A statistical study on the detachment of arc from the main auroral oval using all-sky imaging observations at Athabasca, Canada

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The phenomenon of ‘detached arcs’ was first reported by Anger et al. (1978) to describe the arc-like auroral emissions equatorward of the auroral particle precipitation region. Recently, a common feature of detachment of arc from the main auroral oval has been brought to the attention for SAR (Stable Auroral Red) arcs (e.g., Shiokawa et al., AIP, 2009; EPS, 2017; Takagi et al., GRL, 2018) and STEVE (strong thermal emission velocity enhancement) (e.g., Gallardo-Lacourt et al., JGR, 2018; Yadav et al., JGR, 2021). Although the occurrence characteristics and geomagnetic conditions under which these arcs occur are known, studies comparing the occurrence characteristics and specific geomagnetic under which these detached arcs culminate as pure-red (SAR) arc, STEVE, and red+green arc (arc consisting of both red and green line emissions) are lacking. Based on 15-years (2006-2020) of all-sky imaging observations at Athabasca (magnetic latitude = 61.5˚N), Canada, here we present a comparative statistical analysis on the occurrence characteristics and geomagnetic conditions of detached SAR arcs, STEVE, and red+green arcs. Results show that the occurrence of pure red arcs peaks during low geomagnetic activity, which is in contrast to the occurrence of red+green arcs that peaks during active geomagnetic conditions. In order to access the substorm activity in the longitude zone of the Athabasca ASI, we have analysed the X-component magnetogram at Fort Smith (FSMI; magnetic latitude: 67.28˚N) which is located ~6˚ magnetic latitude poleward of Athabasca. In general, STEVE and SAR arcs tend to occur at the beginning of recovery phase, whereas red+green arcs occur towards the end of expansion phase of a substorm. The geomagnetic activity levels were found to be highest for STEVE and lowest for the SAR arcs. Prior to the STEVE event, the ASY-H index shows gradual increase and STEVE occurred when the ASY-H values maximized, indicating the magnetospheric linkage of STEVE. STEVE is associated with substorms that have abrupt expansion and recovery, whereas substorms exhibit gradual expansion and recovery phase for the SAR arcs. Further, STEVE is found to be associated with the sharp increase in the X-component of the geomagnetic field at FSMI.

Anger et al. (JGR, 1978) https://doi.org/10.1029/JA083iA06p02683

Shiokawa et al. (AIP Conf. Proc., 2009) https://doi.org/10.1063/1.3169292

Shiokawa et al. (EPS, 2017) https://doi.org/10.1186/s40623-017-0745-9

Takagi et al. (GRL, 2018) https://doi.org/10.1029/2018GL079615

Gallardo-Lacourt et al. (JGR, 2018) https://doi.org/10.1029/2018JA025368

Yadav et al. (JGR, 2021) https://doi.org/10.1029/2020JA028622

Keywords: Arc detachment, Auroral oval, Imaging observations

