Enhancing information content from Canadian auroral observations

new results and future plans

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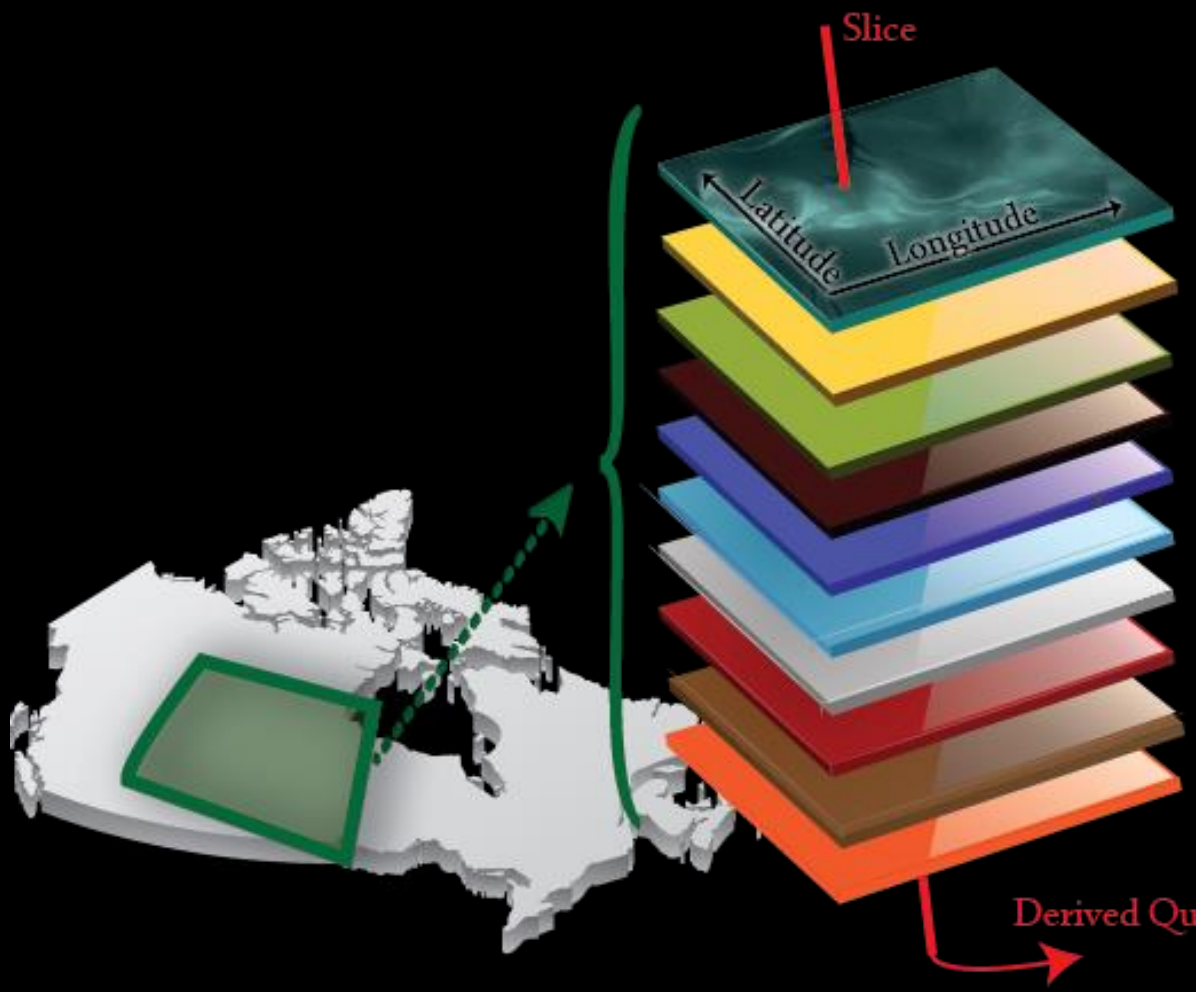
The TREx Challenge



6300A

4278A

8446A

5577A

Imaging riometer

4861A (proton aurora)

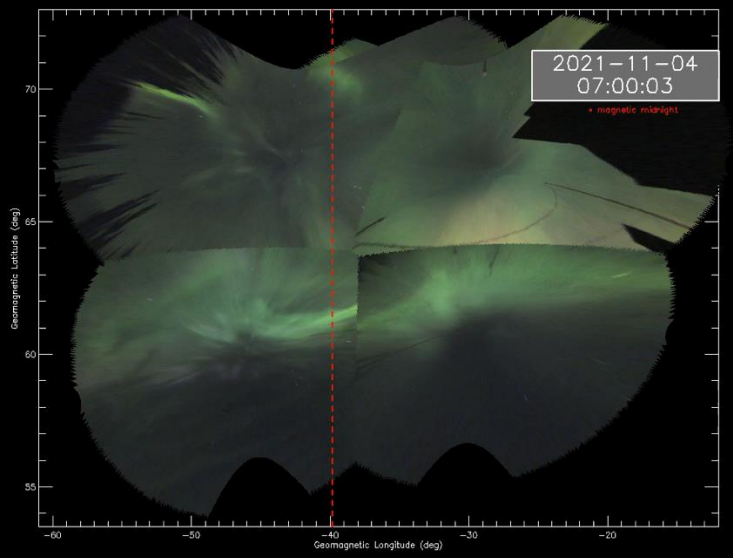
……

SuperDARN, CARISMA, etc.

