Transition Region Explorer (TREx): A Ground-Based Sensor Web for Space Weather Research

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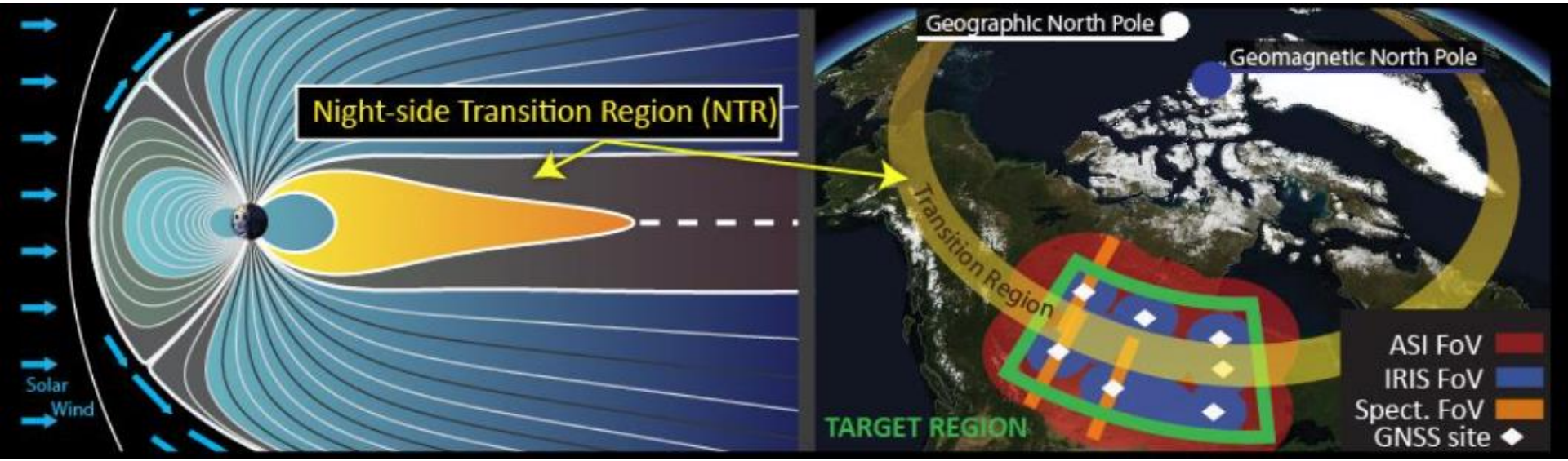
University of Calgary

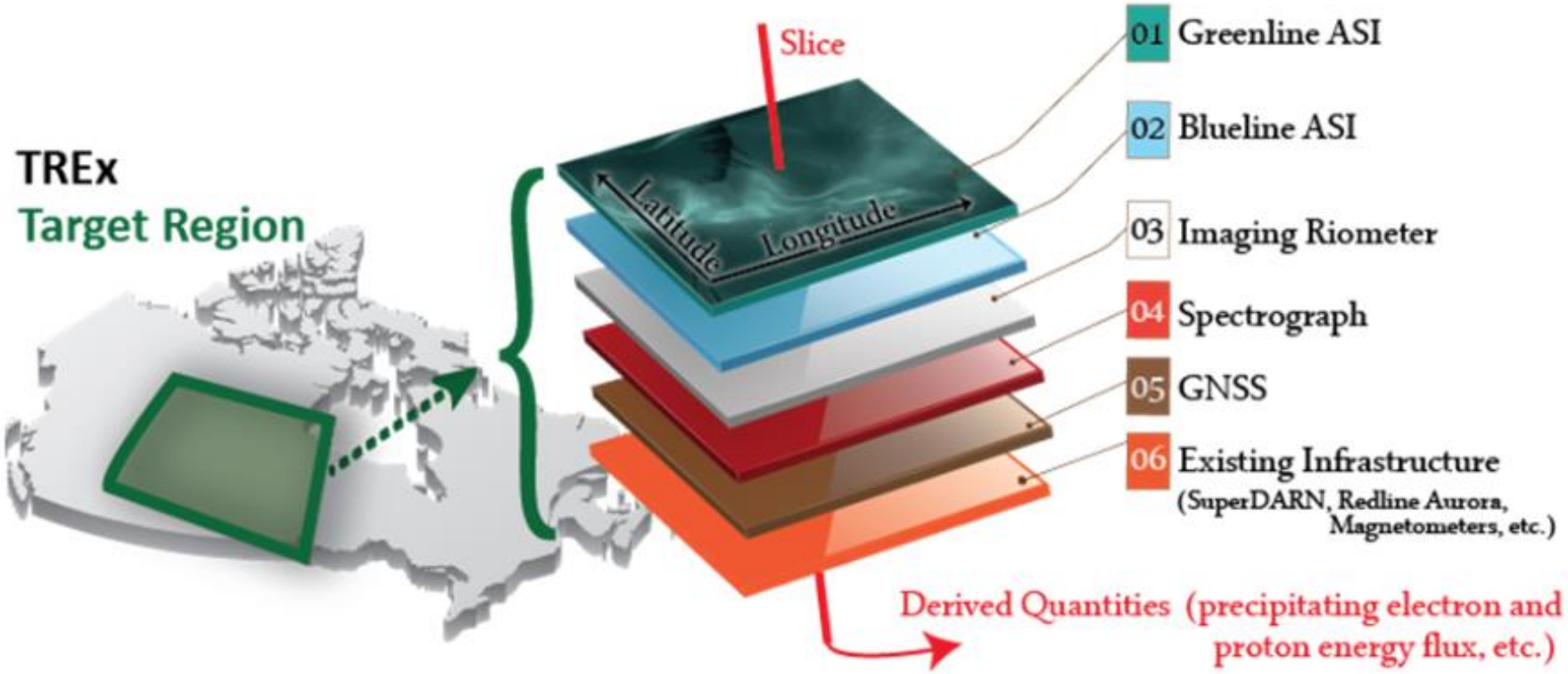
Motivation

"The Transition Region Explorer (TREx) will be a globally unique, ground-based auroral observing facility."



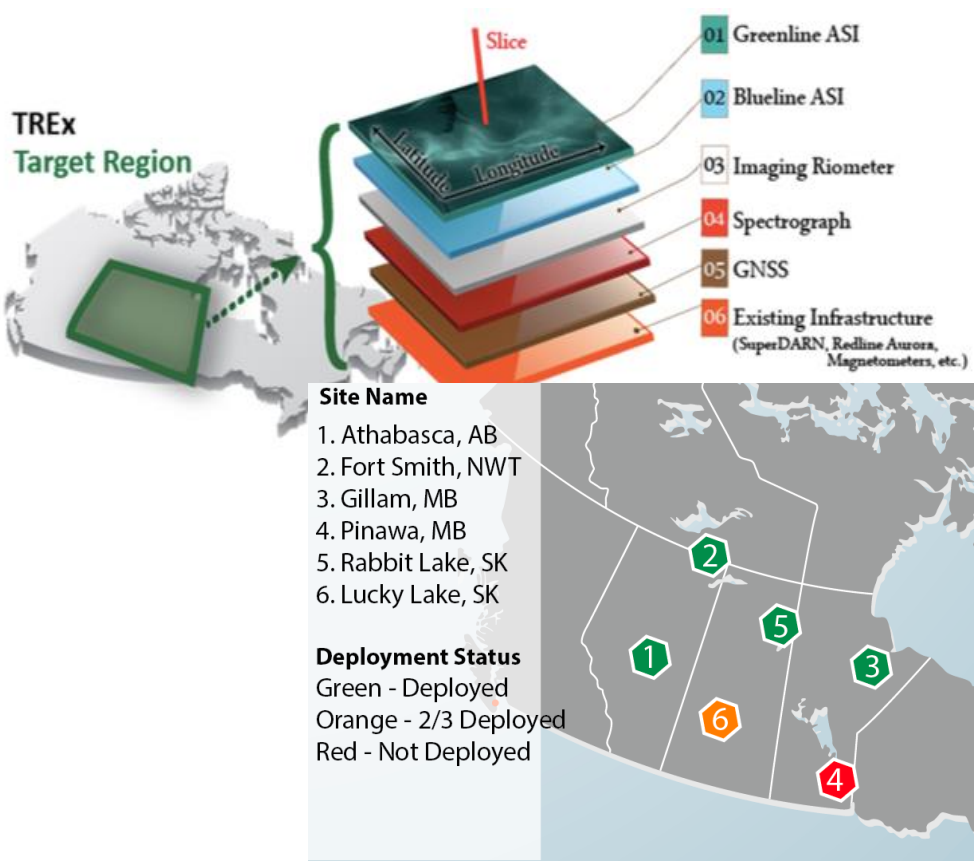
- Magnetospheric dynamics are multi-scale, unfolding over the whole system; in the Nightside Transition Region, these effects drive much of space weather.
- Observations of the aurora, enabled by ground-based geospace remote sensing, provide a multi-scale view of the magnetosphere.
- Multi-spectral information can address gaps in our knowledge and provide key information for exploring space weather effects on systems and climate.

