What is Remote Sensing

Space-borne Platforms and Sensors

- **Electro- optical sensors**
- **Earth observation satellites**

Electro-optical Sensors

- ***Electro-optical*** **sensor** use **non-film detectors.**
- These **detectors** **convert** the **reflected** **and/or** **emitted radiation** **from a ground** scene **to** **proportional** **electrical signals** that are ultimately **used to construct 2-dimensional images** (***digital images***)

Types of Electro-Optical Sensors

- **Video Cameras**

- **Vidicon** Cameras
  - Used in space programs such as **Moon** and **Mars**
  - **R**eturn **B**eam **V**idicon (**RBV**) on early **Landsat (1,2, & 3)**.

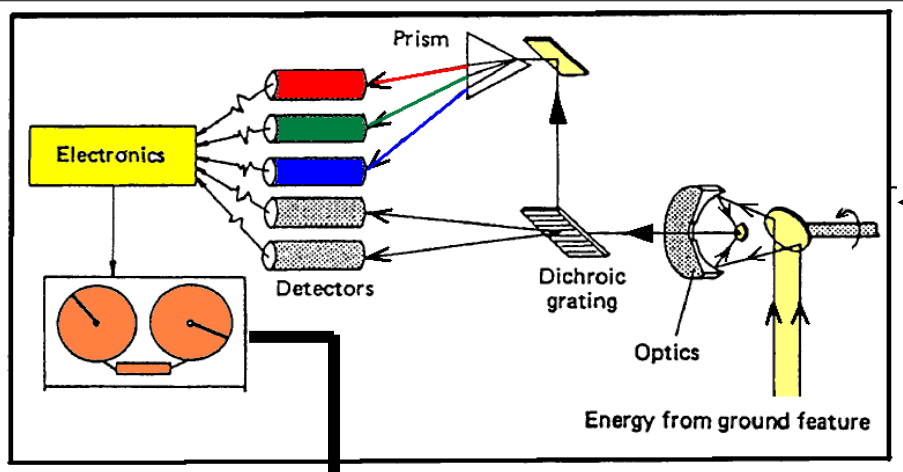
- **Multispectral scanners**.
- **Thermal IR scanners**.

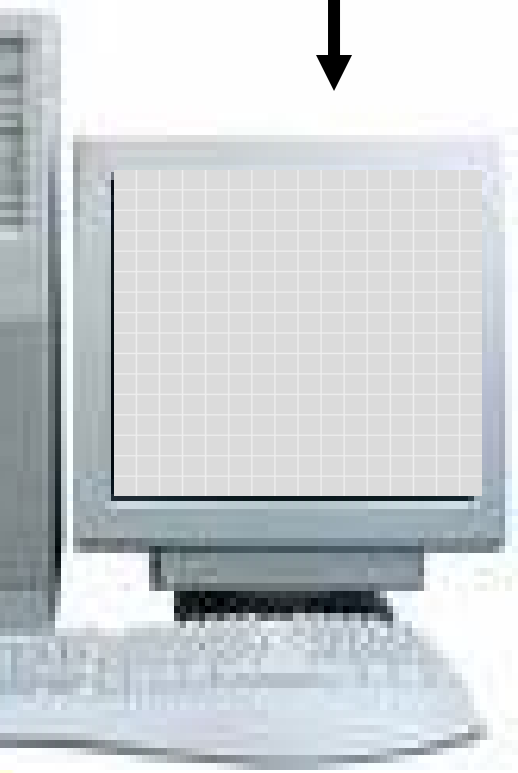
Multispectral video imaging system

Upright: Multispectral video imaging system used by USDA. The system comprises (A) 4 video cameras, (B) an electronic system, (C) recorder for colour composite images, (D) recorders for B/W images, (E) a colour TV monitor to view colour composite images, and (F) a TV monitor to view B/W images.

Downright: A colour infrared video camera.

Basic configuration of an Across-track scanner





Direction of flight

Across-track Scanner

Instantaneous field of view (IFOV)

Angular field of view

Ground swath

Ground strip or scan line

Ground resolution Cell (Pixel)

Advantages

- **Wider coverage of spectrum**
- **Images can be transmitted over radio links.**
- **Real-time display is possible.**
- **The *thermal IR region* have a day night capability.**
- **The detection process is renewable, can be continuously used.**

Characteristics of digital images

- Many of the newer **electro-optical sensor** are digital systems.
  - Use an ***analogue-digital*** (A/D) **converter** that **translates the electronic signals from the detectors to discrete digital numbers (DN).**
  - The collection of **DN can be processed** mathematically **by digital computers**.
  - The **numerical data can be transformed** into **video signals for view on a TV.**
- **Resolution**
  - Spatial resolution
  - Spectral resolution (spectral bands and wavelength covered)
- **Pixel** (Pictorial elements)
  - Resolution: area extent (**n** x **n** meters)
  - Depth (bytes per pixel – grey levels)

  1 byte/pixel = **255** levels

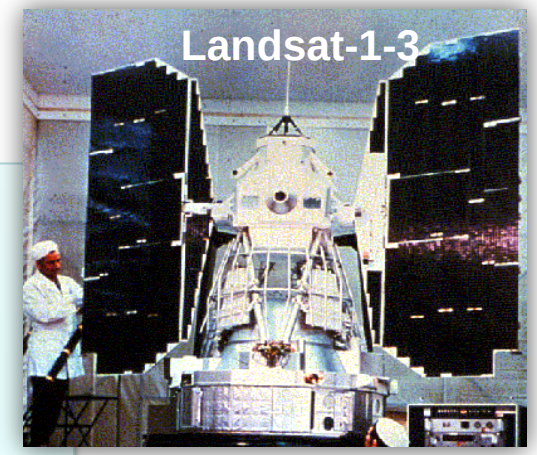
  2 bytes/pixel = **64000** levels

Earth Observation Satellites

- ***Landsat***
- ***SPOT***
- ***ASTER***
- **Meteorological Satellites**
  - **NOAA Satellites**
  - **GOES Satellites**
  - **Meteosat**
- **Ocean Monitoring Satellites**
  - **Nimbus**
- ***Radar Satellites***
  - **Seasat**
  - **ERS-1**
  - ***Radarsat***
- **Earth Observing System**
- **High-Resolution "Small Satellites"**
  - ***IKONOS***
  - ***QuickBird***

Landsat

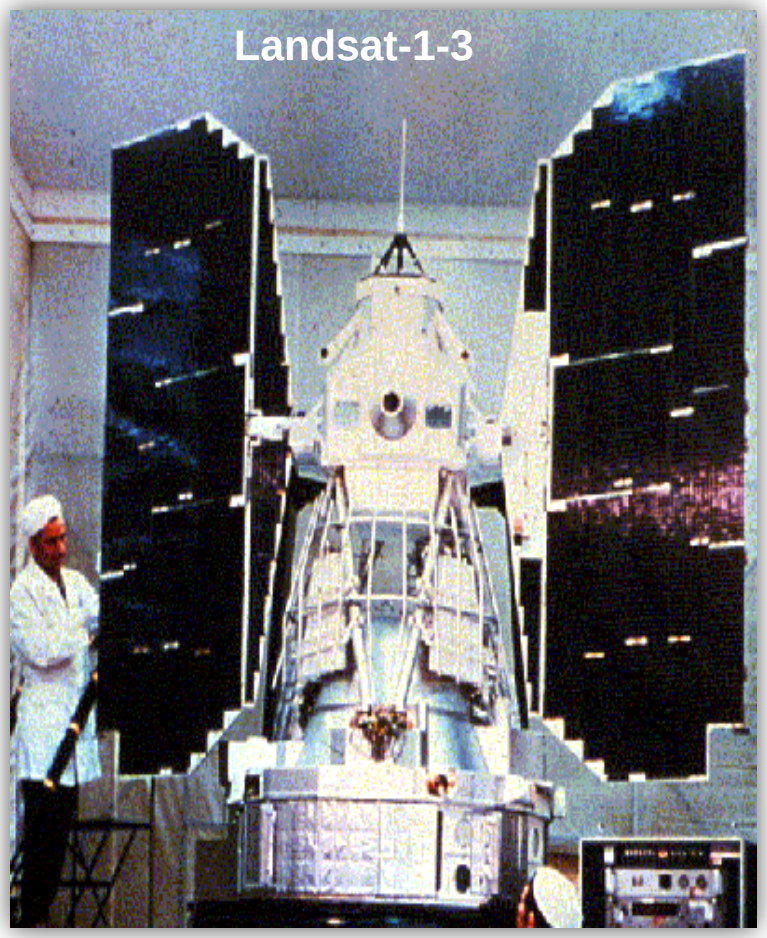
- **NASA**: **E**arth **R**esources **S**urvey (**ERS**) **P**rogram
- First known as the **E**arth **R**esources **T**echnology **S**atellite (**ERST-1**)
- **Landsat-1** was the "**proof-of-concept**" that Earth orbiting satellites could be effectively monitor natural and cultural resources.
- To date, there have been **8 Landsat missions**.
- **Landsat-6** was failed upon launch.
- **Landsat-8** was launched in ***2013***

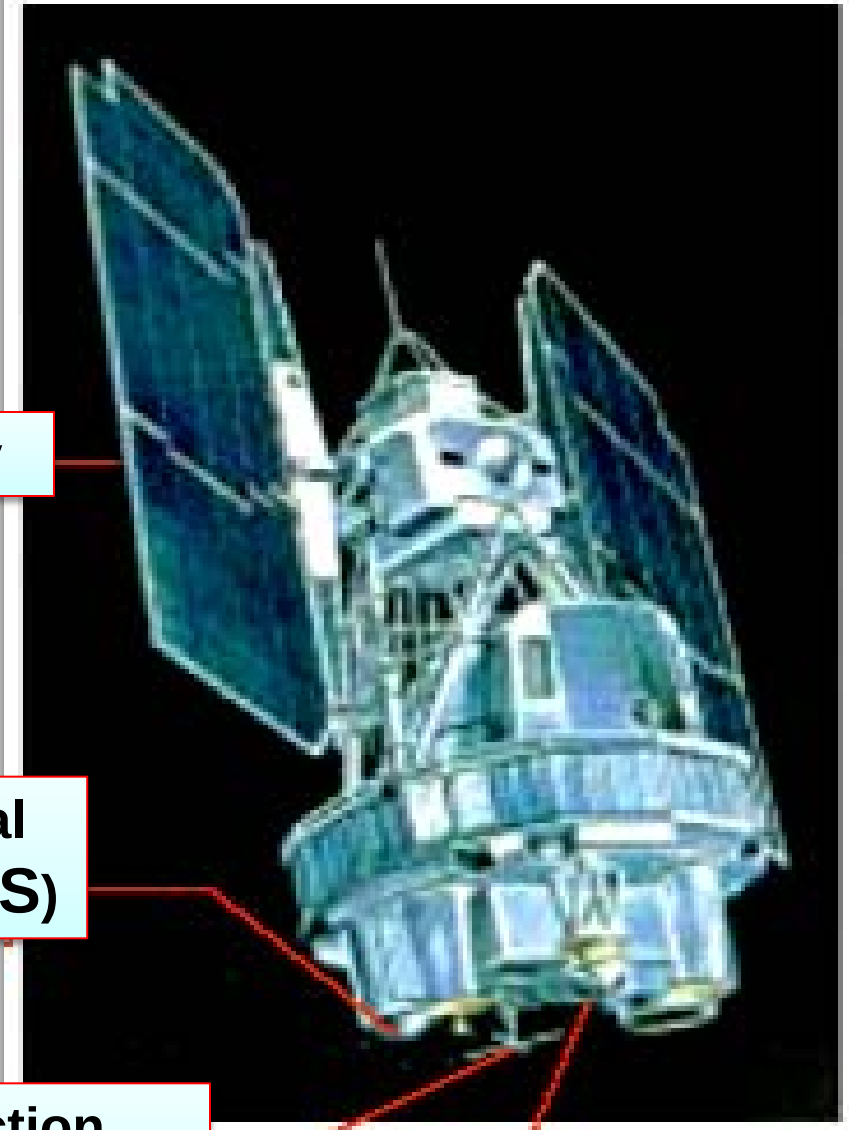


Characteristics of Landsat-1 to Landsat-7 missions

Satellite	Launched	Decommiss-ioned	RBV Bands	MSS Bands	TM Bands	Orbit
Landsat-1	23/1/1972	1/6/1978	1, 2, 3 (simultaneous images	4, 5, 6, 7	None	18 Day 900 km
Landsat-2	22/1/1975	25/2/1982	1, 2, 3 (simultaneous images	4, 5, 6, 7	None	18 Day 900 km
Landsat-3	5/3/1978	31/3/1983	A, B, C, D (one-band side-by-side images)	4, 5, 6, 7, 8	None	18 Day 900 km
Landsat-4	16/7/1982	-	None	1, 2, 3, 4	1, 2, 3, 4, 5, 6, 7	16 Day 705 km
Landsat-5	1/3/1984	-	None	1, 2, 3, 4	1, 2, 3, 4, 5, 6, 7	16 Day 704 km
Landsat-6	5/10/1993	Failure upon launch	None	None	1, 2, 3, 4, 5, 6, 7+ pan band (ETM)	16 Day 705 km
Landsat-7	15/4/1999	-	None	None	1-7, ETM+	16 Day 704 km

Landsat 1-3





Solar array

Multispectral scanner (MSS)

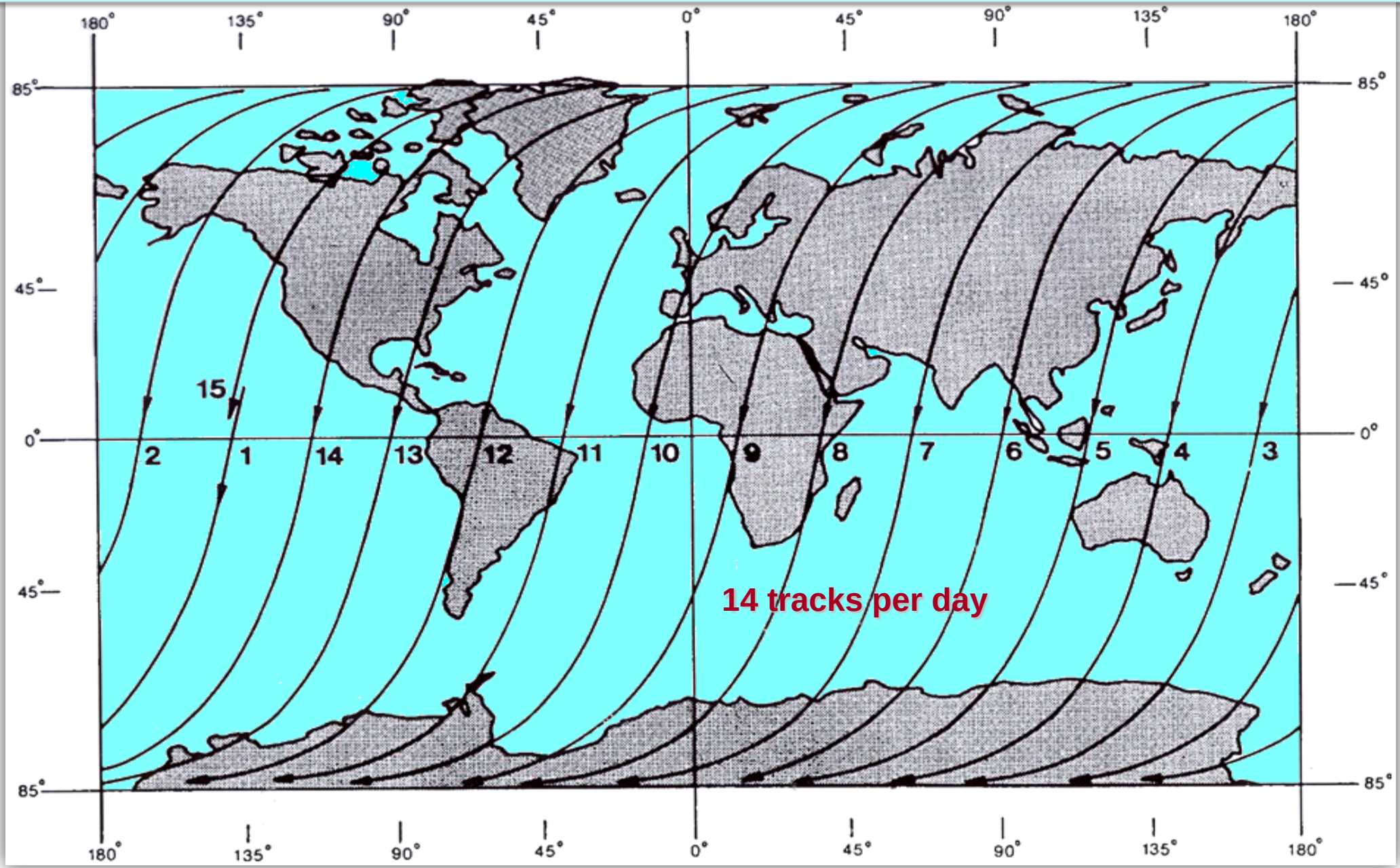
Data collection antenna

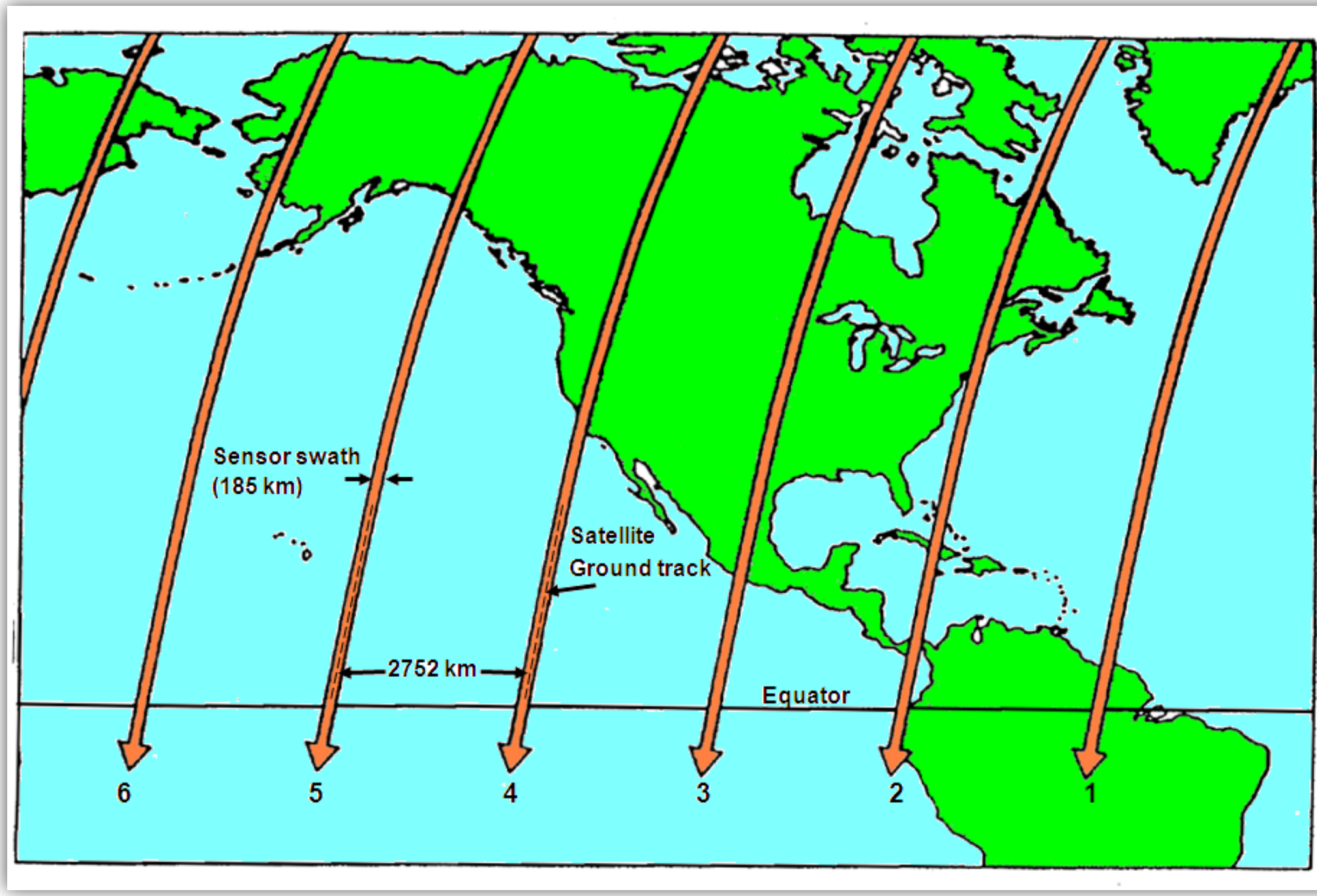
Return beam vidicon (RBV) cameras

Landsat 1-3 Orbital Characteristics

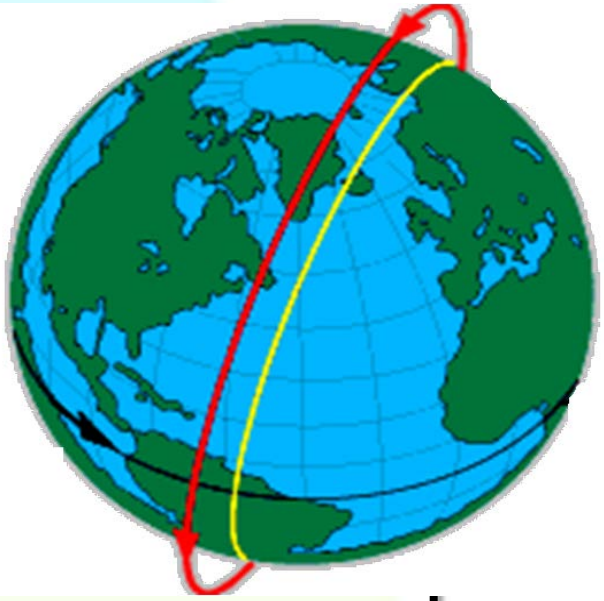
- **Sun Synchronous**
- **Altitude** of ***915*** km
- **Near-polar orbit** passing within 8 of the poles, **14** times a day
- **Passing same point** every **18** days
- **Ground tracks** of ***185*** km, **Interlaced 2,875** km to the west at the equator
- **Side lap**:
  - **26** km (**14**%) **at the equator**,
  - **34**% **at 40 Latitude** and
  - **85% at 80 Latitude**
- **Local pass** occurs at about **9:30 am**

