

Civil Commercial Imagery Evaluation Workshop
March 20-22, 2007

About the Presentations

TUESDAY, MARCH 20, 2007

- **Keynote: USGS Land Remote Sensing Program Coordinator – Dr. Bruce Quirk**

Future of Remote Sensing Session - Greg Stensaas

- **Satellite data for JACIE program planning – Mitretec – William Stoney**
 - *This paper presents a summary and analysis of the 40 or so medium to high resolution land imaging systems (optical and radar) that 24 countries are planning to put in orbit by 2010. All are categorized as civil or dual purpose systems. Many have announced plans for making the data generally available and thus should be considered for future JACIE analysis.*
- **Future of Land Imaging Systems – John Copple – Sanborn**
 - *The number of new platforms available for imaging the earth is at an all time high. Electro-Optical, Radar, Hyperspectral, LiDAR, and others. The information age, an age in which the appetite for data is insatiable, now has the ability to be fed by many forms of data about the Earth. Even as these new sources come online, Google, Microsoft, Yahoo, Mapquest, ESRI, and others are creating even more demand by giving new users access to the Land Image data. Other new demands are emerging from the result of the increased population density of the world, concerns over the future environment, security, and new applications developed as a result of data access. The result is Land Imaging continues to be on a journey of development and increased capability. We will discuss some possibilities for the future as our desire and ability to visualize our world continues to increase.*
- **Use of Commercial Imagery in Microsoft® Virtual Earth™ - Dr. William Gail – Microsoft**
 - *Internet geospatial platforms, such as Virtual Earth, are revolutionizing access to both aerial and spaceborne Earth imagery. Governments and businesses, as well as the general public, are rapidly discovering the many uses of these online services and the importance of the underlying imagery. To meet growing demand, ongoing improvements in both the resolution and currency of imagery will be needed. This presentation will discuss the online imagery demand today and describe where it is going tomorrow.*
- **NOAA International Remote Sensing Study 2005-2016 – Dr. Shawana Johnson – Global Marketing**
 - *Under a contract with the U.S. National Oceanic and Atmospheric Administration (NOAA) Satellite and Information Service Division, Global Marketing Insights, Inc. completed an international research study of the International remote sensing markets for aerial and satellite image technologies. The first segment of the study completed in 2005 focused mainly on the US, Canada and Europe resulted in collecting over 1500 survey respondents. The Asian and Austral Asian Study completed in 2006 resulted in over 400 respondents. The formal results of both studies can be found at www.licensing.noaa.gov and www.globalinsights.com.*

This presentation will include the highlights of the responses concerning the use of High Resolution, Mid-Resolution and Aerial Digital data based on the input of Commercial, Government, and Academic End Users worldwide. This will include a review of the imagery utilized and their most frequently used applications. The presentation will also include the respondent's key political, economic and technical trends impacting them and their use remote sensing imagery. A key aspect of this research was accomplished by on-line research surveys. The surveys focused on eight sectors of the remote sensing industry including; Aerial Film, Aerial Digital, Aerial Sensors, Satellites, and Remote Sensing Hardware and Software, Commercial, Academic and Government end users.

Respondents participated in the study by logging onto an on-line survey and were also interviewed at international industry conferences. The survey participation was high due to the alliances which

Global Marketing Insights, Inc. developed with over 50 industry partners globally who provided the survey to their international databases. These formal studies are the largest remote sensing studies undertaken to date.

Government Overview Session - Tom Stanley

- **NASA** - Edward Grigsby
 - *This presentation covers the status and plans for NASA and the USGS to acquire flight and ground systems for the Landsat Data Continuity Mission, currently projected for launch in late 2011. An update on the operational status of Landsats 5 and 7 will also be provided, along with some notes on other USGS work that supports the goals of JACIE.*
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- **NGA** - Doug McGovern
 - *The technical capabilities and availability of unclassified imagery sources continue to grow at a remarkable pace from a diverse and growing community of commercial imagery providers. The National GeoSpatial-Intelligence Agency has made significant strides in the utilization of commercial imagery in products and services for a globally deployed user base. The future for commercial imagery remains bright with growing anticipation for the successful launches of the WorldView 1 and GeoEye 1 satellites that will usher in a new generation of imaging capabilities.*
- **USDA** - Glenn Bethel
 - *USDA agencies acquire commercial imagery over broad areas of the world, from a variety of sensors, and exploit this imagery to support different agency missions. This presentation will discuss 2006 acquisitions high resolution imagery from aircraft and US commercial imagery companies, as well as USDA's Global acquisitions of mid-resolution imagery. The National Agriculture Imagery Program (NAIP) acquired over 2.6 million square miles of 1 and 2 meter imagery over the lower 48 states. This unprecedented accomplishment employed multiple digital sensors and film cameras to create imagery products that were ortho-rectified, tone-balanced, seamlessly mosaicked, and GIS ready to use. USDA also tasked commercial satellites to create similar imagery base maps for Hawaii, US Territories in the Pacific, and for populated areas of Alaska. In 2006, USDA transitioned Global operational mid-resolution monitoring from Landsat to AWIFS. Issues, opportunities, and problems encountered in 2006 and plans for 2007 will be discussed.*
- **NOAA** - Stephen White
 - *The National Oceanic and Atmospheric Administration (NOAA) conducts research and gathers data about the global oceans, atmosphere, space, and sun, and applies this knowledge to science and service that touch the lives of all Americans. NOAA warns of dangerous weather, charts our seas and skies, guides our use and protection of ocean and coastal resources, and conducts research to improve our understanding and stewardship of the environment which sustains us all. Remote Sensing play's an integral part in the NOAA mission, whether it is for assisting in weather forecast or the mapping of coral reefs. A brief overview of the utilization of high and moderate resolution remotely sensed imagery within NOAA will be presented.*

Industry Overview Session - Tom Stanley

- **DigitalGlobe** - Brett Thomasie, Director Civil Government Programs
 - *In October 2001, DigitalGlobe Incorporated successfully launched the highest spatial resolution (60cm) commercial satellite imaging system called QuickBird. DigitalGlobe™ is currently building its next generation of imaging systems (Worldview satellites) that along with QuickBird, will help to address the strong demand for additional high-resolution image and geospatial content collection and delivery capabilities.*

QuickBird satellite imagery and information products have been used successfully for a wide variety of federal/state/local government and research applications including coastal management and monitoring, homeland security, port and infrastructure security, GIS/mapping, and natural resource management.

The QuickBird satellite has now been producing high quality imagery since reaching operational capacity in early 2002 and the newly-planned WorldView satellite systems (WorldView 1 and WorldView 2) are currently in development and are scheduled to launch in 2007 and 2009.

