LP 4 Impacts of Climate Change on Physical Systems

# of Days	2		
Prior Knowledge	Depending on students' backgrounds they may or may not be able to identify dependent and independent variables. If students struggle with reading easy graphs, they may need more scaffolding prior to the Stations activity.	California English-Language Arts Content Standards	Reading 2.5 Writing 2.3.b, c Listening and Speaking 1.1, 2.0.b, c
Lesson Objective	Students will analyze the sources for climate data and will analyze this data to identify the impact of climate change on physical systems.	Language Goals/Demands	Students will be able to describe the impacts of climate change on the physical system and justify claims with evidence.
Lesson Assessment	Quiz over using data to make conclusions & mitigation strategies	Changes for Next Time	
California State Science Standard	Earth Science 1.c, 4.a, 4.b, 4.c, 6.a, 6.c, 6.d, 8.b; Investigation 1.a, 1.d, 1.m		
Materials Needed	Graphs and Questions for each station; Graphs for Causes; Powerpoint slides for Ice Core Explanations, Mitigation Powerpoint	What Worked Well	

Time	Learning Task or Activity	Method & Notes
Day 1		
3 min	BW: Some scientists collect data from tens of thousands of years ago. How do you think scientists can know what happened so far in the past? Discuss your ideas with a partner	Pair Work
20 min	Data Collection Instrumentation - Show students slide #2 pointing out that the data goes back 100,000 years. - Ask for student input about how data is collected especially from periods long ago. (Talk about thermometers, satellites, etc. and introduce ice cores if students don't suggest this) - Pass out Student Guide for use during this segment	WHOLE CLASS DISCUSSION/ANALYSIS See Slides 4.1.1 for Ice Core Slides See 4.1.1 for Ice Core Slides and Notes See 4.1.2 for Ice Core Guiding Questions If you have access to streaming video, you may replace the slide show and data analysis with the KQED video (20 minutes) on ice cores found at: http://www.kqed.org/quest/television/web-extra-at-the-core-of-climate-change

7 min	Mitigation Introduction - We have talked about the presence of GHG's and how we detect them, how do you think we can limit them? We will be talking about this at different points over the next few lessons. - Have the chalkboard divided into four parts. Assign student pairs to one sector and have them discuss for four or five minutes how we might be able to decrease or "mitigate" GHG emission in these sectors. Have students write ideas on the board under the proper heading Possible Sectors: Transportation, Heating & Cooling Buildings, Industry emissions, Electricity Use	PAIR WORK See Slides 4.1.3, # 1-3 to introduce the activity
12 min	Mitigation Presentation - Present slides on four or five of the wedge strategies that students will use for the summative assessment	LECTURE/SLIDES See Slides 4.1.3 for Mitigation Strategies See Teacher Guide 4.1.3 for copies of mitigation strategies and notes
HW	Concept Maps - Add the following terms and relationships to your Concept Map: Sea Level Rise, Glacial Cover, Ice Cores	HOMEWORK SLIDE See 4.1.3 #8 for homework slide
Day 2		
3 min	BW: What parts of Earth's systems do you think are changing due to increased greenhouse gases? Try and think of two or three possibilities.	INDIVIDUAL SEAT WORK
5 min	Introduction to Stations - Humans are responsible for significant increased carbon emissions that have an impact on physical and biological systems. Today we are going to look at evidence to make claims about the impact of increased emissions on the physical world. You will be divided into groups and rotate through four stations. Each station has the instructions and task cards. You will record your answers on the student handout. - Divide up students into four groups	TEACHER-LED INSTRUCTIONS See 4.2.1 for Station Resource Cards See 4.2.2 for Station Task Cards See 4.2.3 for Student Prompts for the Station Activity

8 min	Station 1: Long-term Temperature Graphs Station 2: Long-term Sea Level Rise Graphs Station 3: Long-term Snow Cover Graphs Station 4: Severe Weather Frequency Graphs	GROUP WORK
8 min	Station 2:	GROUP WORK
8 min	Station 3:	GROUP WORK
8 min	Station 4:	GROUP WORK
10 min	Group Processing/Station Debrief - What claims can be made about climate change? - What is the evidence that climate is changing? What is the impact on physical systems? (Remind students to support their statements with data from the previous day's stations). - Is this evidence convincing?	TEACHER-LED DISCUSSION See 4.2.4 for Discussion Slides
HW	Write a paragraph summarizing the impact of climate change on the physical system. You should mention how confident you feel in the data that supports these claims.	

4.0: Lesson Plan 4: The Impact of Climate Change on Earth's Physical System

Teacher Guides:
4.1.1 – Ice Core Slides
4.1.2 – Ice Core Guiding Questions Handout
4.1.3 – Mitigation Slides

4.2.1 – Station Resource Cards
4.2.2 – Station Task Cards
4.2.3 – Student Prompts for Stations Activity
4.2.4 – Slides for Station Discussion

Lesson Plan 4 Quiz

Optional Video Link

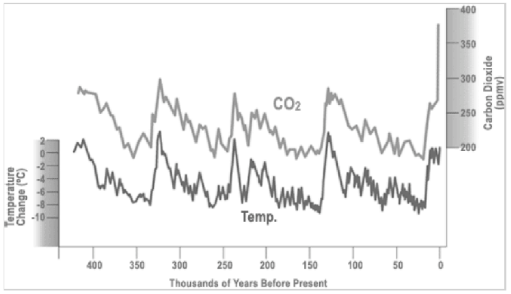
http://www.kqed.org/quest/television/web-extra-at-the-core-of-climate-change

How do we know about the climate from thousands of years ago?

PPT 4.1.1

We have studied how greenhouse gases affect the temperature of the earth and we know a lot about the climate from thousands of years ago. Right now we are going to talk about how we know about climate in the distant past so that we can compare it to our current climate.

Climate Readings Over Time



DATA: Petit, J.R., et al., 2001; NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

PPT 4.1.1

This graph show carbon dioxide and temperature over the last 450,000 years. It isn't important that you understand the graphs so much as that scientists are measuring climate over a very long period of time. As we have seen in previous presentations, the amount of carbon dioxide that is in the atmosphere is much more now than it has ever been in the past 450,000 years although levels were higher millions of years ago. Why do you think it doesn't look like the temperature has gone that much higher? (Answer: Temperature change lags behind the CO_2 increase caused by human activities, so the climate is still responding to the big increase in CO_2.)

How do you think they measured the temperature?

Measuring Devices

- Thermometers were not invented until 1724.
- Other climate measuring devices were not invented until much later.
- How can we make long-term climate graphs?

PPT 4.1.1

At this point, if you have access to streaming video, you can replace the slides with the KQED video (20 minutes) on ice cores found at:

http://www.kqed.org/quest/television/web-extra-at-the-core-of-climate-change

Thermometers are only a couple of hundred years old, but we have data for hundreds of thousands of years. What do you think they use?

Ice Cores!

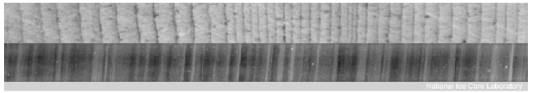
PPT 4.1.1

Ice Cores

- Drilling into glacial ice allows us to see back in time.
- Each winter new snow fall packs on top of previous snow. This creates a new band each year.

PPT 4.1.1

Dating Ice Cores

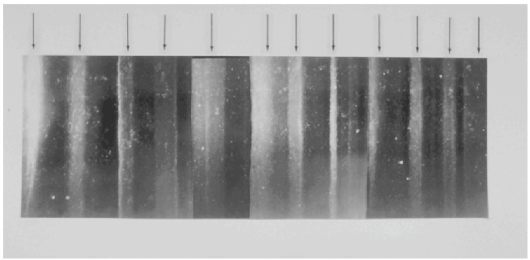


- Ice cores are like tree rings
- Summer ice appears light
- Winter ice appears dark
- How many years do you see?

PPT 4.1.1

The summer bands appear white because the snow experiences 24 hours of sunlight in the polar regions. This changes the texture compared to the 0 hours of sunlight that it receives in the winter.

Dating Ice Cores

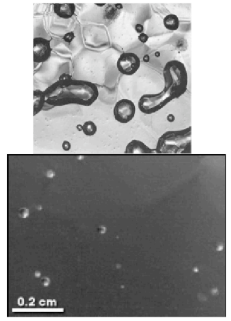


This ice core shows 12 years

PPT 4.1.1

Air Bubbles

- Air bubbles in the ice trap pollen and the atmosphere which is made of gases.
- These help scientists know what the climate was like thousands of years ago.



