

# Climate Change

Adapted from: (1) Chuck Kutschner  
Presentation '15 and (2) Intro to Energy  
Class at Colorado School of Mines

See Chuck's talk at

<https://www.youtube.com/watch?v=XMViBEiG8qk>

Edgewater Seminar IV

April 18<sup>th</sup>, 2017

Presented at the Edgewater Library by

K. Xerxes Steirer, PhD Applied Physics

[ksteirer@mines.edu](mailto:ksteirer@mines.edu)



---

## NEWS

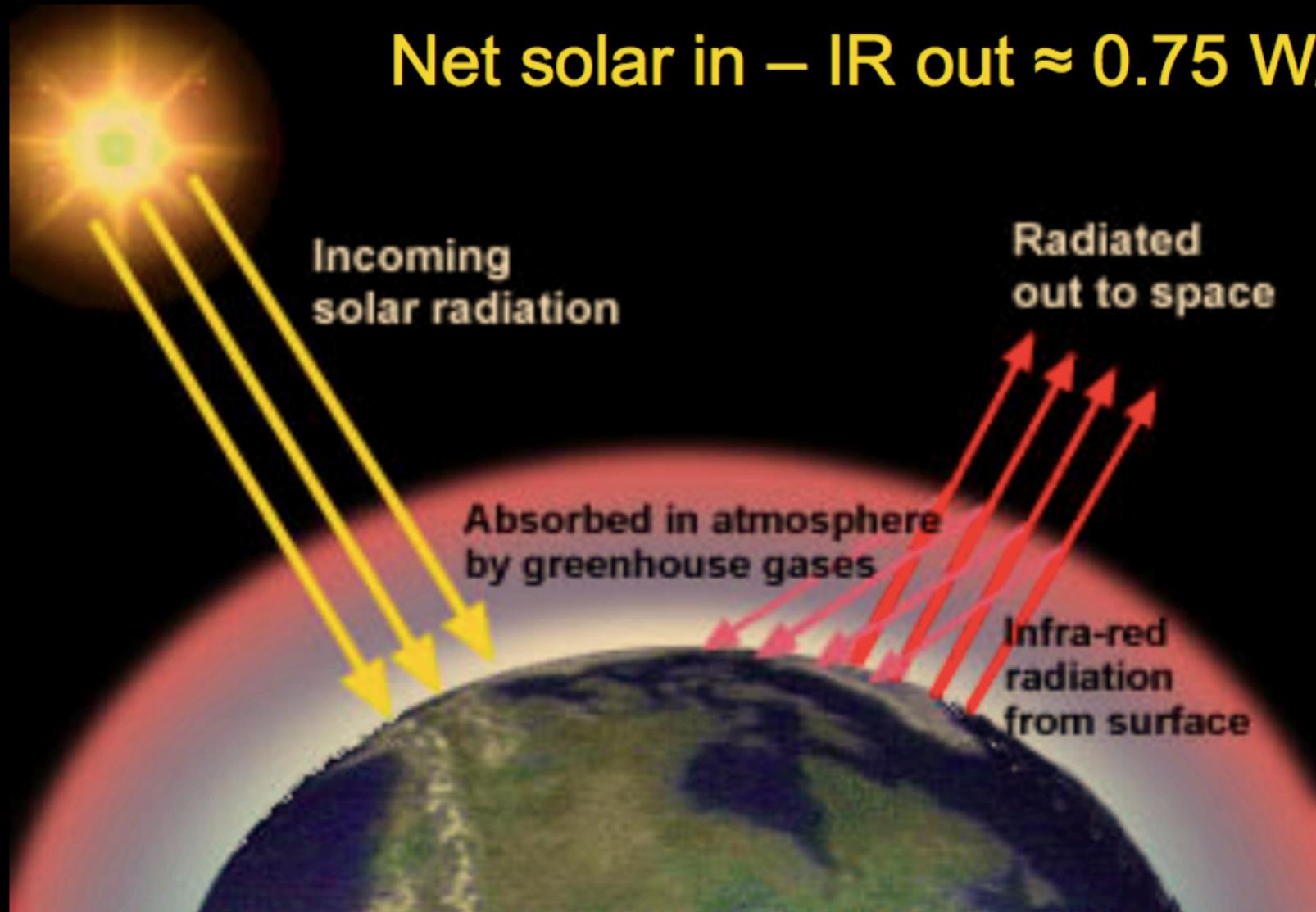
---

# Report: Global Warming Issue From 2 Or 3 Years Ago May Still Be Problem

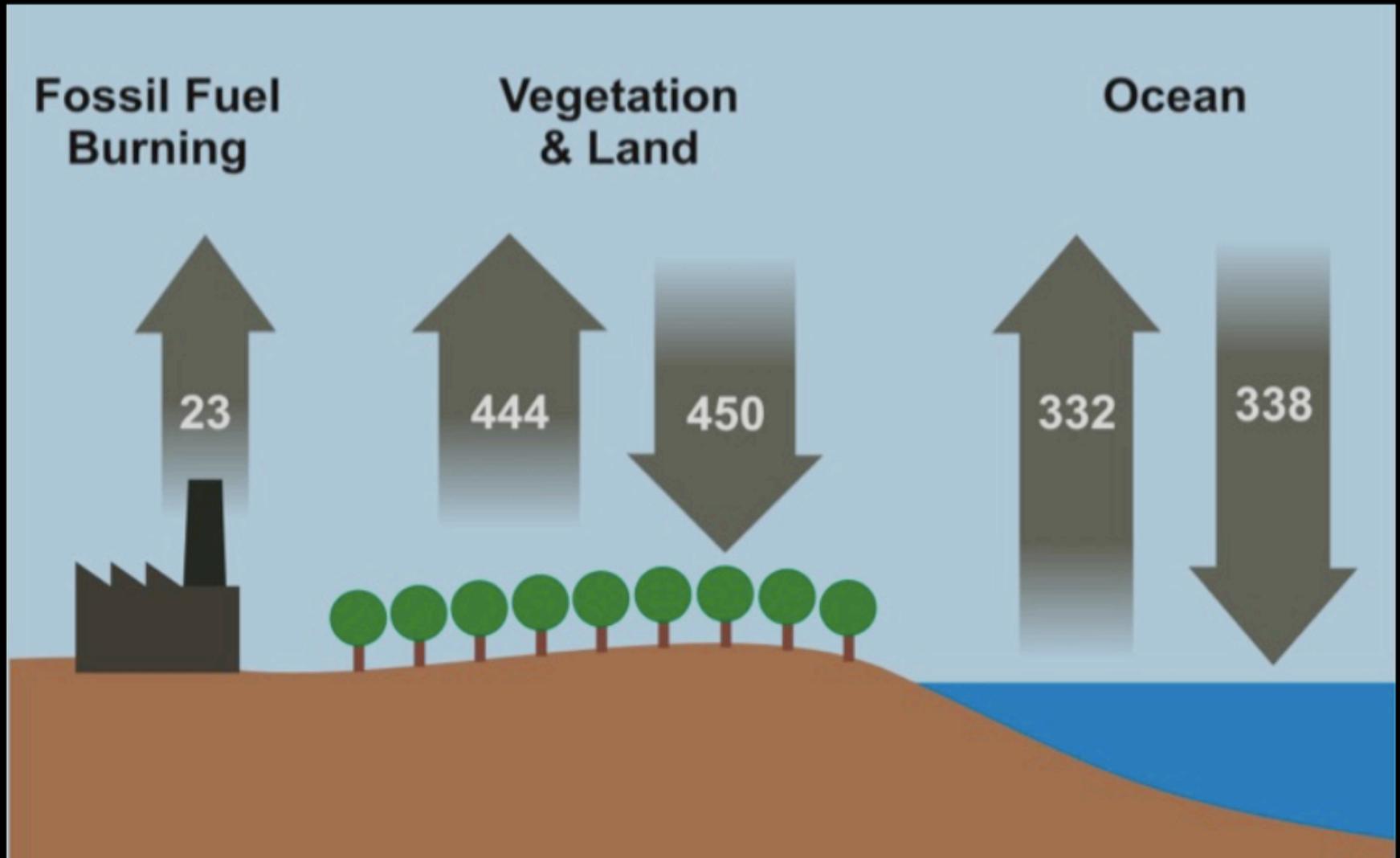
WASHINGTON—According to a report released this week by the Center for Global Development, climate change, the popular mid-2000s issue that raised awareness of the fact that the earth's continuous rise in temperature will have catastrophic ecological effects, has apparently not been resolved, and may still be a problem.

