



2025 Annual Report

MARYLAND COMMISSION
ON CLIMATE CHANGE

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Message from the Commission Leadership



The climate crisis is negatively reshaping Maryland's economy, our geography, and the health of our people. In 2024, the world recorded its hottest year ever, with temperatures reaching approximately 1.5°C above pre-industrial levels.

On behalf of the members of the Maryland Commission on Climate Change ("MCCC" or "the Commission"), we are honored to present our 2025 Annual Report to Governor Wes Moore and the Maryland General Assembly.

Maryland continues to lead with clarity and urgency. Under the Climate Solutions Now Act (CSNA) of 2022, our state has made tremendous progress reducing climate pollution faster than almost any other state.

But headwinds from Federal policymakers threaten to roll that progress back, and with it, our ability to meet our CSNA climate goals. The Commission has devoted substantial time to figuring out ways to navigate the new policy landscape. This report takes into account that reality, and identifies recommendations to move forward.

The Commission looked at the effect of Federal rollbacks on the nation as a whole, and opportunities all states share to keep momentum. Maryland is fortunate to have access to the best advisors and scientists in the world, who provided guidance and are analyzing new greenhouse gas pollution trajectories for Maryland that will inform our next steps.

The recommendations included in this report build on our momentum with those new challenges in mind. They outline bold, achievable strategies that not only cut emissions at the pace science demands, but also strengthen our resilience and prepare every community, especially our overburdened and underserved communities, for the future consequences of climate change.

The climate crisis is negatively reshaping Maryland's economy, our geography, and the health of our people. In 2024, the world recorded its hottest year ever, with temperatures reaching approximately 1.5°C above pre-industrial levels.

Maryland has never shied away from big challenges. We will continue to move swiftly, decisively, and collectively to advance climate solutions that are bold, and grounded in real-world implementation. Together, we will protect public health, grow a thriving green economy, and uphold the core principles of justice, accountability, and environmental stewardship for all Marylanders.

We extend our deepest gratitude to the commissioners, working group members, and staff whose dedication makes this work possible, and to the Marylanders who engaged with us and offered their insights, experiences, and vision for a more sustainable future.



**MDE Secretary
Serena McIlwain**
Commission Chair



Kim Coble
Commission Co-Chair

Introduction

This is the Maryland Commission on Climate Change's 2025 Annual Report.

Final recommendations from the Commission were provided by the working groups and by individual Commissioners and are detailed below for the General Assembly and Governor to consider. For context, this report also highlights the Commission membership, the history of the Commission, the state of climate action in Maryland, and updates on the latest climate science for 2025. This report also includes appendices of to-date progress made on 2024 recommendations and an analysis of the total amount of state money spent on measures to reduce greenhouse gases during the previous fiscal year.



2025 Commission Membership

LEADERSHIP

MDE Secretary Serena McIlwain
Commission Chair

Kim Coble
Commission Co-Chair

STANDING MEMBERS

Kevin Atticks
Department of Agriculture Secretary

Brooke Lierman
Comptroller

Atif Chaudhry
Department of General Services Secretary

Fernando Miralles-Wilhelm
UMCES President

Erik Fisher
Critical Area Commission Chair

Paul Pinsky
Maryland Energy Administration Director

Rebecca Flora
Department of Planning Secretary

Jamie Raley
Maryland Farm Bureau

Frederick Hoover
Maryland Public Service Commission Chair

Russell Strickland
Maryland Emergency Management Secretary

Josh Kurtz
Department of Natural Resources Secretary

Samantha Biddle
Department of Transportation Secretary

David Lapp
Maryland People's Counsel

Carey Wright
Maryland Schools Superintendent

GOVERNOR APPOINTED MEMBERS

Russell Dickerson
Climate Change Expert

Robyn Gilden
Public Health Expert

SENATE PRESIDENT APPOINTED MEMBERS

Brian Feldman
Senator

Michael Powell
Business Community Representative

Jennifer Laszlo Mizrahi
Philanthropic Representative

Jim Strong
Organized Labor Representative

HOUSE SPEAKER APPOINTED MEMBERS

Beth Harber
Philanthropic Representative

David Smedick
Environmental NGO Representative

Gerald Jackson
Organized Labor Representative

Dana Stein
Delegate

Brian Megali
Business Community Representative

LOCAL GOVERNMENT APPOINTED MEMBERS

Mark Belton
*Charles County Administrator,
Maryland Association of Counties*

Michael Bibb
*Town of St. Michael's Commissioner,
Maryland Association of Counties*

Changes in Commission Membership

Welcome New Members

It is a pleasure to welcome Maryland Department of Transportation Acting Secretary Samantha Biddle to the Maryland Commission on Climate Change this year. The Commission thanks Acting Secretary Biddle for her expertise and for her commitment to serving the State.



Thank You to Departing Members

It is with immense gratitude that the Commission wishes a fond farewell to Jesse Iliff, Paul Wiedefeld, and Paul Pinsky.

The Commission thanks all Commissioners and members of the Commission's working groups for moving the vision of the Commission forward.

History of the Commission

The Maryland Commission on Climate Change (“the Commission”) is an independent body originally established under Executive Order in 2007 (01.01.2007.07). The Commission was charged with developing an action plan and firm timetable for mitigating and adapting to the impacts of climate change in Maryland. The Commission first produced a climate action plan that was the catalyst for the Greenhouse Gas Emissions Reduction Act of 2009 (GGRA of 2009).

In 2014, a second Executive Order (01.01.2014.14) expanded the scope of the Commission and its membership to include non-state government participants. In 2015, the General Assembly codified the Commission into law. The Commission advises the Governor and General Assembly “on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change.” Fulfilling this role, the Commission’s focus is to:

Recommend short and longer-term strategies and initiatives to better mitigate the causes and address the consequences of climate change;

Review the most up-to-date climate change science to consider how it might inform State efforts on greenhouse gas (GHG) mitigation, adaptation, resiliency, economics, and policy;

Publicly engage with a wide range of organizations and individuals to share evidence and analysis;

Convene regular working group and full Commission meetings to ensure that sufficient progress is being made across all sectors and communities in Maryland.



The Commission delivers an annual report for the Governor and the Maryland General Assembly that includes recommendations from the Commission’s working groups on the necessary steps to mitigate and adapt to climate change and meet the state’s climate goals. The recommendations provide important support to policymakers at the Maryland Department of the Environment (MDE), which develops the plan to mitigate and respond to the impacts of climate change, as mandated by the Climate Solutions Now Act (CSNA) of 2022.

Working Groups Established by CSNA

Prior to the CSNA, the Commission consisted of a main body and four working groups: the Scientific and Technical Working Group (STWG), the Greenhouse Gas Mitigation Working Group (MWG), the Adaptation and Resilience Working Group (ARWG), and the Education, Communication, and Outreach (ECO) Working Group.