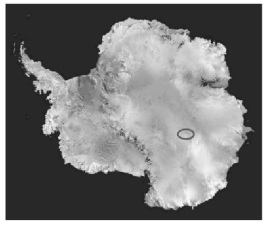
PPT 4.1.1

In the ice, the water molecules (H_2O) have oxygen atoms of different isotopes. The ratio of the amount of one oxygen isotope to another oxygen isotope is used as a proxy for temperature. Scientists can measure the isotope ratio of the ice to determine the past temperature.

Pollen and dust particles are used to infer more about the conditions at that time.

There are gas bubbles trapped in the ice also. This gas can be analyzed to determine the amount of greenhouse gases that were in the atmosphere long ago. This is how scientists can measure the amount of carbon dioxide in the atmosphere.

The Vostok Ice Core



- The Vostok Ice Core is a Russian Station near the South Pole.
- Their ice cores have produced climate data for the past 420,000 years!

PPT 4.1.1

The ice cores can be taken from thousands of feet deep, but the length of the core depends on the length of the drill bit. Most drill bits are 4-6 meters long so scientists get extremely long ice cores (over 2000 meters) from increments of 4-6 meters.

Analyzing the Data: Isn't Heating and Cooling Just a Natural Cycle of the Earth?

PPT 4.1.1

See Student Handout for Ice Core Data

Vostok Ice Core Data
Beginning & Ending Temp. Data

	Age of Ice (years)	Temperature Difference (Degrees Celsius)
Top of Core	0	0
	17	0
	35	0
	53	0
	72	0
Bottom of Core	419095	0.94
	419682	0.51
	420281	0.54
	420888	0.32
	421507	0.15
	422135	0.08
	422766	0.23

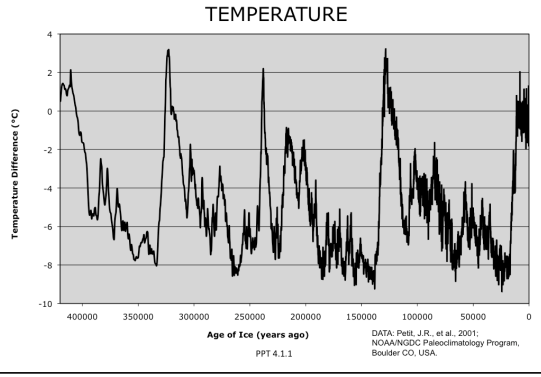
DATA: Petit, J.R., et al., 2001; NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

PPT 4.1.1

These temperatures were collected via an oxygen isotope proxy. The amount of oxygen isotope 18 can be measured and is strongly correlated with temperature.

In what year do the readings begin?

Vostok Ice Core Data



DATA: Petit, J.R., et al., 2001; NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

PPT 4.1.1

Ice Core Data
Sample Carbon Dioxide Data

Gas age (yrs)	CO_2 (ppmv)
2342	284.7
3634	272.8
3833	268.1
6220	262.2
7327	254.6
8113	259.6
10123	261.6
11013	263.7

In what year does this data begin?

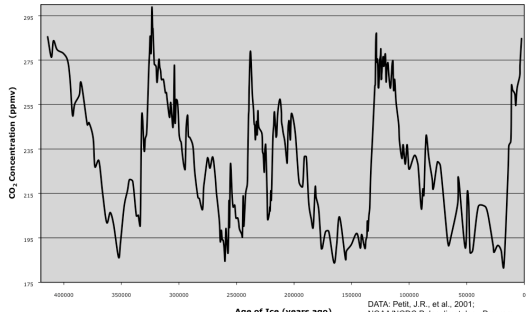
PPT 4.1.1

DATA: Petit, J.R., et al., 2001; NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

CO2 concentration is measured by careful extraction of the gas bubbles.

Vostok Ice Core Data

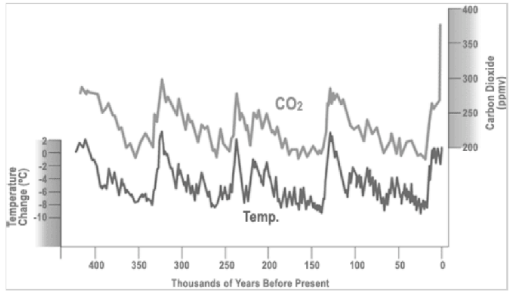
Carbon Dioxide



PPT 4.1.1

DATA: Petit, J.R., et al., 2001; NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

Climate Readings to the Present



DATA: Petit, J.R., et al., 2001; NOAA/NGDC Paleoclimatology Program, Boulder CO, USA.

PPT 4.1.1

These graphs show the recent carbon dioxide level. Previous highs have been surpassed by a great deal.

There is natural variation, but we have disturbed the system to cause unnatural variation.

Given that temperature lags a bit behind carbon dioxide emissions, we can expect to see temperature increases in the future.

Ice Core Conclusions

- The Earth has been this hot before, but it was far different than the conditions we have today. For example, there were no ice caps at the poles.
- The carbon dioxide level has not been this high in the last 420,000 years although it had been much higher millions of years ago.
- If CO_2 keeps increasing, temperatures are virtually certain to surpass highs of the past 420,000 years.

PPT 4.1.1

Name _____

Student Handout 4.1.2: Vostok Ice Core Data

Guiding Question: Aren't cycles of warming and cooling natural for Earth's climate?

Temperature Graphs

1. Looking at the data table, in what year does the temperature data start and stop?

2. Looking at the temperature graph, how many cycles of warming and cooling has the Earth had in the past 420,000 years?

3. Has the Earth ever been this hot in the past 420,000 years?

Temperature & Carbon Dioxide Graphs

4. Look at the temperature and carbon dioxide graphs. When carbon dioxide is highest, what is the temperature at the same time?

5. Look at the data table for carbon dioxide. What is the most recent date shown? What is the carbon dioxide level for that date?

6. What is the current level of carbon dioxide?

7. Based on your answers for questions 4-6, what do you think will happen to temperatures in the near future?

8. Do you think this is part of a natural cycle? Why or why not?

MITIGATING CLIMATE CHANGE

Climate Change mitigation: actions we can take to reduce the emissions of greenhouse gases. For this lesson we will be learning about 4 mitigation strategies. These strategies will help mitigate or reduce the amount of carbon dioxide that is released into the atmosphere.

WHAT WE KNOW

The level of greenhouse gases in the atmosphere have increased, causing the Earth's temperature to rise.

One greenhouse gas in particular, carbon dioxide (CO_2) has steadily increased over the past century largely due to human activity (anthropogenic).

We know that emissions have a significant impact on the world around us. How can we reduce the amount of carbon that is emitted?

This should be a review of earlier lesson

We know this from different sources like the ice cores that we just discussed.

If we want to avoid changing the earth even more, we need to cut down or mitigate the amount of carbon that we use.

At this point have students work in pairs or small groups for 5-7 minutes to come up with ways in which they could reduce carbon emissions in the sectors shown on the next slide.

What is mitigation?

- To decrease force or intensity. To lower risk.

- Earthquake mitigation
- Flood mitigation
- Climate change mitigation

Some official definitions of mitigation: To moderate in force or intensity, to alleviate. To lessen in force or intensity. Elimination or reduction in frequency, magnitude or severity of exposure. To minimize risk.

An informal definition that could be used to discuss the idea: Basically to make something that could be very bad less bad.

Ask for examples of things people do to "mitigate" for the following environmental effects:

Earthquake – build houses to building codes, try to get people to have emergency kits, meeting points.
Floods – build houses on stilts, make walls so the water can't get in. Create dams.
Climate Change – mostly involve decreasing the amount of greenhouse gases of all kinds in the atmosphere. For the most part, mitigation cannot reverse warming that has already occurred, it can only slow or stop what would come without any changes.

How can we reduce carbon emissions?

- Work in pairs to talk about ways in which we could reduce (mitigate) carbon emissions in the following areas. Feel free to write your answers in the appropriate column on the board:
  - Transportation
  - Heating and Cooling Buildings
  - Industry Carbon Output
  - Electricity Use

Mitigation Strategy #1: Transportation Efficiency

A car that gets 30 mpg releases 1 ton of carbon into the air for every 10,000 miles of driving

Fuel efficient cars get more miles per gallon (mpg)

Increasing the fuel efficiency of cars will reduce the amount of CO_2 emitted into the atmosphere

Quick formative assessment: make sure students remember what efficiency means

Mitigation Strategy #2: Transport Conservation

With more cars on the road, the amount of CO_2 emitted steadily increases.

Reducing the time and number of cars on the road will reduce emissions.

Increasing the use of public transportation would reduce the amount of individual driving time.

Mitigation Strategy #3: Building Efficiency

Providing electricity, transportation, and heat for buildings produces high levels of CO_2 emission.

Reducing heating and energy use would reduce the amount of carbon released into the atmosphere.