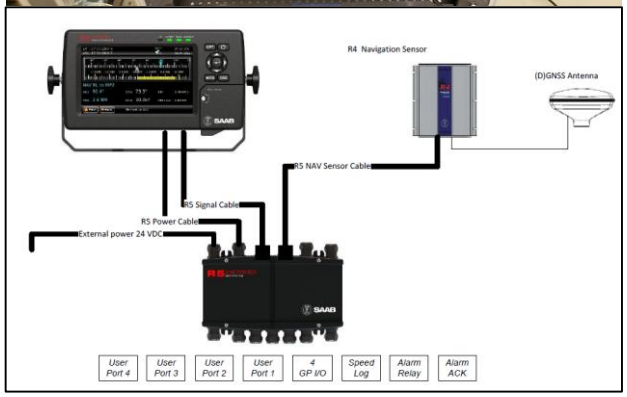
Research and Technological Development Themes



1) Magnetospheric Dynamics and Space Weather Research
2) Space Weather Effects on the Atmosphere and Climate
3) Space Weather Effects on GNSS
4) Intelligent Remote Sensing the Near-Earth Space Environment

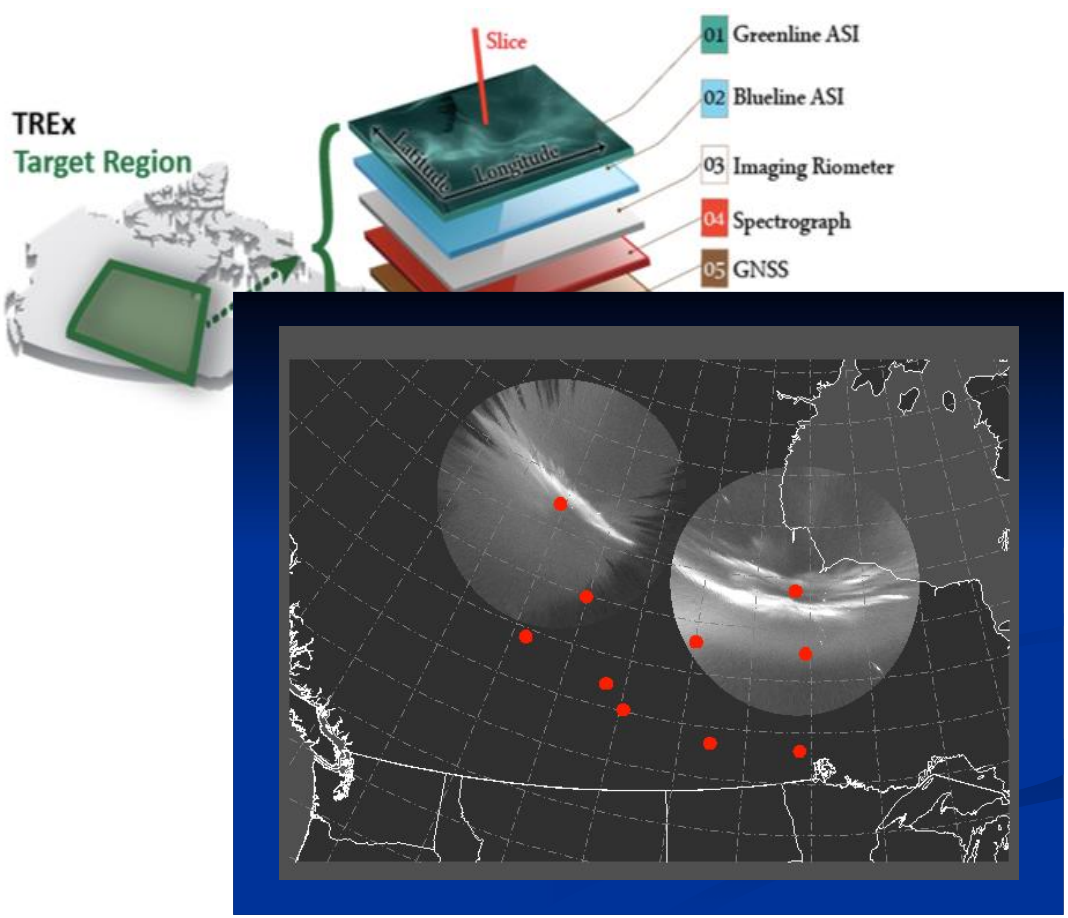
TREx GNSS

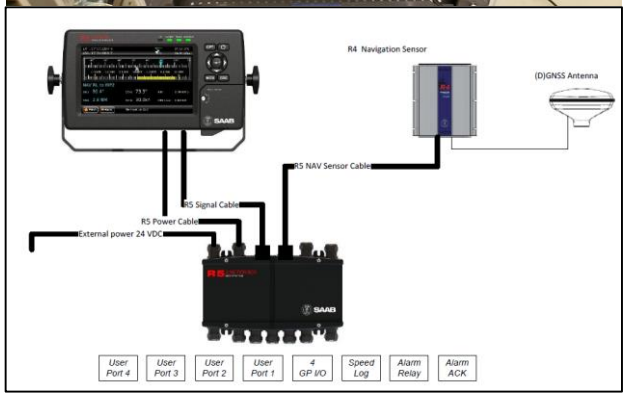




- Front-end RF sampler (GPS, GLONASS, Galileo, Beidou) plus commercial receiver; and land, marine and aviation receivers
- Understand the propagation conditions and impact on systems
- Most significant conditions, observations and parameters?

