CHICAGO BOTANIC GARDEN

Activity 2.2: Recognizing Change (Observation vs. Inference)

Teacher Notes: Evidence for Climate Change PowerPoint

Slide 1 **Introduction**

Slide 2

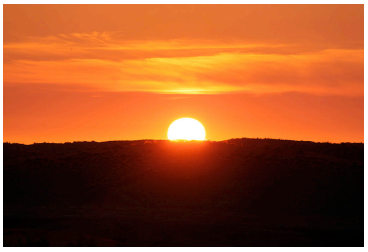
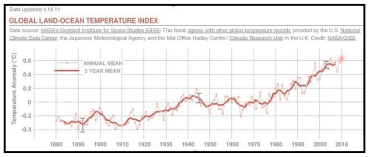


Image 1 (Namib Desert, Namibia)

Observations:
- The sun is on the horizon
- There are no clouds
- The sky is orange/yellow/red
- There is a road

Inferences:
- It is hot
- The sun is rising/setting
- It is dry
- This is a desert

Slide 3



Global Land-Ocean Temperature Index

- All three major global surface temperature reconstructions show that Earth has warmed since 1880.[2]
- With the exception of 1998, the ten warmest years in the 134-year record all have occurred since 2000. 2010 and 2005 rank as the warmest years on record.[3]
- Despite a solar output decline, surface temperatures continue to increase.[4]

Predictions: The global temperature will continue to increase.

Slide 4

Dry ground in the Sonoran Desert, Sonora, Mexico

(Precipitation)

Image 2[9]
Drought: A 2012 study found that soil moisture in already dry areas around the world could decrease as much as 15 percent by 2099.[6]

The 2013 IPCC report (p. 20) notes, "Changes in the global water cycle in response to the warming over the 21st century will not be uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions."[8]

Observations:
- The ground is cracked
- It is brown/red

Inferences:
- It is dry
- It is hot

- It is summer
- It hasn't rained in a long time
- The heat and drought are caused by climate change

Image 3[10]
Rainfall: In another 2012 study, approximately half the analyses found some evidence that human-caused climate change was a contributing factor to the extreme event examined, though the effects of natural weather and climate fluctuations played key roles as well.[7]

Observations:	Inferences:
• There are cars half under water	• It has rained more than usual recently
• The gas station is flooded	• Water is not usually supposed to be there
	• It has rained a lot in a short period of time

Slide 5

Image 4[11]
Water flows through a Moulin on the Greenland ice sheet, December 6, 2013

Rainfall: In another 2012 study, approximately half the analyses found some evidence that human-caused climate change was a contributing factor to the extreme event examined, though the effects of natural weather and climate fluctuations played key roles as well.[7]

Observations:	Inferences:
• There is an ice sheet (or glacier)	• The ice is thick
• There is a river/water on the ice sheet	• The ice is melting
• There are people standing on the ice	• It is below 32 degrees Fahrenheit

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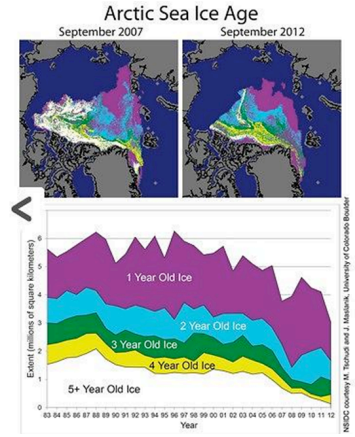
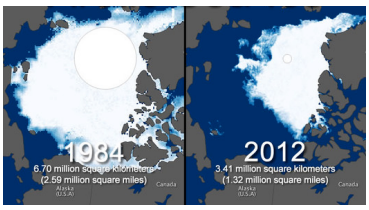
Slide 6





Declining Arctic Sea Ice

Visualization: Arctic Sea Ice Age[12]
Both the extent and thickness of Arctic sea ice have declined rapidly over the last several decades.

Despite the near-average rate of decline in ice extent through the month, August 2014 ended up with the 7th lowest extent in the satellite record. The monthly linear rate of decline for August over the satellite record is now 10.3 percent per decade.[13]

Annually updated sea ice information can be found here: http://nsidc.org/arcticseaicenews/

Visualization: Arctic Sea Ice Coverage[14]
Between 1984 and 2012, more than 50 percent of sea ice cover has been lost—a reduction of 3.29 million square kilometers. Monthly average ice volume for September 2013 was 67 percent lower than the maximum in 1979.[14]

Predictions:
Ice coverage and volume will continue to decrease if the temperature continues to increase.

