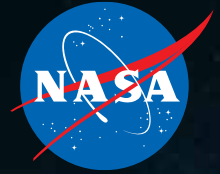


National Aeronautics and
Space Administration



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ECONOMIC IMPACT REPORT

October 2022





Stephan's Quintet, a visual grouping of five galaxies, is best known for being prominently featured in the holiday classic film, "It's a Wonderful Life." NASA's James Webb Space Telescope reveals Stephan's Quintet in a new light. This enormous mosaic is Webb's largest image to date, covering about one-fifth of the Moon's diameter. James Webb Space Telescope is managed at Goddard in Maryland with contributions from industries across the country and international partners across the globe.



Support
by
NASA, ESA, and
Robert Gendler

NASA contributes to our Nation's economic competitiveness, fueling growth in American industry and supporting quality, high-paying jobs across the country. NASA commissioned a study of its national economic impact for FY21, which showed that every U.S. state and the District of Columbia benefited from NASA activities.

Additionally, the report examines the impact of NASA's Moon-to-Mars campaign and investments in climate change research and technology.

The analysis uses a standard national economic input-output model that has been in existence and tested for more than 50 years. In many ways, those numbers are conservative since the overall economic impact of NASA is truly far greater than what any one number can ever hope to convey.

NASA's economic impact is seen in the resurgence of the U.S. commercial space economy, which is seeing unprecedented levels of private investment and growth. It's seen in a surge of new space companies. There is estimated to have been over \$15 billion in private investments in space start-up companies in 2021 and the majority of these investments were made in U.S. companies — in no small part due to NASA's strong support for our domestic commercial space industry through our partnerships, contracts, and technology transfer activities.

NASA's economic impact is also seen in the incalculable value of the climate change data provided by our earth observation satellites and scientists, and shared freely and openly with the world. This lets us understand the magnitude of the challenge that climate change presents and helps provide new knowledge and tools for mitigating and adapting to these changes.

And the economic impact of NASA is international. The agency is one of the most recognized and valued brands on planet Earth and serves as an embodiment of the hope and dream that humans everywhere can cooperate together to explore the stars. Through the International Space Station, our Artemis and Moon to Mars activities, and hundreds of international partnerships in space science, aeronautics, and space technologies, NASA has a truly positive impact on the global economy, with the result that more and more economies around the planet are becoming integrated into the emerging space economy.

These commercial, scientific, and international contributions are additional impacts above and beyond the estimated levels of economic impact calculated in the Economic Impact Report. As time passes, it may well be that some of the most important NASA contributions to our economy come from activities we are barely even aware of today. But we already know of innumerable ways in which NASA's economic impact is strong — and getting stronger.



Bill Nelson
Administrator
National Aeronautics and Space Administration



NASA's vision for Advanced Air Mobility (AAM) Mission is to help emerging aviation markets to safely develop an air transportation system that moves people and cargo between places previously not served or underserved by aviation – local, regional, intraregional, urban – using revolutionary new aircraft that are only just now becoming possible. AAM includes NASA's work on Urban Air Mobility, and will provide substantial benefit to U.S. industry and the public.

NASA's National Economic Impact

While NASA has field centers operating in various parts of the country, the impact of NASA spending (both labor and procurement) is not confined to states that have active NASA facilities.

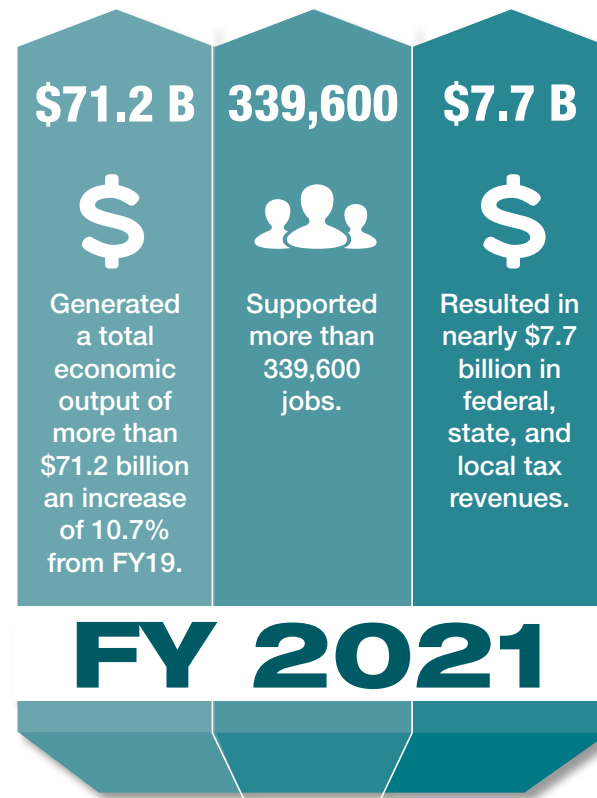
All 50 states see economic benefits from NASA's missions of aerospace research and space exploration.

Results from NASA's research and development activities ripple throughout the national economy, supporting high-tech industries and creating or sustaining tens of thousands of knowledge-intensive jobs. In addition, NASA invests in economically valuable technologies that help the nation maintain its competitive advantage. These investments improve U.S. businesses productivity and global competitiveness.

In FY21, NASA employed more than 19,000 civil servants and had a budget of \$23.27 billion. Through labor expenditures and procurements, this resulted in a significant economic impact across the nation.

