# Atmospheric-ionospheric vertical coupling study focusing on the quasi-6-day oscillation in Sq-EEJ current system

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Atmospheric oscillations in the Sq-EEJ current system using MAGDAS (Global Geomagnetic Observation Network) magnetic field data were analyzed for a comprehensive understanding of the three-dimensional coupled atmosphere-ionosphere-magnetosphere system. In this study, we focus on the 6-day oscillation phenomenon (Q6DO) excited in the troposphere and report its globality, its seasonal dependence of its excitation characteristics, and its solar activity dependence respectively.

It is known that, the quasi-6-day wave (Q6DW), one of the atmospheric waves, is caused by atmospheric heating by moist air in the tropical troposphere [Miyoshi and Hirooka1999] and has a seasonal dependence that strongly develops in the spring and autumn equinoxes [H.-L. Liu et al. 2004]. It has been suggested that the equatorial electrojet (EEJ) has a very high "variability" that fluctuates under the influence of various forcing mechanisms including atmospheric waves from the lower layer. Q6DO in Sq-EEJ current system was verified with CHAMP satellite, Swarm satellite, EEJ intensity data and EEJM (EEJ empirical model) and geopotential height of MLS measurement [Yamazaki et al., 2018]. In addition, the distribution of it near the equator was clarified using the total electron content (TEC) from GPS data and the geopotential height of Aura satellite / MLS measurements. A nearly one-to-one correspondence is found between Q6DW activities in the ionosphere and lower thermosphere [Yamazaki et al., 2019]. However, understanding of wave components in the atmosphere, which is expected to appear in the ground magnetic field fluctuation data excited by the Sq-EEJ current system, is not advanced.

In this study, we analyzed the globality of the 6-day oscillation phenomena in EEJ, the seasonal dependence of its excitation characteristics, and solar activity dependence using magnetic field data of MAGDAS.

For the analysis, we use EE-index, a proprietary index developed by Kyushu University to capture in real time the EEJ, a phenomenon of the ionosphere on the magnetic equator [T. Uozumi et al. 2008] and [T. Ueno et al. 2008]. EE-index is composed of three elements: EDst, EU and EL. EDst represents the global symmetric variation of the magnetic field above the magnetic equator, and EU ·EL represents the variation component of the magnetic field due to EEJ and CEJ, respectively. In this study, we extracted Q6DO in EEJ using the EUEL data from January 1, 2005 to February 25, 2019. The main analysis procedure is as follows.

(1) For the daytime peak of EUEL data (1h value) of each observation point, the quasi-6-day fluctuation component was extracted by a bandpass filter for 5-7 days.

(2) Compare the results of three observation points with more than 60% of the annual data and verify if it is a global phenomenon.

(3) Verification of solar activity dependence by comparison with solar activity index F10.7.

(4) Verification of seasonal dependence.

 

As a result, it was revealed that Q6DO in the Sq-EEJ current system is a global phenomenon that develops at about the same time regardless of magnetic longitude and latitude and is dependent on solar activity. It was also found that Q6DO has similar seasonal dependence to Q6DW in the atmosphere. Details of the analysis will be introduced in the lecture.

As a future work, it is necessary to look at mid-latitude observation points in order to see a wider range of global distribution. Also, between stations with similar magnetic latitudes such as ANC and DAV, there is a difference in the amplitude of Q6DO, therefore it is necessary to grasp and verify the annual fluctuation trends of each station.

Henveforth, how Q6DO originating from thermal convection in the atmosphere will be affected before reaching the ionosphere and excite EEJ fluctuations

That will be displayed using the GAIA model (the numerical model integrated with the atmospheric model that covers the whole atmospheric region and the ionospheric model) This study will be carried out as a part of the joint research of the Kyushu University-GFZ group.

Keywords: Quasi-6-day wave, Equatorial electrojet, Ionosphere, vertical coupling

 