Development of an autonomous FM-CW ionospheric observation system based on reinforcement learning

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Development of an autonomous FM-CW ionospheric observation system based on reinforcement learning

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Equatorial Plasma bubbles (EPBs) of the ionospheric irregularities are known to cause GPS positioning errors and radio wave propagation abnormalities. Recently, numerical experiments have advanced the understanding of the local generation mechanism of EPBs, but the development of environmental field controlling the generation and suppression of EPBs has not yet been fully clarified. This study aims to reveal observationally the structure and generation mechanism of environmental fields in inner-magnetosphere and ionosphere that is linked to the development of EPBs.

We focus on a three-dimensional coupling system of ionospheric E-F regions controlling equatorial jet current (EEJ) as a model that connects the pre-sunset EEJ, pre-reversal enhancement (PRE) at near sunset, and EPBs after sunset. In order to detect this coupling system, we have developed a multi-ionospheric observation project with FM-CW (Frequency Modulated Continuous Wave) radar, MAGDAS (MAGnetic Data Acquisition System) magnetometer network and SDR-based scintillation detector. The FM-CW radar has two kinds of observation modes: one is Ionosonde mode and the other is Doppler mode. FM-CW radar enables continuous multi-mode ionospheric observation by switching between the detection of time evolution from PRE to plasma bubble by Ionosonde mode and the observation of F region electric field by Doppler mode. We have developed a new ”autonomous FM-CW control system” without the manual operation schedule. The new FM-CW system consists of the supervised machine learning and reinforcement learning by using several ionospheric disturbance triggers. In the presentation, we will explain the new FM-CW control system and show the result of examination.