Executive Summary

Plastics

Exposing Their Climate Impacts

What we know, what we need to know, & recommendations for research and policy

May 2025

Plastics & Climate

ENVIRONMENTAL LAW INSTITUTE

Monterey Bay Aquarium

UNIVERSITY OF WOLLONGONG AUSTRALIA

See the full report here.

This report is dedicated to Rose Hoffman and all of our elders who taught us to protect nature, and to Amara Mien Rose Kaufman and the current and future generations for whom we must restore it.

REPORT AUTHORS

Holly Kaufman
The Plastics & Climate Project

Dr. Xia (Alice) Zhu
The Plastics & Climate Project

Cecilia Diedrich
Environmental Law Institute (ELI)

Dr. John Doherty
Environmental Law Institute (ELI)

REPORT ADVISORS

Monterey Bay Aquarium
Aimee David
Eleanore Humphries
Cindy Matuch
Margaret Spring

Dr. Karen Raubenheimer
University of Wollongong

Plastics & Climate

ENVIRONMENTAL LAW • INSTITUTE

Monterey Bay Aquarium

UNIVERSITY OF WOLLONGONG AUSTRALIA

ACKNOWLEDGMENTS

The Plastics & Climate Project would like to thank the people and organizations who shared their time, wisdom, and generous contributions, including:

Advisory Board Members

Jo Banner
The Descendants Project
Dr. Dan Lashof
World Resources Institute
Dr. Kara Lavender Law
Sea Education Association
Dr. Karen Raubenheimer
University of Wollongong, Australia
Dr. Sarah-Jeanne Royer
Hawaii Pacific University
Dr. Leah Stokes
University of Santa Barbara

Institutional Partner

This Project and report would not be possible without the support of our institutional partner, the World Resources Institute, especially:

Angela Anderson
Zachary Byrum
Carrie Dellesky
Dr. Dan Lashof
Laurel Mack-Wilson
Angie Restrepo
Emily Vail

Funders

The Plastics & Climate Project is grateful for financial support from the ClimateWorks Foundation for the production of this report. Additional funders and in-kind contributors include an anonymous donor through the Tides Foundation, the Government of Canada (Vanier Canada Graduate Scholarship and the Banting Postdoctoral Fellowship), and generous friends and individuals.

Public Relations Director

Pamela Wellner
AmplifyEco

Project & Publication Technical Support

Justin Konik
Dr. Usha Pillai

Report Editing & Drafting Support

Dave Grossman
Green Light Consulting

Graphic/Report Design

Annie Dore
BeeSpring Designs

Other Advisors & Supporters

Dr. Thomas Axworthy
Dr. Jamala Djinn
Judith Enck
Environmental Law Institute
Jay Austin
Dr. Rebecca Kihslinger
Sofia O'Connor
Sandra Nichols Thiam
Dr. Lisa Erdle
Dr. Ben Halpern
Amara Mien Rose Kaufman
Molly Morse
Dr. Geeta Persad
Dr. Kim Prather
Dr. Chelsea Rochman
Ieva Rucevska
Dr. Ben Santer
Natalia Skripnikova

EXECUTIVE SUMMARY

Existing scientific data clearly show that plastics affect the climate. However, there are significant gaps and shortcomings in the data, which preclude a complete understanding of how plastics affect the climate and to what extent. This report summarizes the findings of a recently published systematic review of the scientific literature on the plastics-climate nexus in *Frontiers in Environmental Science*. This review highlighted what is and is not known about the impact of plastics on the climate. The *Frontiers* paper outlined a research agenda to fill these knowledge gaps, and it included general policy and other recommendations to support that research and promote the incorporation of plastics' climate impacts in scenarios, inventories, models, analyses, and assessment reports related to plastics, climate, or both. This report synthesizes and elaborates on the *Frontiers* paper to help these issues reach an audience beyond the scientific community.

While conventional plastics and the petrochemicals in them are part of the fossil fuel industry, those fossil fuels are used as feedstocks, not combusted. Nevertheless, the *Frontiers* paper identified and evaluated **three main ways that plastics can influence the climate**.

