Establishing a Geospatial Intelligence Pipeline through Earth SySTEM Education

NOAA/NESDIS CoRP Science Symposium

University of Maryland

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Talking Points

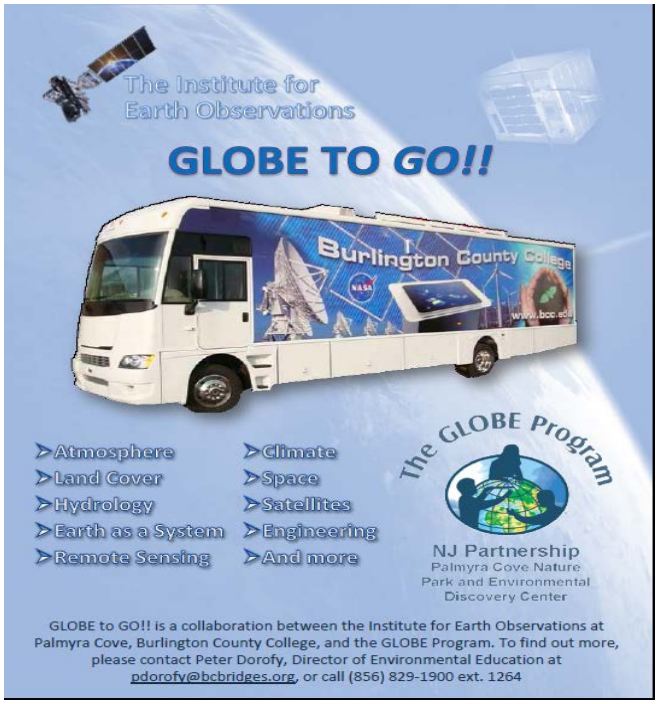
- Science versus Science Education
- National Initiatives
- 21st Century Workforce Development
- Geoscience Literacy
- Impacts on Precollege Education
- Earth SySTEM
- Pipeline in Practice
- Undergraduate Example
- Pre-College Examples

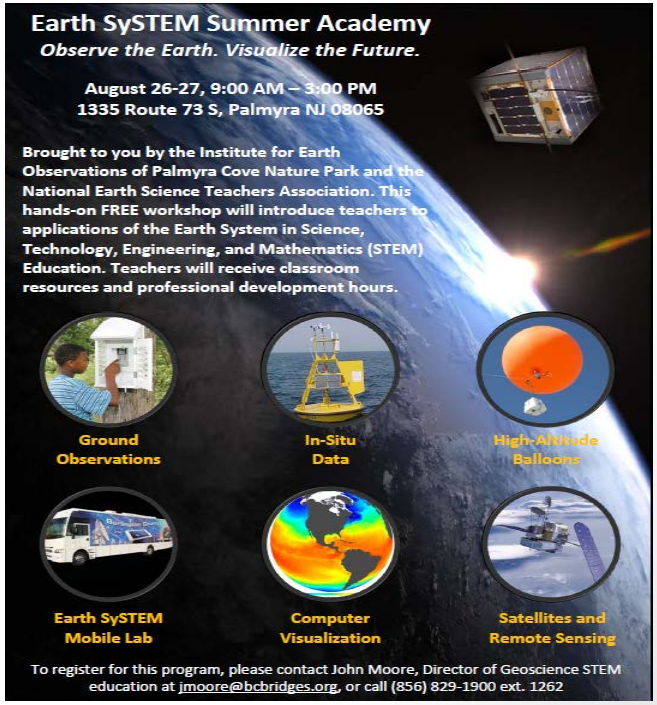
About Myself…

- Graduate Student at Rowan University
- Graduate Student at Montana University
- Director of Environmental Education Palmyra Cove Nature Center, NJ
- 15 years teaching high school physics, chemistry, geospatial technologies
- The American Council of STEM Educators
- NESTA Eastern Regional Director
- GLOBE Scientist
- American Meteorological Society (AMS) LIT Leader
- AMS Board on Outreach and Precollege Education
- AMS Distinguished Educator
- 2013 PAEMST New Jersey State Finalist

Palmyra Cove Nature Park (PCNP)

… is 250 acres of green in a highly developed area on the Delaware River just south of the Tacony Palmyra Bridge. With its woodlands, wetlands, tidal cove and wild river shore line, PCNP serves as an important feeding site for migratory birds. PCNP hosts an average of 5000 pre-K-grad and adult student-learners per year in various programs, camps, and activities.





