DIRECTORATE FOR GEOSCIENCES (GEO) **$836,610,000**
-$133,270,000 / -13.7%

GEO Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Percent
Atmospheric and Geospace Sciences (AGS)	$303.41	-	$234.45	-$68.96	-22.7%
Earth Sciences (EAR)	181.96	-	168.24	-13.72	-7.5%
Integrative and Collaborative Education and Research (ICER)	113.79	-	94.71	-19.08	-16.8%
Ocean Sciences (OCE)	370.73	-	339.21	-31.52	-8.5%
Total	**$969.88**	**-**	**$836.61**	**-$133.27**	**-13.7%**

About GEO

GEO supports basic research that advances the frontiers of knowledge and drives technological innovation while improving our understanding of the many processes that create and sustain vital natural resources on which society depends. Home to NSF's atmospheric and geospace, earth, and ocean research activities and providing administrative oversight to the Office of Polar Programs, GEO investigates diverse Earth processes including the planet's water cycle, interactions across the land-ocean interface, the behavior of ice sheets, and geologic processes responsible for hydrocarbon energy sources and strategic minerals. Earth system predictability is a cornerstone of the basic research supported by GEO; lives are saved and property is preserved by better forecasting and understanding of natural phenomena and environmental hazards such as earthquakes, tornadoes, drought, and solar storms. GEO-supported research improves society's preparation for the effects of these and other disruptive natural events, and GEO prioritizes support for interdisciplinary studies that contribute directly to national research priorities such as Earth system predictability, which includes mitigating the impacts of hazardous events and understanding future availability and distribution of fresh water.

Leveraging the knowledge and techniques of many other disciplines, GEO strongly promotes the growth of convergence research across all fields of science. GEO activities support and promote several of NSF's Big Ideas. GEO is the steward of funds designated for NSF's NNA Big Idea investments. OPP within GEO, in coordination with ENG and SBE, manages NSF's NNA Big Idea, and GEO's ICER division stewards $30.0 million to support crosscutting NNA research. GEO programs also contribute to HDR through the EarthCube activity. As observational sciences, geoscience relies on vast archives of data to forge new knowledge about the Earth. GEO also participates in URoL, primarily with focuses on microbiomes in the aquatic realm. For more information about the Big Ideas, see the narratives in the NSF-Wide Investments chapter.

GEO provides about 60 percent of the federal funding for basic research at academic institutions in the atmospheric, earth, and ocean sciences.

Major Investments

GEO Major Investments
(Dollars in Millions)

Area of Investment[1,2]	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Improving Undergraduate STEM Education (IUSE)	6.00	-	5.42	-0.58	-9.7%
NSF Innovation Corps (I-Corps™)	0.60	-	0.60	-	-
Coastlines and People (CoPe)	6.00	-	15.00	9.00	150.0%
NSF's Big Ideas					
NNA Stewardship	*30.00*	*-*	*30.00*	*-*	*-*

[1] Major investments may have funding overlap and thus should not be summed.
[2] This table reflects support for selected areas of investment. The same table in other directorate/office narratives may not present the same areas; thus funding should not be summed

- IUSE: Funding for the NSF-wide IUSE activity continues to support development of the next generation of geoscientists.
- I-Corps™: GEO will continue support for the NSF-wide I-Corps™ program that connects NSF-funded science and engineering research with the technological, entrepreneurial, and business communities.
- CoPe: CoPe was a new program in FY 2019 and received broad community interest. Through this program, GEO supports projects to build capacity and explore research to understand the impacts of coastal environmental variability and natural hazards on populated coastal regions. Improved Earth system prediction is a major CoPe objective.
- NNA: GEO provides stewardship of the NNA Big Idea. NNA fosters innovations in Arctic observational networks and fundamental convergence research across the social, natural, environmental, and computing and information sciences and engineering that address the intersection of natural, social, and built systems. Improved Earth system prediction is a major NNA objective.

GEO Funding for Centers Programs and Facilities

GEO Funding for Centers Programs
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$3.70**	**-**	**-**	**-$3.70**	**-100.0%**
STC: Center for Dark Energy Biosphere Investigations (OCE)[1]	3.70	-	-	-3.70	-100.0%

[1] The Center for Dark Energy Biosphere Investigations sunsets as planned.

For additional information on NSF's centers programs, please see the NSF-Wide Investments chapter.

