NASA ADVISORY COUNCIL

EARTH SCIENCE SUBCOMMITTEE

March 21-22, 2012
NASA Headquarters
Washington, D.C.

MEETING MINUTES

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Byron Tapley, Chair

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Lucia Tsaoussi, Executive Secretary

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March 21, 2012
Introduction and Announcements

Dr. Byron Tapley, Earth Science Subcommittee (ESS) Chair, opened the meeting and discussed the meeting agenda and possible issues for findings and recommendations. A potential future finding concerns the impending mid-decade report from the National Research Council (NRC), assessing the Earth Science Decadal Survey implementation. Dr. Lucia Tsaoussi, Executive Secretary for the ESS, made administrative announcements.

ESD Overview, Update to the NAC ESS

Dr. Michael Freilich gave an update of the Earth Science Division (ESD), first addressing recent leadership personnel changes in the Science Mission Directorate (SMD), which include the new Associate Administrator (AA) Dr. John Grunsfeld, a former astronaut with a strong interest in the Earth sciences. Dr. Paul Hertz has left the Chief Scientist (CS) position to become the new Director of the Astrophysics Division (APD). Dr. Colleen Hartman is now Acting SMD CS. Dr. Barbara Giles is the new Director of the Heliophysics Division (HPD). No significant re-focusing in SMD is expected in tandem with these changes.

Selected ESD accomplishments include significant research and other nonflight results. The division is putting out new data sets such as the new global Digital Elevation Model, released on the basis of ASTER data; the model features better resolution and accuracy. NASA continues to fund work that advances Earth system science, and has also produced the first complete map of Antarctic ice using synthetic aperture radar (SAR) data, none of which came from NASA instruments. Dr. Daniel Jacob asked if these SAR proposals had been competed in the Research Opportunities in Space and Earth Sciences (ROSES) call. Dr. Freilich responded that while ESD funds the proposals, ROSES does not discriminate against proposals that don't use NASA data; the new model was the natural outcome of a solicitation to understand cryospheric processes, period. It was a discipline-specific proposal written to advance science, and not to advance a certain data set. Asked if NASA funds solicitations for US scientists on international missions, Dr. Freilich explained that the Stand-Alone Mission of Opportunity (SALMON) call fulfills this role, as well as appendices to the SALMON call. Every other year, NASA releases a US Principal Investigator (PI) call, one of which will be in ROSES 12, to facilitate work on international missions. ROSES does not specify which data sets are available. Dr. Tapley emphasized that it is the community's responsibility to find the data, and it is not NASA's place to restrict data; one must make the whole international suite available. Dr. Freilich noted that ESD actively encourages the international community to make data available, but looks to the science community to discover what data sets ESD should use to advance the science.

New land surface temperature data has been derived from the Moderate-resolution Imaging Spectroradiometer (MODIS) instrument on the NASA Aqua satellite, and new measurements also indicate an Arctic ozone hole that is remarkably similar in size and phasing to the Antarctic ozone hole. MODIS data is also being used for land surface change detection and ecosystem disturbance analysis on a global scale, and for forecasting fire season severity in South America using sea surface temperature anomalies, based on a model derived from multiple satellite data. This model allows for reliable 3-5 month lead times. Detailed *in situ* measurements from the ICESCAPE (Impacts of Climate on Ecosystems and Chemistry of the Arctic Pacific Environment) mission recently indicate that thinning ice cover drives changes in Arctic marine ecology. ICESCAPE has discovered huge phytoplankton blooms

that grow beneath one-meter-thick ice; these results soon to be published in Science (Arrigo et al, Stanford University). The mechanism may be connected to melt ponds on the surface of the ice, which focus and diffuse light through the ice cover. Productivity of this under-ice phytoplankton is an order of magnitude larger than the global average, with many implications for the Arctic food web and atmospheric carbon dioxide levels.

In the applications area, ESD continues to transfer knowledge to actual users, with maps being generated by the National Drought Mitigation Center, based on GRACE measurements, showing long-term fluctuations in deep groundwater. NASA's National Environmental Satellite, Data, and Information Service (NESDIS) has enabled the National Oceanic and Atmospheric Administration (NOAA) to utilize OMI/AURA SO_2 data for operational warnings in NOAA's Volcanic Ash Advisory Center, through NASA's Short-term Prediction and Transition project. Dr. Mark Simons asked whether the use of satellites for operational purposes is being embraced more by NASA now than in the past. Dr. Freilich responded that NASA has always to a large extend embraced this philosophy as an agency, and has for years designed missions so that data sets are made available in near-real time. Dr. Simons commented that had been under the impression that operational activities were not necessarily strong motivators in NASA, and questioned whether operational activities were now recognized as important reasons to launch satellites. Dr. Freilich averred that while operations do not drive NASA research missions, nonetheless ESD has a mandate to address climate continuity issues that also contribute to routine operational products. NASA has never shied away from translating its missions to operations. Dr. Tapley noted that there is in fact a policy at NASA that deals with applications for Earth science. Dr. Efi Foufoula-Georgiou commented that there has always been an obvious role for science in serving society, which is also an obvious argument for these missions, for which NASA should be commended. Dr. Freilich added that NASA is sensitive to the needs of other agencies and their need for NASA data.

Within the airborne science program missions, the Earth Science Decadal Survey (DS) and other National Research Council (NRC) reports have strongly encouraged ESD to use airborne assets in service to science. ESD, in response, has been flying instruments all over the world using a whole range of manned and unmanned assets, including IceBridge surveys of Greenland, the Arctic and the Antarctic, and the 2011 ASCENDS DC-8 Airborne campaign which makes active remote sensing (lidar) CO_2 measurements. Other missions are studying rainfall and the microwave signatures of ice and snow; and an infrared imaging spectrometer is contributing to study of the ecosystem. Dr. William Large felt there was much more to be discussed with respect to NASA's airborne assets, to analyze where duplication may be occurring across agencies. Dr. Freilich felt that NASA is leading the nation in these campaigns, and had not received any feedback on duplication; NASA has in fact been helping other agencies, flying NOAA instruments, for instance, and performing reimbursable work for other agencies.

The ESD flight program has had two consecutive, successful launches; Aquarius on 10 June on a Delta II rocket, marking a joint NASA/Argentine Space Agency effort. Aquarius is providing global ocean surface salinity products at moderate space resolution and is working very well. The second successful launch was Suomi NPP (National Polar-Orbiting Partnership), which will continue essential climate, weather and environmental data from polar orbit. Suomi NPP is a multi-agency (DOD/NOAA/NASA) satellite, and will function as an operational component of the meteorological satellite system. Responding to concerns about NOAA cost overruns, Dr. Freilich pointed out that NOAA's component is being run by NASA as a strictly reimbursable mission. Dr. David Siegel asked if there had been any change in thinking in ESD on how to carry out sustained observations for science's sake. Dr. Freilich replied that ESD has not been given a directive to focus on measurements that support this continuity. The Joint Polar Satellite System (JPSS)-1 and JPSS-2 follow-on satellites are not part of this planning; these are being executed by the

Joint Agency Satellite Division (JASD) as reimbursable work. The nation is committed to putting instruments on future JPSS flights, but JPSS flights should be considered as future assets that NASA may or may not utilize for access to space.

ESD continues to fly 16 operating missions, many of which are international. In 2011 ESD held a Senior Review that recommended continuation of all orbital missions flying at present. These missions have been given budgets. In addition, the AcrimSat mission was continued for its utility in measuring total solar irradiance. The Senior Review considered both science and national needs in its deliberations. Dr. Freilich noted that typically, few missions are discontinued, because so many risks have been retired in existing missions, and the need for long continuous data sets are necessary for ESD. Asked about QuickScat, Dr. Freilich replied that the mission is still producing some data, although the antenna is no longer turning. The satellite continues to operate as a highly accurate radar and is retrieving measurements related to snow cover, land inundation, etc. Its attitude has been slightly adjusted to match the Indian scatterometer. The Indian data set is openly available through EUMETSAT.

