

Relationship Between Increase of CO₂ and Climate Change

New Mexico Supercomputer Challenge

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The Causes of Climate Change

Human activities are driving the global warming trend observed since the mid-20th century. Since the Industrial Revolution, the global annual temperature has increased in total by a little more than 1 degree Celsius, or about 2 degrees Fahrenheit. Between 1880—the year that accurate record keeping began—and 1980, it rose on average by 0.07 degrees Celsius (0.13 degrees Fahrenheit) every 10 years. Since 1981, however, the rate of increase has more than doubled: For the last 40 years, we've seen the global annual temperature rise by 0.18 degrees Celsius, or 0.32 degrees Fahrenheit, per decade.(1)

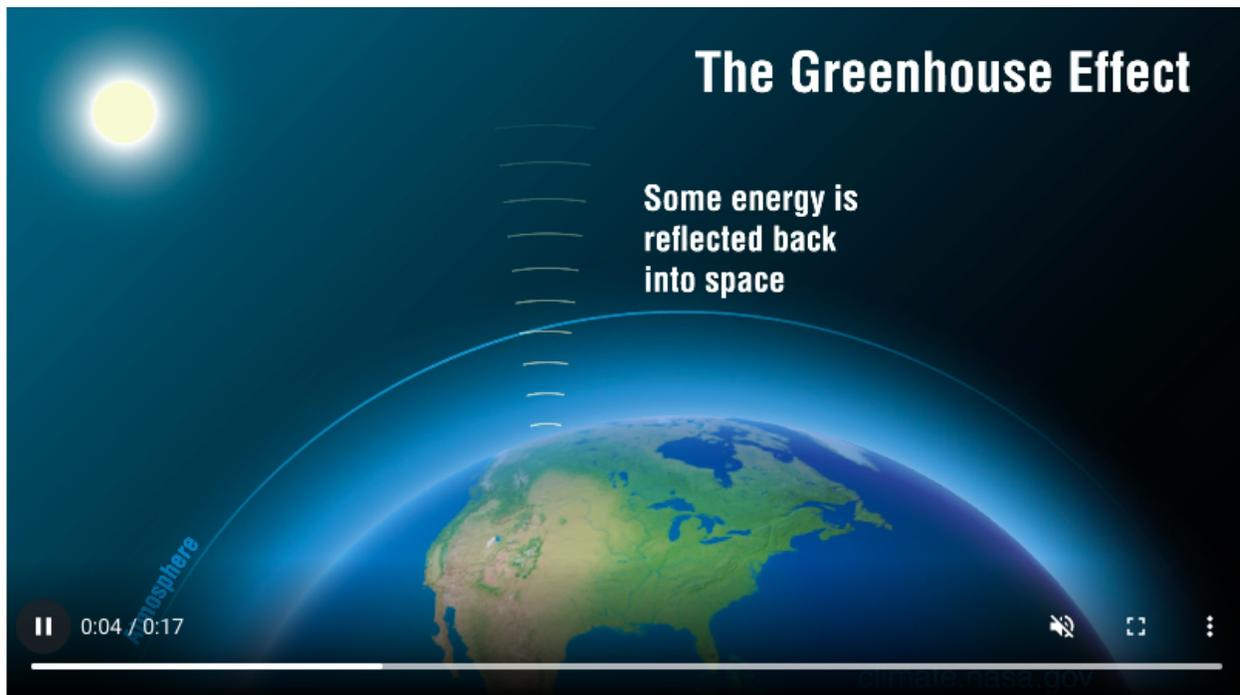
Global warming occurs when carbon dioxide (CO₂) and other air pollutants collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth's surface. Normally this radiation would escape into space, but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter. These heat-trapping pollutants—specifically carbon dioxide, methane, nitrous oxide, water vapor, and synthetic fluorinated gases—are known as greenhouse gases, and their impact is called the greenhouse effect.(2)

Research

Scientists agree that human activity is the primary driver of what we're seeing now worldwide.(1) The unchecked burning of fossil fuels over the past 150 years has drastically increased the presence of atmospheric greenhouse gases, most notably carbon dioxide. At the same time, logging and development have led to the widespread destruction of forests, wetlands, and other carbon sinks—natural resources that store carbon dioxide and prevent it from being released into the atmosphere.(3)

