

Reviewed and Endorsed by

U.S. Climate Change Science Program
<http://climatescience.gov>

Cleanet.org

CLEAN
CLIMATE LITERACY & ENERGY AWARENESS NETWORK

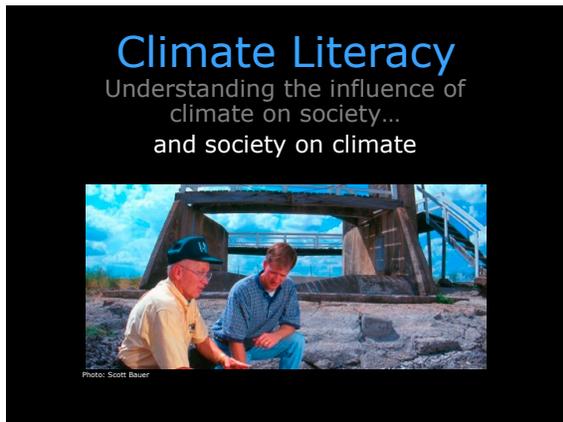
CLEAN Network
 The CLEAN Network is a professionally diverse community of over 570 members committed to improving climate and energy literacy locally, regionally, nationally, and globally. We enable regions, life decisions and actions. The CLEAN network has kept its dynamic group since 2008 and is now led by the CLEAN Network established in 2016.

Join the CLEAN Network
 Tuesdays at 1pm Eastern time CLEAN Network members meet in a teleconference to collaborate and engage with regional climate literacy work, upcoming events, opportunities for collaboration or funding. Frequently guest speakers connect with the group on climate and energy literacy.

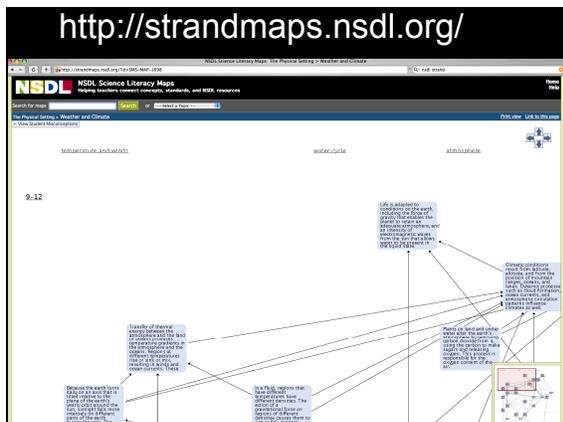
Recent and upcoming television hosts and speakers
 Educators: Search for lessons the Collection of Climate and Energy Educational Resources and learn more about teaching climate and energy science.
 Resource Developers: See the multiple ways in which developers can participate in completing the collection of

Climate Literacy
 Understanding the influence of climate on society...

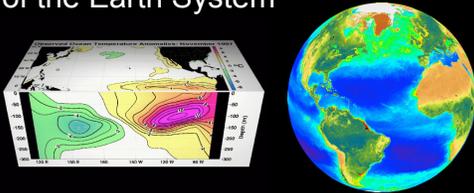
Photo: Scott Bauer



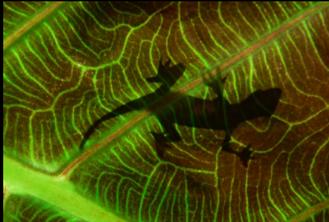




2. Climate Is Regulated By Complex Interactions Among Components of the Earth System



3. Life on Earth Depends on, Is Shaped By, and Affects Climate



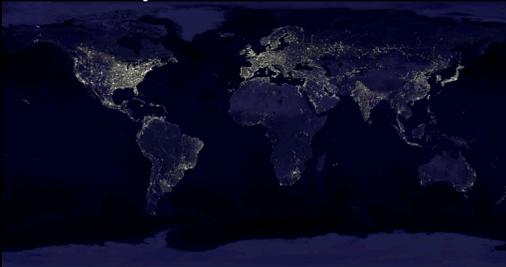
4. Climate varies over space and time through both natural and man-made processes



