The GLOBE Program®
Teacher's Guide

2014







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THE GLOBE PROGRAM

Dear GLOBE Students:

Congratulations! Through your participation in GLOBE, you are joining with students, teachers, and scientists from around the world to help all of us learn more about our planet! As a student scientist you are an important part of the worldwide effort to understand our global environment.

Scientists have long studied Earth's environment and have come to view it as an integrated system. Within this system, important interactions connect all regions and past conditions influence the present and the future. However, environmental scientists cannot take Earth into a laboratory to study it. Instead, they must rely on the collection of data from as many places as possible. Orbiting satellites collect much data about our planet, but measurements by people on the ground are also essential, particularly for local details and phenomena that cannot be measured from space.

As a GLOBE student scientist, you assist other scientists by taking accurate measurements and sharing your data through the Internet. You can contribute data about the air, water, soil, and vegetation around you. Some observations are needed only once while others should be taken every day. Many of these data are collected routinely only by GLOBE students. The datasets you help build will continue to be useful for years, decades, and even centuries. You are making a lasting contribution to human knowledge!

As a GLOBE student, you can learn much about science and your surroundings through your observations and the resulting data. As you take measurements, you will better understand what they mean and learn to recognize patterns in your data. You even can conduct research to answer your own questions about the environment, and as with most scientific research, your investigations will lead to more questions. You can use both the techniques provided by GLOBE and the data reported by you and other students to perform such investigations. Research requires hard work, but the excitement that comes with discovery and new insights makes it worthwhile.

Everyone in GLOBE values your careful contributions as an environmental observer and wants to support your growth as a scientific thinker. We hope your experiences through GLOBE bring you joy and satisfaction.

The GLOBE Program • University Corporation for Atmospheric Research (UCAR)
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THE GLOBE PROGRAM

Dear GLOBE Teachers:

You have joined a worldwide partnership of teachers, students, and scientists working together to strengthen education, help meet educational standards, and learn more about our environment! Through your leadership, your students have the opportunity to use research-quality observations in their studies and to contribute their environmental observations for research scientists and other GLOBE students to use in their work.

As a GLOBE teacher, you have embarked on a bold adventure in both science and education. This Program enables you and your class to engage in a collaborative, scientific inquiry into the world around you. Your students have the opportunity to explore both the far corners of the globe and the wonders of their own neighborhood. GLOBE is here to support your efforts to motivate and educate.

This Teacher's Guide provides the key information that defines the GLOBE Program and supports your implementation of GLOBE with your students. Measurement procedures are specified as protocols with field and lab guides for student use. Instrument specifications are given to guide you in selecting the appropriate devices and supplies. Sections that provide background information will help you and your students understand the science associated with the measurements and provide insight into how to look at the resulting data. Specific learning activities are supplied to help you prepare students for taking data and to support the integration of GLOBE in your curriculum. Suggestions are included based on the experiences of those who have been doing GLOBE with their students, but no one can tell you how best to use GLOBE in your classroom. That is up to you.

Teachers are the key to the success of this Program. Only through your teaching and good work does GLOBE come alive. Everyone in GLOBE values your contributions, and we hope your teaching will be enriched and improved through the use of GLOBE and that you will make it your own. We are confident you will find fun and excitement as your students engage the environment as young scientists.

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GLOBE Student Letter

Dear Teachers and Students,

We would like to share with you what a wonderful experience that the GLOBE Program has been for us.

We have had the fascinating opportunity of being able to record and enter data for going on four years now. Each day is a whole new learning experience for us. In order to make our data work for the whole community, we phone in all of our "stats" to our local CBS affiliate for a daily spot on the five o'clock news. To use our data as a more positive learning experience, we make graphs and charts to compare with years past and other school's data to try and find out more about our planet.

We, however, decided that the whole process of taking and recording data was just not enough. What we needed was a way to be able to use this program on a larger scale. So, we invented a GLOBE Club. This opportunity has proven to be truly worthwile, by allowing us to interact with many different students in our school community. Through our activities, we have made GLOBE a live learning experience. We have been able to take one of the true roles of GLOBE and put it into action by allowing students to take charge of the club. We teach and in turn are taught in a one on one learning environment, in which we are constantly improving and changing our methods and procedures.