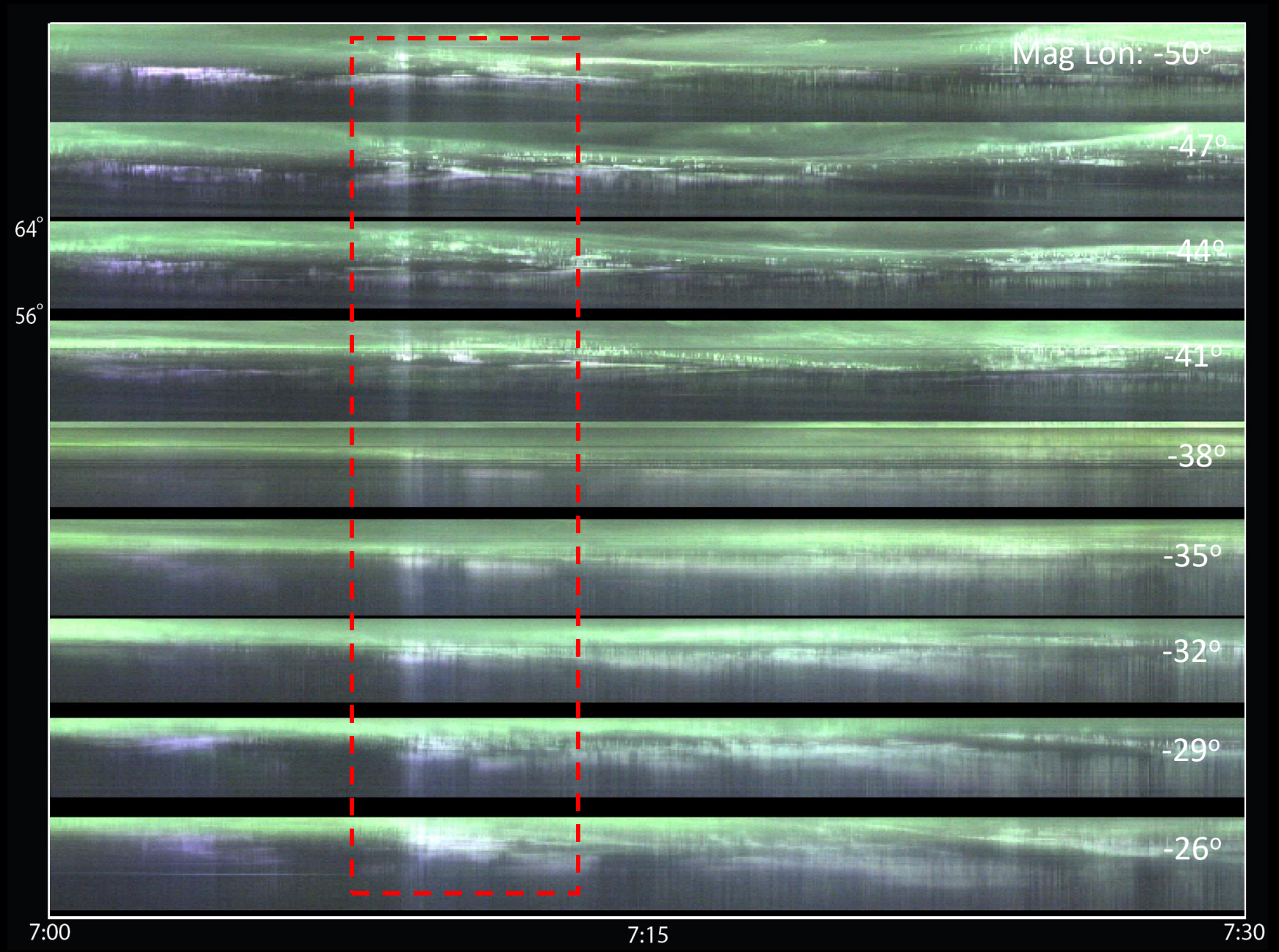
Derived Quantities (precipitating electron and proton energy flux, etc.)


TREx RGB
Rabbit Lake, SK
3Hz burst
N
E
2022-04-07 08:05:00 UTC

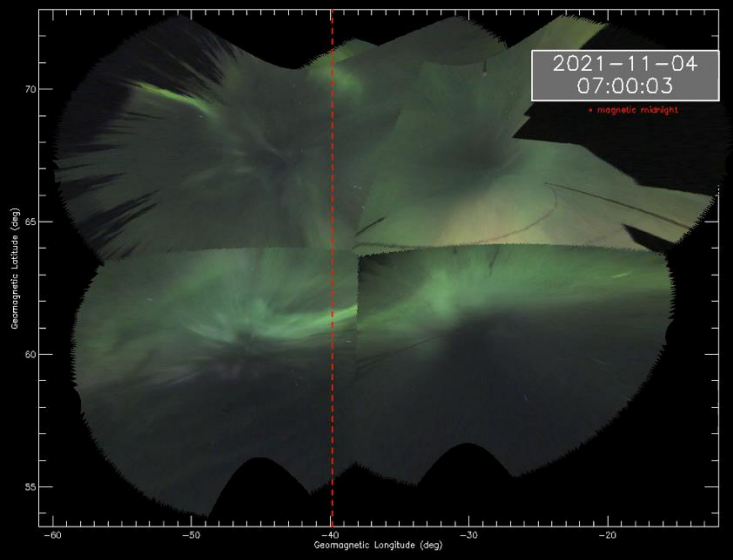
AGU 2022



Coincident RGB imaging with spectrograph luminosity profile confirmed a “flash” of continuum emission that propagated across two cameras within 45 seconds.



