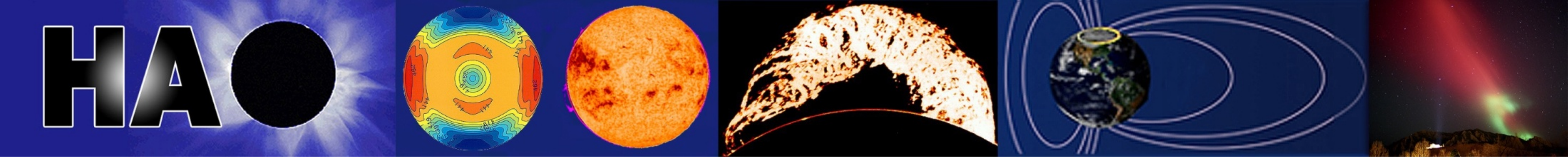


Perspectives on Ionospheric Electrodynamics

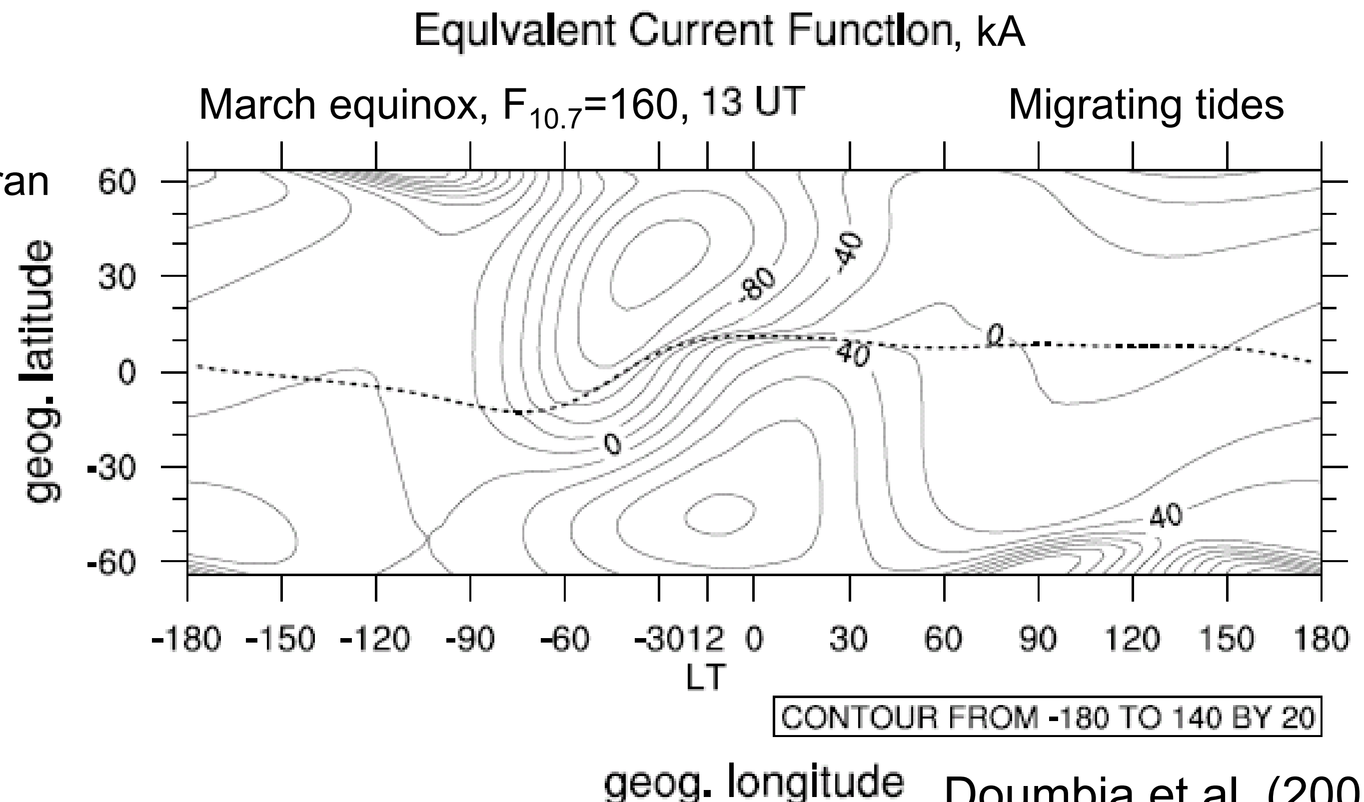
Arthur D. Richmond, NCAR-HAO
and collaborators

- Ionospheric dynamo modeling
- Disturbance dynamo
- Assimilative Mapping of Ionospheric Electrodynamics (AMIE)
- Interactions of ionospheric fields with magnetospheric plasma
- Joule heating impacts on the thermosphere
- Low-latitude evening electrodynamics

Ionospheric Dynamo Modeling

S.V. Venkateswaran

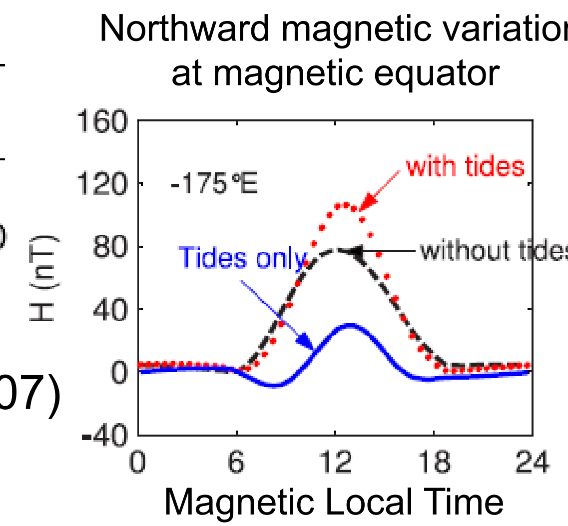
S. Matsushita

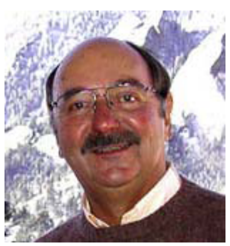


Doumbia et al. (2007)

