NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR) $116,200,000
+$12,100,000 / 11.6%

National Center for Atmospheric Research Funding
(Dollars in Millions)

FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over FY 2021 Actual Amount	Percent
$104.10	-	$116.20	$12.10	11.6%

Brief Description

NCAR is an NSF-sponsored Federally Funded Research and Development Center devoted to service, research, and education in support of the atmospheric and related science research community. NCAR operates world-class observational facilities and computing infrastructure, conducts extensive in-house research, maintains vigorous programs of education, outreach, and the promotion of diversity, and cultivates extensive national and international collaborations. NCAR also carries out research and development on behalf of other organizations, most commonly other U.S. Government agencies.

Major NCAR facilities include the Mesa Laboratory in Boulder, CO; the recently renovated Research Aviation Facility in nearby Broomfield, CO; the NCAR-Wyoming Supercomputing Center in Cheyenne, WY; and the Mauna Loa Solar Observatory on Mauna Loa, HI.

Scientific Purpose

The NCAR mission is to understand the behavior of the atmosphere and related Earth and geospace systems; to support, enhance, and extend the capabilities of the university community and the broader scientific community, nationally and internationally; and to foster the transfer of knowledge and technology for the betterment of life on Earth. NCAR fulfills this mission with highly integrated programs organized around three overlapping primary areas of activity: cutting edge airborne and ground-based observational facilities, community weather and climate models with many thousands of users, and petascale high-performance computing. These are accompanied by a broad portfolio of programs supporting education, career development, public engagement, and increasing diversity in the geosciences. NCAR scientists also collaborate extensively with the academic, private, and government sectors. NCAR's programs are guided by the NCAR Strategic Plan, which emphasizes three overlapping priorities: 1) enhancing and building on NCAR's core strengths in fundamental research in the atmospheric and related sciences; 2) promoting integrated Earth System Science; and 3) advancing actionable science, to help address society's most pressing environmental challenges.

Status of the Facility

NCAR is operated for NSF by the University Corporation for Atmospheric Research (UCAR), a consortium of 120 member universities in the U.S. and overseas. Several significant infrastructure

improvement projects have recently been completed, including a full overhaul of the primary heating and cooling systems at the Mesa Laboratory that will result in considerable increases in efficiency and reduced operating costs. A major renovation of the Research Aviation Facility at the Rocky Mountain Metropolitan Airport has provided new, state-of-the art laboratory, engineering, and technical space in support of the two NSF-owned, NCAR-operated research aircraft and the community of scientists and engineers that use them.

Mesa Lab. *Credit: Copyright University Corporation for Atmospheric Research (UCAR), by Carlye Calvin, licensed under a Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License, via OpenSky.*

The installation of a powerful new supercomputer at the NCAR-Wyoming Supercomputing Center in FY 2022 will result in a more than threefold increase in the computing speeds available to users in the Earth System Science research community. The new system will be called 'Derecho' following a statewide naming competition among Wyoming school students.

Summary of COVID-19 Impacts

The majority of NCAR's programs have continued without interruption during the COVID-19 pandemic, with most community workshops, visitors' programs and other collaborations taking place remotely. Observational field campaigns involving NCAR's ground-based facilities and aircraft have, however, been severely impacted due to travel restrictions and other logistical challenges. These are now being resumed with appropriate COVID safety protocols, and it is anticipated that full operations will be possible by FY 2023.

Meeting Intellectual Community Needs

NCAR provides the user community with models, cyberinfrastructure, observing facilities, and collaborative opportunities, in addition to education, outreach, and training that are essential to the research community. FY 2021 highlights include:

- Every year, NCAR hosts a wide variety of community events including workshops, colloquia, conferences, symposia, and tutorials. In FY 2021, 95 events (600 individual sessions) were hosted: 31 workshops, 54 tutorials, five conferences, and five colloquia. These events reach an estimated total audience of 25,000 people.
- Students, scientists, engineers, weather forecasters, and other professionals from around the country and the world visit NCAR to collaborate with scientific, educational, or technical staff. They participate in community workshops and strategic discussions, conduct independent research, and participate on and/or oversee student, post-doctoral and professional projects. In FY 2021, NCAR hosted 220 visitors from 104 different institutions in 37 U.S. states and 15 countries.
- The Weather Research Forecast Model (WRF) continued to have strong user interest, with cumulative WRF registrations over 56,000 as of the end of FY 2021, and new model registrations averaging over 4,000 per year for the past three years. NCAR hosted the 2021 WRF/MPAS (Model for Prediction Across Scales) Users' Workshop (virtual) in June 2021 with 543 registered participants. NCAR also conducted online virtual WRF tutorials in January and July 2021, capped at 60 students each.