Insulating buildings, using alternative energy sources, and solar water heating are ways to reduce emissions.

Mitigation Strategy #4: Efficient Electricity Production

25% of the world's carbon emissions come from the production of electricity at coal plants.

Since nearly 50% of electricity comes from coal combustion, improving coal plant efficiency will significantly reduce carbon emission.

To do this requires alternative ways of using coal to produce electricity.

Homework:

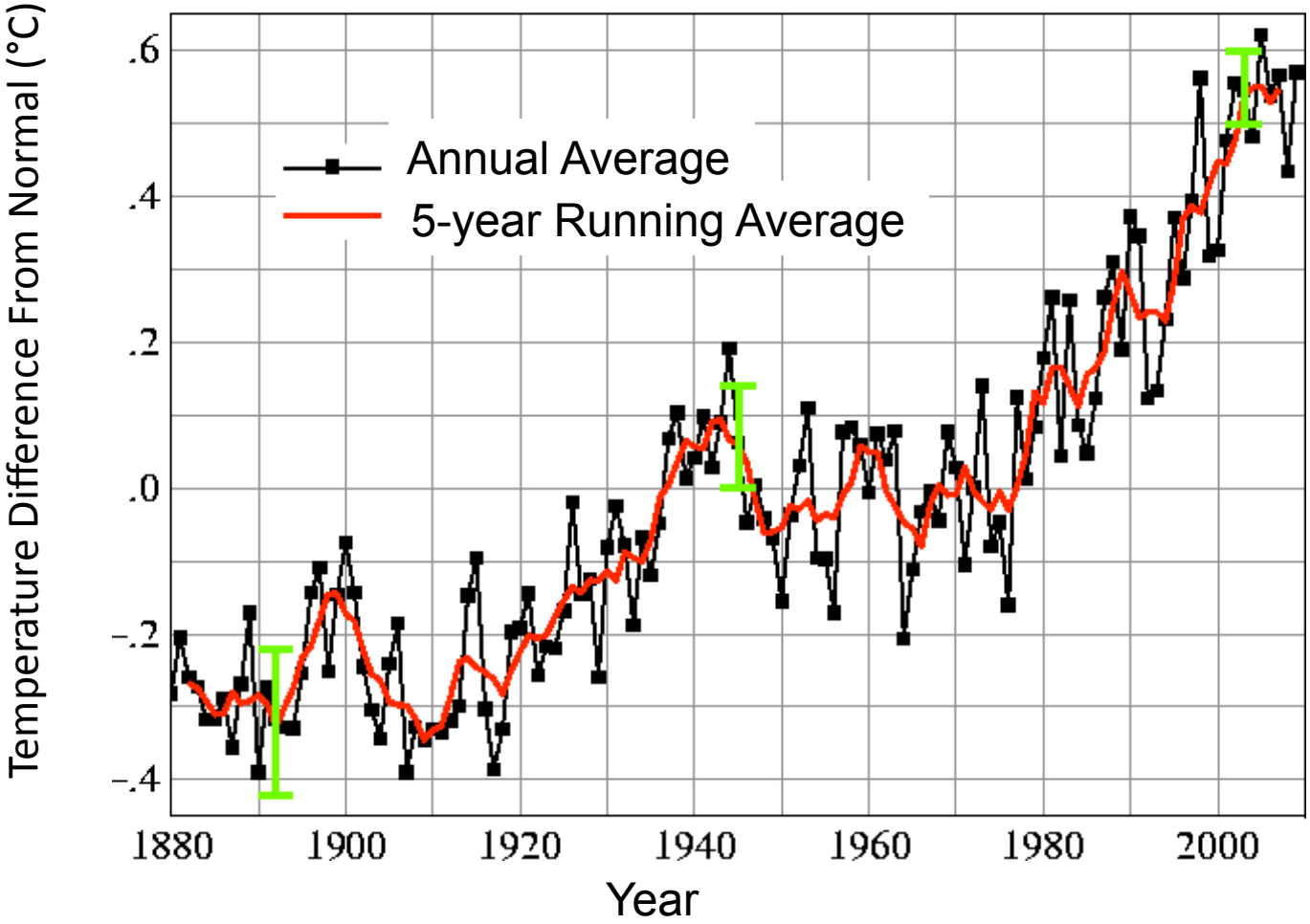
Add the following terms to your Concept Maps

- Sea Level Rise
- Glacial Cover
- Ice Cores

Impacts of Climate Change on Physical Systems

Graph 1: Temperature

Global Ocean and Atmosphere

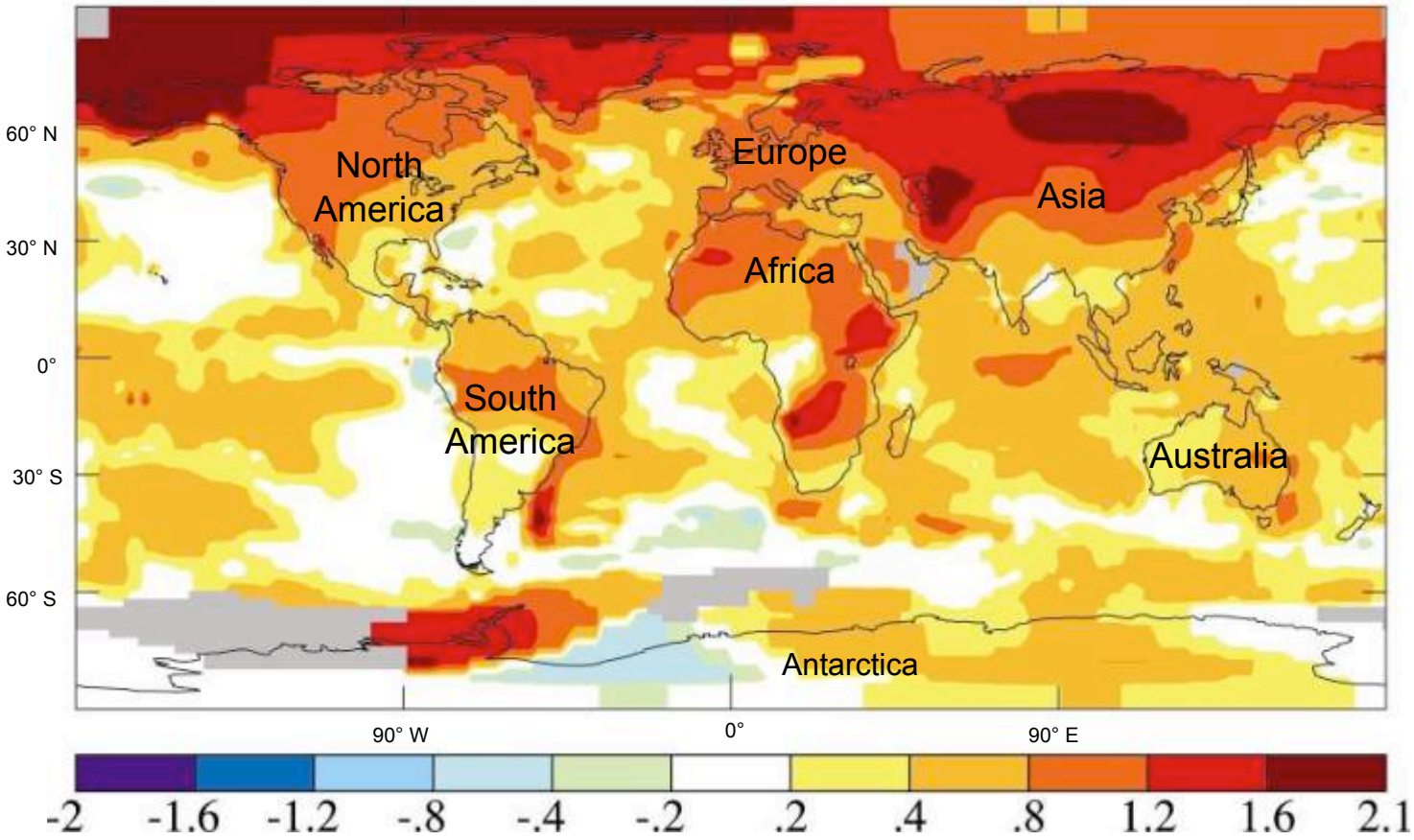


http://data.giss.nasa.gov/gistemp/graphs/

Graph 2: Temperature

2001-2005 Mean Surface Temperature Difference from the Temperatures Recorded from 1951-1980 (in °C)

