2026 Workshop: What are the polar cap patches?

Long title
Redefining Polar Cap Patches: Understanding High-Latitude Irregularities, and their implications for the coupled MIT system
Grand Challenge
Conveners
Leslie Lamarche
Gareth Perry
Lindsay Goodwin
Shasha Zou
Toshi Nishimura
Angeline Burrell
Asti Bhatt
Katrina Bossert
Matt Zettergren
Alanah Cardenas-O’Toole
Bimal Dahal
leslie.lamarche@sri.com
Description

Polar cap patches have long been discussed as F-region plasma density enhancements at least twice the background density, typically ~100-1000 km across. However, debate persists on whether this definition is accurate, helpful, or if "patches" encompass multiple phenomena, given that soft precipitation, Traveling Ionospheric Disturbances (TIDs), and Tongues of Ionization (TOIs) can also produce localized plasma density enhancements. Observational biases further complicate classification. It is therefore argued that in modern high-latitude research this definition is more confusing rather than clarifying. This grand challenge seeks to evaluates “patches” from modeling, theory, and observational perspectives, by bringing together experts not only in polar cap structuring, but also waves and other high-latitude phenomena to see evidence of similarities and differences in different identified structuring in the polar cap and come to some consensus about whether or not present categorization makes physical sense, or if it should be reconsidered. These are now achievable with the availability of the long-term observations in the

polar cap, and the recent advances in numerical simulations such as MAGE, GITM and GEMINI. This grand challenge will feature talks providing background and an extended discussion period, with a focus on keeping the session structured. We encourage submissions contributing to this debate and especially welcome participation from students and early-career researchers, as evolving definitions will shape future studies of the polar cap.

This year's session will focus on the themes of Patch/Polar TID Generation and Dynamics front the Thermospheric Perspective and Small-Scale Irregularities and Plasma Instability Physics Associated with Patches.

Justification

Patches are an important phenomenon for understanding plasma transport, ion-neutral coupling, and currents in the polar region. The high-density plasma is a source of ion upflow/outflow, and manifests as a tracer of multi-scale flow structures. Patches also have Space Weather impacts particularly regarding radio communication and navigation, since the high density plasma and associated irregularities alter HF wave propagation and cause scintillation. The origin of the polar cap patches is one of the objectives of the Priority Science Goal 3 in the 2024 Decadal Survey. The driver of ion outflows is one of the objectives of the Priority Science Goal 2. The HF signal propagation is recognized as one of the Space Weather impacts.

Related to CEDAR Science Thrusts:
Encourage and undertake a systems perspective of geospace
Explore exchange processes at boundaries and transitions in geospace
Explore processes related to geospace evolution
Workshop format
Short Presentations
Keywords
polar cap, patch, TID
View PDF