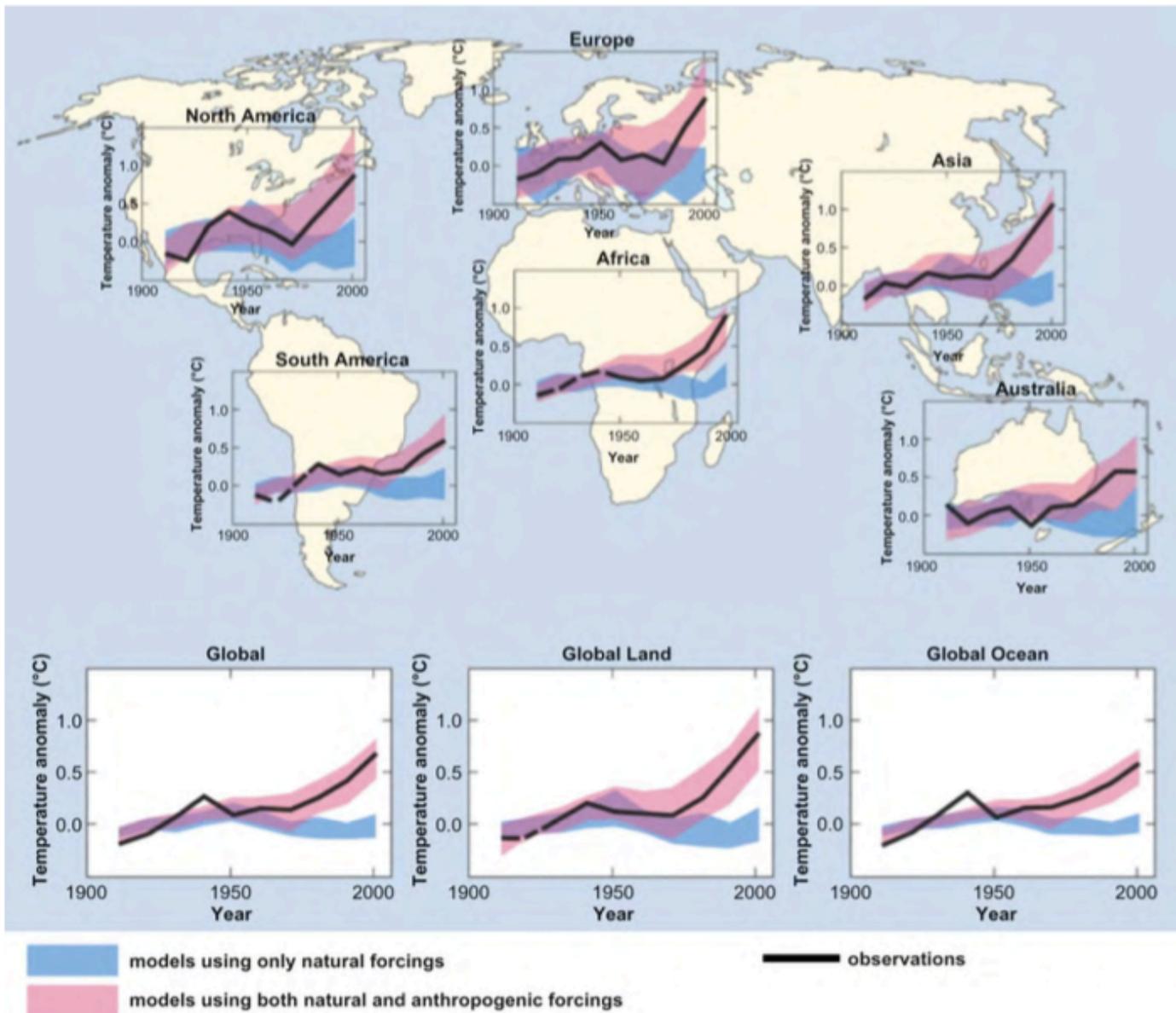
# The Greenhouse Effect

Net solar in – IR out  $\approx 0.75 \text{ W/m}^2$

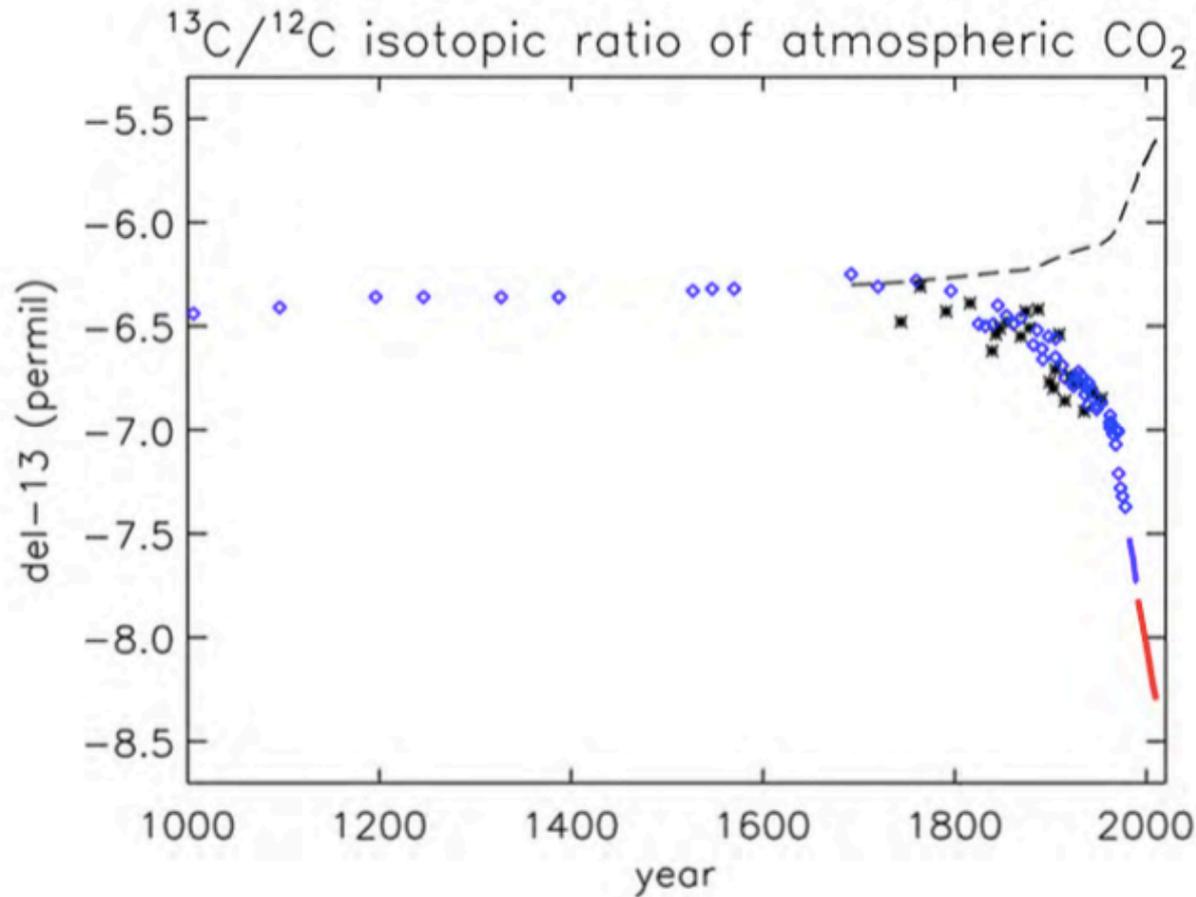


# Global Carbon Dioxide Flux (Gigatonnes)



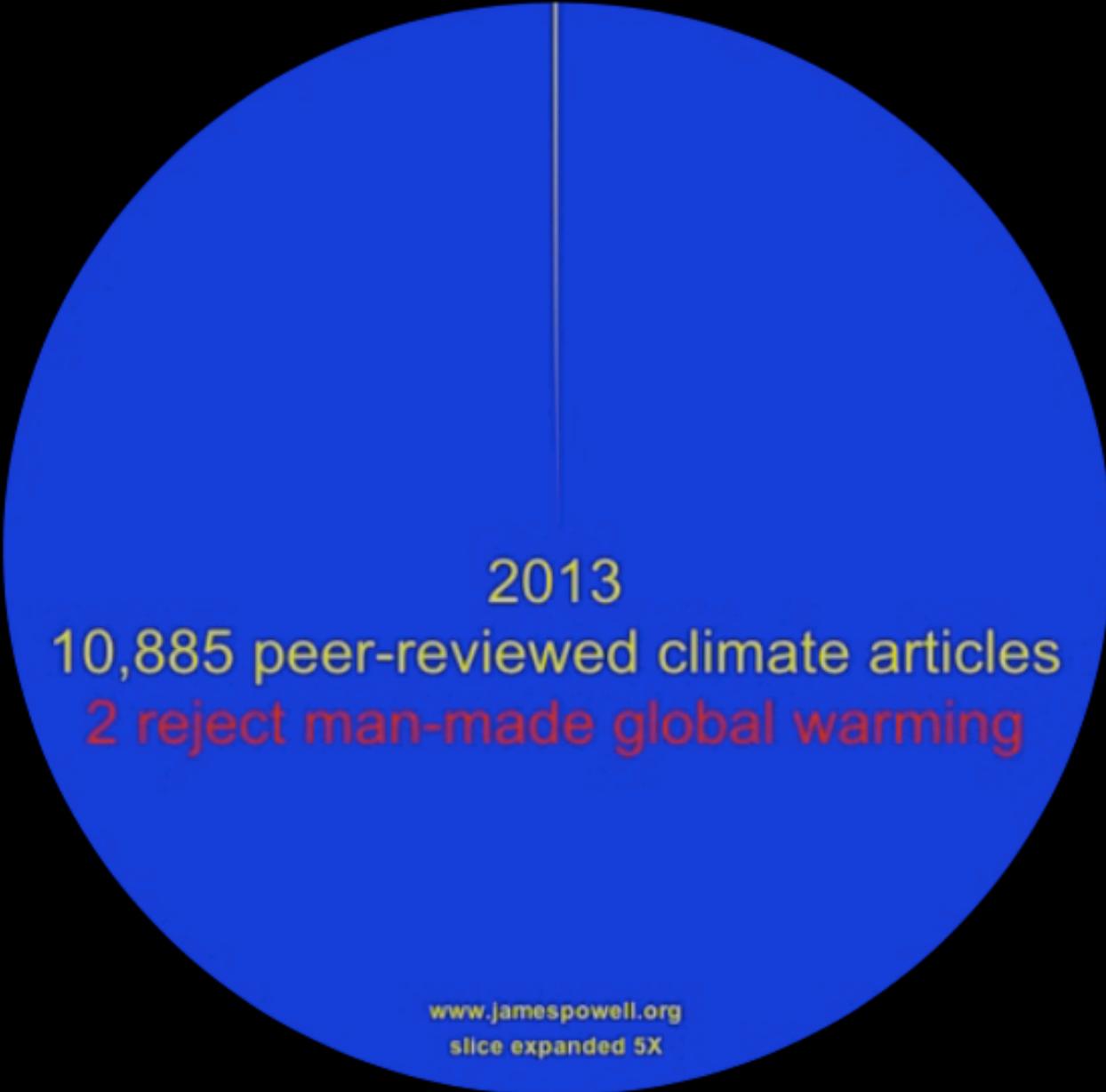


# Burning Ancient Plant Matter Changes the Atmospheric Carbon Character



This is because plants bioaccumulate  $^{12}\text{C}$  in higher concentrations than the atmosphere. In other words, they prefer it.

The observations also exclude volcanic emissions as the main source of the  $\text{CO}_2$  excess in the atmosphere because they would have increased the atmospheric  $^{13}\text{C}/^{12}\text{C}$  ratio (as shown in dashed line).





**Global Warming Consensus Exceeds 99.99%**

24,210 peer-reviewed articles by 69,406 authors  
5 articles, 4 authors reject man-made global warming  
1 author in 17,352 or 0.006%  
The 5 articles have 1 citation

