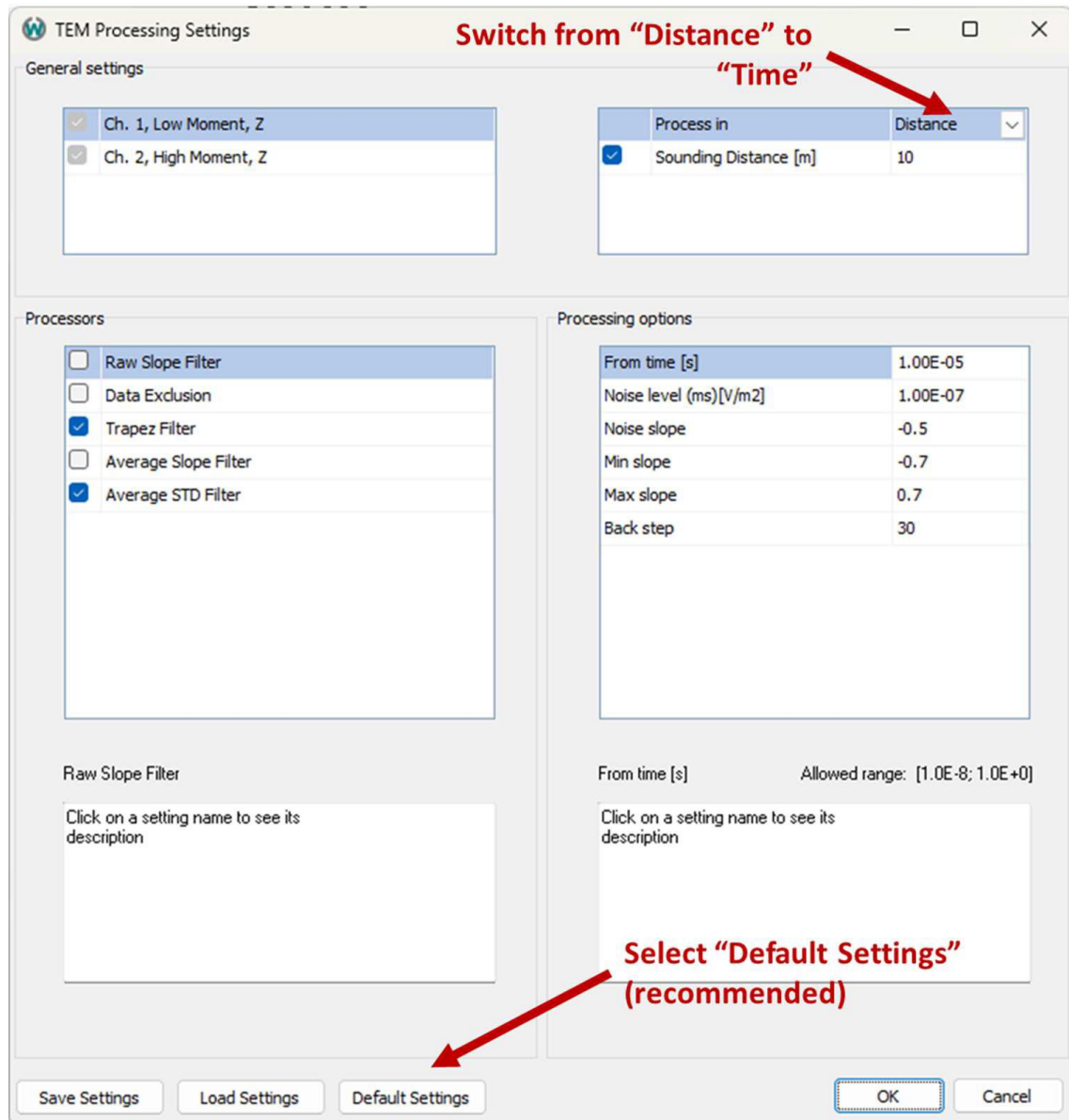
Lastly, the user needs to select time period for the new processing node. The option of auto split is given from Workbench by selecting "Create automatic intervals after _ hours gap". By selecting this option, the user can import data from a long survey i.e., 4 days, and split them into 4 processing nodes by putting 7 hours gap on the option mentioned above. By unclicking this option, the user can select manually which time intervals prefer to use for the new processing node.

We recommend selecting the entire interval and using the auto split option if more than one day of survey have been imported.



