

**National Aeronautics and Space Administration**

**Heliophysics Subcommittee  
of the  
NASA Advisory Council Science Committee**

**May 3–4, 2006  
University of Maryland University College Conference Center  
Adelphi, Maryland**

**MEETING SUMMARY**

**Signed original on file**

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Barbara Giles  
Executive Secretary

**Signed original on file**

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Alan Title  
Heliophysics Subcommittee Chair

**Heliophysics Subcommittee**  
University of Maryland University College Conference Center  
Adelphi, MD  
May 3–4, 2006

**Meeting Summary**  
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*Meeting Report Prepared By:*  
*Robert J. Katt, Consultant*  
*INFONETIC*

## **Heliophysics Subcommittee**

University of Maryland University College Conference Center  
Adelphi, MD  
May 3–4, 2006

### **Wednesday, May 3, 2006**

#### **Plenary Session**

During the morning and early afternoon, the Heliophysics Subcommittee of the NASA Advisory Council (NAC) Science Committee joined the other three subcommittees in plenary session to hear presentations and participate in question and answer sessions with the presenters. This part of the meeting is covered in the separate meeting summary for the Science Subcommittee Planning Conference. The plenary session ended at 2:00 p.m., at which time the Heliophysics Subcommittee convened in separate session in Room 1311 of the University of Maryland Marriott Inn.

#### **Wednesday Afternoon Subcommittee Breakout Session**

Dr. Alan Title, chair of the Heliophysics Subcommittee, introduced himself and asked the other subcommittee members to do likewise. After the introductions, Dr. Title described his background on NASA advisory and National Academy of Sciences/National Research Council (NAS/NRC) study committees. As an introduction to discussing the subcommittee's advisory role with respect to programs of the Heliophysics Division (HPD) of the NASA Science Mission Directorate (SMD), he described two alternative approaches the subcommittee might take. The subcommittee could simply recommend that NASA execute the advice of the latest Decadal Survey on solar and heliosphere physics, *The Sun to the Earth—and Beyond*. The alternative is to provide advice on a science plan for HPD that is consistent with the Division's current and projected budget. A principal point made in both the Decadal Survey and the Division's strategic roadmap document, *The New Science of the Sun-Solar System Connection*, is that heliophysics is a complex and highly interacting system. Dr. Title suggested that the subcommittee reassess the science objectives proposed in these two reports in terms of new scientific results that have come to light since they were written, then develop an implementation strategy consistent with the sense of the reports, the needs of the NASA Exploration Vision, and the current NASA budget. Although the baseline plan should fit within the current budget, the subcommittee could propose options to enhance the science, in the event of either increased funding or increased international collaborations. He stressed the importance of including flexibility in the recommended science plan. In this regard, the Heliophysics Subcommittee will have the advantage of being able to reassess milestones and recommend changes based on discoveries, cost growth, and budget reformulations.

Dr. Title next reviewed the time line of recent solar physics and geospace missions, including missions still in development. The interval between major solar physics missions has been 12–15 years, with focused small and moderate missions spaced about 3 years apart. However, the sequence of missions is fragile, if a major mission such as the Solar and Heliospheric Observatory (SoHO) had been lost early in the mission. Based on lessons gleaned from the history of solar physics missions and an analysis of HPD budget expectations, Dr. Title proposed a two-prong "plan for success:"

Control costs of the large missions to about \$750 million and the costs of focused and strategic missions to \$250 million. If this can be done, a good science plan for heliophysics missions can be constructed within the anticipated budget. However, if a major mission were lost early in its

life cycle, such a plan could lose much of its systems approach to investigating and monitoring the heliosphere (i.e., the distributed Great Observatory of the Heliosphere, comprising multiple spacecraft).

If NASA and HPD can find international partners to participate in the plan for sustaining the Great Observatory of the Heliosphere, then the science effort will be greatly enhanced. There would be more robustness to the systems approach to understanding the complex interactions in the heliosphere.

The subcommittee discussed options for adjusting the HPD program to account for fragility in its overall program and debated whether that program can be regarded as vibrant and healthy for all the fields of research within heliophysics. One suggestion was for an objective assessment of whether the U.S. space science community will be able to keep pace with research capabilities around the world in 10 to 15 years, given expectations for U.S. space science budgets. Also discussed was the possibility of Flagship missions, such as Solar Probe, that exceed Dr. Title's suggested limit of \$750 million. The potential scientific value would have to be weighed against the difficulty of selling the concept for such a mission to funding sources and decision makers without jeopardizing the rest of the HPD program.

