

# NASA Earth Science Education Collaborative (NESEC)

**IGES - Goddard – Langley – Jet Propulsion Laboratory**

**Presentation to National Academies Assessment Committee**

Theresa Schwerin, NESEC PI

Vice President, Education

Institute for Global Environmental Strategies (IGES)

# NESEC Vision

NESEC is enhancing STEM teaching and learning by creating engaging, meaningful, and **authentic STEM experiences and resources** that are based on **NASA Earth science**, tailored to specific **audiences based on their needs**; as a whole reach **diverse learners throughout their lifetimes**; and delivered broadly through **strategic partnerships**.

NESEC Operational Model: Develop – Disseminate - Supp

Enable STEM Education in all 50 States– Document benefits/improvement of including NASA SMEs, content, and authentic experiences to learners of all ages	Improve US Scientific Literacy	Advance National Educational Goals- Supporting Co-STEM goal achievement by 2020	Leverage Through Partnerships – Document benefits/improvement of including NASA Science and collaborative approach
<p><b>Expand participation in NESEC offerings to all 50 states</b> from 2016 to 2020. These include GLOBE Observer, GLOBE field campaigns, and NASA Science Investigations (using GLOBE and NASA Earth system science content)</p>	<p><b>Increase the number of individuals who have the opportunity to actively engage in scientific processes.</b> Achieve 100,000 citizen scientists participating in GLOBE Observer with users in all states, from 2017 baseline (U.S.).</p>	<p>Increase and sustain youth and public engagement in authentic STEM experiences by <b>increasing the number of authentic STEM experiences available for participation from 3 in 2016 to &gt;9 in 2020.</b></p> <p>(Experiences include student research campaigns, GLOBE Observer protocols, data challenges, etc.)</p>	<p>Increase the number of <b>Sustained external partners</b> from 0 in 2016 to 2 sustained partnerships in 2020 (signed letters of agreement).</p>
<p><b>Improve access to resources</b> that support NASA authentic STEM experiences a) increased number of online resources available with NASA Earth science content and SMEs from 10 in 2016 to 50 in 2020; b) expanded use of these resources to all 50 states from 2016-2020.</p>	<p><b>Percentage of repeat users</b> of GLOBE Observer relative to all users increases by 10% in 2020 over 2017 baseline.</p>	<p>Increase number of U.S. student research projects based on NESEC offerings from 2017 Baseline of 31. 2018, this was increased to 179 student research projects. (GLOBE U.S. student research projects, Girl Scout Journeys, Clouds Junior Researchers)</p>	<p>Efforts are underway and will expand in year 4 to identify and engage additional external partners with mutually-beneficial goals that will help further NESEC impact and reach.</p>
<p><b>Increase engagement of NASA SMEs</b> with participants (# and contact hours) compared to 2017 baseline</p>			
<p><b>Document indicators of scientific research and applications</b> that utilize GLOBE</p>			

# Team, Partners and Evaluator

## Team

### **Institute for Global Environmental Strategies**

Theresa Schwerin, PI

### **NASA Goddard Space Flight Center**

Dr. Trena Ferrell, Co-I  
Holli Kohl, GLOBE Observer Coordinator

### **NASA Jet Propulsion Laboratory**

Susan Callery, Co-I

### **NASA Langley Research Center**

Jessica Taylor, Co-I

## Partners and Collaborators

- The GLOBE Program
- GLOBE Implementation Office and DIS
- Association of Science-Technology Centers (ASTC)
- 4-H
- Odyssey of the Mind (OoTM)
- SciStarter/Girl Scouts
- Smithsonian Educator Resource Center
- Cross-Collaborations with the SciAct collective

## Evaluator

Oregon State University –Dr. Heather Fischer, Dr. Martin Storksdieck  
With thanks to Dr. Ann Martin (original evaluator)

# NESEC Activities: Three Interrelated Areas



## Citizen Scientist Observations of

- Clouds
- Mosquito Habitats
- Land Cover
- Trees
- Eclipse (2017, 2019)
- Fire Fuels (coming summer 2019)



## NASA Investigations with GLOBE

- U.S. Air Quality
- Trees Around the GLOBE
- GLOBE Mission Mosquito
- Clouds/Contrails Jr Researchers
- Girl Scouts Journey: Think Like a Citizen Scientist
- ENSO (ended 2018)

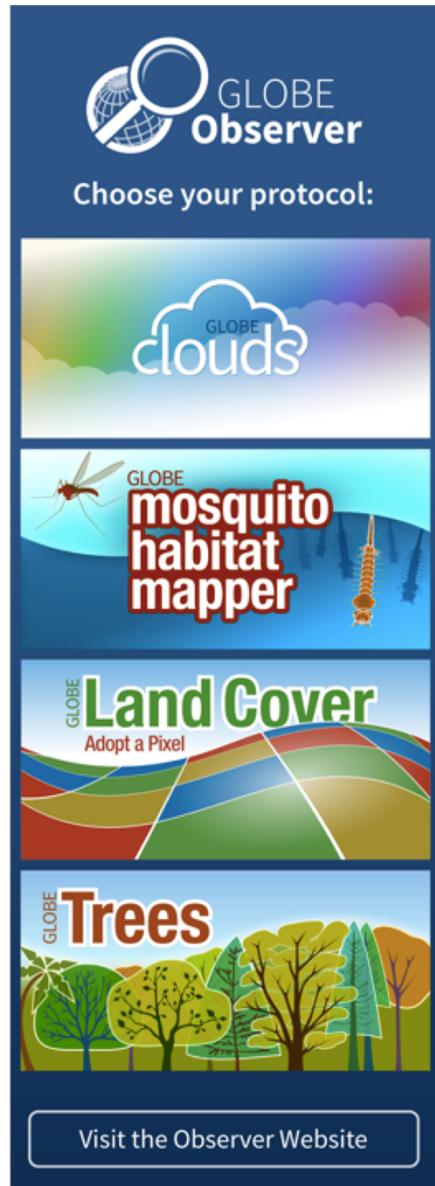
## Strategic Partnerships & Collaborations

