PRESENTER GUIDE

The Dynamics of Climate
A Teacher Professional Development Toolkit for Climate Science

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Introduction

The *Presenter Guide* provides a detailed description of the workshop and PowerPoint program, highlighting the main points of each slide and providing an outline for each activity. It is designed to assist the presenter (facilitator) in implementing the workshop. The workshop addresses the major misconceptions students and adults hold about climate, global warming and climate change. The workshop activities engage participants in analyzing and interpreting climatic data sets and visualizations. Pedagogically, the workshop promotes active learning and collaboration. The originals for printing the handouts, data sets, activity materials, and assessment instruments may be found in the *Materials Packet*. The manual, *The Dynamics of Climate: A Teacher Professional Development Toolkit for Climate Science*, provides an overview of the toolkit, guidelines for conducting effective workshops, and a list of available resources and background readings.

Workshop Materials Checklist

✓Sign-in sheet

✓Statements about climate change, "Why Care about Climate Change?"

✓ Masking tape, chart paper and markers for "Draw a Climate System" activity

✓Carbon Cycle activity materials

✓Light meter and color construction paper (white = snow/ice/clouds; green = vegetation, blue = water/oceans, brown = land) for albedo activity

✓Changes in the Climate System data handouts and response sheets

✓Wedge Game handouts and materials

✓Assessment

General Workshop Outline

8:00 Coffee and Icebreaker

8:30 Welcome, Introductions, Overview and Goals for the Day

9:00 Climate System

9:30 Greenhouse Gases, Greenhouse Effect, and the Carbon Cycle

10:10 The Earth's Energy Budget and the Climate System

10:45 Break

11:00 Climate Data, Variability and Change

12:00 Lunch

12:30 Changes in the Climate System

1:30 Break

1:45 Adaptations and Mitigation, the Wedge Game

2:45 Action and Impacts

4:00 Wrap-up and Workshop Evaluation

Annotated Workshop Outline

8:00 Coffee and Icebreaker

- **Video:** "What is Causing Climate Change"

8:30 Welcome, Introductions, Overview and Goals for the Day

- Indicate that the workshop will focus on the climate system and how changes to the components of this system impact our climate.
- **Activity:** Why Care About Climate Change?
- **Activity:** Climate Knowledge Continuum: Assess participants' climate knowledge before the professional development workshop; inform workshop leaders of participants' prior climate knowledge.

9:00 Climate System

- Stress how changes in the climate system components impact climate.
- **Video:** "What is Climate?"
- **Activity:** Draw a Climate System: Elicit participants' understandings of the climate system and compare and contrast their understandings to the scientific perspective.

9:30 Greenhouse Gases, Greenhouse Effect, and the Carbon Cycle

- Focus on the differences between greenhouse gases and non-greenhouse gases.
- Discuss the greenhouse effect and how it is a natural process but is being changed through human activity.
- **Activity:** Carbon Cycle: Assess participants' climate knowledge of how humans impact the carbon cycle and contribute to the greenhouse effect.

10:10 The Earth's Energy Budget and the Climate System

- Emphasize how humans change the Earth's energy budget by enhancing the greenhouse effect and by changing the Earth's surface.
- Define global warming and put it in perspective with regard to the Earth's natural greenhouse effect.
- **Video:** "GAO: Global Average Energy Budget of the Earth's Atmosphere"
- **Activity:** Albedo: the Earth's Energy Budget and the Climate System: Demonstrate how different Earth surfaces absorb and reflect light and solar radiation.

10:45 Break

11:00 Climate Data, Variability and Change

- Tie climate system components into climate variability.
- Demonstrate how climate variability observed from analyzing climate data performed on different scales: local, state/regional, and global.
- **Video:** "Understanding Climate Change"

12:00 Lunch

12:30 Changes in the Climate System

- **Video:** "Phenology – Climate Wisconsin"
- **Activity:** Looking at the Data: Demonstrate how different situations might affect the climate system, thinking about the feedbacks among the climate system components.

