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Remote sensing of the dynamic plasmasphere by ground-based magnetometer arrays with the magnetoseismic technique

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Ground-based magnetometers can monitor the dynamic plasmasphere through the use of the normal-mode magnetoseismic technique, which infers the equatorial plasma mass density from the observed field line resonance (FLR) frequencies. When two ground magnetometers are located at similar local times and separated by one or a few degrees in latitude, even the weak hum of closed magnetospheric field lines can be detected on a daily basis by comparing the phase differences at the two sites.

By using the magnetoseismic technique, we have observed variations in plasmaspheric density over different time scales, including the annual cycle, the diurnal cycle, and the phases of magnetic storms. In particular, the depletion or density enhancement in the plasmasphere during magnetic storms is found to correlate with concurrent changes in the ionosphere. The diurnal variation in plasmaspheric density at low L shells may be a consequence of the similar variation in the mass density of the thermosphere.

To better understand the coupling between the plasmasphere and the ionosphere using the ground-based magnetometer data, we have developed automated procedures to extract FLR frequencies from data as well as to calculate the equatorial plasma density. We have also extended the magnetoseismic technique to producing two-dimensional snapshots of plasmaspheric density using observations collected by a two-dimensional magnetometer network. We conclude by presenting a new database of plasmaspheric density named ”Ground-based Observations of the PlasmaspHEre through Resonance Sounding (GOPHERS).” The density data are derived from the geomagnetic field observations collected by AUTUMN/AUTUMNX, CARISMA, Falcon, GIMA, McMAC, THEMIS, and USGS stations in North America. We will present examples of the plasma densities in the GOPHERS database, demonstrating the spatio-temporal variations of the plasmasphere in response to solar and geomagnetic activities.

Keywords: plasmasphere, magnetoseismology, magnetic storms, plasmasphere-ionosphere coupling, ground-based magnetometer arrays, remote sensing