

July 2021- July 2022 ANNUAL REPORT

Brazil



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- **Organization and Number of Staff:** 3
- **Funding by:** Brazilian Space Agency
- **Cooperating Organizations/Individuals:** University Federal of Parana; Federal Institute of Para - Obidos; Federal Institute of São Paulo - Campinas; Municipal Secretary of Education of Obidos; Municipal Secretary of Education of Campinas; Municipal Secretary of Education of Codo; Municipal Secretary of Education of Belo Horizonte; Municipal Secretary of Education of Umirim; U.S. Fulbright Program; Institute for Global Environmental Strategies.
- **GLOBE Schools:** 271
- **GLOBE Protocol Areas:** Atmosphere, Hydrosphere and Biosphere
- **Number of Schools Reporting Data over Past Year:** 44
- **Fully trained GLOBE Teachers:** 859
- **GLOBE Observers:** 4271
- **Data entries (from 1/07/2021 to 1/08/2022) by teachers, citizen scientist and weather stations:**
 - Atmosphere: 128.710
 - Biosphere: 1.170
 - Hydrosphere: 1.740
 - **Total: 131.620**



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Program Implementation, International Cooperation in GLOBE Network, and Activities over Past Year (categorized by GLOBE Strategic Plan 2018-2023 Goals):

- **Education**

Brazil faced several challenges with the Covid-19 pandemic. Many schools remained closed in the 2nd semester of 2021, returning to face-to-face activities only in November or December. back to school, several challenges popped up and teachers had to overcome it, making it difficult to conduct GLOBE activities in the classroom.

Unable to carry out face-to-face activities in 2021, the Brazilian Space Agency, the institution that coordinates the GLOBE Program in Brazil, envisioned that online interaction would be the possible way to conduct the activities of the GLOBE program in Brazil. Thus, the first months of 2021 were dedicated to production of online content, including the development of a virtual learning environment. In September 2021, the AEB Escola Virtual was launched, a 100% free digital educational platform, where courses and training activities in space and related areas are made available for students, teachers, and enthusiasts. Since its implementation, 3 online courses and 6 hybrid courses have been held on the GLOBE Program. A brief account of the courses conducted from July 2021 to July 2022 follows:

a) GLOBE Brasil 2021 Workshop - GLOBE Observer Application (September 27 to November 5, 2021)

The Workshop was conducted 100% online and trained 27 people among teacher's science, geography and math, undergraduate students and STEAM professionals in the GLOBE Observer protocols (land Cover, Mosquito, Tree, Cloud). The course participants had access through the platform to material specially developed for teachers, adapted the Globe Protocols to the Brazilian school curriculum and correlated with the UN Sustainable Goals and made available through the platform. In addition, emphasis was given to the development of scientific research projects in schools, explaining scientific methodology and the organization of research in the classroom. In addition, lesson plans and "hands on" activities were made available to teachers to be worked on in schools. In the end, the teachers wrote a pre-project to implement in their school.

Workshop 1st day: <https://www.youtube.com/watch?v=uv5j8Wx7bj4>

Workshop 2nd day: <https://www.youtube.com/watch?v=qKSmDPAEMsg>

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Workshop 3th day: <https://www.youtube.com/watch?v=7J3wGgRGHys>

Workshop 4th day: <https://www.youtube.com/watch?v=Y1DjoSkldll>

Workshop 5th day: <https://www.youtube.com/watch?v=x879dzIHarc>

b) Preparatório para o Simpósio Virtual Internacional de Ciências GLOBE 2022 – (01/26/2021 to 03/11/2022)

This workshop was created to support Brazilian teachers to apply to the 2022 International Virtual Science Symposium (IVSS). The Brazilian GLOBE team answered questions, reviewed the project, and explained the instructions of the IVSS application. As a result, we had 4 projects in the IVSS this year.



c) Workshop GLOBE Brasil 2022 - Óbidos, PA (may 3st to June 02nd)

The course was conducted in a hybrid way with theoretical and practical classes held in the city of Obidos, Para Estate, in the Amazon region. Protocols, theoretical introduction, videos and activities for the classroom and other educational materials were made available to teachers through the AEB Escola Virtual platform. Thirty-five Elementary and High School teachers participated in the workshop. The focus of the training was once again the GLOBE Observer protocols (Clouds, Land Cover, Trees, and Mosquito Habitat Mapper) and at the end of the course, the teachers presented the research proposal they will develop with students at the school.

d) GLOBE 2022 Workshop – Campinas/SP (June 8th to June 9th)

The course was conducted in a hybrid way with theoretical and practical classes held in the city of Campinas, São Paulo Estate. Protocols, theoretical introduction, videos and activities for the classroom and other educational materials were made available to teachers through the AEB Escola Virtual platform. Twenty-two Elementary and High School teachers participated in the workshop. The focus of the training was once again the GLOBE Observer protocols (Clouds, Land Cover, Trees and Mosquito Habitat Mapper) and at the end of the course, the teachers presented the research proposal they will develop with students at the school.

