Knik River Valley near Palmer, Alaska.
Mar. 26, 2018

It's Not Easy Being Green

Leveraging Detailed Spectra and Kinetic Modeling for Deeper Insights into Auroral and Subauroral Phenomena

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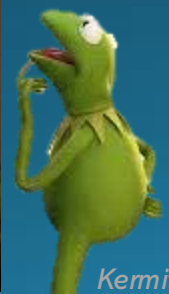

Kermitthefrog instagram

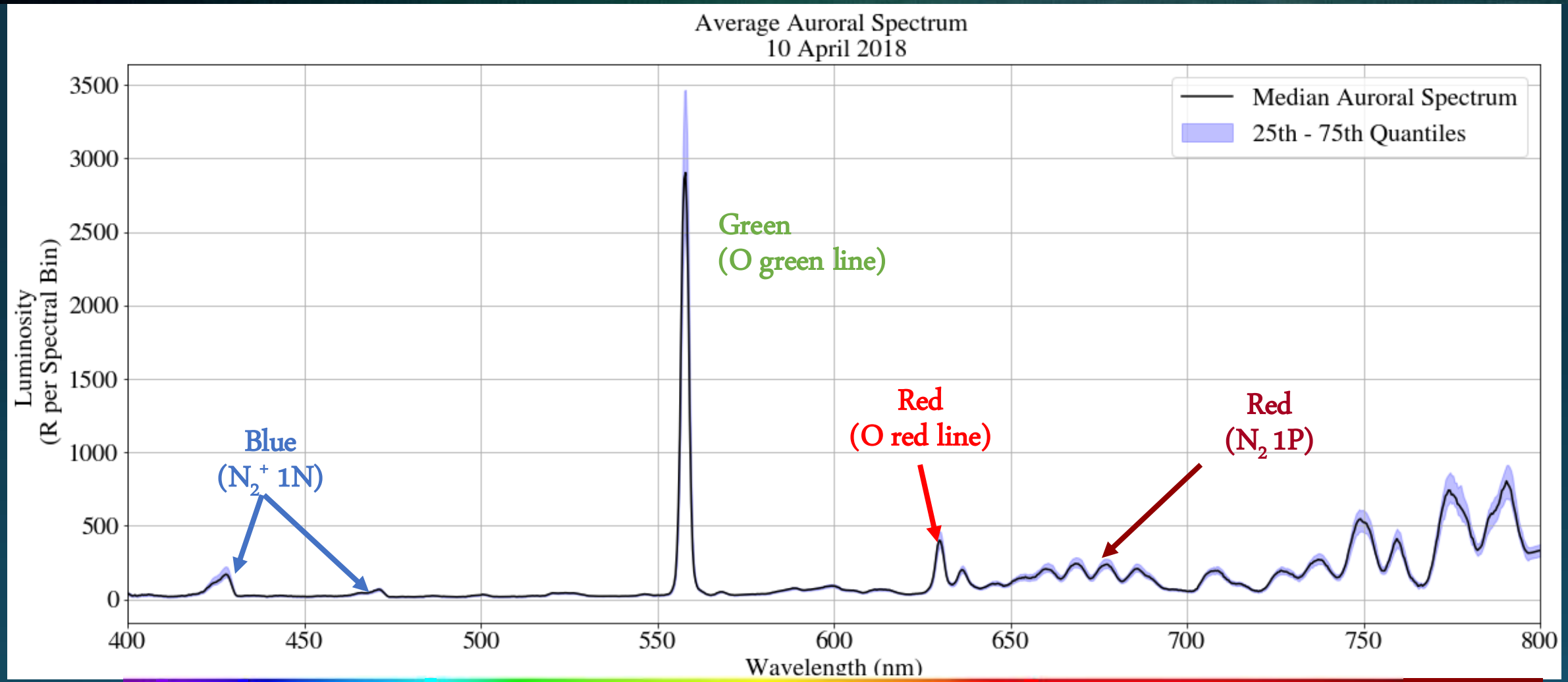
CEDAR Workshop 2024

9 June 2024

Debate: How are Picket Fence Emissions Generated?

