

**NASA Advisory Council Science Subcommittees Meeting**  
**University of Maryland Conference Center**  
**College Park, MD**  
**May 3-4, 2006**

**Meeting Minutes**

**Welcome and Advisory Committee Structure**

The Hon. Harrison Schmitt, Chair of the NASA Advisory Council (NAC) welcomed participants to the meeting, noting the NAC's restructuring under the direction of NASA Administrator Michael Griffin. This change has brought the subcommittees closer together and has altered the total structure of the NAC. Changes are still under way in terms of understanding the network. It had been determined that there was an excessive number of advisory groups in the past, and the present effort is to resolve redundancies in function. Dr. Schmitt welcomed thoughts about the future for subcommittee workings and thanked Associate Administrator of the Science Mission Directorate (SMD), Dr. Mary Cleave, for her assistance in organizing the conference.

The NAC provides independent advice, for the Administrator, for carrying out the Administration's policies and interests. The five major Committees subtended by the NAC are the Aeronautics, Finance, Exploration, Human Capital, and Science. An ad hoc Biomedical Subcommittee has been temporarily convened in an effort to understand long-term issues impacting space flight health. Partnership development and worldwide collaboration will be sought for this issue. Planetary Protection is not represented at this conference, but will be an integral part of activities.

Participants at the conference were expected to get acquainted with the new establishment and to prepare for increasing interaction; select vice chairs for subcommittees; trade contact information; and provide guidance to SMD on Research and Analysis (R&A) and the program mix in view of subsequent budgetary planning. In addition, participants were asked to organize subgroups, determine availability for an upcoming joint meeting in July (tentative dates: July 6 and 7), and review terms of reference (TOR). The July joint meeting will also assist in planning a Fall 2006 Lunar Science Workshop. Lunar-based science, lunar science, and exploration were to be the three main topics of the Workshop. Spacecraft design, the Decadal Surveys, and other strategic inputs will be considered, as well as science objectives and priorities, construction of Broad Agency Announcements (BAAs), broad constraints governing the Exploration Systems Mission Directorate (ESMD), and an architecture for lunar exploration. The Workshop was regarded, in terms of historical importance, as comparable to the Woods Hole conference of 1965 that initiated the Apollo science program.

A return to the Moon will necessitate redevelopment of a deep space operational infrastructure and discipline. NASA must define the distribution of potential lunar resources, perform testing for future Mars exploration, answer major questions about

lunar exploration, lunar-based science, and lunar science. Lunar science has yet to explore the Giant Impact hypothesis, the ages of large basins, the Impact Cataclysm hypothesis, the calibration of Hadean (pre-Cambrian period) impact history, internal structure of the Moon, global sampling, polar cometary volatiles, *in situ* concentration of resources, Mars sampling strategies, and lunar instrumentation networks. Lunar-based science is rich and can include heliophysics with lunar-based instruments such as solar wind composition and determination of regolith and ejecta blanket stratigraphy. Astrophysics observatories, lunar environmental characteristics, parameters for construction, seismic activity, protection of critical systems, thermal cycling, vacuum, radiation are other areas ripe for consideration. The Earth Sciences community can also evaluate this opportunity for multi-sensor, multispectral observations and educational initiatives. Planetary protection strategies, as well as microbial and molecular viability, can be tested in the Moon's extreme environment, particularly in preparation for Mars exploration.

ESMD is currently considering examples of lunar architecture constraints: site selection, payload envelope, exploration enhancement (better spacesuits), mobility enhancement, site selection, pinpoint landing capabilities, and future location of permanent bases. The payload envelope (mass, stowage, power, crew training and skills) and exploration parameters (stay-time, capability of suits/gloves, crew experience and training, robotics integration, work cycles, dust vs. habitat issues) are also issues under debate and development. Dr. Schmitt felt that it was possible to design around dust and did not expect it to be a major engineering issue. The dust issue had been solved in the Apollo program for the lunar rover. Long-term adaptation to a low-gravity environment must be determined. The degree of desired mobility must be determined and must take into account the presence of dust, rover consumables, analytical systems, radiation protection (primarily solar events), lunar flyers for remote sampling activities, and future Mars Rover tests.

Why return to the Moon? The philosophical answer is to satisfy basic curiosity and to continue 150,000 years of human exploration and expansion. The effort will yield new homes, new resources, and new knowledge, and is supported by both the government and private enterprises. A return to the Moon will perpetuate exploration and settlement of space, and offer opportunity for advancement of free institutions. Dr. Schmitt encouraged the SMD to move forward on this initiative.

### **Agenda and Meeting Plan**

Dr. Marc Allen, SMD Director for Policy and Strategic Planning introduced himself and extended his gratitude to committee members for attending the conference on short notice. He noted that the appointment process is not yet complete, and rosters were to be finished as soon as possible. He shared a concern about meeting topics. There is no question that the NASA Science program is a national asset; it has produced missions of high scientific value such as the Hubble Space Telescope, the Cassini-Huygens Saturn/Titan mission, Mars Rovers, and TRACE. The program has been a model of cooperative activity between governmental and nongovernmental entities. However, there are severe budget constraints in Fiscal Year (FY) 07, and thus the subcommittees

need to restart the conversation about the contents of program. The two broad goals of the conference were to exchange information and to make specific recommendations about the mix of activities and assembly of a Science Plan. Dr. Allen reviewed the agenda and reminded participants that the meeting would be conducted in accordance with the Federal Advisory Committee Act (FACA). Minutes of the conference will be available on the SMD website and the NAC website. Dr. Allen introduced Greg Williams, Lisa May and Marian Norris as individuals to consult for organizational questions.

