Project Details

ROSES ID: NNH07ZDA001N
Selection Year: 2008
Program Element: Focused Science Topic

Topic: Prediction of the Interplanetary Magnetic Field Vector Bz at L1

Project Title:
IMF Prediction with Cosmic Rays

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Summary:
Neutron monitors and muon detectors are ground-based instruments that record the byproducts of collisions between high-energy cosmic rays and molecules in Earth's atmosphere. At energies up to ~100 GeV, primary Galactic cosmic rays experience significant modulation in response to solar wind disturbances. Cosmic rays impacting Earth have passed through and interacted with magnetic fields in a large volume surrounding Earth, and they potentially contain signatures that could be used to predict the magnetic field in various directions. Specifically, the gyroradius of a typical neutron monitor primary cosmic ray is ~0.04 AU and that of a muon detector primary is ~0.2 AU. These correspond to solar wind transit times of ~4 and ~20 hours, which is significantly longer than the ~1 hour warning provided by a sentinel making direct measurements at L1.

This project proposes two research tasks aimed at developing and validating a tool to make IMF predictions based on realtime neutron monitor and muon detector data:

-- We will employ quasilinear theory to develop a physics-based method for interpreting cosmic ray fluctuations in terms of properties of the magnetic field integrated along the reverse path of the particle.

-- We will develop predictive digital filters based upon neutron monitor and muon detector data. Past data will be used to optimize the filters, and results will be benchmarked against an autoregressive filter based purely on magnetic field observations.

This project directly addresses the LWS Focused Science Topic (e): "Prediction of the Interplanetary Magnetic Field Vector Bz at L1." The project also directly addresses NASA's strategic goals, in particular Strategic Sub-goal 3B: "Understand the Sun and its effects on Earth and the solar system" and Science Outcome 3B.2: "Understand how human society, technological systems, and the habitability of planets are affected by solar variability and planetary magnetic fields."

Publication References:

Summary: no summary

Reference:
Okazaki, Y.; Fushishita, A.; Narumi, T.; Kato, C.; Yasue, S.; Kuwabara, T.; Bieber, J. W.; Evenson, P.; Da Silva, M. R.; Dal Lago , A.; Schuch, N. J.; Fujii, Z.; Duldig, M. L.; Humble, J. E.; Sabbah, I.; Kóta, J.; Munakata, K.; (2008), Drift Effects and the Cosmic Ray Density Gradient in a Solar Rotation Period: First Observation with the Global Muon Detector Network (GMDN), The Astrophysical Journal, Volume 681, Issue 1, article id. 693-707, pp, doi: 10.1086/588277

Summary: no summary

Reference:
Fushishita, A.; Kuwabara, T.; Kato, C.; Yasue, S.; Bieber, J. W.; Evenson, P.; Da Silva, M. R.; Dal Lago, A.; Schuch, N. J.; Toku maru, M.; Duldig, M. L.; Humble, J. E.; Sabbah, I.; Jassar, H. K. Al; Sharma, M. M.; Munakata, K.; (2010), Precursors of the Forbush Decrease on 2006 December 14 Observed with the Global Muon Detector Network (GMDN), The Astrophysical Journal, Volume 715, Issue 2, pp. 1239-1247, doi: 10.1088/0004-637X/715/2/1239