The CSNA required four new Commission working groups to be established in addition to the four pre-existing working groups: the Just Transition Employment & Retraining Working Group (JTWG), the Energy Resilience and Efficiency Working Group (EREWG), the Energy Industry Revitalization Working Group (EIRWG), and the Solar Photovoltaic Systems Recovery, Reuse, and Recycling Working Group (PVWG). The membership, scope, and required deliverables for these Commission working groups are detailed in statute in Sections 2–1303.1 through 2–1303.4 of the Environment Article.

Each of the four working groups established by the CSNA were required to deliver a study to the Commission and the Maryland General Assembly by December 31, 2023. Due to staffing and budget constraints, the four new working groups and their associated studies were delayed until 2024. As of Spring 2025, all four CSNA working groups have submitted their required deliverables and – with their statutory mandates satisfied – are not actively meeting until reconvened by the Commission. The studies delivered by the CSNA working groups are described below:

Just Transition Employment & Retraining Working Group



Just Transition Employment and Retraining Working Group Study

was prepared for the JTWG with input from the National Renewable Energy Laboratory (NREL). This study is designed to inform the state's decision-making regarding challenges and opportunities for Maryland's workforce resulting from a clean energy transition.

Energy Resilience and Efficiency Working Group



Energy Resilience and Efficiency in Maryland was prepared for the EREWG by the Ralph O'Connor Sustainable Energy Institute (ROSEI) at Johns Hopkins University (JHU). The study addresses key topics related to electricity storage and renewable energy technologies, electric grid modernization, the redevelopment of energy production sites, and the viability of non-emitting energy facilities

Energy Industry Revitalization Working Group



The Renewable Energy Transition in Maryland: Implications for Energy Generating Facilities and Small Businesses was prepared for the EREWG by the University of Maryland's (UMD) Center for Global Sustainability (CGS). The report assesses the impact of the energy transition on small businesses and existing power facilities throughout the state. It assesses the potential for different opportunities and challenges from the clean energy transition, examines current and potential energy transition policies, provides recommendations on funding, financing, and technical assistance for small businesses, and provides further recommendations on how to support these key actors while ensuring a just transition for energy facilities.

Solar Photovoltaic Systems Recovery, Reuse, and Recycling Working Group



A Circular Economy Approach to Solar Photovoltaics in Maryland

was jointly prepared for the PVWG by CGS and ROSEI. The study is designed to inform the state's decision-making regarding policy options for solar PV management in Maryland, including an exploration of how circular economy principles can be applied to solar photovoltaics to manage waste and mitigate supply chain risks, policy frameworks in other jurisdictions, and recommendations for best practices in Maryland.

Maryland Climate Teach-In

The Maryland Climate Teach-In is an annual celebration of statewide climate education during April – coinciding with Earth Month. It encourages and supports climate education activities of all kinds, empowering educators, students, and community members to learn, discuss, and take action to mitigate and adapt to climate change.

The Teach-In is organized by the ECO Working Group, alongside partners and sponsors, including a number of other state agencies, NGOs, and the Bard College World-Wide Teach-In.

Over its three-year span, the Teach-In has grown exponentially from 25 participants in 2023 to an incredible 223 participating educators in 2025. As a reporting partner of the Bard College World-Wide Teach-In, Maryland ranked as the subnational and national leader in total climate education activities for the second consecutive year.

Thanks to the generosity of its sponsors, the 2025 Maryland Climate Teach-In offered prizes as an incentive to participate, including \$2,000 towards a climate education field trip, two \$500 prizes for an on-site climate activity, and a series of climate education materials.

Over its three-year span, the Teach-In has grown exponentially from 25 participants in 2023 to an incredible 223 participating educators in 2025.



Climate Action in Maryland

The State of Maryland continues to work diligently and proactively toward economy-wide decarbonization in alignment with the ambitious climate goals mandated by CSNA and outlined in Maryland's Climate Pollution Reduction Plan (CPRP) – including a 60% reduction in greenhouse gas (GHG) emissions from 2006 levels by 2031 and achieving net-zero GHG emissions by 2045.

Released in December 2023, the CPRP serves as Maryland's roadmap for achieving both near, and long-term climate goals. The report included modeling and analysis demonstrating how the state can reach these targets through current and planned policies driving GHG emission reductions through 2045.

Approximately half of the Maryland's climate policies are currently being implemented as described in the CPRP. Notably, the State has made significant progress in 2025 within the buildings sector, including the implementation of the Building Energy Performance Standards (BEPS) and continued progress in the development of a Clean Heat Standard (CHS) and a Zero-Emission Heating Equipment Standard (ZEHES).

Under § 2-1305 of the Environmental Article, certain State agencies are required to annually report to the Governor and the Commission on Climate Change on the status of programs supporting the state's greenhouse gas reduction efforts and climate action initiatives. These reports, which provide comprehensive, agency-specific updates, are available on the the Commission website.

Maryland has reduced climate pollution faster than nearly any other state. Maryland not only achieved, but exceeded its 2020 goal of reducing GHG emissions by 25%, realizing a 30% reduction from 2006 levels by that year. The most recent State GHG Inventory, covering calendar year 2023, indicates that Maryland has maintained this progress. However, policy uncertainties at both the state and federal levels continue to present challenges in meeting the State's long-term climate goals.

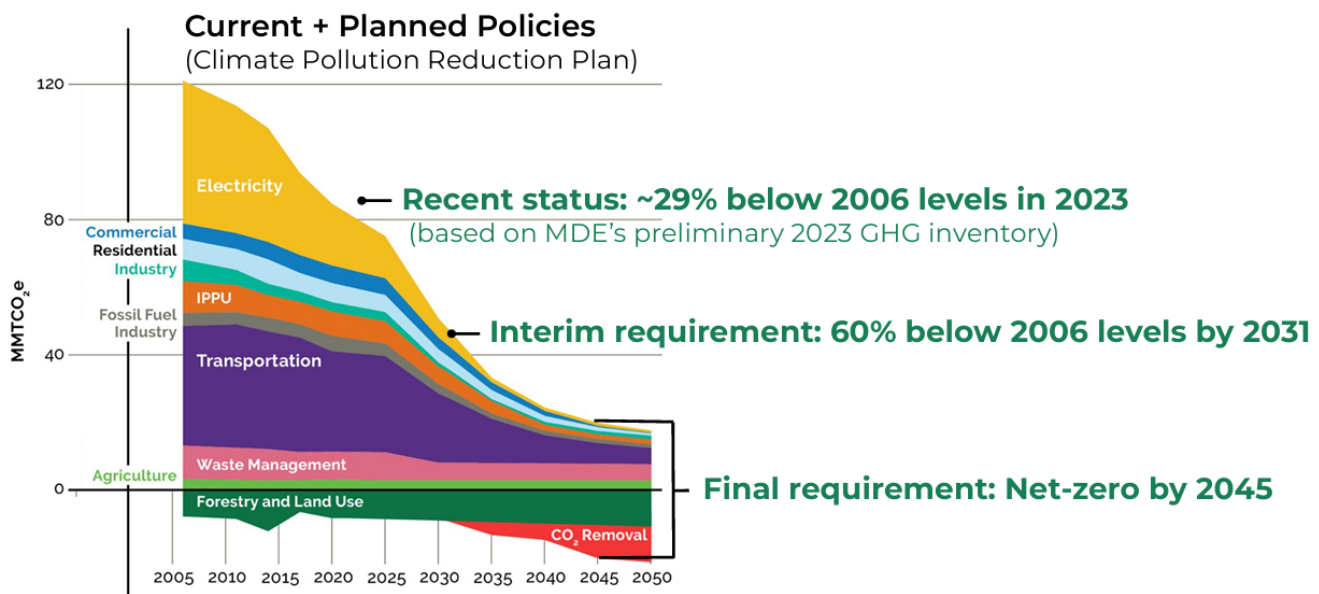


Figure 1: Maryland's statewide GHG emissions and sequestration trends, historical and projected, from 2006 to 2050 based on current and new policies.