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e) GLOBE 2022 Workshop – Codó/MA (July 22nd to July 23rd)

The course was conducted in a hybrid way with theoretical and practical classes held in the city of Codo, Maranhao Estate. Protocols, theoretical introduction, videos and activities for the classroom and other educational materials were made available to teachers through the AEB Escola Virtual platform. Forty-two Elementary and High School teachers participated in the workshop. The focus of the training was once again the GLOBE Observer protocols (Clouds, Land Cover, Trees and Mosquito Habitat Mapper) and at the end of the course, the teachers presented the research proposal they will develop with students at the school.

f) Citizen Scientist Course GLOBE Observer! (June 22th to Sep 4th.)

This course is aimed at the general public aged 13 and over who want to participate in the GLOBE Program as a citizen scientist and contribute to the dissemination of environmental and scientific education in schools and cities from all over Brazil. The course focused on the GLOBE Observer protocols (Clouds, Land Cover, Trees and Mosquito Habitat Mapper) and how people can contribute to science and the environment. 52 citizen scientists were trained in this course.

From July to October 2022, workshops were held in Umirim, Belo Horizonte and Brasília.

● **Science**

In 2021, the Brazilian GLOBE Coordination motivated teachers and students to improve their research. Therefore, the 2021 GLOBE Brazil Workshop was focus on give teaches orientations about how to build a research project based on scientific methodology. Groups of scientists, undergrad students and steam professionals were created to support the teacher to written and developed their projects. Seventeen new projects were developed from that, four were sent to the 2022 International Virtual Science Symposium (2022 IVSS).

a) Title: ECO URBANIDADE - Percepções entre o avanço urbano e meio ambiente

Date: From September 2021 to March 2022

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Location: Obidos, Para, Brazil

Number of participants: 10

Participants came from the following countries: Brazil

A brief description: The ECO URBANIDADE project aims to approach a study that helps students and teachers to analyze and develop solutions to improve or support the theme of land cover (Land Cover) seeking information, measures to deforestation and means of minimizing urban growth. unbridled, identifying their real motives and social relationships, as well as evaluating areas that include data on agriculture and livestock and other activities that seek forms of balance and urbanity between human life and its activities with the environment. To expand the discussion, the project presents an environmental study to support the expansion project of the IFPA (Federal Institute of Education, Science and Technology of Pará), bidos campus, state of Pará, in Brazil and their impacts, carrying out studies of the area surrounding the municipality of Óbidos in the Lower Amazon, bringing their environmental indicators for reflection, debate and awareness of the environment in which we live.

Organization(s): Instituto Federal de Educação, Ciência e Tecnologia do Pará

Country: Brazil

Student(s): Hanna Larissa dos Santos Penha, Jhullia Yandra Cerdeira da Silva, Jaqueline Evenly Moda da Silva, Igor de Oliveira Figueira, Lucas Gabriel Gualberto de Andrade e Samuel Douglas da Mota Viana.

Grade Level: Secondary School (grades 9-12, ages 14-18)

GLOBE Teacher: Luiz Fernando Reinoso

Contributors: Aureliano da Silva Guedes II (Cirurgião-Dentista, licenciado em Ciências Biológicas, mestrando em Gestão de Riscos e Desastres, graduando em Física), José Paulo de Almeida Junior (Técnico e Tecnólogo, Técnico em Enfermagem, Programador, Desenvolvedor de Sites, Graduando em Física) e Alex de Jesus Pinheiro (Administração - IFPA/Óbidos).

Report Type(s): International Virtual Science Symposium Report

Protocols: Relative Humidity, Surface Temperature, Land Cover Classification, Earth As a System

Presentation Poster: [View Document](#)

- b) **Title:** Relação entre fatores socioambientais e a proliferação de vetores da dengue, zika vírus e chikungunya em Paranaguá (PR) com o auxílio da tecnologia (aplicativo GLOBE Observer)

Date: From September 2021 to March 2022

Location: Paranagua, Parana, Brazil

Number of participants: 41

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Participants came from the following countries: Brazil

A brief description: Identify at Paranaguá the socio-environmental factor that facilitated the development of disease-carrying mosquitoes as for mosquitoes' focus and breeding. Looking for common places where garbage is deployed like streets, abandoned places as well spots around the city where the water accumulates are dangerous and maybe proceeding in a mosquitoes' breeding. Search for methods to increase the community interest to fight against the mosquito, elucidate them about their importance in this combat. Teach them ways to minimize mosquitoes' breeding, how they can help in data collection training them on how to use the applicative GLOBE Observer, teach them to do protocols, mosquitoes traps and tips to prevent the mosquitoes proliferation. This project wishes to merge the cases of Dengue, Zika virus and Chikungunya with the land relief, raining cycle and the population comportament.

