

# Distributed Sensor Array for Mid-Latitude Ionospheric Characterization

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## Background & Motivation

This project studies the characteristics of Traveling Ionospheric Disturbances (TID) as they influence GPS signals. The data used in this study is obtained using Connected Autonomous Space Environment Sensors (CASES) GPS receivers that infer total electron content (TEC) from high-resolution dual-frequency observations. These fluctuations can be used to characterize the ionospheric plasma within the TIDs, enabling a better understanding of their composition and nature to enhance the fortification of civilian and military systems against their effects.

While most auroral activity occurs at high latitudes, midlatitude ionospheric disturbances reflect a complex combination of high-latitude geomagnetic forcing and equatorial dynamics.

These disturbances also exhibit unique regional characteristics, making them critical to study in GPS-reliant areas.

Aurora observed at Poker Flat Research Range in Fairbanks, AK, 29 March 2026.



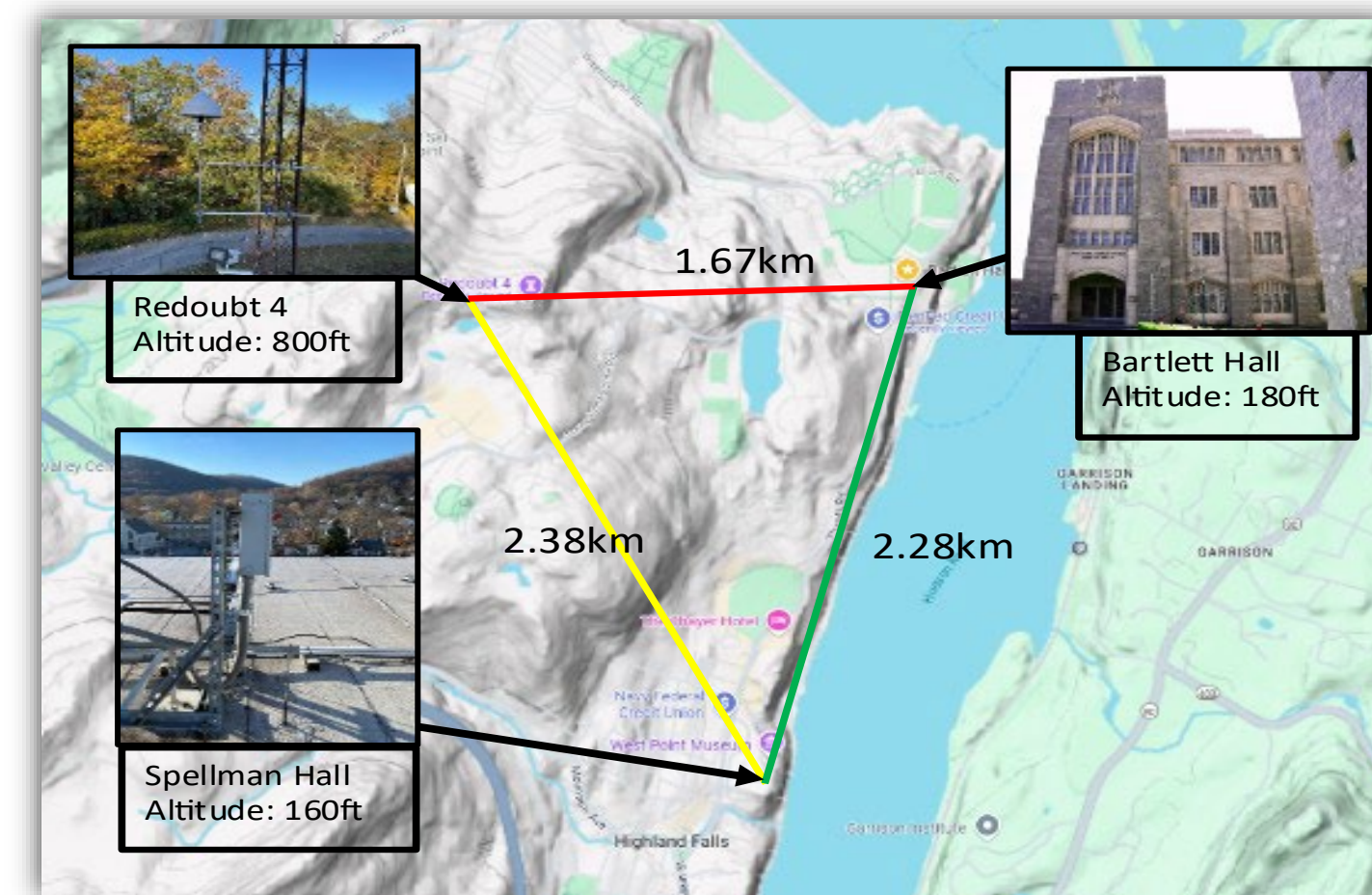
## Collaborating Work

This project is part of the work of a larger research group: COSMIC. We work closely with other cadet research teams doing similar work in ionospheric research. The collaborating projects are currently using ionospheric data collected at the Poker Flat Research Center in Fairbanks, AK, which this project aims to replace with on-site, mid-latitude data.