### Strategic Partnerships

Extend NESEC offerings to strategic audiences (e.g., SciStarter, Girl Scouts, 4-H, ASTC, ACA, Smithsonian, Oscher LifeLong Learning Institute)

### Collaborations within SciAct

Connect to NASA Earth Assets;  
Leverage SciAct networks/expertise;  
Contribute to SciAct Working Groups



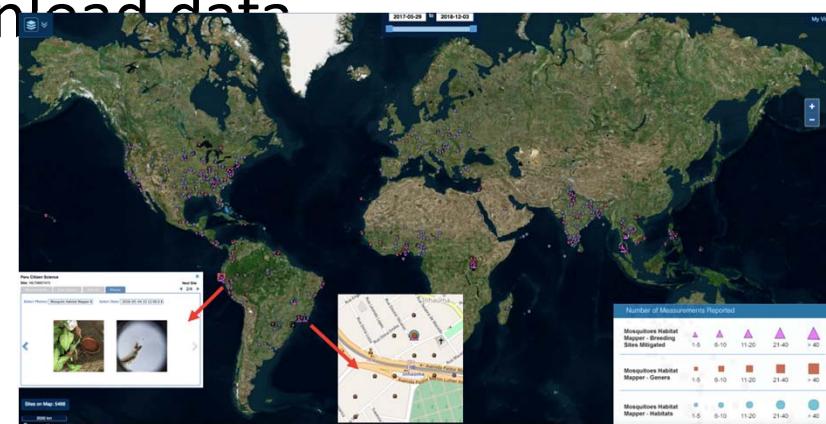
**GLOBE Observer**  
Choose your protocol:

- clouds
- mosquito habitat mapper
- Land Cover  
Adopt a Pixel
- Trees

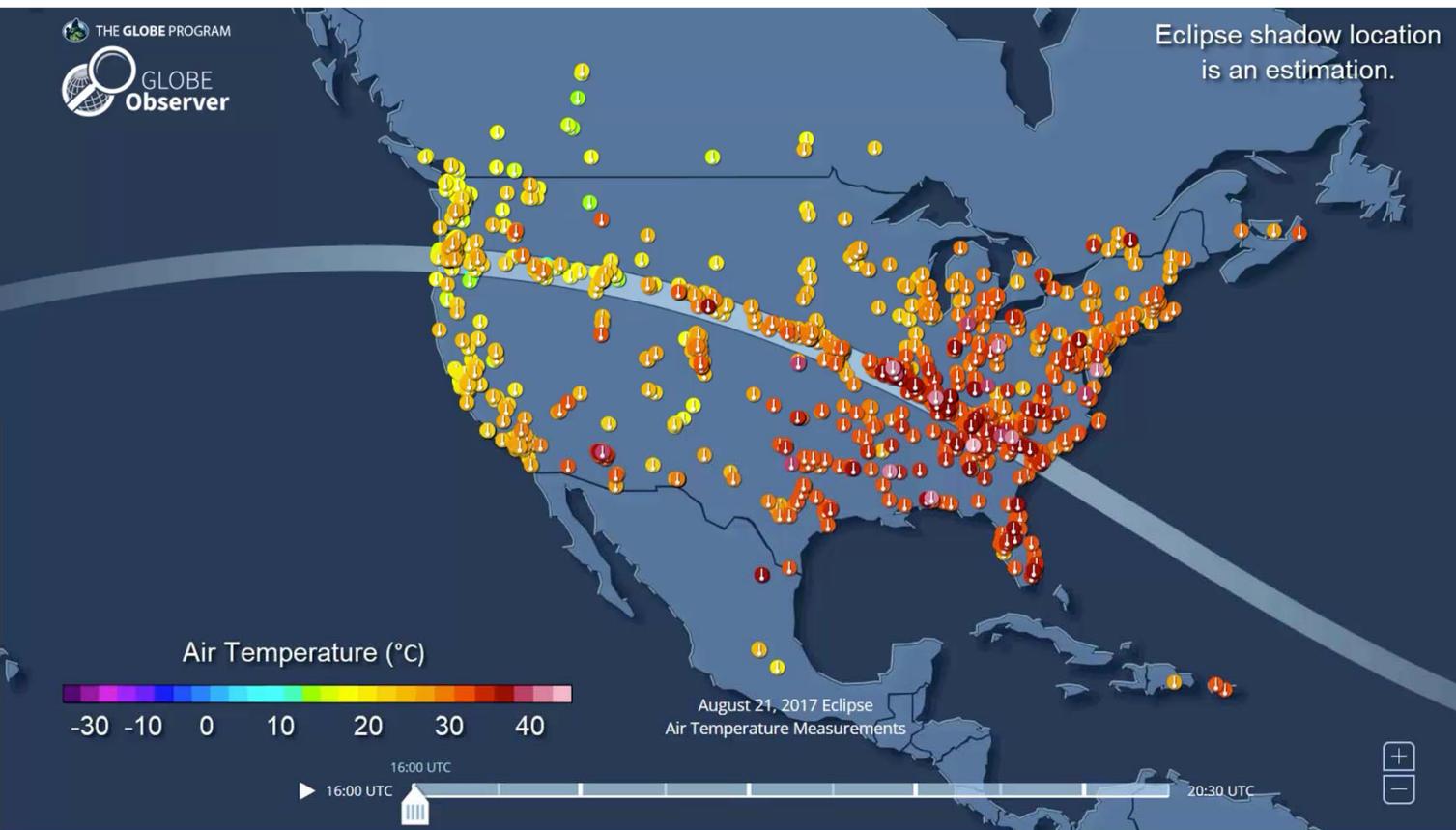
Visit the Observer Website

# GLOBE Observer Citizen Science

- Protocols support NASA Science
- Free mobile app
- Email address registration
- In-app training
- Guided protocol or expert mode
- Visualize and download data



Coming Summer  
2019 Fire Fuels



>100,000 observations of sky conditions and air temperature using GLOBE Observer throughout the day.

## Related Research:

Dodson, J. B., M. Colón Robles, J. E. Taylor, C. C. DeFontes, and K. L. Weaver (2019).

***Eclipse Across America: Citizen Science Observations of the 21 August 2017 Total Solar Eclipse.*** Submitted to *J. Applied Meteorology and Climatology*.

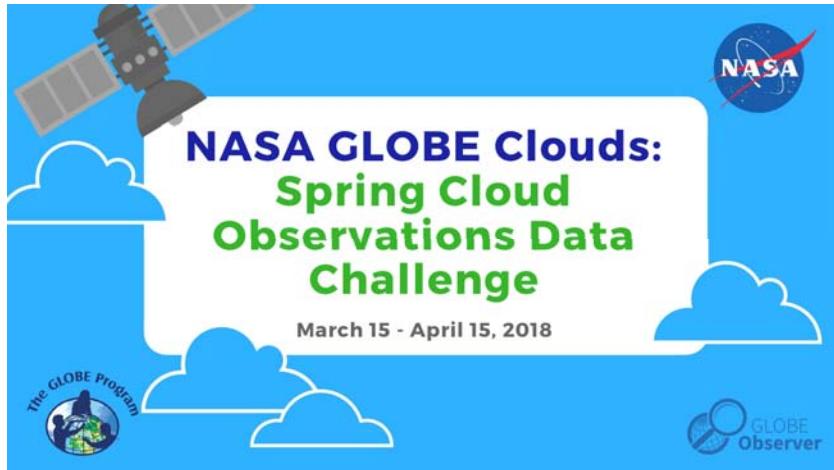
Rahman, I., Czajkowski, K., Jiang, Y., and Weaver, K. ***Effect of The Great American Solar Eclipse on Local Weather: A Study on The GLOBE Citizen Science Data Set***, presented at American Association of Geographers Annual Meeting, April 3, 2019

**Research by Rahman, et al is also a chapter in** the Astronomical Society of the Pacific Conference Series book **“Celebrating the 2017 Great American Eclipse: Lessons Learned from the Path of Totality.”**

***Effects of the Great American Eclipse on Surface Temperatures***, Huntington High School, GLOBE Student Research

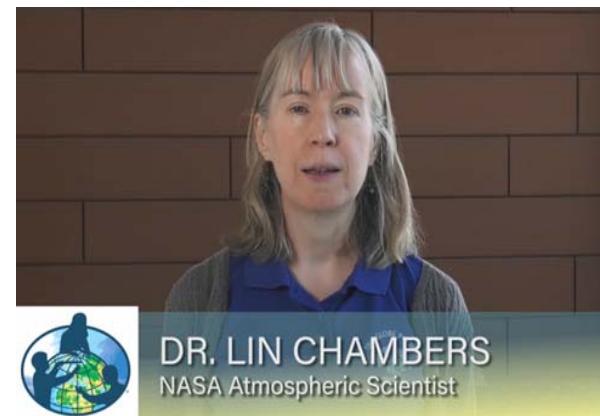
***Analysis of Data Collected During the 2017 Solar Eclipse at Eighty Percent Totality***, Crestwood High School, GLOBE Student Research

# The Power of Data Challenges



## 2018 Spring Clouds Data Challenge (Mar 15-Apr 15)

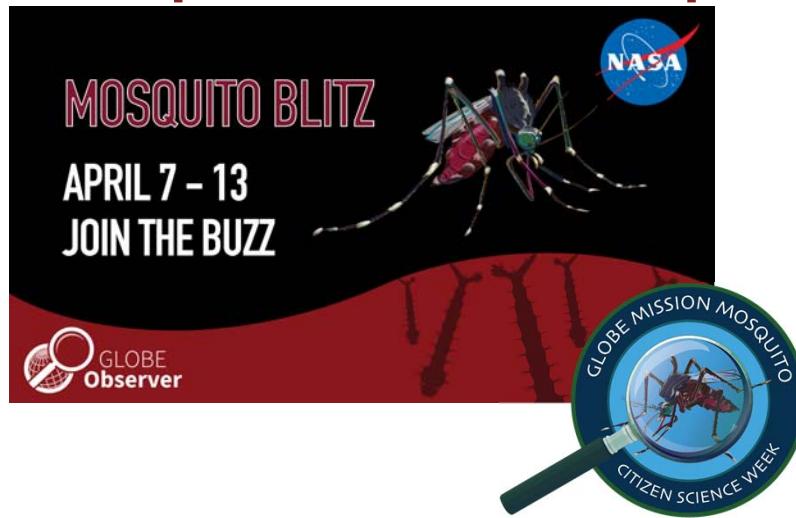
- 56,500 submissions, with >120,000 cloud photos
- 15,000 locations in 99 countries, including every continent
- Over 33,700 of the observations were matched to satellite data by the NASA Langley team.
- A news feature on nasa.gov received over 41,000 views and produced over 130 news articles



