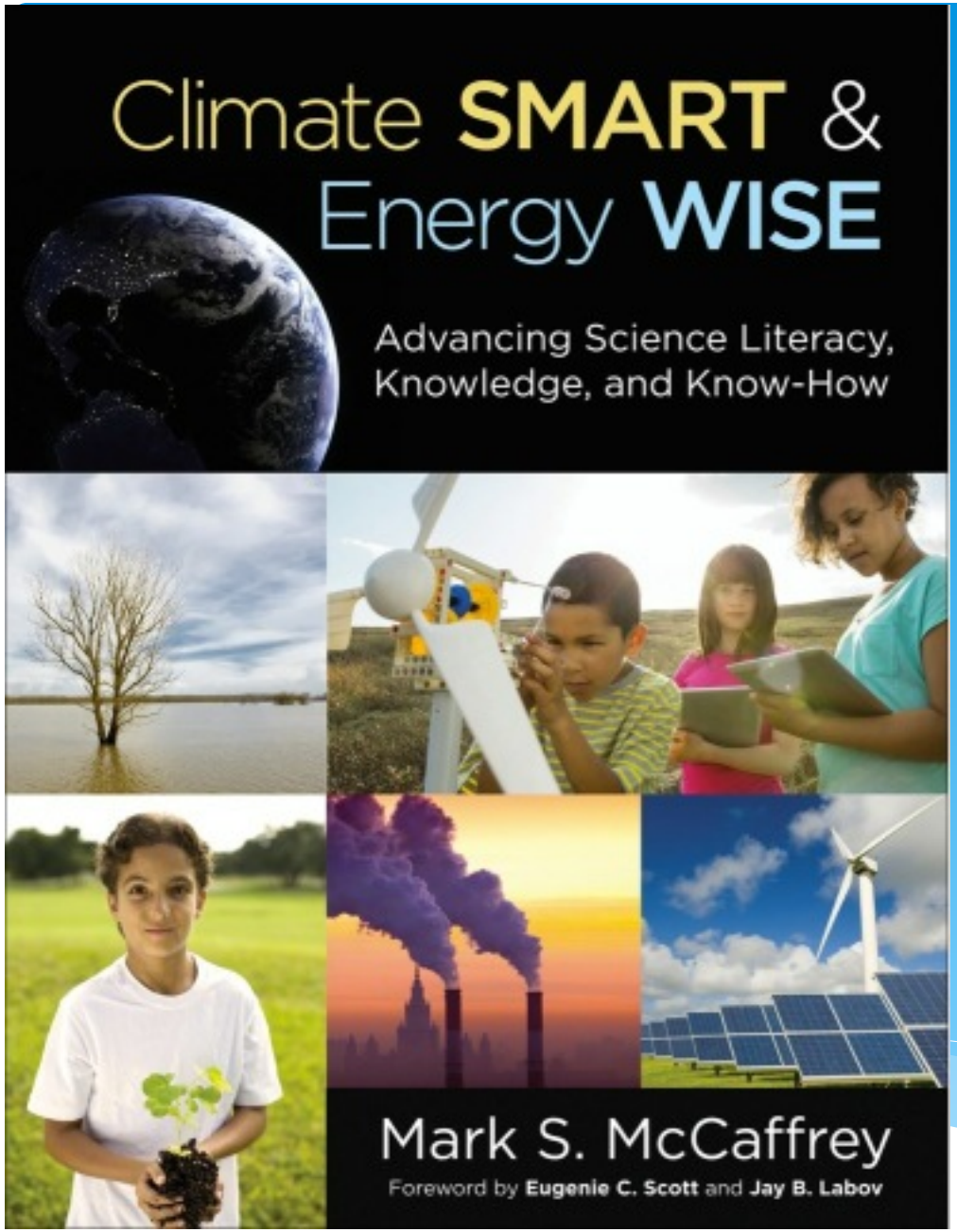
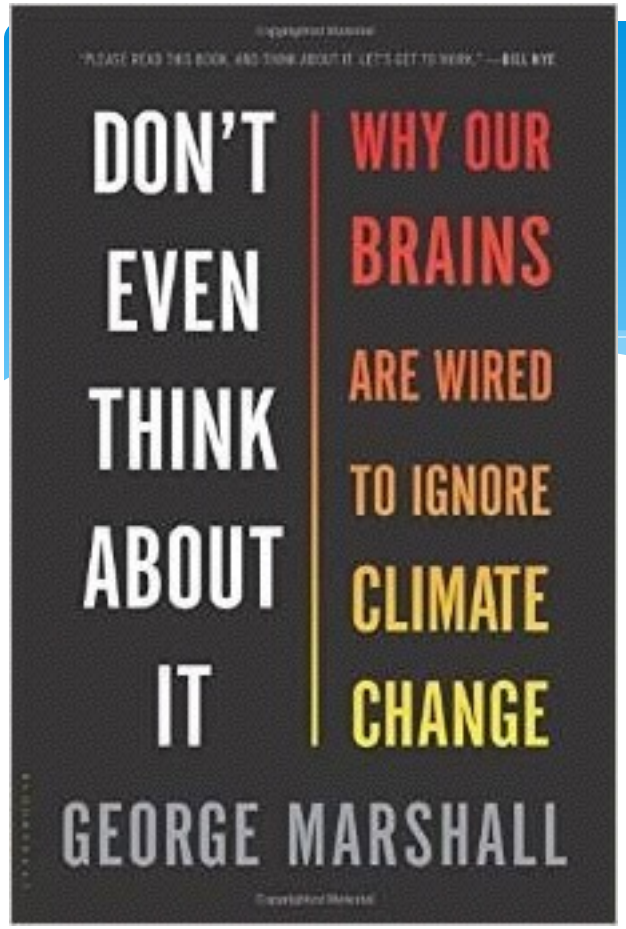


Mark McCaffrey

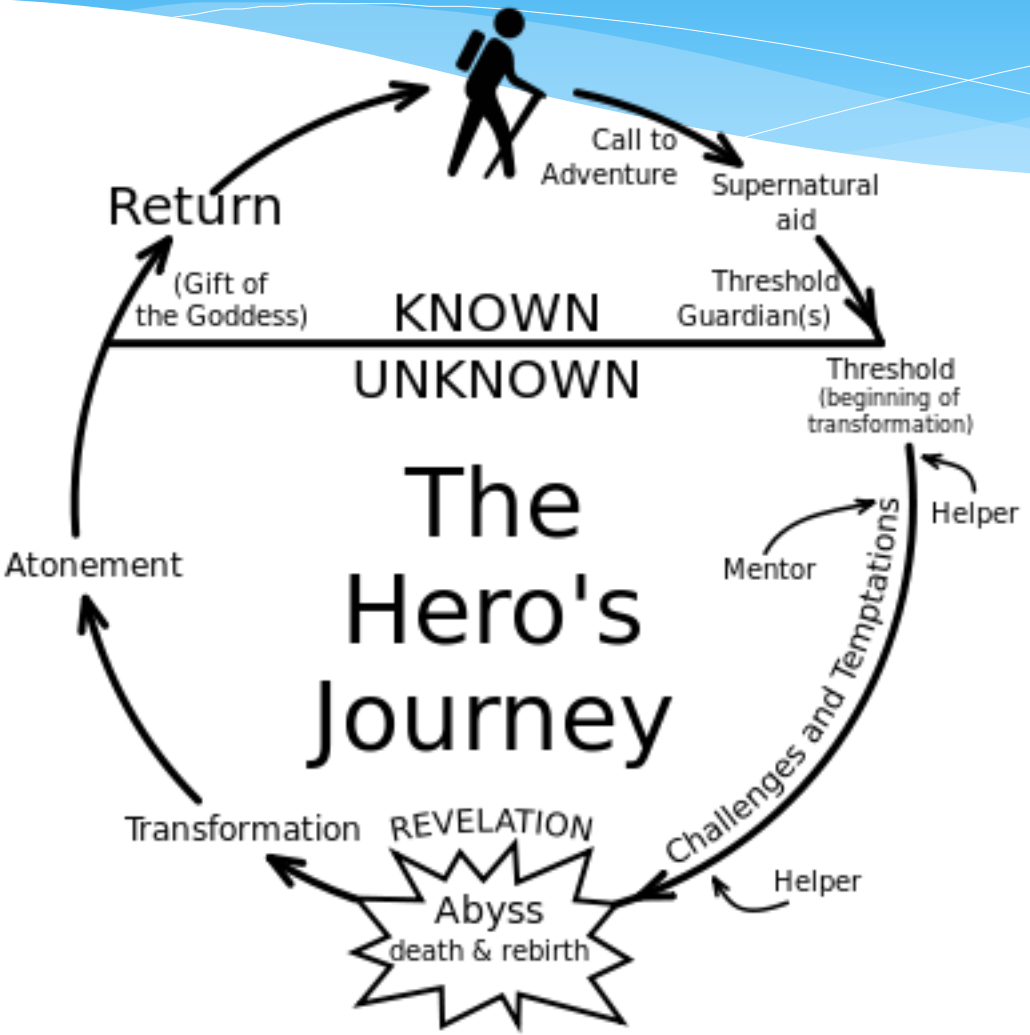
National Center for Science Education
NCSE

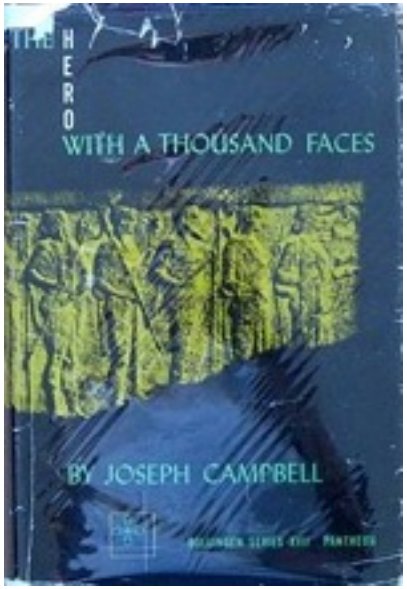


climate one
come together at the commonwealth club

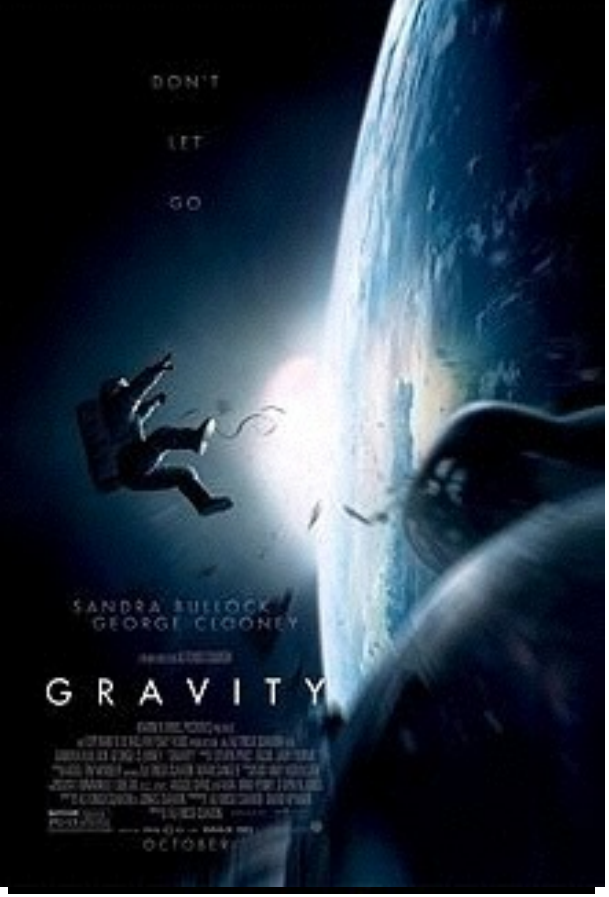
George Marshall

Hero/Heroine's Journey



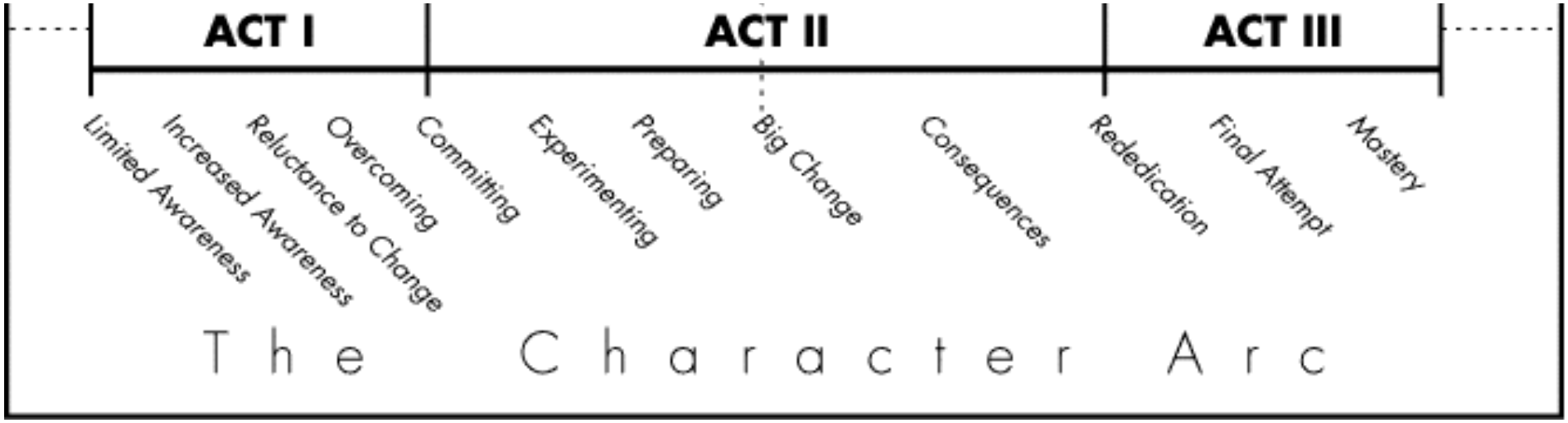


Hero/Heroine's Journey


DON'T
LET
GO
SANDRA BULLOCK
GEORGE CLOONEY
GRAVITY
OCTOBER


LIVE. DIE. REPEAT.
TOM CRUISE EMILY BLUNT
EDGE OF TOMORROW
JUNE 06


BILL MURRAY ANDIE MacDOWELL
GROUNDHOG DAY
SPECIAL 15TH ANNIVERSARY EDITION


ACT I
ACT II
ACT III
Limited Awareness
Increased Awareness
Reluctance to Change
Overcoming
Committing
Experimenting
Preparing
Big Change
Consequences
Rededication
Final Attempt
Mastery
The Character Arc


