

Earth Science Subcommittee Report
February 27-28, 2007 Meeting
Tempe, Arizona

From: The NASA Earth Science Subcommittee – Daniel J. Jacob (chair, djacob@fas.harvard.edu), Roni Avissar, John R. Christy, Lisa Curran, Jonathan Foley, James Hansen, Gregory Jenkins, John Jensen, Patricia Matrai, Julian McCreary, Jean-Bernard Minster, Michael Ramsey, Kamal Sarabandi, Mark Simons, Konrad Steffen, Edward Zipser

To: Edward David, Jr. (Chair, NAC Science Committee)

Cc: Greg Williams (NAC Science Committee Executive Secretary), Michael Freilich (ESD Director), Bryant Cramer (ESD Deputy Director), Jack Kaye (ESD Associate Director for Research), Theodore Hammer (ESD Associate Director for Flight Program), Teresa Fryberger (Associate Director for Applied Sciences). Lucia Tsaoussi (ESS Executive Secretary)

Date: March 21, 2007

Dear Dr. David:

The Earth Science Subcommittee (ESS) met on February 27-28, 2007 in Tempe, Arizona, on the occasion of the NASA/NAC Workshop on Science Associated with the Lunar Exploration Architecture. **Our discussion focused primarily on the recent NRC Decadal Survey (DS) recommendations and their implementation by ESD. This issue requires urgent attention from the NAC as explained below and summarized in Appendix 1.** We also took advantage of Earth Science breakout sessions at the Workshop to discuss Earth Science opportunities from the Moon in the context of lunar exploration. Our findings are presented in a separate ESS report submitted to the NAC under the leadership of member Michael Ramsey. **An important issue for the NAC to address now is the choice of location for the lunar outpost and the opportunity for an orbital L1 location; this has important implications for Earth Science and our recommendations in that regard are summarized in Appendix 2.**

The NRC Decadal Survey, *Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond* (National Academies Press, 2007) is a very important document. It offers the first assessment of satellite mission priorities across the spectrum of Earth Science disciplines and for three agencies (NASA, NOAA, USGS). It does so at a time when public concern over global change is mounting, and it stresses NASA's responsibility for addressing that concern. The DS presents an agenda of 15 new strategic NASA missions for 2010-2020 that target the most pressing questions for understanding our home planet and its ongoing rapid change. The agenda also includes a new line of competed NASA "Venture" missions in the \$100-200M range to enable infusion of new technology and ideas. Overall, we find the program put forth by the DS to be remarkably thoughtful and balanced. The NASA component is fully doable according to the DS if ESD returns to its 2000 real-dollar budget – reversing the 33% cut that it suffered between 2000 and 2007. Preliminary ESD estimates indicate that the DS mission costing is close to the mark. The DS describes its plan as a "minimal, yet robust, observational component of an Earth information system that is capable of addressing a broad range of

societal needs." It warns against cherry-picking missions from the list of 15 as this would disrupt the carefully crafted synergy and balance across fields. **The ESS endorses the Decadal Survey recommendations of 15 priority NASA Earth Science missions for 2010-2020 and urge that the complete program of missions be executed. This will require a NASA Earth Science Initiative to provide the funding level necessary, effectively by restoring ESD budgets to 2000 levels in real dollars.**

Without such an agency-level Earth Science Initiative it would indeed be impossible to implement the DS program, even at a credible partial level. As a result of budget cuts and launch delays, ESD has already slipped behind the timing recommended by the DS (four new missions in 2010-2013, five in 2013-2016, five in 2016-2020). The 7 ESD missions presently in development, and which need to be completed as the DS program is phased in, extend to 2014 (GPM launch). In the current ESD budget outlook through FY14, the next planned AO is in FY08 for an ESSP-sized \$490M mission with 2014 launch date. After FY08 there is no AO planned until FY13. There is no budget for the DS-recommended Venture missions line. The current ESD budget outlook essentially defaults on the Decadal Survey to the point where, in the Survey's own words, one would need to completely reevaluate the entire set of recommended missions. **Without a post EOS Earth Science Initiative as described above, NASA will default completely on the Decadal Survey's recommendations. At a time when the Earth System is undergoing rapid change that urgently needs to be better understood, this default will have dramatic societal implications. An Earth Science Initiative, starting in FY09, is essential to avert this crisis.**