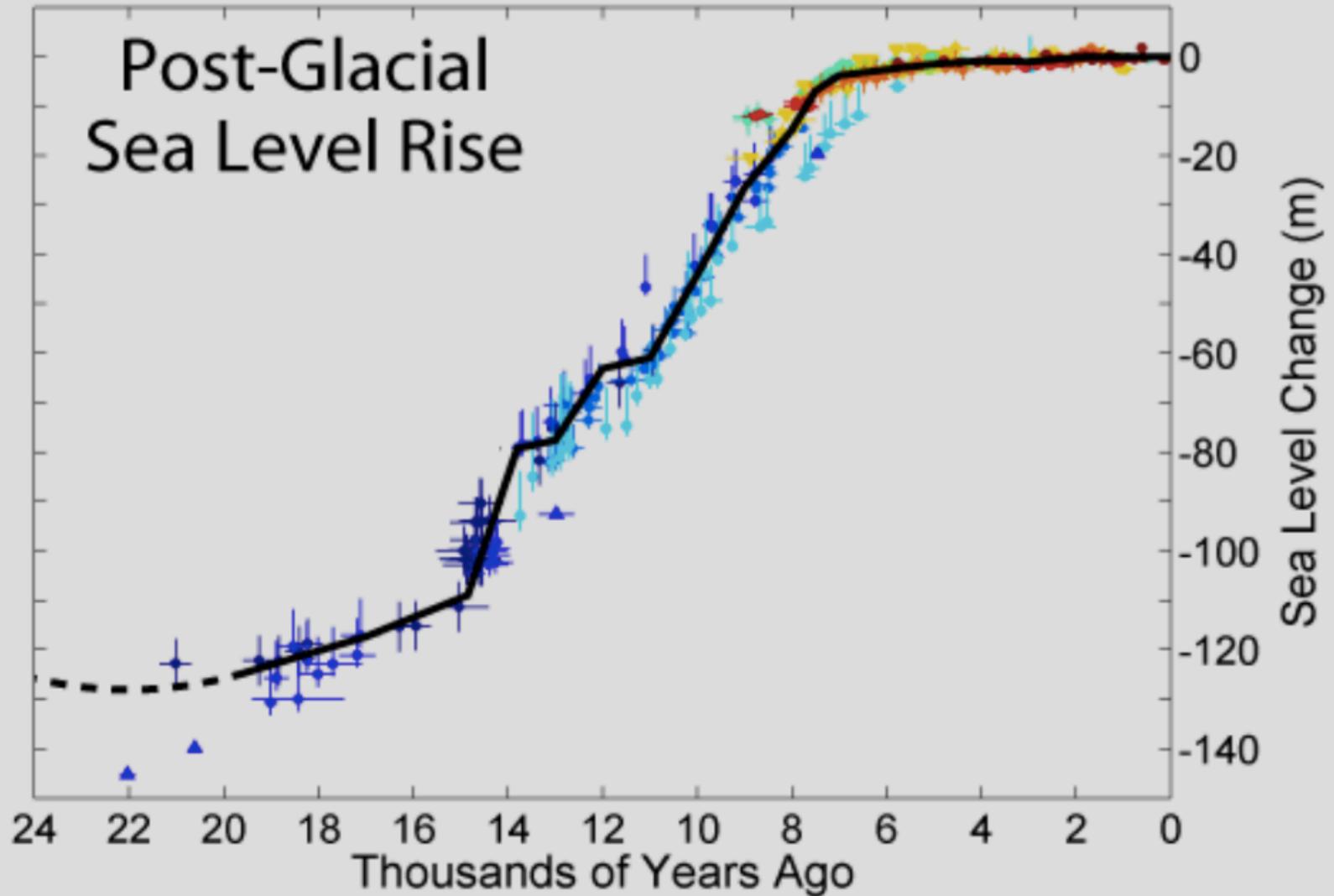
2013-2014

Slice expanded 10X

[jamespowell.org](http://jamespowell.org)

[jamespowell.org](http://jamespowell.org)  
slice expanded 5X

# Stable Sea Levels Support Society



# Up to Date Data Tracking

## Global Climate Dashboard

▼ Climate Change

▶ Climate Variability

▶ Climate Projections

### Glaciers (meters of water equivalent)

Glaciers are shrinking: average thickness of 30 well-studied glaciers has decreased more than 60 feet since 1980.

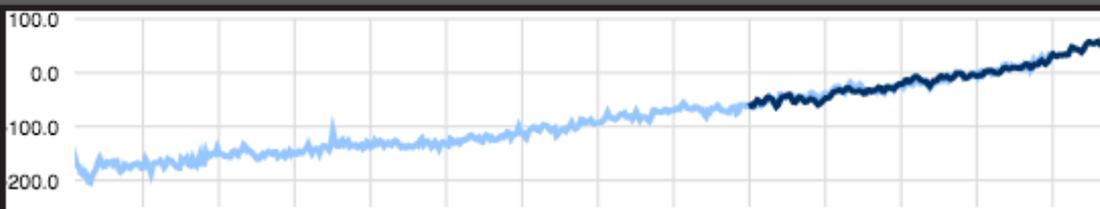
[learn more >>](#)



### Global Average Sea Level (mm)

Sea level rise has accelerated from 1.7 mm/year throughout most of the twentieth century to 3.2 mm/year since 1993.

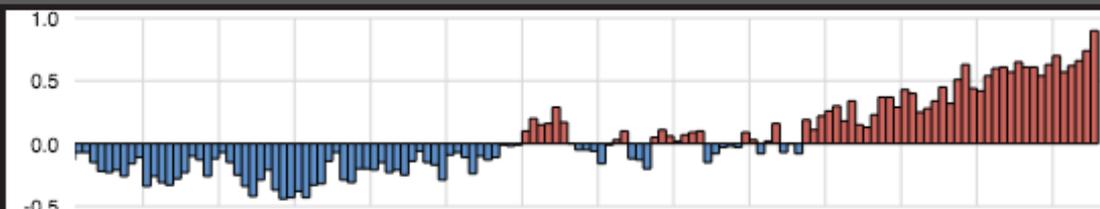
[learn more >>](#)



### Global Average Temperature (°C)

The temperature near Earth's surface is rising: the bars show each year's average temperature compared to the 20th century average.

