

Foundations of a Healthy and Vital Research Community for NASA Science

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Agenda

- Statement of Task
- Committee
- Foundations for the Health of NASA SMD's Research Community:
 - Attributes of Science Community Health and Vitality
 - Assuring Strong Science Priorities
 - Ensuring a Healthy People Enterprise
 - Addressing Programmatic Issues

Study Charge Overview

- Define the data NASA needs to collect to enable Decadal survey analyses & recommend actions to conduct its own analysis of its research community's health and vitality
- Identify the characteristics of a healthy and vital research community.
- Define implementable measures for assessment, considering demographics, career-stage structure, distribution of “hard money” and “soft money” positions, relative dominance of NASA Centers, fraction of funding for the discipline provided by NASA
Enumerate the types of data that NASA should be collecting to enable future assessments and any statutory, regulatory or policy impediments and actionable approaches to reduce them
- Recommend and prioritize best practices

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Report Content

- Identifying the Characteristics of a Healthy and Vital Research Community (*Chapter 2*)
- Foundations for the Health of NASA SMD's Research Community: Assuring Strong Science **Priorities** (*Chapter 3*)
- Foundations for the Health of NASA SMD's Research Community: Ensuring a Healthy **People** Enterprise (*Chapter 4*)
- Foundations for the Health of NASA SMD's Research Community: Addressing **Programmatic** Issues (*Chapter 5*)
- Implementable Measures for Assessing the Health and Vitality of NASA SMD's Research Community (*Chapter 6*)
- Recommending and Prioritizing Promising Practices (*Chapter 7*)

Report provides 13 Recommendations for NASA Science Mission Directorate

Six Attributes of Community Health and Vitality

1. **Clarity of science for efficient research and public support**, using clear scientific questions guiding research and funding,
2. **A representative workforce**, demonstrating diversity, inclusion and equity and competence across a broad range of characteristics,
3. **Sustaining a diverse science enterprise through outreach, acceptance and development**, which is ensured by ongoing outreach to the larger community at all stages and the acceptance and development of its members,
4. **Adequate funding**, in providing support for the long cycle efforts required to maintain and grow a healthy research community,
5. **Resilience to emerging challenges**, leveraging the ability to adapt to changes in the human, technological, and political environment, and
6. **Community standards of conduct**, reinforcing recognized standards of conduct and equity in processes

Attributes address aspects of healthy science, community and support systems

Context – NASA Science and Research

- NASA SMD science accomplishments consistently motivate and inspire
 - More excellent ideas submitted in research proposals than can be funded
 - Continuing stream of undergraduates, graduate students and postdocs interested in performing space research
 - Continued and often increasing support from the stakeholder community
 - Strategic collaboration and synergies with other agencies, public-private partnerships and open science

Evolving SMD systems, even with goals of making the enterprise more future-focused and innovative, will be disruptive and in many cases unwelcome and will require leadership and strategies dedicated to equally balancing multiple goals



Assuring Strong Science Priorities

- Focusing on Clear, Relevant, Science: Assuring Priority for Enablers of Scientific Research (Theory, Facilities, Access, Technology Development, Data Analytics and Modeling)

- *Clarity of science for efficient research and public support, using clear scientific questions guiding research and funding,*



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Elements for Future Science Health and Vitality

Problem Solicitation

Finding: Metrics of participation (center, type of institution, specific institutions, partnership) as well as metrics of research pedigree (completeness of topics, novelty) can provide insight into the forward leaning attributes of SMDs science community. These metrics would be most helpful if recorded, captured, trended, and assessed at regular intervals as part of white paper and RFI solicitation processes.

Problem Assessment, Clarification & Prioritization

Finding: Aggregated data on the results, opportunities and value of various peer reviews and other committees across the SMD enterprise could highlight opportunities to better support the health of the community.

Finding: A dashboard that tracks the multi-objective nature of the challenges of driving science while incentivizing and supporting positive change for a healthy science community would provide visibility to intended and unintended consequences.

