

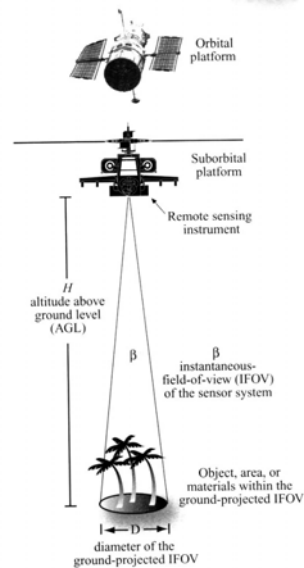
Remote Sensing Platforms & Sensors

Three Modes of RS

- Passive RS using reflected solar radiation
- Passive RS using emitted terrestrial radiation
- Active RS
 - Radar
 - Lidar

Digital Data

- Picture elements – pixels
- Platforms
 - Airborne
 - Satellite
- Sensors
 - Optical: A-to-D conversion
 - CCD: dynamic range (Fig 4.8)
 - Signal-to-noise ratio
 - Spectral sensitivity



Satellite Imaging Systems

- What is a satellite?
 - Orbit
 - Track – orbital, ground
 - Period

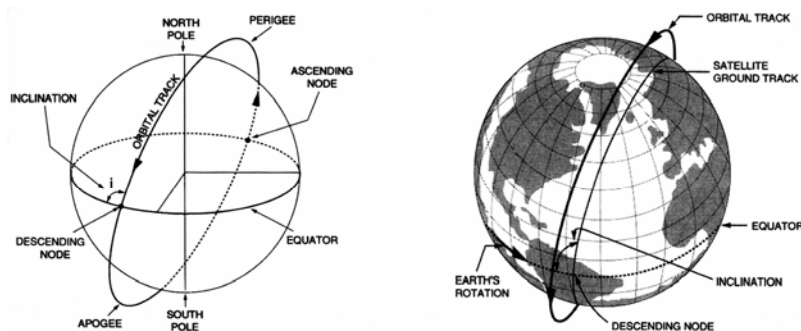
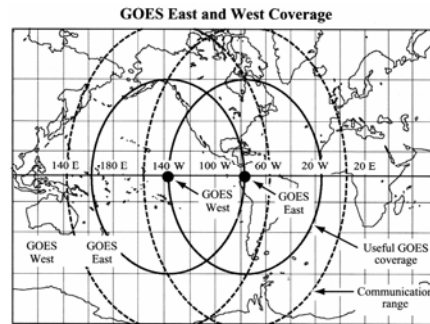


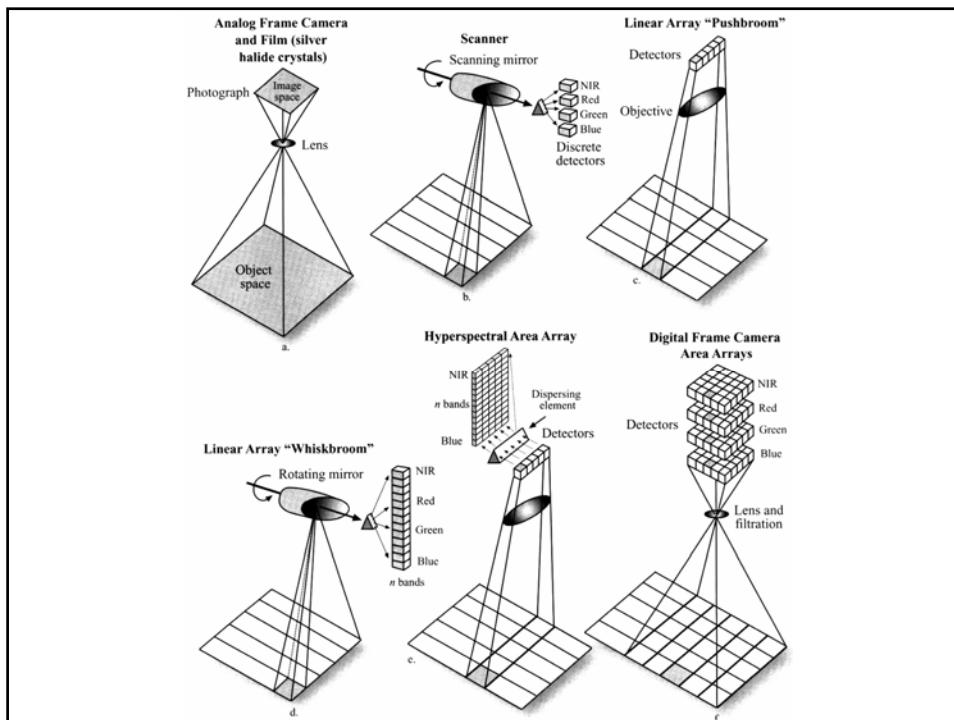
FIGURE 6.1. Satellite orbits. Left: Definitions. Right: Schematic representation of a sun-synchronous orbit

