SENSORS & SOFTWARE®
from RADIODETECTION

IceMap™

Ground Penetrating Radar

Operation Manual

2024-00051-00



SPX TECHNOLOGIES

Product Registration

Return this card to register your product, streamline technical support inquiries and receive updates and notifications. You can mail it to Sensors & Software or register your product online at www.sensoft.ca/product-registration.

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Component Serial Numbers (refer to packing list or the sticker on the component)

Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Comp:	Serial #	Comp:	Serial #
Vendor Name:		Date Received:	

End User License Agreement

Please read the End User License Agreement at **https://www.sensoft.ca/producteula/**

Product Warranty and Limited Liability

Please refer to the terms and conditions included as part of your order acknowledgement and/or invoice for full details of the product warranty and limited liability.

Compliance

IceMap complies with emission compliance standards:

FCC Part 15 Subpart B (USA)
ICES-003:2020 (Canada)

For more information, see **Appendix C – GPR Emissions, Interference & Regulations**

Important Safety Information

Follow your company and national safety procedures and or requirements when operating this equipment in any environment or workplace. If you are unsure what policies or procedures apply, contact your company or site's occupational health and safety officer or your local government for more information.

IceMap contains metal parts that can get extremely cold to the touch. Don't touch metal parts without gloves or some sort of hand protection.

The battery charger/AC adapter must only be connected to a power outlet which provides a protective earth (ground).

Connect the AC power cord only to designated power sources as marked on the battery charger/AC adapter.

The battery charger/AC adapter is rated for indoors use only.

Do not replace detachable MAINS supply cords for the battery charger/AC adapter by inadequately RATED cords.

The exterior of this product should be cleaned using a damp cloth.

Safety Symbols



Consult this documentation in all cases where this safety symbol appears. This symbol is used to inform you of any potential HAZARD or actions that require your attention.

Do not attempt to open or dismantle any part of this equipment unless directed specifically by this manual. Doing so may render the equipment faulty and may void the manufacturer's warranty.

Use authorized accessories only. Incompatible accessories may damage the equipment or give inaccurate readings.

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1 Getting Started

The Sensors & Software Inc. IceMap system uses Ground Penetrating Radar (GPR) technology to measure the thickness of ice.

As IceMap is towed across the ice surface, as shown in Figure 1-1 and Figure 1-2, an internal transmitter constantly sends out pulses of radio frequency energy into the ice. This radio energy pulse reflects from the bottom of the ice and is collected by a receiver inside the Noggin GPR sensor. The ice thickness data is saved and displayed in real time as a cross-sectional image (Figure 1-3)



Figure 1-1: An IceMap survey in operation. The IceMap system is being towed behind a truck. Ice thickness data is sent to a computer in the cab of the tow vehicle to display and save.

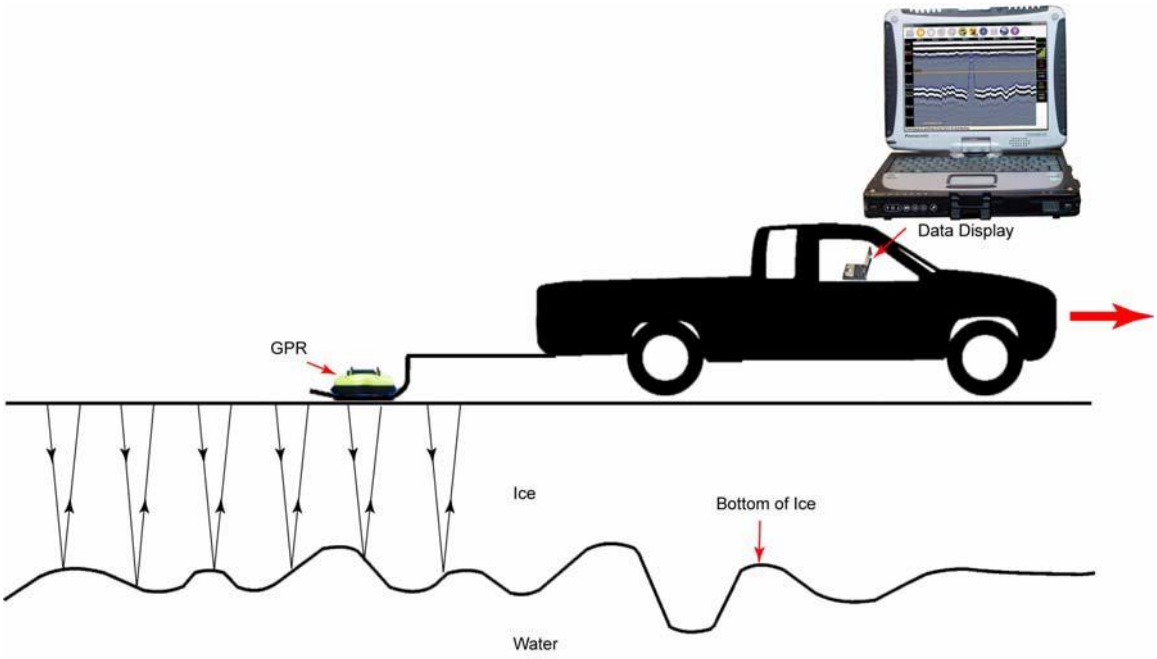


Figure 1-2: A depiction of an IceMap survey. The vehicle tows the IceMap system, which sends radio pulses into the ice to measure ice thickness. The data is saved and displayed on a computer, which is usually located in the cab of the truck.

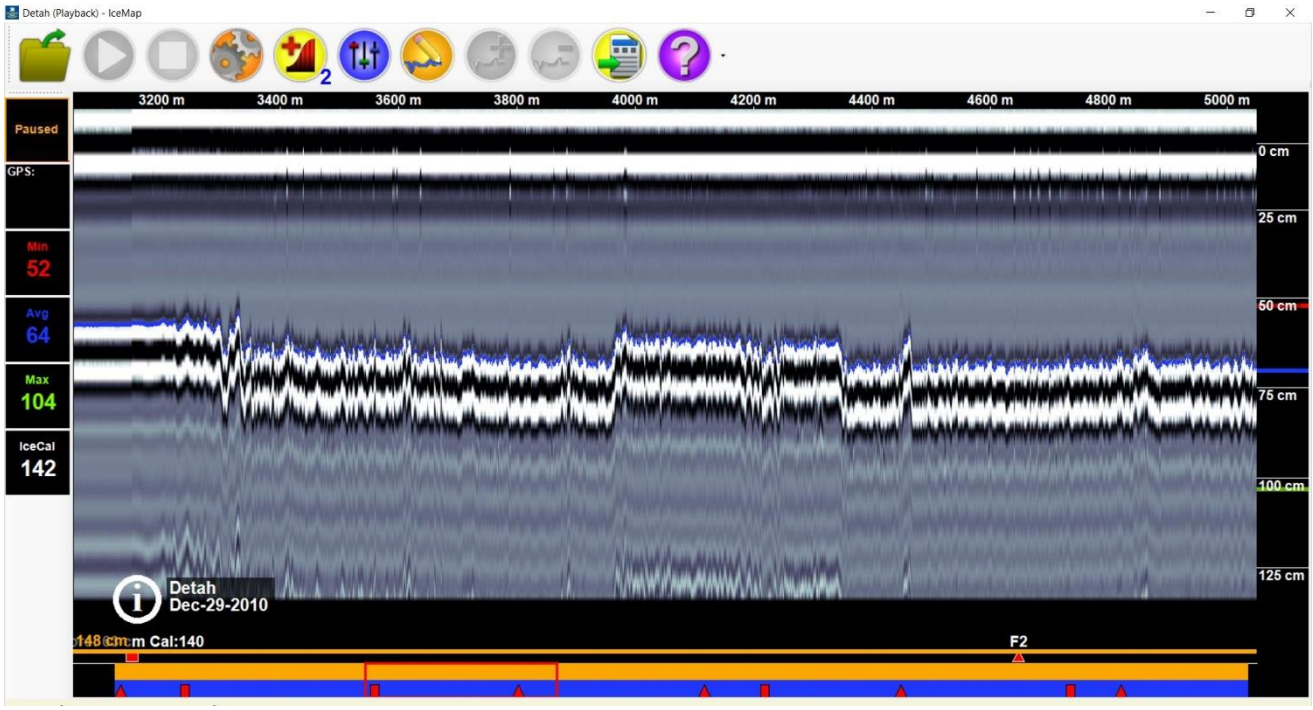


Figure 1-3: Typical IceMap data. The white-black-white bands are the reflection from the bottom of the ice. The bottom of ice should be picked at the top of the highest band; in this case the white band is indicated by the blue line. The vertical scale is about 125 centimeters, and the horizontal scale is about 2000 meters. The ice thickness in this area is about 52 to 64 centimeters thick.

2 IceMap System Assembly

The IceMap system consists of a Computer, the Electronics Case, and a Sled as shown below, in Figure 2-1. The computer, usually kept in the cab of the tow vehicle, is connected wirelessly to the Electronics Case in the sled.



Figure 2-1: IceMap system parts

2.1 Electronics Case

The IceMap Electronics Case is a hinged, plastic case on wheels that houses the Noggin GPR sensor, NIC-500 (Network Interface Controller), and communications and power management devices. The electronics are powered by a 12-volt rechargeable battery.

All connections, except the power connection to the battery, are made at the factory. If any cables are disconnected, refer to Section 13.1 to reconnect them.

2.2 Noggin® GPR Sensor

The Noggin GPR sensor is stored under the Electronics Case divider. The factory-set position (and the position recommended for most ice profiling surveys) is with the long direction of the Noggin running parallel to the long direction of the Electronics Case:



Figure 2-2: Default Noggin GPR sensor orientation for freshwater ice.

However, the foam cutout under the divider has two positions for the Noggin sensor so it can be rotated 90 degrees for surveys on sea ice (Appendix A).



Figure 2-3: Noggin GPR sensor orientation that could be used for sea ice if the default orientation does detect the bottom of the sea ice.

To do this, lift the divider and then move the Noggin GPR Sensor to the new position with long direction of the Noggin perpendicular to the long direction of the Electronics Case.

2.3 Positioning the Electronics Case in the IceMap Sled

The IceMap **Sled** is composed of durable plastic with minimal metal to not interfere with the Noggin GPR sensor.

The **Tow Bar** connection at the front of the sled is designed to attach to different types of vehicles. When the unit is shipped, the tow bar is separate from the sled and must be attached using the bolts provided.

Four metal **Tie-Down Rings** are attached to the inside bottom of the sled. Connect the ratcheting straps to the tie-down rings to secure the Electronics Case to bottom of the sled (Figure 2-4).

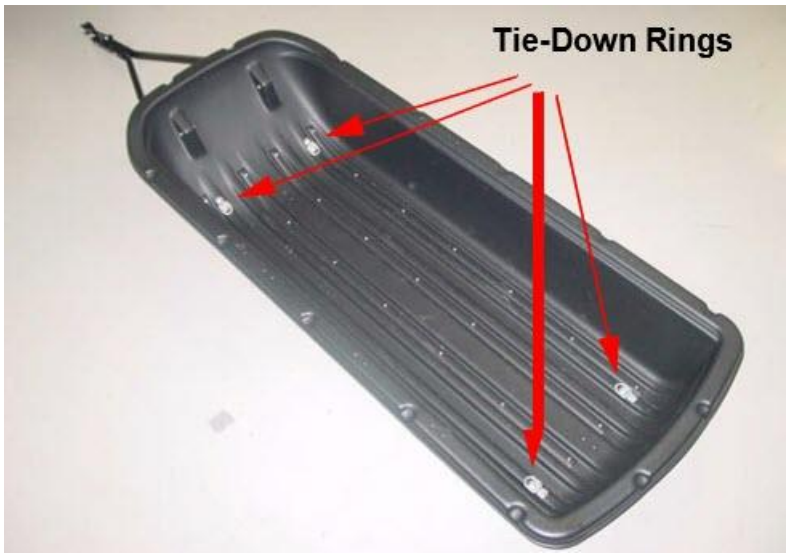


Figure 2-4: The IceMap tie-down rings attached to the inside bottom of the sled to secure the ratcheting straps.



Figure 2-5: Place the non-slip mat in the bottom of the sled.

1) Position the non-slip pad slightly toward the front of the sled (Figure 2-5).

2) Place the Electronics Case in the bottom of the sled.

   This position ensures that the Noggin sensor is as close to the ice surface as possible so that maximum GPR signals penetrate the ice.

3) Position the Electronics Case so that the rolling wheels on the case face the back of the sled so that the wireless electronics will be close to the tow vehicle and computer.

   This position ensures that the Noggin GPR sensor is in optimal position to enable maximum GPR signal penetration into the ice surface. Make sure that the ratchet straps are facing the back of the sled.

4) Attach the strap to the front tie-down (facing the tow vehicle) ring (see Figure 2-4).

   a) Feed the strap through the back handle of the Electronics Case, around the side of the case, and then through the front handle.

   a) Attach the strap to the back tie-down (away from the tow vehicle) ring (Figure 2-6).

   b) Use the ratchet to tighten the straps.

   Note: Avoid over-tightening the strap as it may warp the sled.

5) Repeat step 5 to attach the second strap to the other side of the Electronics Case.

Strap placement secures the Electronics Case while allowing the lid to be opened easily.

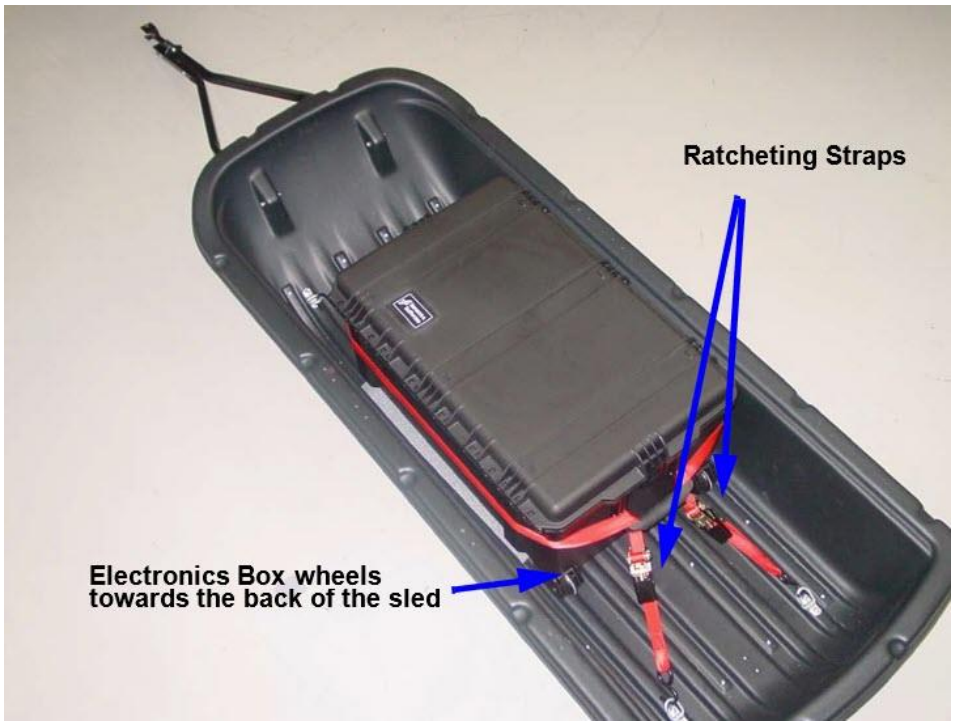


Figure 2-6: The Electronics Case position in the sled. The wheels facing the back to ensure the strongest wireless signal to the computer. The Electronics Case is secured to the bottom of the sled by hooking the straps to the metal rings and positioning the straps as shown. Ratchet the straps tight.

2.4 Toughbook Computer

IceMap data is displayed and stored on a Toughbook computer. The computer is usually kept inside the cab of the towing vehicle where operators can control IceMap data acquisition and monitor the data as it is collected.

The Toughbook computer has a detachable keyboard that is not necessary to have during data collection but is handy for keyboard shortcuts and generating summary reports. For details on attaching or detaching the keyboard from the Toughbook, see the Toughbook manual.

Warning: The Toughbook laptop is not rated to temperatures as low as the IceMap electronics case.

For more details on the lowest operating temperature for the Toughbook, see the Toughbook manual.

2.5 Odometer (optional)

An odometer (Figure 2-7) is an optional accessory that uses a rolling wheel to trigger data collection at equal intervals along the surface. An odometer ensures that the distance on the ground between data sample points, or **Step Size** does not depend on the speed of the vehicle. For example, data collection may vary as the vehicle speed changes, but the step size always remains constant. When data is collected without an odometer, the operator must drive at a constant speed to have a consistent step size. This type of data collection is referred to as a **Free Run** operation.



Figure 2-7: Optional wheel odometer

The odometer cable must be plugged into the port on the NIC-500 labelled “Odometer” (Figure 2-8).



Figure 2-8: Odometer port on the NIC-500

3 Powering IceMap

3.1 IceMap Storage and Operational Temperatures

IceMap has an operational temperature range down to -40º C (-40ºF) providing the following care and maintenance program is followed:

1) The IceMap battery, is charged and stored at room temperature, and is placed in the electronics case before IceMap is used.

2) The IceMap system is powered on after being stored at a temperature of 0ºC (32º F) or higher.

3) The IceMap electronics case is closed during operation. The closed case insulates the electronics from the cold and the electronics will generate enough heat to keep itself warm.

4) If the electronics case is opened to turn the IceMap system off or on, it is closed as quickly as possible to keep the electronics warm.

3.2 Connecting the Battery

To power-up the IceMap system Electronics Case, connect the Power Cable to the battery (Figure 3-1).



Figure 3-1: Connecting the IceMap power cable to the battery in the Electronics Case

Once the battery is connected, all the hardware elements of the IceMap system power up.

3.3 NIC-500 LED Status Message

When the battery is plugged in, IceMap starts an initialization sequence. This sequence will take about 10-15 seconds, and during this time the NIC-500 LED panel displays status messages.

Once this has finished, you will see the following display on the NIC-500:



3.4 Wireless Access Point

The IceMap system uses an access point (**Error! Reference source not found.**) in the Electronics Case to wirelessly send IceMap data to the computer.

3.5 IceMap Sled Cover

Once the Electronics Case has been powered-up, close the lid and then cover the sled with the fabric cover to prevent snow and debris from collecting in the sled (Figure 3-2).



Figure 3-2: The Electronics Case in the sled with sled cover. The cover prevents material from collecting in the sled during data collection.

4 IceMap Data Acquisition Software

1) To open IceMap, double-click the desktop icon .

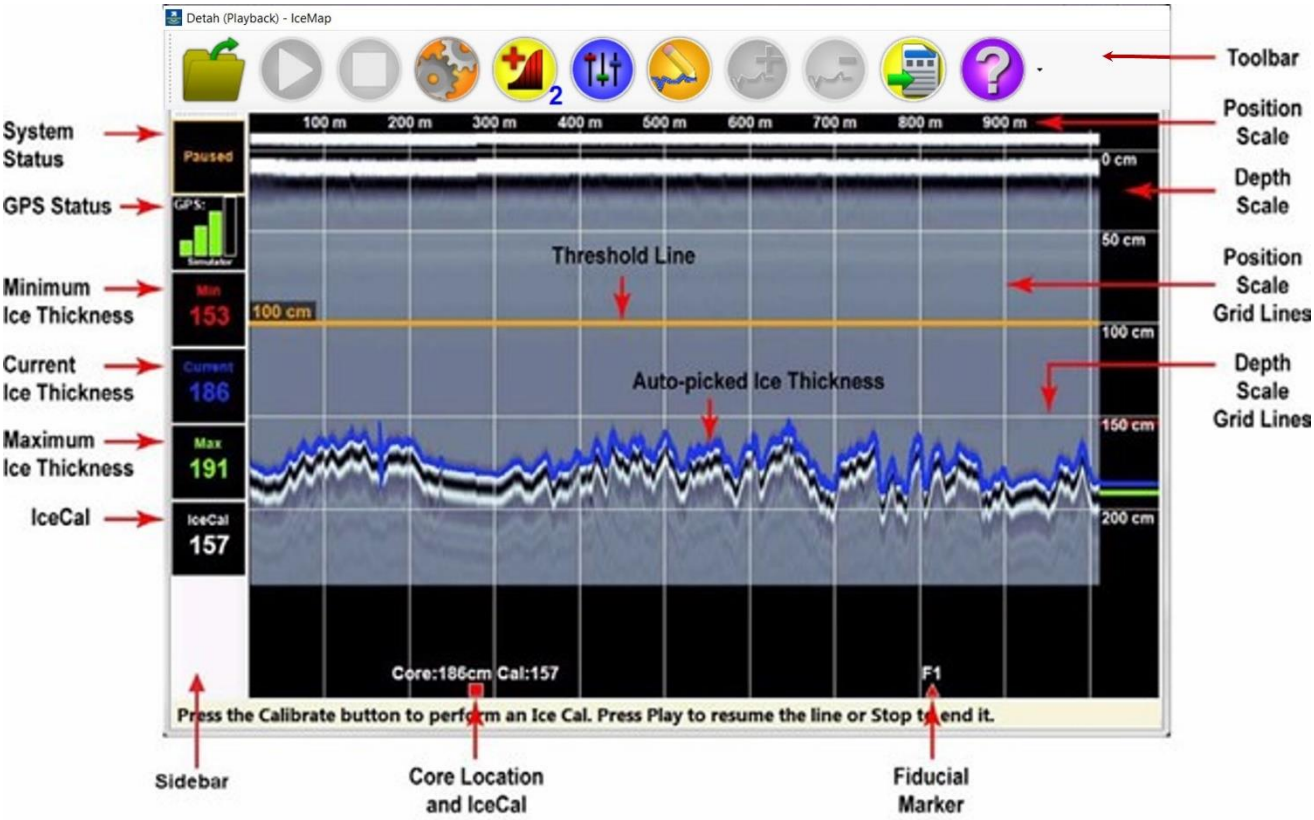


Figure 4-1: IceMap main screen

The IceMap main screen (Figure 4-1) displays a cross-section image of the IceMap data with a horizontal position scale across the top and a vertical depth scale along the right side. These scales have position and depth units in meters (m) and centimeters (cm) if the units are Metric, and feet and inches if the **Units** are US Standard (Section 5.1.2).

The Depth Scale displays a blue bar at the current ice thickness, a red bar at the minimum ice thickness, and a green bar at the maximum ice thickness of the line.

4.1 Threshold Line - Thin Ice Warning

An orange horizontal threshold line is plotted on the IceMap data cross-section image. If the current ice thickness is less than the threshold, the Current Thickness value flashes red and an audible alarm sounds.

To change threshold value, use the up and down arrow keys on the Toughbook computer.

Alternatively:

- Click .
- Click the View Settings dialog box View Settings tab.
- In the Threshold Level (Section 6.1.3) pane, change the threshold level number.

4.2 IceMap Sidebar

The Sidebar displays the following data:

- System Status
- GPS Status
- Minimum Ice Thickness of the current line
- Current Ice Thickness
- Maximum Ice Thickness of the current line
- Ice Cal Value

4.2.1 GPS Status

GPS position is displayed in Latitude/Longitude or UTM depending on the GPS Units setting (to learn more, see GPS Setup (Section 5.2.2).

