



IKONOS, 2004.09.18  
(40.30 N, 104.76 W)

## The GeoEye Satellite Constellation

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March 14, 2006

JACIE 2006



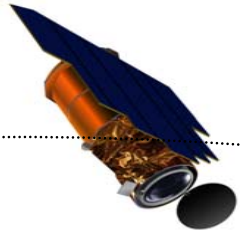
# The GeoEye Constellation



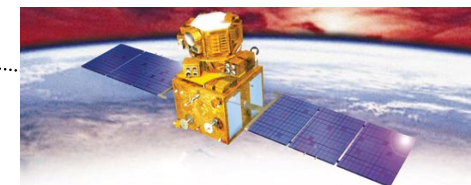
**OrbView-2**  
August 1997



**IKONOS**  
September 1999

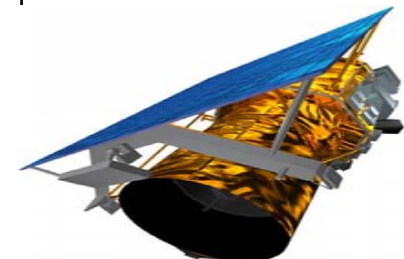


**OrbView-3**  
June 2003



**RESOURCESAT-1**  
October 2003

- GeoEye Constellation
  - OrbView-2
  - OrbView-3
  - IKONOS™
  - IRS RESOURCESAT-1
- Calibration/Validation
  - Image Quality
  - Radiometry
  - Geometric Accuracy
  - Satellite Lifetime
  - Collection Capacity



**GeoEye-1**  
Spring 2007

# IKONOS

- Launch
  - September 24, 1999
- Orbit
  - 681 km, Sun-synchronous
  - 10:20 equatorial crossing
- Imaging Sensors
  - 82 cm Pan, 3.2 m MS
    - Blue, Green, Red, NIR
  - 11 km swath
  - 11-bit radiometry
- Collection
  - Agile pointing & scanning
  - Bidirectional scanning
  - Mono or Stereo
- Revisit
  - 3 day at 60° elevation
  - 1 day at 45° elevation



# IKONOS – 1-meter Color



# IKONOS Image Products

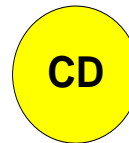
Product	Accuracy
Geo	15m CE90 <sup>(1)</sup>
Geo Ortho-Kit <sup>(3)</sup>	15m CE90 <sup>(1)</sup>
Standard Ortho	50 m CE90
Reference Orthomosaic	25m CE90
Pro Orthomosaic	10m CE90
Precision Orthomosaic	4m CE90 <sup>(2)</sup>
Reference Stereo <sup>(3)</sup>	25m CE90 22m LE90
Precision Stereo <sup>(3)</sup>	4m CE90 <sup>(2)</sup> 6m LE90 <sup>(2)</sup>
Terrain Model	12m LE90

## Formats:

CIB  
NITF<sup>(3)</sup>  
J2000  
GeoTIFF  
8/11 bits

## Band Combinations:

1m Pan  
4m MSI<sup>(\*)</sup>  
1m Color<sup>(\*)</sup>  
1m Pan + 4m MSI<sup>(\*)</sup>  
<sup>(\*)</sup>RGB, CIR, or BGRN



Disk

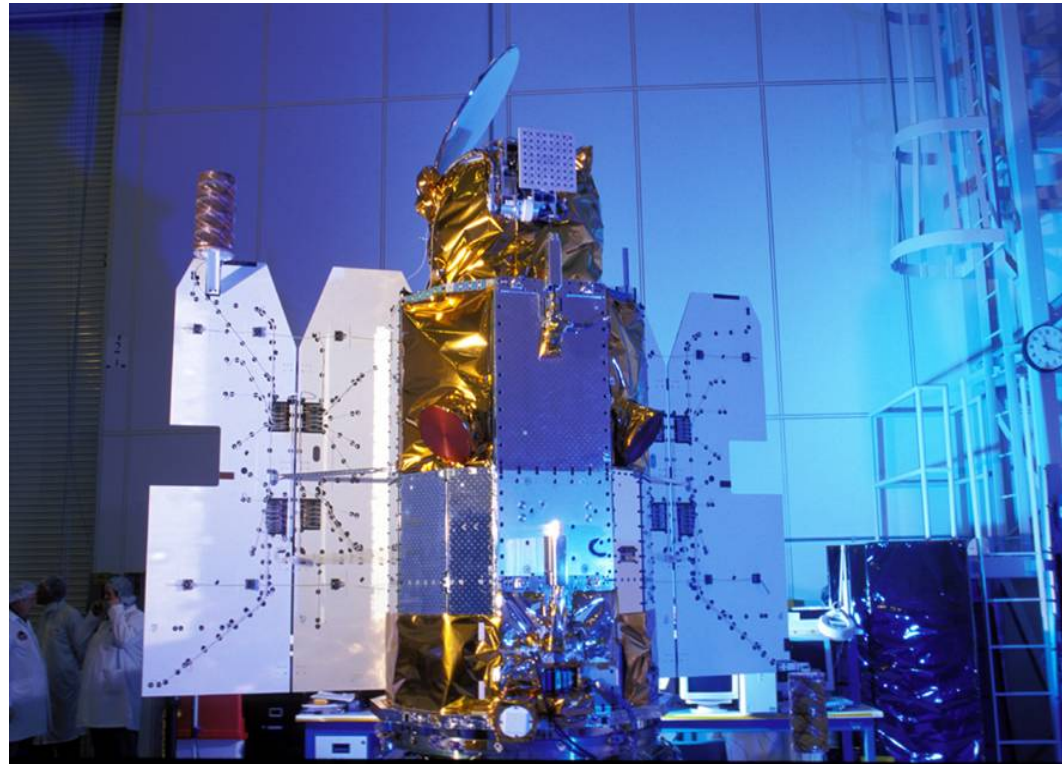


Electronic

- (1) Geo accuracy is exclusive of terrain.  
 (2) Ground Control Points required for precision.  
 (3) Includes RPC Camera Model

# OrbView-3

- Launch
  - June 26, 2003
- Orbit
  - 470 km, Sun-synchronous
  - 10:30 equatorial crossing
- Imaging Sensors
  - 1 m Pan or 4 m MS imagery
    - Blue, Green, Red, NIR
  - 11-bit radiometry
  - 8 km swath at nadir
- Collection
  - NS or EW scanning
  - Mono or Stereo
- Revisit
  - 3 day at 35° elevation



# OrbView-3 1 m Pan & 4 m MS Images



Great Pyramids of Giza, Egypt



Sand Island, near Midway

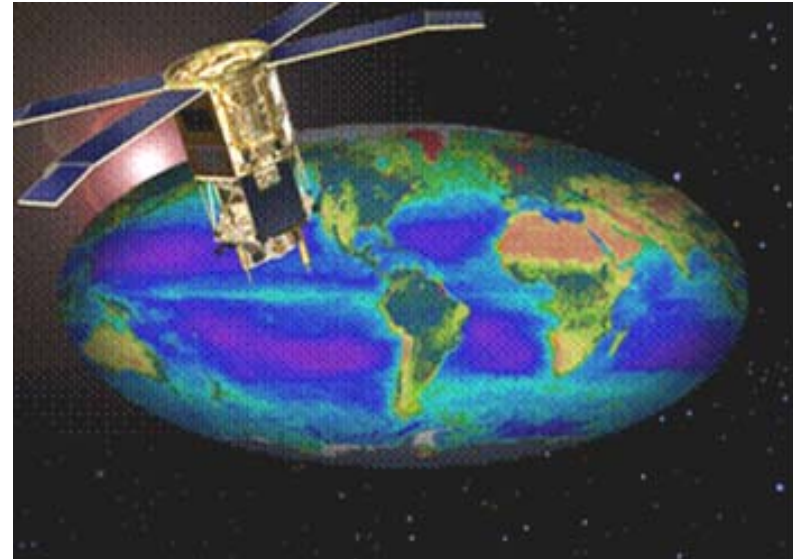
# OrbView-3 Products

- Imagery Products
  - Basic Data Sets
    - Basic Express
    - Basic Enhanced
    - Basic 1:50k
    - Basic 1:24k
    - Basic 1:12k (Future)
  - Geo Data Sets
    - GEO Express
    - GEO 1:50k
    - GEO 1:24k
    - GEO 1:12k (Future)
  - Ortho Data Sets
    - Ortho 1:50k
    - Ortho 1:24k
    - Ortho 1:12k (Future)
- Derived Products
  - Digital Elevation Products
    - DSM
    - DEM
  - Thematic Map Products
    - Vegetation Index Maps
    - Land Cover Maps
  - Feature Maps
    - Topo 1:50k
    - Topo 1:24k
    - Topo 1:12k



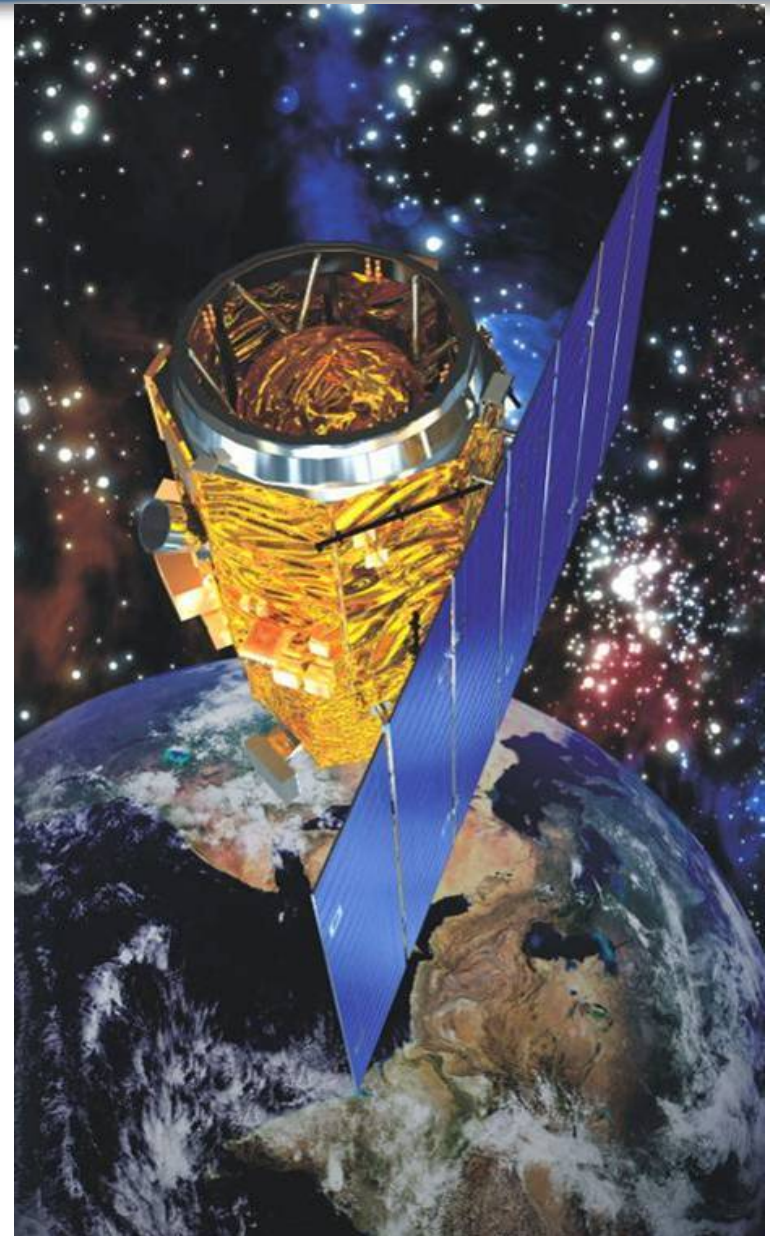
# OrbView-2

- Capabilities
  - Multispectral Imaging
  - Color Bands - 8
  - Spatial Resolution - 1 km
  - Swath Width - 2,800 km
  - Revisit Time - 1 day
  - Orbital Altitude - 705 km
  - Expected Life - 10 years
- Operations
  - Approaching 7 years in orbit
  - In-service availability >99%
- Applications
  - Fishing, Agriculture, Research  
Environmental Monitoring &  
Naval Operations



