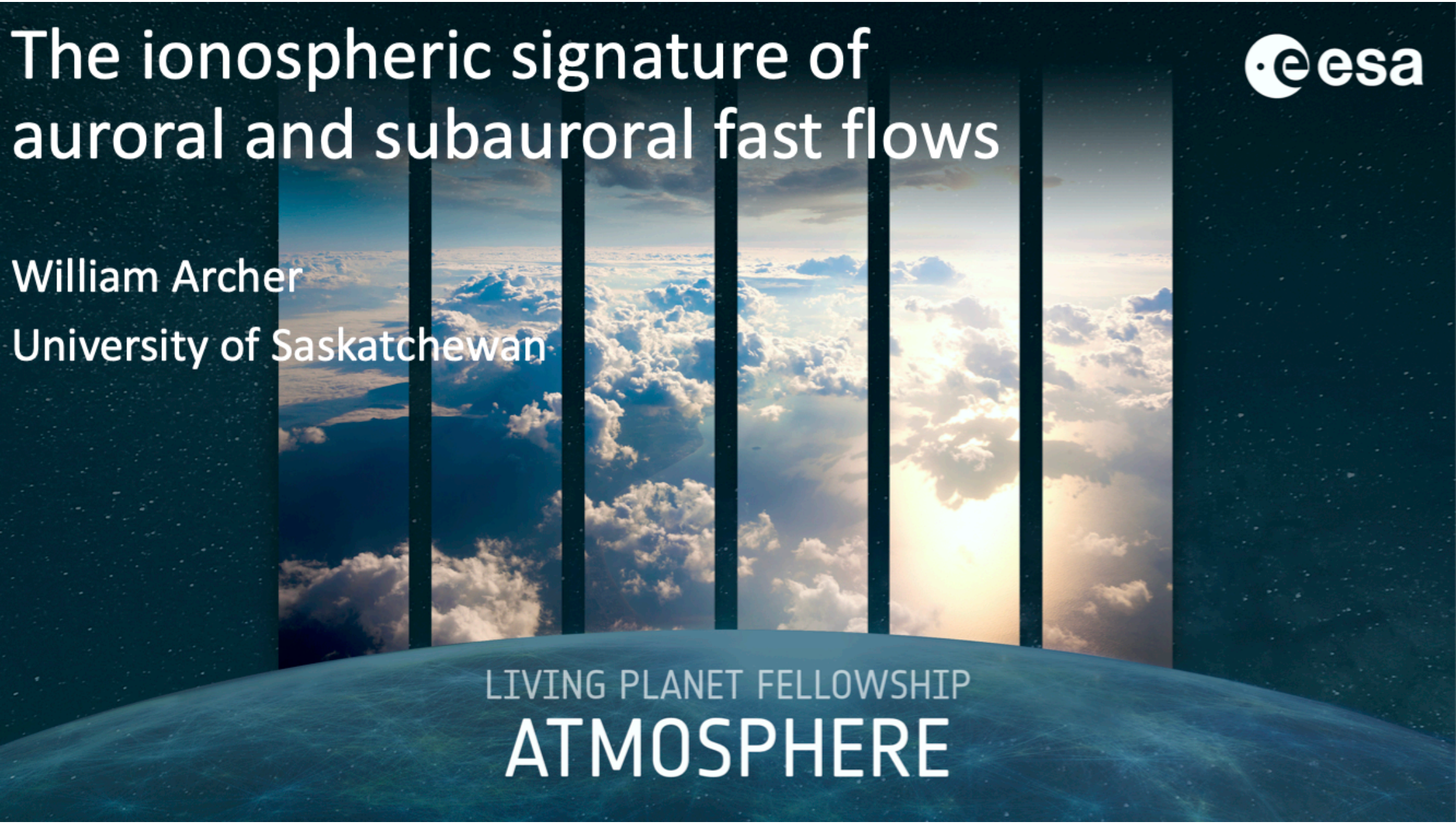
# The ionospheric signature of auroral and subauroral fast flows