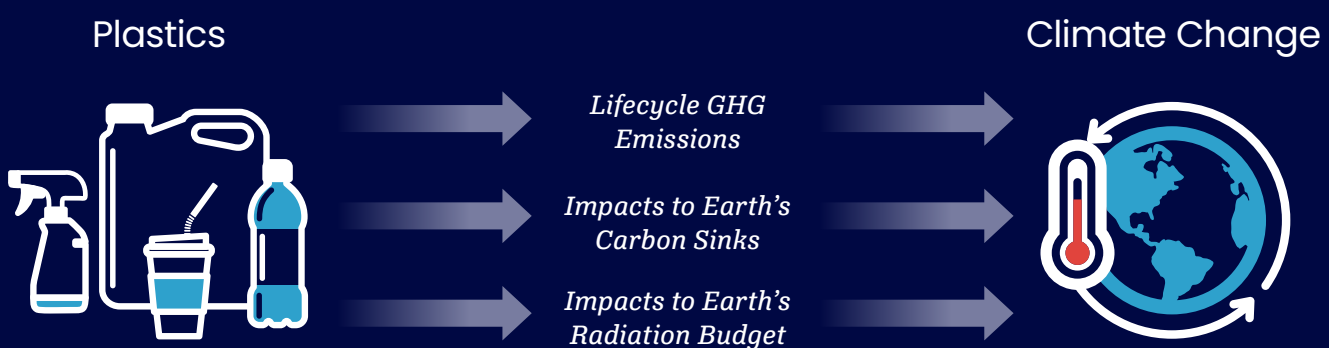
First, all phases of the plastics lifecycle — primary production (including extraction of raw materials), product manufacturing, transportation, consumption (i.e., use), and waste — generate **greenhouse gas (GHG) emissions**, increasing atmospheric GHG concentrations and accelerating global warming. To date, studies have mostly focused on GHG emissions from the two ends of the plastics lifecycle (primary production and waste management) and have given much less attention to the other phases. These and other data gaps make it difficult to discern the full extent of GHGs emitted across the entire plastics lifecycle. The existing data indicate that the plastics lifecycle is responsible for roughly 4% of total global GHG emissions at present, though the data gaps mean it is almost certainly higher (i.e., the plastics sector may be consuming more of the remaining carbon budget than currently assumed).

Second, the various forms of plastic pollution (including macroplastics, microfibers, other microplastics, nanoplastics, and the chemicals in plastics) affect a range of organisms and ecosystems that are vital to the planet's **carbon cycle**, altering the way that carbon is absorbed from the atmosphere and stored in plants, soils, the ocean, and other carbon sinks. The less carbon stored in sinks, the more remains in the atmosphere, which leads to global warming and worsens climate change. Existing data indicate that plastics are adversely impacting the oceans' ability to remove carbon from surface waters and store it in the deep ocean, are harming the health of microscopic marine plants that use carbon dioxide for photosynthesis (and thus act as carbon sinks), and are increasing the release of carbon dioxide from soils. The data for some other metrics relevant to the carbon cycle are not always clear (and are sometimes contradictory), but studies generally find that plastics impact the carbon cycle in ways that increase warming.

Third, plastic particles may physically affect the **Earth's radiation budget**, changing how the planet reflects, absorbs, traps, and moves energy in the atmosphere and on the surface of the Earth. This is still a relatively new area of research, and only a few scientific studies have performed actual tests. Still, the indications are that plastic particles on the surface may increase reflectivity, which would have a cooling effect, and that plastic particles in the atmosphere may directly affect energy exchange between the surface and the atmosphere in ways that would also produce a cooling effect. However, because this area of research is so new and few tests have been done, much remains unknown.

The available science indicates a strong linkage between plastics and climate impacts and points to key areas of further research needed to better understand and quantify those impacts. Because numerous knowledge gaps, unclear results, and methodological shortcomings limit understanding of how plastics affect climate change, the *Frontiers* paper identified specific areas for research attention going forward in each of the three categories of impacts:

- **GHG emissions:** there is a need for more studies that estimate GHG emissions and GHG emissions intensities across the entire plastics lifecycle, particularly for lifecycle stages with little to no existing data and for a broader range of plastic types. In addition to global-scale studies on the plastics lifecycle, more national-level studies are needed to address the fact that the scientific literature is missing GHG data from the plastics lifecycle for most countries. This category of impacts is expected to contribute most to global warming, and filling in the unknowns in this category is a priority.
- **Carbon cycle:** more experiments and modeling efforts are needed that focus on Earth's terrestrial, marine, and coastal ecosystems. More data are needed on ecosystems and natural processes that have received inadequate study and/or where studies have produced conflicting results about plastics' effects on carbon sinks.
- **Radiation budget:** this is the area that is least well understood. More experiments and studies are needed to fill in the knowledge gaps in this category, including research to elucidate the quantities and types of plastics that are infiltrating clouds, the direct and indirect impacts of atmospheric plastic debris, and the effect of plastic particles on the reflectivity of the planet's surface and the melting rate of ice and snow.



Entities in both the public and private sectors, from the international to the local levels, should take steps to support filling in these data gaps and to promote the inclusion of plastics' impacts on climate in carbon accounting, GHG emissions inventories and scenarios, climate models, and any relevant evaluations of plastics' impacts. Only by enhancing understanding of how these two global challenges are intertwined will it be possible to address the impacts of each issue effectively, through science, policy, technology, multi-sector engagement, public awareness raising, investment, and other levers of change.


Plastics
&
Climate
ENVIRONMENTAL
LAW • INSTITUTE
Monterey Bay
Aquarium
UNIVERSITY
OF WOLLONGONG
AUSTRALIA
PlasticsAndClimate.com
Info@PlasticsAndClimate.com