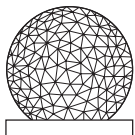


Combining Ionosphere & Sensor Models to Improve CEDAR Science Research

John Swoboda
Shun-rong Zang



MIT
HAYSTACK
OBSERVATORY

Agenda

- (1:30-1:40) John Swoboda Shun-rong Zang – Intro
- (1:40-1:50) Shun-rong Zang – F1 Region Composition
- (1:50-2:10) John Swoboda – Exploring Model Inputs with SimISR
- (2:10-2:30) Lindsay Goodwin - The effect of high latitude distorted ion velocity distributions on radar and satellite observations
- (2:30-2:50) Kay Deshpande - Interfacing ionospheric propagation and plasma instability models for GNSS scintillation studies
- (2:50-3:00) Matt Zettergren - Interfacing models and data (from sounding rocket campaigns)
- (3:00-3:20) Ashton Reimer - Signal Statistics and Parameter Estimation
- (3:20-3:30) Discussion

Goals

- Bring modeling and sensor communities closer together
 - Avoid stove piping
- Improve sensor development and experiment design
 - Help to understand processes that are to be observed
- Overall improve scientific discovery
 - Help validate physical models

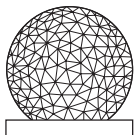
Observability

- Can the phenomena be observed by the sensor?
 - Spatio-temporal resolution
 - Statistical resolution

- Can competing theories be disambiguated?
 - New sensor
 - Sensor fusion



[Karl 2005]

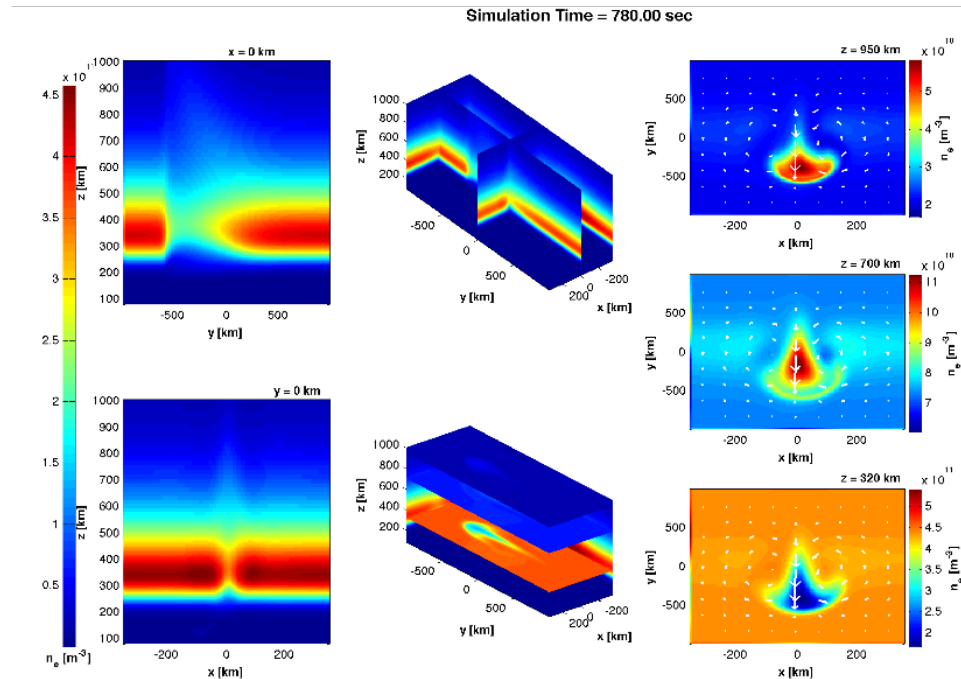


MIT
HAYSTACK
OBSERVATORY

Example Physical Models

- Empirical models
 - Uses sensor data to model physical process
 - Examples: MSIS, IRI

- First principle physics model
 - GEMINI
[Zettergren et. al. 2012]
 - GITM



[Zettergren et. al. 2012]

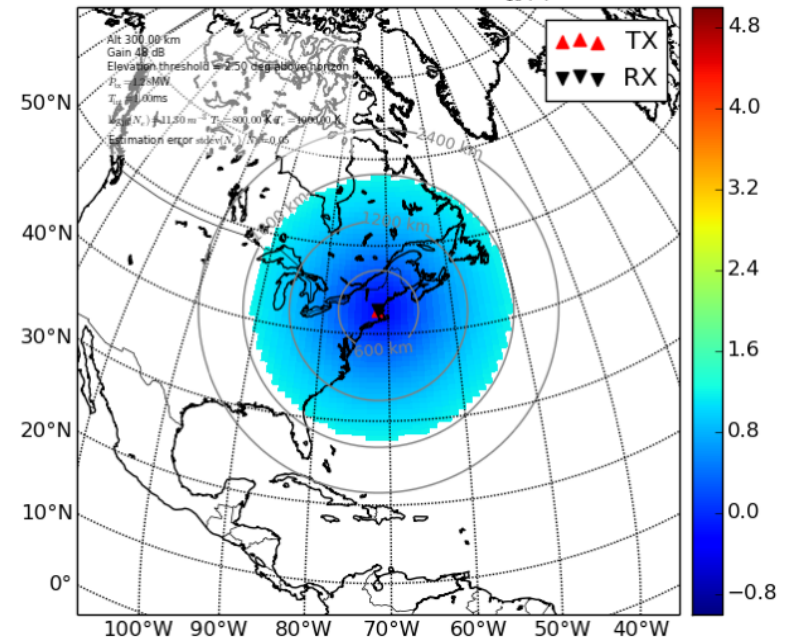


MIT
HAYSTACK
OBSERVATORY

Sensor Models

- Performance models
 - Predicts performance of sensor
 - Example: MIPS
(MIT ISR Performance Simulator)
- Emulation
 - Creates synthetic data
 - Can give example measurements
 - Example: SimISR

Millstone Hill MARS (large aperture) (fixed parameters)
measurement speed ($\log_{10}(s)$)



References

- M. Zettergren, J. Semeter, C. Heinselman, and M. Diaz, “Incoherent scatter radar estimation of Fregion ionospheric composition during frictional heating events,” *J. Geophys. Res. Space Physics*, vol. 116, no. 1, pp. n/a–n/a, Jan. 2011.
- Oliver, W. L., J. M. Holt, S.-R. Zhang, and L. P. Goncharenko, “Long-term trends in thermospheric neutral temperature and density above Millstone Hill,” pp. 1–7, Oct. 2014.
- W. C. Karl, *Regularization in Image Restoration and Reconstruction*, Second Edition. Elsevier Inc., 2005, pp. 183–202.
- J. Swoboda, J. Semeter, M. Zettergren, and P. J. Erickson, “Observability of ionospheric space-time structure with ISR: A simulation study,” *Radio Science*, pp. 1–20, Feb. 2017.
- Zettergren, M. and Semeter, J. (2012). Ionospheric plasma transport and loss in auroral downward current regions. *J. Geophys. Res.*, 117(A6):A06306.

