



The Climate & Energy Literacy Imperative:

Toward an Adult Conversation about
21st Century Science

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National
Center for
Science
Education

<http://ncse.com>

<http://facebook.com/evolution.ncse>

<http://twitter.com/ncse>





Environmental Awareness and Experiences of Nature Among Urban Youth, Dr. Susie Strife- University of Colorado at Boulder

Research Questions: Experience of Nature



How do children define nature?

Where do they find nature in their daily lives?

How do they “experience” nature?

How do they feel when they are in nature?

Future Perceptions



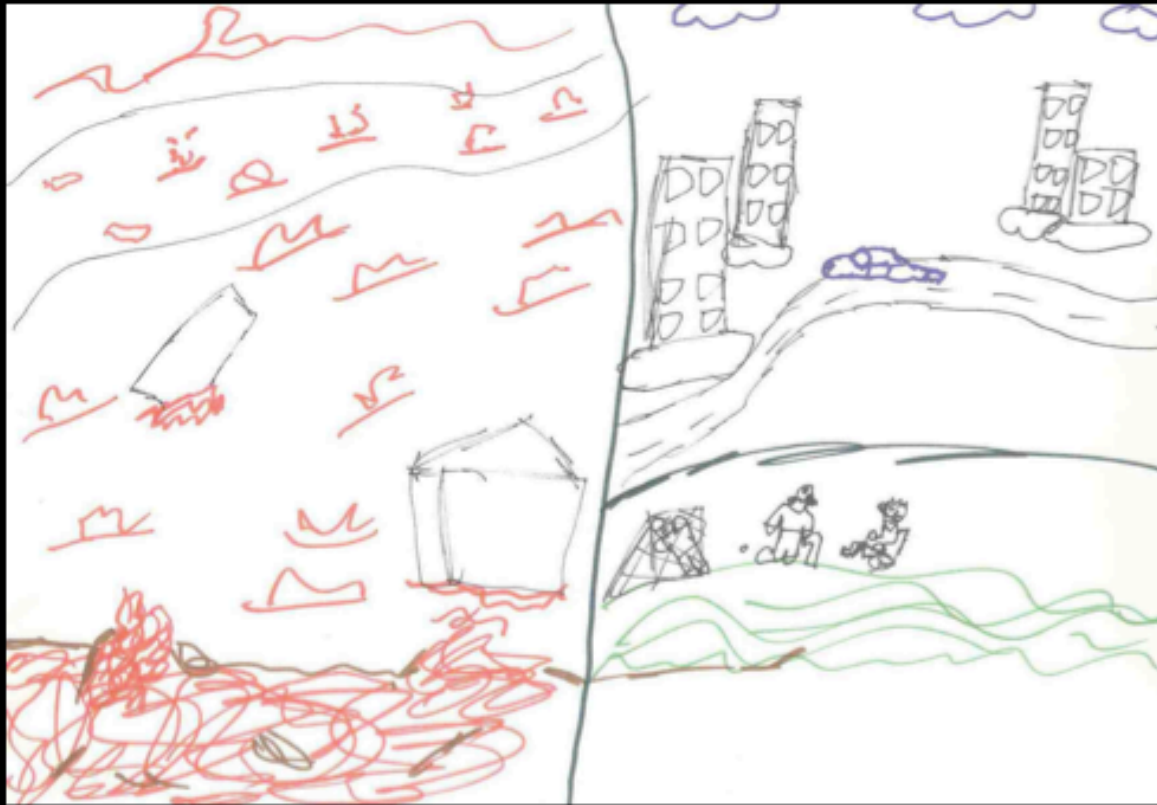
Overview of Results: Environmental Awareness



Environmental Awareness

- Awareness of global problems & feelings/emotions
- Sources of environmental information
- Children's perceptions of the future

Environmental Concern: Fear



"I have had dreams of this place and I woke up crying [pointing to map]. If it keeps going like this maybe the whole world is not going to exist"

"I have had dreams of people crawling out of these smoke filled environments coughing and that really scared me"

Environmental Concern: Sadness



It [environmental problems] makes me feel really self conscious, like I don't want to raise kids or be in the future when this Earth is very dirty and polluting, I don't want it to be! I don't want to be breathing in this dirt!"



Climatic Consequences of Nuclear Conflict

Nuclear Holocaust

Cities burn

Ground bursts

Massive amounts of smoke

Massive amounts of dust

Sunlight absorbed

Sunlight reflected

Very little sunlight reaches the ground

Rapid, large surface temperature drops

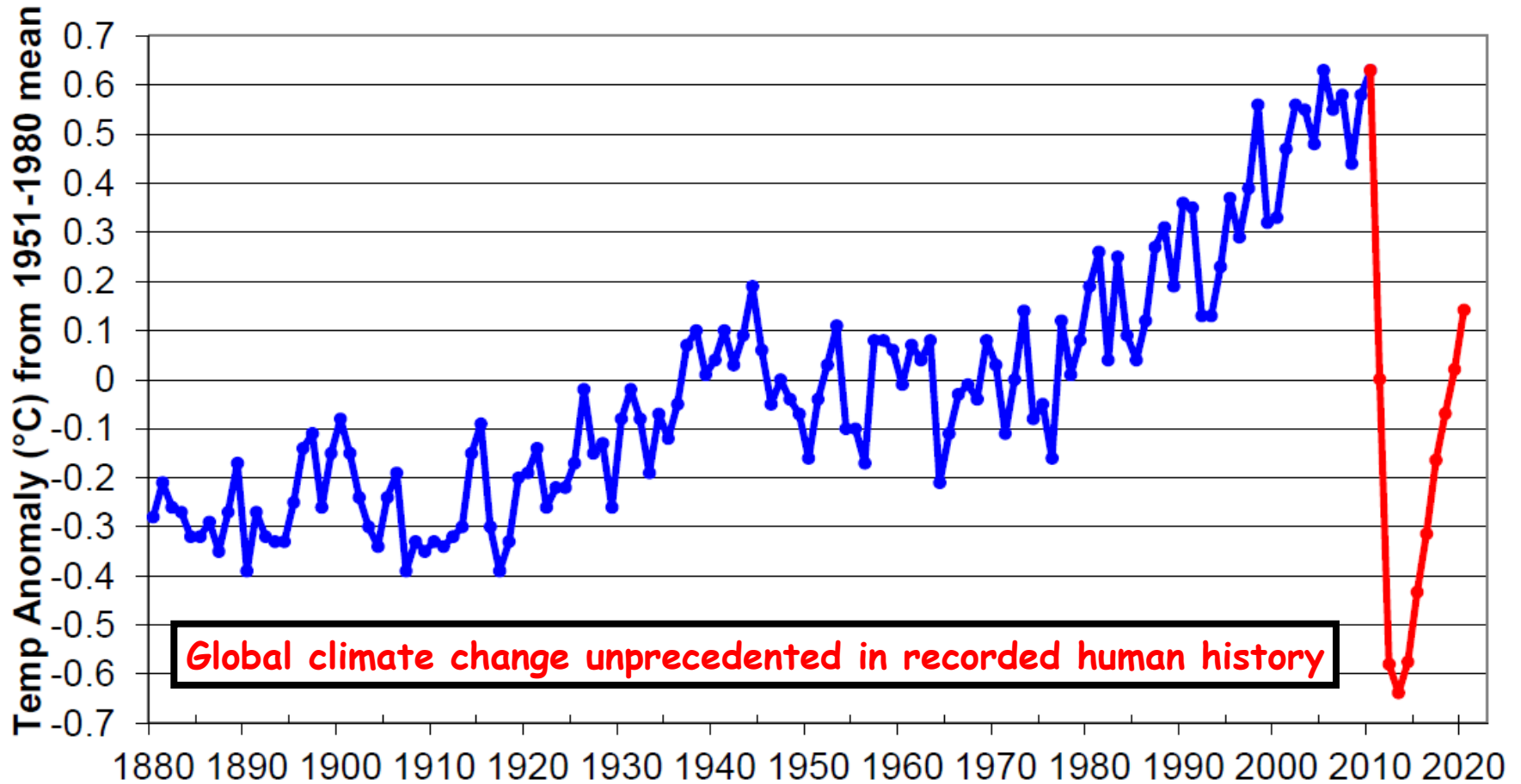
“Nuclear Winter”

Alan Robock

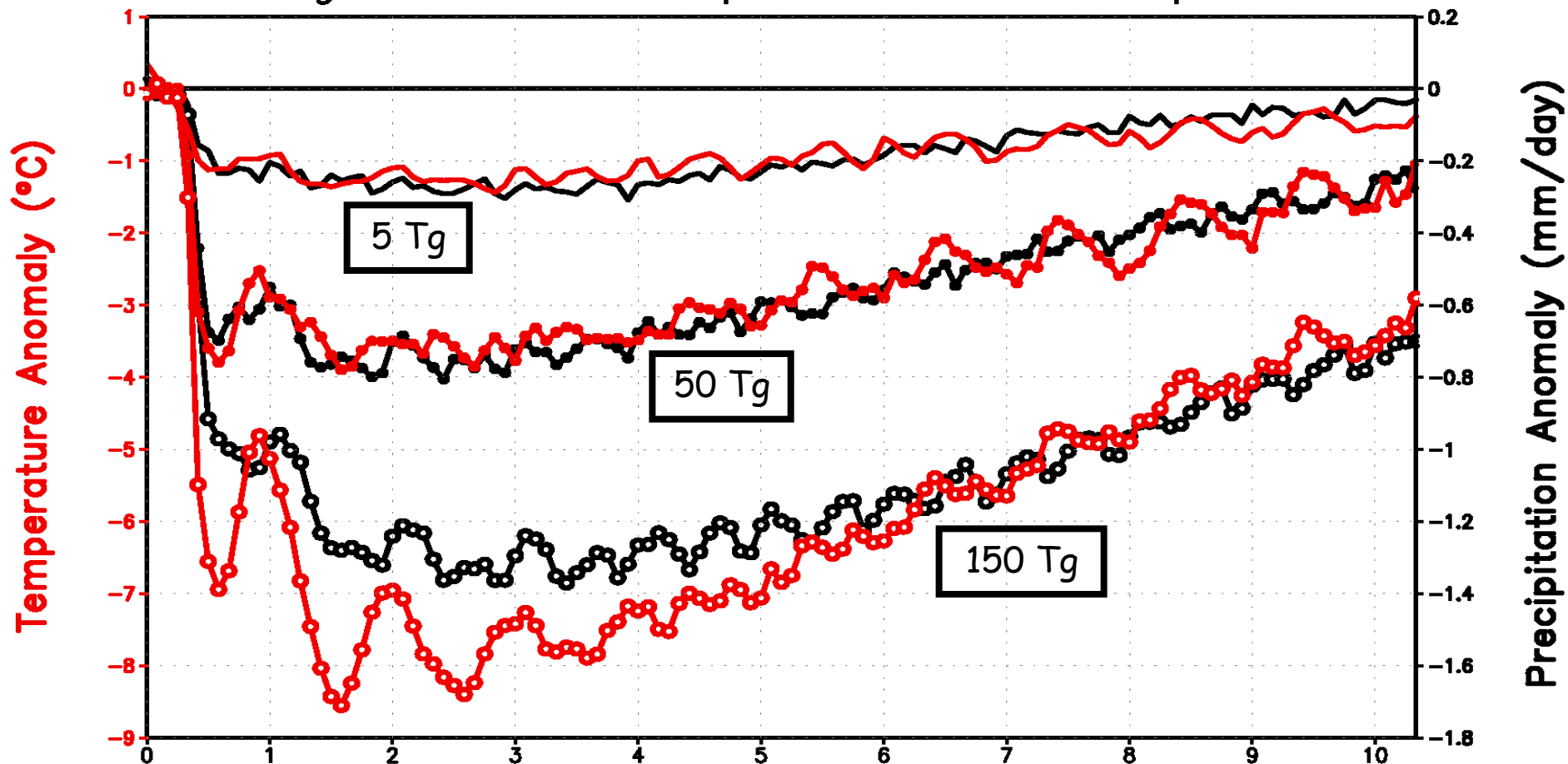
*Department of Environmental Sciences
Rutgers University, New Brunswick, New Jersey USA*

GISS Global Average Temperature Anomaly

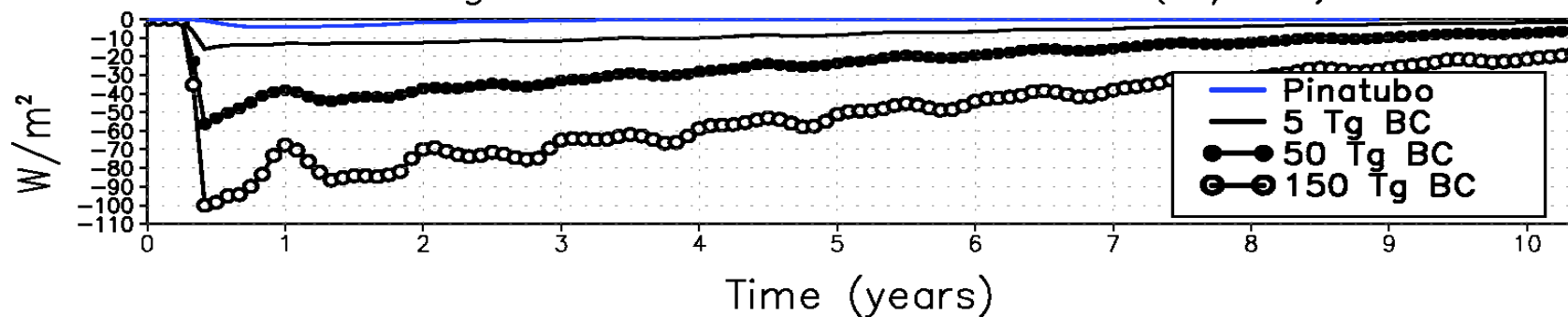
+ 5 Tg smoke in 2011



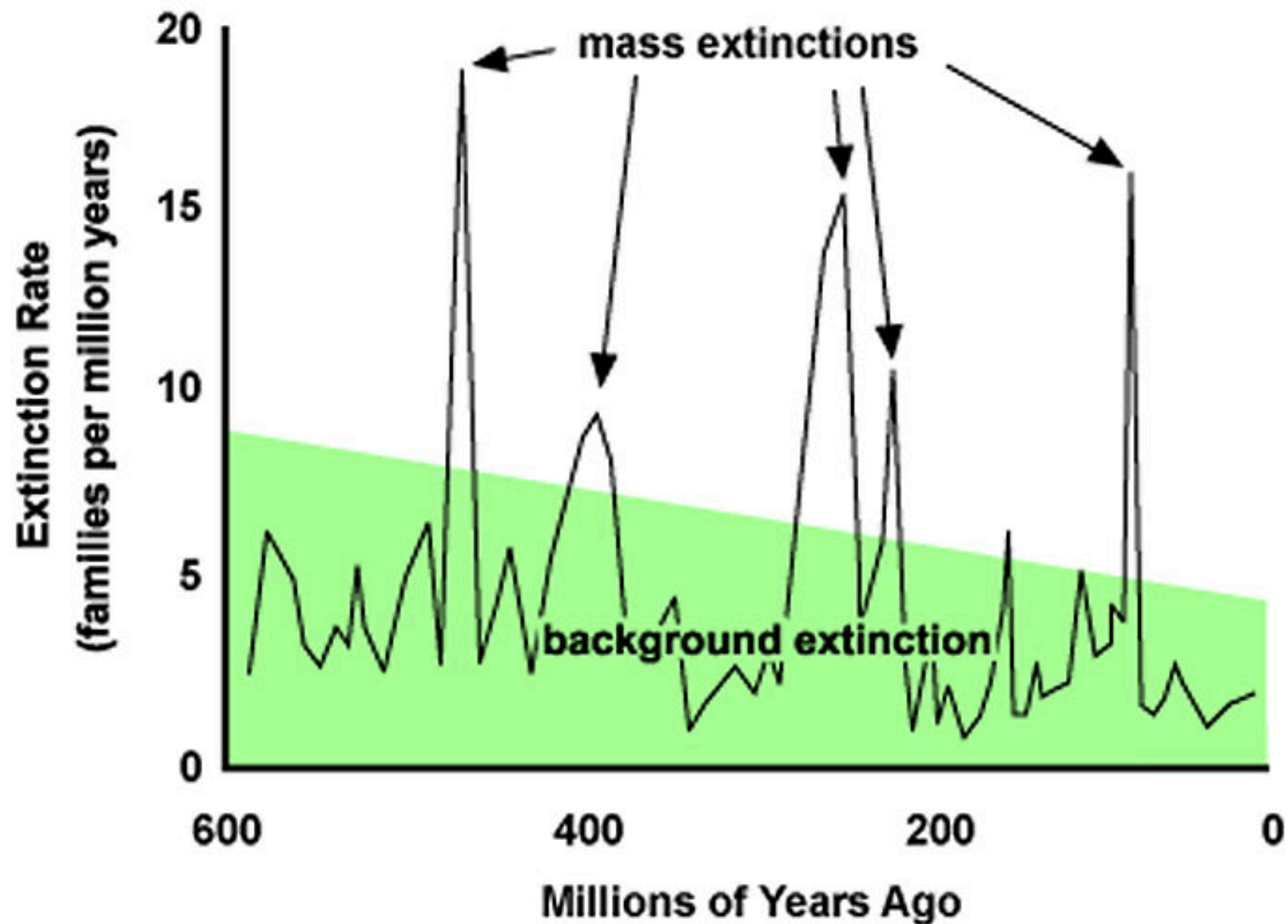
Change in Global Temperature and Precipitation



