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Dr. Madhulika (Lika) Guhathakurta
Living With a Star Program Scientist
NASA Headquarters, Code SS
300 E St. SW
Washington, DC 20546

Dear Lika,

The LWS MOWG, at its meeting on June 19-20, 2003, received excellent and thorough briefings on all aspects of the Living with a Star program, and the broader Sun-Earth Connections (SEC) context, and very much appreciates the insightful and candid discussions. As a result of these presentations and discussions, the MOWG formed certain opinions and findings, which you may find useful in managing the program. With this letter, I would like to summarize these findings and formally transmit them to you and to the Sun-Earth Connection Advisory Committee.

The findings are grouped by subject matter and are not in priority order. The findings are also intended to deal with issues that are current or likely to arise in the future, and thus they concentrate only on potential problem areas. Needless to say, the participants on the LWS MOWG are very encouraged by the manner in which you and the SEC Division are attempting to execute this complex, but singularly important program, and we are dedicated to helping you achieve success.

Finding 1: It is evident that to execute this program, which is undertaking the formidable task of studying the Sun and the Earth as an integrated system, it will be necessary to make trades in missions and their capabilities, in order to fit within the finite available resources. The principles on which these trades will be made need to be established and articulated. A comprehensive science plan needs to be developed which embraces the system approach being pursued by LWS, and presents this program in the context of the many other relevant activities underway in the study of the Sun and its influence on Earth, both internationally and by other Government agencies. A set of Level 1 specifications for LWS needs to be developed. The MOWG considers that these Level 1 specifications should, to the extent possible, preserve the ability of LWS, and the broader SEC program, to study the Sun and the Earth as an end-to-end system. Concurrent observations of key portions of the system, during significant phases of the solar cycle, are essential. The systems approach to LWS science is inherent in the recommendations of the Targeted Research and Technology (TR&T) Definition Team, and the MOWG encourages NASA to implement these recommendations within the overall science plan. The TR&T recommendations, and the entire science plan need to be widely disseminated so as to inform the science community of NASA's commitment to understand the Sun and its influence on Earth as an integrated system.

Finding 2: The MOWG recognizes that many factors, external to LWS, will force trades in the LWS program that may be highly undesirable. The most serious concerns, which are now becoming evident, are increases in launch costs, and the changing posture towards risk in missions, with the resulting growth in estimated, and, eventually, realized cost. The management of SEC is given every encouragement to fight these trends. In the case of launch vehicles the costs appear to be driven by market forces and national space policy, and the only alternative is to seek, wherever possible, inexpensive launch opportunities, such as secondary payloads or contributed launches. The current risk mitigation strategy of NASA is a self-inflicted wound. Unnecessarily large reserves are being required, management oversight is cumbersome, and extensive external reviews are being imposed, all of which are greatly increasing the projected cost of LWS missions, beyond where they were originally priced. It is particularly egregious that these new rules, with their substantial cost impacts, are being imposed on SEC missions, which historically have been able to build low-cost and on-budget missions, with reasonable oversight. The management oversight required by NASA should scale with the size of the mission, and be appropriate for the small and mid-sized LWS missions.

Finding 3: The MOWG is concerned that the change in management oversight, and accompanying reviews, which is now impacting LWS missions, could in time extend to PI-class missions, to their considerable detriment. PI-class missions have been one of the most important programs of the SEC community, and all efforts should be made to protect the approaches that have made them so successful. Indeed, it should be asked why the geospace component of LWS cannot be executed as traditional PI-class missions.

Finding 4: The MOWG recognizes that relief from the expected cost growth in LWS missions can come from increased international cooperation. The MOWG encourages the active pursuit of such cooperation, and offers to help where appropriate. Space agencies with hardware capabilities, or which can provide launches, should be encouraged to become true, committed partners within the International Living with a Star (ILWS) program, by adding key missions and research activities to this global effort to understand the Sun and its influence on Earth. Contributions from the European Space Agency and Member States to the Radiation Belt Storm Probe Mission of LWS and the active pursuit of the Solar Orbiter, would be particularly valuable. It is important in establishing this cooperation that all parties agree on the basic theme of this program—to study the Sun and the Earth as an end-to-end system—and be willing and able to freely contribute data, modeling, and understanding to this system analysis task.