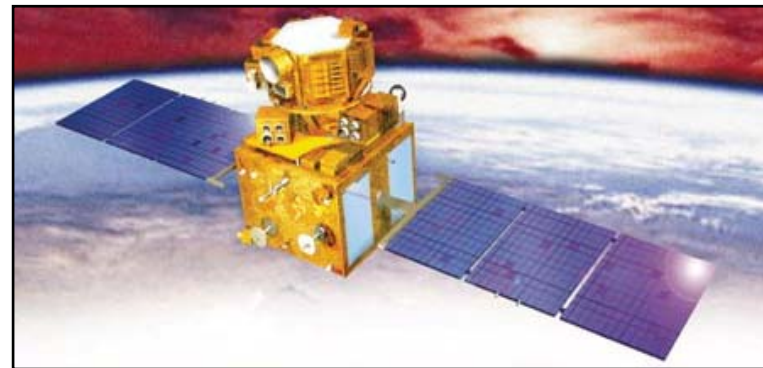
# GeoEye-1

- Launch
  - March 2007
- Orbit
  - 660 km, Sun Synchronous
  - 10:30 am equatorial crossing
- Imaging Sensors
  - Pan 41 cm at nadir
  - MSI 1.64 m, Blue, Green, Red, & NIR
  - 15.2 km swath at nadir
  - 11 Bit dynamic range
- Collection
  - >700,000 km<sup>2</sup> per day
  - Mono or Stereo
  - < 3 day revisit
- Mission Life:
  - 7 years
  - Fuel >10 Years

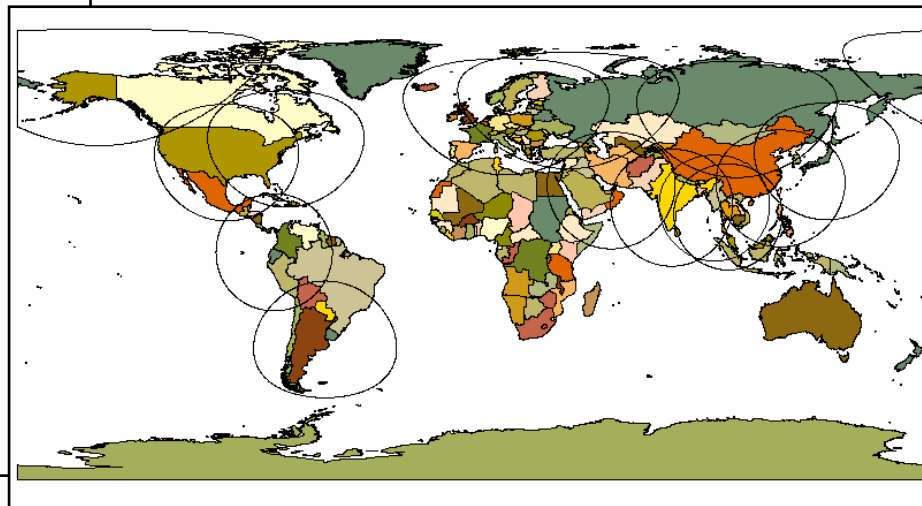


# Indian Remote Sensing RESOURCESAT-1

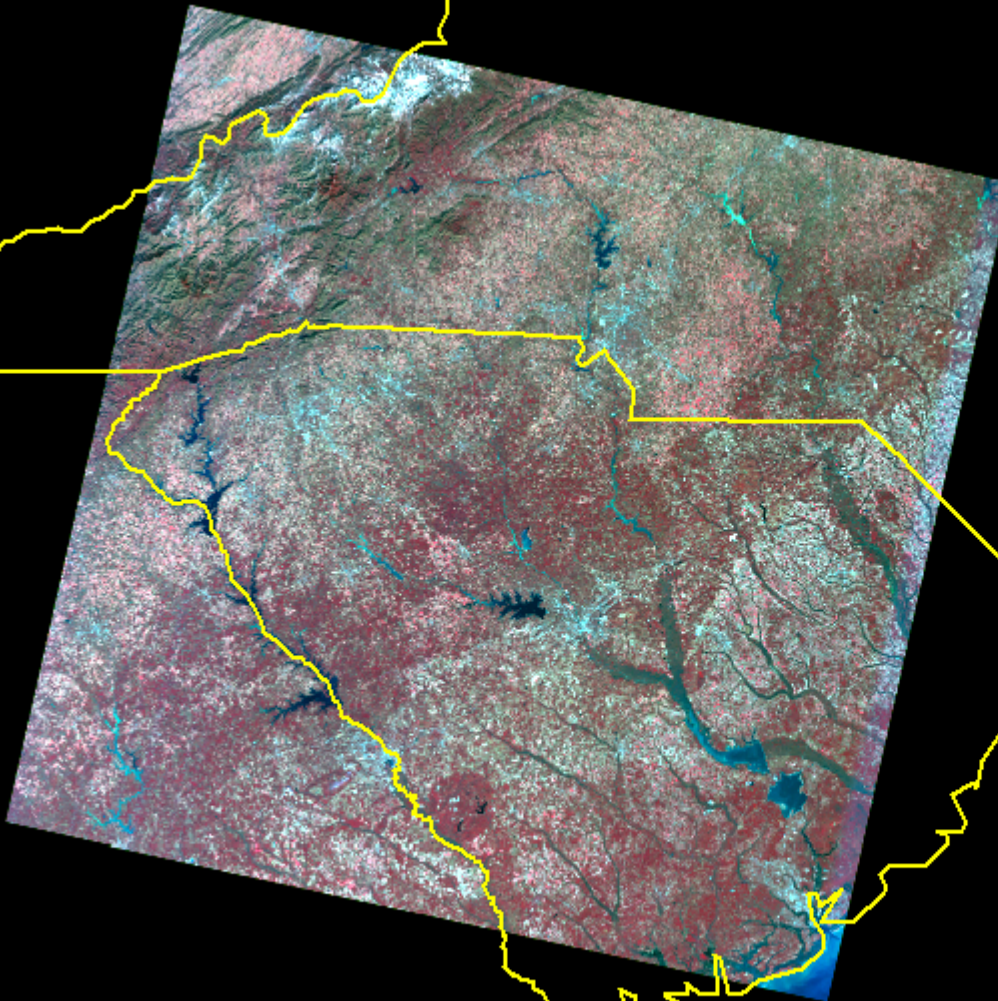
- Orbit
  - 817 km, Sun-synchronous
  - 10:30 equatorial crossing
- LISS-III Sensor
  - Bands: Green, Red, NIR, SWIR
  - 23.5 m GSD, 7-bit
  - 141 km swath
- LISS-IV Sensor
  - Bands: Green, Red, NIR
  - 5.8 m GSD, 7-bit
  - Swath: 3-band, 23 km swath or 1-band 70 km, Steerable  $\pm 26^\circ$
- AWiFS
  - Bands: Green, Red, NIR, SWIR
  - 56 m to 70 m GSD, 10-bit
  - 740 km swath



**IRS RESOURCESAT-1 (P6)**



# AWiFS Sensor on RESOURCESAT-1



- Dual AWiFS Cameras
- 370 km x 370 km scene each (Compare to South Carolina)
- 60 meter GSD (1.1 pixel per acre)
- Green, Red, NIR, SWIR
- 10 Bit Radiometry

# Calibration / Validation Status

## IKONOS & OrbView-3

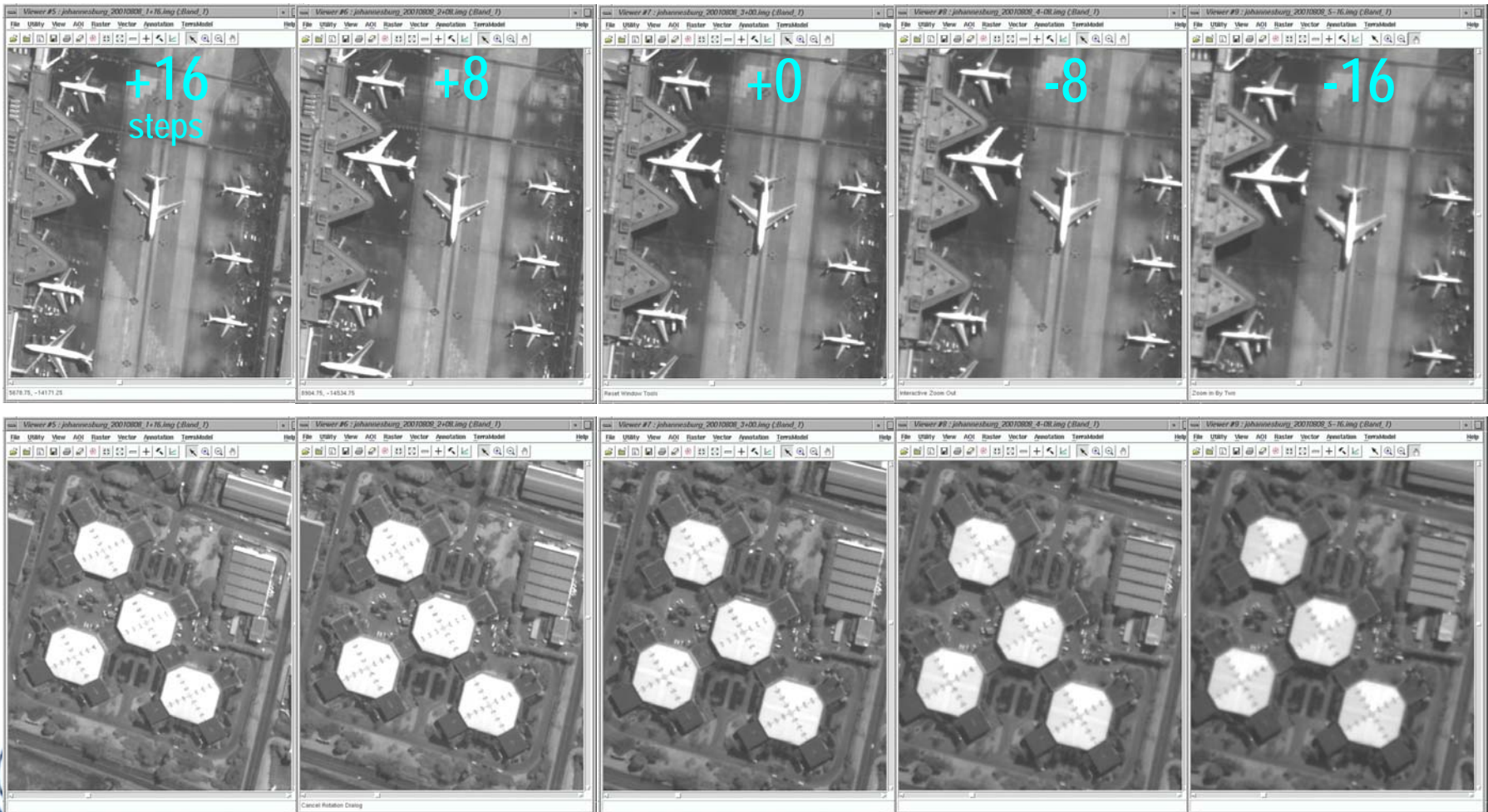


# Image Quality



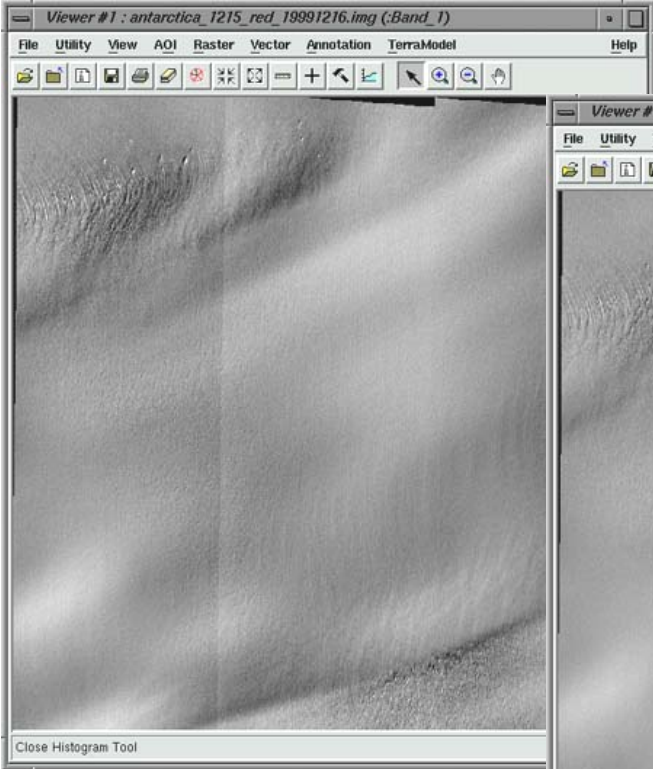
# Quarterly Through-Focus Test

- Technique: Step through 32 steps of secondary mirror to determine ideal location
- Most recent adjustment: 8 steps (200  $\mu\text{m}$  = 2/3 depth of field) on 2005.02.09.

