Lithium and TMA release experiment in midnight lower thermosphere in the full moon condition

Masa-yuki Yamamoto[1]; Shigeto Watanabe[2]; Hiroto Habu[3]; Mamoru Yamamoto[4]; Takumi Abe[3]; Yoshihiro Kakinami[5]; Yuki Furuta[2]; Miguel Larsen[6]
[1] Kochi Univ. of Tech.; [2] Cosmosciences, Hokkaido Univ.; [3] ISAS/JAXA; [4] RISH, Kyoto Univ.; [5] Kochi Univ. of Tech.; [6] Clemson Univ.

In order to clarify interaction process between neutral and plasma atmosphere as well as generation mechanism of many kinds of disturbances in the Earth's thermosphere, development of observation methods of neutral species is important. As for the measurement of the neutral wind profile in thermosphere, chemical release experiments by using sounding rockets have been frequently used in these decades. TMA (Tri-Methyl-Aluminum) is usually used as illuminating trails, however, it has a limitation for using in daytime. Furthermore, F-region neutral wind profile cannot be obtained by the TMA due to the lack of oxygen in higher altitude. In this context, Lithium release experiments have been tried from 1960's in history, and the method was applied again from 2007 for Japanese and U.S. sounding rocket experiments. Improvement of electric imaging devices like CCD, CMOS, EM-CCD in recent dates is significant for fine imaging of faint luminescence of Lithium vapor, hence the Lithium release has become a suitable observation method for the neutral wind measurement.

Since the resonance scattering emission needs the sun light for illumination, Lithium release experiments in evening and dawn is the most appropriate observing condition for its S/N ratio with respect to the background skies. We tried the Lithium releases in such conditions in 2007 and 2012 as the WINDs campaign, then as the next target, Lithium releases in daytime and midnight skies have been tried in 2013. Daytime Lithium releases were carried out at Wallops, NASA on July 4, 2013 (Kihara et al., 2013). As for the midnight condition, since bright light source is required for the resonance scattering, we decided to use moonlight as the light source. The first trial of such Lithium release experiment was carried out on July 20, 2013, at Uchinoura Space Center (USC), JAXA. Three canisters of the Lithium Ejection Systems (LES) onboard the S-520-27 sounding rocket were used for the Lithium release. The LES, firstly used in 2007, can vaporize 125 g metallic Lithium and quickly produce Lithium vapor at the planned altitudes of 125, 115, and 105 km in the downleg, respectively. The experiment date was carefully selected as in the near full moon period, i.e., +/- 3 days centered at the full moon night. As the moonlight at the full moon is about 1/400,000 of the sunlight, extremely faint luminescence should be imaged in the experiment. Thus, we conducted the S-520-27 rocket experiment under the full moon condition with applying of airborne imaging using a JAXA experimental airplane Hisyo as well as multiple high sensitivity imaging equipments with 2 nm band pass filtered lenses previously used in the campaigns.

On July 20, 2013, the S-520-27 rocket was launched at USC at 23:57 JST (LT) and three LES canisters were executed their ignitions at 00:05:17, 00:05:22, 00:05:27 JST, respectively, at altitudes of 120, 110, and 100 km. Ground-based observation of Lithium emission was also operated at Muroto, USC, and Tanegashima, as well as the airborne observation by three observers in the JAXA Hisyo airplane were successfully carried out, though the sky condition at Muroto was not good for imaging. About 1 hour before, the S-310-42 rocket was also launched at USC at 23:00 JST, released the TMA in its upleg and downleg at between 80 km and 146 km. The imaging of TMA trails was also carried out on ground and from the airplane.

The observation of TMA was in full success for about 25 minutes at all of the sites including the Hisyo airplane at an altitude of 41000 feet, and the imaging of moonlit Lithium was also in success from airplane at 43000 feet (12.5 km) and at Tanegashima and USC. The emission was rather intense than expected, but the duration of the emission was shorter than TMA. In this paper, preliminary results of TMA and Lithium release experiments in moonlit midnight condition will be discussed.