GLOBE

Geographic Information Systems (GIS)

Collaborations & Peer Review

High Quality Professional Development

Systems Modeling
GLOBE Model for Student Scientific Research

- Observe Natural Phenomenon
- Pose Research Questions
- Develop Investigation Plan
- Conduct Investigation
- Write Research Report
- Analyze Data
- Share Findings & Conclusions
- Identify New Research Questions
- GLOBE Collaborations

Legend:
- Primary Pathways
- Collaboration Pathways
- Additional Pathways
Other common themes of the ESSPs

- Inquiry-based & project based approaches
- Web-based interactive tools
- Ecosystem measurements (near and far)
- Student-Scientist interactions (on-going)
- Systems thinking
- Investigation of human-environment relationships
- Community of scientists
- Having fun while doing science!
GLOBE Carbon Cycle:
Investigating the Carbon Cycle in Terrestrial Ecosystems

University of New Hampshire: Jen Bourgeault, Rita Freuder, Lara Gengarellly, Mary Martin, Scott Ollinger, Annette Schloss, Sarah Silverberg

Czech Republic: Jana Albrechtova, Kateřina Čiháková, Zuzana Lhotakova, Barbora Semeráková, Dana Votapkova

GLOBE Program Office: Gary Randolph
Why the Global Carbon Cycle?

- The most abundant element in living things
- Accounts for 45-50% of the total mass of the biosphere.
- Present in the Earth’s, atmosphere, soil, oceans, crust
- Important greenhouse gas
- Central part of the Earth’s climate system
- Altered by humans at unprecedented rates
- Primary driver of climate change
Carbon in the Earth System

...Think about our field day discussions...

Atmosphere

Hydrosphere               Biosphere

Pedasphere              Cryosphere
Global Warming Threatens Coffee Collapse in Uganda

Alexis Okeowo in Nsangi, Uganda for National Geographic News
July 24, 2007

South Africa: Eskom Promises Cleaner Energy

Carbon trading market opens in Melbourne

Posted Mon Jul 23, 2007 11:24am AEST

Changes in rainfall man-made, Canadian scientists say

Last Updated: Monday, July 23, 2007 | 4:05 PM ET

CBC News

UN issues desertification warning

Tibet warming at record rate

Posted Mon Jul 23, 2007 5:42am AEST

Tuesday, July 24, 2007

Flooding in England: What can be done?

U.S. governors address climate change


China releases strategy to counter climate change

Nation’s plan aims to improve energy efficiency by 20% by 2010

Global warming may uproot millions

In the coming decades, the effects of global warming are likely to turn millions into refugees.
Carbon Cycle Project Goals

Students will...

• Learn why carbon is an important element in ecosystems, and how it cycles through ecosystems.

• Gain skills in current carbon cycle research techniques.

• Increase their ability to critically think about problems.

• Understand the nature of science research.
Framing Carbon Cycle Lessons

Essential Questions:

Unit Questions:

Content Questions:
Where and how is CO₂ stored in a plant?
What is biomass and how is it measured?
How do scientists measure trees?
How is allometry used to calculate forest biomass?
How much carbon is being stored in the trees near my school?
What determines the upper limit of biomass in a given ecosystem?
Learning Carbon Cycle Science Through:

- Global Carbon Cycle Introductory Activities
- Field measurements of ecosystems
- Hands-on and computer models
- Classroom experiments with plants
- Mind-expanding math exercises designed to alter your view of the world!
Carbon Cycle Introductory Activities

• **Looks at carbon from a global perspective**

• **Use systems thinking to understand cycles and sub-cycles**

• **Introduces students to the important carbon concept of residence time**

• **Help students see the difference between the effects of human presence and human actions on the carbon cycle**

• **Allow students to move around the classroom, discuss with peers and explore science while using reading and math skills**

• **Included Activities: Carbon Cycle Story, Carbon Travels Game, Getting to Know Global Carbon, Pencil and Paper Carbon Modeling**
Modeling

- Introduces students to the use of models in science
- Applicable to students around the world
- Learn how carbon is stored and transferred at the ecosystem and global level
- Understand ways that carbon can change with a change in environmental conditions
- Connection to field collected data

