Project Title:
What are the plasma sources for the long-lived plasmaspheric drainage plumes?

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Project Information:
Central objectives: This project is focused on understanding the source of plasma to sustain the long-lived plasmaspheric drainage plumes observed during long-lived high-speed-stream-driven magnetic storms.

Motivation: The long-lived plumes occur during long-lived high-speed-stream-driven storms with durations up to 11 days [Borovsky et al., 2014]. The plasmaspheric drainage plumes can cause energetic particle precipitation via electromagnetic ion cyclotron (EMIC) waves in the magnetosphere [Spasojevic et al., 2004]. Furthermore, the plumes influence the rate of dayside magnetic reconnection [Borovsky and Denton, 2006; Borovsky, 2014], which controls the amount of solar wind-magnetosphere-ionosphere coupling. The previous studies have suggested several mechanisms to explain the plasma source for the long-lived plumes, such as including substorm disruption of the nightside plasmasphere, radial transport of plasmaspheric plasma in velocity-shear-driven instabilities near the plasmapause, or high upflux of cold ionospheric plasma from tongue of ionization (TOI). However, none of these mechanisms have succeeded in explaining the observed plumes in a satisfactory manner. Theoretical models of ionosphere and plasmasphere used in previous studies substantially underestimate the observed fast refilling rates [Denton et al., 2014].

Science Questions: The overall objectives of the project are to elucidate the source of plasma to sustain the long-lived plasmaspheric drainage plumes. The specific questions are as follows:(1) What are the possible mechanisms to explain the observed fast refilling rates, and what is their relative importance?; (2) What is the role of the mass coupling between ionosphere and plasmasphere within the SED/TOI in the long-lived plumes?; (3) What is the role of the magnetospheric electric field in eroding the plasma at first and later sustaining the plumes during long-lived high-speed-stream-driven storms?

Methodology: The Ionosphere-Plasmasphere-Electrodynamics (IPE) model [Maruyama et al., 2015; Sun et al., 2015] will mainly be used to address the science questions as well as the fully updated 2014 version of the Sheffield University Plasmasphere-Ionosphere Model (SUPIM-14). A kinetic plasmasphere model [Pierrard and Stegen., 2008] will be used to evaluate the kinetic process in the plume formation. The coupled CTIP/RCM will provide a storm time neutral atmosphere to drive IPE. OpenGGCM will provide the electric field in the outer magnetosphere during long-lived high-speed-stream-driven storms to drive IPE. Refilling rates from the model simulations will be validated comprehensively against the observations from the topside ionosphere by DMSP and from the plasmasphere by NASA Van Allen Probes and THEMIS, and by LANL spacecraft in geosynchronous orbit. Numerical experiments will be performed with a suite of state-of-the-art physics-based models to test and verify the various possible hypotheses proposed for explaining the long-lived plumes.

Perceived Significance: This proposal will target the LWS support for the Scientific Committee on Solar Terrestrial Physics (SCOSTEP) Variability of the Sun and Its Terrestrial Impact (VarSITI) International Program. In particular, it will address the goals of the Specification and Prediction of the Coupled Inner-Magnetospheric Environment (SPeCIMEN) project. The outcome of this work addresses , "quantitative prediction and specification of the Earth , " s inner magnetospheric environment based on Sun/solar wind driving inputs. ,

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