1:30 Break

1:45 Adaptations and Mitigation, the Wedge Game

- Carbon dioxide from the burning of fossil fuels is the key greenhouse gas that enhances the greenhouse effect.
- Demonstrate that models predict that the Earth's climate will continue to warm at current carbon dioxide emissions rates, causing catastrophic changes to the climate system.
- Carbon mitigation is an approach to reduce carbon dioxide emissions (greenhouse gases) by reducing the use of fossil fuels, which involves fuel switching, energy conservation, improving energy efficiency and use of alternative and renewable energy sources.
- **Video:** "Adaptation and Mitigation – Climate Wisconsin"
- **Activity:** Wedge Stabilization Game: Demonstrate the use of the wedge stabilization game in reducing greenhouse gas emissions based on individual 'wedges'.

2:45 Action and Impacts

- **Video:** "iMatter"
- **Activity:** Responding to a Changing Climate: Engage participants in thinking about what actions they could take to address global warming and climate change.
- **Activity:** Local Climate Change Issues: Brainstorm individual actions participants can take in small groups.

4:00 Wrap-up and Workshop Evaluation

- **Activity:** Climate Knowledge Continuum Activity (Repeat)
- Thank participants and ask them to complete the workshop evaluation.

Workshop and PowerPoint Outline

NOTE: Some slides have time sensitive data and should be considered for updating. All slides were updated in 2013. You should consider the following slides: 23, 30, 40, 47, and 79

8:30 –Welcome, Introduction, and Overview

- **Slide 1:** Video: "What is Causing Climate Change" Show video during registration. http://www.ucar.edu/webcasts/voices/1-causing.html

  Important talking point:
  Indicate that the workshop will focus on the climate system and how changes to the components of this system impact our climate. The workshop will emphasize climate data and visualizations as evidence of a changing climate system. This data will primarily focus on the last 50-100 years rather than paleoclimate data. The workshop will present this data in a nonbiased fashion, as accepted by the scientific community.

- **Slide 2:** Introduce the development team and project directors; acknowledge NSF as funding source. Icebreaker activity: Why care about climate change?

Activity: Why Care About Climate Change?

Author: Jan Sneddon

Purpose: To assess participants' beliefs and cares around climate change before the professional development workshop (Note: No judgment should be made about participants' beliefs.)

Materials:
Printed statements about climate change
Masking Tape or Push Pins

Procedures:

1. Tape statements around the workshop room before participants arrive.
2. Draw participants' attention to the statements when they arrive.
3. Tell them to read all the statements before the workshop begins and to find the one that resonates most with them.
4. After the introductory workshop slide, have participants go stand in front of the statement that most resonated with them.
5. Have each participant introduce themselves and explain to the group why they chose the statement they did.

6. Debrief this activity by acknowledging but not judging everyone's choices. This can lead into the workshop goals and the Climate Knowledge Continuum activity.

- **Slides 3–7:** Overview the purpose and goals of the project. Activity: Climate Knowledge Continuum.

Activity: Climate Knowledge Continuum

Author: Jan Sneddon

Purpose: To assess participants' climate knowledge before the professional development workshop; to inform workshop leaders of participants' prior climate knowledge.

Materials:
PowerPoint slide with workshop goals
Cardstock with Continuum Ends and Mid Points (optional)

Procedures: Explain the concept of a continuum exercise to participants.

1. You will be asked a series of questions to help us understand the knowledge each person brings to this workshop.
2. You will line up on the Climate Knowledge Continuum according to your perceived level of knowledge.
3. One end of the continuum represents very strong understanding/confidence while the other end represents limited understanding/confidence. The middle can represent neutrality or a middle of the road approach.
4. Once participants find their place, ask those willing to share why they aligned themselves as such. Get input from both ends of the continuum as well as in the middle.
5. The goal is just to observe where people are on the continuum, not to judge their placement.
6. Ask participants a series of questions based on the workshop goals:

Goal 1: What is a climate system and its components?

Continuum Question 1: How confident do you feel in your knowledge of the components of a climate system?

Confident	Moderately Confident	Not at all confident

Goal 2: What are causes and effects of component change?

Continuum Question 2: How well do you understand the causes and effects of changes to the components of the climate system?

Totally Understand	Moderately Understand	No understanding

Goal 3: What are the impacts of these changes?

Continuum Question 3: How well do you understand the impact of the changes to the Earth's climate system?

Totally Understand	Moderately Understand	No understanding

Goal 4: What can we do about it?

Continuum Question 4: How prepared/empowered do you feel as an individual to address the issue of climate change?

I have the power to affect major change!	I can do something	There's no hope ☹

- **Slide 8:** Overview the concepts covered during the program.