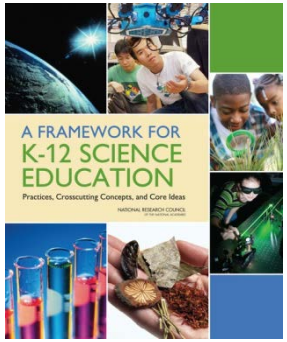
SCIENCE vs. SCIENCE EDUCATION

- National Economy
- National Security
- National Geoscience

Related Events

National Initiatives

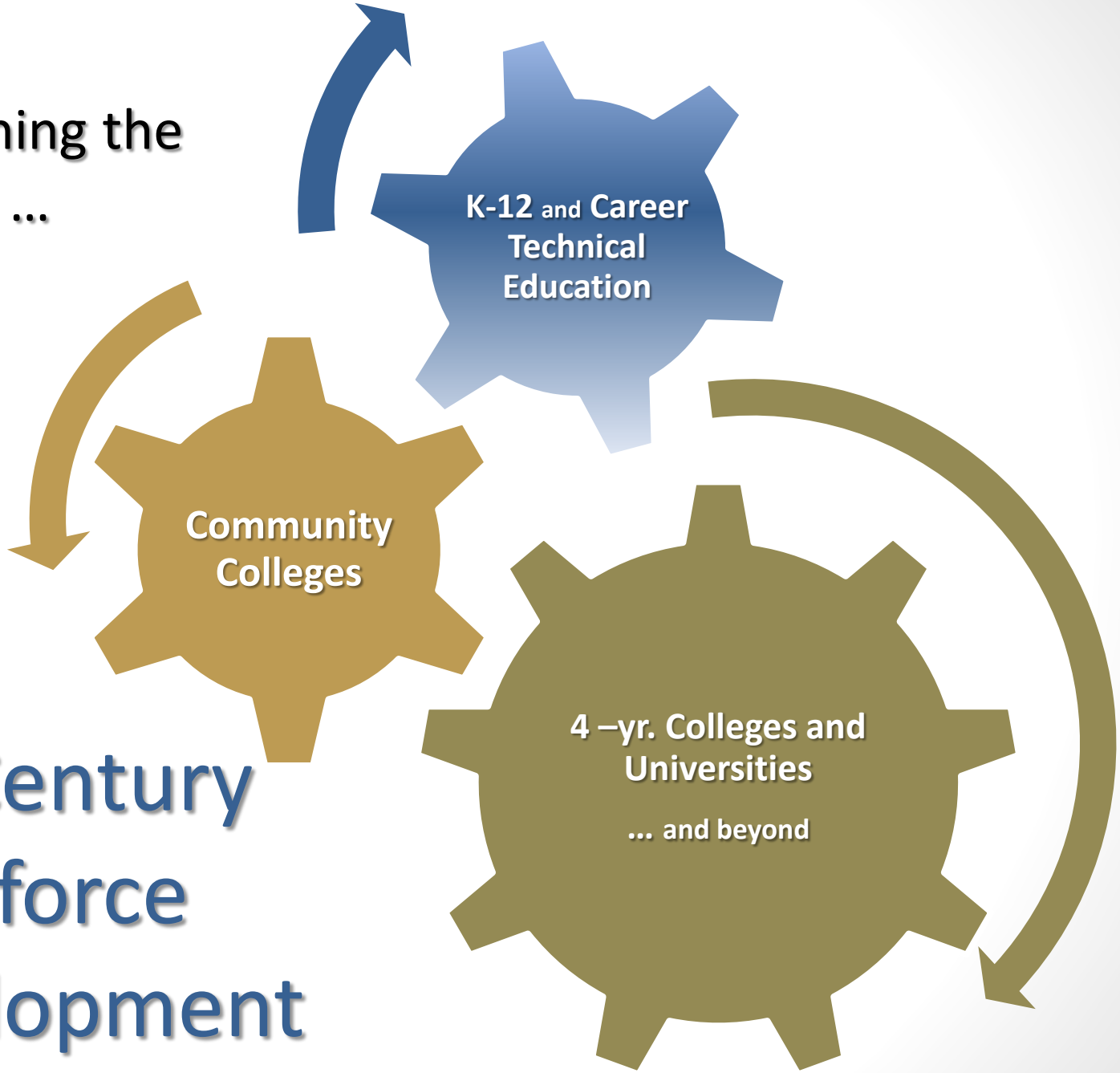
- PCAST K-12 STEM Education Report
  "PREPARE and INSPIRE"
- National Academy of Sciences
  "Successful K-12 STEM Schools"
- National Academy of Sciences
  "Framework for K-12 Science Education
- National Science Foundation
  "Preparing the Next Generation of STEM Innovators"
- Next Generation Science Standards (NGSS)
- American Meteorological Society
  "Earth System STEM Education Policy Statement"



