



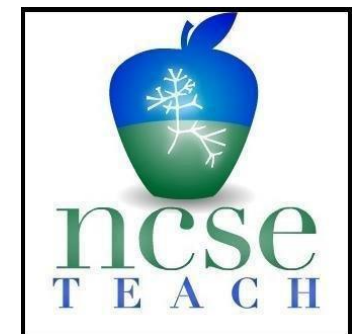
NATIONAL
CENTER *for*
SCIENCE
EDUCATION



Turning Misinformation into Educational Opportunities

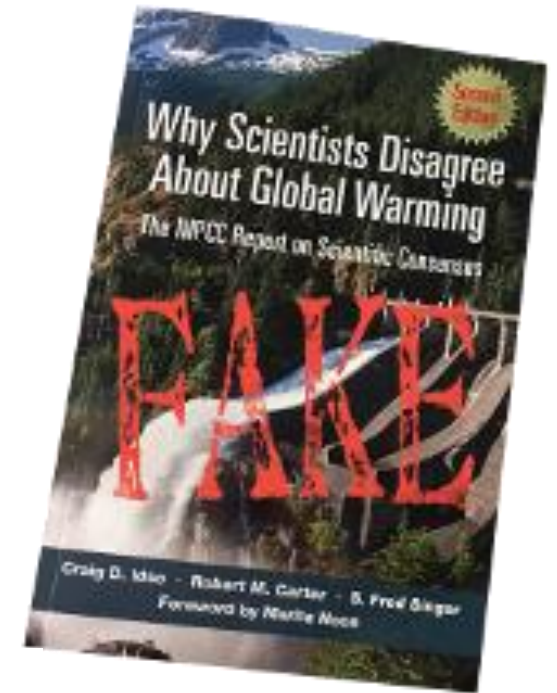


Dr. Brad Hoge – Director of Teacher Support
National Center for Science Education



Turning Misinformation into Educational Opportunity

- Response to Heritage Foundation's mailing to teachers
- Identifies 5 key misconceptions
- Builds Misconception-Based / Place-Based / Inquiry-Based lessons
 - John Cook (George Mason Center for Climate Change Communication)
 - Brad Hoge (Director of Teacher Support at NCSE)
 - Frank Niepold (NOAA / CLEAN)
 - Rebecca Anderson (ACE)



ALLIANCE FOR
CLIMATE EDUCATION

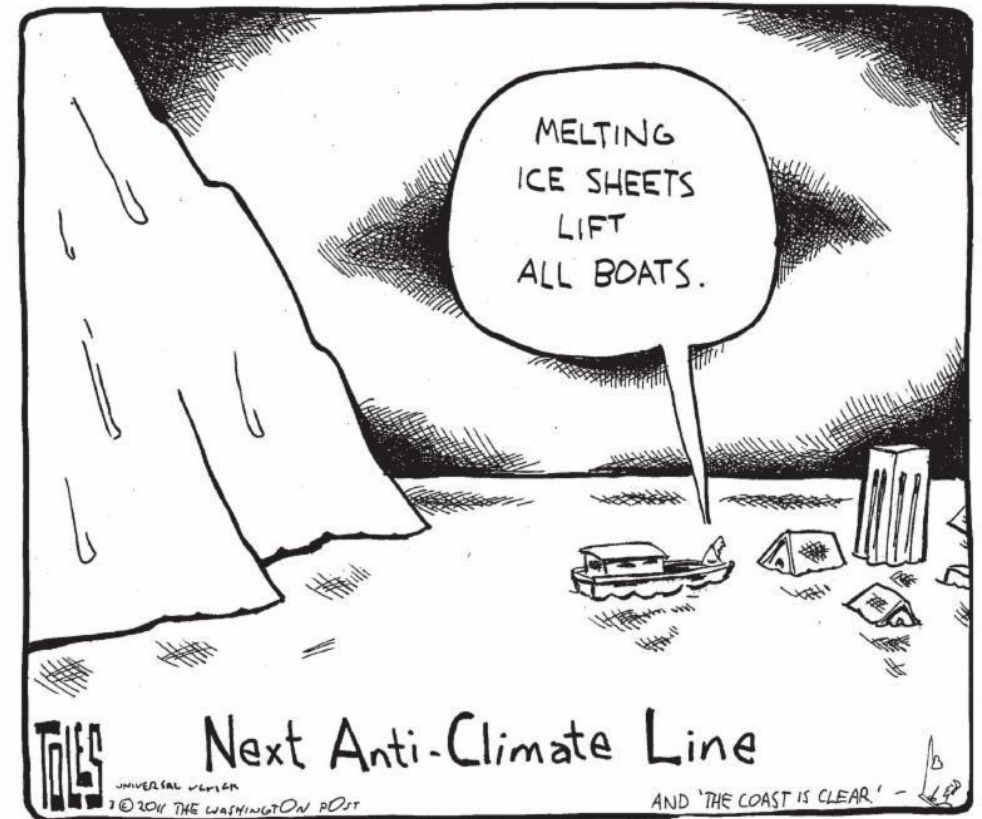


GEORGE MASON UNIVERSITY
CENTER for CLIMATE CHANGE
COMMUNICATION

- NCSE Teacher Ambassador Program / Strategy

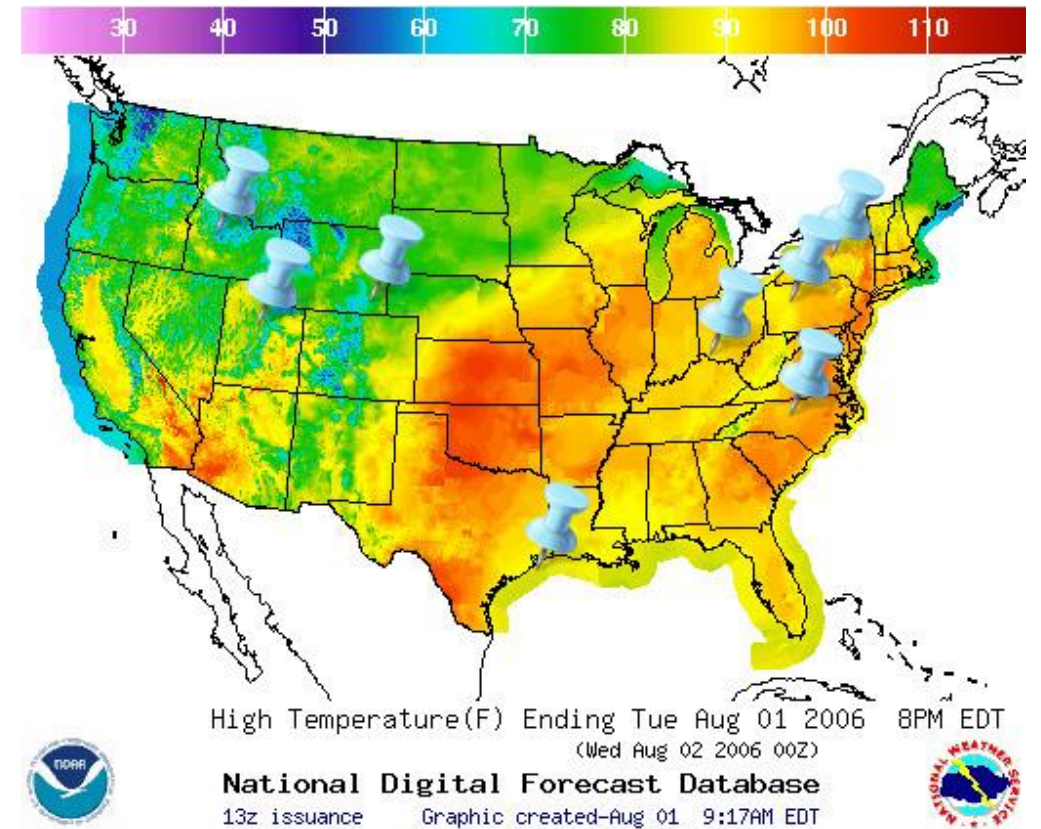
Synergy from Pedagogy of Misconception to Overcome Barriers to Learning

- Cognitive barriers (evolutionary psychology)
 - Probability
 - Proximity
 - Deep time
 - Familiarity
- Ideological barriers
 - Affiliation with groups (social / historical)
 - Affiliation with ratiocination (social / logical)
- Cultural and religious barriers