Maryland is facing the largest structural deficit in decades, currently projected at more than \$1.5 billion in FY27. The CPRP called for roughly \$1 billion in annual spending to achieve the CSNA goals and outlined pathways to generate the necessary revenue. The challenge of balancing the State budget presents an additional hurdle to funding climate action in Maryland. Notably, the CPRP found that implementation of current and planned policies would result in statewide economic benefits: by 2031 total personal income would increase by \$2.5 billion, Gross Domestic Product (GDP) would increase by \$5.3 billion, and the cumulative public health benefits would exceed \$4 billion through 2050.

Sweeping federal rollbacks of critical climate policies, funding, and support present significant headwinds to the implementation of state climate policies. Modeling by the Center for Global Sustainability at the University of Maryland illustrates the nationwide impact of federal actions on GHG emission reductions, and demonstrates that state leadership has the potential to counteract the consequences of these national developments.

According to CGS, “Under enhanced non-federal actions and varying levels of federal climate policy rollbacks or inaction, the United States could achieve 54%-62% GHG emissions reductions by 2035. However, if non-federal actors only maintain existing policies under federal rollbacks, the U.S. could only achieve 33%-43% GHG reductions.” With this understanding, state leadership and collaboration on GHG reduction are more critical now than ever before.

Maryland must continue to actively engage residents, nonprofits, businesses, experts, and environmental groups as partners to shape climate solutions. Convening stakeholder ideas and investing in climate education, inclusive events, cost-effective strategies, and cross-sector partnerships are essential to ensure transparent, participatory action that builds trust, diverse leadership, and better outcomes for Maryland.

Net Greenhouse Gas Emissions (MtCO₂e)

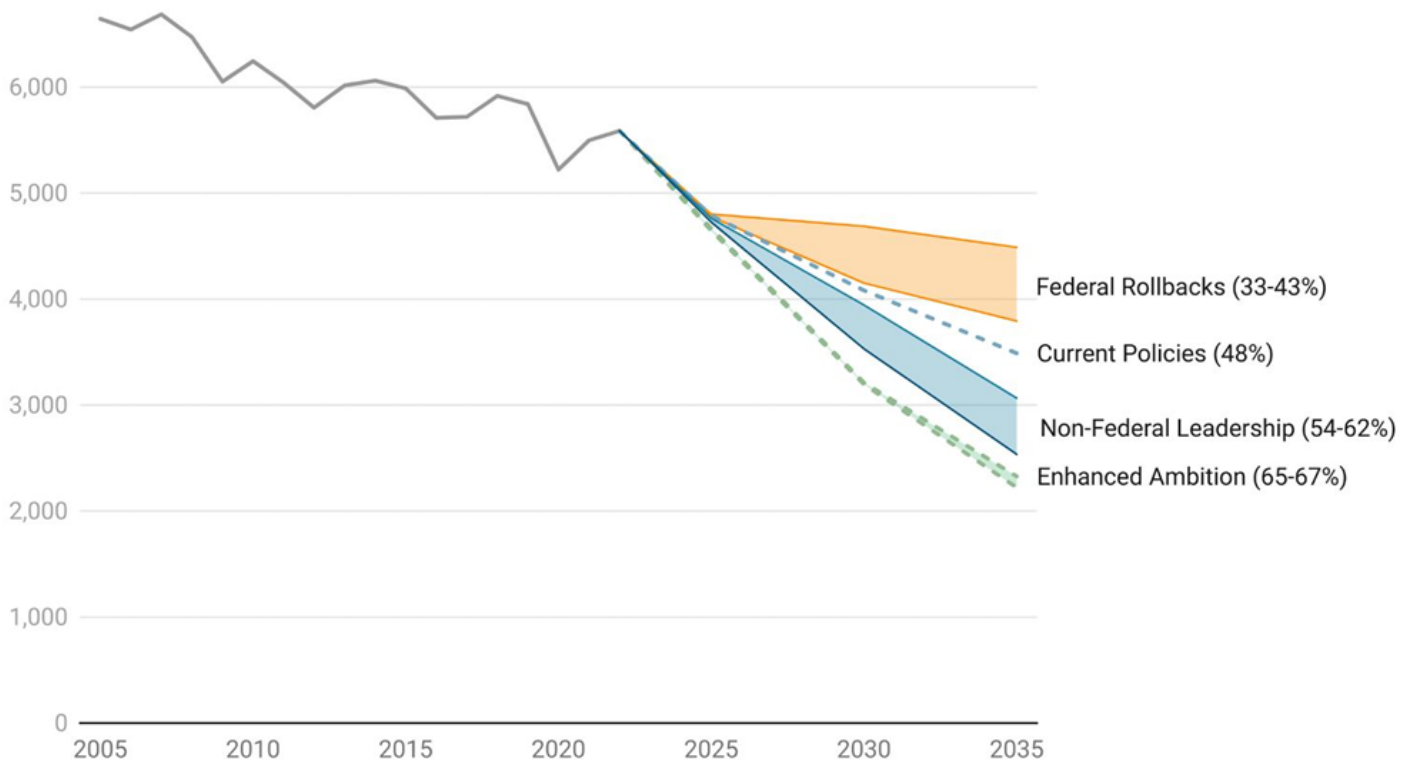


Figure 2: Center for Global Sustainability projection of U.S. net GHG reductions based on varying degrees of federal rollbacks and non-federal leadership.

Recommendations

The following recommendations put forward by the Commission are meant to advise the Governor and General Assembly “on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change” in Maryland.

The MCCC continues to promote its recommendations from prior years except where this year’s recommendations supersede previous recommendations. Annual Reports from prior years are archived on the Maryland Commission on Climate Change website and an accounting of progress to-date on 2024 recommendations can be found in Appendix A of this report.

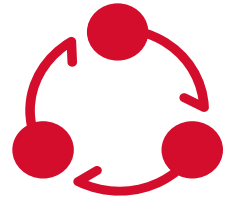
Commissioner Recommendation

Impact of elimination of federal environmental regulations and efforts

Working in partnership with Maryland Universities, request the various state agencies that have purview to investigate and provide an overview of federal environmental regulations that were, or are proposed to be eliminated, that could significantly harm Maryland’s efforts to protect its environment by their absence, and for the state to enact regulations that can help fill the void.



