

# JACIE

Joint Agency Commercial Imagery Evaluation  
Civil Commercial Imagery Evaluation Workshop  
Marriott Hotel, Fairfax, VA  
April 17-19, 2012



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Joint Agency Commercial Imagery Evaluation

**KEYNOTE SPEAKERS**

**Biographies**

***Dr. Waleed Abdalati***



Waleed Abdalati was appointed NASA chief scientist on Jan. 3, 2011, serving as the principal adviser to NASA Administrator Charles Bolden on NASA science programs, strategic planning and the evaluation

of related investments. He is currently on leave from his position as director of the University of Colorado's Earth Science and Observation Center, which carries out research and education activities on the use of remote sensing observations to understand the Earth. Abdalati is also a fellow of the Cooperative Institute for Research in Environmental Sciences at the University. His research has focused on the use of satellites and aircraft to understand how and why Earth's ice cover is changing, and what those changes mean for life on our planet. He also has served as leader of the Ice Cloud and land Elevation Satellite-2 (ICESat-2) Science Definition Team and has led or participated in nine field and airborne campaigns in the Arctic and Antarctic.

His appointment as chief scientist marks a return to NASA, where he worked from 1996-2008. From 2004-2008, he was head of the Cryospheric Sciences Branch at NASA's Goddard Space Flight Center in Greenbelt, Md., where he supervised a group of scientists who carried out research in the development and analysis of remote sensing observations to study the behavior of ice sheets, sea ice, and glaciers. From 2000-2004, he managed NASA's Cryospheric Sciences Program at NASA Headquarters, managing the agency's interests and

research investments in cryospheric research, and serving as program scientist on the ICESat and RADARSAT missions. From 1996-2000, Abdalati was a researcher at Goddard in the Oceans and Ice Branch, where he analyzed satellite and aircraft measurements of glaciers and ice sheets to assess their contributions to sea level rise. He also served as deputy project scientist for NASA's Ice Cloud and land Elevation Satellite (ICESat).

Abdalati received a Bachelor of Science degree from Syracuse University in 1986, a Master of Science degree from the University of Colorado in 1991, and a Ph.D. from University of Colorado in 1996. In the mid 1980s, before returning to graduate school, he worked as an engineer in the aerospace industry, designing, analyzing and testing components of various spacecraft and submarine systems.

He has published more than 50 peer-reviewed papers, book chapters and NASA-related technical reports, with approximately 1,500 citations in the peer-reviewed literature. He has given featured lectures and keynote addresses to the United Nations, AIAA, SPIE, AGU and various other professional and international organizations, as well as public lectures at The Smithsonian Institution, The American Museum of Natural History, and The Adler Planetarium. Abdalati has received various awards and recognition, most notably the NASA Exceptional Service Medal and The Presidential Early Career Award for Scientists and Engineers from the White House.

## Rebecca Moore



Rebecca Moore is a computer scientist and longtime software professional. At Google, she conceived and leads the Google Earth Outreach program, which supports nonprofits, communities and indigenous

peoples around the world in applying Google's mapping tools to the world's pressing problems in areas such as environmental conservation, human rights and creating a sustainable society. Her personal work using Google Earth was instrumental in stopping the logging of more than a thousand acres of redwoods in her Santa Cruz Mountain community. Rebecca also initiated and leads the development of Google Earth Engine, a new technology platform which supports global-scale data-mining of satellite imagery for societal benefit. Rebecca received a bachelor's degree with honors from Brown University in Artificial Intelligence, a master's degree from Stanford University, and is currently on leave from the Stanford Ph.D. program in Computer Science.



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## PLEASE JOIN US!

Date: Wednesday, April 18

Time: 6:00 p.m.

For: No-Host Dinner

At: **CHAMPPS**



11724 Fair Oaks, Fairfax, VA 22033  
(just across the parking lot from the hotel). Please sign up by noon on Wednesday at the registration table. Sample menu and directions are available. **Everyone Welcome.**



Joint Agency Commercial Imagery Evaluation

# JACIE

## Civil Commercial Imagery Evaluation Workshop

Hosted by

NASA, NGA, USDA, USGS

April 17-19, 2012

### AGENDA

#### ***Tuesday, April 17, 2012***

- 8:00 AM Registration
- 9:00 AM Welcome [Greg Stensaas](#) Remote Sensing Technologies Project Manager, USGS EROS
- 9:10 AM Keynote [Dr. Waleed Abdalati](#) Chief Scientist, NASA
- 10:00 AM Break
- 10:15 12:00 PM **Government Sponsor Session:** Moderator [Greg Stensaas](#)
- 10:15 AM NASA [Lawrence Friedl](#) Applied Sciences Program, NASA Headquarters
- 10:40 AM NOAA [Mitch Goldberg](#) Chief of the Satellite Meteorology and Climatology Division
- 11:05 AM USDA [Glenn Bethel](#) Remote Sensing Advisor
- 11:30 AM USGS [Frank Kelly](#) Director, USGS/EROS
- 12:00 PM **Lunch** (*provided with registration*) Set up posters
- 1:30- 3:00 PM **Panel Discussion: "Precision Analysis Supporting Decision-Makers,"** Moderators [Thome](#) and [Stensaas](#)  
Agency Representatives

3:00 PM	Break			
3:15- 5:00 PM	<b>SPOTLIGHT Session:</b> 15 minute updates, Chair <a href="#">Kurt Thome</a>			
3:15 PM	<a href="#">12.014</a>	<a href="#">Stephens, Paul</a>	DMCii	New sensors; update on developments in the DMC Constellation
3:30 PM	<a href="#">12.019</a>	<a href="#">Fonseca, Dr. Leila M. G.</a> and <a href="#">Liporace, Frederico</a>	INPE	Brazilian EO Satellite Program Update
3:45 PM	<a href="#">12.020</a>	<a href="#">Brunn, Andreas</a>	RapidEye AG	Recent Calibration and Validation activities at RapidEye
4:00 PM	<a href="#">12.038</a>	<a href="#">Mulawa, Dr. David</a>	GeoEye	GeoEye-1 Geolocation Assessment and Reporting Update for 2011
4:15 PM	<a href="#">12.012</a>	<a href="#">Neumann, Klaus</a>	Intergraph Z/I Deutschland GmbH	Update on high resolution aerial mapping cameras
4:30 PM	<a href="#">12.025</a>	<a href="#">Thomassie, Brett</a>	DigitalGlobe Incorporated	DigitalGlobe Incorporated Satellite and Aerial Program Update
4:45 PM	Wrap Up	Q&A, Closing Remarks, <a href="#">Greg Stensaas</a> & <a href="#">Kurt Thome</a>		
5:00 -7:00 PM	<b>Poster Session/Reception</b>			
	Evening Activities as desired (on your own)			



An artist's rendition of Landsat 8. Scheduled launch date of January, 2013.

## Wednesday, April 18, 2012

8:00 AM	Registration			
8:30 AM	Welcome	<a href="#">Stensaas/Thome</a>		
8:30-9:45 AM	<b>Session 1:</b> Hi-Resolution, Chair <a href="#">Cal Hagan</a>			
8:30 AM	<a href="#">12.018</a>	<a href="#">Léger, Dominique</a>	Onera – the French Aerospace Lab	On-orbit MTF and defocus assessment methods applied to SPOT5 cameras
8:50 AM	<a href="#">12.002</a>	<a href="#">Freedman, Ellis</a>	Serious Science, LLC	A Constant MTF Resampler
9:10 AM	<a href="#">12.036</a>	<a href="#">Griffith, Doug</a>	NGA	General Image Quality Equation (GIQE)
9:30 AM	<a href="#">12.039</a>	<a href="#">Podger, Dr. Nancy</a>	GeoEye	Image Quality Performance of the GeoEye-1 High Resolution Imaging Satellite
9:45 AM	Break			
10:00-11:40 AM	<b>Session 2:</b> Hi-Resolution, Chair <a href="#">Paul Bresnahan</a>			
10:00 AM	<a href="#">12.015</a>	<a href="#">Mackin, Steve</a>	DMCii	Radiometric Calibration of the high spatial resolution NigeriaSat-2 Satellite VHRI
10:20 AM	<a href="#">12.023</a>	<a href="#">Hopwood, Drew</a>	Astrium GEO-Information Services	Post Launch Commissioning and Testing of Pléiades 1
10:40 AM	<a href="#">12.040</a>	<a href="#">Mattox, Preston</a>	GeoEye	GeoEye-1 New Sensor Mode – 1x2 Multispectral Pixel Aggregation
11:00 AM	<a href="#">12.047</a>	<a href="#">Schiller, Stephen</a>	Raytheon Space and Airborne Systems	IN-Flight Performance Assessment Of Imaging Systems Using The Specular Array Radiometric Calibration (SPARC) Method
11:20 AM	Q&A Sessions 1 & 2			
11:40 AM	Keynote	<a href="#">Rebecca Moore</a>	Google Earth Engine: Petabyte-scale Processing Over Earth Observation Data for Societal Benefit	
12:30 PM	<b>Lunch</b> ( <i>provided with registration</i> )			

1:30-3:30 PM	<b>Session 3: Hi-Resolution, Chair <a href="#">Dave Case</a></b>			
1:30 PM	<a href="#">12.003</a>	<a href="#">Snyder, Greg</a>	USGS	Results of The National Enhanced Elevation Assessment
1:50 PM	<a href="#">12.035</a>	<a href="#">Dellagnello, Marzio</a>	NGA	NGA Multinational Geospatial Co-Production (MGCP) program overview & Commercial Imagery
2:10 PM	<a href="#">12.034</a>	<a href="#">Bresnahan, Paul</a>	NGA	Geolocation Accuracy Re-Evaluations of GeoEye-1 and QuickBird-2
2:30 PM	<a href="#">12.028</a>	<a href="#">Broderson, Dayne</a>	Geographic Information Networks of Alaska	Statewide Alaska Orthoimagery and Elevation Mapping Programs – Status and Results from Year 1
2:50 PM	<a href="#">12.016</a>	<a href="#">Lee, Seungwoo</a>	Satrec Initiative	Automated measurement of SNR of high resolution satellite images
3:10 PM		Q&A Session 3		
3:30 PM	Break			
3:45-5:00 PM	<b>Session 4: Hi-Resolution, Chair <a href="#">Jon Christopherson</a></b>			
3:45 PM	<a href="#">12.031</a>	<a href="#">Ryan, Robert</a>	Innovative Imaging and Research Corp.	Extending the Operational Envelope of Electro-optical Imaging Systems to Include Pre-sunrise and Post-sunset Operation
4:05 PM	<a href="#">12.000</a>	<a href="#">Wagner, Ruedi</a>	Geospatial Solutions Division	The Leica RCD30 medium format camera - A new approach to camera calibration
4:25 PM	<a href="#">12.001</a>	<a href="#">Passini, Dr. Ricardo</a>	Bae Systems GP&S	Accuracy and Radiometric Study on Latest Generation Large Format Digital Fram Cameras
4:45 PM	Wrap up	Q&A/Recap Sessions 3 & 4, Closing Remarks		
5:00 PM	Close			
6:00 PM	No Host Dinner (on your own) at the traditional "Champps." Please join us (see page 4).			



