United States Government Accountability Office

Report to the Chairman, Committee on Science, Space, and Technology, House of Representatives

April 2018

CLIMATE CHANGE

Analysis of Reported Federal Funding

GAO-18-223

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GAO Highlights

Highlights of GAO-18-223, a report to the Chairman, Committee on Science, Space, and Technology, House of Representatives

Why GAO Did This Study

Since 1993, OMB has reported over $154 billion in funding for federal climate change activities, spread across the government—raising questions about fragmentation, overlap, or duplication.

GAO was asked to review federal climate change funding. This report examines (1) reported federal funding from 2010 to 2017 and the extent to which reports on such funding are clearly linked to the federal fiscal exposure to climate change; (2) the extent to which selected agencies reported climate change funding that supports programs where addressing climate change is the primary purpose; and (3) the extent to which the primary purpose programs are fragmented, overlapping, or duplicative.

GAO reviewed OMB climate change funding reports; analyzed budget justifications for six agencies—the Departments of Agriculture, Commerce, Defense, and Energy; the National Aeronautics and Space Administration and the National Science Foundation—representing 89 percent of OMB-reported climate change funding in fiscal year 2014; analyzed documents on primary purpose programs against GAO's fragmentation, overlap, or duplication criteria; and reviewed GAO's prior work on fiscal exposures.

What GAO Recommends

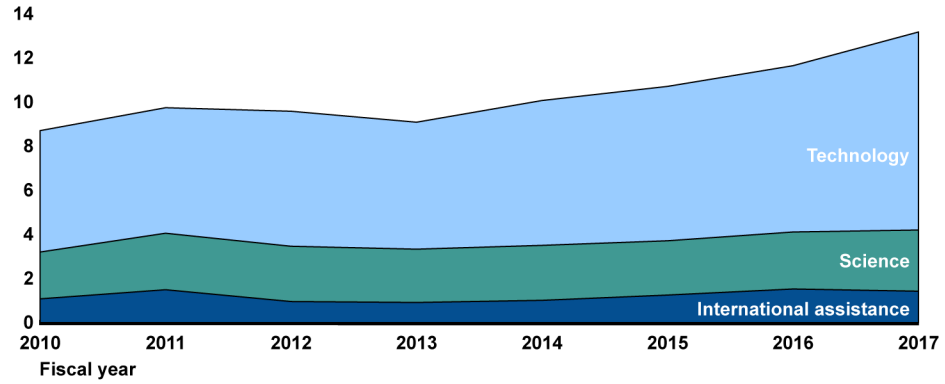
GAO is making two recommendations to OMB for enhancing the information it provides to Congress, in conjunction with future funding reports. OMB agreed with the findings but disagreed with GAO's recommendations, which GAO continues to believe are valid as discussed in the report.

View GAO-18-223. For more information-contact Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

What GAO Found

In its reports to Congress, the Office of Management and Budget (OMB) reported that annual federal climate change funding increased by $4.4 billion from fiscal years 2010 through 2017. For example, reported annual funding for technology to reduce emissions increased by about $3.5 billion, as seen in the figure below. Although OMB included information on federal fiscal exposure to climate change in the President's budgets for fiscal year 2016 and 2017, it did not provide this information in its most recent climate change funding reports. For example, the reports did not include information on programs—such as disaster assistance—whose costs were likely to increase due to climate change which would have provided more complete information for making spending trade-off decisions for climate activities. According to GAO's prior work, more complete information on fiscal exposures and the long-term effects of decisions would help policymakers make trade-offs between spending with long-term and short-term benefits.

Reported Federal Climate Change Funding by Category- Fiscal Years 2010-2017



Source: GAO analysis of Office of Management and Budget (OMB) reports. | GAO-18-223

Note: The figure presents enacted budget authority except for fiscal years 2011, 2013, and 2017. For fiscal years 2011 and 2017, OMB reported proposed budget authority. For fiscal year 2013, OMB reported final operating level funding. Funding is reported in nominal dollars, which are not adjusted for inflation.

Based on its review of the budget justifications of six agencies representing 89 percent of OMB-reported funding, GAO identified few programs (18 of 533) whose primary purpose is to address climate change. The remaining programs were multi-purpose—the budget justifications included other program goals in addition to addressing climate change. The 18 programs represented about 6 percent of these agencies' reported climate change funding for fiscal year 2017.

According to GAO's analysis, the 18 primary purpose climate change programs GAO identified are fragmented across four federal agencies, but the programs serve different purposes, target different audiences, or operate at different time periods and scales, which minimizes potential overlap or duplication. Additionally, agency program managers collaborate through the U.S. Global Change Research Program—a coordinating entity—to avoid potential negative effects from fragmentation. However, climate change programs outside GAO's review have not been analyzed for potential fragmentation, overlap, or duplication.

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Abbreviations

ARM	Atmospheric Radiation Measurement
ASR	Atmospheric System Research
ATLAS	Advanced Topographic Laser Altimeter System
Commerce	Department of Commerce
CESD	Climate and Environmental Sciences Division
CESM	Climate and Earth System Modeling
CCTP	Climate Change Technology Program
CLARREO	Climate Absolute Radiance and Refractivity Observatory
CPF	Climate Absolute Radiance and Refractivity Observatory Pathfinder
DOD	the Department of Defense
DOE	Department of Energy
ICESat	The Ice, Cloud, and Land Elevation Satellite
ICESat-2	The Ice, Cloud, and Land Elevation Satellite-2
LASP	Laboratory for Atmospheric and Space Physics
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation
NOAA	National Oceanic and Atmospheric Administration
NIFA	National Institute of Food and Agriculture
NIST	National Institute for Standards and Technology
OMB	Office of Management and Budget
OCO-2	Orbiting Carbon Observatory-2
OCO-3	Orbiting Carbon Observatory-3
SORCE	Solar Radiation and Climate Experiment
TES	Terrestrial Ecosystem Science
TCSR	Terrestrial Carbon Sequestration Research
TSIS-1	Total Solar Irradiance Sensor-1
TSIS-2	Total Solar Irradiance Sensor-2
USGCRP	U.S. Global Change Research Program
USDA	U. S. Department of Agriculture
UV-B	ultraviolet radiation

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

April 30, 2018

The Honorable Lamar Smith
Chairman
Committee on Science, Space, and Technology
House of Representatives

Dear Mr. Chairman:

Since 1993, the federal government has reported over $154 billion in funding for activities to understand and address climate change, according to data from the Office of Management and Budget (OMB). As reported by OMB, this funding has increased over time and is spread across the federal government. Specifically, federal climate change funding in nominal dollars increased from about $2.4 billion across 10 agencies in fiscal year 1993 to about $13.2 billion across 19 agencies in proposed budget authority for fiscal year 2017.[1] Recognizing that each department and agency operates under its own authorities and responsibilities—and can address climate change in different ways relevant to its own mission—federal efforts have followed a decentralized approach, with individual agencies deciding how to incorporate climate-related information into their planning, operations, policies, and programs. Entities within the Executive Office of the President, such as the Office of Science and Technology Policy and the U.S. Global Change Research Program (USGCRP), work together to coordinate federal climate change activities.

Given the current fiscal constraints facing the federal government, efforts to effectively use resources are particularly important. We previously reported on broad principles that could help policymakers make effective resource decisions during the budget process.[2] Specifically, we reported that a budget process should provide information about the long-term effect of decisions, provide information needed to understand important trade-offs, and provide for accountability and transparency. Additionally,

[1]When adjusted for inflation, reported climate change funding increased from $3.6 billion in 1993 to $12.9 billion in the proposed budget authority for 2017.

[2]GAO, *Fiscal Exposures: Improving Cost Recognition in the Federal Budget,* GAO-14-28 (Washington, D.C.: Oct. 29, 2013) and *The Nation's Fiscal Health: Action is Needed to Address the Federal Government's Fiscal Future*, GAO-17-237SP (Washington, D.C.: Jan. 17, 2017).

in an October 2013 report, we reviewed risks facing the federal budget and found that for some risks, such as weather-related risks, the budget provided incomplete information or potentially misleading signals regarding the full cost of existing commitments.[3] In that report we concluded that, consistent with our prior recommendations to provide information on fiscal exposures in the federal budget process, developing additional information on these budgetary risks could help policymakers make better informed decisions.

In prior work, we also found that policymakers face challenges in making effective budget decisions for programs and activities to address climate change. Specifically, in May 2011, we reviewed federal climate change funding from fiscal years 2003 through 2010 and found that it was organized across the federal government in a complex, crosscutting system.[4] We also found that reported funding increased over time but was not aligned with strategic priorities because there was no coherent government-wide approach for addressing climate change. We recommended that the appropriate entities within the Executive Office of the President clearly establish strategic climate change priorities that consider the full range of federal efforts to address climate change. Further, in November 2015, we found that the federal government's climate information—composed of climate data from satellites and weather stations, climate model projections, and other tools to inform decisions—was fragmented across many individual agencies and did not fully meet the needs of decision makers in federal, state, local, and private sectors.[5] We recommended that the Executive Office of the

[3]GAO-14-28. According to the National Academies of Sciences, Engineering, and Medicine, the ability to attribute the causes of some extreme event types has advanced rapidly since the emergence of event attribution science a little more than a decade ago, while attribution of other event types remains challenging. Confidence in attribution of specific extreme events is highest for extreme heat and cold events, followed by hydrological drought and heavy precipitation. For example, for extreme heat and cold events in particular, changes in long-term mean conditions provide a basis for expecting that there also should be related changes in extreme conditions. National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change*. Washington, D.C.: The National Academies Press. doi: 10.17226/21852.

[4]GAO, *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding Decisions*, GAO-11-317 (Washington, D.C.: May 20, 2011).

[5]GAO, *Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information*, GAO-16-37 (Washington, D.C.: Nov. 23, 2015).

President direct a federal entity to develop a set of authoritative climate change projections and observations and create a national climate information system with defined roles for federal agencies and others. The Executive Office of the President neither agreed nor disagreed with the 2011 and 2015 recommendations and as of June 2017, had not implemented the recommendations.

The reported increase in funding and fragmentation of federal climate information activities raises questions about whether other federal climate change efforts, such as technologies to reduce emissions, may be fragmented, overlapping, or duplicative. This report uses definitions to describe fragmentation, overlap, and duplication among government programs from our prior work.[6] Fragmentation refers to circumstances in which more than one federal agency (or more than one organization within an agency) is involved in the same broad area of national need and opportunities exist to improve service delivery. Overlap occurs when multiple agencies or programs have similar goals, engage in similar activities or strategies to achieve their goals, or target similar beneficiaries.[7] Duplication occurs when two or more agencies or programs are engaged in the same activities or provide the same services to the same beneficiaries.

You asked us to review federal funding for climate change activities. This report examines (1) reported federal climate change funding since 2010 and the extent to which reports on such funding are clearly linked to the federal fiscal exposure to climate change; (2) the extent to which selected federal agencies reported climate change funding that supports programs for which addressing climate change is the primary purpose, versus programs for which addressing climate change is one of multiple purposes; and (3) the extent to which primary purpose climate change programs are fragmented, overlapping, or duplicative.

To address all three objectives, we (1) reviewed government-wide climate change funding reports by OMB from fiscal years 2010 through 2017, and (2) reviewed agency reports, budget justifications and planning

[6]GAO, *Fragmentation, Overlap, and Duplication: An Evaluation and Management Guide*, GAO-15-49SP (Washington, D.C.: Apr. 14, 2015).

[7]We have reported that areas of overlap do not necessarily lead to duplication of efforts because initiatives sometimes differ in meaningful ways or leverage the efforts of other initiatives. See, for example, GAO, *Solar Energy: Federal Initiatives Overlap but Take Measures to Avoid Duplication*, GAO-12-843 (Washington, D.C.: Aug. 20, 2012).

documents for a non-generalizable sample of six departments or agencies—the Department of Commerce, the Department of Defense (DOD), the Department of Energy (DOE), the U.S. Department of Agriculture (USDA), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). We selected these departments or agencies because they represented the largest share (89 percent) of OMB-reported climate change funding in 2014—the most recent OMB data available at the start of our review—and also conducted activities in each of the climate change funding categories described in OMB's reports. The results of our analysis of these departments or agencies' activities cannot be generalized to those of departments or agencies not included in our review. We also interviewed officials from coordinating entities such as the Council on Environmental Quality, and USGCRP. We assessed the reliability of OMB and budget data used in our analysis by comparing data across multiple sources, reviewing documentation about the data, tracing data back to its source, and interviewing officials knowledgeable about the data. We determined these data were sufficiently reliable for the purposes of our reporting objectives and have noted in our report any limitations associated with the data we present.

To determine OMB-reported climate change funding since fiscal year 2010, we analyzed climate change funding data from OMB climate change funding reports by agency and line item. To assess whether these reports are clearly linked to federal fiscal exposure to climate change, we reviewed relevant reports by OMB and others that describe federal fiscal exposure to climate change impacts, and our prior work on providing information on federal fiscal exposures to policymakers to inform their decisions.

To determine the extent to which reported funding supports programs where addressing climate change is the primary purpose, we analyzed budget justifications for the six departments or agencies we selected against a list of climate change terms from OMB and USGCRP reports. For example, we reviewed agency program descriptions for references to "climate change," "renewable energy," "adaptation," and "climate resilience," among others. Based on the program purpose and activities described in agency budget justifications, we categorized programs as primary purpose or multiple-purpose. Primary purpose programs are those programs that agencies described as having addressing climate change as their main focus (e.g., a climate modeling program). Multiple-purpose programs are those programs that agencies described as having several goals in addition to addressing climate change (e.g., a clean

energy technology program designed to promote rural economic development).

To determine whether primary purpose programs were fragmented, overlapping, or duplicative, we reviewed additional program documentation—including authorizing legislation, strategic planning documents, and performance reports—and evaluated program characteristics based on our fragmentation, overlap, or duplication criteria. We also applied our fragmentation, overlap, or duplication criteria to additional multiple-purpose programs. Specifically, we selected one multiple-purpose program from each of the six selected departments or agencies and two programs from departments or agencies outside our review. We selected these programs because they either had the largest reported climate change funding amounts for a multiple-purpose program within that particular department or agency, or the program engaged in similar activities as primary purpose programs.

The term “funding” in this report refers to budget authority, or the authority provided by federal law to enter into financial obligations that will result in outlays involving federal government funds, as reported by OMB in its climate change funding reports required by law. The term “agencies” in this report refers to federal departments or agencies. The term “program” in this report refers to programs or activities that agencies identify as line items in their budget justifications. Unless otherwise stated, we report funding in nominal terms (not adjusted for inflation), and all years refer to fiscal years.

We conducted this performance audit from August 2016 to April 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Since fiscal year 2010, annual appropriations laws have generally required the President to report on use of climate change funds. Specifically, the laws have generally required the President to report all federal agency funding, domestic and international, for climate change programs, projects, and activities to the congressional appropriations

committees within 120 days of submitting the President's annual budget request.[8] In response to these requirements, OMB has issued three reports to congressional appropriations committees. Taken together, the three OMB reports describe climate change funding for fiscal years 2010 through 2017.[9] Generally, these reports included federal agency funding for the following three categories:[10]

- **Clean Energy Technology**, which includes the research, development, and deployment of technologies to reduce greenhouse gas emissions and the reliance on fossil fuel, such as clean energy systems, geothermal, solar, wind, biomass, nuclear, and hydropower (water).[11] It also includes technologies, programs, and processes to increase energy efficiency or reduce energy consumption, such as building efficiency, more effective transmission or distribution of electricity, and vehicle technologies that improve engine efficiency or fuel economy.

[8]Annual appropriations acts prior to fiscal year 2010 have also often included a requirement for the President to issue a report on climate change funding. We have previously reported on the reports OMB issued in response to these prior requirements. In May 1999, we reported about OMB's April 1999 report summarizing federal agency programs related to global climate change. GAO, *Climate Change: Observations on the April 1999 Report on Climate Change Programs*, GAO-T-RCED-99-199 (Washington, D.C.: May 20, 1999). In August 2005, we reported on federal funding for climate change from 1993 through 2004 as reported by OMB. GAO, *Climate Change: Federal Reports on Climate Change Funding Should Be Clearer and More Complete*, GAO-05-461 (Washington, D.C.: Aug. 25, 2005). In May 2011, we reported on federal funding for climate change for fiscal years 2003 through 2010 as reported by OMB. GAO, *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding Decisions*, GAO-11-317 (Washington, D.C.: May 20, 2011).

[9]Specifically, OMB issued reports in June 2010, August 2013, and January 2017. OMB did not issue some of the required reports, such as the report required by the Consolidated Appropriations Act for fiscal year 2017, and did not meet the reporting deadlines for the reports required by the Consolidated Appropriations Act for fiscal year 2014, the Consolidated and Further Continuing Appropriations Act for fiscal year 2015, and the Consolidated Appropriations Act for fiscal year 2016. OMB's report issued in January 2017 responded to the reporting requirements in these three laws.

[10]OMB has also reported funding for tax expenditures related to climate change, and in its August 2013 report, it included a Natural Resources Adaptation category that captured funding for adaptation activities as reported by the Department of the Interior. See appendixes III and V for more information on OMB-reported climate change funding by category since 1993, and appendix VI for more information on OMB-reported tax expenditures.

[11]Biomass is an energy resource derived from plant- and algae-based material that includes crop wastes, forest residues, purpose-grown grasses, woody energy crops, algae, industrial wastes, sorted municipal solid waste, urban wood waste, and food waste.

- **Science**, which encompasses the activities of USGCRP and includes research, modeling, and observing activities to better understand climate change; efforts to analyze the cumulative effects on the environment of human activities and natural processes; and programs to provide climate information to policymakers and the public, in part to inform climate change adaptation decisions.[12] USGCRP also reports annually on funding for climate change science among certain participating agencies in its Our Changing Planet reports.[13]
- **International Assistance**, which uses bilateral and multilateral assistance tools to address three global climate change policy pillars: adaptation, clean energy, and sustainable landscapes.[14] For example, international assistance helps countries invest in energy efficiency programs to reduce emissions, as well as activities to help communities adapt to climate change.

[12]Climate change adaptation—defined as adjusting natural or human systems in response to actual or expected climate change—is one way for the federal government to manage climate risks.

[13]USGCRP's 13 participating agencies include the: Department of Agriculture, Department of Commerce, Department of Defense, Department of Energy, Department of Health and Human Services, Department of the Interior, Department of State, Department of Transportation, Environmental Protection Agency, National Aeronautics and Space Administration, National Science Foundation, Smithsonian Institution, and U.S. Agency for International Development. The Global Change Research Act of 1990 required the Federal Coordinating Council on Science, Engineering, and Technology to report annually to Congress the "expenditures required by each agency or department for carrying out its portion of the USGCRP," among other things. Although this reporting requirement was terminated by statute in 2000, USGCRP continues to provide this information.

[14]Sustainable landscapes sequester carbon, clean the air and water, increase energy efficiency, restore habitats, and create value through significant economic, social, and environmental benefits.

OMB-Reported Climate Change Funding Increased by $4.4 Billion since 2010, but OMB Reports Do Not Provide Information about Fiscal Exposures for Budget Decisions

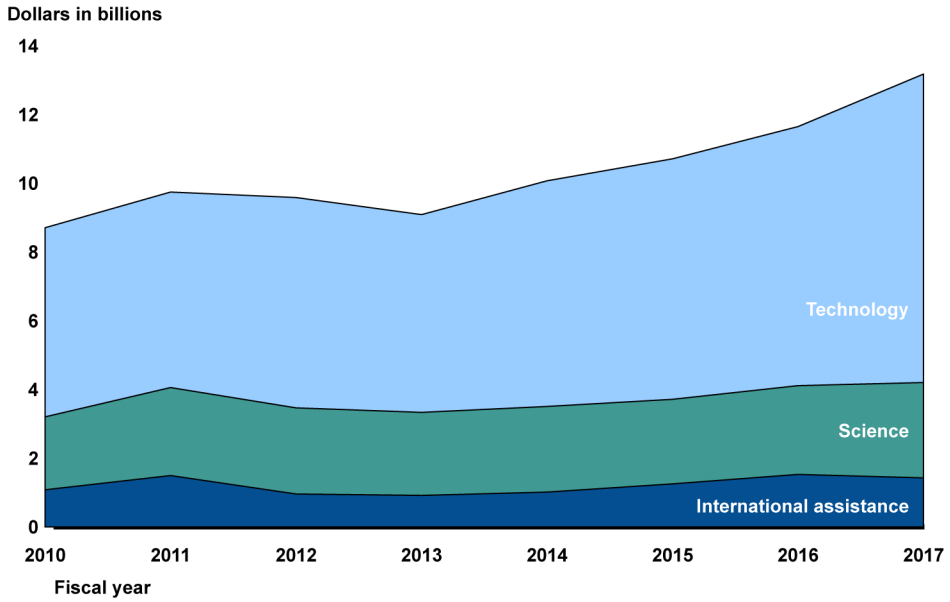
Annual federal climate change funding across all OMB categories increased by $4.4 billion from fiscal year 2010 through fiscal year 2017, according to OMB's three reports on such funding. However, the OMB reports did not provide information about climate-related fiscal exposures to assist policymakers in understanding budget trade-offs for climate change activities.

