Geometric Assessment of DMC Data

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Presented By: Gyanesh Chander*, SAIC

Mike Choate, SAIC
Contract employee under U.S. Geological Survey contract 03CRCN0001
Outline and Introduction

- Landsat 7 Image Assessment System (IAS)
  - Background
  - Expanding the use of IAS
- IAS Geometric Assessment Tools
  - Image to Image assessment
  - Band to Band assessment
  - Ground Control
- SSTL DMC Background
  - Data Sets
  - Statistics
  - Vector Plots
- Conclusions
Landsat 7 (L7) Image Assessment System (IAS)

- The IAS is responsible for offline assessment of image quality to ensure compliance with the radiometric and geometric requirements of the L7 spacecraft and the ETM+ sensor throughout the mission
  - IAS is part of the ground processing system and located at the USGS EROS
  - The NASA GSFC LPSO works with the IAS in analyzing the calibration information and updating the algorithms used within the IAS
  - One of the most important roles of the IAS is generation of the Calibration Parameter File (CPF) that contains all of the necessary parameters for generating a Level-1 products

- IAS is staffed by 3+ FTE
  - Geometric, Radiometric, Spatial expertise
  - Request satellite tasking
  - Coordinate data quality with International partners
L7 ETM+ IAS

Since L7 Launch on April 15, 1999 the IAS has processed

- Generate 1R-FASC 199
- Generate 1R-Night Char 654
- Generate 1R-PASC 2009
- Generate 1R-Day Char 10850
- MTF Characterization 79
- Sensor Alignment 259
- Band to Band 350
- Geodetic Accuracy 1990

- Capable of determining & monitoring gain, bias, noises, & artifacts on a per-detector basis over life of mission
- Calibration trending database over 100 GB today
- Today, Landsat 7 is one of the best-calibrated sensors on orbit
Leveraging L7 IAS

● Expanding the IAS – Working Backward
  ♦ IAS is used as prototype for Thematic Mapper (TM) image assessment system (TMIAS)
    ● Accomplished in partnership with SDSU
    ● Adaptation straightforward: extremely similar instruments

● Expanding the IAS – Working Forward
  ♦ IAS is used as prototype for Advanced Land Imager (ALI) assessment system (ALIAS)
  ♦ IAS tools used for assessment of other sensors and datasets
    ● SSTL DMC, CBERS-2, IRS-P6, Orbview-3
Geometric Supersites

- Supersites are geo-referenced images derived from high resolution source
- L7 IAS was used to build ground reference data sets (supersites)
  - Built from Digital Orthophoto Quadrangulsa (DOQs)
  - DOQs are designed to meet national mapping accuracy standards of 1:24k maps, or ~6 meters
  - Inspection with highly accurate GPS surveyed locations showed most DOQs exceeded 6 meters
- DOQs are mosaiced to create a data set equal to one WRS-2 nominal swath
  - Resampled to match Landsat resolution - 1 meter DOQs reduced in resolution to match PAN band (15m for ETM+ and 10m for ALI)
  - Image chips are pulled from DOQ mosaics
  - USGS 1 arc second DEMs used for ground control height
  - Currently 30 data sets available - these supersites are used for Landsat geometric calibration by using them as geodetic controls
Note that individual DOQ files are visible in the mosaic.
Landsat WRS-2 Supersite Locations
Disaster Monitoring Constellation (DMC)

- The DMC design, consists of a three band imager with a green, red and NIR band that are set to similar band passes as Landsat bands 2, 3 and 4.
- The imager has 32m spatial resolution with a 640 km swath. This is achieved by having two separate banks of cameras, each covering half the swath and overlapping at Nadir.
- DMC data was provided under Technical Assistance Agreement (TAA) UK-08.0000, ACIS Reference ID # 8512 between the USGS and SSTL dated 29 September 2005.
  - The scope of the TAA effort allowed for the USGS RST Project to assist in the radiometric and geometric calibration of the DMC satellites.
Eight L1T DMC images were available
  - L1T utilizes GeoCover imagery for ground control
  - 1km elevation used to account for terrain effects; Global One-km Base Elevation (GLOBE) Project
  - UTM Projection, North Up, WGS84, 32 meter pixel size

DOQ available over 6 data sets
  - I2I performed against DOQ mosaics (6 images)
  - B2B alignment assessment against all 8 DMC images
### DMC Images

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IAS Geometric Tools – I2I

- IAS contains Image to Image (I2I) registration assessment tool
  - I2I characterization is usually performed to compare the relative accuracy between two images
  - One image is selected as reference and another as the search image
  - Points / Image chips (small area of about 64x64 pixel) are selected from reference image and are correlated with the search image
  - The co-registration results provides an insight to the relative accuracy of the search image with respect to the reference image
  - When the correlated points were plotted in the image, it also helps to detect any systematic bias in the image
- Provides numerical evaluation of accuracy of common bands of temporally distinct ETM+ images
- No real restriction on image data sets that can be used, other sensor can be used in assessment
The RMSE measured between the DMC and reference data sets ranged from 7.03 to 23.53 meters in the X direction and 26.20 to 36.67 meters in the Y direction.
Vector Residuals Between DMC and DOQ Mosaic Image
Vectors are Scaled by a Factor of 4000

In all six comparisons there was a slight bias in the line, or more likely along track, direction

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IAS Geometric Tools – B2B

- **IAS contains Band to Band (B2B) registration assessment tool**
  - B2B characterization is performed to ensure that the proper band alignment parameters are provided for the product generation
  - With Landsat, it is typically done by registering each band against every other band (resample bands of higher resolution to coarse resolution)
  - A reference band is selected (with L7 its band 8) and all other bands are adjusted (offset determined) by least square adjustment of the registration solution
  - These band offsets are provided in the CPF so that product generation system can align bands accordingly

- Provides numerical evaluation of accuracy of between band registration within an image

- No real restriction on image data sets that can be used, other sensor can be used in assessment
# Band-to-Band Assessment

Values listed in pixels

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Band-to-Band Assessment Vector Plot (Vectors scaled by a factor of 3000)
Band-to-Band Assessment Vector Plot
(Vectors scaled by a factor of 3000)
Band-to-Band Assessment Vector Plot (Vectors scaled by a factor of 3000)
Band-to-Band Assessment Vector Plot
(Vectors scaled by a factor of 3000)
Conclusion

- Eight SSTL DMC L1T Images were assessed
  - Six scenes compared against reference imagery
  - Eight scenes assessed for band registration
- The RMSE measured between the DMC and reference data sets ranged from
  - 7.03 to 23.53 meters (0.22-0.74 pixels) in the X direction
  - 26.20 to 36.67 meters (0.82-1.15 pixels) in the Y direction
- The RMSE band alignment offsets measured within the DMC data sets had values of up to
  - 12.03 meters (0.37 pixels) in the line direction and
  - 20.03 meters (0.62 pixels) in the sample direction