# Statistical analysis for EUV dynamic spectra and their impact on the ionosphere during solar flares

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The X-rays and extreme ultraviolet (EUV) emitted during solar flares are known to rapidly change the physical composition of the Earth's ionosphere, causing sudden ionospheric disturbances and other space weather phenomena (e.g. Dellinger 1937). Therefore, to understand the effects of solar flare emissions on the ionosphere, it is important to accurately understand the emission spectra of solar flares and their different effects on the ionosphere at different wavelengths.

Solar flares with a long duration tend to have a large effect on ionosphere because they have a large total energy (Qian et al., 2010). For this reason, understanding the exact duration of each solar flare emission spectrum is very important in considering its impact on the ionosphere. The physics-based model is useful for accurately estimate the profile of solar flare emission. Therefore, we have reproduced the flare emission spectra by a newly proposed model based on the physical processes of flare loops (Kawai et al., 2020). In this model, we convert the soft X-ray light-curves observed during flare events into EUV emission spectra using a one-dimensional hydrodynamic calculation and the CHIANTI atomic database (Dere et al., 2019). We examined the “EUV flare time-integrated irradiance” and “EUV flare line rise time” for 21 flare events by comparing the calculation results of the proposed model and observed EUV spectral data. Proposed model succeeded in reproducing the EUV flare time-integrated irradiance of Fe lines which have relatively higher formation temperature. For the EUV flare line rise time, we found there was acceptable correlation between the proposed method estimations and observations for all Fe flare emission lines (Nishimoto et al., 2021).

To study the response of the ionosphere to flare emission, the solar emission spectrum reproduced by using the physical model described above and an empirical model, the Flare Irradiance Spectral Model (FISM; Chamberlin et al., 2020), are input to the Earth’s whole atmospheric model called the Ground-to-Topside Model of Atmosphere and Ionosphere for Aeronomy (GAIA) to simulate the total electron content (TEC) variation in the ionosphere. We compared the statistics of nine solar flare events and calculated the TEC enhancements with the corresponding observed data. The model used in this study was able to estimate the TEC enhancement due to solar flare emission with a correlation coefficient greater than 0.9. The results of this study indicate that the TEC enhancement due to solar flare emission is determined by soft X-ray and EUV emission with wavelengths below 35 nm. The TEC enhancement is found to be largely due to the change in the soft X-ray emission and EUV line emissions with wavelengths such as Fe XVII 10.08 nm, Fe XIX 10.85 nm and He II 30.38 nm.

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