Science Acceleration

Finding: Trends that capture the ratio of basic to applied research funding, as well as parameters identified by each Decadal in each mission area provide measurable indicators of foundational investment

Capturing and trending metrics of participation, novelty, & basic research funding, as well as broadly implementing SMD division-specific best practices can better support the science community

Ensuring A Healthy People Enterprise

- Enabling a Healthy, Representative Workforce
- Engaging Social and Behavioral Scientists in Strategically Shaping the People Enterprise

- **A representative workforce**, demonstrating diversity, inclusion and equity and competence across a broad range of characteristics,
- **Sustaining a diverse science enterprise through outreach, acceptance and development**, which is ensured by ongoing outreach to the larger community at all stages and the acceptance and development of its members,



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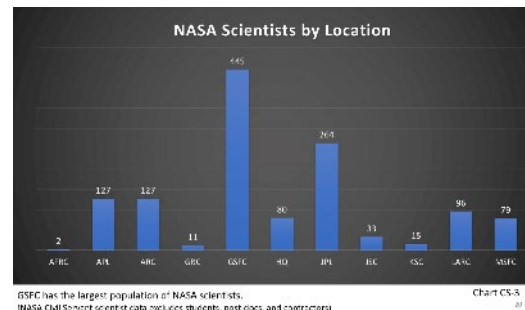
People Enterprise Overview

Today's Space, Earth, Biological and Physical Sciences Research Enterprise consists of **10,000 scientists** as well as the many others without whom the ambitious facilities, instruments, and experiments, as well as the promised transformative discoveries, would be unfulfilled:

- Civil servants at NASA
- Researchers, scientists, engineers & educators at
 - FFRDCs, UARCs, Other federal labs
 - Universities
 - Planetariums, Observatories, Museums
 - Non-profit organizations, e.g., Southwest Research Institute (SwRI), Space Studies Institute (SSI), Planetary Science Institute (PSI), Universities Space Research Association (USRA), etc.
 - Industry



Source: <https://science.nasa.gov/>



Source: Agency Science Workforce Study Phase 1 Report, Science Workforce Study Team, 2021

People Enterprise

Foundations for a healthy research community include strong support for existing talent while cultivating emerging talent, community and stakeholder support through outreach and education

Nurturing and Sustaining Existing Talent

Education and Outreach

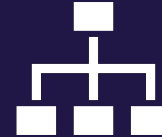
Foundational Support to the People Enterprise



Addressing Programmatic Issues

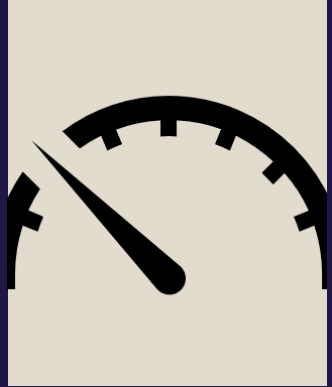
- Establishing Supportive Funding
- Maintaining Continued Support, Advocacy and Focus through Change
- Developing Synergies with International Agencies and Other National and Domestic Partners
- Providing Administrative Oversight of a Healthy and Vital Research Community
- Establishing and Enforcing Community Standards of Conduct

- **Adequate funding**, in providing support for the long cycle efforts required to maintain and grow a healthy research community,
- **Resilience to emerging challenges**, leveraging the ability to adapt to changes in the human, technological, and political environment, and
- **Community standards of conduct**, reinforcing recognized standards of conduct and equity in processes



Implementable Measures for Assessing the Health and Vitality of NASA SMD's Research Community

- Demographics Data on the Space, Earth and BPS Community
- Data Analysis
- Alternative Data Parameters
- Data Collection Beyond NASA
- Data Collection Limitations & Challenges



“Not everything that counts can be counted, and not everything that can be counted counts.”

Attributed to Albert Einstein

Study Conclusions

- Six attributes identify the characteristics of a healthy and vital research community
- 13 recommendations to enable Decadal survey analyses, address data collection, reduce impediments, improve processes, and assess performance against key attributes currently and in the future



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BACKUP

Statement of Task

The National Academies of Sciences, Engineering, and Medicine will appoint an ad hoc committee to address the topic of “Building a Foundation for Assessing the Health and Vitality of the Science Mission Directorate’s Research Communities.” This study will define the data that NASA needs to collect to enable each decadal survey to conduct its own analysis of its research community’s health and vitality. This committee will recommend actions to improve the health and vitality of the communities of researchers to aid in the accomplishment of the NASA research objectives.