OMB-Reported Climate Change Funding Increased by $4.4 Billion from Fiscal Years 2010 through 2017, with Funding for Clean Energy Technology Accounting for Most of the Increase

OMB-reported annual climate change funding across all categories increased from $8.8 billion in fiscal year 2010 to $13.2 billion in proposed budget authority for fiscal year 2017 in nominal dollars (about 50 percent, or 34 percent after adjusting for inflation), with reported agency funding for clean energy technologies (i.e., technologies to reduce greenhouse gas emissions) accounting for most of the $4.4 billion increase, as shown in figure 1.[15]

[15]Nominal dollars are not adjusted for inflation.

Figure 1: OMB-Reported Federal Climate Change Funding by Category, from Fiscal Years 2010 through 2017



Source: GAO analysis of Office of Management and Budget (OMB) reports. | GAO-18-223

Notes: The figure presents enacted budget authority except for fiscal years 2011, 2013, and 2017. For fiscal years 2011 and 2017, OMB reported proposed budget authority. For fiscal year 2013, OMB reported final operating level funding. Funding is reported in nominal dollars, which are not adjusted for inflation.

OMB has also reported on federal funding for wildlife and natural resource adaptation from fiscal years 2010 through 2013. However, the data OMB reported in the adaptation category does not fully represent adaptation funding as it only includes data from the Department of the Interior. OMB reported Department of the Interior funding for adaptation as follows: fiscal year 2010, $65 million; fiscal year 2011, $87 million; fiscal year 2012, $88 million. We did not include funding for this category in fiscal year 2013 because we used OMB's fiscal year 2017 report for fiscal year 2013 funding, and OMB did not report funding under this category in its 2017 report.

Funding in the American Recovery and Reinvestment Act of 2009 (Pub. L. No. 111-5 (Feb. 17, 2009)) and tax expenditures related to climate change are not included in this figure to maintain comparability with earlier GAO reports.

Specifically, reported annual funding for clean energy technology, such as nuclear, biomass, wind, and hydropower programs, increased by about $3.5 billion from fiscal years 2010 through 2017 in nominal dollars. Over the same period, OMB-reported agency funding for science and international assistance increased by $653 million and $346 million respectively, as shown in table 1.

Table 1: OMB-Reported Increases in Climate Change Funding by Category, Fiscal Years 2010 through 2017

Dollars in millions

	Fiscal Year		
Funding category	**2010[a]**	**2017[b]**	**Increase**
Clean energy technology	5,504	8,978	3,474
Science	2,122	2,775	653
International assistance	1,080	1,426	346
Natural resources adaptation[c]	65	NA	(65)
Adjustments for programs in multiple categories	NA	(26)	(26)
Total	**8,771**	**13,153**	**4,382**

Source: GAO analysis of Office of Management and Budget (OMB) data. I GAO-18-223

Note: Funding is reported in nominal dollars and not adjusted for inflation.

[a]Enacted budget authority

[b]Proposed budget authority

[c]OMB has also reported on federal funding for wildlife and natural resource adaptation from fiscal years 2010 through 2013. However, the data OMB reported in the adaptation category does not fully represent adaptation funding as it only includes data from the Department of the Interior. OMB did not report funding for this category in its January 2017 report.

- **Clean Energy Technology**. DOE programs accounted for most of the $3.5 billion increase in annual clean energy technology funding. Specifically, funding for DOE's fusion, sequestration and hydrogen research (about $1.9 billion), energy efficiency and renewable energy programs ($656 million), as well as its carbon capture and storage and power systems research ($564 million) accounted for about 88 percent of the $3.5 billion funding increase from fiscal years 2010 through 2017, with a portion of the increase offset by decreases in other DOE programs, according to our analysis of OMB reports for this period. Funding for National Science Foundation ($486 million) and DOD ($417 million) research accounted for another 26 percent of the funding increase.[16]
- **Science**. NASA programs accounted for most of the $653 million increase in annual science funding. In particular, funding for NASA's science programs accounted for about 84 percent ($546 million) of the

[16]Multiple agencies and programs accounted for the remaining portion of the increase. See appendixes IV and V for more information on reported funding by agency and program line item.

$653 million funding increase from fiscal years 2010 through 2017, based on our analysis of OMB reports. Funding for DOE's biological and environmental research accounted for about another 12 percent ($77 million) of the funding increase.[17]

- **International Assistance**. Department of State and Department of the Treasury programs accounted for the greatest increases in annual international assistance funding. Specifically, State economic support funding increased by $428 million and Treasury funding for the Green Climate Fund increased by $250 million, with half of the increase offset by decreases in other programs.[18]

OMB also reported annual funding for natural resources adaptation in its August 2013 report, but did not include this category in its January 2017 report. In its August 2013 report, OMB reported funding for certain activities at Interior promoting adaptation—adjustments to natural or human systems in response to actual or expected climate change—under the natural resources adaptation category. We previously reported that the Administration was developing criteria to systematically account for a broader suite of adaptation programs.[19] However, OMB staff we interviewed said that it is difficult to parse out adaptation funding for federal facilities because agencies do not necessarily separate it out from routine planning decisions. For example, an agency planning to build a sea-wall to protect a coastal facility might build it higher to accommodate rising sea levels but may not track this spending as climate change-related.

[17]The remaining 5 percent of the funding increase was spread across multiple agencies, such as the National Science Foundation. See appendixes IV and V for more information on reported funding by agency and program line item.

[18]According to our analysis of OMB reports, the reported funding increase for the Treasury's Green Climate Fund was offset by funding reductions across multiple programs, such as the Clean Technology Fund ($300 million), and Strategic Climate Fund ($75 million). See appendixes IV and V for more information on reported funding by agency and program line item.

[19]GAO, *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding Decisions*, GAO-11-317 (Washington, D.C.: May 20, 2011).

OMB Reports Are Not Clearly Linked to Climate-Related Federal Fiscal Exposure to Assist Policymakers in Understanding Budget Trade-Offs for Climate Change Activities

OMB's most recent reports to Congress on climate change funding are not clearly linked to climate-related federal fiscal exposure, although the agency has recently identified climate-related fiscal exposures in the President's budget requests and a separate assessment of the fiscal risks from climate change. Specifically, in 2015 and 2016, OMB identified areas of the federal budget as climate-related because the costs of these programs or activities were likely to increase as a direct or indirect result of climate change.[20] For example, in a section entitled the *Federal Budget Exposure to Climate Risks*, the President's budget requests for fiscal years 2016 and 2017 stated that the imprint of climate change on the federal budget was increasingly apparent in the escalating costs for several federal programs or activities. Over the last decade, the federal government incurred an estimated $357 billion in direct costs from severe weather and fire—for domestic disaster response and relief ($205 billion), crop and flood insurance ($90 billion), wildland fire management ($34 billion), and maintenance and repairs to federal facilities and federally managed lands, infrastructure, and waterways ($28 billion).[21] While acknowledging that it was not possible to identify the portion of these costs attributable to climate change, the President's budget request stated that costs for each of these federal programs have been increasing and are inherently sensitive to climate change impacts, and can therefore be expected to continue to rise as climate change intensifies.

Additionally, in the November 2016 assessment *Climate Change: the Fiscal Risks Facing the Federal Government*, OMB and the Council of Economic Advisers estimated that recurring costs incurred by the federal government due to climate change could average about $64 billion per year across four federal program areas by late century—acknowledging

[20]Individual agencies—such as DOD and USDA—and intergovernmental task forces have also published information about certain programs' fiscal exposures to climate risks since 2010.

[21]Office of Management and Budget, *Analytical Perspectives, Budget of the United States Government for Fiscal Year 2017* (Washington, D.C.: 2016). OMB staff stated that the budget appendix provides detailed information on various appropriations and funds—including a prior year baseline for disaster-relief outlays—but does not reflect the fiscal exposures from climate change over time, such as expenditures related to climate change impacts (e.g., hazard mitigation, adaptation, and changes in disaster-relief over time attributable to climate change). The President's Budget request for fiscal year 2018 does not include a section on federal budget exposure to climate change.

key limitations and uncertainties.[22] The assessment included four federal programs or activities—wildland fire suppression, crop insurance, healthcare in response to poor air quality, and disaster relief in coastal areas—which are outside OMB's climate change funding categories of science, technology, and international assistance. In this assessment, OMB identified climate-related fiscal exposures generally aligned with three of the five areas of fiscal exposure we identified in our 2017 high risk list update: the federal government as property owner, as an insurer of property, and as a provider of disaster relief.[23]

However, the most recent OMB climate change funding reports do not include information on the funding of climate-related fiscal exposures discussed in the 2016 and 2017 Analytical Perspectives and the November 2016 assessment. For example, these reports generally do not include information on the funding of actions taken by agencies to improve their program and facilities' resilience to climate change impacts. In particular, OMB stated in its August 2013 climate change funding report that federal agencies were starting to prepare for climate change through actions outlined in their Climate Change Adaptation Plans—however, federal funding associated with these actions was not included in OMB's 2017 report—based on our review.[24] Similarly, the OMB climate change funding reports we reviewed do not include funding information on other programs—such as federal domestic disaster assistance, flood insurance, and crop insurance—that OMB and others identified as climate-related fiscal exposures.

[22]According to this assessment by OMB and the Council of Economic Advisers, these ranges are projections of costs that would be incurred by the federal government across four program areas given a set of assumptions on which the specific scenarios were modeled. The Executive Office of the President, *Climate Change: the Fiscal Risks Facing the Federal Government* (November 2016).

[23]GAO-17-317. The other two areas of fiscal exposure are the federal government's role as leader of a strategic plan and as the provider of technical assistance to federal, state, and other decision-makers.

[24]For example, key agencies listed under the federal government's sustainability goals to meet its energy efficiency and greenhouse gas emissions reduction targets, such as the General Services Administration, Department of Veterans Affairs and Department of Homeland Security, are not included in the OMB report. OMB instructions for implementing the March 2015 Executive Order 13693, *Planning for Federal Sustainability in the Next Decade*, directs agencies to report their progress implementing and any updates to their Climate Change Adaptation Plans as part of their annual Strategic Sustainability Performance Plan.

We have previously reported that a more complete understanding of fiscal exposures and the long-term effects of decisions would help policymakers make important trade-offs between spending with long-term benefits and spending with short-term benefits.[25] In May 2011, we identified broad principles or criteria for a budget process, including that it should (1) provide information about the long-term effects of decisions; (2) provide information necessary to make important trade-offs between spending with long-term benefits and spending with short-term benefits, and (3) provide for accountability and be transparent, among other principles. Further, in October 2013 we reported that incorporating more complete information on fiscal exposures could help meet these criteria for an effective budget process. In particular, we reported that a more complete understanding of fiscal exposures and the long-term effects of decisions would help policymakers make trade-offs between spending with long-term benefits and spending with short-term benefits, anticipate changes in future spending, and enhance control over federal resources.

According to OMB staff, it is difficult to fully account for actions taken by agencies to improve their program and facilities' resilience, because successful preparedness efforts often involve integrating climate change considerations into existing agency programs, projects, and activities rather than establishing separate and distinct programs. Additionally, OMB staff said that they do not provide information on federal fiscal exposures to climate change in their funding report for two reasons. First, OMB staff said that OMB prefers to conduct a broader examination of federal fiscal risks as part of agencies' enterprise risk management assessments under OMB Circular A-123. Specifically, agencies are responsible for establishing practices that identify, assess, respond, and report on risks. According to the circular, these practices must be forward-looking and designed to help leaders make better decisions, alleviate threats, and identify previously unknown opportunities to improve the efficiency and effectiveness of government. OMB staff said that each agency has discretion to prioritize its risks, decide whether to consider climate change as part of this assessment, and to consider its significance as a risk to agency goals and operations. Second, OMB staff said that the agency has limited capacity and knowledge to assess climate change risks and predict future expenditures on an annual basis, due to the inherent uncertainty in climate projections. In particular, OMB

[25]GAO, *Budget Process: Enforcing Fiscal Choices* GAO-11-626T (Washington, D.C.: May 4, 2011) and GAO-14-28.

staff said that its prior assessments of climate change risks were resource-intensive and reflect a previous administration's priorities. Further, OMB staff said that they defer to Congress on whether the current funding reports are useful, and Congress has not requested information on fiscal exposures as part of OMB funding reports.

However, we and others have reported that understanding the federal government's fiscal exposure to climate change risks is increasingly critical for policymakers charged with making sound investment decisions and acting as stewards of the federal budget over the long term.[26] In November 2017, we reported that DOD's overseas installations do not consistently track the costs of impacts of weather effects associated with climate change. As a result, the military services lack the information they need to adapt infrastructure at overseas installations to climate change impacts and develop accurate budget estimates for infrastructure sustainment.[27] By providing, concurrent with any future climate change funding reports to Congress, funding information for federal programs with fiscal exposure to climate change, OMB would have better assurance that it was providing policymakers with the information necessary for them to make decisions about spending trade-offs, as called for in our criteria for an effective budget process. This information should include costs to repair, replace, and improve the weather-related resilience of federally-funded property and resources; costs for federal flood and crop insurance programs; and costs for disaster assistance programs, among other identified areas of fiscal exposure to climate change.[28]

[26]For example, see GAO, *Disaster Resilience: Actions Are Underway, but Federal Fiscal Exposure Highlights the Need for Continued Attention to Longstanding Challenges*, GAO-14-603T (Washington, D.C.: May 14, 2014); National Research Council. *Disaster Resilience: A National Imperative*. (Washington, D.C.: The National Academies Press, 2012). Ekins, Paul and Speck, Stefan, 2014. "The Fiscal Implications of Climate Change and Policy Responses." *Mitigation and Adaptation Strategies for Global Change*, (Vol. 19: 355 – 374).

[27]GAO, *Climate Change Adaptation: DOD Needs to Better Incorporate Adaptation into Planning and Collaboration at Overseas Installations*, GAO-18-206 (Washington, D.C.: Nov.13, 2017).

[28]GAO-17-317 and GAO-14-28.

Selected Agencies' Programs Whose Primary Purpose is Addressing Climate Change Represent a Small Portion of Their Total Agency-Reported Climate Change Funding

Based on our review of six selected agencies' budget justifications for fiscal years 2010 through 2017, we identified few federal programs whose primary purpose is to address climate change and these programs represent a small portion of their total agency-reported climate change funding. In particular, we identified 18 out of 533 programs in agency budget justifications that met our definition for a primary purpose climate change program, based on the program descriptions in the budget justifications.[29] Seventeen of the 18 primary purpose programs we identified fell under OMB's science category, and one primary purpose program fell under OMB's clean energy technology category (see table 2), according to our analysis of agency budget justifications and OMB reports.

Table 2: Funding for Primary Purpose Programs in Selected Agencies in Our Review, Fiscal Years 2010 through 2017

Dollars in millions

OMB category	Primary purpose program	Agency	Fiscal Year 2010	2011	2012	2013	2014	2015	2016	2017
Science	Climate Research	Commerce's NOAA	219.9	217.8	139.5	135.5	153.3	157.1	158.0	189.9
	Atmospheric Radiation Measurement Climate Research Facility	DOE	42.2	45.8	67.9	68.1	68.6	67.4	65.4	65.4
	Atmospheric System Research	DOE	26.4	27.8	26.3	26.4	26.6	26.0	26.4	26.4
	Climate and Earth System Modeling	DOE	69.1	77.9	70.7	72.9	74.0	71.1	98.7	103.5

[29]We reviewed the budget justifications of six agencies—Commerce, DOD, DOE, NASA, NSF, and USDA—that accounted for $11.4 billion of the $13.2 billion in fiscal year 2017 funding to address climate change as reported by OMB. For two of the six agencies—DOD and NSF—we did not identify any primary purpose climate change programs based on program descriptions in their budget justifications.

Dollars in millions

OMB category	Primary purpose program	Agency	Fiscal Year 2010	2011	2012	2013	2014	2015	2016	2017
	Terrestrial Carbon Sequestration Research	DOE	4.6	3.0	—	—	—	—	—	—
	Terrestrial Ecosystem Science	DOE	28.7	28.7	40.2	38.8	45.3	44.0	40.0	40.0
	CLARREO Pathfinder	NASA	—	—	—	—	—	—	—	19.3
	Glory Mission	NASA	31.8	12.9	—	—	—	—	—	—
	Ice, Cloud, and Land Elevation Satellite	NASA	—	3.8	0.7	—	—	—	—	—
	Ice, Cloud, and Land Elevation Satellite-2	NASA	38.9	59.7	130.5	165.9	182.2	126.5	117.4	112.4
	Orbiting Carbon Observatory-2	NASA	62.0	89.0	93.4	80.3	38.2	17.5	—	10.2
	Orbiting Carbon Observatory-3	NASA	—	—	—	7.4	16.8	1.5	—	26.3
	Solar Radiation and Climate Experiment	NASA	—	4.6	5.3	5.2	5.4	5.4	—	5.4
	Total Solar Irradiance Sensor-1	NASA	—	—	—	—	—	1.0	—	19.6
	Total Solar Irradiance Sensor-2	NASA	—	—	—	—	—	—	—	9.6
	Agroclimatology (formerly Global Change UV-B Monitoring and Research)	USDA	1.4	1.4	1.3	1.3	1.4	1.4	1.4	1.4
	Climate Change Program Office	USDA	2.9	2.2	2.2	2.0	2.5	2.7	2.6	3.0
Clean Energy Technology	Climate Change Technology Program	DOE	9.3	5.5	5.5	5.3	4.9	—	—	—
Total			**537.2**	**580.1**	**583.5**	**609.1**	**619.2**	**521.6**	**509.9**	**632.4**

Legend: DOE = Department of Energy; NASA = National Aeronautics and Space Administration; Commerce's NOAA = National Oceanic and Atmospheric Administration, Department of Commerce; USDA = U.S. Department of Agriculture, — = agencies did not report funding for the program for that year.

Source: GAO analysis of Department of Commerce, Department of Defense, Department of Energy, National Aeronautics and Space Administration, National Science Foundation, and U.S. Department of Agriculture budget justifications. | GAO-18-223

Notes: Funding is reported in nominal dollars and not adjusted for inflation.

For two of the six agencies—DOD and NSF—we did not identify any primary purpose climate change programs based on program descriptions in their budget justifications.

Under the science category, 13 of the 18 programs we identified focused on collecting observations of climate-related variables, such as atmospheric carbon dioxide concentrations and polar ice thickness, to enhance scientific understanding of climate change. The five remaining primary purpose programs we identified focus on other aspects of climate change, such as modeling and providing climate information to stakeholders to facilitate adaptation. According to USGCRP officials, these programs conduct research to support individual agency missions, such as agriculture, and address climate change as a cross-cutting issue, rather than a primary purpose. Appendix I contains further information on the 18 primary purpose programs we identified.

The primary purpose programs we identified represent a small portion of total reported climate change funding for these agencies. For the 18 primary purpose programs we identified, agencies reported about $632 million in proposed funding for fiscal year 2017 in their budget justifications, which represents about 6 percent of the $11.4 billion in total proposed funding to address climate change that OMB reported for these agencies in fiscal year 2017.[30] The majority of the selected agencies' reported funding supports programs where climate change is one of multiple purposes being addressed.

Based on our analysis of agency budget justifications and other documents, most programs (515 of the 533) we reviewed did not meet our definition of a primary purpose climate change program because they were broad-based technology and science programs where climate change is one of multiple purposes.

[30]Due to differences in the timing of agencies' budget justification submissions and OMB's climate change funding reports, agencies and OMB reported different types of funding for each fiscal year other than 2017. For example, for fiscal year 2013, OMB reported funding as "final operating level" whereas agencies generally reported funding for fiscal year 2013 as "actual budget authority."

- For example, 331 of the 515 multiple-purpose programs we identified focus on advancing clean energy technologies, primarily for purposes other than addressing climate change, such as: reducing energy costs, increasing energy security by shifting away from foreign fuel sources, advancing economic development, and improving air quality. Many of these programs are located in DOE, and the 1977 law establishing the agency included congressional findings that the country's increasing shortage of nonrenewable energy resources and increasing dependence on foreign energy supplies presented a serious threat to national security, among other things.[31] One purpose of the law that established DOE was to place a major emphasis on the development and commercial use of solar, geothermal, recycling, and other technologies utilizing renewable energy resources. Clean energy technology programs at the six selected agencies accounted for roughly $8.7 billion of $13.2 billion (about 66 percent) in proposed funding for fiscal year 2017, as reported by OMB.
- Additionally, 137 of the 515 multiple-purpose programs conduct or support climate-related scientific research that agency budget justifications and other documents described as serving multiple purposes, such as weather forecasting or understanding coastal ecosystems in the context of multiple factors. For example, several National Oceanic and Atmospheric Administration (NOAA) programs contribute to observing and modeling the earth's climate, as part of NOAA's weather and severe storm forecasting responsibilities, to ensure the safety of U.S. citizens, public property, and infrastructure.[32] Additionally, the NSF contributed to the USCGRP research program through its broad-based Science, Engineering, and Education for Sustainability Program, which provides funding for research projects on the sustainability of coastal systems in the context of multiple stressors—such as increasing development—in addition to climate change-related stressors such as sea-level rise and ocean acidification.
- The remaining 47 multiple-purpose programs we identified focus on activities such as adaptation or international assistance (23 programs) or activities that fell into more than one OMB category (24 programs). For example, we identified a USDA program for integrated resource

[31]42 U.S.C. § 7111.

