R010-17
Zoom meeting C ：11/4 AM2 (10:45-12:30)
10:45〜11:00

Impacts of VHF anomalous propagation on aeronautical navigation systems and the Es layer structure and dynamics

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The sporadic E (Es) layer is an ionospheric layer with very high electron density and appears at altitudes around 100km. Due to its very high density, VHF radio waves from the ground can be reflected and propagate over a long distance. It has been well known that the FM radio signals with their frequency below 100 MHz can be reflected by the Es layer and propagate over anomalously long distances. Recently, even the aeronautical radio navigation signals such as the localizer (LOC) of instrument landing system (ILS) or VHF omni-directional radio range (VOR) in the frequency band from 108 to 118 MHz can also propagate over long distances via Es layer reflection. The ILS-LOC is an ground-based radio navigation system which is used to provide aircraft with its relative deviations with respect to the center of the designated course. The VOR provides the direction from the aircraft to the VOR station. In a specific geometry where the receiving station is in the main beam of an ILS-LOC, the signal strength of the anomalous propagation signals could exceed the maximum acceptable interference level.

We have been operating receivers of VHF anomalous propagation signals at 8 stations in Japan. We have installed an airborne ILS LOC/VOR receiver in May 2021 at Kure (34.25N, 132.53E) where strong signals at 110.3 MHz are often observed. We observed a number of events where the strength of the 110.3 MHz signals was significantly enhanced and the airborne receiver simultaneously indicated course deviations for the received signals. We identified the signal coming from Hualien Airport, Taiwan by their Morse tone signals. The indicated course deiviations were consistent with the geometry of Kure and Hualien. Thus, we confirmed that the anomalous propagation of the ILS-LOC signals by the Es layer could result in interference to the aeronautical radio navigation systems.

We also found that the indicated course deiviations fluctuate even when the signal strength is high enough for the airborne receiver to stably track the signals. The observed fluctuations in the course deviation may be due to the movement of the Es layer which reflects the signals. Structure and dynamics of the Es layer at the reflection point, which is usually around the mid-point between the transmitting and receiving stations, could be investigated by analyzing the variation of the course deviation indicated by an ILS-LOC receiver.