SWARM satellite and EISCAT radar observations of a strong midnight flow channel

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The SWARM mission makes it possible for the first time to study ionospheric parameters by utilizing two satellites flying in parallel over the auroral ovals. The separation of satellites A and C is 1.5^{o} in longitude. The low altitude of these satellites (450 km) is an advantage when trying to compare the satellite observations with auroral locations and E-region parameters. The third satellite of SWARM (satellite B) has a slightly higher altitude, so its orbit is slowly drifting away from the original three closely spaced satellite constellation. The satellites carry identical versatile instrumentation.

The aim of this paper is to study the SWARM auroral oval crossing during 9 November 2015 near magnetic midnight over Scandinavia and the EISCAT radar facility in Tromso. The EISCAT radars were running a specific mode designed for the SWARM overpass with the UHF radar pointing in the field-aligned direction and the VHF radar pointing vertically up in a tri-static mode providing electric field estimates. The versatile ground-based instrumentation including magnetometers (the MIRACLE network) and all-sky cameras made it possible to study the ionospheric electrodynamics applying the SECS method.

The studied event occurs during a high-speed stream event. The AE index reaches 500 nT during the studied interval 21:35 - 22:00 UT (near magnetic midnight) indicating ongoing substorm activity. The auroral oval is wide during the SWARM overpass and the field-aligned currents (FACs) analysed from the magnetometer data indicate that at least seven upward FAC sheets, all obviously corresponding to auroral arcs, are confined within the oval.

The most striking feature in this event is a strong plasma flow channel measured both by the SWARM satellites and the EISCAT radars close Tromso. The width of the east-west channel is about 1.5^{o} in latitude and the magnitude of the flow corresponds to a southward electric field of 150 mV/m. We will address the following questions: (1) How is the flow channel related to the high-latitude plasma regions and boundaries? (2) What is the role of the flow channel in the local electrodynamic system and in global convection? An interesting fact is that the flow channel seems to be invisible to ground magnetometers.