



**EXTREME WEATHER
&
OUR CHANGING CLIMATE**

an ebook from Moms Clean Air Force

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**FIGHTING FOR
OUR KIDS' HEALTH**



HOW DOES GLOBAL WARMING WORK?

Greenhouse gases—such as carbon dioxide, methane, and hydrofluorocarbons (or HFCs)—trap infrared radiation in the earth’s atmosphere. That’s the greenhouse effect.

The greenhouse effect warms the planet. It is natural, and necessary for life on earth; without it we would not be able to live on a frozen planet. The more greenhouse gases there are in the atmosphere, the more it holds heat.

But beginning with the Industrial Revolution, humans have been adding greenhouse gases to the natural mix that makes the climate comfortable for us. Scientists have been studying humans’ contribution to global warming since 1896. Back in 1917, scientist Alexander Graham Bell, the inventor of the telephone, wrote that the unchecked burning of fossil fuels “would have a sort of greenhouse effect” and “the net result is the greenhouse becomes a sort of hot-house.” Even then, Bell advocated for the use of solar energy!

Bell was correct: Earth’s greenhouse effect has been amplified by the large amount of heat-trapping gases we have emitted into the atmosphere, mainly through the extraction and burning of fossil fuels. Climate scientists can measure the carbon in the atmosphere that is contributed by human activity; it has a specific chemical “fingerprint.”

In addition to carbon dioxide, climate scientists are concerned about short-lived climate pollutants, such as black carbon, soot, methane, HFCs, and tropospheric ozone. They don’t stay in the atmosphere as long as carbon dioxide, but are much more potent greenhouse gases. They account for about one-third of global warming.

The earth is warming quickly. Polar ice is melting and ocean levels are rising.

The very chemistry of the oceans, which absorb carbon, is changing, becoming more acidic.

This is global warming, which is causing climate change. And climate change means our weather is changing, too.

WHAT'S THE CONNECTION BETWEEN GLOBAL WARMING AND THE WEATHER?

Climate change has an enormous impact on our weather. Our weather patterns are unfolding in the context of a warmer climate. And we are all seeing, and feeling, the dramatic ways in which our weather is changing. Climate change is stacking the decks for certain types of extreme weather. New research shows that we may not see more storms, but the intensity of storms is expected to rise.

“Weather on steroids” feels different in various parts of the country. Global warming is making droughts more severe, and it is making rainfall and floods more severe, too. It sounds contradictory, but global warming delivers a double whammy.

There are places on our planet that are naturally dry, of course. And places that are naturally wet. With global warming, the wet get wetter and the dry get drier.

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“The answer to the oft-asked question of whether an event is caused by climate change is that it is the wrong question. All weather events are affected by climate change because the envelope in which they occur is warmer and moister than it used to be.”

CLIMATOLOGIST KEVIN TRENBERTH





THE BIG THREE

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Climate scientists are watching the weather for cues about how global warming is affecting our lives.

They are paying attention to The Big Three.

HEAT AND MEGA-HEAT WAVES

And the air-pollution issues that are related to higher temperatures, like ozone levels.

HEAVY RAINFALL

As we warm the planet, we also increase the risk of heavy downpours. A warmer atmosphere holds more moisture, and as a result, we're seeing an increase in very-heavy-rainfall events.

DROUGHT

According to the U.S. Drought Monitor, parts of every state except for Alaska and Ohio are either abnormally dry or in some form of drought.”

**DR. HEIDI CULLEN,
CHIEF CLIMATOLOGIST, CLIMATE CENTRAL**

Read Dr. Cullen's full interview at the end of this book.

HEAT AND MEGA-HEAT WAVES

We are breaking temperature records, worldwide, at unprecedented rates.

Higher temperatures mean higher ground-level ozone concentrations, which are formed primarily from photochemical reactions between two major classes of air pollutants, volatile organic compounds (VOC) and nitrogen oxides (NO_x).

When ozone is inhaled it irritates the respiratory tract and causes a range of serious health problems.

Extended heat waves are especially dangerous for the elderly and children, whose bodies don't have the same capacity for temperature regulation as adults do. For children playing outside in the summer months, this can be especially problematic.

Extreme heat might be the most dangerous form of extreme weather in the U.S. People can handle excessive heat if the body has the chance to recover during cool nights. As night temperature increases, people become more sensitive to daytime heat, which increases the adverse health effects of excess heat. Hot temperatures can cause heat exhaustion and potentially fatal heat stroke.

Airnow.gov, newspapers, and radio stations provide real time estimates of your local air quality. Check the ozone forecast, and limit outside activity on high ozone days.