### **Ethics and FACA Briefings**

Mr. Adam Greenstone, Office of the General Counsel, presented the particulars of the FACA rules. It is important to note that when a government entity is changing a national vision, opponents will fight that action by chipping away at ethical improprieties, thereby endangering the process. Special Government Employees (SGEs) acting under FACA rules are considered employees of U.S. government. This is legally important because most SGEs are coming from significant endeavors outside the government. An SGE must not exceed 130 days of service in a 365-day period. One hour of SGE activity on any one day counts as one day of service. Mr. Greenstone reviewed basic ethics principles, emphasizing that public service is considered a public trust, requiring absolute integrity. An SGE cannot have conflicting financial or professional interests, and this includes imputed interest. An SGE cannot use nonpublic information for personal use. An SGE is equivalent to an insider, and thus must avoid even the appearance of impropriety or impartiality. SGEs are also subject to post-employment restrictions. Mr. Greenstone outlined 18 U.S.C § 203 and 18 U.S.C § 205 prohibiting representational activities before the Government. Particular restrictions regarding an SGE serving fewer than 60 days in 365 were detailed. Mr. Greenstone invited members to consult General Counsel staff on any activities that may cause concern. To illustrate 18 U.S.C § 208, Mr. Greenstone cited a well-known case involving Boeing Corporation and the DoD, in which Pentagon employee Darlene Druyun violated the statute prohibiting involvement in a particular matter in which the SGE, SGE spouse or dependent child has a financial interest.

Most subcommittee members will be involved with high-level discussions on programmatic and contractual issues. Members must look for guidance for possible recusal during such discussions. If a request for proposal (RFP), for example, concerns financial considerations, within the constraints stated by the statute, a member must recuse himself or herself. Discussing a particular solicitation becomes a particular matter. Procedural decisions such as discussing instruments to be included in a mission, or talking philosophically and policy-wise, are not restricted. As a per se matter, recusal is not necessary in budgetary discussions. However, a level of specificity could cause members step over the line. For example, if a grantee in a particular program is involved in a discussion of elimination of that program, recusal might become necessary. Proposal writing is generally permissible.

Post-employment and gift restriction rules were detailed, with exceptions noted. Participants were invited to consult with the ethics team via e-mail ([ethicsteam@hq.nasa.gov](mailto:ethicsteam@hq.nasa.gov)) for any concerns. All e-mailed questions are logged and considered. Dr. Schmitt offered some further advice for principal investigators who also

functioned as SGEs: There is no general problem with a generally advisory discussion on priorities, as it does not directly affect a decision regarding a specific program. These are strategic vs. “binary” decisions. Dr. Allen agreed that by and large, subcommittee discussions would avoid these pitfalls. However, if one discusses “zeroing out” a program, one should recuse oneself if one has a particular interest in the program.

Ms. Diane Rausch continued with a discussion of the FACA rules, identifying herself as a single-person point-of-contact (POC) for compliance. Advisory committees date back to the Whiskey Rebellion. Today there are 1000 Federal advisory committees advising the Executive Branch, with 60,000 members. The FACA law was passed in 1972 in recognition of the importance of this activity. The law constitutes a useful way to track all the advice that has been given in this context. NASA has 5 FACA-chartered advisory committees: the NAC, Aerospace Safety Advisory Panel (ASAP), International Space Station Advisory Committee (ISSAC), ISS Independent Safety Task Force (ISSISTF) and PNTAB (Positioning Navigating and Timing Advisory Board)

A FACA-ruled advisory committee must provide relevant, important, objective advice, and is open to the public. Any committee automatically terminates after 2 years and must be officially re-started. Record-keeping is extremely important to the process. Each meeting must be conducted under the auspices of “good government” tradition. Each committee is discretionary and must act promptly to complete work and in consensus. The deliberative process is the trigger that makes a matter a FACA matter. Key FACA regulations were briefly reviewed, citing also the NASA Policy Directive, which directs NASA subcommittees to be compliant with FACA, and describing NASA advisory committees as solely advisory. The general requirements of a FACA committee are to file a charter with Congress, provide terms of reference, maintain a balanced membership, hold public meetings, provide points of view only, provide minutes and summaries, maintain public files of written statements, announce all meetings in the Federal Register, and maintain all committee documents for public inspection. An open mike session for public commentary was highly recommended.

The goals of public meetings are to reduce inappropriate influence on government, eliminate closed-door meetings, and to allow the public timely access to the decision process. The meetings must be user-friendly and have everything planned out with sufficient advance notice. Closed meetings are possible under restricted conditions, such as those involving national security, trade secrets/intellectual property, personnel issues, Privacy Act material, or criminal investigations. Such meetings may take place under the “Government in Sunshine” Act, but must be documented and announced 30 days in advance. The bar is high but allowable. A non-FACA meeting would be a purely administrative session on the subject of membership, schedule, operating principles, preparation, or fact-finding. Other examples are site-visit, research, and information-gathering meetings. A non-FACA meeting determination memo would be required, signed by the Designated Federal Official, Agency Committee Management Office, and Office of General Counsel. Ms. Rausch invited members to contact her with any questions.

