

## Using the CEESCOPE™ with Precise Point Positioning GNSS

*The CEE HydroSystems CEESCOPE™ echo sounder's built-in GNSS receivers are all able to access satellite-derived differential corrections using proprietary L-Band signals offered by GNSS equipment suppliers. The signals are subscription-based and offer a "single antenna" solution without any requirement for a separate connection to a RTK base station or cell phone service. The L-Band corrections have scalable accuracies and activation duration.*

The Precise Point Positioning (PPP) mode of GNSS receiver operation relies on a network of ground reference stations operated by the service provider. Data from these ground stations are used to continuously compute positioning errors within the coverage area, and special models and algorithms are applied to improve the accuracy further. The corrections that result from these calculations are broadcast to compatible GNSS receivers over the L-Band frequency through dedicated geostationary satellites positioned over the equator. These special satellites are placed at various longitudes to cover the globe and are not the same systems as the primary GPS-type positioning satellites.

When starting a survey using PPP, a "convergence time" will be required with the GNSS receiver in operation determining the position errors before the full PPP accuracy is reached. During this time, the GNSS receiver will indicate a non-precision corrected position. As the L-Band signal comes from a satellite over the equator, the PPP method requires a clear view of the sky across to the satellite. Unlike the GNSS positioning signal, where there may be dozens of visible satellites, for L-band corrections there will be one or two, making it critical to maintain a clear sky view. This reliance on equatorial satellites means PPP becomes subject to more limitations at higher latitudes as the corrections satellite nears the horizon. GNSS receivers, including those installed in the CEESCOPE™ use two main frequencies of operation: L1 and L2. All receivers utilize the L1 frequency but to achieve higher accuracy in PPP or other operation modes such as RTK, the L2 frequency must also be available. This requires the GNSS receiver to be activated for the L2 signal and the antenna must also be capable of receiving L2. Some antennae are L1-only and therefore are unable to achieve higher precision results. Usually, antennae supplied with CEESCOPE™ kits are L1/L2 capable so will always be able to achieve the highest PPP accuracies offered.

The three PPP services supported by CEESCOPE™ echo sounders are Trimble RTX, NovAtel TerraStar® and Hemisphere Atlas®. As these L-Band PPP services are subscription based, there is a requirement to activate the GNSS receiver inside the CEESCOPE™ to start using the service. The specific activation procedures, accuracies, and background details of the various PPP signals available is discussed below. These services are geo-gated and are available on land and in the near shore coastal zone, with offshore signals managed separately and at a higher cost.

### **Hemisphere Atlas**

The CEESCOPE™ echo sounders using the Hemisphere Eclipse or Phantom (or later generation) GNSS receivers are supplied with the Atlas BASIC PPP service as standard. The Atlas BASIC signal is a unique "lifetime" subscription loaded at the CEE factory, offering low precision corrections with the advantage that the user never has to reactivate the subscription. Atlas BASIC is a superior, multi constellation alternative to free SBAS corrections and provides SBAS type precision when no SBAS signals are present – for example South America or Africa. The Atlas BASIC signal may be upgraded at any time to a higher precision service.

The corrections are offered as follows:

Atlas BASIC:	Lifetime (included)	0.5m horizontal
Atlas H30	Month / annual	0.3m horizontal
Atlas H10	Month / annual	0.08m horizontal (0.2-0.3m vertical)

The coverage map for Hemisphere Atlas is shown below:



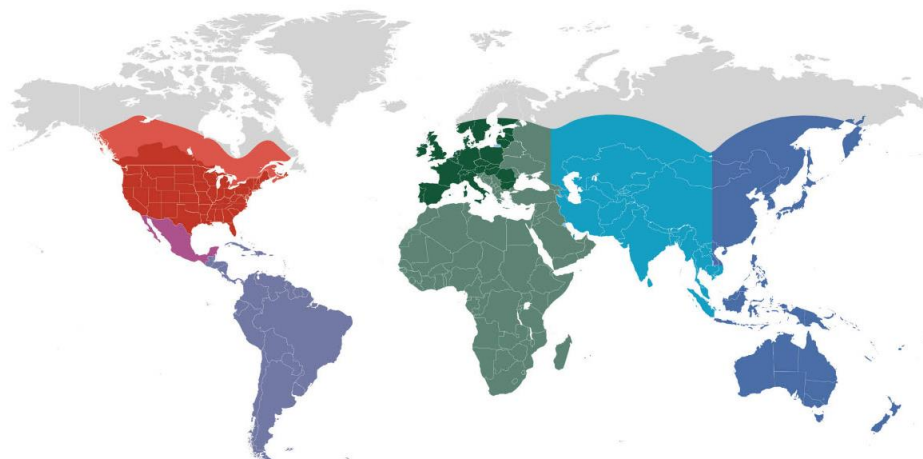
**Activating Atlas Subscriptions:** Hemisphere use a specific activation code for each GNSS receiver that must be loaded onto the receiver while connected using the CEESCOPE™ Programming Cable. The CEESCOPE™ is first set into programming mode (System/GNSS firmware update) with the cable connected to a PC. The Hemisphere PocketMax PC utility is used to interface with the receiver and send the Atlas activation code.