May
2008
Block Area
Monday
lunes
martes
miércoles
27

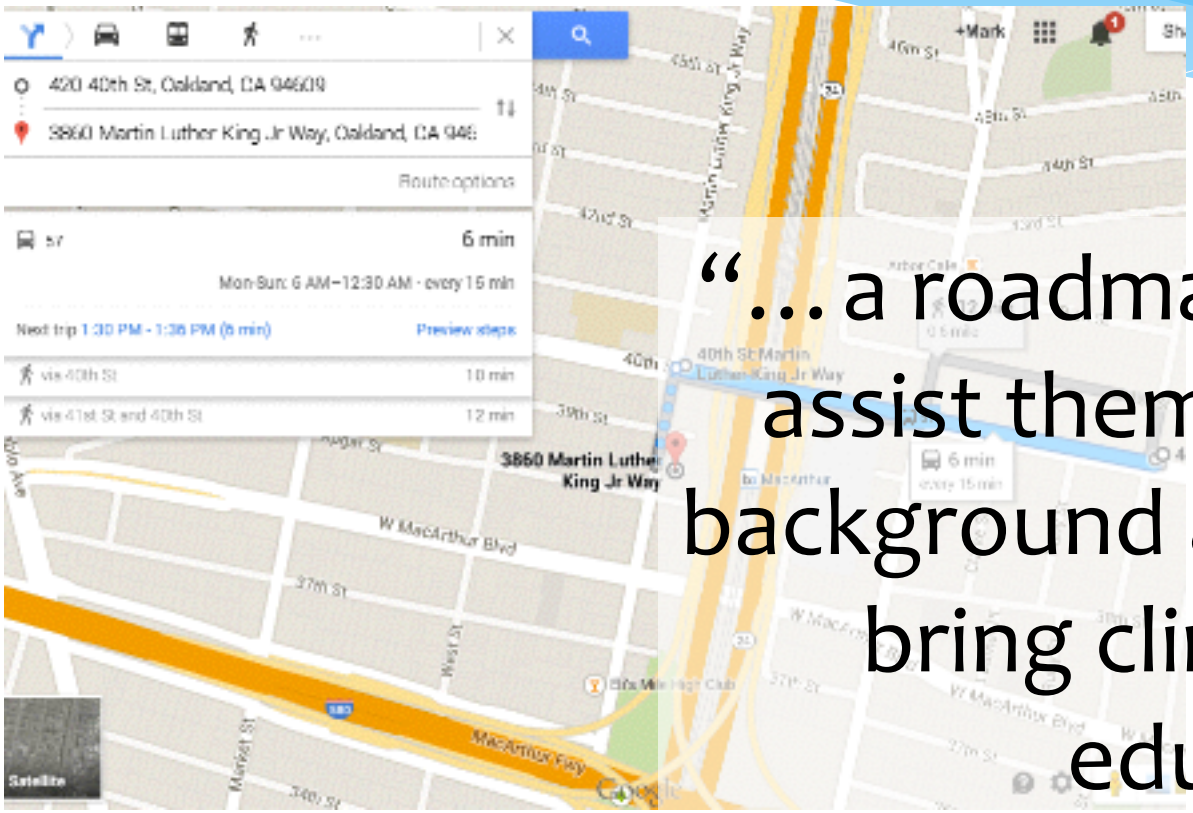

ROHAN
FANGORN
East Emnet
West Emnet
WESTFOLD
Helm's Deep
EMYN MUIL
Falls of Rauros
Sarn Gebir
Dagorlad (Battle Plain)
Dead Marshes
Morannon
Snowbourn
Edoras
EASTFOLD
Nindalf (Wetwang)
CAIR ANDROS
Udûn
Isenmouthe
Barad-dûr
Orodruin
NIMRAIS
Erech
Anórien
Minas Tirith
MINAS MORGUL
Plateau of Gorgoroth
G
O
N
D
Osgiliath
Emyn Arnen
Langstrand
Edhellond
Gilrain
NURN
M


TYPVS ORBIS TERRARVM


Treasure Island
Skeleton Island

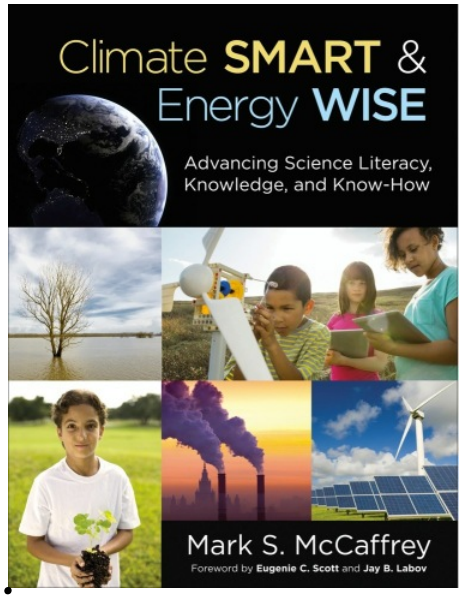
Foreword

by Eugenie C. Scott, and Jay B. Labov

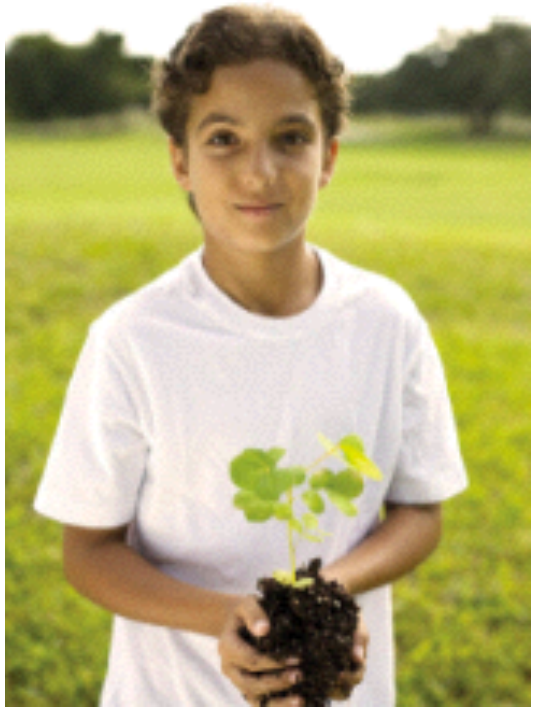


"…a roadmap to teachers to assist them in acquiring the background and resources to bring climate and energy education into their classrooms . . ."

Table of Contents



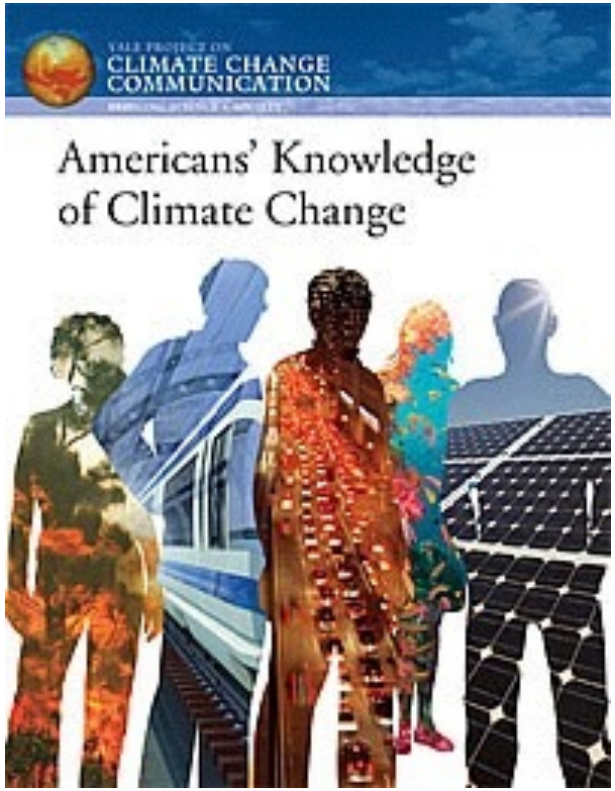
Introduction



"The seeds for a new American revolution in learning….have already been planted.

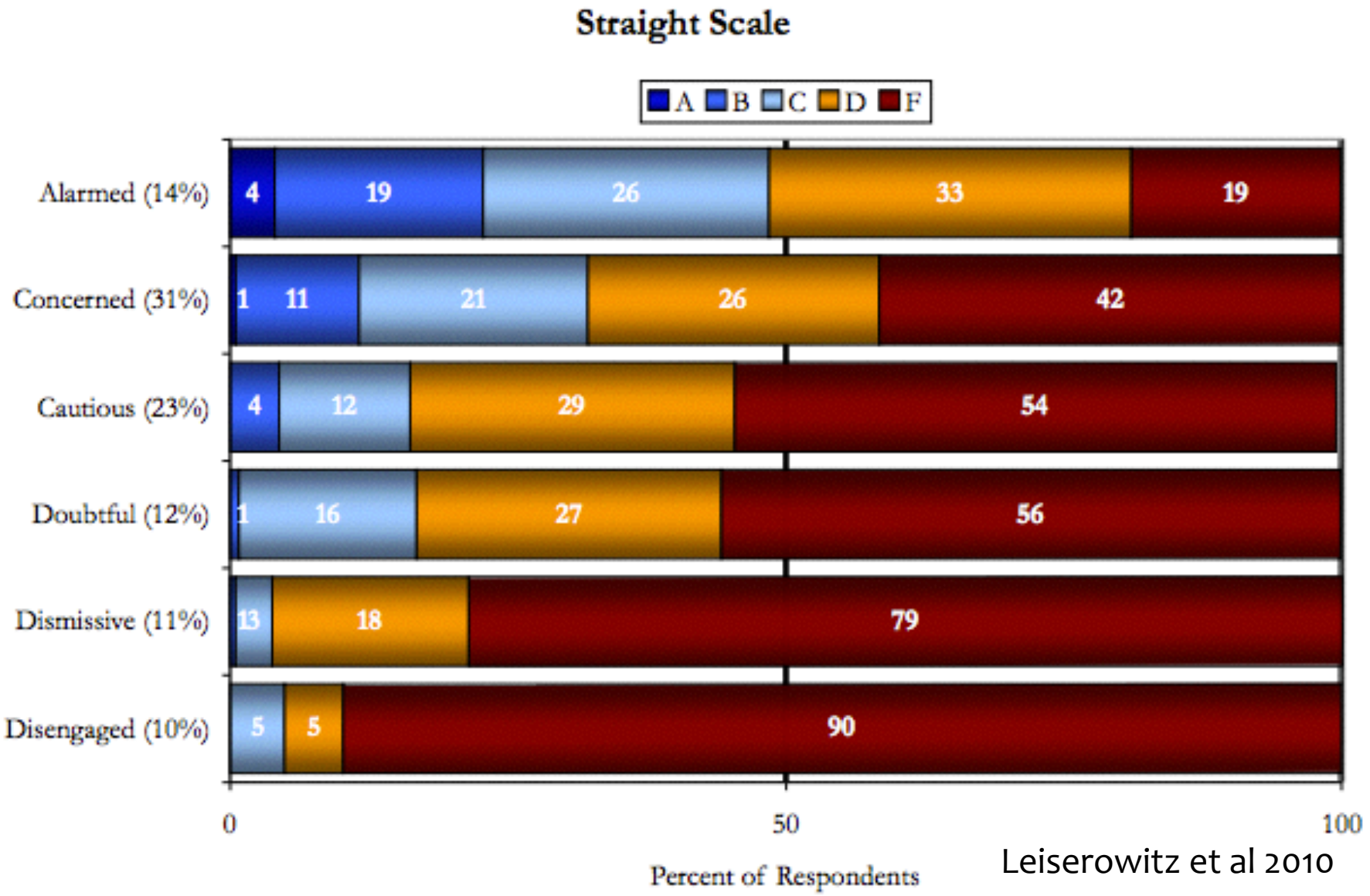
Indeed, they are already starting to sprout and take root."

Most Americans Fail Basic Climate and Energy Literacy



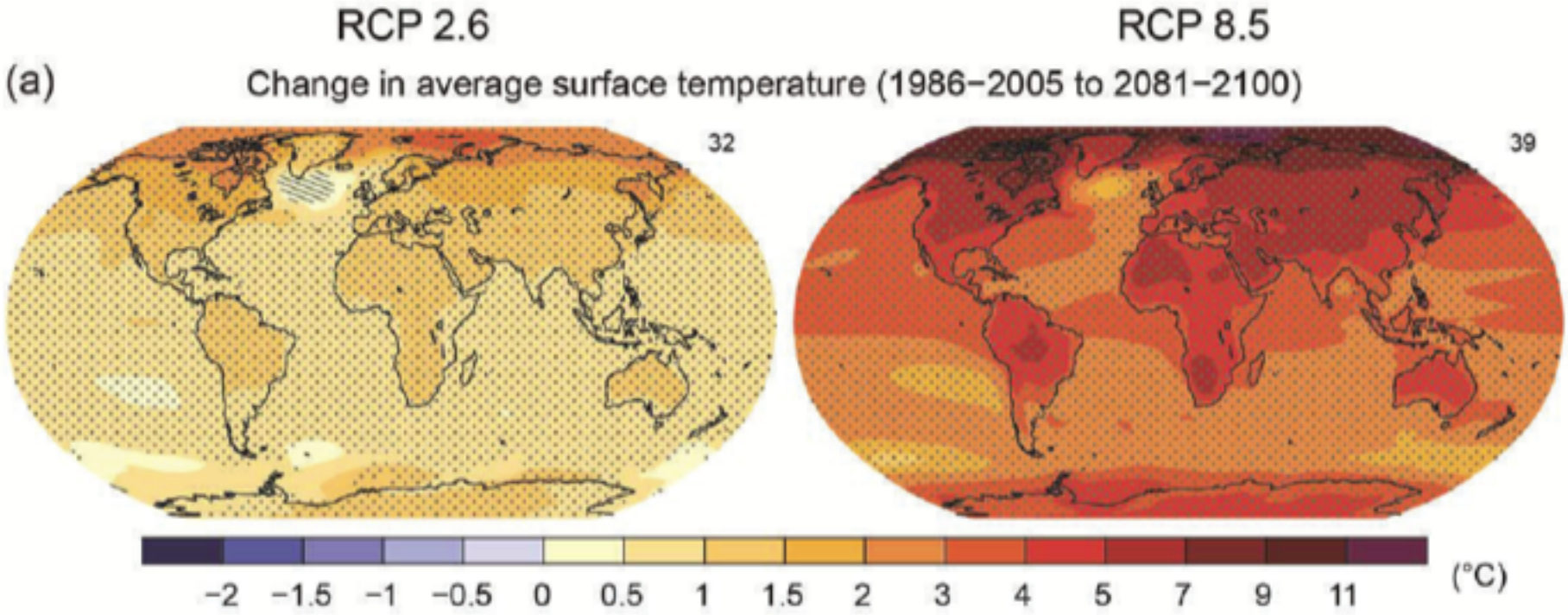
- <20% say they are "very well informed" about climate and energy
- Few teens have ever taken a formal course on the topic
- Results "likely reflect the unorganized and sometimes contradictory fragments of information… teens have absorbed…"

