Basic development of accurate analytical method in order to determine coordinates of artificial illuminating clouds of Barium and Strontium for chemical-release rocket experiments

*Taro Watanabe[1], Masa-yuki Yamamoto[1], Yoshihiro Kakinami[2]

1. Kochi University of Technology, 2. Hokkaido Information University

In order to investigate neutral atmospheric heating phenomenon in the polar cusp, it is necessary to estimate Joule heating and fluctuation of electric field in the cusp. To accomplish this, we conducted a US-Japan joint rocket experiment called the Cusp Region Experiment 1 (CREX-1) in the Arctic region in November 2014, with releasing Ba (to be ionized in a short time by extreme ultraviolet (EUV) from the Sun) and Sr (not ionized in a short time). And then, we observed resonance scattering emission of Ba^+ and Sr simultaneously from two sites on ground so as to obtain fluctuation of the electric field and Joule heating. However, we could not release the gases in the cusp at that time. We are planning additional space experiments, based on the CREX-1 results, using two sounding rockets of the Cusp Region Experiment 2 (CREX-2) and the Joint Japan-US Cusp Heating Investigation (CHI) aiming at observing of the cusp in December 2019.

In this study, we developed a basis of accurate analytical method in order to determine coordinates of artificial illuminating cloud with applying observed data of CREX-1. At the beginning of the analysis, we made calibration data from the RAW images taken at a previous optical system tests. We compared the exposure input-output characteristics of JPEG and RAW to establish an analysis method using RAW images instead of JPEG. Next, we investigated whether it is possible to replace the work of determining centers of the illuminating clouds, which has been carried out by hand, by a method of uniquely determining the luminance maximal by gradient descent method. In addition, we made a background image by a darken composition method and attempted to remove the background brightness gradient trend.

As a result, the characteristics of JPEG image reported by Kakinami et al. (2015) were thought to be arcuate gamma curves, but in RAW images, they were obtained as linear characteristics. Regarding the gradient descent method, although it is possible to uniquely determine the luminance maximal without any human factors, it was found that there is a possibility that the local maximum is not the true center. For background removal by the darken composition method, it is effective for background light gradient removal. However, there is a problem that the shadow of the illuminating clouds appearing in the background image affects the remained shape of the illuminating clouds when removing the background.

Furthermore, we developed an algorithm tracing the three-dimensional position of Ba^+/Sr cloud uniquely without any human factors.

References:
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