[32]For example, NOAA collects observational data on a variety of characteristics, such as weather patterns, precipitation, ocean temperature, and coastal ecosystem characteristics, using satellite and earth-based instruments.

restoration that promotes watershed resilience through forest management, range management, wildlife and fisheries habitat management, and other activities. We also identified a DOD program on sustainable ranges and lands that provides ecosystem vulnerability assessment and ecosystem analysis, observing, modeling and mitigation technologies to support sustainable, realistic access and use of the Army's ranges and lands. Neither the integrated resource restoration program nor the sustainable ranges and lands program falls within one of OMB's climate change funding categories.

Selected Agencies' Programs Whose Primary Purpose Is Addressing Climate Change Are Fragmented but Serve Different Purposes, Audiences, Times, and Scales

The 18 primary purpose climate change programs we identified from selected agency budget justifications are fragmented across multiple federal agencies that address climate change in ways specific to their agency missions.[33] However, we also found that the 18 primary purpose programs we identified serve different purposes, target different audiences, or operate at different times and scales, among other reasons, which minimize potential overlap or duplication among these programs. Additionally, USGCRP officials and program managers collaborate to avoid potential negative effects of fragmentation, according to USGCRP officials we interviewed and National Academies' reports.

Primary Purpose Climate Change Programs Are Fragmented Across the Selected Federal Agencies and Reflect Three Types of Climate Change Activities

The 18 primary purpose programs we identified are fragmented across four of the six agencies we reviewed, and address climate change in the context of their agency missions. These programs conduct activities that generally fall into three broad climate change areas—observing, modeling, and facilitating adaptation to climate impacts (see table 3).[34] See appendix I for additional information about the 18 primary purpose programs.

[33]See appendix I for additional information about the 18 primary purpose programs we identified.

[34]As mentioned previously, fragmentation refers to those circumstances in which more than one federal agency (or more than one organization within an agency) is involved in the same broad area of national need and opportunities exist to improve service delivery (GAO-15-49SP).

Table 3: Focus Area of Six Selected Agencies' 18 Programs with the Primary Purpose of Addressing Climate Change

			Program Focus			
OMB category	**Primary purpose program**	**Agency**	**Climate observing**	**Climate modeling**	**Climate adaptation activities**	**Other**
Science	Atmospheric Radiation Measurement Climate Research Facility	DOE	X			
	Terrestrial Ecosystem Science	DOE	X			
	Atmospheric System Research	DOE		X		
	Climate and Earth System Modeling	DOE		X		
	Terrestrial Carbon Sequestration Research[a]	DOE				X
	Climate Research	Commerce's NOAA	X			
	CLARREO Pathfinder	NASA	X			
	Glory Mission[a]	NASA	X			
	Ice, Cloud, and Land Elevation Satellite[a]	NASA	X			
	Ice, Cloud, and Land Elevation Satellite-2[b]	NASA	X			
	Orbiting Carbon Observatory-2[b]	NASA	X			
	Orbiting Carbon Observatory-3[b]	NASA	X			
	Solar Radiation and Climate Experiment	NASA	X			
	Total Solar Irradiance Sensor-1[b]	NASA	X			
	Total Solar Irradiance Sensor-2[b]	NASA	X			
	Agroclimatology (formerly Global Change UV-B Monitoring and Research)	USDA	X			
	Climate Change Program Office	USDA			X	
Clean energy technology	Climate Change Technology Program[a]	DOE				X
Total		**18**	**13**	**2**	**1**	**2**

Legend: DOE = Department of Energy; NASA = National Aeronautics and Space Administration; Commerce's NOAA = National Oceanic and Atmospheric Administration, Department of Commerce; USDA = U.S. Department of Agriculture

Source: GAO analysis of Department of Commerce, Department of Defense (DOD), Department of Energy (DOE), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), and U.S. Department of Agriculture (USDA) budget justifications and program documents. | GAO-18-223

Notes: GAO identified programs in the budget justifications of four of six selected federal agencies that the agencies described as having climate change as their primary purpose.

Several of these programs focus on a particular program area, but conduct research that contributes to multiple program areas, such as DOE's Atmospheric Radiation Measurement Climate Research Facility, which primarily conducts climate observing, but also includes a modeling component. Additionally, several primary purpose programs award research grants.

[a]These programs are no longer listed as separate line items in agency budget justifications.

[b]These NASA programs are follow-on projects that will replace satellites that are approaching or have reached the end of their mission lifespan.

Observing

Thirteen primary purpose programs we identified within NASA, DOE, NOAA, and USDA collect a variety of climate data in support of their respective agency missions. Specifically, nine NASA earth science missions—two satellites of which were operating in fiscal year 2017—have collected or plan to collect climate observing data, according to our review of NASA budget justifications and program documents.[35] These data include changes in polar ice thickness, varying atmospheric carbon dioxide concentrations, and the effects of aerosols on climate change, as measured from space using satellites and instruments on the International Space Station. NASA provides these data to a wide community of users, including other federal agencies, international partners, academia, and the public, to better understand the Earth system and its response to natural and human-induced changes, according to NASA's 2017 budget justification. Additionally, two DOE programs collect climate data, such as observations on the cycling of carbon between terrestrial ecosystems and the atmosphere, as well as long-term observations of atmospheric variables, such as aerosols, clouds, and incoming solar radiation to improve climate projections and inform the development of solutions to U.S. energy and environmental challenges.[36] One NOAA program collects atmospheric and oceanic observations to describe and understand the state of the oceans and climate variability across multiple time-scales. Lastly, one USDA program monitors ultraviolet radiation (UV-B) reaching the Earth's surface over wide geographic areas of the United States, to improve understanding of ultraviolet radiation impacts and climate change on agriculture.

[35]The two operating satellites are the Orbiting Carbon Observatory-2, which launched in 2014, and the Solar Radiation and Climate Experiment satellite, which launched in 2003. The Total Solar Irradiance Sensor-1 launched in December 2017 and is expected to start returning data in February 2018. Four satellites—the CLARREO Pathfinder, the Ice, Cloud, and Land Elevation Satellite-2, the Orbiting Carbon Observatory-3, and the Total Solar Irradiance Sensor- 2—are under development as follow-on missions to existing satellites or planned satellites and slated to fly in 2018 or later. Two satellite missions—the Glory Mission and the Ice, Cloud, and Land Elevation Satellite were no longer listed as separate line items in NASA's budget justification as of 2011 and 2010, respectively.

[36]According to USGCRP officials, its budget cross-cut includes the basic research activities of these DOE programs, not the application of their research by other DOE programs or external scientists.

Modeling

Two primary purpose programs we identified within DOE focus on climate modeling, although other primary purpose programs we reviewed also include a modeling component in their research. DOE's Atmospheric System Research program uses the agency's climate observing data to model atmospheric processes and develop model parameters to help reduce uncertainty in climate change models and projections. DOE's Climate and Earth System Modeling program develops model components as well as earth system models that include human impacts and natural systems to simulate climate variability and predict change at regional and global scales. Improved climate projections from these programs help inform DOE's energy supply and infrastructure decisions, as well as the development of solutions to environmental challenges, according to DOE program documents.[37] Additionally, NOAA's Climate Research program includes a modeling component that uses mathematical models and high-performance computer simulations to understand atmosphere, ocean, biosphere, and cryosphere dynamics and to make projections about future marine ecosystems, atmospheric composition, and air quality across multiple time scales. DOE's Atmospheric Radiation Measurement (ARM) Climate Research Facility has a modeling component that conducts high resolution modeling of atmospheric and cloud processes using the facility's observational data. DOE, NOAA, and other scientists use the model outputs to better understand cloud formation, earth system science and severe weather.[38]

Adaptation

Two primary purpose programs we identified provide climate information to stakeholders, in part to facilitate adaptation efforts. USDA's Climate Change Program Office (CCPO) provides data, tools, and pertinent information to stakeholders on relevant climate change impacts, such as water availability and wildfires. Additionally, NOAA's Climate Research program has a regional climate data and information component that incorporates research into information and products, ranging from short-term weather forecasts to longer-term climate forecasts and assessments to improve the ability of decision makers and communities to plan for and

[37]Ibid.

[38]Other primary purpose programs also use modeling or develop modeling components. For example, DOE's Terrestrial Ecosystem Science program uses Earth system models to identify research gaps and design field experiments to address the identified uncertainties. USDA's Agroclimatology program develops modeling tools that integrate observing data, ultraviolet effects studies, and satellite observations to study how climate and crop production interact and associated effects on management practices and agricultural economics.

respond to climate variability and change. Both of these programs also coordinate climate research internally and externally, among other activities.

Other Activities

Two DOE primary purpose programs we identified focused on reducing greenhouse gas concentrations in the atmosphere. For example, DOE's Terrestrial Carbon Sequestration Research program conducted research on how to enhance the carbon storage potential of soil and vegetation through economically competitive methods, such as applying coal-combustion byproducts to soil to absorb additional carbon dioxide. Additionally, DOE's Climate Change Technology program supported efforts to accelerate the development and reduce the cost of new and advanced technologies that could avoid, reduce, or capture and store greenhouse gas emissions and increase economic growth. Both DOE programs are no longer listed as separate line items in DOE's budget justifications.[39]

Programs Serve Different Purposes, Audiences, Times, and Scales, and Interagency Collaboration Helps Avoid Potential Negative Effects from Fragmentation

We found that the 18 primary purpose programs we identified serve different purposes, target different audiences, or operate at different time periods and global, regional, or local scales. Further, we found that USGCRP and agency program managers collaborate to help avoid potential negative effects from fragmented climate change programs. Therefore, although fragmented, the 18 programs we reviewed do not show signs of overlap.

Different Purposes, Audiences, Times, and Scales

We found that the 18 primary purpose programs we identified serve different purposes, target different audiences, or operate at different times and scales, among other reasons, which minimizes potential overlap or duplication among these programs. For example, primary purpose programs we identified across DOE, NASA, NOAA and USDA all collect climate observing data related to solar radiance in ways specific to their missions. In particular:

[39]DOE's Terrestrial Carbon Sequestration Research program was not listed as a separate line item in DOE's budget justification after fiscal year 2011 and DOE's Climate Change Technology Program was not listed as a separate line item in DOE's budget justification after fiscal year 2014.

- The ARM Climate Research Facility (a DOE program) collects observational data on aerosols, radiation, clouds, and atmospheric conditions across different climatic regimes to help resolve uncertainties in climate and earth system models. According to agency documents, DOE uses these models for energy and related infrastructure planning. For example, DOE models water availability for energy applications, temperature extremes affecting energy use, and predicting storm and other weather-related impacts on energy delivery.[40]
- NASA satellites, such as the Total Solar Irradiance Sensor,[41] take absolute measurements of the sun's energy input to earth, and the distribution of the sun's energy input across ultraviolet, visible, and other wavelengths of light to quantify solar variations and their effect on the atmosphere and climate. For example, these data enable scientists to study the sun's natural influence on Earth's ozone layer in support of NASA's programmatic mission to monitor and assess the health of the Earth's stratosphere. Scientists also use the data to understand the sun's influence on atmospheric circulation, clouds, and ecosystems.
- NOAA's Climate Research program monitors and models atmospheric and oceanic conditions to understand the state of the oceans, predict climate variability, and develop a variety of products. For example, NOAA uses these data to develop short-term weather forecasts, early warning systems, and longer-term climate forecasts and assessments to improve the ability of decision makers and communities to plan for and respond to climate variability and change, such as changes in sea-level and extreme weather events. [42]
- USDA's Agroclimatology Program—administered by USDA's National Institute of Food and Agriculture (NIFA)—monitors surface-level ultraviolet and photosynthetically-active radiation and studies its

[40]According to USGCRP officials, its budget cross-cut includes the basic research activities of these DOE programs, not the application of their research by other DOE programs or external scientists.

[41]According to program documents, NASA's Total Solar Irradiance Sensor missions measure the sun's energy input to Earth. Various satellites have captured a continuous record of this solar energy input since 1978.

[42]For example, NOAA climate data and early warning systems help communities reduce vulnerability to extreme weather; prepare for drought and water resource challenges; manage risks to coastlines and coastal infrastructure; sustainably manage marine ecosystems; and adapt to and mitigate climate impacts, according to agency documents.

effects on different crop varieties, in accordance with NIFA's mission to invest in and advance agricultural research, education, and extension. Scientists use these data to understand the interactions between crops, climate, and ultraviolet radiation, and assess the effects on management practices and agricultural economics.

Some of the primary purpose programs we identified also target different audiences. In particular, both NOAA's Climate Research program and USDA's Climate Change Program Office (CCPO) provide information to help inform decisions about adapting to climate change, but generally target different audiences. For example:

- NOAA's Climate Research program has a regional climate information services component that provides information and products to improve decision makers' ability to prepare for and respond to short and long-term climate variability and change.[43] The program tailors its information on climate impacts based on regional stakeholder input to help stakeholders and communities expand their capacity to prepare for and respond to floods, drought, wildfire, extreme heat, changes in water supply and snowpack, melting permafrost, sea level rise, and storms.
- USDA CCPO's Regional Climate Hubs program has incorporated data, tools and forecasts from USDA agencies and partners—including NOAA—into integrated services specific to the agricultural and forestry sectors, such as climate impacts on crop varieties, forest health and management, grazing lands, and rural communities.[44] USDA tailors this information to support climate-informed decision-making by farmers, ranchers, and forest landowners, with the goal of maintaining agricultural production, managing natural resources, and supporting rural economic development under increasing climate variability.

Further, some primary purpose programs provide data that supplement research by other programs or that are necessary to ensure data validity. For example, DOE's Atmospheric System Research (ASR) program conducts short-term, targeted field campaigns on specific atmospheric processes to supplement the long-term observational data collected by

[43]Examples of decision makers include water utilities, USDA agricultural extension agents, regional, state, and local planners and communities, among others.

[44]For example, NOAA and USDA collaborate on relevant tools, such as the National Integrated Drought Information System.

the ARM Climate Research Facility, which ASR scientists use to develop model parameters for clouds and aerosols. In turn, scientists within DOE's Climate and Earth System Modeling program incorporate ASR's model parameters and observational data the ARM Climate Research Facility and Terrestrial Ecosystem Science program into its modeling to reduce uncertainty in model representations of atmospheric chemistry, aerosols, and the interactions between ecosystems and climate. Additionally, according to the 2014 *National Plan for Civil Earth Observations*, USGCRP, and the National Academies, airborne, terrestrial, and marine observations supplement satellite observations because they provide high degrees of resolution and density and are essential to validate satellite-derived data products.[45]

Moreover, we determined that primary purpose programs with similar missions were not overlapping or duplicative because they conducted activities over different time periods, at different scale, or collected different measurements. Specifically:

- Within NASA, several primary purpose programs focused on conducting similar observing activities across different time periods. For example, five of NASA's nine primary purpose programs—Ice, Cloud, and Land Elevation Satellite 2, Orbiting Carbon Observatory 2 and 3, and Total Solar Irradiance Sensors 1 and 2—are follow-on missions that are to replace previous or current satellites to maintain the continuity of observational data when the current satellites no longer function. Due to the long lead-time necessary to develop satellites, the development stage of follow-on missions may be concurrent with the operational stage of existing satellites.
- NASA's Orbiting Carbon Observatory satellites make space-based measurements of atmospheric carbon dioxide concentrations at regional and global scales to increase our understanding of how carbon dioxide sources and sinks are geographically distributed, as

[45]Office of Science and Technology Policy, *National Plan for Civil Earth Observations.* (Washington, D.C.: July 18, 2014); U.S. Global Change Research Program, *National Global Change Research Plan 2012 – 2021: A Strategic Plan for the U.S. Global Change Research Program* (USGCRP) (Washington, D.C.: 2012); U.S. Global Change Research Program, *National Global Change Research Plan 2012 – 2021: The Triennial Update* (Washington, D.C.: 2017); and The National Academies of Sciences (NAS), Engineering, and Medicine, *Accomplishments of the U.S. Global Change Research Program* (Washington, D.C.: 2017).

well as how carbon sink efficiencies are changing over time.[46] In contrast, DOE's Terrestrial Ecosystem Science program manages the AmeriFlux network, an interagency effort which measures surface flows of carbon primarily at sites in North America, and conducts targeted field studies on the cycling of carbon, nutrients, and water within specific ecosystems that are poorly understood in models—such as arctic and tropical ecosystems—according to agency documents.[47] Further, although DOE's Terrestrial Carbon Sequestration Research program also conducted research to understand carbon sequestration, it researched how land-based ecosystems' carbon sequestration productivity could be enhanced by changes in land-use patterns, or the addition of absorptive materials to soil, such as coal by-products, among others.

Collaboration

USGCRP officials identified various collaboration methods that USGCRP officials and agency program managers use—such as interagency strategic planning, jointly-funded projects, and routine meetings of relevant officials—that help to minimize potential overlap and duplication among climate change programs.[48] For example, USGCRP's strategic planning process includes working with agency program managers to establish research priorities across the 13 participating agencies.[49] Additionally, NASA and NOAA are statutorily required to submit a joint annual report to relevant congressional committees describing how their earth science programs, which include their climate-related earth observation efforts, will be coordinated.[50]

[46]A carbon sink reabsorbs carbon dioxide from the atmosphere and stores it on Earth. For example, trees remove carbon dioxide from the atmosphere through photosynthesis and oceans absorb carbon dioxide.

[47]DOE, NASA, NOAA, and USDA's Forest Service supported the formation of the AmeriFlux network, which measures carbon flows at over 120 sites.

[48]In September 2012, GAO identified several key considerations for implementing interagency collaboration mechanisms. For the purposes of this report, we did not fully assess USGCRP's efforts against these considerations; however the interagency collaboration methods that we identified are consistent with our prior work. For more information, see GAO, *Managing for Results: Key Considerations for Implementing Collaboration Mechanisms*, GAO-12-1022 (Washington, D.C.: Sept. 27, 2012).

[49]U.S. Global Change Research Program, *National Global Change Research Plan 2012 – 2021*. (2012).

[50]51 U.S.C. § 60505(b).

Some agencies also jointly-fund projects and collaborate on areas of mutual interest. For example, DOE's Atmospheric Radiation Measurement (ARM) Climate Research Facility, NASA and NOAA collaborated on a field campaign to study how aerosols and atmospheric rivers—regions in the atmosphere that are responsible for most of the horizontal transport of water vapor outside of the tropics—contribute to forming snowpacks that supply most of the water in the western United States.[51] According to NOAA, the data will help improve short and long term predictions of precipitation, and help decision makers prepare for extreme precipitation, hazard response, and management of water supply, among other uses. Additionally, we found that although NOAA, NASA, DOE, and USDA's climate observing efforts are designed for different purposes, have different geographic coverage, and take measurements using different instruments, these agencies also collaborate on climate observing activities in areas of mutual interest, such as the Arctic.[52]

Further, USGCRP officials we interviewed said that agency program managers meet regularly to coordinate their efforts for addressing climate change, including through USGCRP interagency working groups focused on specific issues, such as integrative modeling.[53] For example, the officials said that the program managers use meetings to facilitate awareness about different climate change models. Additionally, in response to a 2012 report by the National Research Council that recommended greater coordination and more consistent evaluation of U.S. climate models, USCGRP convenes annual U.S. climate modeling

[51]Other partners include the Scripps Institution of Oceanography and Naval Research Laboratory.

[52]For example, DOE's ARM Facility and NOAA's Global Monitoring Division network collaborate on measurements at NOAA's Barrow, Alaska site, and DOE's Southern Great Plains site. NOAA's Climate Reference Network and USDA's Agroclimatology network both use observations collected by USDA's Agricultural Research Service at its sites in Las Cruces, N. Mex. and Nunn, Colo. NOAA also collaborated with USDA and the University of Alaska-Fairbanks for its sites in Alaska, and both USDA and NOAA collaborated with the Department of the Interior's National Park Service for their observing sites in Big Bend National Park.

[53]Integrated models are advanced models that include the physical, chemical, biological, and human components of the Earth system, as well as the feedbacks among them, to provide more comprehensive and realistic modeling of global change. Other USGCRP interagency working groups include process research, observations, carbon cycle, climate change and human health, education, international activities, sustained assessment, indicators, scenarios, global change information, social-sciences coordination, and adaptation science, according to USGCRP's 2017 update to its strategic plan.

summits to facilitate coordination on specific items of shared interest, such as joint modeling activities.[54]

According to a recent report on USGCRP accomplishments by the National Academies, coordination efforts facilitated by USGCRP reduced potential duplication, improved efficiency, and enabled key advances.[55] Specifically, the National Academies found that USGCRP's coordination efforts enabled key advances in developing global earth observation systems, improving modeling, and incorporating advances in understanding relevant processes to carbon cycle research, among others. For example, USGCRP's Carbon Cycle Interagency Working Group helps coordinate the intensive, interagency field campaigns necessary to unite ground-based, airborne, and satellite-based observations to understand carbon cycle variability and change. The working group supports an interagency call for complementary research proposals across USDA, DOE, NASA, and NOAA to improve the understanding of changes in the distribution and cycling of carbon between the land, ocean, and atmosphere.[56] Nonetheless, the National Academies and others have emphasized the need for continued collaboration among federal agencies regarding their various climate change science programs and activities, such as climate modeling.[57]

However, as we noted earlier, the three funding categories of science, technology, and international assistance in recent OMB funding reports generally do not capture all climate change-related programs and activities, such as actions taken by agencies to increase their resilience to climate change impacts and programs with climate-related fiscal exposure, such as disaster assistance. Additionally, we found that OMB reports and most agency budget justifications we reviewed do not provide sufficient detail to identify and track all climate-related programs and

[54]Moss et al., 2016. *Understanding Dynamics and Resilience in Complex Interdependent Systems: Prospects for a Multi-Model Framework and Community of Practice*. Report of a workshop held under the auspices of the USGCRP Interagency Group on Integrative Modeling, with support from DOE. (December, 2016.)