Recommendations



Adaptation and Resiliency

Climate and Health Profile Report Update

Initiating in 2026, State agencies (Health, Environment) should update the 2016 Climate and Health Profile Report as an online resource for planners, the public, policy makers, and local officials to incorporate updated health and climate impacts data that can be used in evaluating different mitigation and adaptation strategies and interventions. This activity will reflect recently updated analyses such as the comptroller's report and should be in collaboration with academic centers that can assist with the modeling of health impacts associated with climate changes. The report should include the development of tools and "plug and play" examples that make it easier to interpret and use climate and associated health data in decision making. The update of the Climate and Health Profile Report should be completed by the end of 2027.

Next Generation Adaptation Plan Public Tracker

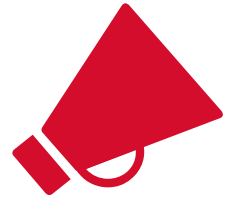
In support of the Governor's Key Performance Indicator, the Department of Natural Resources will develop a public facing tracker released in 2026 that promotes Maryland's progress on the climate adaptive actions listed in the Next Generation Adaptation Plan.

Enhanced Flood Risk Disclosures

In the 2026 legislative session, the General Assembly should take actions to enhance Flood Risk Disclosures in property transactions to reduce exposure to hazardous conditions and notify buyers and lessees of risk earlier in the transaction process. The disclosure should require information on past flood events and future flood risk resources for residential property transactions including rental properties. Tools and resources to inform these disclosures should be made available by the Department of Natural Resources, Maryland Department of Emergency Management, Maryland Department of the Environment, and Maryland Department of Planning in a transparent, user-friendly format.

Recommendations

Education, Communication, Outreach



Continuous Improvement and Accountability in Climate Action

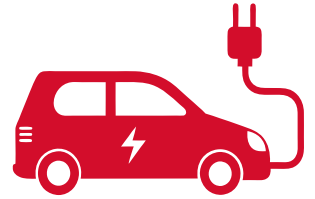
In light of current volatility in policy and funding, as well as worsening extreme weather, the Department of the Environment, as Chair of the Governor's Subcabinet on Climate, should work with the member agencies to annually seek stakeholder input, update and share their Climate Implementation Plans (CIPs), and incorporate climate awareness and messaging into their existing public facing communications such as advertising, websites, and social media. Agencies should annually report on their progress publicly on the Maryland Department of the Environment webpage.

Climate Education Month

Building on the success of the annual Maryland Climate Teach-In, including the Governor's proclamation of Climate Education Week in 2024 and 2025, the Maryland General Assembly should introduce and pass an updated version of FY 2024 House Bill 993 to declare the month of April, coinciding with Earth Month, as "Maryland Climate Education Month."



Recommendations



Mitigation

Protect SEIF and support clean energy projects in development

Strategic Energy Investment Fund (SEIF) balances over and above revenues assumed in the prior fiscal year budget should be used primarily to advance construction of renewable energy projects already in the development pipeline, to invest in energy efficiency and reducing greenhouse gas emissions, and to support low-income utility bill assistance.

Recommend policies to increase the use of low-carbon fuels in the transportation sector

The Maryland Department of the Environment should study and make a recommendation regarding the adoption of a Clean Fuel Standard (also known as a Low Carbon Fuel Standard) or other steps to increase the production, importation, and use of low carbon fuels to reduce emissions from the transportation sector, especially in light of the federal government's rollback of the Advanced Clean Cars and Advanced Clean Trucks programs and federal fuel efficiency standards. The recommendation, including an analysis on the net environmental and economic impacts to the state in line with the goals of the Climate Solutions Now Act, should be published by December 31, 2026.

Develop a heat pump market transformation roadmap

In 2026, the General Assembly should authorize the use of the Strategic Energy Investment Fund for grants and loans for building electrification. The Governor should direct Maryland Energy Administration, Maryland Department of the Environment, Department of Housing and Community Development, Department of Labor, Maryland Clean Energy Center, and any other relevant agency to collectively develop a heat pump market transformation roadmap informed by the state's heat pump deployment goals, including efficient window heat pumps, as detailed in resources like the Climate Pollution Reduction Plan and the NESCAUM states' Multistate Memorandum of Understanding on Accelerating the Transition to Zero-Emission Residential Buildings. To kick-start this market transformation, in 2026 the Governor should direct relevant agencies to encourage and incentivize a targeted heat pump deployment program for households currently using electric resistance and delivered fuels for heating. The same agencies should partner with local Heating Ventilation Air Conditioning (HVAC) contractor networks, heat pump manufacturers, unions, and others to develop and launch a new heat pump workforce development and training program.

Take next steps on developing an economy-wide Cap and Invest program

In 2026 the Moore Administration should evaluate and propose potential designs for an economy-wide Cap and Invest program per the MCCC's recommendations in 2024. Any development of a cap and invest program should hold low-income customers harmless. A percentage of the dividends should be distributed to low-income customers.

Recommendations



Science and Technical

Accounting of Nitrous Oxide Emissions in Maryland

The Maryland Department of the Environment and Maryland Department of Agriculture should improve the state's accounting of Nitrous Oxide (N₂O) emissions and develop strategies to mitigate those emissions. The third most important greenhouse gas and the largest currently emitted destroyer of stratospheric ozone, N₂O is produced predominantly in fertilized croplands, with additional emissions from manure management. At present MDE downscales national estimates of N₂O emissions, but the agricultural practices specific to Maryland could inform improved emission estimates as well as effective mitigation measures.

Measures to Decrease Methane Production and Emission

The Maryland Department of Agriculture and University partners should explore the following measures to quantify and decrease methane production and emission: (a) Decrease nutrient inputs to Chesapeake Bay: Reduced nitrogen from agriculture, wastewater, and stormwater, oxidized nitrogen from combustion and fertilizers, and phosphorus; (b) Investigate wetland restoration methods that do not lead to increased methane production; (c) Develop mechanisms to incentivize manure and waste processing technologies at agricultural, municipal, and industrial sites, at scales appropriate for applications in Maryland, such as composting, anaerobic digestion, or other technologies that capture, transform, or eliminate methane.

Update of the 2008 "Global Warming and the Free State" Report

By December 31, 2027, the Maryland Department of the Environment and the Department of Natural Resources, in partnership with Maryland Universities, should update the MCCC's 2008 Comprehensive Assessment of Climate Change Impacts in Maryland, also known as "Global Warming and the Free State" by incorporating the most recent assessments by the Intergovernmental Panel on Climate Change, the National Climate Assessment and other relevant scientific findings. This update will consider reports, including the following: findings from the 2016 Maryland Climate and Health Profile Report; the STWG's Sea-Level Rise Projections for Maryland, 2023; findings of the study "Maryland's Climate Pollution Reduction Plan" (2023); prospective scenario analysis of Maryland's Net-Zero 2045 goal across the major sectors: transportation, energy, residential, agricultural, etc.; and the 2025 Maryland Plan to Adapt to Saltwater Intrusion and Salinization.