The new WorldView satellite systems will offer:

- *half-meter resolution*
- *8-band multispectral capability*
- *substantially improved agility*
- *daily revisit capability at one-meter resolution or better*
- *improved geo-locational accuracy*
- *substantially improved collection capacity with greater on-board storage and a higher data downlink rate*
- *simultaneous image collection and downlinking*

The WorldView 1 satellite will collect imagery of the Earth at 50 centimeter panchromatic resolution with an orbit altitude of 450 km. WorldView 2 will provide the same panchromatic 50 centimeter resolution imagery as WorldView 1, in addition to offering 1.8-meter spatial resolution 8-band multispectral imagery. The WorldView 2 satellite will also orbit at a higher altitude of 770 km.

The addition of WorldView 1 and 2 will allow DigitalGlobe's customers to revisit collection areas more frequently with the capability of providing repeat coverage over global areas of interest about once daily. The WorldView ground system (in use presently with QuickBird) also includes a more efficient image processing system, multi-satellite collection planning, shorter tasking timelines, and an expanded network of remote ground receiving terminals.

DigitalGlobe's imaging constellation combining both WorldView satellites and QuickBird will be capable of collecting more than 4.5 times the imagery of any current commercial imaging system. By late 2007, WorldView alone will be capable of collecting nearly 500,000 square kilometers (200,000 square miles) per day of half-meter imagery.

In January 2007, DigitalGlobe also acquired GlobeXplorer/AirPhoto USA. The newly combined DigitalGlobe capabilities will now offer end user customers instant Internet access to the world's largest aerial, satellite and map image databases as well as access to customizable subscription/bundled imagery and software tool packages.

- **GeoEye Overview, Operations and Capabilities of GeoEye-1** - William Schuster – COO GeoEye
 - *GeoEye was formed by the acquisition of Space Imaging by ORBIMAGE in January of 2006. The combined company is the world's largest commercial satellite remote sensing company with revenues of \$109 million (as of September 30, 2006) and an archive of 255 million square kilometers. GeoEye operates the high-resolution IKONOS and OrbView-3 satellites for government and commercial customers as well as the low-resolution Orbview-2 satellite providing global, daily coverage for fishing and environmental monitoring. The company will launch GeoEye-1, a next-generation, high-resolution color imaging system, later this year. GeoEye-1 will be the world's highest resolution commercial imaging satellite with a panchromatic resolution of 41 cm (~ 16 inches) and a 4-band multispectral resolution of 1.6 meters. Funding for the development of GeoEye-1 is from both the NGA's Nextview contract and capital raised by GeoEye. This private-public cost sharing reduces the cost of satellite imagery to the government and fulfills the objectives of the president's Commercial Remote Sensing Policy (NSPD-27). The presentation will provide an overview of the company and its operations and will talk specifically about the capabilities of GeoEye-1.*

- **Indian Remote Sensing Satellite Constellation - Present and Future** - Timothy Puckorius – CEO EOTec

- *In March 1988, India launched IRS-1A, the first in a long series of highly reliable remote sensing satellites. By May 2005, India had launched both IRS-P6 (also known as “Resourcesat-1”) and IRS-P5 (also known as “Cartosat-1”) thereby matching or exceeding the performance specifications, resolution and coverage of other global satellite programs. On 10 January 2007, India added yet another feather to its cap in space technology and remote sensing when its tenth Polar Satellite Launch Vehicle (PSLV-C7) put Cartosat-2 into orbit. Cartosat-2 will soon begin providing Panchromatic (Black & White) imagery at better than 1 meter resolution thus expanding India’s support for a wide range of applications such as general mapping and charting; national defense applications, military planning and intelligence; civil and commercial applications such as agriculture and forestry management and environmental monitoring.*

In this lecture, Timothy Puckorius (EOTec’s Chairman and CEO) will present the comprehensive offering of IRS imagery and derived products as well as India’s earth observation plans through 2025. (Earth Observation Technologies LLC (“EOTec”) is the newly appointed managing agent for ANTRIX Corporation Limited for the commercialization of India’s IRS Satellite Program worldwide. ANTRIX employs an integrated global system of imaging satellites and ground station partners to collect, process and distribute IRS satellite imagery and derived products to customers worldwide. With a satellite constellation, worldwide imagery archives, and large-scale product generation capabilities designed to significantly improve the timely delivery and quality of geospatial information, EOTec (on behalf of ANTRIX) serves the worldwide user community of space-based imagery markets for land, sea and atmospheric applications.)

- **CBERS Program: a Reference in the Brazilian Space Program** - Jose Bacellar – INPE

- *The CBERS Program previews the launching of five Remote Sensing satellites, two of which have already been successfully sent to space, in 1999 (CBEERS-1) and in 2003 (CBERS-2, in operation). Those satellites are identical and carry three medium and low spatial resolution sensors: CCD (20m), IRMSS (80m) and WFI(260m). The combined CCD and IRMSS satellite spectral bands cover the seven bands of the TM – Landsat sensor spectrum. Still in 2007, a third satellite (CBERS-2B), equipped with a high space resolution sensor, will be launched.*

The data distribution policy regarding CBERS -1 was similar to the one adopted in Brazil for the Landsat satellites, where each specific product type had a specific price. Results, for that as well as for others reasons, fell way short of those expected.

For CBERS-2, the Brazilian Government decided in favor of the free distribution of images. Users would pick their selection with the help of the Catalog systema, and would receive them by FTP.

The results were amazing, and in a short while over 2,000 images were acquired per week. This amount has already stabilized and in the last three years more than 300,000 images were distributed to over 25,000 different users.

Doing a brief analysis of the CBERS program, one can consider the CBERS -1 served its purpose, regarding the Ground Station system learnship, as well as in regards to the data distribution and customer relationship policy.

CBERS -2 has been widely used by the community of Brazilian users, but it still presents problems that may and should be solved. This satellite has served for the improvement of the radiometric and geometric correction models, to ensure quality products, even in the presence of problems in some of the major satellite systems, such as the Attitude and Orbit Control System (AOCS).

In a near future, we expect a significant improvement in the quality of the images generated by the three sensors of the CBERS-2B satellite. The interesting aspect is that those satellites will have space resolution levels ranging from low (WFI-260M), to medium (CCD-20m) and high (HRC – 2.5m).

The continuity of the CBERS program is assured with the future launching of two more identical satellites (CBERS-3 – 2009 and CBERS-4 – 2011), with four sensors, each: PANMUX, MUXCAM,

IRMSS and AWF. Combined, these bands cover from visible to thermal infra-red and from 5 to 260m, in terms of spatial resolution.