## Thursday, April 19, 2012

8:00 AM	Registration			
8:30 AM	Welcome	<a href="#">Jon Christopherson</a>		
8:35-10:15 AM	<b>Session 5:</b> Active Sensors, Chair <a href="#">Jon Christopherson</a>			
8:35 AM	<a href="#">12.024</a>	<a href="#">Howard, Brant</a>	CompassData, Inc.	Remotely Sensed Ground Control Points Field tests verify accuracy of satellite imagery
8:55 AM	<a href="#">12.045</a>	<a href="#">Tighe, M. Lorraine</a>	Intermap Technologies	Seamless Fusion of Lidar, Radar and Optical Terrain Data
9:15 AM	<a href="#">12.044</a>	<a href="#">Tighe, M. Lorraine</a>	Intermap Technologies	Comparison of X-Band Airborne and Spaceborne Imagery
9:35 AM	<a href="#">12.049</a>	<a href="#">Robinson, Dirk</a>	Skybox Imaging, Inc.	An introduction to the Skybox Earth-observation imaging platform
9:55 AM		Q&A/Re-cap Session 5		
10:15 AM	Break			
10:30-12:15 PM	<b>Session 6:</b> Medium-Resolution, Chair <a href="#">Mike Benson</a>			
10:30 AM	<a href="#">12.027</a>	<a href="#">Guenther, Bruce</a>	NASA GSFC	Status of NPP VIIRS On-orbit Calibration and Performance
10:50 AM	<a href="#">12.048</a>	<a href="#">Chander, Gyanesh</a>	RST EROS	Applications of Spectral Band Adjustment Factors (SBAF) for Cross-calibration
11:10 AM	<a href="#">12.030</a>	<a href="#">Pagnutti, Mary</a>	Innovative Imaging and Research Corp.	Landsat Data Continuity Mission and Sentinel-2 Multi-Spectral Instrument Image Product Simulations for Sensor Comparisons and Data Fusion Research
11:30 AM	<a href="#">12.046</a>	<a href="#">Dykstra, Jon</a>	MDA Information Systems, Inc	A Comparison of Landsat and RapidEye Imagery for Use in Correlated Land Change (CLC) Analysis
11:50 AM		Q&A Session 6		
12:15 PM	<b>Lunch</b> ( <i>provided with registration</i> ) Take posters down			

1:45-3:25 PM	<b>Session 7:</b> Medium-Resolution, Chair <a href="#">Curt Reynolds</a>			
1:45 PM	<a href="#">12.013</a>	<a href="#">Brindle, Laura</a>	DMCii	Radiometric Calibration of the 22m GSD Nigeriasat-X satellite sensor using combined cross-calibration results over Dome-C and Libya 4
2:05 PM	<a href="#">12.041</a>	<a href="#">Helder, Dennis</a>	SDSU	Absolute Calibration of Optical Sensors Using Pseudo Invariant Calibration Sites – Initial Concepts
2:25 PM	<a href="#">12.011</a>	<a href="#">Adams, Victoria</a>	Booz Allen Hamilton	Improving the Way the Government Does Business: The Value of Landsat Moderate Resolution Satellite Imagery in Improving Decision-Making
2:45 PM	<a href="#">12.037</a>	<a href="#">Serbin, Guy</a>	InuTeq LLC	Optical and Thermal Requirements for Agricultural and Environmental Remote Sensing
3:05 PM		Q&A Session 7		
3:25 PM	Break			
3:40-5:20 PM	<b>Session 8:</b> Medium-Resolution, Chair <a href="#">Dave Kohlbrenner</a>			
3:40 PM	<a href="#">12.021</a>	<a href="#">Zakzeski, Audra</a>	NASS/USDA	Improving Agricultural Landcover Classification in the Cropland Data Layer Using the Disaster Monitoring Constellation.
4:00 PM	<a href="#">12.022</a>	<a href="#">Hopwood, Drew</a>	Astrium GEO-Information Services	Using Deimos-1 & UK-DMC2 to Monitor U.S. Crop Conditions During the 2011 Crop Season
4:20 PM	<a href="#">12.032</a>	<a href="#">Pirondini, Fabrizio</a>	DEIMOS Imaging S.L.U.	Data Quality of Deimos-1 & UK-DMC2 Imagery for the Monitoring of 2011 US Crop Season
4:40 PM	<a href="#">12.005</a>	<a href="#">Sampath, Ajit</a>	RST EROS	Assessment of UK-DMC-2, RE, SPOT-5, and RS-2 accuracy
5:00 PM	Q&A/Recap Sessions 7&8			
5:20 PM	Discussion and Conference wrap-up - <a href="#">Greg Stensaas</a> ...Drawings, must be present to win!			
5:30 PM	Close. Thanks for attending JACIE 2012			



**PRESENTERS and MODERATORS**

**Biographies (alphabetical order)**

***Adams, Victoria***



Dr. Adams has 30 years of experience supporting Federal Agencies (including USAID, VHA,

EPA, GSA, DOE, and DoD), Fortune 500 companies (including Unilever, Sony, and Lucent), and non-US governments (the UK, Slovakia, the Russian Federation, and Austria). She has led numerous assignments related to conducting futurist studies, information economics, analytical, quantitative, economic, and feasibility studies, Exhibit 300, cost-benefit analysis, economic impact analysis, and program implementation. She has extensive experience developing quantitative and economic analyses to assess the feasibility of different policy options (especially as regards sustainability issues). She has conducted more than 200 major Federal benefit-cost analyses and program evaluations. She has extensive experience working with senior stakeholders in dealing with economic issues. She is a recognized thought leader and is the author of a book on information economics and numerous articles. Dr. Adams has a PhD in economics and public policy as well as a Masters of Public Administration. Dr. Adams led the effort to conduct a major analysis of Landsat costs and benefits and an alternative analysis against commercial alternatives. She conducted a series of quantitative

and economic analyses to estimate the value of information provided by NASA's geospatial program as it applied to the malaria reduction, volcanic ash, and tuna stocks. She developed a model that estimates the economic and carbon impact of public transit in Chicago and New York.

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***Benson, Michael***



satellite and aerial remote sensing certifications and calibrations. He also was project manager for the USGS implementation of the US Commercial Remote Sensing Space Policy and is currently the project lead for Commercial Data Management at EROS. Since 1993 Mike has also worked in other capacities including management of the USGS EROS production and data distribution. Prior to 1993 Mike was a Photographic System's contract manager at NASA's Johnson Space Center in Houston, Texas for four years. Prior to NASA he worked nine years at EROS as a contractor Image Scientist. Academically, Mike received his BS

Mike currently works on the Remote Sensing Technologies Project at USGS EROS supporting

in Imaging Science from Rochester Institute of Technology in 1976.

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***Bethel, Glenn***



Mr. Bethel currently serves as USDA's Remote Sensing Advisor. In this capacity, he represents

USDA agencies; focusing on national policy, synergy with other departments and the application of remote sensing technologies for USDA mission support. Mr. Bethel plays a national role in the coordination and consolidation of remote sensing and geospatial information for disasters. Before his current position, Mr. Bethel served as the Chief of the Farm Service Agency Remote Sensing Section, where he was responsible for National GIS implementation. He has served as Chief of the Foreign Agricultural Service, Remote Sensing Section where he was responsible for processing of global imagery, geospatial database development, and crop model implementation for global agricultural monitoring. Before joining the federal government, Mr. Bethel worked on contracts supporting FEMA, FAA, DoD, and USDA.

Mr. Bethel has a BS in Agronomy from Virginia Tech and MS in Geographic and Cartographic Sciences from George Mason University. Mr. Bethel serves on numerous working groups including the Civil Applications Committee, Interagency Remote Sensing Coordination Cell (IRSCC), US Group on Earth Observations (USGEO) and leads the USGEO Working group: "Support Sustainable Agriculture and Forestry and Combat Land Degradation." He was appointed to the National Satellite Land Remote Sensing Archive Advisory Committee (Department of Interior), been a member of the Future of Land Imaging Interagency Working Group (Office of the President), chaired the National Digital Orthophoto Program (NDOP) steering committee, and been a member of the National Aerial Photography Program (NAPP) steering committee.

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**Bresnahan, Paul**



Paul Bresnahan is employed by Observera Inc. and supports commercial

satellite imagery geolocation accuracy evaluations as a contractor for the National Geospatial-intelligence Agency (NGA). He has led geolocation accuracy assessments for QuickBird, OrbView-3, EROS-A, EROS-B, SPOT-5, Radarsat-2, Cosmo-Skymed, TerraSAR-X, RapidEye, WorldView-1, WorldView-2, and GeoEye-1. He received an M.S. degree in Geodetic Science

(Photogrammetry track) from The Ohio State University and a B.S. degree in Aeronautical/Astronautical Engineering from the University of Illinois at Urbana-Champaign.

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**Brindle, Laura**



Laura received an BSc in Geography and Geology from The University of Manchester, UK and an MSc in Environmental

Monitoring, Modelling and Management from Kings College London.

She currently works for DMCii as a Satellite Campaign Manager and Calibration Specialist responsible for work on the on-going calibration of UK-DMC2 and Deimos-1 and the initial post-launch calibration of Nigeriasat-X

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**Broderson, Dayne**



Dayne Broderson is the technical services manager for the UAF Geographic Information

Network of Alaska (GINA). He is the technical lead for the University in the Statewide Digital Mapping Initiative. He holds a B.S. in Computer Science from the University of Alaska Fairbanks.

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**Brunn, Adreas**



Andreas Brunn holds a Diploma in Geography and Remote Sensing from the University of Wuerzburg, Germany. Additionally he holds a PHD in

Remote Sensing from the Technical University of Clausthal, Germany. Currently he is working for RapidEye AG, Brandenburg, Germany in the Calibration and Validation Group where he is responsible for all kinds of Calibration and Validation activities. His main research interests are in the fields of Radiometric Calibration and image performance evaluations and in the atmospheric correction of remote sensing data.

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## Case, Dave



Dave Case is a staff officer of the National Geospatial Intelligence

Agency (NGA) and currently works in the Joint Operations and Integration Office. This Office supports the fielding of operational requirements for the agency's analysts community. He is currently the technical lead of small team that works with other NGA organizations supporting the integration of all new sensor data for the analyst workforce. He has worked at NASA as a support contractor for the Earth Resources Branch and as part of industry team that developed the EOS Data Information System for the TERRA and AQUA satellites. He received M.A. and B.A. degrees in Geography (Remote Sensing/GIS Concentration) from the State University of New York at Albany.

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## Chander, Gyanesh



Gyanesh Chander received the Ph.D. in Geospatial Science and Engineering

(GSE) with specialization in Remote Sensing Engineering, and M.S. degree in Electrical Engineering from South Dakota State University (SDSU), Brookings, in 2011 and 2001 respectively. He is currently a Lead Systems Engineer with SGT, Inc., at the U. S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD. His primary responsibilities at EROS include

satellite sensor characterization and calibration research to support ongoing radiometric projects.

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## Christopherson, Jon

Jon Christopherson works at the USGS EROS Center as a contractor for SGT, Inc. With degrees in Electrical Engineering and Space Studies he has worked with ground, airborne, and space-borne



electro-optical sensors for twenty-five years in various defense, aerospace, and civil programs, both domestically and internationally. He currently manages a contractor team supporting the USGS Remote Sensing Technologies Project's work in the assessment of satellite and aerial data as well as other tasks across the broad spectrum of remote sensing.

Jon Christopherson  
Contract Work Manager, Remote  
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## Dellagnello, Marzio



Mr. Marzio L. Dellagnello is a Staff Officer in the International Activities Branch, Mission Integration

Office of the Source Directorate at the National Geospatial-Intelligence Agency (NGA) based in Springfield, Virginia.

Mr. Dellagnello completed his undergraduate degree in 1984 at the University of Kentucky in Lexington, Kentucky. He received a Bachelor's Degree in Geography with Cartography Concentration. In 2005 he completed a Geopolitics Master's Program at the University of Maryland.

In 1997, he joined NIMA's International Co-production Office, serving as a Technical Implementation Specialist of the Global Support Team. This position included performing technical assessment of foreign mapping agencies, supporting international agreement negotiations, and on-site assistance in support of NIMA hard-copy and digital coproduction programs.

In 2000, Mr. Dellagnello was assigned to NIMA's International Co-production Team serving as technical support specialist for the Eurasia-Africa Geospatial Division. Specifically, he was involved with vector databases and GIS applications.

From 2000 to 2005, Mr. Dellagnello chaired the VMap Co-production Working Group (VaCWG), Policy Group. The VaCWG consisted of 19 nations who shared the burden of producing VMap level1 globally.

Mr. Dellagnello currently chairs the Plenary and Steering Groups of the

Multinational Geospatial Co-production Program (MGCP). The MGCP is a consortium of countries collaborating to produce high resolution vector data world-wide.

