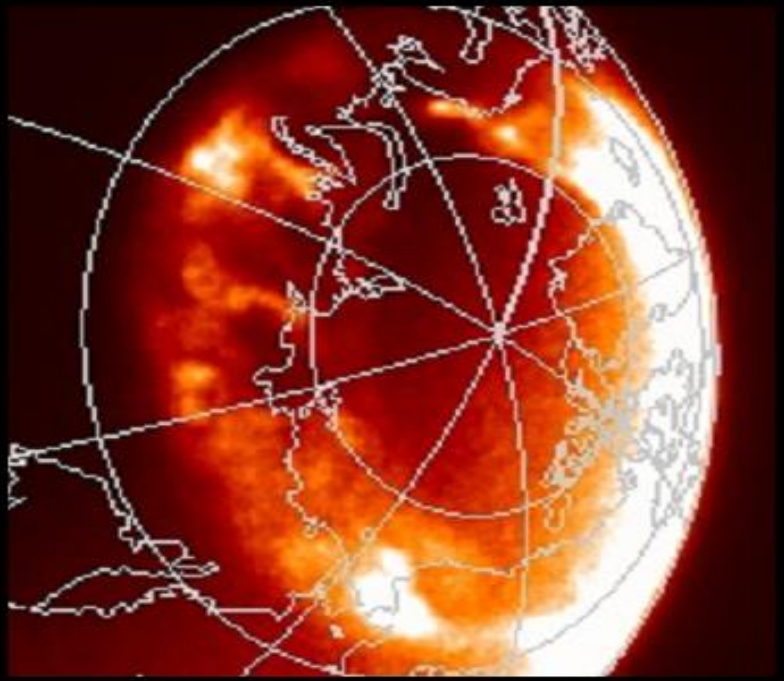
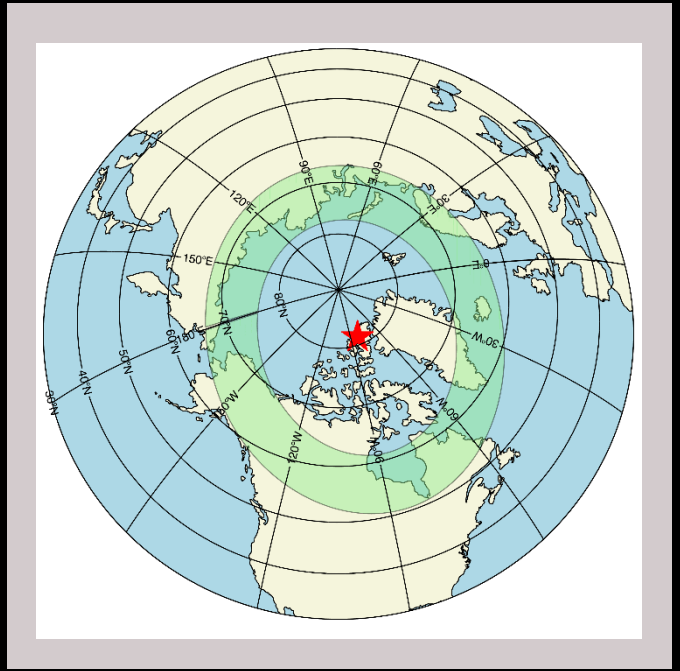
Future of ASI Networks in Canada