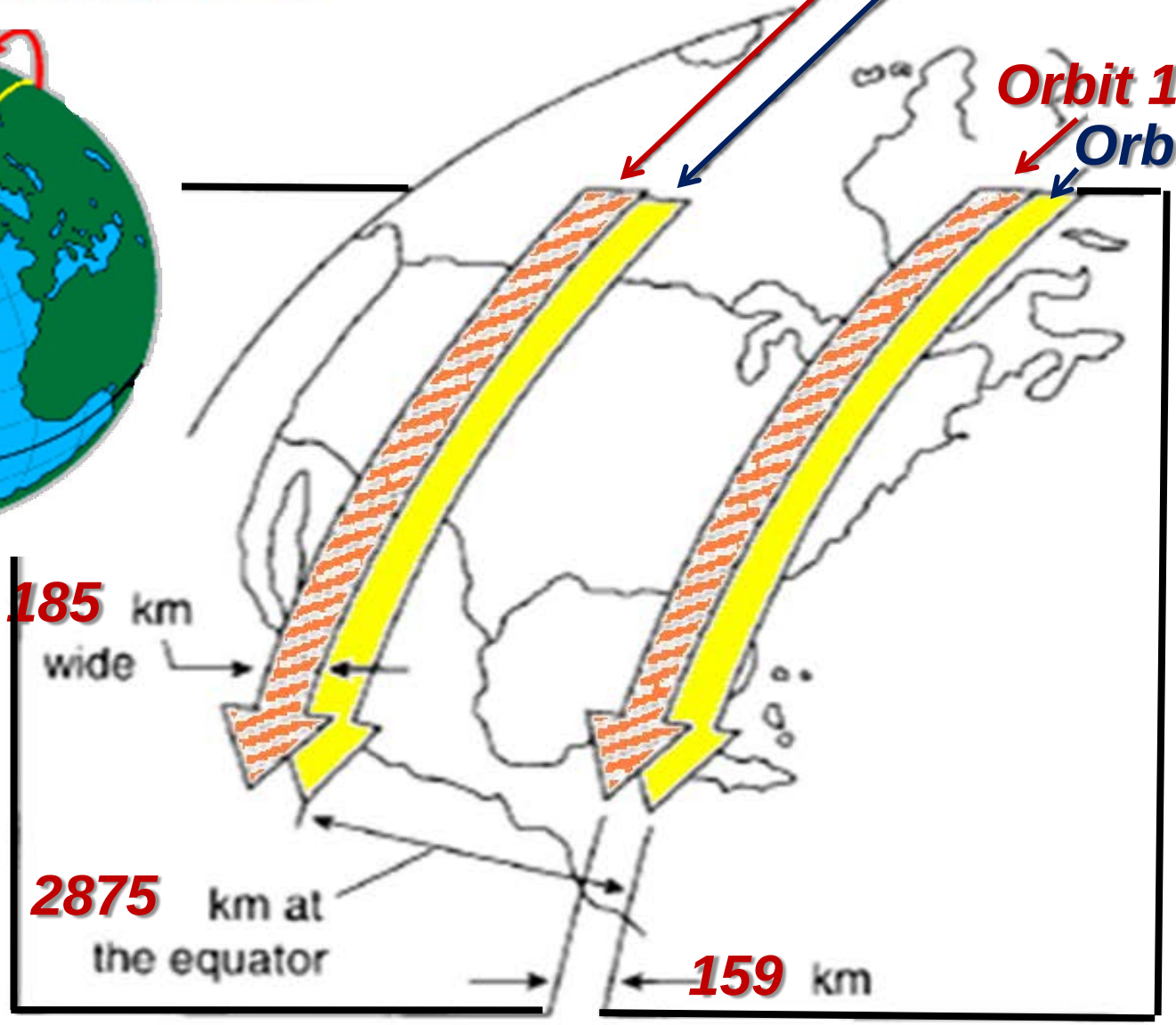
Daylight Ground Tracks for Landsat 1- 3

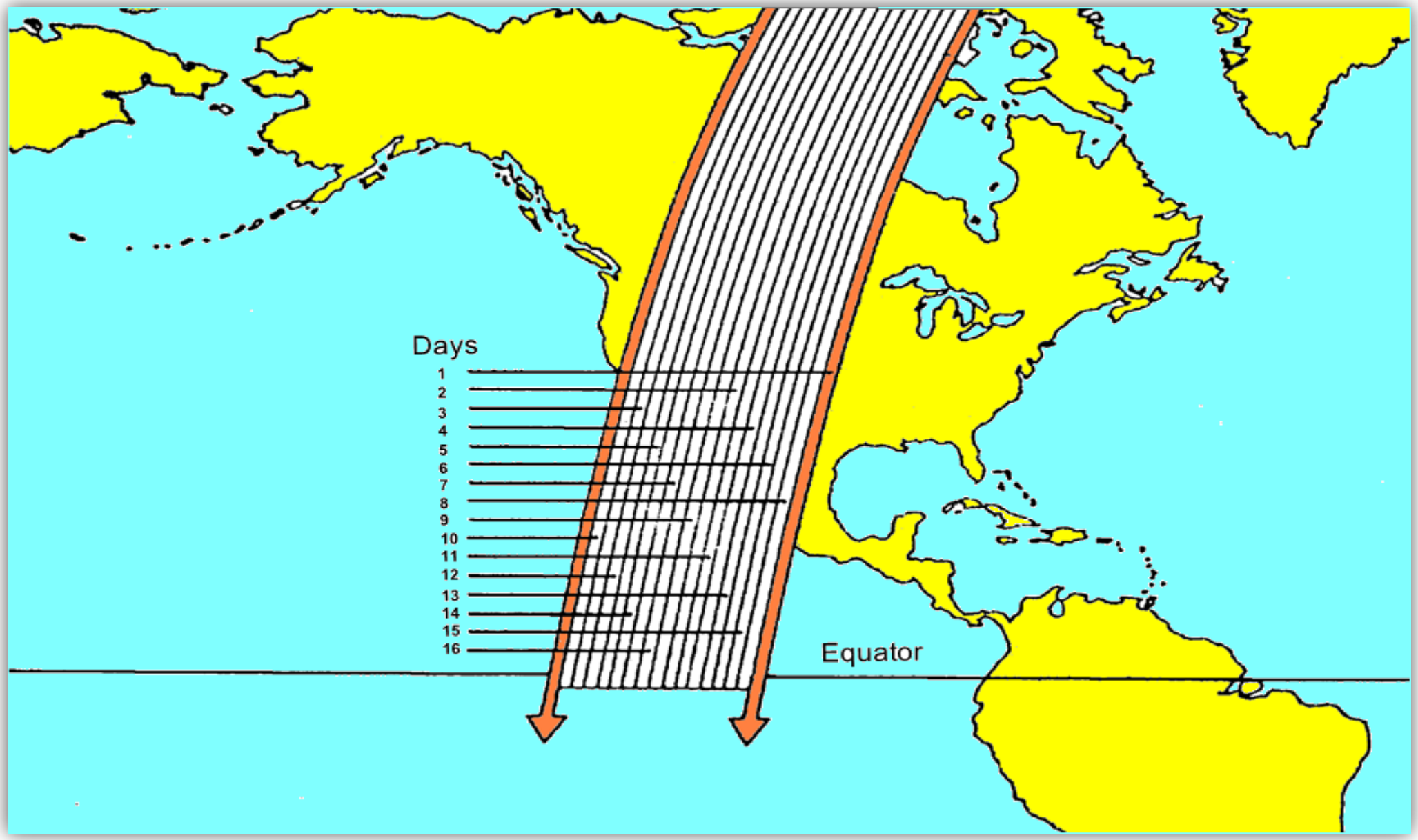



Sensor swath
(185 km)
Satellite
Ground track
2752 km
Equator
6
5
4
3
2
1

Coverage tracks of Landsat 1-3



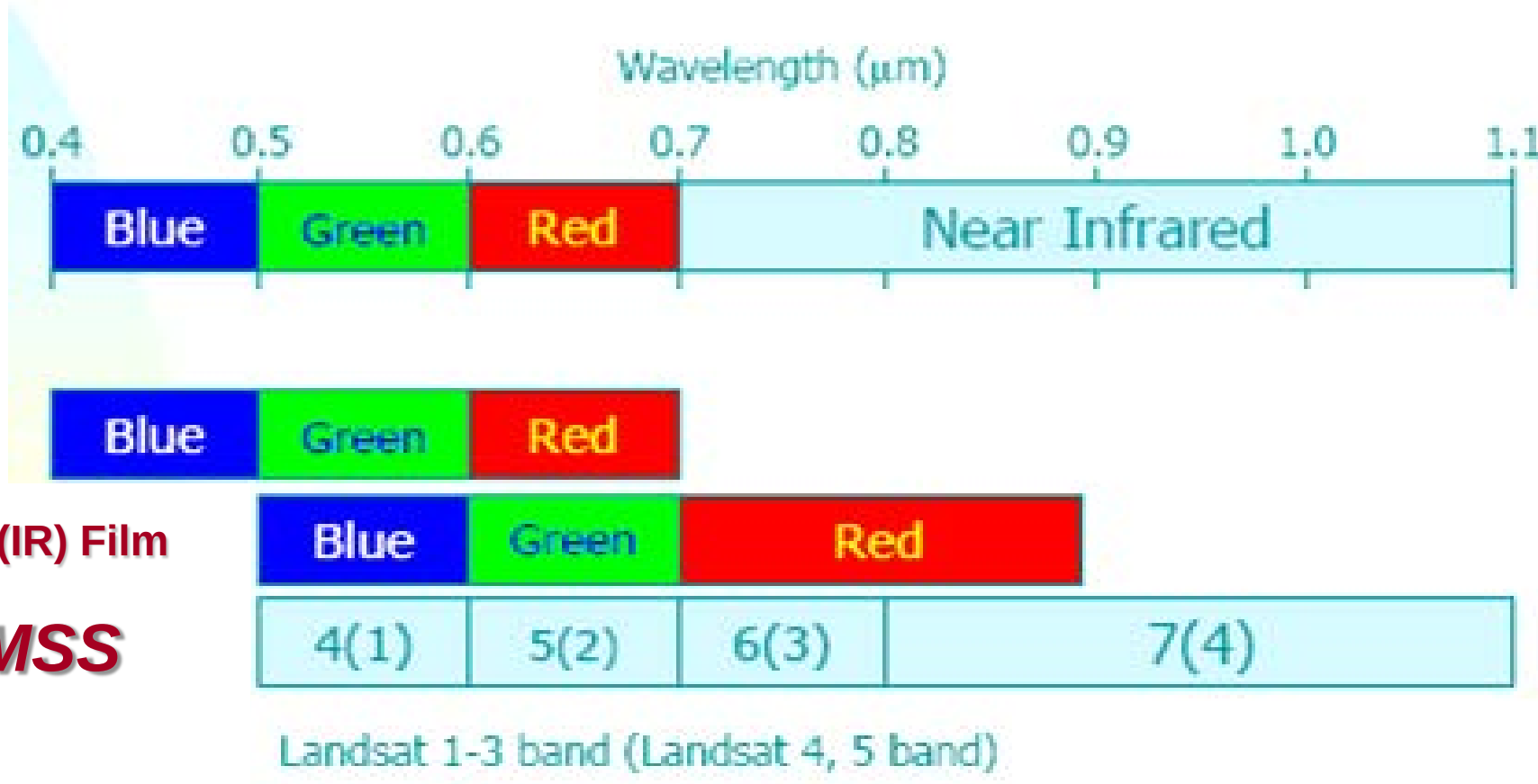



Days
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Equator

Landsat 1-3 Sensors

- **M**ulti **S**pectral **S**canner (**MSS**)
  - **0.5-0.6**, **0.6-0.7**, **0.7-0.8**, **0.8-1.1**μm
  - **Resolution**: **79** m (1-3), **82** m (4-5)
  - **Full seen Coverage**: ***185*** x ***185*** km
- **R**eturn **B**eam **V**idicon **Camera** (**RBV**) – Landsat ***1*** and ***2***
  - **0.47-0.57**, **0.58-0.68**, **0.69-0.83** μm
  - **Failed within weeks of Landsat 1**.