Vafi Doumbia

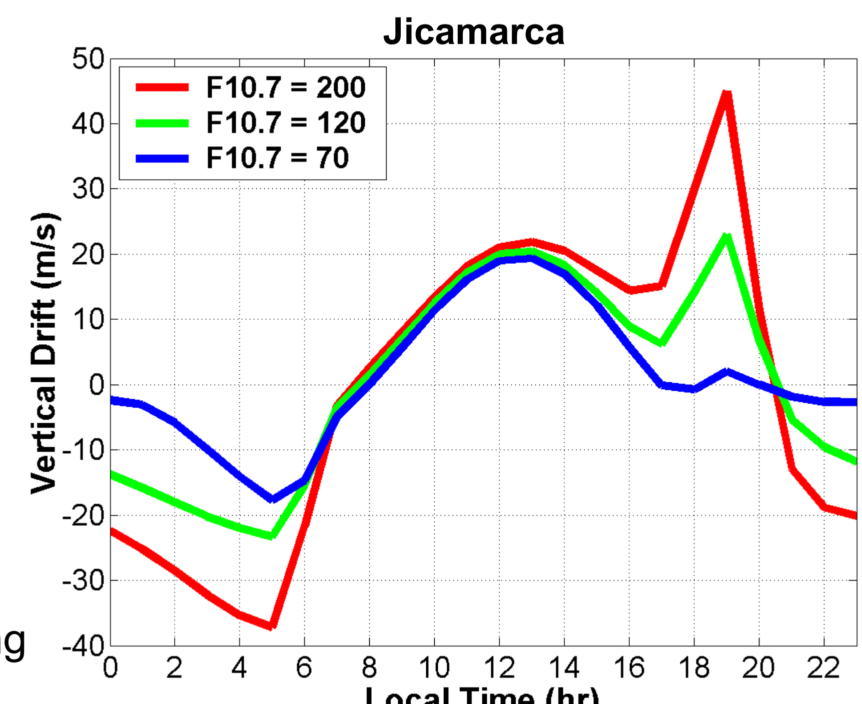
Astrid Maute





Ray Roble

Cassandra Fesen



Cicely Ridley

Tzu-Wei Fang

Ingrid Cnossen

Patrick Alken

Lunar tidal response to stratospheric sudden warmings

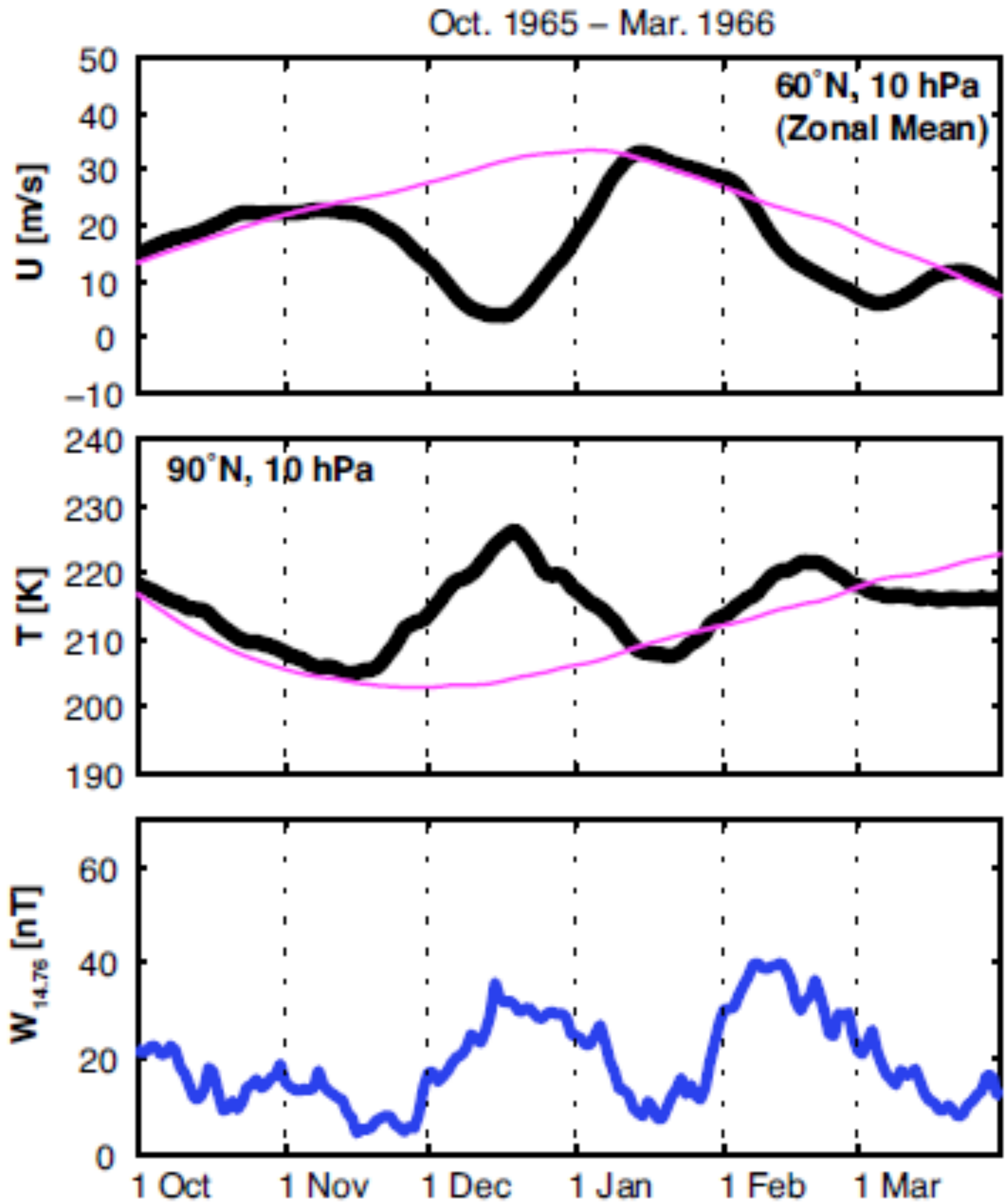
Yamazaki et al. (2012)

Yosuke Yamazaki

Stratospheric zonal-mean zonal wind at 60° N

Stratospheric temperature at North Pole

Amplitude of 14.76-day geomagnetic perturbation at Addis Ababa



Robert Stening

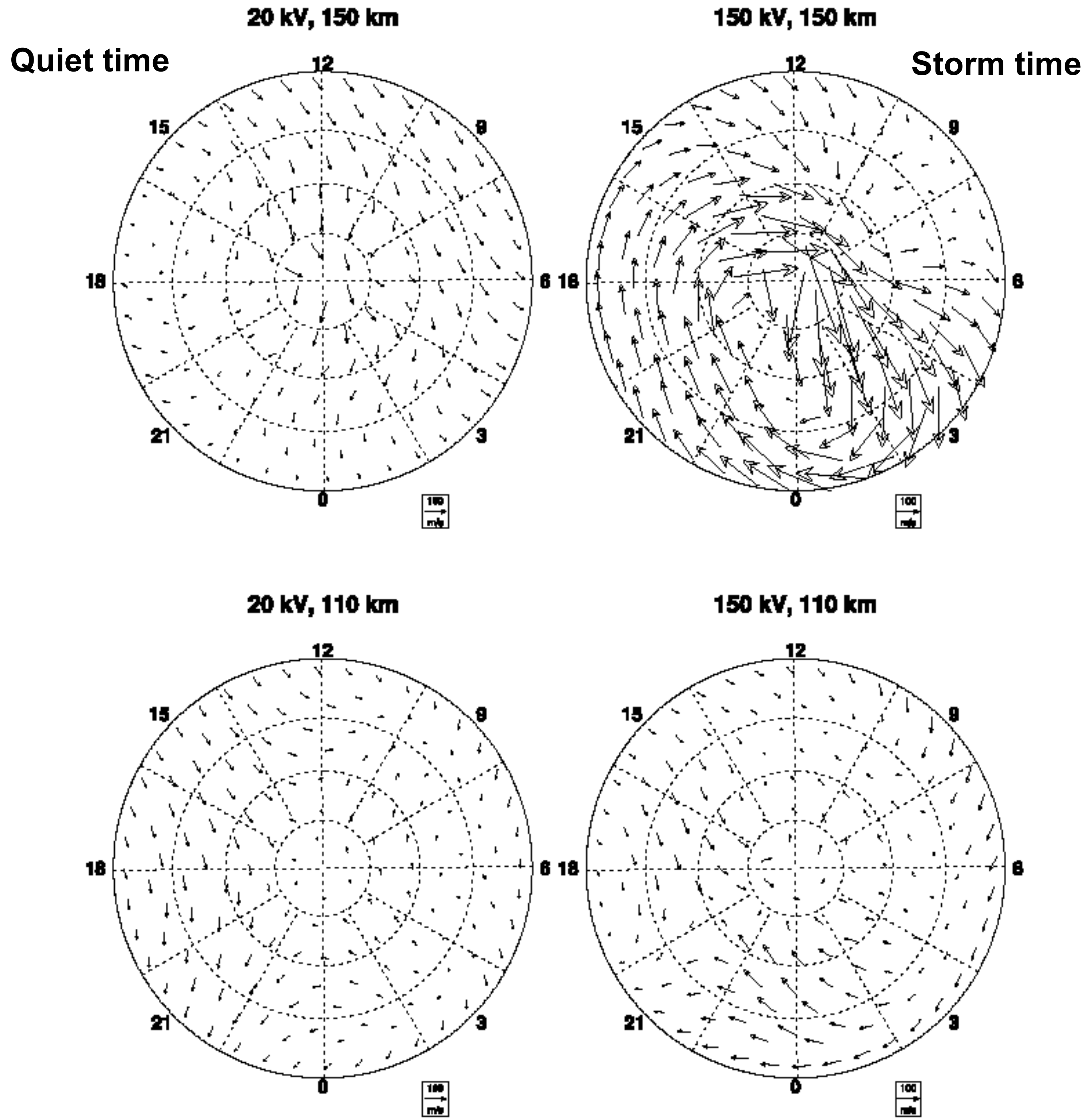
Maura Hagan

Jeff Forbes

Nick Pedatella

Hanli Liu

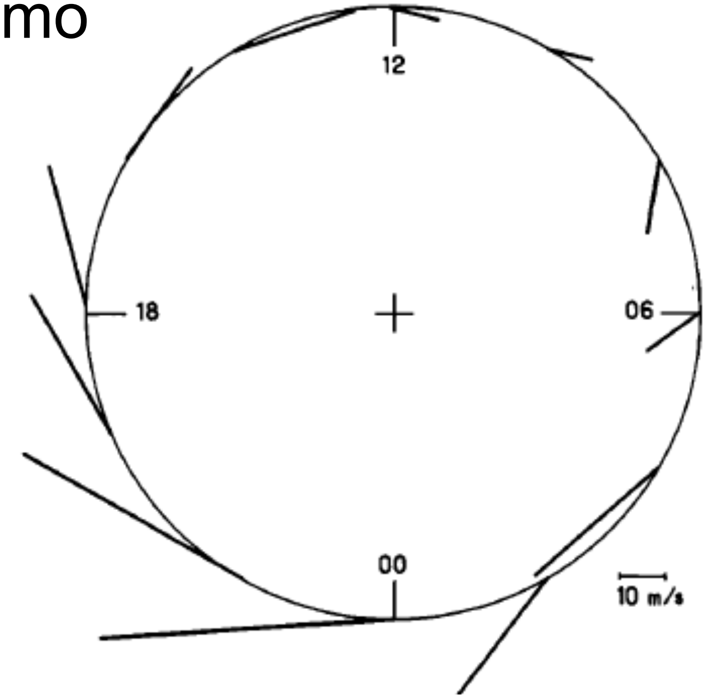
Wind, geomagnetic coordinates, 30-90 lat.