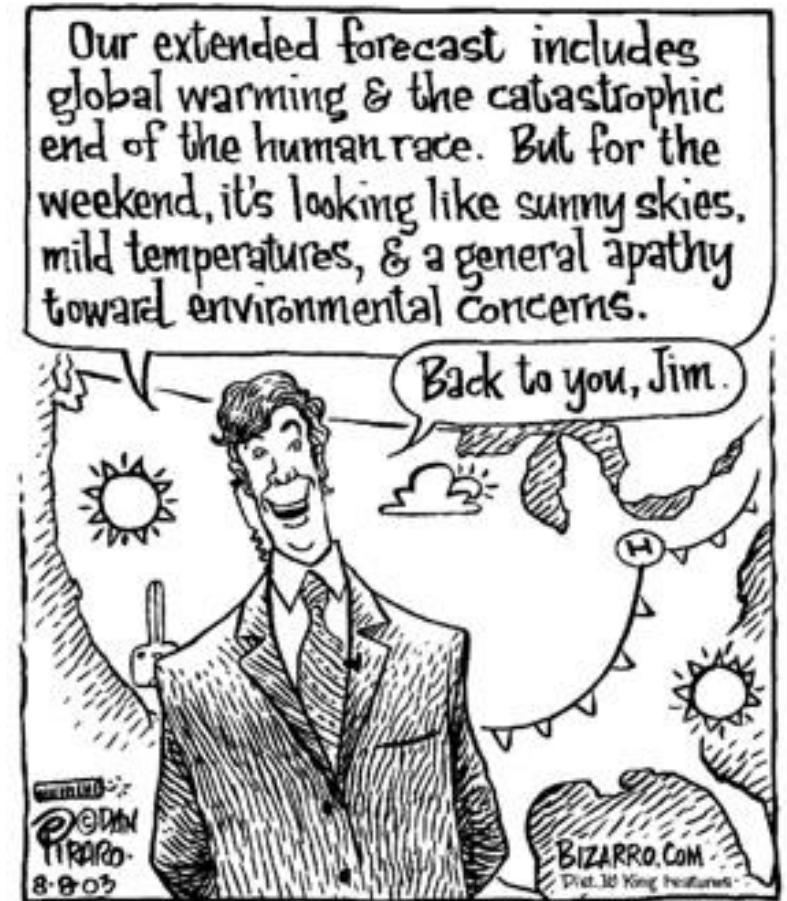
NCSE Ambassador Teachers

- David Amidon – Syracuse, NY
- Bonnie Bourgeois – Salt Lake City, UT
- Jennifer Broo – Cincinnati, OH
- Nina Corley – Galveston, TX
- Alexander Dorsch – New Castle, PA
- Kim Parfitt – Cheyenne, WY
- Kelly Pipes – Wilkesboro, NC
- Erin Stutzman – Boise, ID

