Statement of
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before the

Subcommittee on Science and Space
Committee on Commerce, Science and Transportation
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INTRODUCTION:

Madame Chair, Senator Sununu, Senators, I want to thank you for the opportunity today to address important issues that face the NASA science enterprise. My name is Roy Torbert. I am a professor of physics at the University of New Hampshire, and I represent the University as Director of the Space Science Center within the Institute for the Study of Earth, Oceans and Space. The Institute has 56 faculty who participate in nearly every division of the NASA science effort, as well as theoretical and ground activities supported by other state and federal agencies, including NSF, NOAA, DOE, and DOD. The Institute presently supports 30 engineers, 57 graduate students, and over 70 undergraduates. I myself have served as principal investigator on several scientific instruments for NASA and am now a lead investigator in an upcoming strategic mission for the Heliophysics Division: the Magnetospheric MultiScale mission, or MMS. I have also served the University as Dean of the College of Engineering and Physical Sciences, where the future of a technical workforce, an issue to which I will return, was a daily concern. Presently, I also serve on the NASA Advisory Council Science Subcommittee for Heliophysics. Although this committee has just been constituted and I cannot speak for the committee, I will address some of the issues that the committee has begun to consider.

First, and most importantly, I would like to commend the American people, and you as their representatives, for their significant investment in NASA science. Scientists like me know how difficult it has become to find funding for the many worthy causes that come before you, and we deeply appreciate your continued support. It is a signature achievement of our nation that it finds the means and the will to look beyond the pressures of everyday concerns, to lift our horizons to explore questions about our place in the universe, our relations to our Sun and nearby planets, and how the Earth and its environment have functioned in the past and how they may fare in the future.

Of course, I also believe that the United States has benefited a great deal from this investment: not only is the technological base of our country strengthened by NASA innovations, but our prestige and competitiveness in the world and our educational investment in the future technical workforce are greatly enhanced by NASA science leadership.

THE SPACE SCIENCE BUDGETARY CHALLENGE

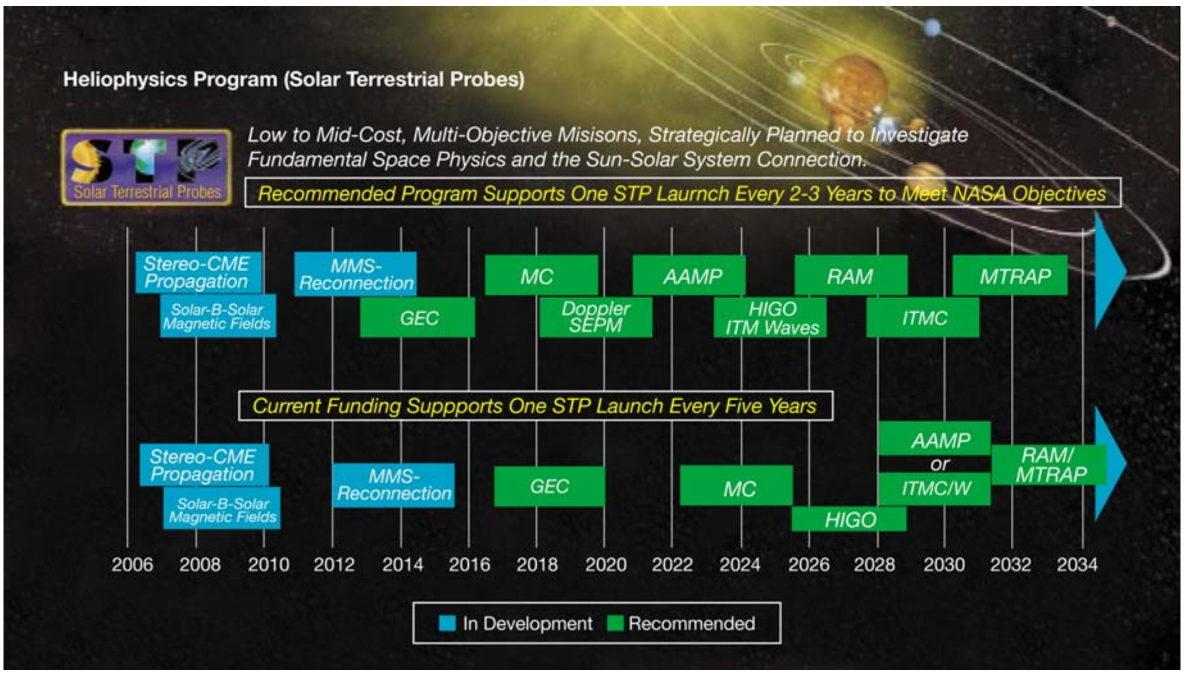
However, there is considerable anxiety in the space science community today about the future of science funding within NASA. In short, the Administrator has been forced to reduce the 5-year run out of the Science Mission Directorate (SMD) by some $ 3.1B to accommodate the requirements of returning the Shuttle to flight status, to service the ISS, and to develop a new Crew Exploration Vehicle for service by 2014. The funding for SMD will therefore grow at only 1% real dollars over this period, and long-planned projects are being stretched out beyond the retirement age of many active scientists in the field. Even before these budgets were proposed for FY07, NASA science programs had sustained a reduction in scope. When the Vision for Exploration was first proposed in 2004, the SMD budget was $ 5.5B and projected to grow to $7B in FY08. The request for SMD in FY07 before you is now $5.33B, which is less in real dollars than was appropriated in 2004.

