**Earth Science Subcommittee Report**
**May 11 and 12, 2010**
**NASA Headquarters**

**From:** The NASA Earth Science Subcommittee – Byron Tapley (Chair, NAC ESS), Daniel Jacob, (Vice Chair NAC ESS), John Christy, Judith Curry, Efi Foufoula-Georgiou, James Hansen, Raymond Hoff, Gregory Jenkins, William Large, Mahta Moghaddam, Patrick McCormick, Anna Michalak, Jean-Bernard Minster, Steve Running, Robert Schutz, David A. Siegel, Hank Shugart, Mark Simons, Konrad Steffen, Charles Vorosmarty, Lucia Tsaoussi (Earth Science Subcommittee Executive Secretary)

**To:** Wes Huntress (Chair, NAC Science Committee)

**Cc:** Jens Feeley (NAC Science Committee Executive Secretary), Michael Freilich (ESD Director), Peg Luce (ESD Deputy Director), Jack Kaye (ESD Associate Director for Research), Stephen Volz (ESD Associate Director for Flight Programs), Lawrence Friedl (Associate Director for Applied Sciences), Lucia Tsaoussi (Earth Science Subcommittee Executive Secretary)

Dear Wes:

The Earth Science Subcommittee (ESS) met on May 11 and 12, 2011 at NASA Headquarters.
The objective of the meeting was to obtain an update on the status of the Earth Science Division in the context of: 1) the budget, including both the revised FY 11 budget and the proposed FY12 budget, 2) the division plans related to the post GLORY launch failure, 3) the science community concerns related to the postponement of the DESDnyI and CLARREO missions and 4) to obtain an in depth review of the Modeling and Data Assimilation activities.

Michael Freilich, ESD Director, gave a comprehensive briefing on the status of the ESD program outlining the impact of the FY 2011 budget appropriation and outlook for the Division under the proposed FY 2012 Presidential Budget Submission. He described the apparent manifestation of the GLORY launch vehicle failure and informed the ESS that, rather than fly a replacement mission, replacement measurements might be obtained by interacting with other mission implementations. He discussed the problems facing the ESD in launching the payloads planned for missions during the coming decade and noted that the availability of acceptable launch vehicles is one of the most significant challenges facing ESD. Launch vehicle reliability, capability and cost, all, pose challenging problems.

He noted that NASA continues to fly the preeminent constellation of Earth Observation Satellites, but that most of the satellites are well past their nominal mission lifetime, after far exceeding their design lifetimes. ICESat and QuickSat have failed during the last year and the Solar Radiation and Climate Experiment (SORCE), Gravity Recovery and Climate Experiment (GRACE), and Cloud Sat satellites are having significant battery issues. In general, the constellation is supporting exceptional scientific research and application advances in the earth science community. Dr. Freilich reported that all missions are expected to continue following the 2011 Senior Review.

Regarding the budget outlook, he reported that the FY11 budget was not finalized until April 2011 and that the FY 2012 budget was less than the President proposed, but above the FY10 budget. Although there are some important deficiencies, there is funding for a significant program. Under direction of the Administration, an Integrated Climate Initiative was developed by ESD as a part of the FY 2011 budget submission and signed by the Office of Management and Budget (OMB) as a closed plan. In developing the plan, the Administration provided guidance on priorities, which do not completely match those of the 2007 NRC Decadal Survey, and recommended a significant increase to the ESD budget to implement the initiative. Since the full funding for the Climate Initiative did not

materialize in the FY 2012 budget, the Administration directed ESD to defer and eliminate specific elements of the proposed program. The other elements of the initiative are being implemented as proposed.

**Finding: The ESS finds that the FY 2011 budget and the proposed FY 2012 budget allows satisfying most of the requirements for a rich and diverse program in the Earth Sciences and Applications. However, the delay in two important missions, included as part of the Integrated Climate Plan, is a significant concern.**

The role of international collaboration in the implementation of the ESD program continues to grow. The establishment of a formal bilateral framework for collaborating with the European Space Agency (ESA) is significant development. The enhanced activity in collaborating with ESA follows a change in ESA's data policy, which now allows more open access and is more consistent with the policy followed by NASA. In other activities, NASA is collaborating with the India Space Agency (ISRO) on a project to continue the important vector surface measurements from Quick Scat, which has reached the end of a successful mission. The French space agency, CNES, is collaborating with NASA to develop the Surface Water and Ocean Topography (SWOT) mission. Other collaborations involve active interactions with the space agencies of Canada, Japan, Argentina and Germany.

**Observation: The set of ESD activities in establishing active collaborations with international partners, particularly with the European Space Agency, is important in meeting the comprehensive demands for satellite observations for science and application purposes. These international collaborations will enable a more robust and complete observation capability.**

As noted above, the FY 12 budget submission was accompanied by specific direction from the administration that CLARREO and DESDynI be placed in a state of indefinite delay. The delay in the missions, which are an important part of the Integrated Climate Initiative submitted as an element in the FY 11 Budget submission, is a significant concern to the ESS. The delay in the DESDynI mission, along with the failure of other international L-Band Radar assets, finds the community without data to support numerous important science and natural hazard needs. Given the importance of the DESDynI measurements of polar ice sheet change and measurements of tectonic deformations of volcanoes, deformation at the continental plate boundaries and capabilities for observing and responding to natural and anthropogenic hazards, the ESS urges that all possible options be considered to recover from the DESDynI mission delay.