Ionospheric Disturbance Dynamo

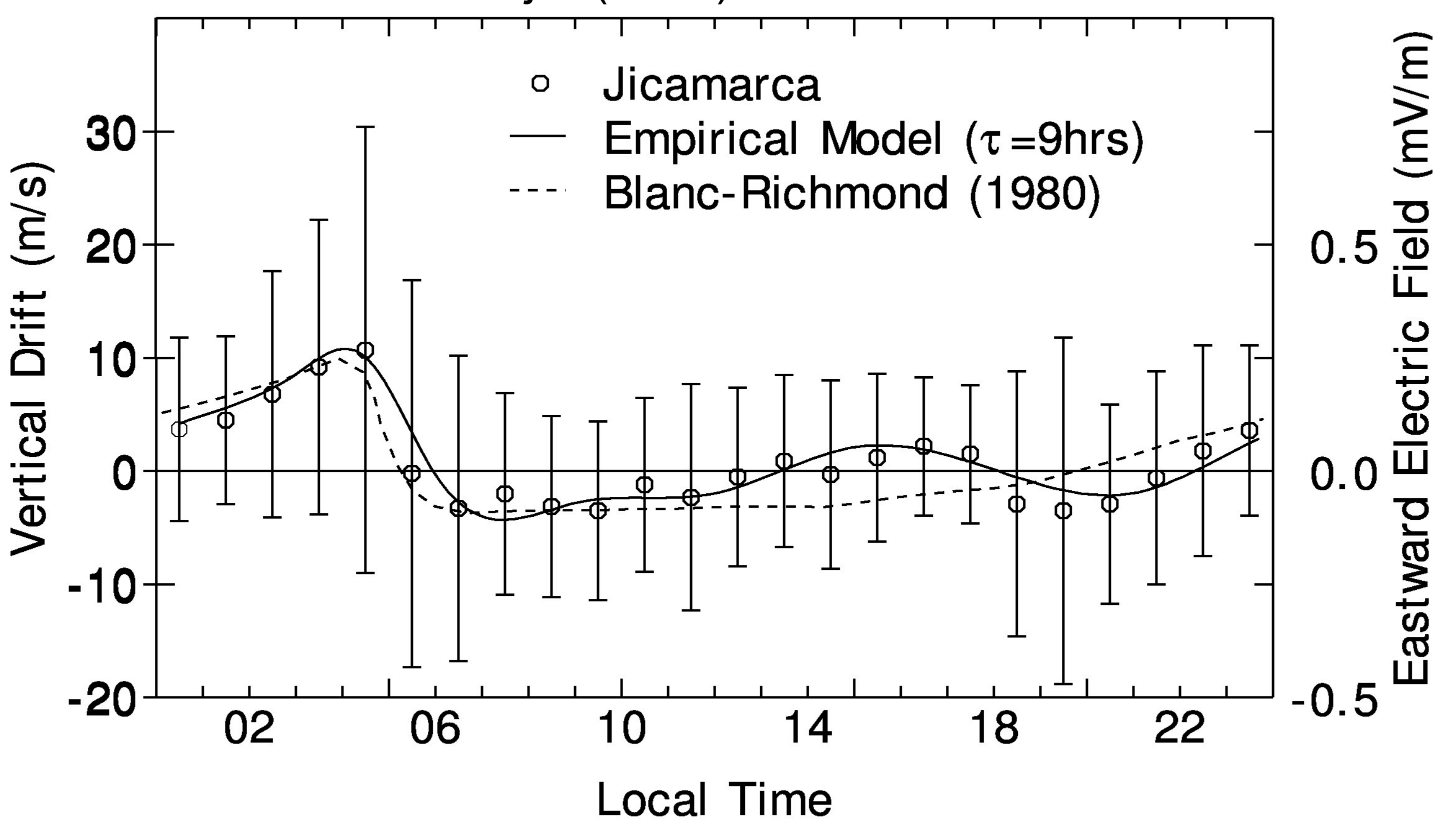
Michel Blanc

Average disturbed (K_p>2+) minus quiet (K_p ≤2+) drifts at Saint Santin (Blanc, 1978)

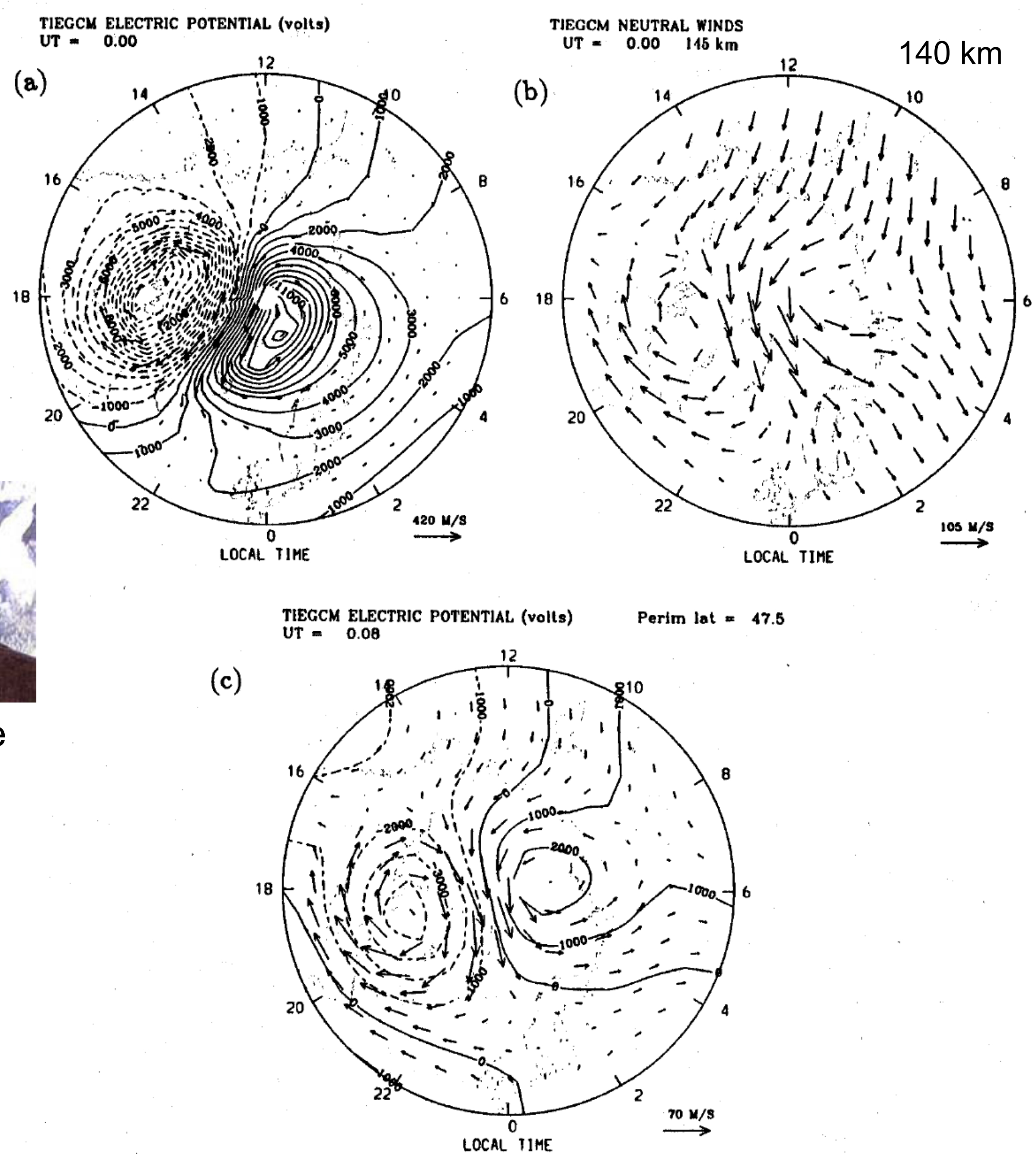


Christine Amory-Mazaudier

Scherliess and Fejer (1997)

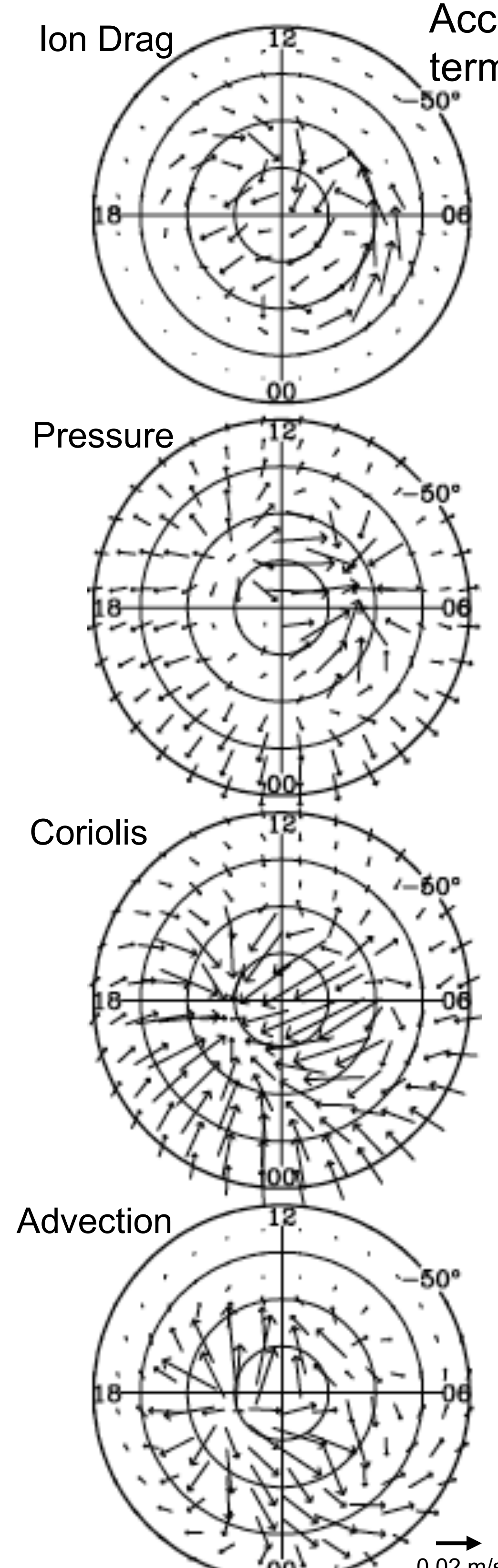


High-latitude Winds and “Flywheel” Effect



Richmond (1995)

Ray Roble



Young-Sil Kwak

Kwak et al. (2007)