AGU 2022



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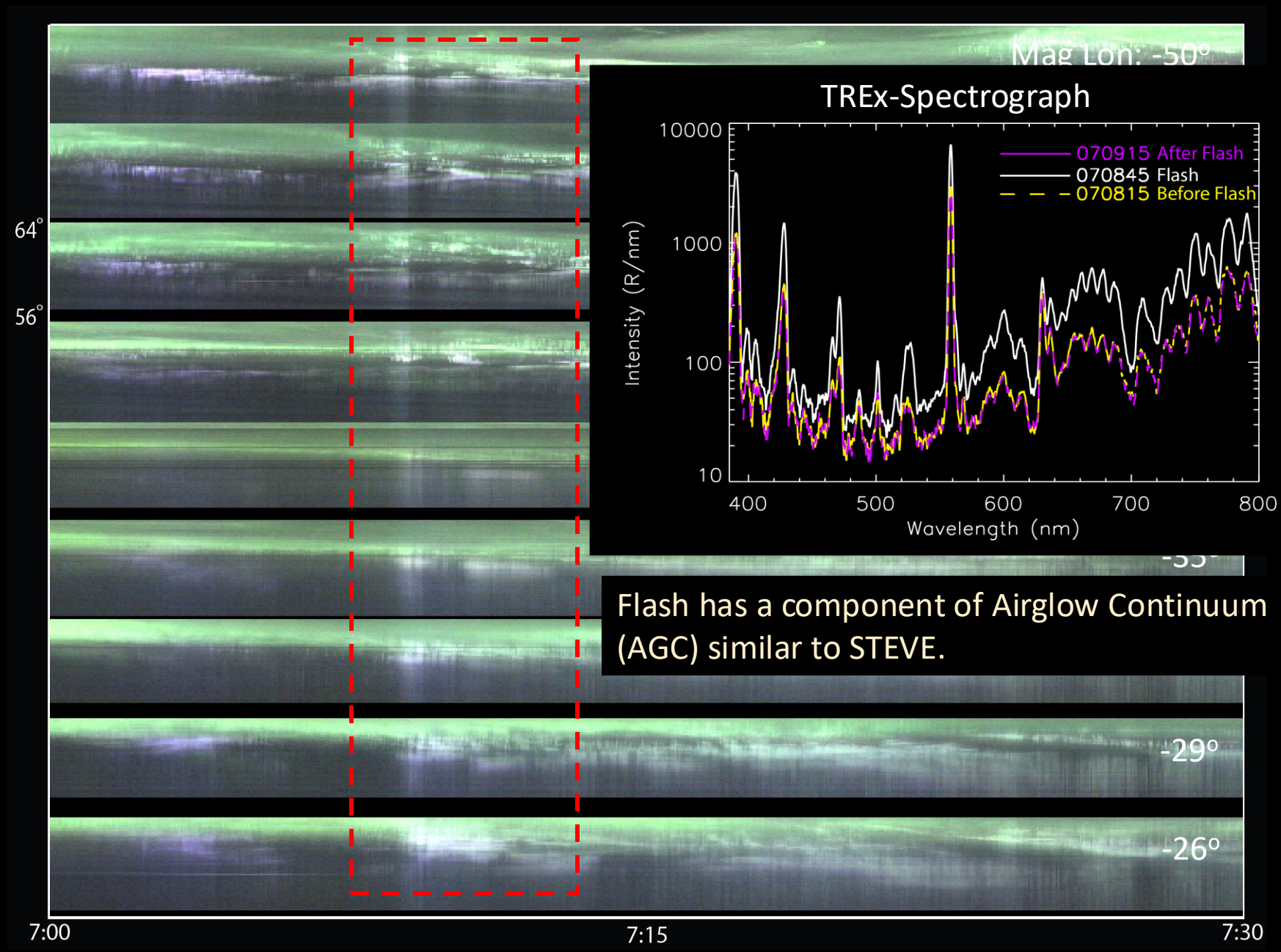


Flash has a component of Airglow Continuum (AGC) similar to STEVE.

Continuum emission is not new.

