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Simultaneous observations of wave mode inside-outside the plasmasphere and their relationship with low-latitude Pi2 pulsations: THEMIS case study

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Abstract. Much evidence has supported that Pi2 pulsations in the inner magnetosphere can be explained by the radially trapped fast mode wave in the plasmasphere. However, most of these studies were based on the observations from single spacecraft in the plasmasphere and low-latitude ground stations within several hours separation of the local time. Here we present simultaneous observations of Pi2 pulsations from 0023 to 0038 UT on January 26, 2009 by three THEMIS probes (P3, P4 and P5) which were located at pre-midnight and a low-latitude ground station Ascension Island (ASC, L$\sim$1.002, MLT$\sim$23). This Pi2 event happened during the growing phase of a moderate magnetospheric substorm with maximum AE index about 590 nT. By using the plasma density from the Electrostatic Analyzer (ESA) and the spacecraft potential measurements from the THEMIS Electric Field Instruments (EFI), we identified that both P4 (L $\sim$ 3.2, MLT $\sim$ 22) and P5 (L $\sim$ 4.3, MLT $\sim$ 22.4) were located inside the plasmasphere while P3 (L $\sim$ 5.8, MLT $\sim$ 23) was located outside the plasmasphere during the Pi2 event. It was found that the compressional components (Bz) of P4 and P5 had high coherence with H component of the low-latitude ASC station, but compressional oscillations of P3 which was located outside the plasmasphere do not show a clear correlation with the ground observations. This provides the evidence that nightside Pi2s at low latitude are generated by the plasmaspheric cavity resonance. For P4 which was located inside the plasmasphere closer to the Earth, Bz oscillates nearly in phase with ground Pi2 within L < 3.4 and shows a phase reversal at L $\sim$ 3.4. For P5 which was also located inside the plasmasphere near the plasmapause, Bz oscillates nearly out of phase with H component on the ground. These are consistent with the phase properties of the radial structure of the fundamental cavity mode oscillation. In addition, the poloidal components (Bz, Ey) of P4 and P5 oscillate nearly in quadrature which indicates the formation of a radially standing wave mode structure. Observations strongly suggest that the plasmaspheric cavity resonance or the plasmaspheric virtual trapped resonance is the source of the low-latitude Pi2 pulsations and the plasmapause is the outer boundary of the cavity.