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Plan Title: As the Arctic Goes, So Does the Rest of the Planet: A Workshop About Teaching Climate Change Using NGSS.

Introduction:
A ubiquitous symbol of global changing climate is a polar bear trapped on an isolated floating iceberg surrounded by open waters. This workshop will capitalize on this iconic image to explore global climate change through the lens of systems interactions in the Arctic region. Why a focus on the Arctic? The polar regions of the world, especially the Arctic, are more susceptible to effects of global climate change. By understanding the symptoms, energy fluxes, and matter cycling through Arctic systems, we can better understand how these changes relate to the rest of the planet. What are the factors involved in a changing climate? What are some of the effects of climate change?

The Arctic consists of an ice sheet and landmasses. The ice and snow in the region adds to the overall energy budget of the Earth in that snow and ice reflect some (5%) solar radiation. This is known as albedo. As the Earth's temperatures increases, more snow and ice melt and less of the Earth's energy budget is balanced as the waters and landmasses in the Arctic begin to absorb more energy. This creates a positive feedback in which the more warming that occurs creates more snow and ice melt which creates more warming and more snow and ice to melt, etc. The melting snow and ice also result in sea level rise in the Arctic, changes in migratory patterns of animals such as the caribou, melting of areas of permafrost, and changes in vegetation and phenology.

The key to using the Arctic as an exemplar is to understand *why* the Earth's temperature is increasing, which is leading to all the additional changes visible in the Arctic. This workshop uses a similar structure of the American Museum of Natural History Climate Change course to help teachers explore the evidence for global climate change.

1. The workshop will engage teachers in an effect of global climate change on a human population in the Arctic. The purpose is to surface questions about what is the impact and why the changes may be occurring.
2. The workshop will then focus on understanding albedo in the Arctic. We will use an idea of the Earth's energy budget and how changing one component of the budget may change an overall balance. Using video clips and images from EdGCM (EdGCM Project of Columbia University and NASA Goddard Institute for Space Studies 2003-2012), teachers will explore the extent to which the Arctic sea ice is melting and how the positive feedback loop is creating additional melting and sea level rise.
3. In order to examine why the snow and ice is melting in the Arctic, the teachers in the workshop will examine evidence for changes in Earth's temperature. They will explore past climate data showing the relationship of carbon dioxide to Earth's

temperature by looking at ice core data graphs. They will then focus on recent levels of carbon dioxide and evidence for increase in global climate temperatures. They will then use the BSCS climate model simulation (BSCS 2013) to make a claim about the evidence that best fits the reason for current temperature changes.

4. After learning about changes in the Arctic and why global temperatures are increasing, teachers will discuss climate change effects in other parts of the world.
5. Finally, teachers will use evidence of past climate changes, current climate conditions, and future predictions to design and describe a model for systems interactions that are involved in global climate change

Define Learners:

Grade Level: Audience is upper elementary and middle school **TEACHERS**. This is a two-day workshop consisting of 15 hours of instruction. This time frame is based on a typical topical workshop offering that the Center for Science Teaching and Learning, Northern Arizona University provides. This workshop is one I plan to implement and is not simply an exercise for this course. Therefore I want to set the context and content realistically for the needs of the inservice teachers our center serves. The pedagogy used in the workshop will be constructivist using three principles for effective learning: 1) addressing learner prior knowledge, 2) abilities to do science and understanding content, and 3) metacognition or reflection on learning (National Research Council 2005).

Population Characteristics: As we transition from current state standards to the Next Generation Science Standards (NGSS), additional professional development will be necessary to introduce teachers to a new approach to teaching science. Our instruction needs to purposefully integrate science and engineering practices, disciplinary core content, and cross cutting concepts. Global climate change is *new* curriculum content in *A Framework for K-12 Science Education* (National Research Council 2012) and NGSS (Achieve 2013). Thus the intended population for this workshop is grade 5-8 formal and informal educators motivated to learn more about the science of global climate change in the context of learning how to implement NGSS. (Note: typically teachers who attend our workshops either self select or are part of grant-funded projects). Each teacher participating in a workshop receives a professional development certificate for 15 hours of instruction. The *content* of the course will be at an adult level designed to deepen the knowledge of workshop participants. The development of the content will use effective classroom strategies, but will not advocate a particular set of instructional materials. The purpose is to develop both content knowledge and to increase pedagogical content knowledge (PCK) of workshop participants. PCK is knowing both the content and effective strategies as expert so that one can effective guide students as novice learners (Keeley 2010).