Organization(s): Escola Estadual Faria Sobrinho

Country: Brazil

Student(s): Clase con 40 estudiantes

Grade Level: Secondary School (grades 9-12, ages 14-18)

GLOBE Teacher: Hélio Édison da Cruz Júnior

Contributors:

Report Type(s): International Virtual Science Symposium Report

Protocols: Mosquitoes

Presentation Video: [View Video](#)

c) **Title:** It got hot, it rained, and puddled the ground! The ENSO weather phenomena influence in mosquitos' positivity in Rio's summer.

Date: From September 2021 to March 2022

Location: Rio de Janeiro, Brazil

Number of participants: 5

Participants came from the following countries: Brazil

A brief description: This study investigated the increase in the proliferation of mosquito populations in Rio de Janeiro's summers comparing seasons of ENSO climatic phenomena. The years of the study are related to the occurrence of strong and moderate weather phenomena in the country: 2015 and 2016, strong cycles of the El Niño that is associated with intense rains and high temperatures and a record of diseases transmitted by the *Aedes aegypti* mosquito. The research also studied the periods of 2017 and 2018, which had moderate cycles of the El Niña climate phenomenon, despite they had caused devastating global and regional effects on the environment and on the populations of several Brazilian areas it didn't interfere the mosquito proliferation. Some weather

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phenomena, such as El Niño and La Niña, occurring repeatedly, can cause extreme events and together with human interference on the planet - deforestation, fires, misuse of land, decreased biodiversity, uncontrolled urbanization, among others, change the global climate. Normally, these ENSO weather phenomena change temperatures and amounts of rainfall in different regions of the country. There is an increase in temperature and rainfall and can have significant impacts on the country population, as can be seen in Rio de Janeiro city, especially in urban areas. Its effects can lead to exposure to extreme conditions, such as natural disasters, droughts, and floods, as well as an increase in the spread of mosquito-borne diseases. The combination of extreme global weather events, urban heat islands, population growth and poor sanitation conditions form the perfect combo for the proliferation of the most dangerous animal on the planet – the mosquito. In the case of Rio de Janeiro, in southeastern Brazil, *Aedes aegypti*, which transmits arboviruses – dengue, Zika, Urban Yellow Fever, and Chikungunya. El Niño has an impact on arbovirus cases because it causes an increase in the temperature of the environment and thus can accelerate the life cycle of *Aedes aegypti*, boosting the number of individuals and bites. The effects of El Niño phenomenon caused increased temperature and precipitation in the city of Rio de Janeiro – where floods and still water flooding were observed phenomena that evidence *Aedes aegypti* mosquito reproduction. La Niña moderate phenomenon influences the climate because it promotes abnormal change in atmosphere pressure in the Pacific Ocean, causing its cooling. These masses of air also make the atmosphere drier. That is, with less humidity it is difficult to form large clouds that cause rains, but the temperature rises. Data for the study were obtained by collecting mosquito larvae in homemade traps and weather gauges stored in GLOBE platform, official Brazilian data, and international website data. The results showed that cases of arboviruses, diseases transmitted by *Aedes aegypti*, increase considerably in years of ENSO climatic phenomena, as observed in 2015/2016, periods of very strong El Niño cycles, but in the moderate La Niña cycle, observed in 2017/2018, there was a decrease in rainfall, higher temperatures causing drier environmental conditions with low humidity. Despite the high temperatures, the reproduction of *Aedes* needs rain (water), therefore, La Niña cycle periods are not conducive to the increase of *Aedes aegypti* mosquito' proliferation. Keywords: *Aedes aegypti*, ENSO climatic phenomena, El Niño, La Niña, precipitation, temperature, breeding sites, arboviruses, life cycle.

Organization(s): Escola Minas Gerais

Country: Brazil



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Student(s): Minas Gerais School Science Club: Juliana Karina Villela, Andrea Silva, Camille Santos, Luís Eduardo Cordeiro de Freitas.

Grade Level: Middle School (grades 6-8, ages 11-14)

GLOBE Teacher: INES MARIA MAUAD

Contributors: Brazilian Space Agency - Aline Velloso and Erick Luiz Silva

Report Type(s): International Virtual Science Symposium Report, Mission Mosquito Report

Protocols: Mosquitoes

Presentation Video: [View Video](#)

- d) **Title:** International Virtual Science Symposium 2022 PLANTING AT HOME: My beanstalk