Those more alarmed know more



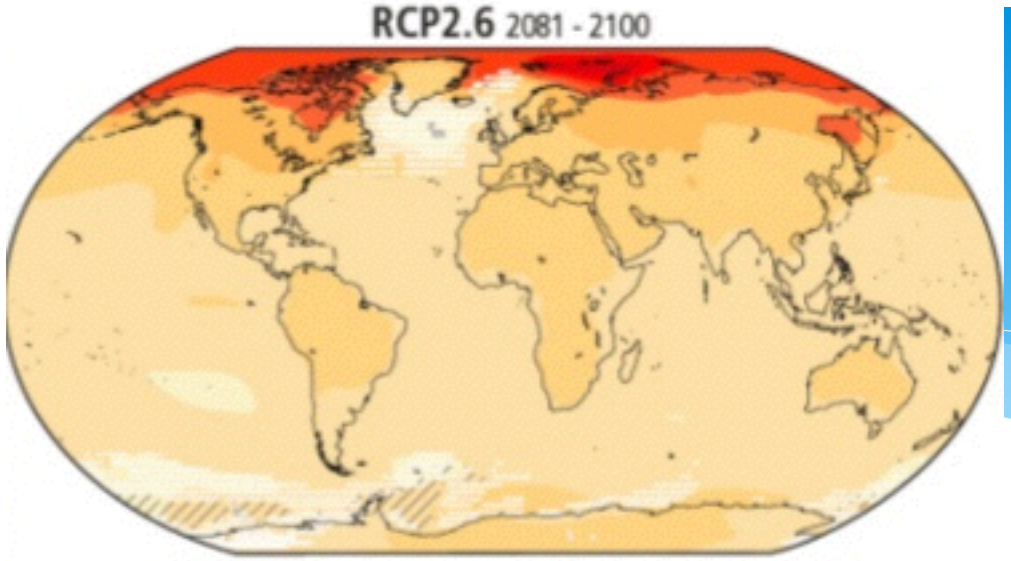
Leiserowitz et al 2010

1) Climate & Energy 101

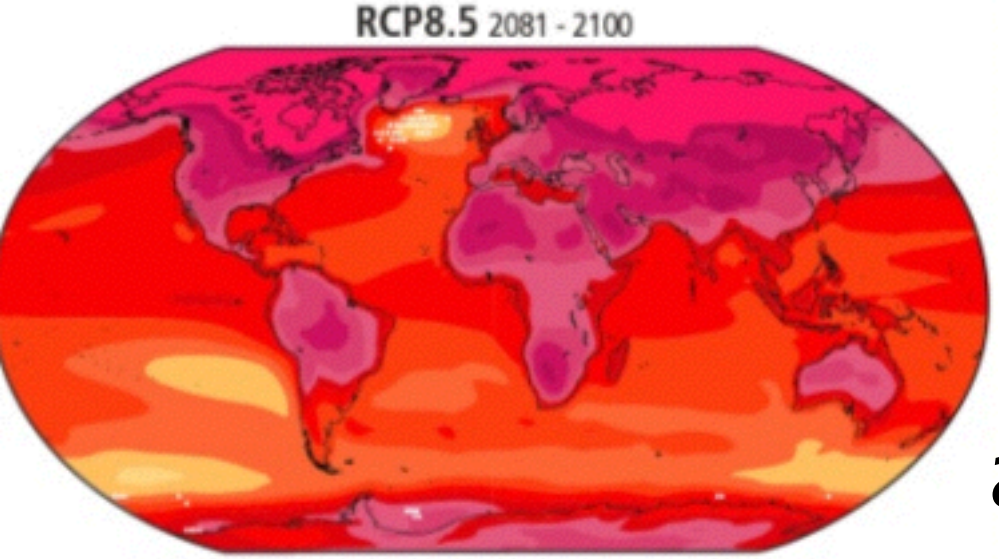


Luke Warm or Red Hot?

Source: IPCC 5AR Summary for Policymakers;
http://www.climatechange2013.org/images/uploads/WGIAR5-SPM_Approved27Sep2013.pdf

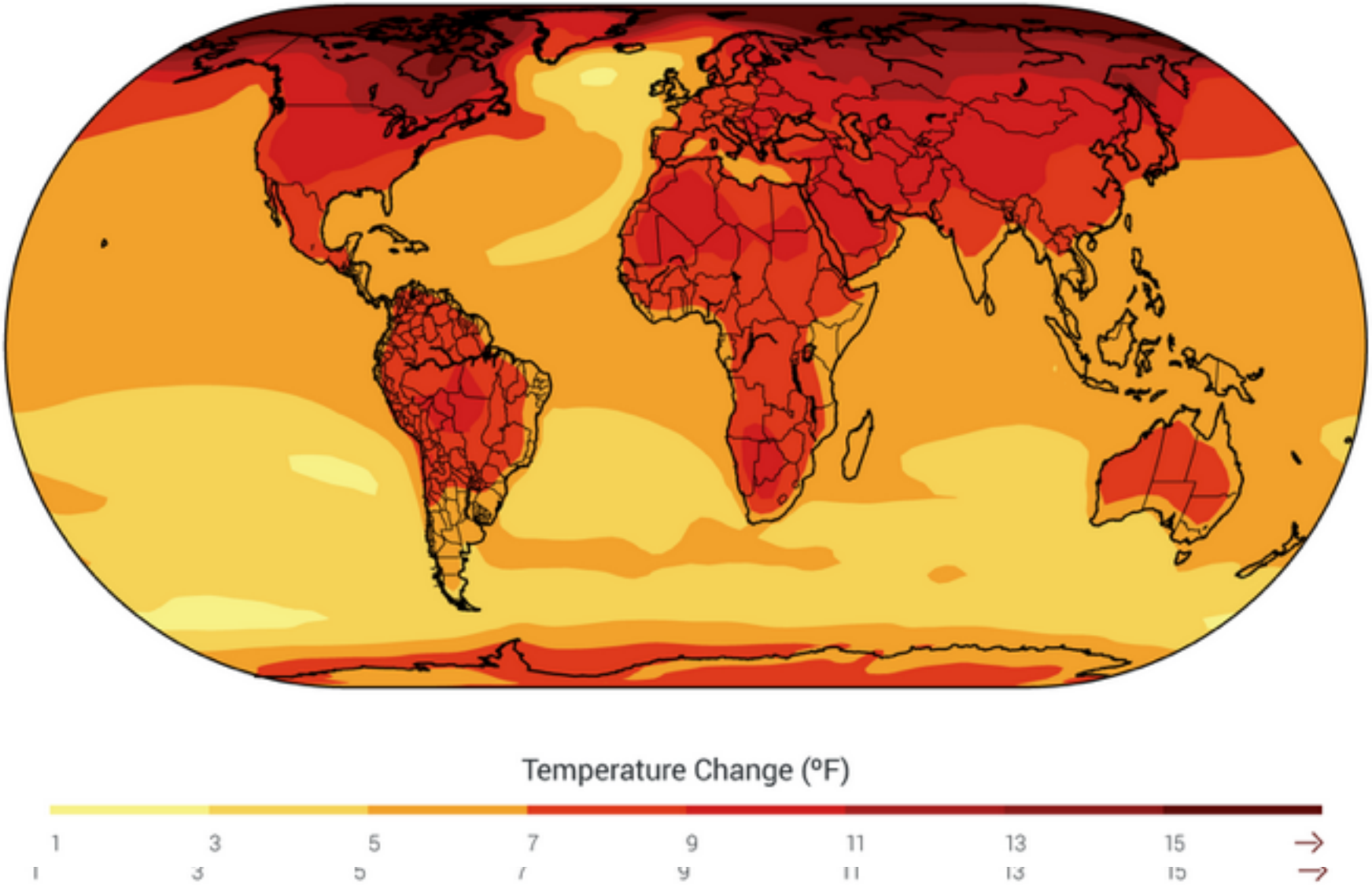


Overview of current climate science.

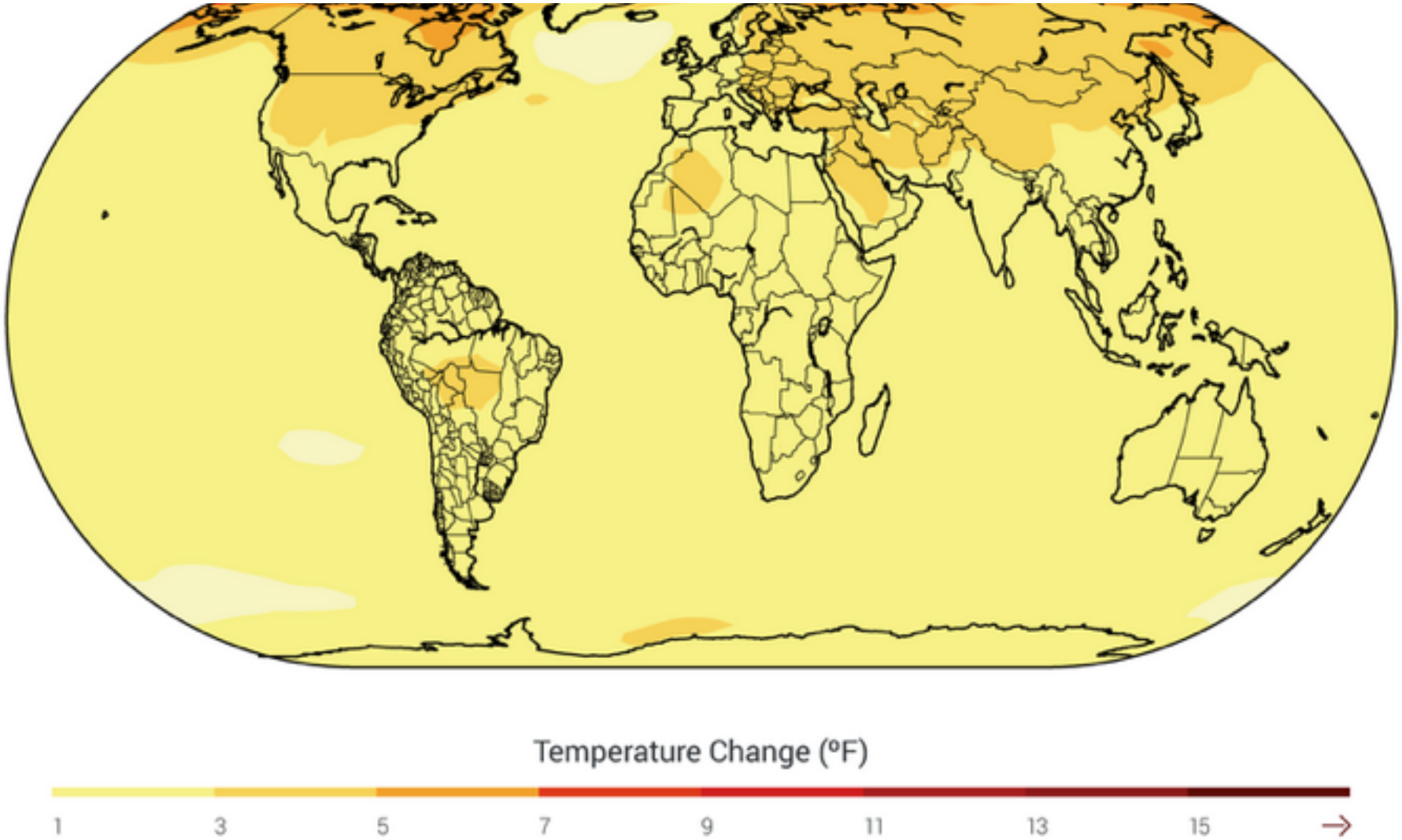


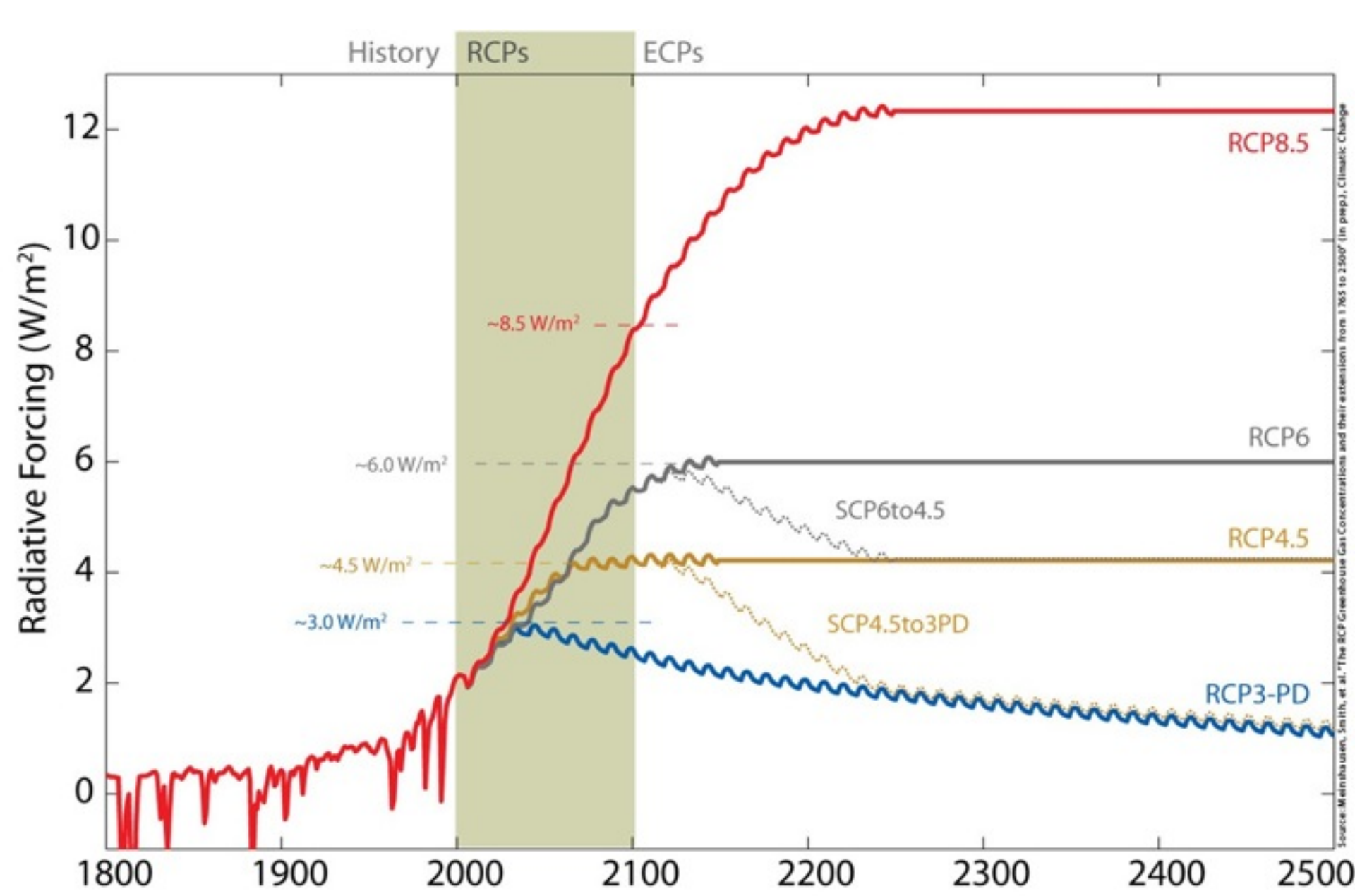
The difference between 8.5 mw^2 and 2.6 mw^2 = total transformation

Continued Emissions Increase (RCP 8.5)