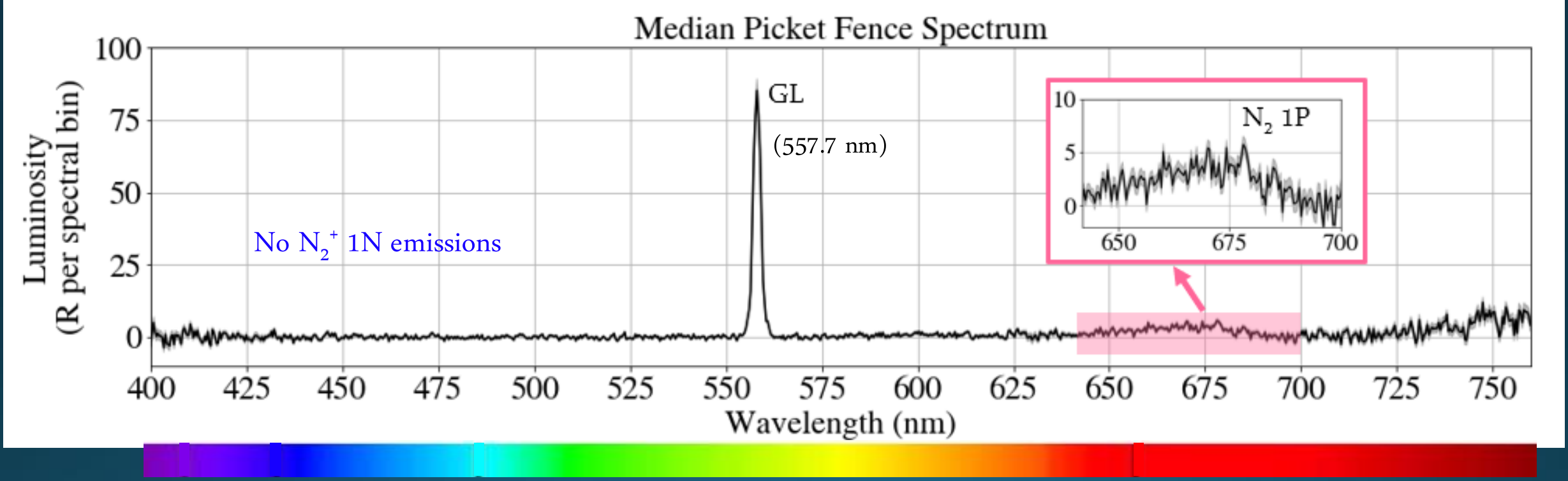
Typical Green Auroral Spectrum

Andrea Klaussner



Debate: How are Picket Fence Emissions Generated?

- Particle precipitation (as in 'regular' green aurora)?



- Probably not – its spectrum is too green (Mende et al., 2019; Gasque et al., 2023). Must be created by an electron population with energies between 7 and 18 eV, which is not consistent with precipitation.

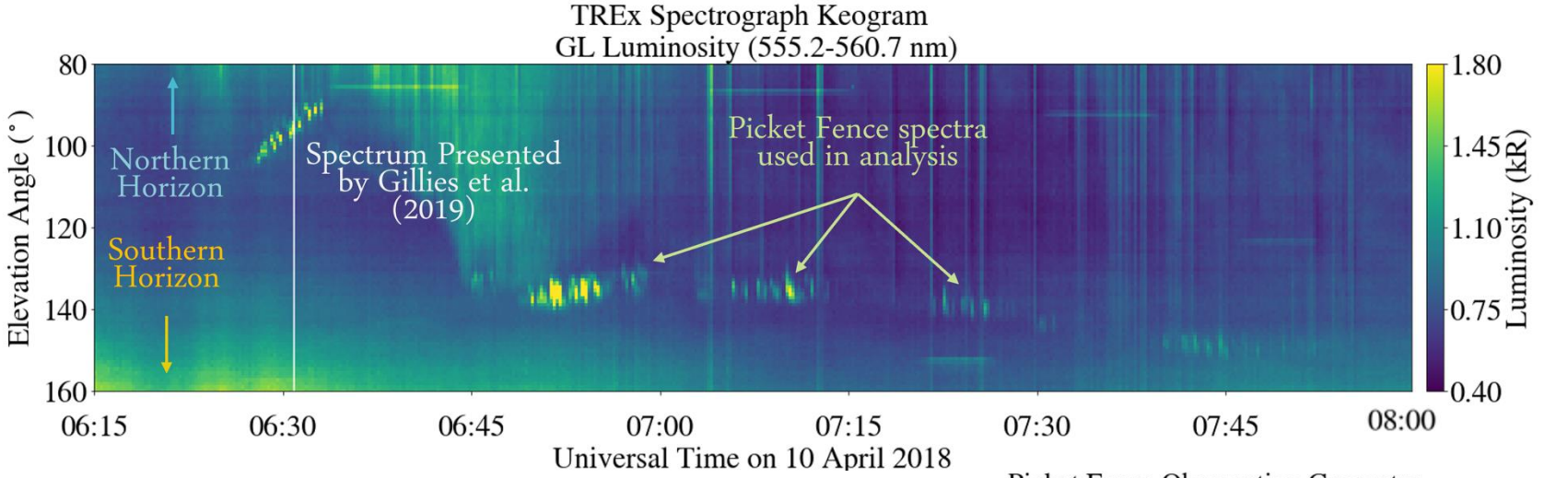
Debate: How are Picket Fence Emissions Generated?

