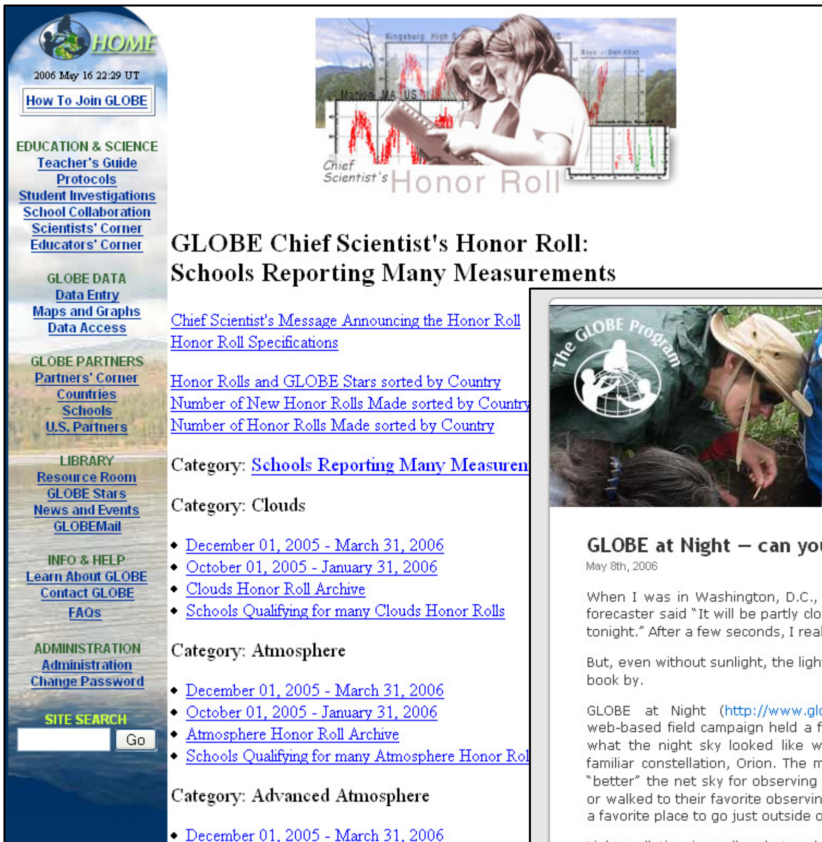
The GLOBE Program

Section III:

Science Investigation Areas

- -- Atmosphere
- -- Hydrology
- -- Land Cover/Biology
- -- Soil
- -- Earth as a System
- -- Ties to Satellite Missions

The GLOBE Program



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How To Join GLOBE

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Chief Scientist's Honor Roll

GLOBE Chief Scientist's Honor Roll:
Schools Reporting Many Measurements

Chief Scientist's Message Announcing the Honor Roll
Honor Roll Specifications

Honor Rolls and GLOBE Stars sorted by Country
Number of New Honor Rolls Made sorted by Country
Number of Honor Rolls Made sorted by Country

Category: Schools Reporting Many Measuren

Category: Clouds

- December 01, 2005 - March 31, 2006
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Category: Advanced Atmosphere

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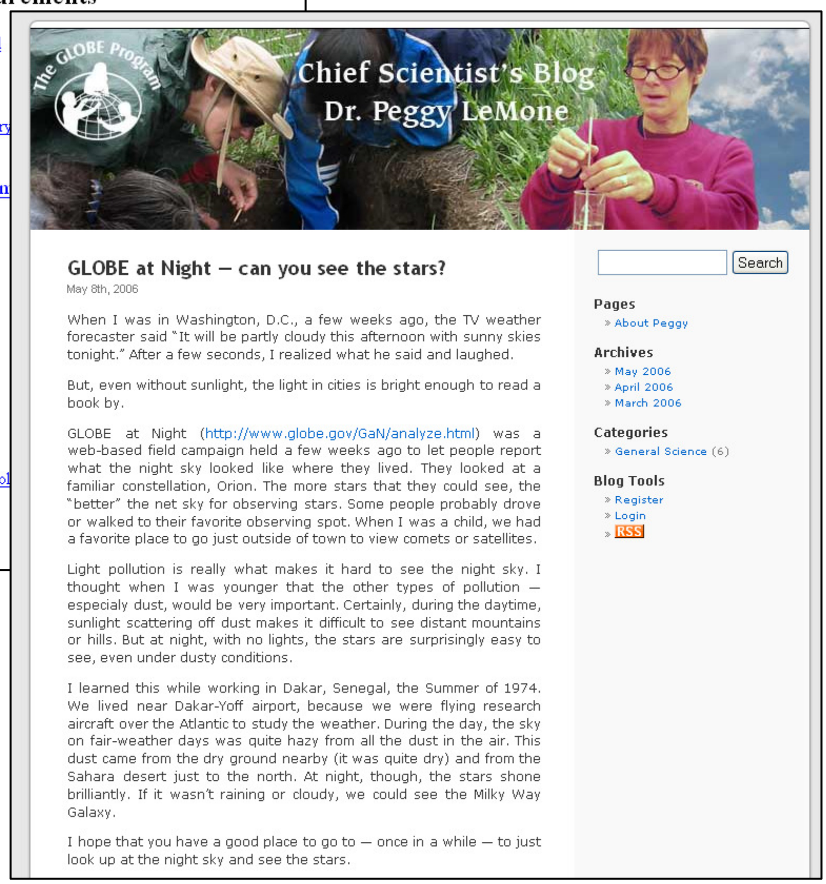

The GLOBE Program

Chief Scientist's Blog
Dr. Peggy LeMone

GLOBE at Night — can you see the stars?

