National Aeronautics and
Space Administration

Hold for Release Until
Presented by Witness

May 18, 2021

Subcommittee on Space and Aeronautics
Committee on Science, Space, and Technology

U.S. House of Representatives

Statement by:
Dr. Gavin A. Schmidt
Senior Advisor on Climate to the Administrator (Acting)
National Aeronautics and Space Administration

117th Congress

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Chairman Beyer, Ranking Member Babin, Members of the Subcommittee and Committee,

My name is Gavin Schmidt, and I am the Director of the NASA Goddard Institute for Space Studies (GISS) in New York and, since February, the acting Senior Advisor on Climate to the NASA Administrator. I have been a climate scientist for almost three decades, and since 2004, I have worked for NASA at GISS, where I am the Principal Investigator for the GISS ModelE Earth System Model.

My scientific work has mainly focused on the development, evaluation, and application of climate models to issues of the detection and attribution of climate change both in the past and in the present. During the past decades, we have learned that space provides a unique vantage point to learn about our planet and to understand it as a system. As the preeminent civilian agency that develops U.S. systems to provide space data, much of what we know today about the long-term changes in our Earth system comes from NASA-built systems going back to the 1960s. We recognize that this role in understanding our Earth system is important for the future and can help inform how we can thrive on our changing planet.

As part of my current role, I have been tasked with developing a renewed climate strategy for the whole of NASA. Today, I would like to share with you the breadth and depth of NASA's work on climate from across the whole agency, covering pure scientific research, technology development, applied science, and education as well as the agency's own emissions and efforts to build greater resilience to climate change. NASA's work on climate is one of the key overarching elements in how the agency is responding to the Administration's priorities.

NASA is legislatively mandated to perform climate-related research and development

By statute, NASA is the lead agency for civil aeronautics research and conducts aeronautics research and development. We fill this role as part of the U.S. Government's responsibility to "increase the efficiency of the Nation's air transportation system" and "protect the environment" (51 U.S.C. § 40102).

NASA has also been tasked with scientific research that can be productively studied from space, including Earth science and Sun-Earth connections (51 U.S.C. § 20301). Specifically, NASA shall

> ...pursue a program of Earth observations, research, and applications activities to better understand the Earth, how it supports life, and how human activities affect its ability to do so in the future. (51 U.S.C. § 60501)

Additionally, the law acknowledges that practical benefits for society will be an important measure of the success of these programs in addition to securing new knowledge about the Earth system and climate change. NASA is also tasked with ensuring our policies on climate related data facilitate their availability and widest possible use to ensure public access to accurate and current data on global warming (51 U.S.C. § 60506).

NASA takes all of these responsibilities very seriously.

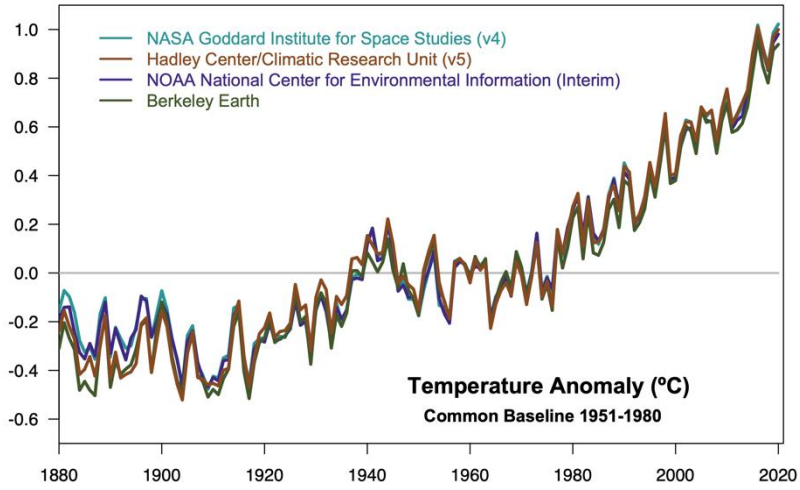

Figure 1: Global surface temperature anomalies since 1880 from four independent methodologies.

