JACIE

Joint Agency Commercial Imagery Evaluation

Civil Commercial Imagery Evaluation Workshop

March 16, 17, 18, 2010

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Contents

KEYNOTE SPEAKERS

Biographies

Deanna Archuleta

Deanna Archuleta is the Deputy Assistant Secretary for Water and Science in the Department of the Interior. As one of two Deputies in Water and Science, she works with Assistant Secretary Anne Castle to oversee the Bureau of Reclamation and the U.S. Geological Survey.

From January 2008 to April 2009, Archuleta served as board chair of the Bernalillo County (Albuquerque) Water Utility, overseeing the completion of the San Juan Chama Drinking Water Project, one of the largest treatment facilities in the United States. Archuleta also won two terms as a county commissioner in Bernalillo County, and was elected to serve as the chair of the commission in 2009, where she focused on economic development, health care, safety and quality of life initiatives, working to encourage local and national businesses to invest resources in the county, creating local jobs and stimulating the economy.

Before her appointment to the Department, Archuleta was the Southwest Regional Director for the Wilderness Society, engaging with local, state and federal elected offi cials as well as a wide variety of stakeholder groups to establish wild land protection throughout the region. She also served on President Elect Barack Obama's Transition Team in Washington, D.C.

Archuleta received a Master's Degree in Sociology from the University of New Mexico in 2000 and is currently finishing her doctoral degree in Sociology at UNM. She received Bachelor of Arts degrees in Sociology and Communications from the University of Washington in Seattle in 1997.

Franz Leberl

Franz Leberl grew up in Austria and received his degrees from Vienna University of Technology. He has worked in the Netherlands, California, Minnesota, Colorado and Austria. Today he is a chaired professor of Computer Science at Graz University of Technology in Graz.

Franz Leberl founded Vexcel Corporation in Boulder, Colorado in 1985 and Vexcel Imaging GmbH in Austria in 1993. Vexcel is the manufacturer of the UltraCam Digital Large Format Aerial Camera systems. He was CEO of the Austrian Research Centers from 1996 to1998 with 1000 employees. In the period 2000-2004 he was President of Commission III (Theory and Algorithms) of the International Society of Photogrammetry and Remote Sensing (ISPRS). His awards include the Otto-von-Gruber Medal from the ISPRS in 1976 and the Fairchild Award from ASPRS in 1991. He is a Fellow of the IEEE (1996). In 2005, he was awarded the Grand Decoration of Honor in Silver for Services to the Republic of Austria.

In May 2006, Vexcel Corp. and Vexcel Imaging GmbH were sold to Microsoft Corporation where Franz Leberl served as a Director of Microsoft Virtual Earth (2006-7). Now back full-time in academia, he is the Dean of Computer Science at Graz University of Technology (2008-2011). His research interests focus on 3D object reconstruction, perhaps best encapsulated by the idea of "wearable photogrammetric computer vision".

Mitch Goldberg

Dr. Mitchell D. Goldberg has extensive experience in the development and improvement of algorithms for deriving atmospheric temperature and moisture profiles and trace gases from satellite observations. He is the Chief of the Satellite Meteorology and Climatology Division at NOAA. The Division has a staff of more than 100 scientists providing the calibration and validation of NOAA satellite instruments, development of algorithms to derive geophysical parameters from satellite observations, training and outreach, and the transition of research to operations. He is a member of the competitively awarded NASA AIRS science team and EUMETSAT IASI Science Working Group, and contributes to both teams by developing and validating scientific algorithms for deriving atmospheric constituents from space-based hyperspectral infrared observations. He is a member of the NOAA Climate Board and the WMO Atmospheric Observations Panel for Climate (AOPC). He is currently the Program Manager for the GOES-R Algorithm Working Group and the Chair of the Global Space-based InterCalibration System(GSICS) and the climate coordinator for the Committee on Earth Observations from Satellites (CEOS). He has received several distinguish awards including two Department of Commerce Gold Medals and the University of Maryland Most Distinguished Alumnus Award.

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AGENDA

Tuesday, March 16, 2010

8:00 a.m.	Registration		
9:00 a.m.	Welcome:	Greg Stensaas	Remote Sensing Technologies Project Manager, USGS EROS
9:10 a.m.	Keynote:	Deanna Archuleta	Deputy Assistant Secretary for Water and Science
9:40 a.m.	Keynote:	Franz Leberl	Univ. of Graz, Austria
10:20 a.m.	**Break**		
10:35 a.m.	Keynote:	Mitch Goldberg	Chief, Satellite Meteorology and Climatology Division, Office of Research and Applications, NOAA/NESDIS

GOVERNMENT OVERVIEW SESSION

11:15 a.m.	USGS	Greg Snyder	Manager, Lidar Program Development Land Remote Sensing Program, USGS
11:40 a.m.	NGA	Dave Sedlak	NGA, Image Quality and Utility
12:05 p.m.	USDA	Glenn Bethel	USDA Remote Sensing Coordinator/Advisor

12:30 p.m. **Lunch** (provided with registration) Set up posters

GOVERNMENT OVERVIEW SESSION (cont.)

1:30 p.m.	NASA	Stuart Frye	SGT Inc. NASA/GSFC, Satellite Systems Engineer
1:55 p.m.	NOAA		

Tuesday, March 16, 2010, continued

2:20 p.m. **Panel Discussion: THE FUTURE of REMOTE SENSING - Moderator: Greg Stensaas**

3:40 p.m. **Break**

Session 1: **MEDIUM RESOLUTION SATELLITE IMAGERY - Chair: Bob Tetrault**

3:55 p.m.	10.019 (abstract number)	Gyanesh Chander	SGT, USGS/EROS	Cross-comparison of the IRS-P6 AWiFS sensor with the L5 TM, L7 ETM+, & Terra MODIS sensors
4:20 p.m.	10.045	Shawana Johnson, PhD	Global Marketing Insights, Inc.	USDA FAS and NGA Joint Project Produce Global Food Security Products based on Commercial Satellite Imagery
4:45 p.m.	Wrap Up	Mike Benson	USGS/EROS	
5:00 p.m.	Poster Session / Reception			

Wednesday, March 17, 2010

8:00 a.m. Registration

Session 1: **MEDIUM RESOLUTION SATELLITE IMAGERY (cont.) - Chair: Bob Tetrault**

8:30 a.m.	10.090	Deviprasad Karnik	Antrix	Resourcesat-2 Mission Status
8:55 a.m.	10.057	Mackin and Crowley	DMCii	Radiometric and Data Quality characteristics of the 2nd Generation Disaster Monitoring Constellation (DMC) satellites.
9:20 a.m.	10.058	Mackin and Chander	DMCii and SGT, USGS/EROS	Comparison of the radiometry of Landsat 7 and the Disaster Monitoring Constellation (DMC) satellites over the Dome-C Calibration site in Antarctica
9:45 a.m.	10.097	Paul Stephens, et al	DMC International Imaging Ltd.	Annual Tropical Forest Monitoring with the DMC Constellation
10:10 a.m.	**Break**			
10:25 a.m.	10.105	Dmitry Varlyguin	GDA corp	DMC Imagery Pre-processing and Analysis: User Experience
10:50 a.m.	10.065	Denis Naughton, et al	University of Arizona, Optical Sciences Center	RapidEye Vicarious Calibration and Radiometric Performance Assessment_2009
11:15 a.m.	10.010	Paul Bresnahan	Observera	Absolute Geolocation Accuracy Evaluation of RapidEye Level 1B and 3A Imagery
11:40 a.m.	10.021	Chander, et al	SGT, USGS/EROS	Radiometric & Geometric Assessment of the Data from RapidEye Constellation of Satellites

Wednesday, March 17, 2010, continued

12:05 p.m.	10.040	Alok Kumar Shrestha	SDSU	Relative Gain Characterization and Correction for Pushbroom Sensor Based on Lifetime Image Statistics

12:30 p.m. **Lunch** (provided with registration) Posters available for viewing

1:30 p.m.	10.120	Ayman Habib, PhD	University of Calgary	A Unified Conceptual Methodology for LiDAR and Camera System Calibration

Session 2: **HIGH RESOLUTION SATELLITE IMAGERY - Chair: Jon Christopherson**

1:55 p.m.	10.100	Brett Thomassie	Digital Globe	DigitalGlobe Satelite and Aerial Program Update
2:20 p.m.	10.043	Drew Hopwood	Spot Image Corporation	Spot Image Service Continuity: Preflight assessment of the Pleiades and SPOT programs
2:45 p.m.	10.073	Mary Pagnutti	Innovative Imaging and Research Corp. (I2R) and MSU	An Automated Tool to Estimate the Spatial Resolution of Products Acquired by High Spatial Resolution Remote Sensing Imaging Systems
3:10 p.m.	10.085	Byron Smiley	Digital Globe	The Absolute Geolocation Accuracy of DigitalGlobe's Satellites: QB02, WV01, and WV02