Eric Donovan, Emma Spanswick, Jun Liang,
Darren Chaddock, and Josh Houghton

Physics and Astronomy

University of Calgary




90°E
120°E
150°E
180°
30°W
60°W
90°W
120°W
80°N
70°N
60°N
50°N
40°N

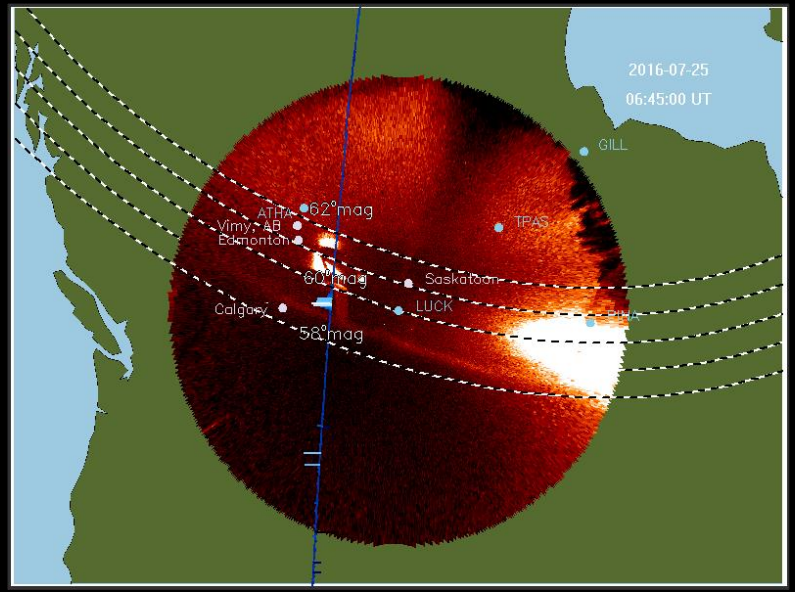

UCalgary AIG Redline ASI
32 centimeters

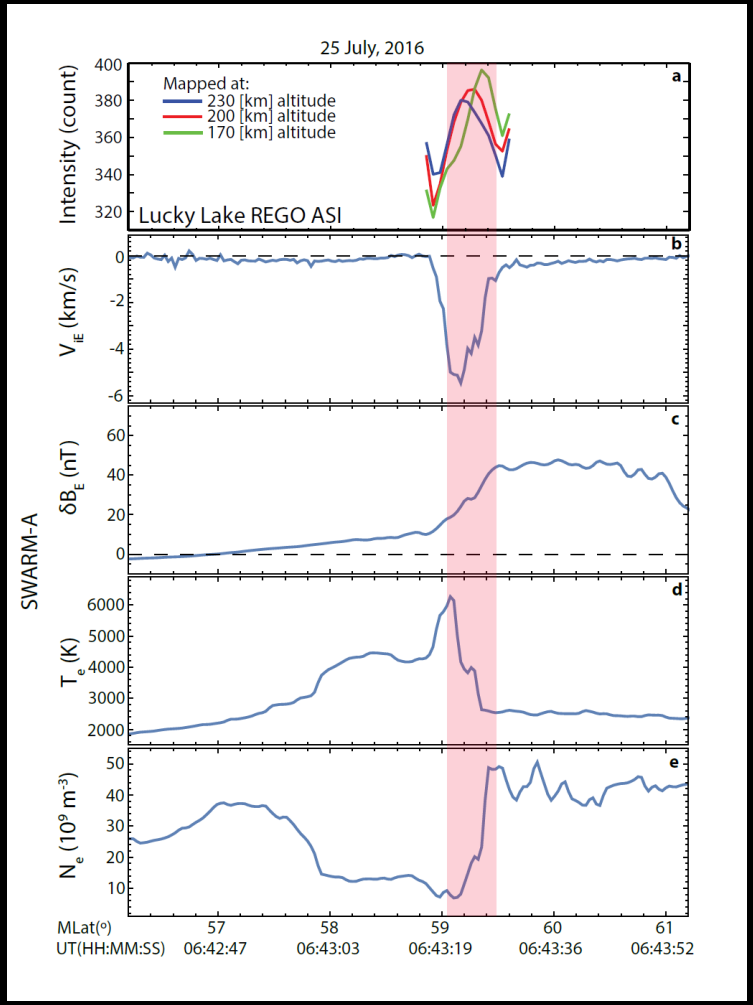
>500 refereed publications over last ~20 years

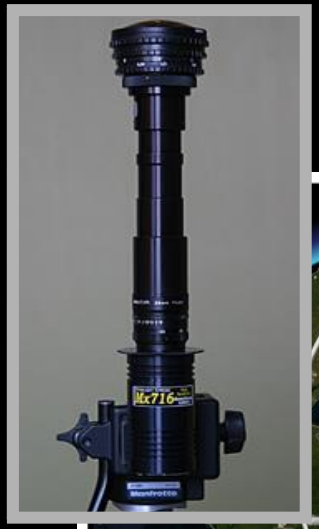
Many discoveries and significant advancements, including

Arcs are on field lines threading the TCS
The magnetosphere controls the shape (E-W alignment) of arcs
FLRs make some but not all arcs
Onset emerges out of the inner edge of TCS
Role of global convection cycle in substorm
Different types of diffuse electron aurora (PPA, APA, & PA)
FACs associated with PPA & PA
First-ever identification of magnetospheric driver of a specific aurora
Patches in PPA & PA move with EXB
Long-lived geographically extensive PA & PPA
Relationship between specific aurora and GNSS inaccuracies