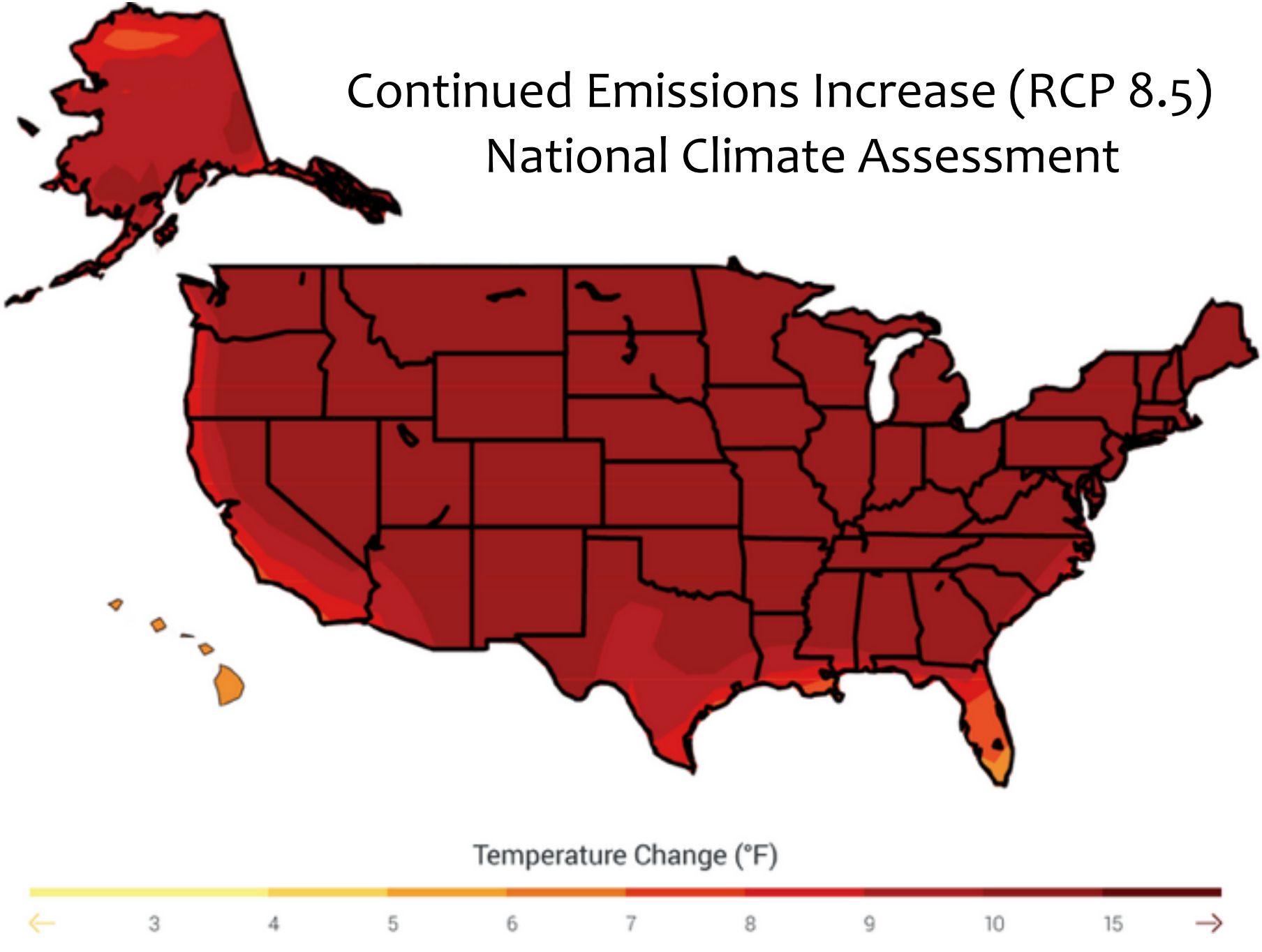
Rapid Emissions Reduction (RCP 2.6)



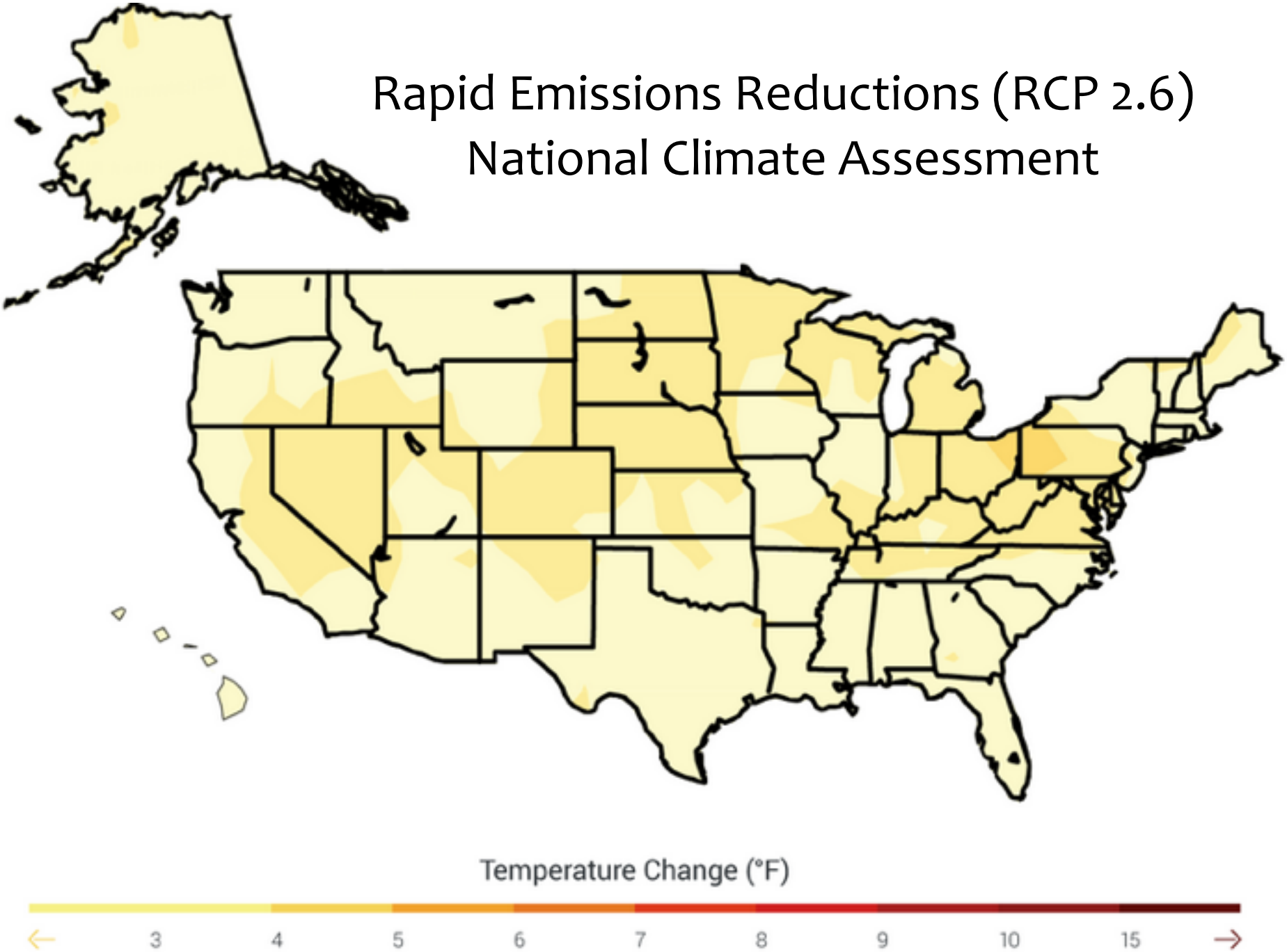


More to the story beyond 2100

Continued Emissions Increase (RCP 8.5)
National Climate Assessment



Rapid Emissions Reductions (RCP 2.6)
National Climate Assessment



2) Teaching (And Learning) About Climate Challenges and Energy Solutions

Highlight the "Guiding Principle of Teaching and Learning"

Guiding Principle for Teaching and Learning

1. People are born investigators and learners.
2. Effective learning focuses on a core set of ideas and practices.
3. Understanding develops over time.
4. Literacy requires both knowledge and practice.
5. Connection to interests and experiences enhances learning.
6. Educational opportunities must be equitable and accessible to all.

Guiding Principle for Teaching and Learning

- Make it local
- Make it human
- Make it pervasive
- Make it hopeful

3) Syncing with the Standards: Tools and Calibration

Where do climate and energy fit into new standards?

Almost Everywhere!

What do ISO 14000 and 4-ESS3-1 have in common?

Both are standards.

What do ISO 14000 and 4-ESS3-1 have in common?

ISO 140000

"help organizations (a) minimize how their operations (processes etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land); (b) comply with applicable laws, regulations, and other environmentally oriented requirements, and (c) continually improve in the above."

What do ISO 14000 and 4-ESS3-1 have in common?

4-ESS3-1

"Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment."

Common Core Math & Language Arts Standards

Common Core Math Principle 1

- **Make sense of problems and persevere in solving them.**
- "… analyze givens, constraints, relationships, and goals."

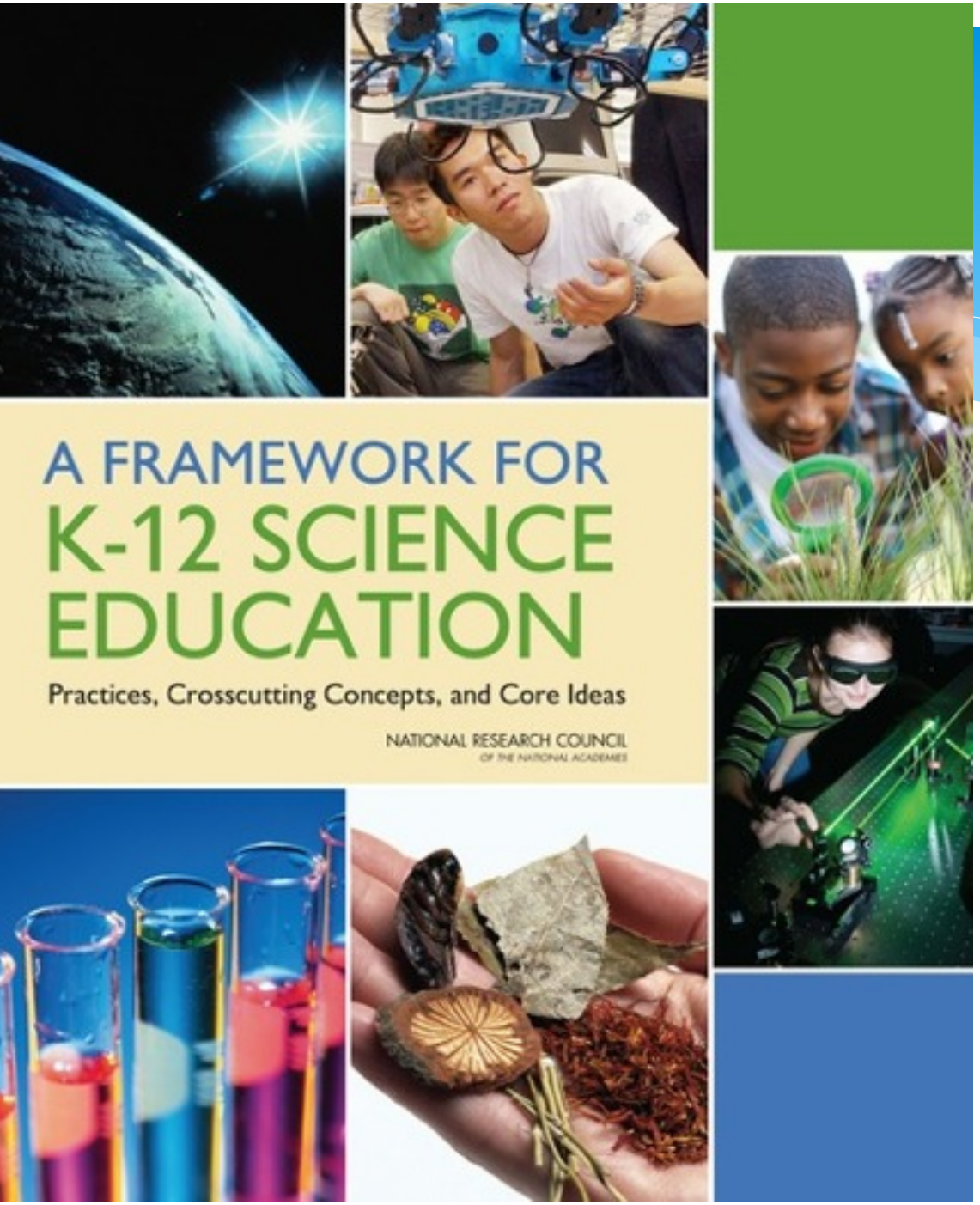
Common Core Math Principle 7

- **Look for and make use of structure.**
- "… discern a pattern or structure. "



Common Core Math Principle 8

- **Look for and express regularity in repeated reasoning.**
- "…notice if calculations are repeated, and look both for general methods and for shortcuts."



NEXT GENERATION SCIENCE STANDARDS

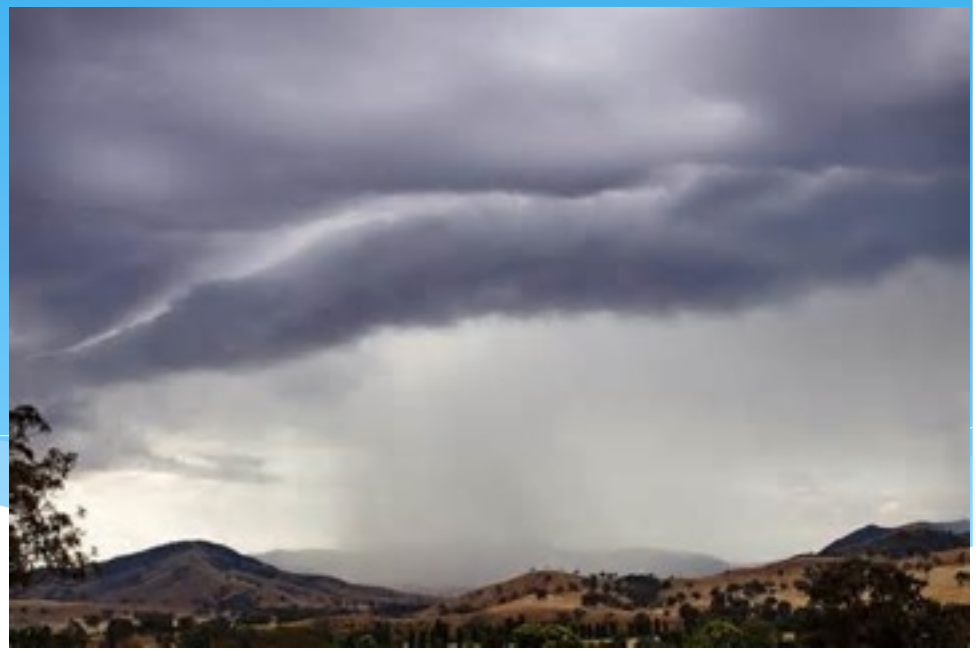
- Based on National Research Council report (2011)
- Science, engineering, and technology practices
- Disciplinary Core Ideas
- Crosscutting Concepts
- For ALL Students

K-PS3 Energy

Observe the effects of sunlight on Earth's surface in relative terms (warmer/cooler) using different

K-ESS2 Earth's System

Observe local weather conditions over time and describe patterns; different times of day, different times of year.



Observe patterns of sun, moon and stars to describe patterns; observe amount of daylight at different times of year.

Determine if plants need sunlight and water to grow; examine reproduction and pollination of plants.

K-2 ETS1 Engineering Design

Identify a problem that can be solved by developing a new or improved tool or objects.

3-ESS2 Earth's Systems

Describe typical weather conditions expected in a particular season; describe climate in different regions of the world.

3-ESS3 Earth and Human Activity

"Make a claim about the merit of a design solution that reduces the impacts of weather-related hazard."

