CIMI Model

Comprehensive Inner Magnetosphere-Ionosphere Model

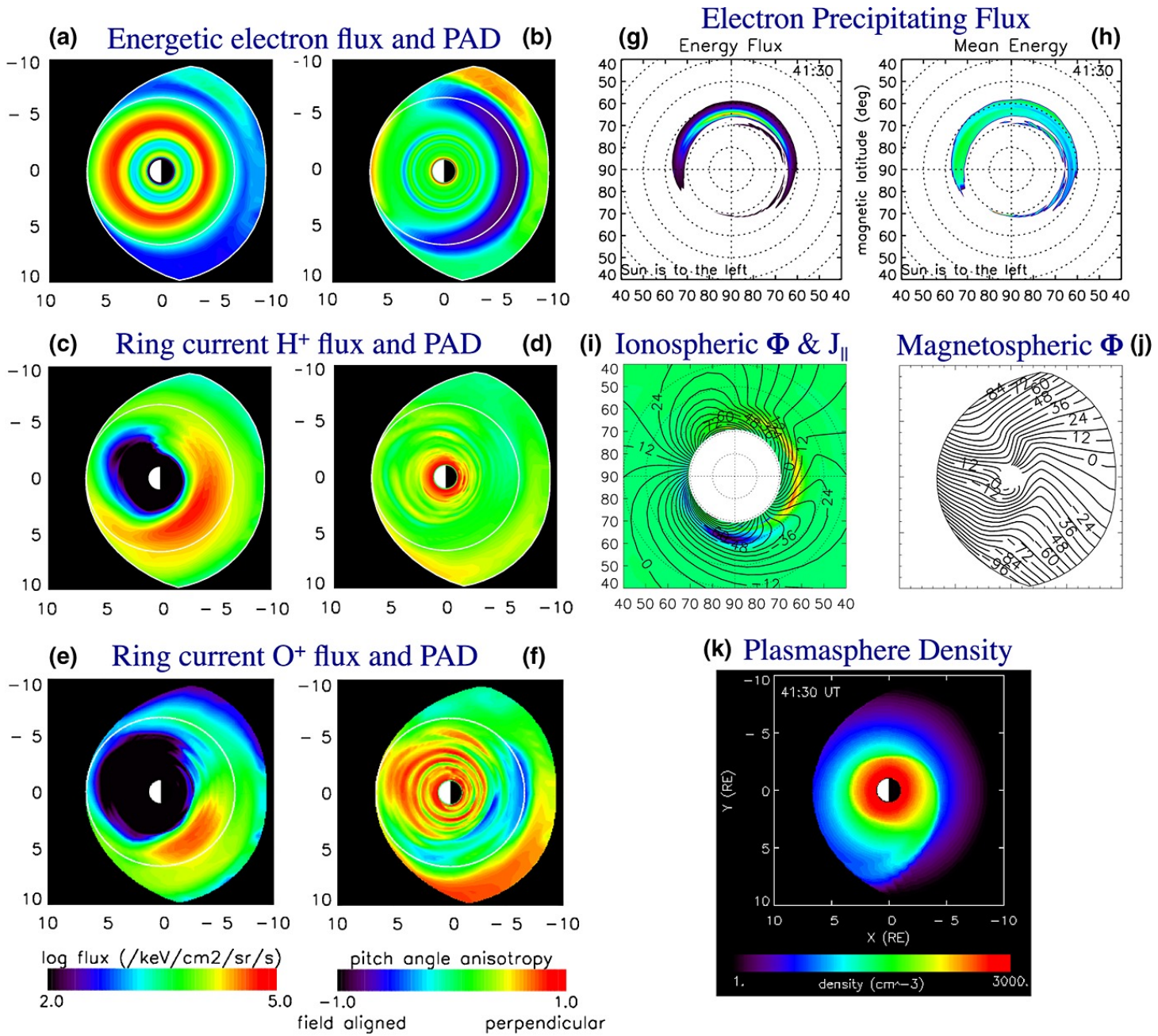
Science Applications

- Ring current and radiation belt dynamics
  - Flux/phase space density/anisotropy/pressure
  - Gain understanding of different physical processes
  - Composition (H+, O+, He+, e-)
  - 3-D global electric field
  - ENA (energetic neutral atom) studies
  - Field-aligned current maps
  - SubAuroral Polarization streams (SAPs)
  - Plasmaspheric dynamics
  - Substorm effects on the inner magnetosphere dynamics

Space Weather Applications

- Nowcasting of ring current and radiation belt electron fluxes/fluence
- Charging Risk Assessment (by coupling with other codes, such as shieldDose-2, NUMIT, DICTAT, NASCAP, etc)