5. Our understanding of the climate system is improved through observations, theoretical studies, and modeling



6. Human activities are impacting the climate system

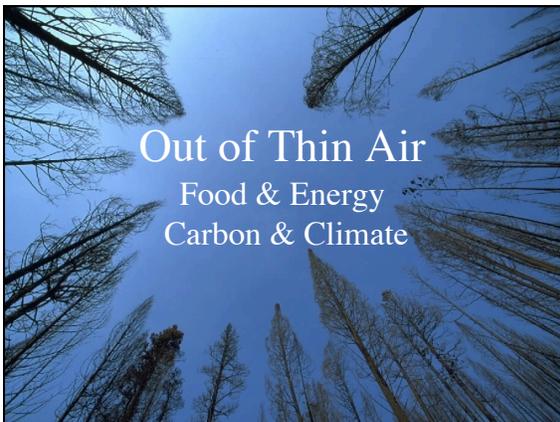


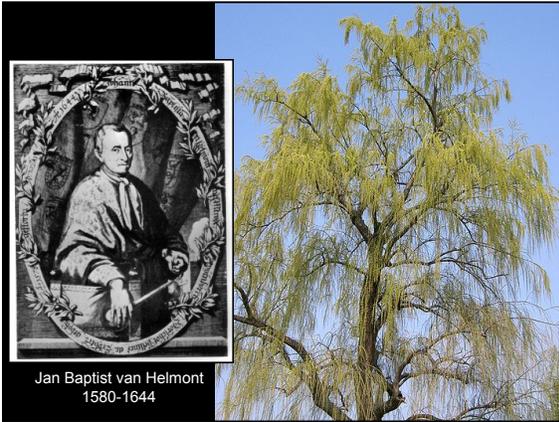
7. Climate change will have consequences for the Earth system and human lives





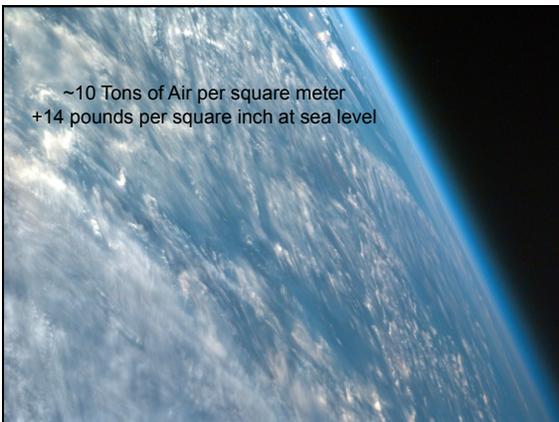




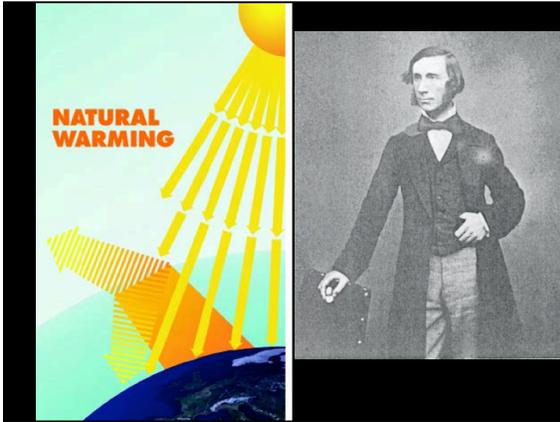


Jan Baptist van Helmont
1580-1644





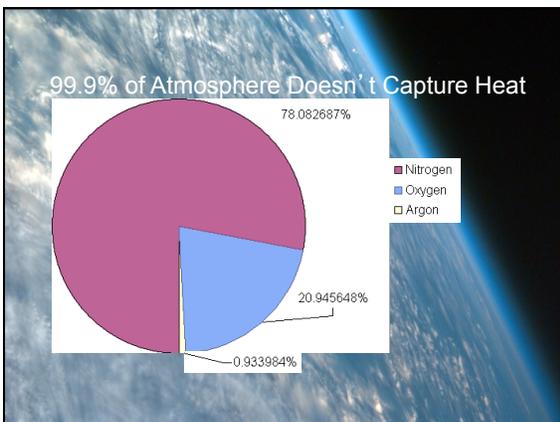
~10 Tons of Air per square meter
+14 pounds per square inch at sea level