Office of Science and Technology Policy

NATIONAL ACADEMY OF SCIENCES

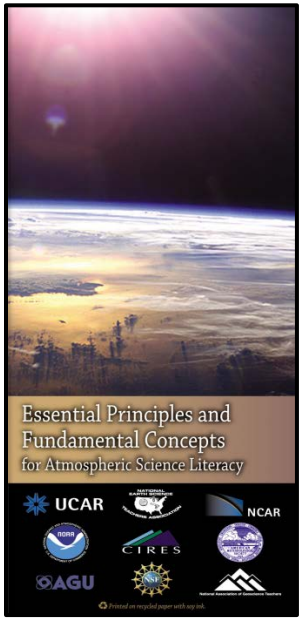
Establishing the Pipeline …

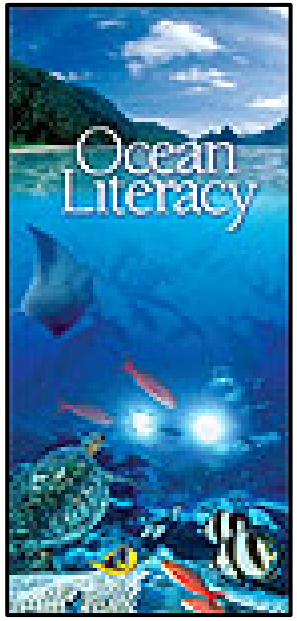


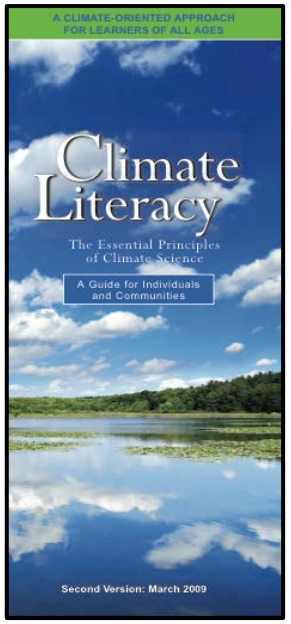
21st Century Workforce Development

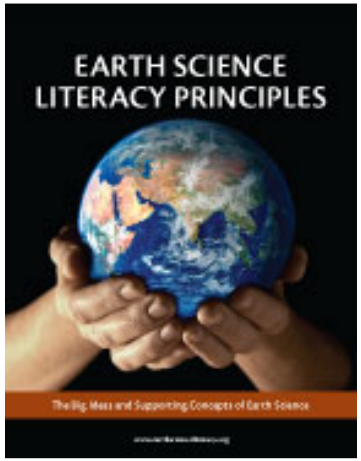
Geoscience Literacy

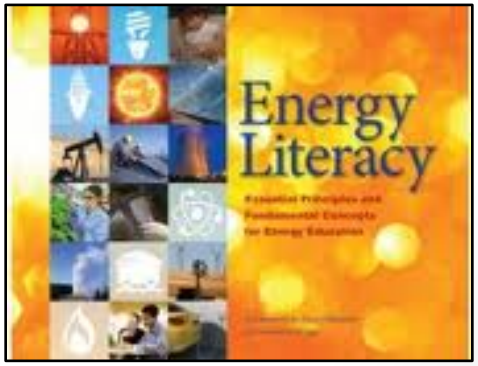
- Earth
- Oceans
- Atmosphere
- Climate
- Energy