To view details about GPS, including signal strength, number of satellites, time, position, and elevation, click **GPS Status** 

.

4.2.2 Min

The Min field displays the Minimum ice thickness for the current line.

The Min and Max values can be reset during collection by clicking on them and answering the confirmation message. This is useful in situations when you start the survey line on grounded ice, the Min and Max values can be reset once the IceMap is on floating ice (see Section 7.2.2).

4.2.3 Current

The Current field displays the current ice thickness in the depth scale.

4.2.4 Max

The Max field displays the Maximum ice thickness for the current line.

4.2.5 Ice Cal

Ice Cal represents the speed of the GPR signal through the in millimeters per nanosecond. A typical value is 140 to 170 but can vary from site to site.

4.3 IceMap Toolbar

The IceMap toolbar displays several buttons for data acquisition, changing the system settings and changing the view settings.

Use the following table as a guide to working with the IceMap Toolbar:

	**Open** a previously collected line (to learn more see Section 9.4).
	**Start** a new line or turn off the system pause (to learn more see, Section 7).
	**Pause** data collection on the selected line (to learn more, see Section 7.2.7).
	**Stop** data collection of the current line (to learn more see Section 9).
	**System Settings** allows you to change Depth, Step Size, and Speed (to learn more, see Section 5).
	During data collection, click the **Ice Calibration** icon to enter a known ice thickness measured from a core (to learn more, see Ice Calibrations).
	During data collection, click the **Flag** icon to add a marker to the line at the current position (to learn more, see Section 7.2.6).
	Click the **Increase Gain** icon to increase the amplification of the signal (to learn more, see Section 7.2.5).
	Click the **View Settings** icon to change your IceMap settings (to learn more, see Section 6).
	Click the **Launch Google Earth** icon, if the application is installed on your computer (to learn more, see Section 7.3).
	Click **Help** to open the IceMap User Guide (to learn more, see Section 11).

5 System Settings Menu

The System Settings dialog enables you to edit the system settings 

To open the system settings dialog box (Figure 5-1), in the IceMap toolbar, click **System Settings**.

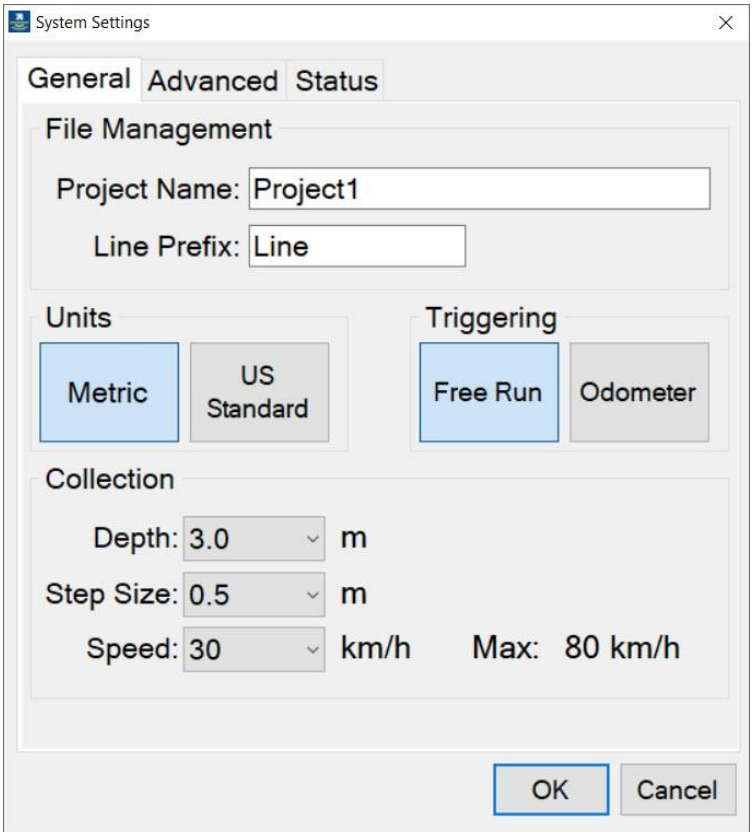


Figure 5-1: System Setup Menu

5.1 General Tab

The System Settings General tab contains features that enable you to identify your project, define how your data will be measured.

5.1.1 File Management

Project Name is the name of the folder the IceMap data files are saved to. The default project name is “Project1.”

To learn more, see Section 5.2.1 for the path where the IceMap data files are saved.

Line Prefix is the name that lines will start with before an incrementing number starting at 00. For example, a Line Prefix of RedRiver will create files with names like RedRiver17; the default line prefix is Line.

5.1.2 Units

Select whether to measure data using Metric or US Standard units.

Click **Metric** to display speed, position, and depth values in kilometers/hour, meters, or centimeters.

Click **US Standard** to display speed, position, and depth values by miles per hour, feet, and inches.

5.1.3 Triggering

Set this parameter to define whether to gather IceMap data collection using Free Run or an Odometer.

Click **Free Run** when you will not be using an odometer with the system.

Selecting Free Run mode adjusts the current system settings to prompt IceMap to automatically collect the required data. The positional accuracy of GPR data collected in free run mode is controlled by the speed the system is traveling relative to the user defined speed setting (to learn more, see Speed and Maximum Speed.

Click **Odometer** when an odometer is connected to the IceMap system.

Note: it is very important to accurately calibrate an odometer to ensure accurate positioning (to learn more, see Odometer Calibration (Section 5.2.3).

5.1.4 Collection

Depth

Click the Depth drop-down list to select the total depth for collecting GPR data:

If units are **Metric**, select a predefined value of 0.5, 1, 2, 3, 5 or 10 meters from the drop-down list.

If units are **US Standard,** select a predefined value of 2, 4, 6, 10, 20 or 30 feet from the drop-down list.

Typical value is 1 to 2 meters or 2 to 6 feet.

Step Size

The suggested value for step size is 0.5m for lake ice and 0.25m for river ice (due to more complex environment for ice formation and more variable thicknesses). Step size is illustrated in Figure 5-2.

Free Run Mode

When you set Triggering (Section 5.1.3) to Free Run**,** the distance is estimated between data collection locations along the ice profile; this is referred to as Step Size. A typical Step Size value is 0.25 to 1.0 m or 1 to 3 feet.

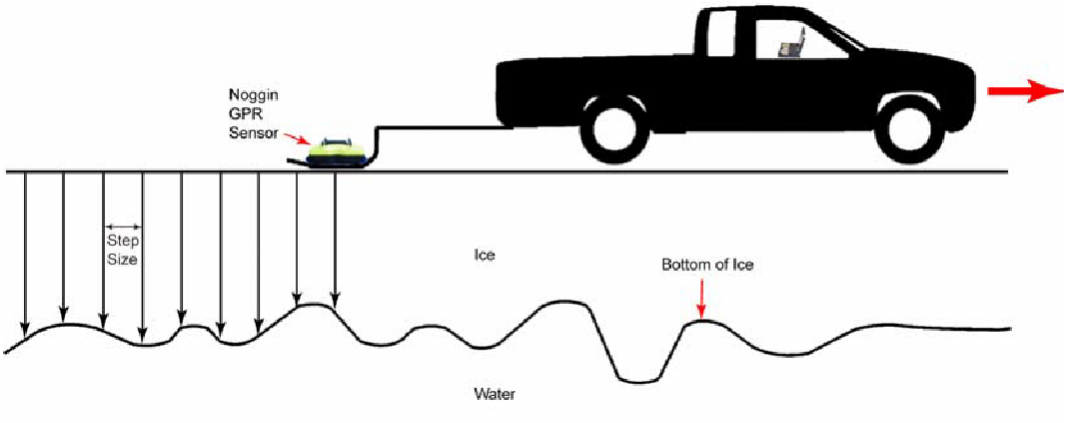


Figure 5-2: Step Size is the distance between data collection points.

If units are **Metric**, select a predefined value of 0.05, 0.1, 0.20, 0.25, 0.5 or 1.0 meters from the dropdown list.

If units are **US Standard,** select a predefined value of 0.1, 0.2, 0.5, 1.0, 1.5, 3 or 6 feet from the dropdown list.

The accuracy of the estimated **Step Size** will vary depending on the speed the data was collected at relative to the speed you defined in Speed and Maximum Speed.

If the data was collected at a faster speed than the one defined in the Speed setting, the data will have a larger step size than indicated by this setting. If the data was collected travelling at a slower speed, then the data will have a smaller step size than indicated by this setting.

Odometer Mode

When you set Triggering set to Odometer, the system collects data at the desired Step Size increment. The accuracy of the Step Size depends on the accuracy of the Odometer Calibration (Section 6.2.3)

Speed & Maximum Speed

From the **Speed** drop-down list, select average speed of the target tow vehicle speed for data collection.

If units are **Metric**, click a predefined value of 1, 2, 5, 10, 15, 20, 25, 30, 40, 50, 60, or 80 km/hr

If units are **US Standard,** click a predefined value of 0.5, 1, 2, 5, 10, 15, 20, 25, 30, 35, 40, or 45 mph.

The **Maximum Speed** for the current depth and step size is displayed. This value may be less than 80 km/hr or 50 m.p.h. if the depth setting is high and the step size setting low.

5.2 Advanced Tab

The **System Settings Advanced** tab (Figure 5-3) enables you to define where the Data Folder will be stored, the GPS Setup configuration, and Odometer Calibration.

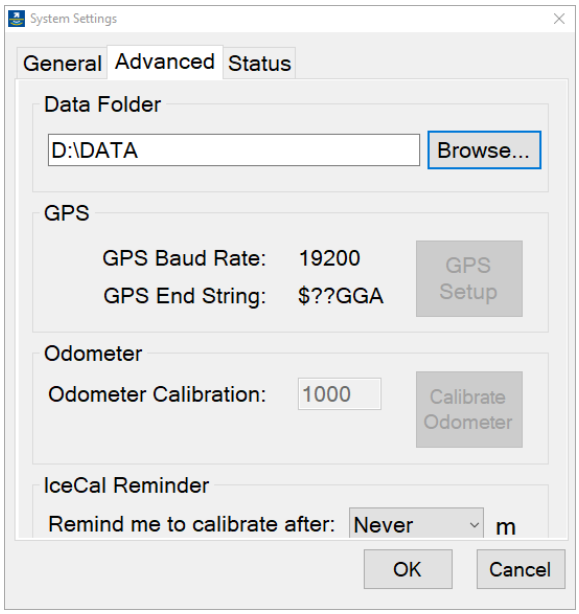


Figure 5-3: System Settings Advanced tab

5.2.1 Data Folder

The Data Folder represents the path and folder name where the IceMap data files are saved on the computer.

Click **Browse** to select a drive letter and folder name. It is important to keep all the data together from a project.

5.2.2 GPS Setup

A GPS system supplied by Sensors & Software is configured in the factory to work with your IceMap system. If the settings are accidently changed, or you are using a third-party GPS, use this section to reconfigure or configure the GPS.

The Global Positioning System (GPS) uses special satellites to determine the position of a GPS receiver located at any position on the surface of the Earth.

The **IceMap** system has a GPS integrated into the Electronics Case (Figure 13-1).

Collecting IceMap data by GPS displays where data has been collected and enables you to extract the location of thin or problem ice areas from IceMap data. GPS also allows ice thickness data to be plotted on Google Earth. GPS information is automatically integrated with the IceMap data; it is also saved as a separate (.gps) file in the data folder.

When a GPS is detected during data collection, it is recommended that you set the Position Scale to GPS Cumulative to display the position axis along the top of the data collection screen (Section 6.1.2).

GPS Setup Menu

To define your GPS settings:

1) In IceMap, click **System Settings** .
2) In the System Settings **Advanced** tab, click **GPS Setup**.

   The **GPS Settings** dialog box (Figure 5-4) enables you to change your GPS unit settings.

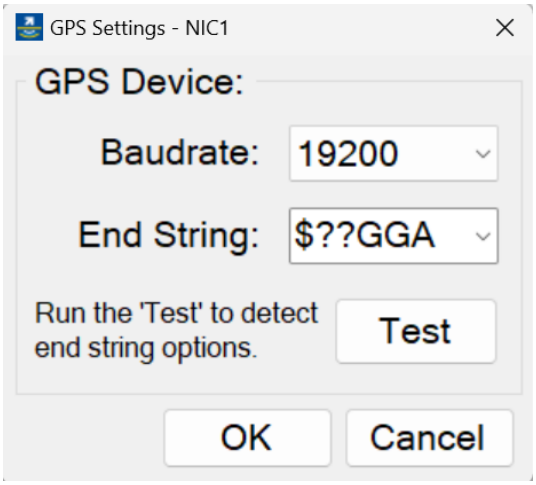


Figure 5-4: GPS Settings dialog

3) **Baud rate** represents the speed that data is sent from the GPS receiver to the serial port of the NIC-500. The Baud rate will be configured at the factory for the Ice Map system (19200). It can be set from the Baud rate drop-down list (Figure 5-5); click 4800, 9600, 19200, 38400, 57600, or 115200.

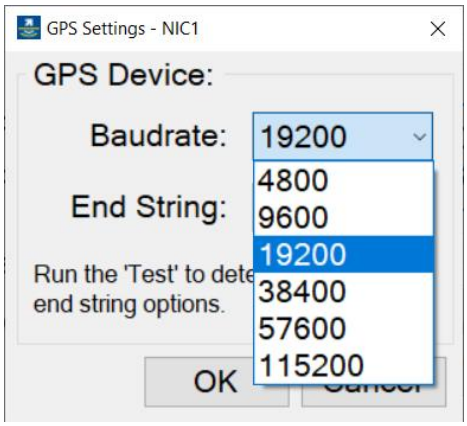


Figure 5-5: Changing the Baud rate for the GPS

After changing the Baud Rate, it is necessary to reboot the IceMap system for the change to take effect.

Once the baud rate is set correctly, clicking **Test** and then selecting the **String tab** (Figure 5-6) will display scrolling information. This indicates that the GPS is communicating properly with the IceMap system. See System Test for more information.

End String

Before using the GPS with the IceMap system, the software needs to identify the prefix of the last NMEA string being sent in each group. In the following example (Figure 5-6), all the strings are the same (GPGGA), so it is the last string that needs to be defined. Depending on the GPS, more than one string can be output; if so, the last one being sent in each group needs to be specified as the End String.

To find the End String for your GPS, click **Test** and then note the first five characters on the last line after each series of strings is written to the screen. These are the five characters that you need to enter in the End String text box.

Refer to the GPS User's Guide for details on how to set up the receiver to output specific NMEA strings or groups of NMEA strings.

System Test

After Baud Rate has been entered, test whether the system is receiving the GPS output:

1) Click **Test**.

2) In the **GPS Status** dialog box, click the **Strings** tab (Figure 5-6).

   The system displays the NMEA strings that are being read successfully.

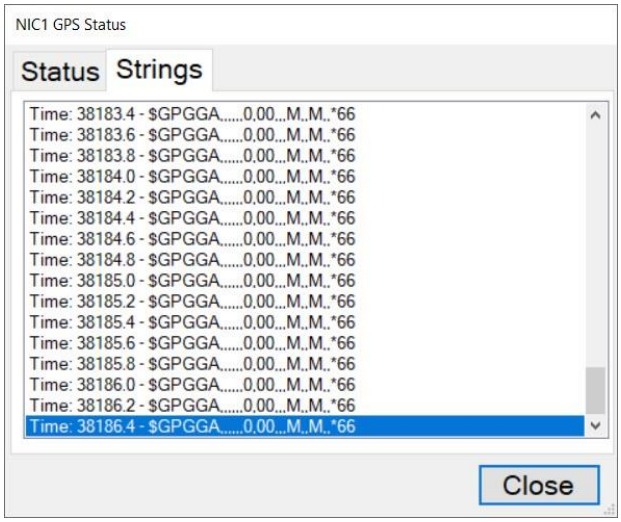


Figure 5-6: The System Test screen showing NMEA strings output by the GPS

   The system displays the NMEA strings that are being read successfully.

3) Record the prefix of the last NMEA string in the list and then enter it in the **End String** text box.

   If the NMEA strings do not appear, change the Baud Rate. If this doesn't work, refer to the GPS User's Guide to learn how to modify the GPS settings so they output NMEA strings across its serial port.

4) Click the **Status** tab (Figure 5-7) to display details about the GPS including signal strength, number of satellites, time, position. and elevation.

   GPS position is displayed in latitude/longitude or Universal Transverse Mercator (UTM) depending on the GPS Units setting (to learn more, see Section 7.1.4 GPS Format).

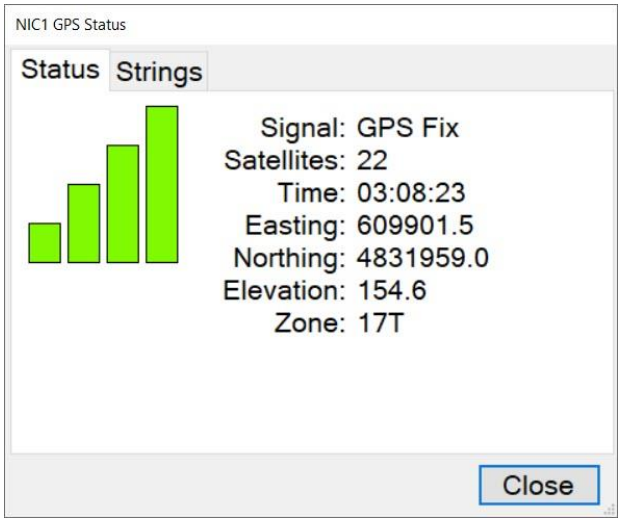


Figure 5-7: The System Test screen showing the GPS Status.

5.2.3 Odometer Calibration

If the Triggering option (Section 5.1.3) is set to Odometer, it is important to calibrate the odometer for accuracy.

Note: calibrate on the longest line possible to ensure accuracy. Calibrating on a 10m long line is not as accurate as a 100m line, especially if you're collecting long lines.

1) Measure the exact distance. Do not use the vehicle odometer to measure calibration distance.

2) In IceMap, click **System Settings**  **.**

3) In the System Settings dialog box**,** click the **Advanced tab.**

4) In the **Odometer pane,** click **Odometer Calibration** (see Figure 5-8). This option is only available when the system is running.

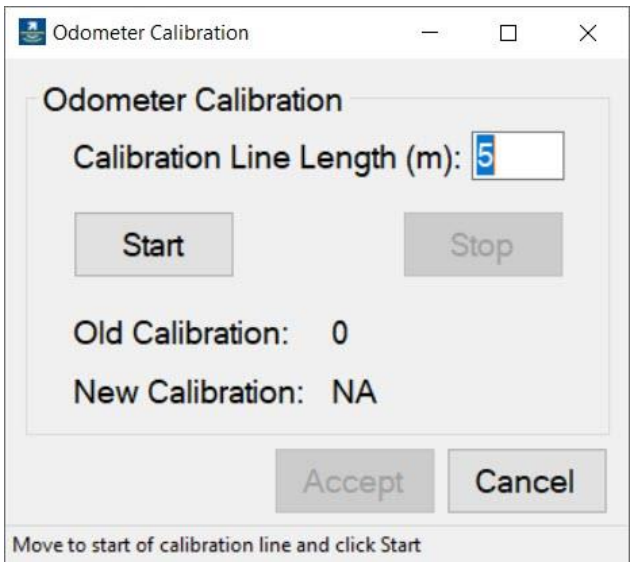


Figure 5-8: Odometer calibration tab

5) In the **Calibration Line Length** field, enter the distance measured in metric or US standard units.

6) Align your vehicle at the start point (the zero measurement) and then click **Start**.

7) Drive to the end of the measured distance and then click **Stop**.

8) To save the new odometer calibration, click **Accept**.

   To use the old calibration, click **Cancel**.

9) To confirm that the odometer calibration is accurate, collect IceMap data over the measured distance and then check that the odometer reading is correct.

5.3 Status Tab

The **System Settings > Status** tab displays information about the performance of the system (Figure 5-9). The battery, temperature, and Wi-Fi levels are displayed as horizontal bars:

- When these bars appear green in color, the system is operating correctly
- When these bars appear red in color, the system is indicating a problem in the corresponding component

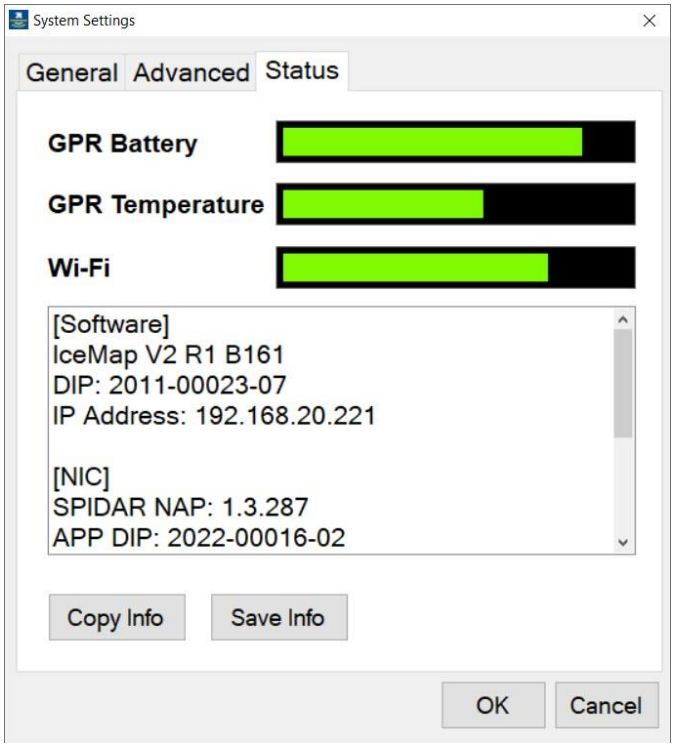


Figure 5-9: Status screen

Battery: When the Battery level turns red it is time to recharge or replace the battery.

Temperature: If the Temperature level turns red, the system is overheating and should be shut down and cooled off before proceeding.

Wi-Fi: If the Wi-Fi level is weak, the IceMap electronics may be having difficulty communicating with the computer.

The lower part of the Status tab displays system details:

- The IceMap software version and serial number
- The Noggin GPR Sensor frequency and serial number
- The NIC-500 embedded software version number and serial number

Clicking on any of the above bars will display the exact value of these settings in a pop-up window.

If the Sensors & Software Service Department requires details about your system, click **Copy Info** to copy the system information to the clipboard so it can be pasted into a document or e- mail.

6 View Settings

The View Settings dialog enables you to edit the IceMap data display settings.

To open, click **View Settings**  on the toolbar (Figure 6-1).