STEVE is a continuum emission and not aurora


2016-07-25
06:45:00 UT
GILL
ATHA
62°mag
Vimy, AB
Edmonton
TPAS
60°mag
Saskatoon
LUCK
Calgary
58°mag


25 July, 2016
Mapped at:
230 [km] altitude
200 [km] altitude
170 [km] altitude
Intensity (count)
Lucky Lake REGO ASI
a
b
c
d
e
SWARM-A
V_{iE} (km/s)
δB_E (nT)
T_e (K)
N_e (10^9 m^{-3})
MLat(°)
UT(HH:MM:SS)
06:42:47
06:43:03
06:43:19
06:43:36
06:43:52



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The THEMIS all-sky imaging array—system design and initial results from the prototype imager

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Available online 10 August 2006

Abstract

Time History of Events and Macroscale Interactions during Substorms (THEMIS) is a NASA MIDEX mission scheduled for launch in 2006. THEMIS will consist of five magnetospheric satellites in equatorial orbits. Three of the spacecraft will have apogees around 12 Re, while the fourth and fifth will have apogees at ~20 and ~30 Re. The 12, 20, and 30 Re apogee orbits will have periods of one, two, and four sidereal days, respectively, meaning that all five spacecraft will be at or near apogee in the same meridian every four sidereal days. Furthermore, these conjunctions will always occur over central Canada throughout the mission duration. The five THEMIS satellites will be instrumented with particle and field detectors for measuring relevant plasma parameters, fields, and bulk velocities in the central plasma sheet (CPS). The THEMIS constellation will bracket the current disruption (CD) and near-earth neutral line (NENL) regions and will provide for the first time an opportunity for unambiguous identification of the radial position in the CPS where the substorm process initiates. The primary scientific objective for THEMIS is to determine which of these processes is responsible for substorm onset. THEMIS cannot close this question without complementary ground-based observations in North America. To this end, THEMIS requires the deployment of 20 white light all-sky imagers (ASIs) in a continent-wide array. These ASIs will operate with a cadence of at least one image every 5 s, and will provide mission critical onset and early expansive phase information. In this paper, we present observations from the prototype THEMIS ASI for one substorm event. This image data demonstrates that the THEMIS ASI has the temporal and spatial resolution necessary to meet the mission requirements. Further, in this event we find that the growth phase arc shows wavelike azimuthal structuring and a brightening that occurs virtually simultaneously along the entire length of the arc that is within the ASI field of view. We attribute this wavelike structure to structure in the CPS. We anticipate that the THEMIS ASI array and *in situ* data will allow for the elucidation of the CPS process that generates this azimuthal structure.