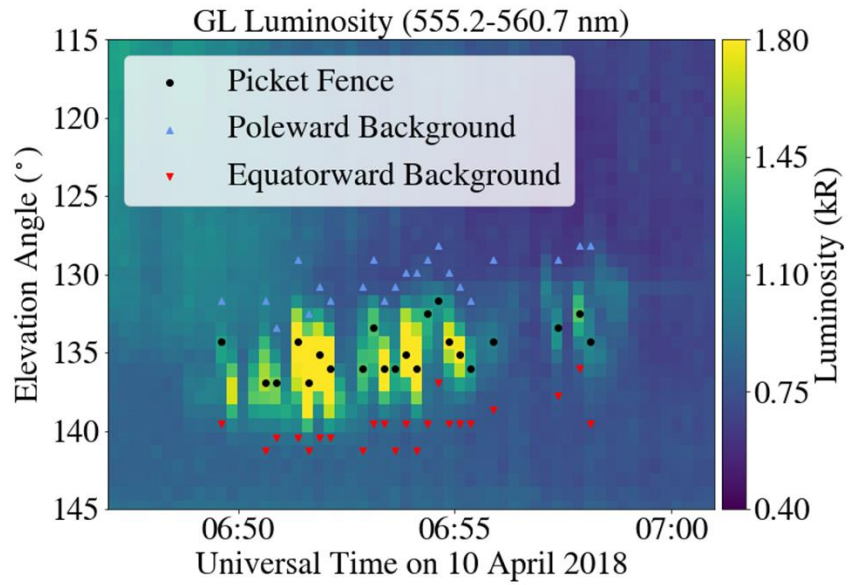
- Particle precipitation (as in 'regular' green aurora)?
  - Probably not – its spectrum is too green (Mende et al., 2019; Gasque et al., 2023). Must be created by an electron population with energies between 7 and 18 eV, not consistent with precipitation.

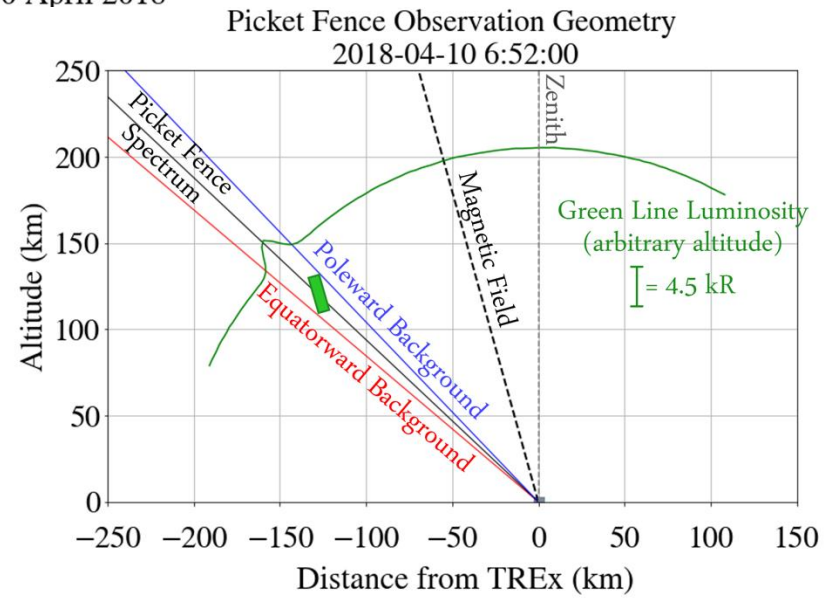
- In-situ electron energization?
  - Possibly! Recent theories (Lynch et al., 2022; Mishin & Streltsov, 2022) propose that picket fence emissions arise when low-altitude electric fields parallel to Earth's magnetic field energize local electrons.