Date: From September 2021 to March 2022

Location: Rio de Janeiro, Brazil

Number of participants: 12

Participants came from the following countries: Brazil

A brief description: International Virtual Science Symposium 2022 PLANTING AT HOME: My beanstalk Samuel, Anthony, Theo, Ana, Magali, Henrique, Rommel Saiyd, Instituto S do Saber Prof^a Jeane de Fátima jeanedefatimab@gmail.com jeanedefatima@hotmail.com Resume: What is the best soil type for growing a bean seed? This work aims to follow the development of the beanstalk in three types of containers containing beach sand, earth and cotton. The young scientists that make up this group of scientific studies reside in several locations in Brazil. Anthony from Italy, Theo from France and Ana from Canada accepted the challenge of accompanying their development in the country they live in. The virtual meetings by google meeting weekly. Local warming, lack of food will be one of the biggest problems for humanity in 2050. Keywords: Development, Observation, Virtual Encounters. INTRODUCTION Food in the 21st century, we are facing global warming, climate change adds an increase in the Earth's temperature and the planting of food will need to be adapted. Creating home planting options such as the right soil type will benefit the family, the community and everyone alike. Beans have many nutrients and they are easy to handle with proper guidance and the creation of infrastructure we can OBJECTIVE The project seeks to provide a very specific view of scientific research, as a tool to help teachers work in groups or individually, have their own discoveries, opinions and have their own visual, sound and tactile stimuli, stimulating creativity and working in team MATERIALS AND METHODS The variety of soils, the amount of seeds that exist. Several countries distributed among 5 continents with a variety of climate, soil and

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vegetation. Differentiate the Food Desert from the Food Swamp Planting beans in different soils Planting one seed frozen and another at room temperature. What will happen? METHODOLOGY With the question Will my beanstalk sprout? The activity of planting and questioning about the types of soil, climate and vegetation around the world was carried out. The challenge was launched and the curiosity to follow the development of brown and black bean seeds placed in recipients with different types of soil through whatsapp, made the interaction of the study group surprise expectations. Planting in cotton, earth and beach sand. Daily photo follow-up by the study group. Planting in a diaper, Theo's idea, as he has a little brother, piqued everyone's curiosity and to our surprise the borotu beans first in the diaper than on the ground. What's up? How to explain such a curious fact. We highlight the wetness of the diaper that provided the budding. He put the bean seed in the ground, covered a lot, we are waiting for it to appear.... we are waiting. Rommel Saiyd fulfilled his frozen and room temperature acerola challenge. The vast majority were in the crowd for the frozen one to sprout first, but the room temperature one appeared all partying showing that it was the first. So far, the frozen one has not sprouted! Ana, who lives in Canada, concluded: "So that's why in winter we don't plant anything" The Story of the Cicada and the Ant was used as income for the winter. I presented the sprouting of the pineapple and its planting and the importance of the roots in planting seedlings Phases Planting the bean seed in three different pots with the following; 1 pot with cotton, 2 pot with sea sand and 3 land. Planting took place on the same day. Watch the development. Who sprouted first? Because? What factors influenced this evolution? Search for typical dishes from a region of your choice: How can technology help increase the productivity of a region? Curricular contents: Development Agriculture Organic production Integrated Protection Conservation and precision agriculture Comments: Images of students and their plantations The vegetable Ratatouille recipe was sent to those in charge so that they could make it together with the students and be able to taste it according to the movie of the same name, in which the mouse commands the chef making the critic praise the very tasty dish, sending the memories of his missing mother. Comparing to movies becomes attractive for this age group, a simple and tasty recipe. The planting carried out provided the opportunity for seasonality work, a benefit for planting at the right time, allowing for a local economy, guaranteeing nutritional characteristics and flavor. Daily processed and unprocessed foods will be made a game using Scratch The packaging and its function, the packaging made with cassava was presented, an innovation that is being studied by USP. Théo Lecarpentier is from France and Anthony Canettieri is from Italy and they take



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classes through meeting. The internet reaches everywhere connecting students around the world.

Organization(s): Brazil Citizen Science

Country: Brazil

Student(s): Samuel, Anthony, Theo, Ana, Magali, Henrique, Rommel Saiyd, Alexandre, Helena , Arthur, Heitor João Matheus TSERE

Grade Level: Middle School (grades 6-8, ages 11-14)

Teacher: Jeane de Fatima Moreira Branco

Contributors: Jeane de Fatima Moreira Branco

Report Type(s): International Virtual Science Symposium Report

Protocols: Earth As a System

Presentation Video: [View Video](#)

Presentation Poster: [View Document](#)

In 2022, we resumed face-to-face activities and the 1st half of 2022 we were training teachers and citizen scientists. In October of 2022, in conjunction with funding obtained by the U.S. Fulbright Program, Dr. Russanne Low, Institute for Global Environmental Strategies, Arlington, USA, partnered with AEB in the development of initiatives designed to increase capacity and reach of GLOBE Brazil and the creation of a land cover change education module for use with educators as well as high school students in Brazil and in the USA.

- **Community**

The community activity was very restricted during the critical periods of the pandemic. Community face-to-face activities were only possible by December 2021. In 2022, GLOBE teachers from all over Brazil restarted their research projects and community involvement. Here are some activities for communities promoted by the Coordination of the GLOBE Program in Brazil.

a) **Title: National Week of Science and Technology - “Semana Nacional de Ciencia e Tecnologia” -**

Date: December 3 to December 10, 2021

Location: Brasilia, DF.

Number of participants: Approximately three hundred students and teachers from schools all Brasilia.

