

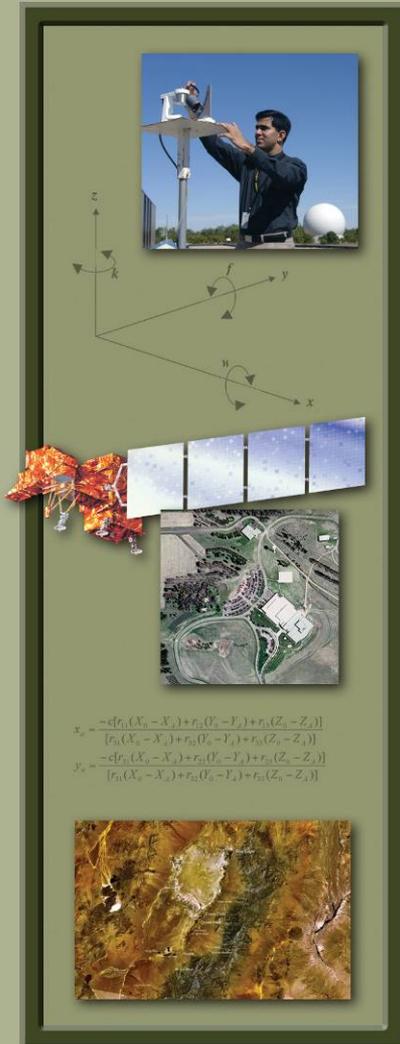


NDOP Meeting IADIWG Update Boulder, CO

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USGS Remote Sensing Technologies Project
<http://calval.cr.usgs.gov/>

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Overview

- **Background**
- **Digital Camera Calibration**
- **Quality Assurance Plan for Aerial Digital Imagery**
- **Lessons learned during Sensor Type Certification**
- **International Collaboration**
- **Conclusions**

Background



- **USGS Optical Sciences Lab (OSL) in Reston, VA**
 - ◆ Responsible for film camera calibration services in the U.S. since 1973
 - ◆ Built in 1953 for Nat'l Bureau of Standards
 - ◆ Recognized as a center of excellence for calibrating airborne film mapping cameras; only film camera calibration center remaining in the world
- **ASPRS panel of experts in 2000**
 - ◆ USGS should address digital aerial sensor and satellite calibration & characterizations processes
- **Digital Camera Calibration at USGS EROS (2002)**
 - ◆ Remote Sensing Technologies Project
<http://calval.cr.usgs.gov/>



Camera Calibration

- **Optical Sciences Lab (OSL) in Reston**

- ◆ USGS Certificate of Calibration for Film Cameras
- ◆ Continue with same process for film cameras and potentially evolving to in situ methods

- **USGS Digital Camera Research began in 2002**

- ◆ *In-Situ* calibration methods & software
- ◆ Laboratory Calibration - S/W (Australis) & control point cage