Poster Session / Reception

WEDNESDAY, MARCH 21, 2007

Industry Overview Session (cont) - Mary Pagnutti

- **SPOT Image Land Remote Sensing System Overview** - Steve Miller - SPOT Image Corporation
 - *SPOT Image is a European based commercial remote sensing company that operates the SPOT family of satellites and also has distribution agreements for data collected by commercial satellite systems owned and operated by other nations. We will present the basic characteristics of the SPOT satellites, the specifications of the data the satellites collect, and the status of recent archive holdings. We will also present information about the Taiwanese Formosat-2 satellite and the Theos (Thailand) satellite; both of which SPOT has responsibility for global data distribution. We will present some examples of recent applications where SPOT data is used by US Government customers. These examples will include projects involving coverage of Cuba, Sudan, Helmand Province, Afghanistan, and various US cities. We will also present information about the use of SPOT's Level 2 Digital Terrain Elevation Data (DTED) product as void fill for the National Geospatial-Intelligence Agency's SRTM DTED 2 project.*

Finally, we will discuss at some length our initiatives involving web distribution of remote sensed data. The company has entered into an agreement with Google to provide extensive landmass coverage with a 2.5 meter resolution color mosaic. We will show some of the features and benefits of deploying satellite imagery within the Google distribution medium. This will include a demonstration of basic imagery viewing and new information services that will involve the Google architecture. Also, we are investing significantly in a web-based architecture for client viewing of data previously purchased and new coverage data available. This architecture will allow for the search, selection, processing, and ordering of satellite data.

- **EROS B Satellite Products and Services** - Rani Hellerman – ImageSat
 - *EROS B satellite was launched in April 25th 2006 by ImageSat International. The satellite is now fully operational and the products and services are available worldwide. EROS satellites acquire high-resolution panchromatic image data.*

EROS satellites are designed to maximize operator flexibility in the creation and adaptation of the daily image acquisition plan. The satellite is deployed in a circular sun-synchronous near polar orbit at an altitude of about 500 km with a spatial resolution of 70 cm on Nadir. EROS B orbits the earth almost 15 times each day delivering imagery data in real time to ground receiving stations worldwide. EROS B can be quickly pointed and stabilized to image customer specified sites on nadir (perpendicular to the surface) or at oblique angles up to 45 degrees.

The presentation is to present the main characteristics of the satellite, the products and the available services from the satellite. We got very good feedbacks from the customers using the data for national security and civilian applications.

- **KOMPSAT-2 Introduction** - Lisa Lee, Andrew Huh - KAI image, Inc.
 - *KOMPSAT-2, which was developed by KARI (Korea Aerospace Research Institute), was launched on July 28, 2006. KARI is like the NASA in the United States. The commercial distribution rights of KOMPSAT-2 were acquired by KAI image and Spot image and KAI image will be responsible for the commercial distribution over the United States, Middle East, and Korea. Spot Image will be distributing the data to rest of the world. Therefore, KAI image would like to participate in up coming 2007 JACIE workshop introducing KOMPSAT-2 to the U.S. government and research institutions from various circles for future cooperation.*

KOMPSAT-2 was launched on July 28, 2006 and now it's on the process of calibration. The data acquired by KOMPSAT-2 will be commercially available in March. KOMPSAT-2 has its resolution of 1 meter panchromatic and 4 meter multi spectral. Since its duty cycle is 20 minutes per orbit, mass storage tasking is feasible. KARI will be in charge of its control and main receiving. More specific data of KOMPSAT-2 can be found in an attached power point file.

If we are authorized to give a presentation in 2007 JACIE workshop, it will be the great pleasure of both KAI image and the users in the point of us having a chance to introduce our newly launched satellite, KOMPSAT-2 and, the users will have another chance of knowing and using high resolution satellite imageries.

- **DMC: Advances in the Small Satellite Constellation Imaging Capability** - Paul Stephens – DMCii
 - *The Disaster Monitoring Constellation (DMC) provides a unique imaging capability from a coordinated constellation of independently owned satellites.*

The first generation of these satellites carry sensors imaging at 32metres gsd with a 650km swath, and designed to provide a daily imaging capability for disaster response.

DMC data is radiometrically corrected and orthorectified to a high standard, and is in use in many national and international applications including precision agriculture, forestry, landcover and habitat mapping, coastal zone management, burn scar mapping, deforestation and disaster response. The DMC also contributes its rapid response capability for disaster relief through membership of the International Charter; Space and Major Disasters.

The paper will show how the second-generation DMC satellite in orbit complements the first satellites and provides greatly enhanced imaging capabilities. The imaging capacity has been extended up to 4100km along-track through improved on-board data storage and addition of faster downlinks. The Beijing-1 satellite also carries a very high-resolution 4 metre panchromatic sensor.

To provide data continuity, and enhanced imaging coverage, several new DMC satellites will be launched in 2008 and 2009. The DMC 32-metre sensor will be upgraded to 22 metres gsd whilst retaining the 650km swath.

The paper provides an overview of a range of international applications of DMC data and provides an up-date on the latest developments in the next generation of DMC satellites and sensors.

- **The New DEIMOS Medium Resolution Satellite** Jose-Luis Casanova, Pedro Duque - U of Valladolid
 - *The Spanish spatial engineering company **DEIMOS Space** together with the Remote Sensing Laboratory of the University of Valladolid (**LATUV**) have set up a new firm, **DEIMOS Imaging**, for the design and implementation, operations and marketing of a fully-equipped Earth Observation spatial system in Valladolid, Spain.*

*This system will incorporate a satellite with a multispectral optical sensor, Green, Red and NIR, with a resolution of 22m and a wide scan of over 600km in 8 bits and 470km in 10 bits. The satellite will send the images to the satellite monitoring station that is currently being built at the **Boecillo Technology Park** (Valladolid, Spain) and it is expected that they will be also sent to a station near the Artic Circle.*

*This new satellite is developed by Deimos Imaging in collaboration with **Surrey Satellite Technology Limited** (SSTL), a leading company in the construction of small satellites based in Guilford (United Kingdom). The satellite is expected to be launched in the first term of 2008 and will have an operational life of at least five years. The new Deimos company will provide different processing-level products for both the European and worldwide Earth Observation industry and, at the same time, it will also develop products and services for end users. Its applications will be mainly used in agriculture, forests, land uses, environment, hydrology, control of natural resources and the monitoring of floods effects and forest burnt scars.*

The processing, filing and image and product distribution centre will be located in the R&D Building of the University of Valladolid, University where the LATUV has been carrying out Remote Sensing activities for over 20 years. The satellite control will be at the Boecillo Technology Park.

*The image capacity and revisiting timing of the new satellite has no precedents at its spatial resolution level due to its great scan, three days in medium latitudes. It will be integrated into the international constellation **DMC** (Disaster Monitoring constellation), formed by satellites from the United Kingdom, China, Nigeria, Algeria and Turkey. The General Manager of the new company, DEIMOS Imaging, is Mr. Pedro Duque, the first Spanish astronaut, who offers to the project his technical expertise and wide experience in the space field.*

In this presentation, technical aspects dealing with the mission planning and the expected products, together with the calibration and validation plans will be shown.