Lesson groupings: Depending on the nature of the activity, different lesson groupings will be employed. For example, there will be some times when instruction will occur instructor to whole group, instructor to small group, small group work, paired work, and individual work. The specific groupings will be described in the context of workshop activities.

Next Generation Science Standards:

There are two specific performance expectations from NGSS (Achieve 2013) in Earth systems science that this professional development workshop would address:

Grade 5 [5-ESS2-1]: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Middle School [MS – ESS3-5]: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

5-ESS2-1.	Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [*Assessment Boundary: Assessment is limited to the interactions of two systems at a time.*]
MS-ESS3-5.	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Topics:

The topics of the workshop are exploring evidence for climate change, particularly from the Arctic and preparing to teach climate change with students within the framework of the Next Generation Science Standards (Achieve 2013). Some of the specific topics include albedo, energy budget, climate models, and the relationship between temperature, carbon dioxide and Earth's climate.

Within the two-day workshop, teachers will use a 5-E learning cycle to *engage* in some impacts of Arctic climate change, *explore* the interactions of Earth's systems, *explain* the increase of carbon dioxide as a driver for climate change, *elaborate* how global temperature changes may affect other regions of the planet; and *evaluate* how new content enhances their own conceptual understanding.

Curriculum Links

This workshop is designed to be stand alone – not part of a course or sequence of workshops. However, as teachers consider implementing a topic such as climate change in their classrooms, they should consider integrating the three dimensions described in *A Framework for K-12 Science Education* (National Research Council 2012) and NGSS (Achieve 2013). As such the content and strategies of the workshop are timely to the needs of teachers as Arizona transitions to NGSS. Climate change is not addressed in current state standards. This workshop will introduce the topic while addressing how the topic can be

taught according to the vision of NGSS. The following table outlines the connections between the three dimensions.

Science Practices	Engineering Practices	Disciplinary Core Content	Cross Cutting Concept
Asking questions about phenomena	Models used to analyze systems	Global climate change	Systems and systems models
Analyze data for significance and patterns	Representations are integral to design process	Human impact to Earth Systems a strong focus	Energy and matter: Flows, cycles, and conservation
Reasoning & argument based on evidence aid in the development of explanations			

Objectives

The objective of the workshop is to provide guided inquiry experiences for teachers to explore the scientific evidence for global climate change using the Arctic region as an exemplar. The learning outcomes focus on teacher understanding of the interactions between the atmosphere, hydrosphere and cryosphere in the Arctic as symptomatic of similar interactions across the globe. (Note: the biosphere and lithosphere are not included in the systems interactions for this workshop due to time constraints. There is not enough to do everything in depth.) The intent is to narrow the evidence related to the relationship between the amount of carbon dioxide and temperature increases.

As a result of participating in this workshop, teachers will be able to:

1. Describe albedo in the Arctic and how albedo influences the Earth's energy budget.
2. Explain the relationship between carbon dioxide, temperature, and global climate changes.
3. Use evidence of past climate changes, current climate conditions, and future predictions to design and describe a model for systems interactions that are involved in global climate change.

Materials

- Chart paper & markers
- Article about Alaskan village of Kivalina (http://www.nydailynews.com/news/national/alaskan-village-vanish-water-decade-scientists-article-1.1412920)
- Global Energy Flow handout (American Museum of Natural History amnh.mrooms.net/pluginfile.php/37656/block_html/content/W1D1.pdf)
- EdGCM visualization data
- Computer set of laptops
- BSCS climate model simulation (BSCS 2013)
- Vostok ice core graphs (BSCS 2013)

- Keeling curve diagram (http://earthguide.ucsd.edu/eoc/special_topics/teach/sp_climate_change/p_keeling_curve)
- Handouts for paired reading strategy
- Handouts for evidence circle discourse strategy
- *Drivers of 20th Century Climate Change* (Shindell 2013)

Time

For the course requirements, it states that the duration of an instructional plan for *students* should be one week or the amount of time needed to cover one curricular unit. One can assume that this equates to roughly 5 hours of student instruction. This plan is for teachers and provides three hours of content and pedagogical content instruction per hour of student instruction – or 15 hours of *adult* instruction.

Scope and Sequence

I used an *Understanding by Design* (Wiggins & McTighe 2005) process to design instruction, which involves three stages of development: 1) identify conceptual understanding, 2) determine measure of success, and 3) create learning activities.