### **Conversation with the Administrator**

NASA Administrator Michael Griffin addressed the plenary session. Dr. Griffin explained that he and Dr. Cleave had convened this conference in response to widespread community reaction to the recent budgetary choices that had been made in the SMD line. Reconsideration of the line should take place in an official manner, and the level of discontent with the FY07 budget for SMD was impressive. Representation from all the science interests at NASA, and not just the loudest voice, should ideally inform any revisit. Dr. Griffin reiterated his deep support for SMD and expressed consternation that communications to the Administrator's office had indicated discontent with Dr. Cleave, as AA of SMD, for the budget decisions. These budget decisions emanate not from Dr. Cleave's direction, but from the Administrator's. Dr. Griffin reminded participants that it was his job to sort out the issues. He invited participants to pose any questions and to spare discussion of the larger strategy for the time being.

Dr. Neil Tyson posed his question in the context of Headquarters' (HQ's) best intentions in constructing the budget, asking how decisions were made in the first place. Dr. Griffin replied that HQ's intention had been to preserve and protect funds allocated to SMD, but that ultimately, commitments made in advance of these decisions could not be kept. He conceded that the substance of these decisions had not been communicated well. Dr. Griffin regretted not communicating this reasoning in sufficiently explicit terms. The rationale had been that SMD would receive a pro rata change as related to the Agency as a whole, which had been projected as 6-7%, with SMD at an historic high and sharing in NASA's fortunes. Ultimately, NASA was not able to give SMD a pro rata share of the increase because the President had affirmed that NASA would keep its commitment to complete ISS and retire the Shuttle. The ISS commitment has been codified in written policy. However, the budget did not properly account for this commitment and came up \$5.7B short. The Shuttle program is very costly and its primary expense is many thousands of people. NASA can't identify sufficient cuts without compromising safety. The bottom line is that the Shuttle runout was underfunded. Further cuts have diminished the budget shortfall to \$4B; the remaining money was taken from Science and Exploration, and by delaying the Crew Exploration Vehicle (CEV) as long as legally possible. At the end of the day, NASA had to remove about \$3B from SMD. The Agency must make intelligent decisions about budgetary realities.

Dr. David Spergel asked for a definition of the process for identifying new science and how will it be evaluated. Dr. Griffin replied that for reasons apart from scientifically based ones, the U.S. has decided to revector the space program and is returning to the Moon. Thus, it is up to the science community to identify what subspecialty can be explored in this context. Dr. Griffin expected to hear input from the committees and subcommittees, a Science Plan, and a statement of the science community's priorities. This iterative process will help to converge upon a useful science objective for the Moon. The community must, however, consider the Administration's policy. The National Academy of Sciences (NAS), the Space Studies Board (SSB), the NAC, and the science subcommittees will help set these priorities. Dr. Schmitt interjected that he had addressed this point earlier, concurring with the description of the process as congruent with his presentation. The science subcommittees are advising ESMD, not just SMD; it is a

broader committee structure than previously realized. Dr. Griffin heartily agreed with the value of the new structure extending its reach. NASA's strengths and fiscal realities will inform this process as well, with the NAC trying to expand its breadth and depth of coverage with informative advice.

Dr. Woo-jun Pak commented that, given the decision by the President, the community is doing its best. He asked if there were anything the science community could do to reverse or change the directive of the President. Dr. Griffin answered that this was not possible, reiterating that the U.S. was not returning to the Moon to do science, and quoting Jack Marburger: "We seek to bring the Solar System within the sphere of influence of mankind." This is the plan until Congress passes another act. Science will be done as the budget permits. NASA must be able to perform a multitude of activities in a way that respects the U.S.'s position as a great nation in possession of a leading space program.

A participant asked why NASA was manufacturing science goals. Dr. Griffin asserted that he would not allow manufactured science goals to be pursued. Lunar science and SMD funds will be clearly segregated, while accomplishing the directive of the President. NASA does not intend to put words in the mouth of the science community. It is up to the science community to choose areas in which to participate.

Dr. Jim Head expressed concern regarding the delayed CEV schedule, which was creating complications. Dr. Griffin replied that the program is realistic after 2010. The difficulty is spinning up a replacement capability while retiring the Shuttle and completing ISS. It is hard not to damage other programs in the process. Delay is not good, but the fact remains that this cannot change.

A participant commented that scientists are wrestling with how they can operate and help ameliorate concerns: looking beyond FY07, how can subcommittees help beyond this particular meeting? Dr. Griffin replied that early relevant input on FY06 modifications/operating plans would be helpful, as well as input on the follow-on to FY07, and early planning on the FY08 budget. On an embargoed basis, there will be ample opportunity for the subcommittees to comment on those plans.

Dr. Bernard Minster asked to what extent the budget could be mitigated by expanding partnerships with other agencies. Dr. Griffin averred that much of what NASA does is in concert with other countries and that a continuation of such activities was desirable.

A participant asked the Administrator to comment on whether 100% of the Shuttle manifest was needed for ISS. Dr. Griffin replied that while the trade space was very small, the Shuttle was risky and expensive, and the schedule was full, he would not refuse to consider an integrated payload that could be made to fit.

Dr. Alan Dressler commented that the community had not had the opportunity to comment on HST and the James Webb Space Telescope, and might have offered a valuable assessment. It was a lesson about engaging the community in the process of setting its own priorities. Dr. Griffin commented that he would not have resurrected a

Hubble mission without community input, but a law appropriating money for Hubble is driving NASA's budget. The loudest voices overcame the process.

