

**Earth Science Subcommittee Report
January 7-8, 2009 Meeting
NASA Headquarters**

From: The NASA Earth Science Subcommittee – Daniel J. Jacob (chair, djacob@fas.harvard.edu), John R. Christy, Jonathan Foley, James Hansen, Raymond Hoff, Gregory Jenkins, Patricia Matrai, Patrick McCormick, Julian McCreary, Jean-Bernard Minster, Michael Ramsey, Steve Running, Kamal Sarabandi, Robert Schutz, Mark Simons, Konrad Steffen, Charles Vorosmarty

To: Jack Burns (Chair, NAC Science Committee)

Cc: Greg Williams (NAC Science Committee Executive Secretary), Michael Freilich (ESD Director), Peg Luce (ESD Acting Deputy Director), Jack Kaye (ESD Associate Director for Research), Stephen Volz (ESD Associate Director for Flight Programs), Teresa Fryberger (Associate Director for Applied Sciences), Lucia Tsaoussi (Earth Science Subcommittee Executive Secretary)

Date: January 26, 2009

Dear Jack:

The Earth Science Subcommittee (ESS) met on January 7-8, 2009 at NASA Headquarters. We received updates on ESD (Michael Freilich), the Research Program (Jack Kaye), the Flight Program (Steve Volz), and the Applied Sciences Program (Teresa Fryberger). We received a report on the Modeling and Analysis part of the Research Program (Don Anderson), with a particular focus on the NASA/GSFC Global Modeling and Analysis Office (GMAO) activities (Michele Rienecker). We received status reports on the Decadal Survey implementation (Steve Volz) and on the Earth Science vs. Space Science Cost Study (Peg Luce). We discussed concerns regarding future gaps in stratospheric monitoring from space.

Our summary recommendations are presented in bold. **We request that you transmit to the NAC four of our recommendations:**

- 1. Midterm review of the Earth Science Decadal Survey**
- 2. ESD leadership in long-term climate monitoring from space**
- 3. Fostering international partnerships for Earth observations from space**
- 4. Open data-sharing agreements with international space agency partners**

We elaborate on these recommendations in the text below and in four Appendices following the standard format. We also include in our letter a number of recommendations for direct consideration by the ESD leadership.

A major topic of discussion at our meeting, as in previous meetings, was the implementation of the NRC Earth Science Decadal Survey (DS) as a blueprint for ESD's strategy over the next decade. Again, we applaud ESD's commitment to execute the DS and its actions to implement the first tier of missions. At the same time, we note that current budgets will allow implementation of only a third of the DS ensemble of 15 NASA missions over the next decade. ESD costing of the DS missions has produced estimates considerably larger than originally put forward by the DS, so that the DS ensemble could not be achieved even with restoration of ESD budgets to 2000 levels (before the 30% cut that has taken place since then). Considering that the DS ensemble of missions was carefully crafted as a

“minimum” synergistic program of Earth observation from space at a time of great societal concern over global change, there is a pressing need to review how to adjust this ensemble to budget realities and bolster opportunities to work with international space agency partners, implement new technologies, and reduce mission costs. Concern over the capability of NPOESS to deliver on long-term measurement continuity of climate variables should also loom large in this context. Review of the DS is urgently needed, not necessarily in terms of scientific priorities but in terms of implementation. The customary midterm review for Decadal Surveys, which in this case would be three years from now, is too late. **We recommend that a midterm review of the Decadal Survey commence immediately to take into account budgetary developments, NPOESS issues, new technologies, and opportunities for collaborations and mission-sharing with international partners. The review needs to be substantial and anchored in accurate projections of mission costs.**

Again, we applaud ESD’s commitment to proceed with Tier 1 of DS missions (SMAP, ICESat-II, DESDynI, CLARREO), as well as supporting development of Tier 2 missions through seed funding. Some support should extend to pre-formulation of Tier 3 missions, which are certain to be revisited in the next Decadal Survey and would gain from improved definition. **We recommend that modest resources be allocated to pre-formulation of DS Tier 3 missions (such as community workshops) in order to improve their definition in preparation for the next Decadal Survey.**

