NASA’s Education Mission

Our mission is …

To advance high quality Science, Technology, Engineering, and Mathematics (STEM) education using NASA’s unique capabilities
GISS supports the New York tri-state area, but around the country, we’re located...
This division has four focuses – earth, heliophysics, planets, astrophysics.
Goddard Campuses

Four campuses with one located on Columbia University’s campus here in New York City.
Goddard Institute for Space Studies

NASA GISS conducts theoretical and experimental research on the causes and consequences of long-term global change, with an emphasis on education and outreach.

The program includes climate modeling, climate impacts, remote sensing of climate system features such as aerosols and clouds, and comparative planetary climates.
Goddard Institute for Space Studies

NASA GISS has a unique focus on climate change & is home-base for a number of NASA & Columbia researchers and scientists...and was once home to John Dewey

Dr. Gavin Schmidt

TED Talk
Models past, present and future climate.

Director of NASA Goddard Institute for Space Studies.

Asks the question: What’s Really Warming The World?

Has worked on educational outreach with the American Museum of Natural History, the College de France and the New York Academy of Science.

Has over 100 peer-reviewed publications and is co-author of Climate’s Change: Picturing the Science.

Awarded the inaugural ACU Climate Communication Prize and named Earth Sky Communicator of the Year in 2011.

“Scientific principles and laws do not lie on the surface of nature. They are hidden, and must be wrested from nature by an active and elaborate technique of inquiry.”

~John Dewey, Reconstruction in Philosophy, 1920
Framework embraces four key stages: **inspire, engage, educate & employ**
To advance **high quality** Science, Technology, Engineering, and Mathematics (STEM) education using NASA’s unique capabilities.

**STEM Engagement**
Providing opportunities for participatory and experiential learning activities that connect learners to NASA-unique resources.

**NASA Internships, Fellowships and Scholarships**
Providing NASA work experiences and research opportunities to improve retention in STEM and prepare students for employment in NASA and STEM industry.

**Educator Professional Development**
Preparing STEM educators and leaders to deliver quality STEM instruction using NASA-unique content.

**Institutional Engagement**
Improving the capacity of U.S. institutions to deliver effective STEM education and conduct NASA mission-related research. An overarching operating principle consistent throughout NASA’s portfolio is a focus on making opportunities available to a diverse audience of educators and learners, including women, minorities, and persons with disabilities.
STEM Engagement

STEM Engagement (SE) activities are designed to provide opportunities for participatory and experiential learning activities that connect learners to NASA-unique resources.

Public Education Activities
foster interactions with learners of all ages to spark an interest in STEM disciplines using NASA-unique materials and resources

Experiential Learning Opportunities
enable learners to acquire knowledge, understand what they have learned, and apply that knowledge through inquiry-based and project-based activities

STEM Challenges
provide creative applications of NASA-related science, technology, engineering, mathematics, and cross-cutting concepts

STEM Engagement activities are based on best practices in motivation, engagement, and learning in formal and informal settings.
Educator Professional Development

EPD uses NASA’s missions, education resources, and unique facilities to provide high-quality STEM content and hands-on learning experiences to in-service, pre-service and informal educators.

- **In-service Educators:** Include those currently practicing in a formal school system.
- **Pre-service Educators:** Have declared an education major or are graduates who have not yet completed training and certification to teach in a formal setting.
- **Informal Educators:** Provide organized educational activities outside of established formal school system.

**Face to Face Institute:**
F2F interaction at a NASA facility conducted through a single delivery model implemented uniformly across all NASA Centers/Facilities while leveraging content specific to each Center/facility, at grade-appropriate levels based on specific audiences, for a minimum of 40 contact hours.

**Partner-Delivered EPD:**
Partner-Delivered EPD provides a uniform set of standards for partners to adhere to when developing or offering EPD in concert with NASA.

**Online EPD:**
Online EPD provides a uniform set of standards for designing, planning and implementing online learning opportunities for educators that encompass a wide range of technologies and approaches that allow participants to go beyond limitations imposed by real-time, in-person EPD.

**Community-Requested EPD:**
Community-Requested EPD provides NASA Centers/JPL appropriate levels of flexibility to meet and respond to the educator professional development needs of their surrounding communities on a case-by-case basis.