William Archer
University of Saskatchewan



# Project overview

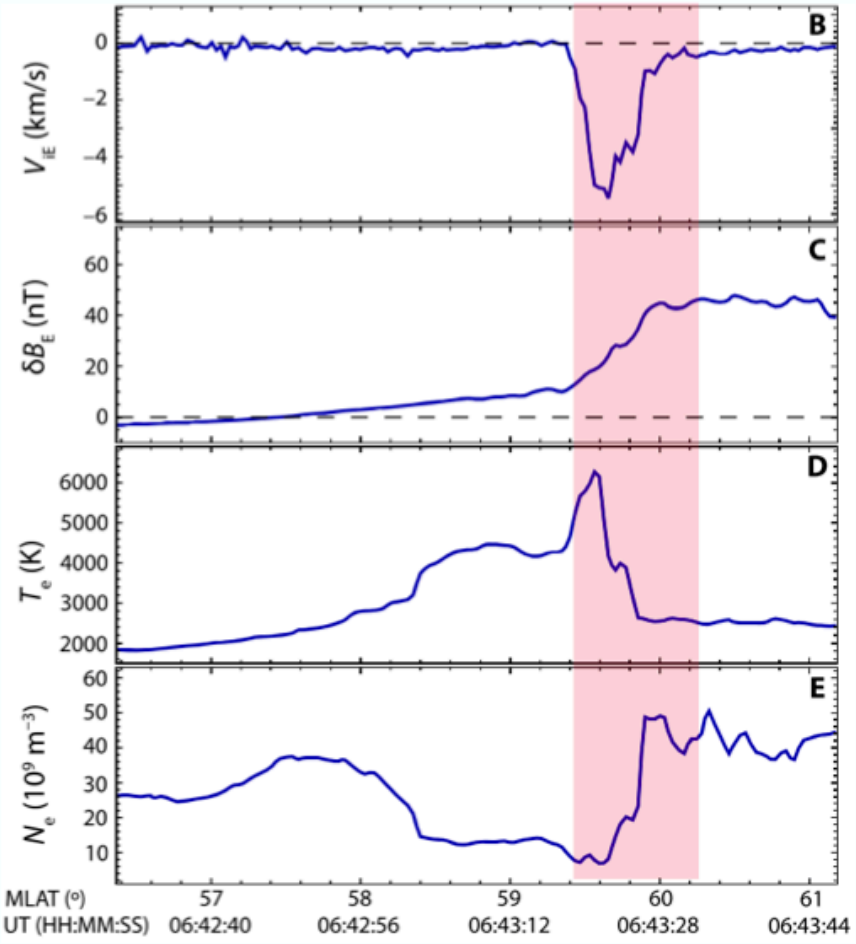
- Topic 1: The mid-latitude density trough and subauroral ion drifts (SAID)
  - 1.1 “Typical” mid-latitude trough.
    Worked with a PhD student on this. Made useful progress for future research.
  - 1.2 SAID and the trough
    Little progress made on this at this point.
  - 1.3 Steve: the optical signature of intense SAID
    Exciting research resulting in 2 publications so far.
- Topic 2: Birkland current boundary flows (BCBF)
  - 2.1 BCBF neutral densities
    Began analysis of raw Swarm accelerometer measurements
  - 2.2 BCBF Hall currents
    Worked with DTU to generate Hall current estimates coincident with BCBF