The average age of arctic sea ice will continue to decrease.

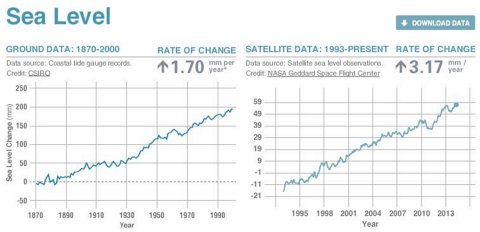
Slide 7

Island Republic of Maldives
Image 5[16]
The island of Male, capital of the Maldives Islands in the Indian Ocean, is at ground zero in Earth's sea level rise dilemma. With a maximum elevation of only 8 feet (2.4 meters), even a modest increase in ocean heights would submerge a majority of its territory. To combat the threat, the government erected a seawall around the entire island.[17]

Observations:
- It is surrounded by water
- There are buildings on the island
- Buildings are close to the water

Inferences:
- It is surrounded by ocean (salt water)
- It has beaches
- There are people living on the island

Slide 8



Island Republic of Maldives
Sea Level Rises[18]

NASA Sea Level Rise Graphs: Sea level rise is caused by two factors related to global warming: the added water coming from the melting of land ice, and the expansion of sea water as it warms up. The graphs show how much sea level has changed since 1993 (right, satellite data record) and about 1880 (left, coastal tide gauge data). Updated graphs can be found on NASA's website:
http://climate.nasa.gov/key_indicators/#seaLevel

Sea level has been rising over the past century, and the pace has increased in recent decades. Part of the increase is due to meltwater from glaciers and ice sheets—and part is due to rising water temperatures: water expands when it gets warmer.[19]

Sea surface temperature increased over the 20th century and continues to rise. From 1901 through 2013, temperatures rose at an average rate of 0.13 degrees Fahrenheit per decade, for a total of 0.40 degrees Fahrenheit.[20]

Predictions:
Sea level will continue to rise
The rate of sea level rise will stay the same
The rate of seal level rise will increase

Slide 9

Image 6 (Snowstorm)

Observations:
- There is a lot of snow on the ground
- The car is covered with snow
- The roads have not been plowed

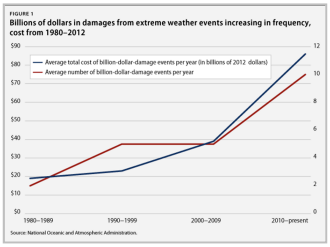
Inferences:
- It has snowed recently
- It will be dangerous to drive
- This is a location where it usually snows

Image 7 (Flooded House[22])

Observations:
- Two houses are half under water
- Trees are partially under water

Inferences:
- It has snowed recently
- It will be dangerous to drive
- This is a location where it usually snows

Increasing numbers of intense precipitation events have been recorded in the United States and globally. The number of extreme weather events, and their economic costs, has been increasing over the past 30 years.[23]



Human influences are having an impact on the increased severity of some extreme weather and climate events, according to the report *Explaining Extreme Events of 2012 from a Climate Perspective.*[24,25]

Predictions:
The number of severe storms will increase
The severity of storms will increase

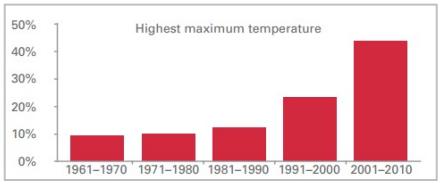
Slide 10

Image 8 (Hot dry landscape[26])

Rainfall: In another 2012 study, approximately half the analyses found some evidence that human-caused climate change was a contributing factor to the extreme event examined, though the effects of natural weather and climate fluctuations played key roles as well.[7]

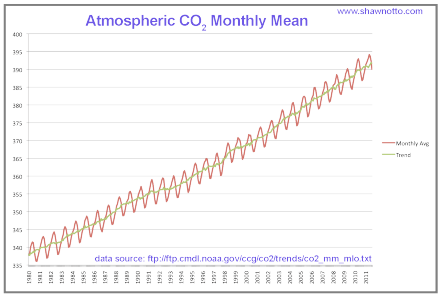
Observations:
- The sun is shining
- There are no leaves on the tree
- The grass is brown