<https://www.nasa.gov/feature/langley/nasa-to-cloud-gazing-citizen-scientists-job-well-done>

# Current Data Challenges

## Mosquito Blitz Week April 7-13, 2019

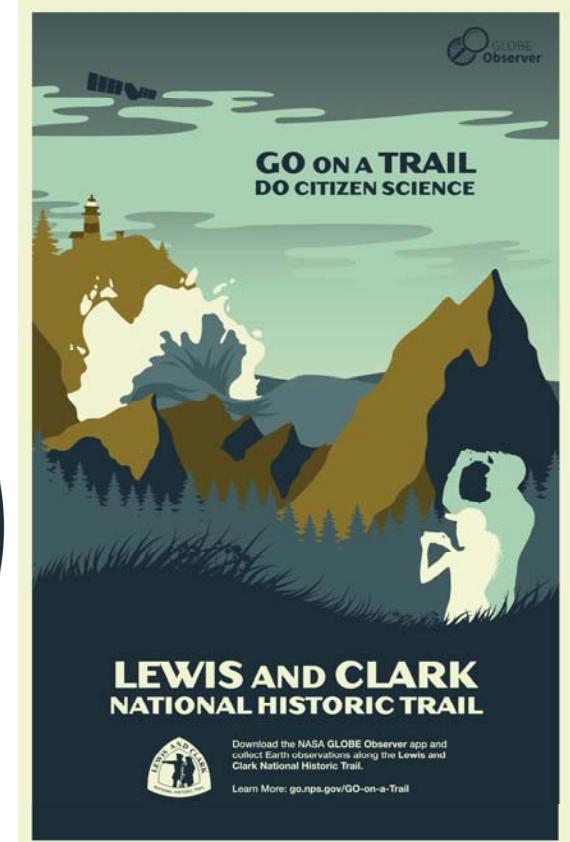


- Find Places water has collected
- Photograph and note if larvae present
- Eliminate the water
- Upload observations

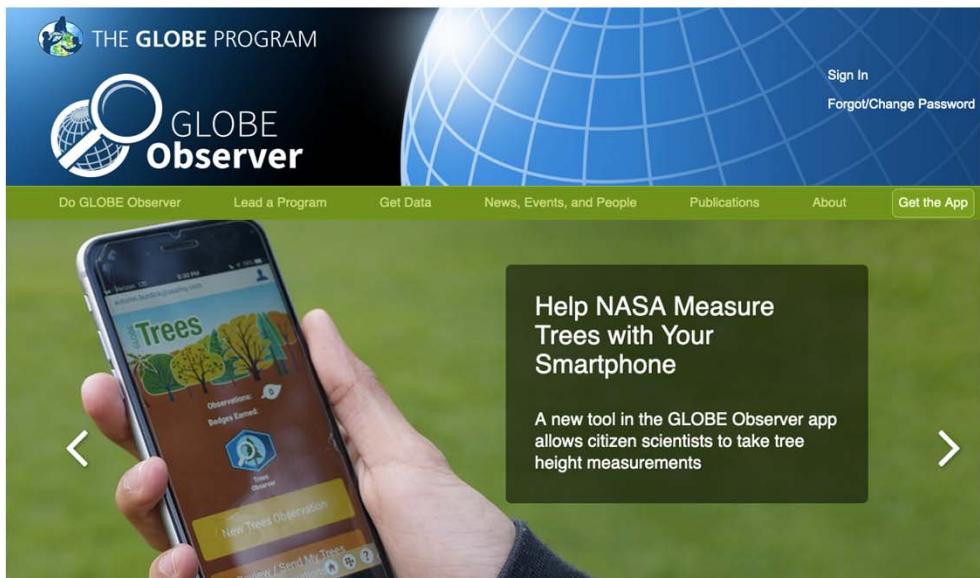
GO on a Trail  
June 1 – Sept 2



<https://observer.globe.gov/do-globe-observer/challenges>



# GLOBE Observer Website and Toolkits for Informal Educators



Resources for citizen scientists, informal educators, and professional scientists

Toolkits are being field tested with libraries, camps, museums. Case studies and programming resources for specific settings are being planned.

## TOOLKIT for INFORMAL EDUCATORS

Connect your organization's mission to real-world science by introducing visitors to GLOBE Observer, an app-based citizen science project. GLOBE Observer can be integrated into programming at museums, science centers, zoos and aquariums, parks, public gardens, libraries and more. Simply engage visitors with a smartphone or tablet, integrate GLOBE Observer into an existing talk or demo, or create a new cart or event centered around the app.

It's easy to get started with GLOBE Observer. Simply [download](#) the app, register for an account and plan your program using the resources included below. In this toolkit, you will find information, activities and resources for each of the app modules. In the [Advanced](#) section, you can find more information on topics such as organizing an event and becoming a GLOBE partner. Have a question? [Contact us](#).