In this testimony, I would like to lay before you two main points. First, the present budget has some significant impacts on the ability of NASA to carry out its planned scientific program; and second, there are structural problems, namely, workforce issues, risk management approaches, and full-cost accounting mechanisms, that, by driving up the costs of major science missions, make these impacts even more severe. Both of these conditions are combining to severely limit the frequency and variety of science opportunities in the near future. First, let us consider the immediate impacts to our space science program.

IMMEDIATE IMPACTS IN THE BASIC SPACE SCIENCE MISSION

The budget numbers above would certainly require that NASA limit its plans for science. Some programs have suffered even more than these numbers imply. As an example, the Solar Terrestrial Probe line, within SMD, which supports the upcoming STEREO solar mission, and which will support MMS, now operates with about 75% of the funding projected in 2004. As a result, the 2010 launch date announced in 2004 for MMS has now slipped to 2013. It is very hard to recruit new students and engineers for a program whose launch date recedes faster than real time! As detailed in a recent, thorough report of the National Academy, entitled “An Assessment of Balance in NASA’s Science Programs,” many of the programs within other divisions, both within SMD and also within the Exploration Systems Mission Directorate (ESMD), such as microgravity life and physical sciences, have suffered even more severe reductions.

The science community, through the NASA strategic planning process, has been attempting to deal with these reductions in an orderly manner, by stretching out the development and launch plans when possible. Below are timelines for one such example of the Solar Terrestrial Probes, as extracted from the “2005-2035 Roadmap for Heliophysics” from the SMD roadmapping effort. The original sequence of missions in 2003, as diagrammed in the top panel, was thought to contain sufficient overlap in development so that complementary fields within the Heliophysics division of SMD, such as solar physics (STEREO mission), magnetospheric physics (MMS), and ionospheric physics (Geospace Electrodynamics Connections, GEC) could each contribute to the division goals of understanding the structure and dynamics of our solar system, its basic physical principles, and how the Sun influences the space and atmospheric environment around the Earth. The 2005 roadmap accepted the new budget realities, as outlined in the bottom panel, but now key missions have been stretched out. In particular, the GEC mission, which is the backbone of NASA research into ionospheric physics, has been deferred "indefinitely, beyond 2015." "Indefinite postponement," as a development timeline, certainly forces many scientists in the NASA enterprise to question the viability of their fields in the future.



