

THE C-CHANGE CONVERSATIONS PRIMER

Answers to the Five Questions
Most Americans Have About Climate Change



C·CHANGE
CONVERSATIONS

Promoting Informed
Discussion About
Climate Change

The earth's climate has always fluctuated for natural reasons, but for the last 10,000 years when human civilization has flourished, it has been remarkably stable. **Today, we are triggering a period of instability that would not be occurring naturally.** We are doing this primarily by burning fossil fuels, which is adding greenhouse gases (carbon dioxide, methane, nitrous oxide) to our atmosphere. These gases make up a minuscule part of the atmosphere, normally less than 1%. Greenhouse gases play an important role in making our planet warm enough to live on. They capture enough heat to give us an average global temperature of about 60°F, supporting the development of human civilization. When we add more greenhouse gases, we trap more heat and upset the carbon balance we have enjoyed since the last ice age. At the same time, we are further upsetting the carbon balance by deforestation and other land use changes.

All of this has already led to significant changes in temperature, water availability, and agricultural systems, and will pose increasing risks for our children and grandchildren.



While the majority of Americans across party lines recognize climate change is happening, many do not understand how it will impact them directly and why there is urgency to address it. To help all of us understand why this is such an important issue, our non-partisan program provides scientifically grounded answers for the five questions many of us have about climate change. They are:

HOW DO WE KNOW CLIMATE CHANGE IS REAL? P1

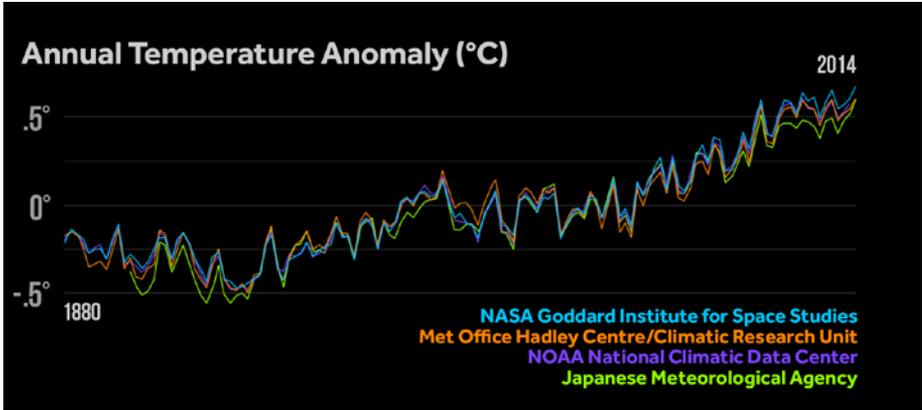
HOW DO WE KNOW CLIMATE CHANGE IS CAUSED BY HUMANS? P2

WHAT IS THE SCIENTIFIC CONSENSUS? P2

WHAT ARE THE DANGERS? P3

IS THERE HOPE THAT WE CAN MEET THE CHALLENGE? P6

HOW DO WE KNOW CLIMATE CHANGE IS REAL?



Measurements:

Scientists measure temperature at over 10,000 sites every day around the world. Four different agencies in the US, UK, and Japan are responsible for analyzing the data. They have found global temperatures are rising swiftly everywhere.

Historical evidence:

There are multiple lines of historic scientific evidence. Paleo-climatologists use ice cores that date back 800,000 years to study the correlation of temperatures and carbon dioxide levels, as well as tree rings and sea-life fossils to research past climates. Carbon dioxide levels have not been this high for at least 3 million years and modern humans have not lived on earth with carbon dioxide levels this high.

Observation:

Older, thicker, Arctic Ocean ice is melting and glaciers are disappearing. Glacier National Park had 150 glaciers in 1910. Today there are 25; it is estimated there could be zero as early as 2030. Additional observations include melting land ice, diminishing snowpack, shifting seasons, increases in certain types of extreme weather, ecosystem and animal migration, longer allergy and mosquito seasons, and worsening air quality.



photo: William O. Field



photo: Bruce F. Molloy

These photos of Alaska's Muir Glacier were taken from the same location, at the same time of year, 60 years apart.

