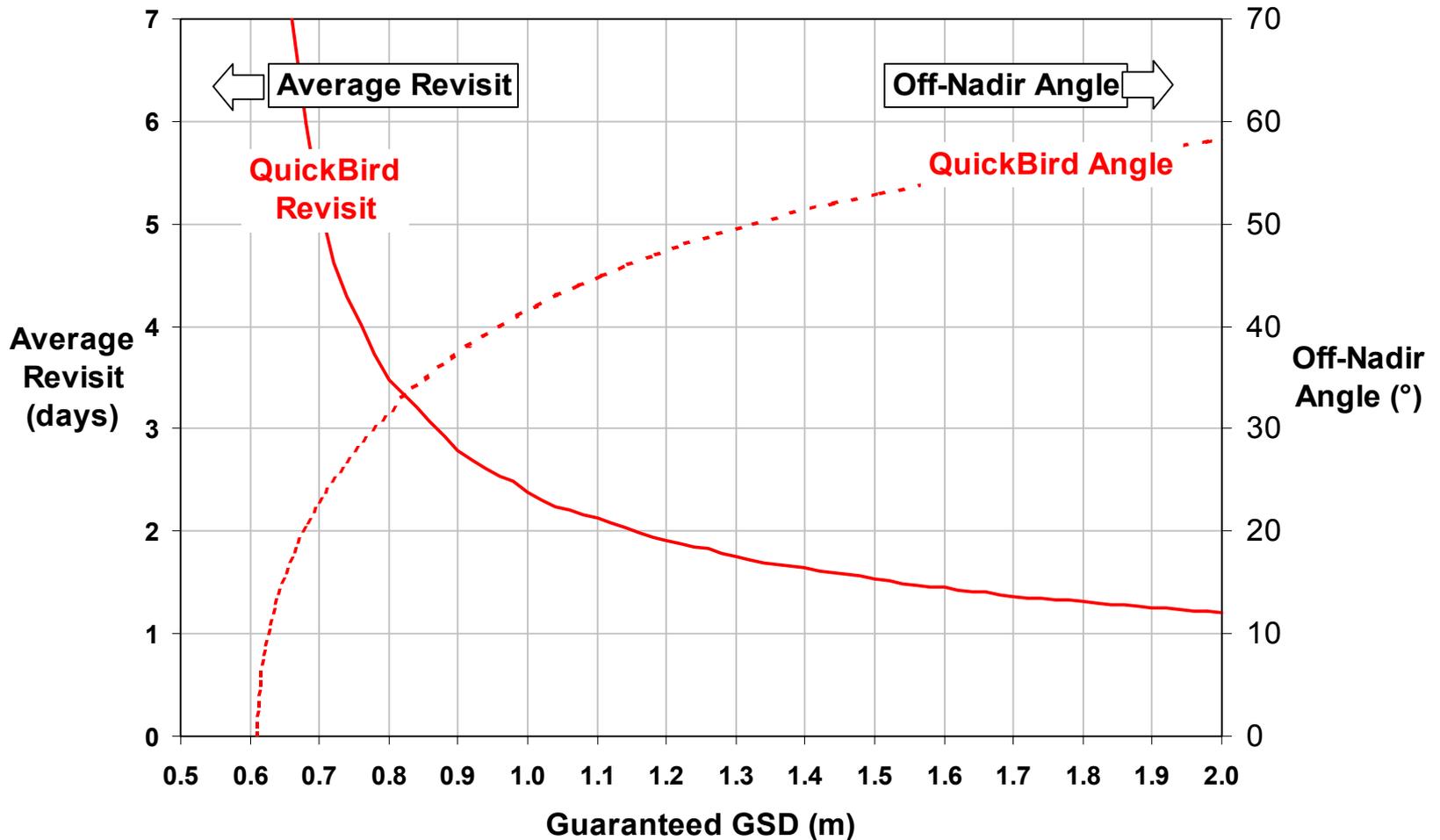# QuickBird-2 System Description and Product Overview

**presented by**
# Jeff Liedtke

JACIE Workshop
March 25 – 27, 2002
Washington D.C.