## Trimble RTX

The CEESCOPE™ echo sounders using the Trimble BD990 (or later generation) receiver can utilize the very high-performance Trimble RTX corrections. The RTX system uses multiple GNSS constellations to offer high active satellite counts and high accuracy. While several RTX performance grades are available FieldPoint®, RangePoint®, and ViewPoint® RTX, only the highest performance CenterPoint® RTX is supported by the GNSS receiver inside the CEESCOPE™:

CenterPoint® RTX	Month / annual	0.025m horizontal / 0.05m vertical
------------------	----------------	------------------------------------

The RTX coverage map is shown below, with four regions served by different equatorial satellites:



Activating the RTX service is most conveniently achieved “over the air”. The activation code is broadcast at a designated time through the L-Band corrections signal, when the CEESCOPE™ must be set up and receiving position data in the open with a clear view to the sky over the equator. Alternatively, a firmware activation code may be entered directly into the GNSS receiver module inside the CEESCOPE™ using a web browser.

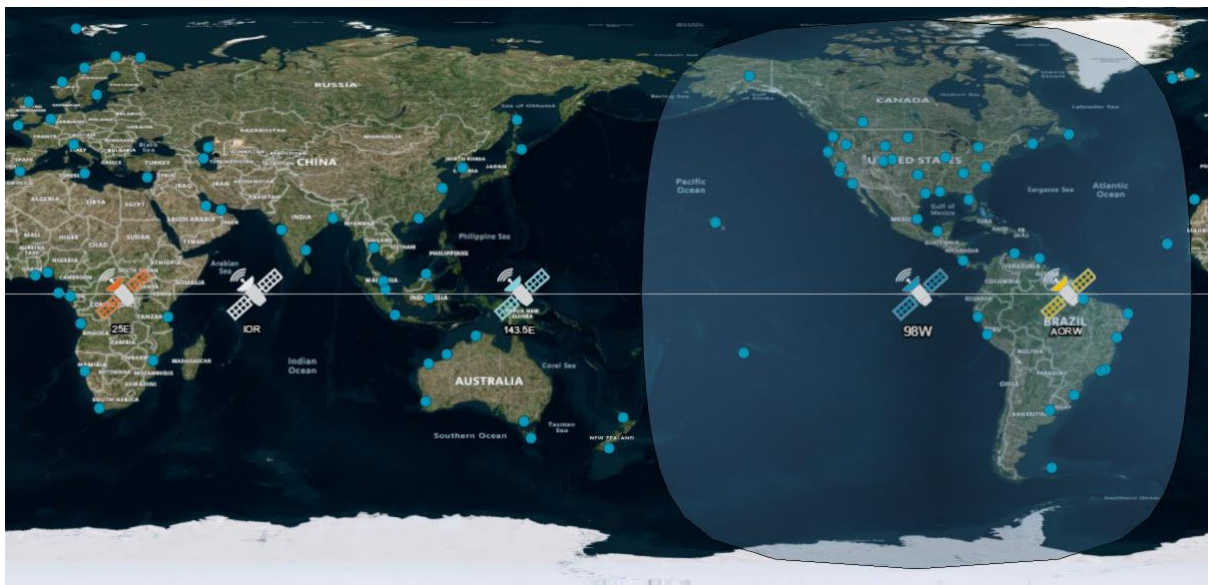
## NovAtel TerraStar

The CEESCOPE™ echo sounders using the OEM628, OEM729 (or later generation) GNSS receivers can access TerraStar L-Band corrections that offer several service levels.

TerraStar-X	Month / annual	0.025m horizontal / 0.05m vertical (1 min convergence)
TerraStar-C	Month / annual	0.05m horizontal / 0.1m vertical (<30min convergence)
TerraStar-L	Month / annual	0.5m horizontal / 0.75m vertical (<5 min convergence)

Like the RTX corrections, TerraStar subscriptions are activated “over the air” with the activation signal sent at a predetermined time to the CEESCOPE™ while in operation and receiving GNSS position.

The TerraStar ground stations, position of the five TerraStar L-Band satellites, and the coverage over the Americas is shown below



## CEESCOPE™ Setup for L-Band Corrections

The CEESCOPE™ RTCM menu should be configured to the L-Band source signal available. The frequency is user selectable, corresponding to which satellite is covering the region however this is unnecessary as the AUTO setting will determine the appropriate frequency depending on the current position. For a converged PPP GNSS solution, the quality indicator code shown on the home screen will show (5) which is typically designating an “RTK Float” solution. When (5) is shown, this confirms L-Band corrections are being received and the solution is converged. As detailed above, this may take several minutes. The Hemisphere Atlas BASIC signal will show a (2) code as this is a lower grade differential position. As an SBAS signal will also show a (2) quality code, the reception of ATLAS L-Band is indicated only by the disappearance of the “RTCM Error” message.