Participants came from the following countries: Brazil

A brief description:

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The National Week of Science and Technology is annual Science Exposition promoted by Ministry of Science, Technology and Innovation to disseminate the science knowledge to the population. During the event, some GLOBE Workshops were made teaching the students to use the GLOBE Observer Apps to collect data about cloud, trees, land cover and mosquito protocols.



GLOBE Workshop with students in the National Week of Science and Technology

b) **Title: “ZikaBus”**

Date: Return of Activists on February of 2022

Location: Paraná’s Coast.

Number of participants:

More than two hundred students

Participants came from the following countries:

Brazil.

A brief description:

The ZikaBus is a project of Federal University of Paraná with support of Brazilian Space Agency. The project is a lab build in a bus that go to Paraná’s coast school to teach about the *Aedes Aegypti* Mosquito lives, procreates and spreads diseases and the Mosquito Protocol. After months without activated because the Covid-19 Pandemic, the ZikaBus returned it Parana’s school on February of 2022.

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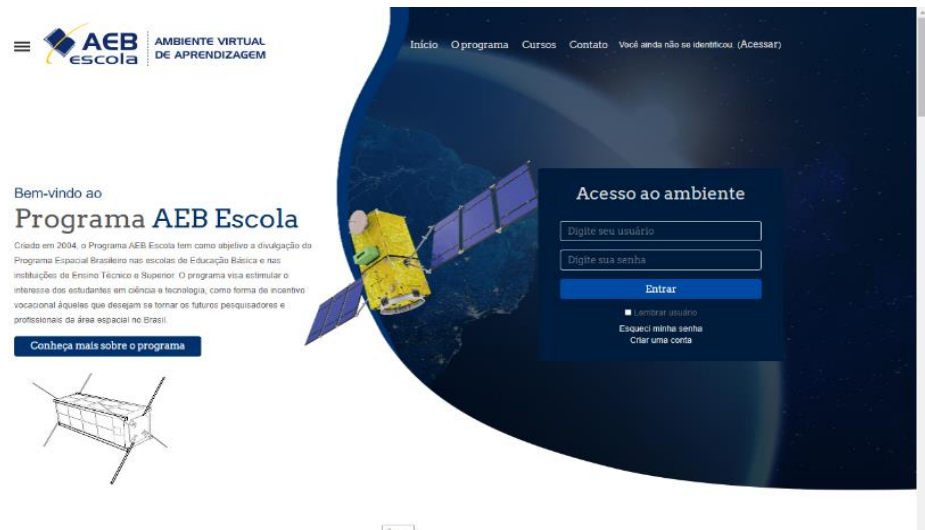
ZikaBus activates in Parana's Schools

- **Technology**

With all the advances that have been made in distance learning over the years, AEB saw an opportunity to expand, simplify and keep better track of the impact of its educational programs through the country by developing a non-profit virtual learning environment (VLE). Then, in August 2021, the idea of the new AEB Virtual Learning Environment (AEB Escola Virtual) came to life.

The platform is intended for AEB's STEAM projects, courses and various events that focus on Space Science studies for an assortment of publics, as a new tool for the agency's educational program "AEB Escola".

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AEB ESCOLA VIRTUAL HOMEPAGE.

'AEB Escola Virtual' is enable the training of various sectors of society in the space theme, sharing the knowledge of professionals in the sector with teachers and students of elementary, middle, and higher education.

The program aims it to be a facilitator in the pedagogical process throughout the execution of those usual educational activities and will allow students to learn in synchronous and/or asynchronous ways, ensuring flexibility and a more democratic mean to disseminate scientific knowledge in a country as vast and diverse as Brazil, reaching people from all regions simultaneously through technology.

It was first open to the public in September 2021 with a GLOBE Observer App workshop. A course was created in the platform for the training, where the students had access to a diversity of courseware, videos and activities adapted from GLOBE's original protocols to Brazilian schools' realities and curriculum.

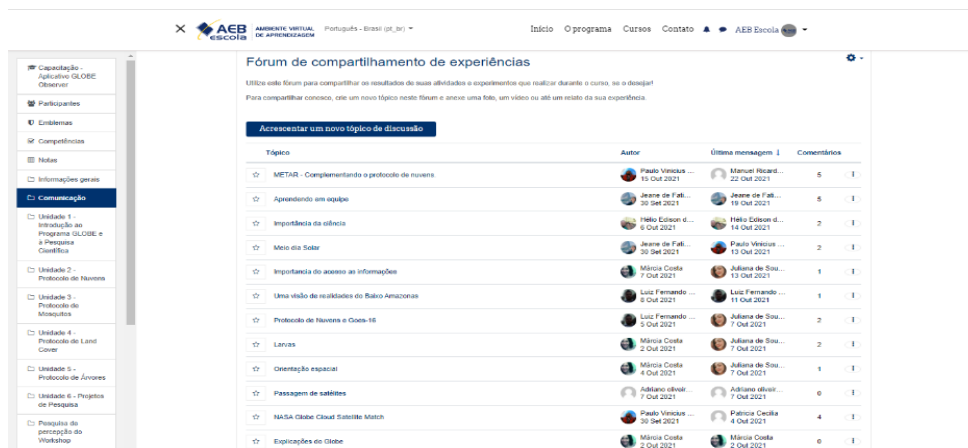


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GLOBE OBSERVER APP WORKSHOP COURSE HOMEPAGE, WITH A BRIEF INTRODUCTORY DESCRIPTION IN PORTUGUESE.

