Fall Technical Meeting Agenda

October 10–11–12, 2011

Cleveland State University, Cleveland Ohio

Sunday, October 9, 2011

6:00-8:30 pm	*Welcome Reception in the Wyndham Lobby*		

Monday

7:30-8:30 am	*Working Breakfast*		*Main Classroom Auditorium Lobby*
	Technology Committee Meeting	**MC Auditorium**	**Sam Batzli, Chair**
	Education Committee Meeting	**MC 101**	**Tom Mueller, Chair**
	OhioView State Meeting	**MC 102**	**Jim Lein, OhioView Director**
8:30-8:50 am	*Welcome*		*Main Classroom Auditorium*
	AV Board Chair Ramesh Sivanpillai, AV Executive Director Rick Landenberger, OhioView Director Jim Lein and CSU Local Host Pete Clapham		
9:00 - 9:40 am	*Keynote Address*		*Main Classroom Auditorium*
	Historical Reflections on OhioView **Honorable Ralph Regula**		
9:40 - 10:10 am	*Special Session*		*Main Classroom Auditorium*
	Emergency Response **Ramesh Sivanpillai Moderator**		
10:10 - 10:30 am	*Break*		

10:30 - 12:00 am	*Educational Applications of Remote Sensing*	*Remote Sensing Lab*

SESSION 1A

Integrating GEOBIA Research with Service Learning: Two Case Studies

J. B. Sharma (Gainesville State College, GeorgiaView) jsharma@gsc.edu

The availability of high spatial resolution data from a variety of sensors and the advent of robust GEOBIA tools has created numerous possibilities for high spatial resolution mapping. High spatial resolution land cover maps are essential for environmental and urban mapping applications and have a very significant economic similitude. Effective GEOBIA based high spatial resolution mapping can involve data fusion from multiple sensors. Two case studies will be presented; one of an urban area of downtown Gainesville, GA and another of a nearby wooded nature preserve. A land cover map of downtown Gainesville has been developed based on 2010 CIR NAIP Imagery and LiDAR. The extent of the impervious surface is used to assess the storm water utility tax that can be used by the County to ameliorate the increasing stream scour and flooding. In the second case, Quickbird multispectral imagery is used to identify tree species in the Elachee Nature Center forest. These classification rule-sets in both cases are developed by undergraduate students using eCognition software and their studies are delivered to stakeholders in the community. Issues relevant to the promotion of GEOBIA education via such service learning projects will also be discussed.

Image Data Sets to Support Remote Sensing Instruction in Virginia's Community Colleges
Baojuan Zheng, James Campbell, and John McGee (Virginia Tech, VirginiaView)
baojuan5@vt.edu

Community college instructors often find they lack teaching materials suitable use at their institutions. This paper describes a set of teaching data developed for use within the community college environment. It provides a selection of easily accessible Landsat 5 TM data sets representing a range of Virginia's environments and regions. It consists of eight data sets in convenient formats, many formed of registered images representing different dates or seasons, which can be used for, but not limited to, change detection and image classification. Together, they represent a cross section of Virginia's landscapes, and offer examples within a reasonable distance of each Virginia's community college. These data sets can be used for a variety of supporting remote sensing instruction; they form a resource supporting STEM education in Virginia's Community College System.

Google Earth in Education Discussion **Rick Landenberger, Moderator**

10:30 - 12:00 pm *Environmental Monitoring with Remote Sensing* *MC101*

SESSION 1B

Glacier Retreating or Glacier Advancing? An Environmental Consequence from Himalayan Perspective
Umesh K. Haritashya (University of Dayton) Umesh.Haritashya@notes.udayton.edu

Climate change science and glaciology has seen some intense discussion in last few years. Great controversy occurred over the IPCC's Working Group II report in Fourth Assessment regarding the nature of glacier fluctuations in the Himalaya in which the IPCC erroneously reported that the Himalaya could be ice-free by 2035. In such a monumental and well produced report, errors can be expected. However, this statement still caused major headlines in *Science News*, and other major news media. In November 2009, the Indian government also prepared a status report of Indian Himalayan glaciers where they rightly pointed out the 2035 error, but also came up with equally an unsubstantiated new error that Himalayan glaciers respond to climate change on timescales of 6,000-15,000 years. Such a response time implies implausible extrapolations of past ice thicknesses. Report also failed to link any physical mechanism, empirical evidence or modeling result. Although both these reports were exaggerated, the status of glacial ice in the Himalaya continues to be a major concern, because so little is known about the complex climate-glacier dynamics and numerous feedback mechanisms operating throughout the Hindu-Kush Himalayan range. While these glaciers are thought to be very sensitive to climate change, we do not yet understand glacier sensitivity to climate forcing, trends in regional mass balance, and glacier melt-water contribution to rising sea level. This presentation will provide current status of these glaciers as we assess their distribution, ice-flow, sensitivity to different climate forcings, and environmental consequences.

Mapping an Invasive Forest Shrub in Southwest Ohio using Landsat TM and ETM+ Data
Mary C. Henry (Miami University of Ohio), David L. Gorchov, mary.henry@muohio.edu

Amur honeysuckle *(Lonicera maackii)* is an exotic invasive forest understory shrub introduced to North America from Asia in the late 1800s. It has become naturalized throughout the Midwestern United States, where it has detrimental impact on native trees and shrubs. As part of a continuing effort to map its spread, we have used Landsat TM and ETM+ data to generate landcover maps, relate field-based measurements to spectral characteristics, and attempt to predict the percent cover of *L. maackii* in woodlots along the leading front of the invasion in southwest Ohio. The availability of free Landsat data has allowed undergraduate and graduate students to contribute to this work, even during times without grant funding and has contributed to our ability to obtain external funding.

Environmental Compliance Monitoring Using Moderate Resolution Systems: The Landsat Example
James Lein (Ohio University), lein@ohio.edu

Despite the well-documented application of remote sensing in environmental analysis and assessment, the operational use of this technology for environmental compliance and enforcement activities remains under-exploited. Because the majority of environmental laws and regulations in the United States were enacted prior to the emergence of a mature science of remote sensing, there exists a degree of skepticism regarding the operational utility and reliability of remotely sensed data as an environmental compliance tool. In this paper research is presented that evaluates the capacity of moderate resolution systems to support environmental compliance requirements and introduces a framework to guide the implementation of satellite-based compliance programs based on the Landsat satellite. Using a case study approach, this paper demonstrates how surface anomalies detected in imagery can be more closely related to meaningful compliance indicators.