A participant asked about the possible impact of another SMD instability, and how committees might behave proactively to prevent such an event. Dr. Griffin replied that NASA would use the Shuttle to complete ISS, grow SMD at a 1% growth rate, and allocate to CEV whatever is left. By definition, the CEV can't overrun. Associate Administrator for Space Operations, William Gerstenmaier, had started budgeting with reserves in programmatic planning as suggested by Tom Young (on the order of 25%). ISS was also budgeted with appropriate reserves. All Exploration planning has been budgeted with this same philosophy. This does not guarantee against overruns, but it "moves the needle." Historically, it has been shown that programs overrun by an average of 30%. NASA's Office of Program Analysis and Evaluation (PA&E) is working on this problem and trying to bring better management practices to the organization. Dr. Griffin believed this was a better approach that must be sustained by stakeholders

A participant asked about the possible influence of an upcoming National Academy of Sciences (NAS) report. Dr. Griffin noted that the NAC advice is limited to the prospective budget, but the President makes the decision. Despite personal opinion, this directive must be carried out. The NAS can make whatever inputs they like, but the inputs may not be reconcilable. As a presidential appointee, the Administrator must live with Administration decisions or resign. Thus far, he had not encountered a decision that would force him to resign.

In response to a question, Dr. Griffin commented that he would not consider transferring requirements to the Department of Energy or to the National Science Foundation.

In response to a question about the parameters of the lunar science budget, Dr. Griffin suggested that the robotics program in ESMD might afford good opportunities for good science. If the science is not defensible, NASA won't do it. Other areas are advanced power systems and *in situ* resource utilization (ISRU). This is all ESMD money. The SMD science portfolio could choose to take advantage of science opportunities in this context. The science community would be well advised to take up opportunities where they are available.

A participant commented that ESMD seems to lean toward low-Earth orbit endeavors, and asked if it were possible to take a fresh look at ISS as it fits into long-term goals. Dr. Griffin replied that one advantage to finishing ISS is the availability of ongoing science. With respect to Exploration, there is no true expertise yet on living and working in space. ISS is part of the learning experience, and NASA will take advantage of it to understand the effects of long-term space flight, mitigation strategies, and hardware development. ISS must be better utilized. Dr. Schmitt offered a follow-up observation, noting that the Ad Hoc Biomedical Committee is aiming to understand the ISS as a biomedical facility. The committee may inherit another role with regard to ISS.

## **SMD Overview**

Dr. Mary Cleave, Associate Administrator (AA) of the Science Mission Directorate, presented recent highlights of the SMD, including WMAP's glimpse of the beginning of the Universe, TRMM data, the New Horizons launch to Pluto, and Stardust's successful sample return. With the integration of Earth Science back into the SMD purview, the breadth of the program has increased. CALIPSO has launched and has joined the "A Train." She described some organizational changes: there is now a Deputy AA for Programs, a Chief Engineer, a Chief Scientist, and a Deputy AA for Technology. These officials oversee the Management and Policy, Heliophysics, Earth Science, Astrophysics, and Planetary Sciences Divisions. Numerous programs reside within each division. The directorate must address the best mix within each division, maintaining a proper balance of small, medium and large missions, and help foresee needs for FY07 and beyond. Input from the community is needed for compilation of a Science Plan. Dr. Cleave displayed high-level budget graphics, illustrating the aforementioned 1% growth rate. Heliophysics and Earth are together in FY07 but will be split in FY08. A comparison budget was displayed and a strategy for budget adjustments was solicited. There is a de facto \$3.1B decrease from the FY06 budget runout. Dr. Cleave expressed her desire to redress complaints, while simultaneously noting that there was not a lot of maneuvering room. SMD wants an executable program based on the advice of the NAC

Numerous questions arose concerning shortfalls and manpower, and Dr. Cleave asked participants to look to Dr. Paul Hertz for some guidance in this area. The Earth Science Decadal Survey was suggested as a point of departure for some strategic advice, but its poor timing relative to the budget was lamented. Advice on program management streamlining was welcomed. A question on relative budget inequities between divisions was deferred with an observation on ongoing rebalancing. A participant noticed that astrophysics gets a 12% dip and another program gets a 12% increase. Dr. Cleave noted that any monetary redistributions would stay within the division. A participant observed that the WISE 2009 launch budget had been cut substantially, and in response, Dr. Cleave welcomed guidance on WISE pending the results of the meeting. She added that the Stratospheric Observatory for Infrared Astronomy (SOFIA) had been zeroed out because SMD was trying to protect good programs. The funding issues are being carefully reviewed. SOFIA could possibly be split between NSF and NASA; the Agency is doing its best to collaborate, but other agencies have the same budget problems as NASA. An interagency collaboration is not the purview of the subcommittees. Questions about launch delays and budget overruns were deflected to breakout session discussions. Questions regarding new processes for instrument development were assigned to Chief Engineer Chris Scolese, and PA&E. In response to cost growth comments, Dr. Cleave averred that NASA was looking for better cost input to the Decadal Survey development; this was being worked internally and externally with the NAS, and ideas were welcome.