Human-caused climate change is already having impacts

Since the late 19th Century, global surface temperatures have risen more than 1.2ºC/2.2ºF according to analyses from NASA GISS (Figure 1), with greater trends on land than over the ocean, and with recent warming rates in the Arctic that are more than three times the global mean. Sea level determined from tide gauges has risen an average of 10 to 12 inches since 1900, and since 1993 is rising at more than 3 mm/year and accelerating according to satellite altimeter data (Figure 2). Since the beginning of comprehensive satellite observations in 1979, summer sea ice in the Arctic has decreased by more than 40%. Water vapor in the atmosphere has increased, and ocean heat content has increased by more than $30x10^{22}$ joules since 1970. These changes were all predicted to arise as a consequence of increases in greenhouse gas emissions, notably carbon dioxide. Climate models from 1970 onwards have, with few exceptions, been successful in predicting the subsequent changes in climate to 2020.

These broad changes in turn are having direct impact on communities in the United States and internationally. Sea level rise, particularly along the U.S. East Coast is leading to a large increase in coastal flood events. Greater intensity of precipitation is contributing to flooding, notably in response to Hurricane Harvey in 2017, but also more generally. Warming is making the ongoing drought in the U.S. Southwest more intense because of the greater evaporative demand from the soil. It is also adding to the intensity of wildfires, the prevalence of pine bark beetles, and poleward shifts of invasive plants and some diseases, like the tick-spread Lyme disease found here in the Northeast United States.

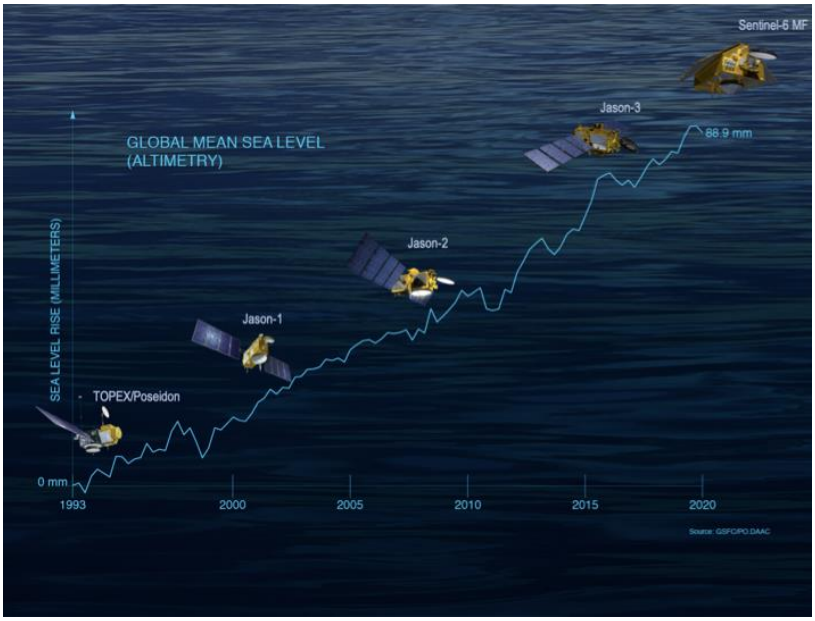

Figure 2: Global sea level changes from satellite altimeters since 1993.

NASA's research portfolio in climate

The backbone of NASA's climate research is the observations that have been made from space since the 1960s, and particularly since 1979. These long-term observations have provided dramatic evidence of climate change; for instance, the continuing loss of mountain glaciers from four decades of Landsat imagery, the mass imbalance of both Greenland and Antarctic ice sheets from the Gravity Recovery and Climate Experiment (GRACE) & GRACE-Follow On gravity measurements, and the rise of global sea level from satellite altimetry missions (see Figure 2). In collaboration with the National Oceanic and Atmospheric Administration (NOAA), Department of Defense (DoD), international partners, and other agencies, we have documented changes in temperatures from the ocean depths to the mesosphere 80 kilometers high in the atmosphere, seen the dramatic collapse of sea ice in the Arctic, and documented the history of the ozone hole and its impact on atmosphere and ocean circulation.

We have tracked most of the factors driving climate from greenhouse gas concentrations, deforestation, and air pollution to solar and volcanic activity. Beyond the trends, NASA research has investigated all manner of climate processes that underlie the emergent patterns of climate variability and change. This includes everything from elucidating the processes of cloud formation, the vertical distribution of rainfall, the phase of cloud condensate, the direct and indirect impacts of aerosols, the mechanisms changing the reflectivity of ice and snow, the impact of atmospheric chemistry, to the spatial and temporal variation of important climate drivers such as carbon dioxide, methane, and nitrous oxides.