The participants were able to view message boards, calendars and, also, use the discussion and Q&A forums, that allowed them to interact with each other, with tutors and with the mentor trainers assigned. They were encouraged to use a forum destined to share the experiences they gathered throughout the workshop, posting pictures and results of their “hands-on” experiments, new findings, observations made, etc.



“EXPERIENCE SHARING FORUM” AND POSTS MADE BY SOME PARTICIPANTS, IN PORTUGUESE.

The participants, on such a challenging time for schools – with emergency distance learning, return to face-to-face classes or no classes at all,

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as it was for many schools in Brazil, could participate in the live sessions or watch the recordings later, that were made available in AEB Escola Virtual.

The courseware itself was built in the platform, although the participants could download their content. It uses a specific VLE resource that mimics the structure of an actual book, so they contain chapters and subchapters. The main advantage of the resource is that it can also carry out videos, external links and pictures that can be viewed by the user without opening another tab in the web browser, as an interactive book.



The screenshot shows the AEB Escola Virtual interface. On the left is a navigation menu with units from 1 to 6. The main content area displays '5. Exemplos de Experimentos Realizados' with a video player and a form for recording observations. The form includes fields for 'No. armadilha:', 'Responsável:', 'Turno:', and 'Data:'. Below the form, there is text describing the experiment and instructions for observation.

EXAMPLE OF HOW THE USER CAN WATCH A VIDEO THROUGH THE BOOK.

- **Communications**

The Communication was made by AEB the social medias, website and virtual platform:

Site: <https://www.gov.br/aeb/pt-br/acoes-e-programas/aeb-escola-1/programa-globe>

Facebook: @agenciaespacialbrasileira

Instagram: @agenciaespacialbrasileira

AEB Escola Virtual: <https://aebescolavirtual.aeb.gov.br/>

- **Plans and Ideas for Next Year:**



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For July 2022 to July 2023, many activities are being planned. So far, October 2022, three workshops have been held in the cities of Belo Horizonte, Umirim and Brasília. Support the research at schools will be one of the main focuses throughout 2023.

a) Land Cover Reseach in Obidos

In conjunction with funding obtained by the U.S. Fulbright Program, Dr. Russanne Low, Institute for Global Environmental Strategies, Arlington, USA, partnered with AEB in the development of initiatives designed to increase capacity and reach of GLOBE Brazil and the creation of a land cover change education module for use with educators as well as high school students in Brazil and in the USA. These projects have been initiated during the period of performance identified above and will continue over the course of the next year. During the period of performance, Low supported three different projects that are building infrastructure for AEB's GLOBE Brazil Program, A-C, described below.

I. Development of AEB Escola/IGES Educational Activity.

The Adopt a Pixel: Exploring Land Cover Change in you Community project is designed to support data-intensive remote sensing education of teachers and students. The final product will be a 3-week module posted on the AEB Escola Learning Management System platform. From September 24-October 1, Low and Sousa completed the fieldwork portion of the project in conjunction with a 4-day workshop with 40 students at the Federal Institute of Para, Obidós.

One of the activities we introduced to the students was land cover analysis using the cloud-based classification portal, Collect Earth Online <https://collect.earth>. Collect Earth Online is made available to scientists and the public by USAID, SERVIR, and NASA, among other sponsors. Our objective was to provide Obidós students real research tools for use in their own investigation of land cover changes in and around their city. The project provides a compelling context for developing quantitative and computer literacy skills. All students at the Federal Institute at Para take courses in environmental science, so they already have been exposed to the background science to understand changes in the Amazon. It is anticipated that these students will continue their research and submit it to the AEB science fair. Work completed by these students will be used as part of a model investigation in a land cover change module that will be developed by Russanne Low, Erick Luiz Sousa, and other students over the next several months.

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Figure 1. Summary of field project, Federal Institute of Para, Obidos

There are 5 steps planned for development of this project.

