Enabling system science: Ionospheric conductivity

**Assimilative approach**
Bring diverse data together
Estimate of uncertainty
Particularly effective in addressing modeling shortcomings

![Image of 2D and 3D diagrams showing ionospheric conductivity](image-url)
Conductivity critical to high-latitude geospace system

Background - Modeling Improvements - Future/Discussion

Electromagnetics governed by conductivity

\[ \mathbf{J} = \tilde{\sigma} \cdot \mathbf{E} \]
Where is conductivity modeling currently?

Background - Modeling Improvements - Future/Discussion
1. Difficulty specifying auroral component

Maxwellian energy particle precipitation assumption

and

Robinson formulas (Robinson et al., [1987])

\[
\Sigma_p = \frac{40E}{16 + E^2} \Phi_E^{1/2}
\]

\[
\frac{\Sigma_H}{\Sigma_p} = 0.45(E)^{0.85}
\]
1. Difficulty specifying auroral component

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2. Height-integrated

\[ J = \tilde{\sigma} \cdot E \]

\[ \int_h \sigma dh = \Sigma \]
Application of modeling improvement:

1. Studying local features in global analyses;
2. Facilitating closer agreement between diverse observations; and
3. Connecting these results to the broader picture: Significance to NEROC community
Optimal Interpolation (OI) technique: 3 Steps

1. Characterize the variability

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2. Accumulate observations

Optimal Interpolation (OI) technique: 3 Steps

1. Characterize the variability

2. Accumulate observations

3. Optimal interpolation

How can we quantitatively test the conductance models?
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~800 km

Ionosphere

SuperDARN radar

Field-aligned currents

AMPERE

\[ \text{O}_2^+, \text{N}_2^+, \text{O}^+ \]
\[ \Delta B = A_{\text{mean}} + H_A \alpha_A \]

Magnetic Potential

\[ A = \sum \text{SuperDARN} \]

AMPERE to predict SuperDARN


\[ A = A^{(mean)} + H_A \alpha_A \]

\[ \text{Magnetic Potential} \]

\[ \Sigma \]

\[ \text{SuperDARN} \]

\[ \Delta B \]

\[ \text{Local Obs.} \]

\[ \text{Global} \]

Conductances from *Cousins et al. [2015]*

Empirical + Robinson = C2015

Conductances from OI output M2016
Background - Modeling Improvements - Future/Discussion
Median Absolute Deviations (MADs)

Total $\Delta B \rightarrow V$ MADs [m/s]

- C2015: 684.2
- M2016: 382.7

AE [nT]

November 30, 2011

Solar Wind

CF

$\Delta B \rightarrow V$ [m/s]
Median Absolute Deviations (MADs)

Background - Modeling Improvements - Future/Discussion

Solar Wind CF

ΔB → V
[m/s]

ΔB → V

November 30, 2011

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- C2015: 684.2
- M2016: 382.7
- M2016+SSUSI: 359.1

AE [nT]

-- M2016
-- C2015

11/4/16

McGranaghan - NEROC Symposium
Median Absolute Deviations (MADs)

Background - Modeling Improvements - Future/Discussion

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ΔB → V

[m/s]

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Reconciling observations

AE [nT]

Solar Wind

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ΔB → V

[AE]

November 30, 2011

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Reconciling observations
Application of modeling improvement:

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Data assimilation at intersection of data and modeling (current understanding)

This community uniquely positioned to take advantage

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Data assimilation:
- Utilize diverse observational system
- Perform system science
- Conduct multi-scale analyses

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