May 8th, 2006

When I was in Washington, D.C., a few weeks ago, the TV weather forecaster said "It will be partly cloudy this afternoon with sunny skies tonight." After a few seconds, I realized what he said and laughed.

But, even without sunlight, the light in cities is bright enough to read a book by.

GLOBE at Night (http://www.globe.gov/GaN/analyze.html) was a web-based field campaign held a few weeks ago to let people report what the night sky looked like where they lived. They looked at a familiar constellation, Orion. The more stars that they could see, the "better" the net sky for observing stars. Some people probably drove or walked to their favorite observing spot. When I was a child, we had a favorite place to go just outside of town to view comets or satellites.

Light pollution is really what makes it hard to see the night sky. I thought when I was younger that the other types of pollution — especialy dust, would be very important. Certainly, during the daytime, sunlight scattering off dust makes it difficult to see distant mountains or hills. But at night, with no lights, the stars are surprisingly easy to see, even under dusty conditions.

I learned this while working in Dakar, Senegal, the Summer of 1974. We lived near Dakar-Yoff airport, because we were flying research aircraft over the Atlantic to study the weather. During the day, the sky on fair-weather days was quite hazy from all the dust in the air. This dust came from the dry ground nearby (it was quite dry) and from the Sahara desert just to the north. At night, though, the stars shone brilliantly. If it wasn't raining or cloudy, we could see the Milky Way Galaxy.

I hope that you have a good place to go to — once in a while — to just look up at the night sky and see the stars.

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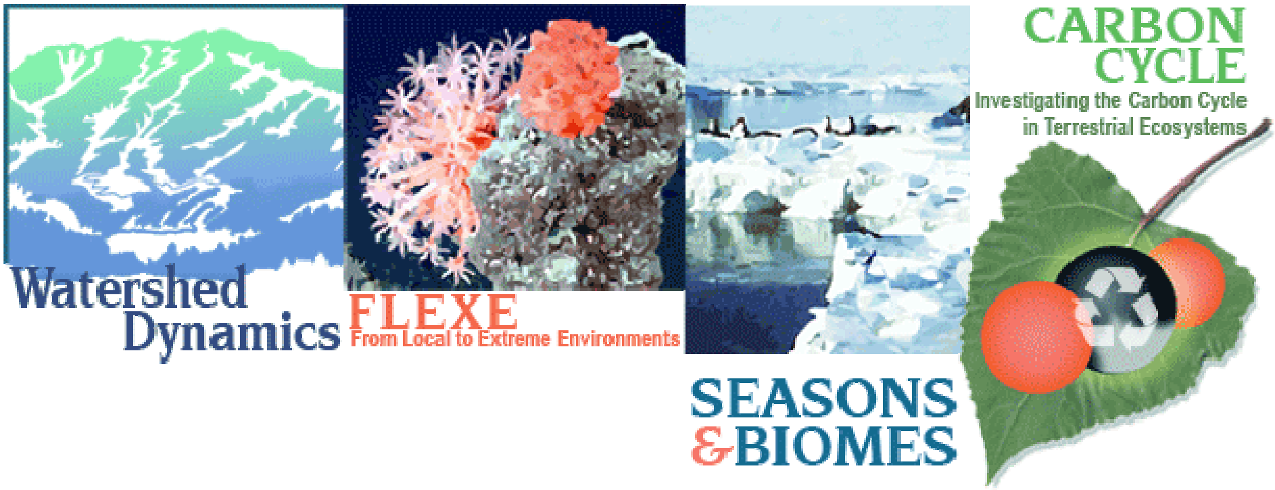
GLOBE Chief Scientist

Dr. Margaret (Peggy) LeMone

Dr. Peggy LeMone is an atmospheric scientist at the National Center for Atmospheric Research (NCAR).
She has participated in over 25 field campaigns, published over 70 articles in science journals, and over a hundred conference reports, articles in World Book Encyclopedia, and other popular venues. Dr. LeMone is a Fellow of the American Meteorological Society and the American Association for the Advancement of Science, and is a member of the National Academy of Engineering.



GLOBE's New Earth System Science Projects (ESSPs)

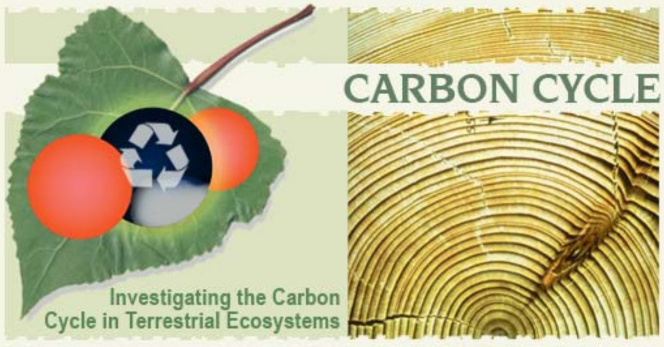
GLOBE has been implementing its Next Generation GLOBE (NGG) plan with the guidance of the GLOBE community and its NASA and NSF sponsors since June 2005. The vision of NGG places greater emphasis on educational outcomes, student research, more opportunities for student-teacher-scientist collaborations around cutting edge Earth system science projects and a greater focus on internationalization and long-term program sustainability.

