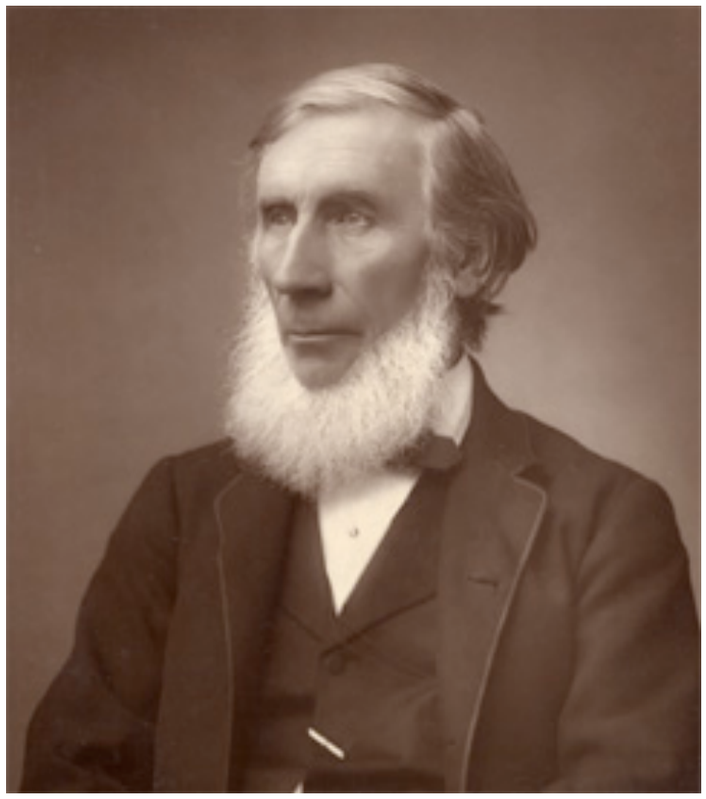
# A Tale of Two Futures

Todd Ringler

# Buckle up ….

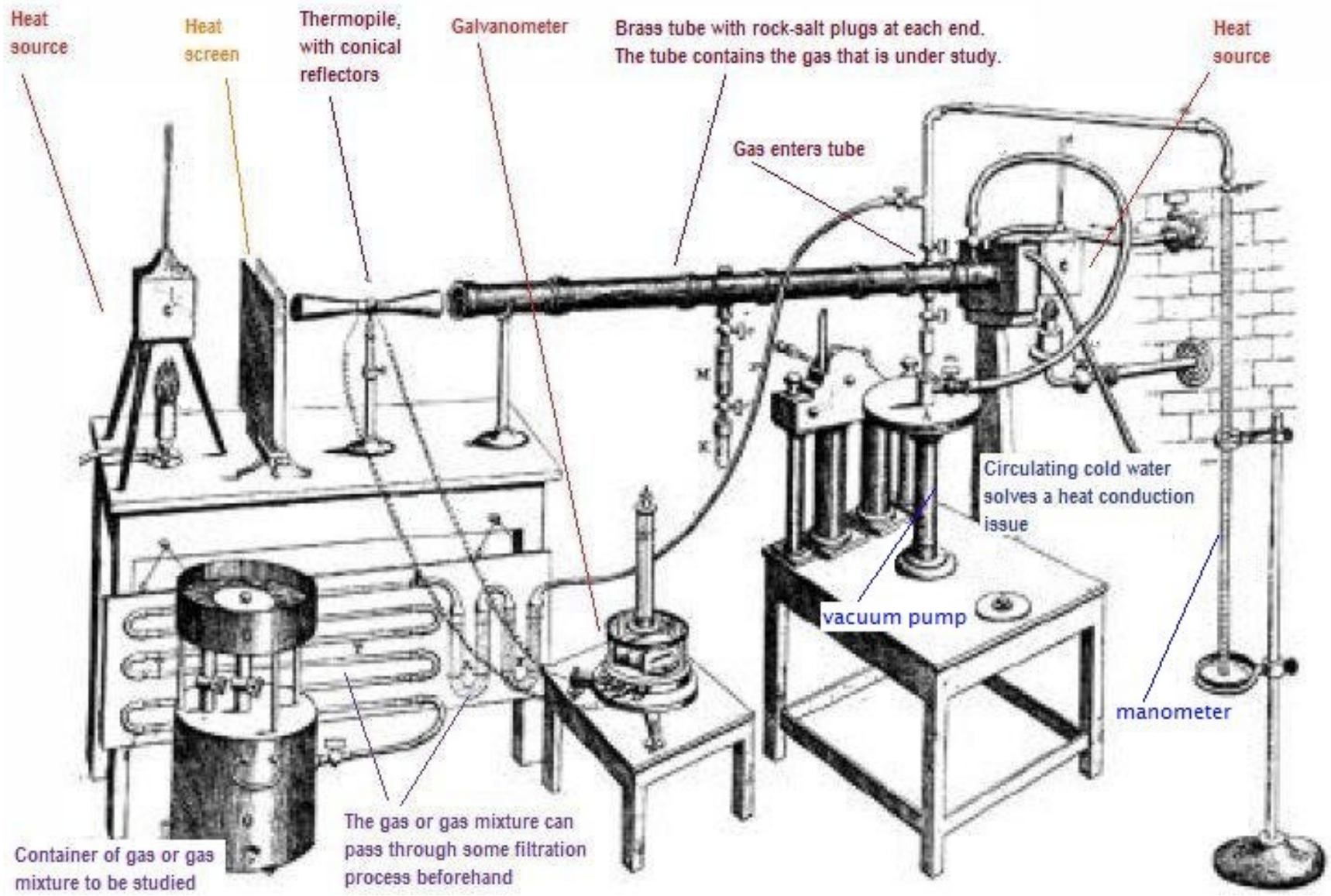
We will cover more then 250 years in the next 20 minutes, starting with the first study of greenhouse gases in 1859 and end with what the Earth’s climate might look like in 2100.

# Greenhouse Gas Induced Warming is Very Old News .....



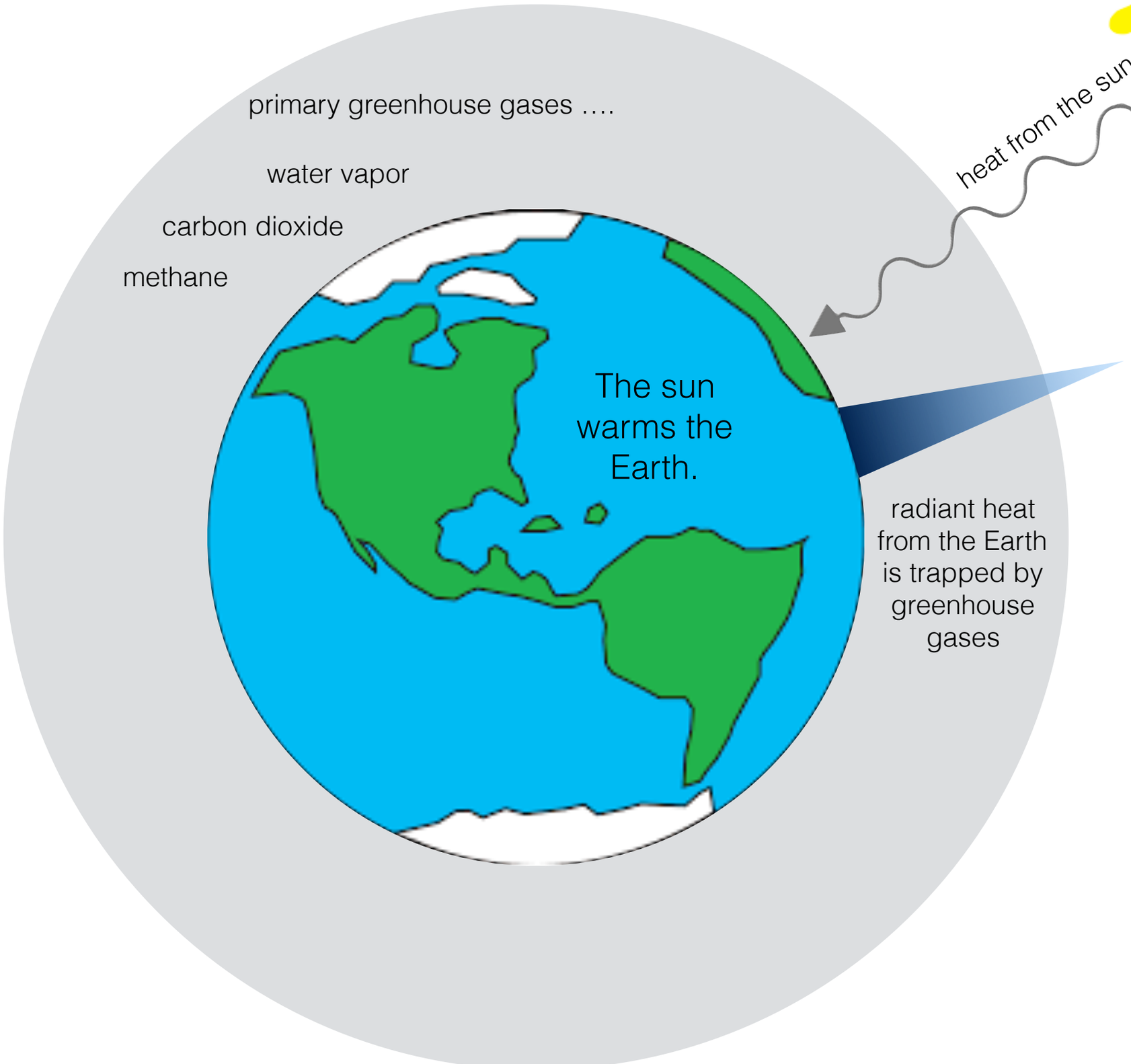
## John Tyndall (1820-1893)

"As a dam built across a river causes a local deepening of the stream, so our atmosphere, thrown as a barrier across the terrestrial [infrared] rays, produces a local heightening of the temperature of the Earth's surface."




