



*Land Processes
Distributed Active Archive Center*



Characteristics of Remotely Sensed Data

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Presentation Outline

- Selecting Your Remotely Sensed Data
- Spatial Resolution
- Spectral Coverage and Resolution
- Geographic Coverage
- Temporal Characteristics
- Data Availability and Accessibility
- Data Cost
- Important Characteristics of Selected Sensors

Selecting Remotely Sensed Data

- By-and-large, remotely sensed data are merely *sources of information* from which meaningful interpretations can be made. The data you select depend mostly on *your information requirements* and on the characteristics of the remote sensing systems and data available.
 - spatial resolution
 - spectral coverage and resolution
 - geographic coverage
 - temporal characteristics
 - data availability
 - data accessibility
 - cost

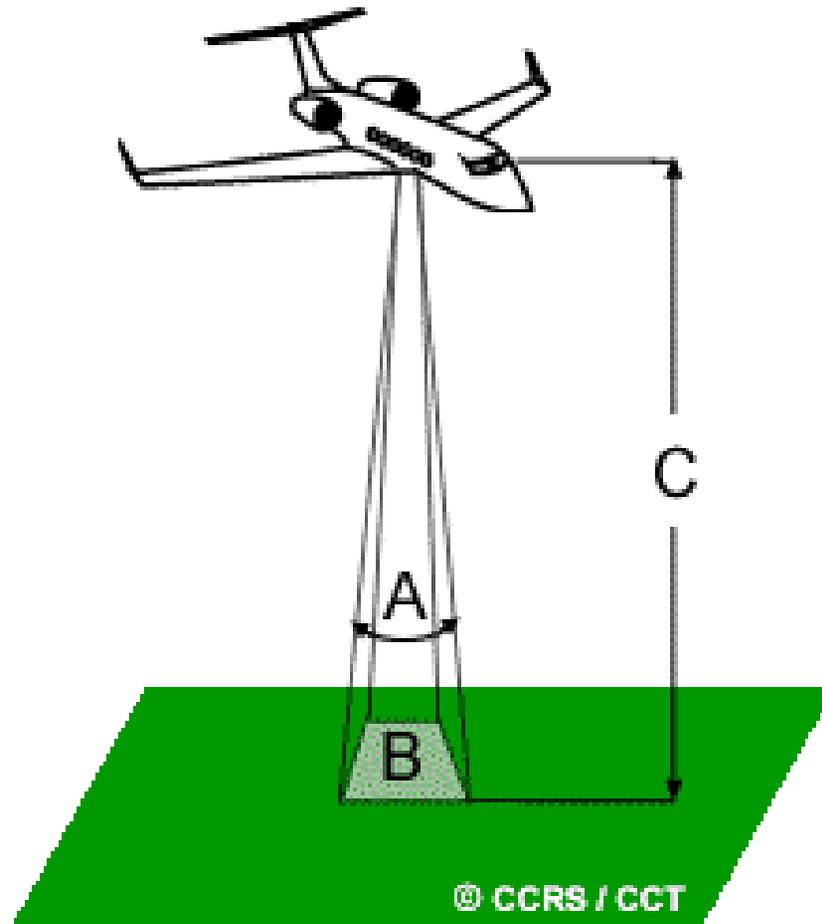
Spatial Resolution



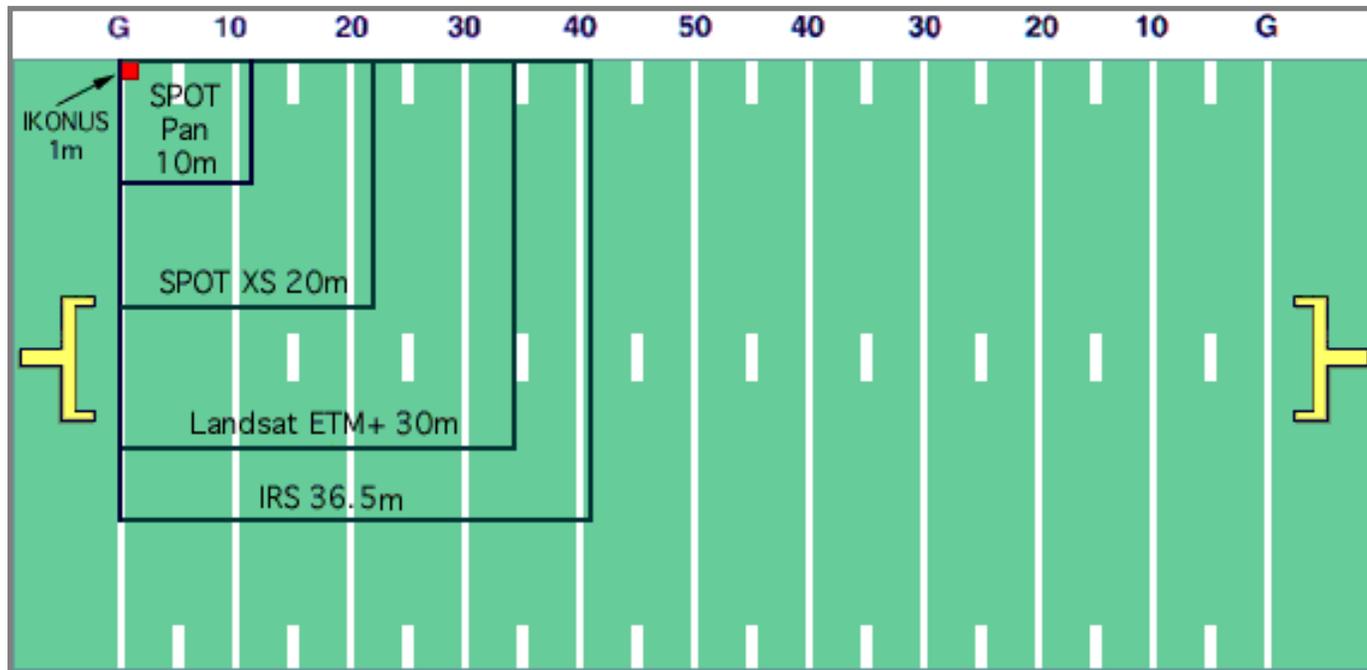
Terms

- **Spatial Resolution** – the practically effective measure for the (theoretical) geometric resolving power of a sensor.
- **Instantaneous Field of View (IFOV)** – the solid angle through which a detector is sensitive to radiation.
- **Ground Resolution Cell** – the area on the terrain that is covered by the IFOV of the detector.
- **PIXEL** – short for *picture element*, which is the smallest discrete component of a digital image and is the area on the ground represented by each DN.

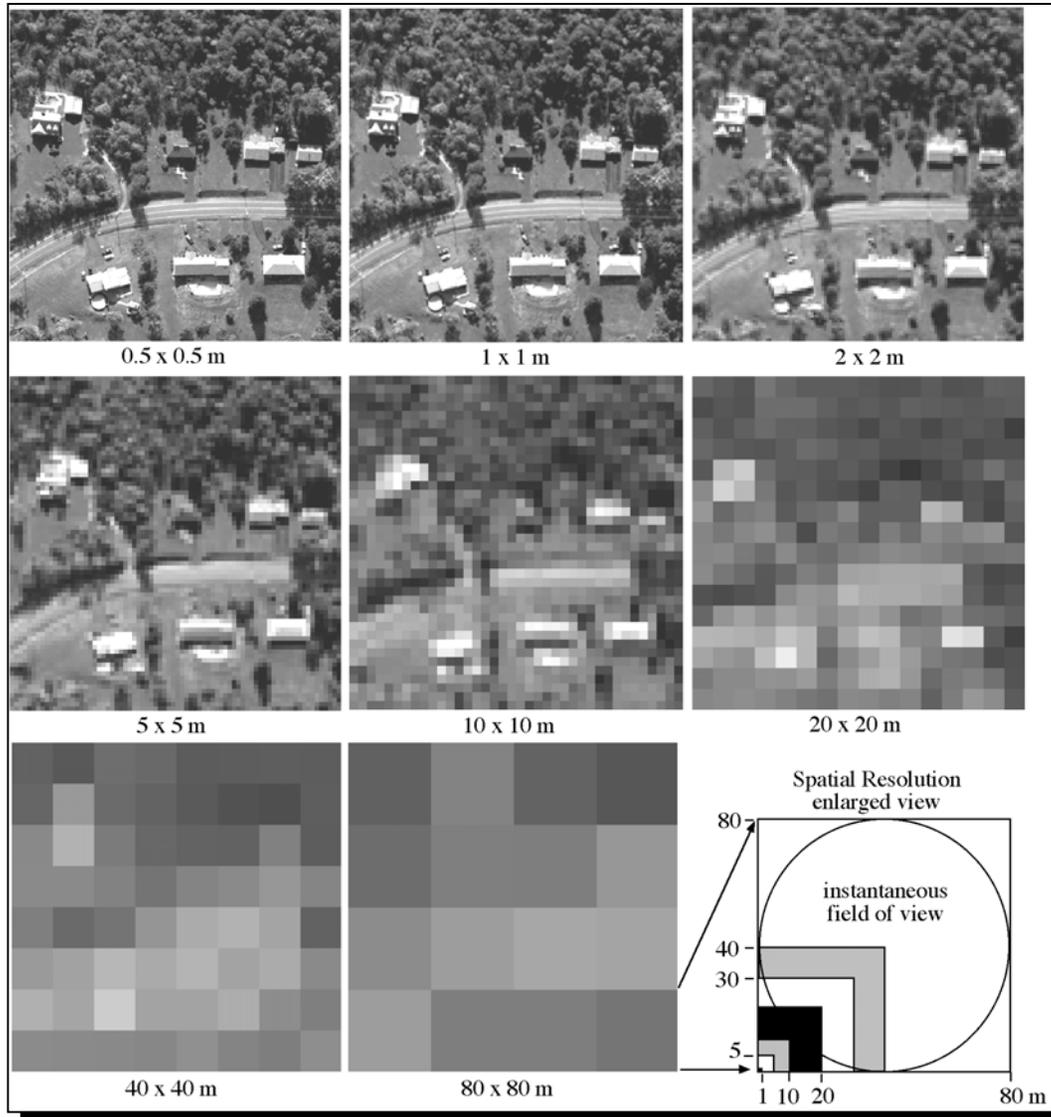
IFOV and Ground Resolution Cell



Ground Resolution Cell Comparisons



Spatial Resolution Comparisons



Spatial Resolution Examples

**Sioux Falls Airport
from Landsat 7**

15 meters



Spatial Resolution Examples (cont.)