Finding 5: The heliosphere is an integral part of the Sun-Earth system. Studies of the heliosphere provide important information about the Sun and its global properties, as well as about the evolution of solar plasma, energetic particles, and magnetic fields that impact Earth. There is currently no strategy to properly include studies in and of the heliosphere within LWS, and one needs to be developed. A Heliospheric Science Definition Team (SDT) needs to be formed and a report of quality similar to that of the Geospace SDT needs to be developed. A simple first step is to drop the name Sentinels for the proposed LWS heliospheric mission, since this name suggests that the only purpose of an LWS heliospheric mission is to serve as a sentinel for disturbances impacting Earth, as opposed to the legitimate role for such missions in the study of the heliosphere as an integral component of the Sun-Earth system.

Finding 6: NASA and the science community appear to have done an excellent job in defining the science and mission strategy to be pursued by the radiation belt and the ionospheric and thermospheric portions of LWS, and have set a level—the so-called core program—below which

the science would be compromised. This science and strategy are expected to form the basis of a forthcoming AO. If the essence of the core science cannot be achieved, a situation that hopefully will be avoided, it will be important to reengage the Science Definition Team to help redefine the program.

Finding 7: There are numerous operating missions that study the Sun, the heliosphere, and geospace, and several important upcoming missions. The LWS missions will add greatly to this comprehensive fleet of spacecraft. There is nothing to prevent, however, and indeed every reason to aggressively pursue the goals of LWS starting immediately with current and anticipated assets. In particular, the MOWG encourages that:

- ✍ Current SEC space assets be continued and their data made available and used to the maximum extent possible.
- ✍ Efforts be made to provide the community with easy and coordinated access to data from multiple missions and models, so that true system-level problems can be addressed. The MOWG was pleased with the recommendations emerging from the recently convened Data and Computing Working Group, and was particularly impressed by the Virtual Observatory concept that is being pursued in each SEC discipline. These Virtual Observatories need to be developed and ultimately linked, as recommended by the working group. The MOWG encourages the LWS program to provide the science community with access to the Virtual Observatories even during their development so that this hands-on experience can be translated into user-advice to the teams developing the systems.
- ✍ Every effort be made to encourage a new paradigm in the community – that researchers need to work jointly on end-to-end problems, having access to and utilizing data from multiple spacecraft, and employing integrating models which are tested against real data.
- ✍ The proposed TR&T Steering Committee be given a special role in coordinating research activities that encourage and facilitate the systems approach to understanding the Sun and its influence on Earth.
- ✍ Consideration be given to selecting and funding Interdisciplinary Scientists, who through appropriate teams can attack cross-disciplinary problems in the Sun-Earth system, and influence the LWS missions to ensure they continue their focus on studying the end-to-end system. This should be a topic of discussion at a future MOWG meeting, along with other possibilities for developing a community dedicated to cross-disciplinary research, such as appropriate graduate student and post-doctoral programs.

Finding 8: The SET program, through cost-effective access to space, studies the influence and effects of the geospace environment on technology. This program will be particularly well linked to the main LWS program if it uses the results of its studies to help define required outputs of predictive models that will be developed as part of LWS.

Finding 9: The study of the Sun-climate connection should be an important component of LWS. A Working Group is currently underway to better define this program, and to help deal with the challenges facing this cross-disciplinary, and cross-NASA-code program. The MOWG looks forward to hearing the results of this Working Group. An action that could be taken immediately is to encourage the Virtual Observatories that are being developed to ensure that data sets are available in formats that can be readily understood and used by climate modelers.

Finding 10: The MOWG was intrigued by the plans for an International Heliospheric Year (IHY), and considers that, if properly managed, it could improve public understanding of the importance of the LWS mission. The planners of the IHY should learn from previous efforts for

such international years, such as the original International Geophysical Year in 1957, and the more recent International Space Year in 1992.

We would be pleased to clarify or expand on the above findings, and are hopeful that they will be useful.

Sincerely,

L. A. Fisk, Chair
LWS-MOWG