To achieve this vision, GLOBE is promoting and supporting students, teachers and scientists to collaborate on inquiry-based investigations of the environment and the Earth System. Working in close partnership with NSF and NASA Earth System Science Projects (ESSPs), GLOBE hopes to add to the many projects currently underway around the world by focusing on four new projects on the cutting edge of Earth system science research.

In June 2006, NSF announced four new Earth System Science Project (ESSP) partners for GLOBE that will provide foci for student research and help the projects with their education and outreach efforts. These projects are:

- The GLOBE Watershed Dynamics Project led by Northwestern University in partnership with Consortium of Universities for Advancement of Hydrologic Science (CUASHI) scientists.
- From Local to Extreme Environments, a deep ocean project led by Pennsylvania State University in partnership with RIDGE and InterRIDGE scientists.
- The GLOBE Seasons and Biomes project, led by the University of Alaska at Fairbanks in partnership with scientists from the International Arctic Research Center (IARC), the International Polar Year (IPY), and NASA satellite missions.
- The GLOBE Carbon Cycle project led by the University of New Hampshire partnering with North American Carbon Cycle scientists.

Visit www.globe.gov/essp to learn more about how GLOBE is adapting and enhancing its Professional Development programs, Web site, database, and data visualization and analysis tools to better support these inquiry-based student research projects!



"Carbon: the building block of life."

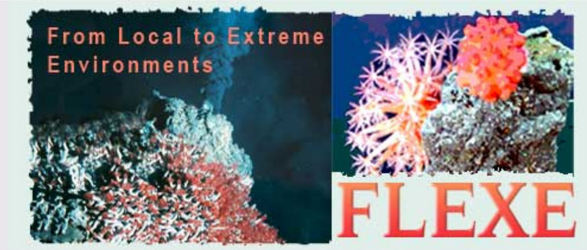
You may have heard this phrase, but have you understood what it really means? Carbon is the most abundant element in living things and accounts for approximately 50% of the total mass of plants and animals. Carbon is also present in Earth's atmosphere, soils, oceans and crust, and cycles between these components on varying time and spatial scales.

Find out more on the Carbon Cycle Project:
[Project summary](#) (PDF)
[Carbon Cycle FAQs](#)
[Czech collaboration](#)
[Carbon cycle diagram](#)

The GLOBE Carbon Cycle Project links an international team of scientists and educational outreach specialists with the GLOBE educational community. Through field exercises, computer modeling, and remote sensing, primary and secondary grade level teachers and students will gain knowledge about current carbon cycle research, develop strong analytical skills, and increase their overall environmental awareness.

Coming soon...
Global Carbon Cycle Model and related materials.

The first Carbon Cycle training session will take place at the Annual Conference in San Antonio, Texas, on Friday, 3 August 2007.



From Local to Extreme Environments (FLEXE) is a GLOBE project involving study of the deep ocean led by Pennsylvania State University in partnership with RIDGE and InterRIDGE scientists.

How extreme is the deep sea? What does it take to flourish along a mid-ocean spreading center 2500 meters below sea level? Characterized by crushing pressure, near freezing temperatures, and no light, the deep sea is the largest environment on Earth. Scientists are currently conducting investigations to learn more about features that make this ecosystem extreme and unique. Join the scientists in the Ridge 2000 program and associated research programs by participating in GLOBE FLEXE.

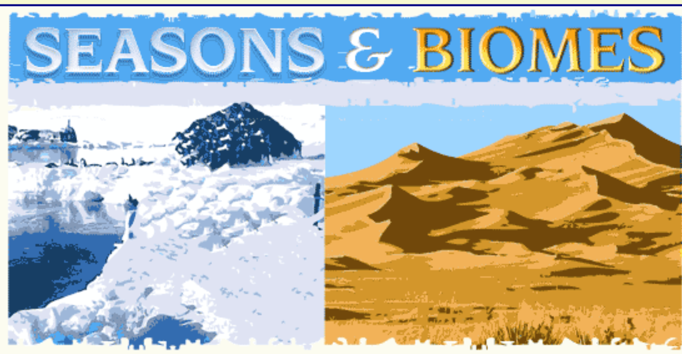
Through comparative protocols and online interactions with project scientists and partner schools, students will gain an understanding of local and the deep-sea environments, the interconnected Earth system, and the process of science. FLEXE students will collect data from their local environment and compare it with data from an extreme deep-sea environment. FLEXE students will compare their data with data collected by a partner school in another part of the world. Scientific reporting and a peer review process will cap the student experience.

For more information, please see the project summary and Web site.

Activities

26 January 2007: **Seafloor to Space Station Phone Call**
March-May 2007: Test select FLEXE activities with pilot schools
September 2007: First FLEXE unit available

As additional FLEXE activities are planned, information about them will be added to this page.



Seasons and Biomes

A biome is a large geographic area of distinctive plant and animal groups that are adapted specifically for a particular environment. Biome type is determined by the climate and geography of a region. Through the GLOBE Seasons and Biomes project, students and teachers will have the opportunity to use GLOBE resources and support to conduct scientific inquiries in their local environments and biomes.

