HEC Needs Assessment – DRD 2g

APAC Task Order 49

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NASA's High End-Computing (HEC) Program – Overview

For several decades, high-end computing has played an important role in supporting NASA's missions, with high-profile contributions including:

- Preparing the Space Shuttle for Return to Flight;
- Designing and improving aerospace vehicles;
- Simulating and analyzing massive Earth systems data to understand potential near- and long-term changes; and
- Developing astrophysical calculations to explore the history and future of our universe.

Today, NASA's High-End Computing (HEC) Program maintains a comprehensive set of resources and services for the agency's four Mission Directorates, the NASA Engineering and Safety Center, external collaborators, and the nation. By closely partnering with each Mission Directorate, the HEC Program addresses their specific resource requirements and user needs. Mission support includes ensuring reliable remote access for a user community spread broadly across NASA centers and partner organizations nationwide.

The HEC Program combines high-end computing facilities and services currently located within the NASA Advanced Supercomputing (NAS) Facility at Ames Research Center and the NASA Center for Climate Simulation (NCCS) at Goddard Space Flight Center. NAS serves the broad spectrum of NASA customers, while NCCS primarily focuses on NASA's Earth science community. Together, these facilities provide more than 130,000 processors and greater than 1.5 quadrillion (thousand trillion) floating point-operations per second (petaflops) peak of computing power to the NASA user community. The HEC Program manages these investments by providing high-level oversight and guidance.

The NAS and NCCS facilities have a long history of providing users with advanced computational technologies, mass storage solutions, network solutions, and other cutting-edge tools and technologies for solving today's most complicated and rigorous science and engineering problems. Ames has been a leader in computational fluid dynamics and thermal protection systems, and Goddard has been a leader in climate and weather modeling research. NASA is dedicated to continuing this tradition of scientific and technical excellence with the broader HEC Program.

HEC Program – Objectives and Organization

NASA's challenging mission to explore space, to design aerospace transportation systems, and to understand the universe and the Earth within it requires the Agency to innovatively apply and extend the most advanced capabilities, technologies, and knowledge. High-end computing is one such powerful leading-edge tool.

Specifically, the mission of NASA's High-End Computing (HEC) Program is to:

Plan and provision high-end computing systems and services to support NASA's mission needs. Operate and manage these HEC resources for the benefit of agency users, customers, and stakeholders.

The HEC Program's mission is guided by its vision that:

NASA's HEC resources are relied on as an essential and pervasive partner by the breadth of agency science, engineering, and technology activities, enabling rapid advances in insight and dramatically enhancing mission achievements.

In addition to this strategic mission and vision, NASA's HEC Program is guided by four overarching goals:

- Provide effective production of HEC resources and services to enable pervasive, timely, and significant mission impacts;
- Infuse HEC into NASA's scientific and engineering communities;
- Assure preparedness to meet NASA's future modeling, simulation, and analysis needs; and
- Ensure that NASA HEC resources and activities are well-managed and wisely used.

The High-End Computing (HEC) Program is managed by the Science Mission Directorate (SMD) with review by the Agency's Strategic Capabilities Assets Program (SCAP), the NASA Chief Information Officer and SMD. HEC is funded by two SMD line items. One line item, the High End Computing Capability (HECC) Project, receives its requirements from all Mission Directorates and serves as an Agency-wide resource. The second, NASA Center for Climate Simulation (NCCS) is funded as an Earth Science Division Project and supports the modeling and analysis of climate and weather-related models and data. The program uses an integrated management approach for its two projects—the HECC Project operated by the NASA Advanced Supercomputing (NAS) Facility at Ames Research Center and the NASA Center for Climate Simulation (NCCS) Project operated by the Computational and Information Sciences and Technology Office (CISTO) at Goddard Space Flight Center.

- The NAS facility at Ames Research Center was established in the 1980s by Congress with a charter to provide high-end computing capabilities for performing numerical simulations of proposed commercial and military aircraft designs. Since then, NAS has continually adapted to meet NASA's changing needs, including the installation and expansion of Pleiades, a world-class supercomputer now capable of more than 1,240 teraflops of peak performance. With Pleiades, the HEC Program has enhanced performance and better facilitated groundbreaking science and engineering in support of all four NASA mission directorates. NAS' integrated resource and service offerings include high-speed networks, archival storage systems, system performance and application optimization, 24x7 user services operations, data analysis, and scientific visualization. In parallel with supercomputer growth, NAS continually develops advanced visualization techniques. NAS has deployed a cutting-edge visualization system, hyperwall-2, which is connected directly to supercomputers, allowing scientists to run more sophisticated concurrent visualizations.

- The NASA Center for Climate Simulation (NCCS) at Goddard Space Flight Center offers an integrated set of supercomputing, visualization, and data interaction technologies to enhance agency capabilities in weather and climate prediction. It serves hundreds of users at Goddard, other NASA centers, laboratories, and universities across the U.S. The NCCS centerpiece is the Discover supercomputer, which links thousands of Intel Xeon processors to perform trillions of operations per second. Discover-hosted simulations span time scales from days (weather prediction) to seasons and years (short-term climate prediction) to decades and centuries (climate change projection). NCCS supports users with a massive data archive, a new data management system, expanded data analysis and visualization capabilities featuring a 17- by 6-foot multi-screen visualization wall, and services for distributing simulation data to users and the broader climate research community.

Users at all the corresponding NASA Centers migrate several petabytes of data to the HEC facilities each year. Together these facilities provide more than 200,000 processors and greater than 2.5 quadrillion (thousand trillion) floating point-operations per second (petaflops) peak of computing power to the NASA user community in the beginning of FY 2014.

HEC Needs Assessment – Background and Approach

The HEC Program Executive and the Board of Advisors for NASA's HEC Program initiated this periodic needs assessment review in June, 2013. The assessment is built on documented contact with the user community and key HEC stakeholders. Its outcome(s) will be used to support the Program and Project Management materials as well as to recommend input to the requirements for future capabilities under the HEC Program. This final assessment report consists of a synthesis of data collected through the user survey and stakeholder interviews. This assessment also describes how HEC users are leveraging supercomputing to meet Agency needs, enhancing the capabilities of the community, and advancing the larger scientific body of knowledge on Earth and our solar system. The assessment process focused on how HEC capabilities support Agency and mission directorate objectives and provided insight into to the specific capacity or purely technical requirements to be met by the HEC sites.

For assessment purposes, the HEC Customer Survey was deployed from July 24th – August 14th, 2013 (please note: the survey tool and data collection remains open through August 28th and the complete raw data will be made available to NASA). During those 22 days, the HEC user community (Users, Principal Investigators, and Program Executives) completed 136 surveys and provided input on HEC usage patterns, current needs, and anticipated future use of NASA HEC systems.

The HEC Customer Survey questions were iteratively developed, reviewed, refined, and validated by a HEC Needs Assessment Steering Group, nominated by the mission directorates, over a period of weeks and were based on a series of questions submitted via a preliminary deliverable earlier in the task order. The members of the Steering Group included Nateri K. Madavan (ARMD), Jerry C. Yan (HEOMD, and Tsengdar Lee (SMD).

The HEC Customer Survey examined and included:

- The demographics (roles, mission directorates, etc.) of the HEC Users
- A review of the current usage patterns and future needs of survey respondents
- Open-ended questions to capture extended and qualitative customer feedback on HEC performance and improvement opportunities

The HEC Survey tool was developed and deployed through the commercial-off-the-shelf (COTS) Key Survey platform (www.keysurvey.com) and was made accessible to NASA's HEC user community online through a dedicated link. Booz Allen captured project level data through the use of group identifier (GID) codes, but allowed survey respondents to maintain personal anonymity. Summary results from this survey will be presented in the following section of the Needs Assessment.

The HEC stakeholder interviews were conducted from July 30th – August 21st, 2013. Booz Allen conducted 33 individual interviews with 9 Users, 16 Principal Investigators, and 8 Program Executives affiliated with NASA's Science, Human Exploration & Operations, and Aeronautics Mission Directorates.

The HEC Steering Group nominated and solicited interviewee candidates from its mission directorate liaisons and Booz Allen scheduled and completed interviews in a rolling wave as contacts were identified. The interviews were completed in parallel with the open period of the HEC customer survey. Booz Allen provided background on the HEC Needs Assessment to all interviewees and described the interview approach to be followed. Participants were assured of their anonymity and that the findings would be presented as a blended composite for the final HEC Needs Assessment report. This interview approach and the principal questions for each interviewee were based off the structured HEC Interview Guide submitted to NASA on June 20th, 2013.

While individual interview experiences varied on the margins, all interviews were based on a series of core questions supplemented with follow-up examinations for clarification or amplification. Each interview spanned ~30-45 minutes and 12-15 questions. Those questions asked of interviewees included:

- How would you characterize your use of NASA HEC systems? What do you use the systems for, what kinds of simulations or experiments do you run?
- How does your use of NASA's HEC systems benefit your project or program?
- How does your use of NASA's HEC systems benefit the Agency or advance its broader missions?
- In your opinion or experience, what are the best things about using NASA's HEC systems? What works well?
- In your opinion or experience, what are the worst things about using NASA's HEC systems? What does not work well?
- What have you learned from your experience with the NASA HEC Program or HEC systems? Are there tips of tricks you would like to share?
- If scientists at other federal agencies were interested knowing more about or using NASA HEC systems, what lessons would you share?
- How do you anticipate your use of, or need of, NASA HEC systems changing in the next year? 3 years? 5 years?
- Tell us about your experiences using NASA HEC systems (e.g. Which ones? For what purposes? How often you use them? Etc.)

- Tell us about your current HEC needs from a capability or a performance standpoint (e.g. storage, computing, visualization, bandwidth, data retrieval, etc.?)
- Do you have additional HEC needs that might merit increased investment by NASA? If so, what are they?
- Tell us about how you decided to use NASA HEC resources? Which ones? For which programs/ projects? What drove that decision?
- What kind of improvements (if any) would you like to see to the NASA HEC systems? If you had a magic wand, what would you change or improve?
- What impact would these [respondents' recommendations] improvements have on your program/project? What impact would they have on NASA's broader missions?
- What question should I have asked you that I did not?

At the conclusion of each interview, Booz Allen requested the opportunity to follow-up with each respondent should clarification be necessary or requested by NASA.

Summary of Needs Assessment Findings

Though the HEC Customer Survey yielded results from more than ~130 members of the NASA HEC community, many of the same themes and HEC needs that emerged from the survey were echoed in the findings from the stakeholder interviews.