Right now, atmospheric concentrations of greenhouse gases like carbon dioxide, methane, and nitrous oxide are the highest they've been in the last 800,000 years. Some greenhouse gases, like hydrochlorofluorocarbons (HFCs), do not even exist in nature. By continuously pumping these gases into the air, we helped raise the earth's average temperature by about 1.9 degrees Fahrenheit during the 20th century—which has brought us to our current era of deadly, and increasingly routine, weather extremes. And it's important to note that while climate change affects everyone in some way, it doesn't do so equally: All over the world, people of color and those living in economically disadvantaged or politically marginalized communities bear a much larger burden, despite the fact that these communities play a much smaller role in warming the planet.(3)

The Greenhouse Effect

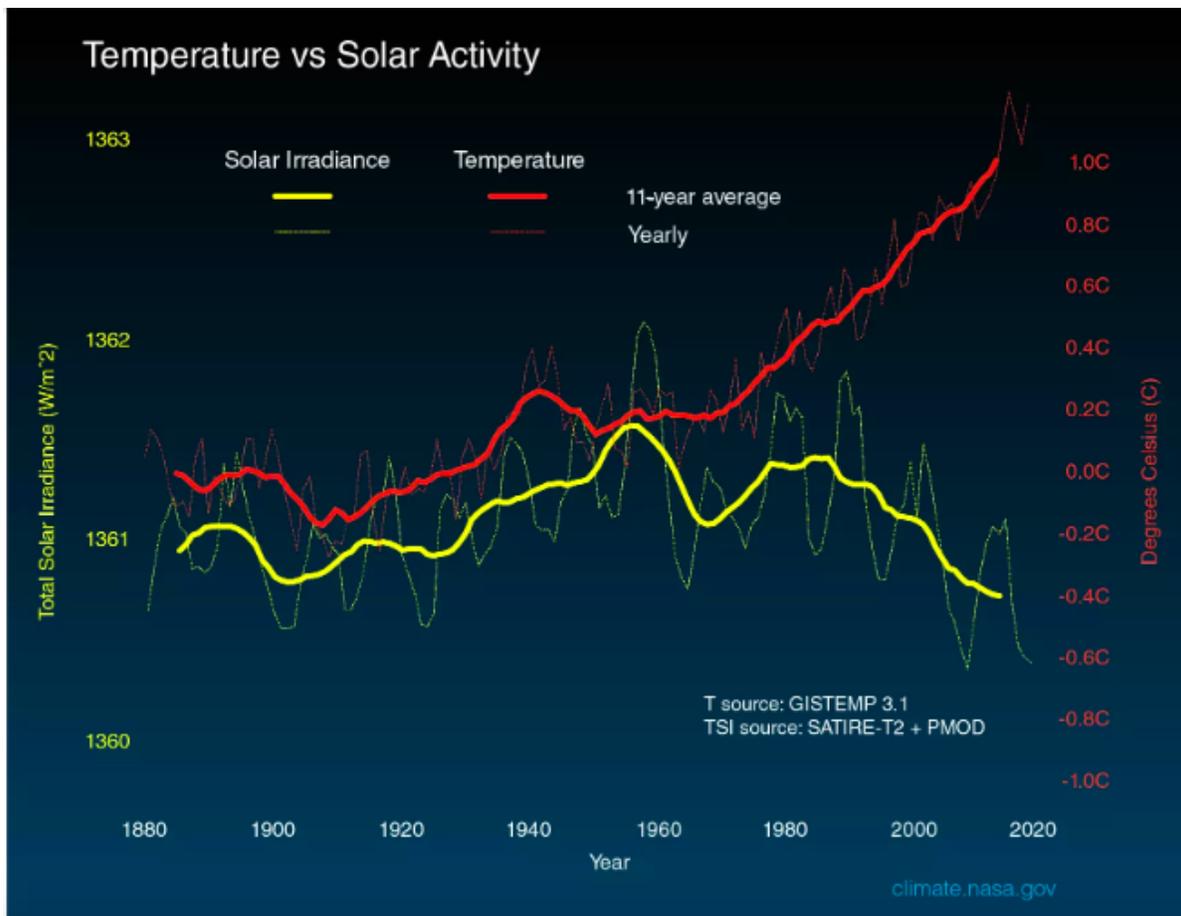


[A simplified animation of the greenhouse effect. Credit: NASA/JPL-Caltech](#)