# Revisit Times / GSD

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Sample Target At 40° North Latitude, Over 1 Year

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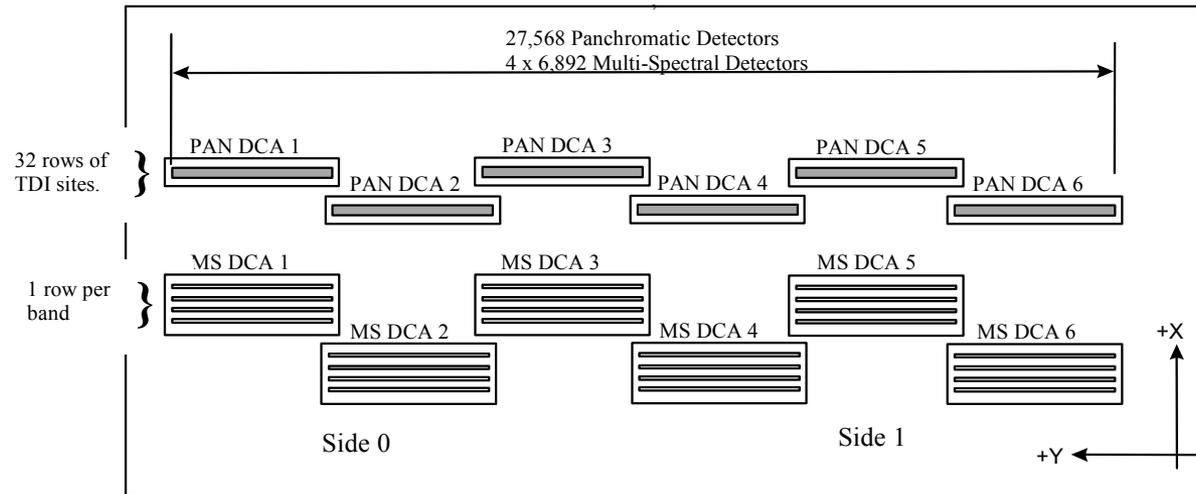
# Bands

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- Pan band is determined by silicon response.

- MS bands designed to match nominal Landsat bands.

- Actual bands (average 50% response points) are as follows :

  - Pan      515 – 875 nm
  - Blue      448.5 – 512.3 nm
  - Green      498.8 – 594.1 nm
  - Red      622.6 – 688.9 nm
  - NIR      759.1 – 863.4 nm



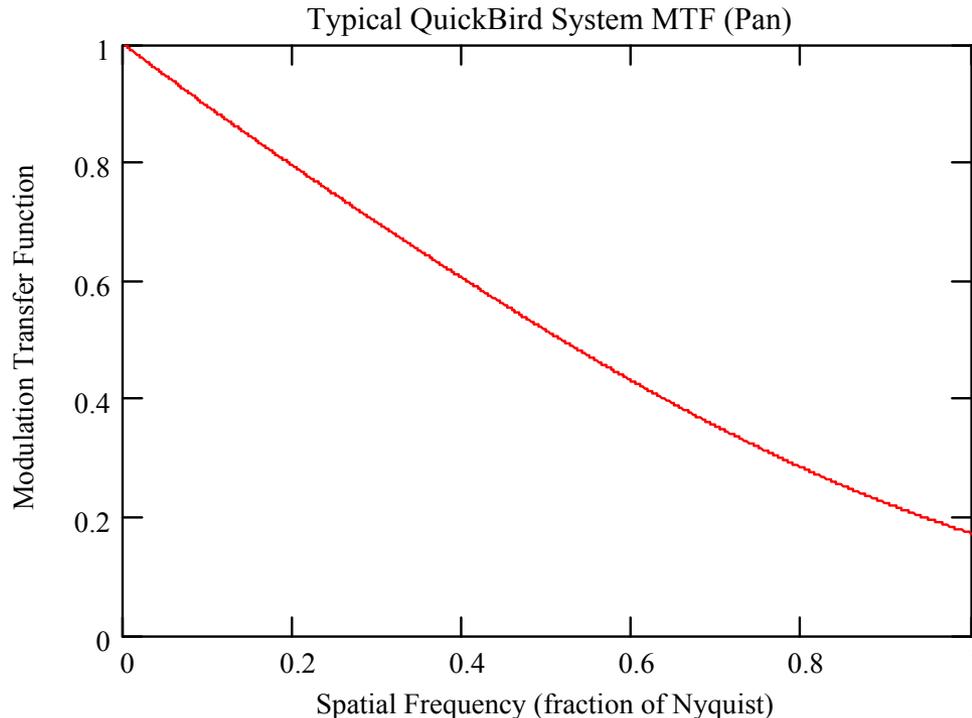System Effective Spectral Quantum Efficiency
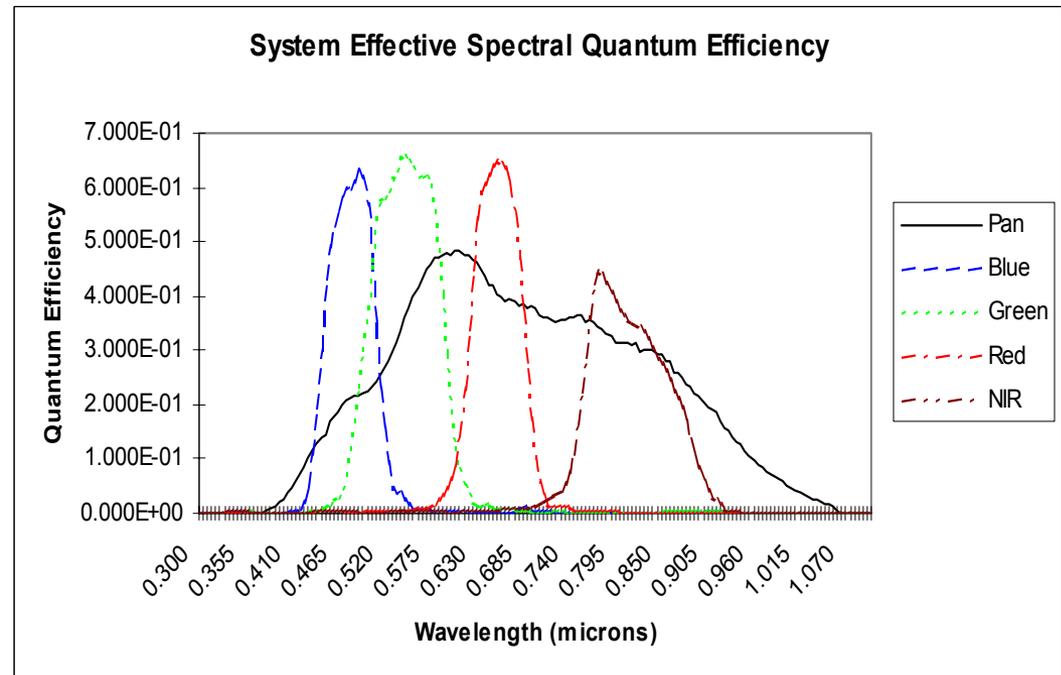
# Focal Plane Layout



