Magnetospheric Radio Tomography Experiments using IMAGE, WIND, and Cluster

S. A. Cummer*, Electrical and Computer Engineering Department, Duke University, Durham, NC 27708, USA (email: cummer@ee.duke.edu).

J. Green, Space Science Data Operations Office, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA.

B. Reinisch, Center for Atmospheric Research, University of Massachusetts-Lowell, Lowell, Massachusetts, USA.

M. Kaiser, Laboratory for Extraterrestrial Physics, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA.

M. Reiner, Physics Department, Catholic University of America, Washington, DC, USA.

R. Manning, Late of Observatoire de Paris, Meudon, France.

K. Goetz, School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota, USA.

I. Christopher, R. Mutel, J. Pickett, D. Gurnett, Dept. of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA.

C. P. Escoubet, ESA/ESTEC,Noordwijk,The Netherlands.

To validate and demonstrate the potential of magnetospheric radio tomography, we have performed three separate experiments using the Radio Plasma Imager (RPI) on the IMAGE spacecraft as the signal source. The WAVES instrument on WIND and the WBD instruments on the four Cluster spacecraft were used as the wave receivers. These experiments were designed to measure the Faraday rotation of the transmitted wave electric field polarization due to propagation through a magnetized plasma. In the proper frequency range, Faraday rotation is proportional to the path-integrated product of the magnetospheric electron density and magnetic field, enabling large-scale measurements of these quantities on the propagation paths in each of these experiments. In August 2000, WAVES received a single frequency (828 kHz) RPI transmission. In October through December 2001, WAVES received two frequency (508 and 828 kHz) RPI transmissions. And in April 2002, WBD on Cluster received stepped frequency (between 100 and 500 kHz) RPI transmissions. Some of the RPI signals have been measured on propagation paths longer than 10 Re. By exploiting the time variation and frequency dependence of Faraday rotation, the integrated electron density/magnetic field product has been measured, with some limitations, in each of these experiments. We report on the novel large scale measurements of magnetospheric plasma and magnetic field generated by each of these radio propagation experiments. We also demonstrate, through these measurements, what quantities can be measured and how best to measure them on a dedicated radio tomography mission. These experiments have also shown that magnetospheric radio tomography can be implemented with existing instrument technology.