Urban Tree Canopy Assessments
Jarlath O'Neil-Dunne (University of Vermont) and Marvin Bauer (University of Minnesota) joneildu@uvm.edu

Remotely sensed data is helping cities across the United States to set Urban Tree Canopy (UTC) goals. Increasing tree canopy in urban areas is seen as an important mechanism for dealing with a multitude of environmental problems ranging from the urban heat island effect to storm water runoff. The UTC Assessment Protocols, jointly developed by the USDA Forest Service and the University of Vermont, have been applied to over 300 communities within the United States and Canada. Both VermontView and MinnesotaView have completed UTC assessments within their states. UTC assessments are an excellent way to connect researchers and decision makers, raise the profile of remote sensing, employ cutting-edge technology, and train the next generation of remote sensing professionals. This presentation will provide an overview of the UTC Assessment Protocols and discuss how other StateViews can get involved with the UTC Assessment program.

12 - 1:15 pm	***Lunch***	***Main Classroom Atrium***

1:15 - 2:45 pm	***Earth Observation Day***	***MC102***

SESSION 2A

Earth Observation Day: Past, Present, and Future
Tom Mueller (California University of Pennsylvania), John (Jay) Morgan, Pia van Benthem, Rick Landenberger, rick.landenberger@mail.wvu.edu,

Earth Observations Day (EOD) is an education and outreach initiative of the AmericaView Consortium and our partners. AmericaView's educational vision involves raising awareness of the many uses of remote sensing technology and satellite imagery. The purposes of EOD include 1) recognizing the importance of remotely sensed data for observing and monitoring the Earth; and 2) promoting the use of remote sensing technology by K-16 teachers throughout the biological, physical, and social sciences curricula. Landsat images are a key resource for EOD activities, and provide teachers with free and easily accessible data needed for spatial analysis in the disciplines of general science, Earth and environmental science, biology, physics, geography, and modern history. In addition to introducing teachers and students to remote sensing fundamentals, EOD events can include hands-on data collection and data analysis of local land cover and land use change, enabling participants to integrate image, map, and ground observations with activities directly tied to science and technology standards. As an outreach activity, EOD 2012 will set the stage for a scale-up of activities in future years in which all StateViews in the growing AmericaView consortium will develop and support EOD events with themes of their choosing, to include hydrology and watershed science, biological conservation, natural hazards management, urban heat island analysis, and other STEM and relevant social science topics. All educational materials developed for EOD will be made available on the AmericaView web site.

Connecting Earth Observation Day to the Local Landscape: The Texasview Experience
Rebecca Dodge (Midwestern State University), P. R. Blackwell (Stephen F. Austin State University) and Teresa Howard, rebecca.dodge@mwsu.edu,

TexasView's Earth Observation Day efforts have focused for the past year on developing a web-based GIS that uses a Landsat mosaic as base layer, and includes maps of physiographic regions, ecoregions and cities/counties/roads in the state. The site also presents a 12-month sequence of MODIS imagery that runs as an animation or can be viewed as single images. The state parks map is included on another layer; eleven parks scattered across the state have direct links to state park web sites with short (3 to 5 minute) videos that tour the parks. The site has been introduced to teachers in the 39-district, 12-county Region 9 geographic area of north Texas, for use in middle- and high-school classes that deal with ecosystems, seasonal changes, and earth science. Based on suggestions made during a recent visit with Texas Parks and Wildlife Department outreach specialists from across the state, several new layers are being added to the site including Biotic Provinces; Natural Regions and Subregions; Rainfall; River Basins; Rivers, Reservoirs, and Major Bays; and Geology. The TPWD has agreed to link their outreach website to the TexasView EODay resources, which are linked to the AV EODay web resources, and to work with TXView to develop more educational outreach materials. Future work will involve broader introduction of the website by TexasView members within their service areas, as well as development of learning activities linked to state science standards that use the web site GIS capabilities. Lesson plans and activities related to application of satellite imagery for land cover and land cover change mapping will be made available from existing sources, and new lesson plans that use the state park videos as "virtual field trips" leading to imagery applications such as classification, NDVI mapping, and change detection will also be developed.

Education Resources Sharing Panel
Moderator: Rick Landenberger (AmericaView Executive Director), Panel: Tom Mueller (PennsylvaniaView), Mary O'Neill (South Dakota View), Jay Morgan (MarylandView), Kevin Czajowski (OhioView), and Stefan Smolski Rick.Landenberger@mail.wvu.edu

AmericaView's mission includes a strong element of K-12 geospatial science and technology education. As an organization that fosters leveraging and sharing of resources, AmericaView partners are often engaged in similar activities involving teacher professional development training institutes, in-person and online support, and classroom visits. Because these activities can involve the use of lessons, lesson plans, lectures, demonstrations, and other resources that require significant time and effort to develop, partners often share their materials in an attempt to reduce each other's workloads, and engage in the highest quality training possible. Despite this, AmericaView has no formal mechanism to share resources efficiently and effectively among themselves. This panel will discuss how they have shared among themselves to this point in AmericaView'shistory, and outline a plan to improve sharing and leveraging in the future.

1:15 - 2:45 pm *Software Tutorial* *Remote Sensing Lab*

SESSION 2B

Remote Sensing Data in a WMS
Sam Batzli (University of Wisconsin Madison) sabatzli@wisc.edu

Web Mapping Services (WMS) are an increasingly popular way to distribute geospatial information. Remote sensing imagery, because of its inherent file size issues, is difficult to share. WMS offers one solution, but there are serious performance limitations to consider. This workshop will offer a demonstration of building of a WMS of satellite imagery from start to finish. It will include discussions about key decisions that need to be made along the way to optimize performance. Attendees will test the WMS in qGIS or related desktop GIS software.