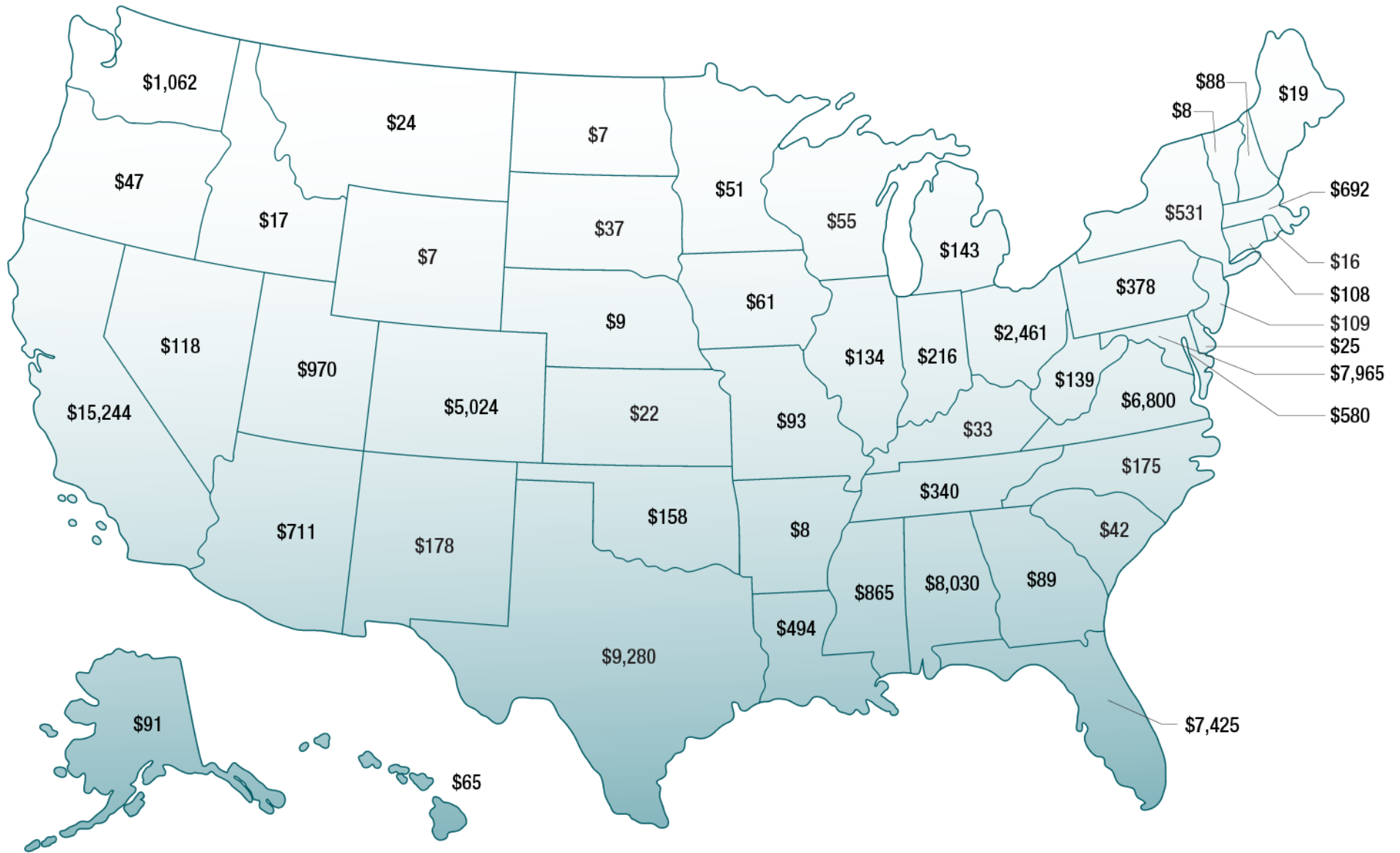
In FY21, NASA's efforts*

- Impacted all 50 states and the District of Columbia.

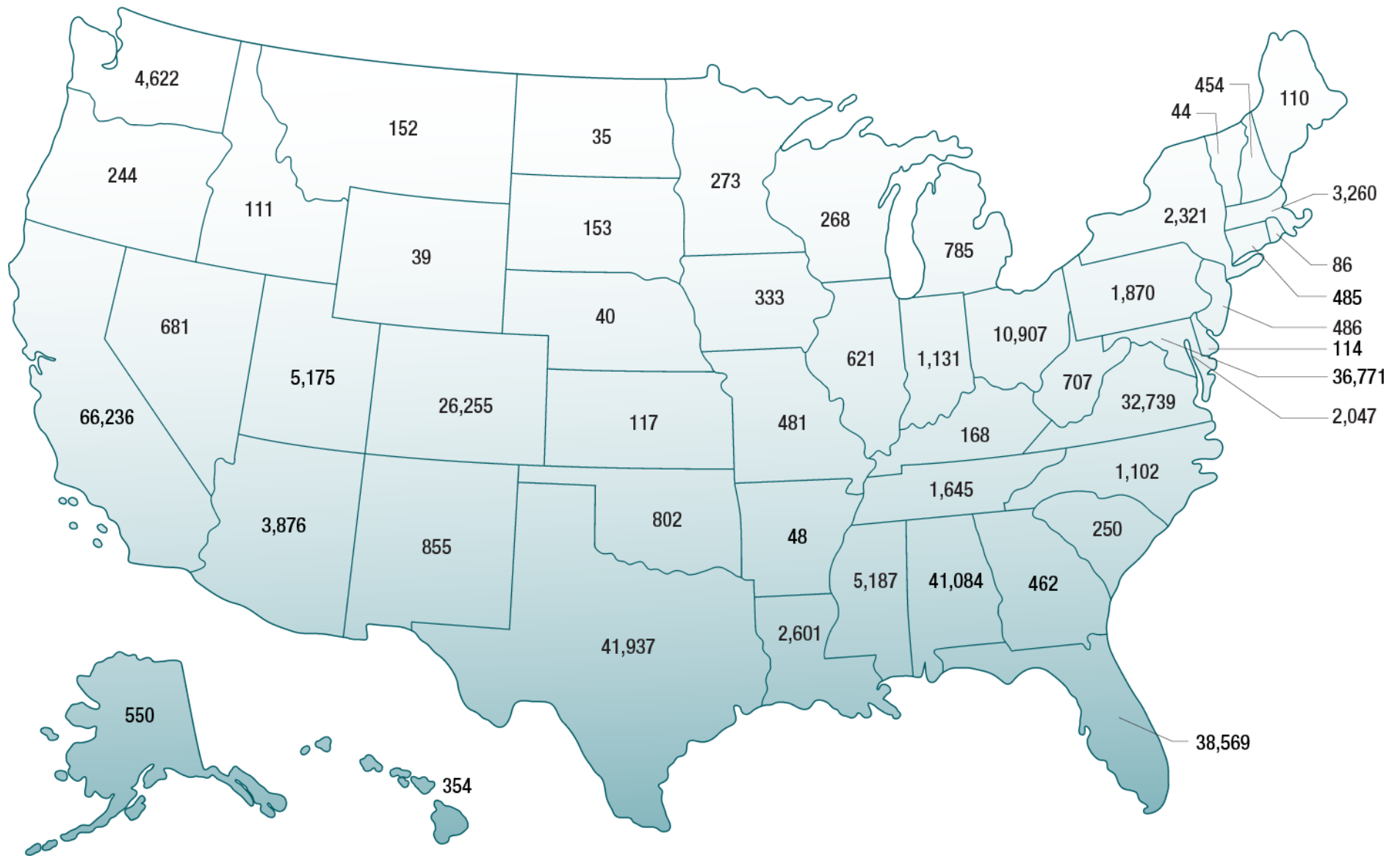


* These are estimates derived by a national economic modeling application [IMPLAN] based on NASA's procurement and labor expenditures.