9:00 – Climate System

- **Slides: 9 – 14:** Activity: As a group, have participants draw a climate system. Have each group share 1-2 elements of their drawing; compare and contrast group drawings. What elements are the same, what elements are different? Have groups compare their drawings to the scientific models (slides 10-12). Summarize slides 13 and 14, differentiating climate, climate system, and weather.

Activity: Draw a Climate System

Author: Dan Shepardson

Purpose: To elicit participants' understandings of the climate system and to compare and contrast their understandings to the scientific perspective.

Materials:
PowerPoint slide with image of climate system (scientific perspective)
Flipchart paper--1 sheet/group
Markers for each group

Procedures: Inform participants that in this activity they are going to explore and learn about the climate system, what makes up a climate system, that climate is determined by the interactions between different components, and that these components provide feedbacks (both positive and negative) to the system.

1. Group participants into groups of 3-4.
2. Ask groups to draw a picture, with labels, of what they think makes up a climate system. What components make up a climate system? What factors influence/cause climate? Give groups about 15 minutes to complete task.
3. Select one group to show and explain their drawing (climate system). Ask another group to show their drawing and explain one way their climate system is similar to and one way it is different from the previous group. Repeat until all groups have shared.

4. Summarize the key aspects of the groups' climate systems (e.g., sun as driver of climate, Earth's tilt/orbit, land cover/vegetation, oceans, atmosphere, and latitude/altitude).
5. Show the climate system image (diagram); the scientific perspective. Ask the groups to compare and contrast their drawing to the scientific perspective. Provide about 5-10 min.

- **Slide 10:** Show the natural climate system model (this slide). Have participants compare and contrast the climate model to their climate system drawing.

- **Slide 11:** Highlight the five components: atmosphere, ice, oceans, land, and vegetation and how they interact, provide feedbacks (negative and positive). They will revisit the components later to see how they are changing.

- **Slide 12:** Show how humans have influenced climate system model (this slide). Have participants compare and contrast the climate model to their climate system drawing. Note: burning of fossil fuels, deforestation, and land use/cover changes. How do these human activities affect the five components?

6. Have each group share 1 way their drawing is similar to and 1 way it is different from the scientific perspective.
7. Describe/summarize the climate system diagram: components (oceans, atmosphere, ice, vegetation, and land) and interactions.
8. Ask participants to explain how changes in the system might impact the system and our climate. For example, changes in vegetation, land cover, or ice; changes in the sun.

- **Slide 13:** Video: Show video that summarizes weather and climate, climate system and how the components affect climate.http://www.youtube.com/watch?v=bjwmrg__ZVw

- **Slide 14:** Overview the key ideas: weather, climate and climate system. Stress how changes in the climate system components impact climate.

9:30 – Greenhouse Gases, the Greenhouse Effect, and the Carbon Cycle

- **Slide 15:** Have participants share their ideas about greenhouse gases and the greenhouse effect.

- **Slide 16:** Point out that oxygen and nitrogen are the most common atmospheric gases and that they are not greenhouse gases. Note that water vapor and carbon dioxide are two of the greenhouse gases (next slide). Greenhouse gases make up a very small amount of the atmospheric gases.

- **Slide 17:** Water vapor is the most common greenhouse gas. Carbon dioxide and methane are the next major greenhouse gases. These are naturally occurring gases, however human activity has increased their atmospheric concentrations as a result of burning fossil fuels and agricultural and landfill emissions.

  Note: Methane gas has the potential to pose an even greater problem as warming causes methane reserves trapped in cold ocean waters and permafrost to be released. Methane hydrates are large reserves of methane trapped in cold ocean waters and in permafrost. As warming occurs in these areas, methane is released. This is most crucial in the arctic areas which are most sensitive to climate change. Ungulates, landfills, agriculture, coal production and other activities also release methane. Increased methane in the atmosphere produces a positive feedback that could potentially increase the progression of warming.

- **Slide 18:** Highlight that the greenhouse effect is a natural process that warms the Earth. Most (not all) of the visible light (solar radiation) passes through the greenhouse gases in the atmosphere. The visible light is then either reflected or absorbed by the Earth (land and water). The absorbed light is emitted as infrared radiation and heat. Some of the infrared radiation is then absorbed by the greenhouse gases and emitted back toward the Earth, warming the Earth.

