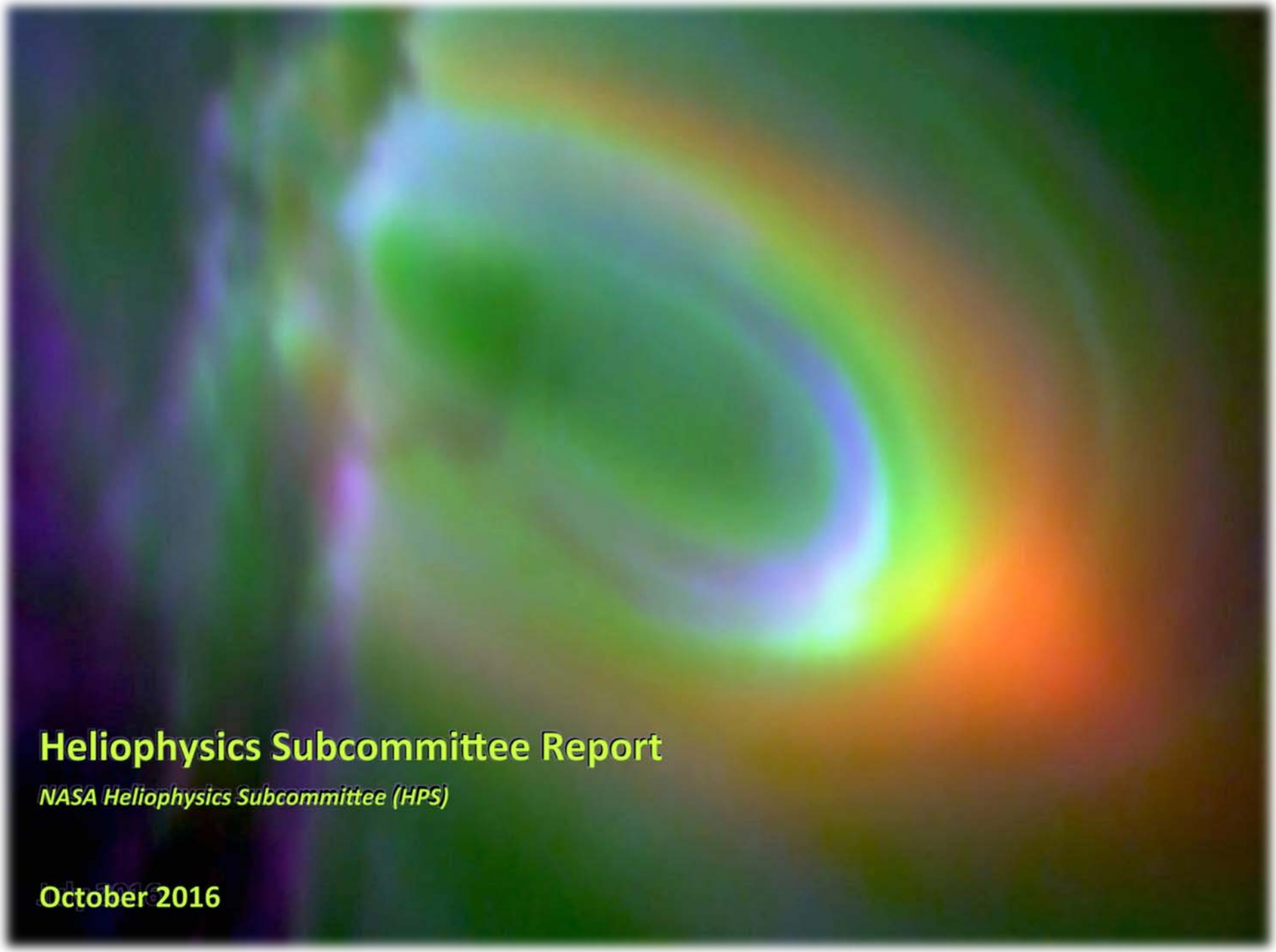