3:35 p.m. **Break**

3:50 p.m.	10.060	David Mulawa, et al	GeoEye	On-Orbit Geolocation Accuracy and Image Quality Performance of the GeoEye-1 High Resolution Imaging Satellite
4:15 p.m.	10.005	Paul Bresnahan	Observera	Absolute Geolocation Accuracy Evaluation of GeoEye-1 Stereo Triplets

Wednesday, March 17, 2010, continued

4:30 p.m.	10.015	Paul Bresnahan	Observera	Absolute Geolocation Accuracy Re-Evaluation of WorldView-1 Basic 1B Stereo Pairs
4:45 p.m.	10.080	Byron Smiley	Digital Globe	Relative Geolocation Accuracy Topics Relevant to DigitalGlobe's Multiband Satellites: Camera Calibration and Band to Band Registration
5:10 p.m.	Wrap up	Jon Christopherson	SGT, USGS/EROS	
5:20 p.m.	Adjourn			
6:00 p.m.	No Host Dinner (on your own) at Champps. Please join us.			

Thursday, March 18, 2010

8:00 a.m. Registration

Session 2: HIGH RESOLUTION SATELLITE IMAGERY (cont.) - Chair: Jon Christopherson

8:30 a.m.	10.022	Jon Christopherson, et al	SGT, USGS/EROS	Using newly built USGS Test Ranges for Geometric Assessment of GeoEye & Worldview-1
8:55 a.m.	10.107	Michael Vaughn	ITT Geospatial Systems	WV-2 Characterization and ICC Profiles

Session 3: AERIAL IMAGERY - Chair: Stephen White

9:20 a.m.	10.072	Mary Pagnutti for Bob Ryan	Innovative Imaging and Research Corp.	Laboratory and On-site Radiometric Calibration of Aerial Multispectral Digital Cameras
9:45 a.m.	10.070	Klaus Neumann		Radiometric calibration of digital aerial cameras
10:10 a.m.	10.075	Stephen Schiller	Raytheon Space and Airborne Systems	In-Flight Vicarious Calibration of High Spatial Resolution Remote Sensing Systems Using Specular Reflectors
10:35 a.m.	**Break**			
10:50 a.m.		Stephen White	NOAA	Digital Imagery Sensor Results, DSS Dual-Cam
11:15 a.m.	10.102	Charles Toth	The Ohio State University	Epipolar Resampling of Pushbroom Satellite Imagery

Session 4: OTHER IMAGING SENSORS (LiDAR, RADAR, SAR, etc.) - Chair: Kurt Thome

11:40 a.m.	10.035	Timothy F. Donato, et al	MDA Fed	RADARSAT-2 Applications for Civil and Commercial Situational Awareness
12:05 p.m.	10.095	Gordon Staples, et al	MDA Geospatial Services	RADARSAT-2: 2009 Agricultural Campaign

Thursday, March 18, 2010, continued

12:30 p.m.	**Lunch** (provided with registration) Take posters down			
1:30 p.m.	10.030	Gian Rocco Verdone for Luciana Di Domenico	COSMO-SkyMed Commercial-ization	The COSMO-SkyMed Satellite Constellation for Earth Observation and applications
1:55 p.m.	10.059	Steve Mackin	DMCii	QA4EO Compliant QA/QC system for automated quality control of large satellite Constellations
2:20 p.m.	10.025	Jeff Czapla-Myers, et al	U. Arizona	Analysis of the Automated Radiometric Calibration Test Site at Railroad Valley, Nevada
2:45 p.m.	**Break**			
3:00 p.m.	10.018	Matthew Polder, et al	Various	Investigation of the LSpec autonomous ground calibration site using MODIS, Landsat ETM+, and IKONOS.
3:25 p.m.	10.055	Sherry Loy	Global Marketing Insights, Inc	Successful INTRA - Agency Collaborations Based on Commercial Imagery and Products
3:40 p.m.	Conference wrap-up, Greg Stensaas, USGS - Drawings, must be present to win!			
4:00	Adjourn			

PRESENTERS

Biographies

Michael Benson

Mike currently works on the Remote Sensing Technologies Project at USGS EROS supporting 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 in Imaging Science from Rochester Institute of Technology in 1976.

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Glenn Bethel

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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Paul Bresnahan

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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Gyanesh Chander

Gyanesh Chander received the M.S. degree in Electrical Engineering from South Dakota State University (SDSU), Brookings, in 2001. 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 on-going radiometric projects. He is leading the Group on Earth Observations (GEO) task DA-09-01a_8 to establish a catalog of prime candidate worldwide test sites for the post launch characterization and calibration of space-based imaging sensors.

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Jon Christopherson

Jon Christopherson works at the USGS EROS Center as a contractor for SGT, Inc. He holds degrees in 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, development of a Quality Assurance Plan for Digital Aerial Imagery along with supporting infrastructure, as well as other tasks across the broad spectrum of remote sensing.

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Jeff Czapla-Myers

Jeff Czapla-Myers completed a Ph.D. in Optical Sciences in 2006. He is currently an Assistant Research Professor with the Remote Sensing Group (RSG) at the College of Optical Sciences at the University of Arizona. His research interests include absolute calibration of Earth-observing sensors, radiometry, instrumentation, and optical design. Current research efforts are focused on automating the ground-based calibration work performed by RSG at the Railroad Valley test site in central Nevada.

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Stuart Frye

Stu Frye is a satellite systems engineer working at the NASA Goddard Space Flight Center (GSFC) and Principal Investigator on Sensor Web technologies that link Earth Observation satellites, aerial and in-situ systems, forecast and nowcast models, and regional/local socio-economic data into an interoperable set of disaster management components and services. He has a Bachelors Degree in Mathematics from the University of California and a Masters Degree in Operations Research from the George Washington University.

Stu is the point of contact for Group on Earth Observations task DI-09-02B_1 and project manager for Regional End-to-End Disaster Pilots coordinating the Committee on Earth Observation Satellites Strategic Implementation Team Disaster Management working group and the NASA Earth Science Technology Office Sensor Web activities. He serves as the technology liaison with the SERVIR project, UN-SPIDER, World Bank, International Red Cross, and other aid and relief organizations to infuse standard web services that provide open access to critical disaster management information, data, and maps via the internet using common desktop tools. Stu was co-winner of the R&D 100 Award in 2008 for the Sensor Web 2.0 technology development and won the 2005 NASA Software of the Year award for his role in the Autonomous Sciencecraft Experiment on-board the EO-1 satellite.

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Dr. Ayman F. Habib

Dr. Ayman F. Habib research interests span the fields of terrestrial and aerial mobile mapping systems, modeling the perspective geometry of non-traditional imaging scanners, automatic matching and change detection, automatic calibration of low-cost digital cameras, object recognition in imagery, LiDAR mapping, and integrating photogrammetric data with other sensors/datasets (e.g., GPS/INS, GIS databases, multi- and hyper-spectral sensors, and LiDAR).

Over the last 10 years. Dr. Habib has supervised 20 graduate students to completion and he is the recipient of several awards such as the Duane C. Brown Senior Award from The Ohio State University (1997), Talbert Abrams "Grand Awards" from the American Society of Photogrammetry and Remote Sensing (ASPRS) in 2002 and 2008, Talbert Abrams "Second Honorable Mention" from the ASPRS in 2004, Best Paper Award from the International Society of Photogrammetry and Remote Sensing (ISPRS) in 2004, and Talbert Abrams "First Honorable Mention" from the ASPRS in 2008.

Dr. Habib has authored more than 200 publications and has been serving as an editorial board member for several national and international journals. His research work in the area of digital camera calibration and stability analysis has been commercialized and implemented by national and international companies in Canada, USA, Korea, Brazil, South Africa, and Taiwan.

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Drew Hopwood

Drew Hopwood has been with Spot Image since 2004, where he was originally a member of the satellite programming team. While working on that team, he designed, implemented, and supervised large collection campaigns over North America. Since becoming a project manager in 2007, he has managed a variety of projects, as well as working with the business development team to create new and innovative solutions. Drew currently holds a Bachelor of Science degree in Geography from George Mason University.

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Dr. Shawana Johnson

Dr. Shawana Johnson possesses twenty-five years of Strategic Planning and Market Research experience to the Hi-Tech Information and Geospatial Technology Industry including General Electric and Lockheed Martin.