Main Points:

Non-greenhouse gases (nitrogen, oxygen, argon) make up 99% of the Earth's atmosphere. These are non-greenhouse gases because they are not affected by infrared radiation (IR), thus they do not absorb or emit infrared radiation.

Greenhouse gases (in order of abundance: water vapor, carbon dioxide, methane, nitrous oxide, ozone) make up less than 1% of the atmospheric gases. They are naturally occurring gases that absorb and emit infrared radiation.

Greenhouse effect is a natural process that makes life on Earth possible. Atmospheric greenhouse gases absorb and emit (radiate) infrared radiation (IR) that is emitted by the Earth's surface. The IR is radiated in all directions, thus some of the IR is radiated back towards the Earth's surface and lower atmosphere, naturally warming the Earth.

How Humans Impact the Carbon Cycle and Greenhouse Effect

- **Slide 19:** Activity: Conduct carbon cycle exercise.

Activity: Carbon Cycle

Purpose: To assess participants' climate knowledge of how humans impact the carbon cycle and contribute to the greenhouse effect

Materials:
See materials packet

Procedures: Explain the concept of a continuum exercise to participants

1. Instructions for implementing the carbon cycle activity and templates for the game pieces may be found in the materials packet. You will be asked a series of questions to help us understand the knowledge each person brings to this workshop.
2. Compare and contrast activity findings to slides 21 and 22 (carbon cycle sources and sinks and human impacts).

- **Slide 20:** Relate the carbon cycle sources and sinks figure to the carbon cycle activity. Note that the oceans are both a source and a sink, that photosynthesis is a sink, and that forest fires and burning of fossil fuels are sources.

- **Slide 21:** Slide shows how human activity (postindustrial) has altered the carbon cycle. Compare and contrast the carbon cycle activity to the figure. Units are peta grams (1,000,000,000,000,000 grams).

- **Slide 22:** Note: Methane (CH_4) sources are cow/agricultural livestock belching (ruminants), decomposition from wetlands and rice paddies, landfill emissions, thawing permafrost.

- **Slide 23:** Show the changes in atmospheric carbon dioxide levels over time – the Keeling curve.

- **Slide 24:** Compare the natural greenhouse effect to the human enhanced greenhouse effect. As the concentration of atmospheric greenhouse gases increases, more of the infrared radiation and heat emitted by the Earth is absorbed by the greenhouse gases which results in more infrared radiation emitted back toward the Earth warming the Earth. This is global warming.

- **Slide 25:** Summarize the key points.

Main Points:

Carbon cycles naturally through the environment, the components of the climate system (e.g., atmosphere, ocean, vegetation, land, fossil fuels); these components may serve as both carbon sources and sinks.

Carbon sink is a component that stores carbon (e.g., fossil fuels).

Carbon source is a component that releases carbon (e.g., the burning of fossil fuels).

The burning of fossil fuels releases carbon (carbon dioxide) to the atmosphere, altering the natural carbon cycle. This adds greenhouse gases (carbon dioxide) to the atmosphere, enhancing the greenhouse effect which contributes to global warming.

Keeling curve shows the increase in atmospheric carbon dioxide levels over time.

10:10 – Earth's Energy Budget and the Climate System

- **Slide 26:** Video: Show energy budget video (slide 26). Video (no sound): The video illustrates how the sun's energy is absorbed, reflected, and emitted by the Earth's land/water, greenhouse gases, and clouds. You will need to walk participants through the video. The figure of the Earth's Energy Budget is the last image of the video—summarize the image. Note: The greenhouse effect is a process within the Earth's energy budget. http://www.youtube.com/watch?v=rP2YCHRPYS8

- **Slide 27:** Relate the Earth's energy budget to the climate system, the absorption and radiation of the sun's energy by the components of the climate system—oceans, ice, vegetation, land, and atmosphere. Conduct the albedo activity demonstrating how different Earth components absorb and reflect the sun's energy.

Activity: Albedo: the Earth's Energy Budget and the Climate System

Author: Dan Shepardson

Purpose: To demonstrate how different Earth surfaces (e.g., ice, water, vegetation, land) absorb and reflect (albedo) light and solar radiation. To compare and contrast the demonstration to the Earth's Energy Budget and Climate System diagrams.