In terms of demographics, both the survey and the interviews asked participants to select their primary functional role as it related their HEC use. Across the survey there was nearly a 50/50 representational split between HEC Users (51%) and Principal Investigators (49%) with no surveys completed by Program Executives. However, of the stakeholder interviews, Program Executives were much better represented with 24% of total participants, behind 48% Principal Investigators, and 27% HEC Users. Both the survey and interviews asked the HEC community about their project or program's affiliation with the Agency's mission directorates and from the survey 70% were affiliated with SMD, 20% with ARMD, 7% with HEOMD, and 3% with NESC. The MD affiliation from the interviewees was slightly more balanced with SMD accounting for 58%, 15% from ARMD, and 27% from HEOMD. No interviewees were primarily affiliated with NESC. The HEC Customer Survey also asked each respondent to identify the NASA Strategic Priority most closely affiliated with their projects' efforts. Unsurprising given the MD affiliations of the respondents, 69% of survey respondents selected Strategic Goal #2 (*Expand scientific understanding of the Earth and the universe in which we live*), and an additional 20% selected Strategic Goal #4 (Advance aeronautics research for societal benefit).[1]

Both the HEC Customer Survey and the Stakeholder Interviews asked respondents to characterize their use of the HEC Systems. A vast majority of interviewees and survey respondents (85%) indicated they were using the HEC systems to run large scale simulations rather than analytic data processing (7%). Similarly, and in a roughly 3:2 margin in both the surveys and interviews,

[1] A complete listing of NASA Strategic Priorities and their associated sub-objectives can be found at http://www.nasa.gov/pdf/516579main_NASA2011StrategicPlan.pdf

respondents indicated that they primarily used Pleiades over Discover as their primary HEC system (please note that more detailed responses are provided in the Appendix).

Strongly related to the characterization of their usage of the HEC systems, almost all respondents noted the criticality of those HEC systems and capabilities to their project or program work. A full 80% of survey respondents noted that they use HEC systems or capabilities on a daily or weekly basis – a sentiment and frequency supported by the stakeholder interviews as well. Perhaps just as revealing, 93% of survey respondents indicated that "Without HEC capabilities they could not complete their project work." This sentiment was echoed unanimously by the HEC community that participated in the stakeholder interviews. However, exactly how NASA HEC systems supported users' research or the advancement of Agency missions differed widely. The sample presented below highlights how some respondents across NASA's MD communities leverage NASA HEC systems in support of Agency objectives:

- **SMD:**
  - *Space weather physics and phenomena*: HEC is used to understand physical processes in plasma and allows for modeling realistic mass ratios. HEC's stability allows for long run times (120+hours at ~5000 cores) that would be impossible to do using regional clusters
  - *Evolution of Earth's polar ice sheets*: Uses HEC to examine long transient runs (5 days; 1000 cores) and conduct large scale Monte Carlo type simulations which allow for the projection of polarization over the next 20 years
  - *Atmospheric impact studies*: HEC is used to develop diagnostics and has supported published studies made possible via large open data sets on the use of air space – ultimately benefitting operational weather forecasts around the world
  - *Understanding the interface between the Sun's photosphere and corona*: HEC is used to support NASA's Interface Region Imaging Spectrograph (IRIS) satellite and mission. Specifically HEC is used interpret and model the complex processes and enormous contrasts of density, temperature and magnetic field within the Sun's interface region
  - *Planet modeling and perturbed physics*: These efforts make use of both new and legacy codes dating back 30+ years and even using HEC systems, these projects typically take up to 2 years to complete and involve hundreds of simulations with variations to parameters and driving functions to assess dependencies and attributions in the model and to compare the findings to observations in the real world.
  - *Space weather predictions and solar storms:* Considering the expense involved in observational space research, HEC is used as a high-ROI tool for running data integrity analyses and simulations in support of NASA missions
  - *Earth science modeling and weather forecasting:* HEC is used to enhance satellite capabilities and to refine forecasting methods (weather, climate) while also supporting operational field campaigns
  - *Analyses of exo-planets*: Uses HEC systems to simulate collision data and planet formation to help understand the origin of the Earth
  - *Supporting the Kepler mission and its pipeline framework extensions*: HEC is used in support of the Kepler Science Operations Center (SOC) which responsible for several aspects of the Kepler Mission, including managing targets, generating on-board data compression tables, monitoring photometer health and status, processing the science data, and exporting the pipeline products to the mission archive.

  - *GEO-5 Assessment*: NASA contributes to the Global Environmental Outlook (GEO) assessment administered under the United Nations Environmental Programme and NASA's HEC systems are used to provide an analysis of the state, trends and outlook of the global environment.
  - *Global climate analyses*: HEC is used to support the Global Precipitation Measurement (GPM) and Tropical Rainfall Measuring Mission (TRMM) – which provide the next-generation observations of rain and snow worldwide every three hours. The mission data advances understanding of the water and energy cycles and extends the use of precipitation data to directly benefit society.
  - *Ocean sea ice and carbon data simulation*: HEC is used to run numerical models on ocean currents and carbon chemistry compositions.
- **HEOMD**
  - *TFD Solutions:* HEC is used in the Agency's Technology Flight Demonstrations (TFD) where demanding level physics code is used for this analysis. HEC supports large datasets necessary for the evaluation of the aerodynamics and aero-heating of the Multi-purpose Crew Vehicle (MPCV) capsules.
  - *Launch pad and mobile launcher:* HEC is used as a relatively low-cost risk management tool to simulate the interfaces between the launch pad and the mobile launcher and to model the most effective placement of ground support vehicles.
  - *Computational Fluid Dynamics (CFD):* HEC is used to provide computational resources to assist in studies of fluid dynamics, aerodynamics and aerothermodynamics. Much of the work involves interactive computer graphics and includes CAD model generation, CFD grid generation, and flowfield visualization. HEC is configured to provide a parallel-computing environment for large scale simulations. These include Direct Simulation Monte Carlo analyses of low density flows as well as traditional CFD computations.
  - *International Space Station (ISS):* HEC supports to the ISS through simulations on attitude controls and case assessment. HEC allows these tests to be conducted quickly – elevating ISS safety
- **ARMD**
  - *Finite Element Analyses*: HEC is used in assessing structural and material composite capabilities by finding approximate solutions to boundary value problems and uses variational methods to minimize error functions and produce a stable solution. This analysis supports NASA vehicle safety and the Agency's vehicle health management initiative.
  - *Aerodynamic modeling:* HEC is used for code development in aerodynamic modeling and large numbers of exploratory tests and simulations which support a wide array of ARMD-affiliated projects.
  - *Roto-craft tool improvement:* HEC is used to develop physics-based tools in support of NASA's Fundamental Aeronautics (FA) program which addresses national challenges in air transportation by enabling advanced performance and environmental air vehicle technologies.

Additionally, the HEC Customer Survey asked a series of Likert-style questions about users' experiences with NASA's HEC systems and asked them to agree or disagree with statements regarding HEC capabilities. Granular responses are included in Table A-19 of the Appendix, but aggregated responses are provided below:

HEC Capabilities Questions	Agree	Disagree	N/A
Overall, HEC resources are adequate to support my project needs.	87%	11%	1%
The current disk storage space is adequate for project needs.	81%	16%	2%
Bandwidth from the HEC to my work location is adequate to support data transfer for my projects.	88%	9%	3%
Without HEC capabilities, I could not complete my project work.	93%	5%	1%
Without HEC capabilities, I could complete my work but with significant delay.	39%	56%	5%
HEC queue delays do not significantly delay my project nor impact my work efficiency.	44%	53%	2%
The HEC system processes my jobs with adequate turnaround time.	69%	27%	3%
The HEC system I use most provides post execution visualization/analysis sufficient to meet my needs.	63%	13%	23%
The HEC system I use most provides persistent disk capacity sufficient to meet my needs.	87%	12%	2%
The HEC system I use most enables my mission objectives by supporting transfer, when necessary, of my output to a location where I can post-process or visualize it.	83%	6%	11%

The HEC Customer Survey also asked a number of broader open-ended questions – many of which were also included in a similar form in the stakeholder interviews. For example, on both the survey and during the interviews, respondents were asked to anticipate the use of, or need of, HEC systems over the next year, 3 years, and 5 years. Another common question examined how the HEC systems could be improved? Another asked for more detail about the respondents' individual project(s).

While it is difficult to make generalizations across dozens of individual responses from a diverse user community with conflicting and, at times, competing HEC needs, a number of overarching themes can be distilled from the qualitative survey responses and from the interview findings. Booz Allen has organized these themes according to NASA HEC Strengths, Challenges, and Opportunities.

HEC **Strengths** that have emerged in a review of the survey and interview findings include:

- PIs and Users are typically able to scale their research and simulations to available HEC capabilities and performance levels – though almost all requested greater performance capability
- Broad consensus that NASA HEC resources are vital for conducting Agency and program work
- PMs indicate strong alignment between program efforts and broader Agency missions – both operationally and in fundamental research thrusts
- System availability and computing power is ideally suited for small to medium-sized runs

- Users and PIs appreciate the flexibility of using multiple NASA HEC Systems and tailor their choice of system to meet their project needs (e.g. Pleiades vs. Discover)
- Users and PIs also appreciate the ability to use the development queue – though there is a belief that the development queue may also be used for small runs and this abuse of function may need to be watched going forward
- Support from NASA HEC Program staff is widely leveraged and valued
- NASA HEC Program visualization services were cited as strong, if underutilized
- NASA HEC systems considered more desirable overall than those at other federal agencies – mostly for stability, reliability, and for small to medium-sized jobs
- Allocation processes seem clear to users and much improved in the last few years
- The systems seem to be upgraded frequently
- Users typically expressed broad satisfaction with levels of support to execute NASA field campaigns which included special queues, prioritization, and script support

HEC **Challenges** that have emerged as themes include:

- Many NASA-affiliated collaborators are foreign nationals – a subgroup of users with difficulty accessing Agency systems
- Queue times (especially for Pleiades) are cited as a consistent concern
- Users reported instability with the Pleiades system when core usage is elevated
- The Lustre system has been repeatedly identified as problematic and confusing
- Of common HEC capability characteristics – online disk storage has emerged as the most the pressing need and concern of users; also widely cited for increased investment were data transfer speeds and number of available cores
- Some users complained that the abundance of small jobs on the HEC systems crowd-out or delay the running of larger experiments or simulations
- Security protocols and password requirements were cited as burdensome
- Though not referenced as commonly as queue waits, I/O bandwidth is a major concern across the HEC user community
- Users noted an acute and persistent shortage of IDL licenses – though many also noted that this shortage has recently improved
- Users reported that when systems are down – for upgrading or for repairs – their projects and research were often impossible to continue
- Multiple users suggested that code is not being written as efficiently as possible which conflicts with HEC systems and extends the overall process when de-bugging is needed

However, a number of HEC **Opportunities** have also emerged as themes and these include:

- Respondents indicated that their future use of HEC resources was largely dependent on their specific project lifecycle, but the desire for stronger capabilities across the board (e.g. cores, visualization, bandwidth, disk storage, etc.) was clear
- Users were able to clearly articulate scientific and Agency benefits from increased HEC capabilities – e.g. realer-time operational support, more accurate and specific fluid dynamics modeling, increased understanding of perturbed physics, increased safety, cost savings, etc.