NASA Output Impact by State (\$M)



NASA Employment Impact by State





Artemis I's Space Launch System rocket (managed at Marshall in Alabama) and the Orion Crew Capsule (managed at Johnson in Texas) sit on the mobile launch pad in Florida.

NASA's human lunar exploration plans under Artemis call for sending the first woman and first person of color to the surface of the Moon and establishing sustainable exploration by the end of the decade. Working with U.S. companies and international partners, NASA will uncover new scientific discoveries and lay the foundation for long-term lunar exploration and development. The agency will use what it learns on the Moon to prepare for humanity's next giant leap — sending astronauts to Mars.

It all starts with U.S. companies delivering scientific instruments and technology demonstrations to the lunar surface, followed by a spaceship, called the Gateway, in orbit around the Moon that will support human and scientific missions, and human landers that will take astronauts to the surface of the Moon. The agency's powerful Space Launch System rocket and Orion spacecraft (pictured on the previous page) are the backbone to build the Gateway and transport astronauts to and from Earth.

Some highlights of the economic impacts that occur throughout the national economy include:

- M2M economic activity across the U.S. supports more than 93,700 jobs.
- M2M spending supports more than \$20.1 billion in total economic output across the country, an increase of 42.6% from FY19.
- The M2M program generates an estimated \$2.2 billion in federal, state, and local tax revenues nationwide.



Moon to Mars (M2M) Campaign

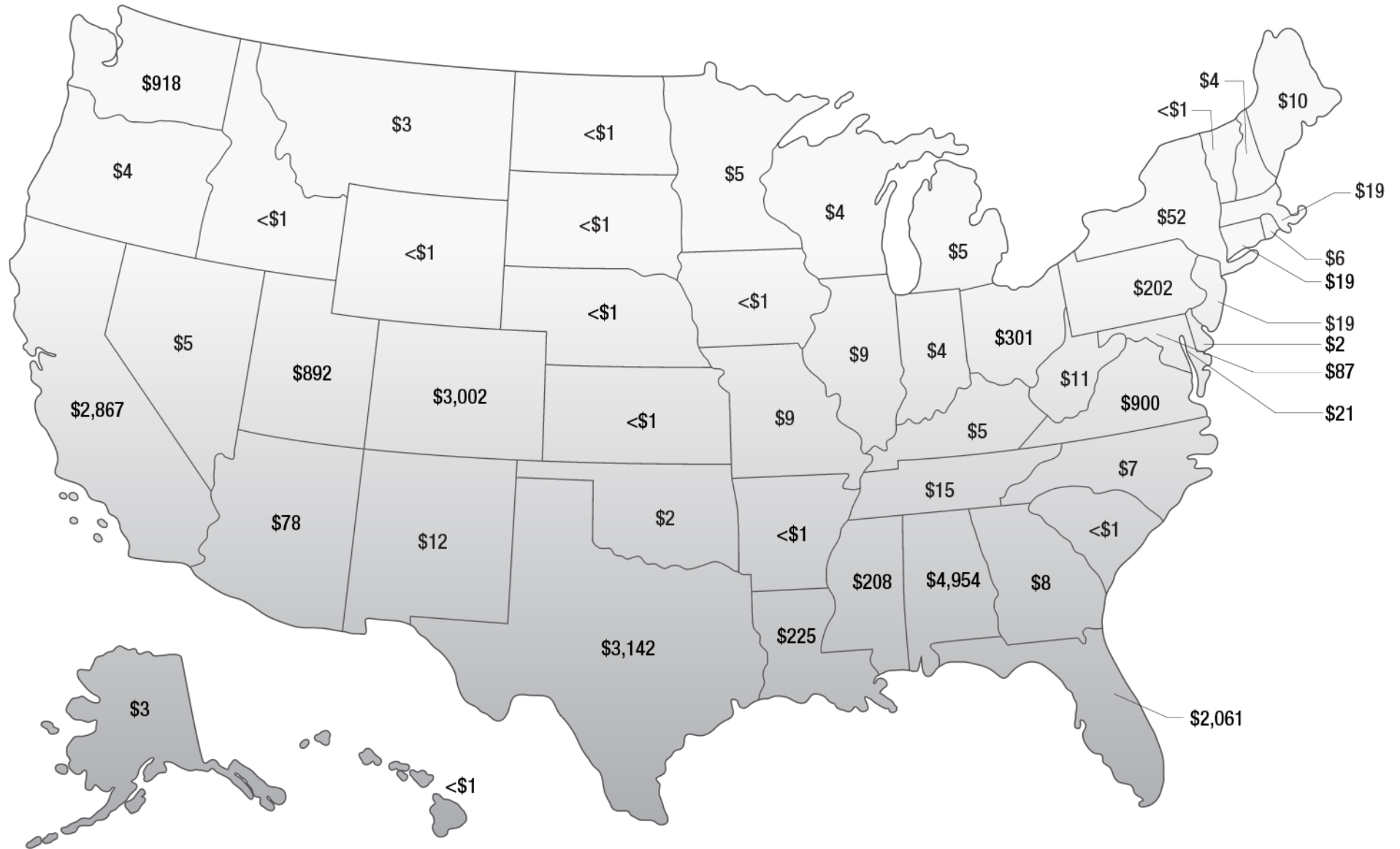
The following represents the variety of programs and projects of the M2M campaign:

- The Space Launch System
- Orion spacecraft
- All ground support equipment for development, testing, and launch of SLS/Orion
- Gateway
- Human Landing System
- Space suits for lunar surface operations
- In situ resource utilization, surface power systems, life support, and other advanced technology developments for a sustained lunar presence
- Mars 2020 & Sample Return
- Commercial Lunar Payload Services