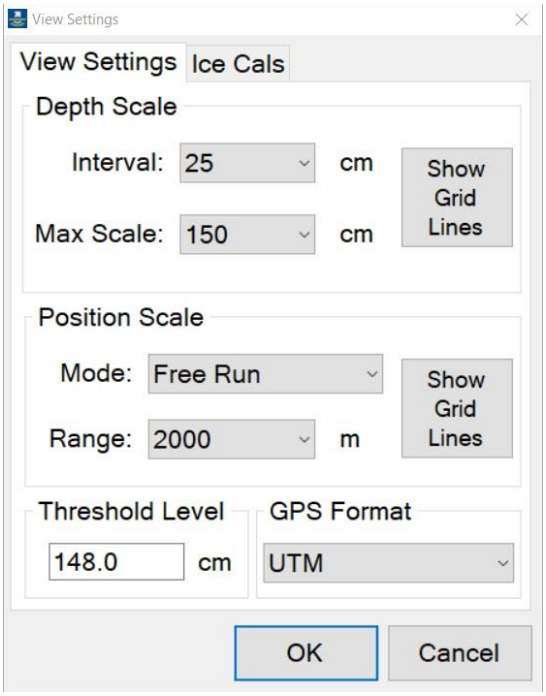


Figure 6-1: View Settings dialog

6.1 View Settings Tab

6.1.1 Depth Scale

Interval

The depth scale interval represents the distance between axis ticks on the depth scale. For example, the Interval on the depth scale in Figure 6-1 is 25 cm.

Interval is normally set to **Auto** which calculates an appropriate distance depending on the Max Scale**.** Otherwise, you can enter a specific labelled tick interval.

Max Scale

Max Scale is the maximum depth that you want displayed on the IceMap cross-section.

Note: This is the depth value that you want to *display*, not the depth value for data acquisition.

Max Scale can be set to a different value than the depth collected. For example, if the depth collected was two meters, set Max Scale to one meter.

Show Grid Lines

Clicking the depth scale Show Grid Lines feature displays horizontal line corresponding to the depth scale labels to be plotted on the cross-sectional data image (see Figure 6-1).

6.1.2 Position Scale

Mode

The distances displayed on the Position Scale are based on GPS (if detected) or Triggering mode: Free Run or Odometer**.**

If a GPS is detected, in the Position Scale drop-down list click **GPS Cumulative**.

GPS Cumulative uses the GPS to calculate the total distance along the line. Be aware that low quality, inaccurate GPS receivers may return an inaccurate position scale.

If a GPS is not available, in the Position scale drop-down list, click **Free Run**.

Free Run mode calculates the distance based on the Step Size and Collection Speed. The accuracy of the Free Run distance measurement depends on how closely the operator moves the system to the tow speed setting.

The odometer calculates the distance based on the total number of traces multiplied by step size. For example, if step size is 0.5m and 100 traces have been collected, the current position is (100-1) X 0.5 = 49.5m (remembering that the first trace is at position 0.0m). The accuracy of this position depends on the accuracy of the Odometer Calibration and odometer wheel slippage.

Range

Range represents the total distance of data that you want to display on one screen in the selected units.

If units are Metric, select a predefined value of 50, 100, 200, 250, 300, 400, 500, 600, 1000 meters, or All.

If units are US Standard, select a predefined value of 150, 300, 600, 800, 900, 1200, 1600, 2000, 3000 feet, or All.

Selecting **All** displays all the data from the survey on the IceMap screen at one time; This makes finding the thinnest sections of the survey easier.

Note: The “All” feature is only available during playback.

Positions are always based on the *set* Speed, not the actual towing speed, so if the Position Scale mode is set to GPS Cumulative and towing speed is not the same as the indicated collection speed, there may be a small discrepancy in the total distance.

Show Grid Lines

Click the position scale Show Grid Lines to display vertical lines corresponding to the position scale labels plotted on the cross-sectional data image (see Figure 6-1)

6.1.3 Threshold

The Threshold Level is represented in the IceMap main screen by an orange horizontal line that is plotted according to a user-defined ice thickness value. If, during data collection, the auto-picked ice thickness goes above the threshold, the IceMap Current Ice Thickness sidebar indicator flashes red and an audible warning alarm sound. Example, if you set the threshold to 50 cm and the ice is picking at 65 cm, there will be no warning. But if the ice gets as thin as 50cm then the system will beep and flash.

To change the ice thickness threshold value, in IceMap Base system, in the **Threshold Level** drop-down list, select a new value.

Alternatively, from the main screen, press the up and down arrows on the computer keyboard.

When saving data and the collection of a line stops, or replaying a previously collected data line, the entire line is re-displayed on the screen. The **Playback Bar** is displayed along the bottom of the screen (see Figure 9-1). An orange outlined box indicates, along the entire data line, where ice is thinner than the current threshold value. If the threshold value changes, this box automatically updates to display the thin areas based on the new threshold value.

6.1.4 GPS Format

GPS Format enables you to select a format for displaying GPS information (Latitude/Longitude or UTM).

6.2 Ice Cals Tab

The Ice Cal value ranges from 100 to 250 and represents the speed of the GPR signal through the ice. The Ice Cal number represents the ice velocity value in millimeters per nanosecond. A typical value is 140 to 170 but it will vary from site to site depending on several factors, such as the amount of air and liquid water in the ice.

Accurate Ice Cals values result in accurate ice thickness data.

Ice Cal values are calculated by completing an **Ice Calibration** after pausing during data collection.

1) To view the Ice Cal values collected on the current line, click **View Settings** .
2) Then click the **Ice Cals** tab (Figure 6-2):

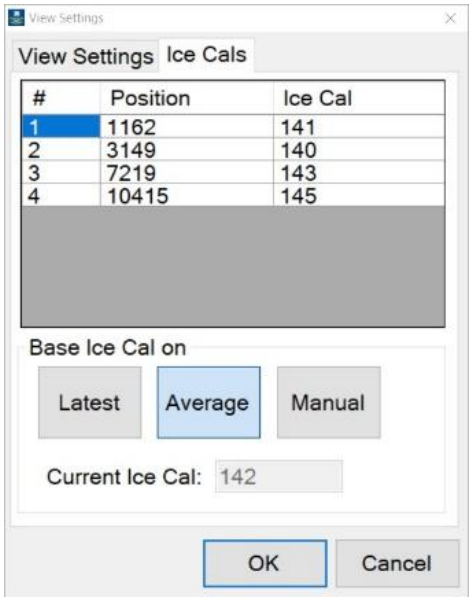


Figure 6-2: Ice Cals tab

3) In the Base Ice Cal on section, select the Ice Cal value based on the **Latest** value, the **Average** value of all Ice Cals or enter a value **Manually**.

6.2.1 How Ice Thickness is Determined

The Depth setting represents how deep the GPR signal attempts to penetrate to the subsurface.

Note: Depth setting is an estimated value that is dependent on the Ice Cal value of the ice.

Ground penetrating radar systems record the time it takes a radio wave to travel to a target and back; they do not measure the depth to that target directly. The depth to a target is calculated based on the velocity (Ice Cal) at which the wave travels to the target and back.

The calculation is as follows:

$$D = V \times T/2$$

Where
D is Depth (m)
V is Velocity (m/ns)
T is Two-way travel time (ns)

7 Collecting IceMap Data

1) When you first run IceMap software, the System Status box displays the word **Searching**.
2) Once the system is detected, the word **Found** appears and a progress bar is displayed as the system initializes.
3) When initialization is complete and the system is ready to collect data, the message changes to **Ready,** and the green **Start** button is enabled for data collection.
4) To start data collection, on the IceMap toolbar click **Start** .

7.1 Select a Line Name

After you click **Start**, the system prompts you for a Line Name (Figure 7-1). A default name populates the text box; the default name is based on the Line Name (see File Management, Section 5.1.1).

The incrementing number is listed, but you can also generate a new default name by clicking **Default Name** in the New Line dialog box; the default line name can be edited or overwritten.

The system enables you to save data to the file name or run without saving data. If data is not saved to a file, the data is lost once it scrolls off the edge of the screen.

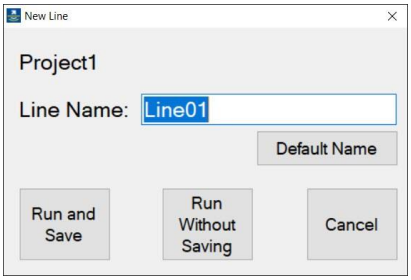


Figure 7-1: The New Line dialog allows users to accept a default name or type a line name or collect data without saving it.

7.2 Starting Data Collection

The system displays a summary of the Project Name, Line Name, Battery Level, and Towing Speed (Figure 7-2). Confirm that all information on the screen is correct.

Click anywhere on the screen to start collecting data.

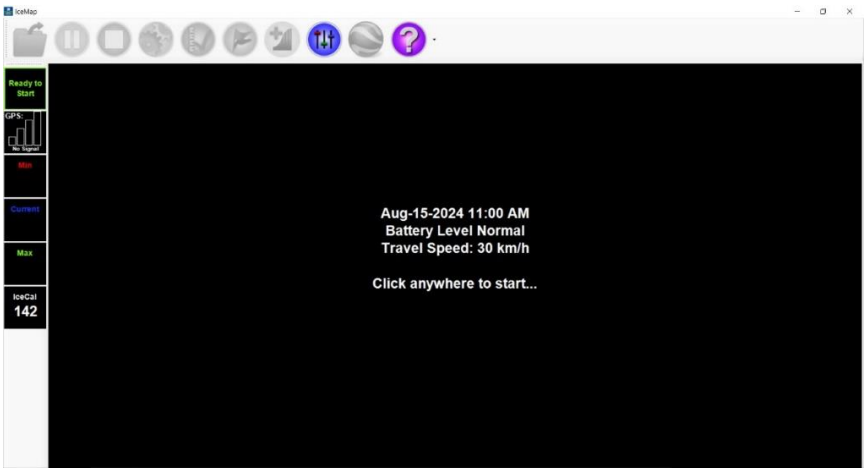


Figure 7-2: Check that the information is correct and click anywhere on the screen to start collecting data.

7.2.1 Data Collection Screen

The data collection screen is shown in Figure 7-3. Data traces scroll onto the screen from right to left; the current data trace is on the right edge of the screen.

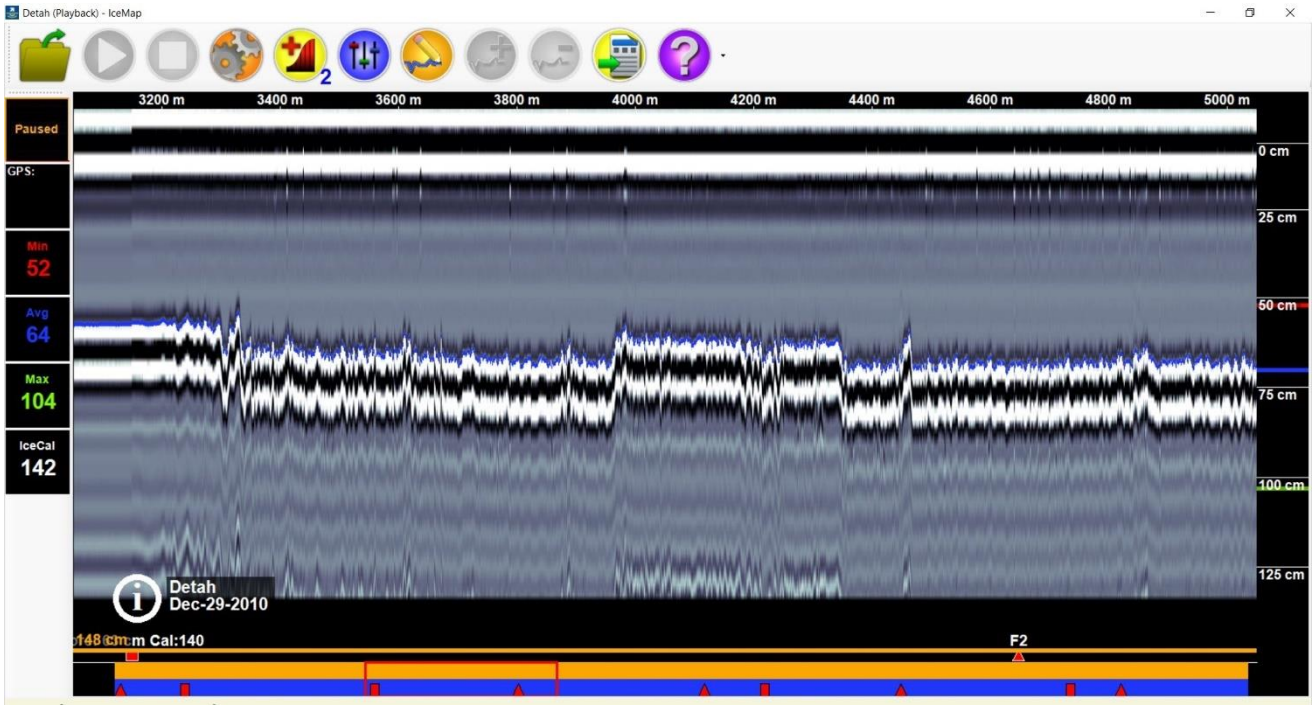


Figure 7-3: Data collection screen

7.2.2 Ice Thickness Values

The left side of the screen displays the Minimum (Min), Current, and Maximum (Max) ice thickness for the current line.

To reset Min and/or Max values, click the number and then select **Reset Ice Thickness**. This feature is useful when the Min ice thickness value is not accurate because the survey line started on shore or passed over grounded ice.

7.2.3 Position Scale

If Triggering is set to Free Run Mode (Section 5.1.3) drive at the specified Speed shown in the System Settings window.

If Triggering is set to Odometer Mode (Section 5.1.3) drive at any speed below the Maximum Speed. Maximum Speed is also displayed on the start screen.

Free Run or Odometer with GPS

If a GPS is detected and collecting data in Free run or Odometer mode with the Position Scale set to GPS Cumulative, the Position Scale across the top of the screen is based on the cumulative GPS distance. The cumulative GPS position is the sum of the distances between all the traces collected.

Note: It is important to understand that the cumulative GPS distance will vary depending on the accuracy of the GPS used.

Free Run with No GPS

If you have set the Position Scale to, and are collecting data in Free Run Mode, the position scale results are based on the total number of traces multiplied by the step size.

For example, if Step Size is 0.5m and 100 traces have been collected, the current position is (100-1) X 0.5 = 49.5m (remember that the first trace is at position 0.0m). The accuracy of this position depends on how closely the operator tows the system at the towing Speed.

Odometer with No GPS

If you have set the Position Scale to, and are collecting data in Odometer Mode, the position scale results are based on the odometer. The accuracy of this position depends on the odometer accuracy including odometer calibration and wheel slippage.

7.2.4 File Size

The length of a IceMap line is typically based on individual water bodies or areas to report on together. IceMap data files are limited to 100,000 traces, which is about 40 km (25 miles) if the interval is set so the typical value of 0.25m.

After collected 90,000 traces, messages will appear on the screen warning users that the maximum file size is approaching so they should prepare to end the current line and state a new one.

Note that if the power is interrupted to the IceMap system during data collection, the data is saved, except for a bit on the end of the line.

7.2.5 Gain

If, during data collection, the bottom of ice reflector appears weak, the operator can increase the gain or amplification of the signal by clicking **Gain**  on the IceMap Toolbar.

The current Gain value is displayed in the bottom right corner of the button. In Figure 7-3, the gain number is 2. Gain represents a value from 1 to 5, low gain to high gain. It is typically set to 1 and only increased when necessary.

Clicking the Gain button with the Gain set at 5 resets to the Gain back to 1.

7.2.6 Flags/Fiducial Markers

To enter flags (or fiducial markers) into the survey data, click **Flag/Fiducial** on the IceMap Toolbar during data collection.

This displays a red triangle on the bottom edge of the data image with in incrementing number, i.e. F1, F2, F3, etc. (to learn more, see Figure 7-3).

To add a flag after the system has passed a point of interest (the point must still be displayed on the screen):

1) **Pause** data collection
2) Click the point of interest.
3) Click the **Flag/Fiducial** button.

Flags typically mark significant points in the data such as, mile markers, landmarks, snowbanks, snow-covered areas, bumpy ice sections, flooded areas, surface water, surface slush, core locations, and so on.

It is a best practice to take notes regarding the flag number and what it corresponds to. This can be very helpful when analyzing the IceMap data later.

7.2.7 Pausing Data Collection

When the system is paused, the operator can obtain information about any data position on the data image, continue to collect data, complete an ice calibration, or stop and exit from the line.

To pause data collection, on the IceMap Toolbar, click **Pause** .

While data collection is paused, clicking anywhere on the data cross-section displays the line position, cursor depth, ice thickness and Latitude/Longitude:

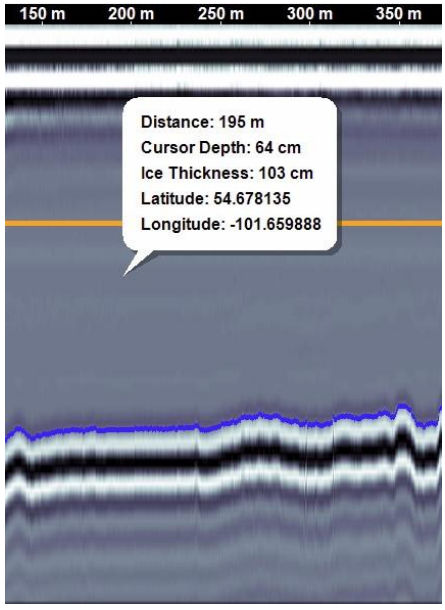


Figure 7-4: While data collection is paused, click anywhere on the image to display information about the ice thickness at the selected point.

To continue collecting data on the same line, on the IceMap Toolbar, click **Start** 

7.2.8 Ice Calibration

Every survey line should include at least one ice calibration to ensure ice thickness accuracy. To complete an ice calibration:

- Stop the vehicle but continue to collect data for another three seconds to create a flat ice bottom reflector on the right side of the data collection screen.
- Click **Pause**.
- Click **Ice Cal** .
- Using the mouse cursor, click the position on the line where the Ice Cal will be performed (Figure 7-5):

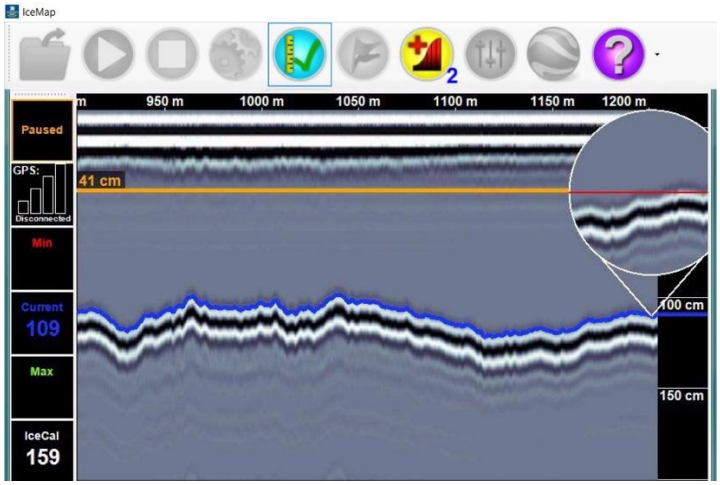


Figure 7-5: Click the screen where the Ice Cal will be performed.

- Drill a hole at the same position as the Noggin GPR Sensor (you may need to move the sled out of the way) to measure the thickness of the ice (Figure 7-6).



Figure 7-6: At a location where IceMap data have been collected, drill a hole through the ice and measure the ice thickness.

- Click the **Ice Cal** button  again. The Ice Cal dialog box allows you to move the data image up or down so the red calibration line corresponds exactly with the top of the white band representing the bottom of ice reflection (Figure 7-7). Alternatively, click **Snap to Auto Pick** to align the red calibration line to the blue pick line.

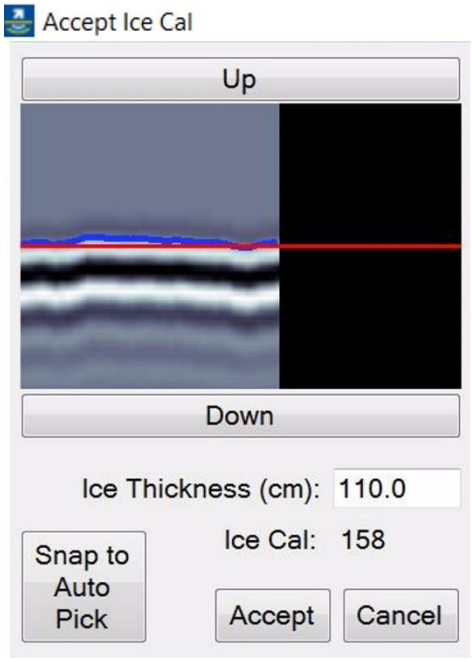


Figure 7-7: Lining up red calibration line

- Enter the ice thickness value obtained from the core measurement.
- If the Ice Cal value is acceptable, click **Accept**. If the Ice Cal value is not acceptable, click **Cancel**.

- Record the **Ice Cal** value in a notebook for future reference.

  When the Ice Cal value is changed, the depth scale of the IceMap data image is automatically updated, depending on how the Ice Cal value is calculated (to learn more, see Ice Calibrations). The key point is that the thickness value of the thinnest ice changes when the Ice Cal value changes.

7.2.9 Stopping Data Collection

To stop and exit the line, on the IceMap Toolbar, click **Stop**  on the IceMap Toolbar.

7.3 Google Earth™ Path

Note: This feature requires a GPS and is only available during data collection.

To display the Google Earth path for the line survey, in the IceMap toolbar, click the Google Earth button .

If you have Google Earth installed, the application opens and plots the path, flags, and Ice Cals for the selected IceMap data line (Figure 7-8).

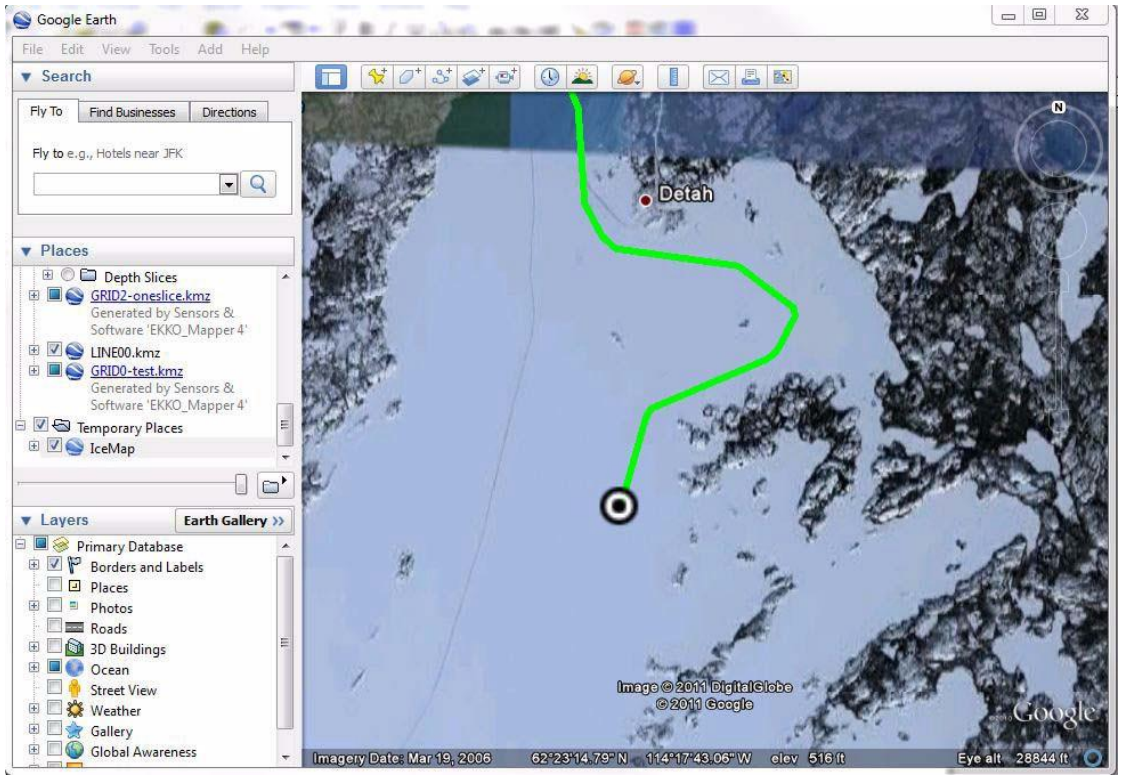


Figure 7-8: IceMap path displayed on Google Earth during data collection.