60 meters



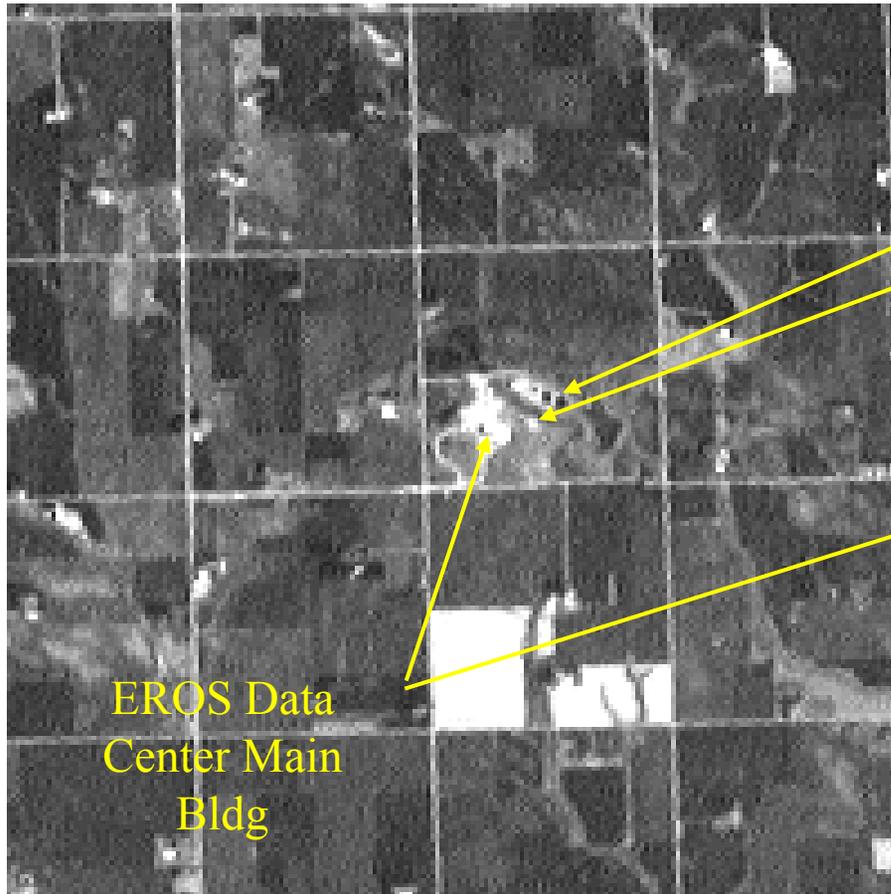
30 meters



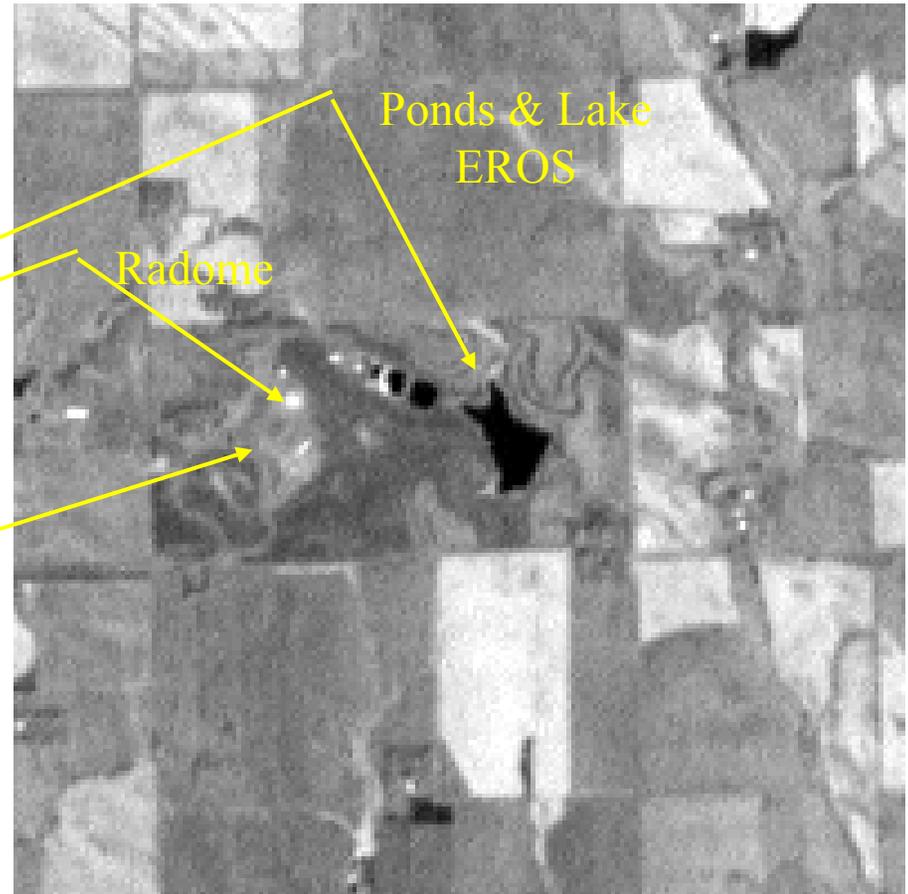
15 meters

More Spatial Resolution Examples

Landsat 7 - 30 meter



Landsat 7 - 15 meter



Final Example....

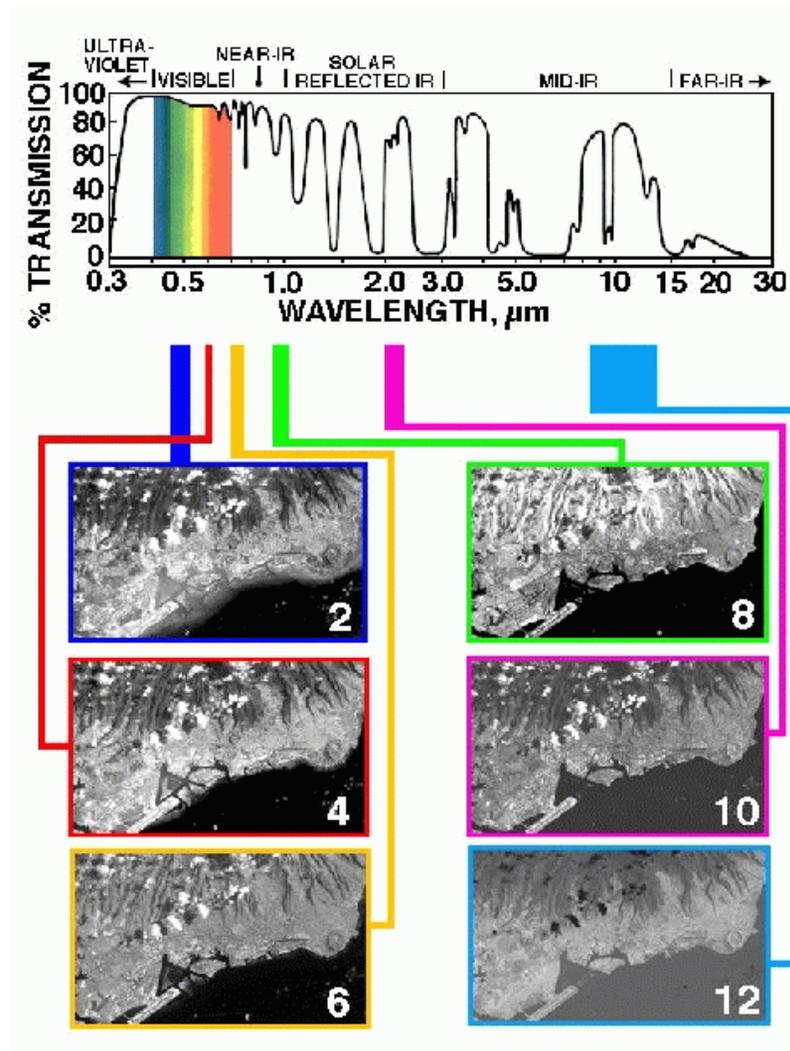
1-Meter
IKONOS

Wow!



Where
is my
car?!

