Dynamics of Cosmic Ray Muon Flux under the Influence of Earth's Atmosphere, Solar Activity, and Geomagnetic Turbulence

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Introduction

- The solar activity, the state of the interplanetary space, and the Earth's magnetosphere and atmosphere are collectively responsible for the intensity of secondary cosmic ray particles being detected by ground-based cosmic ray detectors, as highlighted in (Fig. 1)

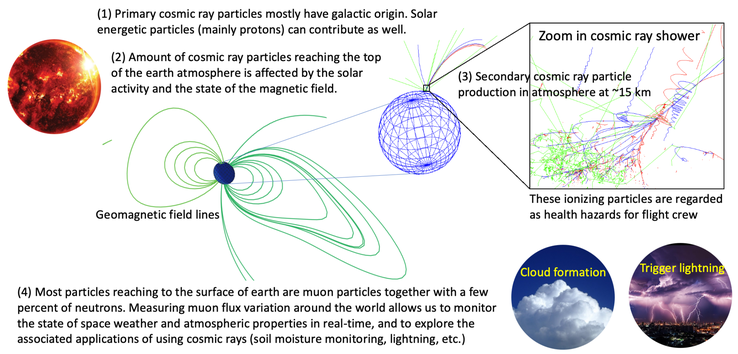

Figure 1: *Cosmic rays: from space to Earth*

- Key challenge: building efficient and affordable network of cosmic ray muon detectors capable of providing the sensitivity accurately to the variations of both space and terrestrial weather patterns.

Motivation

- A network of cosmic ray muon detectors that can provide real-time monitoring of Earth's atmospheric parameters, solar activities and geomagnetic disturbances.
- Possibilities for widespread deployment, facilitating extensive data collection and analysis in various geographical locations.

Detector setup

- Desktop cosmic ray muon detector design:

  (a) Cosmic ray muon detector dimension and configuration

  (b) Detector acceptance study using GEANT4 simulation toolkit (Fig. 2).

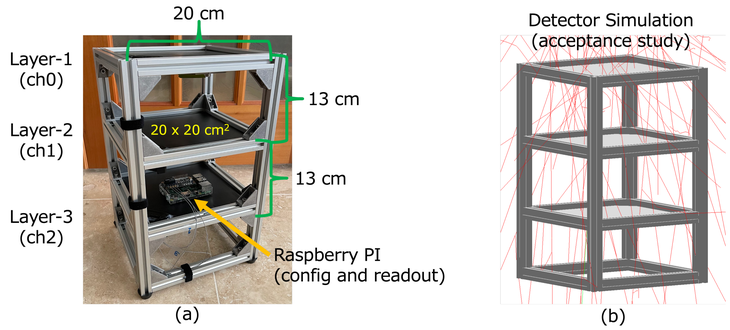

Figure 2: *Muon detector used in this study*

Atmospheric effect on muon flux

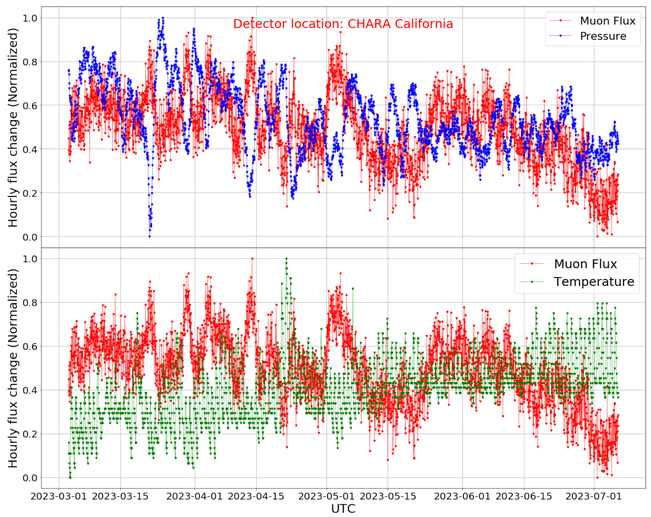

Figure 3: *Muon flux vs pressure and temperature*

- Ensuring the accuracy of muon data by applying temperature and pressure corrections.

Cross comparison of cosmic ray data and space weather Activity

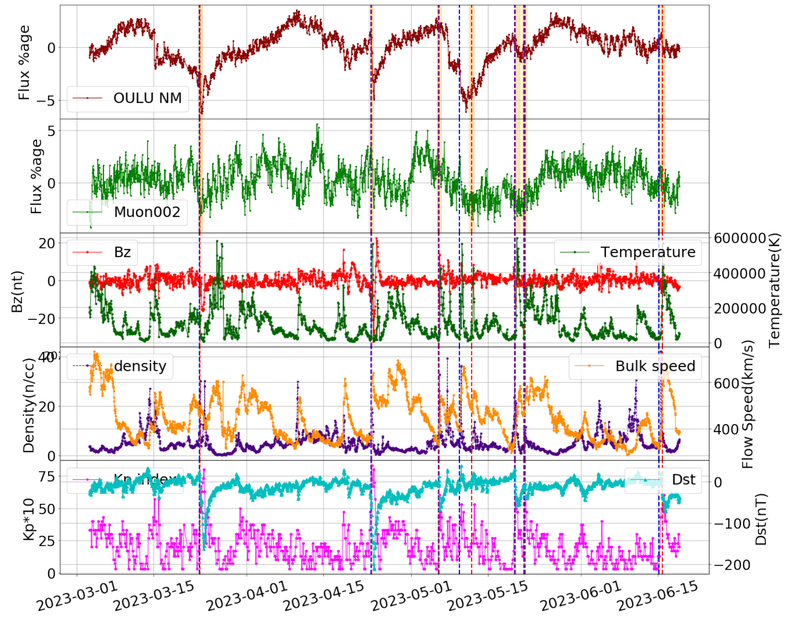

Figure 4: *Cosmic ray flux and space parameters*

Network expansion

- Installed two detectors in Sri Lanka in March 2023 Building more detectors to be distributed in other countries.

Summary

- Oulu and CHARA detectors show similar response to space weather events.
- Pearson coefficients between flux and space parameters are weakly but statistically significant (low p-values i.e 10^{-34}, 10^{-25}).
- Decreasing trend in cosmic ray flux before the geomagnetic storm.

Acknowledgement

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