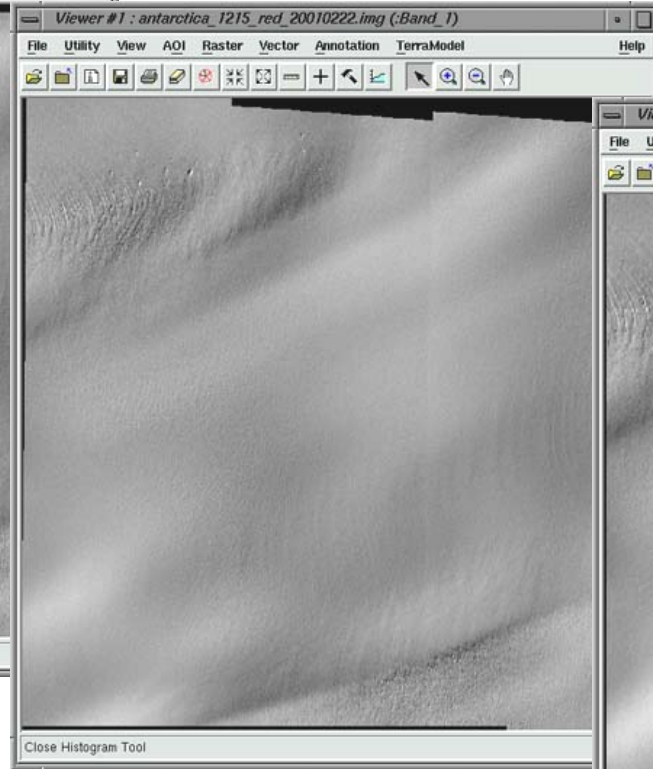


# Radiometry

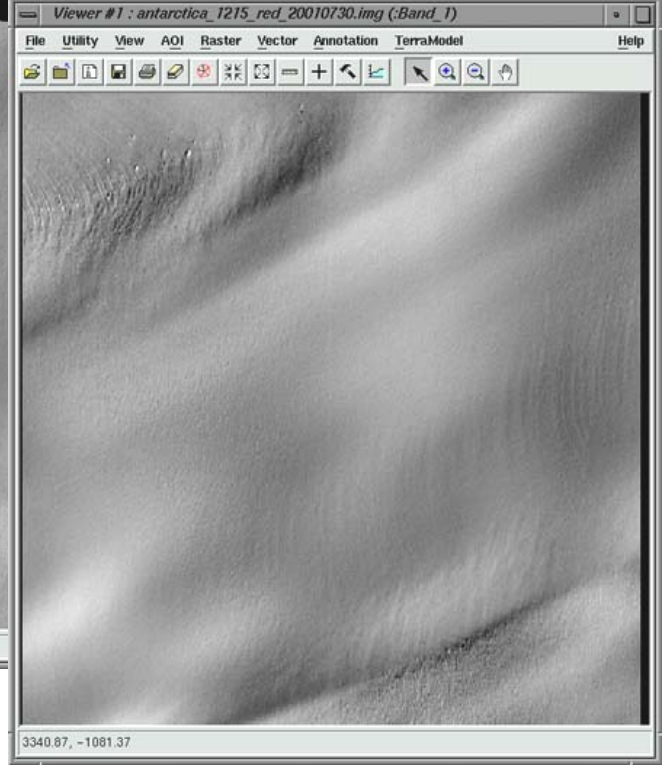
**Good – Meets Spec, <5%**



**Better – Perceptible, <1%**



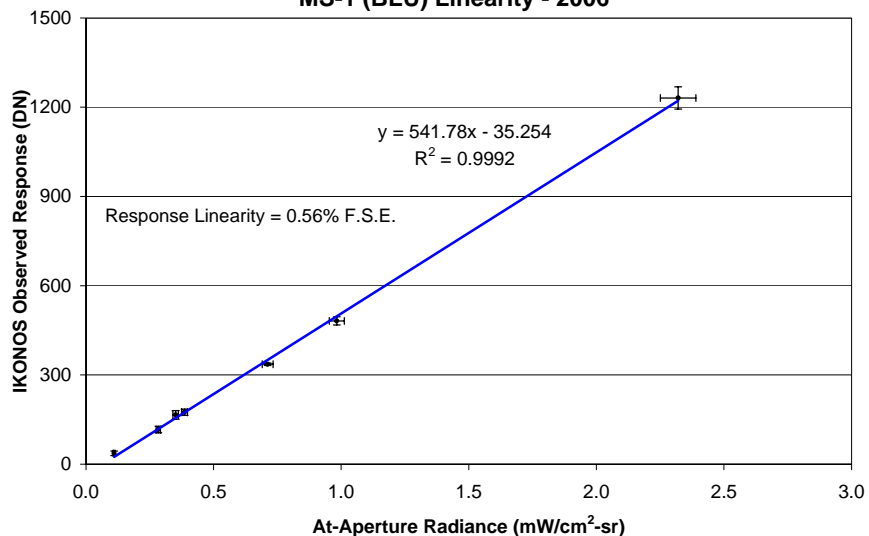
**Best – Imperceptible, <0.5%**



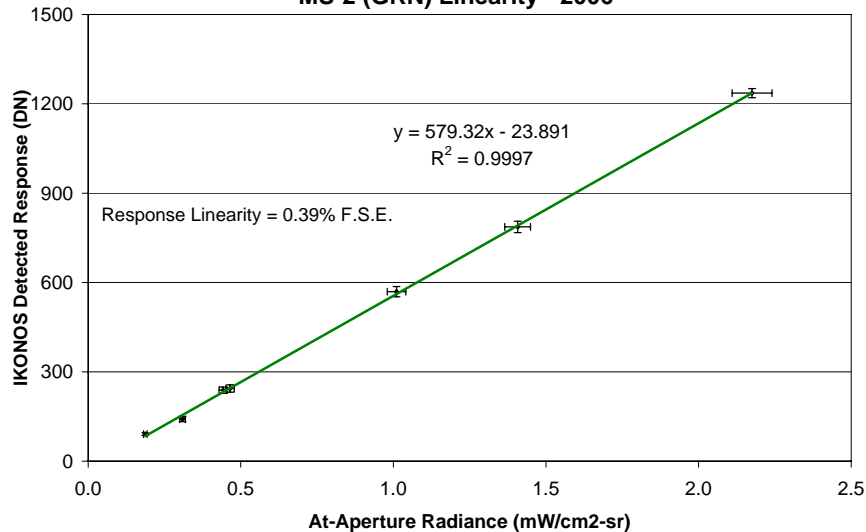


# IKONOS Linearity better than 1%

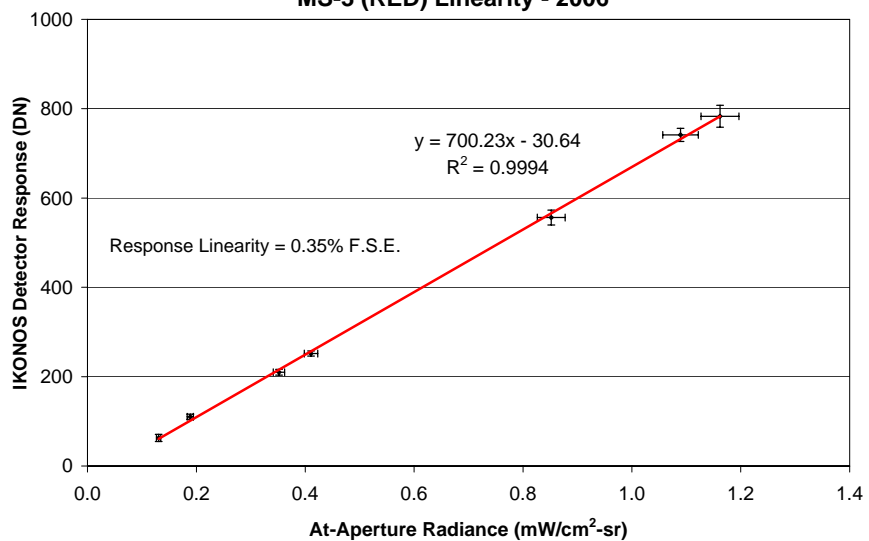
### MS-1 (BLU) Linearity - 2006



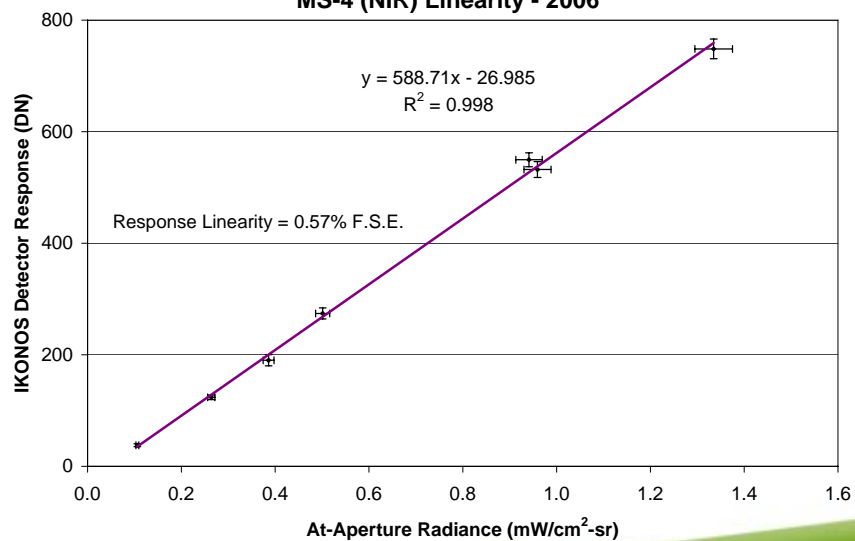
### MS-2 (GRN) Linearity - 2006



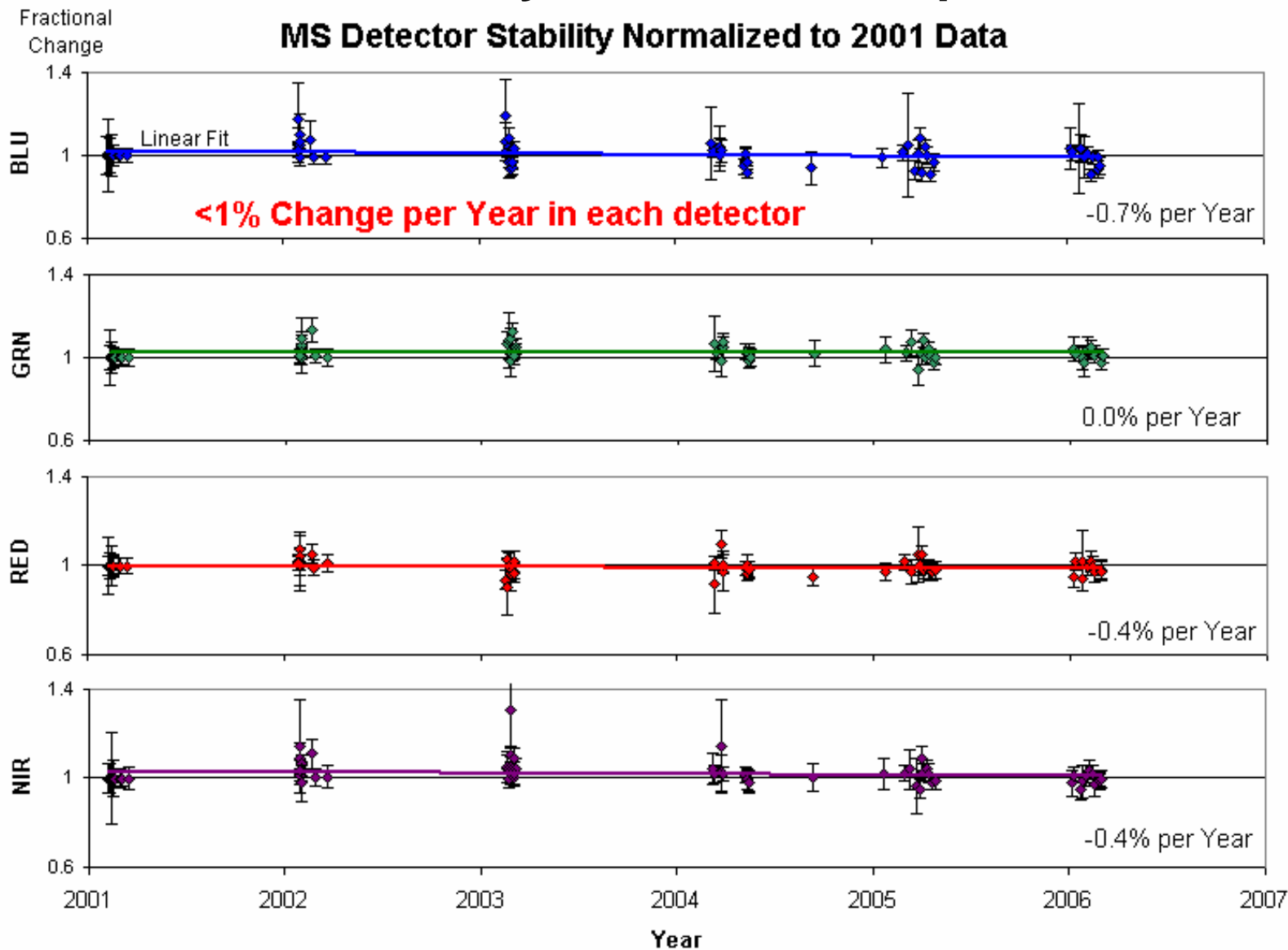
### MS-3 (RED) Linearity - 2006



### MS-4 (NIR) Linearity - 2006



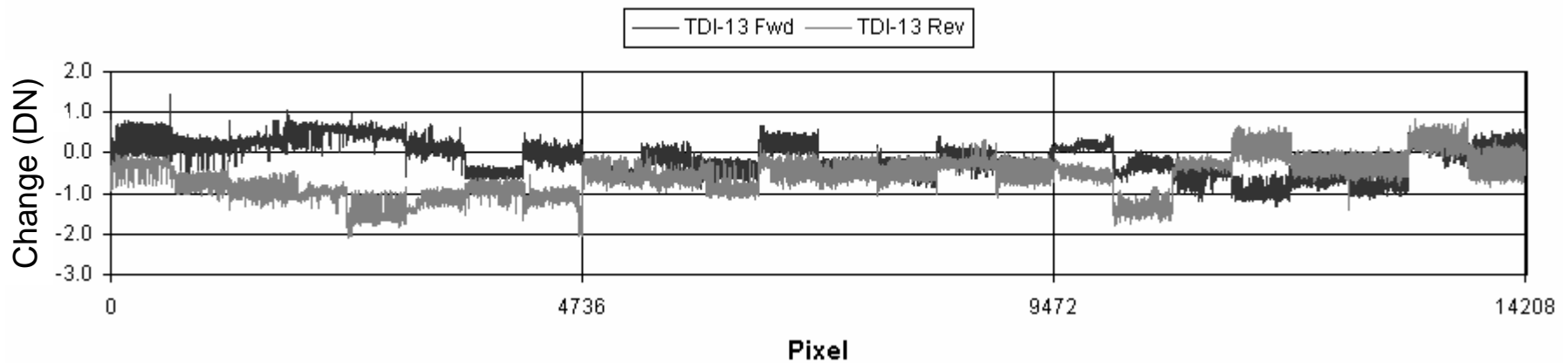
