A machine learning based specification and forecast model of the inner magnetospheric radiation environment

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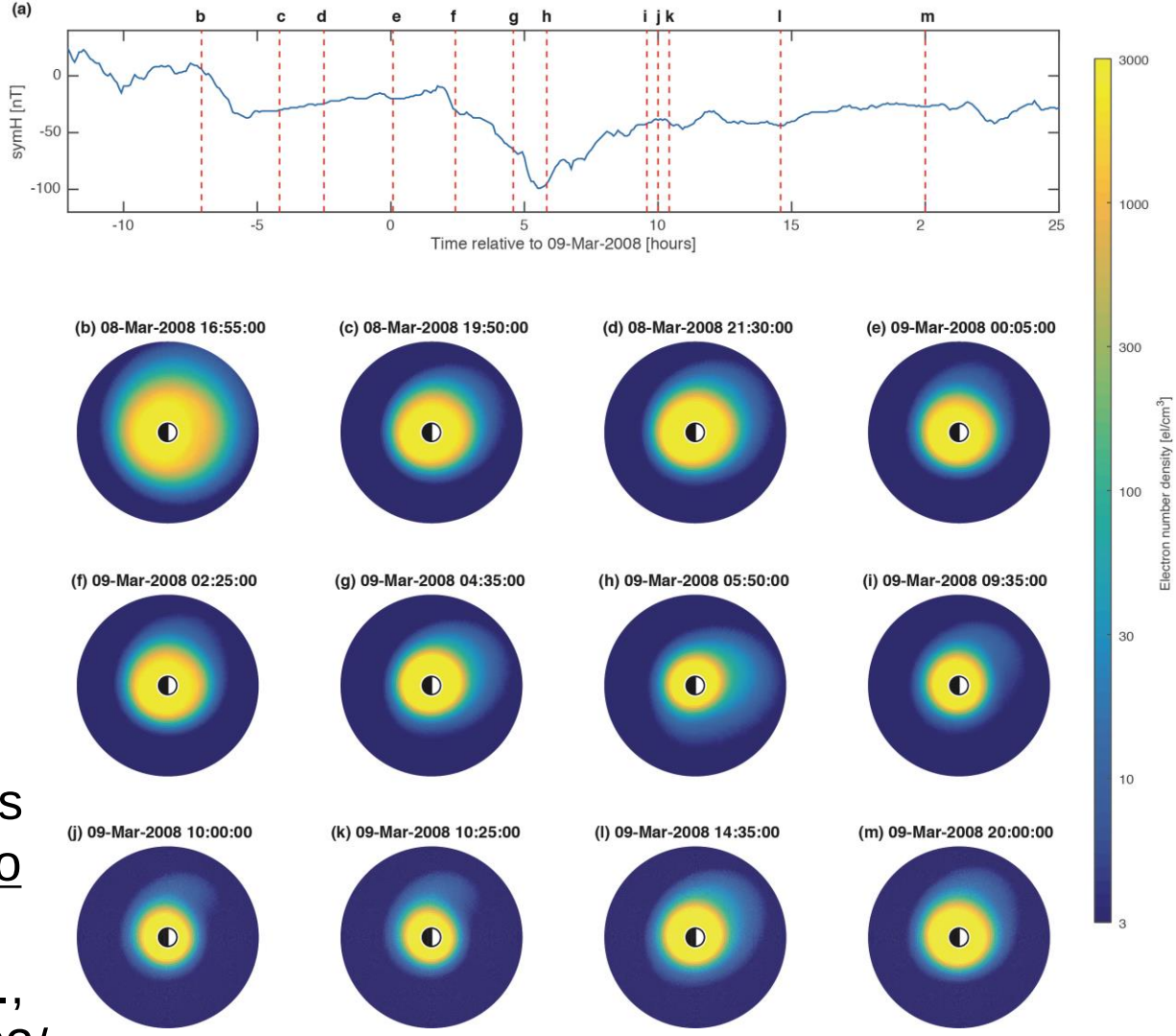
Goals: 2-year effort to produce Artificial Neural-Network (ANN) based model of the Earth's environment:

1. A dynamic plasma density model in 3D: already largely created
2. Chorus wave model in 3D: preliminary model complete
3. Plasmaspheric hiss wave model in 3D: preliminary model complete
4. Energetic electron flux ANN models, from ~1 keV to few 100 keV
5. Energetic proton flux ANN models, from ~1 keV to ~MeV
6. Ultra-relativistic electron fluxes from a fused quasilinear diffusion model, driven by ANN-modeled wave fields, and boundary conditions
7. Long-range forecast (up to +6 days) models as 1-6 above, using SET-derived Dst.