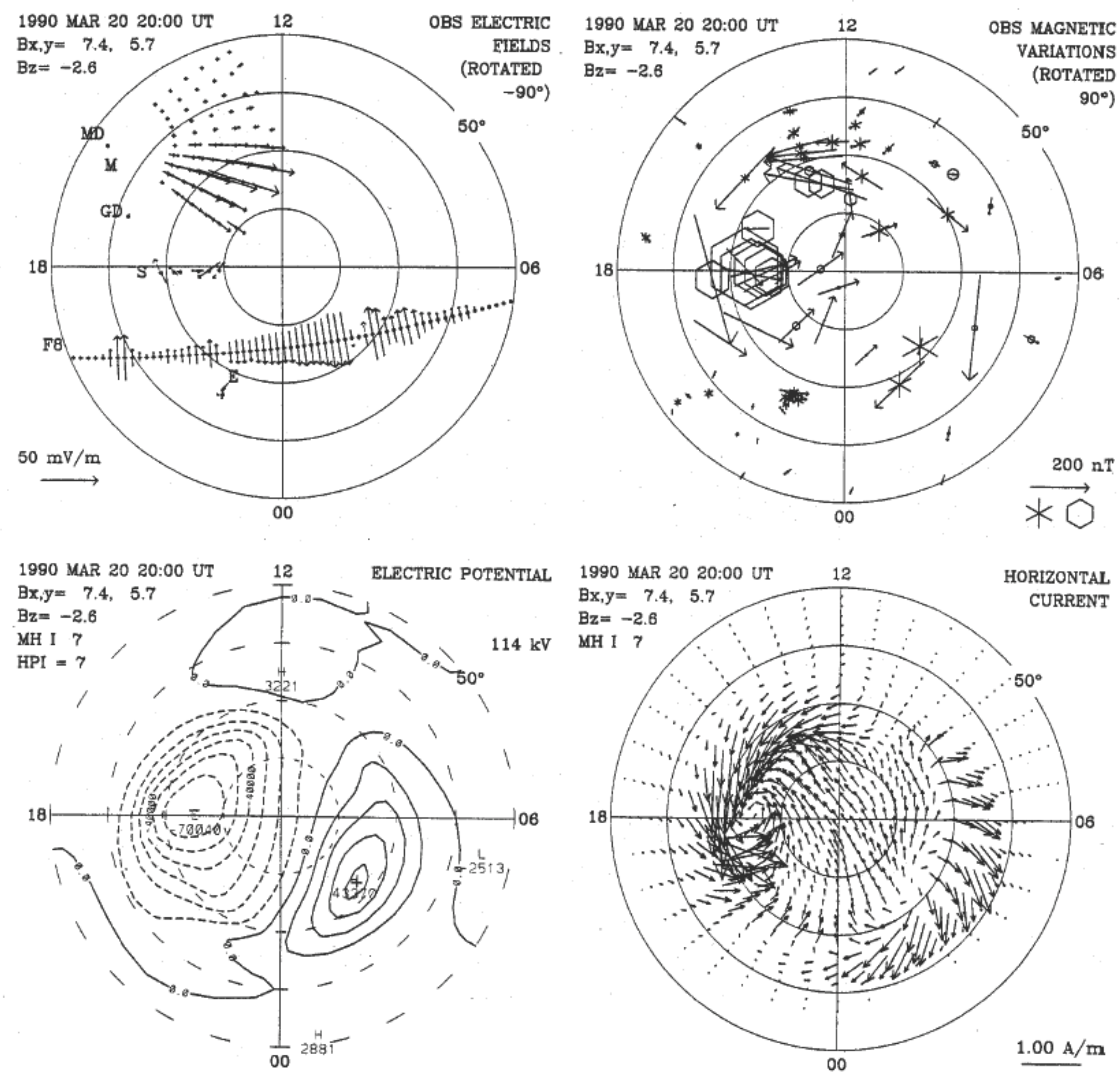
Yosuke Kamide

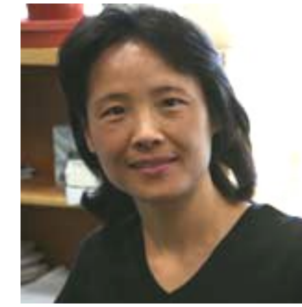
Delores Knipp

Barbara Emery

Byung-Ho Ahn

ASSIMILATIVE MAPPING OF IONOSPHERIC ELECTRODYNAMICS (AMIE)





Gang Lu

Geoff Crowley

Aaron Ridley

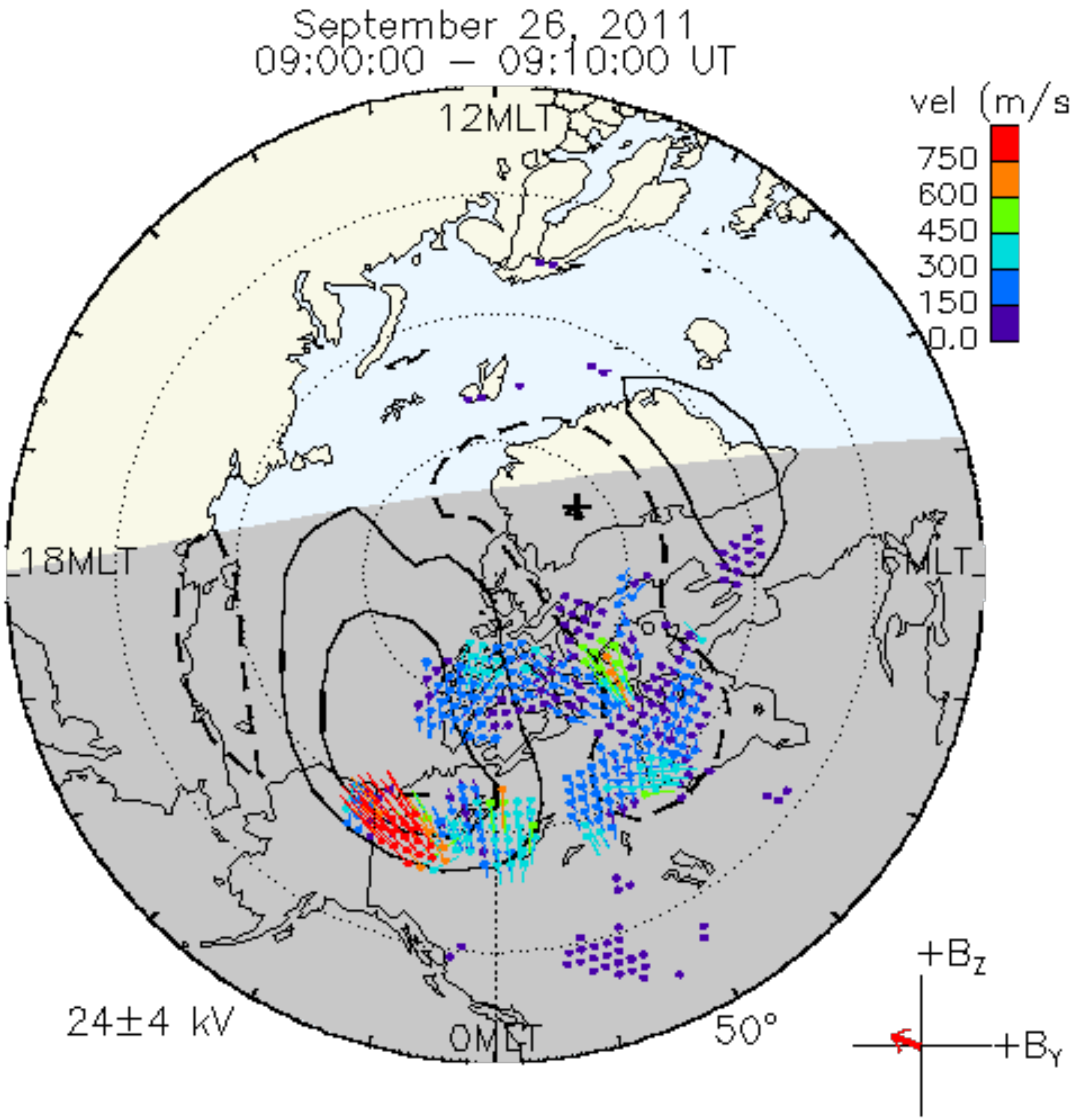
Abena Poku-Awuah

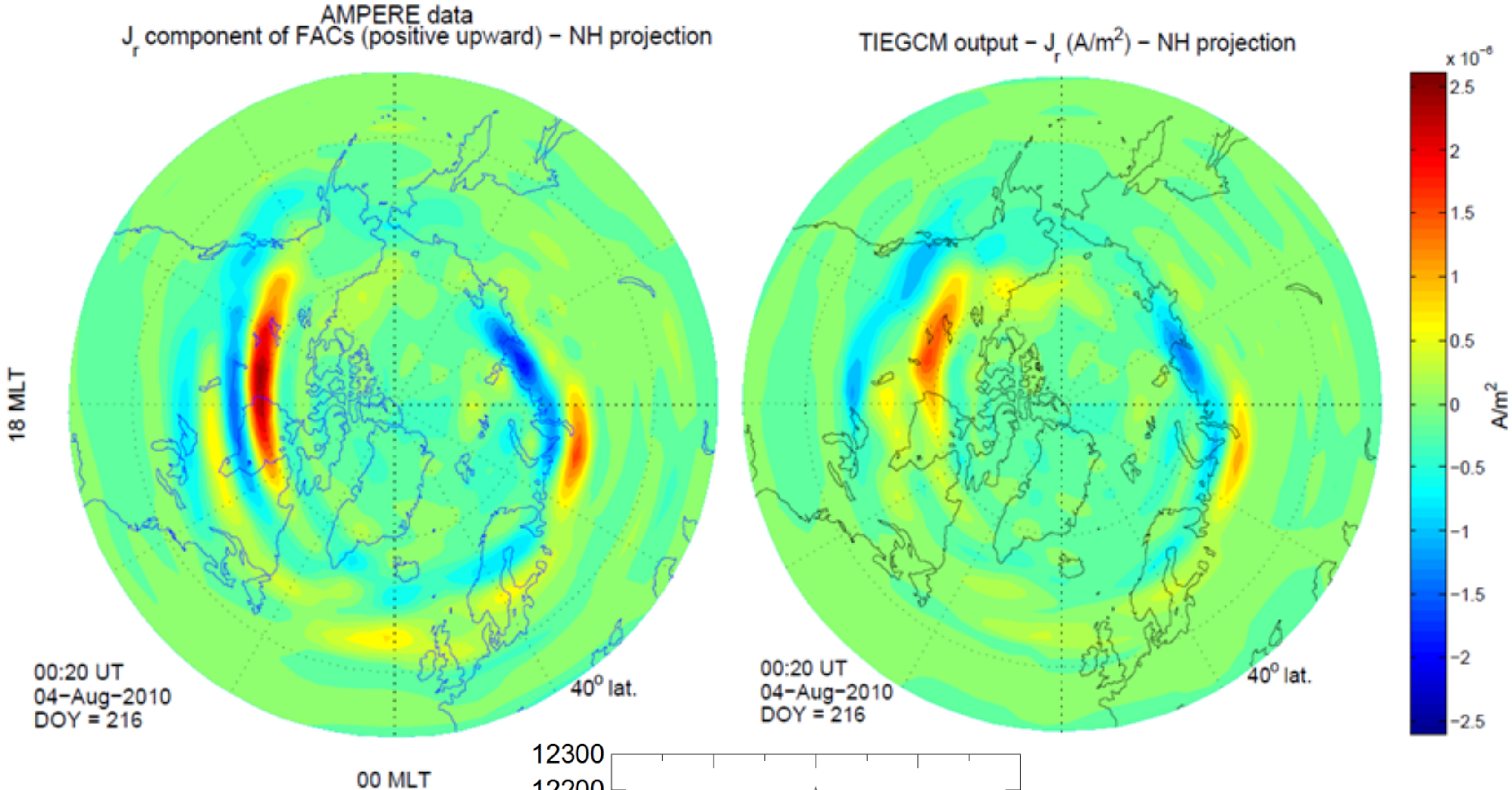
SuperDARN Assimilative Mapping (SAM) procedure