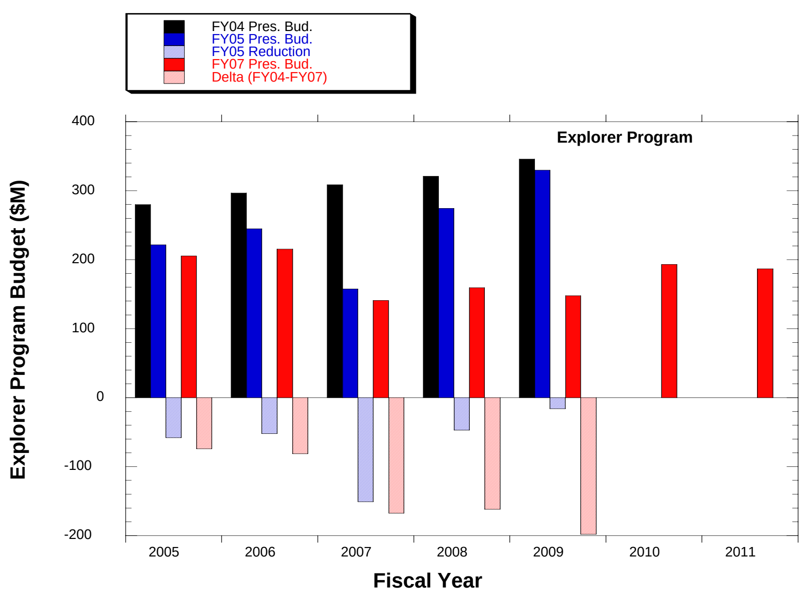
I must point out that these schedule realignments, as painful as they are, resulted from budget reductions prior to those proposed for 2007. The new actions forced on the Administrator, as outlined above, are just beginning to have their impact. It is appropriate that NASA, as primarily a mission agency, will adjust major mission schedules to preserve, as much as possible, its strategic vision.

What is causing considerable anxiety in the science community is the anticipated and extraordinary reductions in the smaller mission opportunities and sustaining research programs that form the support for much of the university-based research where students are involved. Small missions, such as those in the Explorer, Discovery, and Earth System Science Pathfinders programs, provide projects where new concepts are tested for a modest investment and where students first learn the space science and engineering trade.

This is particularly true of the Low Cost Access to Space (LCAS) effort that provides sounding rockets, balloons, and aircraft flight opportunities in a time line that falls within the educational program of a graduate student. Since 2000, the historical launch rate has dropped in half (from about 30 to 15 missions per year), with anticipated further reductions as a result of the 2006 budget. This year, NASA would not accept proposals for remote launch sites for sounding rockets, a critical capability for this program which often requires that the scientist and student teams launch their payloads directly into the specific region of space under study. The present run out budget places even the regular launch facilities, such as those at Poker Flat in Alaska, in danger by 2009.

THE EXPLORER PROGRAM IS AT RISK:

The Explorer program (see http://explorers.gsfc.nasa.gov/) is another prime example of these impacts. Explorers are the original science missions of NASA, dating back to the very first satellite, Explorer 1. They are universally recognized as the most successful science projects at NASA, providing insights into both the remotest part of our universe and the detailed dynamics of our local ionosphere. The Advanced Composition Explorer (ACE) now stands as our only sentinel to measure, in-situ, large mass ejections from the sun and the energetic particles that are a danger to humans in space. Two, TRACE and RHESSI, study the dynamics of the solar surface where large solar storms originate, storms that often threaten satellites and other technological assets that we depend upon. Another Explorer, the Wilkinson Microwave Anisotropy Probe, continues to provide startling insights into the early structure of the Big Bang. Explorers are among the most competitive solicitations in NASA science, and offer opportunities for all comers to propose new and exciting ideas that are selected on the basis of science content, relation to overall NASA strategic goals, and feasibility of execution. The figure below details the budgetary prospects for Explorers. The FY07 proposed run out for Explorers will mean a program that is reduced by over half from its proposed FY04 guidelines.



Courtesy: Daniel Baker

In the 1990's, the Explorer program size mix was adjusted downward from the original "full Explorer" class to smaller satellites, labeled Medium-Explorers (MIDEX) and Small Explorers (SMEX). This was done to enhance the rate of new missions, in the face of limited funding and the cost growth of Explorers, a growth which had followed that of missions in general, an issue to which I will return. Even smaller, so-called "University Explorers" or UNEX, were also proposed but abandoned. For a number of years, this strategy allowed an Announcement of Opportunity (AO) every year, for either a single MIDEX or two SMEX class satellites. There has not been a single AO for Explorers since 2003 and the next possible opportunity is now 2008. That means there will be a five year gap in Explorer launches after the upcoming IBEX launch in 2008. Many university institutions have concluded that the years and dollars of up-front investment, necessary to put forward a successful proposal for the Explorer Program, can no longer be justified in the face of such limited prospects.

I would encourage the Congress to work with NASA to restore the vitality of both the Explorer and LCAS programs.