- Some users requested a more clear and transparent process for job and queue prioritization; specifically users requested documented decision-criteria or the development of a score-based allocation model
- Coding expertise and troubleshooting among HEC support personnel was a fairly common request from PIs
- Some users felt that the HEC Program could be more proactive in communicating upgrades and downtimes to HEC users
- Some users found that moving smaller jobs from Pleiades to Discover was a good way to lower queue times – suggested this may be a way to "tier" efforts
- There may be as much opportunity to improve on the software side (i.e. through coding efficiency and training) as there is in augmenting hardware capabilities
- Some users suggested that the HEC Program should consider developing a Knowledge Management System that could serve a repository of organizational/Agency information on past HEC use, ongoing and historical projects, codes used, experiments run, and papers published, etc.
- Users expressed satisfaction with the recent presentations and webcasts offered by the HEC Program and requested an introductory series on heterogeneous computing may be useful

Next Steps

Over the next week, Booz Allen will present these findings to the HEC Steering Group and will solicit feedback for incorporation. Particular attention will be paid to how the findings can be used to inform the future development of HEC Program Initiation Documentation and a re-justification of the HEC Program budget allocation.

APPENDICES

The tables presented here represent the compiled HEC Customer Survey results for the 136 respondents completing the survey by August 14, 2013. Please note that Booz Allen will provide the entire survey dataset to NASA upon conclusion of the task order period of performance.

Similarly, complete interview notes will be provided to NASA upon conclusion of the stakeholder interviews.

Table A-1

What percentage of your HEC use supports the following Mission Directorates (total must equal 100%)?	SMD	HEOMD	ARMD	NESC
	71%	**7%**	**20%**	**3%**
Statistics based on 133 respondents; 3 skipped.				

Table A-2

What program or project do you primarily support through your HEC use?

Responses:

1 **Aeroelastic Prediction Workshop**
2 **Aeronautical Sciences**
3 **Aeronautics Science: combustion project**
4 **Aerosol GOCART model**
5 **Aerosol-cloud interactions: How 3D science can help to correctly interpret satellite data**
6 **Aerospace Science, RCA**
7 **AIST**
8 **All ... Nastran computation work support NASA missions though all phases of development.**
9 **Carbon cycle science Applied Sciences Program AIST ACCESS MEASURES LCLUC**
10 **Carbon Cycle Science, Upper Atmosphere Research, ASCENDS**
11 **Carbon Cycling in the North Atlantic**
12 **CFD code development that supports a broad range of projects across the Agency**
13 **Climate Impact of Improved Ice-Sheet Ice-Shelf Ocean Atmosphere Interactions**
14 **Climate Modeling**
15 **Cryogenic Propellant Storage and Transfer Project**
16 **Development of GISS Model-E**

What program or project do you primarily support through your HEC use?	
17	DISCOVER-AQ
18	Earth Sciences (ACMAP) Planetary Sciences (Mars EDL)
19	Earth Sciences, Hurricane and Severe Storm Sentinel (HS3) project.
20	Environmentally Responsible Aviation and Fixed Wing projects
21	ERA
22	ERA, Supersonic/High Speed
23	ESOT AIST
24	Estimating the Circulation and Climate of the Ocean (ECCO)
25	FA
26	Formation of Planets and Debris Disks
27	Fundamental Aero/Rotary Wing
28	Fundamental Aeronautics Program, Fixed Wing Project
29	Fundamental Aeronautics Program. Nearly all of this usage currently corresponds to Aeronautical Sciences Project.
30	Funded NASA MFRP and OPR projects.
31	FW
32	FW, RW
33	GCE (GPM), NU-WRF (MAP)
34	GEOS-5
35	GEOS5-CCM (chemistry climate model)
36	GEOSCCM
37	GEOSCCM
38	GISS Model-E Analysis
39	GMAO - Systems and Data Synthesis
40	GMAO data assimilation system
41	GMAO GEOS5
42	Goddard Chemistry-Climate Modeling Project
43	GRAIL
44	Heliophysics Guest Investigators
45	Heliophysics Supporting Research
46	HIAD and Orion
47	High Speed
48	High Speed
49	High Speed Launch Vehicle Design and Analysis
50	High Speed Project under Fundamental Aeronautics Program at NASA Langley
51	High Speed, Fixed Wing
52	HIRAD
53	Human Research (HRP)
54	Hurricane and Severe Storm Sentinel
55	Hydrological Sciences Lab, Goddard, Code 617
56	Hypersonics Project (formally a part of the FAP program, but now a stand-alone project)
57	I mainly work on the GEOS-5 GCM.
58	I perform numerical simulations in support of a heliophysics SR&T grant and Hinode/XRT science.

What program or project do you primarily support through your HEC use?	
59	**I primarily support the Landsat program (and LDCM) but also support Earth Science in general.**
60	**I support HIAD, InSight, Trim Tabs, and SRP. HIAD, Trim Tabs, and SRP are all out of STMD's Game Changing Office. InSight is out of SMD (2016 Mars lander mission).**
61	**ICESAT 2**
62	**International Space Station**
63	**LCLUC, Application Sciences, Terrestrial Hydrology**
64	**Living With a Star Targeted Research and Technology Program**
65	**Lunar Reconnaissance Orbiter, MESSENGER**
66	**Magnetospheric Multiscale (MMS)**
67	**MAP**
68	**MAP**
69	**MAP (other GIDs support NEWS, Applied Sciences, AIST)**
70	**MAP, OBB**
71	**MAP, PMM, AIST**
72	**MFRP**
73	**MHD Simulations of Variability of Magnetized Stars**
74	**MMS**
75	**Modeling exoplanetary systems: dynamics of debris disks**
76	**Modeling gravitational wave sources**
77	**Modeling of Planetary Atmospheres**
78	**Modeling, Analysis, and Prediction program (MAP) Atmospheric Composition Modeling and Analysis Program (ACMAP)**
79	**My NASA grant supported projects**
80	**NASA**
81	**NASA Ames Mars GCM Group (Code SST at NASA Ames)**
82	**NASA Center for Climate Simulation (NCCS) Project**
83	**NASA Energy and Water Cycle Study (NEWS)**
84	**NASA GEOS-5 atmospheric general circulation model**
85	**NASA Hurricane Research Science Program**
86	**NASA MAP & CloudSat/Calipso**
87	**NASA Outer Planet Research Program/NASA Origins of Solar Systems**
88	**NASA Physical Oceanography**
89	**NASA Radiation Sciences**
90	**NASA research grant entitled "Atomistic Simulations for Inhomogeneous Modeling of Giant Planet Interiors"**
91	**NASA ROSES 08 GULF**
92	**NASA ROSES-2012, project titled "Error Covariance Diagnosis and Forecast Impact Estimation in NASA GEOS DAS"**
93	**NASA/MSFC Short-term Prediction Research and Transition**
94	**NCA**
95	**NNX12AB34G**
96	**NSTRF research project on resource allocation ("SCAF")**
97	**Numerical simulations of convection to study planetary interiors**

What program or project do you primarily support through your HEC use?	
98	**NU-WRF**
99	**NU-WRF and LIS**
100	**NXX09AV41AS03**
101	**Observational Cosmology (Code 600)**
102	**OCO-2**
103	**Orion**
104	**Outer Planets Research and Planetary Atmospheres**
105	**PATM "DDSCAT of Crystalline Silicates within Aggregate Grains"**
106	**planetary geology and geophysics**
107	**Rotary Wing**
108	**RW and FW**
109	**s0863**
110	**SAS project: OMPS/LP Simulation and EDR codes testing, evaluation and validation;**
111	**Science of Terra Aqua. In particular, to enhance our understanding of tropical cyclones, tropical weather and generally extreme precipitation events through a better use of AIRS-derived products within an operational global data assimilation and forecast system, the NASA GEOS-5.**
112	**SDO, Kepler missions**
113	**SFW/ERA aero-acoustics ERA/Active Flow Control**
114	**SFW/SUP**
115	**SHP and OPR**
116	**Simulations of the formation and growth of supermassive black holes in galaxies**
117	**SLS**
118	**SLS Buffet Interface Loads modeling.**
119	**SLS, FAP, NESC**
120	**SMD**
121	**Soil moisture and snow observation remote sensing calibration and validation.**
122	**Solar Dynamics Observatory**
123	**Solar Dynamics Observatory**
124	**Solar Magneto-Convection**
125	**Space Geodesy Project**
126	**SR&T**
127	**Subsonic Fixed Wing**
128	**supporting supersonic boundary layer transition program on F-15B aircraft**
129	**Terrestrial Ecology Program**
130	**The Global Modeling and Assimilation Office core efforts, contributing to NASA's Modeling Analysis and Prediction program**
131	**UAVSAR**
132	**VSST ARMD Seedling**

List is based on 132 respondents; 4 skipped.

Table A-3

What is the GID code for your HEC project?