Dr. Title raised the issue of the extent to which risk management processes and procedures installed by NASA in recent years act to raise costs rather than controlling them. In this context, the subcommittee members and HPD staff discussed pros and cons of mission caps, the history of mission overruns, and missions that overran their budgets but were healthy and produced excellent results after funding was increased.

### ***R&A and Program Mix***

Dr. Richard Fisher, HPD Director, discussed the research and analysis (R&A) and flight program content in the Division. He reviewed the current flight program of operating missions and missions in development, the budget, and guiding principles for science planning in the HPD. He agreed with Dr. Title that an executable program for the HPD is one that falls within the Division's resources. If satisfaction with the program can be equated with the degree to which the program's outcome exceeds expectations for it, the only directly manageable term in this equation is the expectations. In particular, he said, the program needs to manage expectations in a context of limited resources. The overall program goals derive from the NAS/NRC Decadal Surveys and other NRC study committee reports. Last year's Heliophysics Strategic Roadmapping Committee defined three research objectives for the HPD, directed to NASA's Agency Strategic Objective to explore the Sun-Earth system. These three objectives, presented in the recommended roadmap for science and technology from 2005 to 2035, are to: (1) open the frontier to space environment prediction, (2) understand the nature of our home in space, and (3) safeguard the journey of exploration.

Mr. Chuck Gay, HPD Deputy Director (Acting), continued the presentation with details of project and mission status in the HPD programs: Solar Terrestrial Probes (STP), Living with a Star (LWS), the Explorer Program, New Millennium Program (NMP), and the operating missions. He listed recent significant accomplishments and upcoming events through October 2006. A top program concern is availability of launch vehicles because of technical issues with both Delta II and Pegasus vehicle systems. At risk are launch schedules for the Solar Terrestrial Relations Observatory (STEREO), Time History of Events and Macroscale Interactions during Substorms (THEMIS), and the Solar Dynamics Observatory (SDO). The second top concern is availability of pyro valves for SDO, in light of failures of valves produced by Conax for that mission. In the

Sounding Rocket Program (SRP), the schedule for redesign of the igniter for the program's Black Brant rockets has slipped.

Dr. Fisher summarized the success of the HPD programs in terms of having achieved a sparse system surveillance capability from the Sun to the edge of the solar system, with 13 spacecraft operating collectively as the equivalent of a fifth space-based Great Observatory. To illustrate the constraints of living within anticipated budgets, Dr. Fisher discussed details of the changes from the fiscal year (FY) 2006 Presidential Budget Request to the FY 2007 request, including changes in outyear (FY 2008–2011) line item amounts. He talked about how the Explorer program will be cooperatively handled with the Astrophysics Division. He presented a list of near-term actions that the HPD was planning to take and a list of guiding principles for thinking about current and future program content. Dr. Fisher then characterized the realistic range of opportunities for adjusting the HPD programs by identifying which knobs [on the program "controls"] could be moved and how the gains could be adjusted, within the bounds of keeping the programs on stable and productive courses. The dimensions and cuts through the trade space for potential adjustments include:

Flexibility by adjusting among the Heliophysics Research, LWS, and STP lines

R&A adjustments among theory, models, and data analysis

The balance of strategic missions versus competed missions

Extending operating missions versus funding for archival data exploration/exploitation (data mining)

Reconsidering the science priorities as ordered in the strategic roadmap recommendations

Altering the balance of mission size among small, medium, large, and "extra large" missions.

In response to subcommittee questions, Dr. Fisher agreed that the budget reflects, with reasonable accuracy, the fragile but viable steady state as Dr. Title presented it. He noted that the constraints on program adjustments include some fenced-off areas, in which attempted reductions would draw reaction from Congress, such as the SRP flight program budget.