This project will contribute critically needed science measurements to validate satellite data used in research on regional climate change, prevention and management of diseases, and understanding of the water and carbon cycles. By monitoring the seasons in your biome, you will learn how interactions within the Earth system affect your local environment and how it in turn affects regional and global environments.

Find out more about the Seasons and Biomes Project:
Project summary (PDF)
Frequently Asked Questions
Descriptions of Land Biomes
International Polar Year (IPY)

Activities

8 Nov 2006 - 15 Feb 2007: Seasons and Biomes Questionnaire
March 2007: Pole to Pole video conference and follow-up web chats

As additional Seasons and Biomes activities are planned, information about them will be added to this page.

Where does your water come from? Do you always have enough or is the supply limited where you live? What factors affect the flow of water in the area where you live? The GLOBE Watershed Dynamics Project will enable students to investigate their own watershed in order to understand the flow of water through the watershed, how human activities within the watershed both depend on and impact its hydrology, and how land use changes can affect the plant and animal communities in the watershed.

This project will offer GLOBE students the opportunity to conduct science investigations on local and regional watersheds using real-time and historical scientific data from the dataset being constructed by the Consortium of Universities for Advancement of Hydrologic Science (CUAHSI).

For more information, please see the project summary.

Activities

July 2007: Workshop for teachers who will be pilot testing the activities
August 2007: The first training session will take place at the Annual Conference

As additional information about these activities, and future Watershed Dynamics activities, becomes available, it will be added to this page.

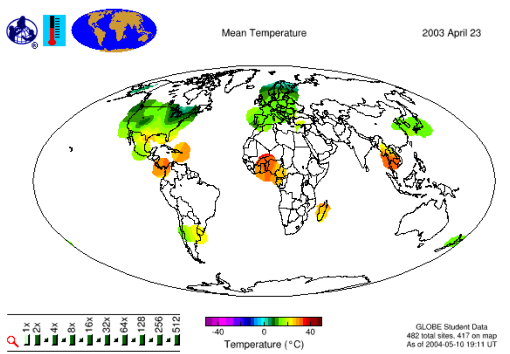
The GLOBE Program:
How it Can Aid Scientific Investigations…

GLOBE is a hands-on **science** and **education** program that has students collect scientifically valid environmental measurements and report them to a publicly available database.

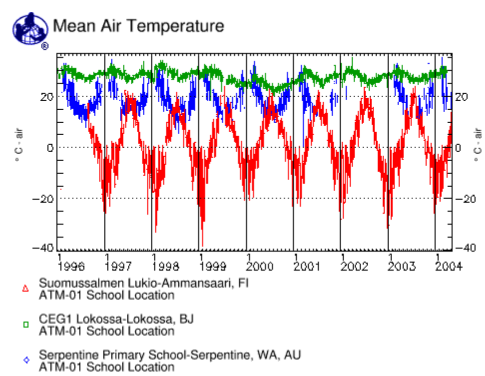
"GLOBE is the quintessentially ideal program for involving kids in science,"
- Nobel laureate Dr. Leon Lederman.

WHY USE GLOBE DATA?

Spatial and Temporal Coverage: GLOBE is a network of over 21,000 schools in over 100 countries. As of February 1, 2008, over 17 million environmental measurements have been collected.



GLOBE Student
Mean Air Temperature Data for April 23, 2003



Comparison of mean air temperature from three different GLOBE schools

Research Quality Data: All data are collected following scientifically valid protocols, and research scientists work to ensure the accuracy of all measurements. All data reporters have undergone first-hand training.

Education and Community Outreach: The GLOBE Program offers an ideal means to partner science and education. The hands-on nature of GLOBE allows students to become involved in authentic scientific research. Since GLOBE relies on a network of partners to implement the program, it is possible to find partners eager to work with your project, or to become a partner yourself. These partnerships involve a variety of groups, such as satellite missions, university departments, science centers and museums.

GLOBE is an interagency program funded by the U.S. National Aeronautics and Space Administration (NASA) and the U.S. National Science Foundation (NSF), supported by the U.S. Department of State, and implemented through a cooperative agreement between NASA, the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado, and Colorado State University in Fort Collins, Colorado.

FOR MORE INFORMATION…
Visit the GLOBE Web site at www.globe.gov, or email our Help Desk at help@globe.gov