Dr. Johnson received her Doctorate Degree in Management from Case Western Reserve University, The Weatherhead School of Management, Cleveland, Ohio where her specialty was Global Economics and Technology Transfer. Dr. Johnson is a Certified Geographic Information Systems Professional (GISP) having met the standards and requirements of the GIS Certification Institute.

At Global Marketing Insights Inc., she serves as President to an international client base providing Strategic Plans, Market Research and Sales and Marketing Services to Federal/National government agencies, state agencies, Satellite/Aerial Sensor Producers, Satellite/Aerial Data Providers and Value Added Data Providers.

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Mr. Deviprasad Karnik

Deviprasad Karnik earned his Bachelor of Engineering Degree (Specialization in Electronics and Communication) from the University of Mysore in India in 1984. Soon after graduation, he joined the Indian Space Research Organization (ISRO) starting his carrier at ISRO's Satellite Centre (ISAC) in Bangalore, India. During the period 1984 – 2008, Mr. Karnik actively contributed to the Environmental testing of Spacecraft hardware and integrated spacecrafts which were made by ISAC. He was also responsible for setting up new environmental testing facilities, manning, maintenance and upkeep of the environmental test facilities at ISAC. Mr. Karnik has actively contributed to various policy level committees of ISRO.

On May 30, 2008 Mr. Karnik joined the Embassy of India, Washington, DC as Counsellor (Space) / ISRO Technical Liaison Officer. In his present capacity, he looks after International Cooperation with NASA/ NOAA and International Space Agencies and Institutions, marketing of ISRO's products and processes besides public relations.

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Sherry Loy

Sherry has been worked for Global Marketing Insights, Inc. for seven years and is a Senior Program Manager. She has an extensive background with 15 years of experience in Project Management, Information Technology and Proposal Development with State and Federal Agencies and Geo-Spatial technology companies.

Sherry has completed studies in Communication Methodology, Market Research principles and has completed a two-year intensive program at Crosby Quality College by Phillips Crosby and Associates focused on quality development and measurement for internal operations and external customer requirements. She has completed several ESRI GIS and Remote Sensing courses and well as completed NASA programs for Small Business Innovation Research technology grants and the Development of Cooperative Research and Development Agreements.

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Dr. Stephen Mackin

Steve Mackin is Chief Scientist for DMC International Imaging. A geologist by training he has been working in Remote Sensing for 25 years for British Petroleum, the British National Space Centre, DLR in Germany and various Universities in Spain and the UK. Interests include hyperspectral remote sensing, application development in general, computer programming and of course calibration and Quality Assurance / Quality Control of earth observation data.

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David Mulawa, PhD

David Mulawa is employed by GeoEye and supports the geolocation accuracy performance for the GeoEye-1 satellite. He has 19 years of experience in photogrammetric R&D and working with systems engineering. He has performed the on-orbit geometric camera calibration of the GeoEye-1 and OrbView-3 satellites. He has received an M.S. degree in Geodesy and a Ph.D. degree in Photogrammetry from Purdue University.

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Denis Naughton

Denis Naughton is a Payload System Engineer supporting sensor calibration and validation efforts at RapdiEye AG. He has participated in the development of a number of commercial and governemnt payload systems that include the IKONOS payload while at Eastman Kokak Company and the COMPASS hypserspectral imaging spectrometer while at the US Army Night Vision Laboratory. He received his M.S degree in optical engineering from the University of Rochester and a B.S degree in physics from the Catholic University of America in Washington, D.C .

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Klaus J. Neumann

Klaus has a Master Degree in Electronic Engineering from the University of Applied Science in Aalen, Germany. He has been working more than 20 years for Carl Zeiss, Z/I Imaging and Intergraph. He had been involved in hardware and software design of high precision scanners and aerial mapping cameras. He is now worldwide responsible within Z/I Imaging for sensor system product management. He is a worldwide acknowledged expert for aerial camera systems.

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Mary Pagnutti

Ms. Mary Pagnutti has over 25 years of engineering experience ranging from large aerospace defense projects to civil remote sensing applications. From 1998-2007 Ms. Pagnutti supported NASA Stennis Earth Science programs where she helped to build a nationally recognized in-flight calibration/validation capability. In 2007 Ms. Pagnutti co-founded Innovative Imaging and Research, a company focused on developing technologies that integrate solid state lighting and imaging systems. Most recently Ms. Pagnutti joined the Mississippi State University Geosystems Research Institute team as a part time research faculty member in support of their small satellite initiative.

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Matthew Polder

Matthew Polder received a BS degree in Physics from Brigham Young University in 1995 and a MS degree in Physics from University of California, Irvine in 1998. He worked for Raytheon Systems from 1999 to 2000 in software development. From 2000 to 2006 he worked for ITT Space Systems (formerly Eastman Kodak) where he developed multispectral and hyperspectral atmospheric, calibration, and other algorithms, requirements and software development, image processing, and training. From 2006 to the present he has worked for Lockheed Martin where he has focused primarily on radiometric calibration, atmospheric simulation, systems engineering, and tool development.

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Stephen Schiller

Stephen Schiller is currently employed as a systems engineer at Raytheon Space and Airborne Systems, El Segundo, CA developing in-flight calibration and validation methods for space-based and airborne imaging systems. He was a co-founder (with Dennis Helder) of the vicarious calibration program at South Dakota State University supporting numerous NASA and USGS remote sensing programs including the NASA/JACIE Commercial Satellite Calibration program in 2000/2001. Stephen received his Ph.D. in Astrophysics from the University of Calgary, Canada; M.S. degree in Astronomy from Ohio State University and a B.S. degree in Physics from Walla Walla University.

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Alok Kumar Shrestha

Alok Kumar Shrestha received his Bachelor degree in electronics and communication engineering from Institute of Engineering (Tribhuvan University, Nepal) and currently enrolled in the M.S. degree in electrical engineering at South Dakota State University, USA. His past experience includes working with Code Division Multiple Access (CDMA) based switching equipments. Shrestha has been working as a research assistant at the SDSU Image Processing Laboratory, since 2007, and has been involved with the radiometric calibration of satellite sensors. He is currently engaged with the relative radiometric calibration of pushbroom sensors (Advanced Land Imager) based on lifetime image statistics and de-striping using the wavelet filtering.

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Dr. Byron Smiley

Dr. Byron Smiley received his physics Ph.D. in May 2002 from the University of Colorado at Boulder. He became involved with satellite remote sensing starting in Aug 2004 when he joined DigitalGlobe as a geolocation analyst. At the time, he worked just with QuickBird-2 (QB02) data. In Sep 2007, when DigitalGlobe launched the WorldView-01 (WV01) satellite, Byron's role at DigitalGlobe expanded to include the monitoring of WV01's absolute geolocation accuracy like QB02. He also had to calibrate the PAN band of WV01 to remove relative geolocation issues like warping and distortion. He now monitors the absolute geolocation accuracy of the three high resolution satellites at DigitalGlobe: QB02, WV01, and WV02.

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Greg Snyder

Greg Snyder manages lidar program development in the USGS Land Remote Sensing Program and is now helping to frame a national lidar plan. Previously he helped implement U.S. commercial remote sensing space policy across Federal civil agencies, served on the USGS Director's staff, and performed market research to evolve USGS cartographic products. Prior to USGS, Greg served as a research photogrammetrist in NOAA's Nautical Charting R&D Lab. He received a BA in Geography from the University of Oregon and a Masters of Science, in Mapping Science, from the Department of Geodetic Science and Surveying at The Ohio State University.

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Gordon Staples

Gordon Staples received the M.Sc. degree in physical oceanography and the B.Sc. degree in honours physics from the University of British Columbia. He joined MDA in 1993 and is currently Senior Technology Manager, Strategic Development, for Geospatial Services. In this role, he is responsible for RADARSAT-2 polarimetry research, management of research projects, development and delivery of radar training, and strategic technical initiative, He is also the Program Manager for the RADARSAT-2 Science and Operational Applications Research Program.

Mr. Staples currently serves on the Executive Committee of the Canadian Remote Sensing Society, and served on the Canadian National Committee of the International Radio Science Union (1999-2007). He is also a member of the IEEE and IGU.

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Gregory L. Stensaas

Gregory L. Stensaas graduated from South Dakota State University with a Bachelor of Science degree in Mechanical Engineering, and has taken post graduate classes at the University of Nebraska–Lincoln and Dakota State University. Greg has 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.

Greg experience also includes being principle engineer for the NASA Earth Observing System Distributed Active Archive Center and systems engineer for the U.S. Geological Survey (USGS) Landsat Data Continuity Mission at the National Center for Earth Resources Observation and Science (EROS).

