Application of dynamical equilibrium model to topside ionosphere specification

Reiko Yoshimura[1]; Takashi Maruyama[1]; Seiji Kawamura[1]

[1] NICT

While IRI model has been updated annually, there are still some shortcomings in the topside part of the model, such as overestimation of the electron density and an unrealistic form of the plasma profile. To refine this empirical model, it would be practical to establish a semi-theoretical model based on a database of observations.

In the topside ionosphere (above the F layer peak), plasma distributions are controlled by the plasma transport process, and field-aligned plasma flows play an important role in determining the plasma density profiles of the topside ionosphere. Upward flows supply plasma above 1000 km during the daytime, while downward flows contribute to maintain the nighttime F region. Dominant ion constituents above the F layer peak are O+ bellow the upper transition height and H+ above it.

In this study, a theoretical plasma distribution under the assumption of dynamical equilibrium condition is applied to represent topside ionospheric plasma density profile to modify empirical and profiler models.

Some of the observed and model-deduced parameters above Japan are used in the theoretical model: foF2 and M3000F2 measured by the ionosonde are used to determine the F layer peak density, NmF2, and F layer peak height, hpF2. The plasma scale height, Hp, and the background neutral scale height, Hn, are calculated using the electron and ion temperatures given by IRI2000 model (Bilitza, 2001) and the neutral temperature given by NRLMSISE-00 model (Picone et al., 2002). The bottomside profile is adopted by the IRI model using the derived NmF2, hpF2 and the solar flux F10.7. The upper transition height is determined by the Triskova-Truhlik-Smilauer empirical model (Triskova et al., 2001). The H+ profile above the upper transition height is assumed as an exponential function that follows H+ scale height. The shape of O+ profile is determined to fit the integrated model plasma density to the total electron content (TEC) obtained by GPS satellite measurements. We compared the model profiles to the incoherent scatter observation data obtained by MU radar at Shigaraki, Japan, to verify the method.

Present model shows good agreement with IRI and MU radar-observed profiles during night time, it predicts thinner structure compared to the IRI and MU profiles after sunrise. The field-aligned plasma flux is calculated from the model profile, which shows upward flow during daytime due to the continuous photoionization in the bottomside F region, and downward flow during nighttime due to rapid recombination in the lower part of the ionosphere. These features are qualitatively consistent with the diurnal variation of the slab thickness (TEC/NmF2), which shows sudden decrease at sunrise and gradual increase during daytime.