Budget

Dr. Freilich reviewed the ESD budget, which had been called out as a highlight of the President's most recently proposed budget; the FY12 and FY13 are only negligibly different, and ESD is stable. In FY12 Congress appropriated what was requested (a differential of only $16M), and it seems likely that Congress will fund FY13 in a similar fashion. No vulnerability from JWST is foreseen at this point. ESD is planning for a more or less flat budget. FY13 is actually $25M over the FY12 budget for ESD. Over the last few years, via the loss of Glory and the Orbiting Carbon Observatory (OCO), ESD has lost about $1B, which has since been covered internally. ESD has received $330M for the OCO recovery mission. The agency now has a different risk posture for launch vehicles (LVs) going forward, and is also carving about $250M in additional costs for LVs, mission delays and re-designs. The subcommittee briefly discussed the liabilities of LV providers in this context. It was noted that NASA has little ability to influence the cost of LVs. One can, however, recognize that there are different LVs with different reliability histories, and the fact that highly reliable LVs are also more expensive. Five Delta IIs are being planned for production, and NASA has released a solicitation for multiple vehicles, including ESD missions. The SMAP mission is on schedule to launch in October 2014, and OCO-2 for no earlier than (NET) July 2014. ESD intends to keep the budget of the non-flight flat between FY12 and FY13.

Within the near-term systematic missions, the Landsat Data Continuity Mission (LDCM; January 2013) experienced a technical failure in a cryocooler for the TIRS instrument; the issue is being worked successfully. The Global Precipitation Measurement (GPM) mission is scheduled for February 2014; the GRACE-FO for 2017; ICESat II for January 2016; and the SAGE III on the International Space Station (ISS) for August 2014. Jean-Bernard Minster asked whether these long time-series and data continuity measurements can be construed as "monitoring." Dr. Freilich felt that this was probably the case; the budgets have been reaffirming that ESD has a mandate to identify long-term measurements that NASA is capable of providing. There has been a sea change in this attitude, as a result. Dr. Foufoula-Georgiou noted that a request was made at a recent AMS meeting to have the board look into the escalating costs of NASA science missions; costs have essentially tripled since the DS came out. Dr. Freilich pointed out that the costs stated in the DS were not endorsed by NASA centers, and in some cases not commensurate with requirements. ESD cannot use estimates from volunteers as a baseline for costs; the DS was uninformed in terms of cost. The costs reflect risk, capabilities, etc., that were not taken into consideration. In addition, NASA must adhere to the guidance of the Climate Initiative. All missions at confirmation must be budgeted at a 70% cost and schedule by independent estimate, with some reserve

held at HQ. Missions will be de-scoped as necessary to keep costs down, sometimes in the wake of oppositional political pull. Dr. Freilich did not feel that costs for ESD were wildly out of hand. Dr. Daniel Jacob asked if hosted payloads would be considered for future strategic missions? Dr. Freilich answered in the affirmative.

Recent LV issues have resulted in a few missions being delayed by a year or so, with CLARREO and DESTynI missions delayed significantly. The Venture class mission, with a cost of about 10% of ESD's budget, represents a competitive, science-driven, PI-led class of orbital and suborbital missions to complement systematic missions. The Venture class program is now fully funded in three "strands": EV-1, an airborne suborbital mission, which has selected 5 separate investigations. EV-2 had a solicitation in September 2011 for a small complete mission (under $150M) or a small stand-alone payload on a Mission of Opportunity (MoO). The EV-instrument call is for spaceborne instruments to be flown on a MoO; proposals for EV-instrument are due May 2012. NASA will help find flights for these instruments. Asked if pre-screening were available for proposals, Dr. Freilich responded that good proposals can always be selected in the next round in the one-step proposal structure. Pre-proposals are not done for missions at the $150M level. The current interest level reflects the pent-up demand for this type of mission call. Dr. Jacob commented that there was a community consensus feeling that a two-step proposal is not supportable. Dr. Anna Michalak added that proposal preparation time would be far too expensive, given current success rates. There was a brief discussion of pros and cons of proposal structures. Dr. Jacob felt that if only one mission gets picked, it seems as if the game is rigged; the odds are awfully low for the new Venture class (as low as one in 24). Dr. Freilich noted that a selling point for the Venture class mission line was that it could be tailored for either national priorities or science objectives. ESD chose to leave this call wide open. A proposal rejection should not be viewed as a damnation- the program can't accommodate all the excellent proposals. Dr. Running pointed out that there are in fact 3-4 opportunities to bid an instrument in EV-2 or EV-instrument call. Dr. Tapley reminded subcommittee members that ESS originally supported Venture class as an excellent idea; it remains to be seen whether it works.

CEOS and International Collaboration

The European Space Agency (ESA) collaboration with NASA continues to move forward for both near- and long-term opportunities in Earth Science; ESA has a flight opportunity in the 2018/19 timeframe, and is considering space for NASA to fly an instrument. The timing fits perfectly with future Venture-class calls. ESD is working hard to encourage ESA's new and open data policy. The Indian Space Research Organization (ISRO) and NASA continue to share excellent collaborations on the scatterometer portion of the Oceansat-2 mission; ISRO recognizes this as an important global mission. ESD is moving forward with the French space agency, Centre National d'Études Spatiales (CNES) on the Surface Water Ocean Topography (SWOT) mission. NASA has also recently signed a cooperative agreement with a joint ISRO/CNES mission. ISRO will have a very healthy flight rate over the next few years. ISRO is also working toward an open data policy, as is the Canadian space agency. It is very possible that ISRO will retire some Tier 2/Tier 3 requirements; but it is up to the community to extract the geophysical data from their instruments. There will be limited opportunities to exchange ideas on design and testing, but Dr. Freilich observed that ISRO greatly improved its scatterometer as a result of NASA discussions that took place during OceanSat mission planning. JAXA, CONAE (Argentina), and DLR (Germany) collaborations are ongoing. JAXA has recovered partial AMSR-E function on its most recent satellite. JAXA's GCOM W1 satellite will launch on 18 May, providing another multichannel microwave instrument. JAXA is under intense pressure to be a revenue center and may be able to provide SAR data to other agencies; NASA hopes for a free and open data exchange. NASA is still prohibited from

collaborating with China, despite the large number of satellites they are launching. Regarding recent travel restrictions, Dr. Freilich reported that ESD is working hard to have participation without presence, and in that spirit recently ran a teleconference with ISRO.

Dr. Tapley asked about potential contributions to the A-train series of satellites. Dr. Freilich reported that NASA is chairing the CEOS Strategic Implementation Team, and that he continues his role as Vice Chair for Integrated Observations Lead at the United States Global Change Research Program (USGCRP). NASA is also participating in national climate assessments through USGCRP, and is helping the Office of Management and Budget (OMB) to focus on integrated environmental analysis. This effort keeps the agencies from performing duplicative work and provides a forum for discussion. Dr. Jack Kaye added that one of USGCRP's recent major activities is the development of a Strategic Plan, which will be focused on science and a broader range of societal objectives. Dr. Kaye felt that NASA's participation was part of a good synergistic, worthwhile effort, and reported having seen a particularly good effort in the carbon cycle area. Asked about the status of National Climate Assessment, Dr. Running replied that the document is well in progress.