4-PS3 Energy

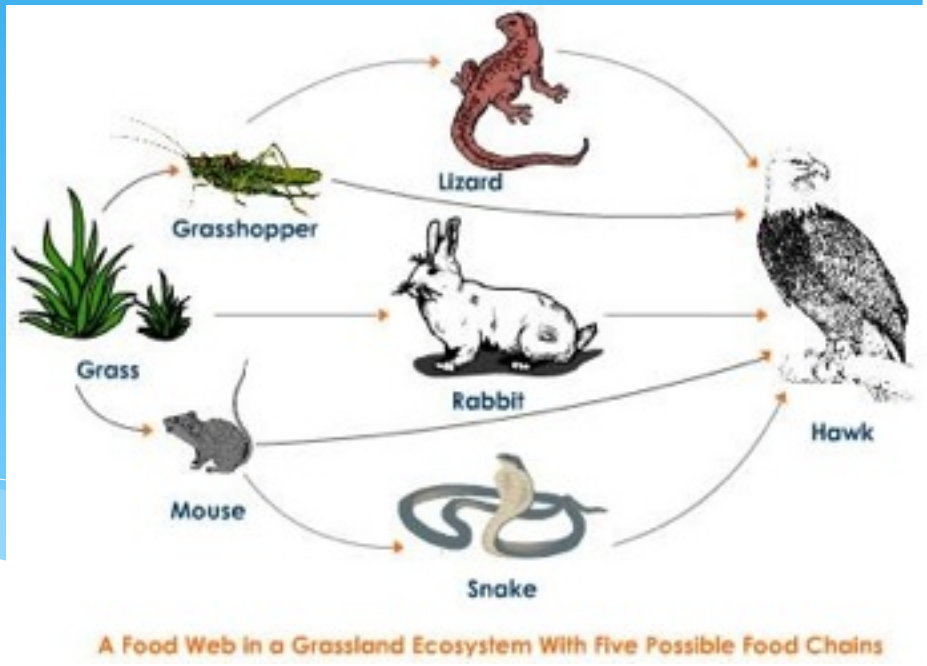
Provide evidence that energy can be transferred from place to place; *"Apply scientific ideas to design, test, and refine a device that converts energy from one form to another."*

4-ESS3 Earth and Human Activity

"Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment"

5-PS3 Energy

"Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun"



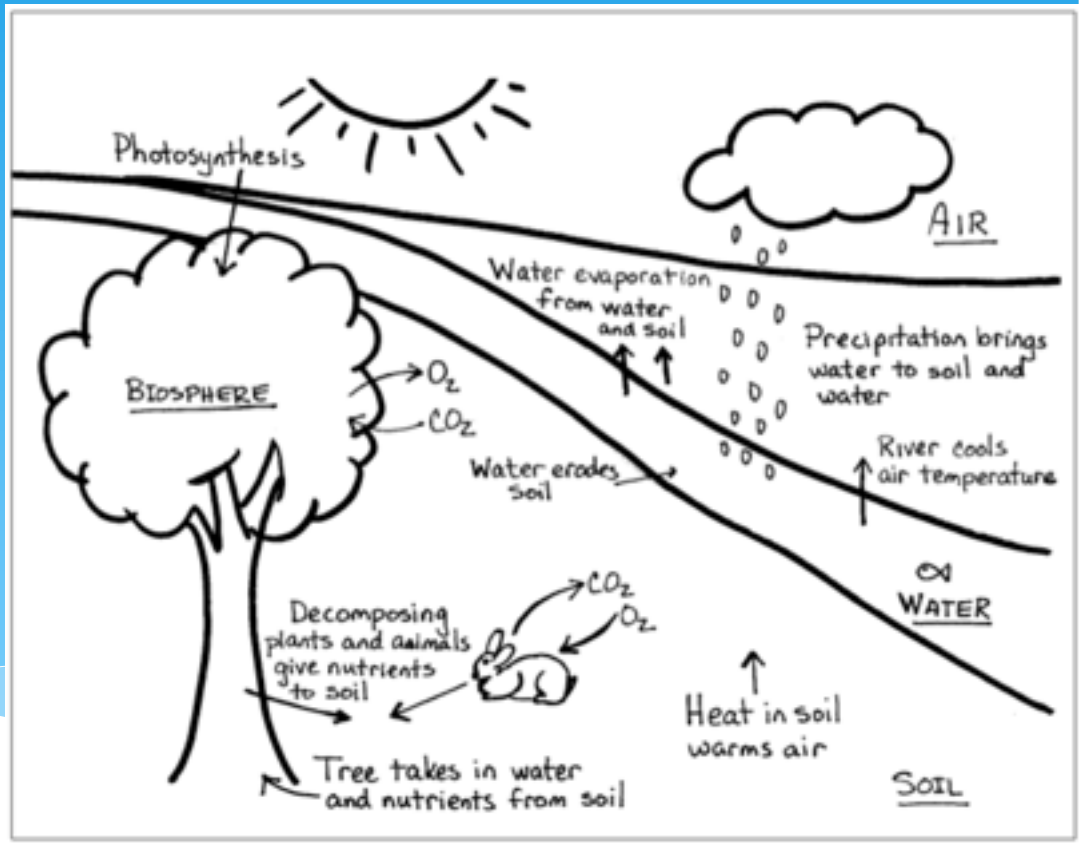
A Food Web in a Grassland Ecosystem With Five Possible Food Chains

5-LS1 From Molecules to Organisms: Structures and Processes

"Support an argument that plants get the materials they need for growth chiefly from air and water."

5-ESS2 Earth's Systems

Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere and/or atmosphere interact.



5-ESS3 Earth and Human Activity

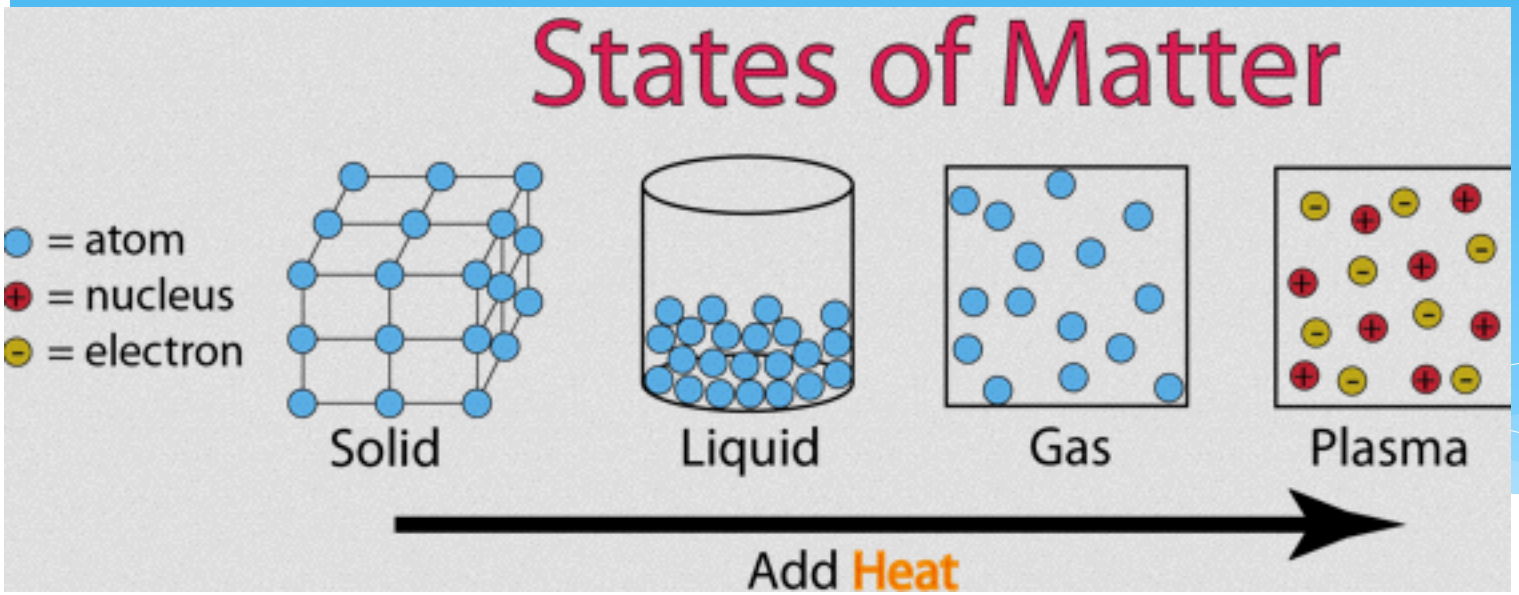
"Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment."

3-5-ETS1 Engineering Design

"Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost."

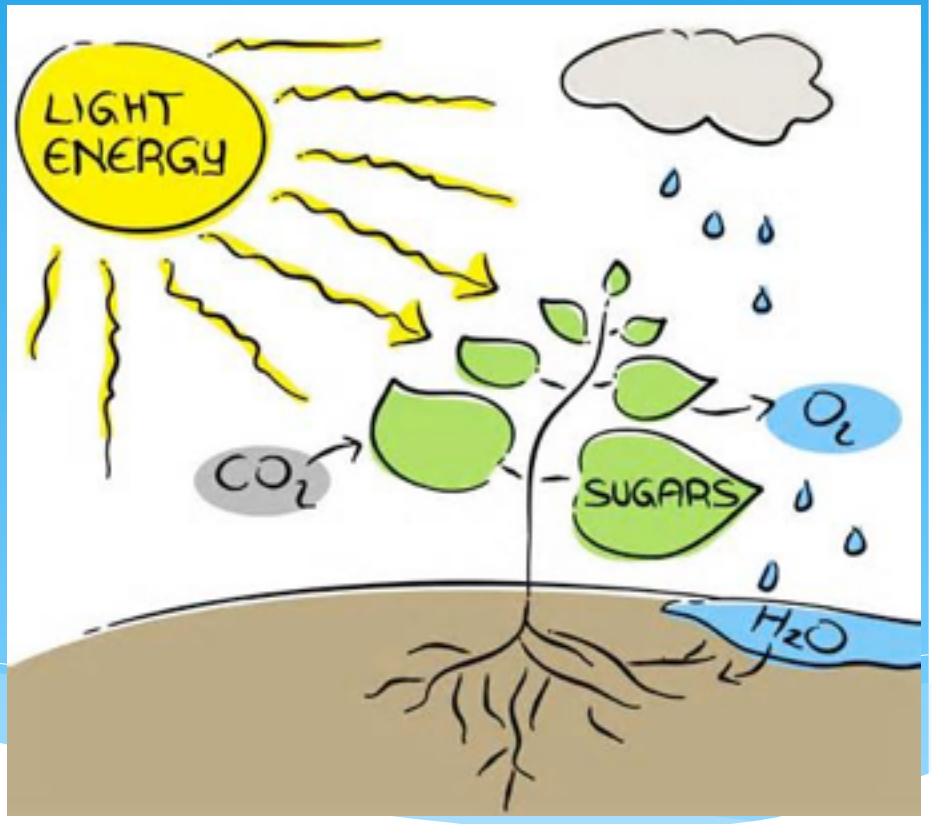
MS-PS3 Energy

Relationship between temperature, kinetic energy; and types of matter, mass and transfer of energy through motion.



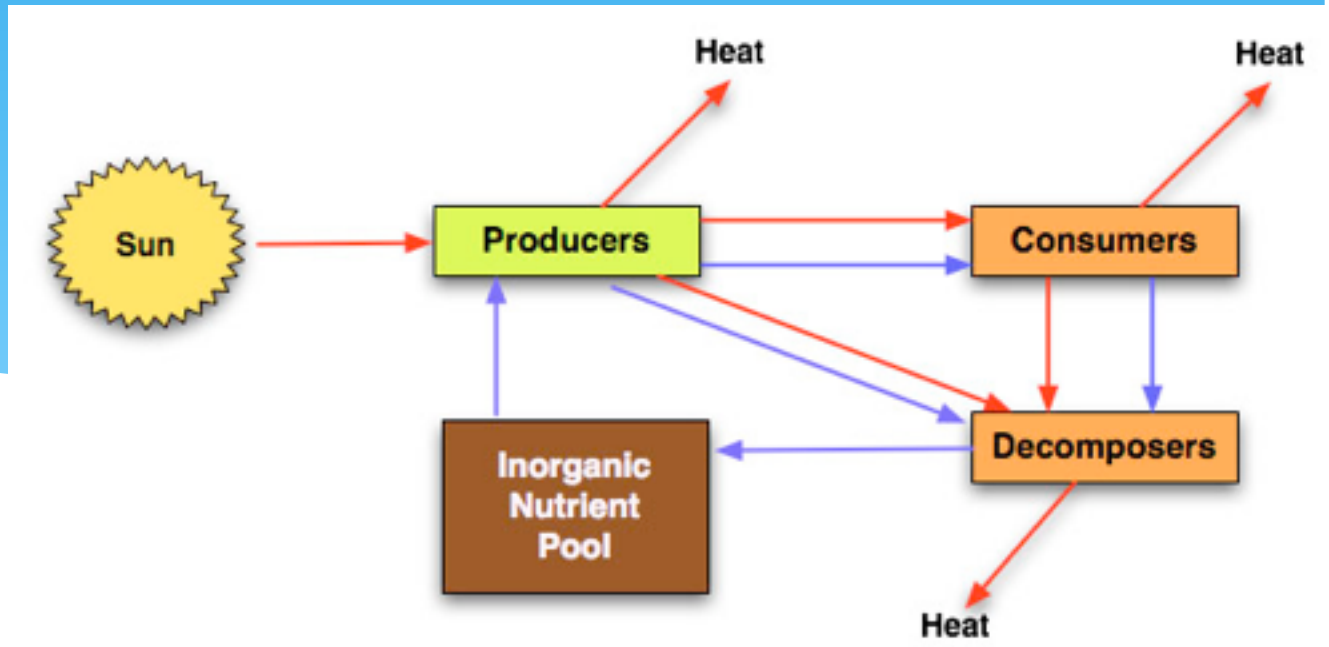
MS-LS1 From Molecules to Organisms: Structures and Processes

Focus on the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms



MS-LD2 Ecosystems, Interactions, Energy, and Dynamics

Modeling cycling of matter and flow of energy among living and nonliving parts of an ecosystem



MS-ESS1 Earth's Place in the Universe

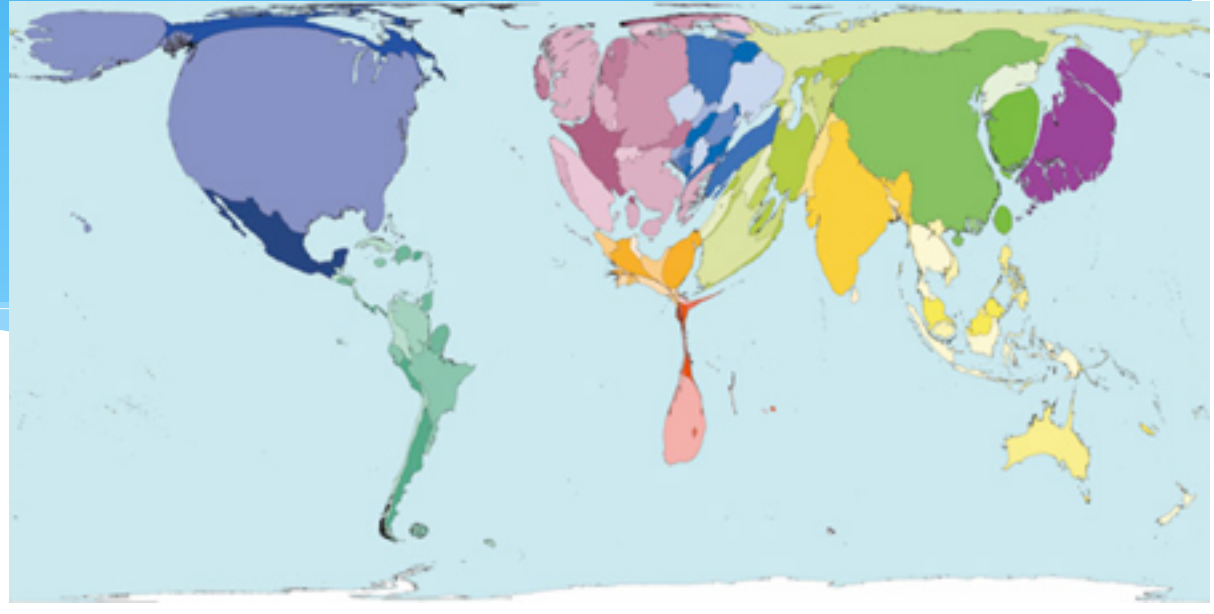
Emphasis on Earth-sun cyclic patterns as reason for the seasons

MS-ESS2 Earth's System

Emphasis on cycling of Earth's materials and flow of energy, including hydrologic cycle

MS-ESS3 Earth and Human Activity

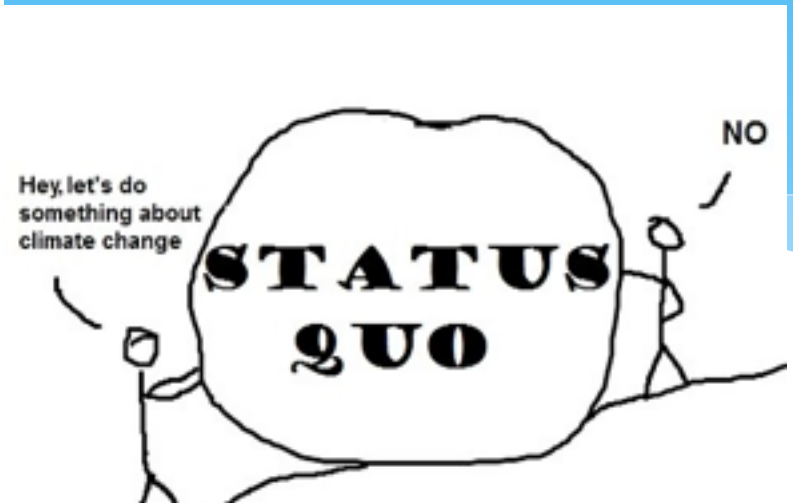
Human impacts on the environment; asking questions to "clarify evidence of the factors that have caused the rise in global temperatures.."