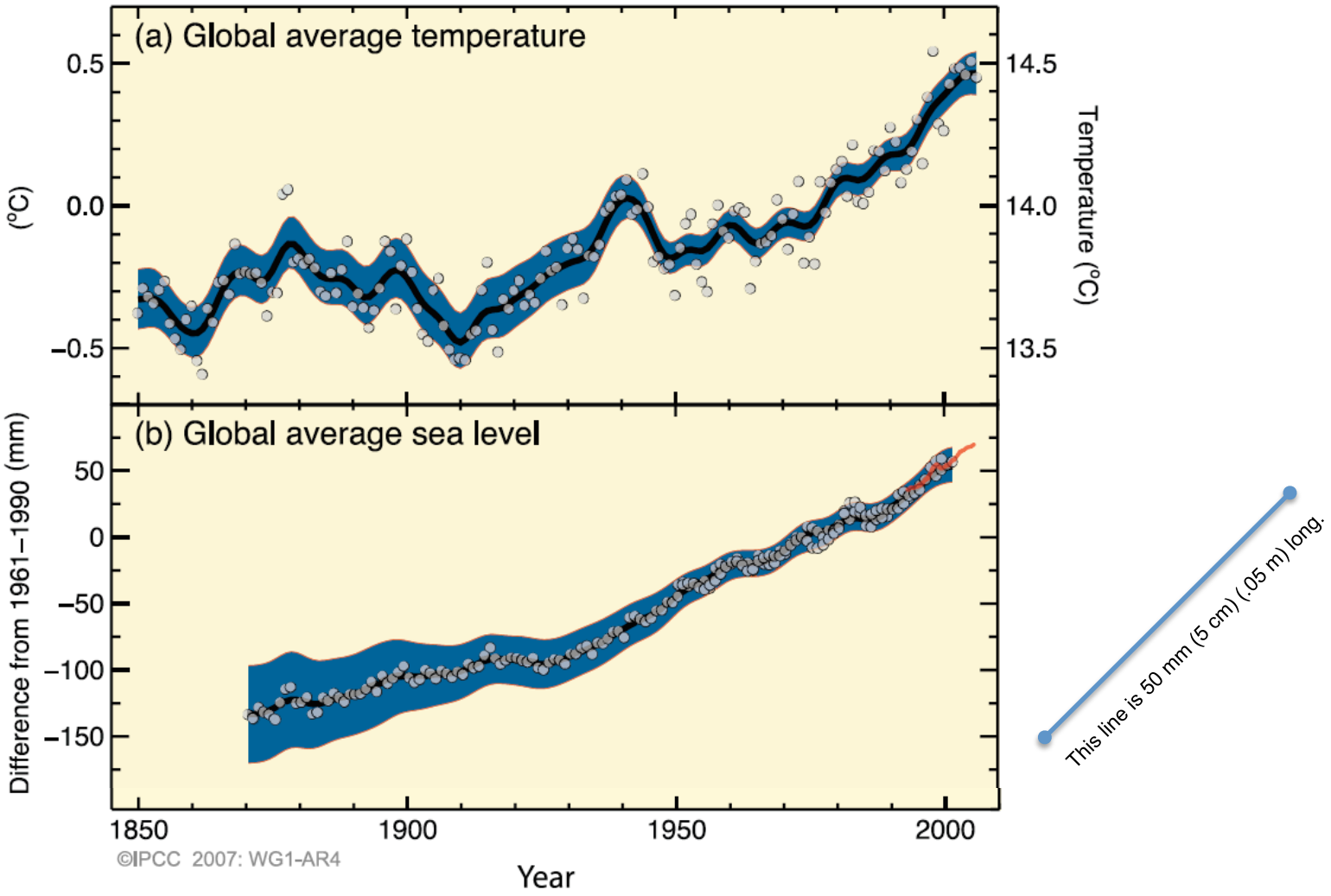
Global Mean = .53



Gray indicates no data.

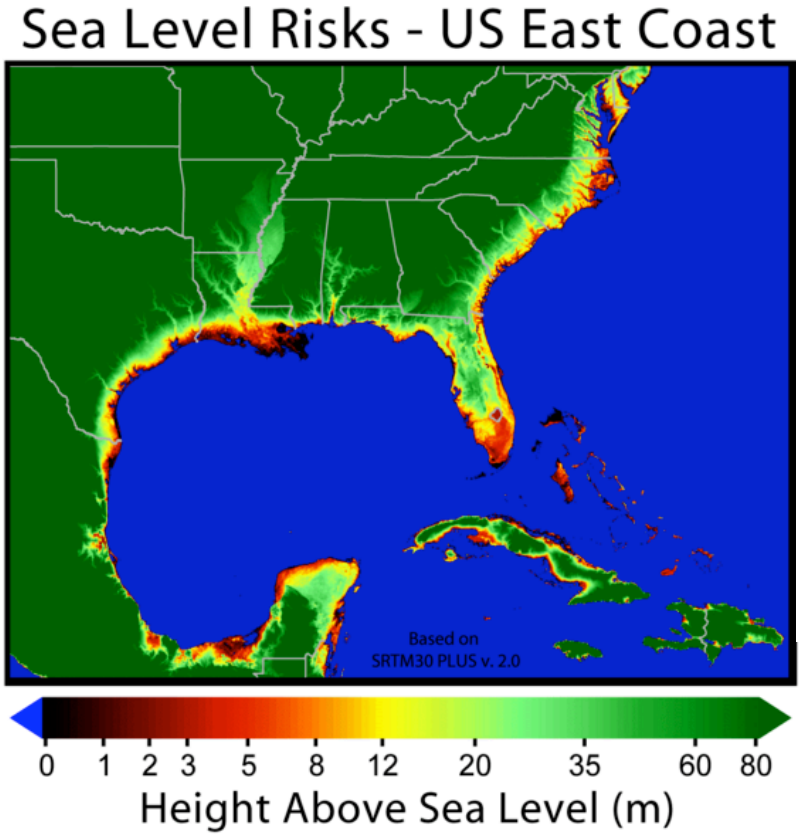
J. Hansen et al., *PNAS 103*: 14288-293 (2006)

Graph 3: Sea Level

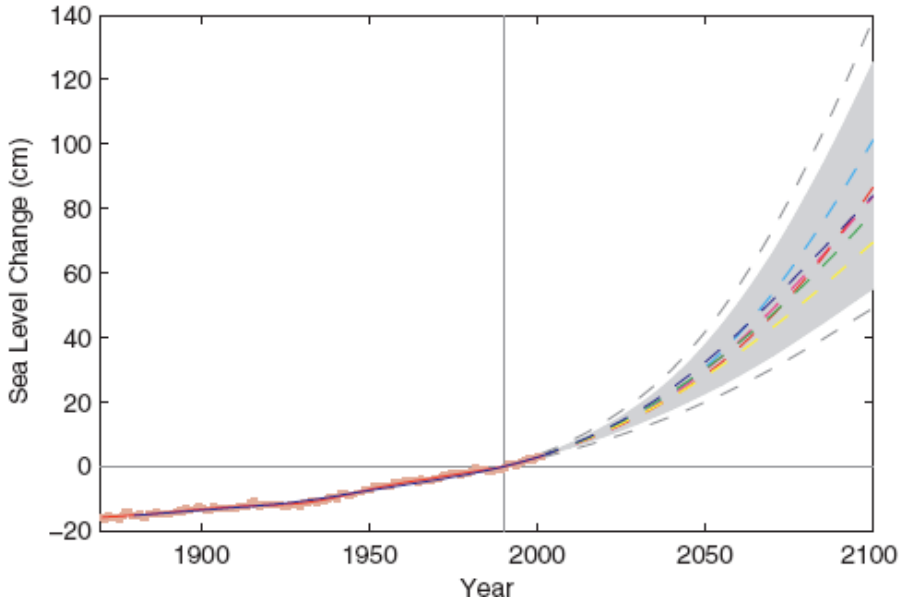


Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties.

Graph 4: Sea Level



This map is designed to emphasize regions of the Eastern United States and Caribbean that are near sea level.



