Break up of a polar cap patch in the nightside ionosphere due to a flow channel event

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Abstract

We report observations of a flow channel event in the evening of the 9th January 2019 under quiet geomagnetic conditions. This multi-instrument study was undertaken using a combination of multiple EISCAT (European Incoherent Scatter) radars, SuperDARN (Super Dual Auroral Radar Network), MSP (Meridian Scanning Photometer) and GNSS (Global Navigation Satellite System) scintillation data. These data were used to build a picture of the evening's observations from 1800 to 2359 UT. A decrease in electron density was observed, from a patch value of 1.4×10^{11} m^3 to a minimum value of 5×10^{10} m^3. In addition, ion velocities in excess of 1000 m s^{-1} and ion temperatures of greater than 2000 K were also observed**.** The flow channel event lasted 13 minutes and segmented a polar cap patch.

Background

The high-latitude ionosphere is highly structured medium in which features develop in response to geophysical conditions, one such event is a flow channel event (FCE) characterised by enhanced ion velocity and a small latitudinal extend (~2°- 4°).

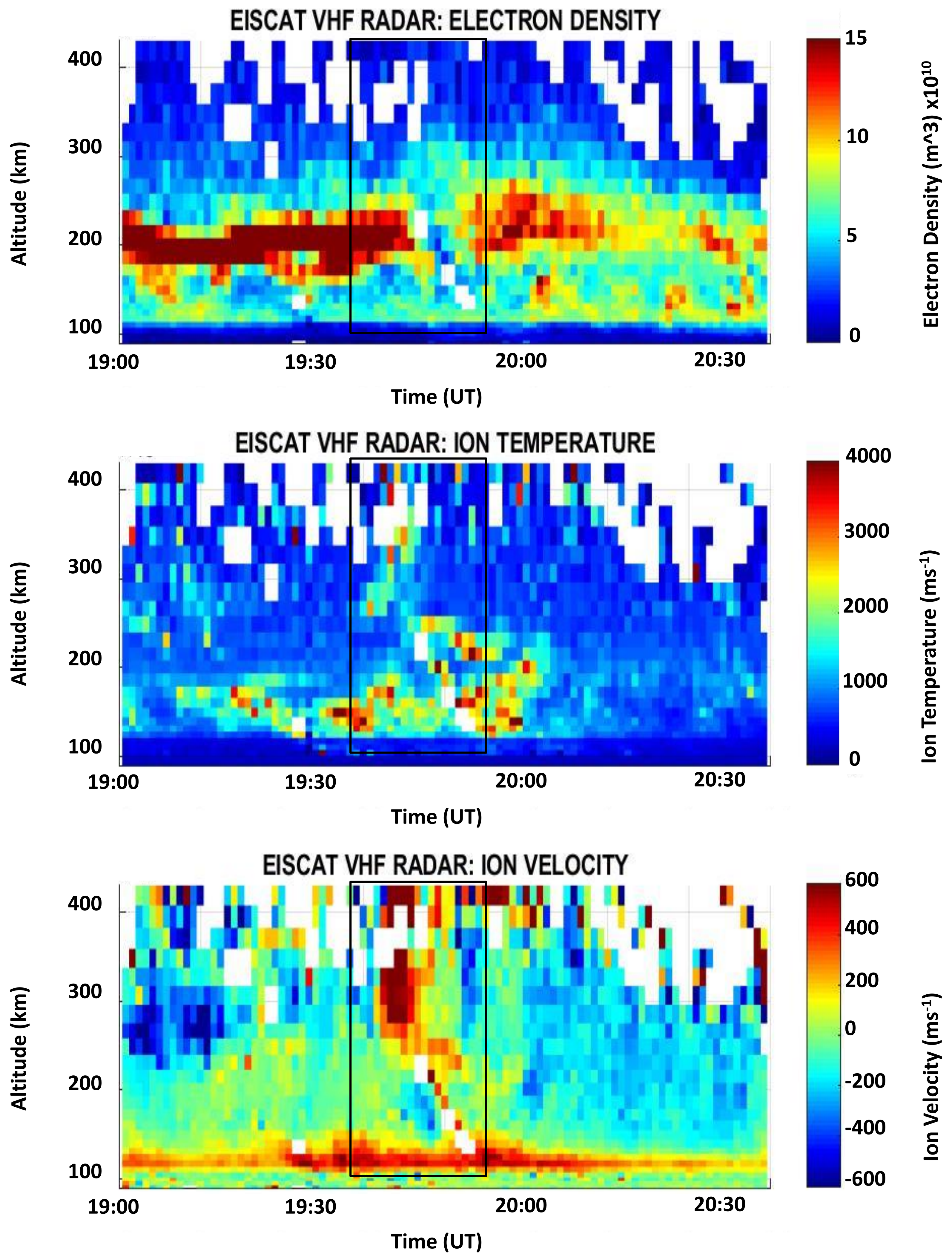

Fig. 1: EISCAT VHF Radar observations, 9th Jan 2019 centred on a flow channel event in the nightside ionosphere.

