



Indian Satellites and Earth Observation System

Indian Remote Sensing Satellites [IRS]

- One of a series of satellites
 - **IRS 1A**
 - 4 bands
 - 72m resolution
 - 148 Km swath & Launched in 1988
 - **IRS 1B**
 - 36m resolution
 - Launched in 1991

IRS (1C) – launched in 1995

IRS (1D) – launched in 1997

–sunsynchronous orbit (10:30)

–817 km height

- Three Sensors

- WiFS for low resolution/large area applications

- LISS - 3 is similar to LANDSAT but with less channels

- PAN has the highest resolution of commercial satellites

IRS-1C's Sensors

- **WiFS**

- whiskbroom
- 188m resolution
- 810 km swath
- 5 day revisit
- AVHRR – like!

- **LISS - 3**

- pushbroom
- 23.5m resolution
 - 70 m for Mid IR
- 142 km swath
- 24 day repeat
- TM/HRV - like

IRS 1C's Sensors

- **PAN**

- pushbroom that can be steered
- 5.8 m resolution (great resolution for the late 1990's)
- 70 km swath
- 24 day revisit

| | Visible B G R | Near IR | Mid IR | Thermal IR |
|-------|------------------|---------|--------|------------|
| WiFFS | | a b | | |
| LISS | 2 3 | 4 | 5 | |
| PAN | 1 | | | |

IRS-1C

The earliest Indian satellite IRS-1C was launched in December 1995 and carried instruments with both high and medium spatial resolutions.

IRS-1C data is available from January 1998 to till date

IRS-1C WIFS data is available from October 4th 1999 to till date

| SENSOR | PRODUCT DESCRIPTION | SCALE | AREA |
|------------|---|----------------|--------------------|
| LISS – III | Standard Full scene based path row products | 1:250,000 | 141 km x 141 km |
| LISS -III | Standard Quadrant scene based path row products | 1:125,000 | 72 km x 72 km |
| PAN | Standard Full Scene based path row products | Not Applicable | 70 km x (70-91) km |
| PAN | Standard Quadrant scene based path row products | Not Applicable | 35 km x 35 km |
| PAN | Standard Sub-scene based path row products | 1:50,000 | 23 km x (23-30) km |
| PAN | Geocoded data products as per SOI toposheet for Indian region | 1:25,000 | 14 km x 14 km |
| PAN | Point geocoded products | 1:12,500 | 9 km x 9 km |
| WiFS | Standard Scene based path row products | 1:2M | 810 km x 810 km |

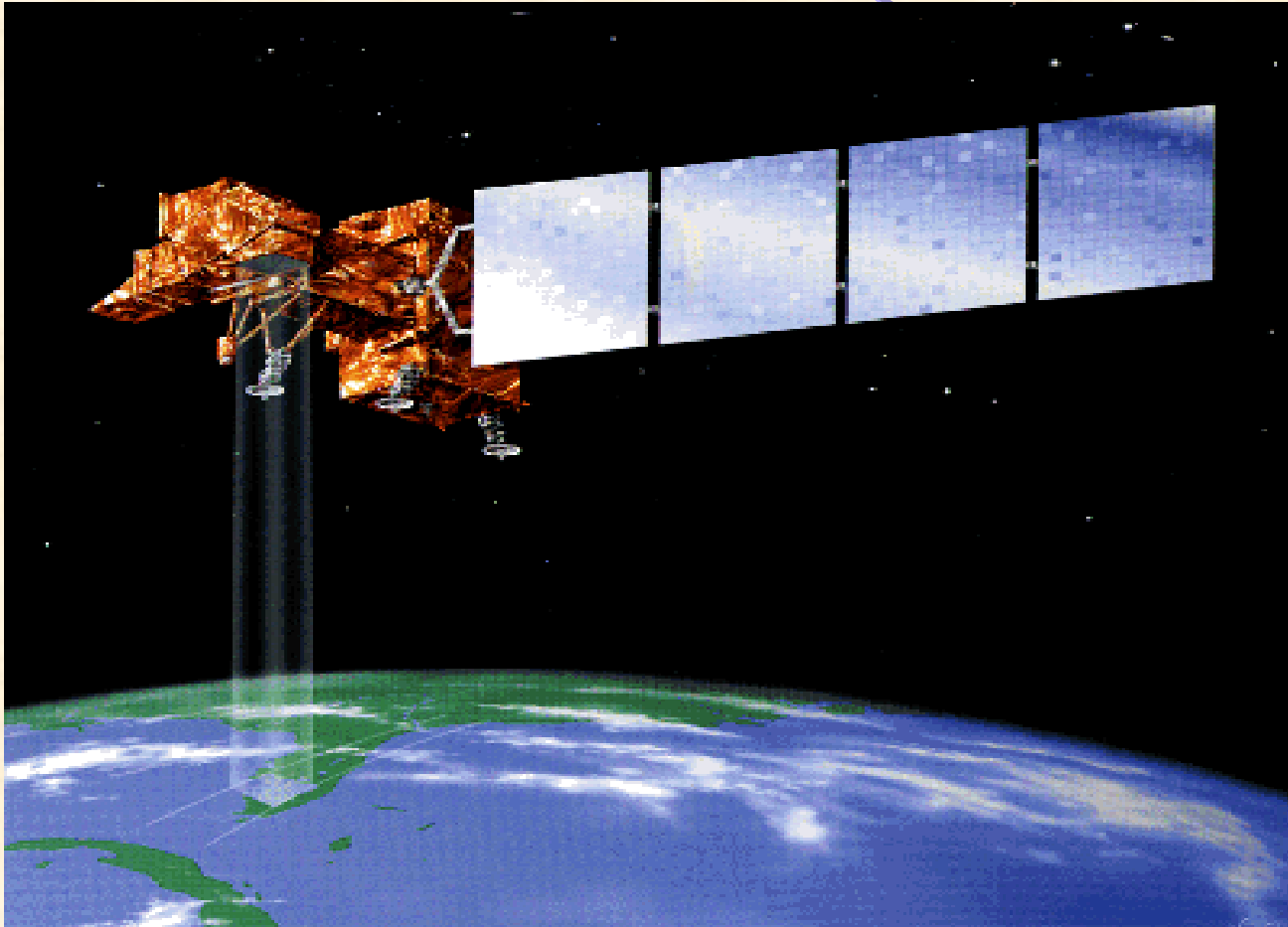
IRS-1D

IRS-1D was successfully launched on September 29, 1997. The satellite is an identical twin to IRS-1C. Thus this satellite couple together gives a revisiting cycle of 12 days as opposed to the single-satellite 24-day revisit cycle.

IRS-1D data is available from April 15th 1998 to till date

| SENSOR | PRODUCT DESCRIPTION | SCALE | AREA |
|------------|---|---------------|---------------------------|
| LISS – III | Standard Full scene based path row products | 1:250,000 | 127 km x 145.5 km |
| LISS -III | Standard Quadrant scene based path row products | 1:125,000 | 63.5 km x 71 km |
| PAN | Standard Full Scene based path row products | NotApplicable | 63 km x 71.8 km |
| PAN | Standard Quadrant scene based path row products | NotApplicable | 31.5 km x 34.5 km (Nadir) |
| PAN | Standard Sub-scene based path row products | 1:50,000 | 21 km x 23 km (Nadir) |
| PAN | Geocoded data products as per SOI toposheet for Indian region | 1:25,000 | 14 km x 14 km |
| PAN | Point geocoded products | 1:12,500 | 9 km x 9 km |
| WiFS | Standard Scene based path row products | 1:2M | 720 km x 778 km |

LANDSAT



LANDSAT

- LANDSAT 1 launched in 1972 was the first non-military remote sensing satellite
 - operated until 1978
- Six LANDSAT's successfully launched
 - LANDSAT 6 experienced 'launch failure'
- LANDSAT 1, 2 and 3
 - 900km altitude
 - 18 day repeat time
 - sun-synchronous (10 AM)
 - MSS detector plus RBS television cameras

Landsat Program Summary

| System | Lounch (End Of Service) | Res (m) | Alt (km) | R (days) |
|------------------|--------------------------------|--------------------|-----------------|-----------------|
| Landsat 1 | 7/23/1972 (1/6/1978) | 80 (RBV), 80 (MSS) | 917 | 18 |
| Landsat 2 | 1/22/1975 (2/25/1982) | 80 (RBV), 80 (MSS) | 917 | 18 |
| Landsat 3 | 3/5/1978 (3/31/1983) | 30 (RBV), 80 (MSS) | 917 | 18 |
| Landsat 4 | 7/16/1982 | 80 (MSS), 30 (TM) | 705 | 16 |
| Landsat 5 | 3/1/1984 | 80 (MSS), 30 (TM) | 705 | 16 |
| Landsat 6 | 10/5/1993 (10/5/1993) | 15 (PAN), 30 (MS) | 705 | 16 |
| Landsat 7 | Dec-98 | 15 (PAN), 30 (MS) | 705 | 16 |

LANDSAT

- LANDSAT 4, 5 and 7
 - 700 km altitude
 - 16 day repeat
 - over same spot 23 times a year
 - 185 km swath
 - sun synchronous (9:45 AM)
 - MSS and TM detectors on 4 and 5
 - MSS and ETM on 6 (never made it to orbit)
 - ETM+ on LANDSAT 7

Sensors on LANDSAT

- MSS
 - 80 m resolution

| Visible B G R | Near IR | Mid IR | Thermal IR | | | | | | | | |
|---|---------|--------|------------|---|---|---|---|---|--|--|--|
| <table border="1"> <tr> <td>4</td><td>5</td><td>6</td><td>7</td></tr> <tr> <td>1</td><td>2</td><td>3</td><td>4</td></tr> </table> | 4 | 5 | 6 | 7 | 1 | 2 | 3 | 4 | | | |
| 4 | 5 | 6 | 7 | | | | | | | | |
| 1 | 2 | 3 | 4 | | | | | | | | |

- TM
 - 30 m resolution
 - 120m for channel 6

| Visible B G R | Near IR | Mid IR | Thermal IR | | | | | | | |
|--|---------|--------|------------|------------------------------------|---|--|---|---|------------------------------------|---|
| <table><tr><td>1</td><td>2</td><td>3</td></tr></table> | 1 | 2 | 3 | <table><tr><td>4</td></tr></table> | 4 | <table><tr><td>5</td><td>7</td></tr></table> | 5 | 7 | <table><tr><td>6</td></tr></table> | 6 |
| 1 | 2 | 3 | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | 7 | | | | | | | | | |
| 6 | | | | | | | | | | |

LANDSAT 7

- Enhanced Thematic Mapper Plus scanner
 - Includes a 15 m PANCHROMATIC channel
 - 0.52 – 0.90 micrometer (blue-green through near IR)
 - 16 day repeat
 - 185 km swath width