GID Code	Program or Project Name
1036	Simulations of the formation and growth of supermassive black holes in galaxies
1253	SLS, FAP, NESC
20609	GEOS-5
21350	Aerospace Science, RCA
26161	Solar Magneto-Convection
26183	Living With a Star Targeted Research and Technology Program
26209	Estimating the Circulation and Climate of the Ocean (ECCO)
27122	Orion
41007/ s1007	Carbon cycle science Applied Sciences Program AIST ACCESS MEASURES LCLUC
41007/ s1007	LCLUC, Application Sciences, Terrestrial Hydrology
41007/ s1007	NXX09AV41AS03
41043	GEOS5-CCM (chemistry climate model)
41136	Soil moisture and snow observation remote sensing calibration and validation.
4721	NASA MAP & CloudSat/Calipso
801	Rotary Wing
A0823	Hypersonics Project (formally a part of the FAP program, but now a stand-alone project)
a0962 and a1035	SFW/ERA aero-acoustics ERA/Active Flow Control
a1004	High Speed Launch Vehicle Design and Analysis
A1036	FW, RW
a1203	FA
a1205, a0962	Environmentally Responsible Aviation and Fixed Wing projects
a1231	Fundamental Aeronautics Program, Fixed Wing Project
a1231	SFW/SUP
a1315	High Speed, Fixed Wing
a1327, a1330	Fundamental Aeronautics Program. Nearly all of this usage currently corresponds to Aeronautical Sciences Project.
a1331	Aeronautical Sciences
a1338	Aeronautics Science: combustion project
a1345, a1384	ERA, Supersonic/High Speed
a1362	CFD code development that supports a broad range of projects across the

	Agency
a1362	High Speed
a1365	High Speed Project under Fundamental Aeronautics Program at NASA Langley
a1367	supporting supersonic boundary layer transition program on F-15B aircraft
a1368,a1379	VSST ARMD Seedling
a1374	I support HIAD, InSight, Trim Tabs, and SRP. HIAD, Trim Tabs, and SRP are all out of STMD's Game Changing Office. InSight is out of SMD (2016 Mars lander mission).
a1374, e0721	HIAD and Orion
a1384	ERA
c1253	SLS Buffet Interface Loads modeling.
d1183	MAP
e0848	Human Research (HRP)
e1122	Cryogenic Propellant Storage and Transfer Project
e1215	NSTRF research project on resource allocation ("SCAF")
f0801	International Space Station
f1150	Aeroelastic Prediction Workshop
g0609; g0620; g2613; g26141; s0818; s0911	The Global Modeling and Assimilation Office core efforts, contributing to NASA's Modeling Analysis and Prediction program
g0620	GMAO - Systems and Data Synthesis
g24168	Fundamental Aero/Rotary Wing
g26102	FW
g26134	NASA Radiation Sciences
g26141, g0620	I mainly work on the GEOS-5 GCM.
G26144	Planetary geology and geophysics
G26144	SHP and OPR
g26153, s1020, s0970, s1131, s1134, s1260, s1261	SDO, Kepler missions
g26158	Solar Dynamics Observatory
g26158	SR&T
g26198	NASA Outer Planet Research Program/NASA Origins of Solar Systems
J1060	All ... Nastran computation work support NASA missions though all phases of development.

o971b	NASA Physical Oceanography
s0742	GMAO GEOS5
s0746	NASA/MSFC Short-term Prediction Research and Transition
s0802	Numerical simulations of convection to study planetary interiors
s0846	NASA Ames Mars GCM Group (Code SST at NASA Ames)
s0847	Carbon Cycling in the North Atlantic
s0860	Space Geodesy Project
s0863	s0863
s0870	Modeling exoplanetary systems: dynamics of debris disks
s0873	Aerosol-cloud interactions: How 3D science can help to correctly interpret satellite data
s0912	MHD Simulations of Variability of Magnetized Stars
s0918	MMS
s0927	NASA GEOS-5 atmospheric general circulation model
s0935	AIST
s0937	NASA Hurricane Research Science Program
S0939	Modeling of Planetary Atmospheres
s0942	MAP (other GIDs support NEWS, Applied Sciences, AIST)
s0942	NU-WRF and LIS
s0942, s1182	GCE (GPM), NU-WRF (MAP)
s0945	PATM "DDSCAT of Crystalline Silicates within Aggregate Grains"
s0958	NASA ROSES 08 GULF
s0961	UAVSAR
s0966	Heliophysics Supporting Research
s0969	My NASA grant supported projects
s0978	MAP
s0984	Formation of Planets and Debris Disks
s0988	Hurricane and Severe Storm Sentinel
s0990	Modeling, Analysis, and Prediction program (MAP) Atmospheric Composition Modeling and Analysis Program (ACMAP)
s1001	Development of GISS Model-E
s1001	NASA Center for Climate Simulation (NCCS) Project
s1001	
s1017, s0950	
S1043	GEOSCCM
s1043	Goddard Chemistry-Climate Modeling Project
s1058	I perform numerical simulations in support of a heliophysics SR&T grant and Hinode/XRT science.
s1080	Earth Sciences, Hurricane and Severe Storm Sentinel (HS3) project.
s1090	Aerosol GOCART model
s1116	DISCOVER-AQ
s1118 s1221	Funded NASA MFRP and OPR projects.
s1119	Carbon Cycle Science, Upper Atmosphere Research, ASCENDS
s1125	SMD

s1137	Science of Terra Aqua. In particular, to enhance our understanding of tropical cyclones, tropical weather and generally extreme precipitation events through a better use of AIRS-derived products within an operational global data assimilation and forecast system, the NASA GEOS-5.
s1138	MAP, OBB
s1146	NASA research grant entitled "Atomistic Simulations for Inhomogeneous Modeling of Giant Planet Interiors"
s1149	Modeling gravitational wave sources
s1160	SAS project: OMPS/LP Simulation and EDR codes testing, evaluation and validation;
s1168	Observational Cosmology (Code 600)
s1170	Earth Sciences (ACMAP) Planetary Sciences (Mars EDL)
s1182	MAP, PMM, AIST
s1189	NCA
S1211	NASA Energy and Water Cycle Study (NEWS)
S1217	NASA
s1229	ESOT AIST
s1235	Magnetospheric Multiscale (MMS)
s1237, 21043	GEOSCCM
s1238	GMAO data assimilation system
s1242	GRAIL
s1261	Solar Dynamics Observatory
s1267	OCO-2
s1269	Climate Impact of Improved Ice-Sheet Ice-Shelf Ocean Atmosphere Interactions
s1278	Outer Planets Research and Planetary Atospheres
s1285	Terrestrial Ecology Program
s1289	NNX12AB34G
s1311	MFRP
s1325	Heliophysics Guest Investigators
s1345	NASA ROSES-2012, project titled "Error Covariance Diagnosis and Forecast Impact Estimation in NASA GEOS DAS"
SSSO	NU-WRF
x0610	Lunar Reconnaissance Orbiter, MESSENGER
	Climate Modeling
	GISS Model-E Analysis
	High Speed
	HIRAD
	Hydrological Sciences Lab, Goddard, Code 617
	I primarily support the Landsat program (and LDCM) but also support Earth Science in general.
	ICESAT 2
	RW and FW
	SLS
	Subsonic Fixed Wing

List is based on 124 responses to the GID code question; 12 respondents skipped. Note that some respondents listed more than one GID code.

Table A-4

Your HEC use best supports which of NASA's Strategic Priorities?	• **5%** **Strategic Goal 1** (7 responses) • **69%** **Strategic Goal 2** (94 responses) • **3%** **Strategic Goal 3** (4 responses) • **20%** **Strategic Goal 4** (27 responses) • **3%** **Strategic Goal 5** (4 responses)
This was a bridge-question in which the selection of Strategic Goal prompted a deeper question to the sub-objective of that Strategic Goal. Responses to Strategic Goal were: • *Strategic Goal 1 (Extend and sustain human activities across the solar system):* • *Strategic Goal 2 (Expand scientific understanding of the Earth and the universe in which we live)* • *Strategic Goal 3 (Create the innovative new space technologies for our exploration, science, and economic future)* • *Strategic Goal 4 (Advance aeronautics research for societal benefit)* • *Strategic Goal 5 (Enable program and institutional capabilities to conduct NASA's aeronautics and space activities)* *Within the sub-objectives 60 of the 136 responses selected sub-objective 2.1 (Advance Earth system science to meet the challenges of climate and environmental change)* *Statistics based on 136 respondents; 0 skipped.*	

Table A-5

What term best describes your role as a user of HEC at NASA?	• **51%** **User** (56 responses) • **49%** **Principal Investigator** (53 responses) • **0%** **Program Executive** (0 responses)
Statistics based on 109 respondents; 27 skipped.	

Table A-6

How would you characterize your HEC system use?	• **85% Large Scale Simulation** (115 responses) • **7% Analytic Data Processing** (9 responses) • **9% Other** (12 responses)
Statistics based on 63 respondents; 0 skipped.	

Table A-7

Which HEC system do you most often use?	• **61% Pleiades** (82 responses) • **36% Discover** (48 responses) • **3% Endeavor** (4 responses)
Statistics based on 134 respondents; 2 skipped.	

Table A-8

What is the primary mechanism for parallelism for your application?	• **80% MPI** (103 responses) • **9% OpenMP** (12 responses) • **6% MPI+Shared Memory** (8 responses) • **5% Serial** (6 responses) • **0% Threading** (0 responses)
Statistics based on 129 respondents; 7 skipped.	

Table A-9

1. Which programming language dominates your HEC application?	• **84% FORTRAN** (113 responses) • **7% C++** (10 responses) • **4% C** (5 responses) • **2% Python** (3 responses) • **0% Vis Support** (0 responses) • **2% Other** (3 responses)
Statistics based on 134 respondents; 2 skipped.	

Table A-10

What systems do you most commonly use for Post-Execution Visualization/ Analysis?	• **28% IDL** (37 responses) • **14% MATLAB** (18 responses) • **14% Homegrown** (18 responses) • **45% Other** (60 responses)
Statistics based on 133 respondents; 3 skipped.	

Table A-11

Indicate the nominal number of independent runs you typically conduct during a calendar year with the HEC system you most often use. (Note: it is understood that each experiment is likely to consist of a series of executions within a queuing system)

Nominal Number of Independent Runs	*Distribution of Responses*
1	2
2	1
4	1
5	2
6	2
7	1
8	2
10	10
12	2
15	3
20	5
25	1
30	5
40	6
50	18
64	1
75	1
80	1
100	12
120	2
150	2
200	12
240	1
250	1
270	1
300	3
350	1
400	3

500	3
600	1
720	1
750	1
800	1
1000	8
1300	1
1500	1
5000	1
7500	1
12000	1

Weighted Average Number of Runs: 1,253.2 **Mode: 50** **Median: 100**

Statistics based on 122 respondents; 14 skipped.

Table A-12

How many "wall clock-hours" does a single experiment typically require? This should be summed over multiple batch jobs to represent an entire experiment.

Typical number of "wall clock-hours" for a single experiment	*Distribution of Responses*
1	7
2	4
3	1
4	2
5	3
6	2
8	7
10	5
12	4
17	1
20	4
24	7
26	1
28	1
34	1
36	1
40	1
48	10
50	1
60	3
72	2

80	**1**
96	**2**
100	**3**
120	**7**
128	**1**
132	**1**
150	**2**
168	**1**
172	**1**
220	**1**
240	**3**
300	**2**
350	**2**
400	**1**
500	**3**
511	**1**
572	**1**
600	**1**
750	**2**
800	**1**
1000	**4**
1200	**1**
1800	**1**
2400	**1**
3724	**1**
4000	**1**
5000	**1**
6000	**1**
15000	**1**
25024	**1**
30000	**1**
100000	**1**
200000	**1**
500000	**1**
550000	**1**

Weighted Average "Wall Clock Hours": 26,072.7 Mode: 48 Median: 72

Statistics based on 122 respondents; 14 skipped.

