SATELLITES IN REMOTE SENSING

LANDSAT-7

QUICKBIRD

IKONOS

ENVISAT

SATELLITES IN REMOTE SENSING

- Satellite is an artificial object that has been intentionally placed into orbit
- Soviet Union launched the world's first artificial satellite, Sputnik 1
- Currently, about 1,200 satellites are operational
- Of these, ~ 500 operational satellites are in low-Earth orbit, 50 are in medium-Earth orbit (at 20,000 km), and the rest are in geostationary orbit (at 36,000 km)
- Satellites are classified as:
- **Earth observation satellites (LandSAT, CartoSAT, Sentinel)**
- Communications satellites
- Navigation satellites (GLONAS, Galileo, IRNSS, ..)
- Weather satellites, and
- Space telescopes

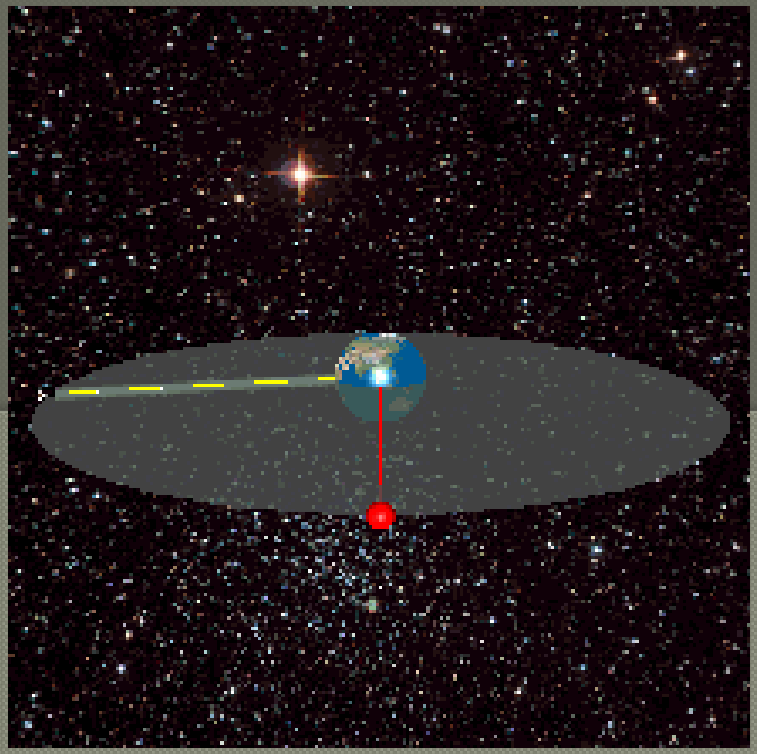
SATELLITES IN REMOTE SENSING

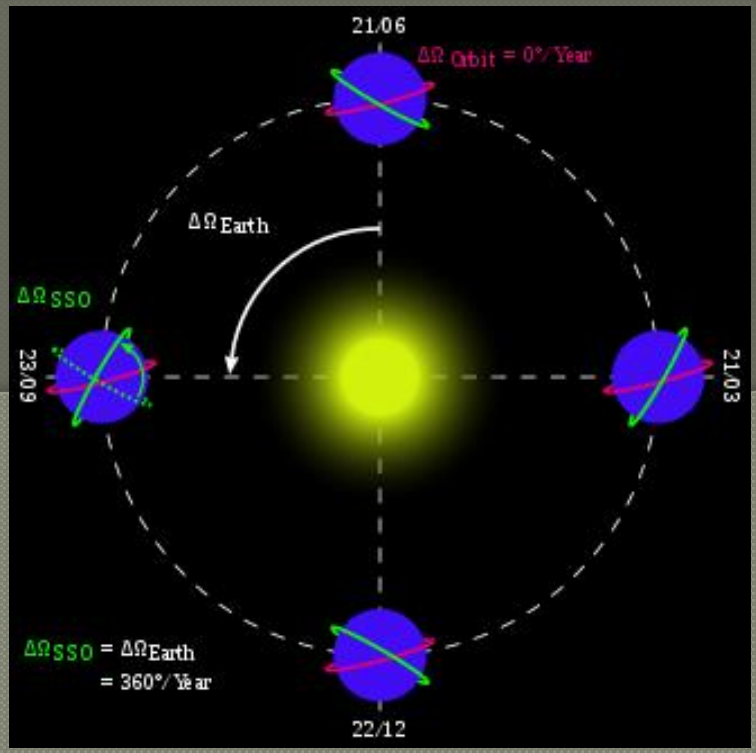
Satellite Sensor (Country of Origin)	Spectral Bands / Wavelength	Spatial Resolution	Temporal Resolution	Major Applications
Coarse / Low Resolution Sensors				
AVHRR (NOAA-USA)	Red (1 band); Infrared (4 bands)	1090 m	1 Day	Discern clouds, land water bodies, snow/ice extent; Inception of snow/ice melting, vegetation change detection
MODIS (NASA –USA)	36 (0.4 to 14.4 μm)	250 – 1000 m	1 Day	Monitor changes in cloud cover, radiation budget, processes occurring in the oceans, on land, and in the lower atmosphere
METEOSAT (Europe)	12 (0.6 to 14.4 μm)	2500 – 5000 m	30 Min	Short-term forecasting; Numerical weather prediction and climatological studies
Multi-Spectral (MS) Sensors				
LANDSAT-7 ETM+ (USA)	7 (0.45 to 2.35 μm)	15 m (Pan) ; 30 m (MS)	16 Days	Change detection of earth features (agricultural development, deforestation, urbanization, development and degradation of water resources) over periods of months to decades
ASTER (Japan)	14 (0.52 to 11.65 μm)	15 m / 30 m / 90 m	16 Days	Digital terrain mapping and modeling; Monitoring vegetation and ecosystem dynamics; Land surface climatology