Landsat TM

1

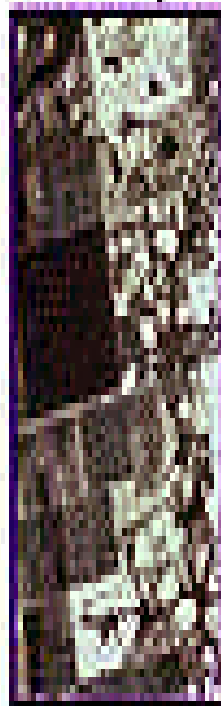
.45-.52 μ m



Visible
Blue

2

.52-.60 μ m



Visible
Green

3

.63-.69 μ m



Visible
Red

4

.76-.90 μ m



Near
Infrared

5

1.55-1.75 μ m



Middle
Infrared

7

2.08-2.35 μ m



Middle
Infrared

6

10.4-12.5 μ m



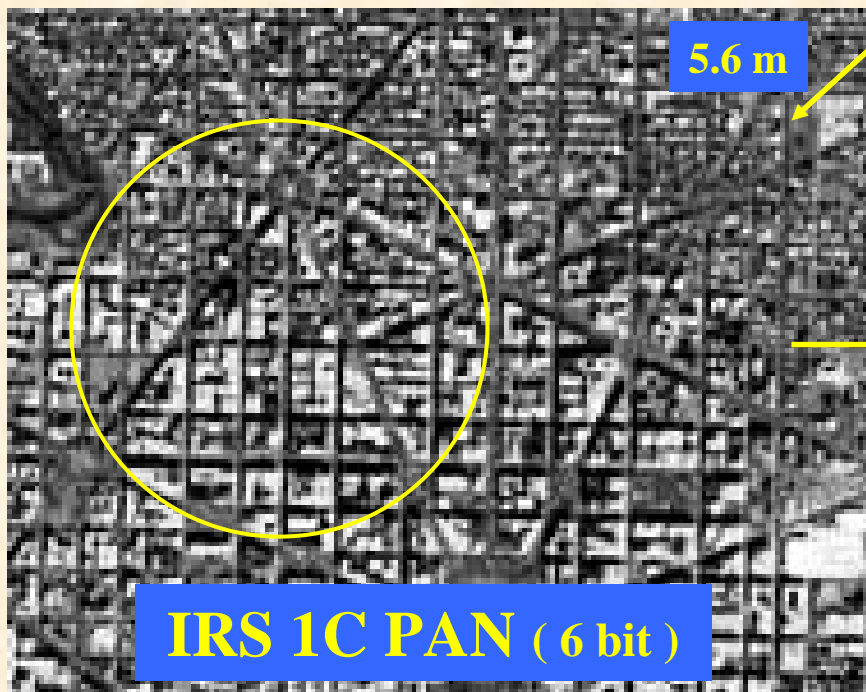
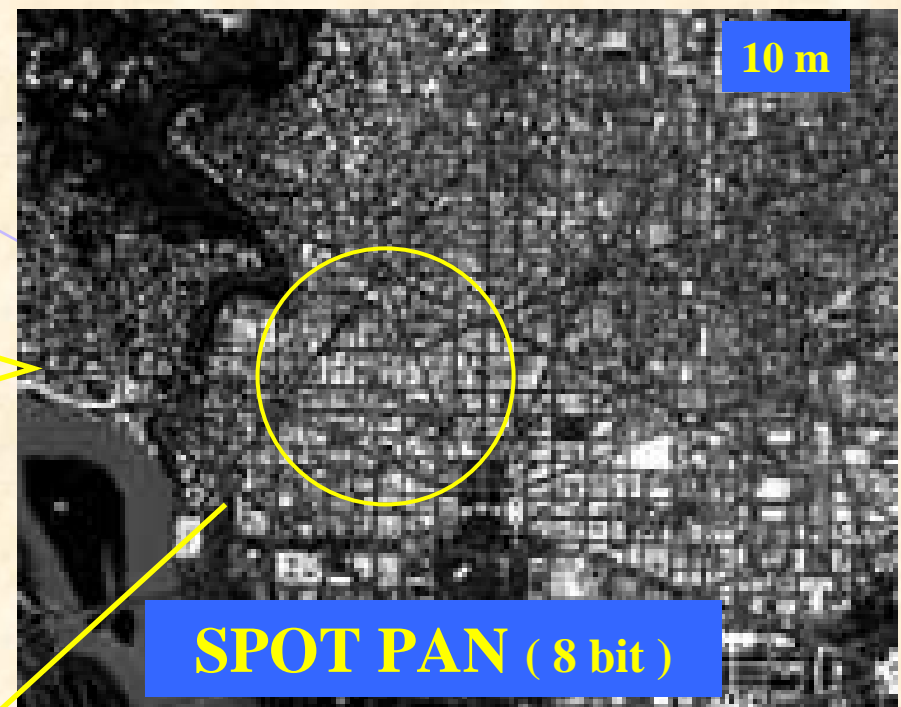
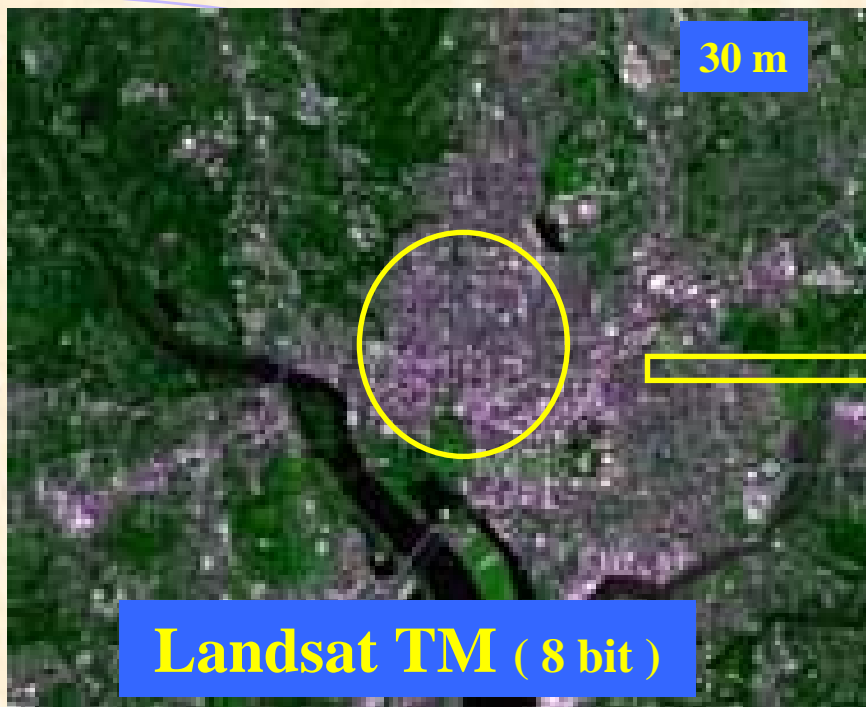
Thermal
Infrared

LANDSAT

- Swath Width: 185 km
- Repeat Cycle 16 days
- Orbit Altitude: 705 km
- Equatorial Crossing: at around 10 a.m. local solar time

Spectral Bands of Landsat-7

| Band | Spectral Range (mm) | Ground Resolution |
|----------------|---------------------|-------------------|
| 1 (Blue) | .450- .515 | 30 |
| 2 (Green) | .525- .605 | 30 |
| 3 (Red) | .630- .690 | 30 |
| 4 (Near IR) | .750- .900 | 30 |
| 5 (Mid IR) | 1.55- 1.75 | 30 |
| 6 (Thermal IR) | 10.4- 12.5 | 60 |
| 7 (Mid IR) | 2.09- 2.35 | 30 |
| Panchromatic | .520-.900 | 15 |



IRS-P3 and IRS-P4

IRS-P3 is a purely research satellite, successfully launched 21 March, 1996 with WiFS sensor such as IRS-1 C/D with SWIR band at resolution 188 x 246 meter.

IRS-P4 (OCEANSAT-1) was successfully launched 26 May, 1999. The satellite is equipped with two instruments:

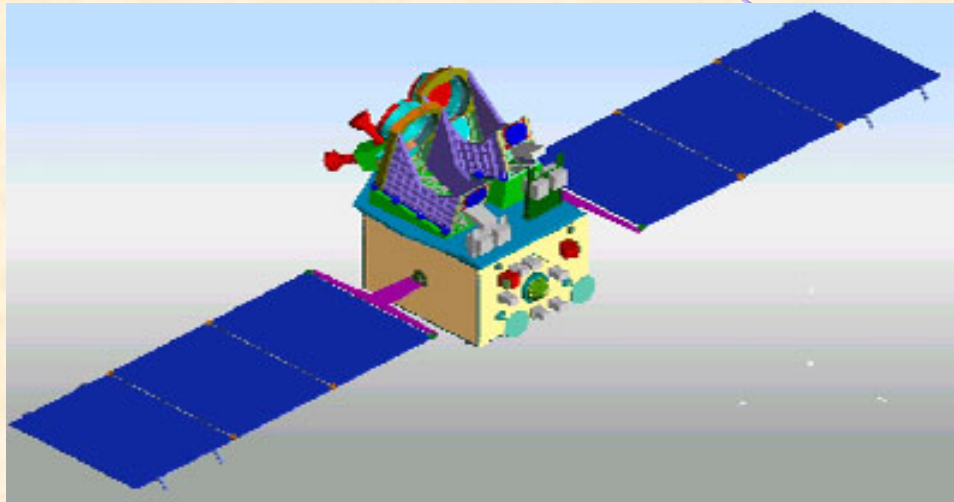
OCM (Ocean Color Monitor)

- Sun synchronous at an altitude of 720 km.
- Operating in eight narrow spectral bands, 0.400 - 0.885 micrometer,
- A resolution of 350 m and a swath of 1420 km
- Used to collect data on chlorophyll concentration, detect and monitor phytoplankton blooms and obtain data on atmospheric aerosols and suspended sediments in the water.

MSMR (Multifrequency Scanning Microwave Radiometer).

- A swath of 1360 km
- Operating in four microwave frequencies both in vertical and horizontal polarization
- Used to collect data on sea surface temperature, wind speed, cloud water content and water vapor content in the atmosphere above the ocean.

IRS P5 (CartoSat 1)



IRS P5 (Carto-Sat) – to be launched in late 2004

Two pancromatic cameras
Resolution is 2.5 m.

