

National Aeronautics and  
Space Administration



# ACTION EARTH

NASA EARTH  
APPLIED SCIENCES  
STRATEGIC PLAN

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2021 - 2026



## EARTH SCIENCE IN ACTION

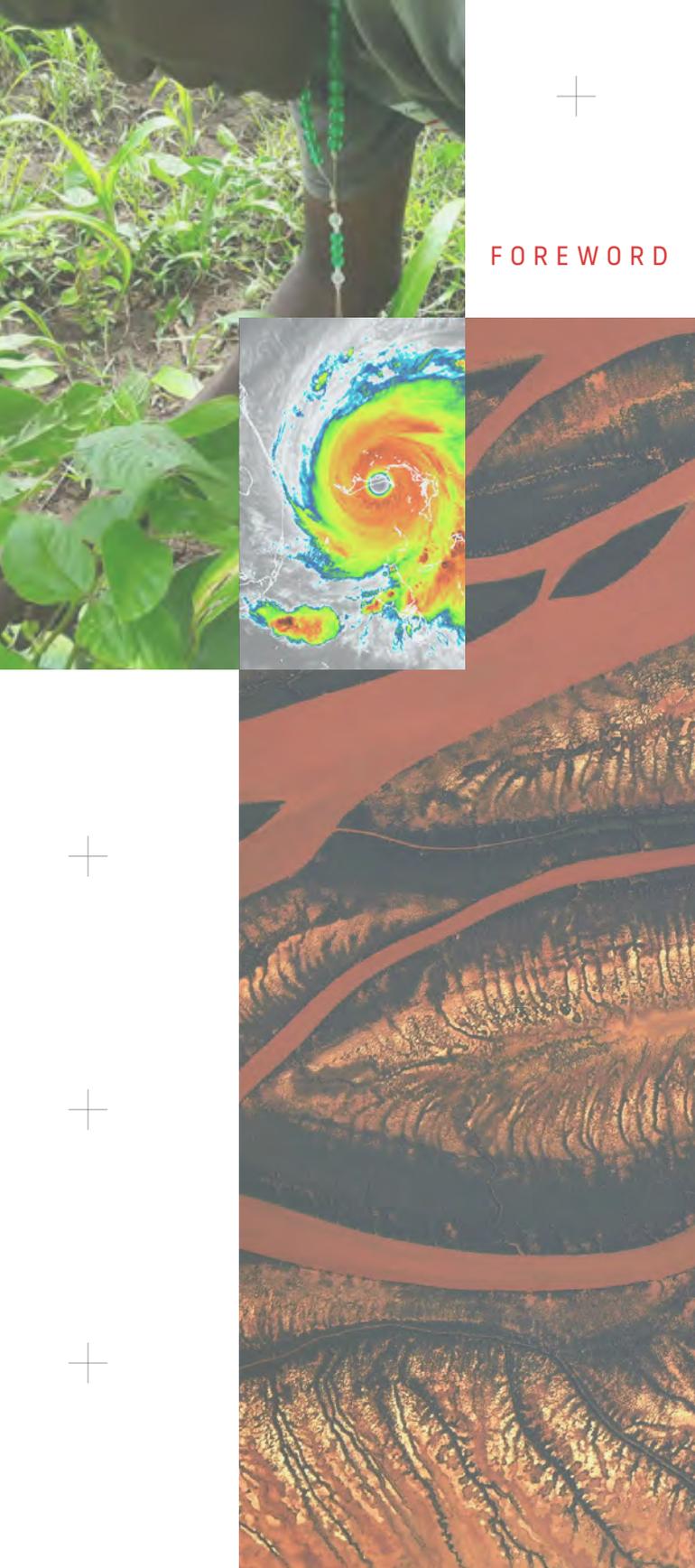
NASA Earth Science has an inspiring mission—to advance scientific discoveries for our nation and the world. Our science is at its most impactful when pressed into action and informing decisions. Our Applied Sciences Program does just that.

This is a transformational moment for Applied Sciences. The pace of change in the Earth system due to the accelerating rate of climate change drives urgency in our actions. Applied Sciences Program must be ambitious and achieve greater impacts than we have ever dared before. Applications of Earth science in business, government, and civil society are primed to expand and thrive – driven by demand and enabled by the possibilities introduced by widely available compute power, powerful new analytics tools, fast and readily available worldwide communication, and partnerships that can provide broad and user-friendly access.

