Earth Science Subcommittee Report
from the May 3-4 2006 NASA Science Planning Conference

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 S. Ramsey, Kamal Sarabandi, Mark Simons, Konrad Steffen, Edward Zipser
TO: Charles Kennel (Chair, NAC Science Committee)
CC: Mary Cleave (Associate Administrator for SMD)
Date: May 10, 2006

Dear Charlie:

We write to report on the findings and recommendations from our Earth Science Subcommittee meeting during the May 3-4 NASA Science Planning Conference at the University of Maryland. We were very pleased to see the reconstitution of the science advisory structure at NASA. We greatly appreciated the openness of information provided at the Conference as well as the help and support of Bryant Cramer (ESD Acting Director), Jack Kaye (ESD Acting Deputy Director) and Lucia Tsaoussi (ESD Executive Secretary) during our subcommittee breakout sessions. Our charge at the Conference was to offer recommendations on (1) the general resource allocation within ESD, (2) the development of an ESD Roadmap as part of the NASA Science Plan due by the end of the year. Our findings on these two topics constitute the bulk of this letter. They must be viewed as preliminary in view of the short amount of time that we had to digest information and discuss various issues.

Before we get into specifics, however, we must express our deep frustration at being put in the position to accommodate the large cuts in Earth Science funding in FY05 and FY06, compounded by long-term prospects of sub-inflationary growth. These cuts have grave impact for NASA to fulfill its unique responsibilities to address critical societal issues dealing with Earth system variability and change, severe weather forecasting, and natural hazards. They damage NASA's ability to fulfill its duties to the Climate Change Science Program. They compromise U.S. competitiveness in Earth science and the training of the next generation of Earth scientists, an issue recently brought to the fore with the Presidential American Competitiveness Initiative. The NRC report, "*An Assessment of Balance in NASA's Science Programs*", released just at the time of the Conference, elaborates on the essential need for NASA to revitalize its science programs. We fully endorse the report, and our recommendations for how best to manage the ESD cuts are done from the perspective of having to do the best out of a very bad situation.

1. Allocation of Resources within ESD

Following our charge at the Conference, we begin with some guiding principles for allocation of resources within ESD, and follow with specific recommendations.

1.1 Guiding Principles

Similarly to the other Science Divisions, ESD relies critically on a sustained schedule of space missions balanced with a healthy R&A and technological development program. ESD is also in a unique position in that it serves not only an exploration need but also NASA's societal responsibility to protect our home planet against Earth system variability and change, severe weather, and natural hazards. NASA has particular capability for protecting our planet through the power of space-based observations. However, this also means that NASA's approach to Earth science research must consider, in addition to the push for scientific innovation and discovery, four additional factors:

(1) Observation of variability and change in the Earth system requires long-term, highly calibrated, highly accurate data sets, and the avoidance of gaps, and such long-term time series must be maintained at the same time that NASA develops the capabilities for new types of observations.
(2) The Earth system can be sampled not only from space but also in situ, and major advances often arise from integration of NASA spaceborne data with observations generated by NASA suborbital platforms and independent research programs, supported by advanced modeling activities.
(3) Successful application of NASA science to societal outcomes generally involves substantial effort in the transition from research to operations, typically involving partnership of NASA with operational agencies (NOAA, EPA, USGS…).
(4) NASA Earth science data sets are of interest to a wide range of users involved in research and applications, in the United States and elsewhere, requiring that these data sets be fully and openly accessible for the most efficient conduct of science.

These considerations require that ESD follow a somewhat different approach to space missions and R&A than other Science Divisions, involving in particular:

(a) Continuity of ever-more advanced and precise means to monitor critical variables while maintaining the long record for assessing the changing Earth system;
(b) Pursuit of collaborative agreements and leveraging opportunities with non-space agencies;
(c) Development of information technology resources to facilitate data archival and mining;
(d) Particular responsibility for R&A to assimilate multiple data sets and develop integrated modeling capabilities.