Science Objectives and Use of GLOBE Data

Atmosphere	Help scientists improve weather forecasting, predictions of climate change, and interpretation of satellite observations.
Combined Atmosphere, Surface, & Soil Temperature	Help scientists calculate the rate of heat exchange between the atmosphere and the soil, and the potential for decomposition and soil weathering (see also entries for Atmosphere Temperature & Soil Temperature).
Clouds and Contrails	• Help tie new measurements of clouds by automated sensors to long-term historical data records of human observations. • Help to identify cloud type more accurately than is possible by remote sensing. • Contribute to determination of how cloud climatology may be changing (a major issue in assessing climate change). • Contribute to improved interpretation of satellite observations of Earth’s radiative balance. • Provide one of the only sources of ground-based observations of contrails, which are challenging to detect by remote sensing due to their small width.
Air Temperature, Precipitation, and Relative Humidity	• Provide a denser network of observations than is available using only official weather stations. • Provide finer resolution data crucial for investigating localized variations (e.g., urban heat islands, microclimates). • Augment data needed for regional forecasts and climate records in areas of the world where there are few official weather stations.
Aerosol	• Provide calibrated ground-based observations to help assess the performance of space-based instruments and to fill in the global views of aerosol distributions provided by satellite remote sensing • Detect the presence of dust, smoke, soil particles, and other aerosols and help scientists track their movement around the world.
Water Vapor	• Provide calibrated ground-based observations to help assess the performance of space-based instruments and to fill in the global views of water vapor distributions provided by satellite remote sensing. • Provide time series of water vapor to supplement non-geosynchronous space-based observations, especially in places where other ground-based instrumentation does not exist.
UV-A	• Provide calibrated ground-based observations to help assess the performance of space-based instruments and to fill in the global views of UV distributions provided by satellite remote sensing. • Provide time series and high spatial density views of the effects of clouds on the distribution of UV-A radiation on the ground.
Ozone	• Identify areas of high and low ozone concentrations and the times of year and weather conditions when they occur. • Help scientists interpret satellite observations of tropospheric ozone. • Provide quantitative measurements of ozone to help local agencies determine the extent of widespread pollution episodes.

Hydrology	Improve the monitoring of surface waters both inland and along the coasts of oceans and seas.
Transparency	• Determine how far light can penetrate the water and support the growth of algae and submerged aquatic vegetation.
Temperature	• Determine the overturning of lakes. • Track the mixing of waters in estuaries and along coasts. • Help determine evaporation rates. • Help scientists determine what can live in the water.
pH	• Help scientists determine what can live in the water, both animals and plants. • Track the mixing of waters in estuaries and along coasts. • Help scientists relate water quality to surrounding soil and geology and to the pH of rain and snow melt.
Conductivity	• Determine the overall loading of salts and other compounds dissolved in fresh water. • Help determine the usability of fresh water for different purposes.
Salinity	• Track the mixing and source of waters in estuaries and along coasts. • Help track the state of saline inland waters.
Alkalinity	• Help determine the vulnerability of fresh waters to changes in pH from inputs of acidity.
Dissolved Oxygen	• Determine what animals can live in the water. • Help scientists determine the mixing of air and water at the water's surface.
Nitrates	• Help scientists determine the potential uses of water. • Help determine the effects of inputs of nutrients from surrounding areas on a water body.
Fresh Water Macroinvertebrates	• Help determine the biodiversity of a fresh water ecosystem. • Help scientists determine the overall state of a water body.
Marine Macroinvertebrates	• Help determine the biodiversity of coastal beach ecosystems. • Help determine the overall state of coastal beach ecosystems. • Test the hypothesis that the distributions of marine animals will change with climate change.

Soil	Help scientists understand soils and how they function, change, and affect other parts of the ecosystem, such as climate, vegetation and hydrology.
Temperature	• Provide new data for tracking climate and annual cycles. • Help scientists determine times of insect emergence and plant sprouting. • Help determine heat transport in near-surface soil. • Help understand the potential for decomposition and weathering of soil. • Help scientists monitor the energy balance of the Earth system.
Moisture	• Help track the water cycle in the Earth system. • Help determine the times of plant sprouting and growth. • Help scientists improve weather and climate prediction. • Help understand the potential for decomposition and weathering of soil. • Compare with existing models and data sets for validation and for local detail.
Field Characterization (structure, color, consistence, texture, and the presence of rocks, roots, & carbonates)	• Help scientists create soil maps. • Help track the global carbon cycle. • Provide information for interpretation of soil temperature and moisture measurements. • Help to interpret the history of the soil. • Provide information to determine the appropriate uses of a soil.
pH	• Help determine what can grow in the soil. • Help determine the effect on the pH of water flowing through soil. • Give insight into other chemical properties in the soil.
Bulk Density	• Help in the interpretation of soil temperature and moisture measurements. • Help determine soil porosity (volume of empty space for air and water) in combination with Particle Density. • Provide some indication of mineral versus organic content of soils. • Help understand the ability of roots or organisms to penetrate the soil horizon.
Particle Density	• Help determine soil porosity (volume of empty space for air and water) in combination with Bulk Density. • Provide some indication of mineral versus organic content of soils. • Help in the interpretation of soil temperature and moisture measurements.
Fertility	• Indicate the suitability of the soil for supporting growth of crops and other plant life. • Provide indication of nitrate and phosphate inputs to water bodies.
Particle Size Distribution	• Determine the mixture of sand, silt, and clay particles in soil. • Provide information to help determine the appropriate uses of a soil. • Provide information for interpretation of soil temperature and moisture measurements. • Provide critical information for mathematical modeling of water, energy, and carbon dynamics in soils.

Land Cover	Help scientists study the terrestrial components of the energy, water, carbon, nitrogen, and other cycles of the Earth system. Help in the understanding of local climate and watersheds.
Sample Site	• Classify land cover for comparison with maps derived from satellite remote sensing.
Biometry	• Help scientists determine the amount of biomass present. • Help validate land cover classifications of sample sites.
Mapping	• Guide systematic observation of land cover classification.
Change	• Determine land cover change in support of the study of changes in local climate, watersheds, and the cycles of the Earth system.