Displaying both IceMap and Google Earth windows, enables you to monitor ice thickness using IceMap and the survey line position with Google Earth.

If the IceMap data collection computer does not have internet access out in the field, before going out to the field to collect IceMap data, use Google Earth's caching feature to save detailed Google Earth images of the survey area. To learn more, see Appendix B.

8 IceMap Data Collection Tips

8.1 Ice Calibrations

Every IceMap survey line should have at least one Ice Calibration to ensure the accuracy of ice thickness measurements. It may be necessary to collect more than one ice calibration on a survey line if conditions change during the survey. Factors that influence collecting additional ice calibrations are:

- Construction vs. Maintenance - More ice cores are required during ice road construction than maintenance.
- Proximity to Shore - more cores when close to shore
- Water Depth - more cores in shallower water
- Lake vs. River - more cores on rivers due to stronger currents
- Currents - more cores on sections of lakes where there are known currents
- Streams - more cores near stream inlets into lakes
- Highly Variable Thickness - if the GPR thickness measurements are highly variable, more cores are recommended

8.2 Collecting Data on Snow-covered Ice

It is recommended that IceMap data be collected on ice with little or no snow; this provides the most accurate ice thickness measurements. When this is not possible, here are a few tips to follow when collecting with snow on the ice:

Always perform your ice calibrations on the areas of thinnest ice. This will ensure that the ice calibration is lower than actual and consequently, as the ice gets thicker, IceMap will report that the ice is thinner than it actually is, erring on the side of caution for safety. This tip is also recommended even when there is no snow.

Do not take the snow depth into account during ice calibrations. For instance, if the core has 16 inches of ice and 4 inches of snow then calibrate with a measurement of 16 inches. This will decrease your ice calibration value, but the thickness measurements will be most accurate in the thinnest sections of ice, where it is most important for safety. IceMap will tend to report the ice thickness is thinner than it actually is in the thicker areas but that is not as much of a safety issue.

Try to perform your ice calibrations where the snow thickness is typical of the area being scanned.

When weight bearing capacity is an issue, try to avoid scanning over snow drifts as they add to the variability in ice calibrations. Due to the insulating properties of snow, the thinnest ice is typically below large snow drifts.

If it is not possible to avoid areas of thicker snow or where the snow thickness is varying, then it is recommended to increase the number of ice calibrations performed to ensure safety.

8.3 Sled

It is important that the sled carrying the IceMap Electronics Case not bounce around too much during data collection, the less bouncing, the better the data quality. If necessary, add a few sandbags to weigh down the sled to reduce bouncing, compress any snow to get the GPR sensor closer to the ice surface and track better.

If using a sled not supplied by Sensors & Software, ensure it does NOT have metal runners. Metal under the GPR sensor interferes with the GPR signal and can make the data completely uninterpretable.

9 Reviewing & Editing Data

After exiting a line when data is being saved the data is re-displayed on the screen from the beginning of the survey. The Minimum, Current, and Maximum Ice Thickness values displayed in the sidebar are updated to the Minimum, Average and Maximum ice thicknesses values for the entire line.

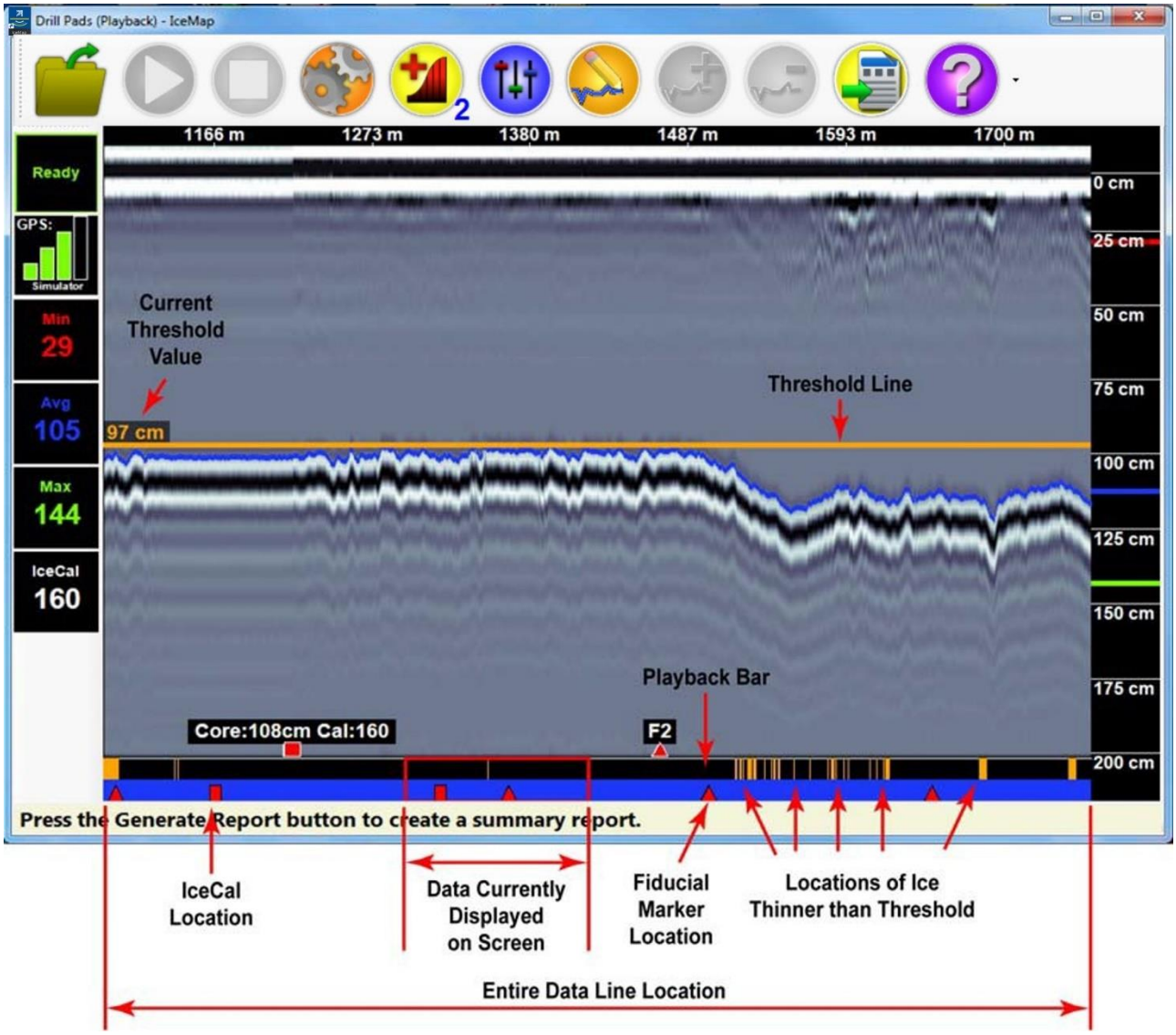


Figure 9-1: The Playback Bar

9.1 Reviewing Data

When data is reviewed, IceMap displays the Playback Bar (Figure 9-1) along the bottom of the screen.

Click any position within the Playback Bar to display that portion of the line.

Use the “z”, + and – hot keys to quickly zoom the data horizontally, to put more or less data on one screen.

Use the hot keys to quickly scroll the screen to the right or left.

The Playback bar also displays the location of every Flag/Fiducial marker (red triangle) and Ice Cal (red squares).

The Playback Bar highlights areas of ice that are thinner than the threshold value by a series of vertical orange lines. If the operator changes the threshold value by using the up (▲) and down (▼) arrow keys, the Playback Bar is automatically updated to display the thinner areas based on the new threshold value, making it easy to find all the positions of ice thinner or thicker than a specific threshold.

Playback Mode contains most of the features available on the IceMap Toolbar (Section 4.3), except for Ice Cal, Flag/Fiducial Marker, and Google Earth.

The Info button in the bottom left corner of the IceMap image can be clicked to toggle the display of the Line Name and Date.



Note: The View Settings options enable you to alter images. For example, the Depth Scale Max value can be changed to display a greater or lesser depth of data, or the Position Scale Range can be changed to display more or less data on one screen, similar to a horizontal zoom.

9.2 Editing Data

If the IceMap survey line started and/or ended on land, or crossed an area of grounded ice, the picks in those areas are from the bottom of ice frozen to the ground surface. As a result, the auto picker might have a hard time picking the bottom of the ice (due to low amplitude pick) and the summary statistics will be inaccurate because of shallow grounded ice picks.

These picks affect the ice thickness statistics, such as the minimum ice thickness value and, when in Review mode, result in more orange highlighted areas displayed below the threshold value; it is a best practice to remove these picks from the line. IceMap's Edit mode enables you to change these portions of a picked survey to create a cleaner, easier to read survey.

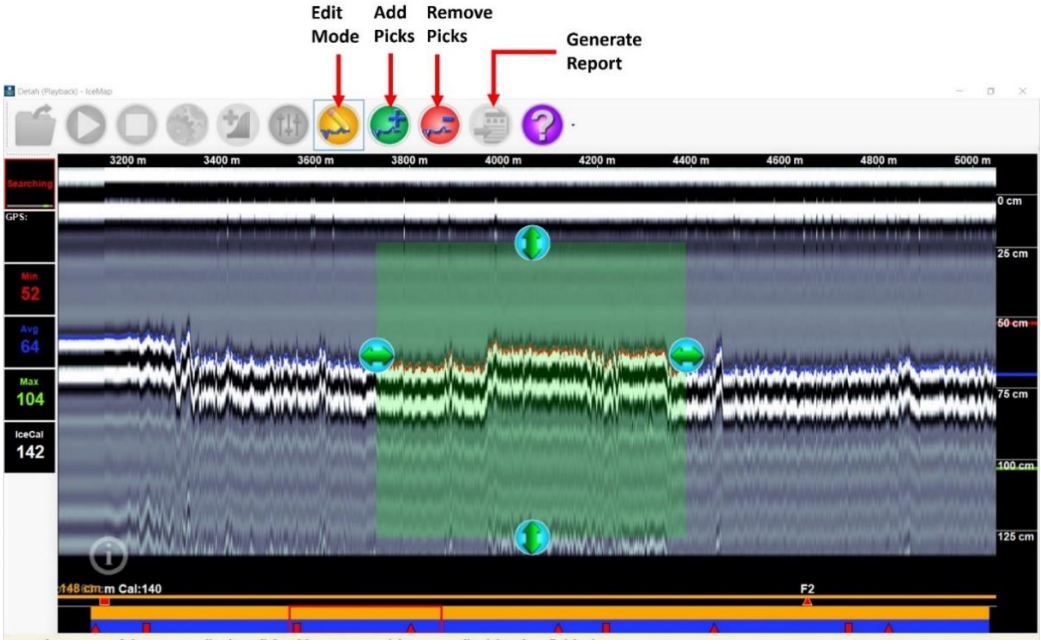


Figure 9-2: Editing Mode

The blue bar, displayed at the bottom of the screen in the playback bar, defines area of the survey that have been picked.

9.3 IceMap Editing Toolbar

When IceMap is in Playback mode, the Ice Calibration, Flag/Fiducial Marker, and Google Earth icons are replaced by the following icons:

- Click the **Edit** icon to start and end the editing process
- Click the **Add** icon to repick data in the selected area of the survey
- Click the **Remove** icon to delete the ice thickness information from the selected area of the survey

9.3.1 Edit a Survey

1) To edit an IceMap survey, in the IceMap Editing toolbar, click **Edit** .

   While you are in Edit Mode (Figure 9-2), the screen is frozen. You cannot scroll beyond what is displayed on the screen.

2) On the laptop screen, to select the area of the survey that you want to edit, click and drag the arrows on each side of the green selector box to define the position range you want to edit. Then click and drag the arrows on the top and bottom of the green selector box to define the depth range you want to edit (see Figure 9-2).

   - Click **Remove** to delete the ice thickness information from the selected area of the survey
   - Click **Add** to insert pick data into the selected survey area.
   - If the automatic picker selects the wrong event (layer of snow, noise signal, etc.), rather than the bottom of ice, press **Remove** to delete the current picks and use the depth range arrows on the top and bottom of the selector box to narrow the depth range, so these other events are not inside the box. Then, click the **Add** button again.

3) Click the **Edit button again** to save the pick edits and navigate to another section of the survey line.

9.4 Displaying a previously collected line

1) To display a previously collected line, in the IceMap toolbar, click **Open** .
2) In the **Open** dialog box, navigate to where your data is saved
3) Select a DT1 file.
4) Click **Open**.

10 Generating Reports & Exports

There are three different types of Exports that can be generated:

- KMZ file – this file is plotted in Google Earth and can show georeferenced, color-coded Ice thickness data
- PDF file – this produces the IceMap Summary report for a given survey line
- CSV file – this outputs the ice thickness data in a spreadsheet format.

Clicking the Generate Report button  will pop-up the following window (Figure 10-1) letting you select the type of export.

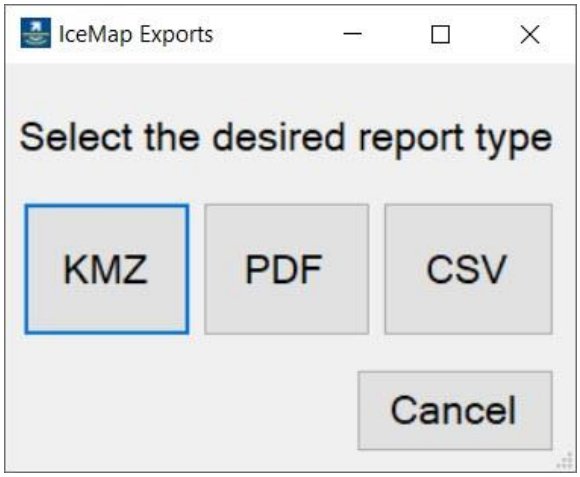


Figure 10-1: Selecting report type

Each one is explained in detail below.

10.1 KMZ File (Google Earth)

A KMZ file is a georeferenced file that can be displayed in Google Earth.

After selecting the KMZ option, you will see a window that lets you select the color range for how ice thickness values are displayed in Google Earth (Figure 10-2).

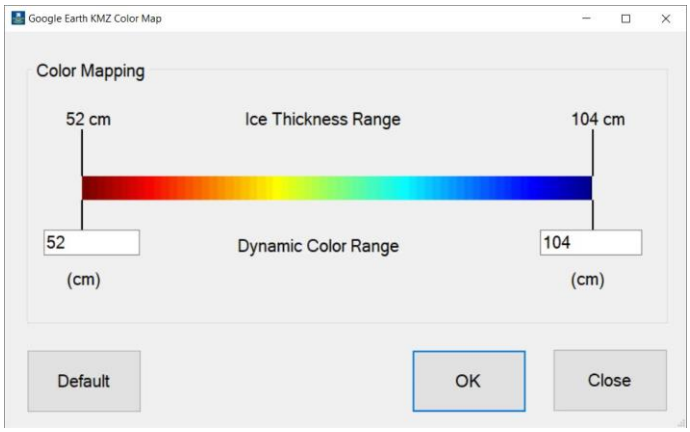


Figure 10-2: Color Map for Google Earth KMZ file

The range of Ice Thickness is displayed above the color bar and the Dynamic Color Range below the color bar. Entering new values in the Dynamic Color range boxes changes the color scale applied to the ice thickness data in Google Earth.

10.1.1 Selecting a Dynamic Color Range

To match the minimum and maximum color scale options to the minimum and maximum ice thickness data set, click **Default**. The color scale displays minimum ice thickness in red on the left end of the color scale, and maximum ice thickness data as blue on the right. All the other ice thicknesses between the minimum and maximum values are displayed as colors within the spectrum as shown.

Use this setting to view the full range of thickness in a line and/or locate thick or thin ice data in a single data set (Figure 10-3).



Figure 10-3: Google Earth image of an ice line displaying colors in full range of ice thickness.

User Defined Values

However, this is not a good option for comparing multiple lines side-by-side as each will have a different ice thickness range. In this case, define the Color Map with a consistent set of minimum and maximum values (Figure 10-4) when you need to compare multiple data sets, such as lines collected in the same location over a period of time, or lines collected adjacent to each other during the same survey.

Predefined minimum and maximum colors enable you to recognize patterns across large sections of ice since specific ice thicknesses will always be represented by the same color (Figure 10-5).

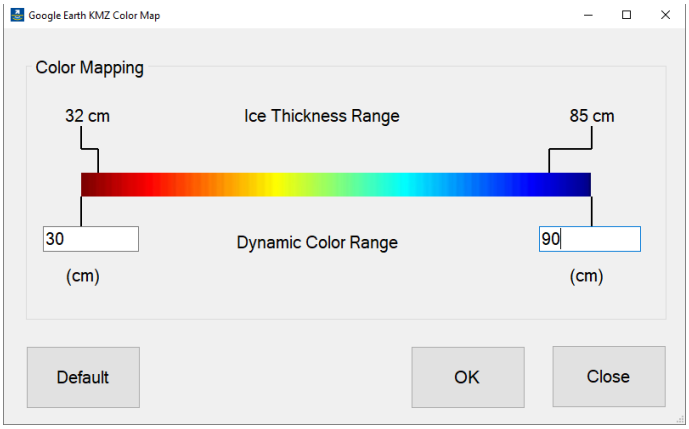


Figure 10-4: KMZ Color Map range set to a predefined ice thickness range.

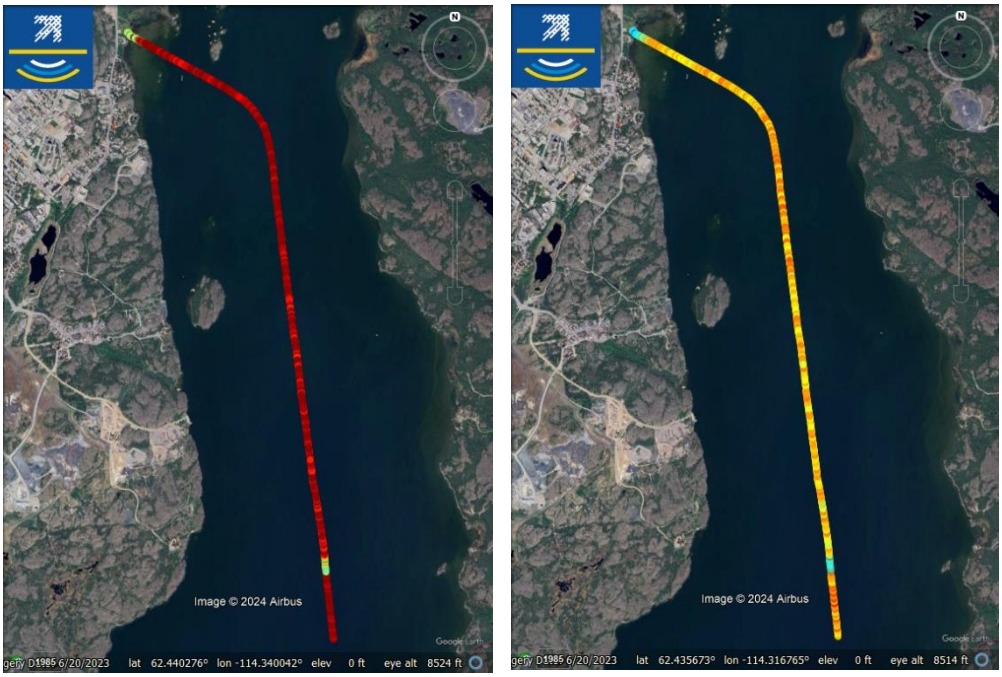


Figure 10-5: Two example data sets plotted with the same maximum and minimum values. The colors indicate the ice was thinner (red vs. yellow) when the line on the left was collected.

You can also set your own minimum and maximum values to highlight thin areas in a data set. Representing ice thicknesses above a defined threshold value and color makes it easier for you to identify thinner sections of ice.

To create a two-color data set that splits ice thickness into above/below threshold colors, set the minimum and maximum color scale values to the same number. In the example in Figure 10-6, 60 cm was used. The resulting path is plotted in Google Earth (Figure 10-7) to show the ice thicknesses above and below the threshold.

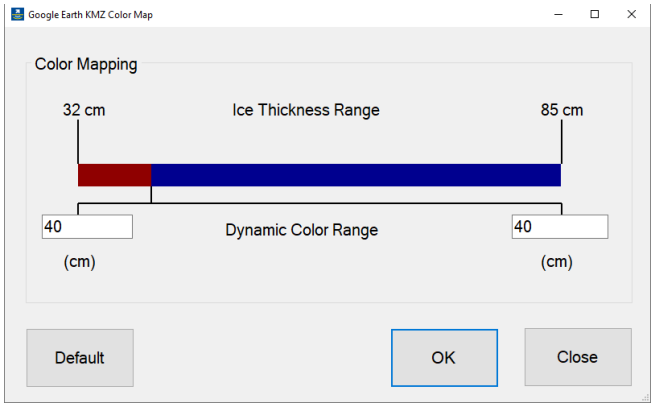


Figure 10-6: Setting a two-color data set which shows ice thickness above and below a threshold, in this case 40 cm



Figure 10-7: Google Earth image of an ice thickness line with the color scale set to a threshold value. In this example, ice thicker than 40 cm is blue and ice thinner than 40 cm is red.

10.2 Google Earth Limitations

Due to Google Earth limitations, ice thickness points cannot be closer than about 1.5 meters (5 feet) and the maximum number of points in one KMZ file cannot exceed 10,000. If either case is exceeded, points are grouped and displayed as single value.

The Google Earth (KMZ) files always display the minimum ice thicknesses. If the ice thickness data have been grouped, for safety reasons, the KMZ file will plot the thinnest point of the grouped ice thickness points.