GEO Funding for Major Multi-User Facilities

(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$359.08**	**-**	**$307.55**	**-$51.53**	**-14.4%**
Academic Research Fleet (ARF)[1]	85.32	-	80.00	-5.32	-6.2%
Arecibo Observatory[2]	4.44	-	1.50	-2.94	-66.2%
Geodetic Facility for the Advancement of Geoscience (GAGE)[3]	5.81	-	11.35	5.54	95.2%
International Ocean Discovery Program (IODP)[4]	53.00	-	47.00	-6.00	-11.3%
National Center for Atmospheric Research (NCAR)[5]	152.44	-	103.70	-48.74	-32.0%
Ocean Observatories Initiative (OOI)	44.01	-	43.00	-1.01	-2.3%
Seismological Facility for the Advancement of Geoscience (SAGE)[3]	14.06	-	21.00	6.94	49.3%

[1] Includes ship operations and upgrade support. The FY 2019 Actual includes $3.0 million for continuity of operations into FY 2020.

[2] The FY 2019 Actual includes $1.50 million for continuity of operations into FY 2020. It excludes $890,000 of FY 2019 O&M costs obligated in FY 2018.

[3] The FY 2019 Actual for GAGE and SAGE reflect part of an operating year as funding for these cooperative agreements were re-phased for continuity of operations into FY 2020.

[4] FY 2019 Actual includes $5.0 million for continuity of operations into FY 2020.

[5] The FY 2019 Actual includes $17.80 million for continuity of operations into FY 2020 as well as $30.94 million in funds re-obligated from prior award.

For information on continuity of operations funding, see the opening narrative of the Facilities chapter. For detailed information on individual facilities, please see the Facilities and the Major Research Equipment and Facilities Construction chapters.

Funding Profile

GEO Funding Profile

	FY 2019 Actual Estimate	FY 2020 (TBD)	FY 2021 Estimate
Statistics for Competitive Awards:			
Number of Proposals	3,643	-	3,700
Number of New Awards	1,366	-	1,200
Funding Rate	37%	N/A	32%
Statistics for Research Grants:			
Number of Research Grant Proposals	3,244	-	3,300
Number of Research Grants	1,149	-	1,000
Funding Rate	35%	N/A	30%
Median Annualized Award Size	$151,886	-	$152,000
Average Annualized Award Size	$218,727	-	$220,000
Average Award Duration, in years	2.9	-	3.0

In FY 2021, the number of research grant proposals is expected to increase as CoPe activities expand, and GEO expects to award about 1,000 research grants. Average annual award size and duration are not expected to materially deviate through FY 2021.

Program Monitoring and Evaluation

External Program Evaluations and Studies

- In FY 2020, the National Academies of Sciences, Engineering, and Medicine will initiate a study that develops a new vision for a systems approach to studying the Earth and the facilities, infrastructure, mechanisms, computation, workforce development, and agency collaborations needed to support that vision. Envisioned as a sixteen-month activity, this vision for a systems approach will inform research activities across GEO.
- In the summer of 2020, EAR anticipates delivery of the report on "Catalyzing Opportunities for Research in Earth Sciences" commissioned to the National Academies of Science, Engineering, and Medicine (the National Academies). The panel of experts leading the study held seven open meetings where they gathered information from the research community. The report will be peer-reviewed prior to its publication.

Workshops and Reports

In FY 2019, OCE held a facilitated "Future of Marine Seismic Capabilities Workshop" with approximately 40 representatives of the academic community and private sector to identify viable options for the continued support of the marine seismic community's need for long-term sustainable access to seismic data collection capability currently available on R/V *Marcus G. Langseth*. The workshop results provided important inputs for the development and release of solicitation NSF 20-533 "Facilitator of Marine Seismic Capabilities for the U.S. Research Community." The Facilitator, planned to be in place mid-late FY 2020, will work with researchers in identifying suitable vessels (commercial, foreign academic, or other) to support NSF-funded seismic research projects and will also be responsible for arranging and negotiating competitive lease agreements for marine seismic research activities that have been determined by NSF to be high-priority projects following the merit review process.

Committees of Visitors (COV)

In 2019, a COV reviewed research programs in OCE. The COV presented their reports[1] to the GEO Advisory Committee at the October 2019 meeting. The COV made several recommendations, including expanding opportunities to support mid-size projects, ways of improving the funding rates for some classes of proposals, and improving the proposal review process.

- In 2020, a COV will review activities in AGS.
- In 2021, COVs will review activities in EAR and GEO education and diversity programs.

The Performance and Management chapter provides details regarding the periodic reviews of programs and portfolios of programs by external Committees of Visitors and directorate Advisory Committees. Please see this chapter for additional information.