Tydall built this device to try to understand why the Earth was not a frozen chuck of ice.

# Greenhouse gases trap heat that would otherwise radiate to space.

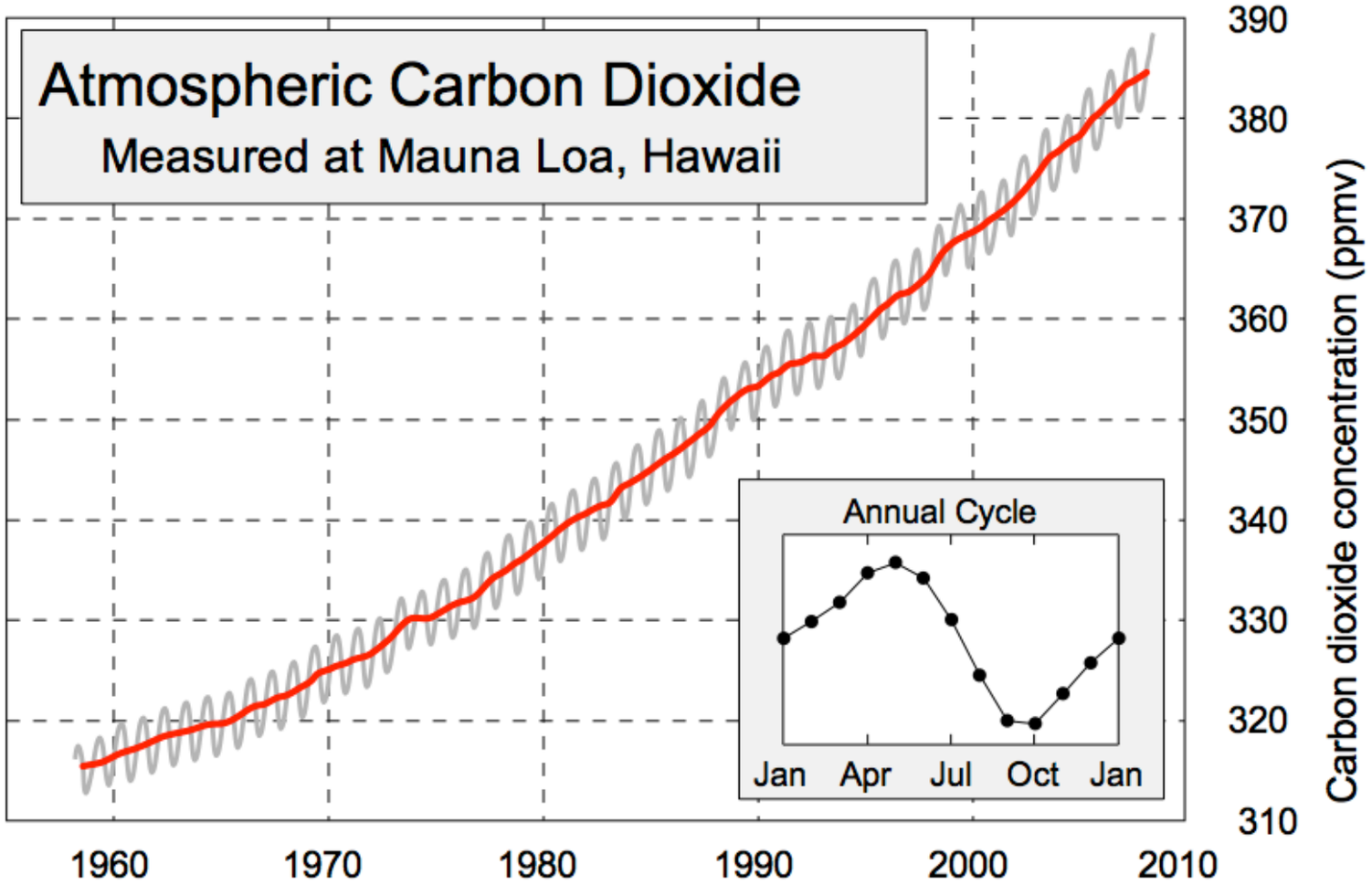



## Svante August Arrhenious (1859-1927)

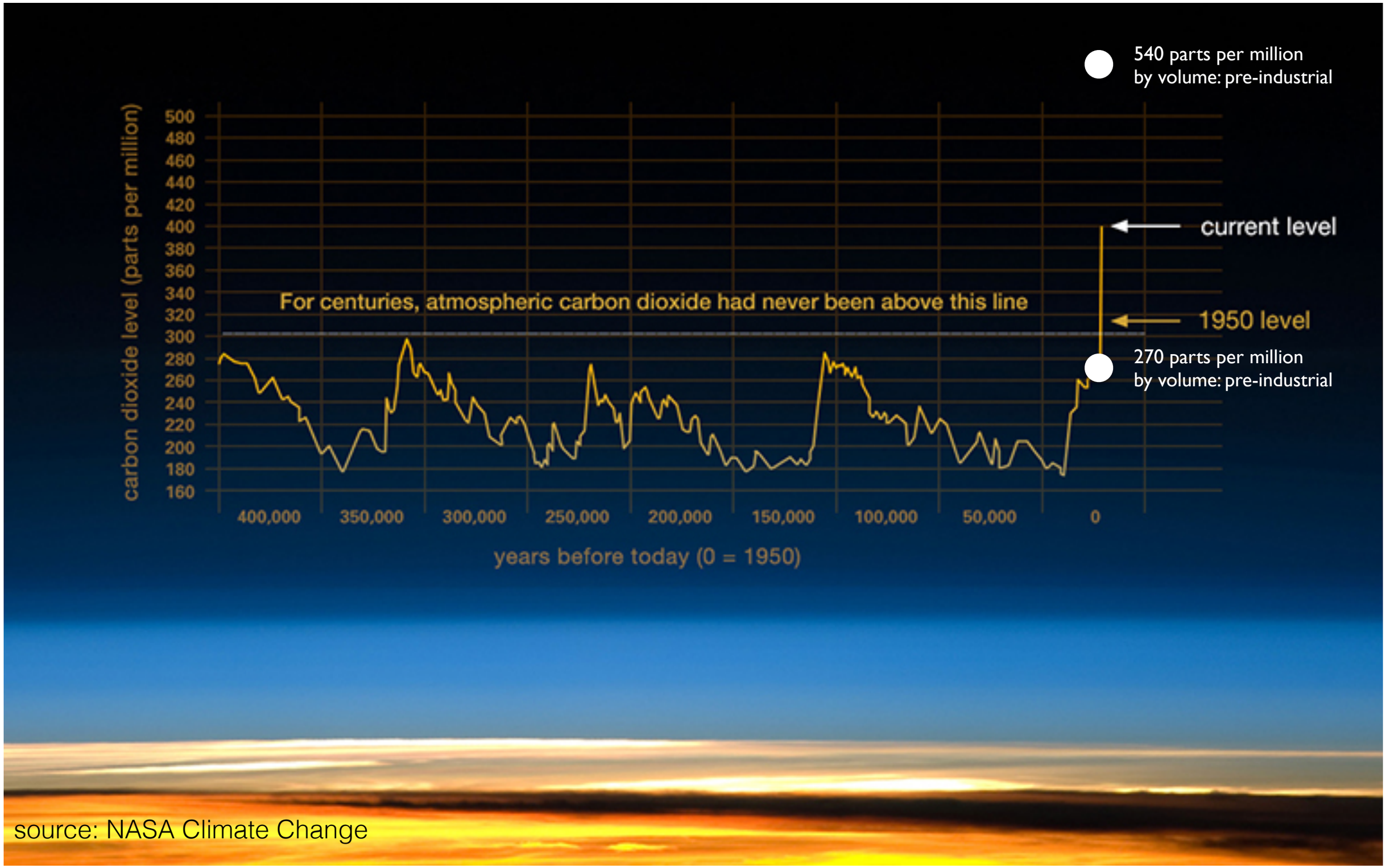
.... any doubling of the percentage of carbon dioxide in the air would raise the temperature of the earth's surface by 4° (Celsius); and if the carbon dioxide were increased fourfold, the temperature would rise by 8° (Celsius)."

The Industrial Revolution harnessed the power of fossil fuels,
but also produced emissions of carbon dioxide.

In the late 1950s Charles Keeling (1928-2005) set out to determine how much carbon dioxide from fossil fuel burning remained in the atmosphere.