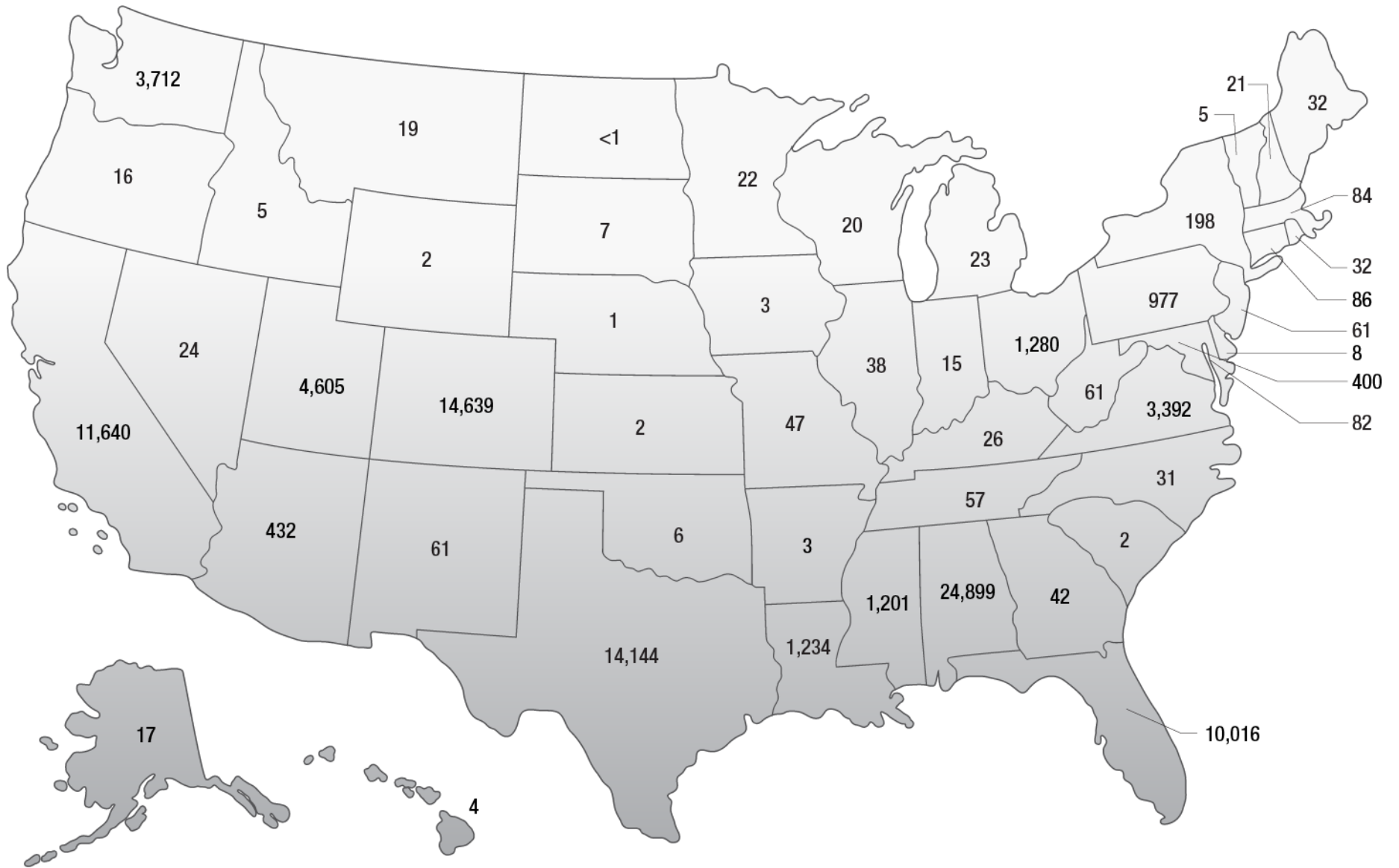
For additional information about NASA's moon to Mars campaign, please visit

[EXPLORE MOON to MARS.](#)

NASA Moon to Mars Campaign Output Impact by State (\$M)



NASA Moon to Mars Campaign Employment Impact by State





This natural color image of Eleuthera Island, the Bahamas, was taken by Landsat 9 on January 18, 2022. Between Landsat 8 and Landsat 9, the Landsat program delivers complete coverage of the Earth's surface every eight days. Landsat is jointly managed by NASA and the USGS, and is an example of NASA partnering with other government agencies to benefit the world.

NASA is a global leader in studying Earth's changing climate. The agency's observations of Earth from space, the air, and on the ground are helping humans learn how the interconnected systems of the planet interact.

NASA has a broad climate research program. Among the many areas NASA studies are greenhouse gases, temperature change, changes in sea ice and land ice, sea level rise, clouds and precipitation, and air pollution. NASA also develops technologies that can be used to mitigate or adapt to climate change, like sustainable aviation technologies.

In addition to providing the nation and world with unique climate observations, analysis, and modeling, this research helps NASA better assess the impacts of climate change on its mission and ensure the resiliency of its facilities and assets. NASA's capabilities in researching Earth and its atmosphere will continue to be critical in understanding causes and effects of temperature changes, sea level rise, and other major climate changes.

- NASA's investments in climate change research and technology economic activity across the U.S. supports more than 37,000 jobs.
- NASA's investments in climate change research and technology spending supports more than \$7.4 billion in total economic output across the country.
- NASA's investments in climate change research and technology generates an estimated \$810 million in federal, state, and local tax revenues nationwide.