Classroom Experiments: Plant-a-Plant

• *Hands-on activities: range of cultivation experiments with real plants*

• *Exploration and validation of variables necessary for plant growth*

• *Demonstrates that CO\textsubscript{2} is incorporated into plant biomass*

• *Understand changes in carbon storage at the plant and ecosystem level*

• *Included Activities: Light, Water, CO\textsubscript{2}, Mineral Nutrients, Temperature, Soil Respiration, Plant-a-Plant Computer Models*
Field Measurements

• Field engagement learning activities that provide necessary background before collecting data

• New carbon storage protocol based on existing GLOBE land cover site set-up and biometry protocols

• Allow students to make connections between the global C cycle and their own schoolyard

• Data can be scaled from the sample site to schoolyard, state, region or country to make carbon storage estimates

• Included Activities: How do Scientists Measure Trees?, Biomass Units, Allometry, Site Set-up, Tree Mapping, Grass, Shrubs and Tree Measurements, Field Biomass Analysis, Scaling Up
Website & Materials

• Currently Available:  
  • Project information  
  • Links to additional resources  
  • General carbon cycle background

• Coming Soon:  
  • Activities & Protocols for download (September 2011)  
  • Podcasts/videos geared toward students for content knowledge (December 2011)  
  • Scientist interviews: How do scientists research the carbon cycle? (February 2012)  
  • Carbon Storage Data Entry (Spring 2012)

http://globecarboncycle.unh.edu
Carbon Cycle Activities
- Activities Concept Map
- Movie related to activity
- Podcast related to activity
- Image related to activity
- PDF document for activity
- PPT related to activity
- Spreadsheet for activity
- Model for activity
- Website link for activity

Individual Modeling Activities
- Paperclip Simulation & Model
- Plant-a-Plant Models
- Biomass Accumulation Model
- Earth Exploration Toolbook: Biomass Model
- Simple Global C Cycle Model
- Global C Cycle with Feedbacks

Download Complete Modeling Activities Package (.zip)
Train-the-Trainer Workshops

**GLOBE Carbon Cycle**

Watershed Dynamics

November 3-9, 2011
Evanston, IL
Registration Information at: The GLOBE Workshop Registration Page (classic website)

April 2012
Durham, NH
Exact Dates to be Announced
Information will be announced through the GLOBE Website

Investigating Carbon in Terrestrial Ecosystems
Seasons and Biomes

Dr. Elena Sparrow¹, Dr. Rebecca Boger², Dr. Leslie Gordon³, Ms. Kim Morris¹, Dr. David Verbyla¹, Dr. Elissa Levine⁴, Ms. Martha Kopplin¹, and Dr. Sheila Yule⁵

¹ University of Alaska Fairbanks, Fairbanks, Alaska
² Brooklyn College, Brooklyn, New York
³ Gordon Consulting, Neskowin, Oregon
⁴ Maryland
⁵ Louisville, Kentucky

Dr. Jessica Robin, Dr. Martin Jeffries
GLOBE Seasons and Biomes

Why Seasons and Biomes?
- Engage students in earth science studies by monitoring seasons in their biomes
- Contribute to climate studies
- Participate in the International Polar Year
GLOBE Seasons and Biomes

Understanding earth system science through

- New phenology and seasonality protocols combined with classic GLOBE protocols

- Inquiry learning & other learning activities

- PD model integrating GLOBE, earth system science, best teaching practices and student scientific investigation process

- Global learning communities
GLOBE Seasons and Biomes

New Protocols Developed
Freshwater Ice Seasonality Investigation

Border ice formation – begins freeze-up

Moat formation- begins break-up

River Ice Freeze-up, River Ice Break-Up, Lake Ice Freeze-up and Lake Ice Break-up Protocols, River Ice Glossary, Lake Ice Glossary, Field Guides, Site Definition Sheet, Data Entry Sheet
Frost Tube Protocol

Frost Tube Measurements 2007-2008

- Fairbanks (Randy Smith)
- Fairbanks (Pearl Creek)
- Fairbanks
- Cantwell
- Healy
- Anderson
- Northway
- Old Crow
- Whitehorse
- Kenny Lake
- Delta Junction
- Dawson
- Takotna
- McGrath
- Anvik
Mosquito Protocols

