

## Frequency of toroidal Alfvén waves observed by Geotail and its relation to plasma mass density

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Plasma mass density is a fundamental quantity in the magnetosphere that controls MHD wave speeds and thus the time constant of global phenomena. Because determination of mass density with particle experiments is in general difficult, the frequency of standing Alfvén waves is commonly used to estimate the density, a technique known as normal mode magnetoseismology. In this presentation we apply this technique to toroidal standing Alfvén waves observed by the Geotail spacecraft to estimate the mass density in the outer magnetosphere. We first demonstrate the validity of the technique by comparing the plasma mass density that is determined from the very unique ion composition measurement made during a Pc5 toroidal wave event [Hirahara et al., 2004] with the mass density that is estimated from the frequency of the wave. We then present a statistical analysis of the fundamental toroidal wave frequency and the mass density for 1995 to 2006. We use ion bulk velocity data to detect fundamental toroidal waves because the velocity has an antinode at the magnetic equator, unlike the magnetic field that has a node there. The fundamental waves are most often detected in the dawn sector and in this sector we find a clear solar activity dependence of the wave frequency. At  $L \sim 10$ , the frequency changes from 4 mHz in 1996 (low solar activity) to 2.5 mHz in 2000 (high solar activity). This translates to a mass density variation by a factor of  $\sim 3$  over a solar cycle.