[55]The National Academies of Sciences, Engineering, and Medicine, *Accomplishments of the U.S. Global Change Research Program.* (2017).

[56]Another coordination effort, under the Interagency Arctic Research Policy Committee, leveraged NASA and DOE observations and experiments to provide complementary ground and airborne measurements of ecosystem responses to changing conditions.

[57]National Research Council of the National Academies, *A National Strategy for Advancing Climate Modeling* (Washington, D.C.: 2012).

activities over time. In particular, most agency budget justifications we reviewed provided detailed information on climate change activities under multi-purpose programs, but generally did not report funding for these climate change activities as separate line items in their budget justifications or as line items in OMB's funding reports.[58]

Further, we reported in October 2014 that there is no comprehensive list of federal programs and funding information—including for government-wide efforts such as climate change—which would help policymakers determine the scope of the federal government's involvement in particular areas, and where action is needed to address crosscutting issues, including instances of fragmentation, overlap, or duplication.[59] We made several recommendations to OMB to ensure the usefulness of a federal program inventory, and provide greater transparency and consistency in federal program funding and performance information; however, as of January 2018, OMB had not implemented them.[60]

According to OMB staff, its climate change funding reports provide a sufficient level of detail for Congress to identify fragmentation, overlap, and duplication within climate change funding. OMB also assesses potential fragmentation, overlap, and duplication government-wide as part of its overall budget process, contained most recently in its Major Savings and Reform volume of the President's budget request for fiscal year

[58]For example, the January 2017 OMB report includes funding for USDA's National Institute for Food and Agriculture (NIFA) under its science category, but does not include further detail on which NIFA programs were included in the reported funding. When reviewing NIFA's budget justification, we found several climate change activities under the Agriculture and Food Research Initiative and other programs, but NIFA did not track actual costs for these activities as line items over time.

[59]GAO, *Government Efficiency and Effectiveness: Inconsistent Definitions and Information Limit the Usefulness of Federal Program Inventories*, GAO-15-83 (Washington, D.C.: Oct. 31, 2014). In a September 2017 report, we identified a series of iterative steps that can be used to develop an inventory and potential benefits. GAO, *Federal Programs: Information Architecture Offers a Potential Approach for Development of an Inventory*, GAO-17-739 (Washington, D.C.: Sept. 28, 2017).

[60]For example, we recommended that OMB revise its guidance to direct agencies to collaborate with each other in defining and identifying programs that contribute to common outcomes, provide complete performance information, and to consult with external stakeholders on their program inventories, among other recommendations.

2018.[61] Additionally, OMB staff said that the U.S. already prepares an inventory of federal climate change programs as part of its biennial Climate Action Report to the U.N. Framework Convention on Climate Change.[62] Further, OMB staff said that they are taking GAO's previous recommendations—to develop a federal program inventory to provide greater transparency and consistently in federal program funding and performance information—into account as part of the broader implementation of the Digital Accountability and Transparency Act of 2014 and GPRA Modernization Act of 2010.[63]

However, as we previously mentioned, several agency budget justifications we reviewed provided detailed information on climate change activities under multi-purpose programs, that were not identifiable based upon the level of detail within OMB's funding reports. Additionally, GAO's specific criteria for identifying fragmented, overlapping, and duplicative programs includes a detailed comparison of programs across several characteristics and a comprehensive assessment of potential positive and negative effects of fragmentation, overlap, and duplication, but these detailed comparisons are generally not included in OMB's justifications for eliminating programs in its fiscal year 2018 Major Savings and Reform volume.[64] Moreover, the 2016 Climate Action Report prepared for the U.N. Framework Convention on Climate Change provides information on U.S. progress toward meeting its emission

[61]Office of Management and Budget, *Major Savings and Reform Volume, Budget of the United States Government for Fiscal Year 2018* (Washington: 2017). Under the previous administration, OMB's assessment of overlapping and duplicative funding was reported as part of the President's Budget in a section titled, *Cuts, Consolidations, and Savings*.

[62]The U.S. Department of State published the most recent Climate Action Report in 2016, which can be accessed at: http://unfccc.int/national_reports/biennial_reports_and_iar/submitted_biennial_reports/items/7550.php.

[63]Digital Accountability and Transparency Act of 2014, Pub. L. No. 113-101, 128 Stat. 1146 (May 9, 2014); GPRA Modernization Act of 2010, Pub. L. No. 111-352, 124 Stat. 3866 (Jan. 4, 2011).

[64]OMB identified 36 programs for elimination or reduction based on fragmentation, overlap, or duplication in the *Major Savings and Reforms* volume of the President's budget request for fiscal year 2018. For 6 of the 36 programs, OMB referenced prior GAO analyses of fragmentation, overlap, and duplication in its justification. We could not determine what criteria were applied to identify fragmentation, overlap, or duplication for the remaining 30 programs because OMB did not include a detailed analysis. For more information on GAO's criteria for evaluating fragmentation, overlap, and duplication among programs, see GAO-15-49SP.

reduction targets and international assistance activities, rather than a comprehensive examination of federal climate change programs, according to our analysis of the 2016 report. Further, because our review focused on six selected agencies' programs based on OMB-reported funding rather than a comprehensive list of federal climate change programs, and OMB reports do not include information on programs with climate-related fiscal exposures, there may be additional opportunities to identify potential fragmentation, overlap, or duplication for federal climate change efforts.

Since 2011, we have reported that identifying and addressing fragmentation, overlap, and duplication have yielded several benefits, such as improved government efficiency, improved program effectiveness, and increased assurance that programs comply with laws and funds are legally spent.[65] We have also reported that increasing interagency collaboration on crosscutting issues may help reduce fragmentation, overlap, and duplication among programs that have been added incrementally over time to address new challenges.[66] Because OMB collects and reports information on federal climate change funding, OMB is uniquely situated to conduct an assessment of potential fragmentation, overlap, or duplication across the full range of agencies engaged in climate change activities. By providing a detailed analysis of such areas to Congress, in conjunction with OMB's funding reports, OMB could help decision makers more effectively target limited resources.

Conclusions

Since 1993, the federal government has reported over $154 billion in funding for activities to understand and address climate change, and annual funding has increased over time, according to OMB climate change reports to Congress. Given the fiscal constraints facing the federal government, we have previously reported that a more complete understanding of fiscal exposures and the long-term effects of decisions would help policymakers make important trade-offs between spending with short-term and long-term benefits. However, the most recent OMB climate change funding reports do not include funding information on federal programs with significant fiscal exposures to climate change

[65]For example, our most recent report on government-wide fragmentation, overlap, and duplication is GAO-17-491SP.

[66]GAO, *Managing for Results: GPRA Modernization Act Implementation Provides Important Opportunities to Address Government Challenges*. GAO-11-617T (Washington, D.C.: May 10, 2011) and GAO-12-1022.

identified by OMB and others—such as federal disaster assistance, flood insurance, and crop insurance. By providing, concurrent with any future climate change funding reports to Congress, funding information for federal programs with fiscal exposure to climate change, OMB would have better assurance that it was providing policymakers with the information necessary for them to make decisions about spending trade-offs. This information should include costs to repair, replace, and improve the weather-related resilience of federally-funded property and resources; costs for federal flood and crop insurance programs; and costs for disaster assistance programs, among other identified areas of fiscal exposure to climate change.

Additionally, based on our review of six selected agency budget justifications, funding for programs whose primary purpose is to address climate change represents a small portion of total agency-reported climate change funding to OMB, and is fragmented across multiple agencies, although we did not find signs of overlap. However, there may be additional opportunities to identify potential fragmentation, overlap, or duplication for federal climate change efforts because several agency budget justifications we reviewed provided information on climate change activities under multi-purpose programs that were not identifiable within OMB's funding reports, and detailed analyses of overlapping and duplicative programs are generally not included in OMB's justifications for eliminating programs, among other reasons. We have previously reported that identifying and addressing fragmentation, overlap, and duplication have yielded several benefits, such as improved program effectiveness, increased collaboration, and improved government efficiency by eliminating or avoiding unnecessary overlap and duplication. By providing, concurrent with any future climate change funding reports to Congress, a detailed analysis of overlapping or duplicative federal climate change programs to Congress, OMB could help decision makers more effectively target limited resources.

Recommendations for Executive Action

We are making the following two recommendations to OMB:

The Director of OMB should provide, concurrent with any future climate change funding reports to Congress, funding information for federal programs with fiscal exposure to climate change. This information should include costs to repair, replace, and improve the weather-related resilience of federally-funded property and resources; costs for federal flood and crop insurance programs; and costs for disaster assistance programs. (Recommendation 1)

The Director of OMB should provide, concurrent with any future climate change funding reports to Congress, a detailed analysis of federal climate change programs it considers to be fragmented, overlapping, or duplicative. (Recommendation 2)

Agency Comments and Our Evaluation

We requested comments on a draft of this product from CEQ, OMB, the Office of Science and Technology Policy, and USGCRP within the Executive Office of the President. CEQ and the Office of Science and Technology Policy did not provide comments. USGCRP provided technical comments, which we incorporated into the draft as appropriate. OMB staff provided oral comments on the draft report. In their comments, OMB staff said that they generally agreed with our findings. However, they disagreed with our recommendations because the staff said that they believe existing budget processes are sufficient for identifying significant fiscal risks to agency operations, including climate change, and for identifying climate change programs that are fragmented, overlapping, or duplicative.

OMB staff said that they disagreed with our recommendation for OMB to provide Congress with funding information on federal programs with fiscal exposure to climate change, concurrent with future OMB funding reports because OMB prefers to conduct a broader examination of federal fiscal risks during the budget process. Specifically, OMB staff said that OMB Circular A-123 directs agencies to conduct enterprise risk management assessments to identify significant risks to agency goals and operations and that agencies have discretion on how to prioritize identified risks and whether climate change should be included. Additionally, outside of the existing budget process, OMB staff said that there is significant uncertainty in climate projections, that the ability to distinguish impacts and decisions associated with climate change from other drivers is often not possible, and that any analyses to evaluate those distinctions or assess future trends in expenditures would require substantial resources. Further, OMB staff said that no test exists to identify climate change programs with fiscal exposures and that its identification of such programs would be subjective and not transparent. OMB staff suggested that we revise our first recommendation to reflect that agencies should consider fiscal exposure to climate change as part of their enterprise risk management assessments under OMB Circular A-123.

We agree with OMB that it is important to conduct a broad examination of federal fiscal risks during the budget process and that agencies should

consider fiscal exposure to climate change as part of their enterprise risk management assessments under OMB Circular A-123. However, we were asked to review reported federal funding for climate change activities, and evaluating agencies' enterprise risk management assessments was outside the scope of our review. For this report, we examined the extent to which OMB's climate change funding reports were clearly linked to federal fiscal exposure to climate change and we found that they were not. We also found that OMB would have better assurance that it was providing policymakers with the information necessary to make climate change spending trade-offs, if in addition to the funding information for science, technology, and international assistance it has previously reported to Congress, OMB also reported similar funding information for programs whose costs were likely to increase due to climate change impacts.

We acknowledge OMB's position that there is significant uncertainty in climate projections, that the ability to distinguish impacts and decisions associated with climate change from other drivers is often not possible, and that any analyses to evaluate those distinctions or assess future trends in expenditures would require substantial resources. The first recommendation does not explicitly call for OMB to provide information on historical or future trends in expenditures related to programs with fiscal exposure to climate change impacts. Additionally, our recommendation does not call for OMB to analyze or distinguish between climate change and other drivers of federal fiscal exposure to climate change impacts, such as coastal development. Instead, our recommendation calls for OMB to provide funding information for federal programs with fiscal exposure to climate change—which could be in the same format as the climate change funding OMB has previously provided to Congress for science, technology, and international assistance. We disagree with OMB's comment that no test exists to identify climate change programs with fiscal exposures and that its identification of such programs would be subjective and not transparent. For example, OMB and others have previously identified federal programs with fiscal exposure to climate change, such as disaster assistance, flood insurance, crop insurance, wildfire management, and other programs that annually incur costs due to weather-related events and that OMB already collects funding information for these programs as part of its preparation of the President's budget request. Further, OMB has previously requested that agencies report information on funds for agency implementation of sustainability goals and resilience measures in the construction and renovation of federal facilities, so it is possible to do so. For these reasons, when the President is required by statute to report on climate change funding, we continue to

believe that implementing our recommendation will provide policymakers with more complete information for making important trade-offs between spending with long-term benefits and spending with short-term benefits.

OMB staff also disagreed with our recommendation for OMB to provide Congress with a detailed analysis of federal climate change programs it considers fragmented, overlapping, or duplicative, concurrent with future OMB funding reports. According to the OMB staff, our recommendation is unnecessary because OMB already assesses potential fragmentation, overlap, and duplication as part of its budget process, contained most recently in its Major Savings and Reform volume of the President's budget request. OMB staff also stated that the statutory requirements for the climate change funding reports have been similar year-after-year. Additionally, the OMB staff said that the United States already prepares an inventory of federal climate-related activities as part of its Climate Action Report to the U.N. Framework Convention on Climate Change. Further, OMB staff also said they are taking our previous recommendations—to develop a federal program inventory to provide greater transparency and consistency in federal program funding and performance information—into account as part of the broader implementation of the Digital Accountability and Transparency Act of 2014 and GRPA Modernization Act of 2010. OMB staff suggested that we revise our second recommendation to direct OMB to more explicitly report on fragmented, overlapping, and duplicative federal climate change programs as part of OMB budget processes.

We agree with OMB that it is important to identify potential fragmented, overlapping, or duplicative programs during the budget process. However, as we mention in the report, the fiscal year 2018 Major Savings and Reform volume of the budget request generally does not include detailed analyses supporting its justifications for eliminating programs, such as comparisons of similar programs across several characteristics and a comprehensive assessment of potential positive and negative effects of fragmentation, overlap, and duplication, as called for by GAO's criteria. We acknowledge OMB's comment that the statutory requirements for the climate change funding reports have been similar year-after-year. However, we continue to believe that OMB's climate change funding reports do not provide sufficient detail for Congress to identify potential fragmented, overlapping, or duplicative programs, because several agency budget justifications we reviewed included information on climate change activities that were not identifiable based on the level of detail in OMB's funding reports. Further, the 2016 Climate Action Report focuses on progress toward meeting emissions reduction targets and international

assistance activities, rather than a comprehensive list of federal climate change programs. We are encouraged by OMB staff's statement that the agency is taking our previous recommendations on federal program inventories into account as part of its implementation of the Digital Accountability and Transparency Act of 2014 and GRPA Modernization Act of 2010. However, we continue to believe that because OMB collects and reports information on federal climate change funding, OMB is uniquely situated to conduct an assessment of potentially fragmented, overlapping, or duplicative programs across the full range of agencies engaged in climate change activities and that by providing this information to Congress in conjunction with its funding reports, OMB could help decision makers more effectively target limited resources.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Director of the Office of Management and Budget, the Director of the Office of Science and Technology Policy, and other interested parties. In addition, the report will be available at no charge on the GAO website at http://www.gao.gov. If you or your staff have any questions about this report, please contact J. Alfredo Gómez at (202) 512-3841 or gomezj@gao.gov.

Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VII.

Sincerely yours,

J. Alfredo Gómez
Director, Natural Resources and Environment

Appendix I: Further Information on 18 Primary Purpose Programs Identified by GAO

This appendix presents additional information on primary purpose programs or activities—those described by agencies as having climate change as their primary purpose—as reported by agencies in annual budget justifications.

1. Climate Research

The Department of Commerce's National Oceanic and Atmospheric Administration's (NOAA) Climate Research program conducts observing and research to predict long-term changes in climate as well as shorter-term variations that are of societal and economic importance.

Program Snapshot

Federal Agency:

Department of Commerce's National Oceanic and Atmospheric Administration (NOAA)

Administering Agency and Relevant Offices:

Climate Program Office (CPO) and Laboratories and Cooperative Institutes within NOAA's Office of Oceanic and Atmospheric Research.

Program Focus Area:

Climate observing.

Grant Eligibility:

Researchers at a variety of institutions and government agencies.

Intended Benefits:

Research intends to benefit communities, decision makers, and other stakeholders' ability to understand and prepare for short and long-term climate variations, such as droughts and natural disasters.

Program Status:

Active.

Sources: GAO analysis of NOAA documents (text); U.S. Government Work (image) | GAO-18-223

NOAA's Climate Research activities are authorized by the National Climate Program Act.[1]

Coordination:

NOAA collaborates with other federal agencies through the U.S. Global Change Research Program (USGCRP) and interagency working groups.[2] Further, National Aeronautics and Space Administration (NASA) and NOAA are statutorily required to submit an annual report to relevant congressional committees describing how their earth science programs will be coordinated. [3]

Examples of program activities:

NOAA's climate research efforts—through its Climate Research Laboratories and Cooperative Institutes; Regional Climate Data and Information; and Climate Competitive Research—include:

- Collecting atmospheric and oceanic observations to understand the state of the oceans and predict climate variability across multiple time-scales. NOAA also uses these data for weather forecasts and warning systems.
- Modeling to understand atmosphere, ocean, biosphere, and cryosphere dynamics to make projections about future marine ecosystems, atmospheric composition, and air quality across multiple time-scales. NOAA's modeling helped develop an improved drought warning system.
- Regional climate information services that provide information and products to improve decision makers' ability to plan for and respond to climate variability and change. NOAA's Regional Integrated Sciences and Assessments program supports regional teams that increase communities' capacity to prepare for and respond to natural disasters.

[1]15 U.S.C. §§ 2901-2908. The National Climate Program Act requires the President to establish a National Climate Program, with the National Climate Program office within NOAA serving as the lead entity responsible for administering the program

[2]Under the National Science and Technology Council, NOAA is a co-chair of the Committee on Environment, Natural Resources, and Sustainability, and has a leadership role in the following subcommittees: disaster reduction, ocean science and technology, air quality research, and global change research, among others.

[3]51 U.S.C. § 60505(b).

2. Atmospheric Systems Research (ASR)

The Department of Energy's (DOE) ASR quantifies the interactions among aerosols, clouds, precipitation, and radiation to improve fundamental understanding of these processes and reduce uncertainty in global and regional climate projections.

Program Snapshot

Federal Agency:

Department of Energy (DOE)

Administering Agency and Relevant Offices:

ASR is in the Climate and Environmental Sciences Division of the Office of Biological and Environmental Research within DOE's Office of Science.

Program focus:

Climate modeling.

Grant eligibility:

Researchers at a variety of institutions and government agencies, excluding DOE labs, among others.

Intended Benefits:

To improve climate projections and inform the development of solutions to energy and environmental challenges. Other applications include water forecasts.

Program Status:

Active.

Sources: GAO analysis of DOE program documents (text); DOE (image). | GAO-18-223

According to DOE program documents, the agency created ASR in 2010 by merging two atmospheric research programs that had focused on different measurement scales.[4]

Coordination:

ASR coordinates closely with the Atmospheric Radiation Measurement Climate Research Facility program and partners with other Climate and Environmental Sciences Division (CESD) modeling programs.[5] ASR scientists participate in semi-annual meetings to discuss findings and research priorities. At the division level, CESD officials collaborate with other federal agencies through the U.S. Global Change Research Program, and interagency working groups.[6]

Examples of program activities:

ASR scientists conduct field campaigns and work with the Atmospheric Radiation Measurement Climate Research Facility to conduct research. ASR also supports research through grants.

- Modeling atmospheric processes and developing model parameters that incorporate ASR's research on aerosols, clouds, and precipitation.[7]
- Targeted observing through short-term field campaigns and experiments on specific atmospheric processes to supplement Atmospheric Radiation Measurement Climate Research Facility data.[8] Scientists have used ASR research to improve their ability to predict future changes in precipitation, cloud cover, and atmospheric energy.

[4]Specifically, DOE merged its Atmospheric Radiation Measurement Program and its Atmospheric Science Program in 2010 to better utilize the measurement capabilities of the newly expanded Atmospheric Radiation Measurement Climate Research Facility in a cohesive manner.

[5]For example, ASR collaborates with DOE's Regional and Global Climate Modeling, Earth System Modeling, and Terrestrial Ecosystem Science modeling efforts.

[6]Under the National Science and Technology Council, DOE is a member of the Committee on Environment, Natural Resources, and Sustainability, and the Director of CESD participates in the U.S. Group on Earth Observations subcommittee.

[7]DOE, *Accomplishments in Atmospheric Science 2008 – 2013*, DOE-SC-0159.

