

# PECORA 20

OBSERVING A CHANGING EARTH

*Science for*

*Decisions...*

MONITORING,  
ASSESSMENT,  
PROJECTION

SIOUX FALLS, SD  
NOVEMBER 13-16, 2017



FINAL PROGRAM





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Rae Kelley, Director of Publications, ASPRS

The Pecora 20 Conference Proceedings  
will be published on the Pecora 20 website  
by the end of December

# PECORA 20

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## Sponsors



## Media Partners



# LANDSAT'S ENDURING LEGACY

## Pioneering Global Land Observations from Space

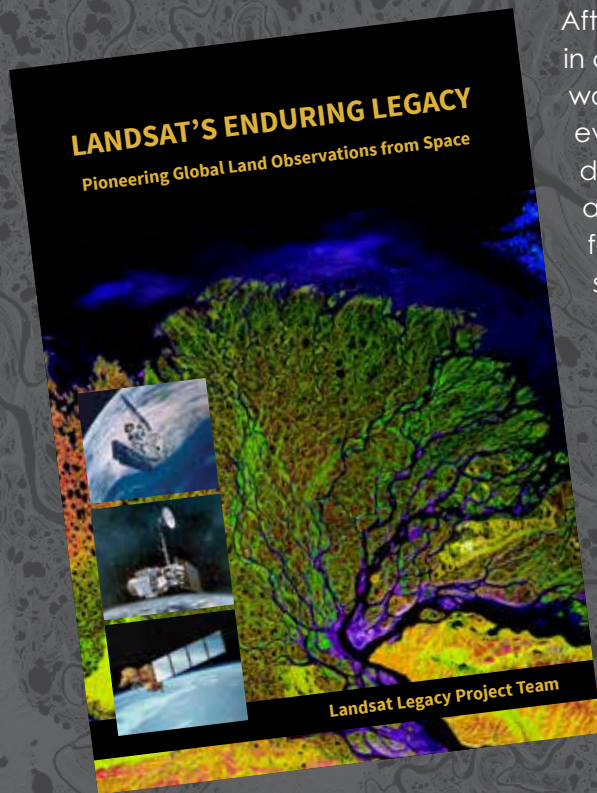
Join us at the Landsat Legacy book unveiling and meet the authors

Wednesday evening from 5:30 pm to 7:30 pm in Exhibit Hall 2

After more than 15 years of research and writing, the Landsat Legacy Project Team is about to publish, in collaboration with the American Society for Photogrammetry and Remote Sensing (ASPRS), a seminal work on the nearly half-century of monitoring the Earth's lands with Landsat. Born of technologies that evolved from the Second World War, Landsat not only pioneered global land monitoring but in the process drove innovation in digital imaging technologies and encouraged development of global imagery archives. Access to this imagery led to early breakthroughs in natural resources assessments, particularly for agriculture, forestry, and geology. The technical Landsat remote sensing revolution was not simple or straightforward. Early conflicts between civilian and defense satellite remote sensing users gave way to disagreements over whether the Landsat system should be a public service or a private enterprise. The failed attempts to privatize Landsat nearly led to its demise. Only the combined engagement of civilian and defense organizations ultimately saved this pioneer satellite land monitoring program. With the emergence of 21st century Earth system science research, the full value of the Landsat concept and its continuous 45-year global archive has been recognized and embraced. Discussion of Landsat's future continues but its heritage will not be forgotten. The pioneering satellite system's vital history is captured in this notable volume on Landsat's Enduring Legacy.

### Landsat Legacy Project Team

Samuel N. Goward  
Darrel L. Williams  
Terry Arvidson  
Laura E. P. Rocchio  
James R. Irons  
Carol A. Russell  
Shaida S. Johnston



# PECORA 20

# W



Bruce Quirk



Thomas Holm

We are delighted to welcome you to Sioux Falls, South Dakota for the 20<sup>th</sup> William T. Pecora Memorial Remote Sensing Symposium. The Symposium is a wonderful opportunity to become better informed on remote sensing science, technology, and applications. This gathering also provides a venue for celebrating noteworthy achievements in Earth observations spanning over five decades.

This year the Symposium will be a two and half day conference starting Tuesday afternoon, November 14 and ending Thursday afternoon, November 16, 2017. We begin with a Welcome Luncheon in the Exhibit and Poster Hall on Tuesday at noon. Following the welcome lunch will be the opening 60-minute plenary session with a keynote address by **Barbara Ryan, Secretariat Director of the Group on Earth Observations (GEO) titled Terrestrial Observations -- Finally Coming of Age**. Four additional plenary sessions will be held on Wednesday and Thursday. The plenary themes collectively span the Symposium theme – **Observing a Changing Earth: Science for Decisions...Monitoring, Assessment, and Projection**. Prior to the opening of the conference, ASPRS will hold workshops throughout Monday and Tuesday morning. There will also be two special Town Hall sessions on Tuesday morning focusing on *Landsat 10 User Needs* and the *EROS Data User Group*. On Wednesday evening, please join us for the unveiling of the Landsat Legacy book and take the opportunity to meet the book's authors. After more than 15 years of research and writing, the Landsat Legacy Project Team and the ASPRS have published a seminal work on the nearly half-century of monitoring Earth's lands with Landsat.

Through the leadership and commitment of the USGS, NASA, the ASPRS and all the Symposium sponsors, especially the Technical Program Committee Chairs – Jesslyn Brown, Martha Anderson and Jennifer Rover, we have compiled an outstanding program for your benefit. With emphasis on recent significant developments in remote sensing, this conference will offer a program on applications of satellite and other Earth observations to monitor, assess, and perform projections of future land and water resources, as well as big data and other analytical technologies to improve decision making utilizing satellite data. Accompanying the plenary sessions are 35 technical sessions with accepted and invited papers, a poster session, exhibit hall, and social and networking events to keep you busy for the duration of the Symposium. This combination of activities comprises a unique opportunity for you to share experiences, successes, and ideas.

Bruce Quirk and Thomas Holm  
Pecora 20 Steering Committee Co-Chairs

## Registration Desk

7:30 AM to 4:30 PM

## Coffee Break

7:00 AM to 8:00 AM—FOYER

## Workshops

**Workshop 2**—Monday, November 13<sup>th</sup>, 8:00 AM to 12 NOON—ROOM 7

### Object-based Approaches to Data Fusion Land Cover Mapping

Jarlath O'Neil-Dunne, *University of Vermont*

We are awash in data. From satellite imagery to airborne lidar to crowd-sourced road networks, there is no location on the Earth's surface that has not been mapped in some shape or form. The current challenge in land cover mapping lies in our ability to integrate these various streams of data in such a way that leverages their strengths while minimizing their weaknesses. This workshop will introduce participants to object-based approaches to land cover mapping that integrate raster, vector, and point cloud datasets into a seamless feature extraction workflow. It is recommended that participants have a strong foundation in remote sensing and GIS, and at least some exposure to OBIA. This workshop is particularly well suited to individuals who are finding it difficult to extract information from the latest generation of high-resolution imaging and LiDAR sensors using OBIA techniques. Specific emphasis will be paid to moving beyond the standard "segment and classify" approach that is typically employed in most OBIA projects, to an iterative workflow that better mimics the type of mapping carried out by human analysts by fully incorporating the spectral, geometric, and contextual information present in an image. Through a series of lectures, demonstrations, and hands-on exercises, participants will be exposed to the methods that will enable them to build effective and efficient OBIA routines.

Demonstrations and exercises will make use of a broad range of remotely sensed (e.g. imagery and LiDAR) datasets and will demonstrate how remotely sensed and thematic datasets can be integrated in an OBIA context.

Participants are encouraged to bring their own computers to use during the hands-on exercises. OBIA software will be provided (requires Windows 10 64-bit).

It is recommended that participants have a strong foundation in remote sensing and GIS and be comfortable using desktop geospatial software. No expertise with OBIA techniques is required.

**Workshop 5**—Monday, November 13<sup>th</sup>, 8:00 AM to 12 NOON—ROOM 9

### Remote Sensing Education, Research and Outreach with the Google Earth Engine

J.B. Sharma, *Institute for Environmental Spatial Analysis, University of North Georgia*

The advent of a scalable cloud computing image processing platforms like the Google Earth Engine (GEE) brings unprecedented possibilities for remote sensing education, research and outreach. The powerful capabilities of GEE are accessible using broadband internet using a Google Chrome browser. This workshop will focus on an interactive exploration of GEE capabilities. GEE has a repository of all of publicly available aerial and satellite data and also allows user upload of imagery for analysis. This workshop will begin with a presentation of examples of GEE in remote sensing, research and education, with a particular focus on education, undergraduate research and outreach. This will be followed by hands on activities including the GEE Explorer, data exploration, supervised classification, and an introduction to a GEE-API based coding environment. The workshop will end with a moderated discussion in which the participants will share their thoughts on how GEE may be used in their educational, research and outreach efforts. Curricula developed for remote sensing applications using GEE will be shared with the participants.

All participants should have a Gmail address and need to request a 'trusted tester' access to GEE. This will give participants access to the JavaScript coding environment within GEE. Coding experience is not necessary and participants will have activities with modifying existing code. The trusted tester access can be requested from: <https://signup.earthengine.google.com/#/>.

**Workshop 9**—Monday, November 13<sup>th</sup>, 8:00 AM to 12 NOON—ROOM 12

## **Introduction to ISR Data Formats and Metadata Standards for GEOINT**

Jason S. Smith, *Harris Corporation*

The FGDC's Content Standard for Digital Geospatial Metadata (CSDGM) has been a staple of the commercial and civilian GIS market since its publication in 1998. However, the military and intelligence communities did not adopt CSDGM for their Intelligence, Surveillance, and Reconnaissance (ISR) needs. Have you ever wondered what body of geospatial data formats and metadata standards these entities work with? Have you wondered what sort of correspondences there may be between these two worlds?

This workshop will provide an introduction to many of the open ISR data formats and metadata standards used by U.S. DoD, IC, and the NATO Allies, and provide insight into the governmental and international standards bodies that govern these standards, specifications, and guidelines.

Topics being discussed include:

- Still Imagery Data Formats and Supporting Metadata Structures
- Motion Imagery Data Formats and Supporting Metadata Structures
- Security Portion Marking Metadata requirements
- Controlled Unclassified Information marking metadata
- Profile Development activities
- Certification & Testing resources
- Collaborative Experiment in data format and metadata creation – common pitfalls to avoid and best practices to emulate

**Attendee Requirements:** laptop is encouraged.

## **Lunch**

12 NOON to 1:30 PM—Foyer

Have lunch with us! .

Admission to this event is included with most registrations.

## *Special Cal/Val Workshop*

### **Cross-calibration of Landsat 8 OLI and Sentinel 2 MSI and its Impact on Data Interoperability**

Dennis Helder, *U.S. Geological Survey*

Monday, November 13<sup>th</sup>, 8:00 AM to 5:00 PM—Room 2, and Tuesday, November 14<sup>th</sup>, 8:00 AM to 12 NOON—Room 2

The EROS CalVal Center of Excellence (ECCOE) invites you to attend our first CalVal Workshop to address cross-calibration of Landsat 8 OLI and Sentinel 2 MSI and its impact on data interoperability.

Our Panel of Experts:

- Landsat Calibration
  - » Brian Markham, *NASA GSFC*
  - » Ron Morfitt, *USGS EROS*
- Sentinel 2 Calibration
  - » Ferran Gascon, *ESA*
  - » Sebastien Clerc, *ARGANS*
- Geometric Calibration
  - » Jim Storey, *USGS EROS SGT*
- Landsat/Sentinel 2 Applications
  - » Jeff Masek, *NASA GSFC*
  - » David Roy, *SDSU*
  - » Adam Lewis, *Geoscience Australia*
  - » Nima Pahlevan, *NASA GSFC/SSAI*

Workshop format:

- Presentations from panel of experts
- Panel discussions
- Audience Q&A

Desired Outcomes:

- Better understanding of cross-calibration of Landsat and Sentinel 2.
- Understanding the impact of cross-calibration on data interoperability.
- Recommendations for further cross-calibration of these sensors.
- Recommendations for cross-calibration methodology of other optical remote sensors.
- Publication of workshop results.

## Workshops

**Workshop 1**—Monday, November 13<sup>th</sup>, 1:30 PM to 5:30 PM—ROOM 7

### **SNAP for Sentinel-2**

Michael Tuohy, Massey University, NZ

Sentinel-2A and Sentinel-2B are European satellites with a multi-spectral instrument providing 12 bit data for 13 bands: 443 nm - 2190nm. The VNIR bands have a spatial resolution of 10m and the best part is it's all free! Sentinel-2A has been acquiring data since late 2015 and Sentinel-2B was launched in March, 2017. With both satellites operating, the re-visit time will be 5 days. While the data may be easy to acquire from either the Sentinel Data Hub <https://scihub.copernicus.eu/> or the USGS <https://glovis.usgs.gov/next>, the data structure is a bit tricky to navigate and working with the data may not be as easy as you might think. To ensure that everyone has the ability to use Sentinel data, the European Space Agency commissioned Brockman Consult <http://www.brockmann-consult.de/> to develop the Sentinel Application Platform (SNAP). This software is available free for Windows, Mac OS and Unix platforms.

The workshop will introduce you to this amazing software and have you analyzing Sentinel-2 data in no time at all.

Specifically, participants will learn how to:

- open Sentinel-2 datasets
- reproject to local map projection
- subset images
- create mosaics
- export to other formats
- add vector layers
- extract pixel values
- use the Graph Processing Tool

Sample data for areas close to Sioux Falls will be used in all the exercises.

Participants should bring their own laptops (Windows or Mac OS) and have already downloaded and installed SNAP with its Sentinel Toolboxes from the ESA website <http://step.esa.int/main/download/>. It is recommended that your laptop has at least 4 GB of RAM.

**Workshop 4**—Monday, November 13<sup>th</sup>, 1:30 PM to 5:30 PM—ROOM 9

### **Proper Care and Feeding of Metadata**

Ryan E. Bowe, Woolpert

Do you feel you are overrun with metadata requests? Does dealing with metadata make you want to “go postal”? With preparation, the care and feeding of metadata maintenance will no longer constitute time-killing drudgery. Several tips and tricks for taming metadata will be presented. After reviewing the different options for geospatial metadata, several key elements of Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata will be discussed in detail and also compared to International Organization for Standardization's 19115 schema. Key sections highlighted in the United States Geological Survey's LiDAR Base Specification will be a focus. A brief journey into ArcGIS metadata options will occur as well.

Attendees should come to the workshop with questions and specific problems. The goal of the workshop is that attendees depart with a workflow in place to create and maintain their own template.

**Attendee Requirements:** None, but laptop and sample metadata is encouraged.



**Workshop 6**—Monday, November 13<sup>th</sup>, 1:30 PM to 5:30 PM— ROOM 12

## **Simple is Better. An Intro to Event-Driven Server-less Architectures for Accessing Planetary-Scale Geospatial Data on AWS**

Joe Flasher, Amazon

Working with large geospatial datasets has never been easier, thanks to the cloud. When data is made available via services like Amazon S3, you can bring your processing to the cloud instead of downloading the data locally to process it. This shift to democratized access of large processing resources alongside valuable data allows innovative solutions to traditional problems. Large satellite imagery collections like Landsat 8 and Sentinel-2 are made freely available through the Amazon Web Services' Earth on AWS initiative (<https://aws.amazon.com/earth>) for anyone to query, analyze or build services on top of.

This workshop will show how, without concern for the details of servers and storage, you can use small amounts of code to quickly build powerful solutions, in this case a disaster response pipeline. The workshop will walk you through an end to end process including 1) creating highly-queryable indexes in real-time from satellite imagery source updates, 2) deploying tooling to monitoring <https://earthquake.usgs.gov/> for high-magnitude earthquakes, 3) responding to high-magnitude earthquakes by querying and collecting the most recent, relevant satellite imagery, and 4) responding to high-magnitude earthquakes by running machine learning on imagery over affected areas and determining potential damage estimates. Services used will include Amazon S3, SNS, Lambda, AWS Batch and datasets available at <https://aws.amazon.com/earth>.

Participants will need AWS accounts to be able to fully participate in the exercises. The session will be using the AWS Command Line Interface as well as the AWS Management Console to deploy and configure services.

**Requirements:** Participants will need AWS accounts to be able to fully participate in the exercises as well as computers with internet connectivity to access AWS services. An AWS account can be obtained at <https://aws.amazon.com/free/>.