Table A-13

How many cores are used in a typical job	• **12%** **Less than 32** (16 responses) • **6%** **32** (8 response) • **11%** **64** (15 responses) • **67%** **More than 64** (90 responses) • **4%** **Unknown** (5 responses)
Statistics based on 134 respondents; 2 skipped.	

Table A-14

What is the amount of output disk storage required for execution and management for your typical experiment in gigabytes?

Typical Gigabytes for Output Storage	*Distribution of Responses*
1	10
2	5
3	1
4	1
5	2
6	1
10	9
16	1
20	2
30	3
32	1
40	2
50	3
55	1
60	1
100	9
132	1
150	1
200	6
250	2
300	4
400	2
500	11
600	1
800	1
1000	12
1300	1
2000	2

2050	1
2500	1
3000	1
4000	1
5000	3
6000	1
10000	7
15000	1
20000	2
30000	3
38000	1
40000	1
100000	3
200000	2

Weighted Average Gigabytes for Output Storage: 25,125.9
Mode: 1000 Median: 400

Statistics based on 124 respondents; 12 skipped.

Table A-15

What is the amount of online storage required for execution and management for your typical experiment in gigabytes?

Typical Gigabytes for Online Storage	*Distribution of Responses*
0	20
1	8
2	8
2.5	1
3	1
5	2
6	1
10	5
20	6
24	1
30	1
32	1
50	5
60	2
75	1
80	1
100	13
200	4
250	1

300	**2**
350	**1**
400	**4**
500	**7**
750	**1**
800	**2**
1000	**5**
1200	**1**
1500	**1**
2000	**6**
3000	**1**
4000	**2**
5000	**6**
6000	**1**
6500	**1**
10000	**3**
15000	**1**
20000	**2**
30000	**3**
100000	**3**
500000	**1**
	Total Responses: 121

Weighted Average Gigabytes for Online Storage: 26,494.4
Mode: 100 Median: 300

Statistics based on 121 respondents; 15 skipped.

Table A-16

How long does your project typically need to be stored on NASA HEC systems	• **1%** **1 Day** (1 response) • **9%** **1 Week** (12 response) • **17%** **1 Month** (23 responses) • **14%** **3 Months** (19 responses) • **59%** **More than 3 Months** (80 responses)

Statistics based on 135 respondents; 1 skipped.

Table A-17

Estimate the network bandwidth (MB/s) for effective use of your Post-Execution Visualization system.

MB/s Required	*Distribution of Responses*
1	7
2	3
3	3
5	1
10	11
20	5
25	1
30	1
40	1
50	7
60	1
100	23
110	1
120	1
150	4
200	1
300	1
500	3
1000	10
5500	1
	Total Responses: 86

Weighted Average MB/s Required: 1,068.6 **Mode: 100** **Median: 150**

Statistics based on 86 respondents; 50 skipped.

Table A-18

How often do you use HEC systems or capabilities to support your primary project or program at NASA	• **54%** **Daily** (72 responses) • **26%** **Weekly** (34 responses) • **4%** **Bi-weekly** (6 responses) • **7%** **Monthly** (10 responses) • **7%** **Quarterly or Less** (9 responses) • **1%** **N/A** (2 responses)

Statistics based on 133 respondents; 3 skipped.

Table A-19

HEC Capabilities Questions	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree	Not Applicable
Overall, HEC resources are adequate to support my project needs.	4% *(5)*	3% *(4)*	4% *(6)*	14% *(19)*	40% *(55)*	33% *(45)*	1% *(2)*
The current disk storage space is adequate for project needs.	1% *(2)*	5% *(7)*	10% *(14)*	21% *(28)*	33% *(45)*	27% *(37)*	2% *(2)*
Bandwidth from the HEC to my work location is adequate to support data transfer for my projects.	3% *(4)*	2% *(3)*	4% *(5)*	24% *(32)*	43% *(58)*	21% *(28)*	3% *(4)*
Without HEC capabilities, I could not complete my project work.	2% *(3)*	2% *(3)*	1% *(2)*	11% *(15)*	12% *(16)*	70% *(95)*	1% *(2)*
Without HEC capabilities, I could complete my work but with significant delay.	24% *(32)*	24% *(32)*	8% *(11)*	11% *(14)*	8% *(11)*	20% *(27)*	5% *(6)*
HEC queue delays do not significantly delay my project nor impact my work efficiency.	16% *(22)*	19% *(26)*	18% *(24)*	21% *(28)*	19% *(26)*	4% *(6)*	2% *(3)*
The HEC system processes my jobs with adequate turnaround time.	4% *(6)*	9% *(12)*	14% *(19)*	21% *(29)*	37% *(50)*	11% *(15)*	3% *(4)*
The HEC system I use most provides post execution visualization/analysis sufficient to meet my needs.	1% *(1)*	3% *(4)*	9% *(12)*	14% *(19)*	35% *(47)*	14% *(19)*	23% *(31)*
The HEC system I use most provides persistent disk capacity sufficient to meet my needs.	1% *(1)*	3% *(4)*	8% *(11)*	16% *(21)*	47% *(63)*	24% *(32)*	2% *(3)*
The HEC system I use most enables my mission objectives by supporting transfer, when necessary, of my output to a location where I can post-process or visualize it.	1% *(2)*	1% *(1)*	4% *(6)*	9% *(12)*	44% *(59)*	30% *(40)*	11% *(15)*

Table A-20

What, specifically could be improved about the HEC system you use most?
Responses: • **Need a factor of 10-100 more resources. Favor jobs that use 20-100% of the machine's total capacity for a short time rather than a plethora of jobs that use less than 1% for days and weeks.**   • **More Pleiades processors to reduce queue wait for my jobs which currently use 2016 cores each. Globusonline seems to be a faster transfer method than shiftc for remote**

What, specifically could be improved about the HEC system you use most?
transfers and should be explored. • **Increase number of compute nodes.** • **A better mechanism for getting accounts, some kind of knowledge management at HEC, particularly about past and ongoing projects, codes used, experiments run, papers published...** • **Queue time is a major concern recently. A few hours of queue time is acceptable for me, but not days.** • **More info from the job queue, e.g. anticipated wait in the queue for a given job. More info when retrieving from the tape archive: expected turn-around time based on current conditions. Longer job maximum length, in the general queue on Discover -- e.g. 24 hrs. or 48 hrs. More info about "current system status", updated near real time; e.g. "Problem with nodes 55 through 60, expecting back online in 2 hrs.", or "Problem with GPFS file system, restarting; expecting return to service in 1 hr.". Currently email is sent on occasion, which is good, but often I experience a system problem of some sort, with no idea if (a) it has been called in already, (b) if it affecting everyone or just me, (c) how long until it is expected to be resolved? The "Discover Job Monitor" webpage is a good resource, but what I'm talking about is an interface where sys admins post blurbs on short term, unexpected problems that they are working to resolve.** • **Currently, the post execution visualization capability (in MATLAB) is slow with XY-forwarding. This takes a long time to get my analysis done. Secondly, we are coming up to the disk capacity limit on our project space on the Discover file system. It would be great if we had more space.** • **All are good.** • **The HEC system is very well run and maintained. However, the current demand exceeds the current HEC compute resources. This results in very long turnaround times that are impact my ability to meet my current milestone.** • **The biggest thing would be to increase the processor (core) count to better accommodate the ever-increasing needs of the HEC community.** • **A better turnaround for jobs requiring 2000-4000 cores** • **I'm happy with the current capability.** • **Turnaround time though I understand the seasonal nature of it.** • **Beyond more resources, continue to improve the devel queue. [The dynamic nature of the devel queue has been a tremendous asset.]** • **Fix the cause of frequent job abort issue we have experienced during the past 10 months** • **Reduce queuing delays, improve system robustness** • **Ability to run 10K to 20K core runs without having to wait for long times Extra no backup disk space would be useful as well. Let me be on record that I love the generally fantastic support provided by NAS user consultants/support staff.** • **Queue system. The queue for PFE is always long and not easy to get through.** • **The Pleiades system is not amenable to development/simulation using leadership-class jobs of 100,000 cores or more.**

What, specifically could be improved about the HEC system you use most?
• Restrict usage to larger jobs. • I only run on HEC systems when I require very large numbers of cores or as a backup to local clusters due to lengthy queue times (even for quick jobs) and persistent problems with file systems going down while I am working. The system is more reliable than it was a few years ago, but I will run locally with longer run times instead of choosing to run on HEC systems. The dominance of available HEC resources by SLS is prohibitive to other projects' ability to use HEC. • I would like to see the applications provided under the "module avail" system updated on a regular basis. For example, I asked that a current version of Subversion be installed. Because I could not provide a list of a specific feature that I wanted to use, it was not upgraded. The installed version is at least three years old. How about installing current versions every year or two by default? For applications frequently upgraded, drop the old versions after four years. For other applications, keep two or three versions available and drop the older ones. The NAS website has lots of good user information on it. I would like to see more information added. • With ever increasing difficulty of problems to be solved, use of more than 3000 cores is needed to be effective to the mission I support. But as it stands, the largest job I can run is no more than 1500 cores. Improving access to more cores or faster cores would greatly alleviate bottlenecks in the solution procedure I use. • I have not been allowed to use HEC in 2 years. However, running out of resources locally to perform simulations needed to get data..... • The limiting factor on my work on the HEC system is the file number quota. I have to actively monitor the output and run state of my jobs to ensure that I don't exceed the quota (500,000 on /nobackupnfs1). It would be nice for there to not be a limit. • Increase stability of platform and disk subsystem Increase capacity of both computational and storage resources Reduce delays for transfers from archive to online disk • Higher bandwidth to other NASA centers. • Obtain enough IDL licenses for usage. • wait times on queues have recently increased • It will be helpful have more IDL licenses • I would like to see support and training for Paraview for post processing (a National-Labs built system for parallel unstructured mesh visualization). • Improve the Pleiades queuing system to give higher priority to large-scale multi-processor jobs. Install more IDL licenses. • Larger SSD local storage on the nodes to support scratch IO work. • Conduct maintenance at off hours • I could use a larger inline disk quota for better efficiency in conducting weather modeling experiments on Discover. I have found the small incremental increases in my quota to be insufficient for conducting more than 1 or 2 modeling sensitivity experiments at a time on the large Continental U.S. domains I typically run. • I use Pleiades to run my models and then use Lou for long term storage. I also then