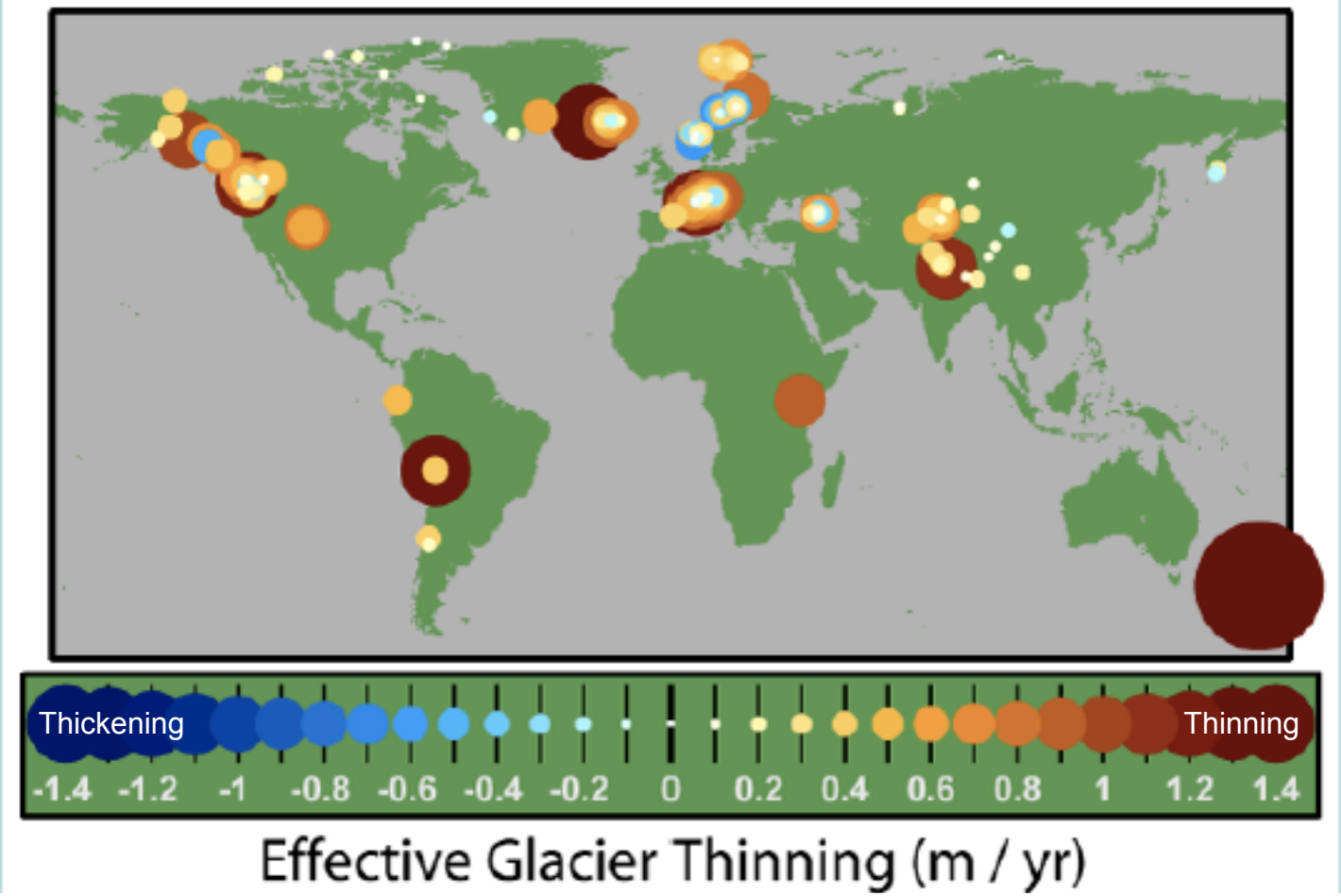
Projected global sea level change. The colored lines represent different models, based on global observations.

1 m = 100 cm = 1000 mm

http://www.globalwarmingart.com/images/2/2c/Global_Sea_Level_Rise_Risks.png

Rahmstorf et al., 2007; *Science*

Graph 5: Glacier Thinning



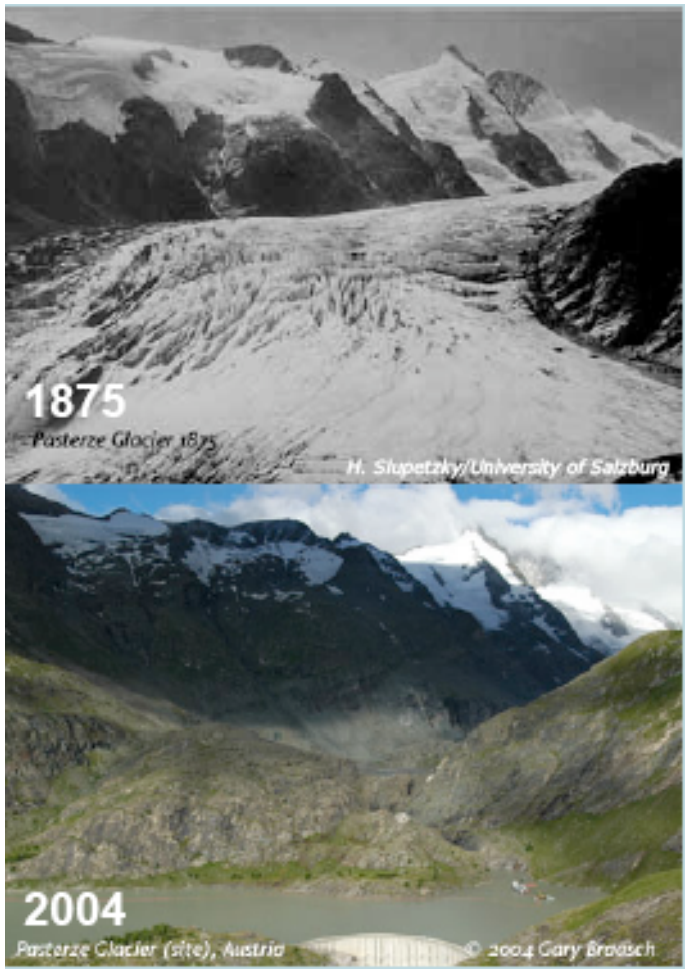
The map shows the average annual rate of thinning since 1970 for the 173 glaciers that have been measured at least 5 times between 1970 and 2004 (Dyurgerov and Meier 2005). Larger changes are plotted as larger circles and towards the back.