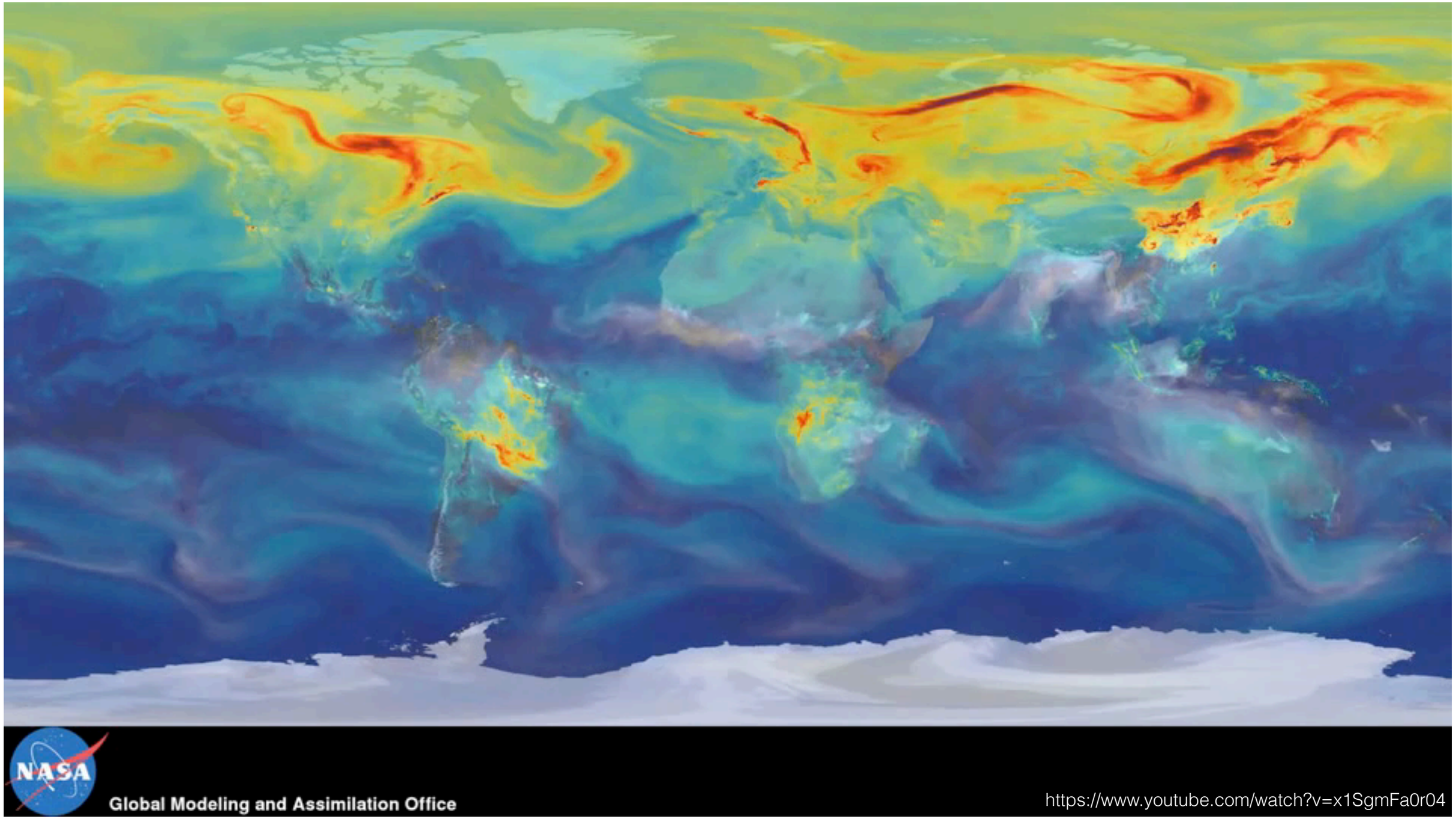


# The burning of fossil fuels (coal, oil, natural gas) can double, triple or even quadruple the amount of carbon dioxide in the atmosphere.



