gLOWCOST: Global Low-Cost Cosmic Detector Network

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Collaborators from Georgia State University (PHY/ASTRO, CS, GEO, CHEM), USA and other global partners

Overview:

- The goal of this project is to make cosmic ray flux measurements worldwide for monitoring the dynamic changes in the space and terrestrial weather in real-time.
- The success of the project requires international collaborations and partnerships, to jointly develop cosmic ray detector network and create a global educational outreach on climate related studies. This project brings together an interdisciplinary team of scientists, engineers, and committed partners from six continents towards studying climate changes on earth.
- This team effort will help catalyze the design and plan for a new Center for Cosmic Ray Science based Climate Research and Awareness, which will constitute a virtual consortium of educational and research organizations, and community stakeholders from all around the globe.

Intellectual Merit:

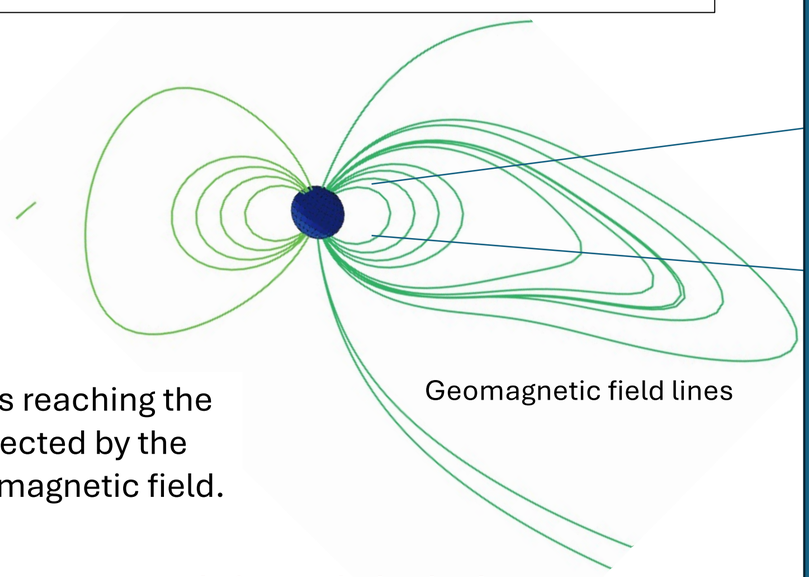
- The fundamental notion of the research follows the detection and analysis of global cosmic ray flux near the surface of the earth with identical detectors at low cost. The data from the global cosmic ray detector network will be used to characterize space and terrestrial weather, particularly in predicting extreme climatic events, in real-time.
- This is the first feasible effort of deploying identical and affordable cosmic ray muon detectors around the world for monitoring the dynamic changes of the space and earth weather with sufficient statistical precision. The growth and expansion of the cosmic ray detector network is a feature of this project by design.
- The data from the network will not only be crucial for studying the applications of cosmic ray measurement but also to provide stringent constraints of cosmic ray shower simulation at global scale influenced by the changes of the solar activity.

The fundamental laws governing the physics of the climate system are known, but the interactions of its many degrees of freedom exhibit emergent behavior that is not easily computable from the underlying laws

["Accelerating progress in climate science", T. Schneider et. al. , Physics Today, 2021]

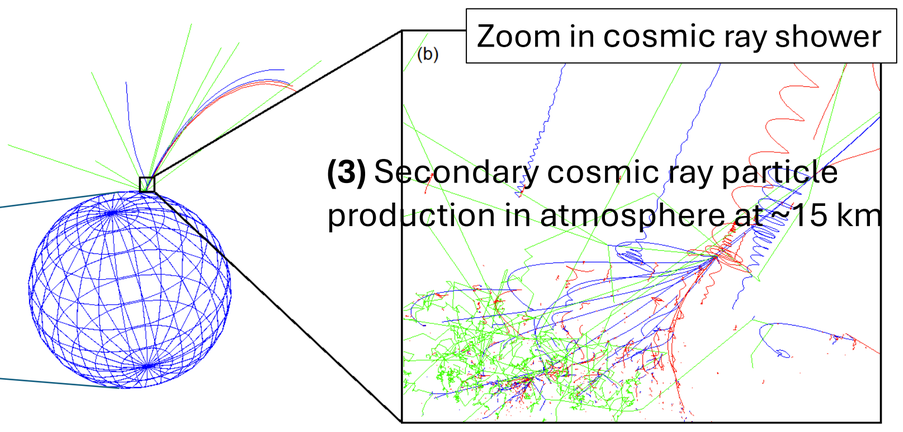
Variation in cosmic ray flux at ground level reflects the effects of the space and terrestrial weather

(1) Primary cosmic ray particles mostly have galactic origin. Solar energetic particles (mainly protons) can contribute as well.



(2) Amount of cosmic ray particles reaching the top of the earth atmosphere is affected by the solar activity and the state of the magnetic field.

