Using the CEE JET 1600 with the SBG Ellipse Motion Sensor and Hydromagic for Personal Watercraft (Jet Ski) Surveys with WiFi

The CEE JET 1600™ hydrographic survey system for personal watercraft (PWC) surveying includes a WiFi module for wireless connection to a tablet screen for navigation and a simplified motion sensor interface for attitude error corrections. Survey data may be recorded inside the CEESCOPE-R™ echo sounder including motion data from the SBG Systems Ellipse MRU. RTK corrections may be received by network using the WiFi link to a waterproof tablet PC running the Hydromagic NTRIP plugin. This presents an integrated package with maximum ease of use, critical for operation in PWC survey environments.

The CEE JET 1600™ is a self-contained single beam hydrographic surveying "add-on" kit designed to be installed on SeaDoo PWC vehicles with the LinQ accessory system. Iinstallation on other vehicles is also possible given user customization.

CEE-JET 1600™ Survey system installed on SeaDoo FishPro PWC (2022 model).

Connecting to the CEESCOPE-R™ WiFi Access Point

The CEESCOPE-R™ echo sounder is installed inside a waterproof protective outer case, along with a high-capacity LiPO4 battery for extended duration operation and a WiFi access point for direct communication with a tablet PC used for real time data display for the operator.

The WiFi access point is powered by the CEESCOPE-R™ through the waterproof Ethernet data cable and will only be activated when the CEESCOPE-R™ is powered

up AND the CEESCOPE-R™ Power over Ethernet (POE) function is also activated. The WiFi module will show an illuminated ring indicating operation.

To power up the WiFi radio, the 802.3af 48V Power over Ethernet must be ENABLED on the CEESCOPE-R™ POWER menu (accessed by pressing the BATTERY icon on the home screen). Depending on the firmware revision, the POWER menu screen may show alternate labeling however there are two POE ports. Port one is a 24V passive POE connected to the LEMO socket on the right side of the CEESCOPE-R™ enclosure; this may be used with an external Ubiquiti Systems Bullet radio to transmit data over 1000m. Port two is the active 802.3af (48V) port connected to the Bulgin RJ45 waterproof Ethernet socket used to power the CEE JET 1600 WiFi module.

When powered by the CEESCOPE-R™, the WiFi radio generates a "hot spot" Access Point discoverable by any device within range. This means survey data may be acquired using only a small fully waterproof tablet or even by a second surveyor on the shore. The system supports multiple connections to the CEESCOPE-R™.

CEE-JET 1600™ Enclosure with CEESCOPE-R™ echo sounder and WiFi access point (battery behind lid).

To successfully establish a WiFi data link with the CEESCOPE-R™, the WiFi adaptor of the acquisition laptop or tablet must be set as a STATIC IP address to match the CEESCOPE-R™ network. The WiFi address should be set to 192.168.2.11. DO NOT use 192.168.2.(1, 2, 10). Note that once the WiFi adapter is set to a static IP, it will NO LONGER be able to connect to other WiFi

networks so this should be returned to the default (Dynamic, DHCP, Automatic) IP address setting if the PC needs to connect to other networks.

Configuring the SBG Ellipse Motion Sensor

The CEESCOPE-R™ has an integrated motion sensor interface, and the CEE JET 1600™ is designed to use the SBG Systems Ellipse. If the Ellipse-E Inertial Navigation System is used, high rate RTK position data are passed out to the MRU from the CEESCOPE-R™'s internal GNSS receiver along with DC power; precise "GNSS aided" motion data are then output back from the MRU to the CEESCOPE-R™, and recorded internally using the unique CEE data format for acquisition. If the non-aided Ellipse-A Attitude and Heading Reference System is used, GNSS aiding data are not transferred but the operation is otherwise identical.

The data messages are as follows:

CEESCOPE-R™ to Ellipse: Selected NMEA 0183 GPS messages at up to 20Hz.

Ellipse to CEESCOPE-R™: TSS1 heave pitch roll attitude output at 20Hz.

The CEESCOPE-R™ applies a precise millisecond time tag to all data messages, keeping timing exceptionally consistent. HYPACK and Hydromagic software can use this time tag in data acquisition for bathymetry (position and depth) data. The benefit for these types of applications is that WiFi may be used to acquire the data with no concerns about latency or lag errors. The use of the CEE format time tag means there is never a concern about any timing problems when telemetering all bathymetry, position, and attitude data to the acquisition device.

