NESTA Shares: Innovative Ways to Teach about Weather and Climate
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Selected NGSS Disciplinary Core Ideas (http://www.nextgenscience.org/)

**K-2** (http://www.nextgenscience.org/kess2-earth-systems)
Students who demonstrate understanding can:
- K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time.
- K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

**3** (http://www.nextgenscience.org/3ess2-earth-systems)
Students who demonstrate understanding can:
- 3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
- 3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.

**Middle School** (http://www.nextgenscience.org/msess2-earth-systems)
Students who demonstrate understanding can:
- MS-ESS2-1. Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.
- MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and spatial scales.
- MS-ESS2-4. Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.
- MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

- MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.
High School (http://www.nextgenscience.org/hsess2-earth-systems)

Students who demonstrate understanding can:

**HS-ESS2-1.** Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

**HS-ESS2-4.** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

**HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

**HS-ESS2-6.** Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

**HS-ESS2-7.** Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

**HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

**HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

**HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

**HS-ESS3-5.** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

**HS-ESS3-6.** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
Selected Examples from the National Climate Assessment (http://nca2014.globalchange.gov/)

Findings

Widespread Impacts (http://nca2014.globalchange.gov/highlights/report-findings/widespread-impacts)

Introduction
Climate change is already affecting societies and the natural world. Climate change interacts with other environmental and societal factors in ways that can either moderate or intensify these impacts. The types and magnitudes of impacts vary across the nation and through time. Children, the elderly, the sick, and the poor are especially vulnerable. There is mounting evidence that harm to the nation will increase substantially in the future unless global emissions of heat-trapping gases are greatly reduced.

- Multiple failures during extreme events
- Cascading events across sections

Human Health (http://nca2014.globalchange.gov/highlights/report-findings/human-health)

Introduction
Key weather and climate drivers of health impacts include increasingly frequent, intense, and longer-lasting extreme heat, which worsens drought, wildfire, and air pollution risks; increasingly frequent extreme precipitation, intense storms, and changes in precipitation patterns that can lead to flooding, drought, and ecosystem changes; and rising sea levels that intensify coastal flooding and storm surge, causing injuries, deaths, stress due to evacuations, and water quality impacts, among other effects on public health.

- Most vulnerable at risk
- Prevention provides protection
- Responses have multiple benefits
- Changes in Air Quality
- Allergies and Asthma
- Food, Water Supply, Diseases (e.g., Diarrhea)
- Extreme Heat

Notes and Suggestions for Learning Activities
Selected NCA Regional Impacts


Evidence for changes in Earth’s climate can be found from the top of the atmosphere to the depths of the oceans. Researchers from around the world have compiled this evidence using satellites, weather balloons, thermometers at surface stations, and many other types of observing systems that monitor the Earth’s weather and climate. The sum total of this evidence tells an unambiguous story: the planet is warming.

**Examples of Regional Impacts**

**Midwest** (IL, IN, IA, MI, MN, MO, OH, and WI)

**Key Message: Impacts to Agriculture**

In the next few decades, longer growing seasons and rising carbon dioxide levels will increase yields of some crops, though those benefits will be progressively offset by extreme weather events. Though adaptation options can reduce some of the detrimental effects, in the long term, the combined stresses associated with climate change are expected to decrease agricultural productivity.

**Forest Composition**

The composition of the region’s forests is expected to change as rising temperatures drive habitats for many tree species northward. The role of the region’s forests as a net absorber of carbon is at risk from disruptions to forest ecosystems, in part due to climate change.
Public Health Risks
Increased heat wave intensity and frequency, increased humidity, degraded air quality, and reduced water quality will increase public health risks.

Fossil-Fuel Dependent Electricity System
The Midwest has a highly energy-intensive economy with per capita emissions of greenhouse gases more than 20% higher than the national average. The region also has a large and increasingly utilized potential to reduce emissions that cause climate change.

Increased Rainfall and Flooding
Extreme rainfall events and flooding have increased during the last century, and these trends are expected to continue, causing erosion, declining water quality, and negative impacts on transportation, agriculture, human health, and infrastructure.

Increased Risks to the Great Lakes
Climate change will exacerbate a range of risks to the Great Lakes, including changes in the range and distribution of certain fish species, increased invasive species and harmful blooms of algae, and declining beach health. Ice cover declines will lengthen the commercial navigation season.

Great Plains (KS, MT, NB, ND, OK, SD, TX, and WY)

Key Message: Energy, Water and Land Use
Rising temperatures are leading to increased demand for water and energy. In parts of the region, this will constrain development, stress natural resources, and increase competition for water among communities, agriculture, energy production, and ecological needs.

Sustaining Agriculture
Changes to crop growth cycles due to warming winters and alterations in the timing and magnitude of rainfall events have already been observed; as these trends continue, they will require new agriculture and livestock management practices.

Conservation and Adaptation
Landscape fragmentation is increasing, for example, in the context of energy development activities in the northern Great Plains. A highly fragmented landscape will hinder adaptation of species when climate change alters habitat composition and timing of plant development cycles.

Vulnerable Communities
Communities that are already the most vulnerable to weather and climate extremes will be stressed even further by more frequent extreme events occurring within an already highly variable climate system.

Opportunities to Build Resilience
The magnitude of expected changes will exceed those experienced in the last century. Existing adaptation and planning efforts are inadequate to respond to these projected impacts.
Beginning to Address Our Challenge

Given the unprecedented convergence of scientific findings, District and State demands on educators, and the national political and economic picture, what are possible actions to begin developing appropriate instructional resources for your classes?