Remote Sensing of Magnetic Fields Induced by Electrojets From Space: Measurement Techniques and Sensor Design Requirements

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The Zeeman effect of the O₂ 118 GHz spectral radiance measurements can be utilized to remotely measure the magnetic field perturbations at altitudes close to the auroral electrojets. The technique has been demonstrated using the measurements provided by the Microwave Limb Sounder onboard the Aura spacecraft. The derived current-induced magnetic field perturbations were found to be highly correlated with those coincidently obtained by ground magnetometers and to be consistent with the well-known auroral electrojet current distribution thereby providing a strong argument for the validity of the technique. With today’s technology, a 118 GHz instrument, can be miniaturized allowing it to fly on small satellites such as CubeSats. A constellation of small satellites with each one carrying a number of these identical mini-radiometers would have the ability to provide simultaneous multipoint measurement of the magnetic field perturbations at altitudes close to the electrojet, thereby greatly advancing our understanding of the ionospheric current system. In this paper, we present the Zeeman magnetic field sensing technique, the requirements and specifications of the instrument, and an example of a cost effectively cubesat mission that provides unprecedented measurements of the evolution and structure of the auroral electrojet system.