Our efforts help establish linkages between formal and informal education, and encourage informal educators who teach STEM subjects through exposure to and knowledge of NASA-related content.
Institutional Engagement

NASA Institutional Engagement builds the capacity of formal and informal education institutions to participate in NASA’s mission. IE:

• **Improves their capabilities** to gain support from external sources; fosters interactions between NASA Centers, academic institutions, and industry.

• **Supports colleges and universities** by helping them gain access to cutting-edge engineering and science facilities and personnel.

• **Enables informal institutions**, to engage their visitors through exhibits and displays that showcase NASA’s dynamic content.

• **Supports the advancement and development of STEM personnel**, programs, and infrastructure to enable formal and informal institutions to conduct NASA-related research and/or deliver NASA-related STEM content.

Institutional Engagement Seeks To:

- Build Capacity
- Encourage Networks & Communities
- Ensure Institutional Diversity
- Sustain Capacity
- Deliver Content

Goddard Institute for Space Studies
NASA Internships, Fellowships and Scholarships

NASA Internships, Fellowships, and Scholarships (NIFS) leverage NASA’s unique missions and programs to enhance and increase the capability, diversity, and size of the Nation’s future STEM workforce.

- **NASA Internships** are competitive awards to support educational work opportunities that provide unique NASA-related experiences for educators and high school, undergraduate, and graduate students.

- **NASA Fellowships** are designed to support research, or senior design projects by highly qualified faculty, undergraduate, and graduate students, in disciplines needed to help advance NASA’s missions.

- **NASA Scholarships** provide financial support to undergraduate and graduate students for studies in STEM disciplines to inspire and support the next generation of STEM professionals.
NASA GISS Climate Change Research Initiative (CCRI)

The NASA GISS Climate Change Research Initiative is a STEM education program that strategically integrates the strategies and resources of the NASA Office of Educations four lines of business inclusive of NIF’s, STEM Engagement, Educator Professional Development and Institutional Engagement to provide significant impact and discovery to the research associated with the science and topics related climate change.
NASA GISS Climate Change Research Initiative: High School & Undergraduate and Graduate Student Interns

CCRI high school, graduate and undergraduate interns will conduct research, gain knowledge in assigned research discipline, and develop and present scientific presentations summarizing their research experience.

Specifically, interns will be expected to:

• Write a scientific research report explaining basic ideas and experimental set-up of the project as well as their contribution to the work
• Prepare and present a PowerPoint summary of their research project to a panel of subject matter experts
• Prepare and present a scientific poster of their research project at the CUNY Summer STEM Research Symposium
CCRI STEM Educators will conduct research, develop research based learning units and assist NASA scientists with the mentoring of high school, graduate and undergraduate students.

Specifically, Educators will be expected to:

• Create and Applied Research STEM Curriculum Unit Portfolio based on their year long research experience integrating NASA unique education resources, tools and content.

• Integrate and implement unique NASA units into their existing STEM courses during the following academic year.

• Mentor and coach high school students in the components of writing a scientific research paper for publishing, team oral research reporting, power point design for scientific presentations and scientific poster design and presentation for local and national research audiences.
## We Have Some Exciting Science Happening

### 2015-2016: CCRI & Summer Internship Research Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Research Area</th>
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<tr>
<td><strong>Faint Young Sun Paradoxes and Habitable Worlds: Comparative Climatology of Early Earth and Mars.</strong></td>
<td><strong>Climate Change in the Hudson Estuary – Past, Present, and Future.</strong></td>
</tr>
<tr>
<td>Applications of Image Morphing Techniques to Analyze Changes to Our Environment</td>
<td><strong>Geometric Phase Sensitivity of an Array of Atom Ring Interferometers as Inter-Ring Distance is Modulated</strong></td>
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<tr>
<td>The Impact of Climate Change on New York City</td>
<td><strong>Fourier Analysis and its Applications to Environmental Engineering</strong></td>
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<tr>
<td><strong>Urban Climate Adaptation Research: New Technologies, Materials &amp; Thinking.</strong></td>
<td><strong>What is Past is Prologue: Climate Systems in the Present and Past for Assessing Ice Sheets and Sea Level.</strong></td>
</tr>
<tr>
<td>Analysis, Design and Construction of an Autonomous Robot</td>
<td><strong>The Ocean circulation and the Global Carbon Cycle</strong></td>
</tr>
<tr>
<td>Climate Change and Probing the Atmosphere Remotely: Simulating Biaxial LIDAR System to Improve its SNR and Attainable Range</td>
<td><strong>Blowing in the wind: can climate models simulate windblown soil with help from observations?</strong></td>
</tr>
<tr>
<td>West African Monsoon Climate Modeling</td>
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### NASA’s Education Vision:

*To advance high quality STEM education using NASA’s unique capabilities*
CCRI Program Deliverables

NYCRI Summer Research Teams:
- Mentor
- Graduate Student
- Teacher Researcher
- Undergraduate
- High School Student

Applied Research STEM Curriculum Unit Portfolio:
- Scientific Research Paper
- Science Poster
- PowerPoint
- 5 Lessons Integrating Research on NASA Content
- Community Outreach

Research Experience & Lesson Integrated into Classroom

Poster/PPT Symposium @ GISS | CUNY Crest Poster Symposium | Enrichment Activities

*Inspiring the next generation of explorers as only NASA can!*

Goddard Institute for Space Studies
Abstract

The Urban Heat Island (UHI) effect is the phenomenon where urban areas retain heat because of their composition of low albedo materials such as asphalt and concrete. Past research using thermal spot sensors revealed that white and green roofs remain cooler than traditional black asphalt roofs. Also, we know the powerful cooling effects of urban vegetation, in the form of bioswales, at the street level. The objective of our study is to expand this research of the well known cooling effects of alternate roofs and urban vegetation by using thermal infrared cameras, while learning the potential of this technology in the study of urban climate. We used a FLIR T650SC thermal camera to gather data on the rooftops and streetscape. This research confirmed what we already knew about white roofs, green roofs, and bioswales. However, the infrared camera captures the entire thermal scene, rather than a mere point like prior data collection. The immensity of the data coupled with more efficient data processing allows us to learn more about the thermal landscape than prior research methods. The new technology enhances our ability to understand urban climate and inform policymakers on urban design.

Introduction

- One billion square feet of mostly black roofing in New York City.
- Black roofing enhances the Urban Heat Island effect where heat gets trapped because of its composition of low albedo materials.
- Increase in frequency and severity of heat waves expected with change in climate.
- By 2050, 66% of people are expected to live in urban areas (UN 2014).
- Green and white roofs offer adaptation and mitigation to the changing climate.
- Installing a green roof can save up to 10% on energy costs in the summer (Synnefa et al. 2008).
- Bioswales also help in reducing the Urban Heat Island effect.
- Bioswales are enhanced green infrastructure to capture storm water runoff, but also have cooling benefits.

Methods and Materials

- FLIR T650SC wide-angle lens
- FLIR Research IR
- Adjust settings to environment at site
- Capture and save images
- Process data using FLIR Tools and Microsoft Excel

Results

Roofscape

- Sedums are inexpensive, drought resistant plants that are used in a majority of green roofs.
- Typical sedum roofs cost $20 and retain 10 gallons of water per square foot (Gaffin et al. 2011).
- Black playground mat average temperature: 151.6°F
- Sedums average temperature: 99.7°F

Bioswales

- Stormwater Green Streets serve the same purpose as bioswales, but on a much larger scale.
- Stormwater Green Street average temperature: 81.2°F
- Newer asphalt average temperature: 114.0°F

Future

- Short Term: Study an experimental roof with six different white membranes to see which performs best.
- Long Term: Further understand the capabilities of this new technology, and how it can enhance urban climate studies in the future.

References
Habitat Space on a Snowball Earth: Understanding Life
On the Outer Edge of the Habitable Zone
Jonathan Chin\textsuperscript{1}, Francesca Lingo\textsuperscript{2}, Mary Anne Woody\textsuperscript{3}, Linda Sohl\textsuperscript{4}
\textsuperscript{1}Brooklyn Technical HS, \textsuperscript{2}City College-CUNY, \textsuperscript{3}Xavier HS, \textsuperscript{4}NASA/GISS at Columbia University

A. Using Earth History to Explore Other Worlds

Habitable planets, by definition, have a surface environment capable of supporting liquid water, which is vital to life as we know it. Earth’s history illustrates phases of habitability that we can use to understand the conditions under which life can arise and thrive, and to guide future NASA missions seeking habitable worlds.

