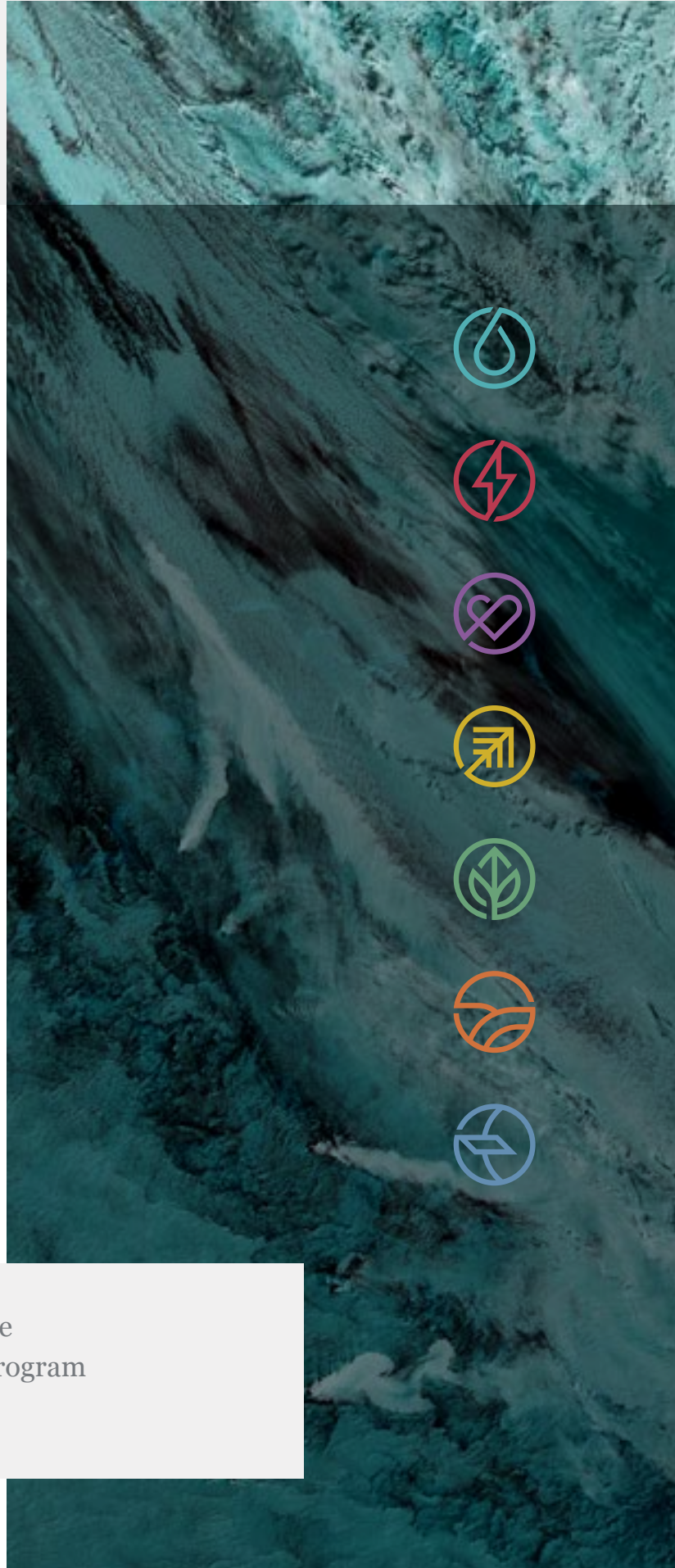**EARTH SCIENCE
APPLIED SCIENCES**

2020 ANNUAL SUMMARY

NASA Earth Science
Applied Sciences Program

APPLIED SCIENCES PROGRAM 2020 ANNUAL SUMMARY

TABLE OF CONTENTS

Cover Image:
A Trio of Plumes in the South Sandwich Islands

Due to their remote location, these volcanoes are some of the least studied in the world.

Source: Aqua

September 29, 2016

APPLIED SCIENCES PROGRAM LEADERSHIP

Lawrence Friedl
Director
lfriedl@nasa.gov

Emily Sylak-Glassman
Deputy Director
eglassman@nasa.gov

A broad team leads and manages the Applied Sciences Program. The team involves the staff at NASA Headquarters and people across NASA Centers, including Associate Program Managers for Applications elements, leadership teams for the Capacity Building program elements, coordinators for Disaster activations, Applications Coordinators for missions, and others.

Applied Sciences Program website: appliedsciences.nasa.gov
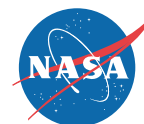
**EARTH SCIENCE
APPLIED SCIENCES**

Painting Pennsylvania Hills

The region of rolling hills and valleys is part of a geologic formation known as the Ridge and Valley Province that stretches from New York to Alabama.

Source: Landsat 8, Terra

November 9, 2020

A TRIBUTE

Michael Freilich passed away in August 2020. He served as the ESD Director from 2006 until his retirement from NASA in early 2019. Mike had a passion for Earth science and understanding how nature worked. He dedicated significant attention to enabling Earth observations and research, and he led ESD in implementing the first Earth Decadal Survey. The joint ESA-NASA Sentinel-6 mission launched in November 2020 bore his name as a tribute to his contributions and passion for oceanography.

I.
INTRODUCTION

I. INTRODUCTION

The Applied Sciences Program within the National Aeronautics and Space Administration (NASA) Earth Science Division (ESD) promotes efforts to discover and demonstrate innovative and practical uses of Earth observations (EO). The program funds applied research and applications projects to enable near-term uses of Earth science information—from formulating new applications, to expediting uptake of Earth science products in practitioners' decision-making. The project teams carry out their projects in partnership with public- and private-sector organizations to achieve sustained use and sustained benefits from Earth observations.

Applied Sciences includes three major lines of business:

- Conception and co-development of Earth science applications
- Capacity Building to enhance skills and capabilities in U.S. workforce and developing countries
- Mission Planning to integrate considerations of applications in development for future Earth science missions

The program also involves numerous activities that serve crosscutting roles, such as communications, impact assessments, and prize competitions. These activities and the elements of the three lines of business constitute program areas.

This document provides a summary of the Applied Sciences Program in 2020 at the program-level, including performance and financial management. There are similar annual summaries for individual program areas, which are available at **appliedsciences.nasa.gov**.

**A Swirl of Old
Supercontinent Silt**

On the island of Spitsbergen,
Norway, glaciers grind up sandstone,
leaving an abundance of sediment
that stains the meltwater.

Source: Landsat 8

August 23, 2020

—

II.
IMPACTS
AND
MAJOR
ACTIVITIES

II. IMPACTS AND MAJOR ACTIVITIES

The past year was a productive one for the Applied Sciences Program. All parts of the program achieved significant advancements in furthering uses of Earth observations. This section identifies select major activities and accomplishments for the program overall.

IMPACT

In 2020, we noted significant impacts along three dimensions, all drawing on technical achievements and strong partnership relationships: 1) Uptake and the transition of applications for sustained use, 2) Reach and the increase in number or breadth of people and organizations engaged, and 3) Value and the recognition of the benefits that accrued through program activities.

Uptake

In 2020, three applications advanced to the highest Applications Readiness Level (ARL) for sustained use in decision-making by an organization.

- The California Department of Water Resources (CA-DWR) began integrating remotely-sensed Snow Water Equivalent (SWE) data into the streamflow volume forecasts it issues, informing water-allocation decisions for agriculture operations; this stemmed from a project led by Noah Molotch (University of Colorado-Boulder).

- The Sargassum Watch System (SaWS) became operational, continuing to issue its monthly bulletin highlighting Sargassum seaweed bloom conditions in the Gulf of Mexico, central Atlantic, and Caribbean Sea; Chuanmin Hu (University of South Florida) led the project. Tourism industries, coastal managers, utilities, and others use SaWS information to prepare for mitigation of Sargassum beaching events.

- The Jane Goodall Institute launched its operational use of the Chimpscapes Decision Support System for Tanzania's Gombe National Park. The system integrates Landsat and Maxar imagery to visualize the trends in chimpanzee habitat and population indicators. Dashboard visualizations help decision-makers prioritize action for chimpanzee habitat conservation through community-led approaches.

In addition, several projects integrated NASA data products into community-facing portals, supporting broad access and scaling of data use.

- Initial release of the OpenET web-based platform began putting NASA data on water use into the hands of farmers, water managers, and conservation groups. The project team conducted special briefings with the American Farm Bureau in 2020 to support awareness and broad future use. Specific stakeholders and state partners had access to this data in 2020 to do case studies, and broad public availability is planned for mid-2021.

- A SERVIR[1] project led by Douglas Morton released a new <u>web tool</u> for tracking forest fires in Amazonia, identifying types of fires and providing actionable information; <u>more info is available online</u>. The dashboard provides information in English, Spanish, and Portuguese.

- NASA Harvest released an online <u>dashboard</u> providing tools to evaluate COVID-19 impacts on agricultural production and food security worldwide.[2]

Reach

We expanded our reach in 2020, working with more people and new organizations.

- Our Applied Remote Sensing Training (<u>ARSET</u>) program reached 27,425 people (an ARSET record) across all 50 U.S. states and in 162 countries. Among its 14 trainings (including a special one on the impacts of COVID-19 on air quality), a training on coastal ecosystems set a single-session record of over 2,900 people from nearly 1,900 unique organizations. ARSET also held its first-ever trilingual training, working with the United Nations (UN) Development Programme to offer a training in English, Spanish, and French on remote sensing and conservation.

- To assist Federal Bureau of Investigation (FBI) agents investigating the massive explosion in Beirut in August, our Disasters program provided 10m-resolution Damage Proxy Maps generated by JPL-Advanced Rapid Imaging and Analysis (JPL-ARIA). The maps allowed agents to broaden the areas for ground surveying, resulting in discovering significant areas of damage not previously located.

- Our SERVIR program (managed jointly with the U.S. Agency for International Development) worked with its global network to conduct 68 projects and 45 trainings that reached over 1,300 individuals from 44 countries.

- In October, the Mexican Navy reported using <u>SaWS</u> Sargassum bloom detection products to mitigate negative impacts of these blooms on the Caribbean coasts of Mexico.

- The Lake Michigan Air Directors Consortium (LADCO) integrated a satellite-constrained meteorological modeling platform into the process for regional haze and ozone air quality planning required by the Clean Air Act. The model incorporated data from the NASA <u>Land Information System</u> and Soil Moisture Active Passive (SMAP) data; assimilation of other data sets is planned.

Value

Our program's activities showed the benefits of Earth observations, as evidenced through direct investments by outside organizations, noteworthy publications, and the results of economic assessments.

- CA-DWR dedicated funding to a streamflow volume forecast project to produce the near-real-time SWE reports, tables, and modeled spatial output for water year 2020.

- The FY21 Federal budget allocated funding to the Department of the Interior (DOI) to support commercial flights of the Airborne Snow Observatory (ASO) across western watersheds; California also provided funding. Our Western Water Applications Office (WWAO) Program initiated the commercialization of ASO technology to expedite scaling and broader coverage for western states; the first flights occurred in 2020.