- The QuickBird focal plane consists of
  - 6 staggered pan arrays, with 32 TDI stages each
  - 6 staggered MS arrays, with four linear arrays each

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# Measured Performance (MTF)

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- Typical pan system MTF at the Nyquist frequency is approximately 0.17 along track, 0.21 cross-track, across field of view and over orbit, with focus optimized.
    - The average edge response slope is about 54% between – ½ pixel and + ½ pixel
- MTF for MS more difficult to measure on-orbit due to lack of large edge targets, but is expected to be be between 0.25 and 0.40, based on modeling.

Typical QuickBird System MTF (Pan)

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# Geolocation

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- Geolocation activities progressing on schedule
- Significant improvements in both absolute and relative geolocation on a weekly basis
- Continuing to improve camera model, attitude and ephemeris errors

| | Including topo displacement & view angle errors | Excluding topo displacement & view angle errors |
|---|---|---|
| **Accuracy Goal** | 82m CE90 | 23m CE90 |
| **Today's Performance** | 100m CE90 | TBD |

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# QuickBird Basic Imagery

- Radiometric Corrections

- Sensor Corrections
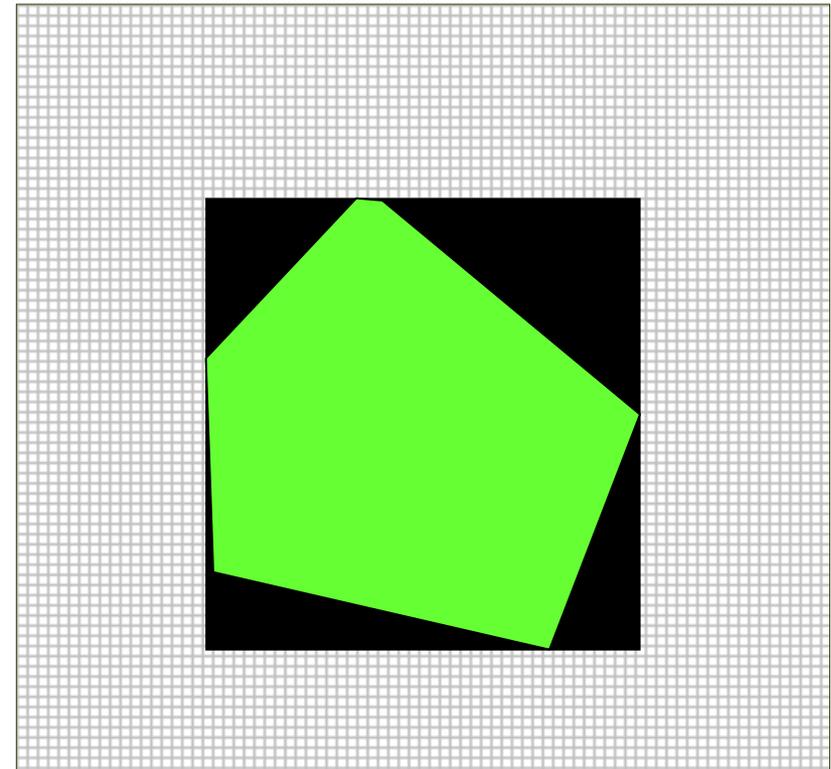
- No Geometric Corrections

