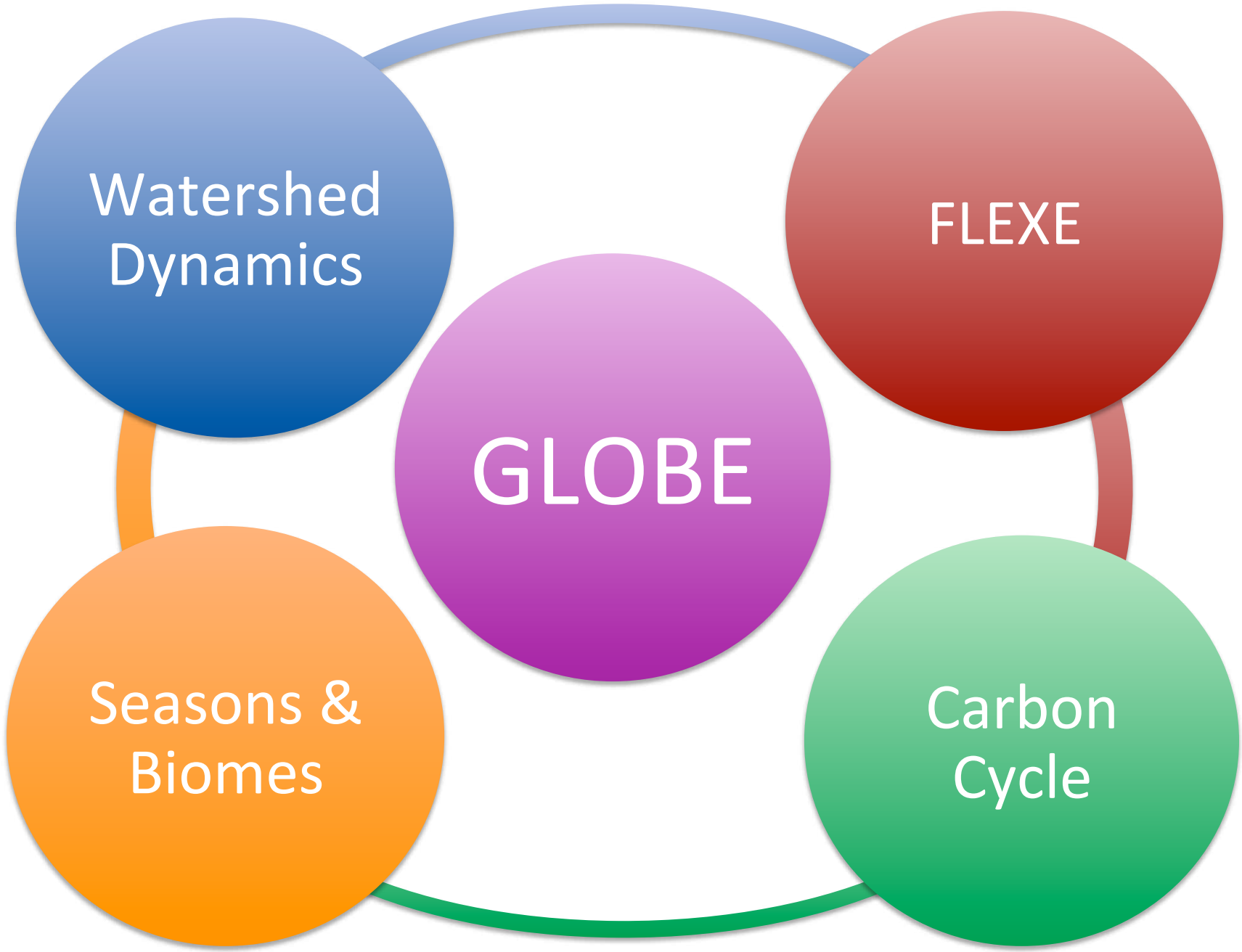
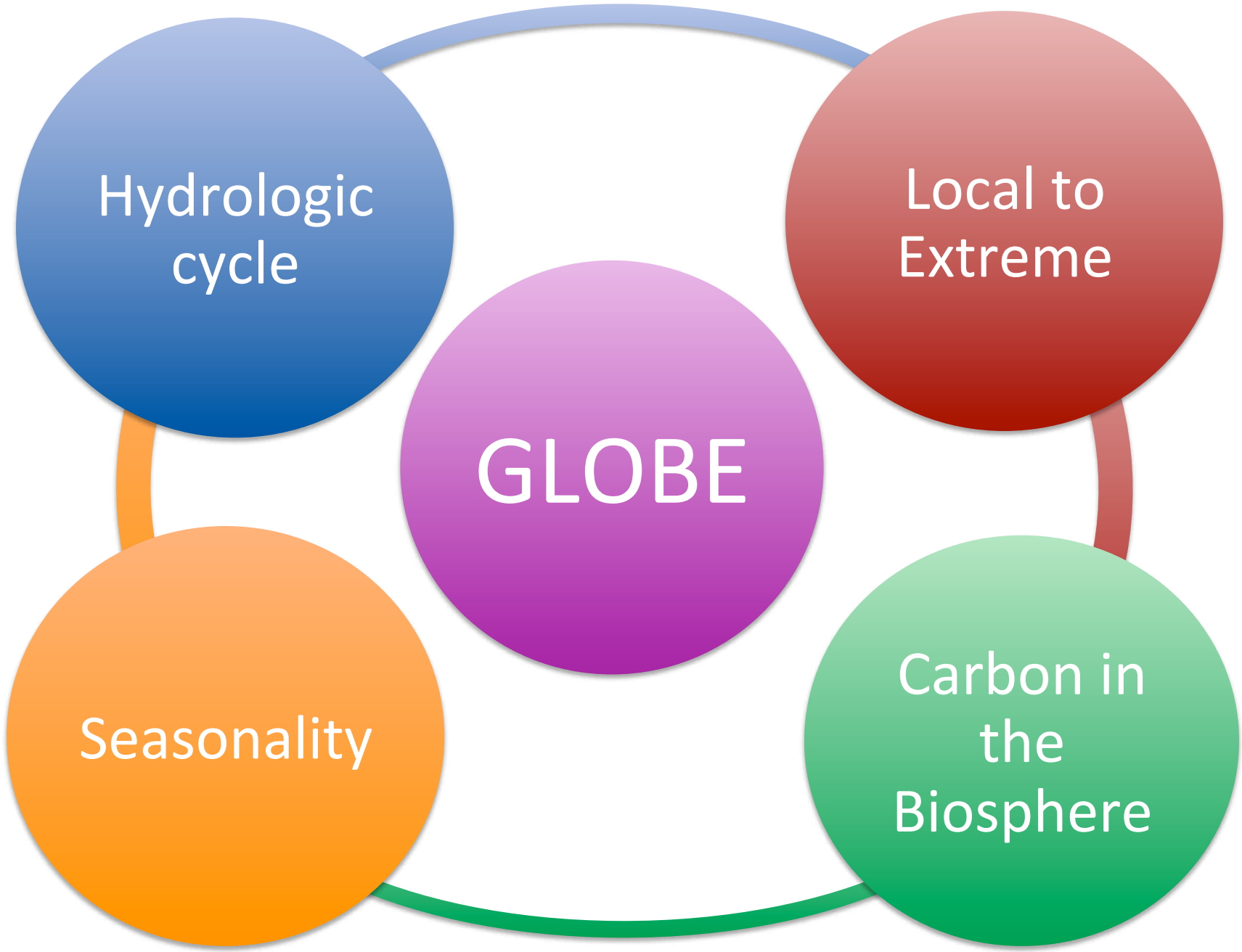
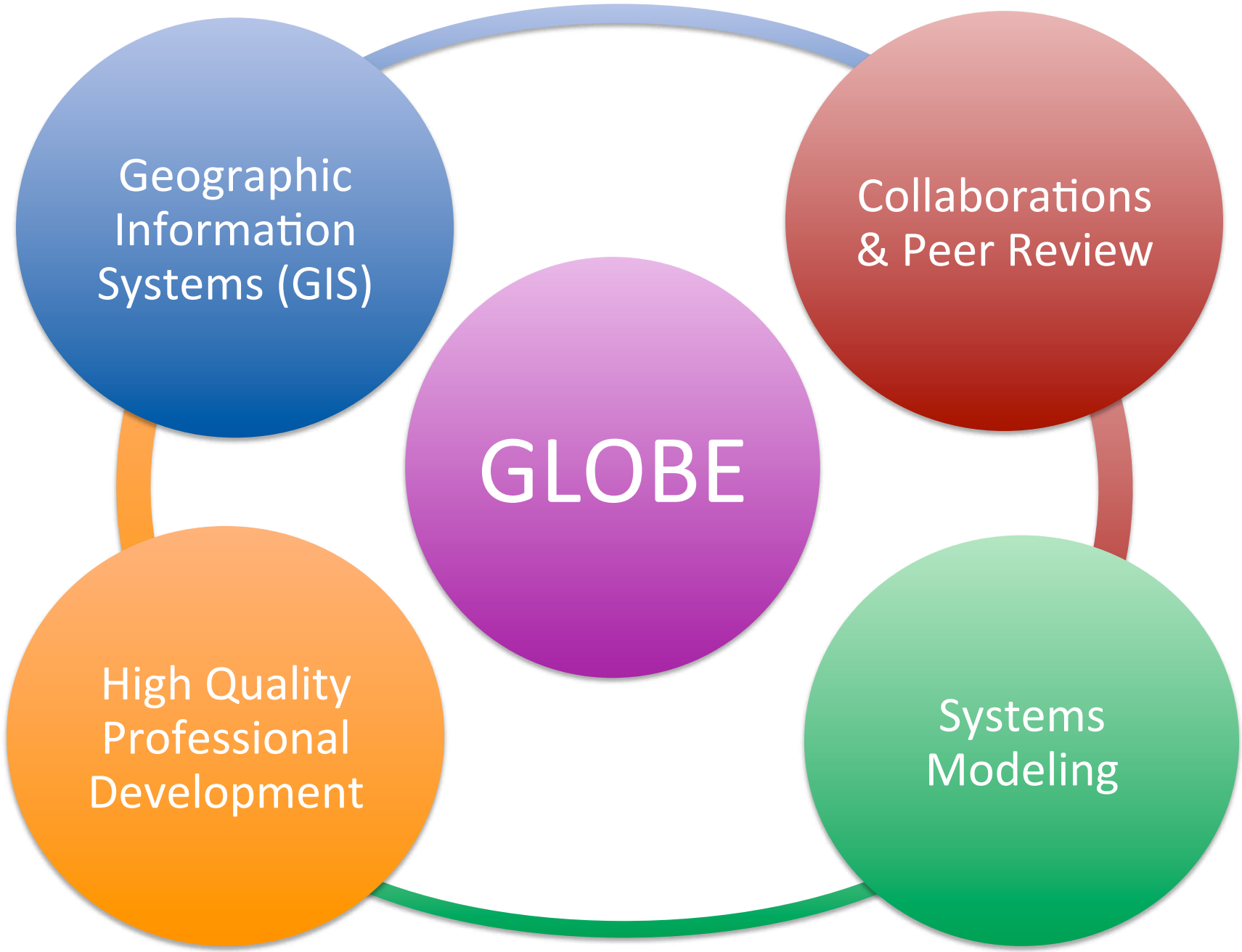
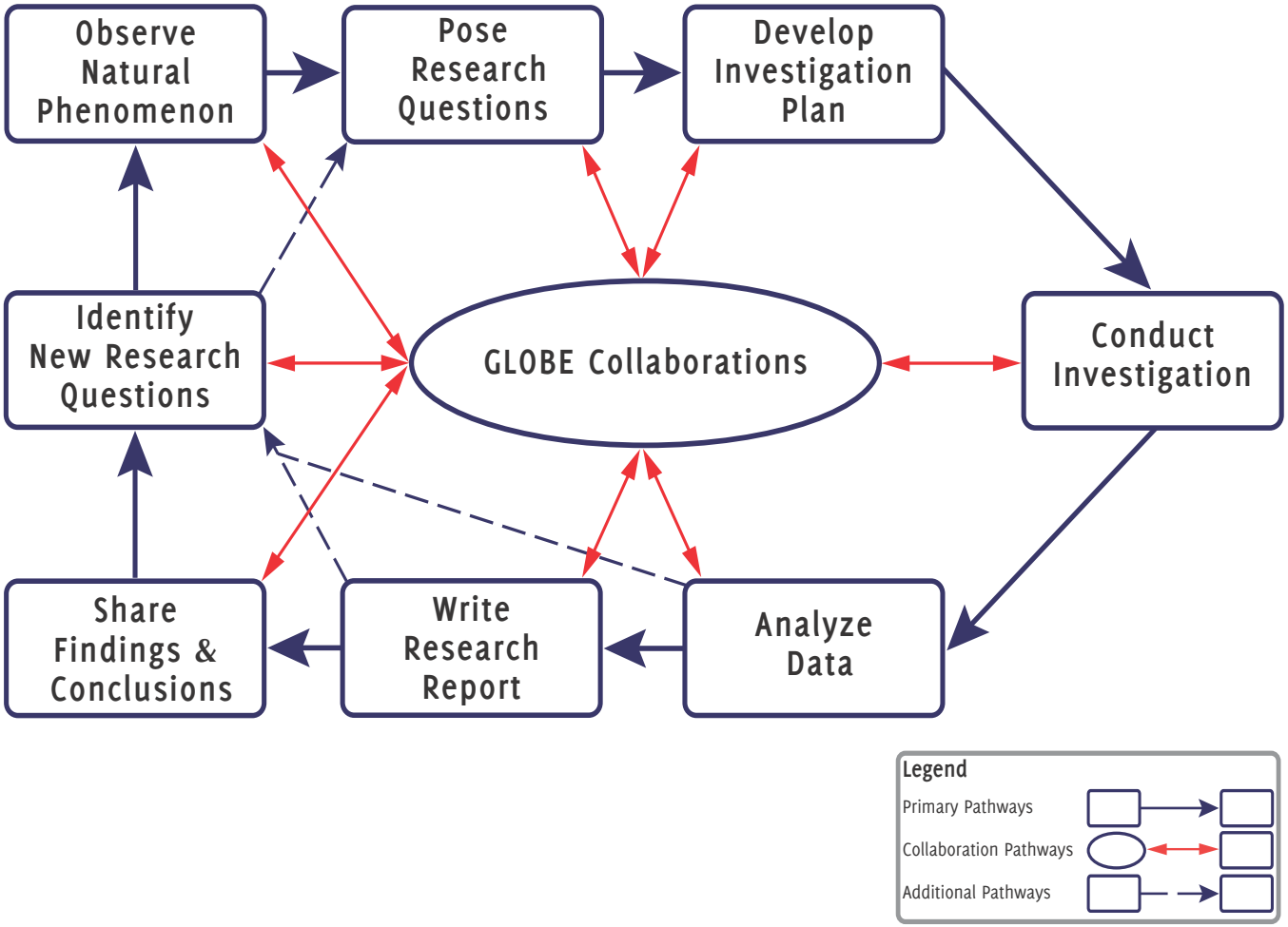
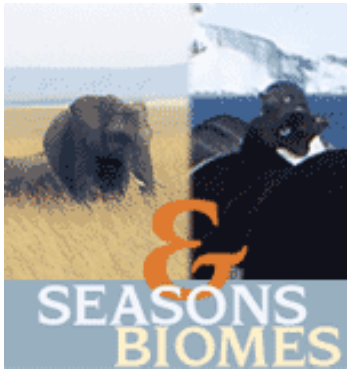