The Cost of Climate Change: Health and Economic Benefits of Action by Maryland

The Maryland Department of the Environment and its University partners should enhance air quality models currently used to calculate co-benefits of criteria pollutants, such as ozone and particulate matter, to include short-lived and locally dominant pollutants, ultrafine particles, and black carbon (soot). The species have major health impacts and are monitored but models have not been evaluated. Costs avoided should be calculated with models, including EPA's Benefits Mapping and Analysis Program (BenMAP).

Update on Climate Science

Global and National Outlook

Global temperatures have hit new records as 2024 was the warmest year on record and for parts of the year the world averaged $\approx 1.5^{\circ}\text{C}$ above pre-industrial (Romanello et al. 2025). This moves the long-term trend closer to the 1.5°C threshold in the Paris Agreement (WMO, 2025). Atmospheric greenhouse-gas concentrations are at their highest levels ever measured (CO_2 , methane, nitrous oxide), with a large year-to-year jump recently reported. This rise is being linked to continued fossil fuel burning and intense wildfire emissions (Friedlingstein et al. 2025). Natural carbon sinks are weakening in some regions, i.e., forests, soils and the ocean are becoming less able to absorb human emissions (Ripple et al. 2025). Studies and synthesis reports in 2024–25 highlight stress on the Amazon, reduced photosynthesis in some forests, and evidence of declining ocean carbon uptake (WMO, 2025; Friedlingstein et al. 2025). Ocean productivity (phytoplankton/chlorophyll) is declining in many regions:

a 2001–2023 analysis finds a measurable, widespread drop in *ocean greenness*, which implies reduced marine carbon uptake and ecosystem stress. This is not just a regional result but denotes a global signal tied to surface warming and nutrient changes (Aggarwal et al. 2024; UNESCO, 2024). Cryosphere changes remain dramatic. Arctic sea ice set a record low *maximum* in 2025, and recent minima continue to rank among the lowest in the satellite era, indicating persistent decline and higher variability (NSIDC, 2025; Bradley et al. 2024; Chandler et al. 2025). Extreme weather signals continue and intensify — heat extremes, extreme precipitation events, drought and wildfire trends are increasing in frequency and/or intensity regionally, with cascading impacts on health, food and infrastructure (WMO, 2025). New regional and process-level findings sharpen risk estimates and tipping-point concerns. A detailed compilation of articles from 2025 that documents cascading impacts, updated projections for glacier/ice responses, and refined estimates for climate extremes and adaptation limits can be found in Nature Climate Change (2025).

At the national level, a new report published by the National Academies reviews trends (hot extremes, precipitation, cold extremes decline, regional shifts) in U.S. climate impacts (National Academies, 2025). This report offers the following major conclusions. (i) Emissions of greenhouse gases (GHGs) from human activities are increasing the concentration of these gases in the atmosphere; (ii) Improved observations confirm unequivocally that greenhouse gas emissions are warming Earth's surface and changing Earth's climate; (iii) Human-caused emissions of greenhouse gases and resulting climate change harm the health of people in the United States; (iv) Changes in climate resulting from human-caused emissions of greenhouse gases harm the welfare of people in the United States; (v) Continued emissions of greenhouse gases from human activities will lead to more climate changes in the United States, with the severity of expected change increasing with every ton of greenhouse gases emitted.

The EPA's *Fifth Edition Climate Change Indicators* documents multiple lines of evidence of increasing impact: beyond heat and wildfires, the report shows rising sea levels, earlier and more variable precipitation, warmer nights, longer growing seasons, changing ocean conditions, and risks to ecosystems (EPA, 2024). The *Fifth National Climate Assessment* (Jay et al. 2023) shows that risk and vulnerabilities are escalating: every increment of warming avoided reduces future harms. It covers regional impacts (coasts, rural/urban, agricultural, infrastructure), stresses on health, biodiversity, water, and other impacts. The 2024–2025 U.S. fire season was among the worst: over 36,000 km^2 burned in the U.S., with several catastrophic wildfires (notably the Palisades and Eaton fires in California) killing dozens, destroying $\sim 11,750$ homes, displacing many, and causing $> \$140$ billion in damages (Kelley et al. 2025).

Extreme weather signals continue and intensify — heat extremes, extreme precipitation events, drought and wildfire trends are increasing in frequency and/or intensity regionally, with cascading impacts on health, food and infrastructure (WMO, 2025).

Climate Science Updates in Maryland

In 2025, Maryland is on track to continue the long-term (since 1895) warming trend of about 2.2°F/century. Local climate has been on a seesaw – the year started with winter (December 2024, January & February 2025) colder and drier than normal (–1.7°F, – 2.56 inches), followed by spring warmer and wetter than normal (3.1°F, 2.58 inches), followed by a warmer and drier than normal summer (0.8°F, –1.41 inches). The monthly evolution of statewide temperatures and total precipitation through August 2025 (Figure 1) showed that in six of the eight months, from February to July, the state was warmer than normal, particularly in March (5.6°F), and that in four of the eight months, the state was drier than normal, especially in August (2.52 inches deficit).