The motion sensor is precisely installed on the GNSS pole with X forward to the bow and Y to starboard. Data output is preset (TSS1 message at 20Hz) as follows:
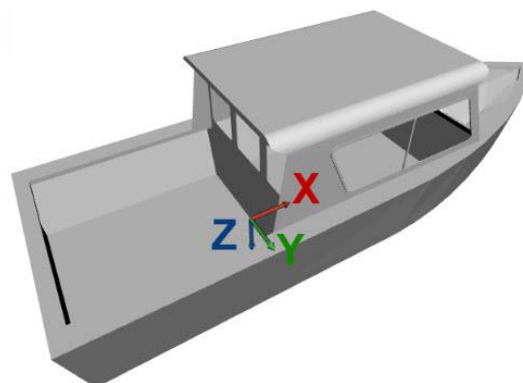

SBG Ellipse reference frames

X Axis – ROLL (positive STBD down)   Heave – Positive upwards

Y Axis – PITCH (positive bow upwards)

To enable motion data in the CEESCOPE-R™ saved data files and real time data export, ensure the HEAVE input is ENABLED and set to 115,200bps on the CEESCOPE-R™ SENSORS menu. If properly connected, a heave value will appear at the bottom on the LCD on the SENSORS menu screen.
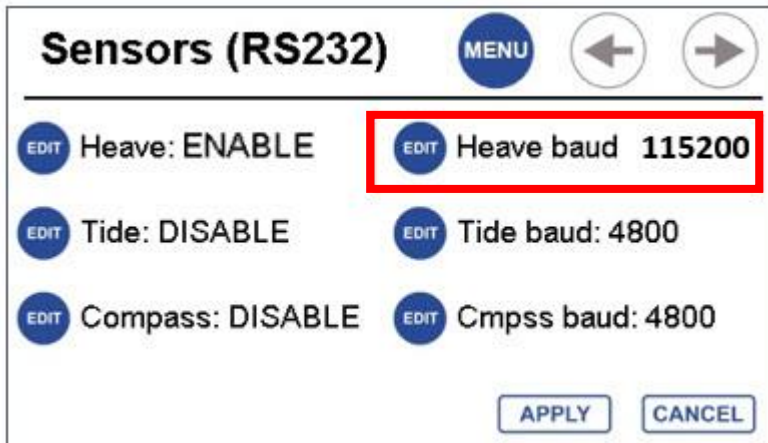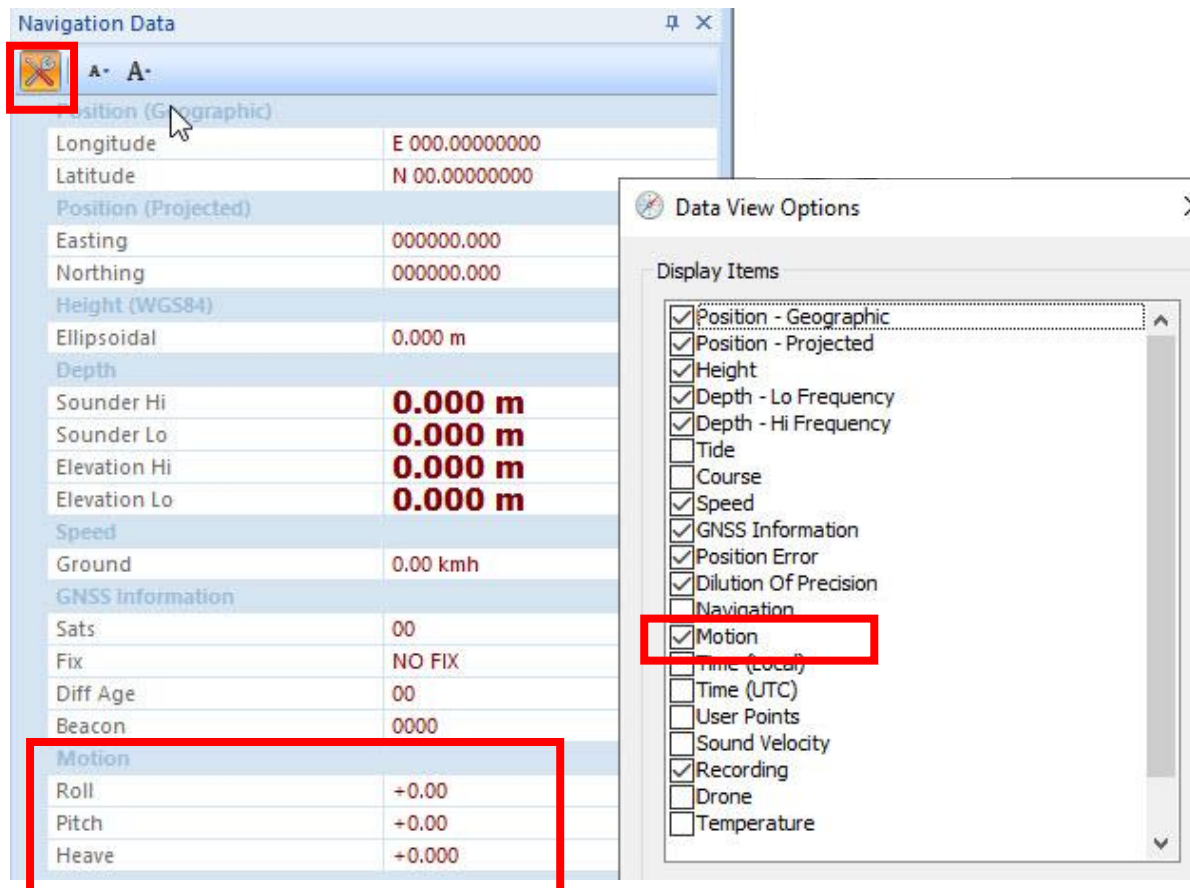