TREx GNSS





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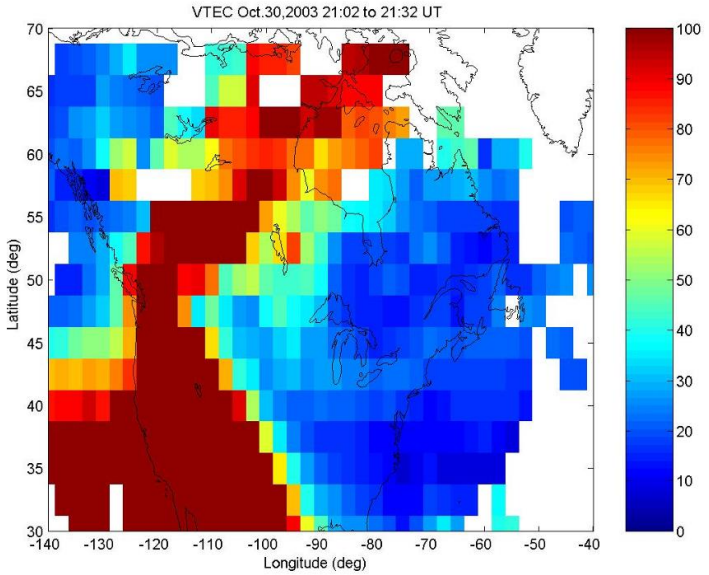
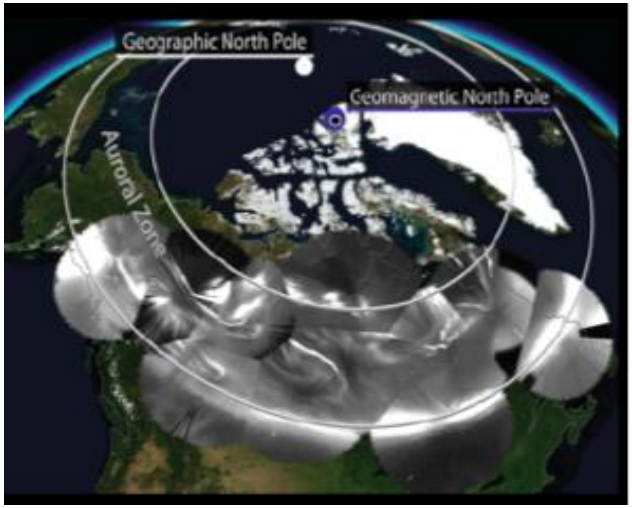
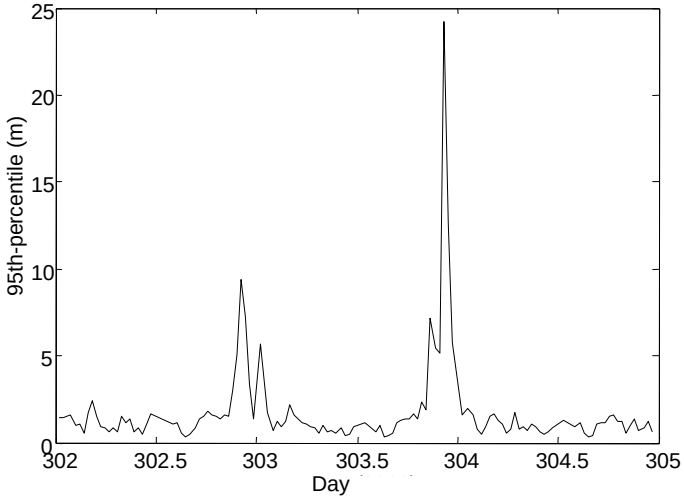
Ionospheric Phenomena Affecting GNSS

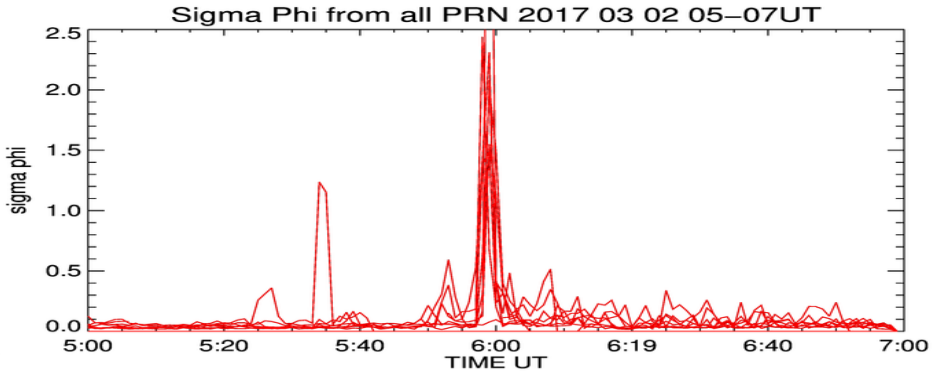
Propagation Conditions

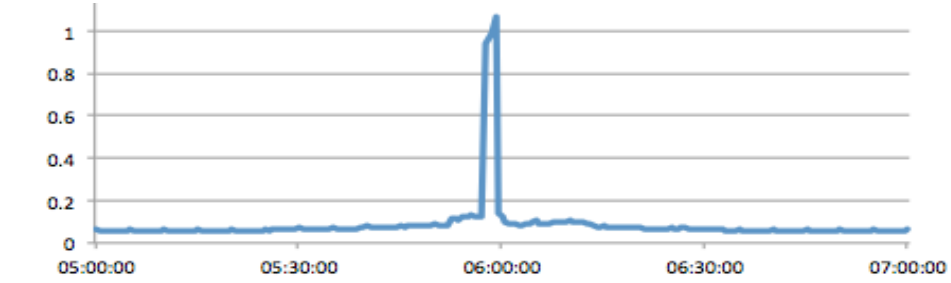




Impact







Ionospheric Phenomena Affecting GNSS

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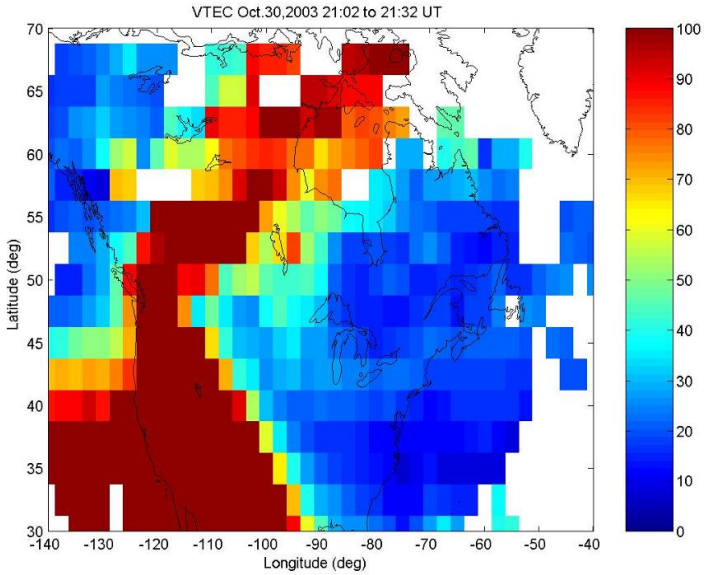