Change in Global Surface SW (W/m^2)

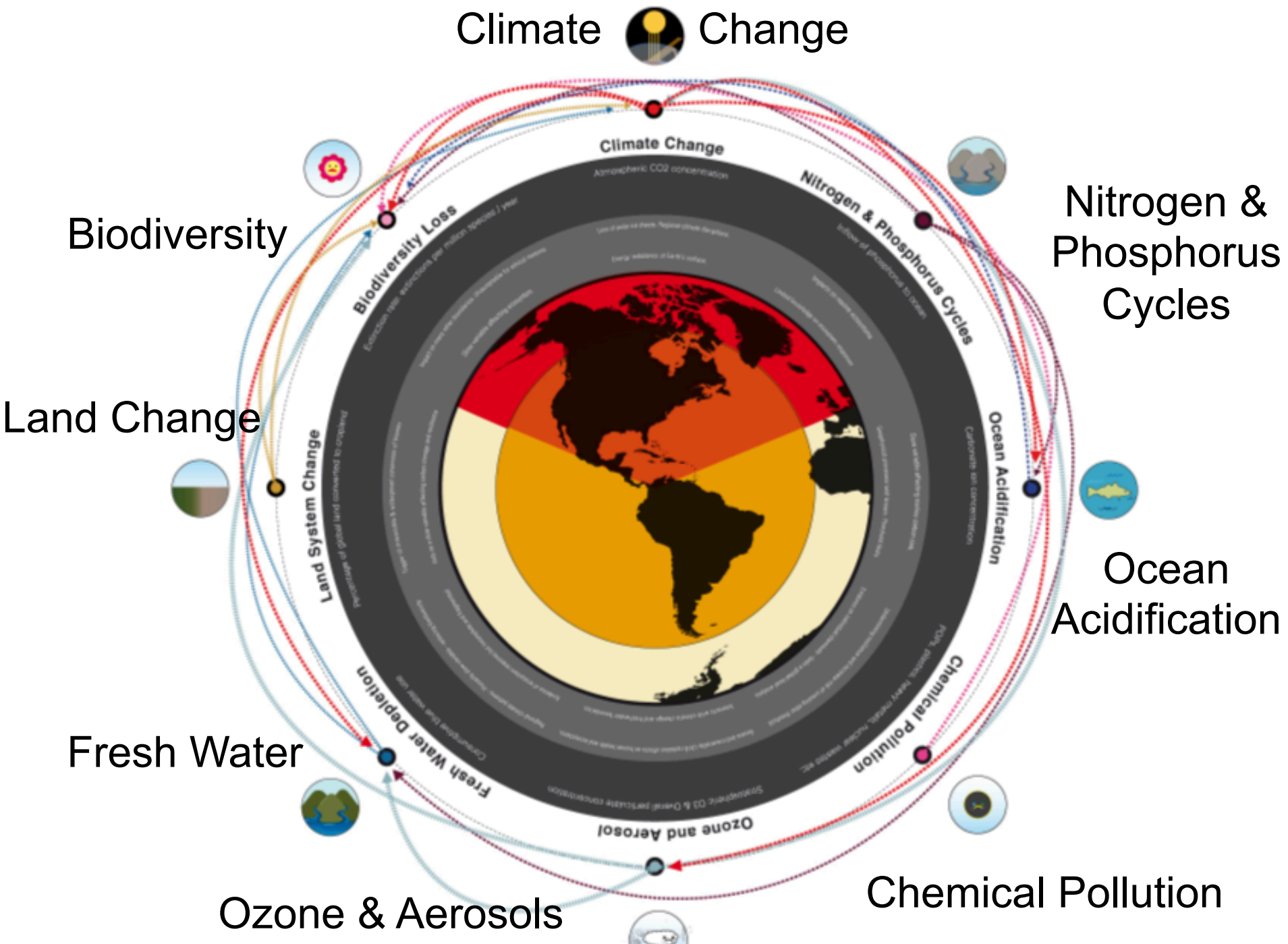


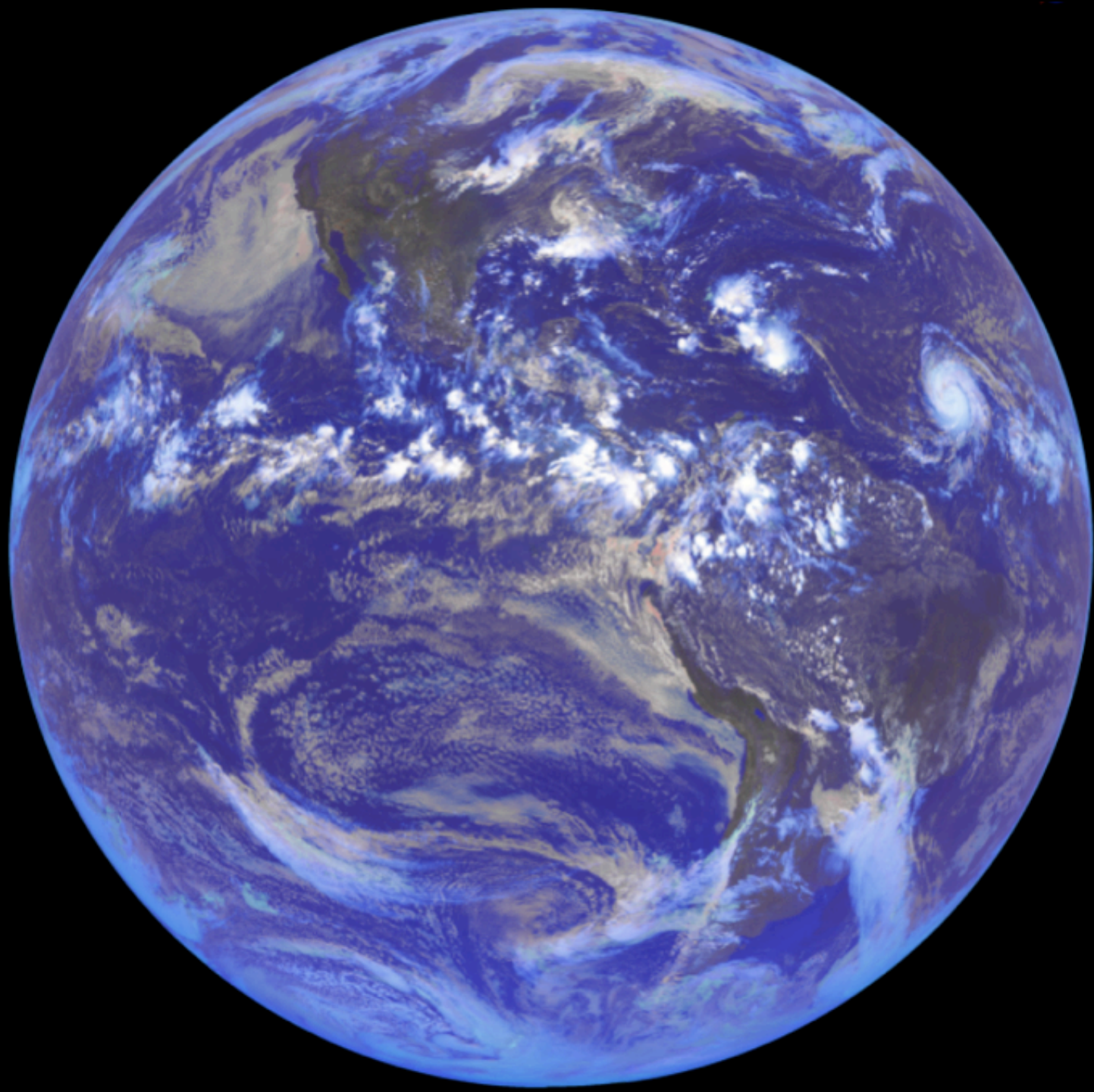
Earth's five mass extinctions



© University of California Museum of Paleontology's Understanding Evolution/evolution.berkeley.edu.

Earth has experienced five major mass extinctions in the past half-billion years. Although it is not reflected on this graph, scientists think a sixth mass extinction may be under way.







MÉMOIRE

SUR

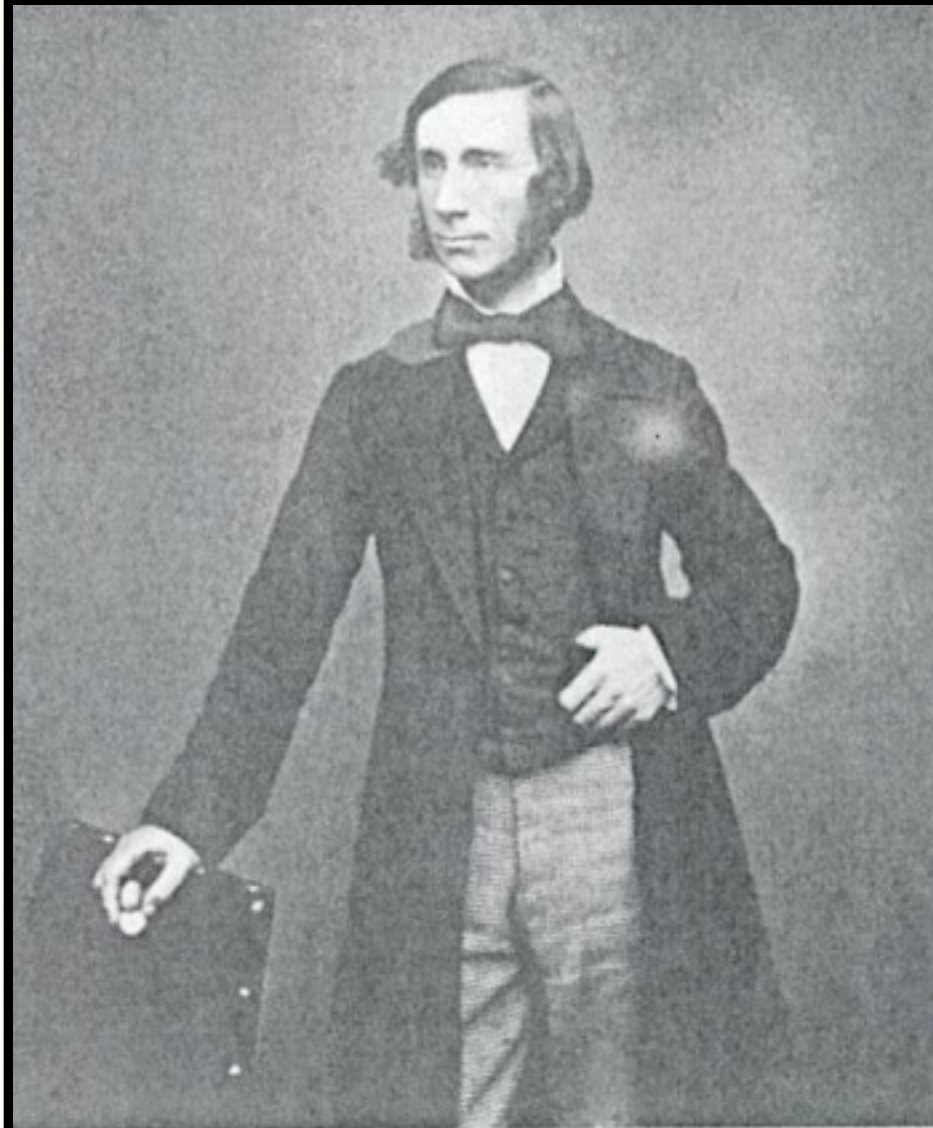
LES TEMPÉRATURES DU GLOBE TERRESTRE ET
DES ESPACES PLANÉTAIRES.

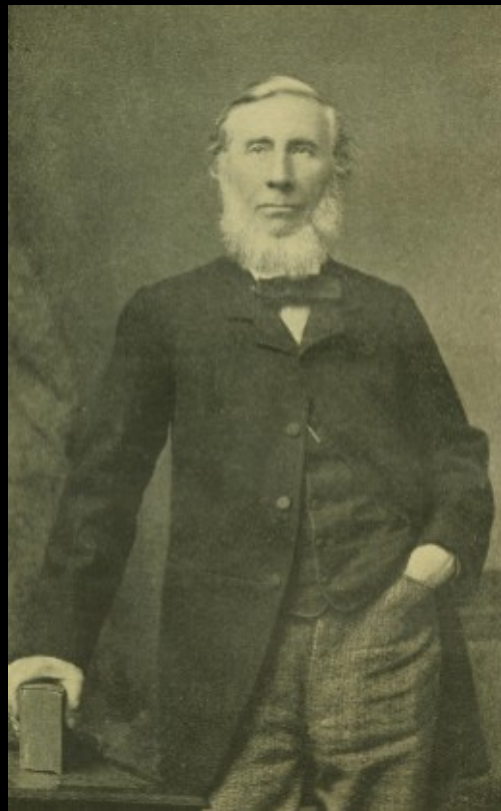
PAR M. FOURIER.

Jean Baptiste Joseph Fourier
(21 March 1768 – 16 May 1830)

Why is the Earth
warmer than it
should be given its
inputs and outputs?

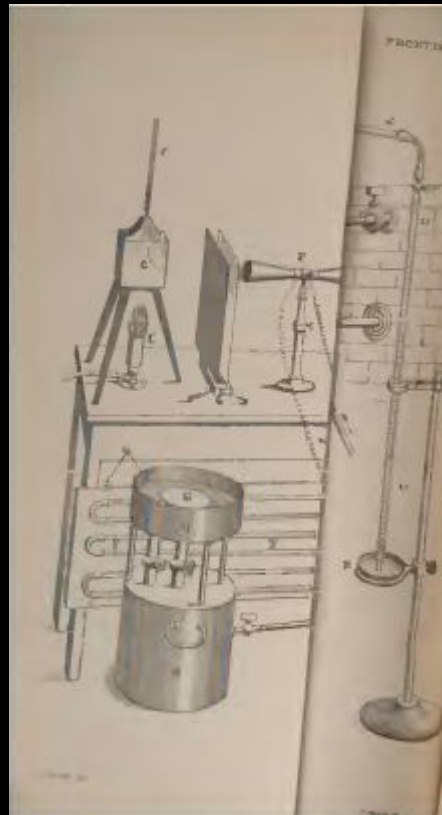
NATURAL WARMING





John Tyndall
(1820-1893)

Mini-atmosphere
in basement of
Royal Institution,
London



CONTRIBUTIONS
TO
MOLECULAR PHYSICS
IN THE DOMAIN OF
RADIANT HEAT.

A SERIES OF MEMOIRS PUBLISHED IN THE 'PHILOSOPHICAL TRANSACTIONS'

AND 'PHILOSOPHICAL MAGAZINE,' WITH ADDITIONS.

BY

JOHN TYNDALL, LL.D. F.R.S.

PROFESSOR OF NATURAL PHILOSOPHY IN THE ROYAL INSTITUTION.

LONDON:
LONGMANS, GREEN, AND CO.
1872.

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Svante Arrhenius
1859 - 1927

THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* By Prof. SVANTE ARRHENIUS*.