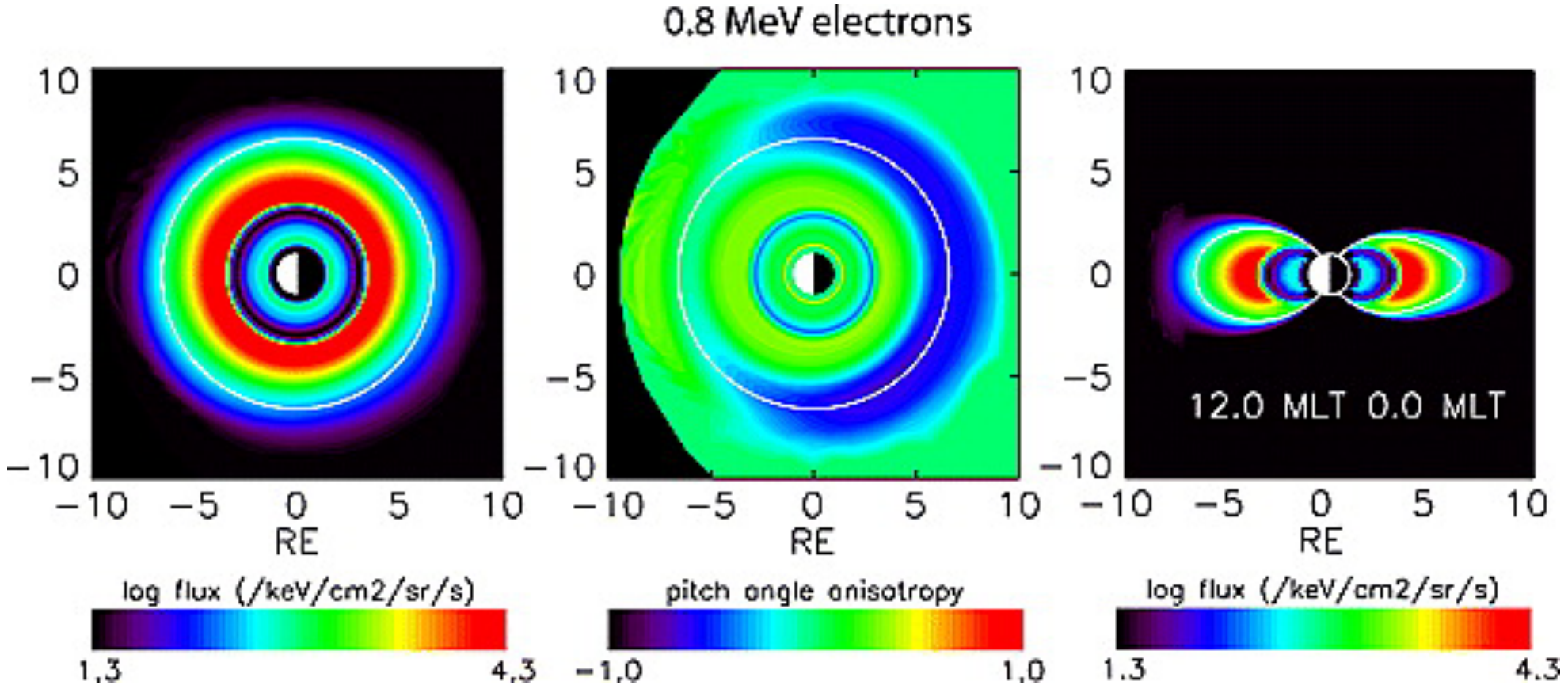
Science Applications



This figure showcases some of the CIMI capabilities/products: (a) energy electron flux, (b) pitch-angle distribution, (c) H+ flux and pitch angle distribution (d), (e) O+ flux, (f) pitch angle distribution, (g) precipitating electron flux into the ionosphere (h) precipitating electron mean energy, (i) Convection potential at the ionosphere and field-aligned currents, (j): Convection potential at the equator, (k): Plasmasphere density map.

Fok, M.-C., R. B. Horne, N. P. Meredith, and S. A. Glauert (2008), Radiation Belt Environment model: Application to space weather nowcasting, J. Geophys. Res., 113, A03S08, doi:10.1029/2007JA012558.

Different Views of the Radiation Belt Electron Fluxes



Left: equatorial view of the flux; middle: equatorial view of the pitch angle anisotropy; right: electron flux

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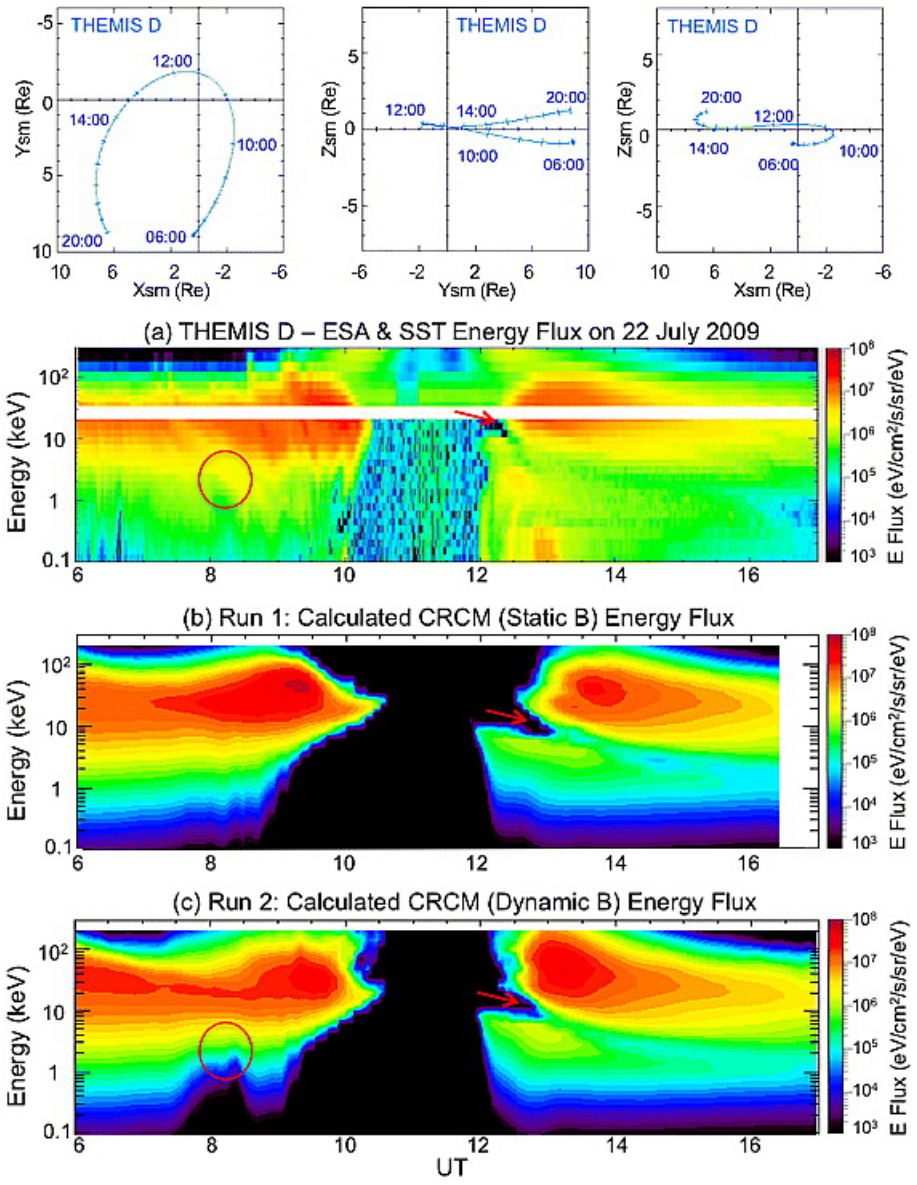
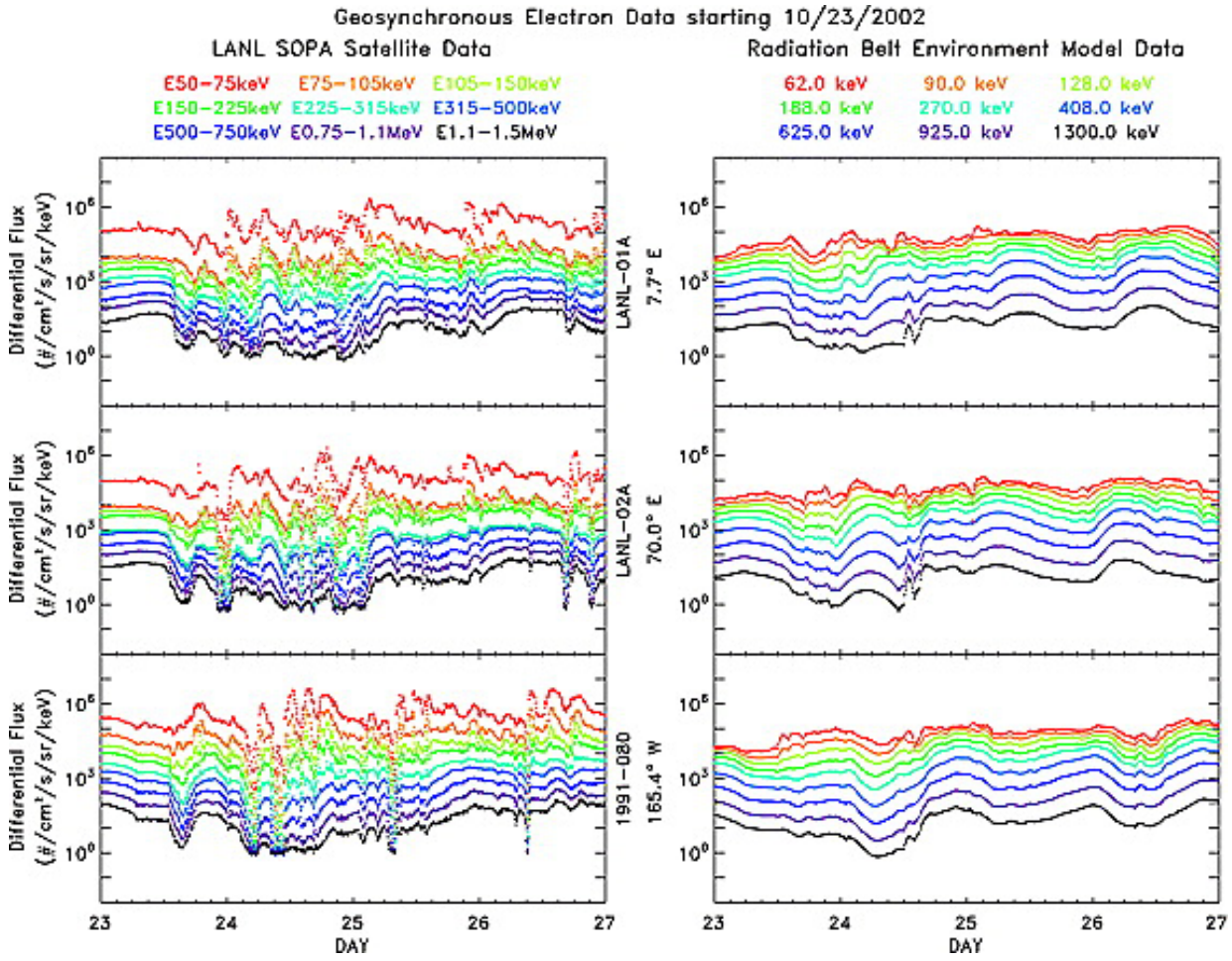
Enabling the Model and Data Comparison along Satellite Trajectories