Our ways of generating power for electricity, heat, and transportation, our built environment and industries, our ways of interacting with the land, and our consumption habits together serve as the primary drivers of climate change. While the percentages of greenhouse gases stemming from each source may fluctuate, the sources themselves remain relatively consistent.(4) Scientists attribute the global warming trend observed since the mid-20th century to the human expansion of the "greenhouse effect" — warming that results when the atmosphere traps heat radiating from Earth toward space. Life on Earth depends on energy coming from the Sun. About half the light energy reaching Earth's atmosphere passes through the air and clouds to the surface, where it is absorbed and radiated in the form of infrared heat. About 90% of this heat is then absorbed by greenhouse gases and re-radiated, slowing heat loss to space.(5)

Human Activity Is the Cause of Increased Greenhouse Gas Concentrations

Over the last century, burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO₂). This increase happens because the coal or oil burning process combines carbon with oxygen in the air to make CO₂. To a lesser extent, clearing of land for agriculture, industry, and other human activities has increased concentrations of greenhouse gases. The industrial activities that our modern civilization depends upon have raised atmospheric carbon dioxide levels by nearly 50% since 1750. This increase is due to human activities, because scientists can see a distinctive isotopic fingerprint in the atmosphere.(5)

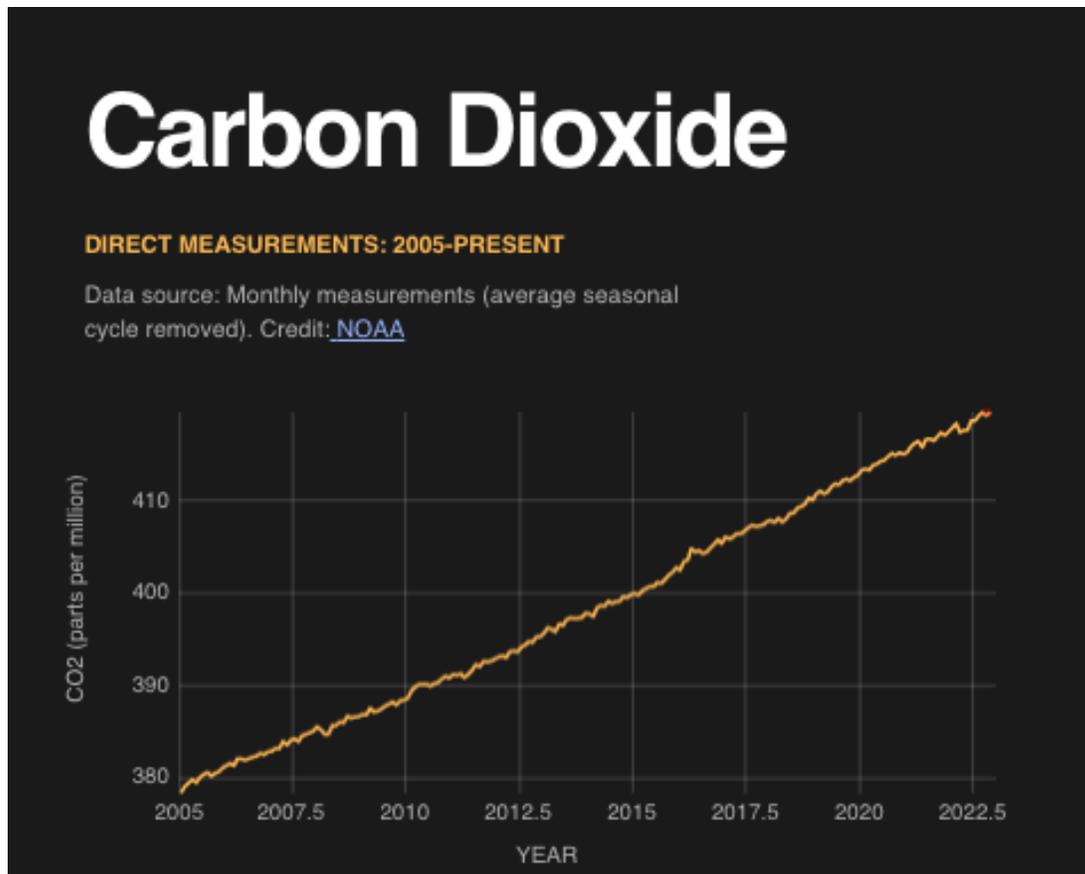


Climate NASA gov

Carbon Dioxide

LATEST MEASUREMENT: November 2022

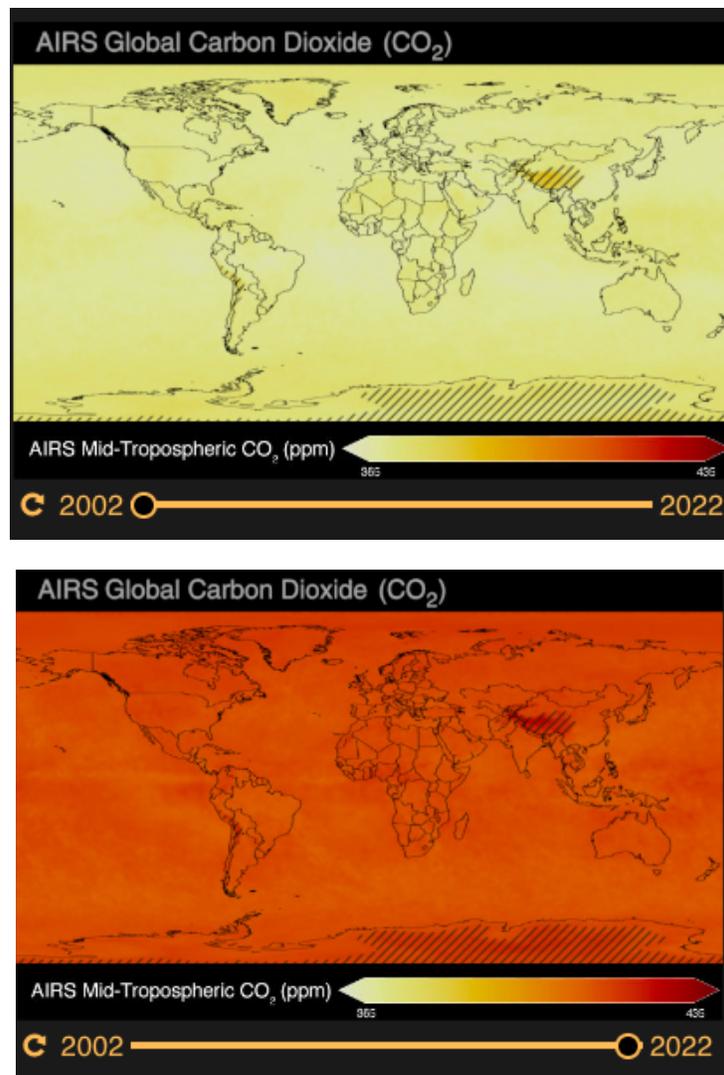
420 ppm