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 film and digital sensor calibration, satellite calibration, and system/product characterization.

Greg is a co-chair of the Joint Agency Commercial Imagery Evaluation (JACIE) program and the chair of the Inter-agency Digital Imagery Working Group. He is currently the Primary Data Acquisition Division (PDAD) Director for the American Society of Photogrammetry and Remote Sensing (ASPRS) and the vice chair of the Committee on Earth Observation (CEOS) Working Group on Calibration and Validation (WGCV).

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J. Paul Stephens

Director of Sales & Marketing for DMC International 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 1st 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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Robert L. Tetrault

Bob has over fifteen years experience in the application of remote sensing technology to agriculture in both the government and private sector. He became the USDA's satellite imagery archive program manager in 2005. He has helped USDA transition from the Landsat satellites series to the Indian satellite ResourceSat-1 and is working on alternative sensors.

Bob is the USDA's point of contact for the satellite imagery archive for acquiring data within the archive and for ordering new data. He works with both government partners and the commercial satellite imagery vendors. Bob's previous work experiences include business development at the commercial company Resource21 and for the FAS Office of Global Analysis as a crop analyst for Argentina and other parts of South America.

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Brett P. Thomassie

Mr. Thomassie has over twenty-five years experience in the remote sensing/GIS industry and joined DigitalGlobe in 1999. He assumes overall responsibility for managing DigitalGlobe's Federal/State/Local Civilian Government sales segment as well as leading the DigitalGlobe Mississippi Operations Office located at Stennis Space Center, Mississippi. Prior to joining DigitalGlobe, Mr. Thomassie was a Program Manager for 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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Kurtis J. Thome

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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Dr. Charles Toth

Dr. Charles Toth is a Senior Research Scientist at the Ohio State University Center for Mapping. He received an MS in Electrical Engineering and a Ph.D. in Electrical Engineering and Geo-Information Sciences from the Technical University of Budapest, Hungary. His research expertise covers broad areas of 2D/3D signal processing, spatial information systems, photogrammetry, high-resolution imaging, surface extraction, modeling, integrating and calibrating of multi-sensor systems, multi-sensor geospatial data acquisition systems, and mobile mapping technology. He is the National Director of EGLR of American Society of Photogrammetry and Remote Sensing, and chairing ISPRS WG I/2 on LiDAR and InSAR Systems, and serves on the Board of ASPRS since 2002. He has published over 200 papers in various journals and proceedings, and most recently, co-edited the first book dedicated to LiDAR technology. He led over 20 research projects sponsored by DoD, NASA, NGA, NSF, Federal DOT, Ohio DOT, etc. He is the recipient of *The Photogrammetric Award (Fairchild)* 2009, *OSU College of Engineering Lumley Research Award* 2008, and *Lumley Interdisciplinary Award* 2007.

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Dr. Dmitry L. Varlyguin

Dr. Varlyguin is Vice President & Chief Scientist at GDA Corp. He has over 15 years of experience working with GIS and image processing systems and a range of commercial and public remotely sensed data. Dr. Varlyguin's previous job related experience includes the position of Research Scientist at the University of Maryland, College Park, the Clark Labs for Cartographic Technology and Geographic Analysis, the George Perkins Marsh Institute, and the Russian Academy of Sciences, in Moscow, Russia. His research interests include: automated analysis of Remotely Sensed data, combined spectral, spatial, and contextual image processing, and the design of iterative, self-learning expert systems.
Dr. Varlyguin received his B.S. and M.S. from Moscow State University and his Ph.D. from Clark University in Worcester, MA.

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Michael Vaughn

My name is Michael Vaughn and I work in the Image Science Center of Excellence at ITT Corporation Geospatial Systems Division, headquartered in Rochester, NY. I received my Bachelor's in Electrical Engineering and Master's in Image Science from the Rochester Institute of Technology. I manage a group of engineers whose primary focus is on the ground processing of remotely sensed sensors as well as airborne platforms. My major focus area is in color science. I have helped to establish a standardized color processing architecture for the processing of remotely sensed imagery (this architecture will be used for airborne systems as well) that is based off the commercial model that I successfully deployed for the processing of professional digital cameras.
I recently led an effort to deploy ground truth targets for the characterization of the WV-2 sensor. This ground truth collection effort will enable better utilization of the WV-2 imagery. Our team has been working to establish this characterization effort into a software application that will enable users to take advantage of a color managed environment.

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Gian Rocco Verdone

Gian Rocco Verdone is employed by e-GEOS S.p.A. He is the Manager of the Product Line of Earth Observation Services in e-GEOS, with the responsibility to define and manage the services of data downlink and products generation at the e-GEOS Matera Station. In COSMO-SkyMed scope he supports the added values product lines in the data exploitation and he is involved in the quality control of images and in the geo-location assessment of the mission.

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ABSTRACTS

(numeric order)

NASA

NASA Web Services Technology Development for Autonomous Asset Tasking and Customized Data Delivery

Abstract: Coordination of satellites to observe event driven targets is still primarily based on telephone calls and Emails between those in the know. NASA is developing technology to improve coverage of disasters, ground-truth science campaigns, and other observations for societal benefit that automate many of these interfaces and is collaborating efforts across civilian, military, and commercial satellite providers to prototype these capabilities. The collaboration is based on standardized web services that provide the ability to combine predictive models, nowcast low resolution observations, triggered high resolution observations, and rapid product/map delivery from a sensor web of satellites, aerial systems, and in-situ data gathering. Web service standards are based on Open Geospatial Consortium specifications and are vetted in pilot and testbed activities on a global scale. These activities are coordinated through the Committee on Earth Observation Satellites and satisfy Group on Earth Observations work plan requirements. Satellite collaborators include NASA, NOAA, USGS, DLR, ESA, CSA, and JAXA. The work addresses needs of UN, World Bank, USAID, Red Cross, and other international organizations and involves regional centers of excellence and national partners from the Caribbean and Southern Africa regions in pilot calibration and validation efforts.

Stuart Frye

10.005

Absolute Geolocation Accuracy Evaluation of GeoEye-1 Stereo Triplets

The National Geospatial-Intelligence Agency (NGA) 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 NGA CCAP evaluation process is the assessment of geolocation accuracy. CCAP assessed the absolute geolocation accuracy of GeoEye-1 stereo triplets, using the middle image for a monoscopic assessment and the fore and aft images for a stereo assessment. CCAP presents the results of the assessments and compares them to vendor-stated specifications and expected performance.

Paul Bresnahan

10.010

Absolute Geolocation Accuracy Evaluation of RapidEye Level 1B and 3A Imagery

The National Geospatial-Intelligence Agency (NGA) 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 NGA CCAP evaluation process is the assessment of geolocation accuracy. CCAP assessed the absolute geolocation accuracy of RapidEye Level 1B and Level 3A images. CCAP presents the results of the assessments and compares them to vendor-stated specifications and expected performance.

Paul Bresnahan

10.015

Absolute Geolocation Accuracy Re-Evaluation of WorldView-1 Basic 1B Stereo Pairs

The National Geospatial-Intelligence Agency (NGA) 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 NGA CCAP evaluation process is the assessment of geolocation accuracy. CCAP assessed the absolute geolocation accuracy of WorldView-1 Basic 1B stereo pairs collected by DigitalGlobe using a scan rate of 24,000 lines per second. CCAP presents the results of the assessment and compares the results to vendor-stated specifications and expected performance.

Paul Bresnahan

10.018

Investigation of the LSpec autonomous ground calibration site using MODIS, Landsat ETM+, and IKONOS.

The LSpec site in Nevada was established in late 2006 as an unattended target facility to support vicarious calibration of visible and near-infrared remote sensing instruments. The key LSpec data include autonomous measurements of the in band playa reflectance values taken at near-nadir viewing conditions every five minutes throughout the day, and aerosol characterization data derived from an on-site sun photometer that is part of the Aeronet network. The use of LSpec as a vicarious calibration site is explored using MODIS, Landsat 7's ETM+, and IKONOS and by comparing LSpec results to those using Railroad Valley.

Carol Bruegge, Mark Helmlinger, Northrop Grumman, Martin Taylor, Matthew Polder, George Cipperly, Ellis Freedman

10.019

Cross-comparison of the IRS-P6 AWiFS sensor with the L5 TM, L7 ETM+, & Terra MODIS sensors

As scientists and decision makers increasingly rely on multiple Earth-observing satellites to address urgent global issues, it is imperative that they can rely on the accuracy of Earth-observing data products. This paper focuses on the cross-comparison of the Indian Remote Sensing (IRS-P6) Advanced Wide Field Sensor (AWiFS) with the Landsat 5 (L5) Thematic Mapper (TM), Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+), and Terra Moderate Resolution Imaging Spectroradiometer (MODIS) sensors. The cross-comparison was performed using image statistics based on large common areas observed by the sensors within 30 minutes. Because of the limited availability of simultaneous observations between the AWiFS and the Landsat and MODIS sensors, only a few images were analyzed. Regression curves and coefficients of determination for the top-of-atmosphere (TOA) trends from these sensors were generated to quantify the uncertainty in these relationships and to provide an assessment of the calibration differences between these sensors.

