Upgrade of equatorial plasma bubble simulation toward coupling with GAIA model

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As space development progresses rapidly, stable use of satellite communication and navigation is strongly demanded, and a highly accurate and reliable positioning system using GPS is required. One of the causes of the GPS error is a physical phenomenon that occurs in the equatorial ionosphere called plasma bubble. A plasma bubble is a phenomenon in which the density stratification in the lower ionosphere becomes unstable and the low-density region rises like a bubble, and the inside of the bubble has a very unstable and irregular structure. Therefore, it has a great influence on radio wave propagation, but it is almost impossible at present to predict the occurrence of plasma bubbles. The purpose of this study is to develop a numerical model that combines a global ionospheric numerical model and a local ionospheric numerical model to predict the occurrence of plasma bubbles self-consistently, and to clarify the conditions of their generation. The global atmosphere-ionosphere coupled model GAIA has a grid spacing of about several hundred kilometers and cannot reproduce local structures such as plasma bubbles. On the other hand, the local ionosphere model can represent the fine internal structure of plasma bubbles because the grid spacing is less than 1 km, but it is limited to a narrow simulation domain and also applies periodic boundary conditions. Therefore, it is not possible to simply expand the simulation domain. Thus, by combining the global model and the local model hierarchically, we aim to develop a model that can reproduce the generation of plasma bubbles consistently with retaining their original advantages. Toward the coupling of the two models, we expand the simulation domain of the local model to cover the whole longitude under natural boundary conditions including diurnal plasma density variations. We will report the current status and initial results of the model development.

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