Data source: Monthly measurements (average seasonal cycle removed). Credit: NOAA

Carbon dioxide (CO₂) is an important heat-trapping gas, or greenhouse gas, that comes from the extraction and burning of fossil fuels (such as coal, oil, and natural gas), from wildfires, and from natural processes like volcanic eruptions. The first graph shows atmospheric CO₂ levels measured at Mauna Loa Observatory, Hawaii, in recent years, with natural, seasonal changes removed. The second graph shows CO₂ levels during Earth's last three glacial cycles, as captured by air bubbles trapped in ice sheets and glaciers.⁽⁶⁾ Since the beginning of industrial times (in the 18th century), human activities have raised

atmospheric CO₂ by 50% – meaning the amount of CO₂ is now 150% of its value in 1750. This is greater than what naturally happened at the end of the last ice age 20,000 years ago. The animated map shows how global carbon dioxide has changed over time. Note how the map changes colors as the amount of CO₂ rises from 365 parts per million (ppm) in 2002 to over 400 ppm currently. (“Parts per million” refers to the number of carbon dioxide molecules per million molecules of dry air.) These measurements are from the mid-troposphere, the layer of Earth's atmosphere that is 8 to 12 kilometers (about 5 to 7 miles) above the ground.(5, 6)



[Data source: Atmospheric Infrared Sounder \(AIRS\). Credit: NASA](#)

Solving the Problem

We can make robust data-driven and model-based predictions about future climate change and, combined with a better understanding of Earth's climate system, come to our own conclusions about "how the relationship Between CO₂ and Climate Change" that can help to better understand "Climate Change" and make sense of guides to climate change policy.

