Whistler-mode chorus waves in the dayside outer magnetosphere: PENGUIn/AGO and THEMIS conjugate observations

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We perform a case study of whistler-mode chorus waves in the dayside outer (>7) magnetosphere under quiet geomagnetic conditions. We use simultaneous conjugate observations made at 1230-1930 UT on 26 July 2008 by three THEMIS spacecraft and ground-based VLF receivers at two automatic geophysical observatories (AGO) in Antarctica supported by the PENGUIn project. Solar wind dynamic pressure was constant and weak (~1 nPa); the Dst index was around -10 nT; and the AE index showed weak activity (<200 nT).

VLF wave intensification was observed by THEMIS A, D, and E. THEMIS A data show that the waves were intensified in a frequency of 500-800 Hz (0.3 to 0.4 fce) and circularly right-handed polarized. Filter bank data show that all three THEMIS probes observed wave intensification in the 287-1240 Hz range around noon and 6-9 RE near the equatorial plane. THEMIS D and E were in almost the same orbit and separated by ~1.5 hours with THEMIS D leading. THEMIS A was in similar orbital phases as and separated in the radial direction from THEMIS D.

VLF signals at the AGO P2 station (AP2: MLAT = -76.6 deg.; MLT = UT-3.5h) were intensified at the frequency range of 500-1000 Hz. At the AGO P3 station (AP3: MLAT = -83.63 deg., MLT = UT - 2h), VLF signals were intensified in the same frequency range; the increase rate was smaller than at AP2. The VLF wave intensification peaked around noon. The AGO AP2 and AP3 stations are mapped along field lines to the outer magnetosphere; the mapped locations on the equatorial plane are 9-10 RE and 10-11 RE around noon, respectively. We also confirm, from fluxgate magnetometer data, that AP2 and AP3 were equatorward of the open-closed boundary.

The observed chorus waves were intensified in narrow ranges of MLT and radial distance. We conclude that the localized intensification continued for at least 1.5 hours. We examine the configuration of magnetic field lines in which the THEMIS spacecraft and the AGO stations reside during the wave intensification, and find that the intensification occurred when field lines have small gradient along a field line (dB/ds) in a wide range of magnetic latitude. We suggest that chorus wave growth in flattened field lines is responsible for the continuous intensification of dayside chorus waves during quiet geomagnetic conditions.