

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

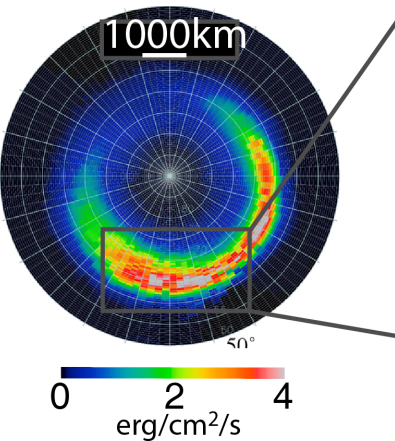
Toshi Nishimura, Aaron Ridley, Matt Zettergren, Yue Deng, Katrina Bossert, Ingrid Cnossen, Larry Lyons, Naomi Maruyama, Ryan McGranaghan, Meers Oppenheim, Marilia Samara, Ying Zou

Grand Challenge Questions

- How much can we improve physics understanding and reproducibility of multi-scale coupling processes?
- What are quantitative properties of meso/small-scale structures in the I-T system?
- What are the roles of meso/small-scale I-T structures and dynamics?
- What are the roles of energy cascading processes?
- What are the roles of small-scale gravity waves?

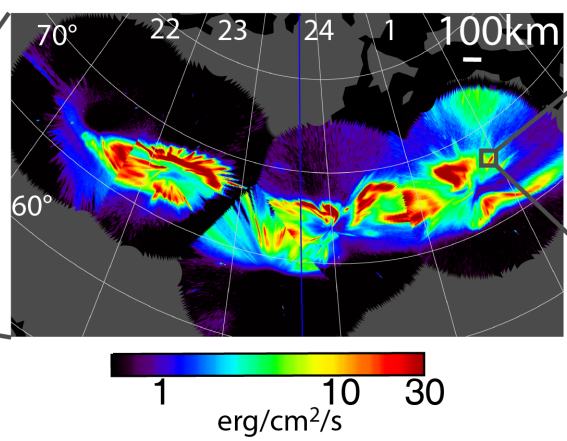
2018 Workshop: Importance of multi-scale I-T processes

(a) Large-scale (>~1000km) precipitation

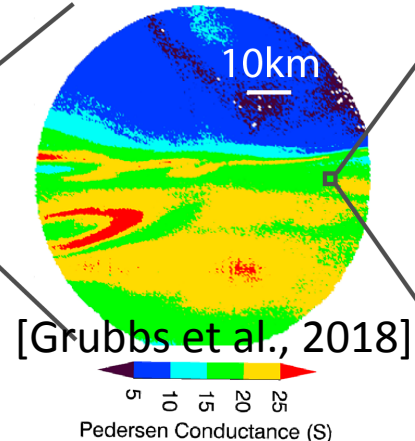


[Mitchell et al., 2013]

(b) Meso-scale (10s-100s km) precipitation

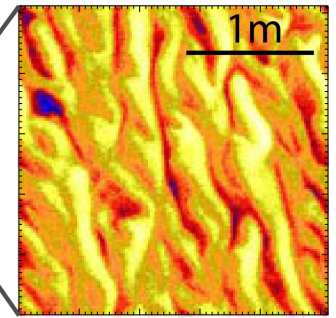


(c) Small-scale (<~10km) conductance



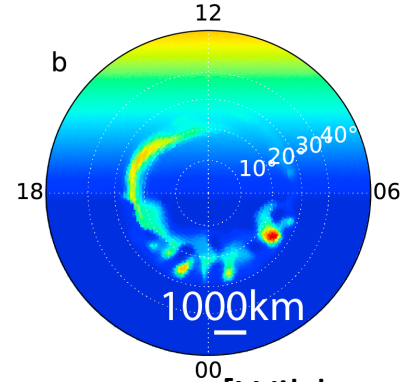
[Grubbs et al., 2018]

