A Sensor Package for Space Weather Global Monitoring Based on Micro Satellite Constellation

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Geospace is the space around the Earth. The geospace environment is disturbed by the solar wind. Disturbances in geospace are causes of satellite anomalies, radiation hazards of astronauts and aircrews on polar route, problem of HF communications, error of high-precision positioning and navigation, and induction current in long-line power cables. Many kinds of social infrastructure are vulnerable to geospace disturbances. Therefore, research and operation of space weather forecast is very important for understanding the current and future condition of space environment to mitigate the risk of geospace disturbances.

To improve the accuracy of space weather forecast, introducing numerical forecast scheme is essential. In case of terrestrial weather forecast, numerical forecast scheme with data assimilation technique based on merging between large number of data points and global simulation of atmospheric large circulation have been applied more than 50 years ago. This effort makes continuous improvement of terrestrial weather forecast. On the other hand, insufficient number of space environment data prevent us to introduce numerical forecast scheme for operational space weather forecast. The accuracy improvement of space weather forecast is highly expected if we realize global space weather monitoring based on constellation of several tens of satellites.

The major difficulties of introducing global monitoring by satellite constellation was cost of satellite, and size and power of the sensors. Large number of costs and human resources are needed to realize the global monitoring of space weather based on constellation of several tens of small satellite.

Miniaturization and power saving of satellite and sensor have been investigated for in-situ measurements of advanced scientific project. However, there are some limits of miniaturization of sensor with keeping the high level of specification.

To breakthrough this situation, we are planning to design and develop a space environment sensor package, which can contribute to safety operation of the micro satellite itself, and can realize low-cost global monitoring of space environment based on constellation of micro satellites. Our planned sensor package includes magnetometer, plasma wave receiver with measuring electron density, low and high energy particle detectors. The data obtained from the sensor package will be used not only for monitoring of the global distribution of currents, fields, and particles but also for understanding conditions of satellite such as, the attitude, charging condition, and risk of CPU malfunction, etc. So we will develop the package as one of the satellite bus component. The first priority of our development task is the mountability of the sensor package for every common micro satellite. Thus, the trade-off among optimization of sensor performance, integration of sensors, and miniaturization and power saving of each sensor needs to be made. Space weather observations by several tens of micro satellite constellation enables us to narrow down the sensor performance of single satellite. This strategy can accelerate miniaturization and power saving of the package. Installing our sensor package on board common microsatellite is beneficial to satellite operator. And this approach enables us to realize space weather global monitoring based on constellation of common microsatellite with low-cost. Then, numerical forecast scheme with data

assimilation technique can be introduced for space weather forecast.

Keywords: space weather forecast, global monitoring, satellite constellation, micro satellite

