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Magnetosphere-ionosphere coupling process in the polar region

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In recent year, a variety of auroral data have been obtained by the comprehensive ionospheric observations using the imagers, radars, and magnetometers. On the other hand, it is very difficult to understand the magnetosphere - ionosphere (M-I) coupling process in this region only from the observed data, because auroral phenomena exhibit the complicated temporal and spatial variations. Thus, it is important to combine the numerical simulation based on the theoretical model with the observed data. As a tool to aid in the interpretation of the observational data, we have been developing the simplified M-I coupling model in the polar region. The purpose of this study is to understand the motion of the mesoscale aurora (from several km to one thousand km), which includes the temporal variations shorter than the Alfven transit time between the magnetosphere and the ionosphere. In this model, therefore, we consider the propagation of Alfven waves in the magnetosphere, the aruroral acceleration region, the ionosphere with the non-uniform conductivity, and the wave reflection process on the boundaries between each region. In particular, our final goal is to add the simplified model of the inductive reflection process on the ionosphere to this model.
In this model, the magnetosphere and the ionosphere were assumed to be the two-dimensional horizontal planes which satisfy one-fluid MHD equations and the height-integrated Ohm's law, respectively. It was assumed that the auroral acceleration region is located on the ionosphere and the Knight relation is satisfied in this region. We assumed that the Alfven waves propagate without the mode conversion and the partial reflection between the magnetosphere and the upper boundary of the acceleration region and the propagation time in the acceleration region is negligible. We solve the continuity equations of the divergent current and the tangential electric field on the boundaries between each region by the finite difference method. The ionospheric conductivity changes with the field-aligned potential difference in the acceleration region. We have already developed the combined model of the acceleration region and the ionosphere. In the presentation, we discuss the results from the test of this model under the various conditions.

Keywords: aurora, magnetosphere-ionosphere coupling, Alfven wave, ionospheric conductivity