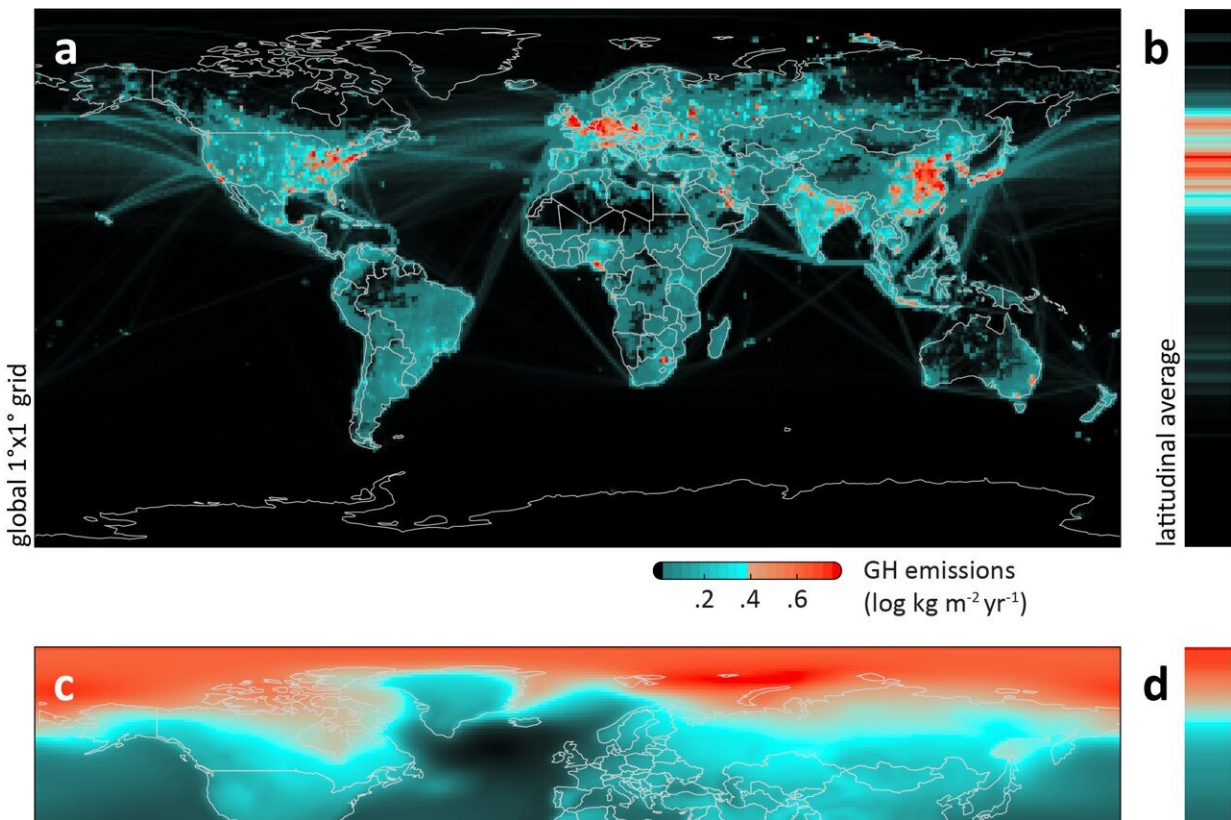


New study puts disparities of climate change on the map

July 14 2021



(A) Anthropogenic GH emissions (CO₂, BC, CH₄, and N₂O) averaged from 1970 to 2018, (B) summarized in columnar form by 1° latitude means. (C) Multimodel ensemble of surface air temperature departures for the RCP 8.5 scenario over 2050-2099 relative to the 1956-2005 temperature baseline, (D) also averaged in 1° latitude bins. Extreme emissions are largely concentrated in human population centers (see fig. S18), while extreme temperature shifts are widespread at high latitudes. By comparison to land, the ocean has a lower amplitude in both datasets, with few emissions and lower projected temperature

shifts. Credit: Monterey Bay Aquarium

New research, led by the Monterey Bay Aquarium, illustrates the disparity between the narrow origins and far-reaching impacts of greenhouse emissions responsible for disrupting the global climate system. Published in *Science Advances* today, the study was built upon the most comprehensive accounting of global emissions from the burning of fossil fuels. It reveals that the regions generating the most emissions are different from those expected to suffer the most severe warming. The result of this comparison shows the fundamental disparities—quite literally putting them on the map—associated with where, and who, will experience the greatest impacts of climate change.