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### **Dykstra, Jon**



Dr. Dykstra serves as VP of Digital Imaging and Director of R&D for MDA Information Systems, Inc. located in Gaithersburg, MD. He received his PhD and MA in Economic Geology from Dartmouth College in 1978 and '75, respectively. Dr. Dykstra served as Director of R&D for Space Imaging in the mid 90's and as Executive Manager at Intergraph Corporation in the late 80's and early 90's, where he designed and developed Intergraph's first GIS-integrated image processing software. Dr. Dykstra's latest activities have been focused on the creation of a global change detection system based on multi-temporal satellite imagery.

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### **Fonseca, Leila M.G.**



Dr. Fonseca graduated in Electrical Engineering, Master of Electrical Engineering and Computer Science at the Technological Institute of Aeronautics and has her Ph.D. in Applied Computing at the National Institute for Space Research, Brazil. She is currently a senior researcher and the Head of Image Processing Division at the Brazilian Institute for Space Research (INPE), Brazil. She has experience in computer science, with emphasis on Digital Image Processing, acting on the following topics: applications in remote sensing, signal processing, image processing, radiometric correction of satellite images, multi-resolution and multi-temporal analysis and mining data.

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### **Freedman, Ellis**



Ellis Freedman has a B.S. from Temple University and an M.S. from Northeastern University, both in physics, and over 34 years experience in remote sensing. In 2010, after 27 years with Lockheed Martin Co., he left the position of Fellow to form his own consulting firm, Serious Science, LLC. He has been Chief Engineer for the calibration of electro optic sensors and the processing of raw data into

imagery for large government and commercial remote sensing systems. As a project lead, he has designed the high level architecture for large data processing systems and developed mathematical algorithms and modeling tools for the correction, enhancement, and exploitation of imagery, and the characterization, detection, and removal of artifacts and noise. He has also led the development, integration, and implementation of a variety of visible, infrared, radar, multispectral and hyperspectral hardware and software systems. He is currently focusing his efforts on providing technical and systems engineering support to commercial imaging systems.

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### **Friedl, Lawrence**



Lawrence Friedl serves as the Director of the Applied Sciences Program within NASA's Earth Science Division. The Program supports efforts to discover and demonstrate innovative and practical applications of Earth science by public and private organizations'. He has been with the NASA Applied Sciences Program since 2002. He has served as the Program Manager for Air Quality applications along with several other applications themes (Coastal Management, Climate, Water Resources).

Among his responsibilities, Lawrence is a Co-Chair of the interagency U.S. Group on Earth Observations (USGEO) and represents the United States on the

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Prior to joining NASA, Lawrence worked at the US Environmental Protection Agency, focusing on applications of geospatial data and technology. He also served as a Space Shuttle Flight Controller in NASA's Mission Control Center for 15 missions, including several Earth science missions.

Lawrence received a Masters degree in Public Policy from Harvard University's Kennedy School of Government, specializing in Science and Technology Policy. He received a Bachelors degree in Mechanical & Aerospace Engineering from Princeton University. He also received a certificate in Space Policy and Law from the International Space University.

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Dr. Goldberg earned his B.S. from Rutgers University, and M.S., and Ph.D. degrees from the University of Maryland. Dr. Goldberg joined NOAA in 1990 and has had held a number of positions of increasing responsibility. He is the Chief of the NESDIS Satellite Meteorology and Climatology Division in NESDIS STAR and is also serving as the Joint Polar Satellite System (JPSS)

Program Scientist. His scientific expertise is in developing scientific algorithms to derive atmospheric soundings of temperature and water vapor from microwave and infrared sounders. At JPSS, Dr. Goldberg serves as independent expert and representative of the science and user communities responsible for ensuring the scientific integrity at all stages of satellite development. Dr. Goldberg has received three Gold Medals, one Silver Medal, and three Bronze Medals from the Department of Commerce and more recently the 2010 NOAA Administrator's Award for leadership in developing and chairing the international Global Space-based Inter-Calibration System (GSICS) program. He received the University of Maryland Most Distinguished Alumnus Award from the Department of Atmospheric and Oceanic Science in 2004.

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After receiving his Ph.D from the University of Utah, Doug has worked 37 years in applied experimental psychology. He was the President (2003-2004) of Division 21 (Applied Experimental and Engineering Psychology) of the American Psychological Association. Part of this work has involved conducting experiments with image analysts to assess the quality and utility of imagery and imagery products from a wide variety of sensors. He has also developed Image Quality

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### **Guenther, Bruce**



Dr. Bruce Guenther is the NOAA SDR Calibration lead for NPOESS and JPSS Programs since 2007. He was the Chief VIIRS Scientist for the final calibrations and characterizations testing of the NPP VIIRS, and was responsible for the first calibration products published for the EOS Terra MODIS sensor. Guenther's current research interests are exploiting VIIRS advances in calibration design and accuracy for uses in optical oceanography studies. Guenther received a Ph.D. degree from the University of Pittsburgh in Aeronomy in 1974. He is a University of Maryland, Baltimore County employee serving in a mobility assignment to NOAA.

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Calvin (Cal) Hagan is a Senior Systems Engineer and Team Lead for the National Geospatial-

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Dennis Helder received the B.S. and M.S. degrees in electrical engineering from South Dakota State University and the Ph.D. in engineering from North Dakota State University. He has been involved with radiometric calibration of the Landsat series of instruments since 1988. He founded the SDSU Image Processing Laboratory in 1991 and is the current director. He has been involved with the Landsat 7 Science Team, the EO-1 Science Validation Team, and the Landsat Data Continuity Mission Science Team. Helder is currently the Associate Dean for Research in the College of Engineering at South Dakota State University.

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Drew Hopwood has been with Astrium since 2004, after obtaining a Bachelor of Science degree in Geography

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Prior to being an entrepreneur, Howard was a hydrogeologist with the United States Geological Survey, Water Resources Division. He supervised well drilling and completion, pump tests and field inventory efforts. Howard holds Bachelors and Masters degrees in Geology with a specialty in hydrology from Indiana University, Bloomington. Howard has been an

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Dr. Frank P. Kelly, USGS EROS Center Director and USGS Space Policy Advisor, comes to the USGS from

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He started his professional career in the US Air Force, where he served in several capacities, including HQ USAF Satellite Acquisition Manager for Defense Meteorological Satellite Program. After retiring from the Air Force, he worked in the private sector as Senior Staff Scientist and later as Vice-President at Atmospheric and Environmental Research, Inc.

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Mr. Kohlbrenner is employed by Observera Inc. and supports

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Seungwoo Lee obtained a BS degree in Computer Science from Ajou University and MS degree in Digital Media from KAIST in

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Currently, he is working on on-orbit calibration and validation of Satrec Initiative's satellites, and studying the relationship between image quality metrics and satellite system design parameters. His research interests include automated image quality assessment and improvement.

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Dominique Léger obtained his diploma in engineering from the "Ecole Supérieure d'Optique (ESO)" in 1973 and his Dr Ing

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Frederico has 10 years experience in the development of MS3, the ground segment software currently used by INPE, which

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He holds a Master degree in Electronic Engineering from Federal University of Rio de Janeiro, and a Doctor degree in Computer Science from the Pontifical Catholic University, also in Rio de Janeiro.

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Steve is Chief Scientist for DMCii and has a first degree in geology and PhD in the application of

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David Mulawa is employed by GeoEye and supports the geolocation accuracy performance for the GeoEye-1 satellite. He has 20 years of

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After an experience in the European Space Operation Centre (ESOC) of the European Space Agency in Germany working on in-orbit infrastructure for manned missions, he went to Madrid, Spain where he co-founded in 2001, together with other 20 space professionals, DEIMOS Space S.L., which has grown to become, in 2011, a multinational group with four companies and more than 500 employees.

In DEIMOS Space he has been responsible until 2010 of the Earth Observation Mission Analysis Division, having worked as Mission Analyst for more than 20 Earth Observation mission studies, mainly for ESA. In 2010 he joined DEIMOS Imaging as Business Development Manager.

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Prior to coming to GeoEye, Nancy worked as a remote sensing/GIS specialist for NAVTEQ Corp, Asia Forest Network, the East-West Center and as a contractor for NASA. Nancy received her PhD from the University of Wisconsin-Madison in Environmental Monitoring.

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Prior to joining USDA in 1998, Curt worked as a Project Manager in northern Kenya for a major water development project funded by the European Union from 1986-1991

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### **Robinson, Dirk**



Dirk Robinson has a decade of experience building systems that capture, store, and analyze images including optical system design, image compression and automatic pattern recognition. Prior to Skybox Imaging, Dirk founded the Digital Optics research group at Ricoh Innovations where he developed novel imaging systems for markets ranging from medical to automotive.

Dirk has been awarded six patents with over twenty patents pending on his imaging system design research. He has published more than twenty-five peer-reviewed publications in the area of imaging and data processing. Dirk received his PhD in Electrical Engineering from the University of California Santa Cruz in 2004.

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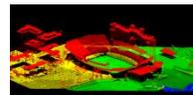


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### **Stensaas, Greg**



Greg Stensaas  
graduated with a  
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Science degree  
in Mechanical  
Engineering  
from South  
Dakota State  
University, and

has taken post graduate classes in Engineering and Information Technology at the University of Nebraska–Lincoln and Dakota State University.

Greg has extensive systems engineering and information systems experience; such as; electro-optical and infrared systems exploitation, development, simulation, and test experience as an electronics engineer and operations research analyst for the U.S. Department of Defense; principle engineer for the NASA Earth Observing System Distributed Active Archive Center, and was the systems engineer for the U.S. Geological Survey (USGS) Landsat Data Continuity Mission at the Earth Resources Observation and Science (EROS) Center.

Greg continues to work at USGS EROS in Sioux Falls, South Dakota and is currently serving as the USGS Remote Sensing Technologies Project Manager, where he is responsible for aerial and satellite sensor calibration and system/product characterization and evaluation. He is the USGS point of contact for the system characterization and continues to work many cross-calibration efforts.

Greg is a co-chair of the Joint Agency Commercial Imagery Evaluation (JACIE) program. He was the Primary Data Acquisition Division (PDAD) Director for the American Society of Photogrammetry and Remote Sensing (ASPRS) and was the chair of the Inter-Agency Digital Imagery Working Group (IADIWG). Greg is currently the chair of the Committee on Earth Observation (CEOS) Working Group on Calibration and Validation (WGCV), and is leading Global Earth Observation System of Systems Quality Assurance Strategy task for the Group on Earth Observation (GEO).

Greg has strong interest in the areas of sensor design and systems application, laboratory and in situ calibration and characterization processes, information storage and access, and system and data quality assurance. Greg has been involved in many system characterization, calibration, and validation efforts, and has presented and prepared numerous scientific analyses and associated science papers.

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### **Stephens, Paul**



Director of  
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Imaging Ltd., part of the Surrey Satellite Technology Group, providing satellite imaging services and disaster response.

After a decade in strategic business consultancy Paul became involved in space when, in 1997, he sought to raise venture capital for a constellation of radar satellites to monitor ocean storms.

He then joined the world leader in small low cost satellites, Surrey Satellite Technology Ltd., and has been active in developing the six-nation Disaster Monitoring Constellation (DMC). Paul also served for several years as a committee member of the British Association of Remote Sensing Companies (BARSC).

Since October 2004 he has served as a Director of DMC International Imaging Ltd., a wholly owned subsidiary of Surrey Satellite Technology Ltd., and since 1<sup>st</sup> January 2009 part of the EADS Astrium Group. He is responsible for developing the rapidly growing commercial activities of DMCii, which provides responsive satellite imaging services, a forest mapping service, and disaster response through the International Charter.

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### **Thomassie, Brett**



Education: BA,  
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Experience: Mr. Thomassie has over twenty-seven years experience in the remote sensing/GIS industry and joined DigitalGlobe in 1999. He assumes overall responsibility for managing DigitalGlobe's Civilian Government sales segment. Prior to joining DigitalGlobe, Mr. Thomassie was a Program Manager for NASA/ITD – SpectralVisions and Project Manager for Lockheed Martin under the auspices of the NASA's Commercial Remote Sensing Program (CRSP) at Stennis Space Center in Mississippi.