http://www.globalwarmingart.com/wiki/File:Glacier_Mass_Balance_Map_png

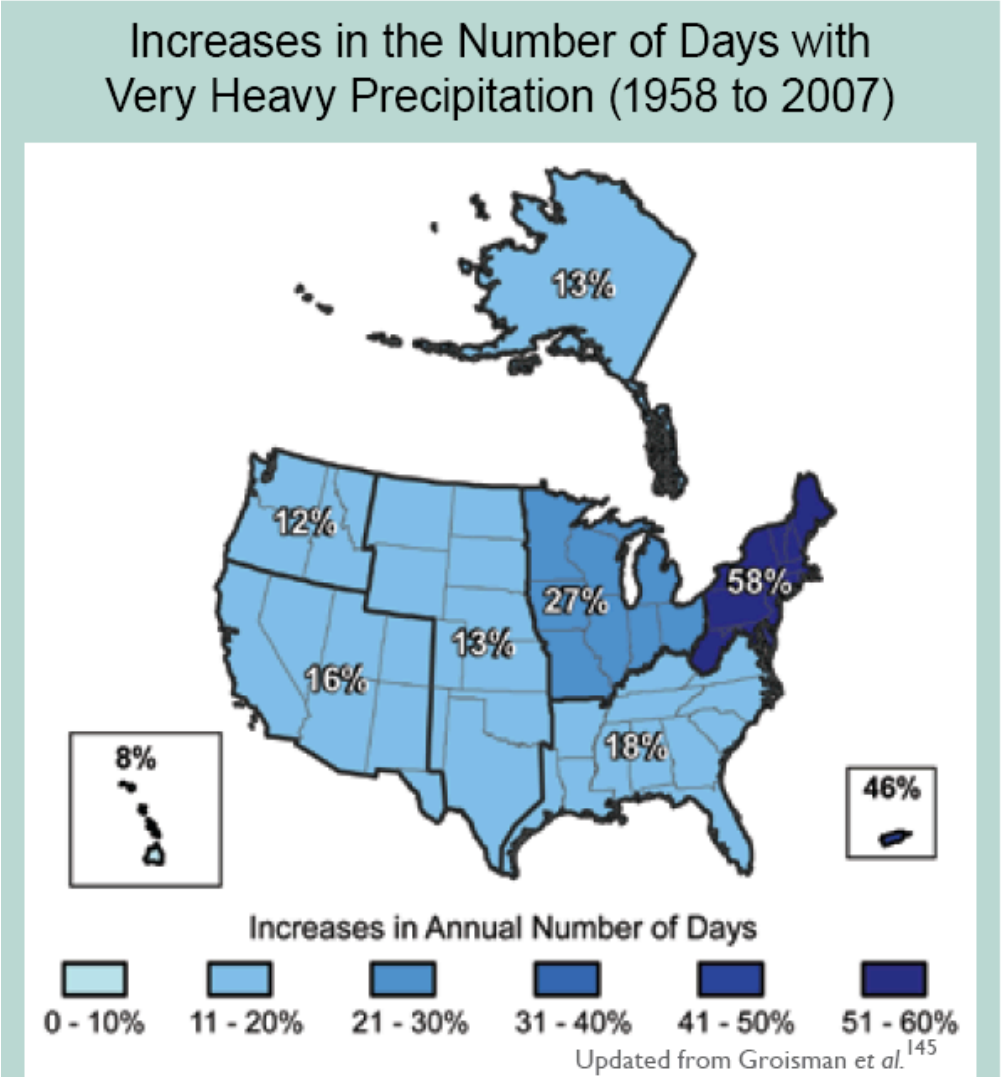
Graph 6: Snow & Glacier Cover

Portage Glacier, Alaska

Pasterze Glacier, Austria

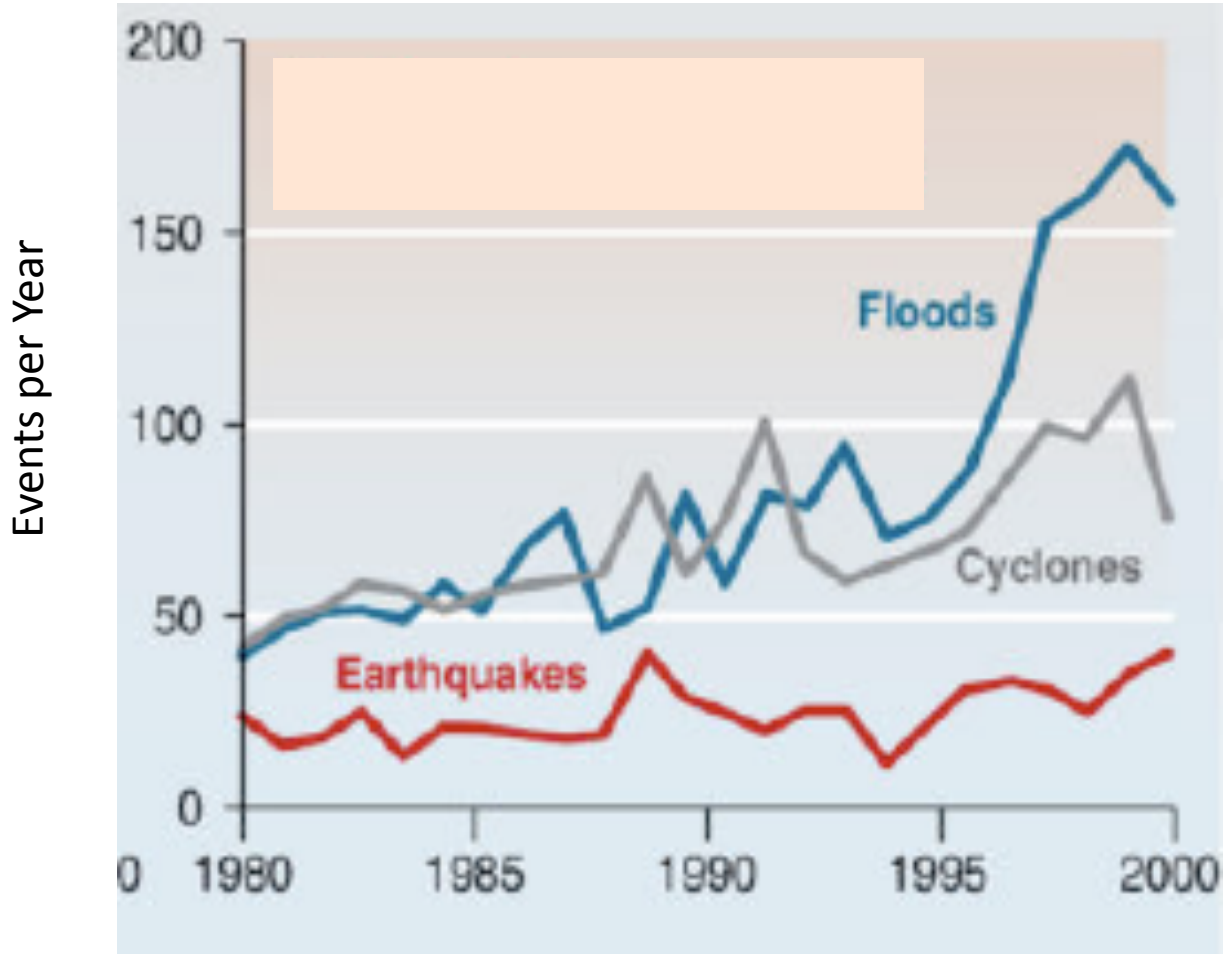


Graph 7: Severe Weather



Very Heavy Precipitation is defined as the heaviest 1% of all events.

Graph 8: Severe Weather



http://maps.grida.no/go/graphic/trends-in-natural-disasters

Station 1 Task Card – Temperature

Evidence for the Impact of Climate Change on the Physical System

Materials
Task Card, Graph 1, Graph 2, Student Handout, p. 1

Instructions

1. As a group, look at graphs 1 & 2. Talk about what you think they represent prior to looking at the questions for this station.
2. Feel free to ask each other questions about parts of the graph that you don't understand or point out parts of the graph that you think are important. It is helpful to start by identifying what each axis represents.
3. **After looking at the graphs, read the questions for this station that appear below. Discuss each question as a group.**
4. After you are finished discussing the questions, **individually answer the two questions for each station on the student handout.**

Station 1 Group Questions

Graph 1

1. What is the difference between the black dots and the red line?

2. How much has temperature, in degrees Celsius, changed since 1880?

3. What does it mean that this graph shows "global ocean and atmosphere temperatures"?

Graph 2

4. Name three places that were colder than normal during 2001 - 2005.

5. Name three places that were warmer than normal.

6. What is the significance of a Global Mean = .53?

Now make an evidence supported claim on your student handout.

Station 2 Task Card – Sea Level Rise

Evidence for the Impact of Climate Change on the Physical System

Materials
Task Card, Graph 3, Graph 4, Student Handout p.1

Instructions

1. As a group, look at graphs 3 & 4. Talk about what you think they represent prior to looking at the questions for this station.
2. Feel free to ask each other questions about parts of the graph that you don't understand or point out parts of the graph that you think are important. It is helpful to start by identifying what each axis represents.
3. **After looking at the graphs, read the questions for this station that appear below. Discuss each question as a group.**
4. After you are finished discussing the questions, **individually answer the two questions for each station on the student handout.**

Helpful Definitions:
Tide Gauge – A device for measuring sea level.
Satellite Altimetry – A satellite image used to judge the elevation above sea level.

Station 2 Group Questions
<u>Graph 3</u>
1. What is the purpose of this graph?

2. What relationship does the graph show?

<u>Graph 4</u>
3. How can you know how high a place is above sea level?

4. Which places have the lowest height above sea level?

5. The map on the right shows different possible projections of sea level rise over the next 90 years. Each line represents a different prediction. If the blue line prediction occurs, will any regions be affected by 2100? If so, which ones?

Now make an evidence supported claim on your student handout.

Station 3 Task Card – Snow and Glacier Cover

Evidence for the Impact of Climate Change on the Physical System

Materials
Task Card, Graph 5, Graph 6, Student Handout p.2

Instructions

1. As a group, look at graphs 5 & 6. Talk about what you think they represent prior to looking at the questions for this station.
2. Feel free to ask each other questions about parts of the graph that you don't understand or point out parts of the graph that you think are important. It is helpful to start by identifying what each axis represents.
3. **After looking at the graphs, read the questions for this station that appear below. Discuss each question as a group.**
4. After you are finished discussing the questions, **individually answer the two questions for each station on the student handout.**

Helpful Definitions:
Glacier – A huge mass of ice that slowly moves over a land mass.

Station 3 Group Questions
<u>Graph 5</u>

1. Look at the scale at the bottom of the figure. What do these colors mean?

2. What places have the most glacier thinning?

3. What is the trend? Are glaciers increasing or decreasing globally?

<u>Graph/Picture 6</u>

4. Why are there two pictures in each column?

5. What do the groups of pictures show?

Now make an evidence supported claim on your student handout.

Station 4 Task Card – Severe Weather

Evidence for the Impact of Climate Change on the Physical System

Materials
Task Card, Graph 7, Graph 8, Student Handout p.2

Instructions

1. As a group, look at graphs 7 & 8. Talk about what you think they represent prior to looking at the questions for this station.
2. Feel free to ask each other questions about parts of the graph that you don't understand or point out parts of the graph that you think are important. It is helpful to start by identifying what each axis represents.
3. **After looking at the graphs, read the questions for this station that appear below. Discuss each question as a group.**
4. After you are finished discussing the questions, **individually answer the two questions for each station on the student handout.**

Helpful Definition:
Cyclone – quickly spinning air like a tornado.