To realize the full impact of NASA Earth Science this decade, we are counting on Applied Sciences to rise to this challenge. This will mean that Applied Sciences must pursue cutting edge ways to expand the scale, scope, and reach of Earth science applications – using only our familiar, traditional ways won't get us there.

This strategic plan is the starting point to get us to that greater impact. I fully support the vision and the goals to accelerate returns from our investments and empower decision makers, and I have high expectations for Earth science applications in this decade! Be bold, Applied Sciences, be bold!

Karen St. Germain, PhD  
Director, Earth Science Division  
Science Mission Directorate



FOREWORD

**E**nabling people to apply insights from Earth science drives us in the Applied Sciences Program. We envision a future where uses of Earth science are common, people widely recognize the benefits, and there's strong desire for more data, insights, and tools. Getting there requires us to be bold and to pursue even more impactful approaches in the coming years.

Earth and space are intrinsically linked. NASA's Earth Science Division discovers new insights about the planet and the complex interactions within the Earth system. Within the Division, Applied Sciences works with institutions worldwide in applying Earth science, powering innovations and improved decisions and actions. We draw on our connections with users to bring their feedback and desires back to our Division colleagues to further

improve NASA's Earth science research and technology.

This Strategic Plan reflects our vision and ambitions. It also reflects our intention to be more expansive in achieving greater impacts. The opportunities are there. Chief among them is pursuing more engagements with private sector and non-profits for expanded reach. And, while continuing high-quality applications development and applied research, the strategy involves new ways of working and re-thinking our traditional methods. Our opportunistic approach gives way to one more intent on scaling. The creation of collaborative spaces can forge multi-sector solutions to pressing challenges, and engaging stories about Earth science benefits can broaden audiences and spark interest in applications to improve daily lives.

As NASA continues to advance our understanding of the Earth, we're excited about the many opportunities to enable greater impacts in applying Earth science, and we welcome you on our journey.

Best regards,

Lawrence Friedl  
Director, Applied Sciences Program

Bradley Doorn

Keith Gaddis

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David Green

John Haynes

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The Applied Sciences Program is part of the Earth Science Division of the NASA Science Mission Directorate.



# VISION

A WORLD WHERE  
EARTH SCIENCE DATA AND  
KNOWLEDGE ROUTINELY  
GUIDE DECISIONS AT ALL  
LEVELS OF SOCIETY –  
AND PEOPLE WANT MORE.

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## — MISSION

Apply insights from Earth science to benefit the economy, health, quality of life, and environment around the globe.

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## — VALUE PROPOSITION

Applied Sciences makes financial and programmatic investments to generate creative solutions and lower the technical and institutional barriers to using Earth science information. Our investments magnify the value of the Earth science information that NASA collects and disseminates. From global to local scales, we bridge gaps between scientific findings and practical applications to expedite benefits.

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We pursue two-way endeavors with organizations along the value chain for effective solutions as well as with our Earth Science Division colleagues to accelerate returns from open data and open science. The significant time and energy we devote to interacting with user communities on technical efforts and skill-building issues builds the Division's reputation as a steadfast partner and enhances adoption of the applications.

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By nurturing networks of researchers, practitioners and users that apply NASA and other Earth observations, we open more pathways to inform everyday decisions, develop sound policy, and enable business opportunities.