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## **Thome, Kurt**



Kurt Thome obtained a BS degree in Meteorology from Texas A&M University and MS and PhD degrees in

Atmospheric Sciences from the University of Arizona. He then joined what is now the College of Optical Sciences becoming full professor in 2006. He served as the Director of the Remote Sensing Group from 1997 to 2008. Thome moved to NASA's Goddard Space Flight Center in 2008 as a Physical Scientist in the Biospheric Sciences Branch. He has been a member of the Landsat-7, ASTER, MODIS, and EO-1 Science Teams providing vicarious calibration results for those and other imaging sensors. He is a Fellow of SPIE and is serving as the calibration lead for the thermal instrument on the Landsat Data Continuity Mission and is the Deputy Project Scientist for CLARREO for which he is also the instrument lead for the Reflected Solar Instrument.

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## **Tighe, M. Lorraine**



Ms. Tighe has just finished a PhD in Earth Sciences at

Ottawa-Geoscience Centre of Carleton Ottawa University. Ms. Tighe is currently the Director, Geospatial Solutions at Intermap Technologies Incorporation, ensuring that the NEXTMap product line is meeting the customer needs. She has been involved in the research of IFSAR data for topographic, forestry, and Geological mapping for the past 20 years.

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## **Wagner, Ruedi**



Ruedi Wagner graduated in 1995 with a Masters degree in Applied Geology from the Free University of Berlin

specializing in Remote Sensing, Photogrammetry and Geoinformation. Prior to joining Leica Geosystems in Switzerland in 2008, he has spent over a decade on the African Continent working as a scientist and manager in Applied Geospatial Imaging, as the Regional Manager Sub-Saharan Africa for Leica Imaging Products as well as a business consultant in corporate strategy and sustainable development.

Ruedi is based at Leica Geosystems' Headquarters in Heerbrugg,

Switzerland, and is the Vice President Imaging of Hexagon Geosystems Geospatial Solutions Division, which is bringing together Leica Geosystems and Z/I Imaging Airborne Sensors.

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## **Zakzeski, Audra**



Audra Zakzeski has been working for the Department of Agriculture National Agriculture Statistics service as a

Mathematical Statistician for three years. She graduated from Pennsylvania State University with a masters in applied statistics and Colorado State University with a bachelors degree in applied mathematics. Audra works on the development and deployment of the Cropland Data Layer. The Cropland Data Layer is a crop specific land cover classification product available to the public.

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## Joint Agency Commercial Imagery Evaluation

### ABSTRACTS (numeric order)

#### 12.000

##### **The Leica RCD30 medium format camera - A new approach to camera calibration**

Ruedi Wagner (presenter), Udo Tempelmann, Ulrich Beisl & Johannes Appell

The Leica RCD30 medium format multispectral camera has since its release in mid 2011 attracted a lot of interest in the airborne mapping market. This is not only the result of its flexibility as a standalone camera, as a camera that can be integrated with Leica and 3<sup>rd</sup> party LiDAR systems as well as a metric camera system that can be installed in lighter aircraft and UA Systems. It is also the plethora of innovative features such as co-registered RGB and NIR data acquisition and bi-directional motion compensation that differentiates this camera from its peers. As a consequence, a new and innovative approach to camera calibration is required. This paper will present the new approach to geometric and radiometric calibration.

#### 12.001

##### **Accuracy and Radiometric Study on Latest Generation Large Format Digital Frame Cameras**

Dr. Ing. Karsten Jacobsen <sup>(a)</sup>

Dr. Ing. Ricardo Passini <sup>(b)</sup>

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Presenter: Dr. Ing. Ricardo Passini

Two latest generation large format digital frame cameras (i.e., the Z/I DMC II 230 and The Microsoft – Vexcel UltraCam Eagle) have been used in large calibration test areas with the purpose to study their geometrical accuracy performance as well as the radiometric characteristics of the rendered images. For these purposes, the cameras have been flown over large calibration test areas at different flying heights, forward and reverse flight patterns over the same flight line, different overlaps (end and lateral). Both used calibration test sites include a large quantity of control and independent check points used during adjustment and quality control. Several patterns of control point number and distribution were tested. All bundle block adjustments were carried out with self-calibration using specifically derived additional parameters for each camera with the purpose to remove possible systematic effects. In relation with the radiometric characteristics, several linear features evenly distributed over the entire area were cross sectioned along edges and their pixel grey shade studied through point spread functions that allows for the derivation of the effective dimension of the ground sample distance that indirectly informs about the possible loss of information with respect to the theoretical value of the projected pixel size of each camera.

#### 12.002

##### **A Constant MTF Resampler**

Ellis Freedman and Dr. Robert Fleming

Presenter: Ellis Freedman

The geometric remapping of pixel values during the processing of digital imagery can significantly affect the final image quality. Most systems include a resampler/interpolator as part of their processing, such as bicubic, that not only degrades the MTF of the image and increases blurring, but varies the degradation with the fractional pixel relocation distance. Thus the MTF of the image is often degraded in an almost random pattern for which compensation cannot be applied. This often hampers attempts to measure the true MTF of the system using ground targets in imagery. To counter this, a replacement table of interpolation kernels has been developed that imposes the same MTF degradation for any pixel shift. The inverse MTF can then be applied such that there is no MTF degradation to the image after interpolation. This presentation provides the results of an analysis and simulation comparing the performance of this Constant MTF Interpolator to other interpolators.

### **12.003**

#### **The Results of the National Enhanced Elevation Assessment**

Greg Snyder, USGS (Lidar Program Development)

The USGS completed a National Enhanced Elevation Assessment in December of 2011. Eight scenarios for a national enhanced elevation data program were evaluated. All scenarios considered the tradeoffs between benefits and costs for varied elevation data quality and replacement cycles. While every scenario resulted in a positive benefit cost ratio, the range of needs met varied from 13 to 66 percent of the requirements identified in the study. Additional scenarios are being examined for meeting a greater percentage of needs, particularly for uses that require very high levels of data quality. Using conservative numbers, the scenarios produced maximum expected benefits of over \$1B annually. The assessment also concluded that the current cooperative program was efficient and resulted in relatively little duplication. The level of current investments nationally, however, was not sufficient to meet more than about 10 percent of the identified requirements. As part of the project, a detailed inventory of existing elevation data was developed as a planning baseline.

### **12.005**

#### **Assessment of RapidEye, UK DMC-2, and SPOT-4/5 datasets**

Aparajithan Sampath, Gyanesh Chander, Jon B Christopherson

SGT, Inc., contractor to the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD, 57198, USA. Work performed under U.S. Geological Survey contract G10PC00044.

This study will assess the geometric and radiometric performance of RapidEye, UK DMC-2 and the SPOT4-5 sensors using imagery acquired over USGS National Test Ranges and pseudo-invariant calibration sites (PICS). The constellation of five RapidEye satellites, launched in December 2008, continue to provide worldwide multispectral imagery. The UK-DMC 2 satellite, launched in July 2009, is a recent addition to the Disaster Monitoring Constellation (DMC) manufactured and operated by SurreySat Technology Ltd. With an improved GSD of 22 m, the UK DMC2 maintains the 660 km wide swath and the green, red, and near-infrared spectral coverage of its DMC predecessors. Since May 2010 the USGS EROS has downlinked over 270,000 images from the SPOT-4 and SPOT-5 sensors. The imagery obtained from these satellites is of interest to a wide variety of users within the USGS and in other federal agencies.

### **12.006**

#### **Assessment of the NASA-USGS Global Land Survey (GLS) Datasets**

Gyanesh Chander<sup>a</sup>, Aparajithan Sampath<sup>a</sup>, Chengquan Huang<sup>b</sup>, Garik Gutman<sup>c</sup>

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Jointly produced by NASA and USGS, the Global Land Survey (GLS) datasets establish a solid baseline for monitoring land surface changes at medium spatial resolution by providing near complete global coverage of Landsat images for all land areas for epochs centered around 1975, 1990, 2000, 2005, and 2010. These datasets are available for free download through many web portals, including the USGS EarthExplorer (EE), USGS Global Visualization Viewer (GLOVIS), and the Global Land Cover Facility (GLCF). The GLS datasets are widely used in a broad range of land-cover and -change studies at local, regional, and global scales, including many funded by the Land Cover Land Use Change (LCLUC) and other NASA and USGS programs. In spite of the wide usage of these datasets, there has been no documented assessment of the quality of the GLS datasets. This poster provides an assessment of the quality characteristics of these data sets (except GLS 2010, which is still be generated), including their spatial coverage, temporal consistency, geodetic accuracy, image completeness, and cloud cover. Results from this study likely will benefit the users of the GLS datasets, and will provide valuable insights for future efforts to develop global datasets for land change monitoring.

## **12.008**

### **Radiometric Cross-calibration of EO-1 ALI with L7 ETM+ and Terra MODIS Sensors Using Near-simultaneous Desert Observations**

Gyanesh Chander

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The Earth Observing-1 (EO-1) satellite was launched on November 21, 2000, as part of a one-year technology demonstration mission but was extended because of the scientific communities' interests. EO-1 has now been operational for more than a decade, providing both multispectral and hyperspectral measurements. As part of the EO-1 mission, the Advanced Land Imager (ALI) sensor demonstrates a potential technological direction for the next generation of Landsat sensors. To evaluate the ALI sensor capabilities as a precursor to Operational Land Imager (OLI) onboard Landsat Data Continuity Mission (LDCM, or Landsat 8), its measured top-of-atmosphere (TOA) reflectances were compared to the well-calibrated Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+) and the Terra Moderate Resolution Imaging Spectroradiometer (MODIS) sensors in the reflective solar bands (RSB). These three satellites operate in a near-polar, sun-synchronous orbit 705 km above the Earth's surface. As part of the "AM Constellation," EO-1 flies one minute behind L7, and Terra flies ~30 minutes behind L7. In this configuration, all the three sensors can view nearly identical targets on the ground. However, because of the differences in the relative spectral response (RSR), the measured physical quantities can be significantly different while observing the same target. The cross-calibration of ALI with ETM+ and MODIS was performed using near-simultaneous surface observations based on image statistics from areas observed by these sensors over four Desert sites (Libya 4, Mauritania 2, Arabia 1, and Sudan 1). The differences in the measured TOA reflectances due to RSR mismatches were compensated by using a spectral band adjustment factor (SBAF), which takes into account the spectral profile of the target and the RSR of each sensor. For this study, the spectral profile of the target comes from the near-simultaneous EO-1 Hyperion data over these sites. The results indicate that the TOA reflectance measurements for ALI agree with those of ETM+ and MODIS to within 5 percent after the application of SBAF.

## **12.011**

### **Improving the Way the Government Does Business: The Value of Landsat Moderate Resolution Satellite Imagery in Improving Decision-Making**

Authors: Adams, Victoria and Emily Pindilli

Presenter: Adams, Victoria

There is a continuous record of Landsat moderate resolution satellite imagery representing nearly forty years of data. Over time, the utilization of this information has increased; today federal agencies, local and state governments, academia, private industry, and international users are taking advantage of the information provided by Landsat. A recent study commissioned by the U.S. Geological Survey to assess the benefits of the Landsat program estimated the value at \$8.7 billion per year to U.S. users alone; over a 15-year period of analysis the cumulative benefits are estimated at nearly \$120 billion. This presentation will describe the approach and results of the benefits analysis.

Currently, Landsat data including archived images are available free of charge to the public. This information is used to monitor changes in sea ice and glaciers, inventory forests, assess habitat, study land use change, observe coastal resources, analyze hurricane damage paths, volcano lava flows, wildfires, and track agricultural stocks, among many other functions. The availability of moderate resolution satellite imagery for all of these applications is vital. The data inform decision-making, helping to improve the allocation of resources and the effectiveness and efficiency of programs.

