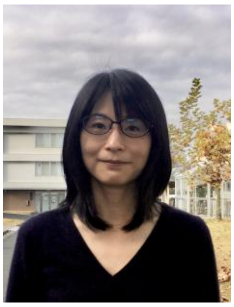

Development of the cosmic-ray propagation model and study of the radiation environment in space-earth system

Shoko MIYAKE
Associate Professor, Ph.D.
Email : s.miyake@gifu-nct.ac.jp

Research Fields Cosmic ray physics, Space weather

Keywords Galactic cosmic ray, Heliosphere, Radiation dose of aircrews

Research Outline

Cosmic rays are the outer heliospheric material that we can directly observe on Earth. Their chemical composition and energy spectrum provide much information about cosmic rays, their sources, and the space where they have journeyed. On the other hand, in space and at high altitudes, cosmic rays cause radiation exposure and damage to electronic equipment. For this reason, in modern society where the use of space is increasing, there is an increasing need to improve the accuracy of quantitative evaluation and prediction of the solar modulation of galactic cosmic rays (GCRs), that is, variations of the cosmic-ray flux due to heliospheric environmental changes according to the solar cycle.

We are developing a numerical model of the solar modulation of GCRs that quantitatively reproduces the observations. Our numerical model has higher predictive accuracy than semi-empirical models based on changes in the sunspot numbers because our model is full-physics bases that can consider drift effects that cause the charge-sign dependence of the solar modulation and observed heliospheric parameters such as the solar wind speed and the heliospheric magnetic field. On the other hand, we are attending many observation projects, the Calorimetric electron telescope (CALET) on the International Space Station, the project for the observation of aurora and cosmic rays in Antarctica (Aurora X), and the winter thundercloud gamma-ray observation project utilizing Citizen Science (Thundercloud Project).

Understanding and predicting the radiation environment of the space/Earth system is essential for risk management in humanity's further development in space. By conducting research with both observational and theoretical perspectives, we hope that our results contribute to humanity's future development in space, including the commercialization of space stations and exploration of the moon and Mars.

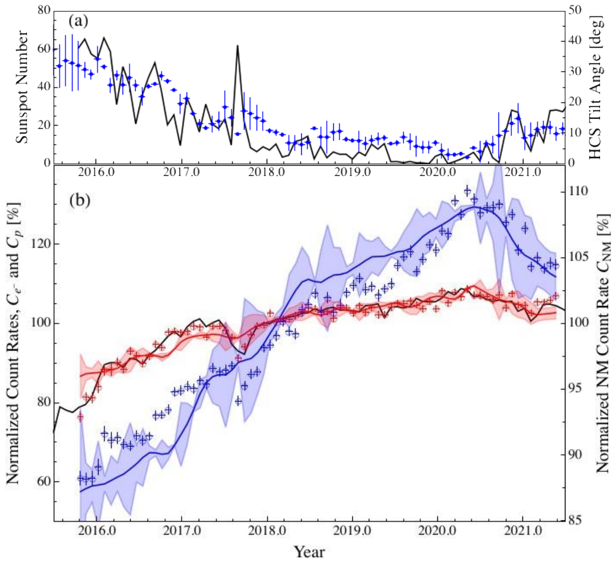

Figure 1. Time profile of the count rates of electrons (blue circles) and protons (red circles) observed by CALET (Figure (b) below). The black curve shows the count rate of a neutron monitor at the Oulu station on the right vertical axis, while the blue and red curves show the electron and proton count rates reproduced by the numerical model, respectively. Each shaded area around the reproduced curve indicates the error deduced from the error of the HCS tilt angle and the regression coefficient between the tilt angle and the reproduced curve. The above figure (a) shows the number of sunspots (black line) and the tilt angle of the heliospheric current sheet (blue dot) (Adriani et al. (CALET Collaboration), Physical Review Letters, 130, 211001 (2023) [Erratum 131, 109902 (2023)].)