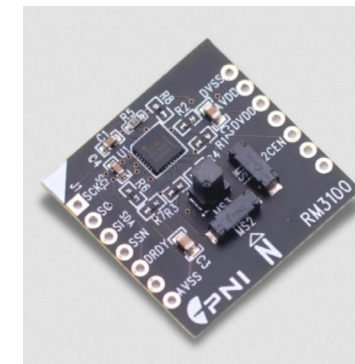
## Acknowledgements

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## Instrumentation



**CASES Receivers**  
Recording TEC to track scintillation responsible for radio and GPS interference



**Magnetometers**  
Recording 3 dimensions of magnetic field to analyze as a potential driver of TEC Scintillation



**Seismometers**  
Recording earthquakes to determine if acoustic-gravity waves are driving TEC Scintillation

### Distributed Network

This is a map of West Point, NY, showing the installation locations for CASES receivers. These collect passive GPS data that derives TEC from pseudo-range measurements.

### Multi-sensor Network

A goal of this project is to incorporate multiple sensors into the network to provide data on magnetic fields and seismic activity. Such data would allow cadets to discern the probable origin of fluctuations and make more accurate characterizations.

## Significance & Goals

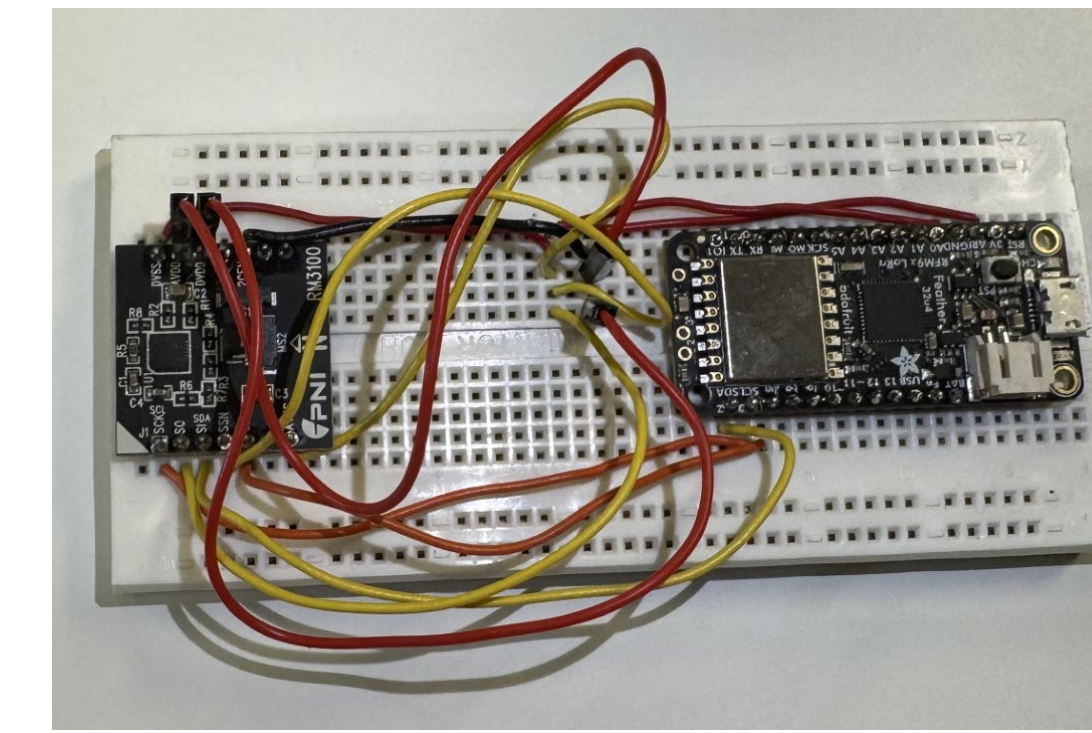
A distributed sensor array at West Point captures variations in the mid-latitude ionosphere using GNSS receivers and ground-based sensors that measure TEC, scintillation, and magnetic field changes. By providing continuous, localized observations in an understudied region, it improves understanding of ionospheric disturbances and their effects on signal propagation. The goal is to establish a reliable, multi-sensor framework that links ionospheric behavior to measurable impacts and supports improved modeling and future integration into research.

