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Study of Pc1 pearl structures observed at multi-point ground stations at Russia, Japan and Canada
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We have investigated possible generation mechanisms of pearl structures of Pc1 geomagnetic pulsations using ground-based multi-point induction magnetometers at Athabasca in Canada, at Magadan in Russia and at Moshiri in Japan. During 3-years of observation (January 1, 2009 to December 31, 2011), we found two Pc1 pulsations with similar dynamic spectrum shapes at three stations simultaneously. For the case 1, which occurred on April 8, 2010, Pc1 pulsations were clearly identified at the three stations in the frequency range of 0.4 to 1.2 Hz. Coherence between the two stations was high ($r > 0.8$). The cross-correlation of the upper envelope of Pc1 waves between the ATH and the MGD, which indicates amplitude modulation of Pc1 due to pearl structures, was also high ($r > 0.8$). In some time interval during the case 1, however, correlation decreased down to 0.5. The case 2 occurred on April 11, 2010 in the frequency range of 0.2 to 0.8 Hz showed that the coherence and cross-correlation between ATH and MGD were both high ($r > 0.8$) throughout the event. The high coherence indicates that the Pc1 pulsations observed at these different stations were propagated from the same source region. However, in case 1, the Pc1 pearl structures were slightly different for different stations. The case 1 showed polarization angle variation depending on frequencies, while the case 2 does not show such dependence, suggesting that the case 1 has a spatially-distributed ionospheric source at high latitudes. In order to understand these different features of Pc1 pearl structures, we made two model calculations of Pc1 peal structures under the different conditions. One model is that the Pc1 waves come from a north-south extended ionospheric source region with slightly different frequencies at different latitudes. This source distribution, causes the Pc1 pearl structure by beating during the duct propagation in the ionosphere. The other model is that the Pc1 waves with different frequencies are mixed at the point source in the ionosphere, assuming that the pearl structures were already made in the magnetosphere. The Pc1 from the point source shows an identical waveform among the different stations. On the other hand, the Pc1 from distributed source region shows slightly different waveforms at different stations. This result suggests that the distributed source region is able to create the different Pc1 pearl structures at different stations through the beating, as observed for the case 1. We conclude that the Pc1 pearl structures are created by both magnetospheric processes and ionospheric beating processes before they reach the ground-based magnetometer at low latitudes.

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