[learn more >>](#)



1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010

← Earlier

Later →

▲ Temperature

▶ Carbon Dioxide

▶ Snow

▲ Sea Level

▶ Arctic Sea Ice

▶ Ocean Heat

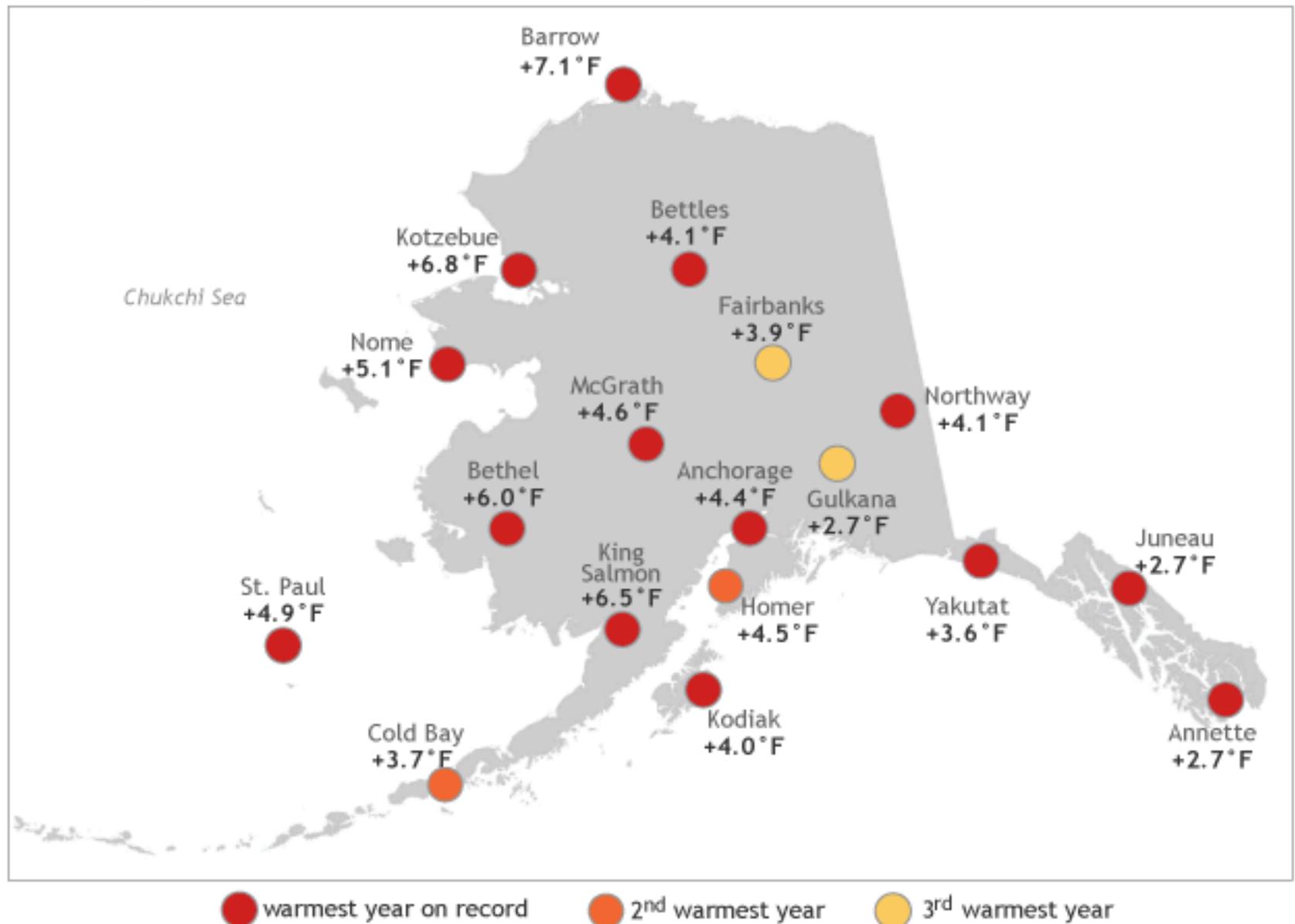
▶ Sun's Energy

▲ Glaciers

▶ Heat-Trapping Gases

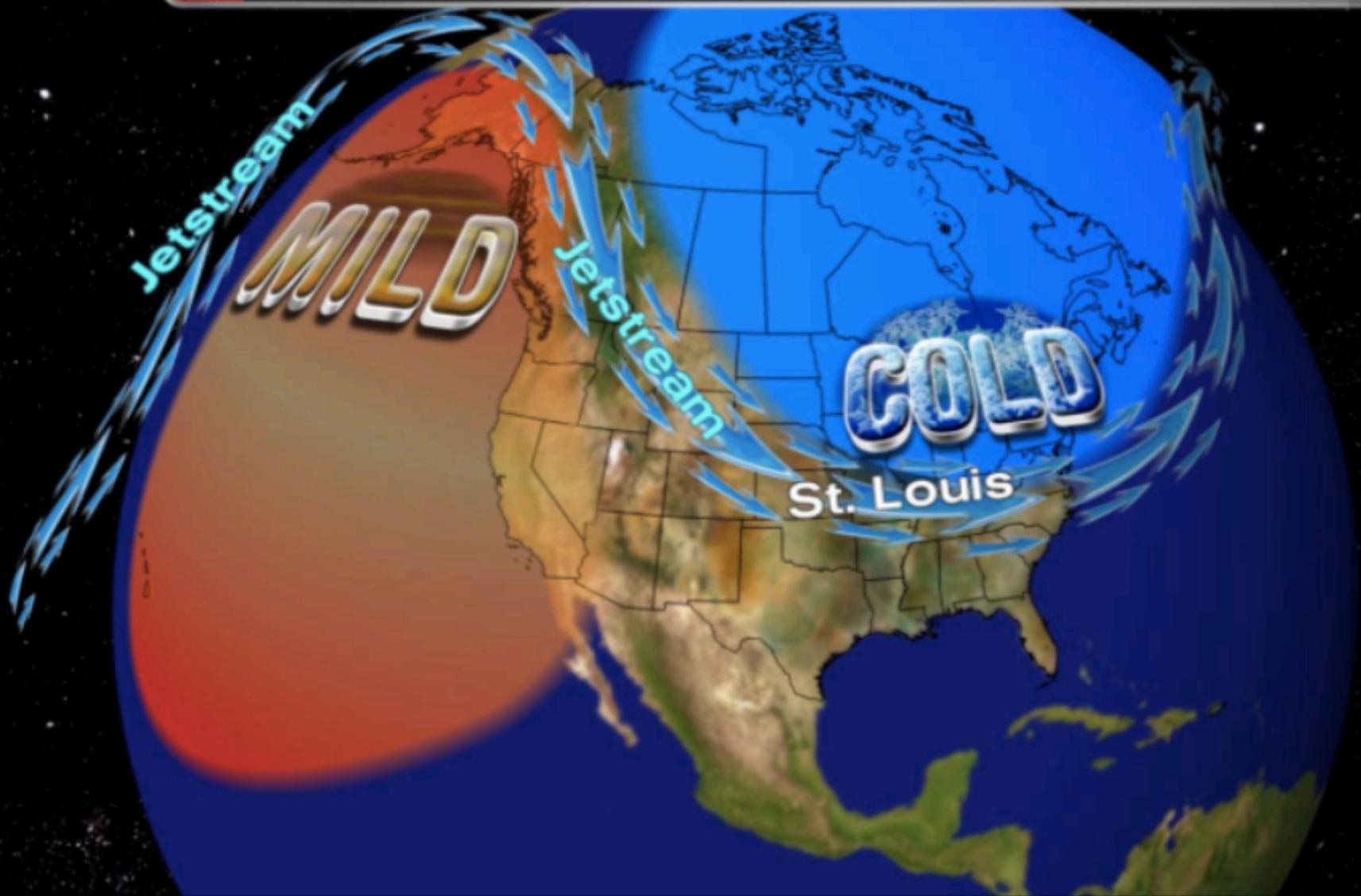
<https://www.climate.gov/>

## 2016 brought record or near-record warmth across Alaska



● warmest year on record    ● 2<sup>nd</sup> warmest year    ● 3<sup>rd</sup> warmest year