### Choose Your Protocol





# Extending reach and featuring NASA scientists through Social: Examples from Trees Rollout March 25, 2019



**SnapChat/Instagram/Facebook Story (left)**  
**Reached over 2.1 million people with**  
Tuesday's (3/26/19) Trees featured **7 NASA**  
**subject matter experts**

**YouTube** (below): Trees video demonstrating how to use the app has over **5k views on**  
**Youtube**, over **8K on Facebook**, and over **4K**  
**on Twitter** (and building).



**Facebook Live on March 26**  
**reached over 84.8K and**  
**featured**  
**5 subject matter experts** for  
trees research at NASA



**NASA Earth was live.**  
Published by Autumn Burdick [?]. March 26 at 12:02 PM ·

We are talking **NASA GLOBE Observer Trees** with NASA scientists! Ask us your questions about trees, and NASA missions (**#icesat2** and **#gedi**) by dropping them into the comments box and we will try to answer them **LIVE**.

# NASA Investigations with **GLOBE**

These GLOBE Campaigns engage educators and students through webinars and direct interactions with NASA scientists, educator resources, intensive observing periods, technical support and mentoring for student research.



## U.S. Air Quality Observations

Scientist: Dr. Margaret Pippin, LaRC

Mentors teachers and students collecting aerosol data that Pippin uses in her research and students use for research projects.

**Started 2016**



## K-12 Student Research Campaign

Coordinator: Brian Campbell, GSFC

Scientist: Peder Nelson, OSU

Observations support NASA ICESat and GEDI Missions

**Started September 15, 2018**

## **GLOBE** **Mission Mosquito**

### K-12, Informal Ed, and Citizen Scientists

Coordinator: Dorian Janney, GSFC

Scientist: Dr. Rusty Low, IGES

Contributing to updated phenology map of N. America;

Observations will support NASA applications/numerical models, potential application for public health

**Started Oct. 2, 2018**

# NASA Investigations with GLOBE



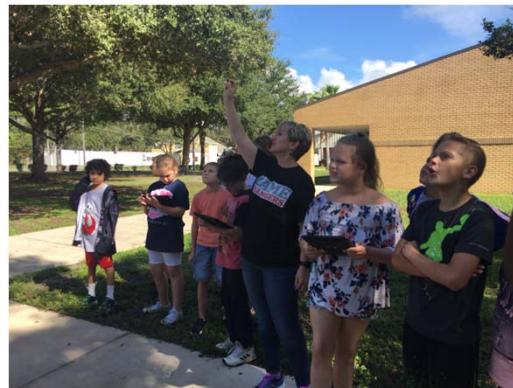
GLOBE Observer Clouds and Mosquito Habitat Mapper are two of seven projects that **Brownie Scouts (K-5)** can select for their Think Like a Citizen Scientist Journey.

GSA completed testing of K-5 Journey, have started professional development with Councils. Plans are to begin **piloting with older scouts later in 2019**.



Above: Rusty Low, IGES, video for Girl Scouts Journey explaining what they will do and why their observation are needed

## GLOBE Clouds Junior Research Team: Contrails Investigation



Student teams collect contrail data for NASA LaRC scientists starting fall 2018.

Junior Researchers are asked to make observations during the fall and develop a research project in the spring GLOBE Student Regional Symposia or International Virtual Student Symposia.

Five U.S. teams, one Thailand team.

*"Technology as a tool is incredibly motivating. Having NASA as a learning partner is also a strong motivator. My students rotate through their science investigation teams daily to make sure their cloud and contrail observations are completed with accuracy and that NASA receives the data in a timely manner.... In our second quarter the county assessment testing showed a 76.83% mastery of the objective that we just could not seem to meet before our participation in GLOBE."*

Caryn Long, Teacher, Treadway Elementary

Right: Marilé Colón Robles "Zooms" with students at Treadway Elementary



# NASA Investigations

## QUICK START GUIDE To Finding Data/Imagery for Student Investigations

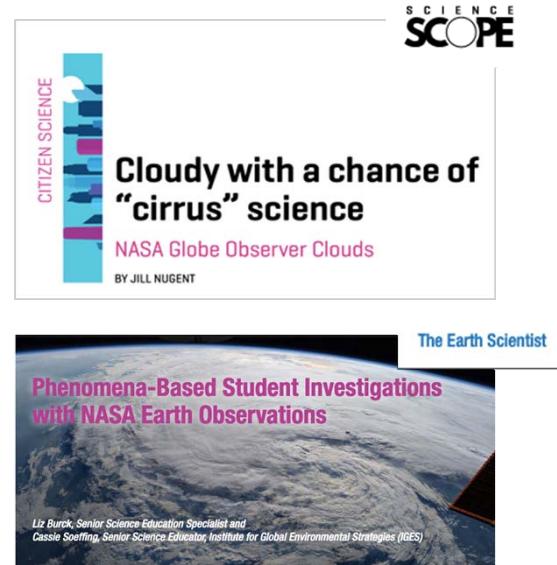
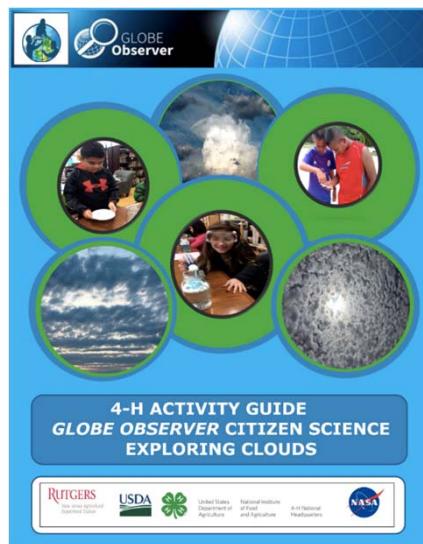
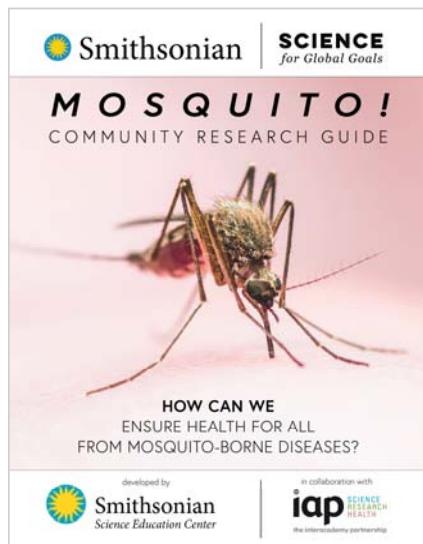


