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On the driving mechanisms for the high-speed westward flow channels in the dusk-side sub-auroral ionosphere: Simulation study

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The dusk-side mid-latitude ionosphere is characterized by fast, sunward flow channels of a few degrees in width, known as Sub-auroral Polarization Streams (SAPS). Occasionally, these regions exhibit distinct, latitudinally narrow enhancements in velocity, referred to as double-peak Sub-auroral Ion Drifts (DSAIDs). SAPS are associated with Region 2 Field-Aligned Currents (R2 FACs) that flow into the low-conductance sub-auroral ionosphere, while DSAIDs have been linked to the presence of a double-conductance trough in this region. A recent statistical study by Nishimura et al. (2022) demonstrated that sub-auroral ion drifts intensify in the presence of electromagnetic waves, with local plasma structures exerting greater control over the velocity characteristics of these westward flows than solar wind or global magnetospheric conditions. In this study, we investigated the occurrence of fast flows in the dusk-side sector during a geomagnetic storm event using the RAM-SCB model. We conducted two simulation studies, one with and one without EMIC waves, to explore the relationships between R2 FACs, electric fields, EMIC wave-particle interactions, proton precipitation, ionospheric conductance, and westward flows in the dusk-side sub-auroral ionosphere. The simulations confirmed that EMIC wave-induced proton precipitation leads to localized enhancements in conductivity, which, in turn, generates high-speed westward flows in the dusk-side sub-auroral ionosphere. Our findings reveal the significant role of wave-particle interactions in shaping ionospheric behavior during disturbed conditions.