Our previous letter emphasized the importance of the DS Venture-class mission line to supplement the DS ensemble of strategic missions with grass-roots injection of new ideas and opportunities. The ESD budget line still does not include any funding for Venture-class missions. **We recommend that ESD formally include Venture-class missions into its budget line, with an AO as soon as possible, as part of its commitment to implementing the Decadal Survey.**

We emphasized in previous letters the critical importance for climate science of long-term monitoring of selected climate variables, and repeatedly expressed our concern over NPOESS’s feeble commitment to climate monitoring. NPOESS cost overruns have led in the recent past to complete de-manifestation of the climate instruments suite. Some instruments have since been restored, but others have not (OMPs-Limb beyond NPP, APS, CMIS) and the status of VIIRS remains uncertain. The core of the problem is that neither NOAA nor DoD (the major partners of NPOESS) have effectively taken on responsibility for long-term climate monitoring from space and the exacting requirements that this implies in terms of instrument precision, calibration, and continuity. We think that it is an opportune time for NASA ESD to assert leadership for satellite-based global change monitoring and multi-decadal climate data records. Of the federal science agencies, only NASA has a history of high-precision global remote sensing and high-volume data processing and delivery from which climate data records can be built and used for global change science. Cost-sharing should be pursued through GEOSS with international space partners who similarly have a stake in climate monitoring. **We recommend that NASA position itself as the leading agency for long-term monitoring of climate from space and that it develop a plan for such monitoring in collaboration with international space partners and independently of NPOESS.**

Improving collaboration with our international space partners is a major issue. ESD engages in vigorous international collaborations through instrument science teams and shared instruments and launch vehicles. But we believe that this collaboration needs to be

more proactive and already engaged at the strategic level. There is no reason that a strategic plan for Earth Science observations, as formulated by the DS, should not be developed at an international level and as a global partnership between space agencies. Our international space partner agencies have scientific priorities similar to NASA, resulting in apparent mission overlaps where one wonders if the agencies are making the best use of their resources. For example, we expect to start having this year CO₂ observations from OCO, but also from GOSAT (JAXA). The first DS mission to be implemented is the soil moisture SMAP mission, while ESA will launch SMOS this coming year to measure soil moisture and ocean salinity. We recognize that there are significant differences between these missions, and that international collaboration on missions can bring in additional costs. It still seems that a more effective way to leverage limited resources could be for individual agencies to take charge of specific missions in a concerted strategy. For example, if our international space partners committed to take charge of some of the DS missions we would be together significantly ahead in terms of implementing the complete DS. **We recommend that ESD increase international collaboration in its strategic vision for Earth Science observations, including implementation of the Decadal Survey.**

One significant requirement for international coordination to succeed is an open data-sharing protocol between space agencies. NASA makes all its Earth Science data openly and easily accessible worldwide, but other space agencies do not. We note that guidelines are in place and responsibilities laid out under CEOS and GEO. ICSU's CODATA (International Council for Science : Committee on Data for Science and Technology) could serve as a useful avenue for active engagement of ESD on this issue. **NASA should negotiate open data-sharing agreements with its international space partners (in particular ESA and JAXA) to (1) remove all impediments to free, open, rapid, and easy access to data; (2) minimize bureaucratic overhead; and (3) develop redundant data centers within each participating country.**

We continue to be pleased with ESD's progress in the processing of proposals. Selection rates average 30% and selection times average 4 months; these are excellent numbers. We are concerned by the low selection rate (20-25%) for New Investigator Program (NIP) proposals. The current cap for these proposals (\$125K/y) could be significantly lowered and still make the program attractive for new investigators to develop their research programs. **We recommend that ESD find a way to increase the NIP selection rate, and suggest that decreasing the funding cap would be an acceptable way to do so.**