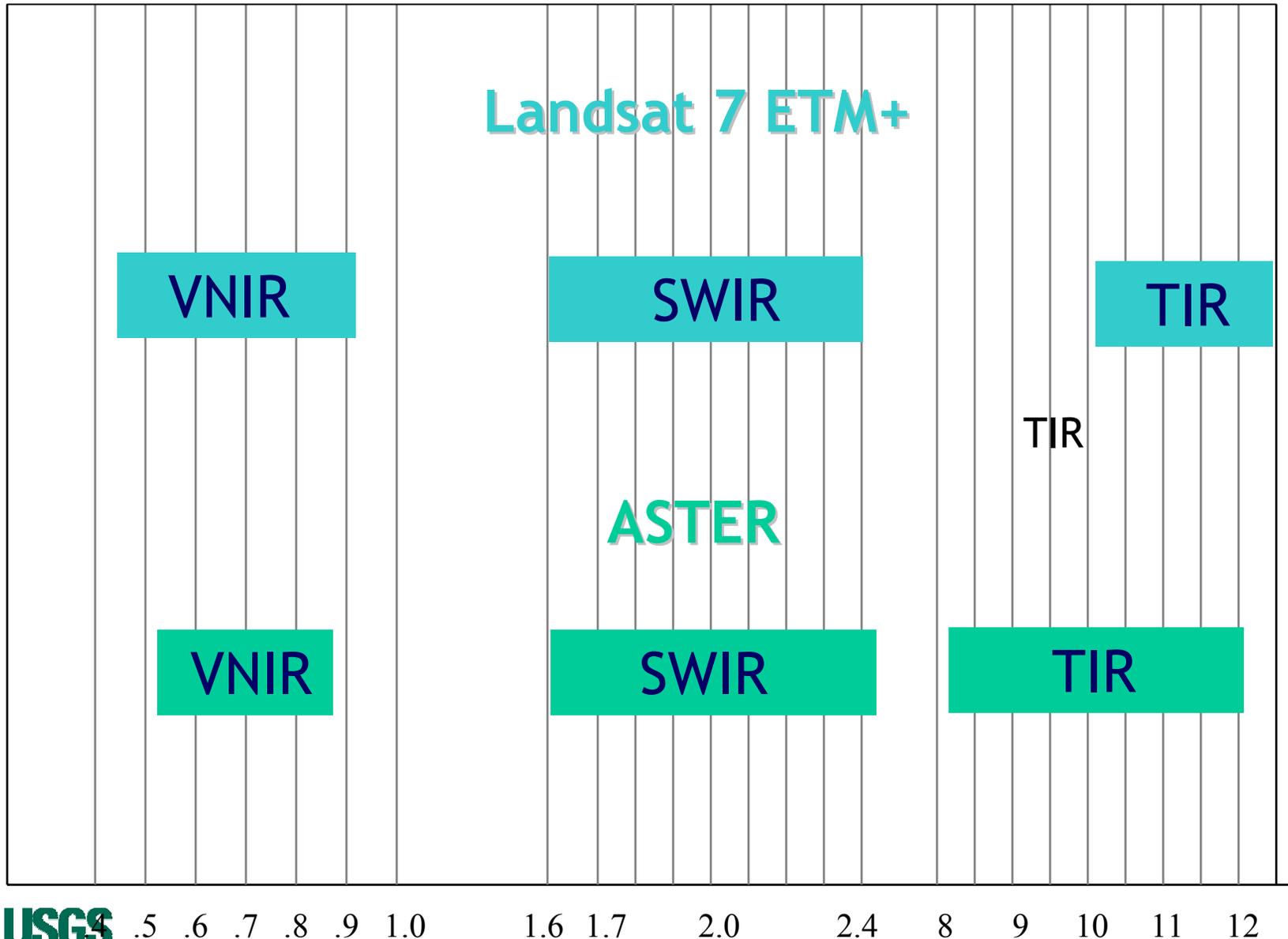
Spectral Coverage & Resolution



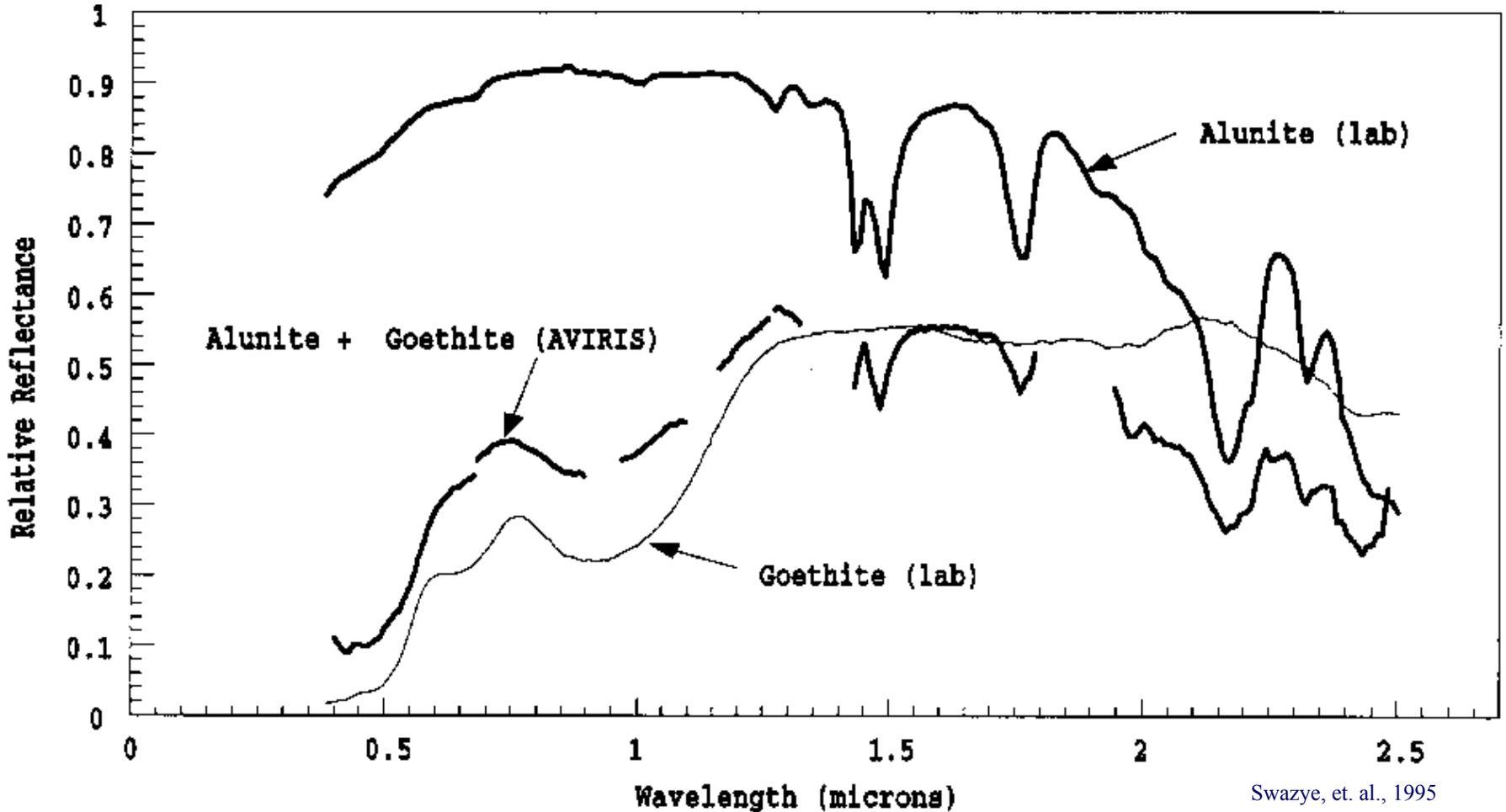
Terms

- **Spectral Coverage** – that portion of the spectrum which a sensor detects.
- **Spectral Band** – A well-defined continuous range (interval) of wavelengths in the electromagnetic spectrum individually sensed by a detector.
- **Spectral Resolution** – a measure of the width of a spectral band or channel; also, the “granularity” with which a sensor divides its spectral coverage into discretely observable parts.
- **Radiometric Resolution** – describes the sensitivity of a sensor; that is, its ability to discriminate very slight differences in radiant energy.