Landsat data provide benefits that are not easily quantifiable; in particular, the value of the information provided to decision-makers is an important attribute of the data. To assess the benefits, the analysis utilized a Bayesian network approach which captures the direct, indirect, and ancillary benefits of Landsat data. Information on the uses of Landsat data were used to characterize benefit categories. A systematic process of decision-tree mapping identified the decisions and outcomes that could be realized from each benefit type. The impact of access to Landsat data was evaluated for each benefit and associated with a monetary value. Summing the value of information to each of the benefit categories resulted in a total value of \$120 billion over a 15-year period of analysis.

## **12.012**

### **Update on high resolution aerial mapping cameras**

Author and Presenter: Klaus Neumann

Digital camera technology is developing rapidly and new sensor designs provide higher geometric accuracy and enhanced radiometric image quality. This presentation will explain current digital camera designs from Hexagon GeoSystems from line to frame sensor, from medium format to large format.

The new medium format Leica RCD 30 camera system offer R G B and NIR data with a single camera head. A two dimensional forward motion compensation is included. The RCD 30 has exchangeable optics for variable focal lengths. It can be operated as standalone, as dual head camera system for large ground coverage, as part of a LIDAR sensor and on board of UAVs.

The Leica XPro line sensor and FramePro frame sensor post processing software packages include a new option for DSM extraction based on semi global matching technology. This option allows fast generation of precise 3D models using only aerial images as input.

The Z/I Imaging DMC II camera family includes up to 250 Mega Pixel single monolithic CCDs which makes any stitching of small format CCDs obsolete. The single CCD design provides excellent radiometric image quality and very high geometric accuracy. Fast frame rates allow flexible use on fast aircraft or high forward overlaps. A guideline on which camera design can be used for which application will be given.

## **12.013**

### **Radiometric Calibration of the 22m GSD Nigeriasat-X satellite sensor using combined cross-calibration results over Dome-C and Libya 4.**

Laura Brindle, DMCii  
Stephen Mackin, DMCii  
Paul Stephens, DMCii

The Nigeriasat-X mission was launched in August 2011 and forms the latest addition to the Disaster Monitoring Constellation. It has the same bandset as the established UK-DMC-2 and Deimos-1 sensors and is the first in the missions to provide continuity of imagery at the 22m GSD spatial resolution.

Calibration was performed using established procedures developed of the Dome-C site in Antarctica and the Libya 4 desert dune field. Corrections for BRDF of the surfaces was made using a snow measurements gathered by the University of Washington, while over Libya 4 a BRDF model derived from the use of intense observations by the UK-DMC-2 sensor was used to correct for view angle effects to the target.

A novel method to derive corrections of the relative gains (detector to detector variations) was examined. The method is based to some degree on previous work carried out at South Dakota State University and provides a means to monitor and update relative gains on a very regular basis.

The overall results suggest that the sensor is as stable as the previous 22m imagers with an absolute calibration that is better than 5% in all spectral bands.

## **12.014**

### **New sensors; update on developments in the DMC Constellation**

J. Paul Stephens, DMC International Imaging Ltd (DMCii)

The Disaster Monitoring Constellation (DMC), coordinated by DMCii, which pioneered daily repeat imaging capability at 30m resolution in 2004, matured with the delivery of greatly improved performance through the three satellites which carry the new generation of 22m sensors. The quality of the 22m DMC multi-spectral imagery has provided the USDA with crop classification accuracy which matched or improved on that achieved with Landsat 5 imagery.

The latest DMC sensor launched in August 2011 on NigeriaSat-2 delivers 2.5m pan and 5m multispectral imagery from an agile SSTL satellite platform, and is commercially available through DMCii.

DMCii has also commissioned three new DMC3 satellites from SSTL for launch in 2014, which will deliver daily 1m capability.

This presentation will provide an update on the operational and future DMC imaging sensors, and the operational applications of constellation services.

## **12.015**

### **Radiometric Calibration of the high spatial resolution NigeriaSat-2 Satellite VHRI**

Steve Mackin, DMCii

Laura Brindle, DMCii

Paul Stephens, DMCii

The Nigeriasat-2 (N2) satellite was launched in August 2011. It carries a 5m multispectral and 2.5m PAN imager with an approximately 20km swath width.

The DMCii calibration consists of the application of multiple methods to avoid biases in the calibration process. The Nigerisat-2 data has four multispectral bands (blue, green, red and NIR) and a panchromatic band.

The major steps were

- Equalisation of the detectors and generation of the relative gain curve using flat-fielding over the Dome-C site.
- Generation of initial radiance estimates using the UK-DMC-2 as the reference satellite over Dome-C in Antarctica
- Use of a radiative transfer code to generate the corresponding radiance values for the Blue and PAN bands not present on UK-DMC-2.
- Application of the generated gain values to data collected over the Libya 4 site, comparing the results to the long term Landsat statistics (11 years of data). Modification of gain values.
- Application of the final generated gain values to data collected over Dome-C, comparing results to Landsat 7.
- Use of novel relative gain method based on heterogeneous images to confirm relative gain values.

In the case of Dome-C corrections were made using a BRDF model based on data provided by the University of Washington, while a BRDF correction based on data collected from the UK-DMC-2 satellite, combined with the Landsat statistics was applied over this site.

The results show an excellent correlation between the computed N2 TOA reflectance and that of the Landsat 7 satellite over both test sites. Given the use of different approaches it suggests little or no “relative” bias between the two satellites. It is expected that the TOA reflectance can be mapped at the sub-0.5% level using this methodology, based on time series of collected data.

### **12.016**

#### **Automated measurement of SNR of high resolution satellite images**

Author: Seungwoo Lee, Kumhui Oh

Presenter: Seungwoo Lee

Automation of image quality assessment has been a popular research topic in remote sensing. Many researchers have studied automated ways for various metrics such as MTF and PRNU. SNR also is an important image quality metric as it shows the dominance of informational signal compare to noise. However SNR has received less attention than other metrics. Many researches regarding SNR studied measurement methods for laboratory environment, or using a specific target image taken in-flight. Only a few have studied a method based on a typical in-flight imagery. Nevertheless, automated measurement of SNR allows us to track SNR at every image acquisition, and thus we are able to monitor sensor degradation or change of noise level in relation to the imaging condition. In the presentation, several difficulties in automation of SNR measurement will be addressed, and our approach and developed algorithm based on homogeneous area detection and pixel-intensity-grouped assessment will be described. The algorithm was applied over hundreds of images from DubaiSat-1, and the results also will be shared in the presentation.

### **12.018**

#### **Title: On-orbit MTF and defocus assessment methods applied to SPOT5 cameras**

Author: Dominique Léger

For a camera onboard a satellite, it is essential to maintain the best image quality during its life, peculiarly the image sharpness. SPOT5 HRG cameras were focused just after the launch; next, both cameras MTFs were assessed. During the satellite life, MTF is regularly assessed and a possible defocusing is evaluated. After some years, a slight decrease in MTF was observed, peculiarly near the right field edge of the HRG2 camera. A slight defocusing was assessed, after which the HRG2 camera was refocused.

First, we present the method used to measure the cameras MTF during the satellite life: we use a step edge method with an artificial checkerboard target. Second, we present the method used to assess the defocus. The principle is to combine several data: MTF evolution (field of view center and right edge), relative MTF between the two HRG cameras, astigmatism and field curvature of both cameras. Last, we present the MTF increase after refocusing, that demonstrates the good evaluation of defocusing.

### **12.019**

#### **Brazilian EO Satellite Program Update**

Authors: Leila Maria G. Fonseca, Frederico dos Santos Liporace

Presenters: Frederico dos Santos Liporace, Leila Maria G. Fonseca

This talk will present the current status of the Brazilian Earth observation satellite program, more specifically the CBERS-3 and Amazonia 1 missions, from a technical, distribution policy and planned schedule perspective. From the technical perspective we will present a brief overview of the CBERS-3 and CBERS-4 payload and subsystems that affect both radiometric and geometric accuracy. The main topic will be the presentation of the pre launch calibration procedures and the obtained results for the MUX and WFI cameras. These tests are scheduled to take place in Feb 2012. We will also present the main characteristics of the Amazonia 1 satellite and its payload, the AWF camera.

The CBERS program was the first one to implement a free data distribution policy for mid-resolution images. The presentation will cover how this policy will be maintained and extended for the next satellites, CBERS-3 and Amazonia 1, and show the latest statistics of distributed images and its use.

It will also include an update on the ground stations outside Brazil and China that will receive and distribute CBERS and Amazonia 1 data.

Finally, we will present the planned dates for the major next CBERS-3 and Amazonia-1 milestones, including launch and start of data production.

## **12.020**

### **Recent Calibration and Validation Activities at RapidEye**

Andreas Brunn, Michael Thiele, Cody Anderson, Horst Weichelt, Scott Douglass, Gregor Trosset, Dietrich Hoffmann

This presentation summarizes the calval activities performed at RapidEye during the last 12 months. A large improvement was made in the spatial radiometric calibration of the RapidEye sensors. Striping and banding performance has been significantly reduced by using the side slither technique. While it is frequently used for the highest resolution sensors, this technique is not that common for the 5 to 10 meter class of sensors. RapidEye has developed a procedure for this method and integrated it into the ground processing system. This presentation will detail the methodology and show results achieved with its use.

Additionally, an absolute calibration campaign has been performed together with the College of Optical Sciences at the University of Arizona, which confirms the absolute accuracy of the radiometric response of the RapidEye multispectral camera. Results from this campaign are supported by the temporal calibration approach which is used to control and maintain the inter satellite stability over time. Recent methods and results will be presented for both the absolute and temporal calibration approaches.

Besides the radiometric calibration aspects described above, we also continually monitor the geometric accuracy of the RapidEye constellation. As a third part of this presentation, we will show results of our geometric accuracy estimates compared to high accuracy aerial orthophotos (Digital Orthophoto Quarter Quads, DOQQ) across the USA.

## **12.021**

### **Improving Agricultural Landcover Classification in the Cropland Data Layer Using the Disaster Monitoring Constellation.**

Audra Zakzeski

Since the inception of the Cropland Data Layer (CDL), a national thematic agricultural specific landcover classification, the National Agricultural Statistics Service (NASS) has adapted their methods to include the newest software and satellite technology. Currently the process has been adapted to use a commercial suite of classification software including ArcGIS, ERDAS Imagine, and See5. There are multiple sources of satellite imagery used to develop the CDL each year. Originally, Landsat-5 Thematic Mapper (TM) and Landsat-7 were the primary sources of satellite data. Landsat has proven to be a vital and reliable resource over the years however with a repeat cycle of 16 days accurately modeling the phenological profile of different crop types with only a lifespan of a couple months was a challenge. The next step on the evolutionary ladder for the CDL was the addition of the Disaster Monitoring Constellation (DMC) Deimos-1 and UK-2 for crop year 2011. The DMC data characteristics of a smaller pixel size, faster repeat cycle, and large swath width aided in the production of an improved 2011 CDL. With the combination of Landsat and DMC data, NASS was able to produce multiple CDLs for 30 states throughout the growing season which were used to help set the official acreage estimates in the major growing regions across the country. A 2011 national product will be released in January 2012 using the aforementioned satellites.

## **12.022**

### **Using Deimos-1 & UK-DMC2 to Monitor U.S. Crop Conditions During the 2011 Crop Season**

Author & Presenter: Drew Hopwood, Astrium Geo-Information Services

Astrium GEO-Information Services was contracted by the USDA to collect and deliver imagery over the lower 48 states twice a month during the 2011 crop season. To accomplish this task, Astrium relied on two satellites: Deimos-1 and UK-DMC2. Both satellites are capable of collecting a 620 km swath of 3-band, 22m resolution imagery. For the last several years, the USDA has relied on a combination of wide swath 56 m meter AWiFS data and medium swath 28 m Landsat data to meet their agriculture monitoring requirement. Now shifting to Deimos-1 and UK-DMC2, the USDA can take advantage of a wide swath similar to AWiFS with higher resolution data than Landsat. In this presentation, we will review the technical specifications of each satellite, discuss the collection strategy that was employed to ensure the maximum delivery of imagery and the overall impact this new imagery had on the USDA's ability to meet their agricultural monitoring need.