CEESCOPE-R™ SENSORS menu

If using the standard Ellipse-A motion sensor, there is no provision for GNSS data input from the CEESCOPE-R™. If using the Ellipse-E INS, the heave option should be set to AIDED on the CEESCOPE-R™ Sensors menu. In this case the following GNSS messages should be output from the CEESCOPE-R™ to improve the motion sensor performance:

GGA: 5Hz+

RMC: 5Hz+

GST: 1Hz

ZDA: 1Hz

As the motion sensor is being used in a fairly simplistic application to correct for pitch and roll deviations, there is limited benefit in GNSS aided motion measurements therefore use of the Ellipse-A will usually be most suitable.

To display motion data in Hydromagic in real time, first access the Navigation data options and select Motion to show the heave, pitch, roll data on the Nav Pane:

Hydromagic navigation data view setup

This selection in the navigation view (or any other setting in Hydromagic) does not affect the recording of motion data. If motion input is enabled in the CEESCOPE-R™ SENSORS menu then it will be automatically recorded in the Hydromagic dataset, whether acquired in real time or from an imported CEE data file.

Editing Data to Apply a Motion Correction to Soundings

Motion data may be applied to collected RAW data during processing to reduce the impact of the PWC motion on the survey results. First, "Use Motion Sensor Readings" must be enabled in the Options / Preferences / Calibration menu. In this case, the PITCH and ROLL values will be used to recalculate the sounding point position for every sounding.

**On the motion senor configuration menu, the heave, pitch, roll conventions should match the motion sensor setup.**

The "use beam steering" option should be checked, so motion corrections are only applied when the motion is out of the transducer beam angle range (typically 9 deg