Gyanesh Chander

10.021

Radiometric & Geometric Assessment of the Data from RapidEye Constellation of Satellites

Cross-comparison was performed between RapidEye sensors from data acquired over Libya-4 site from the five platforms. The top-of-atmosphere (TOA) reflectance data from RapidEye sensors were also compared with the Landsat sensors. Cross-comparison was performed with image statistics based on large common areas observed near-simultaneously by the two sensors. Geometric assessment was performed to study the positional accuracy and relative band-to-band alignment of the image datasets. The position accuracy was assessed by measuring the RapidEye imagery against high resolution aerial imagery, while the band-to-band characterization was performed by registering each band against every other band to ensure that the proper band alignment is provided for an image product.

Md. Obaidul Haque, Gyanesh Chander, Aparajithan Sampath

10.022

Using newly built USGS Test Ranges for Geometric Assessment of GeoEye & Worldview-1

The U.S. Geological Survey (USGS) has developed the first of a series of geometric test ranges over Sioux Falls, South Dakota. The purposes of these test ranges are for evaluating, validating and characterizing high resolution satellite and aerial images. The test range uses accurate and standardized high resolution aerial orthophotos as a reference dataset to compare and characterize the geometric accuracy of satellite and aerial images. This presentation provides a report on the characteristics of the test range and the accuracy of the reference data, along with the results of geometric assessment performed using the test range on high resolution data collected from GeoEye & Worldview-1.

Aparajithan Sampath, Gyanesh Chander, Ronald Hayes, Jon Christopherson

10.025

Analysis of the Automated Radiometric Calibration Test Site at Railroad Valley, Nevada

The Remote Sensing Group (RSG) at the University of Arizona has developed a methodology and corresponding instrument suite to measure the surface reflectance of radiometric calibration test sites. Railroad Valley Playa in central Nevada is the current location of the Radiometric Calibration Test Site (RadCaTS), where the automated system is currently in operation on the 1-km^2 large-footprint site. Prototype ground-viewing radiometers are used in combination with a Cimel Sun photometer and meteorological station to determine the top-of-atmosphere radiance for a given overpass through the use of a modified version of the MODTRAN radiative transfer code. The objective of RadCaTS is to preserve RSG's current level of uncertainty while increasing the number of data sets collected in the absence of ground-based personnel.

The work presented here explores the uncertainty in the instrumentation and methodology used to determine the surface reflectance and top-of-atmosphere radiance. The surface reflectance results are compared to those obtained using ground-based personnel, and top-of-atmosphere radiance results are compared to those obtained from spaceborne sensors. Results include the analysis of the ground-viewing radiometer locations, a comparison of results using Landsat-7 ETM+ and MODIS, and a temporal study of the radiometer calibration coefficients using the solar-radiation-based calibration (SRBC) methodology.

Jeff Czapla-Myers, Nathan Leisso, and Nikolaus Anderson

10.030

The COSMO-SkyMed Satellite Constellation for Earth Observation and its Applications

The COSMO-SkyMed constellation of 4 high definition satellites for Earth Observation will be the most advanced system for monitoring the Environment. The first three satellites were launched in June 2007, December 2007 and October 2008. The last satellite is scheduled for launch in early 2010 and preparations for the 2nd Generation of satellites is underway.
In its full constellation mode, the 4 satellites will be able to image any area on Earth at least daily regardless of cloud cover and day/night. Cosmo SkyMed, with its multi mode acquisition capability, with resolutions up to 1 metre, can be integrated in several operational services increasing the geospatial information content.

Satellite data have been integrated in many operational geospatial services for both maritime and land applications. The high revisit capability of the COSMO-SkyMed constellation of 4 satellites coupled with the all weather capability and it day and night operations makes it the ideal tool for monitoring activities.
The aim of this presentation is to provide:

- Some of the operational use that is currently made of orbiting SAR satellites
- A description of the operational improvements that COSMO-SkyMed will bring to the geospatial information content
- The results of the validation campaigns done over several test areas in order to determine the overall accuracy of the COSMO-SkyMed products

Luciana Di Domenico

10.035

RADARSAT-2 Applications for Civil and Commercial Situational Awareness

With the recent launches of COSMO-SkyMed, RADARSAT-2, and TerraSAR-X a new era in space-based imaging radar observations has been initiated. Like their electro-optical counterparts, IKONOS, QUICKBIRD, Geoeye-1, and Worldview-1/2, these SAR systems provide high resolution space-borne imagery for a variety of geospatial applications. In this presentation several current SAR applications are discussed including:

1) The SAR augmentation of multispectral ground cover classification in cloudy regions
2) Coherent polarimetric change detection for maritime situational awareness
3) Rapid environmental assessment for the oil and gas industry

Timothy F Donato, Marco van der Kooij, William Jefferies, Jeff Hurley, Mike Diller, Cynthia Darce

10.040

Relative Gain Characterization and Correction for Pushbroom Sensor Based on Lifetime Image Statistics

For an ideal pushbroom sensor, a uniform image will be produced when the sensor views a uniform radiance target. However, detector arrays manufactured using the same material may respond differently to the same incoming radiance level due to their operating conditions, manufacturing defects, material inhomogeneities, optical aberrations, and/or launch stress. The effective result is variability in sensor response; thus images acquired by such sensors contain stripes and other image artifacts. To correct striping from the image, the effect of detector-to-detector non-uniform response must be minimized. Historically, with whiskbroom scanners, this has been achieved by estimating the relative gains of detector arrays using histogram equalization on individual scenes. However, for pushbroom scanners, statistics from a sufficiently large number of scenes are needed. This paper characterizes the relative gains for pushbroom sensors by identifying the type of scene that produces the best set of relative gains. Different categories of scenes were defined based on the scene mean and standard deviation, and relative gains were estimated from the statistics of each category. These different relative gains were then applied to imagery acquired by the Advanced Land Imager (ALI) sensor, and the best set was determined by analyzing the different relative gain corrected scenes. The analyses were performed qualitatively using visual comparison and quantitatively using a striping metric. The relative gains estimated from high-mean, high-standard deviation (HMHSD) scenes were identified as the optimal category for reducing striping.

Alok Kumar Shrestha, Dennis L. Helder

10.043

Spot Image Service Continuity: Preflight assessment of the Pleiades and SPOT programs

Spot Image, a worldwide leading provider of geospatial information from Earth observation satellites, will launch four satellites over the next four years. The first two are the twin Pléiades satellites, by operating as a true constellation users will have daily access to 50 cm ortho color products. Next on the launch pad will be SPOT 6 and 7, which will continue to provide users with the mid-resolution and large swath (60km) data they have become accustomed to using from the SPOT family of satellites.

We will present the status of both the Pleiades and SPOT6&7 programs. Providing an in-depth review the capabilities and specification for the Pleiades program, along with preflight testing results of the Pleiades-1 satellite scheduled to launch in Fall 2010. We will review the capabilities the Pleiades' system offers users, including direct tasking and the standard ortho data product. Finally we will discuss our path forward for the calibration of the system post launch.

Drew Hopwood

10.045

USDA FAS and NGA Joint Project Produce Global Food Security Products based on Commercial Satellite Imagery

The successful results of the Interagency collaboration between the National Geospatial-Intelligence Agency (NGA) and the U.S. Department of Agriculture, Foreign Agricultural Service (USDA FAS) in predicting the Iraq drought early enough for Iraqi government officials to avert a famine by arranging for food shipments to the impacted areas led to an expanded four country follow-on project in the 2008-2009 growing year and the 2009-2010 crop marketing year.

The goal of this next project was to develop new remote sensing processes for assessing crop health and predicting harvest yields in growing regions where minimal ground condition information is available utilizing the USDA FAS three-tier data methodology and a convergence of evidence.

Human observations can never be replaced entirely, although high-resolution satellite imagery often used by NGA for intelligence purposes was integrated successfully into existing FAS processing methodologies. Project findings/successes will be highlighted in this presentation along with an overview of the system hosting the project results.