But, GLOBE would not be the program that it is if we didn't have a little bit of fun in the process, right? GLOBE has become a small family for us, one that has treated us very well. It has given us friendships, mentors to look up to, great educations, and so much more. GLOBE has become very important to us. It has become a part of us.

Our "family" wishes you well in your studies with GLOBE. We hope it becomes as much of a part of your lives as ours. Good luck and joyful learning!

Sincerely,

Joseph Neese
8th grader and President of Corpus Christi School's GLOBE Club

Thomas Harrison
8th grader and Vice-President of Corpus Christi School's GLOBE Club

GLOBE Student Letter

Our work with the GLOBE measurements

The first time we came into touch with the GLOBE Program was when we went in the 7th grade. Our chemistry and biology teacher, Mikael Ströberg, introduced the project for our class. He showed us GLOBE's website and asked if someone was interested in doing some of the measurements. After a while, when we had thought about it, we reported our interest. We started to make some of the measurements that were supposed to be done at 12 o'clock; we measured the maximum, minimum and the present temperature. We also measured precipitation, index of pH, the cloud cover and the different sorts of clouds. To recognize the different sorts of clouds was tough in the beginning, because no clouds are exactly the same, but it was interesting when we had learned.

After we had become more secure on the daily measurement, we also made some other measurements, like some hydrology measurements and measurement on the soil moisture. We couldn't make these measurements so often because they had to be done in the morning and we had classes then, but we made them when we had time. The hydrology measurements were the most fun. Then, we went down to the small river Sköldsån and measured the transparency, dissolved oxygen, alkalinity, pH and electrical conductivity.

We registered the results of the measurements on GLOBE's website. We could also go to the archive on the site and look at our results. We could also get in touch with other schools that were involved in the project. We got in touch with a girl from USA. We began to correspond and we sent small weather reports to each other. It was fun to get in touch with young people from other countries and in this way, we got to know more about other countries and we practiced our English knowledge. We still have got contact with the girl and we write to each other sometimes.

We continued with the measurements until we left the school and began at the senior high school. It was fun to follow the weather and the measurements were a meaningful occupation in the breaks. Sometimes it could be a little bit scary to see how people have influenced the climate. We observed this most when the pH value of the precipitation was down to 4. How does the value influence the plants and the animals? What should we do to prevent the acidification and which soil can buffer against precipitation with such a low pH value? There were many questions we had when we made the measurements. The GLOBE measurements have been very good because we have to think much about the environment. The project has also influenced our choice of program to senior high school. It is true that we went in a class with direction at mathematics and science in junior high school but the project made our interest in science larger and made us more resolute that we wanted to work in science in the future.

Our prospect now, when we go in senior high school, in the natural science program, is to try to start up the GLOBE project at our new school, Ale High School. We have talked to our chemistry and biology teacher and she was interested in the project. Our teacher and a colleague to her have been at a GLOBE course in Stockholm. We hope that the project will interest some other students, who can help us with the project. We are looking forward to beginning the measurements again.

Elin and Sofie
Sweden

GLOBE Student Letter

Dear GLOBE Teachers and Student,

My name is TSEUKOP FOSSO MYRIAM, and I am a student at the Technical School of Bafoussam in Cameroon in the second class EF1. Interested in earth science, I have been involved with GLOBE since September 2001.

It is true that the program escaped my notice at first and I was also a bit intimidated and didn't dare participate. During the first sessions and program introduction, I frankly didn't understand a lot. There was a moment when I was even discouraged. But I think that with help of others and the passage of time, I overcame this problem and came to understand everything, I learned a lot, like knowing the weather by just observing the clouds as well as the variation of the colors in the sky, and reading the rain gauge to see how much rain reached the ground.

I confess that I really enjoy making graphs and drawing conclusions and explanations. I have become a bit unbearable to my friends because I want to talk about the Program — knowledge about the clouds and other things — all of the time. This makes me really happy. I also want to spend a lot of time in my future studying science. This is a passion that I believe is like a fire.

