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B 会場 ：11/27　PM1 （13:15-15:15）
13:30〜13:45

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Reproduction of electron density in the lower ionosphere during solar flares by PHITS code

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Solar flare emissions cause ionization of the ionosphere and rapid variation in electron density. Shortwave fadeout (SWF) is caused by increased electron density in the lower ionosphere, primarily due to flare X-ray emission. There are several simulation models for the whole global atmosphere, which can provide electron density variations throughout the ionosphere in solar flare emissions (e.g., GAIA: Jin et al., 2011; WACCM: liu et al., 2010). However, these models do not calculate the electron density variations in the lower ionosphere accurately. In order to estimate the occurrence and magnitude of SWF, it is necessary to accurately estimate the altitude distribution of electron density variation in the ionosphere during solar flare.

In this study, we use the PHITS code (Sato et al., 2024), a particle transport and collision simulation code using the Monte Carlo method, to reproduce electron density variations in the lower ionosphere due to flare X-ray emission. We input the GOES X-ray data into PHITS to simulate the ionization rate (q) in the ionosphere. At this time, we also derived the effective recombination coefficient (α_{eff}) using the electron density (n_e) observed by EISCAT from $n_e^2 = q/\alpha_{eff}$. The α_{eff} values are almost consistent with α_{eff} data during solar flares in the daytime given by Gledhill (1986). Then we reproduced the electron density (n_e) in the lower ionosphere using obtained α_{eff} values. Finally, we compare the electron density calculated by PHITS with the electron density observed by EISCAT during the daytime since 2010. The electron density by EISCAT is reproduced within the range of 1 σ standard deviation of the electron density by PHITS.

The occurrence and magnitude of SWF can be known from the minimum reflection frequency in the ionogram (f_{min}), and the variation of f_{min} value during solar flare corresponds to the electron density variation in the lower ionosphere. We simulated f_{min} values using the electron density calculated by PHITS. Then, we compared their simulated f_{min} with observed f_{min} and validate the reproduction of electron density by PHITS. The correlation coefficient between the simulated and observed f_{min} values is 0.87, and the true positive rate of blackouts is $\sim$80%. In this presentation, we will discuss the reproduction of electron density variations using PHITS in comparison with electron density calculated by GAIA model.