### ***Discussion of Session Product Charts***

Dr. Title led the subcommittee in discussing the content for the three charts to be delivered during Wednesday's closing plenary session of the four NAC Science Committee subcommittees. For the chart "Recommendations on Decision Principles," the subcommittee tentatively adopted the set of Guiding Principles presented by Dr. Fisher at the end of his presentation (several changes were made later). For the chart on "Recommendations on Allocations," the subcommittee discussed at length members' concerns about the decreases in the R&A funding line from the outyear amounts in the FY 2005 budget request. Dr. Fisher described the cost multiplier on mission lifecycle costs that applies if missions are delayed, once they are in development. HPD staff and the subcommittee discussed the amount in the explicit funding line for R&A versus the other "research and data analysis" (R&DA) amounts included in mission lines. A concern is that some important R&A elements, such as the Low Cost Access to Space (LCAS) program, can come only from the explicit R&A funding and cannot be covered by redirecting amounts in the other R&DA lines. Members expressed concerns about the consequences for other projects and areas if funding were moved to restore the R&A line to its previously budgeted level.

Another topic of discussion was the cost of small missions and whether a range around \$250 million per mission was reasonable for missions to accomplish good science. Dr. Fisher described the impact that increasing costs for launch vehicles and services has had on the cost of small to moderate missions. A Pegasus rocket now costs about \$42 million. The next size up is the Taurus, which costs about \$80 million, but has some issues about qualification. A Delta II rocket costs

upwards of \$150 million, and an Evolved Expendable Launch Vehicle (EELV) will, by 2012, cost in the \$180 million range.

The subcommittee drafted the following three charts to be presented in the day's closing plenary session:

*Decision Principles (HPD guidelines for discussing program content)*

- Discover and communicate new scientific knowledge that supports the Exploration, Vision using the unique vantage point of space.
- Undertake high priority space investigations considering NASA goals and priorities.
- Follow scientific recommendations of the Community roadmap and Decadal Surveys.
- Complete missions in implementation.
- Budget for an appropriately balanced R&A and Flight Program.
- Don't spend what you don't have.
- Responsibly manage shared flight programs for the SMD.
- Responsibly manage and operate critical spaceflight communication assets.

*Principal Recommendations*

- The amount of money supporting R&A in the FY07 budget, regardless of where it is categorized, appears roughly appropriate at this time, as compared to other portions of the program. However, the committee requests additional information on the breakout for the full range of R&DA types at the July meeting.
- The health of the R&A program is intimately tied to the health of the Heliophysics Science missions. The principal of completing the missions on time and within cost appears to be the best method of maintaining a healthy R&A program.
- Control costs of our large missions to "on the order of" \$750 million and our focused and strategic missions to be one half of this amount or less. (These amounts assume that launch costs can be held to 1/4 or less of these amounts.)
- In order to achieve the goals of the Decadal Survey, NASA needs to field two-to-three small and one major mission per 15 years, per sub-discipline. International partnerships will be essential to this plan.

*Issues and Concerns*

- We are concerned about short term interruptions in the R&A program that have to be managed.
- We are concerned that we are not starting enough smaller missions.
- We are concerned that processes and procedures will not allow us to develop small missions at sufficiently low cost.

### **Wednesday Afternoon Closing Plenary Session**

At 5:00 p.m., the Heliophysics Subcommittee returned to plenary session with the other three subcommittees. The chair of each subcommittee presented and discussed the three charts from the afternoon's breakout sessions. In presenting the Heliophysics Subcommittee charts, Dr. Title noted that the subcommittee decided it will need to do more work to understand and comment on the issues related to budget impacts on the HPD programs, missions, and long-term health of heliophysics research. In the subcommittee's first recommendation (first bullet above, under Principal Recommendations), "appropriate" should be based on what is needed for a healthy discipline [of heliophysics], based on the quality of new results being presented to the science community (through refereed papers, conference presentations, rapid publication of results, etc.).

**Thursday, May 4, 2006**

The morning plenary session began with comments from the public, in accordance with the rules for addressing the subcommittees announced by Dr. Marc Allen on the previous day. Each speaker who had registered to comment received a 3-minute allotment to address the subcommittees and other conference attendees. Several comments were received in written form only.

After the public comment session, Dr. Gregory Williams explained the procedure for developing the next revision of the NASA Science Plan. He said that the biggest challenge for the subcommittees would be to create a prioritized list of missions, by Division within SMD. The three charts to be prepared by each subcommittee during the morning breakout session should discuss and capture any findings on: (1) the section outline for the Science Plan; (2) prioritization criteria or considerations for missions within their respective SMD Divisions; (3) if possible, a prioritized list of Division missions; and (4) any additional issues or concerns.