- Full scene delivery

- GSD varies with off-nadir angle

  - 61cm (nadir) to 72cm (25°) Pan

  - 2.44m (nadir) to 2.88m (25°) MS

columns
27,552 (pan)
6,888 (MS)

rows
27,424 (pan)
6,856 (MS)
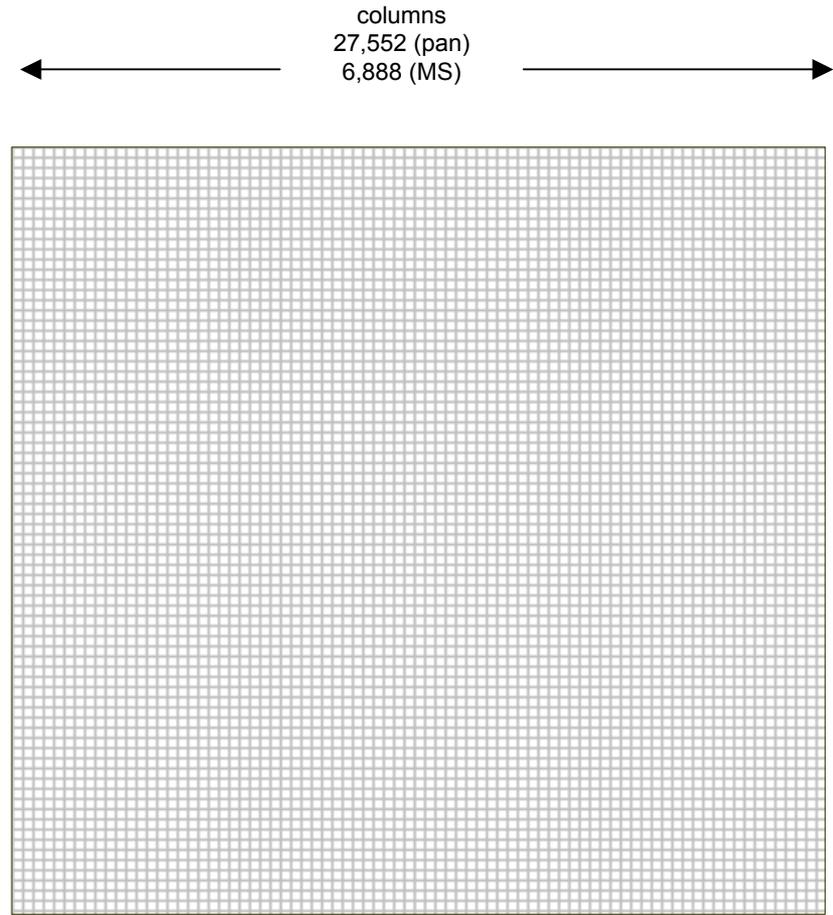
|        | Panchromatic | Multispectral |
|--------|--------------|---------------|
| 8 bit  | 800MB        | 200MB         |
| 16 bit | 1.6GB        | 400MB         |

# Standard Imagery

- **<u>Geometrically corrected</u>**
- Radiometric & sensor corrections
- Resampled to a map projection
- 70cm pan, 2.8m MS
- Customer defined area
  - available by square kilometer with 64 km$^2$ minimum
- Accuracy – 82m CE90%
  - Includes terrain and view angle affects



| | | Panchromatic | Multispectral |
|---|---|---|---|
| 64km$^2$ | 8 bit | 136MB | 34MB |
| | 16 bit | 272MB | 68MB |
| 100km$^2$ | 8 bit | 212MB | 53MB |
| | 16 bit | 424MB | 106MB |

