NASA Goddard Institute for Space Studies

NASA Goddard Space Flight Center, Office of Education

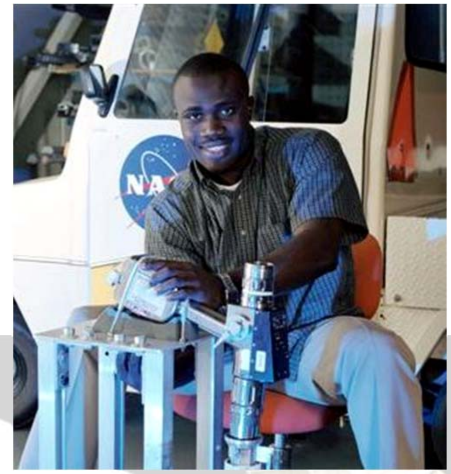
NASA Education Programs

Matthew Pearce,
HSFI OSSI Awareness Day CCNY

Science • Technology • Engineering • Math

NASA's Education Mission

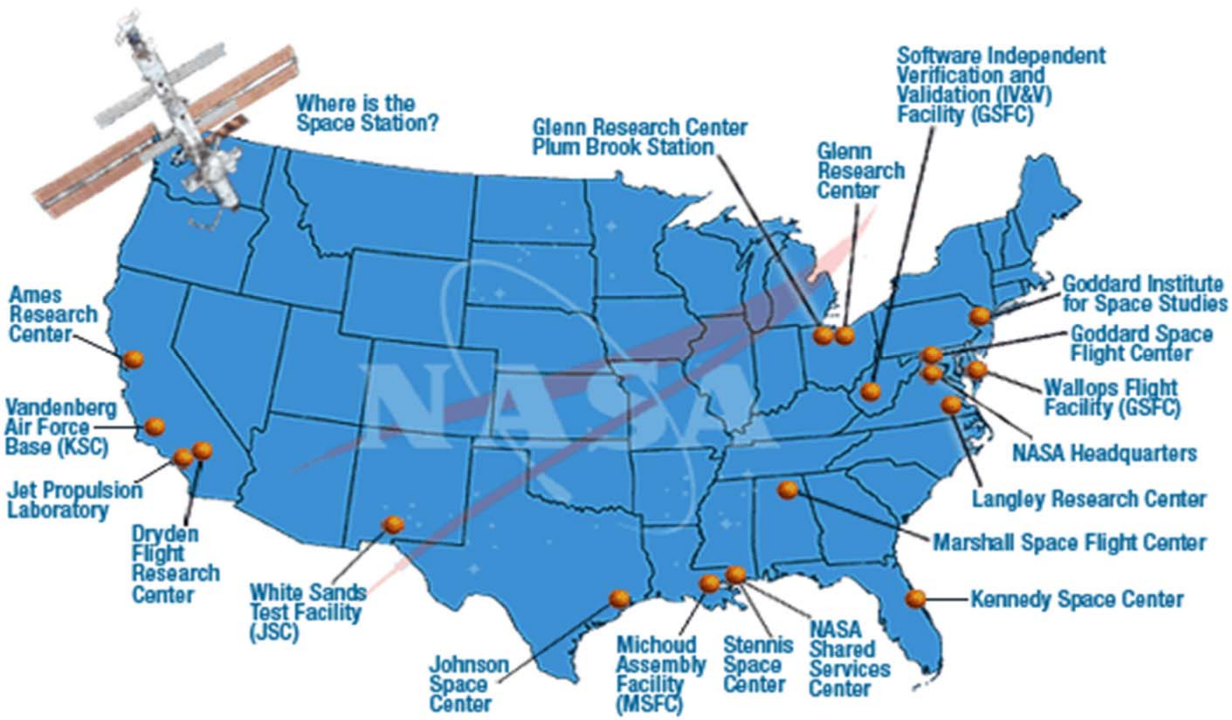
Our mission is …



*To advance **high quality** Science, Technology, Engineering, and Mathematics **(STEM) education** using NASA's **unique** capabilities*

NASA Centers

GISS supports the New York tri-state area, but around the country, we're located…