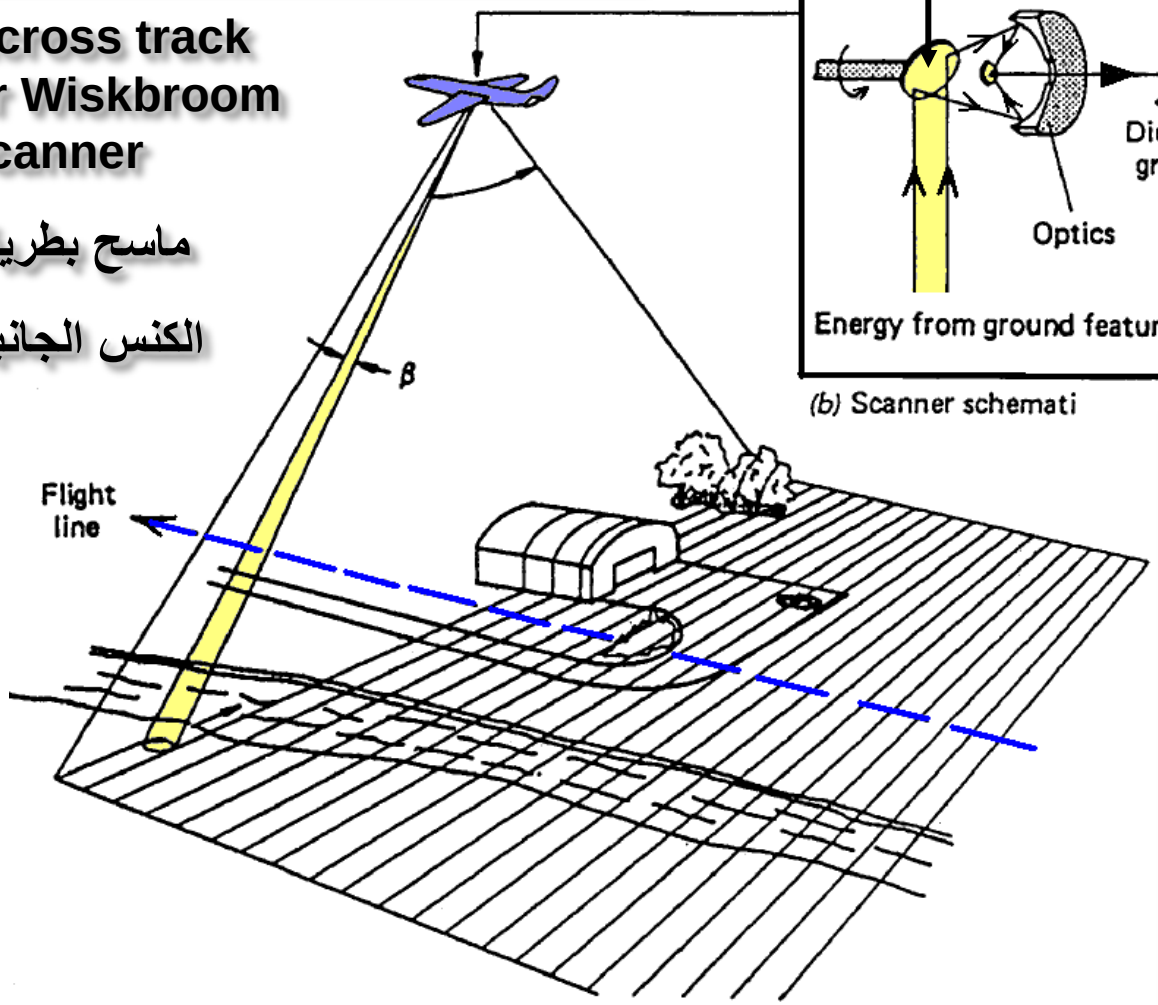
Spectral sensitivity of MSS Bands



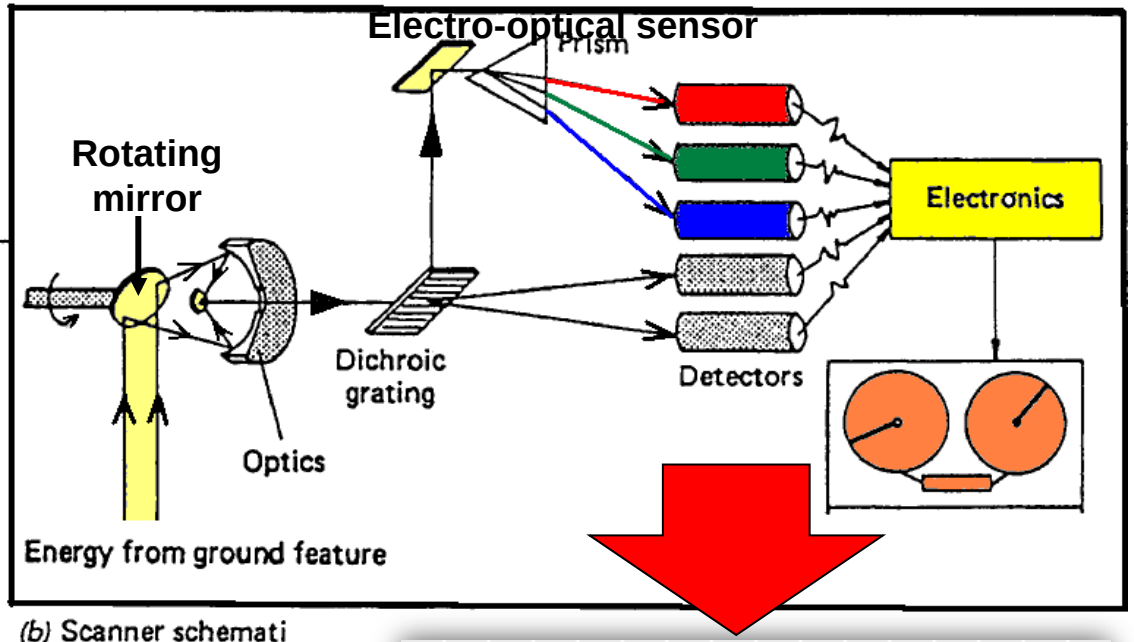
MSS System Operation

Across track or Wiskbroom scanner

ماسح بطريقة الكنس الجانبي



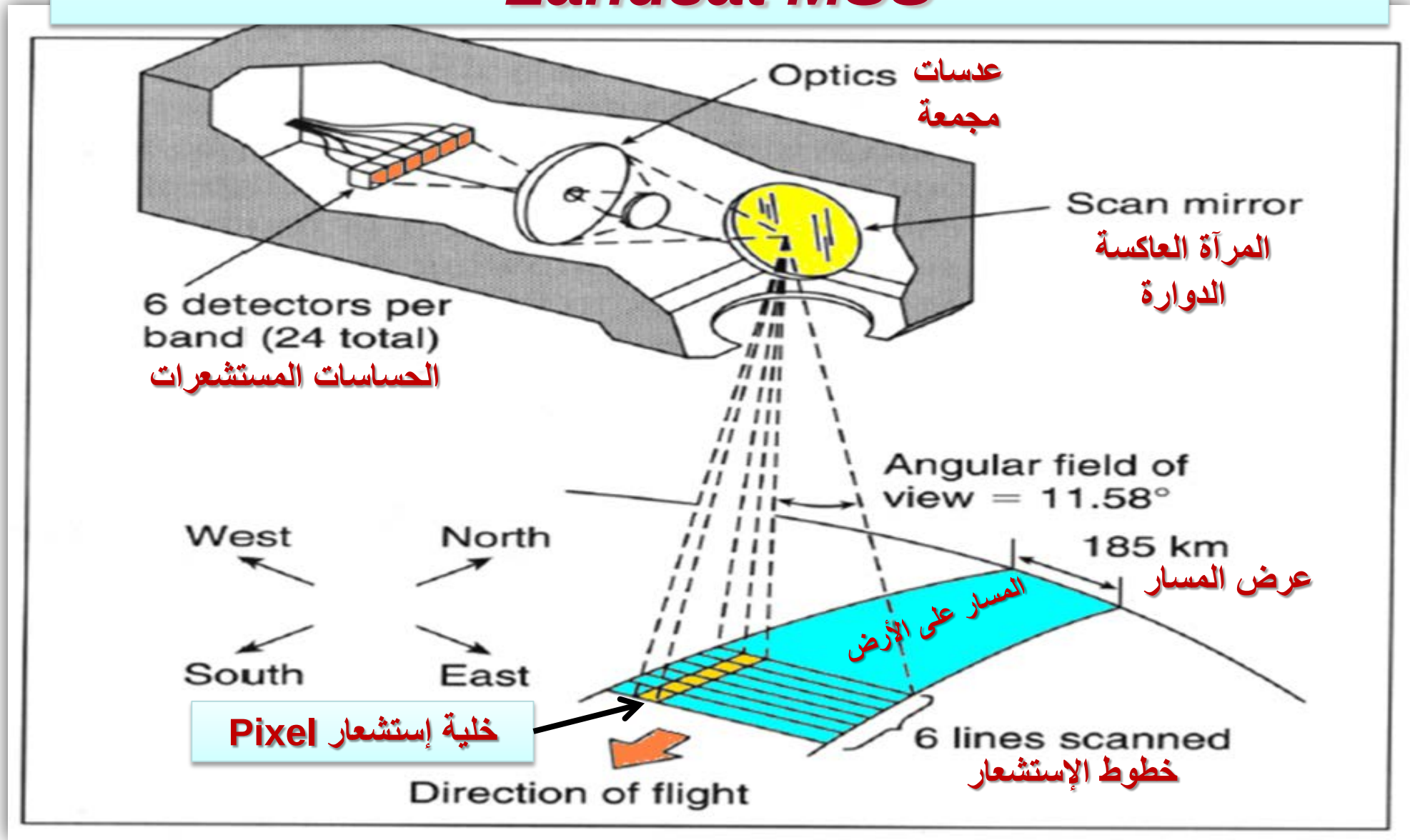
(a) Scanning procedure during flight



(b) Scanner schemati

Flight Direction

Schematic Representation of the Landsat MSS

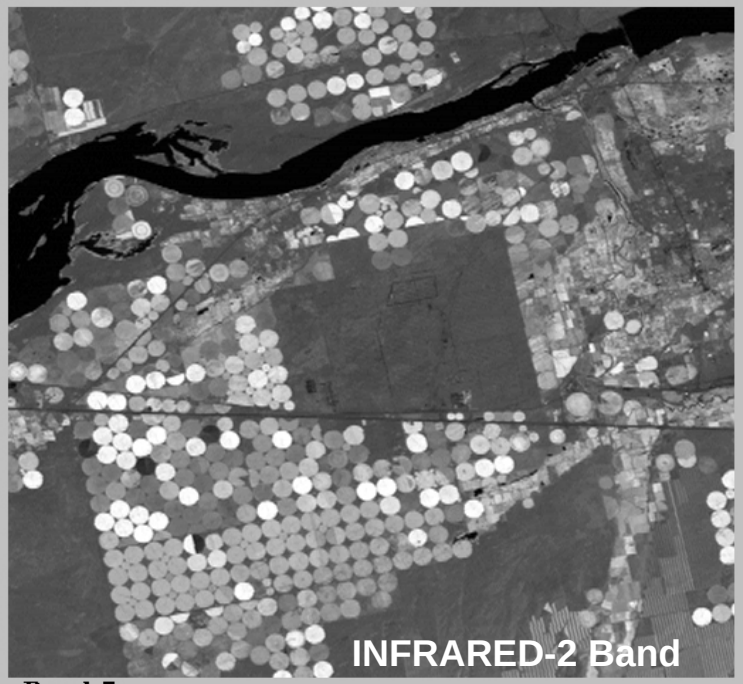


Landsat MultiSpectral Scanner (MSS) Bands

Band 4

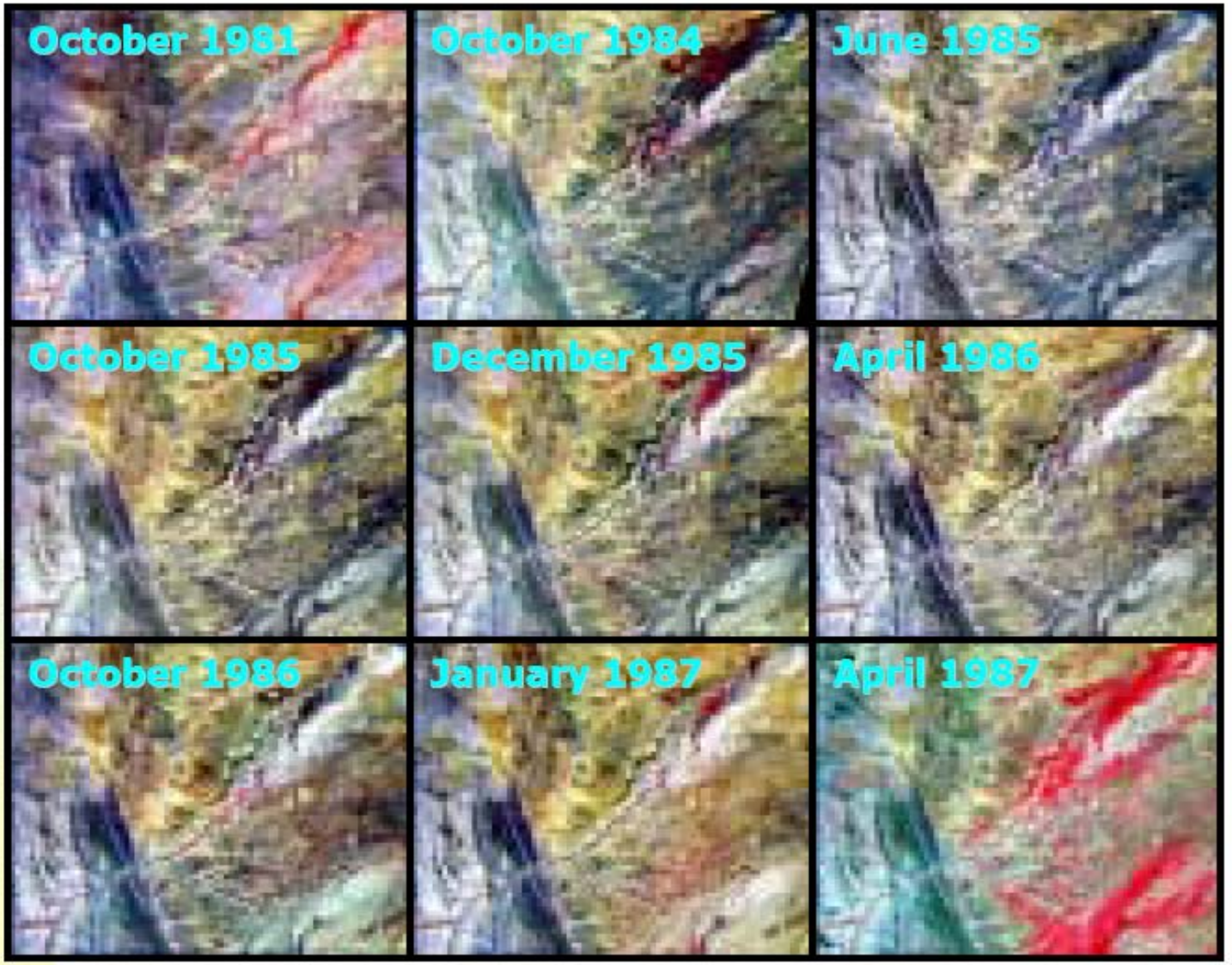
Band 5

Band 6



Band 7

Multi-temporal MSS Images



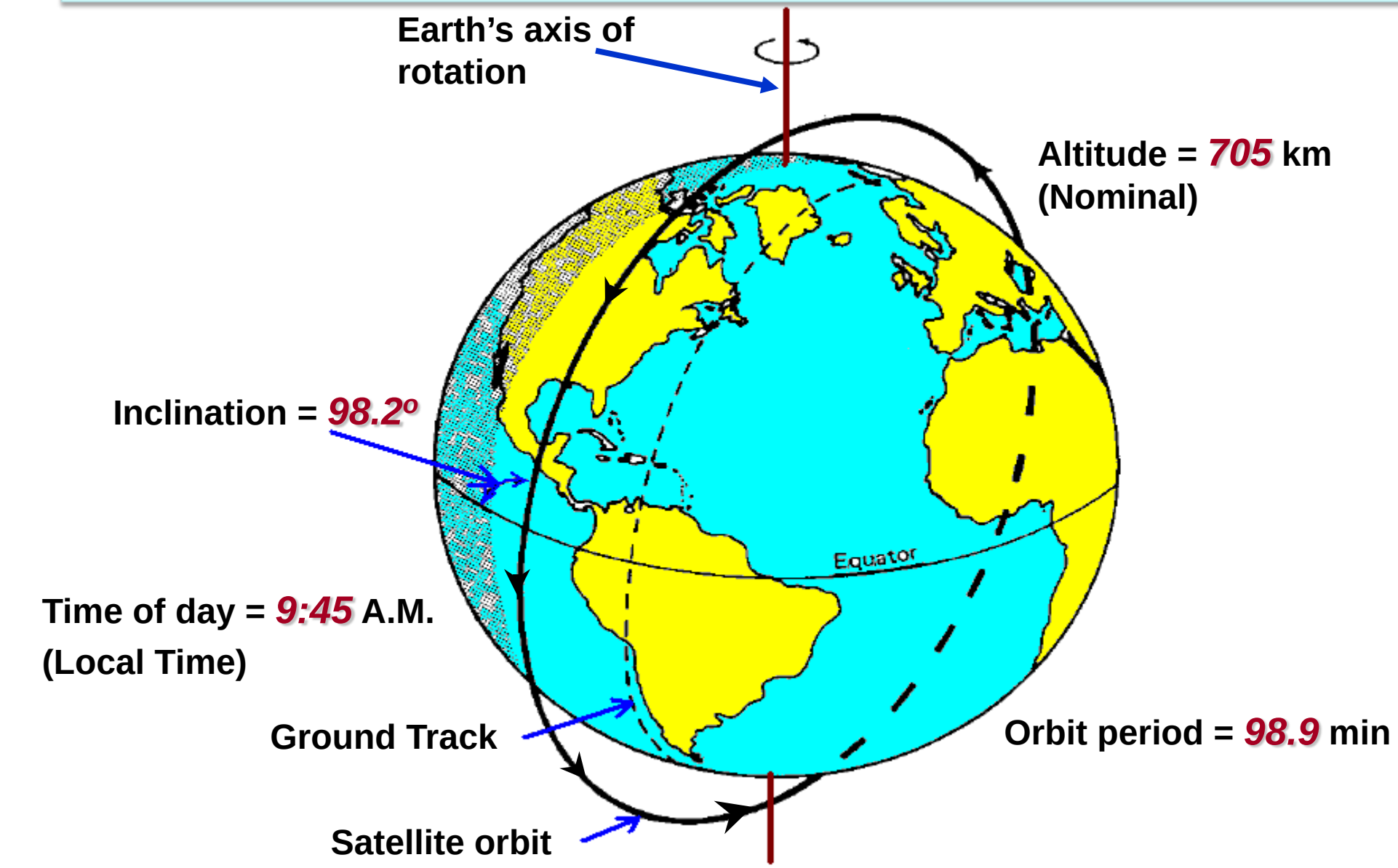
Landsat MSS images of Fowlers Gap station, broken Hill, Western New South Wales, Australia. The image series shows the effect of 3-year draught (starting in 1984, ending February 1987) on the semiarid rangeland vegetation.

Landsat 4-5 orbital characteristics

Landsat 4-5 orbital characteristics:

- **Altitude 705** km
- **Coverage cycle 16** days
- **Local crossing** at about **9:45 am**
- **Smaller side** lap (**7.6% at the equator**)

Sun-synchronous orbit of Landsat 4-5



Landsat 4-5 Sensors

- **No RBV cameras**
- **MSS** same as Landsat 1-3
- **T**hematic **M**apper (**TM**) a new sensor
  - Launched with **Landsat 4 and 5**
  - **7 Bands**, **0.45 - 12.5** µm
  - **Spatial Resolution**:
    - ***30*** **m** for **bands** ***1***,***2***,***3***,***4***,***5***, **and** ***7***
    - **band 6** (thermal IR band, ***120*** m)

TM Spectral Bands

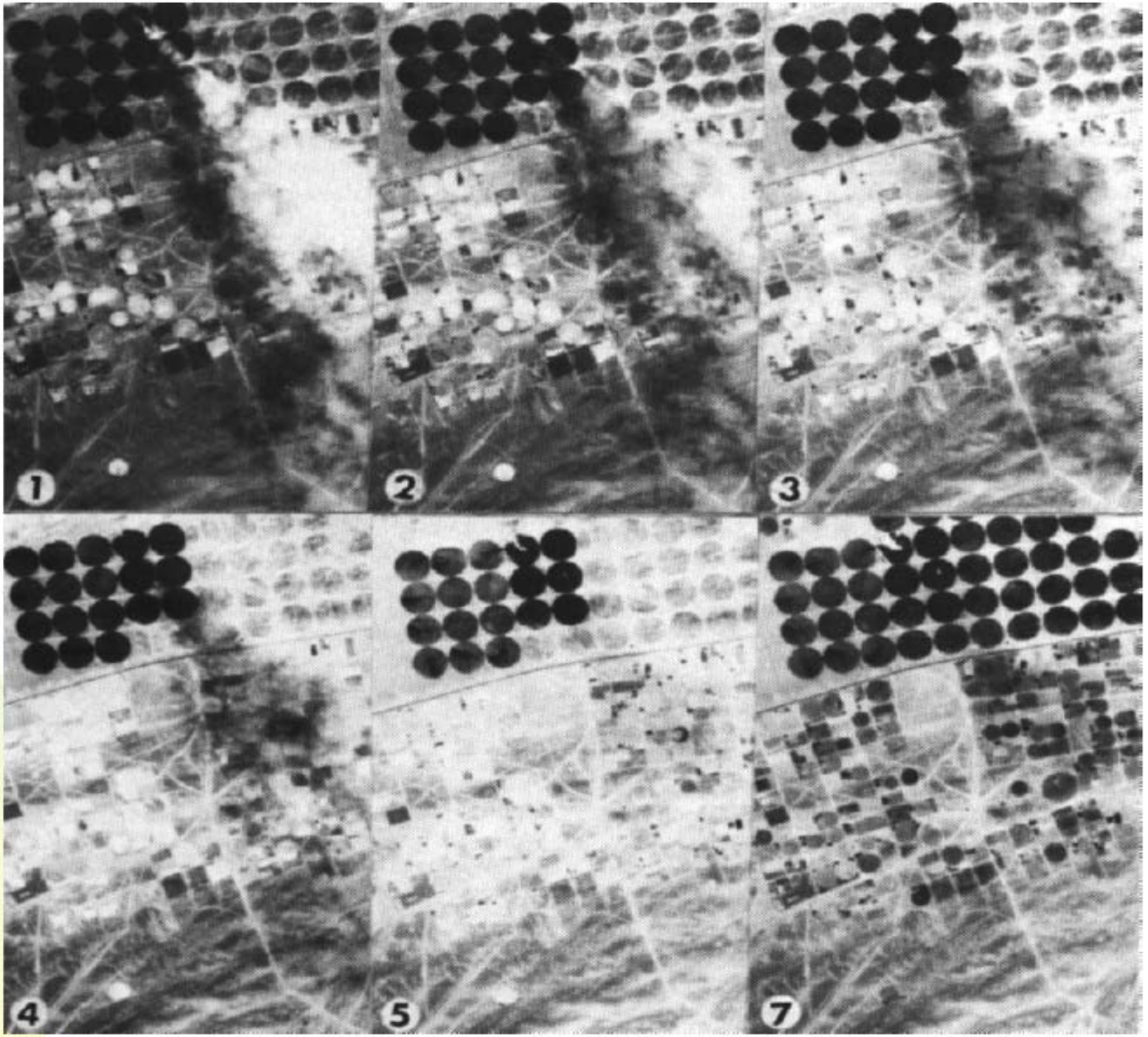
Band No.	Wavelength micrometer	Nominal Spectral Location	Principal Applications
1	0.45-0.52	Blue	Designed for water body penetration, making it useful for coastal water mapping. Also, useful for soil/vegetation discrimination, forest type mapping and cultural feature identification.
2	0.52-0.60	Green	Designed to measure green reflectance peak of vegetation for vegetation discrimination and vigour assessment. Also useful for cultural feature identification.
3	0.63-0.69	Red	Designed to sense in a chlorophyl absorption region aiding in plant species differentiation. Also useful for cultural feature identification.
4	0.76-0.90	Near infrared	Useful for determining vegetation types, vigour, and biomass content, for delineating water bodies, and for soil moisture discrimination.
5	1.55-1.75	Mid-infrared	Indicative of vegetation moisture content and soil moisture. Also useful for differentiation of snow from clouds.
6	10.4-12.5	Thermal infrared	Useful in vegetation on stress analysis, soil moisture discrimination, and thermal mapping applications.
7	2.08-2.35	Mid-infrared	Useful for discrimination of mineral and rock types. Also sensitive to vegetation moisture content.

TM Bands

Landsat 5 TM subscene images (band 1-5, 7) of an agricultural area in ***north-central Saudi Arabia***.

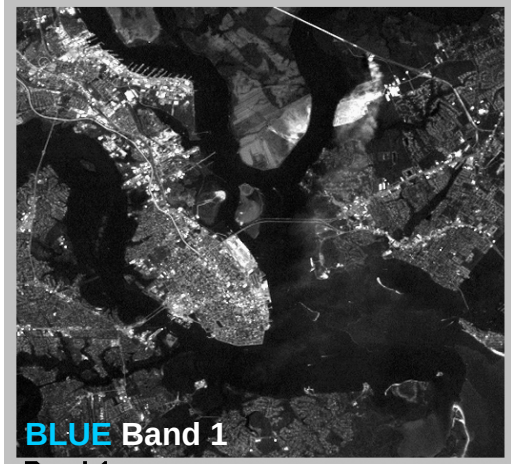
Fires have been set to clear the fields of wheat stubble.

On band 1-3, smoke of the fire is clearly visible. On band 5 and 7, the location of the fire is shown on the top of the image.

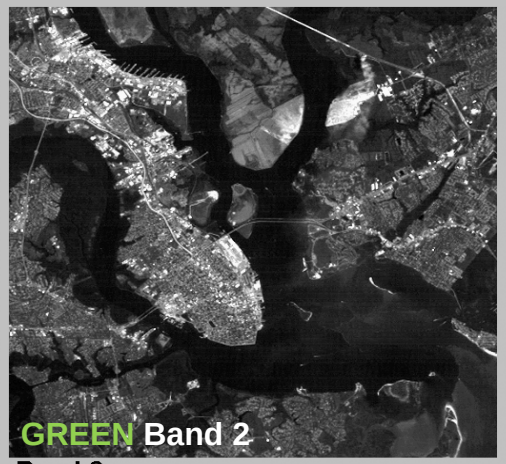


Landsat Thematic Mapper (TM) Scanner Bands

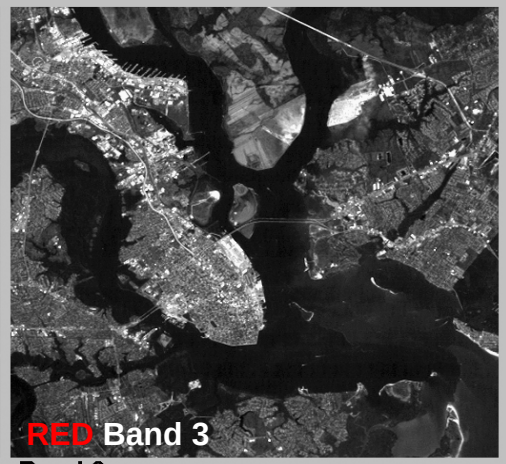
Band #	Band width in Mm	Spatial Resolution
Band 1	0.45-0.52	30 m
Band 2	0.52-0.60	30 m
Band 3	0.63-0.69	30 m
Band 4	0.76-0.90	30 m
Band 5	1.55-1.75	30 m
Band 6	10.4-12.5	120 m
Band 7	2.08-2.35	30 m



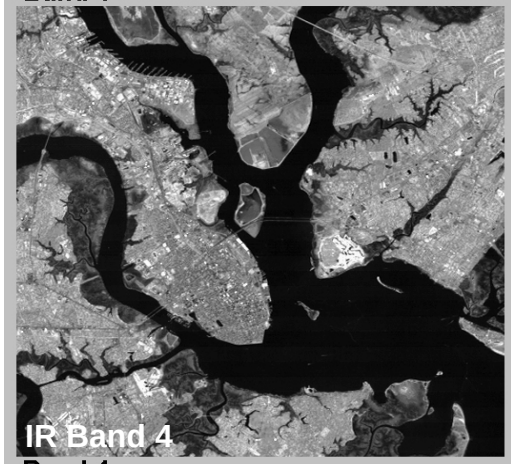
Band 1



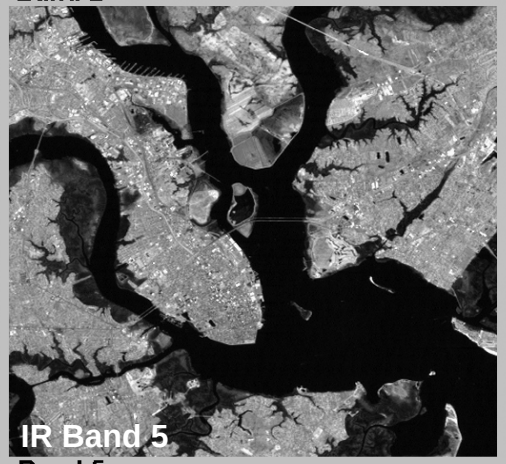
Band 2



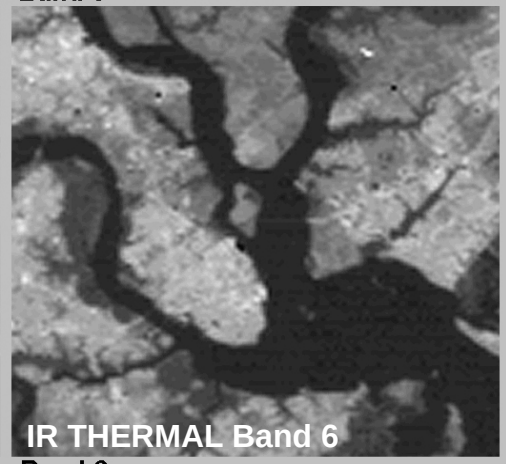
Band 3



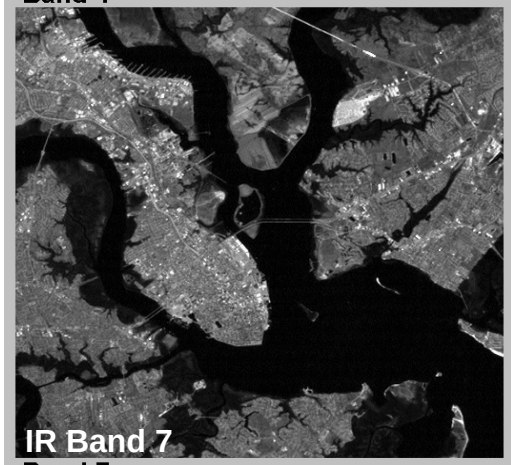
Band 4



Band 5



Band 6



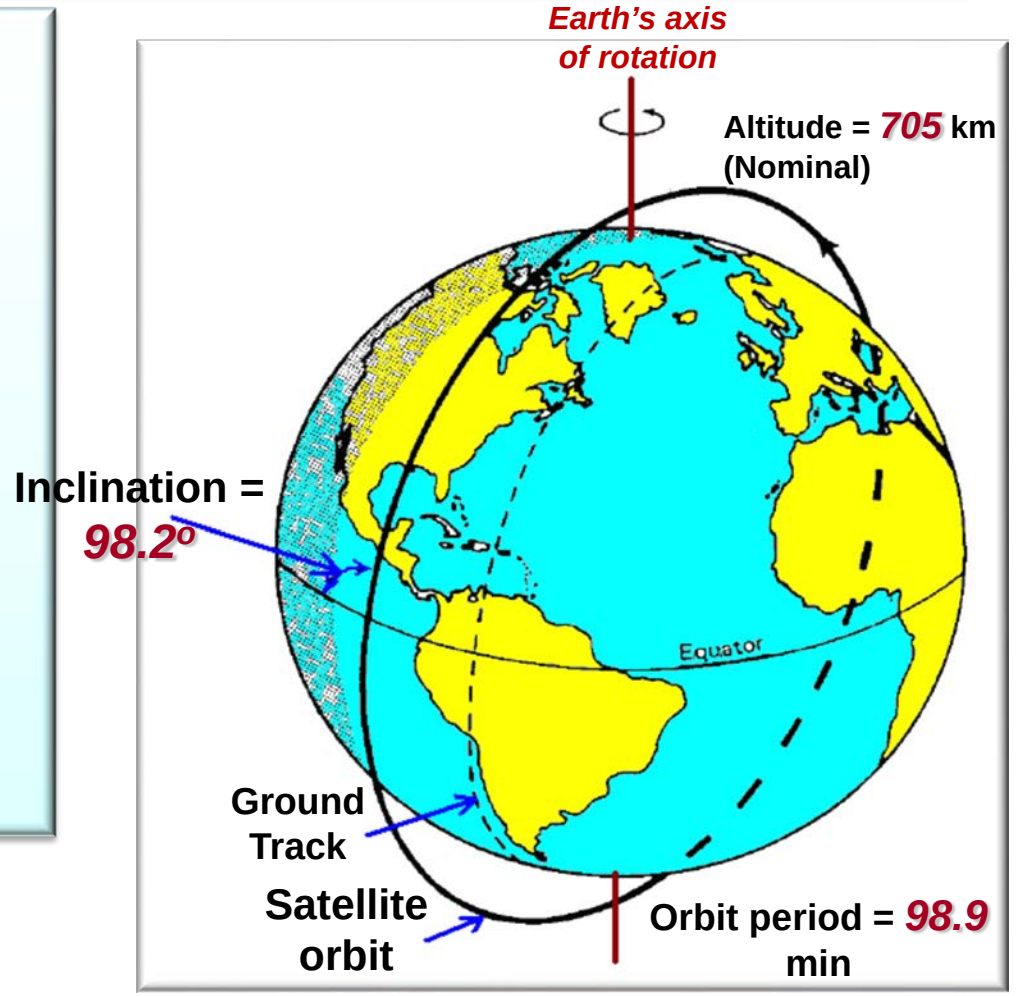
Band 7

True Color Composite 321

False Color Composite 432

Landsat 7

- **Launched** on ***15 April 1999***
- **Orbit**:
  - **Similar to Landsat 4-5**
  - **Sun-synchronous**, **polar**
  - **Altitude**: **705 km**
  - **Repeat cycle**: **16 days**
  - **Local crossing time**: **10:00 am**