for CEE JET applications). This assumes that the transducer will report the same depth for any orientation up to the beam angle. The "Echosounder outputs heave corrected depths" must be checked; heave needs to be disabled as the high rate (10Hz) RTK GNSS is accounting for elevation changes caused by heave.
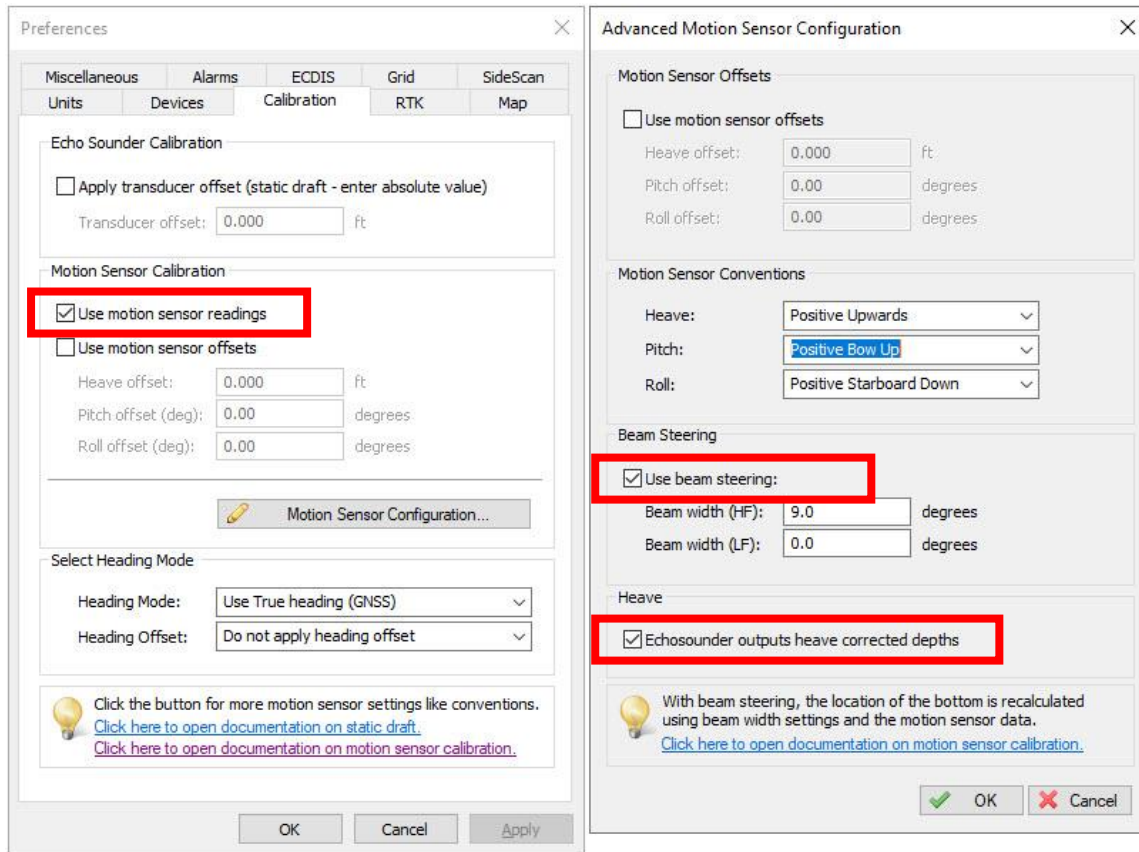

Hydromagic motion sensor data correction setup

The beam steering calculation will reposition and recalculate the sounding points based on the new motion-corrected position using the measured depth and roll / pitch angle. Below is an original uncorrected GNSS track showing the colorized RAW data sounding points over a bottom surface that is largely flat. It is obvious that rapid depth variations occur based on the excessive movement of the vehicle.
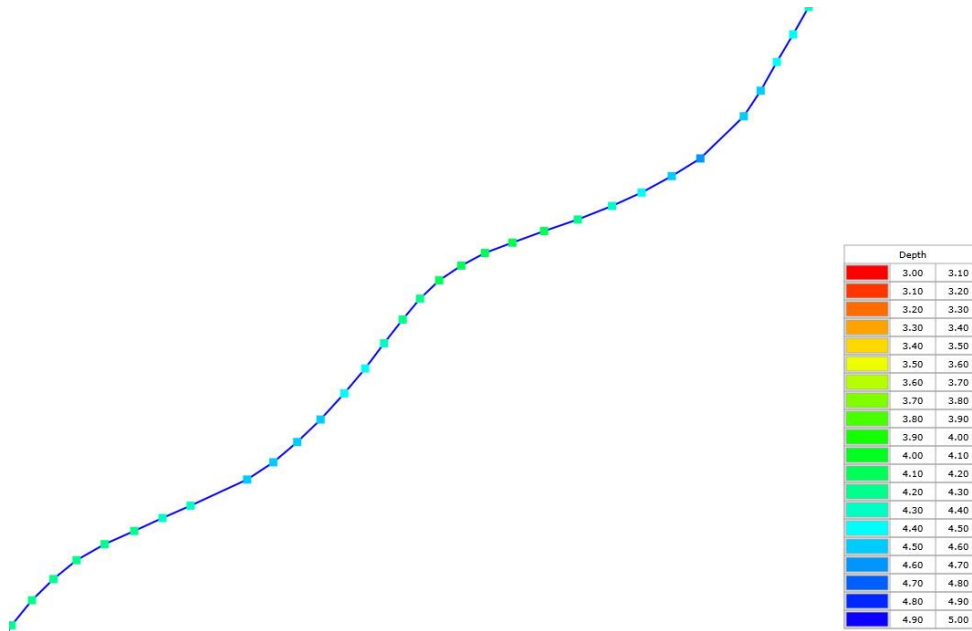
Hydromagic RAW data trace showing depth variations caused by rolling motion of the vehicle.