"One of the dirty tricks of [climate](#) change is that local pollution has far-reaching consequences," says former Aquarium Chief Scientist Dr. Kyle Van Houtan, who led the study during his tenure. "When we burn fossil fuels like coal, oil, and gas locally, we mix them in the experimental chamber pot of our planet's atmosphere. The result is that their warming impacts are often exported to far away locations."

The study reinforces that, while people living near refinery, drilling, and manufacturing facilities experience localized health and environmental impacts, emissions from a relatively small area are raising temperatures in communities and ecosystems around the world.

To reach these conclusions, the study charts discharges of the top four heat-trapping agents, which make up 92 percent of all [greenhouse emissions](#), from 1970 to 2018: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and black carbon (sometimes referred to as PM_{2.5}). The authors compared the sources of those emissions to global temperature projections over the entire surface of the planet.



(A) Pairwise scatter plot of combined GH emissions (Fig. 1A) and projected surface temperature anomalies (Fig. 1C). LCDI is the perpendicular distance from the diagonal of the emission-temperature relationship, capturing the ratio of the vertical and horizontal change between the two datasets and reflecting the local disparity from the global emission-forcing relationship. Hollow circles represent individual $1^\circ \times 1^\circ$ cells ($n = 64,800$). (B) Histogram of the global disparity shows that 99% of pixels fall above zero or occur above the diagonal line in (A). (C) Global projection of LCDI across both terrestrial and marine regions. Negative values (cyan) indicate relatively more emissions than temperature shifts, whereas positive values (black and red) signal the inverse. Both panels are derived from projected near-surface warming over 2050-2099 under the IPCC RCP 8.5 scenario. Credit: Monterey Bay Aquarium

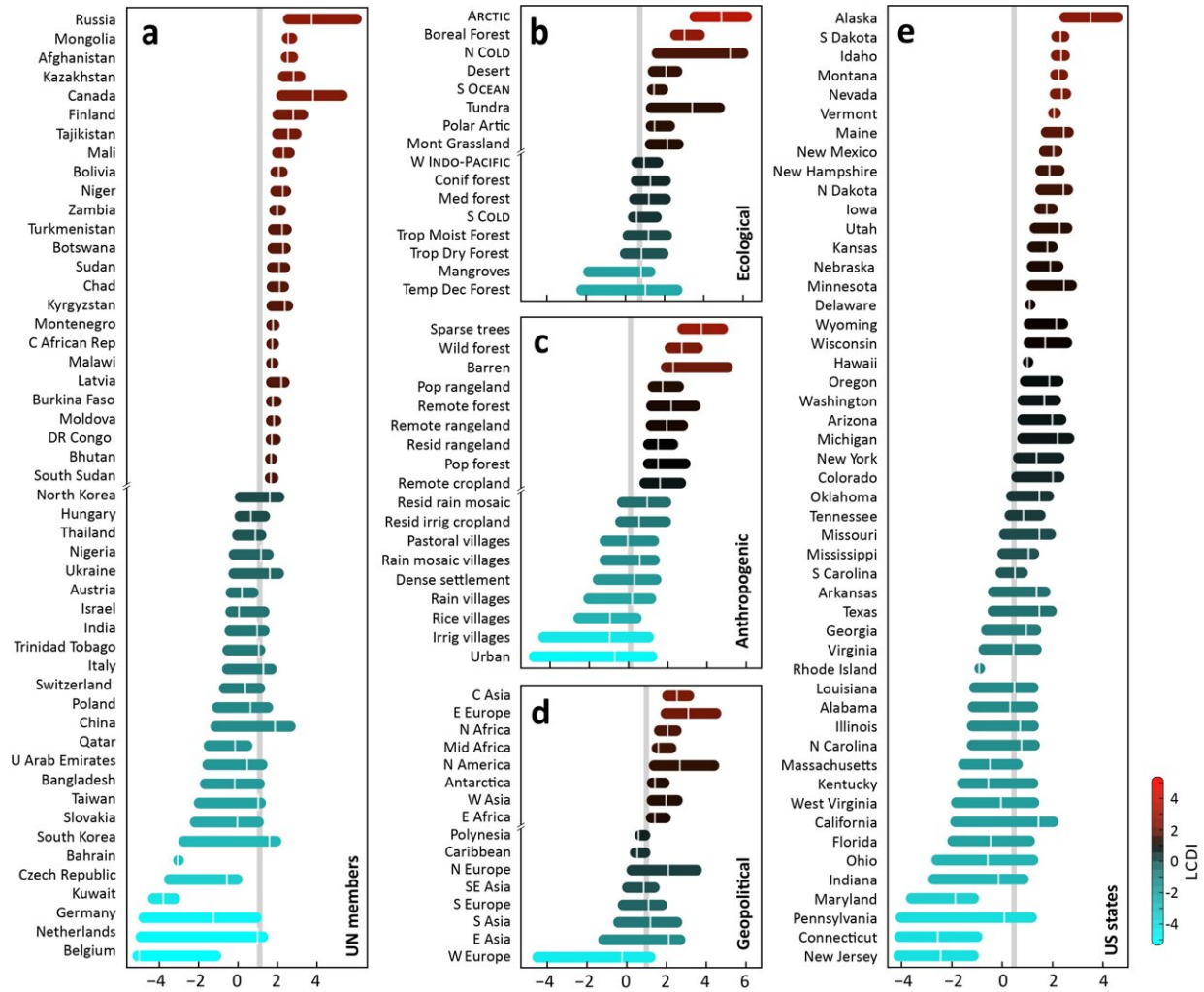
They confirmed that, while the source of emissions causing climate change are concentrated, the impacts are widespread. Remarkably, 90 percent of all greenhouse emissions are generated from human activities across eight percent of Earth's surface area—yet more than half of Earth's landmass will experience extreme warming by the end of the 21st century.

