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宇宙天気事象における太陽風エネルギーのグローバル電離圏と内部磁気圏への伝送過程
Energy transmission from the solar wind to the global ionosphere and inner magnetosphere during space weather events

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When the IMF turns southward, the Region-1 field-aligned currents (R1 FACs) are generated by a dynamo composed of high pressure plasma around the dayside cusp, providing the dawn-to-dusk convection electric field in the polar ionosphere. The convection electric field drives ionospheric Hall currents in high latitudes and Pedersen currents at the daytime geomagnetic equator where the Pedersen current is amplified by the Cowling effect, resulting in the coherent magnetic perturbations at high latitude and dayside dip equator. The convection electric field is transmitted near-instantaneously from the polar to equatorial ionosphere via the Earth-ionosphere waveguide and further transmitted to the inner magnetosphere. The Poynting flux is transported by the Alfven wave propagating upward from the ionosphere, driving the plasma convection in the inner magnetosphere immediately after the enhancement of the polar cap potential. As a result, the ring current develops a few minutes after the increase in the polar cap potential during the substorm growth phase and storm main phase. During the substorm expansion phase, on the other hand, the ionospheric current at mid-equatorial latitudes reverses its direction, that is, the overshielding occurs while the auroral electrojet intensifies. The current reversal is particularly significant at the dayside equator, appearing as the counterelectrojet (CEJ). The CEJ should be connected to the R2 FACs which are driven by the partial ring current associated with the enhanced convection electric field and/or dipolarization in the near-Earth magnetotail. At the onset of geomagnetic storms, the increase in the solar wind dynamic pressure causes the enhancement of the magnetospheric convection. The succeeding southward IMF further intensify the convection electric field, which penetrates to low latitude and drives the stormtime ring current. In the beginning of the recovery phase, overshielding occurs due to the decrease of the southward IMF. The auroral ionospheric currents associated with major storms are so strong as to cause the power outage like in Canada on 13 March 1989. The penetration electric field moves the ionospheric F-region plasma at low latitude and causes anomalous enhancement of the total electron content responsible for the serious GPS positioning errors. The satellite charging due to the auroral electrons during major substorms causes the fatal damage of the satellites, e.g., the damage of the Earth observation satellite, Midori on 25 October 2003. There remain quite a few issues to be addressed in the energy production and transmission in the magnetosphere-ionosphere coupled system. In particular, the physics of the dynamos in the outer and inner magnetosphere should be clarified in the future studies.

キーワード: 対流電場, 過遮蔽電場, 地面電離層導波管, 赤道カウンターエレクトロジェット, 磁気嵐, サブストーム
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