Cousins et al. (2013a,b)

Ellen Cousins

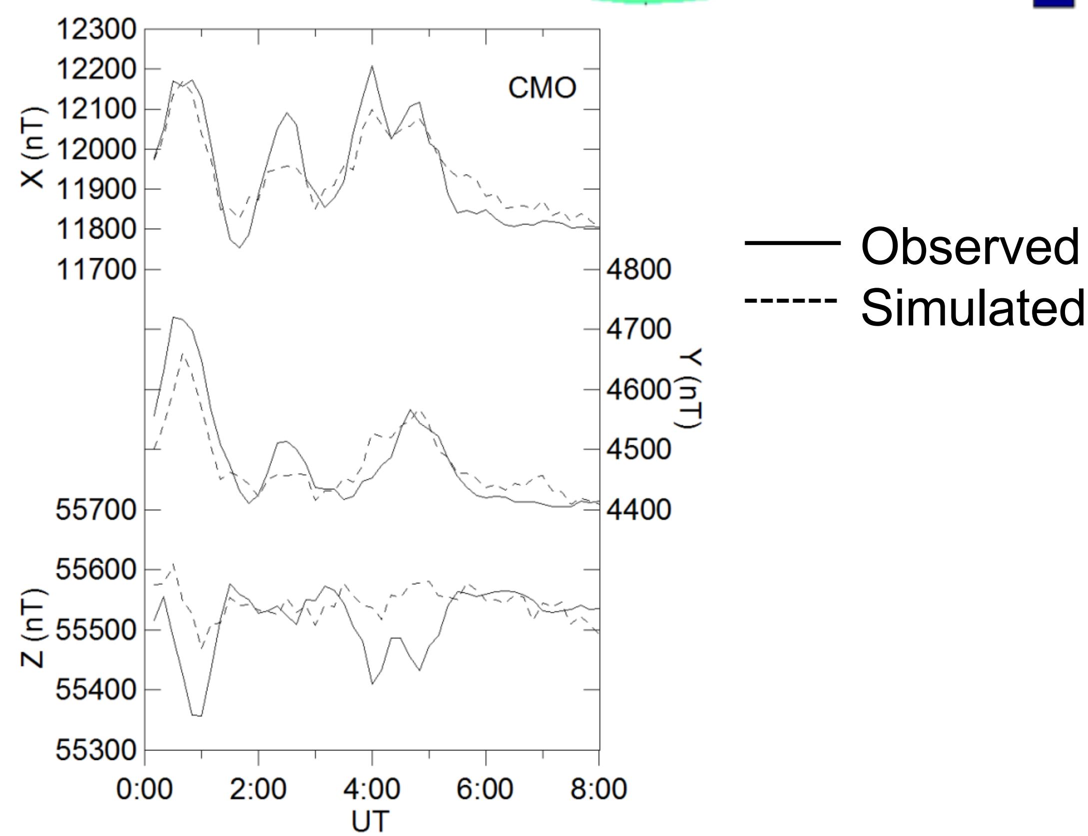
Tomoko Matsuo





AMPERE FAC in the TIEGCM can generate observed ground magnetic perturbations

Marsal et al. (2012)

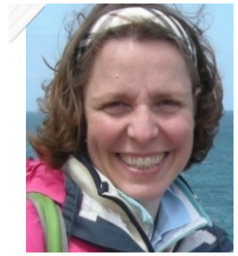


Santi Marsal

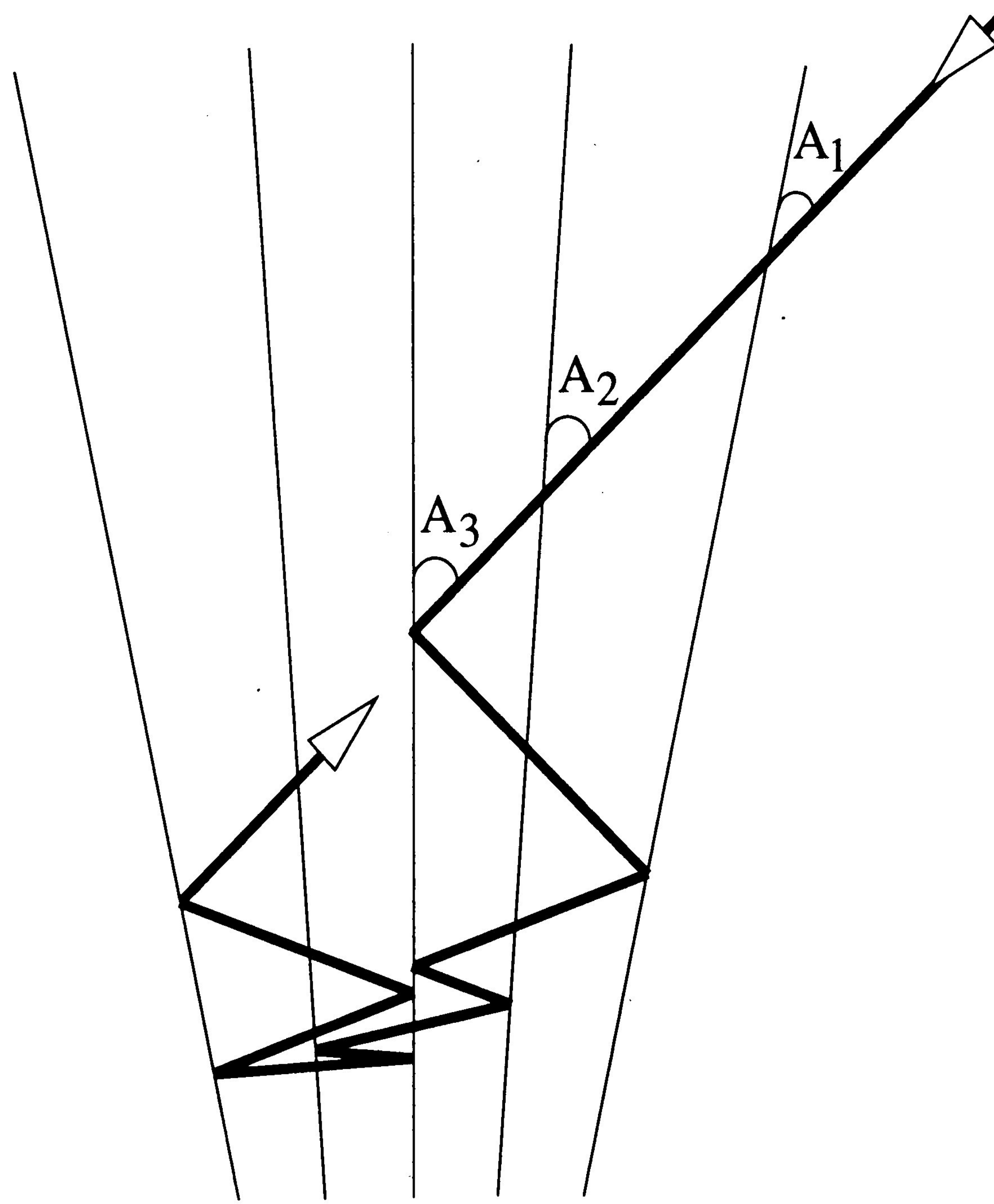
Brian Anderson

“Magnetic Mirroring” of Neutral Atoms

Galand and Richmond (1999)