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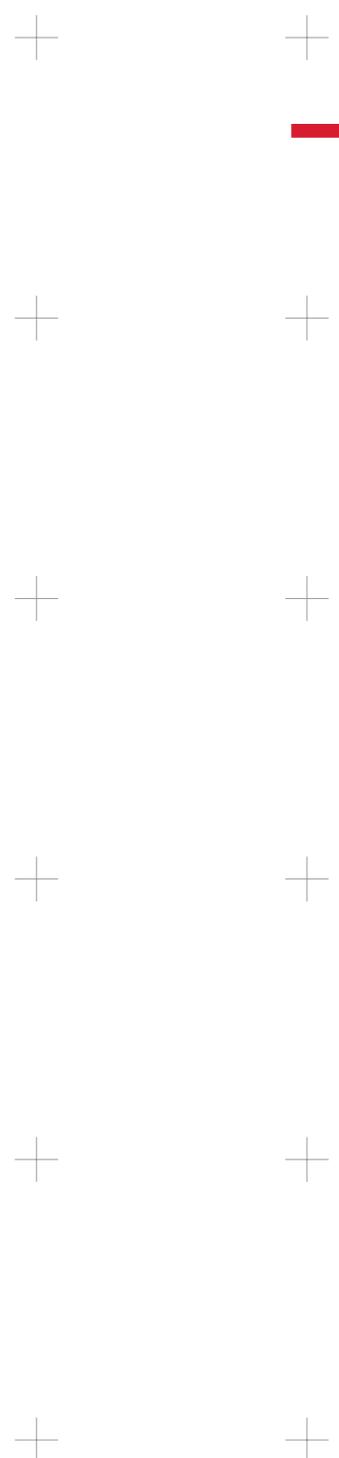
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Applied Sciences serves a fundamental role to advance global knowledge about effective ways to extend and apply Earth science and inform decisions and actions.

- Applied Sciences Advisory Committee





## GUIDING PRINCIPLES



### INNOVATION

We experiment, accept risk, embrace agility and flexibility, and continuously refine our approaches technically and programmatically. We promote opportunities and assess emerging needs to inspire novel applications of Earth science information.



### INTEGRITY

We stay informed of and drive Earth science advances, pursue the most appropriate science for partners' uses, and convey accurate information about the Earth science uses we advance, including the capabilities and the limitations of Earth observations for their application.



### INCLUSION

We create environments where all views and voices are welcome and included with special attention on supporting under-represented and disadvantaged communities. We broaden the communities engaged with and benefiting from Earth Science. We maintain high standards and stop inappropriate behavior, so that everyone can contribute to their fullest potential.



### COLLABORATION

We create environments of collaboration among information producers, applications specialists, partners, and users. We listen to understand perspectives, challenges, needs, and desires for improvement. We pursue and leverage partnerships, working together to extend information and services to benefit society.

GOAL

1

# IMPACTFUL APPLICATIONS

*IMPACTS THROUGH INNOVATION*

Achieving this goal means pursuing innovative and practical applications. It means fostering tools and information products of value to multiple actors and user communities, enabling easier and broader uptake. It means stimulating and pursuing ideas through creative mechanisms, such as collaboration spaces, and customary mechanisms, such as grants and consortiums, and ones we've yet to invent.

Reaching greater impacts means shifting from opportunistic approaches to deliberate ones intent on scaling from the outset. It means focusing on applying Earth science knowledge, drawing on NASA data and modeling as well as non-NASA observations, socioeconomic data, and other capabilities. It also means involving users and their perspectives in research- and mission-formulation activities for accelerating paths to achieve benefits.

**By 2026, Applied Sciences will:**

Pursue efforts to apply and integrate Earth science throughout communities' value chains.

Expand engagement of user communities with NASA Earth Science Teams and enhance applications throughout missions' lifecycles.

Integrate Earth observations into trusted portals and tools across communities, amplifying the reach of Earth science.

Re-examine solicitation mechanisms to identify highly effective approaches and pursue new funding models, supporting co-production and accelerating uptake of applications.

Optimize the replication of successful applications, especially domestically, and pursue opportunities to appropriately scale them.

Advance methods for successful transition of applications and sustained impact.

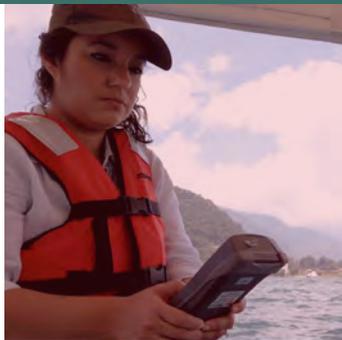


GOAL

2

# KNOWLEDGEABLE AND SKILLED COMMUNITIES

*IMPACTS THROUGH CAPACITY*



Achieving this goal means building and sharing knowledge to enable more proficient user communities and richer applications. It means tapping networks. It means fostering a range of skills to attain sustainable applications. Beyond supporting ways to use Earth science, it involves developing abilities for activities like managing multidisciplinary teams, accessing data and NASA research, engaging users, and expanding communications skills.

