Analysis of the thermospheric neutral wind vector using observed images of *Trimethylaluminium* (*C6H18Al2*) released from sounding rocket in the upper atmosphere

*Yuki Otsuka[1], Masa-yuki Yamamoto[1], Hiroaki Saito[1]

1. Kochi University of Technology

Altitude profiles such as neutral atmospheric density and ionized atmospheric density in the thermosphere/ionosphere fluctuate by solar activity, season, day and night changes. These fluctuations with affecting on ground, communication with artificial satellites, and make affecting there orbits, but the detailed mechanism of occurrence has not been well understood. We have been conducting collaborative experiments with JAXA, NASA, etc. on inverstigating neutral atmospheric wind in the thermosphere/ionosphere, which is thought to play an important role in this mechanism.
In this research, the main objective is to calculate the neutral wind velocity in the thermosphere from the images of TMA observed in rocket experiment by JAXA conducted in July 2013.
JAXA conducted a rocket experiment in July 2013 to clarify the full picture of electromagnetic interaction and ionized/neutral atmosphere interaction acting on mid-latitude ionosphere. S-310-42 and S-520-27 sounding rocket were launched from Uchinoura Space Center(USC). Trimethylaluminum(TMA)was released in the former and lithium(Li) was released from the latter rocket into the upper atmosphere. Sequential optical observation of changes in these luminescent clouds was operated at each observation point and aircraft. Figure.1 shows the flight path of the aircraft/rockets in the experiment, the observation point, the emission region of TMA and Li, etc.
To calculate the wind speed, we use the images of TMA observed in July 2013 rocket experiment. I analyze the image sequence taken from the aircraft(Figure 2) and those images at USC(Figure 3)as a combination in which the TMA clouds are clearly seen and a long-time optical observations were performed. We use the method of Yokoyama(2011)and Kihara(2015)for caluculating of newtral wind speed.

Method by Yokoyama(2011)[1]
1 From the observed image, the central position of the cloud(TMA gas) is obtained from luminance information. Thereafter, the central axis of the TMA gas is obtained.
2 Choose one of the stars in the observed image as the center star. Also select ten stars around that.
3 Correct the distortion of the lens by using the X,Y coordinates of the stars(right ascension , declination) on the image.
4 Convert the coordinates of the obtained central axis are into celestial spherical coordinates. After that, it converts to earth coordinates using observation point information.
5 From the data of each observation point obtained by the above procedure, wind speed is calculated by using triangulation method.

Method by Kihara(2015)[2]
1 From the observed image, the central position of the cloud(TMA gas) is obtained from luminance information. Thereafter, the central axis of the TMA gas is obtained.
2 Correct distortion of the camera lens. After that, convert the coordinates on the image into the elevation and the azimuth angles.

3 After applying the correction, the difference information is obtained from two images of the same point at different times. Then, the wind speed is calculated from the difference information.

We carried ou extraction of central axis of a TMA cloud, extraction of stars on the images, conversion to elevation and azimuth angles, then derived an approximate wind speed profile. However, it is thought te error at the time of detecting the center axis of the TMA cloud and the conversion error at azimuth/elevation angles are influenced. In the future, it is also necessary to correct lens distortion, tilt of camera, and aircraft velocity and altitude changes.
In this presentation, we would like to introduce more precise caluculation method of neutral wind speed.
References
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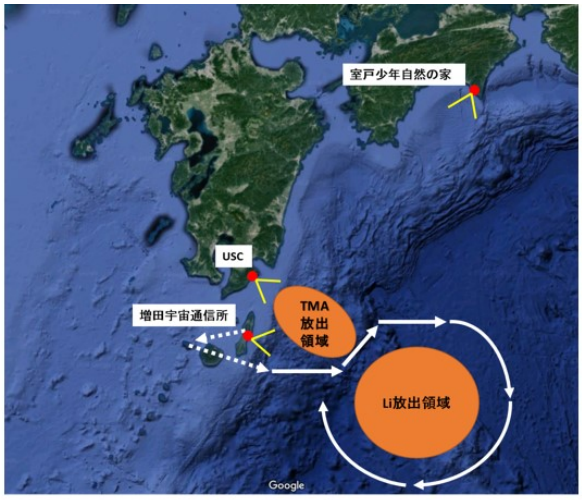

図1 Li、TMAの放出領域、航空機飛行経路、
地上観測点の位置関係

図2 航空機からの観測画像

図3 USCでの観測画像