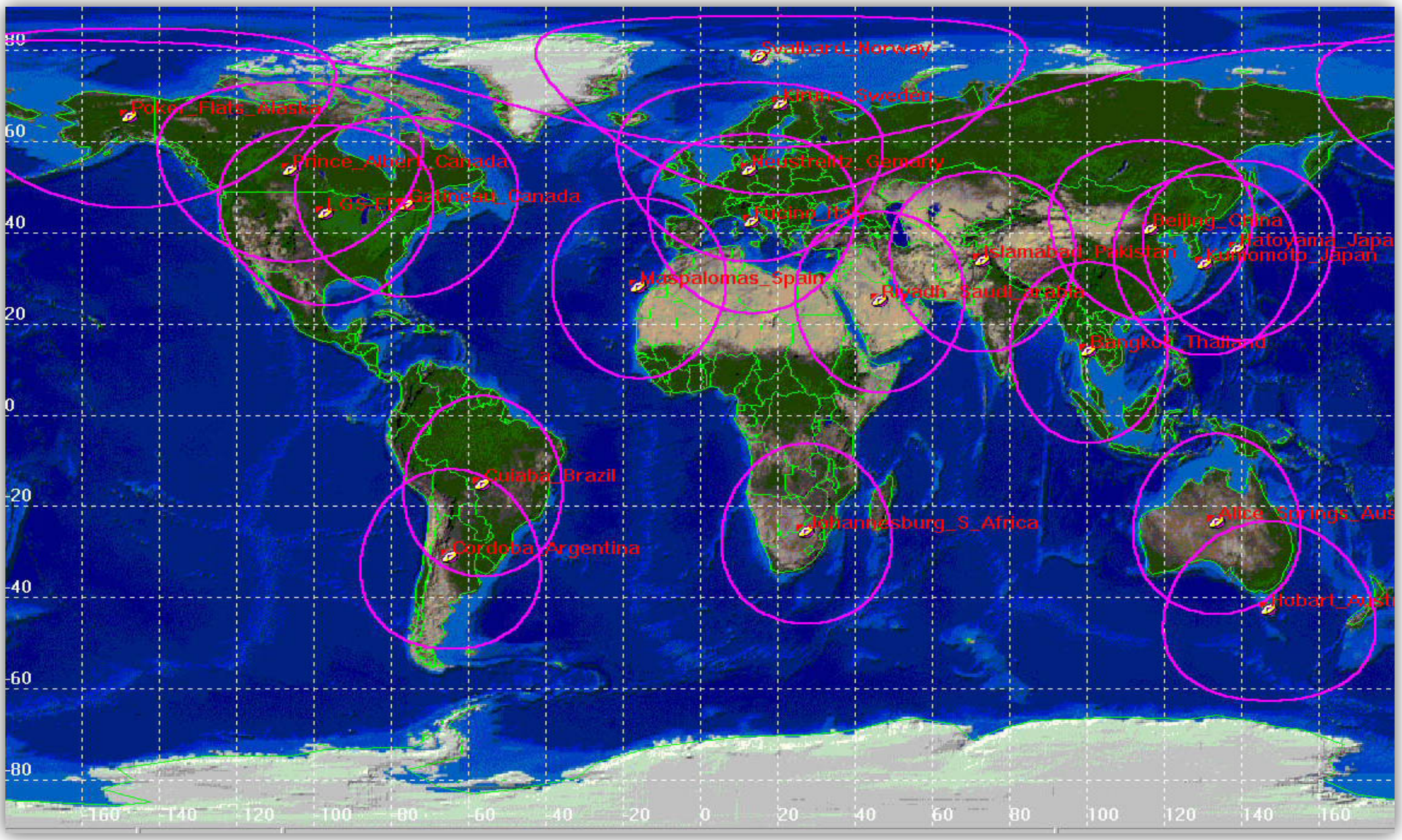
Enhanced Thematic Mapper (ETM+) sensor

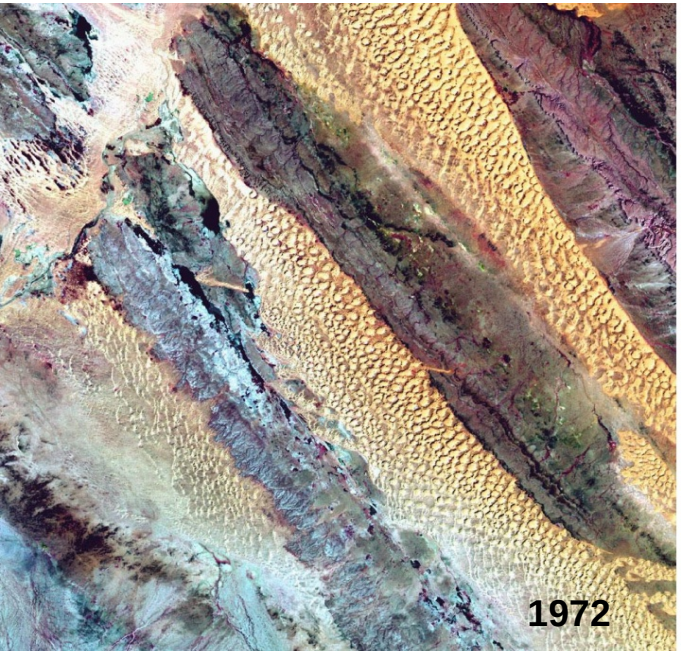
- **Scene size**
  - ❖ ***183*** km **cross track**
  - ❖ ***170*** km **along track**
- **Spectral Bands**
  - ❖ ***8* bands**: **all TM bands +1 panchromatic band**
- **Resolution**
  - ❖**Bands 1 - 5, 7**: ***30*** meters **Visible & IR bands**
  - ❖**Band 6**: ***60*** meters **Thermal IR band**
  - ❖**Band 8**: ***15*** meters **Panchromatic Band**

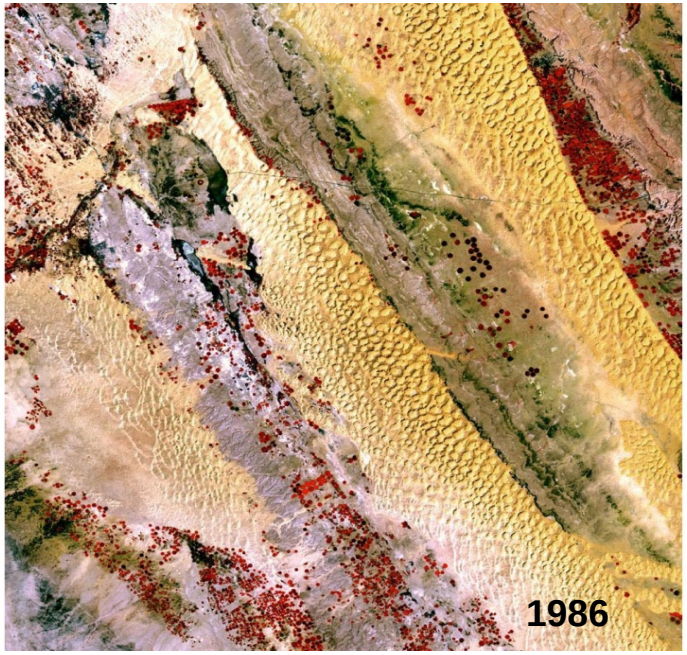
LandSat ETM+ Spectral Bands

Channel	Band	Spectral Range (μm)	Spatial Resolution (m)
1	**Blue**	**0.45 – 0.52**	**30**
2	**Green**	**0.52 – 0.60**	**30**
3	**Red**	**0.63 - 0.69**	**30**
4	NIR	0.76 – 0.90	30
5	Mid IR	1.55 – 1.75	30
6	**Thermal**	**10.4 – 12.5**	**60**
7	Mid IR	2.08 – 2.35	30
8	**Pan**	**0.50 – 0.90**	**15**

LandSat 7 Receiving Stations





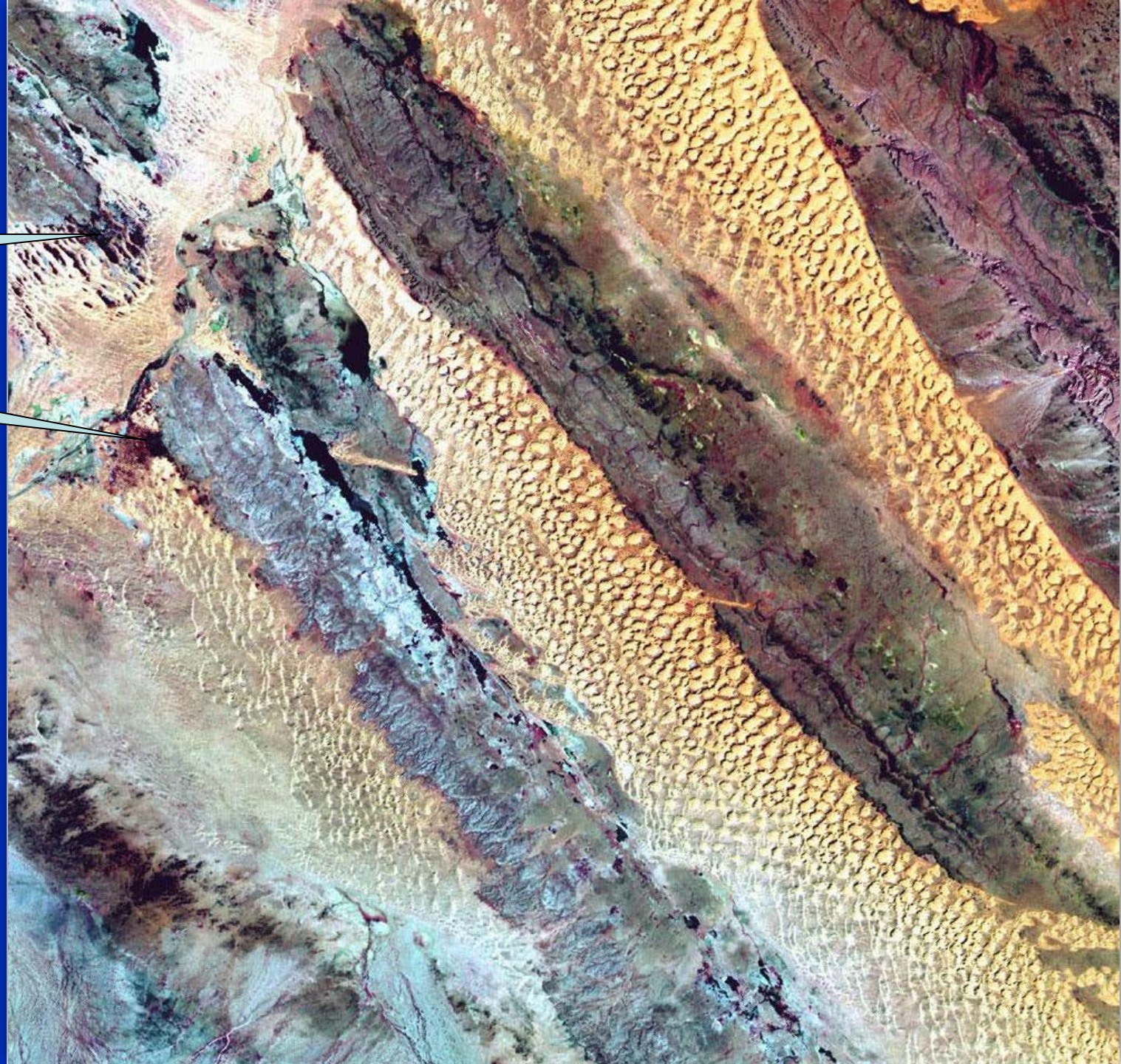


Central Saudi Arabia

- **Sensor: L1 MSS (**December 25, **1972)**, **L4 TM (**February 15, **1986)**, **L7 ETM+ (**January 5, **2003)**
  Lat/Long: 25.993/44.720, **Path/Row:** 167/42
- These images show the development of center-pivot irrigation agriculture in Saudi Arabia. **Areas under this type of irrigation appear as red circles.**
- The **1972** image shows little development in the region, and the cities of **Buraydah** and **Unayzah** are barely discernible on the west edge.
- The cities, as well as a new highway, are shown more clearly at the western edge of the **1986** and **2003** images.
- The **1986** image ***shows*** the ***dramatic impact*** of ***center-pivot irrigation systems***.
- The **2003** image ***shows areas*** of ***increasing irrigation*** and ***areas*** that ***have actually decreased***.

LANDSAT1 MSS

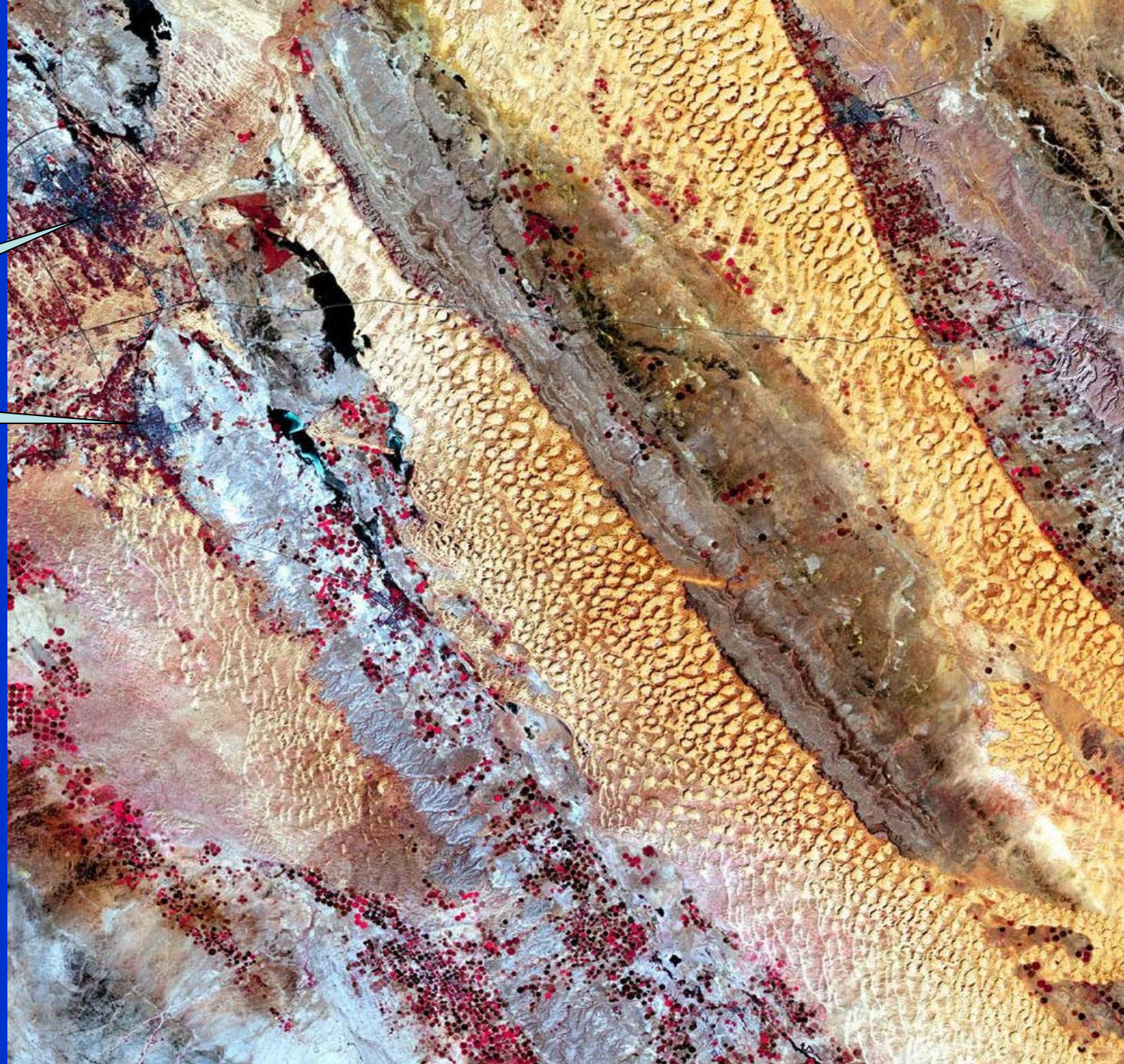
December 25, 1972



LANDSAT4 TM

February 15, 1986

LANDSAT7 ETM+ January 5, 2003



Landsat 8

Orbit

- ***Sun-synchronous orbit*** at an altitude of **705** km (438 mi)
- **233** orbit cycle; covers the entire globe every **16 days**
- Inclined **98.2°**
- Circles the Earth every **98.9 minutes**
- Equatorial crossing time:

  10:00 a.m. +/- 15 minutes
- Scene size: **170** km x **185** km
- Design Life: Minimum of **5** years

LANDSAT 8

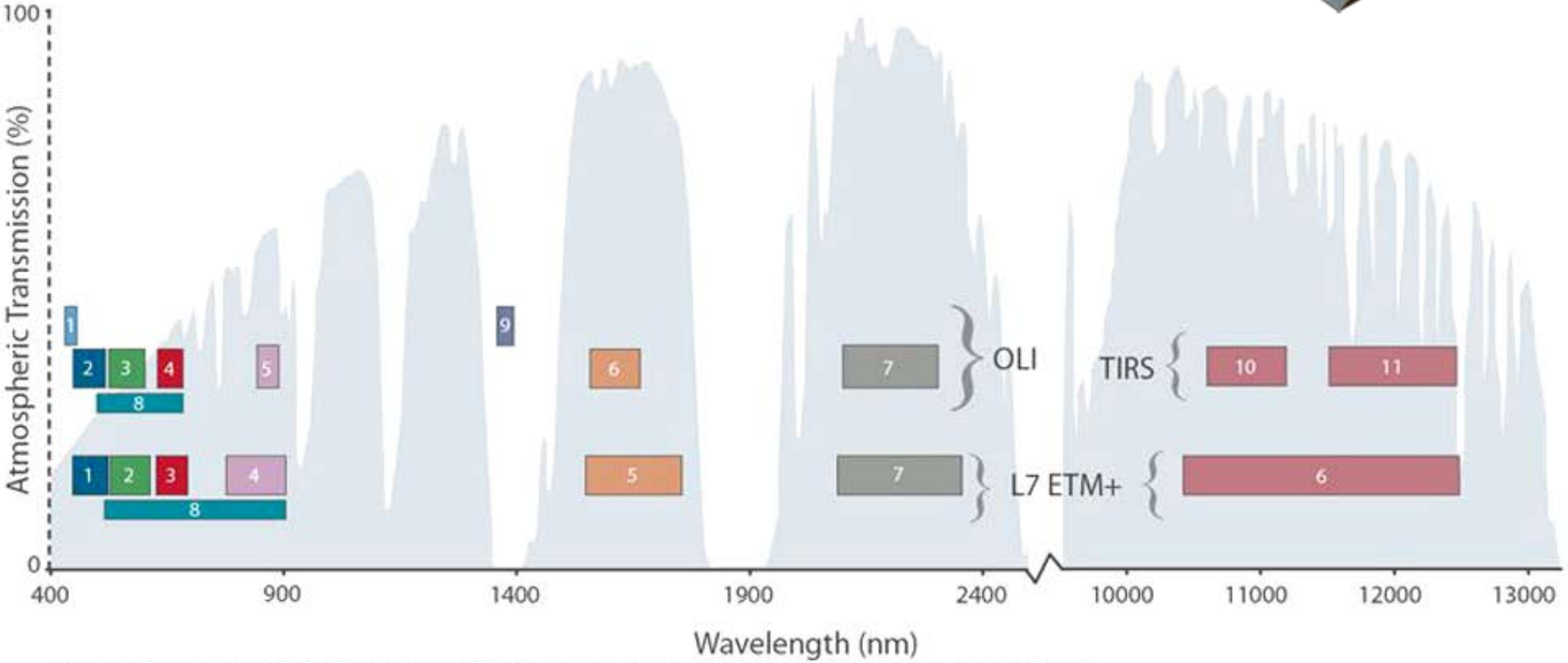
- Landsat 8 carries **two** instruments:
  - The **Operational Land Imager (OLI)** sensor includes refined Landsat 7 bands, along with three new bands:
    - **a deep blue band for coastal/aerosol studies,**
    - **a shortwave infrared band for cirrus detection,**
    - **and a Quality Assessment band**
  - The **Thermal Infrared Sensor (TIRS)** sensor provides two therma bands. These sensors both provide a **12-bit** dynamic range.
  - Products are delivered as **16-bit** images (scaled to **55,000 grey levels).**

- Approximate scene size is **170** km north-south by **183** km east-west (106 mi by 114 mi).

Landsat 8	Bands	Wavelength (micrometers)	Resolution (meters)
Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) Launched February 11, 2013	Band 1 - Coastal aerosol	0.45 - 0.43	30
	Band 2 - Blue	0.51 - 0.45	30
	Band 3 - Green	0.59 - 0.53	30
	Band 4 - Red	0.67 - 0.64	30
	Band 5 - Near Infrared (NIR)	0.88 - 0.85	30
	Band 6 - SWIR 1	1.65 - 1.57	30
	Band 7 - SWIR 2	2.29 - 2.11	30
	Band 8 - Panchromatic	0.68 - 0.50	15
	Band 9 - Cirrus	1.38 - 1.36	30
	Band 10 - Thermal Infrared (TIRS) 1	11.19 - 10.60	100
	Band 11 - Thermal Infrared (TIRS) 2	12.51 - 11.50	100

*** TIRS bands are acquired at 100 meter resolution, but are re-sampled to 30 meter in delivered data product.**

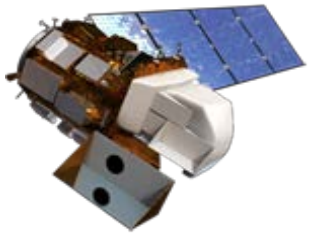
LANDSAT 8



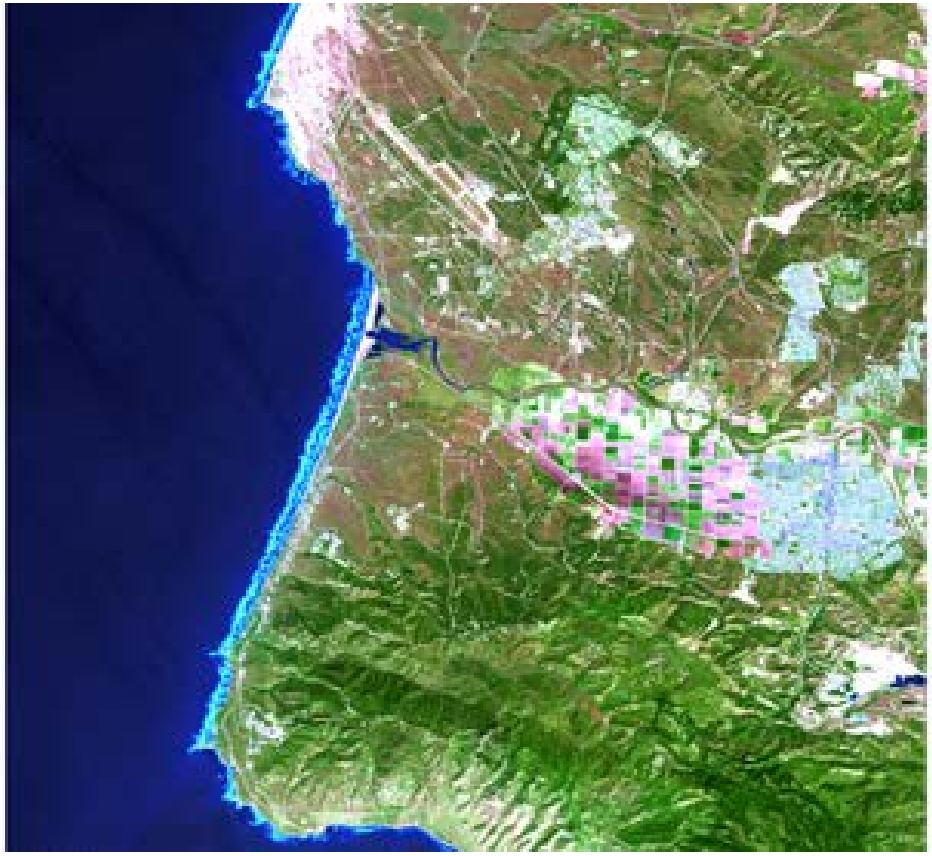
Bandpass wavelengths for Landsat 8 OLI and TIRS sensor, compared to Landsat 7 ETM+ sensor

Note: atmospheric transmission values for this graphic were calculated using MODTRAN for a summertime mid-latitude hazy atmosphere (circa 5 km visibility).