Watershed Dynamics
FLEXE
GLOBE
Seasons & Biomes
Carbon Cycle


Hydrologic cycle
Local to Extreme
GLOBE
Seasonality
Carbon in the Biosphere


Geographic Information Systems (GIS)
Collaborations & Peer Review
GLOBE
High Quality Professional Development
Systems Modeling

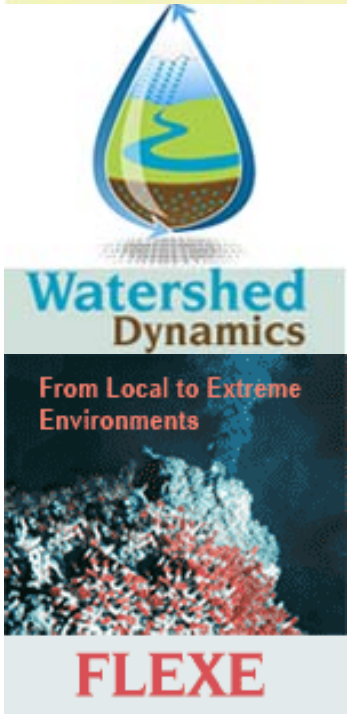
GLOBE Model for Student Scientific Research





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 <u>doing science</u>!



GLOBE Carbon Cycle: Investigating the Carbon Cycle in Terrestrial Ecosystems

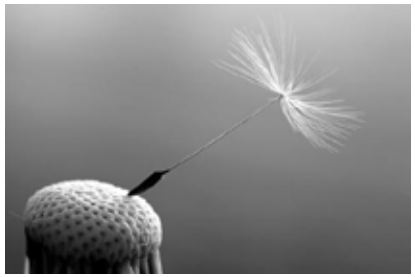
University of New Hampshire: Jen Bourgeault, Rita Freuder, Lara Gengarelly, Mary Martin, Scott Ollinger, Annette Schloss, Sarah Silverberg

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

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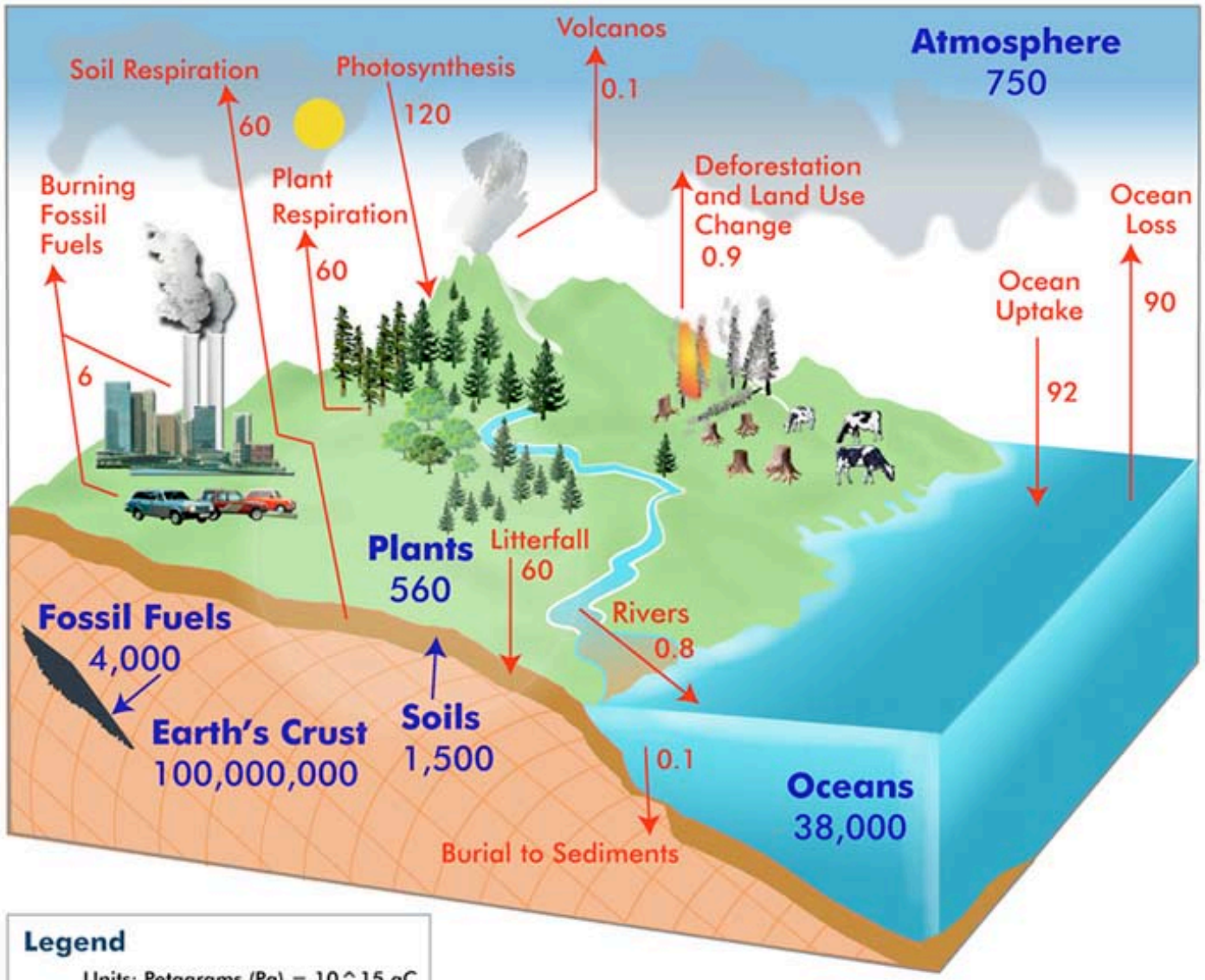
Global Carbon Cycle



Legend

Units: Petagrams (Pg) = 10^15 gC

- Pools: Pg
- Fluxes: Pg/year

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

U.S. governors address climate change

Updated Sun. Jul. 22 2007 2:57 PM ET

Flooding in England: What can be done?

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.

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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.

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Framing Carbon Cycle Lessons

Essential Questions:

Unit Questions:

Content Questions:

Where and how is CO_2 stored in a plant?

What is biomass and how is it measured?

How do scientists measure trees?

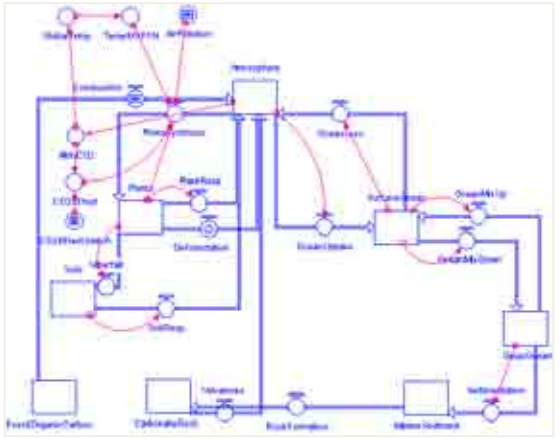
How is allometry used to calculate forest biomass?

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!



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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*

GLOBE Carbon Cycle

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*
- *Included Activities: Paperclip Simulation and Computer Model, Paper and Pencil Carbon Model, Global Carbon Cycle Models, Biomass Accumulation Model, Earth Exploration Toolbook Biomass Model*

GLOBE Carbon Cycle

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_2 is incorporated into plant biomass***
- ***Understand changes in carbon storage at the plant and ecosystem level***
- ***Included Activities: Light, Water, CO2, Mineral Nutrients, Temperature, Soil Respiration, Plant-a-Plant Computer Models***

GLOBE Carbon Cycle

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? (Februrary 2012)
  - Carbon Storage Data Entry (Spring 2012)

http://globecarboncycle.unh.edu

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Home | Carbon Cycle Background | Activities | Team Members | FAQ | Related Projects | Additional Resources | Login