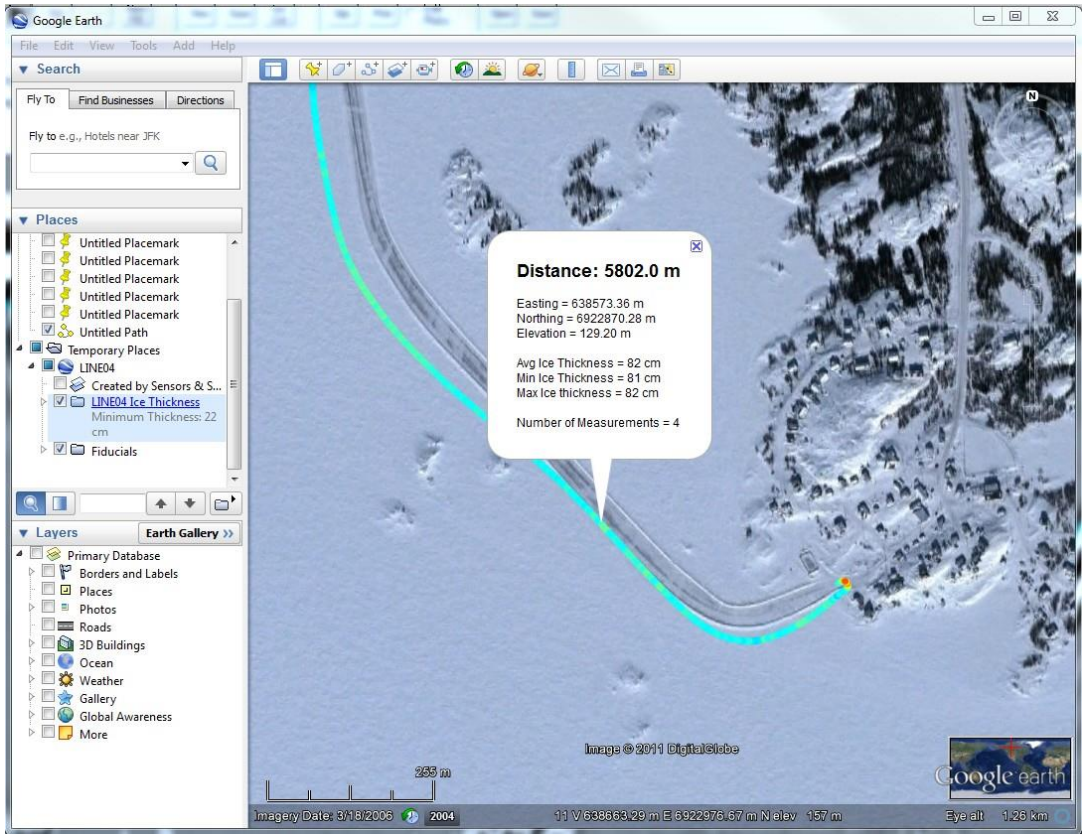


Figure 10-8: Clicking a point in Google Earth displays information about the point including GPS position and whether it has been averaged with other points.

To determine whether ice thickness points have been grouped:

- Plot the KMZ file.
- Zoom in to locate and then click an individual point in the survey (Figure 10-8).
- A text box opens displaying details of the point you selected:
  - the number of data points grouped together to generate that Google Earth point
  - the maximum, minimum, and average ice thicknesses of all the points in the group
- If the point has not been grouped, the maximum, minimum, and average values will be the same

Once you click **OK**, a .KMZ file is generated in the current directory where the data is stored. If you have Google Earth installed on your computer, double click this file to launch Google Earth. This requires internet access, unless you have cached the images for the survey area (for more details, see Appendix B).

Google Earth enables you to display multiple KMZ files at the same time.

10.3 PDF Summary Report

The IceMap Report feature allows you to distill long IceMap surveys into a summary report (PDF file), making it easy to see overall trends and where thin ice is located. Clicking on the PDF button will launch the Report Viewer, allowing you to customize the report before creating the PDF file (*Figure 10-9*).

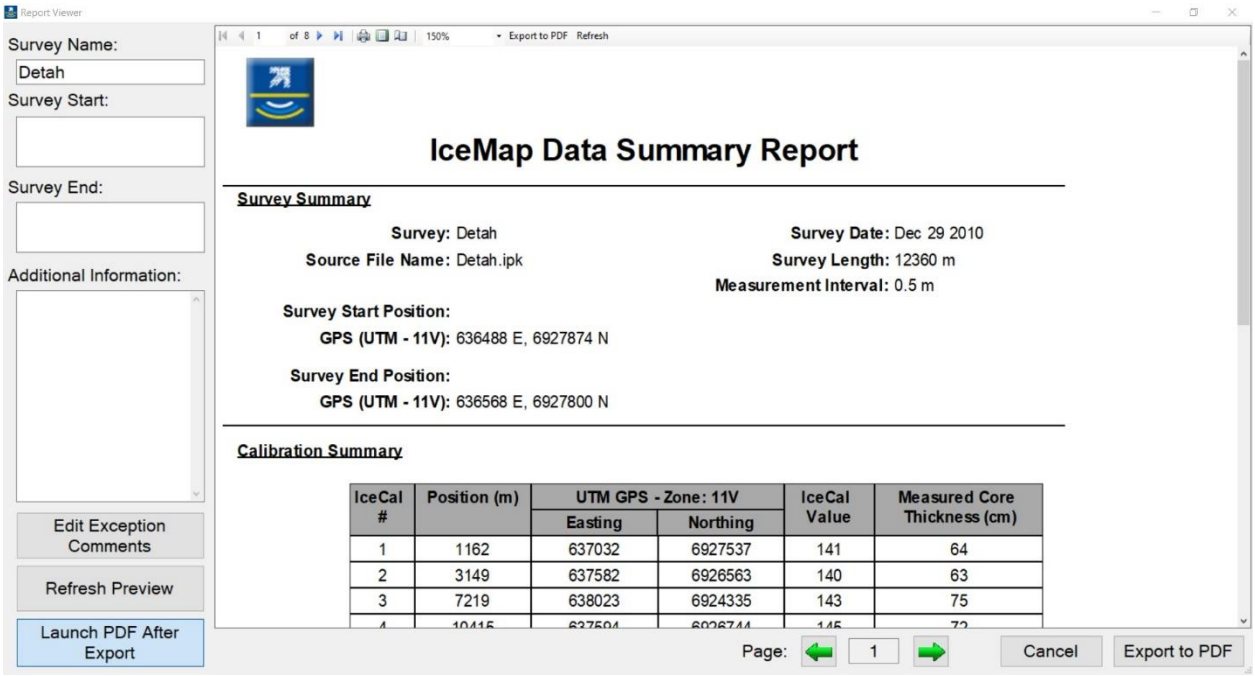


Figure 10-9: Customizing the IceMap Data Summary Report

The fields and buttons available in the report are described below. Most of these fields are optional, and don't have to be filled in:

1) In the **Survey Name** text box, accept the default line name, or enter a name that may be more descriptive of the work you are doing.
2) In the **Survey Start** text box, enter a description of where the survey started.
3) In the **Survey End** text box, enter a description of where the survey was completed.
4) In the **Additional Information** text box, enter any other information that will help the analysts better understand the data they are reviewing.

   For example, you could enter the weather information during the survey, the conditions of the ice at the beginning and end of the survey, or any other observations that may pertain to the survey.

The **Survey Name**, **Survey Start**, **Survey End** and **Additional Information** fields are remembered and automatically filled in with the text from the last report. The text backgrounds are colored orange to indicate that the information may be no longer relevant and should be edited if necessary.

Click the **Edit Exception Comments** button to access a table where you can enter comments about why specific sections of Ice thickness data were excluded from the Summary Report (Figure 10-10). Typical reasons for excluding data include grounded ice, surface water, thick snow, stationary data and poor-quality picks.

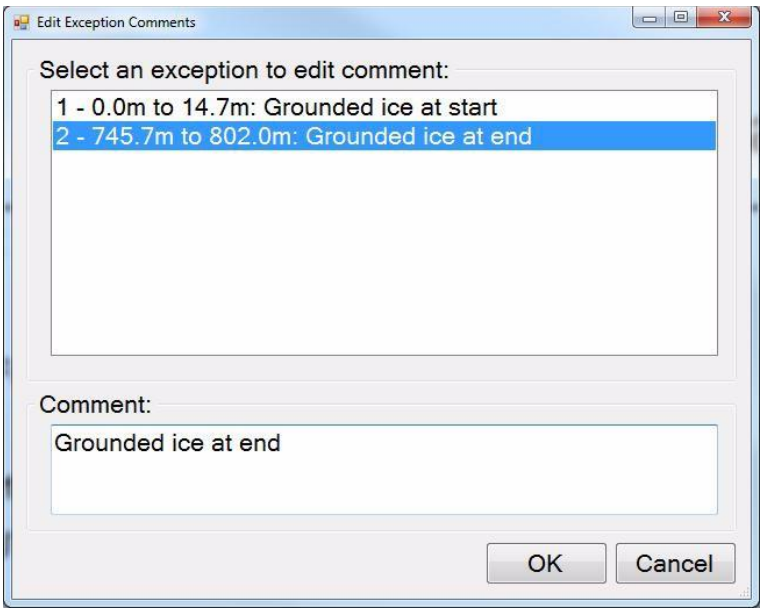


Figure 10-10: Exception comments editor dialog

5) To refresh the report image after editing, click **Refresh Preview.**

6) To open the report as a PDF after you have saved it, make sure the **Launch PDF After Export** button is enabled and a PDF viewing software is installed**.**

7) To save the report, click **Export to PDF**.

Once created, if the PDF does not open automatically, you can view the Summary Report by double clicking on the PDF file name. Alternatively, you might need to launch the file from Windows Explorer.

The report is a multi-page report, showing calibrations, summary of thicknesses and exceptions. It also shows the path of data collection as well as profiles of the thickness. Depending on how long the profile was, it may be split into discrete sections, spanning multiple pages in the report (Figure 10-11).

IceMap Data Summary Report

Survey Summary

Survey: Detah
Source File Name: Detah.ipk
Survey Date: Dec 29 2010
Survey Length: 12360 m
Measurement Interval: 0.5 m

Survey Start Position:
GPS (UTM - 11V): 636488 E, 6927874 N

Survey End Position:
GPS (UTM - 11V): 636568 E, 6927800 N

Calibration Summary

IceCal #	Position (m)	UTM GPS - Zone: 11V		IceCal Value	Measured Core Thickness (cm)
		Easting	Northing		
1	1162	637032	6927537	141	64
2	3149	637582	6926563	140	63
3	7219	638023	6924335	143	75
4	10415	637594	6926744	145	72

Ice Thickness Summary

IceCal Value: 142

Minimum: 52 cm
occurs at: 2209 m

Maximum: 104 cm
occurs at: 6197 m

Average: 64 cm

Ice Thickness Range (cm)		Longest Continuous Section				Total Length of All Sections (m)
Min	Max	Length (m)	Occurs At (m)	Easting	Northing	
52	53	3.5	2225	637515	6926974	16.0
52	54	8.0	2224	637515	6926974	76.5
52	55	54.5	2205	637512	6926990	274.5
52	56	72.5	2214	637514	6926982	550.5
52	57	85.5	2076	637489	6927098	886.0
52	58	489.5	2980	637583	6926563	2072.0
52	59	555.0	3008	637583	6926563	2780.5
52	60	697.0	1274	637065	6927523	3355.0
52	61	798.5	1253	637055	6927528	4007.5
52	62	1401.0	1554	637230	6927424	4679.0

The cumulative length of all sections represents 38% of the total line length.

IceMap Data Summary Report

Exceptions

The following are areas of unusual ice conditions which were excluded from the report by operator intervention and generally indicate off-ice zones, zones of grounded ice or areas of highly irregular ice formation which may not be characterized accurately with automatic ice thickness analysis.

#	Start Position (m)	End Position (m)	Length (m)	Comment
1	0	427	427.0	
2	2255	2256	1.0	
3	12268	12360	91.5	

The cumulative length of all sections represents 4% of the total line length.

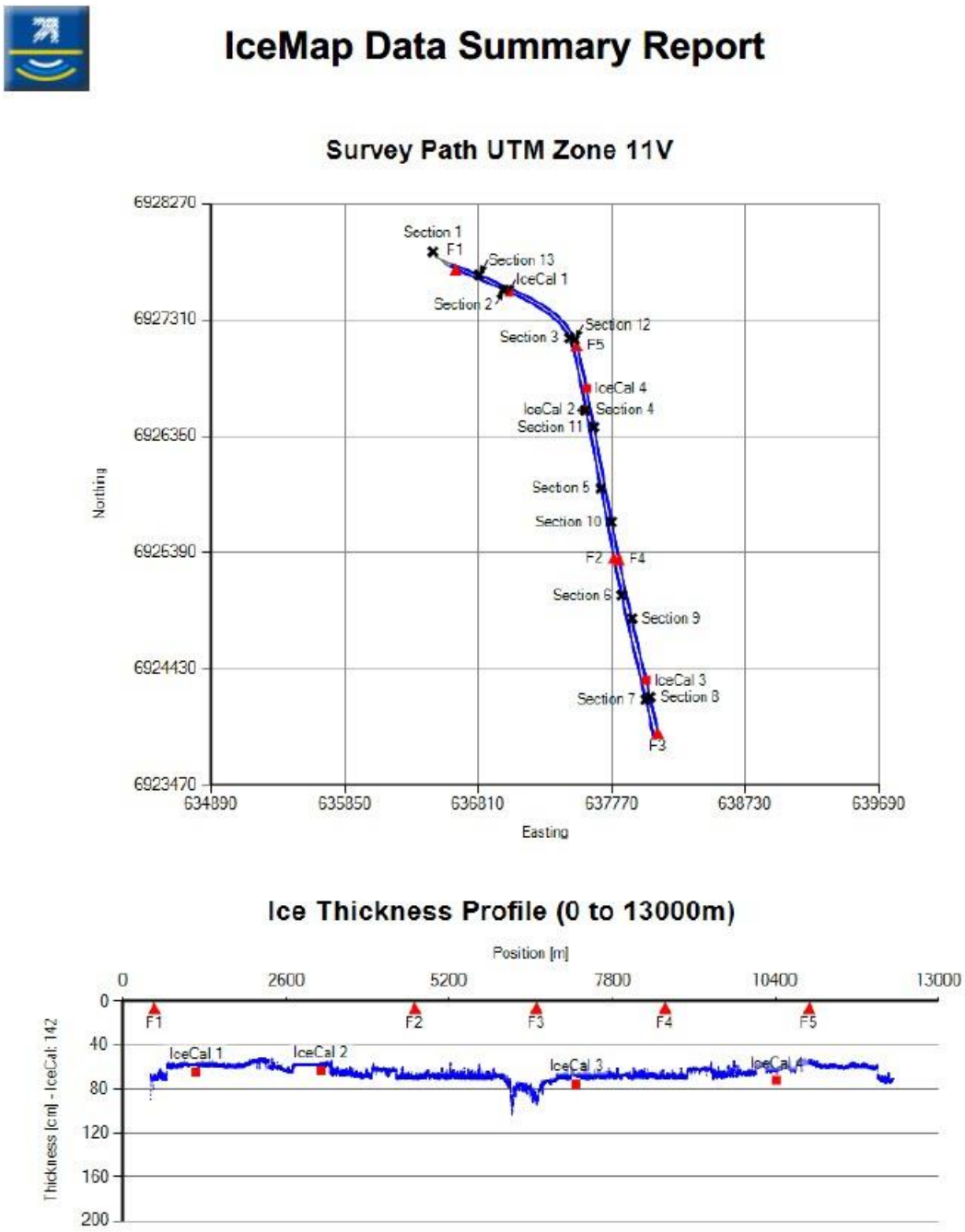


Figure 10-11: Sample of an IceMap Summary Report

The fields in the report are explained below:

10.2.1 Survey Summary

- **Survey**: The name of the survey (the default line name, or a descriptive user-defined name for the survey data)
- **Survey File Name**: The file name for the data file
- **Survey Start and End Positions**: Descriptive and/or physical position where the survey started and ended
- **Survey Date**: The date the survey was done, not the date the report was created
- **Survey Length**: The length of the survey (m/ft)
- **Measurement Interval**: The survey step size

10.2.2 Calibration Summary

- **Ice Calibration #:** The order position of the Ice Cal (1,2,3...)
- **Ice Calibration Position**: The position of the Ice Cal in the survey (m/ft). GPS information for start and end positions and Ice Cal positions
- **Ice Cal Value**: The Ice Cal value at the selected position in the survey
- **Measured Core Thickness**: Ice thickness measured from the core

10.2.3 Ice Thickness Summary

- **Ice Thickness Range** (cm/in): A data summary of the 10 thinnest ice thicknesses
- **Total Length of All Sections**: A list of the 10 thinnest ice thickness ranges, from the minimum thickness to 10 cm thicker in 1 cm increments. If units are feet, a list of the 10 thinnest ice thickness ranges, from the minimum thickness to 5 inches in 0.5-inch increments.
- **Longest Continuous Section Length -** Displays the total distance (m/ft)
- **Length**: The length of the longest continuous section (m/ft) of ice that falls within the selected range.
- **Occurs At**: The line position (m/ft) where the longest continuous section occurs. GPS coordinates for the middle of the longest continuous section.

10.2.4 Additional Information

Enter any information you want to pass on describing the conditions of the survey site, weather, ground conditions, and so on.

10.2.5 Exceptions

The Exceptions section shows areas that were manually removed during editing, such as off-ice zones, zones of grounded ice and areas of highly irregular ice formation that would not be accurately picked with the automatic ice thickness analysis.

10.2.6 GPS Plot

The GPS Plot section shows a plan map of the survey path with the GPS path shown as a thin grey line. The locations with ice thickness information are indicated by a blue line plotted over the survey path. Ice Cal positions are plotted as red squares. Flags/Fiducial Markers are plotted as red triangles. Black X's delineate the start/end of each Ice thickness section profile shown at the end of the IceMap Summary report.

10.2.7 Ice Thickness Profile

The Ice Thickness Profile shows a cross-sectional plot of ice thickness values for the entire survey line. Ice Cal positions are plotted as red squares and Flags/Fiducial Markers are plotted as red triangles.

For long profile lines, not all the ice thickness values can be plotted. For these lines, a number of ice thickness values from a small area are combined and the minimum value plotted.

10.2.8 Ice Thickness Section Profiles

The Ice Thickness Profile shows cross-sectional plots of ice thickness values for a series of sub-sections of the survey line. Each section is the same length with the length automatically determined based on the overall length of the survey line.

Ice Cal positions are plotted as red squares and flags/fiducial markers are plotted as red triangles.

10.3 CSV File

Selecting the CSV option will immediately create a spreadsheet file with information about every point collected (Figure 10-12). This includes the Trace #, GPS position and ice thickness, among others.

Source File	C:\Radar_Data\IceMap\NWT Detah\Detah									
Ice pick process in window from 4.0 ns to 19.0 ns.										
Synthetic positive pulse.										
Ice Cal(mm/ns):	142									
Trace#	GPS Pos(m)	Easting	Northing	Zone	Elevation(m)	T(ns)	Thickness(cm)	Amp(mV)	Quality	Comment
856	172.59	636608.22	6927753.02	11V	130.3	12.86	89.263	30.2	0.606	*
857	172.93	636608.52	6927752.86	11V	130.3	12.32	85.415	29.98	0.552	*
858	173.27	636608.83	6927752.7	11V	130.3	11.76	81.422	32.44	0.629	*
859	173.61	636609.13	6927752.55	11V	130.3	11.08	76.572	34.94	0.7	*
860	173.95	636609.43	6927752.39	11V	130.3	10.22	70.433	20.02	0.412	*
861	174.29	636609.73	6927752.23	11V	130.3	9.72	66.861	51.23	1.02	*
862	174.63	636610.03	6927752.08	11V	130.3	9.68	66.575	56.75	1.157	*
863	174.97	636610.33	6927751.92	11V	130.3	9.7	66.718	56.07	1.135	*
864	175.31	636610.64	6927751.76	11V	130.3	9.7	66.718	56.3	1.128	*
865	175.65	636610.94	6927751.61	11V	130.3	9.72	66.861	54.68	1.071	*
866	175.99	636611.24	6927751.45	11V	130.3	9.82	67.576	56.39	1.199	*
867	176.34	636611.55	6927751.29	11V	130.3	9.9	68.147	54.95	1.088	*
868	176.69	636611.86	6927751.14	11V	130.3	9.98	68.719	54.08	1.095	*
869	177.03	636612.17	6927750.98	11V	130.3	9.98	68.719	54.25	1.076	*
870	177.38	636612.48	6927750.82	11V	130.3	9.92	68.29	54.56	1.052	*
871	177.73	636612.79	6927750.67	11V	130.3	9.86	67.861	55.86	1.184	*
872	178.07	636613.09	6927750.51	11V	130.3	9.82	67.576	56.33	1.191	*
873	178.42	636613.4	6927750.35	11V	130.3	9.86	67.861	57.61	1.19	*
874	178.77	636613.71	6927750.2	11V	130.3	9.92	68.29	55.1	1.089	*
875	179.11	636614.02	6927750.04	11V	130.3	9.92	68.29	54.16	1.076	*
876	179.46	636614.33	6927749.88	11V	130.3	9.98	68.719	54.98	1.127	*
877	179.81	636614.64	6927749.73	11V	130.3	9.92	68.29	53.73	1.063	*

Figure 10-12: CSV Output file

A CSV file can be imported into third-party software for plotting and further analysis including Microsoft® Excel®, and Geographical Information System (GIS) software.

11 Help

The **Help** button  consists of a button as well as a drop-down arrow. Clicking the main button (question mark) will open a PDF version of this user's manual. The other drop-down options are explained below.

11.1 Help

Clicking **Help > Help** also opens a PDF version of this operation manual.

11.2 Quick Start Guide

Clicking **Help > Quick Start Guide** will launch the Quick Start Guide as a PDF file. This is a short document to help you get started using IceMap.

11.3 Reset to Defaults

Clicking **Help > Reset to Defaults** resets all the settings in the program back to default values. This can be useful to troubleshoot the program if you are having problems or unexpected behaviors.

11.4 About

The **Help > About** option displays details of the IceMap software including a description, Version and Release numbers and the copyright (Figure 11-1).

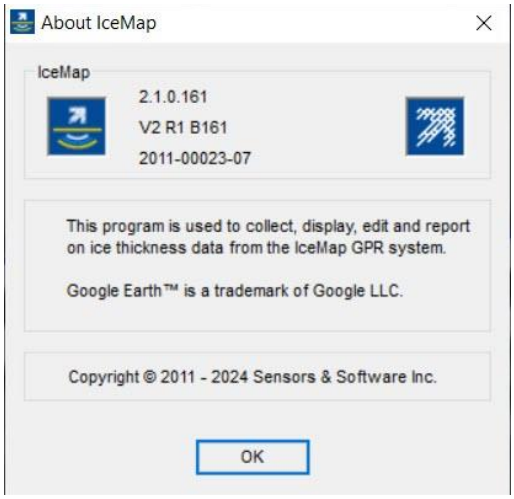


Figure 11-1: About IceMap screen

11.5 Registration

Clicking **Help > Registration** will take you to a screen where you can activate the product license or return the license (Figure 11-2).

Do not return the IceMap license unless instructed by Sensors & Software or a representative of Sensors & Software. Returning the license serial number will disable the IceMap software. This is described in more detail in the **IceMap Software Installation and Troubleshooting Guide**.