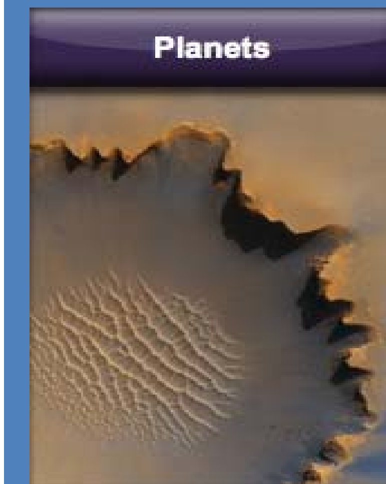


NASA Science

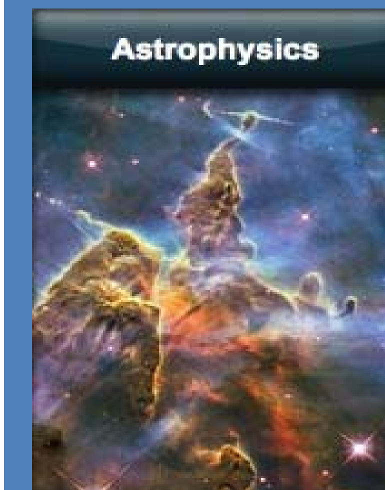
This division has four focuses – earth, heliophysics, planets, astrophysics

Atmosphere composition weather, carbon cycle & ecosystems, water & energy cycles, climate variability change, earth surface & interior

Heliosphere, magnetospheres, space environment



Inner solar system, outer solar system, small bodies of the solar system



The Big Bang, dark energy, dark matter, stars, galaxies, black holes, planets and other suns

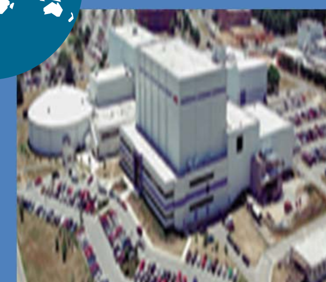
Goddard Campuses

Four campuses with one located on Columbia University's campus here in New York City

Independent Verification & Validation
West Virginia

Goddard Institute for Space Studies
New York

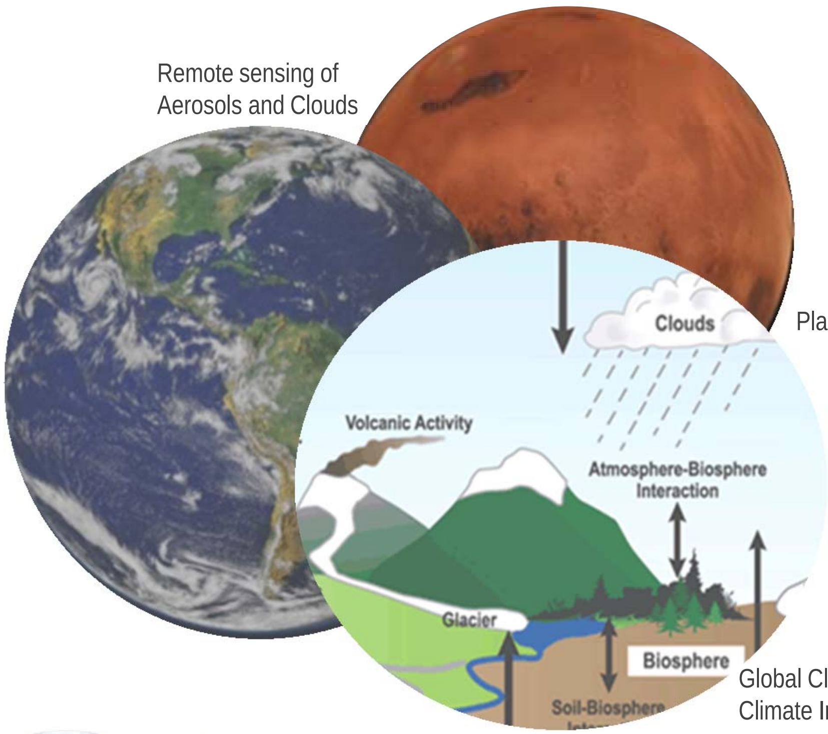
Wallops
Virginia



Goddard Space Flight Center
Maryland

Goddard Institute for Space Studies

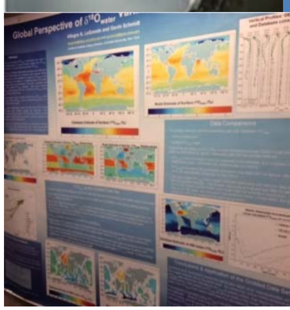
NASA GISS conducts theoretical and experimental research on the causes and consequences of long-term global change, with an emphasis on education and outreach



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 or 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.