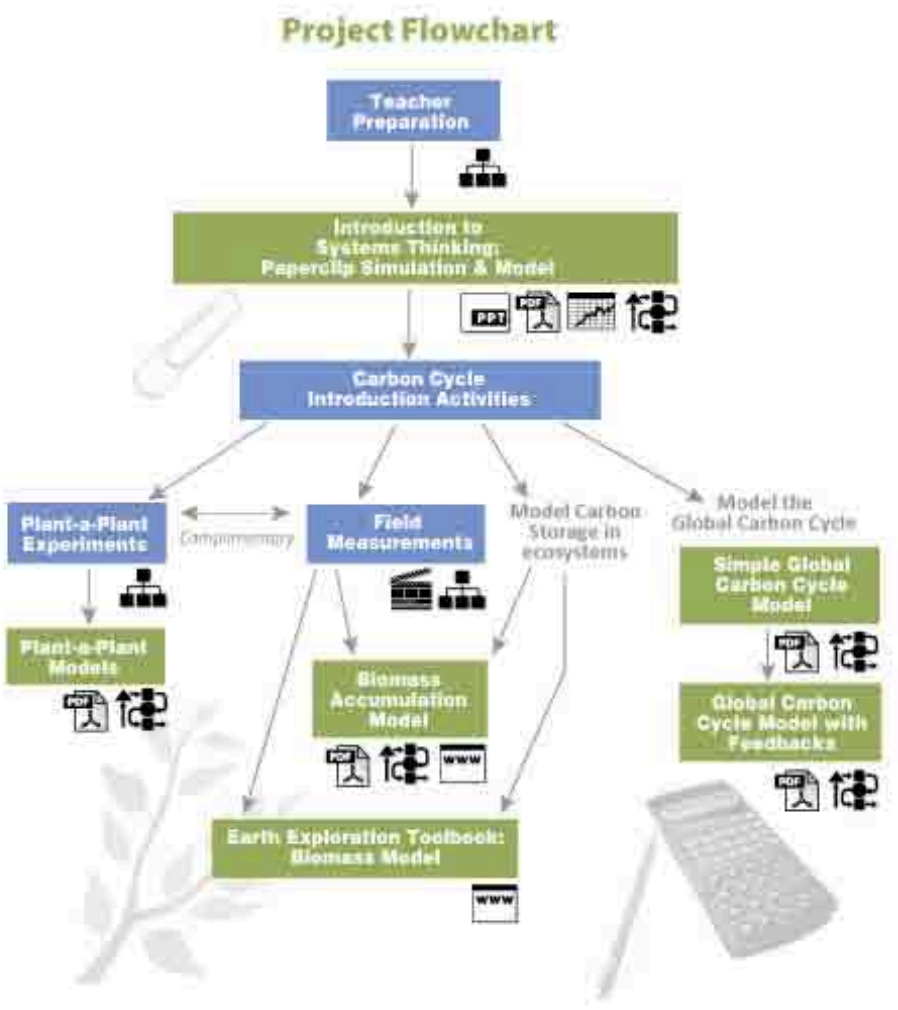
Carbon Cycle Activities

- 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)

GLOBE Carbon Cycle

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

THE GLOBE PROGRAM
CONNECTING THE NEXT GENERATION OF SCIENTISTS

Seasons and Biomes

Dr. Elena Sparrow[1], Dr. Rebecca Boger[2], Dr. Leslie Gordon[3], Ms. Kim Morris[1], Dr. David Verbyla[1], Dr. Elissa Levine[4], Ms. Martha Kopplin[1,], and Dr. Sheila Yule[5]

[1] University of Alaska Fairbanks, Fairbanks, Alaska

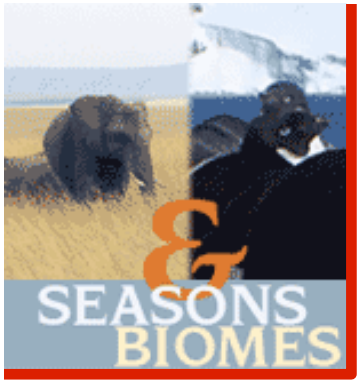
[2] Brooklyn College, Brooklyn, New York

[3] Gordon Consulting, Neskowin, Oregon

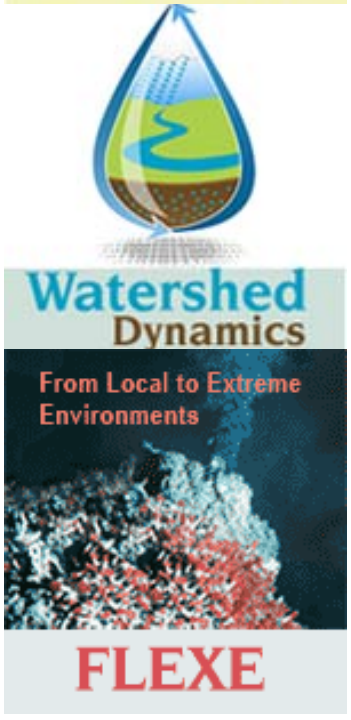
[4] Maryland

[5] Louisville, Kentucky

Dr. Jessica Robin, Dr. Martin Jeffries



GLOBE Seasons and Biomes

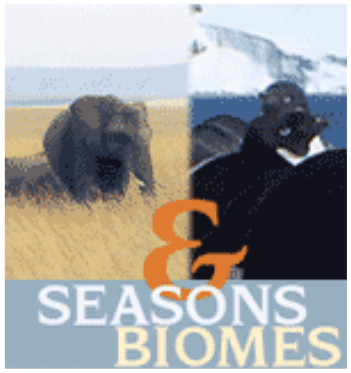


Why Seasons and Biomes?

- 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

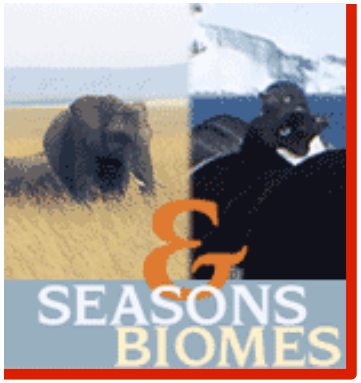
Understanding earth system science through

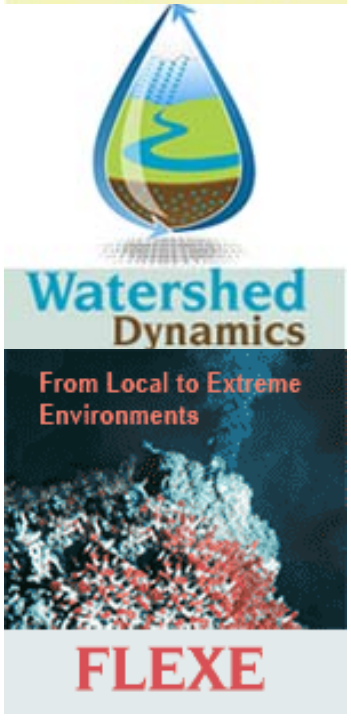
- New phenology and seasonality protocols combined with classic GLOBE protocols

- 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

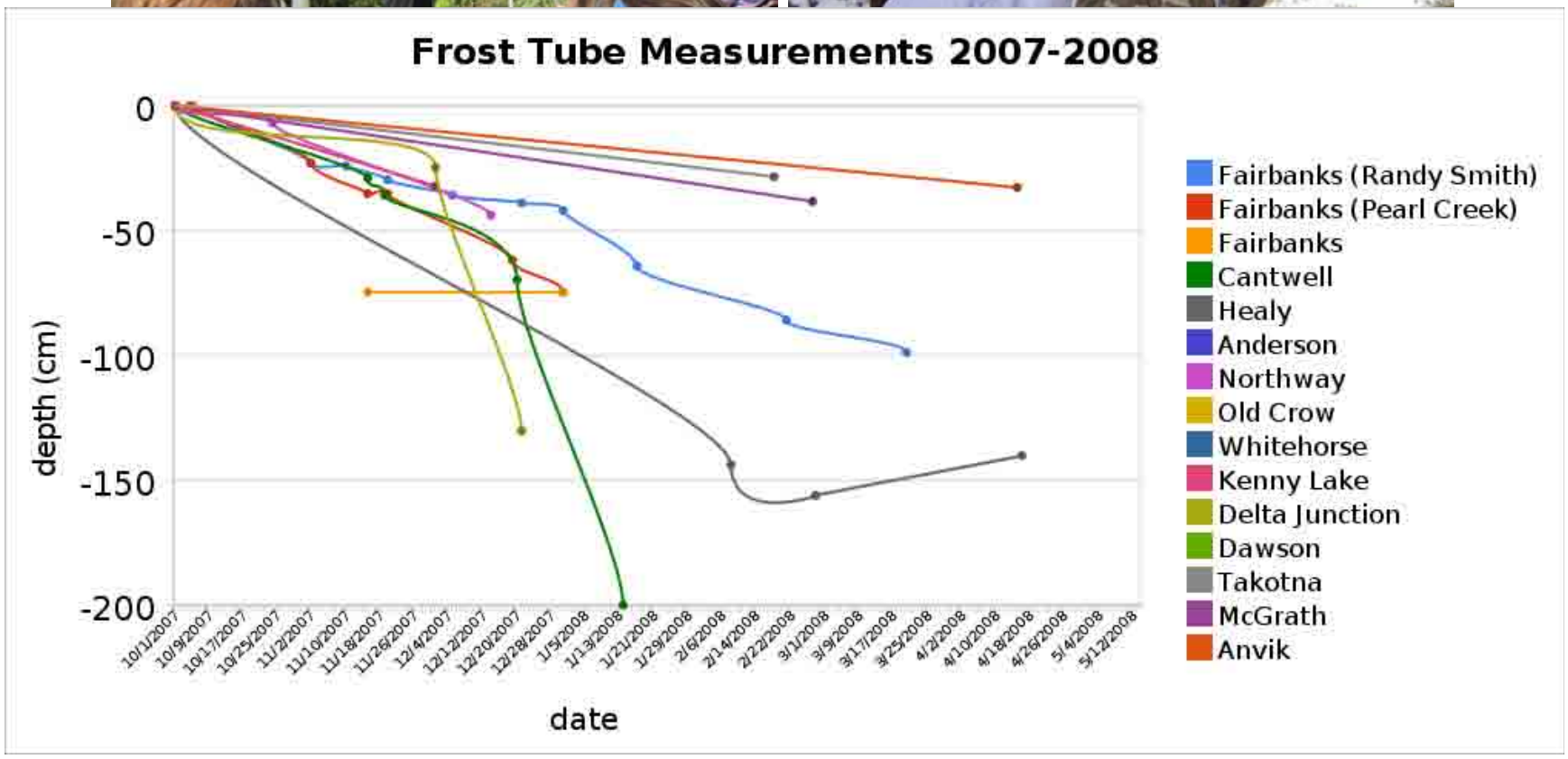
Freshwater Ice Seasonality Investigation

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



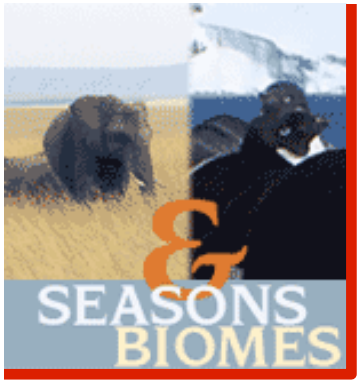
Mosquito Protocols

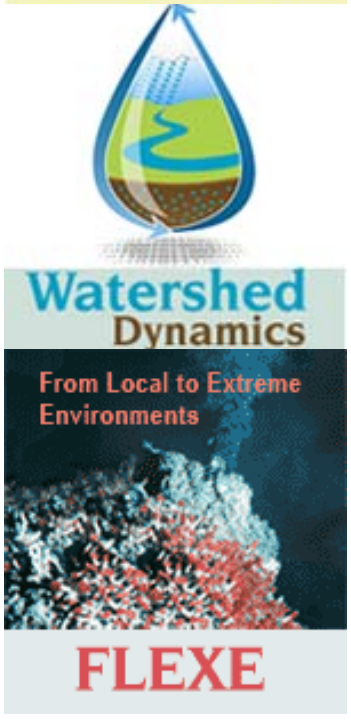
Developed in Collaboration with scientists in