SRTM (USA)	C-band, X-band	90 m	1 Month	Digital terrain modeling; Regional weather forecasting
RESOURCESAT -2 (India)	3 (0.52 to 1.7 μm)	5.8 m (LISS 4)	24 Days	Land and water related mapping; Monitoring water, crop, and soil parameters bodies

SATELLITES IN REMOTE SENSING

Satellite Sensor (Country of Origin)	Spectral Bands / Wavelength	Spatial Resolution	Temporal Resolution	Major Applications
High Resolution Commercial Sensors				
IKONOS (GeoEye – USA)	RGB, NIR (0.445 to 0.853 μm)	0.8 m (Pan) ; 4 m (MS)	3 – 5 Days	Environmental monitoring; Geological studies; Rapid image collection; Disaster response
Worldview-3 (Digital Globe, US)	8 MS, 8 SWIR, 12 CAVIS bands	0.31 m (Pan) ; 1.24 m(MS)	< 1 Day	Land classification; Disaster response; Feature extraction and change detection; Environment modeling
CARTOSAT-2 (India)	0.5 to 0.85 μm	< 1 m	4 Days	Cartography in India, Urban and rural infrastructure development, management and mapping
QUICKBIRD (Digital Globe, US)	4 (0.45 to 0.9 μm)	0.6 m (Pan) ; 2.44 m (MS)	4 Days	Telecommunications; Land use and infrastructure planning; Environmental assessment; Oil and gas exploration
Hyper Spectral Sensors				
HYPERION (USGS-USA)	220 (0.4 to 2.5 μm)	30 m	16 Days	Land cover classification; Soil and crop mapping; Crop health monitoring and yield prediction; Contaminant mapping

SATELLITE ORBITS





A **geosynchronous orbit** is an Earth-centered orbit with an orbital period that matches Earth's rotation on its axis (one sidereal day).
For an observer on Earth's surface, an object in geosynchronous orbit returns to exactly the same position in the sky after one sidereal day.

A Sun-synchronous orbit (SSO) is a nearly polar orbit around a planet, in which satellite passes over any given point of planet's surface at the same local mean solar time.
It is an orbit arranged so that it precesses through one complete revolution each year, so it always maintains the same relationship with the Sun.