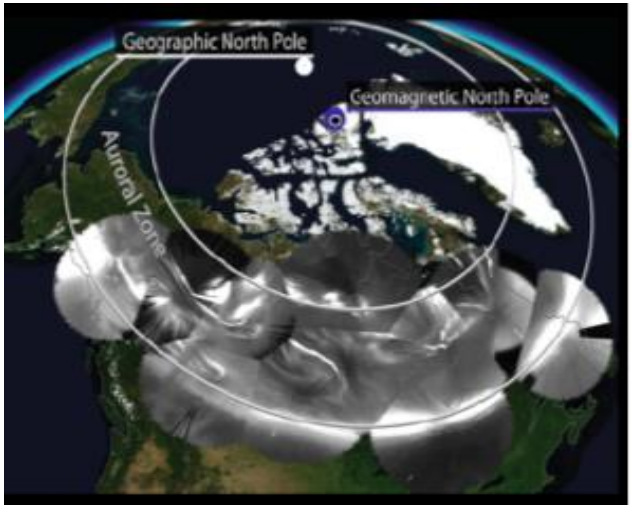

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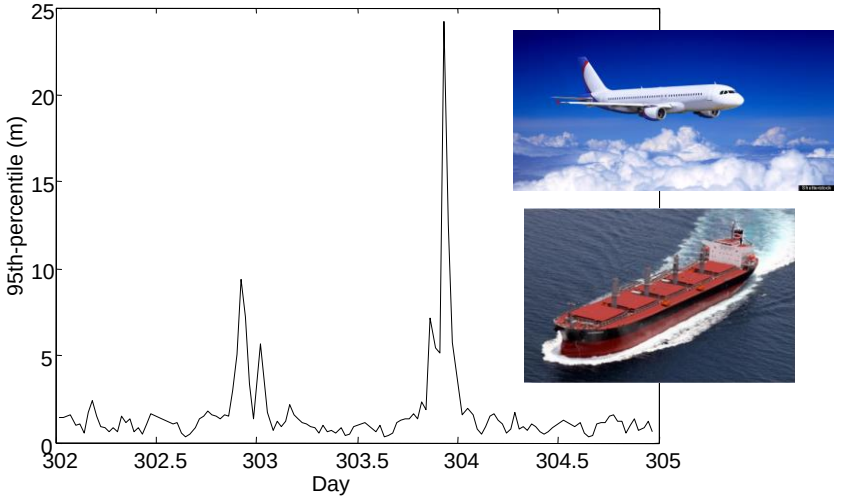
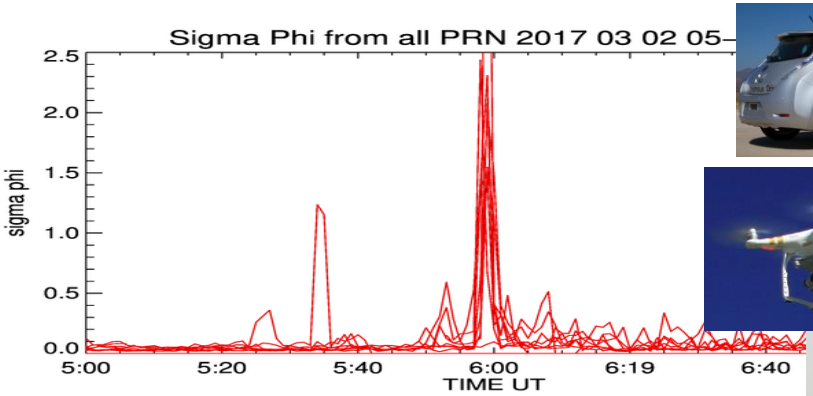
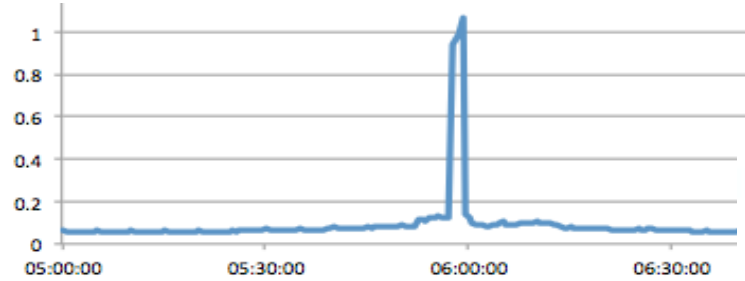


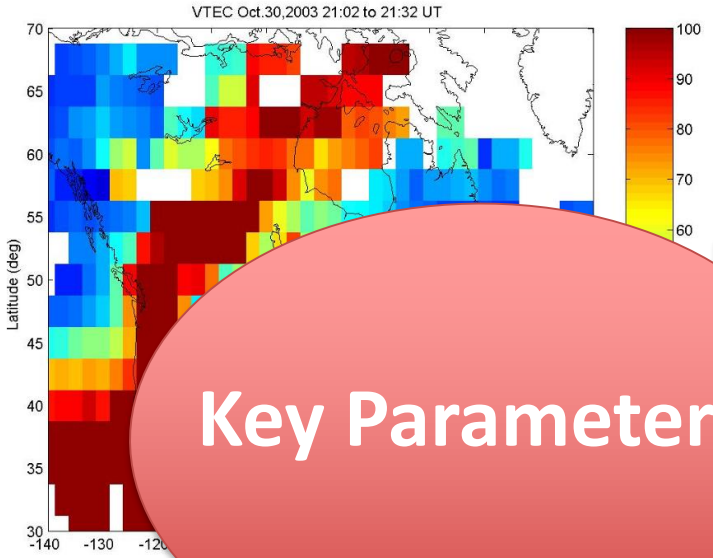




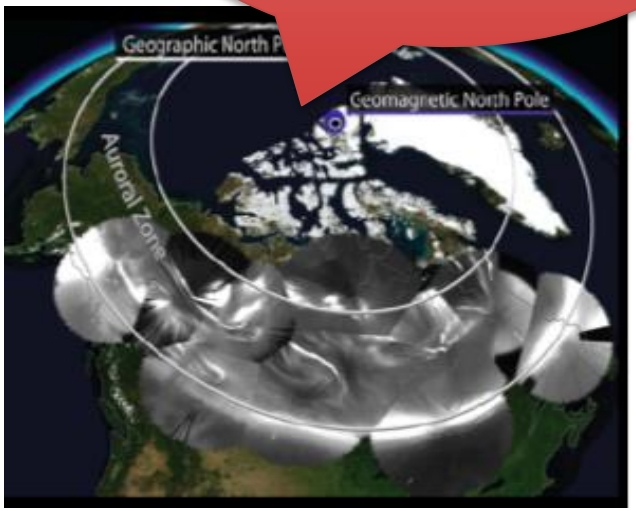
Ionospheric Phenomena Affecting GNSS

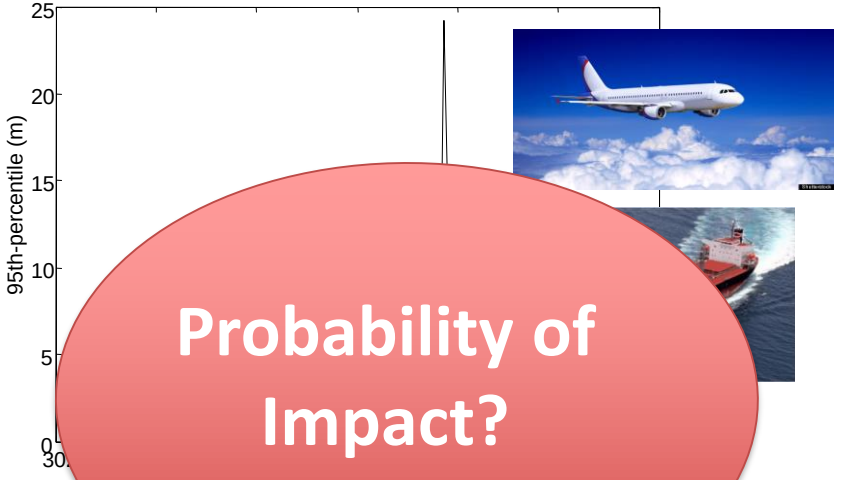
Propagation Conditions

Impact

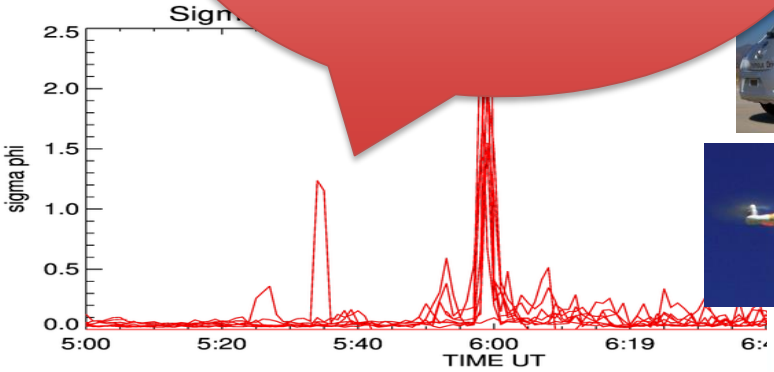


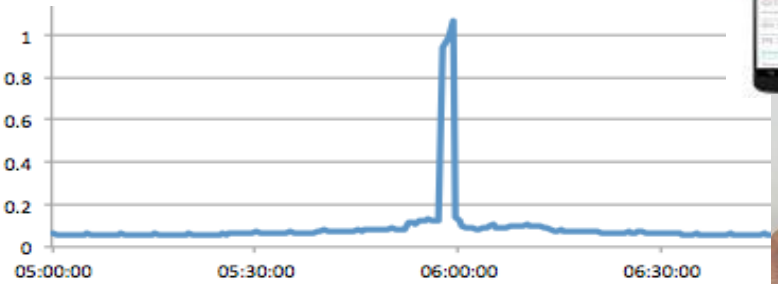
Key Parameter?