Results and Analysis

The FCE is highlighted by the box overlaid on Fig. 1. Using a combination of line profile plots and FWHM the event was found to be 13 ± 2 minutes in length. Prior to the event, the average electron density at an altitude of 200km was $1.8\times10^{11} \pm 7\times10^{9}$ m^3, the minimum value of electron density across the depletion at the same altitude was found to be $5\times10^{10} \pm 1\times10^{10}$ m^3. The ion temperature experienced a rise in temperature from the cool background with the average temperature of the enhancement found to be 2300 ± 200 K. Finally ion velocity showed an increase to velocities in excess of 1000 m s^{-1}. This feature is moving away from the VHF radar, travelling polewards.

An ion velocity enhancement is present in the ESR-32m data (Fig. 2), with velocities found in excess of 500 m s^{-1} and lasting for 10 minutes. The feature is less than 3° in latitudinal width (the distance between the radar beams) as it is only observed on one radar.

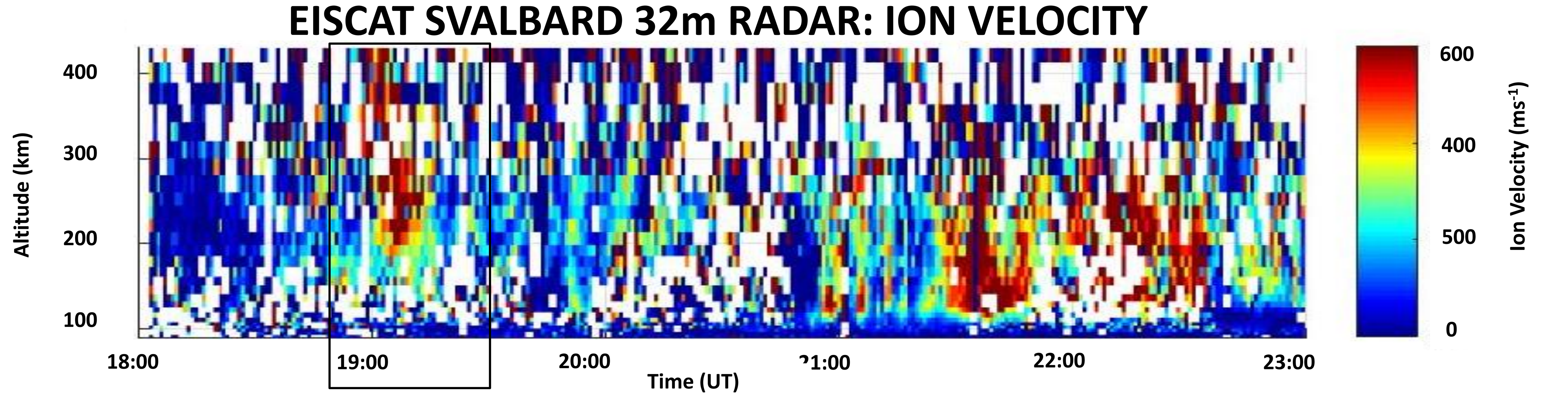

Fig. 2: EISCAT 32m Radar observations, 9th Jan 2019 with a flow channel event found within the box.

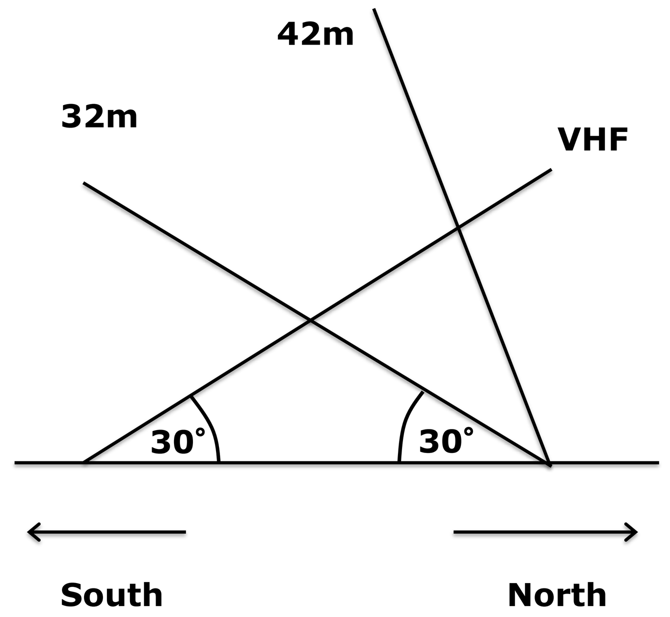

Fig. 3: EISCAT Radar geometries for the 9th January 2019

Radar Geometry

The observing geometry for the EISCAT radars is shown in fig. 3 and the radar positioning relative to the convection pattern at the central point of the FCE is shown in fig. 4.

