

Geomagnetic Storm Effects on Proton Flux in South Atlantic Anomaly

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Abstract

In this research, we investigate the hourly and daily variations of the three-dimensional proton flux distribution around the South Atlantic Anomaly (SAA) caused by geomagnetic storms. We have developed a relativistic three-dimensional test particle simulation code in order to calculate the trajectories of the protons in a time-varying magnetic field background provided by Tsyganenko model TS05. The main input parameter to the model is the Dst index, while the main output variables examined in this study were the maximum flux, the area of the SAA calculated below a selected threshold, and the penetration depth of the protons. The South Atlantic Anomaly (SAA) is considered as an additional source of radiation dose for Low Earth Orbit (LEO) spacecraft and astronauts. Since the radiation environment depends on the particle behavior, the objective of this study is to analyze quantitatively the variations of the proton flux inside the South Atlantic Anomaly (SAA). It was found that the proton flux distribution in the South Atlantic Anomaly (SAA) was affected by the changes in the magnetic field configuration, due to the variations in the input solar storm condition. Computed results were compared with observations.

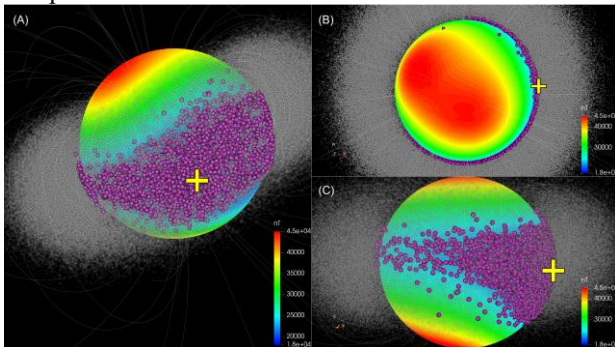


Figure 1: This figure shows three different views (general, top and side views, as demonstrated in Panels (A), (B) and (C), respectively) of the inner radiation belt simulation, including the magnetic field lines (white lines), the contour plots of the magnetic field strength at 1.1 Re (≈ 640 km altitude), and the proton distribution (white points). In addition, it can be detected visually the SAA (blue shaded area), and also the precipitated protons

(magenta). The yellow cross in the panels locates the SAA center [Girgis et al., 2019b].

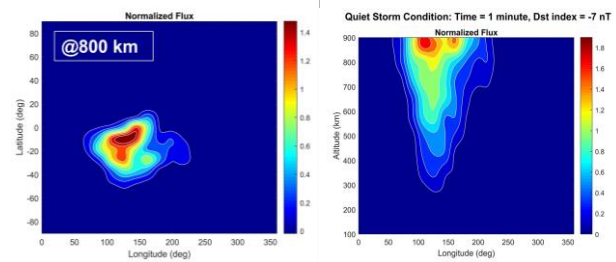


Figure 2: Both panels show the contour plots of the proton flux distribution in the South Atlantic Anomaly (SAA) in two different views: the left panel represents a ground map projection (longitude and latitude) at 800 km altitude, and the right one represents a section view (altitude and longitude) at SAA center. [Girgis et al., 2019b]

References

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