1. Data collection and analysis in an Amazonian city by students (model data for use in the activity) (near completion)
2. Development of background information and educational activities to support student understanding of Amazon land cover change and principles of remote sensing (Erick completes this as part of his MSc thesis)
3. Development of place-based data activity that engages students in the collection of data in situ in their own community. Students conduct an analysis of data from their own community, following steps modeled using the Obidós data as an example.
4. Creation of student data activities for module (3-week module)
 - a. Describing the landcover observed in their pixel
 - b. Statistical analysis of accuracy of student project (confusion matrix analysis of selected points)
 - c. Examining change in their pixel over time, using time series data from Landsat, 1984-present.
 - d. Comparing and contrasting ground-based observations with model-generated land cover data, WorldCover map (Sentinel 2 data, 2020) within their pixel
 - e. Completing a research project that focuses on the data story associated with the analyzed pixel
 - f. Submission of project to AEB science fair, GLOBE IVSS is supported in appendix of lesson.
5. Integration of the data analysis workflow into an interactive module on the AEB Escola platform. (Filipe Guimarães, (aeroespacial.gm@gmail.com) will develop code as part of undergraduate honors thesis, Maria Cecilia Pereira, UFMG supervising scientist).

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6. Formatting and publishing module on AEB Escola platform (Erick Sousa)
7. Evaluation of product (Masters student, education)
8. Cloning and translating module for publishing to stateside platform (Low).
9. International online science experience for Brazilian and US students, collaborating on research using the completed Adopt a Pixel module.

During the period of performance, we completed step 1. A detailed breakdown of how this was accomplished follows.

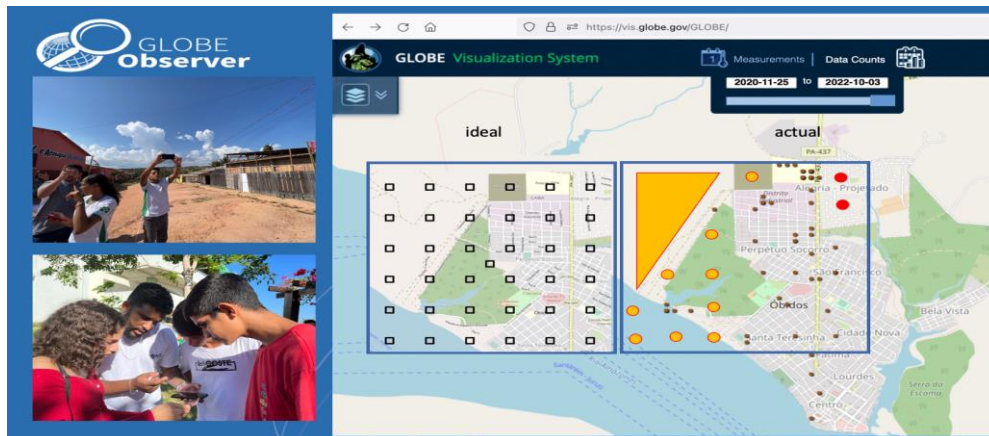
II. Obidós Student Research Component: Exploring Landcover change across Brazil

1. Design of data-rich educational activity for high school students that engages them in exploration of remote sensing science, fosters deep understanding of the importance of the Amazon rainforest to biodiversity and global climate, as well as the importance of sustainable development of the Amazon rainforest to Brazil's economy.
2. The educational activity models data collection and analysis of data from a small community in the Amazon, Obidós, Para, using land cover data obtained from this location using the GLOBE Observer Land Cover tool.
3. A 4-day student workshop was led by Erick Luiz Sousa (FUNCATE) and Russanne Low (IGES) introduced 40+ students from the Federal Institute of Para to the GLOBE Observer data collection tool and immersed students in obtaining gridded data describing land cover patterns in the city of Obidós. Data collection was planned for two field days, with observations made by students at predefined locations across the city.
4. Day 1: Sousa and Low visited Florista Nacional do Tapajos, ICMBio, south of Santarém. We toured the research facility which includes a 45 m observation tower that rises above the canopy, a tower for measuring gas flux and the Area 57 station. This facility provides appropriate and compelling opportunities for students to engage in learning about Amazon rainforest research and conservation. It would be an excellent site to collect land cover data in the integral forest using a systematic sampling grid.
5. Day 2: Traveled by boat from Santarém to Obidós
6. Day 3. Students obtained background information about the project and were introduced to the data collection tool. Students practiced using the tool in the school yard.
7. Day 4: Students were transported by bus to these locations and made field observations.
8. Day 5: students used the cloud-based, open access land cover analysis and classification tool, Collect Earth Online, to develop a high-resolution land cover

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description of their study site 3 km x 3 km study site at 10 m resolution). The analysis of the satellite imagery examined on the platform was enhanced using ground-based photos obtained during fieldwork, to resolve ambiguous features observed in the satellite images.

9. Unfortunately, a regional power outage limited the ability of the students to complete the project on day 6, because we lost a full day of work. We will be working with the students and the educator, Luiz Reinoso, to complete the data collection and analysis tasks. There are two remaining data points to collect, both immediately adjacent to the school yard. Students will complete one additional day in the lab using Collect Earth Online, so that all data points are described by at least 3 student analysts so that error calculations can be included as part of the research design. Sousa and Low will meet with the students via Zoom to complete the workshop and support students in development of their research projects.