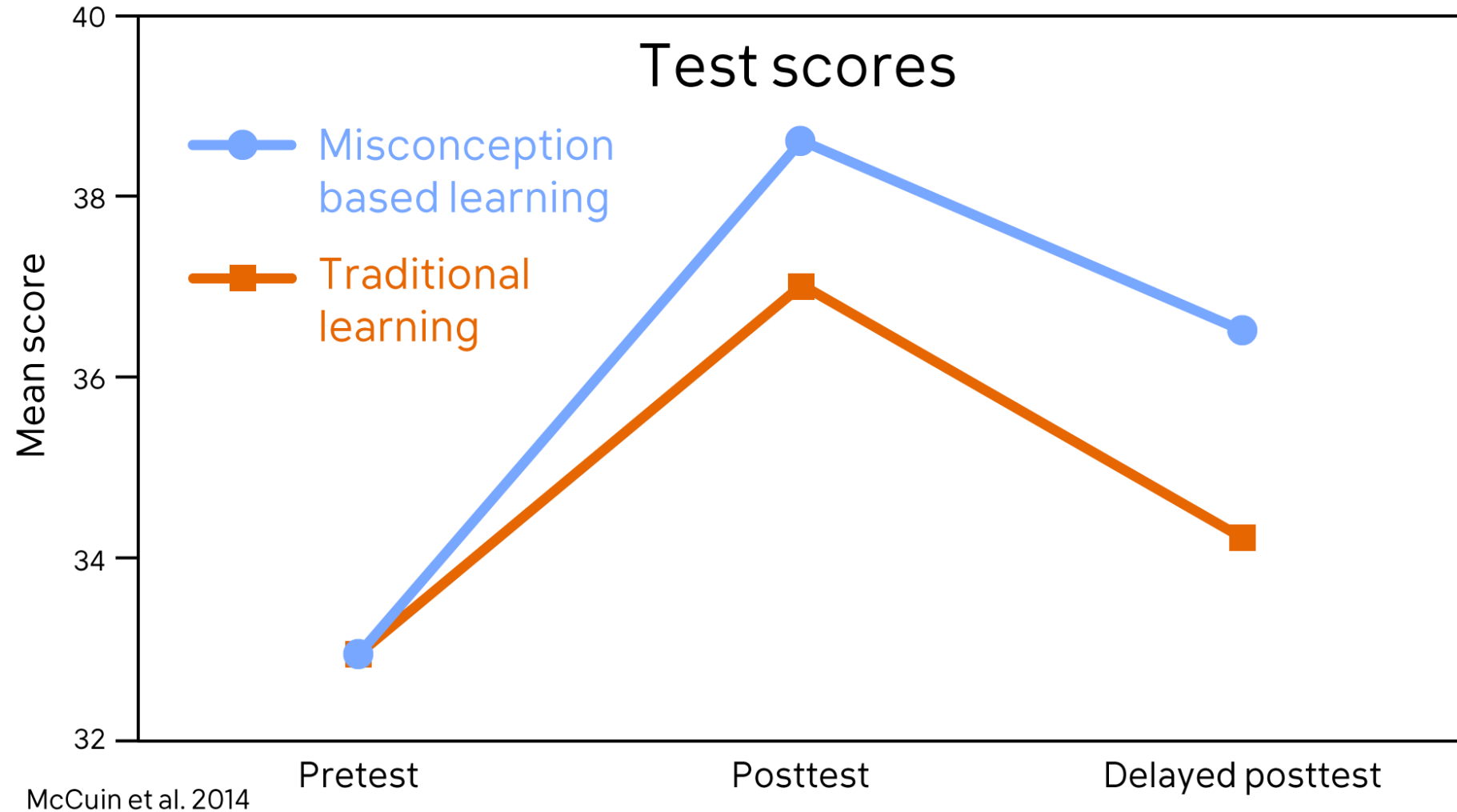


5 Lessons for 5 Misconceptions

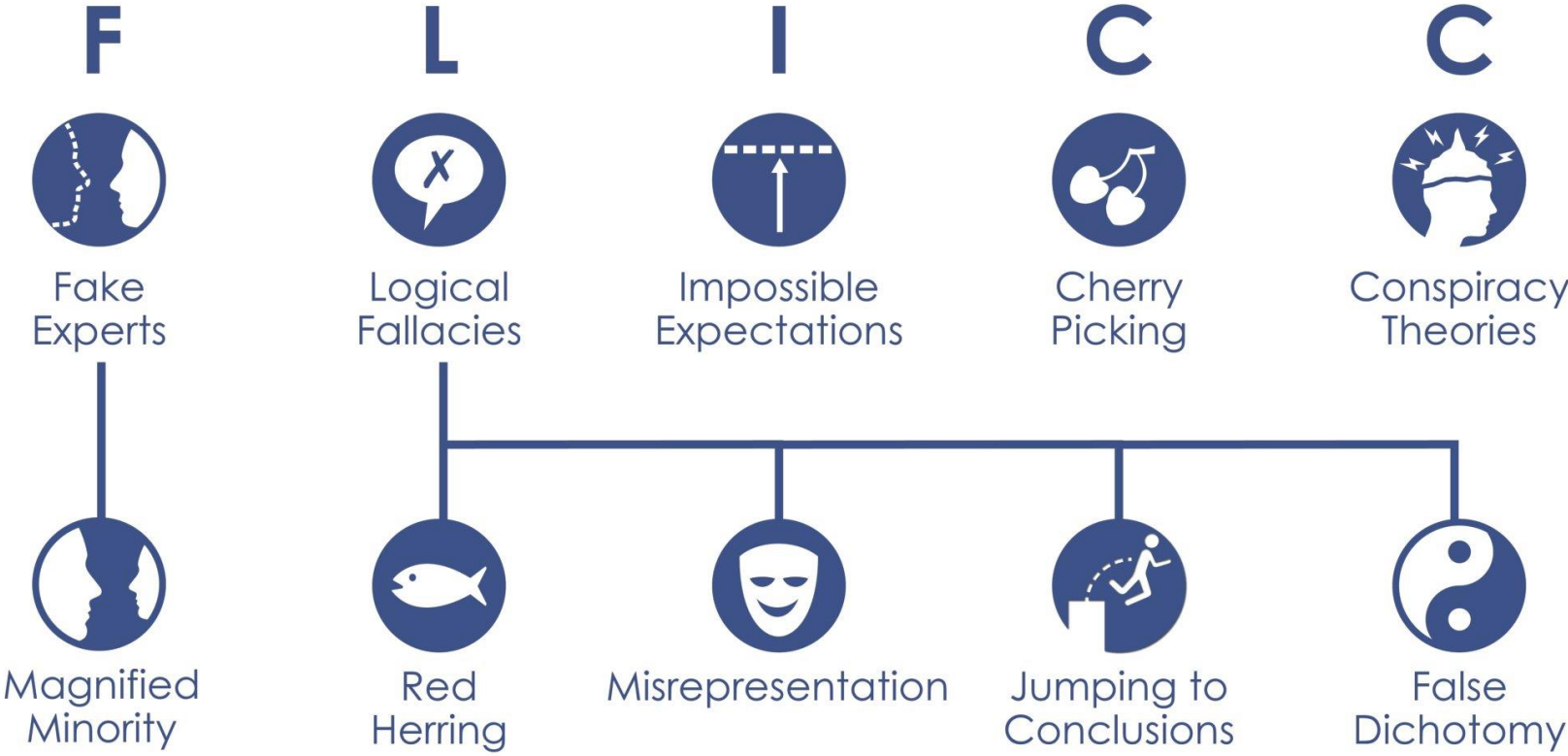
1. Scientists don't agree
2. Models aren't good science
3. It's just a natural process, climate has always changed
4. Extreme weather happens, it's not climate change
5. There's nothing we can do about it



Misconception-based learning



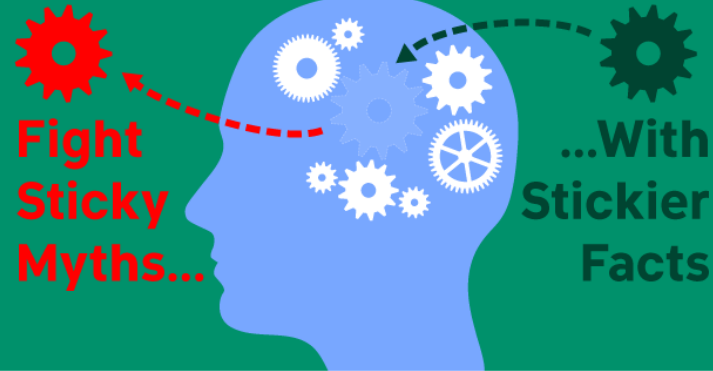
5 CHARACTERISTICS OF SCIENCE DENIAL



Fact-myth-fallacy structure

FACT

Replace the myth with a factual alternative that meets all the causal requirements left by the myth.



**THE
GOLDEN
RULE OF
DEBUNKING**

MYTH/MISCONCEPTION

Warn people before mentioning the myth so they're cognitively on guard.

FALLACY

Explain the technique used by the myth to distort the fact. This enables people to reconcile the fact with the myth.



Pre and Post Tests

How much do you agree or disagree with the following statements?

9. The Earth's climate has changed naturally in the past, therefore humans are not the cause of global warming.

Check one:

- Strongly agree
- Somewhat agree
- Somewhat disagree
- Strongly disagree

10. Climate change is increasing risk from extreme weather.

Check one:

- Strongly agree
- Somewhat agree
- Somewhat disagree
- Strongly disagree

11. Scientists' computer models are too unreliable to predict the climate of the future.

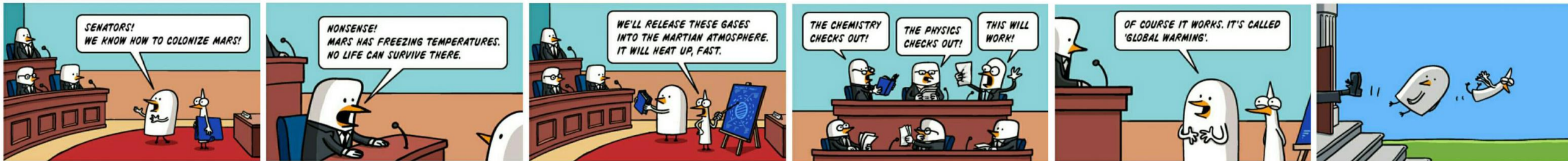
Check one:

- Strongly agree
- Somewhat agree
- Somewhat disagree
- Strongly disagree



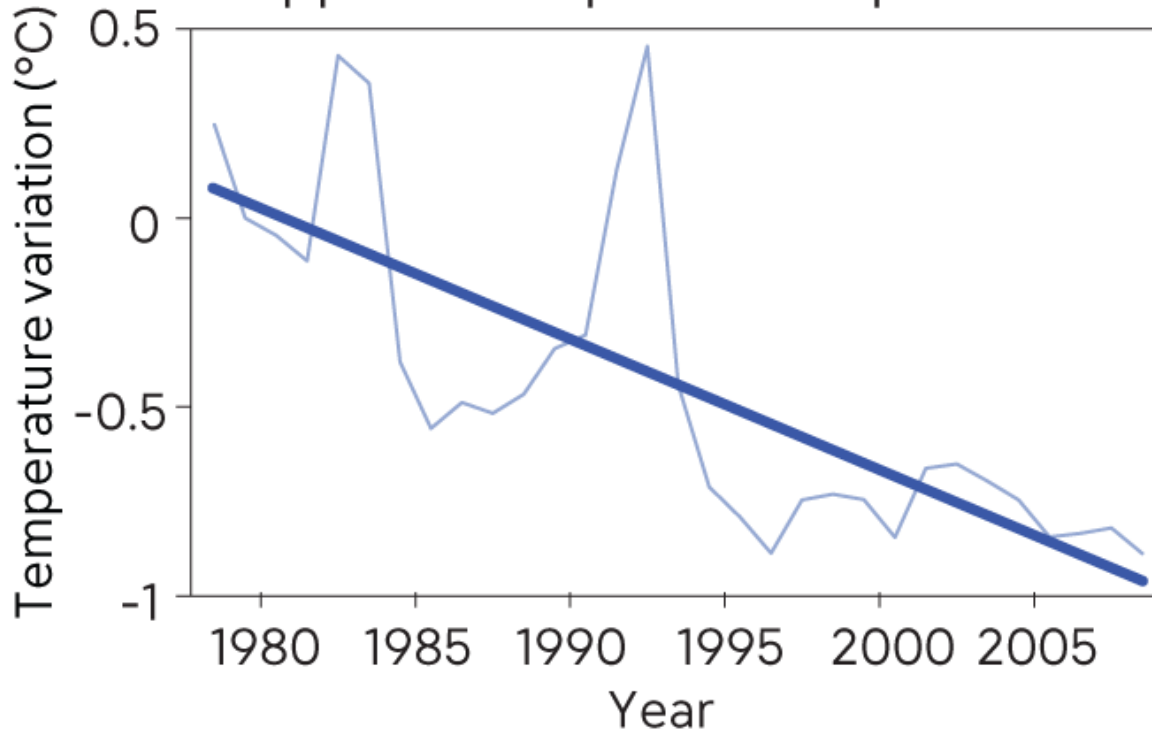
Lesson 1 – Teaching Consensus

- This lesson is a bit different than the rest
- This lesson sets the table for the rest of the unit
- The learning objectives for this lesson focus on skills – particularly inoculation against misinformation
- Closing the lesson with FLICC provides an opportunity for assessment