IRS-P6 (RESOURCESAT-1)

IRS-P6 carries three cameras

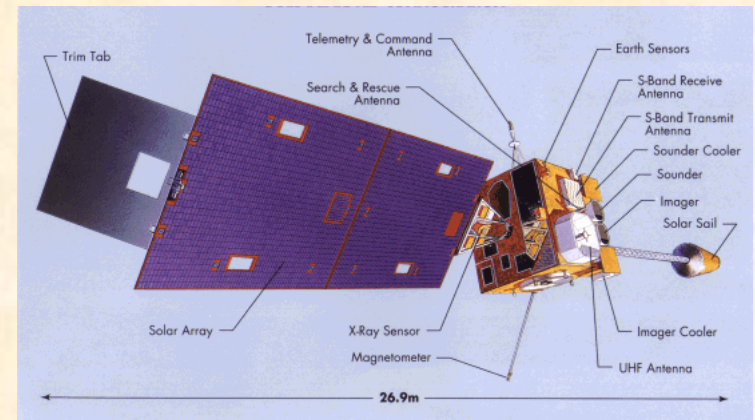
| PAYLOADS | LISS-4 | LISS-3 | AWiFS |
|-------------------------|-----------------------------------|-----------|-----------|
| Spatial Resolution (m) | 5.8 | 23.5 | 56 |
| Swath (km) | 23.9 (MX mode) 70.3 (PAN mode) | 141 | 740 |
| Spectral Bands (micron) | 0.52-0.59 | 0.52-0.59 | 0.52-0.59 |
| | 0.62-0.68 | 0.62-0.68 | 0.62-0.68 |
| | 0.77-0.86 | 0.77-0.86 | 0.77-0.86 |
| | | 1.55-1.70 | 1.55-1.70 |

Meteorological Satellites

- Geostationary Operational Environmental Satellites (GOES)
 - US operates GOES -E and GOES -W
 - observe a whole of the earth within their view
 - images are updated every half hour
 - five detectors: one visible and four IR.
- IFOV in the order of 5-10 km square
 - IFOV = instantaneous field of vision
 - This is the spatial resolution of a satellite
- weather forecasting

GOES Satellites

- GOES - 8
 - operational as GOES -E
 - 75°W
 - Launched 13 April 1994
- GOES - 9
 - operational as GOES-W
 - 135°W
 - Launched 23 May 1995
- <http://www.met.fsu.edu/explores/Guide/satguide.html>
- <http://climate.gsfc.nasa.gov/~chesters/goesproject.html>



- GOES -10
 - 25 April 1997
 - Still a back-up as of 2001

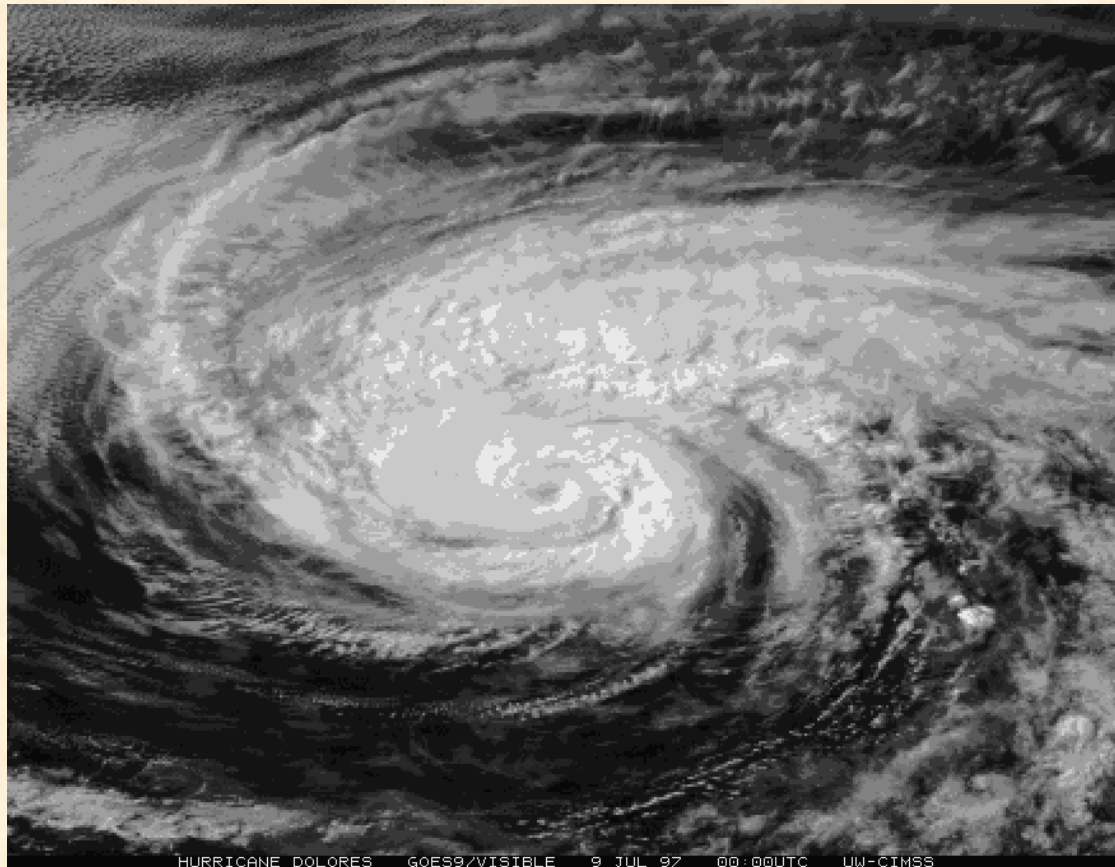
GOES SENSORS



- Early GOES Satellite only had 2 sensors
- Modern GOES (8 and 9) have five bands
 - Allow heights of clouds to be identified
 - Allow sea surface temperatures to be calculated
 - Allow smoke and fire to be identified

A GOES Image

GOES



images are typically used for weather reports.


NOAA Satellites

- NOAA Satellites are a Series of POLAR ORBITING satellites
 - 14 NOAA satellite have been launched since 1970
 - 102 minute orbit period
 - data no more than 6 hours old from current satellites
- The main sensor on NOAA satellite is the AVHRR Sensor
 - 5 bands
 - 1.1 km resolution (IFOV)

Cont ...

- NOAA 14 (1994), 15(1998) and 16 (2000) currently operational
- NOAA 12 still operational and is available as a stand-by.
 - new AVHRR/3 sensor with a new channel on NOAA15 and 16.
 - channel 3A
 - daylight operation
- <http://140.90.207.25:8080/EBB/ml/genlsatl.html>
- <http://psbsgi1.nesdis.noaa.gov:8080/EBB/ml/nic1.html>

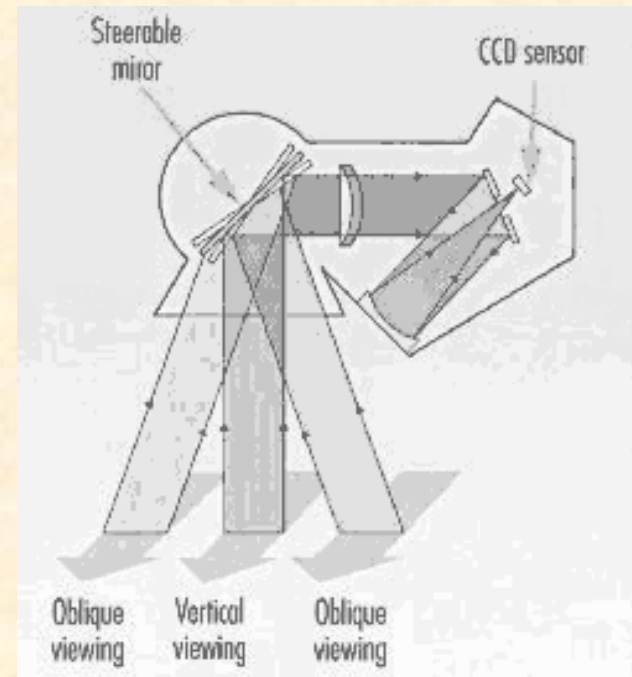
NOAA's Sensors

| B | G | R | Near IR | Mid IR | Thermal IR | | | | |
|---|---|---|---|---|------------|---|--|---|---|
| | |  |  | | |  | |  |  |
| | |  |  |  | |  | |  |  |

- AVHRR/2 sensor has five channels
- AVHRR/3 (on new satellites) have 6th band
 - operates during daylight hours

French SPOT Satellites

- SPOT -2, -3 and -4 now operational
 - launched 1990, 1993 and 1998
 - Sun synchronous (10:30AM)
 - 26 day repeats (14 per year)
 - sensors can be move to give more repeats
 - 2 identical HRV sensors on board:
 - multispectral or panchromatic modes



SPOT's Sensors

- The SPOT HRV sensors can operate in one of two 'mode'
- Multispectral mode
 - 20 meter resolution
 - 3 channels:
G, R and NIR
- Panchromatic mode
 - 10 meter resolution

| Visible B G R | Near IR | Mid IR | Thermal IR | | | | | |
|---|---------|--------|------------|--|------------------------------------|---|--|--|
| <table><tr><td>1</td><td>2</td></tr><tr><td colspan="2">1</td></tr></table> | 1 | 2 | 1 | | <table><tr><td>3</td></tr></table> | 3 | | |
| 1 | 2 | | | | | | | |
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| 3 | | | | | | | | |

SPOT 4 Characteristics

| Band (m) | Spectral range (μm) | Spatial resolution (m) |
|-----------------|--|-------------------------------|
| B1 (Green) | .500 - .590 | 20 |
| B2 (Red) | .610 - .680 | 10 and 20 |
| B3 (Near IR) | .790 - .890 | 20 |
| SWIR (MIR) | 1.58 - 1.75 | 20 |

SPOT 4

- The latest SPOT satellite has an Improved HRV scanner on board
 - Includes a thermal IR and a blue channel in addition to the original 3 channels
- Includes a second ‘VEGETATION’ scanner
 - 1 km resolution
 - Similar to NOAA’s AVHRR

Major Applications

- AGRICULTURE
- PLANNING, LAND USE AND LANDCOVER
- CADASTRAL MAPPING
- CARTOGRAPHY AND TOPOGRAPHY
- URBAN PLANNING
- FORESTRY
- NATURAL RESERVE MANAGEMENT AND PLANNING
- NATURAL HAZARD AND POLLUTION MONITORING
- GEOLOGY, MINERAL AND OIL EXPLORATION
- WATER RESOURCES
- COASTAL AND OCEAN STUDIES
- MONITORING AND SURVEILLANCE

One Meter Satellites

- EarthWatch Inc.
 - 1 m panchromatic and 3.3 m multispectral
 - Quickbird 1 failed to achieve proper orbit
 - Earth Watch reduced workforce by 24%
 - Quickbird 2 was launched in 2001
 - 1 meter PAN
 - 4m Multispectral (RGB +NIR)

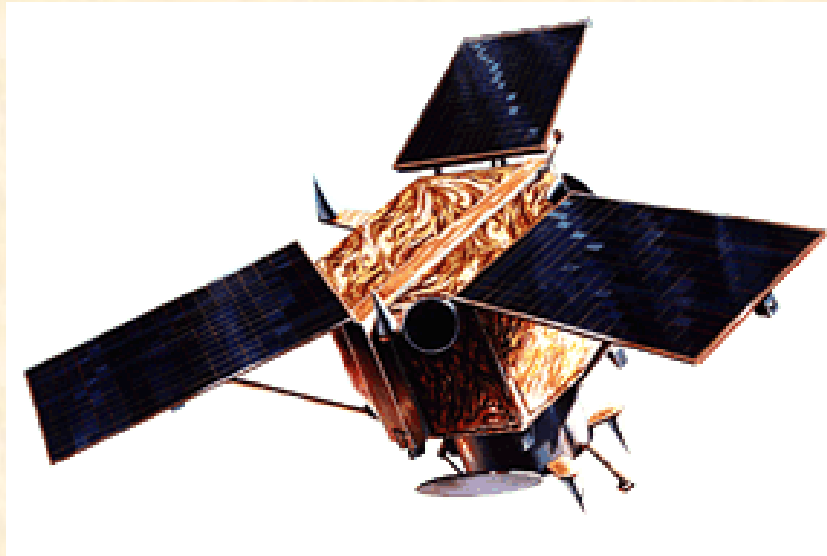
One Meter Satellites

- Space Imaging / EOSAT
 - IKONOS 1 failed at launch in early 1999
 - IKONOS 2 launched late 1999
 - 1 meter PAN
 - 4m Multispectral (RGB +NIR)
 - Sun synchronous with 10:30 AM equitorial crossing

One Meter Satellites

- Orbimage
 - 1 m & 2 m panchromatic
 - 4 m multispectral (RBG + NIR)
 - OrbView – 3 and 4 due for launch in 2001

IKONOS



Space Imaging Inc.