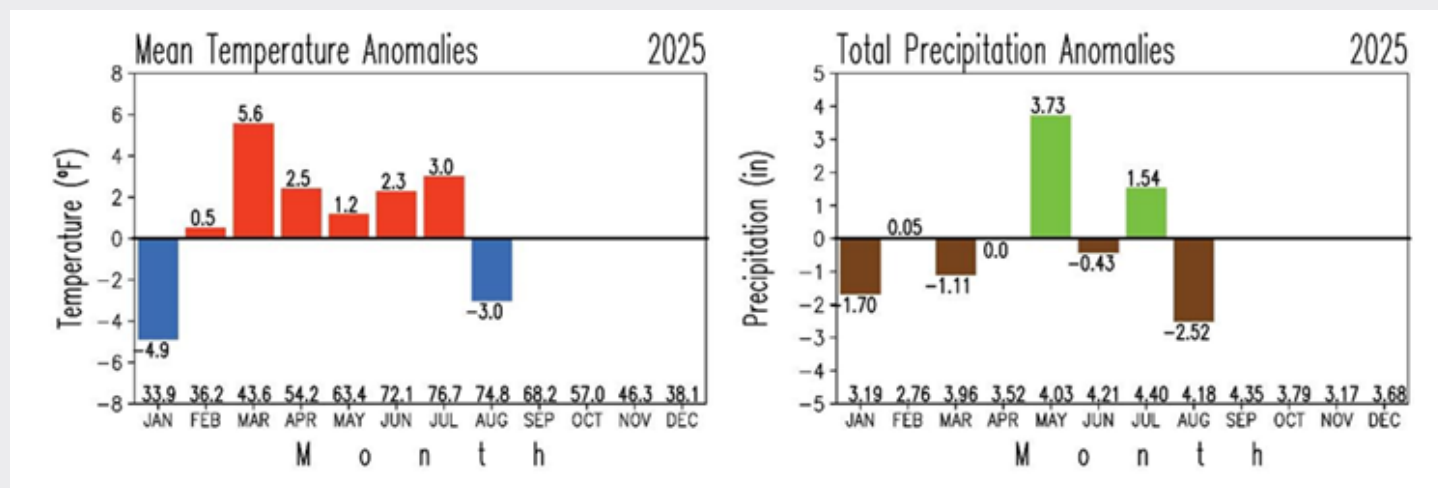


Figure 1: Maryland (statewide) monthly evolution of surface variables and their anomalies from January to August 2025. Anomalies are with respect to the 1991-2020 climatology. Red/blue color represents positive/negative anomalies for mean surface air temperature (left), and green/brown color indicates positive/negative anomalies in total precipitation (right). Temperatures are in °F, and precipitation is in inches. The numbers outside the bars indicate the magnitude of the anomaly, while the number at the bottom of each panel shows the monthly climatology. Data source: NOAA Monthly U.S. Climate Divisional Dataset (NClmDiv), available in preliminary status (v1.0.0-20250905) at: <https://www.ncei.noaa.gov/pub/data/cirs/climdiv/>. The data was downloaded on September 10, 2025.

Impacts of climate change in Maryland have been documented in recently released science communications. The Chesapeake Bay Environmental Center characterizes impacts in the state in five categories: rising sea levels, storms and flooding, shifting ecosystems and habitat loss, agriculture, and health (CBEP, 2025). The Capital News Service (CNS, 2025) describes examples of these impacts across state locations, and in August 2025, the USDA designated Allegany County as a natural disaster area due to flooding, excessive rain and flash flooding (USDA, 2025).

The Chesapeake Bay and Watershed Report Card (UMCES, 2025) was released in June 2025 with scores of “C” for the bay and “C+” for the watershed. The latest report card incorporated new indicators (Temperature Stress, Conductivity), spatial indicator maps, long-term time series for dissolved oxygen, and chlorophyll-a, submerged aquatic vegetation, nutrient loads, and socioeconomic vulnerability metrics. The report card provides a synthesis that links recent extreme heat and intense rainfall in 2024 to declines in some ecological indicators (water clarity, chlorophyll-a).



The 2025 Chesapeake Bay Blue Crab Advisory Report was also released in June (CBP, 2025). This report documents the findings of the winter dredge survey conducted by the Maryland Department of Natural Resources (DNR) and the Virginia Institute of Marine Science (VIMS). The survey results show that blue crab abundance is at the second-lowest level since 1990 (238 million total). The report includes winter dredge indices (time series), juvenile vs. adult breakdowns, and spatial maps of abundance. The blue crab is an economically and ecologically important species in Maryland; low recruitment and adult abundance may reflect climate-related ecosystem stressors (temperature, habitat loss, extreme events) plus fishing and invasive species impacts.

Hypoxia in the Chesapeake Bay was the subject of a couple of relevant publications. A report released by the NOAA Chesapeake Bay Office (VIMS-NOAA-CBP, 2025) documents empirical monitoring of hypoxic volumes in 2024 (near or slightly above long-term averages but with shorter duration), with maps and daily time series, providing an observational baseline useful to connect extreme weather in 2024 with Bay oxygen stress and ecosystem impacts. Model experiments and observational comparisons explain how seasonal wind patterns and watershed inputs drive hypoxia dynamics in the Bay; this is useful for interpreting interannual hypoxia variability (2024–2025 monitoring). This publication contains modeled hypoxic volume time series and sensitivity experiments isolating wind vs. nutrient drivers. This research helps separate climate-driven variability (storms, winds, temperature) from management-driven nutrient trends (Zheng et al. 2024).

The impact of saltwater intrusion in Maryland is explored in recent publications. Saltwater intrusion is a technical and complex issue that is steadily worsening due to climate change's influence on increased flooding and sea level rise. To varying degrees, saltwater intrusion and salinization already impact Maryland's groundwater, surface waters, wetlands, coastal forests, agriculture, and infrastructure. Although progress has been made in understanding current impacts and forecasting future

salinization impacts to agriculture and wetlands, there generally remains no comprehensive understanding of all of the areas currently at risk, and limited knowledge of which areas are at risk in the future (MDP, 2024). Saltwater intrusion is growing in tidal rivers in Maryland (Kaushal et al. 2025), worsened by drought, rising sea levels, altered river flow, and human activities. This threatens drinking water intakes, agricultural soils, and infrastructure. The conversion of farmland to marsh (or degraded land) due to salt stress is already observed in parts of Maryland's coastal plain / Delmarva. A risk framework has been developed for anticipating how climate change and increasing salt pollution coming from both land and saltwater intrusion will trigger chain reactions extending from headwaters to tidal waters (Li et al. 2025). Salt ions trigger chain reactions where chemical products from one biogeochemical reaction influence subsequent reactions and ecosystem responses. This salinization risk framework helps anticipate, prevent, and manage the growing double impact of salt ions from both land and sea on drinking water, human health, ecosystems, aquatic life, infrastructure, agriculture, and energy production.

On the GHG emissions side, two recent publications highlight new science information on methane releases to the atmosphere from land. Methodological advances have been developed for fingerprinting methane sources (clumped isotopes) with applications to wetlands (Sun et al. 2025). This research includes case studies and measurement data useful for regional methane budgets and provides methods that can be applied to Chesapeake wetlands to separate methane from wetlands vs. other local sources, relevant towards interpreting regional GHG budgets. In another investigation, controlled field/mesocosm and biogeochemical analyses from a coastal wetland at the Smithsonian Environmental Research Center demonstrate that warming and altered sulfate cycling reduce anaerobic methane oxidation, causing higher net CH₄ emissions under simulated future conditions (Lee et al., 2025). This research shows wetlands may become a larger methane source as temperatures rise.

Climate change continues to thwart efforts to control air pollution in Maryland; morbidity and mortality due to environmental pollution remain high.

Higher temperatures exacerbate:



Natural biogenic emissions from soils and vegetation;



Evaporation of hydrocarbon-based fuels;



Diesel emissions of black carbon (BC) and ultrafine particles;



Formation of photochemical smog (O3);



Emissions from wildfires.

For example, Figure 2 shows that reductions in coal consumption have dramatically improved concentrations of fine particulate matter, but wildfires are increasingly worrisome in a warmer and drier environment.

