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Up, out, and away: Probing the initial stages of ion outflow with Swarm

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Earth's ionized upper atmosphere is ablated into space at a rate of 1 kilogram per second. This outflowing flux is comprised of significant amounts of heavy ions, such as oxygen, whose source populations in the F region ionosphere are sufficiently cool (˜1000 K) to be strongly gravitationally bound to the Earth. Here lies a mystery: What processes operate on the cool, dense, low-altitude (*F* region) ionospheric plasma to lift it up, out, and away? The European Space Agency Swarm satellite mission is well-suited to address the low-altitude part, and therefore initial stages, of the outflow problem. In this talk we review several non-classical mechanisms that seemingly conspire to drive low-altitude upflow and, ultimately, atmospheric escape. We survey what is known from past measurements made by satellite and ground-based platforms, including Dynamics Explorer, the Defense Meteorological Satellite Program, and incoherent scatter radars. Finally, we examine what the new, high resolution observations from the Swarm electric field instruments can tell us about the initial stages of ion outflow.

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