## **Coffee Break**

3:00 PM to 4:00 PM—FOYER

## Registration Desk

7:30 AM to 4:30 PM

## Coffee Break

7:00 AM to 8:00 AM—FOYER

## Town Hall/Special Cal/Val Workshop

### Landsat 10 User Needs

Moderator: Zhuoting Wu and Greg Snyder, *U.S. Geological Survey*

Tuesday, November 14<sup>th</sup>, 8:00 AM to 10:00 AM—Room 3

In this town hall, the USGS will provide an overview of the Landsat 10 user requirements collection process and summary results followed by a question-and-answer session. The USGS and NASA are working together to develop Landsat 10, scheduled to launch in the 2027 timeframe as part of the Sustainable Land Imaging program. The USGS Land Remote Sensing Program has collected user requirements from a range of applications to help formulate the Landsat 9 follow-on mission (Landsat 10) through the Requirements, Capabilities and Analysis (RCA) activity. User requirements collected through RCA will help inform future Landsat 10 sensor designs and mission characteristics. Current Federal civil community users have provided hundreds of requirements through systematic, in-depth interviews. Academic, State, local, industry, and international Landsat user community input was also incorporated in the process. Emphasis was placed on spatial resolution, temporal revisit, and spectral characteristics, as well as other aspects such as accuracy, continuity, sampling condition, data access and format. This is an opportunity for government, academia, industry users, and data and value-added products providers to learn about the RCA activity and have an open-forum exchange on future Landsat 10 user needs and capabilities.

### Cross-calibration of Landsat 8 OLI and Sentinel 2 MSI and its Impact on Data Interoperability

Dennis Helder, *U.S. Geological Survey*

Tuesday, November 14<sup>th</sup>, 8:00 AM to 12 NOON—Room 2 (continued from Monday)

The EROS CalVal Center of Excellence (ECCOE) invites you to attend our first CalVal Workshop to address cross-calibration of Landsat 8 OLI and Sentinel 2 MSI and its impact on data interoperability.

Our Panel of Experts:

- Landsat Calibration
  - » Brian Markham, *NASA GSFC*
  - » Ron Morfitt, *USGS EROS*
- Sentinel 2 Calibration
  - » Ferran Gascon, *ESA*
  - » Sebastien Clerc, *ARGANS*
- Geometric Calibration
  - » Jim Storey, *USGS EROS SGT*
- Landsat/Sentinel 2 Applications
  - » Jeff Masek, *NASA GSFC*
  - » David Roy, *SDSU*
  - » Adam Lewis, *Geoscience Australia*
  - » Nima Pahlevan, *NASA GSFC/SSAI*

Workshop format:

- Presentations from panel of experts
- Panel discussions
- Audience Q&A

Desired Outcomes:

- Better understanding of cross-calibration of Landsat and Sentinel 2.
- Understanding the impact of cross-calibration on data interoperability.
- Recommendations for further cross-calibration of these sensors.
- Recommendations for cross-calibration methodology of other optical remote sensors.
- Publication of workshop results.

## Workshops

**Workshop 3**—Tuesday, November 14<sup>th</sup>, 8:00 AM to 12 NOON—ROOM 7

### **Accuracy Assessment of Remotely Sensed Data**

Kass Green, *Kass Green & Associates*

This course focuses on the theory, principles, techniques, and practical aspects of thematic accuracy assessment. Participants will receive instruction in how to design accuracy assessment procedures, allocate accuracy assessment samples, collect reference data, and analyze results. Examples of both pixel and object based accuracy assessment case studies, based on actual project data will be presented and lessons learned discussed. The course will review commonly used accuracy assessment protocols and will use real world examples to highlight trade-offs between different approaches. Each participant in this course will come away with a solid understanding of accuracy assessment procedures and the knowledge to properly interpret the results. The course instructor is Kass Green, co-author of the widely acclaimed text, *Assessing the Accuracy of Remotely Sensed Data: Principles and Practices*.

**Workshop 7**—Tuesday, November 14<sup>th</sup>, 8:00 AM to 12 NOON—ROOM 9

### **The State of Earth Observation Using Synthetic Aperture Radar Technology and Data**

Yong Wang, *East Carolina University*

Today, there are many successful studies in which SAR data are used as the primary data source. Examples include global/national land use and land cover, national land survey, agriculture, forestry, fishery, resource exploitation, environmental protection and monitoring, disaster prevention and mitigation, and national security. Therefore, the objectives of this workshop are to present an overview of the state of earth observation using synthetic aperture radar (SAR) with the focus on the current and future development of SAR hardware and processing and analysis software for acquired SAR data using eye-opening applications of SAR and interferometric SAR (InSAR) techniques and datasets. This is a newly developed workshop of a half-day. The course outline is

- » Fundamentals of radar, synthetic aperture radar (SAR), interferometric SAR (0.5 hour)
- Current and operational airborne and spaceborne SARs (0.5 hour)

- The state of airborne and spaceborne SAR hardware (1 hour)
- The state of airborne and spaceborne SAR software (1 hour)
- Eye-opening applications using SAR and InSAR techniques and datasets (1 hour)

**Workshop 8**—Tuesday, November 14<sup>th</sup>, 8:00 AM to 12 NOON—ROOM 14

### **Demystifying the ASPRS Certification Exam**

Robert Burtch, *Ferris State University*

INTERMEDIATE Workshop: Assumes participants have subject knowledge and are serious about taking the Certification Exam.

The purpose of this workshop is to prepare individuals who are planning to sit for the ASPRS Certification exams as a Certified Photogrammetrist or Certified Mapping Scientist in either Remote Sensing, GIS, Lidar, or UAS. The workshop will begin by explaining the purpose and form of the exam. It will then identify key topical areas that an applicant should be aware of prior to taking the exam. Topics will start with a review of the basic concepts and sample questions to show how they will be tested for on the exam. Finally, the workshop will try to identify resources in which exam takers should be aware of and study from in their preparation for the examination.

Topics include: (I) Purpose of the exam (role of the exam in the certification process; format of the exam; topical areas covered on each of the five different exams), (II) Geodesy/Surveying (principles of State Plane Coordinates; surveying technologies; resources for further study), (III) Remote Sensing (important principles; utilization of Remote Sensing for geospatial purposes; review questions; resources for further study), (IV) Geographic Information Systems (important principles; cartographic/mapping concepts; review questions; resources for further study), (V) Photogrammetry (overview of photogrammetric principles; mapping concepts; example exam questions; resources for further study), (VI) Lidar (working principles; utilization of lidar in geospatial science; typical questions one might expect; resources for further study), (VII) Unmanned Autonomous/Aircraft Systems (basic UAS configurations/functionality; overview of regulatory factors; review questions; resources for further study), (VIII) Other topical areas of importance in preparation for the exam.

**Workshop 10**—Tuesday, November 14<sup>th</sup>, 8:00 AM to 12 NOON—ROOM 12

## **Cloud-based Spatiotemporal Data Analysis using Google Earth Engine**

Xingong Li, *University of Kansas*

Google Earth Engine (GEE) is a cloud-based geospatial processing platform for planetary-scale environmental analysis which combines Google-scale data storage and processing power. This workshop assumes some familiarity with Earth Engine and showcases its capability through hands-on sessions where attendants will work through some scripts that are used in global environment and climate trend analysis.

The workshop consists of two parts. The first part is a short review of the basics of Earth Engine and lets the attendants visually explore land cover/use change using global Landsat imagery available on Earth Engine. The second part will cover the fundamentals of Earth Engine data analysis framework and its application programming interfaces (APIs) using snow cover analysis as an example. Attendants will write JavaScript scripts to calculate snow cover frequencies at different temporal scales and analyze global snow cover frequency trends at 500-m resolution using more than 16 years of daily MODIS snow products available on Earth Engine.

All participants should have a Gmail address and should have 'trusted tester' access to GEE. This will give participants access to the Java Script coding environment within GEE. It is possible for those taking the workshop on Remote Sensing, Research, Outreach and Education using Google Earth Engine would then take this workshop to gain more experience. The trusted tester access can be requested from: <https://signup.earthengine.google.com/#/>

## *Town Hall Session*

### **EROS Data User Group**

Moderators: Rynn Lamb and Raad Saleh, *U.S. Geological Survey*

Tuesday, November 14<sup>th</sup>, 10:00 AM to 12 NOON—Room 3

In early 2018, USGS/EROS expects to launch a new initiative to support direct engagement with the Landsat and related remote sensing community through formation of an EROS Data User Group (EDUG). The primary purpose of this user group will be to: (1) provide operational users of Landsat and related products an opportunity and platform to discuss opinions, needs, and concerns in a structured manner; (2) obtain user feedback and input for potential incorporation into EROS operations to support the continuous improvement of USGS products and services; and (3) provide for targeted communications and direct feedback from selected members of the user community regarding internal development efforts.

This town hall session will provide a high-level description of the proposed user group and allow for input and feedback from the Pecora science and applications community. Key elements planned for discussion include: user group description and mission, justification, roles and responsibilities, membership, communication mechanisms, and proposed operational flow.

## Exhibit Hall Hours

12 NOON to 7:30 PM

## Social Event

### Welcome Lunch

Tuesday, November 14<sup>th</sup>, 12 NOON to 1:00 PM—Exhibit Hall 2

Have lunch on us! Come to the Exhibit Hall to visit with the wonderful exhibiting companies in attendance and grab a quick lunch. A great way to begin your Symposium week.

Admission to this event is included with most registrations.

## Welcome/Opening Remarks

Frank P. Kelly, Director, U.S. Geological Survey, EROS Center  
Andrea Travnicek, Deputy Assistant Secretary for Water and Science,  
Department of the Interior

1:00 PM to 2:00 PM—BALLROOM A

## Plenary/Opening Keynote Session

### Terrestrial Observations—Finally Coming of Age

**Barbara J. Ryan**, Secretariat Director, *Intergovernmental Group on Earth Observations (GEO)*



Ms. Ryan is the Secretariat Director of the Intergovernmental Group on Earth Observations (GEO) in Geneva, Switzerland. GEO is comprised of 104 Member States, the European Commission, and 109 international scientific and technical partner organizations. Since becoming Director of GEO in 2012, Ryan has worked to integrate Earth observation systems from around the world into a single, comprehensive system that uses coordinated data to understand how environmental factors impact human life. Prior to her work at GEO, she was the Associate Director for Geography at the USGS, where she was responsible for the agency's remote sensing, geography and civilian mapping programmes, including the Landsat satellites. It was during this time she led the effort to change the decade-old Landsat data policy to full and open, an action resulting in more than 42 million scenes being downloaded globally to date. Ryan has served as chair of the international Committee on Earth Observation Satellites, which coordinates information from more than 100 civilian satellite missions, and in 2008, became director of the World Meteorological Organization's space programme. Ryan has been awarded an honorary doctorate of science degree from SUNY Cortland. She was recently named an Honorary Fellow of the American Geographical Society, and in January 2017, was one of 10 global leaders to be named to the Geospatial World Forum's Hall of Fame.

## Technical Sessions

### TS #1—Special Session

#### **Landsat-derived Global Cropland Products at 30-m (LGCP30)**

Moderators: Prasad Thenkabail, *U.S. Geological Survey* and Russell Congalton, *University of New Hampshire*

2:15 PM to 3:45 PM—Room 2

This special session will present and discuss the world's first Landsat-derived 30-m global cropland products @ 30-m (LGCP30). The focus will be on Landsat-derived global cropland extent @ 30-m (LGCE30) (<https://croplands.org/app/map>). This product maps the entire world's 1.8 billion hectares of croplands at 30-m resolution. The presentations in the session will discuss methods and approaches used in LGCE30. Cropland mapping algorithms (CMAs) including several machine learning algorithms (MLAs) were used on 2-3 years of 16-day Landsat data cubes to derive LGCE30 using Google Earth Engine (GEE) cloud computing. Cropland areas computed for every country in the world as well as cropland areas of sub-national administrative boundaries will be discussed and compared with conventional statistics. Exhaustive discussions on accuracies, errors, and uncertainties will take place- providing error matrices with overall-producer's, user's, and weighted overall accuracies of some 80+ zones of the world.

#### **Global 30-m Cropland Extent Map for the Nominal Year 2015: Derived Using Landsat-8 Time-series Data and Machine Learning Algorithms Computed on Google Earth Engine Cloud**

Prasad Thenkabail, *U.S. Geological Survey*

#### **Evaluating the Performance of Various Sampling Strategies Used to Assess the Accuracy of Large Area Crop Maps**

Russell Congalton, *University of New Hampshire*  
Linnea Dwyer and Kamini Yadav

#### **An Automated Crop Intensity Algorithm (ACIA) for Global Cropland Intensity Mapping at Nominal 30-m Using Landsat-8 and Sentinel-2 Time-Series Data and Google Earth Engine**

Jun Xiong, *U.S. Geological Survey*

Prasad Thenkabail, Pardhasaradhi Teluguntla, Adam Oliphant, Russell Congalton, Murali Krishna Gumma, Kamini Yadav, Richard Massey, and Corryn Smith

#### **Mapping Cropland Extent and Areas of Australia at 30-m Resolution Using Multi-year Time-series Landsat Data and Random Forest Machine Learning Algorithm Through Google Earth Engine (GEE) Cloud Computing**

Pardhasaradhi Teluguntla, *U.S. Geological Survey*

Prasad Thenkabail, Jun Xiong, Adam Oliphant, Murali Krishna Gumma, Russell Congalton, Kamini Yadav, Richard Massey, Aparna Phalke, Jim Tilton, and Corryn Smith

#### **Mapping Croplands of Southeast Asia, Japan, and North and South Korea Using Landsat 30-m Time-Series, Random Forest Algorithm**

Adam Oliphant, *U.S. Geological Survey*

Prasad Thenkabail, Pardhasaradhi Teluguntla, Russell Congalton, Kamini Yadav, Murali Krishna Gumma, Jun Xiong, Richard Massey, and Corryn Smiths

### TS #2—Special Session

#### **Landsat Archive, Product Plans, and Data Continuity**

Moderator: Jennifer Lacey, *U.S. Geological Survey*

2:15 PM to 3:45 PM—Room 7

Landsat represents the world's longest continuously acquired collection of space-based moderate-resolution land remote sensing data. The Landsat program has taken several actions to expand the USGS archive holdings, further the science use, and ensure Landsat data continuity. Through the Landsat Global Archive Consolidation Project and increased satellite acquisitions, archive holdings have reached over 7 million scenes. This special session includes five topics that provide an archive status, science data product status and plans, and future mission plans for continuing Landsat's irreplaceable record.

#### **Ensuring Proper Storage for Earth Science Data Used for Decisions: The USGS Process to Certify Trusted Digital Repositories**

John Faundeen, *U.S. Geological Survey*  
Clara Brown and Keith Kirk

#### **Landsat Archive Status and the Landsat Global Archive Consolidation**

Kristi Kline, *U.S. Geological Survey*

#### **Landsat Collections and Future Landsat Standard Product Plans**

Brian Sauer, *U.S. Geological Survey*

#### **Continuity and Improvements with Landsat 9**

Jim Nelson, *U.S. Geological Survey*

## **An Outlook for Sustainable Land Imaging at the USGS Land Remote Sensing Program**

Peter Doucette, *U.S. Geological Survey*

## **TS #3—Panel Session**

### **Creating a Healthy Remote Sensing Education Pipeline: Moving from K-12 to University**

Moderator: Lindi Quackenbush, *State University of New York, Environmental Science and Forestry*

2:15 PM to 3:45 PM—Room 9

The remote sensing field is growing and changing rapidly. Deployment of novel sensors requires greater prerequisite knowledge and development of new processing methods. In order to ensure we have a well-trained workforce able to advance this field, we need to create a pipeline of students who can engage in advanced study in remote sensing. There are a wide range of activities that can be used to facilitate development of interest and skills at an early level to support advanced undergraduate or graduate study and stimulate interest in remote sensing as both art and science. This session will bring together panelists from members of the AmericaView consortium to present their experiences in a range of pipeline topics including K-12 outreach, service learning, STEM literacy, and curriculum development.