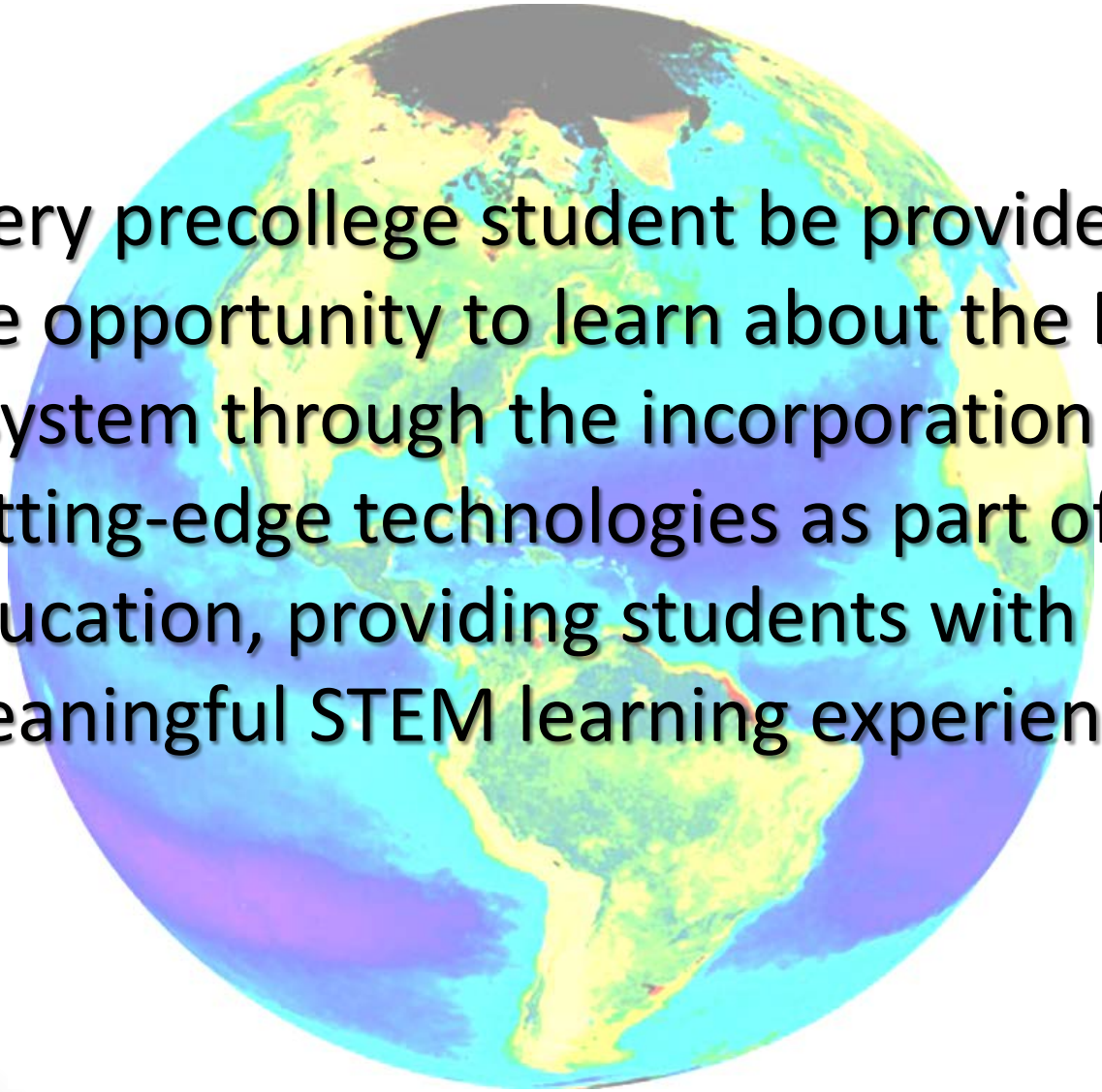






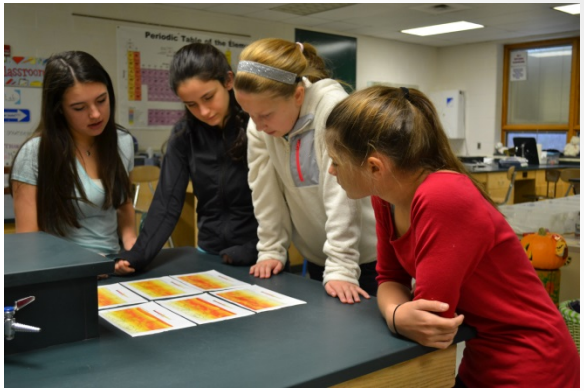


American Meteorological Society Challenge



Every precollege student be provided with the opportunity to learn about the Earth as a system through the incorporation of cutting-edge technologies as part of STEM education, providing students with meaningful STEM learning experiences

Impacts on Precollege Education



- foster an interest and understanding of STEM disciplines and their relationship to Earth system science
- encourage students to pursue a career in STEM disciplines, including earth system science
- promote a lifelong understanding and appreciation of STEM and its role in advancing social and economic well-being
- increase STEM literacy to establish an informed public
- expand opportunities to broaden participation and enhance diversity
- ensure focused, rigorous, and articulated as a sequence of topics and performances
- encourages institutions of higher learning to examine their admissions requirements

Earth SySTEM Education*

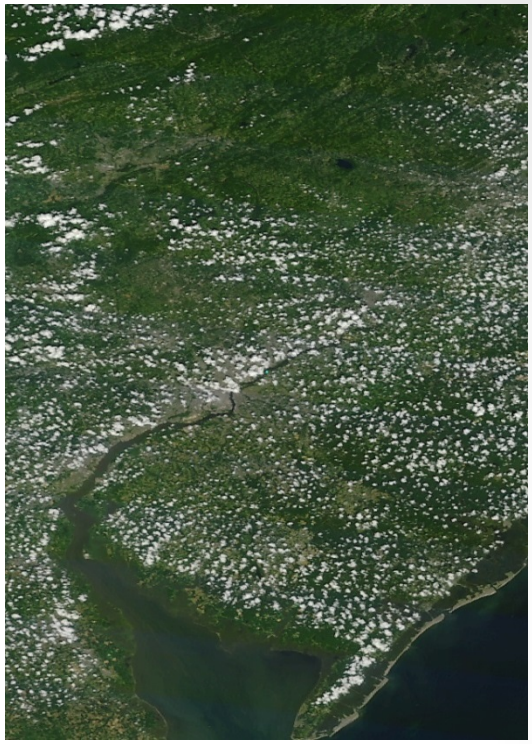
Applications of the **Geosciences*** in **Science, Technology, Engineering, and Mathematics (STEM) Education**

Earth SySTEM utilizes satellite imagery, remote sensing technology, real-time data, and computer visualizations to facilitate interactions between STEM disciplines in the study of Earth as a system.

* Geoscience as defined by the NSF … Earth-Oceans-Atmosphere/Space

- AMS Earth System STEM Education Policy Statement https://www.ametsoc.org/POLICY/2014Earth_STEM_Education.html