Energy spectrogram comparison



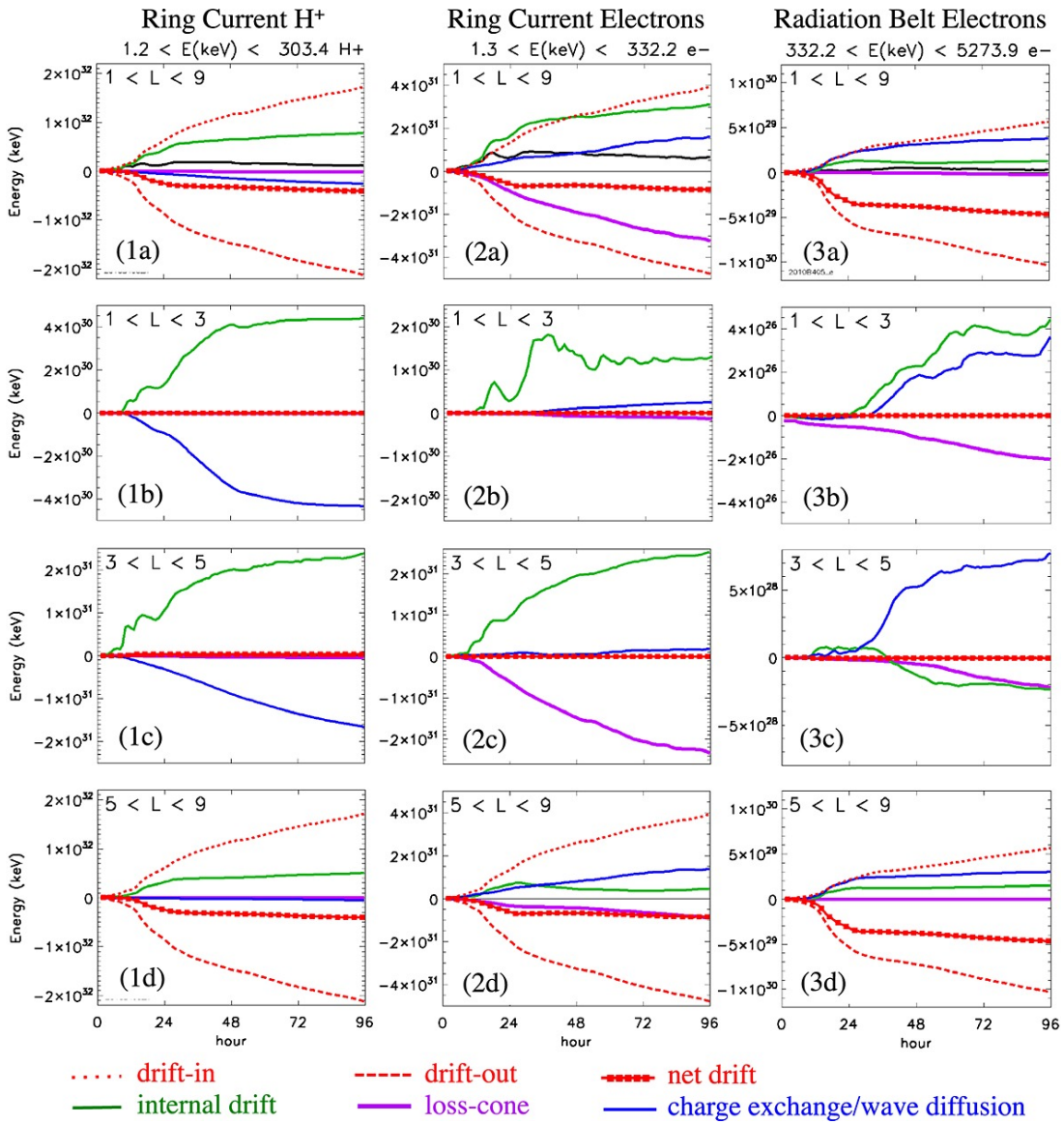
Comparison of temporal variation of fluxes



Fok, M.-C., N. Buzulukova, S.-H. Chen, P. W. Valek, J. Goldstein, and D. J. McComas (2010), Simulation and TWINS observations of the 22 July 2009 storm, J. Geophys. Res., 115, A12231, doi:10.1029/2010JA015443.