**Thursday Morning Subcommittee Breakout Session**

Dr. Title opened the Heliophysics Subcommittee breakout meeting with comments on the reasons for building data analysis and related support into mission budgets, rather than in a separate R&A funding line, where it can be more vulnerable to budget reduction or rescission actions by Congress. He discussed cost factors in NASA flagship missions such as the James Webb Space Telescope (JWST), and Laser Interferometer Space Antenna (LISA) and the cost impact of full-redundancy designs for spacecraft risk reduction.

***Discussion of Issues for Subcommittee Attention and Planning for Future Meetings***

Dr. Title and other members concurred with a suggestion from Dr. Daniel Winterhalter that an extra day of meeting time would be valuable to have in future subcommittee meetings, to work on the problems and issues presented to the subcommittees. There was also concurrence on the value of a teleconference prior to the next meeting to discuss the agenda and help members prepare for the issues that would be addressed in the formal meeting. Dr. Roy Torbert and other members expressed interest in exploring cost containment issues and opportunities in greater depth. In particular, the current balance in NASA procedures between risk management practices and containing mission cost seems worth careful reconsideration in the context of HPD missions. Dr. Fisher agreed to assemble background information on this topic for an upcoming meeting and to invite Mr. Christopher Scolese, NASA Chief Engineer, to discuss it. Dr. Title suggested that the subcommittee also hear from the Explorer Program management office at Goddard Space Flight Center (GSFC) about ways to manage program risks in the context of small to medium missions. In general, subcommittee members were concerned that risk-reduction policies and procedures appropriate for manned missions were being applied inappropriately to the smaller, unmanned spacecraft missions typical of HPD programs.

At Dr. Title's request, each member noted topics she or he would like to discuss at this meeting, at least to plan for more detailed investigation of them at future Heliophysics Subcommittee meetings. Among the topics suggested were the following:

- Mission cost growth and impact of policies and procedures intended to address risk and other issues
- Further discussion of the subcommittee's position on the R&A budget
- A vice-chair for the subcommittee (duties and role in supporting the chair)

- Fate of the Solar Probe mission concept, in the context of the HPD budget and other Division programs
- How will the subcommittee business be set, by top-down direction from NASA or at least in part from members' input on topics of concern?
- Role of the NASA Centers in the cost of HPD missions: are there options?
- Details of the trade space for evaluating shifts in the mission mix
- Role of universities in large missions and impact on training the next generation of heliophysics scientists
- Agenda development for subcommittee meetings, discussion of an agenda prior to each meeting, and sustaining focus on the agenda during the meeting
- The impact of launch cost growth on trade options in HPD programming, including the schedule of future Explorer AOs.

Dr. Title agreed with the suggestion to hold a teleconference prior to the next meeting to discuss a draft meeting agenda. A major agenda topic will be mission development and cost containment. Members commented further on aspects of this topic they wanted to include (see bullets above). In response to a question, Dr. Fisher described ways in which the Heliophysics Subcommittee could be helpful to the HPD. For the short term, knowing the members' reactions on issues such as R&A and the Explorer Program will be useful for program management decisions that arise and require a quick response. For the longer term, subcommittee findings and recommendations that seriously affect "ways of doing business" will be valuable, possibly including suggestions for "outside the box" alternatives on larger systemic issues. Dr. Title added that the charge to the subcommittee is to provide advice to the NASA Administrator on how the HPD should operate.

#### ***Discussion of Community Input to the NASA Science Plan***

Dr. Fisher opened the discussion of the NASA Science Plan with comments on the external and internal drivers and constraints on HPD programs. He discussed the implications for HPD of Presidential initiatives and directives, the National Space Policy (which is being revised at present), legislation, and dependencies on other NASA or partner organizations. The Exploration Initiative calls for NASA to produce a balanced program of research. With respect to legislation, this next revision of the NASA Science Plan is due to Congress by the end of December 2006. With respect to dependencies, Dr. Fisher thinks that NASA heliophysics spacecraft will be essential to providing the space weather monitoring and warnings needed for the next era of manned missions beyond the protection of the Earth's magnetosphere (beyond low Earth orbit). With each alteration in the budget profile, the Division has continued trying to remain consistent with the priorities set by the NAS/NRC decadal surveys, such as the SDO. At present, he does not see a feasible plan for pursuing the Solar Probe mission concept; the objectives of that mission will need to be addressed in a different way, perhaps with a European partner. With respect to partner agencies outside NASA, Dr. Fisher sees interest from the Air Force in space weather for its impacts on situational awareness, including earlier warnings of disturbances through "sentinel" observing spacecraft. Dr. Fisher concluded with a review of the rationale for the current set of missions in planning and development.