HOW DO WE KNOW CLIMATE CHANGE IS CAUSED BY HUMANS?

Carbon molecules from fossil fuel emissions have a different isotope than other carbon molecules, giving them an easily identifiable fingerprint. They are proliferating more rapidly than other carbon molecules.

Scientific models for natural causes of temperature change—such as wobbles in the earth’s orbit and tilt, solar flares and volcanic activity—suggest the earth should be in a cooling phase now. Scientists are not able to account for the current warming trend without including fossil fuel emissions.

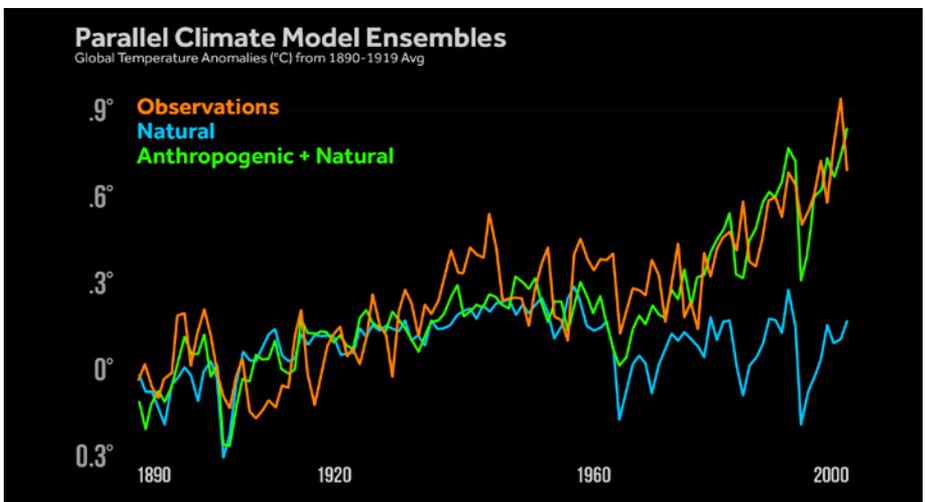
97% of research studies and the oil companies agree, we are causing climate change.

WHAT IS THE SCIENTIFIC CONSENSUS?

According to NASA, 97% or more of climate scientists publishing climate-related research agree that human-caused climate change is happening. This is as strong as the consensus that smoking cigarettes increases the chance of lung cancer.

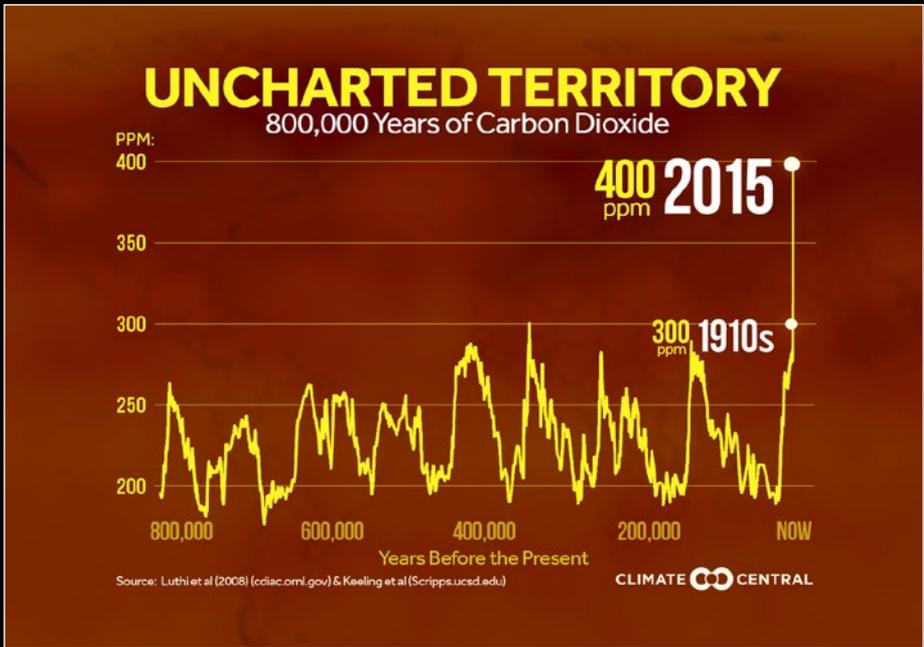
Prestigious scientific associations agree, including the national academies of science of the world’s leading nations, all of which came together and issued a warning about climate change in 2005.