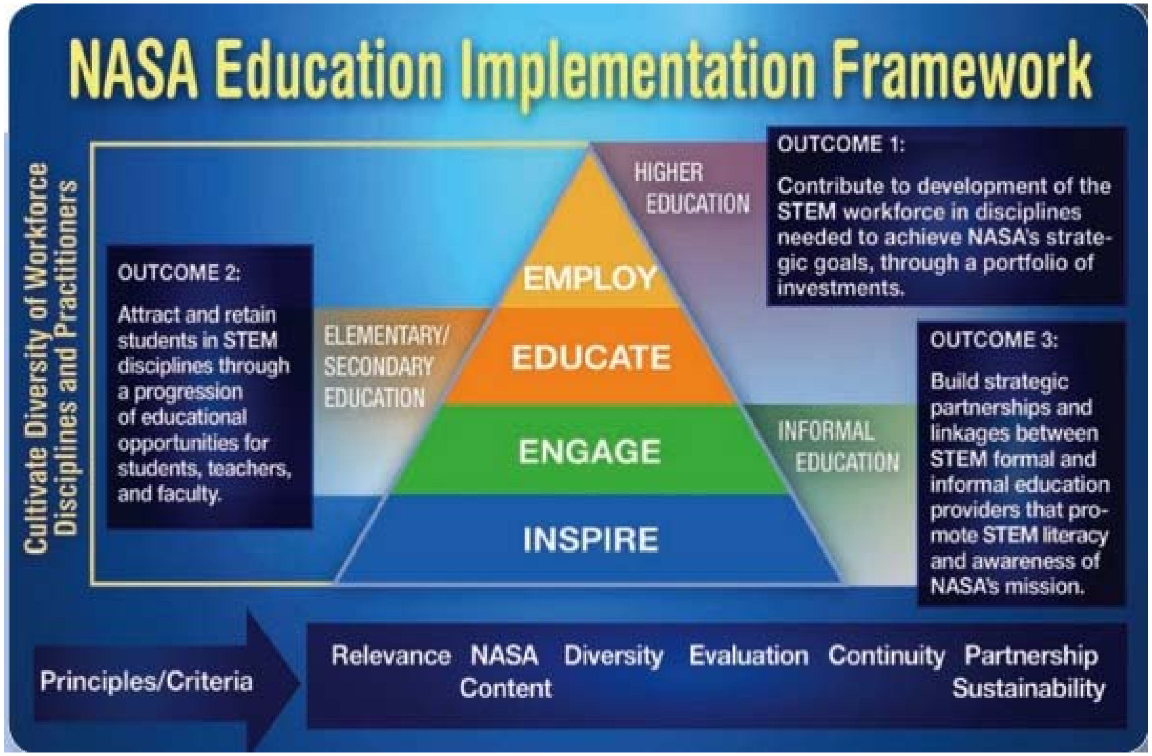
Awarded the inaugural ACU Climate Communication Prize and named Earth Sky Communicator of the Year in 2011.

"Scientific principless 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

NASA Education Implementation Framework

Framework embraces four key stages: **inspire, engage, educate & employ**




National Aeronautics and Space Administration
NASA
REACH NEW HEIGHTS
BENEFIT ALL HUMANKIND
REVEAL THE UNKNOWN

NASA Education Office's Four Lines of Business

To advance **high quality** Science, Technology, Engineering, and Mathematics **(STEM) education** using **NASA's unique** capabilities

NASA Office of Education Four Lines of Business

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

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.