NASA's Investments in Climate Change Research and Technology

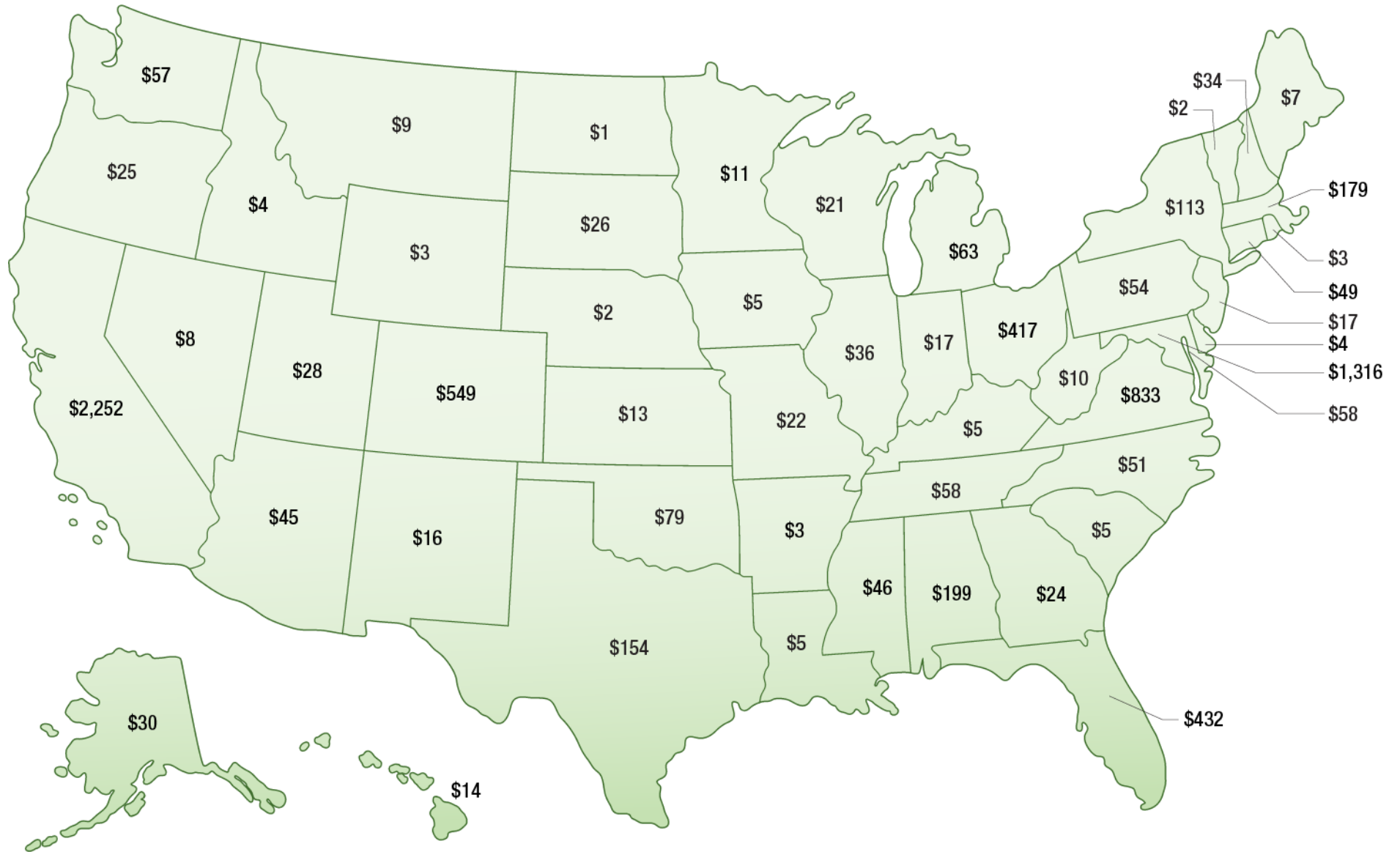
The following represents the variety of programs and projects included in NASA's investments in climate change research and technology:

- **Earth Science Activities**
 - Earth Science Research
 - Earth Systematic Mission
 - Earth System Science Pathfinder Applied Science (Pathways, including SERVIR)
 - Earth System Explorers
 - Earth Science Technology
- **Aeronautics Activities**
 - Advanced Air Transport Tech
 - Advanced Composites Project
 - Advanced Air Mobility
 - Air Traffic Management eXploration
 - Airspace Technology Demonstration
 - Convergent Aeronautics Solutions
 - Cross Program Operations
 - Environmentally Responsible Aviation
 - Hi-Rate Composite Aircraft Manufacturing
 - Hybrid Thermally Efficient Core
 - SMART-NAS Test Bed for Safe TBO
 - Transformational Tools and Technologies
- **Space Technology Activities**
 - Portions of Space Technology Research Grants; Technology Transfer; Small Business Technology Transfer
 - TDM Fission Surface Power
 - GCD Nuclear Systems
- **Portions of Experimental Program to Stimulate Competitive Research (EPSCoR)**
- **Construction and environmental compliance and remediation efforts at NASA facilities**

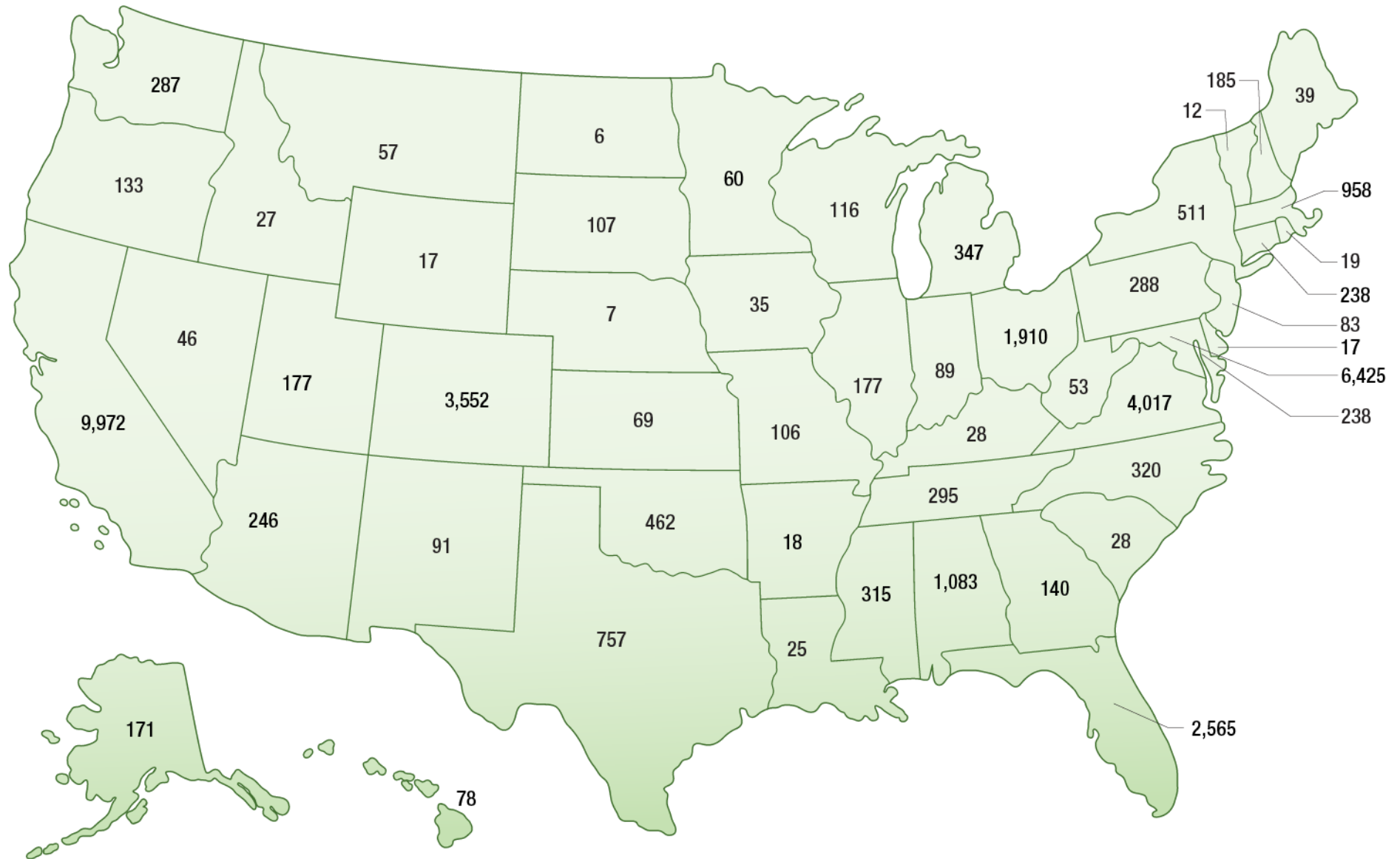
For more information about NASA's Climate Change activities, please visit [GLOBAL CLIMATE CHANGE, Vital Signs of the Planet](#).