(d) Kinetic scale (<~m) density



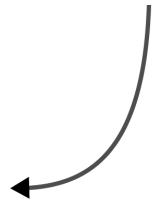
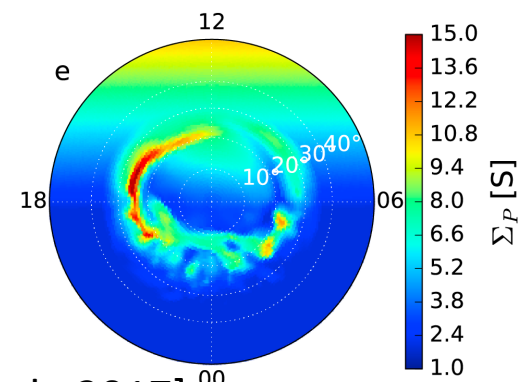
[Oppenheim and Dimant, 2013]

(e) Global MHD conductance



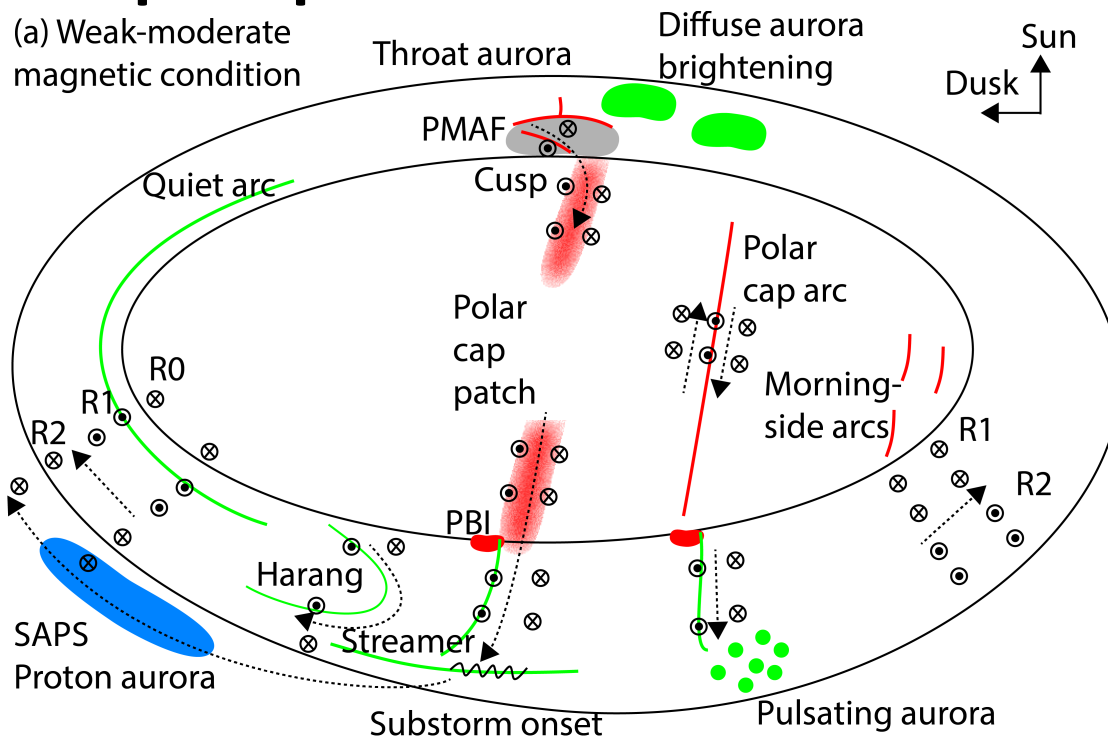
[Wiltberger et al., 2017]

(f) Global MHD + turbulence conductance



Y. Nishimura, Y. Deng, L. R. Lyons, R. M. McGranaghan, M. D. Zettergren (2018), Multi-scale dynamics in the high-latitude ionosphere, *AGU Books on Solar/Heliosphere 3: Advances in Ionospheric Research*, in press (<https://bit.ly/2XC96FX>).

