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Observation of resonance scattering light of Lithium vapor under daytime and moonlight condition and neutral wind analys

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1.Introduction

For the purpose of measurement of neutral atmospheric wind in lower thermosphere, we observed resonance scattering light of sunlit Lithium vapor released from a sounding rocket in the evening thermosphere in 2007 (e.g. Yamamoto et al., 2008). At that time, we successfully measured thermospheric neutral wind profile between 110 km and 400 km. In 2012, we observed resonance scattering light of sunlit Lithium at dawn, and estimated lower thermospheric neutral wind between 76 km and 127 km.

On July 4, 2013, a U.S.-Japan collaborative rocket experiment to observe neutral wind profile in daytime lower thermosphere with Lithium release was carried out at WFF (Wallops Flight Facility), NASA. A rocket to operate chemical release of Lithium was launched at 10:31:40 EDT (14:31:40 UTC). The rocket launched to southeastern direction released Lithium vapor three times between at about 90 km and 130 km altitude during the upleg, at about 40 km horizontally away from a ground-based observation site in WFF. Here we tried to observe of Lithium clouds from the ground-based and airborne observations with collaboration of Kochi University of Technology (KUT) and Clemson University.

On July 20, 2013, a rocket experiment to observe neutral wind profile in moonlit lower thermosphere with Lithium release was carried out at USC (Uchinoura Space Center), Japan. The S-520-27 rocket to operate chemical release of Lithium was launched at 23:57:00 JST and released Lithium vapor three times between at about 80 km and 120 km altitude during the downleg under the almost full moon condition (Moon age was 12). Here we tried to observe of Lithium clouds from 3 ground-based sites and an airplane.

2.Observations

Airborne observation of Lithium cloud was carried out under a condition with the sun at the backward direction while it flew to north-northeast at about 10 km (33,000 feet) altitude and at about 300 km away from the ground site at the southeastern direction. An observation site was set in WFF on ground. In order to detect the Lithium clouds in daytime skies with good S/N ratio, digital cameras (Canon EOS Kiss X4, Nikon D90) with 2 nm band pass filters (BPF) at 671 nm wavelength were used for all digital cameras. We installed three digital cameras in the aircraft NASA-8 and set two digital cameras on the ground site. A video camera (Watec, WAT-120N) with a 12 nm BPF was also used in the aircraft and on ground, respectively.

The Lithium clouds under moonlight condition was observed by using digital cameras, Watec, and cooled EM-CCD (BITRAN BQ-87EM) with 2 nm and 12 nm BPF from the JAXA airplane Hisyo as well as three ground-based observation sites (USC, Tanegashima and Muroto).

3.Results

A Lithium cloud under daytime sky condition was observed for about 25 minutes from the aircraft. The released Lithium vapor formed red clouds along the rocket trajectory just after the release. Afterwards, the Lithium trails were spread into complex shapes by strong wind shear in the altitude. We successfully observed Lithium clouds by the airborne observation.

A Lithium cloud under moonlight sky condition was observed for about 90 seconds from the aircraft and two ground sites.

4.Summary

We successfully observed 2 chemical releases of Lithium from the aircrafts and ground sites on July, 2013, in daytime and midnight. We succeeded the detection of resonance scattering light of Lithium vapor under daytime and moonlight sky condition in lower thermosphere. Owing to this experiment, we confirmed that we can measure altitude profile of the neutral atmospheric wind in lower thermosphere at almost all local time by using the chemical release of Lithium.

In this paper, we will discuss that the observed emission intensity of the resonance scattering light of Lithium vapor under daytime and moonlight sky condition in lower thermosphere, obtained results of the S/N ratio, preliminary results and problems of the neutral atmospheric wind measurement in daytime lower thermosphere.

Keywords: sounding rocket, thermosphere, neutral wind, Lithium Ejection Systems, airborne observation