#### Panelists:

- Lindi Quackenbush, *State University of New York, Environmental Science and Forestry*
- Ken Boykin, *New Mexico State University*
- James Campbell, *Virginia Tech*
- Amber Imai-Hong, *Hawaii Space Grant Consortium, University of Hawaii-Manoa*
- JB Sharma, *University of North Georgia*
- Chandni Witharana, *University of Connecticut*
- Brent Yantis, *University of Louisiana-Lafayette*

## **TS #4—Special Session**

### **Great Lakes Remote Sensing**

Moderator: Brandon Krumwiede, *The Baldwin Group*

2:15 PM to 3:45 PM—Room 3

The Great Lakes represents about 20% of the world's available surface freshwater. When the Polar ice caps and Greenland glaciers melt into the ocean, the percentage approaches 50% (assuming the volume does not change) making the Great Lakes a substantial global resource to manage for future generations. This session will highlight a few unique remote sensing approaches for the Great Lakes Basin which will more accurately characterize changes over time at a sub-meter scale using a variety of sensors. The long-term challenge is how to integrate approaches across borders to provide systematic daily multi-sensor views of the Great Lakes Basin.

### **An Overview of the Binational Great Lakes Wetlands Remote Sensing Project**

Brian Huberty, *U.S. Fish & Wildlife Service*

Brian Brisco, Sarah Banks, Jennifer Corcoran, Jim Klassen, Keith Pelletier, Paul Morin, Laura Chavez, Mike Battaglia, and Joe Knight

### **High Resolution Optical and Radar Mapping and Monitoring of Coastal Great Lakes Wetlands to Inform Wetland Management Decisions**

Michael Battaglia, *Michigan Technological University*

Laura Bourgeau-Chavez, Michael Battaglia, Colin Brooks, Brian Huberty, Sarah Endres, and Brian Brisco

### **Creating High Temporal Frequency Digital Surface Models in the Great Lakes Basin**

James Klassen, *SharedGeo*

### **Dynamic Watercourse Hydrography Updating in Minnesota's Lake Superior Coastal Watersheds**

Jennifer Corcoran, *Minnesota Department of Natural Resources*

## TS #5

### **Snow and Ice**

Moderator: Gabriel Senay, *U.S. Geological Survey*

2:15 PM to 3:45 PM—Room 12

### **Global Land Ice Velocity Extraction (GoLIVE) from Landsat 8 and Sentinel 2a/b**

Ted Scambos, *National Snow and Ice Data Center, CIRES, University of Colorado at Boulder*

Mark Fahnestock, Alex Gardner, Marin Klingler, Twila Moon, and Terry Haran

### **Validation of Landsat 8 OLI and MODIS Aqua Greenland Ice Sheet Surface Reflectance Using Airborne Spectrometry**

Christopher Crawford, *U.S. Geological Survey*

### **Monitoring the Breakup of Sea Ice in the Beaufort Sea using Multi-Sensor Satellite-derived Time-series Data**

Tracy DeLiberty, *University of Delaware*

### **Global Snow Cover Trend Analysis using Cloud-based Geospatial Analysis Engine**

Xingong Li, *University of Kansas*

## TS #6

### **Deforestation and Forest Fragmentation**

Moderator: Randolph Wynne, *Virginia Tech*

2:15 PM to 3:45 PM—Room 14

### **Implementation of a New Spectral Vegetation Index within Google Earth Engine for Automated Forest Loss Mapping**

Lloyd L. Coulter, *San Diego State University*

Kellie A. Uyeda, and Douglas A. Stow

### **Landsat-Scale Trends of Above-Ground Biomass Across Mexico from 1984-2015**

Damien Sulla-Menashe, *Boston University*

Alessandro Baccini, Wayne Walker, Curtis Woodcock, and Chris Holden

### **Soy Moratorium Impacts on Soybean And Deforestation Dynamics In Mato Grosso, Brazil**

Jude Kastens, *University of Kansas*

Chris Brown, Alex Coutinho, Chris Bishop, and Julio Esquerdo

### **Mapping Long-Term Tree Cover Dynamics in Sub-Saharan Africa Using Socio-Ecological Geospatial Data**

Michael Marshall, *Department of Natural Resources, University of Twente*

### **Remote Sensing Time-Series Analysis of Forest Fragmentation and Connectivity in Virginia**

Iris Fynn, *Virginia Tech*

James Campbell

## Coffee Break

3:00 PM to 4:00 PM—Exhibit Hall 2

## TS #7—Special Session

### **Evolution of Global Land Cover Mapping: History and New Developments**

Moderator: Zhiliang Zhu, *U.S. Geological Survey*

4:00 PM to 5:30 PM—Room 2

Land cover maps of the world from paper media to digital formats have been produced over the millennium. These products featured prominently in the development of the world we know today, and the research and development of global land cover maps are still a critical scientific endeavor in our continued effort to understand the world better. In the recent history, a variety of well-known global land cover maps or databases have been developed using advanced remote sensing methods, which having given the scientific community important lessons learned from the development of the products and findings from applications of the land cover information. This session is designed as a unique forum for scientists who have played a role in developing and advancing the field of global land cover mapping to review the history of the development, highlight recent achievements, discuss key issues and knowledge gaps still facing us today, and providing outlooks for future science needs. The audience will learn about global land cover mapping history, recent developments, theoretical treatments, methodology reviews, applications, and global collaborations.

### **Reflections on the IGBP DISCover Global Land Cover Project**

Thomas Loveland, *U.S. Geological Survey*

Jesslyn Brown, Bradley Reed, Zhiliang Zhu, Limin Yang, and Donald Ohlen

### **Landsat Gone Global, Going Global, Still Going...**

Alan Belward, *Joint Research Centre, European Commission*

Noel Gorelick, Jean-Francois Pekel, and Andrew Cottam



## **A Strategy for Global Land Cover Monitoring Using Landsat and Sentinel 2**

Matthew Hansen, *University of Maryland*

## **A Brief and Personal History of Global Land-Cover Data: Have We Evolved from Too Little to Too Much?**

Elaine Matthews, *National Aeronautics and Space Administration*

## **Automated Global Land Cover Mapping From-Glc-2 and a New Mapping Portal in Support of Flexible Mapping With Landsat Data**

Zhiliang Zhu, *U.S. Geological Survey*

Peng Gong, Congcong Li, Jie Wang, Luyan Ji, Yuqi Bai, Huabing Huang, Le Yu, Duole Feng, Yuanyuan Zhao, Greg Biging, Nick Clinton, and Zhiliang Zhu,

## **TS #8—Special Session**

### **Calibration of Satellite Imagery**

Moderator: Dennis Helder, *U.S. Geological Survey*

4:00 PM to 5:30 PM—Room 7

Calibration of satellite imagery is the necessary first step before data users can extract useful, quantifiable information from the imagery. Thus, it is paramount that the calibration step achieves an accuracy and precision that significantly exceeds that required by the applications derived from satellite imagery. Calibration is normally divided into geometric calibration and radiometric calibration – essentially putting the pixels in the right place and giving them the right value. In this session both types of calibration will be addressed from a variety of perspectives. Status and improvements for calibration of various sensor types will be discussed, and insights will be given on new calibration approaches that promise improved accuracy for optical sensors in both the reflective and thermal regions.

### **Augmented Two Line Elements for Landsat Ephemeris Data**

Mark Lubke, *Stinger Ghaffarian Technologies, Inc.*

Ajit Sampath

### **Geometric Verification Algorithm (GVERIFY) to Validate the Accuracy of Landsat Multispectral Scanner and Thematic Mapper Data**

Mark Lubke, *Stinger Ghaffarian Technologies, Inc.*

Ajit Sampath

### **Lifetime Temporal Validation and Absolute Calibration of the EO-1 Hyperion Sensor**

Xin Jing, *South Dakota State University*

## **Compact Thermal Imager Calibrator (CTIC) for Landsat-like Missions**

Mary Pagnutti, *Innovative Imaging & Research*

Kara Burch and Robert Ryan

## **Landsat-8 Thermal Infrared Sensor Radiometric Calibration Status**

Julia Barsi, *Science Systems and Applications, Inc.*

Brian Markham, Simon Hook, John Schott, Nina Raqueno, and Emmett Lentilucci

## **Ground-based Artificial Light Source Radiometric Calibration of the VIIRS Day-Night Band High Gain Stage Early Results**

Robert Ryan, *Innovative Imaging & Research*

Timothy Ruggles, Kara Burch, Larry Leigh, Mary Pagnutti, and Dennis Helder

## **TS #9—Panel Session**

### **Training Next Generation Remote Sensing Scientists**

Moderator: Rebecca Dodge, *Midwestern State University*

4:00 PM to 5:30 PM—Room 9

From cloud computing to no-cost Landsat data and low-cost data collected from Unmanned Aircraft Systems, remote sensing technology is changing faster than ever before at a time when the need for a highly trained and adaptive geospatial workforce is perhaps greater than ever. In this session, StateView panelists from AmericaView, a nationwide consortium dedicated to remote sensing research, outreach, and education, will share their successes in building the remote sensing workforce of tomorrow through a network of undergraduate research opportunities. StateViews may focus research on state-specific issues important to local and regional stakeholders, such as urban expansion, coastal studies, forestry, agriculture, or grazing; international research applications are also available. Panelists will share lessons learned as well as valuable insights about recruiting, training, and mentoring undergraduate students on data processing, information extraction, and presentation skills. This will be followed by a Q&A and discussion session.

Panelists:

- Rebecca Dodge, *Midwestern State University*
- Larry Biehl, *Purdue University*
- Jarlath O'Neil-Dunne, *University of Vermont*
- Ramesh Sivanpillai, *University of Wyoming*
- Yong Wang, *East Carolina University*

## TS #10

### **Floods, Faults and Other Hazards**

Moderator: Jude Kastens, *University of Kansas*

4:00 PM to 5:30 PM—Room 3

### **Rapid Flood Mapping Using Inundation Libraries**

Jude Kastens, *University of Kansas*

Kevin Dobbs, James Halgren and Brian Ashe

### **Automated Mapping of Flood Events in the Mississippi River Basin Utilizing NASA Earth Observations**

Mercedes Bartkovich, *Science Systems and Applications, Inc.*

Nicholas McVey, Helen Baldwin, Olivia Callaway, Dashiell Cruz, and Chris Ploetz

### **Using Landsat 8 to Map the Geomorphology and Structural Geology of Northwestern Venezuela**

Tyler Ricketts, *University of Mississippi*

### **Employing Web Services and Large-scale Automation to Provide Greater Accessibility to Decision Makers.**

Jennifer Martin, *Satelytics*

## TS #11

### **Water and Air Quality**

Moderator: Nima Pahlevan, *National Aeronautics and Space Administration/SSAI*

4:00 PM to 5:30 PM—Room 12

### **Regional Water Quality Measurements of Optically Complex Inland Waters Using New Enhanced Landsat 8 and Sentinel 2 Imagery**

Leif Olmanson, *University of Minnesota*

Patrick Brezonik, Marvin Bauer, and Jacques Finlay

### **Landsat-Sentinel-2 for Aquatic Science: Steps Towards Transitioning from Research to Operations**

Nima Pahlevan, *National Aeronautics and Space Administration/SSAI*

Sudipta Sarkar, Sandeep Chittimalli, and Sundarabalan Subramanian

### **Leveraging Landsat to Map Lake Water Quality for Improved Public Health Decision-making**

Nathan Torbick, *Applied GeoSolutions*

### **Monitoring Air Quality in Shenandoah National Park to Address National Park Service Initiatives Using NASA Earth Observations**

Ellen Bubak, *Science Systems and Applications, Inc.*

Julie Terhune, Nicholas Lenfant, Douglas Gardiner, and Amanda Clayton

## TS #12

### **Fire and Fuel Loads**

Moderator: Birgit Peterson, *U.S. Geological Survey*

4:00 PM to 5:30 PM—Room 14

### **LANDFIRE Remap: Integrating Lidar for Improving Vegetation Structure Mapping**

Birgit Peterson, *U.S. Geological Survey*

Jordan Long, Birgit Peterson, and Kurtis Nelson

### **Disturbance Mapping Improvements for LANDFIRE Remap**

Brian Tolk, *Stinger Ghaffarian Technologies, Inc.*

### **Near Real-Time Monitoring of Wildfire Fuel Conditions in the Great Basin/Southwest U.S.**

Kurtis Nelson, *U.S. Geological Survey*

### **Development of a Landsat-8 Sentinel-2 30 m Burned Area Product**

David Roy, *South Dakota State University*

Haiyan Huang, Luigi Boschetti, Hankui Zhang, Lin Yan, and Zhongbin Li,

### **Utilizing NASA Earth Observations and Google Earth Engine to Map Historical Tree Mortality in Lassen Volcanic National Park**

Anna McGarrigle, *Science Systems and Applications, Inc.*

John Dilger, and Joshua Verkerke

## Social Events

### Exhibitors' Reception

5:30 PM TO 7:30 PM—Exhibit Hall 2

Take this wonderful opportunity to visit with the national and international suppliers exhibiting at the Symposium. An ASPRS tradition, the Exhibitors' Reception is a perfect time to mingle with fellow attendees, thank the Conference Exhibitors', our hosts for the evening, and stop by to view the wonderful Posters on display and interact with the authors. The evening is sure to provide a relaxed environment with light hors d'oeuvres and beverages and a time to come together with old and new friends.

Admission to this event is included with most registrations.

### Posters Sessions

5:30 PM TO 7:30 PM—Exhibit Hall 2

Take time to view the various posters on display and speak with the presenter. Poster presenters are asked to be near their work at this time and available to answer questions and expand on their research. In addition, poster presenters are requested to be near their poster during lunch breaks, as their schedule allows. Posters will be on display throughout the conference and open for viewing.

## Posters

### Advancing the Use of Remote Sensing to Understand Our Changing Earth

#### WorldView-3 SWIR Landuse-Landcover Mineral Classification: Cuprite, Nevada

Kathleen E. Johnson, *DigitalGlobe, Inc.*  
K. Koperski

#### Google Earth Engine for Eigenspace Spectral and Temporal Transforms of Landsat 8 and Sentinel-2 Data Sets

Lance D. Yarbrough, *The University of Mississippi*  
Greg Easson and Eleanor Dietz

#### Validation of the Operational SNPP VIIRS GVF Product using High Resolution Google Earth images

Zhangyan Jiang, *MSG at NOAA/NESDIS/STAR*

#### Development of a Semi-automated Process to Map Agriculture in the Upper Rio Grande Basin During the 2015 Growing Season using Spectral Grouping

Victoria G. Stengel, *U.S. Geological Survey*  
Diana E. Pedraza

#### Evaluation of SMAP at Forested Sites Across a Rainfall Gradient in Northern Minnesota

Greg Liknes, *Bemidji State University*  
William Sea

#### Requirements, Capabilities and Analysis for Earth Observations (RCA-EO)

Greg Stensaas, *U.S. Geological Survey*

#### Snow Cover Seasonality, Trends, and Change Analysis for Kyrgyzstan using MODIS: 2000-2016

Monika A. Tomaszewska, *South Dakota State University*  
Kamilya Kelgenbaeva and Geoffrey M. Henebry

#### Landfast Ice Detection of the Southern Coast of the Alaskan Seward Peninsula, 1997-2017

David Jensen, *Virginia Tech*

## **AmericaView**

### **Update on the Iowa Best Management Practice Inventory, Applications and Associated Datasets**

Robin McNeely, *IowaView - Iowa State University*

### **Modeling the Effects of Environmental Change on Crucial Wildlife Habitat**

Kenneth G. Boykin, *New MexicoView/New Mexico State University*  
Eric Ariel L. Salas, Virginia A. Seamster, Nicole M. Harings, and Keith W. Dixon

### **Using Remote Sensing Data to Improve Geographic Assessments of UV-B Radiation and its Climatology from a Sparse Ground Monitoring Network**

Michael Coughenour, *UV-B Monitoring and Research Program, Colorado State University*

### **Aligning Earth Observation Technologies with Next Generation Science Standards**

Chandi Witharana, *Department of Natural Resources and the Environment, ConnecticutView, University of Connecticut*  
James Hurd

### **South Dakota LiDAR Factsheet**

Mary O'Neill, *South Dakota State University/AmericaView*

### **RealEarth: Visualize Your Data**

Sam Batzli, *WisconsinView*

### **New Methods for Integrating Remote Sensing Imagery and Modeled Inundation Libraries for Rapid Flood Mapping**

Kevin Dobbs, *AmericaView/KansasView*

### **Mapathon—A Volunteer Geographic Information Mapping for Humanitarian Relief**

Pia van Benthem, *University of California-Davis*

### **Integration of Landsat-8 and High-resolution Imagery, and LiDAR to Improve Mapping of Water Bodies at Regional Scales**