# JETSTREAM PATTERN





**+ 1 meter**

# USA: Florida

Weiss and Overpeck  
The University of Arizona



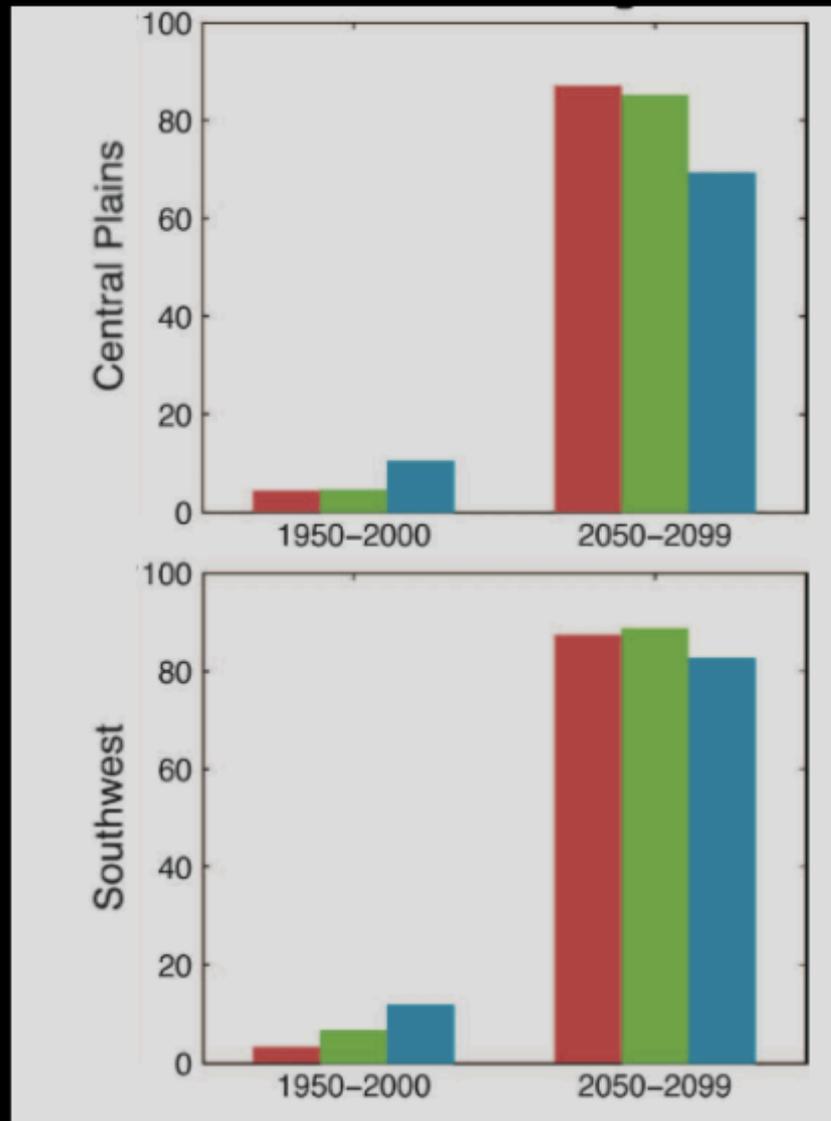
Key West

# Climate change causing US wildfire season to last longer, Congress told

US forest service chief says hotter, drier conditions mean wildfire season lasts two months longer than it did 40 years ago