As our case study, we examine here an extreme ice age referred to as “Snowball Earth.” This event took place ca. 715 million years ago, when life appears to have been making significant evolutionary strides from simple single-celled microscopic organisms to complex multicellular organisms visible to the naked eye.

The geologic record suggests that the Snowball Earth world was quite cold and hostile, with widespread snow and ice on both land and ocean. Where was life finding space to survive? The expectation among paleobiologists has been that for marine life, ocean temperature would be a controlling factor.

B. The Environment

Influences on the Snowball Earth climate that were incorporated into our climate simulations include a dimmer Sun (60% less bright than today) and very low CO\textsubscript{2} (40 ppm).

A comparison of Modern vs. Snowball Earth ocean ice cover area (top row) and the surface air temperature (bottom row) shows how extreme the climate was back then – the Snowball Earth had 34% more ice cover, and the difference in global average temperature was 20°C (nearly triple).

Under such different conditions, we need to understand how changes in the ocean circulation might affect temperature and salinity patterns, as well as the distribution of nutrients – all important factors in allowing life to survive. In the plots above, we see how vertical mixing after 400 years (left) and 2000 years (right) has changed – suggesting that an equilibrium state in the model is not quickly achieved.

C. The Life Forms

The fossil record during the Snowball Earth is poor, so it is hard to know exactly what forms of life were present. To provide some insight into habitat needs at that time, we chose representatives of three kinds of organisms – Cnidaria, Demospongiae, and Cyanobacteria – that might be most closely related to early life.

Cnidaria are both filter-feeders and predators. All organic carbon consumed, through predation and filter-feeding, is expelled into the water column for benthic organisms, such as the Demospongiae, to consume.

Demospongiae are benthic, sessile filter-feeders. These organisms consume primarily particulate nutrition as well as Plankton. These organisms possess genes that allow them to resist adverse temperatures and survive food restrictions.

Cyanobacteria are small, planktonic organisms typically found on the surface of the ocean. They are filter-feeders that consume dissolved organic carbon in the environment. Cyanobacteria are consumed by larger metazoan filter-feeders such as Demospongiae and Cnidaria.

D. Defining Habitats

Using the habitat requirements (in terms of temperature and salinity) of our three modern organisms as a guide, we mapped their possible distribution in a Snowball Earth setting.

This task was done for individual layers of ocean down to depth of roughly 1500m, after which temperature and salinity values became fairly geographically constant.

Ocean Temperature: Not surprisingly, the warmest ocean temperatures occur in shallow tropical regions away from the sea ice front. At greater depths the water cools considerably. Based on temperature alone, we would have predicted that most of our organisms would be found in shallow water environments near the equator.

Salinity: Salinity concentrations increased with depth of water, especially in the tropics, owing to a persistent lens of fresh water at the surface. Since most of our organisms prefer higher salinities closer to the modern ocean value, these organisms would tend to be found at shallower depths only in the polar regions where vertical mixing is stronger.

E. Conclusions

The Snowball Earth ocean environment differs considerably from the modern in terms of three key facets that can influence marine habitat space: temperature, salinity, and circulation patterns. These unexpected results might have influenced the distribution of nutrients. An unexpected result is the possibility that salinity, and not temperature, had a greater influence on the distribution of habitat space for complex organisms.

Further investigations will include a focus on characterizing the final equilibrium state of the ocean; the additional consideration of nutrient availability on habitat space; and an expanded review of modern organism analogues of Snowball Earth life for a greater range of salinity and temperature tolerances.

References


Acknowledgements

This work was supported by the NASA-funded Ice Worlds (JPL/12202) and NASA Exoplanet Science Frontiers (NNX09A019G). NASA’s Office of Education and the NASA Nexus for Exoplanet System Science (NExSS) for their continued support throughout this project. Funding for research provided by NASA’s Astrobiology Grant NNX10AI47G and the NASA Nexus for Exoplanet System Science (NExSS).
A Study of Blue Carbon in Jamaica Bay 2015
Dr. Dorothy Peteet, Stephen Kovari, Mohammad Reza, Stephanie Stern
NASA/Goddard Institute of Space Studies, Lamont Doherty Earth Observatory, New York City Research Initiative

Abstract
Carbon that is sequestered in coastal ecosystems and intertidal marshes is known as “blue carbon.” We investigated and analyzed sediment cores of three marshes in the Hudson Estuary to determine the amount of organic matter and carbon sequestered within them. Maps of Jamaica Bay from 250 years to the present are used to determine why there is a shift in organic matter and a decline in inorganic matter within the last estimated 300 years. We uncovered two possible impacts: i) the growth of Rockaway Spit over the last 250 years has elongated it, limiting the flow of seawater and sand into the bay, and ii) deep dredging may have altered the water flow and deposition of sediments within the bay itself.