Haluk Cetin, *Murray State University*

### **Incorporating Remote Sensing into K-12 Project-Based Science Curricula**

Nancy H.F. French, *Michigan Tech Research Institute*  
Michael J. Battaglia

### **Working with Time-series Landsat Big Data: A Workflow and Experiences with Open Source Software**

Jeong Seong, *University of West Georgia*

### **Mapping and Monitoring Shelterbelt Dynamics in the Red River of the North Valley using Naip and Lidar Data**

Bradley Rundquist, *University of North Dakota*  
Morgen Burke and Earl Klug

### **Multispectral and Texture Feature Application in Mapping Summer Vegetation for Marco Polo Argali in Eastern Tajikistan Pamirs**

Kenneth Boykin, *New Mexico State University*  
Eric Ariel L. Salas and Raul Valdez

## **Applications of Remote Sensing for Improving Decision-making**

### **Unsupervised Classification of Earth Surface for Landslide Detection**

Caitlin Tran, *California State Polytechnic University-Pomona*  
Jessica Fayne, Omar Mora, and Joy Sellman

### **All Quiet on the Northern Front: Remote Sensing Based Retrospection of Human Wellbeing in the Armed-Conflicted Areas of Sri Lanka**

Chandi Witharana, *University of Connecticut*

### **Utilizing Sentinel-2 Satellite Imagery for Precision Agriculture over Potato Fields In Lebanon**

Hanan Abou Ali, *Idaho State University*  
Donna M. Delparte and L. Michael Griffel

### **Applied Remote Sensing as a Means to Assess Brush Control in Western Rangelands**

Chandra Holfield Collins, *USDA-ARS Southwest Watershed Research Center*  
Susan Skirvin, Mark Kautz, and Loretta Metz

### **Global SSEBop Evapotranspiration for Drought Monitoring Purposes**

Stefanie Kagone, *Stinger Ghaffarian Technologies, Inc.*

## **Expedited Start of Growing Season Estimates Assist Rapid Prediction of Invasive Cheatgrass in the Great Basin**

Bruce B. Worstell, *Stinger Ghaffarian Technologies, Inc.*

Stephen Boyte, Danny Howard, Jesslyn Brown, Bruce Wylie, and Devendra Dahal

## **Applying Object-based Image Analysis to the Search for World War II Era Unexploded Bombs Using High-Resolution Multi-temporal and Multi-source Data**

Cynthia A. Miller, *Minnesota State University-Mankato*

Bryan P. Byholm, Anna K. Brand, and Fei Yuan

## **Genetic Algorithm Based Stereo Image Correspondence Using Multi-objective Fitness Function For Remotely Sensed Images**

Manimala Mahato, *Indian Institute of Technology*

Shirish S. Gedam, Jyoti Joglekar, and B. Krishna Mohan

## **Assessing Sustainable Urban Rooftop Designs through the usage of Small Unmanned Aerial Systems and Satellite Imagery: A case study in Auburn, Alabama**

Chandana Mitra, *Auburn University*

Austin Bush and Seth Greer

## **Building Capacity to Use NASA Earth Observations through the NASA DEVELOP Program**

Lauren Childs-Gleason, *National Aeronautics and Space Administration*

## **The Study of Forest Cover Change in Puerto Rico since 1970s using Satellite Imagery**

Fei Yuan, *Minnesota State University-Mankato*

Jose Javier Lopez, Sabrina Arnold, Anna Brand, Jonas Klein, Maureen Schmidt, Erin Moseman, and Madeline Michels-Boyce

## **Selection of Ratings & weightages for preparation of Landslide Susceptibility Zonation (LSZ)**

Sharad Kumar Gupta, *Indian Institute of Technology, Mandi*

Dericks Praise Shukla

## **Assimilation of Earth Observations into Land Surface Dynamic Models General Circulation Models and other Earth System Models**

## **Development of Global Gridded Vegetation Products From S-NPP VIIRS for NCEP Environmental Modeling Systems**

Mingshi Chen, *IMSG at NOAA/NESDIS/STAR*

Zhangyan Jiang, Yunyue Yu, Ivan Csiszar, Marco Vargas

## **Challenges and Innovations in Big Data Analysis for Solving Complex Largescale Problems**

## **Tutorials and Services for Working with Multiple Land Remote Sensing Data Products**

Cole Krehbiel, *Innovatel, Inc.*

Aaron Friesz, Tom Maersperger, Lindsey Harriman, William (Cory) Alden, and Chris Doescher

## **Using Google Earth Engine to Map Water Use and Availability**

Mac Friedrichs, *Stinger Ghaffarian Technologies, Inc.*

## **Big Data, Small Farms: Lessons Learned from Integrating Data Science Approaches with Remote Sensing of Smallholder and Urban Agriculture**

Jessica L. McCarty, *Miami University*

Christopher S.R. Neigh, Mark L. Carroll, Margaret R. Wooten, Molly E. Brown, Glenn M. Sullivan, Rahel Diro, Daniel E. Osgood, Markus Enenkel, and Bristol F. Powell

## **Emerging Roles for Smallsats and Airborne Systems in Operational Monitoring**

## **Multuser Perspectives on Experimental UAS Flight Operations**

Timmera Whaley, *University of Arkansas*

Jason Tullis

## **From Satellite to Drones to Products**

Lucia Lovison-Golog, *SAT-DRONES LLC*

## **Landsat and Sentinel-2: Comparisons Cross-calibrations and Synergies**

## **Monitoring Chlorophyll-a of the Western Basin of Lake Erie with Sentinel-2A and Landsat 8 imagery**

Anita Simic Milas, *Bowling Green State University*

## **Assessing Three Satellite-derived Burned Area Products and Combining with Medium Resolution Data for Characterizing Peatland Fires**

Yenni Vetruta, *South Dakota State University*

Mark A. Cochrane, Suwarsono Suwarsono, Any Zubaidah, and Erianto I. Putra

**Global analysis of Landsat-8, Sentinel-2A and Sentinel-2B temporal revisit intervals**

Jian Li, *South Dakota State University*

**Downscaling Landsat-8 30 m data to Sentinel-2 20 m resolution**

Zhongbin Li, *Geospatial Sciences Center of Excellence, South Dakota State University*

**New initiatives for Monitoring and Projecting Land and Water Cover Use and Change**

**Identifying Forest Conversion Hotspots in the Commonwealth of Virginia Through the Use of Landsat and Known Change Indicators**

Matthew N. House, *Virginia Tech*  
Randolph H. Wynne

**Assessing Land Cover Change During Drought Period in a Coastal Area of Binh Thuan Province, Vietnam Using High Resolution Imagery**

James B. Campbell, *Virginia Tech*  
Hoa Tran and Randolph H. Wynne

**Developing Unbiased Global Et Dataset using an Automated Bias Correction Approach**

Naga Manohar Velpuri, *ASRC InuTeq*  
Gabriel Senay, Stefanie Kagone, and MacKenzie Friedrichs

**Gross Primary Productivity and Seasonal Distribution of Alpine Wetlands from 2001 to 2016 in the Gunnison River Basin, CO**

Sami Chen, *Stanford University*  
Kate Maher

**Land Surface Phenologies and Seasonalities of Croplands and Grasslands in the Prairie Pothole Region Using Passive Microwave Data 2003-2015**

Woubet G. Alemu, *South Dakota State University*  
Geoffrey M. Henebry

**The Land Product Characterization System: A Tool for Comparative Analysis of Satellite Data and Products**

Kevin Gallo, *National Oceanic and Atmospheric Administration*

**Methods for Converting Continuous Shrubland Ecosystem Component Values to Thematic National Land Cover Database Classes**

Leila Gass, *U.S. Geological Survey*  
Matthew Rigge, Collin Homer, and George Xian

**Estimating Percent Tree Canopy Cover Using Landsat Time-Series**

Jill M. Derwin, *Virginia Tech*  
Valerie Thomas, Randolph Wynne, Evan B. Brooks, Christine E. Blinn, Greg Liknes, John Coulston, Mark Finco, Kevin Megown, Gretchen Moisen, Chris Toney, Robert Benton, K. Schelleweis, and Bonnie Ruefenacht

**Changes In Land Use and Consumptive Water Use in Central California**

Martha Anderson, *U.S. Department of Agriculture*  
Kyle Knipper, Wayne Dulaney, Joe Alfieri, Bill Kustas, Yun Yang, Dennis Baldocchi, Feng Gao, and Chris Hain

**Mapping Evapotranspiration for Historical (1984-2015) Water Use and Availability in the Upper Rio Grande River Basin using the Landsat Archive**

Matt Schauer, *Innovate!, Inc.*

**2016 Tree Canopy Cover for the National Land Cover Database: Production Data, Methods, Uses, and a Tour through American Landscapes**

Stacie Bender, *U.S. Forest Service*  
Wendy Goetz, Mark Finco, Bonnie Ruefenacht, Greg Liknes, and Kevin Megown

**Detecting Land Change Using Land Surface Phenology Modeling: An Application to the Dynamic Northern Great Plains**

Lan H. Nguyen, *Geospatial Sciences Center of Excellence, South Dakota State University*  
Geoffrey M. Henebry

**A Road Network Extraction Methodology Applied in Remote Sensing Images of Low and Median Spatial Resolution**

Guilherme Pina Cardim, *UNESP*

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- ✓ Exclusive events and special offers on industry reports
- ✓ Monthly e-Newsletter

## Registration Desk

7:30 AM to 4:30 PM

## Coffee Break

7:00 AM to 8:00 AM—FOYER

## Plenary Session

### Opening Remarks

Becky Morton, ASPRS President

### Current State of Earth Observations—Panel Discussion

Moderator: Barbara J. Ryan, Secretariat Director of the intergovernmental, Group on Earth Observations (GEO)

8:30 AM to 10:00 AM—BALLROOM A

### Michael H. Freilich, Director, Earth Science Division at NASA Headquarters



Dr. Freilich is the Director of NASA's Earth Science Division. The purpose of NASA's Earth science program is to develop a scientific understanding of Earth's system and its response to natural or human-induced changes, and to improve prediction of climate, weather, and natural hazards. A major component of NASA's Earth Science Division is a coordinated series of satellite and airborne missions for long-term global observations of the land surface, biosphere, solid Earth,

atmosphere, and oceans. This coordinated approach enables an improved understanding of the Earth as an integrated system. Prior to coming to NASA, he was a Professor and Associate Dean in the College of Oceanic and Atmospheric Sciences at Oregon State University. He received BS degrees in Physics (Honors) and Chemistry from Haverford College in 1975 and a Ph.D. in Oceanography from Scripps Institution of Oceanography in 1982. Dr. Freilich's honors include the JPL Director's Research Achievement Award (1988), the NASA Public Service Medal (1999), and the American Meteorological Society's Verner E. Suomi Award (2004), as well as several NASA Group Achievement awards. He was named a Fellow of the American Meteorological Society in 2004.

### Harry A. Cikanek, Director (acting), STAR – Center for Satellite Applications and Research, NOAA



Mr. Cikanek is the acting Director for the United States National Oceanic and Atmospheric Administration's Center for Satellite Applications and Research (STAR), the unit of the NOAA Satellite and Information Service responsible for transforming raw and intermediate satellite data flows from NOAA and global observing system satellites into real time weather and environmental data and information products. These feed forecast models, and operations personnel in the National Weather Service, National Ocean Service, National Marine Fisheries Service, and support research, and long term environmental information products to meet NOAA's and its partner weather and environmental information needs to protect life, property and livelihoods. Prior to this assignment, he served just over five years as the first Director of the NOAA Joint Polar Satellite System (JPSS). His major JPSS accomplishments included stabilizing and streamlining the program to tighten its focus on the weather mission while avoiding over \$2 billion in cost. He oversaw the successful transition of the Suomi National Polar Partnership (the first JPSS mission) satellite to NOAA operations and its continued successful operations in support of the NOAA weather mission. Mr. Cikanek began his career as a NASA aerospace engineer. His 30 years at NASA included engineering and program management in rocket propulsion, launch services, space transportation technology, and human exploration of space. He is the author or coauthor of over 25 papers and articles. He is also a recipient of the Presidential Rank of Meritorious Executive, the NASA Outstanding Leadership Medal, and is an Associate Fellow of the American Institute of Aeronautics and Astronautics.

### William H. Werkheiser, Acting Director, USGS



Mr. Werkheiser has served in numerous positions since joining the USGS in 1986. Prior to his position as Associate Director for Water, he was the Regional Director for the former USGS Eastern Region, where he oversaw activities related to biological, geographical, geological, and hydrological research and assessments. He also led the Natural Hazards Initiative Team and the long-term Hurricane Katrina Response and Recovery Team for the USGS. He has over 25 years of experience with the USGS and other agencies working on a variety of environmental and scientific issues.



**Victor H. Leonard**, Senior Fellow, *DigitalGlobe, Inc.*



Mr. Leonard has more than four decades in research, development and operation of space, air and ground remote sensing systems for defense, intelligence, civil and commercial applications. His experience includes a wide variety of management, research, development, engineering and operations positions with the U. S. Air Force, the Boeing Company, the Central Intelligence Agency (CIA), Resource21 LLC and DigitalGlobe relating to IMINT, SIGINT and MASINT

systems and commercial remote sensing.

As Senior Fellow at DigitalGlobe, Mr. Leonard provides thought leadership on a broad range of domains: Established comprehensive corporate R&D roadmap and program, defining more than 40 remote sensing imagery and information projects essential to company growth and increased profitability. Authored numerous white papers and presentations for internal and external decision makers, including seminal art-of-the-possible concepts. Defined overall concept, requirements and programmatic for an imagery streaming service that makes commercial imagery available to remote users within minutes to an hour of collection. Defined overall concept and requirements for a game-changing space and ground system that efficiently assesses mission utility of each imagery pixel and accurately estimates absolute surface reflectance. Defined overall concept and requirements for a next generation cloud-based imagery and information products and services platform. Defined the overall concept and requirements for commercial secure operations. Invited representative for American high-resolution commercial imagery at US and Allied Space Wargames since 2001.

## Exhibit Hall Hours

10:00 AM to 7:00 PM

## Technical Sessions

### TS #13

#### **LCMAP Special Session 1: Foundations**

Moderator: Curtis Woodcock, *Boston University*

10:30 AM to 12 NOON—Room 2

The U.S. Geological Survey (USGS) has a long land cover history, starting with the 1976 landmark *A Land Use and Land Cover Classification System for use with Remote Sensor Data* and including global land cover mapping and the ongoing production of the National Land Cover Database. While these past projects have had a significant impact, land cover data needs are changing due to the demand for increasingly innovative and timely land cover products needed to meet the community's insatiable appetite for science-quality geospatial land cover and land change data. Recent research on the use of the unprecedented depth of the Landsat archive has resulted in the potential to generate higher quality results that include additional land cover variables, more detailed legends, and more frequent land cover and land change geospatial and statistical information. To capitalize on new capabilities, the USGS is working closely with researchers from Boston University and Texas Tech University to implement the Land Change Monitoring, Assessment, and Projection (LCMAP) initiative. LCMAP is envisioned as an end-to-end capability that uses the rich Landsat record to continuously track and characterize changes in land cover, use, and condition and translate such information into assessments of current and historical processes of cover and change. LCMAP aims to generate science-quality land cover and land change products from current and near-real time Landsat data. All available Landsat data for any given location are used to characterize land cover and change at any point across the full Landsat record and to detect and characterize land cover and land change as it occurs.

Three special sessions will: 1) lay out the foundations of LCMAP; 2) review the initial progress toward developing a new generation of land cover and land change products; and 3) examine how these new products are addressing land change applications.