- Dzyubenko et al. 1968 “The ‘Continuum’ in the radiation of an artificial polar aurora’
- Sternberg & Ingham 1972, “Observations of the airglow continuum”
- Sharp et al. 1979 “Coordinated rocket and satellite measurements of an auroral event 2. the rocket observations and analysis”
- Evans et al. 2010, “Discovery of the FeO orange bands in the terrestrial night airglow spectrum obtained with OSIRIS on the Odin spacecraft”
- Harding et al. 2020 “A Mechanism for the STEVE Continuum Emission”

Image credit: Ryan Sault / Alberta Aurora Chasers

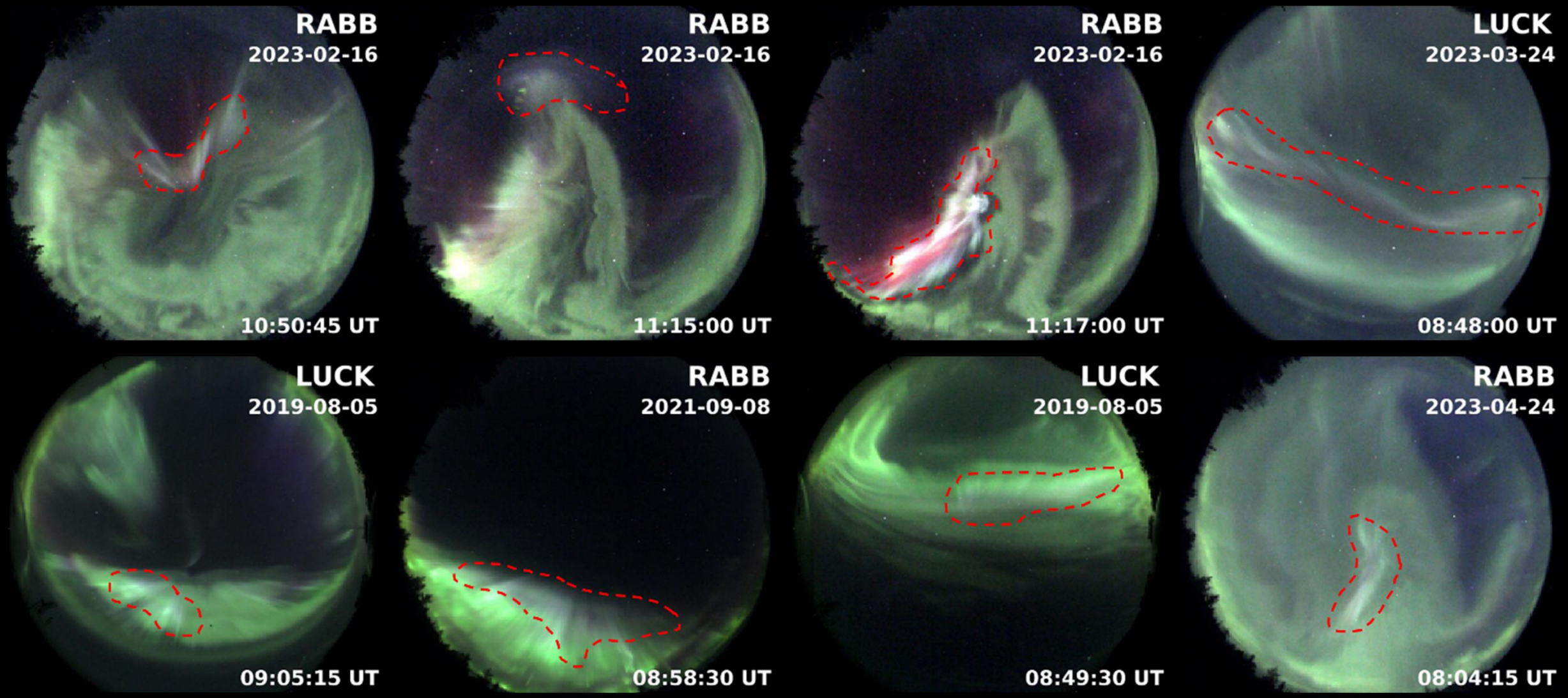
What is new is that TREx-RGB is showing us, for the first time, how common continuum emission is and in what forms it appears.