Processing Settings

Processing Settings are the last step before the user starts to manually process the data. The user has the option to process data either on "Distance" or in "Time". It is recommended to use the "Default Settings".



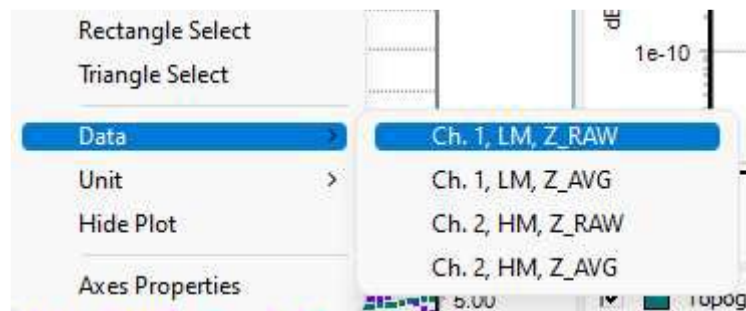
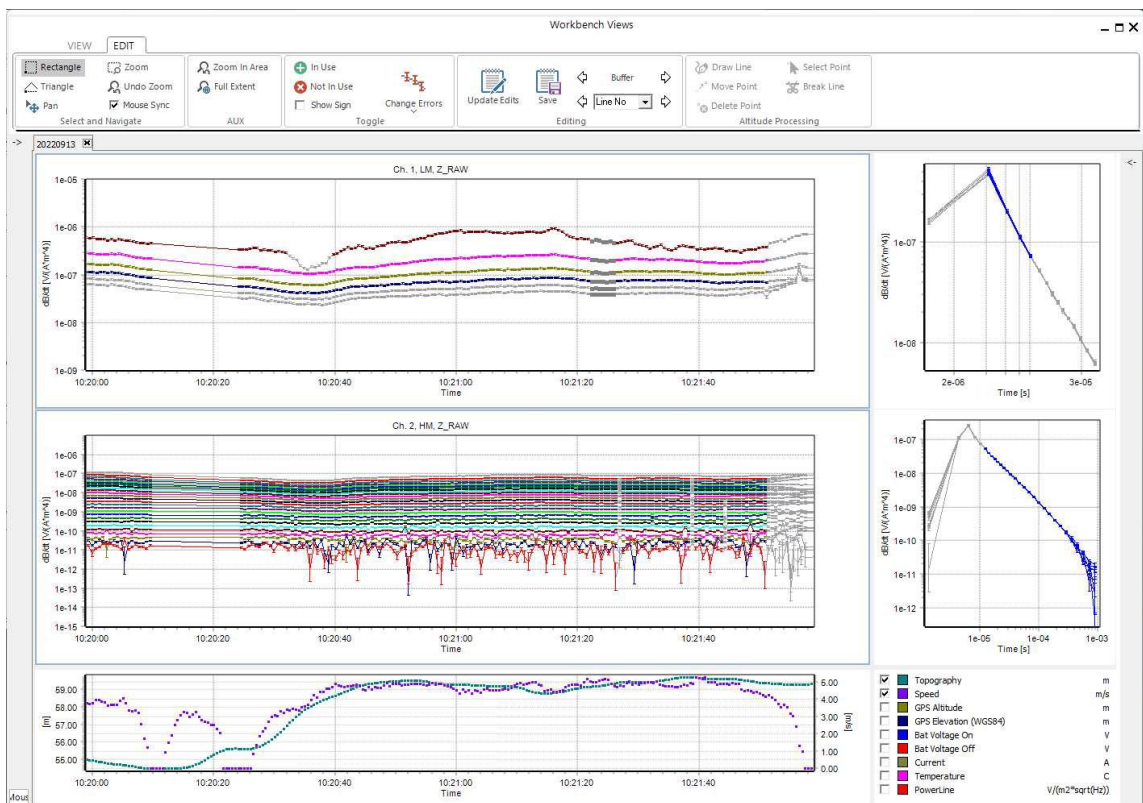
Data Processing - First Step

Data Processing requires two steps and a few adjustments on the view setup. We recommend starting the processing by plotting the raw data of LM (top plot) and HM (middle plot) and speed and topography or current and speed on the AUX plot (bottom plot). After doing that, the user should check/inspect the quality of the data and remove/disable data affected from noise sources, from when the system was standing still (speed 0 m/s) and from turning points where the geometry of the system was not straight.