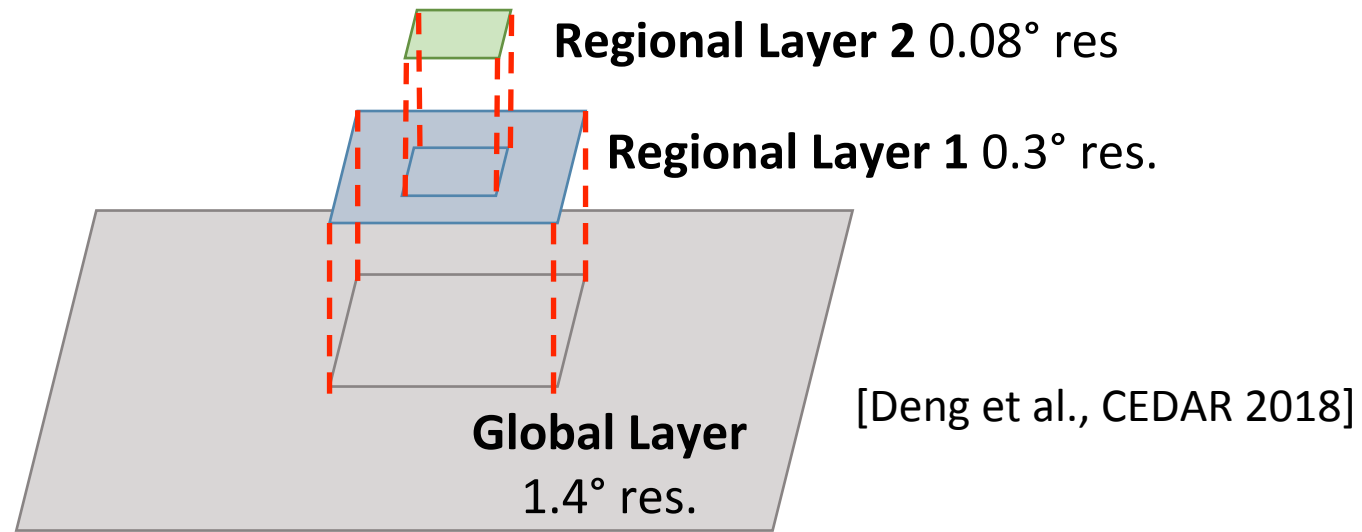
2018 Workshop: Importance of multi-scale I-T processes



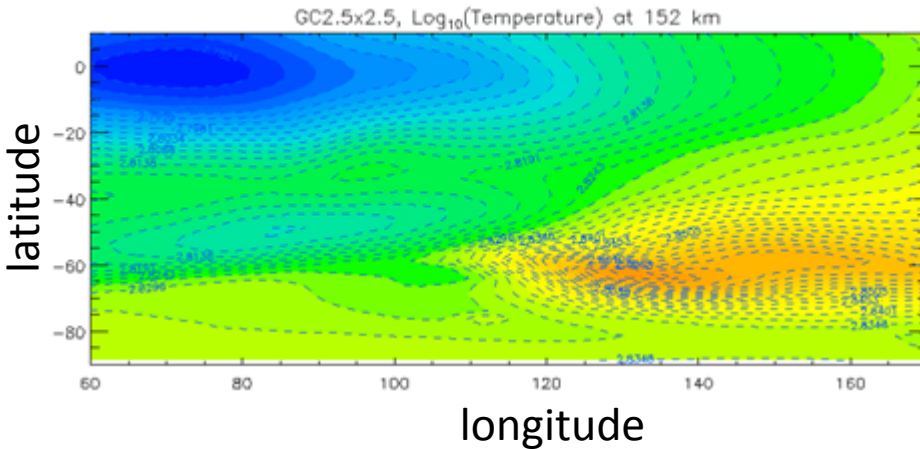
- Auroral electrodynamics [Lynch et al., Donovan et al., Liu et al.]
- Multi-scale FACs [Parham et al.]
- SED plume, shock response [Zou et al.]
- Turbulence [Mishin et al.]
- STEVE arc [Gallardo-Lacourt et al.]