Spectral Coverage of Landsat ETM+ and ASTER

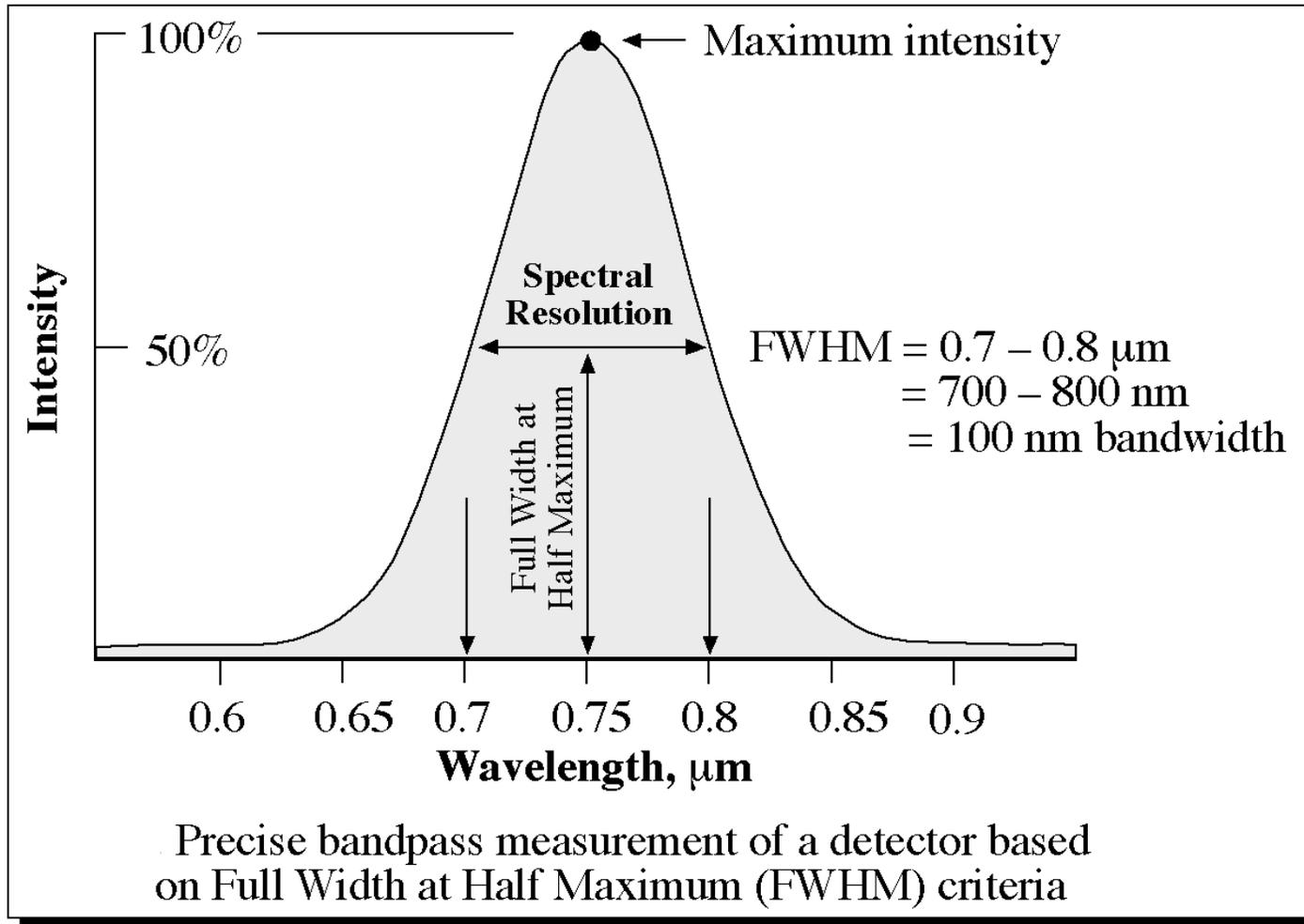


Importance of Spectral Coverage

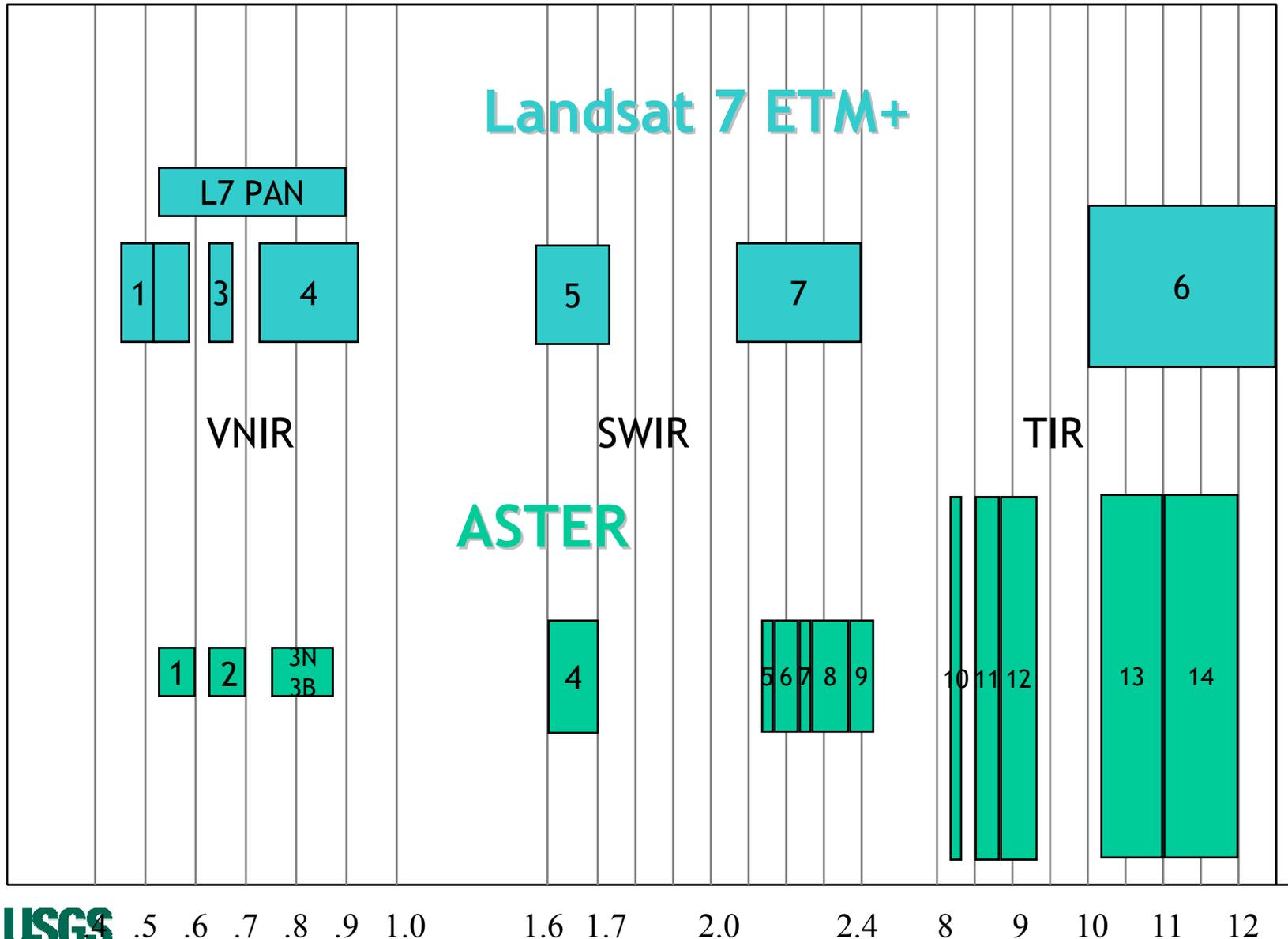


Swazye, et. al., 1995

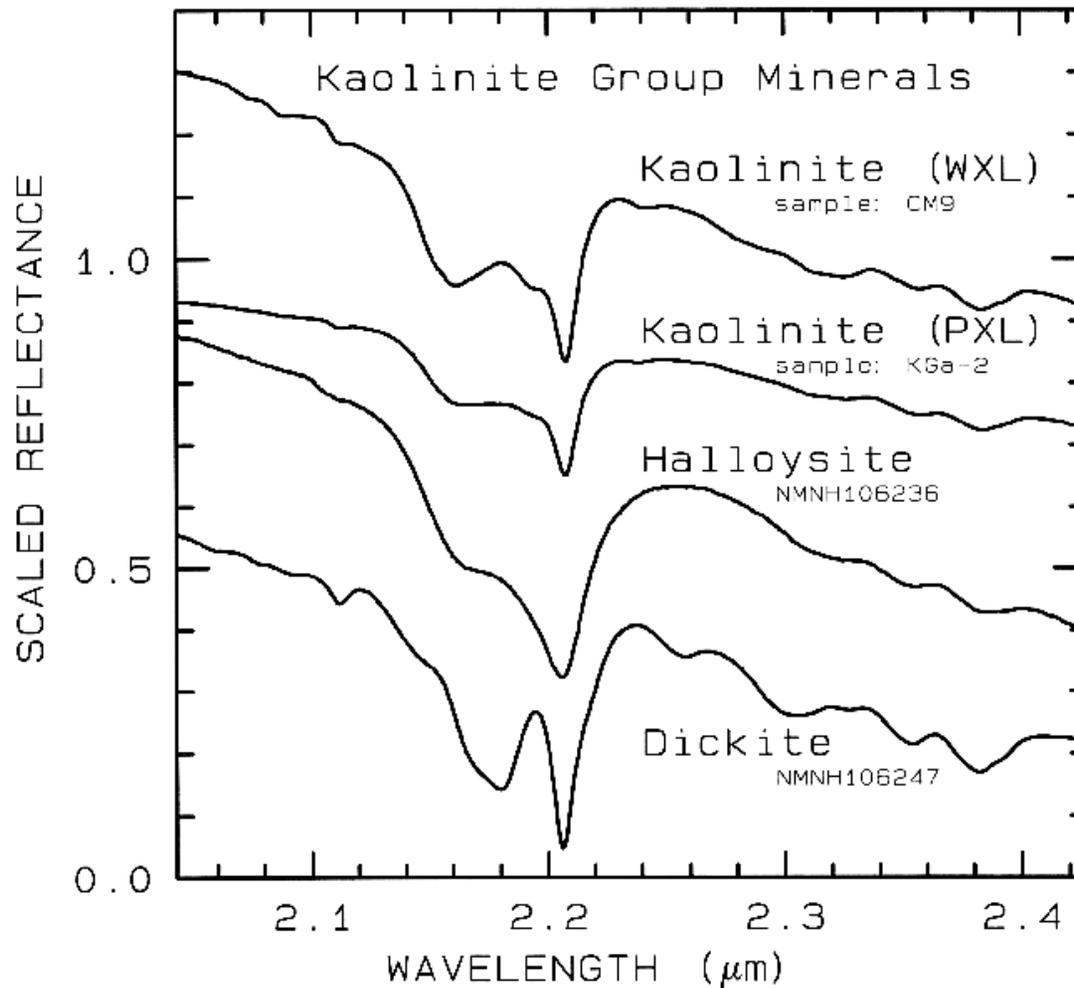
Spectral Resolution



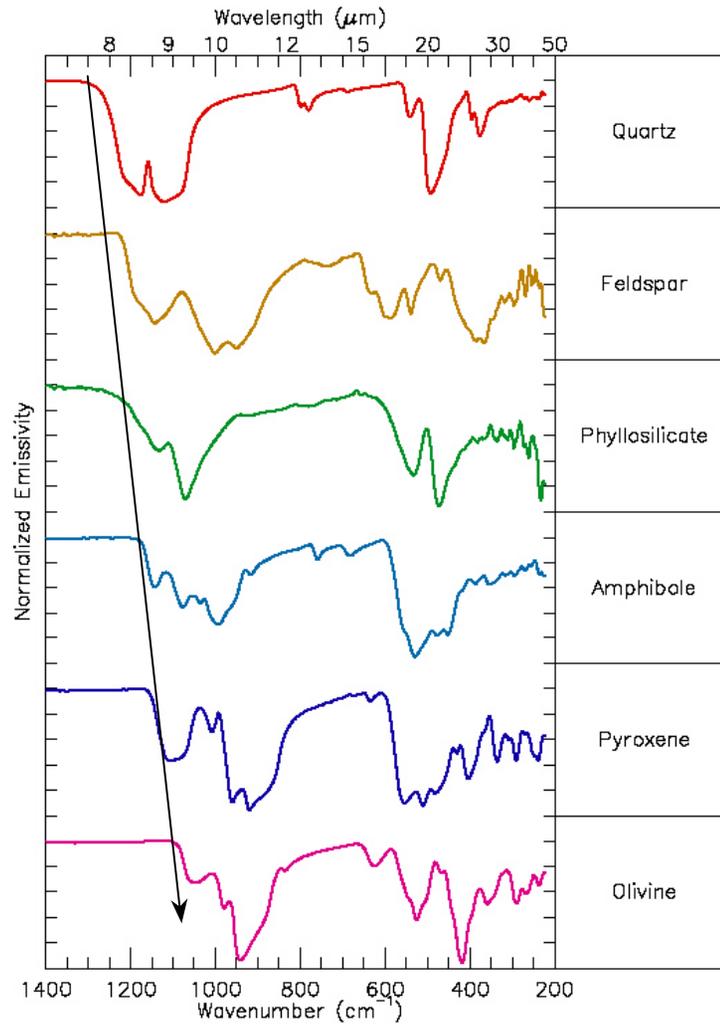
ETM+ & ASTER Spectral Bands and Resolution