- 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

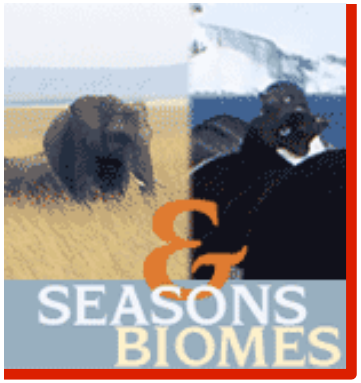
Ice Seasonality Learning Activity

Photo by Markus Eugster

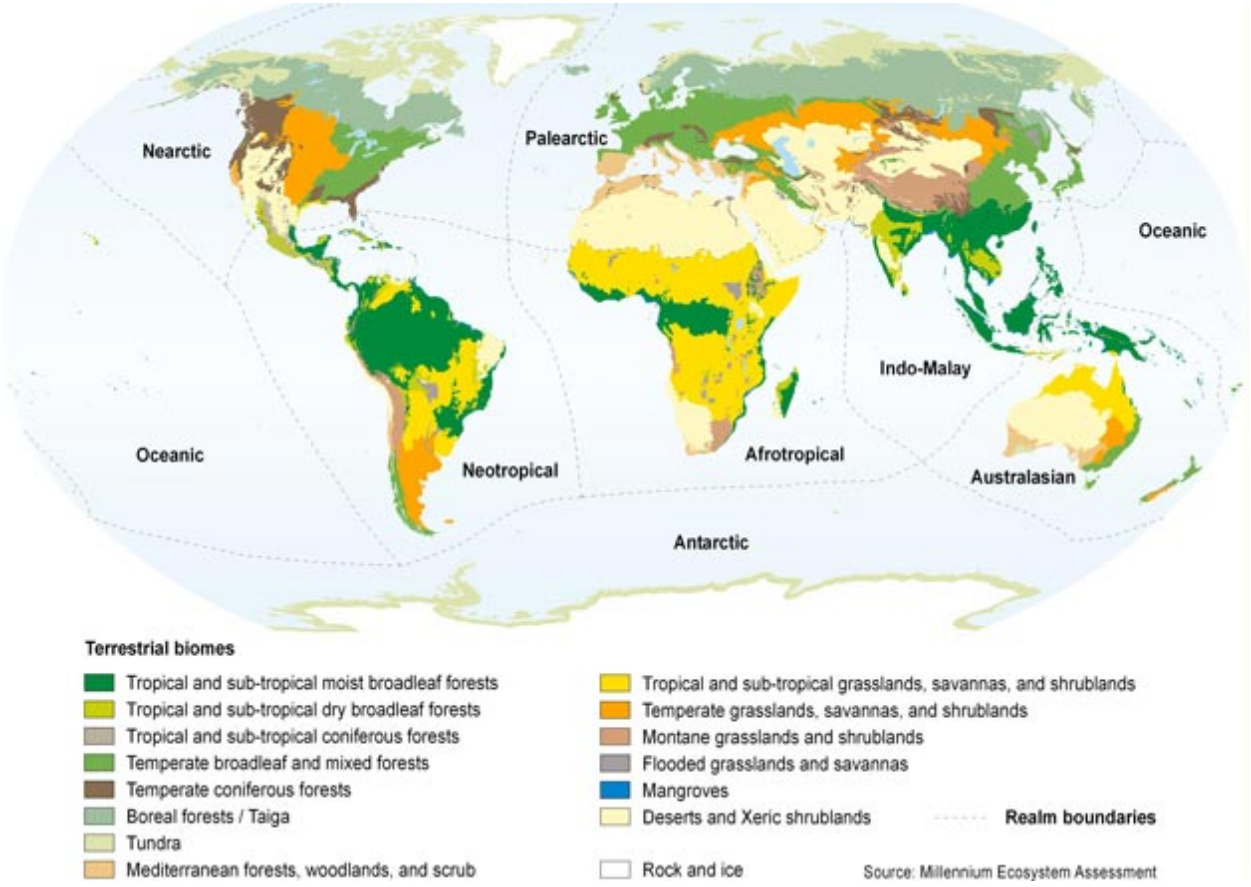
Seasonal Leaf Change Inquiry Learning Activity

Soil Insulation Inquiry Learning Activity

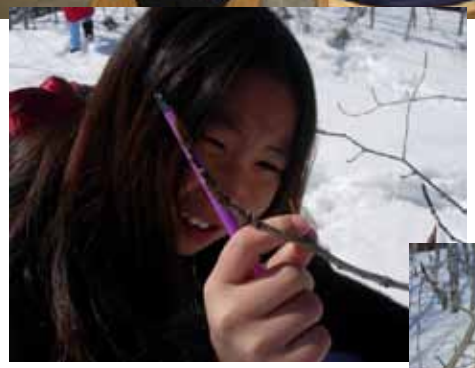
Budburst Inquiry Learning Activity

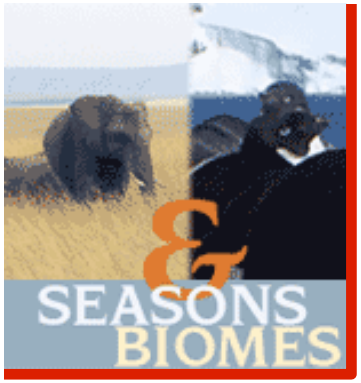


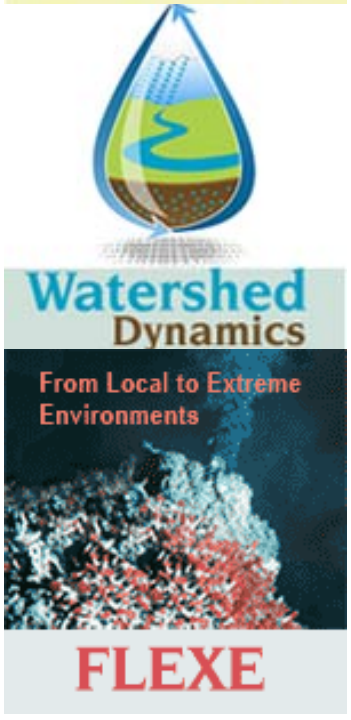
Seasons & Biomes and Carbon Cycle Collaboration