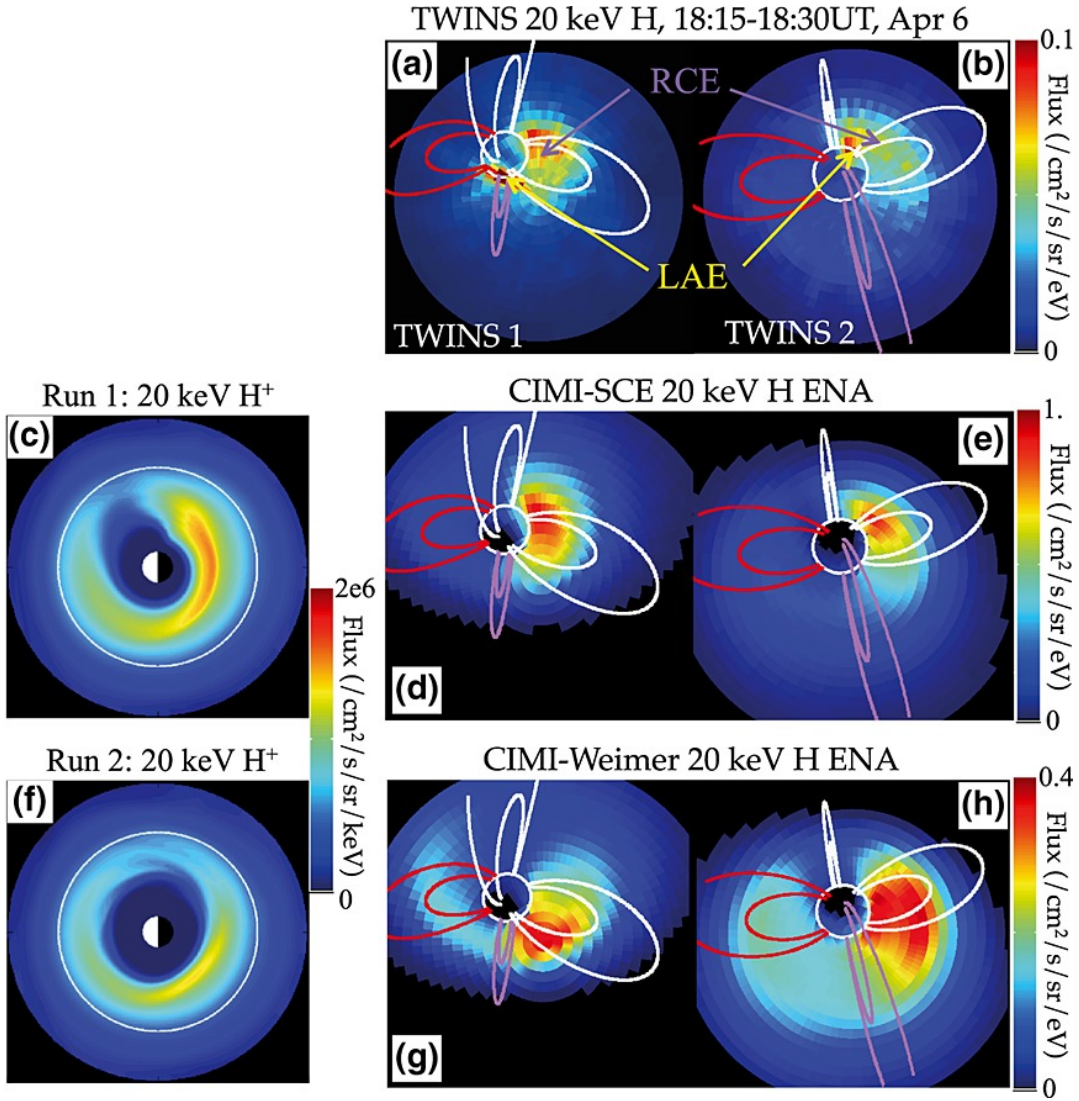
Fok, M.-C., R. B. Horne, N. P. Meredith, and S. A. Glauert (2008), Radiation Belt Environment model: Application to space weather nowcasting, J. Geophys. Res., 113, A03S08, doi:10.1029/2007JA012558.

Isolate and Facilitate a Better Understanding of Different Physical Processes



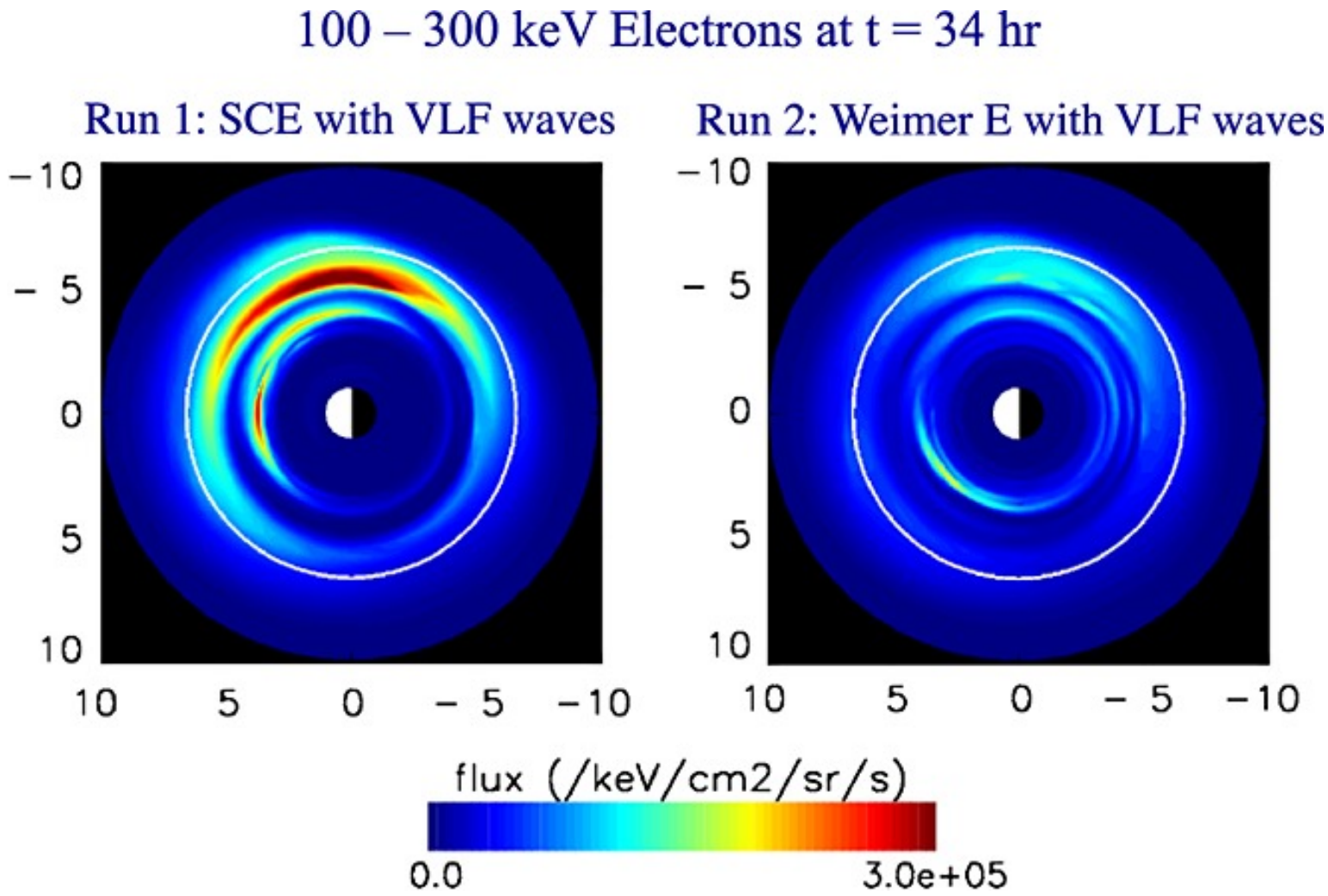
Fok, M.-C., N. Y. Buzulukova, S.-H. Chen, A. Glocer, T. Nagai, P. Valek, and J. D. Perez (2014), The Comprehensive Inner Magnetosphere-Ionosphere Model, J. Geophys. Res. Space Physics, 119, 7522–7540, doi:10.1002/2014JA020239.