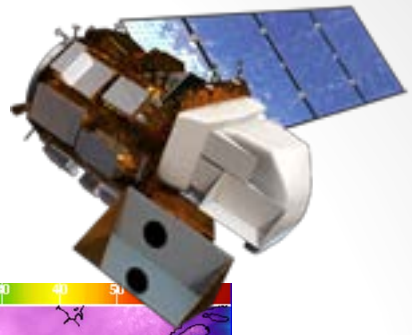
SPACE-EARTH : EARTH-SPACE

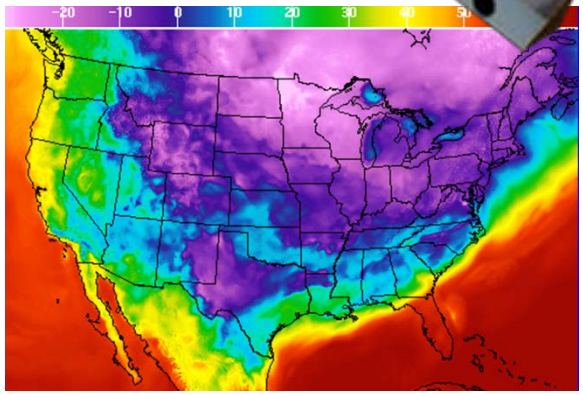


An Integrated “SEES”
Earth SySTEM Educational Model

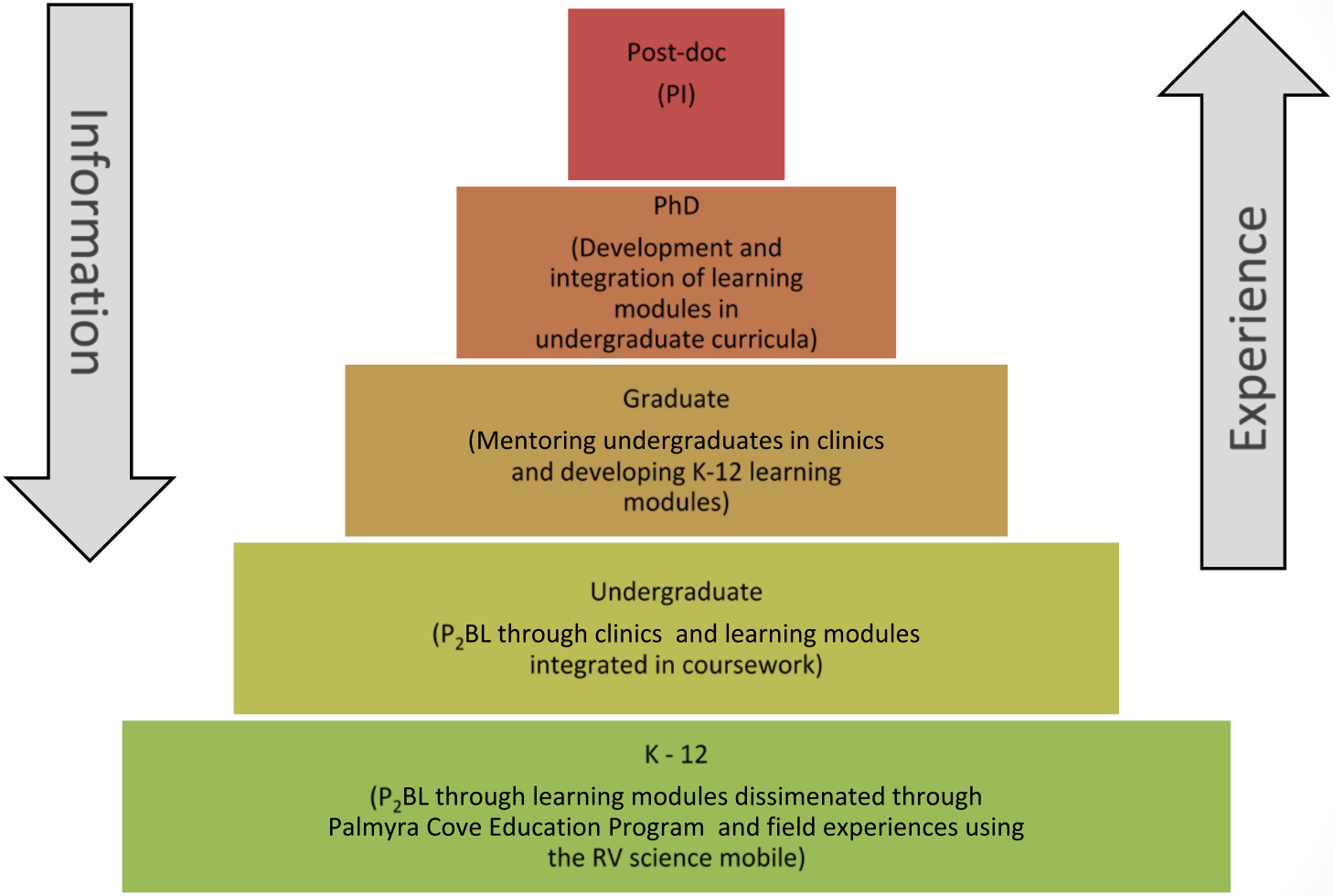
- Fosters Geospatial Thinking
- Identifies geo-referenced data points/sources
- Incorporates Real-time Data
- Develops Geoscience and Remote Sensing content and applications

Geoscience and Remote Sensing Laboratory





- Real-Time Data
- Google Earth Display
- Geographic Information System (GIS)
- Image Analysis
- Study Earth as a System
- Monitoring
- Field Observations and Data Collection


Information
Post-doc
(PI)
PhD
(Development and integration of learning modules in undergraduate curricula)
Graduate
(Mentoring undergraduates in clinics and developing K-12 learning modules)
Undergraduate
(P_2BL through clinics and learning modules integrated in coursework)
K - 12
(P_2BL through learning modules dissimenated through Palmyra Cove Education Program and field experiences using the RV science mobile)
Experience