Goal: ***Given a set of sparse measure-ments of quantity Q, at location r and time t, re-construct Q over all r at any t***



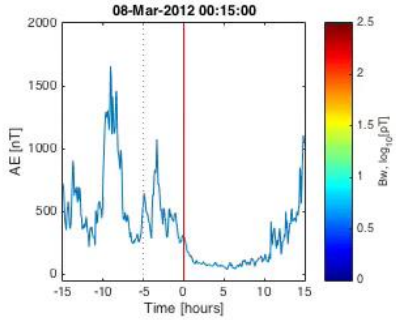
Bortnik, J., W. Li, R. M. Thorne, and V. Angelopoulos (2016), A unified approach to inner magnetospheric state prediction, J. Geophys. Res., 121, 2423–2430, doi:10.1002/2015JA021733.

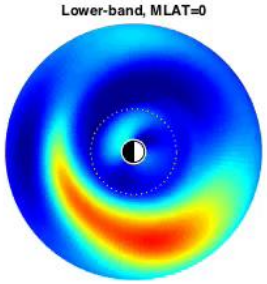
Model input only sym-H (similar to SAMI 3), 5 hr history at 5 min cadence. Easy to use (can reconstruct deep historical events). Easy or forecasting if sym-H is predicted.

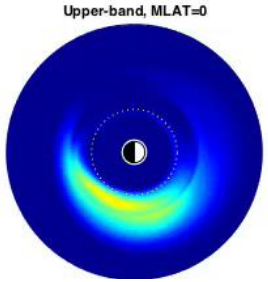
Approach is general: can be applied to any quantity: plasma, hiss and chorus waves

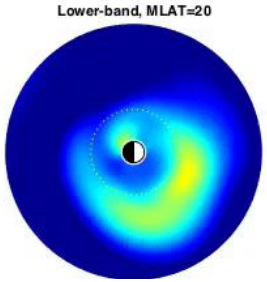
Whistler-mode chorus waves

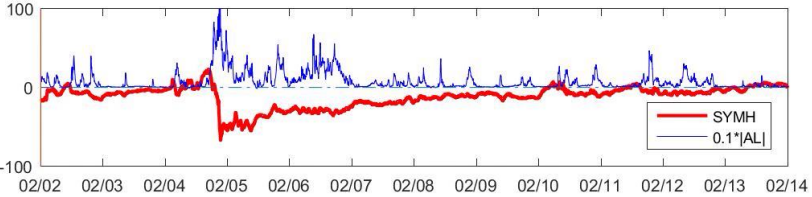
Upper band (0.5-0.8 fce) and lower band (0.1-0.5 fce) waves, measured on THEMIS/RBSP, ~372k pts.

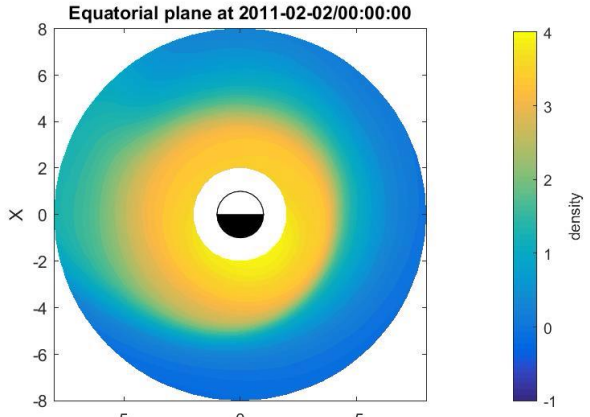






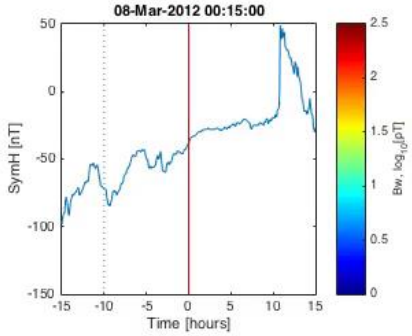


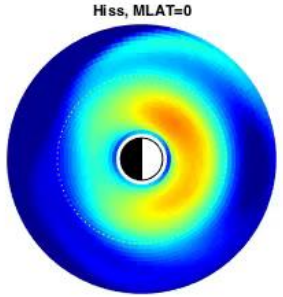


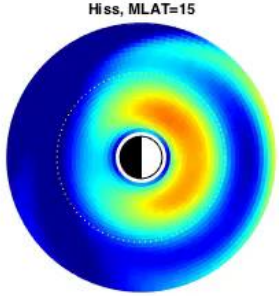


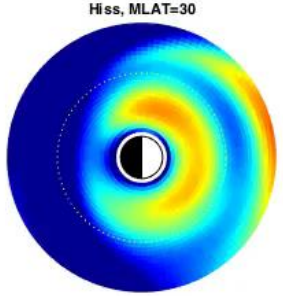
Plasmaspheric hiss waves

Van Allen Probes data, EMFISIS 0.1-2 kHz Bw; Oct 2012-Sep 2014, ~280k samples. Regressed on 10-hrs of sym-H