# IKONOS Stability better than 1% per Year



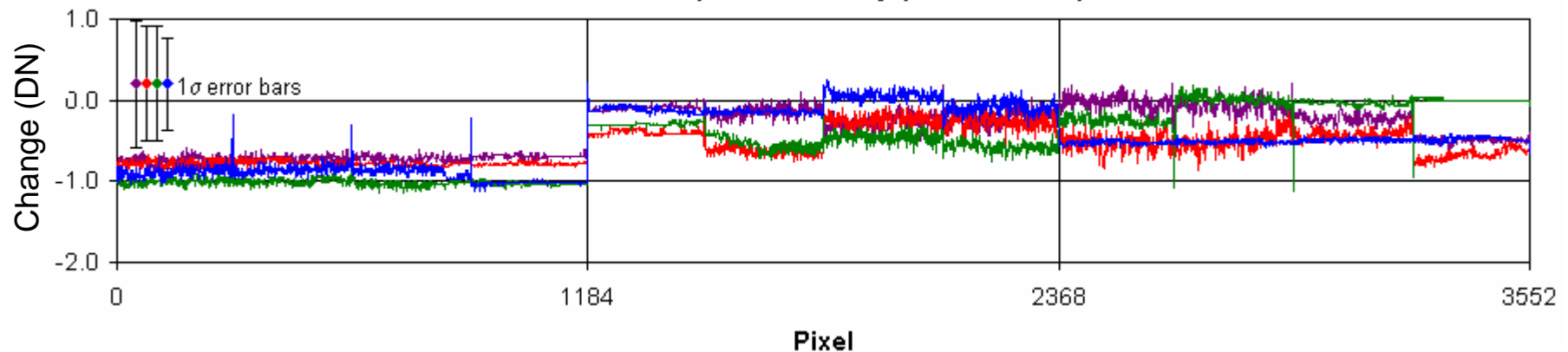
# Dark Response Calibration

(Images Taken with Door Closed)

Pan Dark Response Stability (2005 vs 2001)



MS Dark Response Stability (2005 vs 2001)

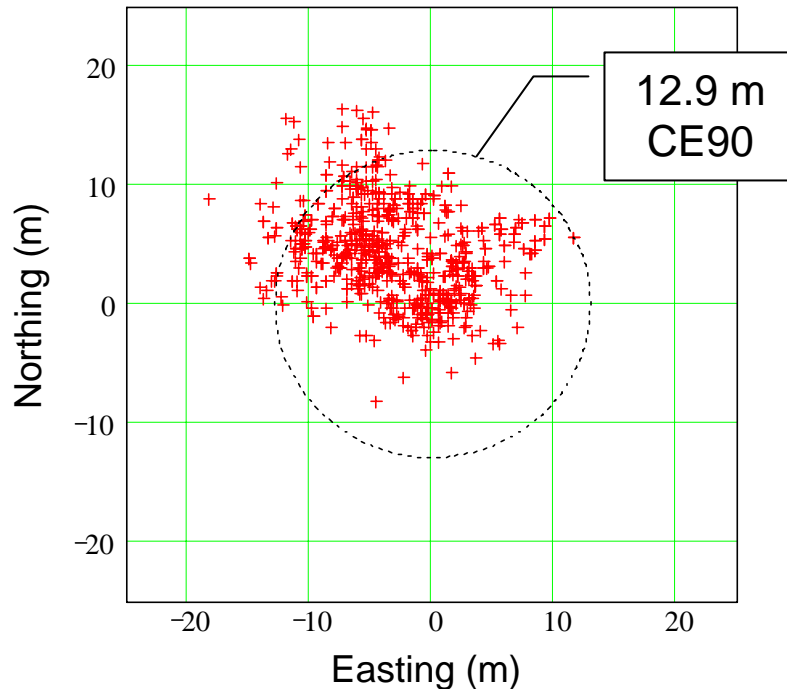


# Geometric Accuracy



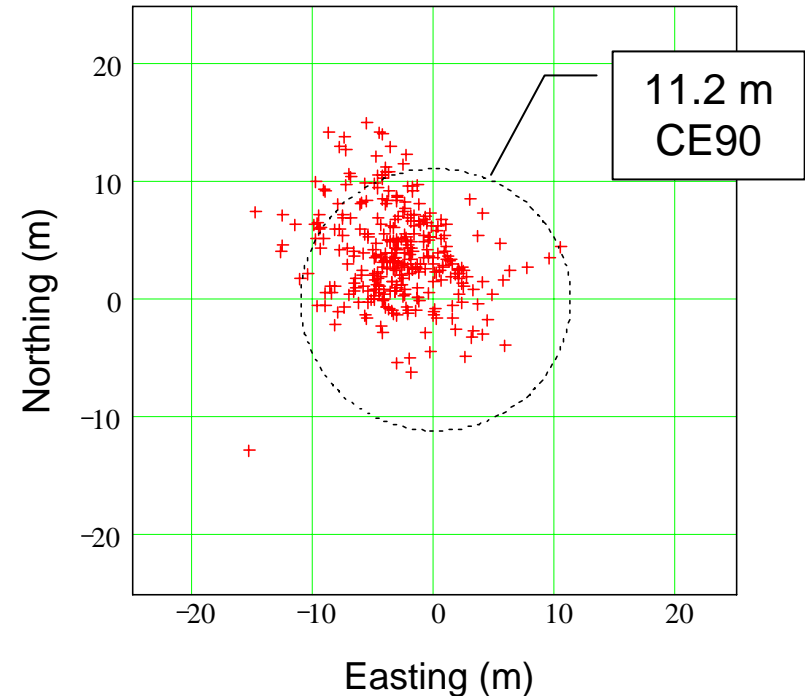
# OrbView-3 Absolute Accuracy

## Mono



- 76 Images
- 698 Mono-drop Points
- 12.9 m CE90 Horizontal

## Stereo



- 36 Stereo Pairs
- 11.2 m CE90 Horiz.
- 7.8 m LE90 Vertical

# IKONOS Accuracy & Stability

## Absolute Accuracy

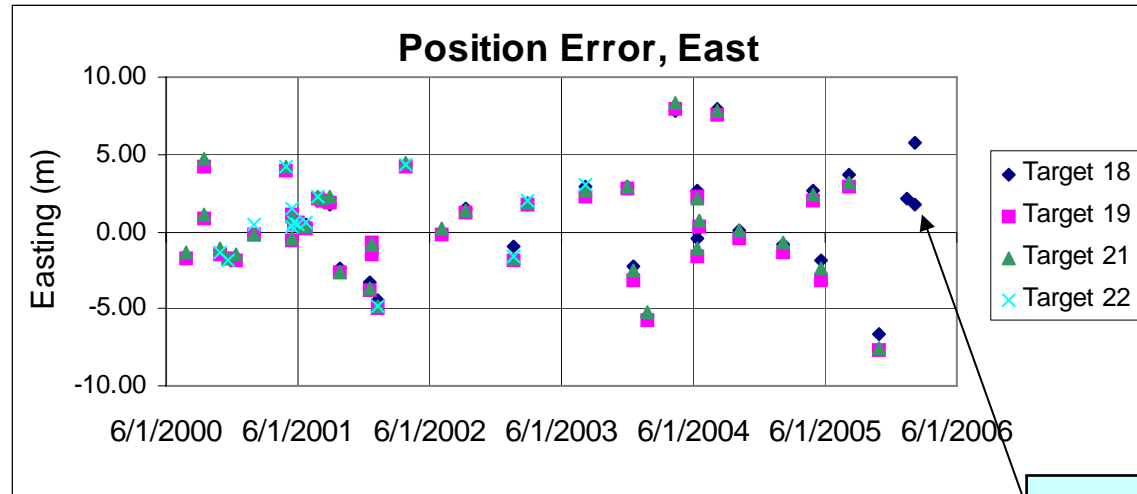
- How close the points are to zero error.