2:45 -3:00 pm *Break*

3:00-445 pm *Remote Sensing of Water Resources* *MC102*

SESSION 3A

Great Lakes Area of Concern Tributary Monitoring Program
Robert Shuchman (Michigan Tech Research Institute), Colin Brooks, Mike Sayers, K. Arthur Endsley, Jamey Anderson, Nate Jessee, Shuchman@mtu.edu

The Michigan Tech Research Institute (www.mtri.org) is developing remote sensing products to help the Great Lakes Observing System (www.glos.us) Area of Concern Tributary Monitoring Program. The purpose of this study is to support ecosystem restoration and protection efforts in five pilot tributaries. Moving west to east the pilot tributaries are: St. Louis River (Lake Superior), Lower Fox River/Green Bay (Lake Michigan), Saginaw River and Bay (Lake Huron), Maumee River (Lake Erie), and Genesee River/Rochester Embayment (Lake Ontario). The purpose of our remotes sensing data is to support efforts that address beneficial use impairments (BUIs) in these areas of concern (AOC) and facilitate measurements of restoration progress. Utilizing Landsat, MODIS, and MERIS satellite sensors, we are generating the following products: lake surface temperature, land cover maps, bottom type mapping, optical depth/water clarity, sediment plume extent mapping, chlorophyll, dissolved organic carbon, suspended minerals, and harmful algal bloom extent mapping. Additionally, we have developed a website (www.glosaocmapping.org) that allows local stakeholders and other Great Lakes users to access up-to-date products that are generated on a weekly, and when possible, daily timescale. Along with current data, we will also be provided historical products going back to 2002 through the end of 2010. This website will allow us receive feedback from researchers and community members in each AOC, and tailor our products to meet their needs and desires when possible. This collaboration will prove to be beneficial as we better understand the environmental monitoring needs of researchers, local interested groups, and stakeholders in each region.

Remote Sensing of Cladophora and Water Clarity in the Great Lakes
Robert Shuchman, Michael Sayers, Liza Jenkins, Colin Brooks, Martin Auer, Guy Meadows (Michigan Tech Research Institute) Shuchman@mtu.edu,

Using a new remote sensing algorithm, we have been able to map Cladophora extent and biomass in the near shore waters of the Laurentian Great Lakes. The algorithm utilizes the blue, green and red visible bands of electro-optical satellites such as MODIS, MERIS, Landsat TM, and higher spatial resolution (~2m) commercial multispectral data from GeoEye and DigitalGlobe. The algorithm maps cladophora using a depth invariant bottom reflectance index and has been successfully tested on satellite data sets of varying resolution of the

Sleeping Bear Dunes National Lakeshore (SBDNL) in Lake Michigan where this is extensive "lake" truth and cladophora extend and biomass. Using 30 meter resolution Landsat imagery, we have been producing maps in 4 of 5 Great Lakes: Lakes Michigan, Huron, Erie and Ontario. In addition to our cladophora extent maps, we have also produced water clarity and optical depth maps using the same algorithm. We have compiled a time series analysis of water clarity over time for Lake Michigan and are currently processing imagery for Lakes Ontario, Erie and Huron. The water clarity time series maps provide a unique look into changing water conditions of the great lakes over a multi-decade time span. This time series graph allows us to see the impact of invasive species and land use changes over time and how water clarity is impacted. Finally, we will be sharing our products through our website, www.mtri.org and other regional web portals.

Using Landsat Remote Sensing to Monitor Geographic Patterns and Temporal Trends of Water Quality of Minnesota Lakes

Marvin Bauer (University of Minnesota), Leif Olmanson, Trent Erickson and Patrick Brezonik, mbauer@umn.edu

Research by the University of Minnesota has documented a strong relationship between Landsat multispectral data and on-site measurements of water clarity, an important indicator of water quality. The high quality, geographic coverage, and availability of Landsat data make it particularly useful for monitoring inland lakes. The geographic coverage of 12,000 square miles per image allows for rapid, inexpensive monitoring of thousands of lakes throughout Minnesota. Its spatial resolution of 30 meters is suitable for monitoring lakes as small as 10 acres and can be used to map in-lake variability. There is strong agreement between in-situ measurements and Landsat estimates. Seven classifications at approximately five-year intervals from 1975 to 2008 have provided an unprecedented record of Minnesota lake water quality. We have analyzed the data for temporal trends and geographic patterns, and relationships of water quality to land use, lake properties and demography. Analyses are possible for individual lakes and lake basins, as well as by county, ecoregion, and watershed. Mean water clarity at the state level has remained relatively stable; 4.6% of lakes had increased clarity and 6.2% decreased. However, there are strong geographic patterns with lower clarity in the south and higher clarity in the north. Deeper lakes tend to have higher clarity and are more stable than shallow lakes and agricultural and urban land use are associated with lower clarity. These patterns are evident at catchment, watershed, county, ecoregion and statewide levels. Data for all lakes and years are available in the LakeBrowser, a web-based mapping tool that enables searches and display of results for individual lakes at: water.umn.edu. The data are widely used by the Minnesota Pollution Control Agency and other agencies and citizens with more than 50,000 annual visits to the website. The results are being used by lake managers and policymakers in making decisions about land development and to improve the management of lake resources. The presentation will conclude with suggestions for other states to consider this application of Landsat remote sensing.

Integrated Remote Sensing For Regional Evapotranspiration Estimation

Subramania I. Sritharan (Central State University), Xiaofang Wei, Ramanitharan Kandiah, Doyle Watts, Robert Vincent, Sridhar Balaji, Christopher Neale, Pete Clapham, Sumantra Chatterjee, John Osterberg, Sri@Centralstate.Edu

An integrated effort was undertaken to find cost optimal methods to estimate evapotranspiration (ET) in the Lower Colorado River (LCR) region using remote sensing for managing the water resources of Colorado River. A multi-year project was undertaken to improve methods currently used by the United States Bureau of Reclamation (USBR) for regional ET estimation and to determine the ET from the riparian areas of the LCR region. Of particular emphasis was the determination and groundtruthing of ET from riparian vegetation in the LCR dominated by Tamarisk. In addition to data from MODIS and Landsat 5 spectral data were gathered through low altitude and medium altitude flight. The work resulted in establishing Bowen Ratio(BR) towers in the riparian vegetation of different densities and in obtaining ET estimates under similar conditions. Remote sensing work involved The work also resulted in estimating the steam- aquifer interaction in the LCR region and results in the improvement of current practices of determining unmeasured returns through such interaction by the USBR.