LAUNCHING VEHICLES IN REMOTE SENSING

- Geo synchronous satellite launch vehicle (GSLV)
  - To launch INSAT type (telecommunication, broadcasting, meteorology) into geostationary orbit
- Polar synchronous satellite launch vehicle (PSLV)
  - To launch remote sensing type (earth observation satellites, Chandrayan, etc.) into sun synchronous orbit

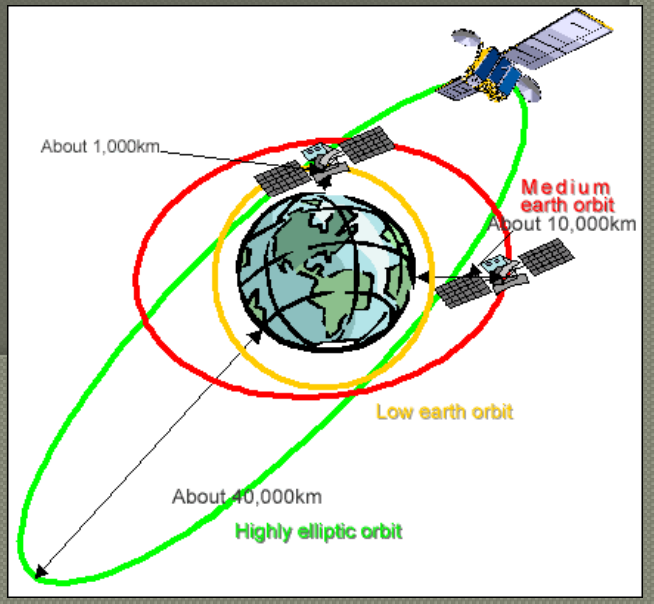
ORBIT HEIGHT

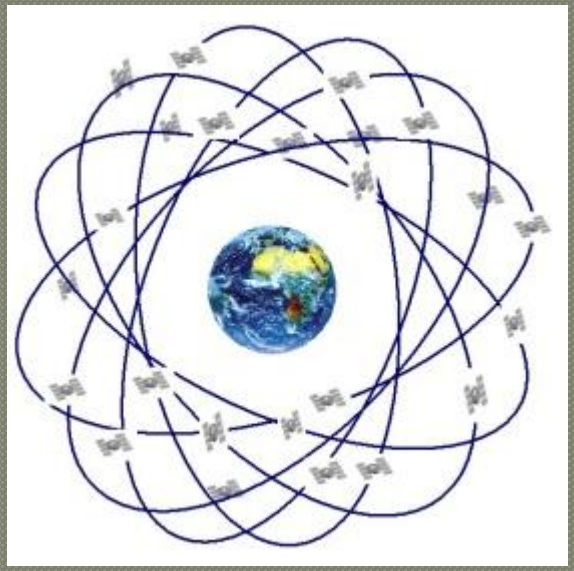
Low Earth Orbit(LEO): Geocentric Orbit with altitudes up to 2,000 km (0–1,240 miles) Orbital period: 84 to 127 minutes

Medium Earth Orbit(MEO): Geocentric Orbits ranging in altitude from 2,000 km (1,240 miles) to just below geosynchronous orbit at 35,786 kilometres (22,236 mi). Also known as an intermediate circular orbits.

Geosynchronous orbit: Orbital period matches with earths rotation on its axis (23 hour 56 min 4 sec). Altitude: 35,786 km

