Investigating of cusp heating process by using chemical releases of Ba/Sr: Initial result of CHI rocket experiment

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In the thermosphere of the cusp region, there are atmospheric heating phenomena that mechanisms are unexplained so far. Lühr et al. [2004] showed atmospheric density enhancements accompanied by the very intense small-scale field-aligned currents (FAC) filaments in the cusp region observed by the CHAMP satellite. They concluded that the Joule heating in the E region of ionosphere caused an up-welling of neutral atmosphere and it led to a density enhancement at 400 km and above. And they also concluded that the small-scale electric field associated with the closure currents of small-scale FACs causing Joule heating may play an important role in the enhancement. In order to obtain the evidence of the Joule heating, more quantitative measurements, especially electric field measurements with high-resolution are required. We observed neutral wind and ion drift with chemical release experiments of Ba/Sr. In November 2014, the sounding rocket experiment named the Cusp Region Experiment 1 (C-REX-1) was launched from Andøya Space Center. C-REX-1 was aimed at measuring the up-welling in the cusp region causing the neutral density enhancements. However, no signatures of the up-welling and small-scale electric field were observed.
We newly developed band-pass filters for ionized Ba (Ba^+, 614.2 nm) and Sr (460.7 nm) with 6 nm bandwidth. The wavelengths of 614.2 nm / 460.7 nm corresponding to the resonance scattering emission of Ba^+/Sr, respectively. We calibrated absolute sensitivity of our system with the filters to determine exposure and ISO speed for Ba/Sr chemical release experiment.
In December 2019, two rocket experiments named C-REX-2 and the Cusp Heating Investigation (CHI) were planned. CHI was launched, but C-REX-2 was postponed due to the low magnetospheric activity and weather conditions. CHI was launched from Svalbard Rocket Range at 09:30 UT, 10 December 2019. And Ba/Sr gases successfully released between the altitude of about 350 km and 180 km (planned nominal) from all of 8 canisters. The resonance scattering emission of Ba^+/Sr gases was optically observed from two ground observation sites of Longyearbyen and Ny-Ålesund in Svalbard, where are about 120 km apart from each other, to determine the velocity of ion drift and neutral wind by triangulation. At each site, we installed two cameras with the filters for Ba^+/Sr. And we successfully obtained the image of Ba^+/Sr drifting. In this paper, we report the initial results of CHI.

References:
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