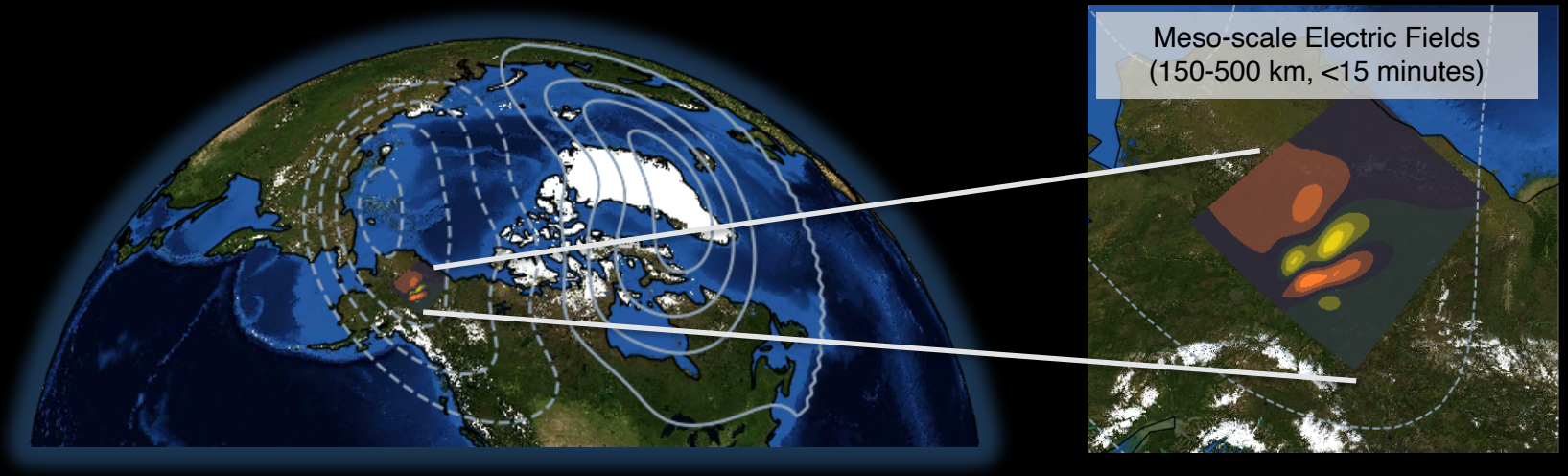


ULF Wave activity and Meso-Scale electric field variability at high-latitude I-T system

Dogacan S. Ozturk[1], Xing Meng[1], Olga Verkhoglyadova[1], Michael Hartinger[2], Josh Semeter[3], Roger Varney[4], Ashton Reimer[4]

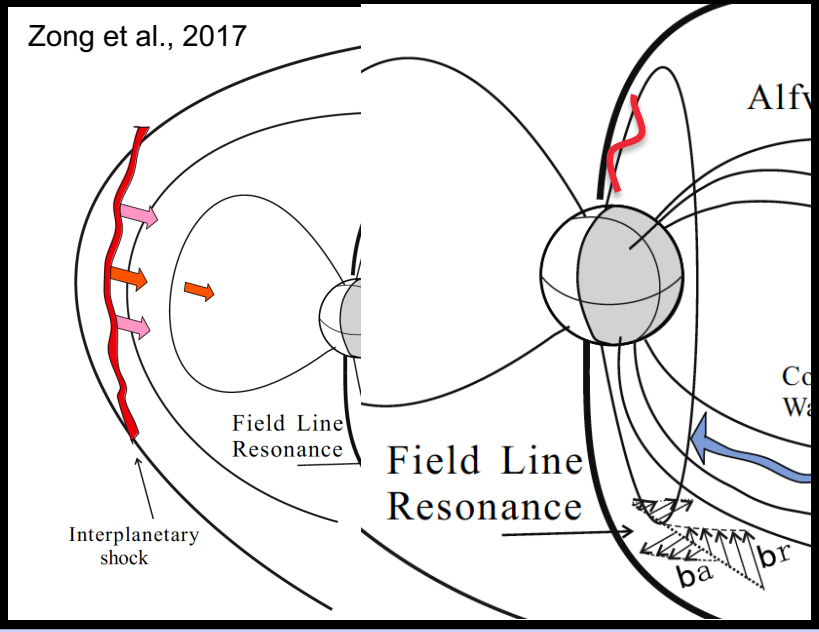
1: Jet Propulsion Laboratory, California Institute of Technology; 2: Space Science Institute; 3: Department of Electrical and Computer Engineering and Center for Space Physics; Boston University; 4: Stanford Research Institute

Jet Propulsion Laboratory
California Institute of Technology

contact: dogacan.s.ozturk@jpl.nasa.gov

© 2019 California Institute of Technology. Government sponsorship acknowledged.