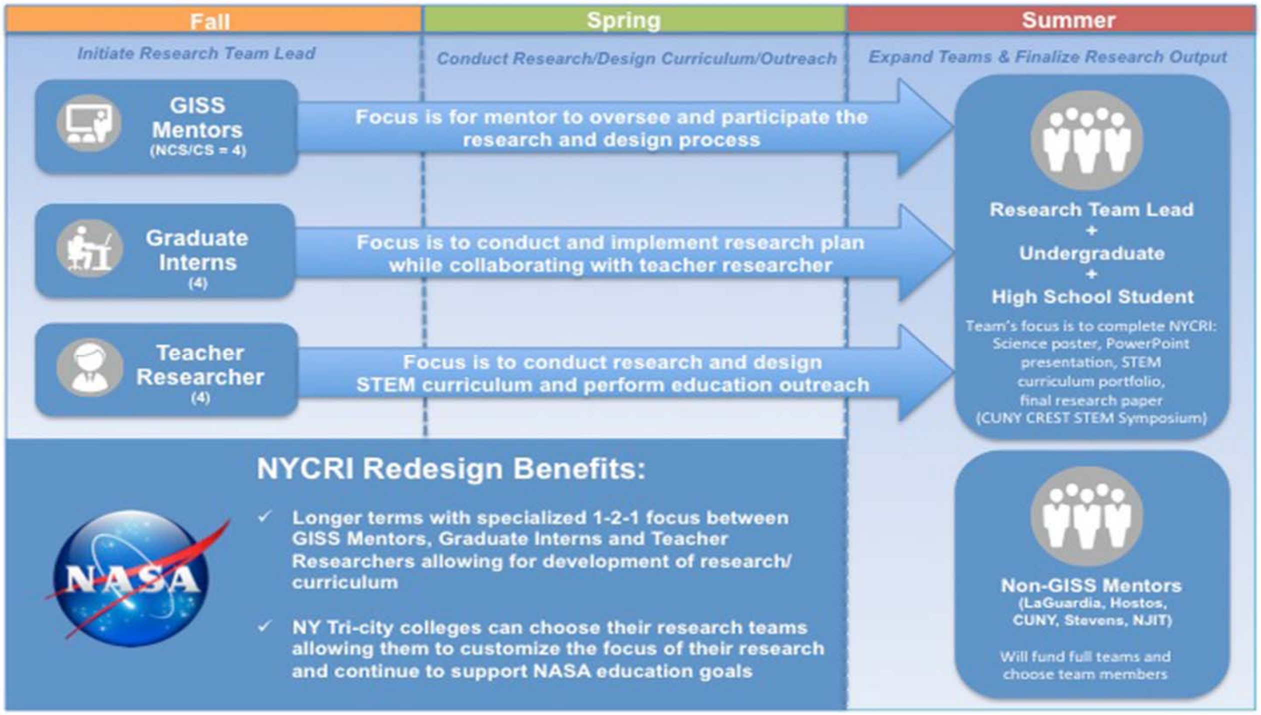
Internships

Fellowships

Scholarships

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

NASA GISS Climate Change Research Initiative Educators

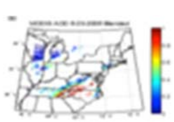
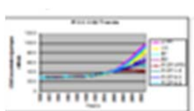
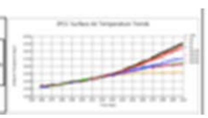
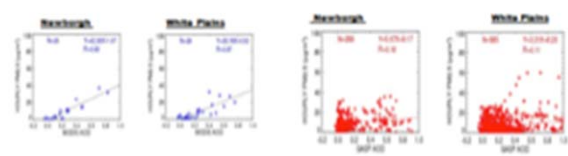
CCRI STEM Educators will conduct research, develop research based learning units and assist NASA scientists with the mentoring of high school, graduate and undergraduate students

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

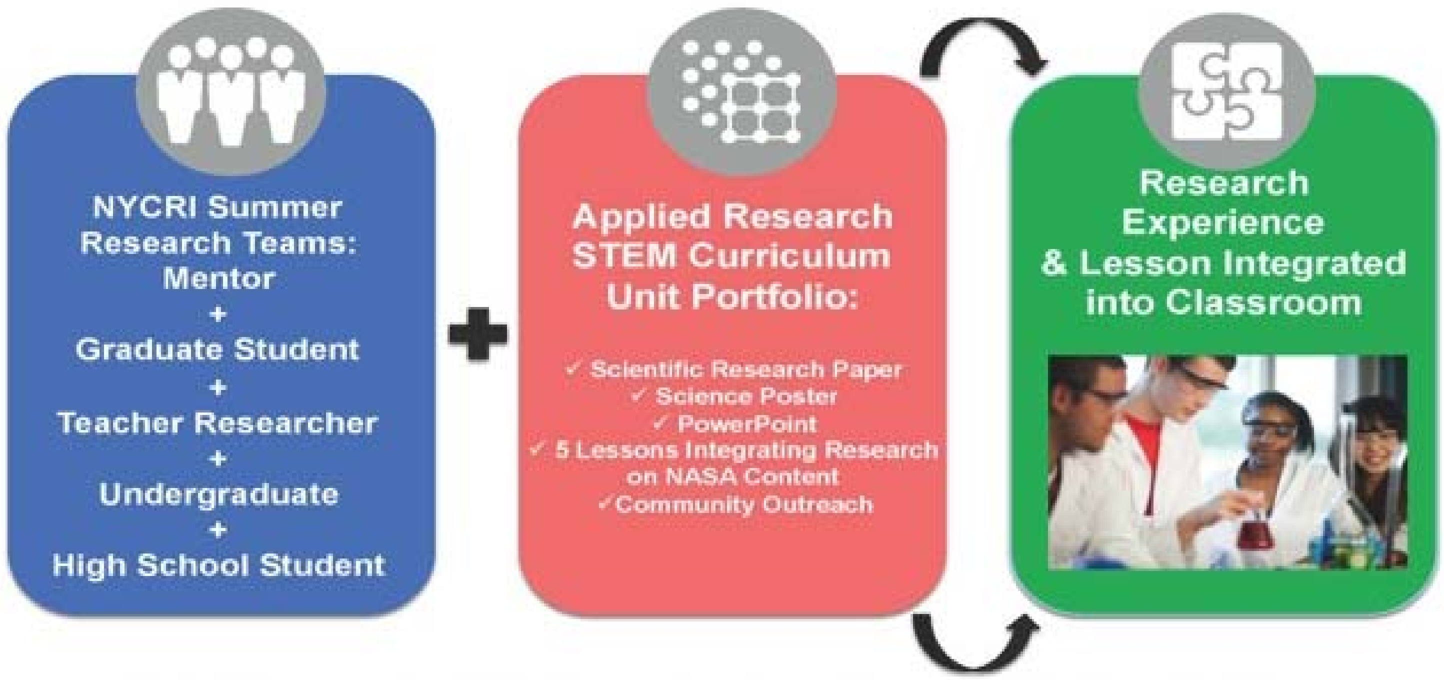
2015 2016: CCRI & Summer Internship Research Projects	
Faint Young Sun Paradoxes and Habitable Worlds: Comparative Climatology of Early Earth and Mars.	**Climate Change in the Hudson Estuary – Past, Present, and Future.**
Applications of Image Morphing Techniques to Analyze Changes to Our Environment	Geometric Phase Sensitivity of an Array of Atom Ring Interferometers as Inter-Ring Distance is Modulated
The Impact of Climate Change on New York City	Fourier Analysis and its Applications to Environmental Engineering
Urban Climate Adaptation Research: New Technologies, Materials & Thinking.	**What is Past is Prologue: Climate Systems in the Present and Past for Assessing Ice Sheets and Sea Level.**
Analysis, Design and Construction of an Autonomous Robot	The Ocean circulation and the Global Carbon Cycle
Climate Change and Probing the Atmosphere Remotely: Simulating Biaxial LIDAR System to Improve its SNR and Attainable Range	Blowing in the wind: can climate models simulate windblown soil with help from observations?
West African Monsoon Climate Modeling	

