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Using 50-Hz observations from an Arrow Gold+ GNSS receiver aboard the CCGS Amundsen, an Arctic research vessel, one Canadian graduate student studies a way to mitigate the impact of ionospheric scintillation on GNSS positioning.

User
University of New Brunswick Graduate Student Sophie LeGresley

Partners
Ocean Mapping Group, UNB

Industries
Research

Challenge
Scintillation impacts GNSS positioning calculations, yet it is both difficult to measure and mitigate. Few studies are being undertaking in the high-latitude Arctic.

Solution
Arrow Gold+® GNSS receiver

Results
LeGresley relied upon 50-Hz observational outputs from the Arrow Gold+ GNSS receiver to measure scintillation in the Canadian Arctic. The observations took place during a summer 2026 expedition aboard the CCGS Amundsen, a research vessel.

FROM STATIC TESTS TO SURGING SEAS: CANADIAN RESEARCHER INVESTIGATES METHOD TO MITIGATE GNSS ERROR IN THE ARCTIC

Several years ago, on the eastern Canada coast, University of New Brunswick (UNB) then-undergraduate student Sophie LeGresley developed a love for analyzing geospatial errors. Now a UNB graduate student, LeGresley has undertaken a "scintillating" research project. Her goal? To develop a method to reduce GNSS error caused by ionospheric scintillation.

WHAT IS SCINTILLATION?

GNSS signals pass from satellites to receivers through the Earth's ionosphere. In this region, free electrons disrupt signals. Even tiny fluctuations in a GNSS signal's path can create meters of inaccuracy in the position calculation.

Today, most errors from ionospheric activity can be corrected for by widely available corrections services such as RTK and SBAS. But sometimes — especially in regions like the equator, Arctic, and Antarctic — GNSS signals undergo an anomaly known as scintillation. At high latitudes, scintillation stems from strong geomagnetic activity, such as a solar storm, which can disrupt the ionosphere, thus causing the signals passing through it to scintillate. What's happening at a high level is that the electron density doesn't stay smoothly distributed during these moments of strong activity. So, when a signal passes through the area of irregular electron distribution, it begins rapidly fluctuating, leading to a weaker single, more error in the measurements based upon that signal, or even signal lock loss. Because scintillation is a random anomaly, it's incredibly difficult to mitigate.

There are fewer scintillation studies being undertaken in hard-to-reach regions like the Arctic, as compared to those taking place at the equator. So that's what she set out to study ...

MONITORING SCINTILLATION TAKES MORE THAN A STANDARD RECEIVER

Scintillation happens quickly, with as many as 20 fluctuations occurring per second, always at random. Because of this, LeGresley needed a GNSS receiver capable of outputting signal observations at a rate of 50 Hertz (50 times per second).

"Think of it like wiggling," LeGresley said. "If a signal is wiggling 20 times per second, you need to observe it at least 50 times per second to be able to see those really fast wiggles."

A 50-Hz observation isn't something most off-the-shelf GNSS receivers do. In fact, most 50-Hz receivers are used exclusively by scientists studying the ionosphere. Yet it just so happens that the UNB physics department runs the Canadian High Arctic Ionospheric Network (CHAIN) across northern Canada, including the Arctic. These CHAIN stations take the 50-Hz observations necessary to monitor scintillation, and their data is available to download online.

For her first testing phase, LeGresley used this scintillation data to create a regional scintillation map, which can be used to estimate the scintillation being experienced by any receiver in that region. These estimates are then used in an open-source precise point positioning (PPP) software, which she modified to account for scintillation in the position solution.

She applied her mitigation method to the static receivers to determine if the scintillation was, in fact, mitigated. For her next phase, LeGresley wanted to study the effectiveness of the mitigation method on a moving receiver, to better mimic real-world applications.

"I wanted to test the mitigation method on messier data, in a real-world application," she said.



LeGresley sets up the Arrow Gold+ GNSS receiver on the roof of the engineering building so she could test the high sampling rate (i.e., 50 Hz).

THE RESEARCH VESSEL THAT CARRIED THE METHOD FORWARD

By chance, elsewhere at UNB around the same time, researchers were gearing up for an Arctic research expedition aboard the CCGS Amundsen. The Amundsen would travel for four weeks from Quebec City to Iqaluit in the Canadian Arctic. Aboard it were scientists from countless organizations studying all sorts of topics.

Researchers from UNB's Ocean Mapping Group went aboard the Amundsen to map ocean floors with high accuracy.

Part of their technology kit included an Arrow Gold+® GNSS receiver made by Eos Positioning Systems (Eos). What makes the Arrow Gold+ unique is that, despite being an off-the-shelf GNSS receiver, it was capable of 50-Hz observations.

"The Amundsen was going to the Arctic anyway, and it was equipped with an Arrow Gold+ for ocean mapping," LeGresley said. "It's great that the Eos receiver just so happens to be able to operate at 50 Hz, which is not common."

As the Amundsen approached its July 2026 departure date, Ocean Mapping Group Research Scientist Dr. Kevin Wilcox worked with Eos to activate the 50-Hz output.

To support Sophie's scintillation research, UNB Research Assistant Tony Furey helped prepare, test, and deploy the Arrow Gold+ and related data collection system. Before the expedition, Furey configured the receiver for 50-Hz GNSS logging and conducted rooftop testing. "We were pretty happy when we saw all the binary messages showing up in the file and could convert them to RINEX with no missing data at 50 Hz," Furey said.

Once the system was validated on land, Furey oversaw installation aboard the Amundsen, including running a 40-meter cable from the acquisition room (where data is logged) to the observation deck, where he installed the Arrow Gold+ .

SCINTILLATING FINDINGS, AND POSSIBLE REAL-WORLD APPLICATIONS

The Amundsen completed the first leg of its journey in August 2026. LeGresley is currently processing the data and interpreting her findings. She hopes to publish her work in early 2027.

So far, she's had promising results, though her findings will remain private until her research is completed.

"I'm excited to share the findings," she said.

That type of result could have positive implications for field workers who use GNSS equipment every day, especially at times of high solar activities. What's uniquely helpful is that LeGresley's research is based on open-source processing-software adjustments rather than hardware adjustments. This makes the mitigation method accessible to all.

"You don't need any special hardware to implement this," she said. "It's just a change to the algorithm, which anyone could modify in any software to implement this."