Can parallel electric fields energize local thermal electrons and drive picket fence emissions?

Observations: The TREx Spectrograph



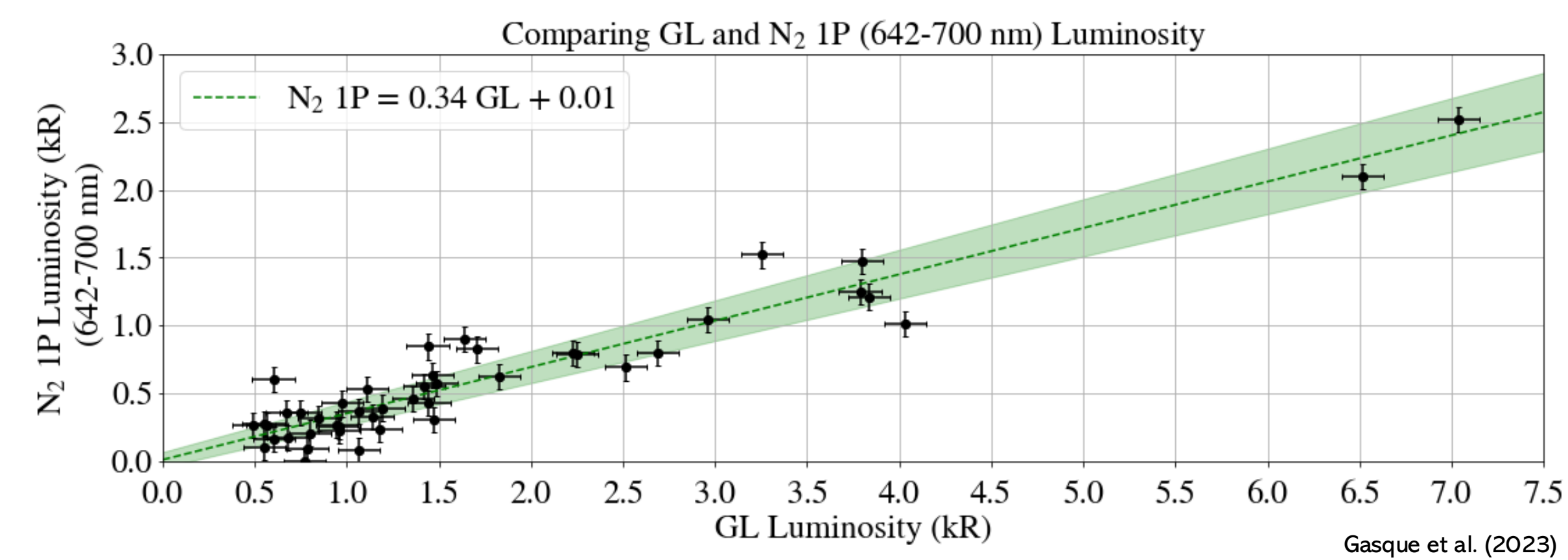




We used spectral observations of the picket fence taken ~40 degrees above the horizon. We'll use these observations in conjunction with modeling to try to test whether parallel electric fields might drive these emissions.

Gasque et al. (2023)

