Making Predictions About Global Climate Change
What Do We Know So Far?

1) Greenhouse gases hold heat.
   – There is a historical link between carbon in the air and temperature (a direct relationship)
What Do We Know So Far?

2) Temperature records show the Earth is the hottest it has ever been during human habitation of the Earth (as seen in recorded and estimated histories and datasets).
What Do We Know So Far?

3) Human population growth, greenhouse gases, and temperature have all exponentially increased in the same fashion (since the later 1800s)
What Do We Know So Far?

4) Elements (like carbon) have cycles in which they flow from biotic and abiotic elements.

- Climate change is a result of the movement of stored carbon in the ground to the air via the mining and combustion of fossil fuels.
What Do We Know So Far?

5) Humans have **some** contribution to this increased carbon level.

- The amount of contribution and whether it is significant or not is a point of debate. However, the general scientific consensus currently is that humans have had some contribution to this effect.
INFERENCES

• INFERENCE: Continued combustion and addition of greenhouse gases into the atmosphere will cause future global temperature increases.

• Now is where people start making predictions - for good or for bad.
  – We want you to be able to make detailed and thoughtful predictions, grounded in evidence!
How To Make A Proper Prediction?

• Use this general format:

Climate change causes [INCREASED/DECREASED]
______________________________________________,
(fill in with a climatic quality, like temperature, precipitation, evaporation, sea level, flooding)

which will cause and [INCREASE/DECREASE] in
______________________________________________,
(fill in with the effect on the environment or on human societies or health)
Example Prediction

• Describe a way that climate change can impact water quantity in coastal US wetlands.

• Climate change will cause an increase in temperatures which will cause an increase in the melting of glaciers. This will raise sea levels. This will increase the amount of sea water entering and flooding into coastal wetlands.
Try these predictions

• In your group, develop a prediction to answer for the group for these questions:

1) Describe how climate change could degrade soil.
2) Describe how climate change could affect water quality in coastal US wetlands.
3) Describe how climate change could affect human health.
4) Describe how climate change could affect food production and agriculture.
Possible Effects of Increased Global Temperatures

• Prediction 1: Sea levels will continue to rise.
  – Models show 90-99% chance of a rise of 0.6-1.9 feet by 2100
  – Why do sea levels rise?
    – Thermal expansion of existing ocean as it gets warmer
    – Melting of LAND-based glaciers and/or ice shelves (NOT ICE CAPS – DON’T USE THIS TERM!!!)

The rising sea
A University of Arizona report published last week in Climatic Change Letters states:
- A one-meter (3.28-foot) rise in sea level, predicted for 2100, would submerge parts of the Gulf and South Atlantic coasts.
- At six meters — a level predicted within the next 600 years — 90 percent of Miami, New Orleans and Virginia Beach would be below sea level.

Growing Risks to Homes from Sea Level Rise and Storms
Homes lying less than 3 feet* above mean high tide (thousands)

*S3-foot increase in global mean sea level is plausible by 2100
Possible Effects of Increased Global Temperatures

• #1: Impacts of Sea Level Rise
  • Saltwater intrusion of coastal freshwater aquifers and habitats
  • Flooding of coastal areas
    • 2/3rds of world population is within 65 miles of a coastline
    • Destruction of housing and infrastructure
    • Contamination of water supplies by sewage or other pollutants
  • Flooding and Loss of Island Nations
    • Creates refugee crisis – the need to move and house people in other places
  • Increased Damage During Storms
    • Large storms will send in storm surges that can damage structures and cause significant flooding
  • Increased Salinity in Estuaries and River Systems
Possible Effects of Increased Global Temperatures

• Prediction 2: Loss of Species Biodiversity
  – Polar (tundra/taiga) habitats and species in most jeopardy
  – As global temperatures increase, the most dramatic change in temperatures will occur regionally at the poles of the Earth.
  – Climate change could be too quick for adaptations to evolve.
Possible Effects of Increased Global Temperatures

• Prediction 2: Loss of Species Biodiversity
  – Coral reefs die out more from ocean acidification and bleaching
    • Reefs are the oceanic biodiversity hotspot of global marine areas
  – Mountain-top species at risk
    • The cold environments of the top of the mountain are heating up
  – Amphibians are at risk
    • Amphibians use subtle changes in temperature and moisture to signal hibernation and reproduction
    • Climate change alters weather for these cues
Possible Effects of Increased Global Temperatures