[8]For example, ASR supplements Atmospheric Radiation Measurement Climate Research Facility's long-term observations with laboratory studies and short-term field campaigns that target specific atmospheric processes in a variety of locations and atmospheric conditions.

3. Atmospheric Radiation Measurement (ARM) Climate Research Facility

The Department of Energy's (DOE) ARM Climate Research Facility provides researchers with observation facilities to improve the understanding and model representation of clouds and aerosols, as well as their interactions with the Earth's surface.

Federal Agency:

Department of Energy (DOE)

Administering Agency and Relevant Offices:

ARM is a scientific user facility within the Climate and Environmental Sciences Division of the Office of Biological and Environmental Research within DOE's Office of Science. An infrastructure board manages the facility, and components of the facility are operated by DOE laboratories.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

To improve the predictive understanding of Earth's climate, and inform solutions to U.S. energy and environmental challenges. Other applications include storm prediction.

Program Status:

Active.

Sources: GAO analysis of DOE program documents (text); DOE (image). | GAO-18-223

According to DOE program documents, the agency established the ARM Climate Research Facility as a national user facility in 2003.[9]

Coordination:

ARM coordinates closely with DOE's Atmospheric Systems Research program and partners with other programs within DOE's Climate and Environmental Sciences Division (CESD).[10] ARM also coordinates with federal agencies through its Science Board and constituent groups.[11] At the division level, CESD officials collaborate with other federal agencies through the U.S. Global Change Research Program, and interagency working groups.[12]

Examples of program activities:

ARM's efforts include:

- Collecting long-term data on aerosols, clouds, and other atmospheric properties from fixed and mobile instruments. Scientists use these data to understand how sunlight, clouds, aerosols, and precipitation affect temperature, weather, and climate.
- High resolution modeling of atmospheric and cloud processes using ARM data. DOE, NOAA, and other scientists use the model outputs to better understand cloud formation, earth system science and severe weather.
- Providing the use of highly-instrumented in situ and remote sensing observation facilities to researchers. Almost 1200 researchers from academia, government, industry and others used ARM facilities in 2016.[13]

[9]The observational sites were originally established under DOE's ARM Program, which DOE established in 1990 and merged with its Atmospheric Science Program in 2010 to become the Atmospheric Systems Research program.

[10]For example, ARM collaborates with CESD's Climate and Earth System Modeling, Environmental System Science, and the Environmental Molecular Sciences Laboratory efforts.

[11]For example, the ARM Science Board, which reviews research proposals, includes NASA and DOD officials. Constituent groups such as ARM's User Executive Committee, and Unmanned Aerial Systems Advisory Panel, include representatives from NOAA, the NSF-funded National Center for Atmospheric Research and NASA.

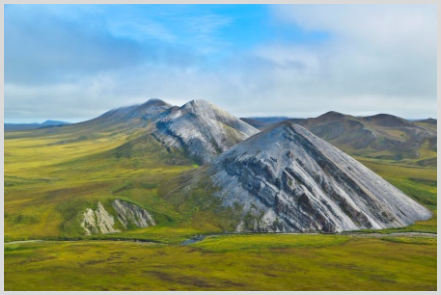
[12]Under the National Science and Technology Council, DOE is a member of the Committee on Environment, Natural Resources, and Sustainability, and the Director of CESD participates in the U.S. Group on Earth Observations subcommittee.

[13]DOE/SC-ARM-16-056.

4. Terrestrial Ecosystem Science (TES)

The Department of Energy's (DOE) TES seeks to improve the representation of terrestrial ecosystem processes in Earth system models to improve climate projections and inform energy decisions.

Program Snapshot



Federal Agency:

Department of Energy (DOE)

Administering Agency and Relevant Offices:

TES is in the Climate and Environmental Sciences Division of the Office of Biological and Environmental Research within DOE's Office of Science.

Program focus:

Climate observing.

Grant eligibility:

Researchers at a variety of institutions and government agencies.

Intended Benefits:

To improve climate projections and inform DOE's energy decisions.

Program Status:

Active.

Sources: GAO analysis of DOE program documents (text); DOE (image). | GAO-18-223

According to DOE program documents, the agency created TES by consolidating predecessor programs on carbon processes and ecological science.[14]

Coordination:

TES coordinates closely with DOE's Subsurface Biogeochemical Research program and partners with other programs within DOE's Climate and Environmental Sciences Division and research at DOE scientific facilities.[15] TES also collaborates with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[16]

Examples of program activities:

TES efforts include:

- Collecting long-term data on carbon flows between land and atmosphere, generally in North America. Scientists at DOE, NOAA, the U.S. Forest Service and others use the data to understand carbon sources and sinks and how they are affected by a variety of factors, such as land-use, disturbance, and climate, among others.[17]
- Using Earth system models to identify research gaps and designing field experiments to address uncertainties. TES provides research results to modeling efforts, to improve climate projections.
- Conducting long-term field experiments focused on regionally or globally significant ecosystems and processes to study their interactions with the climate. Scientists use these data to predict the responses and feedbacks between the climate and these ecosystems, such as permafrost.[18]

[14]In particular, DOE consolidated its Terrestrial Carbon Processes and Program in Ecological Research programs to become the TES program.

[15]For example, TES and the Subsurface Biogeochemical Research program hold joint investigator meetings annually to discuss ongoing research. TES also coordinates closely with the Climate and Earth System Modeling program, among others.

[16]For example, TES participates in the Carbon Cycle Interagency Working Group that includes representatives from 12 agencies, including NOAA, NASA, USDA, NSF and USGS. As part of the Interagency Arctic Research Policy Committee, TES coordinates its Arctic research with NASA's Arctic research, among others.

[17]DOE, NASA, NOAA, and the U.S. Forest Service supported the formation of the AmeriFlux network—an observation network to measure carbon flows at over 120 sites.

[18]TES is studying ecosystems in the Arctic and in tropical rainforests, and whether their stored carbon will be affected by changing climate conditions.

5.Terrestrial Carbon Sequestration Research

The Department of Energy's (DOE) Terrestrial Carbon Sequestration Research supported efforts to identify, understand, and predict the fundamental physical, chemical, biological, and genetic mechanisms controlling carbon sequestration in terrestrial ecosystems.

Program Snapshot

Federal Agency:

Department of Energy (DOE)

Administering Agency and Relevant Offices:

DOE's National Energy Technology Laboratory (NETL) managed the Terrestrial Carbon Sequestration Research program.

Program focus:

Other.

Grant eligibility:

Researchers at a variety of institutions, industry, and DOE labs.

Intended Benefits:

Provide economically competitive and environmentally safe options for offsetting the projected increase in carbon dioxide emissions. Concurrent benefits could include creating wildlife habitat, preventing soil erosion, and boosting local economies, among others.

Program Status:

No longer funded as a separate line item in DOE's budget justification after fiscal year 2011.

Sources: GAO analysis of DOE program documents (text); USDA photo by Lance Cheung (image). | GAO-18-233

According to DOE's budget justification, Terrestrial Carbon Sequestration Research first appeared as a separate line item in fiscal year 2010.[19]

Coordination:

Terrestrial Carbon Sequestration Research was a joint effort of DOE's Office of Science and DOE's Office of Fossil Energy. At the department level, DOE also coordinated with federal agencies through the Climate Change Technology Program.[20]

Examples of program activities:

Terrestrial Carbon Sequestration Research efforts included:

- Supporting research to enhance the carbon storage productivity of terrestrial ecosystems, such as by applying additives to the soil or managing plant root systems.
- Supporting research to develop models, methods and tools to evaluate carbon sequestration strategies.
- Fostering partnerships between landowners, government agencies, and energy producers, such as coal and utility companies to help develop the best approaches for increasing carbon sequestration in soils and plants.

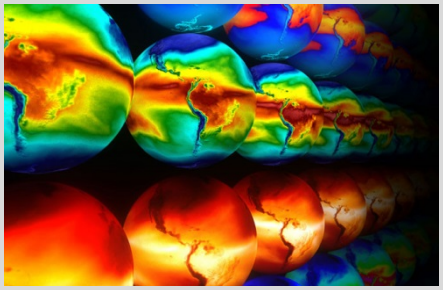
[19]However, DOE conducted carbon sequestration research as part of other programs prior to 2010 as well as after DOE stopped listing Terrestrial Carbon Sequestration Research as a separate line item in its budget justifications

[20]According to DOE program documents, the Climate Change Technology Program was created to coordinate and prioritize the federal government's investments in climate related technology, research, development, demonstration, and deployment.

6. Climate and Earth System Modeling (CESM)

The Department of Energy's (DOE) CESM develops model components as well as Earth system models that include human impacts and natural systems to simulate climate variability (e.g., El Niño) and predict change from decades to centuries at regional and global scales.

Program Snapshot



Federal Agency:

Department of Energy (DOE)

Administering Agency and Relevant Offices:

CESM is in the Climate and Environmental Sciences Division of the Office of Biological and Environmental Research within DOE's Office of Science.

Program focus:

Climate modeling,

Grant eligibility:

Researchers at a variety of institutions and government agencies, including DOE labs.

Intended Benefits:

To reduce uncertainty in Earth system models, including regional climate projections and how extreme events and sea-level will change to inform energy supply and infrastructure decisions. Other applications include water forecasts and agricultural impacts.

Program Status:

Active.

Sources: GAO analysis of DOE program documents (text); DOE (image). | GAO-18-223

According to DOE's budget justification, CESM first appeared as a separate line item in fiscal year 2010.[21]

Coordination:

CESM works in partnership with modeling and other programs within CESD conducting research relevant to modeling.[22] CESM also coordinates with modeling efforts at other agencies through joint projects, the U.S. Global Change Research Program, and interagency working groups.[23]

Examples of program activities:

CESM efforts include:

- Earth System Modeling that develops models to enhance climate projection capabilities, improving climate feedbacks simulations, tipping points, and responses to past and possible future energy pathways.
- Regional and Global Climate Modeling investments to develop model validation metrics and conduct climate analyses to inform DOE's earth system model development and related research.
- Integrated Assessment Research that examines the interactions between human and natural systems, to explore energy system dynamics, future energy technologies and options, land use, and water use, among other topics.

[21]However, DOE and its predecessor agency's involvement in climate modeling date back to the 1960s, with the development of the Livermore Atmospheric Model at Lawrence Livermore National Laboratories.

[22]For example, CESD's Atmospheric Radiation Measurement Climate Research Facility, Atmospheric System Research, Terrestrial Ecosystem Science and others conduct research or collect data relevant for CESM's modeling. CESM also partners with DOE's Advanced Scientific Computing Research program, which is investing in code and algorithm designs for optimal model computation.

[23]For example, NSF and CESM jointly fund the Community Earth System Model, a coupled climate model. NOAA, DOE, NSF and NASA jointly funded the North American Multi-Model Ensemble II project, and NSF, USDA, and DOE jointly funded research on decadal and regional climate predictions. Also, CESD partners with other agencies, such as NOAA, to support workshops that share expertise and how to address research priorities in the context of available resources. Additionally, the Interagency Group on Integrative Modeling coordinates global change modeling activities across ten participating agencies, including NSF, USDA, NASA, NOAA, USGS and EPA, among others.

7. Climate Change Technology Program (CCTP)

The Department of Energy's (DOE) CCTP supported efforts to accelerate the development and reduce the cost of new and advanced technologies that could significantly avoid, reduce, or capture and store greenhouse gas emissions.[24]

Program Snapshot

Federal Agency:

Department of Energy (DOE)

Administering Agency and Relevant Offices:

DOE's Office of Policy and International Affairs within Departmental Administration.

Program focus:

Other.

Grant eligibility:

Not applicable.

Intended Benefits:

Provided analytical and technical support to interagency working groups and advisory committees to the President.

Program Status:

No longer funded as a separate line item in DOE's budget justification after fiscal year 2014.

Sources: GAO analysis of DOE program documents (text); DOE (image). | GAO-18-223

CCTP was created by the President in 2002—and was subsequently codified by the Energy Policy Act of 2005.[25]

Coordination:

CCTP assisted an interagency committee on climate change technology, led by DOE, with participation by the following federal agencies: Agriculture, Commerce, Defense, Interior, State, Transportation, the Environmental Protection Agency, Health and Human Services, National Aeronautics and Space Administration, the National Science Foundation, and the U.S. Agency for International Development.[26]

Examples of program activities:

CCTP efforts included:

- Providing strategic direction and leadership through interagency coordination of research and development planning, programming, and budgeting.
- Conducting portfolio and policy analyses, technology assessments and inventories, and progress reviews, in support of strategic and leadership functions.[27]
- Led international cooperative initiatives, such as launching the Clean Energy Ministerial process and the Clean Energy Solutions Center, among others.[28]

[24]U.S. Climate Change Technology Program, *Strategic Plan,* DOE/PI-0005, (Sept. 2006)

[25]42 U.S. C. § 13389(d). The Energy Policy Act of 2005 states that this program is to, among other things, assist the Climate Change Technology Committee with the interagency coordination of climate change technology research, development, demonstration and deployment to reduce greenhouse gas intensity.

[26]DOE/PI-0005.

[27]DOE, Office of Chief Financial Officer, *FY 2010 Congressional Budget Request,* DOE/CF-036, Vol. 2 (May 2009).

[28]DOE, Office of Chief Financial Officer, *FY 2014 Congressional Budget Request* DOE/CF-0085, Vol. 2 (April 2013).

8. CLARREO Pathfinder (CPF) Mission

The National Aeronautics and Space Administration's (NASA) CPF Mission's goal is to demonstrate the essential measurement and calibration technologies for one of the instruments needed for the full CLARREO mission.

Program Snapshot

Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

CPF is a component of the CLARREO mission within NASA's Earth Systematic Missions, in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Langley Research Center leads the CLARREO mission.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

CPF will reduce risks for the CLARREO mission by demonstrating calibration approaches with other satellite instruments. CPF's establishment of a calibration standard for other orbiting sensors will also improve weather forecasting and the accuracy of climate observations.

Program Status:

Projected launch no earlier than 2022.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

NASA's Earth Science program was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[29]

Coordination:

The CLARREO team coordinates with NASA's Goddard Space Flight Center and Jet Propulsion Laboratory. The CLARREO team also coordinates with the National Oceanic and Atmospheric Administration (NOAA), the National Institute for Standards and Technology (NIST), the Department of Energy (DOE), and academic partners.[30] At the division level, NASA Earth Science collaborates directly with NOAA, and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[31]

Examples of program activities:

CPF Mission efforts include:

- Develop and demonstrate one highly accurate spectrometer instrument to measure reflected solar energy and to serve as an in-orbit standard to calibrate and improve the accuracy of other satellite instruments.
- One year of operation on the International Space Station, and one year of data analysis.

[29]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992) (requiring the NASA Administrator to carry out an Earth Observing System program that addresses the highest priority international climate change research goals).

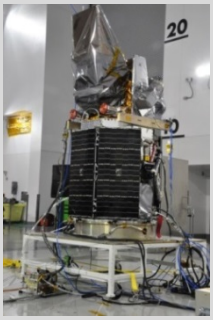
[30]For example, the full CLARREO mission includes inter-calibration and comparison software developed jointly by NASA and NOAA. The NASA and NOAA Administrators are required to review and monitor, through a joint working group, the agencies' missions to ensure maximum coordination in the design, operation, and transition of missions, where appropriate, and submit annual reports to relevant congressional committees on how their earth science programs will be coordinated. 51 U.S.C. §§ 60505(a),(b).

[31]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

9. Glory Mission

The National Aeronautics and Space Administration's (NASA) Glory Mission's goal was to examine how aerosols and solar energy affect the climate, by collecting data on atmospheric aerosol properties and incoming solar energy.

Program Snapshot



Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

Glory was located in NASA's Earth Systematic Missions, in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Goddard Space Flight Center led the Glory Mission.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

Glory would have increased the accuracy of aerosol and solar energy measurements to improve understanding of the Earth's energy budget and climate change regional impacts.

Program Status:

No longer funded as a separate line item in NASA's budget justification. The satellite failed to reach orbit in fiscal year 2011.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

The Glory Mission was part of NASA's Earth Science program, which was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[32] The Glory Mission was reauthorized by the National Aeronautics and Space Administration Authorization Act of 2008.[33]

Coordination:

The Glory Mission team coordinated closely with NASA's Goddard Institute for Space Studies. The Glory team also coordinated with the National Oceanic and Atmospheric Administration (NOAA), the National Institute for Standards and Technology (NIST), the Naval Research Laboratory, and other partners.[34] At the division level, NASA Earth Science collaborates directly with NOAA, and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[35]

Examples of program activities:

Glory Mission efforts included:

- Developing and testing two instruments, the Aerosol Polarimetry Sensor and the Total Irradiance Monitor, which were intended to supply highly accurate measurements of aerosol properties and incoming solar radiation.
- The Glory Mission spacecraft launched in March 2011, but failed to reach orbit due to a launch vehicle equipment failure.[36]

[32]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[33]Pub. L. No. 110-422, tit. II, § 206(a) (Oct. 15, 2008).

[34]For example, the NASA and NOAA Administrators are required to review and monitor, through a joint working group, the agencies' missions to ensure maximum coordination in the design, operation, and transition of missions, where appropriate, and submit annual reports to relevant congressional committees on how their earth science programs will be coordinated. 51 U.S.C. §§ 60505(a),(b).

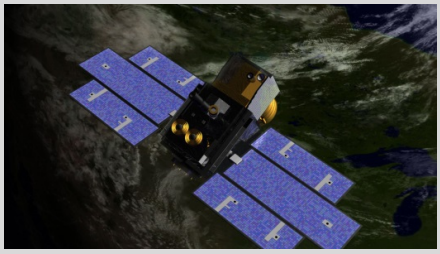
[35]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[36]NASA, *Overview of the Glory Mishap Investigation Results for Public Release.*

10. The Ice, Cloud, and Land Elevation Satellite (ICESat)

The National Aeronautics and Space Administration's (NASA) ICESat measured changes in ice sheet mass and elevation to understand how changing conditions affect ice and sea level.

Program Snapshot



Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

ICESat was located in NASA's Earth Systematic Missions, in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Goddard Space Flight Center led the ICESat mission.

Program focus:

Climate observing.

Grant eligibility:

Not applicable

Intended Benefits:

ICESat provided data on ice sheet changes to better understand the climate system.

Program Status:

No longer funded as a separate line item in NASA's budget justification after completing its mission in fiscal year 2010.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

ICESat is part of NASA's Earth Science program, which was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[37]

Coordination:

The ICESat mission team coordinated with industry and academic partners.[38] At the division level, NASA Earth Science collaborates directly with the National Oceanic and Atmospheric Administration (NOAA), and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[39]

Examples of program activities:

ICESat mission efforts included:

- Developing and launching one instrument, the Geoscience Laser Altimeter System, which quantified ice sheet mass balance and measured global distributions of clouds and aerosols, topography, sea ice and vegetation cover.
- ICESat data led to scientific advances in measuring changes in the mass of the Greenland and Antarctic ice sheets and polar sea ice thickness.[40] It also led to detailed records of land elevation, tree canopies, global standing carbon stocks and terrestrial water storage capacity.
- ICESat completed its mission goal to provide detailed ice elevation data in 2008, and ceased operation in fiscal year 2010.[41]

[37]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[38]NASA, Goddard Space Flight Center, *ICESat: Ice, Cloud, and Land Elevation Satellite,* FS-2002-9-047-GSFC.

[39]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[40]According to NASA, the Geoscience Laser Altimeter System instrument allowed scientists to measure the multi-year height of atmospheric cloud and aerosol layers for the first time to improve understanding of the Earth's climate. For a list of publications that used ICESat data, see http://nsidc.org/data/icesat/research.html.

[41]ICESat operated from 2003 to 2009 and completed its original mission goal in 2008. NP-2010-7-160-GSFC and NASA, *ICESat: Ice, Cloud, and Land Elevation Satellite 2 (ICESat-2) Application Plan.*

11. The Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2)

The National Aeronautics and Space Administration's (NASA) ICESat-2 will continue ICESat's mission to measure changes in ice sheet mass and elevation to understand how changing conditions affect ice and sea level.

Program Snapshot

Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

ICESat-2 is located in NASA's Earth Systematic Missions, in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Goddard Space Flight Center leads the ICESat-2 mission.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

To improve the measurement precision for polar ice sheet mass, sea ice, and other elevation data to better understand the Earth's climate system.

Program Status:

Projected launch in 2018.

Sources: GAO analysis of NASA program documents (text); Orbital Sciences Corporation (image). | GAO-18-223

ICESat-2 is part of NASA's Earth Science program, which was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[42]

Coordination:

The ICESat-2 team coordinates with the U.S. Geological Survey, National Oceanic and Atmospheric Administration (NOAA), academic partners, and others.[43] At the division level, NASA Earth Science collaborates directly with NOAA, and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[44]

Examples of program activities:

ICESat-2 mission efforts include:

- Developing, testing, and launching one instrument, the Advanced Topographic Laser Altimeter System (ATLAS) to provide high-resolution elevation data.[45]
- IceSat-2 will measure changes in polar ice sheet mass, sea ice thickness, and vegetation-canopy heights. It will also provide atmospheric profiles, ocean elevation, and inland water elevations.
- Other data applications may include improving the Navy's ice forecasting system and improving global forecasting for floods and droughts.
- Data will be sent to the National Snow and Ice Data Center, which is jointly supported by NASA, NOAA, and the National Science Foundation.