LANDSAT 8

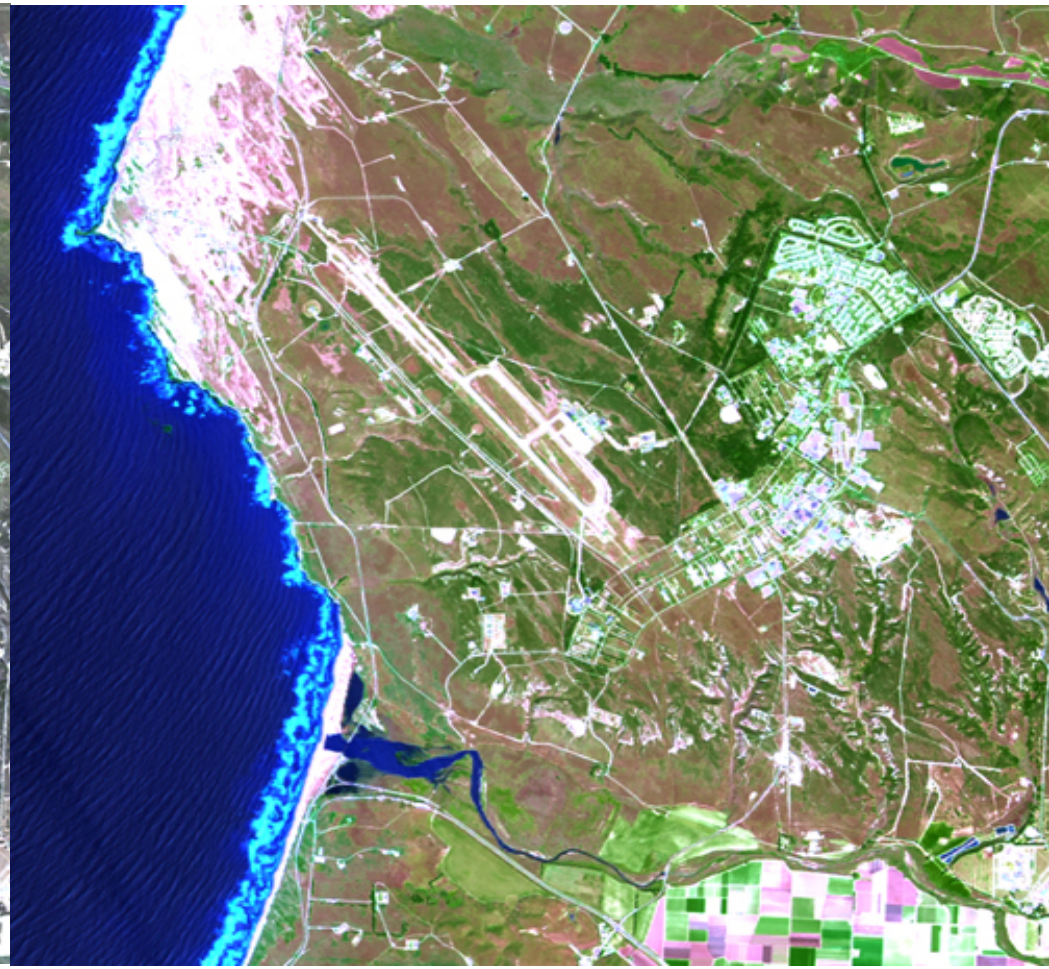


Top right, Full scene;
Bottom Left, Zoom displaying Vandenberg Air Force Base, Vandenberg Village, and Lompoc, CA;
Bottom right, Zoom displaying the Vandenberg Air Force Base and runway. (All images are False color composite (bands 6,5,4)



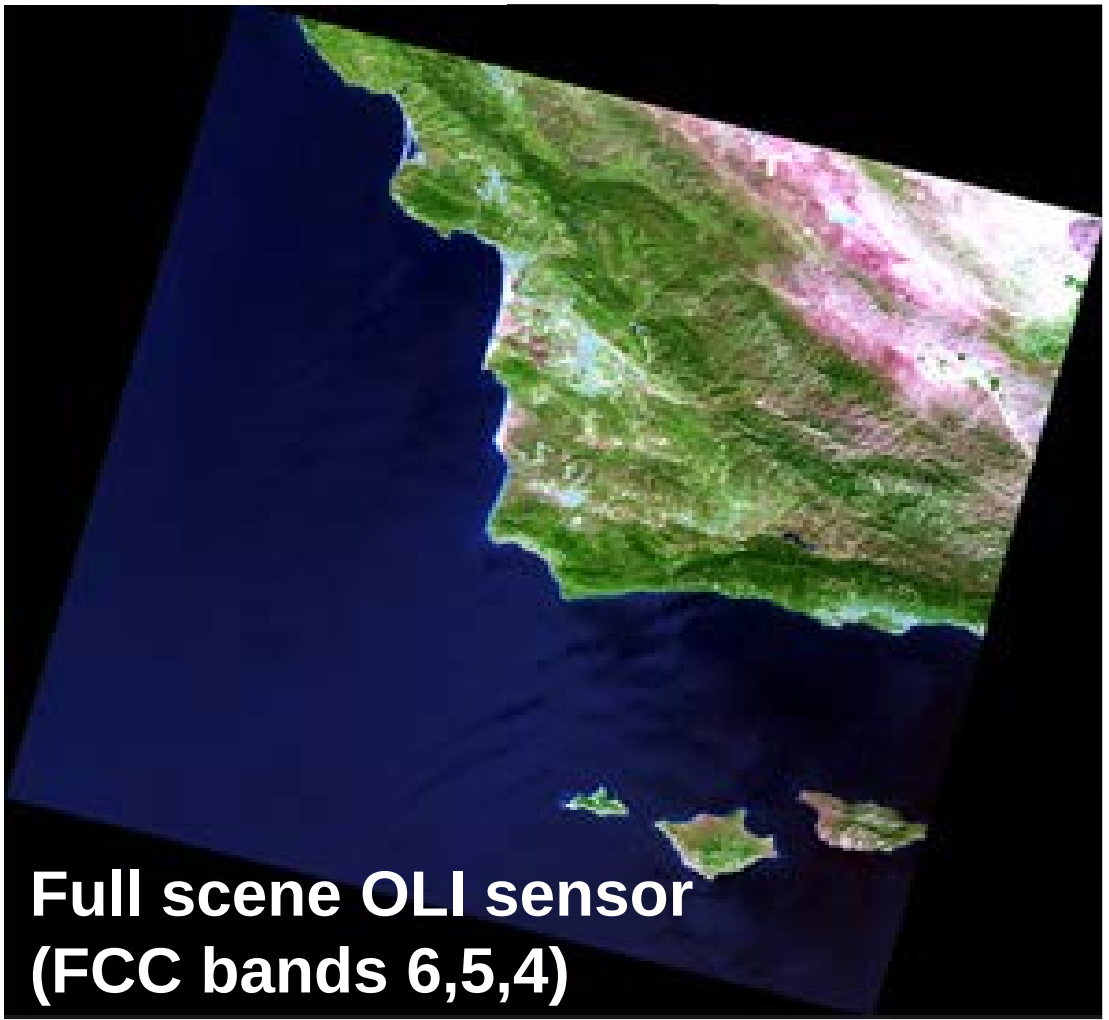
LANDSAT 8

OLI Bands 4,3,2 (TCC Natural Color)



OLI Bands 6,5,4 (FCC False Color)

LANDSAT 8



Full scene OLI sensor
(FCC bands 6,5,4)

Full scene of Thermal Infrared
Sensor (TIRS) Band 10

SPOT Satellite

SPOT – **S**ystem **P**our l'**O**bservation de la **T**erre -initiated by the ***French* government** in late 1970's.

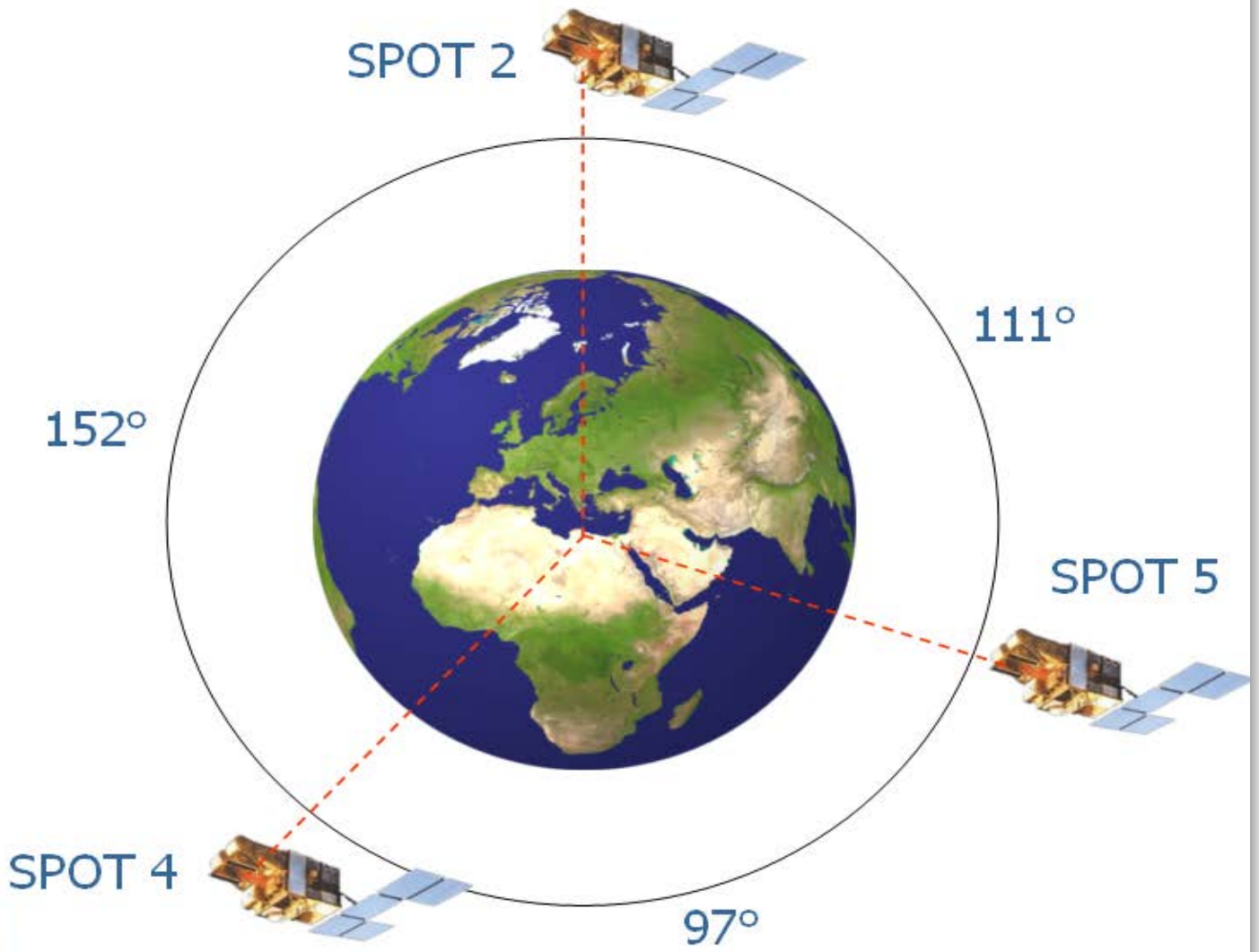
- **SPOT 1**: 21/2/***1986***
- **SPOT 2**: 21/1/***1990***
- **SPOT 3**: 23/9/***1993***
- **SPOT 4**: 26/3/***1998***
- **SPOT 5:** 2/5/***2002***

SPOT orbital Characteristics

- **Near-polar, *sun synchronous* orbit**
- **Altitude *832* km**
- **Local crossing at about *10:30* am**
- **Repeat every *26* days**
- **Off-nadir viewing by *1- 4* days depending on the latitude**
- **The scene coverage *60* x *60* km**

SPOT satellites on orbit

Active SPOT satellites: The 3 satellites have approximate 100°intervals in between them to make more frequent coverage.

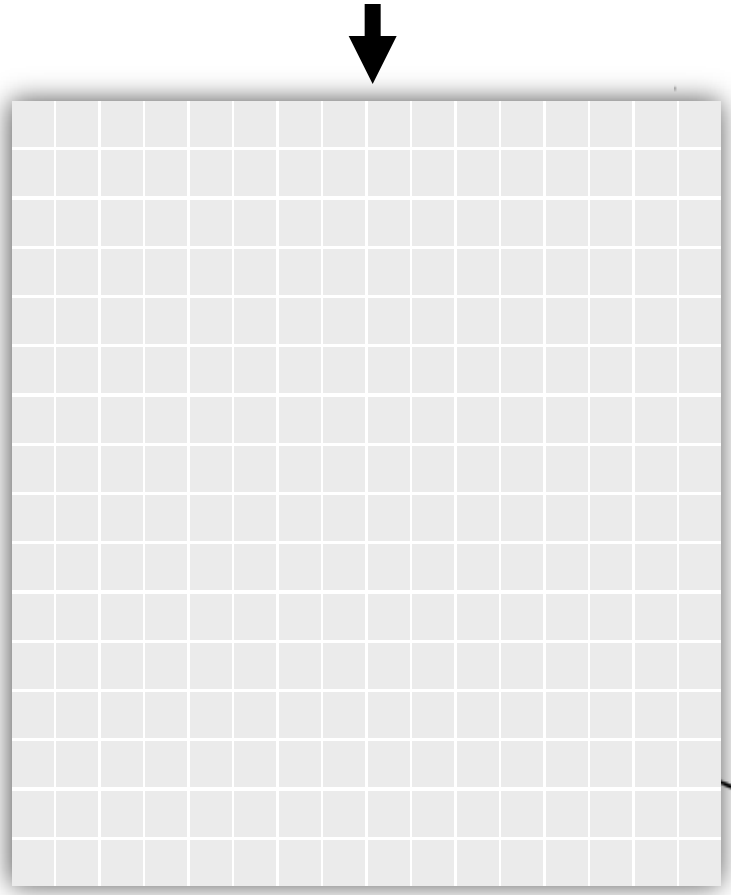


SPOT System Operation

صفين من الحساسات أحدهما فيه 3000 حساس والآخر فيه 6000 حساس

Along-track or Pushbroom Scanner

المسح بطريقة الكنس للأمام



إتجاه الطيران

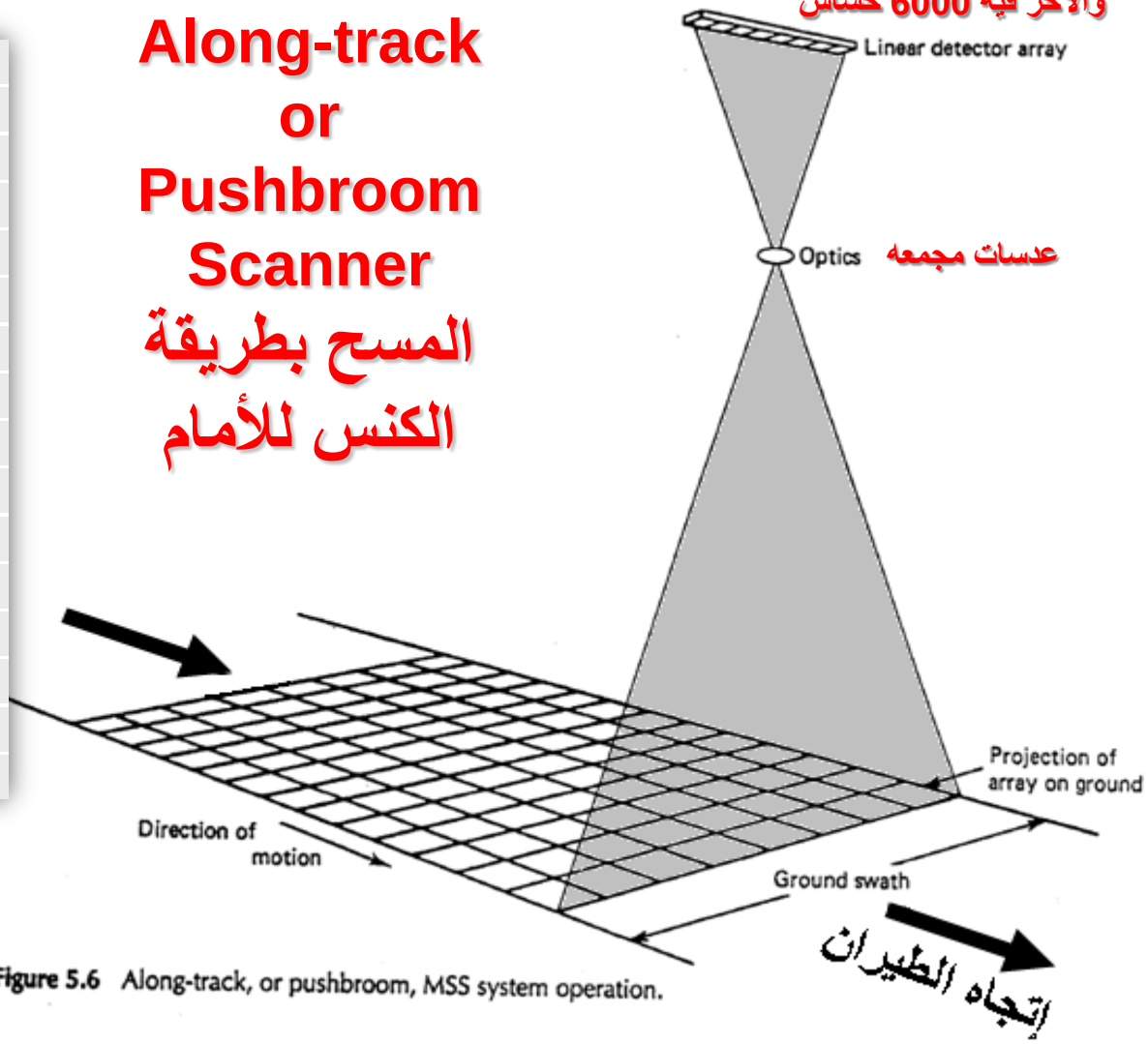
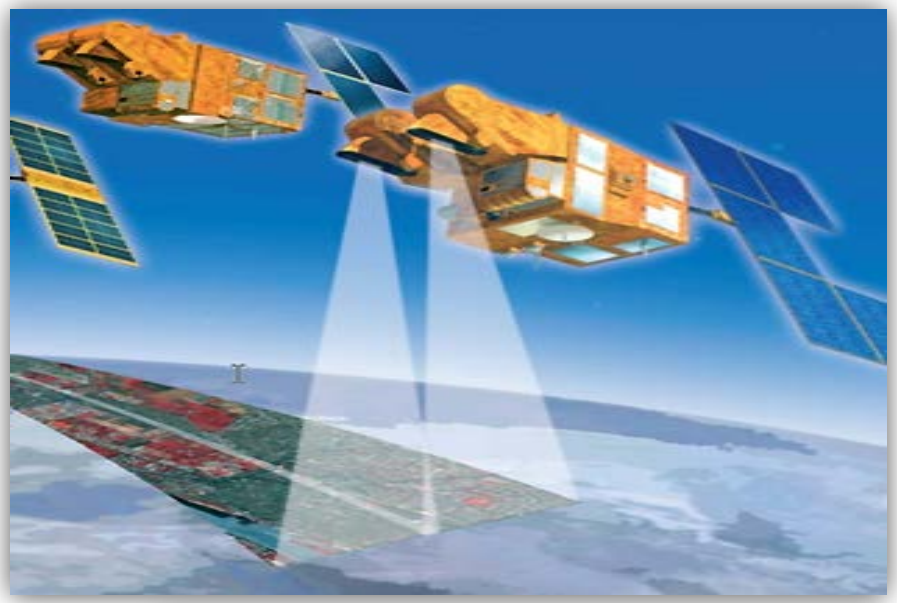


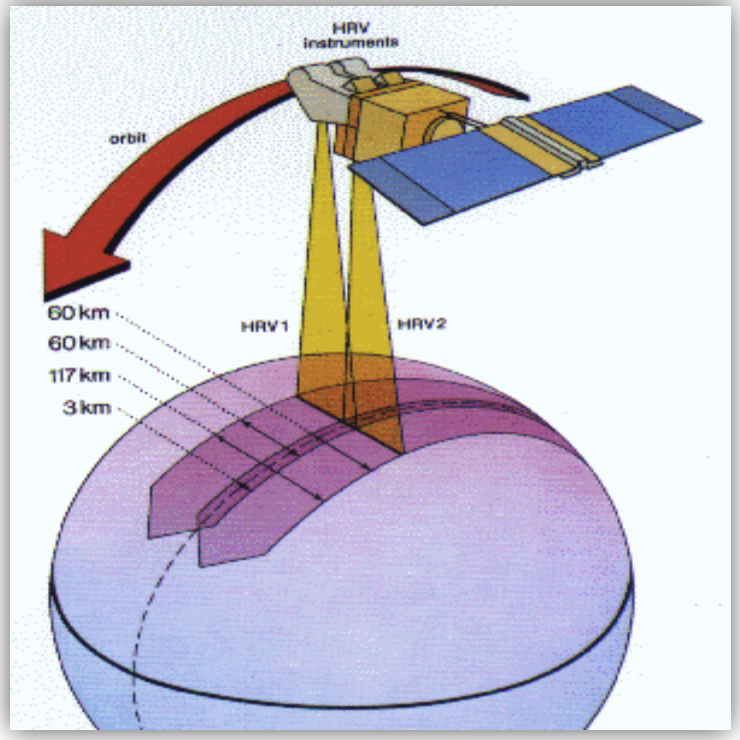
Figure 5.6 Along-track, or pushbroom, MSS system operation.

