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Extreme solar events and their impact to the upper atmosphere as a proxy for early Earth studies

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Abstract

The CHAMP satellite is a low Earth orbiting (LEO) mission with the objective of a precise determination of the Earth's gravity and magnetic field. Among other instruments it carries a high-precision accelerometer on board which is used in this study to investigate the temporal and spatial variation of the atmospheric density caused by the so-called Halloween (extreme solar activity events) events at an altitude of about 400 km. We focus on the variation of the neutral atmospheric density and related temperature in the upper thermosphere during the extreme solar events and compare the absolute density values with state of the art density models such as NRLMISE-00 and Jacchia-Bowman 2008. These so-called Halloween events caused periods with magnetic activities up to Kp values of 9. These atmospheric disturbances originated from CMEs associated with a solar flare of magnitude X17.2 and caused density enhancements up to about 300 - 400% which may lead to significant local rise in exobase temperatures compared to quiet solar conditions. An analysis of these events is used for the investigation of the connection between such extreme solar events and the activity of solar proxies with different age. We show that this approach is important for studies which are related to the evolution of the early Earth atmosphere and for Earth-like nitrogen atmospheres of exoplanets orbiting around active host stars.