Relative per capita CO_2 emissions

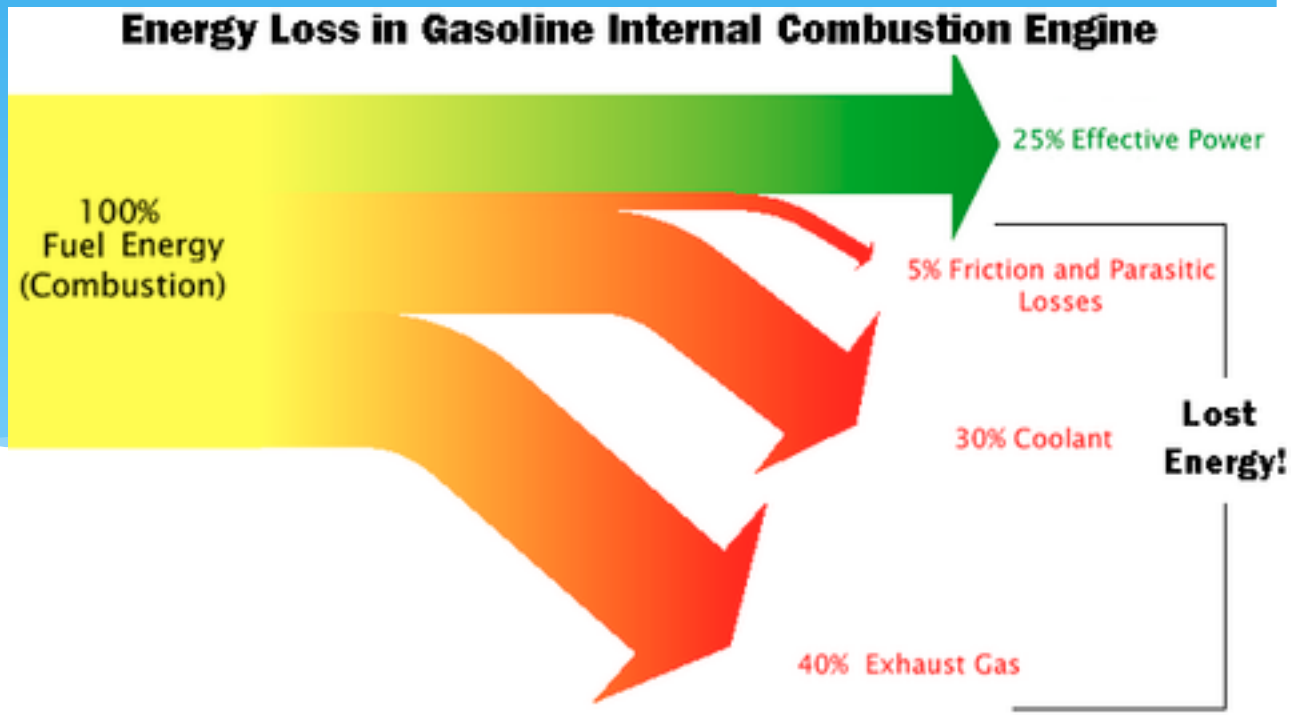
MS-ETS1 Engineering Design

Emphasis on defining design problem to ensure successful solution, "*taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions*"



HS-PS3 Energy

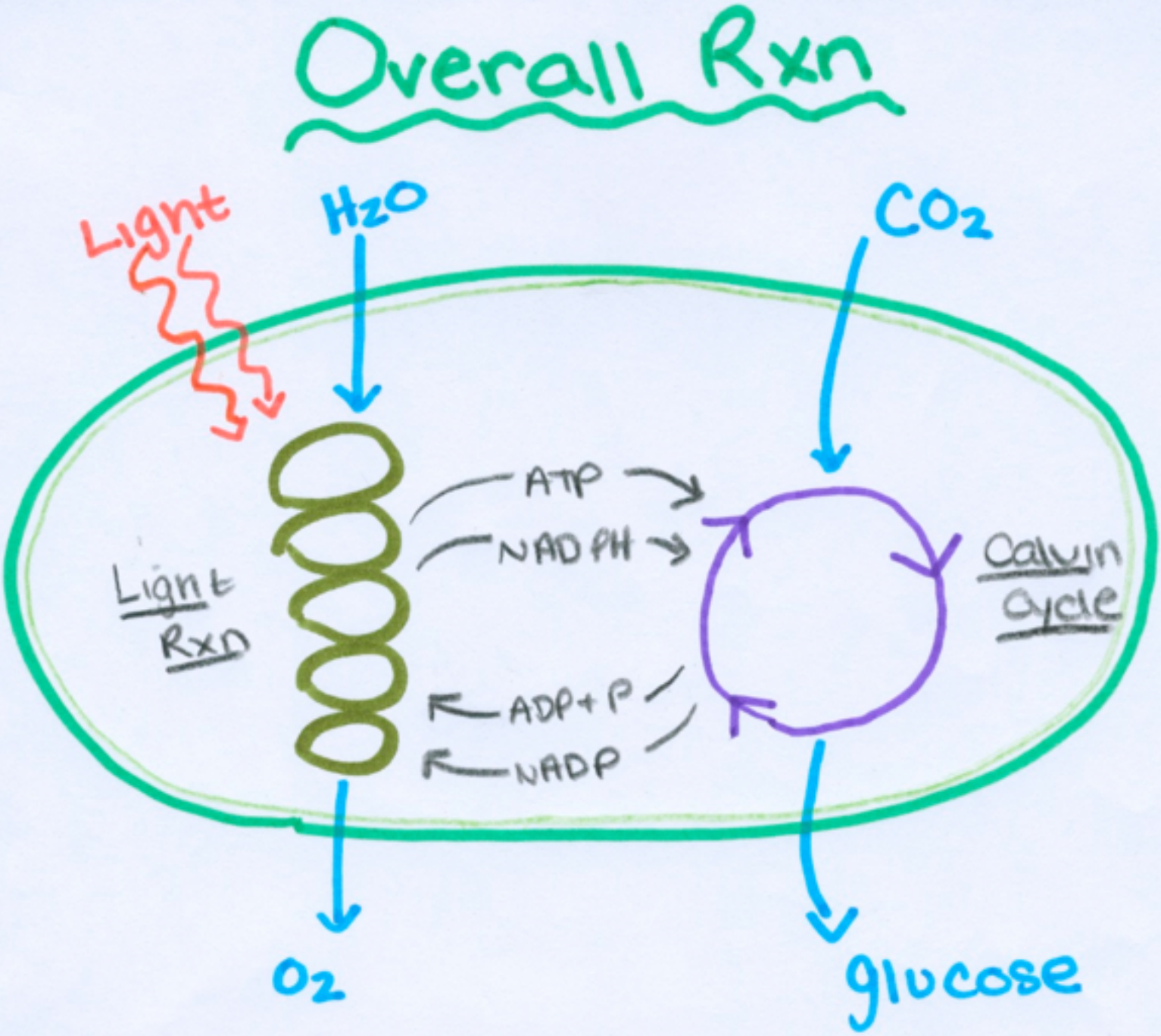
Emphasis on calculating flow and change of energy in a system



HS-LS1 From Molecules to Organisms: Structures and Processes

Photosynthesis transforms light energy into storage of chemical energy; carbon, hydrogen and oxygen form sugar molecules that may combine with other elements

Overall Rxn

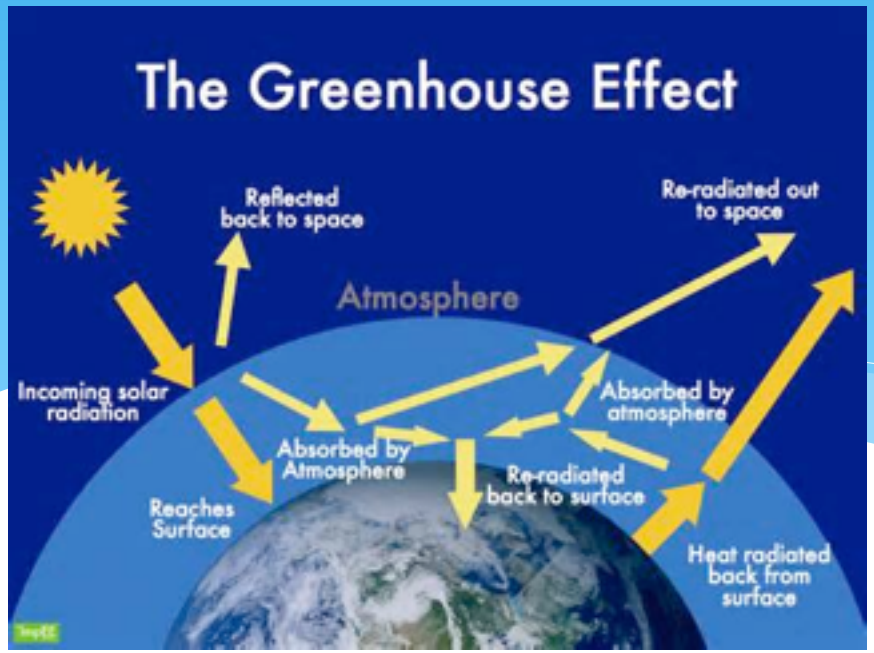

Light
H2O
CO2
ATP
NADPH
Light Rxn
Calvin Cycle
ADP+P
NADP
O2
glucose

HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Design, evaluation and refinement of a solution for reducing human impacts on the environment and biodiversity

HS-ESS2 Earth's System

Analysis of geoscience data on feedbacks that cause changes to other Earth systems; flow of energy into and out of Earth's system resulting in changes of climate



HS-ESS3 Earth and Human Activity

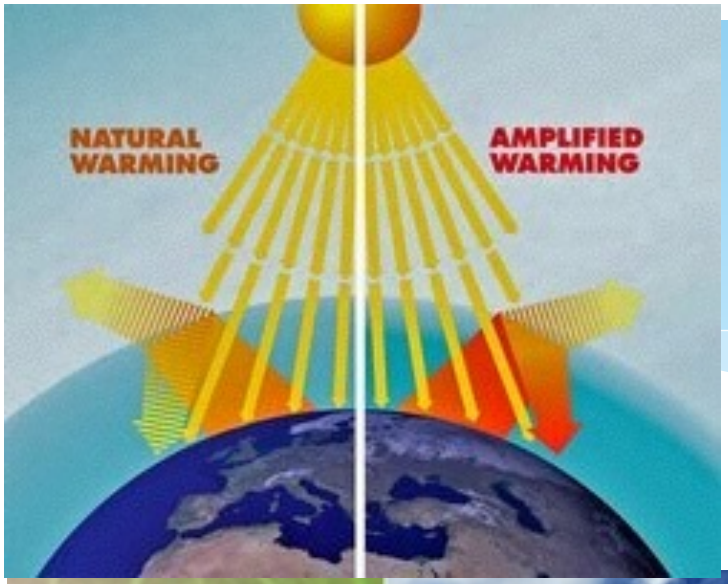
"How the availability of natural resources, occurrence of natural hazards and changes in climate have influenced human activity"

HS-ETS1 Engineering Design

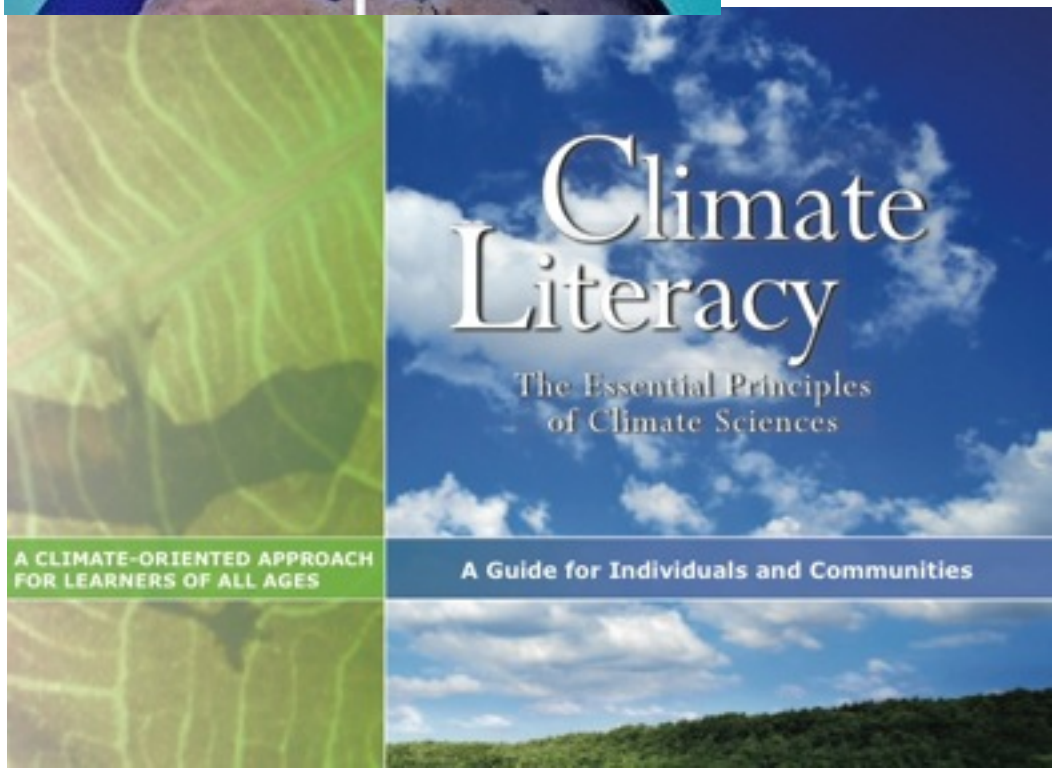
Design solution to a complex real-world problem *"by breaking it down into smaller, more manageable problems that can be solved through engineering"*

HS-ETS1 Engineering Design

Evaluating cost, safety, reliability, aesthetics and potential social, cultural and environmental impacts of a solution, i.e. risks.