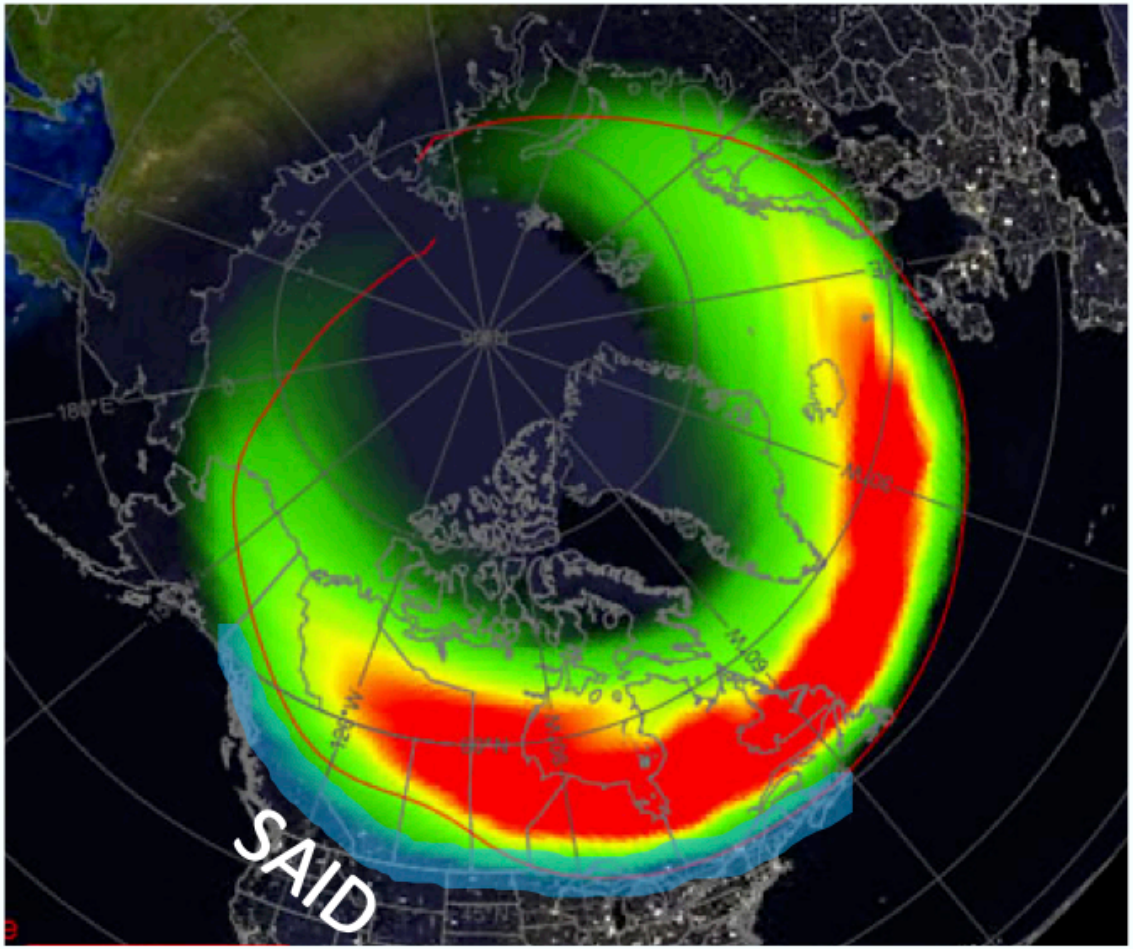
# Challenges and roadblocks

- Topic 1: The mid-latitude density trough and subauroral ion drifts (SAID)
  - 1.1 “Typical” mid-latitude trough.
    Not enough new to justify a publication.
  - 1.2 SAID and the trough
  - 1.3 Steve: the optical signature of intense SAID
- Topic 2: Birkland current boundary flows (BCBF)
  - 2.1 BCBF neutral densities
    Swarm accelerometer measurements are complicated.
  - 2.2 BCBF Hall currents
    No clear pattern seen in Hall current estimates, may be to coarse a resolution.

