National Aeronautics and Space Administration

Earth Science Subcommittee
of the
NASA Advisory Council Science Committee

October 14 – 15, 2009
L'Enfant Plaza Hotel
Washington, D.C.

MEETING SUMMARY

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Lucia S. Tsaoussi	Byron D. Tapley
Executive Secretary	Chair

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Meeting Report Prepared by:
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Earth Science Subcommittee Meeting
L'Enfant Plaza Hotel
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Wednesday, October 14, 2009

Welcome

Dr. Byron Tapley, Earth Science Subcommittee Chair, and Dr. Lucia Tsaoussi, Environmental Science Subcommittee Executive Secretary

Dr. Lucia Tsaoussi called the meeting to order at 8:35 am.

Dr. Byron Tapley, the subcommittee chair, welcomed the members of the Earth Science Subcommittee (the subcommittee, ESS). He gave a short welcoming presentation, saying that he wished to set the stage for the thought process in the meeting and that events presented should steer the subcommittee's proceedings. He asked the subcommittee to formulate its concerns and put its conclusions together the next day into a report to be presented to the Agency.

Dr. Tapley reviewed the criteria that had been used to select items for the meeting agenda: relevance to the Decadal Survey and its status, with regard to mission implementation mode for the suite of missions it has recommended, as well as to data and information systems and the status of long-term plans. Topics meeting these criteria had been brought to Dr. Tsaoussi as agenda suggestions. The agenda then evolved from interactions with programmatic representatives within the Earth Sciences Division (ESD).

Dr. Tapley reviewed the agenda (appendix A). He asked members to consider the interface between the science and applications areas and to formulate questions for the planned question-and-answer session with Dr. Edward Weiler, Associate Administrator for the Science Mission Directorate. He said there would be a discussion about the implementation status of the Decadal Survey.

Dr. Tapley said the subcommittee would try to create a succinct statement of ESD's direction. He referred to a discussion with the technology program about how decisions are made about what technology to go forward with, particularly the question of how much of NASA's resources goes into technology to support missions and how much into technology that does not necessarily have a mission mode.

Dr. Tapley noted that there is an ongoing discussion on international collaboration, related to the question of how the Decadal Survey in Earth Science is implemented. He said the subcommittee needs to consider not only what the Decadal Survey states explicitly but also the measurements that need to be made. He raised the question of what NASA measures, what is left over, and how NASA deals with that. He suggested a discussion about getting some measurements through international collaboration. Four specific groups of measurements had been set in a letter that Dr. Daniel Jacob had prepared based on the January meeting.

Dr. Michael Freilich, Director, ESD, NASA HQ, and Dr. Tapley asked subcommittee members to introduce themselves.

Subcommittee members in attendance:

Dr. Anna Michalak, University of Michigan, Department of Atmospheric and Space Sciences and Department of Civil and Environmental Engineering. This was Dr. Michalak's first face-to-face subcommittee meeting.

Dr. Patrick McCormick, Center for Atmospheric Sciences, Hampton University. Dr. McCromick specializes in remote sensing.

Dr. Konrad Steffen, Cooperative Institute for Research in Environmental Science, University of Colorado at Boulder

Dr. David Siegel, Department of Geography and Institute for Computational and Earth System Science, University of California, Santa Barbara

Dr. Robert Schutz, Center for Space Research, University of Texas at Austin

Dr. Kamal Sarabandi, Department of Electrical Engineering and Computer Science, University of Michigan. Dr. Sarabandi specializes in remote sensing.

Dr. Byron Tapley, subcommittee chair, Center for Space Research, University of Texas at Austin

Dr. Judith Curry, School of Earth and Atmospheric Sciences, Georgia Institute of Technology. Dr. Curry specializes in climate, uninhabited aerial vehicles (UAVs), and information systems.

Dr. Daniel Jacob, subcommittee vice chair, atmospheric chemist at Harvard University

Dr. Gregory Jenkins, Department of Physics and Astronomy, Howard University.

Dr. Patricia Matrai, biological and chemical oceanographer, Bigelow Laboratory for Ocean Sciences. Dr. Matrai is involved in biological production of gases of climatic relevance.

Earth Science Division Overview for NASA Advisory Council - ESS

Dr. Michael Freilich, Director, Earth Science Division

Dr. Freilich highlighted Agency-level status, programmatic accomplishments, mission issues, the status of the National Polar-Orbiting Operational Environmental Satellite System (NPOESS), Carbon Recovery Mission status, and the challenges to an executable ESD program.

NASA's new Administrator and Deputy Administrator, Charles Bolden and Lori Garver, were confirmed on July 16, 2009. NASA's FY10 budget has not been finalized. However, the President's FY10 budget proposal includes substantial increases in ESD funding over the FY09 budget. Even according to the President's budget, however, ESD funding would be only $1.4B in

FY10, far below the $2B needed to fund the program at the level recommended by the NRC Decadal Survey.

In accomplishments, Dr. Freilich noted that the Venture Class solicitation had been issued. The key to success in this program, he said, would be to run it in a sustained and predictable manner, with a solicitation every other year.

In mission issues, Ice, Cloud, and Land Elevation Satellite (ICESat) I and Quick Scatterometer (QuikSCAT) will be ending, while Glory, Aquarius, Landsat Data Continuity Mission (LDCM), Global Precipitation Measurement (GPM), Deep Space Climate Observatory Project (DSCOVER), Soil Moisture Active-Passive (SMAP), ICESat II, Climate Absolute Radiance and Refractivity Observatory (CLARREO), and Deformation, Ecosystem Structure and Dynamics of Ice (DESDynI) are under development.

Dr. Jacob pointed out that the launch schedule, specifically for SMAP and ICESat II, was slipping. Therefore, the Decadal Survey's objectives needed review. The mission information that had been the basis for the Decadal Survey had changed. For example, CLARREO, which had been planned as a mission of moderate cost, about $300M, was ballooning in cost to about $900M, which puts it outside the envelope of what the Decadal Survey envisioned. Dr. Jacob suggested that this is the time to "go back to the drawing board." Dr. Freilich replied that the Decadal Survey had assumed that the program would have about $2B per year by FY10, and that is not the case. Further, the Decadal Survey cost estimates are unrealistically low. Dr. Tapley stated that the issues of resources that Dr. Freilich raised are an important topic to discuss later in the meeting.

On the status of carbon recovery missions, Dr. Freilich discussed the Orbiting Carbon Observatory (OCO), which had failed during launch in February 2009. A near-carbon-copy of the mission could be flown 28 months after authorization is given. Such a mission would be essential to any comprehensive multi-agency monitoring effort to verify the success of carbon mitigation strategies and adherence to international agreements. Dr. Freilich said he had briefed Congress on the issue.

Dr. Freilich reported that the NPOESS (National Polar-Orbiting Operational Environmental Satellite System) project was not going well; there was a crisis in maintaining continuity of several climate observations.

Dr. Jacob commented on the way the funding problem evolves: NASA asks for money to do more, Congress provides some but not all of the money, and the result is that NASA cannot do all that is expected. The solution, he suggested, is to take the mid-term review of the Decadal Survey as an opportunity to rethink the program, because of the disconnect between scope and resources available.

Dr. Jacob also commented that because international collaboration tends to take place at the level of execution rather than at the level of design there is often an overlap in missions; for example, NASA and the European Space Agency (ESA) are both preparing to fly soil moisture missions. He suggested that missions be prioritized globally to fit a global budgetary envelope. Dr. Freilich

replied that there is already some strategic international collaboration. For example, atmospheric chemistry is to be done in tier II and tier III missions, which are not yet being carried out, with the result that NASA is not doing an atmospheric chemistry mission. But the Europeans are. In this sense the system is working well. He added that there are problems associated with international collaboration, including doubts about whether the partner will come through on important matters. It is harder than it sounds to develop a long-term collaborative program that meets the needs of all communities involved. Dr. Tapley commented that the same issues arise with interagency cooperation within the United States, as well as with relationships between government agencies and contractors. He pointed out that NASA needs either to get more funding or to find a way to expand its capabilities.

Dr. Tapley noted that continuity is an important issue that doesn't always get addressed. He asked the subcommittee for a plan that takes into account the tight resources. Dr. Freilich commented that NASA's plan is to get the foundational missions flown out, to move forward as rapidly as possible on the tier I missions in the Decadal Survey, without cutting back on other things. Dr. Sarabandi raised the issue of lowering the cost of missions, which he said is at core of problem. Most missions flown in the past twenty years have had cost overruns or schedule slips, he said. This is not a good way of going forward. He asked why this problem cannot be corrected, why it is an accepted way of doing business. Dr. Freilich responded with an example: In research, he said, it would be good to get ten papers with $100K allocated, but that cannot be done; that is not the way new projects get started. The only way it could be done would be through a focus on paper counting, hitting the metric without accomplishing much. Something similar happens in the space arena. NASA has a skilled, expert workforce in industry. The cost of missions is the cost of that workforce. When NASA has attempted to go in the other direction, the research community has objected that low-cost missions may not satisfy the science needs and may not last long enough.

Dr. Sarabandi replied that it is important that NASA take cost and schedule overruns seriously, rather than accept them as business as usual, expecting missions to cost more than their proposals indicate. Dr. Freilich replied that overruns are a problem; to resolve it, NASA must look at many issues, not beat up on contractors, or headquarters, or centers. Dr. Tapley commented that the problem starts frequently with what the science community asks for.