## Relative Accuracy

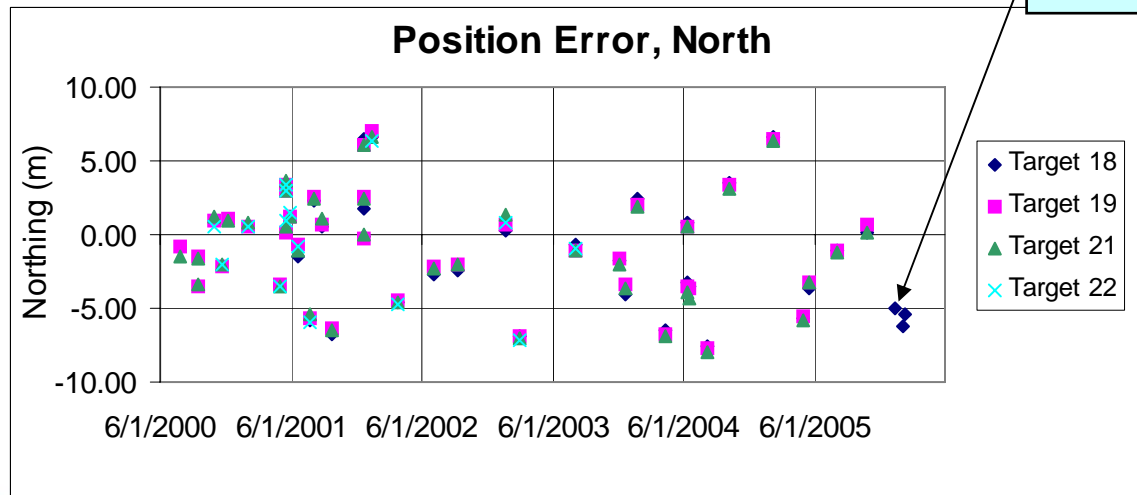
- How close the points on a given day are to each other.

## Stability

- Consistency from year to year.



2006.02.07



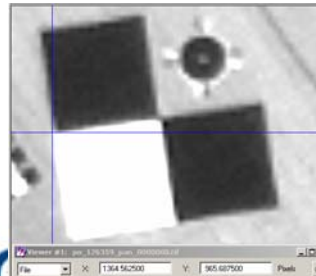
# IKONOS Accuracy Since Initialization

## Calibration History by Production Date

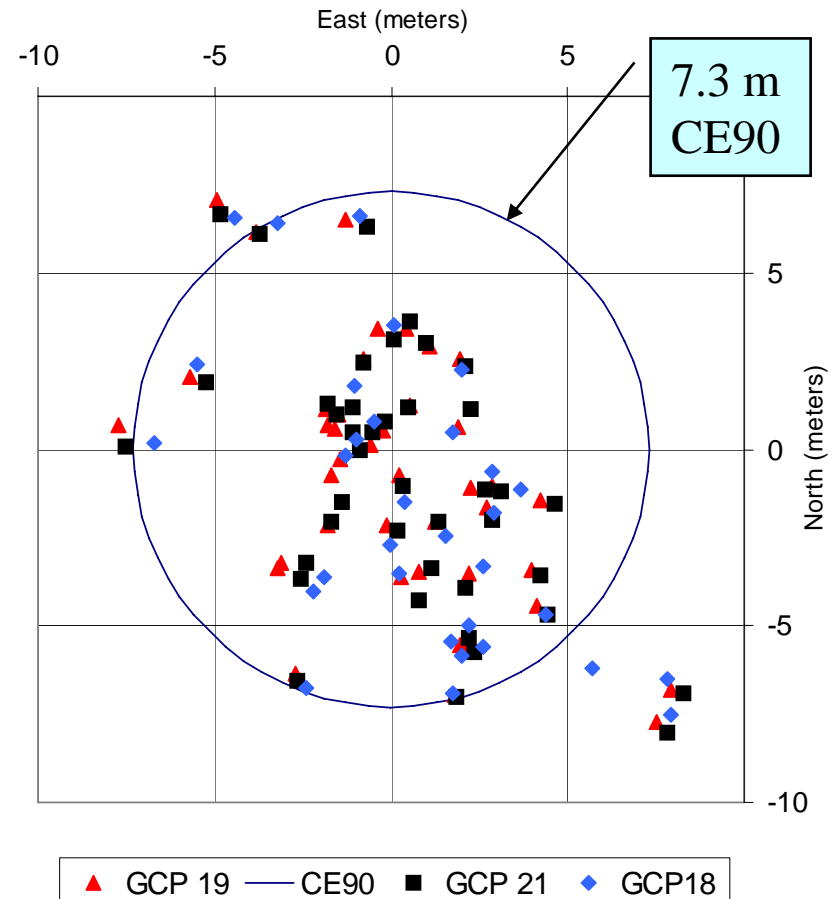
2001.11.19 - Interior Orientation  
~ 150 ppm scale

2002.01.31 - Exterior Orientation  
~ 5 m offset

2005.01.17 – IO & XO  
~ 1 pix between arrays



## Pointing Error, 5/2000 to Present



# Lifetime

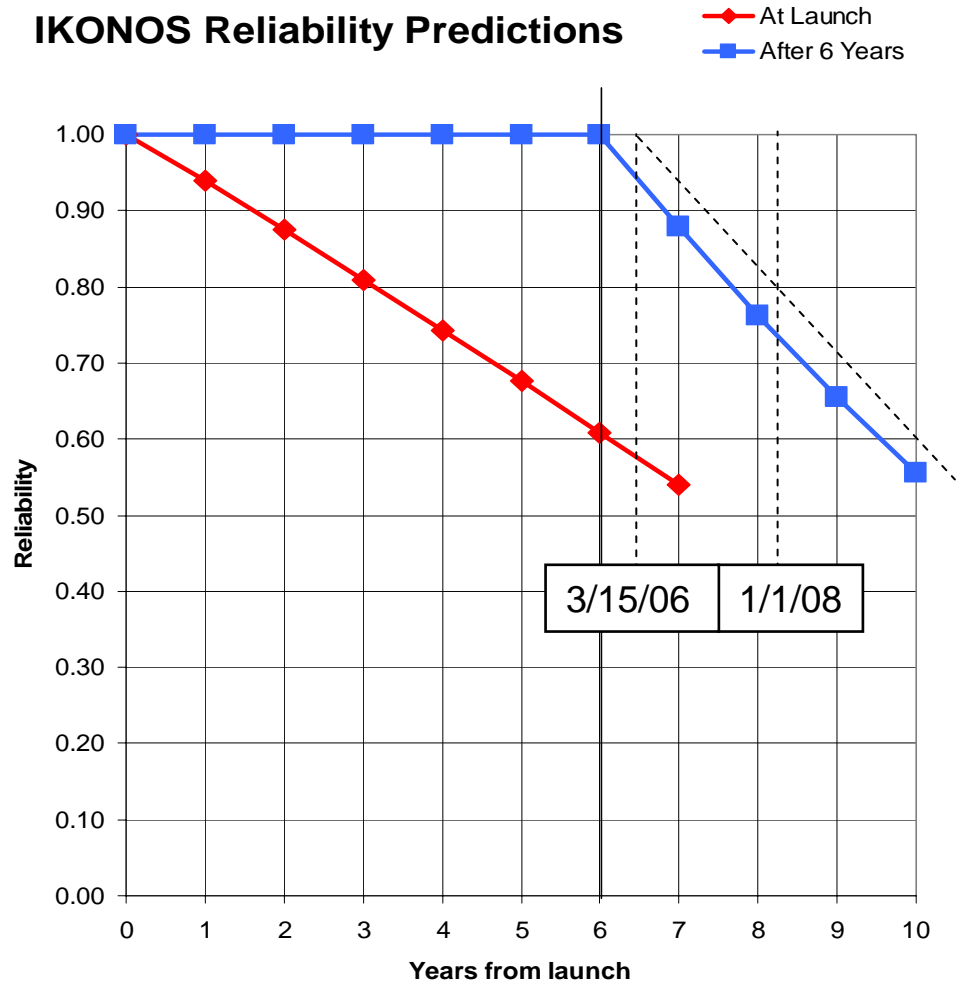




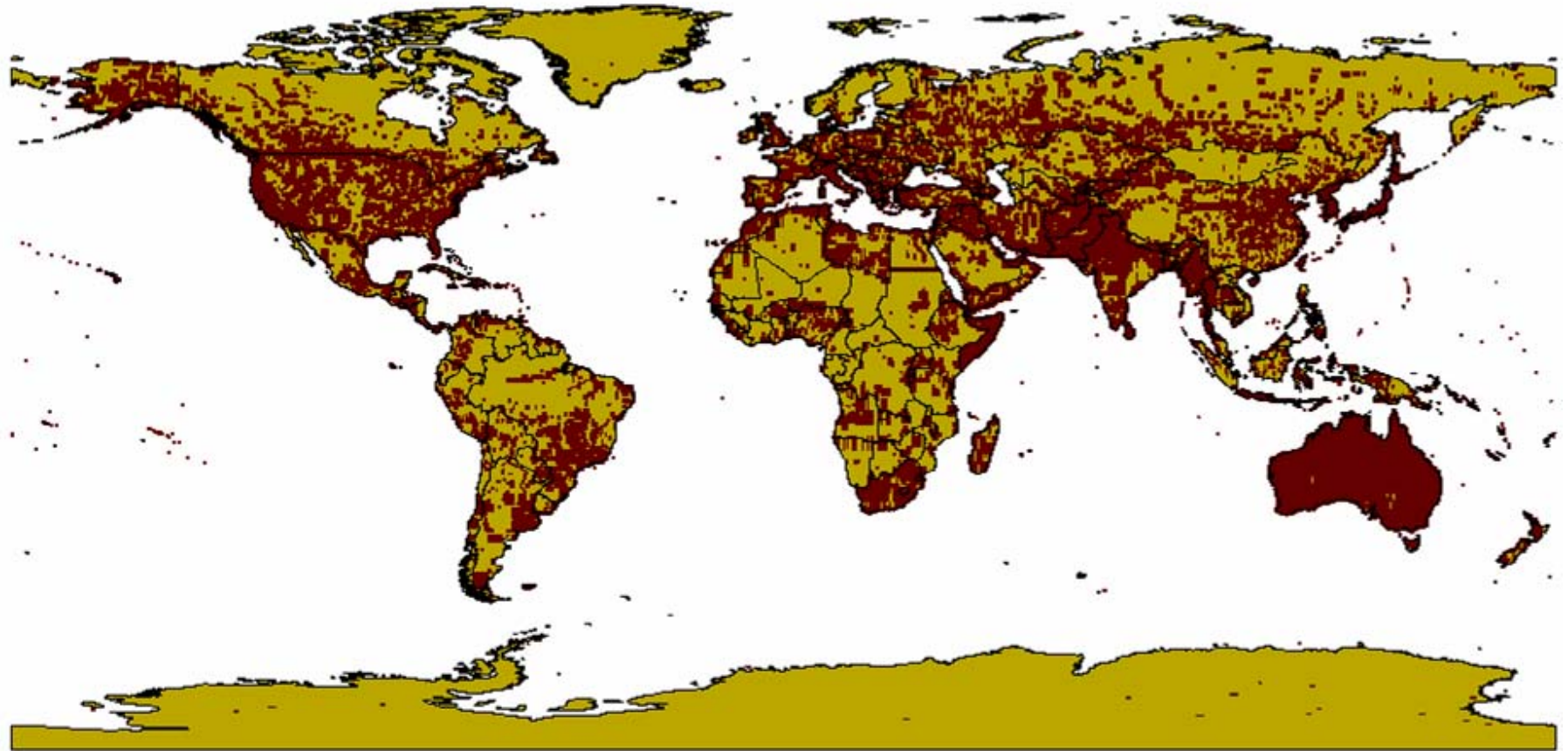
# IKONOS Lifetime

- Reliability evaluation after 6 years on orbit
  - 73% to 1/1/2008
- Updated estimate to today (3/15/2006)
  - 80% to 1/1/2008
  - More than 20 years fuel
  - Solar Cells, Batteries & Sensors performing within specifications.

