Two wave packets of second harmonic poloidal Pc 4 waves with a wave frequency of ~7 mHz were detected by Van Allen Probe A at a radial distance of ~5.8 $R_E$ and magnetic local time of 13 hr near the magnetic equator, where plasmaspheric refilling was in progress. Proton butterfly distributions with energy dispersions were also measured at the same time; the proton fluxes at 10–30 keV oscillated with the same frequency as the Pc 4 waves. Using the ion sounding technique, we find that the Pc 4 waves propagated eastward with an azimuthal wave number ($m$ number) of ~220 and ~260 for each wave packet, respectively. Such eastward propagating high-$m$ ($m > 100$) waves were seldom reported in previous studies. The condition of drift-bounce resonance is well satisfied for the estimated $m$ numbers in both events. Proton phase space density was also examined to understand the wave excitation mechanism. We obtained temporal variations of the energy and radial gradient of the proton phase space density and find that temporal intensification of the radial gradient can generate the two wave packets. The cold electron density around the spacecraft apogee was $>100$ cm$^{-3}$ in the present events, and hence the eigenfrequency of the Pc 4 waves became lower. This causes the increase of the $m$ number which satisfies the resonance condition of drift-bounce resonance for 10–30 keV protons and meets the condition for destabilization due to gyrokinetic effect.