What, specifically could be improved about the HEC system you use most?
use Lou for post-processing. It is easy for me to use up my memory allocation for Pleiades by doing several model runs at the same time. I understand I need to use Pleiades only to run models and Lou is for storage, but even with that scheme Pleiades' allocation is a bit small. • **Retrieval of archive files on Lou is a bit slow.** • **Be more flexible about user quotas and especially in the case of i-nodes** • **Shorter wait times in the Pleiades would always help, but the wait times have not been bad since the last major upgrade (sometime last year, I believe). When I'm working outside of the main hours, it is mildly annoying to have to wait for longer for development jobs (submitted to devel queue) to run, as compared to the normal working hours when cores are dedicated to this queue. I understand the reasoning for this, though, especially when I finish developing a job and want to run it for a long time.** • **It would be nice to have some professional help with data visualization for public communication purposes.** • **I stopped using Pleiades because of long lines. I use Discover all the time. It has a smart scheduling of jobs. I wish Pleiades do something about it too.** • **Longer queues and/or automated management of large jobs that need long execution times. OSSEs require long runs with stops/restarts, which are large I/O burdens, and require "babysitting" to properly run. Parallel I/O also has major potential.** • **I happen to run very large simulations that produce significant volumes of output, so I sometimes run into storage problems. But between better disk management on my part and an increased storage allocation from HEC this problem has been managed. I do still have trouble moving data off of Discover, since I work offsite and need to get the data from Discover, through Dirac, and onto an external system. The fact that this takes multiple steps makes me more likely to leave data on Discover for longer than it has to be and to perform post processing there that really could be accomplished on my local system. So some kind of one-step access from Discover to external systems would be helpful, though I recognize that security concerns might preclude this.** • **Improved job management for large jobs that can't fit into standard queues. We have received excellent support for real-time forecasting for field campaigns, including special queues and help with scripts. However, each one requires careful scripting, crons, etc. that could be more generically supported.** • **1. When I run DDSCAT code at short wavelengths for polarization studies, to maximize the future use of the output, I need to ask to store the polarization output from each of 64 orientations so this generates too many 10K size files so that I am over the limit on the number of files. This means that I have to run the experiment over a much smaller portion of parameter space than is possible given the computing power: it's the number of files that I can store that limits the output. Can an exception be made for the limit not on disk storage space but on the number of files? 2. DDSCAT produces a ddscat.out file that is 100 MB but the useful information is about 1 MB because the ddscat.out file prints out the timing information, which is rarely consulted. Presently, I use an IDL code to strip out lines from the ddscat.out file to help with my local file storage: >TIMEIT Timing results for: ESELF (first call)**

What, specifically could be improved about the HEC system you use most?
>TIMEIT 0.000 = CPU time (sec) >ZBCG2 IT= 1 f.err= 2.193E-03 If there could be a different output file or a local code to strip out these files, that would help on the storage space on backup. • **Massively parallel simulations (8,000-20,000 cores) will require much larger on-line disk capacity (1 gigabyte per core) as well as considerable intermediate term off-line storage (for periods of a year)** • **Pleiades system needs to be upgraded or expanded to accommodate the increased demands. Currently the delay in queues is too long.** • **The system could be a lot faster! Seriously, it does very well for us - as upgrades occur, we take advantage of the faster CPUs.** • **Somewhat larger online disk storage.** • **Fast graphic from discover to local computer.** • **The reliability of the Lustre file system.** • **The reliability of data storage on Pleiades (e.g., /nobackup2) could be improved.** • **Wait time for simulations to run is very long. Hard to use allocated computing hours when you can't get time to run simulations.** • **Improve data retrieval of archived data files.** • **Have less down time** • **The issue of insufficient IDL licenses seems to have been improved in recent months (note that for question 18 I have no idea how much bandwidth is required, only that not being able to get a license has always been the biggest problem!) This survey could also be improved by providing more details on each question: for example, question 17 - does this refer to data stored in the archive (Lou) or on the cluster (nobackup on Pleiades)? And questions 15&16 - how are 'output' and 'online' storage defined? I'm afraid my answers won't be accurate because I'm not sure what some of the questions are actually asking.** • **Larger long-term nobackup space to perform diagnostics is essential. Experiments need to be investigated by multiple users for several months, sometimes years, to extract scientifically-valuable information. The** • **Some cleaning-up or less ambiguous naming of some installed modules on Pleiades. It's not always clear what implementations of MPI, for instance, were built with certain compilers, nor whether it matters. Staff/support is very helpful, but it would be nice not to have to contact them. Login/access from my work location has become more awkward with tighter NASA IT security. It would be nice to be able to access my local CVS repository directly again, instead of having to check out/update locally and copying it over to pfe.** • **I am pretty happy with HEC system, the support is great. File nodes may be needed more in future.** • **We need more capability of large-scale modeling of NASA"s regional earth-system modeling and assimilation system: NASA-Unified WRF. Let's say more frequent use of 5,000~10,000 CPU to conduct continental scale 1km-grid spacing simulation to create next-generation benchmark of regional modeling. For this, we also need more flexible large-scale no-backup space. (I am deputy scientist of NASA-Unified WRF project.)**

What, specifically could be improved about the HEC system you use most?
• **The GPFS hangs on Discover need a solution, and is the cause for too many work stoppages** • **Reduce the limitation on the number of files.** • **Data transfers are slow. This is a persistent issue that we have tried to address in the past.** • **More nodes. Increase in CPU limits. 24-hrs is a hard constraint on how we execute our sequence of jobs.** • **HEC queue delays can be longer than 1 week. The queuing system must be improved. There is a chronic shortage of IDl licenses.** • **Provide projects that have operational needs with priority during development, test and ops phases.** • **Improved tutorials for new users.** • **1. A clearer view of the available/free resources. When the system status webpage shows available & free nodes, there can be significant queue delays. 2. Additional queue for smaller (8-32 CPU) jobs or queues based on CPU requirements 3. An interactive MPI enabled system for debugging without using the job submission queue MPI jobs cannot be run on PFE nodes, making debugging a cycle of a) submit, b) wait for 10 minutes to 1 day, c) analyze the crash/segfault/exit code... The devel queue helps but wait times exceed the run times.** • **More cores to reduce queues** • **Pleiades shows wait time in the queue. I would like to see that implemented on Discover** • **Do not shut it down during business hours for routine maintenance. That causes a lot of us analysts to twiddle our thumbs for 8 hours.** • **improve large job throughput** • **More info and tools for profiling. I learned about some by talking to support people but they should be advertised** • **The agency needs access to a Leadership Class Facility. As the emphasis grows on modeling and simulation with dependence on replacing physical testing and associated facilities, we will sooner rather than later be overwhelmed by the lack of capability within the agency to conduct the simulations required. Just as parallel scaling to O (10) cores does not impact this level of work, neither does capability that supplies O (1000) cores. Too much talk and implied reliance on exa-scale computing and too little action. We must make the commitment or get out of the business. How can anyone honestly enact plans to destroy physical testing facilities without computing capability to replace them (and I am a computational researcher). The needs of many in the agency will be for capability rather than the capacity model currently mandated.** • **The biggest limitation I face is the I/O bandwidth between the file system and processors. Data movement is very time consuming due to slow I/O channels. I am now using non-Ames computing resources because it takes so long to access the data using your resources. I don't need large numbers of compute node. I need to process large datasets in an effective manner. It takes forever to move the data to Ames, takes forever to move data from mass storage to the processor, takes forever to move result**

What, specifically could be improved about the HEC system you use most?
back to mass storage and forever to get the results back for others to post process the data.   *Comments submitted by 75 respondents; 61 skipped.*

Table A-21

HEC System Future Need Questions	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree	Not Applicable
I expect to continue at the same level of usage for the next 3 years (2014-16) [*respondents marking a Disagree/Agree choice were branched to future questions depending on response*)	**6%** *(8)*	**9%** *(12)*	**9%** *(12)*	**12%** *(16)*	**29%** *(39)*	**35%** *(48)*	**1%** *(1)*
I expect to make major adjustments to my usage pattern (e.g. promote development code to production).	**6%** *(2)*	**12%** *(4)*	**12%** *(4)*	**24%** *(8)*	**30%** *(10)*	**15%** *(5)*	**0%** *(0)*
I expect to change the way I use my output data through visualization or post-processing.	**9%** *(3)*	**18%** *(6)*	**30%** *(10)*	**6%** *(2)*	**30%** *(10)*	**3%** *(1)*	**3%** *(1)*
I expect to increase the amount of data I will produce to support my projects by more than 20%.	**0%** *(0)*	**3%** *(1)*	**3%** *(1)*	**13%** *(4)*	**38%** *(12)*	**44%** *(14)*	**0%** *(0)*

Table A-22

Processing Load for All My Projects					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
135	**AIST**	**s0935**	**20**	**100**	**1000**
39	**Carbon Cycle Science, Upper Atmosphere Research, ASCENDS**	**s1119**	**50**	**100**	**200**
95	**Development of GISS Model-E**	**s1001**	**20**	**50**	**100**
92	**ERA**	**a1384**	**100**	**200**	**300**
98	**Estimating the Circulation and Climate of the Ocean (ECCO)**	**26209**	**100**	**200**	**400**

Processing Load for All My Projects					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
48	FA	a1203	50	150	300
64	Fundamental Aero/Rotary Wing	g24168	33	100	200
87	Fundamental Aeronautics Program, Fixed Wing Project	a1231	100	100	100
119	Fundamental Aeronautics Program. Nearly all of this usage currently corresponds to Aeronautical Sciences Project.	a1327, a1330			
110	GEOSCCM	S1043	20	50	100
28	Heliophysics Supporting Research	s0966	10	50	100
2	High Speed, Fixed Wing	a1315	20	40	100
75	I perform numerical simulations in support of a heliophysics SR&T grant and Hinode/XRT science.	s1058	-25	50	100
67	I support HIAD, InSight, Trim Tabs, and SRP. HIAD, Trim Tabs, and SRP are all out of STMD's Game Changing Office. InSight is out of SMD (2016 Mars lander mission).	a1374	25	25	10
86	MAP	d1183	50	200	500
126	MAP (other GIDs support NEWS, Applied Sciences, AIST)	s0942	100	1000	5000
19	NASA Outer Planet Research Program/NASA Origins of Solar Systems	g26198	20	30	40
31	NASA research grant entitled "Atomistic Simulations for Inhomogeneous Modeling of Giant Planet Interiors"	s1146	30	100	300

Processing Load for All My Projects					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
117	**NASA ROSES 08 GULF**	**s0958**	**0**		
8	**NXX09AV41AS03**	**41007/s1007**	**30**	**30**	**30**
22	**OCO-2**	**s1267**	**500**	**500**	**0**
65	**Rotary Wing**	**801**	**20**	**70**	**250**
85	**Space Geodesy Project**	**s0860**	**10**	**30**	**100**
13	**SR&T**	**g26158**	**0**	**0**	**0**
53	**The Global Modeling and Assimilation Office core efforts, contributing to NASA's Modeling Analysis and Prediction program**	**g0609; g0620; g2613; g26141; s0818; s0911**	**100**	**400**	**800**
122			**100**	**700**	**900**

Statistics based on 24 respondents; 112 skipped.

