

November 14, 2006

Dr. Madhuika Guhathakurta
Living With a Star & Stereo Program Scientist
Earth-Sun System Division (DF)
Science Mission Directorate
NASA Headquarters
Mail Suite 3Q11, Washington DC 20546

Dear Lika,

On October 10-11 2006, the LWS MOWG met at the Washington Marriott Hotel in Washington DC. This cover letter and findings summarize the discussions of the MOWG during our Washington meeting and later interactions as we revised the findings.

At our October meeting we received useful updates and reports on the LWS program from program managers and other NASA personnel. Dr. Dick Fisher began with a perspective from NASA Headquarters on several topics including the three LWS flight programs (SET, SDO, and RBSP and associated Missions of Opportunity), NASA's buying power in light of the cost of space access, and plans for LWS beyond about 2012. Discussions about the future of LWS beyond the expected launch of RBSP led to a finding to update the LWS Science Architecture given the changes in NASA and LWS mission phasing since the SAT report.

We continued with a report of highlights of the LWS program from Chris St. Cyr. The TR&T program has had a large positive impact on LWS productivity, as shown by the community's high participation level in special sessions at the upcoming American Geophysical Union meeting. Subsequent discussion led to our finding on ways to make maximum use of TR&T given the new and pending mission data streams. One of those data streams, at 150 Mbps, will come from SDO; we heard about the status of SDO instruments (integrations beginning in early 2007), spacecraft, and the mission operations center from Dean Pesnell.

One major event since our May 2006 meeting was the announcement of the RBSP science investigations in July and the start of the RBSP formulation phase. Barbara Giles reviewed the science payload and introduced the three RBSP missions of opportunity currently in Phase-A competition.

At our May 2006 meeting the MOWG was concerned about the status of the ITSP mission and this concern still exists in the MOWG and the I-T community. We asked for an update of the ITSP science from the recent CEDAR community workshop in June 2006; MOWG member Tony Manucci provided the briefing. The science update was the foundation for the MOWG finding that there remain large uncertainties in the roles of magnetospheric

electric fields and global-scale changes in neutral thermosphere dynamics that can only be addressed with in-situ methods. Furthermore, the status of the IT science is as well defined as any LWS-mission, so the question is how the community might proceed in the next several years in addressing the IT science needs from simultaneous solar and magnetospheric measurements. The MOWG believes that creative solutions are needed to restore ITSP science in an environment of reduced budgets and increased costs for access to space. The MOWG believes that establishing a task force that is focused on the implications of limited availability of long-standing observations of solar wind and magnetospheric inputs and IT science and exploitation of new opportunities was the next logical step.

The MOWG discussed the impacts of the recent decision to remove solar and in-situ space environment sensors from the NPOESS spacecraft in the context of IT science and plans for the LWS science architecture. Given the broad objective of LWS and how its design relies on measurements provided by various agencies to achieve its goals, the NPOESS decision has had a clear negative impact on plans for low-Earth orbit particle science and inputs to IT issues. The MOWG recognized the context of the NPOESS decision and recommends that NASA explore with its interagency partners the actions necessary to restore these critical observations.

Gordon Johnston gave a useful review of planning for lunar science and the anticipated ESMD strategy and architecture. It was clear to the MOWG that a dialogue between participants in ESMD and LWS is necessary for efficient use of LWS expertise such as in the field of space radiation environment. Along the same topic, Ron Turner of ANSER was invited to discuss his views of the impacts of solar particle events on Exploration.

We received an update from Haydee Maldonado on the risk-reduction activities for the Solar Probe mission, with the resulting finding that the MOWG continues to support NASA's efforts in demonstrating the important Solar Probe technologies in the risk-reduction mode.

The LWS MOWG appreciates the professional support we have received from NASA personnel for our first two meetings. Over the next year the LWS missions (SDO & RBSP) will continue to proceed and we look forward to important progress on restoring I-T science.

Sincerely,
Joseph E. Mazur
Chair, LWS MOWG

**LWS MOWG
Finding
on
Roles of LWS Program in ESMD**

The Exploration Systems Missions Directorate is preparing a time-dependent integrated global lunar exploration strategy that will describe major focus areas for lunar exploration. This strategy is expected to be available in December 2006.