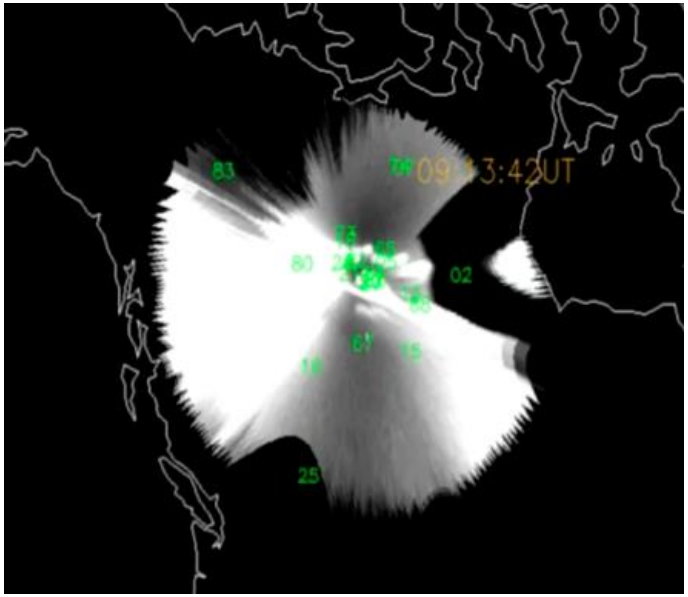


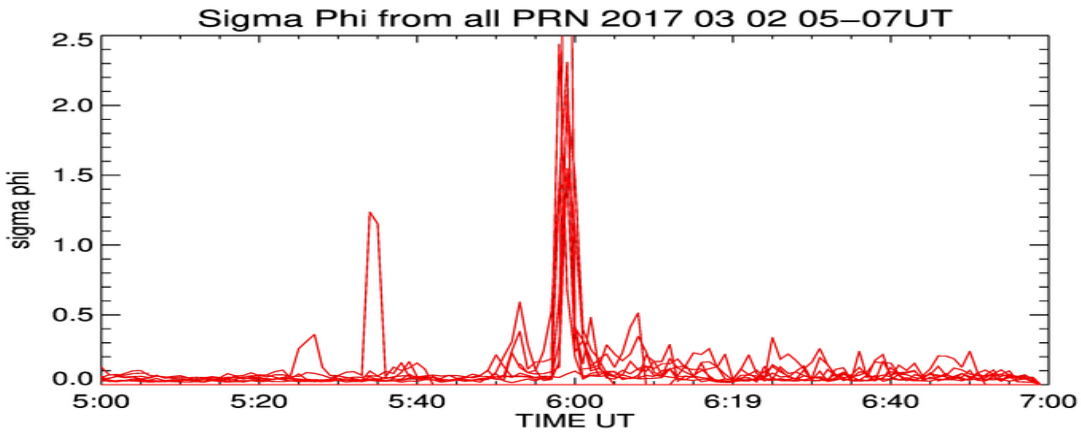
Probability of Impact?

