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Multi-Frequency Investigation of Height-Dependent Drift Variability of the Sporadic E (Es) Layers in the Polar Region Using Canadian Advanced Digital Ionosonde

UNIVERSITY OF NEW BRUNSWICK

THESIS DEFENCE AND EXAMINATION

in Partial Fulfillment

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by

Gopika Rajeev Nair

in the Department of Physics

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Via MS TEAMs

Examining Committee

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Abstract

Ionospheric plasma motion and density gradients affect radio wave propagation by causing irregularities that lead to rapid random fluctuations and altering the propagation characteristics of the signal. While the F-region drift (convection) is well understood in the Polar Cap, the drift in lower ionospheric regions, especially the E region, remains poorly understood due to lack of measurements. To address this gap, we analyzed ionospheric motion during Sporadic E conditions to investigate the morphology and variability of ionospheric drift in the 100-150 km region of the polar cap ionosphere. Characteristics of the three components of drift (vertical, zonal, and meridional) over Pond Inlet (72.70 ° N, 77.95 ° W) were studied using the Doppler interferometry technique employed by the Canadian Advanced Digital Ionosonde (CADI) of the Canadian High Arctic Ionospheric Network (CHAIN). This technique, using spaced receivers oriented magnetically in both E-W and N-S directions, estimates the three-dimensional bulk motions of ionospheric scatterers. Drift measurements at 2.73, 4, 5, and 6 MHz were analyzed, assuming these frequencies correspond to different reflection heights, to explore the altitude variation of the drift. Gaussian fits showed no significant differences in drift velocities for 2.73, 4, and 5 MHz. Still, the 6 MHz data exhibited a larger standard deviation (up to 500 m/s in some cases), indicating higher variability at these heights. Multiple case studies were conducted to explore the factors influencing drift variability in the E region, providing insights into the transition from the collisional to the collisionless region in the ionosphere.