



Oblique propagation of ULF waves in the Earth's foreshock region: THEMIS observations

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The Earth's foreshock, the region upstream the Earth's bow shock, is filled with various particles and waves. The formation of foreshock is resulted from the reflection and leakage of ion toward upstream bow shock. The interaction between backstreaming ions and the incoming solar wind generates ultra-low-frequency (ULF) waves, with frequency ranging from 0.01 to 0.05 Hz. Observations from previous studies have shown that ULF waves can obliquely propagate at a considerable angle (20-40 deg) with respect to the magnetic field. What causes the oblique propagation of ULF waves is still not fully understood. Five THEMIS probes observed wave activities in the foreshock region. With the THEMIS data, we proceed statistical and case studies on the relation between oblique propagation of ULF waves and solar wind parameters. In the statistical study, we select events with ULF waves lasting for at least six minutes under the relatively stable background magnetic field. We find that the ULF waves can propagate at a larger oblique angle than 40 deg; however, there exists a threshold angle at 60 deg for the oblique propagation. Moreover, we find that the direction of the solar wind velocity affects the angle between the propagation direction of waves and the ambient magnetic field. In the presentation, we will also show some cases for which two of the THEMIS probes observed ULF waves simultaneously in the foreshock region.