### **12.023**

#### **Post Launch Commissioning and Testing of Pléiades 1**

Author & Presenter: Drew Hopwood, Astrium GEO-Information Services

Astrium GEO-Information Services, a worldwide leading provider of geospatial information from Earth observation satellites, recently launched the first of two identical very high-resolution satellites. Launched in mid-December 2011, Pléiades 1 provides 50 cm optical products in record time, offering acquisition capabilities tailored to meet the full spectrum of civil and military requirements. With a swath width of 20 km, the Pléiades satellites have the widest imaging swath in their class. The satellite's extreme agility coupled with multiple acquisition modes makes the system very responsive to specific user requirements. In addition, automated production workflows ensure rapid delivery of orthorectified products.

We will present information on the post launch commissioning, and a review of the in-orbit testing of Pléiades 1, with a focus on geometric, radiometric, and overall image quality performance results.

### **12.024**

#### **Remotely Sensed Ground Control Points *Field tests verify accuracy of satellite imagery***

Justin Kusterer and Philipp Hummel, presented by Brant Howard

Many GIS users wish to improve their airborne or spaceborne images' geometry by using ground control. Therefore precise control points are necessary. However, it can be difficult to acquire accurate ground control points due to required turn-around time, high costs or impossible access. CompassData, Inc. a specialist in ground control, has expanded its service to deliver Remotely Sensed Ground Control Points (RSGCPs).

In a comprehensive test, we researched the process of remotely sensing Ground Control Points, and the resulting coordinates of natural and manmade features range from 0.5 m to 2.0 m accuracy. This study's goal is to illustrate our experience with the remotely sensed data and explain how this can be of service to the geospatial community. Further, this paper qualifies the performance of different features, since SAR imagery must be approached in its own way.

### **12.025**

#### **DigitalGlobe Incorporated Satellite and Aerial Program Update**

Brett P. Thomassie

DigitalGlobe continues to operate a growing constellation of high resolution earth imaging satellites (QuickBird and Worldview systems) and added a growing aerial imagery program capability beginning in 2007 to complement its satellite product offerings. The overall DigitalGlobe data acquisition system's capacity to collect over 700 million square kilometers of imagery data annually is well suited for temporal collection of large study areas globally and contributes to the rapid population and updating of its growing image library.

The QuickBird satellite features 60cm panchromatic resolution and 2.4-meter multispectral resolution and has been operating successfully since 2001.

The WorldView-1 launched in September of 2007. This high-capacity, panchromatic imaging system features half-meter resolution imagery. Operating at an altitude of 496 kilometers, WorldView-1 has an average revisit time of 1.7 days and is capable of collecting up to 750,000 square kilometers (466,000 square miles) per day of half-meter imagery. The satellite is also equipped with state-of-the-art geo-location accuracy capabilities and exhibits stunning agility with rapid targeting and efficient in-track stereo collection.

WorldView-2, was successfully launched October 8, 2009. Operating at an altitude of 770 kilometers, WorldView-2 enables DigitalGlobe to provide half-meter panchromatic resolution and 1.8-meter multispectral resolution (8-bands). WorldView-2 will have an average revisit time of 1 day and is capable of collecting up to 700,000 square kilometers (434,000 square miles) per day of half-meter imagery. The WorldView-2 system allows DigitalGlobe to substantially expand its imagery product offerings to customers with a more desirable, higher-performance product. The added spectral diversity provides the ability to perform precise change detection, vegetation analysis and mapping. WorldView-2 incorporates the industry standard four multispectral bands (red, blue, green and near-infrared) and will also include four new spectral bands (coastal, yellow, red edge, and near-infrared 2).

WorldView-3, launching in 2014, will be DigitalGlobe's second high-resolution 8-band multispectral commercial satellite. Operating at an altitude of 620 kilometers, WorldView-3 has an average revisit time of 1.1 days and is capable of collecting up to 676,000 square kilometers per day, further enhancing the DigitalGlobe multispectral collection capacity for more rapid and reliable collection.

The upgraded WorldView ground system (in use presently with QuickBird and WorldView-1) also includes a more efficient image processing system, multi-satellite collection planning, shorter tasking timelines, and an expanded network of remote ground receiving terminals.

In October 2009, DigitalGlobe partnered with Microsoft Corporation and launched the Advanced Ortho Aerial Program (AOAP), an initiative to distribute high-resolution, 30-cm aerial orthoimagery (Advanced Ortho Series – Vision Premium/Precision Aerial product) of contiguous landscapes, initially in the U.S. and Western Europe. As of November 2011, the AOAP Phase 1 initiative has successfully acquired over 9.5 million square kilometers of 30cm imagery. AOAP reflects a DigitalGlobe commitment to increase accessibility and use of high-resolution digital imagery. The AOAP represents the first ever multicontinental aerial imagery collection program collecting high-quality orthoimagery at 30 cm spatial resolution (12-inch) or higher. DigitalGlobe and their partner Microsoft has been using the [UltraCamG](#), a large format digital aerial camera manufactured by Vexcel Imaging GmbH, a wholly owned subsidiary of Microsoft, which is based on Vexcel's UltraCam large format camera systems, the top selling large format aerial sensors internationally.

DigitalGlobe imagery products are designed to support a wide range of civil government project and research applications ranging from land management and natural resource management to asset monitoring and disaster/emergency response and remediation.

## **12.026**

### **Intelligent Data Exploration and Analytics System I.D.E.A.S.™ for Data and Model Discovery and Access**

Shawana Johnson

Consumers of satellite earth observational data are typically unaware of the data and models they need to solve a problem of interest to them, nor how to discover and access these data and models. We will present the Intelligent Data Exploration and Analytics System (I.D.E.A.S.™), which systematically addresses user problems and challenges through intelligent compute responses and guidance rather than the hunt and hope concepts offered today through numerous websites.

I.D.E.A.S.™ consists of a web-deployed Storefront MarketPlace, Smart Engine and High Performance Cloud Computing backbone. It provides for data and model discovery and access to federated NASA and other U.S.

agency data repositories, and available model repositories. Innovative methods for data and model discovery, learned workflows for discovery based on users' problem sets, access and management is used to provide near real-time Modeling as a Service (MaaS) services. These MaaS services provide for model set up, calibration, utilization, and product generation. Model revisions and user collaboration are also provided. I.D.E.A.S.™ is being developed for users to discover and use earth observational satellite (and airborne) data and models to generate value-added solutions and products for users' problem sets, focused on utilizing this data for societal benefit.

This presentation and poster will focus on:

- Ways in which the capability will be applied to provide an end-to-end capability for water management solutions for drought estimation and prediction. Drought management solutions within I.D.E.A.S.™
- Modeling as a Service (MaaS) functionality to demonstrate applicability of utilizing NASA earth observational data for drought estimation and prediction for agriculture with a particular focus on drought estimation and prediction for pasture lands and the resulting effect on grazing animal mortality in arid climates.
- And End User observations concerning the functionality of the system.

## 12.027

### Status of NPP VIIRS On-orbit Calibration and Performance

*Jack Xiong<sup>1</sup>, Changyong Cao<sup>2</sup>, Frank DeLuccia<sup>3</sup>, Bruce Guenther<sup>4</sup>, and Jim Butler<sup>1</sup>*

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The first Visible-Infrared Imaging Radiometer Suite (VIIRS) instrument was launched onboard the NASA's NPP spacecraft on October 28, 2011 from the Vandenberg Air Force Base (VAFB). Following a series of spacecraft and sensor activation and operational activities, the first VIIRS image was acquired on November 21, 2011. The VIIRS collects data in 22 spectral bands, covering wavelengths from 0.41 to 12.5 microns, and produces 22 Environmental Data Records (EDRs) from its calibrated and geolocated Sensor Data Records (SDRs). To maintain sensor on-orbit calibration and data product quality, the VIIRS was built with a set of on-board calibrators (OBC), including a solar diffuser (SD), a solar diffuser stability monitor (SDSM), and a SD attenuation screen system for the reflective solar bands (RSB) calibration and a blackbody (BB) for the thermal emissive bands (TEB) calibration. This presentation provides an overview of VIIRS on-orbit calibration activities, methodologies, and designed OBC functions. It presents an assessment of sensor initial on-orbit calibration and performance based on the efforts from the government-led SDR team. Key sensor performance parameters, such as detector signal-to-noisy ratios (SNR) or noise equivalent temperature difference (NE $\Delta$ T), radiometric gains, and dynamic range, will be determined during its initial Intensive Calibration and Validation (ICV) period and compared with that derived from pre-launch calibration and characterization. Currently identified issues and future calibration efforts, including the Long-Term Monitoring (LTM) activities, lunar calibration strategies, and inter-calibration approaches, are also discussed.

## 12.028

### Statewide Alaska Orthoimagery and Elevation Mapping Programs – Status and Results from Year 1

Authors: Tom Heinrichs and Dayne Broderson

Alaska currently has the oldest and least accurate maps of any state in the United States. This is being improved through the Alaska Statewide Digital Mapping Initiative (SDMI). Outcomes of the first year of the program will be presented, including quality assurance outcomes and web services provision of the orthoimagery and DEM data sets. Prior to SDMI, there existed no statewide orthoimage base for Alaska. Most populated areas, including cities and remote villages, and some areas with economic resources, have been imaged at high resolution and have accurate orthoimagery available; these represent less than 15% of the state. The National Elevation Database (NED) for Alaska is coarse resolution: 2-arcsecond postings—roughly 30x60-meter cells at Alaska's high latitude. The NED is known to contain large errors in some areas of the state. Less than 10% of the state currently has higher accuracy DEMs created with LIDAR, airborne IfSAR, or photogrammetrically.

The Alaska SDMI, a multi-agency partnership, is addressing these shortcomings through two projects. One is the creation of a new statewide orthomosaic imagery baselayer at 1:24,000 NMAS accuracy (12.2-meters CE90). The entire state (1.56 million square kilometers) will be imaged with the SPOT 5 satellite, and a 2.5-meter spatial resolution, multi-spectral, pan-sharpened orthoimage will be produced by 2014. In Year 1, 277,000 sq-km (24% of the state) of orthoimagery was delivered, reviewed, accepted, and made available through open standards geospatial web services. The second project is the collection of an improved accuracy DEM. The first phase is underway with 157,000 square-kilometers of airborne IfSAR data collected in 2010 and delivered in 2011. A 5-meter post spacing, 20-foot contour interval accuracy equivalent (3-meter LE90) DEM and radar backscatter intensity image has been produced and is available via OGC web services. Planning for orthoimagery refresh and completion of the statewide DEM are underway.

## 12.029

### **Reliability of Image Quality Parameters Driven from Various Edge Analysis Techniques**

Authors: Taejung Kim, Jae-In Kim, Hyeon Kim

Presenter: Taejung Kim

As high resolution satellite images become more and more popular, image quality has been one of the key concerns for scientific and industrial applications. Image quality, after launch, is usually assessed by edge profile analysis. One selects edges in between two regions of uniform brightness and retrieves brightness patterns perpendicular to edge directions. From edge profiles one can estimate several image quality parameters, such as RER (Relative Edge Response), HWFM (Full Width at Half Maximum), GRD (Ground Resolvable Distance) and MTF (Modulation Transfer Function) ratio at a cutoff frequency. However, these parameters are very sensitive to edge analysis techniques. For example, values of RER and MTF change greatly with the type of fitting functions used to describe edge profiles. They also change by how edge profiles are smoothed or averaged. We are studying the effects of different edge analysis techniques; type of fitting functions, brightness interpolation methods, etc., on image quality. We are also checking which image quality parameters are less sensitive and hence can be estimated more reliably. At the workshop, we will show results of RER, GRD and MTF extraction from different edge fitting functions. We will show the sensitivity of these parameters and compare the values with true image quality parameters. We will suggest which image quality parameters may be extracted more reliably from edge analysis and which may not.