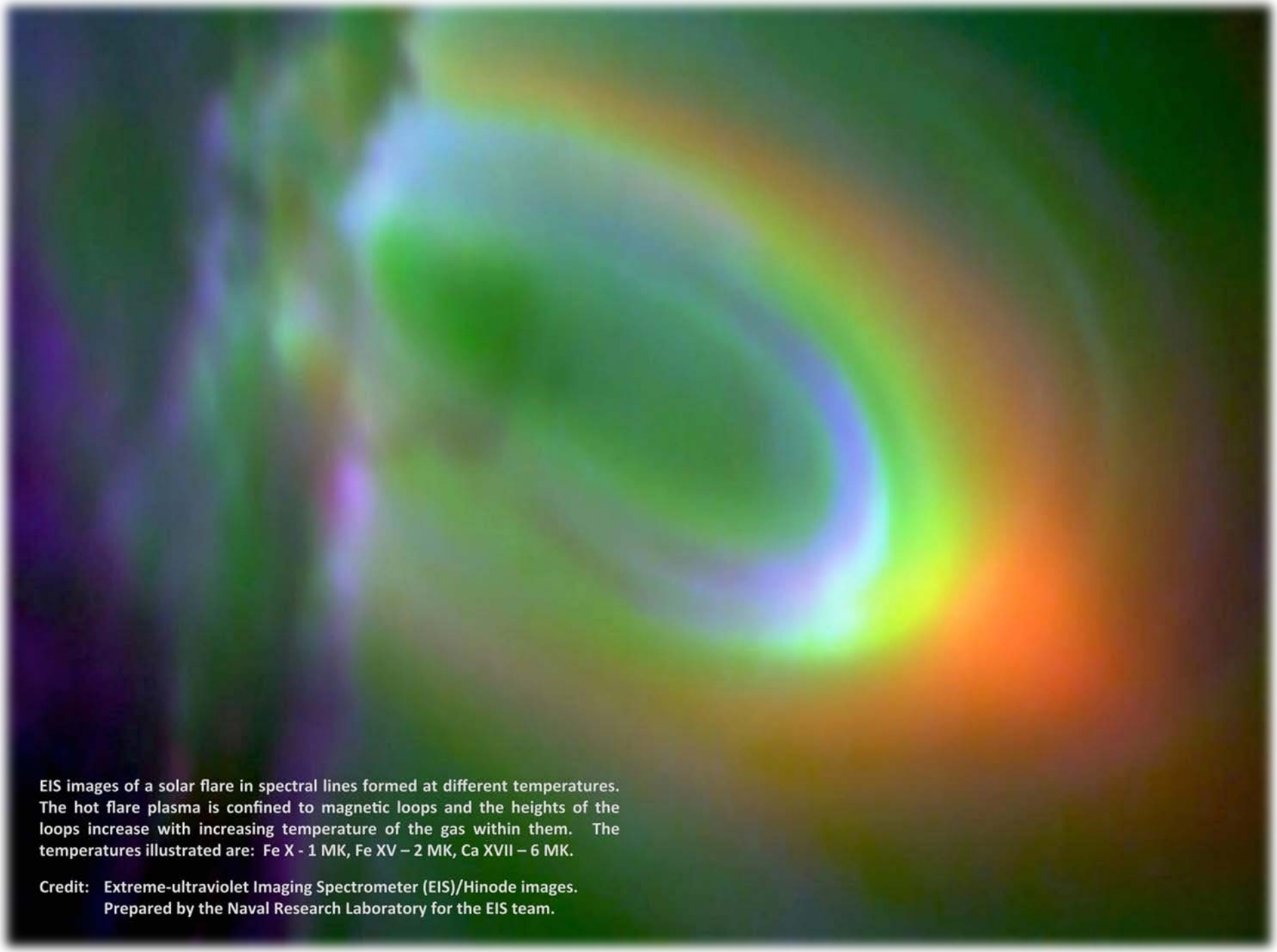