- **RapidEye – A Novel Approach to Space Borne Geo-Information Solutions** - F. Jung-Rothenhaeusler – RapidEye

- *RapidEye AG was incorporated 1998 as a private enterprise in Germany. The search for funding succeeded in mid 2004 when all monies required to build the space- and the ground segment infrastructure could be secured. RapidEye's approach to building the space and ground infrastructure is to task an experience general contractor to deliver the entire system in orbit, fully functioning and calibrated. The system includes the satellites, the satellite control center, a customer ordering and delivery system and the ground processing solution to produce as standard image product ortho-rectified image data.*

The RapidEye business objective is to deliver geo-information solutions to customers which are fully integrated into the work flow of the customers. In other words, we deliver when and what the customers need. To meet this objective we have to build a reliable system which enables us to “guarantee” the delivery of services, this in turn necessitates a system which allows regular monitoring of large areas, daily access to any location on the globe and processing of the image data into information products within 24hrs. These operational requirements are met by our system which consists of 5 satellites, each carrying one optical payload with 5 spectral bands (b,g,r,red-edge, NIR), a GSD of 6.5m and the appropriate ground processing power.

RapidEye will deliver geo-information products for customers with a focus on biomass, such as agriculture, forestry etc, will produce cartographic information and will deliver satellite images and pre-process data to the wider public. Launch is scheduled in late 2007 and the system will become fully operational early 2008, ready for the vegetation season of the northern hemisphere.

Medium Resolution Imagery Session - Robert Tetrault

- **Resourcesat-1 AWiFS Data at the USDA** - Robert Tetrault - USDA/FAS
 - *The US Department of Agriculture (USDA) has purchased Resourcesat-1 satellite imagery for three years, primarily the P6-AWiFS. USDA began purchasing a limited amount of Resourcesat-1 data for domestic crop areas (starting in August 2004) and foreign crop areas (starting in December 2005). For these years, the P6-AWiFS data was used mainly for supplementing Landsat TM imagery in the Department's agricultural applications. In 2006, USDA purchased a significant amount of P6-AWiFS imagery through commercial channels.*

USDA distributes the Resourcesat-1 data, along with other satellite imagery, within several USDA agencies including, National Agricultural Statistics Service, Natural Resource Conservation Service, Agricultural Research Service, Animal Plant Health Inspection Service, Risk Management Agency, the US Forest Service, Farm Service Agency, and Foreign Agricultural Service. These agencies cooperate and share satellite imagery through the USDA's Satellite Imagery Archive.

This presentation will focus on the USDA's collection of P6-AWiFS satellite imagery, its aerial extent and temporal coverage, choices for the product type, access to the collection, and plans for future purchases.

- **Evaluation of Resourcesat-1 LISS-III vs. AWiFS Imagery for Mapping Croplands** - David M. Johnson – USDA
 - *The National Agricultural Statistics Service (NASS) has been utilizing Resourcesat-1 AWiFS imagery for the past three growing seasons to derive cropland classification over intensive agricultural regions of the US. AWiFS, primarily because of its large 740 km swath width, has proven an ideal data source for such an application even given its relatively large 56 m ground sample resolution. The hypothetical question has been raised though, “How would classification accuracy improve (or degrade) if one had access to AWiFS swath width sized imagery but with LISS-III’s 23.5 m pixel resolution?” Because the two sensors are currently on the same satellite, collect data in tandem, and utilize identical 4-band multi-spectral reflectance detectors, the question can already be directly tested. Thus, the USDA acquired two clear sky path dates of LISS-III imagery in parallel with that of AWiFS. The first path collect covers central North Dakota and the second from central Wisconsin. Both path dates are from the mid-summer peak of most crops’ phenologic cycle. Ground truth data from NASS and the Farm Service Agency were used for training and validation of the classifications. Quantitative accuracy assessment results are presented along with subjective findings. The study further attempts to answer the scale question of what the ideal pixel size is for classifying agricultural cover types.*

- **Evaluation of AWiFS Classifiers for Crop Acreage Estimation** - Michael Craig – USDA
 - *The National Agricultural Statistics Service (NASS) moved completely to Resourcesat-1 AWiFS imagery for its Cropland Data Layer (CDL) project after the 2005 crop season. The transition to AWiFS from Landsat TM and ETM has been covered in previous presentations, and will only get a short mention here. This presentation attempts to evaluate different factors affecting the use of AWiFS imagery for crop classification. The State of Arkansas was chosen as the test area for most of the evaluations. The first factor was to compare results from image delivery in 8-bit format versus 10-bit format. Next, type of classifier approach was considered. NASS is changing from the standard classification approach with ISODATA clustering and maximum likelihood classifiers to a regression tree (CART) approach based on See5 software; how does this change affect AWiFS classification? The See5 approach also has a built in smoothing algorithm, known as Smart Eliminate; at what level is this appropriate for AWiFS based classifications? Finally, the application of administrative data, such as the North American Land Cover dataset, was studied with respect to the classifications.*

- **AWiFS Imagery: Processing and Automated Feature Extraction** - Dmitry Varlyguin, Stephanie Hulina, Luke Roth – GDA
 - *There is a growing interest within the Landsat user community in alternative sources of medium resolution imagery, given the current status of the Landsat 5 TM and 7 ETM+ sensors and an anticipated Landsat data gap until the launch of the next generation Landsat sensor. One such promising dataset is Advanced Wide Field Sensor (AWiFS) medium resolution imagery from the Indian Remote Sensing (IRS) agency.*

The ability to operationally utilize AWiFS imagery becomes crucial if this dataset is chosen as a bridge dataset to fill the Landsat data gap. A novel approach to automated feature extraction and mapping is developed by GDA Corp. for AWiFS imagery. The major thrust of the GDA approach lies in its use of multiple lines of evidence and iterative hierarchical self-learning logic to increase the accuracy of the classification. These lines of evidence include spectral, spatial, and pattern information available from the image and global knowledge bases specific to both an object and the sensor.

The presentation will give particular attention to water, snow and ice, and cloud and cloud shadow detection in AWiFS data. The presentation will further discuss the need for AWiFS correction for view elevation changes across the scene and its calibration to surface reflectance values.

The GDA algorithms were developed and tested on over 100 AWiFS scenes covering various seasons, regions, and ground and atmospheric conditions. A validation study proved the reliability and accuracy of the algorithms to AWiFS and Landsat data. Work is underway to extend the algorithms to data from the Liss-III sensor.