Good advice:

- Keep gates 2-5 from LM (maybe discard 2nd gate if it has many fluctuations).
- Keep gates 6-30 from HM.
- Check soundings (press "Shift" and then select data).
- Use the "Buffer" button or select "Line No" to navigate through time or Lines.
- Click "Update Edits" and "Save" often.
- See where you stand with the GIS feature of WB.

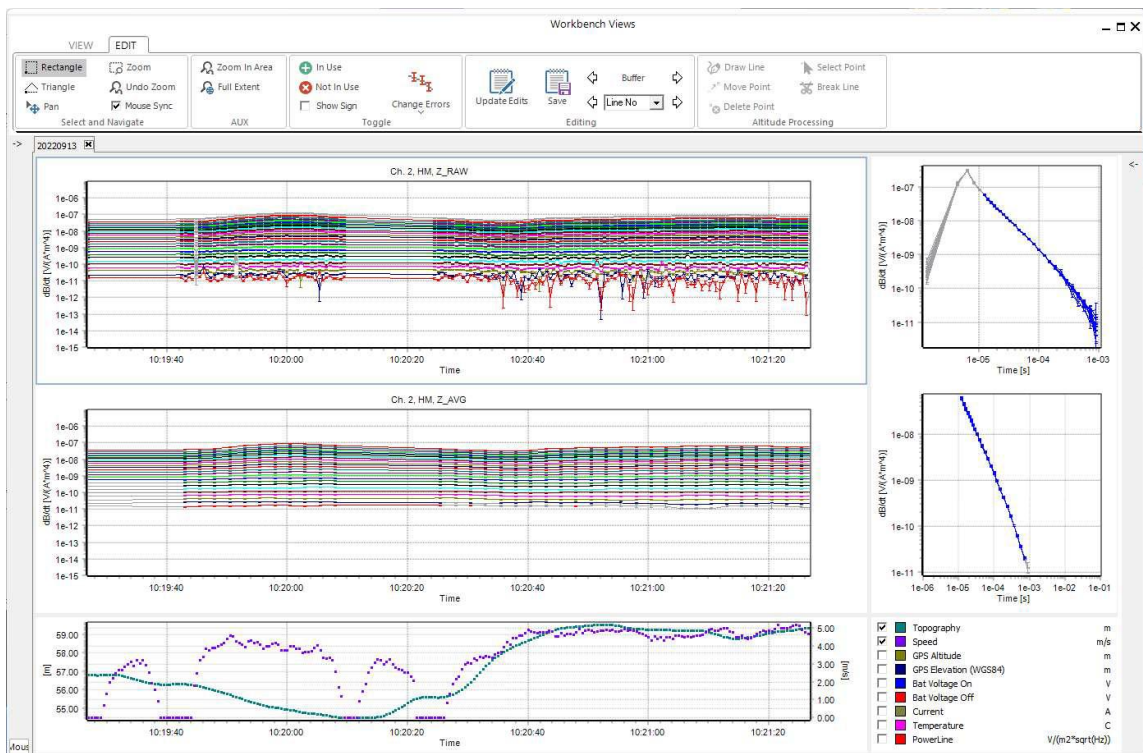
- To disable/enable data select them with the mouse and press Q or A, respectively.
- To switch between LM/HM - Raw/AVG use the right click and select the one you want to work on from "Data".



Data Processing - Second Step

Second Step starts by inspecting the Averaged data (AVG) and is recommend doing it using HM data as a first approach. Change the view setup so there is HM raw data in the top plot, HM AVG data in the middle plot and keep the bottom plot as before. In this step is necessary to check that excluded/included data from RAW agrees with what has been disabled/enabled on AVG. In case there are many mismatches, check LM raw and AVG and make the changes manually.

- You may need to enable data that has been removed automatically due to processing filters, but they are not disturbed by any coupling source, and they can still be used.



Visualization of Ralli Data

The inverted model can be displayed in different ways. Below is a brief description of the most typical ways. The user is directed on the wiki page of Workbench for how to make each of these visualizations, by pressing "F1" under "Visualization tab".

Quality maps - Number of Data, Data Residual and Depth of Investigation

Quality maps can provide information regarding the data misfit, the depth of investigation and the number of data points. The former one shows the efficiency of the inversion (how well the data fitted). The values shown as data residual have been normalized with the data standard deviation. Thus, values below one translates to a fit within one standard deviation. The second one shows the estimated DOI for each inversion model and the latter one holds the amount of data, indicating the S/N ratio on each sounding.