# Meet Steve

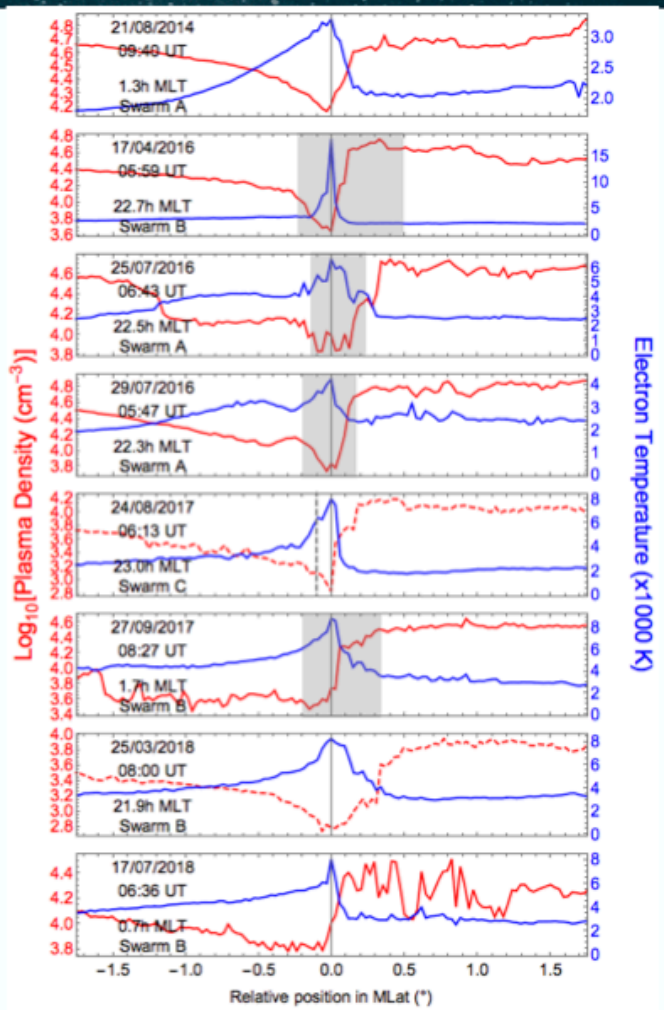
# Steve and SAID



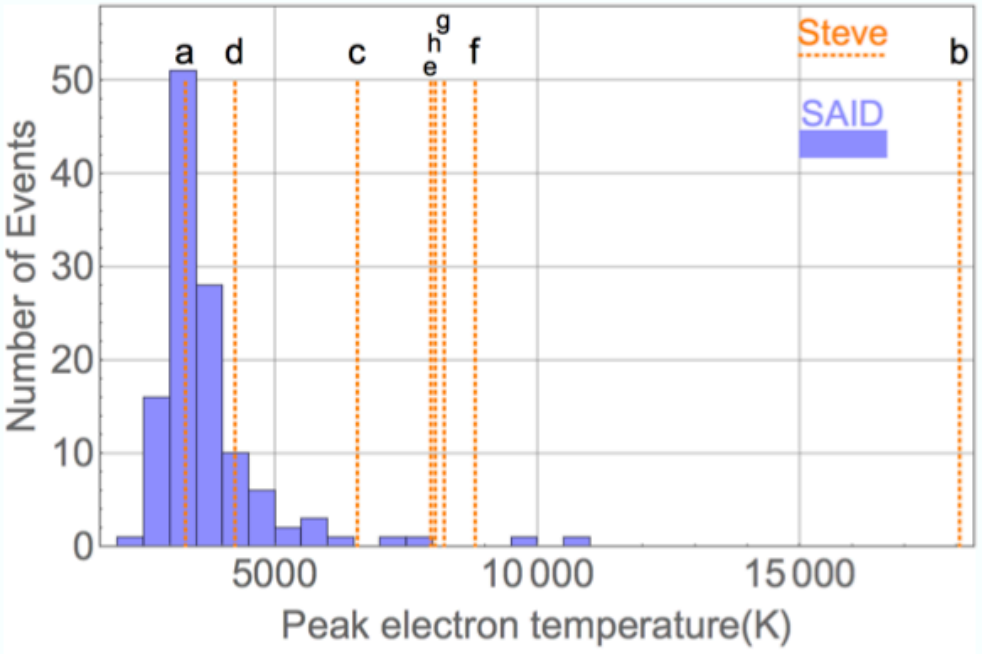




MacDonald et al. 2018

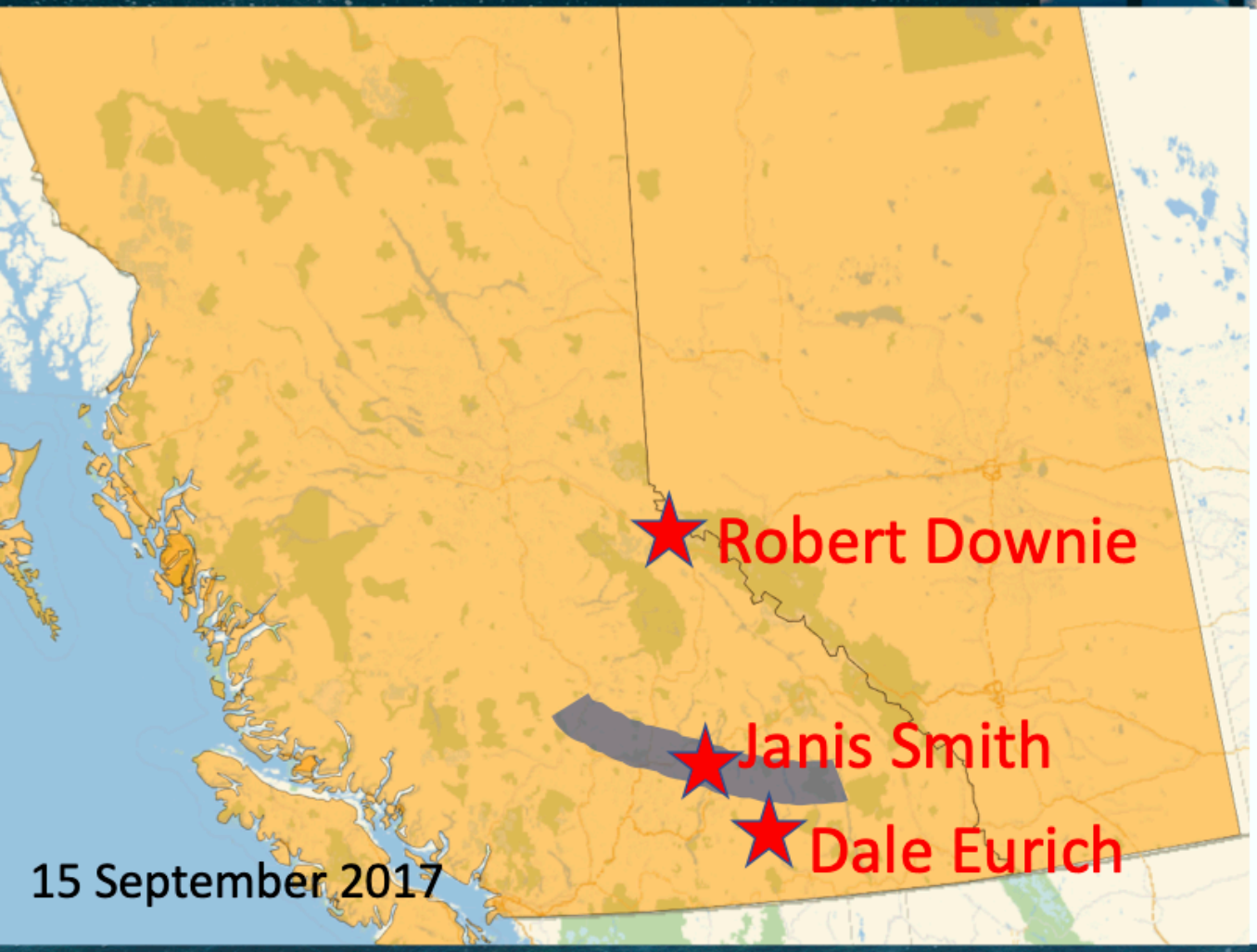
# Steve and SAID




Extreme electron temperature, plasma density, and ion velocity.