Satellite Orbit

- Geostationary
- Sun-synchronous
- Use of a satellite
 - Meteorological
 - Communications
 - Earth observation



Geostationary Operational Environmental Satellite



Resolution

- Resolution: the ability of an imaging system to record fine detail in a distinguishable manner.
- Other non-systematic factors
 - Scene characteristics
 - Atmospheric condition
 - Illumination
 - System deterioration

Resolution (cont.)

- Spatial (IFOV)
- Radiometric (dynamic range)
- Spectral (spectral sensitivity)
- Temporal (revisit interval)
- Trade-offs between forms of resolution
 - e.g., IFOV and spectral bandwidth

Spatial Resolution

- Ground Resolved Distance (GRD)
- IFOV (β)
- Ground-projected IFOV (D)
 $D = H \times \beta$
- Ground Sampled Distance (GSD)
- $GRD \approx 2 \times GSD \approx 2 \times D$

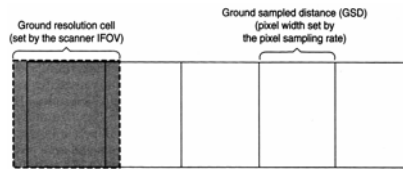
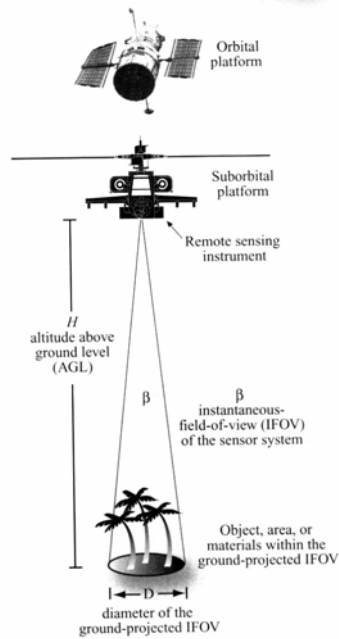


Figure 5.3 Ground sampled distance concept.

Mixels

- Pure & composite signatures
- Where do mixels occur?
- Are mixels good or bad?

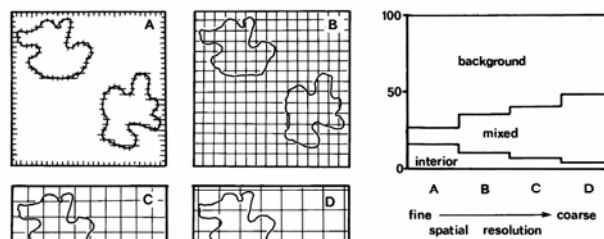


FIGURE 9.7. Influence of spatial resolution on proportions of mixed pixels.