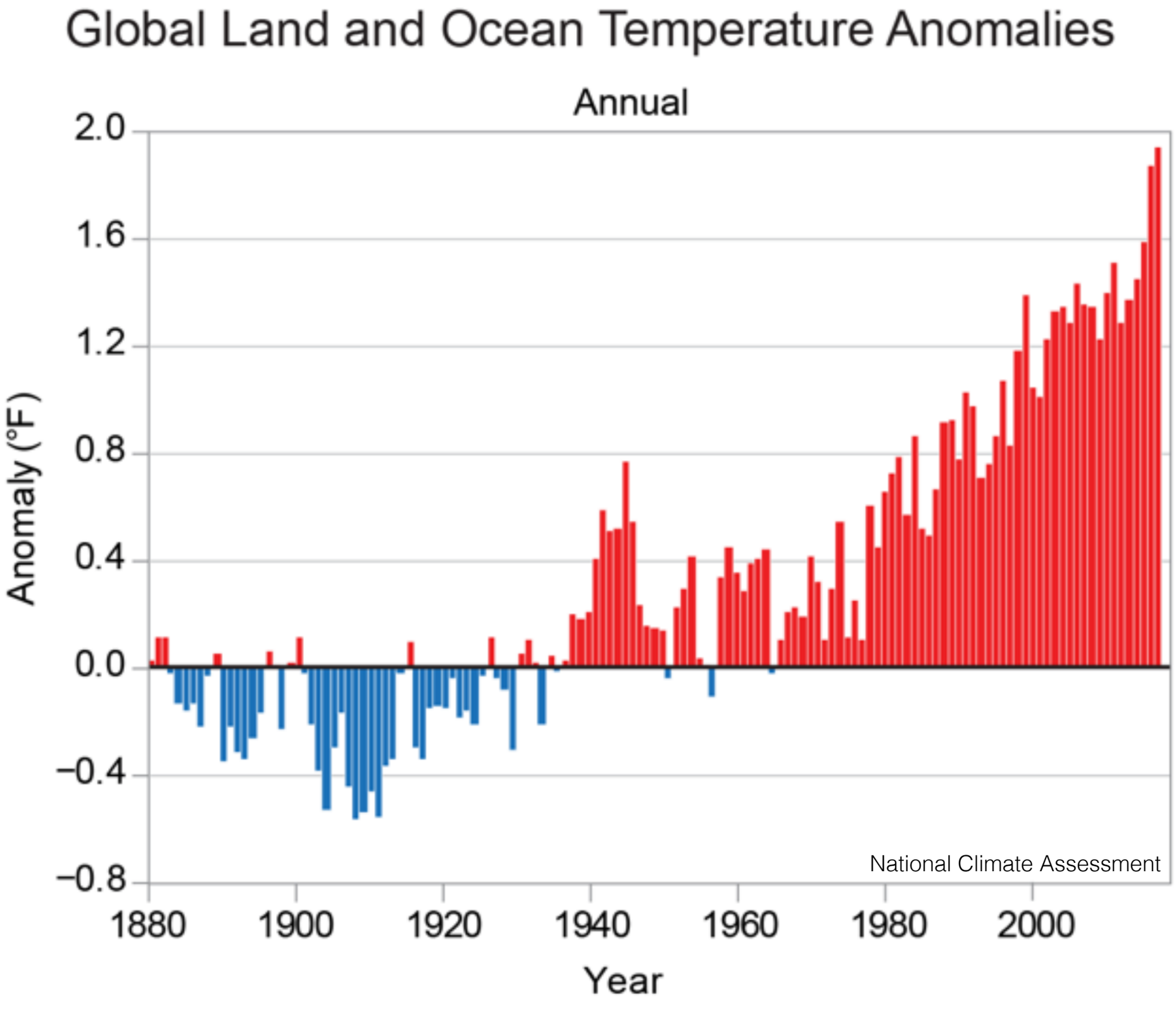

source: NASA Climate Change

# The atmosphere quickly mixes carbon dioxide throughout the atmosphere.

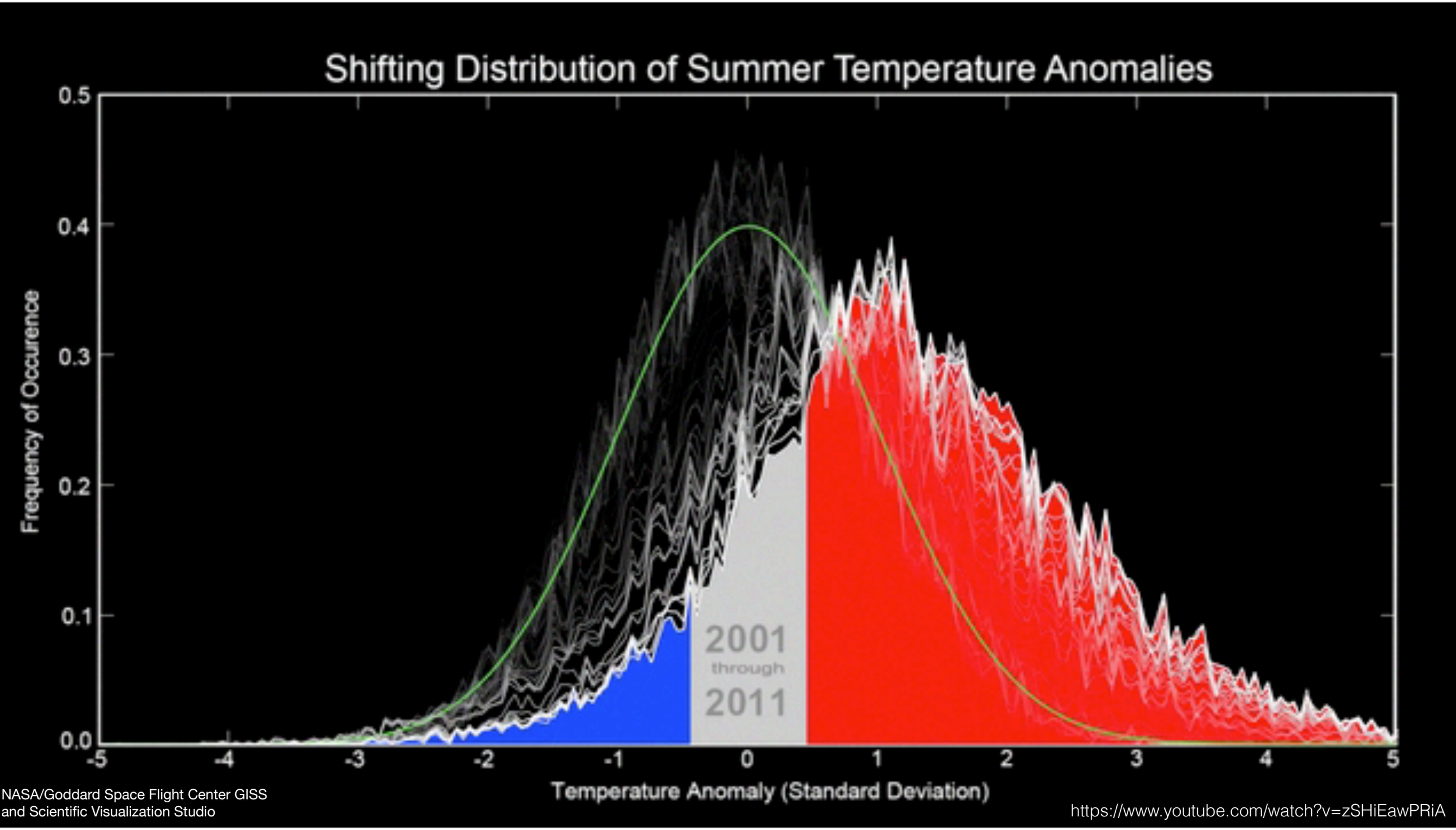



Regardless of where carbon dioxide is created and released, its heat-trapping impact is spread across the Earth.

As expected, more carbon dioxide in the atmosphere leads to more trapped heat that leads to warmer temperatures.

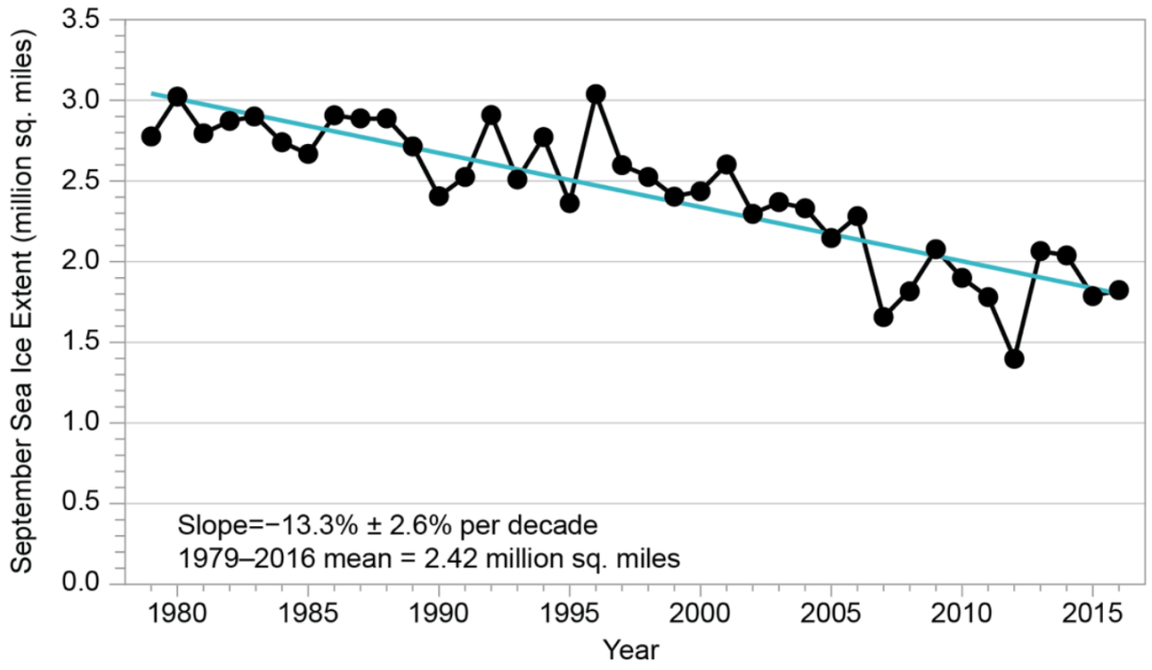


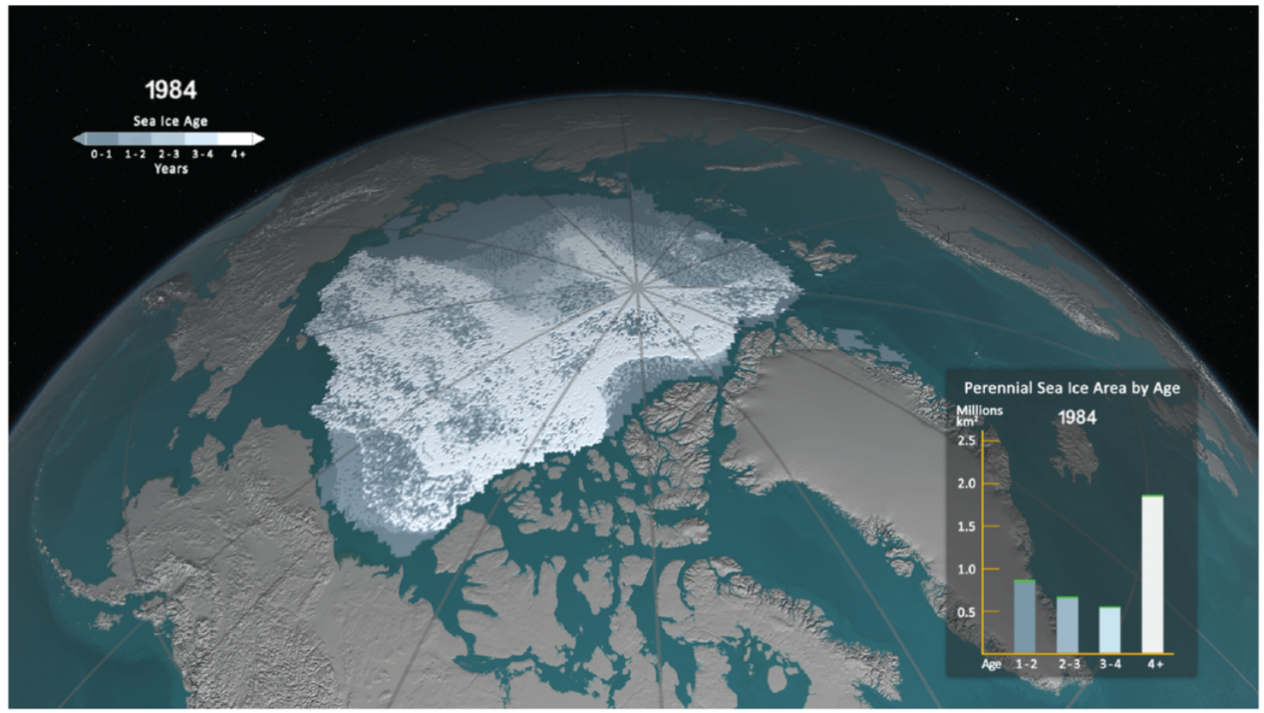
What was considered a hot summer day in 1950
is now an average summer day.




Shifting Distribution of Northern Hemisphere Summer Temperature Anomalies, 1951-2011

# The largest climate change to date has been observed in the Arctic

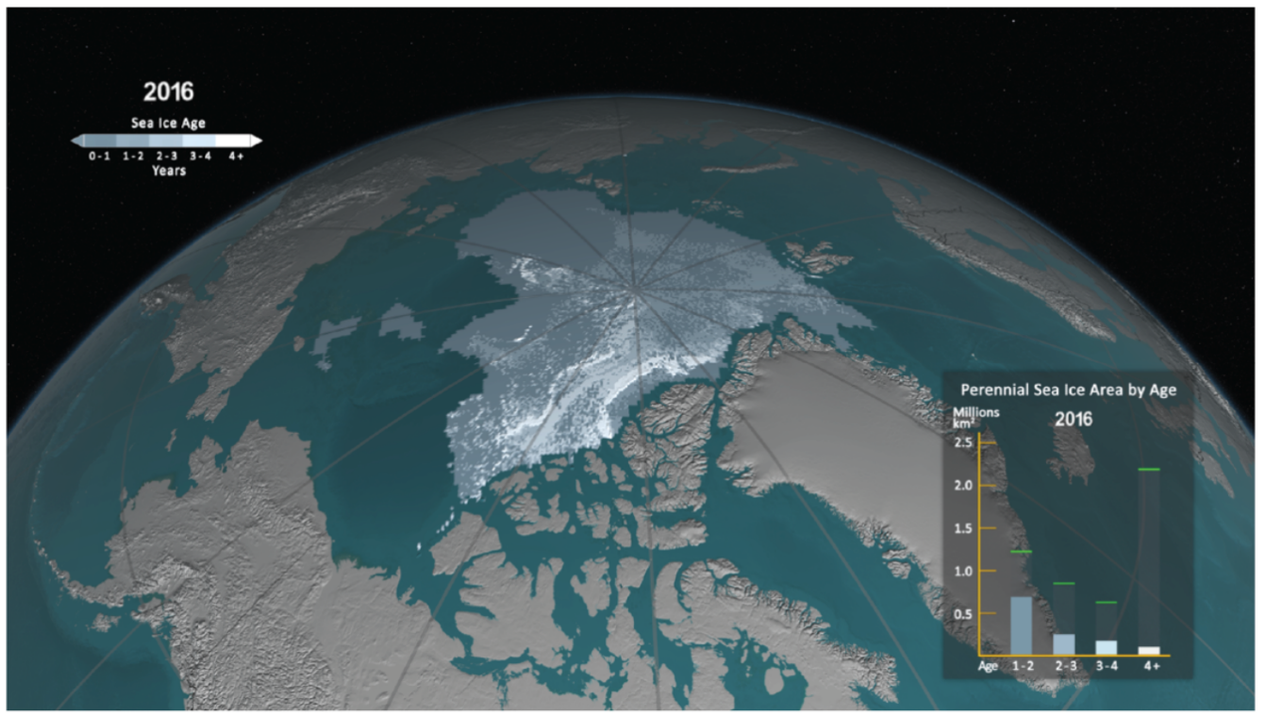



Warmer air and water melts more ice.