1. Enduring Understandings – Conceptual Understandings
   - Global climate temperatures are increasing
   - Some of the most compelling evidence for climate change occurs in the Arctic
   - There is a correlation between the amount of carbon dioxide in the atmosphere and temperature
   - Recent climate changes are due to increased flux of carbon dioxide from human activities

   Essential Question:
   How can learning about changes in the Arctic help in an understanding of current and future global climate change?

2. Assessment:
   - Develop and defend a visual model on chart paper in your small group for systems interactions in the Arctic leading to global climate change
     - Criteria for a successful model will include clear labels and descriptors for factors affecting interactions and change

3. 5-E learning cycle activities (details described below). The teacher participants in the workshop will be seated at tables so they can work as individuals, small group, or whole group.

<u>LESSON DETAILS (Engage, Explore, Explain, Elaborate, and Evaluate)</u>

ENGAGE: Assess teacher prior knowledge and introduce topic

1. Begin the workshop by asking each teacher participant as an individual to list all the impacts he/she can think of that may be attributable to global climate change. This activity is designed to activate thinking and to provide a low stress way to explore the workshop topics.
2. Teacher participants are asked to share their individual lists within small table groups. Discuss how the lists are similar and different. Do you know any evidence for why changes are occurring?
3. Provide participants with a copy of a "case" for global climate change from the Alaskan village of Kivalina (http://www.nydailynews.com/news/national/alaskan-village-vanish-water-decade-scientists-article-1.1412920).
4. Individuals read the article. After completion, teacher participants will engage in small group conversations to discuss their initial reactions of the case with each other. The group should then identify what questions they have about the case (e.g. what is the climate change impact? why are the changes occurring to this village?). This is a brainstorm activity so all questions are respected. The workshop facilitator asks for sample questions from each group and records them on chart paper for the whole class.
5. The facilitator will use a model-based learning approach to help steer the focus for further exploration about the case towards understanding the interactions within systems to understand what factors are influencing the climate to change, resulting in effects such as sea level rise affecting this Alaskan village. The idea of starting with an impact on human populations is to make it personal so that in part, the question of why should we care is addressed.

EXPLORE: Use data from Arctic as an exemplar for a changing global climate

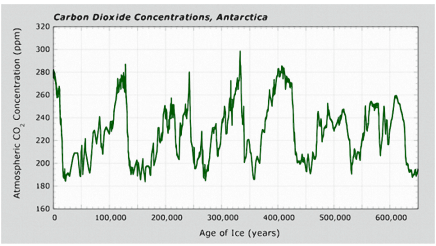
1. Show the whole group a video of changing sea ice in the Arctic. Ask participants to discuss what observations they see happening to sea ice.
2. Introduce albedo to the whole group and provide the handout for Global Energy Flows (American Museum of Natural History n.d.) to individual teachers. In small groups, ask teachers to discuss the idea of the Earth's energy budget and how changing one component, such as reflection of radiation from albedo, may change an overall balance.
3. Provide small groups with a series of images from EdGCM (EdGCM Project of Columbia University and NASA Goddard Institute for Space Studies 2003-2012). The images should show the extent of ice and snow from December-January-February snow and ice cover in three periods of time past, present, and future for comparative purposes. Ask small groups to focus specifically on the Arctic. At table groups, ask participants to identify trends in the data and to interpret what they think the evidence presented in each of the visualization images shows about changes in Arctic.
4. Provide participating teachers with a NASA article describing 2013 changes in Arctic sea ice (http://climate.nasa.gov/news/986). Ask teachers to use a paired reading strategy to read the article (Note: This incorporates strategies from Common Core ELA). After the table is finished reading, small groups will use an evidence circle discourse strategy (Note: Common Core ELA) to make and defend a claim for changes in sea ice based on the evidence presented both in the article and with

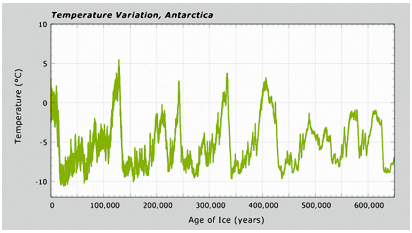
EdGCM visualization images.

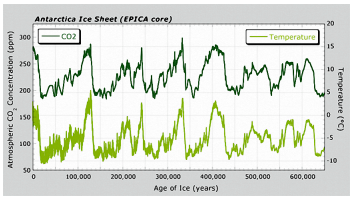
5. As a formative assessment, ask small groups of teachers to visually describe using a systems interaction diagram showing atmosphere, hydrosphere, and cryosphere how a positive feedback loop from reduced albedo is creating additional melting and sea level rise.