Even fossil fuel companies and their trade associations agree.



The blue line indicates that without man’s activities, we would be in a cooling period.

WHAT ARE THE DANGERS?



WE ARE RUNNING OUT OF TIME:

Temperatures are predicted to rise anywhere from 3.6 to 11°F by century's end depending on human activities. The last time global temperatures changed this much occurred at the end of the last ice age; it happened over a period of 10,000 years. Plants and animals had a chance to adapt.

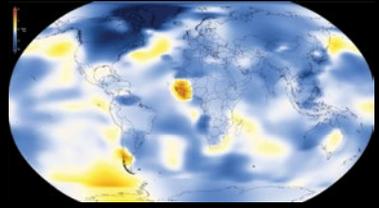
The rapid rate of change predicted this century will disrupt and stress the natural ecosystems and make it difficult for many species, including our own, to adapt.

Small changes can have large impacts. Even minor shifts in global average temperature have a major effect on our natural systems. Scientists say every fraction of a degree matters, so it is critical that we minimize the increase.

DANGERS INCLUDE:

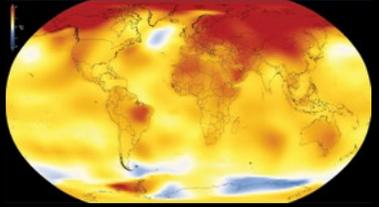
**REDUCED
AGRICULTURAL
AND MARINE FOOD
PRODUCTION IN
MOST OF THE
WORLD**

1880-1887



**INCREASED
FLOODING**

2010-2017



**SIGNIFICANT SEA
LEVEL RISE**

Cooler temperatures are indicated in blue and white, and hotter temperatures are indicated in yellow and red in this graphic showing the increase in average global temperature since the industrial revolution. <https://climate.nasa.gov/vital-signs/global-temperature/>

**MORE INTENSE
DROUGHT AND
HEATWAVES**

Some of the ways climate change is negatively impacting our natural systems include: hotter temperatures that challenge agricultural yields and the marine food chain, increased heavy downpours and flooding, significant sea level rise that threaten cities, infrastructure and key food production regions, and more intense drought and heatwaves.

**RISE IN FREQUENCY
AND SPREAD
OF INFECTIOUS
DISEASES AND
ASTHMA**

Additional impacts include a rise in and spread of infectious diseases and asthma, longer and more expensive wildfire seasons, and loss of biodiversity. Scientists project these changes will significantly and progressively challenge our economy if we continue on our current emissions path.

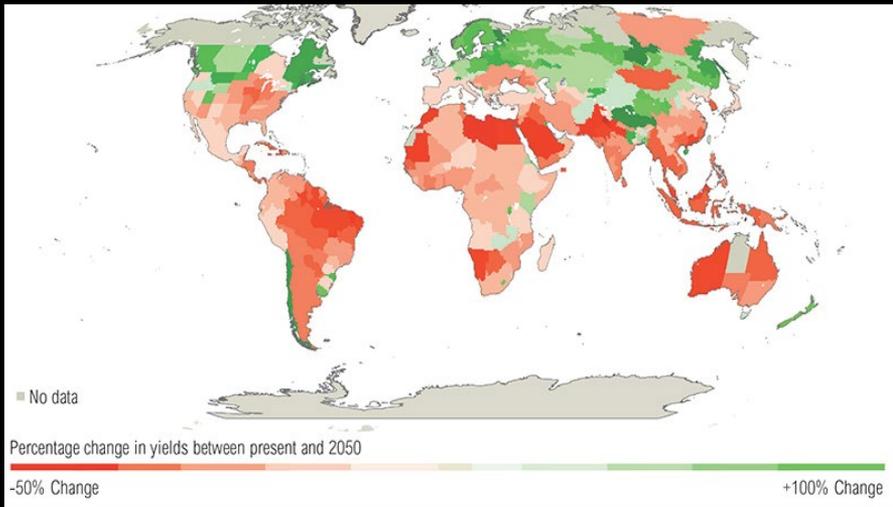
**LONGER AND
MORE EXPENSIVE
WILDFIRE SEASONS**