Flash

Structured, dynamic, and inconsistent

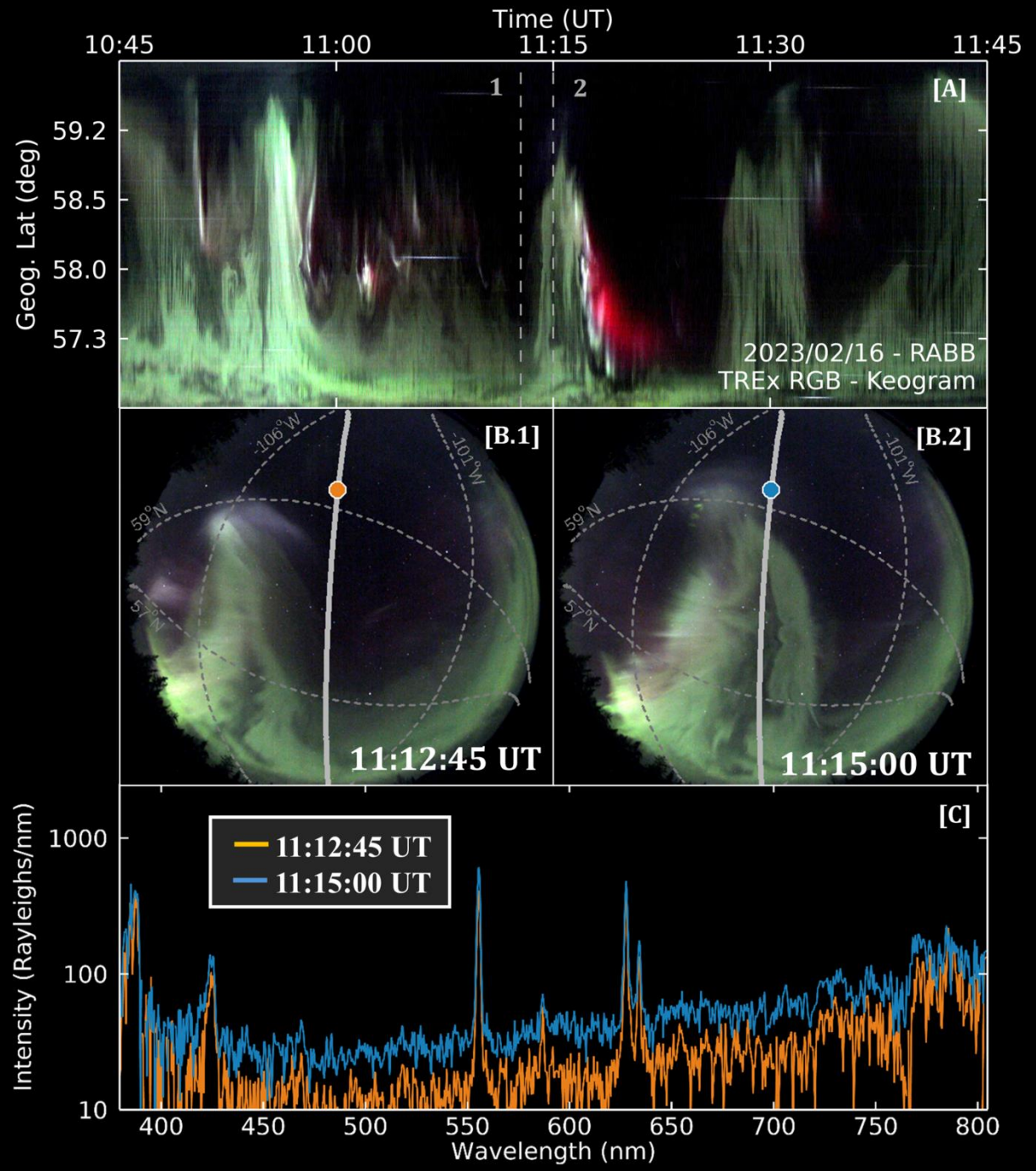
Arc

The structured, dynamic and inconsistent class of events are, by far, the most common manifestation of continuum emission observed in TREx-RGB.



Structured, dynamic, and inconsistent

Events tend to occur adjacent to (or embedded in) the bright aurora and clearly connected to nearby dynamics.