[42]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[43]Scientists from NASA's Jet Propulsion Laboratory also assisted with IceSat-2.

[44]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[45]We previously reported that ICESat-2 has encountered problems with cracked crystals in the flight lasers in ATLAS that will likely cause it to miss its committed launch date and could cause it to exceed its current cost baseline. The project was previously re-baselined in 2014 because of development and design issues, and now plans to launch no earlier than September 2018—11 months later than its previously planned October 2017 launch date. GAO, *NASA: Assessment of Major Projects,* GAO-17-303SP (Washington, D.C.: May 17, 2016.)

12. Orbiting Carbon Observatory-2 (OCO-2)

The National Aeronautics and Space Administration's (NASA) OCO-2 measures carbon dioxide concentrations, to better understand the carbon cycle.

Program Snapshot

Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

OCO-2 is located in NASA's Earth System Science Pathfinder program in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Jet Propulsion Laboratory leads the OCO-2 mission.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

To improve global carbon dioxide measurements to better understand the carbon cycle.

Program Status:

Operational since 2014.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

OCO-2 is part of NASA's Earth Science program, which was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[46] The National Aeronautics and Space Administration Authorization Act of 2000 required NASA to develop a carbon cycle remote sensing applications research program.[47]

Coordination:

The OCO-2 team coordinated with NASA's Goddard Space Flight Center and Langley Research Center. The team also coordinated with the Department of Energy, National Oceanic and Atmospheric Administration (NOAA) and others.[48] At the division level, NASA Earth Science collaborates directly with NOAA, and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[49]

Examples of program activities:

OCO-2 mission efforts include:

- Developed and launched one instrument with three spectrometers to provide high-resolution measurements of carbon dioxide concentrations globally.
- OCO-2 measures carbon dioxide concentrations and its geographic distribution to improve understanding of the global carbon cycle and predictions of global climate change. Other applications may include evaluating carbon cycle impacts for land use and energy policy options.[50]

[46]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[47]Pub. L. No. 106-391, tit. III, § 315(a)(1) (Oct. 30, 2000).

[48]The OCO team worked with international research institutions and private sector partners for the original mission that failed during launch in 2009. NASA reformulated the OCO science team to continue their work for the follow-on mission, OCO-2.

[49]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[50]NASA, *Orbiting Carbon Observatory-2 Launch Press Kit* (July 2014).

13. Orbiting Carbon Observatory-3 (OCO-3)

The National Aeronautics and Space Administration's (NASA) OCO-3 will continue OCO-2's mission measuring carbon dioxide concentrations, to better understand the carbon cycle

Program Snapshot

Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

OCO-3 is located in NASA's Earth System Science Pathfinder program in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Jet Propulsion Laboratory leads the OCO-3 mission.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

To improve carbon dioxide measurements to better understand the carbon cycle.

Program Status:

Launch date to be determined.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

OCO-3 is part of NASA's Earth Science program, which was required established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[51] The National Aeronautics and Space Administration Authorization Act of 2000 required NASA to develop a carbon cycle remote sensing applications research program.[52]

Coordination:

The OCO-3 team coordinated with NASA's Human Exploration and Operations Mission Directorate, among others. The team also coordinated with the Department of Energy, the National Oceanic and Atmospheric Administration (NOAA) and others.[53] At the division level, NASA Earth Science collaborates directly with NOAA, and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[54]

Examples of program activities:

OCO-3 mission efforts include:

- Developing and launching one spectrometry instrument to the International Space Station to provide high-resolution measurements of carbon dioxide and chlorophyll fluorescence globally.
- OCO-3 will use an improved sampling strategy to provide highly accurate measurements of carbon dioxide concentrations, including the ability to explore daily variations in carbon dioxide at a regional scale—as they relate to changes in urban population and fossil fuel use—to improve understanding of the carbon cycle.[55]

[51]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[52]Pub. L. No. 106-391, tit. III, § 315(a)(1) (Oct. 30, 2000).

[53]NASA worked with international research institutions and private sector partners for the original OCO mission that failed in 2009. The OCO-3 mission will use the OCO-2 mission's spare spectrometer, which was based on the original OCO design.

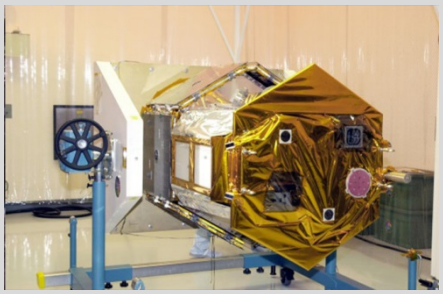
[54]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[55]Eldering et. al., *The OCO-3 Mission: Overview of Science Objectives and Status*, Geophysical Research Abstracts, Vol. 18, EGU2016-5189 (2016).

14. Solar Radiation and Climate Experiment (SORCE)

The National Aeronautics and Space Administration's (NASA) SORCE measures solar radiation properties to better understand solar variability and its effects.

Program Snapshot



Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

SORCE is located in NASA's Earth Systematic Missions in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Goddard Space Flight Center provides scientific and management oversight and support.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

To measure solar radiation to better understand solar variability and its climate effects.

Program Status:

Operational since 2003.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

SORCE is part of NASA's Earth Science program, which was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[56]

Coordination:

SORCE is a joint partnership between NASA and the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) in Boulder, Colorado. LASP designed, built, and tested the scientific instruments. LASP also processes and distributes SORCE data.[57] At the division level, NASA Earth Science collaborates directly with the National Oceanic and Atmospheric Administration (NOAA), and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[58]

Examples of program activities:

SORCE mission efforts include:

- Developing and launching a satellite with four instruments to measure the wavelengths of incoming solar radiation (e.g., x-ray, ultraviolet, visible, and near-infrared) and total solar radiation.
- Improving the precision of previous solar radiation measurements and continuing the long-term data record of solar observations.[59]

Provided data to help estimate past and future solar behavior and climate response and inform research on long-term climate change, natural variability and enhanced climate prediction, as well as atmospheric ozone and ultraviolet radiation.

[56]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[57]Goddard Space Flight Center, *NASA Facts: Solar Radiation and Climate Experiment (SORCE)*, FS-2002-12-052-GSFC. Goddard Earth Sciences Data and Information Services Center archives SORCE data.

[58]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[59]SORCE was designed to operate from 2003 to 2009, but has continued operating beyond its planned lifespan.

15. Total Solar Irradiance Sensor-1 (TSIS-1)

The National Aeronautics and Space Administration's (NASA) TSIS-1 continues SORCE's mission measuring solar radiation properties to better understand solar variability and its effects.

Program Snapshot

Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

TSIS-1 is located in NASA's Earth Systematic Missions in its Earth Science Division, which is part of NASA's Science Mission Directorate. NASA's Goddard Space Flight Center manages and oversees the project.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

To measure solar radiation to understand solar variability and its climate effects.

Program Status:

Launched successfully in December 2017. Instruments powered on in March 2018.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

TSIS-1 is part of NASA's Earth Science program, which was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[60]

Coordination:

TSIS-1 is a joint partnership between NASA and the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) in Boulder, Colorado. LASP designed, built, and tested the instruments, and will process the data. At the division level, NASA Earth Science collaborates directly with the National Oceanic and Atmospheric Administration (NOAA), and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[61]

Examples of program activities:

TSIS-1 mission efforts include:

- Developing and launching two instruments to the International Space Station to measure incoming solar radiation properties and total solar radiation.
- Improving the precision of SORCE's solar radiation measurements and continuing the long-term data record of solar observations.[62]
- Data can be used to study the sun's influence on the ozone layer, atmospheric circulation, clouds, and ecosystems. These measurements are also critical to understanding current and future climate conditions.[63]

[60]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[61]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[62]To bridge the potential data gap between the aging SORCE satellite and the TSIS-1 mission, NASA developed the Total Solar Irradiance Calibration Transfer Experiment using spare parts, which was launched in 2013 as part of the Air Force Space Test Program Satellite, to help calibrate measurements between SORCE and TSIS-1.

[63]NASA, *TSIS-1: Measuring the Sun's Energy Input to Earth,* accessed at https://www.nasa.gov/sites/default/files/atoms/files/tsis_fact_sheet-042617-v1.pdf.

16. Total Solar Irradiance Sensor-2 (TSIS-2)

The National Aeronautics and Space Administration's (NASA) TSIS-2 will continue TSIS-1's mission measuring solar radiation properties to better understand solar variability and its effects.

Program Snapshot

Federal Agency:

National Aeronautics and Space Administration (NASA)

Administering Agency and Relevant Offices:

TSIS-2 is located in NASA's Earth Systematic Missions in its Earth Science Division, which is part of NASA's Science Mission Directorate.

Program focus:

Climate observing.

Grant eligibility:

Not applicable.

Intended Benefits:

To measure solar radiation to understand solar variability and its climate effects.

Program Status:

Projected launch in 2022.

Sources: GAO analysis of NASA program documents (text); NASA (image). | GAO-18-223

TSIS-2 is part of NASA's Earth Science program, which was established in response to a requirement in the National Aeronautics and Space Administration Authorization Act, Fiscal Year 1993.[64]

Coordination:

NASA has contracted with the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) in Boulder, Colorado for a study on two compact instruments for TSIS-2. At the division level, NASA Earth Science collaborates directly with the National Oceanic and Atmospheric Administration (NOAA), and with other federal agencies through the U.S. Global Change Research Program and interagency working groups.[65]

Examples of program activities:

TSIS-2 mission efforts will include:

- Developing and launching two instruments to the International Space Station to measure incoming solar radiation properties and total solar radiation.
- Sustain TSIS-1's mission to continue the long-term data record of solar observations.
- Data may be used to study the sun's influence on the ozone layer, atmospheric circulation, clouds, and ecosystems. These measurements are also critical to understanding current and future climate conditions.[66]

[64]Pub. L. No. 102-588, tit. I, § 102(g) (Nov. 4, 1992).

[65]For example, under the NTSC, NASA is a member of the Committee on Environment, Natural Resources, and Sustainability, and the former Council on Climate Preparedness and Resilience. NASA also has a leadership role in the Working Group on Ocean Acidification. NASA coordinates with international and commercial partners through its data system communities, such as the Committee on Earth Observation Satellites.

[66]NASA, *TSIS-1: Measuring the Sun's Energy Input to Earth,* accessed at https://www.nasa.gov/sites/default/files/atoms/files/tsis_fact_sheet-042617-v1.pdf.

17. Agroclimatology

The U.S. Department of Agriculture's (USDA) Agroclimatology (formerly Global Change, Ultraviolet Monitoring and Research Program) supports an ultraviolet radiation observing network, and uses the data to inform climate forecasting models and assess ultraviolet radiation effects.

Program Snapshot

Federal Agency:

U.S. Department of Agriculture's National Institute for Food and Agriculture (NIFA)

Administering Agency and Relevant Offices:

Colorado State University's Natural Resource Ecology Laboratory administers the program. NIFA's Division of Agricultural Systems, within its Institute of Food Production and Sustainability, provides grant funding and oversight.

Program focus:

Climate observing.

Grant eligibility:

Land-grant institutions, among others.

Intended Benefits:

To improve understanding of ultraviolet radiation impacts and climate change on agriculture. Other applications include atmospheric, biological, ecological, human health and materials sciences.

Program Status:

Active.

Sources: GAO analysis of USDA program documents (text); USDA photo by Jack Dykinga (image). | GAO-18-223

USDA established the Ultraviolet Monitoring and Research Program in 1992 pursuant to the Competitive, Special, and Facilities Research Grant Act.[67]

Coordination:

The program is affiliated with other academic facilities, including the joint NASA – University of Maryland Earth System Science Interdisciplinary Center.[68] USDA's National Institute for Food and Agriculture (NIFA) coordinates with several other USDA agencies, such as the Agricultural Research Service.[69] NIFA also collaborates with other federal agencies, contributes to the U.S. Global Change Research Program, and participates in interagency working groups.[70]

Examples of program activities:

Program efforts include:

- Observing ultraviolet radiation and photosynthetically-active radiation through a network of 38 sites that provide the only source of long-term surface measurements of ultraviolet radiation.[71]
- Studying ultraviolet radiation effects and assessing the combined effect of ultraviolet radiation with other climate stress factors, such as moisture, temperature, and carbon dioxide.
- Developing modeling tools that integrate observing data, ultraviolet effects studies, and satellite observations to study how climate and crop production interact and associated effects on management practices and agricultural economics.

[67]Pub. L. No. 89-106, § 2 (Aug. 4, 1965) (*codified as amended at* 7 U.S.C. § 3157). According to agency documents, USDA established the Ultraviolet Monitoring and Research Program to measure ultraviolet radiation levels over wide geographic areas of the United States and to assess the impact of ultraviolet radiation on crops, plants, animals, and ecosystems.

[68]The program is also affiliated with the Soil-Plant-Atmosphere-Research Facility at Mississippi State University.

[69]NIFA coordinates with USDA's Forest Service and USDA's Natural Resources Conservation Service, among others.

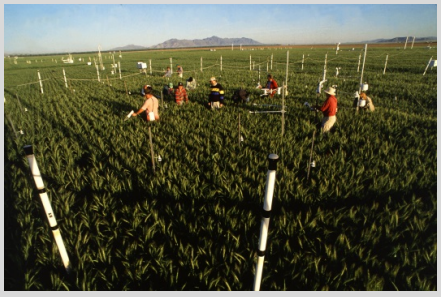
[70]For example, NIFA collaborates with Commerce, DOD, DOE, Interior, EPA, and NSF, among others. Under the interagency National Science and Technology Council, USDA is a member of the Committee on Environment, Natural Resources, and Sustainability.

[71]Data users have included researchers from about 134 academic institutions, 51 state and federal agencies, 15 international agencies, and 42 commercial enterprises, among others.

18. Climate Change Program Office (CCPO)

The U.S. Department of Agriculture's (USDA) CCPO coordinates agricultural, rural and forestry-related climate change program and policy issues department-wide.

Program Snapshot



Federal Agency:

U.S. Department of Agriculture (USDA)

Administering Agency and Relevant Offices:

CCPO is located within USDA's Office of the Chief Economist, in USDA's Office of the Secretary.

Program focus:

Climate adaptation.

Grant eligibility:

Not applicable.

Intended Benefits:

To provide leadership, support and coordination across USDA agencies in helping the US agriculture and forestry sectors assess and manage greenhouse gas emissions as well as prepare for and adapt to climate change.

Program Status:

Active.

Sources: GAO analysis of USDA program documents (text); USDA photo by Jack Dykinga (image). | GAO-18-223

USDA created the CCPO in 2010 within the Office of the Chief Economist.[72]

Coordination:

CCPO coordinates climate change program and policy issues department-wide.[73] CCPO is USDA's focal point for climate change with other federal agencies, the U.S. Global Change Research Program, and interagency working groups.[74]

Examples of program activities:

CCPO's efforts include:

- Leading USDA adaptation planning efforts to identify how climate change may affect USDA's mission and to ensure adaptation is integrated into USDA programs, policies and operations.
- Publishing the greenhouse gas inventory for agriculture and forestry, in conjunction with other USDA and external partners.
- Representing USDA and coordinating USDA participation and technical support for interagency working groups and international meetings.
- Providing data, tools and information to assist land managers, stakeholders and USDA agencies to prepare for relevant climate change impacts, such as changes in water availability and wildfires, with adaptation assessments, planning and implementation, as well as guidance for measuring greenhouse gas emissions.

[72]Prior to 2010, USDA's Global Change Program Office facilitated the agency's participation in the U.S. Climate Change Science Program and the U.S. Climate Change Technology Program, according to USDA's fiscal year 2010 budget justification.

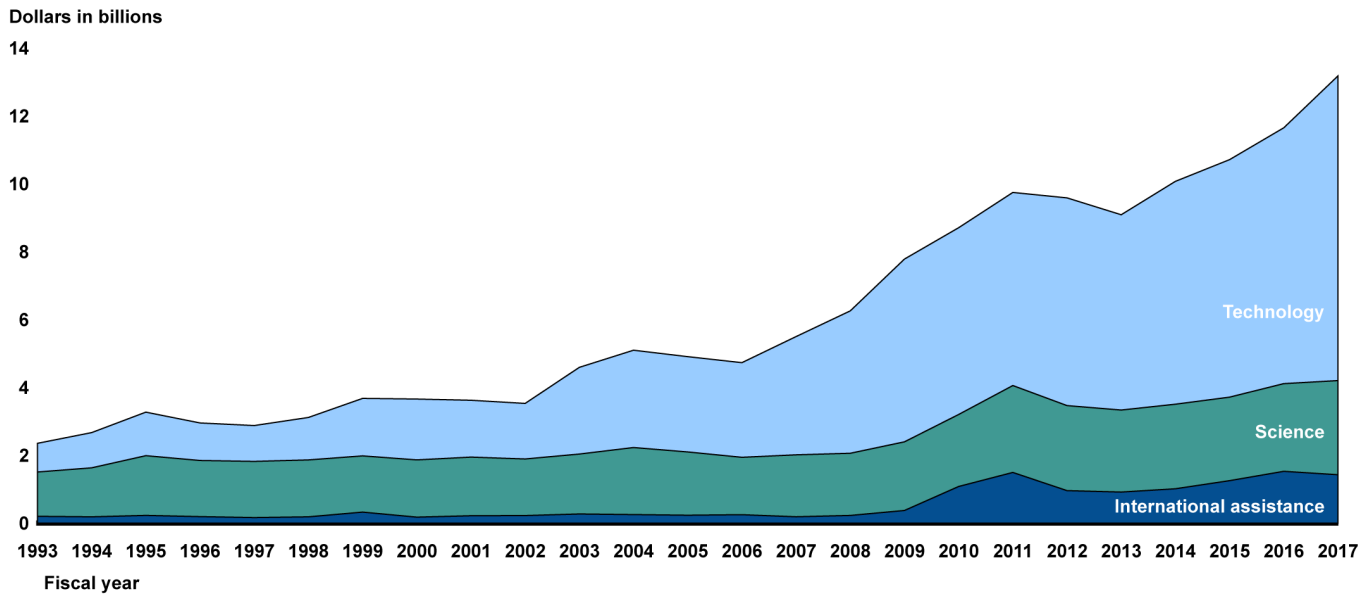
[73]For example, CCPO's Director served as the Chair of USDA's Global Change Task Force, which included representatives from twenty USDA agencies and offices.

[74]Under the interagency National Science and Technology Council, USDA is a member of the Committee on Environment, Natural Resources, and Sustainability, among others.

Appendix II: OMB-Reported Climate Change Funding Since 1993

As reported by OMB, federal funding for climate change research, clean energy technology, international assistance, and adaptation in nominal dollars has increased from about $2.4 billion in fiscal year 1993 to about $13.2 billion in proposed budget authority for fiscal year 2017, with an additional $26.1 billion for climate change programs and activities provided by the American Recovery and Reinvestment Act of 2009.[1] As shown in figure 2, the Office of Management and Budget (OMB) has reported federal climate change funding in three main categories since 1993—clean energy technology to reduce emissions, science to better understand climate change, and international assistance for adaptation, clean energy, and sustainable landscapes.

Figure 2: OMB-Reported Federal Climate Change Funding by Category, from Fiscal Years 1993 through 2017



Source: GAO analysis of Office of Management and Budget (OMB) reports. | GAO-18-223

Note: The figure presents actual budget authority except for fiscal years 2011, 2013, and 2017. For fiscal years 2011 and 2017, OMB reported proposed budget authority. For fiscal year 2013, OMB reported final operating level funding. Funding is reported in nominal dollars, which are not adjusted for inflation.

[1]When adjusted for inflation, reported climate change funding increased from $3.6 billion in 1993 to $12.9 billion in the proposed budget authority for 2017.

OMB has also reported on federal funding for wildlife and natural resource adaptation from fiscal years 2010 through 2013. However, the data OMB reported in the adaptation category does not fully represent adaptation funding as it only includes data from the Department of the Interior. OMB reports Department of the Interior funding for adaptation as follows: fiscal year 2010 $65 million, fiscal year 2011 $87 million, fiscal year 2012 $88 million. We did not include funding for this category in 2013 because we used OMB's fiscal year 2017 report for 2013 funding, and OMB did not report funding under this category in its 2017 report.

Funding in the American Recovery and Reinvestment Act of 2009 (Pub. L. No. 111-5 (Feb. 17, 2009)) and tax expenditures related to climate change are not included in this figure to maintain comparability with earlier GAO reports.