- Oman's Ministry of Agriculture and Fisheries Wealth committed funding for two additional years for a project led by Joaquim Goes (Columbia). The project applies sea surface temperature, height, and ocean color and Earth observations to enhance Oman's capabilities in forecasting environmental threats to coastal resources and supporting analyses of proposed salmon farming and aquaculture projects.

---

1 SERVIR is an element of the Capacity Building program; it is not an acronym

2 NASA Harvest received financial support for the dashboard from ESD's Rapid Response and Novel Research in Earth Science Program, which the Research and Analysis Program oversees.

- Enabled through SERVIR, the United States Agency for International Development (USAID) provided $600K for the Jet Propulsion Laboratory (JPL) to collect additional ground truth data in SERVIR network locations for the upcoming Multi-Angle Imager for Aerosols (MAIA) mission. This work contributes to strengthening the cross-benefits of the SERVIR Network and MAIA's research and applications.

- *Nature* published an underlined article highlighting how human-produced noise and light pollution negatively affect bird reproduction in North America. The paper is based on an Ecological Forecasting project with the National Park Service to apply Earth observation data for conservation decision-making on mitigating threats from sensory pollution.

- *Environmental Monitoring and Assessment* published an article on the value of satellite remote sensing to monitor chlorophyll-a for U.S. lakes and reservoirs. The authors, who are associated with the ESD-sponsored Cyanobacteria Assessment Network (CyAN)[3], calculated that the annual potential avoided costs ranged between $5M and $316M, depending on the satellite program used and timeframe considered.

- Our Valuation of Applications Benefits Linked with Earth Science (VALUABLES) Consortium with Resources for the Future[4] published two analyses on the economic benefits of EO:

  - A paper determined that Landsat data saves Federal agencies up to $7.7 million each year in post-wildfire response costs.

  - A paper concluded that improved human health outcomes valued at approximately $370K resulted from using satellite data to detect a harmful algal bloom and manage recreational advisories in Utah Lake, Utah, in 2017.

Figure 1 (see page 10) features one highlight from each program area. The annual summaries for the respective program areas (available on our website) provide many more examples of such impacts.

STRATEGIC PLAN

In January, we embarked on a strategic planning exercise to refresh our goals, update our value proposition, and reaffirm the principles for implementing program activities. After several sessions reflecting on our accomplishments and our emerging challenges, program leaders concluded that achieving our priorities to advance beneficial uses of Earth science will involve greater engagement with the private sector and nonprofits and more robust scaling of successful applications, while also using our connections to user-communities to bring unique perspectives back to ESD. By the end of 2020, the strategic plan entered the final review stages and layout, with a public release planned for early 2021.

COVID-19

COVID-19 overshadowed much of 2020, and the team found many ways to make the best of the unfortunate situation and full-time telework environment. Some adaptations include:

- The Health and Air Quality program capitalized on the increased attendance in the Group on Earth Observations (GEO) Health Community of Practice, which it leads, to leverage the network in helping its Principal Investigators (PIs) obtain new data in critical regions for their projects. This data will, in turn, help benefit the broader public health community.

---

3 ESD's Applied Sciences and R&A Programs jointly sponsored CyAN; as planned, support began with R&A and transitioned to Applied Sciences for the application development.

4 Resources for the Future is an independent, nonprofit research institution focusing on economics, energy, and the environment.

- Applied Sciences contributed to ESD-wide COVID-19 dashboards, which helped the public visualize Earth observation data for air quality, agriculture, and other topics.

- The ARSET training program ran special webinars on air quality as part of our COVID-19 response; more than 2,000 people across 96 countries and 46 U.S. states participated.

- Our annual Applied Sciences Week activities moved to a virtual environment, expanding our reach to over 1,200 people for the week.

- The Disasters program area team used its proficiency with organizing interagency coordination calls to support COVID coordination during the 21 weeks following government shutdown orders in March.

DIVERSITY, EQUITY, AND INCLUSION

In the aftermath of the killing of George Floyd and other events that sparked national attention on racial inequity and social justice issues, the Applied Sciences team dedicated significant time to these topics. The program initiated team-wide efforts to build awareness and determine actions that we should take, including how we should model NASA's values in our communities. We created a Diversity, Equity, Inclusion, and Ability (DEIA) team, updated language for our solicitations, revised program managers' performance plans to include DEIA, examined review panel composition, and ideated on actions for 2021. Our work connected with similar efforts at the ESD and Science Mission Directorate (SMD) levels, which aligned with NASA's addition of Inclusion as an Agency Core Value.

WEBSITE

In March, the program launched a completely redesigned Applied Sciences website. While maintaining the same web address, the website features a new, contemporary look with much greater functionality. The communications team integrated all the program areas under a single identity for more cohesion. The new site completely revamped the web content, emphasizing the program's impact through more engaging stories and an accessible voice. The new platform is flexible and scalable, allowing us to consolidate four legacy sites into one – ARSET and Disasters were integrated into the Applied Sciences website in 2020 and DEVELOP[5] will follow in 2021.

By the end of 2020, the new website had over 340,000 pageviews (a 1,400% increase from 2019) and over 88,000 new users (a 950% increase). A new set of stories showcasing the people engaged in the work of Applied Sciences was among the most popular content. See the Communications Annual Summary on the Applied Sciences website for more details.

ESD LEADERSHIP

In June, Dr. Karen St. Germain began as the ESD Director, with Sandra Cauffman resuming her role as the Deputy Director. The program team dedicated significant time to informing Dr. Germain about the Applied Sciences Program, our internal structure and team members, external partner engagement, and our roles bringing user perspectives back to ESD. By the end of 2020, staff from the vast majority of Applied Sciences program areas had met directly with the new ESD Director.

---

5 DEVELOP is an element of the Capacity Building program; it is not an acronym

ACCOMPLISHMENTS FIGURE 1

One highlight from each program area is featured below. The Applied Sciences Program website includes annual summaries for the respective program areas, providing many more examples of programs' impacts.

AGRICULTURE

As part of a COVID-19 response, Togo worked with NASA Harvest to rapidly create 10-m maps of the nature and distribution of agricultural land. Together with poverty data, the maps supported the design of Togolese loan programs and social protection policies to supplement the livelihoods of agrarian rural communities and informal workers.

> The agricultural maps we have developed thanks to NASA Harvest data play a role in our process to determine which groups of people to target for the next batch of NOVISSI transfers.

Cina Lawson
Togolese Minister of Post, Digital
Economy and Technological Innovation

CAPACITY BUILDING

In July, the World Food Programme released a new version of its Platform for Real-time Impact and Situation Monitoring (PRISM) for Cambodia. PRISM supports the design of risk-reduction and disaster-response activities. This version includes information from SERVIR-Mekong's near-real-time flood monitoring system (Hydrological Remote Sensing Analysis of Floods, or HYDRAFloods) and drought monitoring tool (Regional Drought and Crop Yield Information System, or RDCYIS), which include Landsat 5, Landsat 7, Landsat 8, Moderate Resolution Imaging Spectroradiometer (MODIS), Sentinel 1, Visible Infrared Imaging Radiometer Suite (VIIRS), Sentinel 2, and Advanced Technology Microwave Sounder (ATMS) data.

DISASTERS

For Hurricane Isaias, the Disasters program activated to provide support to the U.S. Southern Command and Caribbean Disaster Emergency Management Agency. The Advanced Rapid Imaging and Analysis team at JPL created Flood Proxy Maps and Damage Proxy Maps based on Copernicus Sentinel-1 satellite data.

ECOLOGICAL FORECASTING

The Bureau of Land Management manages the National Petroleum Reserve-Alaska on the remote north slope of the Brooks Range, but it has limited data on fish distributions on which to base leasing and management decisions. An Applied Sciences project (led by John Olson (California State University, Monterey Bay)) worked with the Bureau on methods to integrate watershed-specific MODIS data into species-distribution models to enable the prediction of fish occurrence in data-poor regions.

HEALTH & AIR QUALITY

An Applied Sciences project led by Pablo Méndez-Lázaro at the University of Puerto Rico incorporated MODIS, VIIRS, and Geostationary Operational Environmental Satellite-16 (GOES-16) aerosol optical depth measurements into an air-quality forecasting tool to provide an additional three days of notice for poor air quality in the region. In anticipation of a massive Saharan dust storm hitting Puerto Rico in June 2020, the team exercised their prototype early-warning system to support public warnings and advisories; one of their Facebook Live broadcasts reached 370,000 people.

FIGURE 1 CONT'D

WATER RESOURCES

The Navajo Nation's new Drought Severity Evaluation Tool (DSET) became operational on December 10, 2020. The Navajo Nation Department of Water Resources worked with WWAO and the Desert Research Institute to incorporate precipitation and land-surface temperature data from NASA satellites, drought indices, and rain gauge data into the DSET tool, which supports effective allocation of limited water resources and drought relief funds (additional information is available online).

MISSION PLANNING

For the upcoming Surface Water and Ocean Topography mission (SWOT), the NASA-Centre National d'Etudes Spatiales (CNES) SWOT Applications team led a virtual SWOT Hackathon in May. The sprint-like event on real-world applications focused on rapid diagnoses of hurdles the SWOT Early Adopters (EA) faced. The participants successfully resolved more than 50% of diagnosed issues in the first four hours.

COMMUNICATIONS

Program staff crafted 171 stories in 2020 covering Earth science applications, news, and event summaries, and personal profiles of the people involved with our projects. Of the 171 stories, the 30 personal profiles were among the most popular. Four of the top seven stories ranked, according to page views and time-on-page, were personal profiles. The profiles included people associated with our project partners, principal investigators, coders, program staff, and users.

PRIZE COMPETITIONS

The program joined the Department of Defense (DOD)/Defense Innovation Unit's (DIU) xView2 Challenge to automate building damage assessment from natural disasters, including use of satellite imagery. Participants in the international prize competition included over 500 teams, and the winning algorithms detected locations and scored building damage accurately over 80% of the time. The DIU-NASA effort spurred further collaborations, such as developing strategies for collecting synthetic aperture radar (SAR) data to enable response to natural hazards and global events.

SUSTAINABLE DEVELOPMENT GOALS (SDG)

Uruguay's Ministry of Environment completed local and regional feasibility testing and validation of uses of Landsat, Sentinel 2, and other Earth observations to support monitoring of water quality and reporting on SDG indicator 6.3.2 on ambient freshwater quality.

VALUABLES CONSORTIUM

A paper by the VALUABLES team determined that use of the Earth observation-enabled WhaleWatch tool by the commercial shipping industry could both reduce fatal ship strikes with endangered blue whales and save up to $461M annually in compliance costs with the Endangered Species Act.

Laura Makes Landfall

A nighttime view of Hurricane Laura two hours after it made landfall in Louisiana as a category 4 storm.