Dr. Bob Lin of UC Berkeley commented that new NASA rules have increased costs for missions tremendously; different projects can benefit from different types of management. Dr. Cleave agreed that this could be discussed. In response to the U.S. posture on science education, OSTP was suggested as an objective assessment body. Dr. Spergel inquired about the current arrangement with DOE on JDEM, which was

subsequently described as in process. An internal interim report on SOFIA is due shortly. A participant commented that NASA business practices should not be jeopardized by the OneNASA policy; NASA needs to be less risk-averse. In response to a suggestion for capping “Holy Grail” missions, Dr. Cleave replied that these were capped during the development phase and added that, as a former astronaut, she understood the risks inherent in these endeavors

#### **Follow-up statements on FACA Briefing**

Dr. Allen offered a further perspective on the Ethics briefing and stated that conflict of interest is speculative when a program is in development. However, in existing programs, parties to grants and contracts in those programs must recuse themselves from discussions of those programs. Mr. Greenstone generally agreed with this assessment in avoiding particular matters, such as a discussion about the disposition of a specific contract. A discussion about animal vs. human research would not be considered a particular matter, however, allocation discussions would be considered a particular matter. If a solicitation is on the drawing board, it does not constitute a particular matter. If a solicitation exists, the Agency should consider obtaining advice through a BAA. Dr. Schmitt called for an action to make the matter more crisp for the next day’s assembly. Dr. Hertz added that the executive secretaries provide first-line ethics information for each subcommittee.

#### **Chief Scientist Presentation- SMD Research Program**

Dr. Paul Hertz, Chief Scientist of the Science Mission Directorate, offered a discussion of the contents of the research program. The most important message is that research is part every budget line. The 15% cut is only in the R&A line and is relative to desired growth, not the actual budget. Research is enabled by mission lines and their development teams. Top-level principles of research are decisions based on scientific merit, data availability, peer review, community participation, and maintenance of NASA capabilities. One vehicle for participation is the Announcement of Opportunity (AO), which is used to solicit flight investigations. PI-led missions are based on proposals from the science community, averaging 2 launches per year over the last 20 years, and this schedule is expected to continue. Discovery and Explorer program budgets and contents were briefly discussed. The Earth System Science Pathfinder (\$120M per year), Mars Scout (AO released on May 1- \$475M proposal cap), and New Frontiers programs were briefly reviewed. The next Explorer AO will be no earlier than FY08. The Explorer budget, shown in both Heliophysics and Astrophysics, is spread over different line items. The Astrophysics and Heliophysics subcommittees might do well to discuss Explorer together.

NASA Research Announcements (NRAs) were presented. This primarily consists of the Research Opportunities in Space and Earth Sciences (ROSES) NRA, which has more than 50 program elements thus far. ROSES-2006 is offering \$150M in new awards, down from \$180M last year. The research budget is distributed throughout every program, and the bookkeeping is done in different ways in each division. Research is also a “program line” in the NASA budget, covering mission operations, data analysis, etc. Development and operation of flagship missions was presented: significant community funding is

associated with large missions, such as the Hubble Space Telescope and Earth Observing Systems. An aggregated budget was presented, excluding flight hardware programs and mission extensions that have not been subjected to Senior Review, and development (missions, instruments). There is no SMD top-down instruction on how each division is to structure their R&A programs. The total is over \$1B per year.

Science will be enabled by Exploration. Near-term plans include robotic lunar exploration. In the next decade, this will include human sorties to the Moon, followed by long-term and extended human missions to the Moon and to Mars. SMD will fund the most compelling and highest priority science, taking advantage of opportunities within the scope of the existing science program. SMD is asking the SSB to create a study on science objectives for the long-term lunar presence and is planning to solicit concept studies for science investigations for early sorties. The result will be community-based feedback. The draft solicitation is ready to go. Reasons to delay would be the lack of SSB study's input.

In response to a question, Dr. Hertz asserted that ESMD is funding the robotic science only. An ESMD representative clarified this point, explaining that the ESMD budget is covering the measurements necessary to return to the Moon and that science can be derived from these measurement activities. The support is for the exploration components required by ESMD. SMD must determine what that science must be.

#### **Follow-up Questions for the Administrator**

Dr. Griffin entertained further questions from those assembled. A participant commented that increased scrutiny on reliability issues seems to make no sense and asked if these rules could be relaxed for science missions. Dr. Griffin replied that NASA is "oversafetied" by a huge amount on process. The illusion persists that more people on a task is better. NASA has convened a group on Safety and Mission Assurance with AA Bryan O'Connor and will make modifications. Even for small missions, it is not acceptable to lose one. Dr. Griffin expressed irritation at the status quo and at not getting the product NASA needs in this risk-averse atmosphere. However, failure is always a big deal, and NASA winds up in front of Congress. Risk must be considered as a public issue.

A participant observed that the public's great interest in Hubble was encouraging, and NASA should not take it lightly. Dr. Griffin agreed that the people who pay for the program must love it and be excited by it. The public is interested in the frontier for its Space program and continues to be excited by the Mars Rover activity. The public constitutes NASA's stakeholders. NASA is trying to restore this excitement in the manned program without hurting science. A participant noted that the planetary science community is excited to give NAC its input and asked if there were another way to offer commentary. Dr. Schmitt replied that the NAC structure is looking at which subcommittees may be useful; there should be no artificial restrictions to communicating with the NAC. NAC would welcome papers and letters from the subcommittees; it should be as open a process as possible. Dr. Griffin added as a post-script that some of the discontent may stem from a mistake, which was rapidly disbanding subcommittees before

the NAC was completely reconstructed. He apologized for perhaps doing these things in the wrong order.

