Initial reports of DELTA-2 campaign: Neutral wind profile in auroral thermosphere by TMA released from S-310-39 rocket (1)

Masa-yuki Yamamoto[1]; Yuki Yokoyama[1]; Takatoshi Morinaga[1]; Shingo Nanbu[2]; Kengo Yoshita[3]; Shigeto Watanabe[4]; Miguel F. Larsen[5]; Junichi Kurihara[6]; Naomoto Iwagami[7]; Shin-ichiro Oyama[6]; Yasunobu Ogawa[8]; Satonori Nozawa[6]; Takumi Abe[9]

[1] Kochi University of Technology; [2] Hokkaido Univ.; [3] Cosmosciences, Hokkaido Univ.; [4] Dep. of Cosmosciences, Hokkaido Univ; [5] Clemson Univ.; [6] STEL, Nagoya Univ; [7] Earth and Planetary Science, U Tokyo; [8] NIPR; [9] ISAS/JAXA

http://www.ele.kochi-tech.ac.jp/masayuki/

1. Introduction

As a part of the DELTA-2 campaign, we conducted an observation of thermospheric neutral wind by TMA chemical releases from sounding rocket of S-310-39 launched from Andoya Rocket Range (69.29 N, 16.02 E). Main purpose of the campaign is to investigate thermospheric neutral wind under a condition of Joule heating in auroral ionosphere. Based on the results of the DELTA-1 campaign, neutral wind especially in its vertical components is focused to the current study. The sounding rocket S-310-39 was launched at 0:15 UT on January 26, 2009. Chemical releases of TMA (Tri-Methyl-Aluminum) was carried out by on-board canister from 150 km to 80 km in its downleg, generating a dotted luminous trail in the northern sky.

Based on a triangulation technique, thermospheric neutral wind in three-dimensional coordinates can be obtained by analyzing several image sequences taken at two independent ground sites in a baseline of about 100 km. Here, a technique established in triangulation analyses of Lithium release experiment by the WIND rocket campaign in 2007 is applied to the analyses of TMA. Comparison between two analyses of TMA trail and Lithium blobs is also a target of this trial.

2. Observation

TMA ground-based observations were carried out by a collaborative team of Clemson University, Hokkaido University, and Kochi University of Technology. Two TMA camera sites were set at Andoya and Tromso in Norway in the fields of rocket range and EISCAT Tromso radar, as well as another site was set at Abisko in Swedish Royal Scientific Reaserch Station, to become a big delta (triangle) on ground. In each site, three Clemson's TMA cameras (1 film camera and 2 digital cameras) were used. These cameras are specially set in temperature-controlled orange boxes and sequential shutter control program can be operated on a linked laptop PC. Digital cameras of Canon EOS Kiss Digital N were also used for back-up by Japanese team. FOV of these cameras are about 50 degrees and carefully prepared with a slight shifts in each other at the predicted TMA position in the sky along the rocket trajectory. Clear weather conditions in two of three sites were strongly required in the TMA observations, observers in each site communicated with each other on internet and phone lines with reporting weather condition periodically to the rocket range during the flight operation. Auroral conditions were checked in quasi-realtime by EISCAT radar profiles, FPI in Tromso, and the other ground-based instruments, and periodically reported on internet every night during the launch window.

3. Results

The S-310-39 rocket was successfully launched to the geographical North and 190 s after the launch (just after the passage of Apex) chemical releases of TMA began, followed with repetitions of 2 s release every 4 s. Clear dotted line of TMA was easily confirmed by naked-eyes at Tromso and Abisko at the predicted positions and continuously observed for about 25 minutes, although the dotted shape of TMA was rapidly dispersed into the sky and merged in each other within a few minutes. For the analyses of vertical wind velocities, dotted shape of TMA is significant technique. In comparison with diffusive Lithium release in higher altitude range in thermosphere, it would be easier to identify and trace the center of each TMA trail. Unfortunately, we have to launch the rocket under the condition of bad weather at Andoya, one of three TMA camera sites.

4. Summary

Applying triangulation technique to the analyses of TMA images, thermospheric neutral wind profile will be determined. Vertical component in auroral thermosphere would also be confirmed in the detailed analyses. In this paper, initial results of thermospheric neutral wind measurement in case of intense aurora will be presented for the further discussion about a role of Joule heating in the auroral arc, in comparison with datasets of EISCAT radar, FPI, and the other simultaneous observations.