Research Experiences for Teachers

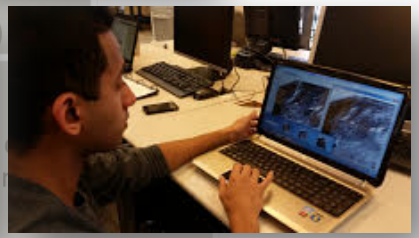
Information

Experience



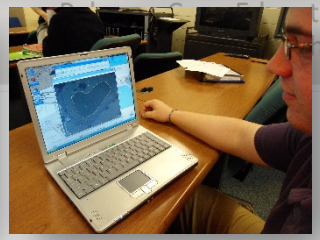
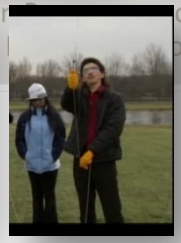
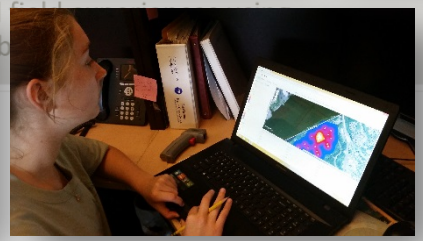
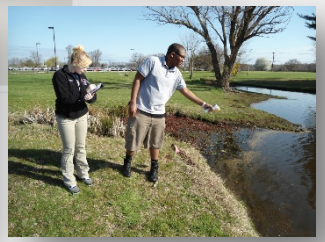




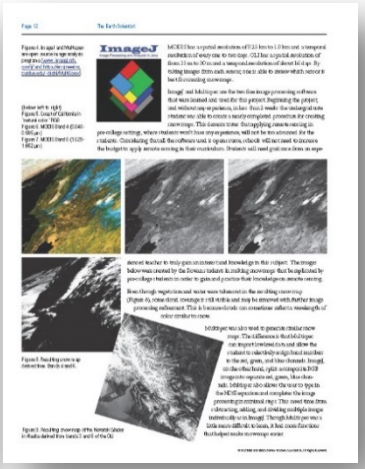


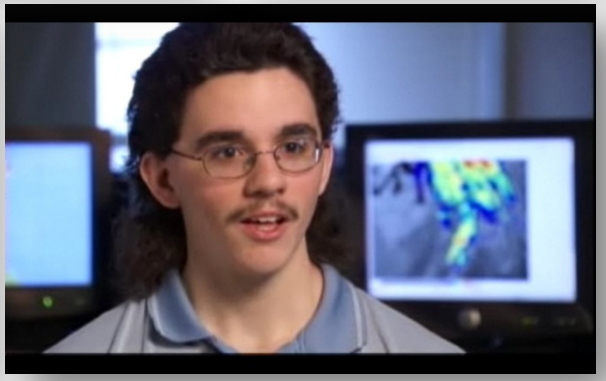




ASSESSMENTS?





The GLOBE Program

IEEE GRSS Geoscience and Remote Sensing Society

Eyes in the Sky II

Satellite Educators Association

Application of Earth SySTEM in Establishing a Geospatial Intelligence Pipeline

Kevin Varghese, Peter T. Dorofy, Rouzbeh Nazari

Rowan University

INTRODUCTION

K-12 Students are given limited opportunity in the classroom to acquire and interpret geospatial information. The next generation science standards (NGSS) include earth system and real-time data; however, this is not yet fully realized in current school curricula. A future workforce trained in geospatial intelligence will be necessary to meet 21st century challenges of a changing global environment. Applications of STEM education in Earth System - Earth SySTEM can be introduced into precollege to graduate curriculum to prepare students for these 21st century geospatial intelligence skills.

PURPOSE

The purpose of this investigation is to demonstrate an application of Earth SySTEM that can be reproduced by K-12 teachers who have limited funding and IT support. The application is the creation of snow maps using free image processing software. A procedure has been documented and slated for publication in a future issue of *The Earth Scientist*, a quarterly journal by NESTA.

FREE RESOURCES

- ImageJ and Multispec Software
- LandsatLookViewer (USGS)
- EOSDIS (NASA)

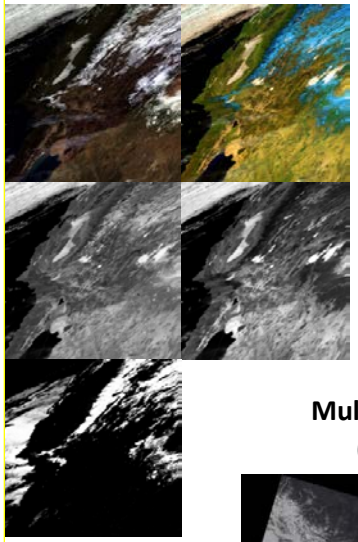
THEORY

- $\text{NDSI} = \frac{0.56-1.61}{0.56+1.61} \geq 0.4$
- Sensors – OLI & MODIS

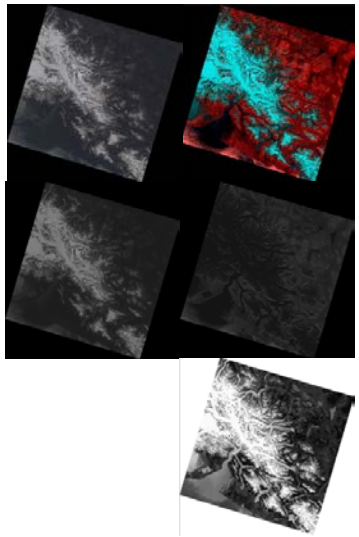
Snow is distinguished from water and clouds by thermal and reflectance properties. The Normalized Difference Snow Index (NDSI) is used to discriminate snow pixels from water, land, and cloud pixels.