Impact of space weather on earth is a global phenomena



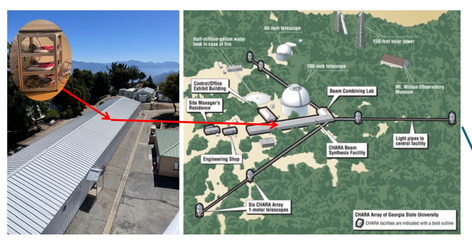
Cloud formation

Triggering lightning

Atmospheric influence on cosmic ray flux

The Earth is an integrated system of dynamic interactions between the atmosphere, ocean, land, ice, and human society. Its evolving and emerging characteristics must be continually explored through observation

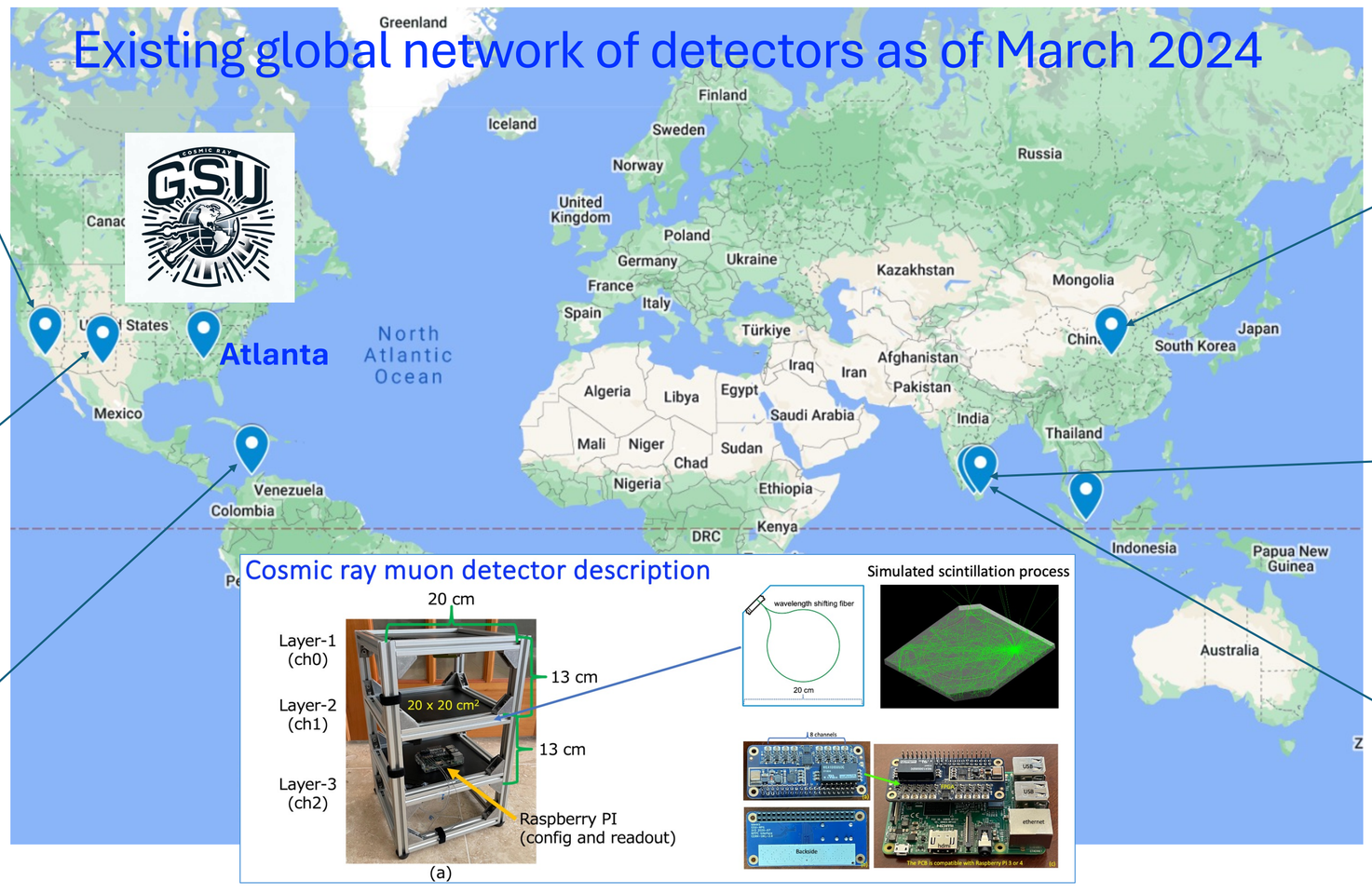
["Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space", National Academic of Science, Engineering, and Medicine, 2018]



Mt Wilson, California

Apache Point Observatory, NM

Santa Marta, Colombia



Xian, China

Colombo, Sri Lanka

Uva Wellassa, Sri Lanka

Broader Impacts:

- The detector network presents a NEW and OPEN research infrastructure to the scientific community.
- Managed by a growing interdisciplinary team of faculty groups, GSU's Atlanta location brings community partnerships, schools, industry and the public worldwide. GSU is designated as a Minority Serving Institution (MSI), with Title III and Title V eligibility. The enrolled STEM student population at GSU is 38.3% African American and 11.8% are Hispanic or Latino origins. GSU is also ranked the most military friendly school in the nation, and graduates more low-income students than most top US universities combined.
- At the international level, through our global partnerships, we will encourage the development of climate science educational modules from myriad contexts targeting K-12 and post-secondary students in different countries. With these modules, students will be able to gain new perspectives of what this common data set can be used for in the context of different STEM fields.
- We have completed the first workshop centering on the detector network as the theme held in a hybrid manner at GSU: https://sites.google.com/view/wacr24/home

Outlook: The detector costs less than the cost of a new smartphone, which makes it practical to install it at many locations worldwide. The typical cost of developing and launching a weather satellite can range from tens of millions to several hundred million dollars. This network of detectors will provide innovative and complimentary tool for providing real-time data for monitoring the dynamic changes of our living space in decades to come. It is indeed a grassroots effort to monitor the impact of climate change.

Acknowledgement: This project is supported by the RISE program [July 2022-June 2024] at GSU (https://research.gsu.edu/rise/)