September 1999

IKONOS

Launch Date September 24, 1999

Launch Vehicle Athena II

Launch Vehicle Manufacturer Lockheed Martin

Ground resolution

1-meter panchromatic (nominal at <26deg off nadir)

4-meter multi-spectral (nominal at <26deg off nadir)

The ground processing software has the capability to rapidly process and mosaic imagery so as to create seamless image products with a consistent pixel ground sample distance (GSD).

Imagery Spectral Response

Panchromatic: 0.45 - 0.90 microns

Multispectral: #1: Blue 0.45 - 0.52 #2: Green 0.52 - 0.60

#3: Red 0.63 - 0.69 #4: Near IR 0.76 - 0.90

(same as Landsat 4&5 TM Bands #1-4)

Nominal Swath Width 11 km at nadir

Areas of Interest a nominal single image at 13 km x 13 km

strips of 11km x 100 km up to 11 km x 1000 km

image mosaics of up to 12,000 sq. km.

up to two 10,000 square kilometer contiguous areas in a single pass within a region

Metric Accuracy 12-meter horizontal and 10-meter vertical accuracy with no ground control

2-meter horizontal and 3-meter vertical accuracy with ground control

These are specified as 90% CE (circular error) for the horizontal and 90% LE (linear error) for the vertical

Orbital Information

Altitude 423 miles / 681 Inclination 98.1 degrees

Speed 4 miles per second / 7 kilometers per second

Revisit Frequency

2.9 days at 1-meter resolution;

1.5 days at 1.5-meter resolution

Orbit time 98 minutes

Orbit type sun-synchronous

Major Applications

- Agriculture monitoring and analysis
- Utilities management
- Civil/urban planning
- Emergency response planning
- Real estate property visualization
- Virtual travel tours
- Media background (for news)
- Land use/Land cover
- Environmental monitoring
- Mining and exploration mapping
- Corridor planning

MAHA KUMB MELA - IKONOS

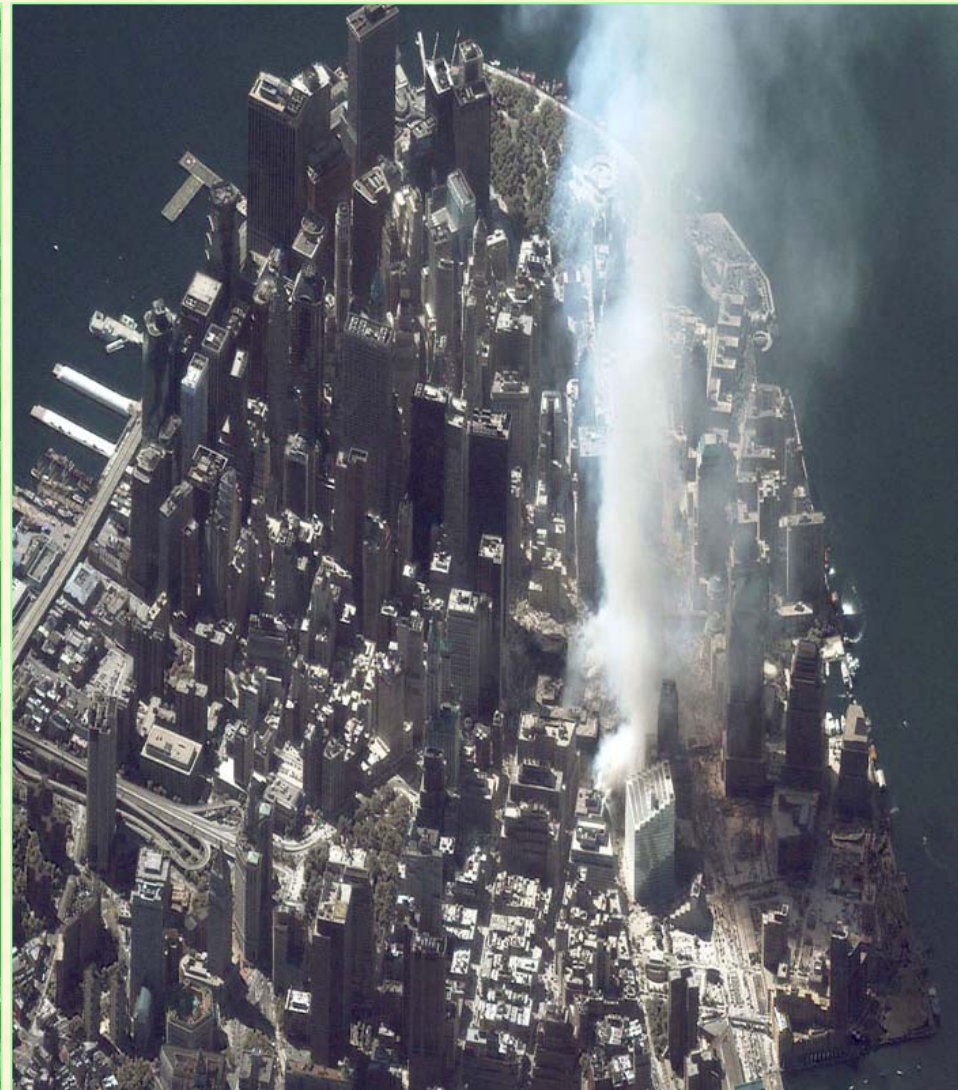


World Trade Center Buildings - IKONOS

Before Attack



After Attack

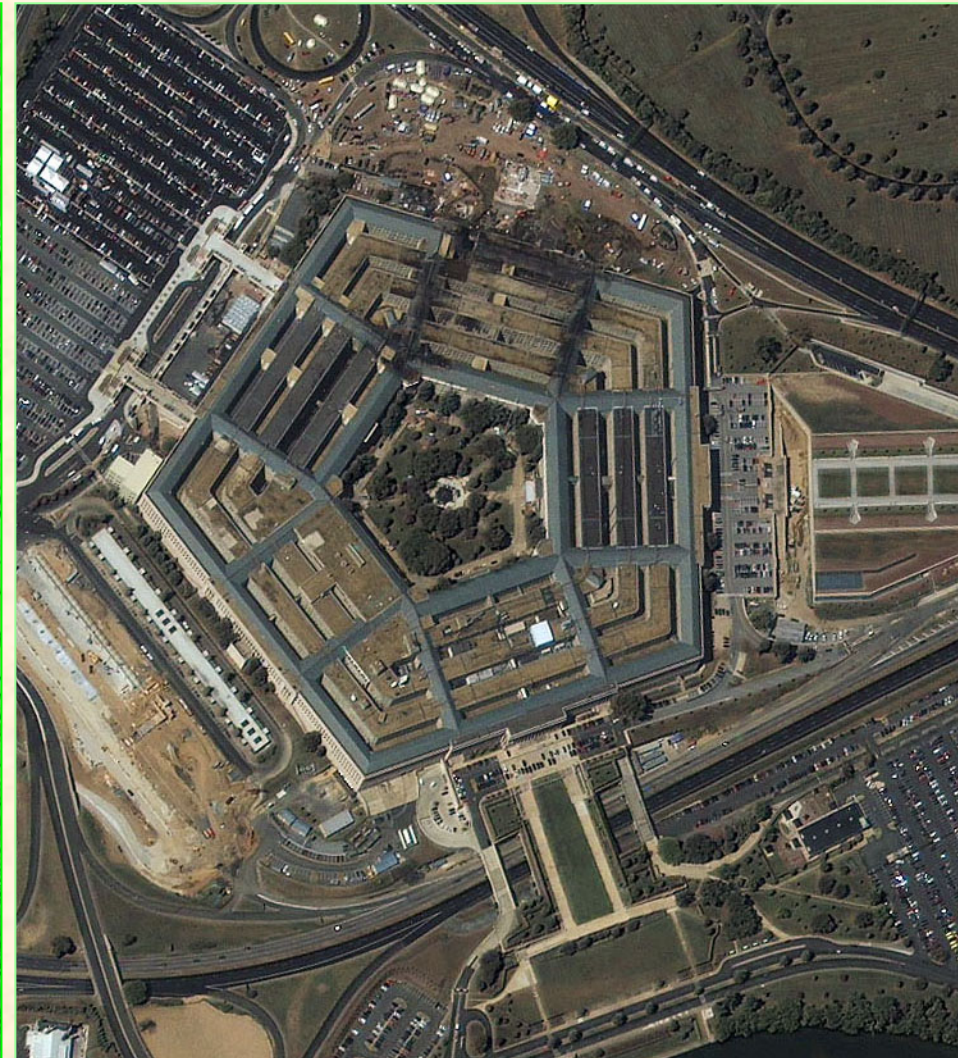


Pentagon Buildings - IKONOS

Before Attack



After Attack



IKONOS



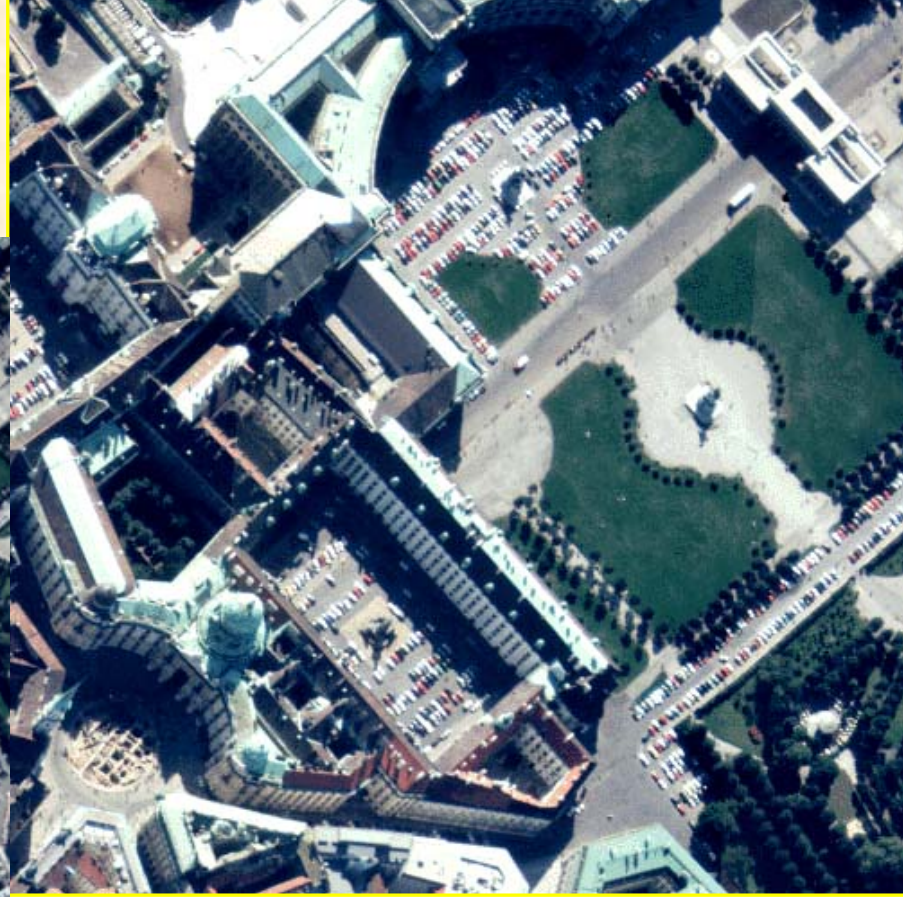
Denver, Colorado (full)



Denver, Colorado (enlargement)

One-meter panchromatic image
of the Bronco Stadium in
Denver, Colorado.