Mapping Seagrass in North Carolina Estuaries Using the WorldView_2 Satellite Data

Yong Wang and Richard W. Curran (East Carolina University) wangy@ecu.edu

Submerged aquatic vegetation (SAV) is a valuable natural resource in North Carolina estuaries. The State's Coastal Habitat Protection Plan (CHPP) has stated a need to monitor SAV coverage over time. Thus, the Albemarle-Pamlico National Estuarine Program (APNEP) SAV Partners has a project underway developing a mapping methodology combining remote sensing and boat-based methods to map SAV. As a partner in the APNEP mapping program, this research investigated the utility of satellite remote sensing image in the mapping of SAV

in NC estuaries. In particular, the data of DigitalGlobe's WorldView-2 (WV-2) satellite launched October 2009 were studied. The WV-2 data are of high spatial resolution (~2x2 m), and 5 visible multi-spectral bands including a "coastal" band (400-450 nm). One WV-2 image per site was acquired. Three sites were Jarrett Bay, Blounts Bay, and Sandy Point. Land and deep water (>2 m) pixels were eliminated from each image and subjected to a principal component analysis (PCA), where the first two components were input into the Iterative Self-Organizing Data Analysis Techniques (ISODATA) unsupervised classification. Ground reference points were used to perform an accuracy assessment. At the Jarrett Bay, where a continuous SAV bed covered 40%-70% of the study site, results showed an 86.4% classification accuracy in water depths < 0.8 m and 40.9% accuracy in water depths > 0.8m. At the Blounts Bay, where SAV coverage was sparse (0%-10%), classification accuracy was 50% in water depth < 0.8 m and remained at 50% in depths > 0.8m. The Sandy Point image was deemed unusable due to extensive sun glint. Most misclassifications were due to dark sediment and the sensor's difficulty in detecting small SAV patches (< 1x1 m). Additionally, according to the environmental conditions present in the images, a water depth threshold where WV-2 can accurately detect SAV was determined at 0.8 m in NC estuaries. With improved water clarity, this 0.8 m threshold would increase. Finally, the unique coastal band was highly susceptible to scattering and absorption due to suspended sediment and colored dissolved organic matter (CDOM) present in the water column of the study area.

3:00-4:45 pm *Software Tutorial* *Remote Sensing Lab*

SESSION 3B

OPTICKS workshop
Tony Wolf, Trevor Clarke, Kip Streithorst and Michael Considine
(Ball Aerospace & Technologies Corp.)

Opticks was originally developed by Ball Aerospace for the US Air Force, specifically the National Air and Space Intelligence Center (NASIC) starting in the Spring of 2000. It was originally created for hyperspectral analysis, but was designed to be easier to use than ENVI, the tool of choice for researchers at the time. Opticks is meant to be used for non-literal exploitation as opposed to geospatial imagery analysis performed by tools such as GRASS and QGIS. Ball Aerospace and the Air Force started working jointly in 2006 to release the core application into the open source, excluding some of the processing algorithms. This was accomplished to great fanfare in December 2007. Both Ball Aerospace and the Air Force continue to support this open-source effort. Since the original open-source release of Opticks, Ball Aerospace and the Air Foce have worked to release some previously closed-source Opticks extensions. Specifically, the IDL Scripting and Spectral Processing extension were transitioned from closed source extensions and brought out into the open source. In a demonstration of our commitment to open source, the Python Scripting extension was developed as open source from day one.

6:00 - 8:00 pm *Networking Dinner* *Wyndham Hotel Banquet Room*

Life, The Universe ... and AmericaView
Tom Cecere (USGS)

As our past has shown, the future is ever evolving and uncertain. This talk will try to place some perspective on the USGS Land Remote Sensing Program, the evolution of AmericaView, and look at some of the possibilities and needs as we move into the future.

Tuesday

7:30 - 8:30 am	*Working Breakfast*	*Main Classroom Auditorium*
	Technology Committee Meeting	**MC Auditorium Jarlath O'Neil-Dunne & Russ Congalton Co Chairs**
	Outreach Committee Meeting	**MC 101 Mary O'Neill, Chair**
	OhioView State Meeting	**MC 102 Jim Lein, OhioView Director**

9 - 10:15	*Poster Session*	*Main Classroom Auditorium Lobby*

SESSION 4A **Showcasing the Knowledge and Resources of AmericaView**
Introduction by Kevin Czajkowski and Brad Shellito, Program Committee Chairs

Mapping cyanobacterial bloooms in the western basin of Lake Erie using MERIS
Jie Ren, Richard Becker, and Kevin Czajkowski (University of Toledo)
jie.ren@rockets.utoledo.edu

Toxic cyanobacterial blooms have been documented in the western basin of Lake Erie in the last several years. An algorithm based on a non-negative linear least squares regression was developed to discriminate the cyanobacterial blooms from other harmless phytoplankton blooms and to extract relative concentrations from Medium Resolution Imaging Spectrometer (MERIS) satellite data. Lee's quasi-analytical algorithm (QAA) was used to calculate total absorption and backscattering coefficients. A non-negative least square algorithm was then utilized to discern relative concentrations of Chlorophyta (green algae), phycocyanin-rich Cyanobacteria (blue-green algae), and colored dissolved organic matter and suspended sediments combined in lake waters using published absorption spectra for these components. Samples collected from the bloom area in the summers of 2009 and 2010 have been compared with MERIS-derived cyanobacterial concentrations and most of them matched well.

Classifying Forested Land Cover Polygons using Prism Samples and Remote Sensing
Meghan Graham MacLean, Meghan.maclean@unh.edu, University of New Hampsphire

The ability to spatially quantify changes in the landscape and create land cover maps is one of the most powerful uses of remote sensing. Recent advances in object-based image analysis (OBIA) have also improved classification techniques for developing land cover maps. An OBIA technique groups similar pixels in an image into segments prior to classification. However, when using an OBIA technique, collecting ground data to classify reference units may not be straight forward, since these segments generally contain a variable number of pixels as well as a variety of pixel values, which may reflect variation in the forest composition on the ground. This study evaluates how many prism sample locations are needed within a forested reference unit in Southeastern New Hampshire to accurately classify that reference unit using dominant tree species. Current guidelines suggest at least 10 prism samples per stand, depending on the stand area. However, because OBIA segments group pixels so that the variance of the pixels values within a segment is less than the between segment variance, fewer prism samples may be necessary in a segment to properly estimate the stand composition. A bootstrapping statistical technique is used to find the necessary number of prism samples to limit the variance associated with estimating the species composition of a segment. In previous studies, one sample location within a reference unit was often used to assess forest cover type for a reference unit, however this study shows that one sample is not enough and generally 7 or more are needed to classify a polygon reference unit in these forested areas. However, the number of samples necessary was generally less than the number suggested by the current guidelines.

