Impacts and Feedbacks in a Warming Arctic: Engaging Diverse Learners in Earth Science Education and Research

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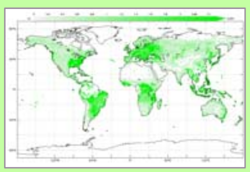
PROJECT NEED

- To build the capacity to navigate the challenges associated with a changing climate, learning in Arctic communities must not only increase knowledge, but also generate new knowledge as the rapid changes occur.
- Citizen science, the process whereby citizens (including K-12 students) are involved in science as researchers, presents a possible mechanism to meet this need.
- However, hypothesis-driven models of citizen science have been criticized for a disconnect between scientific agendas and the priorities and needs of diverse communities.
- The new geoscience education and research program at the University of Alaska Fairbanks, entitled Arctic and Earth SIGNs (STEM integrating GLOBE and NASA), provides new opportunities for K-12 students, pre- and in-service teachers and lifelong learners from diverse communities to engage in citizen science learning.

Tracking spring leaf phenology in Alaska using GLOBE protocols. Photos courtesy of C. Silcox and B. Stroup



Leaf area index (LAI) for May 2002 as observed by the MISR sensor onboard Terra. The darker the color represents greater the leaf area present at the location. Visualization produced by mynasadata.larc.nasa.gov

OVERVIEW & OBJECTIVES

Arctic and Earth SIGNs offers participants citizen science learning experiences that address the climate change challenges arising within their unique community, and is supported by culturally responsive curriculum and research collaboration with scientists.

Objective 1: Develop a high quality climate change education program that includes NASA assets (resources and experts), citizen science, and mobile technology for formal and informal science education settings

Training citizen scientists in phenology monitoring protocols at the Caribou Poker Creeks Research Watershed near Fairbanks, Alaska, USA. Photo by S. Decina.

Objective 2: Engage pre- and in-service teachers in authentic science and engineering learning experiences to model best practice for teaching K-12 Earth Science

Objective 3: Engage citizen scientists and youth in informal, authentic science and engineering education experiences where they produce and apply new information on the impacts of a changing global climate.

METHODS

- This STEM (Science, Technology, Engineering and Mathematics) program trains teachers and community members on climate change concepts and measurement protocols in face-to-face or online workshops.
- More focused learning on the core climate change issues in the participant's community continues through modules that include:
  - GLOBE protocols that best fit the issue,
  - Local ecological knowledge,
  - Historical and current NASA data,
  - Direct contact with NASA subject matter experts,
  - Collaboration with a team of arctic scientists and other partners such as the Association of Interior Native Educators and the 4-H program.

Global Learning and Observations to Benefit the Environment (GLOBE) is the core citizen science methodology used in the Arctic and Earth SIGNs project. It offers participants the opportunity to select a protocol most relevant to their community's needs, while at the same time contributing to global, long-term professional science investigations.

- Students and communities apply the in-depth learning and data they collected to stewardship projects related to the core climate change issue of the community.
- Scientists also use the data collected through the project to address larger scale climate change or remote sensing questions. (Examples: Do native and invasive species respond differently to a changing climate? How well does the SMAP satellite predict the soil moisture observations made by GLOBE citizen scientists?)

Arctic and Earth SIGNs Learning Framework

Learning modules integrating NASA and citizen science/GLOBE
Face-to-face and online modules will engage participants in hands-on, place-based learning at local and global scales with an Arctic climate change focus. The learning method centers on locally relevant citizen science investigations, supporting activities using NASA data and scientists, and culturally responsive curriculum.

Culturally responsive curriculum integrating climate change
Existing culturally responsive curriculum materials will be adapted to include climate change concepts, including the following inquiries:
- What is climate change and how does it affect the Arctic and its people?
- What is the relationship between a changing Arctic and the Earth system?
- How do we understand and observe climate change?

Face-to-face and online courses for educators & community members
The learning modules and curriculum are utilized in a summer training course for in-service teachers, 4-H leaders, and community members. Online courses using the material will target pre-service and in-service teachers across a larger geographic area.

"Meet the Scientist" Sessions
NASA and Arctic scientists connect with classrooms or communities through Google Hangouts. Scientists support unique learning needs of participating communities and help sustain participation and interest.

Citizen Science Investigations
Students, teachers, 4-H groups, and community members select a GLOBE protocol that best matches a climate change issue within their community. They design an investigation that both creates useable data for larger research projects, and informs local challenges associated with a changing climate, including issues caused by:
- Changing active layer and permafrost
- Changing phenology of subsistence species
- Increasing occurrence of invasive species
- Increasing wildfire frequency and extent
- Changing soil moisture and precipitation

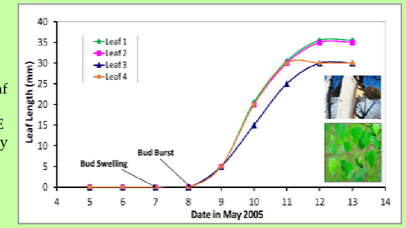
Community Projects on a Climate Change Issue
Citizen science data and NASA assets are utilized to inform a local stewardship effort. A key climate change issue motivates the project and makes the citizen science learning locally relevant.

LOCAL to GLOBAL

LEARNING & OBSERVATIONS

Background:

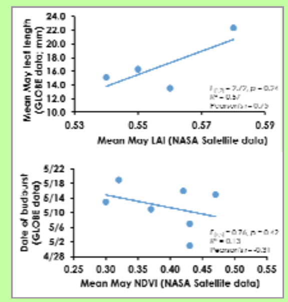
Innoko River School in Shageluk, Alaska (62.39 °N, 159.32 °W) has been tracking spring bud burst and new leaf length of birch (*Betula neoalaskana*) using the GLOBE protocol for the month of May since 2000.



Example of GLOBE green-up data for *Betula nealaskana* (Alaska paper birch) collected by the Innoko River School in Shagleuk, Alaska in May, 2005. Four different leaves were measured, all of which burst on May 8 and reached their full length within 5 days. Photo inserts are from USDA-NRCS PLANTS Database.

GLOBE data is used to ground-truth global phenology datasets, such as Leaf Area Index (LAI) and Normalized Difference Vegetation Index (NDVI) collected by the Multi-angle Imaging SpectroRadiometer (MISR) sensor onboard NASA's Terra satellite. Students can use their own data and compare it to NASA data to see how well the satellites predict the tree leaf phenology in their area.

Example Learning Activity Question: How well does the NASA satellite data predict the phenology observations made by the Innoko River School GLOBE students?



Betula neoalaskana (Alaska paper birch) mean may leaf length (A) and date of bud burst (B) measured using GLOBE protocols by the Innoko River School in Shagleuk, Alaska is plotted against the corresponding NASA satellite data for their location (mean May Leaf Area Index (LAI) and Normalized Difference Vegetation Index (NDVI), respectively).

Example Target Learning Outcomes:

- Students gain experience with STEM practices, such as:
  - Finding and using publically available scientific data
  - Comparing their own measurements to relevant data from other sources,
  - Graphing, analyzing and interpreting data,
  - Using mathematics and computational thinking
  - Constructing arguments based on evidence
- Students understand the importance of their citizen science to larger scale research.

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PROJECT TEAM – Other Members and Institutions

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GLOBE Data Entry & Visualization Consultant: David Overoye

GLOBE School Long Term Phenology Data: Innoko River School, Shageluk, AK: Collected by Students of teacher Joyanne Hamilton