### **Breakout Sessions**

The four subcommittees convened individual breakout sessions to determine initial guiding principles, recommendations on appropriate programmatic balance, and pressing issues and concerns. The subcommittees reconvened and reported on results:

### **Plenary Session- Recap of breakout sessions**

#### *Heliophysics*

##### **Guiding principles-**

- ∞ Discover and communicate science knowledge, while supporting the President's Vision
- ∞ Undertake high priority space investigations.

##### **Program mix-**

- ∞ The amount of money in R&A appears roughly appropriate at this time, pending further details of the budget breakout.
- ∞ The health of the R&A program is tied to the health of the Heliophysics division; the division must eliminate overruns.
- ∞ Costs of large missions should be restricted to \$750M
- ∞ There should be two to three small missions, and one major mission per 15 years, per subdiscipline, including international agencies.

##### **Issues and Concerns-**

- ∞ Short-term disruption to R&A
- ∞ There are not enough smaller missions
- ∞ Procedures will not allow development of small missions at sufficiently low cost.

#### *Planetary Science*

##### **Guiding principles-**

- ∞ The R&A program for the Planetary Science division is larger and more involved with long-term planning, thus more important
- ∞ Prudent, targeted near-term investment in technology is critical to the success of future high-priority missions
- ∞ Effective exploration of the solar system demands a mix of small, medium and large missions.

##### **Program mix-**

- ∞ Cuts to R&A risk major research areas and recruitment for future scientists. R&A should be at least partially restored.
- ∞ Funds should be sought in the reduction of overhead or in delays for future PI-led mission opportunities.
- ∞ For outyears, cost caps should be revisited compared to the size of the R&A line, despite the fact that this does not help the FY07 budget.

### **Issues and concerns-**

- ∞ The subcommittee cannot give serious recommendations on the program mix without the presence of proper expertise, which had been absented in discussion by conflict of interest
- ∞ What is the definition of “corporate” in the budget tables?
- ∞ Should Mars missions be evaluated against non-Mars, planetary science missions?
- ∞ The conflict of interest was more an issue of timing; once the competitions are over, they will disappear.

## *Earth Science*

### **Guiding principles-**

- ∞ Earth Science has a responsibility to exploration and discovery and to addressing societal issues crucial to the future of mankind
- ∞ Understanding variability of Earth systems requires long-term continuity of highly accurate measurements.
- ∞ NASA has important links with NOAA, EPA, USGS, NSF, and must have efficient collaboration with these agencies
- ∞ Maintenance of brain power is critical to U.S. competitiveness
- ∞ NASA is unique in providing open access to data.

### **Program mix-**

- ∞ Make an effort to restore R&A funding and fence future funds
- ∞ Presently planned missions should not be descoped or delayed
- ∞ Extend successful missions beyond design lifetime.

### **Issues and concerns-**

- ∞ Budget cuts are causing serious harm to Earth Science efforts at NASA
- ∞ NASA needs to improve partnerships with other agencies
- ∞ Improve efficiency in costing and building satellites
- ∞ Rate of development of technology is inadequate for enabling scientific innovation and decreasing hardware costs.

## *Astrophysics*

### **Guiding principles-**

- ∞ Decadal Survey and NAS reports
- ∞ Prepare for the future (students, technology)
- ∞ Maintain intellectual diversity
- ∞ Maintain balance between small, medium and large missions
- ∞ Maintain balance among lines in Decadal Survey
- ∞ Utilize concept of “science per dollar”
- ∞ Complete and launch healthy missions in development and operating budget.

### **Program mix-**

- ∞ Maintain healthy R&A

- ∞ Provide technology development
- ∞ Restore Explorer

### **Issues and concerns-**

- ∞ Short-term solutions to FY06 problems, and long-term solutions, should be sought
- ∞ Astrophysics is facing a 25% cut in real dollars over the next 5 years, forcing the agency to reduce 10 operating missions to one or two.

**May 4, 2006**

### **Morning remarks**

Dr. Schmitt expressed appreciation for the attendees' attention to the subject at hand, and encouraged participants to plan for the July meeting. Dr. Allen made some administrative remarks.

### **Public Commentary**

Thirty minutes were allotted for the submission of public comments regarding the complexion of the science program at NASA. Each speaker was permitted three minutes for comment.

#### ***Peter Eisenhardt/Jet Propulsion Laboratory***

The mix needs to be shifted toward smaller missions, strongly favoring a human exploration program. Both of these activities spring from a deep need in our species. Frequent rapid access to space via small missions should be pursued, based on best science. The TRACE and WMAP missions are good examples of such missions, with WISE in line to continue the tradition. WISE has completed and passed all its reviews, and yet has not been confirmed. There seems to be a larger pattern apparent, as other small, well-performing missions have been cancelled. It has been removed from the Explorer program, despite its great value in fostering talented people and providing exciting science. SMD needs a deeper and broader appreciation for the universe.

#### ***William Bottke/Southwest Research Institute***

Mr. Bottke represented the opinions of the Division for Planetary Science, representing 1200 planetary scientists. Solar System exploration is one of NASA's crown jewels and is threatened by the cuts in R&A. The substantial investment in Exploration is also hurting data analysis. Cassini and MRO will continue to collect more high quality data, yet funding for analysis remains too low. The same is true for other successful missions. Withdrawing support for R&A imperils this great history. NASA is urged to heed the advice of the Decadal Survey regarding planetary science. Rebalance the mix. The current plan is tourism, not science.