Appendix III: Climate Change Funding by Category as Reported by the Office of Management and Budget (OMB) from Fiscal Years 1993 through 2017

Dollars in millions

Funding Category	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Technology	845	1,038	1,283	1,106	1,056	1,251	1,694	1,793	1,675	1,637	2,555	2,868	2,808	2,789	3,485	4,196	5,386	5,504	5,690	6,121	5,755	6,567	6,999	7,539	8,978
Science	1,306	1,444	1,760	1,654	1,656	1,677	1,657	1,687	1,728	1,667	1,766	1,976	1,864	1,691	1,825	1,832	2,023	2,122	2,561	2,506	2,417	2,492	2,461	2,584	2,775
International Assistance[a]	201	186	228	192	164	186	325	177	218	224	270	252	234	249	188	227	373	1,080	1,494	958	916	1,013	1,252	1,527	1,426
Natural Resources Adaptation[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	65	87	88	—	—	—	—	—
Adjustments for programs included in multiple categories	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	*(24)*	*(26)*	*(27)*	*(23)*	*(23)*	*(26)*
Total	**2,352**	**2,668**	**3,271**	**2,952**	**2,876**	**3,114**	**3,535**	**3,511**	**3,603**	**3,522**	**4,584**	**5,090**	**5,269**	**5,876**	**5,498**	**6,255**	**7,782**	**8,771**	**9,832**	**9,649**	**9,062**	**10,045**	**10,689**	**11,627**	**13,153**

Source: GAO analysis of Office of Management and Budget (OMB) reports. | GAO-18-223

Notes: Dashes indicate that OMB did not report a value for the account for that year.

Totals may not add due to rounding.

The table presents actual budget authority except for fiscal years 2011, 2013, and 2017. For fiscal years 2011 and 2017, OMB reported proposed budget authority. For fiscal year 2013, OMB reported final operating level funding. Funding is reported in nominal dollars, which are not adjusted for inflation.

Funding from the American Recovery and Reinvestment Act of 2009 (Pub. L. No. 111-5 (Feb. 17, 2009)) and tax expenditures related to climate change are not included in this table to maintain comparability with earlier GAO reports.

[a]International Assistance includes congressionally appropriated assistance by core agencies (i.e. Department of State, Department of Treasury, U.S. Agency for International Development), as well as complementary agencies (e.g. Environmental Protection Agency), but does not include indirect climate assistance nor development finance and export credit agencies. Additionally, the International Assistance total contains funds that are also counted in the Science and Technology totals. Table total line excludes this double count.

[b]In fiscal year 2010 through 2013, OMB reported the Department of the Interior funding for adaptation under interim categories called "wildlife adaptation" and “natural resources adaptation,” while the administration developed criteria to systematically account for a broader suite of adaptation programs. However, the data OMB reported in the adaptation category does not fully represent adaptation as it only includes data from the Department of the Interior. We did not include funding for this category in 2013 because we used OMB’s fiscal year 2017 report for 2013 funding, and OMB did not report funding under this category in its 2017 report.

Appendix IV: Climate Change Funding by Agency as Reported by the Office and Management and Budget (OMB), from Fiscal Years 1993 through 2017

Dollars in millions

Agency	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Department of Agriculture	55	56	60	52	57	53	138	132	54	59	104	116	110	110	109	116	322	567	426	394	274	517	418	405	446
Department of Commerce	66	63	120	113	102	89	93	91	93	100	156	144	146	253	258	286	392	378	455	359	349	384	367	337	397
Department of Defense	—	—	—	—	—	—	—	—	—	—	83	51	59	77	101	176	261	226	143	481	458	469	486	618	643
Department of Energy	963	1,113	1,173	1,008	968	1,186	1,536	1,652	1,665	1,636	2,214	2,519	2,469	2,504	3,158	3,791	4,711	4,564	5,074	4,599	4,404	4,931	5,410	5,844	7,058
Department of Health and Human Services	—	—	—	—	—	35	40	47	54	56	61	62	57	50	47	4	5	4	4	14	10	8	8	8	8
Department of Housing and Urban Development	—	—	—	—	—	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—	0	0	<0.5	7	7
Department of Interior	22	29	27	26	26	26	27	27	27	26	29	29	29	27	27	34	45	128	168	147	55	54	58	57	63
Department of State	1	1	1	3	3	5	7	7	7	7	6	6	7	12	41	59	55	199	149	133	126	127	147	595	632
Department of Transportation	—	—	5	6	13	5	3	—	—	—	27	9	3	17	18	20	45	128	80	92	67	39	28	41	54
Department of Treasury	0	12	35	14	14	18	60	14	54	43	56	52	44	46	46	46	46	421	744	377	380	356	346	331	350
Environmental Protection Agency	26	73	124	114	99	103	126	124	146	136	124	127	130	128	121	131	139	164	172	144	137	135	145	150	170
Millennium Challenge Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	25	41	0	103	352	219	0
National Aeronautics and Space Administration	888	999	1,305	1,218	1,218	1,210	1,155	1,161	1,176	1,090	1,299	1,548	1,449	1,082	1,223	1,221	1,205	1,195	1,422	1,686	1,682	1,744	1,780	1,872	1,965
National Science Foundation	124	142	222	216	222	214	222	229	181	189	212	226	209	215	230	229	293	348	403	680	668	686	703	712	861
Nuclear Regulatory Commission	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	83	68	91	69	86	90
Peace Corps	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12	12	12	12	12
Smithsonian Institution	7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	6	7	11	8	8	8	8	8	9
Tennessee Valley Authority	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	11	10	10	10	16
U.S. Agency for International Development	200	173	192	175	147	163	236	156	157	179	214	195	183	190	114	136	222	383	491	348	334	351	331	304	352
U.S. Trade and Development Agency	—	—	—	—	—	—	16	—	—	—	—	—	—	—	—	—	10	17	21	16	19	22	27	32	42
Total	**2,352**	**2,668**	**3,271**	**2,952**	**2,876**	**3,114**	**3,535**	**3,511**	**3,603**	**3,522**	**4,584**	**5,090**	**4,900**	**4,716**	**5,499**	**6,255**	**7,757**	**8,731**[a]	**9,788**	**9,649**	**9,062**	**10,045**	**10,689**	**11,627**	**13,156**

Source: GAO analysis of Office of Management and Budget (OMB) reports. | GAO-18-223

Notes: Dashes indicate that OMB did not report a value for the account for that year. Zeros indicate the funding that OMB reported for the agency for that year.

Totals may not add due to rounding.

The table presents actual budget authority except for fiscal years 2011, 2013, and 2017. For fiscal years 2011 and 2017, OMB reported proposed budget authority. For fiscal year 2013, OMB reported final operating level funding. Funding is reported in nominal dollars, which are not adjusted for inflation.

[a]Total 2010 funding of $8.731 billion as presented by OMB and reported in this appendix does not match the total of $8.771 billion presented in appendixes III and V. In its June 2010 report that presented these data, OMB noted that totals may not add due to rounding and subtraction of double-counts.

Appendix V: Climate Change Funding by Line Item as Reported by the Office and Management and Budget (OMB), from Fiscal Years 1993 through 2017

Dollars in millions

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
TECHNOLOGY																										
Direct Technology																										
Department of Agriculture	—	—	—	—	—	—	0	0	3	3	42	45	48	49	48	51	271	453	0	265	275	164	400	319	306	319
Agricultural Research Service	—	—	—	—	—	—	0	—	0	—	2	2	2	2	2	2	5	5	0	1	—	—	—	—	—	—
Salaries and Expenses[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33	32	32	33	30	31
Bioenergy Research[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—
Rural Business Service																										
Renewable Energy Program	—	—	—	—	—	—	—	—	—	0	22	23	23	23	23	—	—	—	—	—	—	—	—	—	—	—
Value Added Producer Grants (Cooperative Development Grants)[c]	—	—	—	—	—	—	—	—	—	—	—	—	2	3	3	5	6	4	0	4	1	1	6	1	1	1
Rural Energy For America[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36	5	39	0	39	3	3	53	48	47	69
Biorefinery Assistance Program[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	17	—	—	—	—	—	—
Biorefinery Program for Advanced Biofuels[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55	55	0	—	—	—	—	—	—	—
Forest Service																										
Forest and Rangeland Research	—	—	—	—	—	—	0	0	3	—	1	0	2	2	2	1	1	5	0	—	—	0	6	6	6	6

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Research and Development —Inventories of Carbon Biomass	—	—	—	—	—	—	—	—	—	—	1	0	1	1	1	—	—	—	—	—	—	—	—	—	—	—
Biofuels/ Biomass, Forest and Rangeland Research[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	—	—	—
Commercialization / Renewable Energy[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26	22	21	20	26	26
Natural Resources Conservation Service																										
Carbon Cycle	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	0	9	7	0	7	—	—	—	—	—	—
Biomass Research and Development	—	—	—	—	—	—	—	—	—	3	14	14	13	14	14	0	—	—	—	—	—	—	—	—	—	—
Conservation Operations[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Farm Security and Rural Investment Programs[b,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	16	14	13	13	13	13
Cooperative State Research, Education and Extension Service																										
Biofuels/ Biomass Research, Formula Funds, National Research Initiative	—	—	—	—	—	—	—	—	—	—	3	5	5	3	3	5	5	5	0	5	—	—	—	—	—	—
Office of the Chief Economist																										
Methane to Markets[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	—	—	—	—	—	—	—	—	—	—	—
Salaries and Expenses[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	3	5	2	2	2

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
National Agricultural Statistics Service[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	—	—	—	—	—	—	—
Rural Business Service																										
Rural Energy For America[c,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	55	60	0	70	22	0	0	0	0	0
Repowering Assistance Program[c,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	35	0	0	0	—	—	—	—	—	—
Biorefinery Assistance Program[c,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	75	245	0	0	—	0	100	30	27	0
Energy Assistance Payments (formerly titled Bioenergy Program for Advanced Biofuels)[b,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	85	65	0	27	14	15	15
Rural Business Cooperative Service[b]																										
Guaranteed Business and Industry Loans[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	5	7	8	4	4
Rural Economic Development Loans[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	< 0.5	0	< 0.5	< 0.5	1
National Institute of Food and Agriculture																										
Biomass Research and Development[c,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	20	28	0	28	40	0	3	3	3	3
Research and Education Activities[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	31	56	49	53	48	67
Economic Research Service[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	2	2	2	2
Rural Utilities Service[b]																										
High Cost Energy Grants[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	4	4	8	10	0

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Rural Energy Savings Program Account (Rural Energy for America Sec. 9007)[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	8	0
Farm Service Agency																										
Biomass Crop Assistance Program[b,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	0	25	23	3	25
Commodity Credit Corporation[b,d]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	22	47	56	60	54
Department of Commerce	—	—	—	—	—	—	—	—	—	—	—	—	26	18	22	14	15	18	4	18	40	48	55	55	54	55
National Institutes of Standards and Technology	—	—	—	—	—	—	—	—	—	—	40	28	26	18	—	—	—	—	—	—	—	—	—	—	—	—
Industrial Technical Services—Advanced Technology Program	—	—	—	—	—	—	—	—	—	—	30	18	8	10	6	4	7	15	4	—	—	—	—	—	—	—
Industrial Technical Services—Technology Innovation Program[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Scientific and Technical Services Research Services	—	—	—	—	—	—	0	2	—	—	10	10	18	8	—	—	—	—	—	15	40	48	54	54	54	54
International Trade Administration																										
Operations and Administration[c]	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	2	2	2	0	2	—	—	—	—	—	—

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
National Oceanic and Atmospheric Administration Operations[b]																										
Research and Facilities[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	1	1	1	0	1
Department of Defense	—	—	—	—	—	—	—	—	—	—	83	51	59	77	101	176	261	226	139	143	481	458	469	486	618	643
Research, Development, Test and Evaluation, Army	—	—	—	—	—	—	—	—	—	—	45	15	27	49	69	98	98	93	44	28	32	34	37	36	32	38
Research, Development, Test and Evaluation, Navy	—	—	—	—	—	—	—	—	—	—	16	17	18	17	13	44	54	13	18	11	231	176	210	194	124	152
Research, Development, Test and Evaluation, Air Force	—	—	—	—	—	—	—	—	—	—	3	1	1	0	13	34	108	120	35	104	118	205	181	216	427	418
Research, Development, Test and Evaluation, Defense-wide	—	—	—	—	—	—	—	—	—	—	19	19	13	11	6	0	0	0	42	0	101	43	41	40	35	36
Defense Advanced Research Projects Agency[c]	—	—	—	—	—	—	—	—	—	—	—	17	11	7	6	—	—	—	—	—	—	—	—	—	—	—
Office of the Secretary of Defense[c]	—	—	—	—	—	—	—	—	—	—	—	2	2	4	0	—	—	—	—	—	—	—	—	—	—	—
Department of Energy	595	753	829	683	658	729	890	980	1,050	1,519	2,099	2,390	2,342	2,374	3,032	3,663	4,543	4,399	25,223	4,883	4,388	4,195	4,714	5,196	5,606	6,816
Energy Conservation	—	—	—	—	—	—	—	—	—	897	880	868	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy Conservation Research and Development	346	435	468	415	414	457	518	577	619	622	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
State Energy Grants	—	—	—	—	—	—	—	—	—	45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Weatherization	—	—	—	—	—	—	—	—	—	230	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy Supply / Energy Supply and Conservation	249	318	361	268	244	272	332	315	375	400	667	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Nuclear Energy Research Initiative	—	—	—	—	—	—	—	—	—	32	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Electricity / Electricity Supply and Distribution / Electricity Delivery and Energy Reliability	—	—	—	—	—	—	—	—	—	—	88	73	57	77	120	130	113	109	4340	143	133	123	140	140	196	226
Renewables	249	318	361	268	244	272	332	310	370	368	322	352	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nuclear	—	—	—	—	—	—	0	5	5	—	257	309	291	343	513	682	787	747	0	793	772	738	873	884	936	912
Energy Efficiency and Renewable Energy[c]	—	—	—	—	—	—	—	—	—	—	—	—	1,234	1,166	1,411	1,722	2,179	2,242	16,800	2,355	1,819	1,772	1,913	1,937	2,073	2,898
Fossil Energy Research and Development	—	—	—	—	—	—	24	52	18	184	253	455	374	397	493	611	762	560	3,400	—	—	—	—	—	—	—
Sequestration Research and Development	—	—	—	—	—	—	—	—	—	32	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Greenhouse Gas Emission Reduction	—	—	—	—	—	—	—	—	—	152	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Efficiency and Sequestration[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	545	—	—	—	—	—	—
Carbon Capture and Storage and Power Systems[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	472	436	490	503	533	564
Science	—	—	—	—	—	—	13	33	35	35	298	333	386	391	487	512	700	723	283	—	—	—	—	—	—	—
Sequestration	—	—	—	—	—	—	—	—	—	32	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fusion, Sequestration, and Hydrogen[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	738	902	859	1,007	1,441	1,578	1,853
Energy Information Administration	—	—	—	—	—	—	3	3	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Departmental Administration—Climate Change Technology Program Direction[c]	—	—	—	—	—	—	—	—	—	—	—	0	0	0	1	1	2	9	0	9	—	—	—	—	—	—
Innovative Technology Loan Guarantee Program[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	0	7	5	—	—	—	—	—	—	—	—	—	—
Advanced Research Projects Agency	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy (ARPA-E)[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	9	0	300	275	251	280	281	291	350
Energy (ARPA-E) Recovery Act[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	400	0	—	—	—	—	—	—
Bonneville Power Administration Fund[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	17	10	10	0	13
Race to the Top for Energy Efficiency and Grid Modernization[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0
HomeStar[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0
Energy Security Trust[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	0	0
Environmental Protection Agency	—	43	102	96	86	90	109	103	123	115	102	110	110	109	105	114	111	133	0	140	117	111	108	120	122	139
Environmental Programs and Management	—	35	91	81	70	73	72	76	96	89	82	89	91	90	92	97	94	113	0	123	99	95	100	95	95	108
Science and Technology	—	8	11	15	16	17	37	27	27	26	20	22	19	19	13	17	17	20	0	17	18	16	8	9	8	11
Department of Housing and Urban Development	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.5	7	7
Research and Technology	—	—	—	—	—	—	10	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Management and Administration--Transformation Initiative[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	3	3
Policy Development and Research--Research and Technology[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.5	7	7

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Department of Interior																										
U.S. Geological Survey—Surveys, Investigations and Research—Geology Discipline, Energy Program	—	—	—	—	—	—	—	—	—	—	1	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—
National Aeronautics and Space Administration	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	287	313	363	338	348
Exploration, Science & Aeronautics	—	—	—	—	—	—	—	—	—	—	152	227	208	129	139	137	119	124	31	137	—	—	—	—	—	—
Aeronautics[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	259	255	282	323	305	321
Exploration[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	6	5	5	3	4
Space Technology[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28	25	26	36	29	23
National Science Foundation																										
Research and Related Activities	—	—	—	—	—	—	—	—	—	—	9	11	11	18	21	22	24	26	2	27	341	346	370	370	372	512
Department of Transportation	—	—	—	—	—	—	—	—	—	—	27	5	2	16	17	19	43	125	100	77	91	67	39	27	40	54
Federal Transit Administration																										
Capital Investment Grants	—	—	—	—	—	—	—	—	—	—	26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Research and University Centers and Formula and Bus Grants[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	14	16	18	19	94	100	53	52	33	0	0	0	0
Office of the Secretary of Technology																										
Transportation, Policy, Research and Development	—	—	—	—	—	—	—	—	—	—	1	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Research and Special Programs Administration																										
Research and Special Programs	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
National Highway Traffic Safety Administration	—	—	—	—	—	—	—	—	—	—	—	0	< 0.5	1	1	1	0	1	0	0	10	8	10	0	11	12
Research and Innovative Technology Administration																										
Research and Development	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1
Federal Highways Administration																										
Federal-aid Highways[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19	19	0	19	—	—	—	—	—	—
Federal Aviation Administration																										
Research, Engineering, and Development[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	11	0	5	21	20	21	22	25	25
Facilities and Equipment[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	4	6	4	0	0
Federal Railroad Association																										
Railroad Research and Development[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	0	3	15
Pipelines and Hazardous Materials Safety Administration																										
Hazardous Materials Safety[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
Nuclear Regulatory Commission																										
Salaries and Expenses[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	83	68	91	69	86	90

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Tennessee Valley Authority[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	11	10	10	10	16
Direct Technology Total	**595**	**796**	**931**	**779**	**744**	**819**	**1,009**	**1,095**	**1,176**	**1,637**	**2,555**	**2,868**	**2,808**	**2,789**	**3,485**	**4,196**	**5,386**	**5,504**	**25,499**	**5,690**	**6,121**	**5,755**	**6,567**	**6,999**	**7,539**	**8,978**
National Climate Change Technology Initiative[c]																										
Department of Energy	—	—	—	—	—	—	—	—	—	—	—	—	162	289	—	—	—	—	—	—	—	—	—	—	—	—
Energy Supply and Conservation																										
Energy Efficiency and Renewable Energy[c]	—	—	—	—	—	—	—	—	—	—	—	—	65	66	—	—	—	—	—	—	—	—	—	—	—	—
Nuclear[c]	—	—	—	—	—	—	—	—	—	—	—	—	9	102	—	—	—	—	—	—	—	—	—	—	—	—
Fossil Energy Research and Development																										
Efficiency and Sequestration[c]	—	—	—	—	—	—	—	—	—	—	—	—	89	121	—	—	—	—	—	—	—	—	—	—	—	—
Departmental Administration																										
Climate Change Technology Program Direction[c]	—	—	—	—	—	—	—	—	—	—	—	—	0	0	—	—	—	—	—	—	—	—	—	—	—	—
Environmental Protection Agency																										
Environmental Programs and Management[c]	—	—	—	—	—	—	—	—	—	—	—	—	11	10	—	—	—	—	—	—	—	—	—	—	—	—
National Climate Change Technology Initiative Total	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**173**	**299**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Indirect Technology																										
Department of Energy	250	242	231	212	201	351	417	434	499	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fossil Energy Research and Development	250	242	231	212	201	196	233	242	274	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Coal-Efficient Combustion & Utilization	186	166	144	120	101	105	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Natural Gas--Efficient Combustion & Utilization	64	76	87	92	100	91	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy Supply																										
Nuclear Energy Research and Development	—	—	—	—	—	0	18	22	34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy Conservation Research and Development																										
Weatherization & State Energy Grants	—	—	—	—	—	155	166	169	191	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Biobased Products & Bioenergy	—	—	—	—	—	—	195	200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Department of Agriculture	—	—	—	—	—	—	86	76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Agriculture Research Service	—	—	—	—	—	—	44	46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cooperative State Research, Education, & Extension Service																										
Research and Education Assistance	—	—	—	—	—	—	11	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Initiative for Future Agriculture & Food Systems	—	—	—	—	—	—	—	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Forest Service																										
Forest and Rangeland Management	—	—	—	—	—	—	9	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Executive Operations	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Departmental Administration	—	—	—	—	—	—	< 0.5	< 0.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Alternative Agricultural Research and Commercialization	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Natural Resources Conservation Service																										
Forestry Incentives Program	—	—	—	—	—	—	16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Rural Development																										
Rural Community Advancement Program	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Department of Energy	—	—	—	—	—	—	109	124	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy Supply																										
Solar and Renewable Energy Research and Development	—	—	—	—	—	—	40	70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy Conservation Research and Development	—	—	—	—	—	—	41	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Fossil Energy Research and Development	—	—	—	—	—	—	0	13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Science (Basic Science)	—	—	—	—	—	—	27	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Partnership for a New Generation of Vehicles	—	—	—	—	—	—	73	64	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Department of Commerce	—	—	63	56	42	29	30	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Under Secretary for Technology / Office of Technology Policy	—	—	—	—	—	—	1	0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salaries and Expenses	—	—	0	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
National Institutes of Standards and Technology	—	—	—	—	—	—	29	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Scientific and Technical Research and Services	—	—	—	7	7	7	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Industrial Technology Services	—	—	—	56	48	34	22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
National Science Foundation																										
Research and Related Activities	—	—	53	53	56	47	40	42	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Department of Transportation																										
National Highway Traffic Safety Administration (and FTA prior to FY 1999)																										
Operations and Research	—	—	5	6	13	5	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Indirect Technology Total	**250**	**242**	**352**	**327**	**312**	**432**	**685**	**698**	**499**	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]	[e]
Technology Total	**845**	**1,038**	**1,283**	**1,106**	**1,056**	**1,251**	**1,694**	**1,793**	**1,675**	**1,637**	**2,555**	**2,868**	**2,808**	**2,789**	**3,485**	**4,196**	**5,386**	**5,504**	**25,499**	**5,690**	**6,121**	**5,755**	**6,567**	**6,999**	**7,539**	**8,978**