Role of ULF Waves in Energy Deposition to I-T system



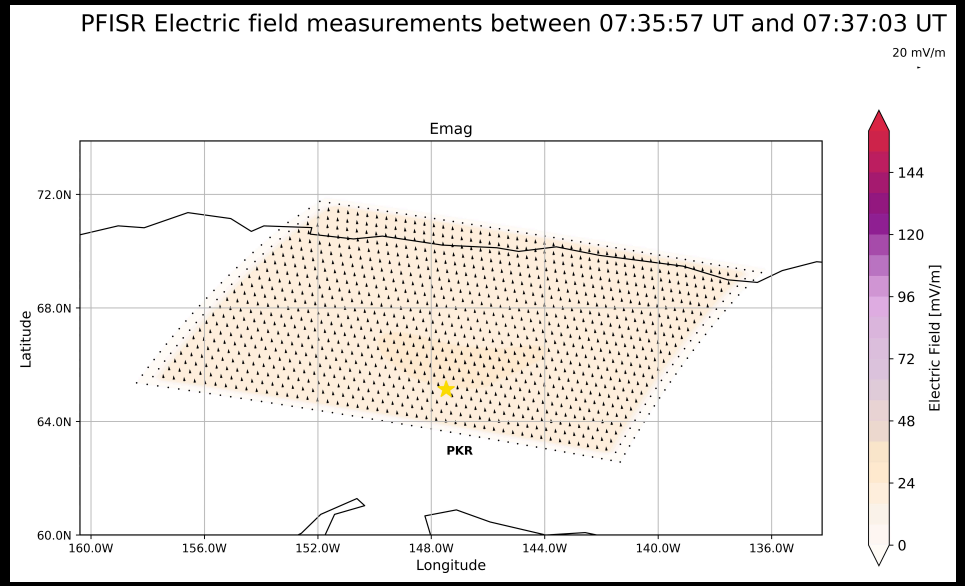
- Significant energy deposition (Joule Heating) to I-T by ULF waves with 0.2-600 second periodicity[1]
- GCMs traditionally use empirical models to estimate electric fields and conductivity which are better suited for scales: > 500 km and >15 minutes[2]
- Ongoing work: including meso-scale variability (100-500 km, <15 minutes)[3]

Can we quantify the contribution of ULF waves to the I-T energy budget using a Global Ionosphere-Thermosphere model?

1 Dessler (1959); Greenwald and Walker, 1980; Allan and Poulter, 1984; Rae et al., 2007,2008
2 Verkhoglyadova et al., 2018 and references therein
3 Codrescu et al. 2008; Deng et al. 2009; Matsuo & Richmond 2008