Discussion

FCEs have previously been observed in the dayside ionosphere forming polar cap patches by Rogers et al. (1994) and Valladares et al. (1994). FCE have also been observed deforming a blob during a substorm by Ishida et al. (2015). To the best of our knowledge, this study presents the first observation of the break up of a polar cap patch on the nightside ionosphere due to a FCE.

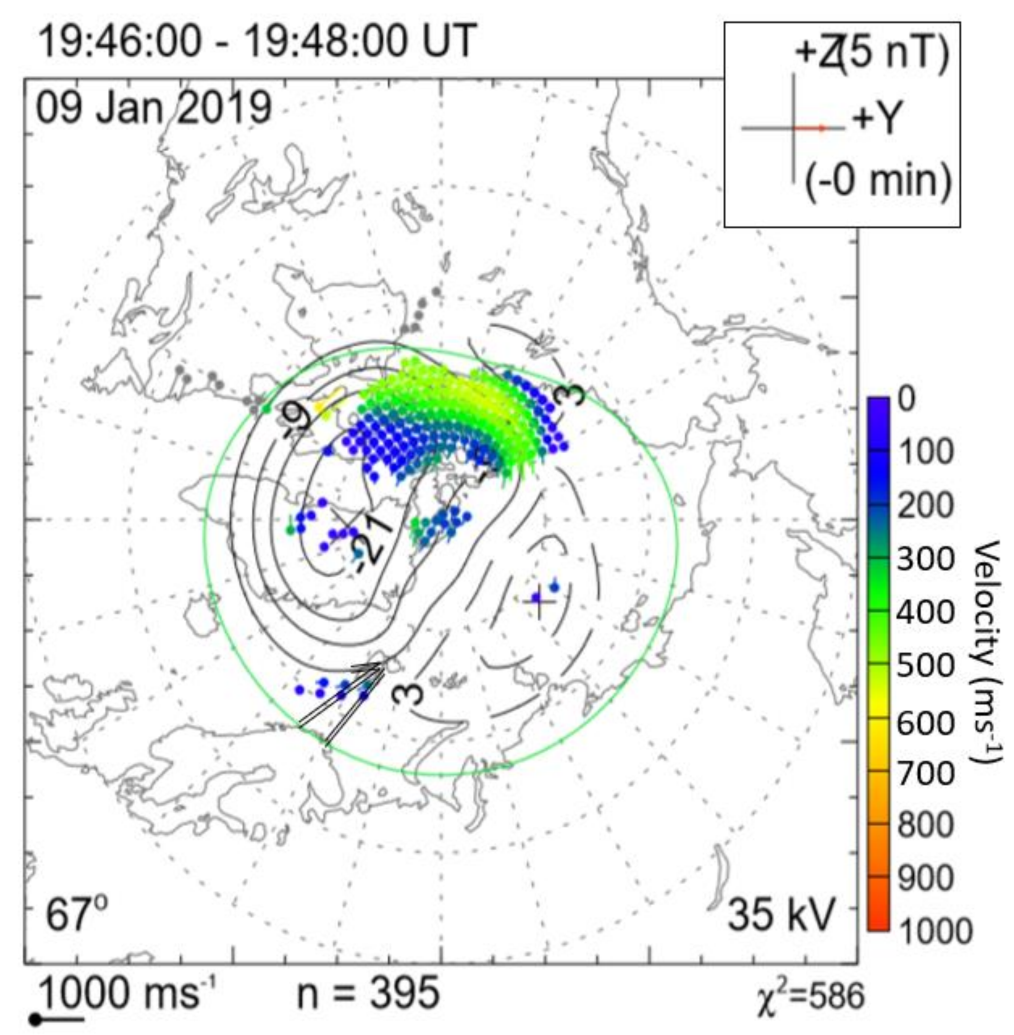

Fig. 4:SuperDARN plot for the central point of the flow channel event observed with the VHF showing plasma in the order of decimetres present between the radar beams

References and Acknowledgements

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