Joint Polar Satellite System (JPSS) Status

Dr. Marcus Watkins, Director of the Joint Agency Satellite Division (JASD), gave an overview of JPSS, which is governed by a national space policy that states that NASA, NOAA and DOD and international partners ensure uninterrupted operational polar-orbiting environmental satellite observations. JPSS shares a common ground system. JPSS requirements are generated by NOAA, and NASA is the primary acquisition agent and system integrator. With the launch of NPP, this system has begun, and JPSS-1 and JPSS-2 satellites will follow. The Program Manager is Dr. Preston Burch at Goddard Space Flight Center. Management councils are shared amongst center leads and NESDIS, and coordination is maintained with DOD. JPSS-1 was designed for a seven-year lifetime, and to accommodate increasing mission assurance requirements. The free flyer approach will accommodate such things as search and rescue instruments, as well the total and spectral solar irradiance sensor (TSIS). JPSS has on-board propulsion, and is also looking for hosted payloads in the future. There are only minor differences between NPP and the JPSS satellites. The overall ground system is comprised of C3S, IDPS, and the field terminal segment (FTS).

NPP launched on October 28, 2011; checkout is going very well. The Visible Infrared Imager Radiometer Suite (VIIRS) issues have been resolved; the tungsten oxide contamination-darkening effect on the mirror is not expected to affect the overall specifications for the mission. NPP commission and operations were turned over to NASA on 7 March. The JPSS program made significant progress in 2011. The next challenges will be to definitize remaining contracts for the Advanced Technology Microwave Sounder (ATMS) and VIIRS, and update the Level 1 Requirements Document (NOAA document and requirements). A launch strategy for TSIS, Attitude Determination and Control Subsystem (A-DCS), and Search and Rescue Satellite Aided Tracking (SARSAT) has yet to be determined. NOAA's Level 1 Requirements Document for NPP, which is primarily a list of data products; it is signed and available for viewing. Detailed product specifications are currently under community review. A program baseline report will be delivered in late FY13. There is a potential small gap between NPP and JPSS-1 if NPP lasts only 5 years.

For funding in 2012 and beyond, Congress appropriated $924M for JPSS. NOAA completed an independent cost estimate (ICE) and a Program Office Estimate for this funding. A $12.2B life cycle cost (LCC) cap includes $3.38B already spent. The program has submitted a multi-year budget estimate, and with the inclusion of the climate sensors, the FY13 budget request is $916.3M. JPSS is continuing to reevaluate the Level 1 Requirements Document, which may include the elimination of the Ozone

Mapping and Profiler Suite (OMPS) Limb on JPSS-2. The LCC includes more than just 2 satellites (instruments, etc.), and the LCC of $12.2B runs through 2028. TSIS, OMPS, OMPS-Limb and Clouds and the Earth's Radiant Energy System (CERES) instruments are being threatened by the cost cap. Dr. Running noted that VIIRS provides the continuity for the MODIS sensor, and asked if there were any formal plans for evaluating which MODIS data products will transfer to VIIRS. Dr. Watkins responded that a science team will continually assess VIIRS data and comparisons with MODIS. The first comparative assessment will occur at about 18 months post-launch to move the process forward. In addressing the concern for the lack of formal science teams, JPSS has scientists that ensure the instruments meet the agreed-to performance. Dr. Jim Gleason reported that NASA is working with NOAA to ensure a low-cost NOAA requirement for determine whether archiving OMPS data at high resolution is a possibility. Spectral resolution for the Cross-track Infrared Sounder (CRIS) instrument is under similar consideration. Dr. Siegel asked about plans to reassess and reevaluate the calibration/validation, such that it be useful for the taxpayers. Dr. Gleason described the situation as a "delicate dance" with NOAA going forward, and expected that the first post-launch assessment will contain reasonable proposals for VIIRS to continue MODIS measurements. NOAA will archive Level 1 and Level 0 products locally, but there are separate, overlapping groups overseeing the requirements. ESS brought up concerns about the diverse needs of NOAA and NASA for both operational and scientific/climate data, as well as for the large investment in NPP. Dr. Watkins noted that NOAA has open forums and routinely invites scientists to attend, and offered to provide the pertinent information for meetings. Dr. Siegel felt that the situation was preposterous. Dr. Freilich observed that an advantage of the JPSS structure is that it reduces some of ESD's exposure to responsibility for improving instrumentation.

ESD Launch Vehicle Challenges

Dr. Stephen Volz presented a status on the particular challenges for LVs in ESD. Policy and practices governing launch vehicle procurement are contained in a National Space Policy Directive (NSPD 40), which states that NASA must use US-developed LVs whenever possible, or national excess capacity such as DOD's Minotaur IV (an approach used for the lunar LADEE mission), or a commercially provided LV (such as Ariane). A partner-contributed LV, wherein there is significant science collaboration is also permissible through a vetted, formal process. JWST will be launched on as Ariane LV, for example. The TRMM satellite flew on a JAXA LV. For OCO-2 and SMAP, ESD could not find a viable solution. National policy states that launch vehicle procurement must avoid undercutting the US launch industry. The Taurus XL failures, and lack of findings on a root cause, have had obvious adverse affects. The Agency must identify a corrective action plan before Taurus XLs can be considered for potential future use. In current the current NASA Launch Services (NLS-II) contract, the Falcon 1 is not offered; the Taurus XL and Athena II are not available, and the Atlas V too expensive to use. ESD is left with the Pegasus and Athena I (small-class); and 5 Delta II "white tails." The Falcon 9 should be ready within about a year, and thus could be eligible for the SWOT and PACE missions. Within 2 years, SpaceX (Falcon vehicles) should be a viable contender for regularly providing vehicles. ESD is in reasonably good shape through 2014. SAGE III is scheduled to be on the 6th Falcon 9 launch; this will be a different qualification in terms of number of launches and cost structure. ESD expects the OCO-2 and SMAP LV issue to be resolved within a few months. The EV-2, SWOT, PACE, ASCENDS, and DESDynI-Radar missions are the most uncertain, as they are scheduled at the end of the decade (2020). are also looking for LVs; NOAA is working with NASA to help procure LVs for the JASON-3 and JPSS-1 missions.

ESD is considering a dedicated LV approach for SMAP and OCO-2, as well as for JPSS-1 and RLSP. The ULA Boeing Delta II and SpaceX Falcon 9 are possible proposers. The language of the Return Link

Service Provider (RLSP) contract includes the possibility of using a Minotaur IV, in the event of receiving only very expensive/very high-risk proposals. A partner-provided approach is being considered for GPM (JAXA launch) and ICESat-2, (USAF manifested with the DMSP-20 satellite).

The hosted payload (HPL), a scientific payload that uses available resources as a secondary payload on a commercially provided launch vehicle, is another option under consideration. In 2010, ESD launched a Common Instrument Interface (CII) project office to investigate possible HPL options. Concerns for the HPL approach are jitter, contamination, pointing, etc. ESD has had a number of workshops and has observed some interest from industry, and included draft guidelines in the EV-1 call. An updated plan will include geosynchronous satellite guidelines. ESD released the first Venture-class, EV-instrument call in February 2012, which explicitly allows geosynchronous HPLs. NASA will also pursue approval to fly on a non-US satellite. ESD will continue to pursue RLSPs for strategic missions, aggressive partnering where feasible, and science payloads to fly as hosted payloads. ESD cannot support a commercial base for mid-range LVs and must make decisions around this. Co-manifesting is likely to be the primary approach by the end of the decade. Performance usually exceeds objectives on co-manifested launches, however, one would not expect microarcsecond accuracy for pointing, e.g.- there will be risks.

ESD Surface Measurement Networks

Dr. Jack Kaye presented an introduction to the main features of ESD surface measurement networks (SMN), which particularly focuses on making high-quality data products for the community and conducting and sponsoring cutting-edge research. ESD SMN provides climatology and trends for measurements not available from satellites, calibration/validation for satellite data, and reference frame development. Ground networks can act as anchors for field campaigns, and tend to drive interagency and international partnerships. Partnerships are essential to SMN, as is an open data policy and comparable, high-quality data.