Reducing global greenhouse gas emissions to slow climate change could prevent millions of premature deaths due to air pollution over the next century, according a new study funded by NIEHS.(7)

To work in this project, our team is collecting data to create simulations and predictions using the Starlogo Nova programming language. We will use NASA Global Climate Change, UCAR Center for Science Education, My NASA DATA website, and different scientific websites to obtain important information to solve our problem.

OUR GOAL

Our model will be an important tool for improving our understanding and predictability of climate change due to CO₂ on seasonal, annual, decadal, and centennial time scales. Our Model will investigate the degree to which observed climate changes may be due to the Cause of Increased Greenhouse Gas Concentrations such as CO₂.

The World | Everyone | Sun | Solar Energy | co2 | car | heat | reflected energy | Black | White | Green | Blue | + Add Breed

Show Trails

Agents: create, each do, delete, delete everyone, delete agent, scatter, scatter everyone, take camera, me, my parent, on collision with, do, collide

```

when setup pushed
  clear terrain
  clean line graph Heat
  clean line graph co2 Levels
  set co2 from cars data box to 0
  set count heat data box to 0
  set Clock data box to 0
  delete everyone
  create 1 Sun (s)
  each do
    my x to 0
    my y to 0
    my z to 25
    my color to color yellow
    my size to 5
    my shape to [https://static.sinova.org/shapes/sphere/sphere]
  create Number of Cars slider value car
  each do
    my size to 3
    my color to color blue
    my shape to [https://static.sinova.org/shapes/vehicles/lambo/lambo]
  scatter

while forever toggled
  create 5 Black (s)
  each do
    Add data to line graph Heat
    x-axis: clock y-axis: count heat
    Add data to line graph co2 Levels
    x-axis: clock y-axis: count co2
    with color = color gray
    set co2 from cars data box to with color = color gr
    set count heat data box to count heat
    set Clock data box to clock
  when Black pushed (s)
    create 50 Black (s)
    each do
      scatter
      set my color to color black
      set my size to Amount of Black slider value x 2
      stamp color black
  when White pushed
    create 50 White (s)
    each do
      scatter
      set my color to color white
      set my size to Amount of White slider value x 2
      stamp color white
      delete
  when Green pushed
    create 50 Green (s)
    each do
      scatter
      set my color to color green
      set my size to Amount of Green slider value x 2
      stamp color green
  
```

The World | Everyone | Sun | Solar Energy | co2 | car | heat | reflected energy | Black | White | Green | Blue | + Add Breed

Show Trails

Agents: create, each do, delete, delete everyone, delete agent, scatter, scatter everyone, take camera, me, my parent, on collision with, do, collide

```

while forever toggled
  call hover
  call decay

procedure: hover
  add parameter
  my z <= 12
  up 0.2
  forward 0.2
  left by random 0 to 41 degs
  right by random 0 to 41 degs
  return nothing

procedure: decay
  add parameter
  if random 0 to 9999 <= 1
    delete
  return nothing
  
```

The World | Everyone | Sun | Solar Energy | co2 | car | heat | reflected energy | Black | White | Green | Blue | + Add Breed