Observations: The TREx Spectrograph



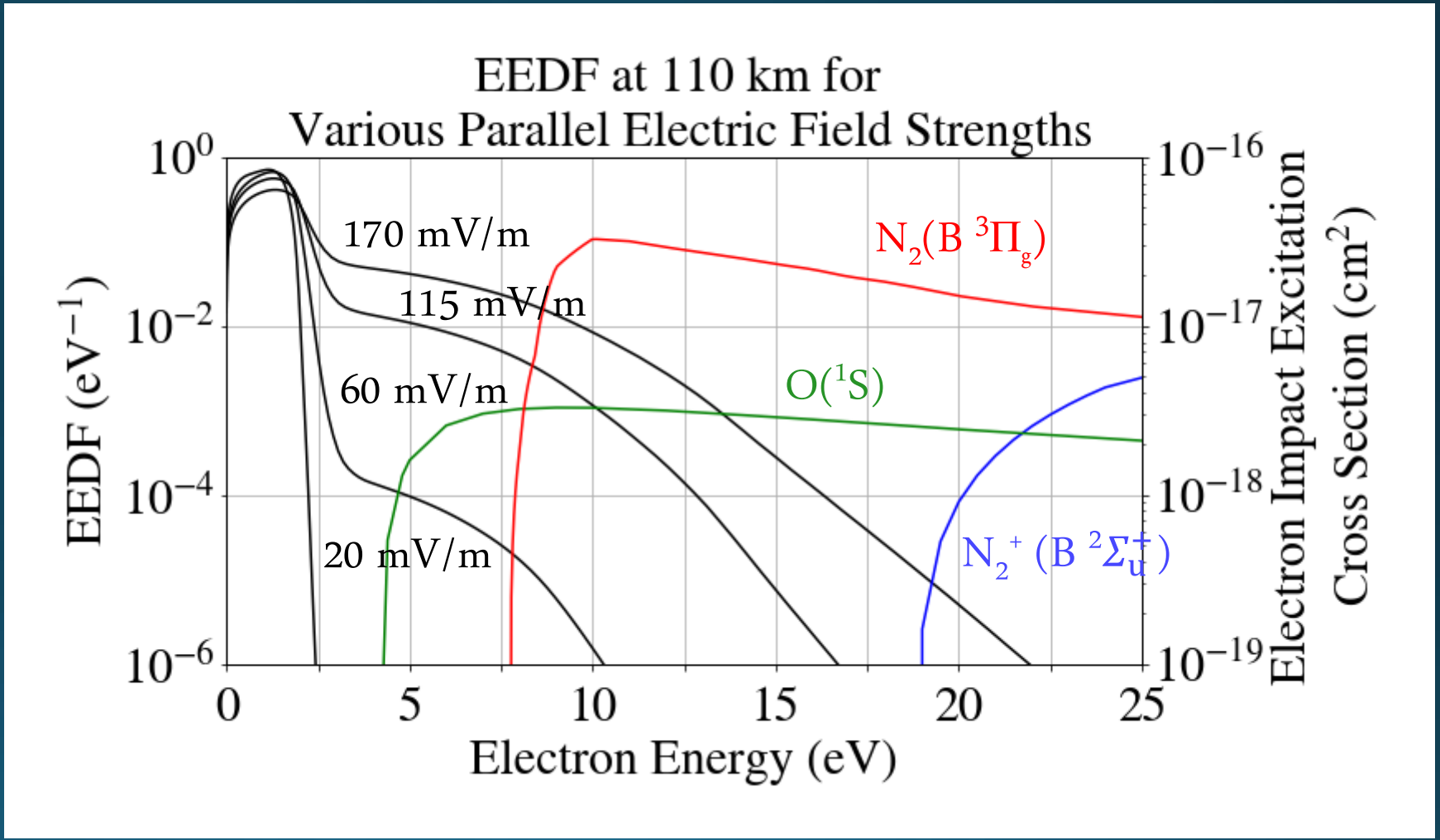
Gasque et al. (2023)