Simulation Setup for the Meso-Scale Electric Fields in the I-T System

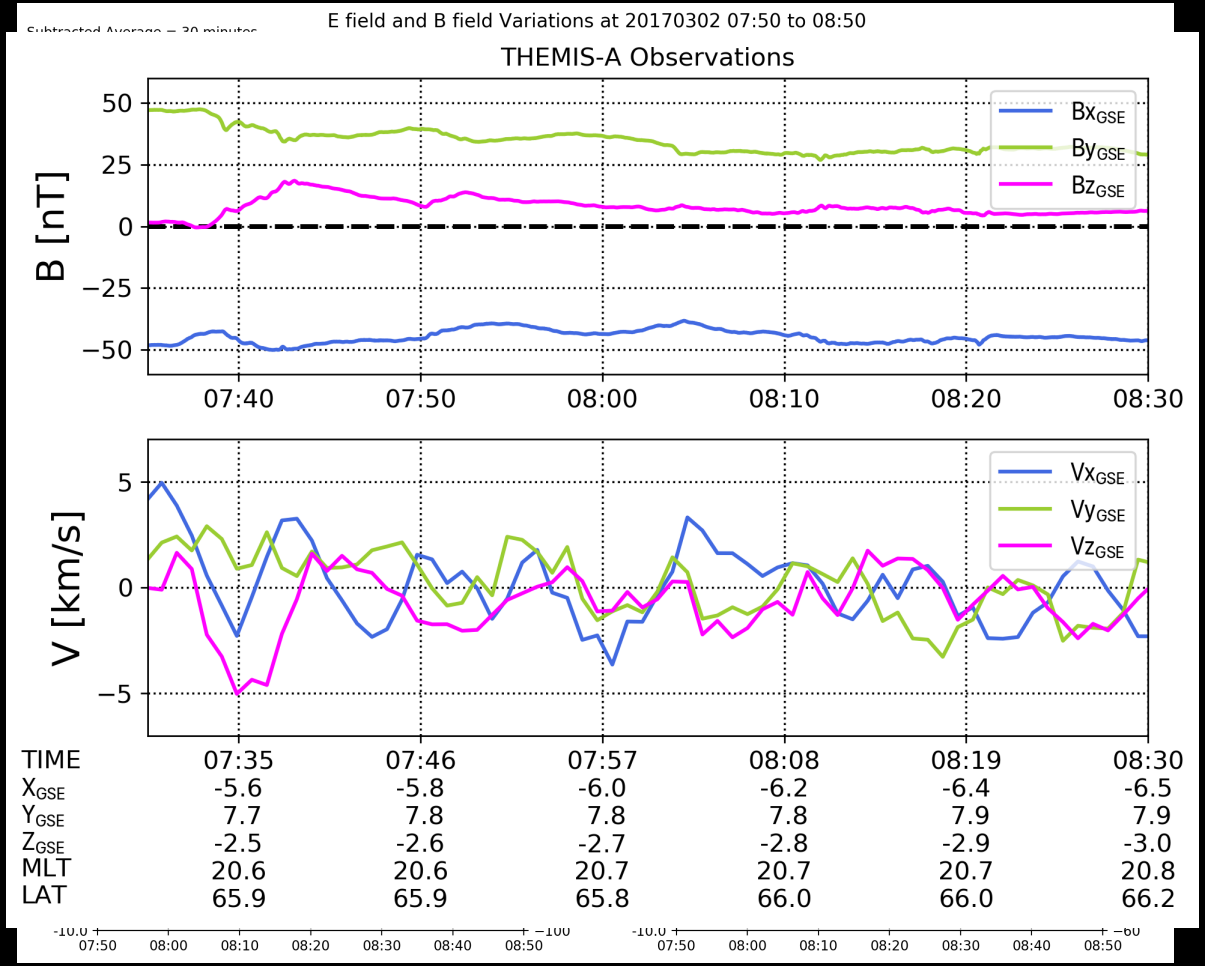
- Modeling of the variability through Global Ionosphere Thermosphere Model (GITM)[1]
- Drivers for Ionospheric Electrodynamics (1-min):
  1. Weimer 2005[2] model for high-latitude ionospheric potentials merged with 2D PFISR measurements
  2. OVATION Prime[3] for auroral particle precipitation
- Simulation grid resolution: 0.75° in longitude, 0.75° latitude, 1/3 local scale height in vertical direction, ~66s temporal resolution



Measurement spatial resolution
[0.05° in latitude and 0.3° in longitude, ~10 km]

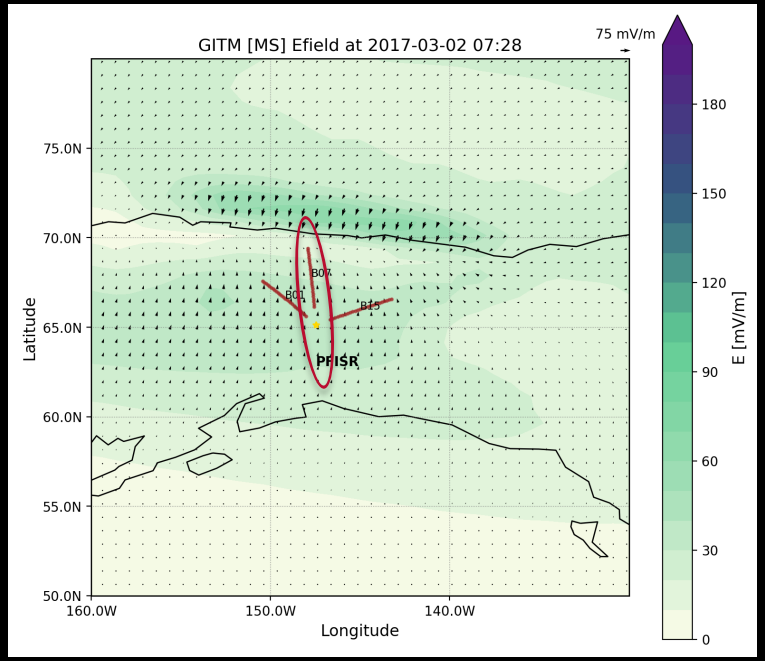
1 Ridley et al., 2006
2 Weimer, 2005
3 Newell et al., 2009

