Hot Science - Cool Talk # 124

Climate Change: Science to Solutions

Dr. Geeta Persad
February 24, 2023
Climate Change: Science to Solutions

Geeta G. Persad
Assistant Professor
Department of Geological Sciences
University of Texas at Austin

Hot Science Cool Talks
The University of Texas at Austin
February 24th, 2023
Consider time...
Consider time...
Climate science is fascinating and powerful!

Why are our deserts where they are?
Atmospheric motion smooths out the gradient

If Earth didn’t rotate, atmospheric motion would look like this...
Instead, Earth’s rotation splits atmospheric circulation into three “cells.”

Sinking air makes it harder for rainstorms to form and dries out the surface.
Climate science is fascinating and powerful!
The deserts are where they are for a reason!
Our climate system is awesome, so what’s the problem?

It’s warming faster than any time since the start of modern human civilization

We can’t explain the current warming without human emissions of carbon dioxide and other heat-trapping pollutants
WARMING AT ALL LEVELS

Temperature change (°F) since 1970

- Austin: +3.7°
- Texas: +2.8°
- United States: +2.6°

Based on linear trends of average annual temperature (1970-2021)
Source: RCP-ACIS.org, NCEI Climate at a Glance
We are in the changed climate now now now.

Climate change made 3-day downpour during Hurricane Harvey 3 times more likely 15% more intense.

Image: New Yorker; Data: Oldenborgh et al., 2018
LONGER STREAKS OF 100°+
Highest Number of Consecutive Days

1970  AUSTIN  2020

Longest streak of high temperatures of 100°+ each year
Source: RCC-ACIS.org
MORE INTENSE RAINFALL
Annual average hourly rainfall (hundredths of inches)

Average hourly rainfall is the total annual rainfall divided by the number of hours with rainfall.
Source: NCEI and RCE-ACIS

CLIMATE CENTRAL
Our climate system is awesome, so what’s the problem?

It’s warming faster than any time since the start of modern human civilization

We can’t explain the current warming without human emissions of carbon dioxide and other heat-trapping pollutants.
1824
Greenhouse effect first described

1856
CO₂ traps heat from sunlight

1896
Burning coal produces CO₂ and traps heat
1824
Greenhouse effect first described

1856
CO₂ traps heat from sunlight

1896
Burning coal produces CO₂ and traps heat

1958
Carbon dioxide concentration at Mauna Loa Observatory*

Full record ending February 12, 2023

*Maunakea data in blue
1824 Greenhouse effect first described

1856 CO₂ traps heat from sunlight

1896 Burning coal produces CO₂ and traps heat

1970s and 80s: Ice cores drilled in Antarctica reveal 100,000s of years of CO₂
1824
Greenhouse effect first described

1856
CO₂ traps heat from sunlight

1896
Burning coal produces CO₂ and traps heat

1950: First numerical weather forecast using the ENIAC computer
1824: Greenhouse effect first described

1856: CO₂ traps heat from sunlight

1896: Burning coal produces CO₂ and traps heat

1975: 3D computer model of Earth’s climate system shows that doubling CO₂ in the atmosphere will warm climate by several degrees
1990s-2000s: Global Climate Models affirm that current observed warming trends cannot be explained without the influence of human emissions.
1824: Greenhouse effect first described

1856: CO₂ traps heat from sunlight

1896: Burning coal produces CO₂ and traps heat

1990s-2000s: Global Climate Models affirm that current observed warming trends cannot be explained without the influence of human emissions.

What’s actually happened to temperature

With both natural and human influences
1824
Greenhouse effect first described

1856
CO₂ traps heat from sunlight

1896
Burning coal produces CO₂ and traps heat

Now: Full 3-D simulation of the entire Earth System down to the scale of individual storms.
The same activities that emit heat-trapping gasses also emit toxic air pollutants, which also affect climate
Reducing the co-emitted pollutants produces societal benefits that make climate action an even better deal!

Global benefits to infant health

Global benefits to agriculture

Increased benefit from cutting both greenhouse gases AND co-pollutants

Persad and Caldeira (2018, Nature Communications); Burney, Persad et al. (2022, Science Advances); Persad et al., (2022, Nature)
So, how do we get there??
Global greenhouse gas emissions by sector
This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.

Energy use in Industry (24.2%)
Energy use in buildings (17.5%)
Transport (16.2%)
Aviation (1.9%)
Shipping (0.7%)
Residential buildings (10.9%)
Commercial (6.6%)
Unallocated fuel combustion (1.9%)
Fugitive emissions from energy production (5.8%)
Energy in Agriculture & Fishing (1.7%)
Cement (3%)
Chemicals (2.2%)
Wastewater (1.3%)
Landfills (1.2%)
Deforestation (0.1%)
Crop burning (5.3%)
Rice cultivation (4.5%)
Agriculture, Forestry & Land Use (18.4%)
Livestock & manure (5.8%)
Iron and steel (7.2%)
Chemical & Petrochemical (3.6%)
Food & tobacco (1.9%)
Paper & pulp (0.6%)
Other industry (10.6%)
Talk about it!
More than half of Americans in almost every congressional district are worried about climate change.

Yale Program on Climate Communications, Howe et al (2015, *Nature Climate Change*)
But we each underestimate how much everyone else cares

Sparkman et al. (2022, Nature Communications)

Policy

Worried about Climate Change

Carbon Tax

Siting Renewal Energy on Public Lands

100% Renewable Energy by 2035

Prevalence of Support/Agreement (%)
We have the technologies already to slow climate change

- Reduce food waste
- Expand utility-scale solar power
- Increase public transit
- Eliminate heat-trapping refrigerant leaks
- Invest in onshore wind power
- Manage supply-chain methane leakage
Every bit of climate action helps

1.5°C
Paris 1.5° stretch goal
Wheat, rice, maize, and soybean production suffers

2.0°C
Paris 2.0° goal
Agricultural yields fall rapidly

3.0°C
If countries fulfill their current Paris Pledges
Fish species go extinct locally

4.0°C
Where we are headed
High levels of food insecurity, development path reversed
Engineer or technician? Build climate-safe infrastructure and implement climate solution tech!

Finance? Help build funds that invest in climate-safe infrastructure or climate solutions!

Marketing? Help make climate action cool!

Artist? Help tell the story of what a climate-safe future could look like!
Consider time...