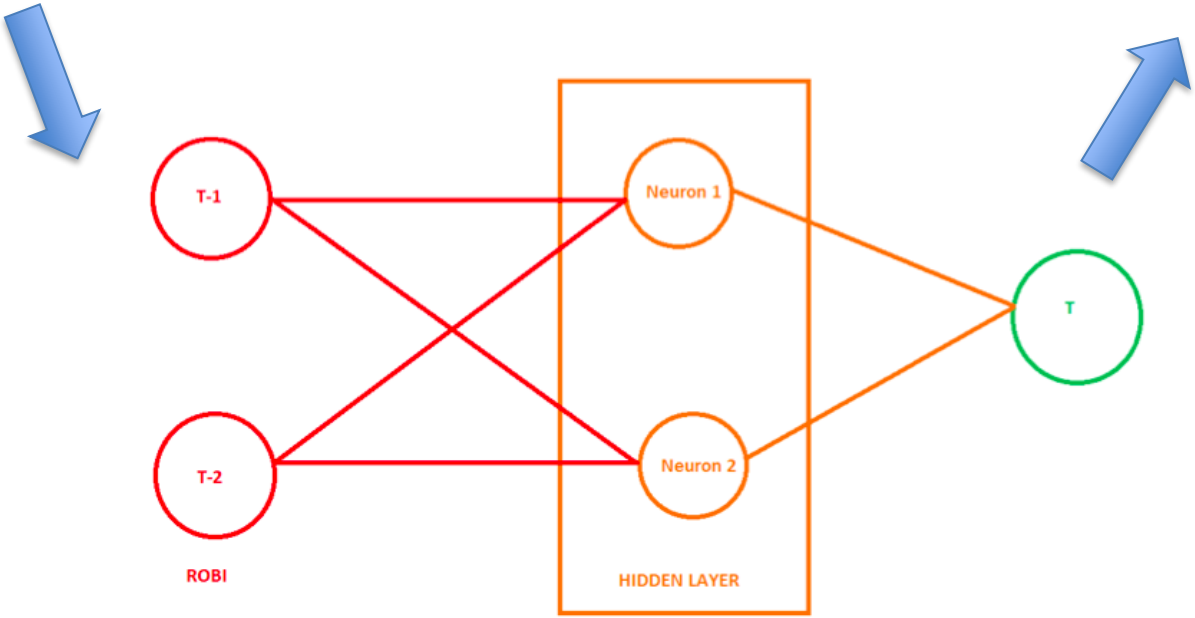




Neural Network Approach







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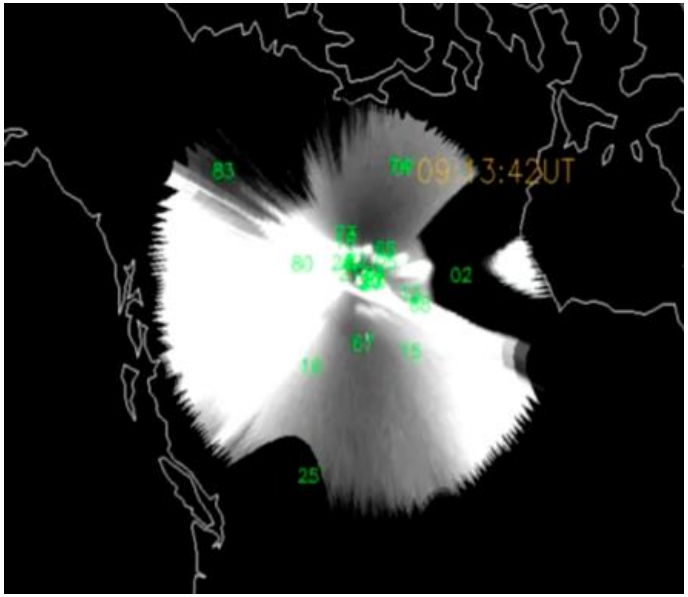
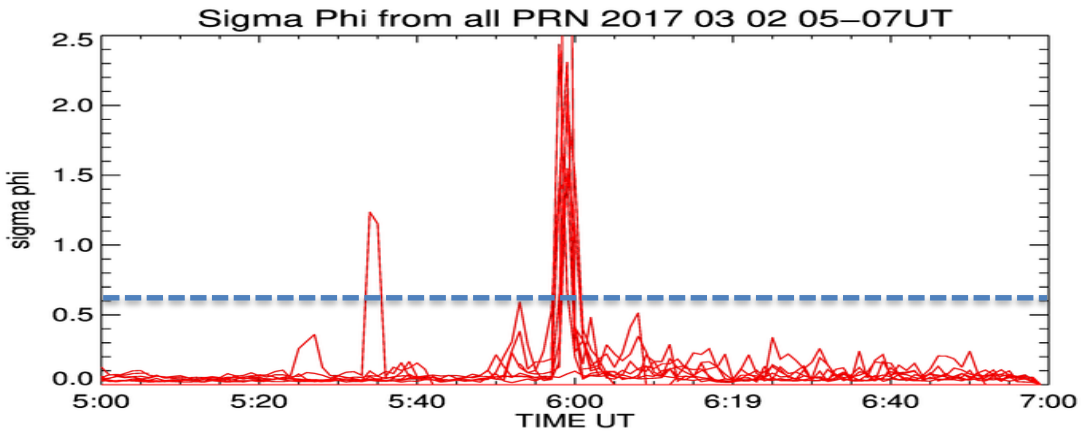
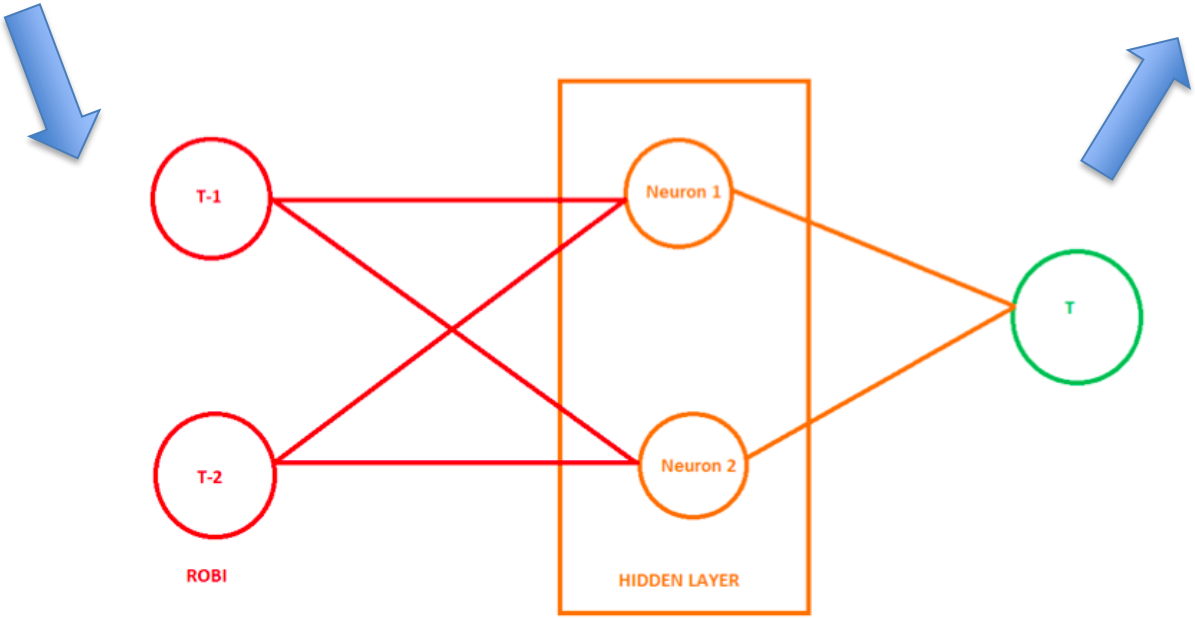
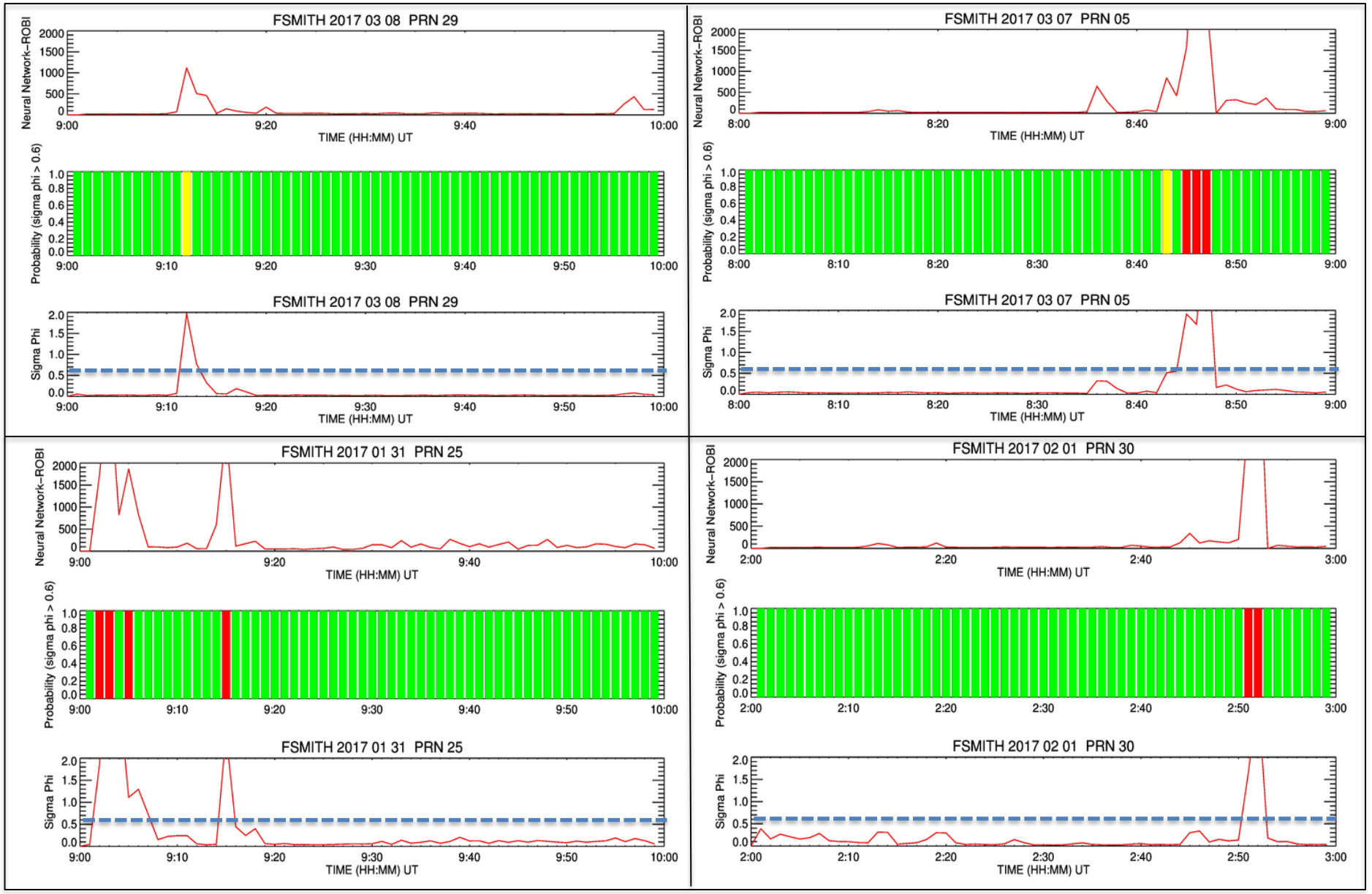


