R005-P15
ポスター 3 ：9/26　AM1/AM2 （9:00-12:30）

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Horizontal structures and movements of sporadic E layers observed with ionosonde receiver networks

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The sporadic-E (Es) layers are high plasma density layers that appear suddenly in the E region of the ionosphere, around 100 km altitude. It is known that tidal winds play a major role in the formation and movement of Es. The horizontal movement of Es has been studied with various observational methods and numerical simulations. Continuous TEC observation has been used to capture the horizontal structure of Es, although Es height cannot be measured. Es height is important because wind is critical to the motion of Es and the distribution of wind is dependent on height. The advantage of ionosonde observation is the ability to measure the altitude. Ionosonde network can detect horizontal structure and movement of Es. However, the distances among four ionosonde facilities of NICT in Japan are longer than typical Es scale, so it is hard to investigate horizontal movement of Es. In this study, we performed multistatic observations with two networks of ionosonde and receivers to investigate the horizontal structure and movement of Es over Japan.

In the observation networks, two ionosonde receivers are newly installed around ionosonde of NICT Radio Observation Facilities at Yamagawa, Kagoshima in June 2023. They are located at Aso and Miyazaki, performing a tristatic observation. The distance is 190 km between Yamagawa and Aso, and 100 km between Yamagawa and Miyazaki. Radio waves emitted from the ionosonde are reflected by the Es layers above the midpoint between the ionosonde and the receiver, and the reflected waves are received by the receiver, which measures the electron density of the Es above the midpoint. We compare the data from the ionosonde vertical observations with the data over the midpoints obtained from the receivers. The horizontal scale of the Es layers is estimated by determining whether the same Es layer is observed at multiple observation points based on the correlation between the density and altitude changes of Es. In the tristatic observation, the direction and velocity of Es horizontal movement are also calculated from the difference in observation time at each site. This network will make simultaneous observation with sounding rocket experiment, RIDE campaign to be launched from JAXA Uchinoura Space Center in Kagoshima in the summer of 2024.

Another ionosonde network consists of an ionosonde at Kokubunji, Tokyo and a receiver at Oarai, Ibaraki, performing a bistatic observation. The distance between ionosonde and receiver is 120 km.

In this study, we will discuss the horizontal structure and horizontal movement of the Es layer with data from these two ionosonde networks.