In collaboration with multiple agencies, including NOAA, the National Science Foundation, and the Department of Energy (DOE), the observations of these processes combined with fundamental research on geophysical fluid dynamics have informed and improved the development of modeling systems on weather to climate that have then allowed for the attribution of the trends we are seeing and the prospects for the future. Much of this work led by NASA and our interagency partners informs the National Climate Assessments developed by the U.S. Global Change Research Program (USGCRP) and the Assessment Reports developed by the UN Intergovernmental Panel on Climate Change (IPCC). My colleague, Dr. Karen St. Germain, the Director of NASA's Earth Science Division (ESD), will expand on these topics in her testimony today.

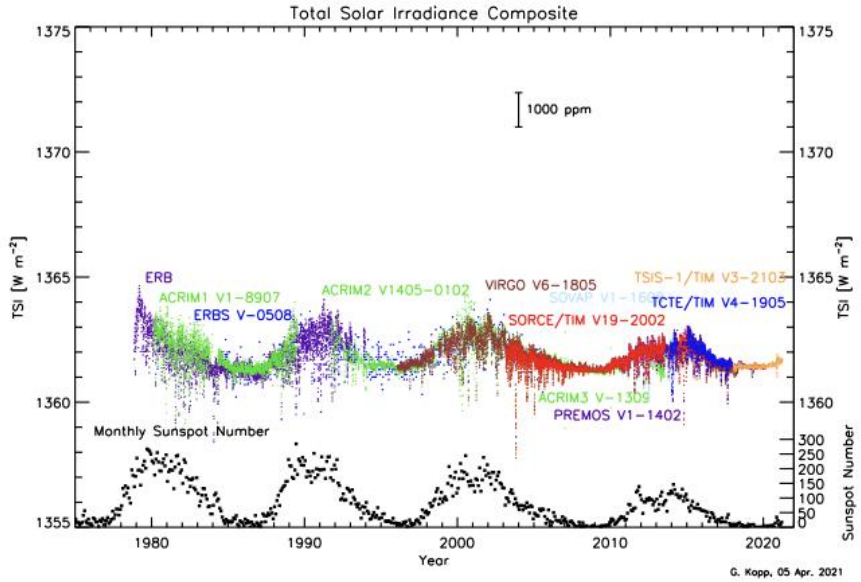

Figure 3. Multi-instrument, multi-agency composite record of total solar irradiance since 1979 encompassing three and a half solar cycles, cross-calibrated to produce a climate quality record.

However, research connections on climate go well beyond ESD. For instance, NASA's Heliophysics Division continues to support investigations on the impacts of variability of solar activity on Earth's climate across all timescales through its Living With a Star (LWS) program. Additionally, work in NASA's Planetary Science Division, under the broad umbrella of astrobiology, investigates habitability both on Earth across 4.5 billion years, on other solar system bodies (such as Venus, Mars and Europa), and on newly characterized exoplanets, often using climate models that were initially developed for modern Earth conditions and expanded to encompass this increasingly broad range of possibilities.

Beyond the Science Mission Directorate, NASA's climate portfolio encompasses research in aeronautics and space technology, focused on clean energy, environmental monitoring, sustainable aviation, and remediation.

NASA Technology can play a key role in climate mitigation

Since its inception, NASA has developed or enabled the development of technologies essential for our core missions in space and planetary exploration, study of our home planet, and commercial flight. Through our technology transfer programs, many of these innovations have been repurposed for use here on Earth. For example, a methane-detection sensor technology for Martian exploration was licensed by JPL to California-based company SeekOps, who both sells these sensors and uses the technology to precisely detect emissions and leaks on well pads across California, North Dakota, Ohio, Colorado, and Texas. This technology transfer opportunity now enables SeekOps to deliver value to improving climate outcomes in two main ways: (1) by improving safety for those on or near the well pads by ensuring better detection of dangerous leaks; and (2) by inspecting the infrastructure and highlighting any unknown hot spots or emissions that could turn into danger zones in the future.

NASA has developed or fostered the development of many technologies that can play a key role in climate mitigation. NASA research and development of advanced vehicle technologies and operational concepts have directly contributed to the dramatic improvement in fuel efficiency of the global civil aviation fleet over the last fifty years. Although aviation only represents 2.1% of global carbon dioxide emissions, it plays a growing role as other sectors turn to low- or no-carbon energy sources. The global aviation industry has coalesced around decarbonization goals for civil aviation, stating a commitment to reduce carbon emissions from aviation by half by 2050, compared to 2005.