The Arctic has, in all likelihood, passed its tipping point toward an ice-free summertime.

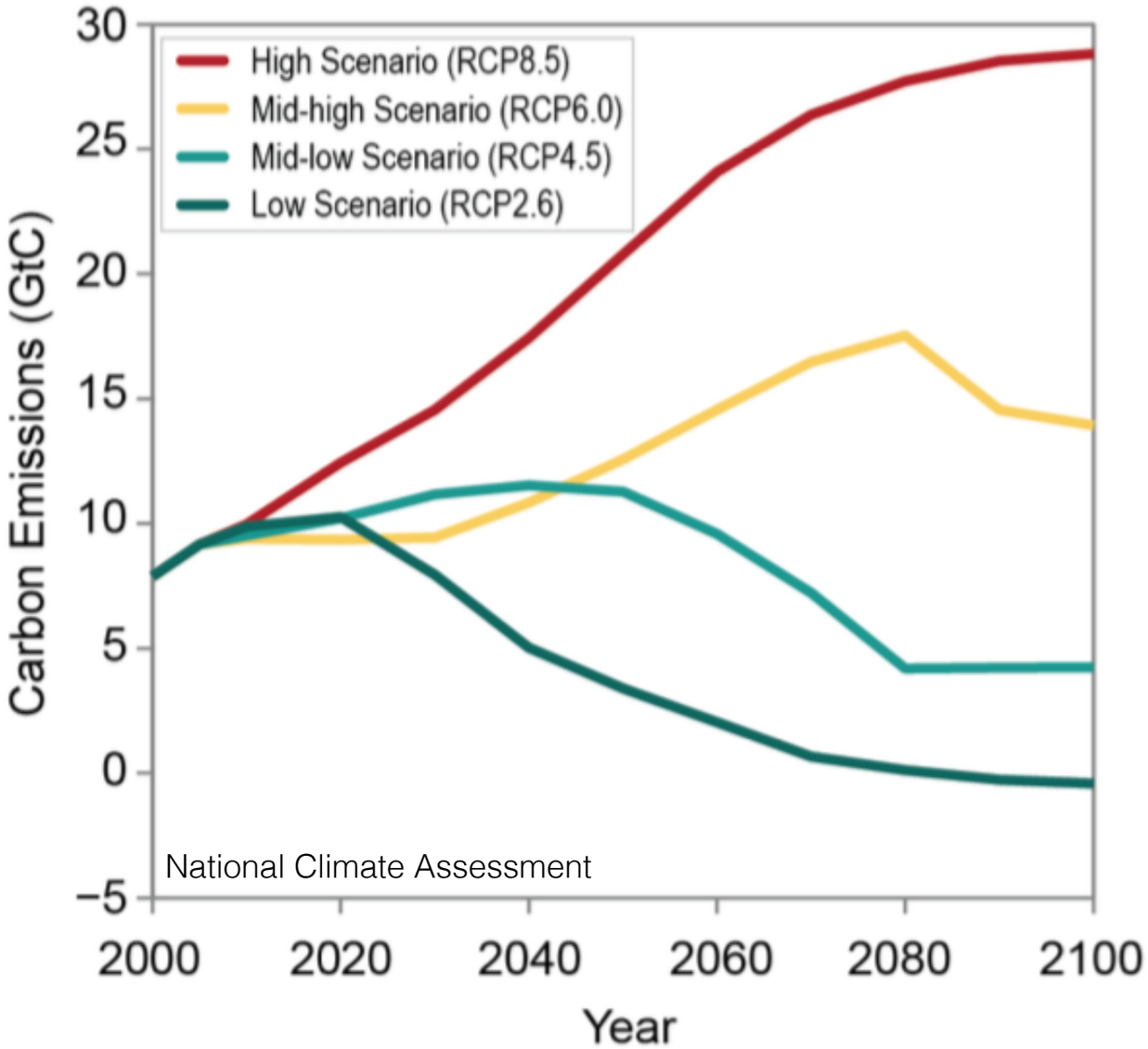
Sometime in the middle of this century (probably in the 2040s) we will observe an ice-free summertime Arctic.



Now turning to look ahead ….
what doe the future hold?

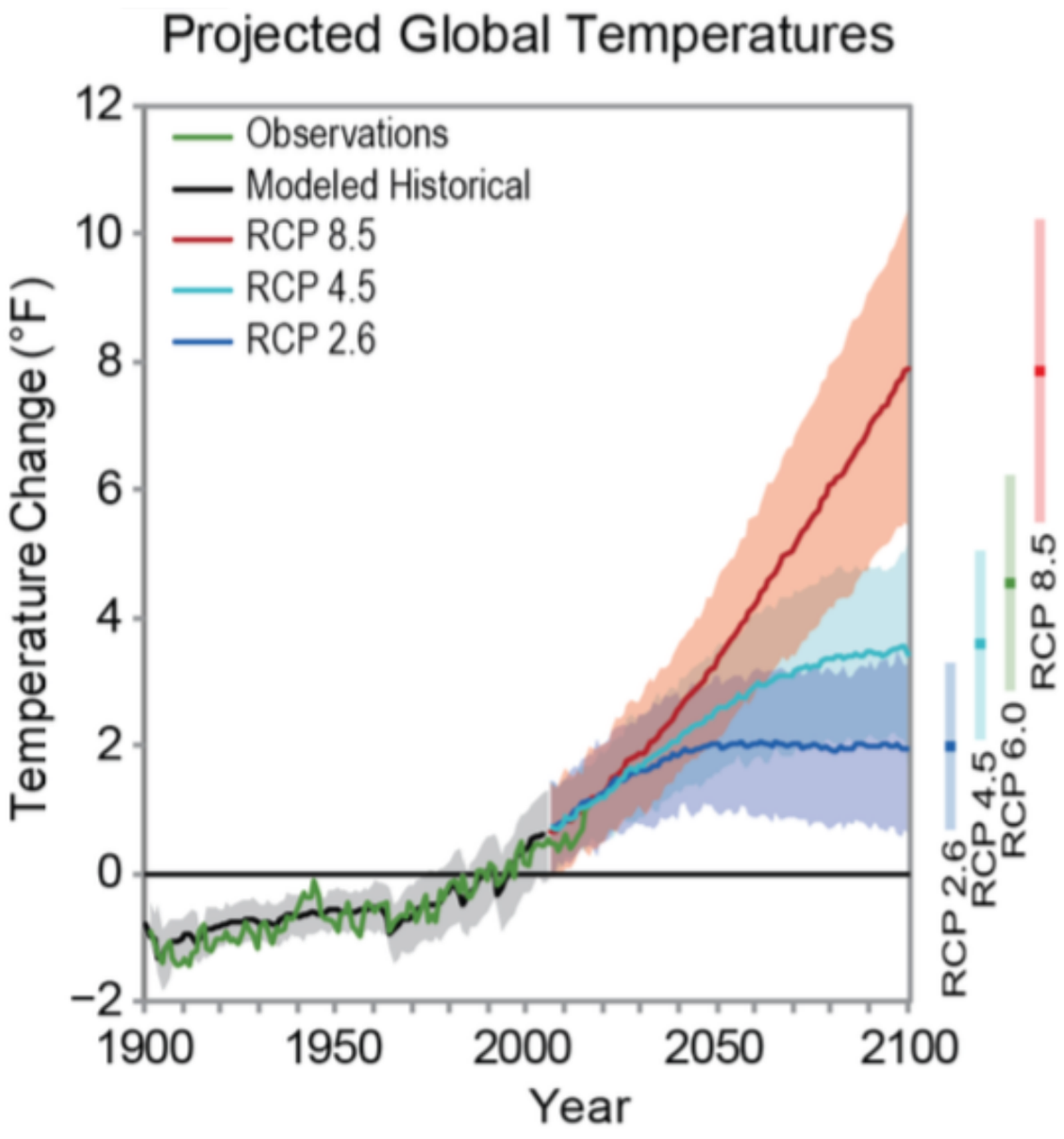
# The magnitude of climate change is still very much in our control.

This is how much fossil fuel we burn.