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# Orthorectified Imagery

- Ortho corrected/corrected for topographic distortions
- Radiometric & sensor corrections
- resampled to a map projection
- 70cm pan, 2.8m MS
- Customer defined area
  - available by square km with 64km$^2$ minimum



| Orthorectified Product Level | CE 90% | RMSE |
|---|---|---|
| 1:50,000 | 25.0 m | 15.2 m |
| 1:25,000 | 12.5 m | 7.6 m |
| 1:24,000 | 12.0 m | 7.3 m |
| 1:12,000 | 10.0 m | 6.1 m |
| 1:10,000 | 8.3 m | 5.0 m |

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# QuickBird Panchromatic Imagery

- 61 – 72-centimeter
  - Basic Imagery
- 70-centimeter
  - Standard
  - Orthorectified Imagery
- 11-bit dynamic range
  - 16 bit file
  - 8 bit file (linear transformation)
- 450-900 nm spectral



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# QuickBird Multispectral Imagery

- 2.44 – 2.88-meter
  - Basic Imagery
- 2.8-meter
  - Standard
  - Orthorectified Imagery
- 11-bit Dynamic Range

- Blue: 450-520 nm
- Green: 520-600 nm
- Red: 630-690 nm
- NIR: 760-900 nm

# Product Metadata

- Defines image collection and product processing information
- Contains the End User License Agreement
- Defines satellite collection and telemetry information
- Defines Rational Polynomial Coefficients (RPCs)

| | Extension | Basic Imagery | Standard Imagery |
|---|---|---|---|
| **Attitude** | .att | **XX** | |
| **Ephemeris** | .eph | **XX** | |
| **Geometric Calibration File** | .geo | **XX** | |
| **Image Metadata File** | .imd | **XX** | **XX** |
| **License File** | .txt | **XX** | **XX** |
| **README file** | .txt | **XX** | **XX** |
| **RPC00B File** | .rpb | **XX** | **XX** |
| **Tile Map File** | .til | | **XX** |

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# Standard QuickBird Product Pricing

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## Product Base Price

| Product Type | Description | Base Price<br><br>panchromatic or multispectral<br><br>Price km$^2$ (USD) | Base Price<br><br>panchromatic or multispectral<br><br>Price mi$^2$ (USD) | Product Options | |
| --- | --- | --- | --- | --- | --- |
| | | | | **Both**<br><br>panchromatic and multispectral | **Pan-sharpened**<br><br>natural color or color infrared |
| Basic Imagery | Radiometric & sensor correction only. Minimum order is 1 scene (272km$^2$). | $30 | $80 | + 50% | NA |
| Standard Imagery | Radiometric, sensor & geometric correction. Minimum order is 64km$^2$/25mi$^2$. | $30 | $80 | + 50% | + 25% |
| Orthorectified Imagery | Radiometric, sensor & orthographic correction to meet specified accuracy. Minimum order 64km$^2$/25mi$^2$. | | | | |
| 1:50,000[1] | | $35 | $93 | + 50% | + 25% |
| 1:25,000[1] | | $45 | $119 | + 50% | + 25% |
| 1:24,000[1] | | $45 | $119 | + 50% | + 25% |
| 1:12,000[1] | | $60 | $159 | + 50% | + 25% |
| 1:10,000[1] | | $70 | $185 | + 50% | + 25% |

[1]Subject to availability of appropriate DEMs and GCPs

Prices for Basic and Standard Imagery, panchromatic and multispectral available today. Other products and options available soon.

# End User License Agreements

| License Type | Fee |
|---|---|
| **Single Site** | **Included** |
| **Single Organization** | **+ 25%** |
| **Multiple Organization** | |
| **2 Organizations** | **+ 50%** |
| **3 - 5 Organizations** | **+ 100%** |
| **6 - 10 Organizations** | **+ 150%** |
| **11 or more Organizations** | **as negotiated** |

# Standard QuickBird Product Delivery

**Order Priority**

| Order Priority | Fee | Time between order placement and start collection date | Image Acquisition Window | Minimum order size | Maximum order size |
|---|---|---|---|---|---|
| Standard | Included | 5 days | > 14 days | Standard | $10,000km^2$ |
| Priority | + 50% | 5 days | $\leq$ 14 days | Standard | 2 scenes |

- Standard delivery (2 day USA; 5 day International) on media or ftp is included in product price

- An additional charge will be assessed for
    - Additional copies of products
    - Rush delivery

# Quality Assurance & Control Background

- To ensure products meet DigitalGlobe's established quality standards, image and product quality are monitored at various stages of:
    - image ingest,
    - product formation, and,
    - delivery
- DigitalGlobe assesses the quality of each product according to internal procedures; some procedures are automated while some are manual.