Atmospheric gas phase networks

Dr. Ken Jucks discussed NASA's involvement in surface gas phase network activity. The Advanced Global Atmosphere Gas Experiment (AGAGE) is NASA-funded, but also receives support from NOAA, Australia and the UK. AGAGE was begun in 1978 as the Atmospheric Lifetime Experiment (ALE), initially designed to study the lifetime of anthropogenic gases. Over time, many international partners joined the network. AGAGE is capable of measuring the gases most relevant to the Montreal Protocol. AGAGE measures over 50 important molecules relevant to the Montreal and Kyoto Protocols, which protect the ozone layer and mitigate climate change, respectively. AGAGE has been able to monitor the reduction of chlorinated fluorocarbons (CFCs) and the concomitant increase in hydro-CFCs (HCFCs). AGAGE data does not overlap with NOAA GMD very well; GMD uses whole air samples and can't measure flux. AGAGE is providing evidence that more remote areas indeed become polluted over time with anthropogenic gases. Measurements imply that total emissions are decreasing very slowly, compared with industry estimates, and also point to correlations between specific industries and particular gas species, by showing emission sources. NASA's will continue to support AGAGE in the near future, as it addresses problems that are not tractable with remote sensing. AGAGE is especially essential to ozone monitoring.

The Network for Detection of Atmospheric Composition Change (NDACC) is a set of more than 70 high-quality remote sensing stations for studying the spatial and temporal variability of the atmosphere, to support field campaigns occurring at varying latitudes and seasons, and to test atmospheric models. NDACC began in 1980s, and is overseen by an international steering committee that supports working

groups and science teams. Cooperating networks tie the data together. NDACC measures ozone, water vapor, breakdown products of CFCs and HCFCs, reactive nitrogen species, greenhouse gases, halocarbons, reactive gases, aerosols, ultraviolet radiation, and temperature. NDACC provides some key inputs to each ozone assessment area mandated by the Montreal Protocol. As various orbital assets disappear, NDACC will be the sole tool for some monitoring change.

SHADOZ, a satellite/model validation system, has stations throughout the tropical regions north and south of the equator. The Total Carbon Column Observing Network (TCCON) is designed to measure CO_2 to high accuracy and precision in the atmosphere. One of its drivers was a validation network for OCO. The Department of Energy (DOE) contributes to TCCON, as do as many other agencies. TCCON instruments include some ground-based FT-IR instruments. TCONN calibration is carried out via *in situ* profiles. There are many international contributors. The next full update of TCONN data is expected by mid- to late summer 2012. Recent activities include a research initiative for ground-based lidar profiling of tropospheric ozone, which takes advantage of existing lidar facilities with NASA, NOAA and UAH. Another effort uses a network of small spectrometers (PANDORA) to measure concentrations of particular gases and ties them to airborne measurements. Some correlations are difficult to make, as in nose-level vs. what is in the column. This portion of SMN is reviewed and competed every 2-3 years, and is interested in whether ESS considers the network a worthwhile activity.

Aerosol/cloud surface network

Dr. Hal Maring presented a briefing on AERONET, the "ground-based satellite" sun photometer network that seeks to characterize aerosol properties, validate satellite and model aerosol retrievals, and validate chemical transport models. AERONET makes a measurement every 15 minutes and is international in scope, comprising about 450 instruments, and 375 operating sites. AERONET is expanding into Asia, Africa and over water. AERONET photometers measure aerosol optical depth, single-scattering albedo, phase function, aerosol size distribution, real and imaginary refractive index, column water vapor, cloud optical depth, and water-leaving radiance (useful for ocean color calibration). All data are freely available on the Internet. AERONET can make distinctions among biomass burning, desert dust, urban/industrial aerosols, mixed aerosols, and ocean aerosols. There is also an AERONET synergy tool that provides data from other sources (MODIS, TOMS, OMI) that help investigators to work with these data in an automated way. A new Maritime Aerosol Network now part of AERONET, which consists of handheld, shipborne photometers. Photometer installation is challenging for a buoy because the photometer must point at the sun.

SEAPRISM (autonomous radiometers on fixed platforms in coastal regions) and distributed regional aerosol gridded observation networks (DRAGON) completed a pilot campaign in 2010 in the Baltimore/D.C. corridor, and has compared its data to satellite data. A full campaign is now being carried out in Japan and Korea, and will be followed by Southeast Asia in late summer 2012. There have been a total of over 850 AERONET publications. AERONET continues to develop additional capabilities, including developing a rain sensor, a laser heterodyne radiometer (to measure CH_4, CO), and a collaboration on a lunar photometer. AERONET is also co-located with some FLUXNET sites.

The Micro-Pulse Lidar Network (MPLNET) is a small, single-wavelength lidar developed at Goddard Space Flight Center (GSFC). There are 16 active sites, and 9f co-located with AERONET sun photometer, the lidar can determine where the optical depth is coming from (altitude). MPLNET is useful for satellite validation, model validation, and detection of clouds. A new site was recently established in Hanoi, and other sites in SE Asia. MPLNET provides vertical distribution of intensity and aerosol layers

at high altitude. MPL lidar can detect thin cirrus clouds easily. There are 60 peer-reviewed publications associated with MPLNET. MPLNET has added personnel, and funding is healthy. The network is in the process of connecting to other lidar networks around the world.

At GSFC, there are three developed three laboratories (SMARTLab, COMMIT and ACHIEVE) that have been designed to enrich NASA Earth Sciences. These laboratories are instruments in shipping container-sized, mobile units. Dr. Jenkins asked if AERONET had been used to validate Deep Blue over the Sahara. AERONET did some preliminary work to attempt to validate Deep Blue (over the Sahara Desert), but found it difficult to place photometers in Sahara. AERONET can't measure subnanometer particles, but GSFC's COMMIT laboratory can do this. There are also AERONET photometers at most BSRN sites.

Precipitation ground validation networks

Dr. Ramesh Kakar, Program Scientist, for TRMM and GPM, presented a briefing on an international effort to provide direct statistical validation (surface) and physical process validation (column) data. The ground validation network includes sites at Wallops Island (Virginia), Melbourne, Kwajalein, and Darwin Australia "super sites." High-altitude aircraft collect remote sensing, and direct validation relies heavily on NOAA's National Mosaic and Multisensor (NMQ), a national network of radars and rain gauges, to identify first-order discrepancies between ground and satellite products. The Wallops super-site contains a dense-gauge disdrometer network, and radar for vertical/radial profiling, etc. Asked about comparisons of standard products and establishing "who is right," Dr. Kakar reported that CMAP, GPCP, and TRMM data are completely different in some parts of the world; radar and radiometers are providing independent measurements of rain. In NASA's case, TRMM should be considered the true standard (and GPM in the future). All NASA measurements are anchored to a global network of radar sites, creating much more confidence. NASA has also collected 13 years of data, and can cross-calibrate data with existing satellites. Data sets with snow are beginning to be provided through newer NOAA radiometers, which measure snow; NASA is currently refining algorithms for the 182-GHz band, in advance of GPM, after which snow data will become a standard product.

Geodetic Networks at NASA

Dr. John LaBrecque addressed both global and regional geodetic networks supported by NASA. The primary goal of the global network is to help to position sensors; the regional networks provide environmental data about environmental hazards. The program is supported by a number of foundation documents. The Williamstown Report (1970) proposed space geodesy for solid earth and ocean physics. Other documents such the Global Geodetic Observing System, Earth Science and Applications From Space, Precise Geodetic Infrastructure (NRC), and the ES Decadal Survey also provide guidance. Space geodesy provides information for navigation and precision positioning. The most stringent application for geodesy at present is sea-level change. The technology has been improving by a factor of ten each decade.