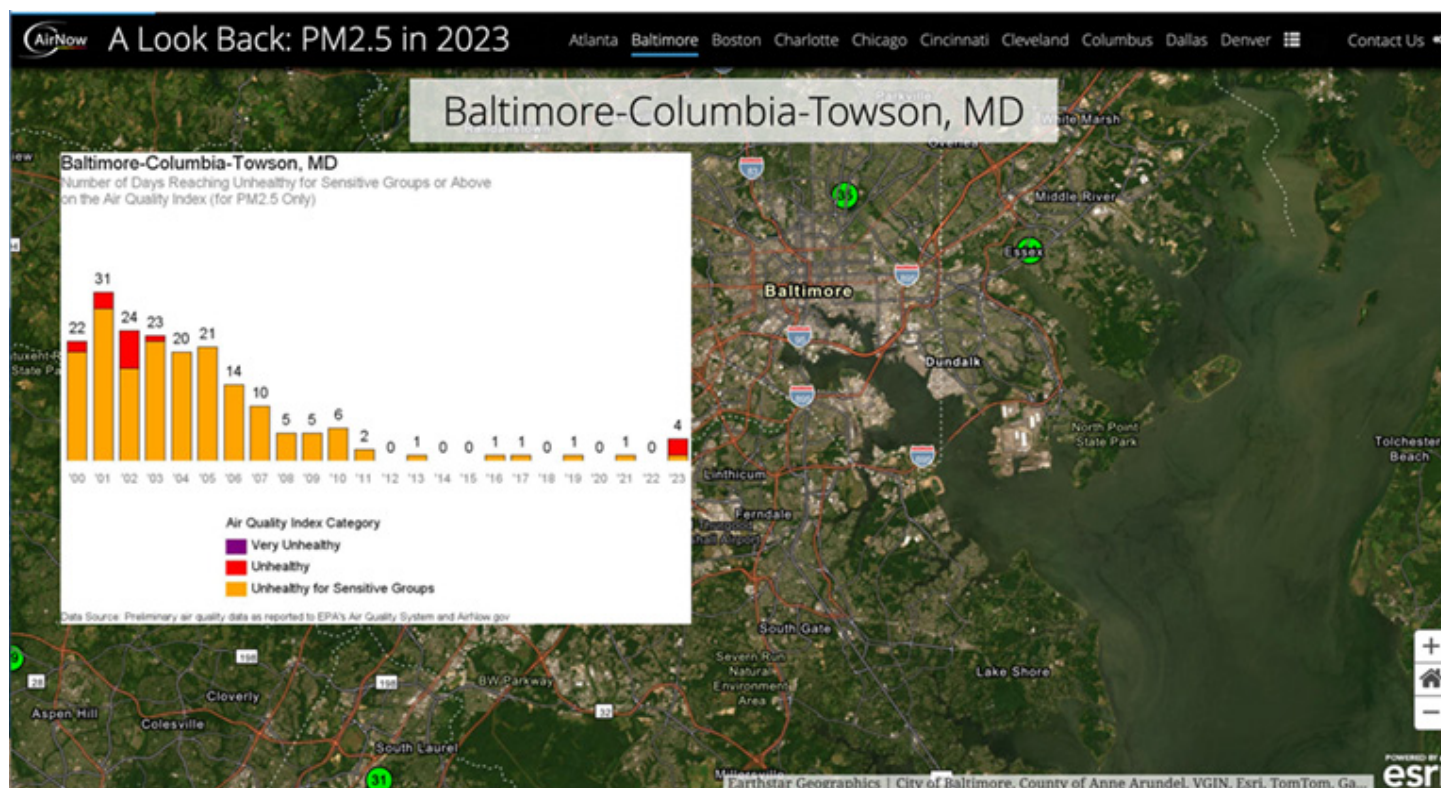
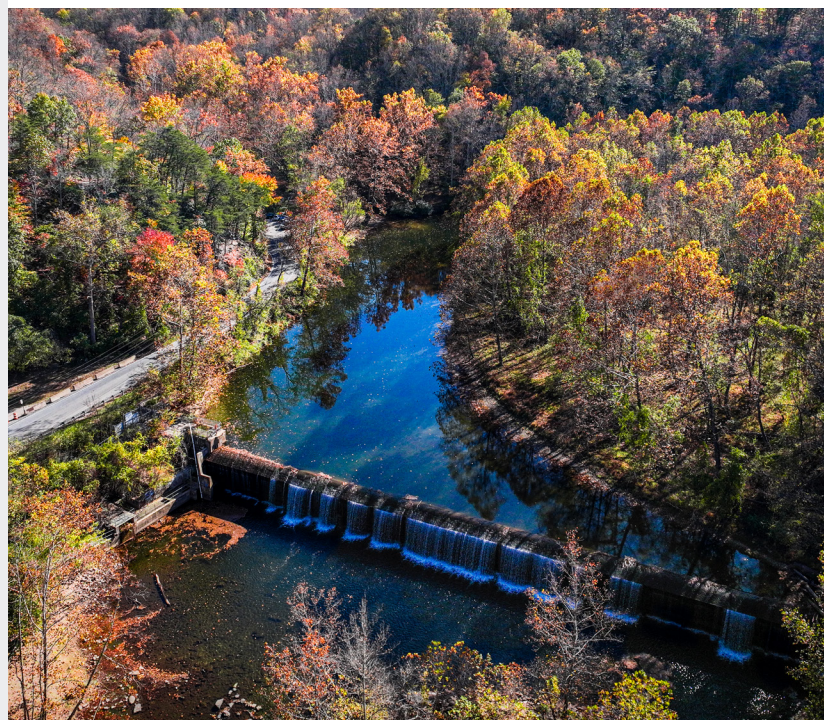


Figure 2: Maryland has seen substantial progress in fine particulate matter, but recently higher temperatures and wildfires have hampered efforts (see **USEPA's AIRNOW** program).

Maryland Climate Data and Technology Developments

The Climate Resilience Network (CRN) continues its development and expansion, bringing together the expertise of UMD scientists with the immediate requirements of Maryland's decision-makers to address the complexities of climate change (Figure 3). Several updates to the CRN have been advanced in 2025, including Hydronet, a water-level network to monitor sea-level and flooding in the Bay and other water bodies. The Maryland Mesonet network continues its development towards improved climate and weather prediction, monitoring variables related to precipitation, temperature, sea level rise, flooding and other climate-related risks. Progress is being made in expanding the Mesonet network to agricultural centers across the state to assess climate impacts on agro-ecosystems.

Through the Maryland Coastal Flood Explorer, DNR and partners continue to develop planning tools to help visualize flood risk and assist local hazard mitigation and planning (Figure 4). This state mapping project provides a look ahead at what areas could become flooded or have potential as beneficial wetlands in the future. This project is intended to help officials prepare for sea level rise and identify areas that need conservation action.

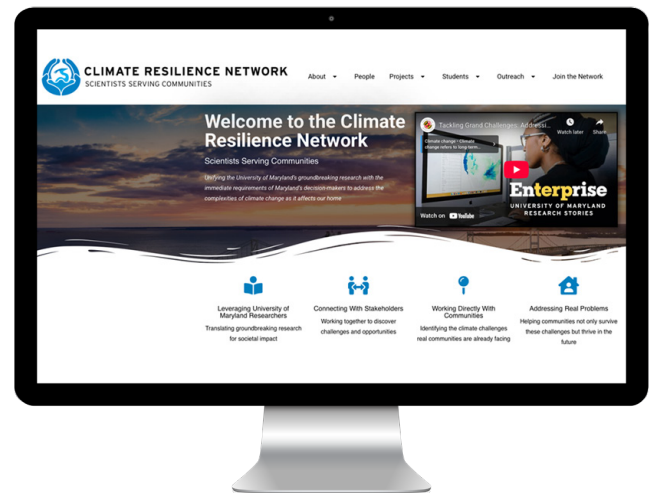


Figure 3: Homepage of the University of Maryland's Climate Resilience Network, a partnership that supports communities in Maryland and neighboring states to educate and mitigate the impacts of our changing climate (<https://climate.umd.edu>).