NASA's Education Vision:

To advance high quality STEM education using NASA's unique capabilities

CCRI Program Deliverables



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

Inspiring the next generation of explorers as only NASA can!

Urban Heat: The “Sixth Sense” lets you see it

Alan Roditi, Andrew Chui, Ethan Johnson

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 roofscape 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 adaptation strategies to climate change in New York City and beyond.

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 tree pits designed to capture storm water runoff, but also have coo

Figure 1 – NYC Cool Roofs program logo on NYPD tow pound white roof

Sponsors:
National Aeronautics and Space Administration (NASA)
NASA Goddard Space Flight Center (GSFC)
NASA Goddard Institute for Space Studies (GISS)
NASA New York City Research Initiative (NYCRI)
NSF Research Experience for Undergraduates (REU)

Contributors:
Stuart Gaffin, Ph.D., Cynthia Rosenzweig, Ph.D.
Alan Roditi, High School Teacher
Ethan Johnson, Undergraduate Student
Andrew Chui, High School Student

Materials and Methods

- **FLIR T650SC** wide-angle lens
- FLIR Tools
- FLIR Research IR

- Adjust settings to environment at site
- Capture and save images
- Process data using FLIR Tools and Microsoft Excel

Figure 2 – FLIR T650SC thermal camera

Results

Roofscape

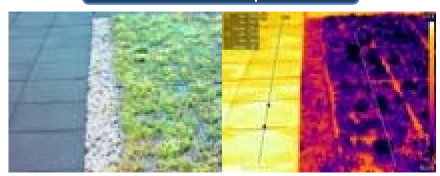


Figure 3 – Con Edison green roof with black playground mats and sedum comparison

- **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**

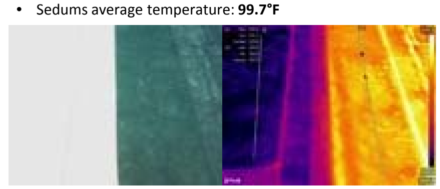


Figure 4 – Con Edison roof with white and black membrane comparison

- White membranes are **highly reflective** materials used as replacements to traditional asphalt roofs.
- White coatings are also used to cool asphalt roofs.

- White membrane average temperature: **123.8°F**
- Black membrane average temperature: **162.9°F**

Green and white roofing are much better at staying cool than black surfaces, which can reach 170°F.

Streetscape

Figure 5 – Soundview Park bioswale and asphalt comparison

- Vegetated **bioswales** maintain a temperature that is half that of the surrounding asphalt.
- The typical bioswale costs **$13,000** with an average water retention of 1,800 gallons (Rosenblum 2012).

- Bioswale average temperature: **82.9°F**
- Asphalt average temperature: **108.7°F**

Figure 6 – Soundview Park Stormwater Green Street and asphalt comparison

- **Stormwater Green Streets** serve the same purpose as bioswales, but on a much larger scale.