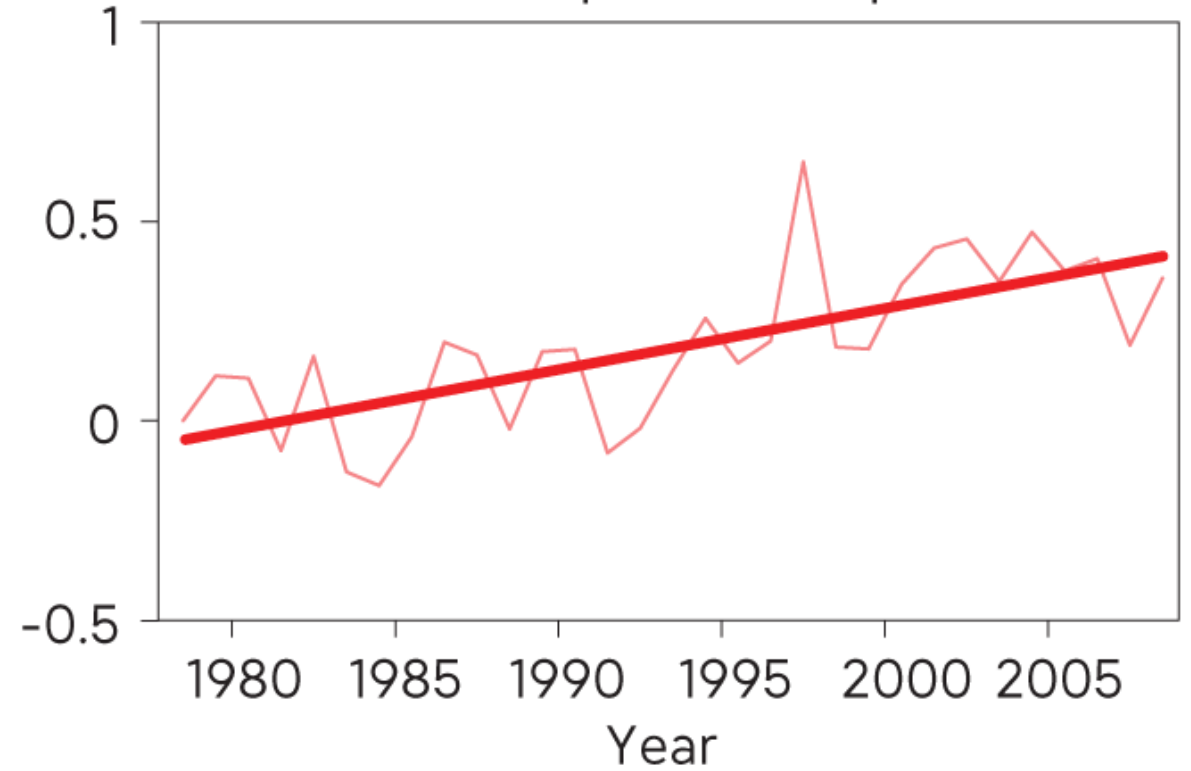


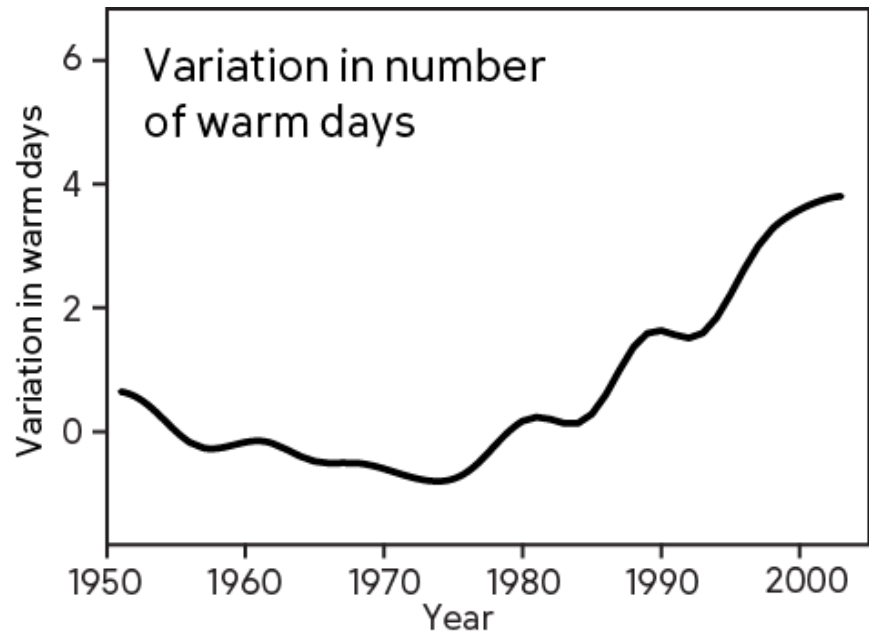
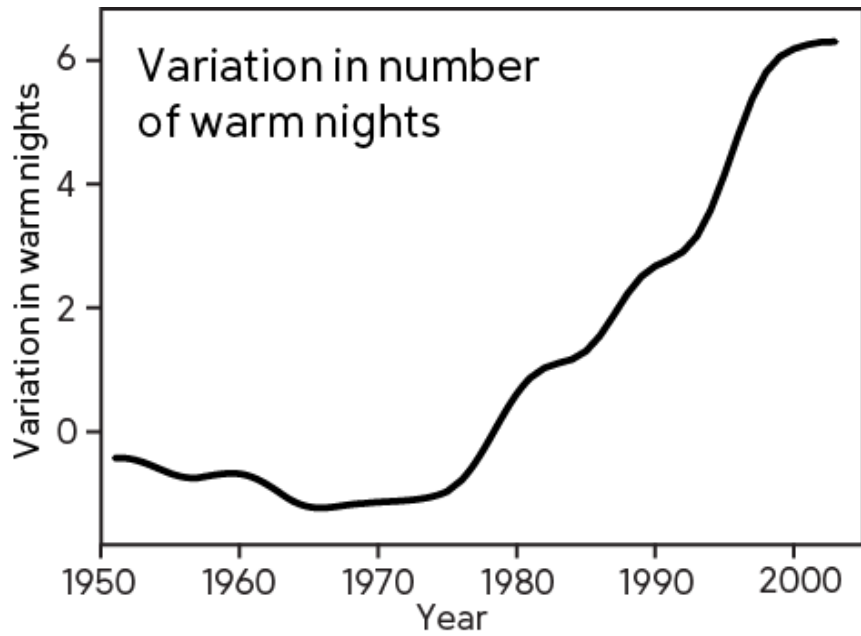
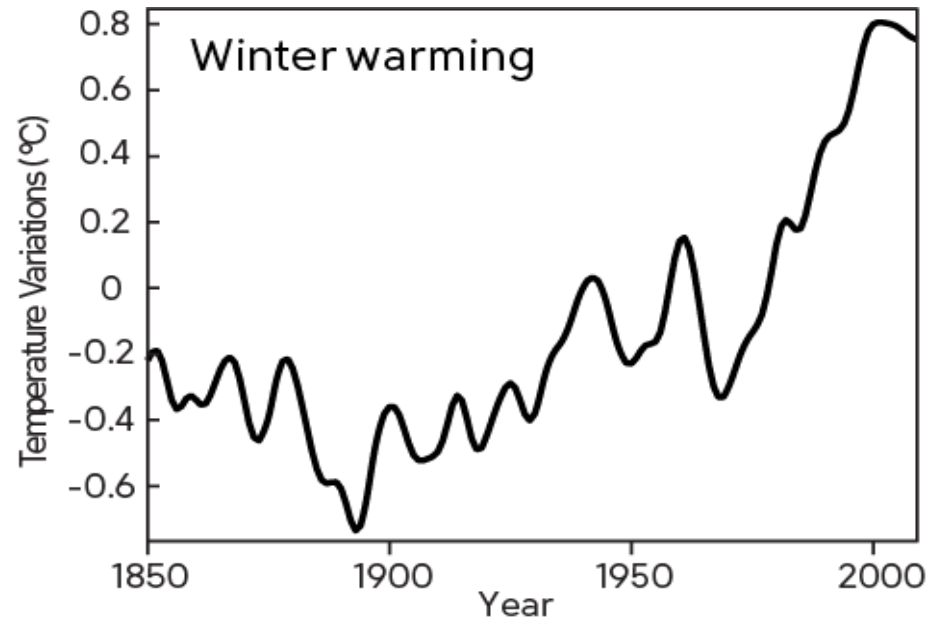
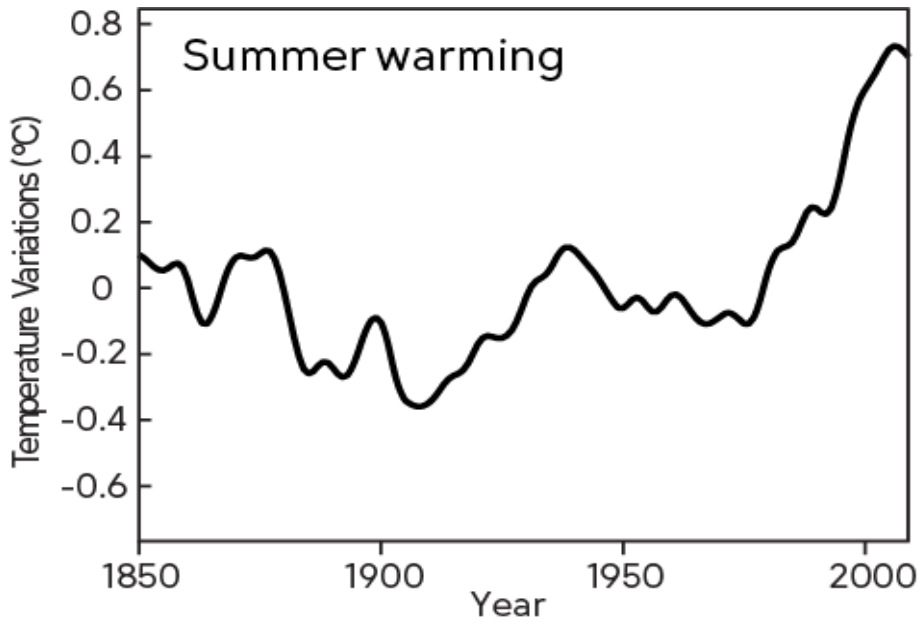
Focus on Data