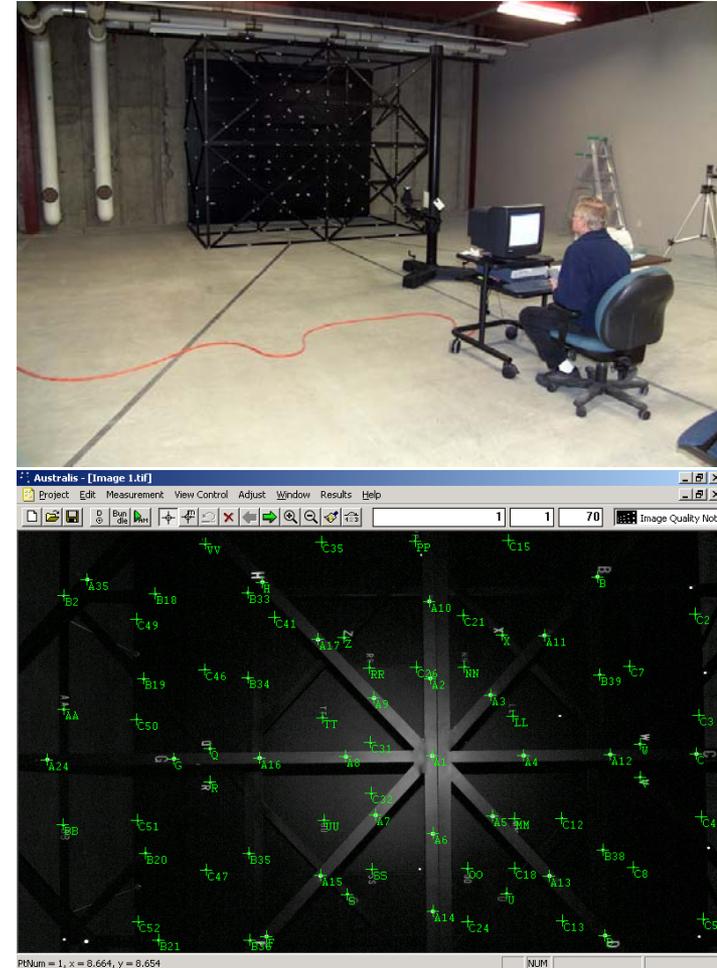


Remote Sensing Technologies Project

- **Satellite Characterization and Calibration**
 - ◆ US system calibration and characterization group
 - ◆ Landsat Data type assessment
 - ◆ Future of Land Imaging
 - **Aerial Mapping Sensor Characterization and Calibration**
 - ◆ Film Camera Calibration
 - ◆ Digital Aerial System Product Characterization
 - ◆ Digital Camera Calibration - Small/Medium Format Cameras
 - ◆ In-situ Calibration for analog and digital sensors
 - ◆ USGS Quality Assurance Plan for Digital Aerial Imagery
 - **Joint Agency Commercial Imagery Evaluation (JACIE) Team**
 - **Characterization and Calibration Sites**
 - **Instrumentation and Validation Sites**
 - **Assessment of new Remote Sensing Technologies**
 - **Commercial Data Acquisition and Management**
-

Digital Camera Calibration

- **USGS Control Point Cage**
 - ◆ Used to determine optical calibration of digital cameras
 - ◆ Usable on small- and medium-format cameras to calculate
 - ◆ Calibration processing is done via the Australis software
 - focal length, principal point offset, lens distortion, ...
- **Modulation Transfer Function target used for spatial resolution assessment**
- **Many contacts continue to call for digital camera calibration support**
- **Multiple cameras & lenses have been tested**



Quality Assurance Plan

- **Inter-Agency Digital Imagery Working Group (IADIWG)**

- ◆ 14 U.S. government agencies involved in aerial imaging, led by USGS
- ◆ USGS Quality Assurance Plan for Aerial Digital Imagery



Quality Assurance Plan

- **Four major components:**

- ◆ Contracting Guidelines
- ◆ Sensor Type Certification (formerly called Manufacturers Certification)
- ◆ Data Provider Certification
- ◆ Image Quality Assessment Guidelines

Status

- In general:

- ◆ Initial plan approved by IADIWG and USGS
- ◆ Briefed to ASPRS, MAPPS, and User Workshop
- ◆ Follow-on workshops being planned
- ◆ Continue to research sensor technologies

Status

- **Contracting Guidelines and Tools**

- ◆ Guidelines and tools for image specifications
- ◆ Best practices for quality specifications
- ◆ Quality assessment procedures
- ◆ Certifications will be used in contract evaluation process (starting with USGS and state and local government agencies)



Status

- **Sensor Type Certifications**

- ◆ Four certification visits completed

- Applanix DSS

- Intergraph DMC

- Microsoft Vexcel UltraCam D and X

- Leica ADS 40

- ◆ Revise process based on initial certification visits

Type Certifications

- **USGS certification completed:**

- ◆ Applanix DSS
 - http://www.applanix.com/products/dss_index.php
- ◆ Intergraph Zeiss DMC
 - <http://www.intergraph.com/dmc/>
- ◆ Microsoft Vexcel UltraCam D (new UltraCam X)
 - <http://www.vexcel.com/products/photogram/ultracam/>
- ◆ Leica ADS-40
 - <http://gi.leica-geosystems.com/LGISub1x2x0.aspx>

- **USGS certification requests**

- ◆ Digital Modular Camera (DiMAC)
 - <http://www.dimacsystems.com/>
- ◆ Airborne Data Systems
 - <http://www.airbornedatasystems.com/>
- ◆ And other inquiries



Status

- **Data Providers Certification**

- ◆ Initial plan drafted and in review
- ◆ Finalize plan and begin initial certifications
- ◆ Proposed network of in-situ ranges across country
- ◆ In-situ range specifications under development