IKONOS



Vienna, Austria (enlargement)

One-meter pan-sharpened image of Vienna, Austria. Shown here are the Imperial Palace and gardens. This imagery is useful for transportation network monitoring, tourism, real estate and other applications

Vienna, Austria (full) April 2000



ANNA UNIVERSITY

*Japanese Satellite
and
Earth Observation System*

JERS-1

(Japanese Earth Resources Satellite)

1. Objective:

Gather data on global land masses while conducting observation for land surveys, agricultural-forestry-fisheries, environmental protection, disaster prevention and coastal surveillance, with emphasis on locating natural resources.

2. Operation Time :

1992 - 1998

3. Sensors:

- SAR (Synthetic Aperture Radar) which is an active microwave sensor
- OPS (Optical Sensor) that measures light reflected from the earth's surface ranging from visible light to short-wave infrared light.

ADEOS

(Advanced Earth Observing Satellite)

1. Goal:

Monitoring global environmental changes such as maritime meteorological conditions, atmospheric ozone, and gases that promote global warming

2. Operation Time :

August 1996 - June 1997

3. Sensors:

- AVNIR (Advanced Visible Near Infrared Radiometer)
- OCTS (Ocean Color and Temperature Scanner)
- NSCAT (NASA Scatterometer)
- TOMS (Total Ozone Mapping Spectrometer)
- POLDER (Polarization and Directionality of the Earth's Reflectance)
- IMG (Interferometric Monitor for Greenhouse Gases)
- ILAS (Improved Limb Atmospheric Spectrometer)
- RIS (Retroreflector In-Space)

AVNIR

(Advanced Visible Near Infrared Radiometer)

| | |
|--------------------------------|--|
| Measurement Objectives: | Land and Coastal Zone |
| Scanning Method : | Electronic(CCD) |
| Wavelength: | Visible(3 Bands),Near-infrared(1) |
| | Panchromatic-Band (visible): 1Bands |
| Spatial Resolution: | 16m, Panchromatic-Band:8m |
| Swath Width: | 80km |

OCTS

(Ocean Color and Temperature Scanner)

Measurement Objectives: **Ocean Color and Sea Surface Temperature**

Scanning Method: **Mechanical**

Wavelength: **Visible: 6 Bands, Thermal-infrared:3 Bands,
Middle-infrared: 1 Bands**

Spatial Resolution: **700m**

Swath Width: **1400km**

MOS

(Marine Observation Satellite MOS-1 / MOS-1b)

1. Objective:

Japan's first marine observation satellite, was launched as a link in a global satellite observation system for more effective natural resource utilization and for environmental protection.

2. Operation Time:

1987 - April 1996

3. Sensors:

- **MESSR (Multi-spectral Electronic Self-scanning Radiometer)**

An electronic scanning radiometer that observes solar light reflected from the earth surface. It is equipped with two camera systems that are set parallel to the satellite's flight direction.

- **VTIR (Visible and Thermal Infrared Radiometer)**

Using a rotating scanning mirror, the VTIR mechanically scans from right to left at right angle to the satellite's flight direction.

- **MSR (Microwave Scanning Radiometer)**

A radio sensor scanning the earth surface along the flight path with its rotating dish antenna.

AVHRR

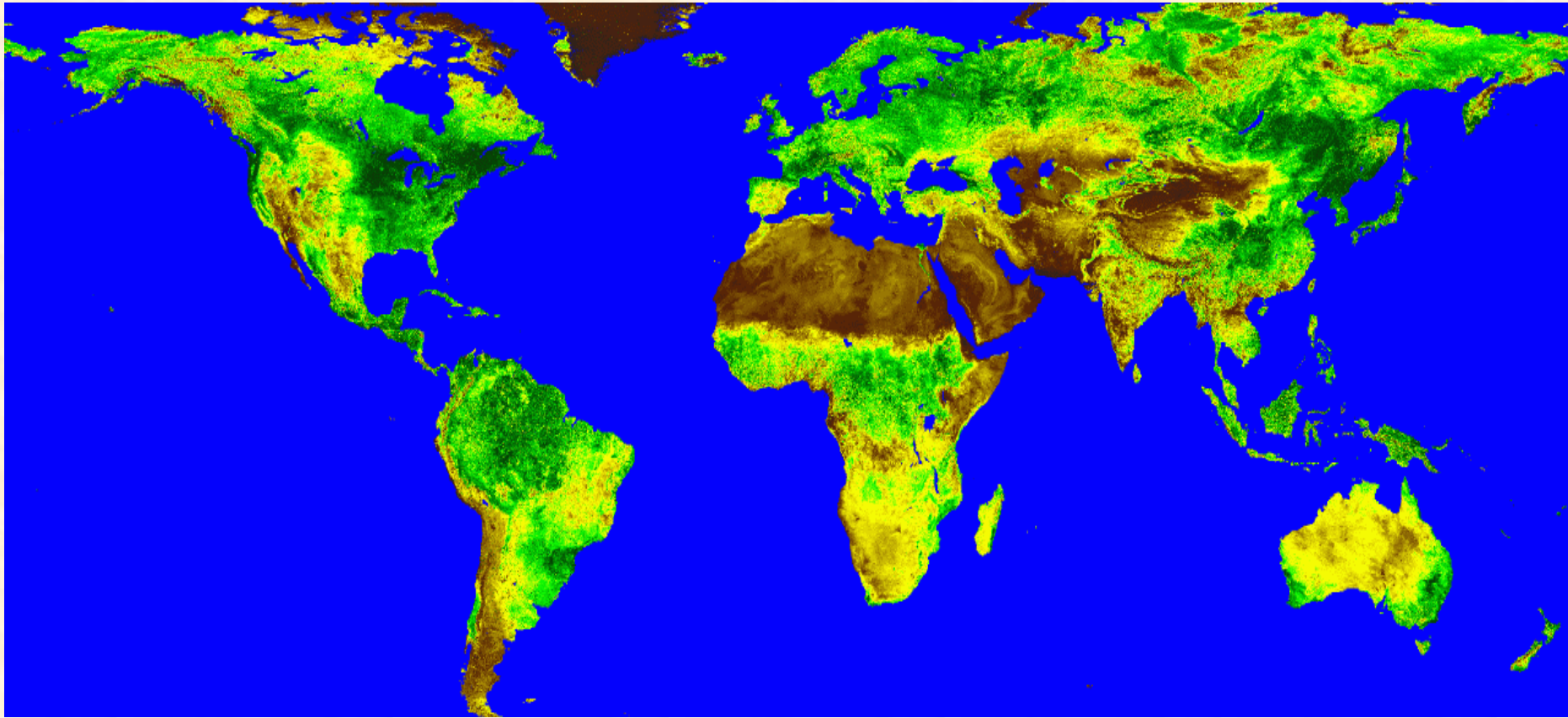
(Advanced Very High Resolution Radiometer)

- 5 channel scanning radiometer.
- Two channels are visible / near infrared and the remaining are infrared channels.
- The AVHRR instrument is capable of detecting small changes in emitted radiation over very small areas, and can detect very small temperature variations over large areas (such as variations in sea surface temperatures of a little as 0.5 C) or small areas of high variations (such as forest fires).
- NOAA-12, NOAA-14, and NOAA-15 are currently in use.
- NOAA-15 is the latest in the series and launched at 1998.

AVHRR Instruments

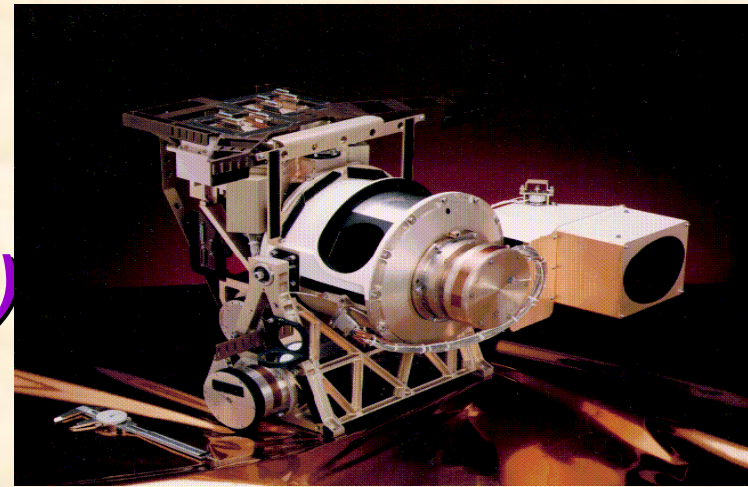
- The advanced very high resolution radiometer
 - Used to determine cloud cover and surface temperatures.
- The solar backscatter ultraviolet spectral radiometer
 - Enables scientists to study ozone concentrations.
- The stratospheric sounding unit
 - Takes temperature measurements in the upper stratosphere.
- The high resolution infrared radiation sounder
 - Takes vertical temperature profiles from the Earth's surface to an altitude of 40 kilometers.
- The space environment monitor
 - Measures the population of the Earth's radiation belts.
- The latest NOAA satellites also carry search and rescue facilities, and other specialized science sensors.