Developed in Collaboration with scientists in

- Thailand
- Madagascar
Invasive Plant Species Protocol
Flowering Phenology Protocols
GLOBE Seasons and Biomes

New Learning Activities Developed
How to Make a Climatograph From Your Local Weather Data

Getting to Know Your Terrestrial Biomes

Ice Seasonality Learning Activity
Seasonal Leaf Change Inquiry Learning Activity

Soil Insulation Inquiry Learning Activity
Budburst Inquiry Learning Activity
Seasons & Biomes and Carbon Cycle Collaboration

Terrestrial biomes
- Tropical and sub-tropical moist broadleaf forests
- Tropical and sub-tropical dry broadleaf forests
- Tropical and sub-tropical coniferous forests
- Temperate broadleaf and mixed forests
- Temperate coniferous forests
- Boreal forests / Taiga
- Tundra
- Mediterranean forests, woodlands, and scrub
- Tropical and sub-tropical grasslands, savannas, and shrublands
- Temperate grasslands, savannas, and shrublands
- Montane grasslands and shrublands
- Flooded grasslands and savannas
- Mangroves
- Deserts and Xeric shrublands
- Rock and ice

Source: Millennium Ecosystem Assessment
Collaboration with Local Experts and Community Members
GLOBE Seasons and Biomes

Global Learning Communities
The International Polar Year

Arctic

Antarctic

What happens in the polar regions affects other world regions
GLOBE Alumni

- Trained with Teachers on S & B
- IPY and S &B Ambassadors
- Facilitate school collaborations through GS Pals
- Arctic Bird Migration discussions between students in Lima, Peru and In Alaska, U.S.
Collaborative Project between the U.S. and Australia: Combining Science, Language and Art

- Classes paired between Australia and Alaska
- Each pair writes and illustrates collaborative mystery story focused on the polar regions
- Scientist mentors
- Books done electronically using web platform
IPY Pole to Pole Videoconferences
Web Chats and Web Forums

Alaska, USA: 4 schools, 62-65 N

Ushuaia, Argentina: 55 S
Kilimanjaro Expedition 2009, 2010

GLOBE Africa, Seasons & Biomes
Globe Tanzania, GLOBE Kenya
GLOBE USA
With virtual participants from more than 90 countries

5790 meters
4,023 m
2804 m
1,830 m
792 m

Change in vegetation with Elevation
Seasons & Biomes and Carbon Collaboration

Terrestrial biomes:
- Tropical and sub-tropical moist broadleaf forests
- Tropical and sub-tropical dry broadleaf forests
- Tropical and sub-tropical coniferous forests
- Temperate broadleaf and mixed forests
- Temperate coniferous forests
- Boreal forests / Taiga
- Tundra
- Mediterranean forests, woodlands, and scrub
- Tropical and sub-tropical grasslands, savannas, and shrublands
- Temperate grasslands, savannas, and shrublands
- Montane grasslands and shrublands
- Flooded grasslands and savannas
- Nangroves
- Deserts and Xeric shrublands
- Rock and ice

Source: Millennium Ecosystem Assessment
# Seasons and Biomes Professional Development model, Face-to-face Workshop

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<th>Monday</th>
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<td><strong>Phenology -Budburst -Green Up -Green Down</strong></td>
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<td><strong>GLOBE Model for Student Scientific Research</strong></td>
<td><strong>Observatio n</strong></td>
<td><strong>Asking a question</strong></td>
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<td><strong>Design an investigation</strong></td>
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**Best Teaching Practices in Science**

Earth as a system

Workshop assessment

(Modified version of the Integrated PD model developed by Sheila Yule for Seasons and Biomes workshop in Arusha, Tanzania, September 2009)
GLOBE Model for Student Scientific Research

- Observe Natural Phenomenon
- Pose Research Questions
- Develop Investigation Plan
- Identify New Research Questions
- GLOBE Collaborations
- Conduct Investigation
- Share Findings & Conclusions
- Write Research Report
- Analyze Data

Legend:
- Primary Pathways
- Collaboration Pathways
- Additional Pathways
GLOBE Seasons and Biomes

Professional Development Workshops

Professional Development Workshops

- International Workshops
- Regional Workshops
- Trained Participant-Led Workshops
GLOBE Seasons and Biomes