Status

- **Quality Assessment Guidelines**

- ◆ Develop digital imagery evaluation tool, documentation, and contract QA/QC guidelines
- ◆ Update guidelines with QA/QC requirements
- ◆ Develop statistical QA/QC methods with recommended contract statistics baseline and performance guidelines



Lessons Learned

- **Common community agreement that an independent sensor certification process for use in acquisition tasks is needed**
- **Consistent definition of sensor calibration terminology and common type certification terms and processes are required**
- **Due to non-disclosure and proprietary information, difficult and time consuming to document the inspection findings without the manufacturer's careful review**
- **A standardized sensor certification would save time and money for both the certifying organization and the manufacturer**

Lessons Learned (cont.)

- **Need for National Acceptance and Implementation of Guidelines**

- ◆ Proper camera calibration was critical to USGS in-house production
- ◆ USGS imposed camera calibration contract requirements for its contracts
- ◆ Agencies at all levels of government are contracting using USGS requirements as the de facto standard
- ◆ USGS can only recommend guidelines and must educate others on the merits of using best practices to ensure the quality of geospatial products.
- ◆ Organizations and agencies must educate their constituents



Lessons Learned (cont.)

- **Guidelines needed for other sensors**
 - ◆ Similar guidelines needed for LiDAR, SAR, IFSAR, and other sensor systems
 - ◆ A general governance model and best practices guidelines need for all sensors

International Collaboration

- ***In-situ characterization methods address calibration stability but doesn't remove the need for calibration***
- ***Software developed via OSU and U of Calgary***
 - ◆ *In-Situ Procedure*
 - Photogrammetric Aero Triangulation (EO) (position/attitude)
 - Interior Calibration (Focal Length/Principal Point/Distortions)
 - ◆ Working with Ayman Habib from U of Calgary
 - Upgrading Bundle Adjustment and Self Calibration (BASC) package to include features and new tools
 - MSAT – Multiple Sensor Advance Triangulation tool
 - Resample – mensuration tool
 - CAST – Camera Stability software



International Collaboration (cont.)

- **Many cameras being sold internationally**

- ◆ Manufacturers all setting up offices worldwide
- ◆ No commonly accepted procedure that is universally used by all
- ◆ Work with International Agencies to establish common and collaborative processes

- **September 2007 GIM International Article – USGS QA Plan**

- **EuroSDR – Dr. Cramer**

- ◆ **European Digital Airborne Camera Certification – EuroDAC²**

- Radiometric and Small/Medium Format camera programs
- PhotoWeek 2007 (USGS paper and EuroSDR papers) (100 year in 2009)
- September 2007 GIM Article
- <http://www.ifp.uni-stuttgart.de/default.en.htm>



International Collaboration (cont.)

- **Australia – Paul Duncan- ICSM**
- **Canada BC Ministry of Agriculture and Lands – Paul Quackenbush**
 - ◆ Community of Practice and Specifications
 - MFDC, LiDAR, Triangulation
 - ◆ Joint S/W development with University of Calgary
- **Asia – emails and correspondence**
- **Need in-situ test site specifications and guidelines**
 - ◆ World-wide test sites
 - http://calval.cr.usgs.gov/sites_catalog_map.php



Conclusions

- **Currently each country, agency, procurement authority, or user establishes criteria for sensor performance acceptance**
 - ◆ Inefficient, time-consuming, and delays acceptance of new technology
 - ◆ Similar or reciprocal sensor type certification processes and other quality processes would benefit the manufacturers and data providers
 - ◆ Beneficial to the end-user benefits from a quality product for applications
- **USGS is interested in collaboration on research, standards development, and certification processes**
- **National working groups, such as IADIWG, EuroSDR, and Canada BMGS, should be extended to an international working group**



Conclusions (cont.)

- **Recommend that the ASPRS and ISPRS Commission I establish a process to work toward a worldwide standard methodology for calibration and certification**
 - ◆ Worldwide sensor type certification process would be beneficial to all those involved in the data acquisition and production process.
 - ◆ Technologies are global and the reciprocal acceptance of another organization's sensor certification is feasible worldwide
 - ◆ ASPRS and ISPRS are best positioned to foster worldwide acceptance of a standard certification process for remote sensing technologies



Thank you

- See: <http://calval.cr.usgs.gov/>
- Questions??