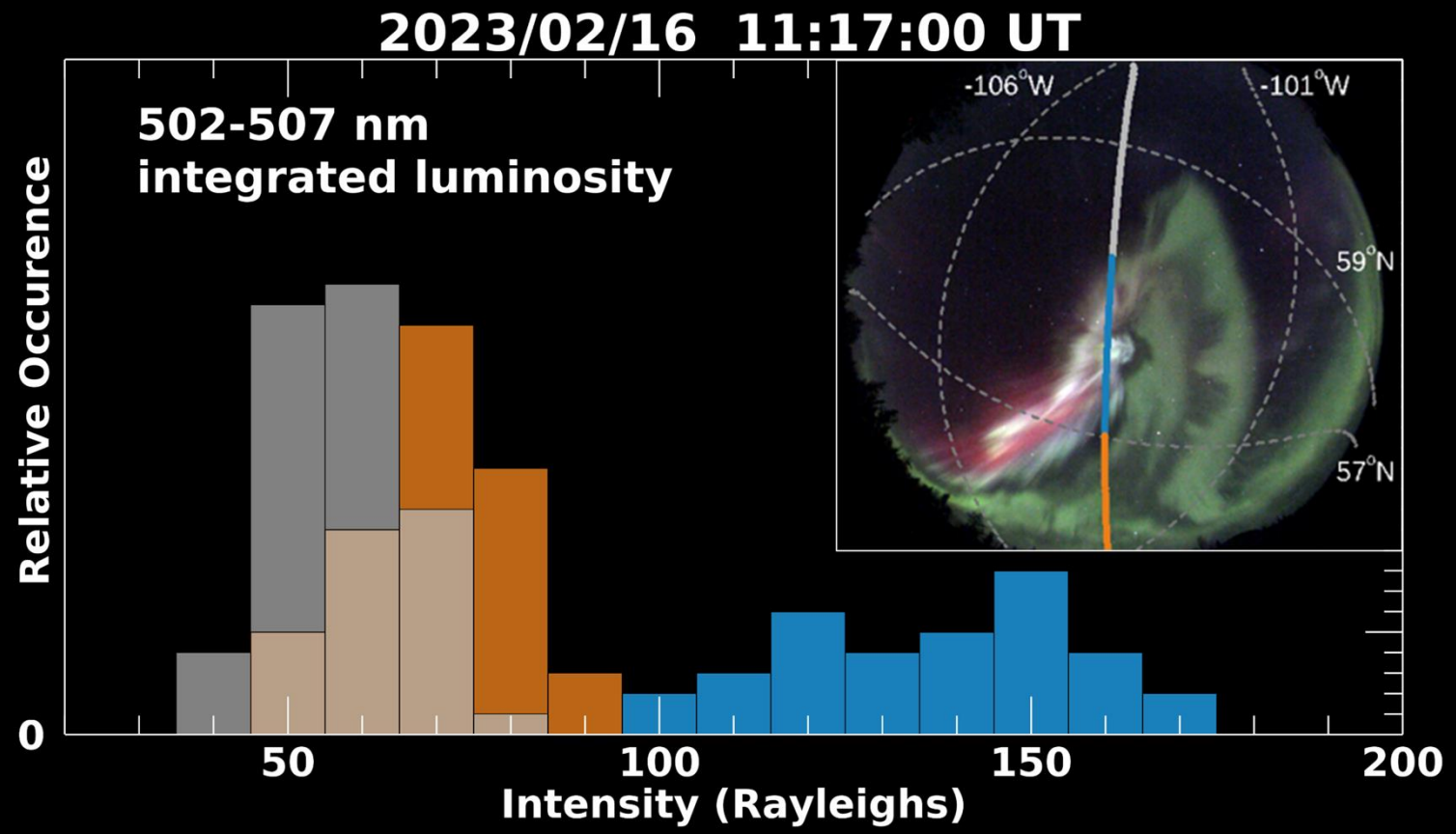


Structured, dynamic, and inconsistent

Events tend to occur adjacent to (or embedded in) the bright aurora and clearly connected to nearby dynamics.

When looking in regions of spectral ‘background’, and processing statistics of luminosities, these events are distinct from the background population.

Continuum spectral intensities in these events are comparable to STEVE and previous observations in conjunction with bright aurora (considered ‘unexplained’, Gattinger et al. 1974).



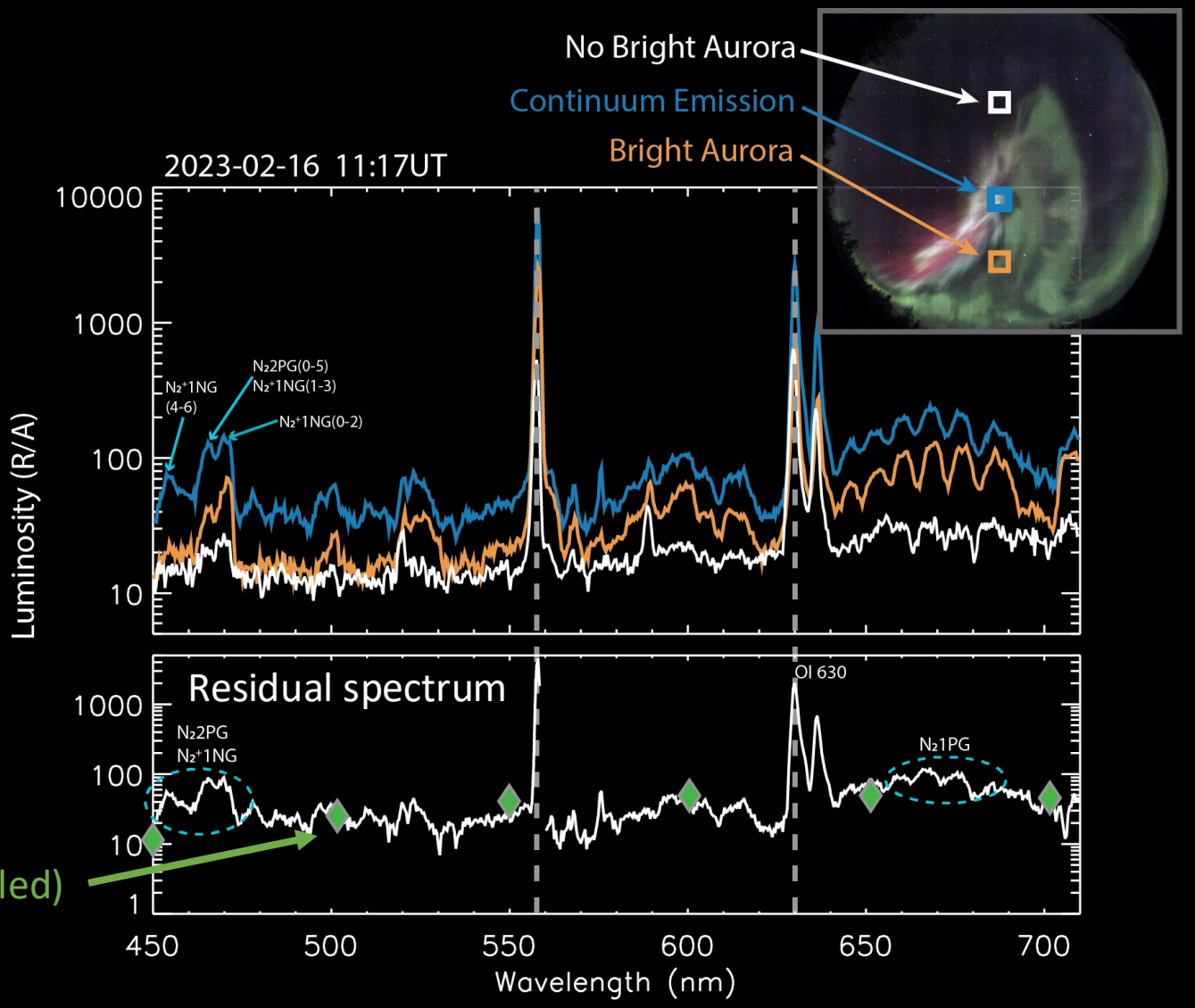
Isolating the spectrum

- Assuming the auroral emissions are locally uniform around the continuum structure (plausible for this structure) we can estimate the spectra of the gray-toned feature.