NASA's Investments in Climate Change Activities

Output Impact by State (\$M)



NASA's Investment in Climate Change Activities Employment Impact by State





The sun rises above the Earth's horizon in this photograph from the International Space Station (ISS) as it orbited 262 miles above the Pacific Ocean. The ISS is the current core of the emerging economy in low-Earth orbit.

NASA, from its inception with the National Aeronautics and Space Act of 1958, has a mandate to involve the international community in its mission of scientific discovery and space exploration. Beyond direct partnerships with dozens of nations over its history, the expansion of humanity's influence into orbit and beyond has led to a booming space economy — satellites, launch vehicles, research and development, space tourism, and more.

Today, there are more than 90 nations active in space, employing more than a million people and representing more than \$107 billion in spending by world governments. The total value worldwide of this space economy has grown to more than \$469 billion. There are 49 active and in development spaceports worldwide, with more proposed. The number of patents awarded to space-related technologies has quadrupled over the past two decades.* In 2031, it is projected that 10.9 million people will be employed in STEM fields in the U.S.**

International Partnerships

NASA's most extensive international partnership orbits approximately 250 miles above the Earth's surface, circling the planet every hour and a half. The International Space Station, representing 15 nations and five space agencies (NASA, Roscosmos, the European Space Agency, Japanese Aerospace Exploration Agency, and the Canadian Space Agency) has been operating for more than 20 years, providing a unique orbital laboratory that has performed thousands of experiments during its operational lifetime. In addition to the ISS, NASA had more than 640 active international agreements for various scientific research and technology development activities in FY21, representing everything from ground-based research and development to scientific instruments that study other worlds.



The Artemis Accords

While NASA is leading the Artemis missions, international partnerships will play a key role in achieving a sustainable and robust presence on the Moon while preparing to conduct a historic human mission to Mars. With numerous countries conducting missions and operations in cislunar space, it is critical to establish a common set of principles to assure the safe and responsible exploration of outer space.

As of October 2022, 21 countries have signed the accords.

United for Peaceful Exploration of Deep Space



* Data from Space Foundation's *The Space Report 2022 Q2* global space economy analysis: <https://www.spacefoundation.org/2022/07/27/the-space-report-2022-q2/>

** U.S. Bureau of Labor Statistics: <https://www.bls.gov/emp/tables/stem-employment.htm>



NASA's all-electric X-57 Maxwell (managed at Armstrong in California) continues to undergo high-voltage ground testing with successful spinning of the propellers under electric power. The principal goals of the X-57 Project are to share the X-57 design and airworthiness process with regulators and standards organizations; and to establish the X-57 as a reference platform for integrated approaches of distributed electric propulsion technologies. Electric aviation has the potential to reduce greenhouse gas emissions from air travel.

Partnerships are an increasingly important part of how NASA creates positive impacts across the U.S. economy. Through partnerships, the Agency provides over 60 years of experience in advanced engineering and testing capabilities, cutting-edge research, and technology development, as well as unique land, to hundreds of commercial companies, academic institutions, U.S. Government agencies, and international entities.

NASA Partnerships continue to evolve and diversify as external partners and capabilities expand. These partners continue to make breakthroughs in exploration technology and science in areas pertinent to NASA's missions. Partnering with all segments is vital in successfully accomplishing NASA missions in everything from returning to the Moon to stay with Artemis, to flight technology like NASA's all-electric X-57 Maxwell (pictured on the previous page).

FY21 NASA Non-Procurement Partnership highlights include:

- 2,655 active domestic and international partnership agreements.
- 697 new domestic and 122 new international agreements.
- 700 different active partnerships with non-Federal U.S. Partners.
- Partnerships in 44 of 50 states.



