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Simultaneous observation of dayside Pc3 pulsations in the foreshock, in the topside ionosphere and on the ground

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After decades of intensive study the question of the origin of dayside Pc3 (ULF waves in the 20-100 mHz band) activity still has not been fully answered. Kelvin-Helmholtz instability at the magnetopause, cavity resonances in different regions of the magnetosphere were proposed as possible drivers of dayside field line resonances, which are regularly observed both in the magnetosphere and on the ground along closed field lines. In the last decade the ULF waves generated in the upstream region (called upstream ULF waves) received little attention, although the relation of ground and magnetospheric Pc3 pulsations to interplanetary conditions (solar wind speed, IMF strength, IMF cone angle) was discovered early in the 1970's, and also the theory of upstream wave generation was developed.

In a recent study we demonstrated a clear correspondence between upstream-related Pc3 events observed at LEO by CHAMP and by the MM100 ground magnetometer array (Heilig et al. 2007). In the case studies presented here dayside Pc3s, observed simultaneously in the terrestrial foreshock (by CLUSTER), in the topside ionosphere (by CHAMP) and on the ground (by MM100 array), are compared. We find, in accordance with theory, that the frequencies of these waves are governed by the IMF strength, and that the wave energy depends on the IMF cone angle. However, a direct correspondence between foreshock ULF events and dayside Pc3s could not be established. Narita et al. (2004), who studied foreshock waves observed by CLUSTER during the months February-May 2002, found that the majority of these waves

are Alfvén waves propagating upstream along IMF and that their period is proportional to the IMF strength. Our combined results strongly support the upstream origin of the considered dayside pulsations. However, it remained an open question how the upstream wave energy couples into the magnetosphere.