EXPLAIN Examine changes in global carbon dioxide and temperature

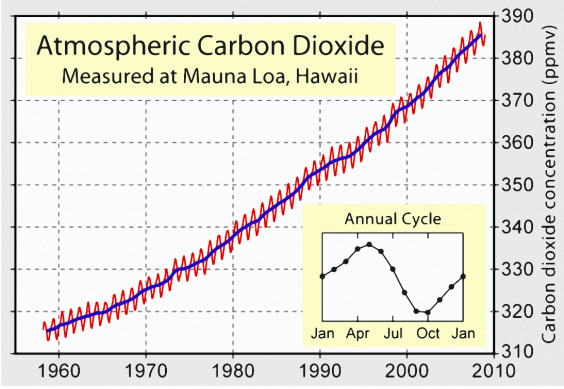
1. Set a context for the following workshop activity to discuss global climate change data: each small group of teachers is part of a climate science team responsible for analysis and reporting of climate change data at a global climate change conference (refer to IPCC reports and United Nations global climate conferences as examples).
2. Provide small groups with individual data graphs from Antarctic ice core data from the BSCS curriculum *Carbon Connections* (BSCS 2013) - (http://carbonconnections.bscs.org/curriculum/unit-01/lesson-02.php). With each graph, small groups analyze patterns and interpret what the data indicate: 1) ancient carbon dioxide graph, 2) ancient temperature variation, and Antarctica ice sheet (EPICA core) data showing both carbon dioxide and temperature variability over the past 600,000 years.







3. Provide each small group with Keeling Curve (http://earthguide.ucsd.edu/eoc/special_topics/teach/sp_climate_change/p_keeling_curve).



4. Each small group examines data and prepares a claim to make to the global climate conference about global climate change. Teacher participants in their small groups will be encouraged to go further using additional, reputable data to enhance their claim. Small groups must prepare a presentation to share with the whole group. When it is time to present at the conference, each team is required to: 1) Present

data analysis, 2) Describe any trends, patterns, or cycles in the data, and 3) Make predictions for the future using data.

5. After all small groups present their claims, explain to whole group how the evidence for changes in carbon dioxide in the Earth's atmosphere is one driver of climate change. Ask the teacher participants to read *Drivers of 20th Century Climate Change* (Shindell 2013). Have teachers in small groups identify other drivers of climate change. Lead a large group discussion on drivers of climate change.
6. Have teacher participants use the BSCS climate model simulation to explore four drivers of climate change (http://carbonconnections.bscs.org/curriculum/unit-03/ecm-full/index.php). (Note: a classroom set of laptop computers will be needed). Have small groups of teachers write an explanation for what they think is the best-fit reason for why the Earth's temperature is increasing.

ELABORATE Discuss impacts of global climate change

1. As a follow up to the conference activity, teachers will explore effects of global climate change. In pairs, teachers will develop a question to investigate about global climate change. For example, a teacher pair can ask the question, "How will global climate change affect human health?" As is often the case, there is often complex, voluminous answers and information about any single effect, like human health.
2. To help pairs of teachers explore the data and answer their questions, the facilitator will establish several stations around the room where pairs of teachers can explore articles, reports, books, videos, and other evidence of global climate change impacts. (Note: a "station" will be a table at which some resources will be set out.) Some possible resources are listed below.
3. Teacher participants will be asked to travel in pairs to visit stations. At each station, the pairs will create (and add to) a list of effects of global climate change. What are details associated with the climate change effect? What are some possible driving factors are associated in producing the effect? A graphic organizer such as the one below will be provided to help scaffold thinking and illustrate the relationship between numerous climate change effects.

Global Climate Change Effect	**Source**	**Details About Climate Change Effect**	**Driving Factors**
Human health	*World Health Organization Mathez (2009) Henson (2011) (Schmidt & Wolfe (2009)*	*Diarrhea, malaria, dengue fever*	*Heat waves Drought Shifting ranges of insects Water contamination*

Examples of Resources for stations about Global Climate Change Effects

- Changing ocean and atmospheric currents (American Museum of Natural History articles)
- Regional predictions for global climate change (IPCC reports and Global Change)
- Extreme weather events (storms, drought, heat waves etc.)

- Changing migratory patterns of vertebrate and invertebrate organisms) Caribou (American Museum of Natural History you tube video) or Polar Bears
- Changes in vegetation zones
- Changes in human health

4. After teachers complete some data collection about global climate change effects, they will return to answer original question. The whole group will discuss some of the questions, evidence, and answers to the teacher pairs' questions.