To accomplish this task, the committee will:

1. Identify the characteristics of a healthy and vital research community.
2. Define implementable measures for assessing the health and vitality of a research community based on the above-identified characteristics, considering demographics, career-stage structure, distribution of “hard money” and “soft money” positions, relative dominance of NASA Centers in performing research in the discipline, fraction of funding for the discipline provided by NASA relative to other funding agencies, and other relevant variables.
3. Based on the above-identified measures, enumerate the types of data that NASA should be collecting to enable future assessments of the health and vitality of the scientific work force and any statutory, regulatory or policy impediments to collecting those data. Recommend practical and actionable approaches that, if implemented, would reduce the identified impediments.
4. Recommend and prioritize best practices for NASA to use to improve the health and vitality of its research communities.

As part of its work, the committee will review and consider the findings of past social science studies of SMD-supported science communities as well as any limitations in available data found by recent Decadal Surveys and any additional information they may have developed for data that NASA was unable to provide. This part of the review will be integrated into the committee’s methods of collecting information specific to NASA science communities. These methods may include commissioned papers, representative community panels, and structured interviews.

Six Attributes of Community Health and Vitality

1. **Clarity of Science for Efficient Research and Public Support.** Clear scientific questions guiding research solicitations to facilitate communication of the mission, alignment of funded research, and societal value to a wide range of stakeholders
2. **A Representative Workforce.** Primary researchers and partners who represent society in general in the US, including the elements of gender, ethnicity, race, place of origin, physical capability, pathways, and experiences, the data on whom are both collected and shared
3. **Sustaining a Diverse Science Enterprise through Outreach, Acceptance and Development.** Acceptance, engagement, and promotion of individuals with diverse experience pathways and levels, from top-line researchers to support professionals. Beyond the metrics and necessary analyses of the workforce, sustainment processes, with their own metrics, must be cultivated, measured and shared. Tapping familiar sources of talent or establishing artificial criteria for inclusion can lead to intellectual echo chambers and adversely impact creativity and innovation. Inclusion of robust career development plans that reflect the opportunities associated with the profession as well as individual capabilities is key. Willingness to accept novel concepts and approaches as a healthy part of competition that values potential at least equally with existing track-records
4. **Establishing Supportive Funding.** Funding agencies that actively support human potential, creativity, the science enterprise, novelty, and a diverse selection of capabilities in their funded programs, which is promulgated into the choice of, and guidance to review panels. While “adequate funding” may be debatable, “supportive funding,” or the distribution of funding from available resources, adequate or not, to best advance the objectives is essential.
5. **Resilience to Emerging Challenges.** Both the institutional and individual capacities to anticipate emerging challenges not only in the science, but to the human, technological, infrastructure and political environments in which it then must readily adapt
6. **Community Standards of Conduct.** Community standards of conduct and equity processes that are uniformly accepted and sufficiently respected to be successfully self-policed, with a review process to externally address situations deficient in ethics, equity processes, and recognition of the value of diverse opinions within the science enterprise

Focusing On Clear, Relevant, Science

Recommendation: NASA's Science Mission Directorate (SMD) should collect key data and trends representative of the research solicitation process and quality of the research produced by the science community. Key indicators and/or efforts:

- Metrics of participation (center, type of institution, specific institutions, partnership);
- Metrics of innovativeness and research pedigree (completeness of topics, novelty). The assessment of the quality of research and science results is likely best handled by periodic peer review;
- Review of peer review effectiveness and data sharing of other division-unique initiatives;
- A dashboard that tracks the multi-objective nature of driving science while incentivizing and supporting change;
- Trends that capture the ratio of basic to applied research funding, and foundational investment as defined in Decadal recommendations.

People Enterprise Overview

Findings:

- The overall SMD science community is interdependent. The health of the overall community is dependent upon the health of the internal NASA civil servant community.
- The Agency Science Workforce Study provides an excellent resource for career planning within NASA.

Recommendation:

- **NASA's Science Mission Directorate should implement the recommendations from the agency Science Workforce Study.** Indicators to measure the success of the implementation could be the degree to which the nomenclature is adopted, feedback from participants in the training and rotational opportunities, and the number of best workforce practices that are shared across NASA centers.

