Effects of Dayside Ionospheric Conductance on the Solar Wind-Magnetosphere-Ionosphere Coupling

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In the present study we address the role of ionospheric conductance in the solar wind-magnetosphere coupling by examining the dependence of large-scale field-aligned currents (FACs) on solar activity. Solar EUV irradiance changes during a solar cycle, and so does its contribution to ionospheric conductance. Therefore we use the F10.7 index as a measure of dayside ionospheric conductance as well as of solar activity. We identified in the past the latitudinal structure of FACs for each of ˜200,000 auroral oval crossings observed by various DMSP satellites, and we use the same event set in this study. The result shows that under fixed external conditions, the FACs become more intense with increasing solar activity not only on the day side but also on the night side. It is also found that the overall FAC system, therefore the auroral oval, moves equatorward as the solar activity increases. That is, the magnetosphere is in a more elevated energy state for higher dayside ionospheric conductance even if the intensity of the external driver is the same. We interpret this result in terms of the configurational change of the magnetosphere due to the dayside R1 current system, which includes the closure currents flowing at the outer boundaries of the magnetosphere. Whereas this current system weakens the equatorial magnetic field on the day side, it strengthens the lobe magnetic field. Therefore, as the R1 current system becomes more intense along with dayside ionospheric conductance, the magnetosphere shrinks on the day side and expands on the night side. The associated increase in the tail flaring angle results in more efficient conversion of the kinematic energy of solar wind (magnetosheath) to electromagnetic energy, which is then transported to the magnetosphere-ionosphere system. We therefore conclude that the solar wind-magnetosphere-ionosphere coupling is more efficient for higher ionospheric conductance on the day side.