- Detailed spectra show evidence of precipitation within the region of continuum (unlike STEVE)

- We believe the residual spectrum can be explained by a superposition of NO2 continuum (green dots) and multiple auroral line.
  - Of note: N2 2PG and N2+ 1NG bands, which are weak in normal aurora but strongly enhanced here. This implies N2 has been vibrationally excited to high levels – strong electron heating.

Sutoh et al. 1980 continuum emission (scaled)



Learning from TREx RGB

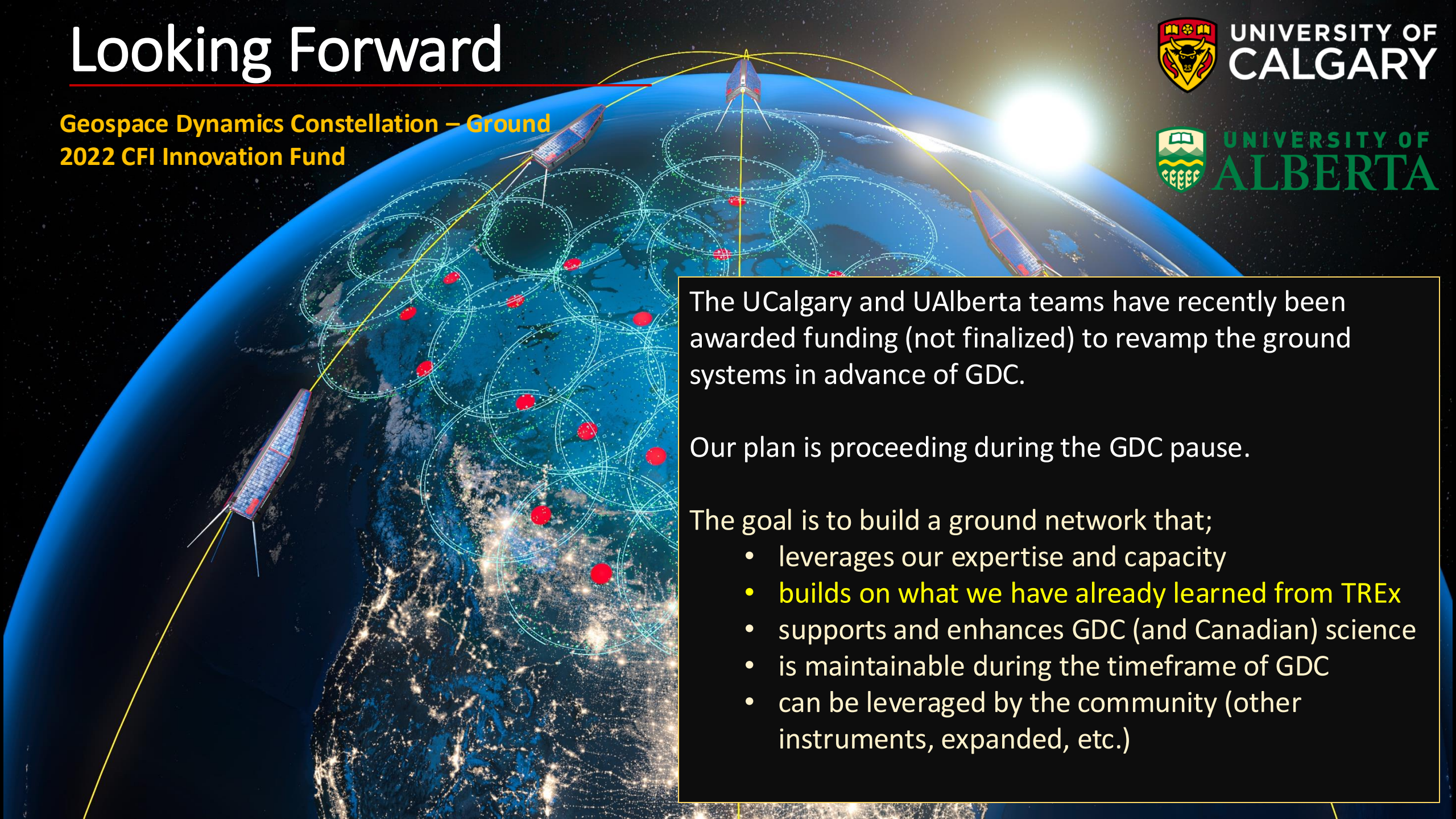
TREx RGB goals: derived 5577A luminosity, EPO movies

What TREx RGB is giving us: derived 5577A luminosity, EPO movies + information about dynamic coupling/heating

This type of non-traditional imaging can add significant value to existing techniques.