**LOSS OF
BIODIVERSITY**

**INCREASINGLY
SIGNIFICANT
CHALLENGES TO
OUR ECONOMY**



In the first decade of this century there were an average of 8 days a year registering a heat and humidity index above 105°F in Philadelphia. Scientists predict that by 2050, there will be 40 such days. To research predictions for your local city go to www.climatecentral.org.



Current models suggest that a global temperature increase of 3°C (5.4°F) would decrease crop yield in much of the world.

Higher levels of carbon dioxide will increase the pollen count, exacerbating asthma and other respiratory diseases.

Climate change threatens the marine food chain, because it makes ocean water more acidic and warmer. Carbon dioxide mixes with ocean water to make carbonic acid which adversely affects shelled creatures that build their shells out of calcium, including Pteropods, which are an important part of the food chain for the fish that humans depend on. Warmer oceans also adversely impact coral reefs, which are the nurseries for 25 percent of all marine life. The reefs are dying at an

alarming rate. Climate change causes sea level rise as land ice melts and water expands with higher water temperatures. It will threaten coastal communities, many of our largest cities, and critical infrastructure around the country. Higher sea levels also increase the damages of storm surges from hurricanes, pushing water higher and farther inland. We see climate change impacts today in regular 'sunny day' flooding in coastal communities around the country.



The fiscal risks associated with sea level rise are extremely high.

THE UNITED STATES DEPARTMENT OF DEFENSE, INCLUDING THE CURRENT SECRETARY OF DEFENSE, DESCRIBES CLIMATE CHANGE AS A SIGNIFICANT THREAT TO NATIONAL SECURITY.

In a study off the coast of California in 2015, 54% of the Pteropods already showed damage to their shells. When scientists put them in water as acidic as is expected by 2100, their shells totally melt away in 45 days.

IS THERE HOPE?

Yes, there is hope because the economic equation is changing

—the cost of inaction is now recognized as being higher than the cost of action. Taxpayers are already paying for climate change through expensive infrastructure projects to protect from rain, floods, and sea level rise. In addition, many natural disasters are increasing in frequency and severity due to climate change's influence, straining national budgets. And, at the same time, our costs of dealing with climate change are rising, the costs of moving to a lower carbon economy are decreasing precipitously.

There is an energy revolution occurring

as new technologies replace the legacy contenders. Specifically, wind, solar, LED lighting and EV cars/battery technology are on the cusp of disrupting their sectors on price alone.

THE COST OF INACTION IS NOW RECOGNIZED AS BEING HIGHER THAN THE COST OF ACTION.

Renewables have overtaken fossil fuels as the cheapest form of new energy in most of the world, and are providing a significant number of jobs. For example, the fastest growing job category in America is wind turbine technician.

In fact, renewable energy sources, even without subsidies, are now the cheapest form of new energy generation almost everywhere in the world. As cheaper renewable energy becomes more widespread in developing countries, it can also bring energy security and access that can help lift people out of poverty.

