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An entropic analysis of the polar cap current systems

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Birkeland currents (field-aligned currents - FACs) flow along magnetic field lines to connect magnetospheric current systems to the high latitudes ionospheric currents. Within the polar cap, tail-shape magnetic field lines are tilted antisunward by the flow of the solar wind, whereas in the return flow region field lines are tilted sunwards due to pressure from the magnetotail driving the sunwards convection of closed flux. At the polar cap boundary (PCB), the opposite bend-back of the field lines on either side of this convection reversal produces a shear in the magnetic field that is associated with a current flowing upwards or downwards. These currents, out of the ionosphere at the dusk PCB and opposite at dawn, are known as region 1 (R1) currents and connect with the cross-field currents at the magnetopause (the dynamo) and in the ionosphere (the load). Similar shears exist at the equator edge of the convection pattern, and the associated region 2 (R2) FACs flow out of the ionosphere at dawn and into the ionosphere at dusk. These FACs are flowing along magnetic field lines, which map to the inner magnetosphere where they enhance the nightside portion of the ring current, named the partial ring current. The aim of the current paper is to review the processes that give rise to current variability on timescales of hours and minutes in response to changes in the interplanetary medium during the March 2015 and June 2015 Geomagnetic storms. To do so, we will describe the behaviour of the field-aligned currents (FACs) that flow into and out of the ionosphere in the polar cap regions, observed by the Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE). Through an entropy analysis, we found a new polar cap current system directly driven by the SW which connect the northern hemisphere to the southern hemisphere