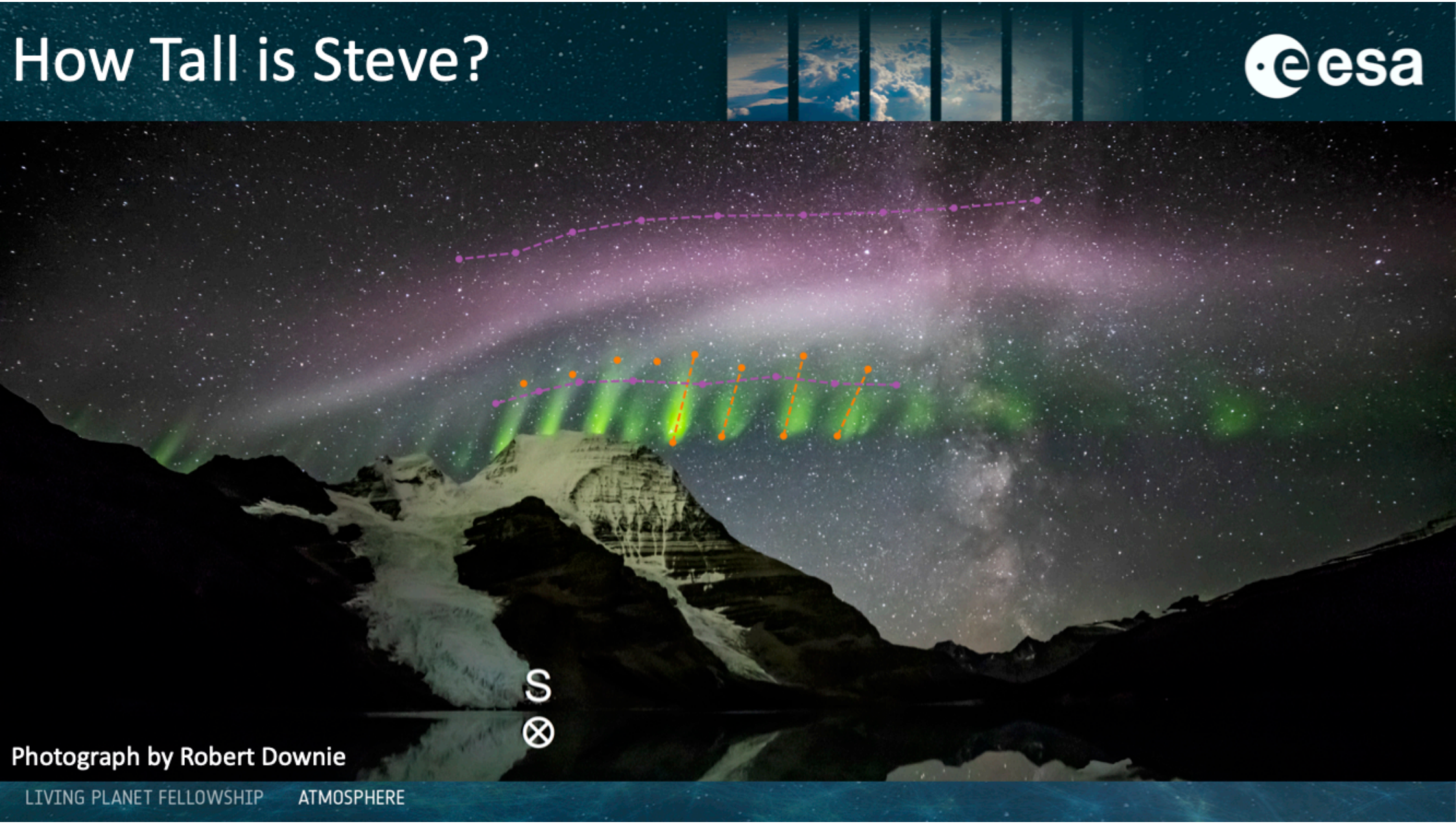


# How Tall is Steve?




- Steve was observed in western Canada 15/09/2017
- Event occurred shortly after substorm onset between 5-6 UT
- Steve and accompanying “picket fence” photographed by dozens of observers
- We used two simultaneous observations to estimate altitude

# How Tall is Steve?



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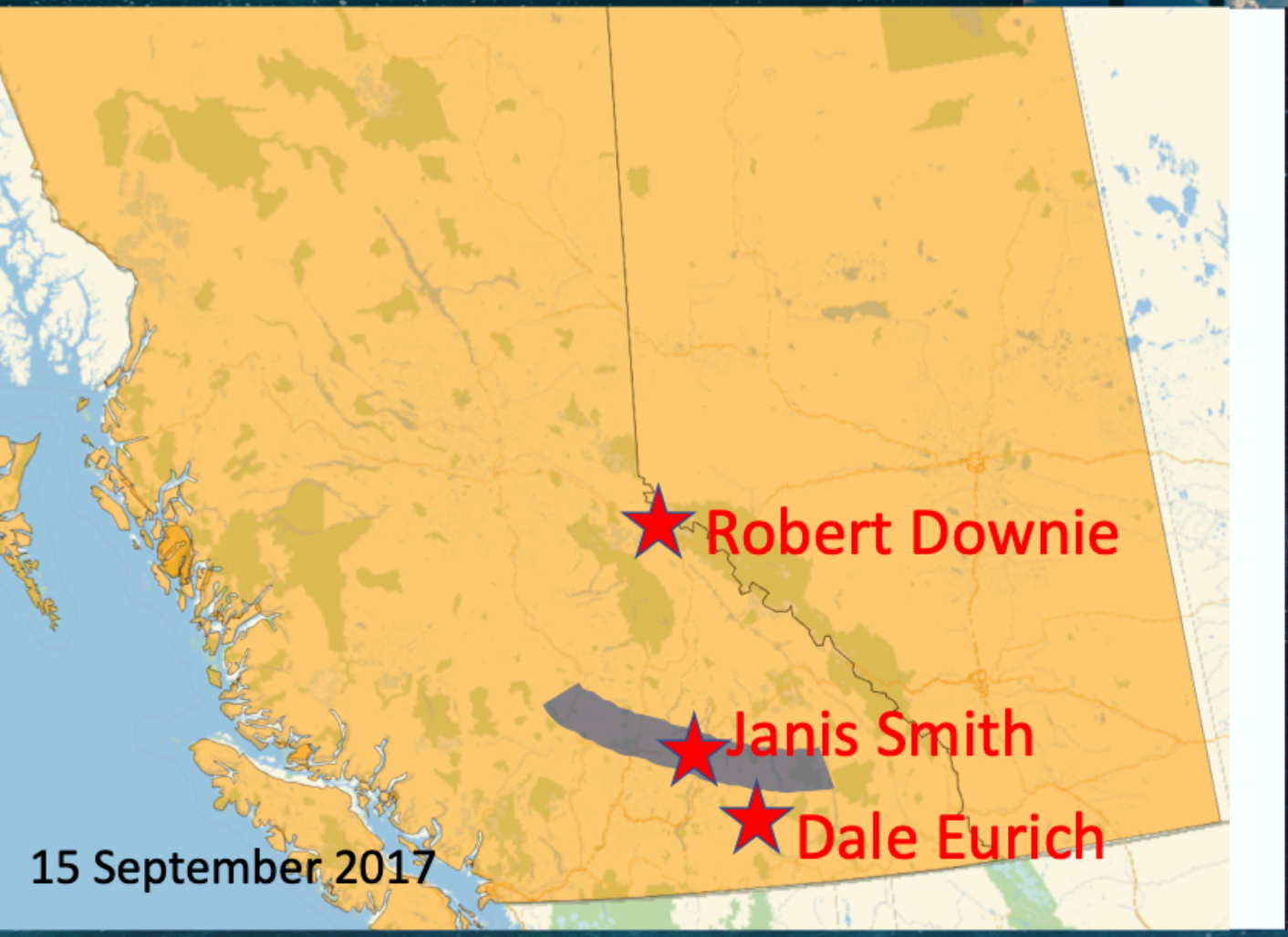


