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Use of magnetic field measurements as an indicator of spacecraft locations

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It is known that the configuration of the magnetosphere is more complicated than that of the intrinsic magnetic field only due to highly dynamical and time-dependent magnetospheric currents. There are empirical magnetospheric models derived from statistical analysis of large data sets. However, the models give us average states, which often results in deviation from instantaneous magnetospheric configurations. It is important to construct a technique to show where spacecraft is located in the magnetosphere, especially, how far from the magnetic equator spacecraft is when we interpret the observational results since the distance from the equator is a significant controlling factor for evolution of plasma temperature anisotropy and plasma wave intensities. In this study, using the data obtained by the THEMIS spacecraft, we show a simple method to estimate spacecraft location relative to the magnetic equator using local magnetic field measurements. The method uses the ratio of Br to |B|, where Br and |B| is the radial component of the magnetic field vector and total magnetic field intensity, respectively. When we choose a simple dipole magnetic field as a reference, we can analytically estimate the magnetic latitude from the measured ratio Br/|B|. Since rising tone chorus emissions are generated in the region close to the magnetic equator and propagate higher latitudes in both the Northern and Southern hemispheres, the method was tested by deriving the latitudinal distribution of propagation direction of rising tone chorus emissions measured by THEMIS. We analyzed 246 rising tone chorus events and statistically derived the latitudinal distribution referring to both the dipole magnetic latitude and the magnetic latitude estimated by Br/|B|. The latitudinal distributions based on the dipole magnetic latitude and estimated magnetic latitude show that 77 % (190 events) and 98 % (241 events) of the events are observed to propagate from the equator to higher latitudes, respectively. It indicates that the magnetic latitude based on the magnetic field measurements is more reliable than the dipole magnetic latitude to show the spacecraft location relative to the magnetic equator. We will test and discuss the performance of our method by comparing the latitudinal distribution of propagation direction of chorus emissions based on the estimated magnetic latitude with that based on the empirical magnetospheric models. We will also discuss capabilities of the method and applications to magnetospheric studies, especially plasma wave phenomena.