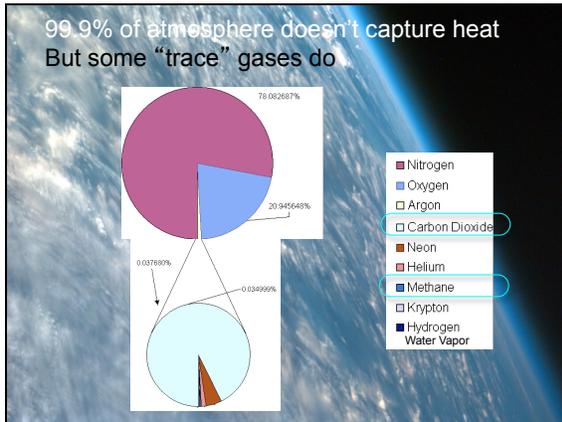


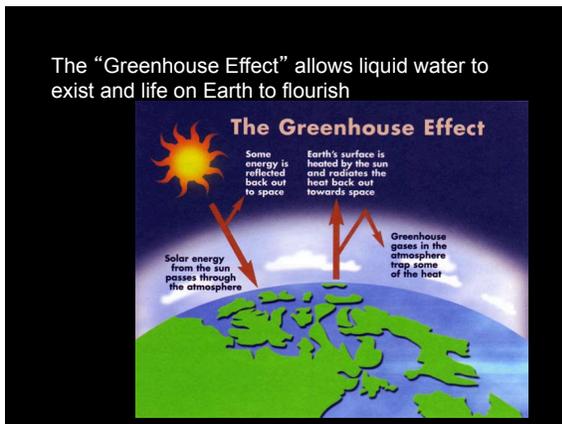
John Tyndall (1820-1893)

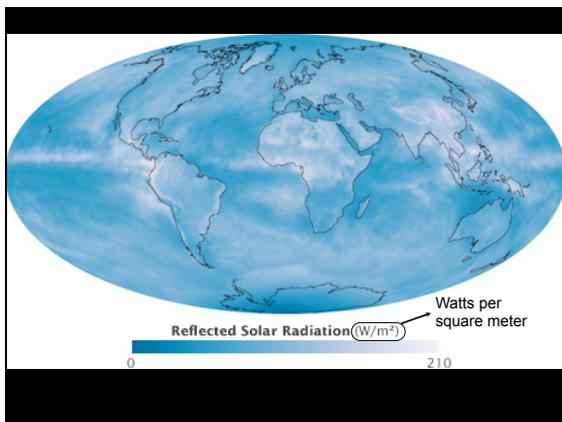
Mini-atmosphere in basement of Royal Institution, London

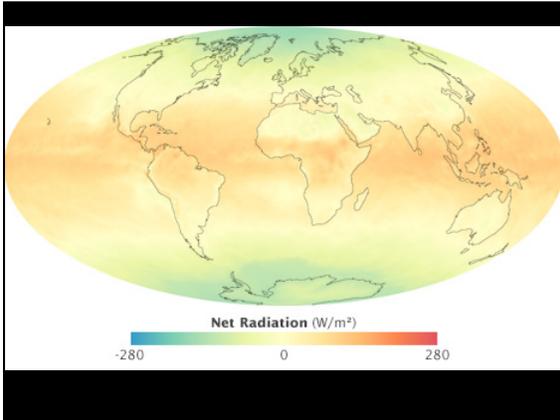
CONTRIBUTIONS
TO
MOLECULAR PHYSICS
IN THE DOMAIN OF
RADIANT HEAT.
A SERIES OF MEMOIRS PUBLISHED IN THE 'PHILOSOPHICAL TRANSACTIONS'
AND 'PHILOSOPHICAL MAGAZINE' WITH ADDITIONS.
BY
JOHN TYNDALL, LL.D. F.R.S.
PROFESSOR OF NATURAL PHILOSOPHY IN THE ROYAL INSTITUTION.
LONDON:
LONGMANS, GREEN, AND CO.
1872.
All rights reserved.