PRODUCT

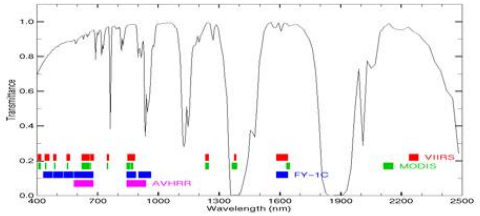
ImageJ Snow Map Trial (California Coast)



Multispec Snow Map (Novatek Glacier)



The 0.6 μm "green" and short-wave infrared near 1.6 μm bands are used in the NDSI algorithm. Index values >= 0.4 are classified as snow pixels.



OBSTACLES

Clouds can have similar reflectance to snow, which makes classification difficult in images that are not "cloud free". In the current model, water at times, is mistakenly represented in the snow maps, and may be a procedural error during image processing. A procedure needs to be created for precollege students. It is important students be engaged in the activity in order to develop young interest in remote sensing.

CONCLUSIONS

Discrimination of snow from land appears to work well; however, there persists a misclassification of pixels as snow, especially off the coast of California, where "true color" images reveal water. ImageJ was able to produce black and white snow maps that easily reveal areas of snow. Multispec produced greyscale images which makes it more difficult to differentiate snow from everything else; however, Multispec is better equipped to work with low level satellite data.

FUTURE WORK

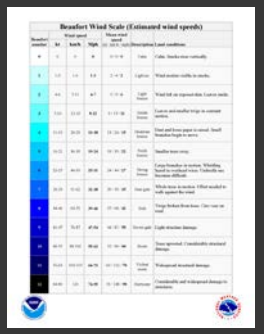
In order to remove the water from snow maps, we have to remove all NDWI values from the image. Creating a threshold limit on the Multispec images are necessary to create black and white images representing only snow. Steps taken to create these snow maps need to be recorded for students to follow.

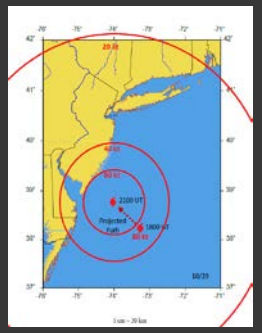
Using Environmental Intelligence to Develop Resilience Strategies: Hurricane Sandy 2012

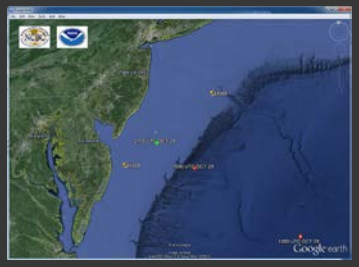
In 2012, New Jersey encountered Hurricane Sandy, a storm of historic proportions. The impacts were significant even though Sandy was classified as post- tropical cyclone as it made landfall. “Hurricane Sandy was the 18th named tropical cyclone of the 2012 Atlantic hurricane season (June 1 – November 30). Sandy formed in the central Caribbean on October 22nd and intensified into a hurricane as it tracked north across Jamaica, eastern Cuba and the Bahamas. Sandy moved northeast of the United States until turning west toward the mid-Atlantic coast on the 28th. Sandy transitioned into a post-tropical cyclone just prior to moving onshore near Atlantic City, NJ” (source: NWS).

- **Buoy Data**
- **Satellite Imagery**
- **Hurricane Tracking**
- **Sea Surface**

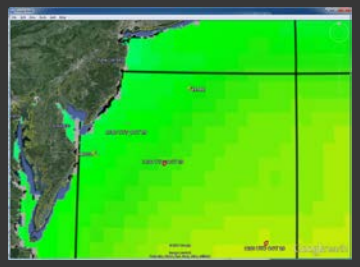
New Jersey M.Y.S.P.A.C.E. Team



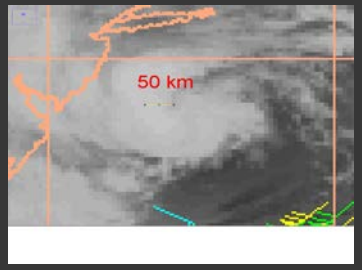




Google Earth overlay of Buoy locations and Sandy Track



Google Earth Sea Surface temperature overlay w/Buoy and Sandy track



GOES 12 Image Analysis Using Image J software to approximate Radius of Maximum Winds (RMW) 29 Oct 2012, 1800 UT.

