SWARM observations of the artificial ionospheric plasma disturbances and field-aligned currents induced by the SURA power HF heating

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It has long been a goal of active experiments to understand the response of the ionosphere to the high-power high-frequency (HF) radio wave pumping. The altitudes of 400-500 km are of particular interest since they correspond to the transition from the region, in which the most intense plasma heating and artificial ionospheric turbulence are observed, to the region where the disturbed plasma escapes to the magnetosphere. No observational data on the properties of plasma turbulence induced by the high-power HF pumping at this altitudinal range existed, until the emergence of a multi-satellite low-orbiting SWARM mission.

A series of experiments were conducted with a conjunction between the midlatitude SURA ionospheric heating facility and the SWARM satellites. We present the first observations made by SWARM on the plasma perturbations and electric currents induced in the F₂ region ionosphere by the O-mode radio wave pumping. In the heated region, significant effects include a localized increase of the electron temperature accompanied by stratification of the electron density and the magnetic signatures of field-aligned currents (FAC) of 0.01-0.02 μA/m² densities. The upward FAC is confined within the central part of the artificially perturbed magnetic flux tube, while the return downward current flows through the ambient plasma adjoining to the boundary of the HF-disturbed region. The spatial structure and amplitude of FACs indicate the current system is likely associated with the unipolar diffusion and excitation of eddy electric currents in the topside ionosphere. Similar effects are revealed in the laboratory experiment but not previously observed in space. The spaceborne experimental information is being accumulated and further analysis is underway.

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