Development of ion drift velocity analyzer for sounding rocket and low-altitude satellite

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The lower ionosphere is known as a unique region where charged particles and neutral particles co-exist. The charged particles tend to move in a direction different from neutral particles, because of a difference in those behaviors against the electromagnetic force. For example, the dynamo current and polarization electric field existing in this region are attributed to a difference in a collision frequency between ion and electron with neutral particles. Characteristic phenomena such as traveling ionospheric disturbance and equatorial spread F are generated due to the diversity of the particles in this region. The momentum transfer between the charged and neutral particles plays an important role in generating these phenomena. Sounding rocket is the most suitable platform which enables us to make in-situ measurement of the particles in this region because low-altitude satellite cannot be in orbit for a long time period because of the atmospheric drag. Thus, it is desirable to make a direct measurement of charged and neutral particles by using instrument on the sounding rocket to further understand such unresolved phenomena.

Chemical release experiment, such as Lithium Ejection System (LES) or Trimethyl Aluminum (TMA) instruments, have been adapted for sounding rocket experiment to get information on neutral wind in the lower ionosphere. In contrast, no instruments to measure a drift of the ionospheric ions is now available in Japan. Only a few studies on the neutral-ion coupling based on the simultaneous measurements on the rocket are available in the literature. Therefore, our understanding of interaction between charged and neutral particles in the weakly ionized plasma has not made much progress because of a lack of observational data. Unfortunately, it is very difficult to reproduce a coupling between charged and neutral particles on the ground, and direct measurements by sounding rocket or low altitude satellite is only the way to provide quantitative information.

Under such a background, we have started developing an ion drift velocity analyzer which enables us to estimate the ion drift velocity and density in the lower ionosphere. It is well known that Ion Drift Meter (IDM) or Retarding Potential Analyzer (RPA) had been installed on low-altitude satellite, such as Dynamic Explorer-2 and Atmospheric Explorer series. Our instrument will be required to have both of these functions. It will also be possible to make simultaneous measurement of the ion drift and neutral wind in the sounding rocket experiment if the present instrument is successfully developed and installed on the sounding rocket together with chemical release experiment. Then, we will be able to conduct quantitative discussion on the coupling between charged and neutral particles.

As the first step of the instrument development, a numerical simulation to design the internal structure was started. The instrument consists of RPA section in the front and multiple sector anodes in the end. Accuracy to estimate incident direction, speed, and temperature of thermal ions is evaluated from the simulation result. The prototype model is to be manufactured after we obtain a confident prospect that the instrument provides the ion density and velocity in a good accuracy. Then, we will put the prototype

instrument in the vacuum chamber and evaluate its performance by generating ion drift. The latest status of our instrument development will be explained in the presentation.

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