R010-09
Zoom meeting C ：11/4 AM1 (9:00-10:30)
09:30-09:45

Reproduction and validation of flare spectra and their impact on the global environment at the X9.3 event of September 6, 2017

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The radiation from the Sun is the most important ionization and heating energy source for the Earth's upper atmosphere. Sudden increase of soft X-ray and extreme ultraviolet (EUV) emissions due to the solar flare accelerates the ionization and molecular dissociation of atmospheric components in the ionosphere and thermosphere, and it may cause strong increase in electron density. This phenomenon is called the sudden ionospheric disturbance (SID), and communication failure caused by the absorption of the short-wave by the SID is known as the Dellinger phenomenon (Dellinger 1937). In order to verify which wavelength of the solar flare spectrum affects the occurrence of the Dellinger phenomenon, we first need observation data of the full wavelength spectrum of solar flare emission and compare with them. However, EUV flare spectra observation with high spectral and temporal resolution are very limited, the numerical model for predicting EUV emissions is needed. One of them is the Flare Irradiance Spectral Model (FISM; Chamberlin et al., 2008). Although FISM is the most widely used model now, this model has some problems such as uncertain physical processes due to empirical model. Therefore, we constructed new flare emission model with physical processes (Imada et al. 2015, Kawai et al. 2020) in order to reproduce the observed flare emission. In our model, the physical process of the plasma in the flare loop is reproduced by combining the one-dimensional hydrodynamic calculation using CANS (Coordinated Astronomical Numerical Software) 1D package with the CHIANTI atomic database (Dere et al. 2019}. Using this model, we reproduced EUV dynamic spectra for some flare events. When we compared observed SDO/EVE MEGS-A spectra with our calculation results, we found that our result clearly reproduced most of the EUV lines during flare.
Furthermore, in order to examine the effect of flare emission on the Earth's atmosphere, we put our calculated flare spectra into the Earth's atmospheric model GAIA (Ground-to-Topside Model of Atmosphere and Ionosphere for Aeronomy; Jin et al., 2011), and then we reproduced the variation of total electron content (TEC). We tried to reproduce the TEC variation of the X9.3 flare on September 6, 2017, then we compared calculated results with the observed TEC amount.
When we used the FISM flare spectrum, difference of TEC amount from the background could be almost reproduced. On the other hand, when the flare spectrum of the CANS model was used, the result varied depending on the presence or absence of the background. This difference which depends on the models is thought to represent which EUV radiation is primarily responsible for increasing TEC. From the flare spectrum obtained from these models and the calculation result of TEC fluctuation using GAIA, it is considered that the EUV emission about 15-40 nm is mainly effect to increasing TEC than that of X-ray emission that has been thought to be mainly effective for SID. Also, from the altitude/wavelength distribution of the ionization rate of Earth's atmosphere by GAIA, it was found that EUV radiation of about 15-40 nm affects a wide altitude of 120-300 km, and TEC is mainly generated by ionization of nitrogen molecules.