The study also mapped the economic disparities that are inherent with

climate change. The researchers showed how more developed and industrialized regions such as western Europe, northeastern North America and the Arabian gulf states emit more extreme amounts of heat-trapping emissions but will experience relatively fewer climate impacts. Countries in Africa and across Central Asia, which produce some of the lowest amounts of these emissions, will experience the most disruption from the impacts of burning of fossil fuels.

The disparities illustrated on the global map can also be found within individual countries. For example, most greenhouse emissions within the United States originate in the more industrialized northeastern region (New Jersey, Connecticut, Pennsylvania). Warming, though, is more likely to happen in the west—most notably in Alaska, South Dakota, Idaho, and Montana.

This study helps visualize the outsized role the ocean plays in absorbing emissions-driven warming. While it is estimated that the ocean takes in about 93 percent of the excess heat that is a consequence of these emissions, the researchers calculated that over 95 percent of the greenhouse emissions measured originated on land.



LCDI model outputs aggregated for cells according to (A) UN member state (including their EEZs), (B) ecological biome, (C) anthropogenic biome, (D) geopolitical region, and (E) U.S. state boundaries. Horizontal bars span the 10th to 90th quantiles, and vertical white bars are the median. Bars pool the LCDI outputs from all GH gas emission scenarios (RCP 4.5 and 8.5) and 21st century periods (2006-2055 and 2050-2099). Regional units retain the color symbology from Fig. 2 and are ranked by their 10th quantile (see fig. S11). Sparsely populated, northern latitude areas (Russia, Arctic Ocean, and Alaska) have low emissions and extreme warming, where densely populated temperate regions (Belgium, western Europe, and New Jersey) have high emissions and relatively small temperature shifts. For display purposes, (A) to (C) show only the outer tails of a larger data series set. The Supplementary Materials present boundary maps for each regional set (figs. S8 to S11) and full versions of abridged series

(figs. S13 to S17). The gray vertical line spanning each panel is the median value of each set. Credit: Monterey Bay Aquarium

In serving this role, the ocean mitigates the worst impacts of climate change for all humankind.

"Our findings offer a stark rendering of what the ocean does for us," says Dr. Van Houtan. "Covering 72 percent of our planet, the global ocean serves as the heart of our climate system, regulating weather patterns and transferring heat and water around the planet. But we can't take the ocean for granted. We need to protect ocean health so that it continues to play this vital role for all people on Earth. We need to focus on drastically reducing greenhouse emissions and adapting to climate impacts so that we can protect and maintain the ecosystem services we all depend on for survival."

Study authors say the warming projections reinforce the urgent need for global collective action to avoid the 1.5 degrees C above pre-industrial levels by the end of the century. It underscores the need for data visualization and science communications to facilitate productive public dialogue about equitable climate solutions. It also highlights the outsized role the ocean plays in mitigating against the worst impacts for all humankind.

"When we listen to the scientific consensus—and to the people suffering most from climate disruption—we see that only a broad, international collaboration to stabilize our planet's climate will work," says Dr. Van Houtan. "And by working together today to reduce our reliance on fossil fuels, we can protect the global [ocean](#) and living world that sustains all life on Earth."

More information: "The geographic disparity of historical greenhouse emissions and projected climate change" *Science Advances* (2021). [DOI: 10.1126/sciadv.abe4342](https://doi.org/10.1126/sciadv.abe4342)

Provided by Monterey Bay Aquarium

Citation: New study puts disparities of climate change on the map (2021, July 14) retrieved 23 June 2024 from <https://phys.org/news/2021-07-disparities-climate.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.