This table lists examples of NASA datasets and imagery that could be used for student investigations related to content and practices in the *Framework for K-12 Science Education*. Explore the data on the left using the online sources listed on the right. Many datasets are available through multiple sources; each source provides unique features, analytical tools, and time periods. Sources are color coded for relative level/ease-of-use: BLUE (introductory), ORANGE (intermediate), and GREEN (advanced).

Supporting student investigations of phenomena with NASA data

Data examples that <i>students</i> can use...	...to investigate these types of phenomena...	...using these online sources of data.					
		Precipitation Measurement Missions <a href="https://pmm.nasa.gov/data-access/visualization">https://pmm.nasa.gov/data-access/visualization</a>	NEO • <a href="http://neo.sci.gsfc.nasa.gov">http://neo.sci.gsfc.nasa.gov</a>	Google Earth Engine Time Lapses <a href="https://earthengine.google.com/timelapse">https://earthengine.google.com/timelapse</a>	The GLOBE Program • <a href="https://www.globe.gov/globe-data">https://www.globe.gov/globe-data</a>	MY NASA DATA • <a href="http://mynasadata.larc.nasa.gov">http://mynasadata.larc.nasa.gov</a>	Change Matters Viewer <a href="http://www.esri.com/software/landsat-imagery/viewer">http://www.esri.com/software/landsat-imagery/viewer</a>
Aerosols: Tiny liquid or solid particles dispersed in the atmosphere; can be caused by natural processes or human activity.	Air quality and pollution (ESS3.C) Earth's energy budget (ESS2.A) Weather & climate (ESS2.D)	■	●	■	●	●	●
Black Marble/Earth at Night: Nighttime view of Earth, showing visible light emanating from man-made sources, e.g., city lights.	Urban growth/heat islands (ESS3.C) Power outages (ESS3.C) Seasonal migration (LS2.C)				●		●
Blue Marble Next Generation: Composite images showing how the surface would look to a human in space if our world had no clouds and no atmosphere.	Seasonal changes on land surface (spring greening, snowmelt, drought, etc.) (LS2.A, ESS2.D)		●				●
Climate: Solar Insolation, temperature, precipitation, albedo, greenhouse gases/carbon, aerosols, and topography.	Factors contributing to global and regional climate (ESS2.D)		●		●	●	●
Earth System: Solar insolation, surface temperature, cloud fraction, aerosols, precipitation, and vegetation index.	Earth system and cycles (ESS2.A)	●	●		●	●	●
Land Cover Classification: Maps displaying the Earth's natural and human-made landscapes as color-coded categories.	Land cover changes (ESS3.C, LS2.C)		●		●	●	
Land Surface: Since 1972, Landsat satellites have been observing Earth's land surfaces and coastal regions. MODIS Near-Real-Time Data: Data for applications related to natural hazards and disasters (e.g., volcano ash plumes, drought, fires, severe storms, and sea ice conditions).	Coastline changes (ESS2.C) Deforestation (ESS3.C) Ecosystems (LS2.C) Natural hazards & disasters (ESS3.B) Sea ice movement (ESS3.B) Water & land use changes (ESS2.C)			●			●

# Partnerships and Collaborations: Examples and Products



## Odyssey of the Mind

Thousands of students, coaches and parents meet NASA subject matter experts at NASA sessions at Odyssey of the Mind World Finals organized by NESEC. NESEC has also developed a NASA collection of creativity and problem solving resources for OoTMers. These include NASA practice problems and a collection of resources featuring NASA people and resources pointing to how NASA scientists and engineers jumpstart the engineering process



# Partnerships and Cross Collaborations

## NESEC Supports the NASA SciAct and NASA SciAct Supports NESEC

NESEC is often in an active advisory role with respect to SciAct partners, providing subject matter expertise, review, content alignment to NASA Earth Science assets and priorities, and content co-creation.

Rich, ongoing collaborations with:

- NISE Net
- NASA@ My Library
- Arctic and Earth SIGNS
- GLOBE Mission Earth
- AREN
- SEES/UT-Austin
- NASA eClips
- Earth to Sky

NESEC Supported WGBH Earth System Science Modules

Right – Example from  
NISE Net 2019 Toolkits

### Exploring Earth: Land Cover (2019)



#### Description

This activity models some of the ways natural processes, such as erosion and sediment pollution, affect Earth's landscape. Data collected from satellites, such as the joint NASA/USGS Landsat satellites, help improve our understanding of Earth's land cover. Orbiting Earth, these satellites monitor changes to land cover to help scientists predict changes due to runoff and erosion, and plan for the future.