NASA plays a critical role in the U.S. contribution to achieving these goals. NASA is investing in cost-sharing partnerships with U.S. industry to research and demonstrate high risk, high payoff technology advancements that will enable entry into service by the early 2030s of next generation single-aisle aircraft which are at least 25% more fuel-efficient than today. NASA and industry will demonstrate first ever high-power hybrid electric propulsion for large transport aircraft, ultra-high efficiency long and slender wings, advanced composite materials

and manufacturing processes, and advanced engine technologies, all based on breakthrough NASA innovation and industry collaboration. The first of these advances – NASA contract awards for flight demonstrations of an electrified powertrain, the heart of the hybrid-electric propulsion system – are expected by the end of summer 2021, with a first demonstration flight occurring as early as 2023.

A key tenet of NASA's focus to improve aircraft fuel efficiency and reduce carbon as well as other harmful aircraft emissions is through improved airspace management and aircraft operations. NASA has collaborated with the FAA and U.S. airlines to reduce carbon emissions through development and demonstration of advanced airspace tools and concepts. In fact, this summer NASA, FAA and industry partners are concluding a five-year collaboration by demonstrating these tools at airports in the Dallas, Fort Worth area. Looking ahead, NASA will advance integrated ground and flight-based technologies for trajectory optimization through every phase of flight, reducing fuel burn, CO2 emissions, contrail formation and ozone impact.

At a smaller scale, NASA is providing solutions to the challenge of all electric flight through development and flight tests of the X-57 all-electric general aviation-sized airplane, in the grand tradition of NASA "X" experimental aircraft. In a joint effort between Armstrong Flight Research Center at Edwards Air Force Base in California, Langley Research Center in Hampton, Virginia, and Glenn Research Center in Cleveland, Ohio, the X-57 will fly for the first time in late 2021 to test and determine the airworthiness of electrified aircraft technologies, such as batteries and electric motors, with applicability to a broad range of electric aircraft configurations and missions. Data from development of the X-57 is being shared with industry and academia to support new industry standards and development of certification pathways for electric aircraft.

As an example of how NASA research can spark commercial innovation, NASA worked with Electric Power Systems, an Industry, California based company, to design and develop the batteries for the X-57. The resulting technology has been licensed to the company for use in other commercially available electric planes, including in Colorado-based Bye Aerospace's Sun Flyer Trainer. The primary use of these batteries are for short duration (approximately 1 hour) flights and could enable the creation or expansion of zero-emissions aviation business models, such as short travel between small airports and vertical take off and landing vehicles for transportation within cities. This Advanced Air Mobility Market is envisioned to blossom to an annual estimated value of $115 billion by 2035.

Figure 4. New aircraft concepts from the ULI (from University of Illinois Urbana-Champaign) using hydrogen fuel cells, and a NASA Turbo-Electric aircraft concept with a superconducting electric drivetrain.

Additionally, NASA's University Leadership Initiative (ULI) supports universities pioneering next-generation technologies for a net-zero carbon emissions aviation future. The most promising ULI concepts will be matured to ground tests in larger facilities or actual flight testing with the goal to position them for commercialization before 2050. Examples of awards include the development of a real-time weather forecasting tool to improve the safety and efficiency of low altitude aircraft operations, led by Oklahoma State University researchers; an assessment of the challenges and opportunities of electric propulsion led by Ohio State University; advanced aircraft concepts with key innovations from the University of Illinois Urbana-Champaign; and an advanced turbine research for hybrid electric propulsion systems led by Pennsylvania State University.

The Space Technology Research Grants (STRG) Program is another grant program that focuses on the development of space technology and applications. For example, STRG is currently funding the Center for the

Utilization of Biological Engineering in Space (CUBES), a consortium of five universities, led by the University of California, Berkeley, and including Stanford University, the University of California, Davis, Utah State University, and the University of Florida. CUBES is the first coordinated and large-scale effort to enable in situ biomanufacturing of crucial mission products to enable sustainable human space exploration, and is currently developing new biomanufacturing technologies that primarily use carbon dioxide, water, and sunlight to make a wide range of products including food, polymers, and pharmaceuticals for future space missions.