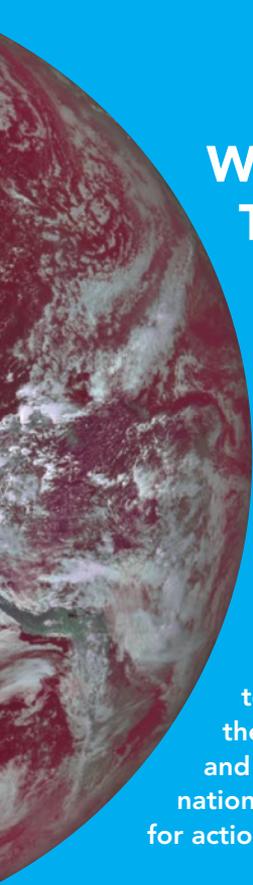
Multinational businesses are acting to mitigate the risk of climate change to their business models and supply chains and are driving more innovation.

China, one of the world's largest emitters of greenhouse gases, has committed to spending \$360 billion on renewable energy by 2020.

By 2025 electric vehicles will be cheaper to build than combustion engines. Volvo is phasing out production of combustion engine cars. Countries like Norway, France, England, India and China have said they will outlaw combustion engines in the near future.

Scientists and entrepreneurs are developing new technologies but need investment support to bring these new ideas to market

RENEWABLES HAVE OVERTAKEN FOSSIL FUELS AS THE CHEAPEST FORM OF NEW ENERGY IN MOST OF THE WORLD.



WE NEED TO PULL TOGETHER TO MEET THIS CHALLENGE OR WE WILL LEAVE A MUCH LESS HOSPITABLE WORLD FOR OUR CHILDREN AND GRANDCHILDREN.

There are many policies across the political spectrum that can work to help mitigate the risks and help us to adapt to these challenges with resilience. To put these policies in place, we need to engage as citizens and demand that our leaders at the local, state and national level start taking action. See the following pages for actions you can take now.

This document extracts key information and graphics from our 45-minute live presentation. We hope you will share what you have learned with your family and friends. If you are interested in sponsoring a *C-Change Primer* in your community, please contact us at info@c-changeconversations.org or go to our website www.c-changeconversations.org to learn more about us and our Conversations Lecture series.



At C-Change Conversations, we rely on a range of sources for our data, including the organizations in the following list. If you are interested in digging deeper into the topic of climate change and renewable energy, you may want to add these to your own independent research. For a full list of footnoted sources on the *Primer*, email us: info@c-changeconversations.org.

Bloomberg New Energy Finance, The BBC, Centers for Disease Control, Climate Central, ExxonMobil, The Financial Times, General Mills, International Energy Agency, NOAA, NASA, The New York Times, Skeptical Science, United Nations, U.S. Department of Defense, World Resources Institute, Yale Program on Climate Change Communication.

WHAT CAN INDIVIDUAL CITIZENS DO TO HELP?

HERE ARE A DOZEN WAYS TO GET INVOLVED:

1 READ UP on climate change, renewable energy, emissions sources and targets, fossil fuel subsidies, and changes to our electrical grid. We have listed a few government agencies, non-profit organizations and media outlets on the previous page that have a wealth of information on the topic. In addition, we recommend these books to get you started:

A Thinking Person's Guide to Climate Change by Robert Henson

Climate of Hope by Michael Bloomberg and Carl Pope

Drawdown, The Most Comprehensive Plan Ever Proposed to Reverse Global Warming. Edited by Paul Hawken

2 HELP START A CONVERSATION in your community. Resiliency, new infrastructure and renewable energy are great topics for a non-partisan conversation on climate change. START A BOOK GROUP with one of the titles mentioned above.

3 Research how you can OPT INTO A RENEWABLE ENERGY SOURCE from your electricity provider.

4 Find out how much of your state's energy comes from renewable energy. INVESTIGATE YOUR STATE'S RENEWABLE ENERGY TARGETS for the next 10 years.

5 CONTACT LOCAL AND NATIONAL LEGISLATORS by phone or email with the following message or something similar:

"I strongly support action on human-caused climate change and investment in renewable energy which will support new jobs. I support those who are forward thinking about reducing our reliance on fossil fuel, rethinking the national grid, curbing emissions and planning mitigation and adaptation strategies for our region and nation."