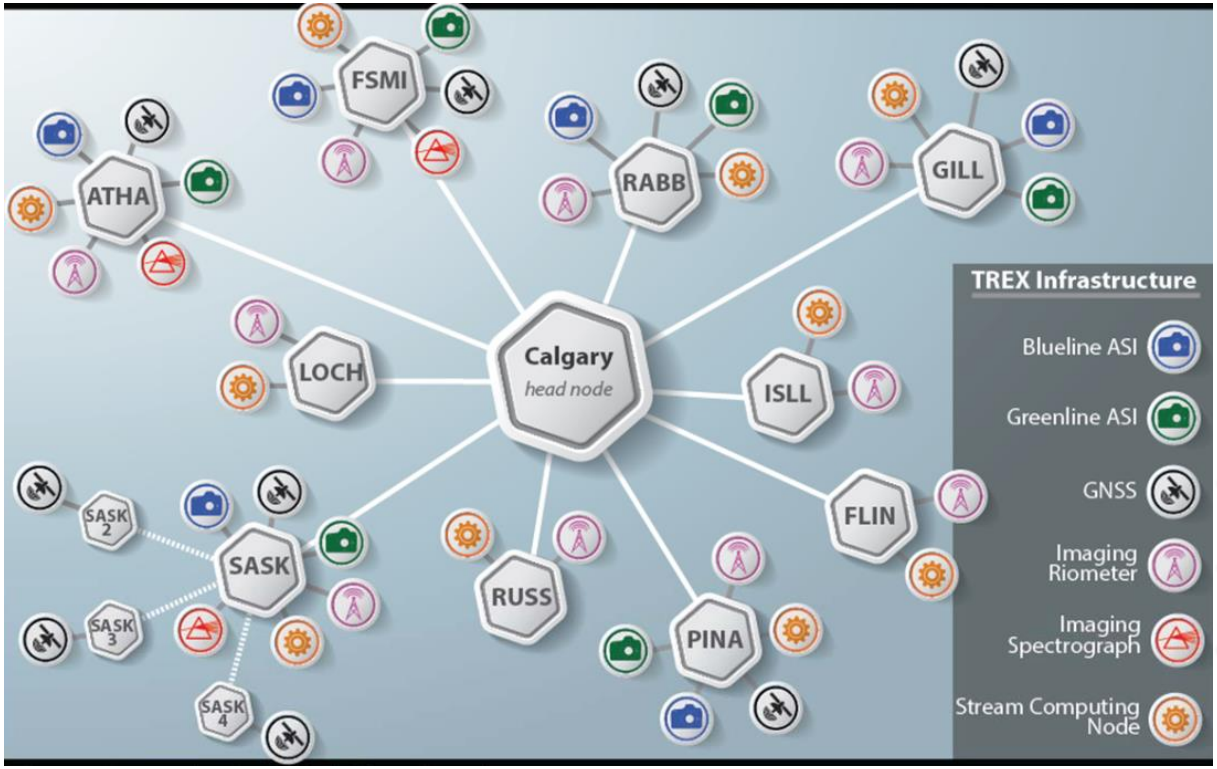


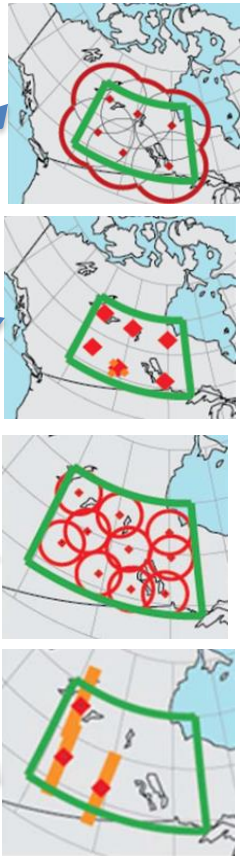


Neural Network Predictions



TREx Observations





Parameters observed or inferred:

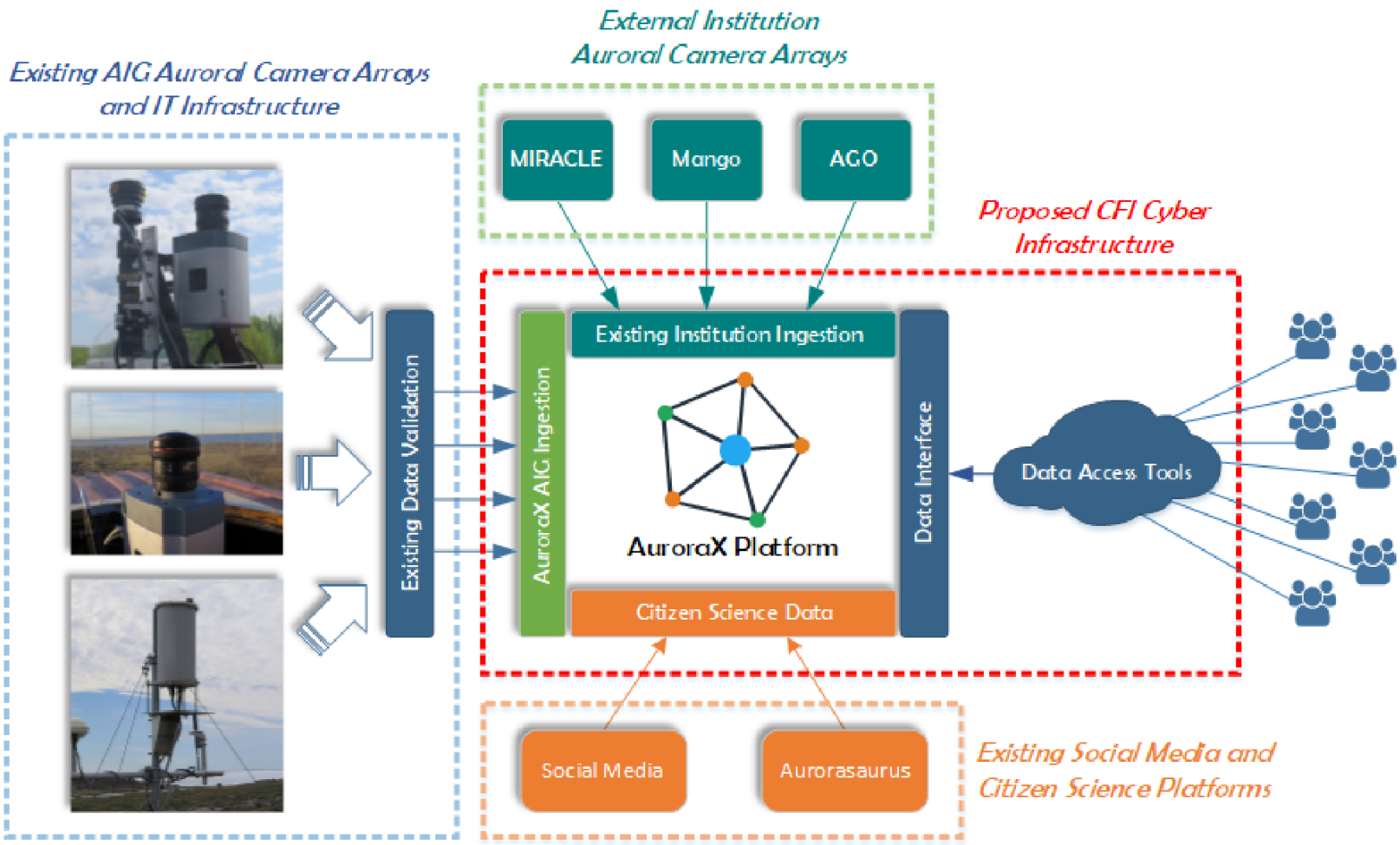
(i) precipitating proton energy flux and characteristic energy;
(ii) precipitating electron energy flux and characteristic energy;
(iii) GNSS TEC and signal perturbations; and
(iv) cosmic radio absorption.

Inference of the presence or absence of >30 keV electron precipitation (imaging riometers), the spectrum of temporal fluctuations of auroral luminosity up to 10 Hz (time series of images from TREx blueline ASIs), maps of velocities of auroral forms, and maps of auroral type will also be enabled.

AuroraX has five key components;

1. A uniform, open data repository that will contain more than 80% of the world's geospace science all sky camera data and associated metadata, calibration information, etc.
2. A virtual observatory (web "front-end") that will access, display and distribute data to scientists in a streamline fashion, coupled to other leading international virtual observatory programs.
3. Machine vision/learning tools and products that will enable the first ever strategic mining and exploitation of the world's auroral dataset based on image content.
4. Tools and APIs that will facilitate access to all optical data in AuroraX from key international virtual observatories and tool sets (e.g. NASA's SPEDAS tools).
5. Aggregation tools for optical data from around the world (e.g. MIRACLE, AUGO), enabling easy adoption for optical observing programs around the world.

