CEDAR Grand Challenge Session: Multi-scale I-T System Dynamics

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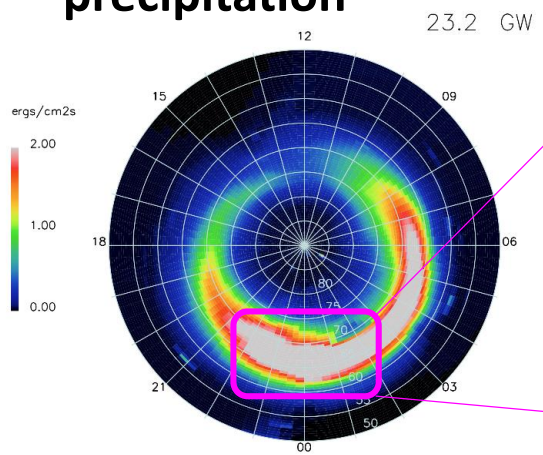
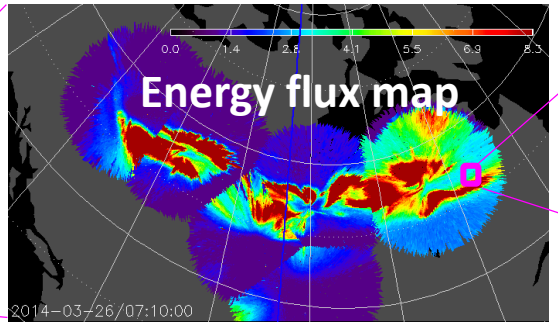
Importance of multi-scale I-T processes

Global (~1000 km) precipitation

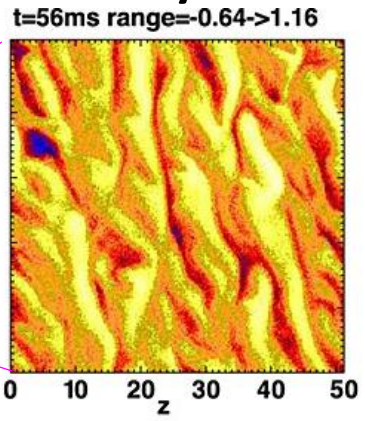


[Newell et al., 2014]

Mesoscale (~100 km) precipitation



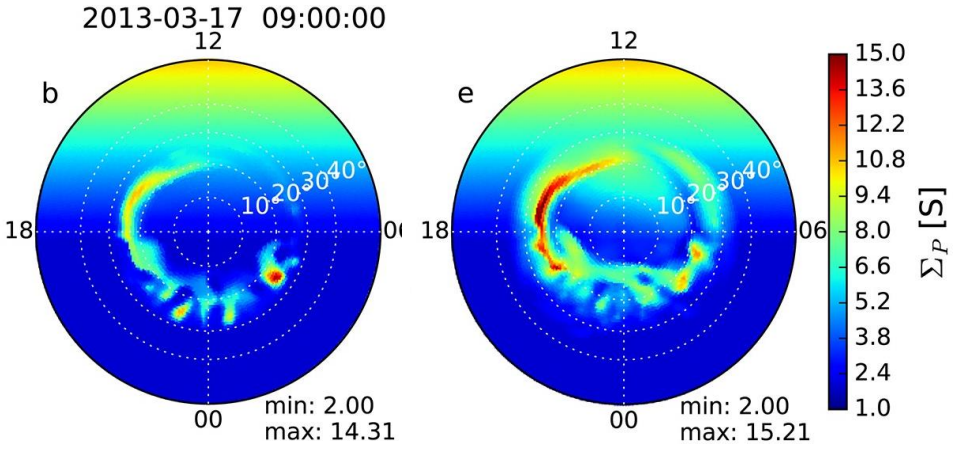
Smallscale (<~10 km) density



[Oppenheim and Dimant, 2013]

MHD conductance

MHD + turbulence conductance



[Wiltberger et al., 2017]

Inclusion of small-scale ionosphere instability substantially increases the conductance and impact on storm development.

Grand Challenge Questions

1. How much can we improve physics understanding and reproducibility of multi-scale coupling processes?

2. What are quantitative properties of meso/small-scale structures in the I-T system? How are they driven by the magnetosphere and atmosphere?

3. What are the roles of meso/small-scale I-T structures and dynamics? How much do they impact on the global state?

4. What are the roles of energy cascading processes in creating increased conductance and the effect of this increase on structures, Joule heating and momentum forcing at global scales?

5. What are the roles of small-scale gravity waves in momentum and energy forcing in the lower and how this drives ionospheric structuring?

2018 Workshop Schedule

Session 1 Monday 13:30-15:30 Discussion on multi-scale M-I-T processes

- **Aaron Ridley and Toshi Nishimura** Introduction to the theme/problem
- **Kristina Lynch** Scene-setting talk: Multiscale M-I processes
- **Erdal Yigit** Scene-setting talk: Multiscale I-T processes
- **Open discussion on Grand Challenge questions**

Session 2 Tuesday 10:00-12:00 Meso-scale processes

- **Brent Parham, Eric Donovan, Shasha Zou, Evgeny Mishin, Bea Gallardo-Lacourt, Kshitija Deshpande** Contributed talks

Session 3 Wednesday 10:00-12:00 Small-scale processes

- **Katrina Bossert, Hanli Liu, Don Hampton, Yue Deng** Data and modeling aspects of small-scale forcing from above and below
- **Tomoko Matsuo Meers Oppenheim, Matt Zettergren, Aaron Ridley, Vania Jordanova** Panel discussion

Year 1

What recent results and resources are available to address the GC questions?

What are hurdles that are stopping us from making progress?

What problems can we realistically push forward over the next 3 years?

Can we identify ways to characterize/parameterize multi-scale driving, and drive meso/small-scale models with global-scale models?

Can we identify collaboration opportunities to conduct research for year-2 and 3?

Session 1. Discussion on Grand Challenge questions (Mon 13:30-15:30)
Session 2. Meso-scale driving (Tue 10:00-12:00)
Session 3. Small-scale driving (Wed 10:00-12:00)

backup

Importance of multi-scale I-T processes

Science understanding of properties of meso/small-scale structures and their feedback to global scale is limited and needed.

Physics-based global simulations need to couple to meso/small scales.

Empirical models exist but often underestimate or smear out meso/small-scale structures. Models that resolve meso/small-scale input needed.

Timeline

Year 1. An introduction to the problems with talks meant to spark discussion on how to best make progress on linking scales, improving parameterizations, and addressing the scientific questions. Identify ways to drive meso/small-scale models with global-scale models as a boundary condition for an event. Form working groups and discuss collaboration strategies. Encourage researchers submit proposals to NSF to attempt to get funding to seriously address this grand challenge.

Year 2. Report updates from working groups and contributors, and discuss strategies to fill gaps to reach the goals. Report on progress of the meso/smallscale models being driven with the global-scale model boundary conditions. Start to investigate parameterizations. Report on statistical analysis of meso/small-scale drivers (fields and particle precipitation) and science results. Decide on more events to explore. Prioritize the goals to accomplish in last year of challenge. Work on group publications that highlight both the scientific and technological accomplishments.

Year 3. Final reports on the model couplings, science results, parameterizations, and meso/small-scale drivers. Finalize group publications that summarize all of the accomplishments over the past four years of effort.