In particular, the ESS notes that administration directions for implementing the FY 12 budget states that the DESDynI-Radar is deferred until affordable. Based on the previous review, the ESS believes that there is science margin available for redefining the mission. The ESS recommends that an urgent planning process be initiated to develop an alternate DESDynI-Radar mission concept that reduces the cost of the overall mission, either through reduced science objectives or through international partnership. We recognize that there may be a loss of some elements of the science contributions, but achieving even a reduced set of the science measurements, with a more timely mission implementation, would be of immense value to the Earth Science community.

**Recommendation: In response to administration directions from the FY 12 Budget related to the DESDynI mission cost, and in view of the urgent science and application needs, the ESD should initiate the activities required to develop a reduced cost L-band radar mission, where the final mission concept would be based on an acceptable compromise between mission cost and science objectives. The potential for international partnership should be considered as a means of achieving the optimum cost/science compromise.**

A significant portion of the meeting was devoted to presentations related to the ESD modeling and data assimilation activities. This topic was scheduled as an outgrowth of a NAC Science Committee concern related to the extent to which the rich spectrum of data collected by the NASA science

satellites is being assimilated into models. The ESS appreciates the comprehensive briefings by Dr. Jack A. Kaye, Associate Director for Research in ESD and Dr. David Considine, Manager of ESD's Modeling, Analysis, and Prediction (MAP) Program. The presentations presented an overview of the role of the modeling and data assimilation in the overall goals of the ESD. It was noted that the overarching goal of ESD is to advance Earth System science, including climate studies, through space borne data acquisition, research and analysis, and predictive modeling. As such the modeling activities are one of the foundations for achieving the research goals.

Presentations from eight different elements of the overall program gave a comprehensive overview of a broad program with a number of stimulating research elements of international importance. The activity has a mission level scope and is providing important contributions to the overall national need for information provided by satellite observations. The effort is centered on observationally driven modeling, which requires a comprehensive assimilation of the observations acquired by the ESD satellites. The effort involves an active interagency collaboration, involving six additional government agency modeling activities, and spans areas from weather and natural hazard to decadal and century scale climate change. The presentations described two major Global Modeling efforts with goals of developing predictions for understanding climate change. NASA relies on the GISS Model E for investigations of the Earth system evolution on the time scales of decades to centennial scales, while for short term to decadal variability; the GEOS 5 modeling system is used. It was reported that neither model involves a fully coupled atmospheric, ocean and land surface model for understanding and predicting the overall Earth system dynamics. It was noted that to support many application related efforts, timeliness is important and a rapid assimilation of the satellite data into the models is required.

The ESS appreciated the extensive briefing and noted that the presentations described broad capabilities and accomplishments, while raising a number of questions. With the diversity of the overall program, there were some elements that could not be covered in the allotted time. The ESS notes that observation-based model development is important and the acquisition of near synoptic global observations represents a unique NASA capability. The issue of the fully coupled Earth System Models is in a primitive state of development and should be given more attention in future activity. Concerns were expressed about code verification and the complexity and diversity of the suite of models being used. Both of these topics suggest a need for a more comprehensive coordination effort. The ESS raised questions about the management of uncertainty and the closely related topics of uncertainty assessment and validation and verification. The topic of in-situ measurements for V&V was not discussed, whereas it should be an integral part of the observation and modeling systems. The ESS will request a briefing on the organizational structure and the overall management concept, along with procedures for programmatic oversight, at subsequent meetings.

**Observations: NASA's various modeling efforts have developed independently and are at differing levels of maturity. Effort should be made to integrate more fully the various elements into a complete, coupled and interactive description of the Earth System. Verification and documentation of the code were identified as important requirements. Both the ability to assimilate satellite data and the prediction capabilities were at differing stages of development in the various elements of the program. Future activities should include a focus on the coupling between the elements of the Earth's Dynamical System.**

The ESS notes a concern by members of the solid earth community related to the lack of visibility of the solid earth efforts and to the lack of success in realizing solid earth related missions. The loss of DESdnyI underscores this concern. It is further noted that in the discussions of the NASA modeling activities, there was no discussion of the NASA state-of-the-art modeling of ice sheets (ISSM), NASA's contributions to understanding and monitoring global seismic and volcanic processes with both observations and models nor NASA's ability to provide near real time estimates from space of the devastation from earthquakes, volcanoes, fires and floods.

**Finding: The solid earth activities are an asset for NASA and they should be recognized as an essential part of its portfolio of modeling activities.**

The next ESS meeting is planned for September 2011.

Sincerely,

The Earth Science Subcommittee
Byron Tapley, Chair