Radiometric Resolution

- The number of digital quantization levels
- Expressed as number of bits
- Determined by signal-to-noise ratio of the sensor

Spectral sensitivity

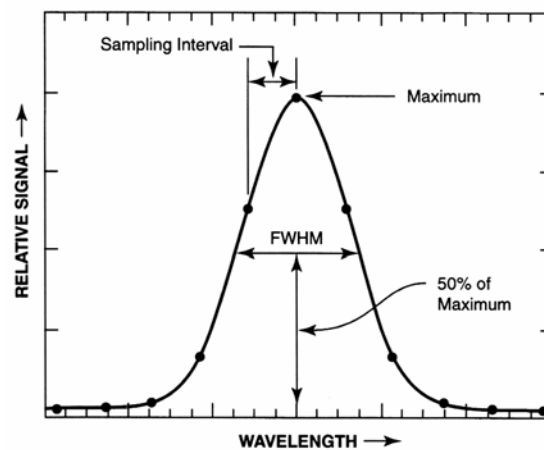
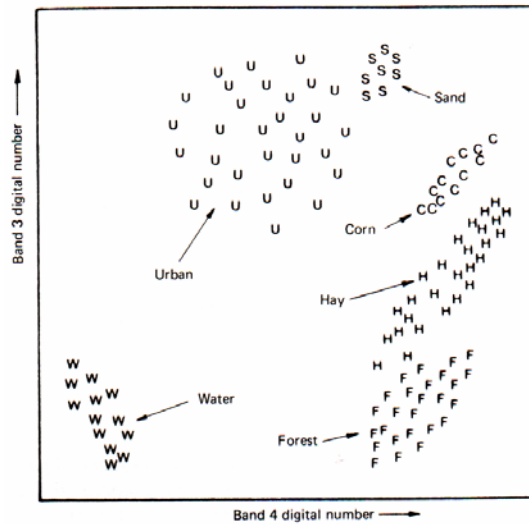


FIGURE 4.10. Full width, half maximum.

Spectral Signatures



Types of Satellite Images

- Landsat-like systems
 - Landsat MSS, TM, ETM+
 - SPOT
 - India Remote Sensing (IRS)
- Broad-scale systems
 - AVHRR (2,3999 km swath)
 - SPOT 4 Vegetation
 - Other NOAA weather satellites (GOES, POLAR, ...)
- Fine-resolution satellite systems
 - IKONOS (1 m – pan, 4 m – multispectral)
 - QuickBird (61 cm – pan, 2.44 m – multispectral)
- Hyperspectral
 - MODIS (36 bands)
 - AVIRIS (224 bands)

Landsat

- Satellite platform & sensors (Landsat1-ERTS)

TABLE 6.1. Landsat Missions

| Satellite | Launched | End of service ^a | Principal sensors ^b |
|-----------|-----------------|-----------------------------|--------------------------------|
| Landsat 1 | 23 July 1972 | 6 January 1978 | MSS, RBV |
| Landsat 2 | 22 January 1975 | 25 January 1982 | MSS, RBV |
| Landsat 3 | 5 March 1978 | 3 March 1983 | MSS, RBV |
| Landsat 4 | 16 July 1982 | ^c | TM, MSS |
| Landsat 5 | 1 March 1984 | ^d | TM, MSS |
| Landsat 6 | 5 October 1993 | Destroyed at launch | ETM |
| Landsat 7 | 15 April 1999 | — | ETM+ |

^aSatellite systems typically operate on an intermittent or stand-by basis for considerable periods prior to formal retirement from service.

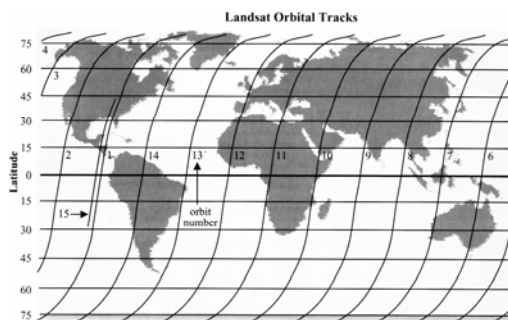
^bSensors are discussed in the text. MSS, multispectral scanner subsystem; RBV, return beam vidicon; TM, thematic mapper; ETM, enhanced TM; ETM+, enhanced TM plus.