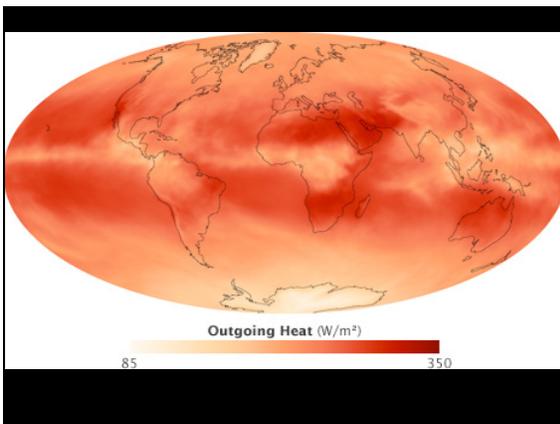






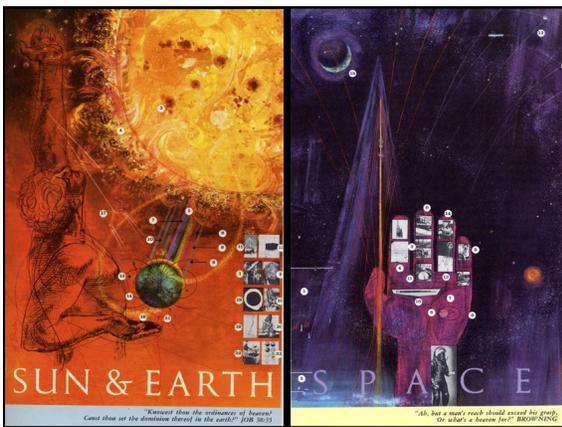














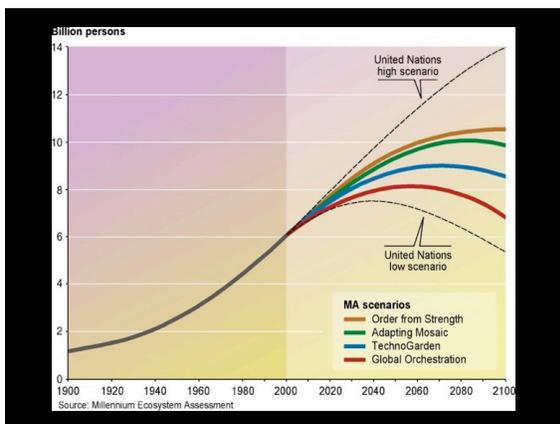
“Our industrial civilization has been pouring carbon dioxide into the atmosphere at a great rate....

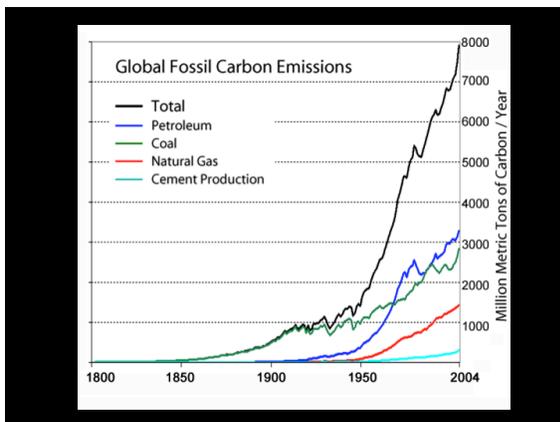
By the year 2000 we will have added 70 percent more carbon dioxide to the atmosphere...

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





Fluorinated Gases

- Sulfur hexafluoride
- HFC (Hydro fluoro compounds)
- PFC (Perfluorocarbon)
- CFC (chlorofluorocarbons)
- Nitrogen trifluoride



Tetrafluoroethane (HFC-134a) boils well below room temperature and was created to replace CFCs

A Private Universe Project

How well do US college graduates understand important science ideas?



A seed grows into a large tree. Where did the mass of the tree come from?

What if I told you that the mass comes mainly from the carbon dioxide in the air?

"A vast majority [of the American public], 85 percent, believes global warming probably is occurring, up slightly from 80 percent in a 1998 poll.

But fewer than four in 10 are very sure of it, a level of uncertainty that reflects broad and continued belief that scientists themselves disagree on whether or not it's happening.”

—Jon Kroznick, social scientist, Stanford University (2007)

National Science Education Content Standards NRC, 1996



- Climate mentioned nine times
- Human impact on climate not mentioned once except:

“In areas where data or understanding are incomplete, such as the details of human evolution or questions surrounding global warming, new data may well lead to changes in current ideas or resolve current conflicts.”