- The Community Earth System Model (CESM) continues to embrace open and transparent model development practices. As such, all model versions are readily available to the broader community on GitHub. This practice replaces the need for frequent model releases.
- The 26th annual CESM Workshop was held virtually in June 2021, bringing together researchers from around the world, including graduate students and early career scientists from universities and federal laboratories. It continues to be the only Earth System modeling workshop in the world, offering new cross-cutting working groups in addition to the regular CESM working groups. This year's workshop had 667 participants—the largest attendance in the workshop's history.
- NCAR's 534-petaflop high-performance computer (Cheyenne) and its GLobally Accessible Data Environment (GLADE) were used by more than 1,900 individuals at over 275 universities. During the year, daily utilization of the primary NCAR supercomputer averaged 84 percent (with 97.4 percent availability). In addition, NCAR maintains and provides simplified access to multi-terabyte datasets relevant to the atmospheric research community. The NCAR Research Data Archive (RDA) delivered more than 7.2 PB of data to 13,500 unique users. In FY 2021, 270 peer-reviewed articles and books cited RDA data sets.
- In FY 2021, pandemic travel restrictions continued to restrict field projects, with several planned campaigns being reduced or postponed. The NCAR-operated NSF Gulfstream G-V flew 121 research hours in support of three local airborne campaigns. In addition, NCAR provided lidar and radar data to a small university-led educational campaign in Fort Collins, CO. NCAR observing facilities staff supported eight universities, involving 12 investigators and 15 students.
- In response to the pandemic, NCAR hosted a biweekly virtual workshop, "Elements of a GEO REU" for PIs, and 10 career development workshops for 16 summer REU sites reaching 250 students.
- With additional funding from NSF, early career faculty, internship and postdoctoral fellowships were extended, and some additional positions supported to reduce disruptions to the careers of these groups of researchers particularly affected by the pandemic.

Governance Structure and Partnerships

NSF Governance Structure

NSF oversight is provided by a team of program officers in the Division of Atmospheric and Geospace Sciences (AGS) working cooperatively with staff from GEO, BFA, and the Office of the General Counsel. Within BFA, the Large Facilities Office and Division of Acquisition and Cooperative Support provide advice and guidance to program staff and assist with agency oversight and assurance. Programmatic oversight and a major part of NCAR's funding is provided by AGS. The award with UCAR, through which NCAR is managed and funded, contains terms and conditions that support AGS's oversight of the NCAR program and includes requirements for UCAR's management of the Center. These include a provision that UCAR submit for AGS approval an annual program operating plan that provides details about how resources will be used in that fiscal year. In addition, NCAR summarizes its past year's accomplishments in an annual scientific report and UCAR must report annually on its management of NCAR. Close coordination between AGS, UCAR, and NCAR helps ensure that scientific and facility priorities remain consistent with those of NSF. AGS program officers and management interact regularly with NCAR leadership and staff at all levels to ensure that NCAR's services and facilities support the evolving needs of PIs funded through AGS core programs. Additional oversight is applied for significant infrastructure upgrades, NCAR-managed community field campaigns, and other complex projects. While project oversight typically involves monthly videoconferences attended by relevant UCAR/NCAR personnel, the core NSF NCAR Integrated Project Team and other program staff

as appropriate, frequent ad hoc interactions by e-mail, telephone, and video conference form the basis of AGS's oversight of NCAR and UCAR.

