SSWARMS: SOLAR STORM WARNING AND RADIATION MONITORING SYSTEM

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OUTLINE

• Rationale
• Space Weather Impact on Earth
• Solar Storm Warning and Monitoring System – SSWARMS
  • Goals
  • Platform
  • Deployment
• Feasibility
• Team Members and Affiliations
RATIONALE

• To enable inter-planetary human exploration
• Master the persistent and grave danger of radiation
  • Solar Energetic Particles (SEP)
  • Galactic Cosmic Ray (GCR)
• Multi-point measurements will help constrain upstream (i.e., toward the sun) solar wind magnetic field and particle empirical models.
  • ENLIL—NASA Goddard
• SEPs stream along these field lines and pose a serious threat to humans traversing interplanetary space.
  • These are intense, directional, and potentially very hazardous.
• GCRs are modulated by the solar magnetic field, but only by a few percent.
EARTH’S SPACE WEATHER IMPACT

- Strong x-ray production from solar flares
  - Degrade or block radio communications
  - Pose a grave danger for astronauts traveling beyond Earth’s orbit
- Coronal mass ejections (CME) cause geomagnetic storms
  - Degrade power grid operations
  - Degrade oil and water pipelines
  - Modify radio navigation signals; reducing accuracy
- Radiation poisoning caused by solar energetic particles (SEP)
  - Inability for humans to perform interplanetary travel
GOAL - SSWARMS

• Provide a continuous monitoring of the inner heliosphere and solar surface
• Empirical models, such as ENLIL, can be improved using continuous, multi-point measurements
  • Measuring magnetic field configuration
  • Particle output and SEPs streaming along field lines
• Inner heliosphere monitoring also provides the possibility of providing actionable information for humans in interplanetary space
  • Expected lead times of hours to days of warnings
  • System of watch/warning/alert similar to tornados allows modification of operations to maintain safety margins.
• For humans operating anywhere in the solar system without the protection of a planetary magnetic field.
  • Mars, asteroids (Ceres).
SSWARMS PLATFORM

- Multi-satellite solution
  - Heterogeneous suite
  - Replaceable
  - Helio-gyro solar sails
    - No fuel
    - Guidance and control
  - Pico-/nano-class of satellites
DEPLOYMENT

- Horseshoe orbits around Venus L4 and L5 Lagrange points
- Determine the distribution of the satellites
  - String of pearls like
  - Cluster
- Require a distribution that provides enough constraints for empirical models and enough coverage to provide actionable information.
Example forecast enabled by SSWARMS.
PROGRAM FEASIBILITY

- Implemented in a step-wise fashion
- Integrated into existing facilities
  - STEREO
  - L1 instruments
- Design as an integrated sensor network
TEAM

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QUESTIONS