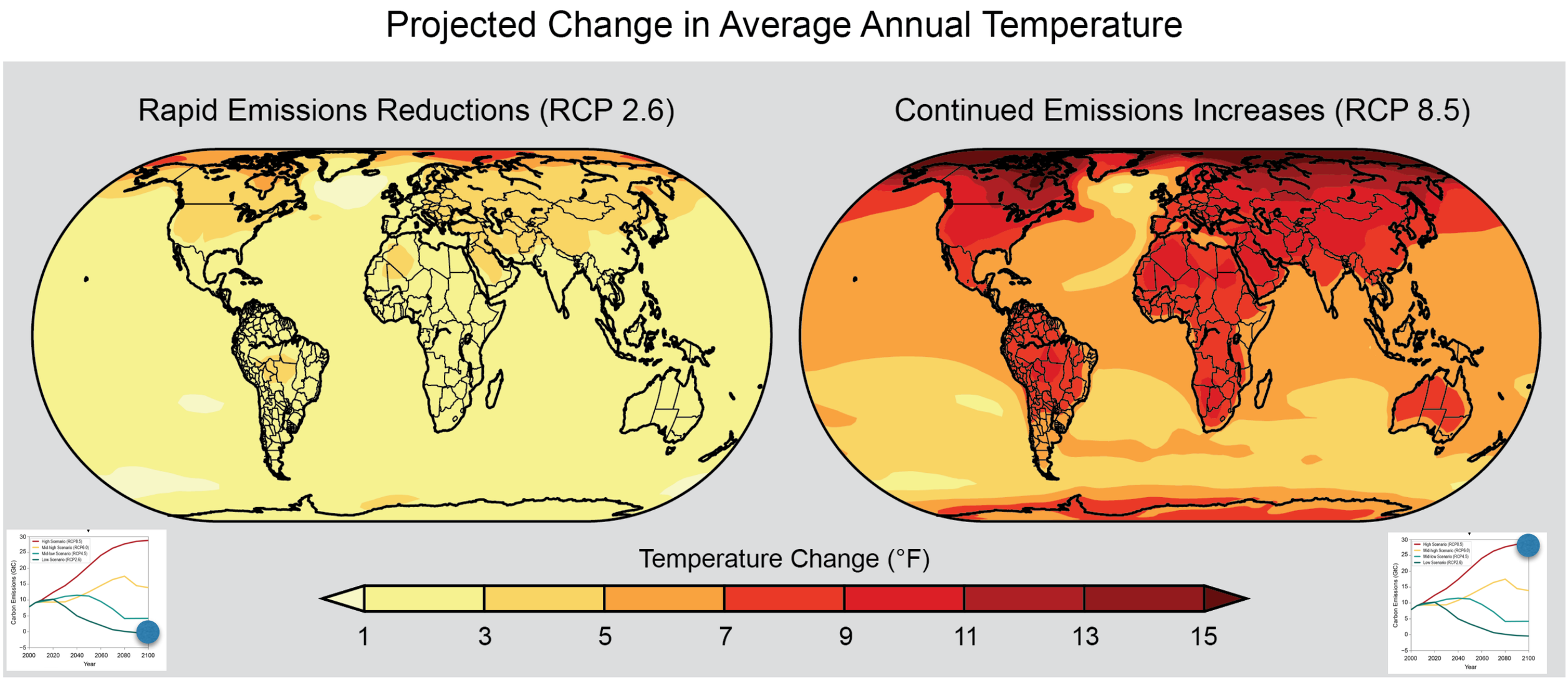

This is our choice.

This is how much the Earth warms.



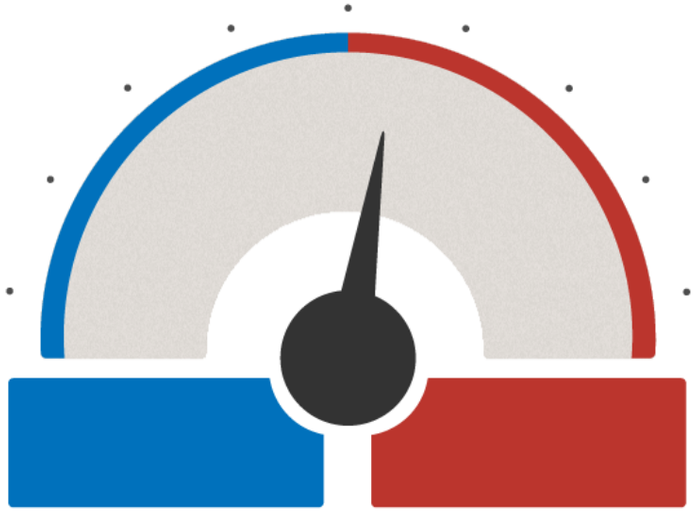

This is the consequence of our choice.

# Our two futures:
# a low-carbon emissions future (left)
# a high-carbon emissions future (right)




Changes in surface temperature can be viewed as an
easy way to measure the size and extent of climate change,
but the real impacts will be felt in other ways.