The results of the project are displayed GEOINT Online which is an on-line, on-demand discovery of and access to geospatial intelligence (GEOINT) content, services, expertise, and support. GEOINT Online is an element of the strategy to transform NGA from solely a product producer to a GEOINT Services Provider with integrated access to GEOINT content, services, expertise and support.

The USDA FAS OGA GEOINT Online Community Site is utilized to display the success and results of the joint project between NGA and the USDA FAS. Accessing this community site provides project-related articles and papers, as well as crop analysis data.

Dr. Shawana P. Johnson

10.055

Successful INTRA - Agency Collaborations Based on Commercial Imagery and Products

The USDA Foreign Agricultural Service, Office of Global Analysis (OGA), International Production Assessment Division, IPAD is responsible for global crop condition assessments and estimates of area, yield, and production for grains, oilseeds, and cotton. Their primary mission is to target, collect, analyze, and disseminate timely, objective, useful, and cost-effective global crop condition and agricultural market intelligence information.

In 2000, FAS developed a USDA Satellite Imagery Archive (SIA) library located at FAS. The SIA is a cost sharing program to maximize the cost effectiveness of USDA expenditures for commercial satellite imagery. The SIA is a data partnership between the Foreign Agricultural Service, Farm Service Agency, Forest Service, National Agricultural Statistics Service, the Agricultural Research Service, The Natural Resources and Conservation Service, the Risk Management Agency and the Animal Plant Health Inspection Service. The SIA is a cost-sharing program to maximize the cost effectiveness of USDA expenditures for satellite imagery and expand the availability of global satellite imagery to the USDA community. Through centralized purchasing and a low cost-business model, participating USDA agencies get access to a large database of domestic and international satellite imagery. This allows the USDA agencies to take advantage of contracts already in place and benefit from the significantly lower prices. The SIA has a global imagery database of more than 35,000 satellite images dating back to 1979. The USDA Satellite Imagery Archive has saved the USDA millions of taxpayer dollars since 2000 by removing redundant satellite imagery purchases and lowering costs through a centralized acquisition business model.

As economic pressures continue to grow, from globalization, population pressures, resource depletion, global warming, etc., the demands for Global Food Security products has raised 100 fold over the past few years and this interagency collaboration helps meet that demand. The successful result of the Satellite Imagery Archive has led to the further development of the site through the Archive Management and Hosting Capability of commercial company i-Cubed, Ft. Collins, CO allowing greater agency access to advanced products.

This presentation will focus on the methods which the agency relationship were developed and how the Satellite Imagery Archive and availability to commercial products is accessed.

Sherry Loy

10.057

Radiometric and Data Quality characteristics of the 2nd Generation Disaster Monitoring Constellation (DMC) satellites.

In late July 2009, two new 2nd Generation DMC satellites were launched with 22m GSD with bands equivalent to Landsat bands 2, 3 and 4. These satellites show a marked improvement in spatial resolution and data quality compared to the first generation systems.

In this presentation the data quality and overall calibration stability of the 2nd generation DMC satellite systems is compared to the 1st generation systems which still form part of the constellation.

Direct comparisons in terms of Signal to Noise, effective Spatial Resolution (MTF) and CCD stability will be given. The absolute calibration and relative satellite to satellite inter-calibration will also be described and the uncertainties of the derived data products will be evaluated.

Steve Mackin, Gary Crowley

10.058

Comparison of the radiometry of Landsat 7 and the Disaster Monitoring Constellation (DMC) satellites over the Dome-C Calibration site in Antarctica

A CEOS sponsored intercomparison between satellite systems took place over the Dome-C site in the austral summer of 2008-2009. A summary of the results of the intercomparison between Landsat 7 and the first generation DMC satellites will be given, with emphasis on the importance of dealing with non-isotropic nadir reflectance due to the BRDF of the surface and atmospheric ozone variations.

The study shows that without suitable correction, even when computing TOA reflectance values for intercomparison between satellites, that single date intercomparisons can have large biases when suitable correction of BRDF and ozone are not incorporated. This has consequences for intercomparisons over CEOS non-instrumented (stable) sites such as Libya.

The methodology of intercomparison at Dome-C provides an example of an approach suitable for future “Virtual” constellations and the need for a suitable international “Gold” standard satellite as an established reference, looking forward to the future use of a TRUTHS calibration satellite system.

Steve Mackin, Gyanesh Chander

10.059

QA4EO Compliant QA/QC system for automated quality control of large satellite Constellations

In the last few years CEOS WGCV has endorsed a set of guidelines for Quality Assurance and Quality Control of Earth Observation Data. The framework known as Quality Assurance for Earth Observation (QA4EO) requires the quantification of uncertainty for every element in the processing chain from Level 0 data up to higher level products. This information is then provided to the end user in the form of a quality indicator with traceability throughout the processing chain back to the fundamental calibration of the system.

DMCii has been involved in the development and support of the guidelines for this system and sees the methodology as a way forward for the automatic management of large constellations of satellites producing terabytes of data.

A prototype QA/QC system based on the QA4EO guidelines which provides an automated control over large volumes of data now being processed for the 2nd generation DMC systems. This system will be described and the corresponding quality indicators (at pixel level) will be presented.

Steve Mackin

10.060

On-Orbit Geolocation Accuracy and Image Quality Performance of the GeoEye-1 High Resolution Imaging Satellite

The GeoEye-1 imaging satellite was launched on September 6, 2008 and commissioning was completed in February 2009. This paper presents the on-orbit analysis methodologies used and the results achieved during the first year of operations of the GeoEye-1 mission. Specifically, analysis of absolute and relative geolocation accuracy, relative radiometric performance, signal-to-noise ratio (SNR), and modulation transfer function (MTF) is presented. Results from these metrics provide a comprehensive description of the operational performance of the sensors and the quality of the imagery.

David Mulawa

10.065

RapidEye Vicarious Calibration and Radiometric Performance Assessment_2009

RapidEye AG is a commercial provider of geo-spatial information products and customized solutions derived from Earth observation data. The source of this data is the unique RapidEye constellation consisting of five LEO satellites that are capable of accessing any point on the Earth with a revisit time of 24 hours. Each satellite incorporates the same pushbroom electro-optical sensor. The Multi Spectral Imager (MSI) collects data in five discrete spectral bands (blue, green, red, red-edge and near-infrared) of the electromagnetic spectrum at a ground spatial resolution of 6.5 meters from a nominal altitude of 630 km. Each sensor has a ground swath width of approximately 77 km and as a system the five sensors are capable of acquiring imagery of up to 4 million square kilometers every day.

A reflectance-based vicarious calibration campaign for two RapidEye sensors (RE3 and RE4) was performed in conjunction with the Remote Sensing Group (RSG), Optical Sciences Center, University of Arizona from April through October 2009. The goal of this activity was the acquisition of in-situ ground measurements of the reflectance of a reasonably bright land target that is both spatially and temporally stable as well as an assessment of the atmospheric conditions above the target. This data was collected by RSG personnel at the well monitored calibration sites at the Railroad Valley (RRV) playa in Nevada and the Ivanpah (IVP) playa in California during simultaneous imaging overpasses of the RE3 and RE4 sensors.

The objectives of this vicarious calibration campaign of the RE3 and RE4 sensors are to; (1) compare the sensor derived radiances from RapidEye Level-1 imagery to the top-of-atmosphere (TOA) radiances calculated from ground measurements, (2) determine the on-orbit sensor spectral response functions for each band (3) establish an initial baseline for mapping the long-term trends in the sensor responsivity and (4) recommend possible adjustments to the RapidEye system calibration parameters used in the preparation of image products.

This paper reports on the results of the recently concluded 2009 vicarious calibration campaign and the continuing efforts to establish the absolute radiometric accuracy of each sensor in the RapidEye constellation.

Jeff Czapla-Myers, Denis Naughton, Andreas Brunn, Scott Douglass, Brian D'Souza, Harald Konstanski

10.070

Radiometric calibration of digital aerial cameras

The use of aerial images for remote sensing applications as an alternative to satellite data increased with the introduction of digital aerial cameras. Some of these systems like the DMC and RMK D from Z/I Imaging have multispectral capabilities and collect R,G,B and NIR image data simultaneously.

Because these cameras have primarily been developed for mapping applications, the remote sensing community is not fully aware about the capabilities and benefits of these sensors. This presentation shows examples for remote sensing applications from users worldwide, where digital aerial images collected with the DMC had been used for vegetation classification, change detection and agriculture monitoring.

A prerequisite to use aerial images successfully for remote sensing projects is a good radiometric camera calibration, ideally an absolute radiometric calibration. Therefore a new radiometric calibration process had been developed at Z/I Imaging and implemented into production for the DMC and the ne w RMK D digital camera systems.
This process will enable the DMC and RMK D to produce radiometrically calibrated imagery with an absolute accuracy comparable to satellite sensors.