Upper atmospheric temperature



Lower atmospheric temperature

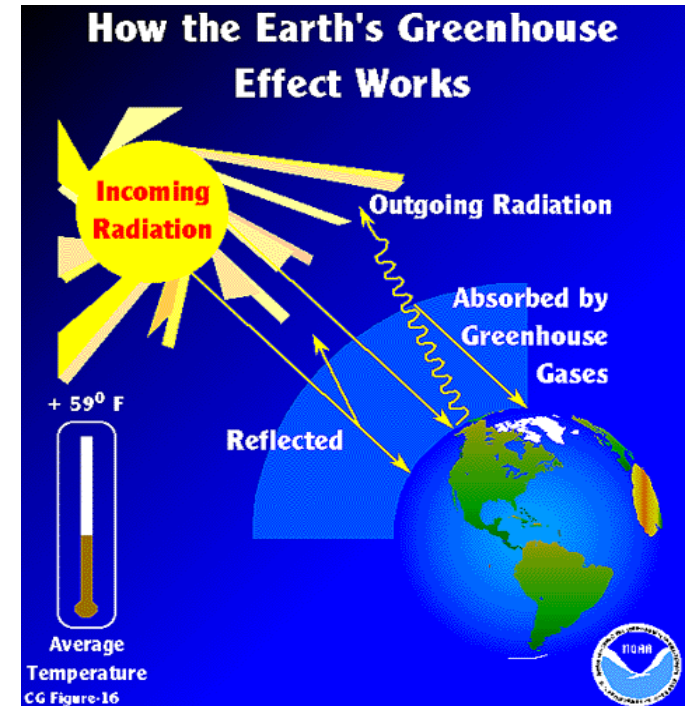




Be a Guide on the Side

Possible questions to guide student inquiry:

- How can the sun impact Earth's average global temperature?
- How can Greenhouse Gases impact Earth's average global temperature?
- Why is the troposphere warmer than the stratosphere?
- Why does each layer cool at night?
- Why are summer days and nights warmer than winter days and nights?
- Do you think the stratosphere has seasonal variations too?
- What happens where the troposphere and stratosphere meet?
- Why are the layers so distinct?



Assess Using FLICC

FACT Based on independent lines of evidence, a scientific consensus has formed that humans are causing global warming.

MYTH 31,000 dissenting scientists prove there's no scientific consensus agreement on human-caused global warming.

FALLACY **Fake experts:** people who convey the impression of expertise but with no relevant expertise are often used to cast doubt on expert consensus.

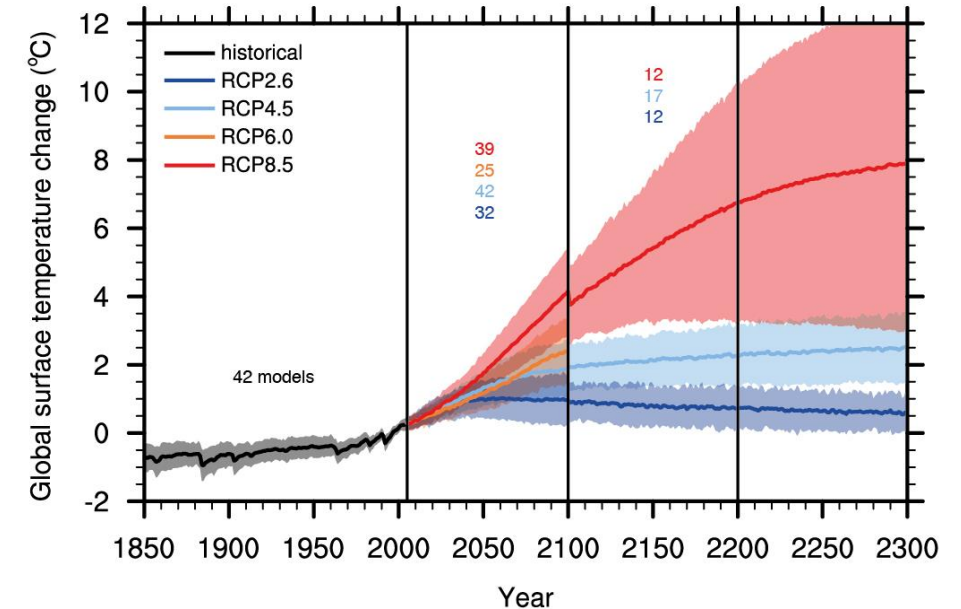


Lesson 2: Climate models

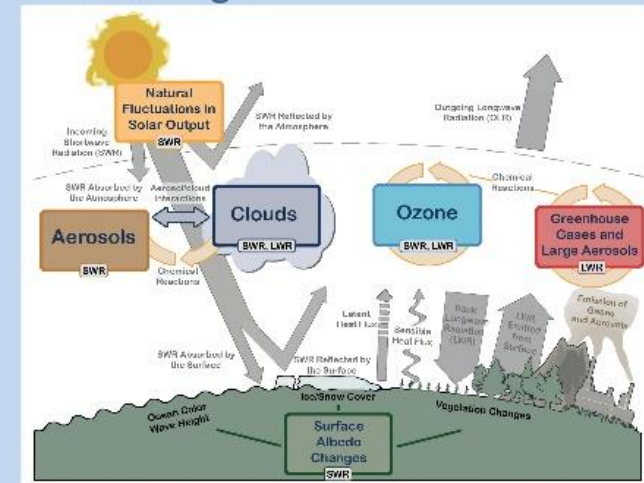
- FACT** Climate models have made many successful predictions of long-term warming and specific climate patterns. While there are parts of climate that are challenging to simulate, such as short-term predictions, models are continually being improved to introduce more detailed physical processes.
- MYTH** Model predictions have failed in the past, therefore models can't be trusted.
- FALLACY** **Impossible Expectations:** No model is perfect but they are useful tools that can reproduce the past and provide insights into the future.