I. *Introduction : Observations of Langley on Atmospheric Absorption.*

A GREAT deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall† in particular has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this: Is the mean temperature of the ground in any way influenced by the presence of heat-absorbing gases in the atmosphere? Fourier‡ maintained that the atmosphere acts like the glass of a hot-house, because it lets through the light rays of the sun but retains the dark rays from the ground. This idea was elaborated by Pouillet§; and Langley was by some of his researches led to the view, that "the temperature of the earth under direct sunshine, even though our atmosphere were present as now, would probably fall to -200° C., if that atmosphere did not possess the quality of selective

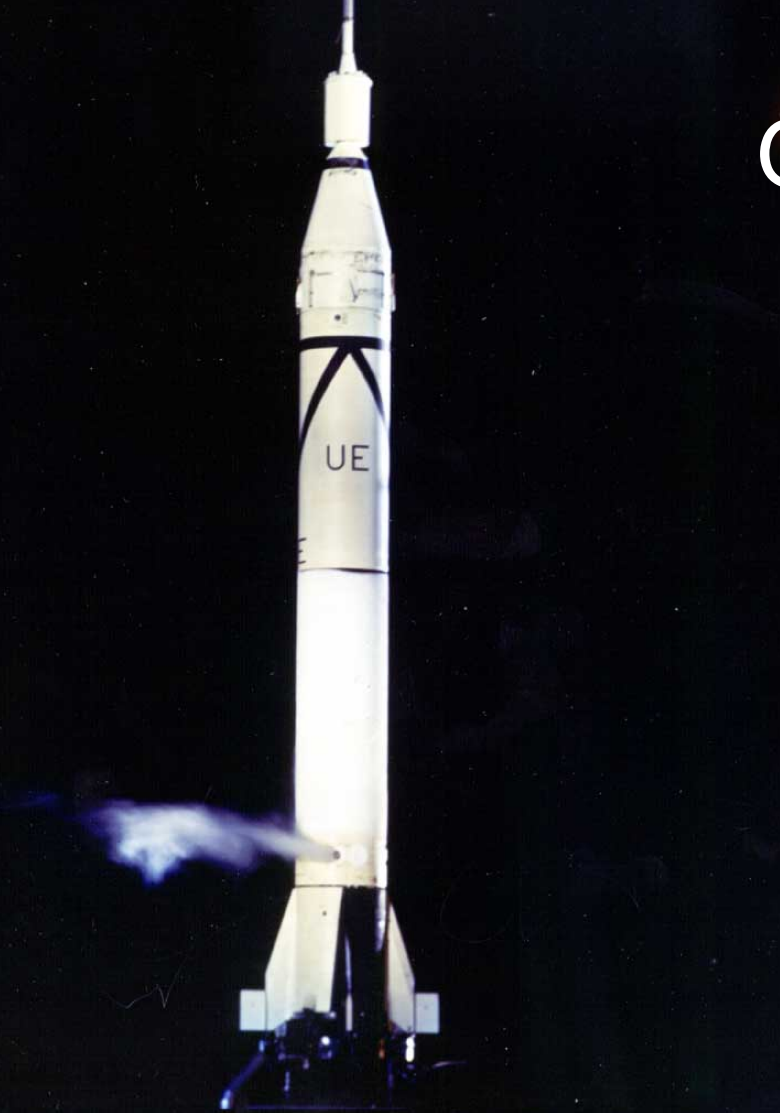
* Extract from a paper presented to the Royal Swedish Academy of Sciences, 11th December, 1895. Communicated by the Author.

† 'Heat a Mode of Motion,' 2nd ed. p. 405 (Lond., 1865).

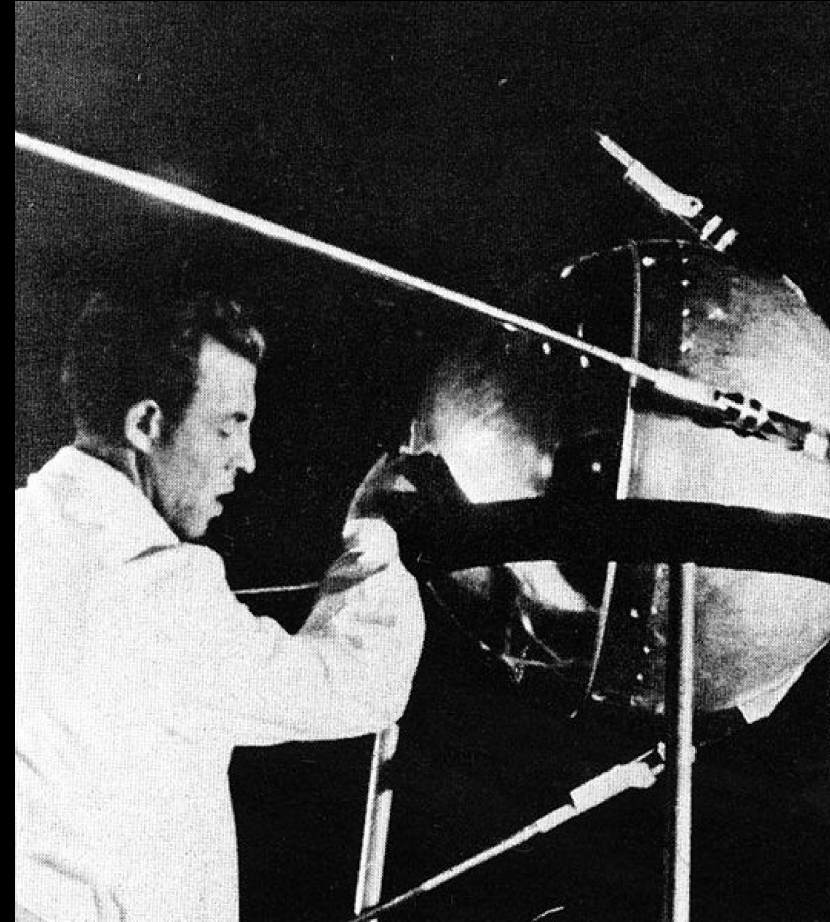
‡ *Mém. de l'Ac. R. d. Sci. de l'Inst. de France*, t. vii. 1827.

§ *Comptes rendus*, t. vii. p. 41 (1838).

International Geophysical Year 1957-58 (IGY)



Remembered for
Sputnik





SUN & EARTH

*"Knowest thou the ordinances of heaven?
Canst thou set the dominion thereof in the earth?" JOB 38:33*



SPACE

*"Ab, but a man's reach should exceed his grasp,
Or what's a heaven for?" BROWNING*



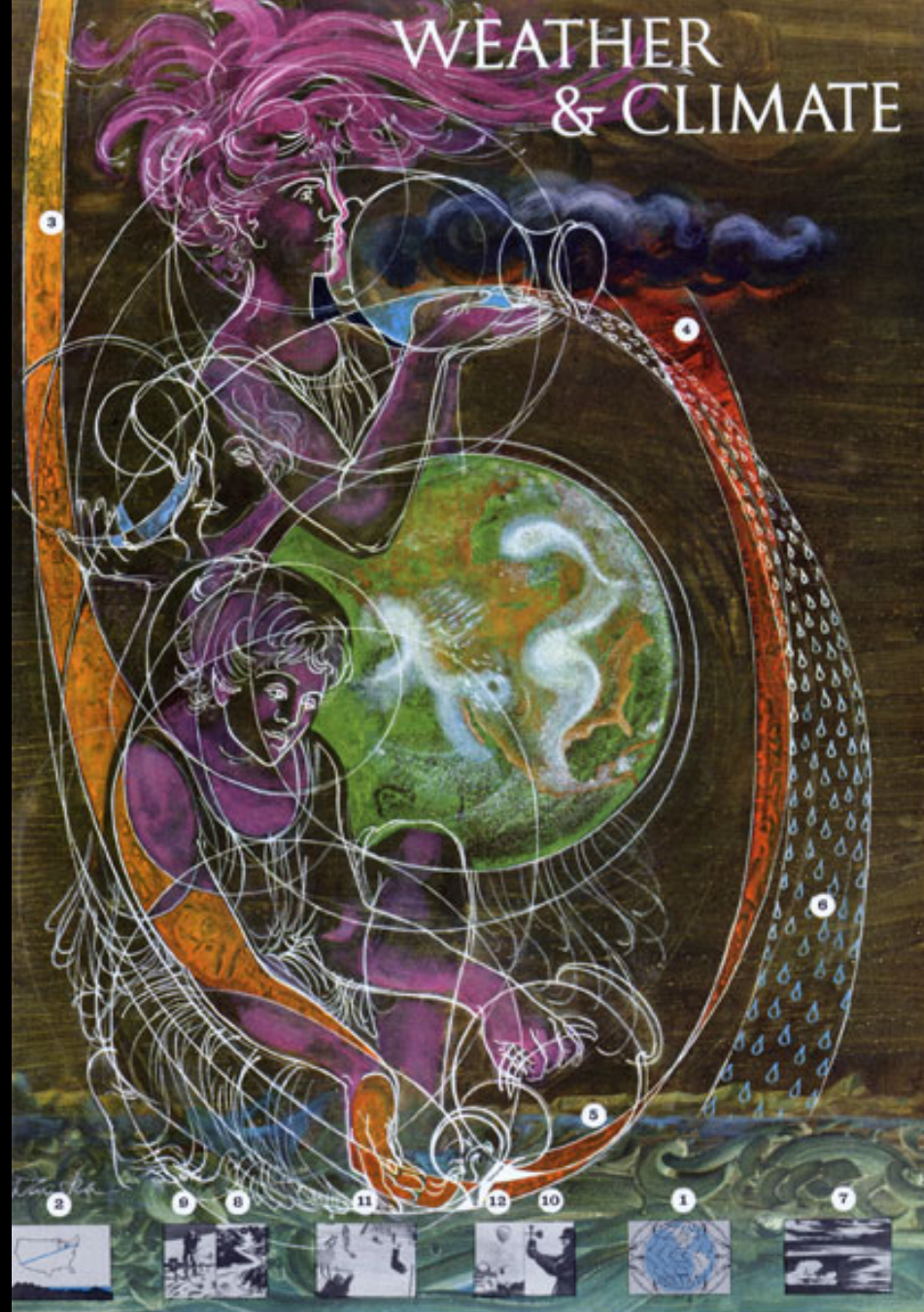
"Vastness! and Age! and Memories of Eld!
Silence! and Desolation! and dim of Night!" POE



"Earth! My likeness! Though you look impassive, ample and spheric th



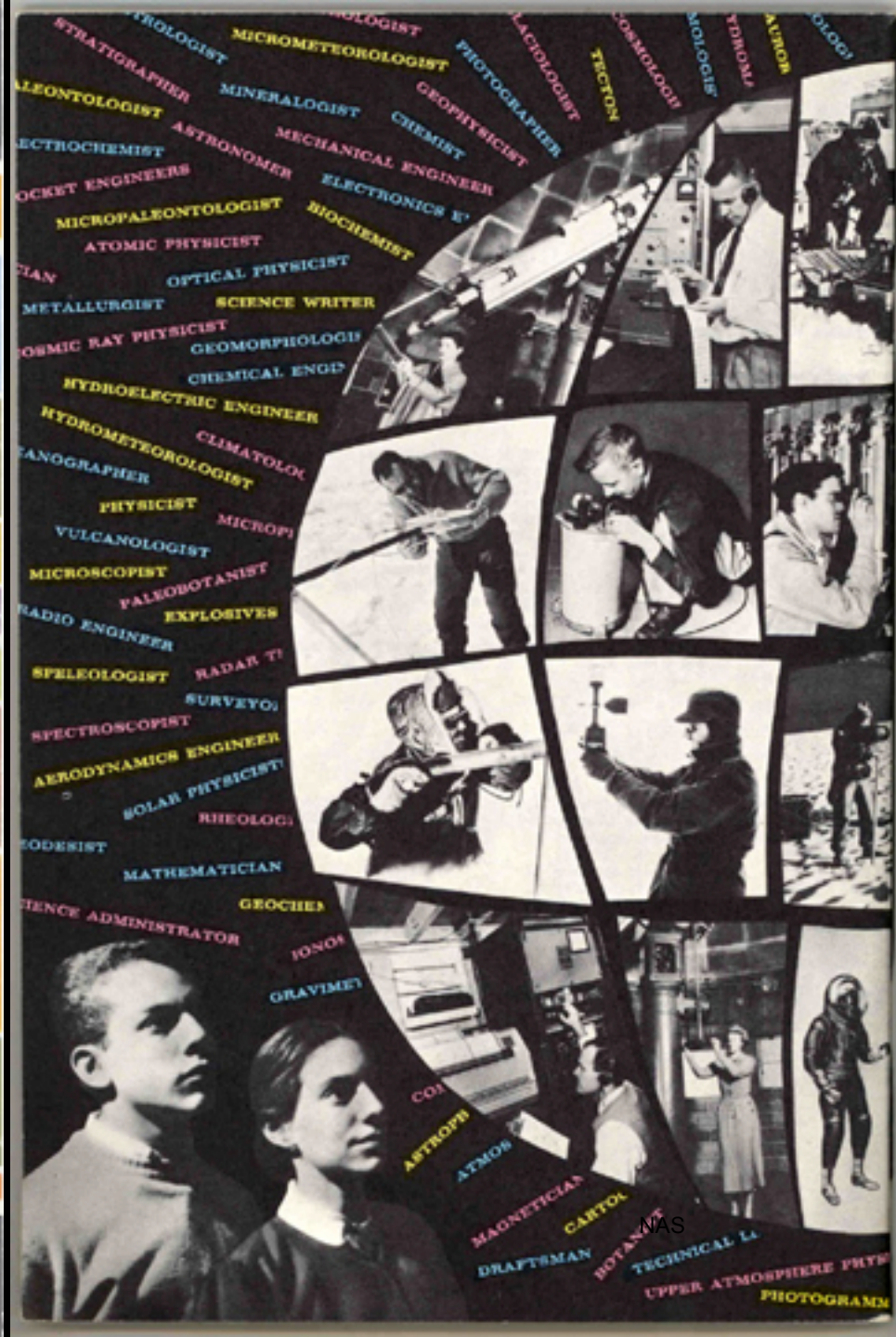
*"Icing the pole or in the torrid clime,
Dark - heaving - boundless - endless and sublime" BYRON*



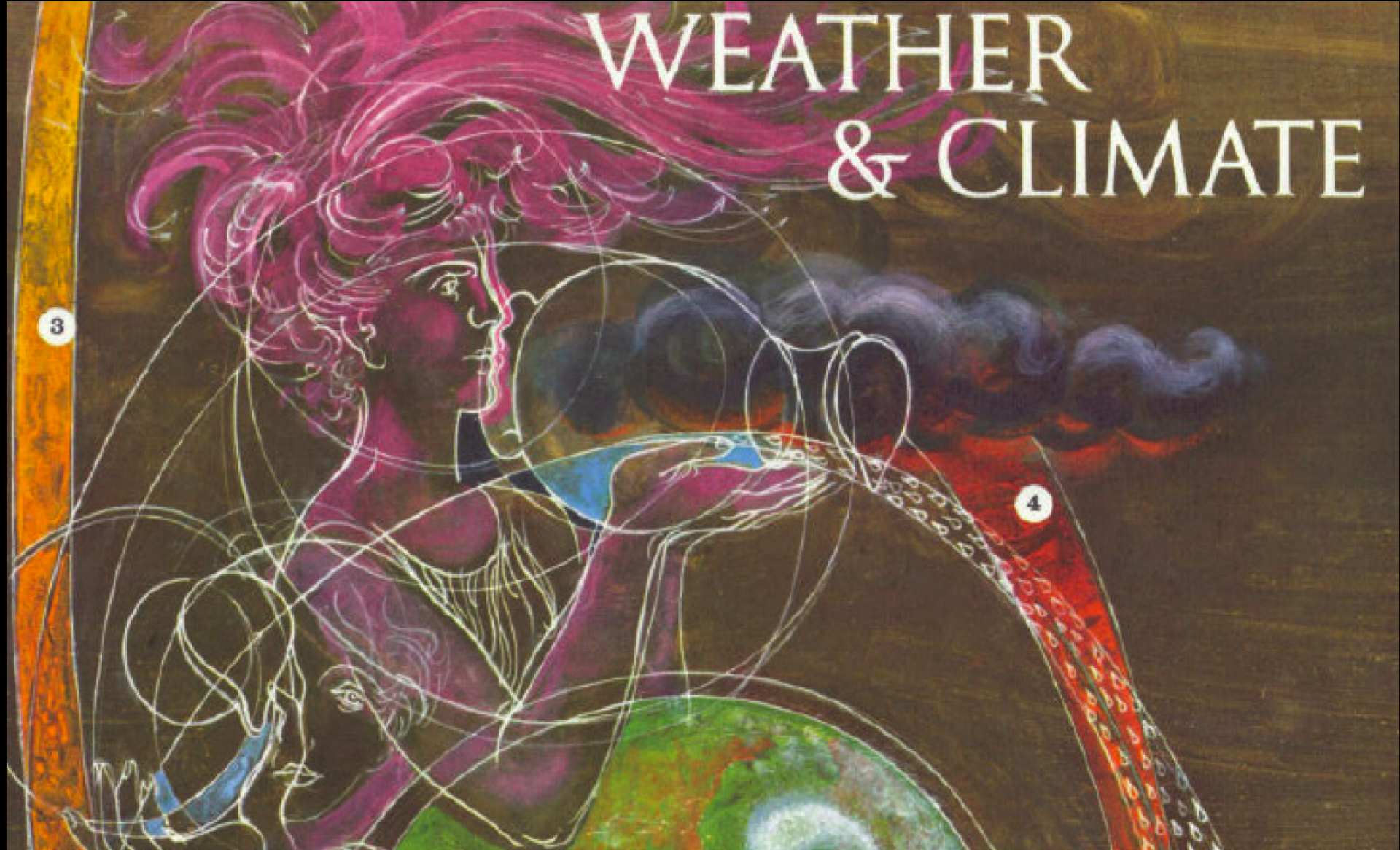
*"The air moves like a river
and carries the clouds with it," DA VINCI*

"Planet Earth"

**THE
MYSTERY
WITH
100,000
CLUES**



WEATHER & CLIMATE



Human Impacts on Greenhouse Effect

“Our industrial civilization has been pouring carbon dioxide into the atmosphere at a great rate....