The ESD Applied Sciences Program plays an important role in enabling the extension of NASA satellite observations from scientific research to societal benefit. The program has had past difficulties in engaging operational agencies and in completing the extension from research to applications. We are pleased to hear of the formation of an Applied Sciences Analysis Group (ASAG) to help define the direction of the Program. We encourage the interest expressed by the Program to contribute to the design of space missions. **Continued vigilance is needed to ensure that the Applied Sciences Program provides the best leveraging of ESD's space-based observations for achieving societal benefit. We encourage the ASAG to help the Program develop metrics of success so that its value to SMD is more apparent.**

The Modeling Program is presently focusing all its resources on the development of Earth System Model (ESM) capabilities at GMAO and GISS. GMAO has been very

successful as a center for research-based data assimilation capability in support of NASA satellite observations, and GISS has been very successful as a climate research center. But we are concerned that these two centers operate with little extramural participation. If they are to represent the core of ESM development at NASA then they need to vigorously entrain the external community in their activities, and the Modeling Program should provide a vehicle for this to happen. Only in that way will the knowledge gained from other NASA programs be effectively transferred to ESM development and data assimilation. Software engineering (such as ESMF) should be done in such a way that facilitates rather than hinders access and involvement by external investigators. We were glad to hear that GMAO plans to set up an external Advisory Board, and this should help in particular to advise GMAO on its long-term reanalysis efforts such as MERRA and its commitments to IPCC AR-5. But external involvement needs to go beyond advising to include broad participation of the community in ESM development and data assimilation activities. On a different level, it is not clear to us how GMAO and GISS are collaborating with other U.S. centers (NCAR and GFDL) that lead parallel ESM development efforts, and how they complement the efforts at these other centers. Considering the scope of ESM development, it seems that a coordinated national strategy is essential to avoid unnecessary redundancies. Finally, it seems to us that the focus of the Modeling Program on ESM development to the exclusion of process modeling (theory, model parameterizations, data analysis) is appropriate only if sufficient resources for process modeling are available through other programs. **We recommend that the Modeling and Analysis Program (1) foster stronger involvement of the external community in ESM development and data assimilation at GMAO and GISS; (2) express a clearer vision of NASA's role in a national coordinated strategy for ESM development; and (3) ensure a proper coordination and balance with process modeling activities within ESD.**

Infusion of new technology into ESD continues to be a topic of ESS discussion. At our previous meeting we applauded the focus of the Instrument Incubator Program (IIP) on enabling the DS missions. But there should be more to the Technology Program. At our initial ESS meetings 2-3 years ago we had discussed development of micro-sensors and micro-satellites but these efforts seem to have gone by the wayside. An important question is how best to entrain universities in the Technology Program and thus develop the new generation of technologists to serve NASA's needs. **We will need to hold a focused discussion of the Technology Program at our next meeting.**

Preliminary findings from the Earth Science vs. Space Science Cost Study indicate that Earth Science missions are not more expensive than Space Science missions for a given complexity index, contrary to prior assumptions. Earth Science missions tend to be more complex because of instrument precision and accuracy requirements that translate into larger, heavier, and more power consuming complex payloads. We remain concerned by the cost of missions and by the endemic cost overruns. The database assembled in the Study should allow some analysis of the underlying factors. We were surprised to hear of the very large gap between the ESD costing of the DS mission ensemble vs. the original costing by the DS. We have no doubt that the ESD costing is more realistic but note that the DS exhorted NASA to find ways to reduce mission costs, for example through increased risk acceptance and better industry engagement. **Reducing mission costs and avoiding cost over-runs should remain a priority for ESD, and the database assembled by the Earth**

Science vs. Space Science Cost Study should offer insights for understanding differences between missions in terms of costs and cost containments.