The Global Geodetic Observing System (GGOS) ensures the availability of geodetic science, infrastructure, and products to support global change research in Earth science, and involves an international effort. GGOS uses four principal techniques: very long baseline interferometry (VLBI); satellite laser-ranging (SLR), global navigation satellite systems (GPS), and Doppler signals received by orbiting satellites by fixed beacons on Earth. The International Terrestrial Reference Frame is a collection of very stable points; it is intended to provide accurately positioned points with respect to Earth's Center of Mass and a set of distant Quasars. The stations in the network are aging (up to 40 years old), and are more concentrated in the Northern vs. Southern Hemisphere. The last Earth Science DS pointed out that

the geodetic infrastructure was on the verge of collapse and recommended revitalization. The Climate Initiative proposed a doubling of support for the network and strongly encouraged participation of international partners. NASA supports about 40% of the GGOS. The PNT Excom (NSPD 39) oversees the network. NASA also works with the International Committee on GNSS (UN Group), NSF, USGS, and DOE.

GGOS seeks to develop a 1-mm reference frame accuracy and 0.1mm/year stability. The primary approach is to co-locate all 4 GGOS techniques in a set of core observatories. The Space Geodesy Project is developing the GGOS/2020 Observatory near GSFC and hopes to complete construction in July 2013. GGOS is helping to rebuild the global network to meet its accuracy and stability requirements. The Europeans have a similar network termed Galileo, the Russians are developing GLONASS, and China is developing Beidou. NASA hopes to use these networks to help improve relative positioning via co-location in space, and is planning to emplace retro-reflector payloads for GNSS satellites. The Russians and Chinese are adhering to this standard, and the Europeans are developing this standard. The USAF is still working on it. GRACE is used as an orbiting geodetic lab for characterizing the GPS satellite Antenna Phase Variation, helping to resolve GPS satellite errors as satellites are replaced. Recommendations from the Precise Geodetic Infrastructure report are being followed. GGOS is also concerned also about strengthening the graduate student population to support geodesy.

NASA supports regional geodetic networks, in a direction toward real-time operations and disaster response. Another application of real-time GPS is providing hazards warnings; for example, it is postulated that GPS could have calculated in a very few minutes the probability of a tsunami in the Banda Aceh earthquake in 2004. NASA also helped to support the GREAT Alert system, which predicted a tsunami in response to the Chile M8.8 earthquake. In 2011, the GEONET GPS Array demonstrated the capability of predicting a tsunami and its direction. It has been found that a tsunami generates displacement of the ocean surface that couples to the ionosphere.

A Disaster Early Warning Network (DEWN) is being proposed as an experimental prototype to take advantage of the currently available 473 GPS receivers broadcasting real-time data. It is thought that GPS data can provide information about the true magnitude of an earthquake within 2 minutes. Also proposed is a Pacific Basin Low Latency Shared Access GNSS Network for the Pacific "Ring of Fire."
The ESD flight program has invested in a TriG spaceborne receiver, which will advance spaceborne science to support the geodetic network. To sense a magnitude 6.0 earthquake in Los Angeles, for example, sensors need to be placed every 10 kilometers. To detect a larger event, a 30-50 km spacing works. Water cycle studies are also enabled using GPS ground networks, using interference patterns generated between the direct and reflected GPS signals.

Dr. Simons commented that these systems need to be appropriately hardened for true operational use, as the first thing that disappears in a disaster is power, followed by telemetry. In the end, therefore, these systems must be autonomous in terms of power and telemetry. As to funding, the National Geodetic Survey (NGS) has joined the effort in placing sensors in the US. The USGS and NOAA provide some receivers but not enough. NSF supports some of these receivers as well.

Discussion

The subcommittee addressed the general outlook on ESD's flat budget, and reiterated its significant concern over the diminished scientific value of NPP/JPSS. Dr. Siegel noted that the algorithms are very

old, and that a suitable data set will require appropriate funding, referring to the situation as a "train wreck."

Dr. Simons felt it important to also convey the community's shock and dismay that DESDynI had been moved to 2021; the mission is always 8-12 years away from launch. The Earth Science community support for this mission has begun to wane. ESS discussed whether a Venture-class mission might support some part of DESDynI science? Dr. Tapley noted two major issues concerning the mission delay: radar measurements and the community impact. Dr. Simons added that DESDynI science is not being provided by the current constellation. The science requires L-band, or perhaps S-band measurements, and short repeat times. Glacier velocity measurements, volcano monitoring, etc., need the short repeat times. Dr. Minster commented that the arguments have not changed since 1992 because the situation has not changed. Dr. Freilich observed that GPS had a killer application at one point, and an Agency that was fully capable of implementing it, but as a science community, one must admit that the application is not killer enough, or the Agency does not have the horsepower to carry it out. Dr. Simons agreed that it has been hard to make the case to develop the spacecraft on the basis of applications. Dr. Minster commented that DESDynI proposals have generally failed either because they were too cheap or too expensive; i.e. for reasons that don't make sense. Dr. Jacob noted that the missions had been severely under-costed by the DS; proposers must come up with a mission that is not a budget-buster. Dr. Freilich suggested that the community focus on an eminently reasonable, executable mission that comes in at cost, after which it could use the example as a wedge to build credibility- the Canadians, ESA and ISRO have flown SAR-type missions at much lower costs.

Dr. Michalak commented that the hard truth may be that at every decision point, there was a stronger science case elsewhere. The other possibility is that short-term needs may have been a distraction. Then there is the cost issue, where there seems to be an assumption that all missions fall into a specific cost bracket. Dr. Freilich commented that while the problem could have been cost, advocacy, the best strategy at present would be to keep the budget as small as possible. Dr. Simons noted that in terms of SAR data, NASA is going into a "dark period" for at least 2 years- there will be no useful data for the 20 March earthquake that occurred in Mexico, for instance. Dr. Freilich suggested that ESS provide a recommendation on whether the current ESS program is executable and balanced; the answer would be useful to Program Managers. Dr. Large felt that another issue was the strength of ESD programs- it seemed to him that a successful ramping of Venture-class orbital missions should be more explicit. Dr. Freilich agreed that plans to ramp up the Venture class missions post-2020 are vague. Dr. Minster expressed interest in how the NRC mid-decade review of Earth Science might provide further guidance to ESD. An NRC representative provided clarification that the NRC charge was very specific; the mid-decade review will strictly assess progress and make recommendations on what NASA can improve and realign; the NRC is not charged with making changes. Dr. Steffen felt that few plans can be completely viable for 10 years, and that here should be a mechanism to review targets, etc. Dr. Freilich noted that while the DS provides recommendations, the actual responsibilities lie with the agencies. In Earth Science, the community is very broad and is influenced by many voices. He also noted that for a major systematic mission at NASA requires roughly 12 years of development time. The Climate Initiative was put together by NASA, USGCRP and OMB, and it is an administrative document. It was written to address a balanced program and addressed large questions as a guiding context for putting individual components together, to maximize various synergies.

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Dr. Tapley opened the day's discussion, identifying the prevailing issues as program balance; specific questions about NASA networks; data archiving/computing/cloud computing; planning for a June/July ESS teleconference to respond to the mid-decade review. He asked Dr. Jacob to draft a statement on importance of networks, emphasizing NASA's extensive effort. Dr. Running expressed concern that these networks are withering, noting that the Canadian network was shut down last year. The trend is bad for land science. Dr. Siegel agreed that ground networks are an integral part of a balanced approach. Dr. Jacob felt that the Venture-class structure was a more important topic for discussion than networks. Dr. Michalak commented that networks appear to be healthy, and that ESS should discuss whether they provide an optimal subset of data. Dr. Tapley pointed out the need to fill in temporal resolution locally, with respect to satellite coverage. Dr. Running felt it was more useful to ask whether there are network synergies that are not being exploited; the synergy between photometers and flux towers is spectacular. Dr. Christy noted that with all these new measurements, there may be serendipitous assets for real-time hazard monitoring, which could demonstrate the value of networks. Dr. Michalak suggested rebalancing the planned meeting times for discussion vs. presentations, and spending two hours per meeting day in discussion. Dr. Tsaoussi offered to arrange pre-meeting teleconferences to identify agenda items.