Fuels	Help scientists identify those areas with high fire danger to protect people, homes, and ecosystems.
Fuel loadings	• Determine the spread rate and intensity of wildland fires. • Calculate the amount of smoke emissions from the fire. • Compute the amount of carbon added to the atmosphere due to a fire. • Calculate the carbon reserves in the dead biomass.
Fuel characteristics	• Calculate fuel consumption and soil heating. • Estimate habitat for organisms depended on coarse woody debris. • Compute tree mortality from fire.

Phenology	Help scientists detect the nature and extent of climate change and its effects on plants and animals.
Green-up, Green-down Budburst, Lilacs, Phenological Gardens	• Delineate the length, start and end of the growing season. • Help scientists interpret satellite observations of greenness.
Hummingbirds	• Determine changes in hummingbird migration as both an indicator and response to climate changes and land cover.
Seaweed Reproduction Phenology	• Determine changes in seaweed reproduction as both an indicator and response to climate changes.
Arctic Bird Migration	• Determine changes in Arctic bird migration as both an indicator and response to global and regional climate changes.

GLOBE Ties to Satellite Missions

AIM
- Aerosols
- Clouds and Contrails
- Column Water Vapor
- Carbon Dioxide (to be developed)

AVHRR
(Instrument on various NASA/NOAA satellites)
- Phenology
- Surface Temperature
- Soil Characterization
- Snow
- Clouds and Contrails

CALIPSO
- Aerosols

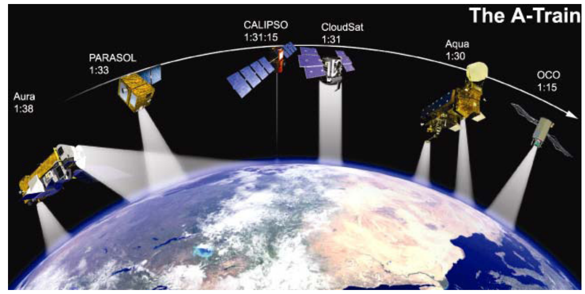
CERES
- Clouds and Contrails

CloudSat
- Clouds and Contrails

ENVISAT
- Aerosols

EOS-Aura
- Surface Ozone
- UVA (to be developed)

EOS- Terra and Aqua
- Land Cover
- Surface Temperature
- Soil Characterization
- Snow
- Clouds and Contrails
- Aerosols
- Column Water Vapor



A group of satellites known as the Afternoon Constellation, or the A-Train. By flying in close proximity, satellites in the A-Train combine to provide detailed observations of the Earth system. GLOBE measurements will contribute to the validation of these missions.

GOES
- Aerosols
- Clouds and Contrails
- Surface Temperature

Landsat
- Clouds and Contrails
- Snow
- Land Cover
- Soil Characterization
- Surface Temperature

OCO
- Carbon Dioxide (to be developed)

SPOT
- Land Cover
- Soil Characterization

TOMS
(Instrument on various NASA/NOAA satellites)
- Surface Ozone

GLOBE Partnerships with Satellite Missions

Satellite(s)	Instrument(s)	GLOBE Protocol(s)
ESSP CloudSat (Earth System Science Pathfinder Project)	**CPR** (Cloud Profiling Radar)	Atmosphere
EOS Terra and Aqua (Earth Observing System)	**MODIS** (Moderate Resolution Imaging Spectroradiometer) **CERES** (Clouds and the Earth's Radiant Energy System) **AMSR/E** (Advanced Microwave Scanning Radiometer-EOS) **AMSU** (Advanced Microwave Sounding Unit) **AIRS** (Atmospheric Infrared Sounder) **HSB** (Humidity Sounder for Brazil) **MOPITT** (Measures of Pollution in the Troposphere) **MISR** (Multi-angle Imaging SpectroRadiometer)	Land Cover Surface Temperature Hydrology Atmosphere Aerosols Column Water Vapor
ESSP CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations)	**LIDAR** (LIght Detection And Ranging)	Atmosphere Aerosols
LandSat	**ETM+** (Enhanced Thematic Mapper Plus)	Clouds and Contrails Snow Land Cover Soil Characterization Surface Temperature
EOS Aura	**OMI** (Ozone Monitoring Instrument) **HIRDLS** (High Resolution Dynamics Limb Sounder) **MLS** (Microwave Limb Sounder) **TES** (Tropospheric Emission Spectrometer)	UVA Surface Ozone Atmosphere Aerosols
AIM (Aeronomy of Ice in the Mesosphere)	**SOFIE** (Solar Occultation for Ice Experiment) **CIPS** (Cloud Imaging and Particle Size Experiment) **CDE** (Cosmic Dust Experiment)	Clouds and Contrails Aerosols Column Water Vapor Carbon Dioxide (in design stage)
GOES (Geostationary Operational Environmental Satellite)	**GOES I-M** Imager Sounder Space Environmental Monitor	Atmosphere Aerosols Surface Temperature
SPOT (commercial satellites)	**HRS** (High Resolution Stereoscopic)	Land Cover Soil Characterization
Various NOAA/NASA satellites	**AVHRR** (Advanced Very High Resolution Radiometer)	Clouds and Contrails Phenology Hydrology Surface Temperature Soil Characterization Water Vapor
Earth Probe TOMS satellite	**TOMS** (Total Ozone Mapping Spectrometer)	Surface Ozone
ESSP OCO (Orbiting Carbon Observatory)	Spectrometer	Carbon Dioxide (in design stage)
AIM (Aeronomy of Ice in the Mesosphere)	**SOFIE** (Solar Occultation For Ice Experiment) **SHIMMER** (Spatial Heterodyne IMager for MEsospheric Radicals) **CIPS** (Cloud Imaging and Particle Size experiment) **CDE** (Cosmic Dust Experiment)	Polar Mesopheric Clouds (in design stage)