Globally yours,

TSEUKOP FOSSO Myriam. Lycée Technique de Bafoussam

GLOBE Teacher Letter

Dear GLOBE Teachers,

I work as a biology teacher in a small secondary school in the northeastern part of Finland near the Russian boarder. I have been involved in the GLOBE Program since 1996 and have been very proud of it.

In my opinion the best thing about the GLOBE Program is that students get a better, long-term chance to study outside instead of theoretical studies inside the classrooms. That makes it much easier for me to motivate the students to study the environment around them.

Because students have to make regular observation about clouds, rainfall and air temperature every day, they get used to it and automatically observe the weather even on their holidays. I think it helps them to learn more about the nature around and even respect it more. If it works out, so I have succeeded in achieving my main purpose as a teacher.

Responsibility and punctuality are abilities that can also be improved while working in the project. One of our ambitious aims is to keep making and reporting our observations as regularly as we have done so far. The other aim is to write a weather report in time, which will be published in the local newspaper at the end of each month.

As a teacher I can easily make good use of all the data taken by GLOBE schools all over the world, which gives me workable instruments to illustrate the complicated weather factors in different parts of the world.

I am always looking forward to the seminars arranged by the Finnish GLOBE organization. It is very rewarding to meet there colleagues that have common interests and of course learn more for example about the GLOBE protocols.

One of the highlights to me and my students was, when we many years ago were able to travel abroad to Zwolle, Holland and meet our GLOBE friends with whom we earlier have had chats before, through the Internet.

We have also made together some Internet web pages, in which we introduce our work in the GLOBE Program. Unfortunately most of them are written in Finnish, but you can look at the diagrams, anyway. Look up our homepage on the GLOBE website.

René Kajava
GLOBE teacher, Suomussalmi High School, Finland

GLOBE Teacher Letter

Dear GLOBE Teachers,

On the personal level, I consider the GLOBE Program a very effective and beneficial program for both the teachers and students. Taking part in this program makes my students see the earth as an interconnected system. The GLOBE program makes my students apply science in their real environment. Besides, it increases students' use of the Internet and enhances teamwork.

The students now are very motivated to learn more about all the scientific concepts. The GLOBE students in my school feel very proud and privileged, since they are acting as small scientists and the data that they are collecting are considered as a reliable resource of research. Students in the GLOBE Program are enhancing their scientific research processes that require higher order thinking skills (in collecting data and analyzing them). As a matter of fact, the GLOBE Program is new in our school and the students didn't get the chance to apply all the protocols, but I can tell that they are very willing to be efficient GLOBE members. The GLOBE Program assures that we are moving on the right track of raising up scientists by encouraging students to learn science through the use of inquiry method.

Finally, I would like to express my thanks the opportunity of taking part in this program. I wish you a very prosperous future with more new and beneficial ideas for research.

OLA EID
GLOBE TEACHER
GERMAN SCHOOL-LABANON

GLOBE Teacher Letter

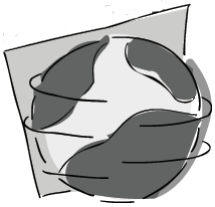
Dear GLOBE Teachers,

My school Stuckey Elementary School has been reporting data since November of 1999. We have made the Honor Roll, and now we have recorded over 2100 pieces of data. The grades involved are grades 3 - 5. The first year I had a science club after school. The children used the soil protocols. This involved a soil profile, identifying the horizons and their composition. They then each took a horizon and reported it to GLOBE. Meanwhile during the school time a revolving schedule for atmosphere was created. Soon the children were collecting data at solar noon on their own and reporting it. They even did this over the weekends and vacations. This certainly taught them math, reading thinking, observation not to mention the scientific process.

The next year, I used my former students to help in the beginning of the year. They in turn taught the others. We then established a hydrology site. Nature was starting this for us. It is a wetland and meadow bog right in our own courtyard. Protocols were taken for that. The children, working in the computer room saw and compared the different graphs and charts and maps. We took part in a greenhouse effect study from the Netherlands and emailed results to the person in charge. We sent a postcard to England for their first Earth Day. Many of the benchmarks for science, math, language, and social studies were met by using the GLOBE program. I'm going to attempt to have the children find another place with our latitude and compare the temperature. Later we will try for a few more graphs such as rainfall comparison, snowfall, etc.