Dr. Curry suggested that the recent uptick in Earth Science funding is related to the Decadal Survey's emphasizing societal benefits rather than the wants of various groups of scientists. This was a sea change. The document was effective because people saw the societal benefit, rather than seeing journal publications. Selling the science that way will change the priorities. Externalities, like politics and severe weather events (e.g., Hurricane Katrina or a tsunami) also come into play and change people's thinking about what is needed. Therefore, priorities change within the planning time of 10 to 20 years that is entailed in the Decadal Survey and subsequent mission development. To sell based on benefits – the best way to keep the pie growing – one has to figure out how to reallocate priorities based on benefits.

Dr. Freilich commented that in the remote-sensing science endeavor, time scales to achieve things are long. The time from the start of a mission's budget development to the mission's end is at least 12 years. If the priorities change halfway, there may be money wasted in the ramp-up

part and the science may never really be addressed. To go with benefit, NASA has to deal with the reality of how long missions take. If NASA had sold the Decadal Survey successfully, he said, NASA would have a budget of $2B now. NASA sold the Decadal Survey concept; Congress only put the Decadal Survey in their cart but never fully paid; after that, when they allocated resources, they wanted to get further results, rather than to keep paying for Decadal Survey missions. On the other hand, the Decadal Survey *was* sold internally, to the NASA community, in establishing priorities.

Dr. Jenkins asked why the cost for the GPM mission had shot up so high. He asked whether in the descoping process there a discussion of how much would be lost. Dr. Freilich replied that there were many reasons for GPM's high cost, including the cost of doing business and the cost of requirements.

Dr. Freilich commented on the involvement of science community. Although management works closely with the science community, in the end it is management that has to allocate a limited amount of resources. A single mission's science community does not see the cost to the rest of the program that is associated with keeping a capability in that mission.

Dr. Michalak asked why, on average, NASA cannot get an unbiased estimate of total costs. In a system in which a mission will be canceled if its budget increases too much ("outside the box"), mission proposers would use realistic numbers, in order not to see their missions canceled. She asked if such a system might be feasible for space-based missions. Dr. Freilich replied that every mission is unique and there are not enough missions to support the generalizations about cost that would be needed to determine the size of the box. He said NASA has a tendency to commit too early to what the cost and schedule are going to be. To get their missions accepted, proposers are motivated to cost them at the minimum cost that results in a credible proposal. The last Administrator said proposals must be made at 70 percent of cost; because of this requirement budgeting is being done more realistically and the program is getting smaller. Less will be started and more will be finished.

Dr. Michalak commented that the people proposing missions are in the role of salespeople: Their incentive is to estimate low. That hurts long-term planning. She asked if there is a way to bring the proposer's incentives closer to something that will motivate them to be realistic.

Research and Analysis Report

Dr. Jack Kaye, Associate Director for Research, ESD

The R&A budget has been mostly flat, but there are new elements in ESD that are closely associated with the Research activities: stimulus funding, Ice Bridge missions and a solicitation for suborbital Venture Class missions led by principal investigators (PIs). In the Research Opportunities in Space and Earth Sciences (ROSES) system of project competition, the speed of selections is increasing, while the success rate for proposers is slowly decreasing.

Dr. Kaye described some R&A programs. The Investigations of Climate and Environmental Change on Arctic Shelves (ICECAPS) project, for example, examines the cryosphere. There is an effort to coordinate this program with the European Union. In the field of computing, modeling, and assimilation, NASA's capabilities are advancing, but NASA's investment in computing capability trails that of other agencies. In education and public outreach, among other things the R&A program continues to manage ESD programs, and to support NASA programs, for young scientists. ESD does a lot of Web-based outreach.

In response to a question from Dr. Tapley regarding the breadth of the modeling program activities, Dr. Kaye explained that while the modeling done in the program includes oceanic modeling, the largest part of it is atmospheric.

Dr. Matrai asked Dr. Kaye to clarify what he meant by "sustained observations" in reference to the suborbital venture class. Dr. Kaye replied that "sustained" in this context means more than seasonal, including potentially up to 3 years of collecting data. This is in contrast to short-term data-collection field campaigns, which may last about 4 weeks.

Dr. Steffen asked if there has been discussion of how the data resulting from the Ice Bridge program will be analyzed. Dr. Kaye replied that no such discussion has taken place but he does expect to see proposals for the analysis, perhaps in the Cryospheric Science program. The data, like all program data, will be made available after preliminary validation. Ongoing competitive opportunities include opportunities for people to work with that data.

Dr. Jacob asked whether, as international collaboration increases, Dr. Kaye anticipates the R&A program to be charged with interpreting observations from foreign satellites, and if so whether there is in place a mechanism for NASA to acquire the data from these satellites, given that space agencies in other countries are not as open with their data as NASA is with its. Dr. Kaye replied that NASA expects people to look at the most appropriate data sets, whatever their source. NASA does provide some mechanisms for obtaining foreign data. NASA leads by example on data policy, communicating that data shared are more valuable than data hoarded; with more people looking at the data, there is better validation and the ability to do quantitative science increases. Other nations may not agree, but they are gradually coming to NASA's view. Now NASA can engage in bilateral conversations with China; in the past that was not allowed.

Dr. Siegel asked how the R&A program might respond if in the future NASA does not have the array of measurements that it has today. Dr. Kaye replied that for the foreseeable future, NASA will have a role in looking at global Earth system evolution, assessing long-term variability, and connecting new observations to prior ones. NASA has unique expertise in looking at Earth system trends, whether the data come from NASA's sensors or from another nation's. NASA has the investigative community.

Dr. Matrai commented that it is often impossible for investigators to get foreign data. Cooperation must take place at a high level to make it possible for American scientists to obtain foreign data. Dr. Tapley suggested that the subcommittee discuss the issue later in the upcoming discussion on international collaboration.

Flight Program Development Status and Implementation Framework
Dr. Stephen Volz, Associate Director for Flight Programs for ESD

Dr. Volz discussed the mission life cycle, from pre-formulation to formulation to development to operation, showing where the various ESD missions are in the process. He explained that the program's goal is to have as many missions as possible in operation. A senior review earlier this year recommended that all missions currently in operation remain in operation, even though many are past their design lives. However, QuikSCAT and ICESat - II have developed technical problems recently and are expected to fail soon.

The Flight Program does other work as well. For example, after OCO's loss, the Flight Program investigated other possible ways to carry out the OCO mission, perhaps flying it as secondary payload on another mission. The study found that an OCO carbon copy carried the lowest risk both programmatically and technically. Staff have been allocated and procurement of long-lead items has begun, but expensive equipment cannot be procured until the OK from the Administration to go ahead comes through.

Missions in development and formulation, and their planned launch dates:

Mission	Proposed Launch Date	Phase
Aquarius	2010	Development
Glory	2010	Development
GPM	2013/2014	Formulation
LDCM	2012	Formulation
NPP	2011	Development
SMAP	2015	Formulation

The missions in development and formulation are all fully funded. When the cost of missions at these stages has gone up, it has been because of instrument delays or mission delays.

Dr. Volz made several comments that were relevant to the subcommittee's discussion about cost and budget. He said a mission's cost is not really known until the mission has gone through the development cycles. The primary reason for cost increases in development is the addition of instruments. Over the next 5 years, the flight program plans to launch missions costing a total of $700M to $1B per year. The priority is to get the foundational missions planned as soon as possible.

In staffing, there is a new program manager, Eleanor Ketchum, for the Earth Systematic Missions Program Office. ESD has received priority for staffing. This reflects recognition within the Science Mission Directorate of Earth Science as a growth field.

The program's priority is to get the missions in development Phase C/D, then ready to launch and into operation.

Question-and-Answer Session

Dr. Edward Weiler, Associate Administrator of the Science Mission Directorate

Dr. Weiler told the subcommittee that NASA is expecting to get an FY10 budget within the next few weeks. NASA expects a response from the Office of Management and Budget (OMB) about NASA's proposed FY11 budget by Thanksgiving of this year. President Obama's FY11 budget should be released on February 1 of next year.

In response to a comment by Dr.Tapley, Dr. Weiler said NASA is waiting Administration decision regarding the OCO copy future mission. He said a decision from high levels on the future of NPOESS Program was awaited.

Dr. Jenkins asked how ESD is viewed by the NASA and Obama Administrations. Dr. Weiler replied that within NASA there is strong support for Earth Science, and under the Obama Administration, Earth Science is the NASA program most likely to see a budget increase.

Dr. Jacob stated his understanding that the stimulus money and the ESD budget increase were directed toward implementing the Decadal Survey. But it is not possible for NASA to implement the Decadal Survey; he asked if that creates an accountability problem. Dr. Weiler replied that it is clear that $400M in one fiscal year will not implement $10B or $20B of missions. He explained that he and Dr. Freilich had had to educate Congress, to explain that funding is needed continuously for the missions that are foundational to the Decadal Survey. Dr. Jacob commented that trying to implement the Decadal Survey has resulted in emphasis on tier I missions, at the cost of tier II and tier III missions. Some tier I missions have been transformed since the Decadal Survey and are different from what was described in the Decadal Survey report by adding requirements and increasing costs. For the Decadal Survey's mid-term review, he suggested, NASA should be thinking more broadly about its investments in Earth Science.

Dr. Weiler answered that if all the missions were prioritized based on equally unrealistic costs, then reordering priorities would destroy the credibility of any future Decadal Survey. Decadal Surveys have done well for the Astrophysics program because NASA never changes the priorities, despite huge cost overruns. He said that if one of the four tier I missions was grossly undercosted but the others were not, there might be some basis for changing priorities. Dr. Freilich noted that CLARREO was the most egregiously undercosted.

Dr. Jacob replied that if the Decadal Survey is going to be implemented only at the tier I level over the next decade, then the program does not deliver even closely what the Decadal Survey intended it to be: a cohesive ensemble of missions to serve the diversity of the community of Earth Sciences. This period, as the mid-term review was approaching, would be a good time to think about possible opportunities with international partners to deliver on broader areas of Earth Science and to take a broader perspective.

Dr. Weiler responded that the tiers are based on scientific priority and technical readiness. Dr. Jacob noted that the priority reflects timing as well as importance. The tier I missions were an ensemble of missions that had an interest in being in space together; they were timely for the first part of the decade. Tier II or tier III missions may be just as important. Dr. Weiler answered that the Decadal Survey modus operandi should not be broken without compelling reason. Having priorities from the National Academy is invaluable in Washington.

Dr. Siegel asked Dr. Weiler to comment on the differences between the Astrophysics and Earth Science programs and how those differences affect Decadal Survey implementation. Dr. Weiler responded that the Earth Science program has additional challenges; for example, it is not clear who is in charge of global climate change – NASA, the National Oceanic and Atmospheric Administration (NOAA), or the U.S. Geological Survey (USGS). These decisions need to be made at the policy level. While cautioning the subcommittee not to change the Decadal Survey lightly, Dr. Weiler acknowledged that the way the Earth Science program has unfolded over recent years is not completely consistent with the Decadal Survey's assumptions and that therefore Decadal Survey changes may be called for.

Dr. Weiler commented that shortly after the Earth Science Decadal Survey was completed, NRC changed its way of doing Decadal Survey studies. Earth Science missions were severely undercosted in the Decadal Survey, because their cost estimates were based solely on input from scientists. Now in doing Decadal Surveys, NRC considers input from cost analysis and budget people. He warned that if another Earth Science Decadal Survey were done using more accurate cost numbers and more recent budget numbers, it would cut back on the number of missions.

Dr. Steffen commented that the Earth Science Decadal Survey is necessarily limited because societal needs are changing faster in Earth Science than in other areas; consequently some reshuffling between tiers may be necessary. Dr. Freilich asked if 10 years is the right amount of time between reevaluations.

Dr. Jacob asked if there should be more effort to better formulate the tier II and tier III missions. In the current system, tier II and tier III missions are essentially neglected. Dr. Freilich pointed out that the technology program supports the needs of tier II and tier III missions and early study money has gone to the tier II missions.

Dr. Schutz asked Dr. Weiler for his perspective on international collaboration. In response Dr. Weiler cited the example of a Mars mission. Because of rising costs (caused in turn by tougher missions), NASA was approaching the point where it no longer has a Mars program. At the same time, Europe has no Mars program, because of ESA's cost constraints. Thus the United States and Europe came together to run one program. There are some problems. Collaboration is easiest

at the highest levels, more difficult further down in program implementation. There is a difference in culture, in that NASA's data goes out to the world, but ESA's does not.

Dr. Jenkins suggested partnerships with small countries, such as nations in West Africa that have no infrastructure and rely on NASA for data. Dr. Weiler replied that Administrator Bolden has initiated a program to reach out to nontraditional partners – not just Europe and Japan. Earth Science is a good area for such partnerships, because some of what Earth Science does, like ground validation stations, can be done inexpensively.

Dr. Sarabandi commented that once programs mature, there must be a way to transition them out of NASA. Dr. Freilich explained that some programs stay with NASA because Congress provides funding for the work to NASA and not to the agency that would take over – typically NOAA. Dr. Sarabandi suggested a change in the business model: Perhaps NASA could start charging the end user. Dr. Tsaoussi commented that Martha Maiden, program executive for Earth Science Data Systems, had done an analysis, which had shown that charging for access to data would not be worthwhile. Dr. Steffen commented that there is a program in place through which images can be ordered for a fee. Dr. Freilich added that the business model exists only for high-resolution data. No one has been able to find a commercial business model for the low-resolution data needed for science.

In response to a question from Dr. Tapley, Dr. Weiler commented that the President's Office of Science & Technology Policy (OSTP) has been busy dealing with other pressing matters, especially health care. Still, NASA's Earth Science Program is much more on the President's radar screen than it has been in 8 years, and promises to be even more so in coming months, when health care is no longer the center of so much attention.

On the topic of education, Dr. Weiler commented that the attitude of the present Administration is different from that of previous ones, which took the position that it is not NASA's job to educate. Administrator Bolden is passionate about STEM: science, technology, engineering, and math. He has met with the Department of Education and has encouraged NASA to expand education programs. NASA education programs, Dr. Weiler said, work mostly with teachers, because that approach provides the highest payoff: One teacher might reach 100 or 150 students. Dr. Weiler quoted Administrator Bolden as saying to President Obama, "If NASA doesn't do something to inspire your two girls in the next 2 years you should fire me."

NASA's education program, Dr. Weiler explained, is evolving. Some programs are going to the Associate Administrator for Education while others are staying with their respective program offices. The focus is on providing tools to teachers. In the past, teachers were provided with posters. Now they are provided with lesson plans.

Dr. Sarabandi commented that NASA has no program for new investigators. Dr. Kaye explained that in fact there is one: the New Investigator Program (NIP) which is a competitive program for people within 5 years of getting their PhD.

Dr. Jacob commented that 3 years ago the subcommittee had been asked to consider how the lunar exploration program could serve Earth Science needs. He asked for an update on this

effort. Dr. Weiler replied that the Augustine Commission is expected to report on this soon. When the Augustine Commission report is complete, NASA will respond to it and the President will consider both the report and NASA's response and will make recommendations.

Dr. Jenkins asked how the public views the missions – four to six Decadal Survey missions plus Venture Class – that are being carried out. Dr. Weiler answered that the Earth Science program is not connecting with the public; it should be selling its product and getting more money to save the planet. He asked how to reach the public better. Dr. Curry replied that the public and Congress and the decision-makers seem to put a high premium on discovery "gee-whiz" science. Earth Science is past that stage, seeking predictive capability. NASA has to sell the benefit, as was done with the Decadal Survey. Unless the benefit is presented, people lose interest. Dr. Weiler agreed. He related a personal conversation in which a neighbor of his expressed surprise that NASA does Earth science. He suggested that the subcommittee address the Earth Science program's publicity problem.

Dr. Michalak likened the Earth Science program, in the public's mind, to the dentist: People wish it were not necessary. To fix things they wish they did not have to deal with, people will always want to get away with as little investment as possible. Adding a "gee-whiz" element may make people more willing to support the program. Dr. Weiler agreed.

Dr. Tapley thanked Dr. Weiler for coming.

Current Status of Decadal Survey Mission Implementation

Dr. Stephen Volz

Dr. Volz discussed the status of the Decadal Survey tier I, tier II, and Venture Class missions, as well as cross-mission activities (data systems, mission studies, and technology) and year-end projections.

Projects start at pre-phase A, preformulation, then go through formulation phases A and B, and then through implementation phases C through F. Once a mission is into pre-phase A, responsibility for mission execution rests with the mission project office. Tier I missions are being carried out first.

Projected launch dates of tier I missions:

SMAP: 2015
ICESat II: 2015
CLARREO: 2017 - 2019
DESDynI: 2017 - 2019

There are two models for mission development: directed (at a NASA Center) and competed via an announcement of opportunity (AO). Decadal Survey missions are developed through the

direct process. Typically a mission is assigned to a center, where the project office will be. Venture Class missions; on the other hand, are competed through a solicitation/proposal process.

Dr. Volz discussed the development status of missions. The Decadal Survey missions that are in development are all in pre-phase A, except for SMAP, which is in phase A. Pre-phase A and phase A are the time for broad community input. In later phases decisions will be limited to project people. It is in phase B that a preliminary cost and schedule are developed and reported to Congress.

The tier II projects are funded at $10M per year for FY09 and FY10 for science definition studies. This is not enough money for mission development.

In response to a question from Dr. Siegel, Dr. Volz explained that stimulus money had been used for SMAP. Dr. Freilich added that there are restrictions on how stimulus funding can be used. Dr. Volz commented that SMAP was the one of the first four missions that would be launched sooner if the program had more funds.

Dr. Volz raised cross-cutting questions:
Is there a more efficient way to build spacecraft than to have each mission build its own? A solicitation will soon be issued for spacecraft architecture studies, in the hope that the program can save 20 – 30 percent on spacecraft by buying several at a time.
How can the program ensure that what is being planned and built now will be able to accept data 10 to 15 years from now?
How can the program fold new missions in, while keeping the old system working?

Earth Observing System Data and Information System (EOSDIS) Long-Term Plans
Ms. Martha Maiden, Program Executive, Earth Science Data Systems

Ms. Maiden spoke about the Earth Observing System Data and Information System (EOSDIS**)** in the Decadal Survey era and about plans for the long-term archiving of NASA Earth Science data. EOSDIS is the data and information system for the Earth Observing System (EOS).

Dr. Jean-Bernard Minster, a subcommittee member who was not able to attend in person, joined the meeting via a skype connection.

Over the years, the data storage infrastructure has been built up, with data centers co-located with centers of scientific discipline expertise. Each data center (also known as distributed active archive center, DAAC) holds a different kind of data. The DAACs make EOS data publicly available. Originally, the Earth Science Data and Information System (ESDIS) project was responsible for operating the EOS data and information system. Now the data system needs to be continued for the long term as a research resource.

The Earth Science Data Systems program gets its charge from the Decadal Survey, which states, "Teams of experts should be formed to consider assimilation of data from multiple sensors and all sources, including commercial providers and international partners."

There was a discussion about latency: Dr. Tapley asked how much time it takes for data to become available. Ms. Maiden replied that the ESDS group, working with the Applied Sciences group, is putting together a near-real-time system. At present it typically takes 24 hours. Dr. Steffen asked if the data that is available within 24 hours is lower-quality data and if it is followed by a second round of data. Ms. Maiden said that is correct. Dr. Freilich pointed out that an orbit takes 100 minutes and this must be factored into the time needed to obtain "near real time" data.

Dr. Jacob said it is difficult for external users to use NASA high-performance computing resources: There are restrictions for non-citizens, and access is limited whenever there is a bug. He asked if there is a way to make it easier for external users. Dr. Maiden replied that Dr. Tsengdar Lee is currently working on the problem. Dr. Lee is limited by the restrictions of the Federal government's policy on IT security.

Dr. Minster stated that an application that involves near-real time will be useful only once people are aware that it exists and know how to ask for it. He suggested that NASA should participate in exercises such as the California shakeout. Dr. Freilich agreed and said NASA would be making that known. Dr. Maiden said JPL is closely involved with the California shakeout.

Dr. Freilich asked if the National Archives and Records Administration (NARA) is focused on the preservation of records while NASA is focused on use. Dr. Maiden confirmed that that is correct. Both NARA and the National Data Centers are permanent archival agencies, while NASA is not.

Dr. Siegel asked about the process that NPOESS Preparatory Project (NPP) data sets go through. Dr. Maiden replied that the Science Team is supposed to send her group a report with information that will allow them to set up a strategy for storage.

Dr. Freilich commented that data that came from a NASA research spacecraft and have geophysical utility will find their way into the Earth Observing System (EOS) active archive and will be made available to NASA's research community and the world's. But to say that at the outset would discourage other nations from making investments of their own.

Dr. Curry commented that NASA data is available to remote-sensing scientists. But before other people, including industry and weather people, can use the data, a new cyber infrastructure is needed to take it to the "I" level. Dr. Curry believes NASA is the right agency to carry this out. The community needs to strategize about it, addressing issues like interoperability and semantic searches. The data needs to be made useable by non-remote-sensing scientists. Dr. Maiden commented that there is some movement in this direction. Dr. Curry commented that the

necessary link between data and people in both the non-remote-sensing science community and the applications community still needs to be established. Dr. Maiden replied that that task would be a good one for ESDS to take on.

Dr. Minster, in Paris to chair a meeting of the International Council for Science (ICSU) World Data Center System, related that in the 1990s, ICSU had asked the DAACs to be part of the World Data Center System, but the DAACs were not accepted because they did not archive data long term. That has changed. Dr. Minster proposed that the DAACs now join the World Data Center System. If they did so, their share would constitute about eighty percent of the data in the system. Dr. Maiden said NASA's joining the system had already been considered informally: She had discussed the possibility with the European Space Information System (ESIS) project manager, with Dr. Tsaoussi, and with the DAACs. NASA still needed to discuss it further and to take formal steps. Dr. Tapley asked whether the formal process begins with ICSU or with NASA. Dr. Minster said a letter has been sent asking if there is interest. If the answer is yes, the DAACs will be sent guidelines for submitting proposals. Dr. Freilich commented that this seemed like the tail wagging the dog. If NASA has a data policy that is the envy of the world and NASA's archive system holds 80 percent of the world's data, ICSU should be asking what they need to do to have NASA join, not having NASA send in a proposal so that ICSU can see if NASA is qualified. Dr. Minster seemed to try to reply, but the skype connection died before he could complete a sentence.

General Discussion

Dr. Steffen suggested that subcommittee meetings might be more focused, limited in scope, to allow more time for discussion, because with the present structure, there is too much information to respond to. He suggested, also, more feedback at each meeting about what came out of the last meeting. Dr. Matrai agreed, suggesting that the focus be limited, so that there would be more time for discussion and for developing action items for ESS.

Dr. Siegel asked whether there had been formal responses to the recommendations from the January meeting. Dr. Tsaoussi explained that the formal response goes from NASA to the NASA Advisory Council (NAC). She said the NAC deliberates the issues recommended by the ESS before they make recommendations to NASA.

Dr. Jacob commented that over the last few years, the process has relaxed and it has become more tolerated for the subcommittee to provide informal recommendations, suggestions, and comments to ESD. In past meetings, Dr. Jacob said, Dr. Freilich had chosen to respond to the subcommittee. There was frustration with this process, because the subcommittee was not getting good feedback from the NAC. Dr. Tapley asked whether the subcommittee has a written charter. Dr. Tsaoussi answered that it has, she has distributed it, and she will distribute it again.

Dr. Tapley commented that the ability to assimilate information in a group is limited. He considered whether rules would allow meetings to be extended beyond the official meeting time, perhaps to dinner; this could be in conflict with the requirement that the subcommittee meetings be open to the public. Dr. Tsaoussi added that discussions leading to consensus have to be made in an open, advertised, public meeting, not off site.

Dr. Sarabandi again raised the issue of how the subcommittee members are working together and should structure with their meeting. Dr. Tapley paraphrased, saying the issue is whether the questions the committee wrestles with are generated in a response mode, whether the committee can raise questions and ask NASA to respond to them.

Dr. Tsaoussi explained that to develop the agenda, ESD works with the subcommittee on developing issues. Dr. Tapley added that it is up to the subcommittee and Dr. Freilich to decide what is appropriate for the agenda. Dr. Tsaoussi agreed, adding that some issues may miss the agenda because of timing. Dr. Matrai suggested that perhaps fewer topics should be presented, so that there is more time for discussion. As it is, the material presented is too much to digest. Less material would enable participants to be more constructive and proactive in their comments.

Dr. Michalak commented that longer meetings are not the solution. She suggested that the kind of information that is being communicated in presentations instead be sent out to members before the meeting, so that the discussion could begin at the meeting's start. The information would not need to be sent out in viewgraph form; it could be done in a short Word document.

Dr. Tsaoussi suggested that this discussion was an opportunity to plan the next meeting. In planning the present meeting, she said, there was not much input from the subcommittee members; therefore she had provided background information. Dr. Steffen commented that the presentation viewgraphs are helpful. Dr. Tapley stated his interpretation that these comments were not criticism of the presentations; the frustration came only of not having enough time for discussion.

Dr. Freilich pointed out that for the subcommittee to have the background documents and information prior to the meeting, the contributors would have to prepare materials early. The public meetings themselves would focus on a small number of selected topics upon which the subcommittee would decide. Dr. Freilich continued, saying the focus in the meeting would be on the few identified topics.

Dr. Jacob commented that this does not amount to much change; what is proposed is exactly what the subcommittee has been doing. Dr. Matrai commented that there has been frustration all along, because the meetings amount to a review, not a discussion. Because there are so many topics, the discussion in each area is forced to end before it is complete. Dr. Schutz commented that the discussion of presentations sometimes offers subtle but important points that would not arise if there were no presentations, just viewgraphs distributed to the subcommittee members for

review. Dr. Curry suggested a compromise: Send out detailed information and then have a brief presentation at the meeting.

In reference to the problem that Dr. Freilich had laid out – that the Decadal Survey had assumed more money than the budget provides and ESD has dealt with the discrepancy by letting project schedules slip – Dr. Raymond Hoff asked whether Dr. Freilich was asking for the subcommittee's opinion or not. Dr. Freilich explained that he had raised to the SMD Associate Administrator the question of what ESD could do about its scope being incommensurate with its resources, but had not received an answer. Now Dr. Freilich was raising the same question to the subcommittee. What mix of causes for the problem did they see? How much of it was underfunding? Dr. Freilich encouraged the subcommittee to make a recommendation. He reminded them that they had had tremendous influence with Venture class planning.

Dr. Sarabandi commented that sometimes the issues are presented as an over constrained problem. For example, whenever cost overruns are raised, the subcommittee is told the problem cannot be attacked. The result is that the subcommittee does not get a chance to focus on solutions and is left with no way to approach the problem. He suggested studies to find alternative ways of doing things.

Dr. Freilich discussed approaches to various kinds of issues. In areas in which the subcommittee has expertise, he said, the subcommittee should design meetings so that that expertise can be communicated effectively. For key problems that the subcommittee identifies for which not many members have expertise – including implementation of space missions – the subcommittee articulate the problem and send it through the NASA system for NASA to address.

Dr. Tapley pointed out that there is a tendency to always err on the side of making higher requirements; this contributes to high costs. Dr. Siegel suggested a discussion about what the subcommittee could do to solve the cost problem. He asked whether, for example, the subcommittee should develop recommendations for, say, what ESD should do if it had funding for only three-fourths of the Decadal Survey missions.

Dr. Jacob commented that the subcommittee is supposed to provide tactical, not strategic, advice. NASA gets its strategic guidance – like the priority missions that ESD should fly – from the National Research Council (NRC). Dr. Tsaoussi agreed that the Science Mission Directorate (SMD) looks at Decadal Surveys to provide strategy and the subcommittee's job is not to overturn that but to provide more detailed advice.

Dr. Curry agreed that there is nothing to be gained by overthrowing the Decadal Survey. But science, technology, and political climate all change over the course of 10 years. She said the subcommittee needs to evaluate the strategic aspects of proceeding. For example, if new technology makes a tier II mission obsolete by the time of its inception, that should be discussed. Dr. Jacob agreed that the subcommittee should discuss these issues, but it is not up to the subcommittee to say a mission is obsolete. He reiterated that the Decadal Survey's mid-term

review is coming up and that mid-term reviews are often perfunctory; however, this review is the opportunity for the NRC to reconsider priorities. The mid-term review must be started now and must be more than perfunctory.

Dr. Matrai asked whether any projects were classified in tier III only because the technology wasn't there; if so, those should be reevaluated. Dr. Freilich suggested that the next Decadal Survey is the place for reevaluation, because the whole community is represented there. Dr. Jacob pointed out that for example CLARREO had been billed as inexpensive mission but was ballooning into a large mission. It is up to the subcommittee to point out that this is not what the Decadal Survey intended and to suggest that it be reevaluated.

Dr. Freilich explained that mid-term reviews are mandated by Congress; the subcommittee may request certain things be included in one. Raising the alarm, if the subcommittee thinks it warranted, would be a legitimate role. But he warned the group that a Decadal Survey's cachet is huge; Congress respects it. Therefore the subcommittee should be careful in what it requests in the mid-term review. To cover delays, the Decadal Survey contains language about moving broken vehicles into a breakdown lane – that is, if a project gets out of its programmatic box, pushing it aside and doing the next project – but this notion fails to take into account the interests of constituencies that don't like being pushed aside. Further, too many cars seem to be breaking down and ending up in the breakdown lane. There has to be a balance.

Dr. Large commented that ESD's partnerships have not been very effective. The pressure under which ESD is working to do too much with too little funding impedes its ability to function. ESD needs to get itself out from under this pressure. Recently, stimulus money helped, but that is not likely to be repeated. Dr. Freilich commented that getting out from under the pressure means having a smaller program, even giving up some good things from the program in order to have reserve money. He asked the subcommittee to identify things being done that are not of the highest priority. The ESD program is about $1.5B per year, with only about $1M reserve per year.

Applied Sciences Program Overview

Dr. Michael Freilich, Director, Earth Science Division

Dr. Freilich explained that the Applied Sciences program's leadership was in transition. Mr. Lawrence Friedl had agreed to take on some leadership responsibilities. Dr. Freilich spoke about strategic goals, gave a program overview, and spoke about singular accomplishments and near-term issues.

The Applied Sciences program strives to provide information products that are useful for others in policy making, resource management and planning, and disaster response. The program is organized to promote applications for societal benefits.

Singular accomplishments include collaboration between ESD and the Environmental Management Division (EMD): NASA talking to NASA regarding planning future infrastructure. It is useful for ESD to develop supporters inside the agency.

Dr. Freilich cited SERVIR as an example of an accomplishment. SERVIR establishes a multinational data portal in which measurements and outputs are in one place, in an understandable fashion for people who have to make decisions on environmental matters. SERVIR started in Central America in 2004 or 2005; its hub is in Panama. The President of Panama goes to SERVIR to get information on which to make decisions. SERVIR is being expanded to Africa, with the help of the U.S. Agency for International Development.

The Applied Sciences program is running about 180 projects in total.

A near-term issue is that the Applied Sciences program must improve its ability to synthesize the results from projects. There is a lot of interest on the part of Congress in what the Applied Sciences Program does. Members are concerned about demonstrating that what they're doing is helping their constituents.

Dr. Curry commented that the Applied Sciences Program seems to be evolving in the right direction. She said she had had the impression earlier that some of what the program did was stunts. She asked how the program had started: Was it top-down? Dr. Freilich replied that some projects were top-down and others were funded.

Dr. Jacob commented that multi-agency solicitations are an idea that the subcommittee should push. They should be pursued at the administrator level, the NASA Administrator talking to, for example, the U.S. Environmental Protection Agency Administrator; this is the only way money would be available for them. Dr. Freilich commented that a program of multi-agency solicitations could help make ESD very effective. But such a program might be done better with a broad area announcement (BAA) at the directorate level.

Dr. Steffen suggested partnerships with industry. Dr. Freilich agreed that a partnership need not be with a Federal agency. Dr. Curry pointed out that there are issues with competing with private sector companies. Mr. Friedl commented that transitioned programs do not have to go to Federal agencies; they can go to the private sector.

Dr. Siegel suggested that AOs could be written to require proposers to come up with matching funds. This could be a source of some needed funding. Mr. Friedl (in the audience) commented that SMD policy is that cost sharing cannot be required.

Public Comment Session

Stratospheric Satellites - ***Warren Wiscombe, NASA Goddard***

Dr. Wiscombe gave a very short presentation on "stratosats," balloons that fly at the edge of space for a year or more. Technology to control the trajectories of these balloons is being developed. Advantages of stratosats are fast turnaround and low cost.

Dr. Tapley adjourned the meeting for the day.

Thursday, October 15, 2009

General Discussion
Dr. Byron Tapley

Dr. Tapley began the day with a review of the subcommittee's concerns. These included the issues raised in the subcommittee's January 2009 meeting (the mid-term review of the Earth Science Decadal Survey, ESD leadership in long-term climate monitoring from space, international partnerships for Earth observation from space, and international data-sharing agreements). These were background for an April 2009 NAC plenary, which recommended that a process be established for assigning requirements and funding Earth satellite observations. Additional concerns raised in a July telecon included data continuity, OCO recovery, the progress of tier I projects and prospects for tier II and tier III missions.

The subcommittee discussed a draft recommendation:

Short title: Process for establishing requirements and funding for non-science Earth observations.
Short Description: The NASA Administrator should work with the Director of the OSTP and other agencies to define a process for prioritizing and funding the Earth-observing requirements beyond those specified in the recommendations from the NRC Decadal Survey to advance Earth System Science.

Dr. Siegel asked how "non-science" was defined. Dr. Tsaoussi replied that "science" may refer to the SMD portfolio. She and Dr. Tapley agreed that the wording is poor; "non-science" means "operational." He said the recommendation needed work.

Ethics Briefing
Rebecca Gilchrist, Office of General Counsel (OGC), NASA Headquarters

Ms Gilchrist explained that advisory committee members are special government employees (SGEs). An SGE is someone who is "retained, designated, appointed, or employed to perform temporary duties, with or without compensation, for a period not to exceed 130 days out of any 365 days." As SGEs, subcommittee members are subject to ethics rules for employees. Ms Gilchrist explained that the rules are designed to protect not only NASA's integrity but also the public's perception of NASA's integrity. Ethical violations might throw into question what employees are doing on the subcommittee.

Subcommittee members are subject to civil service ethics rules while they are serving on the subcommittee. Some of these extend to when members leave.

Ms Gilchrist pointed out that the conflict of interest rules, some of which apply to SGEs, are codified in Title 18 of U.S. Code, the rules for criminal law. Some of these apply to SGEs. The biggest of these are bribes and conflicts or interest. A member with a conflicting interest is disqualified from participating in a discussion that will have a direct and predictable effect on that interest. For these specific matters, members should recuse themselves. Subcommittee discussion about a contract or grant with which an SGE is involved does constitute a conflict of interest.

Dr. Tapley commented that his institution has many Earth Science programs. The subcommittee makes recommendations on the programs from which individuals at his institution compete for funds. Clearly the organization benefits from the recommendations the subcommittee makes. Ms Gilchrist replied that a matter so specific that it will have an impact on an SGE's employer is not usually discussed by advisory committees anyway.

Dr. Tapley commented that priorities are a gray area, since they may involve recommendations to keep or drop specific missions. Ms Gilchrist replied that the subcommittee works at a high enough level of generality so that there is usually no conflict of interest. The closer the discussion gets into what is being done right now, the more risk of conflict there is. For specific grants, if a member or his or her institution is involved, the member should recuse him or herself. Dr. Tsaoussi commented that watching for such things is part of her role.

Ms Gilchrist explained that an SGE may participate in a discussion about a program that does not have a predictable effect. The discussion may affect competition, but that does not mean a particular company will win the competition.

Ms Gilchrist pointed out that the right course of action is not always clear. She advised committee members to try to be on the safe side and she invited them to bring questions to her. In an uncertain area, she recommended that the member recuse him or herself and ask Dr. Tsaoussi to check with OGC.

Representational conflicts are also in the criminal code. Post-employment restrictions rarely come up, though these are still covered by criminal law.

In response to a question from Dr. Tapley, Ms Gilchrist said that if a subcommittee member's employer has a grant with NASA but the subcommittee never discusses the grant, there is no conflict of interest.

An SGE may not accept a gift from a contractor that is worth more than $25, if the gift is offered because the SGE is a subcommittee member. This rule does not apply to personal relationships. SGEs are subject to the Hatch Act, which governs political activities, but only when they are serving, or representing themselves as SGEs. Dr. Freilich added that NASA has a policy that if a NASA employee makes it clear that he or she is not representing NASA, the employee can speak freely.

For decisions about how to behave, Ms Gilchrist recommended the *Washington Post* test: Members should ask themselves how their behavior would look on the front page of the *Washington Post*.

Ms Gilchrist and the OGC Ethics Team are available for questions at ethicsteam@hq.nasa.gov. Subcommittee members were also invited to reach the Ethics Team through Dr. Tsaoussi.

Earth Science Goals and Objectives

Dr. Jack Kaye

Dr. Kaye explained that every NASA division has a goal and a set of questions and objectives, which are used in strategy documents. This is in some sense the way NASA describes itself to the world. They show up in performance documents. In the coming years, NASA will enter into a new strategic planning cycle and thus revisit objectives. Dr. Kaye asked the committee to think about this in the context of ideas to describe Earth Science.

The current structure, which goes back about 10 years, is described in terms of variability/forcing/response/consequence/prediction. It includes a goal – to study planet Earth from space to advance scientific understanding and meet societal needs – as well as six focus areas. The objectives talk about understanding, quantification, characterization, and predictive capability. Dr. Kaye explained that the coming years will bring opportunities to change this description.

Dr. Kaye asked what the subcommittee wants for the future. He suggested that the group begin a dialogue. Should the present structure be retained? Should ESD's work be tied to societal relevance? Should NASA use climate change research to benefit society? Dr. Kaye said the subcommittee's recommendations in these areas could help ESD.

Dr. Kaye pointed out that the way NASA describes itself externally does not have to be how NASA works internally.

Dr. Curry commented that the objectives are well put, but the goal and questions could be improved. The verbs "document," "understand," and "predict" would be better for the goal statement. The way the questions are posed is not well aligned with what ESD is doing.

In response to a question from Dr. Siegel about why input was being requested, Dr. Kaye explained that over the next few years, ESD will have some opportunities to change the way it describes things. ESD may be asked without much notice to propose new wording for its goals and objectives, and the subcommittee might have to provide input in an uncomfortably short timeframe; for that reason he was asking for input early.

Dr. William Large pointed out the risk of ESD getting so broad that it loses focus. He suggested that ESD could be clear about what it is *not* going to do. Dr. Kaye replied that the most important thing is that the conversation take place and that it include the questions "Where do we stop?" and "How does what we do relate to what other agencies do?" and "Is there something that makes us different from the others?"

Dr. Large commented that saying you are studying planet Earth from space puts you apart from everyone.

Dr. Jacob agreed with Dr. Curry that the objectives are well put. In the goal, "study," and "document" are weak words, he said. He suggested, instead, "observe." He agreed with Dr. Curry that the questions are weak; he suggested consolidating them into two or three. He agreed with Dr. Kaye's distinction between how ESD presents itself externally v. internally. He said the organization by current focus areas serves the purpose well.

Dr. Sarabandi asked how long one set of questions, which never get answered, can continue to serve as a motivating factor when ESD presents itself outside NASA. On the issue of societal benefit, he commented that ESD needs to suggest a remedy. For example, some of what can be done about global warming needs to be articulated, so that changes are in hand as time goes by. Otherwise, people will stop reacting.

Dr. Michalak commented that changing the questions may be perceived as not sticking with a goal. She suggested instead making the questions or objectives more achievable, so that the program could achieve one objective and then move on to the next one. More concrete questions would allow NASA to say, "Here is what you will get from the investments you are making."

Dr. Freilich pointed out that there is a perception in the new Administration that ESD's role is to provide and demonstrate technology that has application to Earth Science needs. He asked the subcommittee to help ESD articulate that ESD's primary role is to do Earth system science, not to provide technology. Dr. Tapley commented that no entity other than NASA has the capability to use that technology to do the science. Dr. Sarabandi commented that the need for NASA's unique ability to do the work from space could be challenged. Dr. Freilich replied that space

provides the global view with the appropriate coverage and accuracy to make it possible to understand the linkages between processes.

Dr. Siegel paraphrased Dr. Freilich to say that upper management believes NASA's purpose is to provide technology for others. That would mean that NASA is not a science agency. Dr. Freilich asked the committee, understanding that challenge, to help craft the words by which NASA can communicate to the outside that NASA does science and applications in addition to data acquisition.

Dr. Jenkins raised the issue of climate change: NASA is in the right position to quantify the changes that climate change is bringing. NASA's role in this area is not clear from the goals and questions being discussed.

Dr. Kaye commented that ESD knows what ESD means by the goals and objectives, but others may not, so he was asking the subcommittee for their viewpoint. He said the dynamic is not "How can we do a better job on the science?" but "How can we employ the science we have to quantify impacts and help people make adaptations and make decisions now for the coming decades?"

Dr. Matrai asked whether the purpose of the requested rewording was to help ESD begin a new strategic plan. To what extent might that plan already be determined for the next 15 years by the Decadal Survey? Dr. Freilich replied that Dr. Kaye had laid out the three basic imperatives:

1. The new Agency leadership has decided they want a new strategic plan.
2. The Science Mission Directorate's strategic plan needs to be reevaluated in light of the new Decadal Surveys expected in the coming years for three of the directorate's four divisions.
3. If ESD were to become a directorate, it would be essential to have crisp descriptions available.

Dr. Matrai replied that in light of Dr. Freilich's comments, the rewording of the document must become a major action item for the subcommittee. Dr. Curry suggested that the NASA directive's words "as only NASA can" be kept in mind in the revision. Dr. Jacob cautioned that the mantra "as only NASA can" could be more constraining than helpful. What makes NASA unique is observation from space, and that is spelled out in the goal. It does not need to be spelled out in the objectives. A unique capability of NASA is the end-to-end paradigm of going from observations all the way to understanding. This distinguishes NASA from other agencies. Dr. Tapley agreed.

Dr. Siegel suggested that the goals and objectives should include applications in a real way. He suggested including, for example, climate modeling in support of Intergovernmental Panel on Climate Change (IPCC) activities. Perhaps the meaning of "applications" should be expanded.

Dr. Tapley asked whether the subcommittee should take the document revision as a homework activity and discuss it at the next meeting or whether it was needed sooner. Dr. Gregory Williams suggested that a revision would be valuable for the director-level (SMD) science plan, which is

to be issued in May or June of 2010. Dr. Williams suggested that in its documents NASA needs to sell to its stakeholders the idea that NASA is a science agency.

Dr. Matrai stated that if the subcommittee is to make a meaningful contribution to this effort, then meaningful time needs to be allocated for that conversation at the next meeting.

Dr. Large suggested that some exchange before the next meeting could help the process. Dr. Tsaoussi said recommendations should come out of discussions that take place in an open forum communicated to the public, usually FACA rules are met best at face-to-face meetings. Any telephone communication in between should be for information only, in preparation for the face-to-face meeting. She suggested that the next meeting should be scheduled well ahead of time, so that as many of the subcommittee members as possible could attend. Dr. Tapley suggested a teleconference before the next meeting; perhaps the preparation could be done by e-mail.

Dr. Siegel suggested that NASA needs to play up the discovery aspect of its work; there are discovery issues that are relevant to Earth Science, for example, the melting of Greenland. Dr. Jacob warned that ESD should not frame itself as doing discovery, because NASA will never be on par with the Exploration Directorate in that area.

NASA Earth Science Technology Program

George Komar, Associate Director/Program Manager, NASA Earth Science Technology Office

NASA's Earth Science Technology Office (ESTO) develops technology to support science. Projects are competed; competition is open to everyone. Solicitations are issued regularly and frequently.

ESTO programs include observation technologies and information technologies. Over the past 11 years, 505 projects funded by ESTO have been completed. These projects were carried out by PIs from 102 organizations in 32 states and the District of Columbia, about 28 percent of them at NASA and the rest in other institutions, public and private. Projects are evaluated for the usefulness and for future relevance of their products. These technologies will support Decadal Survey missions. The program also seeks to inspire young scientists and engineers. In 2009, 140 students from more than 39 institutions were involved.

Dr. Curry commented that the role of science in driving the technology has become focused by the Decadal Survey. She asked if this means that the direct role of the science program is disconnected. Dr. Komar replied that it does not. He explained the process by which science drives the technology program: Internally ESTO works with Dr. Kaye, as well as other associate directors at headquarters, to see that ESTO's solicitations meet the program's needs. ESTO discusses with Dr. Freilich what they need to target to support the needs of missions recommended by the Decadal Survey.

Dr. Tapley asked about the factors influencing decisions about what kind of technology to develop. Dr. Freilich commented that if the program is broadened in scope, it might yield benefits in 10 or 15 years, but that would take funding away from projects that could be carried out in the near term. He asked for the subcommittee's input on how to strike that balance.

Dr. Jacob commented on the distinction between science-driven and Decadal Survey-driven technology: Decadal Survey-driven technology is directed at specific scientific solutions; it can be converted to science over the next decade. The more-broadly-science-driven agenda, on the other hand, may look further ahead and may also look at transformational technologies that would apply across a broader area. He suggested that NASA should still invest some resources – perhaps twenty percent – from the technology program into these farther-reaching programs. He asked if the technology program's AOs could focus on cost reduction for technology for Decadal Survey missions. Dr. Komar replied that reducing cost is part of what his program does.

Dr. Freilich asked whether the solicitation structure for technology to support tier III projects is based on the notional implementation that was identified in the Decadal Survey, or on a more open approach to achieving the capabilities that those missions would have. Dr. Komar answered that in the last Instrument Incubator Program (IIP), Dr. Freilich had given ESTO the Decadal Survey specifications as a basis from which to work. He suggested that for future tier III solicitations, a small amount of money could be set aside for game-changing technologies.

Dr. Large asked whether it is in pre-phase A that a mission's needs are determined and whether that is where cost escalation first becomes a problem. Dr. Komar answered that in pre-phase A a mission's needs get narrowed down. Dr. Freilich said the Agency does not commit to a cost and a schedule until key decision point C (KDP-C, the transition from formulation to implementation). The technology program is working at proof of concept at pre-pre phase A level. Translating that into space-qualified hardware involves a huge effort.

Dr. Siegel suggested that changing some costing processes may be a way to realize cost savings. He asked if any reassessment of the process is being done. Dr. Freilich replied that there are Agency-wide documents mandating what reviews need to be done at each level of project development. He said that is an Agency-wide issue and not a good topic for the subcommittee. There is an attempt to avoid doing technology development within a flight project, because it would be very expensive. In fact, when unexpected technology development challenges occur late in a project, the cost escalates tremendously.

Dr. Sarabandi asked why ESTO's budget is so low and who will provide the technology ESD needs if ESTO does not. Dr. Komar replied that it was possible that ESD would use technology developed by the other directorates, although there is no cross-cutting technology program at NASA. With the 3.5 percent or 4 percent of the budget that ESTO has, ESTO does the best it can.

Dr. Freilich asked the subcommittee for its recommendation for a rebalancing of ESD's funds, on the assumption that the overall ESD budget is not going to increase.

Dr. Sarabandi commented that if NASA is not a science agency, it had better be a technology agency. Dr. Tapley warned the subcommittee against taking a direction in which NASA is not a science agency. Dr. Sarabandi clarified that he meant only to emphasize that the technology is also a flagship for the Agency. NASA's technology is almost unique – not many others are making the instruments NASA uses. Dr. Tapley agreed on the importance of doing the technology to get the capability.

In response to a question from Dr. Large, Dr. Komar replied that there is a program in NASA for technology transfer from the Federal government to private industry. He cited the example of the 2-micron laser, which is being picked up by industry.

Applied Sciences Advisory Group Status

Dr. Raymond Hoff

The Applied Sciences Advisory Group (ASAG) was holding a meeting concurrently with the subcommittee's meeting.

The Applied Sciences Program is required to prepare a report through the subcommittee from the Administrator to Congress on a provision in the 2006 appropriation that requires NASA to form ASAG and to have an independent evaluation of the Applied Sciences Program. The independent evaluation was done by National Academy of Sciences (NAS) in 2006. The next step would be for ASAG to write a letter report through the NAC and its associated committees to the NASA Administrator.

Dr. Hoff explained that ASAG had spent its first year providing input to Teresa Fryberger on program strategy. A report on that effort would be coming out shortly and will form basis of strategy for the Applied Sciences Program to make awards for projects. Dr. Fryberger had left the Applied Sciences group; Mr. Friedl, acting in her position, would reply to ASAG's questions about program effectiveness.

Dr. Freilich asked whether the flexible projects approach provides for some projects to be outside the competitive ROSES. Dr. Hoff replied that that is under consideration. Funding that comes from Congressional directives does not typically go through ROSES. In some cases, however, NASA does require projects with funding specially provided by Congress to go through ROSES and compete. This is an effort to "make lemonade out of lemons": The funding for these projects is beyond NASA's normal budget. It may not be spent the way NASA managers would have chosen to spend it, but the ROSES process ensures that the projects are legitimate.

Dr. Tapley suggested that the subcommittee assimilate its comments into letter form. He asked whether there were issues beyond the four that the subcommittee had developed at last January's meeting, plus the one that the NAC Science Committee had put into play.

Dr. Jacob stated his understanding that Dr. Freilich had passed on to the NAC the recommendation that NASA try to set itself up as a monitoring agency, and the recommendation had been poorly received. Dr. Tapley replied that there still had not been a formal response to the recommendation. With regard to the other issues, Dr. Tapley noted that before acting, the subcommittee needs to understand how the NAC Science Committee is organized before submitting recommendations. Dr. Tsaoussi said she would look into this.

Dr. Jacob commented that it had been very useful at the subcommittee's previous meetings to have Dr. Freilich respond to the recommendations point by point.

Dr. Large suggested that instead of making recommendations, the subcommittee put together options and ask groups at higher levels to make choices. Dr. Tapley replied that when that method had been used in the past, not all the recommendations made went up to management and those that did were edited by the NAC.

Dr. Jacob commented that the subcommittee had discussed almost all of the major points in the letter that had resulted from last January's meeting. However, several concerns expressed by members about resources about direction and allocation of resources had not been addressed at this meeting. He suggested that these issues be discussed at the next meeting. Dr. Tsaoussi said she would prepare to do so.

There was discussion about joining ICSU, as Dr. Minster had proposed. Dr. Tapley said he could see nothing but the upside for NASA applying for membership. Dr. Freilich suggested that NASA's approach might be to get involved and then see whether NASA could use it to NASA's advantage.

Dr. Tapley asked subcommittee members to send their suggestions by e-mail to himself, Dr. Tsaoussi, and Dr. Jacob.

Dr. Tapley raised the question of the mid-term review of the Decadal Survey. Dr. Jacob commented that if the subcommittee waits long enough, the mid-term review will take place by default. He used examples that had been raised throughout the meeting: the ballooning cost of CLARREO and the unresolved NPOESS problems. He suggested a discussion about whether it was still the same mission, about whether the circumstances are changing so much that it is time for NRC to take another look at, for example, the mission priority tiers. Those tiers may have been based not only on scientific importance but also on technological readiness and on data gaps, things that have changed. Further, Dr. Jacob said, some information was missing when the Decadal Survey was written: The eventual costing and budget were not commensurate with the Decadal Survey's assumptions. These things make the mid-term review critical.

Dr. Jacob pointed out that the review is mandated by 2012, so it would have to start next year; he suggested that it start immediately. Mid-course reviews have tended to be perfunctory, but in this case the mid-term review's charge should state that the present circumstances could not have been anticipated at the time of the original report. Dr. Large suggested finding out how the charge for the mid-term review is set, and trying to get some input into that. Dr. Freilich

suggested that the subcommittee focus on the scope of mid-term review. His interpretation of the subcommittee proceedings, he said, was that the subcommittee wanted the mid-term review to serve as the next Decadal Survey. Dr. Tapley said this was not the subcommittee's intent; rather, the subcommittee wanted to ask NRC whether they indeed wanted their recommendations to apply given the circumstances that had developed. The review is not for scientific priority but for implementation. Is stretching the schedule the only way to respond to inadequate funding?

Dr. Sarabandi asked what NASA's position would be if NRC's response was that the Decadal Survey in its present form should not be implemented. Dr. Tapley asked what effect that response would have on projects that had already been committed to.

Dr. Freilich paraphrased Dr. Jacob's question about CLARREO: whether in fact the mission that is being proposed, based on the science requirements and questions that are laid out in the Decadal Survey, addresses the Decadal Survey's intent for that mission. CLARREO, because it is not close to being implemented, can be changed. The other tier I Decadal Survey missions are farther along in the process. But the Decadal Survey is more than the missions: Its 25 recommendations also include increased research, applications, airborne infrastructure, and computing and modeling. When NRC's mid-term review suggests a different implementation of some parts of the Decadal Survey, Dr. Freilich asked, how will NRC decide which parts to look at? How will NASA charge them with which parts to look at? What is the space in which they are doing the balance? Dr. Tsaoussi said she would see if there is an existing agreement between NASA and NRC about how to go about doing that. If so, the subcommittee can add to it. She noted that it is the Agency writes the charge.

Dr. Large stated that NASA's question to NRC is whether NRC can suggest a better response to low budgeting than stretching out the schedule. Dr. Jacob suggested stating clearly the circumstances that have changed. Dr. Freilich cautioned against using language that effectively asks NRC if they still endorse the Decadal Survey, but rather asking whether NASA's implementation approach is appropriate to the present circumstances.

Dr. Michalak paraphrased the problem: Given that funding is inadequate and that only so much can be done, is following the tier I - tier II priorities still the right approach? The tiers were based not only on mission importance but also on the fact that when the Decadal Survey came out, some missions would not be ready to be launched for years – and that reason for putting a mission in a particular tier may no longer apply.

Dr. Matrai asked Dr. Freilich if in fact it was the subcommittee's job to review priorities. Dr. Tapley replied that it is not the subcommittee's role to make such decisions. Dr. Freilich agreed, saying that in terms of missions and program balance – things that are encompassed in the Decadal Survey – NASA is not going to respond to anyone other than NRC. He asked for the subcommittee's advice about what should give about how what to do under the circumstances – have fewer missions or riskier (less expensive) missions, for example. Dr. Tapley suggested that the question is what NASA can do in the short haul that is constructive, specifically about its mission sequence.

Dr. Jacob said that last January, at a NAC Science Committee meeting following the subcommittee meeting, one recommendation was that NASA initiate mid-term review of the Decadal Survey. The Science Committee did not approve that recommendation, because of uncertainties about the budget: Stimulus money might be coming, and the new Administrator might prioritize Earth Science. By the time of the present meeting, though, the budget picture was clearer, so this would be a good time to recommend initiation of the mid-term review to the NAC again.

