2022 Workshop: Auroral system science

Long title
Auroral system science enabled by heterogeneous distributed data and model fusion
Conveners
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Meghan Burleigh, NRL
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Description

This workshop combines both data and modeling studies of auroral physics. Its particular focus is the ionospheric responses contributing to system-science characterizations of the coupled magnetosphere-ionosphere (MI). We emphasize development of new tools for incorporating data from distributed, heterogeneous, multiple sources, and the incorporation of these into state-of-the art models and data assimilation approaches. Specific topics of interest include (but are not limited to):
- Mapped reconstructions of distributed field-aligned current (FAC) and flow fields, e.g. from distributed magnetometry and field measurements
- Mapped reconstructions of auroral precipitation input from imager arrays and TEC arrays
- 3D and time-dependent modeling, and associated visualization, of non-idealized auroral arc structures through physics-based and data-driven models
- Machine learning studies using available databases to explore relationships between ionospheric flow maps, FAC patterns, and conductance patterns
- Use of various mathematical descriptions of Maxwell’s equations for inverting measurements, e.g. current continuity and the Poynting theorem
- Reconstructions of ionospheric energy inputs using multiple, distributed, and heterogeneous measurements including simultaneous use of in situ and remote sensing techniques
- Reconstructions of electron density using multiple TEC measurements
- Multiscale simulations encapsulating small- and regional- scales in global models
- OSSE and nested-OSSE tools for exploring experiment design of heterogeneous observational platforms for distributed system science studies

In addition to these topics, the workshop welcomes presentations on general topics combining data from arrays of high-latitude sensors, modeling auroras and their effects, and data inversions as applied to MI coupling problems.

Agenda

For this Cedar session workshop, *Auroral System Science Enabled by Heterogeneous Distributed Data and Model Fusion* (Friday 24 June, 10-12), we plan two sessions of shared presentations followed by mediated discussion. The topics in the session description can be ordered along many topic axes. For the first hour, we will have a 30-minute shared presentation focussing on flows and currents, followed by a panel discussion. For the second hour, we will have a 30-minute shared presentation focussing on density and energy, again followed by panel discussion. There will be a short break between the two sessions.

We are considering some sort of associated-to-this-session sticker to put on associated posters for identification during the poster session. Please let us know if your poster has bearing on this session, and join our session Friday morning for the panel discussions. We look forward to interesting conversations with an intent to seed new collaborations and projects in this area.

Agenda:

For the first hour (10-11 am), we will have a 30-minute shared presentation **focussing on flows and currents**, followed by a panel discussion:

Presentations:

Spencer Hatch, UIB - Local mapping of polar ionospheric electrodynamics (Lompe)

Alex Mule, Dartmouth - Swarm-ThemisGBO conjunction database and auroral arc featurization

Toshi Nishimura, BU, given by Larry Lyons, UCLA - Observation of multi-scale convection and aurora

Meghan Burleigh, NRL - Using the right model for the science: a nested OSSE approach

Jules van Irsel, Dartmouth - 2 threads for 3D auroral modelling: how to drive it and how to look at it

Panel discussion topic prompts: (leads K Lynch, Dartmouth / M Zettergren, ERAU)
–what are “matching” patterns of J/E/sigma
–the eternal question of uncertainty in model estimates
–auroral feature recognition
–listing of upcoming potential collaborations and projects

For the second hour (11-12 noon), we will have a 30-minute shared presentation **focussing on density and energy**, again followed by panel discussion.

Don Hampton, UAG/GI - Mapped aggregate auroral imagery and GBO arrays

Anthea Coster, MIT - Distributed arrays of TEC arrays

Romina Nikoukar, APL - Next-generation of beacons for ionosphere studies

Seebany Datta-Barua, IIT - Automating cloud detection and instrument conjunctions

Kike Rojas Villalba, Cornell - Farley Buneman and multiscale modelling

Yue Deng, UTA - multiscale modeling / Joule heating

Panel discussion topic prompts: (leads M Zettergren, ERAU / K Lynch, Dartmouth)
–poynting bookkeeping;
–GBO development;
–listing of upcoming potential collaborations and projects

Justification

This workshop session consolidates, presents, and shares scientific developments created during the Auroral Reconstruction CubeSwarm (ARCS) NASA MIDEX Concept Study Report (CSR) which was completed in winter of 2022; the workshop aims to connect and adapt these and similar approaches with other community efforts. The systems science tools developed in this ARCS study, and the auroral examples and science questions explored therein, have substantial synergy with other projects; they illustrate many of the systems science questions highlighted in recent CEDAR community documents, in the context of auroral ionospheric physics.
We choose “panel discussion” in the pulldown menu of format options, but

importantly plan to include short presentations as well, combining input from both ARCS-team and non-ARCS-team scientists.

Related to CEDAR Science Thrusts:
Encourage and undertake a systems perspective of geospace
Develop observational and instrumentation strategies for geospace system studies
Workshop format
Panel Discussion
Keywords
auroral ionosphere, MI coupling, system science, modeling
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