The LWS MOWG recognizes the potential applications of LWS scientific knowledge, observations, and modeling to Exploration, specifically in the area of the space radiation environment. The LWS MOWG believes that elements of the LWS program, such as ongoing TR&T research and planning of real-time data from the RBSP mission, can play a role in ESMD. To facilitate the use of ongoing LWS efforts in ESMD, the MOWG recommends that a dialogue between SMD and ESMD be established to enable participants in the LWS program and its managers to better understand the concepts for lunar operations in the Exploration strategy. As a result, outputs from LWS could address critical Exploration needs in areas such as event forecasting, environment monitoring, shielding studies, and planning for lunar operations.

**LWS MOWG
Finding
on
LWS Targeted Research & Technology Funding**

In the near future, an extensive suite of new databases will become available to the LWS community: the Solar-B mission was successfully launched in October 2006 and launches of LWS and other Heliophysics missions (SDO, STEREO, TWINS, THEMIS etc.) are pending. Whereas each mission has its specific science goals, synthesis of the individual databases is essential for furthering the goals of LWS, by advancing the scientific understanding of the Sun-Earth system as a whole. To accomplish this, a platform is required that fosters research integrating data acquired for, and used by, different disciplines. The LWS TR&T grants program was conceived to be such a cross-disciplinary platform.

The LWS MOWG reiterates the unique and essential role of the TR&T program in enabling system science using the data from disparate missions. The MOWG further recognizes that the TR&T program has achieved notable successes and enthusiastic community engagement during the three years since its inception. The MOWG therefore believes that continued strong support and future augmentation of this program will significantly advance the LWS goals in securing from the new databases the characterization, understanding, and prediction of the Sun-Earth system needed to properly understand its societal impacts and utility.

**LWS MOWG
Finding
on
Impacts of Loss of NPOESS Solar and Space Environment Sensors**

The LWS program strives to quantify the dynamics of the Sun-Earth environment by taking a systems approach to its satellite missions and research. Through its selection of missions and supported research, NASA strives to understand this vast and complex system; however, no single U.S. agency has the resources to supply the full complement of assets required. Therefore NASA, as well as other agencies (e.g., NSF, DoD, NOAA, & DoE) depends on the assets provided by the other agencies to cooperatively develop effective and comprehensive scientific and operational observational, modeling, and theory programs. This is accomplished through long-term planning, with the necessary assumption that each agency will fulfill its stated commitments.

With the recent removal of some space environment and climate instruments from the planned NPOESS payloads, critical elements of the planned interagency and international suite of measurements will no longer be available, impacting the ability of the LWS program to accomplish its mission. In particular, a large number of the goals identified by the LWS Geospace Mission Definition Team relied heavily on ionospheric, magnetospheric, and solar measurements that had been planned for NPOESS payloads and these payloads have recently been removed. The loss of the NPOESS solar and space environment instruments, therefore, impairs the goal of the LWS program to establish an end-to-end understanding of the Sun-Earth system and its impacts on human endeavors. The LWS MOWG recommends that NASA explore with its interagency partners the actions necessary to restore these critical observations.

**LWS MOWG
Finding
on
Ionosphere-Thermosphere Storm Probes**

The Ionosphere-Thermosphere Storm Probes (ITSP) mission is a key component of the Living With a Star program, designed to increase our scientific understanding of the geospace region that impacts society most directly. Variations in the Sun's energy inputs to the earth, especially during geomagnetic storms, disturb the electron density, temperature, composition and dynamics of the ionosphere and thermosphere, affecting navigation and communications systems, radar, power distribution systems and satellite orbits. ITSP's key measurements of the middle latitude ionosphere and thermosphere will resolve compelling science questions concerning the sources and nature of space weather variability. This new understanding is crucial for mitigating adverse ionosphere-thermosphere (I-T) effects on human technological systems, and is therefore central to the successful execution of the LWS program.