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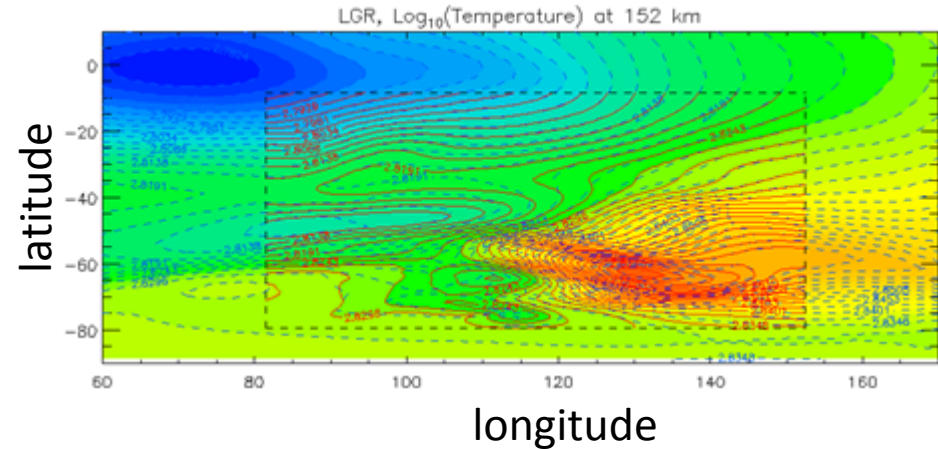
2018 Workshop: Importance of multi-scale I-T processes



GITM Temperature (global grids only)

