

Open Science Approach to High-Energy Atmospheric Phenomena of Japanese Winter Thunderstorm and Lightning

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Recent discoveries of high-energy gamma rays from lightning and thunderstorm opened a new interdisciplinary field, the “high-energy atmospheric physics” (Dwyer et al., *Space Science Reviews*, 2012). Powerful winter thunderstorms along the Japan sea are one of ideal targets for ground-based high-energy radiation measurements because the low-altitude winter thundercloud make it easier for gamma rays to reach the ground with less atmospheric absorption. Since 2014, we have been gradually developing a multi-point mapping observation network for the winter thunderstorm and lightning. In 2015, we obtained our initial research fund via “academic crowdfunding” and started development of new portable and low-cost radiation detectors, which were installed at high schools, universities, a museum, and a private company in Kanazawa, Komatsu, Toyama, and Kashiwazaki area. In 2017, the detectors in Kashiwazaki recorded a series of high-energy gamma-ray detections after a lightning discharge, which provided us an unequivocal observational evidence for photonuclear reactions triggered by lightning (Enoto, Wada et al., *Nature*, 2017). Our collaboration are aiming at distributing portable detectors not only to researchers but also to citizen supporters to cover wider observational areas, and also will try to make a new web platform for citizen scientists to participate in our remote monitoring and analyses of the detectors as one of the open science. To further enhance our approach, some of our members launched the “Kyoto Open Science Meetup” (<http://kyoto-open.science>), which has been providing a monthly meetup for researchers and citizen supporters to communicate for the open science (Ono, Ikkatai, and Enoto, IIAI-AAI, 2017).

Keywords: Open Science, High-energy atmospheric physics, Lightning, Thunderstorm