Validation of solar flare emission spectra and their impact on the ionosphere

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Solar flares suddenly emit strong multi-wavelength electromagnetic emissions. Among these emissions, X-rays and extreme ultraviolet (EUV) emissions rapidly change the physical composition of the Earth's thermosphere and ionosphere, thereby causing space weather phenomena such as the sudden ionospheric disturbance etc. (Dellinger 1937).

To predict the effects of flare emissions on the Earth's upper atmosphere, empirical and physical models have been developed. We verify the extent of reproducing the flare emission spectra using a newly developed simple method based on the physical process of the flare loop (Kawai et al., 2020). In this method, 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” of the EUV emissions for 21 the events by comparing the calculation results of the proposed method and observed EUV spectral data. Proposed method succeeded in reproducing the EUV flare time-integrated irradiance of the Fe VIII 13.1 nm, Fe XVIII 9.4 nm, and Fe XX 13.3 nm, as well as the 5.5-35.5 nm band. For the EUV flare line rise time, there was acceptable correlation between the proposed method estimations and observations for all Fe flare emission lines.

Furthermore, in order to examine the effect of flare EUV emission on the Earth’s ionosphere, we input our calculated flare EUV spectra that mentioned above to the Earth's atmospheric model GAIA (Ground-to-Topside Model of Atmosphere and Ionosphere for Aeronomy; Jin et al., 2011). We investigated the ionospheric response to solar flare emission by comparing the total electron content (TEC) variation in the ionosphere reproduced by GAIA with observations. This study statistically revealed which wavelengths in the solar flare emission spectrum affect which altitude in the ionosphere.
In this presentation, we will discuss the statistical analysis results of the ionospheric response due to differences in solar flare emission spectra.

Keywords: Solar flare, UV radiation, X-rays