Recent community activities and inputs to the MOWG reaffirm the scientific approach of ITSP to acquire comprehensive in-situ data from a pair of spacecraft, in conjunction with UV remote sensing to provide the broad spatial context. The observations are crucial for achieving physical understanding of newly discovered mesoscale and global scale dynamic plasma features formed during geomagnetic storms. Existing hypotheses suggest that electric fields of magnetospheric origin, and global-scale changes in neutral thermosphere dynamics combine to create the observed plasma structures in ways not yet understood. The ITSP mission that simultaneously measures AC and DC electric fields, large and small-scale plasma structure, and neutral composition and dynamics in-situ within a broader global context is needed to achieve scientific understanding.

The LWS MOWG shares the view of the community that ITSP is a high-priority LWS mission and shares their concern about mission delays. The original plan for implementing the LWS missions enabled the ITSP to achieve crucial collaborative measurements needed to characterize the response of the I-T system to variations in solar EUV radiation (measured by EVE on SDO), and the response to inner magnetospheric processes (measured by Radiation Belt Storm Probes). But the delay in initiating the ITSP mission means that overlaps with SDO and RBSP (2008 and 2012 launches, respectively) are now increasingly unlikely.

In the current NASA environment, the MOWG strongly recommends that LWS form a dedicated and responsive task force of community members to understand the implications of delaying ITSP. This task force would assess opportunities for ITSP to achieve the needed solar energy input specifications from models or measurements other than SDO. The group should assess and formulate a response to possibly limited availability of long-standing observations of solar wind and magnetospheric inputs, for example as available from ACE and DMSP. Creative solutions are needed to restore ITSP science in an environment of reduced budgets and increased costs for access to space. Partnerships with other stakeholders in the ionosphere-thermosphere science area must be pursued vigorously. Announcements for missions of opportunity should be created to take advantage of partnership opportunities as they arise. Proactive communications between LWS, other I-T stakeholders, and the scientific community are needed to restore ITSP science and fulfill LWS strategic objectives.

**LWS MOWG
Finding
on
Solar Probe Technology Risk Reduction**

The Solar Probe mission promises to provide one of the most important, transformational breakthroughs in our understanding of the Sun-Heliosphere system, similar in science impact to the discoveries of previous planetary encounter missions such as Voyager or Pioneer. Providing ground-truth *in-situ* observations along with imaging of one of the last, unexplored regions of the solar system, Solar Probe promises to revolutionize the field of heliophysics, and is of fundamental importance to LWS, SMD, NASA and the scientific community in general. To this end, the recently released Solar Probe Science and Technology Definition Team (STDT) report (NASA/TM-2005-212786) outlines an exciting mission which can be launched as early as 2014, assuming adequate resources are available. As part of this process, the Solar Probe STDT identified a series of risk mitigation activities to reduce overall mission risk, and help identify the lowest cost approach to carrying out this historic mission.

The LWS MOWG recognizes the enormous progress that has been made by the STDT, and fully supports these ongoing risk mitigation activities. We encourage the continuation of these risk mitigation activities, and we recommend, in particular, that NASA continue with the Solar Probe heat-shield prototype construction to reduce overall mission risk, assuming sufficient funds are available.

**LWS MOWG
Finding
on
Updating the LWS Science Architecture Plan**

From its beginning, Living With a Star was conceived as an integrated program that would employ all techniques for scientific observation, data analysis and theory/modeling, to study the science of the connected Sun-Earth system. The Science Architecture Team (SAT) reaffirmed this concept and in its report developed a strategic plan for how LWS would achieve these goals. Much has changed, however, in the five years since the SAT report. First, the schedule of LWS missions is different than originally envisioned. Second, the TR&T Program has been redefined with new elements such as the Focused Science Teams and Strategic Capabilities. Third, and perhaps most importantly, with the advent of the Vision for Exploration, the emphasis at NASA has changed to the Sun-Solar System Connection.

Given these major new developments, the MOWG finds that the science architecture plan for LWS needs to be updated. The new architecture, however, should maintain the concept that LWS is a single, integrated program. It should show how all the components of LWS work together to achieve the Program's goals. Such a plan will also help to advocate the program and to demonstrate its usefulness to the Vision for Exploration and to the rest of NASA. The MOWG urges the LWS program scientist to undertake the development of an updated architecture plan. This will undoubtedly require a much broader community involvement than simply the MOWG.