If the motion sensor option is enabled, upon generating a sounding file in post processing the individual sounding points will be relocated as shown below, to reflect their true position and depth more accurately during periods of high pitch / roll:
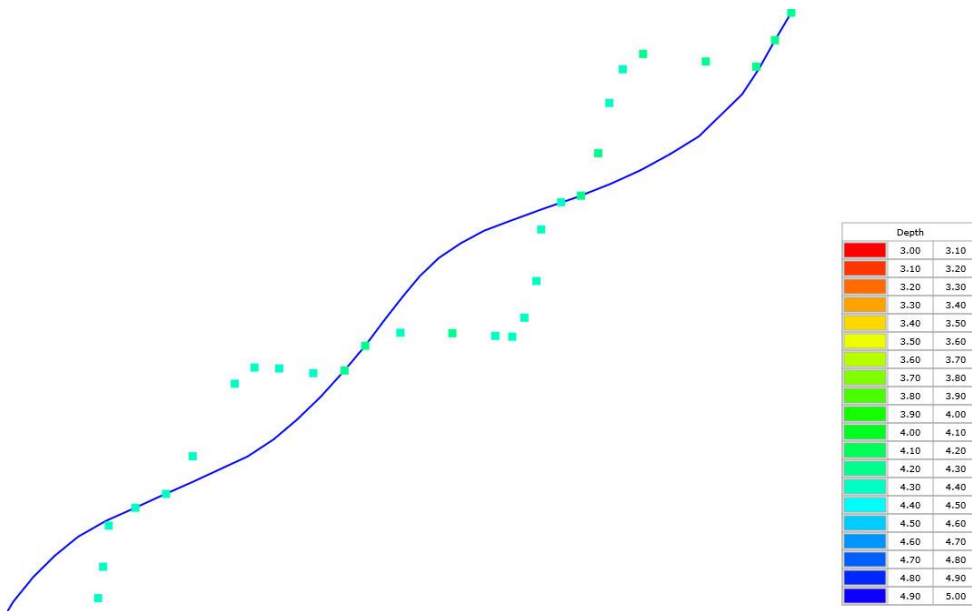
Hydromagic edited sounding data trace after motion corrections applied – note depth fluctuations are eliminated.

Data should be reviewed to determine whether periods of excessive motion should be eliminated from the survey entirely. Real time / RAW data will never have motion corrections applied prior to the post processing stage.

Configuration of Network RTK (NTRIP) Corrections

Alongside the built-in UHF radio for RTK corrections, the CEESCOPE-R™ further enhances the available options for accurate positioning with post processed (PPK) and Network RTK. For network RTK, the CEESCOPE's WiFi interface allows users to simply pass NTRIP corrections from the waterproof tablet to the CEESCOPE-R™.

To receive network RTK corrections from the Hydromagic NTRIP caster, the appropriate RTCM input must be selected in the CEESCOPE "RTCM" menu. The corrections format being received through the NTRIP caster must match the entry in the CEESCOPE-R™. The menu options shown for "RTCM Version" will be firmware dependent and may be a specific corrections format or simply "RTK".

*GNSS menu indicating CEESCOPE-R™ GNSS receiver IP address.*
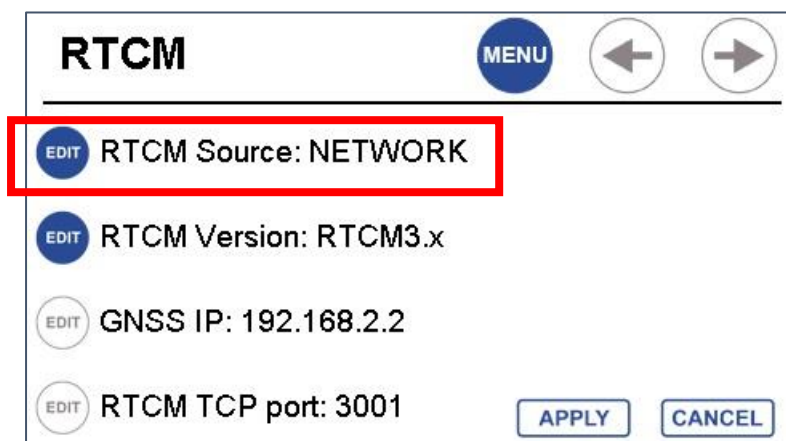
RTCM menu showing RTK corrections selection.