Dr. Barbara Giles, Executive Secretary of the Heliophysics Subcommittee, reviewed the outline for the SMD section of the NASA Science Plan and presented a proposed outline for the section on the Heliophysics Research Area. The process being used to create the SMD Science Plan is essentially the same as was used for the previous version. The roadmap document produced in 2005-2006 by the Heliophysics Strategic Roadmapping (SRM) Committee addresses sub-goal 3B in the 2006 NASA Strategic Plan. This roadmap document has been reviewed by the former Sun-Earth Connection Advisory Committee (SECAS), the Earth and Space Science Subcommittee,



the mission operations working groups (MOWGs) for HPD missions, and the NAS/NRC Space Studies Board. The total space available for the Heliophysics Research Area in the SMD Science Plan is about 20 pages, and the proposed outline is based on extracting, at a summary level, key themes, major points, and supporting data from the Heliophysics Roadmap. After Dr. Giles presented the schedule for delivering draft material for the SMD Science Plan, the subcommittee discussed how to provide its input prior to May 31, to fit with this schedule.

To explain where deviations from the Heliophysics Roadmap would be needed, Dr. Giles presented information on the impact of the recent budget changes on the pace of implementation of missions either in development or planned for the period covered by the roadmap. The members discussed with Dr. Giles, Dr. Fisher, and other HPD staff the implications of the budget for roadmap priorities and timing, including the prospects for additional funding to enable planning for the Solar Probe mission to proceed. The partnership with ESA for Solar Orbiter was also discussed. Dr. Edward Deluca and Dr. Daniel Winterhalter agreed to draft a statement on the Solar Probe mission for the subcommittee's review.

Dr. Todd Hoeksema, who had been a co-chair of the Heliophysics SRM Committee, reported on the roadmapping process and highlighted key themes and elements of the resulting roadmap document. The Heliophysics SRM Committee had emphasized the strategic importance of the Explorer Program to get results needed to achieve larger goals. In particular, Explorer missions can fill in the gaps in the Great Observatory of the Heliosphere and foster the health of the science community by providing competed opportunities for academic researchers. The Heliophysics Subcommittee and HPD staff discussed advantages and disadvantages of splitting the Explorer Program funding line into a competed line specific to heliophysics and a second line specific to astrophysics. The consensus was to pursue this topic further at the next meeting. Dr. Hoeksema completed his presentation, noting that the SRM committee had developed a set of "achievement boxes," each of which has a detailed requirements flow-down, to support the milestones for each of the three decades in the roadmap's planning horizon. These boxes were not included in the roadmap document, but they have been preserved. He suggested that these details could help the Heliophysics Subcommittee relate the delays resulting from budget changes to when the phased achievements in the roadmap would occur under revised plans. Dr. Hoeksema discussed with the other subcommittee members the relevance of the roadmap to the Exploration Initiative goals (see page 116 of the roadmap report) and the potential for combined missions with other SMD Divisions, such as a Mars Scout mission to study aeronomy of ionized upper atmospheres, which might be undertaken jointly with the Planetary Science Division.

The subcommittee discussed Dr. Janet Kozyra's draft replacement for the subcommittee's recommendation on R&A (first bullet of yesterday's slide on *Principal Recommendations*) and then discussed the need to address cost factors and potential cost controls and changes in policy and procedures for smaller unmanned spacecraft missions. Dr. Title asked the subcommittee to email him any additional issues and concerns to be included in the draft letter, which will be circulated for review by the full subcommittee. Dr. Title then adjourned the morning breakout session, and the subcommittee returned to the plenary session room.

### **Thursday Afternoon Subcommittee Breakout Session**

After reconvening in separate session at 1:00 p.m., Dr. Title asked the Heliophysics Subcommittee members to think about potential topics for short talks on heliophysics research that could be conducted on the Moon, for presentation at a fall 2006 NASA conference on lunar science, which Senator Harrison Schmidt had described during the plenary sessions. The members agreed to pass the request for topics and titles of such presentations to the science

community at the upcoming meetings of the Solar Physics Division of the American Astronomical Society (AAS) and at the Spring 2006 meeting of the American Geophysical Union (AGU). Suggestions for topic titles, accompanied by two or three sentences of description, should be sent to Dr. Giles.