SPOT receiving stations

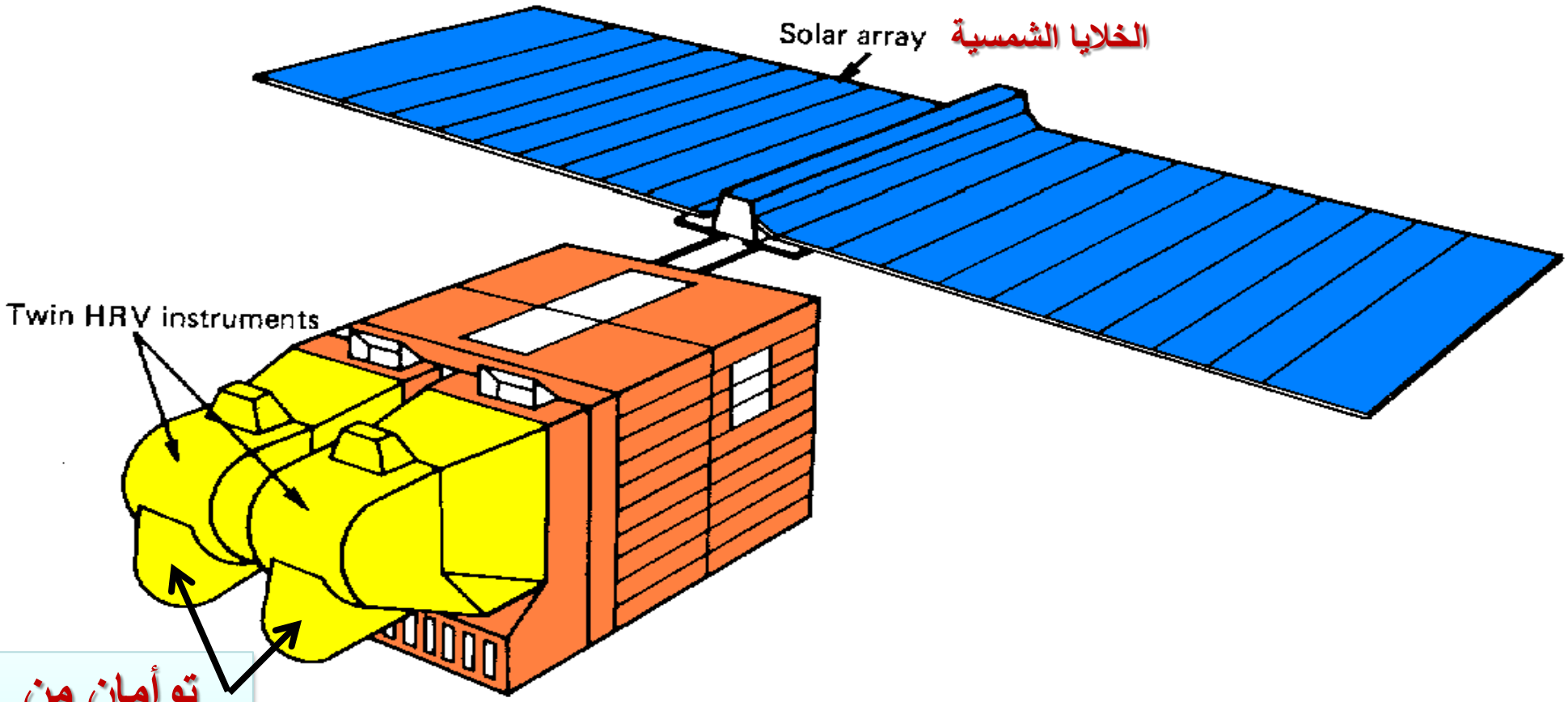
SPOT Sensors

- **Two identical High Resolution Visible (HRV) imaging systems**
- ***10*** **m resolution panchromatic (0.51-0.73µm)**
- ***20*** **m resolution multispectral (0.50-0.59, 0.61-0.68, 0.79-0.89µm)**
- ***60*** **km wide under nadir viewing**
- **Stereo viewing is possible**



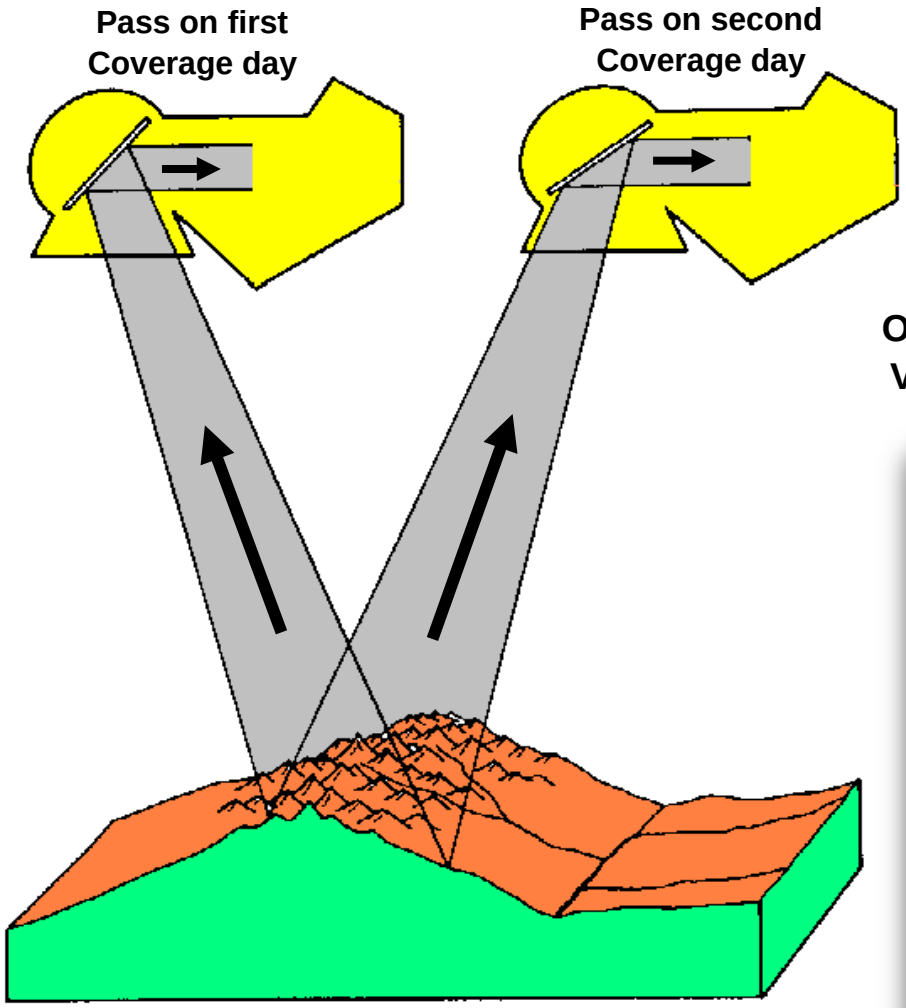


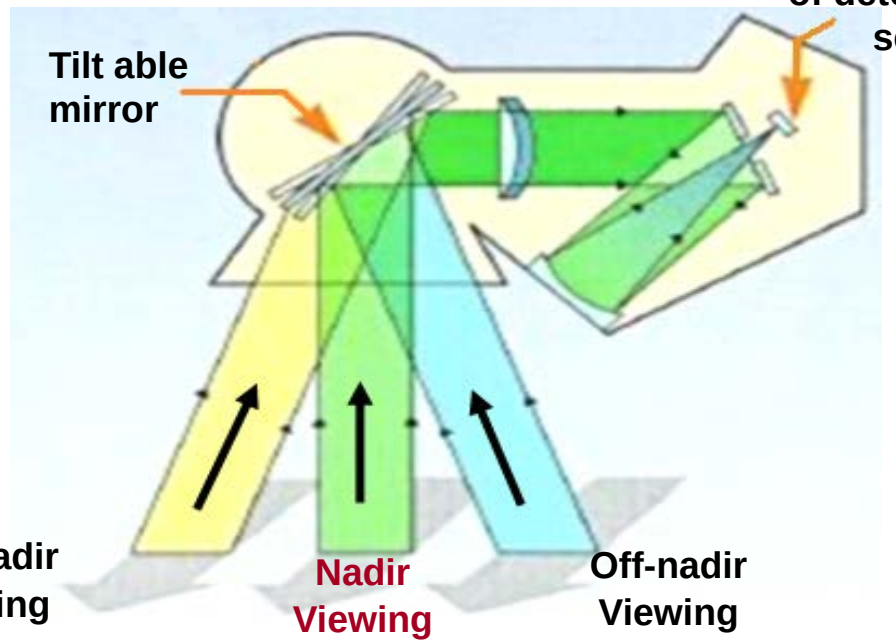
Twin HRV on SPOT

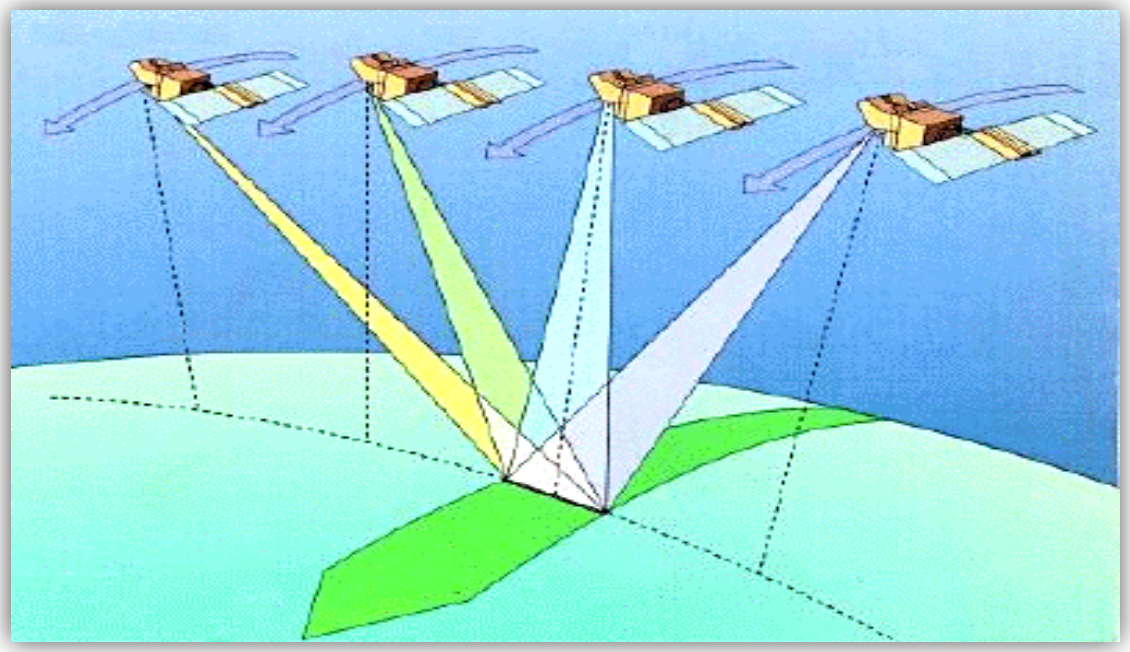


توأمان من المستشعرات المتماثلة

SPOT off-nadir viewing







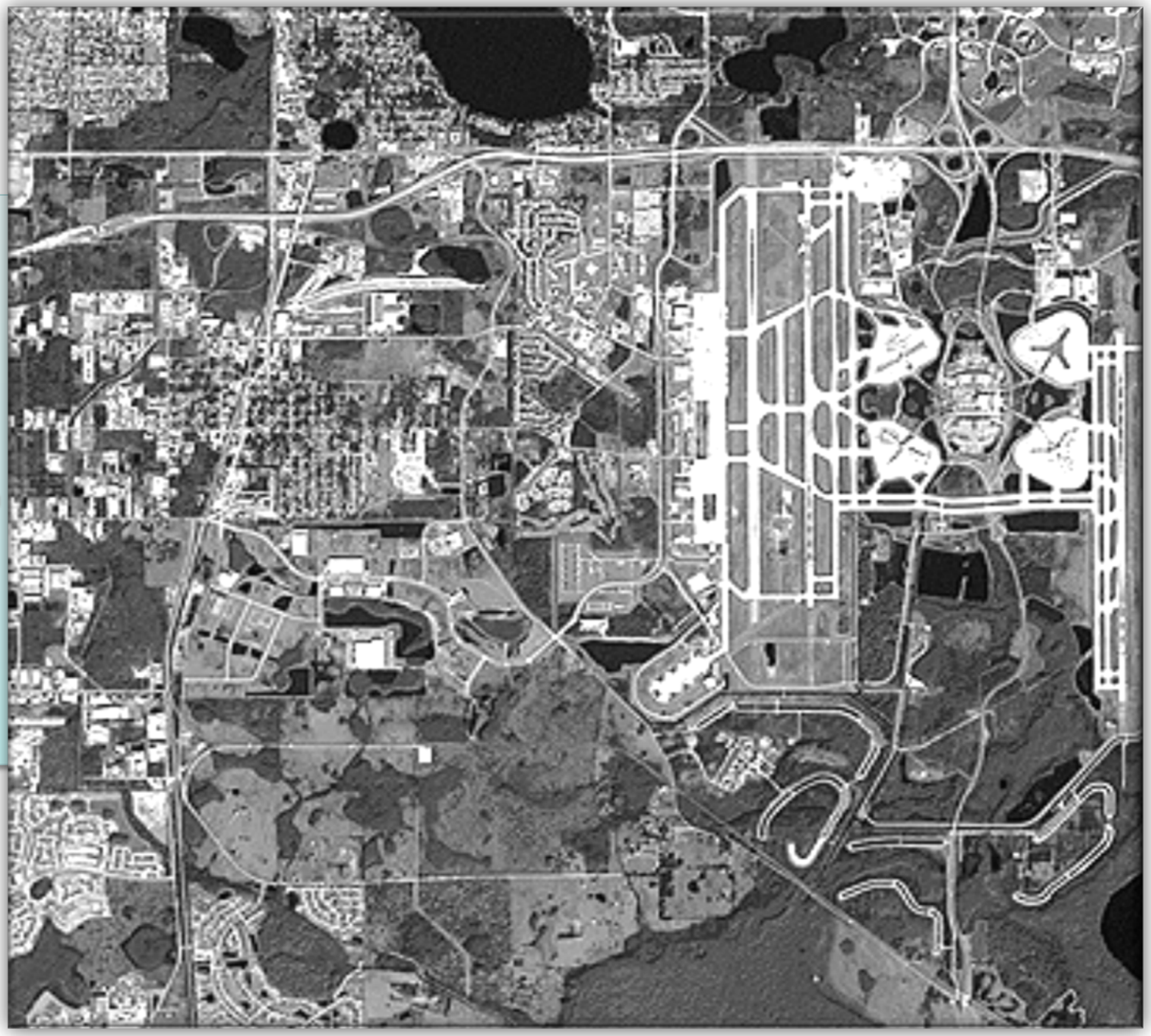
Characteristics of Spot High-Resolution Visible (HRV) system

	Multispectral mode	Panchromatic mode
Spectral bands Green Red Reflected IR	 0.50 - 0.59 µm 0.61 - 0.68 µm 0.79 - 89 µm	0.51 - 0.73 µm
Ground resolution cell (nadir viewing)	*20* by *20* m	*10* by *10* m
Detectors per spectral band	*3000*	*6000*
Ground-swath width (nadir viewing)	*60* km	*60* km

SPOT-5 Satellite Sensor Characteristics

- **Launch Date:** May 3, ***2002***
- **Orbital Altitude:** ***822*** kilometers
- **Orbital Inclination:** ***98.7°, sun-synchronous***
- **Equator Crossing Time:** ***10:30 AM*** (descending node)
- **Orbit Time:** ***101.4*** minutes
- **Revisit Time:** ***2-3*** days, depending on latitude
- **Swath Width:** ***60*** Km x ***60*** Km to ***80*** Km at nadir
- **Digitization:** ***8*** bits/pixel (***256*** levels)
- **Resolution**
  - **Pan:** ***2.5m*** **from 2 x 5m scenes**
  - **Pan:** ***5m*** **(nadir)**
  - **MS:** ***10m*** **(nadir)**
  - **SWI:** ***20m*** **(nadir)Image**
- **Bands**
  - **Pan:** ***0.48 - 0.71 µm***
  - ***Green: 0.50 - 0.59 µm***
  - ***Red: 0.61- 0.60 µm***
  - ***Near IR: 0.78 – 0.89 µm***
  - ***Shortwave IR: 1.58 – 1.75 µm***

SPOT PAN Panchro-matic Image

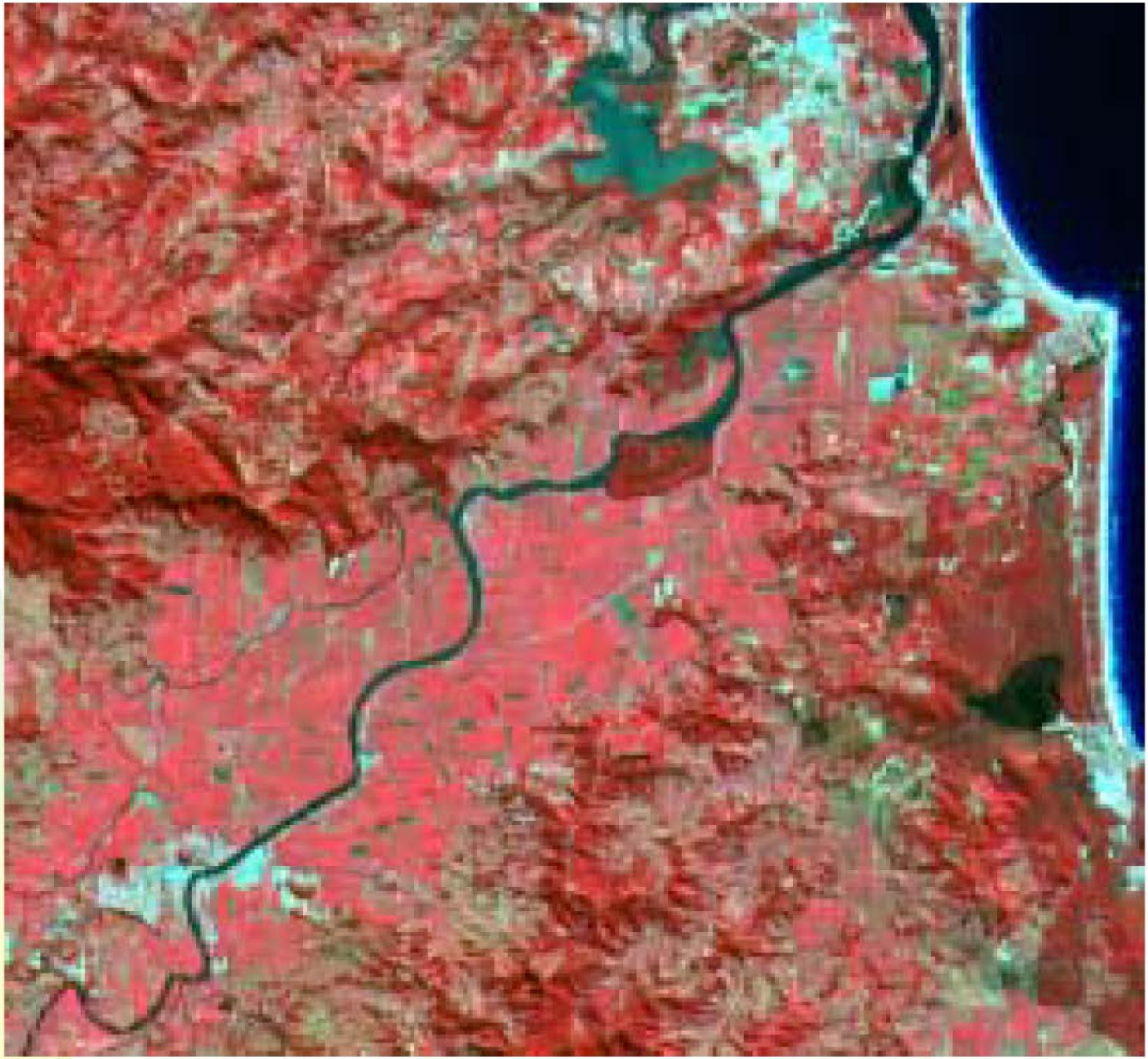


SPOT PAN panchromatic image

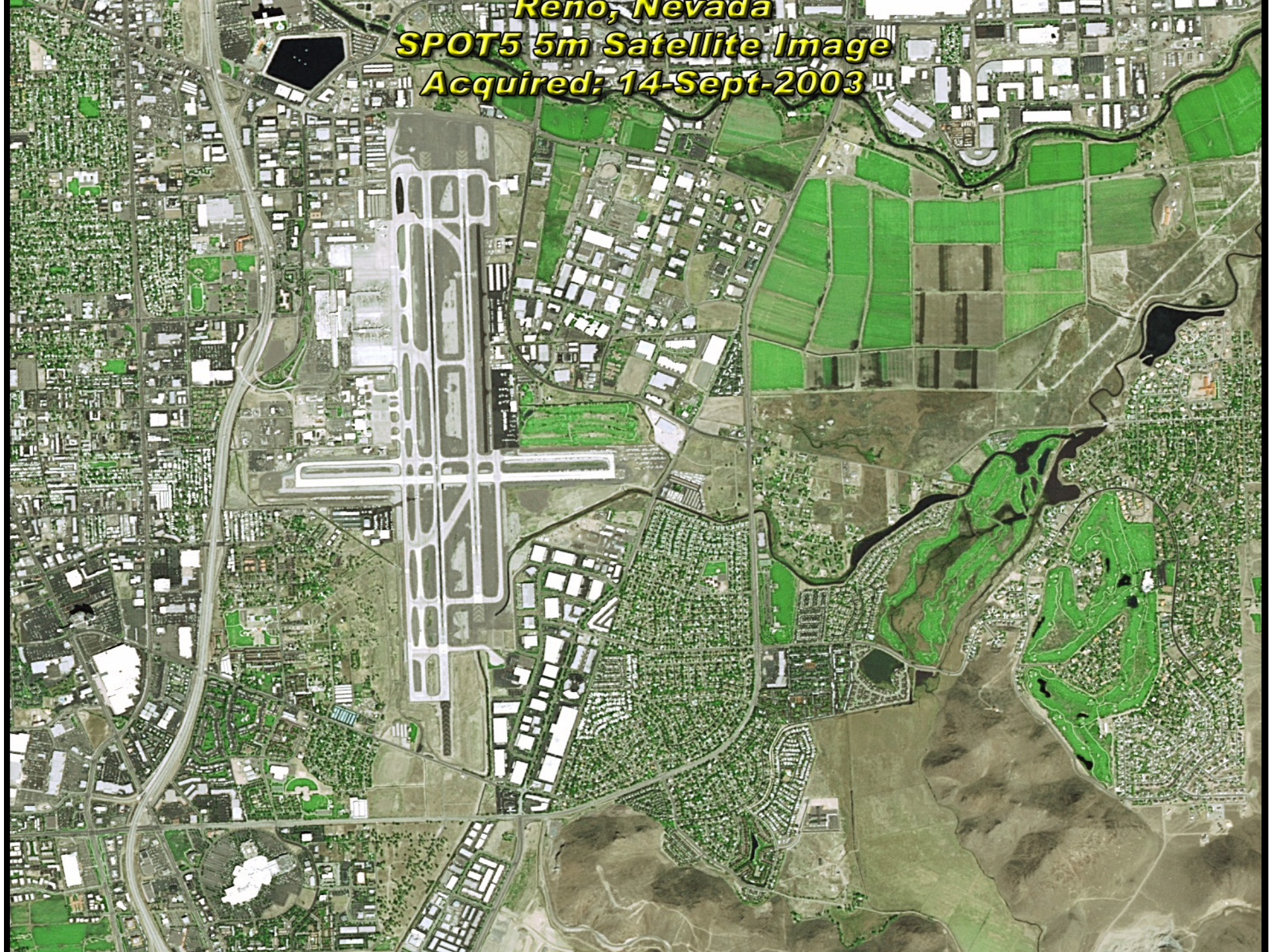
SPOT panchromatic image of Tweed River valley, North New South Wales, Australia. The agriculture fields (sugarcane) and drainage and road network is clearly seen on this 10m resolution image. The spectral response is 0.51-0.73 μm.