CIMI can be Used to Study Ring Current Dynamics via ENA Imaging



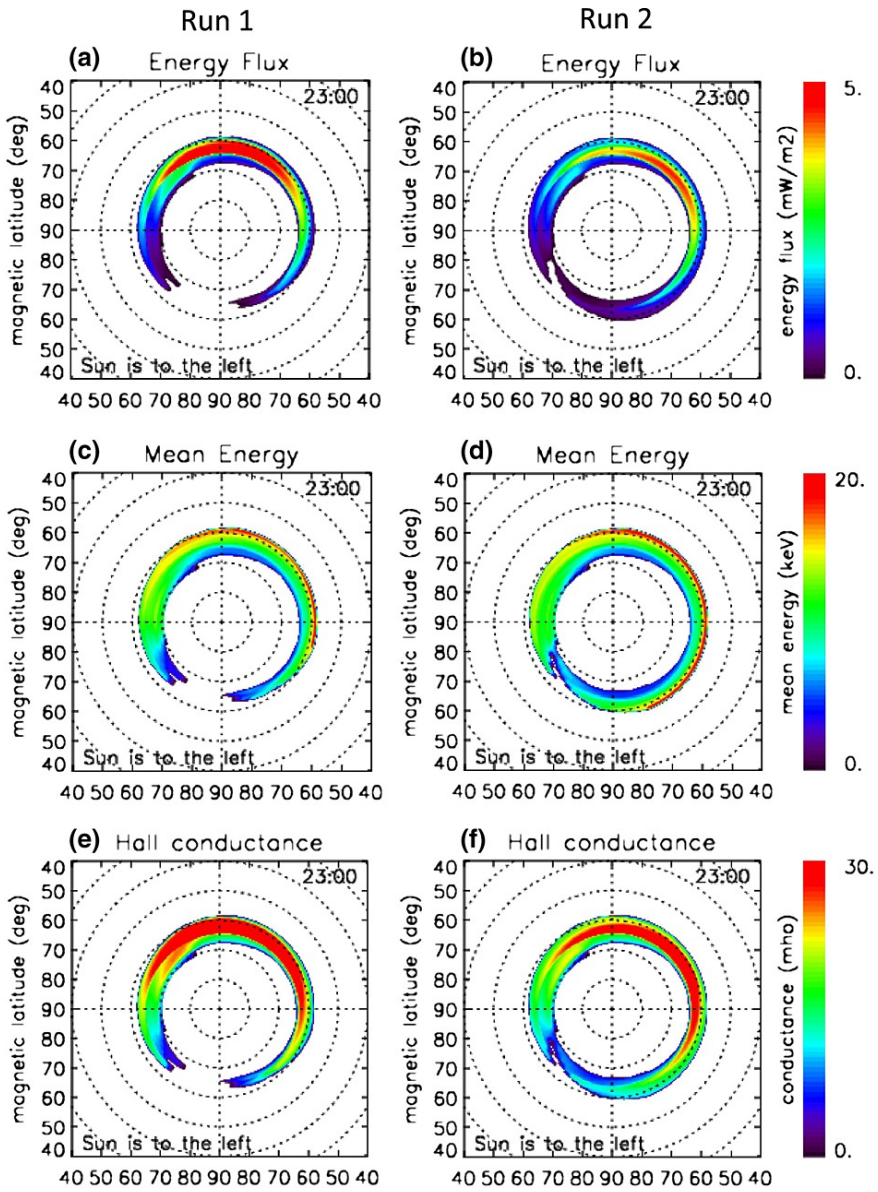
Fok, M.-C., N. Y. Buzulukova, S.-H. Chen, A. Glocer, T. Nagai, P. Valek, and J. D. Perez (2014), The Comprehensive Inner Magnetosphere-Ionosphere Model, J. Geophys. Res. Space Physics, 119, 7522–7540, doi:10.1002/2014JA020239.

Study Waves' Impacts on Ring Current-Radiation Belt Particle Dynamics



Fok, M.-C., N. Y. Buzulukova, S.-H. Chen, A. Glocer, T. Nagai, P. Valek, and J. D. Perez (2014), The Comprehensive Inner Magnetosphere-Ionosphere Model, J. Geophys. Res. Space Physics, 119, 7522–7540, doi:10.1002/2014JA020239.