Student Research Investigations
Effect of A Power Plant on Chena River Freeze-up

By Elizabeth Bennett

Other Parameters Measured:
Air temperature
Soil temperature,
Water Temperature
Ground and River surface temperature

Downstream of Power Plant

Upstream of Power Plant
Mosquito studies in Khanompitaya School
In Thailand
GLE in Capetown, South Africa

Innoko River High School Students: Integrating Indigenous Knowledge and GLOBE in an Alaskan Boreal Forest Study,

Students from Model Secondary Schools for the Deaf in Washington DC and from Indiana collaborated on a Budburst Study
GLOBE Seasons and Biomes

- Protocols
- Teacher Networks
- Global Learning Communities
- Student Networks
- Local Learning Communities
- Scientist Networks
- Learning Activities
- Student Projects
GLOBE Seasons and Biomes

Thank you for your attention
GLOBE Seasons and Biomes Collaborators

The Arctic System Science Thermokarst Project
Experimental Program to Stimulate Competitive Research

GLOBE Partnerships in Argentina, Australia, Czech Republic, Belgium, Canada, Cameroon, Croatia, Dominican Republic, Estonia, Germany, Greenland, Madagascar, Norway, Peru, S. Africa, Switzerland, Tanzania, Thailand, U.S.

GLOBE Africa, GLOBE Europe/Eurasia, GLOBE Latin America/Caribbean, GLOBE North America

U.S. Embassy in Estonia
Watershed Dynamics

The Watershed is a natural unit of study
- Watersheds provide natural boundaries for environmental investigations
- Water is a limiting factor to sustaining life and the resources vary around the world
- Humans will impact the water cycle

Using scientific datasets in GIS investigations
- Access to large-scale scientific datasets and professional technology
- Ability to draw conclusions about global issues by asking geospatial questions
Using GIS data to investigate the water cycle
Geographic Information Systems

Allows user to visualize and analyze geographic data

**Web-based** for easy access

**FREE TO USE**

[http://wdi.fieldscope.org](http://wdi.fieldscope.org)
**Water Availability**

Students investigate the water cycle by analyzing precipitation, surface runoff, and evaporation data

- When does precipitation come?
- Where does it go?

**Human Impact on the Watershed**

Students research a watershed to determine the relationship between land cover and stream discharge

- What is a watershed?
- How do humans impact the watershed?
- As land cover changes over time, how does streamflow respond?

Using GIS data to investigate the water cycle
Water Availability

- Targets grades 7-12
- Data available for US and International
- Curriculum translated to Spanish
  - Available soon
- *special thanks to Roberto Quiros and GLOBE Costa Rica*

Human Impact on the Watershed

- Targets grades 9-12
- Data available for contiguous US
- Curriculum is adaptable for local investigations

Using GIS data to investigate the water cycle
## GIS Tools and Data

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<th>Activity</th>
<th>Technology</th>
<th>Data</th>
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<td>Cmap concept maps</td>
<td>NARR (NCEP, National Weather Service, NOAA, Dept of Commerce)</td>
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<td>My World GIS</td>
<td>NCEP-DOE AMIP-II reanalysis</td>
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<td>Web-GIS by FieldScope</td>
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<td>Human Impact on the Watershed</td>
<td>NetLogo models</td>
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<td>My World GIS</td>
<td>Aerial image (Terraserver)</td>
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<td>NLCD (USGS, EPA, NOAA, NASA, et al)</td>
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<td>Streamgage data (USGS via NWIS and CUAHSI HIS)</td>
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Using GIS data to investigate the water cycle
FLEXE-style Student-Scientist Forum

http://wdscientist.northwestern.edu
http://wdscientist.northwestern.edu/response

Using GIS data to investigate the water cycle
FLEXE-style Student-Scientist Forum

3 scientists and 300 students participated
Students investigated the relationship between land cover and streamflow in watersheds
Scientists read student findings and provided feedback

http://wdscientist.northwestern.edu
http://wdscientist.northwestern.edu/response

Using GIS data to investigate the water cycle
Train-the-Trainer Opportunity

Carbon Cycle Collaboration
November 3-9, 2011
Evanston, IL

Training in both Watersheds & Carbon Cycle materials

http://wd.northwestern.edu/professional-development

Using GIS data to investigate the water cycle
Contributors

http://wd.northwestern.edu

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Using GIS data to investigate the water cycle
FLEXE Project Overview

FLEXE Four-Year Project GOALS:

To help students deepen their understanding of:

- **earth systems science**, in particular through contrast with concepts *illustrated by deep-ocean processes (the extreme!)*

- **scientific inquiry skills**, including the process and nature of science

To evaluate FLEXE activities’ effectiveness

To integrate with GLOBE
Why the deep-sea?