Heliophysics Subcommittee Report

NASA Heliophysics Subcommittee (HPS)

October 2016



EIS images of a solar flare in spectral lines formed at different temperatures. The hot flare plasma is confined to magnetic loops and the heights of the loops increase with increasing temperature of the gas within them. The temperatures illustrated are: Fe X - 1 MK, Fe XV – 2 MK, Ca XVII – 6 MK.

Credit: Extreme-ultraviolet Imaging Spectrometer (EIS)/Hinode images.
Prepared by the Naval Research Laboratory for the EIS team.

Heliophysics Subcommittee (HPS) Membership

HPS Membership -

- Vassilis Angelopoulos (University of California, Los Angeles)
- Spiro Antiochos (NASA Goddard Space Flight Center)
- Jill P. Dahlburg (Naval Research Laboratory, Chair)
- Bart W. De Pontieu (Lockheed Martin Space Systems Corporation)
- Heather A. Elliott (Southwest Research Institute)
- Lynn Kistler (University of New Hampshire)*
- John Leibacher (National Solar Observatory)*
- Michael W. Liemohn (University of Michigan, Vice-Chair)
- William Matthaeus (University of Delaware)*
- Ralph L. McNutt, Jr. (The Johns Hopkins University)
- Neil Murphy (Jet Propulsion Laboratory)
- James M. Russell III (Hampton University)
- Roger W. Smith (University of Alaska Fairbanks)
- W. Kent Tobiska (Space Environment Technologies)

** New Member*

08-09 August 2016 HPS Meeting, Agenda

Monday August 8; 3H42

8:30 Subcommittee Room Open

9:00 Welcome, Overview of Agenda — J. Dahlburg, HPS Chair

9:10 Heliophysics Division Overview — S. Clarke, NASA HQ

9:30 Flight Program Status — P. Luce, NASA HQ

9:50 Risk Tolerance/CubeSats — Subcommittee

10:20 BREAK

10:30 Heliophysics Science Performance Assessment, input for the FY2015 NASA PAR – Review and Assignments — Subcommittee

12:30 LUNCH: Science Presentation: Mary Voytek, "NExSS: The Nexus of Exoplanet System Science, an interdivisional research initiative."

1:30 Subcommittee work session(s) — Subcommittee

3:15 BREAK

3:30 High-end computing status — T. Lee, NASA HQ

4:30 Panel Surveys — M. Kessel, NASA HQ

5:00 ADJOURN

Tuesday August 9: 3H42

8:30 Subcommittee Room Open

9:00 SWAP update — E. Talaat, NASA HQ

9:30 Science Centers — M. Kessel, NASA HQ

10:00 Early Career Program — L. MacDonald, NASA HQ

BREAK

Heliophysics Science Performance Assessment, input for Subcommittee the FY2015 NASA PAR -Working — Subcommittee

12:15 LUNCH

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3:30 Heliophysics Science Performance Assessment, input for Subcommittee the FY2015 NASA PAR – Final Work and Voting — Subcommittee

4:15 Discussion, including future meeting dates, potential agenda topics, action items — Subcommittee

4:30 Debrief with Heliophysics Division Director — S. Clarke, NASA HQ

5:00 ADJOURN

Steve Clarke provided a summary on 5 October about the NASA Heliophysics Division [HPD].

HPS August 2016 Comment

The HPS offers sincerest congratulations for the outstanding recent promotions – of HPD's Dr. Jeff Newmark to the position of Deputy Associate Administrator of the Science Mission Directorate [SMD], and of HPD's Dr. John Lee to the position of Deputy Director of the Joint Agency Satellite Division [JASD].

Also, the HPS is glad and grateful to hear that Steve Clarke achieved exceptions to the NASA HQ hiring freeze for both HPD staffing vacancies.

08-09 August 2016 HPS Meeting, Information Briefings

08 August -

- NExSS, Nexus of Exoplanet System Science,
  Dr. Mary Voytek, NASA SMD Senior Scientist for Astrobiology
- Status Update on NASA High End Computing [HEC],
  Dr. Tsengdar Lee, HASA HEC Program Executive for SMD

09 August -

- Risk Tolerance, with emphasis on how this pertains to CubeSats,
  Dr. Jeff Newmark, NASA Deputy Associate Administrator of SMD
- HPD Research & Analysis [R&A] Briefing, and Proposals Compliance Update,
  Dr. Arik Posner, NASA HPD Discipline Scientist
- Space Weather Action Plan [SWAP] and the Living with a Star [LWS] Program,
  Dr. Elsayed Talaat, NASA HPD Discipline Scientist
- Panel Surveys Update,
  Dr. Mona Kessel, NASA HPD Discipline Scientist

NExSS: NASA Exoplanet System Science Research Coordination Network

A Cross-division Initiative

This SMD interdivisional research coordination network is in its 2nd of three years of activity. NExSS links 207 researchers towards effectively addressing the interdisciplinary research topic of exoplanet habitability. Mary's briefing was of great interest to HPS, both topically and also from the general perspective of the NExSS virtual collaborative structure itself, the goal of which is to break down barriers between divisions, disciplines, and stove-piped research activities in order to achieve significant progress on well-defined objectives.