Climate Literacy Missing in Action

Not well addressed in State Science Education Standards

- 30 states do note impacts of anthropogenic change
- 19 states don't mention at all
- 17 states focus on mechanisms
- 7 states note fossil fuels impacting climate
- 5 states note land use changes impacts
- 3 states focus on mitigation strategies

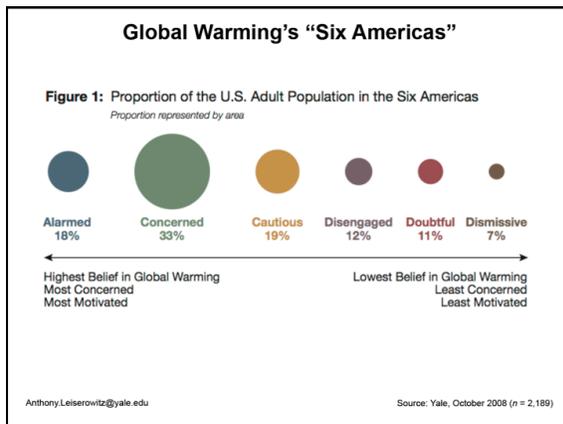
Kastens & Turrin, 2008

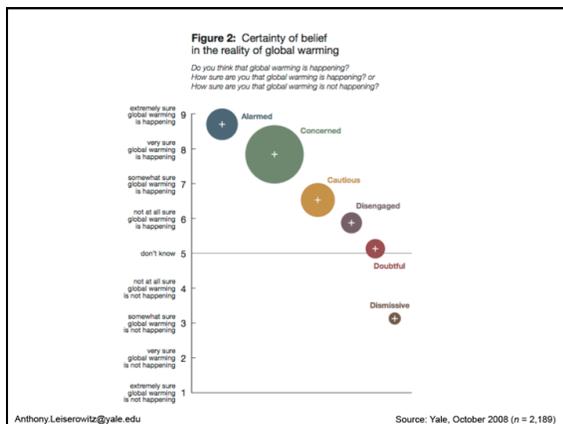
Climate Literacy Missing in Action CIRES Study of Colorado Teachers

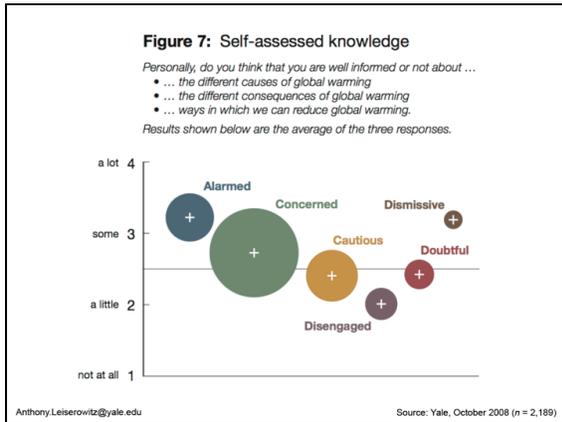
- Less than 50% formally address climate change
- Only a third of Earth and Physical Science teachers had professional development about climate change
- Popular media common source of information, leading to mix of perspectives and opinions
- About a third reported being encouraged to address climate change
- About 10% had been actively discouraged from doing so

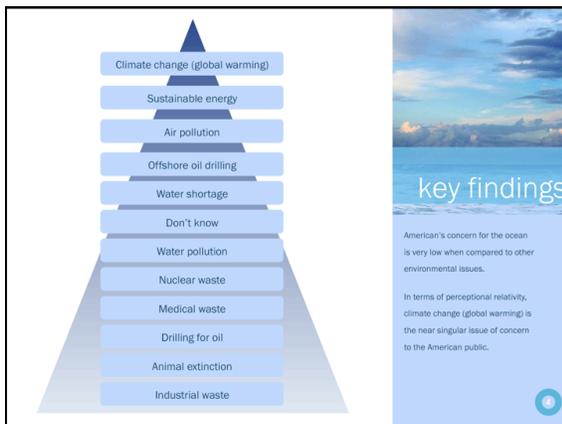



Dr. Sarah Wise
CIRES Visiting Fellow







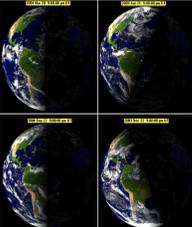
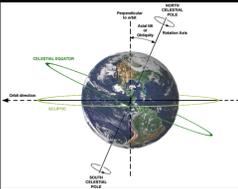


Get complete survey results and continuously updated information from ongoing analysis and tracking surveys at:

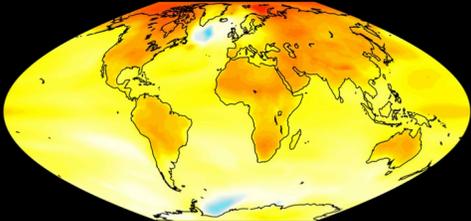
www.TheOceanProject.org

The Ocean Project provides our Partners with cutting edge market and conservation communications research, effective resources and tools, and other challenging and creative ideas and information for advancing ocean conservation education and action with your visitors and the public.