Source: Suomi NPP

August 27, 2020

—

III.
PROGRAM PORTFOLIO AND MANAGEMENT

III. PROGRAM PORTFOLIO AND MANAGEMENT

In 2020, the Applied Sciences Program maintained three major lines of business: Applications, Capacity Building, and Mission Planning, as well as five major program-wide functions: Communications, Impact Assessments, Prize Competitions, Risk and Resilience, and Sustainable Development Goals. This section describes these lines of business and functions and also includes information about the Applied Sciences Advisory Committee, program personnel, program-led ESD-level efforts, a private sector strategy development effort, and other program activities.

LINES OF BUSINESS

APPLICATIONS

The program continued to implement five Applications elements: Agriculture and Food Security, Disasters, Health and Air Quality, Ecological Forecasting, and Water Resources.[6,7] Application Area leaders included: Brad Doorn for Agriculture and Food Security as well as Water Resources, David Green for Disasters, John Haynes for Health and Air Quality, and Woody Turner for Ecological Forecasting. Section IV of this document contains some information about each Applications element; additional details are available in the respective 2020 Applications Area annual summaries. Applied Sciences also supported additional activities related to energy, infrastructure and transportation, and urban sustainability; of these three, energy received the most attention in 2020.

Two program areas sponsored solicitations as part of the 2020 SMD Research Opportunities in Space and Earth Sciences (ROSES) announcement. Health and Air Quality (HAQ) solicited proposals for members of its next Health and Air Quality Applied Sciences Team (HAQAST). The program area ran a peer review panel, selected 14 HAQAST team members, and held a kickoff meeting in February 2021. Ecological Forecasting solicited for applications projects focused on protected areas or ecosystem restoration; the program expected to make selections in early 2021. The Water Resources and HAQ program areas also prepared solicitations for the SMD ROSES-21 announcement in February 2021.

Energy

We continued to sponsor the Prediction of Worldwide Energy Resources (POWER) tool, a web-based platform that employs NASA Earth observation data (e.g., solar irradiance) to support the renewable energy, building design, agriculture, and other communities. NASA Langley Research Center operates POWER in coordination with the NASA Atmospheric Science Data Center. POWER continued to support tens of thousands of users in 2020.

---

6 These Applications align with five of the eight Societal Benefit Areas of the international Group on Earth Observations: Agriculture, Disasters, Ecosystems, Energy, Health, Infrastructure & Transportation, Urban sustainability, Water.

7 Each program area includes weather- and climate-related effects.

In early 2020, we perceived that POWER had significant growth potential for greater economic and societal benefits beyond those provided to its strong, existing set of users, especially given POWER's extensive private-sector user base. Bucking the traditional approach of developing an expansion plan internally, we accessed skills and capacities outside of NASA and contracted with the firm ICF[8] to help the program craft a development plan. The contract included efforts to characterize current and future potential end users (especially private-sector industries), develop a business plan for investment, craft a community engagement strategy, and create use cases to illustrate specific applications of POWER and the associated benefits. The business-like plan and other deliverables are due in 2021, and the program will use the information in future planning efforts.

CAPACITY BUILDING

Our Capacity Building program area continued to improve the capabilities of individuals and institutions to access and apply Earth observations. Led by Nancy Searby, Capacity Building (CB) maintained three center-based program elements – ARSET, DEVELOP, SERVIR[9] – plus a pilot effort focused on indigenous peoples. Section IV of this document contains some information about the CB program area and its elements; additional details are in the 2020 CB annual summary.

For the SMD ROSES-21 announcement, CB-SERVIR prepared a solicitation to identify members of the next SERVIR Applied Sciences Team, which will commence in late 2022.

MISSION PLANNING

Applied Sciences enables the involvement of applications-oriented users in the planning, development, and other activities associated with Earth science satellite missions. This work facilitates end-user engagements that identify applications throughout the mission life cycle and provide feedback, helping to broaden awareness of, and preparation for, the mission.

Mission Applications Workshops

The following are example events in 2020 that supported missions in formulation and development:

- In May, we hosted an Early Adopters Workshop jointly for the Tropospheric Emissions: Monitoring of Pollution (TEMPO) and MAIA missions. The 140+ participants previewed early versions of MAIA aerosol and particulate matter data products and browsed the latest versions of synthetic TEMPO data products, which they could test in their decision tools. Based on feedback received at the workshop, the TEMPO team plans to distribute Level 2 and Level 3[10] synthetic data products and consider different netCDF file structures for the "fast" synthetic data to better conform to the operational data products and American Standard Code for Information Interchange (ASCII) files expected by health practitioners.

- In May, the NASA-CNES SWOT Applications Team led a virtual SWOT Hackathon. The sprint-like event used SWOT simulated data to address hurdles that SWOT Early Adopters faced, and participants resolved more than 50% of the diagnosed issues in the first four hours. For example, while trying to apply SWOT to improve flood forecasting over the Godvari basin in India, users found that the SWOT simulator was not producing information for the basin; the hackers revised the file and defined the correct directory for orbits to resolve the issue.

---

8   ICF is the name of a company; it is not an acronym

9   ARSET conducts hands-on training courses for professionals to access and apply Earth observations in their decision-making activities. DEVELOP is a national program for participants to gain experience applying Earth observations through 10-week feasibility projects with nonprofits, state and local governments, and other organizations. SERVIR is a joint venture with USAID supporting developing nations in uses of EO and geospatial tools in development decision making; there are five SERVIR hubs across Africa, Asia, and South America.

10 NASA Earth Science uses data processing levels to indicate the amount of data processing.

- In November, TEMPO hosted its 2020 Early Adopters Workshop. Approximately 150 domestic and international participants received demonstrations, the latest information about synthetic data products, and examples of application experiment requests. Participants identified a need for additional synthetic products and pre-launch training materials to facilitate use of TEMPO data. U.S. participants included representatives from the Minnesota Pollution Control Agency, Maricopa County Air Quality Department, California Air Resources Board, and Idaho Department of Environmental Quality.

Early Adopters

Applied Sciences runs Early Adopters (EA) efforts with missions to encourage user organizations to test simulated data products in the pre-launch timeframe so they can be well prepared to use mission data in the post-launch phase. Early Adopters can engage the science team to consult on technical issues and are expected to provide feedback to the mission team from their unique perspectives.

In 2020, Emily Sylak-Glassman and Kartik Sheth oversaw a review of the Early Adopters Program. Over ten missions had implemented Early Adopters since 2010, and the review assessed the variety of implementation approaches and the effectiveness of practices employed. We will complete the report associated with this study in 2021 and produce an EA program guide to promote greater consistency in future EA implementation.

Designated Observables (DO)

Based on priority observations identified in the 2017 Earth Decadal Survey[11], ESD continued multi-Center architecture studies for four observing systems: Aerosols & Clouds, Convection and Precipitation (A-CCP); Mass Change (MC); Surface Biology and Geology (SBG); and Surface Deformation and Change (SDC). In 2020, NASA Earth Science began contracts with RTI International[12] to support the DO Study Teams with characterizing applications user communities and expanding users beyond customary ones, with a particular focus on private sector industries.

The applications study for SBG concluded in Fall 2020, having focused on four, primary application areas and user communities: fire ecology and risk, agriculture and water resources, algal blooms and water quality, and mineral resources, with additional insights on value-added service providers. The study focused highly on latency needs of the user communities. The SBG Study Team included the information in the analysis of the architectures. We may seek to pursue additional user communities in 2021.

The applications studies for MC, SDC, and A-CCP are set to complete in May 2021.

PROGRAM-WIDE FUNCTIONS

COMMUNICATIONS

Our Communications team had a strong year in broadening awareness about Applied Sciences and NASA Earth Science. Led by McRae Lent and Aries Keck, the team crafted 171 stories, including applications, news and event summaries, and personal profiles. All year, the Communications team continued its collaborations with the Earth Observatory. In April, we held its first-ever "Story Slam" event, which Lia Poteet emceed; each program manager told a five-minute narrative-form story about an application of NASA Earth science data. In September, we rolled out a major update for the award-winning NASA Space For U.S. site, which showcases uses of NASA Earth data in all states; the update allowed multiple stories per state.

Complete details about the Communications program area are in its 2020 annual summary.

---

11 Earth Decadal Survey available at http://nap.edu/24938

12 RTI International is the name of a company; it is not an acronym

IMPACT ASSESSMENTS

We continued our cooperative agreement with Resources for the Future in the VALUABLES Consortium. VALUABLES competitively selected and initiated five community-based projects to conduct socioeconomic impact assessments for health, ecosystems, and water-quality applications. VALUABLES expanded the consortium to 12 members and refreshed its 11-person Scientific Council with an interdisciplinary group of Earth and social scientists to expand engagement with relevant communities.

PRIZE COMPETITIONS

The program's Prize Competitions initiative, led by Shobhana Gupta, supported activities across Applied Sciences to use open innovation approaches to enhance their impacts. For example, staff supported the Disasters team in working with the DOD's Defense Innovation Unit on the recent *xView2 Challenge* to automate building damage assessment from natural disasters. The DIU-NASA effort spurred further collaborations, including an effort to develop strategies for collecting SAR data to enable response to natural hazards and global events. The program also organized Applied Sciences efforts for the COVID-19 Space Apps Challenge in May and the International Space Apps Challenge in October; Applied Sciences contributed several challenges to each event. In addition, the program worked with the HAQ program area and experts at NOAA and Microsoft to design a prize competition (occurring in 2021) for cloud-processing-based algorithm solutions to analyze satellite data to identify cyanobacteria blooms in small water bodies.

RISK AND RESILIENCE

The Risk and Resilience initiative, led by Shanna McClain, began efforts in 2020 to support the program areas to incorporate issues of risk and resilience into their program planning, applications development, and partner support activities.

SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals initiative, led by Argie Kavvada, supports the efforts of countries, UN organizations, and others to apply Earth observations to support the goals, targets, and indicators identified in the UN's Agenda 2030. The program's involvement in the SDGs is primarily through work with the Group on Earth Observations (see Section VI), with some dedicated projects to demonstrate and advance uses of NASA data for sustainable development. The SDGs cover all the themes of the Applied Sciences applications elements and capacity-building program elements.

ADDITIONAL ITEMS

DIVERSITY, EQUITY, AND INCLUSION

In 2020, Applied Sciences dedicated significant time and attention to issues of diversity, equity, and inclusion, with particular attention to racism, racial inequity, and social justice. Initial efforts focused on sessions to promote open dialogue, learning, and greater awareness, which helped the team identify areas for action. We discussed ways to use Applied Sciences leadership positions in our communities to signal and model the value of diversity, equity, and inclusion. This work connected with similar efforts at the ESD and SMD levels, which aligned with the addition of Inclusion as a NASA Core Value.

To address DEI issues, the program created a Diversity, Equity, Inclusion, and Ability (DEIA) team, updated language for solicitations, revised program managers' performance plans to include DEI, examined review panel composition, and ideated actions for 2021. We held special discussion sessions for the NASA Headquarters team on June 10, September 2, and December 9; at the December 9 session, Torry Johnson from NASA's Minority University Research Education Project (MUREP) addressed the team to review MUREP and discuss collaboration opportunities. In November, SERVIR held a Virtual Gender Exchange event to share information on gender-supporting practices. We also added a routine segment on DEI issues to our biweekly staff meetings, bimonthly program reviews, and the director's weekly memo.