- **A Question of Scale: Multiple Comparisons of Landsat, AWiFS, DMC and QuickBird** - Michael Coan - SAIC/USGS/EROS
 - *Multiple acquisitions of AWiFS, DMC, and Landsat 5 were acquired in the late spring, midsummer, and early fall of 2006, over the Pinedale and Jonah Fields (giant natural gas fields in the Green River Basin) in southwestern Wyoming. Quickbird scenes over a small portion of the area were also acquired. Field observations of landscape components were made throughout the area, and used to estimate percentage of each type of ground cover at the QuickBird scale (2.4m resolution). The estimated percentage classifications of the Quickbird scenes were used to generate training data for the L5, DMC, and AWiFS (30m, 32m, 56m) scales, and applied to their common footprints. The spectral and spatial scales unique to each sensor yielded differences in their ability to classify percentages of the landscape components.*

- **Cross Calibration of the L7 ETM+ and L5 TM with the Resourcesat-1(IRS-P6) AWiFS and LISS-III Sensors** – Gyanesh Chander - SAIC/USGS/EROS
 - *The ability to detect and quantify changes in the Earth's environment depends on satellite sensors that can provide calibrated, consistent measurements of Earth's surface features through time. A critical step in this process is to put image data from subsequent generations of sensors onto a common radiometric scale. Increasingly, data from multiple sensors are used to gain a more complete understanding of land surface processes at a variety of scales. The ResourceSat-1 Satellite (also called IRS-P6) was launched in a polar Sun-synchronous orbit on Oct 17, 2003. It carries three sensors: the High Resolution Linear Imaging Self-Scanner (LISS-IV), the Medium Resolution Linear Imaging Self-Scanner (LISS-III), and the Advanced Wide Field Sensor (AWiFS). These three sensors are used together to provide images with different resolution and coverage. To understand the absolute radiometric calibration accuracy of IRS-P6 AWiFS and LISS-III sensors, image pairs from these sensors were compared to images from the Landsat 5 (L5) Thematic Mapper (TM) and Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+) sensors. The approach involves calibration of nearly simultaneous surface observations based on image statistics from areas observed simultaneously by the two sensors.*

- **Radiometric Calibration of AWiFS Using Vicarious Calibration Technique** - Mary Pagnutti, Kara Holekamp – SSAI / NASA SSC
 - *A radiometric calibration assessment of the AWiFS (Advanced Wide Field Sensor) on the Indian Remote Sensing Resourcesat-1 satellite was performed by the NASA Applied Research & Technology Project Office (formerly the Applied Sciences Directorate) at the John C. Stennis Space Center. A reflectance-based vicarious calibration approach, requiring ground-based measurements coincident with satellite acquisitions and radiative transfer calculations, was used to estimate at-sensor radiance. The AWiFS is a 4-band, multispectral, moderate-resolution (60 m) imaging sensor that operates in the visible through short-wave infrared spectrum and is currently being considered as a Landsat-like alternative. Several study sites near the Stennis Space Center that attempted to span the dynamic range of the sensor were employed. Satellite at-sensor radiance values were compared to those estimated to determine the sensor's radiometric accuracy. The results of this evaluation provide the user community with an independent assessment of the radiometric accuracy of AWiFS image products, which are commercially available through GeoEye®. These results are an extension of an independent assessment made by the University of Arizona Remote Sensing Group, the South Dakota State University Satellite Calibration Group & Image Processing Lab, and the NASA Applied Sciences Directorate at the John C. Stennis Space Center the previous year.*

- **SSC Geopositional Assessment of AWiFS Orthorectified Product** - Kenton Ross, Ruby Stubbs – SSAI / NASA SSC
 - *The geopositional accuracy of an AWiFS (Advanced Wide Field Sensor) orthorectified product was evaluated. Specifically, the image products were acquired by the Indian Remote Sensing Resourcesat-1 satellite, then orthorectified by GeoEye®. Analysis was performed using DOQs (digital orthophoto quadrangles) and other reference sources of similar accuracy. A total of six AWiFS images were characterized. These images were acquired over the continental United States from June through September 2005. The images were equally divided between the two AWiFS cameras. Forty to fifty check points were collected manually per scene and analyzed to determine overall circular error, estimates of horizontal bias, and other systematic errors.*

- **Geometric Characterization of DMC** - Gyanesh Chander - SAIC/USGS/EROS
 - *Satellite data from the Surrey Satellite Technologies LTD (SSTL) Disaster Monitoring Constellation (DMC) was assessed for geometric quality. The DMC data consisted of imagery registered to Landsat orthorectified imagery produced from the GeoCover program. Relief displacements within the DMC imagery were accounted for by using global 1km Digital Elevation Models (DEMs) available through the Global One-km Base Elevation (GLOBE) Project. Positional accuracy and relative band-to-band accuracy were measured. Position accuracy of the DMC imagery was assessed by measuring the imagery against Digital Orthophoto Quadrangles (DOQs) which are designed to meet national map accuracy standards at 1:24000 scale, this corresponds to a horizontal Root Mean Squared (RMS) accuracy of approximately 6 meters.*
- **Analysis of Radiometry and Data Quality of DMC Satellite Systems** - Stephen Mackin, Gary Crowley, Paul Stephens, Dave Hodgson – DMC
 - *A detailed analysis of the UK-DMC radiometry and data quality is presented and compared to that from other sensors including Landsat 5 and 7. The overall results from the absolute calibration at Railroad Valley, Nevada show a two year stability profile with little change in the absolute calibration values (1% to 4%). Additionally the relative inter-band stability over a three year period has an r.m.s. variation of the order of 0.25% based on over 80 images collected over the DOME-C calibration site in Antarctica.*

Analysis of dark images collected over the Pacific Ocean at night and white images from the Antarctic test site show that the DMC has a higher Noise Equivalent Radiance (NER) than the Landsat satellites. However, detailed analysis has revealed the source of noise artefacts in the data which is related to the odd/even pixel readout of the linear CCD arrays, which once addressed will reduce the NER values to a comparable level to that of Landsat.

An outline of the calibration procedure and analysis methodology will be presented with summary statistics on the observed variations. Overall the UK-DMC has proven to be a very stable instrument with little or no variation in the absolute band and relative inter-band radiometry with a noise profile that once corrected approaches that of the Landsat 5 and 7 satellite systems.

THURSDAY, MARCH 22, 2007

Medium/High Resolution Imagery Session - Terry Lehman

- **NVision Rapid Image Processing and Distribution System for Satellite Data Commercialization in Vertical Industries** - Joel Lawhead, Craig Harvey – NVision
 - *Background: Currently an entire satellite image scene is the smallest unit of sale for imaging companies because of the processing and administrative and licensure overhead of selling smaller amounts of data or derivative products. Yet most new potential applications of Remote Sensing focus on abbreviated areas of interest relative to a full satellite scene, regardless of the satellite. Moreover, untapped markets typically will require a derivative information product rather than the raw data. This disconnect between profitability and actual market need has been an impediment to expanding the space based data market beyond the federal government. NVision Solutions Inc. created Web-based algorithms and software which can make it profitable for satellite image acquisition companies to provide high-level industry-specific real-time information as a service or a derivative image product.*

Introduction: NVision rapid image processing and distribution system can do virtually any automated combination of image operation in real-time on small and medium format satellite and aerial data for distribution via a customizable Web interface based on client, user, or operator needs. Intermediate products may be stored or deleted as they are created in real time. The distribution is not limited to image products but can be a high-level answer to specific questions about the state of national and international agriculture. Customers who wish to verify this type of information could then purchase a small subset of the source image from the satellite company rather than the entire scene through an automated order processing system similar to ordering books or software online. These sales would represent a new market and an expanded customer

base. The system is not limited in geographic scope. It can process an entire region or a single field.