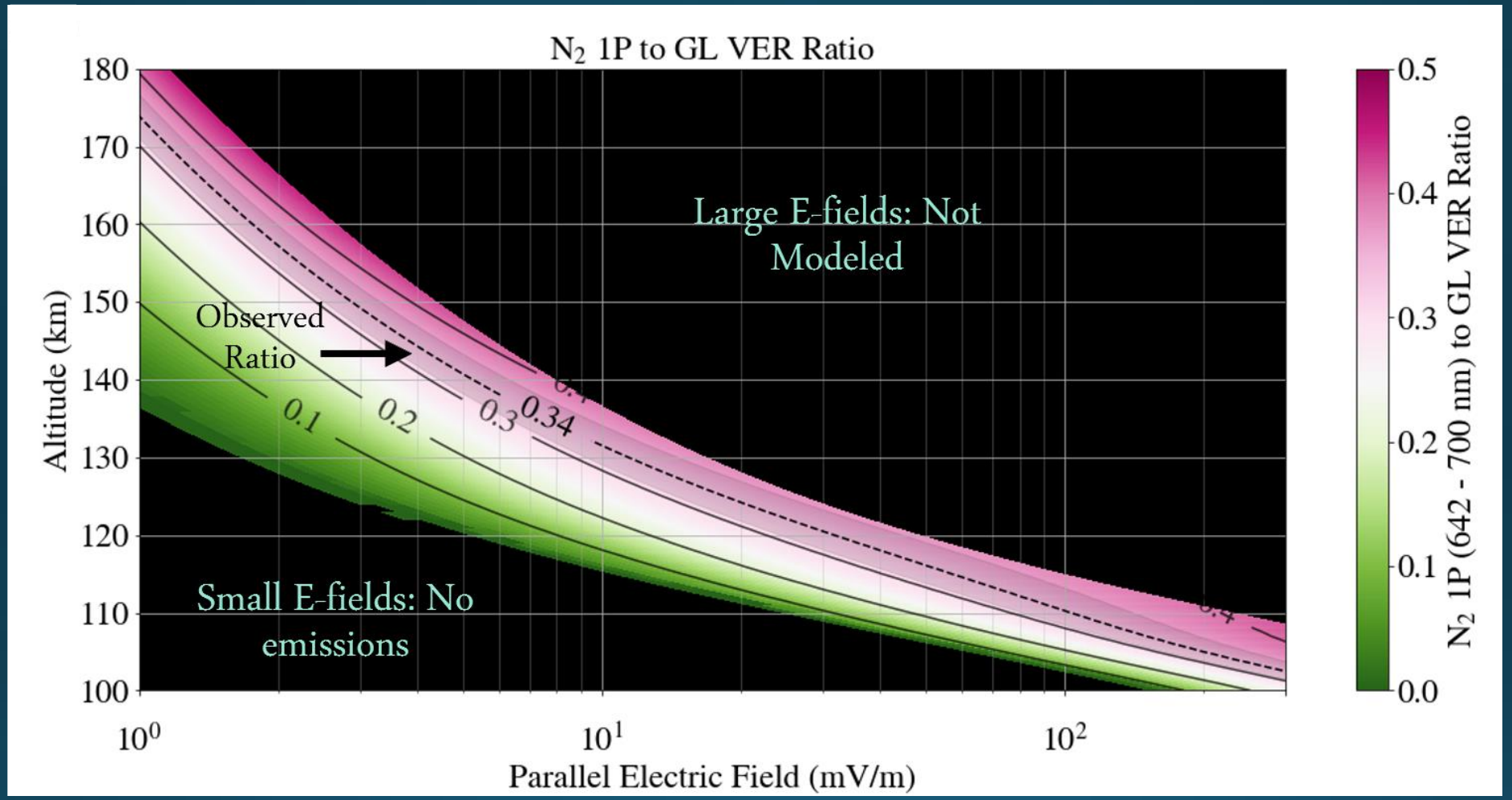
Can a model driven by parallel electric fields replicate the observed ratio between GL and N_2 1P while also NOT producing N_2^+ 1N emissions?

Kinetic Modeling

Gasque et al. (2023)

Increasing the applied parallel electric field strength stretches the tail of the electron energy distribution function to higher energies





Gasque et al. (2023)

Results: The specific emission ratio observed in the picket fence can be produced by ~80–150 mV/m parallel electric fields at 110 km

…so the parallel electric fields hypothesis is viable…

Other Picket Fence-like Emissions

- Fragmented Aurora-like Emissions (Dreyer et al., 2021)

Dreyer et al. (2021)

Other Picket Fence-like Emissions

- Fragmented Aurora-like Emissions (Dreyer et al., 2021)

- Enhanced Aurora (Hallinen et al., 1985)
  - Modeling (Karlsson et al., 2005) suggests these could be generated by parallel electric fields in the downward current region.
  - May occur as often as 50% of the time that the aurora is visible