Collaboration with Local Experts and Community Members



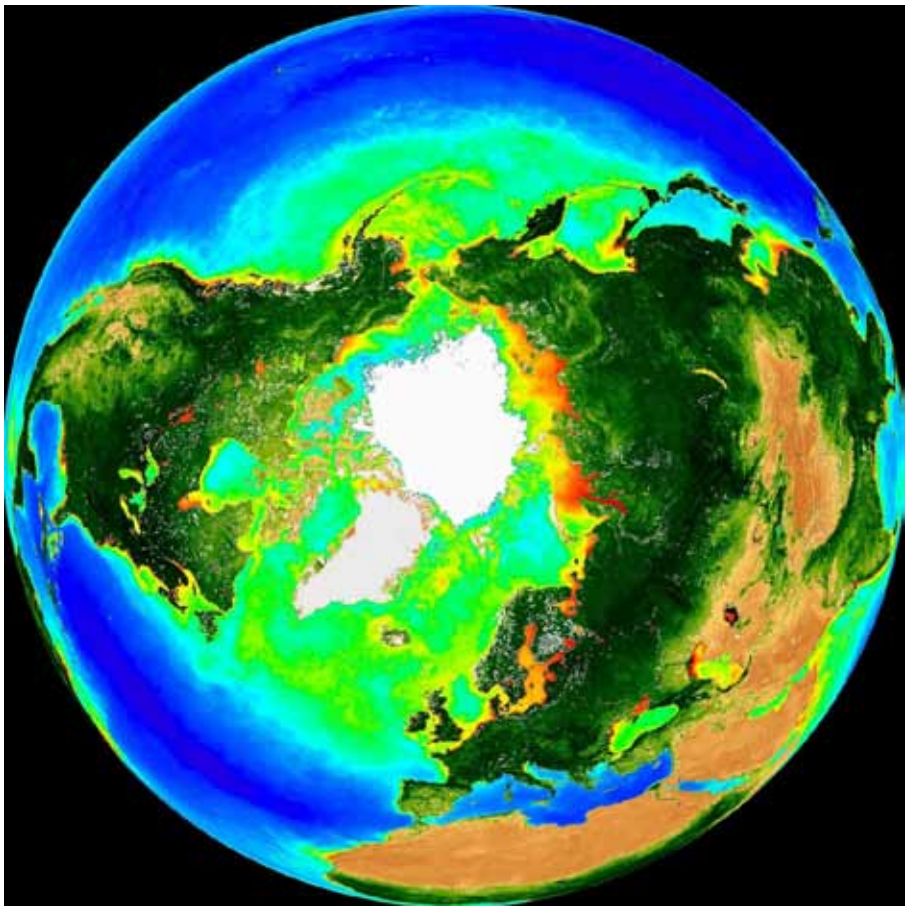




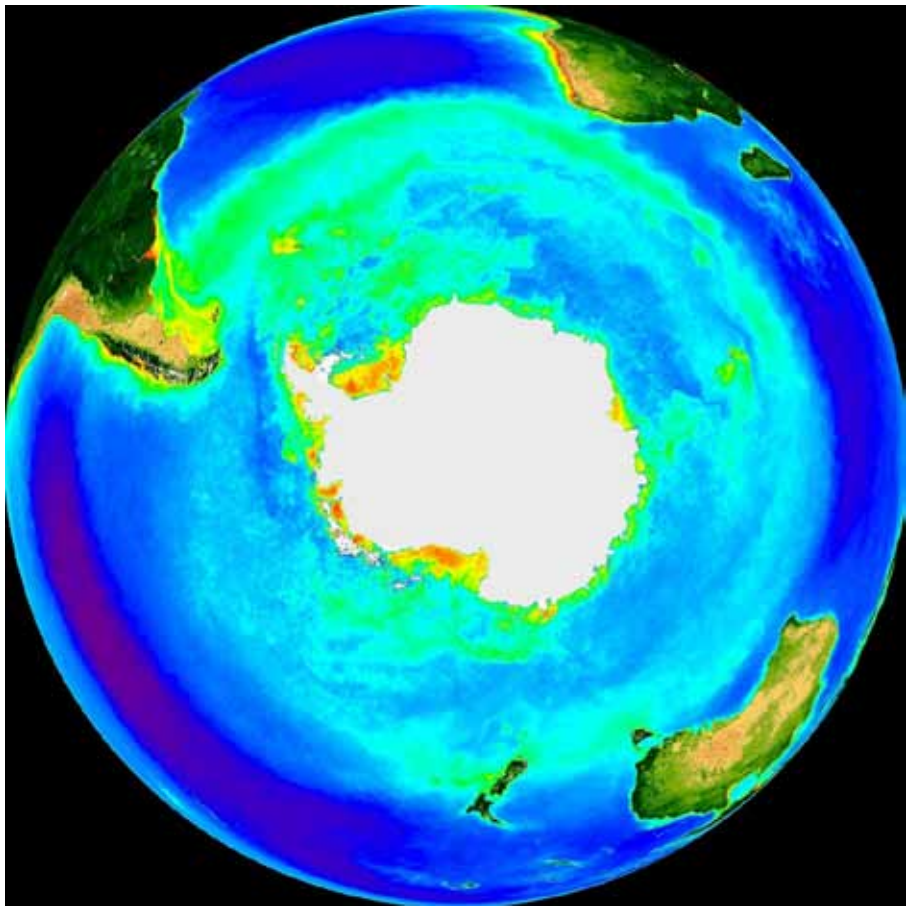
GLOBE Seasons and Biomes

Global Learning Communities

The International Polar Year



Arctic



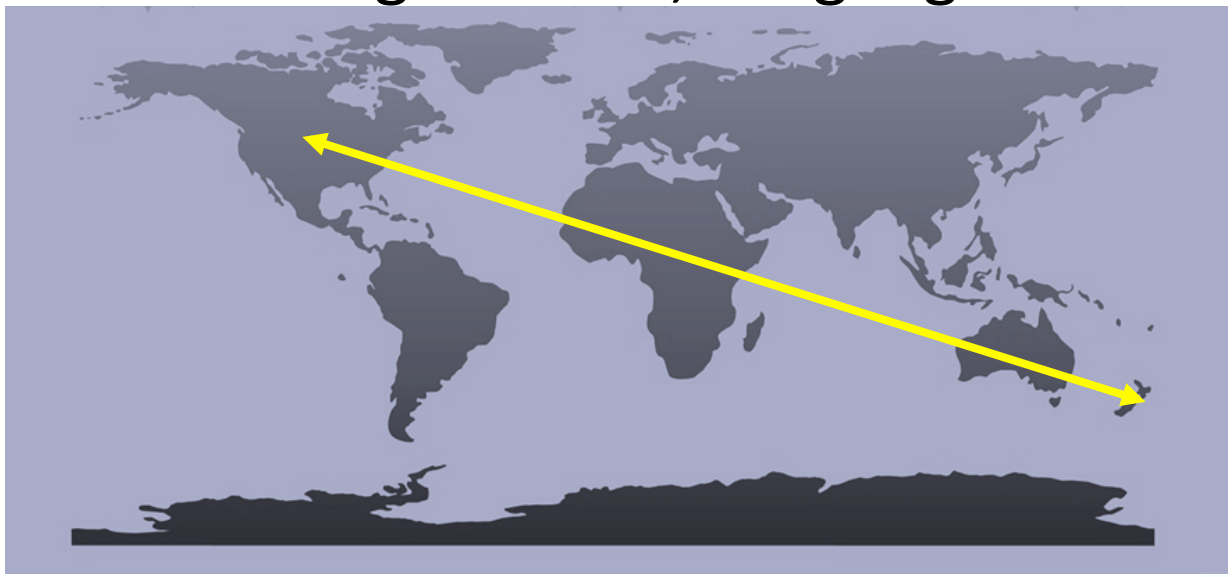
Antarctic

What happens in the polar regions affects other world regions

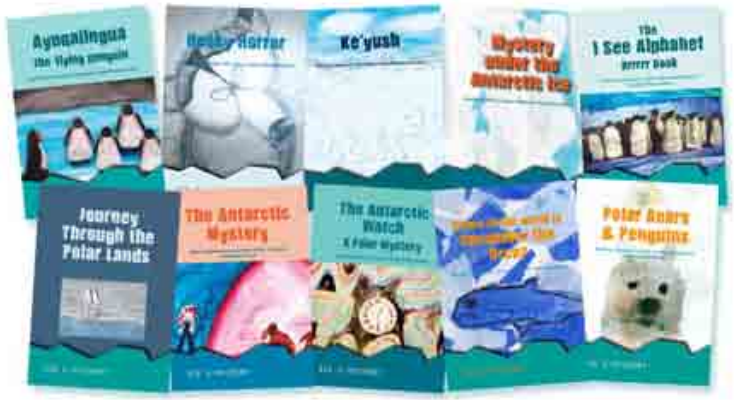
GLOBE Alumni

- 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



Ice Mystery e-Polar Books

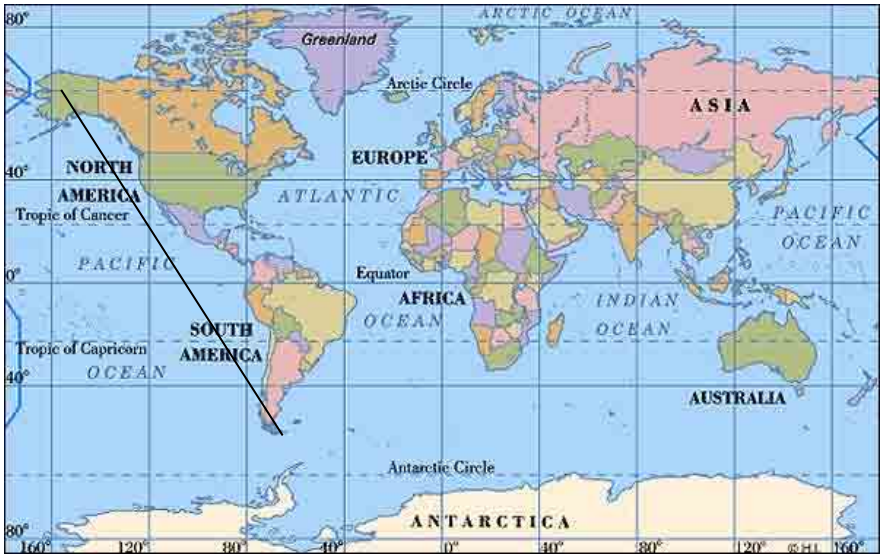


- **Classes paired between Australia and Alaska**
- **Each pair writes and illustrates collaborative mystery story focused on the polar regions**
- **Scientist mentors**
- **Books done electronically using web platform**

IPY Pole to Pole Videoconferences

Web Chats and Web Forums

Ushuaia, Argentina: 55 S



Alaska, USA: 4 schools, 62-65 N

Kilimanjaro Expedition 2009, 2010

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

5790 meters

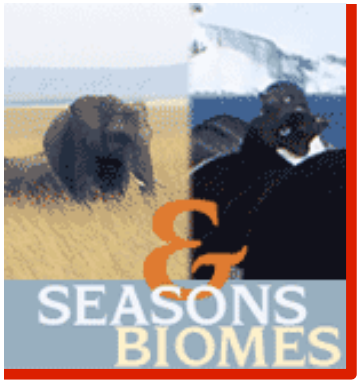
4,023 m

2804 m

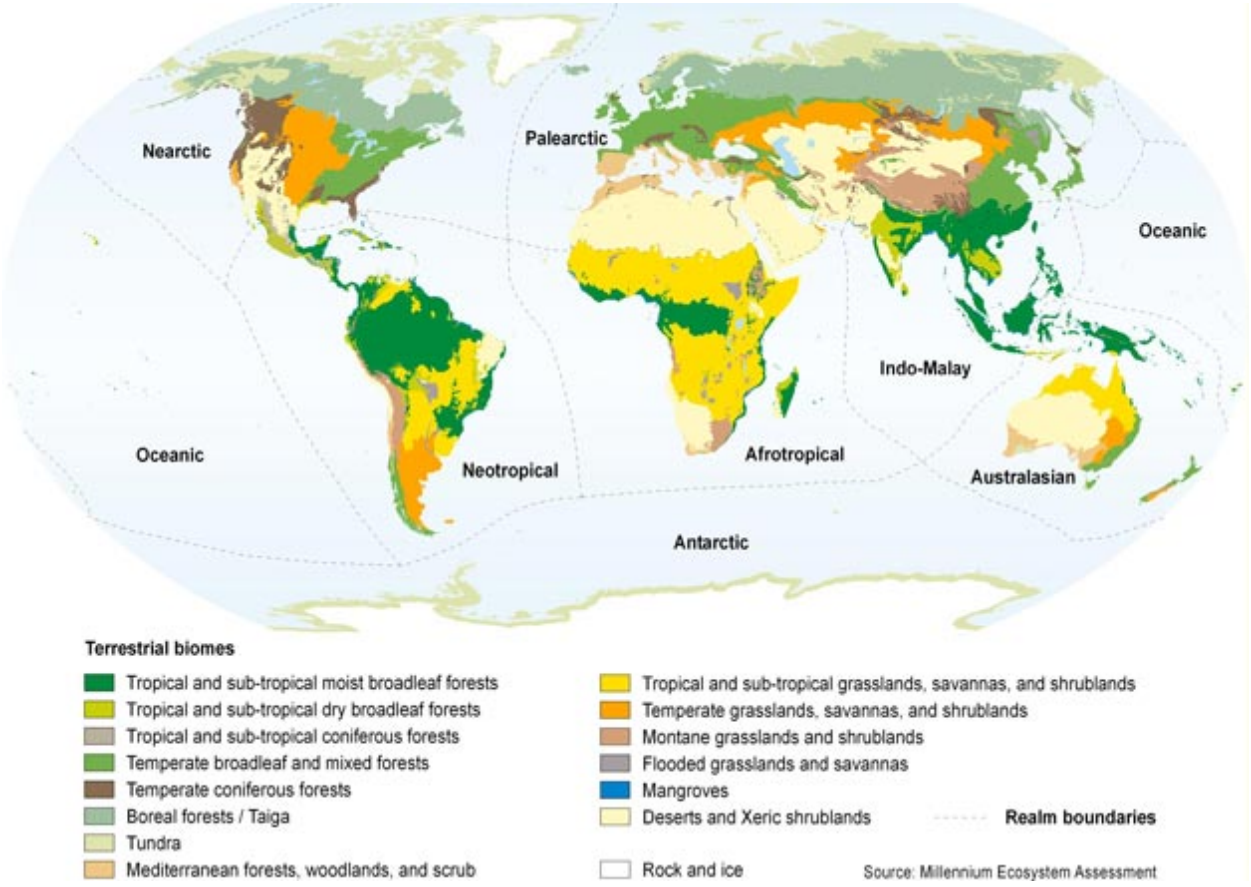
1,830 m

792 m

Change in vegetation with Elevation



Seasons & Biomes and Carbon Collaboration

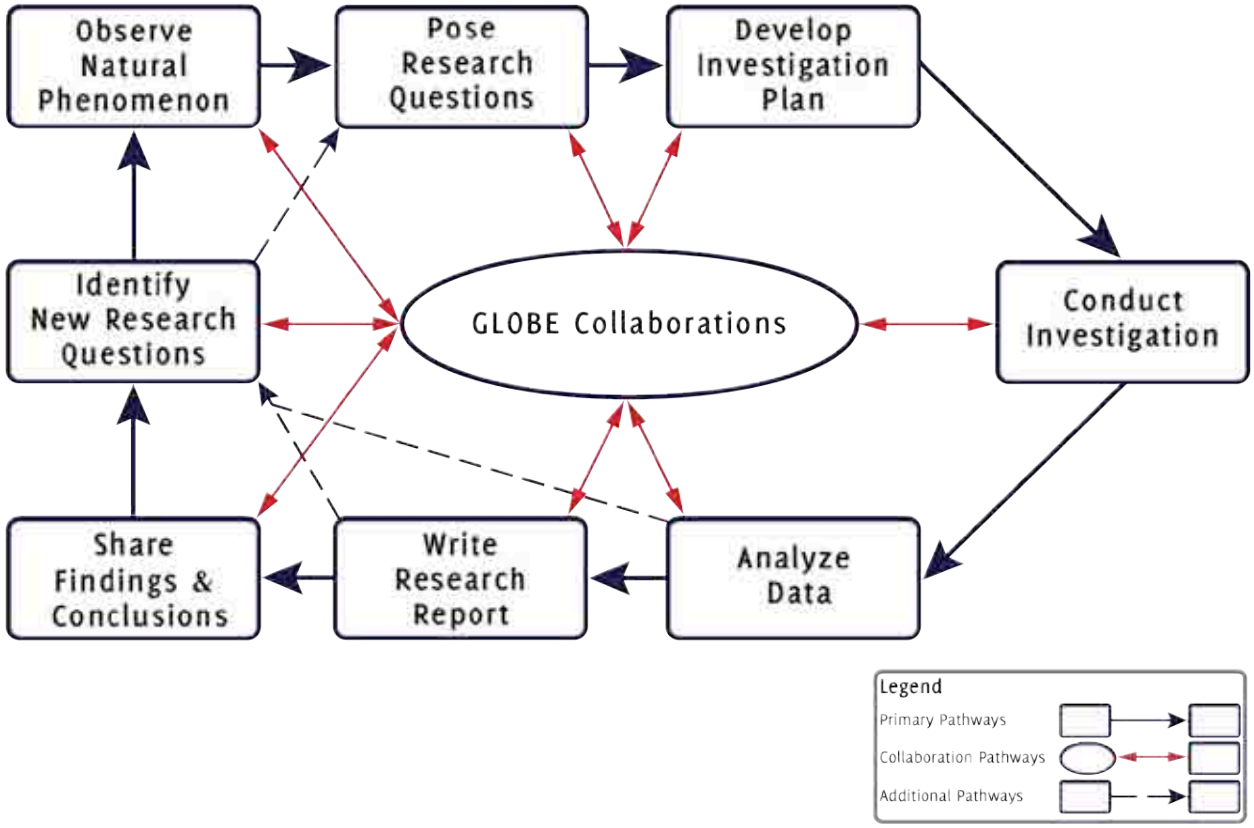


Seasons and Biomes Professional Development model, Face-to-face Workshop

	Monday	Tuesday	Wednesday	Thursday	Friday
Science Content and Process	Introduction and setting the scene	Atmosphere	Phenology -Budburst -Green Up -Green Down	Hydrology -Transparency -Temperature -Dissolved O_2 -Electrical conductivity -pH	Ice Seasonality -Freeze Up -Break Up Frost Tube
GLOBE Model for Student Scientific Research	Observation	Asking a question	Data collection and analysis	Design an investigation	Putting it all together
Best Teaching Practices in Science					
Earth as a system					
Workshop assessment					

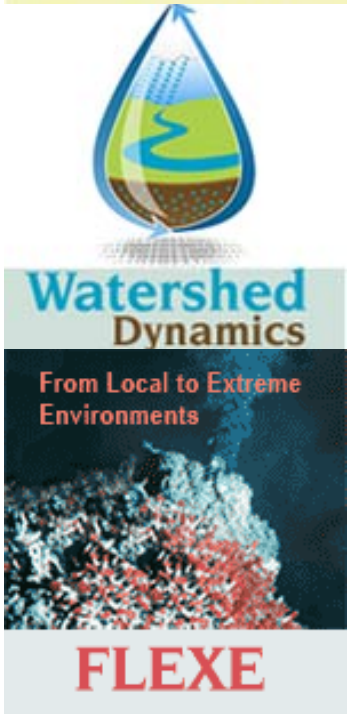
(Modified version of the Integrated PD model developed by Sheila Yule for Seasons and Biomes workshop in Arusha, Tanzania, September 2009)