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
SCIENCE																										
U.S. Global Change Research Program																										
Department of Agriculture	55	56	60	52	57	53	52	56	51	56	60	70	62	61	61	65	47	109	0	157	116	108	115	97	98	124
Agricultural Research Service	17	18	24	24	26	27	26	28	29	30	35	37	38	38	40	39	20	20	0	22	36	38	38	45	45	65
Cooperative State Research, Education, & Extension Services																										
Research and Education	11	12	10	10	12	7	7	9	4	9	8	16	5	4	2	4	—	—	—	—	—	—	—	—	—	—
Economic Research Service	1	1	1	1	1	1	1	1	1	<0.5	0	0	0	0	0	0	0	1	0	1	2	2	2	1	2	3
Natural Resources Conservation Services	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	2	3	3
Conservation Operations	2	2	2	2	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Forest Service																										
Forest and Rangeland Research	24	23	23	15	17	17	17	17	17	17	17	17	18	18	19	22	22	32	0	28	26	26	27	25	28	28
National Institute of Food and Agriculture[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	56	0	106	50	40	43	20	15	19
National Agricultural Statistics Service[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	1
Animal and Plant Health Inspection Service[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	< 0.5	< 0.5
Farm Service Agency[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	1	1
Office of Chief Economist[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3	3

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Department of Commerce	—	—	—	—	—	—	—	—	—	—	—	—	—	235	236	272	377	360	218	437	319	301	329	312	283	342
National Oceanic and Atmospheric Administration																										
Operations, Research, and Facilities	66	63	57	57	60	60	63	67	93	100	98	116	120	226	229	265	274	309	0	315	245	233	285	264	252	307
Procurement, Acquisition and Construction[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	9	7	7	101	49	218	120	69	64	40	44	28	31
National Institute of Standards and Technology	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	2	2	0	2	5	4	4	4	4	4
Department of Energy																										
Science—Biological & Environmental Research	118	118	113	113	109	106	114	114	116	117	112	129	127	130	126	128	168	165	65	191	211	209	217	214	238	242
Environmental Protection Agency																										
Science and Technology	26	30	22	18	13	13	17	21	23	21	22	17	20	19	16	17	18	21	0	22	18	17	18	16	19	22
Department of Health and Human Services	—	—	—	—	—	35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	10	8	8	8	8
National Institutes of Health	—	—	—	—	—	35	40	47	54	56	61	62	57	50	47	4	5	4	0	4	8	10	8	8	8	8
National Institute of Environmental Health Sciences	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
National Eye Institutes	—	—	—	—	—	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
National Cancer Institute	—	—	—	—	—	21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
National Institute of Arthritis and Musculoskeletal & Skin Diseases	—	—	—	—	—	< 0.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Centers for Disease Control and Prevention	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—	—	—	—
Department of the Interior																										
U.S. Geological Survey																										
Surveys, Investigations, and Research	22	29	27	26	26	26	27	27	27	26	28	28	27	27	27	34	45	63	0	81	59	55	54	58	57	63
National Aeronautics and Space Administration																										
Science, Aeronautics, and Technology	888	999	1,305	1,218	1,218	1,210	1,155	1,161	1,176	1,090	1,144	1,321	1,241	953	1,084	1,084	—	—	—	—	—	—	—	—	—	—
Science[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	1,086	1,071	237	1,285	1,390	1,395	1,431	1,417	1,534	1,617
National Science Foundation																										
Research and Related Activities	124	142	169	163	166	167	182	187	181	189	188	215	198	197	207	207	269	319	121	370	333	316	313	331	339	348
Smithsonian Institution																										
Salaries and Expenses	7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	6	7	0	11	8	8	8	8	8	9
Department of State																										
International Organizations and Programs[c]	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	39	—	—	—	—	—	—
Other- non-add[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3	3	—	—	—
Department of Transportation	—	—	—	—	—	—	—	—	—	—	—	4	1	1	1	1	2	3	0	3	1	1	1	1	1	1

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Federal Highways Administration																										
Federal-aid Highways[c]	—	—	—	—	—	—	—	—	—	—	—	4	1	< 0.5	< 0.5	1	< 0.5	0	0	0	0	0	0	0	0	0
Federal Aviation Administration																										
Research, Engineering, and Development[c]	—	—	—	—	—	—	—	—	—	—	—	0	< 0.5	< 0.5	< 0.5	< 0.5	2	3	0	3	1	1	1	1	1	1
Federal Transit Administration																										
Research and University Research Centers and Formula Bus Grants[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0	0	0	0	0	0	0	0
U.S. Agency for International Development																										
Development Assistance	—	—	—	—	—	—	—	—	—	6	6	6	6	13	14	14	17	36	0	43	—	—	—	—	—	—
Development Assistance- non-add[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	11	11	6	9	10
U.S. Global Change Research Program Total	**1,306**	**1,444**	**1,760**	**1,654**	**1,656**	**1,677**	**1,657**	**1,687**	**1,728**	**1,667**	**1,725**	**1,803**	**1,660**	**1,488**	**1,825**	**1,832**	**2,023**	**2,122**	**641**	**2,561**	**2,506**	**2,417**	**2,492**	**2,461**	**2,584**	**2,775**
Climate Change Research Initiative																										
Department of Agriculture	—	—	—	—	—	—	—	—	—	—	2	6	8	8	—	—	—	—	—	—	—	—	—	—	—	—
Agricultural Research Service	—	—	—	—	—	—	—	—	—	—	0	1	2	2	—	—	—	—	—	—	—	—	—	—	—	—
Forest Service																										
Forest and Rangeland Research	—	—	—	—	—	—	—	—	—	—	1	5	6	6	—	—	—	—	—	—	—	—	—	—	—	—
Department of Commerce																										

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
National Oceanic and Atmospheric Administration																										
Operations, Research, and Facilities	—	—	—	—	—	—	—	—	—	—	18	34	46	34	—	—	—	—	—	—	—	—	—	—	—	—
Department of Energy																										
Science—Biological & Environmental Research	—	—	—	—	—	—	—	—	—	—	3	27	25	28	—	—	—	—	—	—	—	—	—	—	—	—
National Aeronautics and Space Administration																										
Science, Aeronautics, and Technology	—	—	—	—	—	—	—	—	—	—	3	65	94	95	—	—	—	—	—	—	—	—	—	—	—	—
National Science Foundation																										
Research and Related Activities	—	—	—	—	—	—	—	—	—	—	15	30	25	25	—	—	—	—	—	—	—	—	—	—	—	—
Department of State																										
International Organizations and Programs	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Department of Transportation	—	—	—	—	—	—	—	—	—	—	—	4	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Federal Highway Administration																										
Federal-aid--Highways	—	—	—	—	—	—	—	—	—	—	—	4	1	0	—	—	—	—	—	—	—	—	—	—	—	—
Federal Transit Administration																										
Formula Grants and Research	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Federal Aviation Administration																										

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Research, Engineering, and Development	—	—	—	—	—	—	—	—	—	—	—	0	0	—	—	—	—	—	—	—	—	—	—	—	—	—
U.S. Agency for International Development																										
Development Assistance	—	—	—	—	—	—	—	—	—	—	—	6	6	13	—	—	—	—	—	—	—	—	—	—	—	—
Climate Change Research Initiative Total	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**41**	**173**	**204**	**203**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**
Science Total	**1,306**	**1,444**	**1,760**	**1,654**	**1,656**	**1,677**	**1,657**	**1,687**	**1,728**	**1,667**	**1,766**	**1,976**	**1,864**	**1,691**	**1,825**	**1,832**	**2,023**	**2,122**	**641**	**2,561**	**2,506**	**2,417**	**2,492**	**2,461**	**2,584**	**2,775**
INTERNATIONAL ASSISTANCE																										
Core Agencies																										
Department of State	—	—	—	—	—	—	—	—	—	—	—	5	7	12	41	59	55	199	—	149	133	126	127	147	595	632
International Organizations and Programs	1	1	1	3	3	5	7	7	7	7	6	5	6	6	6	29	29	39	—	39	37	35	36	36	36	46
Economic Support Fund[c]	—	—	—	—	—	—	—	—	—	—	—	0	1	6	32	26	24	158	—	110	96	91	92	112	559	586
Diplomatic and Consular Affairs[c]	—	—	—	—	—	—	—	—	—	—	—	—	0	0	3	4	2	2	—	0	0	—	—	—	—	—
Department of Treasury	—	—	—	—	—	—	—	—	—	43	56	52	44	46	46	46	46	421	—	744	377	380	356	346	331	350
International Development Assistance																										
Global Environment Facility[f]	—	12	35	14	14	8	60	14	41	38	56	32	20	26	26	26	26	26	—	89	60	62	72	82	101	88
Debt Restructuring																										
Tropical Forest Conservation	—	—	—	—	—	—	—	—	13	5	—	20	24	20	20	20	20	20	—	20	12	11	0	0	0	0
Asian Development Bank[c]	—	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—	—	—	—	—	—	—	—
Clean Technology Fund[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	300	—	400	230	196	210	201	171	0
Strategic Climate Fund[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	75	—	235	75	110	75	63	60	0

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Green Climate Fund[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	250
Central American and Caribbean Catastrophe Risk Insurance Program[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	13
U.S. Agency for International Development	—	—	—	—	—	—	236	156	157	174	208	195	183	190	100	122	222	383	—	491	348	334	351	331	304	352
Development Assistance	200	173	192	175	147	163	169	109	112	116	140	125	134	118	89	88	113	313	—	446	322	308	296	272	268	310
Development Credit Authority	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Economic Support Fund	—	—	—	—	—	—	19	8	—	12	6	9	5	33	0	6	94	44	—	19	12	27	55	59	21	42
Assistance for the Independent States of the Former Soviet Union	—	—	—	—	—	—	35	34	31	30	48	47	34	30	5	15	—	—	—	—	—	—	—	—	—	—
Assistance for Eastern Europe and the Baltic States	—	—	—	—	—	—	12	4	13	11	8	7	5	6	3	11	—	—	—	—	—	—	—	—	—	—
Assistance for Europe, Eurasia, and Central Asia[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	15	26	—	26	15	0	0	0	16	0
International Disaster Assistance	—	—	—	—	—	—	—	—	—	4	4	2	2	2	2	2	0	0	—	0	0	—	—	—	—	—
Andean Counterdrug Initiative	—	—	—	—	—	—	—	—	—	—	2	3	2	0	0	—	—	—	—	—	—	—	—	—	—	—
P.L. 480 Title II Food Aid[c]	—	—	—	—	—	—	—	—	—	—	—	1	1	1	0	—	—	—	—	—	—	—	—	—	—	—
Core Agencies Total	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**323**	**1,003**	**—**	**1,384**	**858**	**840**	**834**	**824**	**1,230**	**1,334**
Complementary Agencies[c]																										
Department of Agriculture																										
Forest Service																										
Forest and Rangeland Research[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	5	—	4	3	3	3	3	1	3

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Department of Commerce	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	11	—	11	—	—	—	—	—	—
National Oceanic and Atmospheric Administration																										
Operations, Research and Facilities[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9	9	—	9	—	—	—	—	—	—
International Trade Administration																										
Operations and Administration[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	—	2	—	—	—	—	—	—
Department of Energy	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	13	—	13	13					
Energy Supply																										
Solar and Renewable Energy Research and Development	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Energy Efficiency and Renewable Energy[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	8	—	8	9	—	—	—	—	—
Fossil Energy Research and Development																										
Efficiency and Sequestration[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	3	—	3	—	—	—	—	—	—
Carbon Capture and Storage and Power Systems[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—
Science[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	3	—	3	1	—	—	—	—	—
Energy Programs[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	13	9	9	9
Adjustments for programs included in multiple categories	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(13)	(13)	(13)	(9)	(9)	(9)

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Environmental Protection Agency																										
Environmental Programs and Management[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20	21	—	21	18	16	17	17	17	19
Adjustments for programs included in multiple categories	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(9)	(7)	(8)	(8)	(8)	(10)
Millennium Challenge Corporation[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	2	—	25	41	0	103	352	219	0
National Aeronautics and Space Administration																										
Science[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	—	6	3	6	6	6	6	7
Adjustments for programs included in multiple categories	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	(3)	(6)	(6)	(6)	(6)	(7)
National Science Foundation																										
Research and Related Activities	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	6	—	9	6	6	4	2	1	1
Peace Corps																										
Peace Corps	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	13	12	12	12	12
U.S. Trade and Development Agency	—	—	—	—	—	—	16	—	—	—	—	—	—	—	—	—	10	17	—	21	16	19	22	27	32	42
Complementary Agencies Total	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**50**	**77**	**—**	**110**	**100**	**76**	**180**	**428**	**297**	**93**
International Assistance Total	**201**	**186**	**228**	**192**	**164**	**186**	**325**	**177**	**218**	**224**	**270**	**252**	**234**	**249**	**188**	**227**	**373**	**1,080**	**—**	**1,494**	**958**	**916**	**1,013**	**1,252**	**1,527**	**1,426**
WILDLIFE ADAPTATION[g]																										
Department of Interior																										
National Park Service																										

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Operation of the National Park Service[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	10	0	10	—	—	—	—	—	—
Fish and Wildlife Service																										
Resource Management[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	40	0	59	—	—	—	—	—	—
State and Tribal Wildlife Grants[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—
Bureau of Land Management																										
Management of Lands and Resources[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	15	0	18	—	—	—	—	—	—
Bureau of Indian Affairs																										
Operation of Indian Programs[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—	—
Wildlife Adaptation Total	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**0**	**65**	**0**	**87**	**—**	**—**	**—**	**—**	**—**	**—**
NATURAL RESOURCES ADAPTATION[e]																										
National Park Service																										
Operation of the National Park Service[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—
Fish and Wildlife Service																										
Resource Management[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—
Bureau of Land Management																										
Management of Lands and Resources[c]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18	—	—	—	—	—
Bureau of Indian Affairs																										

ACCOUNT	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	ARRA[a]	2011	2012	2013	2014	2015	2016	2017
Operation of Indian Programs[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	—	—	—	—	—
Bureau of Reclamation																										
Cooperative Landscape Conservation[b]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—	—	—
Natural Resources Adaptation Total	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**—**	**88**	**—**	**—**	**—**	**—**	**—**
Total Climate Change Funding	**2,352**	**2,668**	**3,271**	**2,952**	**2,876**	**3,114**	**3,535**	**3,511**	**3,603**	**3,522**	**4,584**	**5,090**	**5,269**	**5,876**	**5,498**	**6,255**	**7,782**	**8,771**	**26,140**	**9,788**	**9,649**	**9,062**	**10,045**	**10,689**	**11,627**	**13,156**

Source: GAO analysis of Office of Management and Budget reports. | GAO-18-223

Notes: Dashes indicate that OMB did not report a value for the account for that year. Zeros indicate the funding that OMB reported for the account for that year.

Totals may not add due to rounding.

The table presents actual budget authority except for fiscal years 2011, 2013, and 2017. For fiscal years 2011 and 2017, OMB reported proposed budget authority. For fiscal year 2013, OMB reported final operating level funding. Funding is reported in nominal dollars, which are not adjusted for inflation.

Climate-related tax expenditures are not included in this table to maintain comparability with our 2005 report, *Climate Change: Federal Reports on Climate Change Funding Should Be Clearer and More Complete*, GAO-05-461 and our 2011 report, *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding Decisions*, GAO-11-317.

[a]In its June 2010 report, OMB reported funding for climate change programs and activities in the American Recovery and Reinvestment Act of 2009 (Pub. L. No. 111-5 (Feb. 17, 2009)).

[b]Funding for this account has been added since our 2011 report, *Climate Change: Improvements Needed to Clarify National Priorities and Better Align Them with Federal Funding decisions*, GAO-11-317.

[c]Funding for this account has been added since our 2005 report, *Climate Change: Federal Reports on Climate Change Funding Should Be Clearer and more Complete*, GAO-05-461.

[d]OMB identified funding for this account as mandatory under the Food, Conservation, and Energy Act of 2008 (Pub. L. No. 110-234 (May 22, 2008)).

[e]OMB did not distinguish between indirect and direct technology funding for this year.

Appendix VI: Climate Change Tax Expenditures as Reported by the Office of Management and Budget (OMB), from Fiscal Years 2003 through 2017

Dollars in millions

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Tax provisions that may reduce greenhouse gases															
Energy production credit (without coal)[a]	380	330	219	440	410	900	360	780	1,020	1,452	1,719	1,759	1,540	1,940	2,240
Credit for alternative motor vehicles and refueling property[b]	90	70	70	110	260	170	130	240	260	100	180	260	540	550	670
Exclusion of utility conservation subsidies	110	100	80	110	120	120	140	140	130	270	250	250	430	450	470
Credit for holding clean renewable energy bonds	—	—	0	20	20	40	70	80	100	70	70	70	70	70	70
Allowance of deduction for certain energy efficient commercial building property	—	—	0	80	190	170	60	80	90	70	70	40	30	(10)	(30)
Credit for construction of new energy efficient homes	—	—	0	10	20	30	30	20	20	70	40	20	760	20	0
Credit for energy efficiency improvements to existing homes	—	—	0	230	380	230	570	1,950	1,460	780	0	0	270	0	0
Credit for energy efficient appliances	—	—	0	120	80	120	130	130	50	210	300	130	—	—	—
Credit for residential energy efficient property[c]	—	—	0	10	10	20	110	180	180	910	1,010	1,140	850	770	460
Credit for business installation of qualified fuel cells	—	—	0	30	30	0	—	—	—	—	—	—	—	—	—
Energy investment credit[d]	—	—	—	—	—	40	270	530	600	1,040	1,270	1,360	1,010	1,470	970
Qualified energy conservation bonds	—	—	—	—	—	0	0	10	40	20	30	30	30	30	30
Industrial CO2 capture and sequestration tax credit	—	—	—	—	—	—	—	—	—	60	60	70	80	110	150
Advanced nuclear power production credit	—	—	—	—	—	—	—	—	—	—	—	—	0	140	140
Total energy tax provisions that may reduce greenhouse gases	580	500	369	1,160	1,520	1,840	1,870	4,140	3,950	5,052	4,999	5,129	5,610	5,540	5,170

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy grants															
Energy grants in lieu of energy investment credit[d,e]	—	—	—	—	—	—	1,050	3,090	4,460	5,080	8,080	4,710	2,300	1,200	650
Total (tax provisions plus grants)	580	500	369	1,160	1,520	1,840	2,920	7,230	8,410	10,132	13,079	9,839	7,910	6,740	5,820

Source: GAO analysis of Office of Management and Budget reports. | GAO-18-223

Notes: Dashes indicate that OMB did not report a value for the account for that year. Zeros indicate the funding that OMB reported for the agency for that year.

OMB did not report revenue effects for existing tax expenditures that may reduce greenhouse gases from fiscal years1993 through 2002. OMB began reporting revenue effects for existing climate-related tax expenditures in response to recommendations from our 2005 report, *Climate Change: Federal Reports on Climate Change Funding Should Be Clearer and more Complete*, GAO-05-461. Data for 2003 and 2004 were presented in OMB's April 2006 report. Data for 2011 was presented in OMB's June 2010 report.

[a]Estimates of revenue loss from coal provisions have been removed from the tax expenditure estimate in the budget. In previous years, the Energy Investment Credit was contained within the New Technology Credit. Prior to OMB's August 2013 report, the energy production credit was referred to as the new technology credit (without coal).

[b]Prior to OMB's August 2013 report, the tax credit for alternative motor vehicles and refueling property was referred to as the tax credit and deduction for clean-burning vehicles.

[c]Prior to OMB's August 2013 report, the credit for residential energy efficient property was referred to as the credit for residential purchases/ installations of solar and fuel cells.

[d]In previous years, the energy investment credit was contained within the New Technology Credit. The Energy Investment Credit also includes the business installation of fuel cells, which was an independent entry in tables from previous years. Estimates of revenue loss from the micro-turbine provision have been removed from the tax expenditure estimate in the budget.

[e]Firms can take an energy grant in lieu of the energy production credit or the energy investment credit for facilities placed in service in 2009, 2010, or 2011 or whose construction commenced in 2009, 2010, or 2011. The grants are considered outlays and are direct substitutes for the energy tax provisions.

Appendix VII: GAO Contact and Staff Acknowledgments

GAO Contact

J. Alfredo Gómez, (202) 512-3841 or gomezj@gao.gov

Staff Acknowledgments

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