Keywords: Aurora; Substorm; Imaging; Magnetosphere; Ionosphere; THEMIS

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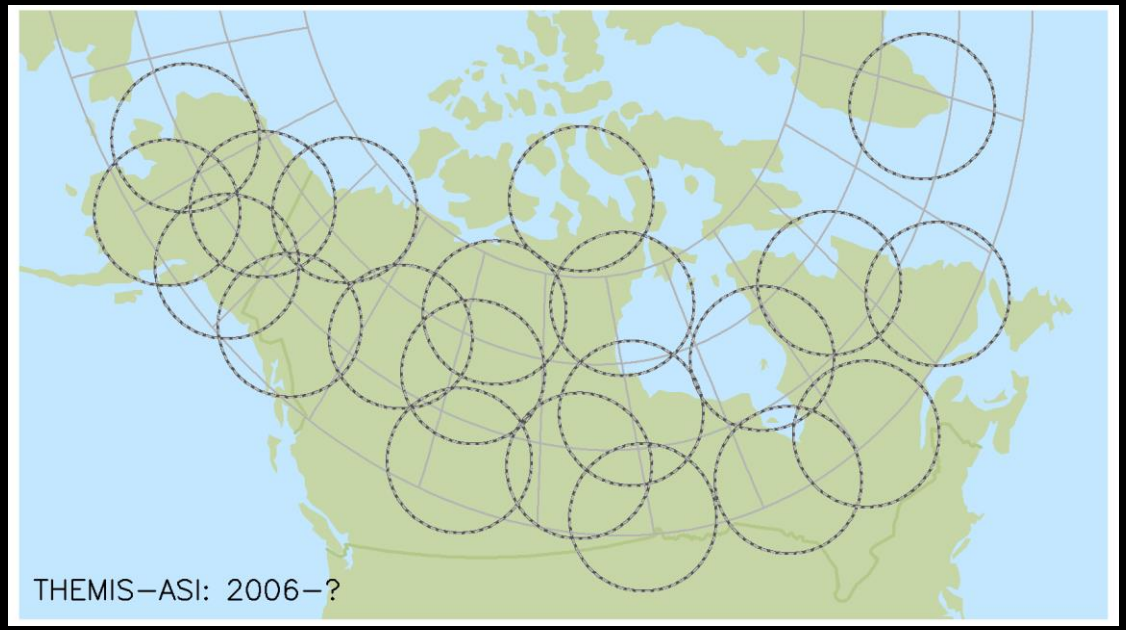
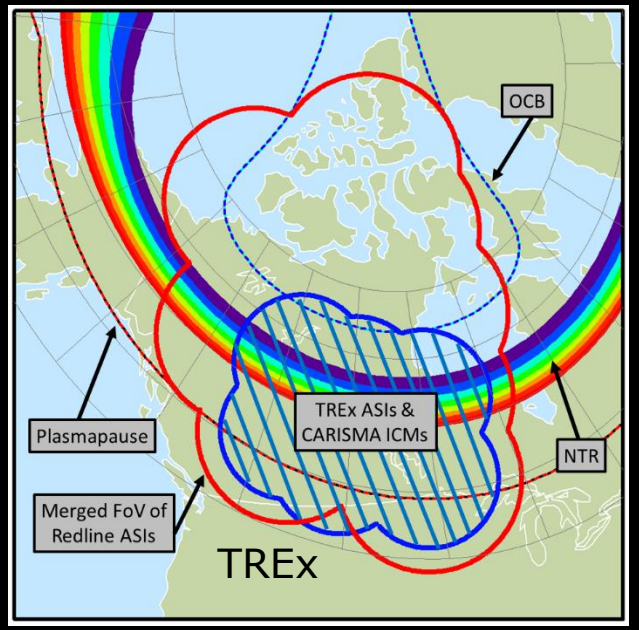
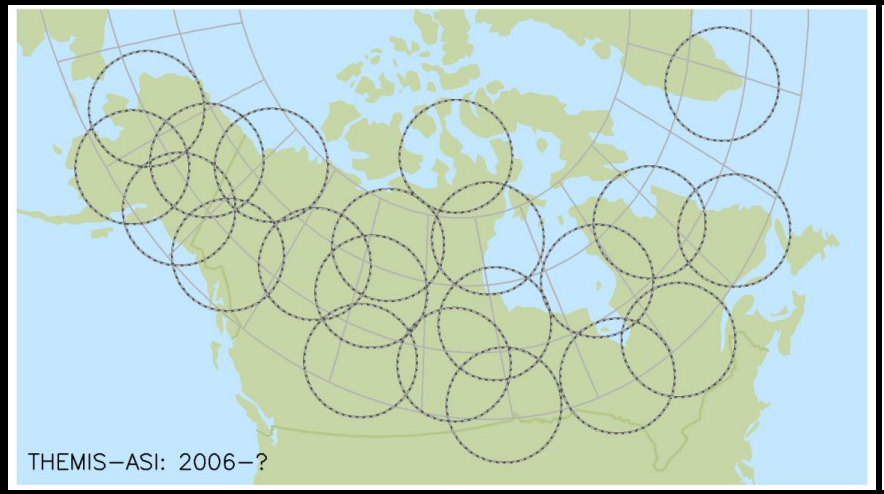
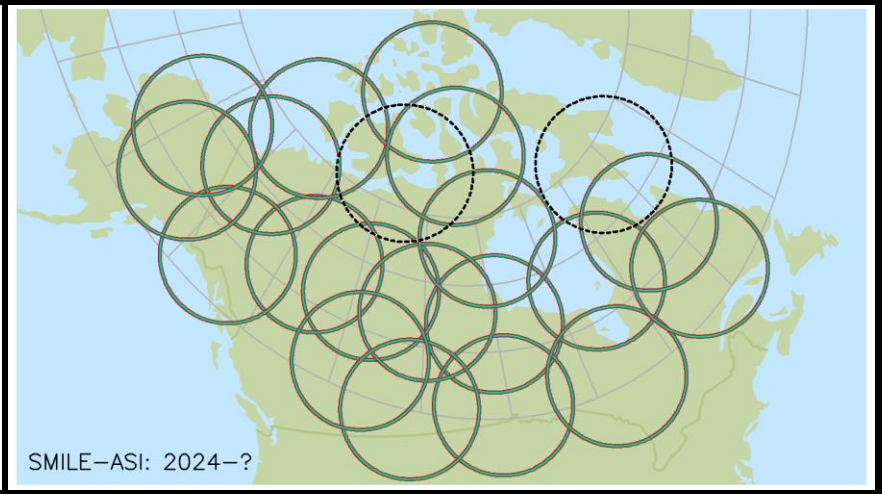

THEMIS–ASI: 2006–?