1.2 Principal Recommendations

Within the constraints of the overall ESD budget, we were presented by Bryant Cramer with the current budget breakdown and various options to optimize this allocation in a manner most beneficial to Earth Science. On the basis of this information, we offer the following recommendations:

1. **Restore R&A funding, at least in substantial part, in FY07.** The large retroactive cut in FY06 will have devastating effects on the research community, especially

young researchers, if it is not alleviated in FY07. A one-time cut can be at least partially absorbed by phasing of contracts, delay of purchases, etc., but a long-term cut of that magnitude would have severe impacts on the lifeblood of the Earth science community, with strong negative implications for the ability of the community to meet national needs at a time when the importance of Earth science and global change issues are growing markedly. In addition, a vigorous satellite program cannot take place without a strong and stable R&A program. As pointed out in the above-mentioned NRC report, full restoration of R&A across all NASA Science Divisions would require only a very small percentage increase in the SMD budget.**Do not further delay any of the currently planned missions.** A sustained and balanced schedule of satellite missions is essential for the vitality of Earth science. The currently planned missions have all been delayed. Delays add cost to the missions and prevent the planning of new missions. In the case of GPM, the delay jeopardizes the international partnership and the mission itself.**Extend the lifetime of missions currently in space for as long as they return high-quality and useful data,** The costs of these extensions are modest and maintenance of long-term data sets is of particular value, as mentioned in our guiding principles.**Optimize the mission profile by launching medium-class missions (~$500M) every 1-2 years with an additional ESSP mission (~$250M) every four years.** The current budget projections presented to us by Bryant Cramer can sustain 6 medium-class missions and 3 ESSP missions through 2025. Medium-level missions offer in general the best data return for investment, provide a diversity of data sets to serve broad constituencies of the Earth Science community, and can constitute the backbone for building a NASA strategic vision for Earth Science. ESSP missions offer opportunities to infuse new ideas and should be widely competed. Large missions (~$1B) have the benefit of offering simultaneous observations of a large number of variables, but they are difficult to manage and often result in launch delays and unanticipated costs.**Release an AO for an ESSP and a medium-level mission in FY07; do not wait until FY08.** An AO in FY07 will re-energize the community and enable a timely schedule for new missions.**Restore funding for technology development (severely reduced since the end of the New Millenium Program) to enable scientific innovation and decrease mission costs.** We are particularly interested in the potential for microsatellites (payload < 25 kg) to provide cheap access to space in the long-term future.**Seek to decrease the costs of missions through (a) co-funding by international partners and U.S. agencies (NOAA, DOD…), (b) technological innovations, and (c) acceptance of some increased risk.** Costing procedures for satellite missions must be improved in the future to avoid being faced with cost overruns that require unexpected cuts in R&A.

There are other budget allocation issues that we did not have time to address, notably (1) funding for suborbital science, (2) funding balance between ROSES-competed R&A and "mission science", (3) full-cost accounting of civil servants and the overhead procedures at NASA Centers. We hope to examine these issues at our next meeting. (2) and (3) may be of importance in terms of the resources needed to restore R&A funding.

2. Construction of the Earth Science Roadmap

Strategic planning in ESD in the past has taken place independently for the six focus areas: (1) atmospheric composition, (2) carbon cycle and ecosystems, (3) climate variability and change, (4) Earth surface and interior, (5) water and energy cycle, and (6) weather. The NASA Science Plan due at the end of 2006 requires the integration of these different focus areas into a single Earth Science roadmap. The main challenge in constructing such an Earth Science roadmap is to identify a prioritized list of missions cutting across the focus areas. A stable, robust program for ESD requires a balance between the six focus areas in terms of scheduled missions, while seeking synergies and partnerships across the focus areas. There should also be significant opportunities for cost reductions through collaborations with other U.S. agencies and with international space agency partners.

The NRC Decadal Survey on Earth Science Applications from Space (ESAS), due to be completed at the end of the calendar year, specifically addresses the prioritization of future satellite missions for Earth Science and should guide ESD's strategic vision. The deadline imposed by the NASA Science Plan requires that a preliminary prioritization be put in place before official input from the NRC Decadal Survey, with the understanding that this prioritization will need to be adjusted on the basis of the NRC input. We discussed at the meeting the mission concept priorities previously identified by the individual NASA focus areas. These priorities were developed thoughtfully by the focus area program managers in consultation with their communities, and they often correspond to one or more of the mission concepts submitted to the NRC Decadal Survey as part of its Request For Information (RFI). However, we do not feel comfortable at this time in making even preliminary recommendation on priority mission concepts. We need further input from the Earth Science community. We plan to seek this input over the next few months and develop on that basis a preliminary list of prioritized missions, to be updated subsequently with input from the NRC Decadal Survey.

We hope that the NAC SSC will find our preliminary findings and recommendations useful and we are at your disposal for further information.

Sincerely,

The Earth Science Subcommittee