The Ocean Project

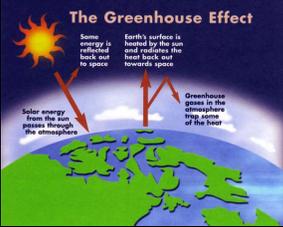
<u>Naïve & Misconceptions</u>	<u>Science Concept</u>
In summer we're closer to the sun	Axial tilt is reason for the seasons
	
	Schneps, 1985

<u>Naïve & Misconceptions</u>	<u>Science Concept</u>
Air is invisible and weightless	Air has density and momentum
	
	AAAS, 2007

<u>Naïve & Misconceptions</u>	<u>Science Concept</u>
Climate is averaged weather	Weather & Climate are different processes and studied differently
	

Naïve & Misconceptions

How could a few trace gases warm the entire planet?



The Greenhouse Effect

Some solar energy from the sun passes through the atmosphere. Earth's surface is heated by the sun and radiates heat back out towards space. Greenhouse gases in the atmosphere trap some of the heat.

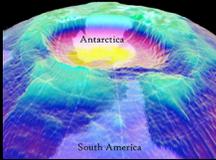
Science Concept

+99% of gas concentrations in atmosphere don't capture heat

Oh, and by the way, it's not really like a greenhouse

Naïve & Misconceptions

Global warming caused by ozone hole



Antarctica

South America

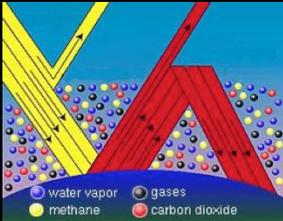


Science Concept

Global warming caused by human activities, especially burning fossil fuels

Naïve & Misconceptions

Solar radiation bounces/reflects off Earth

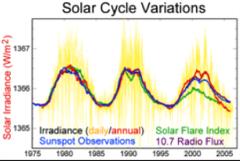
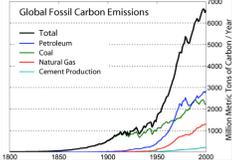


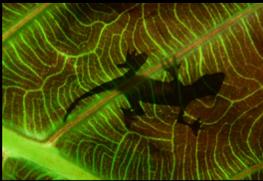
water vapor
methane
gases
carbon dioxide

Gautier, 2006

Science Concept

Incoming UV and visible are transformed into outgoing IR heat

<p><u>Naïve & Misconceptions</u></p> <p>Global warming is just natural cycles</p>	<p><u>Science Concept</u></p> <p>Human activities warm the planet</p>
	

<p><u>Naïve & Misconceptions</u></p> <p>Plants get their mass from water and nutrients through their roots</p>	<p><u>Science Concept</u></p> <p>Plants get mass from “thin air” and experience seasonal cycles</p>
	

<p><u>Naïve & Misconceptions</u></p> <p>Energy is stuff from the ground (that we're running out of)</p>	<p><u>Science Concept</u></p> <p>Fossil fuels = concentrated buried solar energy</p>
	
<p><small>Rule, 2005</small></p>	

Naïve & Misconceptions **Science Concept**

Carbon is destroyed when burned

Energy is converted into work/heat; matter is rearranged but not destroyed

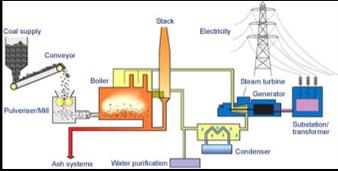


Madsen, 2007

Naïve & Misconceptions **Science Concept**

Cars run on gas. Electricity comes from a power plant.

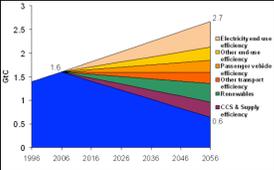
Energy for transportation and electricity is generated by burning fuel to make heat.