[1] www.nsf.gov/geo/acgeo_cov.jsp

People Involved in GEO Activities

Number of People Involved in GEO Activities

	FY 2019 Actual Estimate	FY 2020 (TBD)	FY 2021 Estimate
Senior Researchers	5,174	-	4,700
Other Professionals	2,928	-	2,600
Postdoctoral Associates	628	-	600
Graduate Students	2,524	-	2,300
Undergraduate Students	2,339	-	2,100
Total Number of People	**13,593**	**-**	**12,300**

DIVISION OF ATMOSPHERIC AND GEOSPACE SCIENCES (AGS) **$234,450,000**
-$68,960,000 / -22.7%

AGS Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Percent
Total	**$303.41**	**-**	**$234.45**	**-$68.96**	**-22.7%**
Research	**118.55**	**-**	**105.71**	**-12.84**	**-10.8%**
Education	**2.26**	**-**	**3.54**	**1.28**	**56.4%**
Infrastructure	**182.59**	**-**	**125.20**	**-57.39**	**-31.4%**
Arctic Logistics	0.25	-	-	-0.25	-100.0%
Arecibo Observatory[1]	4.44	-	1.50	-2.94	-66.2%
NCAR[2]	152.44	-	103.70	-48.74	-32.0%
Research Resources	25.47	-	20.00	-5.47	-21.5%

For information on continuity of operations funding, see the opening narrative of the Facilities chapter.

[1] The FY 2019 Actual includes $1.50 million for continuity of operations into FY 2020. It excludes $890,000 of FY 2019 O&M costs obligated in FY 2018.

[2] The FY 2019 Actual includes $17.80 million for continuity of operations into FY 2020 as well as $30.94 million in funds re-obligated from prior award.

About AGS

AGS supports fundamental research activities that lead to improved understanding of the dynamics of the sun, the physics, chemistry, and dynamics of the Earth's atmosphere and near-space environment, and how the sun interacts with the Earth's atmosphere. Improved understanding drives state-of-the-science model development and improved predictability of weather, climate, and space weather events. AGS provides support for: (1) basic science projects and (2) the acquisition, maintenance, and operation of observational and cyber-infrastructure facilities and services that enable and support modern-day atmospheric and geospace science research activities. AGS support occurs via the traditional individual investigator merit-reviewed multi-year grants, limited duration exploratory research projects, and collaborative and multi-investigator group projects.

In addition, research is conducted using world-class facilities provided by the National Center for Atmospheric Research (NCAR). Through improvements to our understanding of severe weather events, and the development of sophisticated computer models that simulate and forecast such events and their impacts, AGS helps protect life, property, and natural resources, and contributes to the establishment of a weather-ready and space weather-ready nation. AGS-supported scientists lead innovations ranging from the miniaturization of sensors that fly on CubeSats, to the development of models that provide the scientific basis of forecasting a variety of severe weather hazards. AGS also funds STEM education, fosters the success of early career scientists, and supports the continuing development of a world-class scientific and technical workforce that contributes significantly to the nation's economic vitality.

About 32 percent of the AGS portfolio is available for new research grants. The remaining 68 percent supports research grants made in prior years and the research infrastructure that supports the capabilities, creativity, and innovation of the atmospheric and geospace science community. AGS frequently participates in major NSF-wide initiatives and long-standing NSF programs, such as the Major Research Instrumentation program. AGS also partners with other programs within GEO, across other NSF directorates, and with other federal agency partners, to help ensure that the most impactful science is being funded.

DIVISION OF EARTH SCIENCES (EAR) **$168,240,000**
-$13,720,000 / -7.5%

EAR Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$181.96**	**-**	**$168.24**	**-$13.72**	**-7.5%**
Research	**131.07**	**-**	**111.79**	**-19.28**	**-14.7%**
Education	**5.69**	**-**	**4.81**	**-0.88**	**-15.5%**
Infrastructure	**45.20**	**-**	**51.64**	**6.44**	**14.3%**
GAGE[1]	5.81	-	11.35	5.54	95.2%
NNCI	-	-	0.29	0.29	N/A
SAGE[1]	14.06	-	21.00	6.94	49.3%
Research Resources	25.32	-	19.00	-6.32	-25.0%

For information on continuity of operations funding, see the opening narrative of the Facilities chapter.

[1] The FY 2019 Actual for GAGE and SAGE reflect part of an operating year as funding for these cooperative agreements were re-phased for continuity of operations into FY 2020.

About EAR

EAR supports fundamental research into the structure, composition, and evolution of the Earth, and the life it has sustained over the four and a half billion years of Earth history. The results of this research will lead to a better understanding of Earth's changing environment (past, present, and future), the natural distribution of its mineral, water, biota, and energy resources, and provide methods for predicting and mitigating the effects of geologic hazards such as earthquakes, volcanic eruptions, floods, and landslides.

EAR supports research in geomorphology and land use, hydrologic science, geobiology and low temperature geochemistry, sedimentary geology and paleobiology, geophysics, petrology and geochemistry, tectonics, and integrated Earth systems. In addition to these fundamental research programs, EAR has an Instrumentation and Facilities program that supports community-based, shared-use facilities and the acquisition and development of instrumentation by individual investigators; and an education program that funds several activities to attract and support students and young investigators to the field of Earth science.

