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Statistical analysis of internal modulations in pulsating aurorae with a large dataset of a high-speed imager

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Pulsating aurorae are a major type of diffuse aurora, characterized by quasi-periodic pulsations in brightness ranging from a few seconds to several tens of seconds. They sometimes coexist with shorter-period variations of a few Hz, called ”internal modulations.” The hierarchy of these periods has observationally shown to correspond to the intensity variations in chorus wave which is responsible for electron precipitation causing pulsating aurorae. However, the number of reports on internal modulation is limited due to the high sampling rates (>10 Hz) required for optical observations to investigate internal modulation. The factors controlling the presence or absence of internal modulation has not been well understood.

This study aims to statistically investigate how the periodicity of chorus wave activity, which determines the presence of internal modulation, is controlled in the magnetosphere, and how this results in differences in characteristics such as the morphology of the pulsating aurora and the energy of the precipitating electrons. This has been made possible by the recently published dataset of 10-Hz sampling images obtained by the High-speed Auroral Imaging (HAI) system at Syowa Station. We first tried a frequency filtering to determine the timings and regions with internal modulations for an example data. It is confirmed that a simple way of subtracting running average from the original auroral intensity shows enough performance to detect the modulation. This method of detecting internal modulation is applied to a three-year data set from 2017 to provide a statistical view of the internal modulation, with a particular focus on its relationship to auroral morphology.