Substorm onset latitude and the steadiness of magnetospheric convection

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We study the role of substorms and steady magnetospheric convection (SMC) in magnetic flux transport in the magnetosphere, using observations of field-aligned currents (FACs) by the Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE). We identify two classes of substorm, with onsets above and below 65° magnetic latitude, which display different nightside FAC morphologies. We show that the low-latitude onsets develop a poleward-expanding auroral bulge, and identify these as substorms that manifest ionospheric convection-braking in the auroral bulge region. We show that the high-latitude substorms, which do not experience braking, can evolve into SMC events if the interplanetary magnetic field (IMF) remains southwards for a prolonged period following onset. Our results provide a new explanation for the differing modes of response of the terrestrial system to solar wind-magnetosphere-ionosphere coupling, as understood in the context of the expanding/contracting polar cap paradigm, by invoking friction between the ionosphere and atmosphere.