**By the year 2000
we will have added
70 percent more
carbon dioxide to
the atmosphere...**

**If it remained, it
would have a marked
warming effect on
the earth's climate,
but most of it would
probably be
absorbed by the
oceans...**

**Conceivably, however,
it could cause
significant melting of
the great icecaps and
raise sea levels in
time.”**

**Planet Earth: The Mystery with 100,000 Clues
National Academy of Sciences
1958**

Feb. 2, 1962



EACH DAY HUMBLE SUPPLIES ENOUGH ENERGY TO MELT 7 MILLION TONS OF GLACIER!

This giant glacier has remained unmelted for centuries. Yet, the petroleum energy Humble supplies—if converted into heat—could melt it at the rate of 80 tons each second! To meet the nation's growing needs for energy, Humble has applied science to nature's resources to become America's Leading Energy Company. Working wonders with oil through research, Humble provides energy in many forms—to help heat our homes, power our transportation, and to furnish industry with a great variety of versatile chemicals. Stop at a Humble station for new Enco Extra gasoline, and see why the "Happy Motoring" Sign is the World's First Choice!

HUMBLE
OIL & REFINING COMPANY

A stylized illustration of a gas station with a large canopy over the pumps.

ENCO

The Enco logo, which is a yellow circle containing a stylized, smiling oil derrick character.

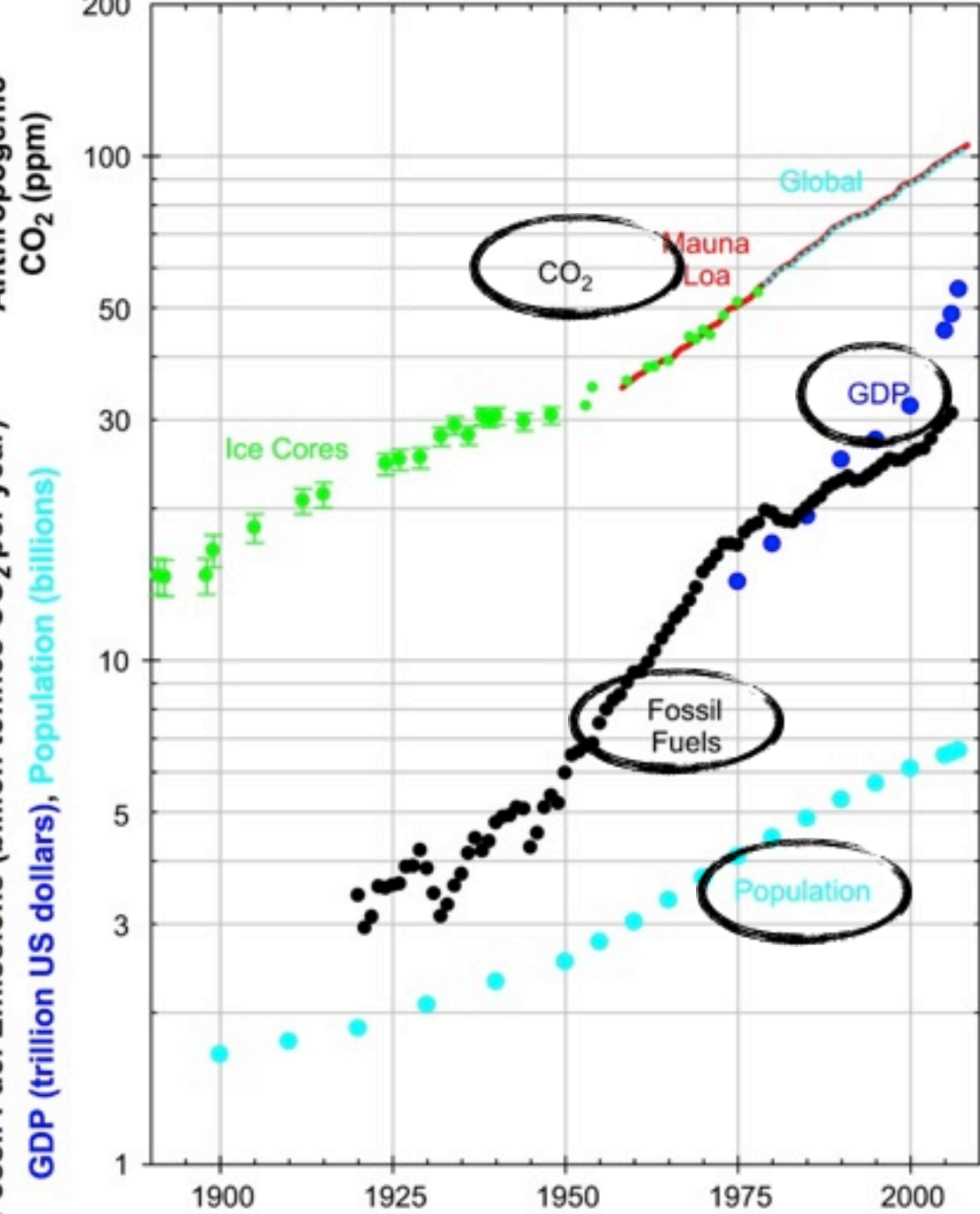
America's Leading Energy Company

Charney Report 1979

Doubling of CO₂
will likely result in
2 to 3.5C
temperature
increase, with
larger increases
in higher latitudes

Carbon Dioxide and Climate: A Scientific Assessment

Report of an Ad Hoc Study Group on Carbon Dioxide and Climate
Woods Hole, Massachusetts
July 23-27, 1979
to the
Climate Research Board
Assembly of Mathematical and Physical Sciences
National Research Council



Correlation is not causation... and yet multiple lines of evidence show these are related.

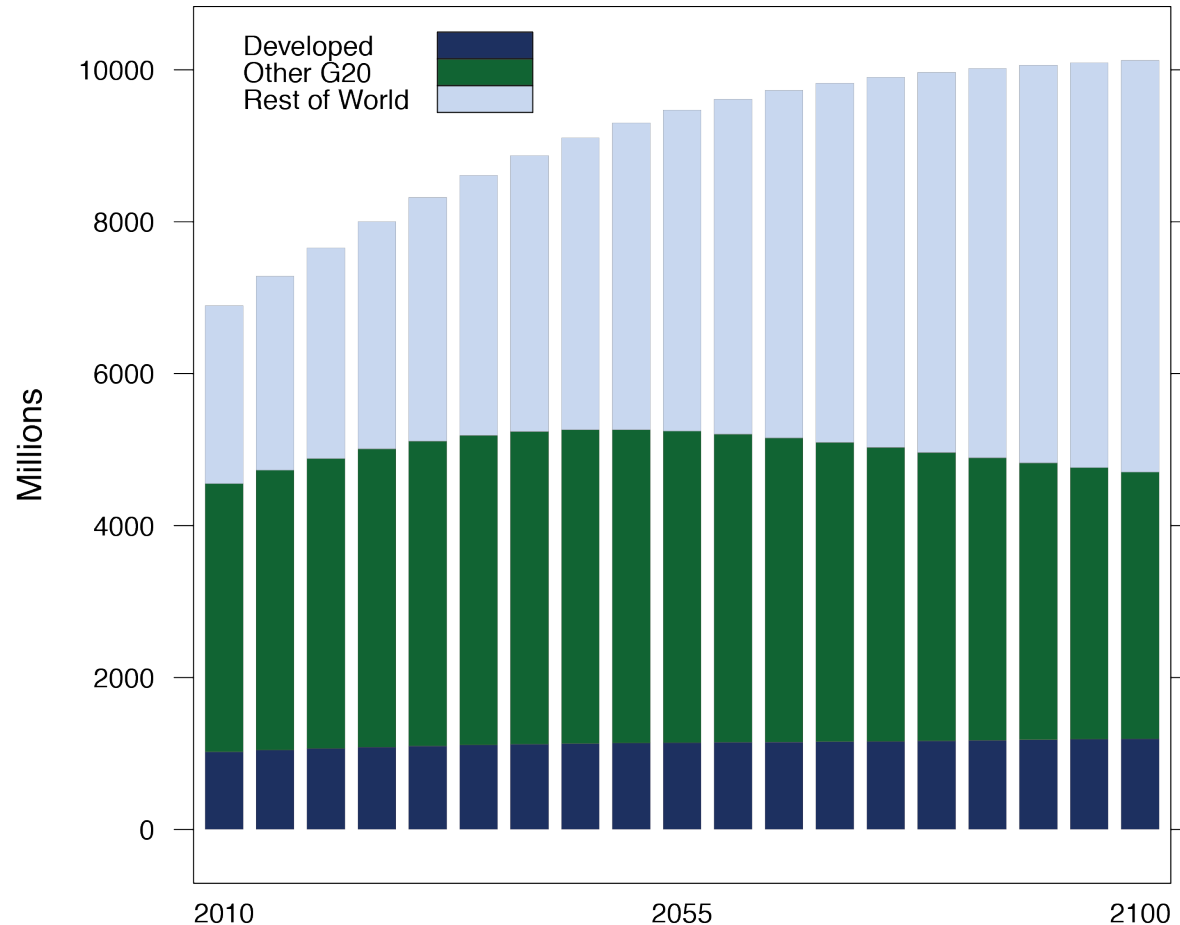
Ten Indicators of a Warming World



Seven of these indicators would be expected to increase in a warming world and observations show that they are in fact increasing. Three would be expected to decrease and they are in fact decreasing. (NOAA)

MIT Energy and Climate Outlook: 2012

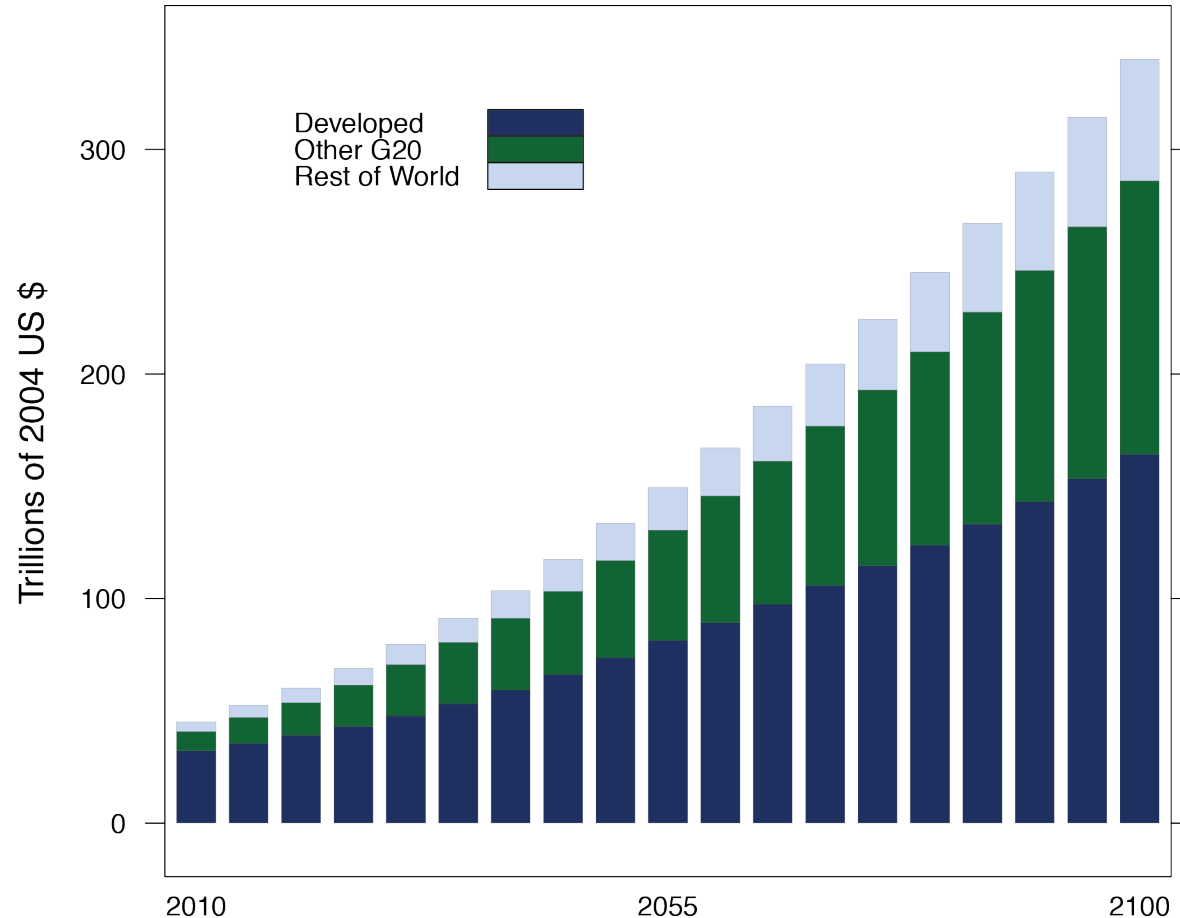
<http://globalchange.mit.edu/Outlook2012>



World Population (UN, 2011)

MIT Energy and Climate Outlook: 2012

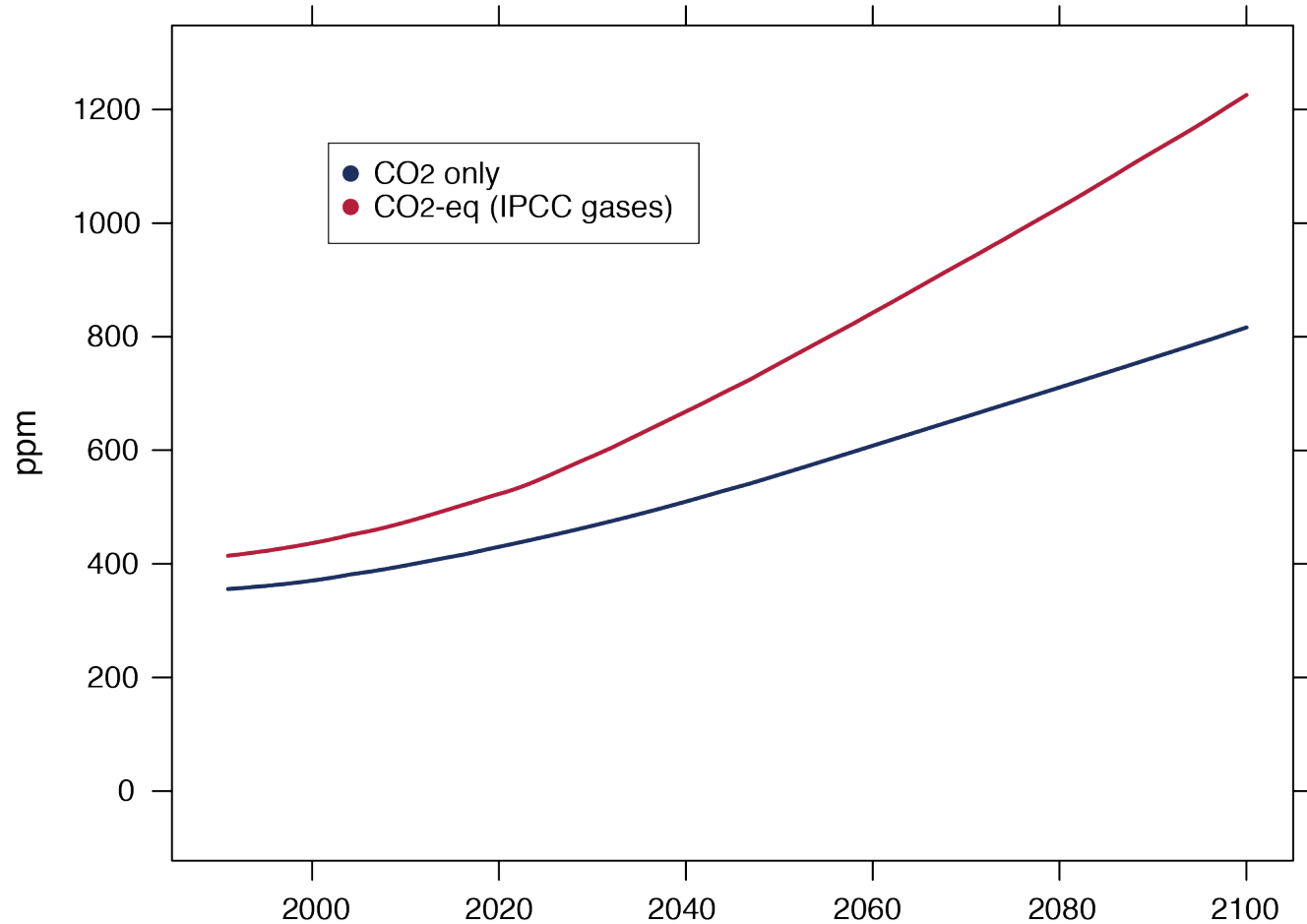
<http://globalchange.mit.edu/Outlook2012>