- Stormwater Green Street average temperature: **81.2°F**
- Weathered asphalt average temperature: **107.1°F**
- Newer asphalt average temperature: **114.0°F**

Green Infrastructure reduces runoff, and is great at staying cool!

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.

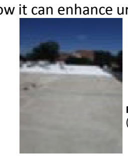


Figure 7 – GAF Corp. experimental roof (Image credits courtesy of Tom Taylor)

References

Title image: https://upload.wikimedia.org/wikipedia/commons/3/39/NYC_Top_of_the_Rock_Pano.jpg
Nasa logo: http://aesp.psu.edu/assets/images/logo-nasa.png
FLIR Image: https://www.google.com/search?q=urban+heat+island+nyc&biw=1240&bih=681&source=lnms&tbm=isch&sa=X&ei=a6yeVZDSFMm4-AHIsIDwBQ&ved=0CAcQ_AUoAg#tbm=isch&q=flir+t650sc&imgrc=AAlL7NDBbbL3lM%3A
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Habitat Space on a Snowball Earth: Understanding Life On the Outer Edge of the Habitable Zone

Jonathan Chin[1], Francesca Lingo[2], Mary Anne Woody[3], Linda Sohl[4]

[1]Brooklyn Technical HS, [2]City College-CUNY, [3]Xavier HS, [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.

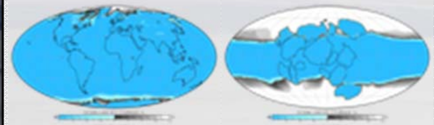
As our case study, we examine here an extreme ice age referred to as "Snowball Earth." This event took place ca. 715 million years ago, when life appears to have been making significant evolutionary strides from simple single-celled microscopic organisms to complex multicellular organisms visible to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

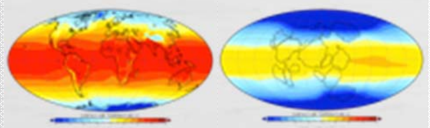
The geologic record suggests that the Snowball Earth world was quite cold and hostile, with widespread snow and ice on both land and ocean. Where was life finding space to survive? The expectation among paleobiologists has been that for marine life, ocean temperature would be a controlling factor.

B. The Environment

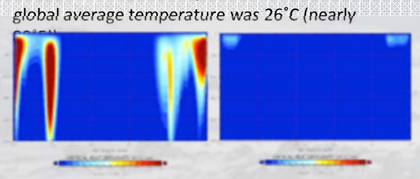
Influences on the Snowball Earth climate that were incorporated into our climate simulations include a dimmer Sun (6% less bright than today) and very low CO_2 (40 ppm).

Modern | Snowball Earth





A comparison of Modern vs. Snowball Earth ocean ice cover area (top row) and the surface air temp-erature (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 26˚C (nearly



Under such different conditions, we need to understand how changes in the ocean circulation might be affecting 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.

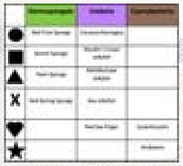
Cyanobacteria are small, planktonic organisms typically found on the surface of the ocean. They are filter-feeders that consume dissolved organic carbon in the environment. Cyanobacteria are consumed by larger metazoan filter-feeders such as Demospongiae and Cnidaria.

D. Defining Habitats

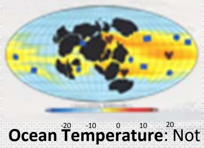
Using the habitat requirements (in terms of temperature and salinity) of our three modern organisms as a guide, we mapped their possible distribution in a Snowball Earth setting.

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.

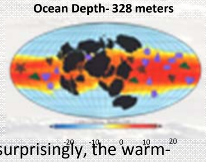
Symbol Guide



Ocean Depth- 116 meters

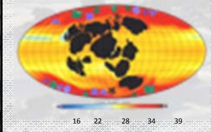


Ocean Depth- 328 meters

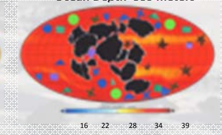


Ocean Temperature: Not surprisingly, the warm-est ocean temperatures occur in shallow tropical regions away from the sea ice front. At greater depths the water cools considerably. Based on temperature alone, we would have predicted that most of our organisms would be found in shallow water environments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

Ocean Depth- 43 meters



Ocean Depth- 559 meters



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 strong

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 (especially vertical mixing) that might influence 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 early 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.