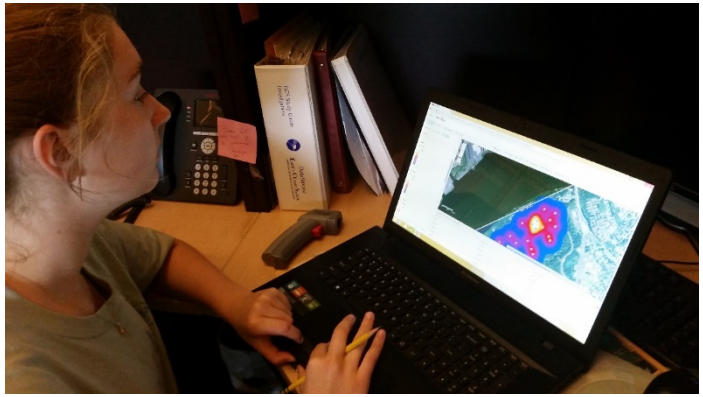
Suomi NPP Visible Image Overlay in Google Earth showing Buoy, Sandy track. 29 Oct 2012, 1800 UT

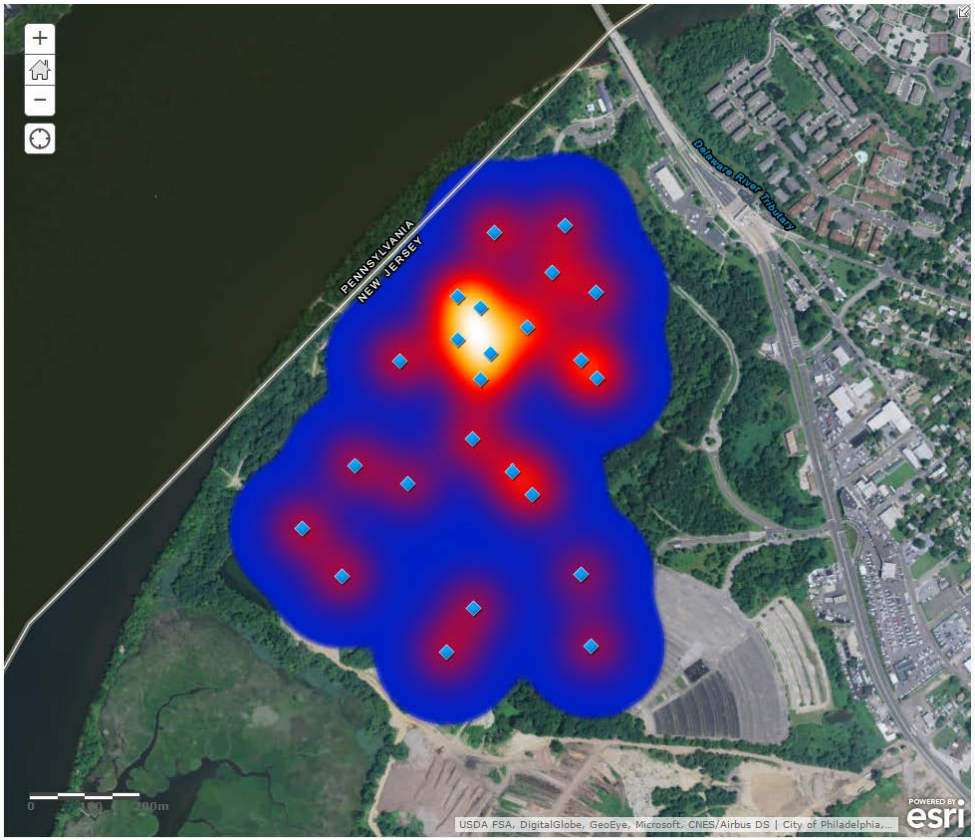
$$V_r = V_{max} \left(\frac{R}{r}\right) x$$

*Formulas derived for this project were developed by Dr. S. A. Hsu, Louisiana State University

This project uses multiply sources of remote sensing data and scientific research to calculate the impacts of a hurricane wind field. “Tropical storm-force winds are strong enough to be dangerous to those caught in them. For this reason, emergency managers plan on having their evacuations complete and their personnel sheltered before the onset of tropical storm-force winds, not hurricane-force winds Hurricane-force winds, 74 mph or more, can destroy buildings and mobile homes. Debris, such as signs, roofing material, siding and small items left outside become flying missiles during hurricanes. Winds can stay above hurricane strength well inland”.
(source: National Hurricane Center).

Through **applications of physics principles and mathematical formulas***, students are able to calculate wind speeds throughout the hurricane’s wind field. Remote Sensing data from NOAA’s National Climatic Data Center, National Buoy Data Center, and the National Weather Service are all important data sets used in this project.




PENNSYLVANIA
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USDA FSA, DigitalGlobe, GeoEye, Microsoft, CNES/Airbus DS | City of Philadelphia,...
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esri

The American Council of STEM Educators

John D. Moore
mr.moore.john@gmail.com

- “Making the Case for GeoSTEM Education”
- “An Opportunity for Innovation in STEM Education: GeoSTEM”
- “GeoSTEM: Establishing a Geoscience and Remote Sensing Laboratory”
- “Exploring New Frontiers in Earth System Education: GeoSTEM”