Show Trails

Agents: create, each do, delete, delete everyone, delete agent, scatter, scatter everyone, take camera, me, my parent, on collision with, do, collide

```

while forever toggled
  if clock >= 100 and clock <= 300
    call drive

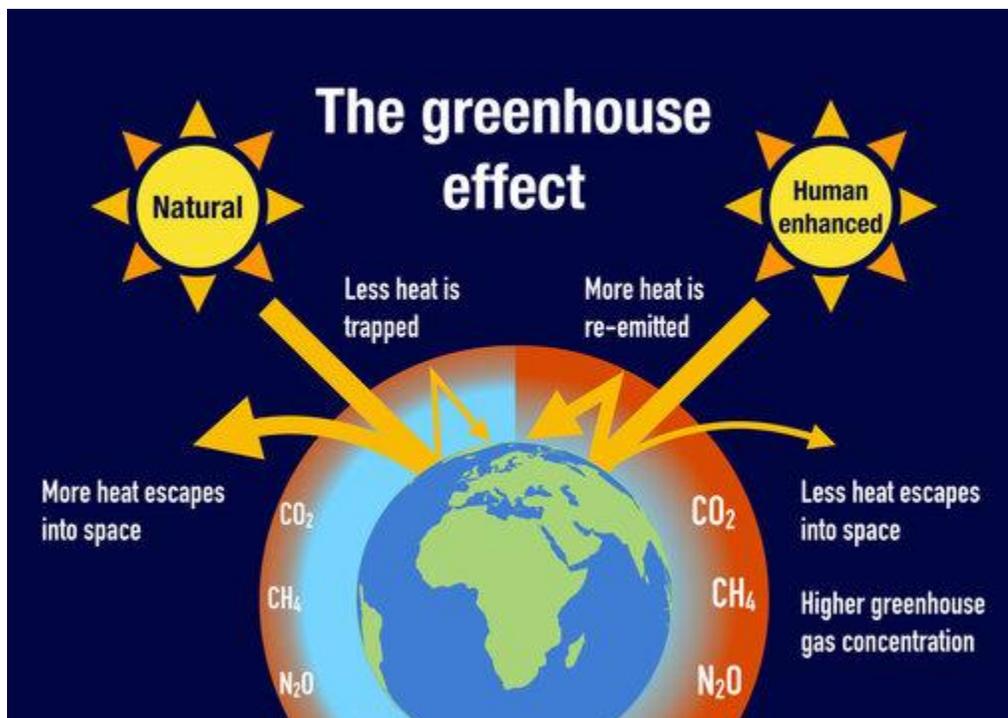
procedure: hatch car co2
  add parameter
  create 1 co2 (s)
  each do
    my color to color gray
    my shape to [https://static.sinova.org/shapes/pyramid/pyramid]
    my size to 3
  return nothing

procedure: drive
  add parameter
  forward 1
  left by random 0 to 9 degs
  right by random 0 to 9 degs
  if random 0 to 99 <= 5
    call hatch car co2
  return nothing

repeat 100 times
  
```

Conclusion

In conclusion there are a lot of things that cause climate change. We have a model and a representation of what causes climate change and of a way we can stop it from happening or at least predict the next time climate change might happen. Some causes of climate change include burning fossil fuels that cause CO₂ gasses to produce and cause climate change. We have noticed a change in the global annual temperature which is that the temperature went up a little bit more than 2 degrees fahrenheit or 1 degree celsius and it keeps on rising even more since the year 1880 which has multiplied over the ages. The climate change happens when the carbon dioxide traps sunlight and solar radiation. The reason the earth's temperature rises is because the trapped sunlight and solar radiation cause heat in the atmosphere which stays there for a long time because it is captured in the carbon dioxide gasses.