"Regular" Aurora

Enhanced Aurora

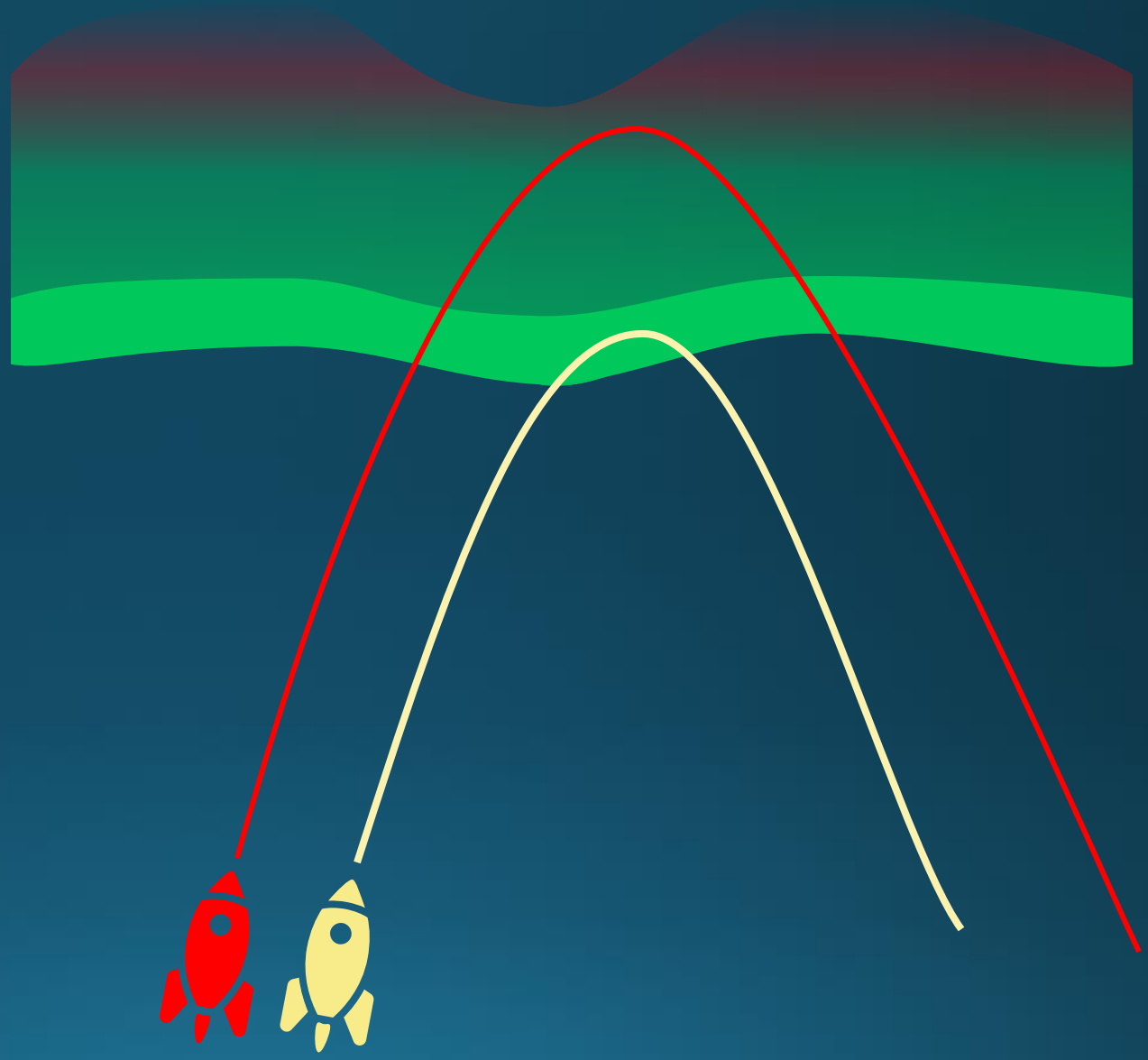
Credit: Vincent Ledvina, theauroraguy.com

Ongoing Work

- Recently awarded Living with a Star (LWS) Focused Science Topic (FST) funding to study conductivity variations associated with STEVE, the picket fence, and other subauroral phenomena, which will fund, among other things, efforts to determine the relationship between STEVE and the picket fence

- This summer, an REU student (AJ Juarez) will be working on a statistical study of enhanced aurora in TREx data.

- We recently proposed a rocket to attempt to measure parallel electric fields within optical phenomena for the first time.



Origins: CEDAR 2022

Summary: It's Not Easy Being Green

- Observations of picket fence spectra differ quantitatively from green aurora spectral observations, suggesting different origins.
- Kinetic modeling driven by local parallel electric fields replicates picket fence spectra without requiring particle precipitation.
- At 110 km, parallel electric fields between 40 and 70 Townsend (~80 to 150 mV/m at 110 km) reproduce observed picket fence spectra.
- Certain auroral features may also be produced locally by a parallel electric field – we've submitted a rocket proposal to attempt to measure these fields.

Want more information? Check out the paper!

Thank you for your attention!
Any questions?

Email me:
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