## 12.030

### **Landsat Data Continuity Mission and Sentinel-2 Multi-Spectral Instrument Image Product Simulations for Sensor Comparisons and Data Fusion Research**

Mary Pagnutti (presenter), Robert Ryan, and Kara Holekamp

Internationally there are now more than 50 Earth observing satellites acquiring panchromatic and multispectral imagery with spatial resolutions comparable to or better than Landsat. As the quality of these alternate data sets improves, the greater the likelihood is that they will be incorporated into the scientific community, particularly in cases where cloud cover limits adequate temporal sampling. Since all of these Earth observing satellite remote sensing systems have sensor and data specifications that differ from Landsat, it is important to understand how these differences impact Earth science research. One such system is the European Space Agency's (ESA) Multi-Spectral Instrument (MSI) on-board the two Sentinel-2 satellites, the first of which is expected to launch in 2013. The Sentinel-2 satellites are planned to provide high resolution (10-20 meter) imagery globally with a 5 day revisit time in order to meet the operational requirements of the European Union-ESA Global Monitoring for Environment and Security program. One of the Sentinel-2 goals is to provide SPOT and Landsat-like data continuity, while incorporating advances in technology. In order to evaluate how the MSI may be used in conjunction with Landsat Data Continuity Mission (LDCM) and the Landsat archive for Land Cover Land Use Change (LCLUC) research, MSI and LDCM image products were simulated. Simulations were based on high spatial resolution hyperspectral data such as that from AVIRIS. Spectral synthesis and spatial synthesis based on ground sample distance (GSD) and modulation transfer function (MTF) were performed and noise effects were incorporated when simulating the imagery. This presentation contains simulation results along with an overview of the integrated set of algorithms used to generate the simulated image products.

### **12.031**

#### **Extending the Operational Envelope of Electro-optical Imaging Systems to Include Pre-sunrise and Post-sunset Operation**

Robert Ryan (presenter), Mary Pagnutti, Kara Holekamp

Several time critical operational activities such as emergency response rely heavily on high spatial resolution electro-optical true color, color infrared and panchromatic imagery taken by digital sensors mounted on airplanes or satellites. While the ability to task and field such systems has grown tremendously in the last decade, these systems tend to acquire data only during daylight and good weather conditions due to sensor limitations. Emergency related, time critical applications however, need all weather, day and night imagery and even though RADAR, LiDAR and thermal infrared imaging systems can provide improved data acquisition opportunities, high resolution electro-optical imagery is still preferred for many problems. Although digital framing camera silicon sensors are far more sensitive than film systems, concepts of operation have not changed much in the last decade. Both Bayer array and individually filtered framing camera heads are at least an order of magnitude more sensitive than film cameras, which increases the potential to use them during significantly lower illumination settings. Large area framing digital multispectral and panchromatic cameras with Time Delay Integration (TDI) capabilities are extremely sensitive and could extend the range of traditional imaging systems from pre-sunrise to post-sunset. These systems can already be used for artificial light mapping, which is useful for emergency response and planning. Example ground and aerial imagery acquired under extremely low light conditions, radiative transfer and sensor modeling are shown along with a discussion on how these low light image acquisitions can support emergency response, energy and environmental applications.

### **12.032**

#### **Data Quality of Deimos-1 & UK-DMC2 Imagery for the Monitoring of 2011 US Crop Season**

Authors: Fabrizio Pirondini, Mónica Díez, Alfredo Romo, Cristina Moclan, Jorge Gil, DEIMOS Imaging S.L.U., Spain

Presenter: Fabrizio Pirondini

DEIMOS Imaging has acted as image provider to Astrium GEO-Information Services in the frame of the USDA contract to collect and deliver imagery over the lower 48 states twice a month during the 2011 crop season. The campaign has been carried out using two satellites, Deimos-1 and UK-DMC2, providing 22-m resolution imagery in 3 spectral bands (R, G, NIR).

In the frame of this contract we have delivered more than 120 million cloud-free km<sup>2</sup> of imagery over six months, providing a unique dataset of the Lower 48.

In this presentation we will show the main results of the image acquisition campaign, with emphasis on data quality issues: absolute and relative calibration activities, and radiometric optimization of the dataset. We will also describe the procedure to cope with the strict geolocalisation requirements, and the results obtained. Finally, we will present how we produce natural color images through the generation of a synthetic blue band, and how these images have been used in 2011 to support natural disasters monitoring across the US, covering flooding, large forest fires and tornadoes.

### **12.034**

#### **Geolocation Accuracy Re-Evaluations of GeoEye-1 and QuickBird-2**

Paul Bresnahan

NGA

The National Geospatial-Intelligence Agency (NGA) Image Quality and Utility (NIQU)/Civil and Commercial Applications Project (CCAP) is responsible for the assessment of civil and commercial remote sensing systems for the Department of Defense and Intelligence Community. A major component of the NIQU/CCAP evaluation process is the assessment of geolocation accuracy. NIQU/CCAP re-assessed the absolute geolocation accuracy of

both GeoEye-1 and QuickBird-2. NIQU/CCAP presents the results of the re-assessments and compares the results to vendor-stated specifications and expected performance.

### **12.035**

#### **NGA Multinational Geospatial Co-Production (MGCP) program overview & Commercial Imagery**

Marzio Dellagnello  
NGA

The National Geospatial Intelligence Agency (NGA) is a founding member of the Multinational Geospatial Co-Production Program (MGCP). The program is a one of a kind arrangement where member nations agree to participate on a voluntary basis by signing a multilateral MOU and sharing production responsibilities. The program enables each member nation not only to share data, but also to exchange program requirements, production processes and track status. The purpose of MGCP is to help meeting the worldwide demand for high-resolution geospatial vector data. Currently the program is scheduled to produce over 3,000 one-degree cells of vector data. The primary source for this program is the high resolution commercial imagery that is available via the NextView license which is designed for more efficient and effective sharing of data. This presentation will provide an overview of MGCP and show how and why commercial imagery is used to support the program. We will also discuss lessons learned and provide input to improve the sharing of imagery for future programs such as this.

### **12.036**

#### **General Image Quality Equation (GIQE)**

Doug Griffith, Ph.D  
NGA

The General Image Quality Equation is a tool which allows users to predict the NIIRS performance of imaging systems based on a small number of parameters. The GIQE is frequently used by commercial imagery vendors to predict the quality of images that they are providing to the National Geospatial-Intelligence Agency (NGA). The current General Image Quality Equation (GIQE 4.0) and its predecessors were developed using hardcopy imagery and have been found of late to not provide accurate NIIRS predictions. Recently, the NGA Image Quality and Utility (NIQU) program initiated an effort to develop an update to the GIQE which provides more accurate predictions for a wider range of collection system configurations and for a greater range of collection conditions and geometries. Current efforts have centered upon the use of Barton's Human Visual System model as a key component of the GIQE. The pending update has demonstrated much improved NIIRS predictions even in cases of high noise and sub optimal focus. The current status and development process for this upcoming update will be briefed.

### **12.037**

#### **Optical and Thermal Requirements for Agricultural and Environmental Remote Sensing**

Guy Serbin<sup>1</sup>, E. Raymond Hunt Jr.<sup>2</sup>, Craig S.T. Daughtry<sup>2</sup>, and Martha C. Anderson<sup>2</sup>

<sup>1</sup>InuTeq LLC, Washington, DC

<sup>2</sup>USDA/ARS Hydrology and Remote Sensing Laboratory, Beltsville, MD

Current and future planned remote sensing platforms allow for near-daily monitoring of agricultural and environmental parameters. While these systems are of great utility, there exist a number of applications that are or will remain underserved by remote sensing suites. We have identified a number of applications that are underserved by current remote sensing platforms. Important biophysical parameters that would be monitored include live vegetation cover, chlorophyll content, photosynthetic efficiency, vegetation water content, non-photosynthetic vegetation cover (NPV, e.g., senescent vegetation such as crop residues and dry grasses), evapotranspiration, and vegetation stress. Chlorophyll content estimation requires at least one band in the "Red Edge" region between 680-750 nm, and we evaluate the potential effectiveness of single band Red Edge configurations vs. the three bands that will be on the upcoming Sentinel-2 mission. Ideally, remote sensing of NPV requires three shortwave infrared bands between 2025 – 2230 nm that allow for calculation of the Cellulose Absorption Index. While current and planned multispectral sensors can acquire most of these parameters, none are suited for remote sensing of NPV, which

provides unique and important information about tillage practices, rangeland health, brush fire hazards, soil organic carbon dynamics, soil erosion, and water quality. An ideal advanced multispectral system should contain at least 18 spectral bands, including bands for atmospheric correction in the optical spectrum and split thermal bands at 10.8 and 12.0  $\mu\text{m}$  to calculate land surface temperatures for evapotranspiration. Other requirements for an agricultural monitoring system are 12-bit or better quantization, signal-to-noise ratio  $> 250$ , temporal resolution  $< 7$  days to ensure cloud-free scenes and to capture critical crop growth stages, and pixel size  $< 60$  m. These spectral requirements should also be used as requirements for future coarse-spatial resolution sensors that will replace the MODIS and VIIRS sensors. Lower temporal resolution hyperspectral sensors such as the proposed HypIRI mission would augment such systems by allowing acquisition of high-quality imaging spectroscopy data for comparison with lower spectral resolution multispectral data, and for developing improved next-generation sensors. This concept is based on discussions about satellite data requirements for agricultural monitoring and does not represent official USDA or ARS policy.

### **12.038**

#### **GeoEye-1 Geolocation Assessment and Reporting Update for 2011**

Presenter: Dr. David Mulawa

The GeoEye-1 high-resolution imaging satellite continues to provide very good geolocation accuracy performance. This update includes the absolute and relative geolocation accuracy assessment test results from 2011 and Q1 2012. The Field Angle Map and camera interlock angle calibration methods that were used are described.

### **12.039**

#### **Image Quality Performance of the GeoEye-1 High Resolution Imaging Satellite**

Presenter: Dr. Nancy Podger

This paper will present an overview of the Image Quality performance of the GE-1 sensor since commissioning in Spring, 2009. The radiometric calibration and assessment processes and performance will be discussed. Other image quality metrics will also be reviewed such as Modulation Transfer Function and Signal-to-Noise.

### **12.040**

#### **GeoEye-1 New Sensor Mode – 1x2 Multispectral Pixel Aggregation**

Presenter: Preston Mattox

GeoEye recently added capability to the GeoEye-1 spacecraft in the form of a new sensor mode. This mode features simultaneous panchromatic collection at an increased rate coupled with multispectral collection that uses 1x2 pixel aggregation. Topics covered will include a comparison of multispectral imagery collected with 1x1 aggregation versus the new 1x2 aggregation, pan-sharpened products, and traditional quality metrics (MTF, SNR, radiometry).

### **12.041**

#### **Absolute Calibration of Optical Sensors Using Pseudo Invariant Calibration Sites – Initial Concepts**

Authors: Dennis Helder (presenter)  
Nischal Mishra  
Sandip Shrestha

The use of Pseudo Invariant Calibrations Sites, or PICS, for long term trending of visible and infrared sensors has been established and is widely used by many members of the calibration community. PICS in the Saharan desert especially have been shown to be stable to within 2-3% over long time periods using sensors such as Landsat 7 ETM+ and MODIS Aqua and Terra. However, so far these methods have only been used for trending the calibration of satellite instruments and the overall calibration of the sensor still depends on anchoring these trends absolutely using a second methodology such as simultaneous nadir overpasses or vicarious calibration methods. In this presentation we propose a methodology that can be used to achieve absolute calibration using PICS alone. Central to this approach is the development of a surface and an atmospheric model. As an example of this approach,

we will show initial results obtained using the Hyperion hyperspectral sensor and the PICS commonly known as Libya 4. Establishing an absolute calibration capability using PICS will allow the satellite calibration community to reduce the cost of calibration while at the same time improving comparisons between sensors.