Reaching greater impacts means growing, domestically and internationally. It means expanding communities with capable individuals and engaged organizations using Earth science effectively. It involves concerted efforts to enhance diversity and increase inclusion. It means empowering upcoming generations and historically under-represented and disadvantaged groups for greater innovation and Earth science benefits.

**By 2026, Applied Sciences will:**

Introduce new skill-building approaches and partnerships to dramatically expand domestic and international audiences for using Earth science, building on existing training capabilities.

Develop the capacities of, and avenues for, scientists, project teams, partners, and users to craft engaging stories about how NASA data, other Earth observations, and related information benefit people and society.

Expand knowledge on methods to quantify social, environmental, and economic impacts of Earth science, increasing refereed publications, use cases, and interdisciplinary pursuits.

Broadcast information about Earth science-related career paths, helping students, young professionals, and especially under-represented groups identify opportunities.

Strengthen incentives with academia and scientific institutions to pursue applications, develop associated skills, and reward connections between research and applications.

GOAL

3

# THRIVING PARTNERSHIPS AND PRIVATE SECTOR VENTURES

*IMPACTS THROUGH REACH*



Achieving this goal means expanding connections with businesses, foundations, and nonprofit organizations, while continuing to build upon our robust partnerships with government agencies. It involves our learning and adopting new practices around the acceleration of applications, commercialization, and business innovation.

Reaching greater impacts means connecting Earth science with more and new audiences. It means non-linear growth. It involves embedding Earth science data in the products and services that others provide. It means increasing the demand for Earth science knowledge to further economic development, conservation and humanitarian efforts as well as resilient communities, supply chains, sustainability, and advances in health.

**By 2026, Applied Sciences will:**

Pursue opportunities across sectors that can benefit from the use of Earth science, implementing targeted partnerships with businesses, foundations, and nonprofit organizations.

Work to embed Earth science information in the products and services that private companies, nonprofit organizations, government agencies, and others provide to their clients as well as in their own tools and internal decision-making.

Formulate partnerships with incubators, accelerators, and other entities aligned to support our engagement aims.

Advance Division-wide discussions with industries to understand value chains, challenges, data interests, and scientific questions, helping translate this information into initiatives, research agendas, and application development opportunities.



EARTH SCIENCE IN ACTION

*A farmer analyzes surface temperature data to improve irrigation scheduling and increase yields. A forester applies vegetation indices and forest patterns to safeguard biodiversity and support sustainable wood products.*



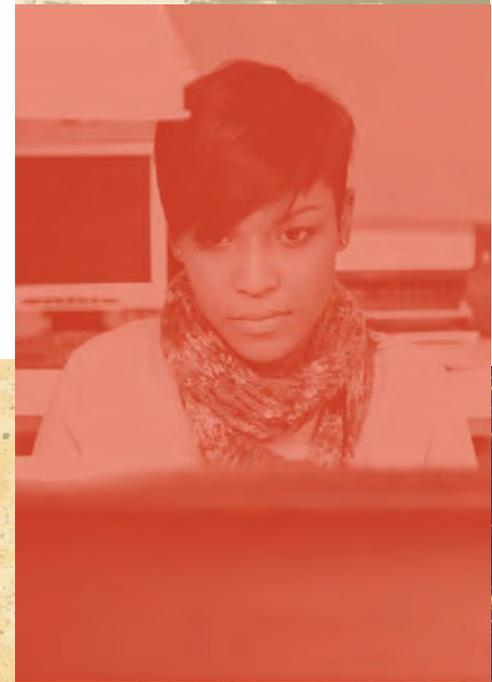
*An early career urban planner enrolls in a NASA Earth science training and develops ways to apply environmental data in adaptive land-use planning.*



*A shipping company uses ocean currents data to route vessels, improving resilience in supply chains. A nonprofit uses air quality data to alert sensitive populations and advise about healthy lifestyles.*



*An insurance analyst applies surface water maps to assess flood vulnerability and release aid in a timely manner. A public health official uses precipitation data to assess vector-borne disease hotspots and target actions to reduce exposure.*





# SUCCESS

Applied Sciences performance and success are predicated on sharing information and communicating impacts with our community, partners and the public as well as within NASA.

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Whether or not a particular application succeeds, we must share the results. When applications succeed, we must share the information to encourage others to adopt it. We must recognize and celebrate the achievement. When applications underperform, we must share the information, so that others may learn from our experiences and approach the same problem in a new way. We must also consider opportunities for scaling appropriate activities to achieve greater returns on our investments.