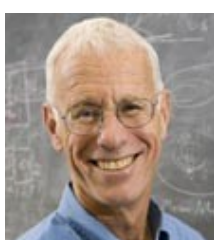


Marina Galand



Low-Latitude Ionization by Energetic Neutral Atoms

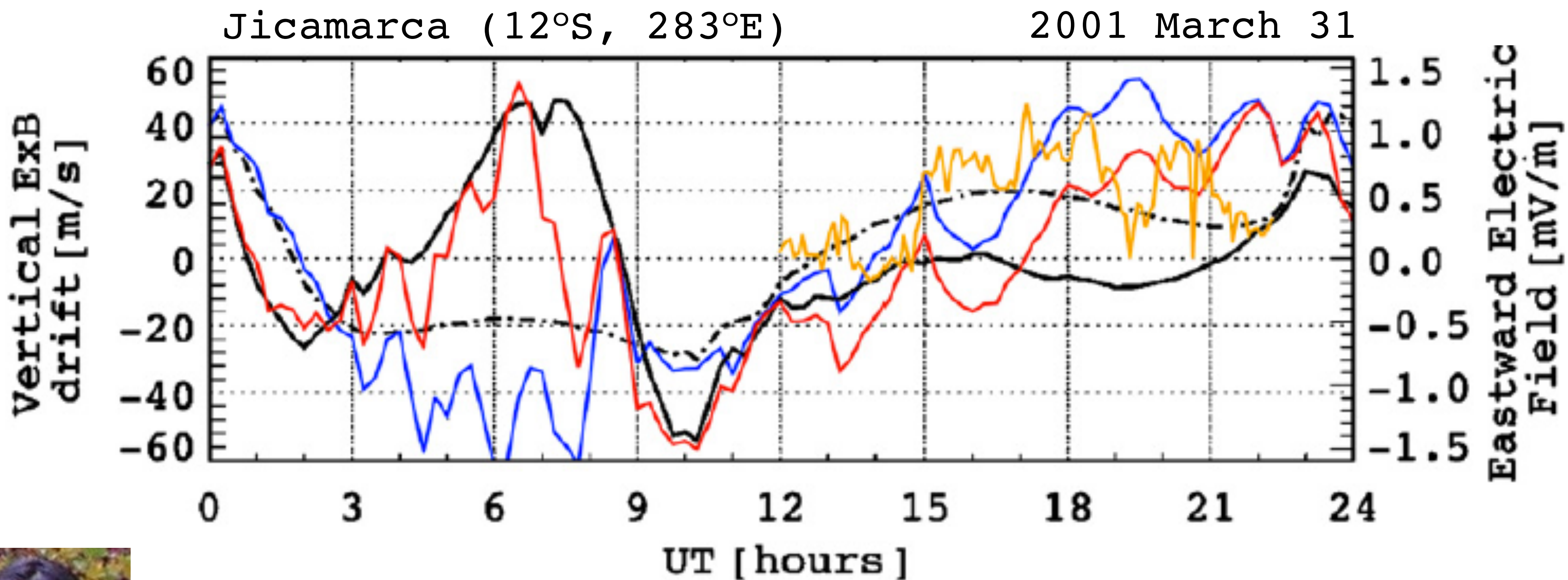
Lyons and Richmond (1978)



Larry Lyons

Storm-Time Electrodynamics: Interactive Magnetosphere/Ionosphere/Thermosphere Modeling

Maruyama et al. (2007)



Naomi Maruyama

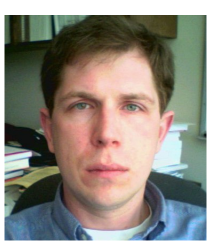
CTIPe/RCM simulations

- Quiet-time reference
- Wind only
- Hilat potential only
- Wind + Hilat potential

Observation

Christophe Peymirat

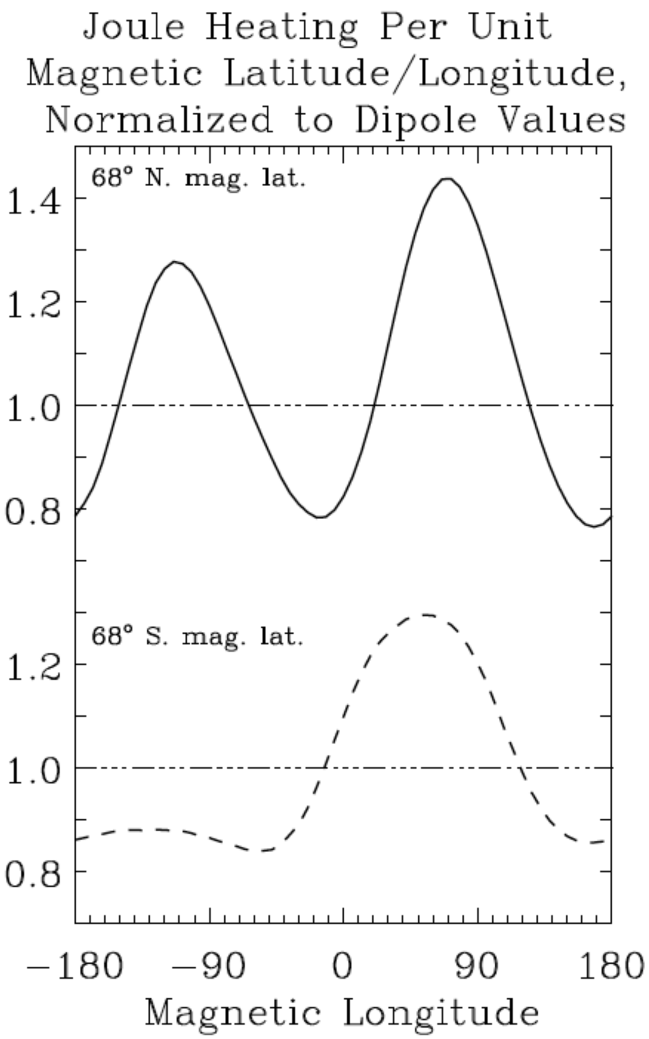
Tim Fuller-Rowell



Stan Sazykin

Arsene Kobea

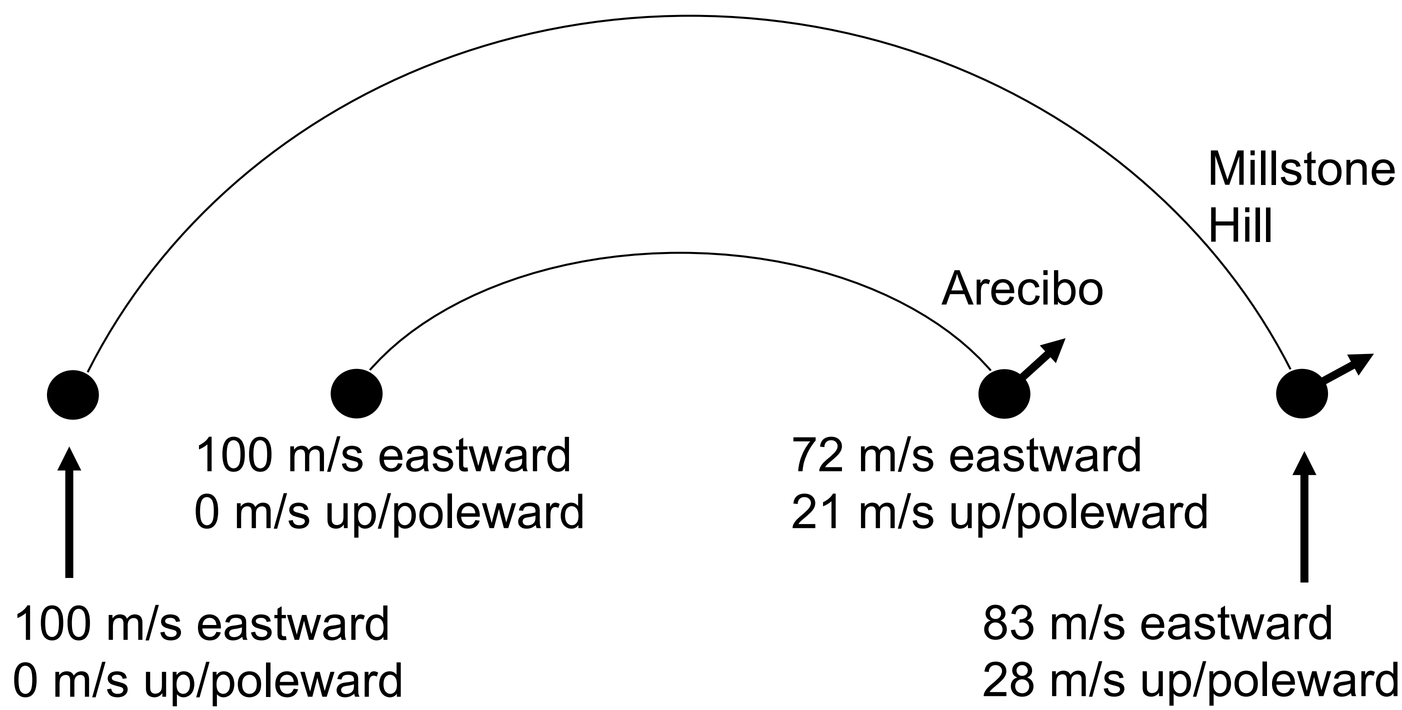
Non-Dipolar Geomagnetic Field Effects on Ionospheric Electrodynamics Calculated Using Magnetic Apex Coordinates



Gasda and Richmond (1998)

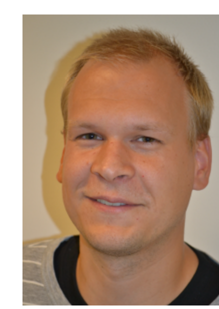
Sarah Gasda

Differences of $\mathbf{E}\times\mathbf{B}/B^2$ Velocities at Conjugate Points



John Emmert

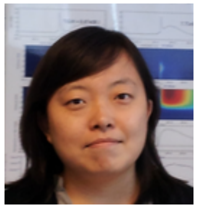
Emmert et al. (2010)
Laundal and Richmond (2017)



Karl Laundal

Density Response at 400 km to Joule Heating at Different Heights

Huang et al. (2012)