08 August 2016 NASA High End Computing [HEC]

Tsengdar Lee briefed the HPS about

-- The current oversubscribed status of NASA HEC as related to HPD researchers' difficulty in obtaining NASA HEC resources, *and*

-- That since the NASA HEC facility space is physically full, there is not any near-term way for SMD to purchase more HEC allocation for any part of NASA science research since (a) NASA HEC resources are severely oversubscribed and demand is increasing, and (b) there is no place to site new HEC hardware.

Dr. Lee then described his vision for a new HEC facility at Ames:
~$40M for all infrastructure modules, and~$150M fully populated.

In consideration of the pressing oversubscription difficulties across the SMD, the HPS suggested that a rapid survey should be made on the topic of HEC status and plans at other US Agencies* which also sponsor discovery R&A.

-- The survey should describe each Agency's: HEC capability and capacity; numbers of HEC users; expenditure per year (for HEC support personnel and infrastructure, and for new HEC-related hardware); and, the Agency's HEC allocation policy.

-- The purpose of the survey would be to summarize what other Agencies are doing to address their researchers' needs for HEC resources, as input to NASA decision-making.

** including, e.g., NSF, DOE SC, DOE NNSA, DoD HPCMP*

09 August 2016 Risk Tolerance, and CubeSats

Jeff Newmark discussed with the HPS the topic of risk tolerance, with emphasis on how this pertains to CubeSats.

All NASA CubeSats are not the same --

-- There are ROSES (Research Opportunities in Space & Earth Science) CubeSats, which are governed by NASA Procedural Requirements [NPR] 7120.8; *and,*

-- There are AO-response CubeSats, which are governed by NPR 7120.5E (for Class-D missions)

The HPS found this discussion with Jeff to be very helpful, and requested an update at the next HPS meeting about the Class-D further subdivisions that are being considered.

HPS would also like to further explore with HPD the topic of Low Cost Access to Space [H-LCAS] CubeSats which are long-lived and productive.

09 August 2016 HPS R&A Recommendation to HPD

Recommendation: NASA HPD should promote the existence of the open website for submitting press-worthy research results [http://bit.ly/SubmitHelioHighlight] and consider the development of an HPD Research and Analysis [H-R&A] grants annual report template, including example science highlights.

Major Reason for the Recommendation: Members of NASA HQ HPD staff have commented that it is sometimes difficult to extract significant scientific accomplishments from the existing process of annual progress reporting for R&A grants. There is no format specified for these reports and they come in a wide variety of lengths and depths. The HPS would like to note that it is understood that often scientists are modest and do not wish to brag. However NASA's R&A researchers need to help NASA by being more accountable about their outstanding results which were enabled by NASA R&A funding.

Consequences of No Action on the Proposed Recommendation: Without wide promulgation of this highlights website and development of a report template that enables the timely submission of NASA-funded research and analysis achievements in clear language accessible by a general scientific audience, the HPD will not be made aware of the full scope of accomplishments attained by its efforts, which will adversely affect their reporting requirements.

09 August 2016 R&A Proposals: Compliance, Panel Surveys

HPD R&A Proposals Compliance: A recent HPD R&A review panel pointed out a proposal with serious non-compliance issues. All of the proposals were then checked, and many substantial violations were found. Only ~50% of the proposals were within guidelines, for font sizes, margins, etc. Accordingly, the HPS concurred with the thoughtful HPD decision currently to provide just a warning for up to 5% non-compliance issues, and with the way forward of:

a) Promulgating compliance policy clearly in community newsletters; *and,*
b) Further clarifying compliance language in all future NSPIRES R&A calls.

HPD R&A Proposals Panel Surveys: This process, which is anonymous, is enabling considerable helpful input and comments. For example:

-- From proposers, on the topic of reviewer comments, the proposers found reviewer comments to be helpful and also consistent with the score for the current review (but not consistent with the scores from previous reviews);

-- From reviewers, when asked about the new 10-page limit for HPD Guest Investigator [H-GI] proposals, the reviewers resoundingly answered 'yes' for both 'adequate length' and also for 'easy to review.'

09 August 2016 HPD R&A Proposals *(continued)*

Solutions for bettering the HPD R&A proposals process include:

Implementing DRIVE (Diversify, Realize, Integrate, Venture, Educate) which will enable funding more proposals; *and,*
Offering proposal-writing workshops led by NASA HPD HQ personnel at future heliophysics community meetings.