Electron Precipitation Characteristics into the Ionosphere



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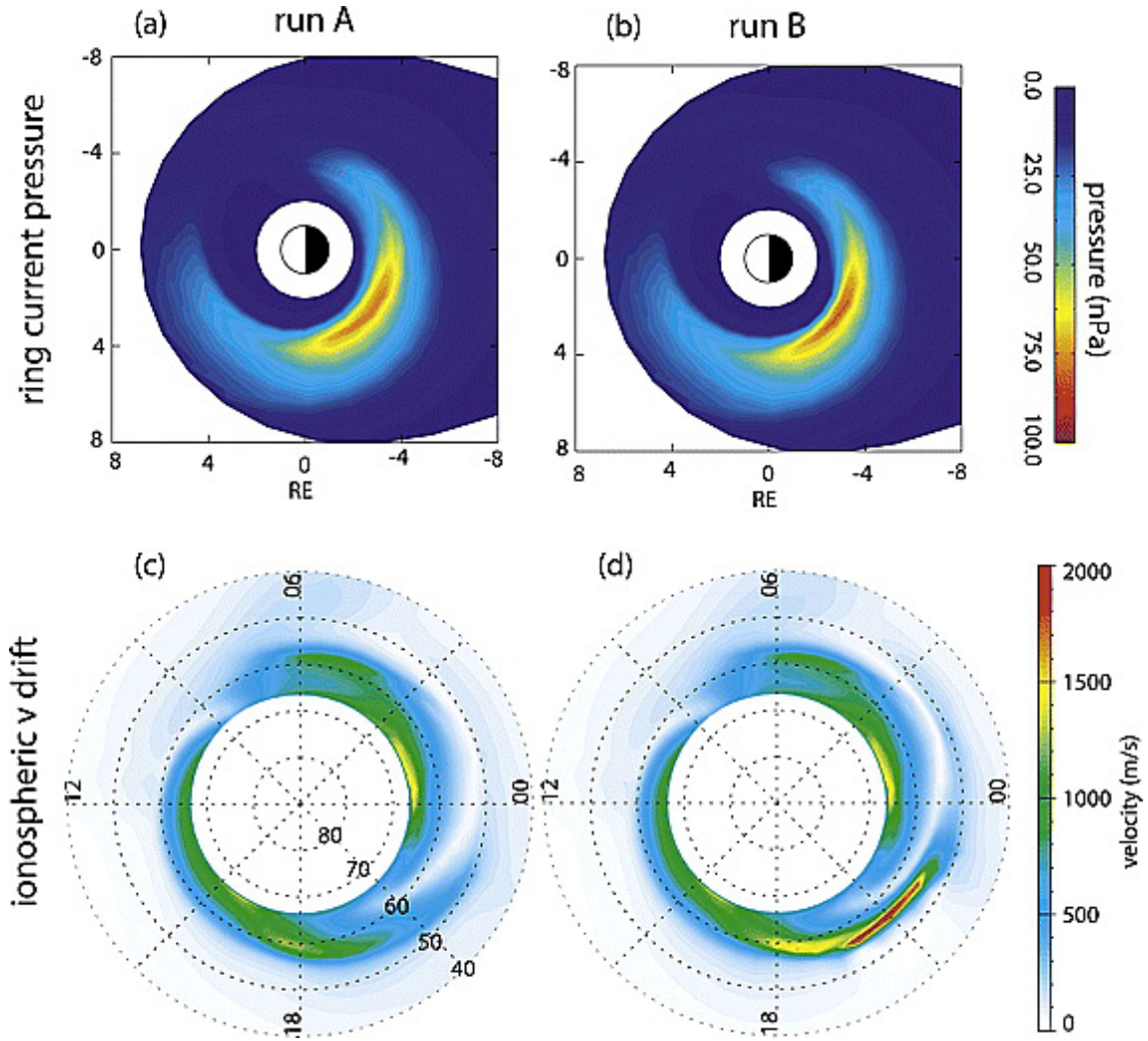
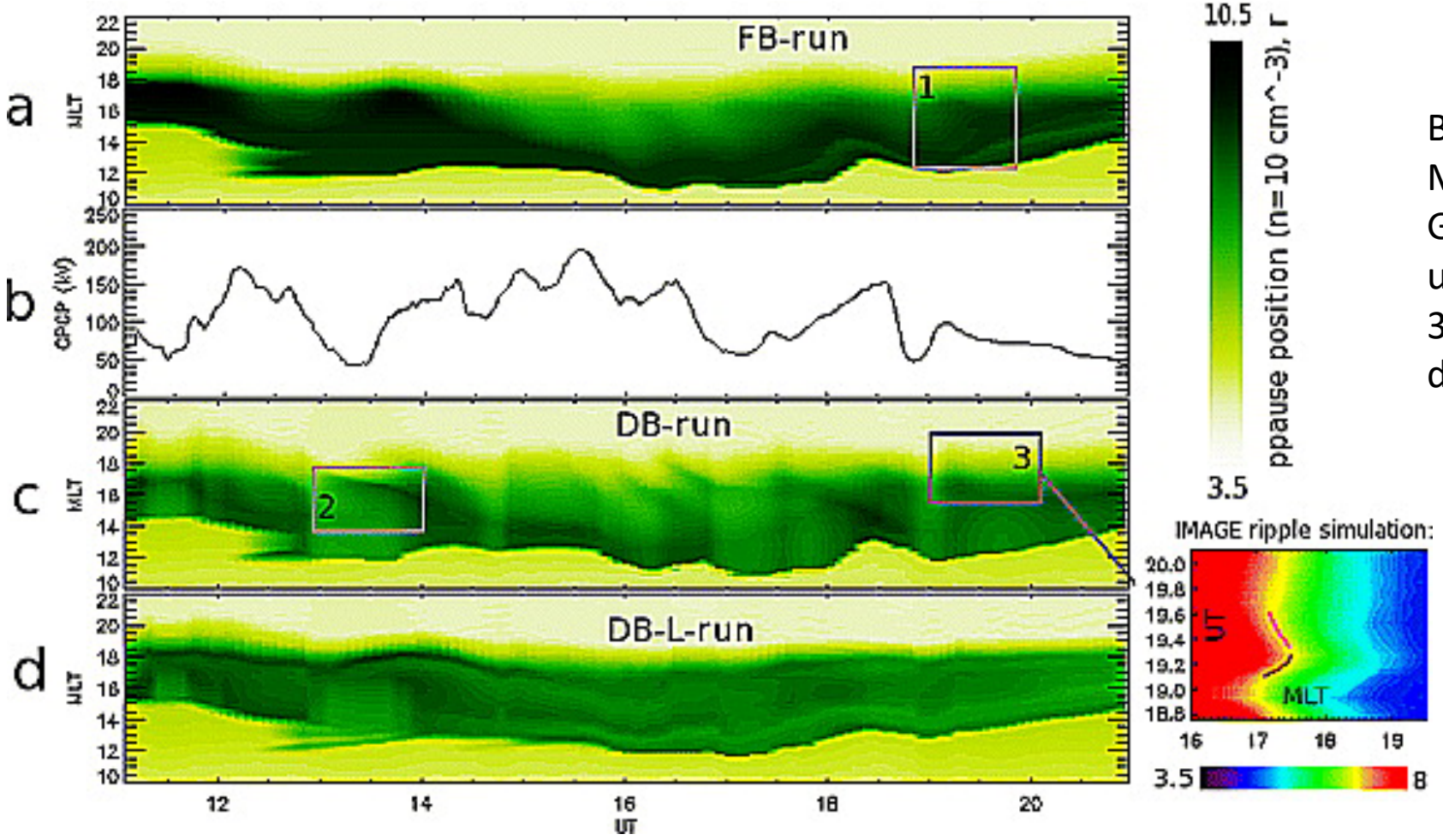
Can be used to Model Physics of SAPs



Zheng, Y., P. C. Brandt, A. T. Y. Lui, and M.-C. Fok (2008), On ionospheric trough conductance and subauroral polarization streams: Simulation results, J. Geophys. Res., 113, A04209, doi:10.1029/2007JA012532

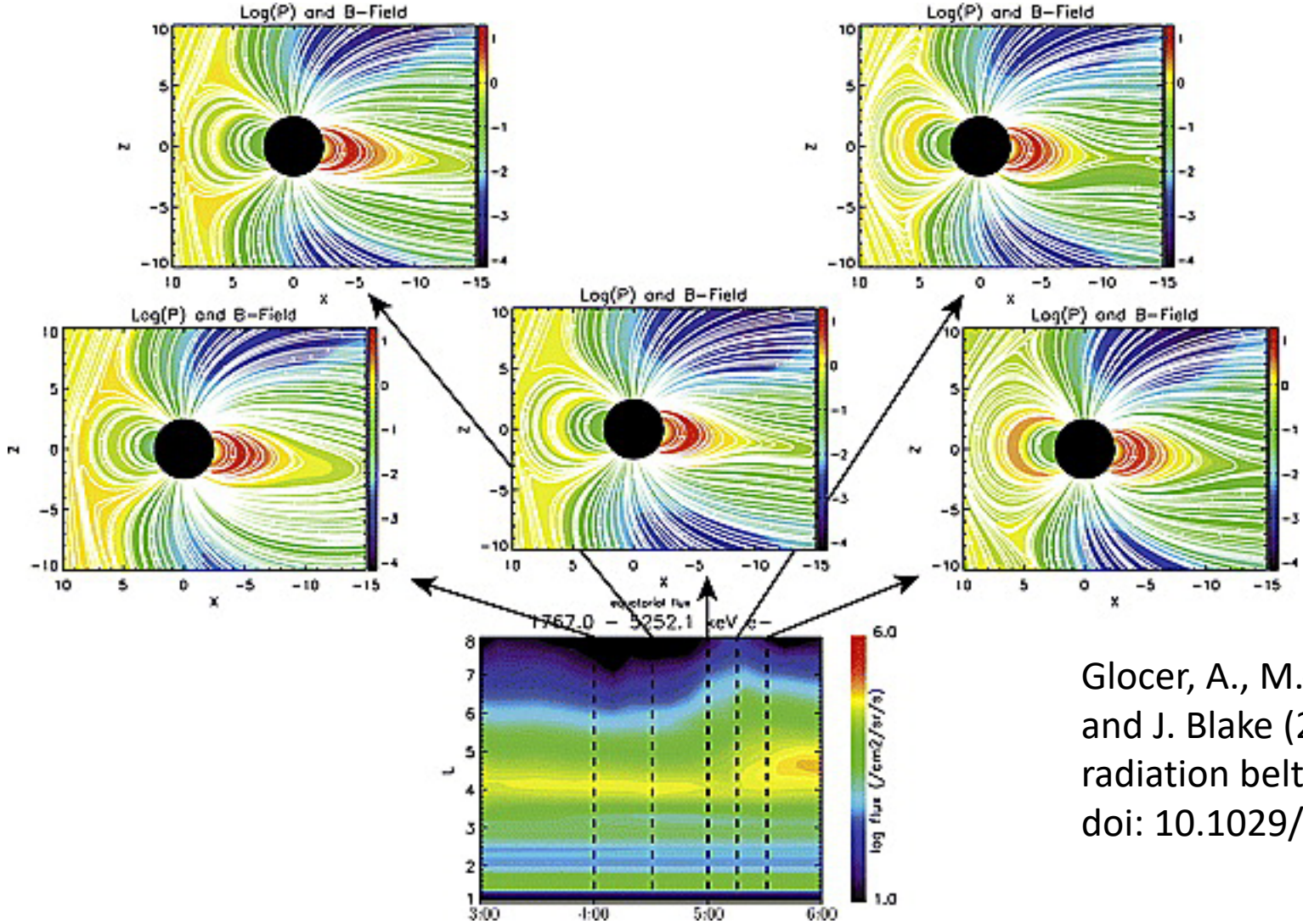
SAPs: subauroral polarization streams

Plasmasphere Dynamics/Structures



Buzulukova, N., M.-C. Fok, T. E. Moore, and D. M. Ober (2008), Generation of plasmaspheric undulations, Geophys. Res. Lett., 35, L13105, doi:10.1029/2008GL034164.