• Hydrothermal vents and cold seeps offer **novel** examples of integrated Earth Systems.

• The **contrast** with more familiar local ecosystems helps deepen students’ understanding.

• Vents and seeps are “**EXTREME**”
  - Immense pressure
  - Extreme temperatures, steep gradients
  - Toxic fluids, low pH
  - Absence of light
FLEXE Components

- Comparison of Data/Environments
  - Local/Schoolyard data (primary data)
  - Partner school data / GLOBE database (secondary data)
  - Deep-Sea data (‘EXTREME’ data)
FLEXE Components, con’t.

- Links to the Extreme Environment
  - Facilitated interaction with scientists around data analysis (FLEXE Forum)
  - Live Research Cruise featured via interactive website
FLEXE Components, con’t.

- Community of Learning

  Student ← Teachers → Student
  Student ← Scientists → Student

- Student-Student (Partner school exchange, Peer Review)
- Student-Scientist (FLEXE Forum, Cruise website)

The GLOBE Program

From Local to Extreme Environments
Systematic Evaluation

Energy Unit & partial FLEXE System pilot tested in Fall ‘07, revised, added partnering function and final tested in Spring ‘09
- 44 GLOBE schools involved from four countries (US, Germany, Thailand, Australia) with ~1400 students.
- Evaluation of effect of international vs. domestic partnering
- Analysis of student data using argumentation analysis and ‘QQ’ surveys.

Ecology Unit & FLEXE Forum tested in Spring ‘10
- 36 schools involved from 4 countries (US, Thailand, England, Costa Rica) with ~1100 students
- Evaluation of effect of student-scientist interaction (FLEXE Forum)
- Analysis of students’ Forum responses over time.
FLEXE Results

- **Earth Systems Science Understanding:** FLEXE has developed and tested two instructional units - one on **Energy Transfer**, and a second on **Ecology**. Both units emphasize the use of data and the process of scientific investigations in understanding earth systems science.

- **Science Process Skills:** We have developed and demonstrated the effectiveness of innovations like web-based student peer review, student-scientist forums, and the integration of student schoolyard research with data from extreme environments.

- **Science Education Research:** FLEXE has successfully implemented international web-based projects in which students interact with each other and with scientists online, all while complying with very high standards concerning **human subjects protection**.
General findings

• The deep-sea environment IS engaging for students.
  • FLEXE makes deep-sea concepts accessible to students.
  • The contrast with “local” does help deepen students’ understanding.
• Scheduling of “live events” (i.e., FLEXE Forums, Peer Review, Cruises) within the school year is challenging but doable.
• Middle school students are capable of valid peer review.
• International Partnerships result in greater impact on student learning.
• Student-Scientist interactions via FLEXE Forum are considered very positive (from teacher feedback) and are effective in engaging learners.
• FLEXE Forums are scalable although require an education intermediary. We are currently testing these ideas with the other ESSPs.
FLEXE Publications


More to come!
On behalf of our team:

Liz Goehring (Pennsylvania State University)
Dr. Bill Carlsen (Pennsylvania State University)
Dr. Chuck Fisher (Pennsylvania State University)
Dr. Steve Kerlin (Northern Kentucky University)
Dr. Matt Smith (University of Florida)
Eric Simms (University of California, San Diego)
Along with entire Ridge2000 research community

Many Thanks to YOU, the GLOBE community!
To Learn More About Any of the Projects Attend one of Today’s Workshops -

9:00 – 11:30
Seasons and Biomes (Lavender Room)
Carbon Cycle (Juniper Room)
Watershed (Insight Room)
FLEXE (Wisdom Room)

12:30 – 15:00
Seasons and Biomes (Lavender Room)
Watershed (Insight Room)
FLEXE (Wisdom Room)