The collective is a powerful dissemination network to connect our content to audiences

Monthly tagups, workspace (smdepo.org) enable to learn about SMD-wide activities, opportunities, others work, and to share our work

NESEC Team members participate fully on all SciAct Working Groups (Girls & STEM, Native American, Ed Tech, Visualizations)

**Map Your Backyard Land Cover!**

Let's make a land cover map. You can use your backyard or a park or any area outside that you can sketch out the overall shape and then divide it into smaller areas. You can use a grid or a piece with colored covers if you need to. Use two steps for each square to cover a bit more ground.

1. Are you moving along, notice what's covering the ground? Is it grass, trees, rocks, or water? What is it?

2. Are you moving along, notice what's covering the ground? Is it grass, trees, rocks, or water? What is it?

3. Move back over the land and carefully draw or write what the land cover looks like on the grid to the right. Are you moving along, notice what's covering the ground covered in each of the land cover categories below?

**RESULTS**

COLOR	DESCRIPTION
Green	Grass, flowers or plants
Yellow	Trees, shrubs, or bushes
Red	Rock or sand
Blue	Water
Orange	Concrete or pavement

Join a community of participants working with NASA to collect land cover data from around the world. From above, NASA's Global Observers app allows users to contribute place data from anywhere in the world. Learn more at [observer.globe.gov](http://observer.globe.gov)



# Evaluation: Oregon State University

- Provide strategic guidance to the NESEC team on project focus and productive connection to external partners;
- Provide support for product and program development based on conceptual and empirical evidence; and
- Provide evidence for project reach and impact, focused on goals and metrics that align with key goals that are guiding the overall NASA SMD Science Activation program.

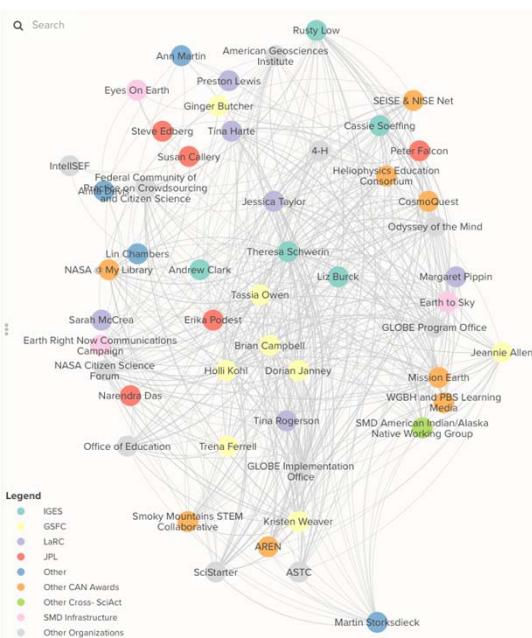
*Note: Evaluation in years 1-2 focused on front end-user needs assessments and formative evaluation activities.*

# OSU Evaluation Studies

## Understanding Participation

### 1. Social Network Analysis of NESEC Team and Partners

Creating a Connected System of Partners



### 2. Volunteer Survey: "Nibble and Drop"

Understanding volunteer motivations, participation, and user experience.

Random, stratified sample of 4,000 (75,000 N. American)

>1,000 responses (Jan 31-March 31) OSU is analyzing data for peer reviewed publication.

### 3. Scientist Engagement Framework

Developing and testing framework for scientist data discovery boot camps

## Understanding and Documenting Effectiveness

### 4. Scientific Value Added

Using published framework on research productivity via Citizen Science to assess GO contribution to science.

*(A Science Products Inventory for Citizen-Science Planning and Evaluation, Wiggins, et al, 2018)*

### 5. Embedded Assessments

Embedded Assessments based on performance measures; Test data quality while measuring outcomes.



## NASA Earth Science Education Collaborative (NESEC)

**PI and Institutional Co-Is:** **IGES:** Theresa Schwerin, PI; **GSFC:** Dr. Trena Ferrell, Co-I; **LaRC:** Jessica Taylor, Co-I; and **JPL:** Susan Callery, Co-I

### GLOBE Observer (GO)

H. Kohl, GO Coordinator, GSFC  
K. Weaver, GO Deputy Coordinator, GSFC

### Science Outreach (Dr. H. Amos, GSFC)

### Protocol Science Leads

- Clouds (M. Robles, LaRC)
- Mosquitoes (Dr. R. Low, IGES)
- Land Cover (P. Nelson, M.S., OSU)
- Trees (B. Campbell, GSFC)

### Communications and Social Media

(A. Burdick, SSAI)

### App Development Team (D. Overoye, SSAI)

### Toolkit Teams

Clouds (M. Robles, LaRC)  
Land Cover (J. Allen, GSFC)  
Mosquitoes (C. Soeffing, IGES)  
Designer (H. Mortimer, GSFC)

#### Note:

*This chart shows activity leads and does not include all team members*

### NASA Investigations with GLOBE

- U.S. Air Quality (Dr. M. Pippin, LaRC)
- Clouds/Contrails (M. Robles, LARC)
- Trees Around the GLOBE  
(B. Campbell, GSFC lead and P. Nelson, M.S., OSU, co-lead)
- GLOBE Mission Mosquito  
(D. Janney, GSFC lead, and Dr. R. Low, IGES co-lead)
- Girl Scouts Citizen Science Journey (T. Owen, GSFC)

