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On the relative roles of the neutral density and photo chemistry on the solar zenith angle variations in the V2 layer characteristics of the Venus ionosphere under different solar activity conditions

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1 Extended Abstract

Using an in-house developed one dimensional photo-chemical model (1D-PCM), which considers production and loss of 11 ions namely, CO_2^+, CO^+, C^+, N_2^+, N^+, He^+, $O^+(^2D)$, $O^+(^2P)$, $O^+(^4S)$, O_2^+ and NO^+, characteristics of the V2 layer in the Venus ionosphere has been studied. It is noted that existing ionospheric model for the Venus ionosphere, such as the IonA (Ionization in Atmospheres) model, not only over/under estimate the peak electron density of V2 layer, it also has significant departures from the observations on the solar zenith angle and solar activity control. The IonA model uses VenusGRAM model (Venus Global Reference Atmosphere Model) as input for the neutral density and considers Venus atmosphere consisting of CO_2, O, and N_2 molecules only. Further, it oversimplifies the ion chemistry by assuming Venus ionosphere to have O_2^+ as the only dominant ion species. Using VTS3 model, an empirical model based on measurements from Orbiter Neutral Mass Spectrometer on Pioneer Venus Orbiter (PVO) which considers profiles of six neutrals (CO_2, O, CO, He, N, and N_2), we modified IonA model, named as IonA-VTS3, to find that it reproduced the altitude of V2 peak electron density (hmV_2) quite well. However, the model still lacked in reproducing observed peak V2 electron density (NmV_2). The in-house developed one dimensional photo-chemical model (1D-PCM) not only estimated NmV_2 accurately, the hmV_2 was also reproduced quite well. Comparison of Venera and PVO radio occultation measurements with 1D-PCM and IonA-VTS3 calculations reveals the role of complex chemical reactions in determining the features of peak altitude and density of V2 layer during different solar activity periods. We surmised that differences in the observed and IonA modeled peak V2 layer altitudes were due to the limitations associated with VenusGRAM neutral density model. It shows that variations in the neutral density controls the V2 layer peak density height. 1D-PCM calculations also showed that the complex chemistry including production and loss reactions of 11 ions could reproduce the variations in the peak density of Venusian ionosphere during different solar activity conditions. It suggests that the ion-chemistry has wider control over the peak plasma density in the Venus ionosphere.