It's a vicious cycle. When temperatures rise, so does energy use, as more people keep air conditioners running for longer periods. Unless your utility is providing only solar or wind energy (and that's not happening anywhere—yet) this means that more carbon from burning coal and methane from natural gas development goes into the atmosphere, causing more global warming.





HEAVY RAINFALL

In a warmer world, there is more evaporation of moisture—from the air, and from large water bodies, including oceans. A warmer atmosphere holds more moisture—there’s simply more water vapor up there. So when it rains, we get very heavy rainfall.

The US is receiving an increasing proportion of its rainfall from intense, one-day, heavy precipitation events.

The Northeast, specifically, has received more intense rainfall than usual in the past decade.

Those kinds of fast and furious rainfalls bring flash floods.

This is as much of a problem inland—as folks in Vermont and Tennessee know all too well—as it is in our coastal towns and cities, where rising sea levels make storm surges more destructive, as we saw with Hurricane Sandy.

EXTREME DROUGHTS OF LONG DURATION

During a drought, the sun bakes the soil, and that heats up the air even more. When rain finally does fall, heavy and fast, it just runs off the surface. That kind of rainfall doesn't help the plants at all. It also causes flash flooding.

The U. S. Heartland may see Dust Bowl conditions from Kansas to California by 2050. This has an obvious impact on our ability to grow food.

As vegetation dies from heat and drought, it throws off more CO₂, which leads to more warming.

Drought, higher temperatures, and earlier snowmelt create the perfect conditions for wildfires. We are now experiencing monster fires that consume tens of thousands of acres in record time. Current U.S. wildfire seasons last two months longer and burn up twice as much land as they did forty years ago.

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*“A 100,000-acre wildfire used to be unusual;
you would see one every few years.
Those type of fires are becoming a yearly occurrence.”*

FOREST SERVICE EMPLOYEE CARL ALBURY

Climate Progress reports that: “History speaks for itself. Wildfires are becoming longer, more acres are burning, and the costs and fatalities are on the rise as well. Climate change is setting the stage for the new age of conflagration, bringing warmer temperatures and extensive, prolonged drought. Insect infestations made possible by warmer winters are also killing off huge areas of forests, leaving acres of dead standing trees, ready to burn.

The seven largest U.S. fire seasons since 1960 have burned in the last thirteen years, and 2013 has already resulted in the most destructive wildfire in Colorado history and caused the death of nineteen firefighters in Arizona.”





THE BIG PICTURE

Our climate is growing unstable. We are experiencing an unprecedented kind of “high energy” weather.

Humans have had 10,000 years of a comfortable, life-enhancing climate on earth. We don’t want that to end!

In a rapidly warming climate, with our weather whiplashing between monstrous events, no one wins.



WHAT CAN YOU DO TO SLOW THE RATE OF GLOBAL WARMING?

Global warming is the mother of all air pollution problems—and the only way to solve it is to cut greenhouse gas emissions, like carbon and methane.

1. You can support the passage of EPA regulations that cut carbon pollution from power plants. The EPA has the authority to regulate carbon, which the Supreme Court has ruled is a pollutant.

[Sign our petition here.](#)

2. Unite to end tax breaks for oil and gas companies. They have been supported by taxpayers for more than a century—and they are making record profits, but paying nothing to cover the costs to all of us of their pollution. They don't need tax subsidies.

[Sign our petition here.](#)

3. You can write to your utility provider and demand more renewable energy sources in your electricity mix.
4. You can use the power of your dollars: buy appliances with the highest energy efficiency standards, and ask your local shops to carry them. If you remodel, take advantage of all the ways to insulate your house. Energy is precious, and we don't want to waste it.





JOIN THE MOTHER OF ALL CAMPAIGNS

Over 150,000 moms, dads, brothers, and sisters are uniting for an end to the air pollution that harms our children's health and compromises our climate.

Join Moms Clean Air Force and unite to slow global warming now.

www.momscleanairforce.org

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View a list of resources about climate and extreme weather here:

<http://www.momscleanairforce.org/extreme-weather-resources>

THE DOUBLE WHAMMY: FLOODS AND DROUGHTS

INTERVIEW WITH DR. HEIDI CULLEN

Heidi Cullen—a Leadership Circle member of Moms Clean Air Force and our go-to source on all matters of weather and climate—is the Chief Climatologist for Climate Central in Princeton, New Jersey. Prior to that, she was the climate expert and correspondent for The Weather Channel where she helped start Forecast Earth, the first weekly program on climate change and the environment. Cullen has also worked as a scientist at the National Center for Atmospheric Research in Boulder, Colorado. She received a B.Sc. in engineering and operations research from Columbia University and a Ph.D. in climatology and ocean-atmosphere dynamics from Columbia University's Lamont-Doherty Earth Observatory. Cullen's first interview with Moms Clean Air Force, on the connection between weather and climate, quickly became one of our most popular resources.