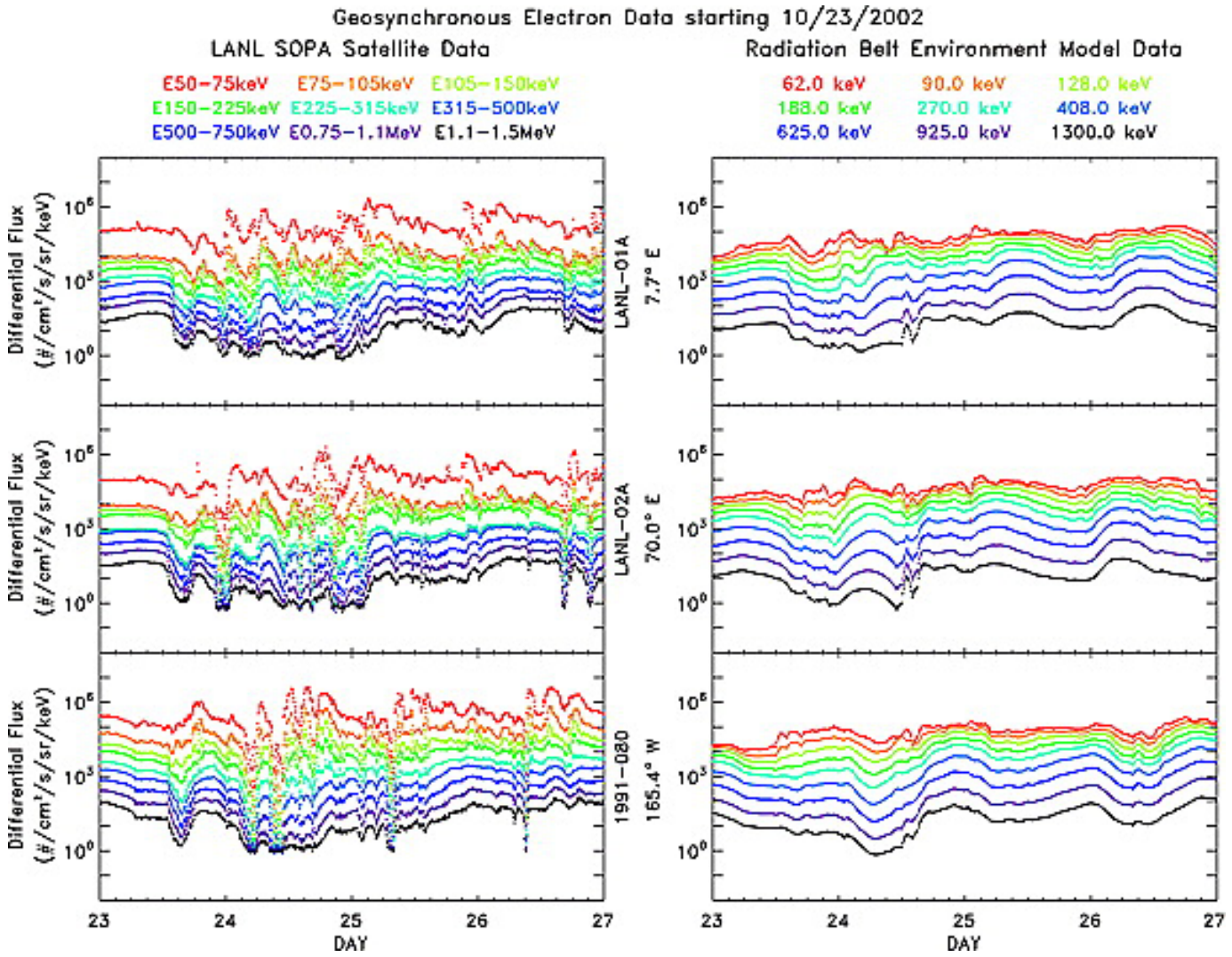
The Coupled RBE (part of the CIMI) and SWMF can be used to study the Substorm/Dipolarization's Effects on Radiation Belt Dynamics



Glocer, A., M.-C. Fok, T. Nagai, G. Tóth, T. Guild, and J. Blake (2011), Rapid rebuilding of the outer radiation belt, J. Geophys. Res., 116, A09213, doi: 10.1029/2011JA016516.

Space Weather Applications

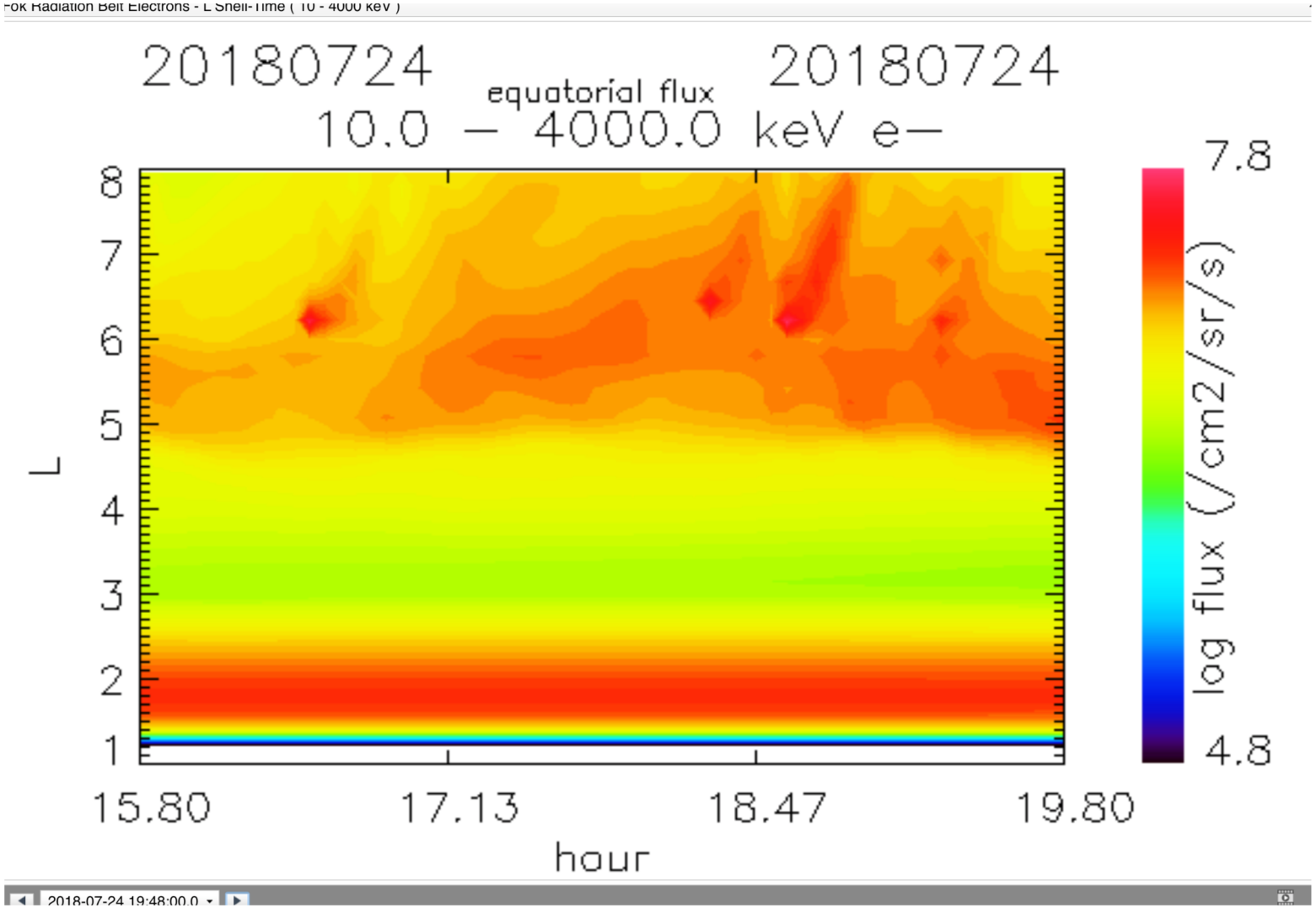
Nowcasting of Fluxes at Different Energies for the Entire Inner Magnetosphere