CONCERNS ABOUT THE RESEARCH AND ANALYSIS (R&A) BUDGETS:

A specific concern to university-based scientists is the impact on the sustaining Research and Analysis (R&A) budgets. The R&A program initiates many of the new, small scientific avenues that eventually lead to the major mission concepts that NASA pursues. They are highly competitive, maximize the science investment of on-going missions by allowing all scientists to use available data, and are heavily weighted toward student and young faculty participation. These are moderate-term efforts, usually lasting three to four years, where new research and particularly theoretical approaches are explored. The Administrator has been forced by his budget realities to propose an immediate reduction of 15% in these programs. That may not seem catastrophic at first sight, but a sudden reduction in any long term program can have large effects. Because in any given year, approximately two thirds of the budget is already committed, next year the budget available for new grants must be reduced accordingly by 50%, on average. In some programs, it has been announced that it will be as much as 80%. If the budget were allowed to inflate, this rate would slowly recover in the next few years, but, with the present budget prospects, there is skepticism about its future. There is universal acceptance that these realities will inevitably reduce the number of new students who enter university programs like mine.

I have emphasized the budget impacts to programs with which I am associated, but nearly all science programs, both within SMD and Exploration Systems, are similarly affected, in some cases even more so. For example, the Earth Science division depends to a larger extent on the R&A program, and is therefore more severely reduced. The newly constituted NASA science advisory subcommittees will be forced to re-align strategic plans to available budgets and are beginning to study how the recently completed Roadmaps and the NRC Decadal Study plan can best be executed. Of particular concern are two findings of the above-mentioned NRC "Assessment of Balance" report (finding #'s 2 and 4): that the balance between large and small missions within NASA science activities is not optimal, and that the cost-to-complete of space and Earth science missions should be scrutinized. As shown here, much of the mission stretch-out in programs like STP and Explorers occurred even before the recent FY07 budget proposal, when the NASA Science Enterprise as a whole enjoyed budgets that were kept at least even with inflation, and sometimes even better. How much worse will it be if SMD must live with a declining inflation-adjusted budget?

I would encourage the Congress to augment the small mission and R&A effort in the NASA science budget.

WHAT ARE FACTORS INCREASING THE COSTS OF NASA MISSIONS?

Why is it that the costs of the major NASA and other space agency missions have grown far faster than inflation? Or even technical inflation? I will offer three possible reasons, that all probably contribute, and some recommendations to address these problems.

First, it is clear that nearly all space projects require a great deal of technical competence, and a correspondingly competent workforce. There has been a steady erosion of that workforce, not only at NASA but across the entire country, and this fact has been decried from many quarters. The NRC report, "Rising Above the Gathering Storm," makes this case most energetically. Other technical industries have been able to compensate somewhat by tapping the pool of highly-trained immigrants and foreign students, and often outsource work abroad. As spacecraft are ITAR sensitive items, this pool is not available to NASA or to its outside space-enterprise partners, even to us at universities, because of the constraints of the law. All the space programs at NASA, DOE, NOAA, and the DOD feel this shortage acutely. And the situation will shortly be worse. NASA recently commissioned the NRC to study how the workforce necessary to carry out the Vision for Exploration, can possibly be maintained, given the impending retirement of much technical talent with the baby boomers. I was invited to participate in that study where it became clear that the real shortage lies in the lack of engineers and scientists who had actually built, hands-on, space hardware and know how the hardware can be integrated and function within larger, more complex systems. I submit to you that the NASA science programs are a critical source of this needed native talent, whether they remain in NASA science programs or move out into the larger industrial base. Education at its very best is a process of discovery, of trial-and-error, and the efficacy of learning-by-doing has been proven over many years. NASA science is a natural partner for universities by providing a wide-array of opportunities for student participation where a mistake does not lead to a catastrophic loss of life or operational mission capability. I recently read a sobering article in Newsweek about students at MIT who opted out of the technical curriculum. They often cited a lack of excitement that could sustain them through a grueling educational program: it just wasn't "cool." For many, many students, NASA science provides the "coolness" factor. From robots on Mars, to solar storms, to questions about the origin of the Universe, NASA science is an exciting enterprise. In this light and in view of the key role of NASA science in the "Gathering Storm" report, it is unfortunate that NASA is not a component of the President's new "American Competitiveness Initiative." It is particularly discouraging that, at the critical moment when NASA science programs are needed most urgently by our educational institutions, we are forced to consider how to down-size their participation.