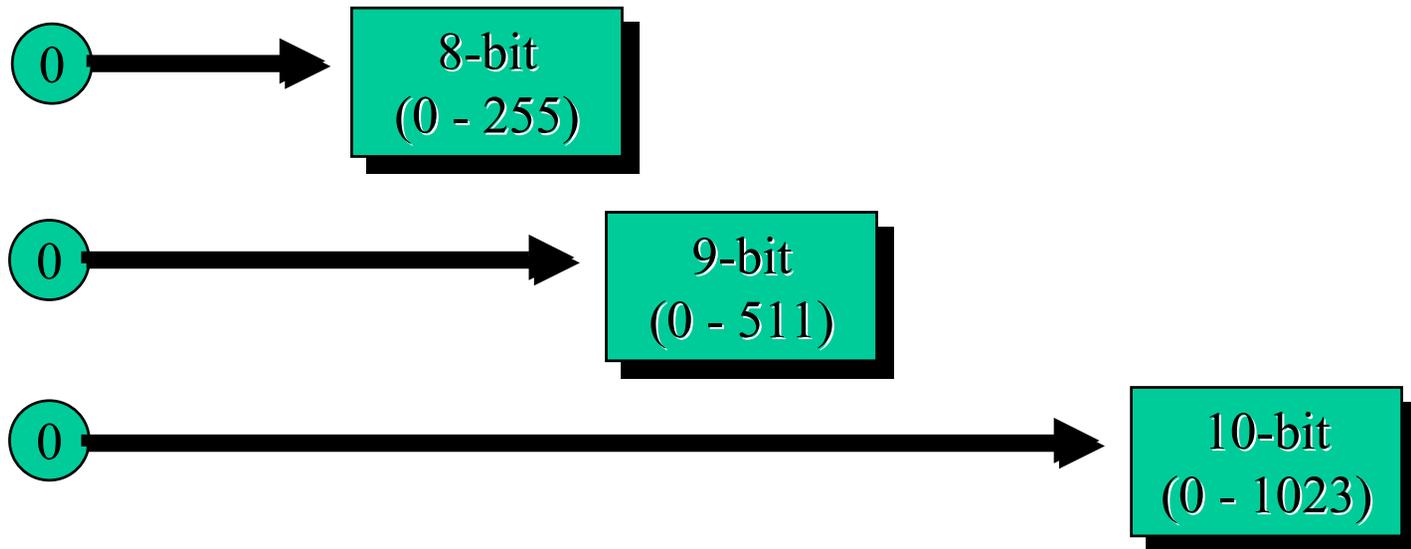
Importance of Spectral Resolution



Importance of Spectral Resolution



Radiometric Resolution



Jenson, 2000

Importance of Radiometric Resolution

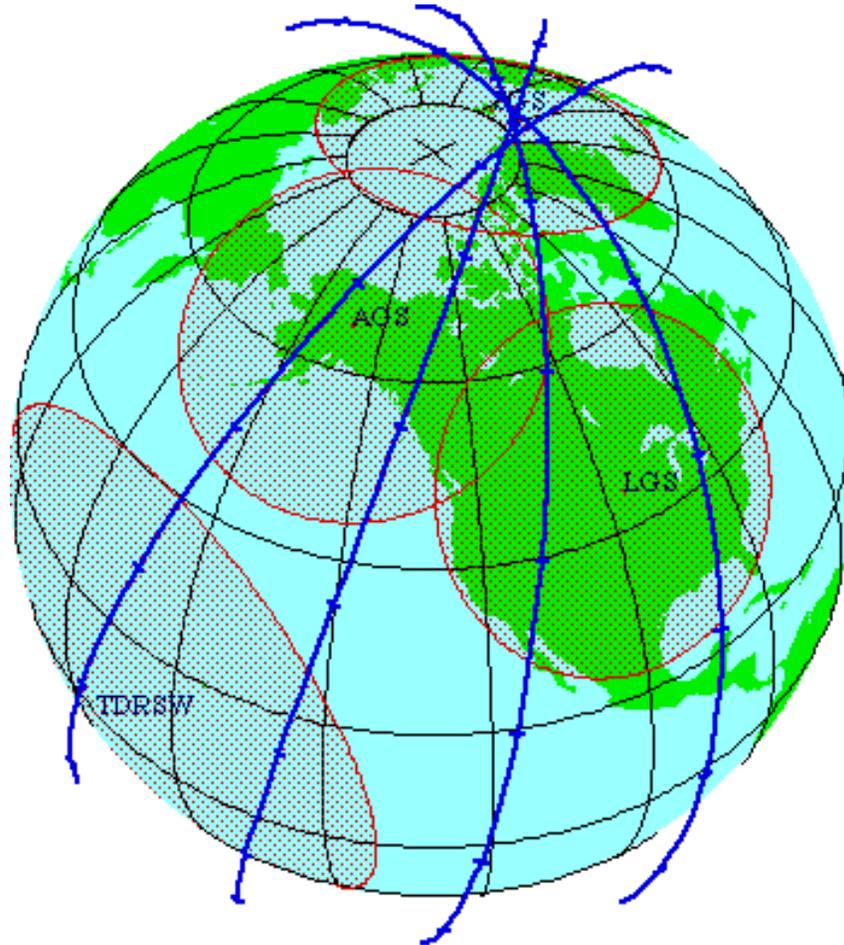


2-bit (0-3 DN)

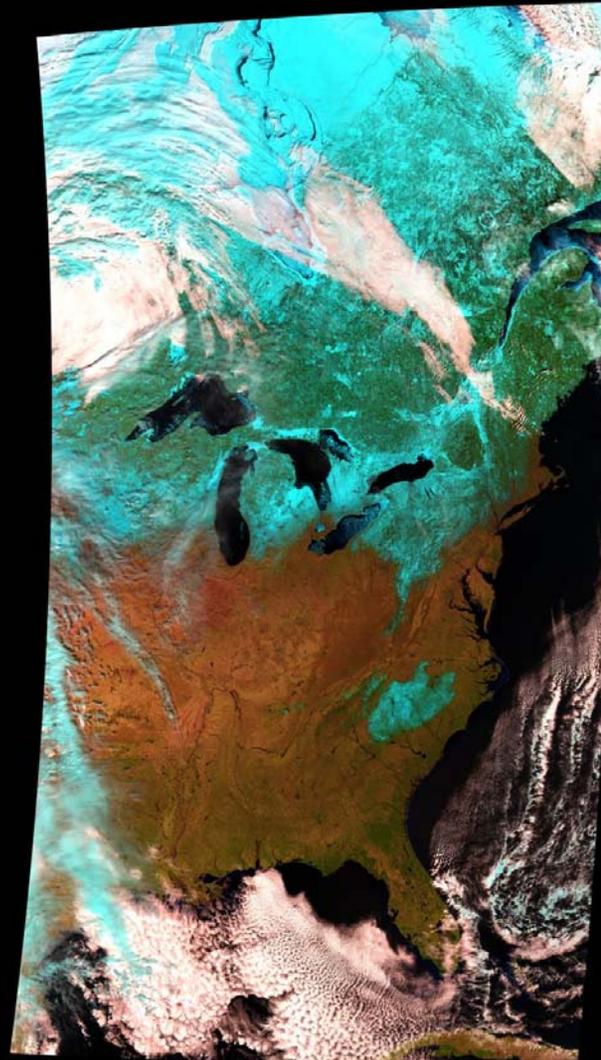
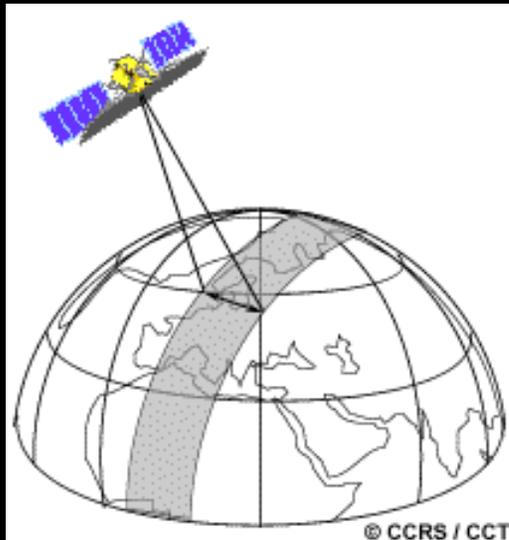


8-bit (0-255 DN)

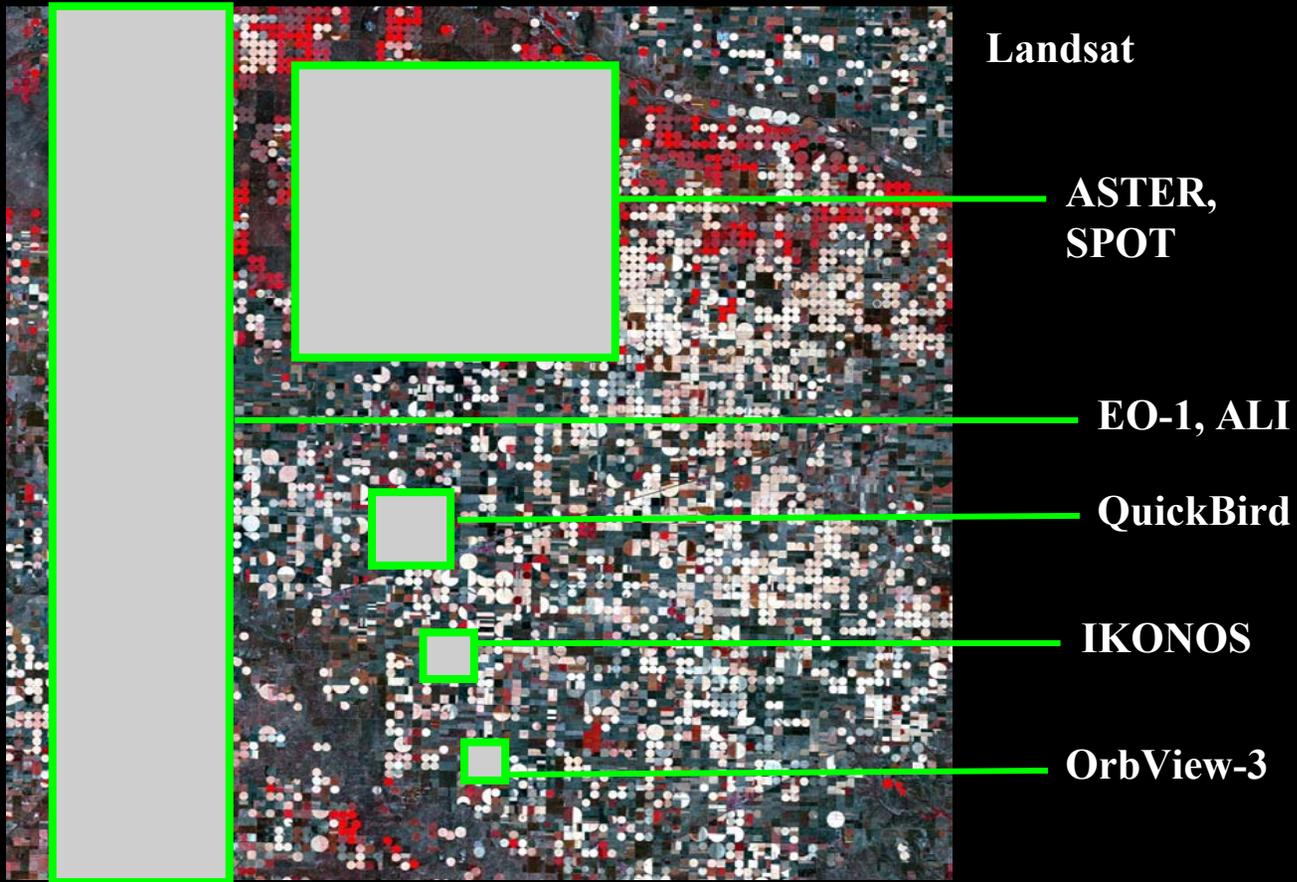
Geographic Coverage



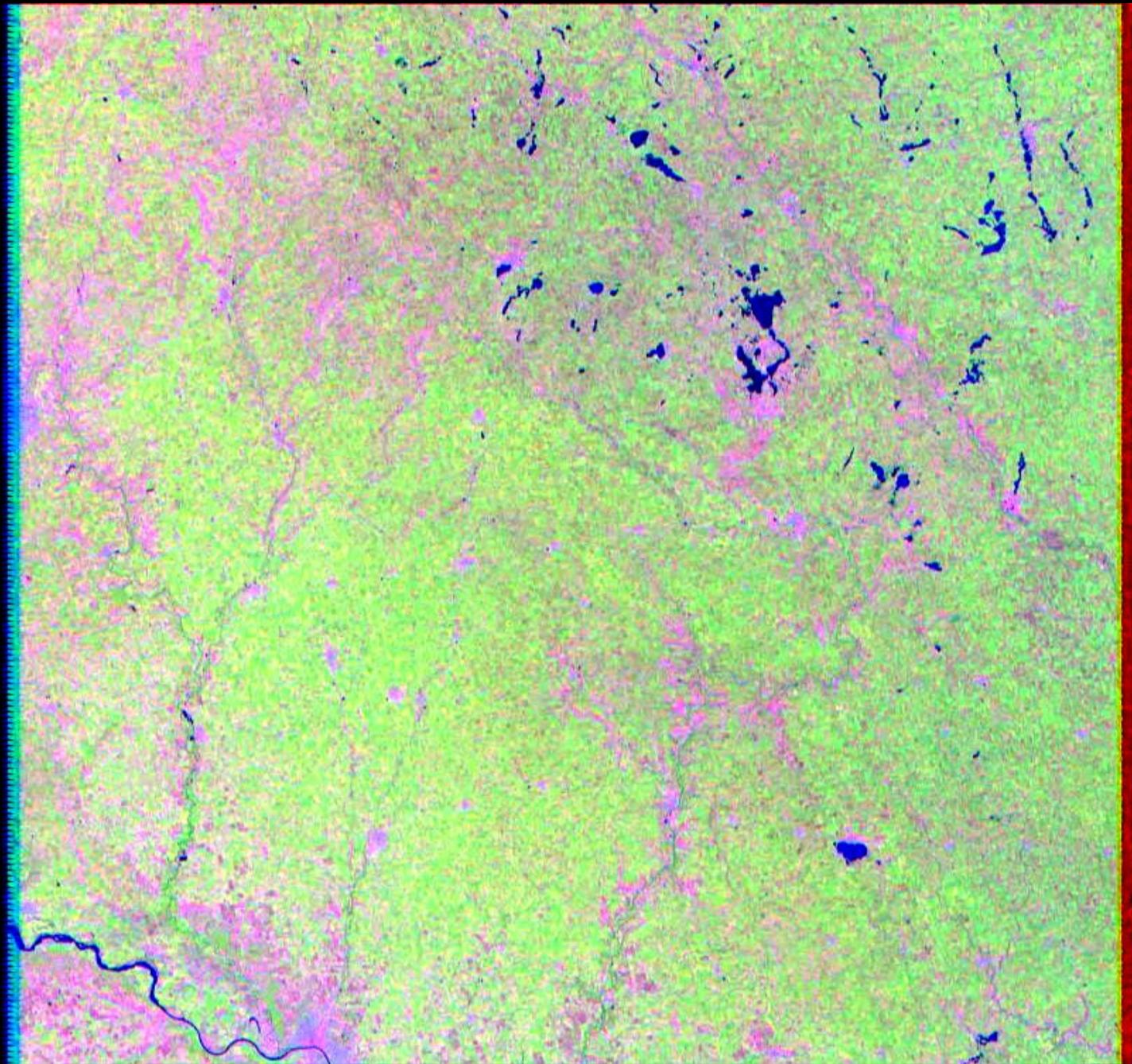
Role of Swath Width in Geographic Coverage