EVALUATE

Assessment:

- Teacher small groups will develop and defend a visual model on chart paper describing systems interactions in the Arctic as indicative of global climate change
    - Criteria for a successful model will include clear labels and descriptors for factors affecting interactions and change

Procedure: Small groups draw models on chart paper. Each group hangs model after completion. Individual participants will conduct a gallery walk using small post it notes to comment on group models. Comments can include questions, observations, and additional information. Once participants complete the gallery walk, the whole group will engage in a larger conversation about the evidence for global climate change beyond the Arctic.

After the final model discussion, participants will reflect on new knowledge using a 3*2*1 strategy on how their understanding of global climate change has been affected by taking this workshop.

3 new ideas that you developed or uncovered during the course of the workshop
2 pieces of evidence that you consider the most compelling for global climate change
1 question you would like to ask a climate scientist

Note: This assessment is designed to allow workshop participants to demonstrate their understanding through creation and explanation of their models. I feel that this will be a powerful concluding activity because participants will need to make a claim about their thinking, share it with others in their small groups, negotiate the best way to display and label their thinking, and evaluate the thinking of other groups. In many ways, this is what we have been doing on an individual basis in this class with our topical conversations and with our final projects.

Supplementary Materials

- Arctic ice sheet melting video (http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice.php, http://climate.nasa.gov/news/986,

- American Museum of Natural History *Global Energy Flows* handout amnh.mrooms.net/pluginfile.php/37656/block_html/content/W1D1.pdf
- EdGCM data visualization handouts showing predictions for Arctic ice sheet melting (EdGCM Project of Columbia University and NASA Goddard Institute for Space Studies 2003-2012)
- Vostok ice core data graph copies (BSCS 2013)
- Keeling Curve graph (http://earthguide.ucsd.edu/eoc/special_topics/teach/sp_climate_change/p_keeling_curve)
- *Drivers of 20th Century Climate Change* (Shindell 2013)
- *Climate Literacy* booklet (http://library.globalchange.gov/climate-literacy-the-essential-principles-of-climate-sciences-hi-resolution-booklet)

Assessment (Also see Evaluate in scope and sequence)
Teachers will not receive a grade for participation in the workshop. This does not mean that their knowledge will not be assessed. As explained above, individual teachers will demonstrate their thinking by designing and describing a model for how systems interact to influence global climate change. The intent of this summative assessment is to help teachers synthesize the concepts explored in the workshop and to reflect on their own learning. Because learning is social, the assessment is designed to access individual ideas, share with small group, provide critical feedback to other groups, and then come to a consensus as a whole group. The final result of the group discussion will be "take away" messages about global climate change. The messages will be written on sentence strips by workshop participants and posted.

Evaluation
Typically, a workshop evaluation is used with teacher participants to self assess general reactions to the workshop. They answer such questions as, Was the content understandable? Delivered in a manner that was consistent with standards-based learning? Paced properly? etc. I propose evaluating the workshop at two levels: reflection of content and NGSS understanding.

1. Provide workshop participants with a copy of Climate Change Literacy handbook and copies of the NGSS performance expectations addressed in the workshop. Ask each teacher to personally review the NGGS performance expectation that best matches his or her grade level (5th grade or middle school). Discuss with table group how the workshop modeled the integration of the three dimensions and helped them understand what the performance expectation is asking of students.
2. Ask participants to reflect on how their understanding of workshop objectives by measuring their own learning on the workshop progression chart.