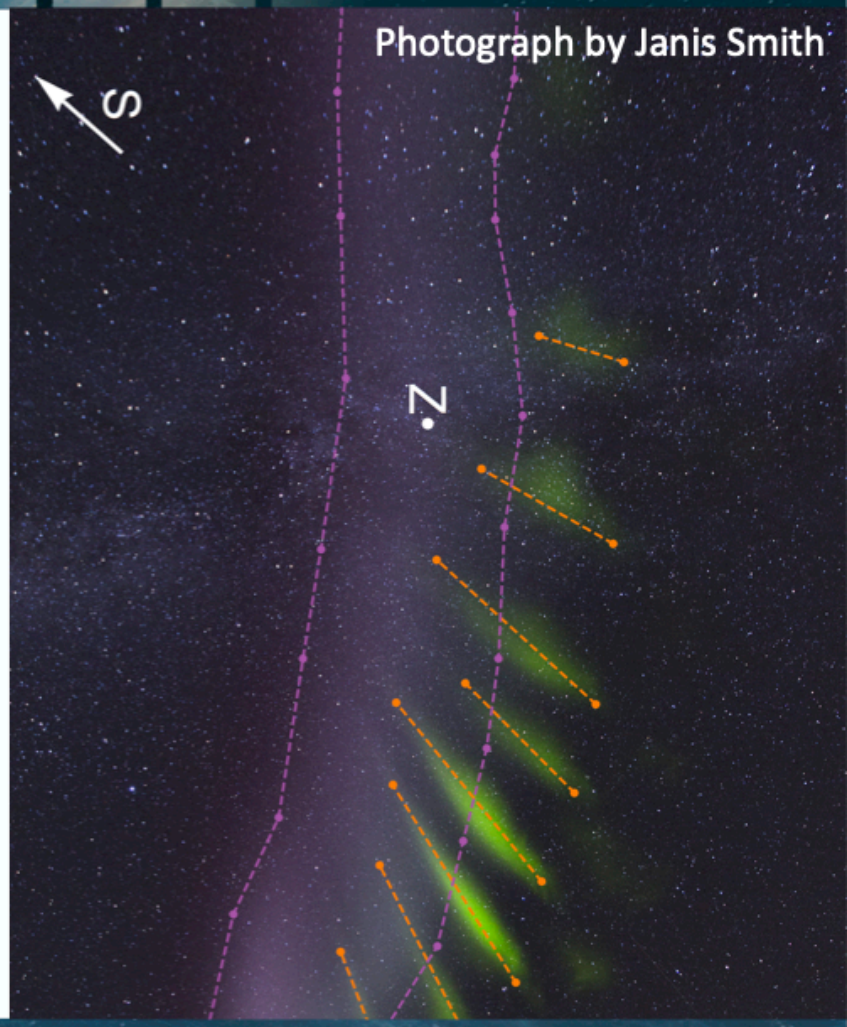

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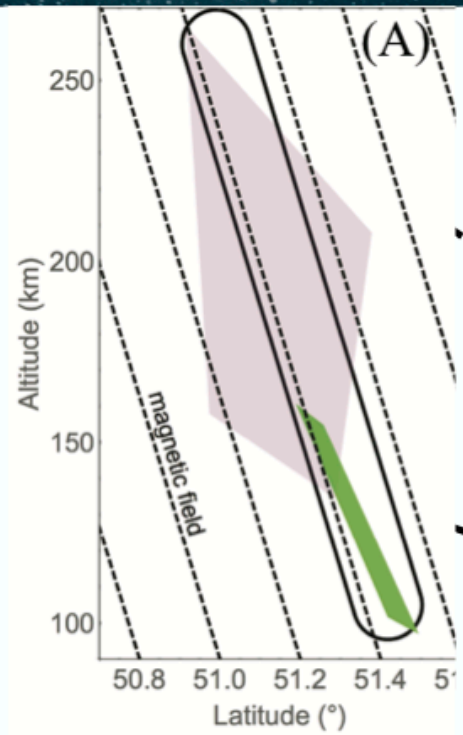
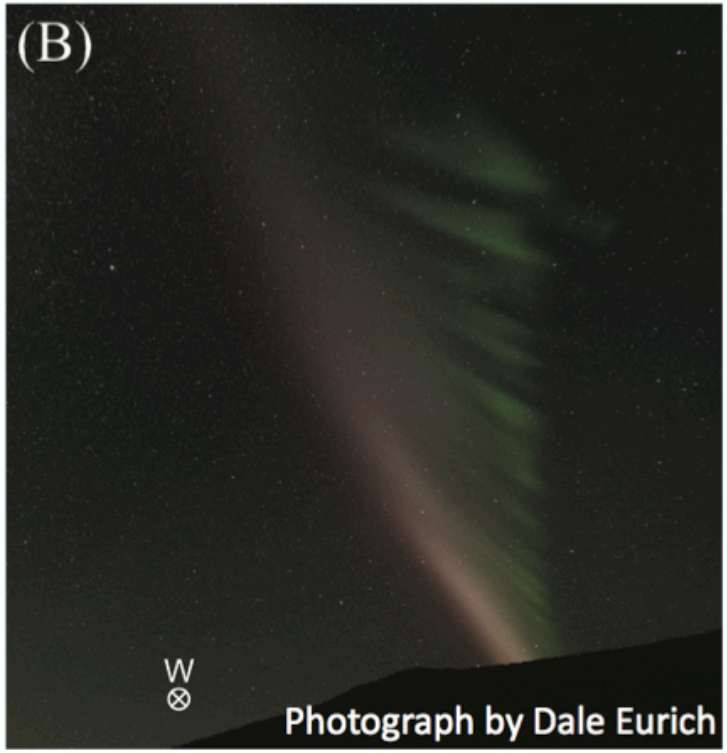



JS

North

RD

# How Tall is Steve?

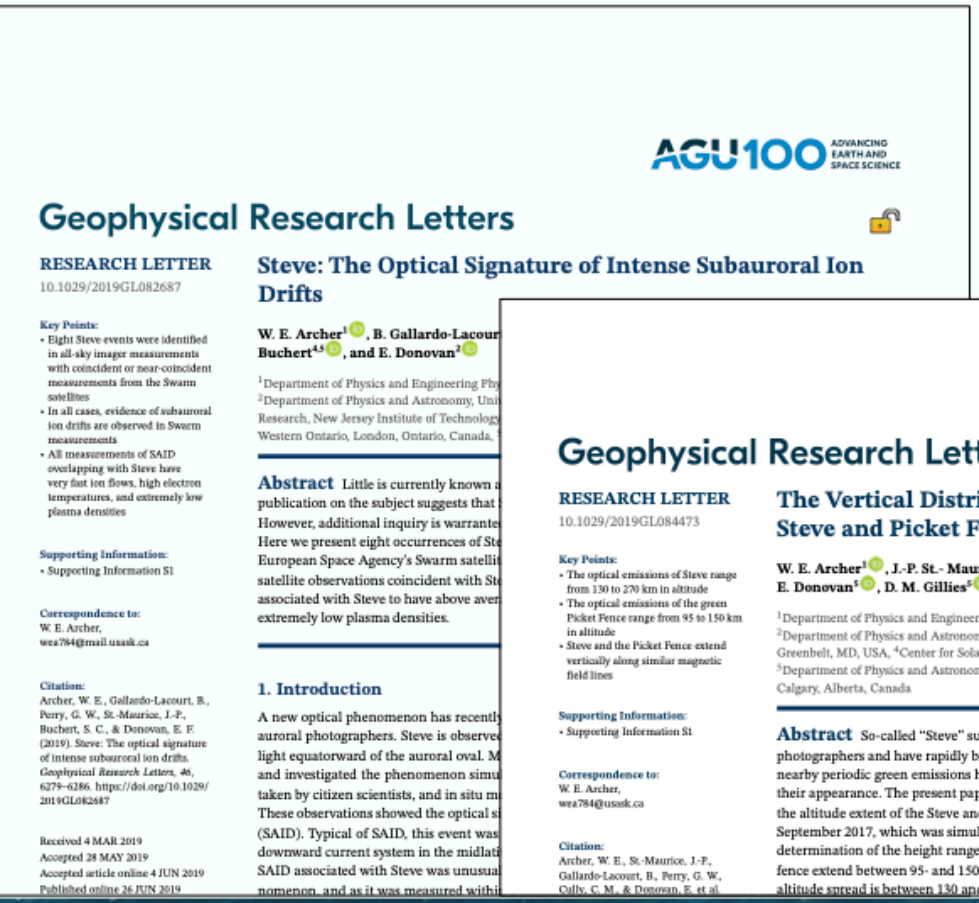
esa

# Plan for Next Year

- Topic 1: The mid-latitude density trough and subauroral ion drifts (SAID)
  - 1.1 “Typical” mid-latitude trough.
  - 1.2 SAID and the trough
    Investigate the relationship between substorms and the trough
  - 1.3 Steve: the optical signature of intense SAID
    Watch for clear research opportunities
- Topic 2: Birkland current boundary flows (BCBF)
  - 2.1 BCBF neutral densities
    Revisit this dataset
  - 2.2 BCBF Hall currents
    Revisit this dataset

# Question?

Thank you for your attention.