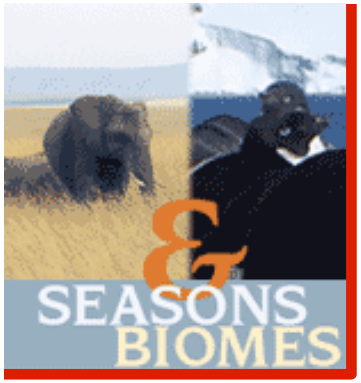
GLOBE Model for Student Scientific Research

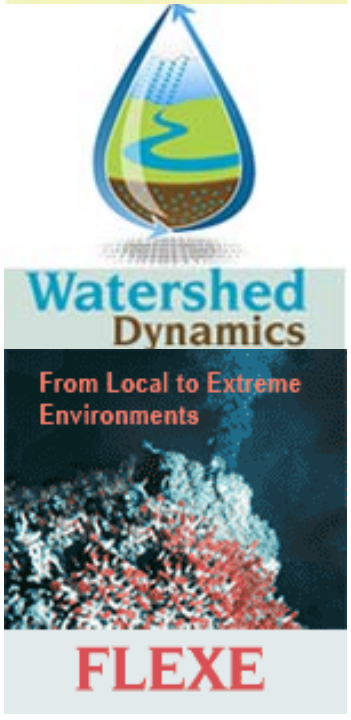


GLOBE Seasons and Biomes

Professional Development 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

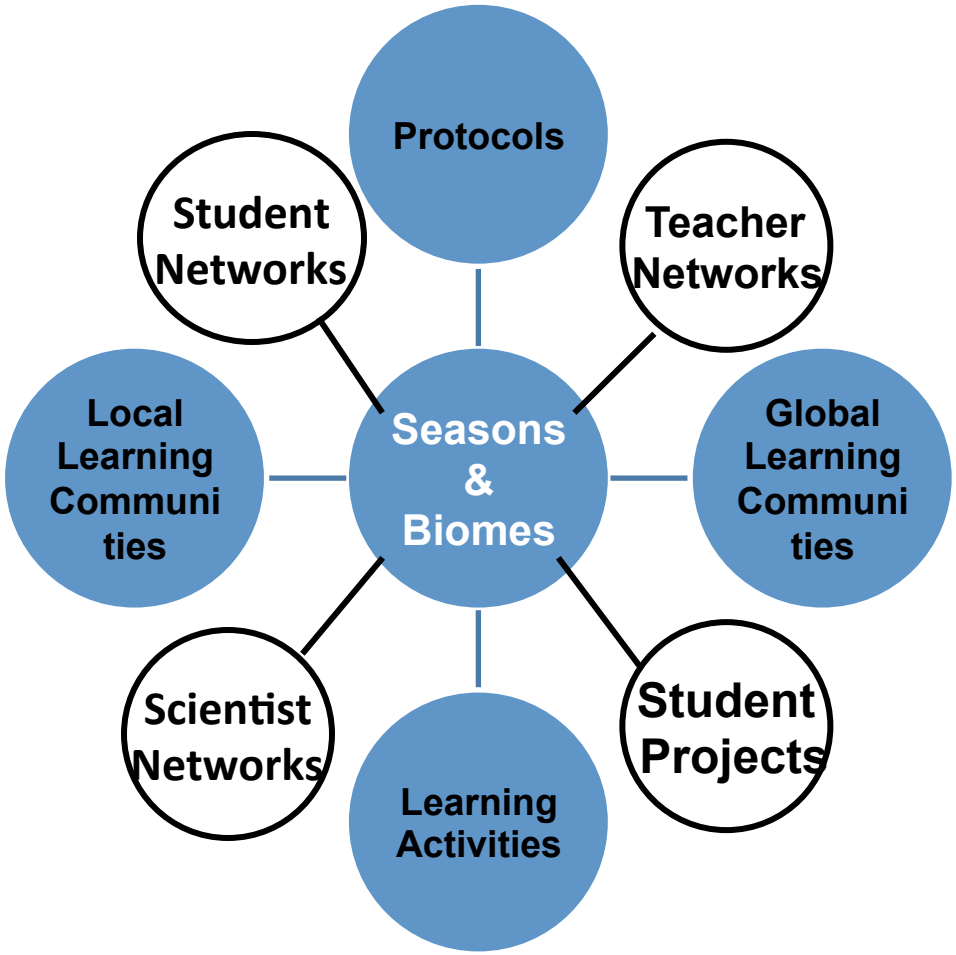
Mosquito studies in Khanompitaya School
In Thailand

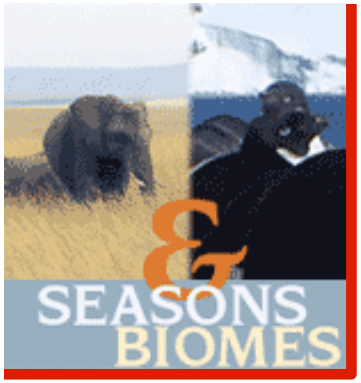
GLE in Capetown, South Africa

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

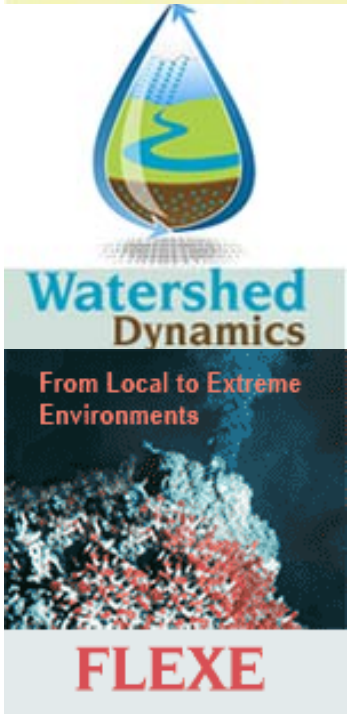
Students from Model Secondary Schools for the Deaf in Washington DC and from Indiana collaborated on a Budburst Study

GLOBE Seasons and Biomes





GLOBE Seasons and Biomes



Thank you for your attention

GLOBE Seasons and Biomes Collaborators

UAF
UNIVERSITY OF ALASKA
FAIRBANKS

International Arctic Research Center
IARC
University of Alaska Fairbanks

Alaska EPSCoR
Experimental Program to Stimulate Competitive Research

The Arctic System Science Thermokarst Project

Center for Global Change & Arctic System Research

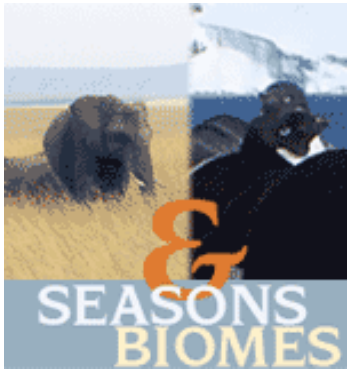
GLOBE Partnerships in Argentina, Australia, Czech Republic, Belgium, Canada, Cameroon, Croatia, Dominican Republic, Estonia, Germany, Greenland, Madagascar, Norway, Peru, S. Africa, Switzerland, Tanzania, Thailand, U.S.

SNRAS
SCHOOL OF NATURAL RESOURCES & AGRICULTURAL SCIENCES

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

IPST

U.S. Embassy in Estonia



Carbon Cycle

FLEXE

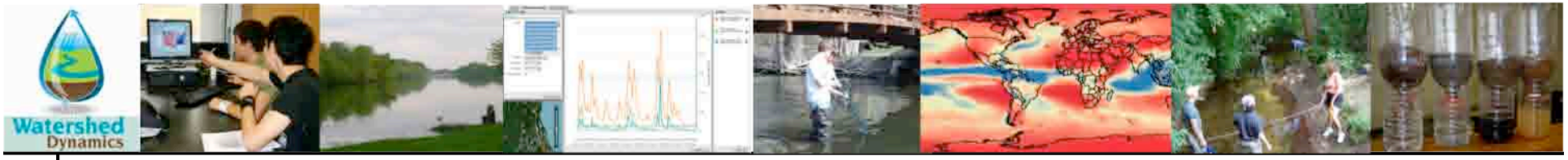
Watershed Dynamics

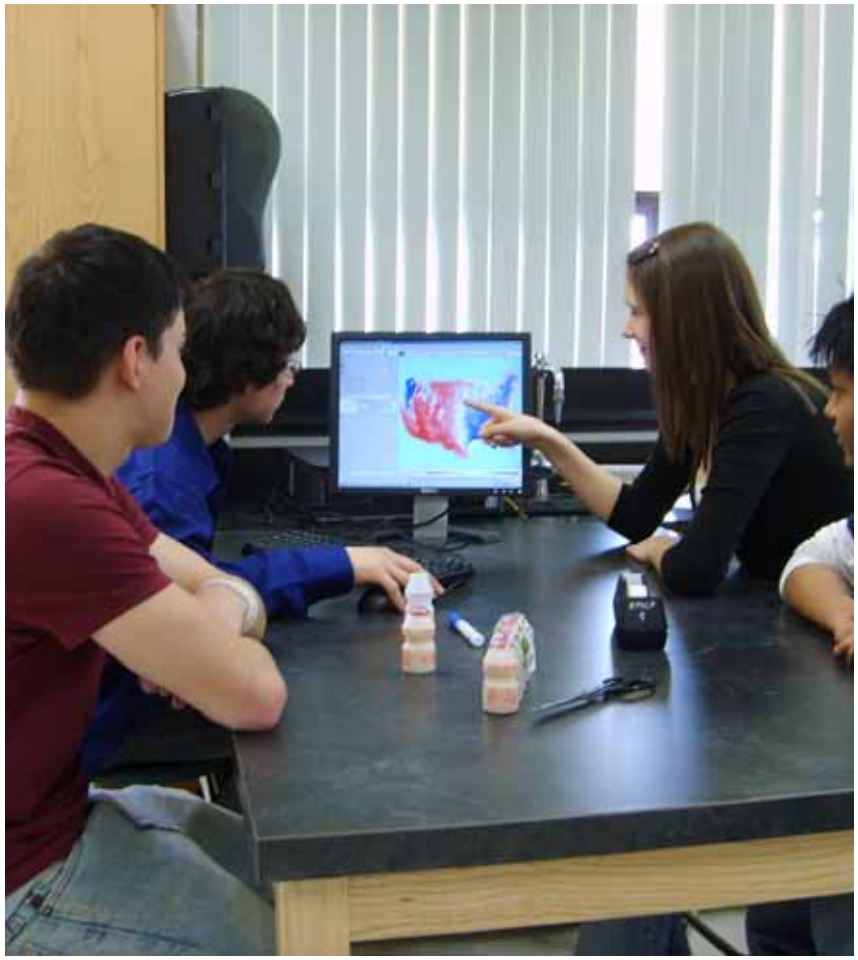
The Watershed is a natural unit of study

- 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





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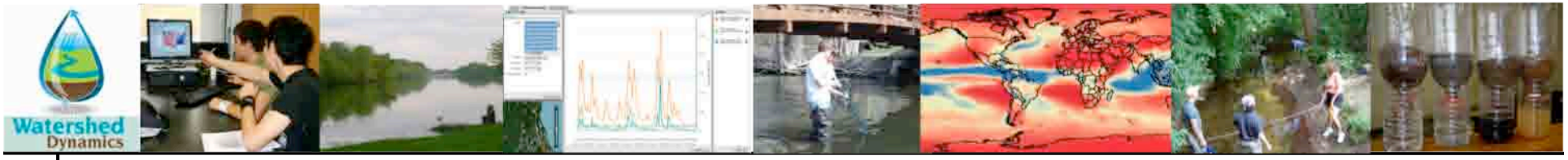