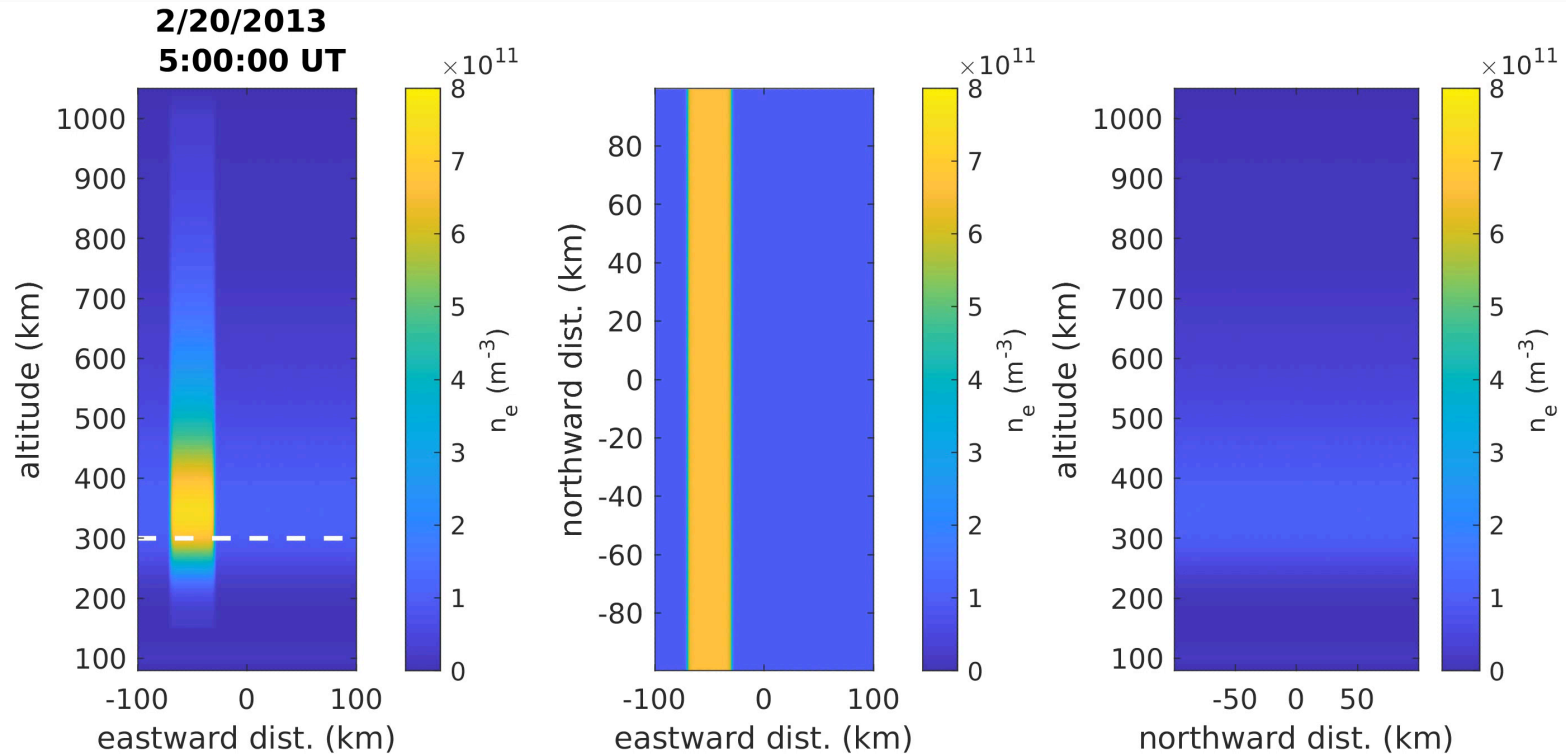


GITM Temperature (with grid refinement)



- The grid refinement allows to resolve localized structures.
- Application to flow channels and local precipitation (today's session)

2018 Workshop: Density irregularity formation



[Deshpande et al., CEDAR 2018]

- 3-D gradient drift instability
- Formation of \sim km-scale density irregularities from a density blob
- Reproducing radio signal scintillation
- More discussion on density irregularity formation (today's session)

2019 Workshop Schedule

Session 1 Thursday 16:00-18:00 (Hilton Mesa A)

- **Meghan Burleigh** Gravity wave influence on the I-T system
- **Jonathan Snively** Gravity wave influence on the I-T system
- **Sharon Vadas** Gravity wave influence on the I-T system
- **Meers Oppenheim** Kinetic-scale dynamics
- **Larry Lyons** Meso-scale plasma observations
- **Naomi Maruyama** Plume simulation

Session 2 Friday 10:00-12:00 (Hilton Mesa A)

- **Event discussion: Nishimura, Ridley, Y Zou, Lyons, Maruyama, S Zou, and data providers (Coster, Zhang, Varney, Bristow)**
- **Cheng Sheng** Multi-scale M-I-T simulation
- **Sebastijan Mrak** Density irregularity observation
- **Matt Zettergren** Density irregularity simulation
- **Kristina Lynch** Auroral arc electrodynamics
- **Shasha Zou** Polar cap patch formation
- **Leslie Lamarche** Scintillations and density irregularities
- **Elsevier book discussion**



Review Book planning: Multi-Scale Coupling and Energy Transfer in the M-I-T System

Editors: Toshi Nishimura, Olga Verkhoglyadova, Yue Deng, Cheryl Huang

Tutorials and reviews of the current status of multi-scale coupling processes and fundamental physics. Not a collection of papers.

The topics include;

- Multi-scale M-I-T system overview
- Fundamental processes in multi-scale coupling
- Recent advances in observations and modeling
- Key parameters include aurora/particles, density, flow, Poynting flux, waves, ion-neutral interaction
- Feedback from the ionosphere to the magnetosphere

Please let us know if you are interested in being part of the book. We may also contact you to contribute some writings/figures.



2019 AGU Fall Meeting Session

Cross-scale Coupling and Energy Transfer in the mid and high-latitude M-I-T System

Conveners: Toshi Nishimura, Olga Verkhoglyadova, Larry Lyons

Last year: 51 abstracts with 2 oral sessions