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Acknowledgments

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NASA GISS Climate Change Research Initiative Poster

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

Lamont-Doherty Earth Observatory
Columbia University | Earth Institute

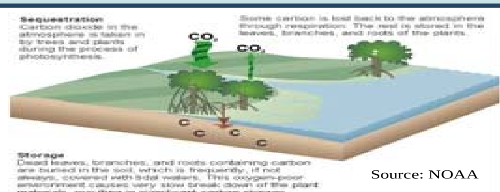
Abstract

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. Deep dredges in the bay called "borrow pits" have created artificial depositional basins. 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

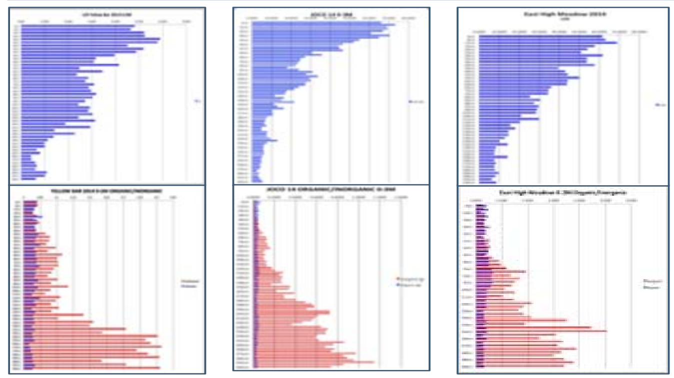


Source: NOAA

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?

Results from Yellow Bar, JoCo and East High Meadow Marsh



Methodology

Step 1: Sub-sample cores at 4cm increments.

Step 2: Dry and sample for LOI.

Step 3: Analyze the data to determine organic and inorganic g/cm³ with depth.

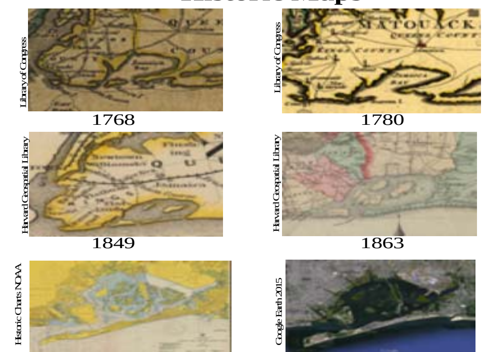
Loss on Ignition (LOI)

Samples were taken at 4 cm increments from the core, dried for 24 hours at 100° C, and burned at 500° C for 2 hours.

$$\text{LOI} = \frac{\text{Dry Weight} - \text{Burned Weight}}{\text{Dry Weight}}$$

Step 4. Pick macrofossils for AMS dates to calculate carbon g/m²/yr

Historic Maps



1768 1780
1849 1863
1948 2015

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

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- 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.

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- Research poster and participate in a center poster session at the end of the semester/ academic year