Conclusion: Industries that immediately benefit from automated change detection include Precision Agriculture, Forestry, Homeland Security, Insurance, and Defense. A prototype system was developed in cooperation with NASA Stennis Space Center through a Dual Use Cooperative Agreement. NVision Solutions has elected to retain the intellectual property and stands ready to provide customized client solutions based on this technology breakthrough.

- **A System for Visualization, Evaluation, Analysis and Quality Simulation of Satellite Images** - Marcelo Fontenele S. Santos, Frederico dos Santos Liporace, Antonio Machado e Silva – Gisplan
 - *The objective of this work is to present a system developed to support the quality assessment of remote sensing satellite images.*

The system is divided in two modules, one for general use that allows viewing and evaluation of image quality, and another, of restricted use, for analysis and simulation of different scenarios.

The first module is developed to work on Linux and Windows and will be available for free from the Brazilian National Institute for Space Research (INPE). It allows the visualization of satellite images and the evaluation of the radiometric and geometric quality of those images.

Some of the computations performed for radiometric evaluation are: correlation between neighboring detectors for the identification of faulty detectors; difference of the mean and standard deviation on regions imaged by different detector arrays; and some parameters as mean, standard deviation, entropy and signal/noise.

Regarding geometric evaluation, the system computes parameters related to the internal and external geometry. The external geometry indicates the quality of the geographic positioning of the image, while the internal geometry indicates the precision when taking measures such as distance, area, angle, etc.

During geometric quality evaluation the system computes parameters such as translation, rotation, scale (and length variation), scale in orthogonal directions (and anisomorphism) and shear.

The second module is tightly coupled to the MS³ (Multi-Satellite Station System) and was developed to be used by INPE technicians in the MS³ environment (PC/Linux).

It allows analysis by using scenarios. Each scenario is composed by the viewing geometry, ephemeris data, attitude data, control-points, digital elevation models (DEM), among others parameters, linked to the geometric correction model. The operator can change the scenario parameters and compare the results obtained in different scenarios. An additional feature of this module is the detection of possible sources of geometric distortion for the different distortions observed during the geometric quality evaluation process.

In this way, it is possible to define the best source for ephemeris data, the best kind of attitude data and the ideal DEM resolution during orthorectification.

It can also be used to observe the influence that the precision of different kinds of data, related to the geometric correction process, have on the final image quality. For example, we could compare a scenario where the ephemeris data can be considered correct with another where the data has been contaminated with noise produced using its precision specification. The same procedure can be applied to attitude, control-points and DEM.

There are also radiometric analysis scenarios, where the operator can select which procedures and in which order they should be applied for the radiometric correction of the image. Also, the operator can compare the results obtained by using different calibration parameters.

The concept of a scenario also helps on the identification of sources of image quality degradation.

It is also possible to perform analytical studies by using simulation scenarios, including the modeling of new sensors. It could be used, for example, to evaluate the influence of the Attitude and Orbit Control System specification in the final image quality of a certain sensor, before it is launched.

- **Using Reflectance Based Calibration Technique for High/Medium Resolution Sensors** - David Aaron, Larry Leigh, Dennis Helder – SDSU
 - *Satellite imaging systems measure radiance values in terms of voltage levels. Conversion of the voltage levels to in-band, top of atmosphere radiance values is performed through gain coefficients or equations. Vicarious calibration, using the reflectance based calibration technique, is a direct methodology used to monitor and trend the gain coefficients. South Dakota State University's Satellite Calibration Group, in cooperation with Stennis Space Center, has maintained a continuing program for independent evaluation of sensor radiometric gain calibration for both high and medium resolution satellite sensor systems. Results from the 2006 collection season will be reported for the Orbview-3 high resolution, the Quickbird high resolution, and for the AWiFS medium resolution sensor systems.*

- **Earth Observations to Assess Impact of Hurricane Katrina on John C. Stennis Space Center** - Bill Graham - NASA
 - *The peril from hurricanes to Space Operations Centers is real and is forecast to continue; Katrina, Rita, and Wilma of 2005 and Charley, Frances, Ivan, and Jeanne of 2004 are sufficient motivation for NASA to develop a multi-center plan for preparedness and response. Remote sensing decision support provides critical insight for managing NASA infrastructure and assisting Center decision makers. Stennis Space Center's (SSC) Managers require geospatial information to manage the federal city. As was demonstrated at SSC in response to Hurricane Katrina, NASA Centers are efficiently activated as local command centers, playing host to Federal and State Agencies and first responders, to coordinate and provide evacuation, relocation, response, and recovery activities. Immediately following Katrina, Stennis Space Center's (SSC) power and network connections were down, hardware was inoperative, technical staff was displaced and/or out of contact, and graphical decision support tools were non-existent or less than fully effective. Despite this circumstance, SSC EOC implemented its response operations posture to assess damage and activate recovery plans. To assist Center Managers, the Applied Sciences Program (ASP) activated its archive of high-resolution data over the site. Supplementing this data, NASA obtained high resolution imagery, post-Katrina over SSC and much of the affected coastal areas from the Department of Defense (DOD) Clear View contract. The USGS EROS Data Center provided vital support by serving the Clear View imagery and other data through its "Hurricane Katrina Disaster Response" Web site clearinghouse.*

Integrating multiple image data types and other information sources, ASP applied an all-source solutions approach to develop decision support tools that enabled managers to respond to critical issues such as expedient access to infrastructure and deployment of resources, provision of temporary shelter, logistics control of critical supplies, and the mobilization and coordination of assets from ground crews to aircraft/airspace management. Furthermore, ASP developed information products that illustrate risks to SSC's infrastructure from surge, inundation, and flood. Current plans include developing wind-risk prototype products for refinement and adoption into EOC plans.

High Resolution Imagery Session - Terry Lehman

- **Use of High Resolution Orthoimage Data for European Union Agricultural Policy Implementation** - Dimitrios Kapnias, Simon Kay, Pavel Milenov, Pär Åstrand - IPSC
 - *The implementation and management of the Common Agricultural Policy (CAP) within the European Union (EU) has always been challenging, especially following enlargement from 15 to 27 member state countries (between 2004 and 2007). During this time, agricultural policy needs in the EU have become increasingly based upon geographically referenced data. In 2007, some 8.5 million farmers will be required to locate precisely their fields, in order to be assessed for subsidies relating to crop management and environmental concerns.*

The implementation of a Land Parcel Identification System (LPIS), based upon geographic data such as precise orthoimagery, has been the foundation for this field location need. For most EU countries, up-to-date airborne digital orthoimages at a product scale of 1:5,000 are used as the background for the implementation and maintenance of the LPIS; however, a number of countries have also used large area coverages of satellite data for the same purpose. Such data have been used for control of the agricultural subsidies since the 1992. Since then, the demand for HR and VHR imagery for control has greatly increased, steadily replacing the need for field visits and facilitating the communication with farmers.