Materials:
Light meter
Construction paper (white = snow/ice/clouds; green = vegetation, blue = water/oceans, brown = land)
Earth's Energy Budget and Climate System diagrams (ppt slides)

Procedures: Inform participants that in this demonstration you are going to measure albedo, reflectivity, of different colored sheets of construction paper. The different colors represent the different Earth surfaces or the components of the climate system. Participants will compare and contrast the demonstration to the Earth's energy budget and climate system. (Note: the light meter should be set at the smallest scale possible.

1. Place the different colored sheets of construction paper on a table under a light source. Tell participants that white represents snow/ice, green represents vegetation, blue represents

water/oceans, and brown represents land/bare ground. Note: black could be used to represent asphalt and gray concrete.

2. Have a participant hold the light meter (face up) about 2 feet above the construction paper and measure the incoming light. Then have the individual turn the light meter face down measuring the reflected light from each colored construction paper. To determine the albedo of each colored paper divide the reflected light by the incoming light.
3. Show the Earth's energy budget and climate system diagrams (ppt). Ask the participants to compare and contrast the demo to the scientific perspective.
4. Ask participants to explain how changes in the Earth's surface (different colored paper) might impact the Earth's energy budget and climate system. Changes in vegetation, land cover, or ice would impact albedo, increasing or decreasing the Earth's temperature. For example: as polar snow/ice melts more water (blue) and land (brown) are exposed to solar radiation, which have lower albedo than snow/ice. Thus water and land reflect less and absorb more solar radiation, causing the Earth to warm. Note that the Earth's temperature may be changed by changing the Earth's albedo. Note: global warming is not restricted to changes in greenhouse gases; changes in albedo may also cause global warming.

- **Slide 28:** Show how to calculate albedo (reflected light) and common albedo values. The higher the albedo the lower the amount of energy absorbed. The more energy absorbed the more infrared radiation and heat emitted.

- **Slide 29:** Discuss energy budget and climate system.

- **Slide 30:** Show the change in global temperature due to global warming.

Main Points:

Humans change the Earth's energy budget by enhancing the greenhouse effect and by changing the Earth's surface (land cover)—the absorption and reflection of the sun's energy.

Global warming is the increase in average temperature of the Earth's atmosphere over land and oceans. In the last 100 years the Earth's average temperature increased by about 0.8 °C (1.4 °F) with about two thirds of the increase occurring over the last three decades.

10:45 – BREAK

11:00 – Climate Data, Climate Variability, and Global Warming

- **Slides 32 – 33:** Give introduction to climate data and analysis of data from local to global scales.

- **Slides 34 – 35**: Local: On local scale (nearby city, Chicago): Analyze the trend and variability from 1958 to 2010 for the annual mean temperature and annual precipitation.

- **Slides 36 – 37:** State/Regional: On state scale (Indiana): Analyze the trend and variability from 1895 to 2010 for the annual mean temperature and annual precipitation.

- **Slides 38 – 39:** National: On the national scale (contiguous U.S.): Analyze the trend and variability from 1895 to 2010 for the annual mean temperature and annual precipitation.

- **Slides 40 – 41:** Global: On the global scale: Analyze annual mean temperature anomalies from 1895 to 2010 (departure from 1901-2000 normal) (9). Discuss trend, variability, and departure from normal. Also notice larger margins of error prior to about 1950. Analyze annual precipitation anomalies from 1900 to 2010 (10).

- **Slide 42:** Discuss similarities and differences among different scales of data.

- **Slide 43:** Show examples of climate datasets and monitoring.

- **Slide 44:** Show example of El Nino/La Nina here, with an El Nino event on the left and La Nina on the right. The top maps show sea surface temperatures (SSTs) across the Pacific Ocean and the bottom maps show the departure from normal or SST anomalies. You can see that during an El Nino event, there is enhanced warming of the equatorial central and eastern Pacific (area of red shades in bottom left), whereas this area is characterized by enhanced cooling (area of blue shades in bottom right) during a La Nina event and the warmer SSTs are confined to the western Pacific. The atmosphere responds to these changes in sea surface temperatures, and large-scale circulations and weather systems are influenced across much of the globe.

- **Slide 45:** Show El Nino/La Nina typical Wintertime Patterns. As seen in the top image, El Nino events typically result in abnormally warm and dry conditions during winter across the lower Great Lakes region. During La Nina events, the polar jet stream typically dips farther south across much of the contiguous U.S., which usually focuses the track of storm systems and results in an abnormally wet winter near Indiana. These maps help show how climate variability exists over multiple seasons.