Evaluating 25 Years of Environmental Change Using A Combined Remote Sensing Earth Trends Modeling Approach: A Northern California Case Study
Heather DeWalt, hd173106@gmail.com Ohio University,

Environmental change is a pressing global issue that affects regions in different ways. Mountain glaciers are an important resource for monitoring how regions are being affected by global changes because their advance and retreat are influenced by fluctuations in precipitation and temperature. Monitoring these change trends can be accomplished through the use of remote sensing. Using Mt. Shasta in northern California as the study area, this thesis employed a time-series approach to remote sensing image analysis coupled with a Markov-based procedure to define the environmental trajectories active in the region and project those trends into the future. This experimental approach was applied to a series of yearly images from 1985 to 2010 to examine the

long-term implications of environmental change which were then projected forward in varying increments to 2110. The long-term change signal showed that El Nino cycles strongly influenced regional land cover patterns and controlled glacial advance and retreat. When this pattern was projected into the future, two scenarios were observed: 1) growth if El Nino cycles strengthen or 2) recession if El Nino cycles weaken. Because there is a possibility that the glacier will recede, the area should continue to be monitored.

Are the Rising Ocean Temperatures Affecting the Cholera Outbreaks Around the World?
Riley Mayberry and Emma Clark, Westerville North High School, Susan Wasmund, wasmunds@westerville.k12.oh.us

The disease, Cholera, is an infection of the intestines that is caused by the bacterium, *Vibrio cholera*. The symptoms of the disease include severe diarrhea that can occur up to two hours or up to five days after the infection takes place. This can then lead to extreme dehydration or kidney failure. Of the people that develop the symptoms, 80% are mild and 10-20% are severe. If the disease is left untreated, there is a 50% chance that the disease could be fatal. Cholera spreads by infected fecal matter, which can then be consumed by tainted food and/or water, or from poor sanitation. In the news recently, there have been stories about the massive cholera outbreaks in Haiti. This got us wondering if global warming has anything to do with the outbreaks. When we looked up global warming and cholera, we found out that the cholera bacteria, *v. cholera* was born and spread in the water. This got us wondering if the increasing ocean temperatures were making the cholera bacteria grow more. To start off, we looked online at the reported number of cholera cases per year. It was noticed that overall, gradually, year by year the number of reported cholera cases went up. We took note of this, and then went to look up the ocean temperatures. Just like the cholera cases, the overall temperatures of the ocean water gradually went up year by year. After we made our graphs of the cases and the water temperature, we noticed that the two graphs were very similar in their patterns. When we put the cases and temperature together in one graph, we noticed an overall increase in the cholera cases with the ocean temperature going up. This brought us to the conclusion that the cholera bacteria is in fact, being affected by the rising ocean temperatures. Especially in the past few years, the water in the ocean has been getting warmer, and the cases of reported cholera have also been growing. We believe that our hypothesis of the cholera outbreaks being impacted by the rising ocean temperatures, and thus, global warming, was correct.

Earth Observation Day: Past, Present, and Future
Tom Mueller (California University of Pennsylvania), John (Jay) Morgan, Pia van Benthem, Rick Landenberger, Rick.Landenberger@mail.wvu.edu

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SATELLITES: Improving Spatial Abilities Through Geospatial Technologies
Kevin Czajkowski and Mikell Lynne Hedley (University of Toledo), Kevin.czajkowski@utoledo.edu

The SATELLITES Program (Students and Teachers Exploring Local Landscapes to Interpret the Earth from Space) is an educational outreach program for K-12 teachers and students that has been implemented by the OhioView Remote Sensing Consortium. SATELLITES has now been spread to West Virginia, Maryland and Pennsylvania via AmericaView. The goal of the program is to bring geospatial technology (Geographic Positioning Systems (GPS), Geographic Information Systems (GIS) and remote sensing), and physical geography/Earth science content into classrooms to improve students' spatial abilities. The emphasis of this program is to engage students in real science while forming student/teacher/scientist partnerships. This program has been designed to help teachers meet academic standards in science and technology and to some degree mathematics, language arts and social

studies. Teachers in the program attended a one-week summer institute. Students participate in the GLOBE surface temperature field campaign and develop inquiry-based research projects based on climate change or renewable energy. Students going through SATELLITES have shown statistically significant improvements in spatial abilities using a spatial abilities test developed through the Association of American Geographers (AAG). Students present their research at the OhioView SATELLITES conference each April.

The Urban Land Use Change and the Relationship between Land Surface Temperature and NDVI in Cleveland Area

Xi Li (University of Toledo), xi.li2@rockets.utoledo.edu

Cleveland's population has been declining since the 1950s. Thirty-two other U.S. cities are now larger than Cleveland, once the fifth largest city in America, though the pace of loss slowed considerably in the 1990s. In 2000 the United States Census Bureau listed Cleveland's population at 478,403. According to 2005-2009 American Community Survey 5-Year Estimates, the total population drops to 439,013. The number of households has also declined at a slower pace than population, and stood at 190,638 in 2000 and 185,738 in 2009. This project uses Satellite images with classification method to analyze the urban land use change of Cleveland area (Cuyahoga County) compared with its population change and examine the Urban Heat Island (UHI) effect and its relationship with Normalized Difference Vegetation Index (NDVI). This project performed a supervised classification of Landsat scene of the Cleveland area using the maximum likelihood classifier. Derivation of LST and NDVI are performed by Erdas and processed by GIS. The research shows that the population of Cleveland continues to drop while the city keeps urban sprawl. The property of households of Cuyahoga County keeps increasing slowly. However, the average number of household members had fallen. LST values are relatively higher in the built-up than in the suburbs. As for NDVI, values in the built-up are far lower than in the suburbs. LST and NDVI have totally opposing changing trends. Mean LSTs and mean NDVIs have distinct differences with certain different land-use types.

Advanced Remote Asset Collection and ODOT Educational Partnerships and Utilizing UAS Technology for Remote Sensing Operation at the Ohio Department of Transportation

Fred Judson (Ohio Department of Transportation, District 2), Fred.Judson@dot.state.oh.us

Ohio Department of Transportation District 2 formed mutually beneficial partnerships with Penta County Vocation School, Rhodes College GIS programs and University of Toledo interns which assisted with the collection of the ODOT's largest asset inventory: signs. These signs were collected at minimal cost to ODOT and gave the students experience in solving real world problems with cutting edge GIS solutions. Through the advances in web technologies, ODOT District 2 has been able to develop and deliver sophisticated tools via the internet and form partnerships to help accomplish a monumental task more effectively than any other method of collection to date. This presentation will cover the technology and partnerships which lasted for spring and summer of 2010 collecting 40,000 signs for an estimated total value of 1.5 million dollars.