Funding the Space, Earth and BPS Research Community

Findings:

- **Data associated with grants funding would be helpful** in determining the impacts of grant oversubscription, churn, institutional policy risk impacting the research community. Key data to include are the ratio of directed to competed research dollars, numbers of grants per PI/Co-I/Science PI, grant award success rates per PI/Co-I/Science PI, numbers of supported research contracts per PI/Co-I/Science PI and/or hours per week expected to support specific research contracts.
- Although there are significantly more proposals than can be funded, and nearly 95% of those identified as “Excellent” are funded, understanding what does not get funded, particularly unfunded “Excellent,” “Very Good” and “Good” quality proposals, can provide insights into potential opportunities for improving the process. **Simple data could inform future opportunities to pair inexperienced and experienced investigators.**
- NASA is a federal agency and funding comes from congressional appropriations. This makes planning beyond a 2-or 3-year cycle very difficult since new administrations and congress are likely to have differing priorities. When combined with the recommendation to develop an **integrated dashboard of annual priorities and budget allocations** across all Decadal science categories and SMD programs and projects to show at-a-glance investments and progress against planned science missions the following recommendation can further strengthen SMD’s ability to exhibit a “constancy of purpose” in development and execution of its Decadal missions.

Funding the Space and Earth Sciences Research Community

Recommendation:

- **NASA's Science Mission Directorate should track within each budget cycle the investments in projects inside NASA and projects providing funding outside NASA through the NASA Office of the Chief Financial Officer.**
- The funding within NASA should be examined both by discipline and by location. The funding distributed beyond NASA should be studied by career stage of PIs, funding per institution, and breadth of research teams. Additional data to include reflect the status of the health of the grant-writing community. Key data to include are the ratio of directed to competed research dollars, numbers of grants per PI/ Co-I/ Science PI, grant award success rates per PI/ Co-I/ Science PI, numbers of supported research contracts per PI/ Co-I/ Science PI and/or hours per week expected to support specific research contracts. cont.) Because the Science Mission Directorate's budget is driven by the President's budget request and congressional authorization and appropriations, NASA's Science Mission Directorate (SMD) should develop an integrated dashboard of annual priorities and budget allocations across all Decadal science categories and SMD programs and projects to show at-a-glance investments and progress against science planned missions and the scientific results they deliver.
- This data visualization tool permits interested members of the science research community, the Administration, and members of Congress to view the consistency (or inconsistency) of funds allocation and spending across the life-cycle of missions and can be used to address changes in directions over time and support the need for a consistent and stable budget for science missions. This also adds to the potential to improve greatly on adherence to cost and schedule planning.

Developing Synergies with International Agencies, Other U.S. Government Agencies, & Domestic Partners

Finding:

- Productive partnerships and joint efforts in each of the areas of international collaboration, inter-agency collaboration, commercial partnerships and citizen science are indicators of a healthy and growing science community. Because the specifics of each of these partnerships are temporal and dependent upon the geopolitical climate, funding strategies, market conditions, international financial conditions, popular science topics, etc., specific relevant metrics will also change over time. However, a simple indicator of the trend of the partnerships in each of these areas may provide an indicator of overall health.

Recommendation:

- NASA's Science Mission Directorate should **define, collect, and report metrics of collaboration and partnership in each of the areas of international collaboration, inter-agency collaboration, commercial partnerships, and citizen science** as indicators of a healthy and growing science community.

Providing Administrative Oversight of a Healthy and Vital Research Community

Finding:

- There is a need for a single executive leadership position within SMD, supported by adequate staff, which is responsible for oversight of the data collection and analysis that provides insight into the health and vitality of the science community. This person would also be responsible for use of this data to ensure SMD is meeting the DEIA goals contributing to the health and vitality of the community.

Recommendation:

- NASA's Science Mission Directorate (SMD) should **appoint a senior executive (perhaps with Senior Level rating) with oversight responsibility for the collection and analysis of data used to determine how well SMD is doing in creating a vibrant and healthy science community and the degree to which they are meeting diversity, equity, inclusion, and accessibility (DEIA) goals**. Specific responsibilities of the person in this position will include:
 - Ensure progress is being made across the directorate,
 - Benchmark other agencies and recommend promising practices for consideration,
 - Work in cooperation and collaboration with the other agency offices/departments (Chief Scientist, other directorates, Office of Human Capital Management, Small Business, etc.), and
 - Apprise the SMD Associate Administrator (AA) and Division Directors on a regular basis of progress being made and barriers to accomplishment of established DEIA goals.The executive should report to either the AA or Deputy Associate Administrator for the SMD and will negotiate with the AA SMD on appropriate staff support to facilitate the successful conduct of the duties of the position.