Notable CUBES results include the development of a novel solar-powered biohybrid system that uses an electrochemical cell and unique microbes to absorb carbon dioxide and transform it into organic feedstocks to supply chemical and biological manufacturing systems. Other team members have generated additional significant advances in plant and algae-based production of pharmaceuticals, increasing photosynthetic efficiency and light utilization for improved crop production, novel methods of biomanufacturing nitrogen fertilizers, and the production of high-strength bioplastics. These innovations are not only pioneering new ways to sustain humans in space, but also are generating technologies that can help secure a sustainable future here on Earth.

Prizes and competitions are an innovative mechanism to engage the public in solving tough challenges related to NASA's mission. A 2018 competition that was developed in partnership with the Robert Wood Johnson Foundation focused on an aerosol monitor that could be used both on the International Space Station and in urban polluted environments. Two winning designs are currently being refined for flight readiness and integration, one from Applied Particle Technologies of St. Louis, Missouri, and the other from Access Sensor Technology of Fort Collins, Colorado, while both companies are also using their technology in terrestrial applications as well.

Today, another NASA prize competition, the CO_2 Conversion Challenge, seeks to create a carbon neutral manufacturing system that can be used in space, as well as on Earth. This type of system will allow NASA to send humans on long duration space missions using readily available resources. It could also be useful for Earth applications allowing the planet to break free from the reliance on natural resources such as oil, natural gas, and coal. The Challenge received over 20 entries in the initial phase, with the top three teams set to receive $350,000; $200,000; and $100,000 for first, second, and third place respectively. These three teams hail from California and New York and their proposals are currently being evaluated with an anticipated award date in June of this year.

NASA's climate research has a broad range of stakeholders

NASA partners with American companies and universities to develop and demonstrate technologies that advance sustainability across a variety of sectors. One mechanism used to advance technology for NASA and space applications is the Small Business Innovation Research (SBIR) program. NASA has awarded contracts to a number of commercial entities to further the agency's climate-related research and analysis. Virginia Diodes, headquartered in Charlottesville, Virginia, for example, has received several awards from the NASA SBIR Program, including one to supply a receiver for a CubeSat deployed from the International Space Station in May 2017. Called IceCube, this bread-loaf-sized satellite measured ice clouds in low Earth orbit until October 2018. These measurements produced the world's first map of the global distribution of atmospheric ice, which have an important effect on Earth's energy budget and therefore our climate.

Applied Geosolutions, a New Hampshire-based small business, has also received SBIR funding for its Rice Decision Support System (RiceDSS). RiceDSS improves real-time rice production forecasting and assessments of growing conditions. According to Applied Geosolutions President Willian Salas, the funding provided the company with a unique opportunity to help promote economic stability while addressing key humanitarian issues associated with climate change and the global food supply system. The company is planning to provide consulting services, leveraging the use of forecasts to optimize efficiency and support adaptation and mitigation strategies.

Extremes that are being increasingly influenced by climate change can often require a rapid turnaround emergency response, and we are partnering with a number of state and local agencies in responses to disasters from wildfires to hurricanes. NASA has also partnered with local government entities to help plan for climate

change and sea level rise in urban environments. For instance, NASA input into the New York City Climate Change Panel has been important in helping the city set new standards and planning guidelines.

NASA also partners with members of the interagency community, through agreements with specific agencies, as well as in the agency's participation in interagency working groups. For example, building upon a number of years of collaboration, NASA also signed a Memorandum of Understanding with DOE in October 2020 to further potential collaboration in a number of key areas, including space nuclear power and propulsion, lunar surface infrastructure, and science and innovation. In 2018, NASA and DOE jointly conducted a successful test of an integrated 1kW nuclear fission power system in the Nevada National Security Test Site that was a precursor to demonstrate a fission surface power system on the Moon, an effort that is currently underway through a collaboration between NASA, DOE, and industry. The technology developed through these efforts could have potential applications to furthering Earth-based low carbon energy.

NASA actively participates in the USGCRP to help coordinate the global change research activities of 13 U.S. agencies. NASA also is a member of the White House's National Climate Task Force (NCTF), as well as the NCTF's Climate Innovation Working Group. In addition, NASA participates in a variety of subject matter specific working groups both within the U.S. Government and with international organizations, such as the International Civil Aviation Organization (ICAO) and the UN.