#### **12.044**

##### **Comparison of X-Band Airborne and Spaceborne Imagery**

M. Lorraine Tighe

The cloud belt of the world benefits from synthetic aperture radar data collections platforms because they are able to penetrate cloud, haze, smoke, and light rain as well as operate during the night time for 24/7 data collections. The last decade the remote sensing community has seen had access to a plethora of spaceborne X-band systems where there are now extensive archives for COSMO-SkyMed, ENVISAT, TerraSAR-X, Tandem-X sensors suitable for evaluation of historical displacement and generation of digital elevation models of large areas. To demonstrate the value of using radar imagery from systems having diverse parameters, X-band images of Bolzano, Italian Alps and GAP, French Alps were compared to airborne X-band orthorectified radar imagery (called NEXTMap) from the STAR platform of Intermap Technologies. This comparison effort investigated the absolute and relative horizontal accuracy and the visual appearances of X-band imagery from Tandem-X, SRTM-X, COSMO SkyMed, and NEXTMap. This report has also investigated the spatial content of the X-band imagery. Results indicate that as terrain slope increased and image resolutions decreases, there were greater horizontal errors. Features identified in the NEXTMap ORI and examined in all spaceborne images, were found to have greater detail and able to represent sharp features best. It was found that the horizontal errors were roughly equal in magnitude in the north-south and east-west directions for all data sets.

#### **12.045**

##### **Seamless Fusion of Lidar, Radar and Optical Terrain Data**

M. Lorraine Tighe

Digital Elevation Models (DEMs) provide fundamental information that is required for many 3D geo-spatial applications. Several technologies are currently being used to generate DEMs with different scale, detail and accuracy. Interferometric synthetic aperture radar (IFSAR), light detection and ranging (LiDAR) and stereo photogrammetry are the most commonly used technologies for generating accurate elevation datasets. Among these, IFSAR is typically the most cost effective and affordable method to generate accurate, high-resolution DEMs for nationwide or large-area applications, while LiDAR provides more accuracy and detail, particularly for urban and forested areas. Additionally, the advanced technology of high-resolution satellite imagery and large-format digital cameras, coupled with direct geo-referencing technology and auto-correlation algorithms has greatly enhanced the results of the photogrammetric DEM process. DEM fusion techniques combine DEM data from different sources together to gain the advantages of each of the individual technologies and to produce a single DEM result that provides more detailed and reliable elevation information with improved accuracy and lower cost. Fusing multiple information sources together also produces a more efficient representation of the DEM data. This paper presents an overview of the unique characteristics of DEMs derived from these different technologies and discusses the benefits of the fusion process for a variety of applications such as water management, urban planning, telecommunications and flood plain mapping.

#### **12.046**

##### **A Comparison of Landsat and RapidEye Imagery for Use in Correlated Land Change (CLC) Analysis**

Jackie Luders, presented by Jon Dykstra

The Correlated Land Change (CLC) process utilizes a multitemporal stack of coregistered multispectral scenes, typically Landsat data. Employing MDA Information System's patented CCA (Cross Correlation Analysis) change procedure, a change measure is calculated, on a pixel-by-pixel basis, between all possible 2-image-pair permutation within the multitemporal image stack, resulting in high confidence change identification where each change feature has met the strictest measures. This process has already proven successful and MDA is currently applying CLC using Landsat data across the globe, using data from 1984 to present.

However, using 30-meter Landsat data has raised several questions: what change is not being captured due to the spatial resolution of the data, could a higher resolution satellite system such as the 5-meter RapidEye constellation provide information that Landsat might not, and what would be the cost/benefit of applying CLC to RapidEye data? RapidEye is not free, as is the Landsat data via EROS Data Center, and required additional preprocessing such as precision orthorectification; RapidEye data has 5 spectral bands versus the 6 spectral bands of the Landsat system; data file sizes are significantly larger than Landsat thus increasing processing time; there are periodic band-to-band misregistration issues in the RapidEye data that could significantly impact change detection analysis. Also, RapidEye does not have the uniquely Landsat advantage of having standardized archives going back several decades. However, CLC using Landsat data has its own set of issues in that the Landsat-7 imagery collected post-2003 has the Scan Line Corrector (SLC errors, requiring additional dates to offset the missing data within the gaps, and has significantly coarser spatial resolution than the RapidEye imagery.

The study area selected is the city of Fuzhou, the capital and one of the largest cities in Fujian Province, People's Republic of China. Significant change has occurred in this area and provides an excellent testbed for evaluating small subtle urban changes as well as larger, more apparent changes.

This presentation will discuss the costs and trade-offs of using either Landsat or RapidEye data in the CLC change analysis. While every project is unique, this information could aid in the decision-making process for future analysis. Each of the two datasets requires unique pre-processing steps before beginning the actual comparisons. Balancing the quality of the results against the cost, whether in financial or time resources, can affect the ultimate decision as to which type of data a user selects for a particular project.

#### **12.047**

##### **IN-Flight Performance Assessment of Imaging Systems Using the Specular Array Radiometric Calibration (SPARC) Method**

Stephen Schiller

The Specular Array Radiometric Calibration (SPARC) method fulfills two roles for in-flight sensor performance analysis that may not always be distinguished clearly. First, it addresses the basic concept of vicarious radiometric calibration and image quality analysis in the solar reflective spectrum. The technique provides data for deriving formula coefficients establishing a fixed relationship between raw detector response in digital numbers (DN) and output pixel values in absolute SI units along with spatial knowledge to take into account size-of-source effects. The second role is one of assessment. This refers to the temporal validation of the radiometric and spatial performance determining quantitatively how well the calibration is being maintained in the post launch environment over the life of the mission. In this presentation, attention will focus on the SPARC technique as an assessment tool to measure radiometric and spatial response stability. Such a performance assessment over time will depend on the consistency and reproducibility of the SPARC method over multiple collection events. The assessment of GeoEye's IKONOS sensor over a period of 2 years using the SPARC method will be described.

#### **12.048**

##### **Applications of Spectral Band Adjustment Factors (SBAF) for Cross-calibration**

Gyanesh Chander

SGT, Inc., contractor to the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center, Sioux Falls, SD, 57198, USA. Work performed under U.S. Geological Survey contract G10PC00044.

To monitor land surface processes over a wide range of temporal and spatial scales, it is critical to have coordinated observations of the Earth's surface acquired from multiple spaceborne imaging sensors. However, an integrated global observation framework requires an understanding of how land surface processes are seen differently by various sensors. This is particularly true for sensors acquiring data in spectral bands whose relative spectral responses (RSR) are not similar and thus may produce different results while observing the same target. The intrinsic offsets between two sensors caused by RSR mismatches can be compensated by using a spectral band adjustment factor (SBAF), which takes into account the spectral profile of the target and the RSR of the two sensors. The motivation of this work comes from the need to compensate the spectral response differences of multispectral

sensors in order to provide more accurate cross-calibration between the sensors. In this study, radiometric cross-calibration of the Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+) and the Terra Moderate Resolution Imaging Spectroradiometer (MODIS) sensors was performed using near-simultaneous observations over the Libya 4 Pseudo Invariant Calibration Site (PICS) in the visible and near-infrared (VNIR) spectral range. The RSR differences of the analogous ETM+ and MODIS spectral bands provide the opportunity to explore, understand, quantify, and compensate for the measurement differences between these two sensors. The cross-calibration was initially performed by comparing the Top-of-Atmosphere (TOA) reflectances between the two sensors over their lifetimes. The average percent differences in the long-term trends ranged from -5% to +6%. The RSR compensated ETM+ TOA reflectance (ETM+\*) measurements were then found to agree with MODIS TOA reflectance to within 5% for all bands when Earth Observing-1 (EO-1) Hyperion hyperspectral data was used to produce the SBAFs. These differences were later reduced to within 1% for all bands (except Band 2) by using Environmental Satellite (ENVISAT) SCanning Imaging Absorption SpectroMeter for Atmospheric Cartography (SCIAMACHY) hyperspectral data to produce the SBAFs.

### 12.049

#### **An introduction to the Skybox Earth-observation imaging platform**

Dirk Robinson (presenter), Dan Berkenstock, Julian Mann, John Fenwick, Mike Trela, Jonny Dyer, Ronny Votel

Skybox Imaging, an early-stage provider of timely overhead imagery and derived data, is scheduled to launch its first commercial, high-resolution Earth-observation optical imaging spacecraft, SkySat-1, in the fourth quarter of this year. The SkySat-1 payload departs from traditional architectures by leveraging a two-dimensional imaging array. In this presentation, we describe both our novel imaging architecture and our process for delivering both traditional image products as well as entirely new data products such as High-Definition video. We will explain our photogrammetric sensor model and review our progress and plans for calibrating and validating the products of our products as we prepare for our launch.

### 12.050

#### **Deimos-2: cost-effective, very-high resolution multispectral imagery**

Authors: Fabrizio Pirondini, DEIMOS Imaging S.L.U., Spain, Enrique Gonzalez, DEIMOS Satellite Systems, Spain  
Presenter: Fabrizio Pirondini

ELECNOR DEIMOS Imaging (Spain) owns and operates Deimos-1, the first Spanish Earth Observation satellite. Launched in 2009, it collects a 620km swath of 3-band, 22m resolution imagery. The Deimos-1 satellite is among the world leading sources of high resolution data, having provided yearly coverages of Africa to ESA-GMES in 2010-2011, bimonthly coverages of US Lower to USDA (through Astrium GEO-Information Services) during the 2011 crop season, and monthly coverages of Spain to the Spanish government.

ELECNOR DEIMOS is currently building the Deimos-2 satellite, which will be a very-high resolution, agile satellite capable of providing 1m PAN and 4m Multispectral (4 bands) imagery, with a 12km-wide swath. The whole end-to-end Deimos-2 system has been designed to provide a cost-effective and highly responsive service to cope with the increasing need of fast access to very-high resolution imagery.

The satellite is being developed together with SATRECI (South Korea), and it will be integrated and tested in the new ELECNOR DEIMOS Satellite Systems premises near Madrid, Spain. The ground segment, which includes a receiving/commanding ground station in Spain, is being completely developed in-house by ELECNOR DEIMOS. The development is on schedule, with PDR passed in May 2011 and CDR to be held in May 2012. The launch is planned for the end of 2013.

In this poster we will describe the main features of the Deimos-2 system, with details on the expected image quality and updated information on the development schedule.

### 12.051

#### **A Smallsat Mission Concept to Enhance Global Temporal Repeat Coverage at Landsat Resolution**

Darrel Williams

The Terrestrial Ecosystem Dynamics mission (TerEDyn, pronounced ‘terra’ ‘dine’) concept is an innovative multispectral Earth observation smallsat mission designed to augment Landsat by providing more frequent global temporal repeat coverage. TerEDyn is both low-risk and low-cost because it takes advantage of proven, high-heritage components in the instrument, spacecraft and ground segments.

## **12.075**

### **Characterisation of the sources of uncertainty over the Dome-C and Libya 4 Test Sites**

Steve Mackin

There is a growing need to reduce the uncertainties in the cross-calibration process over CEOS endorsed sites. As we move towards greater numbers of satellites operating as both true and virtual constellations, methodology is required to provide a uniform and accurate calibration so that satellites can be used interchangeably to provide high quality data both for climate studies, where there is the highest need for accuracy and many other application areas.

DMCii has been collecting large amounts of data over two specific and very different sites, the Dome-C snowfields of Antarctica which is an instrumented site and the Libya 4 Pseudo-Invariant Calibration Site (PICS) which is not instrumented. The problems faced for satellite data suppliers is to identify and remove any biases between different sensors. These may be inherent to the sensor calibration or in most cases related to the use of the calibration site itself. Key parameters related to the Atmospheric variations and surface variability (including BRDF) will be examined and the effects of these parameters on the accuracy of the calibration retrieval will be discussed.

### **2012 JACIE Planning Committee**

NASA: Kurt Thome, Karen Hoselle\*

NGA: Cal Hagan, Dave Case, Dave Kohlbrenner\*, Paul Bresnahan\*

USDA: Curt Reynolds

USGS: Greg Stensaas (chair), Mike Benson, Jon Christopherson\*, Carrie Jucht\*

\*Denotes contractor

**Thank You for attending the 2012 JACIE Workshop!**

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**JACIE 2013**

**Renaissance St. Louis Grand Hotel**

**St. Louis, MO**

**April 16 – 18, 2013**

Program compiled by Carrie Jucht, SGT, contractor to the USGS/EROS