POES -3rd Generation NDVI Image



SeaWiFS

*(Sea-viewing Wide Field Sensor)
on SeaStar Satellite*



- Launched at August 1, 1997
- Channels: 8 bands (wavelength range 402-885nm)
- Orbit Type: Sun Synchronous at 705 km
- Swath Width: 2,801 km LAC (58.3 degrees)
- Swath Width: 1,502 km GAC (45 degrees)
- Spatial Resolution: 1.1 km LAC, 4.5 km GAC
- Revisit Time: 1 day

GOES

(Geostationary Operational Environmental Satellites)



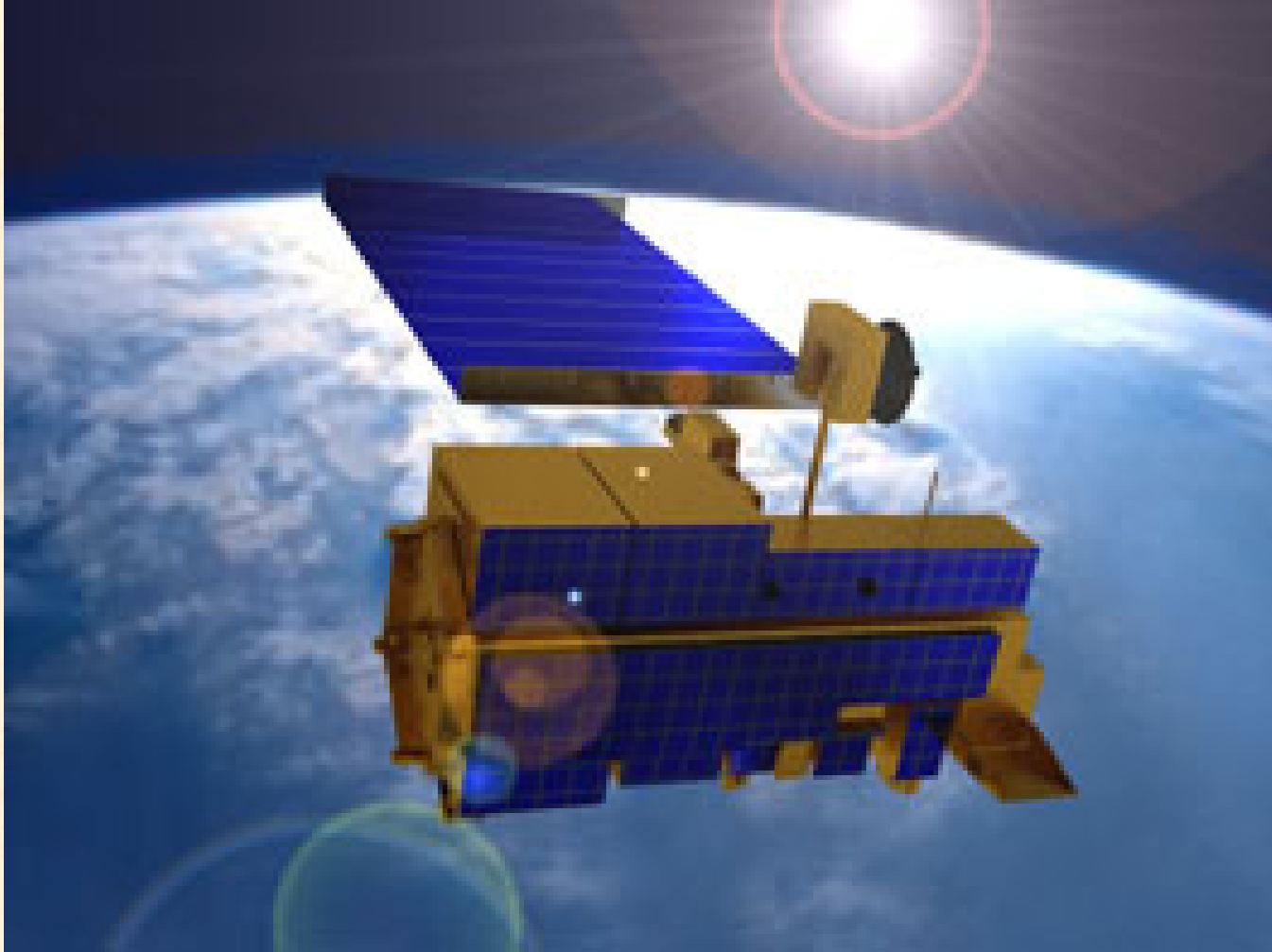
- The GOES series of satellites is the primary weather observation platform for the United States.
- The latest generation, GOES I-M, represent an advance in data products for weather forecasting and storm warnings over the previous series of geostationary satellites.
- GOES I-M is a 3-axis stabilized system vs. the older spin-scan system, providing more accurate geo-location of earth images.

METEOSAT



- Europe's geostationary weather observation satellite
- Meteosat was launched in November 1993.
- The 4 channel, 3-spectral-band high resolution radiometer constitutes the main payload on board Meteosat.
- The radiometer scans in 3 spectral bands: Visible, Infrared, and Water Vapor.
- The instrument allows continuous imaging of the Earth with images sent every half-hour.

Terra EOS Satellite



Launch of Terra Satellite and It's Characteristics

- Diameter: 3.5 m
- Length: 6.8 m
- Weight: 5190 kg
- Power: 2530 W average
- Instrument Data Rate: 18,545 kbps average
- Design Lifetime: 5 years



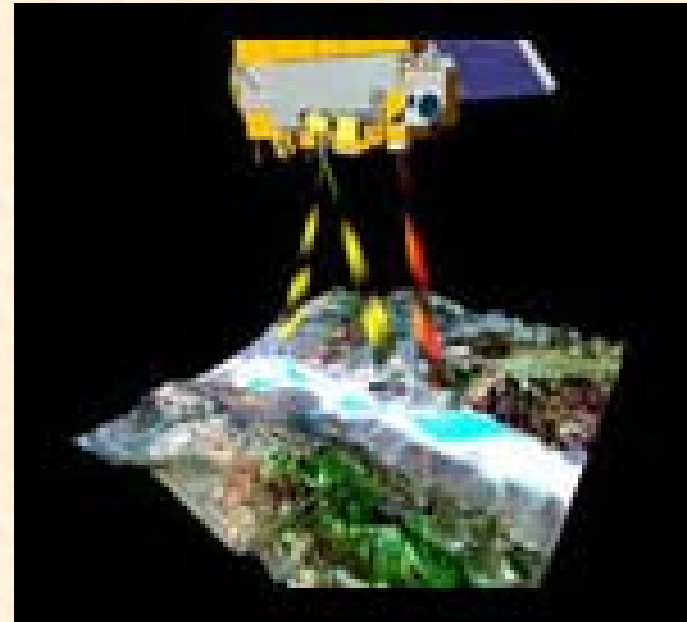
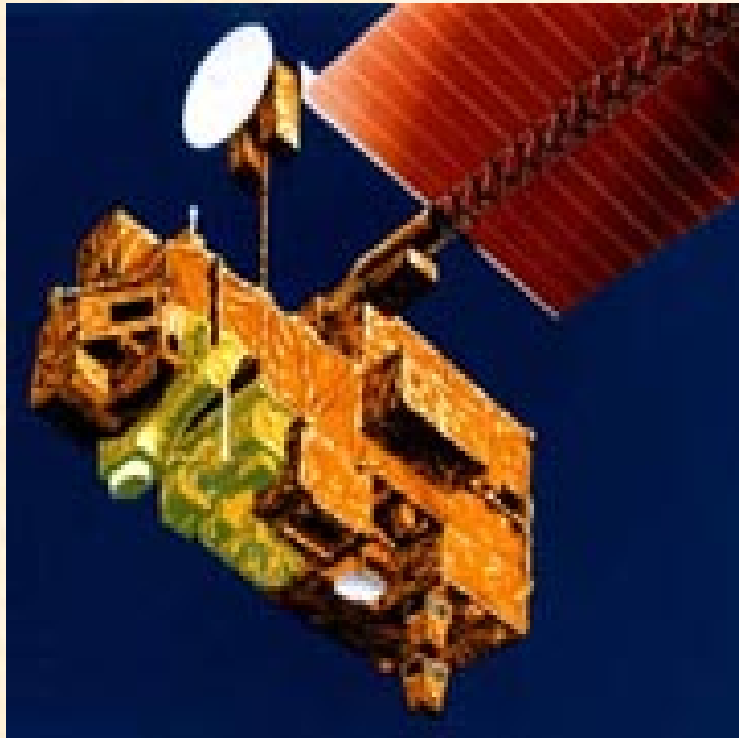
Terra EOS Terra Satellite

Sensors on board:

- **ASTER:** Advanced Spaceborne Thermal Emission and Reflection Radiometer
- **MODIS:** Moderate-resolution Imaging Spectroradiometer
- **CERES:** Clouds and the Earth's Radiant Energy System
- **MOPITT:** Measurement of Pollution in the Troposphere
- **MISR:** Multi-angle Imaging Spectro-Radiometer

ASTER

***Advanced Spaceborne Thermal Emission
and Reflection Radiometer***



ASTER Instrument Characteristics

Aster Subsystems

VNIR

SWIR

TIR

Ground Resolution:

15m

30m

90m

Spectral Range

Band 1: 0.52 - 0.60 μm

Nadir looking

Band 2: 0.63 - 0.69 μm

Nadir looking

Band 3: 0.76 - 0.86 μm

Nadir looking

Band 3: 0.76 - 0.86 μm

Backward looking

Band 4: 1.600 - 1.700 μm

Band 5: 2.145 - 2.185 μm

Band 6: 2.185 - 2.225 μm

Band 7: 2.235 - 2.285 μm

Band 8: 2.295 - 2.365 μm

Band 9: 2.360 - 2.430 μm

Band 10: 8.125 - 8.475 μm

Band 11: 8.475 - 8.825 μm

Band 12: 8.925 - 9.275 μm

Band 13: 10.25 - 10.95 μm

Band 14: 10.95 - 11.65 μm

Swath Width (km)

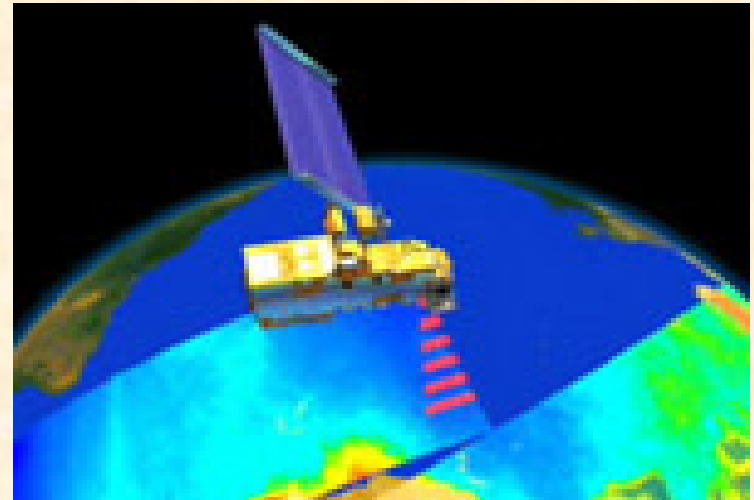
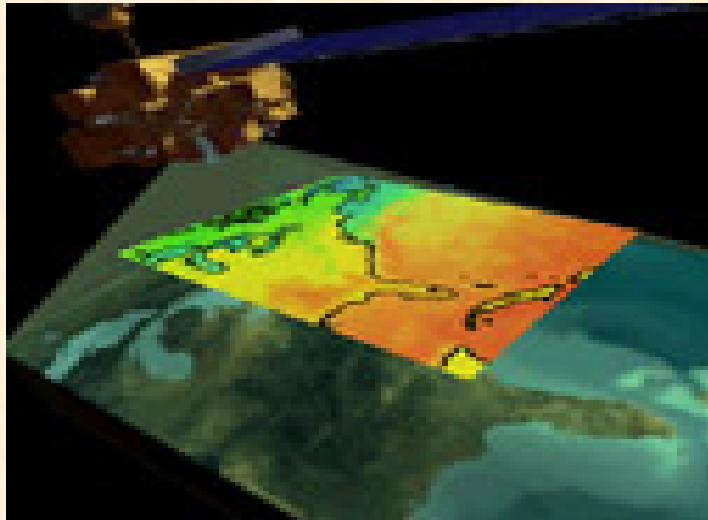
60

60

60

MODIS

Moderate Resolution Imaging Spectroradiometer



MODIS Technical Specifications

- Orbit: 705 km, sun-synchronous, near-polar, circular
- Swath Dimensions: 2330 km (cross track) by 10 km (along track at nadir)
- Spatial Resolution: 250 m (bands 1-2)
500 m (bands 3-7)
1000 m (bands 8-36)
- Design Life: 6 years



RADARSAT

Canadian Space Agency

RADAR is an acronym for
Radio Detection And Ranging

A Radar system has three primary functions:

- It transmits microwave (radio) signals towards a scene
- It receives the portion of the transmitted energy backscattered from the scene
- It observes the strength (detection) and the time delay (ranging) of the return signals.

