

Chemical releases from the sounding rockets - old but new technique to observe thermosphere and ionosphere

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Chemical releases from the sounding rockets for observing dynamics and properties of lower thermosphere and ionosphere have been conducted since 1950's. Vapors of sodium (Na), lithium (Li), barium (Ba), and strontium (Sr), and tri-methyl aluminum (TMA) are released as a tracer of neutral wind and ion drift velocity. Ionized Ba (Ba^+) is used as a tracer of ion drift because Ba is immediately ionized by solar EUV after the release while the others are used as tracers of neutral wind. The chemical release experiments using Na, Li, Ba, and Sr require solar or lunar illumination to visualize the chemical clouds while TMA does not require them because of chemiluminescence. The chemical release experiments had contributed to understand dynamics of thermosphere and ionosphere but the number of experiments decreased due to limitation of optical observation etc. However, since the performance of CCD has been improved in the past decade and one can detect dark resonance scattered light, the chemical release experiment has been draw renewed attention from scientists again. Lithium ejection system was newly developed in Japan and the chemical release experiment of Li was conducted in Uchinoura, Japan in 2007 after a long interval. The experiment achieved success to release Li and vertical profile of neutral wind velocity together with diffusion velocity were obtained in the dusk. Similar experiments were successfully conducted in the dawn in Uchinoura, Japan in 2011, in the dusk in Marshall Islands in 2013, and in the daytime in Wallops, US in 2013. The results showed strong wind shears exist around 100 km altitude. We estimated altitude profile of neutral density from the diffusion velocity. The Li cloud was detected under the condition of moonlit in Uchinoura, Japan in 2013. These experiments show that the wind profile is observable in all local time. The ejection systems of Barium and Strontium were newly developed in US. The chemical release of Ba and Sr was conducted in Andoya, Norway in 2014 and neutral and ion drift velocities were simultaneously observed. Further, another experiment using Ba, Sr, and TMA was executed in 2019 and Ba and Sr experiment was also executed in Norway in 2019. In this paper, we summarize the results of chemical release experiments in recent decade and present new experiment planed in Japan.

Keywords: sounding rocket, chemical release, lithium, Li, barium, Ba, strontium, Sr, tri-methyl aluminum, TMA