The subcommittee discussed the presentation by Dr. Lennard Fisk, chair of the NAS/NRC Space Studies Board, on the Board's report, *An Assessment of Balance in NASA's Science Programs*. Dr. Nathan Schwadron suggested that the issue of sustaining U.S. competitiveness in science and engineering could be linked with the President's American Competitiveness Initiative (website: <http://www.ed.gov/about/inits/ed/competitiveness/index.html>). The members returned to discussing how risk and cost trades are made in NASA programs, projects, and missions. For insight on the issues involved, Dr. Fisher recommended a recent book by Diane Vaughan, *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA*. Next, the members discussed ways that HPD programs contribute to human space exploration, including protecting the safety of spacefarer's beyond Earth's magnetosphere and putting more observing spacecraft in the heliosphere to lessen the risks of human space travel and exploration. Dr. Title will draft a paragraph on this topic for the subcommittee's consideration. He asked members to send comments on how they see the role of a vice-chair for the subcommittee. After thanking the members for their participation and noting the value of the subcommittee's discussions during the past two days, Dr. Title adjourned the meeting at 2:00 p.m.

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**AGENDA**

Plenary sessions are in roman face; subcommittee breakout sessions are in *italics*.

**May 3, 2006**

8:00–8:30 am	Welcome and Advisory Committee Structure	H. Schmitt
8:30–8:45 am	Agenda and Meeting Plan	M. Allen
8:45–9:45 am	SMD Status and FY06/07 Budget Overview	M. Cleave
9:45–10:00 am	Break	
10:00–11:00	Conversation with the Administrator	M. Griffin
11:00 am–12:00 pm	Ethics and FACA Briefings	D. Rausch A. Falcon
12:00–1:00 pm	Working Lunch	
1:00–1:45 pm	Science AOs and Grants	P. Hertz
1:45–2:00 pm	Plan for the Afternoon Breakout Sessions	M. Allen
2:00–5:00 pm	<i>Breakout: Discussion on R&amp;A and Program Mix</i>	<i>Division Directors</i>
5:00–6:00 pm	<i>Subcommittee Reports and Plenary Discussion</i>	<i>Subcommittee Chairs</i>
Evening	Subcommittees Working Dinner	

**May 4**

8:00–8:30 am	Public Comment Period	
8:30–9:00 am	Science Plan Overview and Plan for Breakout Sessions	G. Williams
9:00 am–12:00 pm	Breakout: Roadmaps and Community Input to NASA Science Plan	Division Directors
12:00–1:00 pm	Working Lunch	
1:00–2:30 pm	Subcommittee Reports, Discussion, and Next Steps	Subcommittee Chairs
2:30 pm	Adjourn	

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**SUBCOMMITTEE MEETING PARTICIPANTS**

Title, Alan, <i>Chair</i>	Lockheed Martin
Clemmons, James	Aerospace Corporation
Deluca, Edward	Harvard-Smithsonian Center for Astrophysics
Gibson, Sarah	NCAR High Altitude Observatory
Giles, Barbara, <i>Executive Secretary</i>	NASA Headquarters
Hoeksema, Todd	Stanford University
Kozyra, Janet	University of Michigan
Lin, Robert	University of California, Berkeley
Russell, James, III	Hampton University
Schwadron, Nathan	Boston University
Suess, Steven	NASA Marshall Space Flight Center
Torbert, Roy	University of New Hampshire
Walker, Raymond	Univ. of California Los Angeles
Winterhalter, Daniel	NASA Jet Propulsion Laboratory

Committee member David S McKay was not able to attend this meeting

**PRESENTATION MATERIALS**

**Presentation Slides**

1. Alan Title, Heliophysics Subcommittee Chair. *Guidelines for Constructing a NASA Science Plan for Heliophysics*.
2. Richard Fisher, Heliophysics Division Director, Science Mission Directorate, NASA. *R&A/Program Mix Break-Out: Heliophysics Subcommittee*. May 3, 2006.
3. Charles Gay, Heliophysics Division Deputy Director, Science Mission Directorate, NASA. *Heliophysics Division Program Status*.
4. NASA SMD staff. *Roadmaps and Community Input to NASA Science Plan: Heliophysics Subcommittee*.