#### **Land Change Monitoring, Assessment, and Projection (LCMAP): Expanding the Understanding and Management of Land Change**

Thomas Loveland, *U.S. Geological Survey*

John Dwyer and Curtis Woodcock

## **Large Area Annual Land Cover Maps Derived from Analysis Ready Landsat Time Series Data**

Zhe Zhu, *Texas Tech University*

## **Analysis Ready Data: Reconditioning the Landsat Archive to Support Time Series Investigations**

John Dwyer, *U.S. Geological Survey*  
Thomas Loveland and Calli Jenkerson

## **Collection of National Land Cover and Land Change Reference Data for a 30+ Year Time Series Accuracy Assessment**

Bruce Pengra, *Stinger Ghaffarian Technologies, Inc.*  
Warren Cohen, Todd Schroeder, Sean Healey, Stephen Stehman, and Zhiqiang Yang

## **Accuracy Assessment and Area Estimation for Annual Land-Cover Monitoring**

Stephen Stehman, *State University of New York*  
Thomas Loveland, and Bruce Pengra

### **TS #14**

#### **Landsat/Sentinel Cross-Calibration Session 1**

Moderator: Brian Markham, *National Aeronautics and Space Administration*  
10:30 AM to 12 NOON—Room 7

#### **Cross-Calibration of Landsat 8 OLI and Sentinel 2 MSI and its Impact On Data Interoperability--Workshop Results and Analysis**

Dennis Helder, *U.S. Geological Survey*

#### **Operational Sentinel-2A L1C and Landsat-8 Collection-1 Time-series Registration**

Lin Yan, *South Dakota State University*  
David Roy, Haiyan Huang, Zhongbin Li, and Hankui Zhang

#### **Improving Landsat-8/Sentinel-2 Registration Accuracy**

James Storey, *Stinger Ghaffarian Technologies, Inc.*  
Michael Choate, Rajagopalan Rengarajan, and Mark Lubke

#### **A Small Satellite Piggy-Back Calibrator (PBR) Enabling Accurate Absolute Radiometric Calibration**

Mary (Becky) Cudzilo, *Surrey Satellite Technology US LLC*

## **Uncertainty of the TOA Radiance predicted by MODTRAN-5 using Monte Carlo Simulation**

Cibele Teixeira Pinto, *South Dakota State University*  
Ruy Morgado de Castro, Larry Leigh, and Dennis Helder

### **TS #15—Panel Session**

#### **Petascale High Performance Computing**

Moderator: Steve Swazee, *GITA Executive Director/SharedGeo*  
10:30 AM to 12 NOON—Room 9

With the growth of daily commercial, higher resolution, optical and radar satellite systems to the explosion of centimeter level cameras on Unmanned Aerial Systems, the question is not can one get imagery but how can one handle it all? Petascale High Performance Computing is a major emerging technology system that has bypassed traditional remote sensing computer workstation approaches. This panel is designed to facilitate a broad discussion of where the industry is today and where it is going in the future. The panelists represent a cross section of academic, business, and government sectors.

#### **Panelists:**

- Chris Doescher, *U.S. Geological Survey*
- Lanny Faleide, *Satshot.com*
- Mark Korver, *Amazon Web Services*
- Paul Morin, *University of Minnesota*

### **TS #16**

#### **Landcover and Landcover Change**

Moderator: Kristi Saylor, *U.S. Geological Survey*  
10:30 AM to 12 NOON—Room 12

#### **Unlocking Landsat's Landscape Narratives: Landcover in the Cloud**

Robert Kennedy, *Oregon State University*  
Justin Braaten, Sam Hooper, Joseph Hughes, Zhiqiang Yang, and Peder Nelson

#### **Multi-algorithm Sequencing for Land Cover Change Monitoring**

Eric Bullock, *Boston University*  
Curtis Woodcock

## **A Polyalgorithm for Land Cover Trend and Change Detection**

Valerie Thomas, *Virginia Tech*

Rishu Saxena, Layne Watson, Randolph Wynne, and Valerie Thomas

## **The Time Series Global Land Surface Satellite (GLASS) products**

Shunlin Liang, *University of Maryland*

## **Mapping Smallholder Forest Plantation Dynamics in Andhra Pradesh using Multitemporal, Multiresolution Earth Resource Satellite Data**

Randolph Wynne, *Virginia Tech*

Valerie Thomas, Evan Brooks, Jill Derwin, Gregory Amacher, Kelly Cobourn, Haripriya Gundimeda, Matthew House, Paige Williams, Sara Cerv, James Rakestraw, and Rishu Saxena

## **TS #17**

### **Bathymetry and Shoreline Mapping**

Moderator: Vaughn Ihlen, *U.S. Geological Survey*

10:30 AM to 12 NOON—Room 3

### **Active-Passive Data Fusion for Global, Nearshore Bathymetry Retrieval**

Nick Forfinski-Sarkozi, *Oregon State University*

Christopher Parrish

### **Evaluating the Potential for Near-Shore Bathymetry on the Majuro Atoll, Republic of the Marshall Islands, Using Landsat 8 and WorldView-3 imagery**

Sandra Poppenga, *U.S. Geological Survey*

### **Best Practices for Use of Remote Sensing Derived Elevation Models in Sea-Level Rise Assessments**

Dean Gesch, *U.S. Geological Survey*

### **WorldDEM Ocean Shoreline Validation and Verification**

Michael Caruso, *University of Miami*

Hans Graber, Ernest Fahrland, John Collins, and John Hargrove

### **Structure-From-Motion Derived Historical Orthomosaics and their Applications**

Lisa Wirth, *University of Alaska*

## **TS #18**

### **Forest Canopy Height and Structure**

Moderator: Steve Covington, *The Aerospace Corporation*

10:30 AM to 12 NOON—Room 14

### **Large-Area Site Index Maps Using Disparate Lidar Datasets and Landsat Data for Better Planted Pine Forest Management**

Ranjith Gopalakrishnan, *University of Eastern Finland*

Jobriath Kauffman, Valerie Thomas, and Randolph Wynne (Presenting)

### **Using Lidar to Inform Management of Minnesota's Aspen and Red Pine Forests**

George Host, *University of Minnesota-Duluth*

Kristina Nixon, Paul Meysembourg, William Berguson, and Daniel Buchman

### **Land Cover Classification of the Lake of the Woods/Rainy River Basin by Object-Based Image Analysis of Landsat and Lidar Data**

Leif Olmanson, *University of Minnesota*

Marvin Bauer

### **Integrating Airborne Lidar and Landsat Data to Quantify Forest Aboveground Biomass Amount and Uncertainty**

Lindi Quackenbush, *State University of New York*

Siqi Li

### **Tree Height Estimation in Sloped Plateau Area with Dual-Polarization InSAR Techniques and Datasets**

Yong Wang, *East Carolina University, University of Electronic Science and Technology of China*

Huimin Li

## *Social Event*

### **Lunch with Exhibitors'**

Wednesday and Thursday, November 15<sup>th</sup> and 16<sup>th</sup>; 12 NOON TO 1:30 PM—Exhibit Hall 2

Take some time out of your busy week and have lunch with Exhibitors. A much needed 90-minute break in the middle of the day will surely refresh you with a complimentary lunch and some good conversation. Take time to meet with our generous exhibiting companies, view posters, and even catch-up with friends.

Admission to this event is included with most registrations.

## Plenary Session

### Opening Remarks

Frank P. Kelly, Director, U.S. Geological Survey, EROS Center

### Presentation of the 2017 William T. Pecora Award

Michael H. Freilich, NASA and William H. Werkheiser, USGS

1:30 PM to 3:00 PM – Ballroom A

The William T. Pecora Award is presented annually to individuals or groups that make outstanding contributions toward understanding the Earth by means of remote sensing. The award is sponsored jointly by the Department of the Interior (DOI) and the National Aeronautics and Space Administration (NASA).

### 2017 Group Award

**International Charter on Space and Major Disasters**—For outstanding support to the global community during times of crisis. From the first Charter activation in 2000 to ongoing activations in 2017, the Charter has provided satellite imagery free of charge for disaster response purposes throughout the world. The humanitarian mission, design and implementation of the International Charter on Space and Major Disasters make it highly deserving of the William T. Pecora Team Award.

### 2017 Individual Award

**Darrel L. Williams**—For outstanding contributions toward understanding terrestrial ecosystems by means of Landsat remote sensing. Dr. Williams' career has been dedicated to development and advancement of digital remote sensing and the Landsat program in particular, as envisioned by William Pecora and Secretary Udall a half-century ago. In stature and achievements, he lives in the true spirit of the USGS/NASA Pecora award and deserves the recognition that this award is intended to honor.

### Perspectives on Progress and Challenges in Remote Sensing—Panel Discussion

Moderator: Stan Morain (Pecora Award 2007), Research Professor/Emeritus Professor, University of New Mexico

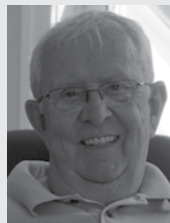


For over 40 years, Dr. Morain carved a distinguished career in remote sensing recognized locally, nationally, and internationally. His contributions focused on educating his students and developing professional ties to research communities in many developing countries on the applications of remote sensing in several societal benefit areas, but primarily in agriculture, transportation, and public health. In pursuit of his vision, he worked with many research teams and governments in Latin America, Asia, and Africa. In the early 1970s, with the advent of Landsat, he was among the first to use satellite imagery for crop and vegetation analyses. In 1973, his interests were re-directed toward developing countries wishing to adopt Landsat technology for natural resources management.

Stan has served the remote sensing community through his involvement in the American Society for Photogrammetry and Remote Sensing (ASPRS) and the International Society for Photogrammetry and Remote Sensing (ISPRS). He is an ASPRS Honorary Member and an elected ASPRS Fellow, past editor of PE&RS, and past president of ASPRS. In ISPRS he is a past president of Commission I (Platforms, Sensors, and Imagery), served as a council member and treasurer, and as technical secretary in Commission VIII, Working Group 2 (health). He also was active in the International Council for Science (ICSU), and the intergovernmental Group on Earth Observations/ User Interface Committee (GEO/UIC). He is an elected Fellow in the Geology/Geography Section of the American Association for the Advancement of Science (AAAS).

Panelist—Pecora Award Winners

### Samuel N. Goward (2008)



Dr. Goward pursues biophysical applications of land remotely sensed data. He has been actively involved in the land observation missions since the 1970s, specifically focused on Landsat and AVHRR. His recent research has focused on evaluating North American forest disturbance and regrowth from the historical Landsat observation record for the North American Carbon Program (NACP). He currently is serving as a member of the NACP science steering group. He served as the Landsat Science Team Leader for Landsat 7 and continues

as a member of the Landsat Science Team today. In addition, he served as the Co-Chair for the USGS National Land Satellite Land Remote Sensing Data Archive (NLSLRSDA) advisory committee. In recognition of his long-standing commitment to land observations and the Landsat mission, Dr. Goward has received the USGS John Wesley Powell award, the USGS/NASA William T. Pecora award and the ASPRS SAIC Estes Teaching award. He continues to serve as an associate editor for Remote Sensing of Environment.

#### **Curtis E. Woodcock** (2016)



Dr. Woodcock has held academic positions at the University of California, the City University of New York and Boston University. His primary research interests are: the use of remote sensing to monitor land change, including topics of time series analysis, cloud/cloud shadow detection, and validation of time series results; terrestrial carbon dynamics; the causes and consequences of land cover and land use change. Dr. Woodcock was the 2016 William T. Pecora Award winner for "outstanding contributions toward understanding the Earth by means of remote sensing." He was the co-team leader for the Landsat Science Team.

#### **Darrel L. Williams** (2017)



Dr. Williams joined Global Science and Technology as their Chief Scientist in February 2010 upon retiring from a distinguished 35-year career in NASA. At NASA, he conducted remote sensing research to develop enhanced techniques for assessing terrestrial ecosystems worldwide. Over time he assumed science management positions of increasing responsibility, including international field campaign manager, Branch Head, Landsat Project Scientist, and Laboratory Associate and Acting Chief. He worked

with and mentored several EOS-era Project Scientists (Terra, Aqua, ICESat, NMP Earth Observer-1, Landsat Data Continuity Mission, etc.), and received NASA medals for Outstanding Leadership (1997) and Exceptional Service (2000). In 1999 Williams received the "Aviation Week and Space Technology 1999 Laurels Award" for outstanding achievement in the field of Space in recognition of his science leadership role for the Landsat 7 mission. In 2006, he received an "Outstanding Alumni Award" from the School of Forest Resources at the Pennsylvania State University where he received his B.S. and M.S. degrees in Forest Science in 1973 and 1974, respectively. Williams attained his Ph.D. in Physical Geography from the University of Maryland in 1989.

#### **Coffee Break**

3:00 PM to 4:00 PM—Exhibit Hall 2

## *Technical Sessions*

#### **TS #19**

#### **LCMAP Special Session 2: Initial Results**

Moderator: Virginia Burkett, *U.S. Geological Survey*

3:30 PM to 5:00 PM—Room 2

The U.S. Geological Survey (USGS) has a long land cover history, starting with the 1976 landmark *A Land Use and Land Cover Classification System for use with Remote Sensor Data* and including global land cover mapping and the ongoing production of the National Land Cover Database. While these past projects have had a significant impact, land cover data needs are changing due to the demand for increasingly innovative and timely land cover products needed to meet the community's insatiable appetite for science-quality geospatial land cover and land change data. Recent research on the use of the unprecedented depth of the Landsat archive has resulted in the potential to generate higher quality results that include additional land cover variables, more detailed legends, and more frequent land cover and land change geospatial and statistical information. To capitalize on new capabilities, the USGS is working closely with researchers from Boston University and Texas Tech University to implement the Land Change Monitoring, Assessment, and Projection (LCMAP) initiative. LCMAP is envisioned as an end-to-end capability that uses the rich Landsat record to continuously track and characterize changes in land cover, use, and condition and translate such information into assessments of current and historical processes of cover and change. LCMAP aims to generate science-quality land cover and land change products from current and near-real time Landsat data. All available Landsat data for any given location are used to characterize land cover and change at any point across the full Landsat record and to detect and characterize land cover and land change as it occurs.

Three special sessions will: 1) lay out the foundations of LCMAP; 2) review the initial progress toward developing a new generation of land cover and land change products; and 3) examine how these new products are addressing land change applications.

## **A New Generation of U.S. Land-Cover Products**

Christopher Barber, *ASRC Federal Inuteq*

Alisa Gallant, George Xian, Qiang Zhou, and Bruce Pengra

## **A New Generation of U.S. Land Change Products**

Jim Vogelmann, *U.S. Geological Survey*

## **Deconstructing Developed and Forested Areas in the Chesapeake Bay Watershed**

Peter Claggett, *U.S. Geological Survey*

## **Comparing Land Cover Trends Project's Normalized Annual Change and LCMAP's Annual Change in the Puget Lowland Ecoregion**

Roger Auch, *U.S. Geological Survey*

Kristi Saylor, Stephen Stehman, Bruce Pengra, and Janis Taylor

## **TS #20**

### **Landsat/Sentinel Cross-Calibration Session 2**

Moderator: Jim Storey, *Stinger Ghaffarian Technologies, Inc.*

3:30 PM to 5:00 PM—Room 7

### **Refined Absolute PICS Calibration Model Over Libya-4 using Sentinel2A and Landsat 8 Collection-1 data for Validation**

Morakot Kaewmanee, *South Dakota State University*

Dennis Helder

### **SMACAA Atmospheric Code for BRDF Retrieval and APICS First Principles Methodology as Applied Imaging Satellite Sensor Calibration**

Larry Leigh, *South Dakota State University*

Leah Ervin, and Dennis Helder

### **Large Area Saharan PICS Development for Calibration and Stability Monitoring of Optical Satellite Sensors**

Mahesh Shrestha, *South Dakota State University*

Larry Leigh, Dennis Helder, and Thomas Loveland

### **Endmember-Based Aerosol Inversion Technique for the Atmospheric Correction of Landsat OLI**

Minsu Kim, *Stinger Ghaffarian Technologies, Inc.*

## **Landsat 8 Operational Land Imager: Relative Gain Estimation Using Unbiased Global Earth Imaging**

Obaidul Haque, *Stinger Ghaffarian Technologies, Inc.*

Julia Barsi, Dennis Helder, and Esad Micijevic

## **Landsat-8 OLI On-Orbit Radiometric Performance and Landsat-9 OLI-2 Radiometric Performance Predictions**

Brian Markham, *National Aeronautics and Space Administration*

Julia Barsi, Ron Morfitt, Ed Kaita, Md Obaidul Haque, Lawrence Ong, Phil Dabney, Jeffrey Pedelty, Raviv Levy, and Esad Micijevic

## **TS #21**

### **Agriculture and Drought**

Moderator: Rick Mueller, *U.S. Department of Agriculture*

3:30 PM to 5:00 PM—Room 9

### **Estimating Excess Moisture Conditions with Earth Observation Data**

Catherine Champagne, *Agriculture and Agri-Food Canada*

### **Vigor and Evapotranspiration of Soybean Grown Under Different Management Systems Monitored by Landsat**

Anita Simic, *Bowling Green State University*

### **Validation of MinNDTI Method for Remote Sensing of Crop Residue and Tillage Practices Using Multi-Temporal Landsat 8 and Sentinel-2 Imagery**

Michael Graham, *Virginia Tech*

James Campbell, Baojuan Zheng, Craig Daughtry, Yang Shao, and Megan O'Rourke

### **Investigating Patterns of Drought Influence on Land Use and Land Cover in the Great Plains with Landsat Time Series Data**