ESD Modeling Program Integration and Management

Dr. Kaye presented a brief introduction to the ESD modeling program, responded to some feedback about overall management, etc. Dr. Kaye presented a brief introduction to the ESD modeling program and responded to some feedback about overall management, etc. However, the discussion between presenter Dr. David Considine and the ESS turned instead to the efficacy of NASA modeling efforts. In response to some strong criticism concerning GISS models, Dr. Considine responded that NASA systems are still evolving capability and will be able to use more data over time. Dr. Jacob noted that while NASA plays a role in process modeling, it is not yet clear that NASA has a role to play in developing an independent Earth system model, versus contributing to ongoing Earth system modeling efforts. It seems that process-level modeling is more important at NASA. Dr. Michalak commented that external PIs and NASA centers have complementary skills: external PIs are good at coming up with innovations but terrible at scaling them up; on the other hand there is a tendency to build up everything from scratch at NASA centers. Dr. Considine responded that NASA absolutely depends on interagency connections and external groups for data to support ocean models, to cite one example. NASA products are also provided to the community on a widespread, regular basis for a number of modeling organizations. Dr. Christy commented that GISS is generally considered a poor model in the industry and regulatory agency arena for forecasting; it takes a huge effort to develop a predictive model, and NASA probably does not have the horsepower. Dr. Considine replied that a strategic goal of ESD is prediction; this is one way to address the strategic goal. There are arguments for abandoning this approach, and NASA would end up with description and diagnosis. There is a strong desire for stakeholders to have 10 and 20-year timescale predictions; right now GISS effort is pushing on producing annual prediction. More reliance on external models can address longer-term problems, which can help move GISS to a more capable model. Dr. Christy suggested taking the best data available and testing it within NASA.

Dr. Foufoula-Georgiou felt that while NASA was not expected to be a leader in predictive capability, the Agency should not abandon the effort. All the NASA assets/elements are valuable in helping the prediction framework move forward; it would be better to discuss whether the synergisms are explored on a constant basis to move all modeling forward. NASA does not need to reinvent the wheel and contribute to IPCC by itself. Dr. Siegel noted that some modeling offices can do this uniquely and can support the observational efforts. Dr. Jacob agreed that GISS has made unique contributions to the understanding of climate, but it is not clear why GISS should contribute to IPCC; it is becoming monstrous and is not

worth NASA's time. Dr. Michalak suggested optimizing the synergy; pointing out that the CMS carbon monitoring system was started up in a very strange way, such that the community suddenly feels it is reinventing the wheel in the NASA centers; it seemed that the proposals aligned themselves to building on what NASA has already. Dr. Freilich commented that ESD obviously needed to bridge the communication between the solicitation language and the community.

Earth Science Communications

Dr. Lawrence Friedl presented a briefing on recent activities in Earth Science Communications, with one of its major activities relating to the dissemination of Education and Public Outreach (E/PO) information. E/PO communications refer to a broader sense of the term; specifically, communications to the sponsors/stakeholders, science community, general public, the scientifically attentive public, scientific users, the technology and engineering community, internal components of NASA, etc. Participants in this effort are ESD, SMD, the Office of Communication (OOC), the Office of Legislative and Intergovernmental Affairs (OLIA), and the Office of Education. ESD has an annual E/PO retreat to coordinate its communications effort from top-down and bottom-up. Other federal agencies are also involved; USGCRP has a new objective to "communicate and educate," for instance, and NASA has provided leadership to this USGCRP activity. Responsibilities of the OOC at NASA include interactions with formal media, launch-related public affairs, social media, and web presence. ESD supports the scientific Visualization studio, Earth Observatory websites, etc., and also helps to develop apps for smartphones and iPads.

Dr. Kaye addressed some specific examples, such as ESD's Earth Observation website, which hosts the satellite image of the day, such as images of floods, fires, landslides, etc. The website receives high traffic, and NASA has been getting anecdotes from professors utilizing the site. A Global Climate Change website is hosted by the Jet Propulsion Laboratory (JPL), which has received a Webby award for "best science site." This site includes a feature called "Eyes on the Earth 3-D." ESD also supports such efforts as Science on a Sphere (SOS), Dynamic Planet (much smaller than SOS) and the NASA Hyperwall. SOS was developed by NOAA but NASA develops much content for it. The Hyperwall is a multi-screen media wall that can support 9-15 screens and is typically used at conferences such as AGU, AMS, etc., and can be used for downloading content from the Scientific Visualization site. NASA's EarthNow App for iPads and smartphones reported 150,000 downloads over a three-week period. NASA will also be supporting an Earth Day event on the National Mall. For World Water Day in 2012, GRACE data and USGS groundwater data were featured on a display in Times Square, New York. Field campaigns such as IceBridge provide multiple communication activities and regular blog posts.

Dr. Friedl reviewed the communications objectives of building awareness, promoting recruitment (tapping into the creativity of youth), motivating and energizing within the community base, and broadening the base of users by promoting the value of Earth Science across fields and sectors. NASA is just one of many Federal agencies, however, and there seems to be little public awareness that NASA carries out Earth science. This information is overshadowed by NASA's human exploration activities. NASA does very well at describing results of missions, but many of its best stories are integrated and involve data from multiple sources. Earth Science doesn't have broad name recognition yet within NASA, and its missions tend not to be well known by name. Principles going forward for communications will include balancing NASA-centric communications with partnering organizations; supporting wholesale (raw tools) and retail (promotional) activities; providing opportunities in the community to allow a bottom-up approach; using traditional approaches and emerging methods (apps, blogs, YouTube); assessing activities; and reviewing progress and success.

Dr. Kaye emphasized the great enthusiasm within the ESD for supporting this activity. Dr. Simons suggested that ESD offer opportunities for a visitor program, such as inviting a reporter to spend a day with a NASA staffer. Dr. Kaye responded that while ESD cannot pay for content, it would be happy to accommodate reporters. Field campaigns can take on guest reporters, but the scientist can't be distracted from his/her primary goal. NASA also holds "media days" for the missions. Dr. Siegel commented that all the activities appear to be bottom-up and very disjointed; some coordination is desperately needed. Dr. Friedl welcomed feedback from the community, but also cautioned against being too controlling. Dr. Kaye added that different funding pathways are a challenge to manage; there is no organization chart. Dr. Freilich felt that the larger question should be how ESD can take advantage of communications to craft messages that will inform and develop the knowledge of readers. Dr. Siegel suggested eliminating out-of-date information, and also observed that sometimes the messages from Headquarters and the NASA centers are different and confusing. Dr. Kaye commented that ESD should avoid restriction and allow people access to what they need. Dr. Ming Wei added that NASA is trying to build awareness to allow collaboration, and not duplication, by focusing on projects. Dr. Foufoula-Georgiou, recommended, as a top-down approach, offering science awards for undergraduates, to help them learn content and teach their peers. Dr. Christy asked how NASA bloggers are handled. Dr. Kaye responded that there is an Agency policy on the role of the scientist and the freedom of expression. In terms of funding, Dr. Friedl added that ESD communication efforts are well beyond E/PO, supported by programs and directors. Dr. Wei noted that NASA maintains the Earth to Sky effort with the National Park Service, and other partnerships through USGCRP such as NOAA and NSF. There is engagement on many levels with multiple mechanisms. Dr. Freilich noted that all the agencies are aware of these communication efforts.

Going forward, Dr. Friedl reported that NASA will continue to emphasize integrated stories; empower and enable researchers to participate; continue to engage in intergovernmental activities; call attention to NASA Earth science accomplishments in a reasonable manner; invest in scientific visualization and provide content; foster active on-line presence; emphasize more top-down messaging; and leverage what NASA is already doing in social media.