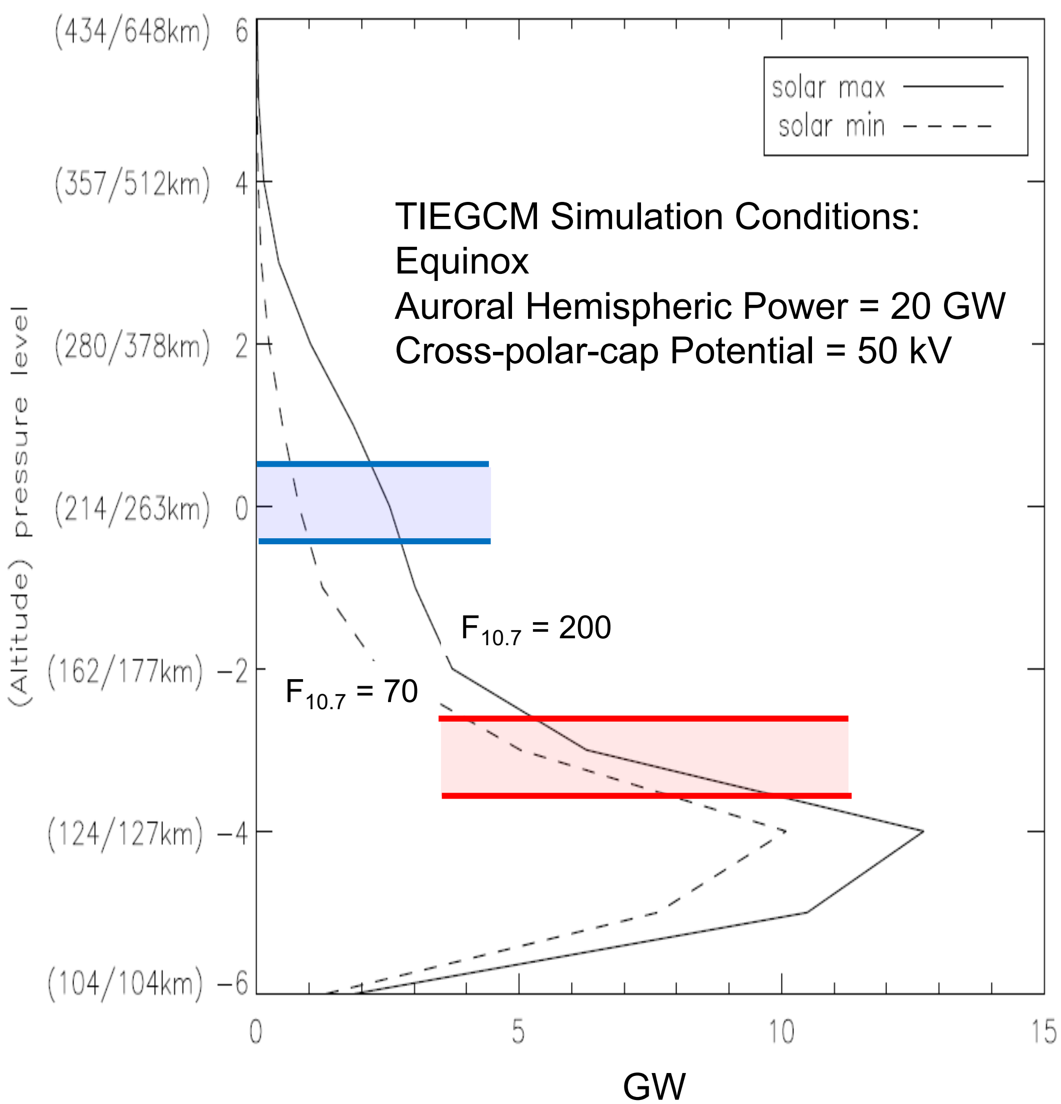


Yanshi Huang

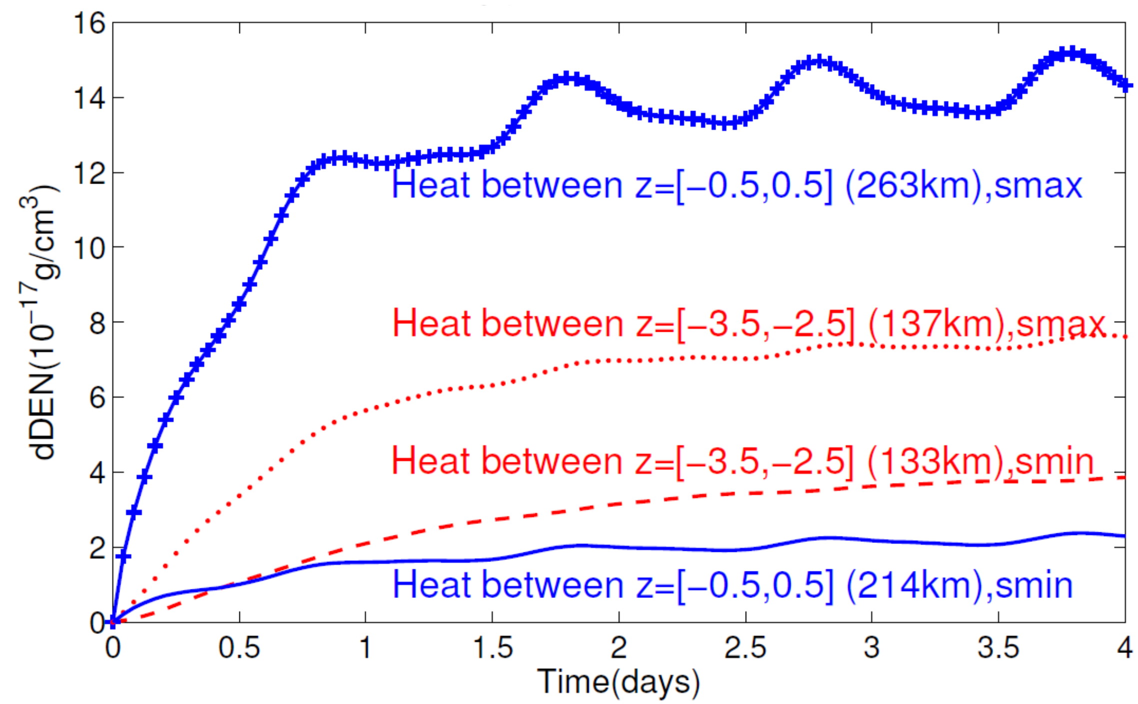
Yue Deng

(smin/smax)

Globally Integrated
Joule Heating Per Scale Height



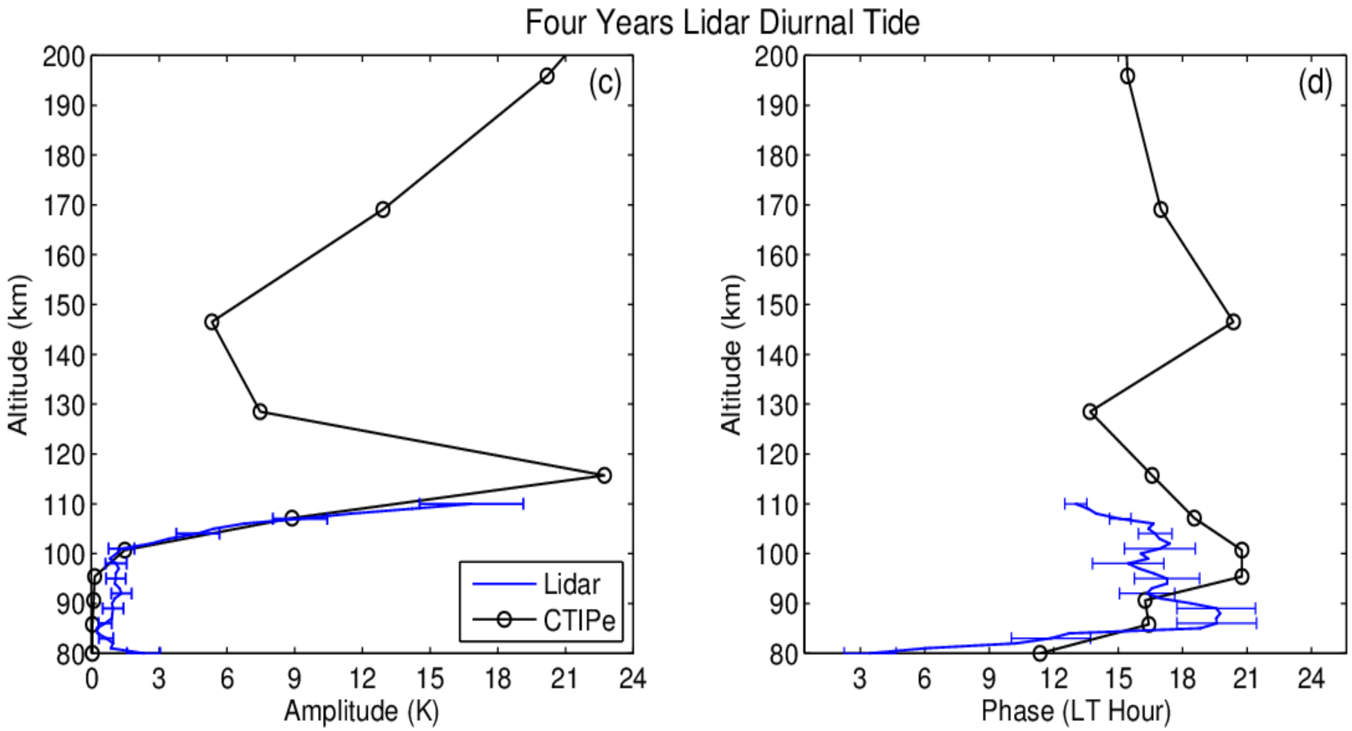
Contributions to Density Perturbations at 400 km

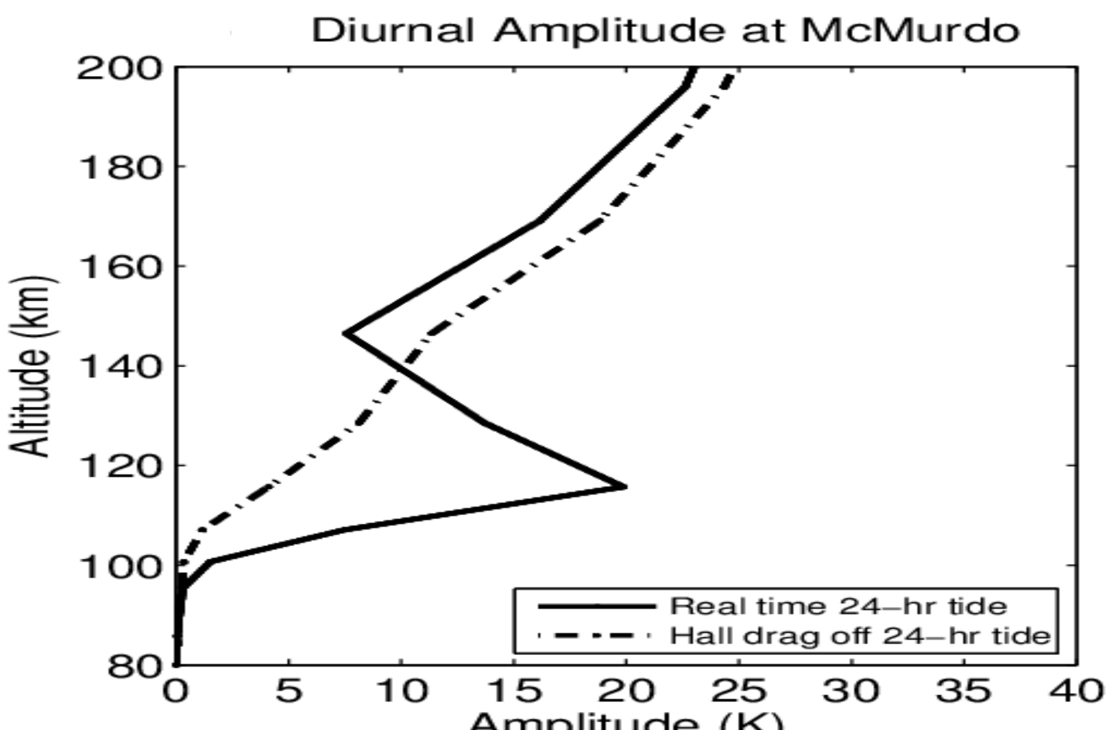


Much more Joule heat is deposited in the E region than in the F region, but F-region heating dominates the density response during at least the first 12 hours of a storm, especially at solar maximum.