Heather Tollerud, *U.S. Geological Survey*

Jesslyn Brown and Thomas Loveland

## TS #22

### **Landcover Classification Algorithms**

Moderator: David Roy, *South Dakota State University*

3:30 PM to 5:00 PM—Room 3

### **Using the 500 m MODIS Land Cover Product to Derive a Consistent North America 30 m Landsat Land Cover Classification and Implications for Global 30 m Land Cover Mapping**

Hankui Zhang, *South Dakota State University*

David Roy

### **The Rapid Land Cover Mapper: A Useful Alternative for High Resolution and Small Scale Land Study**

Ross Eveltizer, *Northeast Iowa Resource Conservation & Development*

Darrell Napton, and Suzanne Cotillon

### **Reusing Low-Accuracy and Variable-Accuracy Land-Cover Maps for Automatic Forest/Non-Forest Classification**

Peter Kennedy, *University of Lethbridge*

Craig Coburn

### **A Hybrid Approach to Realistically Downscaling Land Use Patterns**

Evan B Brooks, *Virginia Polytechnic Institute and State University*

John W. Coulston, Kurt H Riitters, and David N Wear

### **Estimating and Mapping Individual Pixel Accuracy for Classified Remote Sensing Images**

Giorgos Mountrakis, *State University of New York*

Reza Khatami, and Steve Stehman

## TS # 23

### **Evapotranspiration for Water Management**

Moderator: Martha Anderson, *U.S. Department of Agriculture*

3:30 PM to 5:00 PM—Room 12

### **A Review of Remote Sensing of Evapotranspiration Models for Agricultural Water Resources Management**

Hatim Geli, *New Mexico State University*

Christopher Neale and James Verdin

### **Analysis of Satellite-Based Water Use Dynamics Using Historical Landsat Data (1984-2014) in the Southwestern United States**

Gabriel Senay, *U.S. Geological Survey*

Matthew Schauer, MacKenzie Friedrichs, Naga Manohar Velpuri, and Ramesh Singh

### **An Intercomparison of Evapotranspiration Estimates Derived Using Thermal-Based Satellite Remote Sensing for Irrigation Management in California Vineyards**

Kyle Knipper, *U.S. Department of Agriculture*

William Kustas, Martha Anderson, Joseph Alfieri, John Prueger, Feng Gao, Lynn

McKee, Lawrence Hipps, and Maria Mar Alsina

### **Investigating Impacts of Drought and Disturbance on a Forested Landscape in North Carolina, USA using High Spatiotemporal Resolution Evapotranspiration Databases**

Yun Yang, *U.S. Department of Agriculture*

Martha Anderson, Feng Gao, Christopher Hain, William Kustas, Asko Noormets,

Ge Sun, Randolph Wynne, and Valerie Thomas

### **An Open Source Tool to Estimate Regional and Field-Scale ET For Decision Makers**

Mitchell Schull, *University of Maryland*

Chris Hain, Martha Anderson, Xiwu Zhan, and Christopher Neale

## TS #24

### **Forest Mapping and Insect Damage**

Moderator: Robert Kennedy, *Oregon State University*

3:30 PM to 5:00 PM—Room 14

### **Using Landsat Time Series to Improve Mapping of Forest Composition and Condition in the Northeastern United States**

Valerie Pasquarella, *University of Massachusetts-Amherst*

### **Using Landsat to Assess the Extent and Severity of Forest Defoliation from Gypsy Moth Larvae in Eastern Connecticut Forests**

James Hurd, *University of Connecticut*

Chandi Witharana, Daniel Civco, and Jason Parent

**A Multi-Index Landsat-Derived Model for Spruce Budworm Defoliation Detection and Quantification: Examples of Past and Current Outbreaks (1970s and 2000s)**

Parinaz Rahimzadeh, *University of Maine*

Aaron Weiskittel, Daniel Kneeshaw, and David MacLean

**Analyzing and Mapping Landscape Disturbance Across Glacier National Park Using a Landsat Time Series**

Antonio Alvarado, *Science Systems and Applications, Inc.*

Ryan Avery, Charlotte Mays, Suzannah Richards, Zachary Wardle, Joseph Harris, Sunita Yadav-Pauletti, Jordan Lubbers, and Jemiris Gonzalez-de Jesus

**Wavelet-Based Multisensor Data Fusion Aided by Temporal Analysis**

Sherin Ghannam, *Virginia Tech*

A. Lynn Abbott, Mohamed Hussein, Randolph Wynne, Valerie Thomas, and James Campbell

## Special Event

### Landsat's Enduring Legacy Book Unveiling

5:30 PM to 7:30 PM—EXHIBIT HALL 2

Join us at a special evening session for the unveiling of the Landsat Legacy book and take the opportunity to meet the book's authors. After more than 15 years of research and writing, the Landsat Legacy Project Team and the ASPRS have published a seminal work on the nearly half-century of monitoring Earth's lands with Landsat. Born of technologies that evolved from the Second World War, Landsat not only pioneered global land monitoring, in the process it also drove innovation in digital imaging technologies and encouraged development of global imagery archives. Access to this imagery led to early breakthroughs in natural resources assessments, particularly for agriculture, forestry, and geology. With the emergence of twenty-first century Earth system science research, the full value of the Landsat concept and its continuous 45-year global archive has only recently been recognized and embraced. This pioneering satellite system's vital history is captured in this notable book.

Sponsored by



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## Registration Desk

7:30 AM to 4:30 PM

## Coffee Break

7:00 AM to 8:00 AM—FOYER

## Exhibit Hall Hours

8:00 AM to 1:00 PM

## Plenary Session

### Opening Remarks

Frank P. Kelly, Director, U.S. Geological Survey, EROS Center

### Trends in Big Data Analytics and Progress in Using Earth Observations—Panel Discussion

Moderator: Kass Green, Kass Green and Associates

8:30 AM to 10:00 AM—BALLROOM A

**Michael S. Warren**, Co-founder and CTO, *Descartes Labs*



Dr. Mike Warren is the Co-founder and CTO of Descartes Labs. His past work spans a wide range of disciplines, with the recurring theme of developing and applying advanced software and computing technology to understand the physical and virtual world. He was a scientist at Los Alamos National Laboratory for 25 years, and also worked as a Senior Software Engineer at Sandpiper Networks/Digital Island. His work has been

recognized on multiple occasions, including the Gordon Bell prize for outstanding achievement in high-performance computing. He has degrees in Physics and Engineering & Applied Science from Caltech, and he received a Ph.D. in Physics from University of California, Santa Barbara.

**Joe Mascaro**, Director of Academic Programs, *Planet*



Dr. Joe Mascaro is a tropical ecologist and Director of Academic Programs at Planet, a San Francisco-based aerospace company that operates the largest fleet of Earth-imaging satellites. Joe works with universities and individual investigators to utilize Planet's unprecedented imaging resources to enhance primary research and education, improve forest monitoring and conservation, expand food security, and promote ecological resilience for some of the world's most vulnerable communities.

**Adam Lewis**, *Geoscience Australia*



Dr. Adam Lewis began his career as a Forester in Victoria. He played a lead role in Victoria's first Geographic Information Systems and in new GIS-based approaches to forest and land planning. On completing his PhD at the ANU, Adam went on to develop the first depth & elevation model of the Great Barrier Reef and its catchments in 1998. In the early 2000's his work with the Great Barrier Reef Marine Park Authority provided the essential information base to support re-zoning of the

GBR Marine Park. That project won 2004 the Banksia Environmental Award for Government Leading by Example. Adam now leads Geoscience Australia's National Earth and Marine Observation Branch, including the Australian Geoscience Data Cube, which was recognized in the Geospatial World Leadership Awards in 2016. The Data Cube is internationally recognized for transforming the analysis of Earth Observation datasets, and is delivering unique new information on Australia's land, water, and coasts.

**Anne Hale Miglarese**, Founder and CEO, *Radiant.Earth*



Ms. Anne Hale Miglarese is the founding CEO of Radiant.Earth, a non-profit organization working to aggregate the world's open Earth imagery and providing access and education on its use to the global development community. Prior to launching Radiant.Earth, Anne served as President and CEO of Fugro Earth Data, as President and CEO of PlanetiQ and a Principal Director at Booz Allen Hamilton. Anne has also worked for the National Oceanic and Atmospheric

Administration, the SC Water Resources Commission and the SC Department of Natural Resources. Anne was the founding chairperson of the National Geospatial Advisory Committee and served on the Federal Geographic Data Committee Marine and Coastal Data Subcommittee for 6 years.

**Peter Becker** – Product Manager for Imagery, *Esri*



Peter Becker is Product Manager for Imagery at Esri and focuses on the integration of imagery into the ArcGIS Platform. What started off as a proof of concept to dynamically serve the Landsat GLS dataset in 2002 became the foundation of the ArcGIS Image Server technology. After working as Technical Manager for MAPS geosystem an aerial survey and mapping company in the Middle East and Germany, Peter joined Esri in 2005 and has been instrumental in the

development of Esri's imagery capabilities for the access, processing and analysis of a wide range of imagery and raster data.

## Technical Sessions

### TS #25

#### **LCMAP Special Session 3: Time Series Research and Development**

Moderator: James Vogelmann, *U.S. Geological Survey*

10:30 AM to 12 NOON—Room 2

The U.S. Geological Survey (USGS) has a long land cover history, starting with the 1976 landmark *A Land Use and Land Cover Classification System for use with Remote Sensor Data* and including global land cover mapping and the ongoing production of the National Land Cover Database. While these past projects have had a significant impact, land cover data needs are changing due to the demand for increasingly innovative and timely land cover products needed to meet the community's insatiable appetite for science-quality geospatial land cover and land change data. Recent research on the use of the unprecedented depth of the Landsat archive has resulted in the potential to generate higher quality results that include additional land cover variables, more detailed legends, and more frequent land cover and land change geospatial and statistical information. To capitalize on new capabilities, the USGS is working closely with researchers from Boston University and Texas Tech University to implement the Land Change Monitoring, Assessment, and Projection (LCMAP) initiative. LCMAP is envisioned as an end-to-end capability that uses the rich Landsat record to continuously track and characterize changes in land cover, use, and condition and translate such information into assessments of current and historical processes of cover and change. LCMAP aims to generate science-quality land cover and land change products from current and near-real time Landsat data. All available Landsat data for any given location are used to characterize land cover and change at any point across the full Landsat record and to detect and characterize land cover and land change as it occurs.

Three special sessions will: 1) lay out the foundations of LCMAP; 2) review the initial progress toward developing a new generation of land cover and land change products; and 3) examine how these new products are addressing land change applications.

#### **Exploring the Landsat Archive Using Time Series Analysis**

Curtis Woodcock, *Boston University*

#### **Using a 30-year Landsat Time Series of Arctic and Boreal North America to Investigate Climate Change Impacts on Disturbance, Phenology, and Productivity**

Damien Sulla-Menashe, *Boston University*

Curtis Woodcock, Chris Holden, and Mark Friedl

#### **Impact of Climate Variability on Landsat Time Series and Implications for Change Monitoring**

Chris Holden, *Boston University*

Curtis Woodcock

#### **Monitoring Tropical Forest Degradation Using Time Series Analysis of Landsat Data**

Eric Bullock, *Boston University*

Curtis Woodcock

#### **Using Time Series and Statistical Inference Methods to Estimate Unbiased Land Cover Change Areas in the Colombian Amazon**

Paulo Arevalo, *Boston University*

Curtis Woodcock and Pontus Olofsson

### TS #26

#### **Imaging Datasets**

Moderator: Peter Doucette, *U.S. Geological Survey*

10:30 AM to 12 NOON—Room 3

#### **Joint Agency Commercial Imagery Evaluation (JACIE)**

Greg Stensaas, *U.S. Geological Survey*

#### **An Update on Spaceborne Remote Sensing**

Jon Christopherson, *Stinger Ghaffarian Technologies, Inc.*

#### **Bridging Civilian and National Security Agencies: Update on the Civil Applications Committee**

Paul Young, *U.S. Geological Survey*

#### **NAIP Orthophotography for Land Cover Mapping Tasks: A Review with Recommendations**

Aaron Maxwell, *West Virginia University*

Tim Warner

**Global Fiducials Imagery: New Opportunities for Advancing the Use of Remote Sensing to Understand Our Changing Earth**

Bruce Molnia, *U.S. Geological Survey*

**TS #27**

**Cropland Mapping and Yield Estimation**

Moderator: David Johnson, *U.S. Department of Agriculture*

10:30 AM to 12 NOON—Room 7

**Regional Estimation of Crop Yields from Satellite Imagery: The State of the Science, The State of the Industry**

David Johnson, *U.S. Department of Agriculture*

**Updated Methods for Retro Processing: Reprocessing the 2008 Cropland Data Layer**

Avery Sandborn, *U.S. Department of Agriculture*

Patrick Willis, Richard Hardin, Robert Seffrin, and Lee Ebinger

**Fusing Sentinel-1 with Harmonized Landsat Sentinel-2 for Crop Mapping**

Nathan Torbick, *Applied GeoSolutions*

**A Unique Global Hyperspectral-Imaging Spectral Library of Agricultural crops (GHISA) to Study Globally Dominant Crops**

Itiya Aneece, *U.S. Geological Survey*

Prasad Thenkabail, Terry Slonecker, and Alfredo Huete

**CropRef: Reference Datasets and Techniques to Improve Global Cropland Mapping**

Jun Xiong, *U.S. Geological Survey*

Prasad Thenkabail, Russell Congalton, Kamini Yadav, Pardhasaradhi Teluguntla, Adam Oliphant, Murali Krishna Gumma, Richard Massey, and Corryn Smith

**TS #28**

**National-scale Data Coordinated Within the Multi-Resolution Land Characteristics Consortium (MRLC) - Special Session**

Moderator: Jonathan Smith, *U.S. Geological Survey*

10:30 AM to 12 NOON—Room 9

The Multi-Resolution Land Characteristics (MRLC) Consortium demonstrates the national benefits of USA Federal collaboration. Starting in the mid-1990s, MRLC has grown into a group of 10 USA Federal Agencies that coordinate the production of five National products, including the National Land Cover Database (NLCD), the Coastal Change Analysis Program (C-CAP), the Cropland Data Layer (CDL), the Gap Analysis Program (GAP), and the Landscape Fire and Resource Management Planning Tools (LANDFIRE). This session will overview the current status and future plans of these MRLC products.

**The National Land Cover Database, Delivering Land Cover Change Data for the Nation Since 2001: History, Status and Future Plans**

Collin Homer, *U.S. Geological Survey*

**NOAA's Focus on the Coasts: Bringing High Resolution Land Cover Mapping to the Multi-Resolution Land Characteristics Consortium**

Nate Herold, *NOAA Office for Coastal Management*

**10 Years of Annual National Land Cover Products - the Cropland Data Layer**

Rick Mueller, *U.S. Department of Agriculture*

**The NLCD Tree Canopy Cover Data Product**

Greg Liknes, *U.S. Forest Service*

**LANDFIRE Remap - Developing a New Baseline Product Suite**

Birgit Peterson, *U.S. Geological Survey*

## TS #29

### Urban and High Resolution Land Cover Mapping

Moderator: Kevin Gallo, *National Oceanic and Atmospheric Administration*

10:30 AM to 12 NOON—Room 12

### Characterizations of Urban Land Cover by NLCD and Other Global Mapping Efforts

George Xian, *U.S. Geological Survey*

### Urban Land Cover and Impervious Surface Changes in the Great Plains Between 2001 and 2011

Kevin Gallo, *National Oceanic and Atmospheric Administration*

George Xian

### Rapid Estimation of Tree Diversity Using Satellite Remote Sensing Within the Urban Environment

Abel Ramoelo, *Council for Scientific and Industrial Research*

Moses A. Cho, Sabelo Madonsela, and Sibusisiwe Makhanya

### Shadow Removal in High Resolution Remote Sensing Images Using Local Inpainting Strategy

Samara Calcado de Azevedo, *São Paulo State University (UNESP)*

### Evaluation of Landsat-Based Change Detection Methods using Ultra-High Resolution Land Cover Datasets

Michael Norton, *Chesapeake Conservancy*

## TS #30

### Forest Change - Disturbance/Recovery

Moderator: Kurtis Nelson, *U.S. Geological Survey*

10:30 AM to 12 NOON—Room 14

### A Landsat Spectral Ensemble for Forest Disturbance Mapping

Warren Cohen, *U.S. Forest Service*

### Examining the Relationship Between Landsat Spectral Recovery and Volume Growth on Harvested Sites in the Southeastern United States

Todd Schroeder, *U.S. Forest Service*

### Edyn: Dynamic Signaling of Subtle yet Persistent Changes to Forests

Evan Brooks, *Virginia Polytechnic Institute and State University*

Zhiqiang Yang, Valerie Thomas, and Randolph Wynne

### Integrating Site- and Non-Site Specific Accuracy Assessments Approaches for Validating Land Change Maps

Mark Nelson, *U.S. Forest Service*

### A 44-Year Time Series of Forest Structure in Northwestern Montana Using the Entire Landsat Archive Length from MSS to OLI (M2O)

Rick Lawrence, *Montana State University*

Shannon Savage

## Special Events

### Geospatial Munch and Meet!

12 NOON to 1:30 PM—Ballroom B

Come have lunch and meet industry leaders in geospatial technologies and sciences! The Early Career Professionals Council, Education and Professional Development Committee, Student Advisory Council, and the Corporate (Sustaining) Members Council have joined forces to bring a fun lunchtime experience focusing on getting to know your peers and learning more about what ASPRS has to offer. During the lunch hour, subject matter experts will give short talks about:

- Major advancements and innovations in GIS/RS/P science
- How to become an ASPRS Certified Professional
- Free and Paid Web Trainings
- Where to find reference/study material
- AND MUCH MORE!!