AGU100 ADVANCING EARTH AND SPACE SCIENCE

Geophysical Research Letters

RESEARCH LETTER
10.1029/2019GL082687

**Steve: The Optical Signature of Intense Subauroral Ion Drifts**

**Key Points:**
- Eight Steve events were identified in all-sky imager measurements with coincident or near-coincident measurements from the Swarm satellites
- In all cases, evidence of subauroral ion drifts are observed in Swarm measurements
- All measurements of SAID overlapping with Steve have very fast ion flows, high electron temperatures, and extremely low plasma densities

**Supporting Information:**
- Supporting Information S1

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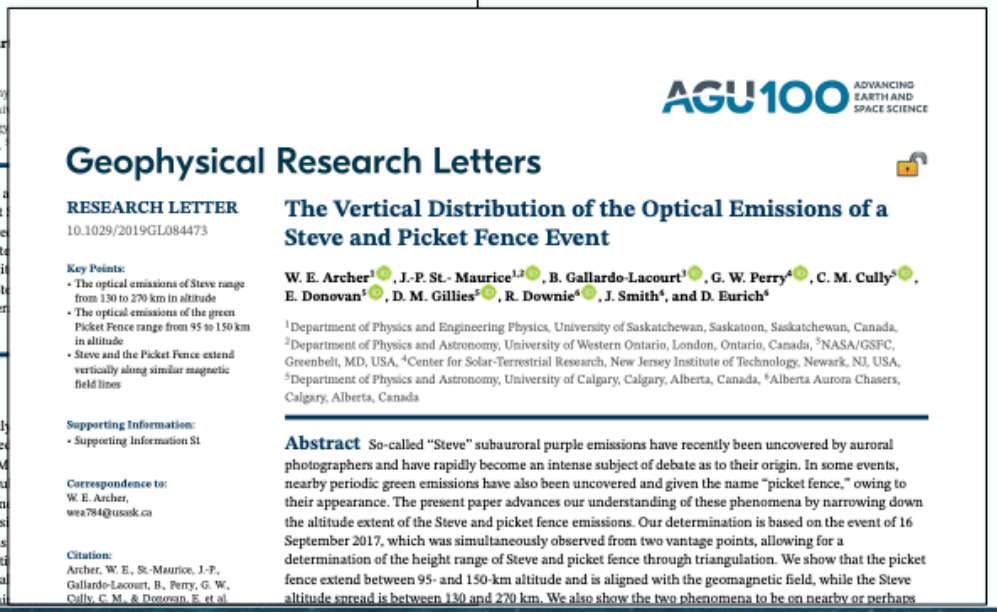
**Abstract** Little is currently known a
publication on the subject suggests that
However, additional inquiry is warrante
Here we present eight occurrences of Ste
European Space Agency's Swarm satelli
satellite observations coincident with St
associated with Steve to have above aver
extremely low plasma densities.

## 1. Introduction

A new optical phenomenon has recently
auroral photographers. Steve is observe
light equatorward of the auroral oval. M
and investigated the phenomenon simu
taken by citizen scientists, and in situ m
These observations showed the optical s
(SAID). Typical of SAID, this event was
downward current system in the midlati
SAID associated with Steve was unusua
nomenon, and as it was measured withi



AGU100 ADVANCING EARTH AND SPACE SCIENCE

Geophysical Research Letters

RESEARCH LETTER
10.1029/2019GL084473

**The Vertical Distribution of the Optical Emissions of a Steve and Picket Fence Event**

**Key Points:**
- The optical emissions of Steve range from 130 to 270 km in altitude
- The optical emissions of the green Picket Fence range from 95 to 150 km in altitude
- Steve and the Picket Fence extend vertically along similar magnetic field lines

**Supporting Information:**
- Supporting Information S1

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**Citation:**
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**Abstract** So-called "Steve" subauroral purple emissions have recently been uncovered by auroral photographers and have rapidly become an intense subject of debate as to their origin. In some events, nearby periodic green emissions have also been uncovered and given the name "picket fence," owing to their appearance. The present paper advances our understanding of these phenomena by narrowing down the altitude extent of the Steve and picket fence emissions. Our determination is based on the event of 16 September 2017, which was simultaneously observed from two vantage points, allowing for a determination of the height range of Steve and picket fence through triangulation. We show that the picket fence extend between 95- and 150-km altitude and is aligned with the geomagnetic field, while the Steve altitude spread is between 130 and 270 km. We also show the two phenomena to be on nearby or perhaps