Inferences:
- It is very hot
- It has not rained recently
- The tree and grass are dead, caused by heat and lack of water



According to a 2010 World Meteorological Organization survey, 100 percent of the countries in the world reported their highest recorded temperature after 1960, and 44 percent were between 2001 and 2010.[27,28]

Slide 11



Carbon Dioxide Levels/Keeling Curve

The Keeling Curve shows a pattern of steadily increasing carbon dioxide in the atmosphere since 1958.

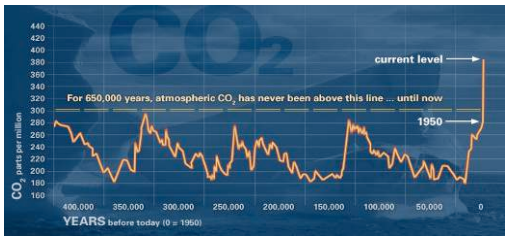
Scientists reconstruct past climate conditions through evidence preserved in tree rings, coral reefs, and ice cores. For example, ice cores removed from 2 miles deep in the Antarctic contain atmospheric samples trapped in tiny air bubbles that date as far back as 650,000 years. These samples have allowed scientists to construct a historical record of greenhouse gas concentration stretching back hundreds of thousands of years.[29]

Observations:
- Atmospheric CO_2 is increasing
- There is a seasonal difference in CO_2 concentration
- There is more CO_2 in the atmosphere in the summer than in the winter

Inferences:
- CO_2 was lower before 1958

Predictions:
CO_2 will continue to increase

Slide 12



Historical Carbon Dioxide Levels

Observations:
- The sun is on the horizon
- There are no clouds
- The sky is orange/yellow/red
- There is a road

Inferences:
- It is hot
- The sun is rising/setting
- It is dry
- This is a desert

Levels of carbon dioxide are higher today than at any time in the past 650,000 years.[30]

Human activity (fossil fuel burning, deforestation, land use) add CO_2 to the atmosphere.

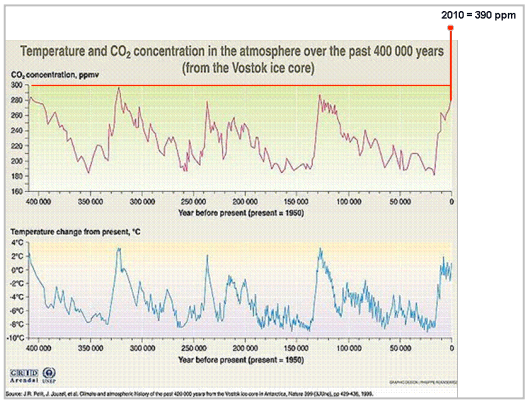
Predictions:
Something happened around 1950 to cause CO_2 to increase dramatically.
CO_2 will continue to increase.
Unless we change something, human activity will continue to add CO_2 to the atmosphere.

Slide 13

What are your predictions for the future?
Have students answer the final question on their handout.

TEACHER REFERENCE ONLY

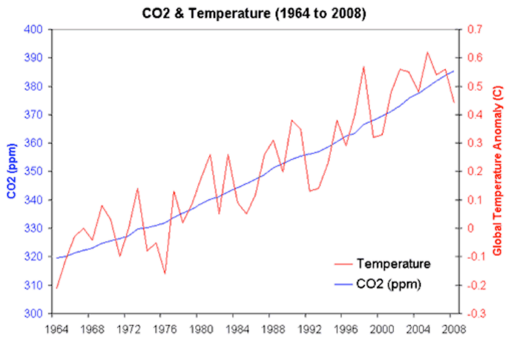
Slide 14 (Historical CO_2 and Temperature)



This is for your reference. This graph will form the basis of the work in Activity 2.5: Historical Climate Cycles

Correlation between CO_2 and temperatures from 650,000 B.C.E. to the present.[31]

Slide 15 (Current CO_2 and Temperature)



Graph: Temperature and CO_2 comparison using annual atmospheric carbon dioxide (*NOAA*) and annual global temperature anomaly (*GISS*) from 2002 to 2008.[32]