SPOT XS multispectral image

SPOT multispectral image of Tweed River Valley, North New South Wales, Australia. The false colour composite is made of Red: Band 3 (0.79-0.89μm), Green: Band 2 (0.61-0.68 μm), Blue: Band 1 (0.50-0.59 μm) with a ground resolution of 20m.




Tripoli International Airport, Libya
Spot5 2.5m Satellite Image
Acquired: 07-Oct-2002
www.satimagingcorp.com
Copyright © 2005 Spot Image - All rights reserved

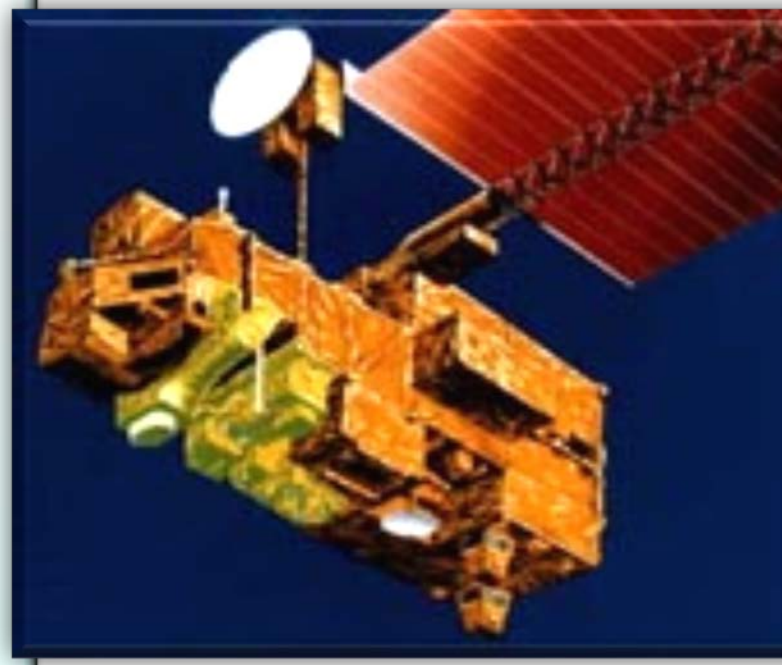

Reno, Nevada
SPOT5 5m Satellite Image
Acquired: 14-Sept-2003

ASTER sensor

- **ASTER** (**A**dvanced **S**pace borne **T**hermal **E**mission and **R**eflection **R**adiometer) is one of ***five*** remote sensory devices on board the **TERRA** satellite launched into orbit by **NASA** in ***1999***.
- The instrument has been collecting surface data since February ***2000***.
- **ASTER** is a cooperative effort between NASA and Japan's Ministry of Economy Trade and Industry (METI).
- **ASTER** provides high-resolution images of the Earth in ***15*** different *bands*, ranging from **visible** to **thermal infrared**.
- The spatial resolution of **ASTER** images ranges between ***15***, ***30*** and ***90*** m.
- ASTER data are used to create detailed maps of surface **temperature** of land, **emissivity**, **reflectance**, and **elevation**.

ASTER orbit

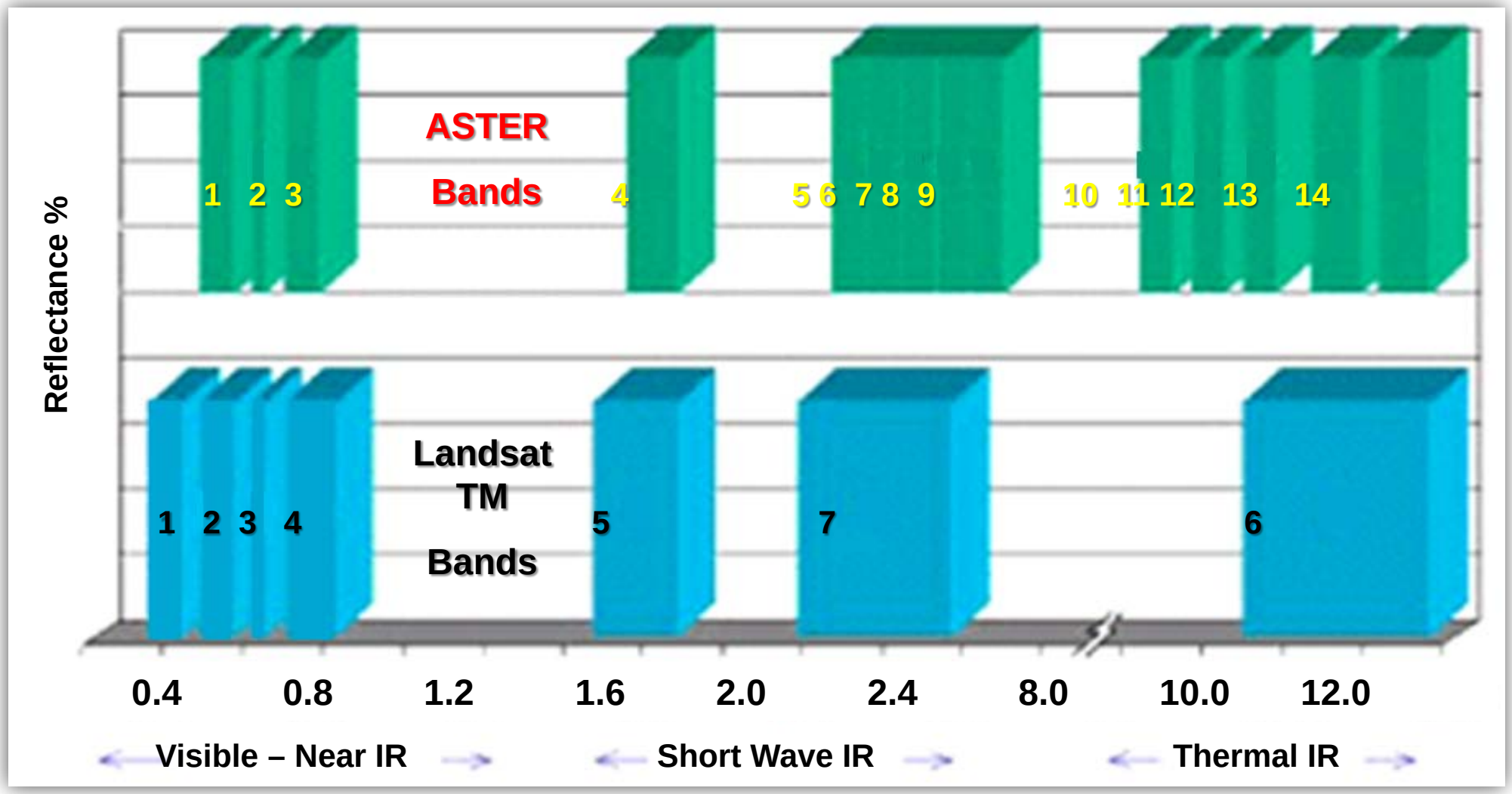
- **Launch date:** December ***1999***
- **Orbit**:***705*** **km** altitude, ***polar*** **sun-synchronous**, so that at any given latitude it crosses directly overhead at the same time each day.
- **Orbit inclination: *98.3* degrees** from the Equator.
- **Orbit period**: ***98.88*** **minutes**
- **Equator crossing: *10.30* a.m.** (north to south)
- **Swath width: *60* km**
- **Ground track repeat cycle: *16* *days***, i.e. every 16 days (or 233 orbits) the pattern of orbits repeats itself
- **Builder:** Lockheed Martin

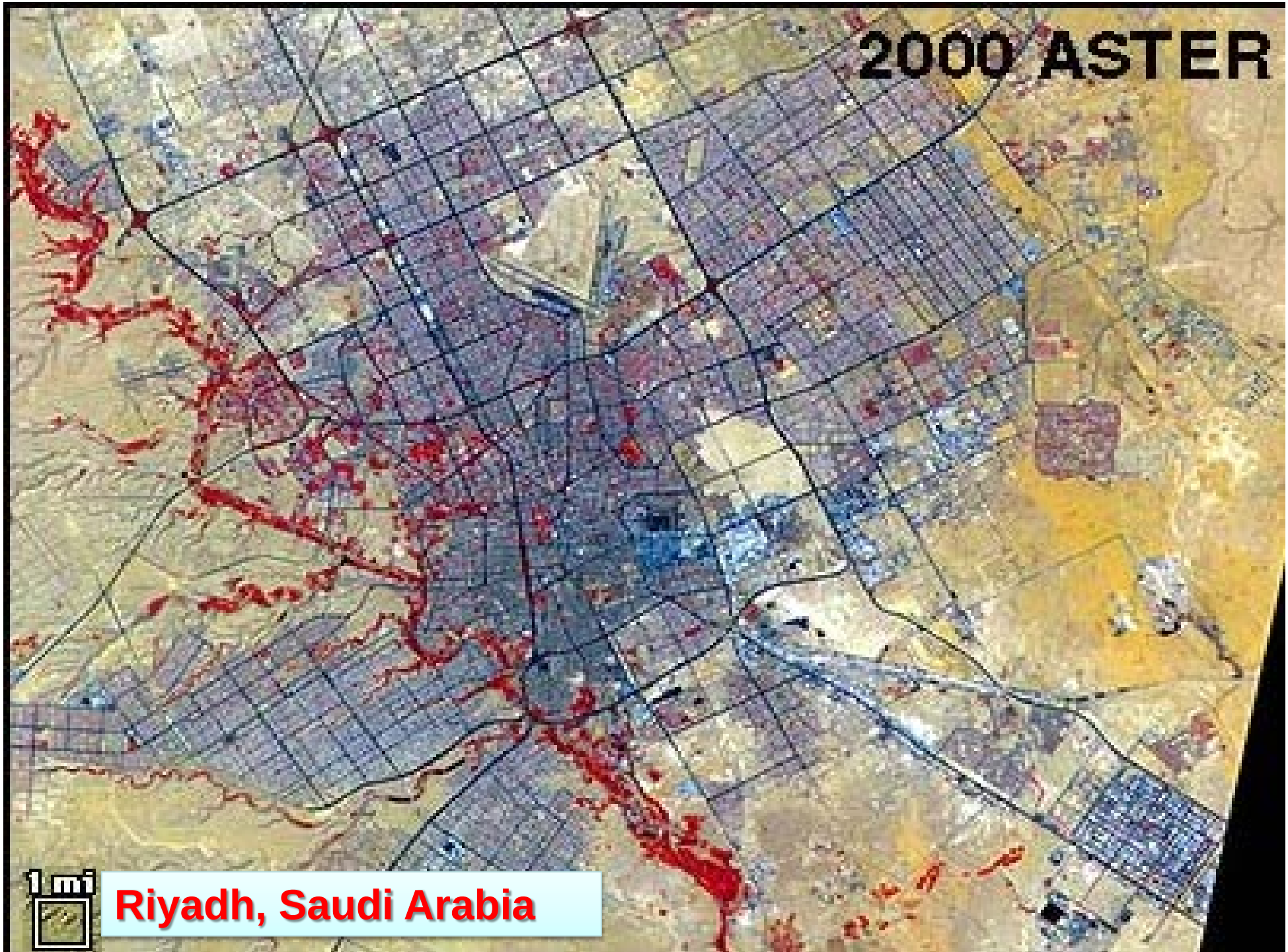


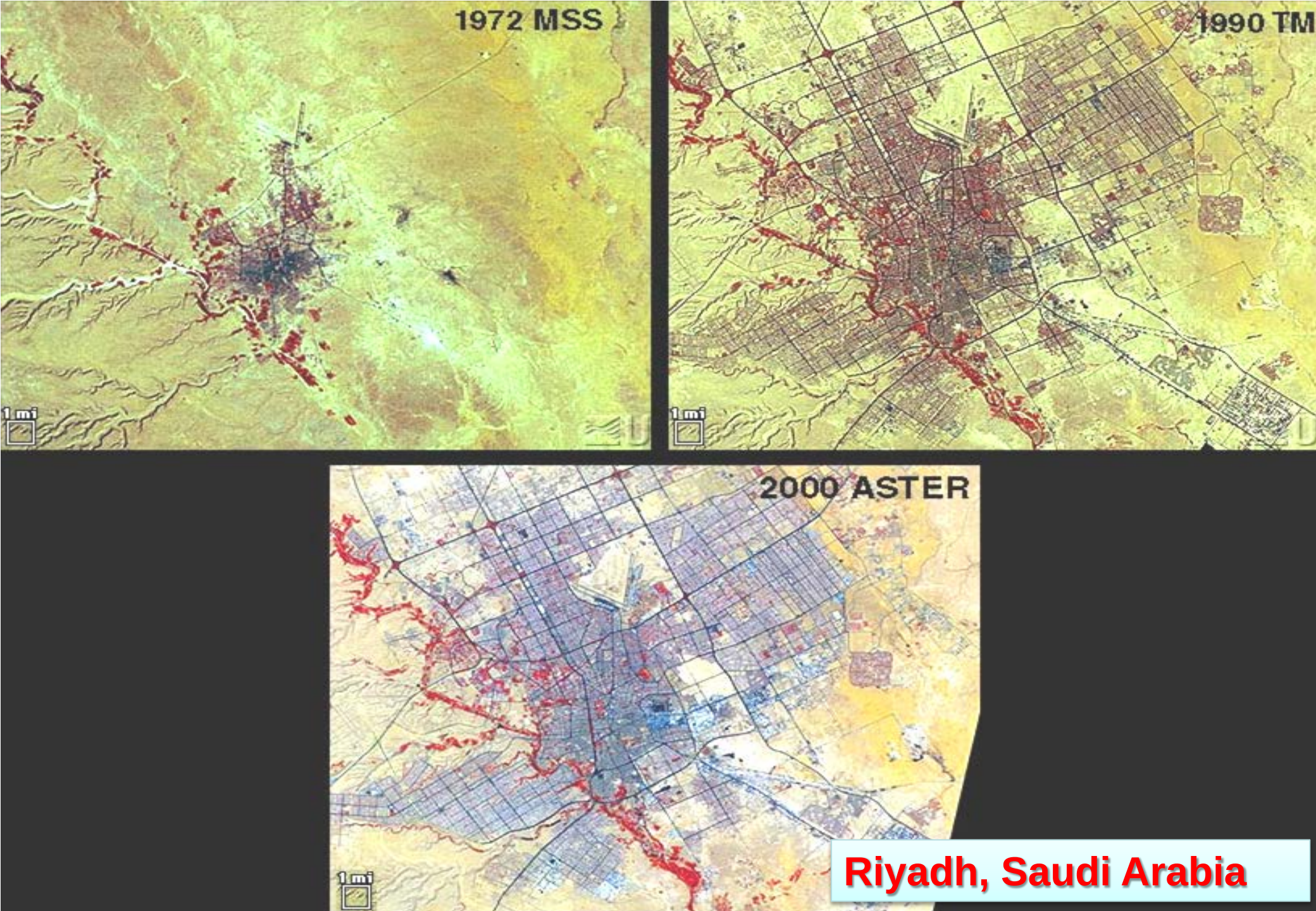
ASTER bands characteristics

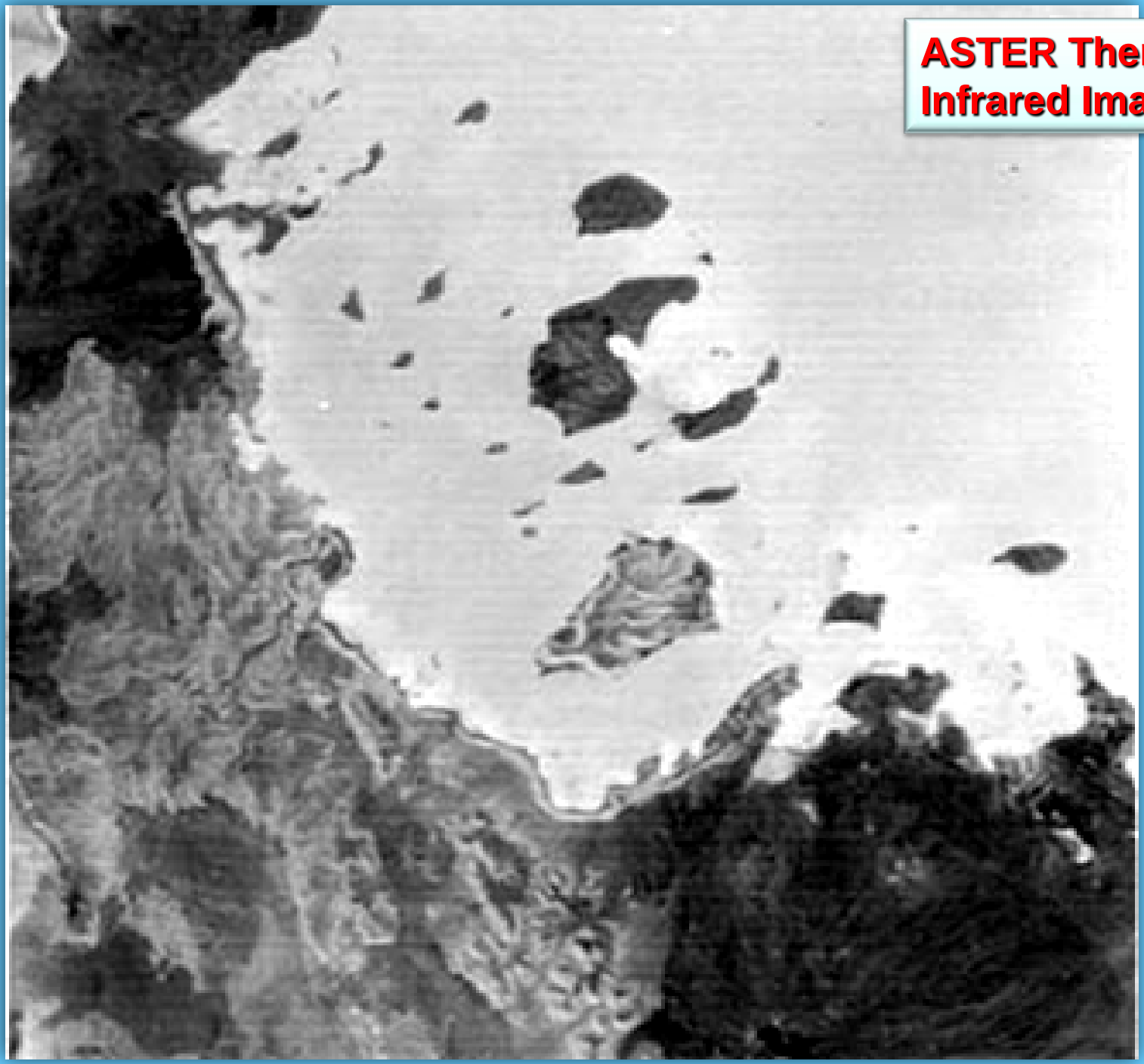
Band	Label	Wavelength (μm)	Resolution (m)	Nadir or Backward	Radiometric Resolution (bits/pixel)	Description
B1	VNIR_Band1	0.520–0.600	15	Nadir	8	Visible Green
B2	VNIR_Band2	0.630–0.690	15	Nadir	8	Visible Red
B3	VNIR_Band3N	0.760–0.860	15	Nadir	8	Near Infrared
B4	VNIR_Band3B	0.760–0.860	15	Backward		
B5	SWIR_Band4	1.600–1.700	30	Nadir	8	Short-wave Infrared
B6	SWIR_Band5	2.145–2.185	30	Nadir		
B7	SWIR_Band6	2.185–2.225	30	Nadir		
B8	SWIR_Band7	2.235–2.285	30	Nadir		
B9	SWIR_Band8	2.295–2.365	30	Nadir		
B10	SWIR_Band9	2.360–2.430	30	Nadir		
B11	TIR_Band10	8.125–8.475	90	Nadir	12	Long-wave Infrared or Thermal IR
B12	TIR_Band11	8.475–8.825	90	Nadir		
B13	TIR_Band12	8.925–9.275	90	Nadir		
B14	TIR_Band13	10.25–10.95	90	Nadir		
B15	TIR_Band14	10.95–11.65	90	Nadir		

Comparison between ASTER bands and Landsat TM bands




2000 ASTER
1 mi
Riyadh, Saudi Arabia


1972 MSS
1990 TM
2000 ASTER
1 mi
1 mi
1 mi
Riyadh, Saudi Arabia


ASTER Thermal
Infrared Image

Commercial “ small “ satellites

- ‘Small’ satellites are those with low orbit with less mass compared with those major satellites
- Usually high resolution data
- Allow design for special purposes
- Low cost and flexible to launch
- Can be designed, manufactured and launched by, e.g. small companies, research institutes, or universities

Commercial ‘small’ satellites

Satellite	*Operator*	*Launch Date*	*Resolution (pan)*	*Resolution (ms)*	*Swath*
IKONOS	SpaceImaging	24/9/1999	1 m	4 m	11km
QuickBird	DigitalGlobe	18/10/2001	0.61 m	2.44 m	16.5km

IKONOS

- Commercial remote sensing system operated by SpaceImaging
- Weight 726 kg
- Launched on 24 September 1999
- Orbit altitude 681 km
- Revisit frequency: 3 to 5 days off-nadir and 144 days for true-nadir
- Sun-synchronous orbit