GLOBAL WARMING BRINGS US HEAVIER RAINSTORMS AND FLASH FLOODING - BUT IT ALSO MAKES DROUGHTS MORE SEVERE AND LONGER LASTING. THAT SEEMS COMPLETELY CONTRADICTIONARY. I CALL IT THE "CLIMATE DOUBLE WHAMMY." CAN YOU HELP US MAKE SENSE OF THIS?

Let's start with the more droughts/more rain part. Basically, when it comes to precipitation, scientists often say "the rich get richer and the poor get poorer." In other words, the wet get wetter and the dry get drier.

There is a physical argument behind this effect. There are places on our planet that are naturally dry and places that are naturally wet. It has to do with where high and low pressure systems fall on our planet. High pressure systems generally denote stable, dry, descending air, and they correspond to drier regions. Low pressure systems generally denote moist, unstable, ascending air, and low pressure systems correspond with wetter regions.

According to a draft form of the forthcoming Third National Climate Assessment Report, the northern tier of the U.S. (especially the Northeast and Alaska) is projected to see increased precipitation, while the southern tier (especially the Southwest) is projected to see a decrease.

WHAT ABOUT THE INCREASED INTENSITY OF DOWNPOURS?

That's the other part of this double whammy. If you get the feeling that heavy downpours are more intense than they used to be, you're not imagining it. The most extreme precipitation events (those in the top one percent of intensity) have increased in every region of the contiguous states since 1950.

The rise in intensity has been greatest in the Northeast and least in the Northwest, although it's still a rise. Climate scientists believe the reason for heavier rain events is simple: in a world warmed by heat-trapping greenhouse gases, there's more evaporation, the atmosphere can hold on to more water, and when that water vapor condenses as rain or snow, there's more of it.

It is important to note that while the trend in intensity has been upward, it has not been steady with ups and downs from one decade to the next. This shows something else climate scientists often point out: human-caused climate change hasn't replaced natural variability; it comes on top of it.

AND WHAT ABOUT PLACES THAT ARE MORE NATURALLY DRY, BUT STILL GET RAIN FROM TIME TO TIME?

Take the U.S. Southwest. It's a dry region, but it does get some rain. The concern—and climate models consistently agree—is that the region will see an overall decrease in precipitation. When it does rain, the rain will be heavier with longer periods of drought in between. In other words, less rain overall but heavier when it does come. This can create conditions that lead to flash flooding.

SO THESE SUPER SOAKERS—THEY DON'T HELP BREAK THE DROUGHTS?

Not necessarily. Think about the dream rain for a farmer: it is soft, slow, steady rain that comes down over a long period and soaks into the soil.

THAT'S A GARDENER'S DREAM RAIN TOO!

Yes. But what's happening more and more often is that the heavy rain runs right off the baked surface of a drought-stricken earth, and it can take a great deal of the topsoil with it. The rain simply can't soak in and replenish soil moisture. That's what crops need, of course.

AND THEN WE HAVE A COLD SPRING, AND IT MAKES PEOPLE THINK, WELL, GLOBAL WARMING ISN'T SO BAD AFTER ALL.

It is so important to understand the enormous difference between natural climate variability—which we will always have—and our manmade contribution to the climate, and how that affects our weather. We cannot be taken by surprise when we have a cold winter or spring.

But we must remember that in everything now, there is a steady drumbeat of warming in the background. And there's a time lag in the warming effect.

WILL YOU TALK ABOUT THAT? I HEAR SCIENTISTS REFER TO THE EFFECTS WE ARE SEEING NOW REALLY DUE TO GREENHOUSE GASES SENT UP IN THE 1980S. HOW CAN THAT BE?

The short answer is the ocean. The ocean has been doing us an enormous service. It has been pulling in more than 90% of the heat that is being generated by greenhouse gas emissions. The ocean takes longer to warm up than the air. Think about how long it takes to boil a pot of water. The ocean has a high heat capacity.

We are tampering with a slow moving system that has a ton of different components—our climate. So many things absorb the additional warming: the continents, the oceans, and ice sheets.

When our climate system gets loaded up with all this additional heating, the system stays warm for a very long time. That is why we think of the warming as essentially irreversible for thousands of years. I think of as the creating the "perfect risk."

YOU CAN'T UNBAKE THE BROWNIE?

Exactly. You can't unboil the egg.

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