Station 4 Group Questions

<u>Graph 7</u>

1. What do the colors and percentages mean?

2. What patterns do you notice about severe rainfall over the past fifty years?

<u>Graph 8</u>

3. What is the time scale for this graph?

4. What do the different colored lines mean?

5. What pattern do you notice about these natural disasters?

6. Which of the events are associated with climate?

Now make an evidence supported claim on your student handout.

Name _____

Student Handout 4.2.3
Evidence for the Impact of Climate Change on Earth's Physical Systems

Station 1 Conclusions: Temperature

1. Based on graphs 1 & 2, what claim (conclusion) or claims can you make about global temperatures?

2. What is your evidence for this claim?

Station 2 Conclusions: Sea Level Rise

1. Based on graph 3 & 4, what claim (conclusion) or claims can you make about the impact of climate change on sea level rise?

2. What is your evidence for this claim?

Station 3 Conclusions: Snow and Glacier Cover

1. Based on graph 5 & 6, what claim (conclusion) or claims can you make about the impact of climate change on snow and glacier cover?

2. What is your evidence for this claim?

Station 4 Conclusions: Severe Weather

1. Based on graph 7 & 8, what claim (conclusion) or claims can you make about the impact of climate change on severe weather systems?

2. What is your evidence for this claim?

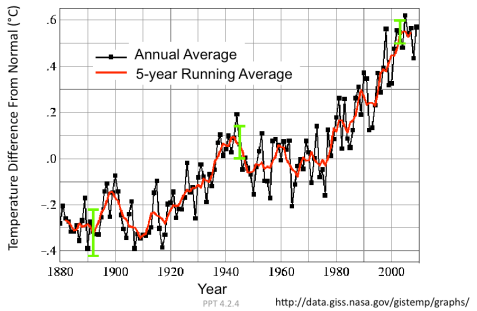
Impacts of Climate Change on Physical Systems

PPT 4.2.4

[These slides are the station resource cards. They may be helpful to project during your debrief of the station activity so that students can refer to specific points of evidence.]

Graph 1: Temperature

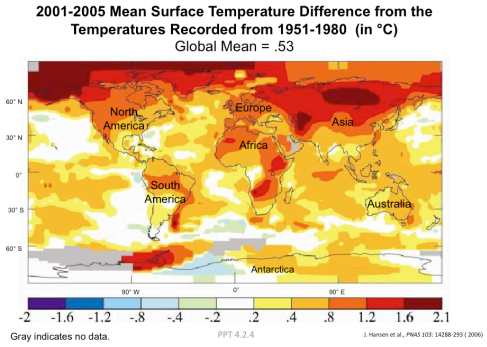
Global Ocean and Atmosphere



PPT 4.2.4 http://data.giss.nasa.gov/gistemp/graphs/

-What is the difference between the blue dots and the red line?
-- How much has temperature changed since 1880?
-- do you think this is enough to affect anything?

Graph 2: Temperature



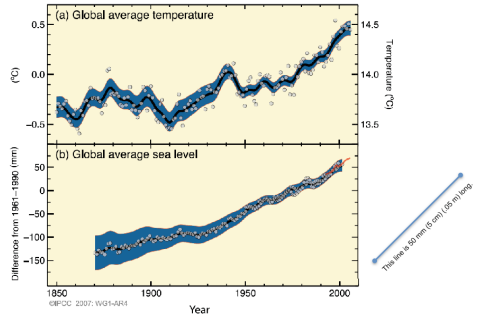
This picture shows a map of the world and whether the temperatures were different than normal over a 5 year period.

-- Which areas were colder than normal?

-- Which areas were hotter than normal?

- What is the significance of a Global Mean = .53

Graph 3: Sea Level



Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties.

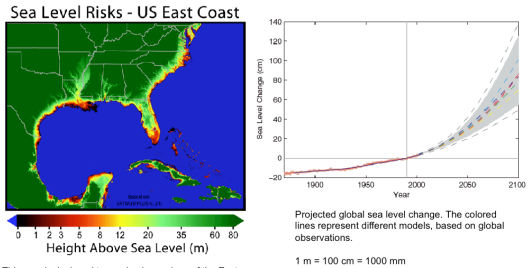
IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.*

Figure SPM.3. ***Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) {FAQ 3.1, Figure 1, Figure 4.2, Figure 5.13}***

1. What is the purpose of these graphs?
2. What relationships do the graphs show?
3. How is this related to climate change? If we had to make a concept map relating the findings in these graph to climate change, what would it look like?

- From 3000 years ago to the start of the 1800's, sea level was almost constant, rising at .1 to .2 mm/year. (you may want to stop and ask students how big a millimeter is). Since 1900, the level has risen at 1-2 mm/year; That is ten times as much as before. Since 1992, satellite measurements indicate a rate of about 3 mm/yr.

Graph 4: Sea Level



This map is designed to emphasize regions of the Eastern United States and Caribbean that are near sea level.

http://www.globalwarmingart.com/images/2/2c/Global_Sea_Level_Rise_Risks.png

Projected global sea level change. The colored lines represent different models, based on global observations.

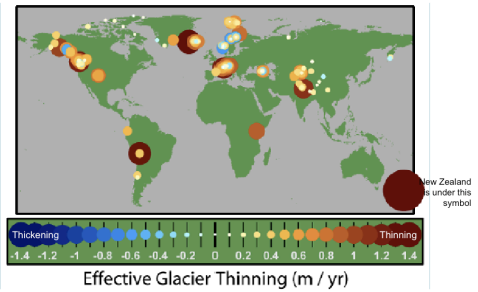
1 m = 100 cm = 1000 mm

Rahmstorf et al., 2007; *Science*

PPT 4.2.4

The map on the right shows the eastern United States and its height above sea level.
-How do you know how high a place is above sea level?
- Which places have the lowest height above sea level?
The graph on the right shows different possible projections of sea level rise over the next 90 years. Each line represents a different prediction. If the blue line prediction occurs, will any regions be affected by 2100?

Graph 5: Glacier Thinning



The map shows the average annual rate of thinning since 1970 for the 173 glaciers that have been measured at least 5 times between 1970 and 2004 (Dyurgerov and Meier 2005). Larger changes are plotted as larger circles. This does not include the ice sheets of Greenland or Antarctica.

http://www.globalwarmingart.com/wiki/File:Glacier_Mass_Balance_Map_png

1. What does the scale mean at the bottom of the figure?
2. What is this graph trying to show?
3. What conclusions can you draw about climate change? What is your evidence?

This sample of mountain glaciers excludes the primary ice sheets of Greenland and Antarctica.

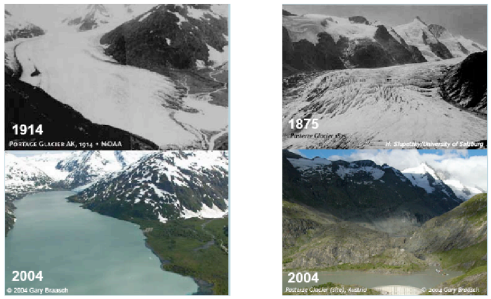
It should be acknowledged that glacier sampling is heavily biased towards North America and Europe. Substantial unsampled mountain glaciers exist in South America, Asia and the margins of Antarctica. However, the glacier distriution is also not uniform. Africa has only a handful of glaciers and continental Australia has none. Despite their relative importance, none of the marginal Antarctic glaciers have had their mass balance sampled at least 5 times since 1970.

These estimates of ice sheet thinning do not include glacier mass lost due to iceberg calving. Such calving is not significant for most mountain glaciers since only a small proportion of these glaciers terminate in large bodies of water.

The time scale for this glacial thinning is unavailable.

Graph 6: Glacier Cover

Portage Glacier, Alaska **Pasterze Glacier, Austria**

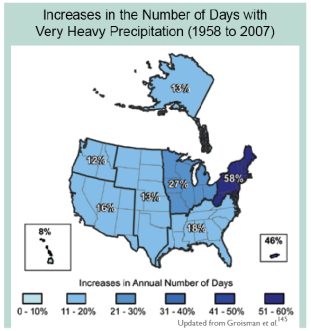


PPT 4.2.4

1. What do the pictures show? Were they taken at the same location?
2. Is there a relationship to climate change? What is your evidence? What evidence would you need to make your claim stronger?

- Since 1980, glacier retreat has threatened the existence of many of the biggest glaciers in the world. This process has increased a great deal since 1995.
- **Ask students: What effect could this claim about snow and glacier cover have on you? Even if it is happening far away.

Graph 7: Severe Weather

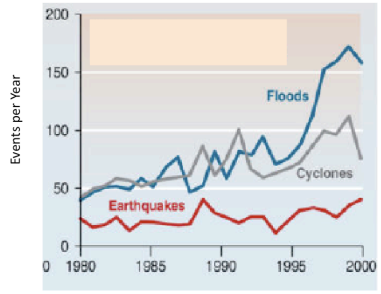


PPT 4.2.4

1. What is the time scale?
2. What do the different colors mean?
3. What conclusions can you draw about the relationship between climate change and severe weather events?
4. How convincing is this relationship?

