Spectral analysis of equatorial plasma bubbles obtained by high-resolution bubble model and C/NOFS satellite

*Tatsuhiro Yokoyama[1], Charles L. Rino[2], Charles S. Carrano[2], Keith M. Groves[2], Patrick A. Roddy[3]

1. National Institute of Information and Communications Technology, Japan, 2. Institute for Scientific Research, Boston College, USA, 3. Air Force Research Laboratory, USA

Equatorial plasma bubbles (EPBs) are a well-known phenomenon in the equatorial ionospheric F region. As it causes severe scintillation in the amplitude and phase of radio signals, it is important to understand and forecast the occurrence of EPBs from the space weather point of view. EPBs are presently considered to evolve from the generalized Rayleigh-Taylor instability. It has been proposed that large-scale wave structure (LSWS) at the bottomside of the F region should be an important seeding of EPBs. However, it is quite difficult to observe the evolution of EPBs from a specific LSWS structure. Therefore, numerical modeling is a powerful tool to study the condition of EPB occurrence and day-to-day variability. In order to simulate the instability in the equatorial ionosphere, a three-dimensional high-resolution bubble (HIRB) model with a grid spacing of as small as 1 km was developed. Using the HIRB model, the nonlinear growth of EPBs from LSWS-like seeding, the formation of very turbulent internal structures such as bifurcation and pinching, and the east-west asymmetry of EPBs have been demonstrated.
A recent upgrade of the HIRB model has made it possible to conduct simulations with sub-kilometer grid spacing. Once EPBs penetrate into the topside ionosphere, turbulent internal structures become very significant. From the preliminary spectral analysis of higher-resolution simulation results, we obtain the power law characteristics of the turbulent structures of simulated EPBs. There are two power law components with a break point at around a few km wavelengths. The power law characteristics are consistent with past in situ observations such as the C/NOFS satellite to some extent. For more detailed analysis, wavelet-based analysis can be applied for the turbulent structures of the simulated EPBs, and the results can be compared with the same analysis applied for the C/NOFS satellite data. Such spectral information may be useful for the quantitative evaluation of radio wave scintillation intensity.

Keywords: equatorial plasma bubble, simulation, C/NOFS