NASA needs to maintain its investment in space science programs that allow universities to attract and engage undergraduate and graduate students in all aspects of mission development and deployment--- from proof of concepts studies, to proposal submittal, to prototype development, to launch, data analysis, and publication. Whether these programs have short or long time horizons, there are ways to allow the next generation of space scientists to participate in all aspects of an exciting NASA mission.

A second factor in the cost of science projects is the management of risk. Since the first Explorer I, NASA science projects have been extraordinarily successful. But over the years, the management procedures and quality assurance burden for science projects has grown to an almost unsustainable level, and is has been driven to be commensurate more with manned missions, without any quantifiable impact in actually improving the final reliability of science missions, as far as many scientists can discern. I think the American people accept that the space business is risky, especially during launch and re-entry. Administrator Griffin has observed that, since two percent of these launches never achieve orbit, it makes no sense to spend hundreds of millions of dollars on procedures that might improve the reliability of payloads far beyond that, and I emphasize there is debate whether we are actually achieving more reliability. We have all learned that unnecessary risk in manned space programs has tragic consequences and clearly more must be done to minimize that risk. It is equally true that *not* taking risks in leading-edge science projects has undesirable results: not only must science continue to push the technological envelope where failure is a risk that accompanies new ideas, but these projects provide opportunities for training staff and students in an environment where failure is not life-threatening, where a student can gain hands-on experience in the real work of building state-of-the art instrumentation, and, having gained this expertise, these students can go on to form the workforce of future operational and manned missions.

Now, no scientist likes the idea of failure. Not only are increasingly precious resources lost, and explanations to committees such as yours required, but even more importantly, many valuable years of all our team members, especially students, and even whole careers, are put at risk. With my university team, I have watched fifteen years of hard work vanish in the first few seconds of launch; in this case, a European launch. I can tell you that the silence that followed was agonizing. But that team picked itself up, worked with both NASA and ESA to rebuild those four satellites, and today this mission is on-orbit and returning remarkable results. Exploration, in its very nature, engages adversity, and it is the manner in which we overcome it that defines us as a nation.

I note that NASA SMD is presently undertaking a top-to-bottom review of the risk categories of its missions, and the processes that are appropriate for each class of mission. In that review, it is important that the "one-NASA" approach still allow a clear differentiation of different levels of missions, from manned shuttles and CEV's to very inexpensive sounding rockets. The scientific community applauds this effort, and wishes to work with the NASA centers to fashion procedures and processes that are appropriate to each of these levels, and that can be both cost effective and successful.

Third, and finally, there are some issues of accounting for costs that, quite frankly, are mystifying to the science community. NASA science centers have recently moved to a new accounting system, so-called Full Cost Accounting, which, on the surface, is a step forward, in that missions must account for all the costs associated with their full execution. Previously, there were center-based budgets, where the costs of maintaining needed expertise were carried in different accounts than the missions themselves. If these budgets were re-distributed to the mission budgets which then paid the costs, we would achieve more budget transparency. But, we cannot see where this distribution has been done. Furthermore, there is an inherent risk in this approach when the number of missions decreases, as seems to be the present case. If there is a certain amount of funding required to maintain center expertise, then a smaller number of missions must show higher required levels of funding to bear the fixed base costs, and therefore fewer missions and so on. The LCAS program stands in particular danger from this dilemma as the launch rate slowly dwindles. Taken to its ridiculous limit, pretty soon you have one single very expensive mission.

SUMMARY:

What is it that the science community is asking of NASA and this Congress? Through some serious work of the Advisory committees, we will be examining with NASA the balance of large and small programs. We realize that NASA is first-and-foremost, a mission agency with exciting goals to accomplish. But these goals and missions cannot be accomplished without a sound technical and scientific basis which is provided by the proper mix of supporting research and focused development. We will be asking NASA to consider programs that help educate and train the next generation of space scientists and engineers. We will be asking NASA to evaluate the proper level of risk for science missions to allow science multiple opportunities to provide the technical progress and student training so that future manned and un-manned major missions can be reliably and affordably carried out. We would like to examine how the new center financial systems can be structured to provide faithful cost accounting in a manner that does not improperly burden science missions. And, we would ask the Congress, in considering the budget level for NASA, to give high priority to restoring funding for the science enterprise as a whole.

I thank you for this opportunity to discuss the budget implications for the NASA science program, one of our nation’s precious assets that we all want to nurture to an ever more inspiring and productive future.