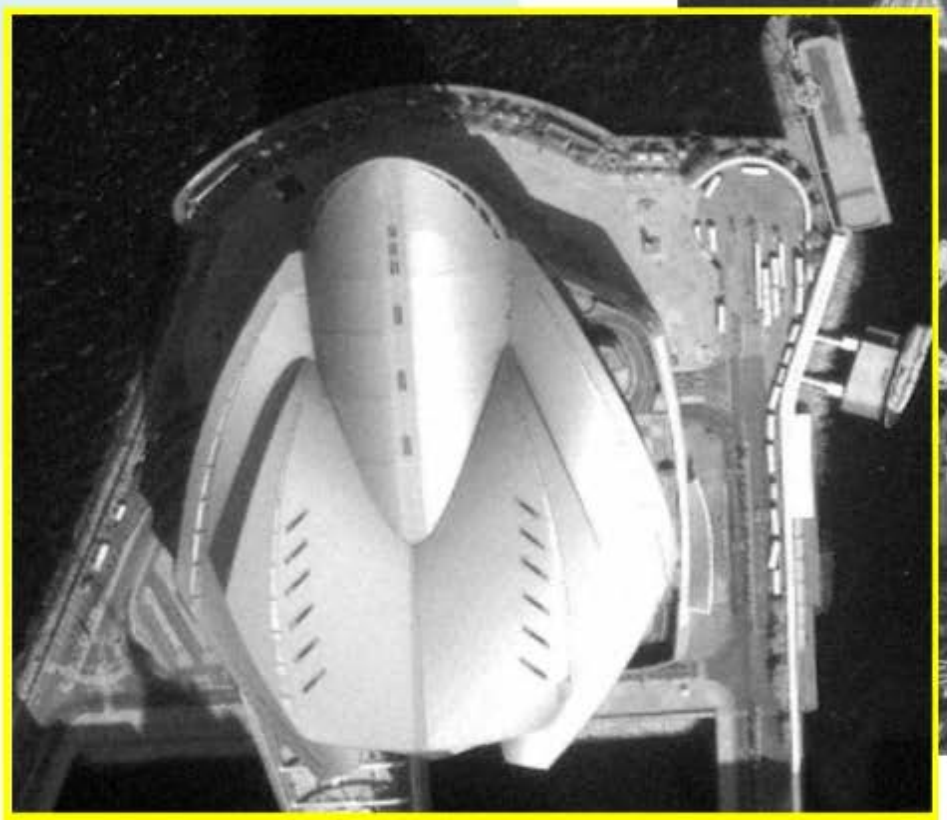
IKONOS

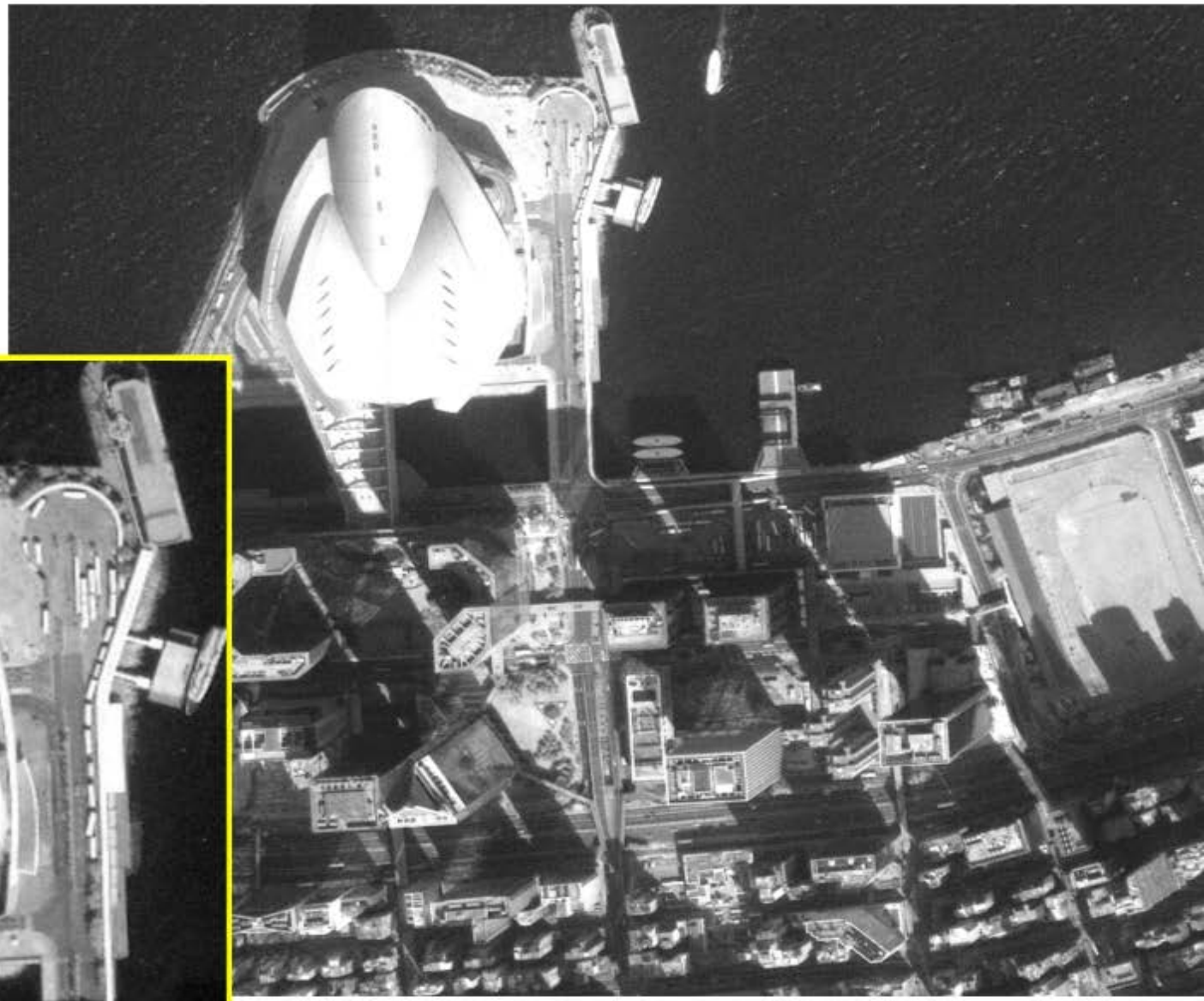
- Ground resolution: 1-m panchromatic; 4-m multispectral
- Imagery Spectral Response
  - Panchromatic: 0.45-0.90μm
  - Multispectral: 0.445-0.516; 0.506-0.595; 0.632-0.698; 0.757-0.853μm
- Nominal swath width: 11km at nadir
- Areas of interest: 11x11km
- Accuracy: 12m horizontal, 10m vertical with no ground control

IKONOS panchromatic image

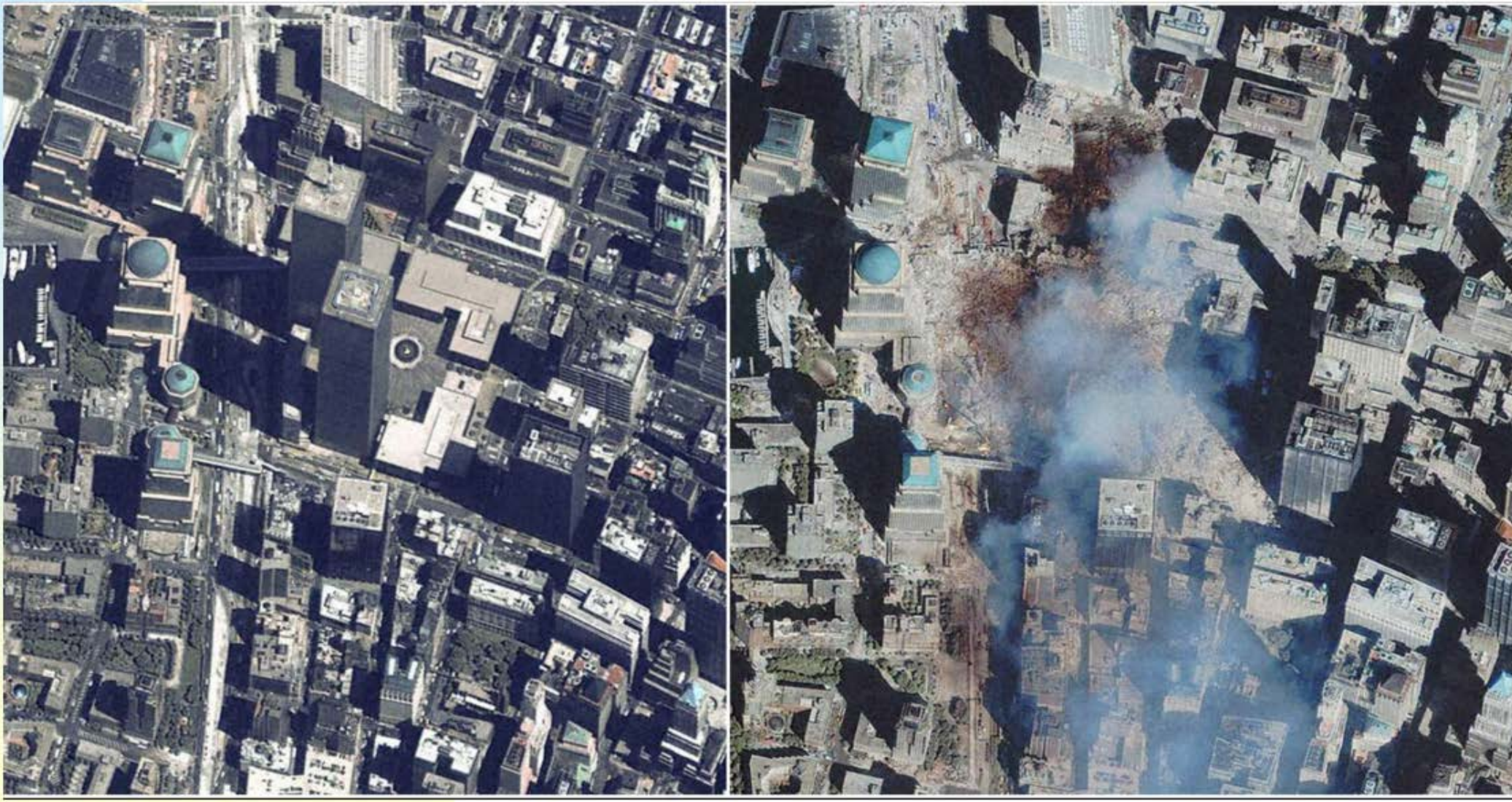
Wan Chai and Hong Kong Convention and Exhibition Centre, 21/11/1999.

Courtesy spaceimaging.com



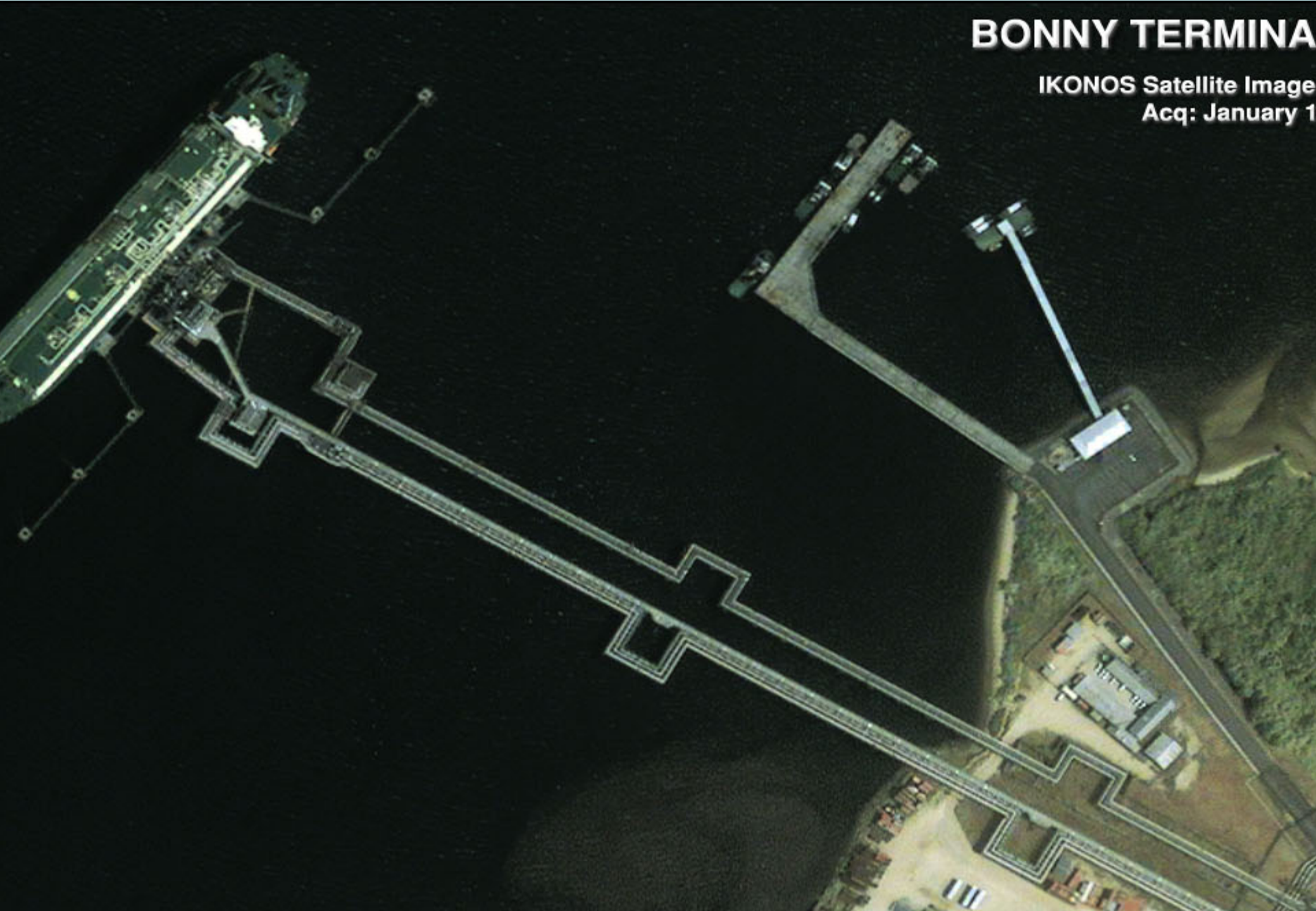


IKONOS images



Manhattan: before (left) and after (right) 11 September 2001 attack.

Courtesy spaceimaging.com


BONNY TERMINA
IKONOS Satellite Image
Acq: January 1

QuickBird

- Commercial remote sensing system operated by DigitalGlobe
- Weight 950 kg
- Launched on 18 October 2001
- Orbit altitude 450 km
- Revisit frequency: 1 to 3.5 days at 70cm resolution
- Sun-synchronous orbit

QuickBird features

- High spatial resolution: up to 61 cm panchromatic; 2.44 m multispectral at nadir
- Nominal swath width: 16.5km at nadir
- Radiometric response: 11bits (2048 grey levels)
- Panchromatic and multispectral images
- Open systems

Spatial and spectral resolution

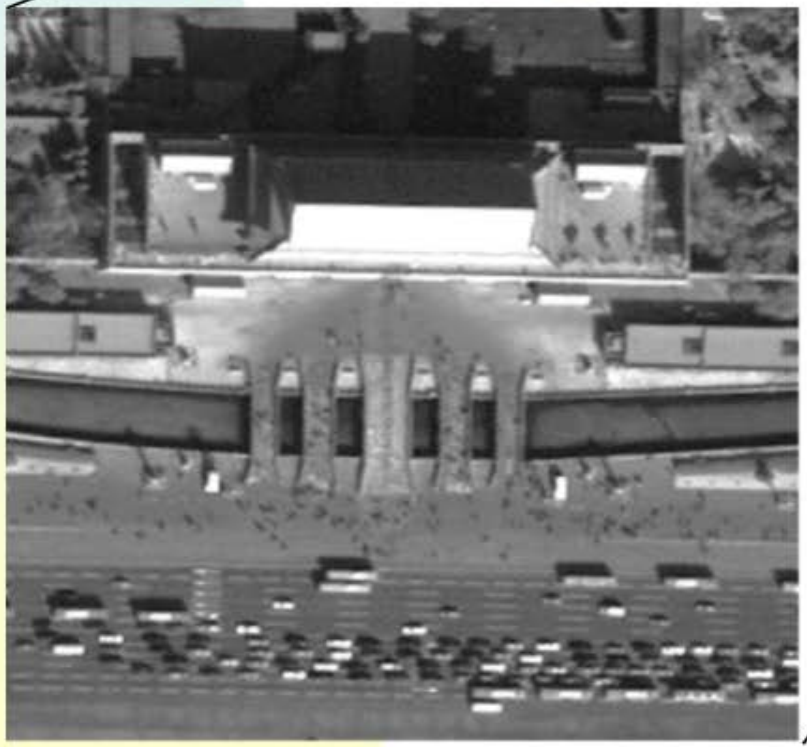
For QuickBird

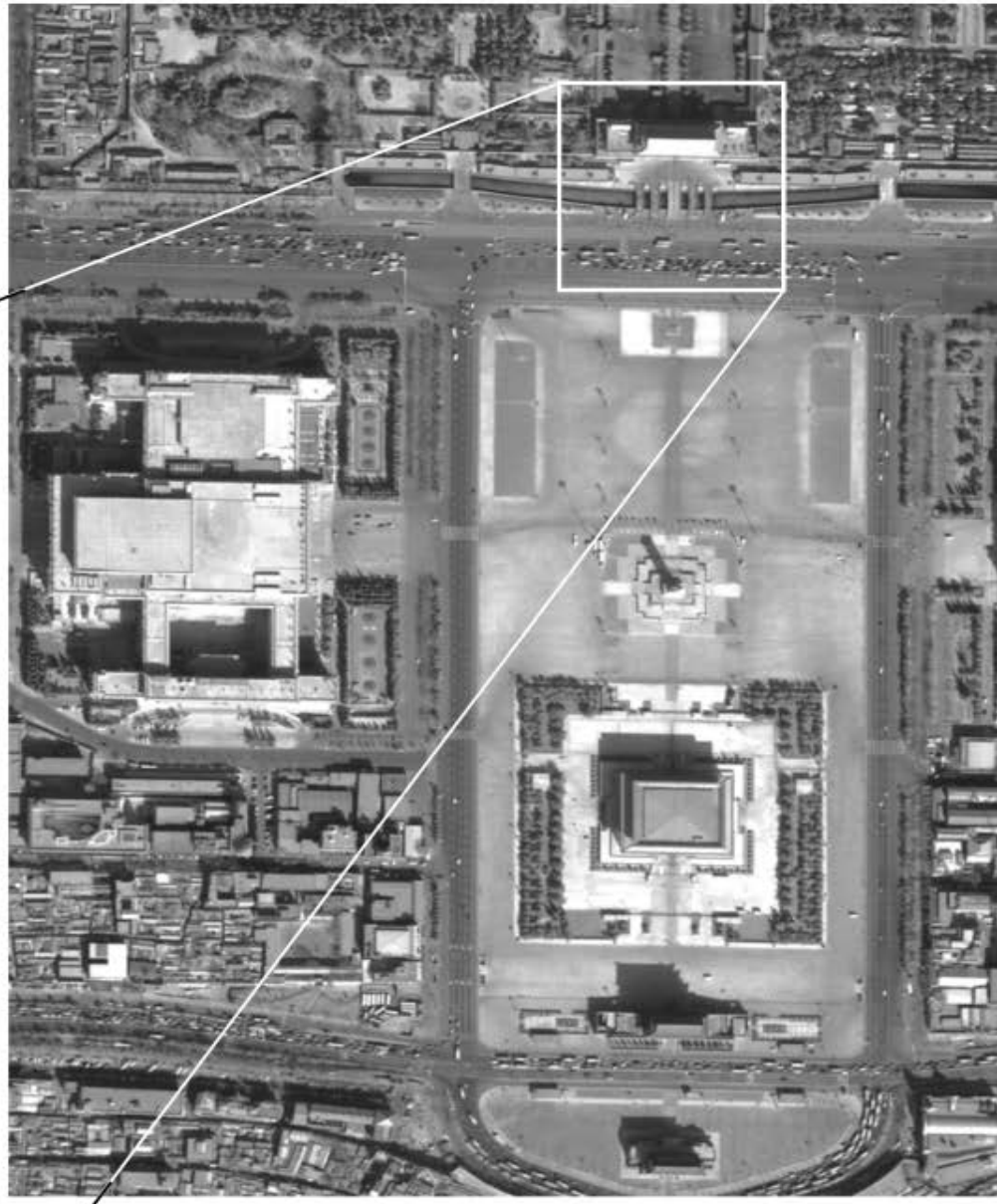
Spatial and Spectral Resolution					
	Panchromatic	Multispectral			
Spectral characteristics	Black & White	Blue	Green	Red	Near IR
	450-900 nm	450-520 nm	520-600 nm	630-690 nm	760-900 nm
Pixel Resolution	61-72 cm	2.44 – 2.88 m			
Scene Dimension	27,552x27,424 pixels	6,888x6856 pixels			
Scene Size	272 km^2 (nadir) to 435 km^2 (25° off-nadir)				
Swath	16.5 km (nadir) to 20.8 km (25° off-nadir)				
Image Accuracy					
Positional Accuracy	CE 90%	RMSE			
	23 m	14 m			

Data source: DigitalGlobe (digitalglobe.com)

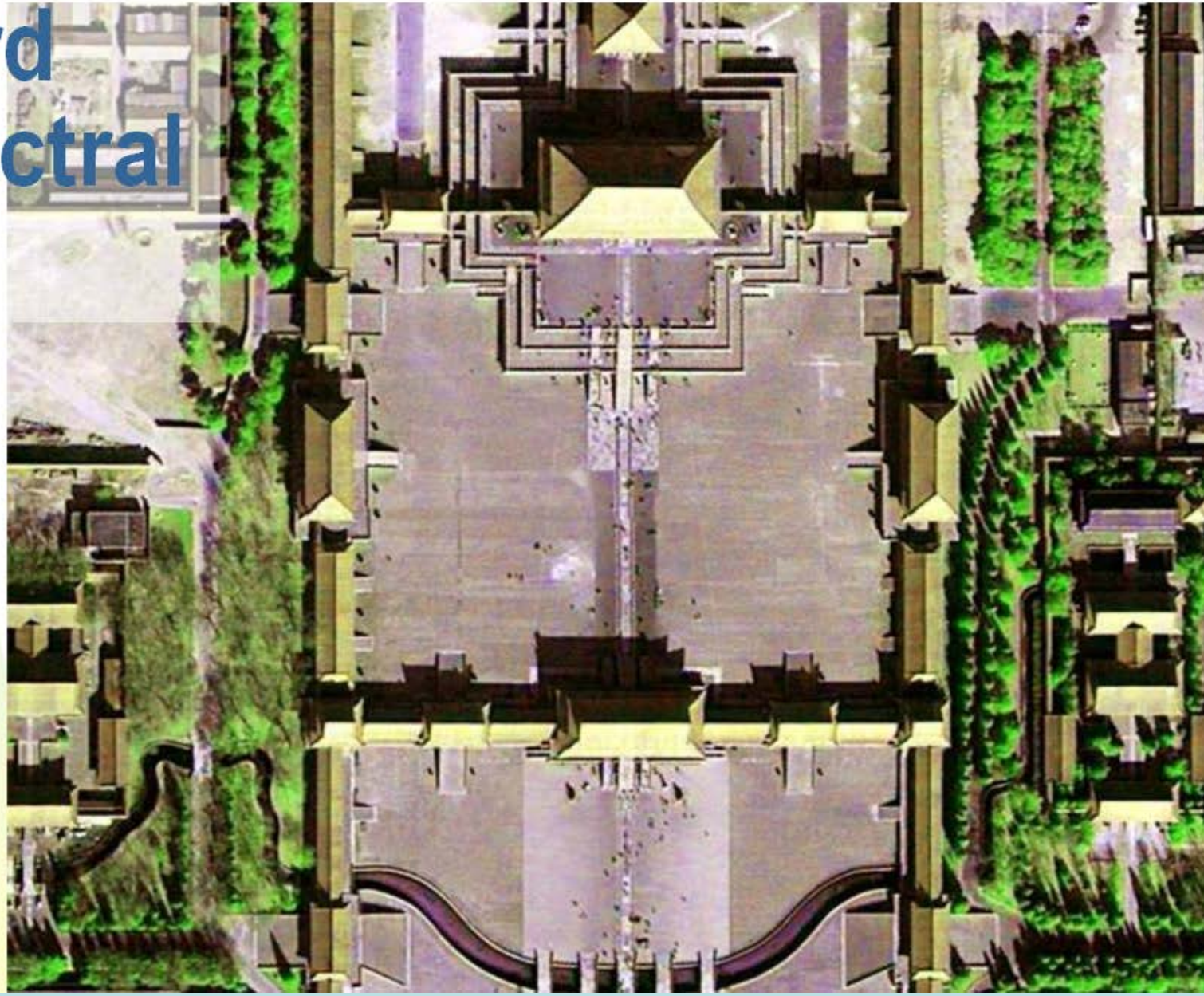
QuickBird panchromatic image

QuickBird Panchromatic image over Tian-an-men Square of Beijing





QuickBird multispectral image



QuickBird natural colour image with 2.44m resolution, taken over Forbidden City, Beijing.


QuickBird 60cm Satellite Image
Riyadh, Saudi Arabia
Acquired: 30-Dec-2005
Riyadh, Saudi Arabia
www.satimagingcorp.com


Riyadh, Saudi Arabia