The European Commission has lead the widespread application of such image data use, by providing scientific support, technical guidelines, specifications and financing, currently around €6m (~\$7.8m) for 2007. This presentation will cover the Commission's management of high resolution orthoimage use and dissemination via web portal services, and give an overview of future EC requirements and challenges in the context of agricultural policy.

- **Evaluation of Digital Surface Models Generated from High-Res Satellite Imagery** - Chunsun Zhang, Joanne Poon, Armin Gruen – SDSU
 - *This investigation explores the potential of stereoscopic high-resolution satellite imagery (HRSI), for producing digital surface models (DSMs) using an alternative sensor orientation model, namely bias-corrected rational polynomial coefficients (RPCs), and a hybrid image-matching algorithm. To serve both as a reference surface and a basis for comparison, a Lidar DSM was employed in the Hobart testfield, a region of differing terrain types and slope. The accuracy assessment took into account varying terrain conditions, with heighting accuracy determinations being carried out for 10 different rural and urban land cover classes. The results indicate that DSMs can be generated from stereo IKONOS Geo imagery to an accuracy of 1.7m to 4.5m (RMS, 1sigma) depending upon terrain and land cover conditions. Results improve markedly in feature-rich open and relatively flat terrain, with sub-pixel accuracy being achieved at check points surveyed using the global positioning system (GPS). This assessment demonstrates that the outlook for DSM generation from HRSI is very promising.*

- **QuickBird-2: Geolocation Statistics from 2005 and 2006, Showing the Transition to adp40** - Dr. Bryon Smiley – DigitalGlobe
 - *At JACIE 2006, DigitalGlobe presented quarterly geolocation statistics for imagery acquired throughout 2005. Toward the end of 2005, the 90th percentile of image CE90s rose to just beneath the 23 meter spec line. Further calculation suggested that better attitude files (produced using attitude determination program 4.0, or adp40) would improve the absolute geolocation accuracy, decreasing the 90th percentiles of all four quarterly bins to about 14 meters. adp40 was integrated into DigitalGlobe's production facilities on 15 May 2006. Geolocation statistics from 2005 and 2006 will be presented that show the transition to adp40 and the actual improvements will be compared to expectations.*

- **System Characterization Results for the QuickBird Sensor** - Kara Holekamp, Kenton Ross, Slawomir Blonski – SSAI / NASA SSC
 - *An overall system characterization was performed on several DigitalGlobe® QuickBird image products by the NASA Applied Research & Technology Project Office (formerly the Applied Sciences Directorate) at the John C. Stennis Space Center. This system characterization incorporated geopositional accuracy assessments, a spatial resolution assessment, and a radiometric calibration assessment. Geopositional assessments of standard georeferenced multispectral products were obtained using an array of accurately surveyed geodetic targets evenly spaced throughout a scene. Geopositional accuracy was calculated in terms of circular error. Spatial resolution of QuickBird panchromatic imagery was characterized based on edge response measurements using edge targets and the tilted-edge technique. Relative edge response was estimated as a geometric mean of normalized edge response differences measured in two directions of image pixels at points distanced from the edge by -0.5 and 0.5 of ground sample distance. A reflectance-based vicarious calibration approach, based on ground-based measurements and radiative transfer calculations, was used to estimate at-sensor radiance. These values were compared to those measured by the sensor to determine the sensor's radiometric accuracy. All imagery analyzed was acquired between fall 2005 and spring 2006. These*

characterization results were compared to previous years' results to identify any temporal drifts or trends.

- **IKONOS Performance and Technical Update** - Martin Taylor – GeoEye
 - *The IKONOS satellite continues to provide excellent service and performance after 7½ years on orbit. The most recent radiometric and geometric evaluations show that the instrument and vehicle are performing within specification with no significant disruptions to service. We will present the most current evaluations of radiometric stability, relative response, linearity, dark count and focus, along with an improved method of monitoring instrument radiometric response. We will also present on-going geometric evaluations, highlighting a recent investigation into our geometric processing algorithm and the resulting accuracy improvement.*
- **Case Study of IKONOS & OV-3 Stereo Photogrammetry in Support of Aircraft Arrival Procedures – Enhancing Capacity, Safety and Reducing Fuel costs** - Dejan Damjanovic – GeoEye
 - *At present, many airports in the world (approximately 14,000) would like to increase their hourly air traffic, but are constrained by capacity issues. These capacity issues are in turn caused by the amount of airspace that must be “reserved” around each aircraft, and the type of Arrival or Departure procedure that can be flown.*

Using GPS, GLONASS and eventually the European GALILEO navigation system, more efficient procedures can be found in and out of airports, but that requires performing a new analysis of the Terrain and Obstacles around the airport. The existing airport terrain & obstacle analysis is frequently not WGS-84 compliant, and thus not usable with GPS navigation devices.

Since 9/11, airport authorities worldwide have been increasingly reluctant to allow such analysis to be conducted using terrestrial aircraft sensors (due to security concerns). Stereo Satellite imagery from systems such as IKONOS and OV-3 can be used to conduct the same type of Terrain and Obstacle survey needed in support of these requirements.

We will present a project that we have recently completed in South America at 13 airports with hazardous terrain or hazardous obstacles. Stereo Photogrammetry using IKONOS, was used to construct complete 3D models of the airports surroundings, using BAE SOCET SET CLEARFLITE application.

These new procedures allow more airplanes per hour in and out of each airport, increase the safety margins in effect for each flight, and save the fuel burned for each flight. Actual completed GIS 3D models of airfield, terrain and obstacles will be shown along with the presentation.

Aerial Imagery Session - Jon Christopherson

- **National Agriculture Imagery Program (NAIP)** – Shirley Hall – USDA
 - *The U.S. Department of Agriculture’s Farm Service Agency implemented an innovative imagery acquisition program in 2003 called the National Agriculture Imagery Program (NAIP). Established to meet USDA’s compliance and programmatic imagery needs, the NAIP strategy is to collect 1 meter resolution orthoimagery over roughly 20% of the conterminous U.S. and 2 meter resolution orthoimagery over the remainder of the nation’s agricultural lands each year. In 2006, NAIP reached full scale operation, issuing nearly \$28.5 million in contract awards and acquiring 1 meter resolution imagery in 13 states and 2 meter resolution imagery over agricultural program lands in 35 states.*

NAIP has been able to significantly reduce imagery acquisition costs through successful cost-share partnerships with Federal, State and local entities, innovative procurement strategy, and effective utilization of changing technology. In addition to support for USDA and partner agency programs, other agencies and private industries have begun to realize the potential of NAIP to meet their operational needs. NAIP is also a key component of the proposed national imagery acquisition initiative; Imagery for the Nation.

