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Response of the Ionospheric Current System to Southward IMF Turnings

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We present results from a study of the behavior of the auroral electrojet indices following abrupt southward turnings of the IMF Bz. The auroral electrojet indices are calculated from observations made by more than 100 ground based stations provided by the SuperMAG collaborators. Based on three simple criteria we selected 73 events. In each event the interval of analysis started at the time of the IMF Bz southward turning and ended 45 minutes later or at the onset of any abrupt energy unloading event in the magnetosphere, regardless of size. We refer to this period as the "pre-unloading phase". To isolate the dependence of the auroral electrojets on the solar induced ionospheric conductivity during this phase we separated the standard AU/AL indices into two new sets of indices defined by the upper and lower envelope of the north-south component for all sunlit stations (AUs/ALs) and for all stations in darkness (AUd/ALd). Based on events and statistical analyses we can conclude that following a southward turning of the IMF Bz the AUd/ALd indices show no measurable response while the AUs/ALs indices clearly intensify. The intensifications of AUs/ALs are dependent on the intensity of the solar wind driver (as measured by IMF Bz or the Akasofu ε parameter). The lack of AUd/ALd response does not depend on the intensity of any subsequent substorm.
We find that during these isolated events the ionospheric current system is primarily confined to the sunlit ionosphere. This truncated version of the classical global DP-2 current system suggests that auroral electrojet continuity is not maintained across the terminator. Because of its conductivity dependence on the solar zenith angle, this truncated global current pattern is expected to be highly dependent on UT and season and thus can be asymmetric between hemispheres. Thus we argue that the global two-cell DP-2 current system is not a consequence only of a southward turning of the IMF but requires also the reduction of the conductivity gradient at the terminator.