4) Teaching Climate Literacy



Unpacking the Essential Principles and Fundamental Concepts of Climate Science

1) The Sun is the primary source of energy for Earth's Climate System

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

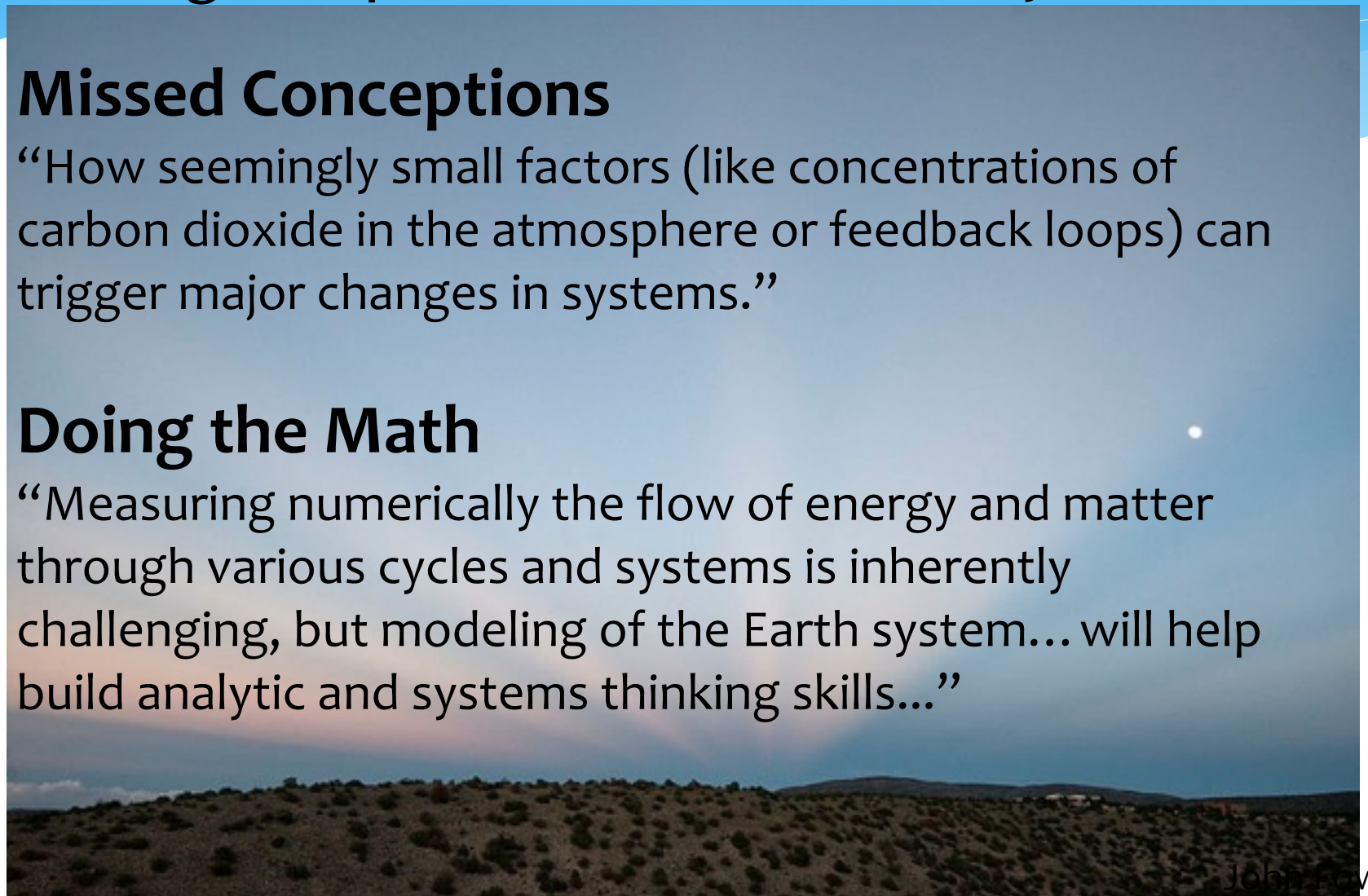
6) Human activities are impacting the climate system

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

Hansueli Krapf

Example

2) Climate is regulated by complex interactions among components of the Earth System



Missed Conceptions

"How seemingly small factors (like concentrations of carbon dioxide in the atmosphere or feedback loops) can trigger major changes in systems."

Doing the Math

"Measuring numerically the flow of energy and matter through various cycles and systems is inherently challenging, but modeling of the Earth system… will help build analytic and systems thinking skills…"

John Fowler

Middle School

Energy flows- NEED Project - Putting Energy into Education

http://cleanet.org/resources/41911.html

CLEAN

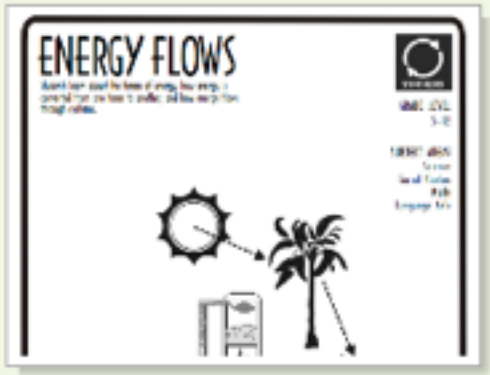
CLIMATE LITERACY & ENERGY AWARENESS NETWORK

Energy flows

Jump to this Activity »

http://www.need.org/files/curriculum/guides/Energy%20Flows.pdf

NEED Project – Putting Energy into Education



This activity introduces students to different forms of energy, energy transformations, energy storage, and the flow of energy through systems. Students learn that most energy can be traced back to nuclear fusion on the sun.

Activity takes one to two 45-minute class periods. Additional materials necessary.

Discuss this Resource»

Learn more about Teaching Climate Literacy and Energy Awareness»

Energy Flows

Students learn about the forms of energy, how energy is converted from one form to another, and how energy flows through systems in this hands-on activity.

Grade Levels:

Elem Elementary

Int Intermediate

Sec Secondary

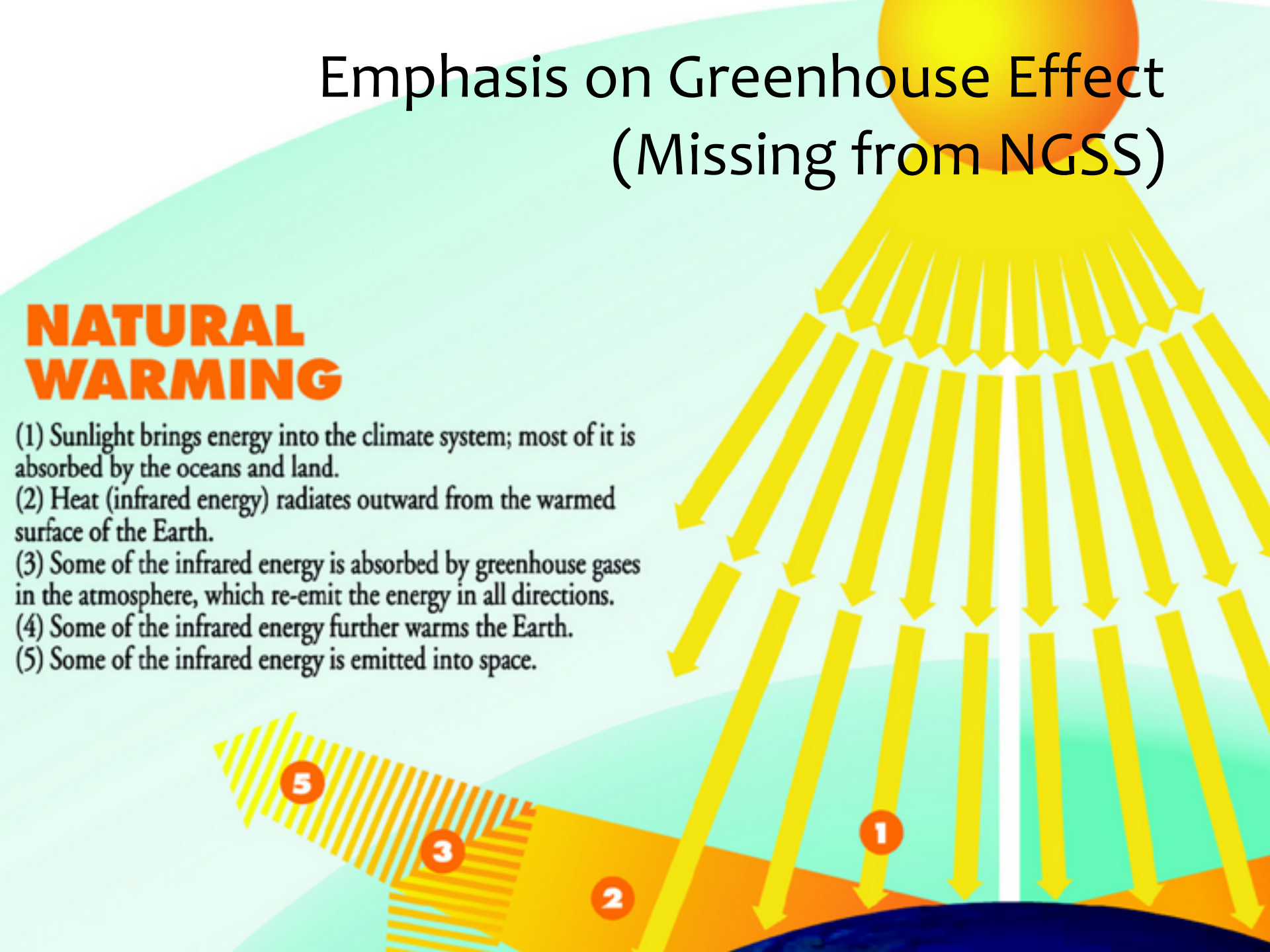
Subject Areas:

Science

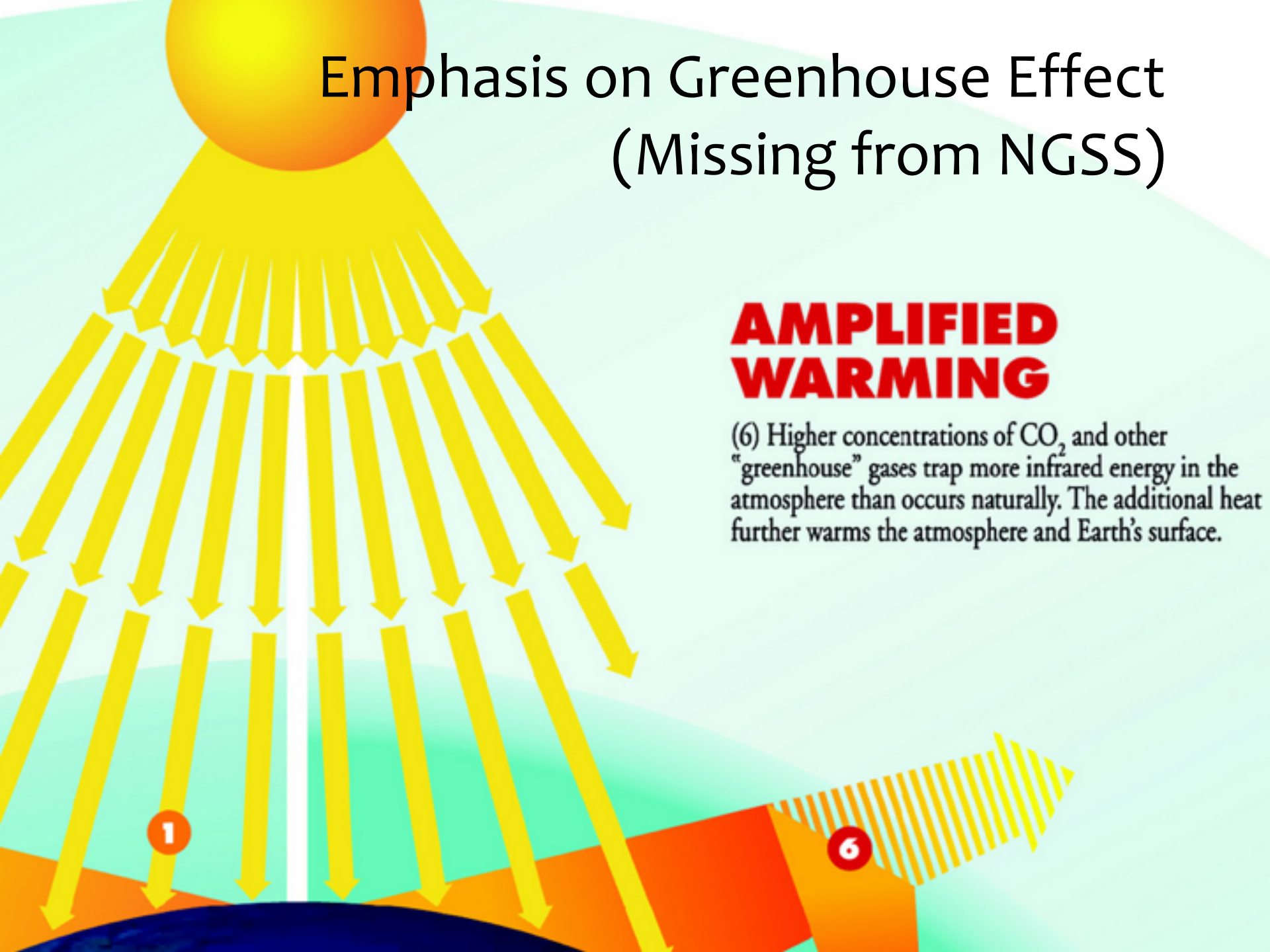
Language Arts

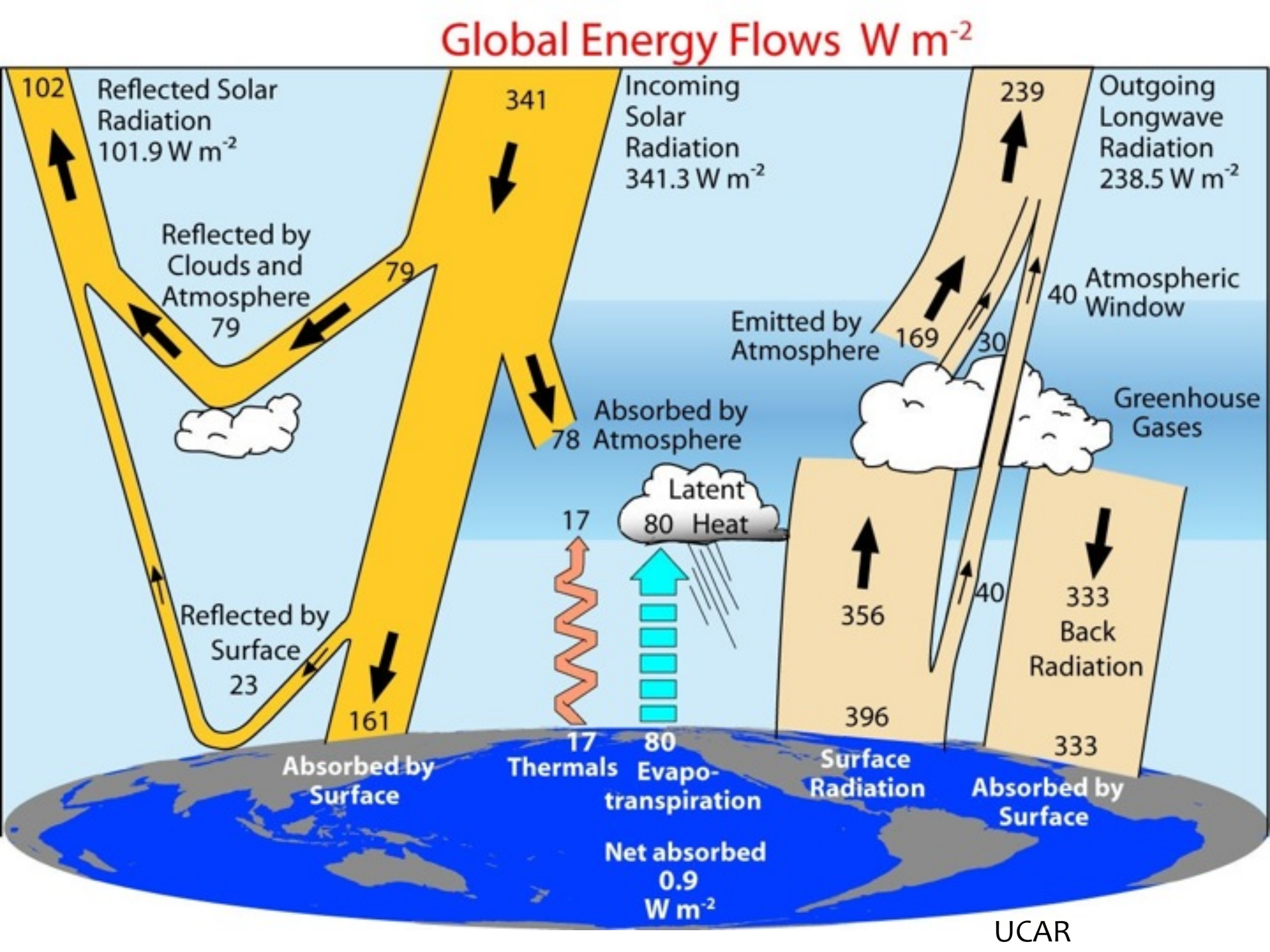
NEED National Energy Education Development Project