Role of Swath Width in Geographic Coverage







Temporal Characteristics

- Repetitive Coverage
- Equatorial Crossing Time
- Historical Coverage (time in orbit)



Temporal Resolution

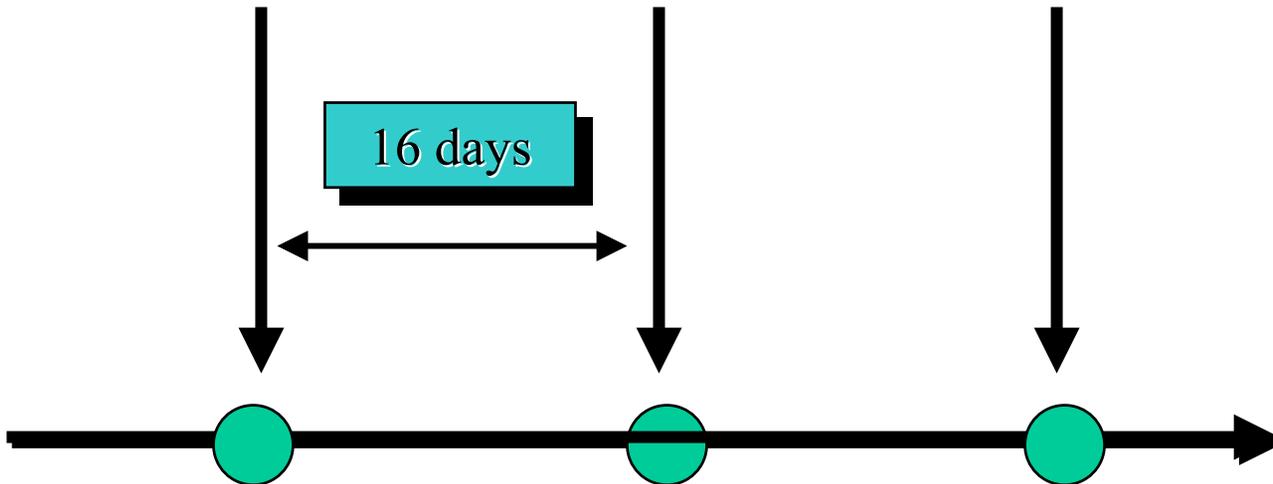
Remote Sensor Data Acquisition

June 1, 2001

June 17, 2002

July 3, 2003

16 days



What about trade-offs?

Trade-Offs with Selected Satellite Systems

AVHRR/ MODIS

- spatial resolution, 250m, 500m, 1000m

2048 km swath

- global coverage, 2 days

MISR

- spatial resolution, 275m, 550m, 1100m

360 km

- global coverage, 9 days

Landsat

- spatial resolution, 15m, 30m

183 km

- 16 day orbital repeat
- seasonal global coverage

ASTER

- spatial resolution 15m, 30m, 90m

60 km

- 45-60 day orbital repeat
- global coverage, years

Commercial Systems

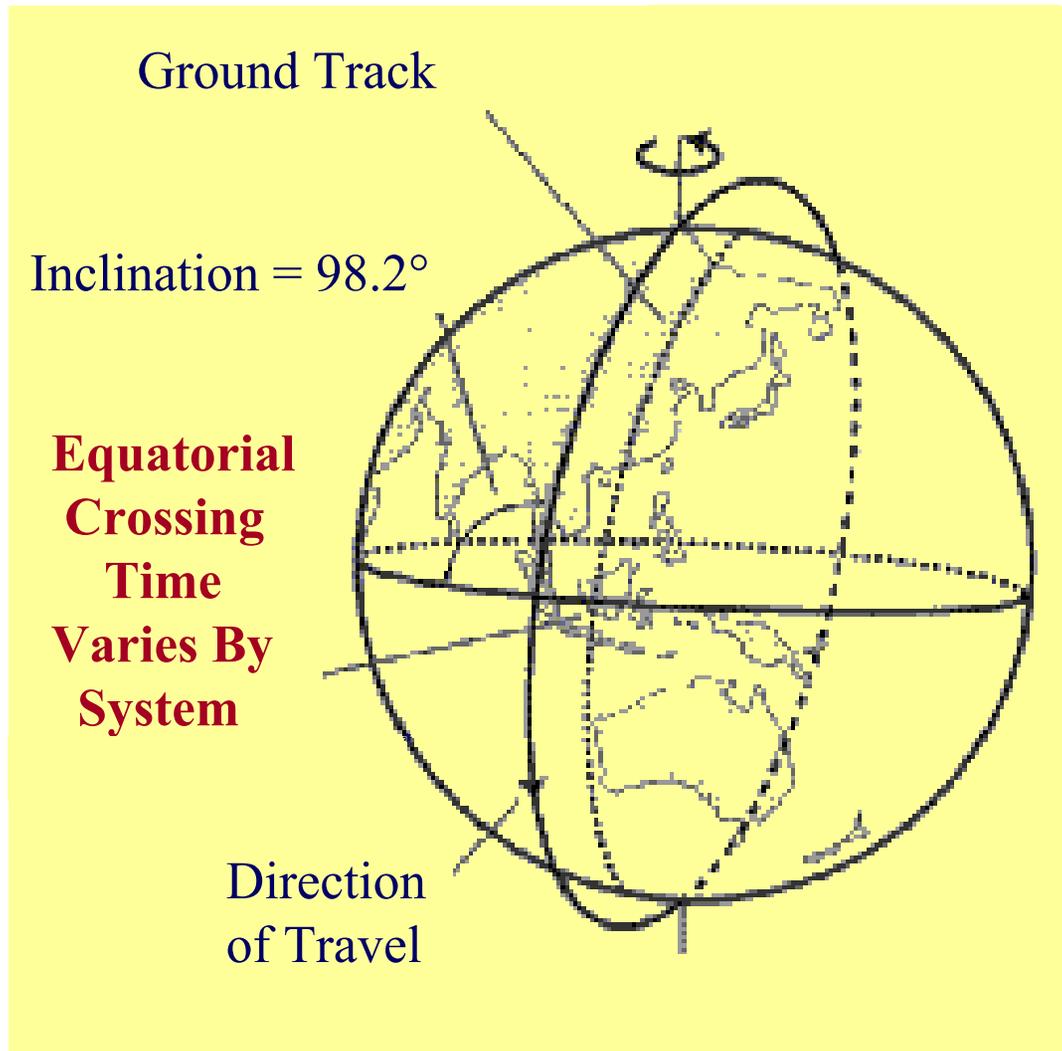
- spatial resolution 1m, 5m

~ 10 km

- global coverage, decades



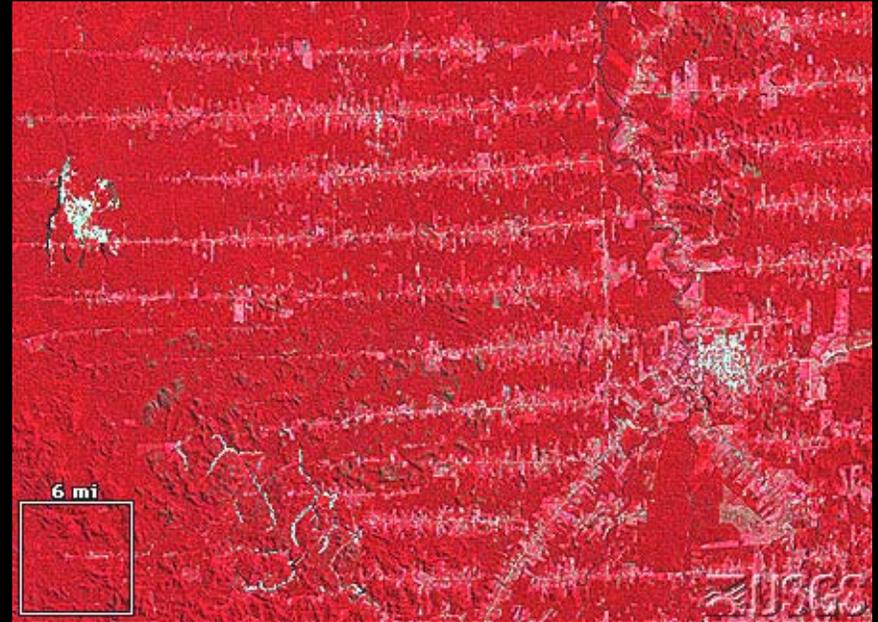
Significance of Equatorial Crossing Time