OCB
Plasmapause
TREx ASIs &
CARISMA ICMs
NTR
Merged FoV of
Redline ASIs
TREx


THEMIS–ASI: 2006–?


SMILE–ASI: 2024–?

Geospace Dynamics Constellation – Ground (GDC-G)

	ASI-RGB	ASI-Redline	Riometer	Magnetometer	GNSS	Spectrograph	Fabry-Perot
1	■	■	■	■	■		
2	■	■	■	■	■		
3	■		■	■			
4	■	■	■	■	■		■
5	■		■	■	■		
6	■	■	■	■	■		■
7	■	■	■	■			
8	■	■	■	■	■		
9	■	■			■	■	
10	■	■			■	■	■
11				■			
12	■						
13	■	■			■		■
14	■		■	■			
15			■	■			
16	■	■				■	
17	■	■	■	■	■	■	
18	■			■		■	
19	■	■			■	■	
20				■	■		
21	■						■
22			■	■			
23	■	■	■	■	■		■
24	■	■	■	■		■	
25	■	■		■	■	■	
26	■	■	■	■	■	■	
27	■		■	■		■	

UCalgary Space Remote Sensing Group Data Landing Page

Welcome to the UCalgary Space Remote Sensing (SRS) Data Landing Page. This website is intended to provide resources to discover, learn, access, and utilize the data from our vast networks of autonomous instrumentation deployed across Canada (and beyond).

Open Data Archive

Browse our open data archive. The archive is accessible using a variety of methods, including HTTP, FTP, Rsync, and experimental API-based access.

- HTTP: by project, by instrument type
- Rsync: `rsync rsync://data.phys.ucalgary.ca`
- FTP: `ftp://data.phys.ucalgary.ca`
- API: learn more **experimental**

Dataset Documentation

Learn more about our available datasets (instrumentation, operating modes, data descriptions, etc.)

Learn more

Working with our data

Explore UCalgary supported resources for retrieving and using our data.