World GDP

MIT Energy and Climate Outlook: 2012

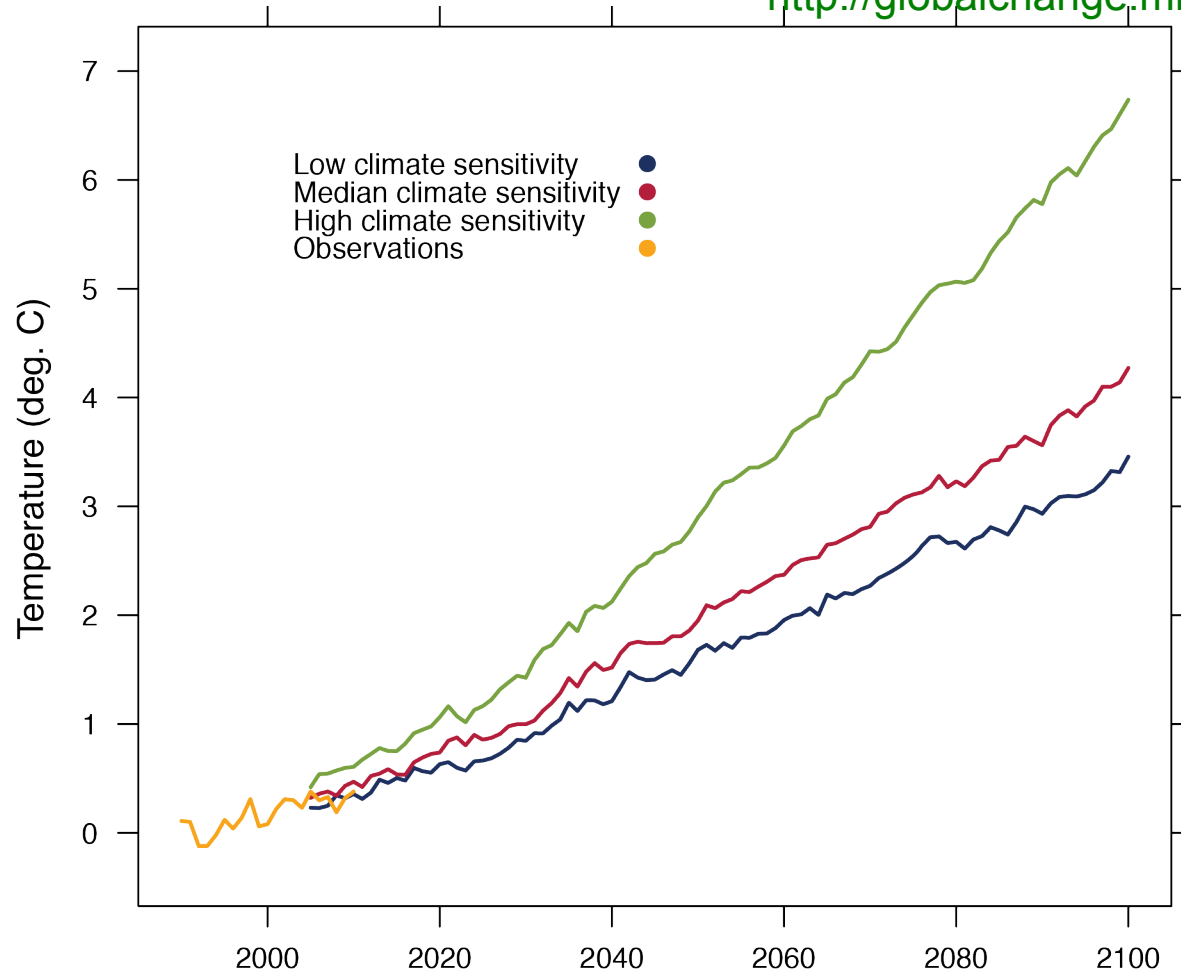
<http://globalchange.mit.edu/Outlook2012>



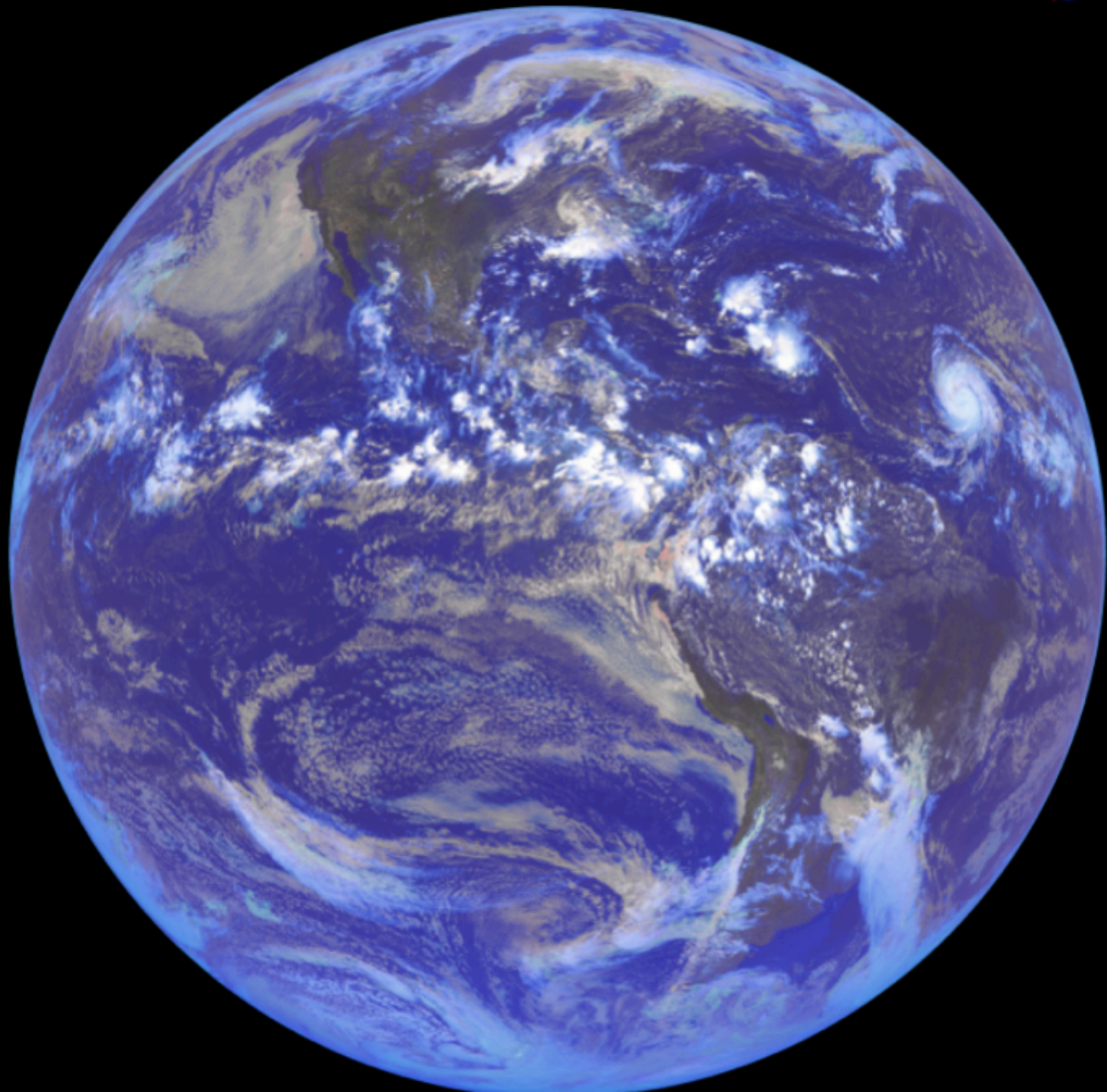
Projected CO₂ and GHG

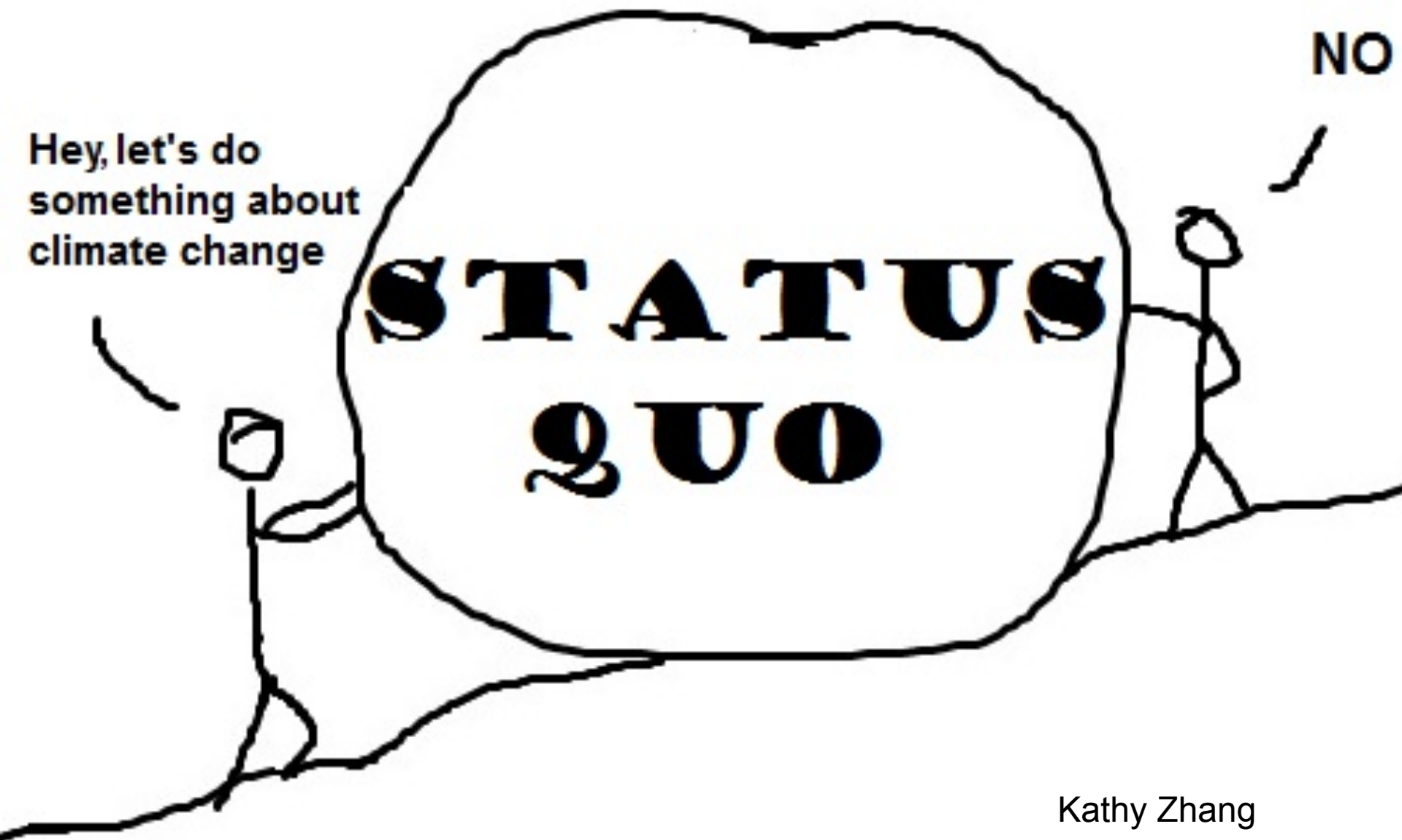
MIT Energy and Climate Outlook: 2012

<http://globalchange.mit.edu/Outlook2012>



Projected Mean Surface Temperature Increase





Kathy Zhang

Climate Skeptic



What they think of themselves

Climate Analyst



What they think of themselves

Climate Advocate



What they think of themselves



What Climate Analysts think of them



What Climate Skeptics think of them



What Climate Analysts think of them



What Climate Advocates think of them



What Climate Advocates think of them



What Climate Skeptics think of them

STANLEY COHEN



STATES OF DENIAL

KNOWING ABOUT
ATROCITIES AND SUFFERING

States of Denial:

Knowing about Atrocities and Suffering
(Cohen 2001)

- 1) Literal (It's not happening)
- 2) Interpretive (It's happening but not what you think)
- 3) Denying the implications and responsibility

Where do we go from here?