Importance of Historical Coverage

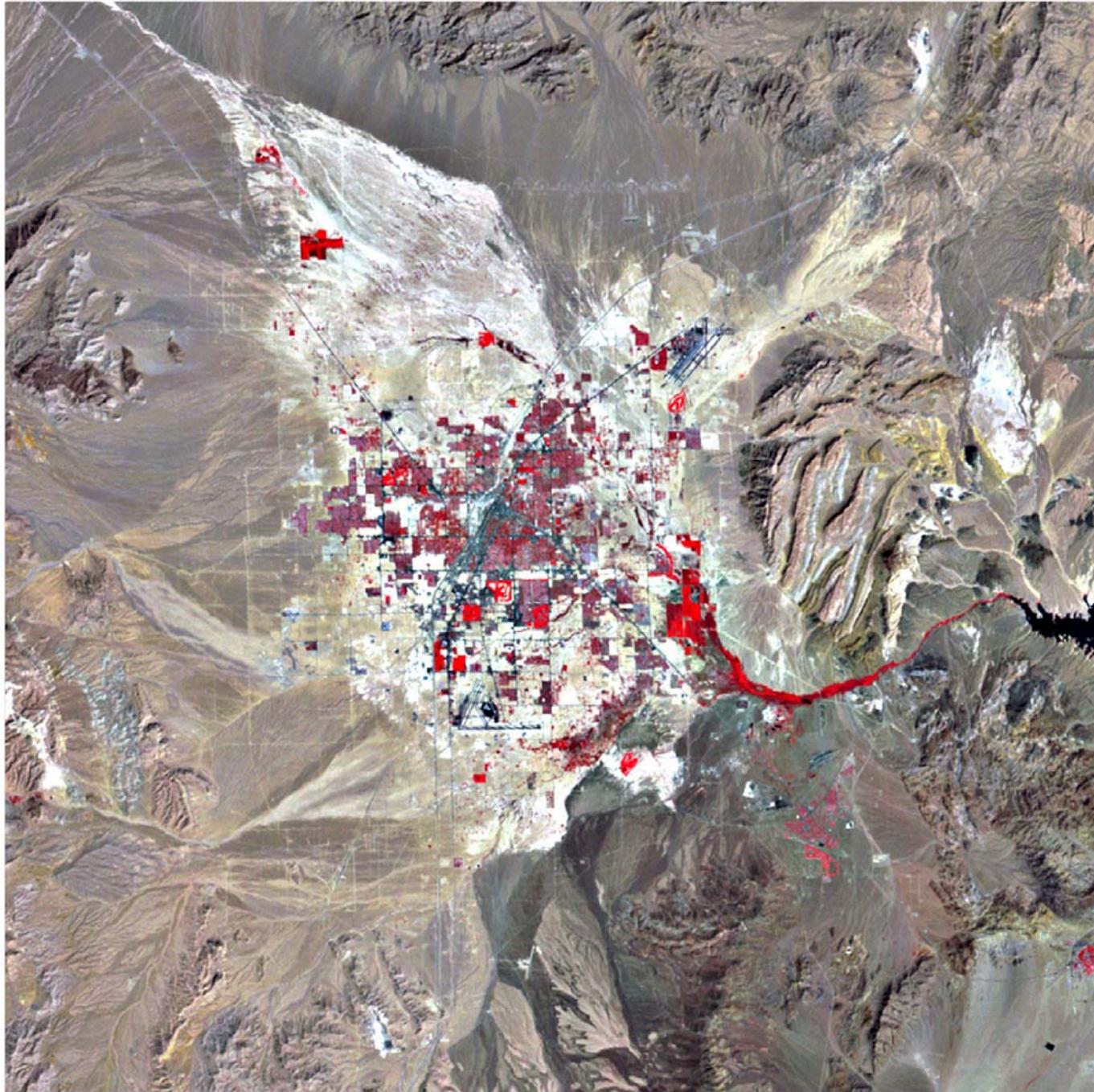


Brazilian Rain Forest - 1975

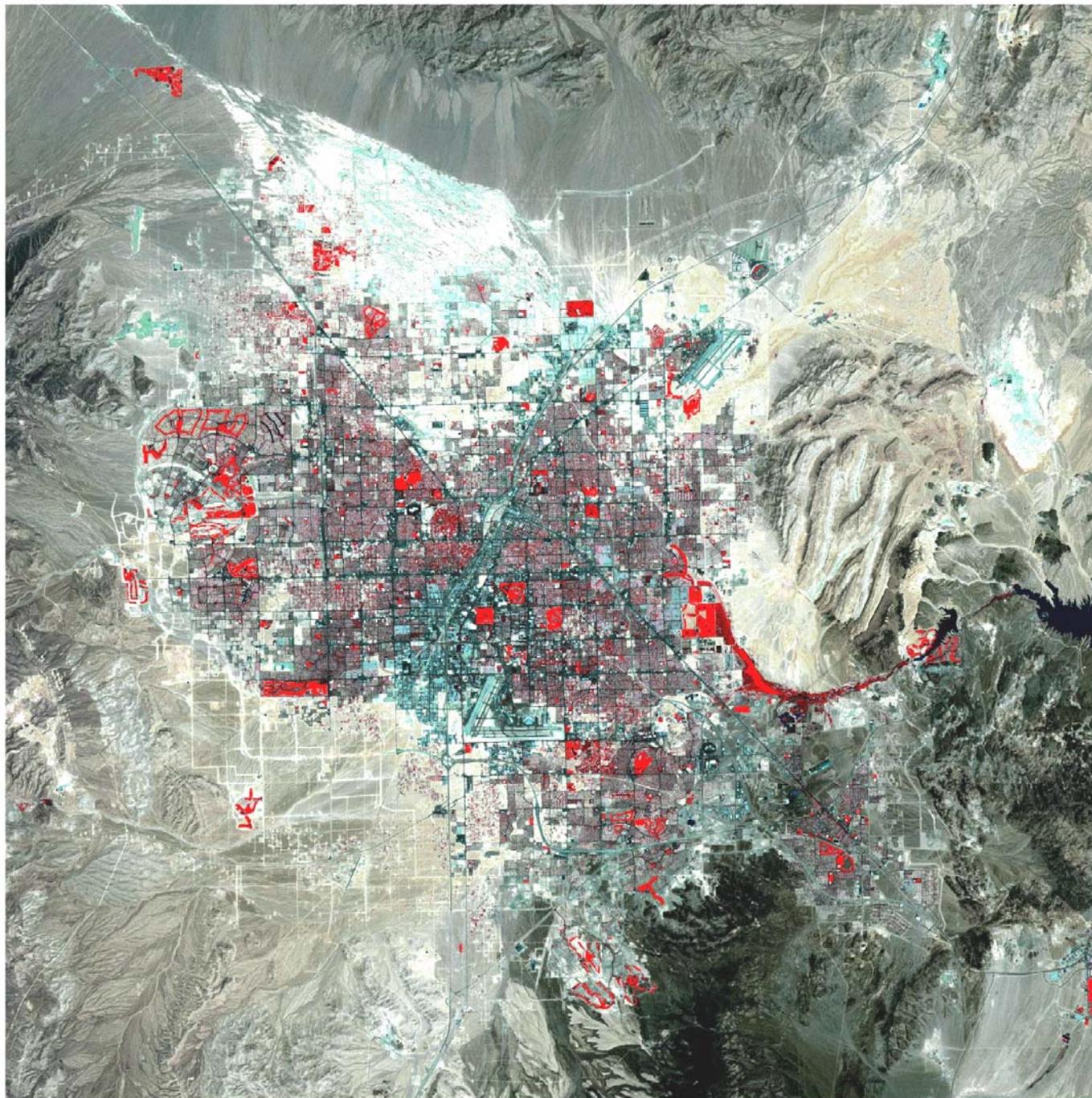


Brazilian Rain Forest - 1992

Multi-Spectral Scanner (MSS) - September 13, 1972



Enhanced Thematic Mapper (TM) – June 15, 1999



Data Availability and Accessibility

- Data Availability Depends on Variety of Factors:
 - System characteristics and acquisition strategies
 - Ground station networks
 - Data policy
 - Pricing policy
- Data *accessibility* is different from *availability*. It relates primarily to the mechanics of actually locating, selecting, and retrieving the data you wish to use in your study. Data search and order tools (a.k.a., user interfaces) are used to access remotely sensed data.

Data Costs

- Cost of data varies tremendously, from free to very expensive, depending on data type and provider.
- Sample Data Costs:
 - Landsat MSS (historic data) \$200/scene
 - Landsats 4/5 TM \$425/scene
 - Landsat 7 ETM+ (L0 and L1) \$475 and \$600/scene
 - Landsat 7 ETM+ (SLC-off & gap-filled) \$275/scene
 - SPOT \$2,300-\$10,000/scene
 - ASTER \$55/scene
 - MODIS Free
 - IKONOS, QuickBird, OrbView-3 \$30-\$150/sq. mile*

*minimum order requirements frequently apply.

Important Characteristics
of
Selected Land Remote Sensing Satellite Systems
(not including ASTER or MODIS!)

Advanced Very High-Resolution Radiometer (AVHRR) Instrument Characteristics



Band Number	Spectral Range (micrometers)	Ground Resolution
1	0.58 to 0.68	1.1 km
2	0.73 to 1.10	1.1 km
3A	1.58 to 1.64 (N 15-17)	1.1 km
3B	3.55 to 3.93	1.1 km
4	10.5 to 11.3	1.1 km
5	11.5 to 12.5	1.1 km

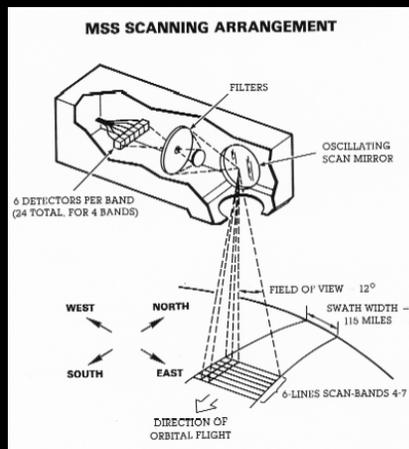
Swath Width:	2399 km
Repeat Coverage Interval:	Daily
Altitude:	833 km
Quantization:	10 bits
On-board data storage:	Up to 5 tape recorders
Inclination:	Sun-synchronous, 98.8°
Equatorial Crossing:	Descending, 7:30 a.m. and 2:30 p.m.
Launched:	Starting in 1978 (to present)

Landsat Multispectral Scanner (MSS)

Instrument Characteristics



Number	Range (micrometers)	Resolution (m)
4	0.5 to 0.6	80
5	0.6 to 0.7	80
6	0.7 to 0.8	80
7	0.8 to 1.1	80
8	10.5 to 12.6	120 (Landsat 3 only)



Swath Width:

185 km

Altitude:

920 km (Landsats 1-3)

705 km (Landsats 4 & 5)

Repeat Coverage Interval:

18 days (215 orbits)

16 days (233 orbits)

Quantization:

6 bits, stored as 8

On-board data storage:

Wide-band video tape recorder

Inclination:

Sun-synchronous, 99.2°; 98.2°

Equatorial Crossing:

Descending, 9:45 a.m.