RADARSAT Specifications

SAR Characteristics

Frequency / Wavelength

5.3GHz/C-band 5.6 cm

RF Bandwidth

11.6, 17.3 or 30.0 Mhz

Transmitter Power (peak)

5 kW

Transmitter Power (average)

300 W

Maximum Data Rate

85 Mb/s (recorded) - 105

Mb/s (R/T)

Antenna Size

15m x 1.5m

Antenna Polarization

HH

CONT..

Orbit Characteristics

| | |
|------------------------|--------------------|
| <u>Altitude</u> | 793-821 kilometres |
| <u>Inclination</u> | 98.6 degrees |
| <u>Period</u> | 101 minutes |
| <u>Ascending node</u> | 18:00 hours |
| <u>Sun-synchronous</u> | 14 orbits per day |

Coverage Access Using Maximum Swath Width

| | |
|------------------------------|--------------|
| <u>North of 70 degrees N</u> | Daily |
| <u>North of 48 degrees N</u> | Every 4 days |
| <u>The Whole Earth</u> | Every 6 days |

RADARSAT Specifications (cont.)

Imaging Modes

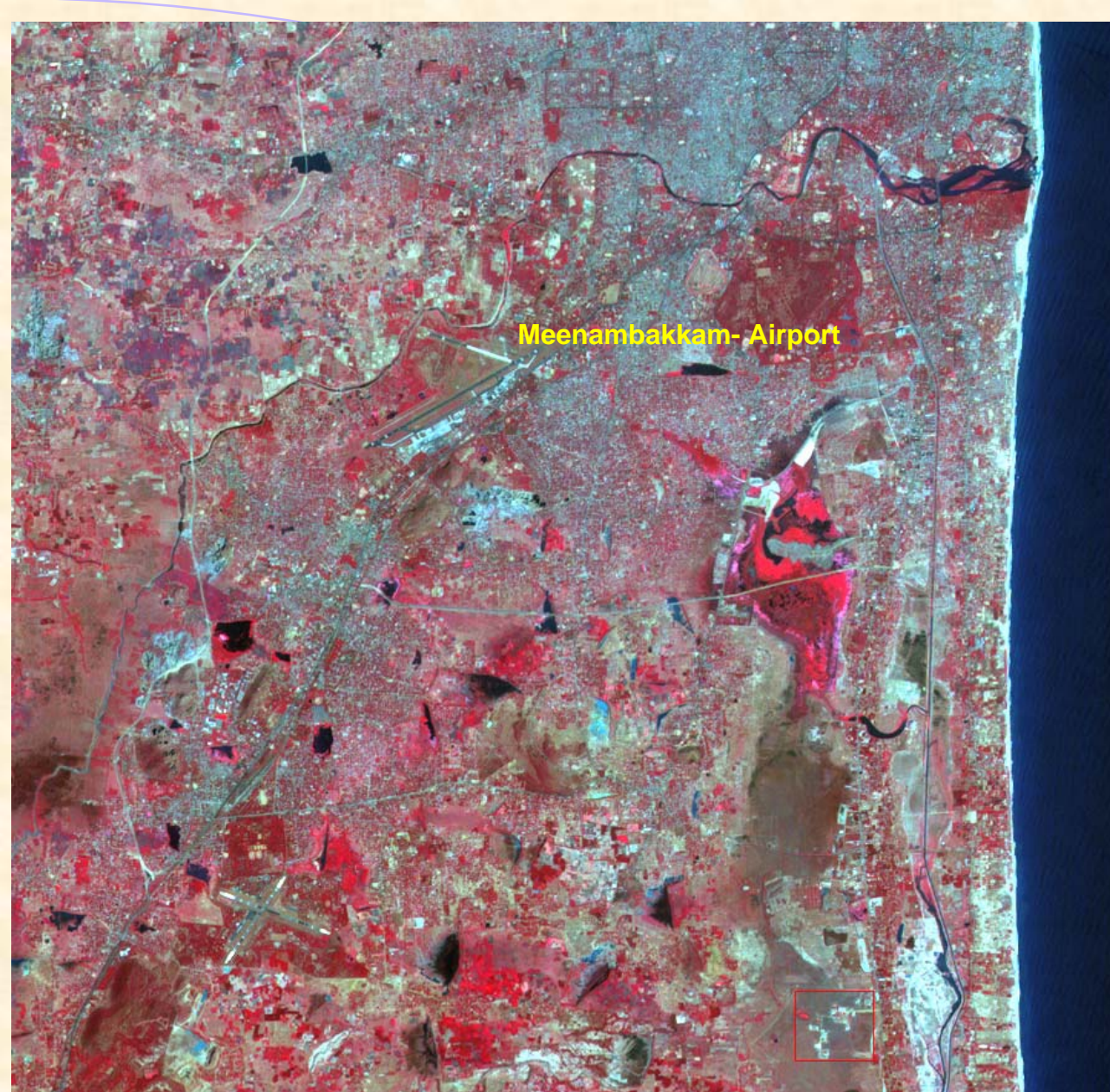
| MODE | NOMINAL RESOLUTION (m) | NO. OF POSITIONS/BEAMS | SWATH WIDTH (km) | INCIDENCE ANGLES (degrees) |
|----------------|---------------------------|---------------------------|---------------------|-------------------------------|
| Fine | 8 | 15 | 45 | 37-47 |
| Standard | 30 | 7 | 100 | 20-49 |
| Wide | 30 | 3 | 150 | 20-45 |
| ScanSAR Narrow | 50 | 2 | 300 | 20-49 |
| ScanSAR Wide | 100 | 2 | 500 | 20-49 |
| Extended(H) | 18-27 | 3 | 75 | 52-58 |
| Extended(L) | 30 | 1 | 170 | 10-22 |

- “All-weather capability”
 - see through cloud and rain, and at night
- Different features are portrayed or discriminated compared to visible sensors
- Some surface features can be seen better in radar images:
 - ice, ocean waves
 - soil moisture, vegetation mass
 - man-made objects, *e.g.* buildings
 - geological structures

*ESA Satellites
and
Earth Observation System*

ATSR (Along Track Scanning Radiometer)

- Objective: sea surface temperature, cloud observations, land and ice surface emissivity
- Spectral channels: 4 co-registered channels at 1.6, 3.7, 10.8 and 12 micro-meter
- IFOV: 1 km x 1 km (nadir), 1.5 km x 2 km (forward view)
- Swath width: 500 km



Chennai environ viewed from IRS – ID
LISS III digital data

SATHYABAMA DEEMED UNIVERSITY

(From IRS-P6 LISS III satellite data)



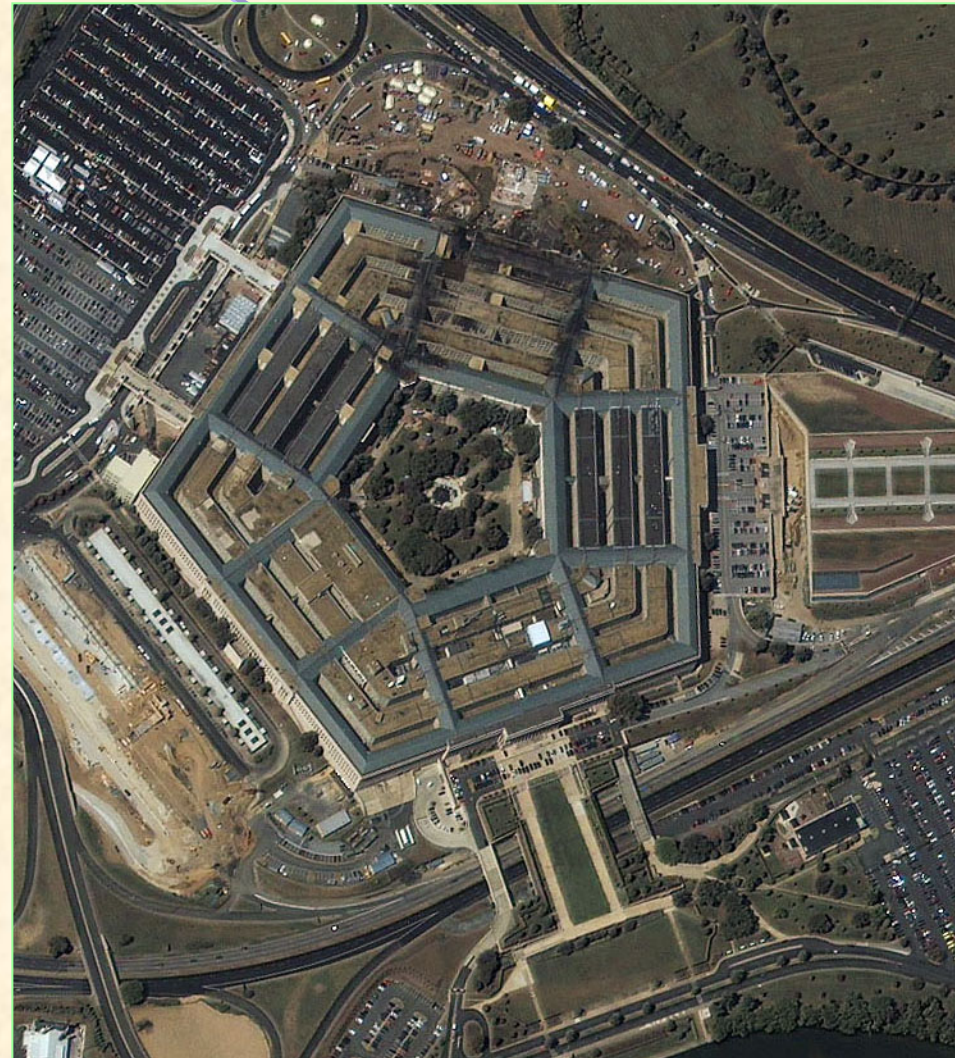
Pentagon Buildings - IKONOS

(11th September, 2001)

