2014 Workshop: Data Assimilation and Inverse Problems

Long title
Data Assimilation and Inverse Problems for High-Latitude Electrodynamics
Conveners
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Description

To address system-level CEDAR science questions, we need an effective approach to combining observations obtained from various ground-based sensors (ISR, SuperDARN, magnetometers, imagers, FPIs, and more) as well as space-based sensors (drift meters, magnetometers, particle analyzers, imagers, and more). The objective of this workshop is to identify the challenges of data assimilation and inverse problems for high-latitude electrodynamics and to discuss potential solutions. Short presentations will be followed by a roundtable discussion. Some of the issues addressed will include:

- How to proceed towards obtaining self-consistent patterns of field-aligned currents, ionospheric conductivity, electric fields, Pedersen and Hall currents, and neutral winds.

- How to integrate global and local perspectives by effectively fusing observations sampled at different spatial and temporal scales.

- How to incorporate wind dynamo and ionospheric conductivity within a self-consistent inversion for all relevant parameters.

- What are appropriate regularization techniques for inverse problems of high-latitude electrodynamics.

- How to estimate and account for uncertainties and biases in different observation types and in a model, and how to validate inversion results without knowledge of the ground truth.

Agenda

Introduction (pdf) by Tomoko Matsuo (CU/NOAA)

AMPERE (pdf) by Brian Anderson (APL)

Mapping ionospheric electrodynamics with AMPERE and SuperDARN data (pdf) by Ellen Cousins (NCAR)

Improving space-based data for data assimilation (pdf) by Delores Knipp (CU)

Adaptive technique for high-latitude conductivity covariance refinement (pdf)by Ryan Mcgranaghan (CU)

Reconciling surface measurements with ionospheric measurements (pdf)by Russel Cosgrove (SRI)

Tomography of auroral features by Michael Hirsch (BU)

Mahali: Space Weather Monitoring Everywhere (pdf) by Josh Semeter (BU)

Importance of winds on high-latitude electrodynamics (pdf) by Arthur Richmond (NCAR)

Justification

This workshop is aligned with CEDAR New Dimension Strategic Thrust #6: Manage, Mine, and Manipulate Geoscience Data and Models. The methodology discussed will facilitate addressing system-level CEDAR science questions regarding Magnetosphere-Ionosphere-Thermosphere coupling, especially as pertaining to electrodynamics at high-latitudes.

Summary

The CEDAR workshop on Data Assimilation and Inverse Problems for High-Latitude Electrodynamics was held in the Kane-210 room on the University of Washington campus from 10:00 through 12:00 on Thursday, 26 June 2014. The agenda included an introduction followed by eight short presentations (two by graduate students, listed below) and an open discussion. There were about 50 participants, who actively contributed to the discussion. Our hope is to continue our discussion and to foster future collaboration among the community members targeting outstanding issues raised during the workshop, some of which are listed below.

- Examining the validity of the electrostatic electric field assumption and determining its appropriate timescale.

- Taking advantage of technology advances and crowd-sourcing.

- Assessing the scientific benefit of many noisy inaccurate observations vs. fewer clean accurate observations.

- Quantifying the optimal configuration of sensors.

- Integrating global and local perspectives by effectively fusing observations sampled at different spatial and temporal scales.

- Determining the impact of small-scale features on a global picture.

- Assessing the impact of new estimation techniques on global models.

- Proceeding towards obtaining self-consistent patterns of field-aligned currents, ionospheric conductivity, electric fields, Pedersen and Hall currents, and neutral winds.

- Incorporating wind dynamo and ionospheric conductivity within a self-consistent inversion for all relevant parameters.

- Accounting for effects of neutral winds on the electrodynamics. Examining whether or not the flywheel effect can be seen in observations.

- Estimating the 3-D conductivity distribution to understand the 3D current closure, and the relationship between local and global current systems.

- Examining appropriate regularization techniques for inverse problems of high-latitude electrodynamics.

- Selecting appropriate basis functions (global vs. local) for a given problem.

- Estimating and accounting for uncertainties and biases in different observation types. Separating instrumental effects from geophysical effects.

- Validating inversion results without knowledge of the ground truth.

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