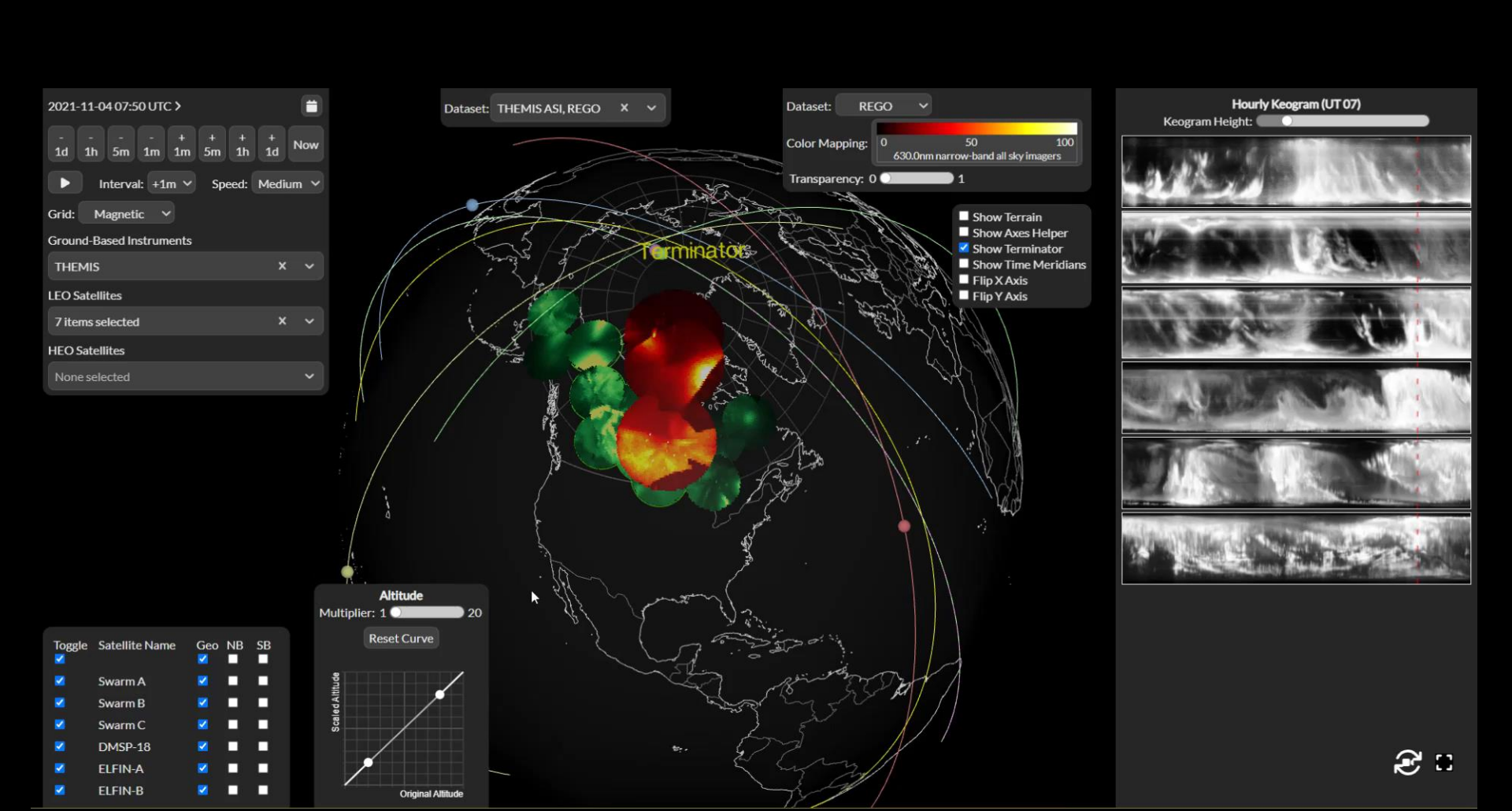
- How to download data
- Explore crib sheets
- Explore API and software packages

Learn more

Data Discovery (Virtual Observatories)

Explore our data through a variety of virtual observatories developed to support our data.

- Data Portal (summary data viewing, including RT)
- Swarm-Aurora
- AuroraX


2021-11-04 07:50 UTC
- 1d
- 1h
- 5m
- 1m
+ 1m
+ 5m
+ 1h
+ 1d
Now
Interval: +1m
Speed: Medium
Grid: Magnetic
Ground-Based Instruments
THEMIS
LEO Satellites
7 items selected
HEO Satellites
None selected
Dataset: THEMIS ASI, REGO
Dataset: REGO
Color Mapping: 0 50 100
630.0nm narrow-band all sky imagers
Transparency: 0 1
Show Terrain
Show Axes Helper
Show Terminator
Show Time Meridians
Flip X Axis
Flip Y Axis
Terminator
Hourly Keogram (UT 07)
Keogram Height:
Altitude
Multiplier: 1 20
Reset Curve
Scaled Altitude
Original Altitude
Toggle
Satellite Name
Geo
NB
SB
Swarm A
Swarm B
Swarm C
DMSP-18
ELFIN-A
ELFIN-B

Crib Sheets

This crib sheet is provided to support access, utilization, and plotting of UCalgary optical datasets. It is intended as a base set of code that a user may edit and manipulate to serve their own needs. Crib sheets contains UCalgary verified and validated procedures for plotting and manipulating UCalgary ASI data for common use cases. Use of this crib sheet does not require acknowledgment, it is freely distributed for personal scientific use. The crib sheet (or elements of the crib sheet) must not be ingested into third party libraries without written consent of the UCalgary team. Please also remember to perform due diligence on all data use. We recommend comparison with verified data products on data.phys.ucalgary.ca to ensure that any user output does not contradict operational summary plots. Data use must be acknowledged according to the information available for each data set - please see data.phys.ucalgary.ca. If you encounter any issues with the data or the crib sheet, please contact the UCalgary team for support (Emma Spanswick).

