

観測ロケット搭載用イオンドリフト速度測定器の開発

Development of ion drift velocity analyzer for sounding rocket

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Characteristic physical processes such as the dynamo current and polarization electric field are known to exist in the lower ionosphere where coexistence of charged and neutral particles is believed to play an important role. In this region, the charged particles may move in a direction different from neutral particles due to a difference in those behaviors against the electromagnetic force. The momentum transfer between these particles affects the dynamics in this region although few observational evidence of this process based on in-situ measurement has reported. Therefore, it is desirable to make a direct measurement of charged and neutral particles by instrument on the sounding rocket, which provides an opportunity of local measurement in the lower ionosphere, to further understand the unresolved phenomena.

As an instrument to observe ion drift speed and direction in the ionosphere, Ion Drift Meter (IDM) or Retarding Potential Analyzer (RPA) had been frequently used on low-altitude satellite for a long time. We are developing a new type of Ion drift Velocity Analyzer (IVA) which is expected to have two functions of the IDM and RPA. It will enable us to estimate the velocity vector, density and temperature of the ionospheric ions on sounding rocket, and thereby we will be able to conduct quantitative discussion on the coupling between charged and neutral particles.

In the IVA, the sensor part consists of RPA section in the front and multiple sector anodes of IDM section in the end and is connected with the electronic box. The prototype model was already developed based on the simulation result that confirms validity of the design. The prototype instrument was put in the vacuum chamber to evaluate its performance in the circumstance similar to the ionospheric plasma. The experimental evaluation is made in terms of the following items: 1) Validity of ion current by the sensor electrode to estimate the plasma density, 2) Validity of retarding potential profile of the current to derive the ion drift energy (velocity), and 3) Validity of the current distribution by multiple electrodes to calculate the ion temperature.

The sounding rocket "S-310-46" experiment with a main purpose of simultaneous measurement of neutral and charged particles in the dayside sporadic E layer will be conducted in summer of 2024. The IVA instrument will be installed on this rocket together with other instruments to observe important parameters to investigate physical process in the sporadic E layer. A total of 36 small sector electrodes will be included in the sensor so that an estimation of the drift velocity vector can be made with enough accuracy. The triangular voltage with an amplitude of 4 V will be applied to the RPA section with respect to the rocket potential.

In the presentation, the latest status of the instrument development will be introduced.

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