The New York Times

June 9, 2010

don't believe
in global warming

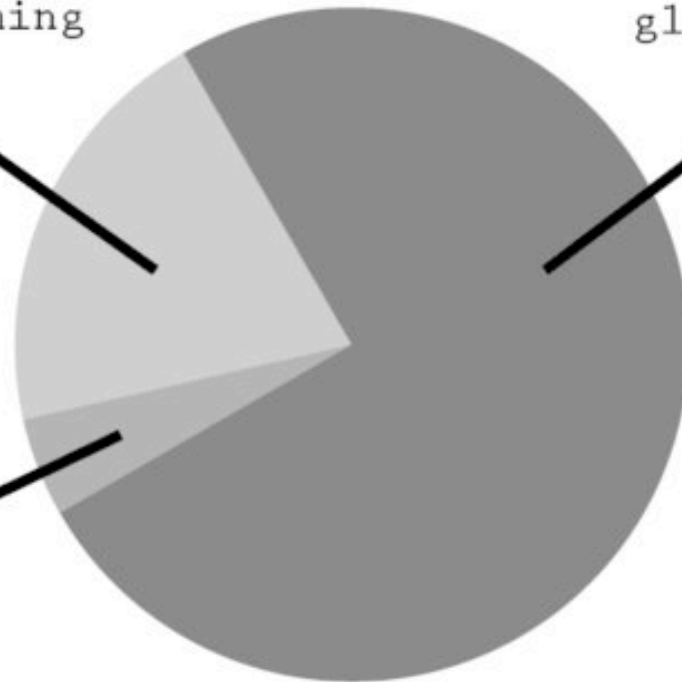
believe in
global warming

OP-ED CONTRIBUTOR

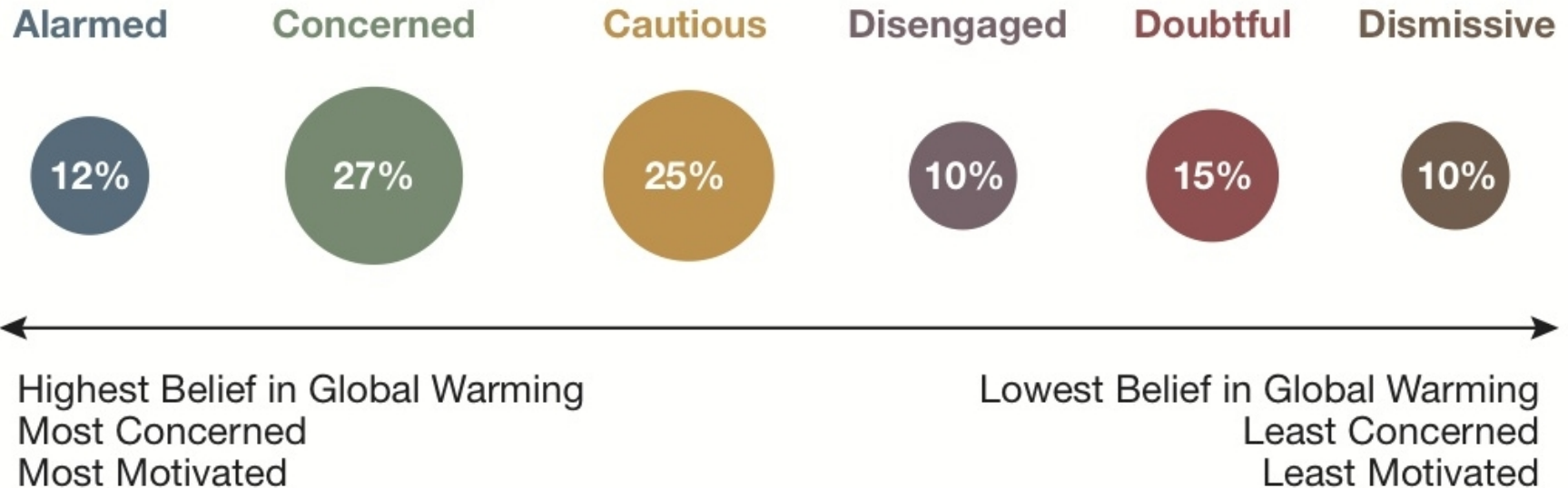
The Climate Majority

By JON A. KROSINICK

don't believe
in pie charts

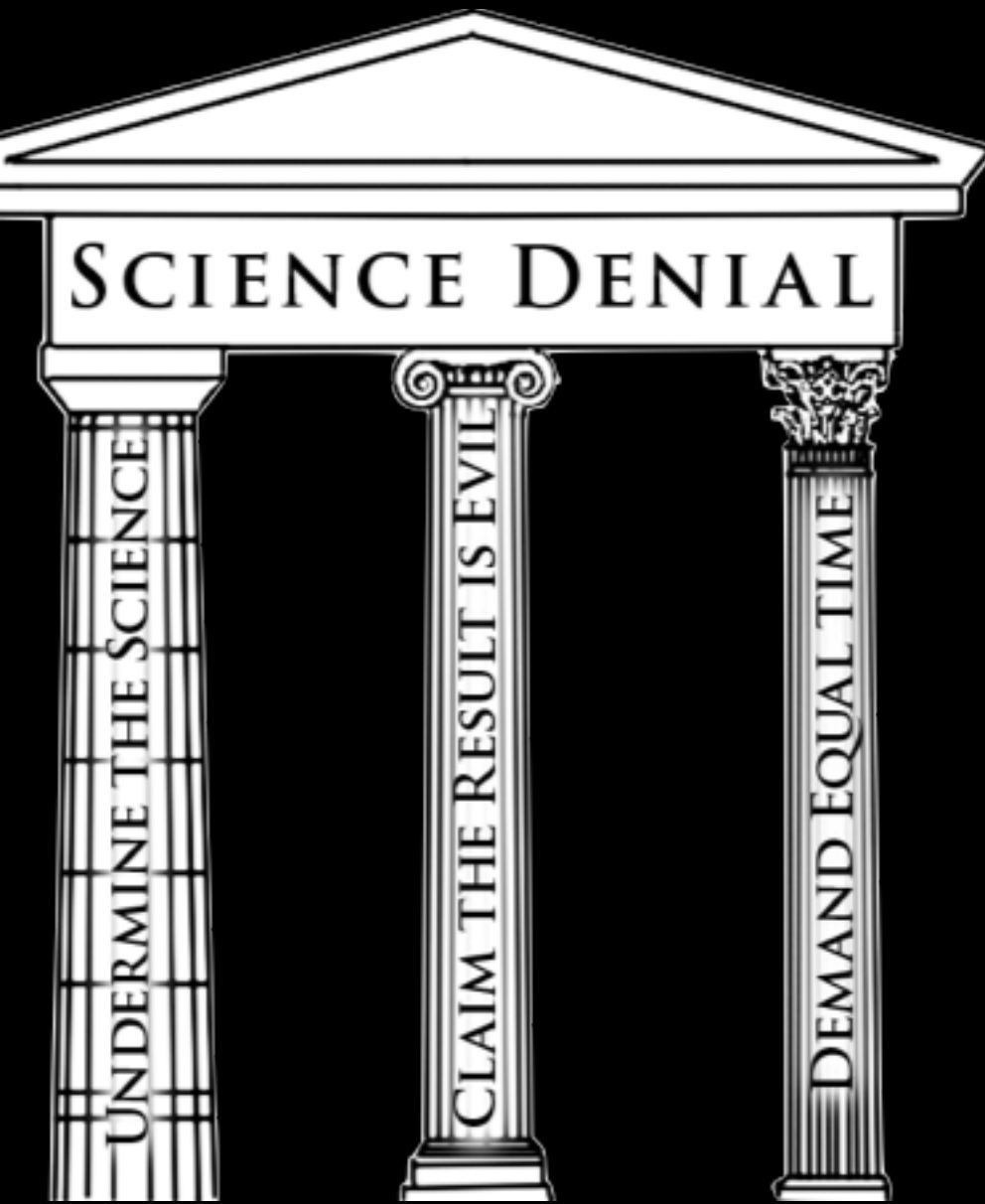


Why?



Proportion represented by area

Source: Yale / George Mason University



Pillars of Denial

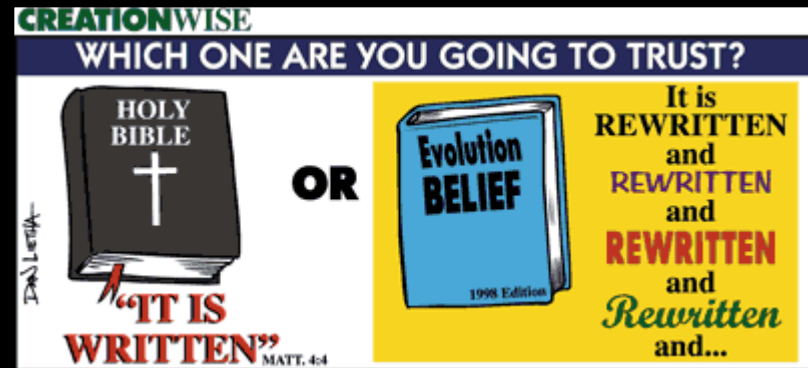
1. Science (Bad/
wrong)
2. Ideology (Bad
outcomes for society
will result)
3. Culture (Demand
equal time to be “fair
and balanced”)

“Pillars of Creationism”

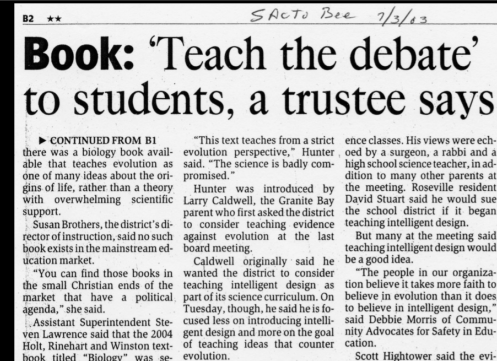
Evolution is weak



Evolution and religion are incompatible



It's only “fair” to teach creationism with evolution



Pillars of Climate Change Denial

Climate change is weak science



Climate change is anti-capitalist/ liberal (big government)



Teachers should "teach both" (avoid dogma; promote critical thinking)



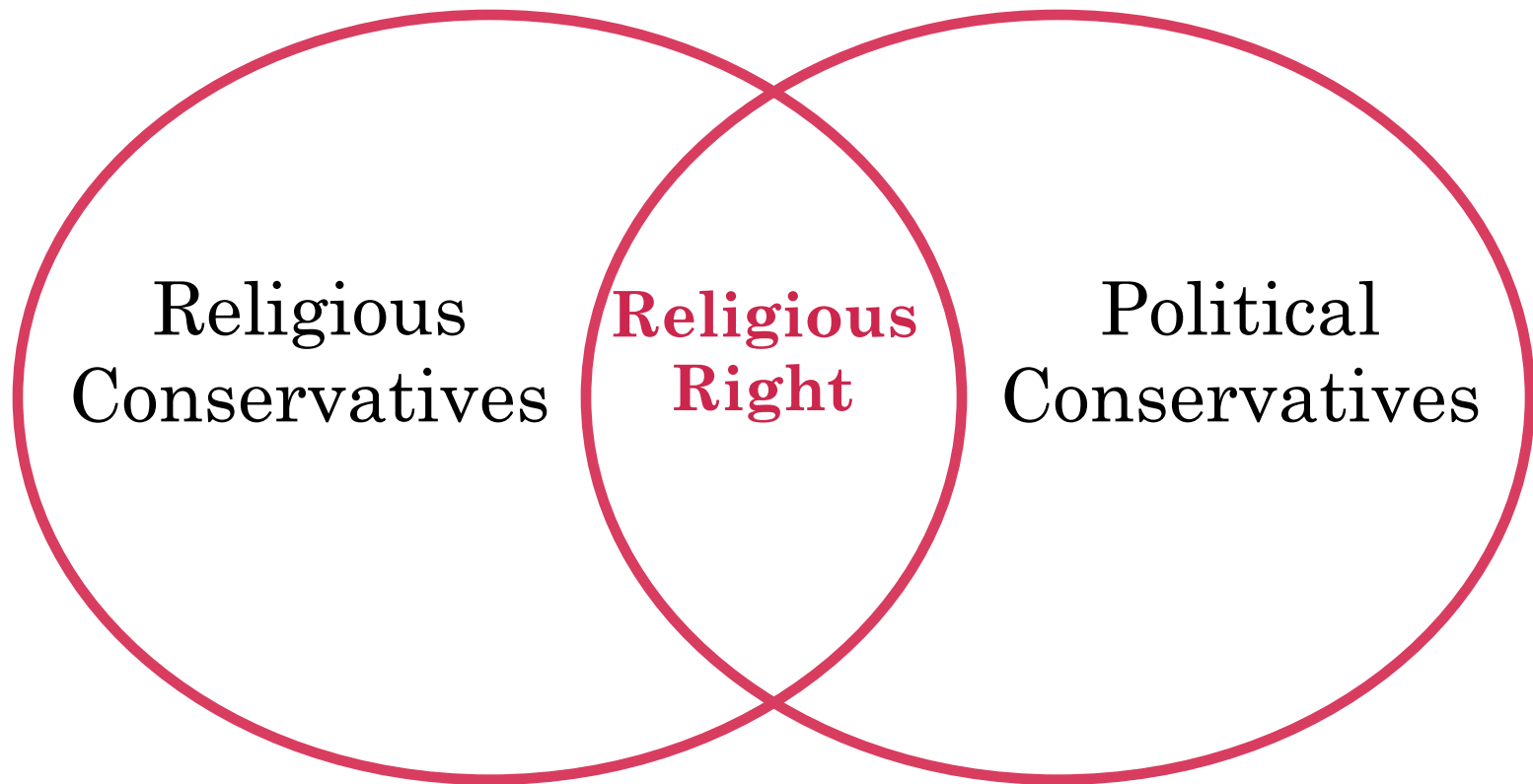
Questioning the Science

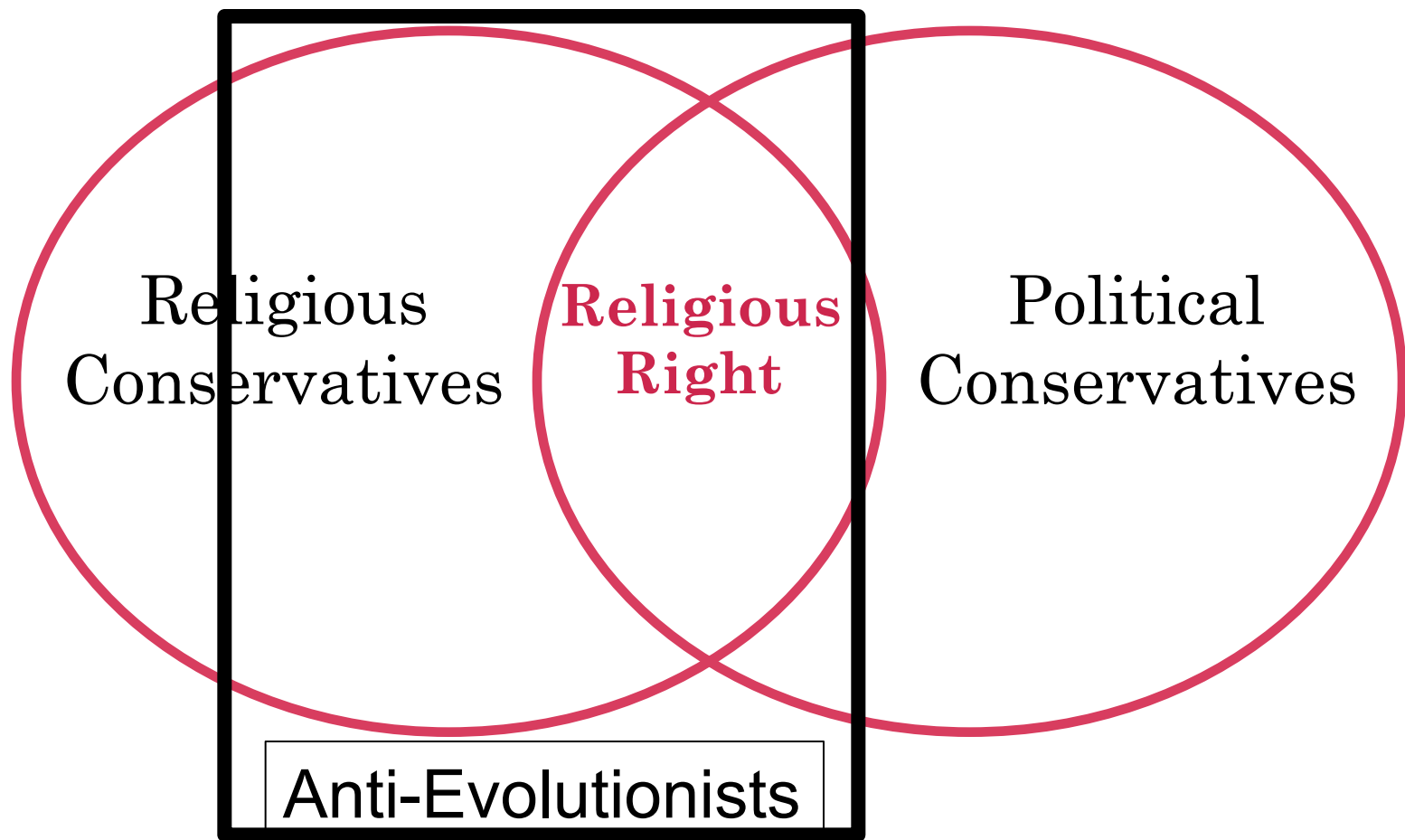
- “Should the public come to believe that the scientific issues are settled, their views about global warming will change accordingly. Therefore, ***you need to continue to make the lack of scientific certainty a primary issue in the debate***”

“Winning the Global Warming Debate: An Overview”
2002 Memo for GOP Congressional Candidates,
Luntz Research Companies.

Donald A. Brown <http://Climateethics.org>

- Skepticism is “both the oxygen and catalyst of science”
- Malicious disinformation about climate science is not skepticism
- Free speech is “morally reprehensive” if it “deceives people about vitally important matters”





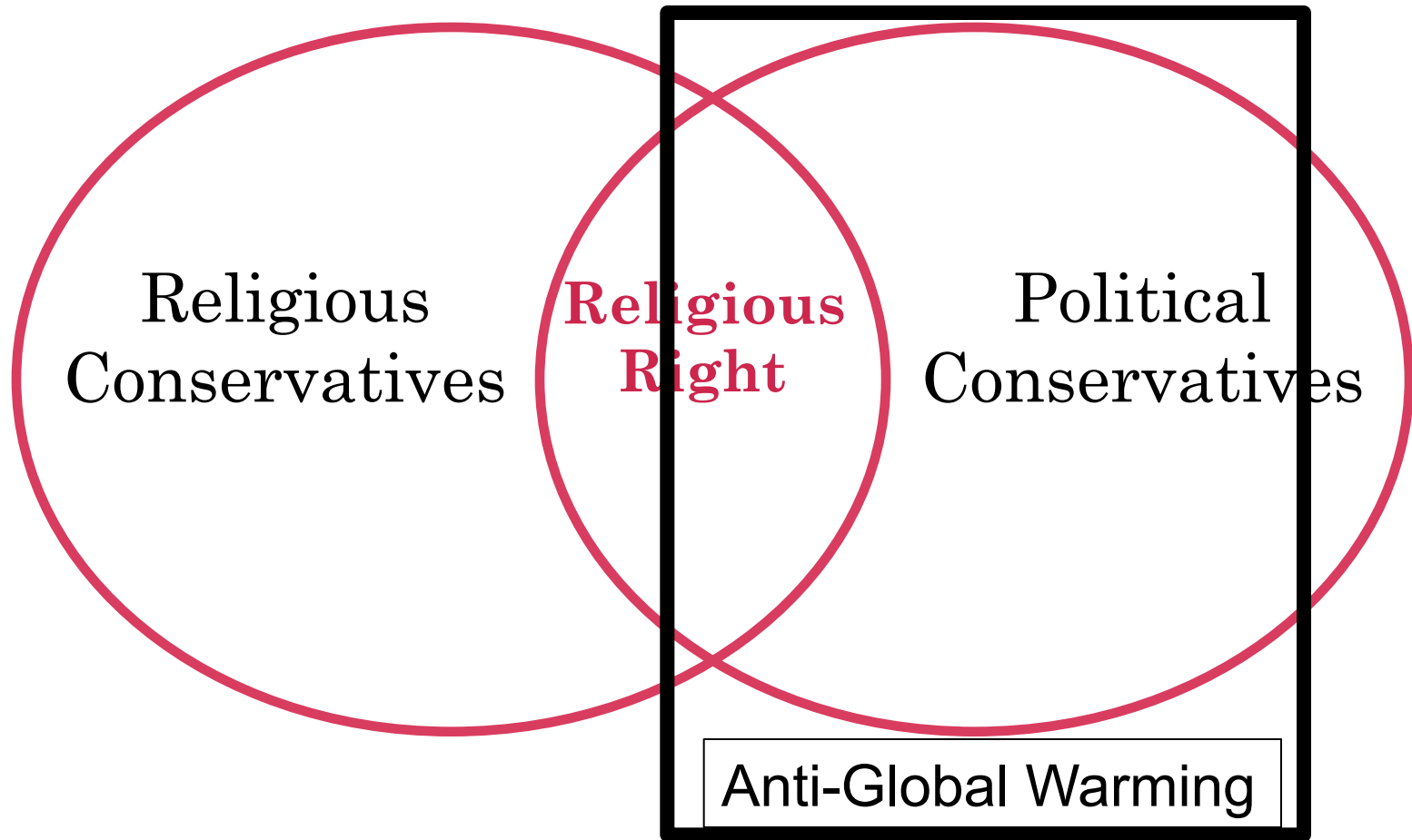
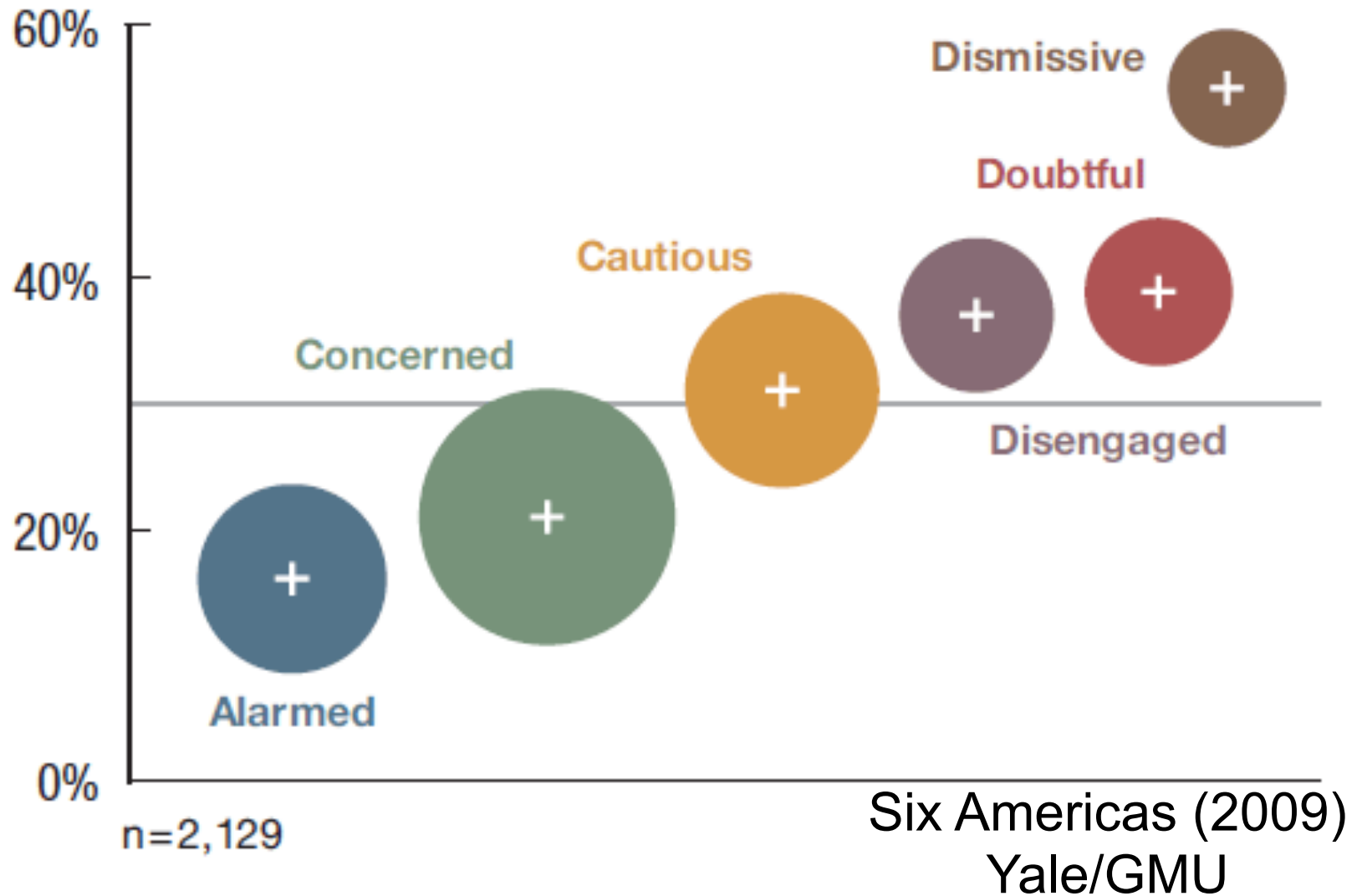