Lidar-derived Carbon Estimates in Encroaching Juniper Woodlands

Temuulen Sankey, Rupesh Shrestha, Joel Sankey, and Stuart Hardegree (Idaho State University), Temuulen Tsagaan Sankey, sankteki@isu.edu

We present a new technique to estimate aboveground C storage in encroaching juniper woodlands in the South Mountain watershed, southwestern Idaho, USA using high-resolution, 3-dimensional lidar measurements of individual juniper trees.

Using Landsat Satellite Imagery to Monitor Post-fire Forest Dynamics in the Daniel Boone National Forest, Kentucky

Christine McMichael, Mary A. Arthur and Gretchen X. Sovkoplas (Morehead State University), c.mcmichael@moreheadstate.edu

Multi-temporal Landsat imagery was used to assess landscape patterns of forest response to burning and analyze relationships between spectral vegetation indices and field-measured forest characteristics.

Near Real-Time and Historical MODIS and AMSR-E Image Data for Modeling Studies
Larry Biehl, Magda Galloza, Bala Gnanasekaran, and Oluwatoba Omotilewa (Purdue University) biehl@purdue.edu

The Purdue Terrestrial Observatory is providing real-time images of the United States in support of projects such as the West Nile virus modeling study being conducted by UNI GEoTREE.

Precipitation Effects on pH Levels on Medium Bodies of Water
Shelby Noffsinger, Roswell-Kent Middle School

My project is about precipitation and how it affects pH levels on medium bodies of water. I did this because I learned that when lakes have a high acidity or alkalinity level, it could kill off fish population. I wanted to know why this is. I found two lakes and took pH and precipitation samples. Next I graphed the data for eight days. Finally I compared the difference in the pH and precipitation samples of both study sites. The data supported my hypothesis. However, the pH would have to drop drastically for fish life to stop reproducing.

How temperature affects the bounce of a basketball: A study on dirt and asphalt
DaehV'yair Ellis, Roswell-Kent Middle School

My project is about surface temperature and how the temperature affects the bounce of a basketball. I did this because I wanted to know when would be the best time to play basketball. My hypothesis is that a basketball will bounce lower at colder temperatures. I went on some web sites to gather information. I gathered temperatures of asphalt for 15 days then graphed the data. I found the data supported my hypothesis for the first ten days, but did not support my hypothesis the last five days. I think this could give basketball players advantages over other players if they have this knowledge.

Temperature Over Time
Jon'tel Palmer and Jordan Payne, Roswell-Kent Middle School

Our project is about surface temperature over time and if the surface temperature will get warmer or colder over time. We gathered temperatures outside for 10 day and recorded our data. We then graphed the data we recorded. Our hypothesis was that temperature will get colder over time. Our data supported our hypothesis for four days and the data did not support our hypothesis for six days. This type of study will help scientists learn more about the environment. We feel a longer study is needed.

The Albedo Effect on a Solar Hot Dog Cooker: UV Light, the Sun, and a Heat Light
Ariyonniyia Cobbin, Roswell-Kent Middle School

This project is about the albedo effect on a solar hot dog cooker and how to asve energy by using one. First we contacted Fluker Farms and got information on how far to adjust a UV light bulb from the solar cooker. This was 15cm. Next we performed three sets of experiments on the solar cooker with the sun, a heat lamp, and a UV light bulb. Finally we compared our data from the graphs to see which source worked the best. The data did not support our hypothesis. We thought the sun would be the best energy source, but the data showed a heat lamp to be the best energy source to cook a hot dog with a solar cooker.

Comparison Study of Soil Temperature: 5cm versus 10cm
Adam Watters, Roswell-Kent Middle School

The project I did was easy and fun but long. My project studied soil temperature at different depths. This project could be important to people like weathermen and scientists. The data supported my hypothesis which was the further down into the soil you go, the the warmer the soil becomes. I only did this on one surface type (short grass) but I think it might be interesting to try different surfaces to see if the data still supports my hypothesis.

Construction of a Complete Daily Evapotranspiration Timeseries at Cibola National Wildlife Refuge, Southwest USA
Ramanitharan Kandiah, Xiaofang Wei, Sumantra Chatterjee, Subramania Sritharan, Doyle Watts, John Osterberg (Central State University)

Abstract In 2007 and 2008, Alliance Universities (AU), a consortium of universities and the United States Bureau of Reclamation (USBR) used ground based techniques and remotesensing to assess evapotranspiration (ET) of

riparian vegetation in the Cibola National Wildlife Refuge (CNWR)of southwest USA. Daily ETs were estimated with the data gathered from Bowen Ratio towers at three locations in CNWR. In addition, LANDSAT5 data was also used with Surface Energy Balance Algorithm for Land (SEBAL) algorithm to estimate the ET for the days LANDSAT5 overpassed the region.However due to the instrumental errors and the environmental constraints the complete daily ET datafrom any method was unable to directly gather at any station. The missing ground based ET values at astation can be constructed in three ways; using the correlations between the ground truth ET values and remote sensing based ET values, using the spatial correlations with the other stations and meteorologicalvariables and using the temporal correlations with the past ET data at the particular station. However which approach suits to the construction depends on the quantity and the quality of the data available. The study presented here a comparison of these three approaches at the station, Slitherin in CNWR. In thefirst method was based on the linear regression approach. The spatial and the temporal correlations wereachieved using Artificial Neural Networks (ANN). Further the heteroscedasticity was checked, and theuse of GARCH models in studying daily ET timeseries was explored.

Integrating Geospacial Technology into the K-12 Curriculum: Experienced Teachers as "Coaches"
Stefan Smolski, Rick Landenberger, Timothy Warner, Jim Rye, and Todd Ensign

Implementing new skills, new technology, and project-based learning models in today's middle and high school science classrooms can be difficult, given the high student-to-teacher ratio, state and national testing requirements, high number of competing content areas, and limited contact time. Although there are numerous science education professional development opportunities in West Virginia, implementing the new concepts, technologies and teaching models introduced in professional development experiences is not guaranteed. "Coaching", a process by which a teacher who is experienced in using the technologies and models to teach specific content provides mentoring/encouragement to teachers who are not experienced, is an effective means to help these teachers implement professional development in the classroom. We offer an example of a geospatial science and technology-rich professional development program that is using the coaching approach in the sequence of two linked graduate-level courses, Geospatial Elements of the Water Cycle I and II during the Summer and Fall 2011 semesters at 10 middle and high schools in West Virginia.