We look forward to joining you for lunch on Thursday. Come prepared to take notes on the presentation to win prizes!

### Lunch with Exhibitors'

Wednesday and Thursday, November 15<sup>th</sup> and 16<sup>th</sup>; 12 NOON to 1:30 PM—Exhibit Hall 2

Take some time out of your busy week and have lunch with Exhibitors. A much needed 90-minute break in the middle of the day will surely refresh you with a complimentary lunch and some good conversation. Take time to meet with our generous exhibiting companies, view posters, and even catch-up with friends.

Admission to this event is included with most registrations.

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## Plenary Session

### Presentation of the Pecora Symposium Student Competition Poster Awards

Amy Budge, *University of New Mexico-EDAC*

1:30 PM to 1:45 PM—BALLROOM A

The Pecora Symposium Student Competition Award is a “one-time” award funded and presented by the New Mexico Geographic Information Council (NMGIC), Inc. The purpose of the award is to encourage students to pursue careers in the geospatial sciences and to develop research and applications of these technologies. The Student Competition Award is bestowed upon students who present outstanding papers and posters at the Pecora symposium. The Award consists of two individual categories (posters and papers) that are evaluated and judged separately. Three monetary awards will be made in each category: First place (\$300); Second place (\$150); and Third place (\$75). Winning papers and posters will be posted on the NMGIC, Pecora, and ASPRS websites.

To qualify for consideration of the Award student(s) must be enrolled at an accredited institution of higher education chartered to award higher degrees and must be the principal author(s) of the paper or poster. If more than one student authors the paper or poster, one of the student authors also must be the presenter of the paper or poster at the Pecora Symposium. Each nominee must verify their eligibility and willingness to participate in the Student Competition Award.

Criteria for evaluating the papers and posters are:

- Relevance of the topic and content of the paper/poster to advancements in research or applications of any of the following: remote sensing, image processing, data processing/modeling, GIS and related technologies.
- Quality of the presentation, including: Is the presentation clear, concise, and to the point? Are the illustrations/graphics easy to read? For posters – Is the layout of material easy to follow and understand?

Awards for the paper presentations will be mailed to the awardees after the symposium.

### New Breakthroughs in Earth Observations and Applications— Panel Discussion

Moderator: Thomas R. Loveland, *USGS*

1:45 PM to 3:00 PM—BALLROOM A

The future of land remote sensing and the continuation of Pecora's vision. Perspectives from panelist on their views on big data, data integration, monitoring, assessment, and projection. Special emphasis on the next generation of land remote sensing with prominent early-career remote sensing scientists and applications specialists giving their vision for the future.

Panelist



**Valerie J. Pasquarella**, Postdoctoral Fellow, *Northeast Climate Science Center*

Dr. Valerie Pasquarella works at the intersection of remote sensing and ecology, using time series of satellite imagery to improve mapping and monitoring of landscape dynamics. She is currently a Postdoctoral Research Associate with the DOI Northeast Climate Science Center and the Department of

Environmental Conservation at the University of Massachusetts Amherst. Having lived and worked in Southern New England for over a decade, Dr. Pasquarella actively collaborates with a number of local research groups and land management agencies, and her research has strong regional ties. Ongoing projects include using Landsat time series to improve forest composition mapping and near-real-time monitoring of gypsy moth defoliation. She is also interested in time series approaches to mapping early successional habitat and invasive plant distributions, with a long-term goal of utilizing all available Landsat observations to advance understanding of multi-scale multi-species interactions over large spatial extents.

**Justin L. Huntington**, Associate Research Professor, *Desert Research Institute*



Dr. Justin Huntington is an Associate Research Professor at the Desert Research Institute and Western Regional Climate Center in Reno, Nevada. Justin received his Ph.D. in Hydrology from the University of Nevada - Reno in 2011. His research interests are focused on land surface energy balance measurement and modeling, surface and groundwater interactions, drought, and remote sensing. He is a member of the 2012-2017 Landsat Science Team, and serves on Nevada Governor Brian Sandoval's drought commission.

**John A. Gamon**, Professor, *University of Nebraska-Lincoln*



Dr. John Gamon studies the “breathing of the planet” - the exchanges of carbon and water vapour between the biosphere and the atmosphere that affect ecosystem productivity and help regulate our atmosphere and climate. Of particular interest are the effects of disturbance (fires, succession, weather events and climate change) on these basic processes. Additional research questions involve the

detection of plant physiology, ecosystem function, species composition, and biodiversity using non-contact sampling methods. Much of this work is done with optical monitoring (remote sensing and automated field methods), and entails the development of new monitoring methods and related informatics tools.

**David J. Lary** - Professor and Founding Director of the Center for Multi-scale Intelligent Integrated Interactive Sensing Center for Space Science, *University of Texas at Dallas*



Prof. David Lary received a First Class Double Honors B.Sc. in Physics and Chemistry from King's College London (1987) with the Sambrooke Exhibition Prize in Natural Science, and a Ph.D. in Photochemical Computer Modeling of Atmospheric Chemistry from the University of Cambridge, Churchill College (1991). The thread running through all the research is physics in service of society through the use of data driven insights using observation and automation to facilitate discovery, with a

focus in the area of human health and the health of infrastructure. A key part of this is the analysis of massive data sets (Big Data) using machine learning and high performance computing, and IoT devices for smart decision-making. In 2001 David was invited to join NASA for his work on data assimilation as the first distinguished Goddard fellow in Earth Science and stayed at NASA till 2010, receiving six NASA awards for his research and technology development. While at NASA he worked in several offices including the Data Assimilation Office (now the Global Modeling and Assimilation Office), the Atmospheric Chemistry and Dynamics Branch, the Science Integration and Visualization Office, and the NASA Goddard Earth Sciences Data and Information Services Center. In 2010 David joined the Hanson Center for Space Science at the University of Texas at Dallas where he has focused on Big Data and Machine Learning from remote sensing in service of society using satellites, smart cities, the internet of things, remote control aerial vehicles and machine learning. He is about to deploy a network of airborne allergen sensors across Chattanooga, TN, for a smart city asthma and allergy early warning system.

## Coffee Break

3:00 PM to 4:00 PM—FOYER

## Technical Sessions

### TS #31

#### **Preparing Data for Scientific Analysis and Advancing Access**

Moderator: Tom Maersperger, *U.S. Geological Survey*

3:30 PM to 5:00 PM—Room 2

#### **AppEARS: Providing Easy Access, Extraction, and Fusion of Analysis Ready Data from Multiple Big Earth Science Data Records**

William (Cory) Alden, *Innovate, Inc.*

Cole Krehbiel, Tom Maersperger, Lindsey Harriman, Aaron Friesz, Rob Quenzer, Kevin Impeccoven, Aafaque Aafaque, and Chris Doescher,

#### **Making Remote Sensing Data “Just Work” Using Standards-based Web Services**

Aaron Friesz, *Innovate, Inc.*

#### **An Open Data Cube Architecture for Water Management and Land Change Assessment**

Brian Killough, *National Aeronautics and Space Administration*

#### **Validation of Operational Cloud and Cloud Shadow Detection Algorithms for Landsat Data**

Pat Scaramuzza, *Stinger Ghaffarian Technologies, Inc.*

## TS #32

### Phenology

Moderator: Jesslyn Brown, *U.S. Geological Survey*

3:30 PM to 5:00 PM—Room 7

#### **Assessment of Vegetation Greenness Trends (1989 - 2016) and the Responses to Climatic Variability in the Conterminous United States**

Lei Ji, *ASRC InuTeq*

Jesslyn Brown

#### **Influence of Extreme Weather on Land Surface Phenology in the United States in Last Three Decades**

Lingling Liu, *South Dakota State University*

Xiaoyang Zhang

#### **Impacts of Wildfires on Land Surface Phenology of Western US Forests**

Jianmin Wang, *South Dakota State University*

Xiaoyang Zhang

#### **What Can Phenometric Lapse Rates Tell Us About Change in Highland Pastures?**

Geoffrey Henebry, *South Dakota State University*

Monika Tomaszewska, and Kamilya Kelgenbaeva

#### **Impacts of Interannual Variation in Data Quality from AVHRR, MODIS and VIIRS Time Series on Land Surface Phenology Detection**

Xiaoyang Zhang, *South Dakota State University*

#### **Inter-Comparison of MODIS and VIIRS Vegetation Indices Using One-Year Global Data**

Tomoaki Miura, *University of Hawaii-Manoa*

## TS #33—Special Session

### National Land Cover Database: Past, Present and Future

Moderator: Collin Homer, *U.S. Geological Survey*

3:30 PM to 5:00 PM—Room 9

This session will overview the design, products and status for NLCD 2016 and future programmatic plans for NLCD. NLCD 2016 products include land cover and urban imperviousness re-mapped for 2001-2016, tree canopy produced for 2011- 2016, and new 2016 products of percent shrub, bare ground and herbaceousness. NLCD 2016 is expected to be more accurate and comprehensive than any previous NLCD release, and will offer users an unprecedented set of land cover and land cover change products designed to continue, expand and advance NLCD applications.

#### **NLCD 2016 Past and Present Product Comparison**

Jon Dewitz, *U.S. Geological Survey*

Suming Jin

#### **NLCD 2016 Landcover Design**

Suming Jin, *ASRC InuTeq*

Limin Yang, Patrick Danielson, Jon Dewitz, Collin Homer, and George Xian

#### **NLCD 2016 Imperviousness Product**

Jon Dewitz, *U.S. Geological Survey*

Michelle Funk

#### **NLCD 2016 Shrub and Grass Products**

Collin Homer, *U.S. Geological Survey*

#### **NLCD Future Plans**

George Xian, *U.S. Geological Survey*

Collin Homer



## TS #34

### **Wetlands and Surface Water Bodies**

Moderator: Sandra Poppenga, *U.S. Geological Survey*

3:30 PM to 5:00 PM—Room 12

### **Annual Maps of Water-Related Land Cover Types (Open Surface Water Body, Natural Wetlands, and Paddy Rice) Through Analyses of Landsat Images in Google Earth Engine**

Xiangming Xiao, *University of Oklahoma*

Zhenhua Zou, Geli Zhang, Jinwei Dong, and Bangqian Chen

### **Tracking Pluvial-Related Expansion and Contraction of Water Bodies in the South Dakota Prairie Pothole Region Using the Landsat Record with an Object-Based Image Analysis Approach**

Nathan Roberts, *Penn State University*

Douglas Miller

### **Characterizing Wetland Landscapes with Landsat Dense Time Series Data**

Jennifer Rover, *U.S. Geological Survey*

Alisa Gallant, and Qiang Zhou

### **Utilizing NASA Earth Observations to Model Past and Present Distributions of Invasive Species in Alaskan Wetlands**

Timothy Mayer, *Science Systems and Applications, Inc.*

Emma Hatcher, Sarah Carroll, Audrey Martinez, and Brian Woodward

## TS #35

### **Mapping for Management and Species Dynamics**

Moderator: John Faundeen, *U.S. Geological Survey*

3:30 PM to 5:00 PM—Room 14

### **Identification of Moderate Intensity Forest Management in the Southeastern U.S. with Multitemporal Landsat**

Valerie Thomas, *Virginia Tech*

Randolph Wynne, Evan Brooks, Quinn Thomas, Louise Chini, R. Bin Mei, and David Wear

### **Using Google Earth Engine and Landsat Time Series to Model National Forest Inventory Variables**

Ty Wilson, *U.S. Forest Service*

### **Mapping and Quantifying Biodiversity and Ecosystem Services Related to Terrestrial Vertebrates: A National Approach**

Kenneth Boykin, *New Mexico State University*

William Kepner, Anne Neale, and Kevin Gergely

### **Mangrove Mapping and Monitoring Using Earth Observation Satellite Data**

Zhiliang Zhu, *U.S. Geological Survey*

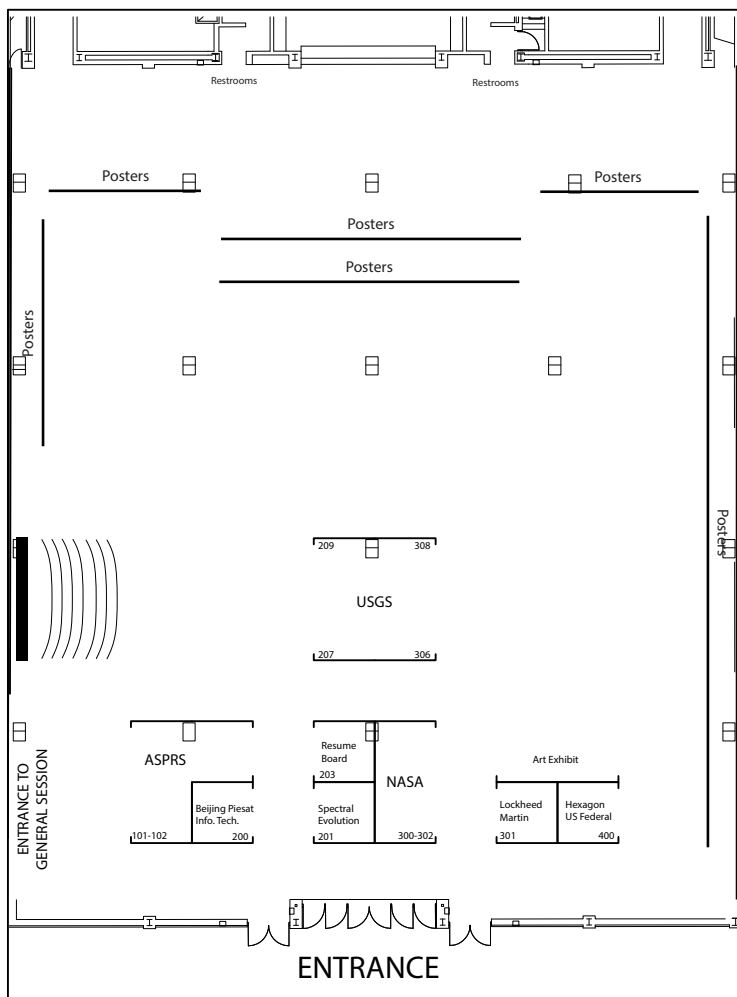
Chandra Giri

### **Using Unmanned Aerial Systems to Evaluate Shrub Community Characteristics in a Semi-Arid Landscape**

R. Douglas Ramsey, *Utah State University*

Christopher McGinty

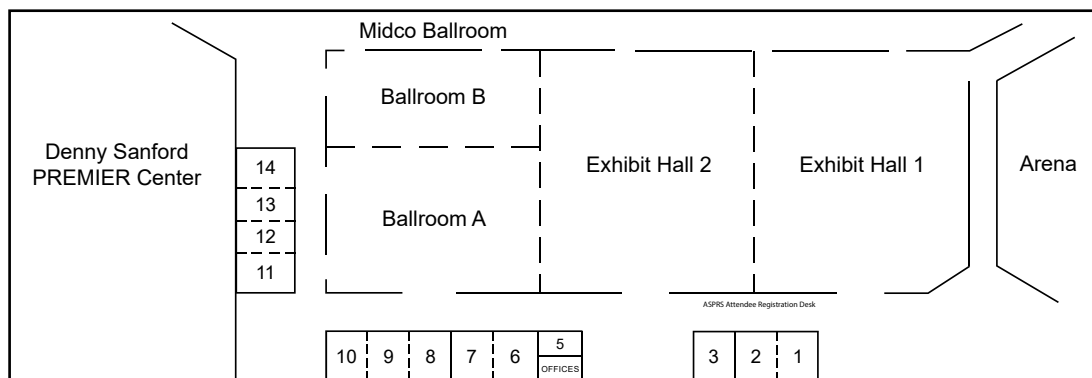
## Exhibit Hall Floor Plan



## Exhibitors

<b>Beijing PIESAT Information Technology Co., Ltd</b> <a href="http://www.piesat.cn">http://www.piesat.cn</a>	<b>Booth 200</b>
<b>Hexagon US Federal</b> <a href="http://hexagonusfederal.com/products/geospatial/erdas-imagine">http://hexagonusfederal.com/products/geospatial/erdas-imagine</a>	<b>Booth 400</b>
<b>Lockheed Martin Space Systems Company</b> <a href="http://www.lockheedmartin.com/goesr">www.lockheedmartin.com/goesr</a>	<b>Booth 301</b>
<b>NASA</b> <a href="http://www.nasa.gov">www.nasa.gov</a>	<b>Booth 300</b>
<b>Spectral Evolution</b> <a href="http://www.spectralevolution.com">www.spectralevolution.com</a>	<b>Booth 201</b>
<b>USGS</b> <a href="http://www.usgs.gov">www.usgs.gov</a>	<b>Booth 207</b>

## Denny Sanford Premier Center Floor Plan



## **Beijing PIESAT Information Technology Co., Ltd**

<http://www.piesat.cn>

Beijing PIESAT Information Technology Co., Ltd (PIESAT for short) is a Chinese high-tech enterprise specializing in research and application of satellite technology (Remote sensing satellite and Navigation satellite). Founded in 2008, PIESAT made providing professional services and applications of domestic satellites its mission. PIESAT has independently developed software Pixel Information Expert (PIE), offering its clients integrated solution of geospatial information application.