APPLIED SCIENCES ADVISORY COMMITTEE

The Applied Sciences Advisory Committee (ASAC) is a federal advisory committee that serves as a community-based, multi-sector forum to discuss Earth science applications and provide strategic and programmatic guidance to ESD and the Applied Sciences Program. ASAC held a virtual meeting July 28-30, 2020. The primary topics for discussion included: using consortium as a programmatic model, applications and the ESD Research and Analysis (R&A) Program, applications and the ESD Data Systems Program, and diversity and equity within the Earth science community. In the Fall, ASAC delivered a report from the meeting, articulating eight findings and six recommendations.

During 2020, we identified and recruited potential candidates for the committee. Having focused on improving gender diversity in recent years and achieving approximate parity, we set out on improving racial diversity in the committee membership. We also focused on increasing representation from private sector organizations. Near the end of 2020, NASA renewed the ASAC charter with minor updates, with onboarding of new members to begin in 2021.

Jay Skiles graduated (aka, retired) in September, 2020, after 30 years at NASA. With Applied Sciences, he served as an Associate Program Manager with Ecological Forecasting and previously as a DEVELOP Science Advisor. He approached his work with scientific integrity and a passion for sharing knowledge with others. Our Tribute.

PROGRAM PERSONNEL

Across Applied Sciences, the program leadership team at NASA Headquarters and the centers was largely stable in 2020 with only one change. In Ecological Forecasting, Associate Program Manager (PM) Jay Skiles (Ames Research Center) retired mid-2020, and Laura Rogers (Langley Research Center) started as an Associate PM. In addition, it was an award-winning year for many in Applied Sciences - Figure 2 features notable awards for Applied Sciences staff and people we sponsor.

We strongly supported NASA Internships in 2020, especially in the Summer and Fall seasons:

- Lisette E. Melendez worked with the Applied Sciences Diversity, Equity, and Inclusion team on a variety of related efforts such as research and development of a 14-week "Did You Know" email series focused on inclusive language, and a Diversity Pathways Project working to foster increased engaged with underrepresented groups in NASA Earth science.

- Jinna Brim evaluated data on award rates in Applied Sciences solicitations, comparing data across ESD and gathering baseline community demographic data by which to assess project diversity.

- Emily Kennebeck assessed Earth science applications project approaches to address the SDGs.

AWARDS FIGURE 2

Applied Sciences Website

The Applied Sciences Program website won a Platinum-level MarCom award in the Government category, recognizing outstanding achievement in communication.

Helena Chapman

Helena Chapman received the American Veterinary Epidemiology Society Honorary Diploma Award, recognizing her career contributions and distinguished service to improve animal and human health in the spirit of One Health.

Sue Estes

Sue Estes received the NASA Exceptional Public Service Medal, recognizing her strong leadership and sustained contributions in managing public health projects and engaging the health and air quality communities.

Africa Flores

Africa Flores with SERVIR received the Geospatial Woman Champion of the Year award, recognizing her efforts to increase the use of Earth observations across environmental programs, develop capacities, and inspire women around the world.

Keith Gaddis

Keith Gaddis received the NASA Early Career Public Achievement Medal, recognizing his significant performance and contributions in support of NASA's mission and goals.

John Haynes

John Haynes received the NASA Exceptional Service Medal, recognizing his efforts in advancing innovative and practical uses of NASA Earth Science observations for improving public health and decision-making.

Argie Kavvada

Argie Kavvada received the 2020 NASA Headquarters Excellence in Innovation Award, recognizing her global leadership in advancing sustainable development through Earth observations.

Hannah Kerner

Hannah Kerner with NASA Harvest became a Forbes Magazine *30 Under 30* honoree, recognizing her work in machine learning and satellite data for climate mitigation, agriculture, and food security globally.

Catherine Nakalembe

Catherine Nakalembe with NASA Harvest received the 2020 Africa Food Prize, recognizing her work promoting the use of remote sensing and machine learning in smallholder agricultural contexts to bolster food security throughout Africa.

Nancy Searby

Nancy Searby received the 2020 Individual Excellence Award from the international Group on Earth Observations, recognizing her exceptional commitment to the Group's mission, productive partnerships, and impactful contributions in the area of capacity development.

Woody Turner

Woody Turner received the 2020 NASA Headquarters Excellence in Achievement Award, recognizing the outstanding progress in using NASA observations and models to advance the science of biodiversity, its role in the Earth system, and its application to decision-making.

- The Capacity Building program had 13 interns in the summer and fall. Summer interns included: Aariana Maynard, Andy Velez, Ben Hodgkins, Grace Finstrom, Hannah Wetzel, Jonathan Mo, Kylee Hartman-Caballero, and Zac Marks. Fall interns included: Ella Haugen, Shilpa Kannan, Monica Namo, Barri' Ragland-English, and Rachel Chang.

- Collectively, they researched Capacity Building approaches and smart practices, created a training for under-served urban youth about remote sensing and urban applications (extreme heat, flooding, and canopy cover), analyzed CB program statistics, and created data visualizations and maps, an infographic, and a video.

- Our Disasters Program, Risk and Resilience initiative, and the R&A Ocean Biology and Biogeochemistry Program jointly sponsored Evan Margiotta and Abigail Major to conduct a vulnerability assessment of Sargassum impacts on the Caribbean, as well as Ashley Kleinman to study marine debris and litter.

PROGRAM REVIEWS

We continued to conduct bimonthly program reviews to take stock of both the substantive and administrative aspects of the program. During the year, we modified the review agendas to allow greater discussion time on specific topics. While this change reduced the number of specific applications projects covered at each review, the discussions provided significant time for reflection and cross-program connections, which were especially important in the COVID-19 remote work environment. Discussion topics included: low-level ARLs, scaling and replications, cross-benefits of research and applications, massive open online classes, e-books reporting system updates, and life-work balance. We productively employed online collaboration tools such as Google Jamboards, to support discussions on some topics.

In 2020, we introduced a new Unsung Heroes series at our program reviews. This series calls attention to the many people working on Applied Sciences projects who we do not usually hear about. For this initiative, we highlight people who are not part of the project leadership team or are early in their careers. This series helps us showcase the breadth and backgrounds of people involved in our work as well as the range of jobs and skills that go into our Earth science applications projects. In 2020, we recognized 14 people, highlighting two to four people at each review. We also followed up with personal profiles of some of these individuals on the program website.

CROSS-BENEFIT OF APPLICATIONS AND RESEARCH

ESD leadership continued to focus attention on an element in the 2017 Decadal Survey intended to encourage efforts to accelerate the cross-benefit of research and applications. The Earth Science Advisory Committee addressed this topic at its March 2020 meeting. Lawrence Friedl and Jack Kaye (Directors of the respective Applied Sciences and Research and Analysis [R&A] Programs) presented current and ongoing activities focused on the cross-benefit work; managers from Applied Sciences and R&A also presented examples of joint work in air quality, ecosystems, and disasters.

The programs also identified specific areas with strong potential for additional collaborations: sea level rise and coastal resilience, agriculture, water quality (including harmful algal blooms), energy (including carbon connections and management), and air quality.

ESD LEADERSHIP

As mentioned in Section II, Dr. Karen St. Germain became the ESD Director in June. Applied Sciences Program staff dedicated significant time in 2020 to inform her about the program and its roles, accomplishments, and plans.

ESD-LEVEL EFFORTS

Applied Sciences personnel serve as program scientists for Division-level activities.

Land, Atmosphere Near real-time Capability for Earth Observing System (LANCE)

David Green continued to serve as the ESD Program Scientist for the Land, Atmosphere Near real-time Capability for EOS (LANCE), which leverages existing data processing systems to provide data for timely needs of some applications communities. The LANCE User Working Group (UWG) met virtually in September 2020. The UWG reviewed the status of LANCE operations,discussed the future of LANCE, and recommended that NASA look for opportunities to collaborate with other agencies regarding sources of new Near Real-time (NRT) data. The event also included the announcement of a new NASA/U.S. Forest Service (USFS) instance of the Fire Information for Resource Management System (FIRMS) tool for the U.S. and Canada.

In 2020, LANCE introduced new NRT products from VIIRS (Black Marble Night-time Light product, Deep Blue Aerosol product and Cloud Mask product) and Advanced Microwave Scanning Radiometer 2 (AMSR2) unified products (eain and ocean). FIRMS was among the top NASA websites accessed. In the 2020 American Customer Satisfaction Index

(ACSI) survey, LANCE scored five points above the ACSI average and twelve points above the Federal Government average; it was the highest score LANCE had ever achieved. A MODIS NRT Global Flood Mapping product, with partial funding from our Disasters program area, was under development in 2020, with a release expected in 2021.

Socioeconomic Data and Applications Center (SEDAC)

In 2020, Nancy Searby continued to serve as the ESD Program Scientist for the Socioeconomic Data and Applications Center (SEDAC), which focuses on the integration of Earth observations and other socioeconomic and environmental data in support of both research and applications related to human-environment interactions. In 2020, SEDAC created a Global COVID-19 Viewer to visualize COVID-19 cases and mortality patterns and trends in relation to demographic and other potential exposure and vulnerability factors. SEDAC also updated the POPGRID Viewer with additional georeferenced population data from diverse sources, enabling users to easily compare different years and data sets for user-defined areas of interest. SEDAC released more than a dozen new or updated interdisciplinary data sets in 2020, such as the 2020 Environmental Performance Index, which compares national environmental performance over more than 20 years. In June, SEDAC held a virtual meeting of its UWG. In addition, the *Countryside: The Future* exhibit at the Solomon R. Guggenheim Museum in New York City featured SEDAC and other NASA data.

Global Partnerships

ESD maintains partnerships with four major international entities to pursue topics of mutual benefit: Conservation International (CI), Mercy Corps, Google, and Microsoft. Applied Sciences personnel support all four partnerships; Emily Sylak-Glassman and Shanna McClain lead the Mercy Corps partnership, and Woody Turner and Keith Gaddis lead the partnership with CI. The following are among the many highlights in 2020:

- **Mercy Corps**

  NASA and the humanitarian organization Mercy Corps continued their partnership pursuing ways that Earth observations can support resilience in humanitarian contexts. In May, we participated in a virtual event on adapting to a changing world, which was part of Mercy Corps Resilience Roadshow. In December, staff at SERVIR's regional hubs around the world learned from Mercy Corps' experience in expanding access to weather and climate services. The seminar included information about how gender norms in different countries shape the climate information men and women can access, and how, if these norms are not taken into account, climate service provision can reinforce gender inequities.

- **Conservation International**

  In June, the Liberian Environmental Protection Agency formally endorsed the remote-sensing-based ecosystem extent tool developed with the NASA-Conservation International partnership as the basis for its national system of ecosystem accounting. In November, the Botswana Department of Surveys and Mapping expressed their satisfaction with the mapping of ecosystem extent developed with NASA-Conservation International partnership.