- **Imagery for the Nation** - William Burgess – NSGIC
 - *The Imagery for the Nation (IFTN) initiative was introduced by the National States Geographic Information Council (NSGIC) in 2005. It is now being managed by the National Digital Orthophoto Program (NDOP). The basic elements of IFTN and its current state of development will be described in this presentation. Information will also be provided on a nationwide survey that was conducted during 2006 to determine if IFTN would gain broad acceptance and meet the business needs of government at all levels.*

- **Airborne Ortho-Mapping for Rapid Response** – Eric Liberty – APPLANIX
 - *The evolution of airborne Ortho-mapping for Rapid Response applications as a new and vital specialty within the remote sensing world is accelerating far more quickly than envisioned. What only recently became possible through modern developments in digital imaging technology and GNSS/IMU Direct Georeferencing capabilities, now presents emergency first-responders with several new capabilities for specific time-critical application needs. Applanix has encapsulated these into a new product offering called the DSS RapidOrtho. Case examples highlighting specific data collection efforts and processing efficiencies will be overviewed to demonstrate the effectiveness of using the DSS RapidOrtho product for Rapid Response applications.*

- **Geometric Calibration of the Buckeye** - Mitchell Pierson, Donald Moe - US Army Corp and SAIC/USGS/EROS
 - *The USGS has been providing support to the Corps of Engineers (COE) over the past year for the geometric calibration of the Buckeye, an off-the-shelf medium format digital camera system. The US Army is using this system with different focal length lenses for the acquisition of high-resolution imagery. These lenses contain large lens distortions that can be measured and modeled. Once modeled, it is possible to correct for these distortions such that the aero-triangulation solutions will provide the best possible accuracies at the ground.*

The first calibration of the COE lenses was done in the calibration laboratory of the EROS Data Center, where a calibration cage was multiply imaged and a free-network triangulation solution on the images was performed. Even though this procedure provides a very accurate modeling of the camera system, a much more economical and less time consuming procedure is needed. To this end, an in situ self-calibration technique and a field deployable laboratory substitute are being investigated. These techniques will provide either, or both, a full calibration capability or the verification of the current calibration. This presentation will describe the results of the first calibration method and report on the progress of the in situ method.

- **Mapping Underwater Benthic Habitats From ADS40 Digital Airborne Imagery Using Semi-Automated Methods** - Chad Lopez, Kass Green, Bill Stevenson, John Wood, Jim Simons, Dan Bubser, Keith Patterson, Harold Rempel, Anne Miglarese – EarthData International, The Alta Vista Company, PSGS at NOAA Coastal Services Center, Harte Research Institute, Texas A&M University-Corpus Christi, Coastal Fisheries Division, Texas Parks and Wildlife Department, Vineon, Inc., Avineon, Inc, EarthData International, EarthData International
 - *The state of Texas recently adopted a Seagrass Monitoring Program that calls for the mapping of seagrass beds along the Texas coast to assess status and trends. The NOAA Coastal Services Center (NOAA CSC) is working cooperatively with the Texas A&M University-Corpus Christi Center for Coastal Studies and the Coastal Fisheries Division of the Texas Parks and Wildlife Department to develop benthic habitat data to support this need. The NOAA CSC chose EarthData International and its partners The Alta Vista Company and Avineon, Inc. to map benthic habitats, primarily seagrass beds, along the coastal bend of Texas using ADS40 digital airborne imagery. Multiple object oriented mapping methods, including Feature Analyst class-by-class extraction, Feature Analyst unsupervised and Classification and Regression Tree (CART) Analysis, and Definiens Professional and CART analysis, were evaluated for a small pilot region in Redfish Bay, Texas. Accuracy assessment was performed for each method. Based on the pilot results, the method of image segmentation using Definiens Professional and classification through CART analysis was chosen for the full project area. Training sites in the form of polygons were collected both in the field and in the office through photointerpretation. A random selection of sites for each class was chosen for accuracy assessment and the remaining sites were used as signature training sites for CART analysis. Labeling rules for each class, created through CART analysis, were used to label every polygon across the entire project area. Once the class labels were*

applied, modeling and editing of incorrect polygon labels was performed based on local knowledge of the project area, previously collected field data, and field data collected on a subsequent signature validation trip. This paper presents the most recent results of this ongoing mapping project.

- **Medium-format Digital Cameras, a Study into the Calibration, Stability Analysis and Integration with High-Res Satellite Imagery** - Ayman Habib, Anna Jarvis, Gregory Stensaas - Geomatics Engineering/USGS
 - *The study of photogrammetry involves the determination of three-dimensional positional information from two-dimensional imagery. This information is used for countless applications, including ortho-image production, map creation, construction planning, and military reconnaissance. The type of camera traditionally employed for these various applications were large format analogue cameras. In recent years, however, the use of digital cameras for photogrammetric purposes has become more prevalent. The switch by some users from analogue to digital cameras has been fueled by the decreasing cost and increasing resolution capabilities of digital cameras. There are several other benefits that come from their use, some of which include: ease of use; availability; and rapid development. The use of digital cameras in photogrammetry will not completely replace analogue ones, however, since it cannot entirely compete with the ground coverage and resolution capabilities of film cameras. However, for close-range applications, or smaller flight blocks, digital cameras have become more practical and cost efficient. In addition to replacing analogue cameras in certain applications, digital photogrammetry has also spawned new markets in photogrammetry and mapping to emerge.*

The growth of the field as well as the increase in the diversity of applications has numerous advantages; however, there are a few issues of concern which must be addressed before digital imaging systems can be fully accepted as an alternative to analogue ones. These concerns include camera calibration and stability analysis. The calibration procedure for high accuracy analogue mapping cameras is traditionally performed by a regulating body (such as NRCan and the USGS), where trained professionals ensure that high calibration quality is upheld. There is, however, a wide spectrum of designs for digital cameras and it has thus become more practical for camera manufacturers and data providers to perform their own calibrations when dealing with digital cameras. In essence, the burden of the camera calibration has been shifted into the hands of the airborne data providers. The development of standards and procedures for simple and effective digital camera calibration for medium format digital cameras is outlined in this paper, after which a stability analysis procedure will be introduced while considering the different geo-referencing alternatives. Standards and specifications for calibration and stability analysis will be outlined, and the research will investigate the performance of medium format digital cameras for various applications using different georeferencing techniques, and suggests guidelines that can be adopted by the mapping industry. In addition, the investigation into the integration of MFDC with high resolution satellite imagery, for the purpose of enhancing the weak geometry of line scanners while benefiting from the large ground coverage offered by high resolution satellite imagery, will be presented.