# Carbon emissions drive surface temperatures that, in turn, drive regional impacts.

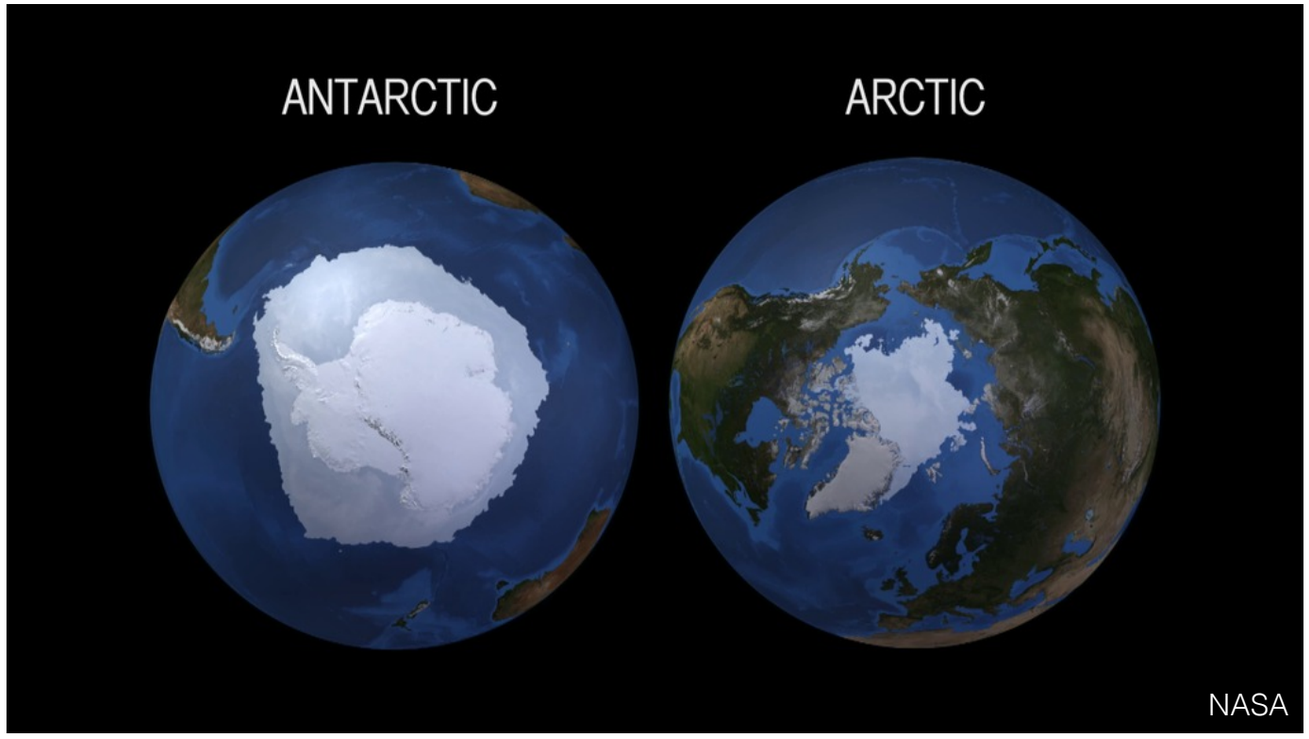


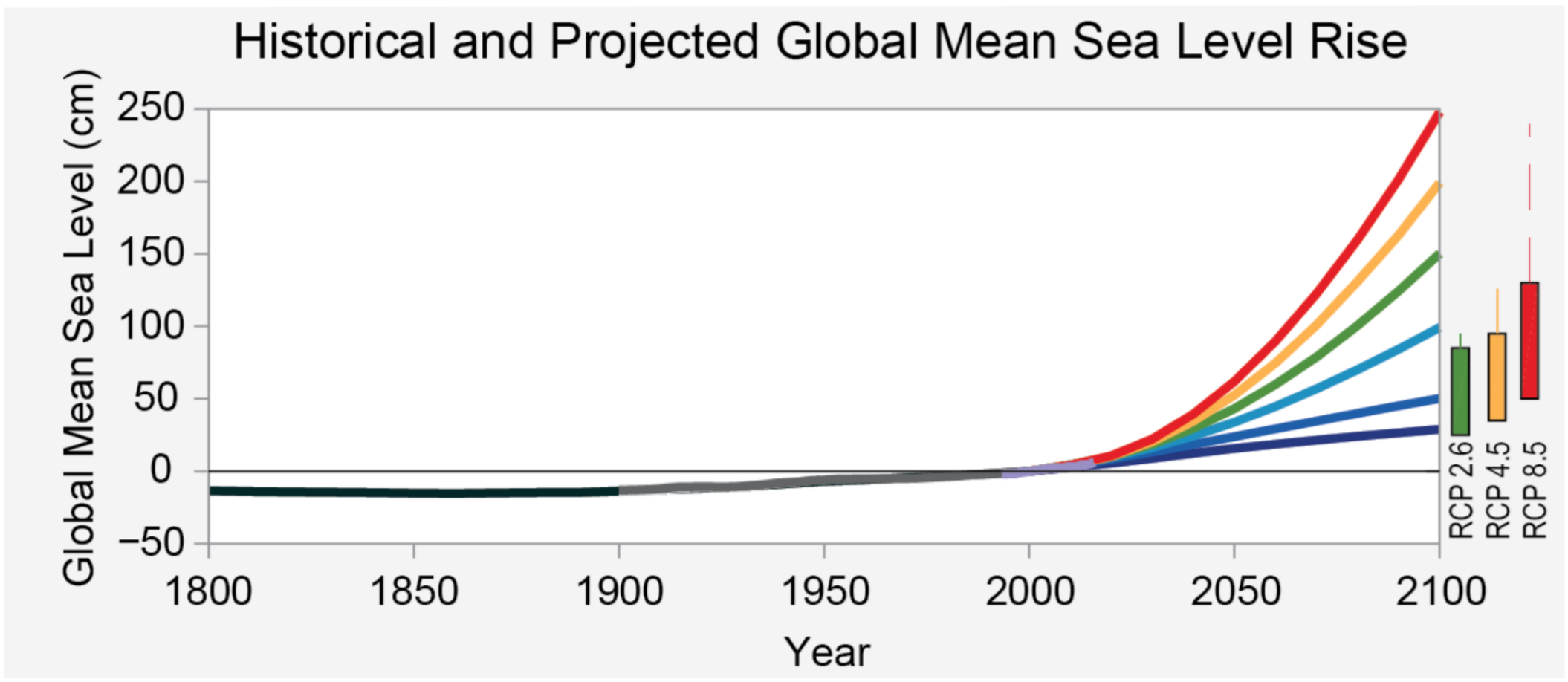
Carbon emissions drive ….

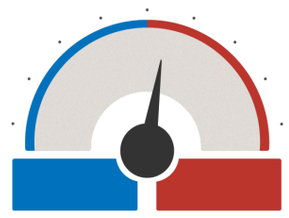
a longer growing season,
stronger droughts across the US,
stronger hurricanes in the Atlantic,
less wintertime snowpack in the Rockies,
earlier springtime river run-off in the Rockies,
more intense rainfall events,
more frequent coastal flooding,
and a longer fire season.

Let’s take a quick look at the most widespread impact of global climate change.

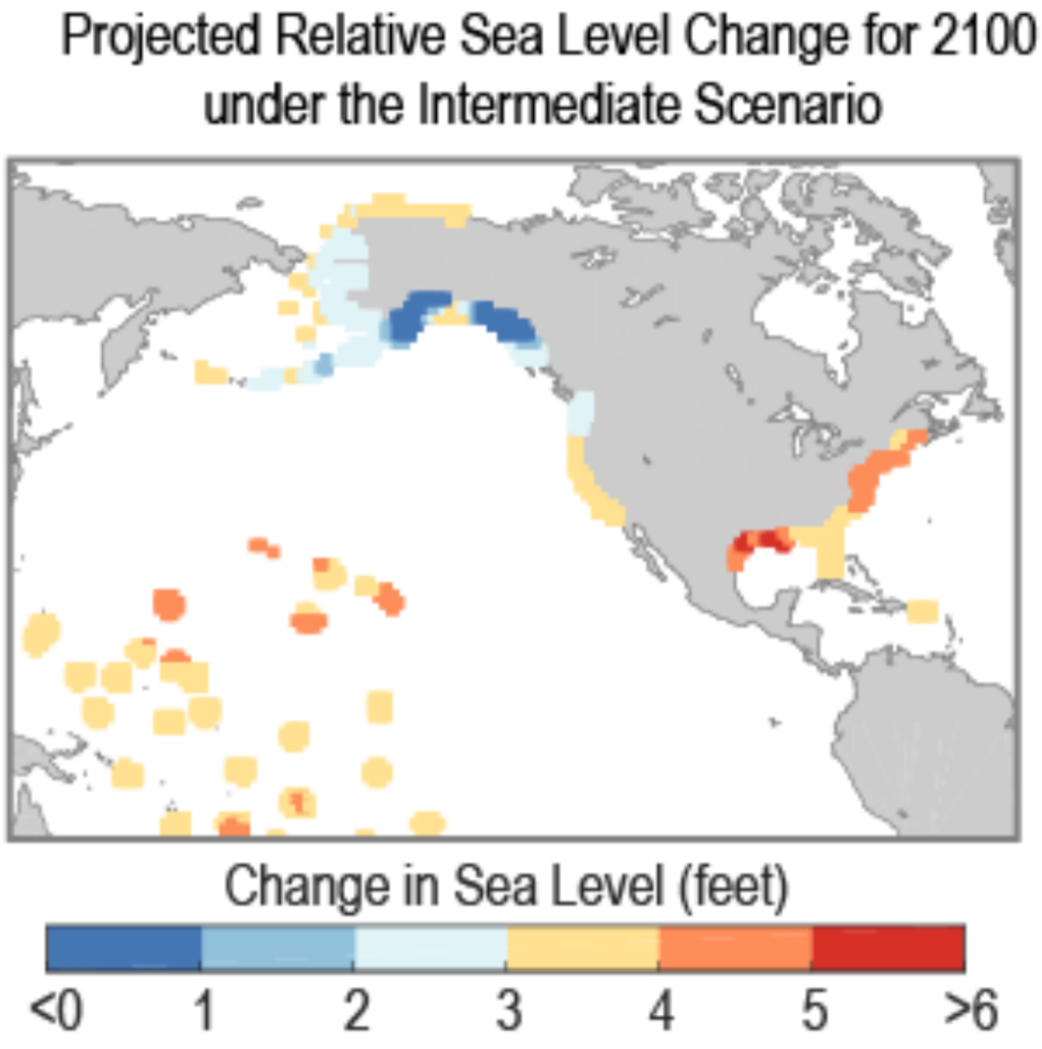
# Warmer air and water melts more ice.



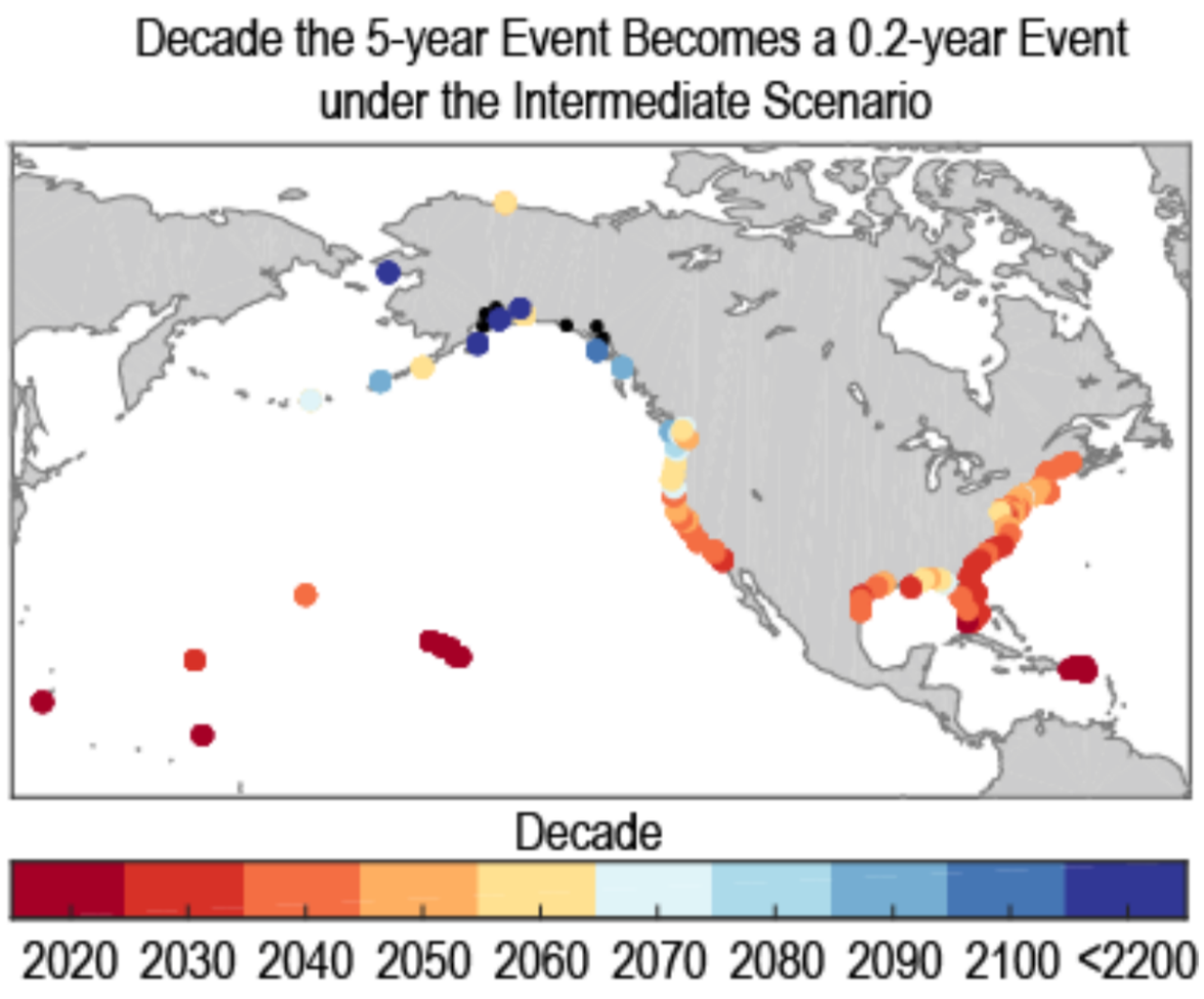



Average estimate of sea-level rise by 2100 for a high-carbon future.