Last June I was sent to a workshop to become a GLOBE trainer. I have already done the soil portion for Wayne County and hope to do other workshops for other counties and/or states. There are numerous skills we can do with this program. We are limited only by our imagination.

Dawn Kittle
Stuckey Elementary School
Redford, Michigan



The GLOBE Program

Overview

Global Learning and Observations to Benefit the Environment (GLOBE) is a hands-on international environmental science and education program. GLOBE links students, teachers, and the scientific research community in an effort to learn more about our environment through student data collection and observation.

The goals of GLOBE are:

- to enhance the environmental awareness of individuals throughout the world;
- to contribute to scientific understanding of the Earth; and
- to help all students reach higher levels of achievement in science and mathematics.

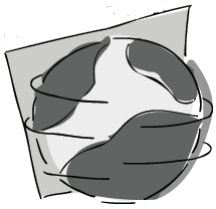
Students from the ages of approximately five through eighteen years in schools throughout the world conduct a continuing program of scientifically meaningful environmental measurements. GLOBE students transmit their data to a central data processing facility via the Internet, receive vivid images composed of their data and data from other GLOBE schools around the world, acquire information from a variety of sources, and collaborate with scientists and other GLOBE students and communities worldwide in using these data for education and research.

The measurements taken by the GLOBE students serve two important purposes. First, participating scientists use these data in their research programs to improve our understanding of the global environment. Second, students not only learn how to carry out a scientifically rigorous program of Earth observations, but also learn to use their own measurements, together with data from other GLOBE schools, as a key part of their study of environmental science. Through contact with and mentoring by scientists, the students receive feedback about the value of their data sets in world class scientific research.

GLOBE provides extensive educational materials to enrich the learning experience of participating students. These materials include a wide variety of classroom and field activities to help students place their measurements in a broader context and relate their own local observations to global environmental issues.

Using state-of-the-art technology, GLOBE creates a forum for students to communicate with their peers around the world, thus fostering alliances among students and increasing not only their environmental understanding but also their understanding of other cultures and their sense of global community.

GLOBE Education and Science



GLOBE is science and education, not just science education. GLOBE teachers and students join with research scientists to form broadly distributed research teams. Students collect data that are valuable to these researchers' work on various scientific inquiries. This collaboration and the authenticity of the data collected stimulate learning and offer opportunities for dynamic new approaches to education.

Behind every GLOBE measurement protocol and instrument specification is a science research team committed to the use of data collected by students following these protocols. The GLOBE science investigations are competitively selected through a process that involves peer review of proposals. Once a proposed project is chosen, each team reviews all data submitted for their protocols for accuracy and consistency. This review may include contacting GLOBE teachers to ask questions about these data. When collected accurately and consistently, GLOBE student data have repeatedly met the requirements for professional research use.

As a science and education program, GLOBE neither begins nor ends with data collection. Scientists collect data to gain understanding, and students can do the same. Teachers are encouraged to stimulate and reinforce their students' natural interest in their surroundings. Student interest can take form in questions that they want to answer, and taking data is part of addressing their questions. Recording, assembling, and analyzing data are a necessary part of the process leading to answers, new insights, and refined questions, and data reporting is essential for GLOBE implementation to give students an authentic science experience.

Data reporting is the step which makes the GLOBE collaboration real. Through GLOBE, members of the science community provide content, support, and mentoring to the primary, middle, and secondary education community. However, scientists get nothing for these efforts unless student observations are reported and included in the GLOBE archive. For the community of GLOBE schools to have a rich database of observations to use in student research and activities, each school must do its part by sharing its measurement results. Finally, the quality and quantity of student data reported to GLOBE is the best measure of accomplishment that can be provided to those who fund and support the GLOBE Program.

GLOBE provides materials and infrastructure to support students in carrying out the process of science, which is often called inquiry. First and foremost, GLOBE supplies the protocols and instrument specifications so that students can be assured that their measurements are valid observations of the environment and comparable with data collected by others around the world. In this Teacher's Guide and on the GLOBE Web site, background information is provided to place the measurements in a scientific context, and discussions and examples are given of how to analyze the data. Learning activities are provided to help teachers prepare students to collect data, to aid students' understanding of the science associated with their measurements, and to support students' efforts to gain facility with various analysis techniques.