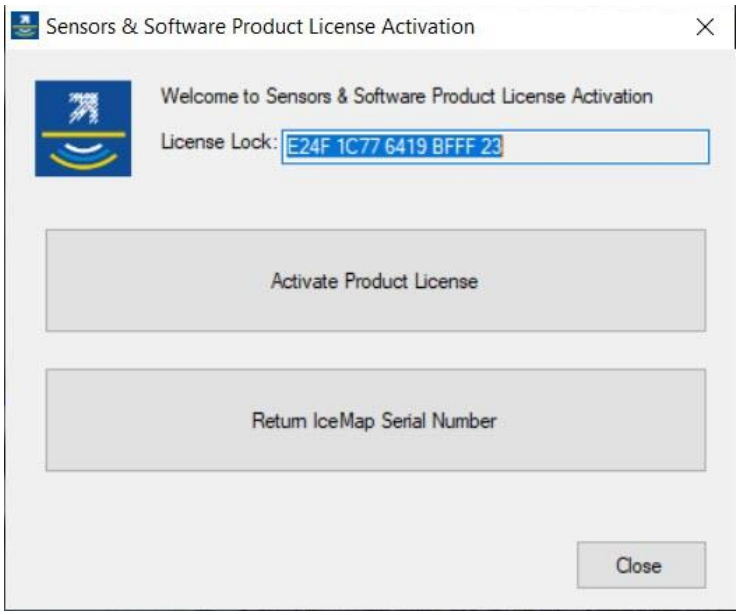


Figure 11-2: Activating the Product License

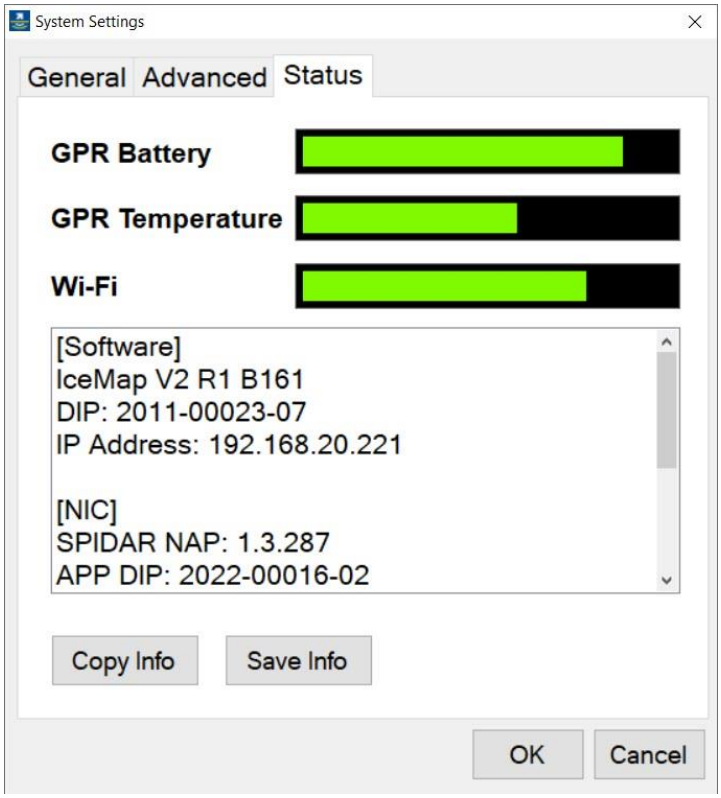
12 Troubleshooting

IceMap is designed to minimize user problems; however, all electronic devices are subject to possible failure. Use the following solutions should you have an issue with your IceMap system.

12.1 Power Supply Problem

If you are running a system and the battery voltage gets too low, the first error message you see may indicate a connection problem with the NIC-500, however the problem is more likely that the Wireless Access Point has shut down due to lack of sufficient power.

1) To check your battery level, in the System Settings Menu (Section 5.3) click the **Status** tab and check the battery level.



   a) If the level is below the yellow threshold, the battery needs to be recharged or replace.

   b) If the battery level is sufficient but the system still is not running, check that the light on the connector to the Noggin is on. If this light is off, then there is a problem with the connection from the NIC-500 to the Noggin.

2) Check the battery cable from the NIC-500 to the Noggin GPR Sensor.

3) Check the battery voltage with a voltmeter.

Try to do this while the battery is still attached to the IceMap system to get a true measure of the voltage while under load (it will be necessary to open the battery case or belt battery case and connect the voltmeter to the positive and negative battery terminals).

If the battery has a low voltage or seems dead, try the system with another battery (if available), or give the battery a good 12–14-hour charge and try running the system again.

c) If the battery does not charge up to 12 Volts or more, it should be replaced.

4) IceMap batteries are fused to protect the system.

   a) Open the battery case and check that the 10 Amp fuse is OK.

   b) If necessary, replace it with one of the spare fuses available inside the battery case.

Note: Be cautious of attempting to power the IceMap system through a 12V power port (like a car lighter). These kind of power connections can be temperamental; they can disconnect for a split second when hitting a bump, causing the system to shut down and lose some data on the current line.

12.2 Connection Problem

If the system power supply is OK (see above) but the Noggin GPR Sensor does not respond there may be a communication failure between the NIC-500 and the Noggin.

If an error occurs, an error message will appear on the IceMap screen:

1) Disconnect the power source to completely shut down the system.

2) Make sure that cable connectors are protected from high tension (this is the most likely break point).

3) Disconnect the cables and check for damage.

   Check for bent pins on the cable or on the 37-pin connection on the back of the NIC-500 and carefully straighten them with needle-nosed pliers.

   Clean out any dirt, moisture, oil, etc. and reconnect, ensuring that all cable connections are tightly secured.

   Sometimes vibrations cause the cable connections to loosen just a bit and break contact, and this can cause errors.

4) Disconnecting cables and reconnecting them may provide a better contact and solve the problem.

5) Power the system back on and try running the system again.

If the power supply and cable are OK, the problem is likely a failure of the Noggin GPR Sensor or the NIC-500. These components have no user-serviceable parts so it will have to be returned to Sensors & Software Inc. for inspection and possible repair (see Section 12.8).

12.3 Computer Problem

The computer should be handled with care. If the computer does not power up and boot up, there may be a problem with the CPU or the storage media. If this occurs, contact Sensors & Software Inc.

12.4 Wi-Fi Connection

Connection issues may be caused by the amount of metal between the PC and the sled; specifically, the tow vehicle itself. If the tow vehicle has an external rear mounted cab or fuel tank you may need to change the location of the Toughbook laptop or use an external antenna to improve communication between the computer and the NIC-500 in the electronics case.

12.5 Noggin GPR Sensor Problem

When the IceMap system is powered-up for data collection it runs through a system initialization sequence and a message will be displayed on the screen for a few seconds.

An error message indicates an internal problem with the Noggin. If an error occurs, power the system down, check connections. Power it up again and retry data acquisition.

If the error persists, contact Sensors & Software Inc. (see Section 12.8).

12.6 Odometer Problem

Make sure odometers are properly calibrated and connected.

12.7 Creating a Test Line for Data Quality

One of the best ways of detecting problems with the GPR system is:

1) Shortly after receiving the system and getting comfortable with its operation, collect a line of data at a convenient, easily accessible location.

   The line does not have to be too long, but 10 meters is a good guide. This data line should be saved electronically and perhaps plotted out on paper and dated.

2) Collect a test line every 6 months and, by reviewing the previous data, system problems can be detected early. If there is a suspected problem with the system, this test line could be collected and compared with earlier tests.

12.8 Contacting Sensors & Software Inc.

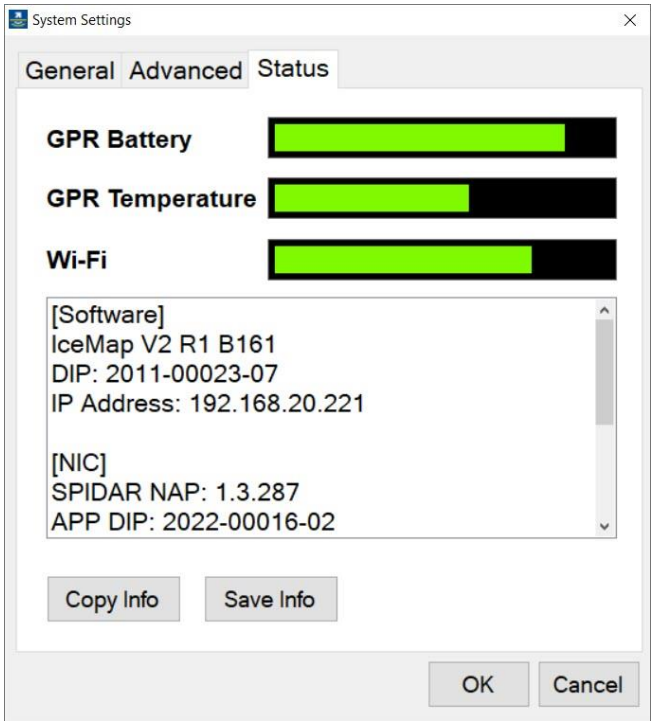
If you develop problems with your IceMap system, contact your agent or Sensors & Software Inc.

Sensors & Software Inc.'s hours of operation are 9:00 AM to 5:00 PM Eastern Standard Time, Monday to Friday. You can contact Sensors & Software Inc. at:

Sensors & Software Inc.
1040 Stacey Court
Mississauga, Ontario
Canada L4W 2X8
Tel: (905) 624-8909
Fax: (905) 624-9365
E-mail: sensoft_sales@spx.com
Website: http://www.sensoft.ca/

When contacting Sensors & Software Inc., please have the following information available:

- Noggin and NIC-500 Serial Numbers. This information is available under the **System Settings > Status tab** (Section 5.3)



- Version number of the IceMap data acquisition software. This is available under the **Help > About** menu (Section 11.4)
- The error number or message appearing
- A brief description of when the error is happening and the operating conditions (temperature, humidity, sunshine, system, and survey setup, etc.)

13 Care and Maintenance

13.1 IceMap Electronics Case Connections

All connections, except the power connection to the battery, are made at the factory. If any cables are disconnected, refer to the figure below, and follow the instructions to reconnect them.

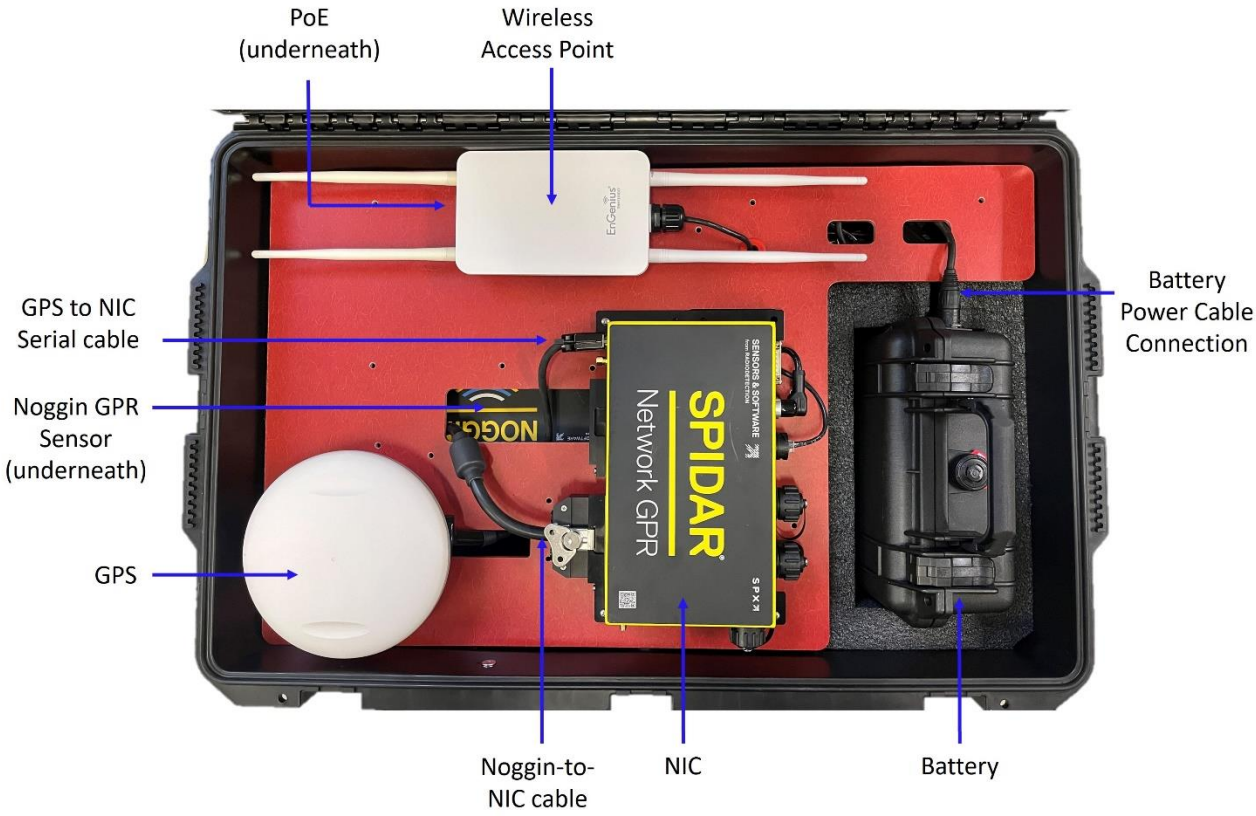


Figure 13-1: IceMap Electronics Case components.

1) Connect the black **Noggin-to-NIC-500** cable's 37-pin male D connector to the **Noggin GPR Sensor** (under the divider). Tighten the latch to secure this attachment.

2) Feed the cable through the square hole in the divider and then attach the **Noggin-to-NIC** cable's 37-socket female D-connector end to the Port labelled "1", a 37-pin receptacle on the **NIC-500**. Tighten the latch to secure this attachment.

3) Connect the Y-shaped **GPS Serial Power Cable** to the GPS receiver, the NIC-500, and the PoE electronics:

   a) Connect the square 12 pin female connector to the **GPS** receiver.

   b) Feed the 9-socket female serial cable through the narrow rectangular hole in the divider and then attach it to the 9-pin male serial connector on the **NIC-500**. Secure this connection with the thumbscrews.

   c) Feed the round 4-pin cable through the slot in the divider and then attach it to the 12 V-out connector on the **PoE Box.**

4) Connect the **NIC-to-PoE** cable from the Ethernet port on the NIC-500 to the Ethernet port labelled **NIC-500** on the **PoE Box**. Tighten the screw caps on both ends to secure this connection.

Warning: Ensure this connection is correct. Connecting the NIC-500 to the Ethernet port labelled "Wi-Fi", instead of the Ethernet port labelled "NIC" on the PoE Box will damage the system.

5) Connect the **Wireless Access Point** cable to the Ethernet port labelled Wi-Fi on the **PoE Box**:

   a) Feed the cable through the small round hole in the divider and then attach the other end to the wireless access point Ethernet port (underneath the divider).

   b) Tighten the screw cap to secure the connection.

6) Connect the yellow **Power Cable** from the 12V IN port on the **PoE Box**. Connect the other end of this cable to the 12 Volt battery.

   Note: Do not connect the battery until you are ready to power up the system and acquire IceMap data (to learn more, see Section 3).

13.2 Battery Care (12V)

1) IceMap systems use 12-volt sealed lead acid batteries. They are fused with a 10 Amp fuse to protect them from short circuit damage
2) The IceMap contains an 18 or 20 Amp-hour battery. This battery unit should run the IceMap system for about 6 hours before recharging is necessary.
3) If long days of data surveying are typical, is a best practice to carry a second battery
4) If batteries are maintained in a charged condition, they will give long life and reliable service. Improper use and lack of maintenance will greatly reduce their life.
5) Sealed lead acid batteries should never be left in a discharged condition for any period of time. Charge the batteries as soon as possible after use
6) Charge batteries at room temperature whenever possible
7) The IceMap system contains a voltage monitoring circuit that will turn off the unit when the input voltage drops below 10.2 volts
8) If a battery has been deeply discharged or left in a discharged condition for a long time, it may not accept a charge immediately when connected to the charger (The fast charge LED will not light). If the fast charge light does not come on within six hours, the battery should be considered damaged and be discarded
9) Do not assume that a battery that is still charging after eight hours is nearing the end of its charge cycle. Typical charging time for an empty battery is 12-14 hours from start of fast charge
10) Ensure that the batteries are fully charged before storing. If practical, store the batteries in a cool place, 10°C (a refrigerator is ideal), but make sure the temperature is not likely to drop below -30°C or the electrolyte may freeze and possibly split the case.

13.3 Cable & Connector Care

1) The cable connectors, as well as the connectors on the Noggin, NIC-500, and PoE electronics need to stay clean and free of dust and moisture. Use a brush or air spray to

clean dust, lint, and other foreign particles from these connectors

2) When the system is not being used, make sure the connections are covered to prevent dust and moisture from collecting inside. If the connectors are exposed, cover them with some sort of dust cap.

3) Cables are designed to be as tough as practical

4) Careless use of cables, such as making them carry loads that they are not designed for can cause internal damage

5) Connectors are weak points in any system. With the use of this product in rough, dusty and outdoor environments, you can minimize potential down time by treating the cables and connectors with respect.

6) Cables and connectors are not designed to suspend or tow or otherwise carry the weight of systems. They are part of the electronic circuit and should be treated accordingly. When not in use they should be placed in their storage box.

13.4 Storage Cases

Equipment that is transported and stored loosely is more susceptible to damage. All equipment should be stored in its shipping case or a storage box. Sensors & Software has shipping cases available as options.

13.5 System Spare Parts

For customers working in remote areas, or if downtime in the field is unacceptable, consider buying spare parts such as extra cables, batteries, and chargers.

14 Case Studies

This section shows some examples of IceMap data.

14.1 Fresh Water Ice

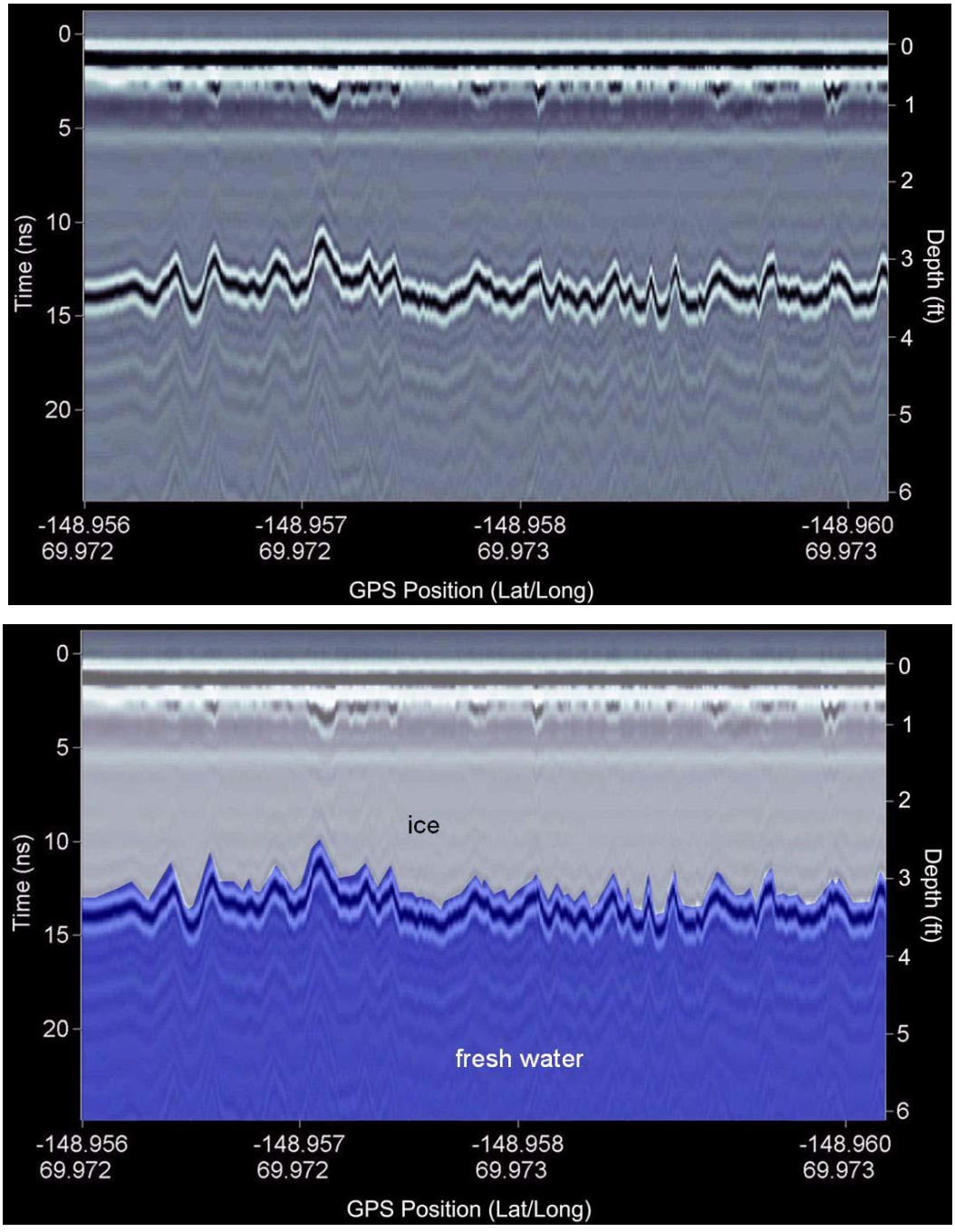


Figure 14-1:Typical data of ice over fresh water.