The NSF Gulfstream V research aircraft. *Credit: Copyright, University Corporation for Atmospheric Research (UCAR), by Chad Slattery, licensed under a Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License, via OpenSky.*

External Governance Structure

As a consortium of universities and the manager of the national center, UCAR has the responsibility to engage the atmospheric and related sciences community, including universities and the broader scientific community, in its governance, planning and program implementation. Strong involvement of the external community is essential for effective NCAR science and facility planning, especially on longer time scales.

Formal mechanisms by which NCAR and UCAR receive community advice and input include a dedicated subcommittee of the UCAR Board of Trustees; standing external advisory committees for each NCAR laboratory, the NCAR Director and certain targeted initiatives; advisory panels for the allocation of computational and observational resources; governance bodies for the community models; and *ad hoc* panels providing advice on matters such as technical requirements for the next supercomputing upgrade. NSF staff often attend these meetings as observers, receive their reports, and discuss their findings, recommendations, and any necessary actions with NCAR/UCAR management. NSF may supplement this information with other activities such as community workshops or studies conducted by the National Academies of Sciences, Engineering, and Medicine.

Partnerships and Other Funding Sources

To support, enhance, and extend the capabilities of the university community and the broader scientific community, NCAR leverages NSF support with funding provided by other federal agencies and non-federal sources. In addition to NSF's $104.10 million investment in FY 2021, NCAR received approximately $40.80 million in support from other federal agencies, primarily the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the Department of Energy, the Department of Defense, and the Federal Aviation Administration. NCAR's non-Federal sources of income included State and local governments, universities, commercial organizations, and non-profits. This additional funding extended NCAR's core research into a wide variety of user-driven applications, such as wildfire management, road and aviation safety, public health, and renewable power generation.

Funding

Total Obligations for NCAR

(Dollars in Millions)

	FY 2021	FY 2022	FY 2023	ESTIMATES[1]				
	Actual	(TBD)	Request	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
Aircraft Support	$11.07	-	$12.50	$12.50	$12.50	$12.50	$12.50	$12.50
Computational Infrastructure	34.28	-	38.20	38.20	38.20	38.20	38.20	38.20
Other Facility Support	23.35	-	26.00	26.00	26.00	26.00	26.00	26.00
Research and Education Support	35.40	-	39.50	39.50	39.50	39.50	39.50	39.50
TOTAL	**$104.10**	**-**	**$116.20**	**$116.20**	**$116.20**	**$116.20**	**$116.20**	**$116.20**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends September 2023.

Annual support for NCAR is determined by NSF's priorities, the amount authorized by the NSB, and the availability of funds. Most major recurrent infrastructure costs are accommodated within this core funding—including periodic technology upgrades to the NCAR supercomputers, periodic aircraft inspections and maintenance, and buildings upgrades and maintenance. Additional funding may be provided for specific projects, such as the renovation of the NSF-owned NCAR Research Aviation Facility. Supplemental funding was also provided in FY 2021 to help mitigate the impacts of the pandemic on postdoctoral researchers and early career staff. Additional funding requested in FY2023 would support infrastructure upgrades to reduce NCAR's Carbon footprint; new initiatives in computational facilities and research; and an increased emphasis on actionable research to improve the nation's resilience to climate change and extreme events such as wildfire, drought, floods, and hurricanes.

Reviews

NSF conducts a comprehensive review of NCAR's science programs, facilities, and management at the mid-point of each five-year award. The 2021 review comprised four site visits by teams of 10-12 external experts. The visit focuses were: (1) Observing Science and Facilities; (2) Computation and Data Science and Facilities; (3) Community Modeling and Data Assimilation and (4) Management. The first three visits occurred between May and June 2021, and the fourth was held in August 2021. NSF is working with NCAR's management to review the site visit findings and incorporate them into NCAR's program plans. A Business Systems Review is planned during FY 2022.

Renewal/Recompetition/Termination

The current five-year award to manage and operate NCAR was made to UCAR with a start date of October 1, 2018. This award may be extended by an additional five-year term subject to satisfactory performance by the awardee. A determination of satisfactory performance will be informed primarily by the findings of the recent comprehensive mid-term scientific and management reviews. If recommended, UCAR may be invited to submit a renewal proposal for a second five-year term that will be reviewed by an external panel.