Data Collection & Analysis: Management of a Data Stream Review and Criteria Against Which to Evaluate Outcomes

Findings:

- The Office of the Chief Scientist, Office of Diversity and Equal Opportunity, and SMD collect large amounts of data but are not effectively sharing data, coordinating, or collaborating on required corrective actions.
- The collector of NASA's community data, OCS, has no control over the use of the data to make changes.
- NASA has many programs, offices, and activities focused on data collection, diversity, and inclusion of its employees, but there appears to be little or no interaction, collaboration, or planning among them.

Recommendation:

- NASA's Science Mission Directorate (SMD) should **establish a collaborative working group among SMD, the Office of the Chief Scientist, the Office of the Chief Human Capital Management, and the Office of Diversity and Equal Opportunity to establish clear goals, collect and evaluate demographic results, and identify action required to mitigate deficiencies.** A single senior executive official within SMD (with adequate supporting staff) should be assigned with oversight and coordinating responsibilities.

Data Availability: DEIA Demographic Indicators

- Ideally, data can be used to assess diversity along many axes and must be collected distinct from proposal submission and must not be used in proposal selection processes.

Recommendation:

- NASA's Science Mission Directorate should use diversity, equity, inclusion, and accessibility (DEIA) indicators from collected demographic data to identify characteristics associated with success for space and Earth science careers and research health and performance. NASA should also use the DEIA data to examine potential weaknesses in the processes and culture

Data Availability: NSPIRES Data

Findings:

- The demographic survey NSPIRES offers to responders is limited.
- NASA is potentially missing a large number of proposers/investigators in basing its diversity information on data contained within the NSPIRES system since only investigators responding to original NASA solicitations for research proposals enter data into the NSPIRES database.

Recommendation

- NASA's Science Mission Directorate (SMD) should **collect relevant culture and demographic data to obtain a comprehensive understanding of the longitudinal health and vitality** of the relevant space and Earth science communities. This effort should include demographic **aspects beyond race and gender**. NASA SMD should **work with social scientists** to develop a plan to capture and examine these data regularly while minimizing the potential for survey fatigue.

Data Availability: Engaging Experts

Finding:

- There are opportunities to improve existing processes used by SMD to better identify and diversify its institutional pool by engaging social scientists and similar experts in process development, strategic planning and tracking, cross-correlation of data from multiple sources, and encouraging scholarly use of some of the data.

Recommendation:

- NASA's Science Mission Directorate should **consult with external science and technology organizations to examine possible paths to acquire more complete information**. In particular, the National Center on Science and Engineering Statistics at the National Science Foundation (NSF) would be a resource, given its experience in gathering information about science and engineering awardees. Moreover, NSF has a vested interest in the adequacy of the data, for NSF partners with NASA in supporting some of the Decadal surveys. A **standardized data collection instrument** would allow data to be shared more easily across disciplines.

Data Availability: Alternative Parameters

Recommendation:

- NASA's Science Mission Directorate (SMD) should collect relevant culture and demographic data to obtain a comprehensive understanding of the longitudinal health and vitality of the relevant space and Earth science communities. This effort should include **demographic aspects beyond race and gender**. SMD should **work with social scientists to develop a plan to capture and examine these data** regularly while minimizing the potential for survey fatigue.

Finding:

- Data on employee-centric work environments can be important for retention and growth of STEM communities.

Recommendation:

- NASA's Science Mission Directorate (SMD) should define SMD's space and Earth science research community to **include not only the principal scientists, but also the network of professionals and skilled workers who enable the research, advocates who have public interest in the SMD mission, and potential members such as disciplinary aligned students and researchers who could submit proposals**. SMD's goal should be to understand a broader membership in its community to ensure its overall health and vitality. **Sampling of these populations should be considered in development of survey strategies.**

Data Availability: Addressing Limitations

Recommendation:

- NASA's Science Mission Directorate, should collaborate on multiple fronts:
- SMD should **collaborate with the Space Technology Mission Directorate, Office of the Chief Scientist, Office of STEM Engagement (OSTEM), the Office of Chief Human Capital Management, and Office of Diversity, Equity, and Opportunity (ODEO)** should work together to expand the questions on the Office of the Chief Scientist demographic survey and seek approval from the Office of Management and Budget for employment of their resultant proposed survey.
- NASA's Science Mission Directorate should **work with the Office of Management and Budget, Office of Science and Technology Policy, Office of Personnel Management, NASA Office of Diversity and Equal Opportunity, the NASA Office of Diversity and Inclusion, NASA Office of General Counsel,** and other relevant government organizations, to identify and eliminate barriers to the collection of more relevant data.

