Pseudobreakup and substorm expansion controlled by ionospheric convection changes

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We present a comprehensive study of a sequence of a pseudo breakup and substorm expansion using magnetic and HF radar measurements, auroral imaging from the IMAGE spacecraft and energetic particles from geosynchronous satellites. Global magnetometer chains from the polar cap to the dip-equator show the development of the DP2 electric field during the growth phase, which followed a sudden southward turning of the IMF on February 2, 2002. Three DP2 reductions were observed during the 90 min substorm growth phase, the first two of which were followed by further DP2 enhancement. Electron precipitation measured by the IMAGE FUV/SI13 at 16-17 MLT at 70-75 degrees magnetic latitudes was coherent with these changes of DP2, and the dusk-side proton precipitation measured by the IMAGE FUV/SI12 showed more gradual changes reflecting the overall DP2 changes. The DP2 convection changes were seen clearly in the SuperDARN data. Prior to the second two convection reductions, but not prior to the first, flow shear of the Harang discontinuity was observed to develop in the post-midnight sector. The Harang discontinuity shifted equatorward from 75 to 68 degrees magnetic latitudes as the growth phase developed. The second reduction led to auroral brightening and reduction of the Harang flow shear, but was soon followed by an enhancement of convection that seemed to have prevented evolution into a full substorm expansion and lead reformation of the Harang shear. In contrast, the third reduction in the convection was prolonged and followed by a full substorm expansion. An auroral enhancement was not observed after the first reduction in the convection. Our results suggest that both auroral activity on the night-side and auroral precipitation on the afternoon-to-dusk region are strongly controlled by global convection, that reduction in convection leads to substorm expansion or pseudo break-up only under the condition of a well-developed Harang flow shear, and that an enhancement of convection prior to full expansion-phase development leads to termination of the expansion phase (i.e. a pseudo breakup).