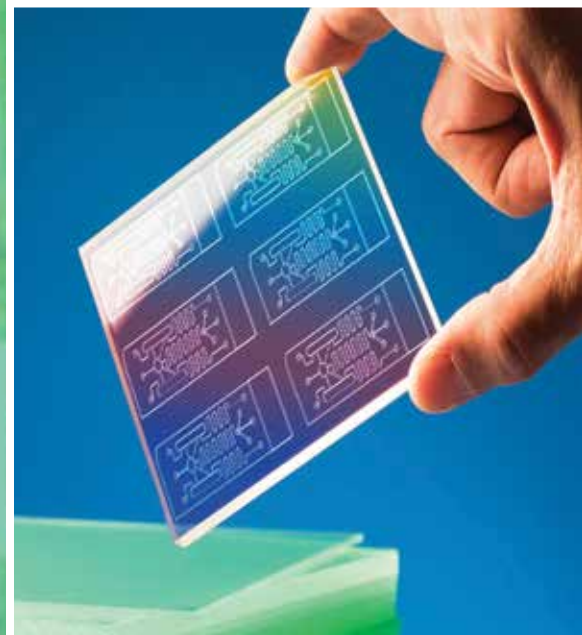
FY21 Innovative Non-Procurement Partnership Examples

- **NASA's Aeronautics National Campaign:** thirteen companies and one university have signed agreements with NASA's Advanced Air Mobility National Campaign to continue work towards integrating air taxis, cargo delivery aircraft and other new air vehicle concepts into the national airspace system to move people and cargo between places not previously served or underserved by aviation.
- **Jet Propulsion Lab (JPL):** providing Deep Space network services to Astrobotic under a reimbursable Space Act Agreement supporting plans for commercial space lunar exploration. Astrobotic's first lunar lander, Peregrine, is scheduled to launch from NASA's Kennedy Space Center in Florida.

For more partnership examples: <https://www.nasa.gov/partnerships/recent-partnerships.html>



Plenty Unlimited maintains plant health using robotics in nearly every step of the farming process. The growing environment mimics the closed-loop environment developed by NASA in the Biomass Production Chamber that demonstrated how to grow plants without sunlight or open air. Credit: Plenty Unlimited Inc.



NASA drives economic development and growth through technological innovation. When NASA develops the advanced technologies necessary for space exploration or makes breakthrough scientific discoveries about the universe, it isn't just applicable to the Agency's missions in space. Many of these developments find applications in everyday American life. Through spinoff technologies and the Agency's Technology Transfer Program, NASA provides an impact on American lives beyond dollars and jobs.

Infusing NASA Technology into the American Economy

NASA's Technology Transfer Program ensures that innovations developed for exploration and discovery are broadly available to the public, maximizing the benefit to the Nation. The first step in getting NASA technology into your daily life are New Technology Reports (NTRs), detailing any invention, discovery, improvement, or innovation that was either conceived or first put in practice as part of NASA work. In addition to NTRs, every year NASA personnel file dozens of patent applications and enable hundreds of people to access NASA-developed software for use in research or business. These spinoff technologies find new and beneficial applications in health care, transportation, public safety, energy, industrial production, and more. From new remote sensor technology that helps doctors better diagnose patients to new insulation to make power plants more efficient, NASA technology has an impact on the daily life of every American in myriad ways.



Tech Transfer 2021

- 1,542 New Technology Reports
- 67 new patent applications filed
- 112 patents issued
- 5,168 software usage agreements

Indoor Farming

- The need to generate oxygen and grow food in space inspired NASA to test indoor agriculture techniques.
- Thanks to agency-funded research, private companies are building on NASA's vertical farm structure (the first ever built in the United States), plant-growth "recipes," and environmental-control data to create successful indoor farms (pictured on the previous page).
- After decades of NASA research, the Controlled Environment Agriculture (CEA) industry expanded dramatically in the 1990s due in part to hundreds of millions of dollars invested by high-tech companies. In FY21, the global vertical farming market was worth about \$3.1 billion and is projected to reach \$9.7 billion by 2026*.
- Imagery and full article here: <https://spinoff.nasa.gov/indoor-farming>

* [Vertical Farming Market worth \\$9.7 billion by 2026 – Exclusive Report by MarketsandMarkets™ – Bloomberg](#)

For more information on NASA Environmental Solutions, please visit: [Environmental Solutions Through NASA Technology](#)

Summary: NASA Impacts by State

	National Impact		Moon to Mars		Climate Change	
	Jobs	Output	Jobs	Output	Jobs	Output
Alabama	41,084	\$8,030,000,000	24,899	\$4,954,000,000	1,083	\$199,000,000
Alaska	550	\$91,000,000	17	\$3,000,000	171	\$30,000,000
Arizona	3,876	\$711,000,000	432	\$78,000,000	246	\$45,000,000
Arkansas	48	\$8,000,000	3	\$1,000,000	18	\$3,000,000
California	66,236	\$15,244,000,000	11,640	\$2,867,000,000	9,972	\$2,252,000,000
Colorado	26,255	\$5,024,000,000	14,639	\$3,002,000,000	3,552	\$549,000,000
Connecticut	485	\$108,000,000	86	\$19,000,000	238	\$49,000,000
Delaware	114	\$25,000,000	8	\$2,000,000	17	\$4,000,000
Florida	38,569	\$7,425,000,000	10,016	\$2,061,000,000	2,565	\$432,000,000
Georgia	462	\$89,000,000	42	\$8,000,000	140	\$24,000,000
Hawaii	354	\$65,000,000	4	\$1,000,000	78	\$14,000,000
Idaho	111	\$17,000,000	5	\$1,000,000	27	\$4,000,000
Illinois	621	\$134,000,000	38	\$9,000,000	177	\$36,000,000
Indiana	1,131	\$216,000,000	15	\$4,000,000	89	\$17,000,000
Iowa	333	\$61,000,000	3	\$1,000,000	35	\$5,000,000
Kansas	117	\$22,000,000	2	\$1,000,000	69	\$13,000,000
Kentucky	168	\$33,000,000	26	\$5,000,000	28	\$5,000,000
Louisiana	2,601	\$494,000,000	1,234	\$225,000,000	25	\$5,000,000
Maine	110	\$19,000,000	32	\$10,000,000	39	\$7,000,000
Maryland	36,771	\$7,965,000,000	400	\$87,000,000	6,425	\$1,316,000,000
Massachusetts	3,260	\$692,000,000	84	\$19,000,000	958	\$179,000,000
Michigan	785	\$143,000,000	23	\$5,000,000	347	\$63,000,000
Minnesota	273	\$51,000,000	22	\$5,000,000	60	\$11,000,000
Mississippi	5,187	\$865,000,000	1,201	\$208,000,000	315	\$46,000,000
Missouri	481	\$93,000,000	47	\$9,000,000	106	\$22,000,000
Montana	152	\$24,000,000	19	\$3,000,000	57	\$9,000,000