Lesson 2 - Modelling

- Two approaches
 - Predict a trend and build a model to help from the demands of the prediction
 - Identify components of the climate system and arrange them into a 2-dimensional model



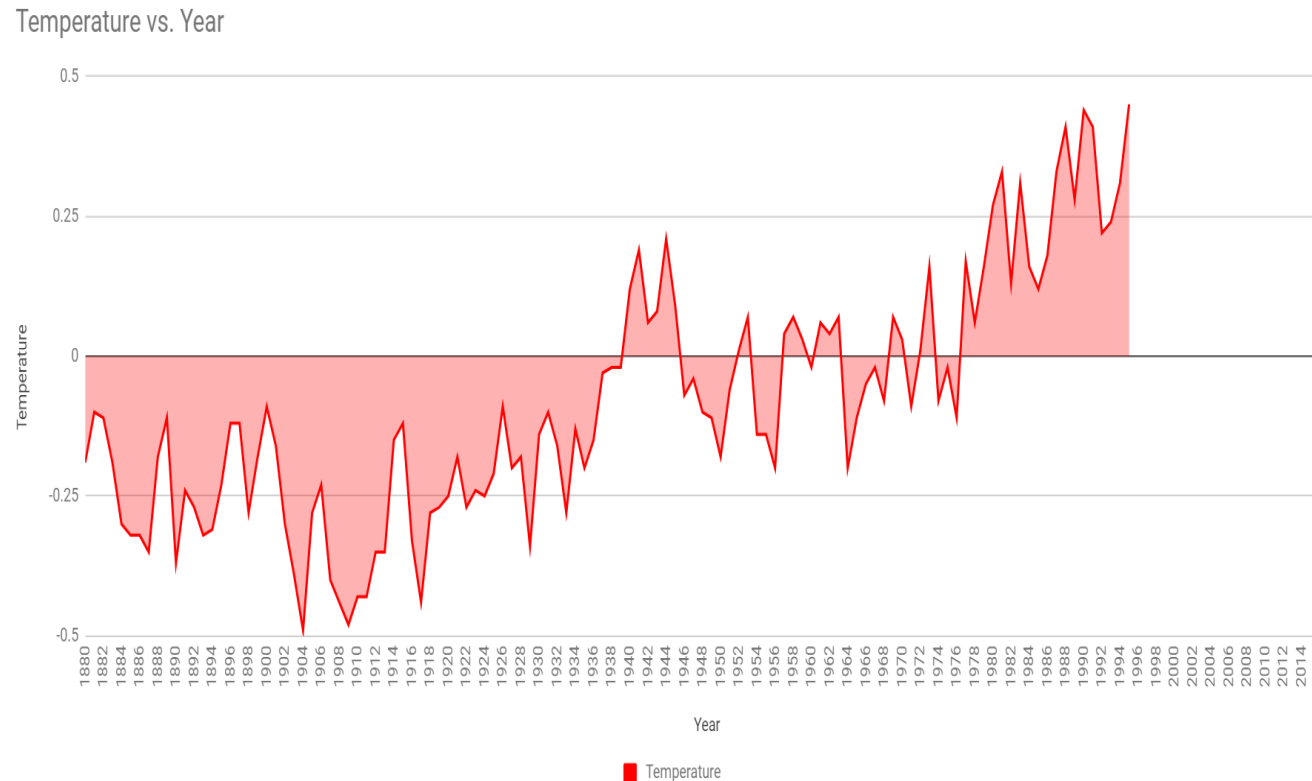
Climate models are based on the main drivers of climate change



IPCC 2013 report available at:
<http://www.climatechange2013.org/report/full-report/>

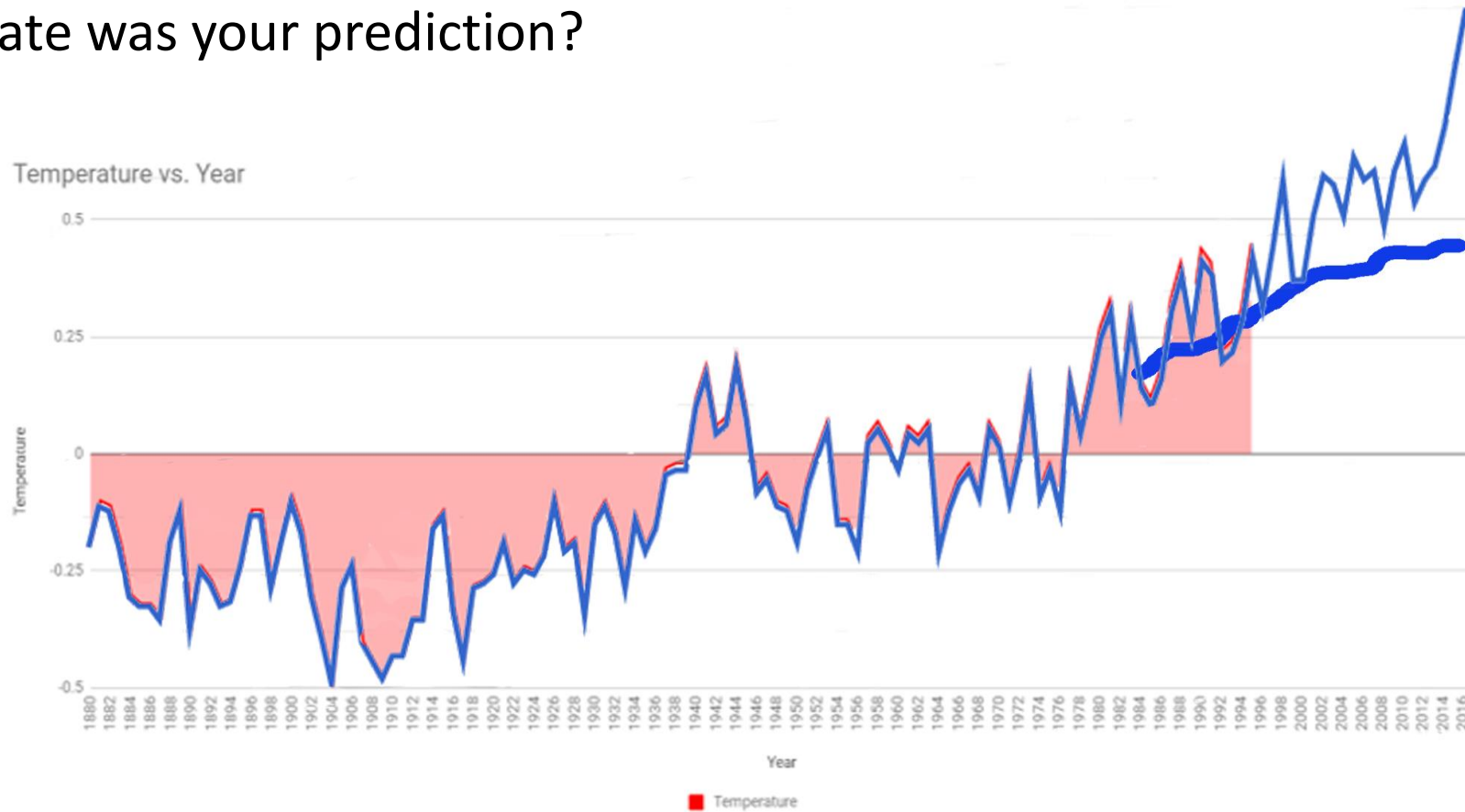
Predicting the Future

Predict the trend shown to the year 2017



Compare to Actual Data

How accurate was your prediction?



Now predict the trend to the year 2030, 2050, and 2100.

Lesson 3: Past climate change

FACT

Modern climate change is abrupt and driven by human activity, distinguishing it from past climate change.

MYTH

Natural climate change in the past implies current climate change is also natural.

