RECENT RESEARCH ACTIVITIES

Master Plan 2020: Study of coupling processes in the solar-terrestrial system

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Outline

"Coupling processes in the solar-terrestrial system" aims to study the solar energy inputs into the Earth and the response of Geospace (magnetosphere, ionosphere, and atmosphere) to these energy inputs[1]. Solar energy can mainly be divided into two parts: solar radiation and solar wind. The former involves infrared, visible, ultraviolet and X-ray, while the latter is the high-speed flow of plasma particles. Solar radiation is maximized at the equator. Atmospheric disturbances are actively generated near the Earth's surface and further excite various types of atmospheric waves, which propagate upward carrying energy and momentum. On the other hand, the energy associated with solar winds converges into the polar regions where disturbances are generated. Part of the energy is transported toward lower latitudes and lower atmospheric regions. This project was selected as an important project in the Master Plan 2014 and 2017 by the Science Council of Japan. Recently, it was again selected in the Master Plan 2020.

We propose to establish large atmospheric radars with active phased array antennas at the equator and the arctic region. In the equatorial region, we focus on the Indonesian region where atmospheric disturbances are most intense. We strive to establish a comprehensive observatory in Indonesia with the Equatorial MU (EMU) radar as the main facility. Additionally, we are part of an international collaboration to construct a state-of-the-art radar, called EISCAT_3D, in northern Scandinavia. We also develop a global observation network of portable equipment from the equator to both polar regions. With these radars and global network, we will study the flow of the energy and materials in the whole atmosphere.

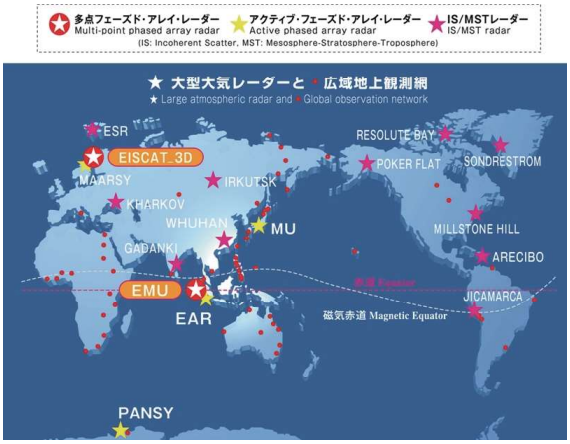

Figure 1. Large atmospheric radars and global observation network

Equatorial Fountain

Cumulonimbus convection is active in the equatorial atmosphere. It generates various types of atmospheric waves that propagate upward to transport energy and momentum into the upper atmosphere, including the ionosphere. In addition, different kinds of materials (atmospheric minor constituents) originating at low- and mid-latitude regions that converge into the equatorial region are blown upward through the tropopause; they eventually reach the middle atmosphere and spread around the globe. In the upper atmosphere, there are plasma disturbances, and the equatorial ionization anomaly is generated around the equator. We will capture the energy and material flow occurring in all height ranges of the equatorial atmosphere as the "Equatorial Fountain" using the Equatorial MU (EMU) radar. In 2001 we established the Equatorial Atmosphere Radar (EAR) in West Sumatra, Indonesia and continue our observations as part of an international collaboration. In this project, we propose developing the EMU radar, which is 10-times more sensitive than the EAR. Master Plan 2020 may help the realization of the EMU in the near future.

Reference

[1] Tsuda, T., M. Yamamoto, H. Hashiguchi, K. Shiokawa, Y. Ogawa, S. Nozawa, H. Miyaoka, and A. Yoshikawa, A proposal on the study of solar-terrestrial coupling processes with atmospheric radars and ground-based observation network, *Radio Sci.*, 51, 1587-1599, doi:10.1002/2016RS006035, 2016.