14.2 Grounded Ice on Sandbars

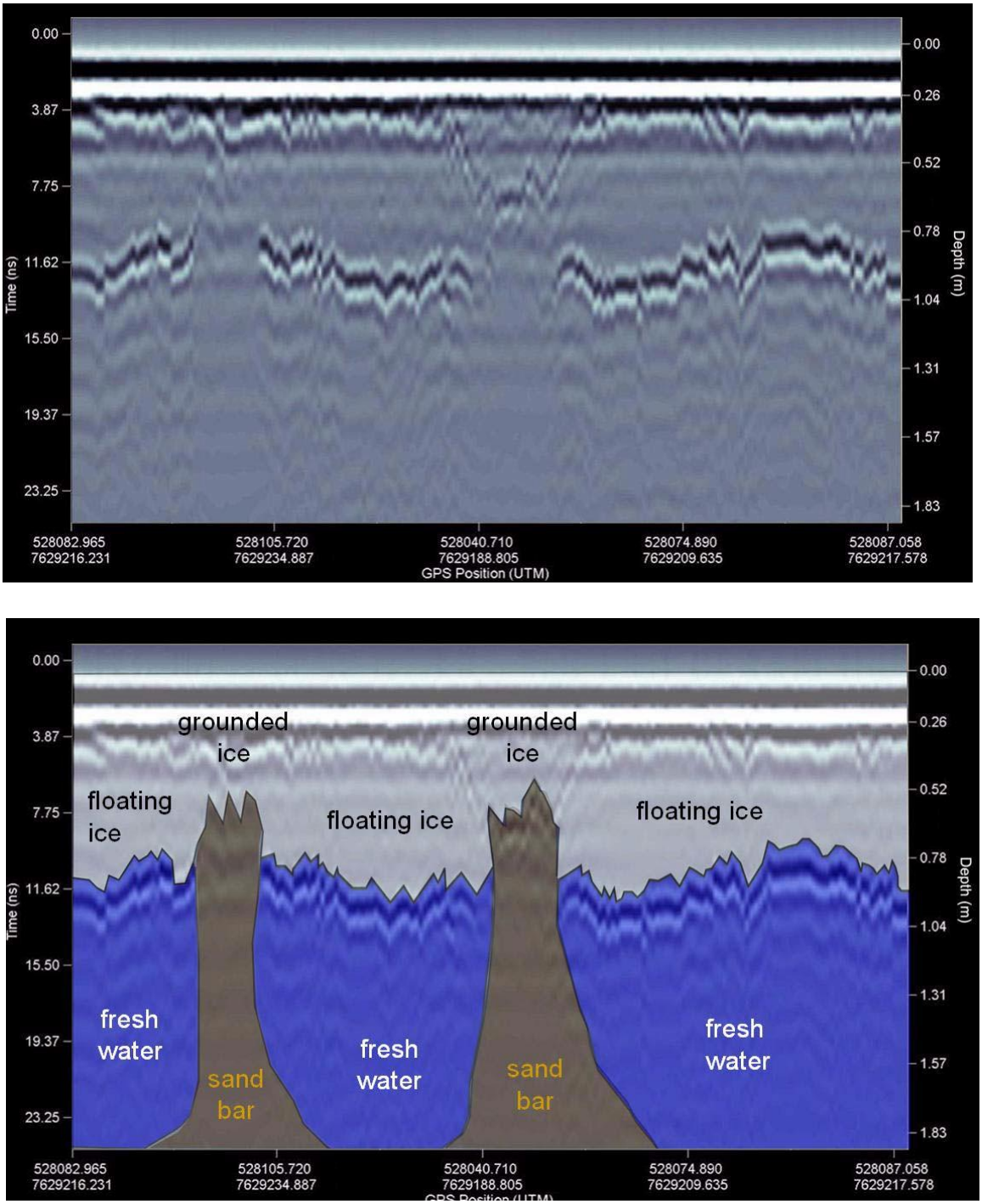


Figure 14-2: Weak reflections in the data image may be caused by ice frozen to the bottom.

14.3 Grounded Shore Ice

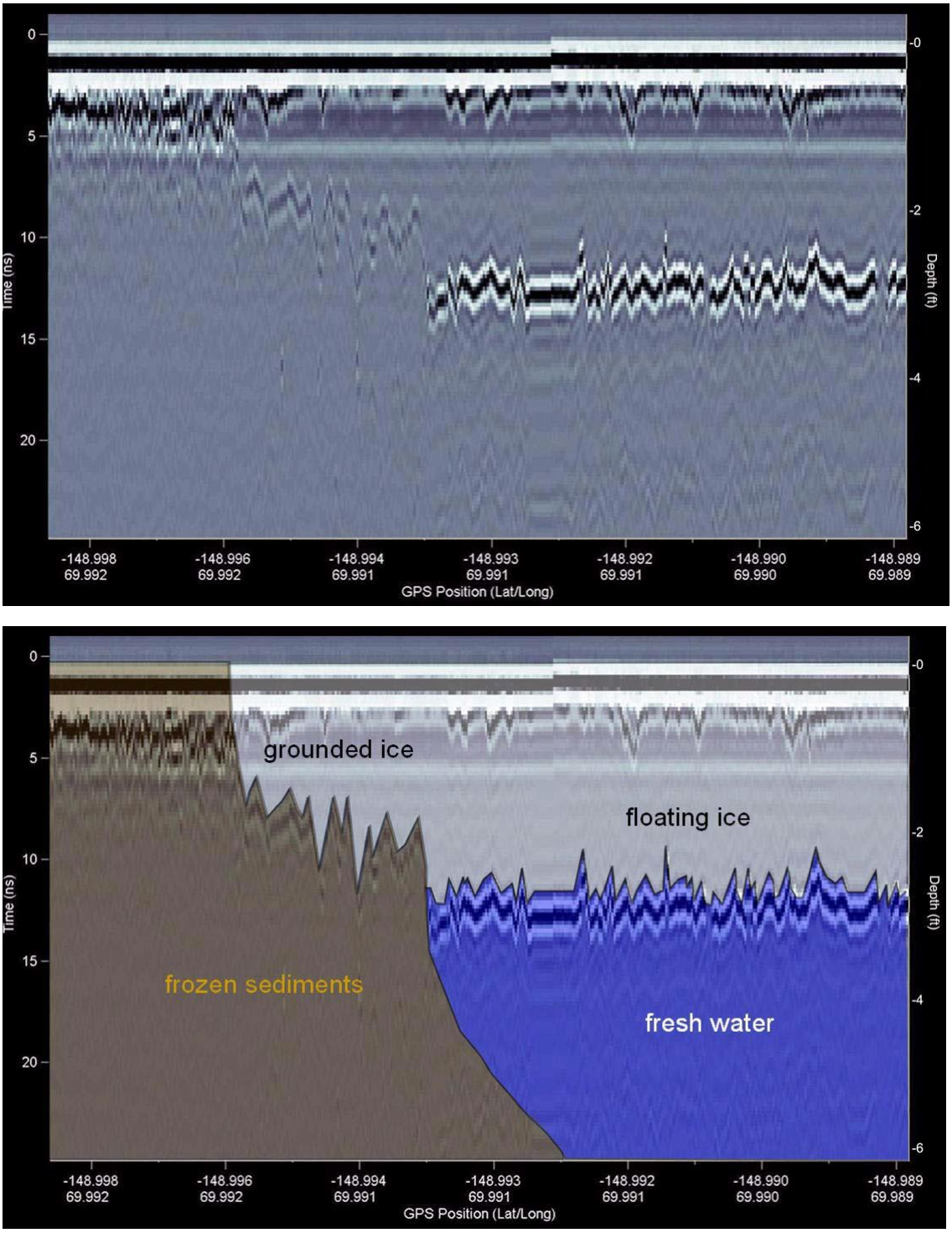


Figure 14-3: Weak reflections near shore are usually caused by ice frozen to the bottom.

14.4 Grounded Shore Ice with Wet Sediments

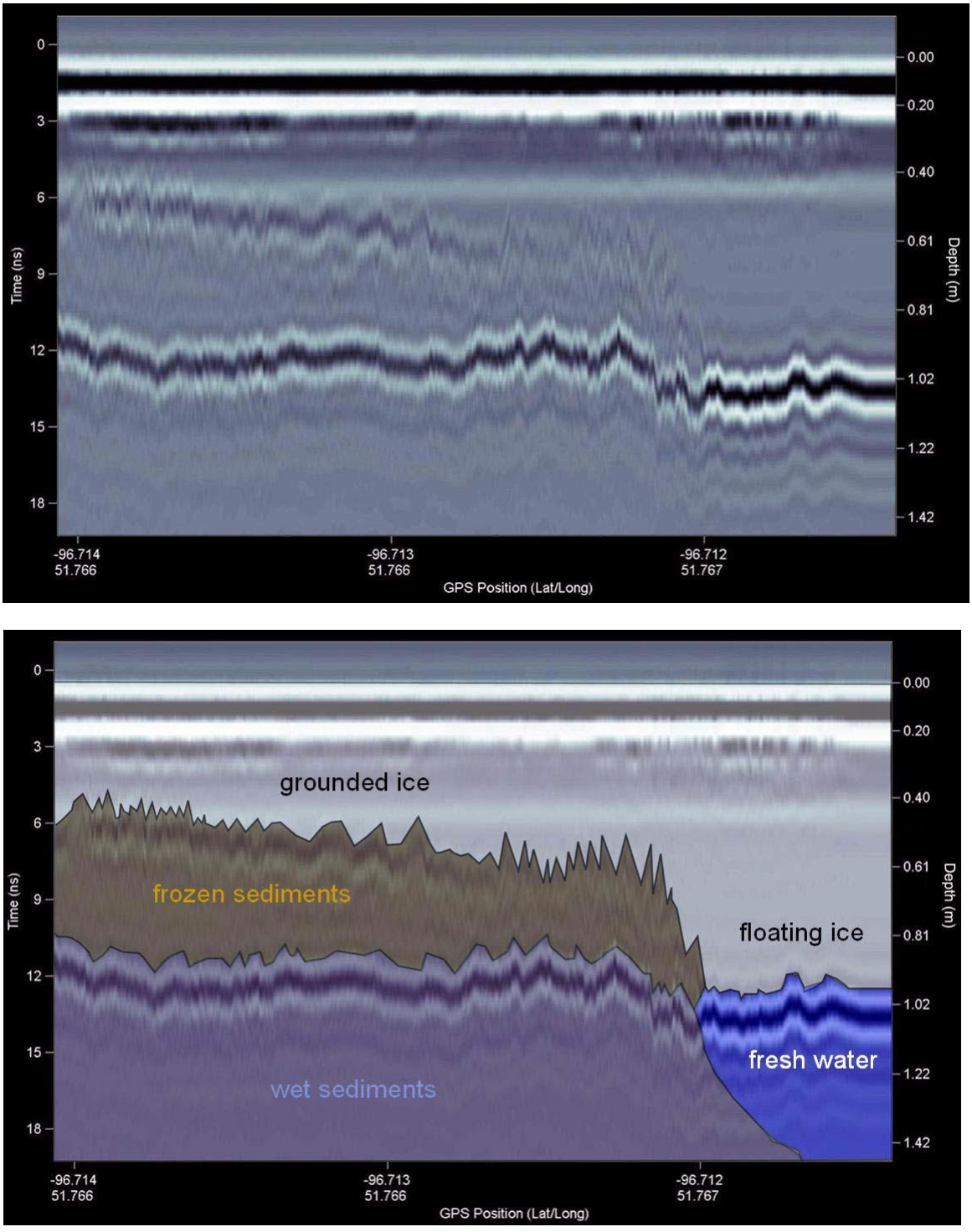
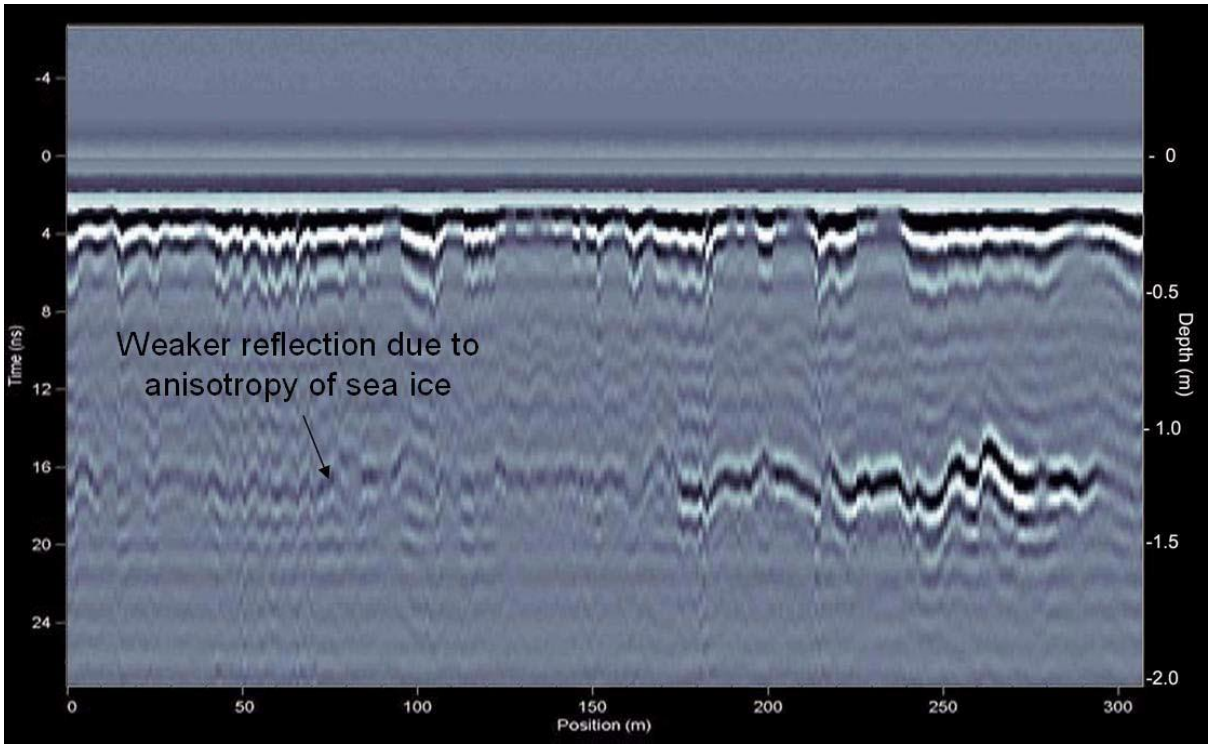
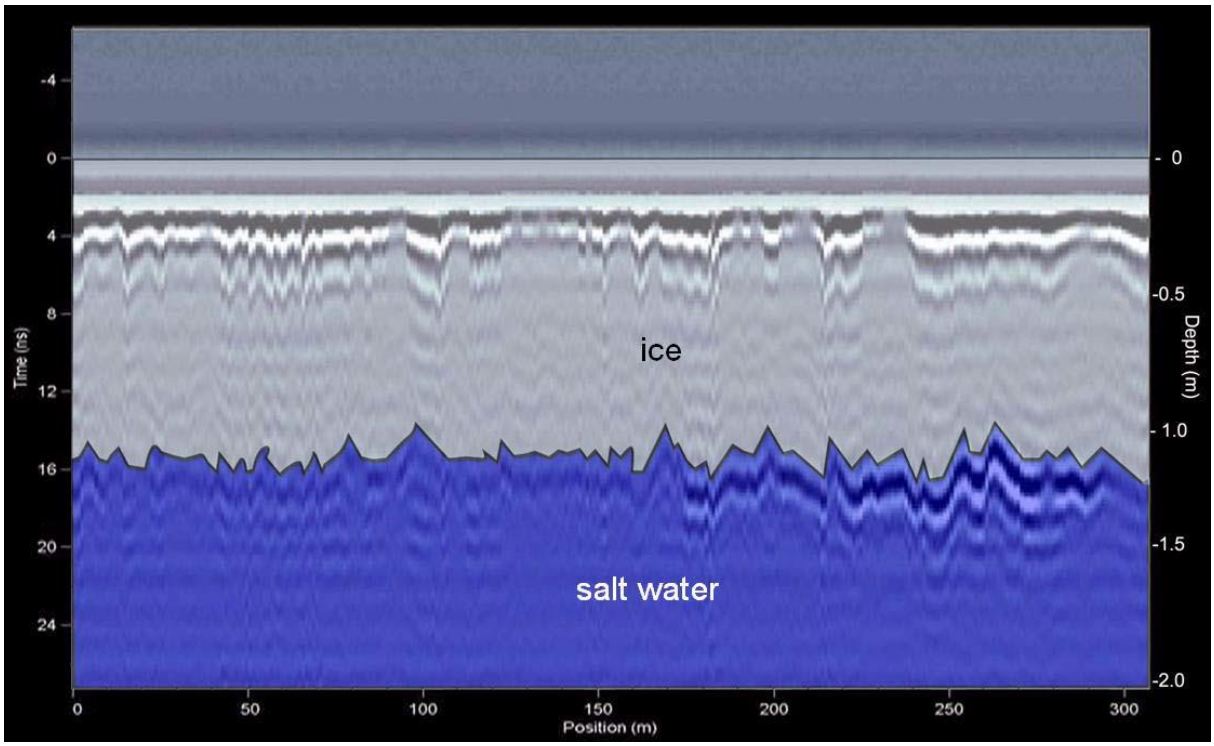


Figure 14-4: Weak reflections near the shore are usually caused by ice frozen to the bottom. The deeper strong reflection is the interface between frozen ground and wet ground.

14.5 Scanning on Sea Ice

Sea ice has different properties than freshwater ice. Sometimes, depending on the crystal orientation and age of the ice, it attenuates the GPR signal resulting in very weak reflections. Re-collecting the data with the GPR turned 90 degrees usually improves the strength of the ice bottom reflector (see Section 2.2).





Appendix A – Special Considerations for Sea Ice

A-1 Antenna Orientation

Unlike freshwater ice, sea ice is anisotropic (of unequal physical properties along different axes) with respect to GPR signals. This means that GPR signals penetrate through the ice better when the GPR antennas are in one orientation than in other orientations. As a result, the ice/water interface may seem to fade in and out or sometimes may not be visible at all.

Example: data displayed in Figure A-1 was collected with the antenna oriented in line with the direction of motion of survey line. With the antenna in this orientation, there is no evidence of the sea ice/water boundary. There appears to be a response around the 12.75 ns (about 1.0 m) position that could be misinterpreted as the sea ice/water interface since it is the strongest reflection evident in the data. However, based on drilling information, it is not the bottom of ice reflector and most likely a multiple of the snow/ice interface.

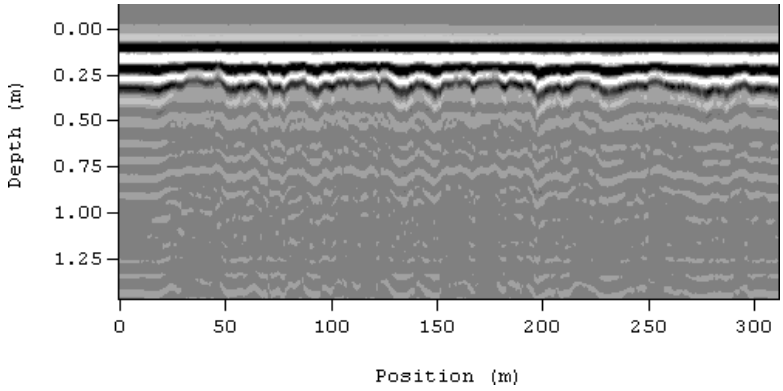


Figure A-1 Sea ice profiling with the antenna oriented parallel to the survey line. Note that the sea ice/water interface, which should be around 1m, is not visible.

Figure A-2 displays approximately the same data as Figure A-1, but data for this survey line was collected with the antenna rotated 90 degrees so that it was perpendicular to the direction of the survey line. The sea ice/water boundary is now clearly defined at around 17ns (about 1.01 m).

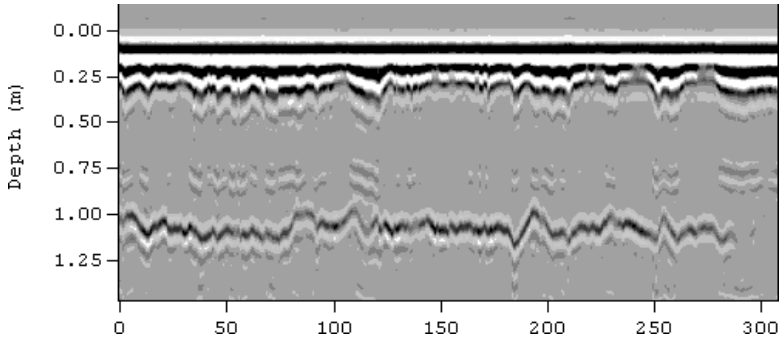


Figure A-2 Sea ice profiling with the antenna rotated 90 degrees from the direction of the survey line (perpendicular). The sea ice/water interface is now visible at about 1m of depth.

Figure A-1 shows that sea ice, when compared to typical freshwater ice, can return significantly more reflections in the data image. These reflections can be caused by the actual structure in the ice and snow/ice reflections and multiples. These extra reflections can easily be misinterpreted as the bottom of the ice. Drilling, at least initially, is necessary to confirm the actual ice thickness.

To highlight how sea ice return extra reflections compare Figures A-3 and A-4. the results displayed in Figure A-3 were gathered with the antenna oriented in line with the direction of survey line. in this image the sea ice/water interface is clearly visible.

In Figure A-4, the antenna was rotated 90 degrees so that it is oriented perpendicular to the direction of the survey line. While the sea ice/water boundary is still evident, it is much weaker than that observed in Figure A-3. Near the end of line in Figure A-4, the sea ice/water boundary response becomes much stronger, but in this case, it was a result of the vehicle turning around rather than a reorientation of the preferred axis in the sea ice.

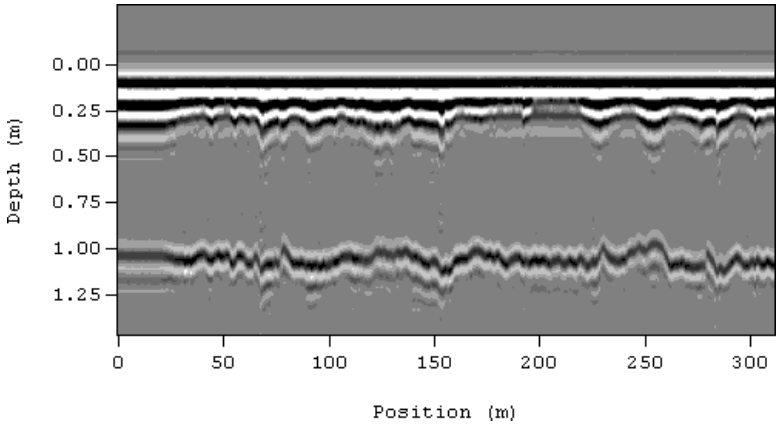


Figure A-3 Sea ice profiling shows the sea ice/water interface with the antenna oriented in the same direction as the survey line (parallel).

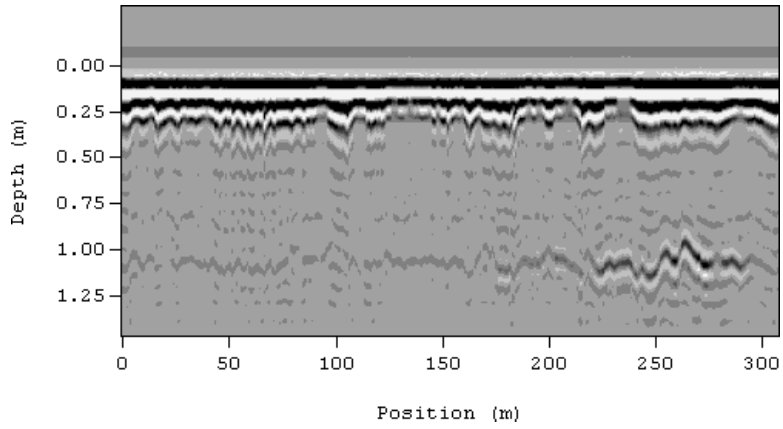


Figure A-4 Sea ice profiling shows the sea/ice interface with the antenna oriented 90 degrees to the survey line (perpendicular). Notice that the sea ice/water interface is still visible but much weaker.

In the first 2000 traces, the sea ice/water reflection is evident until around the 1500m position. At approximately 1500m the position of the antenna was rotated 90 degrees. The lost signal instantly reappears on the next section. The reflection is again lost between 2000-2200m and 2500-2750m, but the antenna was not rotated. From position 3000m to 6860m, a strong response is observed for the sea ice/water interface. Around position 7064m, the vehicle made the transition from snow covered to a ploughed section. The tail end of the last section shows the transition moving off the ice onto land.