FALLACY

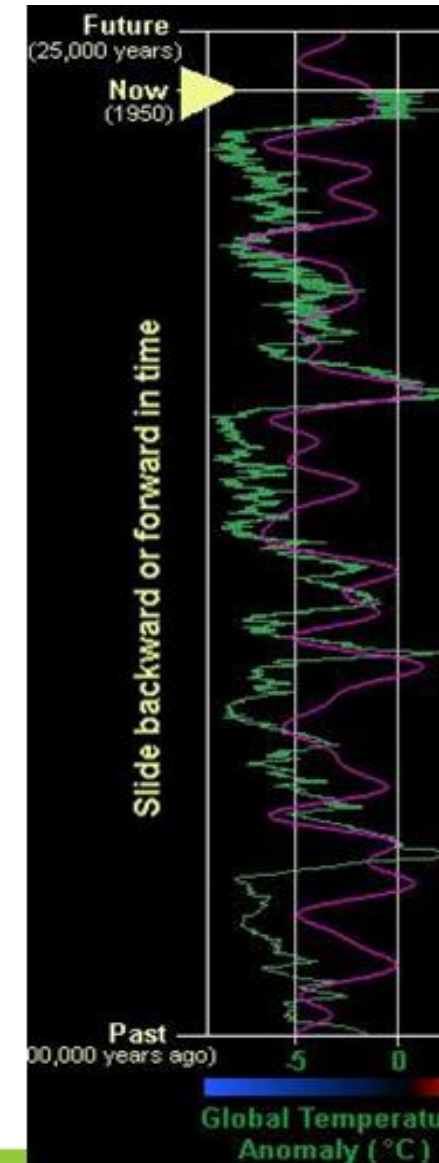
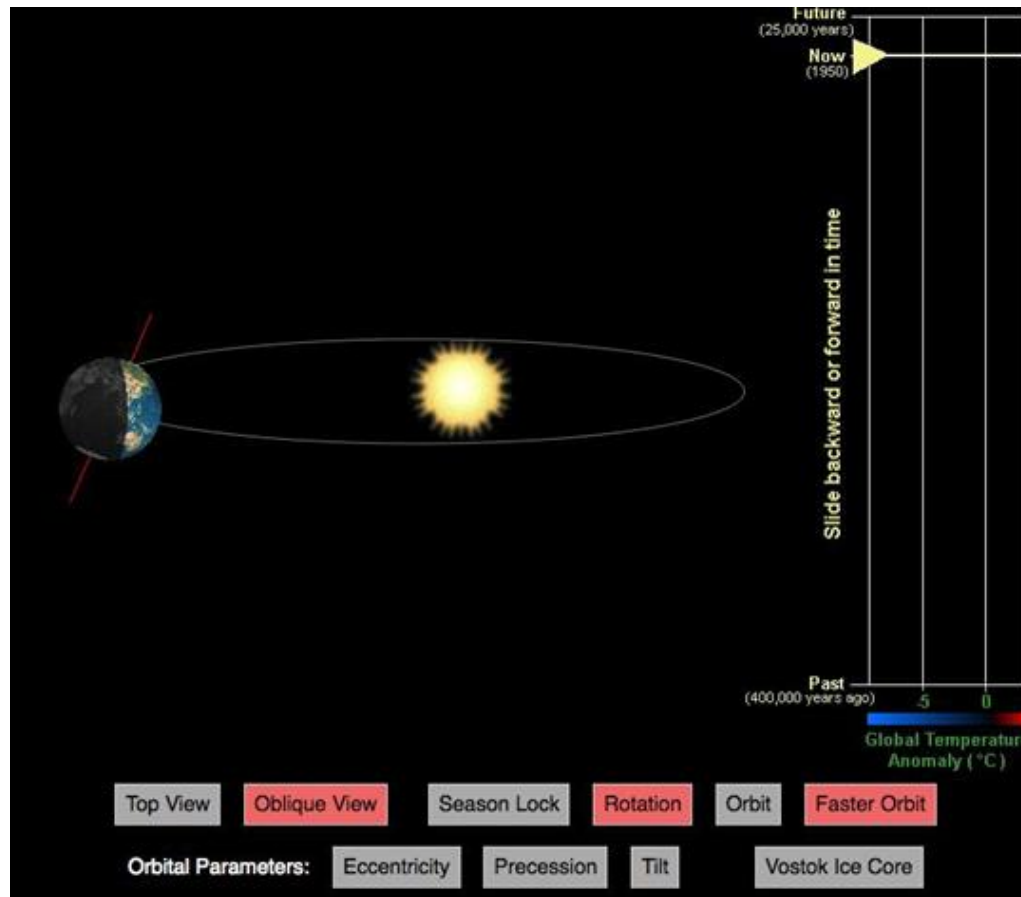
Jumping to conclusions: Just because climate change was caused by natural causes in the past doesn't necessarily mean it's naturally caused now.

Lesson 3 – Past and Present

- Addresses the challenges of deep-time and stochasticity
- Milankovitch cycles
- Puts anthropocentric climate change into perspective



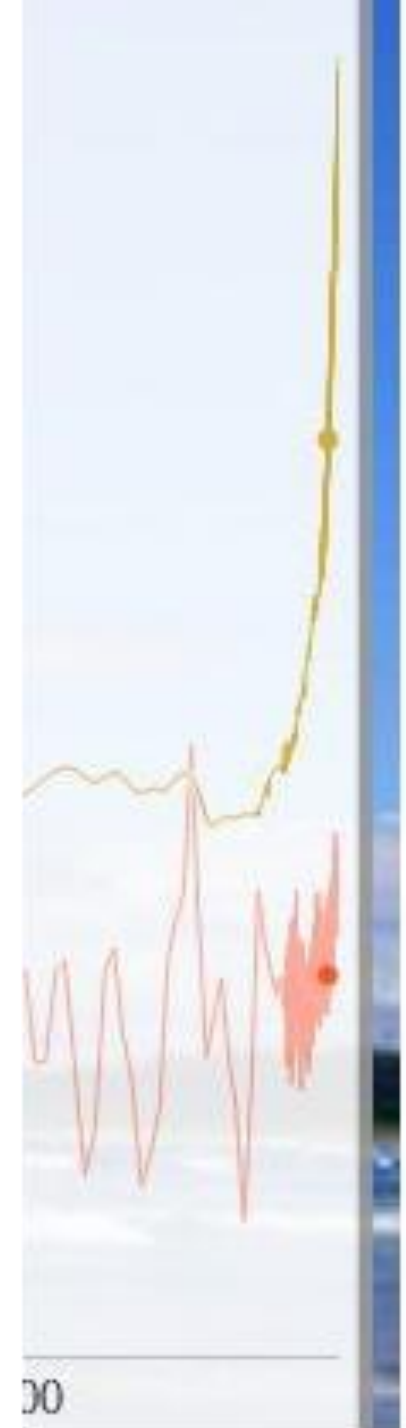
"Our sun is more than four billion years old, and has already reached about half its life expectancy. It is now time to plan for the future of mankind, and a positive first step is the election of someone willing to face this problem..."



<https://cimss.ssec.wisc.edu/wxfest/Milankovitch/earthorbit.html>



http://www.kcvs.ca/site/projects/JS_files/HistoricClimateChange/history.html



Lesson 4: Extreme weather

- FACT** Risk from extreme weather is increasing, albeit some forms of extreme weather are more confidently linked to global warming than others.
- MYTH** Extreme weather always happens, so warming isn't making extreme weather worse.
- FALLACY** **Jumping to conclusions:** Just because extreme weather happened in the past doesn't mean climate change isn't having an influence now.

Lesson 4 – Extreme Weather

- Focuses on the connection between extreme weather and climate
- Identifies extreme weather events / conditions in student's area?
- Uses local data

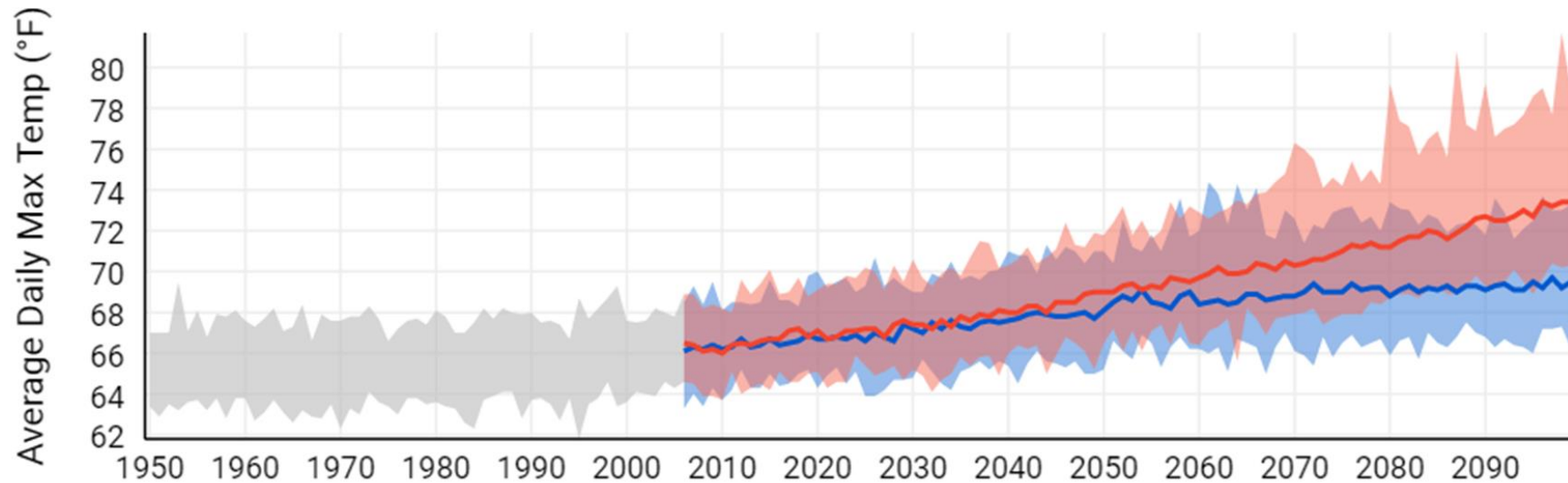


Examples from NCSE Teacher Ambassadors

- David Amidon – Lake effect snow in upstate New York
- Bonnie Bourgeois – Snow melt and drought in Salt Lake City, UT
- Nina Corley – Flooding on Galveston Island, TX
- Kim Parfitt – Wildfires in Wyoming
- Erin Stutzman – Snow melt, wildfires and insect infestation in Idaho