IKONOS Reliability Predictions



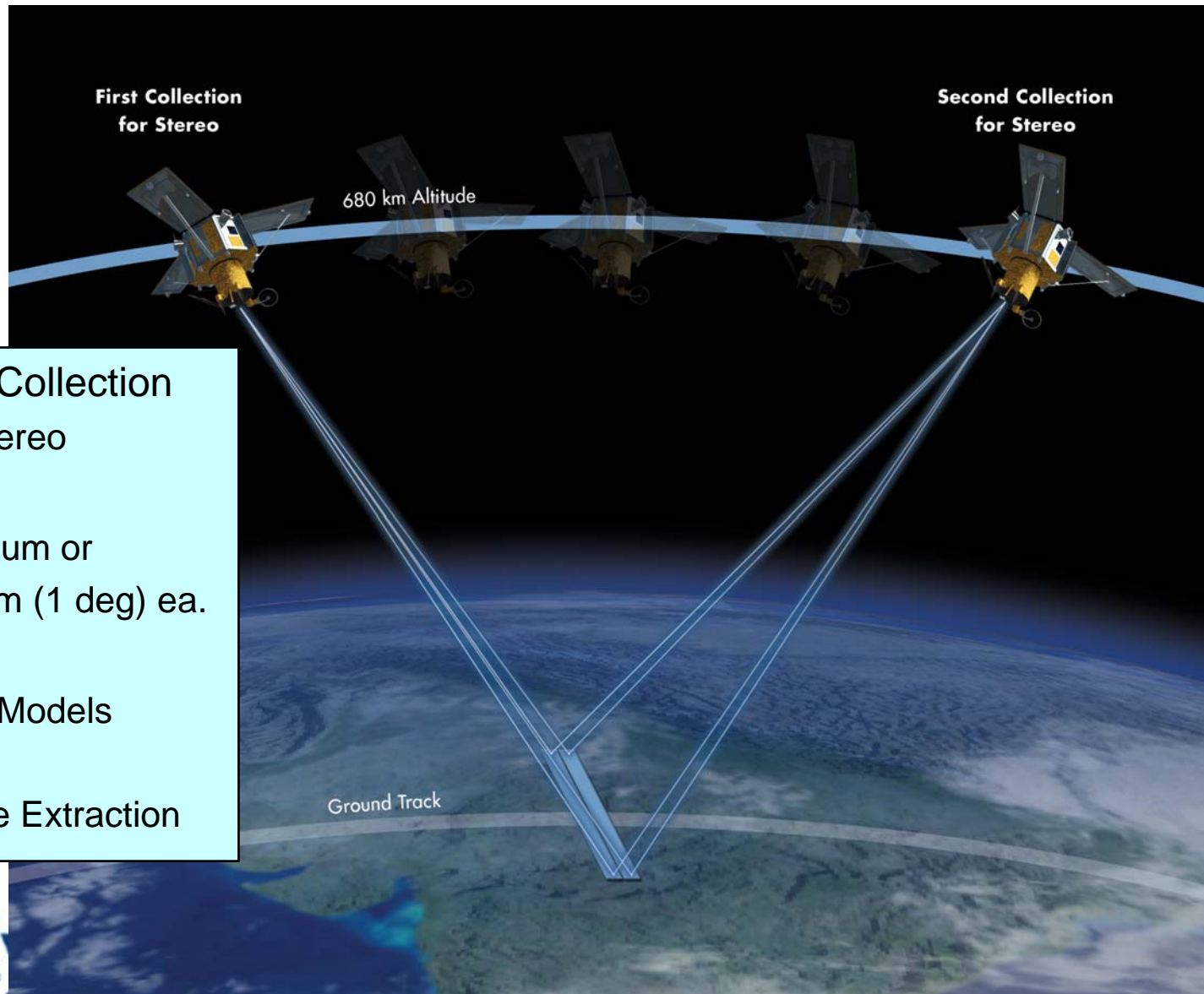
# Collection Capacity



**OrbView-3 and IKONOS  
Combined Archive  
253 million sq km of imagery**

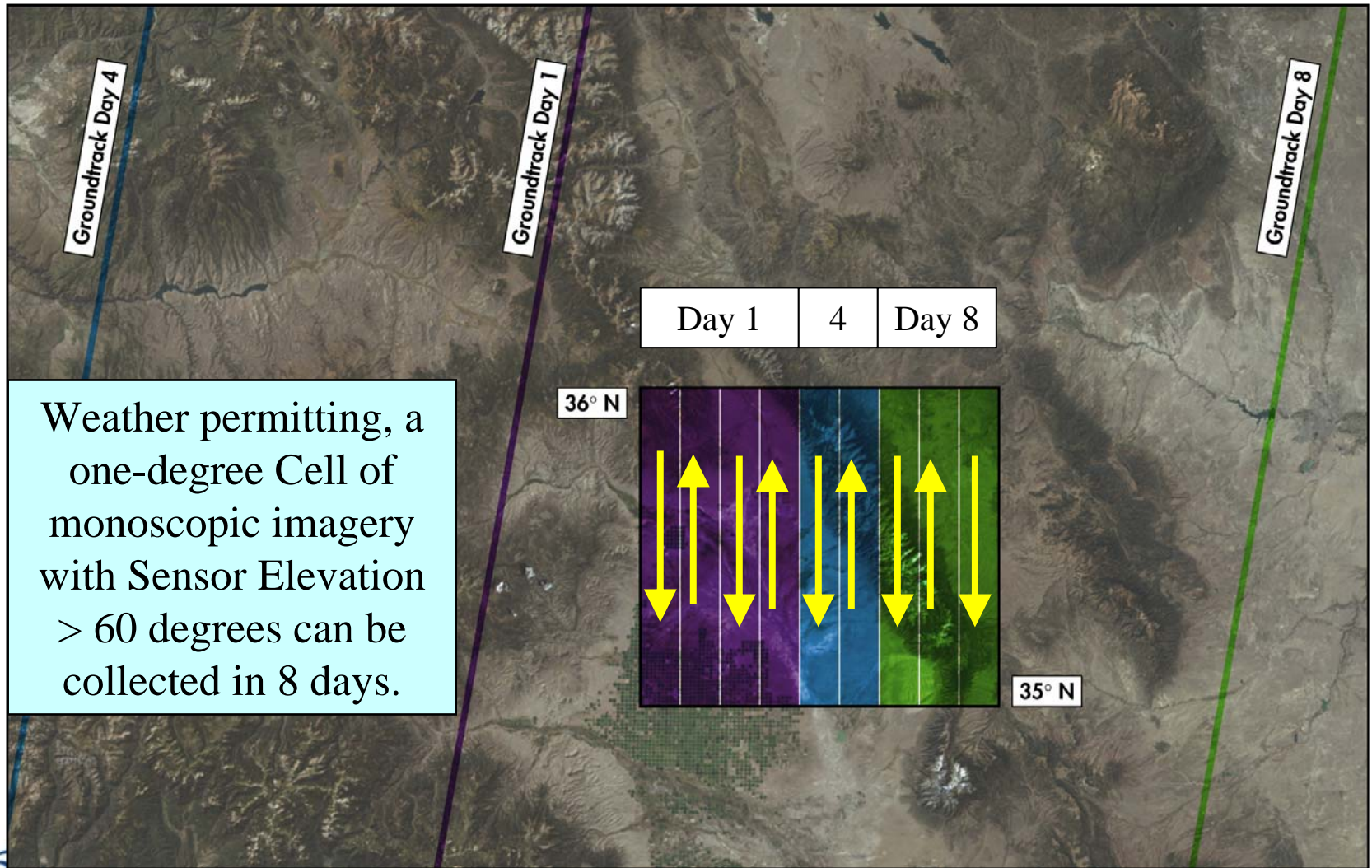


# Stereo Collection



- IKONOS Stereo Collection
  - Same Pass Stereo
- Strip Lengths
  - 280 km Maximum or
  - 2-strips, 112 km (1 deg) ea.
- Applications
  - Terrain & Site Models
  - Geolocation
  - Airfield Feature Extraction

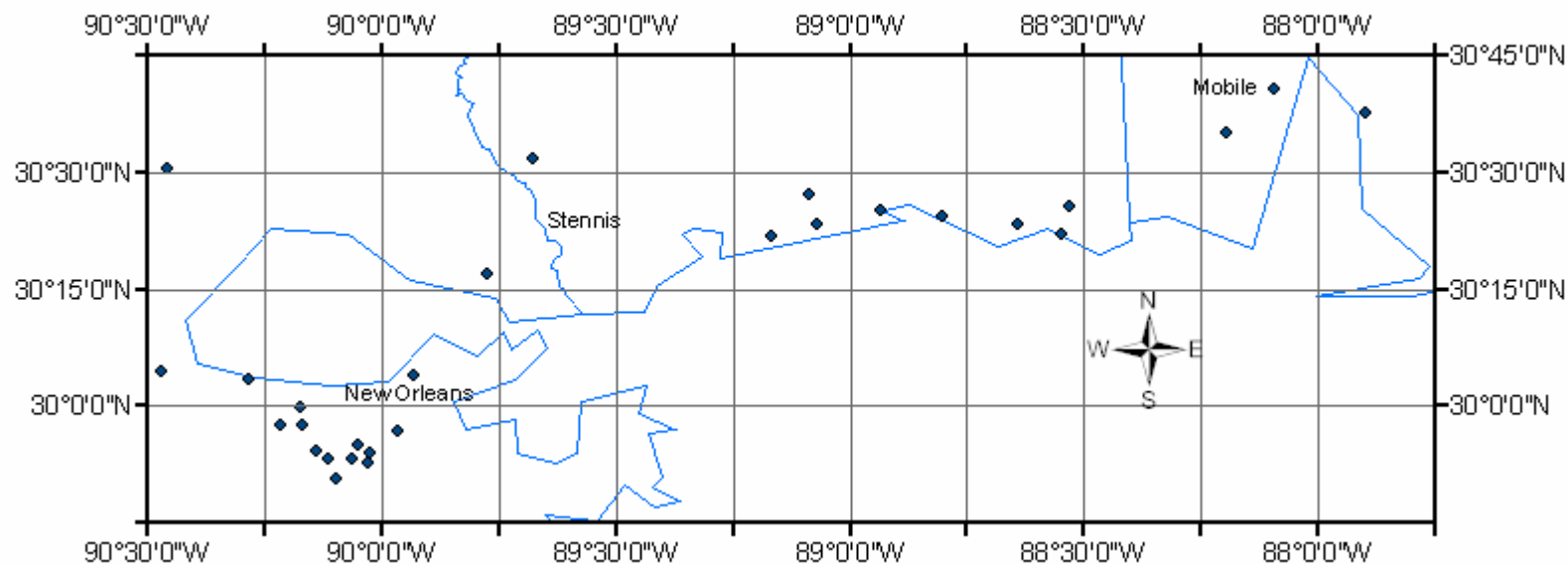
# 1-Degree Cell Collection - Mono



Weather permitting, a one-degree Cell of monoscopic imagery with Sensor Elevation > 60 degrees can be collected in 8 days.