Before Attack



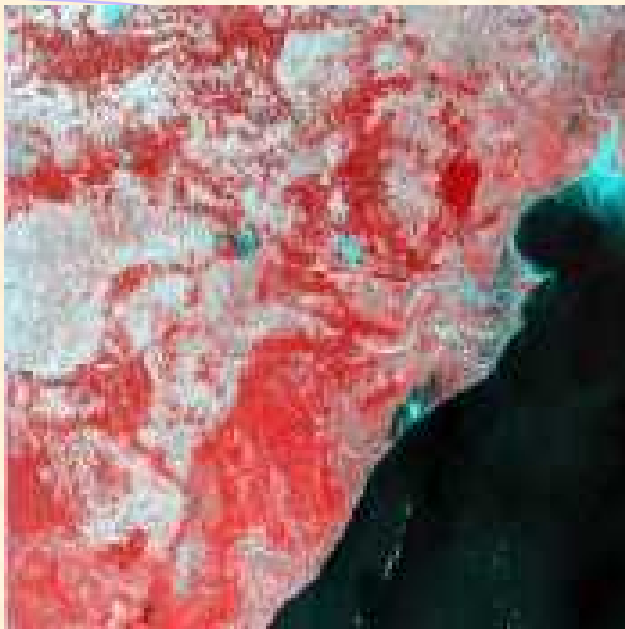
After Attack



QUICK BIRD SATELLITE IMAGE (0.6 m)



Multi resolution satellite data



WiFS DATA (180 m)



LISS III DATA (23.5m)

PAN DATA (5.8 m)

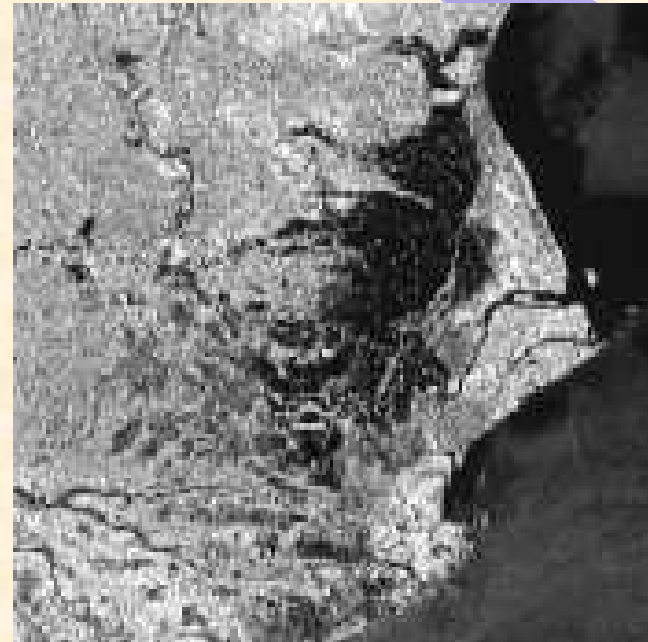


VISIBLE REMOTE SENSING



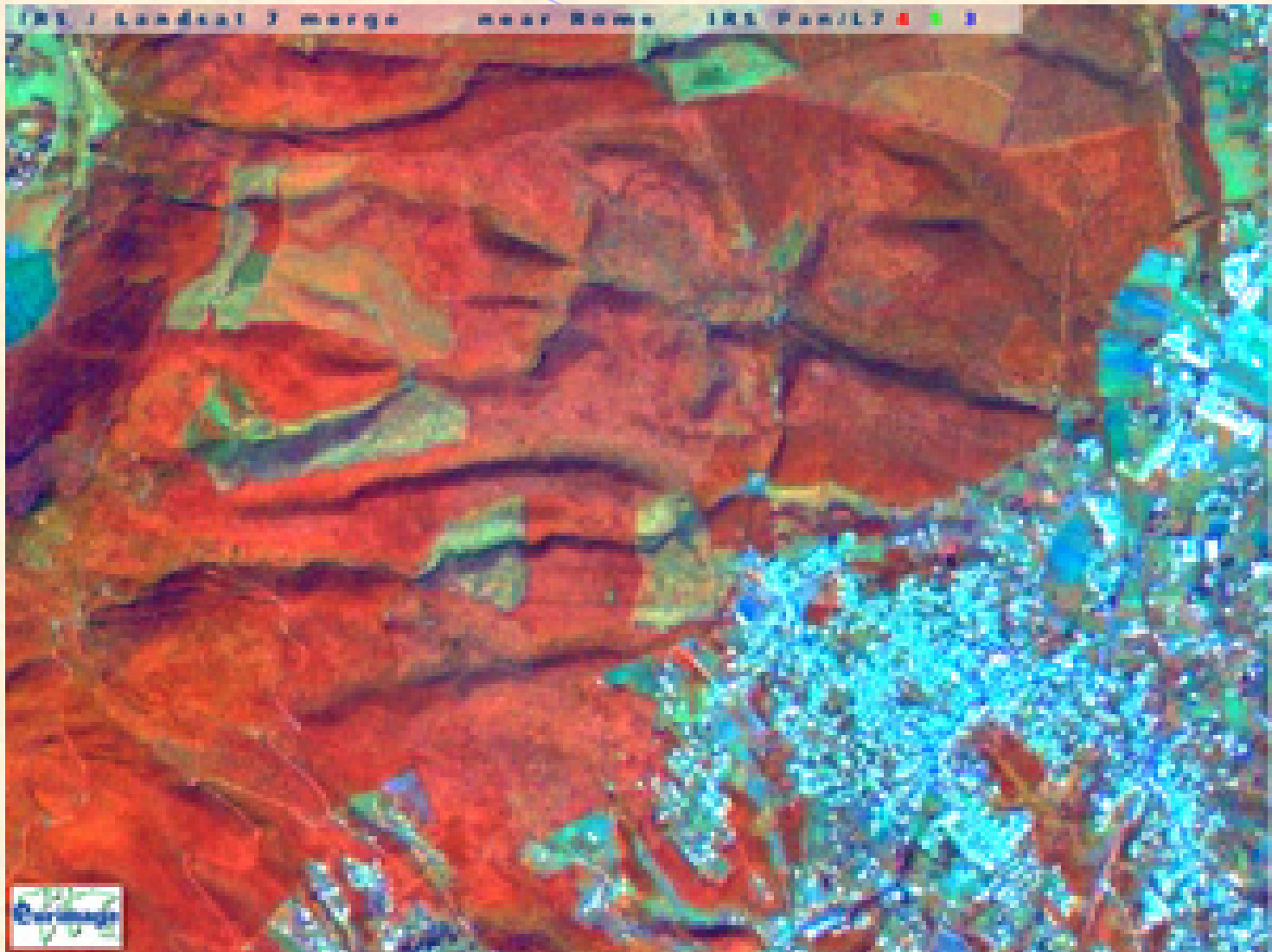
LISS III +PAN (5.8m)

MICROWAVE REMOTE SENSING

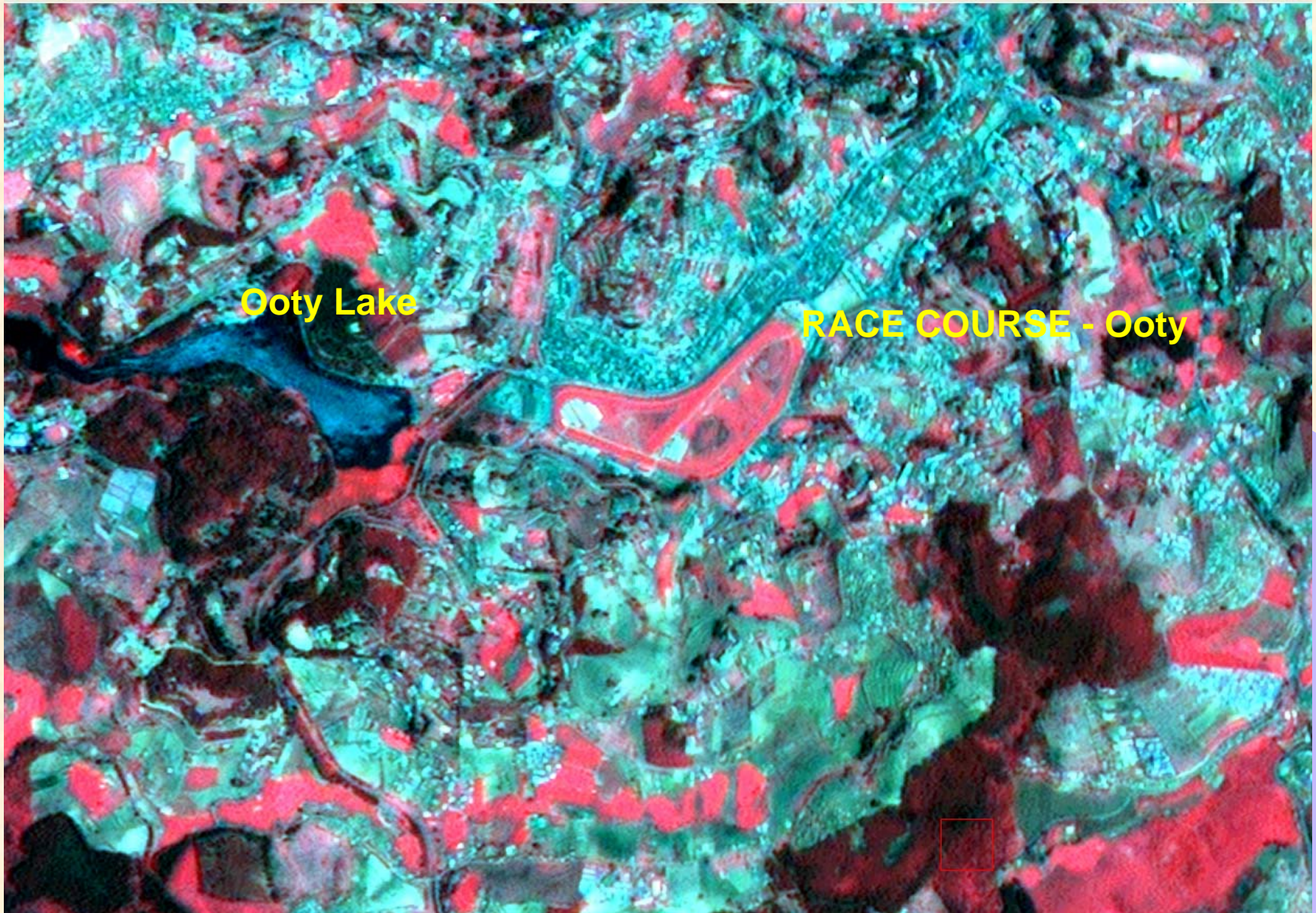


RADARSAT

IRS 1D + LANDSAT MERGED



IRS 1D (LISS 3 + PAN MERGED)





Multi-spectral
Resolution, 4 metres



Panchromatic
Resolution, 1 metre



Pan-sharpened
Resolution, 1 metre

HIGH RESOLUTION REMOTE SENSING



WTC MISHAP



SAMPLE IKONOS DATA



SAMPLE QUICKBIRD DATA



Trapani, Sicily
Pan-sharpened multi-spectral
infrared

Resolution, 70 cm

Near Trapani, Sicily
Pan

Resolution, 70 cm