The phase-in of the Decadal Survey recommendations must begin immediately to avoid further lag. **We recommend that the FY 08 AO for an ESSP-class mission be redirected to a Decadal Survey mission, initiating implementation of the first phase of the DS (2010-2013).** Infusion of new ESD funds in FY09 through the aforementioned Earth Science Initiative will then be critical to keep the pace and maintain the vitality in the implementation of the DS missions. We recommend that an AO for a Venture-class mission be released in FY09, and that the second strategic DS mission be selected in FY10. **We recommend a long-term mission schedule starting in FY09 with a Venture-class mission and a strategic Decadal Survey mission selected in alternate years.**

Financial realities obviously mandate that creative approaches be sought in implementing the DS recommendations. As pointed out by the DS, substantial cost savings can be achieved through partnerships with foreign space agencies and these should be aggressively sought. Earth Science observations from space are of global interest, and NASA should leverage on the investments made by other countries through instrument cost-sharing and data exchange agreements. The CEOS constellations presently being developed in different areas of Earth Science are a promising vehicle for such partnerships. They will require discipline and flexibility in accommodating the interests and schedules of our international partners. The stakes are too high for NASA not to do this. **We strongly endorse the CEOS constellation concept for international partnerships in Earth Science observations, and encourage ESD to invest in the concept as a means of implementing the full suite of Decadal Survey recommendations.**

Mission cost overruns and delays have been an endemic financial problem for the ESD, in effect clogging the pipeline for future mission opportunities. Addressing this problem is of critical importance. We were pleased to learn of the new mission costing

model now being implemented in ESD that will be used over the next few months for costing the DS missions. However, we heard of no clear plan to address cost overruns and delays. Risk mitigation is a major factor in cost overruns, and the DS encouraged NASA to accept more risk in its missions. The ESS agrees. **We recommend that ESD develop procedures to reduce mission cost overruns and prevent delays, including some acceptance of increased risk.**

As budget pressures rise to implement the DS missions, the ESS strongly reaffirms the importance of preserving research budgets. **It is extremely important, as budget lines are developed for future missions, that ESD research budgets (R&A and mission science) be maintained and grown at least in line with inflation.** The importance of preserving research budgets was stressed in our previous letters. Under no circumstances should the percentage share of the ESD budget devoted to research be shrunk to support new satellite missions. Support for new missions must come from growth in the overall ESD budget. In addition, ESD should not attempt to save small amounts of money by discontinuing current missions in orbit as long as the data continue to be of value for Earth science. **We recommend that missions already in orbit be continued past their design lifetime contingent on their usefulness as determined by the Senior Review Process.**

A continuing source of tension in assessing space-based measurement priorities for Earth Science is to balance the need for exploratory new measurements with that for long-term sustained observations of critical Earth variables. The DS provides only limited guidance on this issue, in part because its deliberations preceded the disastrous NPOESS descoping of June 2006 which led to the loss of several long-term climate sensors. Our previous letter to the NAC (October 2006) elaborated on the need to restore these climate sensors and noted that the collection of long-term Earth System data sets should be viewed not as routine monitoring but as critical for Earth Science and as a challenge for technology innovation. We are aware of ongoing negotiations between NASA and NOAA on the restoration of long-term climate observation capabilities aboard NPOESS and through other means, but unfortunately we have not been authorized to share in the contents of these negotiations. NRC will convene a workshop on long-term climate measurements this coming summer and we urge NASA and NOAA to act on the recommendations from that workshop. **We reiterate our recommendation that NASA assume responsibility for sustained long-term measurements of total solar irradiation and outgoing thermal radiation.** Our rationale for this recommendation was developed in our October 2006 letter.

We also spent some time discussing the problem of uncosted carryovers in ESD budgets and the possibility for ESD to recover some of those funds. We recognize that there are a number of reasons for these uncosted carryovers, and individual accounting is complicated by the large number of ESD grants (~1500). We suspect that an important factor is the excessive delay in the proposal selection and funding processes. This delay builds lag into the system and complicates the investigators' schedules for hiring staff or students, and this can then in turn compromise timely spending on the project. Selection and funding delays have been getting progressively worse over the past five years. We were pleased to hear that ESD plans to speed up its proposal selection and funding process, but note that major problems still exist in at least some ESD programs. **We recommend that ESD speed up its procedures for selection of proposals and transfer of money to investigators. We believe that this will help to decrease the uncosted carryover problems in the future.**

Because of our limited meeting time in Tempe and the pressing need to address the Decadal Survey recommendations, we had to postpone to our next meeting discussions of the suborbital program and of the technology development program. Four additional topics that we wish to cover at our next meeting are: (1) the status of the NPOESS re-scoping and strategies for maintaining continuity in critical long-term Earth Science observations; (2) the compatibility between Earth Science objectives for the Lunar Exploration Architecture and the DS recommendations; (3) a discussion of the ESD data systems program, which plays an increasingly important role for managing the growing ESD data sets and represents a substantial wedge in ESD's budget; (4) improving schedules for proposal review panels, selection notification, and money flow to selected investigators.