Name	Category	Python	IDL
Load, calibrate, and plot single channel ASI data	Basic	Jupyter Notebook Open in Colab	IDL (coming soon)
Load, calibrate, and plot multi channel ASI data	Basic	Jupyter Notebook Open in Colab	IDL (coming soon)
Georeferencing single channel ASI data	Basic	Jupyter Notebook Open in Colab	IDL (coming soon)
Georeferencing multi channel ASI data	Basic	Jupyter Notebook Open in Colab	IDL (coming soon)
Multi network mosaics	Advanced	Jupyter Notebook Open in Colab	IDL (coming soon)
Downloading data using the API	Experimental	Jupyter Notebook Open in Colab	IDL (coming soon)

Active Work

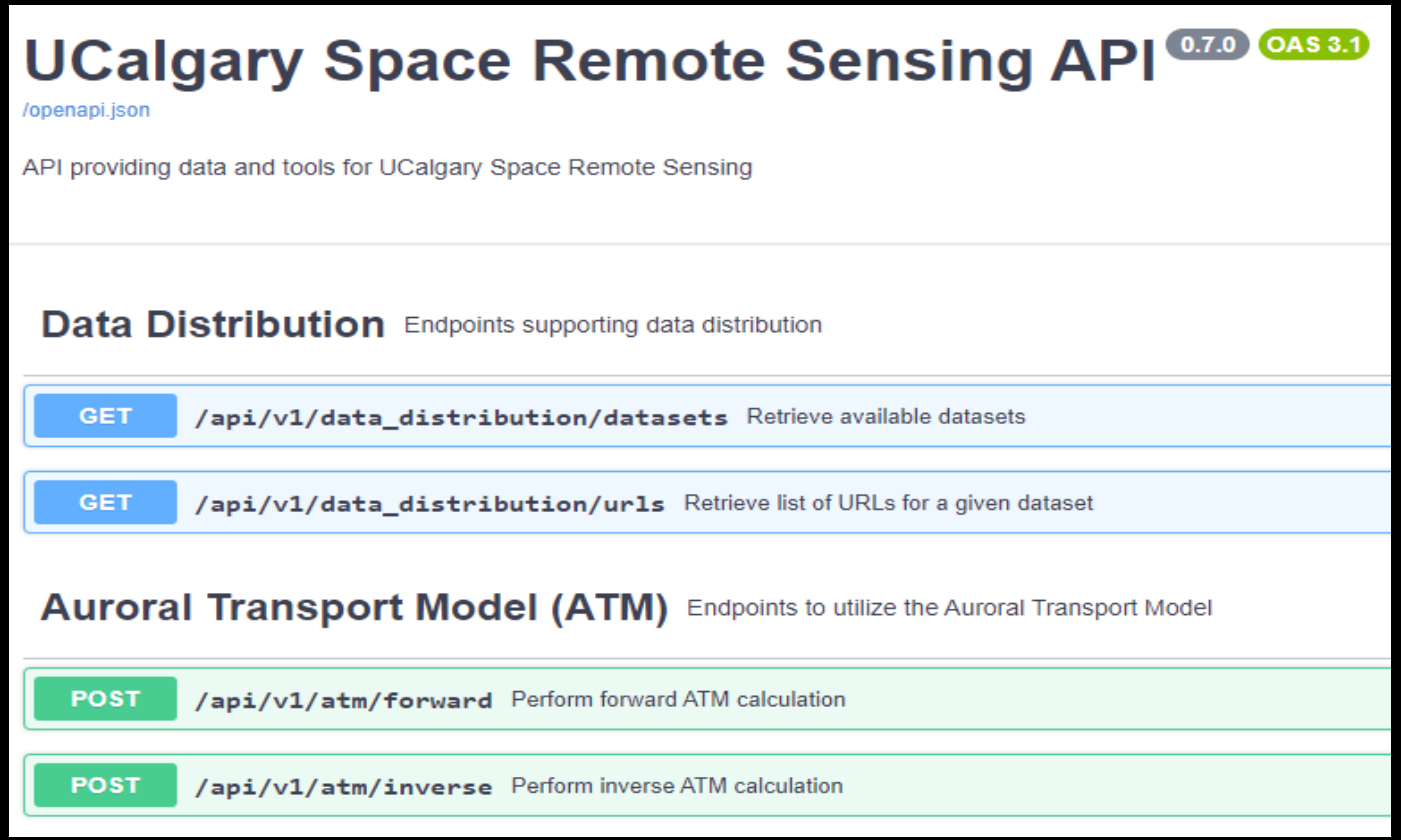
Python data analysis and plotting tools

- PyAuroraX release v1.0.0 will include this functionality
- Release planned for June
- Will include advancement of current crib sheets to utilize the new library functionality, the ability to run and analyze results from J. Liang's TREx Auroral Transport Model (ATM)