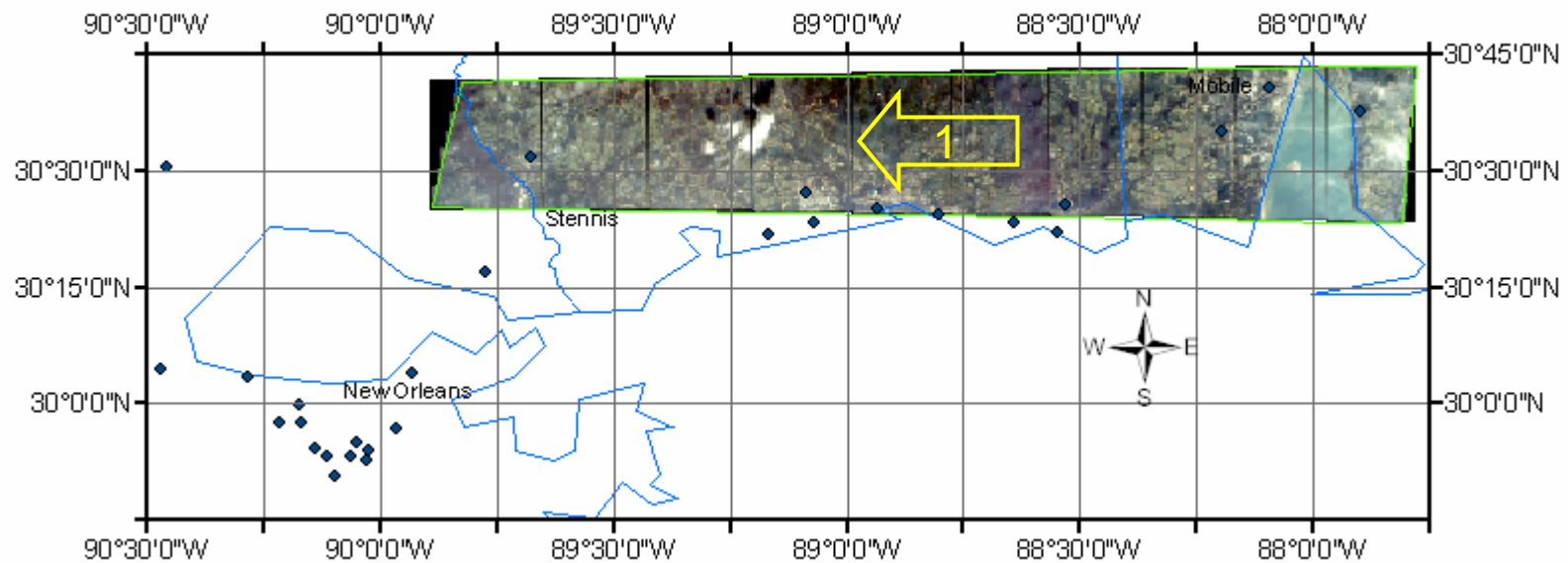
# Collection Example - Katrina

IKONOS Image Collections 2005.09.02



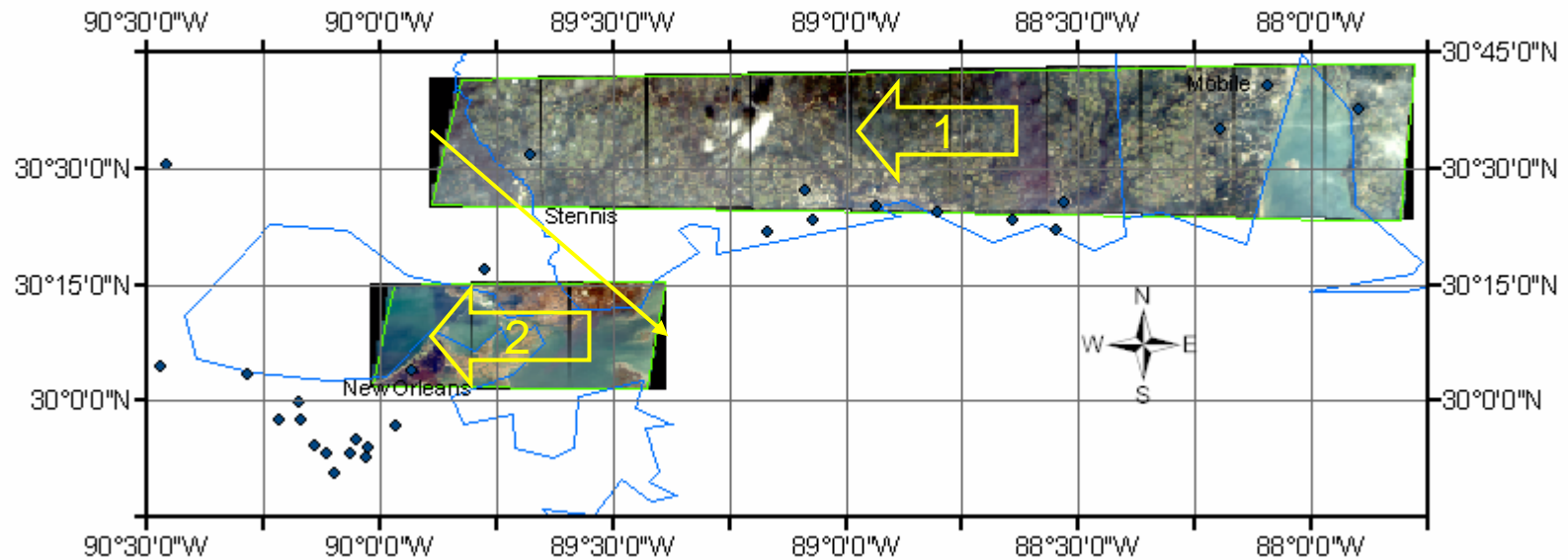
16:49:39.3 Z  
33.1° Elevation Angle

IKONOS Image Collections 2005.09.02



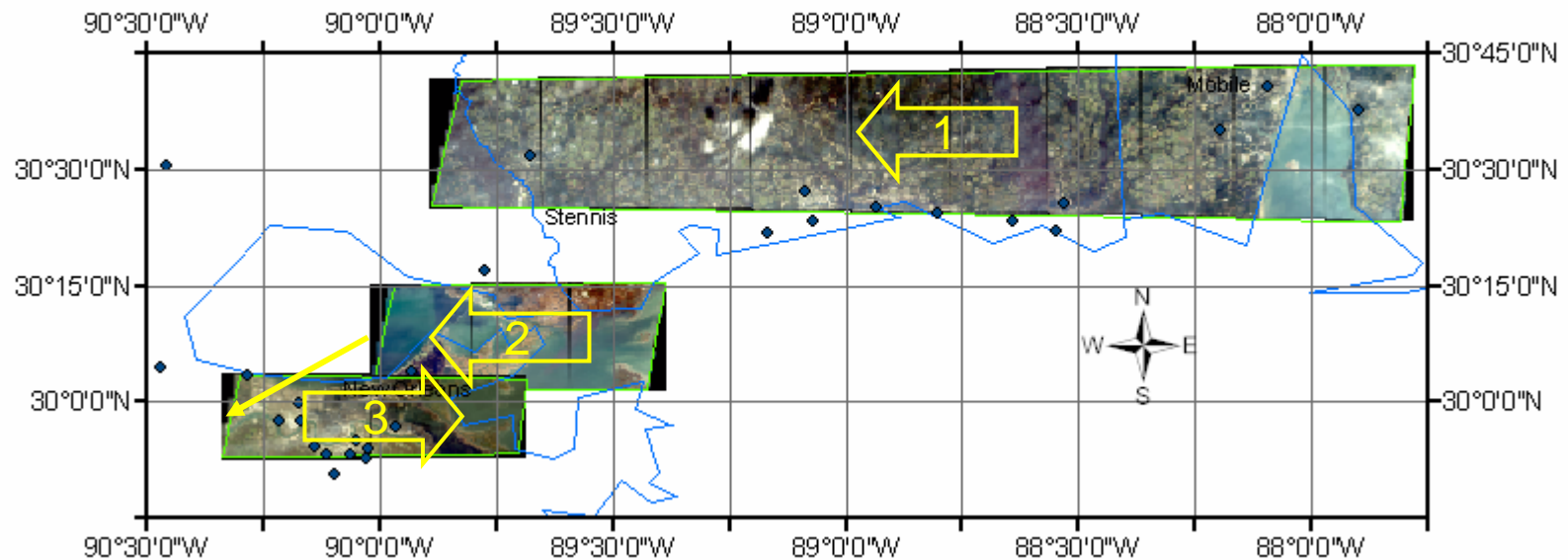
**16:50:20.5 Z**  
**40.1° Elevation Angle**

