One-to-one correspondence between the vertical evolution of AKR and global high-correlation Pi 2: ARASE and MAGDAS observations

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At the onset of substorms, various phenomena appear different areas of the magnetosphere. Pi 2 and auroral kilometric radiation (AKR) are detected in a wide extent of the magnetosphere, and thus those are accepted as the indicators of substorm onsets [e.g. *Saito*, 1969; *Gurnett et al.*, 1974]. AKR is believed to emanate from the auroral acceleration region, and the frequency of AKR is almost equal to the electron gyro-frequency of the region. Therefore, we can remotely monitor the altitude of AKR occurrence region with AKR frequency [e.g., *Gurnett and Anderson*, 1981; *Morioka et al.*, 2007]. It also means that vertical evolution of auroral acceleration region can be remotely diagnosed with temporal variation of AKR frequency range. *Morioka et al.* [2009] investigated AKR dynamics, and presented that there exist two-stage vertical evolution of AKR and auroral acceleration region.

Global high-correlation Pi 2 is observed on the night side and in a wide latitudinal range from high-latitude to the magnetic equator with high-correlation waveform [*Uozumi et al.*, 2009]. *Uozumi et al.* [2011] found that global high-correlation Pi 2 is also correlated with temporal variation of AKR power. This feature was further confirmed by a comparative study between AKR observed by Arase satellite and Pi 2 observed by MAGDAS/CPMN network [*Uozumi et al.*, SGEPSS fall meeting in 2018]. According to the studies of *Uozumi et al.* [2009, 2011, 2016], oscillation of global high-correlation Pi 2 is synchronized with the oscillation of the field aligned current (FAC) of the substorm current wedge (SCW). *Morioka et al.* [2009] suggested that two-stage vertical evolution of auroral acceleration corresponds to the two-step reinforcement of the FAC of the SCW. So, it is expected that there exists some correspondence between global high-correlation Pi 2 and vertical evolution of AKR.

In this study, we conducted a comparative study concerning temporal variation of AKR frequency range and ground Pi 2 pulsation with data sets obtained by the High Frequency Analyzer (HFA) of the Plasma Wave Experiment (PWE) on board the Arase (ERG) satellite [*Kasahara et al.*, 2018; *Kumamoto et al.*, 2018] and the MAGDAS/CPMN equatorial ground magnetometer [*Yumoto et al.*, 2006]. We searched for AKR events during the interval from April to October 2017, and 40 AKR events were selected. It is found that 33 out of 40 events exhibited that the maximum altitude of the AKR range (A_{max}) modulated in the Pi 2 period range, and temporal variations of A_{max} tend to be correlated with global high-correlation Pi 2. Our observation suggests that one-to-one correspondence between each pulse of vertical evolution of AKR, FACs of SCW and global high-correlation Pi 2.