Looking Forward

Geospace Dynamics Constellation – Ground
2022 CFI Innovation Fund



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UNIVERSITY OF ALBERTA

The UCalgary and UAlberta teams have recently been awarded funding (not finalized) to revamp the ground systems in advance of GDC.

Our plan is proceeding during the GDC pause.

The goal is to build a ground network that;

- leverages our expertise and capacity
- builds on what we have already learned from TREx
- supports and enhances GDC (and Canadian) science
- is maintainable during the timeframe of GDC
- can be leveraged by the community (other instruments, expanded, etc.)

Looking Forward

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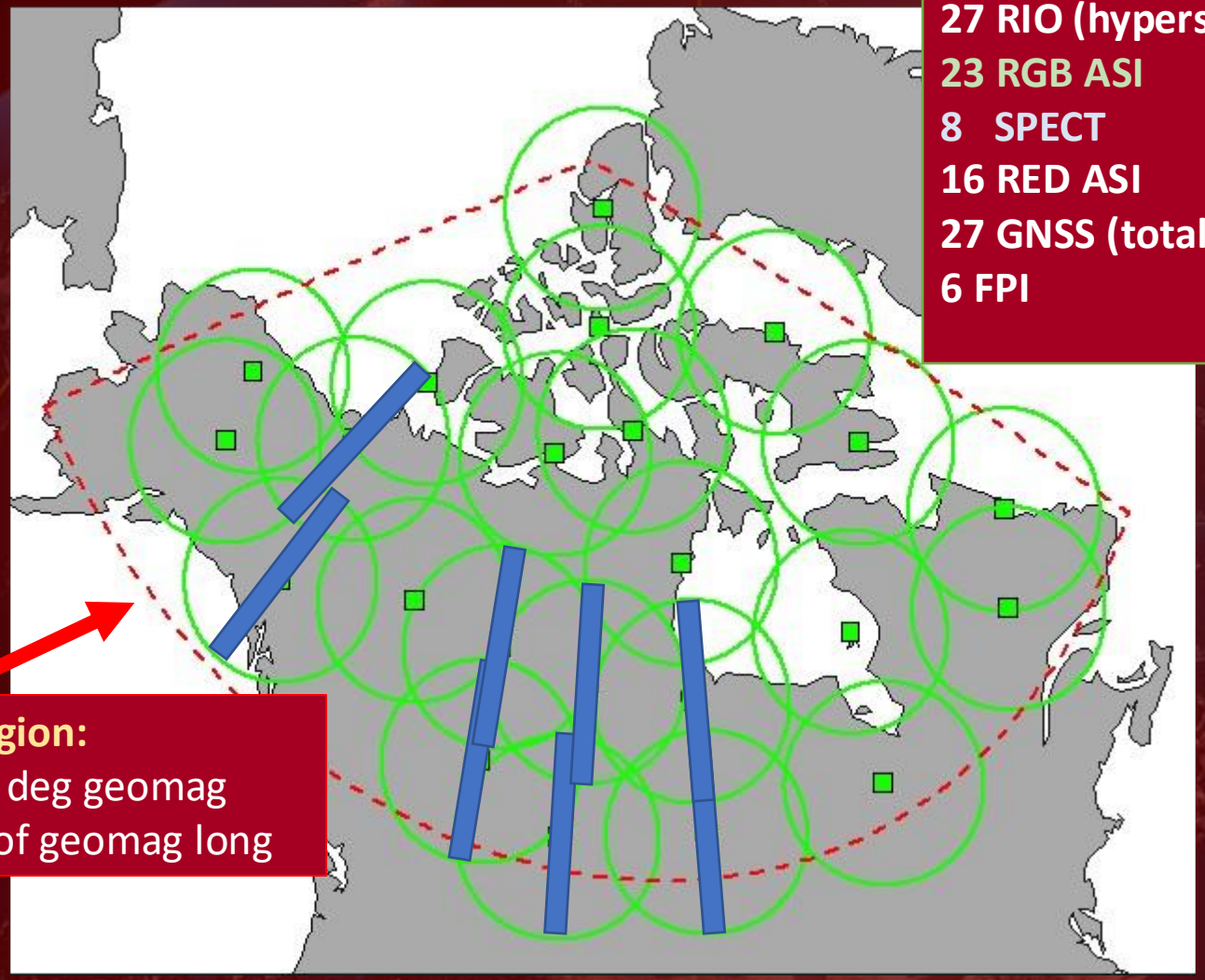
GDC-Ground Infrastructure



27 MAG (fluxgate)
27 RIO (hyperspectral)
23 RGB ASI
8 SPECT
16 RED ASI
27 GNSS (total)
6 FPI

Target Region:
~58 to 90 deg geomag
>120deg of geomag long

27 “core sites”

“The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.”

- Marcel Proust

Summary

- Use of non-traditional imaging techniques can add valuable information to key outstanding science questions… and also generate new ones…
  - What is structuring the heating (spatially and temporally)?
  - Why near the edge of the bright aurora?
  - What is the interplay between the ionospheric state (preconditioning?) and precipitation?

- We are preparing to integrate this type of imaging into future networks (2026+)