Abstract

The magnetic storm that commenced on June 22, 2015 was one of the largest storms in the current solar cycle. Availability of in situ observations from the Magnetospheric Multiscale (MMS), the Van Allen Probes (VAP), and THEMIS in the magnetosphere, field-aligned currents from AMPERE, as well as the ionospheric data from the Floating Potential Measurement Unit (FPMU) instrument suite on board the International Space Station (ISS) represents an exciting opportunity to analyze storm-related dynamics. Our real-time space weather alert system sent out a “red alert” warning users of the event 2 hours in advance, correctly predicting Kp indices greater than 8. During this event, the MMS observatories were taking measurements in the magnetotail, VAP were in the inner magnetosphere, THEMIS was on the dayside, and the ISS was orbiting at 400 km every 90 minutes. Among the initial findings are the crossing of the dayside magnetopause into the region earthward of 8 RE, strong dipolarizations in the MMS magnetometer data, and drops in the fluxes seen by the MMS FPI instrument suite. At ionospheric altitudes, the FPMU measurements of ion density show dramatic post-sunset depletions at equatorial latitudes that are correlated with the particle flux drops measured by the MMS FPI. AMPERE data show highly variable currents varying from intervals of intense high latitude currents to currents at maximum polar cap expansion to 50 deg MLAT and exceeding 20 MA. In this paper, we use numerical simulations with global magnetohydrodynamic (MHD) models run at the Convection and the Rice Convection Model (RCM) of the inner magnetosphere in an attempt to place the observations in the context of storm-time global electrodynamics and cross-check the simulation global Birkeland currents with AMPERE distributions. We present model-predicted effects of dipolarizations and the global convection on the inner magnetosphere via data-model comparison.

Predictions

The Rice University Space Weather forecast system sent out a “Red Alert” on June 22, 2015, when a major CME was measured in the solar wind. The forecast system uses the solar wind and IMF parameters measured by ACE as inputs to a neural network to predict space weather 1 and 3 hours ahead. The realtime prediction (blue histogram) and real-time estimate of Kp (red dots) are shown in this capture, from http://mms.rice.edu/realtime.html. Dot of less than -200 and AE over 1000 were forecast.

Spacecraft Suite

This event occurred during the commissioning of the Magnetospheric Multiscale Mission (MMS), and was not the first storm that it encountered. On March 17, only a few days after its March 12 launch, MMS magnetometers measured the St. Patrick’s Day Storm, but few other MMS instruments had been deployed. For this event, many, but not all, of the MMS instruments were “up and running.” Also deployed in the magnetosphere for this storm were THEMIS Van Allen Probes, and Cluster. Ionospheric monitors included ISS, AMPERE, and DMS. MMS was designed to be 180 degrees away from THEMIS so that one group would have apogee on the dayside while the other is in the tail. In this case, MMS was at apogee in the magnetotail. After the CME impact, THEMIS was in the free streaming solar wind and MMS was near the reconnection line in the magnetotail. MMS measured several dipolarizations of the field from 2-7 UT on June 23. The model correctly predicted the shape and magnitude of the perturbations but was slightly off in the timing of them.

Field-Aligned currents and convection

The high magnetic field strength resulted in strong polar cap flows and very severe field aligned currents. Strong IMF By’s resulted in several intervals of predicted flows which were essentially a SINGLE rotating convection cell in each hemisphere. These were more clear in the Northern polar cap, since this time was that of maximum dipole tilt toward the Sun. These predicted flows were confirmed by DMSP flow measurements. DMSP southern flow measurements were hampered by low densities.

ISS Observations

The ISS saw significant density depletions at the time of the dipolarizations, in the evening subauroral zone. These will be discussed in the Sazykin paper this afternoon.

Conclusions

This event may be the best-observed and modeled solar storm ever because of the amazing assets in space. We expect many more exciting results as the analysis continues.

http://mms.rice.edu/June22

Paper Number SM41C-2498 Fall 2015 AGU