Throughout this Teacher's Guide, references are provided to Science Concepts and to Inquiry Abilities. These are intended to facilitate the process of integrating GLOBE into the curricula of classes, schools, and school systems. GLOBE recognizes that the job of teachers is to educate students and that taking measurements is only a means to that end. Accordingly, each teacher should choose from GLOBE those measurements and activities that help accomplish his or her instructional objectives. Starting gradually and undertaking GLOBE measurements in a way that can be sustained and become a routine part of student activity is recommended. GLOBE provides a wide variety of content

and this Guide includes indications of the appropriate levels for various items – primary (K-4), middle (5 - 8), and secondary (9 - 12). Still, GLOBE hopes that every school will grow to report data for every measurement that is appropriate to the abilities of its student population.

GLOBE and Student Inquiry

Every area of learning involves mastery of content (concepts and facts) and process (techniques and procedures). Taking authentic scientific observations certainly enriches the study of concepts in science and geography and provides data for use in math classes along with opportunities to apply math in data analyses. Beyond this, the study of the environment provides an area of scientific research that is accessible to students at an early age. Students can do science. They can begin with curiosity and questions, observe, measure and analyze, and reason their way to logical conclusions supported by their data. This process is student inquiry, and it can bring the excitement of scientific research to the sometimes routine activities of data collection.

GLOBE provides material and infrastructure that can make the inclusion of student inquiry in education easier. Inquiry provides a complete context that makes GLOBE more educationally meaningful.

GLOBE and Standards for Education

In this *Teacher's Guide*, protocols and learning activities are related to the standards they address. In the United States, there is growing insistence that teaching be directed to address specific standards. Many countries in GLOBE and virtually every state in the United States have adopted standards for education, including science education. These standards vary, and it is not presently possible to provide a correspondence between GLOBE elements and every set of standards. However, there is much in common among the different sets of standards for science education.

For this *Teacher's Guide*, GLOBE has chosen to use the National Science Education Standards published by the US National Academy of Sciences, selected additional content standards that GLOBE scientists and educators feel might make appropriate additions to standards, and the National Geography Standards prepared by the (US) National Education Standards Project.

Evolution of The GLOBE Program

Since the first GLOBE *Teacher's Guide* in 1995, the number of protocols has more than doubled and there have been some changes in protocols based on experience. This is to be expected in any scientific endeavor. All data reported to GLOBE have been retained, even when collection techniques have shifted.

Different types of equipment have become available, and this has led to a number of options for taking certain measurements. There are also certain GLOBE measurements that are only appropriate within a limited geographical area and others where the scope of protocol training is beyond what can normally be included in GLOBE's train-the-trainer workshops. All of the available protocols are included to enrich the content available for GLOBE participants.

The 2005 GLOBE *Teacher's Guide* was a comprehensive advance on the 1997 Teacher's Guide. The 2002 *Teacher's Guide* should be viewed as an interim step leading to this major revision. A number of new features such as *Field Guides* and *Lab Guides* and *Looking At the Data* sections were included in all chapters. The Guide was designed to allow teachers to more easily extract from it those sections that they wish to use in their classrooms without the need to rewrite or edit the material.

This 2014 version contains updated visualizations and data sheets that mimic the new website more closely. The complete 2014 *Teacher's Guide* is only available electronically on the GLOBE website. CD versions will be available in limited numbers for those with limited Internet access. Additionally, efforts are under way to make the GLOBE Teacher's Guide more user-friendly; therefore you will find much more inter-activity in the Teacher's Guide than in previous versions. The new *Teacher's Guide* has been influenced by many members of the GLOBE community.

In general, considerable effort has been made to incorporate into the 2014 *Teacher's Guide* all the good ideas that have surfaced over the last decade and incorporates images and links to the new GLOBE website. Inevitably there will be further improvements and corrections in the future. These can be made incrementally to the Guide as presented on the GLOBE website.