^cTransmission of TM data failed in August 1993.

^dAt the time that this summary was prepared, there was no recording capability; transmission by direct downlink only.

Landsat MSS

- Sun-synchronous
- Period: 103 min
- Revisit time: 18 days
- Swath width: 185 km
- Spatial res: 79 x 79 m
- Scene: 185 x 175 km



WRS

- 233 N-S Paths, 119 Rows

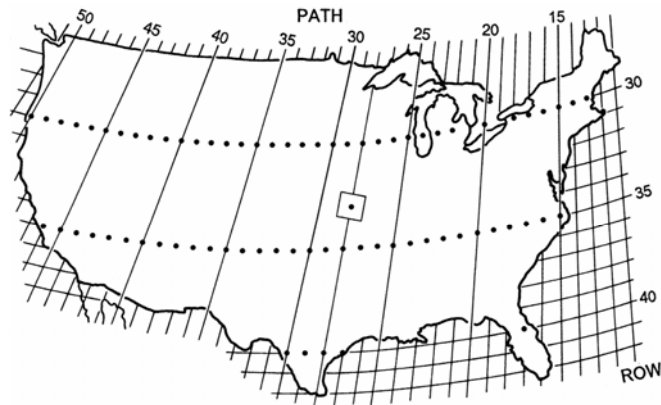
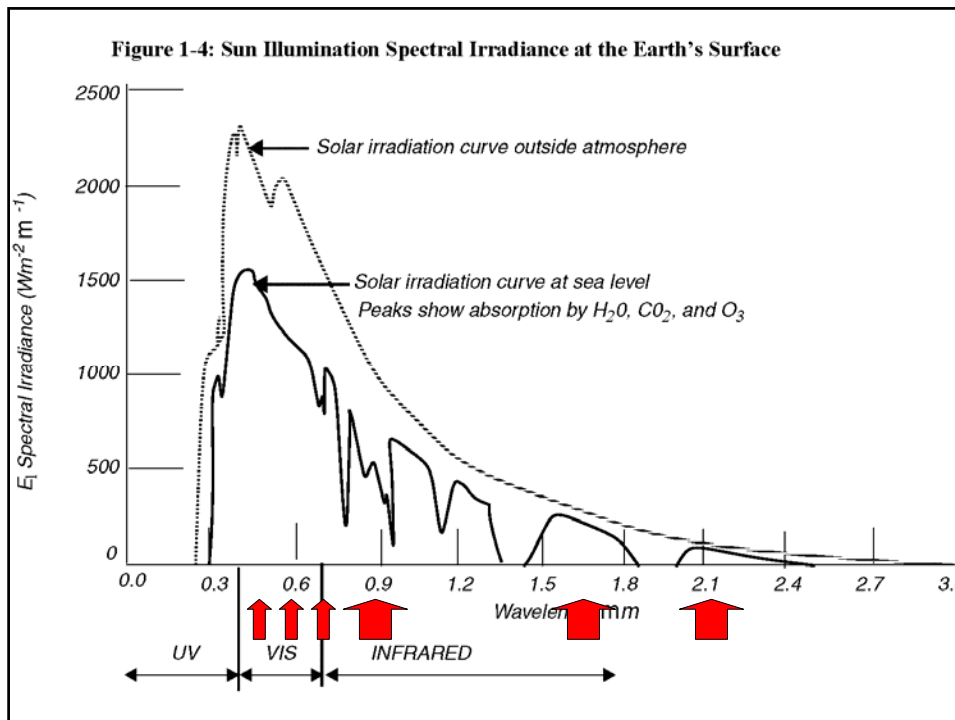


FIGURE 6.13. WRS path-row coordinates for the United States.