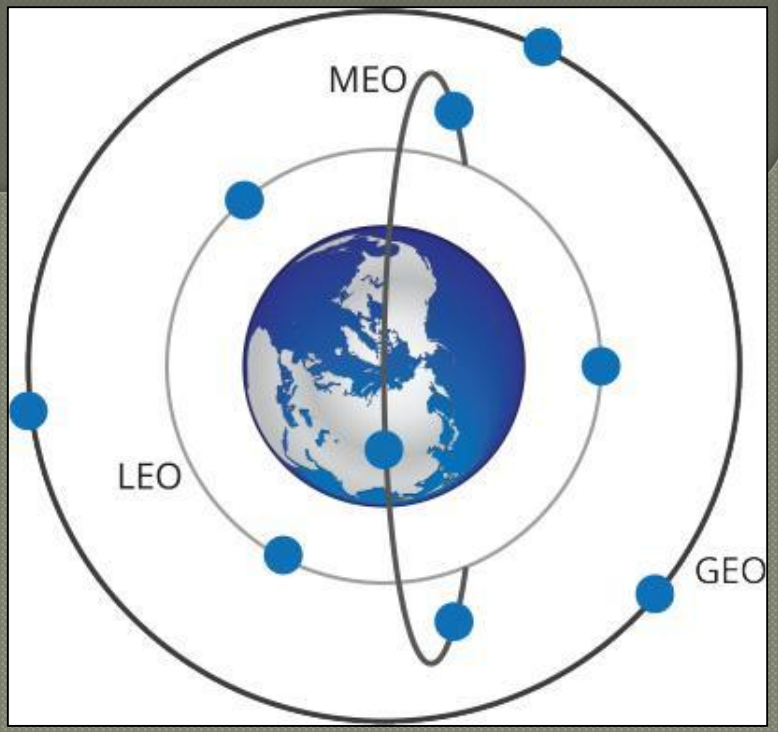
High Earth Orbit : Geocentric Orbits above the altitude of geosynchronous orbit 35,786 km (22,240 miles).





EARTH ORBITS

Low Earth Orbit(LEO): Used in Telecommunications, data (email type) communication, Move at extremely high speed. Satellites changes their position relative to earth quickly



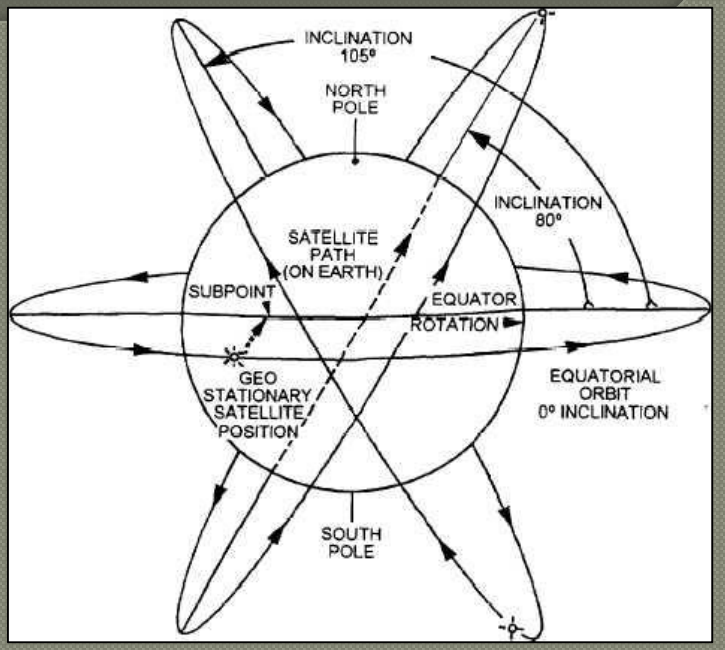
Medium Earth Orbit(MEO): Used in navigation such as GPS, Glonass, Galileo. Also includes communication satellites that cover N-S poles. Orbital period: 2 to 24 hours

Geosynchronous orbit: Used in communication satellites. Has fixed antenna. No need to track satellite motion.

ORBIT INCLINATION

Inclined Orbit: An orbit whose inclination in reference to the equatorial planes is not 0.

Polar Orbit: An orbit that passes above or nearly above both poles of the planet on each revolution. Inclination of very close to 90 degrees



Polar Sun-Synchronous Orbit (SSO): A nearly polar orbit that passes the equator at the same local solar time on every pass.

Non-inclined Orbit: An orbit whose inclination is equal to zero with respect to some plane of reference

Near Equatorial Orbit: An orbit whose inclination with respect to the equatorial plane is nearly zero. This orbit allows for rapid revisit times (for a single orbiting spacecraft) of near equatorial ground sites.

SATELLITE ORBITS

Circular satellite orbit: For a circular orbit, the distance from the Earth remains the same at all times.