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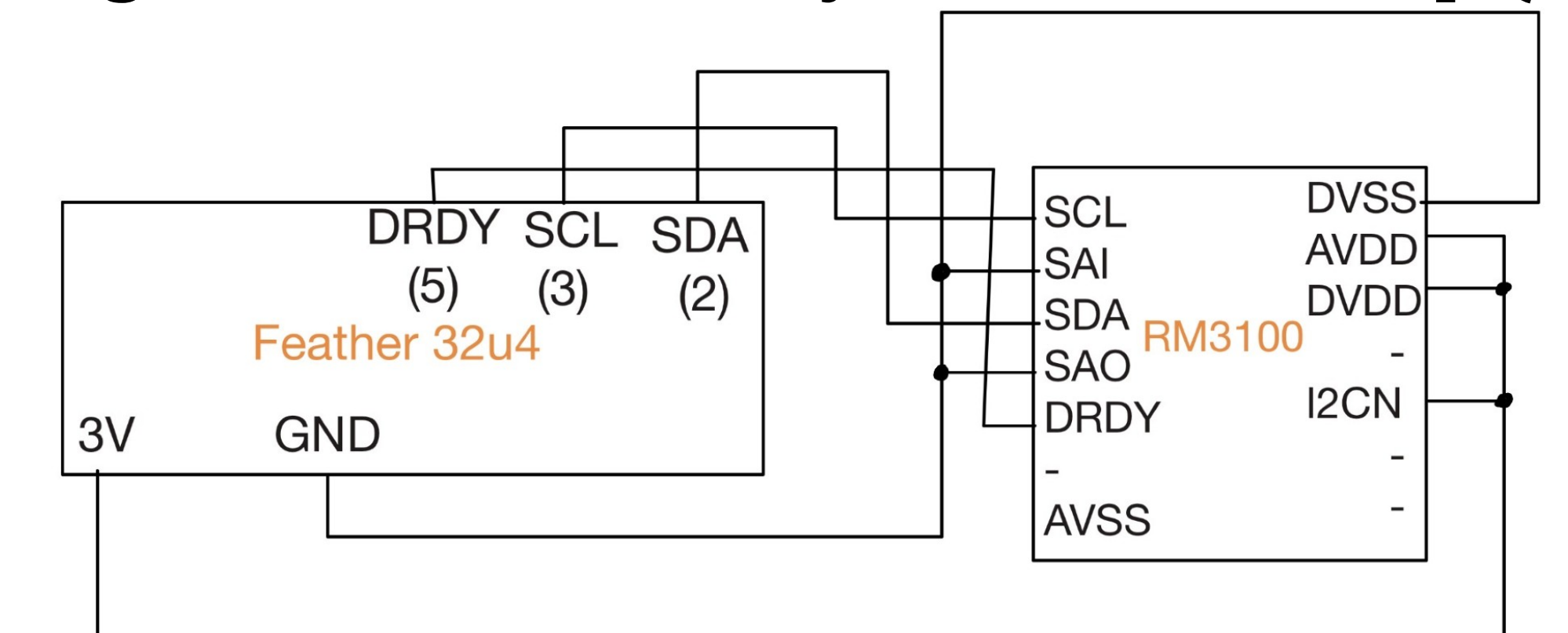
## Sensor Suites & Prototypes



### Magnetometer Assembly Suite

The magnetometer assembly suite prototype consists of a PNI RM3100 Tri-Axis Magnetometer running through an Adafruit Feather 32u4 microcontroller, which currently must be plugged into a computer.

### Magnetometer Assembly Suite Circuit Map (I2C)



### CASES Antenna (Bartlett Roof)

The CASES receiver in Bartlett Hall receives data via a choke-ring antenna on the roof, connected directly to the SHARC Lab by a coax cable. Our off-site receiver at Redoubt 4 records data onto a hard drive that is periodically checked. Our final receiver will record data the same way. We aim to achieve network integration to stream data in real-time to the SHARC Lab from both our CASES receivers and magnetometers upon deployment.



## Abbreviated References\*

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