# Quality Control Background

- DigitalGlobe products are evaluated for four types of anomalies;
    - radiometric
    - geometric
    - image
    - processing
- Initial qualitative assessment is performed upon receipt of imagery at the Longmont facility from the Remote Ground Terminals.  Initial qualitative image assessment consists of:
    - cloud cover assessment and,
    - image quality based on environmental factors such as:
        - Haze, fog
        - Smoke
        - Shadows

# Initial Image Quality Assessment

- **Analyses:**

    - Conduct analysis of data following collection

    - Assess usability of imagery against order requirements

    - Characterize cloud cover estimates for future use

    - Ensure usability of imagery to fulfill customer orders

    - Detect and resolve problems related to cloud cover assessment

    - Conduct review of initial problem reports

    - Early detection of image anomalies

# Radiometric Quality Assessment

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- Imagery assessed for the following radiometric anomalies:
    - Apparent Bit Error
    - Banding
    - Bright Object Anomaly
    - Compression Artifact(s)
    - Excessive Saturation
    - Over Exposure
    - Under Exposure
    - Low SNR
    - Spectral Banding
    - Streaking
    - Wrong TDI
    - Other Radiometric error

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# Geometric Quality Assessment

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- Imagery assessed for the following Geometric anomalies:
    - Band misregistration
    - DCA stitch error
    - Drift
    - Excessive absolute geolocation error
    - Excessive relative geolocation error
    - Excessive pointing error
    - GCP geolocation error
    - GCP obscured
    - Inadequate overlap of order
    - Seam or Break
    - Skew
    - Other Geometric Anomaly

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# Image Quality Assessment

- Imagery assessed for the following technical anomalies:
    - ACS problem
    - Dropouts or gaps in imagery
    - Incorrect calibration params applied
    - Jitter
    - Missing or incorrect support data
    - Out of focus
    - Spatially uniform smear
    - Spatially varying smear
    - Wrong image or area of interest
    - Other image quality anomaly

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# Image and Product Quality Assessment

- Imagery assessed for proper processing:
  - **Metadata Checks for Basic 1A:**
    - DDD Date incorrect
    - License Type incorrect
    - Cloud Cover incorrect
    - Off Nadir Angle incorrect
    - Band ID incorrect
    - Output Format incorrect
    - NRD Fill incorrect
    - Radiometric Correction incorrect
    - Delivery Media incorrect
    - Geolocation coordinates incorrect
  - **Metadata Checks for Basic 1B = Basic 1A +:**
    - Dynamic Range incorrect
    - Resampling Kernel incorrect

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# Image and Product Quality Assessment

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- Imagery assessed for proper processing:
  - **Metadata Checks for 2A = 1B +:**
    - Pan Sharpening per order incorrect
    - Tiling per order incorrect
    - Pixel Spacing incorrect
    - Map Projection per order incorrect
    - Datum per order incorrect
    - Area of Interest per order incorrect
  - **Product Checks per order:**
    - Verify all metadata params above are applied to product, plus:
    - MBR for AOI orders incorrect
    - Delivery media flaws (open data)
    - Other processing anomaly

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# Quantifying Quality

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- Procedure quantifies a repeatable qualitative assessment process

- QC Assessment uses two forms:

  - Existing Product QC Checklist used to record <u>Product and Processing Anomalies</u> (order parameters & metadata)

  - Product Anomaly Severity Matrix

    - Quantifies severity of anomalies identified in the "Image and Product Anomaly Table ", including:

      - Radiometric, Geometric, Image Quality, Product Processing
      - Environmental anomalies are not addressed at this time

- Severities are are compiled for products & pass/fail determined by a threshold depending on product size (anomaly density)

# Product Pass/Fail

- Forms for Quality Controlled products are stored in the appropriate pass/fail directory

- Product that pass QC are packaged, shipped and invoiced

- Products that do not pass QC are sent to Customer Service to confirm that the client wants the product

  - If Customer rejects product, the order is cancelled and/or portion not meeting QC retasked

  - If the Customer wants the product, the order is packaged, shipped and invoiced

  - Customer has two weeks to accept or reject the order