Figure 33: Proportion “born again” or evangelical

Would you describe yourself as “born-again” or evangelical?





- Environmentalism and climate change are a new religion.
- Their policies are devastating to the world's poor and threaten the sanctity of life.
- They “target our youth with a global vision”.
- James 4:7, "Submit therefore to God. Resist the devil and he will flee from you."

Global Warming.org

May Cooler Heads Prevail



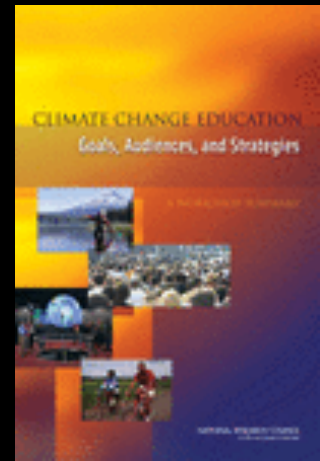
- Global warming may or may not be a problem. Man may or may not be driving it. Given the uncertainties, a significant amount of global regret may apply if we divert too much of our global wealth to solving what may be a non-existent or trivial problem, especially if that diversion mires billions in poverty.
- On the other hand, we may also regret not doing anything if man-made global warming does turn out to be a problem.

What is the
role of
education?

Challenges to Climate Change Education

NRC Workshop Report 2011

1. Climate change is complicated
2. Science and solutions are cross disciplinary; should be taught throughout across the curriculum
3. Not well coordinated or represented in standards
4. It has been politically polarized



And more....

- Emotional and sociological challenges
- Taught as controversy, giving “both sides” equal weight



Teach the Controversy! ("Academic Freedom" Bills)

- Promotes "Critical Thinking" Skills
- More Science (not less) through debate
- But leads to confusion
- Undermines solid science understanding



SEVEN THEORIES OF CLIMATE CHANGE

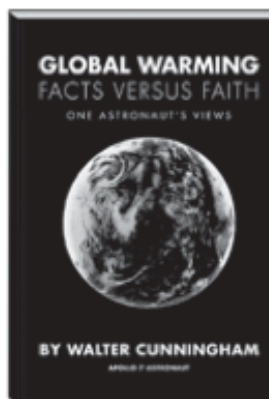
Why does climate change?
What is man's role?
What do leading scientists believe?

BY JOSEPH L. BAST
PRESIDENT, THE HEARTLAND INSTITUTE

the science, insisting that "in the end, science will win."

Facts.

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The Heartland Institute
2010, 17 pp.

"A beautifully written and easy to understand factual account that debunks climate alarmism."

— S. Fred Singer, Ph.D.
Coauthor, *Climate Change Reconsidered*

Available for free online at heartland.org.

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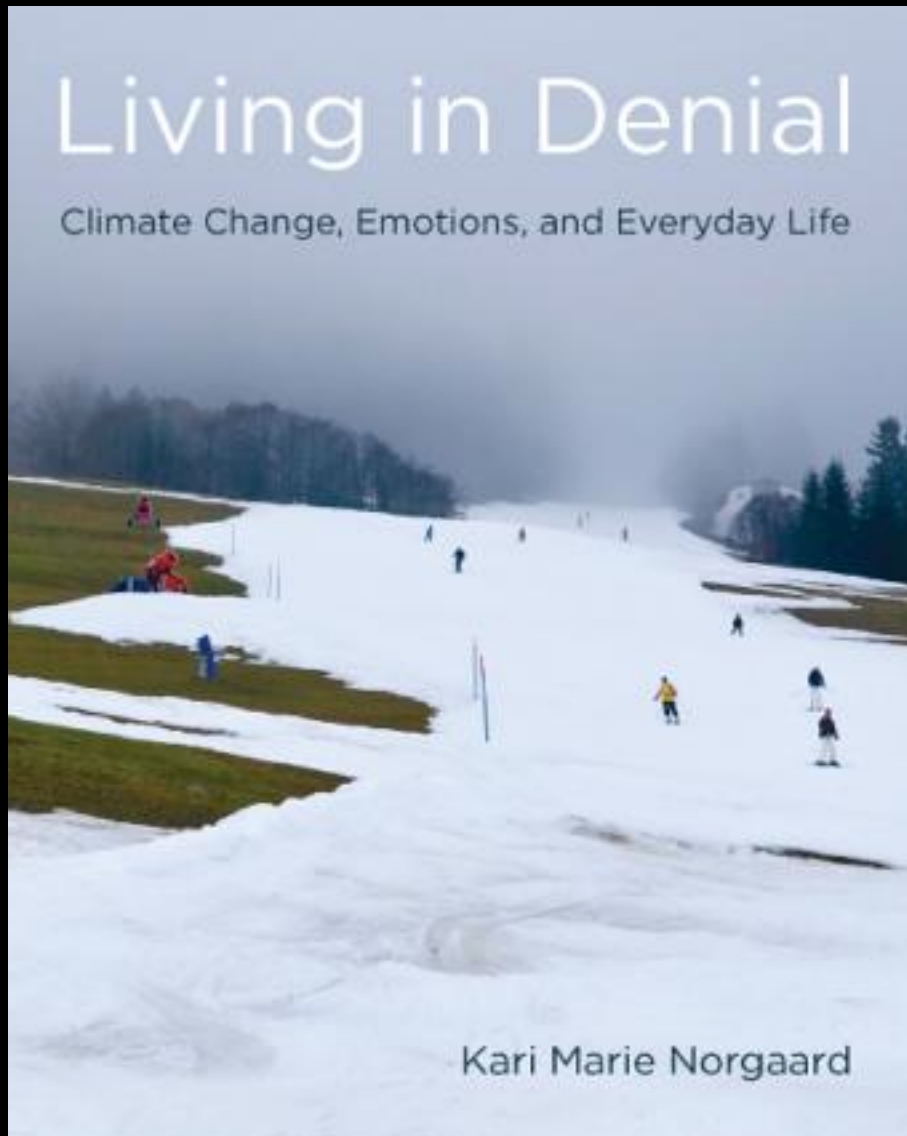
THE HEARTLAND INSTITUTE
IDEAS THAT EMPOWER PEOPLE



THE GREAT
GLOBAL
WARMING
SWINDLE

A documentary by
Martin Durkin

Denying the Implications & Responsibility



Focus on Norway

- Social numbing
- Motivated avoidance
- Climate change is “common knowledge and unimaginable”

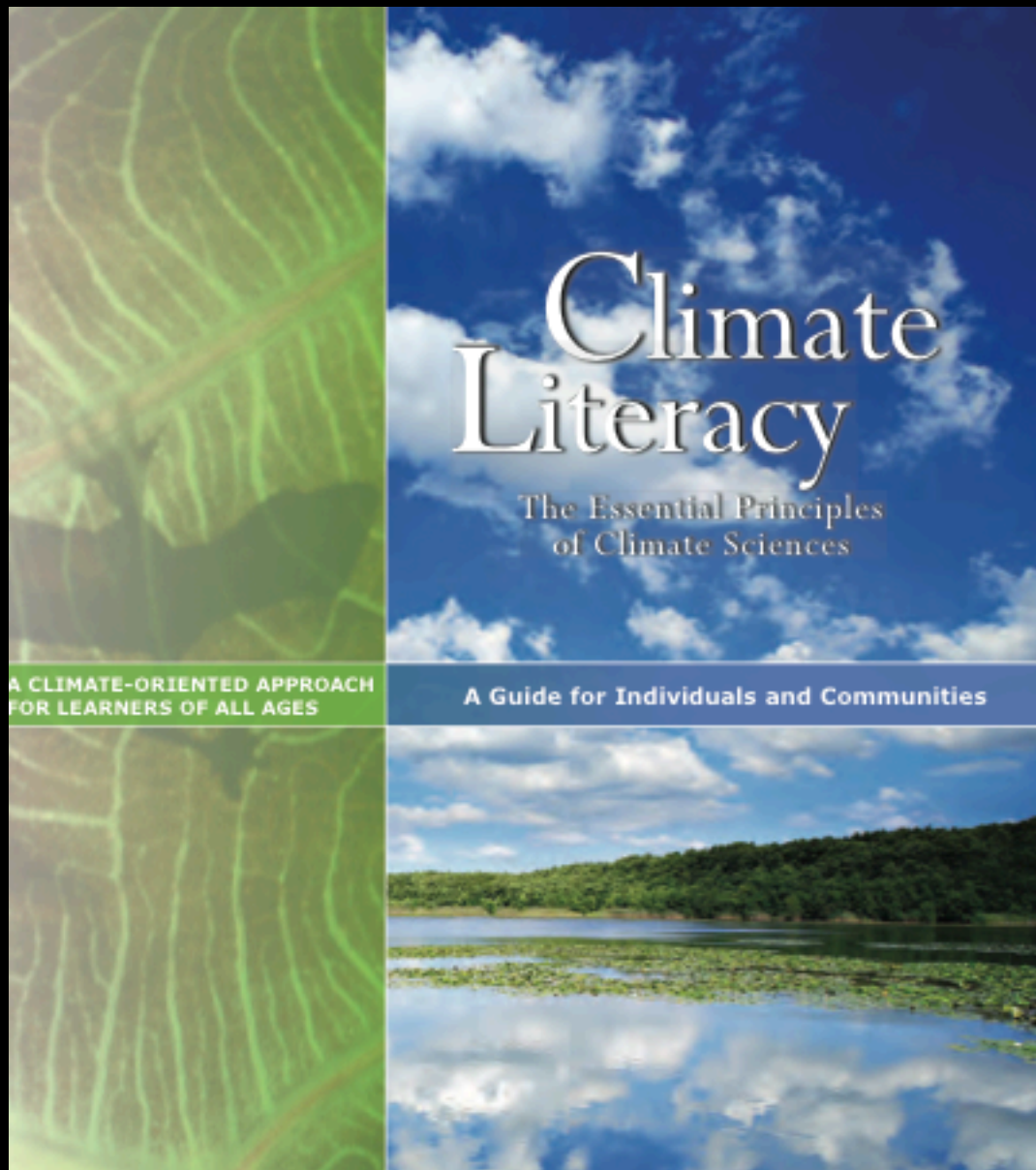


GLOBAL
WARMING
READY

DIESEL
FOR THE NEW GENERATION

Good News?





<http://globalchange.gov/resources/educators>



U.S. Global Change Research Program

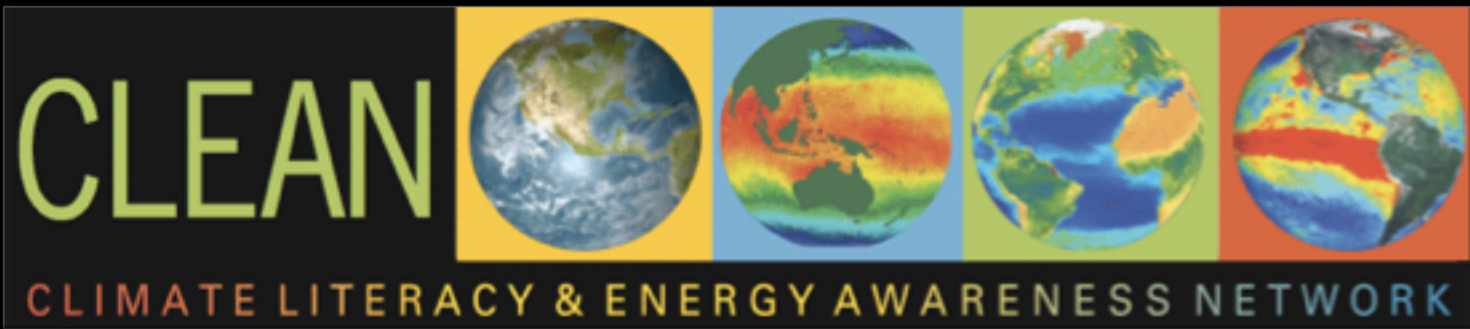




Energy Literacy

**Essential Principles and
Fundamental Concepts
for Energy Education**

*A Framework for Energy Education
for Learners of All Ages*



<http://cleanet.org>

- ~400 high quality learning resources
- Vetted for scientific accuracy and pedagogical potential

http://www.acespace.org/



ALLIANCE FOR
CLIMATE EDUCATION
EDUCATE. INSPIRE. ACTIVATE.

search

CONNECT



email: *

cell phone:

zip:



ABOUT

DOT

ACTION TEAMS

BLOG

EDUCATION

DONATE

FREE HIGH SCHOOL CLIMATE ASSEMBLIES



Watch the ACE Assembly Trailer

Students Reached

1 2 0 3 4 2 6

Schools Visited

1 7 5 7

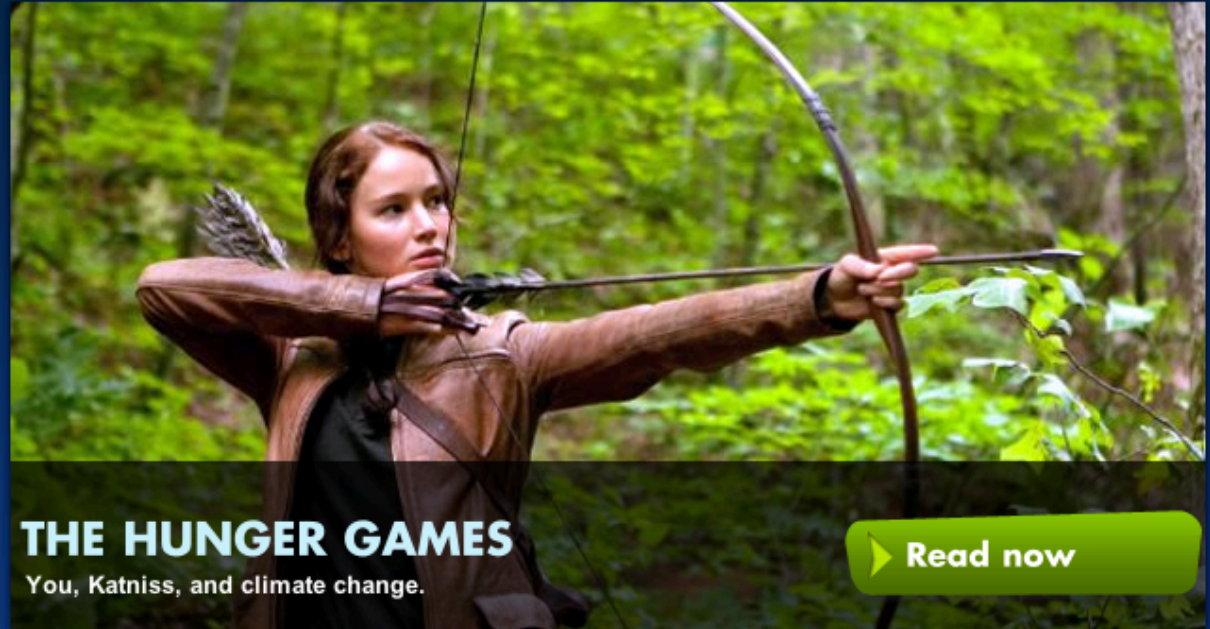
BOOK an **ASSEMBLY**

Teacher? Learn more | ACE Near You

Rave Reviews

see all »

I just want to thank you again for the



THE HUNGER GAMES

You, Katniss, and climate change.