Introduction
Wetlands play a major role in climate stability as they process and sequester large amounts of carbon. However, the quantity of carbon storage depends on the rate of production/decomposition and the environmental stresses placed upon it. The salt marshes are an integral part of the global carbon cycle. Recent studies of Jamaica Bay marshes indicate that there are a number of stressors that include waste treatment plants, deep dredging and sea level rise. Our work focused on the amount of organic and inorganic material in sediment cores from which we are awaiting C-14 AMS dates to calculate blue carbon sequestration through time.

Carbon’s Role in the Wetlands

<table>
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<tr>
<th>Methodology</th>
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<tbody>
<tr>
<td><strong>Step 1:</strong> Sub-sample cores at 4 cm increments.</td>
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<tr>
<td><strong>Step 2:</strong> Dry and sample for LOI.</td>
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<tr>
<td><strong>Step 3:</strong> Analyze the data to determine organic and inorganic g/cm² with depth.</td>
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<tr>
<td><strong>Step 4:</strong> Pick macrofossils for AMS dates to calculate carbon g/m²/yr</td>
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</tbody>
</table>

Results from Yellow Bar, JoCo and East High Meadow Marsh

Questions
How have the organic/inorganic composition of Jamaica Bay Marshes been changing through time; and what drives these changes? What is rate of blue carbon storage through time?

Historic Maps

Conclusions
Over the past 250 to 300 years, the growth of Rockaway Spit has lessened the inundation of ocean water into the bay, probably affecting the amount of inorganic sediment carried in. This extension probably diminished the amount of inorganic sediment we find in the marsh peat. Dams on the streams entering the bay may have also limited sediment supply. The deep borrow pits created by dredging for the construction of both Floyd Bennett Field and Idlewild Airport (now John F. Kennedy International Airport) serve as artificial anthropogenic sediment sinks. Macrofossils for AMS dating, x-ray florescence, and carbon and nitrogen isotopes will aid us in calculating the rate of shifts in blue carbon and inorganic sediment through time.

Acknowledgments
Goddard Space Flight Center
GISS
NYCRI
NASA GISS High School STEM ARE
(STEM) Academic Research Experience

AREP – Minimum Requirements:
• 16 years of age at the start of AREP, minimum 3.0 GPA, U.S. citizen.

AREP – Placement Process:
• Applicants are accepted by the research experience program at their school and recommended to participate by advisor.
• Students will be on-site for a minimum of three half-days per week while the school is in session.
• Length of placement will be a minimum of ten weeks.

Deliverables:
• Research poster and participate in a center poster session at the end of the semester/academic year
The (GLOBE) program is a worldwide hands-on, primary and secondary school-based science and education program. GLOBE’s vision promotes and supports students, teachers and scientists to collaborate on inquiry-based investigations of the environment and the Earth system working in close partnership with NASA, NOAA and NSF.

GLOBE community consists of more than 66,000 GLOBE-trained teachers representing over 24,000 schools around the world. In addition, over 10 million students have participated in GLOBE — contributing more than 100 million measurements.

NASA & GLOBE have partnered to provide teacher professional development throughout NYC metropolitan area.
NASA/GISS and the Intrepid Sea Air and Space Museum have partnered to provide educators with a multi-day training to implement BEST and Intrepid STEM Curriculum into instruction for students grades K-9.

The engineering design process is a series of steps that engineers use to solve problems. BEST activities are different because they provide no “recipe”. Students’ must “imagine and plan” before they begin to build and experiment.