Dr. Siegel reiterated his concern that there is currently no sense of what is really important or interesting, and that communications would benefit from top-down direction. Government Performance Rating Act (GPRA) content, for instance, is useful for press releases. Dr. Freilich noted that this is the reason why NASA's program managers (PMs), who are generally scientists, get involved with understanding results and communicating up the chain the importance of these results. There is also a relatively routine flow of press releases about NASA science results, and how widely and where they should be communicated. NASA's Public Affairs Office (GPAO) logs these releases on a daily basis. Dr. Kaye recommended that community members contact program managers or program scientists, who can then interface with Public Affairs, or with NSF. Dr. Michalak recommended setting up a website to which a PI can send a press release. Dr. Simons noted that on a yearly basis, PIs send their slides to the PMs. Dr. Jacob suggested that it might be more effective to ask each PI to send slides describing activities for prior year. In addition, the there is a NAC Education committee that deals with communications issues.

Applications and Satellite Mission Planning

Dr. Friedl presented an overview of applications planning in ESD, citing the development of applications as part of Earth Science overarching objectives as identified in the DS. As a result the ESD would like to charge the Applied Sciences Advisory Group (ASAG) to conduct an in-depth examination of the integration of applications into satellite mission planning and implementation, and is asking ESS for its

feedback on this recommendation, to identify considerations and key issues. Because a typical NASA project life cycle can be 5-8 years, and pre-formulation phase up to 2 years, it is a challenge for ESD to effectively include the consideration of mission-enabled applications. The division tried to increase its effectiveness in this are by creating a role of Program Applications lead for missions; adding language to the L1RD, adding content to the mission SDT, and initiating a study of data latency.

The Program Applications (PA) lead is responsible for bringing an applications perspective into mission planning and is the Applications equivalent of the program engineer or program scientist. The PA lead functions to organize the applications community to imagine and anticipate applications; and to alert management as to what would increase or decrease an application value. ESD would like the ASAG to study how to measure application value.

The L1RD includes explicit wording on applications and data latency requirements for a mission, and could include data continuity if it were deemed necessary. Data continuity is also part of a longer-term discussion with agencies such as NOAA. The SDT now considers applications upfront, and they are part of the teams deciding on the requirements. Application-oriented SDTs are already in place for the ICESat-2, SMAP, CLARREO, and DESDynI-R missions.

An ESD study on data latency has identified capabilities, requirements, and user needs, and has examined possible methods and mechanisms to deliver data for meeting data latency targets. Dr. Jacob commented that NASA doesn't do operational missions, as satellites are typically aloft for 2-3 years. Dr. Friedl noted that MODIS has been supporting the operational community. Dr. Freilich regarded ESD's role in operations as being able to find the sweet spot that both serves science and the community, and to help to allocate funds in missions. Dr. Minster commented that there is an obvious social obligation to do as well as possible. Dr. Freilich agreed, but added that contrary to some belief, rapid response is not part of the ESD mandate, but NASA does have the responsibility to bring assets to bear if possible.

To illustrate how applications are integrated into the mission life cycle, Dr. Friedl used SMAP as an example. The mission will be holding an application workshop before the selection of the SDT, followed by an Early Adopter/SDT workshop to weigh in on relative values of the applications. It has been found, generally, that the applications community has science needs and questions similar to that of the science community, and that NASA needs to familiarize the applications community with the mission development process to help them understand the often lengthy mission development timelines. It appears necessary to reach back to missions in operation, or nearing launch, to bring applications into their activities. Applications users are often focused on data access, formats, and latency, and the mission must help them to bridge the gap to look at measurement needs.

Items for ASAG consideration are how to build abilities; identify the type and level of engagement in mission phases, as well as the expectations of applications users (what are their responsibilities to the ES research community?). Other questions to consider are: What is coming from the application involvement; how to measure application value; has it increased the value to the applications value of the mission; has there been an impact on science or an impact on mission development? ESD would like to see what is working and not working? ASAG would report its findings to ESS for open discussion and for recommendations to NAC and NASA.

Discussion

Dr. Running suggested that ESD not waste too much time on non-science stakeholders who don't understand mission parameters/products, and instead be clear on what the product is, without overpromising. The application scientist level is the right level. Dr. Minster commented that since 1963, people have been struggling to assign value to weather pictures from space; it would not be helpful to start assigning these values. Dr. Friedl responded that he was not implying monetary/economic value; the idea is to ask ASAG to assess the value/effectiveness of ESD's applications efforts. Dr. Foufoula-Georgiou recounted that when GPM was being planned, there were days of discussion of what would be helpful to a hydrologist, and was curious to see if one could reconstruct how the process took place. Dr. Friedl noted that ASAG would be looking at past and potential processes for incorporating applications. Dr. Foufoula-Georgiou also suggested looking at missed opportunities. A caveat was raised for changing "in-depth study" to "investigation" re: FACA rules. Dr. Tapley instructed the ASAG to meet in an open session to decide what the study will be, staying within FACA rules. ESS reached consensus and approved the charge back to the ASAG.

Dr. Tsaoussi raised a brief issue relating to the NAC Infrastructure and Technology Committee (IT), regarding NASA computer-related infrastructure. The NAC Science Committee has identified a recommendation on this issue, and the July 2012 NAC, the SC and IT committee will potentially jointly discuss data systems. Dr. Tapley will represent the ESS to the SC, and can carry recommendations to this meeting. ESS agreed to firm up plans for a teleconference prior to that meeting.

Discussion with SMD AA John Grunsfeld

The new SMD Associate Administrator, astronaut Dr. John Grunsfeld, addressed the ESS. He related that his favorite part of flying in space was looking at the Earth, and appreciating the fragility and beauty of Earth. In his decade in space, he felt that the influence of humans on Earth could be seen clearly over time; plumes of aerosols coming from Asia, roads, fires at night, marked changes in Madagascar and South America, deforestation, and extensive development in the Middle East. Dr. Grunsfeld was deeply interested in the interdisciplinary opportunity of NASA's partnership with NOAA, and regarded his role in SMD as helping to change and save the world. He planned to talk extensively to the public about loss of biodiversity, to raise awareness, interpret data for policy, and make good decisions. Students should be encouraged to become good decision-makers through science. He encouraged ESS to go out into their communities and share concerns and enthusiasm about Earth Science. From the perspective of the Administration, the ES enterprise is very important. Dr. Grunsfeld was pleased with the budget in current situation, in that it could have been much worse. He also cautioned members of ESS as representatives of NASA to keep in mind that the ESS is not an advocacy group, and as individuals, they are serving as Special Government Employees (SGEs), to enable decision-making at Headquarters, to allow the Agency to be driven by a transparent, data-driven, decision-making process.

Dr. Running reported his despair, as an IPCC author, that only about 50% of the US public is convinced that critical global change is occurring, and recommended that astronauts, with their high visibility and celebrity, address the public on this matter. Dr. Grunsfeld mentioned that there is even a split in the astronaut corps on the changing Earth, and took the suggestion as an action.

Dr. Christy commented that in order to effect changes in places of great need, accountability, democratic ability, rights for women, etc., must be introduced. Poverty, the root cause of much destruction on Earth, will continue to wreak its havoc otherwise. Dr. Grunsfeld added that NASA has a worldwide "brand" in surprising places, and investments in NASA have had wide-ranging leverage. There was a suggestion to involve the State Department to increase such leverage.

Dr. Grunsfeld addressed the issue of scarce and expensive launch vehicles. At the NASA top line, commercial cargo and crew, ISS, and JWST are largely driving the launch vehicle discussion. Commercial cargo will drive the selection; right now Orbital and SpaceX are the producers, and it is hoped that Delta II prices will be driven down by competition. Dr. Jacob supported the concept of hosted payloads on commercial satellite as the only way to maintain healthy missions. Dr. Grunsfeld agreed, as long as the mission was a good match with the observation environment, and felt that this could be a good ESS recommendation, and encouraged the use of ISS too, as it provides the ride, the communications, and the possibility of repair.