The GLOBE Program in an Urban School
Steve Frantz (Roswell-Kent Middle School, Akron Ohio), sfrantz@akron.k12.oh.us

This poster highlights the 5th year of the GLOBE Program in Akron, Ohio. After initial funding setbacks this year, a collaborative effort by energized parents, students and teachers has resulted in a new hope and renewed implementation of the GLOBE Program within the school. With much excitement, GLOBE Program students soared to new heights never before seen at our school. This session represents a journey through our 2010-2011 school year, witnessing student activities, ideas for sustainability, and the celebrations of student success.

Opportunities and problems with identifying archaeological sites using LiDAR and Ground Penetrating Radar(GPR)
Mallory Haas, Cleveland State University

Over the summer of 2011 two separate but equally interesting Archaeological projects were underway in Cleveland and Newark, Ohio. Both projects presented obstacles in identifying the amounts of disturbance, alteration and possible potential for future exploration to the sites. In the poster we will present the fortunate ability to expand the understanding of a prehistoric site, for expansion and continued interpreted preservation through LiDAR. The second site located in Forest Hill park of East Cleveland was once the summer home of philanthropist John D. Rockefeller. Through the identification of the home's foundations, the possible areas for excavation and present ground-truthing the latent anomalies from the GRP, all in which have produced a better understanding of the historic use of the site and its changing yet viable continuing use to the community. This poster will demonstrate the perhaps new-found connection of a solitary mound to an existing Hopewell site and through a more precise discernment of an historical site, its potential not only as a resource for a differing look at one of the wealthiest families to arise in this country as well as its future as a vehicle for teaching ecology, biology, archaeology and geology with the use of remote sensing.

2011 Japan Earthquake and Tsunami Analysis
Jake Gurecky, Diamond Lorenc, and Daniel Wyandt, Penta Career Center,
Dan Wyandt [dwyandt@pentanet.k12.oh.us]

Comparison of Roofing Tile Surface Temperatures
Ben Napolitan and Victor Kasinec, Eileen Murphy McGuire (mcguire22@compuserve.net), Lakewood Catholic Academy

Investigation of Shoreline Surface Temperatures in Lakewood, OH
Emily Morabeto and Frannie Smith, Eileen Murphy McGuire (mcguire22@compuserve.com), Lakewood Catholic Academy

Does Car Idling Heat the Earth?
Liam McGuire and Noah Militello, Eileen Murphy McGuire (mcguire22@compuserve.com), Lakewood Catholic Academy

10:15 - 10:30 am ***Break***

10:30 - 12:00 am ***Special Session*** ***Main Classroom Auditorium***

SESSION 5A

Terrestrial Wetland Global Change Research Network (TWGCRN)
Alisa Gallant, Research Scientist, U.S. Geological Survey, Earth Resources Observation Science (EROS) Center, Sioux Falls, SD

The Terrestrial Wetland Global Change Research Network (TWGCRN) is a growing network of U.S. and Canadian organizations, scientists, and research sites created to provide rigorous scientific information on (1) the long-term impacts of climate/global change on terrestrial wetlands and associated uplands (wetland-upland landscapes) of North America and (2) the options resource managers and other stakeholders have to mitigate negative impacts. Our overall approach is integrated across scales, methods, and research efforts. Our results are comparable across the network because we use standardized protocols. TWGCRN field-research nodes are instrumented, at a minimum, with acoustic recorders to monitor the sounds of amphibians, birds, and other sources make at individual wetlands (extensive study sites). We measure additional variables at sites studied more intensively from the ground, including water level, air and water temperature, precipitation, water quality, presence of pathogens, and vegetation structure, to varying extents. We use data from an array of satellite and airborne sensors to provide broader-scale, spatiotemporal environmental context to assess landscape conditions, such as timing and duration of snow and ice cover, characteristics of vegetation green-up, primary productivity, the degree of dryness and standing water, land cover, and relative habitat connectivity. Comparing data collected from satellite sensors with data collected from the ground allows us to describe seasonal biotic and abiotic landscape conditions relative to seasonal calling phenology, occupancy, species diversity, and entire soundscapes at wetlands within and across research nodes.

Ecosystem Monitoring Panel
Moderator: Rick Landenberger, AmericaView Executive Director
Participants: Alisa Gallant, USGS EROS – Wetland Upland Landscapes, Yong Wang, North Carolina View – Estuaries / Coastal Zones, Teki Sankey, IdahoView – Grasslands Marv Bauer, MinnesotaView – Lakes, Russ Congalton, New Hampshire View – Forests

Accurate, efficient, timely, and consistent ecosystem monitoring is critical to understanding how Earth's major biological systems are functioning. The need to understand ecosystem dynamics across a broad range of ecosystem types rests on the fact that healthy and prosperous human communities require a healthy and productive biosphere. The goal of the Ecosystem Monitoring panel discussion is to inform the audience of the primary issues, challenges, and opportunities that characterize and shape remote sensing-based ecosystem monitoring techniques in wetlands, coastal zones, grasslands, lakes, and forests. Panelists will provide a brief (3-4 minute) overview of the monitoring and assessment issues in their respective fields, followed by a moderated question and answer session with the audience. Although the emphasis will be on remotely sensed monitoring techniques, panel members will touch on ground reference data collection and related sampling issues, including how networks of scientists and technicians engage in coordinated monitoring and assessment efforts across space and time to acquire a broader understanding of the disturbances and stresses that shape their respective ecosystem types.

12 - 1:15 pm ***Lunch*** ***Main Classroom Atrium***

1:15 - 2:45 pm ***NASA Glenn*** ***MC102***

SESSION 6A

Airborne Hyperspectral Imaging Studies of Lakes, Wetlands, Forests and Reefs
John Lekki, NASA Glenn Research Center Engineer

Overview of Ohio Aerospace Institute
Susan Thierl, Project Manager

1:15 - 2:45 pm	*Software Tutorial*	*Remote Sensing Lab*

SESSION 6B

Intro to eCog workshop
Bruce Gorham (University of Arkansas)

This 2-hour workshop will explore the principles of GeoObject-Based Image Analysis (GEOBIA) for remote sensing through a combination lecture and hands-on experience. The session will begin with an introduction to GEOBIA followed by a detailed, hands-on example of basic GEOBIA principles: the human cognitive process, image segmentation, object (segment) analysis, object classification, and ruleset development. Workshop participants will engage in a more detailed exercise employing multi-date aerial photography. Subject matter will include project creation, image preprocessing, ruleset construction for a basic land-cover map, and exporting specific features to a vector shapefile. The ruleset construction section will challenge participants to bridge the gap between traditional image processing techniques and the human-cognitive process for understanding images. A basic understanding of GIS principles is recommended.