Rapid Altitude Growth of Diurnal Tide in Temperature at McMurdo

Fong et al. (2015)



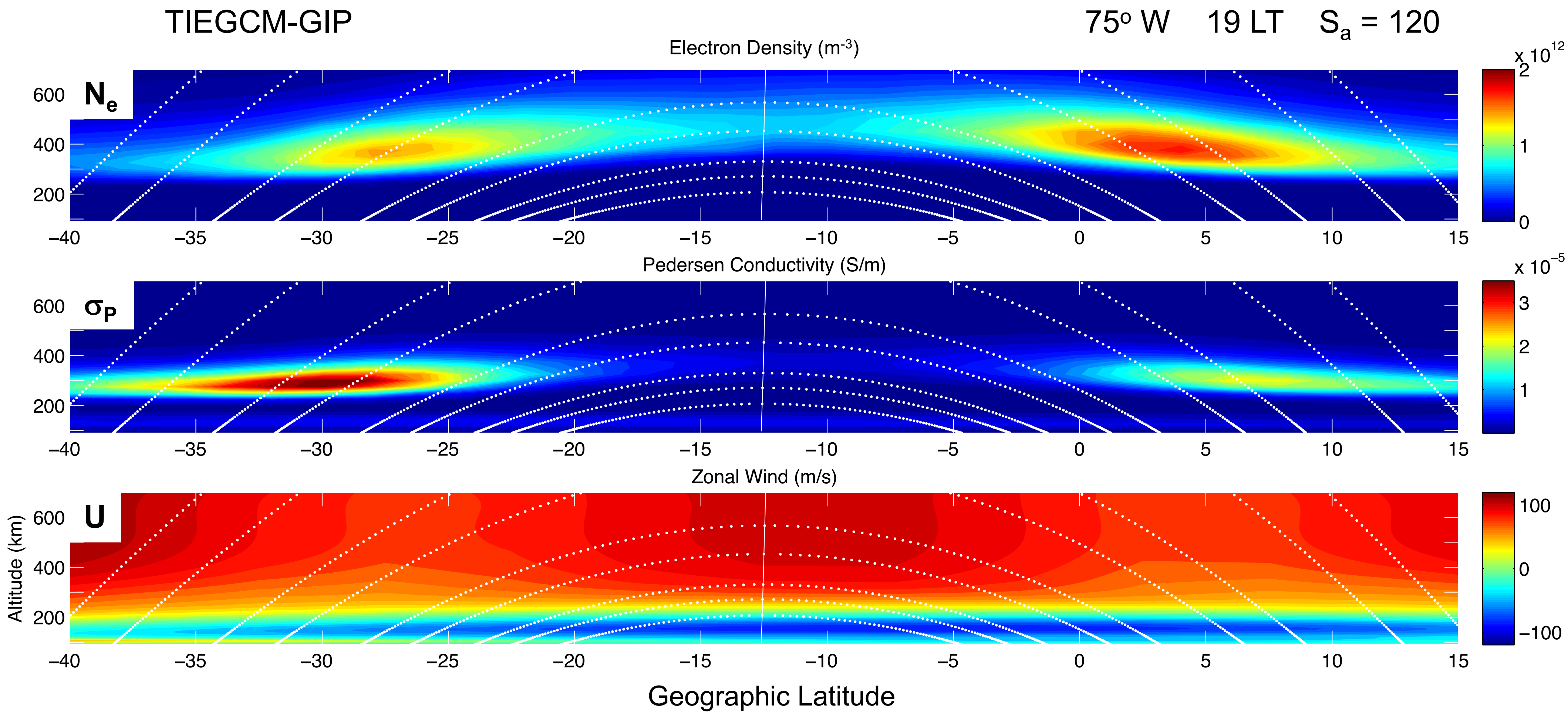


Weichun Fong

Xinzhao Chu

Tim Fuller-Rowell

Low-Latitude Evening Electrodynamics



Tzu-Wei Fang

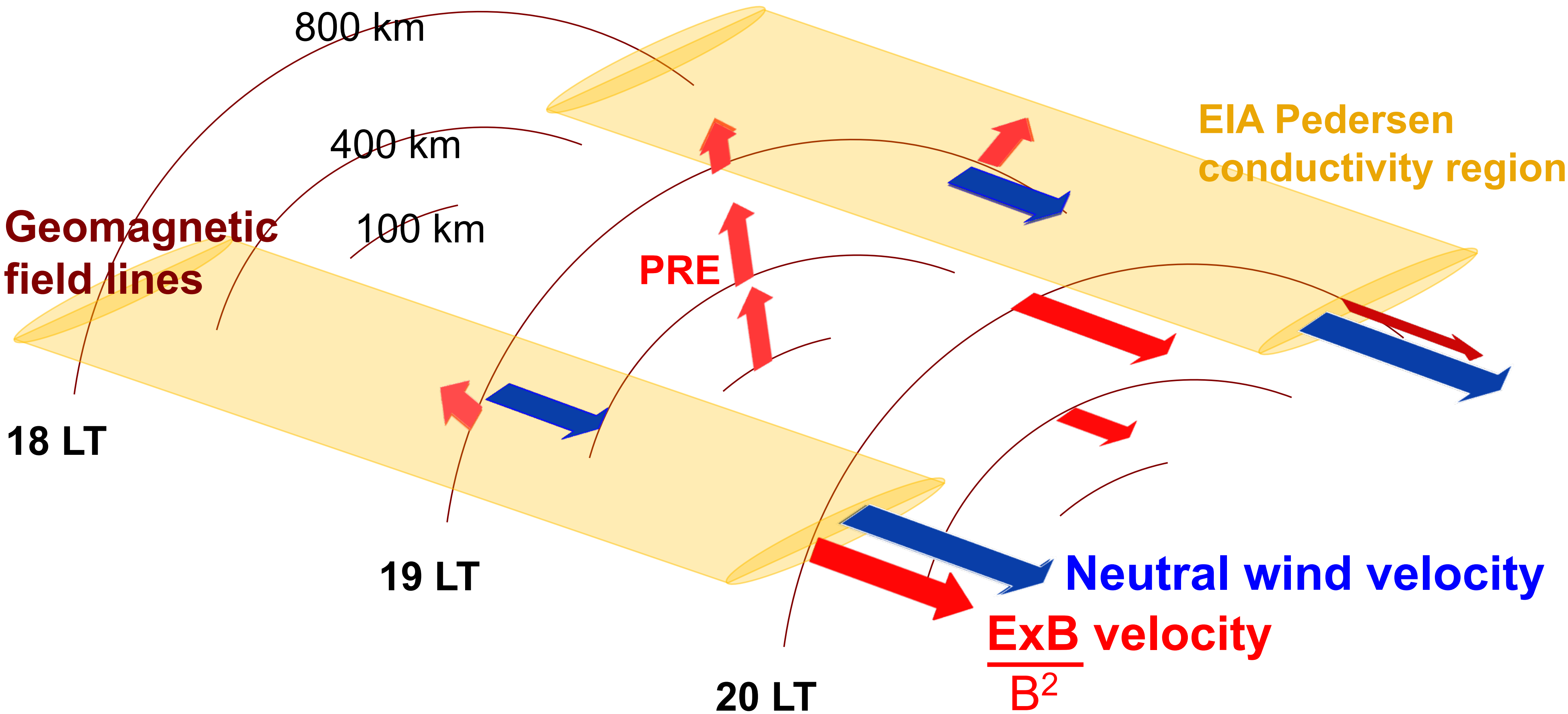
Astrid Maute

Will Evonosky

Richmond et al. (2015)

Richmond and Fang (2015)

Evonosky et al. (2016)



- ExB convection is practically constant along magnetic field lines.
- Differences between neutral wind velocity and ExB velocity create drag on convection.
- Eastward neutral wind at EIA latitudes increases with height and toward the east, tending to drag plasma along.
- Continuity of ExB convection requires vertical inflow around 18.5-19 LT, producing pre-reversal enhancement (PRE) of vertical drift around 400 km.
- Upward ExB convection extends through E region, where the equatorial electrojet exerts drag on the convection.

Concluding Remarks

Ionospheric electrodynamics involves interactions:

- ionization processes
- ionosphere dynamics
- neutral dynamics
- tides and waves (coupling with lower atmosphere)
- coupling with magnetosphere

It therefore requires collaborative research.

Advancements call for:

- extensive observations
- whole-atmosphere modeling
- coupled magnetosphere/ionosphere/atmosphere modeling
- data assimilation