HPD R&A Proposals processes next steps include:

Surveying the proposers who submitted the 10-page H-GI proposals, and if their feedback is positive HPD will initiate broadening the 10-page limit to more HPD ROSES calls.

As part of HPD's long-term strategy, plans are that HPD R&A funding will nearly double in FY18 & FY19.

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10:30 Heliophysics Science Performance Assessment Input the FY2015 NASA PAR – Overview	TBD, NASA HQ
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[illegible]	Subcommittee
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The primary work of the HPS during the August meeting was to develop an assessment of HPD's scientific performance.

GPRAMA, and Strategic Objective 1.4

The GPRAMA (Government Performance and Results Act**) Strategic Objective 1.4 is to understand the Sun and its interactions with Earth and the solar system, including space weather.**

During its August meeting, HPS reviewed the progress of the Heliophysics Division in the area of Objective 1.4, with focused attention on these three Performance Goals:

- **1.4.1:** Demonstrate progress in exploring the physical processes in the space environment from the Sun to Earth and throughout the solar system;
- **1.4.2:** Demonstrate progress in advancing understanding of the connections that link the Sun, Earth, and planetary space environments, and the outer reaches of the solar system; and,
- **1.4.3:** Demonstrate progress in developing the knowledge and capability to detect and predict extreme conditions in space to protect life and society and to safeguard human and robotic explorers beyond Earth.

HPS August 2016 Heliophysics FY16 Science Performance Assessment

Resulting from substantial deliberation, under the leadership of HPC members Bart De Pontieu and John Leibacher (for 1.4.1), Vassilis Angelopoulos (for 1.4.2), and Michael Liemohn (for 1.4.3), **on 09 August the HPS concluded that, for all three Performance Goals:**

> **Expectations for the HPD research program were fully met in the context of the resources invested and, moreover, the NASA Heliophysics Division has newly achieved original and generative contributions.**

Accordingly, the HPS unanimously voted in favor of GREEN ratings for all three HPD Performance Goals 1.4.1, 1.4.2, and 1.4.3.

HPS Sept 2015 Heliophysics FY15 Science Performance Assessment: Goal 1.4.1

Exploring the physical processes that structure and drive our space environment is essential for the utilization and the human exploration of space and, consequently, is one of the great challenges for NASA's science program.

The HPS substantiated its unanimous GREEN rating for the associated Performance Goal 1.4.1 as follows.

The HPD has made major progress recently in the area of fundamental space environmental exploration, as exemplified by new understanding of the physical mechanisms underlying the formation of sunspots, the heating processes in the solar wind, and the physical mechanisms that govern magnetic reconnection.

HPS August 2016 Heliophysics FY16 Science Performance Assessment: Goal 1.4.2

The solar wind permeates the heliosphere. It has profound effects on planetary environments and planetary evolution, it interacts strongly with Earth's ionosphere and atmosphere, and it drives dynamic processes at the edge of the solar system.

The HPS substantiated its unanimous GREEN rating for the associated Performance Goal 1.4.2 as follows.

The HPD has provided new insights on how solar imaging can be used to predict geoeffective coronal mass ejections. Heliophysics scientists have revealed how the solar wind creates geoeffective shocks at Earth; how it evolves en route to, and interacts with, other planets; and, how it interfaces with the local interstellar medium. At Earth, the driving of the mesosphere by atmospheric activity that is powered, in turn, by solar-heating, has been further elucidated. In sum, this year the HPD has made seminal contributions in our understanding in this area of research and development with significant potential for improving our predictive capability of space weather phenomena at Earth and the planets.

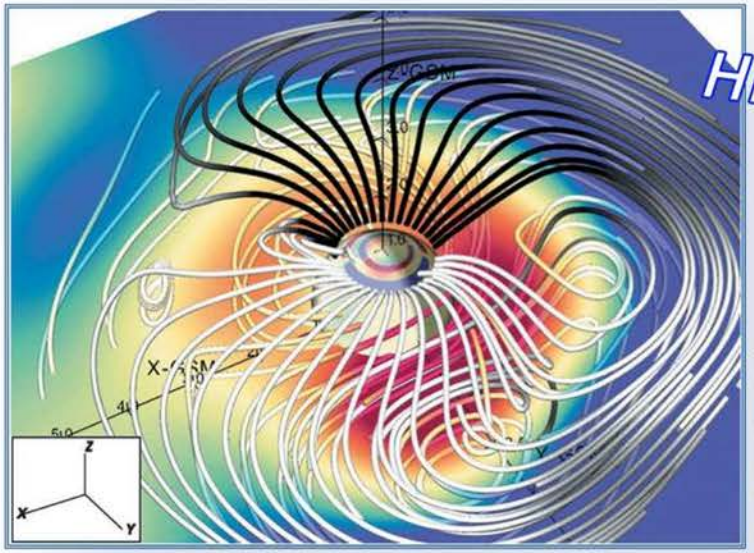
HPS August 2016 Heliophysics FY16 Science Performance Assessment: Goal 1.4.3