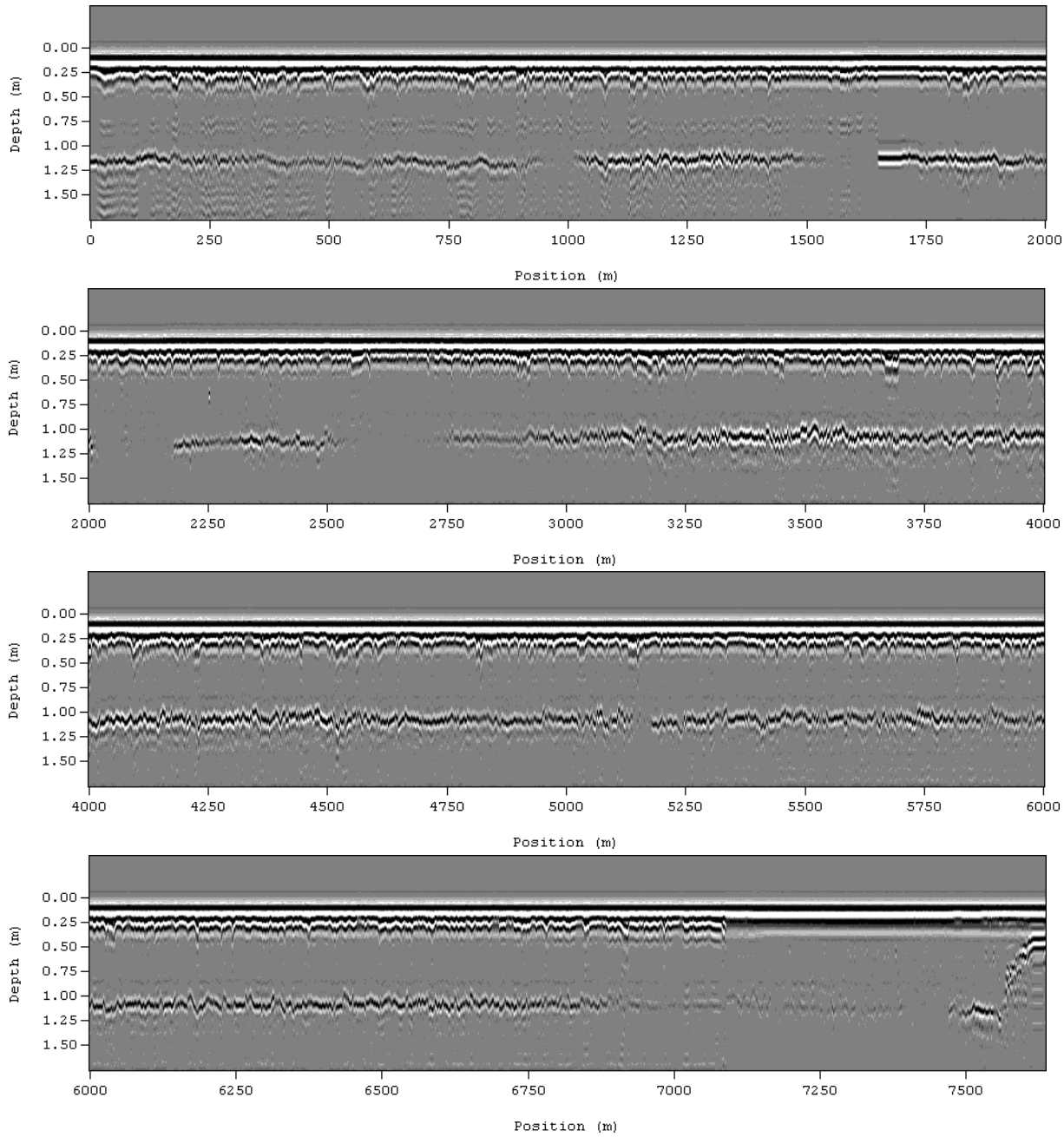


Figure A-5 An 8000-meter-long section to show how often it may be necessary to rotate the antenna. The total section is broken into 4 parts, each one approximately 2000 meters long

A-2 Signal Strength and Gain Settings

As mentioned in the previous section, when collecting ice profiling data over sea ice, the signal strength (amplitude) is much smaller than that observed in freshwater ice data. Because of this, gain settings are crucial for displaying a good sea ice profiling image.

You may need to increase the Gain setting during data collection.

Appendix B – Caching Google Earth Information

B-1 Background

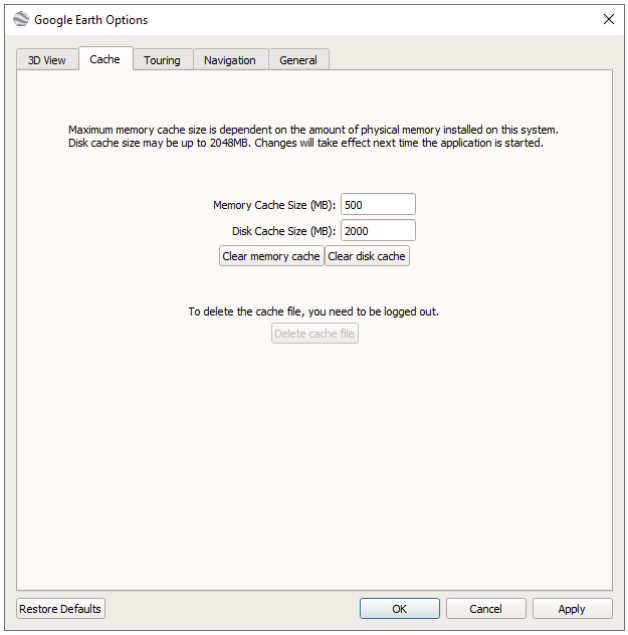
GPR data from a variety of Sensors & Software GPR systems and software packages can be displayed in Google Earth. When the PC is connected to the internet, Google Earth automatically updates surface images as users navigate around the Earth. When no internet connection is available, Google Earth can display surface images that have been previously viewed and saved (cached) into the PC memory. This allows GPR data to be viewed in Google Earth at anytime, anywhere in the world with no internet access required.

The following procedure outlines how to cache Google Earth images on a field PC so GPR data images can be overlain on high resolution surface images when there is no internet connection.

B-2 Google Earth Cache Settings

1. Make sure that the PC is connected to the internet and that Google Earth version 6 (or higher) is installed.

2. Launch Google Earth; select **Tools – Options** on the toolbar. Select the **Cache** tab.



3. Verify that the **Disk Cache Size (MB)** is set to 2000.

4. Verify that the **Memory Cache Size (MB)** is set to the maximum value for the PC.

To determine this, enter a value of **2000** and select **Apply**. Google Earth will automatically determine the maximum available **Memory Cache** for the PC set the value.

5. Click **OK**.

6. Click **OK** to exit the Google Earth Options dialog box.

B-3 Caching Google Earth Images

Navigate in Google Earth to the GPR survey location. Make sure to zoom in on all potential survey areas so the desired image resolution is achieved. Google Earth automatically saves the viewed images to the PC so that they are available when there is no internet connection. A maximum of 2000 MB of images can be saved; once this limit is reached the oldest images are replaced with newer ones.

B-4 Using Cached Google Earth Images

When Google Earth is accessed with no internet connection available, a warning message is automatically displayed indicating that there is no connection. The message asks the user to perform a diagnostic test to resolve the problem. Users should select **No**. Google Earth will launch normally and display only the images previously cached.



When exiting Google Earth, a message appears asking if the user wants to save their GPR data into the **"My Places"** folder. If the user would like to retain the GPR data images for future reference, select **Save**; otherwise select **Discard** to prevent the **My Places** folder from becoming cluttered with numerous data images. Saved data resides in the Google Earth program.

Appendix C – GPR Emissions, Interference & Regulations

All governments have regulations on the level of electromagnetic emissions that an electronic apparatus can emit. The objective is to assure that one apparatus or device does not interfere with any other apparatus or device in such a way as to make the other apparatus non-functional.

Sensors & Software Inc. extensively test their pulseEKKO®, Noggin® and Conquest® subsurface imaging products using independent professional testing houses and comply with the latest regulations of the USA, Canada, European Community, and other major jurisdictions on the matter of emissions.

GPR instruments are considered to be UWB (ultra-wideband) devices. The regulatory regimes worldwide are devising new rules for UWB devices. Sensors & Software Inc. maintains close contact with the regulators to help guide standard development and assure that all products conform. You should continually monitor the "News" link on our website (www.sensoft.ca) for updates on standards.

Refer to the following sections to learn about specific GPR guidelines in specific jurisdictions.

C-1 FCC Regulations (USA)

This device complies with Part 15 of the USA Federal Communications Commission (FCC) Rules. Operation in the USA is subject to the following two conditions:

1. this device may not cause harmful interference
2. this device must accept any interference received, including interference that may cause undesired operation.

Part 15 – User Information

This equipment has been tested and found to comply with the limits for a Class A digital device, where applicable, and for an ultrawide bandwidth (UWB) device where applicable, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING

Changes or Modifications not expressly approved by Sensors & Software Inc. could void the user's authority to operate the equipment.

Certification of this equipment has been carried out using approved cables and peripheral devices. The use of non-approved or modified cables and peripheral devices constitutes a Change or Modification outlined in the warning above.

Operating Restrictions

Operation of this device is limited to purposes associated with law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction. Parties operating this equipment must be eligible for licensing under the provisions of Part 90 of this chapter.

FCC Interpretation of Operation Restrictions issued July 12, 2002
(FCC Order DA02-1658, paragraph 9)

The regulations contain restrictions on the parties that are eligible to operate imaging systems. [1] Under the new regulations, GPRs and wall imaging systems may be used only by law enforcement, fire and emergency rescue organizations, by scientific research institutes, by commercial mining companies, and by construction companies. Since the adoption of the *Order*, we have received several inquiries from the operators of GPRs and wall imaging systems noting that these devices often are not operated by the users listed in the regulations but are operated under contract by personnel specifically trained in the operation of these devices. We do not believe

1. See 47 C.F.R. §§15.509(b), 15.511(b), and 15.513(b)

that the recent adoption of the UWB rules should disrupt the critical safety services that can be performed effectively only through the use of GPRs and wall imaging systems. We viewed these operating restrictions in the broadest of terms. For example, we believe that the limitation on the use of GPRs and wall imaging systems by construction companies encompasses the inspection of buildings, roadways, bridges and runways even if the inspection finds no damage to the structure and construction does not actually result from the inspection; the intended purpose of the operation of the UWB device is to determine if construction is required. We also believe that the GPRs and wall imaging systems may be operated for one of the purposes described in the regulations but need not be operated directly by one of the described parties. For example, a GPR may be operated by a private company investigating forensic evidence for a local police department.

FCC Permitted Mode of Usage

The GPR antenna must be kept on the surface to be in compliance with FCC regulations. Use of the antenna is not permitted if it is lifted off the surface. Use as a through-the-wall imaging device is prohibited.

GPR Use Coordination

FCC regulation 15.525(c) (updated in February 2007) requires users of GPR equipment to coordinate the use of their GPR equipment as described below:

TITLE 47--TELECOMMUNIC-500ATION

CHAPTER I--FEDERAL COMMUNIC-500ATIONS

COMMISSION PART 15_RADIO FREQUENCY DEVICES

Subpart F_Ultra-Wideband Operation Sec.

15.525 Coordination requirements.

(a) UWB imaging systems require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination.

(b) The users of UWB imaging devices shall supply operational areas to the FCC Office of Engineering and Technology, which shall coordinate this information with the Federal Government through the National Telecommunications and Information Administration. The information provided by the UWB operator shall include the name, address and other pertinent contact information of the user, the desired geographical area(s) of operation, and the FCC ID number and other nomenclature of the UWB device. If the imaging device is intended to be used for mobile applications, the geographical area(s) of operation may be the state(s) or county(ies) in which the equipment will be operated. The operator of an imaging system used for fixed operation shall supply a specific geographical location or the address at which the equipment will be operated. This material shall be submitted to:

Frequency Coordination Branch, OET
Federal Communications Commission

445 12th Street, SW, Washington, D.C.
20554
Attn: UWB Coordination

(Sensors & Software Inc. Note: The form given on the following page is a suggested format for performing the coordination.)

(c) The manufacturers, or their authorized sales agents, must inform purchasers and users of their systems of the requirement to undertake detailed coordination of operational areas with the FCC prior to the equipment being operated.

(d) Users of authorized, coordinated UWB systems may transfer them to other qualified users and to different locations upon coordination of change of ownership or location to the FCC and coordination with existing authorized operations.

(e) The FCC/NTIA coordination report shall identify those geographical areas within which the operation of an imaging system requires additional coordination or within which the operation of an imaging system is prohibited. If additional coordination is required for operation within specific geographical areas, a local coordination contact will be provided. Except for operation within these designated areas, once the information requested on the UWB imaging system is submitted to the FCC no additional coordination with the FCC is required provided the reported areas of operation do not change. If the area of operation changes, updated information shall be submitted to the FCC following the procedure in paragraph (b) of this section.

(f) The coordination of routine UWB operations shall not take longer than 15 business days from the receipt of the coordination request by NTIA. Special temporary operations may be handled with an expedited turn-around time when circumstances warrant. The operation of UWB systems in emergency situations involving the safety of life or property may occur without coordination provided a notification procedure, similar to that contained in Sec. 2.405(a) through (e) of this chapter, is followed by the UWB equipment user. [67 FR 34856, May 16, 2002, as amended at 68 FR 19751, Apr. 22, 2003]

Effective Date Note: At 68 FR 19751, Apr. 22, 2003, Sec. 15.525 was amended by revising Page 925 paragraphs (b) and (e). This amendment contains information collection and record-keeping requirements and will not become effective until approval has been given by the Office of Management and Budget.

FCC GROUND PENETRATING RADAR COORDINATION NOTICE

NAME:

ADDRESS:

CONTACT INFORMATION [CONTACT NAME AND PHONE NUMBER]:

AREA OF OPERATION [COUNTIES, STATES OR LARGER AREAS]:

FCC ID: QJQ-NG500 FOR NOGGIN 500 SYSTEM

EQUIPMENT NOMENCLATURE: [E.G. NOGGIN 500]

Send the information to:

Frequency Coordination Branch., OET
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554
ATTN: UWB Coordination
Fax: 202-418-1944

INFORMATION PROVIDED IS DEEMED CONFIDENTIAL

C-2 Industry Canada Regulations - English

Industry Canada published it regulations for ground penetrating radar (GPR) on Mar 29, 2009, as part of the RSS-220 titled 'Devices Using Ultra-Wideband (UWB) Technology'.

Industry Canada has made a unique exception for GPR by not requiring user licensing. The user does have to comply with the following directives:

(1) This Ground Penetrating Radar Device shall be operated only when in contact with or within 1 m of the ground.

2. This Ground Penetrating Radar Device shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

Should the ground penetrating radar be used in a wall-penetrating mode then the following restriction should be noted by the user:

(1) This In-wall Radar Imaging Device shall be operated where the device is directed at the wall and in contact with or within 20 cm of the wall surface.

2. This In-wall Radar Imaging Device shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

Since operation of GPR is on a license-exempt basis, the user must accept the following:

Operation is subject to the following two conditions:(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

C-3 Règlement d'Industrie Canada - Français

Industrie Canada a publié des règlements pour les appareils géoradar (GPR) le 29 mars 2009, dans le cadre du RSS-220 intitulé "Dispositifs utilisant la bande ultra-large (UWB)".

Industrie Canada a faite une exception unique pour GPR en n'exigeant pas de licence par utilisateur. L'utilisateur doit se conformer aux directives suivantes:

(1) Ce géoradar périphérique doit être utilisé que lorsqu'il est en contact avec ou moins de 1 m du sol.

2. Ce géoradar périphérique doit être utilisé que par les organisations d'application de la loi, les instituts de recherche scientifique, des sociétés minières commerciales, entreprises de construction et de secours d'urgence ou des organisations de lutte contre les incendies.

Si le géoradar est utilisé dans un mode de pénétration au mur, la restriction suivante est à noter par l'utilisateur:

(1) Ce dispositif d'imagerie radar doit être utilisé lorsque l'appareil est orienté vers le mur et en contact avec ou dans les 20 cm de la surface du mur.

2. Ce dispositif d'imagerie radar doit être utilisé que par les organisations d'application de la loi, les instituts de recherche scientifique, des sociétés minières commerciales, entreprises de construction et de secours d'urgence ou des organisations de lutte contre les incendies.

Parce que l'exploitation de GPR est sur une base exempte de licence, l'utilisateur doit accepter le texte suivant:

La fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositif.

Appendix D – Instrument Interference

Immunity regulations place the onus on instrument/apparatus/device manufacturers to assure that extraneous interference will not unduly cause an instrument/apparatus/device to stop functioning or to function in a faulty manner.

Based on independent testing house measurements, Sensors & Software Inc. systems comply with regulations in Canada, USA, European Community, and most other jurisdictions. GPR devices can sense electromagnetic fields; external sources of electromagnetic fields, such as TV stations, radio stations, and cell phones, can cause signals detectable by a GPR which may degrade the quality of the data that a GPR device records and displays.

Such interference is unavoidable, but sensible survey practice and operation by an experienced GPR practitioner can minimize such problems. In some geographic areas emissions from external sources may be so large as to preclude useful measurements. Such conditions are readily recognized and accepted by the professional geophysical community as a fundamental limitation of geophysical survey practice. This type of interference present in GPR recordings is not considered as an equipment fault or as a failure to comply with immunity regulations.

Appendix E – Safety Around Explosive Devices

Concerns have been expressed regarding the hazard of GPR products being used near blasting caps and Unexploded Ordnance (UXO). Experience with blasting caps indicates that the power of Sensors & Software Inc.'s GPR products is not sufficient to trigger blasting caps. Based on a conservative independent testing house analysis, it is considered a precautionary best practice to keep the GPR transmitters at least 5 feet (2m) away from blasting caps.

Some customers carry out experimental trials with their blasting devices to conform to safety regulations. Sensors & Software recommends that GPR users routinely working with explosive devices to develop a systematic safety methodology in their work areas.

The UXO issue is more complex, and standards on fuses do not exist for obvious reasons. To date, no problems have been reported with any geophysical instrument used for UXOs. Since proximity and vibration are also critical for UXO, the best advice is to be cautious and understand the risks.

Appendix F - Health & Safety Certification

Strong radio frequency Electromagnetic (EM) Fields may pose a health hazard. Normal EM fields have been studied extensively over the past 30 years with no conclusive epidemiology relating EM fields to health problems. Detailed discussions on the subject are contained in the references at the end of this Appendix.

The USA Federal Communication Commission (FCC) and Occupational Safety and Health Administration (OSHA) both specify acceptable levels for electromagnetic fields. Similar power levels are mandated by corresponding agencies in other countries. Maximum permissible exposures and time duration specified by the FCC and OSHA vary with excitation frequency. The lowest threshold plane wave equivalent power cited is 0.2 mW/cm^2 for general population over the 30 to 300 MHz frequency band. All other applications and frequencies have higher tolerances as shown in graphically in Figure F-1.

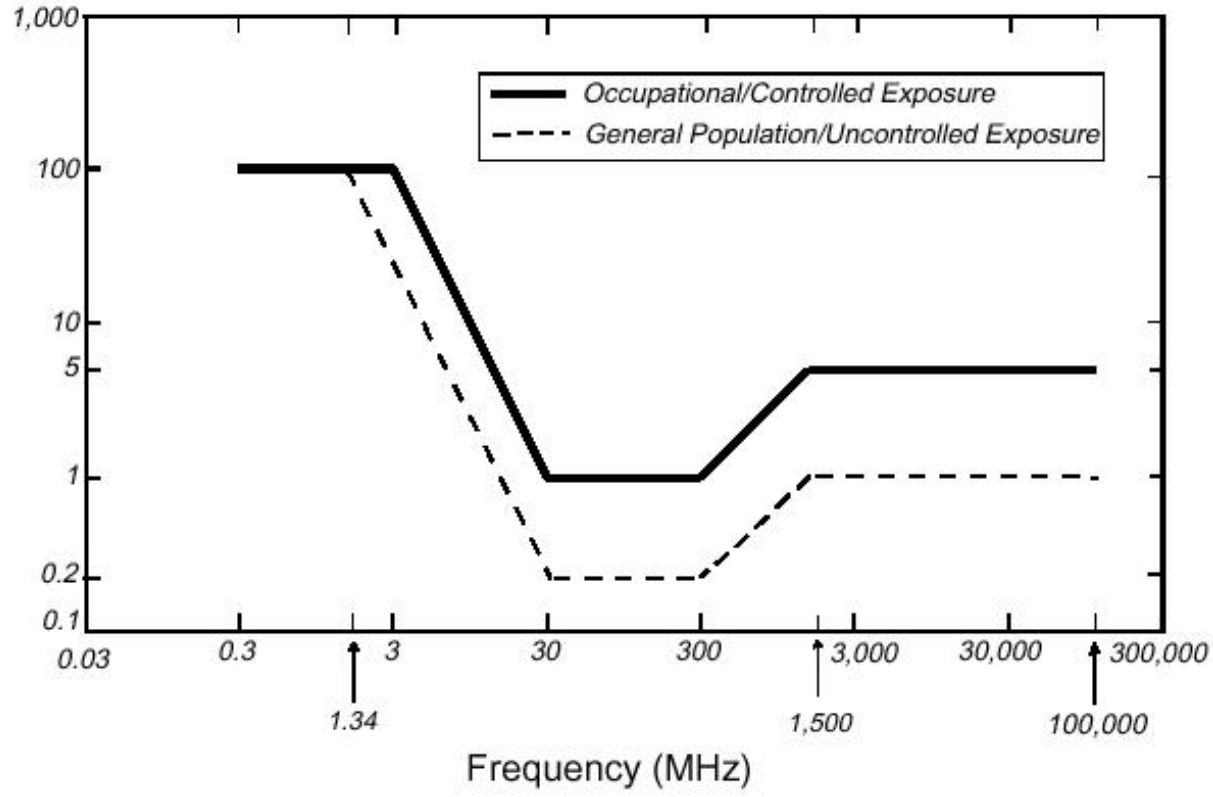


Figure F-1: FCC limits for maximum permissible exposure (MPE) plane-wave equivalent power density mW/cm^2.

All Sensors & Software Inc. pulseEKKO, Noggin, and Conquest products are normally operated at least 1 m from the user and as such are classified as mobile devices according to the FCC. Typical power density levels at a distance of 1 m or greater from any Sensors & Software Inc. product are less than 10^{-3} mW/cm^2 which is 200 to 10,000 times lower than mandated limits. As such, Sensors & Software Inc. products pose no health and safety risk when operated in the normal manner of intended use.

References

1. Questions and answers about biological effects and potential hazards of radio-frequency electromagnetic field.

   USA Federal Communications Commission, Office of Engineering & Technology

   OET Bulletin 56
   (Contains many references and web sites)

2. Evaluation Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

   USA Federal Communications Commission, Office of Engineering & Technology

   OET Bulletin 56
   (Contains many references and web sites)

3. USA Occupational Safety and Health Administration regulations paragraph 1910.67 and 1910.263.

Web Sites

www.fcc.gov/Bureau/EngineeringTechnology/Documents/bulletin

www.osha-slc.gov/SLTC (see radio frequency)

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