Occurrence climatology of *E*- and *F*-region field-aligned irregularities in the middle latitudes as observed by the Daejeon 40.8 MHz coherent scatter radar in South Korea

Young-Sil Kwak[1,2], Tae-Yong Yang[1], Hyosub Kil[3], Jeaheung Park[1,2], Jong-Min Choi[1], and Wookyoung Lee[1,2]

[1]Korea Astronomy and Space Science Institute, Daejeon, South Korea

[2]University of Science and Technology, Daejeon, South Korea

[3]The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA

Electron density irregularities in the ionosphere interrupt the propagation of electromagnetic waves and are problematic for navigation and communication systems. For this practical importance, significant efforts have been made to establish information on the occurrence climatology of such irregularities, to understand the onset conditions of such irregularities, and to predict or avoid the impact of these irregularities on the society. While the irregularities occur in all latitudes, less attention has been paid to the irregularities in middle latitudes. This may be because the irregularities in middle latitudes are not as severe as those in other latitude regions. However, middle latitudes are also the place where various forms of irregularities occur.

A new 40.8 MHz coherent scatter radar was built in Daejeon, South Korea (36.18ºN, 127.14ºE, dip latitude: 26.7ºN) on 29 December 2009, and has since been monitoring the occurrence of field-aligned irregularities (FAIs) in the northern middle latitudes. We report on the occurrence climatology of the *E*- and *F*-region FAIs as observed by the Daejeon radar between 2010 and 2018. We examine the occurrence types of the irregularities and the dependence of the irregularities on geophysical conditions (local time, altitude, season, solar cycle, and magnetic activity). These results can be used as a tool for investigating the onset conditions of the middle-latitude irregularities.

The characteristics and occurrence climatology of the E region FAIs by analyzing the Daejeon radar data are as follows: (1) We have identified repeatedly occurrence of the FAIs at specific LT zones and classified them as continuous, QP, and afternoon FAIs; (2) The occurrence rate of E-region FAIs has significant seasonal dependence: maximum in summer and minimum in spring; (3) The FAI occurrence rate shows an decreasing tendency with an increase of the solar flux; (4) It is found that no relation is found between FAIs SNR and top frequency (ftEs) (or blanketing frequency (fbEs)). Instead, it suggests that large values of (ftEs - fbEs) enhance the SNR of FAIs.

The characteristics and occurrence climatology of the F region FAIs by analyzing the

Daejeon radar data as follows: (1) We have identified repeatedly occurrence of the FAIs at specific LT and altitude zones and classified them as post-sunset, nighttime, pre-sunrise, and post-sunrise FAIs; (2) The occurrence rate of the post-sunrise FAIs is largest in equinoxes, but the occurrence rate of the nighttime FAIs is largest in summer. The occurrence rates of the post-sunset and nighttime FAIs are greater than those of the pre-sunrise and post-sunrise FAIs; (3) The post-sunset FAIs are the most pronounced feature in terms of the occurrence rate and SNR; (4) The post-sunrise FAIs often appear as two thin layers; (5) The FAI occurrence rate shows an increasing tendency with an increase of the solar flux; (6) The Doppler velocity and spectral width observed by the Daejeon radar are a few times smaller than those observed by the MU radar.