API – continue development and expand functionality (e.g., Jun's ATM)

Verify and release gridded data products

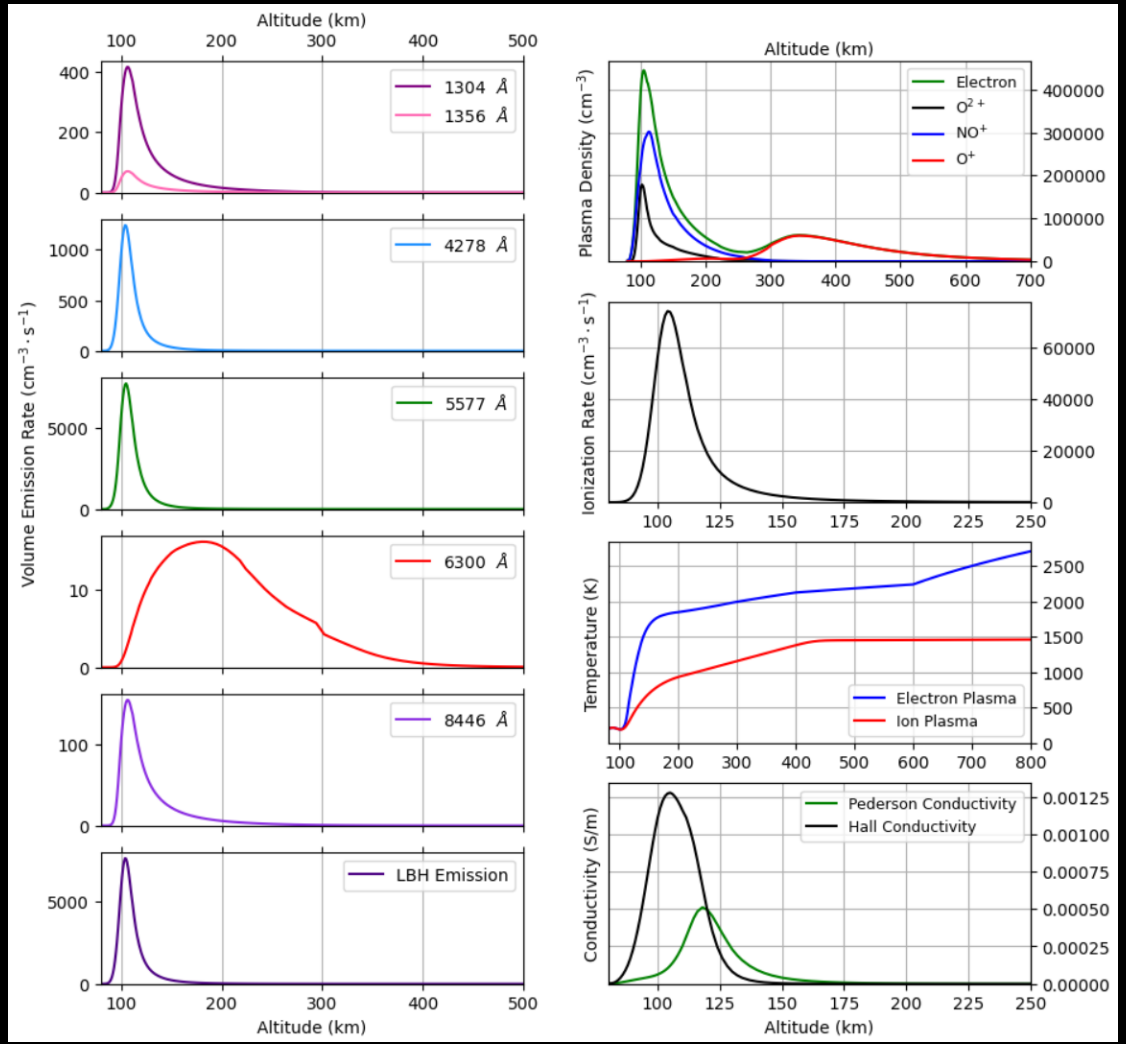
Release AuroraX Event Explorer upgrade



https://api.phys.ucalgary.ca

TREx ATM

Example of forward function outputs



Future Work

Python and IDL libraries (Python release planned for June, IDL will come close behind)

API – continue development and expand functionality

Generation of additional higher-level gridded data products to address community needs

HAPI endpoints for timeseries datasets