Emphasis on Greenhouse Effect (Missing from NGSS)

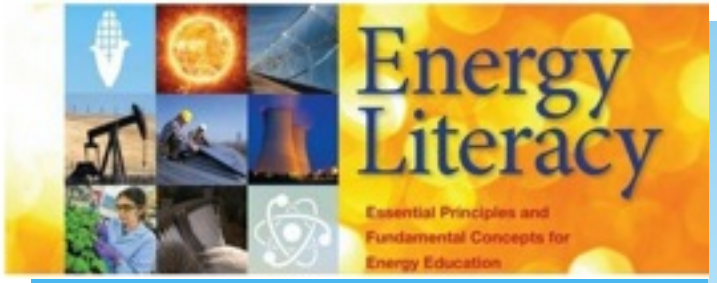


Emphasis on Greenhouse Effect (Missing from NGSS)

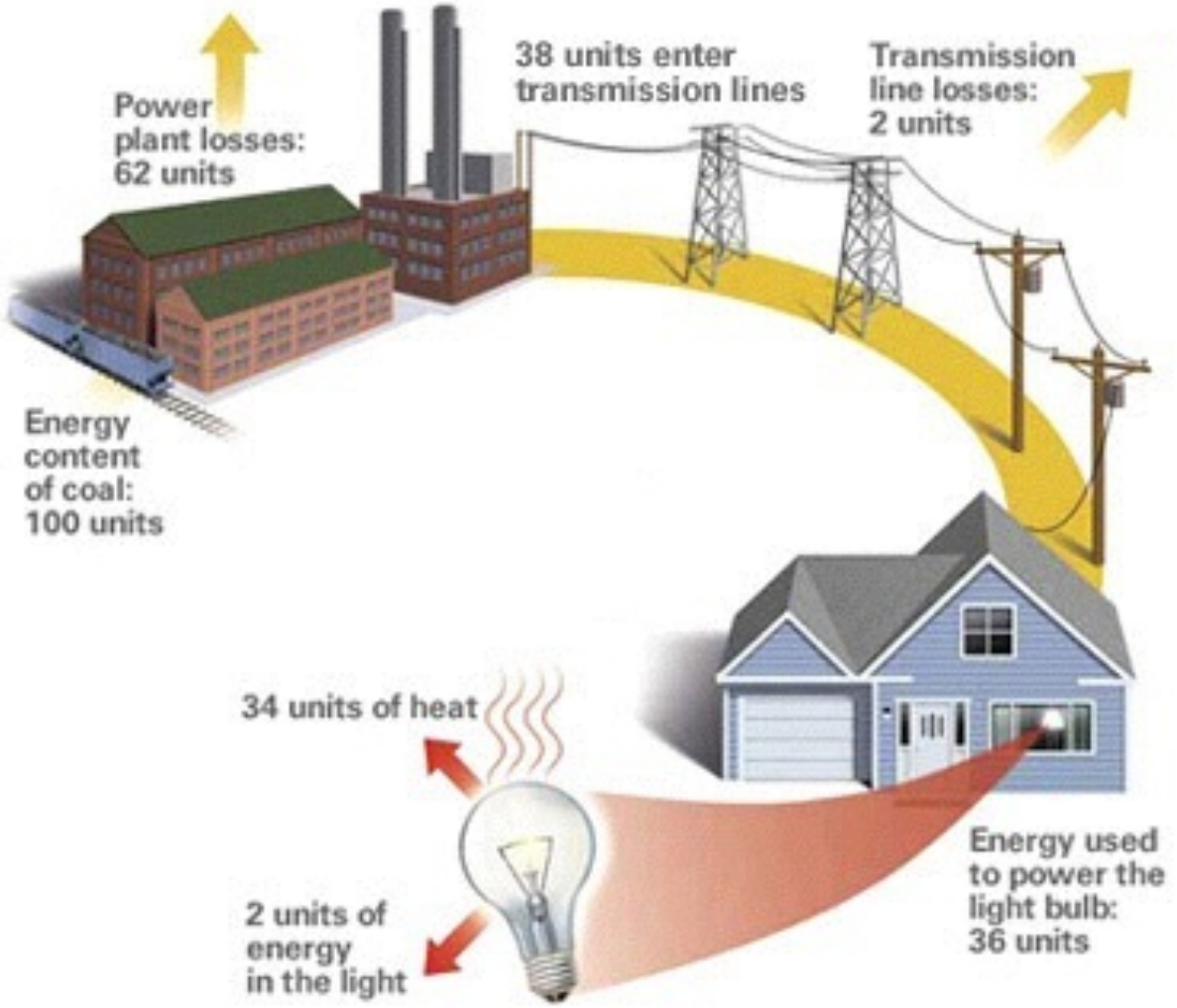



Global Energy Flows W m-2
102
Reflected Solar Radiation 101.9 W m-2
341
Incoming Solar Radiation 341.3 W m-2
239
Outgoing Longwave Radiation 238.5 W m-2
Reflected by Clouds and Atmosphere 79
79
40 Atmospheric Window
Emitted by Atmosphere
169
30
Greenhouse Gases
Absorbed by 78 Atmosphere
Latent 80 Heat
17
Reflected by Surface 23
161
356
40
333 Back Radiation
396
333
17 Thermals
80 Evapo-transpiration
Absorbed by Surface
Surface Radiation
Absorbed by Surface
Net absorbed 0.9 W m-2

UCAR



5) Teaching Energy Literacy



Unpacking the Essential Principles and Fundamental Concepts of Energy

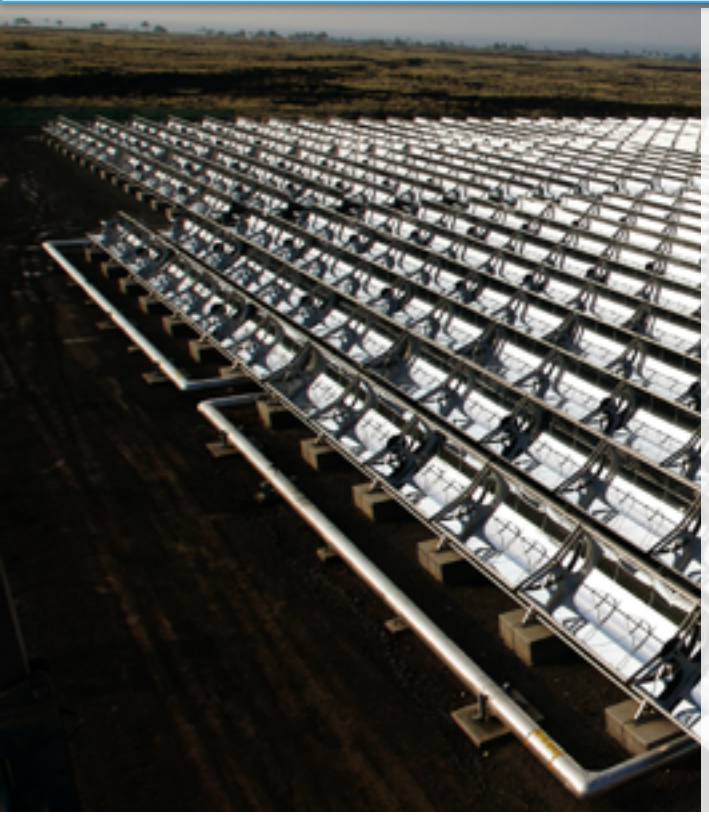
Energy Literacy Essential Principles

1. Energy is a physical quantity that follows precise natural laws
2. Physical processes on Earth are the result of energy flow through the Earth system
3. Biological processes depend on energy flow through the Earth system
4. Various sources of energy can be used to power human activities, and often this energy must be transferred from source to destination.
5. Energy decisions are influenced by economic, political, environmental, and social factors
6. The amount of energy used by human society depends on many factors
7. The quality of life of individuals and societies is affected by energy choices

Xklaim

National Council for Science and the Environment

Improving the scientific basis for environmental decisionmaking



2015 National Energy Education Summit Crystal City, VA – Monday January 26, 2015

Energy and Climate Change

15th National Conference and Global Fourm on Science, Policy and the Environment

January 27-29, 2015

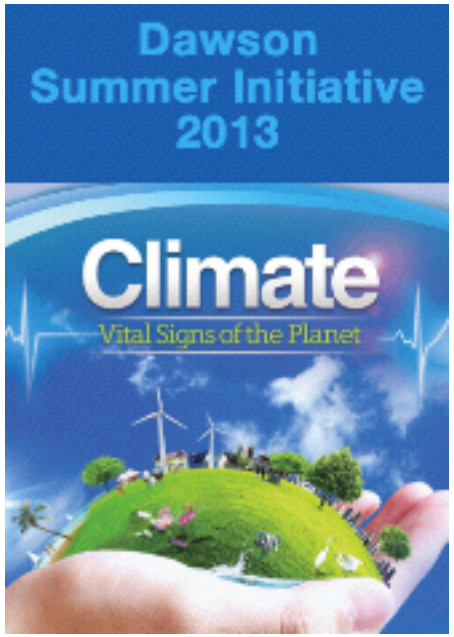
Washington, DC

6) Programs that Work

Many stellar programs exist and can be scaled up!

ace alliance for climate education

Green Schools National Network



American College & University Presidents Climate Commitment

Planting Seeds for Career Pathways

7) Countering Skepticism, Doubt and Despair

- Tell the truth
- Teach throughout curriculum

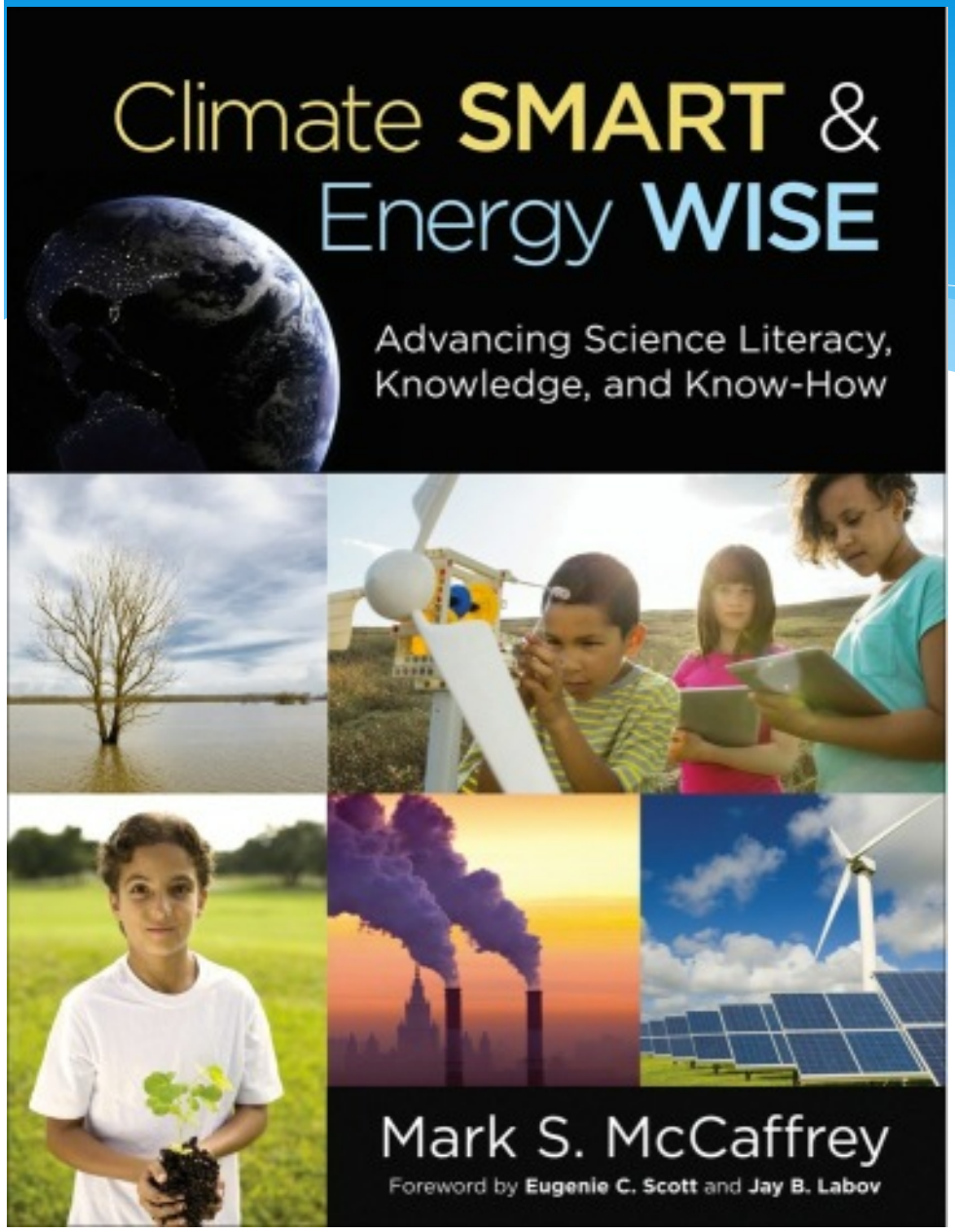
Integrate responses and solutions

Explore career pathways

8) Knowledge, Know-how and Informed Action

Transforming schools into living laboratories

Literacy + Infrastructure = New American Learning Revolution



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