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The foreshock wave activity under quasi radial magnetic field in lunar distances: Statistical study

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We present a large statistical study of the ultra-low frequency (ULF) waves in the terrestrial foreshock. These waves are excited in the upstream region by energetic ions streaming along the solar wind magnetic field lines connected to the bow shock. Although these waves propagate upstream and grow in the solar wind frame, they are blown down by the solar wind flow and thus their amplitudes would grow toward the bow shock. In our previous study based on ARTEMIS observations, we demonstrated that the statistically determined growth rate is positive but also the cases of a wave decay are frequently observed. We have shown that even if a possible influence of the Moon and its wake is excluded, the growth rate is decreased by non-linear effects leading to a saturation of the wave amplitude. To eliminate this problem, we have selected intervals allowing identification of an initial stage of wave amplitude growth (either in spatial or temporal sense). Our study revealed that the growth rate depends on the wave type being larger for compressive variations of the magnetic field strength and plasma density than for variations of magnetic field components. The analogous study of velocity fluctuations leads to smaller growth rates and we discuss possible causes of this disagreement.