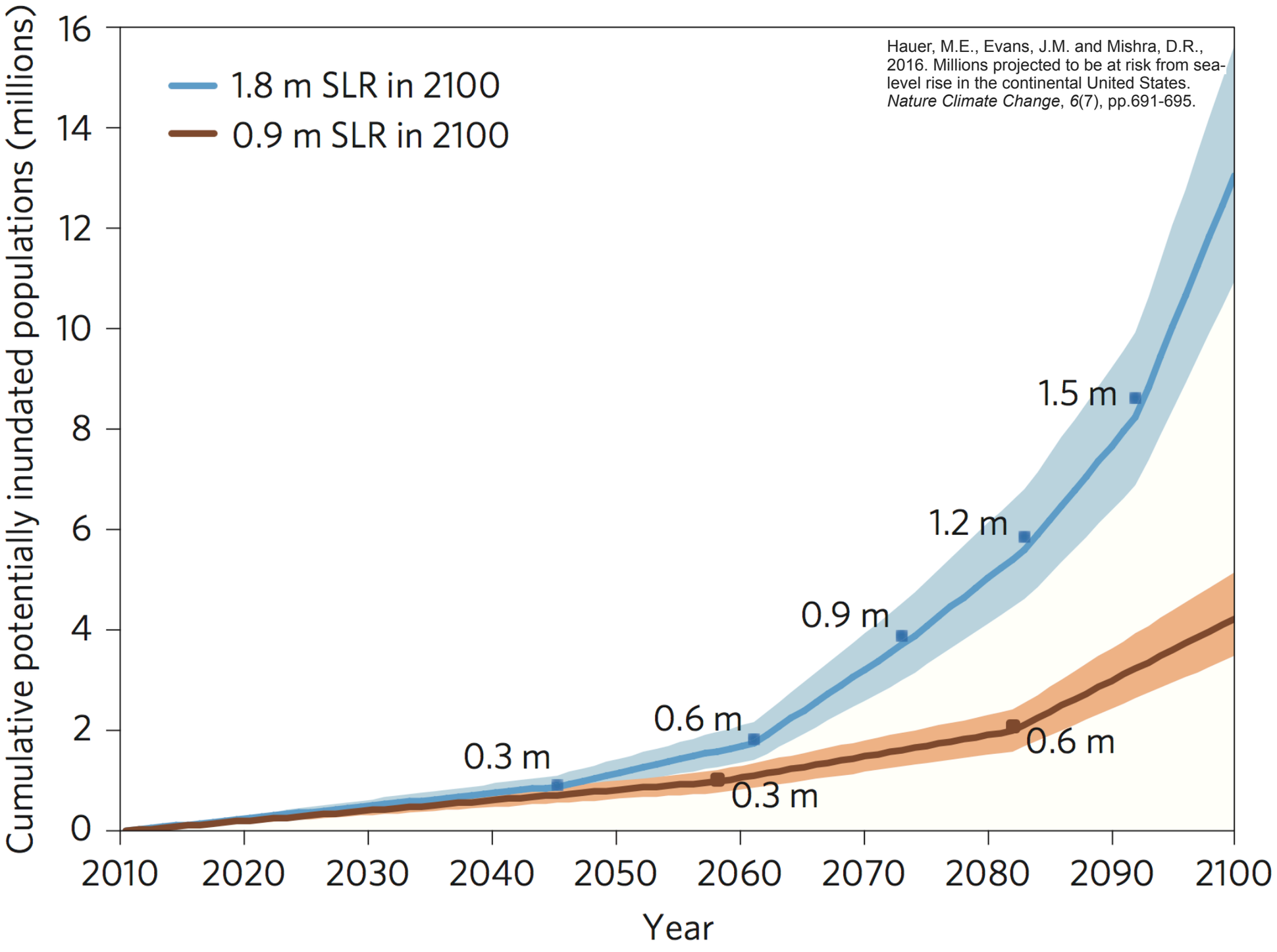



But that 3.3 ft is not distributed evenly around the Earth's coastline.

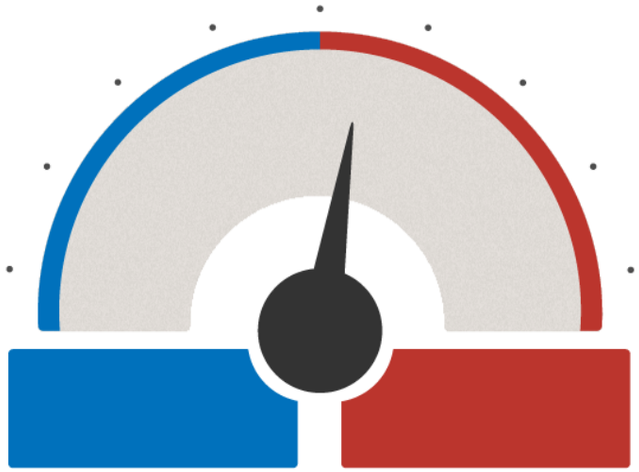



The once every 5-year high water event is already the nearly monthly high water event along the East coast.

# Why might New Mexican's living at 7000 ft care about sea-level rise?




A high-carbon future will displace millions of U.S. citizens from their homes. Worldwide, this number will be in the 10s to 100s of million of people.

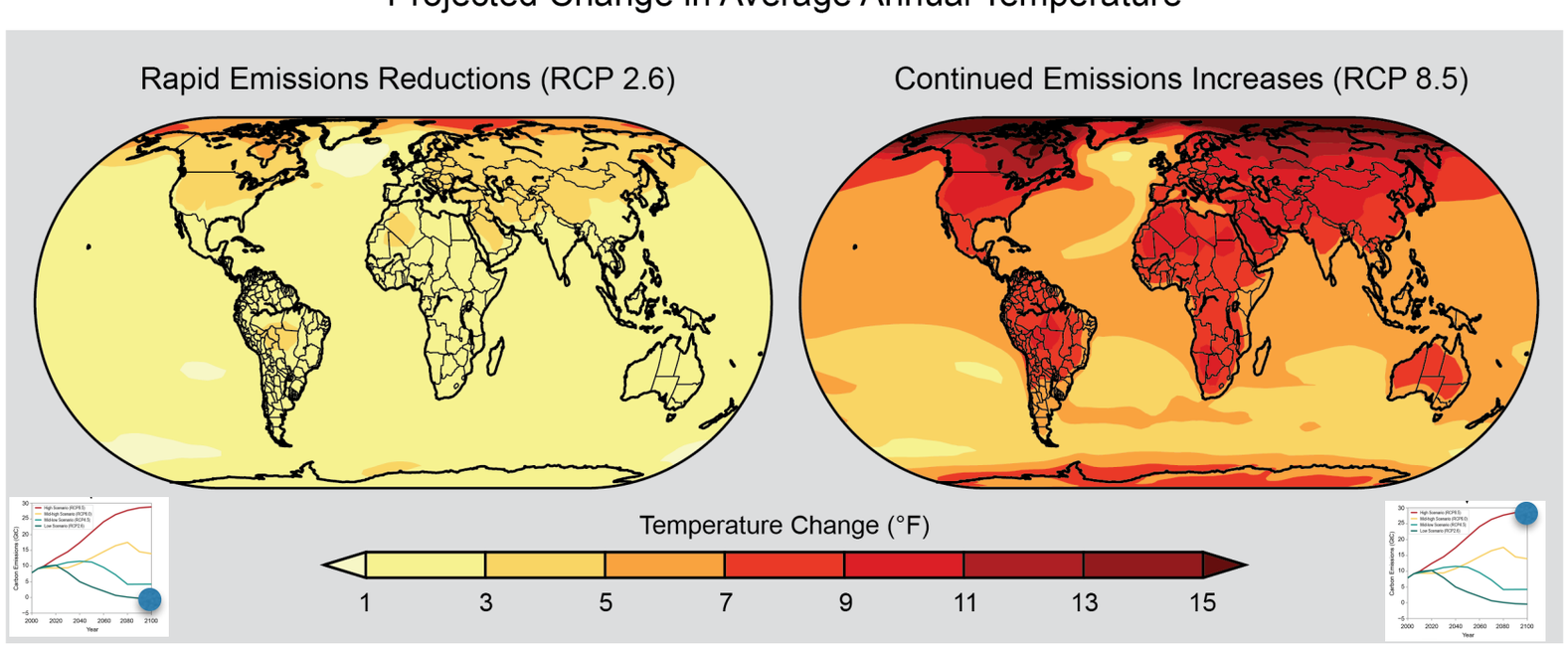


Collectively, we set the
dial on carbon emissions.

dial it
down

keep it
turned up

Projected Change in Average Annual Temperature




Climate science can help us understand the
benefits and consequences of our two futures,
but, collectively, the future is ours to choose.

# Thank you!