Update on Climate Science References

- Agarwal, V., Chávez-Casillas, J., Inomura, K. et al. (2024). Patterns in the temporal complexity of global chlorophyll concentration. *Nat Commun* 15, 1522. <https://doi.org/10.1038/s41467-024-45976-8>
- Bradley, A.T., Hewitt, I.J. (2024). Tipping point in ice-sheet grounding-zone melting due to ocean water intrusion. *Nat. Geosci.* 17, 631–637. <https://doi.org/10.1038/s41561-024-01465-7>
- CBEP (2025). <https://bayrestoration.org/climate-change/>
- CBP, (2025). Chesapeake Bay Program 2025 Blue Crab Advisory Report, <https://www.chesapeakebay.net/what/publications/2025-chesapeake-bay-blue-crab-advisory-report>
- Chandler, D.M., Langebroek, P.M., Reese, R. et al. (2025). Antarctic Ice Sheet tipping in the last 800,000 years warns of future ice loss. *Commun Earth Environ* 6, 420. <https://doi.org/10.1038/s43247-025-02366-2>
- CNS (2025). <https://cnsmaryland.org/2025/07/07/climate-change-is-a-local-issue-and-heres-whats-happening-in-every-part-of-maryland/>
- EPA (2024). Climate change indicators in the United States (Fifth ed., EPA 430-R-24-003). www.epa.gov/climate-indicators
- Friedlingstein, P., O'Sullivan, M., Jones, M. W., et al. (2025). Global Carbon Budget 2024, *Earth Syst. Sci. Data*, 17, 965–1039, <https://doi.org/10.5194/essd-17-965-2025>.
- Jay, A.K., A.R. Crimmins, C.W. Avery et al. (2025). U.S. Global Change Research Program, Washington, DC, USA. <https://doi.org/10.7930/NCA5.2023.CH1>
- Kaushal, S.S., Shelton, S.A., Mayer, P.M. et al. 2025, Freshwater faces a warmer and saltier future from headwaters to coasts: climate risks, saltwater intrusion, and biogeochemical chain reactions. *Biogeochemistry* 168, 31. <https://doi.org/10.1007/s10533-025-01219-6>
- Kelley, D. I., Burton, C., Di Giuseppe, F. et al. (2025). State of Wildfires 2024–2025, *Earth Syst. Sci. Data*, 17, 5377–5488, <https://doi.org/10.5194/essd-17-5377-2025>.
- Lee, J., et al. 2025. Climate-induced shifts in sulfate dynamics regulate anaerobic methane oxidation in a coastal wetland. *Science Advances*. DOI: 10.1126/sciadv.ads 6093
- Li, M. R.G. Najjar, S. Kaushal et al. (2025). *Environmental Science & Technology Letters* 12 (8), 881-892, DOI: 10.1021/acs.estlett.5c00505
- National Academies (2025). Effects of Human-Caused Greenhouse Gas Emissions on U.S. Climate, Health, and Welfare. Washington, DC: The National Academies Press. <https://doi.org/10.17226/29239>.
- Nature Climate Change (2025). <https://www.nature.com/nclimate/articles?year=2025>
- NSIDC (2025). Arctic sea ice sets a record low maximum in 2025, <https://nsidc.org/sea-ice-today/analyses/arctic-sea-ice-sets-record-low-maximum-2025>
- Ripple, W., Wolf, C., Mann, M. et al. (2025). The 2025 state of the climate report: a planet on the brink, *Bioscience*, 0, 1-12. <https://doi.org/10.1093/biosci/biaf149>
- Romanello, M. Walawender, M., Hsu et al. (2025). The 2025 report of the Lancet Countdown on health and climate change, *The Lancet*, DOI: 10.1016/S0140-6736(25)01919-1
- Sun, J., et al. (2025). Constraining wetland and landfill methane emissions using clumped isotopologues and monitoring methods. *Journal of Geophysical Research: Biogeosciences* (2025). DOI / link: <https://doi.org/10.1029/2024JG008249>
- UMCES, 2025, 2025 Chesapeake Bay and Watershed Report Card, <https://www.umces.edu/sites/default/files/2025-chesapeake-bay-watershed-report-card.pdf>
- UNESCO. 2024. State of the Ocean Report. Paris, IOC-UNESCO. (IOC Technical Series, 190). <https://doi.org/10.25607/4wbg-d349>
- USDA (2025). <https://www.fsa.usda.gov/news-events/news/08-01-2025/usda-designates-allegany-county-maryland-natural-disaster-area-due>
- VIMS / NOAA / Chesapeake Bay Office — Chesapeake Bay Water-Column Hypoxia Monitoring: End-of-Year Data Report 2024 (published 2025). PDF: <https://www.chesapeakebay.net/what/publications/chesapeake-bay-water-column-hypoxia-monitoring-end-of-year-data-report-2024> (chesapeakebay.net)
- World Meteorological Organization, 2025, State of the Global Climate, WMO-No. 1368, https://wmo.int/sites/default/files/2025-03/WMO-1368-2024_en.pdf
- Maryland Department of Planning, 2025. Maryland's Plan to Adapt to Saltwater Intrusion and Salinization PDF: <https://planning.maryland.gov/Documents/OurWork/RRP/envr-planning/Marylands-plan-to-adapt-to-saltwater-intrusion-and-salinization.pdf>
- Zheng, Y., et al. (2024). Effects of seasonal wind regimes on the evolution of hypoxia in Chesapeake Bay: Results from a terrestrial-estuarine-ocean biogeochemical modeling system. (Book chapter / modeled study; journal link / Sciencedirect) — abstract: <https://www.sciencedirect.com/science/article/abs/pii/S0079661124000132> (ScienceDirect)

Attachments

Appendix A: Progress on 2024 MCCC Recommendations

This attachment provides a progress update on outcomes from recommendations made by the Commission in the 2024 Annual Report.

Appendix A is available [here](#).

Appendix B: State of Maryland Greenhouse Gas Reduction Spending Analysis 2025 Annual Report

The Maryland Department of the Environment (MDE) developed this report that analyzes the total amount of state money spent on measures to reduce greenhouse gases during the previous fiscal year, including what percentage benefited disproportionately affected communities (DACs). This report for fiscal year 2025 is the third publication of State Spending on Greenhouse Gas Reduction since the requirement took effect on June 1, 2023. In addition to greenhouse gas reduction spending data, this year's report outlines the improved data collection process through the newly formed partnership between the Department of Budget and Management (DBM) and the Maryland Department of the Environment (MDE) as well as the new methodology for determining benefits to DACs.

Appendix B is available [here](#).