PIESAT headquarters in Beijing and has branches and representative offices in over 20 cities nationwide. PIESAT has more than 600 employees, and has a strong R&D team of which over 80% are geomatics experts.

PIESAT has ISO9001 certification, CMMI L3 certification and AAA-level credit rating. It holds multiple patents, 9 software product registrations, and 56 software copyrights in RS image processing software, GIS software and geospatial information 3D visualization platform. With its expertise and experience in remote sensing, GIS, and BeiDou satellite navigation technology, PIESAT has undertaken or participated in a series of national key projects in meteorology, marine and maritime application, water resources management, environmental protection, emergency response and surveying and mapping.

PIESAT also provides IT project consulting service to national satellite projects and other industries. PIESAT provided consulting and design service to multiple satellite projects such as ZY-3, ZY-102C, environment satellite project and ocean satellite project. With the support of national technology development strategy and policies, PIESAT undertook 3 counts of National Key Technology Research and Development Program, one count of National High-tech R&D Program of China (aka "863" Program), participated in "High Resolution Earth Observation System" (a National Science and Technology Major Project of China), took lead in over 10 top-level design and software development projects across the industries.

## **Hexagon US Federal**

<http://hexagonusfederal.com/products/geospatial/erdas-imagine>

Hexagon US Federal is an independent subsidiary for Hexagon Safety & Infrastructure's U.S. federal business. As a premier provider of integrated geospatial and technical solutions to the US Government, Hexagon empowers government agencies to make smarter and faster operational decisions. Hexagon US Federal helps its government customers create intelligent maps, analyze geospatial intelligence, manage assets and infrastructure, and provide

**Booth 200**

dispatch emergency services. It transforms complex data from disparate sources into real time actionable information. With its deep industry expertise and long tradition of technical innovation, Hexagon US Federal also helps its government customers optimize and streamline their operations, protect their critical assets, improve operational performance and readiness while reducing costs.

Stop by Hexagon US Federal's booth #400 to see ERDAS IMAGINE, the world's leading geospatial data authoring system. ERDAS IMAGINE incorporates geospatial image processing and analysis, remote sensing and GIS capabilities into a powerful, convenient package and is the cornerstone of every remote sensing workflow. It enables you to easily create value-added products such as 2D images, orthophoto mosaics, landcover classification, 3D flythrough movies, vectors derived from imagery, and cartographic-quality map compositions from geospatial data.

If your government organization has remote sensing and image processing requirements in support of planning, reporting, decision making or providing a critical visualization and analysis services to other organizations, ERDAS Imagine provides you the tools you need. ERDAS Imagine excels at accurately extracting key information from a wide variety of imagery and remote sensing data types, allowing you to realize the maximum potential value from your imagery.

Learn more about Hexagon US Federal's remote sensing solutions at <http://hexagonusfederal.com/products/geospatial/erdas-imagine>. Or contact Matt Falter at 703 264 5605 or [Matthew.Falter@HexagonUSFederal.com](mailto:Matthew.Falter@HexagonUSFederal.com).

## **Lockheed Martin Space Systems Company**

[www.lockheedmartin.com/go/esr](http://www.lockheedmartin.com/go/esr)

Headquartered in Bethesda, Maryland, Lockheed Martin is a global security and aerospace company that employs approximately 97,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services. More than 70 nations rely on Lockheed Martin employees, products, and technologies to help them protect and connect their citizens and advance scientific discovery. In a time of growing unpredictability and evolving threats, innovation and performance are at the center of everything we do.

**Booth 301**

**Booth 400**

## **NASA**

[www.nasa.gov](http://www.nasa.gov)

NASA's Applied Sciences Program promotes efforts to discover and demonstrate innovative and practical uses of Earth science data and knowledge. The Program supports and funds applied research and applications projects that foster uses of Earth-observing satellite data and scientific knowledge by public and private sector organizations in their policy, business, and management decisions. The project results and enhanced decision-making improve quality of life and strengthen the economy.

All Program activities support goals to deliver near-term uses of Earth observations, build capabilities for applying Earth science data, and contribute to satellite mission planning. The portfolio of projects delivers results and societal benefits by applying Earth observations to improve water management, disaster response, disease tracking, ecosystem management, international development, food security, and many other topics. The projects are carried out in partnership with end users to enable sustained use and sustained benefits.

## **Spectral Evolution**

[www.spectralevolution.com](http://www.spectralevolution.com)

SPECTRAL EVOLUTION full range UV-VIS-NIR spectrometers, and spectroradiometers are used worldwide for many lab and field assignments due to their reliable, robust, rugged yet lightweight design and user-friendly features including: 100% photodiode array construction for low noise and reliable battery operated performance; fast, full spectrum measurements with no moving gratings; integral dark shutter and autoexposure for one-touch scans.

The SPECTRAL EVOLUTION PSR+ and RS-3500 spectroradiometers are designed for remote sensing applications including geological remote sensing, ground truthing, spectral remote sensing, environmental and climate research, crop and soil research, vegetative studies, forestry and canopy studies, radiometric calibration transfer, upwelling and downwelling measurement and more.

The PSR+ and RS-3500 are both portable full range, UV-VIS-NIR instruments with high resolution and low noise. DARWin SP Data Acquisition software includes 19 vegetation indices in a pull down menu, including the NDVI and Red/Green indices which can be used to determine the health of a plant or a canopy. The PSR+ provides the field researcher with the option of using direct attach lenses for standoff measurements or a fiberoptic cable with FOV lenses, a contact probe, sphere, pistol grip, our unique leaf clip and other accessories. The RS-3500 is equipped with a fiber optic cable and works with all our accessories including

## **Booth 300**

FOV lenses. Both instruments offer auto-exposure, auto-dark correction, and auto-shutter for one touch operation.

SPECTRAL EVOLUTION maintains a facility in Lawrence, Massachusetts which houses all operations including, design, prototyping, manufacturing and in-house repair, as well as a state of the art spectral, spectral radiance and spectral irradiance calibration facilities for periodic calibration of customer equipment in the UV, VIS, NIR and SWIR wavelength regions. See our website at [www.spectralevolution.com](http://www.spectralevolution.com) for more information.

## **USGS**

[www.usgs.gov](http://www.usgs.gov)

## **Booth 207**

The Earth Resources Observation and Science (EROS) Center is a field center for the U.S. Geological Survey (USGS). EROS is dedicated to understanding a changing Earth through its land change monitoring expertise and land change science information system technologies. EROS serves as the world's primary source for remotely sensed land images of the Earth; enables the investigation and understanding of the condition of the planet's landmasses; and provides land change science information and knowledge for the Nation and the globe. EROS researchers, computer experts, engineers, administrators, and leaders use their diverse and unique expertise to ensure continuous and timely collection and delivery of accurate and relevant data, information, and knowledge on land use, cover, and condition.

## **Booth 201**



# remote sensing

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## Aim and scope:

*Remote Sensing* (ISSN 2072-4292) publishes regular research papers, reviews, letters and communications covering all aspects of remote sensing science, from sensor design, validation/calibration, to its application in geosciences, environmental sciences, ecology and civil engineering. Our aim is to publish novel/improved methods/approaches and/or algorithms of remote sensing to benefit the community, open to everyone in need of them. There is no restriction on the length of the papers or colors used. The method/approach must be presented in detail so that the results can be reproduced. Moreover, authors are encouraged to submit their original codes/data as supplementary information for the paper.

The scope of Remote Sensing includes:

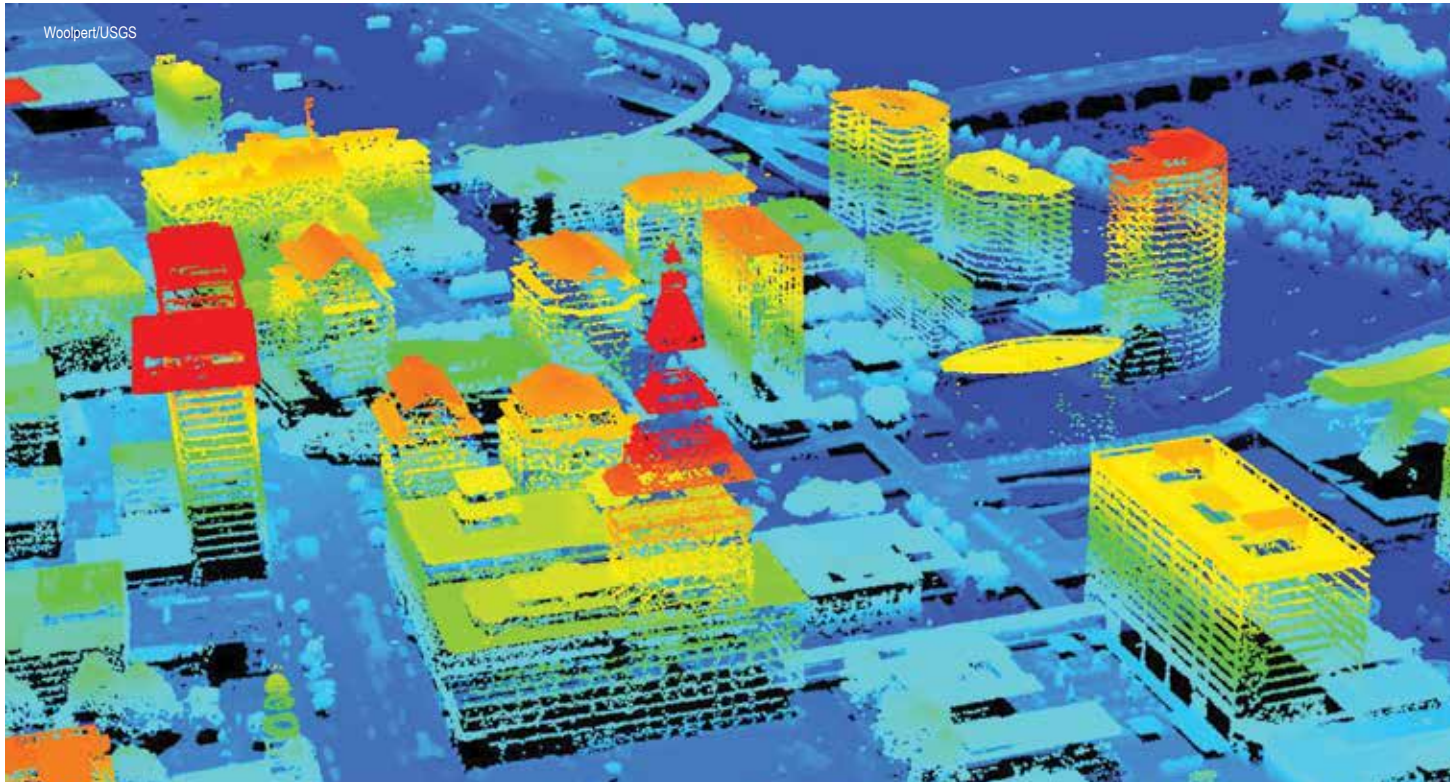
- Multi-spectral and hyperspectral remote sensing
- Microwave remote sensing
- Lidar and laser scanning
- Unmanned aerial vehicles
- Satellite image processing and pattern recognition
- Data fusion and data assimilation
- Remote sensing applications

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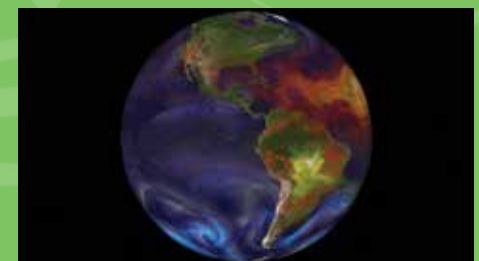
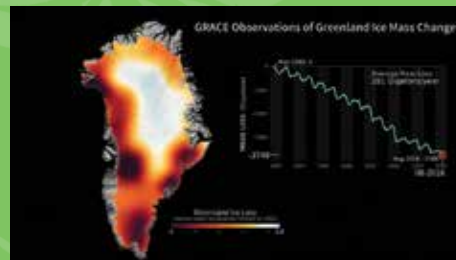
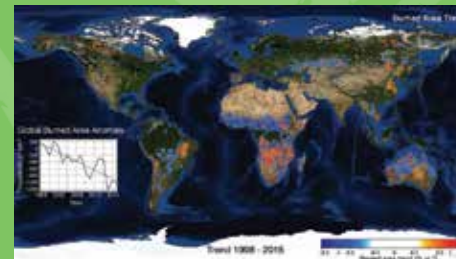
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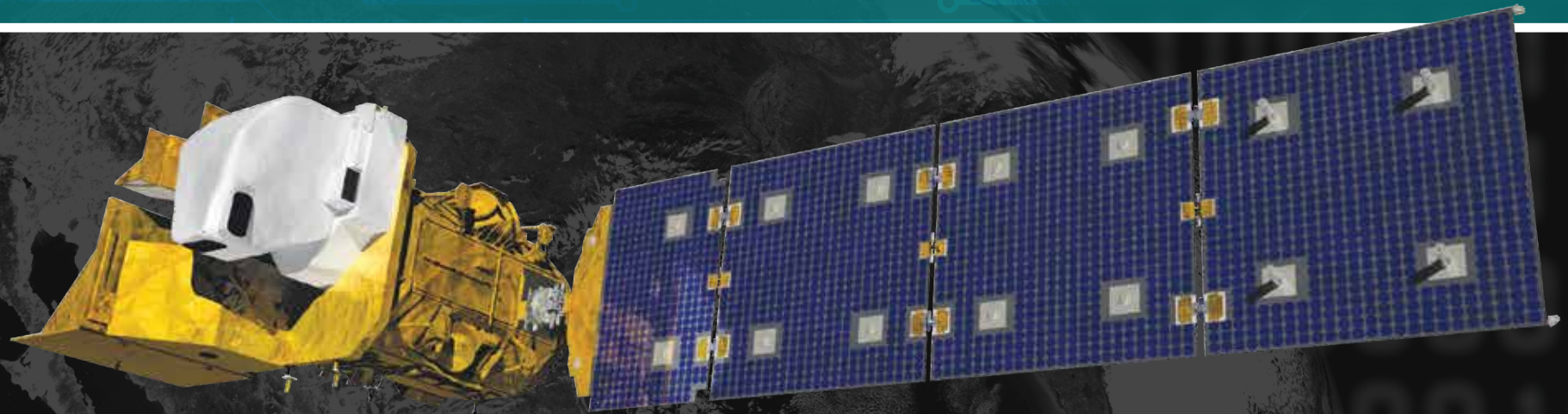


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