3/1/2017 CIR-driven Storm
Simulation vs. Observation (THEMIS)

![Proton Flux (THEMIS-D)](image1)

![Proton Flux (THEMIS-E)](image2)

![OpenGGCM (cir_20170301_fb001_etanew_3d)](image3)

![OpenGGCM (cir_20170301_fb001_etanew_3d)](image4)
Extra Slides
Simulation vs. Observation (THEMIS)

Proton Flux (THEMIS-D)

Proton Flux (THEMIS-E)

OpenGGCM (cir_20170301_fb001_etanew_3d)

OpenGGCM (cir_20170301_fb001_etanew_3d)
Simulation vs. Observation (RBSP)

Average Proton Flux (RBSP–A)

Flux [1/cm²·sr·s·keV]

03/01/2017 12:00 to 03/01/2017 16:00

L: 1.2 - 2.0, 4.0 - 5.0, 6.0 - 6.1, 6.0 - 6.0, 5.0 - 4.0, 2.6
MLT: 5.0, 14.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 24.0
MLAT: 14.2 - 1.0 - 7.0 - 10.0 - 12.9 - 13.0 - 14.0 - 15.0 - 16.8 - 17.0 - 18.2

OpenGGCM (cir_20170301_fb001_etanew_3d)

Flux [1/cm²·sr·s·keV]

03/01/2017 12:00 to 03/01/2017 16:00

L: 4.0 - 5.0, 5.8 - 5.0, 5.0 - 4.0, 2.8
MLT: 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 24.0
MLAT: 10.0 - 7.0 - 4.0 - 2.0 - 0.0 - 2.0 - 4.0 - 7.0 - 10.0 - 13.7

Average Proton Flux (RBSP–B)

Flux [1/cm²·sr·s·keV]

03/01/2017 12:00 to 03/01/2017 16:00

L: 1.2 - 2.0, 4.0 - 5.0, 6.0 - 6.1, 6.0 - 6.0, 5.0 - 4.0, 2.6
MLT: 5.0, 13.3, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.9

OpenGGCM (cir_20170301_fb001_etanew_3d)

Flux [1/cm²·sr·s·keV]

03/01/2017 12:00 to 03/01/2017 16:00

L: 4.0 - 5.0, 5.8 - 5.0, 5.0 - 4.0, 2.7
MLT: 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.4
MLAT: 13.0 - 10.0 - 8.0 - 6.0 - 4.0 - 2.0 - 0.0 - 7.0 - 10.0 - 13.7

Energy Levels:
- 180 keV
- 121 keV
- 99 keV
- 58 keV
- 44 keV
- 33 keV
- 24 keV
- 13 keV
- 7 keV
- 1 keV
Model Parameters vs THEMIS
Plasma Sheet Injections

• Narrow (1-3 $R_E$) channels of earthward-moving plasma

• Flow Bursts
  – Short-duration (1-2 min) high-speed flows (generally $V>400$ km/s)

• Bursty Bulk Flows (BBFs)
  – Segments of moderate-speed flows (generally $V>100$ km/s) with flow burst(s)

• Usually accompanied by dipolarization front

• Primary means of plasma transport into inner magnetosphere during active times

Yang et al., 2011
Model Components

• OpenGGCM
  – 3-D stretched cartesian grid
  – Solves semi-conservative MHD equations for single fluid
    • Plasma energy, not total energy, conserved
  – Solves ionosphere potential on 2-D spherical grid using conductances, field-aligned currents
  – Main inputs: solar wind plasma parameters, interplanetary magnetic field

• CTIM (Coupled Thermosphere-Ionosphere Model)
  – Models chemical and photo-chemical reactions
  – Determines conductances
  – Main inputs: FACs, auroral precipitation, solar EUV

• RCM (Rice Convection Model)
  – 2-D ionosphere grid representing footpoints of flux tubes
  – Solves motion of flux tubes due to potential, magnetic induction and drift
  – Main inputs: outer boundary conditions, ionosphere potential
Model Coupling Methodology

- **OpenGGCM -> Ionosphere**
  - Sends MHD density, pressure, auroral precipitation, FAC
  - Receives Ionosphere Potential

- **RCM -> Ionosphere**
  - Receives Ionosphere Potential
  - Sends RCM FACs, auroral precipitation
    - Blends with MHD values

- **RCM -> OpenGGCM**
  - Convert flux tube content to pressure and density (and vice-versa)
  - Receives MHD pressure, density at boundary
    - Flux tube volume-weighted averages along field line
  - Sends RCM pressure, density
    - Nudge MHD P, n values (RCM influence greater in inner region)
    - RCM feedback slowly ramped up after MHD initialization period