	National Impact		Moon to Mars		Climate Change	
	Jobs	Output	Jobs	Output	Jobs	Output
Nebraska	40	\$9,000,000	1	\$1,000,000	7	\$2,000,000
Nevada	681	\$118,000,000	24	\$5,000,000	46	\$8,000,000
New Hampshire	454	\$88,000,000	21	\$4,000,000	185	\$34,000,000
New Jersey	486	\$109,000,000	61	\$19,000,000	83	\$17,000,000
New Mexico	855	\$178,000,000	61	\$12,000,000	91	\$16,000,000
New York	2,321	\$531,000,000	198	\$52,000,000	511	\$113,000,000
North Carolina	1,102	\$175,000,000	31	\$7,000,000	320	\$51,000,000
North Dakota	35	\$7,000,000	1	\$1,000,000	6	\$1,000,000
Ohio	10,907	\$2,461,000,000	1,280	\$301,000,000	1,910	\$417,000,000
Oklahoma	802	\$158,000,000	6	\$2,000,000	462	\$79,000,000
Oregon	244	\$47,000,000	16	\$4,000,000	133	\$25,000,000
Pennsylvania	1,870	\$378,000,000	977	\$202,000,000	288	\$54,000,000
Rhode Island	86	\$16,000,000	32	\$6,000,000	19	\$3,000,000
South Carolina	250	\$42,000,000	2	\$1,000,000	28	\$5,000,000
South Dakota	153	\$37,000,000	7	\$1,000,000	107	\$26,000,000
Tennessee	1,645	\$340,000,000	57	\$15,000,000	295	\$58,000,000
Texas	41,937	\$9,280,000,000	14,144	\$3,142,000,000	757	\$154,000,000
Utah	5,175	\$970,000,000	4,605	\$892,000,000	177	\$28,000,000
Vermont	44	\$8,000,000	5	\$1,000,000	12	\$2,000,000
Virginia	32,739	\$6,800,000,000	3,392	\$900,000,000	4,017	\$833,000,000
Washington	4,622	\$1,062,000,000	3,712	\$918,000,000	287	\$57,000,000
Washington, DC	2,047	\$580,000,000	82	\$21,000,000	238	\$58,000,000
West Virginia	707	\$139,000,000	61	\$11,000,000	53	\$10,000,000
Wisconsin	268	\$55,000,000	20	\$4,000,000	116	\$21,000,000
Wyoming	39	\$7,000,000	2	\$1,000,000	17	\$3,000,000
Total	339,643	\$71,244,000,000	93,735	\$20,111,000,000	37,002	\$7,414,000,000



NASA and Northrop Grumman completed a solid rocket booster motor ground test for future flights of the agency's Space Launch System rocket at Northrop Grumman's test facility in Promontory, Utah, July 21. The booster motor, called Flight Support Booster-2 (FSB-2), fired for a little over two minutes and produced more than 3.6 million pounds of thrust. NASA's economic impact is felt across the nation including states without NASA centers.

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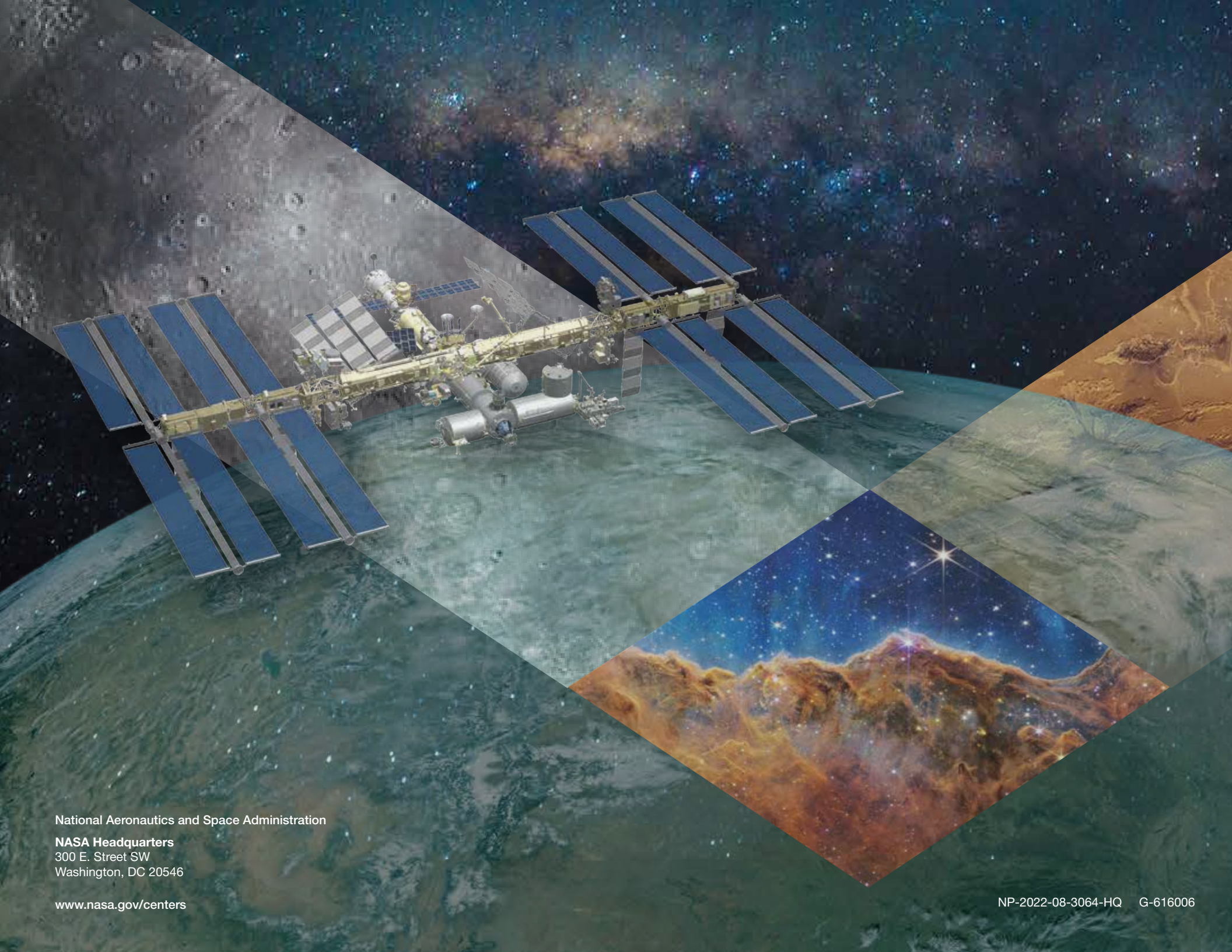


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