The termination of SAGE-II, the failure of the SAGE-III Russian bus, and the non-restoration of OMPS-Limb on NPOESS (beyond NPP) raise concern about continuity in stratospheric profiling observations. NASA has a Congressionally-mandated responsibility for monitoring the stratospheric ozone layer under the Clean Air Act. This is an important responsibility as we enter a period of ozone recovery possibly complicated by climate change. At present, the Aura satellite with OMI and MLS provides ozone column measurements and vertical profiling of stratospheric gases. Aura will be at the end of its design lifetime in 2009, though extended operations might allow OMI and MLS to continue collecting data until 2013. Continuity of ozone column measurements with OMPS-Nadir on NPOESS is still in doubt, and even then there will be no vertical profiling information. The GACM DS mission would provide stratospheric profiling (among other atmospheric measurements) but it is in Tier 3 and not expected for launch before 2020. There may be opportunity to remediate this issue through launch of the already-built SAGE-III instrument (presently in storage at LaRC) together with the ACE solar occultation instrument from the Canadian Space Agency. Preliminary estimates suggest that a SAGE-III/ACE solar occultation mission could be conducted for \$120-200M with Canadian partnership. ESD should explore how scheduling such a mission for launch in low-inclination orbit in 2013 would affect the DS mission schedule. Such a mission should not be considered part of the DS strategic or Venture-class mission lines. **We recommend that ESD examine the implications for DS implementation of launching a SAGE-III/ACE stratospheric profiling mission in 2013 and report on this analysis at our next meeting.**

We noted in previous letters that ESD's Suborbital Program has improved greatly in its stability and direction. We had been concerned about the low usage of the aircraft but are pleased to hear that this usage had increased by 60% from 2007 to 2008, certainly at least in part due to the perceived stability of the Program. The purchase of two Global Hawk aircraft provides a potentially valuable resource for the Venture-class mission line.

Our next meeting will take place in April 2009 jointly with the other SMD subcommittees and the NAC. Specific topics for our next meeting will include (1) review of the Technology Program, (2) discussion of long-term data curation and management needs.

Sincerely,



The Earth Science Subcommittee (Daniel J. Jacob, chair)

APPENDIX 1: Proposed Recommendation for the NAC Science Committee

Subcommittee Name: Earth Science

Chair: Daniel J. Jacob

Date of Public Deliberation: January 7-8, 2009

Date of Transmission: January 26, 2009

Short Title of Proposed Recommendation: **Midterm review of the Earth Science Decadal Survey**

Short Description of Proposed Recommendation:

We recommend that ESD undertake immediately a midterm review of the Earth Science Decadal Survey. The review needs to be substantial and anchored in accurate projections of mission costs.

Outline of the Major Reasons for Proposing the Recommendation:

We applaud ESD's commitment to execute the DS and its actions to implement the first tier of DS strategic missions. At the same time, we note that current budgets will allow implementation of only a third of the DS ensemble of 15 NASA missions over the next decade. ESD costing of the DS missions has produced estimates considerably larger than originally put forward by the DS, so that the DS ensemble could not be achieved even with restoration of ESD budgets to 2000 levels (before the 30% cut that has taken place since then). Considering that the DS ensemble of missions was carefully crafted as a "minimum" synergistic program of Earth observation from space at a time of great societal concern over global change, there is a pressing need to review how to adjust this ensemble to budget realities and bolster opportunities to work with international space agency partners, implement new technologies, and reduce mission costs. Concern over the capability of NPOESS to deliver on long-term measurement continuity of climate variables should also loom large in this context. Review of the DS is urgently needed, not necessarily in terms of scientific priorities but in terms of implementation. The customary midterm review for Decadal Surveys, which in this case would be three years from now, is too late.

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

The opportunity to build a coherent program of Earth Science observation from space that follows the spirit of the DS but accounts for budget realities and major new developments will be missed.

APPENDIX 2: Proposed Recommendation for the NAC Science Committee

Subcommittee Name: Earth Science

Chair: Daniel J. Jacob

Date of Public Deliberation: January 7-8, 2009

Date of Transmission: January 26, 2009

Short Title of Proposed Recommendation: **ESD leadership in long-term climate monitoring from space**

Short Description of Proposed Recommendation:

We recommend that NASA position itself as the agency in charge of long-term climate monitoring from space, with the increased resources that this implies, and that it develop a plan for such monitoring in collaboration with international space partners and independently of NPOESS.