Promising Practices

Recommendation:

- NASA's Science Mission Directorate should develop a Mentor-Protégé Program for Minority Serving Institutions, including Historically Black Colleges and Universities, Hispanic Serving Institutions, Tribal Colleges and Universities, Asian American and Pacific Islander Serving Institutions, Alaska Native and Native Hawaiian Institutions, Native American Serving Non-Tribal Institutions, Predominantly Black Institutions, etc., to help them train and develop principal investigators and researchers.
- In addition, NASA's Science Mission Directorate should continue to work closely with outside professional societies, e.g., American Physical Society (APS), American Astronomical Society (AAS), American Geophysical Union (AGU), etc., in development and expansion of mentoring programs. This will enable NASA to collect data and engage in longitudinal tracking of its research communities.

Community Standards of Conduct

Finding:

- NASA is compliant with federal guidance on developing and publishing policies defining standards of conduct. The complexities of enforcement to ensure improved and appropriate behaviors by members of the space, Earth, biological and physical scientists in interactions with each other were effectively addressed in recommendations for NASA for the astrophysics and astronomy community by the Astro2020 Decadal survey and should be considered for application across SMD. Continued assessment of this subject by subsequent state of the profession panels in each discipline area will evolve final recommendations for SMD overall.

Table 6.1: Key Metrics and Indicators

Key Characteristic	Key Metrics and Indicators Within NASA	Key Metrics and Indicators Beyond NASA
Clarity of science for efficient research and public support	<ul style="list-style-type: none"> Participate in outreach programs to inform stakeholders Monitor fiscal dashboard 	<ul style="list-style-type: none"> Ensure diverse panels for decadal Examine consensus, or lack thereof, in decadal
A Representative Workforce	<ul style="list-style-type: none"> Compare demographics of SMD workforce with that of the US population Consider many facets of an individual Examine the data with guidance from social scientists 	<ul style="list-style-type: none"> Compare demographics of people submitting proposals with that of the US population Compile main list of members of the community beyond NASA to collect demographic information for comparison Consider many facets of an individual Examine the data with guidance from social scientists
Outreach, Acceptance, and Development	<ul style="list-style-type: none"> Implement the Science Workforce Plan Examine results from culture surveys (perhaps the Federal Employee Viewpoint Survey) to identify weaknesses Prepare and assess professional development plans Examine access to opportunities and resources across the SMD Compile data from outreach programs 	<ul style="list-style-type: none"> Outreach to historically under-served communities Develop Bridge programs and assess success Work with professional societies to reach people from minoritized groups
Establishing Supportive Funding	<ul style="list-style-type: none"> Ensure internal review panels are diverse, including all facets of an individual Use doubly anonymous review panels within NASA Develop fiscal dashboard 	<ul style="list-style-type: none"> Use doubly anonymous review panels Work with academic institutions to leverage funds with institutional match
Resilience to emerging challenges	<ul style="list-style-type: none"> Use results from culture data to ensure all voices are heard Examine decision-making points and participants for inclusion Examine meeting agendas to ensure all voices are heard Ensure equal access to opportunities and resources Make regular use of the Delphi technique to envision future issues and solutions Encourage virtual peer review panels 	<ul style="list-style-type: none"> Examine demographics of teams on external proposals to ensure that all voices are included Work with professional societies to examine the culture at meetings and workshops Work with institutions to examine the culture
Community standards of conduct	<ul style="list-style-type: none"> Examine code of conduct within NASA to ensure clarity in reporting and consequences Use results from culture survey to examine consonance with code of conduct Examine methods of verifying data 	<ul style="list-style-type: none"> Require institutions supported by NASA funds to endorse a common code of conduct that has a clear reporting structure and consequences Work with professional societies to develop community standards of conduct for meetings and workshops