Dr. Grunsfeld encouraged the science community to take up the issue of computing, as NASA will soon face an enormity of data from JWST. In trying to do climate modeling with fidelity, GPU computing could be a possible solution. He hoped that such supercomputing techniques would be more widely used, as it can reduce computing time from weeks to overnight. To make progress, a significant effort must be undertaken with this technology. The national laboratories at Los Alamos National and Oak Ridge, as well as researchers in China, are actually using chips specifically designed for high-performance computing. This is a good opportunity for ES systems modeling to be accelerated. Dr. Grunsfeld also encouraged citizen science, engaging the public in science topics via local participation in recording temperatures, pressures, etc.

Discussion

The ESS discussed ways in which distributed data systems/computing could be done better, and logical ways to transfer legacy systems, agreeing that NASA must anticipate the evolution of computing systems. Dr. Minster recommended that NASA should be at the leading edge, but not bleeding edge. GPU computing is not quite where it needs to be in development. Dr. Tapley commented that because many problems are driven by large volumes of input/output, one must carefully select test cases and evaluate them. Dr. Simons noted that many of these issues are being discussed by experts in organizations such as NSF, and they are not something ESS is in a position to evaluate; how then does the community ensure that NASA can take advantage of new techniques if they are useful? It should be done in the context of the learning that is occurring- a huge effort has been going on for 4-5 years. Dr. Freilich commented that it would behoove ESS to keep in mind NASA strategy, and the nation's dependence on the information that ESD produces. Mission risk is also an issue; ESS recommendations should point back to risk for the enterprise while recommending approaches.

ESS and an NRC representative discussed setting up a teleconference to address the release of the Decadal Survey Midterm Evaluation Report. Dr. Tapley wrote a finding on programmatics, which he would circulate, and asked for statements on the network, launch vehicles, and possibly ES Communications. ESS also requested that presenters provide pointed issues for ESS feedback.

Dr. Tapley adjourned the meeting at approximately 2:20 p.m.

Appendix A
Attendees

Committee members
Byron Tapley, ESS Chair, University of Texas
John Christy, University of Alabama, Huntsville
Efi Foufoula-Georgiou, University of Minnesota
Daniel Jacob, Harvard University
Gregory Jenkins, Howard University
William Large, National Center for Atmospheric Research
Anna Michalak, Carnegie Institution for Science
Jean-Bernard Minster, University of California, San Diego
Patrick McCormick, Hampton University
Steve Running, University of Montana
David Siegel, University of California, Santa Barbara
Mark Simons, California Institute of Technology
Konrad Steffen, University of Colorado, Boulder
Lucia Tsaoussi, Executive Secretary, NASA Headquarters

NASA Attendees
Jay Al-Saadi, NASA Headquarters
Marcus Allen, NASA Headquarters
Andy Carson, NASA
Ellen Cohen, NASA Headquarters
David Considine, NASA Headquarters
Mitra Dutta, NASA Headquarters
Richard Eckman, NASA Headquarters
T. Jens Feeley, NASA Headquarters
Michael Freilich, NASA Headquarters
Lawrence Friedl, NASA Headquarters
Jim Gleason, NASA GSFC
Ken Jucks, NASA Headquarters
Ramesh Kakar, NASA Headquarters
Jack Kaye, NASA Headquarters
William Lau, NASA GSFC
Allison Leidner, NASA Headquarters
Michael Little, NASA Headquarters
Martha Maiden, NASA Headquarters
Andrea Martin, NASA
Dave McCormick, NASA GSFC
Dennis McSweeney, NASA Headquarters
Peter Meiser, NASA Headquarters

Marian Norris, NASA Headquarters
Mike Seablom, NASA
Stephen Volz, NASA Headquarters
Amy Walton, NASA ESTO
Marcus Watkins, NASA
Diane Wickland, NASA Headquarters
Ming Wei, NASA Headquarters
George Komar, NASA ESTO
Hal Maring, NASA Headquarters

Non-NASA Attendees
T. Blankenship, Booz Allen Hamilton
Sarah Burgess-Herber, Booz Allen Hamilton
Kaitlin Chell, Caltech
Andrew Chen, Lockheed Martin
Anne Connor, House Science Committee
Dom Conte, Orbital Sciences
Lewis Groswald, NRC
Daniel Leone, Space News
Brian Lottman, Northrop Grumman
Christine Mataya, Booz Allen Hamilton
Maya Buchanan, Booz Allen Hamilton
John Petheram, Lockheed Martin
Joan Zimmermann, Zantech IT

Appendix B
ESS Membership

Byron Tapley, ESS Chair
Director, Center for Space Research
University of Texas

John Christy
Earth System Science Center
University of Alabama, Huntsville

Judith Curry
School of Earth and Atmospheric Sciences
Georgia Institute of Technology

Efi Foufoula-Georgiou
National Center for Earth-Surface Dynamics
University of Minnesota

(GOV) James Hansen
Goddard Institute of Space Studies
NASA

Daniel Jacob, ESS Vice Chair
Department of Earth and Planetary Sciences
Harvard University

Gregory Jenkins
Department of Physics and Astronomy
Howard University

William Large
Oceanography Section
National Center for Atmospheric Research

Mahta Moghaddam
Radiation Laboratory
University of Michigan

Anna Michalak
Department of Atmospheric, Oceanic and Space Sciences
University of Michigan

Jean-Bernard Minster
Institute of Geophysics and Planetary Physics
University of California, San Diego
Patrick McCormick
Center for Atmospheric Sciences
Hampton University

Steve Running
Department of Ecosystem and Conservation Science
University of Montana

Hank Shugart
Department of Environmental Sciences
University of Virginia

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

Mark Simons
Division of Geological and Planetary Sciences
California Institute of Technology

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

Appendix C
Presentations

1. Earth Science Division Update; *Michael Freilich*
2. CEOS and International Coordination; *Michael Freilich*
3. JPSS Status; *Marcus Watkins*
4. ESD Launch Vehicle Challenges; *Stephen Volz*
5. ESD Atmospheric Gas Networks; *Ken Jucks*
6. ESD Aerosol/Cloud Surface Network; *Hal Maring*
7. ESD Precipitation Ground Validation Networks; *Ramesh Kakar*
8. Geodetic Networks at NASA; *John LaBrecque*
9. ESD Modeling Program Integration and Management; *David Considine*
10. Earth Science Communications; *Lawrence Friedl*
11. Applications and Satellite Mission Planning; *Lawrence Friedl*

Appendix D

NAC Earth Science Subcommittee
NASA Headquarters 300 E Street SW, Washington, DC.
Agenda
21-March-2012 @ 2E39

8:30-8:35	Opening remarks	L Tsaoussi
8:35-8:50	Meeting charge	B Tapley
8:45-9:50	Earth Science Division Update	M Freilich
9:50-10:00	Coffee Break	
10:00-11:00	CEOS and International Coordination	M Freilich
11:00-11:30	JPSS status	M Watkins
11:30-12:00	Discussion	ESS Members
12:00-1:00	Lunch	
1:00-1:30	Launch Vehicle Status	S Volz
1:30-1:45	ESD Ground Networks Overview	J Kaye
1:45-2:30	Atmospheric gas phase networks	K Jucks
2:30-3:10	Aerosol/cloud networks	H Maring
3:10-3:20	Precipitation ground validation networks	R Kakar
3:20-3:30	Coffee Break	
3:30-4:15	Geodetic networks	J LaBrecque
4:15-5:00	Discussion	All
5:30	Adjourn	

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8:30-8:45	Session Overview	B Tapley
8:45-9:30	Modeling program integration/management-Follow up discussion	J Kaye/D Considine
9:30-10:00	Discussion with SMD AA	J Grunsfeld
10:00-12:00	Earth Science Communications	J Kaye/J Friedl
12:00-1:00	Lunch	
1:00-2:00	Applications and Satellite Mission planning	S Volz/J Friedl
2:00-2:30	Findings & Recommendations	ESS Members
2:30-3:00	Letter writing/next meeting	ESS Members
3:15	Closing remarks /Adjourn	