## Our success with this Strategic Plan means:

Applications using Earth System knowledge are in high demand domestically and internationally and are prominent within NASA, the Earth science community and beyond.

A vibrant, diverse, and growing community exists with the skills to use, assess value, and communicate the importance of Earth science information on a societal and personal level.

High-quality applications that incorporate Earth science spark innovations in the economy, environmental sustainability, and public services.

Success means the Applied Sciences Program is recognized as an impact-oriented program, an applications leader, a trusted and sought-after partner, an active convener, and an effective champion of Earth science that amplifies NASA's mission and benefits society.

## INTERSECTING ACTIVITIES

These items apply to each of our goals and shape our overall program.

## ACCELERATING RETURNS

Science spans basic research through applications. The rich interactions across the spectrum create inspirations and benefits in both directions. As we promote efforts in open source science and to amplify the cross-benefits of research and applications with the Earth Science community, we seek to quicken discovery and usage, create new lines of research and application, and accelerate returns.

## RESILIENCE

Earth science presents unique insights into risks from natural and anthropogenic stresses. Our efforts help translate those insights into fostering resilient communities, enabling significant benefits or avoided losses. We work together with public and private sector partners in characterizing vulnerabilities and exposure to risks, providing information to guide actions and sustainable resilience.

## KNOWLEDGE SHARING

Decades of work with Earth science applications have built knowledge about effective ways to apply Earth science products to inform choices and guide decisions. Continuing to share this knowledge is critical to enabling greater benefits. New activities involve compiling collective knowledge, sharing interactive guidebooks, and enabling enriching forums for project teams, proposers, and partners.

## GEOSPATIAL SERVICES

Geographic information systems and other geospatial technologies are common tools in user communities to analyze and guide decisions. They represent important opportunities to disseminate NASA's open data and to enable applications. Building on an internal assessment of geospatial services, our activities with geospatial technologies, products, and services apply across our program and align with the Earth Science Division's geospatial efforts.

Current areas of Applied Sciences:



AGRICULTURE



CAPACITY BUILDING



DISASTERS



ECOLOGICAL FORECASTING



HEALTH & AIR QUALITY



WATER RESOURCES



MISSIONS

The Fiscal Year 2022 President's Budget Request calls for new application efforts focused on climate, energy, wildfires, and environmental justice; changes to this page are pending.



## VOICE

Many individuals, organizations, and communities benefit from NASA's investments in Earth science. Greater awareness of the benefits can spur even more applications and benefits. Applied Sciences cultivates engaging stories about our projects and people, celebrating our partners' achievements, and featuring fresh, diverse voices to reach new audiences. Our stories and our storytelling have a power to showcase impactful uses and enable the uptake of Earth science that is as important as our technical innovations.



## CONNECTIONS

Amplifying societal returns from Earth science begins from the initial design of scientific pursuits, observing architectures, and spacecraft missions. Applied Sciences actively engages with other parts of NASA Earth Science Division to support its goals. As we support the Division's engagements with the Earth science community, our direct connections with end-user communities provide us with unique opportunities – and a responsibility – to provide input to the Division on novel research questions and beneficial design elements.

We enable the early and ongoing consideration of applications throughout missions' lifecycles. We support improved abilities for people to develop applications, contribute to mission planning and design, and be prepared to use data after launch. We encourage feedback on data and information products from unique user perspectives. We facilitate interactions among researchers and users at ever-growing levels of complexity for discussions of novel research pursuits. Collectively, these efforts grow users' awareness and anticipation of Earth science missions, data, and research as well as their interest in Earth science and the benefits to society.





# HOW

# WE WORK

## USER-CENTERED

Greater emphasis on user-centered ways helps our project teams and partners be more successful in designing and developing sustainable, impactful solutions. We plan to expand our methods for collaborating with partners, integrating users more into applications design and development. An increased use of design-thinking, needs-oriented, and co-production approaches complements our traditional engineering-based method. The broader range of methods improves our flexibility as we listen to, empathize with, and understand users' perspectives and conditions.

## MARKET-ORIENTED

Market-oriented approaches incorporating user information enriches our work in existing areas and the pursuit of new ones. We plan to conduct market research studies across our program areas to support our planning and priority-setting. Information in market research studies about sector characteristics, preferences, and perceptions helps us target key populations to serve, identify trusted associations and portals, prioritize solicitation methods and topics, and design engagement and outreach activities.