| Band | Bandwidth (μm) | IFOV (m) | Quantization (bits) | Off Nadir Viewing | Temporal Resolution (days) | Altitude (km) | Total Data Rate (Mbits/s) | Number Pixels per Line | Swath Width (km) |
|---|----------------|-------------|---------------------|-------------------|----------------------------|---------------|---------------------------|------------------------|------------------|
| Landsat Multispectral Scanner (MSS) on ERTS 1, 2 and Landsat 3, 4, and 5 | | | | | | | | | |
| 4 ^a | 0.50-0.60 | 79 × 79 | 6-8 | No | 18 | 917 | 15 | 2340 | 185 |
| 5 | 0.60-0.70 | | | | | | | | |
| 6 | 0.70-0.80 | | | | | | | | |
| 7 | 0.80-1.10 | | | | | | | | |
| 8 ^b | 10.4-12.6 | 240 × 240 | | | | | | | |
| Landsat Thematic Mapper (TM) on Landsat 4 and 5 | | | | | | | | | |
| 1 | 0.45-0.52 | 30 × 30 | 8 | No | 16 | 705 | 85 | 3000 | 185 |
| 2 | 0.52-0.60 | 30 × 30 | | | | | | | |
| 3 | 0.63-0.69 | 30 × 30 | | | | | | | |
| 4 | 0.76-0.90 | 30 × 30 | | | | | | | |
| 5 | 1.55-1.75 | 30 × 30 | | | | | | | |
| 6 | 10.4-12.5 | 120 × 120 | | | | | | | |
| 7 | 2.08-2.35 | 30 × 30 | | | | | | | |
| NOAA Advanced Very High Resolution Radiometer (AVHRR -12) Local Area Coverage (LAC) Data | | | | | | | | | |
| 1 | 0.58-0.68 | 1100 × 1100 | 8 | No | Daily | 861 and 845 | — | — | 2700 |
| 2 | 0.725-1.10 | 1100 × 1100 | | | | | | | |
| 3 | 3.55-3.93 | 1100 × 1100 | | | | | | | |
| 4 | 10.3-11.3 | 1100 × 1100 | | | | | | | |
| 5 | 11.5-12.5 | 1100 × 1100 | | | | | | | |
| French SPOT High Resolution Visible Sensor Systems (HRV) 1, 2, and 3 | | | | | | | | | |
| Multispectral Mode | | | | | | | | | |
| 1 | 0.50-0.59 | 20 × 20 | 8 | Yes | Variable | 832 | 25 | 3000 | 60 |
| 2 | 0.61-0.68 | 20 × 20 | | | | | | | |
| 3 | 0.79-0.89 | 20 × 20 | | | | | | | |
| Panchromatic Mode | | | | | | | | | |
| 1 | 0.51-0.73 | 10 × 10 | 8 | Yes | Variable | 832 | 25 | 6000 | 60 |



SPOT

- 1986 SPOT1 ~ 2002 SPOT5
- Sun-synchronous
- Revisit time: 26 days, off-nadir 2.5 days
- Sensors:
 - HRV (landsat class sensor)
 - Swath width: 117 km, 60 km off-nadir
 - Spatial res: 20 x 20 m (MS) or 10 x 10 (Pan)
 - Scene: 185 x 175 km
 - Vegetation: 1 km res
 - HRVIR: 2.5 m res (pan)

Broad-scale Coverage Sensors

- AVHRR (NOAA Polar Orbiting Env. Sat.)
 - Swath: 2,399 km
 - Spatial res: 1.1 km
- SeaWiFS (NASA Orbview 2)
 - Swath: 2,800 km
 - Spatial res: 1.1 km

Other Sensors

- Fine-resolution satellite systems
 - IKONOS (1m – pan; 4m – MS)
 - QuickBird (0.6m – pan; 2.44m – MS)
- [http://www.spotimage.fr/html/ 167 171 1 81 .php](http://www.spotimage.fr/html/167_171_181_.php)