- 6 CONSIDER SUPPORTING A PRICE ON CARBON to reduce carbon emissions through market mechanisms. The current price of producing and using carbon-rich resources does not capture the costs of climate change and health impacts. We pay for those separately as taxpayers. Economists and policymakers are calling for a price on carbon that reflects its true cost so that the market would work correctly. In fact, even many conservative leaders support a carbon fee with revenues returned to taxpayers as a way to use market mechanisms to lower emissions and lessen the risks. Let them know if you agree.
- 7 CONSIDER INSTALLING RESIDENTIAL SOLAR on your house.
- 8 CONSIDER BUYING AN ELECTRIC CAR. Want more information? Climate Central has put together a climate friendly car guide: <http://climatefriendlycars.climatecentral.org>
- 9 MAKE SURE YOUR HOUSE IS AS ENERGY-EFFICIENT AND WELL-INSULATED AS POSSIBLE. Consider moving from oil to natural gas or geothermal. Check to see that your appliances are the most energy efficient.
- 10 RECYCLE, REDUCE FOOD WASTE, COMPOST! Landfills are significant sources of methane.
- 11 Consider moving towards A PLANT-BASED DIET, think about cutting down on beef and lamb intake.
- 12 SUPPORT AND GET INVOLVED with community action groups and non-profit organizations that are working on this issue.

NEED MORE IDEAS OR HAVE SOME TO OFFER?

Continue the conversation at
www.c-changeconversations.org

ABOUT C-CHANGE CONVERSATIONS

C-Change Conversations promotes non-partisan discussion about the risks and opportunities associated with climate change. We present clear, unbiased, scientific information to our fellow citizens with the hope of creating awareness of how climate change will affect them personally and why there is such urgency to address it.

Our **Climate Change Primer**, developed with input from Climate Central and the Yale Program for Climate Communications, provides answers to many of the questions most Americans have about climate change.

Our **Conversations** lecture series provides a forum for community members across the political spectrum to learn from and question experts on the potential impacts of climate change on our economy, geopolitical security, health and safety. Our featured speakers are listed below:

Agriculture

Tim Searchinger, Research Scholar, Woodrow Wilson School and Princeton Environmental Institute; Senior Fellow, World Resources Institute

Economic Threat and Opportunity

Bill Golden, Executive Director, National Institute of Coastal and Harbor Infrastructure

Bob Litterman, Founder Kepos Capital; former head of firm-wide risk, Goldman Sachs

Dr. Peter Hoeppe, Head of Geo Risk Research Center, Munich RE; Chair, Finance Forum on Climate Change for the German Government

Energy

David Crane, Former CEO, NRG

Jigar Shah, Founder, SunEdison; author, *Creating Climate Wealth: Unlocking the Impact Economy*

Geopolitical Security

Rear Admiral (Ret.) David Titley, Professor of Practice in Meteorology, Penn State University (Co-sponsored with the Foreign Policy Research Institute)

Investments and Business

Panel Discussion on Green Investing:

Investment Experts from Allianz Global, Morgan Stanley and Rockefeller Company
Brian Reynolds, Executive Director, ClimateMoneyPolitics; Member, United Nations Economic & Social Council

Public Policy

Alice Thomas, Climate Displacement Program, Refugees International
Elizabeth Thompson, Vice President for U.S. Climate and Political Affairs, Environmental Defense Fund

Christine Todd Whitman, Former Governor of New Jersey; Former Administrator, Environmental Protection Agency

Science, Weather and Sea Level Rise

Dr. Max Holmes, Senior Scientist, Woods Hole Research Center; Advisor to the U.S. Department of State

Dr. Stephen Pacala, Petrie Professor of Ecology & Evolutionary Biology, Princeton University; Former Head, Princeton Environmental Institute; Chair, Climate Central

Bernadette Placky, Director, Climate Central's *Climate Matters* program; former award-winning TV weather forecaster

Dr. Robert Kopp, Rutgers University, Director of Earth, Ocean and Atmospheric Sciences Institute

Science Journalism

Michael Lemonick, Science Editor, *Scientific American*; Writer-at-large, Climate Central; former journalist, *Time* magazine and author of its first cover article on climate change

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