### NESEC Strategic Partnerships/ SciAct Cross-Collaborations

T. Schwerin, IGES

### NASA Center SME Engagement

Dr. T. Ferrell GSFC  
J. Taylor, LaRC  
R. Zimmerman Brachman, JPL

### NASA SciAct Working Groups

Women and STEM (Lead: J Taylor, LaRC)  
Education Technology (Dr. H. Fischer, OSU)  
Native American/America Indian (J. Allen, GSFC, Dr. R. Low, IGES)  
Visualization (T. Schwerin, IGES)

### Leveraging Partners (Not funded under NESEC)

GLOBE Implementation Office (Dr. T. Murphy and K. Wegner)  
GLOBE DIS (L. Dallas)  
Earth to Sky (A. Davis, lead, and J. Giddens, co-lead)  
Odyssey of the Mind (S. Micklus)  
Association of Science-Technology Centers (W. Staveloz)  
Smithsonian Science Education Center (A. Radloff)

### NESEC Evaluation

Dr. H. Fischer  
Dr. M. Storksdieck  
Oregon State University

# Backup Slides



# THE GLOBE PROGRAM



## An International Science and Education

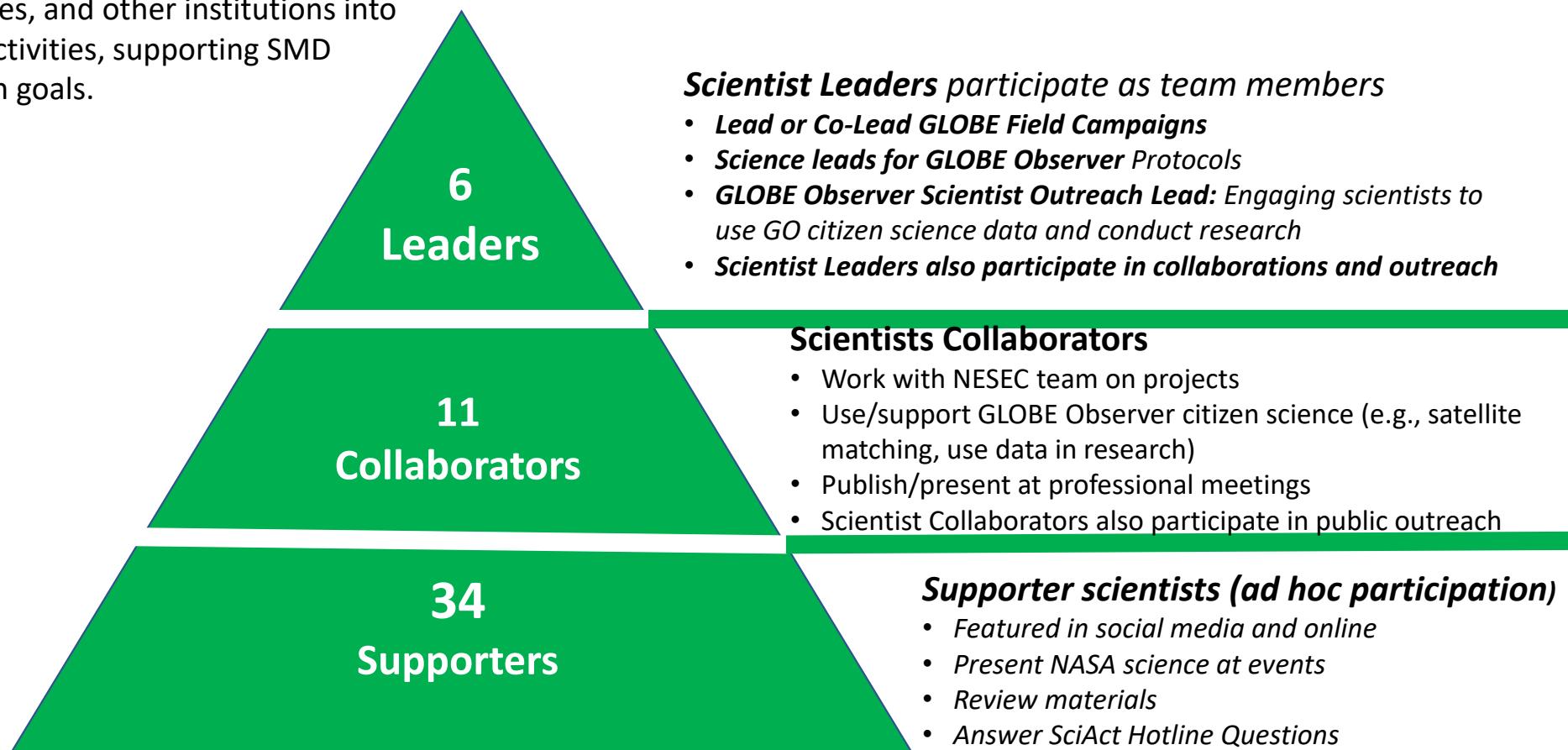
- 121** Countries
- 33,904** Schools
- 35,534** Teachers
- 130,481** GLOBE Observers
- 164,795,911** Measurements
- 114,425** Measurements this month



## 2018 Scientist Engagement

Unique to NESEC is integration of NASA Subject Matter Experts at Centers, universities, and other institutions into project activities, supporting SMD education goals.

FY 2018, [51 NASA-funded](#) scientists participated in NESEC activities  
(100% increase from 2017)



# GLOBE Observer Citizen Science

FY 2016-2018, >29,000 people had an authentic STEM Experience with GLOBE Observer