All space-based capabilities are subject to effects of the space environment. NASA mission data and NASA-funded numerical models, across all heliophysics disciplines ranging from solar through magnetospheric to upper atmospheric physics, are used to advance knowledge about space weather phenomena capable of adversely affecting life and society here on Earth as well as human and robotic explorers beyond Earth.

The HPS substantiated its unanimous GREEN rating for the associated Performance Goal 1.4.3 as follows.

Multi-year and multi-satellite data sets were critical to imparting statistical significance to long-term space environmental specification trends and in identifying truly extreme space weather events. Examples include: the statistically significant data which elucidates how our upper atmosphere is growing colder and more humid and hence which points to a new and extreme boundary condition at the edge of space; a breakthrough in global modeling of the Earth's magnetic field as result of the dramatic increase in space-based sampling of **the inner magnetosphere**; and, a new ability to understand and predict the trajectories of **solar energetic particles [SEPs]** that can present major hazards to space and air vehicles and to their onboard human crews.

HPS August 2016 Heliophysics FY16 Science Performance Assessment: Goal 1.4.3



HPD GPRAMA Rating: Illustrative Example

A reconstruction of the inner magnetosphere ionosphere current system, derived from Van Allen Probes data.

*Reference: Stephens G. K., M. I. Sitnov, A. Y. Ukhorskiy, E. C. Roelof, N. A. Tsyganenko, and G. Le (2016), "Empirical modeling of the storm time innermost magnetosphere using Van Allen Probes and THEMIS data: Eastward and banana currents," JGR, **121**, 157 – 170*

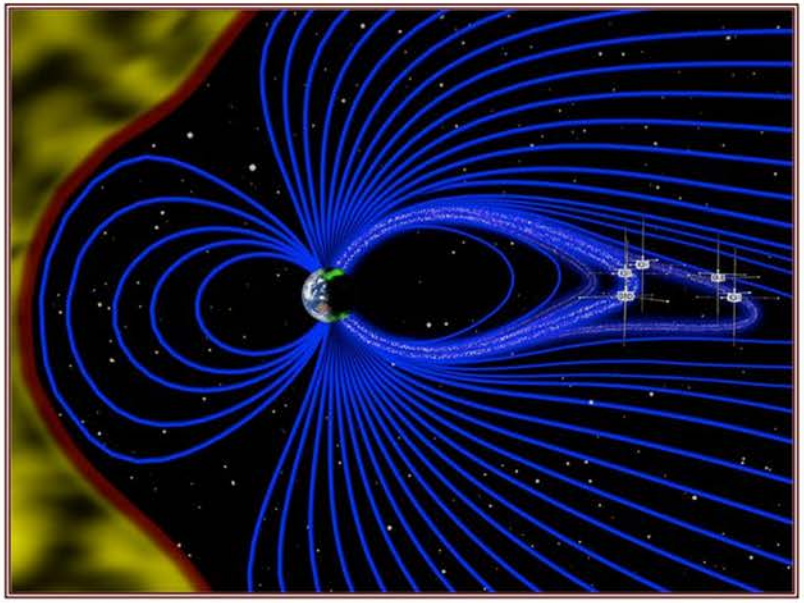
*Image Credit: JGR cover: **121**, 1*

Breakthrough achieved in global magnetic field modeling improves understanding space weather effects. The Van Allen Belts, named for their discoverer James Van Allen, are two toroidal regions encircling Earth, where charged particles from the Sun and space are trapped by our planet's magnetic field. NASA's Van Allen Probes mission has dramatically increased the sampling of **the inner magnetosphere**, including robust observations of 65 geomagnetic storm time frames. This has led to the first data-derived reconstruction of the global current system deep within the radiation belts, which is a significant advance. Accurate specification of this system is critical for understanding and simulating geoeffective space weather such as large geomagnetic storms that can induce intense electrical currents at the Earth's surface which can be hazardous to power grids.