2:45-3:00 pm	*Break*

3:00 - 4:45 pm	*Geospatial Integration with Remote Sensing MC101*

SESSION 7A

Growth of Kolkata, India– Past, Present And Future: A Synergistic Analysis Using Cartographic, GIS, Remote Sensing, and Cellular Automata Modeling
Chandana Mitra (Auburn University) Chandana.Tina@Gmail.Com

This study provides, to our knowledge, one of the most thorough spatio-temporal assessments of urban growth in Kolkata (India). The objectives were (1) to determine the growth of Kolkata over 300 years using Landsat images and GIS techniques, (2) to ascertain factors behind Kolkata city's population explosion in the 20th Century; (3) to project how the urban land cover of Kolkata will grow in the next 25 years (2025), using the CA-Markov urban growth model and (4) to project the growth of Kolkata to the present (2010) using CA-Markov and validating the image with present Google Earth scenario. The delineation of the urban growth of Kolkata city is achieved using historical paper maps, Landsat images (1990 and 2000), and topographical maps. The analysis shows that the maximum land cover growth occurred during and after India's independence in 1947, when millions of refugees migrated from Bangladesh and surrounding states. There has been a fourfold increase in urban land cover during that time period and the rate of growth continues. CA-Markov model results suggest that the city will expand towards the south, southeast, and along the river by 2025. This expansion will be mainly along lines of communication, primarily the river Ganges and the railway lines. The analysis also revealed that growth rates over the period 2000 to 2025 might exceed the growth rates in the most recent 20 years period. The methodology is a synergistic blend of historical cartographic analysis, satellite remote sensing and urban growth modeling. Contemporary assessment of past, present and future growth of cities in developing countries is critical to future analysis of planning strategies, environmental impacts, and land management.

Using Geospatial Technology for Monitoring and Tracking Agricultural Sewage Sludge
Brad Shellito (Youngstown State University)

Sewage sludge is a by-product from wastewater treatment plants (WWTPs) and is sometimes applied as a treatment to agricultural fields. Regulations are in place for land application of sludge, and this project tracks the 'final destination' of sewage sludge from WWTPs in Mahoning County, OH, as it ends at permitted fields, landfills, or other destinations. Geospatial Technologies are used for the visualization, mapping, and monitoring of land applied sewage sludge, as well as analysis of the relation to nearby land use features.

A to Z in Technology Transfer: From NASA-Funded OhioView Research Grant to a Start-Up Company Providing Satellite Monitoring Services for Drinking Water and Recreational Reservoirs
Robert Vincent (Bowling Green State University) rvincen@BGSU.edu

A NASA OhioView grant, funded through the NASA Glenn Research Center in 1999-2000, supported approximately $50,000 of research per each OhioView member for a year. The BGSU Department of Geology used those funds to

collect water samples in Lake Erie during a Landsat 7 overpass, and the TM data were used to create an algorithm that employs Landsat TM data to map content variations of phycocyanin, the pigment that gives blue-green algae (cyanobacteria) its color, in incipient algal blooms in surface water. This first algorithm has an accuracy of a few parts per billion, as tested with a withheld data set. A peer reviewed paper was published on this outcome in 2004 and BGSU applied for and was awarded U.S. patent number 7,132,254 in 2006. In February, 2008, a new Ohio-chartered company, Blue Water Satellite, Inc. (BWSI), began operations in Bowling Green, Ohio. The company has raised venture capital and has had sales in several states and countries. BWSI has recently signed a joint marketing agreement with Hach, a global company in water quality testing and water quality analysis.

Filling the Gaps – Using STARFM to Create Synthetic Landsat Images for Dates When Landsat Imagery Is Unavailable
Ed Olexa (USGS, Northern Rocky Mountain Science Center), Rick Lawrence (Montana State University), Jennifer Watts (University of Montana), rickl@montana.edu

Landsat has been the most widely used Earth observation satellite during the history of remote sensing. One limitation on the use of Landsat for some studies, however, has been the lack of adequate temporal coverage within a single season. Landsat's 16-day return interval, combined with cloud coverage, can often result in only one to two usable scenes in a given year. The Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM) seeks to help alleviate this limitation. STARFM uses a date-paired MODIS/Landsat image set to generate models that can be used to create a synthetic Landsat image for another date for which MODIS data are available but Landsat data are not. We tested STARFM by creating synthetic Landsat images for dates where we also had actual Landsat images to compare predicted pixel values with observed values. Tests were conducted in both a cropland and a rangeland setting. Correlations between predicted and observed reflectance values were very high for dates near the date-paired MODIS/Landsat image set, but decreased as time increased between the date-paired set and the prediction date. Classification results using a time series of synthetic Landsat images were significantly higher than with single-date Landsat images (best overall accuracies of 95% versus 87%). We will demonstrate the operation of STARFM.

3:00 - 445 pm	*Software Tutorial*	*Remote Sensing Lab*

SESSION 7B

Intermediate eCognition
Jarlath O'Neil Dunne (University of Vermont)

Humans rely heavily on contextual information to identify features. The workshop will focus on replicating human cognition through the use of iterative GEOBIA workflows that allow contextual information to be brought into the classification process. Specific techniques covered include variables, loops, and distance calculations. This is an intermediate/advanced workshop. It is recommended that participants have a strong foundation in remote sensing and GIS, and at least some exposure to eCognition.

Wednesday

7:45 am	*Field Trip*	*NASA Glenn Research Center*

We will load the bus at 7:45 am, arrive at NASA Glenn at 8:20 am, and return to the Wyndham at noon.

Tour of NASA Glenn Research Center
Welcome by R. Joe Shaw, Deputy Director, Office of Technology Partnerships and Planning, NASA Glenn Research Center; Tour of 10x10 Supersonic Wind Tunnel, Flight operations and Photovolatics research laboratory.

NASA Glenn Research Center in Cleveland, Ohio, is one of ten NASA centers. Glenn is an essential component of NASA and an integral contributor to the region. Located near Cleveland Hopkins International Airport and the Cleveland Metroparks' Rocky River Reservation, Glenn's main campus, Lewis Field, is situated on 350 acres of land and contains more than 150 buildings. The world-class facilities at Lewis Field include wind tunnels, drop towers, vacuum chambers and an aircraft hangar. Ramon "Ray" Lugo III currently serves as Glenn's director—the eleventh director in a distinguished line of leadership.

12:30 pm	*Networking and Social Time*

Rock & Roll Hall, Waterfont Attractions, Public Square
Rock & Roll Hall of Fame Tour & Lunch on your own