- **Google**

  This partnership focuses on increasing the public's access to and use of Earth observations to explore our planet. A key advance in 2020 included the integration and cataloging of NASA data into Google Earth Engine; integration of Black Marble High Definition data is planned for 2021. A new effort, led by Argie Kavvada, began to combine NASA capabilities in air quality with Google's machine learning techniques to improve monitoring and prediction of air pollution at local and community scales. A January 2021 kickoff meeting is planned to start discussions and work streams on this activity.

- **Microsoft**

  This partnership focuses on providing decision support in smart cities by integrating Earth observations in cloud-based services. Key activities in 2020 included the conclusion of the urban resilience work with the city of Chicago and the migration of the work into the Azure cloud computing environment. In 2021, this partnership will pursue opportunities to improve data access and processing of climate data and climate change scenarios for application by public users.

**From Mine District
to Lake District**

Once a center for brown coal,
central Germany is transforming
mining pools into lakes.

Source: Landsat 5, Landsat 8

April 23, 2020

—

IV.
PROGRAM
PERFORMANCE
AND
BUDGET

IV. PROGRAM PERFORMANCE AND BUDGET

Through its projects and programmatic activities in 2020, the Applied Sciences Program advanced uses of NASA's Earth science data to benefit the economy, health, quality of life, and environment around the globe. This section conveys the performance of our project portfolio, highlights information about our financial management in Fiscal Year 2020 (FY20), and provides insights about our projects and project teams.
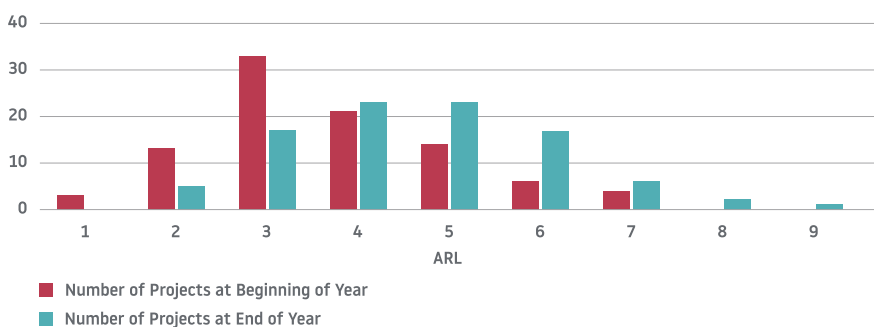
PERFORMANCE

Applied Sciences continued its use of the nine-step Applications Readiness Level (ARL) index, which it developed in 2011 to track the maturation of applications and integration of Earth observations into end-user organizations' decision-making activities.[13] The ARL index provides a scale for expected advancement along a continuum, starting with a concept and progressing through levels of development and transition to sustained use.

We met our annual performance goals for FY20 for 40% of our applications projects to advance 1 ARL and 3 projects research ARL 8 or 9. In FY20, 62% of the decision-support applications projects tracked advanced one ARL (58 of 94), and three projects reached ARL 8 or 9.

Figure 3 shows the distribution of ARLs for projects at the beginning and end of the tracking period (September 1-August 31). At the beginning of the performance year, there were projects ranging from ARL 1 to ARL 7, and ARL 3 was the most common level. At the end of the year, the range was ARL 2 to ARL 9, and ARL 4 and ARL 5 were the most common levels.

Two projects reached an ARL value of eight, indicating that they were completed and qualified with their functionality proven. One project reached an ARL value of nine, indicating it was deployed and in use in decision-making.

The ARL index has three main tiers pertaining to applications development. In general, ARLs 1-3 encompass application discovery and feasibility; ARLs 4-6 address application development, test, and validation; and ARLs 7-9 focus on application demonstration in partners' systems, transition, and sustained use.

Projects have a range of starting and goal ARLs. Not every project is intended to progress to ARL 9, but projects are expected to progress from a lower ARL to a higher ARL during the time that they are funded.

Projects per ARL Step at Beginning and End of Year

Number of Projects at Beginning of Year

Number of Projects at End of Year

Figure 3. The number of projects at each ARL step is shown in the beginning of the year (blue) and at the end of the year (red).

---

13 The ARL index adapted the NASA Technology Readiness Level scale used to assess technical maturity during sensor and hardware development.

The majority of projects advanced at least one ARL level. As shown in Figure 4, 34 projects advanced one ARL, 18 advanced two ARLs, and six advanced three or more ARLs; 36 projects did not advance an ARL in the performance year.

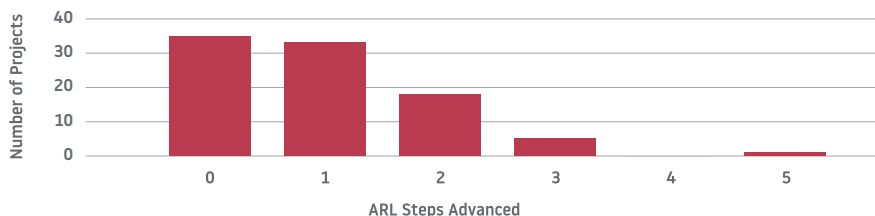*Projects by the Number of ARL Steps Advanced*

Figure 4. This figure shows the number of projects that advanced by a particular number of ARL steps.

For projects that advanced in ARLs, it was most common that they advanced one ARL. Of the 36 projects that did not advance an ARL, all but six started prior to 2019; this pattern suggests that the lack of ARL progression was not because these projects were new and experiencing issues with project initiation. These 36 projects are distributed among all the program elements.

Furthermore, the tracking showed that the lower a project's ARL at the beginning of the time period, the more likely it advanced an ARL. Our assessments showed that 71% of projects at ARL 1-3 advanced an ARL step, compared to 54% of projects at ARL 4-5 and 40% of projects at ARL 6-7. This pattern may suggest that progression at higher ARLs is more challenging than progression at lower ARLs.

FINANCIAL MANAGEMENT

Applied Sciences received $53,326,000 in appropriated funds in FY20; this amount was 13% above the program's five-year average budget. The Applied Sciences funding represented 2.7% of the total Earth Science Division budget.

Figure 5 shows the allocation of funding according to Applied Sciences program areas and activities.[14]
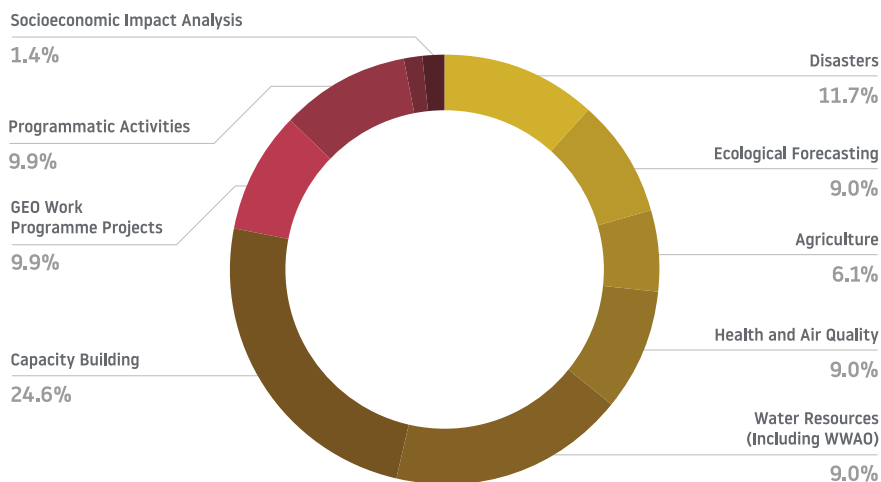

Figure 5. Percentage of FY20 funding by program areas and other major activities. All funding corresponding to Applications and Capacity Building is shown in a shade of yellow/brown.

Socioeconomic Impact Analysis 1.4%
Programmatic Activities 9.9%
GEO Work Programme Projects 9.9%
Capacity Building 24.6%
Disasters 11.7%
Ecological Forecasting 9.0%
Agriculture 6.1%
Health and Air Quality 9.0%
Water Resources (Including WWAO) 9.0%

---

14 The GEO Work Programme Projects align with the program areas with funding through a centralized pool.

Applied Sciences uses the following general funding mechanisms for applications and applied research activities; Figure 6 shows the relative amounts allocated by each mechanism.

- **Applications Projects and Applied Research Projects via Individual Grants**

  We conduct solicitations through SMD's annual ROSES announcement using a competitive, peer-review process to support programmatic selection. We employ both single-step and two-step proposal processes as well as one involving cost-sharing with the partner organization.

- **Applied Sciences Teams via Grants**

  We pursue competitively selected, peer-reviewed projects through ROSES that enable members of a team to work together to address common challenges, emerging issues identified by user engagement, or replication of successful applications. Examples include HAQAST and the SERVIR Applied Sciences Team.

- **Directed NASA Teams**

  We support teams of civil servants and contractors at the NASA centers to address prioritized, sustained activities. Examples include DEVELOP, the SERVIR Coordination Office, ARSET, and the Disaster Activation Teams.

- **Consortia**

  We support consortia of organizations that combine skills and capacities across entities with flexibility and agility to be responsive to emerging needs. Examples include NASA Harvest and VALUABLES, which are cooperative agreements selected through a competitive, peer review process, and the Western Water Applications Office, which is a center-based consortium.

FY20 Applied Sciences Funding by Category

Programmatic Support and Other Funding
19.5%

Consortia (Completed and Directed)
13.9%

Applied Science Teams (Completed)
15.5%

Directed NASA Teams
19.8%

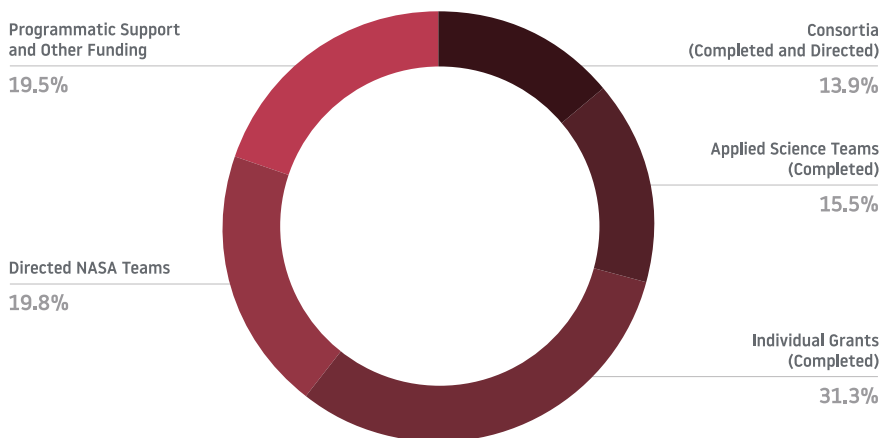Individual Grants (Completed)
31.3%

Figure 6. This shows the relative amount of funding allocated via different mechanisms in FY20.