## COMMUNITY LEADING

Our personnel and project teams actively participate in and lead committees and working groups nationally and internationally. We engage with sector-specific associations, industry groups, and Earth science societies to leverage resources and pursue collective goals. We collaborate through the Group on Earth Observations, the United States Group on Earth Observations, the Committee on Earth Observation Satellites, and other organizations to widen our reach and impact. We plan to build on these efforts and expand our connections, using our positions to also emphasize inclusion and diversity.

## IMPACT-FOCUSED

We place a high priority on substantial and lasting impacts – both our own and our communities. We continually assess our methods and outcomes, consider alternative approaches and remain agile. For our project portfolio, we plan to evaluate our Applications Readiness Level metric, making adjustments for more user-centered approaches and expanding use as a diagnostic tool. Together with traditional solicitations, we plan to examine acquisition approaches that favor flexibility and provide incentives for performance. We are vigilant in writing our solicitations and reviewing proposals to reduce biases and ensure diverse review panels to support evermore impactful projects.

## APPENDIX

# DEFINITIONS

### Applications

Applications refer to uses of Earth science data and information products to inform decisions and guide actions of organizations for management, policy, and business activities. They are also referred to as Earth science applications or decision-support applications.

### Applications Readiness Level

Applications Readiness Level (ARL) is a nine-stage index to track the progression and maturity of applications projects. ARLs are an adaptation of the NASA Technology Readiness Levels.

Generally, ARLs 1-3 encompass discovery and feasibility; ARLs 4-6 address development, testing, and validation; and, ARLs 7-9 focus on transition and adoption of the application by the user organizations.

### Design Thinking

A design methodology that applies a hands-on, user-centric approach to solving problems. Design thinking involves efforts to understand, explore, and materialize solutions, and there are six stages: Empathize, Define (the problem), Ideate, Prototype, Test, and Implement.

### Co-Production

Co-production refers to the development of applications done collaboratively among users, scientists, project teams, and other specialists and partners. Ideas are shared and improved with all participants working together in all phases of the project. Co-production also refers to the contribution of multiple knowledge sources and capacities from different communities spanning the science-policy-society interface.

### Communities

Communities refer to networks of individuals and organizations that have a common, collective interest, such as the water resources community or air quality community. The Earth science community refers to the broad collection of people, universities, professional societies, nonprofit organizations, companies and industry associations, interagency and

intergovernmental committees, and others with connections to, and a focus on, Earth science and remote sensing. This community has common interests around technical, policy, and other topics and can raise awareness on the importance and benefits from Earth science knowledge.

### Geospatial Services

Geospatial services provide location-based information and tools to organizations and consumers to support actionable insights and informed decisions.

### Market Research

Market research refers to the systematic collection of information about particular audiences and characterization of their attributes, preferences, attitudes, behaviors, and perceptions. The information supports the identification of insights and trends, which organizations use to guide their planning, priorities, investments, and other decisions. The term is distinct from marketing, which is more associated with advertising strategies.

### Partner

An individual or organization that works with Applied Sciences.

### Resilience

The ability of a system, community or society to resist, absorb, adapt, and recover from stresses, shocks and threats in a timely and efficient manner, including through

the preservation and restoration of its essential basic structures and functions.

### User

An individual or organization that uses the data, information, or other products to support their activities for their benefit or for the benefit of others.

### Value Chain

A value chain is a set of activities in a community, sector, or industry to generate a product or service. The value chain for the Earth Observations Enterprise notionally includes actions by providers of observations and observation system infrastructure; brokers of data and information products; researchers and applications specialists; intermediaries who use the data and information products to create tools and solutions; organizations that apply them in decision making; and, users who benefit. A value chain is not necessarily linear, and interactions occur among the parts of the value chain.

## REFERENCE DOCUMENTS

NASA Strategic Plan 2018	2019 National Plan for Civil Earth Observations
SMD Science Plan 2020-2024	2030 Agenda for Sustainable Development
2017-2027 Earth Science Decadal Survey	Sendai Framework for Disaster Risk Reduction
	Paris Climate Agreement

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# EARTH SCIENCE ACTION



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