During this presentation the radiometric calibration process and the tools used for calibration will be described.

Klaus Neumann

10.072

Laboratory and On-site Radiometric Calibration of Aerial Multispectral Digital Cameras

With the increasing need for environmental monitoring, improved remote sensing data is paramount to observe and assess large areas. The ability to transform remote sensing data to bio-geophysical information is highly dependent on both relative and absolute radiometric calibration. In addition, many scientific and quantitative investigations including those that compare data sets from multiple systems require absolute radiometric calibration. Currently most aerial systems have focused on relative radiometry for image flat fielding and color balancing. Although many advanced CCD-based multispectral cameras are capable of being absolutely radiometrically calibrated, the benefits of such have not been widely exploited by the multispectral aerial remote sensing community. This paper discusses optical imaging system parameters, methods and validation techniques required to absolutely radiometrically calibrate multispectral imaging systems. Laboratory relative and absolute radiometric calibration of Z/I Imaging's Digital Mapping Camera and RMK-D digital aerial multispectral cameras using a NIST traceable integrating sphere are discussed. Recent advances in LED-based calibration systems and how they could help enable on-site radiometric calibration is also covered.

Robert Ryan and Mary Pagnutti

10.073

An Automated Tool to Estimate the Spatial Resolution of Products Acquired by High Spatial Resolution Remote Sensing Imaging Systems

The spatial resolution of a digital EO remote sensing imaging system product is an important image quality characteristic when determining the utility of an imaging source. Although spatial resolution is often described solely by ground sample distance, there are other parameters that effect image sharpness that need to be considered including relative edge response (RER) and modulation transfer function (MTF). Knowledge of an imaging system product's MTF is also used to develop robust image restoration or sharpening algorithms. Most current methods for assessing these spatial resolution characteristics rely on pre-deployed engineered targets and as such are performed only at selected times within pre-selected scenes. To address this insufficiency an automated Spatial Resolution Verification Tool (SRVT) has been developed that will estimate a product's MTF and RER by finding and utilizing uniform, high-contrast edges from typical acquired urban scenes. The SRVT can be used to evaluate the image quality of a single image, a product over time and products from different systems. This presentation discusses the basis of the tool, its validation, planned enhancements and potential uses.

Mary Pagnutti, Robert Ryan, Kara Holekamp

10.075

In-Flight Vicarious Calibration of High Spatial Resolution Remote Sensing Systems Using Specular Reflectors

Physics-based exploitation of image data from electro-optical remote sensing systems requires knowledge of the accuracy, stability and repeatability of the sensor's radiometric response. Vicarious calibration methods, using ground based targets, provides a distinctive approach to obtaining this knowledge by evaluating performance under true post launch operational conditions for both the sensor and target of interest.

The standard reflectance-based vicarious calibration method has proven to be effective at delivering accurate at-sensor radiance knowledge. However, in general, the method explicitly relies on using large natural uniform surfaces (i.e. desert playa) and extensive surface and atmospheric ground truth collected coincident with the sensor acquisition.

For high spatial resolution airborne and orbiting sensors, bright sub-pixel intensity sources (watts/str) become a useful alternative. Radiometric performance characterization is achieved by providing a known at-sensor irradiance spectrum from a small target. Such calibration references can be created using specular reflectors producing point sources with a controlled upwelling intensity traceable directly to the solar spectral constant.

There are several advantages to consider. First, the targets are small, inexpensive, portable and easy to deploy at any location. Next, the specular reflectance is stable such that it can be measured in the laboratory much more accurately than diffuse reflectance and transferred unchanged directly to the field, eliminating the need to "walk the site" with a portable spectroradiometer. Also, the intensity can be adjusted to excite detectors anywhere over the sensor's dynamic range. Finally, the small target spatial properties of the reflectors allow the upwelling direct solar flux to be isolated from the surface background signal and sky path radiance based on image data alone. As a result, the only ground truth needed at the image acquisition for predicting an at-sensor irradiance is atmospheric transmittance. The simplification of calibration targets and ground truth provides the potential for the deployment of an end-to-end calibration system supporting cross-sensor and cross-platform data fusion.

In this presentation, the SPecular Array Radiometric Calibration (SPARC) method will be demonstrated based on data collected with the IKONOS satellite operated by GeoEye. The analysis includes a direct comparison with the reflectance-based technique.

Stephen Schiller

10.080

Relative Geolocation Accuracy Topics Relevant to DigitalGlobe's Multiband Satellites: Camera Calibration and Band to Band Registration

Two of DigitalGlobe's high resolution satellites have more than one spectral band. QuickBird-2 (QB02) has five: one panchromatic band (PAN) and four multispectral bands (B, G, R, N). WorldView-2 (WV02) has nine: one panchromatic band (PAN) and eight multispectral bands (B, G, R, N; C, Y, RE, N2). The PAN band of both these satellites serves as the base for advanced products, like PAN colorization/ sharpening. It is vital that the PAN band itself has no warping, rubbersheeting, or other relative geolocation issues induced by poorly chosen camera model parameters. The calibration the WV02 PAN camera will be discussed. The relative geolocation accuracy of the WV02 PAN band will be compared to the relative accuracy of the PAN band aboard QB02 and WorldView-1 (WV01).

Furthermore, the geolocation of the same pixel in different spectral bands should be exactly the same, but usually it is slightly different. This small amount of geolocation shift between bands is another kind of relative geolocation accuracy, call it band to band registration. Every multispectral band aboard QB02 and WV02 has a characteristic registration when compared to the corresponding PAN band. The band to band registration of both satellites will be quantified and contrasted. Calibration data will show that for both satellites, the misregistration is small and random, and arises from unavoidable fluctuations in the satellite attitude. Before the post launch verification was complete, the uncalibrated WV02 had even more band to band misregistration from the unoptimized camera models used for each multispectral band.

Dr. Byron Smiley

10.085

The Absolute Geolocation Accuracy of DigitalGlobe's Satellites: QB02, WV01, and WV02

DigitalGlobe's satellite imaging constellation now includes three high resolution satellites: QuickBird-2 (QB02), WorldView-1 (WV01), and the new WorldView-2 (WV02), launched 8 Oct 2009. Routine monitoring with identical methods reveals that each satellite has a different absolute geolocation accuracy. For the established satellites, QB02 and WV01, quarterly absolute geolocation statistics over the last two years will be presented. In the nine quarters ending with and including 3Q2009, the 90^{th} percentile of average geolocation error for QB02 always fell between 13.4 and 20.8 meters projected to nadir, while for WV01 the same 90^{th} percentile was between 4.0 and 5.3 meters projected to nadir. All WV02 absolute geolocation data from launch to the current quarter will be presented and compared to QB02 and WV01. The time line and approach to the final absolute geolocation accuracy of WV02 will be presented.

Dr. Byron Smiley

10.090

Resourcesat-2 Mission Status

The global geospatial market has been expanding with multiple numbers of service providers in value addition, software and solutions. However, the number of space based remote sensing data providers continues to be confined to handful of companies or government agencies.

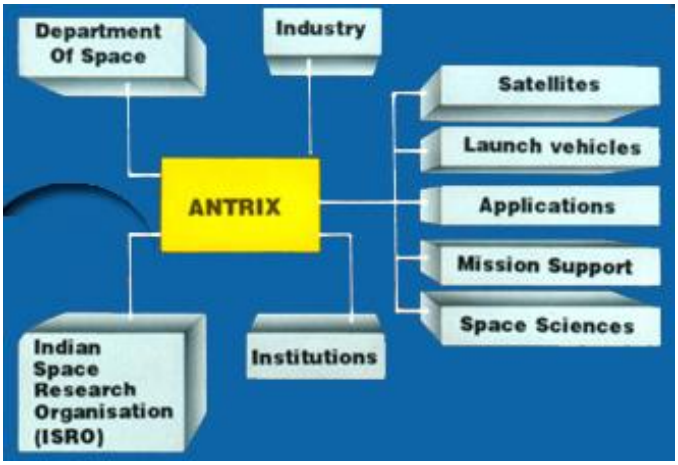
India's Space Program has contributed to the wealth of space systems for Earth Observation (EO) with the systematic development and long range planning of Indian Remote Sensing (IRS) satellites. IRS Missions, born from local requirements to meet India's national needs, have expanded globally thanks to the IRS program's success and the international marketing efforts of Antrix Corporation Limited (Antrix), the marketing arm of ISRO.