PROJECT INFORMATION

To assess progress regarding the program's annual performance goals, we track projects that develop and enhance decision-support applications. There were 94 such projects for the FY20 performance year. Table 1 shows the distribution of these projects across Applications and CB-SERVIR Applied Sciences Team (AST), including the active projects aligned with the GEO Work Programme.

PROGRAM AREA	NUMBER OF PROJECTS
CB-SERVIR AST	20
Disasters	12
Ecological Forecasting	11
Health and Air Quality	13
Water Resources	14
GEO Work Programme	24

Table 1. Number of projects tracked through ARLs in FY20 performance year.

The principal investigators (PIs) for the projects are affiliated with institutions across the U.S., with the majority affiliated with academic institutions. Figure 7 shows the distribution of PIs by state. The states with the highest number of PIs include Maryland (18), California (15), and Virginia and Colorado (9). In total, Applied Sciences PIs represent 29 states, Washington D.C., and Puerto Rico. These figures represent only the PI home institutions; other project team members may reside at other institutions. Thus, although PIs are not located in every state, states can be involved with Applied Sciences via other means, including resident Co-Investigators or partners. These figures do not reflect activities by CB-ARSET and CB-DEVELOP, which routinely touch nearly every U.S. state each year, or activities accomplished by NASA Harvest, VALUABLES, or WWAO.
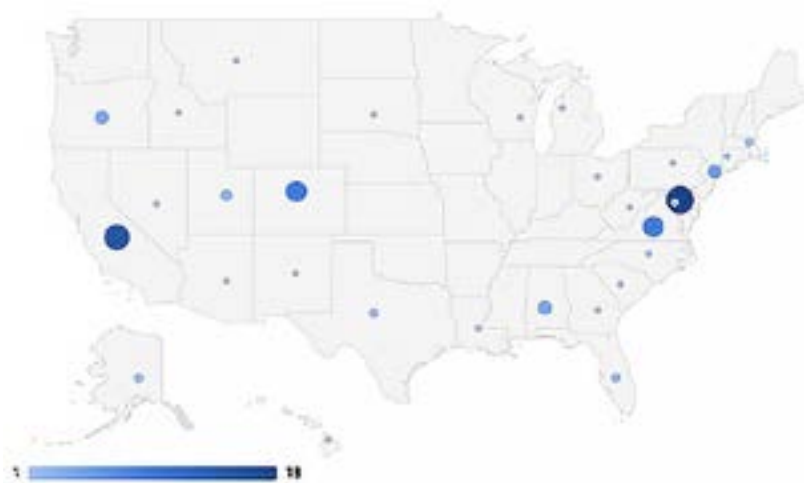

Figure 7. Locations of project PI home institutions in the U.S. The size and tone of the dot indicate the number of project PIs in the state. One project PI based in Puerto Rico is not shown.

(Note: An Earth science application may occur in a different state than that of the PI's home institution.)

In some cases, multiple project PIs reside at the same home institution.
Table 2 shows the insitutions with multiple PIs.

INSTITUTION	NUMBER OF PIS
University of Maryland-College Park	9
NASA Jet Propulsion Laboratory	6
NASA Goddard Space Flight Center	5
University of Colorado, Boulder	4
Brigham Young University	3
Columbia University	3
Oregon State University	3
Conservation International	2
George Mason University	2
Johns Hopkins University	2
NASA Marshall Space Flight Center	2
Stanford University	2
University of Alaska-Fairbanks	2
University of Alabama-Huntsville	2
University of California, Santa Barbara	2
University of Houston	2

Table 2. Institutions with multiple project PIs

Cloud Rosettes in the Sky

Actinoform clouds pop up off the western coast of Australia.

Source: Aqua

January 29, 2020

—

V.

PROGRAM ASSESSMENT

V. PROGRAM ASSESSMENT

All in all, the Applied Sciences Program had a very productive year, especially considering the adjustments made due to the COVID-19 pandemic. Program leadership was extremely pleased with the performance of the program and, more importantly, with how program staff maintained their strong leadership, connections with their partners and communities, and overall productivity.

This section captures key reflections on the year, including program activities that went well and some that did not unfold as planned and how we adjusted based on what we learned. This discussion focuses mostly on program management topics rather than applications achievements, which Section I addressed. In addition, the annual summaries for the individual program areas include an assessment and reflections specific to each area.

COVID-19

The global pandemic overshadowed almost everything in 2020. By and large, the program staff made an impressive switch to a full-time telework situation in early March. (The program's switch to video-based staff meetings in 2019 was helpful in aiding the adjustment.) The staff continued to adapt throughout the year, finding ways to remain productive, reduce inefficiencies, and stay connected to their communities. There were clearly challenges with the new arrangements on both personal and professional fronts, as well as with technology and connectivity. Throughout the year, program personnel discussed the situation and made adjustments, such as reducing staff meetings to alternating weeks and freeing up large, meeting-free blocks of time to enable concentrated time for planning, writing, and other activities.

Our peer-review panels moved to a virtual environment, which proved highly effective. In fact, COVID-19 likely accelerated an existing trend toward more virtual review panels. While virtual panels eliminate some positive aspects of in-person meetings, such as networking and ideation among panelists, benefits such as easier scheduling, faster panel results, reduced travel costs, and reduced carbon emissions seem to outweigh the downsides. We expect to make greater use of virtual panels even after the pandemic subsides.

During 2020, we noted a slow-down in some projects, as the partners focused on their core activities during COVID or the inefficiencies of remote work and loss of field work took a toll.

The extreme telework environment prompted greater exploration and use of online, digital, collaboration tools. For example, we made greater use internally of digital surveys, digital collaboration mechanisms (e.g., Google Jamboard), and other tools in 2020 than ever before. In addition, we used the virtual environment to our advantage at times. For example, our program's virtually-conducted Applied Sciences Week event in August reached many more people than usual, as did the virtual Water Resources team meeting and HAQAST Showcase in July, the virtual HAQ team meeting in September, and many others. The increased reach is leading us to consider more hybrid approaches for events in 2021 and beyond, including the technology investments needed to make them effective.

Most members of our team noticed that the remote work environment created stresses or exacerbated some that existed before the pandemic. There seemed to be an explosion of meetings and overfilled calendars, as countless digital events and tagups were needed to replace the informal, brief connections enabled by in-person work. We also experienced a virtual tsunami of email messages. The email increase positively reflected an attitude of inclusion and communication, yet it created stress or, at times, miscommunication when emails went unread. We addressed life-work balance head-on at the November Program Review, sharing personal strategies and identifying actions to provide people larger, connected blocks of unscheduled time. This balance will continue to be an issue to address in 2021 and beyond.

FINANCIAL MANAGEMENT

We had our best year ever managing our finances. Based on budgetary re-phasing adjustments made in previous years, the program team committed record levels of resources in the first three months of FY20. By March 2020, the program had released 80% of its budget total, ahead of its benchmark. Throughout FY20, our commitment and obligation percentages led the division, and our strong costing figures reflected the early obligation of funds. By the end of FY20 (September 30), we had committed 96.9% and obligated 96.5% of our budget, and the figures were 99.4% and 99.1% respectively by December 31.

Over the course of 2020, some projects experienced costing slowdowns, primarily due to the impacts of COVID-19. Budget reallocations within projects, such as shifting travel funds into other project activities, also occurred.

In 2020, we experienced some minor issues with delayed obligations of FY19 funding by NASA centers. While some centers were quite responsive and obligated funding expediently, there were a few cases of delayed funding obligations despite numerous notices. The monetary amounts in these cases were small relative to the total program budget, but we instituted new timelines for center obligation of FY20+ funds to ensure we allocate public resources in timely and effective ways.

PROJECT IMPLEMENTATION

As the FY20 performance indicated (see Section IV), the program had a strong year and numerous applications projects advanced. Of the projects tracked, 68% increased one ARL or more. We had some strong examples of applications successes (see Section I) and progress along the ARL scale. Overall, we were very pleased with the progress and impact of the broad Applied Sciences project portfolio.

We understand that half of the performance year occurred before the COVID-19 impacts and restrictions, which affected field work, especially in Summer 2020. Throughout the course of 2020, the program managers and associates reported that some projects' partners had reduced their engagements with the projects, as they addressed COVID-19 impacts and priorities within their own organizations. Overall, we are cautious about our 2020-2021 performance period.

In recent years, the program has been focusing on replication and scaling of successful applications projects. In 2020, the degree of attention SMD and ESD leadership devoted to these topics rose significantly. On the one hand, the program could cite several examples of completed or ongoing replication and scaling efforts. However, division and directorate leaders expressed a desire for more examples and methods to improve awareness. We continued to address substantive approaches to increase scaling as well as improve our communication to address issues of perception; this issue will continue to be a prime area of focus in 2021 and beyond.

Sections II and III described program activities in 2020 related to the topics below. Here, we reflect on the activities, including what went well and what to improve.

DIVERSITY, EQUITY, AND INCLUSION (DEI)

As described in earlier sections, we began deliberate efforts in 2020 to address DEI issues collectively as a program, with particular attention to racism and racial inequity. NASA adopted Inclusion as a new Core Value, and there was a very positive response. DEI became a regular topic in our staff meetings and program reviews, and five people enthusiastically volunteered to serve on the program DEI Steering Group – Keith Gaddis, Shobhana Gupta, McRae Lent, Shanna McClain, and Nancy Searby. Their work aligned with similar efforts at the division and directorate levels.

The DEI Steering Group developed many sound actions to pursue, including facilitated diversity dialogues, standard language in solicitations, an inclusive language e-mail series, diversity pathways efforts, an analysis of project selection, and a code of conduct. We pursued many of these items, such as incorporation of standardized language in our solicitations and analysis of our project selections. However, the program suspended or cancelled some efforts due to Executive Order 13950 issued in mid-September.[15]

As we pursued these issues, program staff were well aware of the continued needs to address aspects of diversity in the Earth sciences in addition to race, such as gender. For example, CB-SERVIR held a virtual gender exchange event in November to share gender-supporting practices.

In addition, the program's new strategic plan (for release in 2021) reflects our commitment to DEI as a core principle reflected in our expectations of ourselves and the community.

CROSS-BENEFITS OF APPLICATIONS AND RESEARCH

As described above, the program continued efforts to accelerate the cross-benefit of research and applications, as suggested in the 2017 Earth Decadal Survey. The emphasis was on supporting a functional, two-way cooperation on topics. In spring, we compiled a table depicting the current and potential interactions of Applied Sciences Program areas with the R&A Program's six science focus areas and 14 sub-elements; in summer, the R&A Program conducted a similar activity from their perspective. There were many commonalities between these two efforts, yet the Applied Sciences Program assessment seemed more optimistic or ambitious about potential opportunities.