We are at your disposal for further information.

Sincerely,

The Earth Science Subcommittee

APPENDIX 1: Proposed Recommendation for the NAC Science Committee

Subcommittee Name: Earth Science

Chair: Daniel J. Jacob

Date of Public Deliberation: Feb 27-28, 2007

Date of Transmission: March 21, 2007

Short Title of Proposed Recommendation: **NASA Earth Science Initiative to act on the recommendations of the NAS Decadal Survey**

Short Description of Proposed Recommendation:

The ESS endorses the Decadal Survey recommendations of 15 priority NASA Earth Science missions for 2010-2020, and urges that the complete ensemble be executed in a timely way for a minimum balanced program. This requires a post-EOS NASA Earth Science Initiative to provide the funding level necessary. Such an Initiative can be funded by restoring the ESD budget to its 2000 level in real dollars.

Outline of the Major Reasons for Proposing the Recommendation:

The NAS Decadal Survey offers the first assessment of satellite mission priorities across the spectrum of Earth Science disciplines for three agencies. It does so at a time when public concern over global change is mounting, and it stresses NASA's responsibility for addressing that concern. The DS presents an agenda of 15 new strategic NASA missions for 2010-2020 that target the most pressing questions for understanding our home planet and its ongoing rapid change. The missions have been carefully selected to address strategic imperatives in Earth Science and climate change, and they represent a carefully crafted synergy and balance across Earth Science disciplines. The DS agenda also includes a new line of NASA "Venture" missions in the \$100-200M range to enable infusion of new technology and competition of new ideas. Overall, the ESS finds the program put forth by the DS to be remarkably thoughtful and balanced. The NASA component is doable if ESD returns to its 2000 real-dollar budget – reversing the 33% cut that it suffered between 2000 and 2007.

Outline of the Consequences of No Action on the Proposed Recommendation:

Without a post EOS Earth Science Initiative as described above, NASA will default completely on the NAS Decadal Survey's recommendations. At a time when the Earth System is undergoing rapid change that urgently needs to be better understood, this default will have dramatic societal implications.

APPENDIX 2: Proposed Recommendation for the NAC Science Committee

Subcommittee Name: Earth Science
Chair: Daniel J. Jacob
Date of Public Deliberation: Feb 27- Mar 1, 2007
Date of Transmission: March 21, 2007

Short Title of Proposed Recommendation: **Enabling Earth Science as part of the Lunar Exploration Architecture**

Short Description of Proposed Recommendation:

A lunar-based Earth Observatory would be an important resource for Earth Science and ESS recommends that it be given higher priority in future lunar planning. The proposed outpost location at Shackleton Crater will offer very limited views of the Earth (< 10% of the time) and not meet the needs of most Earth Science applications over the long-term. Alternative lunar or orbital locations should be explored. We adopted a formal criterion of success: *acceptable* (Earth views > 50%) and *desirable* (Earth views > 90%). Alternative lunar or orbital locations must be explored in order to achieve the *desirable* outcome.

Outline of the Major Reasons for Proposing the Recommendation:

Two overarching questions were addressed at the workshop: (1) what unique/complementary set of observations can be made from the moon that would enhance data from LEO/GEO satellites; and (2) could those measurements be made from the proposed lunar outpost location? We concluded that a lunar-based Earth Observatory would offer a unique, stable, serviceable platform for global, continuous, full-spectrum views of the Earth and could address a range of Earth Science issues (long range transport of pollution plumes, volcanic eruption monitoring, ecosystem health, ice sheet disintegration, etc.). The current outpost location is not optimal for Earth observation, but it could still be useful for instrument testing in the early stages of lunar exploration. The final location should be subject to careful analysis now and considered thoughtfully during the next phase of planning for a lunar outpost. The subcommittee identified unique advantages for a lunar-based Earth Observatory such as a common location for all instruments and a consistent architecture across instruments. A phased growth approach from relatively simple to more complex instrumentation involving human or robotic sorties to the optimal location is recommended.

Outline of the Consequences of No Action on the Proposed Recommendation:

Assuming the current outpost location does not change and without the ability to place Earth observing instruments at a site on or above the lunar surface, the ability to conduct Earth Science from the Moon would be very limited.