Formation and Evolution of Polar Cap Ionospheric Patches and Their Associated Upflows and Scintillations: A Review

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Polar cap patches are common phenomena, especially during southward interplanetary magnetic field (IMF) conditions, in the polar ionosphere. We summarized the recent new progress about the formation and evolution of patches as well as their impact on the magnetosphere-ionosphere-thermosphere (M-I-T) coupling processes and space weather. The dayside reconnection and bursty sunward return flows produced by the modulation of nightside reconnection, are confirmed as the dominated mechanisms to separate the entering ionization into islands (patches). The patches evolve along streamlines of the Dungey convection cycle from the dayside to the nightside and exit the polar cap modulated by pulsed nightside reconnection. However, they slowly move and rapidly fade away behind a lobe “reverse” convection cell when the IMF suddenly changed to northward. Rapidly moving patches are associated with clear ion upflows due to frictional heating and offer more upwelling ion fluxes. Patches often produce significant scintillations due to strong density gradients at their edges, especially during their merging into the auroral oval, which will result in variable disturbances to High Frequency (HF) radio communications, over-the-horizon radar location errors, disruption and errors to satellite navigation and communication.

Keywords: Polar cap patches, Magnetosphere-ionosphere coupling, Ion upflows, Ionospheric scintillations