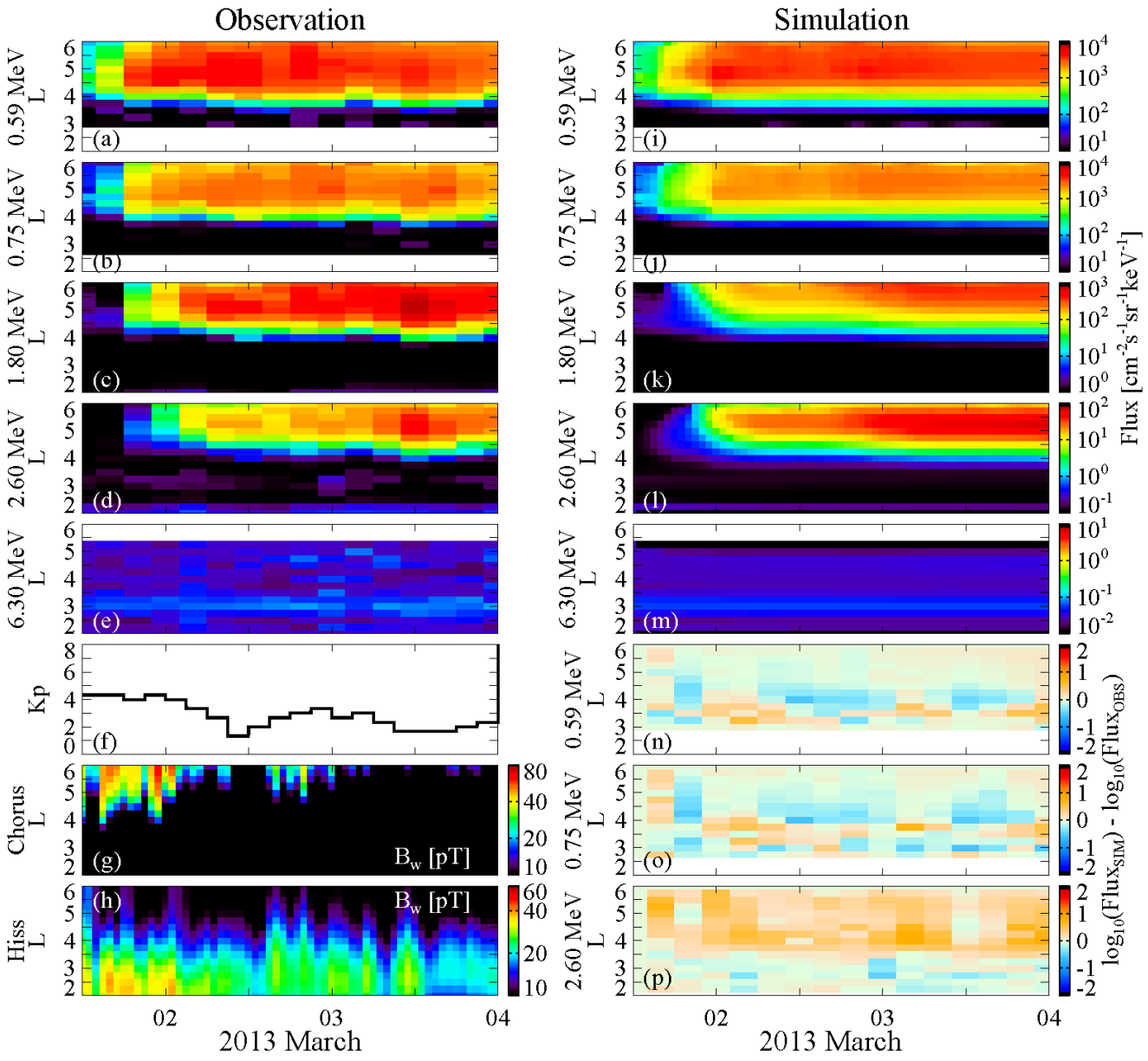




Chu, X. N., J. Bortnik, W. Li, Q. Ma, V. Angelopoulos, and R. M. Thorne (2017), Erosion and refilling of the plasmasphere during a geomagnetic storm modeled by a neural network, *Journal of Geophysical Research,* doi: 10.1002/2017JA023948.

Application in modeling boundary and driving conditions

Bortnik et al., (2018), Artificial Neural Networks for Determining Magneto-spheric Conditions, in *Machine Learning Techniques for Space Weather*, Elsevier Inc., doi: 10.1016/B978-0-12-811788-0.00011-1.



Any/all models can be immediately transitioned to operations through SET's Space Weather center. Long-range models fed by +6 day ANEMOMELOS Dst predictions

Instructions

In a brief panel style presentation (5-min presentation plus 1 minute between speakers), we would appreciate each of you addressing: your proposed topic,

1. the goals of your work,

2. accomplishments to date, and

3. your vision of how the results of your work can benefit space weather services and be made available for transition into space weather operations.

Please keep your presentation to approximately 4 slides.