#### ***James Klimchuk/Solar Physics Division/AAS***

Mr. Klimchuk was a Naval Research Laboratory employee and Chair of the Solar Physics Division. His opinions represented the consensus of the Solar Physics community. The main message is that R&A and Explorer are critical to the Solar Physics program. R&A provides a training ground for future scientists, a source of new ideas, but primarily

enables the programs to do great science in real time, earning the best return on investment. Ensure the long term health of the program by getting control of cost growth in major missions. Fix short-term problems. In the case of Explorer, the budget has been cut in half, and the community worries that it will never return to a healthy funding level. For R&A, the picture is confusing. Heliophysics was levelly funded, but other graphs have shown a decline. What is the real story? How much money is really available across the portfolio in FY05-7? Once this is identified, fix the current shortfall. Have a consistent accounting system.

***Glenn Mason/APL***

Dr. Mason is a Professor Emeritus at the University of Maryland, and a heliophysicist who has worked on such missions as ACE, STEREO and SAMPEX. The FY07 program does not get the mission mix right, and the R&A concern is well founded. R&A is the most efficiently spent money in NASA; fiercely and frequently competed. It makes no sense to cut R&A as it has been a very successful program, returning good science. In the 1990s, the Explorer program had a call for missions every year. The line is being shut down, but it is needed because it is an important tactical part of intellectual strategy. There is synergy, for instance, between the Gamma Ray Observatory and the SWIFT mission. Voyager and Ixion is another example. It is not just a sop for small groups and is critical for future leaders in the field. These missions are implementable at relatively low cost and higher risk; more bang for the buck. NASA needs to understand imaginary boundary conditions (conflicts). Science should not suffer disproportionate cuts.

***Cole Miller/University of Maryland***

Dr. Miller cited the valuable results of a recent gravitational wave project, and made the case for LISA as a vehicle for studying black hole/black hole mergers, which would constitute a robust test of General Relativity. This is a key question for cosmology- how did structure first form in the universe? LISA will be examining these epochs and will prove to be a unique probe of this crucial time in the universe. LISA is creative and has profound potential, deserves full support.

***William Smith/AURA, Inc.***

Mr. Smith represented the opinion of AURA, the managing organization for the Hubble Space Telescope and the James Webb Space Telescope. AURA does not support deferral or cancellation of Flagship missions to save other missions. They are an important part of the mix, provide a tremendous support for the community, providing many millions in grants. They are very important and would be sorely missed. The discussion has been healthy but is in an early stage of the process, and will evolve over the next 6 months. Congress has yet to act. Roughly \$180M will be necessary to restore R&A and small missions; this is within the realm of possibility. Mr. Smith urged the community to make a consensus statement on the matter.

***James Green/University of Colorado***

Dr. Green introduced himself as a Principal Investigator for the Cosmic Origins Spectrometer for the SM-4 mission. He urged the community to defend large missions, the Great Observatories, and particularly the Hubble Space Telescope. Large missions

produce great science and engender great public support. The return justifies the expensive cost. The community must stand by these large missions and help NASA. There is a perception that SM-4 is a burden to the astronomical community; the marginal cost of its completion is comparable to an Explorer mission. Launching SM-4 sooner would help reduce cost overruns. The community should restate support for HST and JWST.

***Dennis Ebbets/Ball Aerospace***

Mr. Ebbets introduced himself as an astronomer and systems engineer. He expressed support for a healthy mix of missions, to include Origin probes and Vision missions, which are peer-reviewed and selected. Final reports are available on these missions. Funding for technology development seems to have disappeared and is necessary for bringing science missions to appropriate Technology Readiness Levels (TRLs). NASA must get back on the Roadmap for the Single Aperture Far Infrared Observatory (SAFIR) and Terrestrial Planet Finder (TPF). The Hubble Space Telescope mission has demonstrated the value of having a space-servicing capability in Space Operations. In-space servicing should be considered as part of design and mission architectures, *ab initio*. Many credible scenarios are available for this concept.

***Domenick Tenerelli/Lockheed Martin***

Mr. Tenerelli, a program manager for Hubble Space Telescope, had also worked on Lunar Prospector, the Space Infrared Telescope Facility (SIRTF), and the Image program. In the Astrophysics division, the higher costs of telescopes should be factored in from the beginning. Certain missions are being considered that will be more expensive than the James Webb Space Telescope. Simpler systems should be considered. An example is SIRTF; allotted only \$500M, its science return is nonetheless significant. Single string electronics systems should be considered; this can be done for less than \$1M. Oversight and quality of engineers must be addressed. Oversight should not be an issue, outstanding engineering ensures a sound product.

**Development of the NASA Science Plan**

Mr. Gregory Williams, NASA Science Mission Directorate, presented an overview on the development of the latest NASA Science Plan (SP), which is developed every three years. This year will mark the first time the SP has been developed under a combined Science Mission Directorate. The key feature for the SP is community involvement and planning. The schedule is compressed, and legislation is present that must be responded to. The NASA Authorization Act stipulates that NASA produce a Science Plan by December 2006, with specific features that include identifying missions that NASA will initiate, design, and develop through the year 2016. In addition, missions should be prioritized with a rationale for each ranking.