BEST activities include (partial list): Build & launch a Satellite to Orbit the Moon, Design a Lunar Buggy, Design & Launch a Crew Exploration Vehicle, Launch Your CEV, Build a Solar Oven, 3D Printing, Hubble Exhibit.
The Global Precipitation Measurement (GPM) Satellite will collect precipitation data from around the world.

Knowing where and how much rain or snow falls globally is vital to understanding how weather and climate impact both our environment and Earth’s water and energy cycles. Precipitation patterns have effects on agriculture, fresh water availability, and responses to natural disasters.

GPM 1 year of Storms
James Webb Space Telescope

- 6.6m Telescope
- Successor to Hubble & Spitzer.
- Demonstrator of deployed optics.
- 4 instruments: 0.6 to 28.5 μm
- Passively cooled to < 50 K.
- Named for 2nd NASA Administrator

- Complementary to WFIRST, ELT, ALMA, etc
- NASA + ESA + CSA: 14 countries
- Lead: Goddard Space Flight Center
- Prime: Northrop Grumman
- Operations: STScI
- Senior Project Scientist: Nobel Laureate John Mather
NASA's Orion Spacecraft

**ORION EFT-1**

*Exploration Flight Test*

- **Delta IV Heavy**
- **Launch Pad**
- **Liquid Fueled Upper Stage**
- **Orion Crew Vehicle**
- **Service Module**
- **Crew Capacity**: 2 to 6
- **Flight Time**: 4.5 hours
- **Range**: 3600 miles

- **REENTRY**: 4,000°F
- **Launch**
  - **Orion**
  - **Upper Stage**
  - **Booster**
  - **Common Booster Core**
- **Delta IV Heavy**
- **RL-10B**

**RETURN to Earth**

- **Parachutes**
- **Reduces air speed from 300 mph to 20 mph**
- **Parachute Deployment**

**Orion Crew Vehicle**

- **Heat Shield**
- **Aeroshell**
- **Heat Shield Deployed**
- **Heat Shield Deployment**

**EFT-1 WILL TEST**

1. **Launch and Separation Events**
2. **Software and Component Hardware (especially in the Van Allen Belt)**
3. **Heat Shield**
4. **Parachutes**

**Orion Pacific Ocean**

- **Orion Launch**
- **Delta IV Heavy**

**Delta IV Heavy**

- **SLS-37**
- **Orion Launch**

**REENTRY**

- **4,000°F**

**500 mph to 20 mph**
Excellence & Innovation through Collaborative Partnerships

NASA
The City University of New York (CUNY)
Hostos Community College
LaGuardia Community College
Queensboro Community College
Columbia University
Medgar Evers College
Opportunity Network
Goddard Institute for Space Studies
Goddard Space Flight Center
New Jersey Institute of Technology
National Science Foundation
NOAA
Intrepid Sea, Air & Space Museum
American Museum of Natural History
New York City Center of Space Science Education
Hayden Planetarium
Lamont-Doherty Earth Observatory
New Jersey City University
New York Space Grant
New Jersey Space Grant

Bringing together the best of the New York City tri-city area and nationally
to conduct collaborative scientific research through the NYCRI
NASA’s Education Web Resources

- **NASA Wavelength: Resources for Educators**
  - http://nasawavelength.org

- **NASA Education: Education Express and All NASA Education Programs**

- **Free Online STEM EPD:**
  - http://www.txstate-epdc.net

- **Search NASA Education Resources:**
  - http://www.nasa.gov/education/materials/#.Vei6EItvrSQ

- **NASA For Students:**

- **STEM Lessons From Space**
  - http://www.nasa.gov/audience/foreducators/stem-on-station/lessons

- **Internships at Goddard:**
  - http://www.nasa.gov/centers/goddard/education/internships.html

- **NASA Goddard Institute for Space Studies:**
  - http://www.giss.nasa.gov

- **NASA Goddard Office of Education:**
  - http://www.nasa.gov/centers/goddard/education/about.html
Let's Connect!

NASA Education Vision: To promote high quality STEM education using NASA's unique resources

- NASA Education Website:

Goddard Institute for Space Studies

"Every great advance in science has issued from a new audacity of imagination."
– John Dewey
Support & Partnership

Thank you for your time today!

We look forward to partnering with you, and having you be a part of the NASA family…

“Every great advance in science has issued from a new audacity of imagination.”
– John Dewey
NASA’s Goddard Office of Education

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