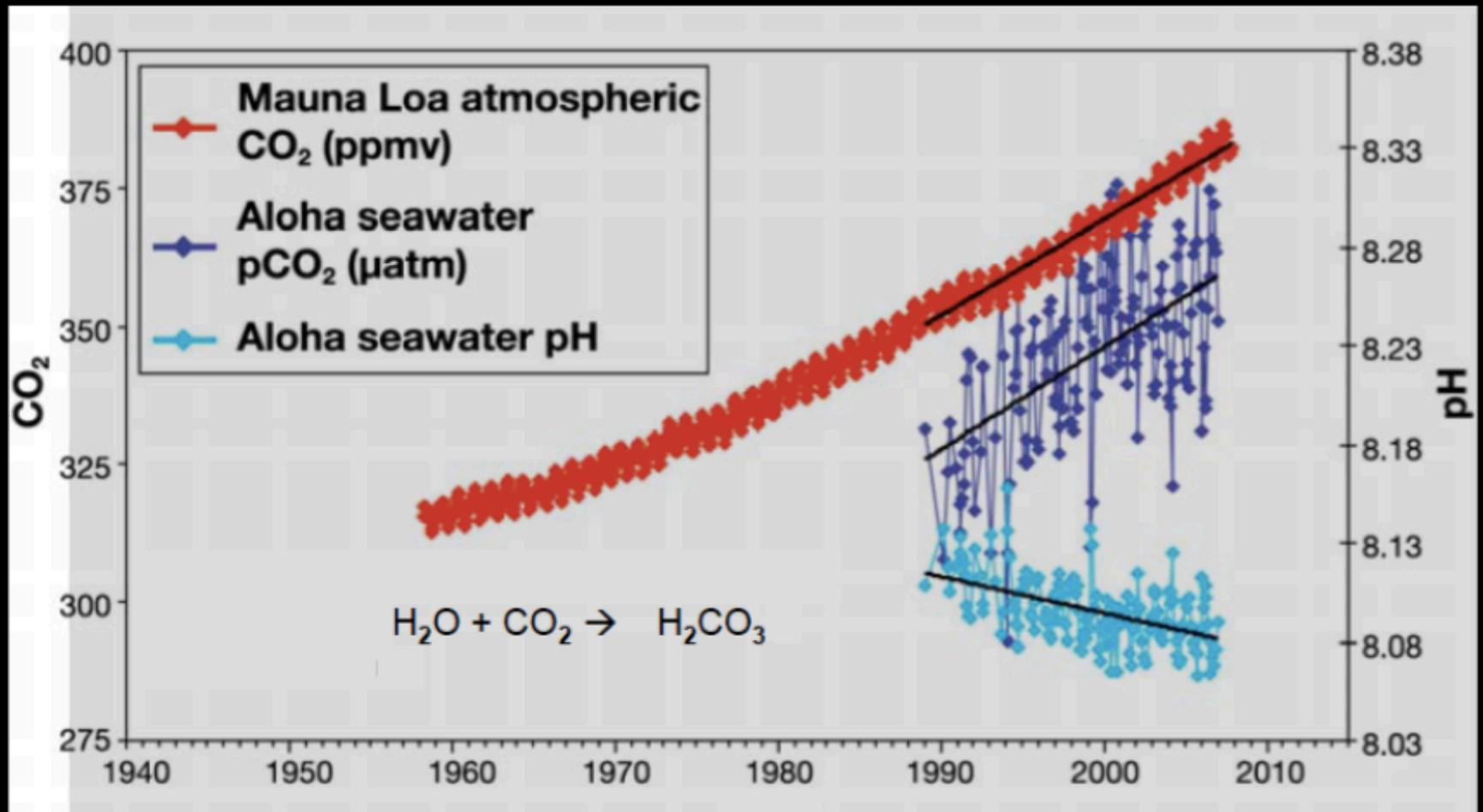


# Probability of Megadrought in U.S.



Cook, et al. , *Science Advances*, February 12, 2015

# Oceans Are 26% More Acidic

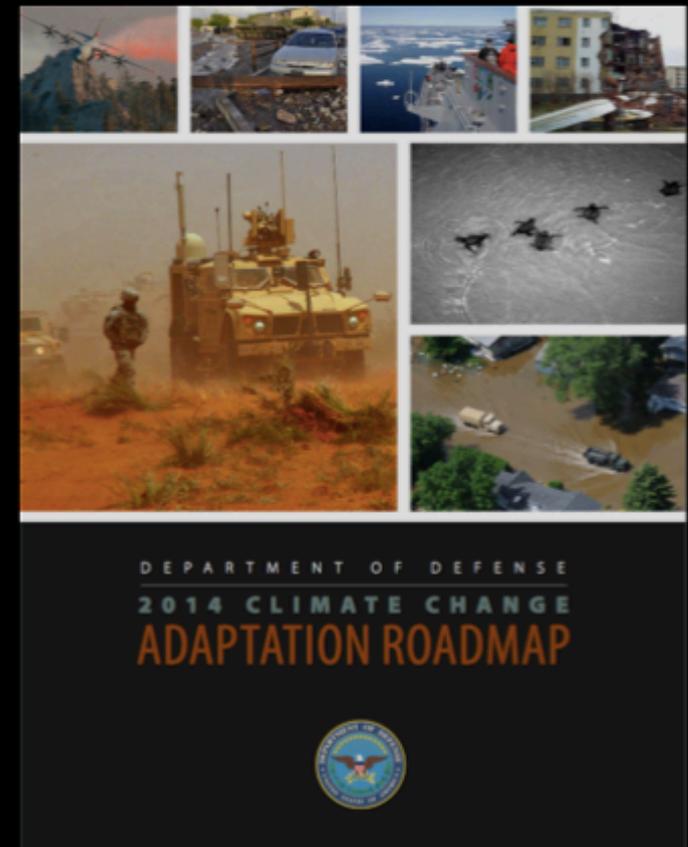




# National Security and the Accelerating Risks of Climate Change

CNA Military Advisory Board

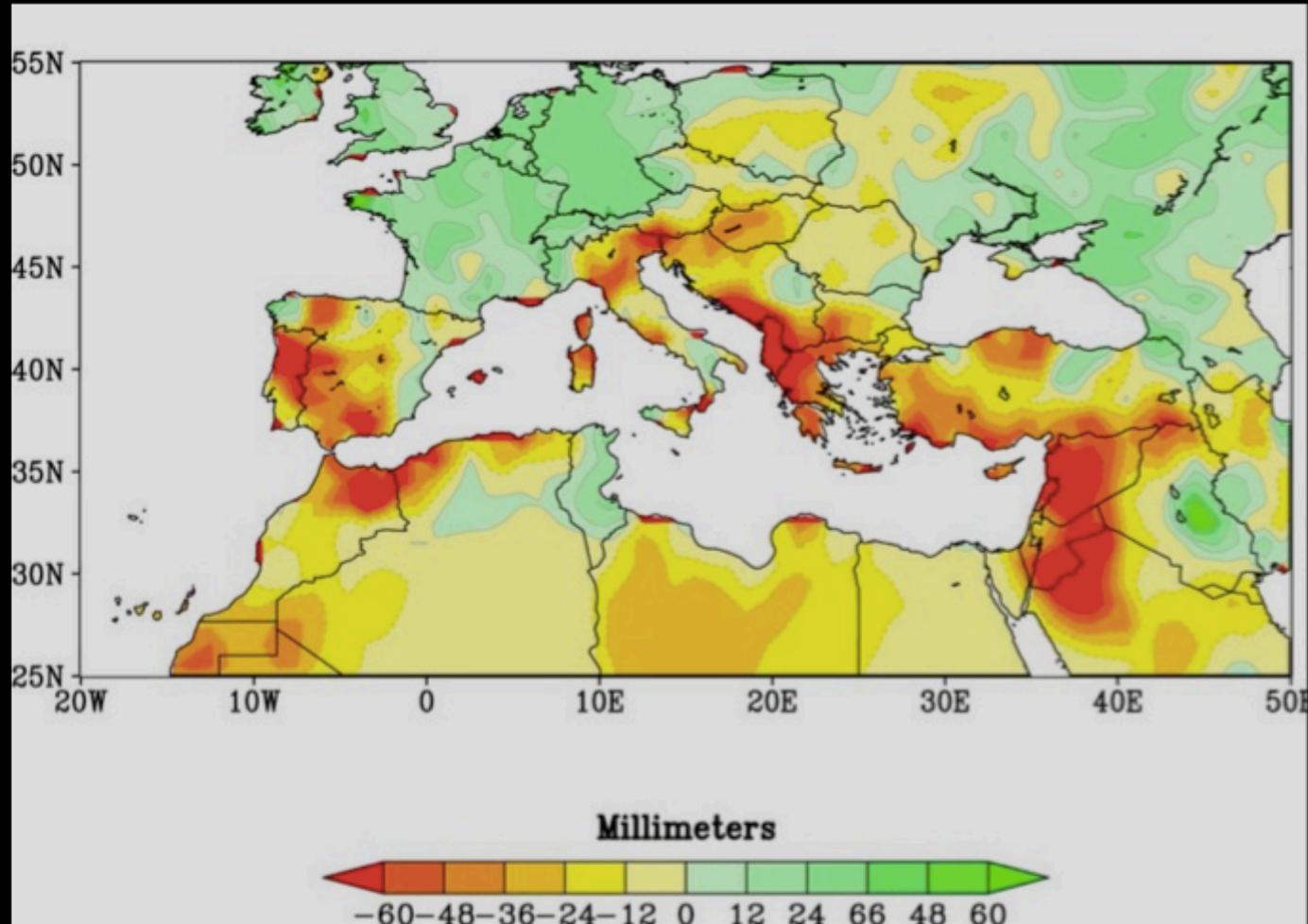
May 2014



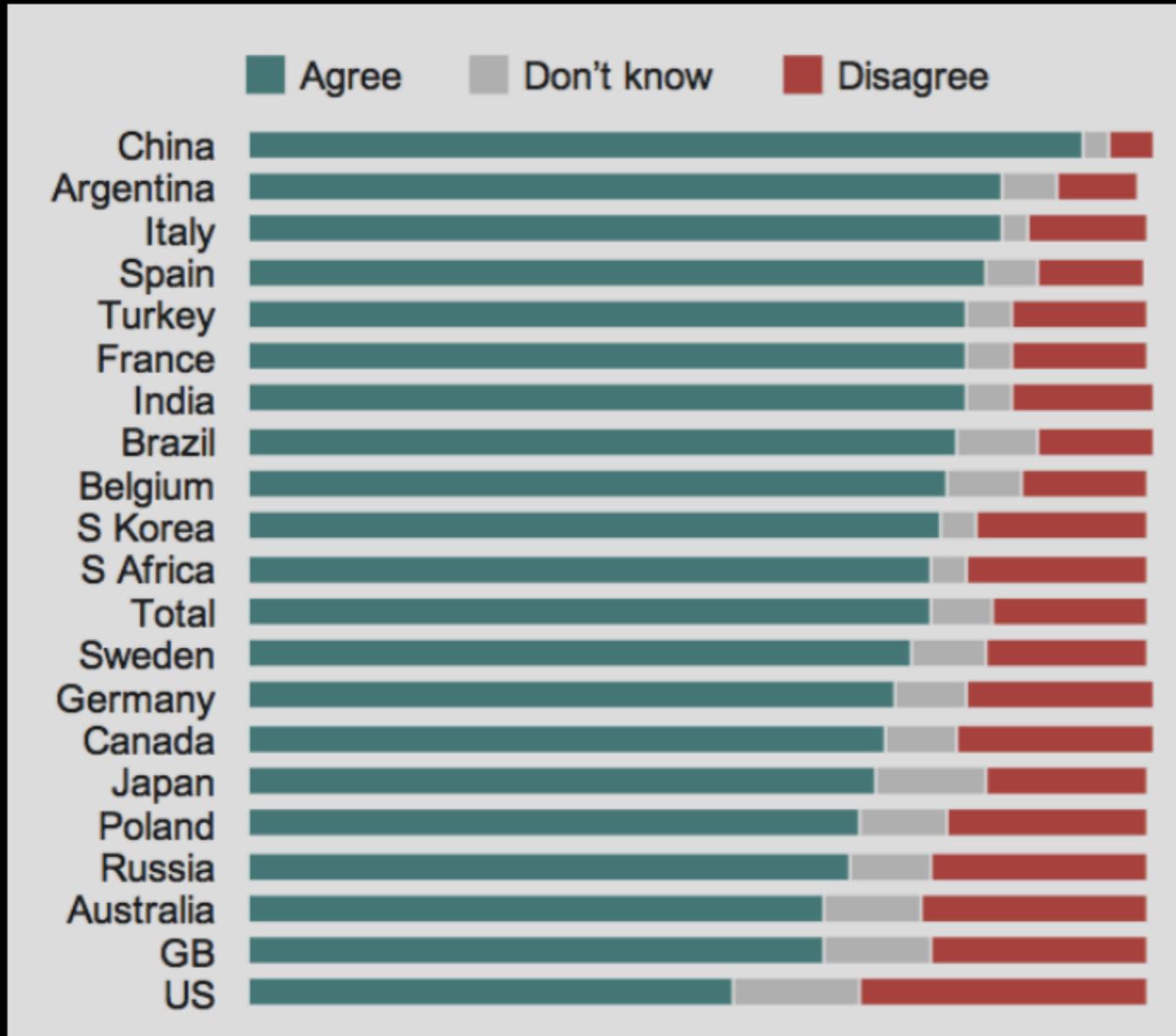
*“The national security risks of projected climate change are as serious as any challenges we have faced.”*

*“The days of climate change as a future concern are over.”*

# 2011 NOAA Study: Human-caused climate change a major factor in more frequent Mediterranean droughts

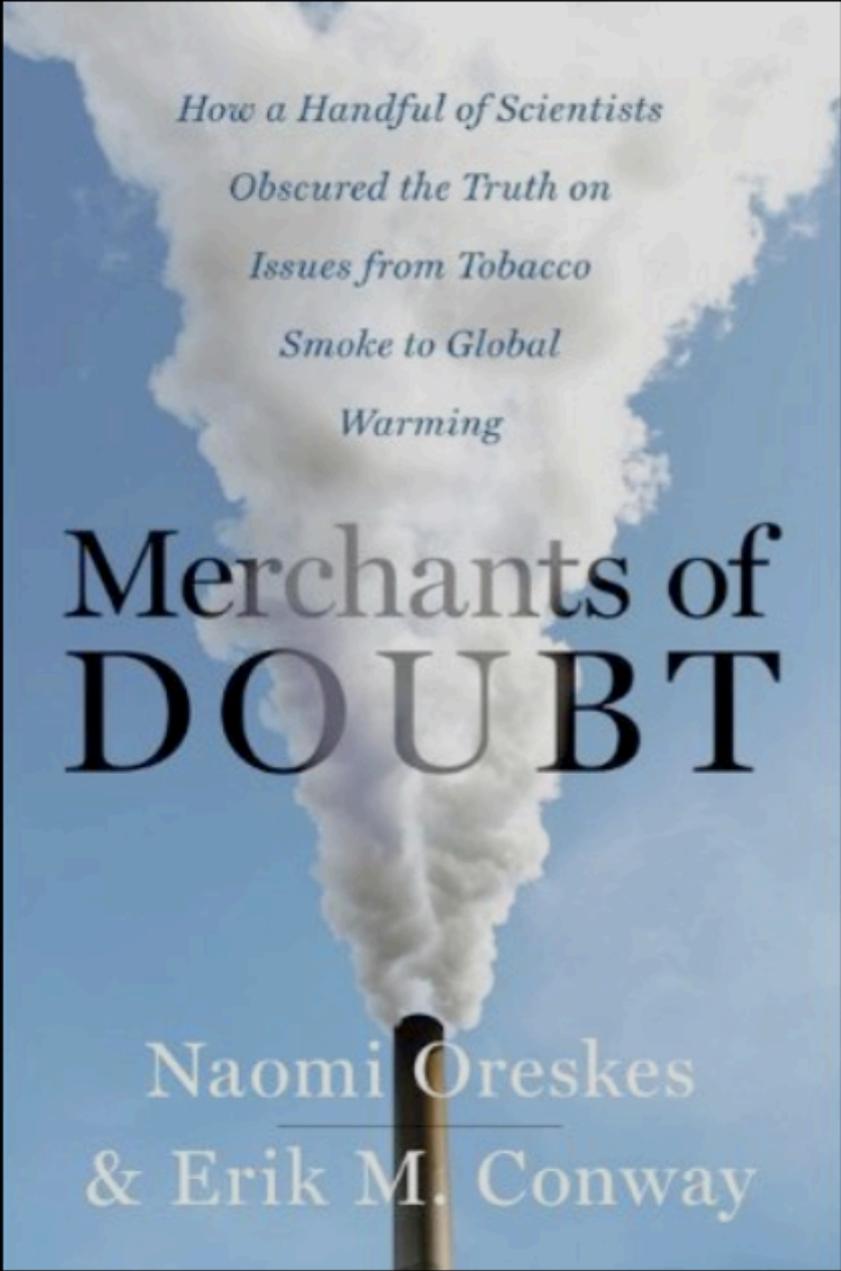


# Ipsos poll: Climate change caused by humans



# Go to: [SkepticalScience.com](http://SkepticalScience.com)





*How a Handful of Scientists  
Obscured the Truth on  
Issues from Tobacco  
Smoke to Global  
Warming*