THEMIS Sees Auroras Move to the Rhythm of Earth's Magnetic Field

NEW OBSERVATIONS FROM THEMIS [TIME HISTORY OF EVENTS AND MACROSCALE INTERACTIONS DURING SUBSTORMS] LINK INTENSE MAGNETOSPERIC DISTURBANCES TO MAGNETIC RESPONSES ON THE GROUND.

- Substorms are elemental magnetospheric disturbances during which energy is released from the tail of the Earth's magnetosphere and injected into the inner magnetosphere and ionosphere, intensifying radiation fluxes and creating auroras.
- Using simultaneous observations by NASA's fleet of five THEMIS spacecraft and magnetically conjugate all-sky cameras and magnetometers from the ground underneath the aurora, scientists ascertained for the first time an unambiguous physical connection between the ground and space phenomena of an isolated substorm. Earth's magnetic field in space was observed to vibrate in a roughly six-minute cycle, and the northern lights dancing in the night sky over Canada brightened and dimmed at the same pace. The source of the space currents was identified to be the plasma compressions, which forced the intense space currents to be diverted along the magnetic field lines and onto the aurora.
- Understanding the physics of how and why auroras are powered during such events can help us learn more about the space environment that surrounds our planet, especially at more complex and dynamic times of space storms.



An artist's rendition of a cross-section of the magnetosphere, with the solar wind (left) in yellow and Earth's magnetic field lines in blue. The five THEMIS probes were well positioned to directly observe the source of energy that lit up the aurora: plasma compressions and magnetic oscillations at a ~6-min cycle. These pulsations cause field aligned currents that in turn accelerate electrons which bombard the upper atmospheric oxygen and nitrogen, releasing photons and brightening a region of the aurora. The arrival of the current pulses and the auroral emissions were captured by ground-based observatories.

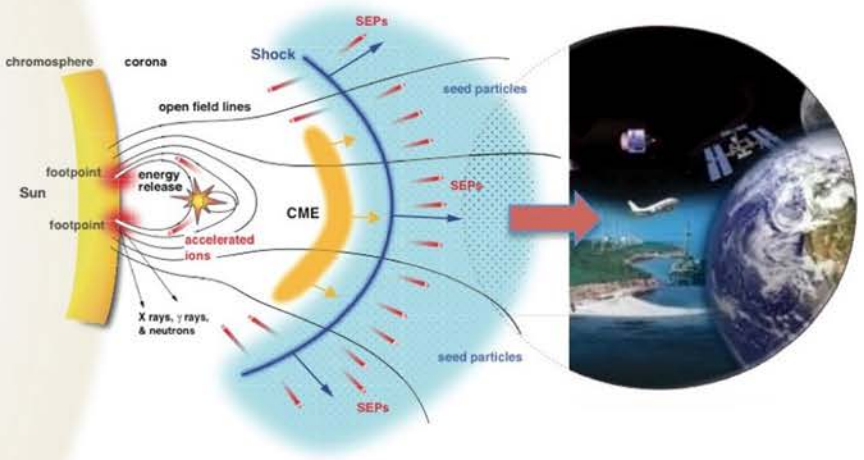
URLs: [http://www.nasa.gov/feature/goddard/2016/nasa-s-themis-sees-auroras-move-to-the-rhythm-of-earth-s-magnetic-field]; [http://themis.ssl.berkeley.edu/news.shtml (item: September 12, 2016)]

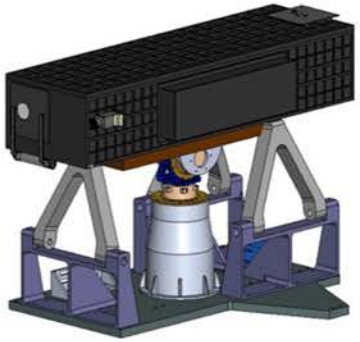
E.V. Panov, Baumjohann, W., Wolf, R.A., Nakamura, R., Angelopoulos, V., Weygand, J.M., Kubyshkina, M.V., "Magnetotail Energy Dissipation During an Auroral Substorm," Nature Phys, (2016) [doi: 10.1038/nphys3879].