<https://crt-climate-explorer.nemac.org>



Lesson 5: Climate solutions

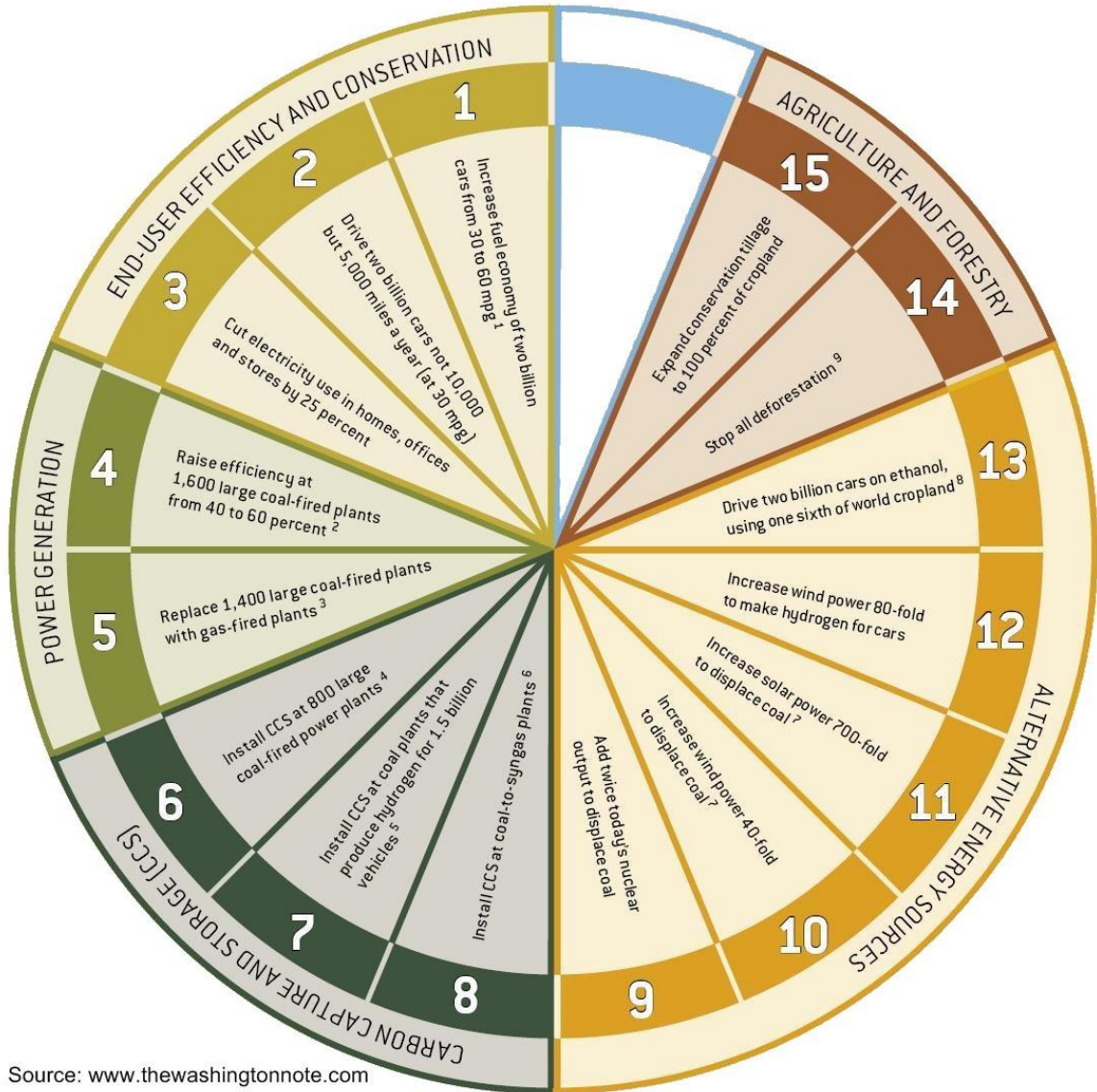
- FACT** There are multiple strategies to reducing carbon emissions, and there are realistic paths to preventing climate change if we try many solutions at once.
- MYTH** Renewables like solar or wind are not enough to solve climate change.
- FALLACY** **Cherry picking:** focusing on just one or a few possible solutions ignores that solving climate requires a multi-pronged strategy.

Lesson 5 – Solutions

- Utilizes the Wedge Stabilization Strategy Game (various options)
- Focuses on unique opportunities in student's area
- Focuses on identifying local responses (Project Dropdown)



"Try blowing on it."



Source: www.thewashingtonnote.com

Projected Carbon Emissions

Vehicle Efficiency and Use

Number of Cars (in Billions)	2.00
<input type="range" value="2.00"/>	0.5 4
Fuel Consumption (L/100km)	10.0
<input type="range" value="10.0"/>	2 12.5
Average Distance Driven (km)	16093
<input type="range" value="16093"/>	4000 16093

Show/Hide Assumptions

Reality Check

realistic

http://kcv.s.ca/site/projects/JS_files/Stabilization_Wedges/stabilizationWedges.html

Project Drawdown


DRAWDOWN
THE MOST COMPREHENSIVE
PLAN EVER PROPOSED TO
REVERSE GLOBAL WARMING

<https://www.drawdown.org/solutions-summary-by-rank>

Summary of Solutions by Overall Rank

This table provides the detailed results of the Plausible Scenario, which models the growth solutions on the Drawdown list based on a reasonable, but vigorous rate from 2020-2050. Results depicted represent a comparison to a reference case that assumes 2014 levels of adoption continue in proportion to the growth in global markets.

NOTE: Energy Storage (utility-scale & distributed), Grid Flexibility, Microgrids, Net Zero Buildings, and Retrofitting were not modeled independently to avoid double counting impacts from other solutions.



Rank	Solution	Sector	TOTAL ATMOSPHERIC CO ₂ -EQ REDUCTION (GT)	NET COST (BILLIONS US \$)	SAVINGS (BILLIONS US \$)
1	Refrigerant Management	Materials	89.74	N/A	\$-902.77
2	Wind Turbines (Onshore)	Electricity Generation	84.60	\$1,225.37	\$7,425.00
3	Reduced Food Waste	Food	70.53	N/A	N/A
4	Plant-Rich Diet	Food	66.11	N/A	N/A
5	Tropical Forests	Land Use	61.23	N/A	N/A
6	Educating Girls	Women and Girls	59.60	N/A	N/A
7	Family Planning	Women and Girls	59.60	N/A	N/A
8	Solar Farms	Electricity Generation	36.90	\$-80.60	\$5,023.84
9	Silvopasture	Food	31.19	\$41.59	\$699.37
10	Rooftop Solar	Electricity Generation	24.60	\$453.14	\$3,457.63
11	Regenerative Agriculture	Food	23.15	\$57.22	\$1,928.10
12	Temperate Forests	Land Use	22.61	N/A	N/A
13	Peatlands	Land Use	21.57	N/A	N/A
14	Tropical Staple Trees	Food	20.19	\$120.07	\$626.97
15	Afforestation	Land Use	18.06	\$29.44	\$392.33
16	Conservation Agriculture	Food	17.35	\$37.53	\$2,119.07
17	Tree Intercropping	Food	17.20	\$146.99	\$22.10
18	Geothermal	Electricity Generation	16.60	\$-155.48	\$1,024.34
19	Managed Grazing	Food	16.34	\$50.48	\$735.27
20	Nuclear	Electricity Generation	16.09	\$0.88	\$1,713.40

TMEO Lessons



- <https://ncse.com/teach/sandbox>
- Shared Google Drive Folder at https://drive.google.com/open?id=1CYJtr91pZHBHyaqjKXjCdt_B235Zcbq (or e-mail me for the links 😊)
- ACE Recorded Webinars at <https://vimeo.com/acespace>



Contact me

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- NCSE.com/teach
 - Teacher Newsletter
 - Classroom Resources
 - Dealing with Denial