Read now



HOT & BOTHERED Blog

BRINGING GREEN WASTE TO TORRENCE

April 10th, 2012 | 0 comments

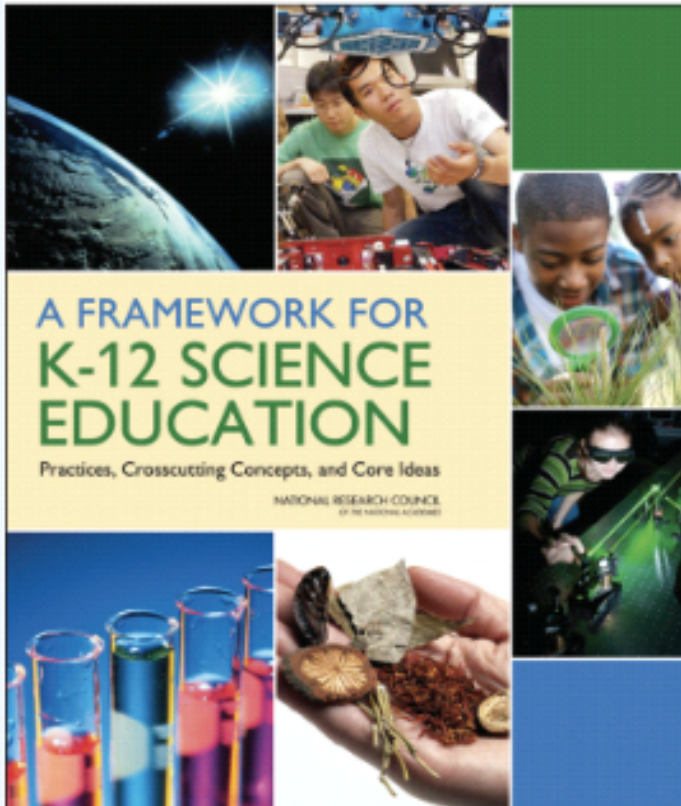


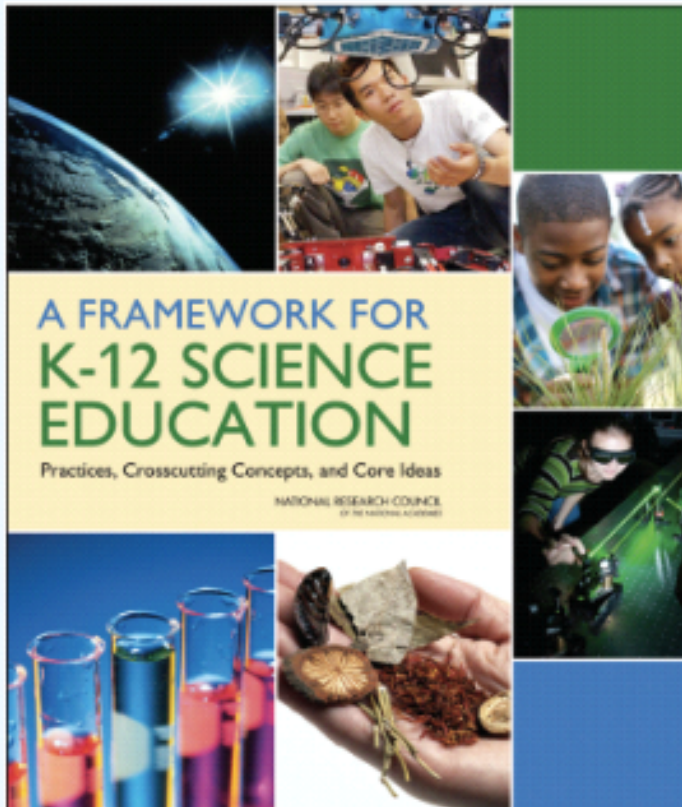
Alliance for Climate
Education on Facebook

National Research Council Framework (2011)



Next Generation Science Standards (Winter 2012-13)





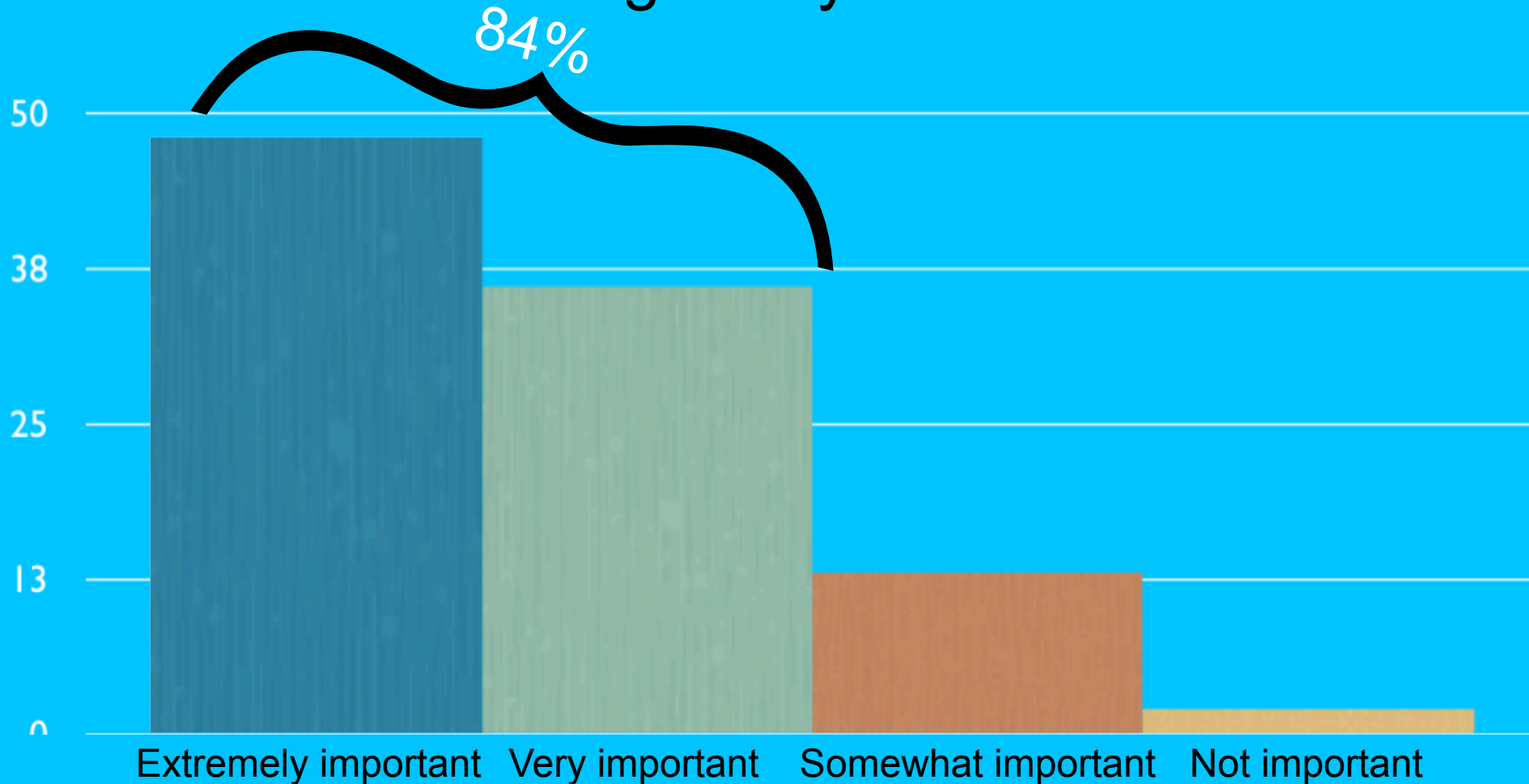
Energy Crosscutting Theme

Climate and Global Change science taught across sciences and engineering

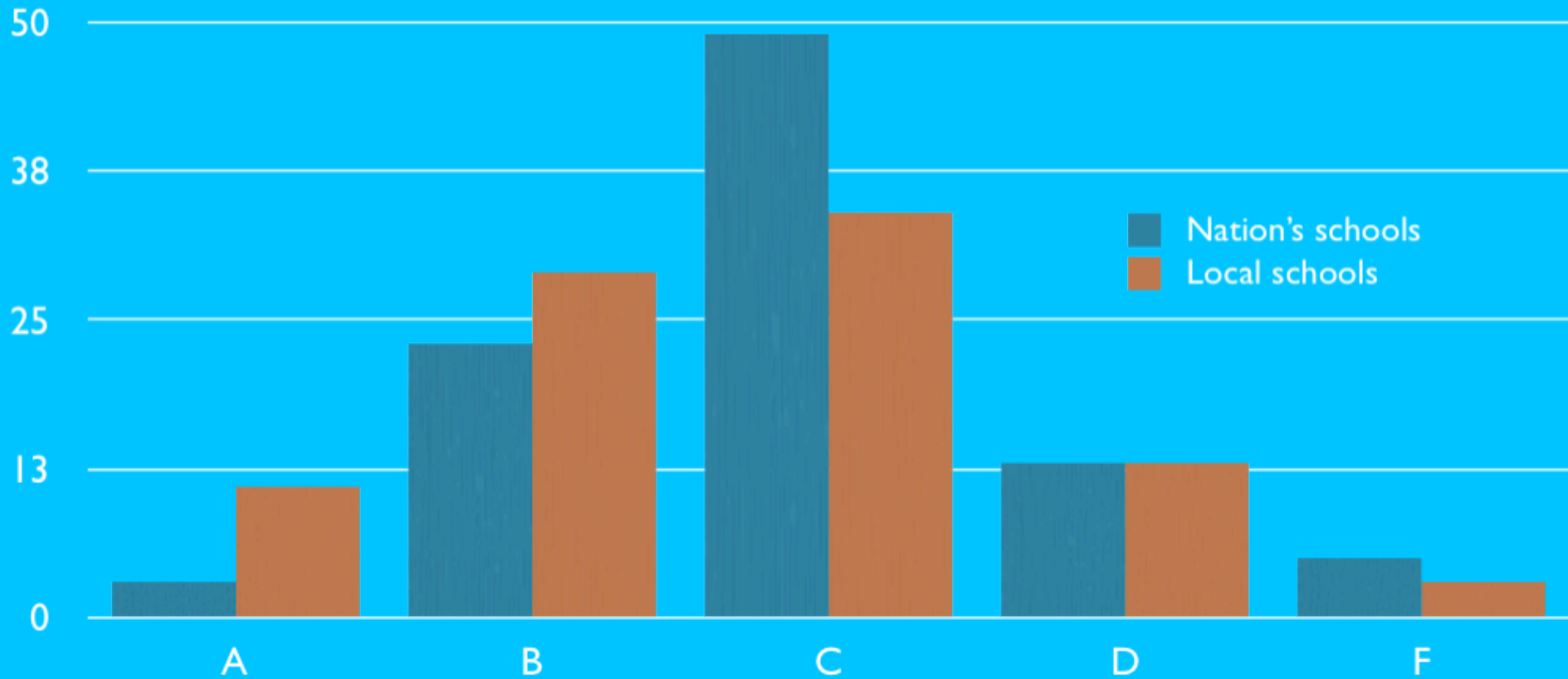


26 States Involved in Next Generation Process

How important do you think improving the quality of science education in our public schools is to our country's ability to compete globally?



What grade would you give science education in public schools?

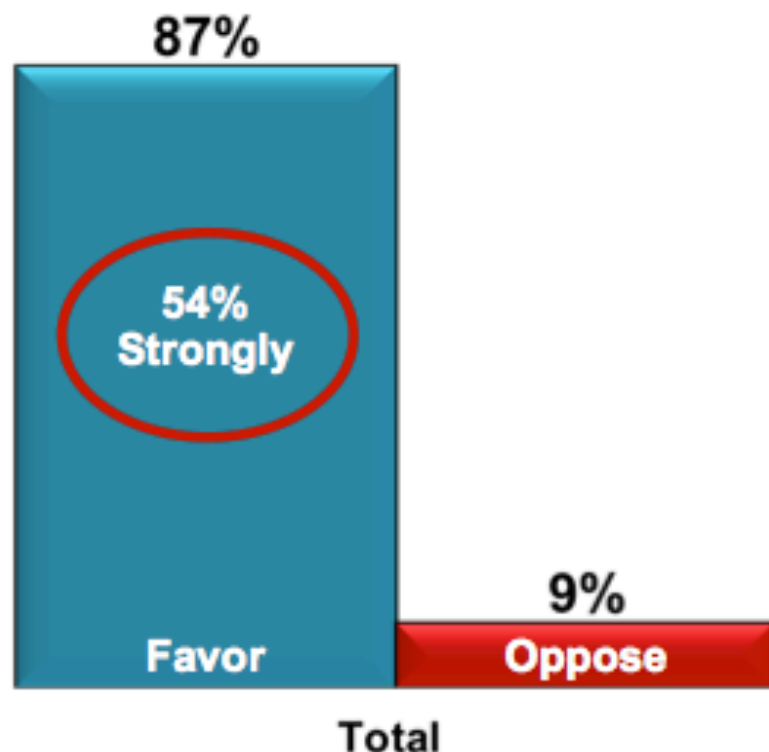


Attitudes Toward New Science Standards



There is broad support for these new science standards.

New Science Standards



Voter Sub-Groups	Strongly Favor	Total Favor
Male	53%	85%
Female	55%	89%
18-44	55%	89%
45+	53%	84%
Northeast	62%	86%
Midwest	52%	88%
South	49%	87%
West	55%	87%
White	52%	86%
African American	55%	91%
Less Than College	49%	87%
College+	60%	87%
Republican	49%	85%
Independent	54%	86%
Democrat	60%	91%
Parents	52%	89%
Non-Parents	54%	86%
Teacher Household	54%	81%
Union Household	53%	88%





NATIONAL CENTER for Science Education

DEFENDING THE TEACHING OF EVOLUTION & CLIMATE SCIENCE

NCSE provides information and advice as the premier institution dedicated to keeping evolution and climate change in the science classroom and to keep out creationism and climate change denial. [LEARN MORE >>](#)

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[TAKING ACTION](#)

[CREATIONISM](#)

[EVOLUTION](#)

[CLIMATE](#)

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Climate Change

[Climate Change 101](#)

[Climate Change Denial](#)

[Teaching Climate Change](#)

[Climate Change: Taking Action](#)

QUICK LINKS

- ["Intelligent Design" on Trial](#)
- [Reports of the NCSE](#)

CLIMATE CHANGE EDUCATION

UNDERSTANDING AND TEACHING
THE SCIENCE BEHIND
GLOBAL CLIMATE CHANGE

Welcome to the National Center for Science Education's climate change education initiative. Long respected for its work in defending and supporting the teaching of evolution in the public schools, in 2012 NCSE launched this new initiative to defend and support the teaching of climate change. This section of the website includes the four main sections of the climate change education resources here.

What NCSE does/can do

- Assist in local flareups, track and collate flareup data
- Support, train, and engage local activists
- Build networks of scientists, lawyers, clergy, businesses, activists, policymakers
- Develop and lobby for good standards
- Lobby against bad bills and for good ones
- Connect teachers with good educational materials
- Analyze and refute denialist educational materials
- Serve as clearinghouse for media, activists, scientists, lawyers, policymakers, and other stakeholders

Clifton Park, NY

- Parent contacts NCSE: “My daughter’s 9th grade Earth Science teacher is doubt-mongering the scientific consensus that climate change is occurring and is mainly due to human activity.”
- NCSE guides parent through school bureaucracy, puts her in touch with local science education leaders.
- Teacher agrees to stop undermining climate science.





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