- **Slide 46:** Show observed sea ice extent (left) and departure from normal (right) data are routinely updated and made available online for analysis. Here is an example from

October 2011 across the northern hemisphere. Notice the decrease in observed extent and the negative trend in extent anomalies.

- **Slide 47:** Discuss the Drought Monitor as a great resource to see recent drought conditions across the entire country and North America, while also providing a means of reporting impacts you are experiencing personally. Notice the Exceptional Drought (D4) intensity across much of Texas and Oklahoma from early November 2011. Abnormally dry conditions across this area and parts of the southeast are typical of La Nina events.

- **Slide 48:** Transition from climate data and variability to understanding global climate change and predicting our future climate.

- **Slide 49:** Discuss how technology is being used with predicting the future global climate. Show how resolution of the simulated globe has improved over recent decades, thus allowing us to better forecast a more realistic climate system. Notice the addition of various components of the climate system to simulations as technology has improved.

- **Slide 50:** Discuss how models are being verified and assessed by simulating the past and comparing the results to what was actually observed. Show how recent forecast matches the observations best when both natural and man-made (anthropogenic) forcings are simulated together in the model.

- **Slide 51:** Include how global climate models are being initialized with previous data and then computed along various predicted scenarios (different CO_2concentrations). Reiterate how improvements in computing power will allow for better resolution in climate models and the potential for more accurate predictions.

- **Slide 52:** Video: NCAR video. Show some possible outcomes for the future. May need to show separate slides to link to animations from the UCAR multimedia website: http://www2.ucar.edu/news/understanding-climate-change-multimedia-gallery#visualizations

  Note: These videos should be tested before use as some Internet connections and/or computers may not be able to handle the size of these files.

Main points:

Due to variability at multiple scales, changes in our climate as a whole are impossible to analyze by only looking at one location on our earth. We must assess past trends in data at all scales combined to see the big picture. Global average temperature trends can help provide some insight, but it is important to understand that this is limited to the amount

and coverage of available past temperature data world-wide. We can better understand what global climate changes are occurring as we increase the coverage and time span of available data. In order to get an idea of the earth's future climate, we must have a firm grasp on our past and robust computer technology available.

Intro – tie climate system components into climate variability: the many components of a climate system all serve to influence variations in Earth's climate. Variations in temperature, precipitation, and other weather elements are always a part of our climate. For example, on any given day there are parts of the country that are abnormally warm or dry, while other locations are abnormally cold or wet. Such variations occur at many different scales in both area and time.

Climate variability observed from analyzing climate data: we can observe this climate variability through the analysis of climate data that is performed on these different scales. To get a better idea of what our climate is doing on a global scale, we must gather data starting at the smallest scale. In this part of the workshop, we'll analyze some examples of climate data in a scale-up approach: starting at a local scale, and expanding out to regional/state, then national, and finally global. In a sense, we will "zoom out" to see the big picture.

12:00 – LUNCH

12:30 – Changes in the Climate System

- **Slide 54:** Video: Climate system activity. Introduce the activity and show the video. The video talks about phenological changes. http://vimeo.com/17612530

Activity: Looking at the Data

Author: Ted Leuenberger

Purpose: To demonstrate how different situations might affect the climate system.

Materials:
Data slides produced as hard copies for each group

Procedures: Display the Climate System diagram during the activity (slide 55).

1. Divide the participants into 5 groups. Give each group the appropriate copies (atmosphere, ice, ocean, land, and vegetation). Have them discuss how that data might affect that part of the climate system and how that data might influence all parts of the climate system. Provide each

group with the appropriate "Changes to the Climate System" worksheet to guide their data analysis and interpretations (See below and materials packet for copies).

2. Have each group analyze their data sets that illustrate how each component of the climate system has changed. Each group will share their analysis, answering the guiding questions (provided as a handout and on this slide). The next slides (#57 to #118) contain copies of the data that each group analyzed. The intent is to share only a few examples, not each slide, based on each group's analysis/sharing. **Emphasize that each group should share only those 1 to 3 slides that seem most significant to them. Avoid letting groups talk about every data slide.**
3. Have each group discuss their conclusions. Reference ppt slides only if needed. There is an additional slide after the land data (slide 103) to help with discussion. The world map will progress from 1700 through 1990.