# Merchants of DOUBT

Naomi Oreskes  
& Erik M. Conway

Syrian Refugees: Flight Into the Unknown

MARCH 2015

# NATIONAL GEOGRAPHIC

CLIMATE CHANGE DOES NOT EXIST

EVOLUTION NEVER HAPPENED

THE MOON LANDING WAS FAKE

VACCINATIONS CAN LEAD TO AUTISM

GENETICALLY MODIFIED FOOD IS EVIL

# THE WAR ON SCIENCE



A WORKER ADJUSTS A DORAMA OF A MOON LANDING AT THE KENNEDY SPACE CENTER

# BP says CO2 emissions unsustainable, warns on global warming

In its Energy Outlook 2035, BP predicts that CO2 emissions will exceed levels which scientists says pose a threat to climate change unless coordinated action is taken

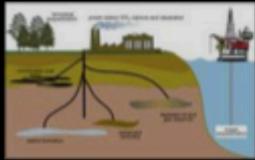


Carbon emissions are not sustainable, BP has said Photo: ALAMY

By Andrew Critchlow, Commodities editor

3:21PM GMT 17 Feb 2015

# Carbon-Free Energy Options



Carbon capture & storage



Nuclear



Efficiency



Renewable Energy

# Energy Efficiency

- **Buildings** (40%) – envelope design, daylighting, better lights, efficiency standards
- **Transportation** (30%) – lighter weight vehicles, public transportation, PHEVs
- **Industry** (30%) – heat recovery, better motors, CHP