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- Successor to Hubble & Spitzer.
- Demonstrator of deployed optics.
- 4 instruments: 0.6 to 28.5 μm
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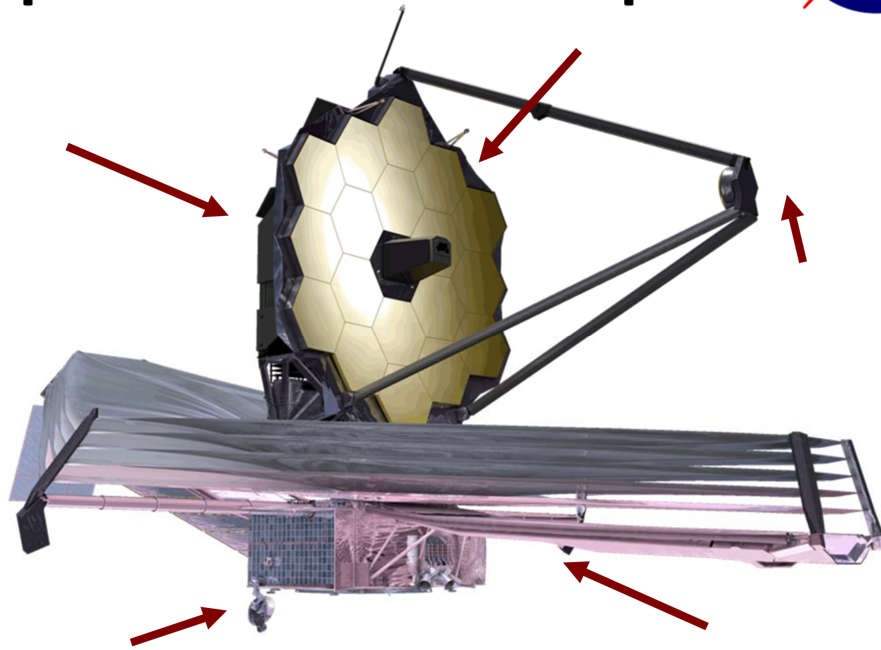
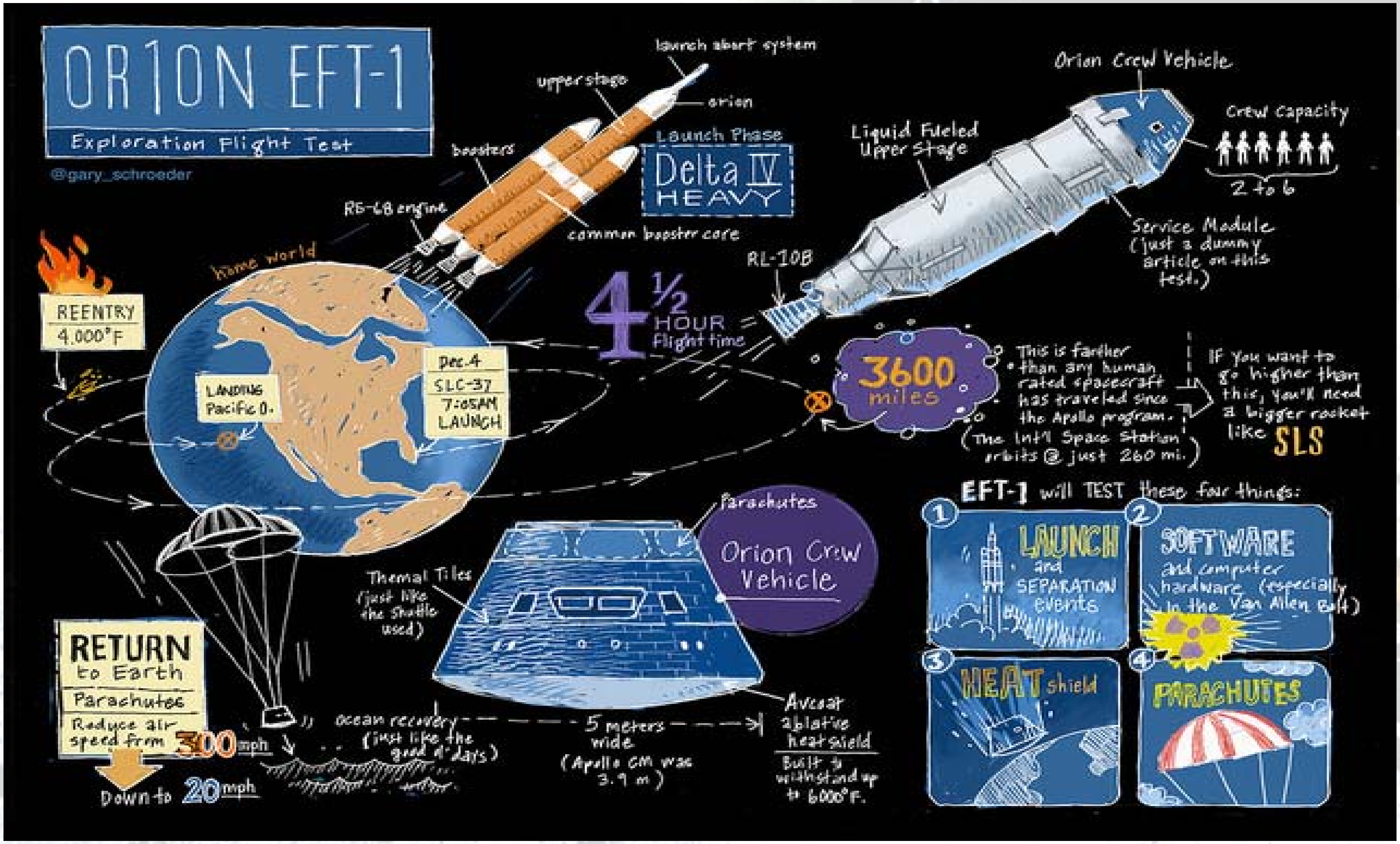


- Complementary to WFIRST, ELT, ALMA, etc
- NASA + ESA + CSA: 14 countries
- Lead: Goddard Space Flight Center
- Prime: Northrop Grumman
- Operations: STScI
- Senior Project Scientist:
  Nobel Laureate John Mather

NASA's Orion Spacecraft



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NASA's Education Web Resources

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  - http://www.txstate-epdc.net
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  - http://www.nasa.gov/education/materials/#.Vei6ElvrSQ0
- NASA For Students:
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- 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:
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- NASA Education Website:
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and having you be a part
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– John Dewey

NASA's Goddard Office of Education

Please contact me at…

Matthew Pearce
Education Program Specialist
NASA Goddard Institute for Space Studies (GISS)
2880 Broadway, Office 568
212-678-6038 (o)
646-419-0144 (c)
Matthew.D.Pearce@nasa.gov


Any
Questions?