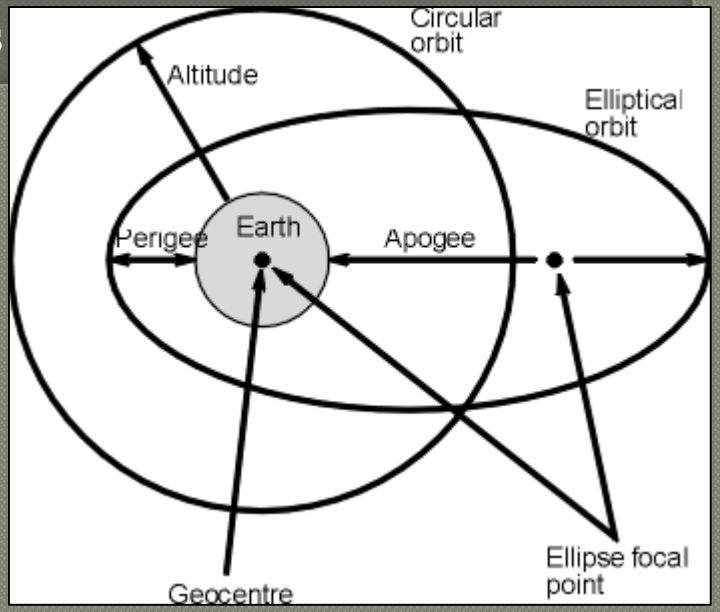
Elliptical satellite orbit: The elliptical orbit changes the distance to the Earth

Synchronous Orbit: An orbit where the satellite has an orbital period equal to the average rotational period of the body being orbited and in the same direction of rotation as that body

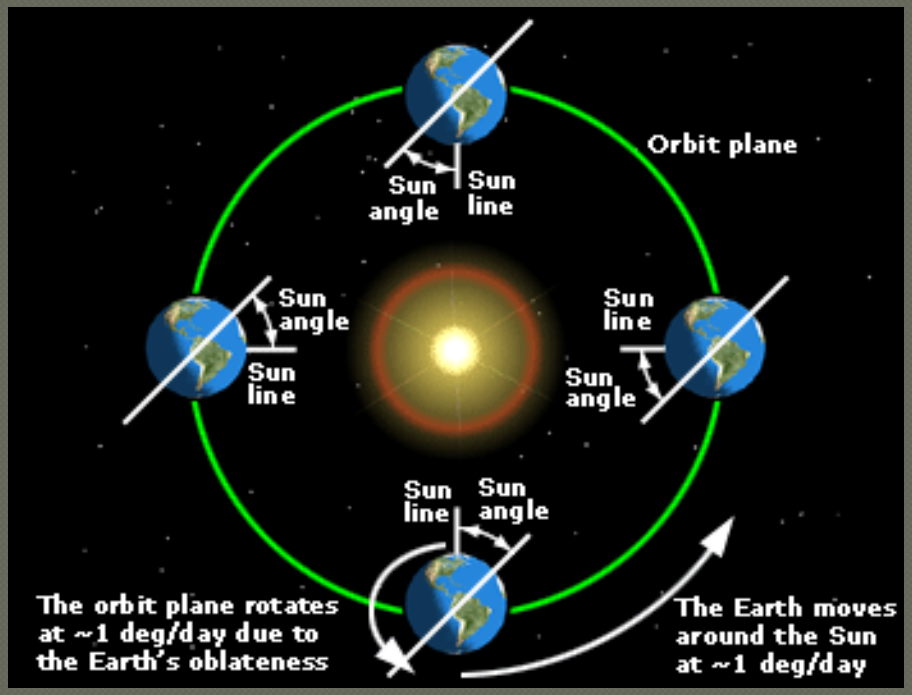
Geo Synchronous Orbit: Orbits with an altitude of approximately 35,786 km (22,236 mi).