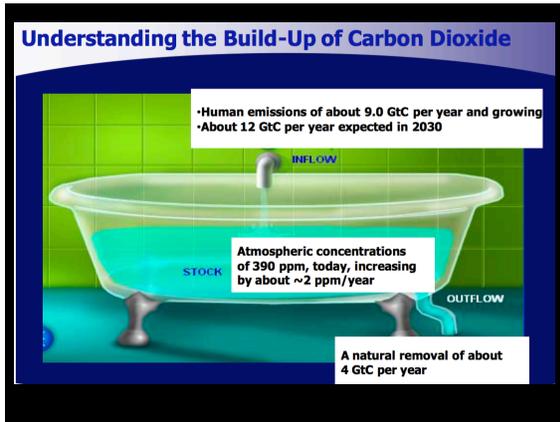
Naïve & Misconceptions **Science Concept**

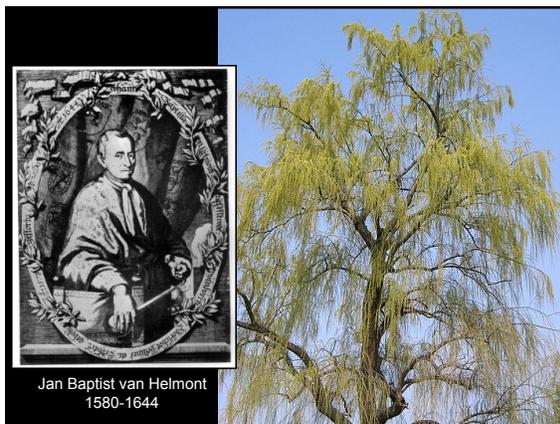
We'll be able to soon reverse global warming

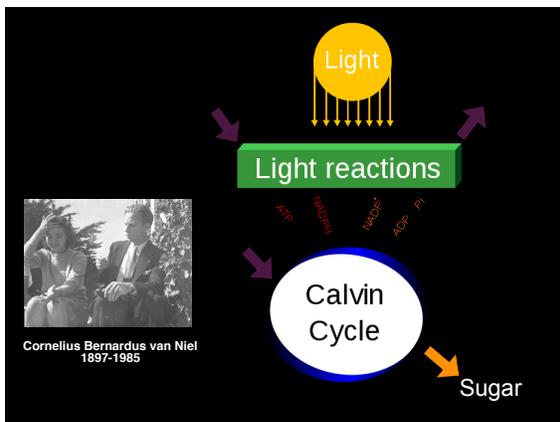
The accumulation of GHG in the atmosphere is difficult to slow, let alone reverse

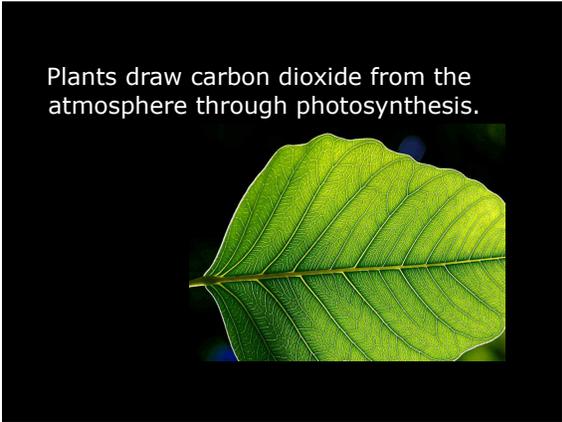



Sterman & Sweeney, 2007





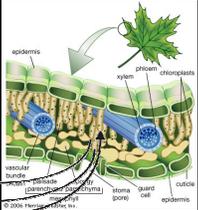




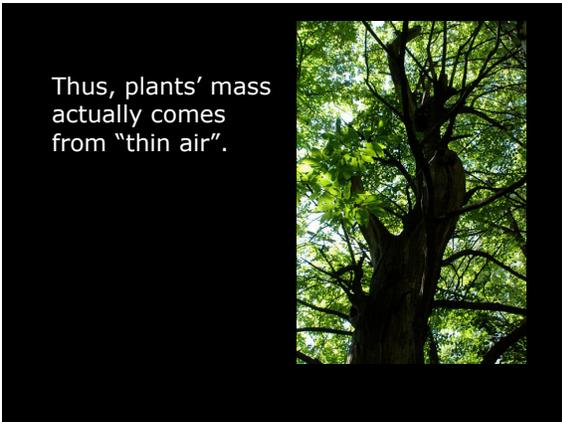


Carbon Dioxide
 CO_2
 $\text{O}=\text{C}=\text{O}$
Carbonic Acid

Photosynthesis



O_2
 H_2O
 CO_2



Sunlight + water + carbon dioxide =
carbohydrates (sugars) + O₂ + water



Over millions of years, the
carbohydrates are transformed into
“hydrocarbons” or fossil fuels like coal.





One gallon of gasoline = 98 tons of biomass
(buried solar energy)