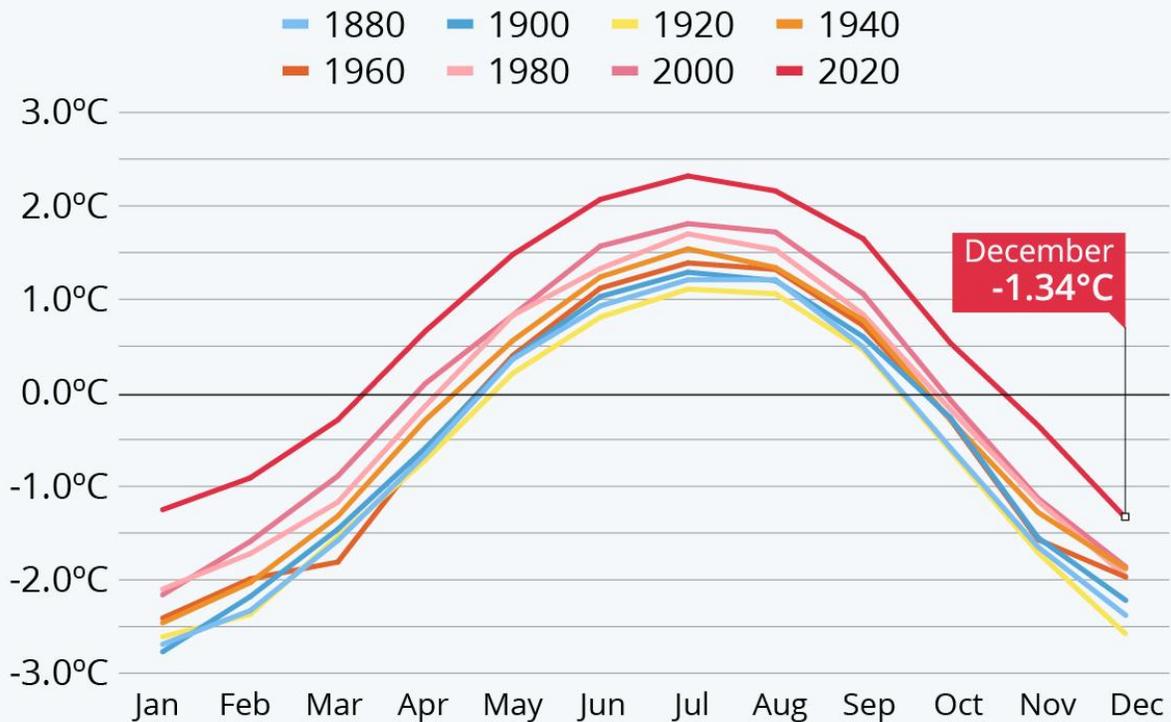


The research we have done shows that we haven't been keeping track of the burning of fossil fuels which has greatly affected the production of harmful gases that stay in our atmosphere. Humans have burned fossil fuels for 150 years without keeping track of how much greenhouse gases we have been storing and not letting float into the atmosphere to be let out. The gases can get trapped into widespread destruction of forests, wetlands, and other carbon sinks—natural resources that cause the greenhouse effect and that form heat. At this time the gases like carbon dioxide, methane and nitrous oxide are the most produced gases ever since the last 800,000 years. Gases like hydrochlorofluorocarbons aren't produced naturally and are produced by human kind. These type of gases causes the earth to heat up by a lot. The gases have made the earth heat up close to 1.9 degrees fahrenheit during the 20th century tha has caused an immense amount of bad weather extremes and deadly

routines.

Earth is Heating Up

Monthly divergence from average temperature
(calculated for 1880-2015) in selected years