Regarding the need for greater cross-benefits among the programs, program leadership assessed that there were issues of substance and perception at work. We recognized our program's role in tapping the applications-oriented users to help identify potential research questions and data needs from user communities, and increased the frequency and range of user feedback. We recognized that ESD personnel were not familiar with the structure and mechanics of the Applied Sciences Program, and we arranged an initial briefing with the R&A Program staff to familiarize them and planned other briefings for ESD overall. We recognized the need to pursue integrated applications and research stories together with R&A, an effort we started and need to pursue in earnest in 2021. Finally, we recognized that the many interactions between the two programs were unacknowledged, so we made an effort to better document and communicate them with division and directorate leadership.

MISSION PLANNING

By and large, we had a strong year in connecting with flight projects and support of missions in formulation and development. As mentioned above, hackathons and workshops with SWOT, MAIA, and TEMPO were standout events, especially to engage Early Adopters and resolve issues. Our efforts with the four Designated Observable (DO) studies supported the division's goals and the decadal survey's guidance to consider applications during the early stages of the mission lifecycle. All the major DO presentations to ESD leadership in 2020 included materials and discussions about applications. In addition, the firm RTI International worked with each DO study team to characterize potential user communities and help NASA expand its customary user communities, especially to include private-sector industries.

PRIZE COMPETITIONS

We continued use of prize competitions to reach broad audiences to generate ideas. Over the course of the year, we recognized issues in the ability of the program areas to incorporate these competitions into their strategies and portfolios of activities. Consequently, prize competitions will address program-level topics in 2021.

---

15 The Biden Administration rescinded EO 13950 in January 2021; the program will look to resume suspended activities.

COMMUNICATIONS

We had a very successful year regarding program communications and the development of technical content. The launch of the redesigned Applied Sciences website in March was a watershed moment that led to increased publication of stories, news, and personal profiles. It was rewarding to be able to call attention to our project teams, partners, and applications community and recognize their work and impacts. At year's end, we assessed that the vast majority of our materials consisted of web-based, written content and concluded that the program needs to broaden the range of platforms and types of outreach employed in 2021.

VI.
COMMUNITY LEADERSHIP

VI. COMMUNITY LEADERSHIP

Applied Sciences supported and sponsored numerous community activities as part of overall efforts to enhance the use of Earth observations. The following items highlight notable conferences and symposia that program personnel attended and summarize the program's participation in key interagency committees.

COMMUNITY EVENTS

National Council of Science and the Environment (NCSE)

Applied Sciences continued its long-term support of the National Council of Science and the Environment, sponsoring NCSE's Annual Conference again in January 2020. This conference focused on Science in Environmental Decision-Making, and numerous program staff spoke at sessions or exhibits. We co-sponsored this event for ESD with the R&A Program.

American Meteorological Society (AMS)

Numerous personnel from across Applied Sciences participated in the 100th Annual Meeting of the American Meteorological Society. This year's meeting theme was *The AMS Past, Present and Future: Linking Information to Knowledge to Society*.

American Geophysical Union (AGU)

The 2020 AGU Fall Meeting shifted to an entirely virtual format in 2020, with events spread across three weeks in December. Numerous personnel from Applied Sciences gave talks, organized sessions, supported the exhibits, and more.

Applied Sciences continued its support of the Ignite@AGU storytelling event, which celebrated its 10th consecutive year of bringing fast-moving, engaging talks to AGU. Among the 10 speakers at this year's event were two from Applied Sciences – Emil Cherrington with CB-SERVIR and Jonathan O'Brien with CB-ARSET.

Applied Sciences Week

In early August, we held our annual Applied Sciences Week to highlight many ways that people use NASA Earth science data to improve decisions, support the economy, and improve the quality of life. This year, we shifted from the usual in-person event at NASA Headquarters to an entirely virtual format. The event featured 44 presentations about work with partner organizations for Earth science applications, additional breakout sessions, and a map-a-thon. Over 1,200 people tuned in over the week, with over 550 unique attendees and a daily average of 312. The week served as the capstone event of the CB-DEVELOP Program's 2020 Summer Term, highlighting the work of 65 DEVELOP participants in 15 projects with 25 partners.

NASA-USFS Pitch Fest and Idea Forum

In 2020, Applied Sciences and the U.S. Forest Service (USFS) held a two-part Pitch Fest and Idea Forum. This event was part of ongoing efforts to enhance connections with the resource management community to solve research and operational challenges through Earth observations data.

In June, staff from NASA and USFS pitched opportunities to use NASA Earth data for land and natural resource management, such as fire and fuels management, forest hydrology, and soil mapping. Over 320 people participated, 52 ideas were pitched, and the real-time virtual chats led to scores of connections between researchers and practitioners. Based on attendees' ratings, Pitch Fest finalists proceeded to part 2, the Ideas Forum.

In November, Ideas Forum participants conducted follow up discussions on projects identified at the Pitch Fest. Since projects were at different levels of maturity, this forum served as a collaborative environment to provide feedback to teams as well as to discuss information about data and tools to help the ideas reach their potential. Topic areas included vegetation monitoring and prediction, fire management, land cover and landslide inventory, restoration, and fire hazard prediction.

Understanding Risk Forum

On December 1-3, Applied Sciences represented NASA Earth at the global Understanding Risk Forum. This biennial event showcased the latest innovations in the field of risk identification, facilitating novel partnerships across a variety of sectors. The 2020 forum included numerous sessions dedicated to the burgeoning role Earth observations play in such fields as anticipatory action, supply chain disruption, and developing nature-based solutions. Many ESD partners presented in the forum sessions, including the European Space Agency (ESA), CNES, Japan Aerospace Exploration Agency (JAXA), and Indian Space Research Organisation (ISRO).

INTERAGENCY

United States Group on Earth Observations (USGEO)

USGEO is the formal mechanism by which relevant federal agencies determine and coordinate policy and decisions to ensure U.S. global leadership in Earth observations activities, operations, and research and with the Earth Observations Enterprise. Lawrence Friedl serves as one of the USGEO Co-chairs, and numerous personnel in ESD and Applied Sciences are active in USGEO working groups or USGEO-led activities.

USGEO had a very active year, as it began implementing parts of the 2019 National Plan for Civil Earth Observations, which the Office of Science and Technology Policy (OSTP) released at the AGU Fall Meeting in December 2019. The plan introduced the concept of the Earth Observations Enterprise (EOE), which spans academia, government, nonprofits, and the private sector. Applied Sciences personnel assumed active roles in task teams set up to address specific actions in the plan and to support engagement with the EOE. USGEO also revived its website in 2020, which Applied Sciences hosts as part of its contributions to USGEO.

USGEO began the third round of its Satellites Needs Process, in which agencies identify and submit needs for satellite data products to NASA. In October, NASA received 123 needs submissions from other agencies, and began its efforts to analyze the needs to determine if or how it could fulfill them. Applied Sciences engaged more actively in this third round, leveraging expertise at the NASA centers to support the needs analysis. ESD expects to deliver the results of this analysis in July 2021.

USGEO leadership held a town hall in January at the AMS Annual Meeting to describe the 2019 National Plan for Civil Earth Observations. They also met with staffers from the House Committee on Science, Space, and Technology in January to discuss the National Plan. They participated in a virtual panel session in July at the summer meeting of the Earth Science Information Partners (ESIP) Federation, and held a town hall at the AGU Fall Meeting in December to report on progress on the National Plan and other activities.

United States Global Change Research Program (USGCRP)

USGCRP supports cooperation across its 13 federal agency members to advance understanding of the changing Earth system and maximize efficiencies in federal global change research. From Applied Sciences, John Haynes represents ESD on the Interagency Crosscutting Group on Climate Change and Human Health (CCHHG), which coordinates federal scientific activities related to the human health impacts of global climate change.

Interagency Council for Advancing Meteorological Services (ICAMS)

ICAMS is the formal mechanism by which all relevant federal departments and agencies coordinate implementation of policy and practices to ensure U.S. global leadership in the meteorological services enterprise. ICAMS received its formal charter in July 2020, with four standing committees: Committee on Observational Systems; Committee on Cyber; Facilities, and Infrastructure; Committee on Services; and Committee on Research and Innovation. From Applied Sciences, John Haynes represents ESD on the Committee on Services.

Monsoons in Pakistan

Historic amounts of rain led to
flooded fields and swollen rivers
in southeastern Pakistan.

Source: Terra

September 21, 2020

—

VII.
INTERNATIONAL
ACTIVITIES

VII. INTERNATIONAL ACTIVITIES

The Applied Sciences Program continued to actively participate in international activities in 2020. Although the COVID-19 pandemic impacted our important relationship-building activities, it also created unexpected opportunities. As in previous years, some of the program's international activities were executed within individual program areas such as CB-SERVIR or Disasters; specific highlights pertaining to these activities are covered in individual annual summary documents for each program area. This section describes program-wide activities pertaining to international bodies such as GEO and the Committee on Earth Observation Satellites.

GROUP ON EARTH OBSERVATIONS

The program continued its active engagement and leadership in GEO Flagships, Initiatives, and Community Activities in 2020. Both program personnel and program-sponsored teams contributed to these activities. Our support to specific GEO Work Programme elements and to new GEO working groups formed in 2020 is summarized below.

GEO Projects

In late 2017, Applied Sciences launched 32 projects ($17M over four years) associated with nine elements in the GEO Work Programme: AmeriGEO, Earth Observations for Ecosystem Accounting (EO4EA), Earth Observations for Health (EO4Health), GEO Global Water Sustainability (GEOGloWS), GEO Biodiversity Observation Network (GEOBON), GEO Vision for Energy (GEOVENER), Global Flood Risk, Global Wildfire Information System (GWIS), and Human Planet Initiative.[16,17] Some projects completed in 2020 with the remainder scheduled to conclude in 2021.

In addition to performing applied research and applications work, the program expected project teams to engage with people from other countries and organizations also working on that Flagship, Initiative, or Community Activity. The intent was to broaden U.S. engagement in GEO (and associated networks) beyond federal agencies to U.S. academic, private, and nonprofit organizations.

In April, the program consulted with the GEO Secretariat officials responsible for the GEO Work Programme to gauge their sense of the 32-projects' impact, regarding both substance and engagement. The GEO officials indicated that they were largely unaware of the specific contributions of the 32 projects, yet they were aware and had positive impressions about areas where NASA personnel played Executive Secretary roles and led specific Work Programme elements. Based on these insights, we plan to change the Applied Sciences approach to supporting the GEO Work Programme as well as our requirements for communications and engagement for any future projects we support.

GEO Working Groups

In March, GEO requested nominations for four new working groups (WGs): Capacity Development, Climate Change, Data, and Disaster Risk Reduction. The Applied Sciences Program organized the identification and nomination of NASA personnel to be part of the U.S. team on each working group. The following individuals began serving on the working groups in 2020: Jacqueline Lemoigne-Stewart (Earth Science Technology Office [ESTO]) on the Data WG; Patrick Taylor (LaRC) on the Climate Change WG; Betzy Hernandez Sandoval (Marshall Space Flight Center [MSFC]) on the Capacity Development WG; and David Borges (LaRC) on the Disaster Risk Reduction WG.

---

16 Our investment was intended as a stimulus package supporting the launch of the updated GEO Work Programme, timed for the GEO Plenary the U.S. hosted in Washington, DC, in October 2017.