Table A-23

Total Processing SBU					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
135	**AIST**	**s0935**	**20**	**100**	**1000**
39	**Carbon Cycle Science, Upper Atmosphere Research, ASCENDS**	**s1119**	**50**	**100**	**200**
95	**Development of GISS Model-E**	**s1001**	**20**	**50**	**100**
92	**ERA**	**a1384**	**100**	**200**	**300**
98	**Estimating the Circulation and Climate of the Ocean (ECCO)**	**26209**	**100**	**200**	**400**
48	**FA**	**a1203**	**50**	**150**	**300**
64	**Fundamental Aero/Rotary Wing**	**g24168**	**33**	**100**	**200**
87	**Fundamental Aeronautics Program, Fixed Wing Project**	**a1231**	**100**	**100**	
119	**Fundamental**	**a1327, a1330**	**200**	**600**	**1000**

Total Processing SBU					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
	Aeronautics Program. Nearly all of this usage currently corresponds to Aeronautical Sciences Project.				
110	GEOSCCM	S1043	50	100	200
28	Heliophysics Supporting Research	s0966	10	50	100
2	High Speed, Fixed Wing	a1315	20	40	100
75	I perform numerical simulations in support of a heliophysics SR&T grant and Hinode/XRT science.	s1058	0	50	100
67	I support HIAD, InSight, Trim Tabs, and SRP. HIAD, Trim Tabs, and SRP are all out of STMD's Game Changing Office. InSight is out of SMD (2016 Mars lander mission).	a1374	25	25	10
86	MAP	d1183	100	200	400
126	MAP (other GIDs support NEWS, Applied Sciences, AIST)	s0942	100	1000	5000
19	NASA Outer Planet Research Program/NASA Origins of Solar Systems	g26198	25	30	35
31	NASA research grant entitled "Atomistic Simulations for Inhomogeneous Modeling of Giant Planet Interiors"	s1146	30	100	300
117	NASA ROSES 08 GULF	s0958	0		
8	NXX09AV41AS03	41007/s1007	10	10	10
22	OCO-2	s1267	250	2500	0
65	Rotary Wing	801	20	70	250

Total Processing SBU					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
85	Space Geodesy Project	s0860	10	30	50
13	SR&T	g26158	0	0	0
53	The Global Modeling and Assimilation Office core efforts, contributing to NASA's Modeling Analysis and Prediction program	g0609; g0620; g2613; g26141; s0818; s0911	100	400	800
122			100	700	900

Statistics based on 25 respondents; 111 skipped.

Table A-24

Total Number of Concurrent Job Runs					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
135	AIST	s0935	20	100	1000
39	Carbon Cycle Science, Upper Atmosphere Research, ASCENDS	s1119	0	0	0
95	Development of GISS Model-E	s1001	0	0	0
92	ERA	a1384	0	100	100
98	Estimating the Circulation and Climate of the Ocean (ECCO)	26209	0	0	0
48	FA	a1203	35	70	100
64	Fundamental Aero/Rotary Wing	g24168	0	100	200
87	Fundamental Aeronautics Program, Fixed Wing Project	a1231			
119	Fundamental	a1327, a1330	100	150	150

Total Number of Concurrent Job Runs					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
	Aeronautics Program. Nearly all of this usage currently corresponds to Aeronautical Sciences Project.				
110	GEOSCCM	S1043	50	100	200
28	Heliophysics Supporting Research	s0966	0	0	0
2	High Speed, Fixed Wing	a1315	15	15	15
75	I perform numerical simulations in support of a heliophysics SR&T grant and Hinode/XRT science.	s1058	0	0	0
67	I support HIAD, InSight, Trim Tabs, and SRP. HIAD, Trim Tabs, and SRP are all out of STMD's Game Changing Office. InSight is out of SMD (2016 Mars lander mission).	a1374	25	25	10
86	MAP	d1183	50	100	200
126	MAP (other GIDs support NEWS, Applied Sciences, AIST)	s0942	100	1000	5000
19	NASA Outer Planet Research Program/NASA Origins of Solar Systems	g26198	10	15	20
31	NASA research grant entitled "Atomistic	s1146	30	100	300

Total Number of Concurrent Job Runs					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
	Simulations for Inhomogeneous Modeling of Giant Planet Interiors"				
117	NASA ROSES 08 GULF	s0958	-50		
8	NXX09AV41AS03	41007/s1007	40	40	40
22	OCO-2	s1267	0	400	0
65	Rotary Wing	801	20	70	250
85	Space Geodesy Project	s0860	10	10	30
13	SR&T	g26158	0	0	0
53	The Global Modeling and Assimilation Office core efforts, contributing to NASA's Modeling Analysis and Prediction program	g0609; g0620; g2613; g26141; s0818; s0911	0	0	0
122					

Statistics based on 23 respondents; 113 skipped.

Table A-25

Total Persistent Storage (on disk)					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
135	AIST	s0935	20	100	1000
39	Carbon Cycle Science, Upper Atmosphere Research, ASCENDS	s1119	20	40	60
95	Development of GISS Model-E	s1001	40	100	200
92	ERA	a1384	100	200	300
98	Estimating the Circulation and Climate of the Ocean (ECCO)	26209	100	200	400
48	FA	a1203	25	35	50

Total Persistent Storage (on disk)					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
64	**Fundamental Aero/Rotary Wing**	**g24168**	**33**	**100**	**200**
87	**Fundamental Aeronautics Program, Fixed Wing Project**	**a1231**			
119	**Fundamental Aeronautics Program. Nearly all of this usage currently corresponds to Aeronautical Sciences Project.**	**a1327, a1330**	**150**	**300**	**450**
110	**GEOSCCM**	**S1043**	**50**	**100**	**200**
28	**Heliophysics Supporting Research**	**s0966**	**10**	**50**	**100**
2	**High Speed, Fixed Wing**	**a1315**			
75	**I perform numerical simulations in support of a heliophysics SR&T grant and Hinode/XRT science.**	**s1058**	**25**	**50**	**100**
67	**I support HIAD, InSight, Trim Tabs, and SRP. HIAD, Trim Tabs, and SRP are all out of STMD's Game Changing Office. InSight is out of SMD (2016 Mars lander mission).**	**a1374**	**20**	**20**	**10**
86	**MAP**	**d1183**	**100**	**200**	**300**
126	**MAP (other GIDs support NEWS, Applied Sciences, AIST)**	**s0942**	**100**	**1000**	**5000**
19	**NASA Outer Planet Research Program/NASA Origins of Solar Systems**	**g26198**	**10**	**20**	**30**
31	**NASA research grant entitled "Atomistic Simulations for Inhomogeneous Modeling of Giant Planet Interiors"**	**s1146**	**30**	**100**	**300**
117	**NASA ROSES 08 GULF**	**s0958**	**-10**		
8	**NXX09AV41AS03**	**41007/s1007**	**10**	**10**	**10**
22	**OCO-2**	**s1267**	**0**	**0**	**0**
65	**Rotary Wing**	**801**	**20**	**70**	**250**

Total Persistent Storage (on disk)					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
85	**Space Geodesy Project**	**s0860**	**10**	**30**	**50**
13	**SR&T**	**g26158**	**0**	**0**	**0**
53	**The Global Modeling and Assimilation Office core efforts, contributing to NASA's Modeling Analysis and Prediction program**	**g0609; g0620; g2613; g26141; s0818; s0911**	**100**	**400**	**800**
122			**100**	**700**	**900**

Statistics based on 23 respondents; 113 skipped.

Table A-26

Total Persistent Storage (on tape)					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
135	**AIST**	**s0935**	**20**	**100**	**1000**
39	**Carbon Cycle Science, Upper Atmosphere Research, ASCENDS**	**s1119**	**50**	**100**	**200**
95	**Development of GISS Model-E**	**s1001**	**100**	**200**	**400**
92	**ERA**	**a1384**	**100**	**200**	**300**
98	**Estimating the Circulation and Climate of the Ocean (ECCO)**	**26209**	**100**	**200**	**400**
48	**FA**	**a1203**	**25**	**35**	**50**
64	**Fundamental Aero/Rotary Wing**	**g24168**	**33**	**100**	**200**
87	**Fundamental Aeronautics Program, Fixed Wing Project**	**a1231**			
119	**Fundamental Aeronautics Program. Nearly all of this usage currently corresponds to Aeronautical Sciences Project.**	**a1327, a1330**	**200**	**400**	**600**
110	**GEOSCCM**	**S1043**	**50**	**100**	**200**

Total Persistent Storage (on tape)					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
28	**Heliophysics Supporting Research**	**s0966**	**10**	**50**	**100**
2	**High Speed, Fixed Wing**	**a1315**			
75	**I perform numerical simulations in support of a heliophysics SR&T grant and Hinode/XRT science.**	**s1058**	**0**	**0**	**0**
67	**I support HIAD, InSight, Trim Tabs, and SRP. HIAD, Trim Tabs, and SRP are all out of STMD's Game Changing Office. InSight is out of SMD (2016 Mars lander mission).**	**a1374**	**20**	**20**	**20**
86	**MAP**	**d1183**	**100**	**500**	**1000**
126	**MAP (other GIDs support NEWS, Applied Sciences, AIST)**	**s0942**	**100**	**1000**	**5000**
19	**NASA Outer Planet Research Program/NASA Origins of Solar Systems**	**g26198**	**20**	**30**	**40**
31	**NASA research grant entitled "Atomistic Simulations for Inhomogeneous Modeling of Giant Planet Interiors"**	**s1146**	**30**	**100**	**300**
117	**NASA ROSES 08 GULF**	**s0958**	**-10**		
8	**NXX09AV41AS03**	**41007/s1007**	**10**	**10**	**10**
22	**OCO-2**	**s1267**	**0**	**0**	**0**
65	**Rotary Wing**	**801**	**20**	**70**	**250**
85	**Space Geodesy Project**	**s0860**	**10**	**30**	**50**
13	**SR&T**	**g26158**	**5**	**15**	**25**
53	**The Global Modeling and Assimilation Office core efforts, contributing to NASA's Modeling Analysis and Prediction program**	**g0609; g0620; g2613; g26141; s0818; s0911**	**100**	**400**	**800**

Total Persistent Storage (on tape)					
	Program	GID Code	FY13 Baseline Plus 1 Year	FY13 Baseline Plus 3 Years	FY13 Baseline Plus 5 Years
122					

Statistics based on 22 respondents; 114 skipped.