Can be fluences too

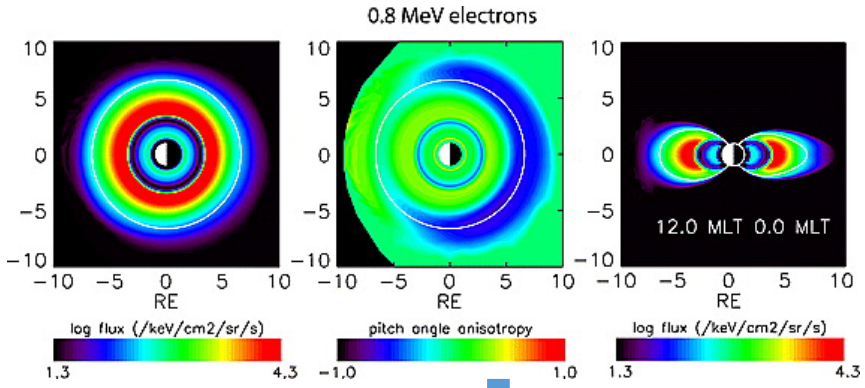
Fok, M.-C., R. B. Horne, N. P. Meredith, and S. A. Glauert (2008), Radiation Belt Environment model: Application to space weather nowcasting, J. Geophys. Res., 113, A03S08, doi:10.1029/2007JA012558.

Nowcasting of Fluxes at Different Energies in L-T (on iSWA)



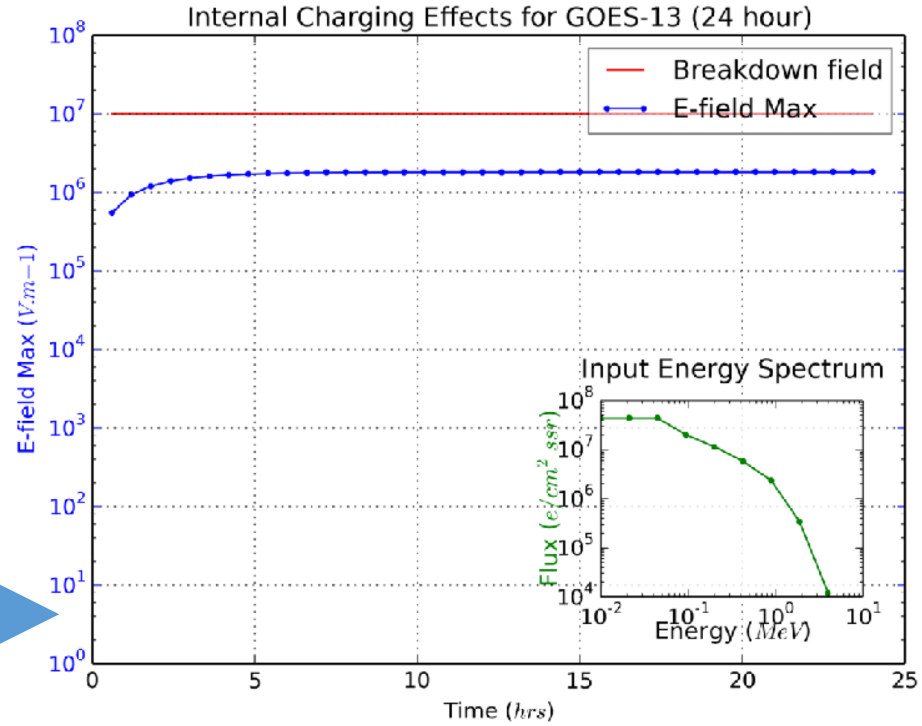
https://iswa.gsfc.nasa.gov/IswaSystemWebApp/

Providing Internal Charging Risk Assessment



Modelled electron spectra

Impact models such as DICTAT, NUMIT, SHIELDDOSE-2

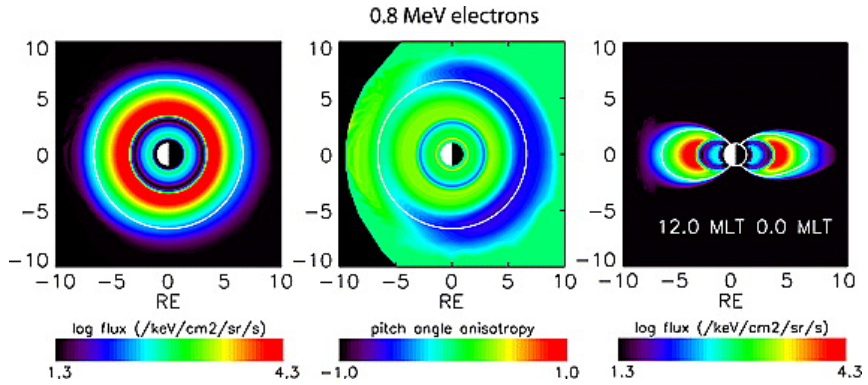


Outputs include the charging electric field, current, charge density profiles, dose-depth curves, and others depending on a specific impact model

https://www.spenvis.oma.be/help/background/charging/dictat/dictatman.html

https://ccmc.gsfc.nasa.gov/models/modelinfo.php?model=Fok%20Radiation%20Belt%20Electron

Providing Surface Charging Risk Assessment



Modelled electron spectra

Impact models such as NASCAP-2k

Provide estimates of surface voltage

NASCAP-2k = NASA/Air Force Spacecraft Charging Analyzer Program

ESD (Electrostatic Discharge)/IESD (Internal Electrostatic Discharge)

Using a flux/fluence threshold (for a certain energy or certain energy range) as a quick, rough estimate of potential risks.

These are based on past findings/experiences/publications.