17 Additional elements we support include GEO Global Agricultural Monitoring (GEOGLAM) and Earth Observations for the Sustainable Development Goals (EO4SDG); these elements were not part of the project solicitation that led to the 32 projects launched in 2017.

GEO Work Programme Elements

Many of the GEO Work Programme Elements we support align directly with Applied Sciences program areas. For example, GEOGLoWS aligns with Water Resources and EO4Heath with Health and Air Quality. Below, we cover the activities that are program-wide in nature; program area summaries cover ones aligned with that area .

AmeriGEO

Applied Sciences continued its strong engagement with AmeriGEO, with Betzy Hernandez Sandoval serving as the lead. AmeriGEO connects countries in the Americas for better coordination on access to and uses of Earth Observations, geographic information, and statistical data. In September, Applied Sciences personnel participated in the international 2020 AmeriGEO Americas Symposium and several spoke at the event. This year's symposium officially announced Health as the newest AmeriGEO focus area, joining Food security, Disasters, Biodiversity and Ecosystems, and Water Resources.

Earth Observations for the Sustainable Development Goals Initiative (EO4SDG)

Applied Sciences continued to lead the EO4SDG, with Argie Kavvada serving as the EO4SDG Executive Secretary and Lawrence Friedl as one of three EO4SDG Co-chairs. Highlights pertaining to EO4SDG include:

- Developed the first EO Toolkit for Sustainable Cities and Human Settlements; included designing the toolkit and collecting case studies in 2020, with release in February 2021 by UN-Habitat in support of SDG Goal 11 and the New Urban Agenda

- Coordinated the second annual EO4SDG Awards for announcement at the 2020 GEO Plenary, increasing the number of awards and categories and significantly increasing the number of nominations

- Released a special issue of the journal *Remote Sensing of Environment* focused on Earth Observations for the Sustainable Development Goals

- Presented at the World Data Forum, GEO Symposium, Atlantic International Research Centre's Networking series, sessions at the AGU Annual Meeting, and more.

Human Planet Initiative (HPI)

The HPI focuses on advancing the development and uses of Earth observations, geospatial data, and analytics for assessing the human presence on Earth, especially focusing on the built environment, population density over time, and spatial patterns and processes of an urbanizing world. Applied Sciences continued its support of three projects supporting HPI and of Robert Chen from SEDAC and Columbia University as a HPI Co-lead. In 2020, HPI produced the 2020 Atlas of the Human Planet for release in January 2021; this atlas highlights 34 examples of data uses related to disaster risk reduction, environment, urbanization, and sustainable development. The UN Statistical Commission endorsed a new global method for classifying and comparing cities, urban areas, and rural areas around the world. HPI organized sessions at the American Association for the Advancement of Science annual meeting in February and at the AGU Fall Meeting in December.

COMMITTEE ON EARTH OBSERVATION SATELLITES (CEOS)

ESD continued its strong engagement with CEOS again in 2020, with active leadership and engagement in numerous CEOS entities. Applied Sciences supported ESD's efforts through leadership of the Working Group Disasters, with David Green as the Chair and David Borges as the Executive Secretary, and leadership of the Working Group on Capacity Building and Data Democracy, with Nancy Searby as the Chair. Brad Doorn and personnel from NASA Harvest, such as Alyssa Whitcraft, actively participated in CEOS support of GEO Global Agricultural Monitoring

(GEOGLAM). Argie Kavvada and Lawrence Friedl supported the CEOS SDG Ad Hoc Team, which made significant progress focusing on three SDG indicators for water, urbanization, and land degradation.

At the CEOS Plenary in October, NASA ESD accepted the role as CEOS Chair for 2021 and announced the theme for the 2021 CEOS Chair term: *Space-based EO Data for Open Science and Decision Support*. With this theme, ESD seeks to broadly disseminate the relevance of CEOS remote sensing activities and contributions in support of open science and decision-making. ESD expects to emphasize accessibility, transparency, reproducibility, and support of global initiatives with an open science approach.

INTERNATIONAL PARTNERSHIPS

Applied Sciences was actively involved in ESD partnerships with foreign governments and regional organizations. Two notable examples from 2020 include:

Rio de Janeiro

In October, between NASA and the city of Rio de Janeiro extended a partnership agreement for five additional years. This partnership agreement supports use of Earth observations data to enable ongoing efforts to anticipate, monitor, and better assess risks and resilience related to multiple natural hazards in the vicinity of Rio, such as flooding, inundation, mudslides, drought, and landslides. NASA gains unique feedback on Earth science data products as well as insights on innovative applications. The partnership agreement runs through December 2025. A public event to highlight the extension is planned for January 2021.

Central American Integration System (SICA)

In June, SICA published a report summarizing the accomplishments and benefits that occurred the first year after the NASA-SICA joint statement was established. The organizations cooperated on over 30 individual meetings, eight SICA-focused DEVELOP projects, the Understanding Risk Central America conference, the region's COVID-19 response, and awareness of relevant NASA data resources to build resilience. Additional opportunities to collaborate include discussions on risk reduction, the blue/green economy, food security, and water issues in the Central American Dry Corridor.

Red River Flooding

Unique geography means the river
flows north from Minnesota to Canada,
where ice jams lead to spring flooding.

Source: Landsat 8

April 17, 2020

—

VIII. LOOKING AHEAD

VIII. LOOKING AHEAD

The Applied Sciences team looks to 2021 as a significant opportunity to further advance uses of Earth observations and their benefits to society. The year also offers us additional prospects to leverage our connections with user communities to benefit ESD.

A major 2021 event is the inauguration of President Biden. The incoming Biden-Harris Administration has identified four key priorities – Climate, Economy, Equity, and Restoring America's Global Leadership. These priorities offer numerous opportunities for NASA Earth Science and Earth science applications to contribute through both ongoing and new efforts that began this year.

We look forward to completing our new strategic plan, conveying it to our communities, and implementing our new goals. We will continue to use technical content and communications efforts as part of our strategy to encourage new organizations to pursue using Earth observations or encourage current partners to pursue new uses. In 2021, we will review elements of our program's identity to ensure consistency. We will also integrate the CB-DEVELOP website into the main Applied Sciences Program website to further consolidate our online presence.

In 2021, the program will sponsor multiple solicitations in the omnibus SMD ROSES-21 announcement. The Water Resources and the Health and Air Quality areas will solicit proposals for new applications and applied research projects. The CB-SERVIR program will solicit proposals in a two-stage effort to select its next Applied Sciences Team. In February 2021, the next Health and Air Quality Applied Sciences Team will commence work.

We will continue our deliberate attention to, and emerging efforts on, diversity, equity, and inclusion, including advancing efforts within the communities with which we engage. Also, as we likely transition back to in-office work at some point in 2021, we will seek to maintain the lessons learned and advantages gained from the remote work environment.

A-CCP	Aerosols & Clouds, Convection and Precipitation
ACSI	American Customer Satisfaction Index
AGU	American Geophysical Union
AMS	American Meteorological Society
AMSR2	Advanced Microwave Scanning Radiometer 2
ARL	Applications Readiness Level
ARSET	Applied Remote Sensing Training
ASAC	Applied Sciences Advisory Committee
ASCII	American Standard Code for Information Interchange
ASO	Airborne Snow Observatory
AST	Applied Sciences Team
ATMS	Advanced Technology Microwave Sounder
CA-DWR	California Department of Water Resources
CB	Capacity Building
CCHHG	Crosscutting Group on Climate Change and Human Health
CEOS	Committee On Earth Observation Satellites
CI	Conservation International
CNES	Centre National d'Etudes Spatiales
DEI	Diversity, Equity, and Inclusion
DEIA	Diversity, Equity, Inclusion, and Ability
DEVELOP	Name of a program element; not an acronym
DIU	Defense Innovation Unit
DO	Designated Observable
DOD	Department Of Defense
DOI	Department Of the Interior
DSET	Drought Severity Evaluation Tool
EA	Early Adopters
EO	Earth Observations
EO4EA	Earth Observations for Ecosystem Accounting
EO4SDG	Earth Observations for the Sustainable Development Goals Initiative
EOE	Earth Observations Enterprise
EOS	Earth Observing System
ESA	European Space Agency
ESD	Earth Science Division
ESIP	Earth Science Information Partners
ESTO	Earth Science Technology Office
FBI	Federal Bureau of Investigation
FIRMS	Fire Information For Resource Management System
GEO	Group on Earth Observations
GEOBON	GEO Biodiversity Observation Network
GEOGLAM	GEO Global Agricultural Monitoring
GEOGLoWS	GEO Global Water Sustainability
GEOVENER	GEO Vision for Energy
GOES	Geostationary Operational Environmental Satellite
GWIS	Global Wildfire Information System
HAQ	Health and Air Quality
HAQAST	Health and Air Quality Applied Sciences Team
HPI	Human Planet Initiative
ICAMS	Interagency Council for Advancing Meteorological Services
ICF	Name of a company; not an acronym
ISRO	Indian Space Research Organisation
JAXA	Japan Aerospace Exploration Agency
JPL	Jet Propulsion Laboratory
JPL-ARIA	JPL-Advanced Rapid imaging and Analysis
LADCO	Lake Michigan Air Directors Consortium
LANCE	Land, Atmosphere Near real-time Capability for EOS
MAIA	Multi-Angle Imager for Aerosols
MC	Mass Change
MODIS	Moderate Resolution Imaging Spectroradiometer
MSFC	Marshall Space Flight Center
MUREP	Minority University Research Education Project
NASA	National Aeronautics and Space Administration
NCSE	National Council for Science and the Environment
NOAA	National Oceanic and Atmospheric Administration
NRT	Near Real-Time
OSTP	Office of Science and Technology Policy
PI	Principal Investigator
PM	Program Manager
POWER	Prediction of Worldwide Energy Resources
PRISM	Platform for Real-time Impact and Situation Monitoring
R&A	Research and Analysis
RDCYIS	Regional Drought and Crop Yield Information System
ROSES	Research Opportunities in Space and Earth Sciences
RTI International	Name of a company; not an acronym
SAR	Synthetic Aperture Radar
SBG	Surface Biology and Geology
SDC	Surface Deformation and Change
SDG	Sustainable Development Goal
SEDAC	Socioeconomic Data and Applications Center
SERVIR	Name of a program element; not an acronym
SICA	Central American Integration System
SMAP	Soil Moisture Active Passive
SMD	Science Mission Directorate
SWE	Snow Water Equivalent
SWOT	Surface Water and Ocean Topography mission
TEMPO	Tropospheric Emissions: Monitoring Of Pollution
UN	United Nations
U.S.	United States
USAID	United States Agency for International Development
USFS	U.S. Forest Service
USGCRP	United States Global Change Research Program
USGEO	United States Group on Earth Observations
UWG	User Working Group
VALUABLES	Valuation of Applications Benefits Linked with Earth Science
VIIRS	Visible Infrared Imaging Radiometer Suite
WG	Working Group
WWAO	Western Water Applications Office