Likewise, the Agency is also participating as subject matter experts in ICAO's Committee on Aviation Environmental Protection (CAEP) Long-Term Aspirational Goal Task Group. The activity was chartered by the ICAO 40th Assembly in 2019 to explore the feasibility of a long-term global aspirational goal for international civil aviation CO_2 emissions reductions, including options and roadmaps for their realization. The Task Group will provide results to the 41st ICAO Assembly in 2022.

Internationally, NASA also has partnerships with space agencies across the world to develop, build, launch and maintain platforms and instruments for long-term climate data, including satellite altimetry missions (see Figure 2) through partnerships with the National Centre for Space Studies, European Space Agency, and the European Organisation for the Exploitation of Meteorological Satellites. NASA's Global Learning and Observations to Benefit the Environment (GLOBE) Program and Aerosol Robotic Network (AERONET) have a presence in nearly 125 countries, helping to promote international collaboration and citizen science across the world.

Particularly notable is SERVIR, a joint NASA and USAID initiative in place since 2005, which works in partnership with leading regional organizations worldwide to help over 50 developing countries in Asia, Africa, and the Americas use information provided by Earth observing satellites and geospatial technologies to support sustainable, climate-resilient decision-making. Current climate-related efforts include: the promotion of adaptation and resilient development informed through the use of geospatial information and data to provide critical early warning forecasting systems and help strengthen disaster risk reduction and response; the support of food security decision-making through forecasts and modeling, helping countries anticipate and take action on agricultural conditions in response to drought and other climate shocks; and using data on land use and land cover to help inform and demonstrate improved land management to reduce emissions and conserve biodiversity. NASA and USAID also support the Multi-Angle Imager for Aerosols (MAIA) mission, which studies how human health is affected by different types of particulate matter, the impacts of which are expected to intensify with climate change.

Other international partnerships are being formed with the C40 global cities organization to ensure that these municipalities have access to the relevant data for their unique challenges.

NASA is building resilience for its facilities

NASA recognizes that climate change will have significant impacts on our ability to fulfill our mission. For examples, rising sea levels have the potential to impact our coastal launch infrastructure at both the Kennedy Space Center in Florida and the Wallops Flight Facility in Virginia, as well as the Langley Research Center in

Hampton Roads, Virginia. Moreover, the increase in hurricane activity along the Gulf Coast increases the threat of disruptions to our Mission Operations and training facilities at Johnson Space Center in Texas each year.

In 2010, NASA initiated the Climate Adaptation Science Investigator Work Group (CASI) to expand collaboration among its Earth scientists, applications researchers, and institutional stewards in order to help manage climate change risks at each of its Centers and facilities. This led to multiple workshops and Center-specific adaptation plans identifying local vulnerabilities and determining their associated risks to operations and missions.

The Agency recognizes that in order to mitigate impacts, we must implement proactive measures to reduce our environmental, institutional, programmatic, and operational risks. This includes integrating our climate data and modeling into the Agency's decision and policymaking processes, as well as identifying and implementing adaptation strategies to address potential mission impacts. Center master plans now include sustainability as a key goal in facility development.

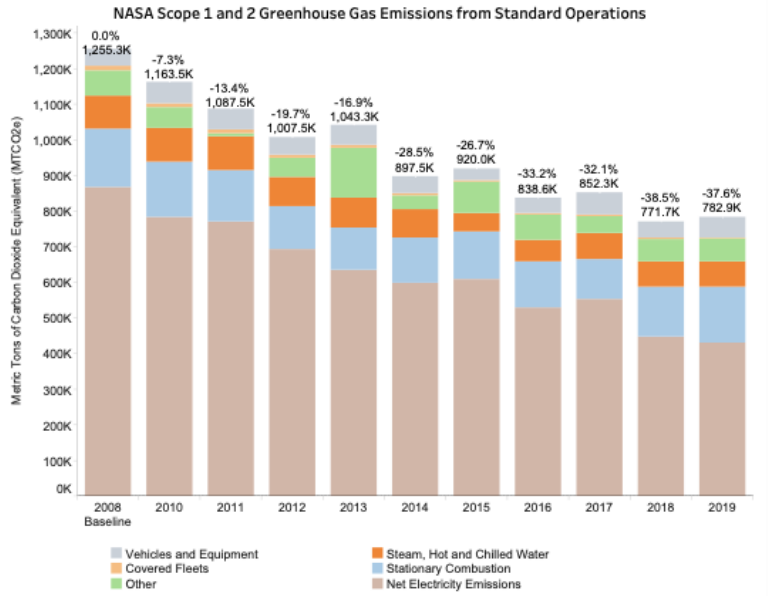

Figure 6. Greenhouse gas emissions from 2008 to 2019 from NASA Standard Operations.