• Prediction 3: Changes in Ocean Current Patterns
  – Changes in ocean temperatures have the capacity to alter current flow.
  – Melting ice can change salinity of water and flow of currents.
  – Currents have great impact on land climates. Changes in currents can change local climates.
  – Example: The Gulf Stream
    – At the end of the last ice age, melting land ice changed the salinity of the Gulf Stream and it stopped flowing.
    – Europe did not get the warm current and extended their ice age.
Possible Effects of Increased Global Temperatures

• Prediction 4 -- Changes in Local Climates
  • Increased temperature can increase evaporation.
  • This could mean increased precipitation or more severe precipitation patterns
  • Local areas may get more or less precipitation compared to the past, which could cause problems for certain industries and activities
Possible Effects of Increased Global Temperatures

• Prediction 5 – Potentially More Severe/Extreme Weather
  • Increased temperatures could heat up water and air and allow it to store more energy
    • Increased evaporation creates more droughts
    • Increased precipitation leads to more local flooding and runoff
  • Increased temperatures cause more frequent and more intense storms. Storms could cause more damage or more runoff
Possible Effects of Increased Global Temperatures

• Prediction 6 - Change in Food Production
  – Increased temperatures will increase soil water loss.
    – Soil undergoes desertification
  – Increased precipitation causes more soil erosion
  – Increased sea levels can cause salinization of coastal agricultural soils
  – All of these things will reduce agricultural land productivity and food production
Possible Effects of Increased Global Temperatures

• Prediction 7 - Human Health Problems
  – Increased temperature can help increase the ranges of disease vectors, especially insect vectors
    – Mosquito range and survival increases leading to increases in mosquito-related disease
    – Expected increase in tick related disease as ticks can survive for longer in more areas
### Possible Effects of Increased Global Temperatures

- **Prediction 8** - Release of greenhouse gases from thawing permafrost and ice
  - There is a LOT of carbon-based materials stuck in ice. As materials in ice thaw, they will be decomposed.
    - If they are decomposed in the presence of oxygen, they will produce CO$_2$.
    - If they are decomposed in low oxygen environments, they will produce CH$_4$.
  - Both of these emissions are greenhouse gases and can trap heat.
    - Methane is an incredibly strong greenhouse gas and heats 20-30 times more than equal levels of carbon dioxide.
Possible Effects of Increased Global Temperatures

- **Prediction 8** - Release of greenhouse gases from thawing permafrost and ice
  - Additionally, some gas is simply in the ice and trapped in it. Methane trapped in an icy crystalline structure are called methane hydrates
    - As the icy structure melts with more heat, the sequestered methane in it is released into the air.
  - Methane hydrates are found in ice and in deep ocean floor deposits.
Feedback Loops

• Much of the concern is that lots of climate phenomenon are in a positive feedback cycle.
  – Positive feedback cycles state that if something in a system changes, it will incite further changes that cause the initial change to only enhance.
  • Increases in one variable cause increases in another OR decreases in one cause decreases in another.
  • Climate positive feedback cycles mean the climate will be pushed towards an extreme rather than find equilibrium
    – A negative feedback cycle would result in a system balancing out increases with decreases.
Feedback Loops

• Positive Feedback Examples
  – Albedo means the reflectivity of a planet’s or land’s surface
    • Light colored items have high albedo (reflect light)
    • Dark colored items have low albedo (absorb light)
  – In this example, ice reflects most radiation back to space. So less ice causes more light to absorb into Earth, which increases heat, which melts more ice.
Feedback Loops

• Positive Feedback Examples
  – As permafrost melts, it will release a lot of trapped greenhouse gases
  – These gases trap heat
  – More of these in the atmosphere will cause higher temperatures and only melt more permafrost
  – The system is driven to an upper extreme, rather than going back to equilibrium
Feedback Loops

• Negative Feedback Examples

- Increased temperatures
- Increased evaporation
- Increased cloud coverage
- Decreased light exposure
- Decreased greenhouse warming
- Increased albedo (reflectivity)
- Decreased temperatures