Mean Resistivity Maps

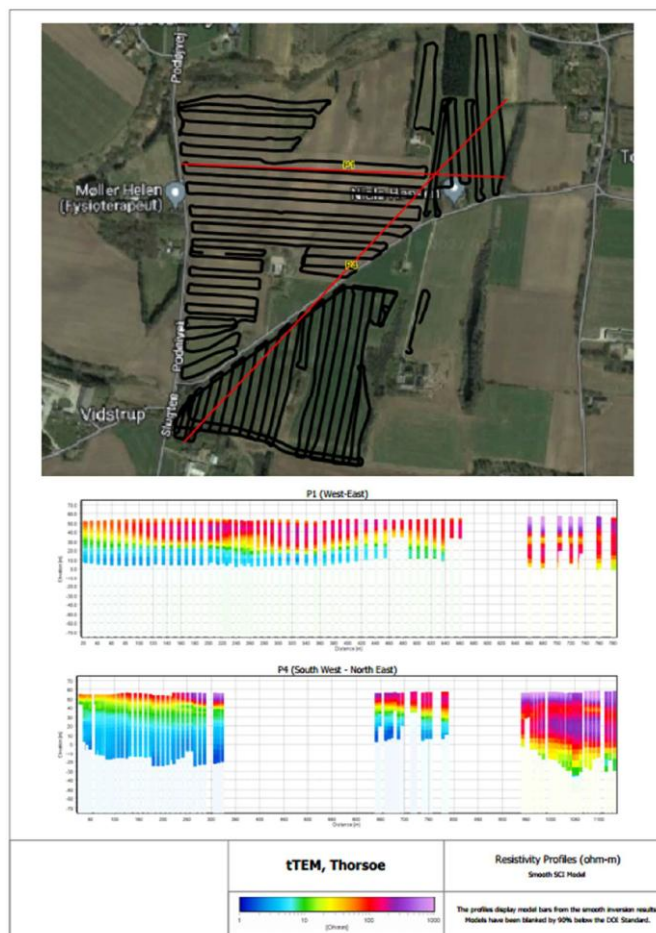
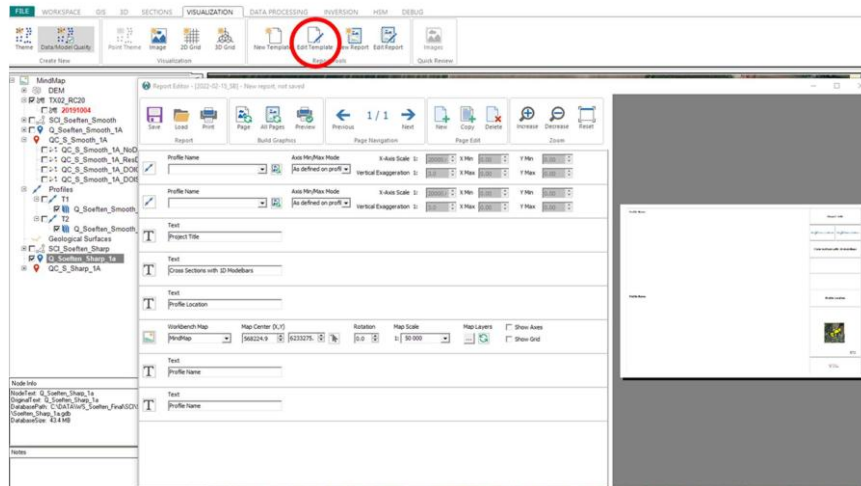
With Mean Resistivity Maps, horizontal slices all through the study are being created. They have uniform specified intervals, and their starting point can be the topography of the area (depth) or the distance from the sea level (elevation). Mean resistivity values for every horizontal slice are calculated from each model and interpolated to a regular grid.

Section/Profiles

Profiles are termed the vertical slices that have been picked through the study area. On each profile information can be added, such as inversion models, borehole data, elevation etc.

10.1 SURVEY REPORTING

In Aarhus workbench it is possible to generate a report including QC maps and themes. The first step is to create templates. This is done in Edit Template on the Visualization ribbon. After creating a Template, a New Report can be made where the Template is added. The user can make 2 templates, one for QC plots and Mean Resistivity Maps. In addition, a template for cross sections could be made. For further details Workbench Wiki page is helpful. Press F1 to open Wiki and then Workbench guides and then number 8: Report Tools Guides.



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