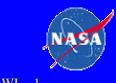


The Living With A Star Geospace Missions

13 August 2003

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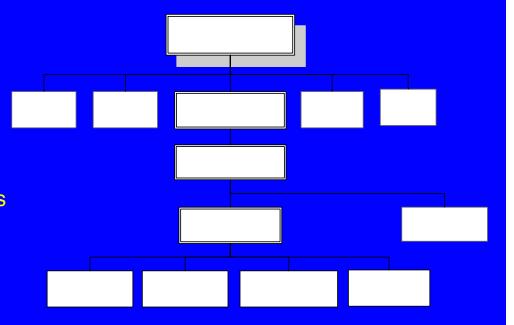


Living With a Star Summary



LWS Objectives

- Identify and understand variable sources of mass and energy coming from the Sun that cause changes in our environment with societal consequences
- Identify and understand the reaction of geospace regions whose variability has societal consequences
- Quantitatively connect and model variations in the energy sources and reactions to enable an ultimate US forecasting capability on multiple time scales
- Extend the knowledge and understanding gained in this program to explore extreme solar terrestrial environments and implications for life and habitability beyond Earth





Geospace Mission Definition Process



- Geospace activity has societal consequences
 - Potentially damaging conditions for spacecraft
 - Disruptions to communications and navigation systems
 - Health hazards for astronauts
 - Increased satellite drag
 - Induction of ground currents that can disrupt terrestrial power grids
- Mission objectives defined by Geospace Mission Definition Team
 - Different from traditional Science Definition Team by including engineering support to develop viable mission concepts
 - Final report issued in September 2002
 - Describes prioritized mission objectives
 - Proposals constrained by available funding

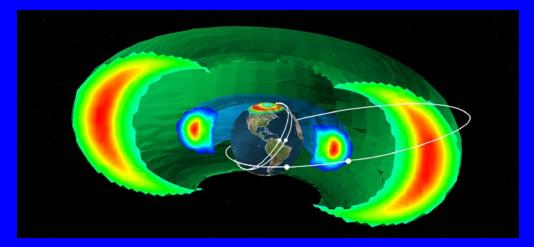




Geospace Network



- Two Radiation Belt Storm Probes (RBSP)
 - Launch in early 2010 to study radiation belts
- Two Ionosphere-Thermosphere Storm Probes (I-TSP)
 - Launch in mid-2008 to make in situ ionosphere-thermosphere measurements
- Far ultra-violet (FUV) imager
 - Instrument on mission of opportunity
 - High altitude to provide I-T context information
- Solar EUV measurements
 - Instrument on Solar Dynamics Observatory
- Concurrence of measurements is critical
- \$400m funding limit
 - Real-year dollars
 - Excludes FUV





I-TSP Measurement Requirements

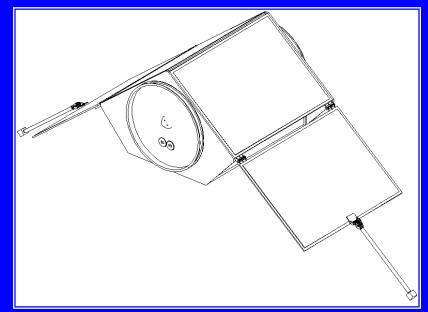


Core

- Plasma density and fluctuations
- Plasma density altitude profile
- DC electric fields
- Neutral density and mass composition
- Neutral temperature
- Vector neutral wind
- Scintillations

Baseline

- Low-energy electrons
- Magnetic field
- AC electric field
- Augmentation
 - Ion mass composition
 - Electron temperature
 - Ion temperature





NASA

I-TSP Key Mission Requirements



| Parameter | Requirement | Driver |
|--------------------|--|-----------------------|
| Mission Life | 3 years, 5 yr. expendables | Propellant, cost |
| Redundancy | Single-string | Cost |
| Orbit | 450 km circular; i=55°-65°; 10°-20° local time separation; latitude diff. < local time diff. | In situ measurements |
| Orientation | Nadir, fixed yaw | Plasma, neutral meas. |
| Attitude Knowledge | 0.3°, 3σ | Neutral wind meas. |
| Attitude Control | 3.0°, 3σ | Neutral wind meas. |
| Elec. Cleanliness | Elec. clean ram face; >10% of external surface conducting | Plasma meas. |
| Parts Reliability | Level 2 | GSFC quality reqts. |
| Availability | 95% | Cost |
| Data Return | 95% | Cost |

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RBSP Measurement Requirements



Core

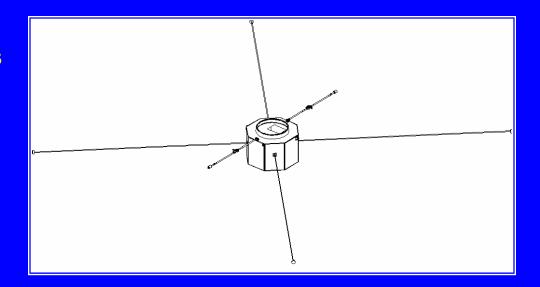
- Radiation belt electrons
- Vector magnetic field
- Ring current particles
- AC magnetic fields
- DC/AC electric fields

Baseline

- Radiation belt ions
- Inner belt protons
- Low-energy ions and electrons
- Energetic neutral atom imaging (on a separate high-altitude, high-inclination spacecraft)
- High-energy electrons and protons (on a low altitude, high inclination spacecraft; I-TSP is a viable candidate)

Augmentation

Add third axis to electric field measurements





NASA

RBSP Key Mission Requirements



| Parameter | Requirement | Driver |
|-----------------------|---|---------------------------------------|
| Mission Life | 2 years | Radiation, cost |
| Redundancy | Single-string | Cost |
| Orbit | 500km x 30,600km; i<18°; slightly different orbit periods | Radiation belt coverage |
| Spin Axis Orientation | Ecliptic normal | E-field, power, attitude disturbances |
| Spin Rate | At least 3 rpm | E-field measurements |
| Attitude Knowledge | 1.0°, 3σ | E-field measurements |
| Attitude Control | 5.0°, 3σ | E-field measurements |
| Mech. Config. | At least 8-sided, symmetrical | E-field measurements |
| Parts Reliability | Level 2 | GSFC quality reqts. |
| Availability | 95% | Cost |
| Data Return | 95% | Cost |

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Challenge



- How do we leverage the advances of the small satellite community to maximize the science return of the LWS geospace missions?
- ...within the constraints of a NASA strategic program
 - Program does not control instrument selection
 - Risk averse NASA culture
 - Full NASA quality and review requirements
 - NASA/KSC-provided launch vehicle