WAYS TO BECOME INVOLVED IN GLOBE

1) Work with an existing partner

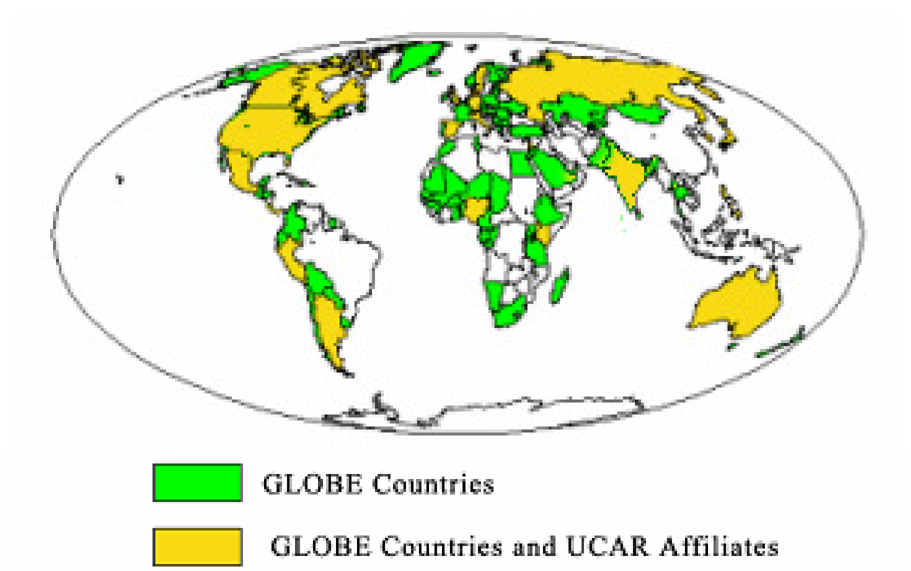
GLOBE has partners in 109 countries and almost all U.S. states. The complete list of these partners, including contact information, can be found on the *Countries* and *U.S. Partners* links found on the GLOBE Web site at <www.globe.gov>. The diversity of partnerships makes it possible to find partners that are appropriate for inclusion in an array of projects.

2) Include GLOBE in the outreach portion of your scientific projects

GLOBE would be glad to suggest ways that you could incorporate portions of the GLOBE Program into your project. Please email the GLOBE Program Office at <regionalscienceprojects@globe.gov> to discuss possible collaborations.

3) Use GLOBE data in your research project

All GLOBE data are publicly available. With data ranging from land cover classifications in Bahrain to cloud observations in the Marshall Islands, you may be able to find just what you are looking for. Powerful search tools on the GLOBE Web site allow you to narrow down the exact data you need. Numeric data can be downloaded in a variety of formats (web-based, delineated text, or shape files), or visualized using our online mapping and graphing tools.



GLOBE countries that have UCAR Affiliate Institutions, depicted in yellow in the graphic below, include Argentina, Australia, Canada, Denmark, Germany, Japan, India, Israel, Italy, Kenya, South Korea, Mexico, Nigeria, Panama, Peru, Philippines, Russia, Spain, Sweden, the United Kingdom and the United States.

Scientists are Talking about GLOBE . . .

Elissa Levine, NASA Goddard Space Flight Center: The comprehensive suite of GLOBE measurements that is being collected by students is critical for Earth science research -- for assessing current conditions, for monitoring changes and for driving, testing and creating models for predictions into the future. GLOBE soil data, in particular, are among the most important parameters for ecosystem modeling and interpretation of remotely sensed data. Each soil characterization measurement submitted by a GLOBE school adds to the existing soil profile data base and improves the quality of soil maps and algorithms that soil scientists can derive.

Michael Lewis, NOAA National Weather Service, Jackson, Kentucky: Schools using the GLOBE protocols provide routine and accurate data which are beneficial to the National Weather Service for verification of rainfall, snowfall and temperatures. Additionally, GLOBE meteorological data, especially rainfall, are helpful for identifying flooding potential in specific local areas. Over the longer term, numerical atmospheric modeling critical to weather forecasting demands more high quality data. GLOBE measurements such as soil composition, soil infiltration, land cover, and land utilization are important data to be integrated into the models.

Steve Running, University of Montana: The Earth's surface covers 150 million square kilometers. To understand it we need data from all over the world. The power of GLOBE is the thousands of sample points we can get from GLOBE schools every year.

David Verbyla, University of Alaska Fairbanks: There is currently no network of on-the-ground plant phenology observations to validate growing season models and estimates derived from satellite data. GLOBE schools' plant phenology observations will be the only source of wide-spread growing season observations for research to better understand climate change

Paul Schlumper, Georgia Tech: GLOBE data are crucial to our research efforts in the environmental management area. There are many instances where GLOBE data are the only data available for certain measurements or certain parts of the world.

Roger Bales, University of Arizona: GLOBE hydrology measurements fill a critical gap in water monitoring and assessment efforts in the United States and worldwide. GLOBE schools sample many smaller streams and lakes that are under-represented in the professional monitoring programs run by government agencies. We have now reached the point where GLOBE constitutes one of the largest water-quality networks in the United States and is certainly the one with the most readily available data.