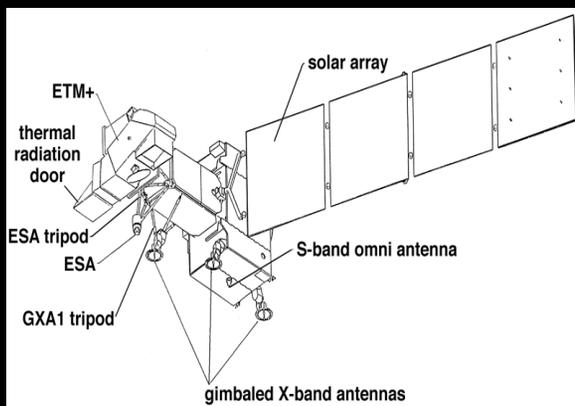
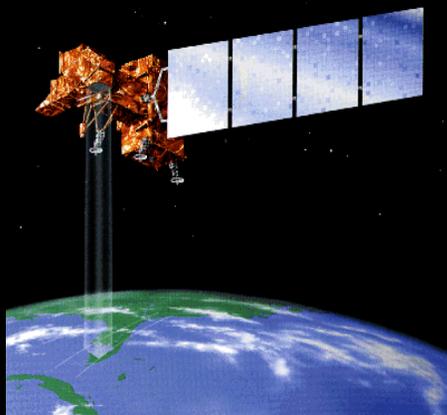
Launched:

July, 1972; January, 1975;

March, 1978; July, 1982;

March, 1984

Landsat 7 Enhanced TM+ (ETM+) Instrument Characteristics

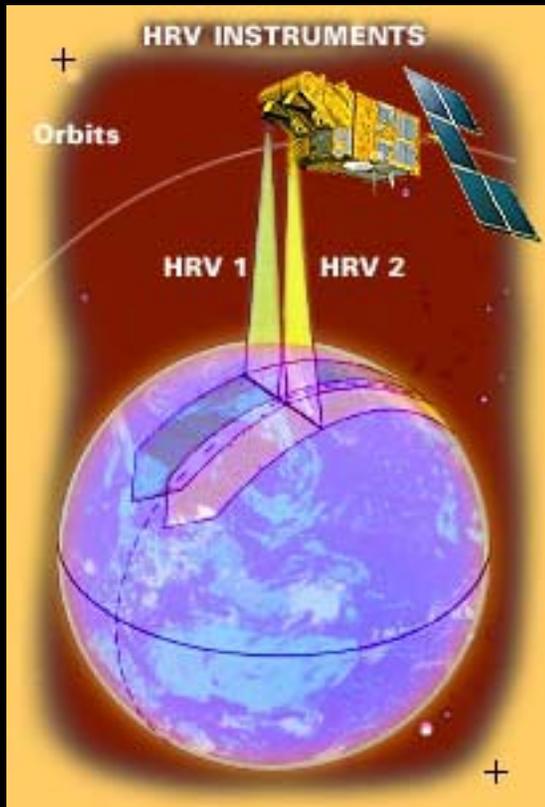


Band Number	Spectral Range (micrometers)	Ground Resolution (m)
1	.450 to .515	30
2	.525 to .605	30
3	.630 to .690	30
4	.750 to .900	30
5	1.55 to 1.75	30
6	10.40 to 12.5	60
7	2.09 to 2.35	30
Pan	520 to .900	15

Swath Width: 183 km
Repeat Coverage Interval: 16 days (233 orbits)
Altitude: 705 km
Quantization: Best 8 of 9 bits
On-board data storage: ~375 GB (solid state)
Inclination: Sun-synchronous, 98.2°
Equatorial Crossing: Descending, 10:00 a.m.
Launch vehicle: Delta II
Launched: April 15, 1999

SPOT 1-3 HRVs

Instrument Characteristics



Band Number	Spectral Range (micrometers)	Ground Resolution (m)
1	0.52 to 0.59	20
2	0.61 to 0.68	20
3	0.79 to 0.89	20
Pan	0.51 to 0.73	10

Modes:

XS and P

Swath Width:

Pointable up to $\pm 27^\circ$ (900 km)

Repeat Coverage Interval:

60 km (117 km)

Altitude:

26 days (369 orbits)

Quantization:

822 km

On-board data storage:

8 bits

Inclination:

2 recorders (22 min. ea.)

Equatorial Crossing:

Sun-synchronous, 98.2°

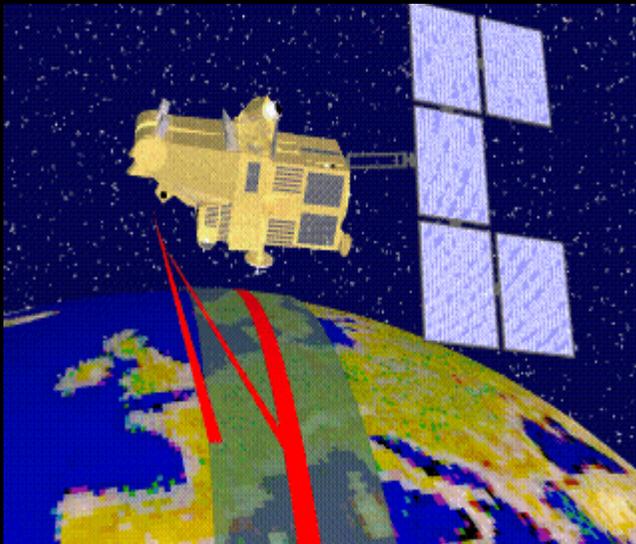
Launched:

Descending, 10:30 a.m.

Feb., 1986; Jan., 1993;

Sept., 1993

SPOT 4 & 5 HRVIR and Vegetation Instrument Characteristics



Band Number	Spectral Range (micrometers)	Ground Resolution
0 (Veg)	0.43 to 0.47	20m and 1km
Mono (4)	0.61 to 0.68	10m
Pan (5)	0.48 to 0.71	5m/2.5m
1	0.50 to 0.59	20m on 4/10m on 5
2	0.61 to 0.68	20m/10m and 1km
3	0.78 to 0.89	20m and 1km
SWIR	1.58 to 1.75	20m and 1km

HRVIR Modes:

XS and P
Pointable up to $\pm 27^\circ$ (900 km)

Swath Width:

60 km and 2250 km

Repeat Coverage Interval:

26 days (369 orbits)

Altitude:

822 km

Quantization:

Best 8 of 9 bits

On-board data storage:

2 recorders (40 min. ea.)

Inclination:

Sun-synchronous, 98.8°

Equatorial Crossing:

Descending, 10:30 a.m.

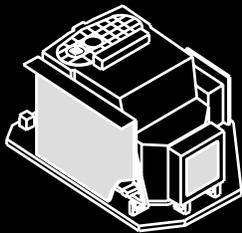
Launched:

March, 1998; May, 2002

Earth Observing -1 (EO-1) Advanced Land Imager (ALI) Instrument Characteristics

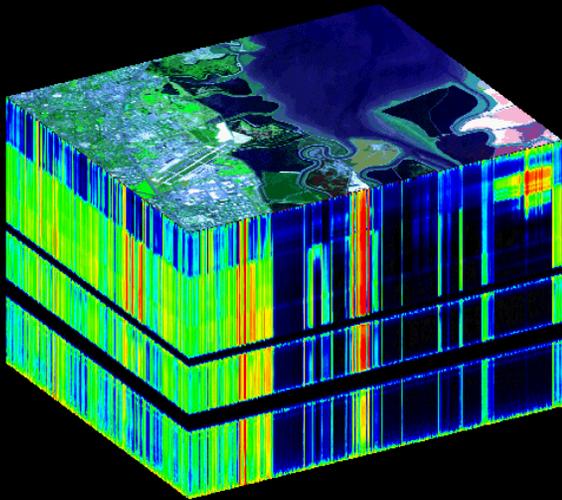


Number	Range (micrometers)	Resolution (m)
MS-1'	.433 to .453	30
MS-1	.450 to .515	30
MS-2	.525 to .605	30
MS-3	.630 to .690	30
MS-4	.775 to .805	30
MS-4'	.845 to .890	30
MS-5'	1.20 to 1.30	30
MS-5	1.55 to 1.75	30
MS-7	2.09 to 2.35	30
Pan	.480 to .690	10

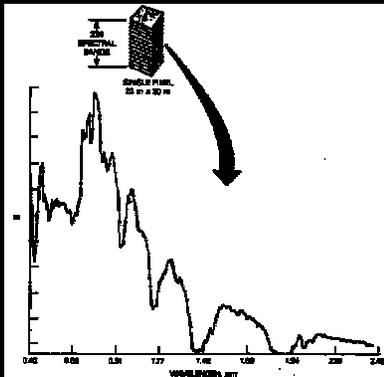


Swath Width:	37 km
Repeat Coverage Interval:	N/A
Altitude:	705 km
Inclination:	Sun-synchronous, 98.2°
Equatorial Crossing:	Descending, 10:00 a.m.
Launch vehicle:	Delta 7320
Launched:	November 21, 2000

Earth Observing -1 (EO-1) Hyperion Instrument Characteristics



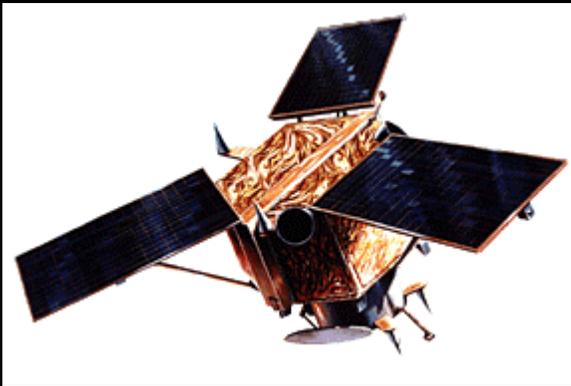
Spectral Range	0.4 μm – 2.5 μm
Spectral Resolution	10 nm
Number of Bands	220
Spatial Resolution	30 m
Swath Width	7.7 km



Altitude:	705 km
Inclination:	Sun-synchronous, 98.2°
Equatorial Crossing:	Descending, 10:00 a.m.
Launch vehicle:	Delta 7320
Launched:	November 21, 2000

IKONOS

Instrument Characteristics



Band Number	Spectral Range (micrometers)	Ground Resolution (m)
1	0.45 to 0.52	4
2	0.52 to 0.60	4
3	0.63 to 0.69	4
4	0.76 to 0.90	4
Pan	0.45 to 0.90	1

Swath Width:	11 km
Repeat Coverage Interval:	<3 days (via pointing)
Altitude:	681 km
Quantization:	8 bits
On-board data storage:	Solid state recorders
Inclination:	Sun-synchronous, 98.1°
Equatorial Crossing:	Descending, 10:30 a.m.
Launch vehicle:	Athena II
Launched:	September 24, 1999

QuickBird

Instrument Characteristics



Number	Range (micrometers)	Resolution (m)
1	0.45 to 0.52	2.5
2	0.52 to 0.60	2.5
3	0.63 to 0.69	2.5
4	0.76 to 0.89	2.5
Pan	0.45 to 0.90	0.61

Swath Width:	16.5 km
Repeat Coverage Interval:	3.5 days (via pointing)
Altitude:	450 km
Quantization:	11 bits
On-board data storage:	Solid state recorders
Inclination:	Sun-synchronous, 98°
Equatorial Crossing:	Descending, 10:30 a.m.
Launch vehicle:	Delta II
Launched:	October 19, 2001

OrbView 3

Instrument Characteristics



Number	Range (micrometers)	Resolution (m)
1	0.45 to 0.52	4
2	0.52 to 0.60	4
3	0.64 to 0.70	4
4	0.76 to 0.90	4
Pan	0.45 to 0.90	1

Swath Width:	8 km
Repeat Coverage Interval:	3 days (via pointing)
Altitude:	470 km
Quantization:	11 bits
On-board data storage:	Solid state recorders
Inclination:	Sun-synchronous, 97.3°
Equatorial Crossing:	Descending, 10:30 a.m.
Launch vehicle:	Pegasus XL
Launched:	June 26, 2003

Questions?