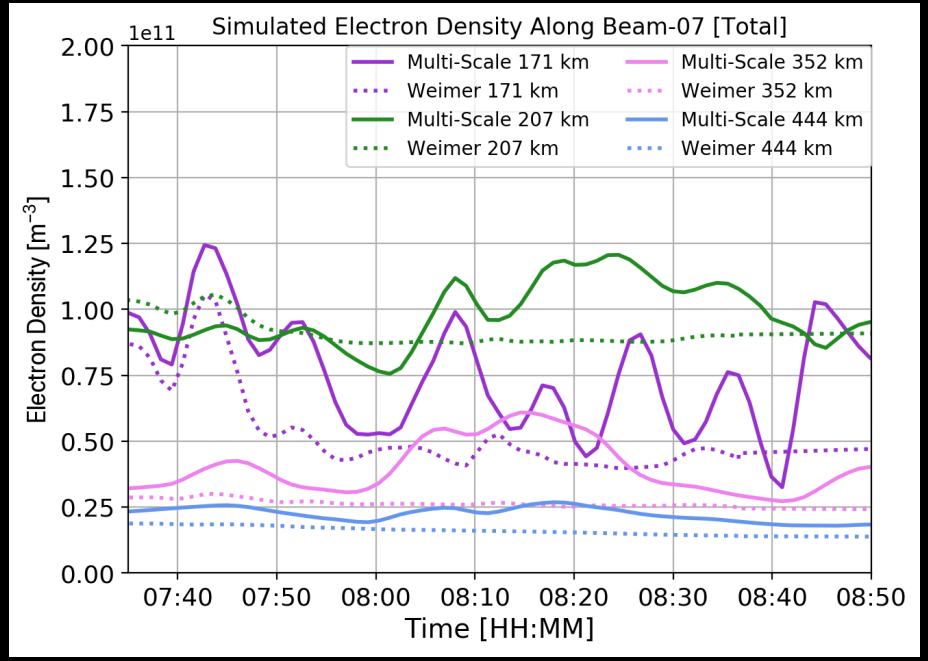
Observations of Electric and Magnetic Fields



- THEMIS-A (~20.5 MLT) recorded dipolarization-like signature in the magnetosphere around 0737 UT.
- PKR magnetometer (~20.5 MLT) and PFISR electric field measurements are compared.
- Two different frequency: high (2-4 minute) and low (10-15 minute)
- No significant response in E_{NS} - B_{EW} (right)

Simulated Electron Density Response to Meso-Scale Driving





- Response differs with altitude, lower altitudes showing stronger oscillations
- The ~10 minute wave energy was mostly deposited in the E-region altitudes
- Low SNR in data, validation work ongoing.

Conclusions:

- PFISR and PKR measurement showed perturbations at the same time interval in which THEMIS-A measurements indicated magnetotail activity.
- Both high and low frequency perturbations were present in electric field and magnetometer measurements.
- The simulated response showed a strong altitude dependence with 10 minute periodicity.

Future work:

- Consistent treatment of conductivity (particle precipitation) is necessary to fully understand energy dissipation by ULF waves.
- More event and conjunction studies will be performed to better understand the coupling between M-I-T systems and characteristics of energy deposition.

Thank you.

Acknowledgements

- This work is funded by the NASA ROSES 2016 Heliophysics LWS Science (NRA NNH16ZDA001N) Program.
- GITM is developed and supported by Prof. Aaron Ridley at University of Michigan.
- Simulations were done on NASA High-End Computing Program through the NASA Advanced Supercomputing Division at Ames Research Center, and Stampede Supercomputer at Texas Advanced Computing Center at University of Texas at Austin.
- We acknowledge use of NASA/GSFC's Space Physics Data Facility's OMNIWeb (or CDAWeb or ftp) service, and OMNI data.
- We acknowledge NASA contract NAS5-02099 and V. Angelopoulos for use of data from the THEMIS Mission. Specifically: C. W. Carlson and J. P. McFadden for use of ESA data; K. H. Glassmeier, U. Auster and W. Baumjohann for the use of FGM data provided under the lead of the Technical University of Braunschweig and with financial support through the German Ministry for Economy and Technology and the German Center for Aviation and Space (DLR) under contract 50 OC 0302.
- We acknowldge the use of the VT SuperDARN Web site (vt.superdarn.org) for access to radar data and data products. SuperDARN is a collection of radars funded by national scientific funding agencies of Australia, Canada, China, France, Italy, Japan, Norway, South Africa, United Kingdom and the United States of America.
- Simulation results have been provided by the Community Coordinated Modeling Center at Goddard Space Flight Center through their public Runs on Request system (http://ccmc.gsfc.nasa.gov). The Weimer Model was developed by Daniel R. Weimer at Virginia Tech. The Ovation Prime Model was developed by Patrick Newell at JHU/APL.

Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov