

**National Aeronautics and Space Administration**

**Science Mission Directorate**

**Earth Sciences Division**

**Applied Sciences Advisory Committee**

**Hotel Adagio**

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**December 11-12, 2014**

**Meeting Minutes**

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**Peter Meister, Executive Secretary**

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**Kass Green, Chair**

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Day 1: December 11, 2014

Session 1: Welcome and Meeting Objectives

Mr. Peter Meister, Executive Secretary of the Applied Sciences Advisory Committee (ASAC) of the Earth Sciences Subcommittee (ESS) of the NASA Advisory Committee (NAC), opened the meeting and turned it over to Ms. Kass Green, ASAC Chair. Ms. Green thanked the members for attending. The meeting was to cover a number of topics, with a good deal of focus on the Applied Sciences Program (ASP) strategic plan.

*Applied Science Program Review*

Dr. Lawrence Friedl, Director of ASP, Earth Sciences Division (ESD), explained that the Program had tried to be responsive to the Committee and welcomed this opportunity for perspectives on what ASP has been doing. ASP focuses on applications, capacity building, and mission planning within four primary applications areas: health and air quality, water resources, disasters, and ecological forecasting.

Within capacity development, ASP supports the DEVELOP training program, Applied Remote Sensing Training (ARSET), the SERVIR initiative to enable environmental monitoring for developing nations, and the Gulf of Mexico Initiative (GOMI) to address coastal management issues. GOMI will be closing at the end of Fiscal Year 2015 (FY15). Dr. Friedl also noted the Early Adopters program, initiated with the Soil Moisture Active Passive (SMAP) satellite to conduct pre-launch applications research in order to accelerate use of the satellite's data. Finally, ASP established the Applications Readiness Levels (ARLs), which help determine where Principal Investigators (PIs) are in the maturation process. ASP looks to ASAC for feedback and findings to help set the Program's scope and priorities.

One topic of this meeting was to review the seven primary recommendations made at the May 14, 2014, meeting, and their status within ESD. There would also be discussion of how to best organize in advance of the next iteration of the Decadal Survey (DS). One of the concerns is that the National Research Council (NRC) committee conducting the DS still thinks in terms of a linear bridge metaphor between "pure science" and applications, which is not the most appropriate way to view applications.

In regard to mission planning, a recommendation from ASAC noted that it is best to integrate applications requirements into the planning early. This includes Announcements of Opportunity (AOs). The 2015 AOs can include early integration. The Venture AO references but does not require applications, though proposers may receive extra credit for including them. In regard to data and mission planning, there have been a number of activities, including a retreat.

The strategic plan will include language related to the adoption of applications, and there will be some analysis activities in this area in FY15. The ASAC recommendation on tools for data access and use emphasized accelerating development of tools, particularly for the Land and Atmosphere Near real-time Capability for Earth Observing System (LANCE). The GOMI funds will shift to capacity building in order to grow that area.

Ms. Green noted that ASAC would discuss the ESD response to the letter. Dr. Michael Freilich, ESD Director, responded to some portions of the letter more directly than others. Dr. Friedl replied that Dr. Freilich had not yet closed out the letter. Some specific topics from the letter

would be addressed the next day, while some are in process and others are not yet ready to be discussed. Ms. Green said that although there was no need for a session on every single point, ASAC did need to address them, obtain status information, and possibly ask for help.

ESS wrote a letter complimenting ESD for the Division's multiple satellite launches in FY14, as well as its increased use of the International Space Station (ISS) as a platform. The letter also praised, and encouraged greater use of, early adopter programs. ESS requested that the NASA Earth Science Technology Office (ESTO) present a report to the next ESS meeting, and Ms. Green planned to request an applied science report. In addition, the National Climate Assessment report came out. ESS asked to see the sustained land imaging document, but was informed that it constitutes proprietary advice to the Administration and will not be released publicly. In part, it addresses the future of LandSat, in which both ESS and ASAC have an interest. A recommendation regarding K-12 education about Earth science touched on the issues of education at NASA. Finally, there was discussion of the upcoming DS.

It will be important for the NRC to address applied sciences in the next DS. Dr. Freilich has been looking at inputs from the DS, which can make recommendations on the substance of the nation's Earth science program and its balance, though the decisions rest with the agencies that implement the program. The various communities and stakeholders will have opportunities to comment on these issues, including research applications.

### Session 2: ESD and Applied Sciences Overview

Dr. Friedl explained that the new framework for the National Civil Earth Observations Plan (the Plan) relies on two broad categories: sustained observations, which are measurements generally taken for 7 years or more; and experimental observations, which are measurements taken for a more limited time. Not all of these are space-based. Within sustained observations are two categories: public services and Earth systems research. This framework provides agencies a way to talk to the Office of Management and Budget (OMB) about upgrades, needed observations, and other activities. The Plan lays out priorities, starting with sustained observations for public services, moving to experimental observations, and ending with assessment of priorities and upgrades. While the document is called a "plan," that term stems from legislation. In practice, it is more like guidance rather than a specific ranking of what will and will not be implemented.

The Earth science community needs to identify the priorities for the Plan, which will come out in 2017, the same year as the next DS. OMB has been looking for a framework like this in order to set forth priorities. The first Plan essentially laid out the framework for discussion; the 2017 Plan can be much more descriptive and definitive regarding priorities. The hope is that the community will identify the observations it needs so that the Plan can reflect them.

Dr. Susan Moran pointed out that the DS included a lot about observations and reflected those with the greatest societal benefit. She wondered if the NRC would consider it a failure if the questions were to be answered with no applications for the data. Dr. William Gail said that the original DS did not view all science as having to result in applications. There were no metrics for success on the applications side, despite the fact that applications often strengthen science.

Dr. Molly Macauley observed that the previous DS was issued when the nation had a new president who made climate a priority. She wondered how another president might react to the

upcoming DS. Dr. Friedl replied that the next DS will include Administration priorities and thoughts. Dr. Freilich told ESS that the DS, Administration priorities, and NASA priorities together form the direction. Dr. Philip Ardanuy said that it looks like NASA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Geological Survey (USGS) will provide input to the next DS. The focus will be on science; it is unclear how far it will go into applications. There is a backlog of unfulfilled priorities from the last DS.

Dr. Freidl reported that the budget appropriations for NASA Earth science have been relatively stable over the last few years. Earth Venture (EV) opportunities have all been PI-led and competitively selected, falling within three mission areas:

- Earth Venture Sub-Orbital (EVS) – Sustained sub-orbital investigations
- Earth Venture Mission (EVM) – Complete, self-contained, small missions
- Earth Venture Instruments (EVI) – Full function, facility-class instruments; Missions of Opportunity (MoO)

ESD just selected a second round of EVI and EVS missions, and is about to do a call for instruments and EVM. In addition to implementing the five missions selected recently, ESD hopes to do aspects of two others. All have a climate dimension. The EVI-2 instruments are the Global Ecosystem Dynamics Investigation (GEDI), which will examine the above-ground carbon balance of the land surface, and ECOSystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), which will use high spatiotemporal resolution to identify the vegetation diurnal cycle and how ecosystems change with climate. Both will deploy on the ISS.

Dr. Woody Turner added that ECOSTRESS will look at agriculture, crop water, evaporation, and drought stress. Applications are assumed, though they were not a selection criterion. Regarding the “extra credit” for proposals including applications, Dr. Ardanuy pointed out that PIs will perceive that as a tie breaker that could elevate their proposals. He asked if ISS might be close to full. Dr. Turner explained that ISS moves payloads on and off, and this is a temporary placement.

Dr. Freidl said that the Research Opportunities in Space and Earth Sciences 13 (ROSES 13) solicitation was to continue some of the products using the Suomi National Polar-orbiting Partnership (NPP) mission, in addition to developing new applications. The selections included 35 standard data products and 2 applications. In general, not many projects came in with the quality ASP sought. There was also a Suomi NPP applications workshop, which emphasized the need to further encourage use of LANCE and learn how other agencies plan to use it.

The Office of Science and Technology Policy (OSTP) has encouraged NASA and other agencies to accelerate the release plan for Shuttle Radar Topography Mission (STRM) data. As a result, data have been released for Africa, North and South America, northern Europe, and some Pacific islands. In the FY14 budget, NASA’s Sustainable Land Imaging (SLI) focus was to be on studies to define the scope. Dr. Friedl presented four candidate architecture classes. NASA and USGS have briefed OMB and OSTP, and are awaiting a decision.

FY14 was a big year for Earth science launches, which Dr. Friedl reviewed. The SMAP launch was imminent, as well. The Tropical Rainfall Measuring Mission (TRMM) was going dark in April 2015, following one final period of data collection. The mission, which has run out of fuel, has been a workhorse and has introduced some excellent applications. Tropospheric Emissions:

Monitoring of Pollution (TEMPO) is an EVI instrument currently awaiting a ride to geostationary orbit. There are concerns about the Venture cost cap and schedule, however. The project had to drop some proposed activities, and there is some apprehension regarding the likelihood of the mission achieving its goals.

An April meeting of the Moderate Resolution Imaging Spectroradiometer (MODIS) science team discussed whether to maintain mean local time (MLT) or to maintain altitude while allowing MLT to drift. The team is taking comments from the community. SMAP started the Early Adopters program in order to generate interest in the data products. This has turned out to be extremely popular, and ESS has since urged other missions to incorporate this program. A number have done so, though some are more official than others.

ESD is also looking at three fundamental global challenges: food security, water availability, and disaster response. The effort seeks to learn what leading global organizations – from Coca-Cola to the United Nations – are doing in these areas. The initiative is looking at 25 such organizations for potential partners and eventually will have high-level meetings with a few of these to discuss opportunities.

The FY15 budget for ASP was likely to increase by about 10 percent over that of FY14. For the third year in a row, the ARLs have exceeded the 25 percent metric, which is now going up to 35 percent. PIs are becoming increasingly familiar with the ARLs, which are seeding the conversation. However, it is important not to advance the standard too quickly. There has yet to be an analysis of whether ASP is doing enough risky work.

The Program is conducting two-phase feasibility studies for applications. NASA pays for the first stage, with the partner contributing during the second phase. Recent solicitations in water and health/air quality have had a success rate of only 12 percent, which is low. The concern is that this low rate will discourage future proposals. There were good projects that ASP could not select due to funding restrictions. Dr. Turner noted that there are no additional points given to proposals written by Early Adopters, but those proposers could be more likely to write a better proposal, reflecting greater experience in understanding what is needed. Therefore, it is an implicit advantage, though not an explicit factor. Dr. Moran wondered if solicitations could call out Early Adopters; Dr. Friedl said that ASP will consider the comment.

In the capacity building area, SERVIR has a new hub, in the lower Mekong region with a base in Bangkok. The NASA Administrator, Mr. Charles Bolden, will attend the kickoff event in the spring. Mr. Bolden is also very engaged with the DEVELOP program and has paid particular attention to the young professionals who attend the annual Earth science applications showcase.

ARSET sponsored webinars on introducing Earth science products and tools to users; one such event, on water quality, had 111 participants. There are issues on how to take this to scale and broaden the thinking. ARSET is increasing the budget for training the trainers, and providing materials to groups doing their own training. Dr. Ardanuy noted that NOAA, which sees itself as purely operational, does not have the same openness as NASA. Dr. Friedl agreed that there does not seem to be a lot of reprocessing at NOAA. He took that as an action to follow up.

ASP has emphasized attending meetings with the various science teams and pursuing greater connections in order to ensure that the applications community is familiar with the science

activities. This has not been easy to track. Dr. Friedl requested that ASAC ask ESD to establish a centralized place to announce these meetings. ASP needs to know when these meetings occur without having to constantly query the individual science team leaders.

ASP has its own version of science teams, one on air quality and another on SERVIR. An example of how to use MODIS information to monitor water quality demonstrated how the Program can help USGS save money. Success resulted when the project team engaged users, data products served a clear need, there was an economic analysis, and cost savings aligned with USGS incentives. ASP is looking at this and other projects in order to determine key characteristics of successful applications.

Publications are not a metric, but ASP does document them; the Program compiled a publications list as ASAC requested. This will eventually go to Dr. Freilich. Dr. Gail advised ASP to track citations, which Dr. Friedl agreed would be helpful. He noted that ASAC had also encouraged ESD to do an applications handbook, which will begin soon. The Program expects that incorporation of applications into mission planning will take more time. In addition, many satellites are in extended mission phase, but not all have follow-on, and there is a need to prepare for some of these.

ASP has funding for a communications specialist, though the availability of office space is a problem. Finally, ROSES provides funding for workshops and symposia. Workshop/symposia funding can include preparation, the meeting, the results, and dissemination. The next ROSES call goes out in February, while the current call continues through March.

### Session 3: Geospatial Services Industry

The next speaker was Dr. David Potere, a principal with The Boston Consulting Group (BCG), which has been looking at practical uses of Earth data. BCG's geanalytics group has determined that about 80 percent of all business has a geospatial element. At the same time, Google has identified one of its business challenges as to communicating to governments the value of geospatial services. Therefore, Google enlisted BCG to help define the geospatial services sector, and assess its size, impact, and trends.

The resulting study identified three types of users: business, consumers, and government/NGOs. It found that there are 500,000 high-wage jobs in geospatial services, the same number as in the airline industry. The revenue is about equal to that of the U.S. paper industry, and 63 percent of the jobs are in the private sector. This nascent industry is still fragile because the data collection is primarily through governments. Geospatial services drive \$1.6 trillion in revenue and \$1.4 trillion in savings. These are dollars touched by geospatial insights, not direct dollars. U.S. consumers value the services at \$37 billion annually, which is what they would be willing to pay to obtain information that is now free. The U.S. geospatial services sector has three primary layers: geo-expert industries, geo-apps and devices, and location-based data. BCG determined that the various elements are highly interconnected and dependent upon one another.

The study began by defining the industry, for which BCG surveyed thousands of firms to determine their reliance on geospatial information. The greatest revenues are for those who make devices and software. An example would be Google Maps. Business relies heavily on geospatial services for both planning and operations, with examples being the logistics of transportation,

facilities placement, mining, and agriculture. These involve major strategic decisions that are location-based and cannot be undone. BCG found that 51 percent of senior business leaders have used Web-based mapping services, and 40 percent see such services as a U.S. competitive advantage. The United States is in a high-growth phase right now but has not yet achieved full integration. Relative to most other nations, however, this country is a leader.

### *Discussion*

Dr. William Hooke asked how BCG derived the revenue figures. Dr. Potere said that this was not the most detailed set of economic figures, and precision is elusive at this point. He added that BCG has done many surveys like this one. Most people do not think in geospatial terms, so the surveys begin with examples of geospatial services. He would like to learn more about the end users. It would also be helpful to know how all of these data are used. In some ways, the business area is even more difficult to pin down. It would be helpful to promote knowledge of geospatial services, as the average American does not understand why this is important.

It was suggested to Dr. Potere that since Google is promoting this, the company will likely get credit for work that was actually done by NASA applied scientists, the stewards of that information. NASA should get credit where it is due, as that leads to the funding the Agency needs. Ms. Green agreed, noting that it took a while for Google to credit LandSat.

Dr. Potere said that GPS was considered in the study, though BCG excluded military use. The study included weather satellites in the total count of satellites. For the work BCG does, GIS data are many times more valuable than are remote sensing data. Dr. Macauley asked about the choice to use the term “geospatial.” She also wanted to know what the study left out. Dr. Potere explained that neither Google nor BCG was happy with “geospatial,” but there had to be a way to express that the topic involved Earth observation. As for exclusion, the study did not include government, defense, emergency response, or weather applications.

Dr. Green noted that many applications benefit from pinpointing location, but another side of that is timeliness and latency. Dr. Potere agreed that timeliness is part of the value. The data have almost turned into a commodity in the United States, but that is not true elsewhere. Some countries do not want the information made available, and it is surprisingly expensive in Europe. The result is that businesses cannot make decisions as efficiently as they can here. Dr. Pietro Ceccato observed that some businesses still have issues with access to climate information.

Dr. Gail said that there are huge opportunities here. In the future, he expects that the connections will become even more important across seemingly disparate types of information. He wanted to know who will take command of that, the geospatial people or the business people who learn geospatial management. Dr. Potere replied that the work must be anchored, because it is not good practice to graft retail algorithms onto telecommunications, for example. Some businesses need access to additional industrialized tools. A corporate environment will have statistical people who know how to use the new bridging technologies. Google has people who are tackling the issue of nesting data. BCG thinks in terms of creating an ecosystem for the data, along with unfettered access to data, in hopes that people will innovate and deploy new algorithms using the engine environment.

Dr. Sarah Hemmings asked how the United States compares with other countries in terms of growth in geospatial services, and the extent to which the United States subsidizes others. There



is income generated that is not captured. Dr. Potere cautioned against relying too heavily on the growth framework. In a lot of countries, the high resolution and GPS capabilities are born out of defense. Many U.S. companies are experiencing their biggest growth internationally. The United States has been a pioneer on each of these dimensions.

Ms. Green asked about gaps and what might have held the field back. Dr. Potere replied that technology is one of the important gaps. The data volume explodes as the technology grows. So computing and storage are the big challenges. There is also a weakness in the area of intermediaries creating useful products. The lack of universality or connectivity is another issue, and continuity is important.

#### Session 4: Applied Sciences Strategic Plan

Dr. Friedl reviewed the Strategic Plan for 2015-2020, which lays out ASP's vision, mission, goals, and implementation steps. The Plan describes how to inform research based on applications and actual use of the data. It draws on space policy, seeking to energize the domestic industry, develop new market opportunities, promote adoption of international policies to facilitate access to government environmental data, and develop civil applications and information tools based on the data.

The United States Global Change Research Program (USGCRP) Strategic Plan and the Earth science DS both envision collaboration between science and applications. The perception is that ASP works, meaning there is no need for a radical change, but refinements to the strategy will be helpful moving into the future. ASAC has had some influence with four recommendations: understanding how to apply Earth science for societal benefit, effective application of Earth observations, identification of the characteristics of successful Earth science applications, and acceleration of the development of tools leading to successful Earth science applications.

From an applications standpoint, one of the questions involves determining which industry is best associated with this discipline. If the geospatial industry is maturing, how will ASP ensure that the industry knows of and uses NASA's data products? Projections show talent shortfalls in many core geospatial functions over the next 5 to 10 years. ASP can help address that as part of the capacity building program. In addition, it is crucial that the field get ahead of some food and water security issues.

The Strategic Plan will encompass strategic and high-level implementation; goals that serve overarching desired outcomes; objectives that articulate specific, measurable targets; implementation to articulate use of less traditional approaches; and methods beyond regular grant applications. This area should scale up and identify the priorities in engagement with others.

The vision describes a future state of success. To realize this, ASP identified eight characteristics of the desired scenario:

- Users can access needed products; use is routine
- Organizations commit resources and have the people and capabilities to apply the information
- Users can integrate data where there is value added
- On-going relationships
- Sense of value is substantiated and widely accepted

- Sustained opportunities for profit, efficiency, etc.
- Recognition of connection between research and impacts
- Organizations are interested and invested in NASA missions and research

Growing from this is the mission statement, for which ASP sought ASAC comments:

*Enable and expand beneficial uses of Earth observations – ensuring sustained uses if we can, showing only potential value if we must – but always beneficial uses of Earth observations.*

Dr. Freidl next presented three strategic goals, plus an internal goal:

1. Advance beneficial applications of Earth observations and knowledge of methods to enable applications.
2. Increase capabilities and workforce expertise supporting organizations' innovation, pursuit of applications, and assessment of benefits.
3. Enhance the value and benefits of NASA Earth Science flight missions from concept through operations.

Internal program management goal:

- Advance program effectiveness through sound business and public management practices.

Dr. Freilich had expressed that Goal 1 might be two separate goals involving applications directly versus knowledge of methods to enable applications. Goal 2 supports data access and use. Goal 3 focuses on future missions; this is a new program dimension that calls for specific emphasis. Applied science must currently “pay to play,” while the reverse is true for research.

The September retreat brought together many NASA people who work in the applied science area. Some of these ideas were presented at that time, and ASP received helpful feedback. The Program emphasized three themes: engagement, both inside and outside of NASA; entrepreneurship, to develop novel implementation strategies, funding, and other ideas, such as enabling high-scoring PIs whose projects are not funded to take their scores out to Kickstarter; and evaluation, which is about performance, results, and communications.

The workshop also addressed some programmatic tensions, most of which are a function of limited time and funds. A workshop exercise gauged participant thinking about these tensions. For example, should ASP take an in-depth approach with fewer programs or take a broader approach? The workshop indicated a slight preference for a broader reach.

The ASP lines of business fall into three categories: applications in mission planning; societal and economic applications; and capacity building. The key principle is ongoing experimentation. The draft logic model incorporates resources and inputs; activities and outputs; outcomes; and impacts. User and market studies must go beyond demographics to include psychographics and technographics. There is also potential for project brokering; Dr. Friedl presented examples. Some of the researchers at the NASA centers do not know how to navigate the system to work on applications, and ASP is thinking about how to enable that.

Applied science initiatives will begin in the areas of food security, water availability, and disaster response. The next set of missions will have a great deal of focus on water, and agriculture

requires water, so the initiatives and missions have some synergy. Another effort is identification of potential strategic partners.

#### Session 5: Applied Sciences Strategic Plan Discussion

Dr. Ardanuy said that he wondered how the nation would be worse off if applied science did not exist. It is important to consider how Earth science is maximizing the nation's return on investment. If it were not for ASP, it would be all serendipitous. The Strategic Plan is designed in part to maximize the benefit to society that NASA provides. The cup is half full but could be all the way full. That sets the stage for the Strategic Plan, but it is not articulated clearly.

#### *SWOT Analysis – Strengths*

Ms. Green led ASAC in a SWOT analysis, which involves looking at strengths, weaknesses, opportunities (near/long term), and threats (and barriers). She began by asking the ASAC members to note strengths in the Strategic Plan. Dr. Hooke said that he saw strength in the word “entrepreneur.” This would be a chance for NASA to explore new ways to develop applications and to do so more rapidly. He would like to see this idea developed more fully. As with business incubators, he thinks of people coming into NASA for a period of weeks to see what they could generate. It might be more rapid than the current approach. The resulting applications would be self-selecting. He was also taken with the idea of methods for enabling applications. ASP is small, so the greatest leverage might come from making it easier for others to create applications instead of developing applications as NASA.

Dr. Macauley said there is a lot of talent in NASA, and this set up everything very well in a number of ways. Dr. Gail praised the plan as mature. Dr. Ceccato thought the goals and vision were strong, though he wanted more on how to achieve them. He also wanted more on long-term engagement with users, the shift to the demand side, and how ASP will answer the demands. Dr. Nancy Dickson thought it was a very impressive move away from the pipeline model and did a good job of incorporating feedback. She liked the attention to Early Adopters and the prioritization of interactions. Dr. Moran agreed that the bridge metaphor needs to be updated. She thought the Strategic Plan remained bridge-oriented, however. Mission planning activities and applied science activities feed each other across the bridge, but both are doing science. Both have science teams, and they should be on each other's teams. Getting rid of the bridge concept is key; anything to promote a new metaphor and weed out the ideas that continue relying on it would be good. Ms. Green said that the report is very strong and focused. Dr. Ardanuy liked that each goal had quantifiable achievements and milestones, though he would have liked more granularity, given that the plan covers 5 years.

#### *SWOT Analysis – Weaknesses*

For weaknesses, Dr. Hooke said that the second part of the vision statement makes it sound like it is about people who are addicted to ASP. The goal is to have more people who have grown better at identifying opportunities and who quickly see where the possibilities lie, rather than just the super-users wanting more of the same. The idea should be to pull up the underlying motivation and challenges behind the demands for more. There should be an answer to what people will do with the data, rather than just wanting it. The users are knowledgeable, they know what they have, and they know why they want it. He wanted the customers to be demanding because of their acumen and because they do not want to fly blind into the future. Dr. Friedl agreed. That language could go into the text. Dr. Hooke suggested something like “alertly

recognizing additional possibilities for new observations.” The need is for smart users. When an application saves lives, or even makes money for a company, there is a direct benefit.

Dr. Ardanuy thought it should be expressed in terms of refining the use and application, and wanted to add “so they can best accomplish their needs.” Dr. Gail asked about creating demand for additional observations. Dr. Freidl said that the word “demand” came up at the retreat but did not get universal support. He wanted the ASAC reaction. He would like to see Earth science come across strong and point out the political need.

Dr. Macauley saw two weaknesses. She appreciated the vision of companies or other agencies telling Congress that they require something, but NASA also needs them to co-invest. In addition, this is still a hard community to understand, with its acronyms and jargon. What works best is if NASA has a solution to an identified problem. ASP must figure out how to get to the new people with the real questions. NASA follows three compelling science questions, and ASP should also develop three compelling questions for which the Program could provide solutions.

Dr. Gail did not see sufficient progress, nor did he see anybody getting excited about the applications in this document. It is thorough, but there is no thrill to it. He tried to think from the start-up perspective. What is it that motivates people to take this work and create a business from it? First, it is people-based, not process-based. People who start businesses have a passion and think the business is important and solves a problem. People who start businesses look for nuggets, as if they are prospecting. There are boot camps for software people, and ASP may need a boot camp for geospatial entrepreneurs.

Dr. Ceccato said that it is not clear how to find the demand. Working with the questions of the different actors is the challenge. There should be long-term thought about how to sustain commitments. Dr. Friedl replied that the Program tries to encourage multi-disciplinary teams in the funding calls, so that users have more than one option. ASP has been thinking about this issue, and feels that by enabling lasting relationships, it has addressed the long-term concerns.

Dr. Dickson liked the idea of brokers connecting ideas, but she was concerned about how ASP would determine which organization it would broker with, and she did not see involvement of other Federal agencies. She thought there should be more communication with Federal agencies. For example, the U.S. Department of Agriculture (USDA) and the Central Intelligence Agency (CIA) are already working on food security issues and have been for a long time. NASA should be interacting with them, although she realized that coordination might not be politically feasible. Dr. Dickson was also not sure about some of the examples and models Dr. Friedl presented. ASP might use marketing studies to address the point about the thrill of applications. She suggested launching marketing studies in an iterative process in order to learn. She did like the point about moving beyond the demand for more.

Dr. Moran said that she had thought more about the bridge metaphor. She did not like the broker idea, because it still assumes a distance. She suggested thinking more in terms of the word “infiltrator,” which better suits the way she thinks the plan should operate. The applied science teams should infiltrate the whole mission, and should be partners.

Ms. Green thought the slides moved into new things that are not in the plan. She would prefer focus on a few strong ideas. She did like the metrics, and she agreed that success is gauged by

sustained use. However, she thought there was a need for better focus. Dr. Friedl said that some of the presentation, including examples of models, reflected what came out of the retreat. The purpose of this plan is to articulate organizing principles and priorities, while also creating a space to show that this is not a status quo approach and that ASP wants to do something different from the rest of ESD.

Dr. Ardanuy thought it had been established that Earth science at NASA has benefits. He suggested highlighting several significant accomplishments and tying them to where ASP is trying to go in the future. Dr. Friedl agreed, adding that the highlights could include partner comments on what they see as potential. Dr. Gail said that this is what can make ESD successful within NASA. Dr. Friedl said that leadership needs to hear this from the community. The goal is emphasis on applied science, whether that happens through more funding for ASP or a culture change in ESD.

#### *SWOT Analysis – Opportunities*

The discussion shifted to opportunities. Dr. Ardanuy said that the National Weather Service (NWS) has a function called “Weather Ready Nation” and an ambassador initiative. Ambassadors are encouraged to collaborate with others who add value to the enterprise; they extend the NWS reach. Any organization can become an ambassador. What they do is up to them. Raytheon is creating a weather-readiness course, for example. There are 1,000 ambassadors, and they each do something different. NASA could use the concept that participants are part of the enterprise. There could be Early Adopter conferences as part of this.

Dr. Hooke said that social scientists talk about “co-producers of knowledge.” He likes that. Political leadership is an opportunity; politicians understand what it means to translate money into societal benefits. If ASP can show them that this is how NASA can accelerate the payoff from the investment, they will become the Program’s biggest fans.

Dr. Macauley asked Dr. Friedl to elaborate on engagement with Earth science. He replied that the thinking was that if ASP is going to engage, and the users come up with ideas, there has to be a way to determine the quality of the ideas or how they might better evolve. Researchers and managers need to be brought to more common ground, listening to each other. The dialogue at NASA evolved over time. Engagement is where the various elements can understand each other, better articulate their needs, and come together. Dr. Macauley liked that, and suggested using social media as part of engagement, as it is “low hanging fruit.”

#### *SWOT Analysis – Threats*

Dr. Gail thought that one of the biggest threats is that people think ASP’s work is easy, and some even think the work is already done. The way to turn this into an opportunity is to test how the work is done, as if the test itself is a research project. Dr. Ceccato asked about information services. Dr. Friedl said that other agencies have responsibilities in these areas, like flight delays or traffic, and not everything can go through NASA. Dr. Ceccato replied that access can be increased. It should be possible to find NASA information on a smart phone. Dr. Dickson advised using the open access nature of applied science as a promotional tool. She thought ASP should look at how other social sciences, like medicine, approach applications. For example, medical need drives medical research, rather than the other way around.

Dr. Moran said that the threat is that applied science is separate and the rest of ESD does not have to get involved, which gets back to the bridge analogy. A small opportunity is in the science teams, which should include applied scientists on the missions and mission specialists on the applied science teams. The Early Adopter program came about because the science team was a mixed group and made it happen.

Dr. Ardanuy saw a threat in the fact that while the Strategic Plan has three goals, its initiatives are rather nebulous. The corresponding opportunity might be in setting a challenge for a major accomplishment in each of these areas, something that might be measured, with a timeline of 5 years, for example. It is possible that ASP might not want to commit highly ambitious goals to writing, but the Program should at least know what it wants to do in that regard.

Dr. Gail said that many universities have technology licensing, and the level of success varies. Success does not just happen; it is a function of hard work. It is analogous to where applied science is. ASP has a difficult and important job, and it is not recognized as such. ASP needs recognition.

Ms. Green said that applied science constitutes an opportunity and needs to become a better one. Getting the message out is an opportunity, and it includes increasing the ASAC membership, for which there are more slots. ASP should determine how it can best use ASAC to get the messages out. A threat is the changing environment on Capitol Hill. Not everyone loves climate change research. Dr. Friedl said that showcasing agricultural and health benefits will allow members of Congress to see elements they support even if they do not support climate research per se. This might be something to discuss with Dr. Freilich. When Mr. Bolden goes overseas, all anyone wants to talk about are applications. NASA has already shown that Earth observations can appeal to a broad political base. The applications community is trying to help the research community understand the storytelling that begins with applications and ends with the research behind them. The linear model is so strong that even the storytelling is linear.

#### *ASP Program Manager Discussion*

Dr. Friedl thanked ASAC for the input, some of which will go into the plan, and some of which will help implement it. He asked to have the ASP program managers and associates talk with ASAC. First was Dr. Green, who said that he would be interested in examples of successful Federal programs trying to do something similar. Dr. Dickson suggested NOAA's Office of Scientific Assessment.

Dr. Turner explained that he works on both the research and the applied sides. They are not that different, so the bridge metaphor is not that appropriate. Probably everyone in ASP started as a researcher. One of the problems he sees is that when ASP first started, the program managers went out of their way to distinguish themselves, and now it is too easy for the program scientists to see them as "others." In some cases, he is doing more research for ASP than he does when he is on the research side. He thought applied science should take back some of the space in ESD. Dr. Gail thought this was a very important point. Research and applications should be as similar as possible. Other fields in NASA point to what they have done to succeed. ESD should be able to do that with applied Earth science. There is a sense that ASP does projects, but it also makes the field progress. Dr. Dickson said that translational medicine is a parallel, and it deals with many of the same issues.

Dr. Green said that there are applications that would probably be done anywhere in the private sector; the other space is ASP's job. The program managers know what is in the pipeline and could express it with more excitement. They do not need to reinvent everything, but they do have to be innovative. That would help with the level of expectation. Dr. Ardanuy said that they could wait for heroes to solve the problems, but what this group does is apply repeatable, successful processes. He agreed to write a piece reflecting this.

Dr. Gail questioned the assumption that a lot of this would happen anyway. Applied science is central to making applications happen. Dr. Green said that one of the issues is that there is a collaborative space that the group is not yet fully exploiting, and that affects their ability to move things forward. It could be that the bridge metaphor lingers from the time when the model was research to operations. It may be that the dialogue between research and applications should emphasize co-owned funds to ensure a common interest. Dr. Friedl added that the two-phase approach has changed the dialogue and advanced both research and applications, but the co-owned funds approach could enhance collaboration.

Dr. Nancy Searby said that the tensions Dr. Friedl mentioned in his presentation are key in the ASP prioritization process. It would be helpful to have feedback from ASAC, especially further advice on how to achieve balance. Dr. Hooke noted that there are barriers to accessing NASA data. This program could lower those barriers and making the data available. Young people need role models in this arena. The first visionary who succeeds like a Steve Jobs or Mark Zuckerberg will inspire people. He noted that NWS has a community model in the form of a rapid prototyping capability.

Dr. Lucien Cox said that moving research to operations is an effort that can benefit from ASAC help. Dr. Cindy Schmidt said that associates like her are hired because they can communicate with the community and also know NASA well. There are nuggets they have not yet promoted. There is a need to document the process of making a good application, which will be in the applications handbook. Dr. Friedl said that the Strategic Plan will also address it.

Dr. Vince Ambrosia said that the Strategic Plan will increase visibility with the community and spotlight ASP successes. The community needs to hear about this, which can be done through social media and video links as well. Dr. Green returned to the issue of lessons learned. Every agency sees a need to communicate more. The NOAA ambassador program allows NOAA to bring in partners and talk about what the organization does. Others should feel comfortable talking about the application side of NASA, and it would help to have them speak for ASP.

#### *Additional Discussion*

Dr. Friedl thanked everyone for their perspectives. He will report back to ASAC. Regarding having more members on the Committee, ASP had a list of candidates already but wanted to wait until after the Strategic Plan had been presented. There will be some new members in 2015.

Ms. Green reminded the Committee that they would talk with Dr. Freilich the next day and asked if there were topics to decide upon in advance. He was expecting to respond to the letter. Dr. Macauley wanted to ask about the DS and the integration of the framework of the OSTP plan. Dr. Friedl said that the priority given to lists of specific measurements that have to be sustained for public services resulted from the assessment that the U.S. Earth observation group did over

the last several years, when it evaluated all of the highest priority observations serving the broadest areas. Those are the top tier. The next assessment is starting now and will include desired observations.

Dr. Gail said that it is still not clear who does sustained science, as NASA and NOAA disagree, and Congress gets involved. Two meetings ago, Dr. Freilich challenged ASAC to justify the work and prove it has value. Dr. Friedl said that Dr. Freilich sees the value, but also maintains that the attention applied science receives is disproportional compared to the budget. Therefore, he has challenged ASP to step up its game, which the Program has done. It might help to ask Dr. Freilich if he feels that communications have improved, and what else is needed. That could lead to the desired conversation. He probably does not need more examples. He is supportive of APS.

Dr. Friedl noted that Dr. Art Charo of NRC would be talking with ASAC about the next DS. The call for nominations will come out soon. ASAC members should talk to their communities about it, since panel membership influences the DS. Dr. Gail said that in the original DS, the applied scientists sought a chapter on the science of applications, but instead the chapter was a list. They should try again for the next version.

#### Session 6: Public Comments

There were no comments from members of the public.

#### Day 2: December 12, 2014

#### Session 7: Discussion with ESD Leadership

Dr. Freilich joined the ASAC meeting via videoconference. Ms. Green said that she wanted to review the last letter ASAC sent, as well as getting his thoughts on the DS and on the role of applied science in the DS. She also wanted to know how the OSTP plans influence the DS. Dr. Freilich explained that NASA's Science Mission Directorate (SMD) is close to having a Statement of Work (SOW) for the DS. The interest of the other agencies and their scope of participation is an open issue that will have a bearing on the final NRC Statement of Task (SOT). NASA wants the DS to address the balance between flight and non-flight programs. Within the latter, NASA would like input on the balance among applications, research and analysis (R&A), and technology development. The role of other agencies is to be determined and is a delicate problem. With respect to the role of OSTP's National Earth Observation document, there is a general desire that NRC take note of it, and some believe that NRC should be constrained by it. NRC will likely see it as an Administration position with which it might or might not agree. NRC will not ignore it, however.

Dr. Macauley said that the OSTP report sets forth a simple framework between experimental and sustained observations. She asked if NRC should think in terms of that framework. Dr. Freilich answered that they should and they will. NASA has already spun off a continuity study that addresses the role of long data sets in research. Dr. Macauley noted that NRC has started using the cost appraisal and technical evaluation (CATE) process. She asked if that should extend beyond the big missions to applications and other projects. Dr. Freilich replied that he does not



find costing very useful, nor is he convinced that these estimates can be made skillfully. It is a hard job, and no one is good at it. It either dashes hopes or kills aspirations. He is unaware of any need for something like a CATE process for scientific or applications programs, especially since CATE focuses on hardware.

Ms. Green asked what ASAC might do to help support the DS. Dr. Freilich replied that the answer depends on how NRC decides to organize its activities. Dr. Gail said that one thing the first DS did not do well was to advance the state of the art of applications. Creating applications based on Earth science information is a challenging problem with many unknowns. He suggested that the DS ought to have room to push the advance of the process of creating applications as its own discipline. Dr. Freilich replied that the NRC might then make suggestions about testing applications. The DS committee will look at the overall program in ESD and other agencies, so he does not expect a lot of attention to this part of it.

Regarding LandSat, Dr. Freilich explained that, at the request of the Administration, NASA went to USGS and examined various land imaging aspects, then sent a report to the White House. The FY15 appropriation has explicit language on LandSat activities. First, the LandSat-9 appropriation is \$64.1 million, with no mission cost cap. However, there was a statement that the mission should cost a lot less than LandSat-8, while having all of the capabilities of LandSat-8 and a continuous 8-day repeat. The appropriation says that nothing in LandSat-9 shall cause USGS to have to modify its ground systems to accommodate the data. No approach shall be undertaken that differs from this approach, nor can the mission take an approach that might increase the risk of a gap or increase risk to user communities.

Regarding collaboration with other Federal agencies, there is a lot of that already, and changes in personnel at NOAA should not affect it. Dr. Stephen Volz, who recently moved from NASA to NOAA, does understand the NASA point of view. He is highly skilled and tremendously accomplishment-oriented. Dr. Freilich has spoken with Dr. Volz and expects good communication, but that will not be a change vis-à-vis NOAA. The only positive might be efficiency in communication.

Dr. Ardanuy asked if there might be any high-level gaps to close between NASA and NOAA. In addition, the European Space Agency (ESA) has asked NOAA to consider formation flying, and ESD has experience with that on the A-Train. Dr. Freilich said that formation flying is proven. ESA prefers to think of it as convoy flying, and is open to discussing it, as is NOAA. The foundational missions are in place for building virtual constellations. As for gaps that might improve productivity, he did not see that as within ASAC's purview.

Ms. Green asked for further feedback on ASAC's recommendations. Dr. Freilich replied that the recommendations about the role of applications in Venture-class missions were less enthusiastically received and possibly less realistic to integrate. Regarding the role of applications, Early Adopters, and the Distributed Active Archive Centers (DAACs) so that the user communities can be ready to analyze and use the data as close to launch as possible, that was a good recommendation that ESD took very much to heart. Dr. Freidl and his team have done dramatically good things that are substantive and far-reaching. All of the systematic missions are now working with applications and everyone wants early applications workshops

because they want to hear what the applications communities are thinking. Applications of NASA data and the accomplishments of the flight sciences program speak to the Strategic Plan. ESD will benefit dramatically from advice ASAC can give in those areas. The financial allocations for the capacity building programs were considered in developing the FY16 budget.

Dr. Hooke asked if there are things that keep him up at night where ASAC or applications could help. Dr. Freilich replied that ASAC is extremely impressive and he is pleased with the Committee, which has a strong, mutually respectful relationship with Dr. Freidl and his team at all levels. ASAC brings diverse perspectives and articulates them well.

Ms. Green said that the linear model of research leading to applications has been taken over by a more cooperative, use-inspired approach. She asked how the use-inspired approach is being integrated into ESD, and why Dr. Freilich did not think applications were appropriate for Venture class. Dr. Freilich explained that Venture class is delicate. It was established for a number of reasons, including whether one could approach instrument development with new, different, and more efficient management philosophies. ESD wanted a nimble, flexible program that could more easily respond to changes in the science context of the overall Earth system science enterprise, and wanted to see if these missions could be done for significantly lower cost and under significant schedule constraints. Most of those things are not parallel to the idea of the non-scientific applications community. The latter will bring to bear investments to products tailored to the needs of societal users. Venture-class missions are relatively low-cost and short-term. The Earth system science that ESD does is very complex and highly nonlinear. It is practiced by, and primarily informs, research experts. The applications arena takes the understanding and measurements to make products that address other aspects of society. Applications involve leveraging knowledge, understanding, and measurements into products that provide answers to non-research questions. Applications build on knowledge.

Dr. Gail said that he agreed up until the last statement. He thinks that applications science has its own creation of knowledge, in its own domain. Dr. Freilich said that “understanding” is the word he meant, not knowledge. Ms. Green cautioned against relying on the linear model. Applications can drive science questions by identifying gaps in science, sending research off to find more. Dr. Freilich replied that one can only have an application when there are measurements and a body of understanding, along with a clear question to make a focused product. The applications community articulates the needs of the rest of society.

Ms. Green thanked him for his time. She praised ASP and said that it is a pleasure to be involved with the Program. Dr. Freilich thanked ASAC for the members’ time, passion, and dedication, and promised that ESD will do what it can to address ASAC questions and concerns.

*Additional Discussion*

After Dr. Freilich left the meeting, Dr. Ardanuy said that he was struck by the gap between the pure academic pursuit of understanding the Earth and translating observations into applications. Dr. Moran agreed, noting that Dr. Freilich and the ASAC members differ in how they conceptualize the process. Dr. Dickson said that physicians tell researchers the problems they have that require solving, and agriculture is similar. There should be communication of the problems that need to be solved effectively with Earth science. Dr. Hooke was concerned that

Dr. Freilich does not seem to think about how much more could be done with incremental increases to this work.

Dr. Turner said that this is a dialogue, and Dr. Freilich has come quite a way. This meeting is the first to discuss changing the metaphor, and ASAC members can bring him along only after they figure it out themselves. Regarding Venture-class missions, it would help to give Dr. Freilich sample language in a document. What ASAC wants is not radical. The challenge in the next DS is to write that science and applications are really the same thing. Every mission has an applied component. It is all part of the same dialogue. When ESD started ASP, it was different because it had to be in order to keep a separate, viable program. Now the Program needs to re-establish connectivity and continuity. ASAC is on the cutting edge.

Dr. Ardanuy said that that changed his thinking. New Earth systems science enables new applications. At the same time, there are needs for applications, and society must have these applications. So an applications need could drive NASA. Dr. Turner said that that should go into the first chapter of the DS. Dr. Hooke added that leaders do not get society to change 180 degrees. Instead, they listen to people, take the concerns, make them tangible, then create a framework to do something. When Dr. Freilich hears from ASAC, he thinks that of course they believe that applications are important. If he heard from PIs, they could persuade him.

Dr. Gail said that the community knows how to do science, but the techniques for doing applications are still lacking. Therefore, the DS should include a separate chapter on improving the ability to do applications. The number of pure scientific discoveries in Earth science may be declining, while the number of applications may be increasing. Ms. Green noted that ASAC said that in the last letter; she advised repeating it. Dr. Gail added that it is no longer possible to distinguish between applications knowledge and scientific knowledge so strongly. Dr. Ceccato thought it would be helpful to show Dr. Freilich the demand for both together. Dr. Gail suggested looking at some case studies. The DS said that Earth science is special because it is a product of both intellectual curiosity and practical applications. Dr. Freilich is not leveraging that. Ms. Green said that he has changed over the years, though possibly not as fast as ASAC likes. He does respond to a well-crafted message.

Dr. Moran pointed out that the SMAP Early Adopters have produced 12 publications that were submitted to a journal on hydrology. These will be bound together. If Dr. Freilich saw a copy of that publication, he could see that users produce fundamental knowledge and research, and have questions. Ms. Green said that she would personally give it to him. Dr. Friedl thought there might be too much focus on Dr. Freilich and that the emphasis should be on the message needed to reach a broader audience. Ms. Green agreed. She noted that ASP is looking at potential opportunities that will allow them to set priorities for particular communities, such as water managers. She asked what they use, how they access it, what they need, and how can NASA work with them?

Dr. Green said that part of the gap stems from whether the science question behind the market question is being captured, which requires that applied science articulate the science question well. Dr. Friedl said that that is in the Strategic Plan, to articulate back the research question. Dr. Green noted that the ASP scope is more encompassing. They must do research, analysis,

marketing, and development. They are conducting some substantial science and might not be giving themselves sufficient credit. The communications must be versatile. Ms. Green agreed. There is too much focus on use. Dr. Gail said that the science community must understand that applied science is helping them by raising core questions.

#### Session 8: Earth Science Decadal Survey

Dr. Friedl explained that Dr. Charo of NRC and Dr. Shali Mohleji of the American Meteorological Society (AMS) were to speak with ASAC about the upcoming DS. ESD and the Earth science community have been looking for ways to support applications and expand the value and benefits of the Earth science missions, models, and research. ASAC previously recommended greater consideration of applications in NASA mission planning and in the DS.

#### *The 2017-2027 NRC Decadal Survey*

Dr. Charo told ASAC that the Committee on Earth Science and Applications from Space (CESAS), a standing committee sponsored by NASA, will organize the DS study. The Committee will set up the DS, monitor the program in the implementation of its recommendations, and organize the midterm assessment of the DS.

The first DS tried to recommend a program of observations and related activities tied to applications and societal needs. However, a tightened budget resulted in NASA having a backlog of recommended missions, as well as greater responsibility than anticipated. Meanwhile, NOAA is stabilizing its weather satellite portfolio while trying to avoid a gap between the NPP spacecraft and the Joint Polar Satellite System (JPSS), and USGS has LandSat-8 up and must begin LandSat-9 soon in order to avoid an interruption in measurements.

For the 2017 DS, Dr. Charo expects CESAS to generate consensus recommendations from the Earth and environmental science and applications community on an integrated approach to U.S. space-based Earth system science programs. The DS will consider science priorities, implementation costs, new providers and technologies, interagency cooperation, and international leverage. The Committee will be informed by applicable law, strategic plans, relevant studies, and key policy documents. Dr. Charo expects the DS to identify opportunities and challenges; assess operations and gaps in the programmatic record; prioritize space-based research activities; and make recommendations to facilitate development of a robust, balanced, and resilient program. There will be discussion about what is essential in Earth sciences.

The approach will view Earth science as a system, with research driven by user needs, science informing policy, and all projects inherently multi-agency. It will differ from the prior DS in that it will not recommend to an aspirational budget. Some of the recommended activities from the previous DS grew tremendously, so an effort will be made to view projects in context of the overall budget. High-priority programs should not be allowed to grow at the expense of everything else. This will provide increased opportunities to consider new ideas, and more attention will be given to different ways to do things that are innovative. For example, the last DS did not recommend anything for ISS, which is now a popular platform. A baseline program will not be assumed, and greater attention will be given to continuity, as well as to the international scene.

There may be greater emphasis on measurements as opposed to specific missions. The problem is that NRC is told to look at costs, and it is not possible to cost measurements. Instead, NRC assesses the costs of the missions that make measurements, which introduces some uncertainty. The DS will recommend the CATE process for larger items, though CATE can create tension and cause an imbalance in science activities.

The process thus far has been slow, in part due to NOAA, and the Committee cannot start operating until it has a contract, which probably will not occur until late winter or early spring. A website is already up for nominations, however, and NRC expects to have about 100 members serving on the steering committee, study panels, and working groups.

Dr. Charo said that Dr. Freilich requested a study analyzing the needs for continuity of NASA's sustained remote sensing observation of the Earth from space. The intent is to define "continuity" and metrics that ESD can use. Many missions are candidates for continuation, enough to consume ESD's budget several times over. Some measurements coming to NASA used to belong to NOAA. The study committee used both qualitative and quantitative frameworks; most of report is on the latter. This works best for research aimed at quantifying global change. A framework to evaluate relative value across different applications is very challenging. In an economic cost-benefit analysis, the value-centered framework attempts to summarize the value of funding a particular project. The committee's value-based decision framework requires several inputs, and scoring is subjective. There are questions about how useful this study will prove to be.

There is no explicit link between the DS and the OSTP report, but OSTP will be a factor in the DS. Dr. Ardanuy asked whether the DS can look at how to use block buys. Dr. Charo said that block purchases can be difficult unless a mission is deemed a series at its beginning. Dr. Gail noted that the distinction between sustained and operational observations plagued the first DS. Dr. Charo did not think it would be an issue this time, but the SOT has not been written yet. ASAC brought up some important questions that should be mentioned early, so the members should ask Dr. Freilich to note those issues. The SOT is critical.

### *Models for Science*

Dr. Mohleji explained that she works with Dr. Hooke. Regarding Dr. Freilich, some of his intellectual space and the ASAC intellectual space are erroneously seen as being mutually exclusive. In fact, everything can be done in the same space. There are new problems that require both scientific knowledge and applications. The model for usable science asks if the research produces curiosity-driven knowledge that benefits no one, or if that research can be used. The goal is to have accessible, well-deployed research capabilities in order to reconcile supply and demand. The optimal relationship involves mutual engagement, discussions, co-production, and public ecology.

Among various models for co-production of knowledge, a new model has users both pushing and receiving knowledge. This model allows for generation of research questions from users, co-location of users and researchers, and mutual input. A tangible example is NWS, which has forecasters co-located with emergency managers. The latter tell the forecasters what they need for an evacuation, for example, and the forecasters respond. Co-production enables collaborative

research, in which the users and researchers work together in all phases of the project. Cooperative research allows investigators to learn more about the applications, while users learn more about the research, which they then find more credible. Trust and lasting relationships result. There is a need to identify the potential users, their needs, their strengths, and how to move the science. Congress and the White House have different views of science; Congress wants more connection between science and applications. Therefore, the applied sciences need to make the case that the discipline is useful to society.

Dr. Gail suspects that Dr. Freilich thinks that any ability of the user to set the information agenda is a diversion rather than an improvement of the basic science. Dr. Mohleji said that he seems worried about setting the agenda or replacing paths that already exist. The National Science Foundation (NSF) has added a societal impact component to its proposals. This does not take away anything, but it does add a dimension. Shaping and designing the agenda should be a collaborative process. Dr. Hooke offered another metaphor, that of an aircraft pilot and co-pilot, who have the same agenda. The risks are much higher in hierarchical cockpits. Collaboration works much better.

Dr. Green saw the word “agenda” as challenging. He prefers to think in terms of who generates the questions, which can be much richer if it comes from both sides. It is more productive. He asked about the rate of learning achieved through cooperative research. Dr. Mohleji replied that the rate of learning is mutually productive. Researchers learn more about their research when they see stakeholder and user engagement.

### *Discussion*

Dr. Friedl asked Dr. Mohleji how to get to the model of users both pushing and pulling for knowledge, and how to sustain that model once it has been achieved. He also wanted to know how to get that model into the DS. Dr. Mohleji said that the NRC talks about engaging the user through all phases, so there is a need to think about what the program should accomplish. Finding ways to engage users and understanding how to move back and forth with them is key.

Dr. Charo said that the last DS tried to get at some of these. The applications panel was charged with developing a framework for bringing in users, and they tried to have users on the panels. These things need a structural home, however. The applications panel was hurt by spooling up at same time as the rest of the DS; the panel should have met beforehand.

Dr. Ardanuy said that it seems like applications will be at a disadvantage in the DS without any kind of priority. Dr. Hooke added that it seemed like Dr. Charo was pointing out that the pace of technology advance and social change is picking up. Therefore, the pace of applications should pick up as well. ASAC has had a lot of discussion about applied science as a discipline that needs attention as much as basic science does. Dr. Moran noted that in Dr. Mohleji’s collaborative model, the users move into the researcher box, so there are different levels of users. It is important to target the ones who are most effective and feeling the most pain. They make things happen because they have no choice.

Ms. Green asked how to get those people nominated and onto the DS panels and subcommittees. Dr. Moran thought that Dr. Friedl would know a lot of the PIs, and she could identify some as

well. Dr. Gail noted that AMS has a blog and other outlets for recruitment. Dr. Hooke thought that Dr. Charo and NRC should work with Dr. Freilich to ensure appropriate representation from different dimensions. Dr. Friedl said that to do that, there will need to be a larger call for involvement in the Earth science community. The community could do workshops, for which there are ROSES funds, as noted previously. It would help for ASAC to discuss what it wants to do to promote culture change. It will also be helpful to have non-NASA people stating their needs. Ms. Green said that the applied science community should have people working on the DS who understand these issues and who will be engaged and good partners. She thought ASAC might be putting too much effort into models and not focusing on doing good work.

### Session 9: Data Access and Applications

Dr. Friedl said that at the last couple of meetings, ASAC has discussed data and mission planning, as well as tools for data access and use. In May, the Committee made several recommendations in these areas. The ESD Data Systems Program oversees data-related efforts and has tried to make data discovery and access easier. The meeting was now to receive an update on this area. Within the U.S. Group on Earth Observations (USGEO), there is a data management working group that plans to come up with metrics and capabilities for discoverability, accessibility, and usability. This group hoped to receive ASAC feedback on what they have done and what they need to do, along with further advice.

#### *ES Data Systems*

Dr. Jeanne Behnke explained that the Earth Observing System Data Information System (EOSDIS) was founded 20 years ago. The Earth science data policy promotes use of data by the community. Prioritization of EOSDIS enhancements are guided by User Working Groups (UWGs) at each DAAC. Dr. Behnke reviewed EOSDIS activities in 2014 and noted that there are 12 discipline-oriented archives. EOSDIS recently surveyed more than 4,000 users about Earth science data at the DAACs, and held meetings with more than 200 science data systems developers. EOSDIS has a metrics system to evaluate system performance, and it also offers user services. Each DAAC has a UWG that includes users, providers, scientists, and others.

The DAACs work directly with new missions to determine how to support the user community on data and access issues prior to launch. Work performed for new mission early adoption at DAACs is funded within the availability of Core Operations funds. These latter activities are done within the DAAC basic budget, though the program must be careful with its resources. New ideas are pushed out for the DAACs to adopt, though they might not have sufficient funds to do so.

Dr. Friedl asked about the impact of the funding issues, and whether ASAC should write a recommendation that the data system or ESD should budget for more of this. Dr. Behnke said that it was popular. The Ice, Clouds, and Land Elevation Satellite (ICESat) mission will need to do a detailed requirements analysis, then receive a budget for any new tools. It is time for a business model change.

LANCE is part of EOSDIS, providing a central point of access to high-quality, near-real-time (NRT) data products for land and atmosphere studies within 3 hours of satellite observation. This

is a great growth area. There has been a threefold increase in NRT imagery download through Worldview and Global Imagery Browse Services (GIBS). EOSDIS hopes to put more data into GIBS. Additional NRT imagery is available, as are MODIS 8-day rolling vegetation indices. The system will be adding MODIS rolling surface albedo soon.

Recommendations from the September, 2014, LANCE UWG meeting include the following:

- Since global Suomi-NPP products will not be available before late 2015, the Direct Readout Laboratory (DRL) could provide an interim source for non-global products. LANCE should consider ways to fast track products when they are ready.
- NRT data from the Advanced Microwave Scanning Radiometer 2 (AMSR2) and the Multi-angle Imaging SpectroRadiometer (MISR) should be made available through LANCE.
- Other platforms, such as SMAP, should be considered.

In the near future, LANCE should revisit the composition of the UWG to include guidance on new instruments coming to LANCE, and should consider what NRT products could be of interest on the ESA Sentinel satellites.

#### *Data User Needs, Present and Future*

Dr. Chris Lynnes reported that in a review of the user needs analysis group, the Earth Science Data System Working Group identified more than 20 different kinds of users. The Group determined that documentation is still a serious issue in data discovery and there should be content included in dataset landing pages to facilitate discovery. The working group has a successor in the Vision 2020 Working Group. The Vision group listened, then distilled the vision elements, which are higher level concepts. These still need editing and reshaping.

The visions were divided into three groups. The visions for discovery that received the most reaction were:

- Machine Level Discovery and Access
  - All data are available for search and access via machine-callable Application Programming Interfaces (APIs)
- Virtual collections organized/oriented around a science problem
  - Sharable among the community
  - Examples include event-based bundles and application-based bundles

The visions for usage with the most impact included a rich set of capacity-building and translation mechanisms exists to help leverage data for use by people with limited literacy in science, technology, and/or English. A section of the access program addressed some of this. Finally, the vision for integration that received the strongest reaction was that NASA data can be combined with data from other agencies, nations and entities.

Moving forward, there will be further vetting, editing, and reshaping, and the Visions group is looking at possible implementation strategies. The group will make recommendations to EOSDIS for adoption of the vision elements. Dr. Lynnes hoped to get ASAC ideas as well.



Ms. Green said that in the ASAC letter, the Committee said that NASA should look at universal adoption of LANCE. Dr. Lynnes reported that that is part of this process, though some of the recommendations require review. Ms. Green noted that some data have been rapidly and successfully adopted by multiple users. She asked how that informed the working group's activities. Dr. Lynnes said that he would be taking that back to the Vision group. Dr. Behnke added that some EOSDIS comments were under review as part of an annual analysis.

Dr. Lynnes next discussed data rods. There is an effort to expand the initial concept by making it more acceptable and looking for more efficient ways to organize at the data management site. They are integrating data elements into Giovanni, a web service, which will be expanded. Dr. Behnke added that EOSDIS is continuously evaluating system architectures and technologies to improve access and usage of NASA Earth science products through working groups and the DAAC. EOSDIS is also leading efforts to develop standards for metadata, service interfaces, and product formats.

Dr. Lynnes explained that the Big Earth Data Initiative (BEDI) will improve discoverability, accessibility, and usability of data from Federal Earth observation systems. The initial focus is on high-impact datasets, including those from:

- USGCRP National Climate Assessment
- Climate Data Initiative
- Earth Observation Assessment

BEDI will build on existing highly successful data systems, policies, and practices through interagency coordination with the USGEO Data Management Working Group (DMWG). NASA will contribute to the DMWG by:

- Providing support, leadership, and expertise in the management of earth observation data
- Identifying and selecting appropriate NASA developed information and products, and sharing them with USGEO DMWG

NASA will also work with interagency partners (primarily NOAA and USGS) to develop joint recommendations and guidance for other U.S. Federal agencies, such as:

- USGEO Data Model for earth observation data
- Criteria for data discoverability, accessibility, and usability
- Concept for the "BEDI Common Framework"
  - Specific recommendations and guidance on data management practices and standards for implementation across the federal government

Dr. Friedl explained that ASAC had requested an update on data rods. General information on steps and plan for data rods include the following:

1. Advanced Collaborative Connections for Earth System Science (ACCESS) ROSES-11, a project on data rods that introduced concept and showed value
2. ACCESS ROSES-13: additional project on data rods; in process
3. More data rod projects to be conducted with other users and providers to achieve diversity in both data types and in applications needs.
4. Through steps 2 and 3, characterize needed resources
5. Develop standards process

6. Develop turn-key approach to DAACs. This step will allow data rods to “widely deploy.” The rate limiting factor will be interest and resources rather than process.

### *Discussion*

Ms. Green thanked Drs. Behnke and Lynnes for the presentations and the direct response to ASAC’s request. Dr. Friedl said that one of the next steps is to take up data continuity, but there may be issues regarding EOS and Suomi NPP. ASP is hearing that Level 3 products and reprocessing are not in the plans for the JPSS era. Dr. Behnke elaborated. The processing heritage belongs to NOAA, which processes data differently from NASA. EOSDIS now has permission to go forward with EOS-like products, which seem to be what LANCE users want. JPSS has a different processing plan, and much depends on what NASA wants to do. Any encouragement from ASAC regarding applications would certainly help NASA plan for the resources that would be needed for the JPSS1 timeframe.

Dr. Dickson asked what elements of BEDI keep Drs. Behnke and Lynnes awake at night. Dr. Behnke said that the project is very daunting and indeed keeps some people awake figuring out the resources. It is not possible to do everything for everybody. Dr. Lynnes noted that he leads BEDI at the Goddard Space Flight Center (GSFC) DAAC. Most of what they need is available, but work must be done to create something seamless.

Dr. Friedl asked about the user working group nomination process. Dr. Behnke said that there is a rotation, and the chair confers with the program scientists. Every DAAC has a relationship with a headquarters program scientist. Feedback from ASAC is also useful. Each DAAC meeting is scheduled separately, but her office has a master copy of the schedule available. She also offered to share the LANCE Working Group minutes from September.

### Session 10: Applications and Measurement Continuity

Dr. Friedl sought to follow up on the issue of continuity. Dr. Charo had talked about identifying some of the factors in the quantitative science objectives. ASP wanted to propose that someone determine the applications factors. Ms. Green asked for the concepts by which ASAC members would set priorities. Dr. Gail was skeptical that they could achieve a useful result. No one outside of the science community would know or care, and there would be second-guessing of applications. Metrics can be deceptive. Ms. Green thought that if NRC cannot figure out how to think about continuity for applications, ASAC should step forward and provide a conceptual framework. Dr. Hooke said that there are examples of the kinds of problems that are hard to solve, and perhaps ASAC should illustrate the complexity so that society can better understand what is happening on the planet.

Dr. Moran observed that USDA relies on LandSat quite heavily. She asked if a case study might be possible. Ms. Green replied that there are outstanding case studies that highlight the possibilities, and Dr. Friedl pointed out that the SOT asked for case studies. Dr. Hooke said that there is currently an assimilation of all kinds of data streams. There must be some information accumulating on what happens when these data deteriorate or are unavailable. Dr. Friedl explained that there had been a retrospective study to identify priorities, and by far and away precipitation was the greatest one. The bottom line might be something other than lives saved,

perhaps a denial-of-data approach. USGEO and others have done assessments that could factor into this. The continuity report comes out in March.

Dr. Gail advised laying out what is used and the criticality. Breadth cannot be the criteria. If one area relies on a measurement deeply, it is critical. Dr. Ceccato mentioned doing an adjusted healthy life index for the World Health Organization (WHO). The analysis incorporated all of the environmental factors and looked at the impact on vectors and on human health. “Adjusted life years” was the ranking factor.

### Session 11: ASAC Meeting Synthesis

Ms. Green noted that the last letter was excellent and she would like to write something like it again. She thought ASAC should make comments on the Strategic Plan. Dr. Ardanuy said that the co-production concept warranted mention, as well as the idea that research and applications are not that different. He had already begun writing something. Dr. Dickson advised that, instead of co-production, it might make more sense to speak of collaborative products of researchers and practitioners. Practitioners can be scientists. In addition, she prefers collaboration to cooperation, the latter being more active. She agreed to work with Dr. Ardanuy on this piece. Dr. Dickson also wanted to see ASP give greater priority to communications. The Program has good stories, yet they are not on the web page. ASP should not wait for everything to be perfect; information should get out. Another priority should be the handbook, which would ideally be a living document, possibly with case studies organized by sectors. She would like to underscore collaborations and other options.

Dr. Hooke said that NASA has a big communications apparatus. He wondered if anyone there takes care of ASP. They should be all over this, and the Program should have more people working for it. Dr. Dickson agreed, adding that a full-time person would free Dr. Friedl from all of the writing duties. Dr. Ardanuy said that for the three focus areas of food security, water availability, and disaster relief, he would like to see more. He asked about a joint meeting held a couple of years ago. Dr. Friedl said that it was good. There had been a recommendation to do more collaboration with all parts of ESD, including R&A and the Earth Science Technology Office (ESTO). ASP found that the level of projects was not what it sought, and R&A declined to partner. ASP then decided to do its own work. He agreed to ask if NOAA would be willing to collaborate.

Ms. Green advised using Dr. Dickson’s analogy with the health field. Dr. Gail suggested also using a SMAP case study. The scientists could convey that their mental model transformed. Dr. Moran agreed, noting that she could find some scientists willing to say that the applications people understood them well. Dr. Friedl said that ASP recognized years ago that there needed to be a standing science team. The Program decided to use the ROSES process to call for individuals to be on the applied science teams. That way, if an issue came up, there would already be people with funds in place to be on a “tiger team” that could tackle issues. ASP also wanted them to identify some potential data products. They were to model the science teams that met regularly. It has taken time for the science teams to think more about this.

Dr. Moran noted that if the science teams are equally important to the missions, the missions would send funds to ASP. Dr. Friedl replied that there was discussion to streamline when the teams are meeting. Dr. Moran said that she would support that. She asked whether, since ASP is funding personnel on mission teams, those teams understand their responsibility to ASP? Do the Suomi people realize that they are on the team in an applications capacity? Dr. Friedl said that they did, but that it would not hurt for ASP to reinforce the message.

Dr. Gail suggested that it might be time to declare victory. The field has gone from convincing people they need applications to barely being able to keep up with demand. Applied science has to keep ahead in order to keep up. He committed to writing that piece.

Dr. Green said that some programs have an increasing call for applications, but ASP is also being called as a responsive program. He saw an opportunity, in that it is a different capability, so there is a new level of expectation. Whether and how ASP will respond will be the driver. Regarding communications, he wondered if ASP has a strategy it could use for texts, Twitter, and so on. Dr. Dickson said that it is important to have a good website to which social media is driven. Ms. Green observed that NASA has social media covered. Communications will be part of the letter.

Regarding the upcoming DS, Ms. Green wanted to know if there was anything ASAC should be doing. Was there anything Dr. Charo described that they disliked or thought was missing? As for the panels, should ASAC write something on how the Committee thinks they should be structured and who should be on them? Dr. Hooke said that the applications perspective should be represented on the senior panel and the subpanels. ASAC should say something about the size of the applications community relative to the size of the satellite community, and mention the application community's diversity. ASAC should also revisit the process by which the nominations happened last time and make sure that Drs. Gail and Macauley are nominated again instead of leaving it to chance. They will provide institutional memory.

Dr. Gail said that the chapter on applications should address the need for applications to be done better and more methodically, in addition to permeating the entire document. There should be a technology chapter and, in addition, each mission should address what new applications knowledge it will generate.

Dr. Hooke advised using multiple op-ed pieces to highlight the fact that there is a discipline known as applications. Ms. Green added that ASAC wants the best people to step forward and be involved in the DS, emphasizing practitioner needs. ASAC getting the word out helps build awareness. Dr. Gail said that the message might be that this is an exciting time to get into applications. He would avoid abstract arguments and instead rely on case histories, such as SMAP. Regarding non-traditional users as candidates for the DS panels, Dr. Hooke pointed out that they would have to be able to understand the satellite missions right away, rather than spending all of their time coming up to speed. He also thought that diversity of background will be critical for the DS, however. Ten years from now, there will be new technology capabilities and a new workforce. Dr. Friedl asked that the next ASAC meeting have something on capacity building. He can bring in the people running the fellowships.

Ms. Green advised including a statement praising the data access experts for their presentation and their work. Dr. Friedl agreed, noting that the work they have done is impressive and ASAC should encourage more. He suggested that the statement say that ASAC applauds the work they have done with SMAP within the margins and urges ESD to recognize that there may need to be additional support and resources in this area, possibly with a revised funding model. It would also be a good idea to applaud the progress LANCE has made. Dr. Ceccato agreed to write the finding. Dr. Friedl added that ASAC had asked the data access experts for data analysis and is looking forward to seeing that. Dr. Moran noted that the previous letter stated that they needed additional funding, and ASAC should repeat that point, especially since they have done so well. She offered to write something on this point. Dr. Friedl said that there will be a teleconference after the continuity report and SOT are issued.

Mr. Meister pointed out that the Committee charter says that ASAC is supposed to provide guidance to the ESD Director, so any input on the DS should go that route. A group recommendation or nomination to the NRC committee is not something ASAC can do, though the individual members can take such actions.

Ms. Green thought the letter had sufficient content. For each applications area, ASAC also planned to ask program managers what they are doing to make people aware of the DS and generate interest. Dr. Friedl said that they had discussed the issue in *Space Policy* to promote commercial space opportunities, along with full and open timely access to data. He wondered if there might be a conflict. Dr. Hooke said that there was potential for conflict, but that is not the biggest issue outside of companies. Dr. Ardanuy added that the use of the data can lead to adverse use of the Earth's resources. Not all uses are neutral or positive.

Dr. Hooke said that this was a terrific meeting; others agreed, and at the next meeting it might work well to have the program managers actually at the table.

#### Adjourn ASAC

The meeting adjourned at 4:05 p.m.

## **Appendix A Attendees**

### **ASAC Membership**

Kass Green, ASAC Chair  
Phil Ardanuy  
Pietro Ceccato  
Nancy Dickson  
Bill Gail  
Bill Hooke  
Molly Macauley  
Susan Moran (via Skype)  
Lawrence Friedl, ASP Program Director  
Peter Meister, ASAC Executive Secretary

### **Other attendees**

Vince Ambrosia  
Bob Chen  
Lucien Cox  
Brad Doorn  
David Green  
Sarah Hemmings  
David Potere  
Cindy Schmidt  
Nancy Searby  
Jay Skiles  
Woody Turner

### **Other – Via Webex/Telecon**

Jeanne Behnke  
Art Charo  
William Graham  
John Haynes  
Ashutosh Limaye  
Christopher Lynnes  
Ted Mason  
Shali Mohleji  
Kevin Murphy  
Doreen Neil  
Jay Skiles  
Jerry Smith  
Jeff Stehr

## **Appendix B**

### **ESD Applied Sciences Advisory Committee Membership**

Ms. Kass Green, Chair  
Kass Green and Associates

Dr. Philip E. Ardanuy  
Raytheon Company

Dr. Pietro Ceccato  
International Research Institute for Climate and Society

Dr. Nancy Dickson  
Harvard Kennedy School

Dr. Molly Macauley  
Resources for the Future

Dr. Bill Hooke  
American Meteorological Society

Dr. William B. Gail  
Global Weather Corporation

Dr. Susan Moran  
USDA

## **Appendix C Annotated Agenda**

### **Background**

The Applied Sciences Advisory Committee (ASAC) serves as a community-based, multi-sector forum to discuss Earth science applications and provide strategic and programmatic guidance to the Earth Science Division (ESD) and the Applied Sciences Program. The ASAC provides analysis, findings, advice and recommendations to inform decisions on the programmatic scope and priorities regarding applied research, knowledge utilization, and applications.

Within ESD, the Applied Sciences Program has a specific focus on expanding Earth science applications, building applications knowledge and capacity, and enhancing the applications value of satellite missions. There are some topics, such as data access, that are ongoing issues and cut across ESD overall.

### **Purpose & Objectives**

This meeting provides an opportunity to discuss key issues, review progress, and identify topics needing special analysis. The purposes of this meeting are to inform the ASAC of key issues facing ESD on applications and to receive ASAC advice and recommendations. The specific set of topics for this meeting includes:

- Applied Sciences Strategic Plan 2015-2020
- Data and Data Access
- Earth Science Decadal Survey
- Applications and Measurement Continuity

Important objectives of the meeting include:

- Feedback on draft Strategic Plan
- Responses to ESD activities on data access
- Identification of activities for Earth Science Decadal Survey
- Key topics for ASAC deliberation and advice in 2015

At a minimum, a product of the meeting is a draft summary or outline of the ASAC's findings and recommendations.



**Day 1: December 11, 2014 (all times PST)**

*Gathering and Set-up* 8:15 – 8:45

**Session 1: Welcome and Meeting Objectives** 8:45 – 9:30

**Opening Remarks**

Kass Green, ASAC Chair

Lawrence Friedl, ESD Associate Director for Applied Sciences

Peter Meister, ASAC Executive Secretary

**Introductions (All)**

**Summary of 2014 Meetings of ASAC and Earth Science Subcommittee** (*Green, Friedl*)

**Agenda and Meeting Overview** (*Green, Friedl*)

*Background*

This session will briefly review the ASAC's terms as an official advisory committee. The session will specify when and how members of the public can provide their comments. The session will also allow all the participants, both in person and on-line, to introduce themselves.

The ASAC held a physical meeting in January 2014 and a follow-on telecon in April 2014; the ASAC issued a letter report to ESD in May 2014 with findings and recommendations. In addition, the Earth Science Subcommittee (ESS) held a meeting in May 2014. This session will review the ASAC findings and recommendations in the May 2014 letter, and it will summarize the main topics from the ESS meeting.

The ASAC is pursuing a new style to its meetings, focusing on fewer topics and allocating more time for in-depth discussion. As such, this session will review the agenda, putting the meeting in context with prior meetings and identifying key topics for discussion and the desired objectives.

*ASAC Decision or Action*

Clarifications or questions about the ASAC or ESS meetings in 2014.

Agreement to agenda or specific suggestions to revise, such as omissions or commissions.

**Session 2: ESD and Applied Sciences** 9:30 – 10:50

**Overview & Status of Major Activities** (*Friedl*)

*Background*

The session will review briefly the Applied Sciences Program's objectives and provide a brief status of major items that ESD and the Applied Sciences Program have been addressing, including significant national and international activities influencing Earth science applications. As the following session will address the Program's new Strategic Plan, this session will focus primarily on broader Agency, ESD, national, and international topics. This session will also

provide a summary of the recent workshop assessing the socio-economic impacts and value of “open” geospatial information.

#### *ASAC Decision or Action*

Nothing specific. Information is primarily to provide context to support discussions (in this and later sessions) and engender questions and feedback. In-depth discussions of Program-specific items should occur in later sessions.

#### *Break*

### **Session 3: Applied Sciences Strategic Plan**

**11:05 – 12:15**

#### **Overview of Strategic Plan 2015-2020** (*Friedl*)

#### **Discussion**

#### *Background*

Applied Sciences current strategic plan covered 2010-2014, and the Program developed a new strategic plan for the 2015-2020 period. In developing it, Applied Sciences used information from our general discussions with ESD leadership, meetings with the ASAC, input from the Program’s September 2014 retreat, and general discussions with partners and others. The plan is not a radical departure, though it re-casts the goals and objectives for the timeframe and introduces specific initiatives. The plan also conveys the implementation bases and the principles that the Program follows in its execution.

This session will review the main elements of the new strategic plan and begin the ASAC discussion of the plan. The afternoon is devoted to discussion of the plan.

#### *ASAC Decision or Action*

The ASAC action (Session 3 & 5) is to discuss and provide feedback on the plan.

#### *Break*

#### *Working Lunch with Session 4*

### **Session 4: Geospatial Services Industry**

**12:30 – 13:45**

#### **Summary of Industry Study** (*BCG Representative, Invited*)

#### *Background*

The Boston Consulting Group (BCG) published a report in 2012 on the U.S. geospatial services industry. Sponsored by Google, this report sized the industry (jobs, revenue) and estimated the wider impacts of the industry (revenue, costs). BCG stated that the industry has revenues of approximately \$75billion and the broader impact extends much farther with \$1.6trillion in revenues. The study credits government support for satellites and clear and open data policies governing data, though it portends a talent shortage.

If confirmed, this session will have one of the study authors present and discuss the study.

*ASAC Decision or Action*

Information is primarily to provide context to support discussions on strategic plan.

*Break***Session 5: Applied Sciences Strategic Plan****13:45 – 16:45****Discussion***Background*

This session will continue the discussion of the strategic plan.

*ASAC Decision or Action*

The ASAC action (Session 3 & 5) is to discuss and provide feedback on the plan. An ASAC decision is what, if anything, to discuss with ESD leadership.

**Session 6: Public Comments****Open Period for Public to Make Statements for the Record****16:45 – 17:00***Background*

This session allows for members of the public to make statements for the record. If there are no public commenters, this session allows for continued discussions on the plan and/or time to compile preliminary findings from Day 1.

*ASAC Decision or Action*

None planned. ASAC can determine whether to formulate actions in response to comments, topics, or issues raised by the public.

*Adjourn for Day 1**Dinner for ASAC & Others (No Host)**approx. 18:00***Day 2: December 12, 2014 (all times PST)***Gathering and Set-up***8:00 – 8:30***Review of Agenda and Updates***8:30 – 8:45****Session 7: Discussion with ESD Leadership****8:45 – 10:15**

**Comments by ESD Director** (*Michael Freilich, NASA; via telecon*)

**Discussion with ESD Leadership** (*Led by Green*)

*Background*

The ESD Director will discuss major items facing the Division and the Earth science community. This session is a primary time for ASAC to interact with ESD leadership, follow-up from previous meetings, ask questions, and understand context for applied sciences and applications.

*ASAC Decision or Action*

No specific action. In general, this session is to gather perspectives and input from ESD Leadership to use in crafting appropriate and actionable advice and recommendations.

*Break as needed***Session 8: Earth Science Decadal Survey****10:15 – 12:30****Introduction to Topic** (*Friedl*)**Speaker: Earth Science Decadal Survey** (*Art Charo, NRC; via telecon*)**Speaker: Earth Science Supply and Demand** (*Shalini Mohleji, AMS Policy Program*)**Discussion***Background*

The next Earth science Decadal Survey is planned for release in the 2017 timeframe. The Statement of Tasks is in development. The NAS/NRC Space Studies Board and its Committee on Earth Science and Applications from Space (CESAS) is leading the Survey, and other Boards are expected to also participate.

The upcoming Decadal Survey will revisit items and named mission backlog set forth in the first Decadal Survey, especially to assess whether they are still relevant. The Decadal Survey will address opportunities and challenges for research and applications, and it will also likely address issues of balance across and among the flight and non-flight portions of NASA Earth science. All this will be done recognizing the current budget realities, so that the Decadal Survey can be realistic yet perhaps somewhat aspirational and motivational for the community. With the new USGCRP strategic goal to “inform decisions,” the Decadal Survey may also need to address efforts to build capacity to achieve such a goal.

In its May 2014 letter, the ASAC recommended that “NASA should ensure that applications are an integral part of the upcoming Earth Science Decadal Survey.” The ESD Director commented on this topic in his reply to ASAC.

This session will address the issue of applications in the context of the upcoming Decadal Survey, including ways to enable an integrative approach amongst research and applications. The session will receive an update on planning for the Decadal Survey. The session will also include a speaker to discuss the latest thinking in the science policy research community on the relationship between supply and demand of science toward advancing desired societal outcomes.

*ASAC Decision or Action*

The ASAC action is to identify steps to promote applications in the context of the upcoming Decadal Survey as well as steps to organize ASAC-led items for Decadal Survey.

***Working Lunch with Session 9***

**Session 9: Data Access and Applications****12:30 – 14:00****Introduction of Topic** (*Friedl*)**Speaker: Earth Science Data Systems** (*Jeanne Behnke, Kevin Murphy, Chris Lynnes, NASA*)**Discussion***Background*

Access to NASA Earth science data (or information products derived from it) by applied and applications-oriented users is core to the Program's objectives. As part of enhancing the value and return from the satellites, NASA has an inherent interest in in cost-effectively making data accessible and enabling awareness of the accessibility. The ESD Data Systems program oversees the Earth Science Data and Information System (ESDIS) and the Distributed Active Archive Centers (DAAC), and other data-related efforts. In recent years, ESDIS and the DAACs have pursued efforts to make data discovery and access easier to a wider range of users. In addition, boundary organizations and intermediary organizations have increased methods to serve data, information products, and decision-making tools using Earth science data.

ASAC addressed the topic of data access at recent meetings, and ASAC made several data-related findings recommendations in its May2014 letter report to ESD. This session will follow-up on the data access topic and discuss ongoing efforts to improve data access for the applications community. For example, the session will review ESD activities on data rods, as requested by ASAC in the May 2014 letter. In addition, the session will cover activities under USGEO to establish criteria for assessing the relative capabilities in discoverability, accessibility, and usability of Earth observations data.

*ASAC Decision or Action*

The ASAC action is to provide feedback to ESD and Applied Sciences on this topic, including feedback on progress, merits, and deficiencies. Building on previous findings and recommendations, ASAC should provide advice for further improving data access for applications users.

A key issue is the balance of roles within ESD for applications-oriented data access and user characterization, especially by Applied Sciences and Data Systems. ASAC should provide advice on this balance and associated recommendations on roles in a collaboration as well as success milestones.

**Session 10: Applications and Measurement Continuity****14:00 – 14:30****Introduction of Topic** (*Friedl*)**Discussion***Background*

The NAS/NRC has an ad hoc committee providing guidance, framework and metrics to assist NASA ESD in the determination of when a measurement(s) or dataset(s) should be collected for extended periods, prioritize the relative importance, and identify the characteristics of and extent to which data gaps and/or performance degradation are acceptable for given measurement(s).

This session will discuss the topic, including possible information on the applications aspects of the study.

This session's topic is one NASA will request an in-depth analysis from ASAC in 2015 based on the findings and recommendations of the study. Thus, this session will introduce the topic with abbreviated discussion time.

#### *ASAC Decision or Action*

The formation of a team to examine applications-related issues and metrics related to continuity.

### **Session 11: ASAC Meeting Synthesis**

**14:30 – 15:00\***

#### **Synthesis & Discussion of Meeting, Findings, Recommendations** (*Green*)

#### **Review Meeting, Actions, Next Steps** (*Green, Friedl, Meister*)

#### *Background*

This session is devoted to discussing, reflecting on, and synthesizing material covered at the meeting, and the session will identify key findings and recommendations from the meeting. The session will identify topics to scope the eventual letter/report that the ASAC will send NASA; the primary audiences are the ESD Director and Applied Sciences Program.

This session won't necessarily draft the letter/report. Instead, the ASAC Chair will likely discuss the overall preparation of the letter/report in this session, including tasking the writing assignments for individual members.

This session will review the meeting overall, including if the primary objectives of the meeting were met. This session will summarize the actions of the meeting. The session will also discuss the next ASAC telecon/meeting, such as timing, location, and topics.

#### *ASAC Decision or Action*

The key actions are agreement on key topics for the letter/report, identification of writing assignments, and agreement on a schedule for production. One set of outputs is a list of actions, suggested topics for next ASAC meeting(s), and timeframe for next ASAC meeting(s).

***\* Room is available later than 15:00 if discussion runs longer.***

#### ***Adjourn ASAC***

***Note: The ASAC Chair will talk with ESD Director after the meeting on the ASAC findings.***

## **Appendix D**

### **Presentations**

1. Overview and Meeting Objectives, *Lawrence Friedl*
2. ESD and Applied Sciences, *Lawrence Friedl*
3. Applied Sciences Strategic Plan, *Lawrence Friedl*
4. Geospatial Services Industry: Putting the U.S. Geospatial Services Industry on the Map, *David Portere*
5. Earth Science Decadal Survey;  
The 2017-2027 NRC Decadal Survey for Earth Science and Applications from Space and Status of the “Continuity” Study, *Art Charo*  
Models for Science, *Shali Mohleji*
6. Data Access & Applications, *Jeanne Behnke, Chris Lynnes*
7. Applications & Measurement Continuity, *Lawrence Friedl*