Workshop Learning Progression

Increasing Sophistication Of Thinking

Objective	Initial Understanding	Understanding	Confident Understanding
1. Describe albedo in the Arctic and how albedo influences the Earth's energy budget.	Ice and snow reflect light. Albedo is the amount of light energy reflected by a surface, like ice.	The sun is the primary source of energy for Earth's climate system (Principle 1 Climate Literacy). The Earth's energy budget is determined by how much of the sun's energy is being absorbed or reflected. Albedo in the Arctic is an example of reflected radiant energy in the Earth's budget.	The Earth's energy balance may be out of balance if too much radiant heat is trapped within the Earth's systems. One of the reasons of this imbalance of energy is a reduction in albedo, particularly from areas like the Arctic. This causes a positive feedback loop, creating more warming, and less albedo.
2. Explain the relationship between carbon dioxide, temperature, and global climate changes.	Global climate warming has something to do with carbon dioxide and the greenhouse effect.	Climate is regulated by complex interactions among components of the Earth system (Principle 2 Climate Literacy). Greenhouse gases such as water vapor, carbon dioxide, and methane occur naturally in small amounts and absorb and release heat energy more efficiently than abundant atmospheric gases like nitrogen and oxygen. Small increases in carbon dioxide concentration have a large effect on the climate system.	Climate varies over space and time through both natural and human processes. (Principle 4 Climate Literacy). Scientific observations indicate that global climate has changed in the past, is changing now, and will change in the future. The magnitude and direction of this change is not the same at all locations on Earth. Paleoclimate data and current carbon dioxide levels in the atmosphere provide clues to the correlation between carbon dioxide and temperature.
3. Use evidence of past climate changes, current climate conditions, and future predictions to design and describe a model for systems interactions that are involved in global climate change.	Model of systems interaction show a simple relationship of energy flow and matter cycling to describe climate and climate change.	Models represent a climate system that shows in-depth interactions between the atmosphere, hydrosphere, and cryosphere systems.	Model of systems interactions uses data (past, present, and future) to show a sophisticated understanding of Earth's energy balance and how carbon dioxide cycles though the atmosphere, hydrosphere, and cryosphere (systems addressed in the

			workshop). Feedback loops (e.g. albedo) are included in model.
4. How has your understanding about and ability to teach NGSS changed?	I have heard about NGSS but have not yet explored any performance expectations	I know that NGSS is based on *A Framework for K-12 Science Education* and includes 3 dimensions: science and engineering practices. Disciplinary core content, and cross cutting concepts	I have experienced a performance expectation from NGSS and understand what integration of the 3 dimensions means. I can transfer this understanding to instructional design with my students.

3. Once each participant has reflected on their own learning progression, ask them to complete a workshop evaluation. A sample of the ranking for how each workshop participant's understanding has changed as a result of participation in the workshop is provided below.

Evaluation Example:

Please rate the specific sessions of the workshop according to their effectiveness in helping you understand the learning objectives. Please refer to the workshop learning progression in determining your rating.

	Highly Effective	**Sort of Effective**	**Not Effective**	**Not sure yet**	**Not Applicable**
Describe albedo in the Arctic and how albedo influences the Earth's energy budget.					
Please comment on your rating					
Explain the relationship between carbon dioxide, temperature, and global climate changes.					
Please comment on your rating					
Use evidence of past climate changes, current climate conditions, and future predictions to design and describe a model for systems interactions that are involved in global climate change.					
Please comment on your rating					

How your understanding about and ability to teach using NGSS has changed					
Please comment on your rating					

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Conclusion

The purpose of the final project for me was to develop a professional development workshop for teachers that can be implemented through the Center for Science Teaching and Learning, Northern Arizona University where I work. I wanted the workshop design to include elements for building an understanding of the climate science related to global climate change and how to teach/model climate change using NGSS for grades 5-8 teachers and informal educators. We have found that many teachers in this audience need additional professional learning to enhance content understanding. One approach we have used is to concentrate on the cross cutting concepts described in *A Framework for K-12 Science Education* (National Research Council 2012) and NGSS (Achieve 2013). Climate science is a powerful topic to help build increased understanding about Earth systems and models.

I am pleased with the results of this draft design for professional development. I think the learning objectives and content can be achieved in two days of instruction using principles of constructivist learning and inquiry skills. I like the flow of engaging teachers with an issue, uncovering the issue at a regional level, using the example to explore climate change at a global level, recognizing other global issues associated with climate change, and asking teachers to synthesize their thinking by drawing their own mental models for climate change.

The challenge in offering this type of professional development is first and foremost – getting teachers in the room to learn. Currently, climate change is not part of Arizona standards. Arizona is in the process of transitioning to NGSS, but that may not happen for a few years. This type of workshop may need to be built in to other grant-funded workshops designed to build content knowledge. Another option may be to offer this type of workshop as a special opportunity for preservice teachers. Another challenge is to convey to workshop participants that the content of the workshop is just a beginning of what should be a longer journey in continuous study of global climate change. New data, current events, online resources are being produced constantly. This should be a topic that is introduced in

the classroom and referred to frequently. This is a great opportunity for students to engage in STEM learning. Challenges could be posed to students to design solutions, develop school or community policies, and create art to communicate, etc.

This is the topic of the 21st century. As such I see that even if workshop does not get taught as written, elements of the workshop and American Museum of Natural History course will be used in other professional development settings. If nothing else, an increase in personal understanding will help me in my work with teachers to make connections within other topics of science curriculum to global climate change.