Dr. Jenkins asked what will happen in the mid-term review if no action is taken. Dr. Freilich answered that the Heliophysics program had earned about a D+ in its mid-term review, the first in the program, because it was not implementing the Decadal Survey on the schedule and with the scope that NRC had recommended. The reason for the failure was that resources were not available to do it in the way NASA wanted to do it, just as the the subcommittee was pointing out in the Earth Science program.

There was more discussion about the charge that NASA would give the NRC for the Decadal Survey review. Dr. Large clarified that the charge is not for the Decadal Survey, but for a strategy to deal with the discrepancy between scope and resources.

In response to a question from Dr. Matrai, Dr. Freilich stated that a mid-term review takes 12 to 18 months. Dr. Matrai pointed out that if the review ends at mid-term, it may be under way already. Dr. Jacob said the report is delivered at mid-term. Dr. Jenkins pointed out any change recommended by the mid-term review should affect missions that are scheduled to be launched years from now; missions to be launched soon are too far along to be affected.

There was more discussion about Decadal Survey priorities and what is being requested of NRC. For example, Dr. Jacob said, considering the ballooning of the cost of CLARREO, NRC could ask NASA to do the Surface Water Ocean Topography (SWOT) project first instead. This would be not a major strategic revision of the Decadal Survey, but an implementation decision. Dr. Freilich suggested that Dr. Jacob was trying to get NRC to say something other than "It looks like NASA is not producing on the schedule we gave them." Dr. Jacob agreed. Dr. Tapley said it amounted to asking NRC whether, given the constraints, NASA was asking NRC if NASA's understanding of the priorities was correct.

Dr. Tapley asked the group for thoughts about how to phrase the issue of Decadal Survey implementation strategy, and what the thought process was. Dr. Matrai suggested the subcommittee's statement about international cooperation to cover gaps in climate data. The issue was to ensure a way not to have a data gap, given the rescheduling of data-gathering missions. Dr. Freilich advised that the group should be as precise as possible. He suggested recognizing that there may be pending data gaps and there is a need to be sensitive to the issue. Dr. Michalak suggested coordination in planning future missions. Dr. Matrai replied that because a data gap is highly likely, something should be done to cover it. Dr. Michalak recommended that NASA work together with its international colleagues to plan future missions, so that the international community would not duplicate efforts in one area while leaving gaps in another.

Dr. Tapley commented that there is a major international discussion among NASA, ESA, and the Committee on Earth Observation Satellites (CEOS) but Earth Science is not part of the discussion. He asked whether that discussion includes science requirements. Dr. Freilich replied that it does. The role of the CEOS is to coordinate the international approach to Earth observations from space. CEOS provides the forum for discussions among the implementing agencies. The subcommittee could ask what connections ESD has for agreements with other major space agencies. Dr. Large commented that some partnerships are costing too much. For example, Aquarius is now delayed because of a partner. Dr. Freilich commented that the record shows that international partnerships do not decrease the costs of missions, but they do make missions more robust – missions stay on schedule better and get canceled less. Dr. Matrai pointed out that the delay of some missions may cause programs outside of NASA that depend on NASA data to miss important data. International data exchange may be the only way to avoid such gaps.

Dr. Tsaoussi proposed setting up the next meeting. Dr. Tapley suggested holding it in late February or early March, after the budget has been released. Dr. Tsaoussi pointed out that every year in March the subcommittee's membership changes: New people join and others leave.

Dr. Tapley proposed that the meeting be for at least two days. He asked the subcommittee members to submit agenda items to Dr. Tsaoussi.

Dr. Tapley thanked those present for their participation and adjourned the meeting at 2:36 pm.

Appendix A, Agenda

NAC Earth Science Subcommittee

L'Enfant Plaza Hotel
480 L'Enfant Plaza, SW, Washington, DC.
Ballroom A (Lobby level)

AGENDA

Wednesday, October 14, 2009

8:30 – 8:45	Introductory Remarks Review & meeting charge	B. Tapley
8:45 – 9:45	Earth Science Division Update	M. Freilich
9:45 – 10:15	Research Program Update	J. Kaye
10:15 – 10:30	Coffee Break	
10:30 – 11:00	Flight Program Update	S. Volz
11:00 – 11:30	Applied Sciences Update	M. Freilich
11:30 – 1:00	Lunch	
1:00 – 2:00	Question-and-Answer Session with Science Mission Directorate Assistant Administrator	E. Weiler
2:00 – 2:45	Decadal Survey Implementation	S. Volz
2:45 – 3:00	Coffee Break	
3:00 – 3:45	EOSDIS long term Plans	M. Maiden
3:45 – 4:30	Discussion	All
4:30	Adjourn	

Thursday, October 15, 2009

8:30 – 8:45	Session Overview	B. Tapley
8:45 – 9:45	Ethics briefing	R. Gilchrist
9:45 – 10:00	Earth Science Goals & Objectives	J. Kaye
10:00 – 10:30	Discussion	All
10:30 – 10:45	Coffee Break	
10:45 – 11:30	Earth Science Technology	G. Komar
11:30 – 12:00	Discussion	All
12:00 – 1:15	Lunch	
1:15 – 2:00	ASAG status	R. Hoff
2:00 – 3:00	Letter writing/next meeting	All
3:15	Adjourn	

Appendix B, Subcommittee Roster

Earth Science Subcommittee Membership
September 29, 2009

Byron D. Tapley, *Chair*
University of Texas, Austin

Lucia S. Tsaoussi, Executive Secretary
NASA Headquarters

John R. Christy
University of Alabama in Huntsville

Judith Curry
Georgia Institute of Technology

James Hansen
Goddard Institute of Space Studies

Raymond M. Hoff
University of Maryland

Daniel Jacob, Vice Chair
Harvard University

Gregory S. Jenkins
Howard University

William Large (Pending member)
National Center for Atmospheric Research

Patricia Matrai
Bigelow Laboratory for Ocean Sciences

Patrick McCormick
Hampton University

Anna M. Michalak
The University of Michigan

Jean-Bernard Minster
University of California San Diego

Steve Running

University of Montana

Kamal Sarabandi
The University of Michigan

Robert Schutz
The University of Texas

Hank Shugart
University of Virginia

David A. Siegel
University of California, Santa Barbara

Mark Simons
California Institute of Technology

Konrad Steffen
University of Colorado at Boulder

Charles Vorosmarty
University of New Hampshire

Appendix C, Meeting Attendees

Earth Science Subcommittee Meeting

L'Enfant Plaza Hotel
Washington, D.C.
October 14 – 15, 2009
Attendees

Earth Science Subcommittee

Tapley, Byron, *Chair*	University of Texas at Austin
Curry, Judith	Georgia Institute of Technology
Hoff, Raymond	University of Maryland
Jacob, Daniel, Vice Chair	Harvard University
Jenkins, Gregory	Howard University
Large, William (pending member)	National Center for Atmospheric Research
Matrai, Patricia	Bigelow Laboratory for Ocean Sciences
McCormick, Patrick	Hampton University
Michalak, Anna	University of Michigan
Sarabandi, Kamal	University of Michigan
Schutz, Robert	University of Texas at Austin
Siegel, David	University of California, Santa Barbara
Steffen, Konrad	University of Colorado at Boulder

NASA Employees

Bauer, Robert	NASA/ESTO
Considine, David	NASA HQ
Di Joseph, Mary	NASA GSFC
Doorn, Bradley	NASA HQ
Eckman, Richard	NASA
Feeley, Jens	NASA
Freilich, Michael	NASA/ESD
Friedl, Lawrence	NASA HQ
Gilchrist, Rebecca	NASA HQ OGC
Goodman, Michael	NASA HQ
Halpern, David	NASA HQ
Hildebrand, Peter	NASA GSFC
Jucks, Ken	NASA HQ
Kakar, Ramesh	NASA HQ
Kaye, Jack	NASA
Ketchum, Eleanor	NASA GSFC
Komar, George	NASA/ESTO
Lipschultz, Fred	NASA HQ
Luce, Margaret	NASA HQ
Maiden, Martha	NASA HQ

Norris, Marian	NASA HQ
Pasciuto, Michael	NASA/ESTO
Tsaoussi, Lucia	NASA HQ
Valinia, Azita	NASA GSFC
Volz, Stephen	NASA HQ/ESD
Walter, Amy	NASA/ESTO
Weiler, Ed	NASA HQ
Williams, Gregory	NASA
Wiscombe, Warren	NASA
Woods, Dan	NASA HQ
Yuhas, Cheryl	NASA HQ/ESD

Other Attendees

Bass, Randall	ITT
Bauer, David	Northrop Grumann
Black, Dan	Raytheon
Carroll, Tom	Lockheed Martin
Conte, Dom	Self
Criscione, Joe	Stellar Solutions
Eden, Frank	Eden Consulting
Geist, John	Harris
Hacker, Jill	Harris
Jairam, Laura	ITT
McCarthy, John	Orbital
McDonald, Bridget	Medill News Service
P[?]theram, John	Lockheed Martin
Quintal, Miriam	Lewis-Burke Associates/VCAR
Rogers, Richard	Stellar Solutions
Sood, Kiran	Medill News Service
Wallace, Cynthia	Harris
[illegible]	University of Colorado
[illegible]	Raytheon