A Science Plan draft outline is currently in progress. It is constructed as follows: Preamble; NASA Science Story; Purpose and Progress; Summary of Science Questions and Prioritized Missions, Common Elements of Strategy; Research Areas; Science Enabling and Enabled by Human Exploration; and Summary: On the Brink of Understanding. Mr. Williams presented the Science Plan schedule, noting that it needed

to be reviewed in a very short time. Key dates and deadlines were detailed. Fall 2006 will be another opportunity for the community to comment upon the draft. The biggest challenge is the prioritization of missions and the rationale behind it.

The NAC and the subcommittees can assist the process by having each division provide its own prioritization, using the results of the planning conference now in progress. Mr. Williams welcomed comments on the proposed outline, thoughts on the criteria, and airing of issues and concerns.

### **Breakout Sessions**

The four subcommittees separated into morning sessions.

### **Lunch Presentation- NRC SSB Briefing**

Dr. Lennard Fisk, chairman of the SSB, provided an overview on the Board's latest report, entitled "An Assessment of Balance in NASA's Science Programs." The report was written in response to the 2005 Budget, and addressed the impact of Exploration on the Science program. The SSB's response has been affected by the start-and-stop nature of the roadmapping activities. SSB has reviewed the most recent Science Roadmap and the use of ISS. The report also addresses the latest manifestation of the FY07 budget and is directed toward Congress. The SSB is at greater liberty to point up the budget shortfall. The report begins with an important statement, to wit: NASA is being asked to accomplish too much with too little. NASA is expected to complete the ISS, continue the Shuttle program, develop CEV, and continue Science program. It is a simple mismatch of program and funding. The Executive Branch and the Legislative Branch need to seriously examine this mismatch and identify ameliorative actions. The consequence of the mismatch is the removal of \$3.1 B over 5 years for SMD. The impact of this has been to create a Space Science budget that is not robust and is imbalanced. This causes the program to be less sustainable. R&A and small missions are a linked process; they are part of a pipeline of research that holds the programs together with human capital and technology. The current budget complexion endangers this pipeline. To fix this problem, it appears that about 1% of the total budget per year is needed to ameliorate the damage. The SSB report also deals with other program elements such as Life Science and Microgravity- they have been reduced 70%. The consequence is that the community of researchers needed to conduct long-term space flight has been even more seriously disrupted than SMD. The same level of budget restoration could also address this shortfall.

Dr. Fisk commented that in reexamining the cost of flagship missions, it was found that every one is very much more costly than originally anticipated. This fact has disrupted the smooth pathway of overall program planning at NASA and has further disrupted the balance of missions. SSB does not have an answer to this, but it is probably the single most difficult problem that faces SMD. Consequently, the report recommends a real analysis upon which to determine a real budget. There should be a careful examination of the approaches to cost, schedule and risk management, and lower-cost options. Science priorities haven't changed, but NASA must ask: can NASA do them for less?

A past strength of NASA's program has been the intimate involvement of the science community. Dr. Fisk was glad to see the community's vigorous response in engaging its reconstituted science subcommittees. Dr. Dressler noted that the importance of costing and the timing of surveys are not reconcilable issues. Dr. Fisk agreed that a better job can be done in costing, but in the past the Decadal Survey had not been off the mark. The costing issue may be rooted in changes in mission execution. This is a legitimate concern. Dr. Griffin commented that some of the difficulty in planning a good program is direction from Congress and the fencing off of programs, setting constraints when selecting on science strategy alone. Dr. Fisk encouraged NASA and the subcommittees to develop the science plan it wants, regardless of overlaps. It is a different playing field. At the very least, NASA should ask itself these questions, even if there is political breakage along the way. The single most important task is to lay down a 5/10/15 year plan and ask what the content should be. Dr. Griffin added that the Columbia Accident Investigation Board had also taken Congress and the Administration to task for why NASA does what it does. If SSB would lend its support to NASA in addressing Administration constraints on NASA, the comment would be heeded. A participant remarked that the science mission has actually expanded to include fundamental physics and hoped Congress would take this into account.

Dr. Fisk emphasized the need to continue to deliver the message that the space program, in all its dimensions, is important to the nation's future. He expressed disappointment that the President had not recognized NASA in his Competitiveness Initiative. A participant commented that the Competitiveness Initiative is important, in that there are internal and external factors, such as rising costs of processes and procedures, and little time to assess how the U.S. will maintain its competitiveness in the space sciences. Dr. Fisk felt that drawing attention to R&A and small missions was to recognize that they pave the way for things to come. There was particular concern about the role of universities in maintaining the competitive spirit. An analogy was drawn to big businesses soliciting small business for innovative ideas and better products. Universities are the small business equivalent in the space science program. The government as a whole is ignoring this issue.

A participant asked if there were any way to measure independent investment in R&A. Dr. Fisk doubted that such small factors were measurable in any appreciable sense. The enterprise at universities is more than faculty and includes post-doctoral students, etc., funded through the Federal government. Speculation was raised regarding the solicitation of endowment funding to supplement R&A. Dr. Fisk commented that the signal from NASA would have to be very strong in terms of making it a worthwhile investment. Others felt that endowment funding would just keep things afloat; it would not be a huge amount of money and there would be few options. A participant commented that the light at the end of the tunnel was 2010. If the space program is important, the Federal government should respond to the community's concerns.

Dr. Allen expressed gratitude for Dr. Fisk's briefing and adjourned the Plenary Session.

### **Breakout session PM**

The four subcommittees departed the Plenary Session for a final regrouping.