Worksheet Example:

Changes to the Climate System:
ICE

How has the component changed?
What is the evidence of this change?
How might global warming have caused this change?
Describe how the other components of the climate system impact the component:
- Land→
- Vegetation→
- Atmosphere→
- Ocean→

Describe how changes to the component might impact the other components of the climate system:
- →Land
- →Vegetation
- →Atmosphere
- →Ocean

How might these changes impact climate?

- **Slide 55:** Review the climate system.
- **Slide 56:** Provide overview of the analysis worksheet.
- **Slides 57-119:** Go through data sources participants are analyzing as needed, and are for use by participants during the sharing session. Note: the intent is not to show all of the slides.
- **Slide 120:** Present key questions for summarizing/discussing the results presented by each group.

1:30 – BREAK

1:45 – Adaptations and Mitigation: Responding to a Changing Climate

- **Slide 122:** Note: the effects of climate change are occurring throughout the world, and therefore strategies must be employed to deal with these effects on scales ranging from individual to societal action.

- **Slide 123:** Video: Show video to introduce adaptations and mitigation. Have participants summarize the video based on the guiding questions. This animated video produced by the Wisconsin Educational Communications Board distinguishes the roles of mitigation and adaptation in responding to climate change. The video offers examples of actions that humans can take as individuals and a society to adapt to and mitigate the impacts of climate change on natural and built environments. http://vimeo.com/17652611

- **Slide 124:** Introduce the Wedge Stabilization Game – developed by the Carbon Mitigation Institute, (Princeton, BP and Ford Motor Co.) as a tool to dramatize strategies to avoid a doubling of atmospheric CO_2 in the next 50 years.

Activity: Wedge Stabilization Game

Note: Instructions for implementing the wedge stabilization game and templates for the game pieces may be found in the materials packet. The Princeton University wedge stabilization game may be found at: http://cmi.princeton.edu/wedges/game.php

- **Slide 125:** Review the net increase of carbon annually, due to fossil fuel burning. Note the "drains" which act as carbon sinks – oceans and uptake by plants. These drains should be considered small leaks in the tub (only 4 of the 800 contained in the atmosphere).

- **Slide 126:** Highlight that based on current predictions, an average of 16 billion tons of carbon will be added per year in 50 years, doubling the pre-industrial levels. This level of atmospheric carbon could bring about significant human, weather, and ecosystem impacts. Note units: 2.1 billions of tons of carbon = 1 ppm.

- **Slide 127:** Show current emission data and average future emission estimations, as well as the extended emissions path 50 years into the future.

- **Slide 128:** Highlight the current path to a doubling of carbon, versus stabilizing carbon at current levels for 50 years. Note that this is the interim goal with long-term reduction in carbon emissions the ultimate goal (the 50 year interval is utilized to develop reduction strategies, technologies and practices.)

- **Slide 129:** Discuss the ultimate goal, which is to achieve approx. 570 ppm of atmospheric carbon (slightly below the pre-industrial levels – 600 ppm.)

- **Slide 130:** Note: a stabilization wedge is a portfolio of strategies which can be utilized to "flat-line" carbon emissions for 50 years. Keeping emissions flat will require the world's societies to fill in eight wedges of strategies, which represent ways of making energy with no or reduced emissions or storing carbon to prevent its release into the atmosphere. Each wedge should be considered a way of subtracting from the expected increase.

- **Slide 131:** Discuss that the wedges described in the game represent existing technologies. There is no single magic bullet, for a shotgun approach to achieving carbon stabilization requires utilizing a variety of wedge strategies.

- **Slide 132:** Read the directions (available in activity packet.)

- **Slide 133:** After conducting the activity, have teams share their wedge strategies and review these take home messages.

- **Slide 134:** As time allows, have some or all teams share the impacts of their strategy on the climate system components.

Main Points:

Carbon dioxide from the burning of fossil fuels is the key greenhouse gas that enhances the greenhouse effect contributing to global warming.

Models predict that the Earth's climate will continue to warm at current carbon dioxide emission rates, causing catastrophic changes to the climate system.

Carbon Mitigation is an approach to reduce carbon dioxide emissions by reducing the use of fossil fuels. It is a strategy that involves fuel switching, energy conservation, improving energy efficiency, and the use of alternative and renewable energy sources.