NASA's institutional greenhouse gas emissions from standard operations are falling

Since the inception of the U.S. Government's Annual Energy Data Report in 2008, NASA has seen a consistent downward trend in greenhouse gas emissions. These trends have been driven mainly by reduced electricity use that have arisen from modernization of facilities, including switches to more energy efficient lighting, better insulated buildings, and more efficient HVAC systems. Further progress will require a greater focus on emission cuts specifically.

As part of the NASA response to Executive Order 14008, the Agency is creating a Climate Action Plan to include specific activities to further resilience and educate management, including procurement, finance, and facilities, on the need to embed climate change mitigation and adaptation into our decision-making procedures. This effort builds on the foundation of previous efforts.

NASA is contributing to STEM engagement and education around climate

One of NASA's most accessible websites targeted to children is https://climatekids.nasa.gov, which covers the science and observations of climate change. Targeted to upper-elementary-aged children, the site is full of games, activities, and articles that make climate science accessible and engaging.

For a broader audience, NASA's Global Climate Change website, https://climate.nasa.gov, is the leading source of up-to-date climate change data and information for the public. Today, the website is a top-three NASA website, with almost 10 million annual visitors and 23 million pageviews.

More broadly, NASA's Science Activation Program, a collaborative model leveraging partnerships through a network of science and community-based institutions, enables NASA science experts and content to engage learners of all ages across. Currently, our Science Activation Program includes eight climate-related projects reaching K-12 and undergraduate students, and communities across the country.

Among other efforts, the Arctic and Earth STEM Integrating GLOBE and NASA (SIGN) trains teachers, 4-H leaders, and community members on climate change concepts, culturally responsive curricula, and environmental observing protocols relevant to Alaskan climate change issues in face-to-face and online courses. In Maine, the Real World, Real Science project, led by the Gulf of Maine Research Institute, uses NASA's rich array of data assets to engage middle school learners in explorations of weather and climate, ecosystem change, and stability, and the ways that human and natural systems intersect.

More directly, the NASA GISS Climate Change Research Initiative is a year-long STEM engagement opportunity for New York metropolitan area educators and graduate students to work directly with NASA scientists and lead research teams in a NASA research project. Outputs include peer-reviewed in-depth lesson plans using NASA data and analysis that are aligned with the Next Generation Science Standards.

Further development of NASA's Climate Strategy

In recent months, NASA has convened a Climate Strategy Working Group (CSWG) with representatives from all the Agency's Mission Directorates and from multiple NASA Centers to develop an Agency climate strategy that will provide an integrated approach to the Agency's climate portfolio and will address the Administration's priority for a government-wide approach in response to the climate crisis. NASA recognizes that while its climate portfolio is broad and deep, the Agency can be more integrated across programs, Directorates, and Centers, as well as connected to our interagency and other partners. Additionally, the Agency lacks a single "point of entry" to learn more about the entirety of NASA's climate portfolio, how research and applications have been successful, and the opportunities for potential new partnerships.

For instance, although many Earth Science Division's Applied Sciences programs involve climate change, climate is not a central focus for any one of the programs. Conversely, much of the science applied to climate change issues at NASA does not reside within the Applied Sciences programs at all. This has led to a patchwork of climate-related partnerships that have been successful but narrowly tailored and somewhat haphazard. For instance, while New York City has benefitted greatly from NASA input into its decision-making progress, neighboring towns in New Jersey or Connecticut have not. One question will be how more targeted outreach, training, and partnership-building can further the aims of environmental justice. Many communities that are being or will be affected by climate change might not have the resources or tradition of partnering with NASA.

The CSWG is currently working on a white paper to address these and other challenges for presentation to NASA leadership.

Summary

NASA has long recognized that climate science and climate change are fundamental parts of our mandate, and for decades we have worked on fundamental and applied research in these areas. With the increasing evidence for serious impacts and the elevation of this topic by the Administration, it is time for a renewed focus on all the aspects of climate change that NASA works on and a commitment to ensure that the data and understanding that NASA has and will continue to accumulate will be used for the benefit of society.