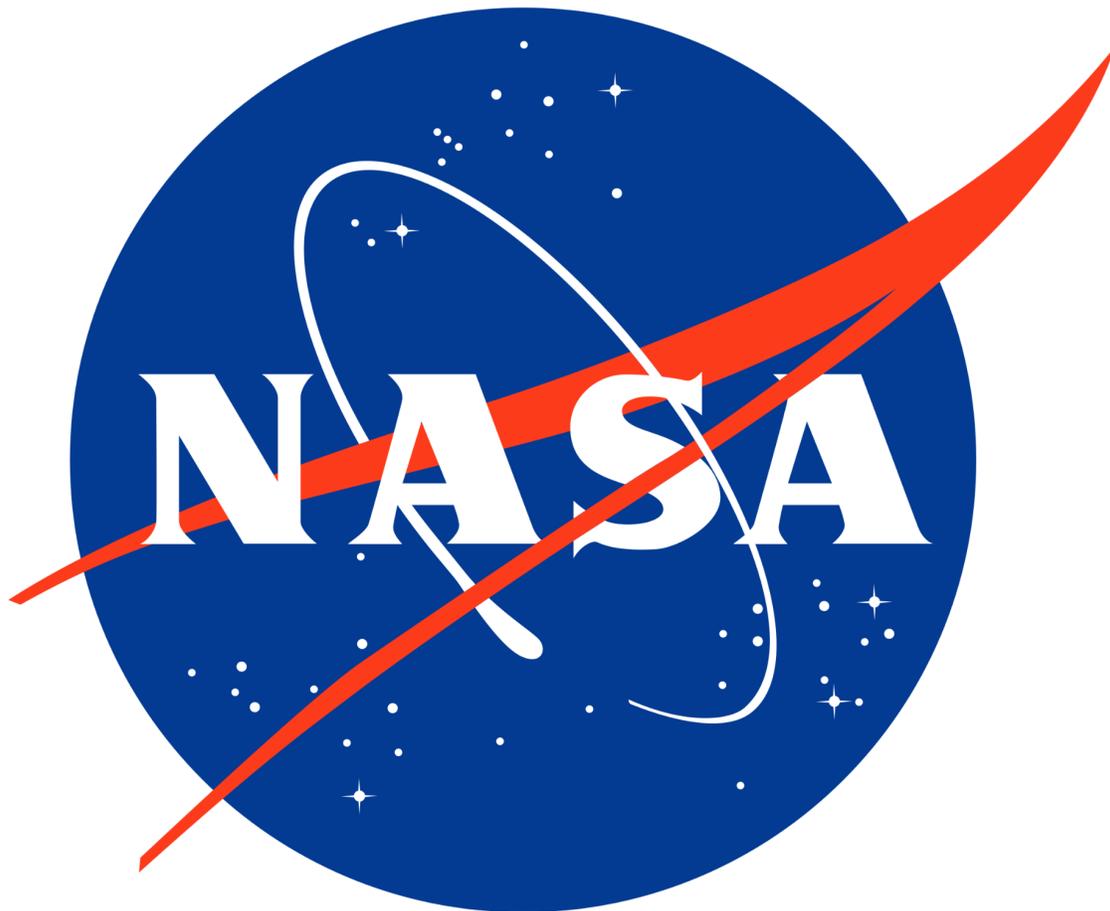
Source: NASA



statista

Our research also includes a way we can solve the problem which is to make a robust data-driven and model based prediction so we can track the climate change. With the prediction and a better understanding of the earth's climate system combined we can make our own conclusions about the relationship between CO2 and climate change. Another way we can also solve the problem with climate change is to reduce the amount of greenhouse gas

emissions to be able to at least slow it down. This plan would help prevent a lot of deaths due to air pollution over the next century according to a study funded by NIEHS. To work in this project we will collect data to create simulations and predictions using a unicef project called star logo nova programming language. we will use different programs like one that's called MY NASA DATA website.



Our model is a very important tool which is good for understanding and predicting climate change and when it's going to happen due to CO₂ at different times of the year. The model we created will be able to investigate the climate changes that are the cause of the increased greenhouse gas concentrations like the gas CO₂.

Classes | Relationship Between Deforesta... | Greenhouse Gases with cars mo... | +

shova.org/Gordon_RamsayV2/projects/868398/

STARLOGO NOVA New Project Remix Save Version Saved Run Code Logged in as Gordon_RamsayV2 My Projects

Please click largest values first on land set up

setup Show CO2 Graph
forever Hide CO2 Graph

count heat: 31
co2 from cars: 765
Clock: 166
Number of Cars: 0 (slider 0-100)

CO2 graph: x-axis: Co2 count (0-100), y-axis: CO2 (0-500)

Heat graph: x-axis: Heat (0-100), y-axis: Heat (0-20)

Reset CO2

Green Blue White Black

Amount of Green: 0 (slider 0-100)
Amount of Blue: 0 (slider 0-100)
Amount of White: 0 (slider 0-100)
Amount of Black: 0 (slider 0-100)

28 FPS (1.61)

Apr 3 12:57 EXTND

Classes | Relationship Between Deforesta... | Greenhouse Gases with cars mo... | +

shova.org/Gordon_RamsayV2/projects/868398/

STARLOGO NOVA New Project Remix Save Version Saved Run Code Logged in as Gordon_RamsayV2 My Projects

Agents: create, each do, delete, delete everyone, delete agent, scatter, scatter everyone, take camera, me, my parent

Show Traits

when setup pushed

- clear terrain
- clear line graph Heat
- clear line graph co2 Levels
- set co2 from cars data box to 0
- set count heat data box to 0
- set Clock data box to 0
- delete everyone
- create 1 Sun (s)
- each do
 - set my x to 0
 - set my y to 0
 - set my z to 25
 - set my color to color: orange
 - set my size to 5
 - set my shape to built-in shape: Sphere
- create Number of Cars slider value car (s)
- each do
 - set my size to 3

while forever toggled

- Add data to line graph co2 Levels for co2 from cars
- count co2 within 200 steps with color: gray
- set co2 from cars data box to count co2 within 200 steps with color: gray
- set count heat data box to count heat within 200 steps
- set Clock data box to clock

while forever toggled

- if clock = 4000
- set clock to 0

when Hide Heat Graph pushed: hide Heat

when Show Heat Graph pushed: show Heat

when Show CO2 Graph pushed: show CO2

when setup pushed

Apr 3 12:57 EXTND

References and Notes

1. What is the Atmosphere? UCAR Center for Science Education.
2. The Climate System. UCAR Center for Science Education.
3. Global Temperature. NASA Global Climate Change.
4. Carbon Dioxide. NASA Global Climate Change.
5. Climate Data Mapper. NOAR Climate gov.
6. The Causes of Climate Change. NASA Global Climate Change.
7. Human Activity Is the Cause of Increased Greenhouse Gas Concentrations. NASA Global Climate Change.