While the IRS-1A satellite served national needs, the launch of IRS-1B in 1991 marked the advent of international commercialization for the IRS program. The advanced twin satellites IRS-1C and 1D further paved the way for IRS's significant role in the Geospatial data market through the establishment of International Ground Stations around the globe.

The availability of high-resolution data from the IKONOS and QuickBird missions, for example, have helped further propelled an ever increasing demand for more accurate geospatial data for decision making in the context of mitigation and the management of disasters. India's contribution to the supply of high-resolution imagery includes the CARTOSAT-1 mission with its 2.5m along track stereo imaging capability, and the CARTOSAT-2 mission with its agile ability to image virtually any place on the globe at 1m resolution.

Since 2005, India's RESOURCESAT-1 mission has been serving the global EO community in support of a variety of Earth imaging applications thanks to the satellite's three different sensors that routinely provide resolutions and four different swaths with a revisit of 5 days. 2010 will mark the addition of the RESOURCESAT-2 to the existing constellation of IRS satellites thereby continuing the legacy of RESOURCESAT-1 while offering new and advanced capabilities to meet the expanding needs of the user community making it possible to meet varying market requirements.

In this lecture, Antrix will endeavor to present an update on the status of the Resourcesat-2 mission (which is scheduled for launch in mid-2010), a summary of its enhanced features and capabilities over Resourcesat-1, and the plans for calibration and validation of the data post launch.



Deviprasad Karnik, K. R. Sridharamurthy, PhD

10.095

RADARSAT-2: 2009 Agricultural Campaign

As part of a SAR validation campaign, MDA will acquire and analyze a dense time series of RADARSAT-2 quad-pol data to define and quantify the performance of C-Band SAR missions for classifying and monitoring agricultural crops. The basics of polarimetric theory are summarized and discussed in the context of SAR. Calibration of polarimetric SAR, which is an important issue for the extraction of meaningful polarization information, is reviewed. In particular, the presentation will examine what information on crop type, acreage, yield and health can be retrieved with multi-pol, multi-temporal SAR.

Gordon Staples, William Jefferies, Ron Caves

10.097

Annual Tropical Forest Monitoring with the DMC Constellation

The recent addition of two new 22-metre EO satellites into the DMC constellation has increased significantly the capacity and capability of the system, contributing an additional resource for the monitoring of destruction, degradation and regeneration of forests as part of the monitoring of carbon resources.

The frequent revisit of the DMC has been particularly effective in regular imaging of large tropical rainforest areas in the Amazon Basin since 2005. In October 2009 DMC International Imaging Ltd started to image the whole of sub-Saharan Africa under the European Global Monitoring for Environment and Security (GMES) program. The ability to provide frequent imaging of the Congo Basin contributes an important information layer for the international and local efforts to monitor and manage forest resources, and moves from decadal mapping of forest resources to an operational annual service. DMCii is also working with several organisations to deliver forest monitoring products based on DMC data in Indonesia.

This paper compares the 22 metre and 32 metre DMC image products and capabilities. It also discusses the DMC forest monitoring programme in Amazon, Congo and Indonesia and derived forest products.

Paul Stephens, Owen Hawkins, Gary Holmes

10.100

DigitalGlobe Incorporated Satellite and Aerial Program Update

DigitalGlobe continues to operate a growing constellation of high resolution earth imaging satellites (QuickBird and Worldview systems) and added a growing aerial imagery program capabiity beginning in 2007 to complement its satellite product offerings. The DigitalGlobe data acquisition system's capacity to collect over 475 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 (290,000 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 will enable 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 will be capable of collecting up to 975,000 square kilometers (376,000 square miles) per day of half-meter imagery. The WorldView-2 system will allow DigitalGlobe to substantially expand its imagery product offerings to customers with a more desirable, higher-performance product. The added spectral diversity will provide the ability to perform precise change detection, vegetation analysis and mapping. WorldView-2 will incorporate 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).

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 launched the Clear30 program, an initiative to distribute high-resolution, 30-cm aerial imagery of contiguous landscapes, initially in the U.S. and Western Europe. The Clear30 initiative is a new program that reflects a DigitalGlobe commitment to increase accessibility and use of high-resolution digital imagery. To collect the first ever multicontinental aerial imagery at 30 cm spatial resolution (12-inch), DigitalGlobe and their partner Microsoft will use 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.

Brett P. Thomassie

10.102

Epipolar Resampling of Pushbroom Satellite Imagery

High-resolution satellite images have become an essential source for several applications world-wide, including global topographic mapping, change detection and environmental monitoring. Since the launch of the IKONOS in September 1999, there have been tremendous developments in the high-resolution commercial satellite imaging market. The number of systems has increased with many more scheduled to be launched in near future. Then the technology has also improved a lot, and not only the spatial resolution and swath width increased, but the temporal resolution (revisit time) and georeferencing accuracy have seen significant improvements too. Note that the excellent multi-spectral capabilities have been always a trademark of satellite imagery. All these advancements have paved the way to growing use of satellite imagery for small- and medium-scale mapping, as the performance level became comparable to high altitude photography. As an increasing number of applications have started to use satellite imagery, the need for efficient stereo satellite image processing capabilities has started to grow. The exploitation of epipolar geometry is essential in airborne stereo image processing environment, as it can reduce the search space for matching and enable epipolar image resampling for 3D displaying. However, unlike the well-known frame cameras, the pushbroom camera adopted at the most high-resolution satellite systems does not produce straight epipolar lines and no epipolar pair exist for the entire scene. These properties make it difficult to establish the epipolar geometry of pushbroom cameras for epipolar image resampling. Even relying on simplified sensor models such, as a 2D affine transformation, there are serious restrictions on the assumptions. To overcome limitations of currently proposed methods, a new method, exploiting RPC (Rational Polynomial Coefficients) sensor model, is proposed. First, epipolar curve pairs for the entire scene are determined based on the finding that the epipolar line is locally straight and the epipolar pair exists locally. Second, a new epipolar image generation algorithm is developed. The algorithm has been tested on IKONOS images and results showed significant improvement compared to existing methods. Since epipolar line determination and the epipolar resampling processing are a prerequisite for many photogrammetric operations, including image matching, DEM (Digital Elevation Model) generation, ortho-rectification, map compilation, and stereo display, the proposed method is expected to improve the processing of stereo satellite imagery and, consequently, the quality of any derived photogrammetric products.

Charles K. Toth, Jaehong Oh, Dorota Brzezinska

10.105

DMC Imagery Pre-processing and Analysis: User Experience

DMC imagery is delivered by a family of satellites carrying the same multi-spectral sensor. The data offers a unique combination of ground resolution, spatial coverage, and temporal revisit. The presentation will offer a user experience with applicational processing and analysis of the DMC imagery.

Challenges with using DMC imagery from multiple satellites and dates in one application will be discussed. The presentation will give particular attention to crop type detection with DMC data. The presentation will further discuss operational DMC calibration to surface reflectance values.

Dmitry Varlyguin

10.107

WV-2 Characterization and ICC Profiles

With the launch of WorldView-2 this past October, a new horizon for remotely sensed imagery was opened. The eight band sensor built by ITT Space Systems Division that is at the center of the WorldView-2 satellite will enable much more utility and quality from multi-band remotely sensed imagery. Characterization of the eight band sensor along with the usage of ICC profiles provides ground processing software with the parameters needed to fully take advantage of WorldView-2's unique capability. The characterization and implementation structure is discussed as well as several possible application scenarios covering both airborne and satellite imagery.

Michael Vaughn

10.120

A Unified Conceptual Methodology for LiDAR and Camera System Calibration

The availability of three-dimensional surface data is valuable for several industrial, agricultural, security, environmental, hazard assessment, and military applications. With the wide-spread adoption of Differential Global Positioning Systems (DGPS), Inertial Navigation Systems (INS), and digital imaging systems, directly geo-referenced photogrammetric and Light Detection And Ranging (LiDAR) systems have become the most prominent technologies for deriving surface information. Accurate recovery of such information from either system is dependent on the quality of system calibration procedure, which defines the calibration parameters for the individual sensors in each system as well as the mounting parameters relating such sensors (e.g., the lever arm and boresighting angles relating the coordinate systems of the implemented sensors – GPS, INS, and camera/laser scanner – within each system). This talk introduces a unified conceptual methodology for photogrammetric and LiDAR system calibration. The system calibration parameters are estimated while reducing discrepancies between conjugate surface elements derived from overlapping flight lines using either system. Using such a procedure, the optimum flight configuration as well as the minimal control requirements for reliable estimation of the system calibration parameters will be derived. Experimental results verifying the feasibility and performance of the presented methodologies will be presented throughout this talk.

Dr. Ayman F. Habib

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Thank You for attending the 2010 JACIE Workshop!

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