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The October 28, 2003 extreme EUV solar flare and resultant extreme ionospheric effects: Comparison to other Halloween events and the Bastille Day event

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Abstract

Some of the most intense solar flares measured in 0.1 to 0.8 nm x-rays in recent history occurred near the end of 2003. The Nov 4 event is the largest in the NOAA records (X28) and the Oct 28 flare was the fourth most intense (X17). The Oct 29 flare was class X7. These flares are compared and contrasted to the July 14, 2000 Bastille Day (X10) event using the SOHO SEM 26.0 to 34.0 nm EUV and TIMED SEE 0.1–194 nm data. High

time resolution, ~30s ground-base GPS data and the GUVI FUV dayglow data are used to examine the flare-ionosphere relationship. In the 26.0 to 34.0 nm wavelength range, the Oct 28 flare is found to have a peak intensity greater than twice that of the Nov 4 flare, indicating strong spectral variability from flare-to-flare. Solar absorption of the EUV portion of the Nov 4 limb event is a possible cause. The dayside ionosphere responds dramatically (~2.5 min 1/e rise time) to the x-ray and EUV input by an abrupt increase in total electron content (TEC). The Oct 28 TEC ionospheric peak enhancement at the subsolar point is ~25 TECU (25×10^{12} electrons/cm^2) or 30% above background. In comparison, the Nov 4, Oct 29 and the Bastille Day events have ~5–7 TECU peak enhancements above background. The Oct 28 TEC enhancement lasts ~3 hrs, far longer than the flare duration. This latter ionospheric feature is consistent with increased electron production in the middle altitude ionosphere, where recombination rates are low. It is the EUV portion of the flare spectrum that is responsible for photoionization of this region. Further modeling will be necessary to fully understand the detailed physics and chemistry of flare-ionosphere coupling.

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