2:45 – Actions and Impacts

- **Slide 135:** Refer back to wedge stabilization game and emphasize that we will now talk about personal actions.

- **Slide 136:** Reemphasize the interconnectedness of any mitigation or adaptation actions to the entire climate system.

- **Slide 137:** Discuss individual actions that refer back to climate change issues. Note that there are pros and cons with the possible outcomes in the examples.

- **Slide 138:** Have participants in groups read and discuss one scenario and then have them share their response to the guiding questions and discuss as a group. Have each group provide an overview of their scenario.

Activity: Responding to a Changing Climate

Author: Dan Shepardson

Purpose: To engage participants in thinking about what actions they could take to address global warming and climate change.

Materials:
Copies of scenarios, one scenario per person

Procedures:

1. Group participants into groups of 3-4.
2. Provide each group with a different scenario
3. Select one group to share their scenario and answers to the guiding questions. Provide time for other groups to discuss the scenario and answers. Repeat until all groups have shared.
4. Summarize the key aspects of the groups' answers.

- **Slide 139:** Discuss each method of persuasion and give examples of how to affect change in others.

  Note: Influence examples for explanations
  - Liking - People respond more positively to people they view positively.
    - Example of imitating friends
    - Create your own example
  - Social Proof - People do things they see others do.
    - Example of reusing plastic sacks as trash liners
    - Create your own example
  - Authority - People tend to obey figures of authority.
    - Example of Al Gore or Obama climate initiatives
    - Create your own example
  - Perceived Scarcity - A perceived lack of something makes that item more valuable.
    - Example of polar bears or gasoline
    - Create your own example
  - Reciprocity - People tend to return a favor.
    - Example of CoCoRaHS (rain gauge for reporting)
    - Create your own example
  - Consistency - People do things they see as exemplifying their image of themselves.
    - Example of victory gardens for patriotism, soil conservation for stewardship
    - Create your own example

- **Slide 140:** Have participants identify 3 potential local climate issues and what they could do to adapt to the issues as individuals. When considering issues, mitigation of these issues may be considered. A greater consideration could also be the idea of adapting to changes. You do not necessarily have to fix the problem, but adapt to the resulting changes. On flip chart, have each person/group share one individual action. Include "Community" and "Regional" sections on flip chart, but save discussion of these next two scales for the next slide.

Activity: Local Climate Change Issues

ISSUE	INDIVIDUAL ACTION (link to climate system)	COMMUNITY ACTION	REGIONAL ACTION

Procedures:

1. Brainstorm individual actions participants can take in small groups (5-10 minutes).
    - Possible actions to break mental blocks:
        - Drive less
        - Reduce coal-derived electricity use
        - Consider alternative energy options
        - Add green space on your property
        - Calculate and reduce carbon footprint
        - Reduce, reuse, recycle
        - Plant carbon sinks
        - Control invasive species
        - Increase vegetative mass
        - Increase duration of ground cover
        - Manage landscapes efficiently to reduce erosion, nutrient application
        - Selectively clear timber
        - Use cover crops
        - Use public transportation
    - Encourage innovative thinking

- **Slide 141:** After discussion of individual actions, discuss how individual action can cause changes in community action and how community changes can cause regional changes. Use flip chart to write community and regional activities down. Make sure you refer back to the climate system.

Climate Change Wheel: A resource showing possible actions and resulting changes in carbon dioxide emissions. This is a free resource from: Modern Woodmen of America 1701 1st Ave. Rock Island, IL 61201 1-800-322-9805 www.modern-woodmen.org Click on "Free resource": Ecology Awareness Program

- **Slide 142:** Video: Show video of youth "iMatter" movement: http://www.youtube.com/watch?v=nqmfsxzGyxE. Discuss national organizations that advocate climate change mitigation.

4:00 – Wrap-up and Workshop Evaluation

- **Slides 143 - 147:** Ask the participants one thing that they learned about each of the goals. Repeat Climate Knowledge Continuum Activity.

Activity: Climate Knowledge Continuum Activity (Repeat)

- **Slide 148:** Reiterate the topics covered.

- **Slide 149:** Mention webpage(s) for additional information.

- **Slide 150:** Thank participants and ask them to complete the workshop evaluation. Handout Certificate of Completion (optional).