**IKONOS Image Collections 2005.09.02**



16:50:48.4 Z  
48.8° Elevation Angle

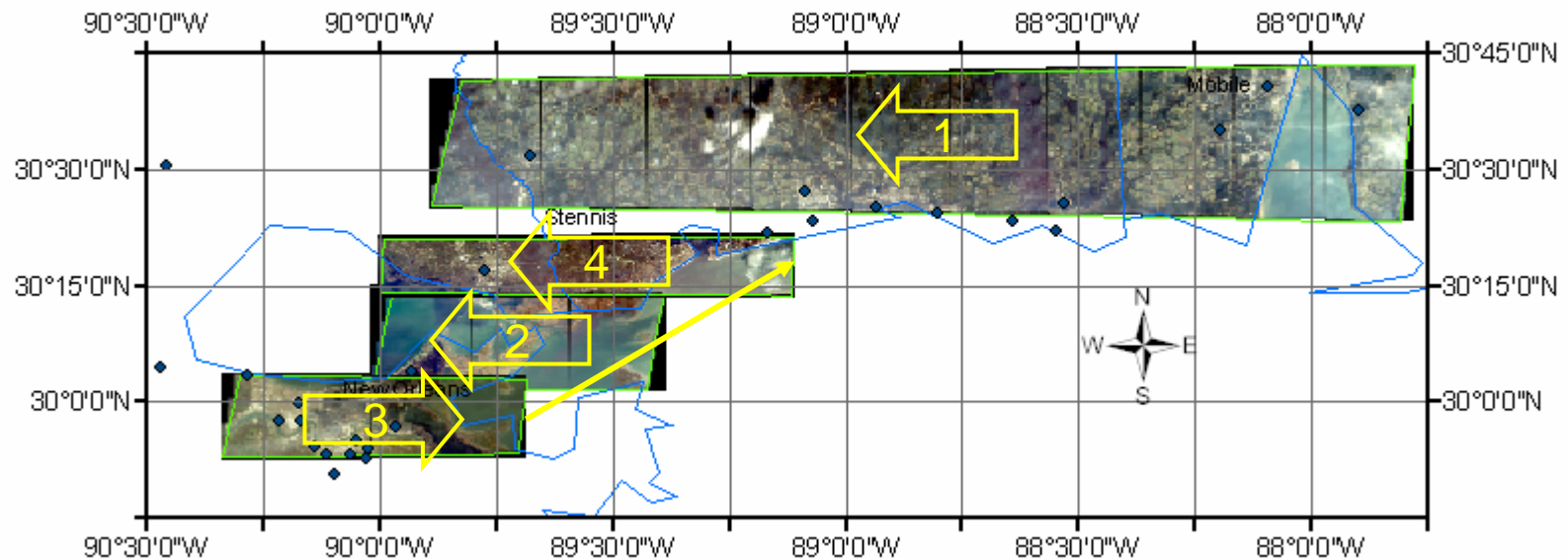
IKONOS Image Collections 2005.09.02





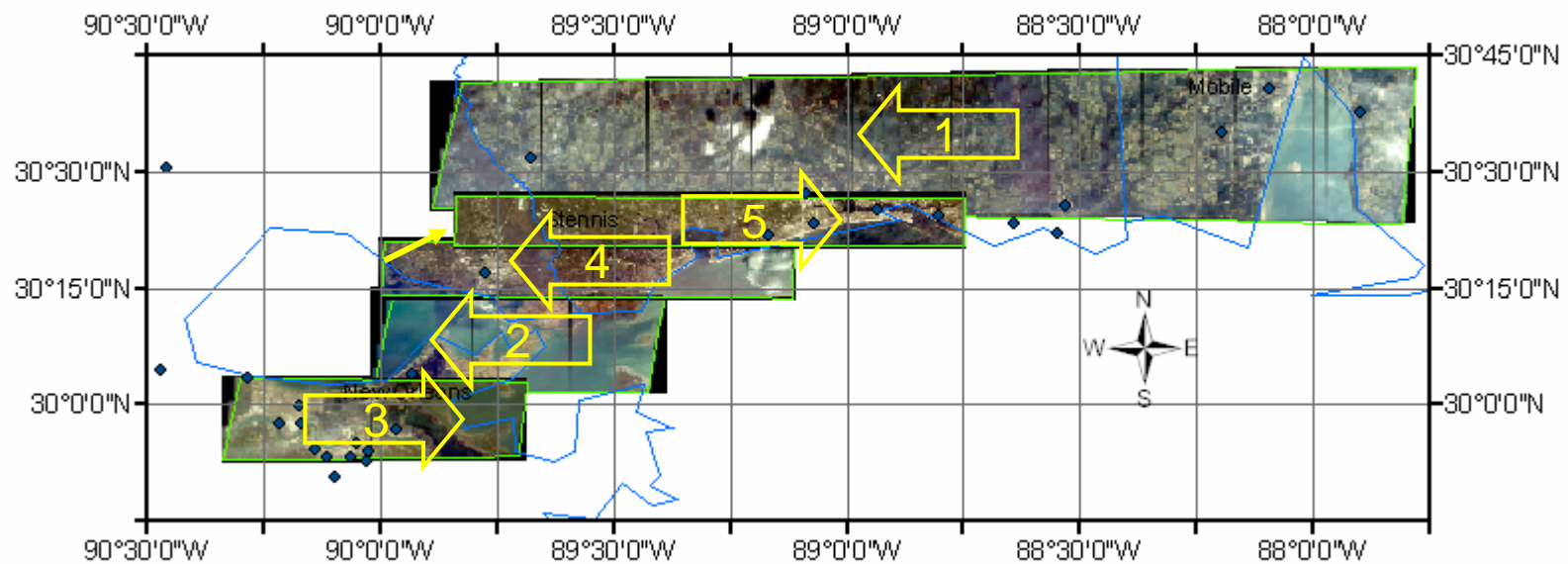
16:51:13.1 Z  
64.9° Elevation Angle

IKONOS Image Collections 2005.09.02



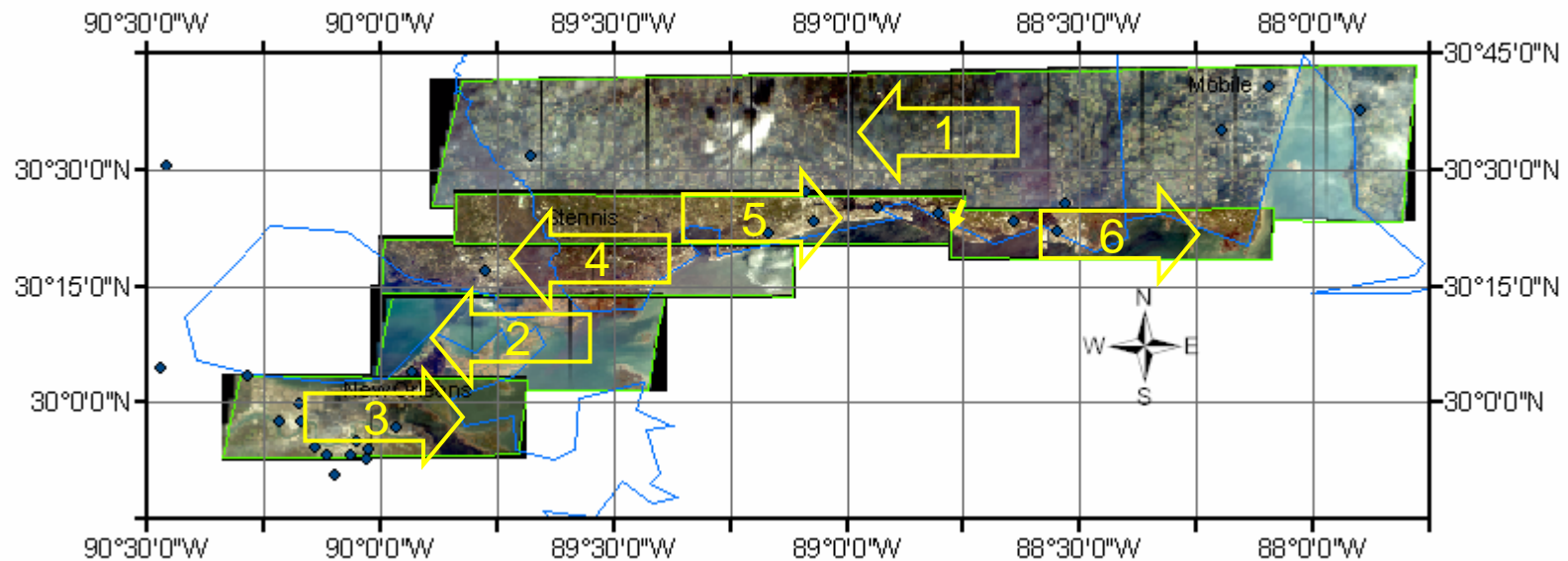
16:51:37.9 Z  
80.8° Elevation Angle

IKONOS Image Collections 2005.09.02



**16:52:10.8 Z**  
**76° Elevation Angle**  
**13,000 km<sup>2</sup> Total Image Collection on One Pass**

IKONOS Image Collections 2005.09.02



# IKONOS Deliveries on 2005.09.03

Delivery Contents	Size
Overview Images & Shapes	.02 GB
1m IKONOS Ortho Pan+MSI in GeoTIFF	30 GB
1m IKONOS Geo Pan+MSI in NITF	30 GB
1m RGB pre-Katrina Orthomosaic of New Orleans	12 GB
Public Relations Imagery	1 GB
5m pre-Katrina color orthomosaic of entire region	2 GB
NED DEM in DTED format of entire region	0.2 GB
<b>Total each delivery</b>	<b>75 GB</b>

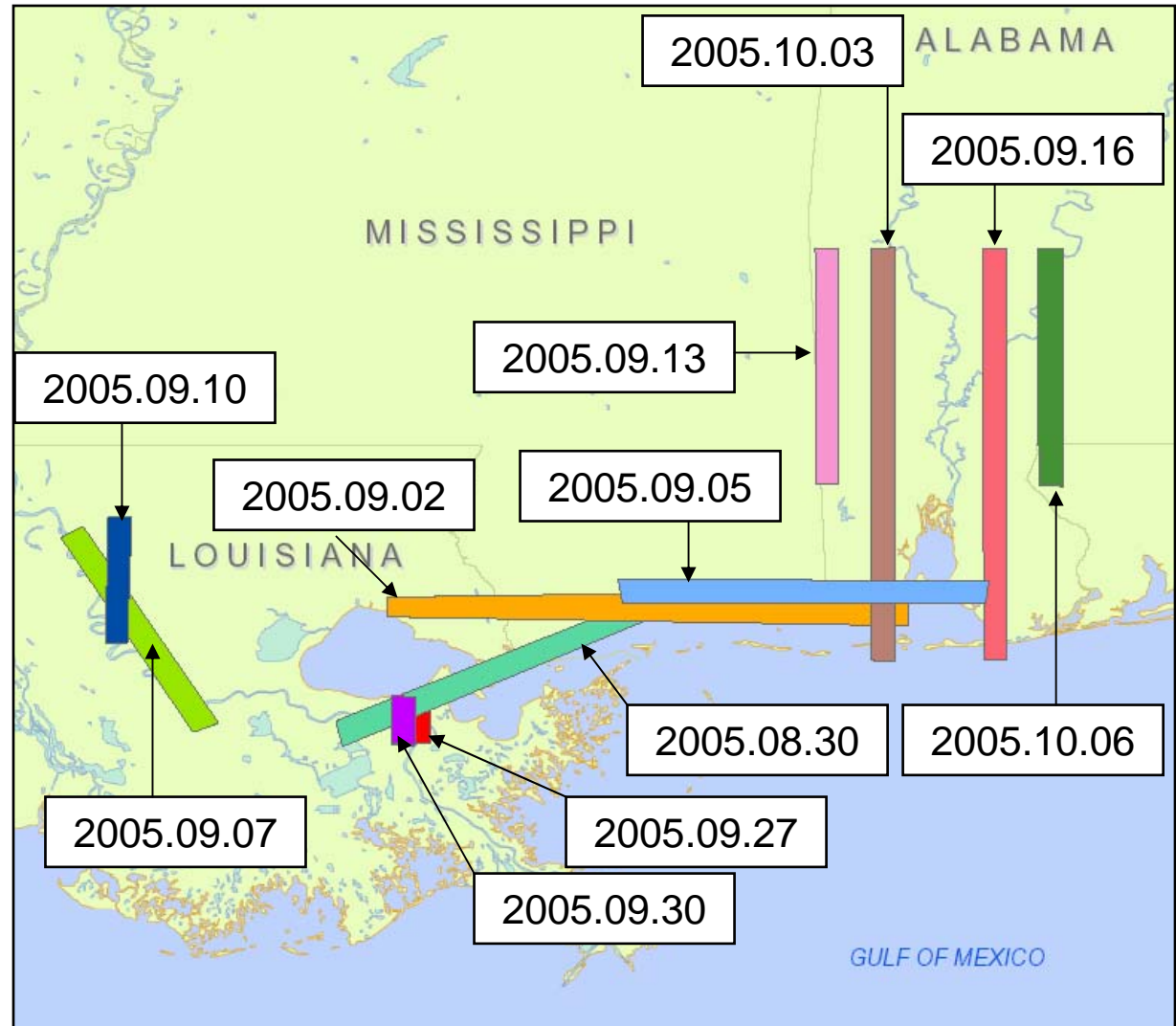
- Deliveries
  - 2x FTP
  - 9x counter-to-counter air freight
  - 2x will call
  - 1x internal
- Total
  - 1 Terabyte

Color Balanced Orthomosaic 2005.09.07



# OrbView-3 Katrina Collection

Coordination of OrbView-3 & IKONOS collection will improve emergency response in the future.



# Conclusion

- GeoEye Constellation
  - IKONOS & OrbView-3 for high resolution
  - GeoEye with higher resolution 1Q2007
  - RESOURCESAT-1 for global crop assessment
  - OrbView-2 for ocean research & fish.
- IKONOS Performance in 2005
  - Stable Image Quality
  - Stable Radiometry
  - Stable Geometric Accuracy
  - Reliability: 80% to 2008.
- Operations
  - Demonstrated capacity for high-volume, quick-response collection & production.



# Thank You!

Questions?

- Customer Service  
800.232.9037  
703.480.7537

customer.service  
@geoeye.com

- Online  
[www.GeoEye.com](http://www.GeoEye.com)



Shuttle Discovery, 2005.04.08