Ideal and actual gridded observation points, Adopt a Pixel Project, Obidós. Red dots indicate where data still needs to be collected. Yellow dots indicate places where it was not possible to collect data, due to either inaccessibility of the data collection site (dense forest) or potentially dangerous conditions for data collection (landfill, in grey; and area of illegal cutting and smallholder agriculture plots, orange triangle). Replicate data were collected by two or more students in several locations.

III. Supporting citizen science infrastructure in Brazil: collaboration with the Projeto Interinstitucional de Ciência Cidadã na Escola (PICCE) project.

Dr. Rodrigo Antes Reis, UFPR, was awarded funds from the State of Paraná to develop a citizen science project for students to be implemented in schools statewide, Low is an advisor on this project and has been meeting with the science faculty developing the protocols and instructed a graduate course

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focusing on citizen science and pedagogy, providing graduate students associated with the project theoretical background on the use of citizen science as an educational tool in formal, informal and nonformal educational settings. This work took place April-June 2022.



PICCE app mockup.

A total of 12 protocols are currently in development for use by teachers in science education at their schools, ranging from microplastics and marine debris inventories to descriptions of local biodiversity in and around school yards. This project is a direct outgrowth of the work conducted by AEB and GLOBE Brazil, who introduced Reis to citizen science in 2017, and stimulated creation of a funded project that supports student collection of data on paper and using a mobile app. This project engages 12 teams of scientists, graduate students and undergraduates in development of the program, learning materials and a mobile app. The goal of this project is to identify citizen science projects of local importance and interest, such as water quality, pollinator and medicinal plant counts, inventory of endangered but culturally important araucaria trees, student safety and health, and landslide hazards.

On an international scale, citizen science program governance seeks to ensure that data obtained by independent projects are open, interoperable, and accessible. The PICCE program is ensuring data interoperability with GLOBE citizen science data in three areas: Mosquito Habitat Mapper, Land Cover, and Trees. The strategies employed follow.

1. Mosquito Habitat Mapper. The existing GLOBE Observer Mosquito Habitat Mapper app is used as a data collection tool for PICCE's Project Aedes. Educational materials developed by the Project Aedes team are now being tested. Once published, these materials can be shared widely by the GLOBE



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- Brazil program. The educational materials include a student background book, a teacher's facilitator guide, and lesson plans.
2. The PICCE program will be collecting land cover data using the same land cover protocol as GLOBE Observer. The PICCE program requires land cover data to be collected for each study site and each protocol supported by PICCE except for the obesity protocol. These data will be formatted so that they can be submitted to the GLOBE program via an API and merged with GLOBE data.
 3. PICCE is developing a protocol to identify and monitor the endangered Araucaria tree. The Araucaria is an ancient tree that predates the dinosaurs and has an important role in both Atlantic rainforest biodiversity and culturally, by supplying forest products (edible seeds and timber). The Araucaria protocol will mirror the GLOBE Trees protocol, so that the Araucaria data can be merged with GLOBE Trees data for analysis.

Because of the attention paid to interoperability of data, the PICCE project directly supports the expansion of GLOBE Brazil's influence in schools and is expected to be an important future partner.

b) The Zika Bus.

The Federal University of Paraná obtained state funding to create a mobile teaching lab, the Zika Bus, to promote health and science education in high need, underserved communities. The bus also promotes the use of the GLOBE Observer Mosquito Habitat Mapper in its onsite programming during mosquito season. The Zika Bus is a direct outcome of the funding supplied by USAID 2016-2019 to IGES (R. Low, PI) for the testing of the GLOBE Observer Mosquito Habitat Mapper following the onset of the Zika epidemic (2015) in Brazil. The GLOBE Observer Mosquito Habitat Mapper app, associated educational materials, and hardware provides the backbone of educational programming. The COVID-19 epidemic delayed site and school visits until spring 2022, when the project was officially launched.

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UFPR's Mobile Education Classroom, the Zika Bus, the graduate student team, and educational resources developed for teachers to support use of GLOBE Observer Mosquito Habitat Mapper data.

A concrete outcome of this work has been to begin steps to integrate scientists working with the Zika Bus and PICCE more into the GLOBE Brazil team. UFPR has trained several graduate students that are able to now serve as local GLOBE trainers. These include Dani Hostin, who has experience with Mosquito Habitat Mapper, Land Cover and Trees, and Michele, who is a PhD student and teacher in Paranagua, who has engaged students in Mosquito Habitat Mapper projects for several years. In particular, Dani Hostin serves as the coordinator of the graduate student team delivering Zika Bus programming. Her research project involves using serious games (scientific games) as a modality to teach science. She will be testing a serious game as part of the Zika Bus programming.

c) 1st GLOBE Program Brazil Meeting

In this, students from all over Brazil will have the opportunity to present the research carried out in 2022. The 1st GLOBE Program Brazil Meeting is planned to take place in November 2022, It will be another way to prepare teachers and their students for VISS 2023.

d) Online and hybrid workshops

Further online and hybrid workshops are planned to take place in 2022-2023.