Geographic Information Systems

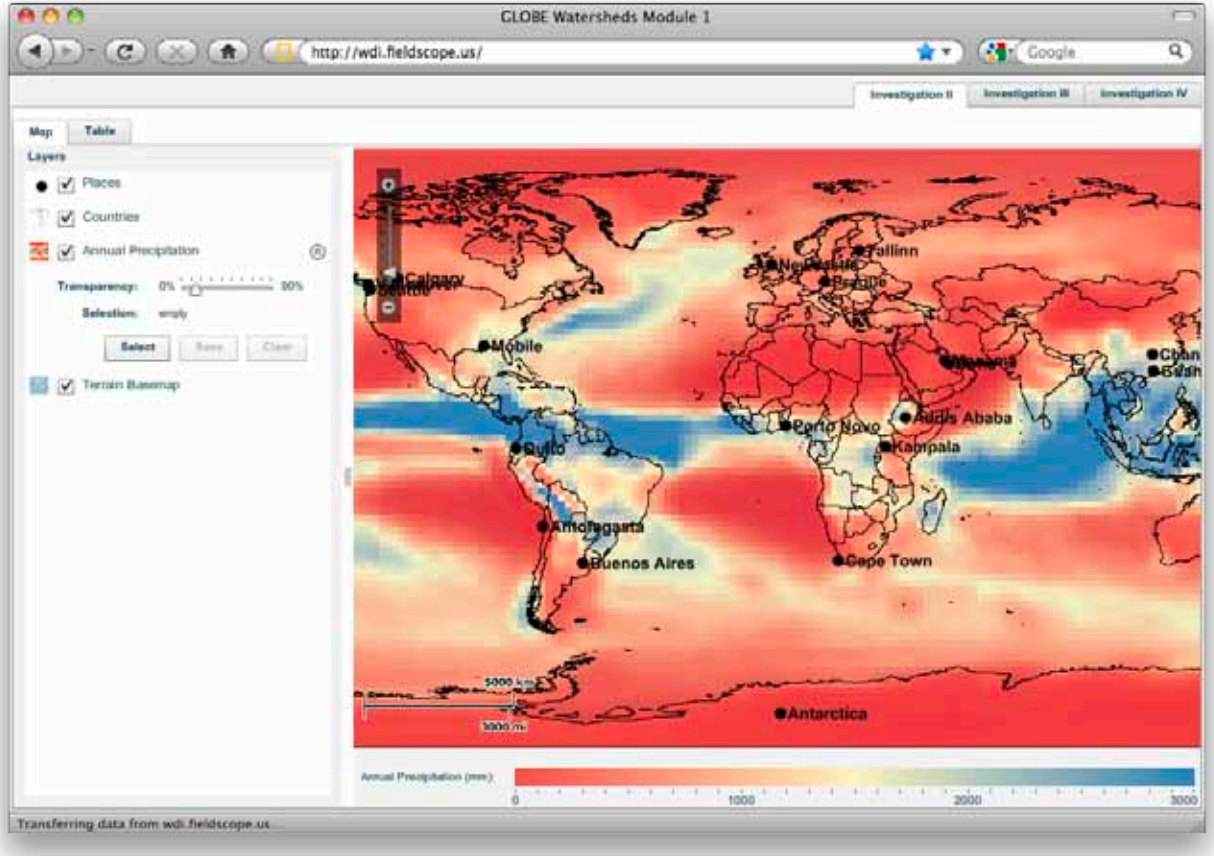
NATIONAL GEOGRAPHIC FieldScope
COLLABORATIVE MAPPING FOR EDUCATION

Allows user to visualize and analyze geographic data

Web-based for easy access

FREE TO USE

http://wdi.fieldscope.org



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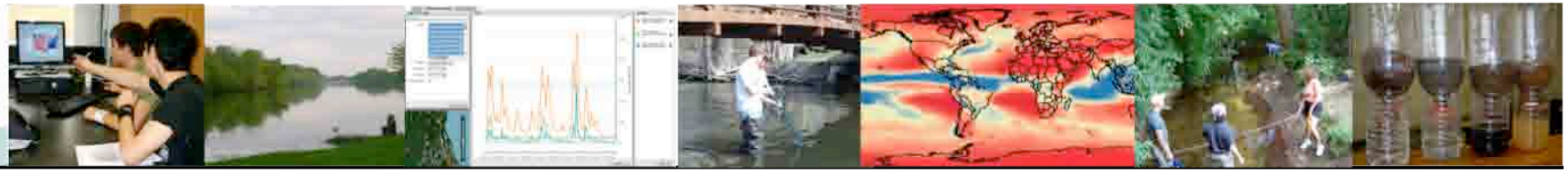

Water Availability

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?

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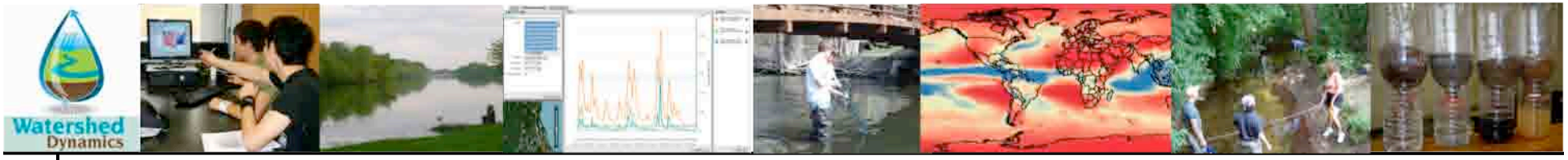

Water Availability

- 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

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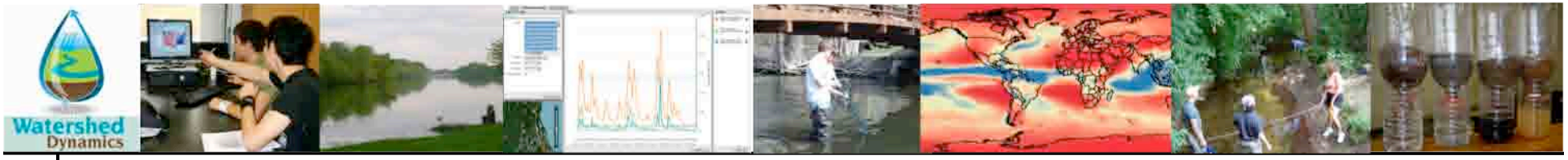

GIS Tools and Data

Activity	Technology	Data
Water Availability	Cmap concept maps	
	My World GIS Web-GIS by FieldScope	NARR (NCEP, National Weather Service, NOAA, Dept of Commerce) NCEP-DOE AMIP-II reanalysis
Human Impact on the Watershed	NetLogo models	DEM (USGS) Aerial image (Terraserver)
	My World GIS Web-GIS by FieldScope	NLCD (USGS, EPA, NOAA, NASA, et al)
		Streamgage data (USGS via NWIS and CUAHSI HIS)

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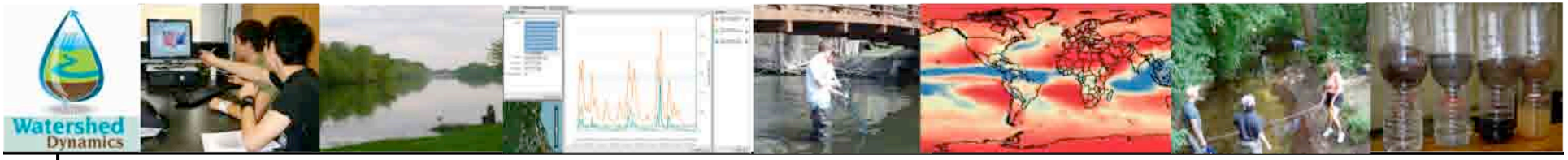
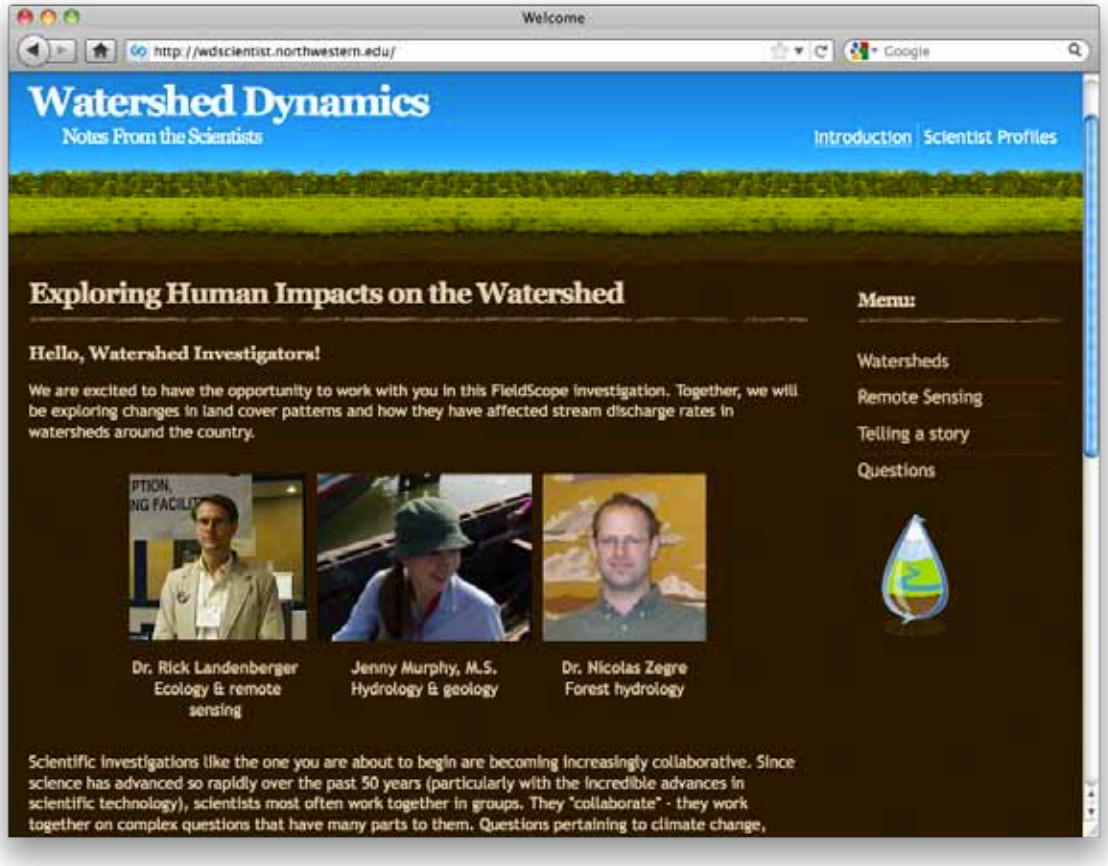


FLEXE-style Student-Scientist Forum



http://wdscientist.northwestern.edu

http://wdscientist.northwestern.edu/response

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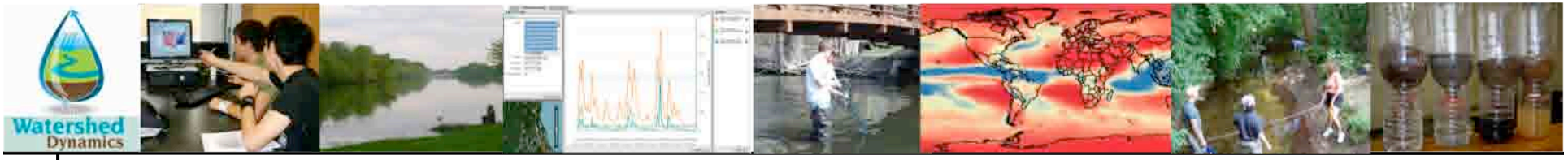
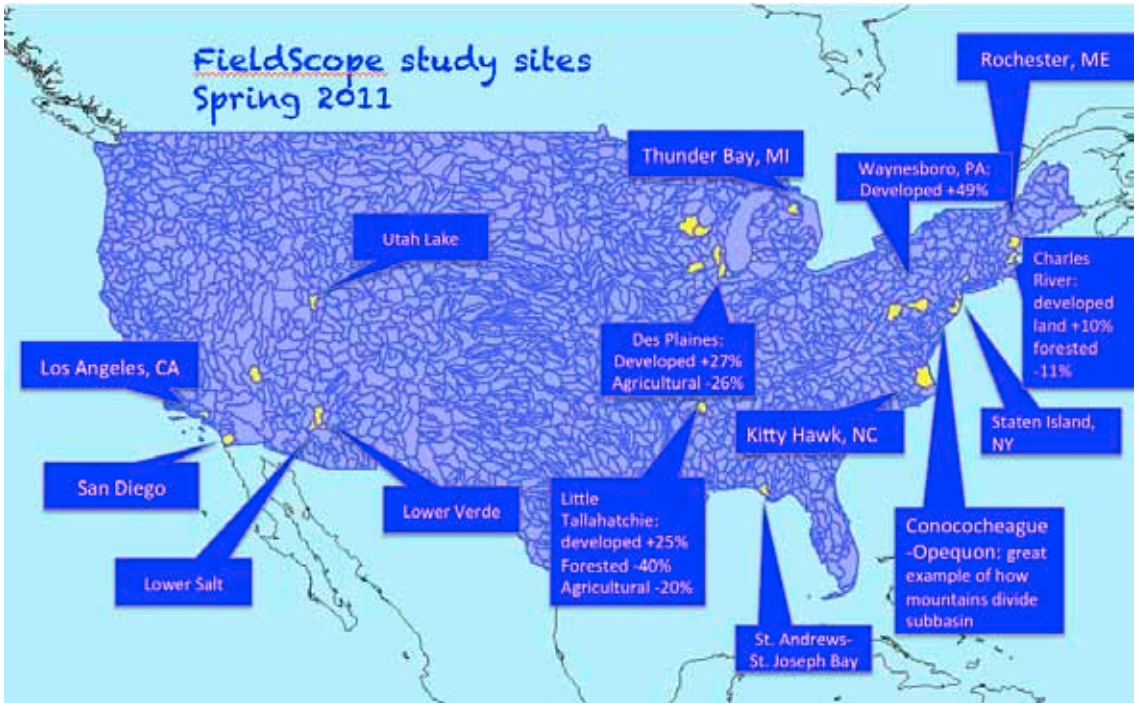