Table A-27

If you have indicated a change in your usage patterns, please explain how this change is driven by your project needs (moving code from development to production, sensitivity analyses requiring multiple runs with different inputs, a major re-processing of observational data, etc.)

Responses:

- **For past 10 years (1993-2003) we have demonstrated the feasibility and utility of global-eddying ocean and sea ice state estimation for science climate applications. But the model configuration we have been working with (18-km horizontal grid spacing) although it permits eddies and hence sufficient to demonstrate technical feasibility of solving this type of optimization problem, is a very problematic resolution in terms of ocean science. Eddies are not sufficiently well resolved. This choice was dictated by available compute resources and was the correct choice at the time. As we move forward towards increasingly accurate ocean/ice/carbon/ecology state estimates, higher resolution is key to more realistically resolving the physics.**
- **I'd like to increase my usage if the queue time issue is resolved.**
- **Increasing fidelity of numerical CFD simulations and increased complexity of application geometry and systems.**
- **Moving code from one development environment to another; then moving from development to production.**
- **A new project need may be starting up.**
- **Expecting to complete more sensitivity studies. Current usage in limited by the robustness of the NASA codes I am using that tend to be numerically unstable.**
- **Primary driver is need for increased fidelity + increased reliance on simulations**
- **This change is driven by the emergence of new projects over the next 3 years, beginning in FY14 that all require substantial computational analysis support.**
- **I have recently started using the NAS system again and expect to move more work to it in the future. I also expect that as the NAS system grows, it will be easier to run bigger jobs and this will make it easier and more productive to make analyses for more complicated and larger configurations.**
- **Move code from development to production and carry more sensitivity experiments requiring multiple runs with different parameters and schemes.**
- **Increase is driven by increase in model resolution, updates in code (more computationally intensive parameterizations) and a re-processing of seasonal and**

If you have indicated a change in your usage patterns, please explain how this change is driven by your project needs (moving code from development to production, sensitivity analyses requiring multiple runs with different inputs, a major re-processing of observational data, etc.)

decadal forecasts with updated climate model (FY13 baseline + 3 years).

- **Small increases in total persistent storage represent long-term retention of past simulation cases for analysis and comparison with ongoing tectonic processes and remote data collection.**
- **A major component of our products will become finalized next year and moved to production over the next three years. By 5 years from now we will be dealing with near-real time products, which should greatly increase the amount of CPU we will use and the storage we will need.**
- **This project is focused on more and more complex OSSEs with time, in addition to cycling through optimization and uncertainty analysis steps, which require ensemble runs.**
- **Our newly funded MAP project moves from standard modeling to a focus on land and atmospheric data assimilation, which requires ensemble simulations. These simulations increase our processing and I/O requirements proportional to the number of ensemble members--typically 10-50. Hence, our 3-year out estimates are factors of 10.**
- **Project finished. Now, need to do more post-processing.**
- **Improvements in parallelization algorithms will allow the much larger scale particle-in-cell simulations that are necessary to perform fully kinetic analyses related to the upcoming MMS satellite mission to study the physical basis of magnetic reconnection and particle acceleration in the magnetosphere.**
- **Finer resolutions require more processors and produce larger output files**
- **need to run multiple ensemble sensitive simulations**
- **I will soon be incorporating code improvements from the code development team for one project, which will substantially improve memory management. I am also beginning to use a new code for different simulations. In ~1-3 years, I will begin performing 3D simulations.**
- **Hoping to get more modeling projects funded this year and in the coming years which would mean more usage of HEC systems. These projects are moving to higher resolution and ingesting large amounts of observational data, which requires large increases in computing resources.**
- **Major change to higher resolution atmospheric modeling.**
- **We plan to implement more accurate simulation methods and perform qualitatively more accurate simulations of planetary interiors.**
- **Moving from dev. to production (Launch is 7/1/14). Major reprocessing campaigns follow with the last one (in 2016) using all mission data.**
- **A major re-processing of observational data.**

Comments submitted by 25 respondents; 111 skipped.

Table A-28

What, if any, any additional HEC systems would assist you in continuing your analysis for the next 5 years?
Responses: • More cores with larger memory capabilities would be helpful. • Keep the presentations/screecasts coming. An introductory series on heterogeneous computing would be nice. • Faster processors and more of them. Keep great visualization group to help understand results. • A factor of 10 to 50 increase in available compute cycles for ecco applications would allow breakthrough accuracies in the estimation of ocean climate and interaction with ice/carbon/ecology/atmosphere/land, leading to fuller utilization of NASA earth-observing satellites for producing actionable information for grand-challenge earth science applications. • New compute nodes. • It would be great if a distributed computing server license of MATLAB was available so I can run my MATLAB code on Discover on many nodes. • Na • Increasing the compute and storage resources on Pleiades. • Again, the biggest thing is to maximize the number of available cores to accommodate bigger jobs and more users • 1. More bigmem nodes on Pleiades - many of my jobs require large memory on head node, and these jobs have to wait longer than normal before moving to execution queue. 2. Flow visualization of large cfd data without transferring files to my local workstation • I have no comments. • Vtune + bandwidth. Earlier access to emerging technologies. • Support for maintaining precompiled and optimized versions of in-house NASA codes • Significantly larger compute capacity. • Continually updating to the latest hardware. • Unsure. • Higher bandwidth connection from coast to coast of the USA for large scale data transfers. Faster access to data residing on disks, both writing to and reading from them for application use. Development of better algorithms to solve difficult computing issues with the available resources. And a better educated system support staff on how best to use and access HEC resources. • Increases number of nodes, disk space, network speed and reduce queuing time. • More access to CPU-hours.... I have low i/o band width • Currently Pleiades is almost unusable because of the very slow turnaround time, so it is very difficult to use our allocation there. If the queue structure there could be changed, we would have more resources available to us. Our mode of job

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submission (shorter cycling jobs) is driven by (i) the desire to share computational resources with others and (ii) the large data volume of model output. • **Continue to supply state-of-the-art computational facility.** • **More processors, more accelerators. More!** • **Programing support for a HEC tuned and developed fem analysis code.** • **I think the current system I use (discover) is sufficient for my research needs.** • **Since the code I use is openmp, HEC systems with more than 16 threads would be a great asset.** • **Interaction with Lou post-processing has been difficult (no success yet).** • **Being able to access my archived model output files on Lou via a opendap or thredds server.** • **We want to switch to product evaluation and visualization using HEC s/w and capabilities instead of what we have developed in-house so far. It will be important though to be able to use these via a web interface that makes them available to the public.** • **Bigger memory nodes would help as our particular code cannot be divided up into chunks to divvy out among nodes. We need every processor to have access to every piece of our simulation domain, so our resolution is limited by the maximum memory in a node. Therefore, nodes with larger memory (or more large memory nodes) would be especially helpful.** • **It would be wonderful. I would say now the situation is fragile. I can use only discover due to long lines at Pleiades etc. I guess, there are too many users on Pleiades, or the scheduling should be changed. I always liked to use two supercomputers so that the project will be performed with no interruptions. If discover stops for few days, then my work stops as well. In the past, Columbia has been a good reliable backup for my work, but now it is gone. I did not try Endeavour yet.** • **Parallel I/O longer queues** • **Parallel I/O support. We really need this ASAP.** • **Enabling the use of more processors will allow more complex particles to be modeled with ddscat. This is state-of-the-art computations that even 5 years ago were considered computationally intractable. I extend a thank you to the HEC staff for your support. The help desk is always there and very helpful.** • **Will be great!** • **Adequate online disk storage capability.** • **Increase the number of IDL licenses.** • **I think continuing to upgrade the CPU and storage capabilities to keep up with the state of the art would be adequate for our needs** • **Very good. More resources more production.** • **Probably need more cores an potentially a new HEC system to keep up with the competition.** • **More processors**

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• **I think everyone appreciates the continuing improvements in terms of speed and/or quantity of processors.** • **More short term storage** • **Please keep doing your excellent job. I am fully satisfied with the quality of the customer service, with the promptness in which issues are solved, and with the overall performance of the systems. My only need, as stated, is to increase the long-term nobackup online disk space for diagnostics.** • **Lots of SBU, modest increase in home and scratch disk space.** • **Nothing special: more nodes with more memory.** • **Tools with visualizations, and data processing.** • **Probably, dedicated CPU and hard disk for NASA-unified WRF project for rapid development and conducting larges-scale high-resolution modeling.** • **More cups to enable larger kinetic simulations.** • **I'd like to thank the NASA advanced supercomputing (NAS) division staff for the great service and support of our NASA projects! I wish this great service will continue for the next 5 years.** • **Basically, more of the same** • **None that I can think of.** • **I need high I/O bandwidth for processing large datasets.** • **More storage on nobackup** • **N/a** • **Perhaps if a dedicated computer, say Pleiades+, was available that could be used for large jobs, which take many cores and wall clock hours to complete, jobs in the Pleiades "long queue" would not sit for up to a week before being processed.** *Comments submitted by 55 respondents; 81 skipped.*

HEC Program

Projected Growth of Demand

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Projections from Survey of Users August 2013

- Survey of Users had approximately 20% response
- Respondents estimated growth of their computing needs, compared to their current allocations
- Respondents were asked to identify key factors in any changes to their usage patterns
- No adjustments seemed necessary from interviews with program managers

Projected HEC Demand Average Percentage

	Baseline (FY13)	Baseline+1 (FY14)	Baseline+3 (FY16)	Baseline+5 (FY18)
Processing Load for all My Projects	100%	156%	275%	557%
Total SBU	100%	153%	357%	599%
Total Concurrent Jobs	100%	121%	194%	385%
Total Persistent Disk Storage	100%	141%	261%	566%
Total Persistent Tape Storage	100%	143%	260%	591%

Based on August 2013 need assessment of existing customer base with approximately 30 respondents

Projected HEC Demand Maximum Percentage

	Baseline (FY13)	Baseline+1 (FY14)	Baseline+3 (FY16)	Baseline+5 (FY18)
Processing Load for all My Projects	100%	600%	1100%	5100%
Total SBU	100%	350%	2600%	5100%
Total Concurrent Jobs	100%	200%	1100%	5100%
Total Persistent Disk Storage	100%	250%	1100%	5100%
Total Persistent Tape Storage	100%	300%	1100%	5100%

Based on August 2013 need assessment of existing customer base with approximately 30 respondents