Ring Current Electron Precipitation During the 17 March 2013 Geomagnetic Storm

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The electron and ion flux in the near-Earth environment can change by orders of magnitude during geomagnetically active periods. This can lead to intensification of particle precipitation into the Earth's atmosphere. The process further affects atmospheric chemistry, which may potentially impact weather and climate on the Earth’s surface. In this study, we concentrate on ring current electrons, and investigate precipitation mechanisms using a numerical model based on the Fokker-Planck equation. We focus on investigating the main precipitation mechanisms, and their connection with atmospheric parameters. We investigate the 17 March 2013 storm using the convection-diffusion 4-Dimensional Versatile Electron Radiation Belt (VERB-4D) code. We quantify the impact of the storm on the electron ring current, and the resulting electron precipitation. We validate our results against observations from the Polar Operational Environmental Satellites (POES) mission, the low Earth orbiting meteorological satellites National Oceanic and Atmospheric Administration (NOAA-15,-16,-17,-18,-19), and Meteorological Operational Satellite MetOp-02, as well as the Van Allen Probes, and produce a data set of precipitating fluxes that covers an energy range from 10 keV to 1 MeV. Additionally, we use this data set for calculation of altitude-dependent atmospheric ionization rates at 60-110 km, a prerequisite for atmospheric models to estimate effects of geomagnetically active periods on chemical and physical variability of the atmosphere at high latitudes. Atmospheric ionization rates are validated against Atmospheric Ionization during Substorm (AIMOS 2.1-Aisstorm) and Special Sensor Ultraviolet Spectrographic Imagers (SSUSI) ionization rates, and show good agreement at high geomagnetic latitudes during the storm time.