Outline of the Major Reasons for Proposing the Recommendation:

Long-term monitoring of selected climate variables is of critical importance for climate science. NPOESS has proven to be an inadequate vehicle for this purpose. NPOESS cost overruns have led in the recent past to complete de-manifestation of the climate instruments suite. Some instruments have since been restored, but others have not (OMPs-Limb beyond NPP, APS, CMIS) and the status of VIIRS remains uncertain. The core of the problem is that neither NOAA nor DoD (the major partners of NPOESS) have effectively taken on responsibility for long-term climate monitoring from space and the exacting requirements that this implies in terms of instrument precision, calibration, and continuity. This is an opportune time for NASA ESD to assert leadership for satellite-based global change monitoring and multi-decadal climate data records. Of the federal science agencies, only NASA has a history of high-precision global remote sensing and high-volume data processing and delivery from which climate data records can be built and used for global change science. Cost-sharing should be pursued through GEOSS with international space partners who similarly have a stake in climate monitoring.

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

Continuity of long-term records of critical climate variables will be in peril.

APPENDIX 3: Proposed Recommendation for the NAC Science Committee

Subcommittee Name: Earth Science

Chair: Daniel J. Jacob

Date of Public Deliberation: January 7-8, 2009

Date of Transmission: January 26, 2009

Short Title of Proposed Recommendation: **Fostering international partnerships for Earth observations from space**

Short Description of Proposed Recommendation:

We recommend that ESD increase its coordination with international space partner agencies in its strategic vision for Earth Science observations, including implementation of the Decadal Survey.

Outline of the Major Reasons for Proposing the Recommendation:

ESD engages in vigorous international collaborations through instrument science teams and shared instruments and launch vehicles. But we believe that this collaboration needs to be more proactive and already engaged at the strategic level. There is no reason that a strategic plan for Earth Science observations, as formulated by the DS, should not be developed at an international level and as a global partnership between space agencies. Other agencies have scientific priorities similar to NASA, resulting in apparent mission overlaps where one wonders if agencies are making the best use of their resources. For example, we expect to start having this year CO₂ observations from OCO, but also from GOSAT (JAXA). The first DS mission to be implemented is the soil moisture SMAP mission, while ESA will launch SMOS this coming year to measure soil moisture and ocean salinity. We recognize that there are significant differences between these missions, and that collaborative missions can bring in additional costs. It still seems that a more effective way to leverage limited resources would be for individual agencies to take charge of specific missions in a concerted strategy. For example, if our international space partners committed to take charge of some of the DS missions we would be together significantly ahead in terms of implementing the complete DS.

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

The opportunity to build a coherent program of Earth Science observation from space on an international scale will be missed; such international coordination is essential to execute the “minimum yet robust” program of the DS.

APPENDIX 4: Proposed Recommendation for the NAC Science Committee

Subcommittee Name: Earth Science

Chair: Daniel J. Jacob

Date of Public Deliberation: January 7-8, 2009

Date of Transmission: January 26, 2009

Short Title of Proposed Recommendation: **Open data-sharing agreements with international space agency partners**

Short Description of Proposed Recommendation:

NASA should negotiate open data-sharing agreements with its international space partners (in particular ESA and JAXA) to (1) remove all impediments to free, open, rapid, and easy access to data; (2) minimize bureaucratic overhead; and (3) develop redundant data centers within each participating country.

Outline of the Major Reasons for Proposing the Recommendation:

One significant requirement for international coordination of space missions to succeed is an open data-sharing protocol between space agencies. NASA makes all its Earth Science data openly and easily accessible worldwide; but other space agencies do not. We note that guidelines for this are already in place and responsibilities laid out under CEOS and GEO.

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

The opportunity to develop an effective international program of Earth observation from space will be missed.