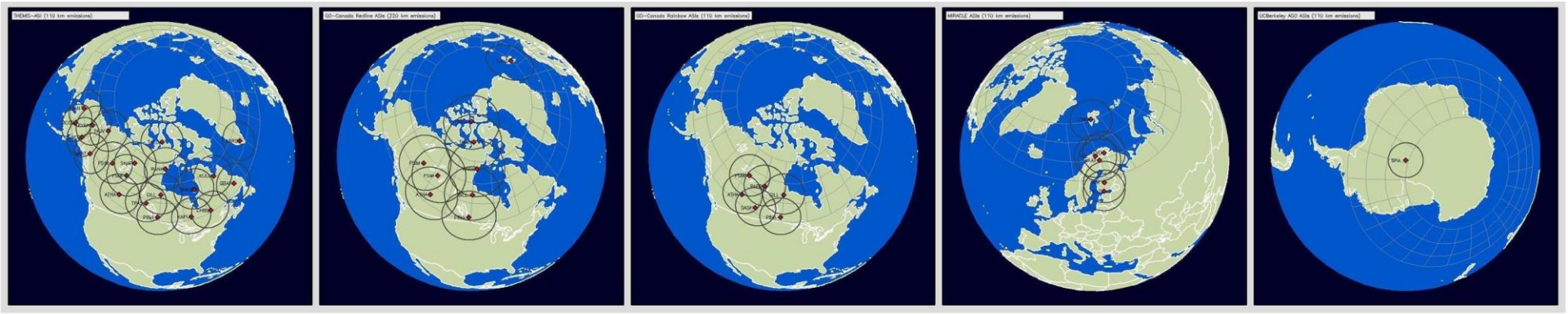
Swarm-Aurora



Data flow into AuroraX systems.

Survey of all accessible and applicable auroral datasets to be used in the development and validation.

Swarm-Aurora is bound to incorporate five data auroral data sets during this project…



THEMIS-ASI

Data & Operating Details
- Black & white, 256X256 images.
- 3 second cadence, 1 second exposure.
- 21 ASIs operational during test epoch.

Basic Data Products
- Full resolution images raw & mapped
- Keograms (X256)
- Thumbnauils (32X32)
- Mosaics (110 km assumed now)

Contact
- Eric Donovan (edonovan@ucalgary.ca)
- Harald Frey (hfrey@)ssl.berkeley.edu)

Data Landing Page
- data.aurora.phys.ucalgary.ca
- themis.ssl.berkeley.edu/overview_data.shtml

GO-Canada REGO

Data & Operating Details
- 630 nm, 512X512 images.
- 3 second cadence, 2 second exposure.
- 9 ASIs operational during test epoch.

Basic Data Products
- Full resolution images raw & mapped
- Keograms (X256)
- Thumbnauils (32X32)
- Mosaics (230 km assumed now)

Contact
- Eric Donovan (edonovan@ucalgary.ca)
- Emma Spanswick (elspansw@ucalgarty.ca)

Data Landing Page
- data.phys.ucalgary.ca

GO-Canada Rainbow

Data & Operating Details
- Color, 256X256 images.
- 6 second cadence, 5 second exposure.
- 6 ASIs operational during test epoch.

Basic Data Products
- Full resolution images raw & mapped
- Keograms (X256)
- Thumbnauils (32X32)
- Mosaics (230 km assumed now)

Contact
- Eric Donovan (edonovan@ucalgary.ca)
- Emma Spanswick (elspansw@ucalgary.ca)

Data Landing Page
- data.aurora.phys.ucalgary.ca

MIRACLE-ASI

Data & Operating Details
- Heterogeneous array
- narrow band ASIs
- Color ASIs
- X ASIs operational during test epoch.

Basic Data Products
- Full resolution images raw & mapped
- Keograms (X256)
- Mosaics

Contact
- Kistie Kauristie (kirsti.kauristie@fmi.fi)

Data Landing Page
- http://www.geo.fmi.fi/MIRACLE/ASC/

NSF AGO

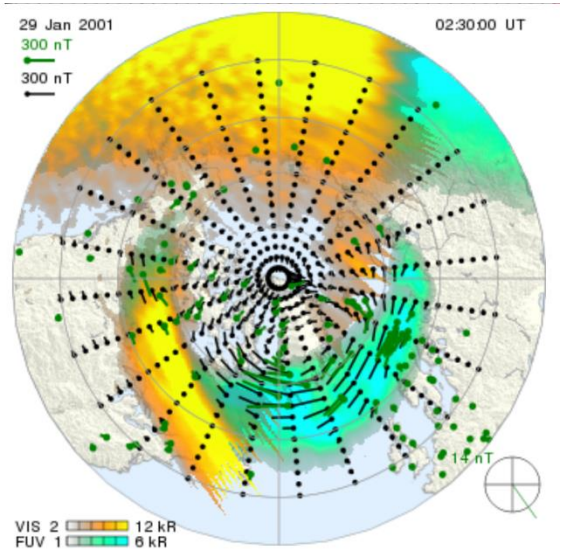
Data & Operating Details
- narrow band ASIs
- blueline and redline, simultaneous
- 1 ASI operational during test epoch.

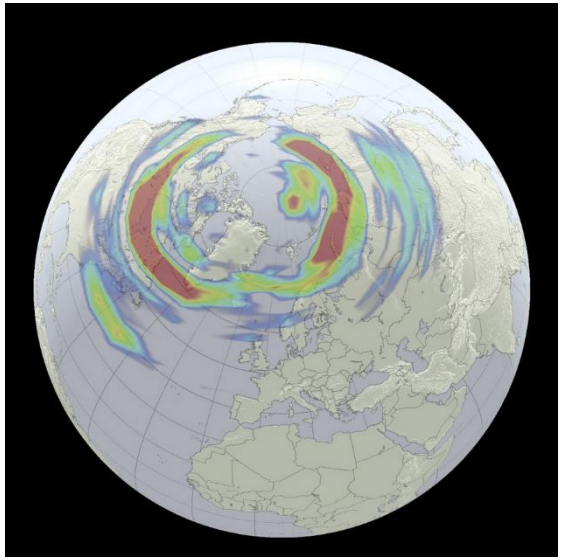
Basic Data Products
- Full resolution images raw & mapped
- Keograms (X256)

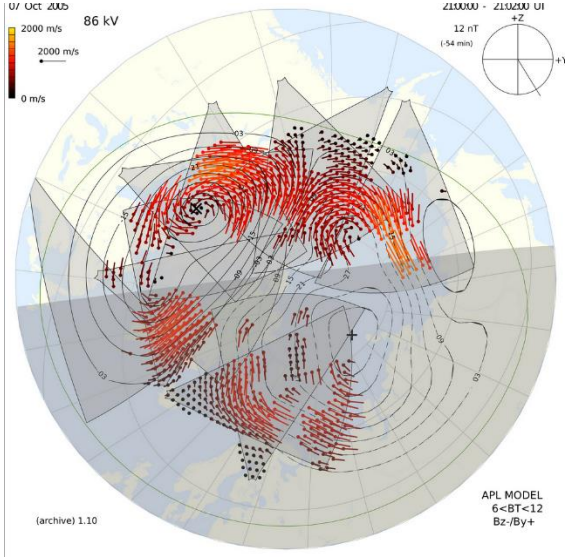
Contact
- Harald Frey (hfrey@)ssl.berkeley.edu)

Data Landing Page
- contact PI

The Swarm-Aurora team has already collected the keograms for the test epoch for these five projects.







Build the set of APIs and web infrastructure to bridge SuperDARN, SuperMAG, AMPERE, and Swarm-Aurora/GAIA.