Space Weather Effects on Proton Flux Variations in the South Atlantic Anomaly: A Numerical Study performed by Test Particle Simulations

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In this study, we assess the hourly variations of the three-dimensional proton flux distribution inside the South Atlantic Anomaly (SAA) during a geomagnetic storm. We have developed a relativistic three-dimensional guiding center test particle simulation code in order to compute the proton trajectories in a time-varying magnetic field background provided by Tsyganenko model TS05 and the corresponding time-varying inductive electric field. The Dst index is the main input parameter to the simulation model, while the maximum proton flux, the area of the SAA calculated below a selected threshold, and the penetration depth of the protons are the main output variables investigated in this study. Since the LEO spacecraft and human-related activities are already affected by space weather conditions, the South Atlantic Anomaly (SAA) is also believed to create an additional source of risk. As the radiation environment depends essentially on the particle flux, the objective of this study is to estimate quantitatively the proton flux variations inside the South Atlantic Anomaly (SAA) in quiet and in storm conditions. So far, it was found that after several drift periods, the protons in the South Atlantic Anomaly (SAA) could penetrate to lower altitudes during geomagnetic storm event, and that, the SAA maximum flux value and the corresponding area, varied differently with respect to altitudes. Numerical results were compared with observations by NOAA 17 and RD3R2 instrument mounted on International Space Station (ISS).