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Variations of chorus source location: comparison of Cluster data and the backward-wave oscillator model

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We study the motion of the source region of magnetospheric chorus emissions using multipoint measurements of VLF wave emissions and geomagnetic field onboard Cluster spacecraft. The wave data from STAFF instrument are used to obtain the energy flux in chorus waves, and the chorus-source region is found as the region where the energy flux is bi-directional. The geomagnetic-field data are matched to a parameterized model of local magnetic field, and the spatio-temporal dynamics of the magnetic field is obtained on this basis. Comparison of these data shows that the chorus-source location remains related to the magnetic-field minimum, while the position of this minimum can vary rather strongly during periods of enhanced geomagnetic activity. These results support the backward-wave oscillator (BWO) model of chorus emissions, which attributes chorus generation to an absolute instability of whistler-mode waves in the presence of a step-like velocity distribution of energetic electrons. Such an instability takes place in a small vicinity of the local “magnetic equator” of a magnetic flux tube. Quantitative agreement between the data and the model is demonstrated by the results of numerical simulations of self-consistent equations of magnetospheric BWO in which the experimentally obtained time-varying profile of the geomagnetic field is used.