UVSC Pathfinder: UV Coronal Imaging-Spectrograph for the Parameterization of Coronal SEP Sources

GEOEFFECTIVENESS OF THE SHOCK PRODUCED BY A CORONAL MASS EJECTION [CME] DEPENDS ON THE PRESENCE OR ABSENCE OF SUPRATHERMAL SEED PARTICLES THAT ACT AS SEEDS FOR SOLAR ENERGETIC PARTICLES [SEPS] PRODUCTION.

- The UVSC Pathfinder, funded by the NASA Heliophysics Low Cost Access to Space [H-LCAS] program, is being built by NRL to measure the asymmetry and non-thermal broadening of the UV (121.6 nm) Hydrogen Lyman-a line emitted by the solar coronal plasma, to detect the presence of suprathermal seed particles and shocks that are essential for the acceleration of SEPs.
- The UVSC Pathfinder instrument is manifested for launch to geosynchronous orbit [GEO] aboard the DoD Space Test Program [STP] STPSat-6 satellite, as a Department of the Navy [DON] Space Experiments Review Board [SERB] space experiment.
- The DoD STP will provide integration, launch, and one year of operations following the STPSat-6 launch in April 2019 from Cape Canaveral, FL.





***Top**: Shock-produced SEPs are a known hazard to spacecraft operations and human activities in space.*

***Left**: The Ultra-Violet Spectroscopic Coronagraph [UVSC] Pathfinder shown in its launch configuration. A design review is scheduled for October 2016 , and delivery for spacecraft integration is scheduled for February 2018.*

*J.D. Moses, Ko, Y.-K., Laming, J.M., Provornikova, E.A., Strachan, L., Tun Beltran, S., "Ultraviolet [UV] and extreme UV spectroscopy of the solar corona at the Naval Research Laboratory [NRL]," Applied Optics, **54**, F222-F231 (2015).*

Jill Dahlburg, HPS Chair

EDUCATION

PH.D., in Plasma Physics,
College of William & Mary,
1985

M.S. in Physics,
College of William & Mary,
1981

B.A. in Liberal Arts,
St. John's College in Annapolis,
1978

PROFESSIONAL BACKGROUND

Superintendent,
Space Science Division,
U.S. Naval Research Laboratory,
2007 - *pres*

Senior Scientist for Science Applications,
Executive Directorate,
U.S. Naval Research Laboratory,
2003 - 2007

Director,
Division of Inertial Fusion Technology,
and Co-Director,
Theory & Computing Center
General Atomics
2001- 2003

Head,
Distributed Sensor Technology Office,
Tactical Electronic Warfare Division,
U.S. Naval Research Laboratory,
2000

EXPERIENCE

Dr. Jill Dahlburg is Superintendent of the Naval Research Laboratory's Space Science Division [NRL SSD]. In this DON Senior Executive Service position, she leads conception, planning, and execution of space science research and development programs across a scope that encompasses:

- Theoretical, experimental, and numerical research of geophysics S&T, solar and heliospheric physics, and the high-energy space environment
- Conception, design, fabrication, integration, test, operation, and experimentation with forefront space instrumentation that is flown on satellites, sounding rockets, and balloons

Dr. Dahlburg began her federal career at NRL in 1985, working as a research plasma physicist. Her early work included contributing to laser-matter interaction research and spearheading the development of the first three-dimensional multi-group radiation transport hydro-code appropriate for laser-plasma modeling. Her community service includes:

- Chair of the DON Space Experiments Review Board, and member of the DoD SERB (2007-*pres*)
- Member of the DOE National Nuclear Security Administration [NNSA] Defense Programs Advisory Committee (2014-2016)
- Chair of NASA's Heliophysics Subcommittee (2015-*pres)*, and member of the NASA Advisory Council's Science Committee (2015-*pres*)
- Co-chair of the NRC DEPS Study Committee: Peer Review and Design Competition Related to Nuclear Weapons (2014-2016)

Her previous professional service includes:

- Chair of the American Physical Society [APS] Panel on Public Affairs (2011 & 2012)
- Chair of the DOE Office of Science Advanced Scientific Computing Advisory Comm. (2005-2007)
- Chair of the APS/ Division of Plasma Physics (2005)
- Member of the NRC AFSB Committee on Improving the Effectiveness and Efficiency of U.S. Air Force Pre-Acquisition Planning (2014)
- Divisional Associate Editor (Plasma Physics) of the Physical Review Letters (1996-2000)
- Fellow of the APS, elected in 2001


When you have a good idea: never give up!