In general, about 49 percent of the EAR portfolio is available for new research grants. The remaining 51 percent supports research grants made in prior years and the research infrastructure needed by this community.

DIVISION OF INTEGRATIVE AND COLLABORATIVE EDUCATION & RESEARCH (ICER) **$94,71,000**
-$19,080,000 / -16.8%

ICER Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Percent
Total	**$113.79**	**-**	**$94.71**	**-$19.08**	**-16.8%**
Research	**101.24**	**-**	**89.29**	**-11.95**	**-11.8%**
Education	**12.55**	**-**	**5.42**	**-7.13**	**-56.8%**

About ICER

ICER supports novel, complex, or partnership projects in both research and education. These investments cut across traditional boundaries within the geosciences, encouraging interdisciplinary activities and responding directly to critical needs of the entire geoscience community. ICER's principal goals are to develop innovative means to initiate and support geoscience education, attract underrepresented groups to careers in the geosciences, foster the interchange of scientific information nationally and internationally, and join with other parts of NSF in major integrative research and education efforts. In addition, in partnership with several of the NSF directorates, ICER will advance the NNA Big Idea by investing funds to support convergent activities that transcend the traditional disciplinary boundaries of individual NSF directorates and offices. In FY 2021, the division will make strategic investments in multidisciplinary research areas, international activities, education, diversity, and human resource development. A continuing emphasis in FY 2021 is in the area of Coastlines and People (CoPe), which supports research focused on understanding the impacts of coastal environmental variability and natural hazards on populated coastal regions. The results of ICER investments will assist in ensuring that the U.S. has a well-educated and diverse workforce in the geosciences and in related technical fields such as resource exploration.

In general, about 82 percent of the ICER portfolio is available for new research grants with the remaining amount supporting grants made in prior years.

DIVISION OF OCEAN SCIENCES (OCE) **$339,210,000**
-$31,520,000 / -8.5%

OCE Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual Amount	Change over FY 2019 Actual Percent
Total	**$370.73**	**-**	**$339.21**	**-$31.52**	**-8.5%**
Research	**170.69**	**-**	**155.41**	**-15.28**	**-9.0%**
Centers Funding (total)	3.70	-	-	-3.70	-100.0%
STC: Center for Dark Energy Biosphere Investigations[1]	3.70	-	-	-3.70	-100.0%
Education	**5.38**	**-**	**4.58**	**-0.80**	**-14.9%**
Infrastructure	**194.65**	**-**	**179.22**	**-15.43**	**-7.9%**
ARF[2]	85.32	-	80.00	-5.32	-6.2%
IODP[3]	53.00	-	47.00	-6.00	-11.3%
OOI	44.01	-	43.00	-1.01	-2.3%
Research Resources	12.32	-	9.22	-3.10	-25.2%

For information on continuity of operations funding, see the opening narrative of the Facilities chapter.

[1] The Center for Dark Energy Biosphere Investigations sunsets as planned.

[2] Includes ship operations and upgrade support. FY 2019 Actual includes $3.0 million for continuity of operations into FY 2020.

[3] FY 2019 Actual includes $5.0 million for continuity of operations into FY 2020.

About OCE

OCE supports cutting-edge research, education, and infrastructure that advances the Nation's scientific knowledge of the oceans to support the U.S. economy over the long-term, provides vital information regarding national security matters such as sea level rise, and advances U.S. leadership in ocean science and technological innovation. OCE provides support of basic, including interdisciplinary scientific research and technology development to better understand the drivers of ocean circulation and other physical and chemical parameters, biodiversity and the dynamics of marine organisms and ecosystems, and changes in the marine environment as exemplified by ocean acidification. OCE also supports research on the geology and geophysics of the ocean margins and sub-seafloor to investigate natural hazards such as earthquakes and volcanic eruptions, nearshore processes affecting the coasts, the long-term evolution of marine systems, and other fundamental ocean processes. Ocean education emphasizes the interdisciplinary nature of ocean sciences, and commonly leverages research facilities and infrastructure via telepresence to far and distant seas. Since ocean science requires access to the sea, OCE supports research vessels, deep submergence capability including submersibles and autonomous vehicles, and technologically-advanced sensors and instrumentation. Broadly speaking, research, education, and infrastructure funded by OCE addresses the central role of the oceans in a changing Earth and as a national strategic resource, as recognized by numerous reviews by external bodies (e.g., the National Academies Decadal Survey Sea Change).

In general, about 29 percent of the OCE portfolio is available for new research grants, with the remainder supporting grants made in prior years and the research infrastructure needed by this community.