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RESEARCH POSTS:

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Feb 2021 to date	Sr. Advisor on Climate Science to the NASA Administrator
May 2014 to date	Chief
2012–2014	Deputy Chief
2004 to date	Physical Scientist
	Center for Climate Systems Research, Columbia University
2014 to date	Adjunct Senior Research Scientist
2004–2014	Adjunct Research Scientist
2002–2004	Research Scientist
1998–2002	Associate Research Scientist
1996–1998	NOAA Postdoctoral Fellow in Climate and Global Change
1994–1996	**Centre for Climate and Global Change Research** McGill University, Montreal. Postdoc.

EDUCATION:

1990–1993	**University College London** PhD (with E.R. Johnson). "The calculation, scattering and stability of topographic Rossby waves"
1985–1988	**Jesus College, Oxford University** First Class B.A. (Hons) in Mathematics

AWARDS AND RECOGNITION:

- Robert H. Goddard Honor Award (2020)
- Honorary Doctor of Science, Bristol University, UK (2018)
- Honorary Doctor of Science, Williams College, MA (2017)
- AAAS Fellow (2017), AGU Fellow (2018)
- Outstanding Leadership Medal (GSFC, 2017)
- AGU Stephen Schneider Lecturer (2013)
- AGU Inaugural Climate Communication Prize (2011)
- EarthSky Science Communicator of the Year (2011)
- AGU Citation for Excellence in Refereeing: JGR (2010), Paleoceanography (2004)
- NASA Special Act Award (2010), Performance Award (2007)
- Scientific American 50 "Research Leader" (2004)
- University College London: Andrew Rosen Prize (1991)
- Jesus College: Progress Prize (1986), Collection Prize (1987), Exhibitioner (1987–8)
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GRADUATE STUDENT SUPERVISION:

· Nathan Lenssen (Columbia). PhD Topic: *Detection and Attribution of decadal climate change* (joint with L. Goddard)
· Keren Mezuman (Columbia). PhD Topic: *Impacts of agriculture on nitrate aerosols and climate* (joint with A. Fiore and S. E. Bauer)
· Marion Benetti (LOCEAN, France). External examiner, (supervisor G. Revedrin)
· Christy Field (Columbia). PhD Topic: *Modeling the impacts of production and climate on ^{10}Be in ice cores* (joint with D. Rind, S. Hemming)
· Allegra LeGrande (Columbia). PhD Topic: *The climate imprint on the oxygen isotopic composition of water: Observations, proxies, and coupled isotopic model simulations* (joint with W. Broecker)
· Jiping Liu (Columbia). PhD Topic: *Sea ice influence on climate change* (joint with David Rind)
· Duane Thresher (Columbia). PhD Topic: *Using Tracers in a GCM in Comparison with Proxy Records to Determine Ocean Conditions During the LGM and Subsequent Deglaciation* (joint with David Rind)
· Gilles Delaygue (LMCE, France). External examiner, (supervisor J. Jouzel)

CHAIRED WORKSHOPS AND SYMPOSIA:

· 6th US Climate Model Summit, June 2020 (Chair)
· 5th US Climate Model Summit, April 2019 (Co-Chair)
· "Using paleoclimate modelling to constrain future climate projections", Co-Convenor, AGU Joint Assembly, May 2015
· "Using paleoclimate modelling and data to learn about the future", Co-Convenor, EGU, March 2013 and April 2015.
· "Using paleo-climate model/data comparisons to constrain future projections" (workshop organiser), March 2012, Bishop Museum, Honolulu
· "Using Paleoclimate Observations and Analysis for Improving Earth System Prediction", Co-Convenor, Oct 2011, WCRP Open Science Meeting, Denver
· "First International workshop on Climate Informatics" (workshop organiser), August 2011, New York Academy of Sciences
· "AR5 Science Workshop" (workshop organiser), November 2008, Columbia University, New York
· "The Arctic and Antarctic Oscillations: Feedbacks and Connections With the Climate System", Co-Convenor, AGU, December 2000

COMMUNITY SERVICE:

· AGU Climate Communications Prize Committee (2013–2016), Chair (2015–2016)
· Associate Editor *J. Climate* (2005–2016)
· NCAR Community Climate System Model Advisory Board (2009–2015)
· CLIVAR/PAGES Intersection Panel (2004–2013). Co-chair (2006–2013)
· ESMF Advisory Panel (2002–2007), CLIVAR PPAI Panel (2005–2007)
· Popular Mechanics, Advisory Board (2007–2014)
· Member American Geophysical Union