The frequency of storms won't go up, but the intensity will go up.

Graph 8: Severe Weather



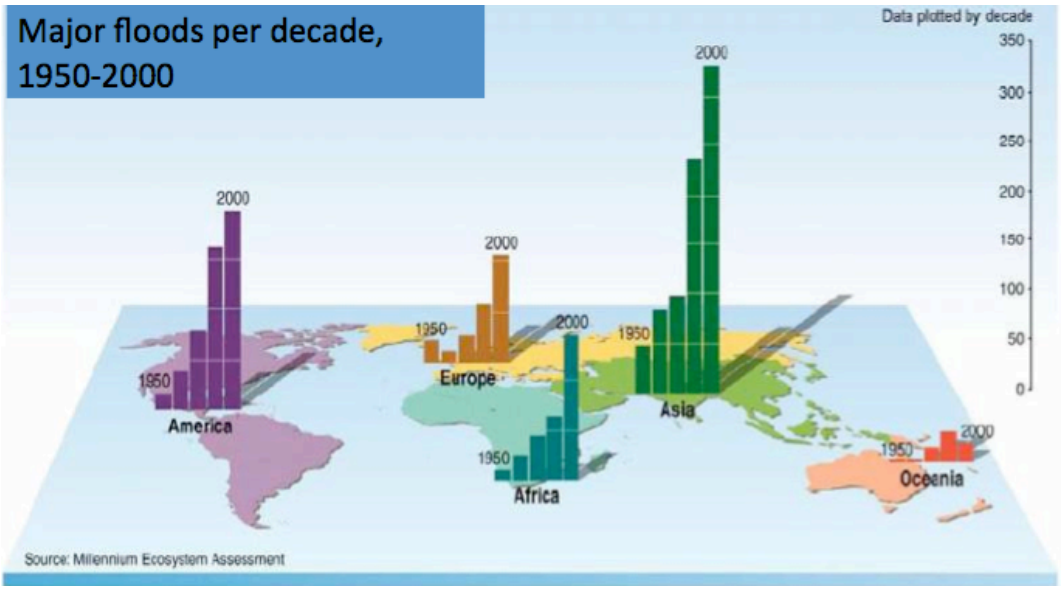
PPT 4.2.4 http://maps.grida.no/go/graphic/trends-in-natural-disasters

1. What is the time scale?
2. What do the different colored lines mean?
3. What conclusions can you draw about the relationship between climate change and the frequency of severe weather events?
4. How convincing is this relationship? Does this strengthen or weaken your conclusions from the previous slide?

- The number of severe weather disasters due to climate (like floods and cyclones) are increasing in comparison to natural disasters (like earthquakes).

Student Name _____
Lesson Plan 4 Quiz

Use the graph below to answer questions 1-3.



1. Looking at the diagram, circle the trend for major floods per decade in America.

   A. Major Floods Increase
   B. Major Floods Decrease
   C. Major Floods Stay the Same

2. What is the global trend of major floods since 1950?

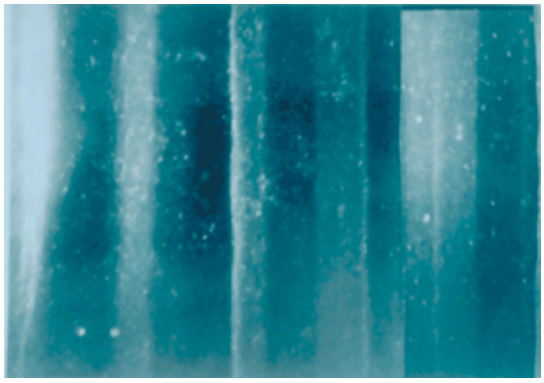
3. Provide two pieces of evidence that support this claim.

4. How do scientists determine climate conditions from 100,000 years ago?

   A. Thermometer Readings
   B. Satellite Images
   C. Tree Rings
   D. Ice Cores

4. About how many years does this ice core sample represent?

A. 1-2 years
B. 4-5 years
C. 15-16 years
D. 25-26 years



5. Provide two examples for how people can mitigate climate change through transport conservation.

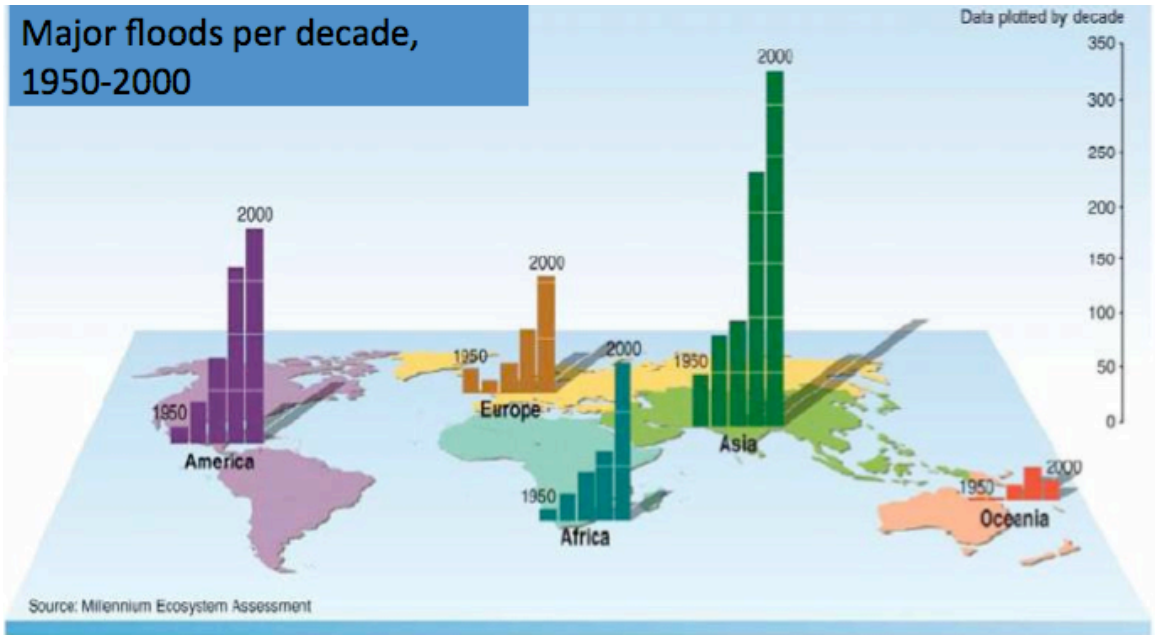
1.

2.

6. Why does insulating buildings help mitigate climate change?

Student Name ____Key_____
Lesson Plan 4 Quiz

Use the graph below to answer questions 1-3.



1. Looking at the diagram, circle the trend for major floods per decade in America.

   A. **Major Floods Increase**
   B. Major Floods Decrease
   C. Major Floods Stay the Same

2. What is the global trend of major floods since 1950?

Major flooding has increased on every continent since 1950.

3. Provide two pieces of evidence that support this claim?

Flooding in America has increased steadily from about 10 floods in 1950 to over 200 floods in 2000.

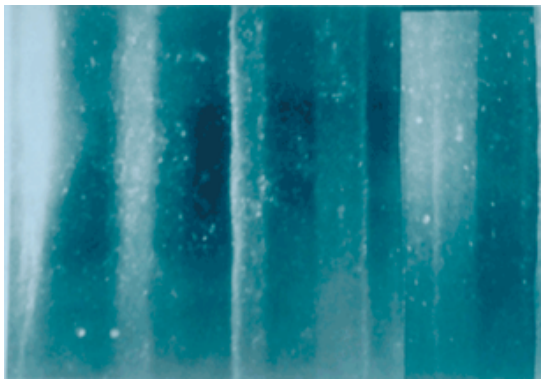
Flooding in Africa has increased steadily from about ten floods in 1950 to about 100 floods in 2000.

4. How do scientists determine climate conditions from 100,000 years ago?

A. Thermometer Readings
B. Satellite Images
C. Tree Rings
D. Ice Cores

4. About how many years does this ice core sample represent?

A. 1-2 years
B. 4-5 years
C. 15-16 years
D. 25-26 years



5. Provide two examples for how people can mitigate climate change through transport conservation.

1. Take public transportation

2. Walk or ride a bicycle to nearby locations

6. Why does insulating buildings help mitigate climate change?

Insulating a building prevents heat from escaping. This means that heating systems use less electricity. Since the electricity comes mostly from coal-powered power plants, the decrease in electricity will decrease the amount of carbon emissions.