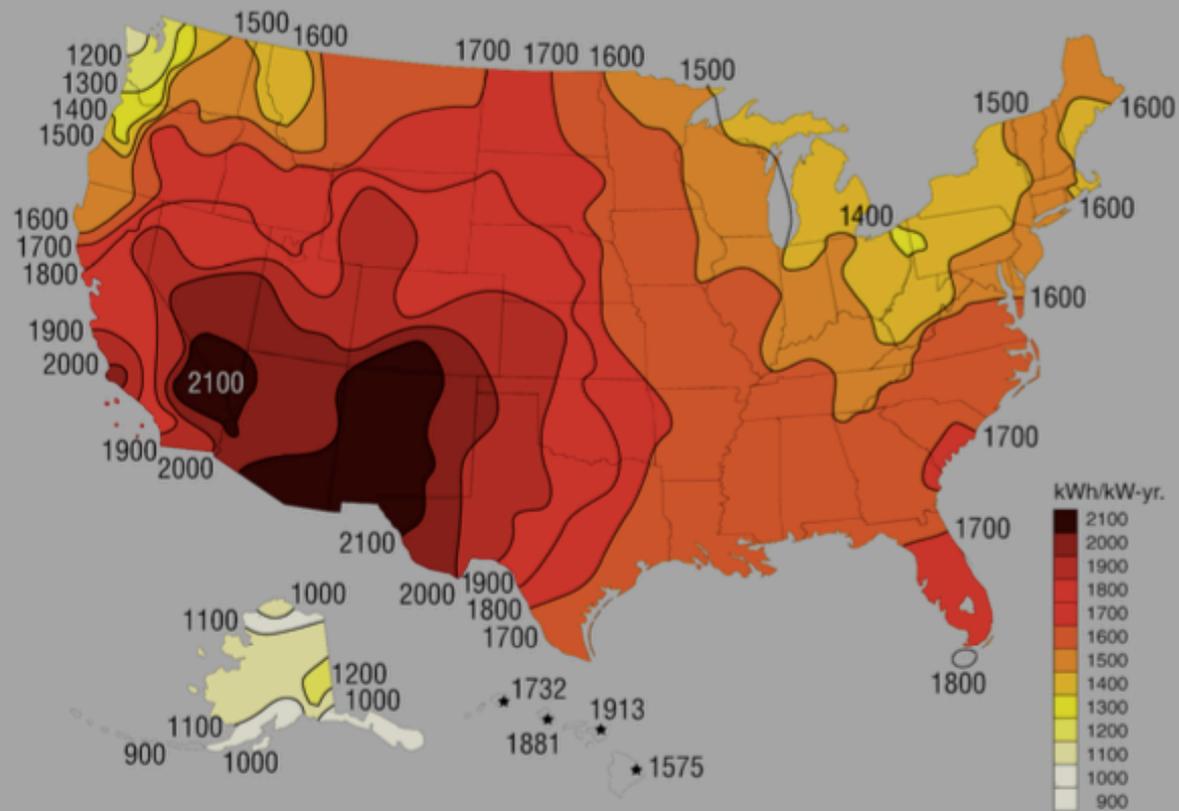


# Germany sets solar record, meets half of electricity demand

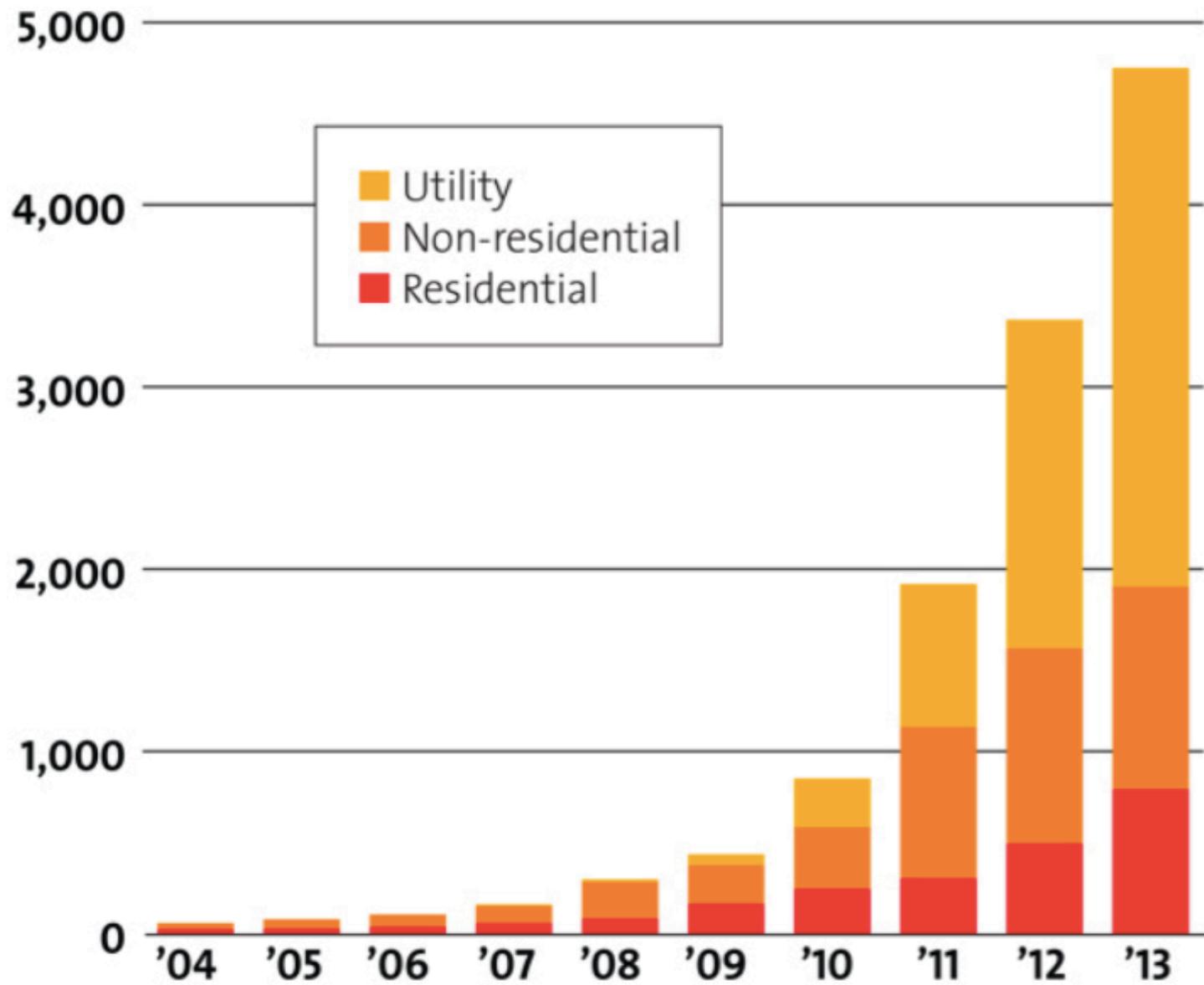
By Ian Steadman | 28 May 12



# PV Resource: Germany vs. U.S.



# New solar installations in the United States (in megawatts)



Source: SEIA

Mother Jones

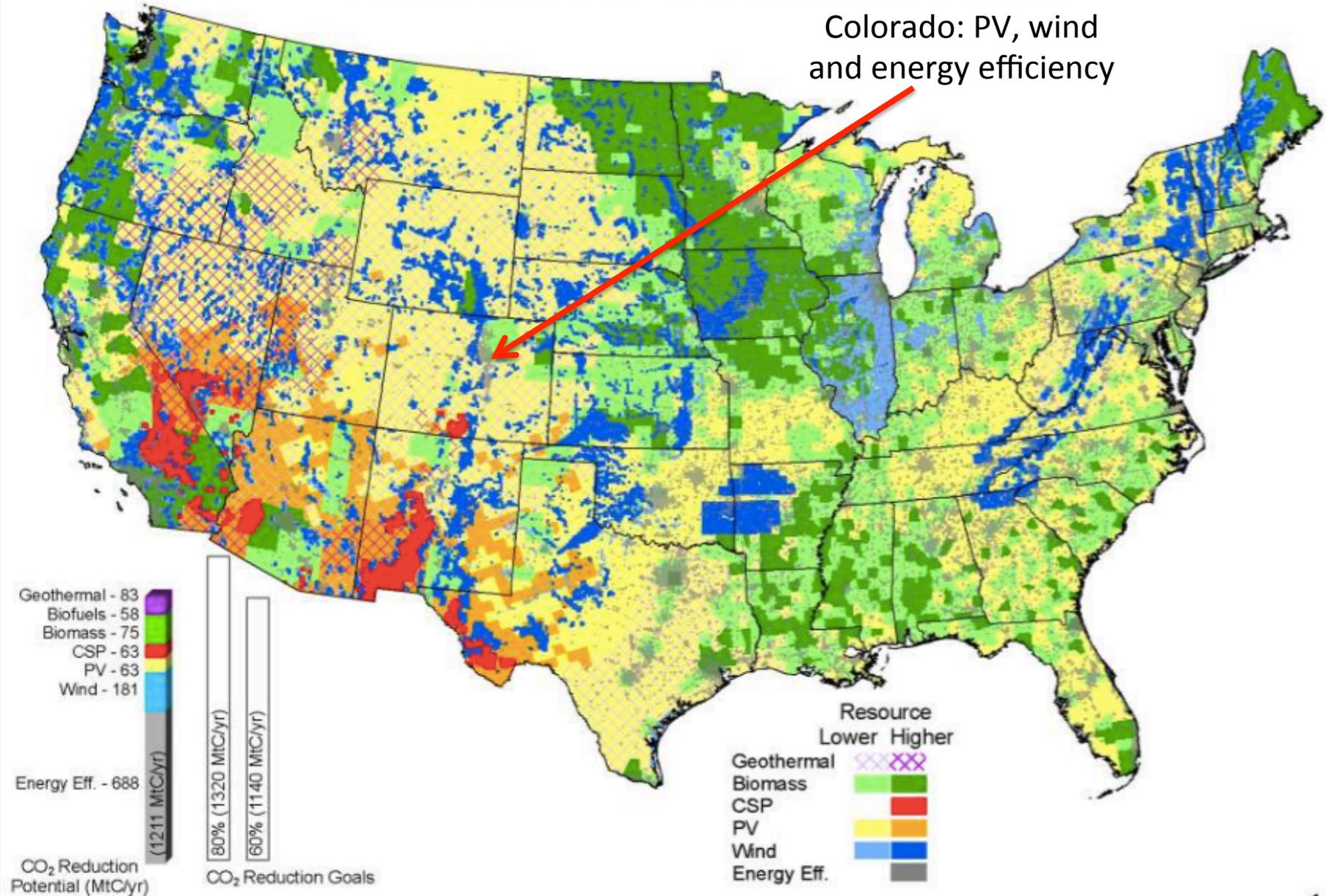
# Horns Rev Offshore Wind Farm North Sea, Denmark



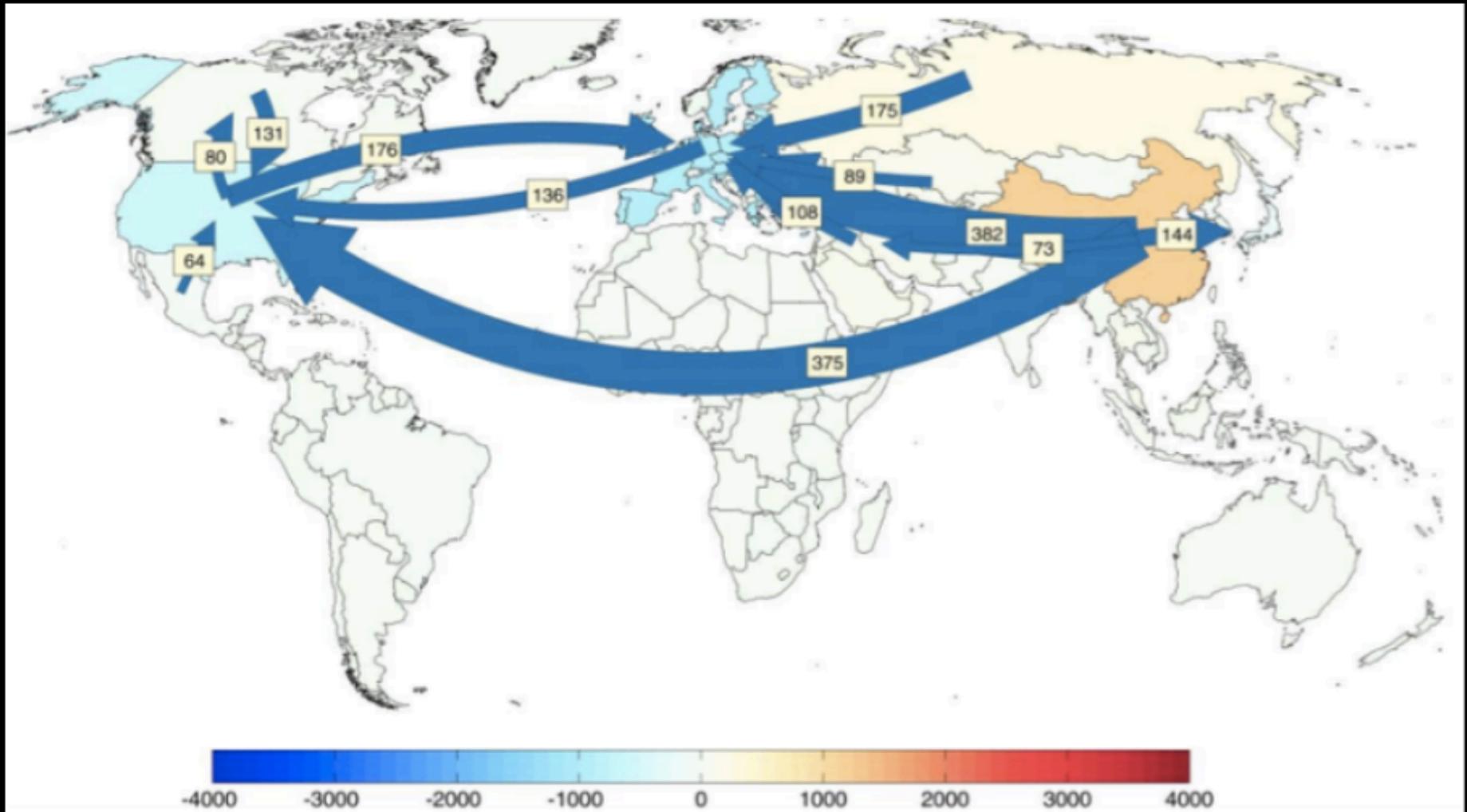
- Photo used by permission of Uni-Fly A/S

# Potential Reduction in U.S. Carbon Emissions

Colorado: PV, wind  
and energy efficiency



# Outsourcing Our Emissions to China



Values for 2007. EU is treated as one region. Units: MtCO<sub>2</sub>

Source: [Peters et al 2012](#)

# More Resources and Reading

- [https://www.nytimes.com/2016/05/03/us/resetting-the-first-american-climate-refugees.html?\\_r=0](https://www.nytimes.com/2016/05/03/us/resetting-the-first-american-climate-refugees.html?_r=0)
- <https://www.theguardian.com/environment/2016/dec/01/climate-change-trigger-unimaginable-refugee-crisis-senior-military>
- **Example of a Sinking State**

The island nation of Tuvalu has struck an agreement with New Zealand to accept its 11,600 citizens in the event that rising sea levels overtake the country. Tuvalu is made up of eight tiny coral atolls, with a total land area of just 26 square kilometers (10 square miles). The highest point in Tuvalu is only 4.5 meters (14.7 feet) above sea level.

  - <http://www.nationalgeographic.org/encyclopedia/climate-refugee/>
- Low lying areas at risk: Maldives, Venice, Manhattan, New York; London, England; Shanghai, China; Hamburg, Germany; Bangkok, Thailand; Jakarta, Indonesia; Mumbai, India; Manila, Philippines; and Buenos Aires, Argentina
- watch CO2 accumulation here <http://www.esrl.noaa.gov/gmd/ccgg/trends/ff.html>
- Learn about climate skepticism [skepticalscience.com](http://skepticalscience.com)