Susan Postawko, University of Oklahoma: While it's true that we may have a pretty good idea of the overall temperature and precipitation patterns in many countries -- like in the United States or in parts of Europe where there are plenty of weather stations -- what we don't necessarily know is how much variation there is over a region. GLOBE student data can help us understand small-scale variations in temperature and precipitation. Student measurements of clouds, temperature, and precipitation are making a real contribution in truly understanding our day-to-day weather, as well as the long-term climate of our planet.

Bob Keane, US Forest Service, Montana: The highest cost involved in making fuel maps for fighting wildfires is in collecting the field data essential for creating accurate maps. Most natural resource agencies do not have the time, money or resources to sample fuels. The GLOBE Program provides the perfect solution with students committed to learning about fuel and fire management and ecology collecting the valuable data.

Alex Philp, University of Montana: Here at the University of Montana, Missoula, research scientists are utilizing GLOBE data for their own global models related to complex biogeochemical processes. As a necessary complement to data derived from existing and future NASA EOS satellite missions, GLOBE data are crucial for ground-truth validation of these models. Given the tremendous costs that would be normally associated with the breadth of data collection achieved by GLOBE schools around the world, scientists at the University of Montana have worked to incorporate GLOBE data into the very fabric of their research. Without the GLOBE Program, researchers could not event consider funding the necessary for ground based data collection.

David Brooks, Drexel University: There is no doubt that, when GLOBE measurements of aerosols become available, they will fill a monitoring gap that cannot be filled in any other way. Some aerosol data are currently obtained from satellite-borne instruments such as NOAA's AVHRR (Advanced Very High Resolution Radiometer) and NASA's TOMS (Total Ozone Mapping Spectrometer) and SAGE (Stratospheric Aerosols and Gas Experiment) satellites, but ground-based validation is essential to improve our ability to monitor aerosols over land as well as ocean. Continuous ground-based monitoring is also necessary to improve algorithms for assessing the impact of aerosols on climate. Currently the only global aerosol monitoring network provides less than 100 operational instruments on the ground; this does not provide adequate coverage for scientific research in areas like global transport of aerosols during events such as volcanic eruptions.

Brent Holben, NASA Goddard Space Flight Center: NASA's AERONET program collaborates with NOAA to study aerosols from a globally distributed network of radiometers and from satellite information. There is almost no information on aerosol loading where most of the world's population resides -- in urban areas. The GLOBE Program targets those areas through school participation. It is fundamental that measurements in these areas continue and expand such that medical researchers may analyze and understand the impact of aerosols on the health of our people and children.

Joan Clemons, UCLA: Urban areas usually straddle a number of distinct microclimates. To study urban heat islands, we need to have exhaustive data from across these climate gradients. In Los Angeles this means data from within the coastal zone and inland and at elevated locations. GLOBE student data opens up more research possibilities for studying urban areas through the collection of more data and at the same time allows students to learn about the ecology of cities.

Jack Fishman, NASA Langley Research Center: GLOBE children around the world will participate in the validation of satellite measurements as new capabilities from the EOS- and Post EOS-generation of satellites initiate systematic observations of global change as we enter the new millennium. Thus, GLOBE students will be contributing to the success of these missions as scientists use their measurements as an integral component of validating what is seen from space.

Mark Schwartz, University of Wisconsin-Milwaukee: GLOBE students offer a rare opportunity to get linked plant phenology and meteorological data from a set of widely distributed sites. Such information is crucial for model validation and for establishing correspondence between satellite-derived and surface measurements of phenology This research has important implications for global change modeling and monitoring efforts.

Jim Washburne, University of Arizona: You will not find a scientist who would not add to their observational network. GLOBE is a voluntary observational network that provides scientists critical environmental data that would otherwise not be available. GLOBE observations could be the first indication that something is amiss with limited observational programs, as was the case with the "discovery" of the Antarctic ozone hole. There is, for example, considerable bias in the current NOAA/National Weather meteorological Service Network based at low altitude airports.

Wayne Faas, National Climatic Data Center: At NCDC, we are currently comparing GLOBE student data to co-op (volunteer) and operational National Weather Service data as we hope to use the student data in climate monitoring. In order to determine the value of using GLOBE student data in climate change analyses, NCDC is computing and plotting monthly averages of temperature for both GLOBE data and co-op data and analyzing the differences. NCDC is also using GLOBE student data to validate extreme events such as flash floods, hurricanes, and tropical storms, etc. The advantage of the GLOBE student data is that it arrives in real time, whereas the co-op data comes in by mail and can take as much as a month to be received. The more GLOBE schools we have, the better.

Paul Ruscher, Florida State University: The GLOBE Program ties in directly with the NOAA and NASA missions, which involve the study of our planet and its atmosphere. As a scientist, I am concerned that the National Weather Service has virtually abandoned the taking of cloud type observations, and cannot take surface-based cloud cover observations for any cirrus, cirrocumulus, or cirrostratus clouds, since NWS ceilometers only cover clouds whose base extends down to 12,000 ft. These high clouds have been shown in climate studies to be extremely important in monitoring climate conditions, and are often harbingers of worsening weather conditions. GLOBE student observations potentially are the only reliable comprehensive sky observations available to the scientist who studies clouds and their effects.