The "NTRIP Plugin for Hydromagic" should be added to the devices list. The connection configuration should be as follows:

Type: TCP/IP   Host IP: 192.168.2.2   IP Port: 3001

The IP address or server web site must be entered in the "hostname" along with the Port number designated by the network RTK provider. When the user name and password are entered, the refresh icon may be pressed which will populate the corrections streams list. Then the appropriate ground station may be selected.
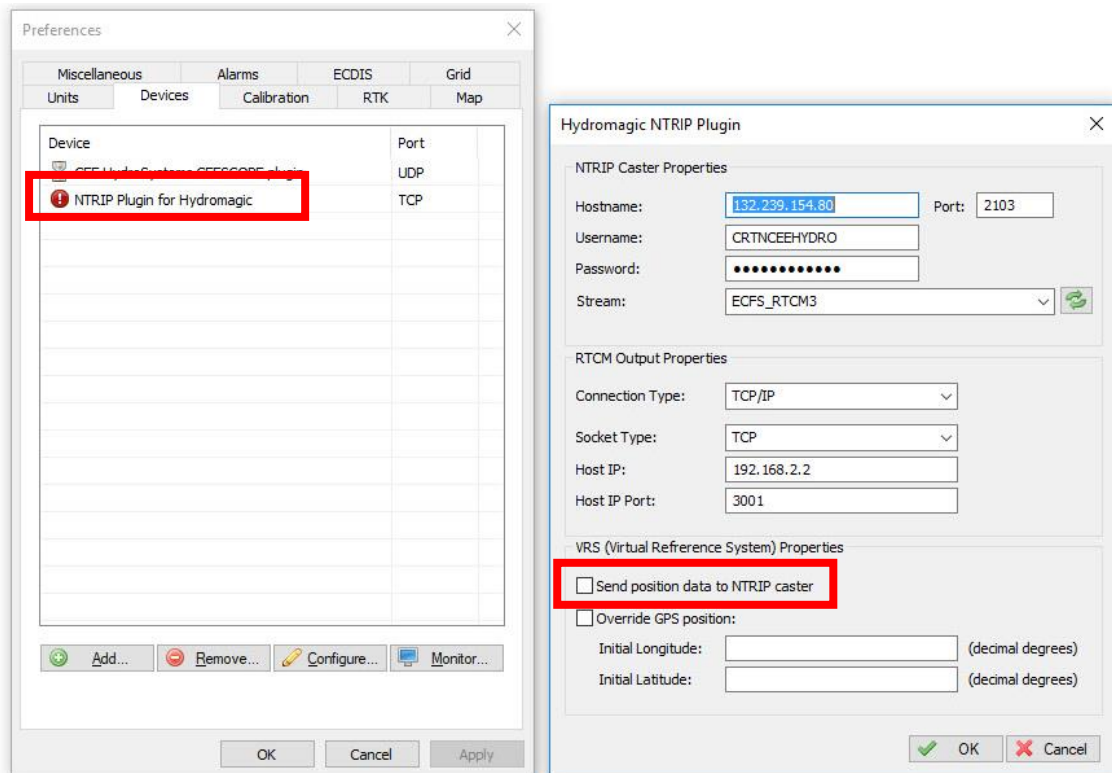
Ensure that "Send position to NTRIP caster" is checked when the service requires the user's GNSS position, for example on all VRS subscriptions.

If the TCP/IP connection is interrupted during surveying, corrections can restarted by selecting the NTRIP plugin in the Devices menu and pressing "configure" then "OK" without altering any settings. Restarting Hydromagic will also reinitialize the NTRIP corrections.

The "Monitor" screen is useful to show the reception and transmission of NTRIP corrections. Incoming corrections being received but not forwarded means a comms error with the CEESCOPE-R™ (for example incorrect IP address or NETWORK not selected in the CEESCOPE-R™ RTCM menu); no corrections being received (blank screen) is likely a result of an incorrect password / user login.

In the preferences menu, GPS alarms can be selected on the Alarms tab to further highlight any loss of RTK corrections owing to a communication problem with the NTRIP stream. During an alarm event, "reset alarm" from the tool bar icon will cancel

the alarm, or the alarm will clear once RTK position quality has been regained. The alarm will only activate once RTK quality has first been achieved, then lost.
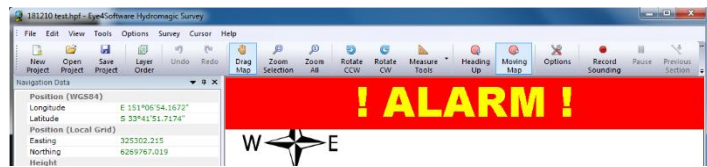
Hydromagic RTK alarm setup and alarm indication