FLEXE-style Student-Scientist Forum



http://wdscientist.northwestern.edu

http://wdscientist.northwestern.edu/response

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

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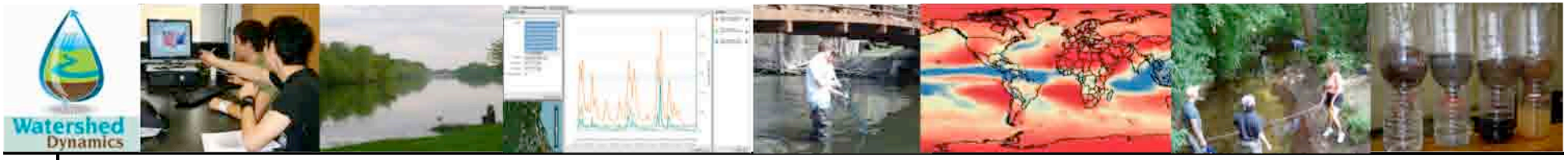

Train-the-Trainer Opportunity

Carbon Cycle Collaboration

November 3-9, 2011

Evanston, IL

Training in **both** Watersheds & Carbon Cycle materials

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

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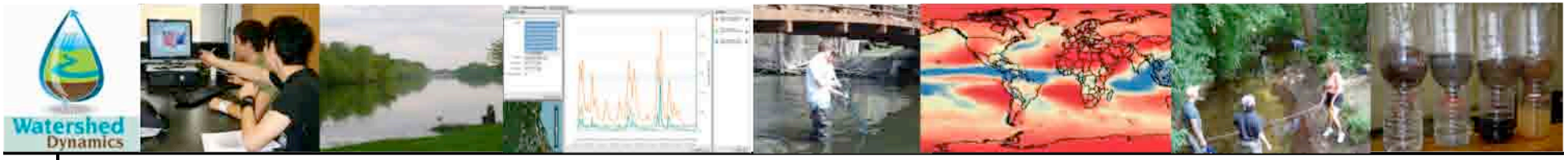
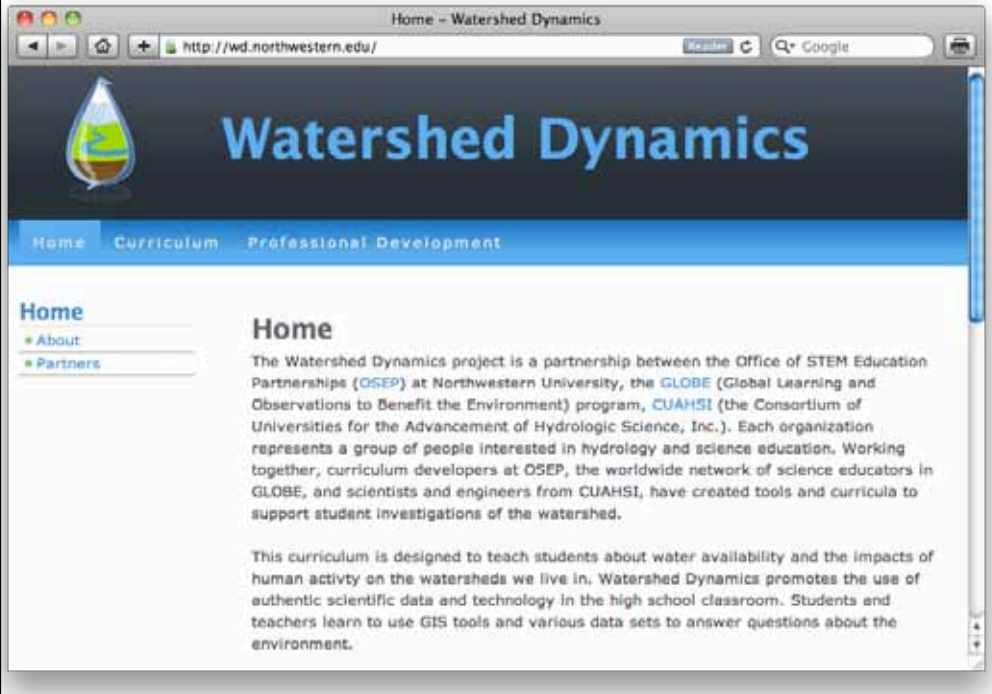


Contributors

http://wd.northwestern.edu



Kemi Jona

Northwestern University

Danny Edelson

National Geographic

Colleen Buzby

Northwestern University

Gary Randolph

GLOBE Program Office

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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

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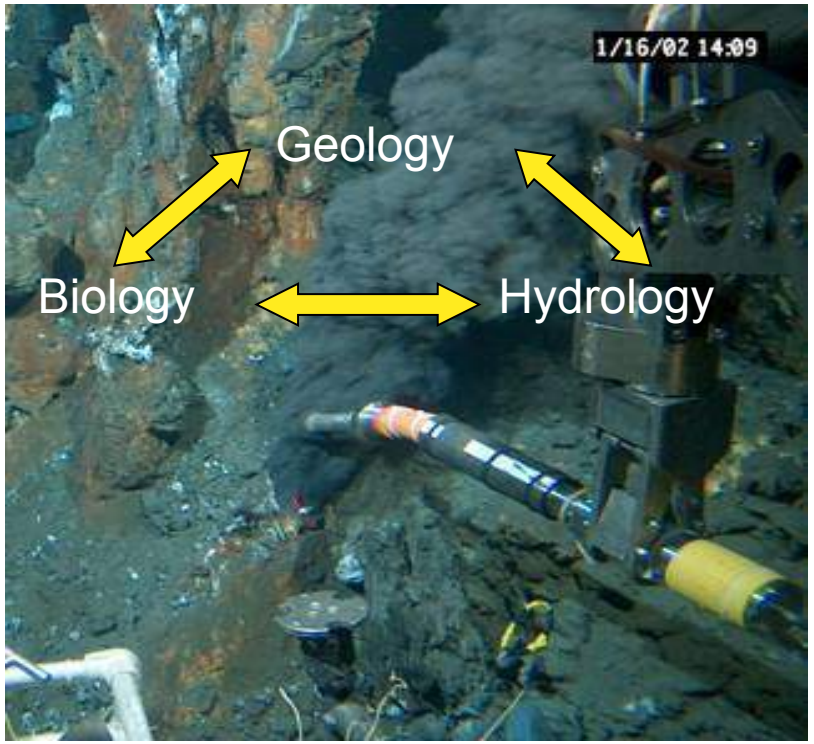
Why the deep-sea?

- 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



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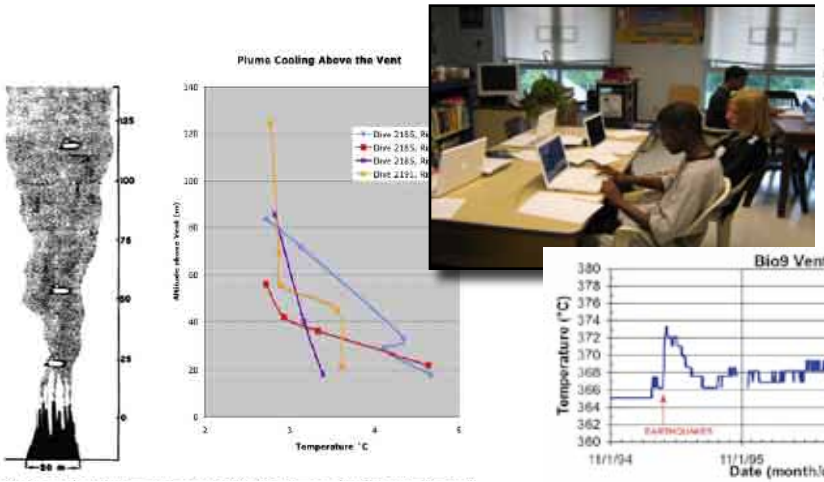
FLEXE

FLEXE Components

- **Comparison of Data/Environments**
  - ✓ Local/Schoolyard data (*primary data*)
  - ✓ Partner school data / GLOBE database (*secondary data*)
  - ✓ Deep-Sea data (*'EXTREME' data*)



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From Local to Extreme Environments

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

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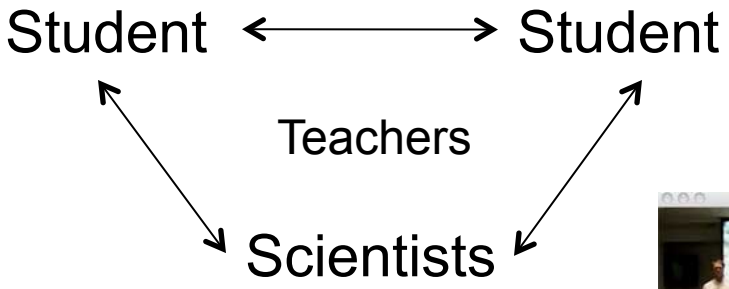
FLEXE Components, con't.

- **Community of Learning**



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

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From Local to Extreme Environments

FLEXE

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.

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FLEXE

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**.

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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

FLEXE Publications

Kerlin, S., Goehring, E., Carlsen, W., Larsen, J., Fisher, C. (2009). Design of an online global learning community: International collaboration of grades 7-9 science students. *CSCL 2009: Proceedings of the 9th International Conference on Computer Supported Collaborative Learning Vol. 2.*

Kerlin, S., Goehring, E., Carlsen, W. (2010). Online science classroom collaborations: a comparison of domestic and international learning communities. *ICLS 2010: Proceedings of the 9th International Conference of the Learning Sciences Vol. 2.*

Kerlin, S., Carlsen, W., Kelly, G. & E. Goehring (2011). Students' Online Argumentative Discussions of Local and Extreme Environments. *WEEC 2011: Proceedings of the 6th World Environmental Education Congress.*

More to come!

The GLOBE Program

From Local to Extreme Environments

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!

The GLOBE Program

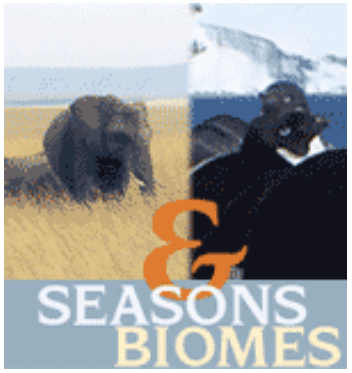
NOAA

ridge 2000
from mantle to microbe

PENNSTATE
1855

NSF
National Science Foundation

NASA



To Learn More About Any of the Projects Attend one of Today's Workshops -

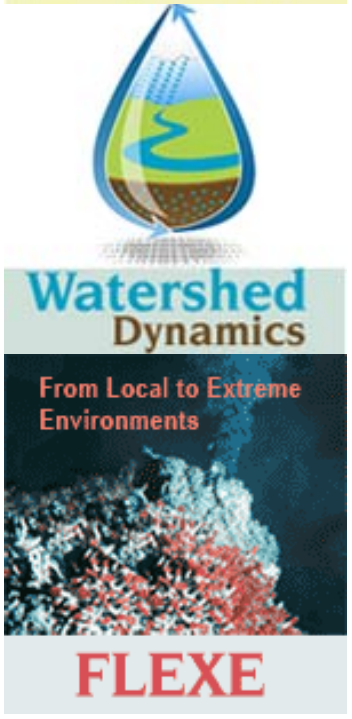
9:00 – 11:30

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)