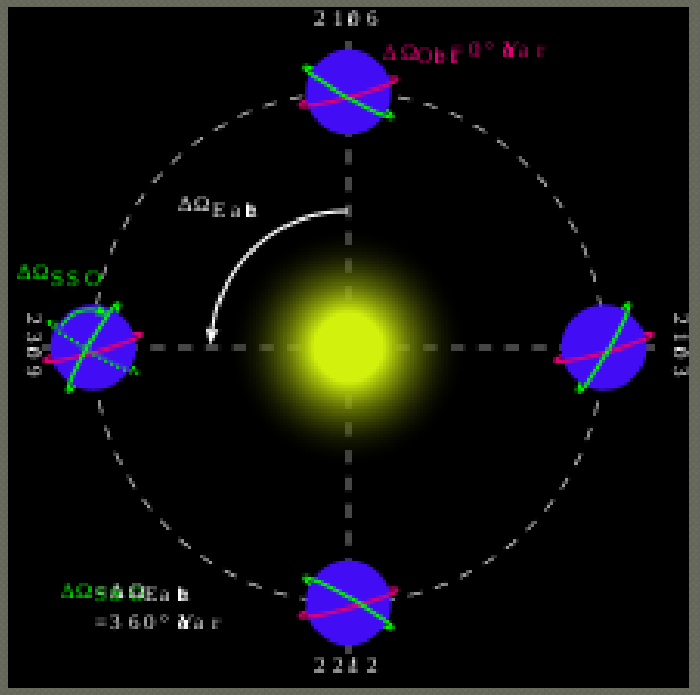
Geo Stationary Orbit: A geosynchronous orbit with an inclination of zero. To an observer on the ground this satellite would appear as a fixed point in the sky

Sun Synchronous Orbit: An orbit which combines altitude and inclination in such a way that the satellite passes over any given point of the planets's surface at the same local solar time

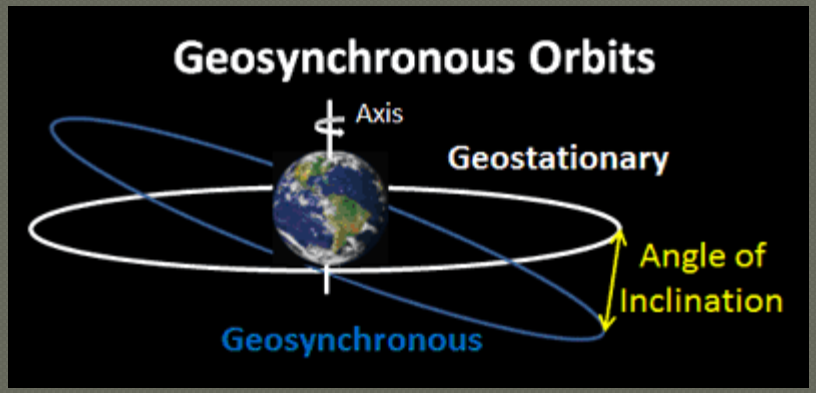


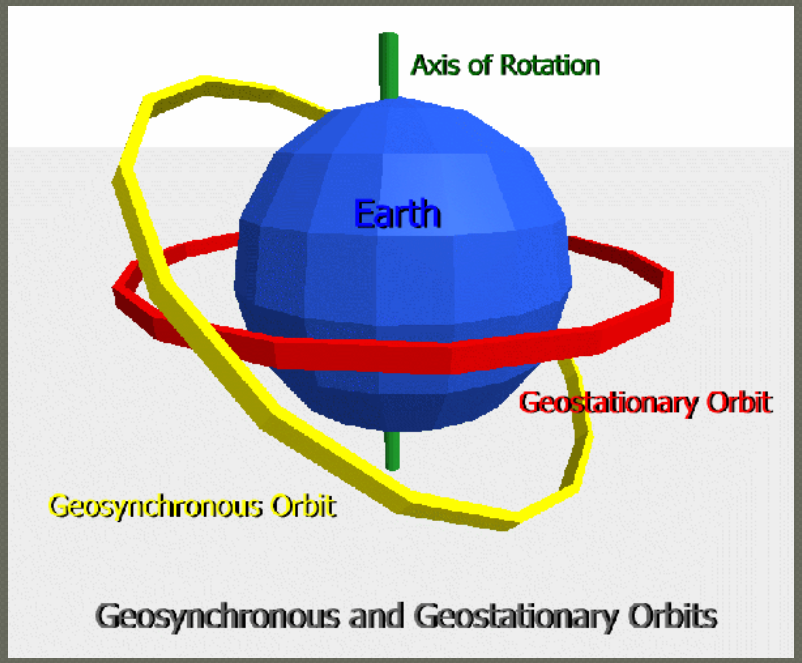
SUN SYNCHRONOUS ORBIT

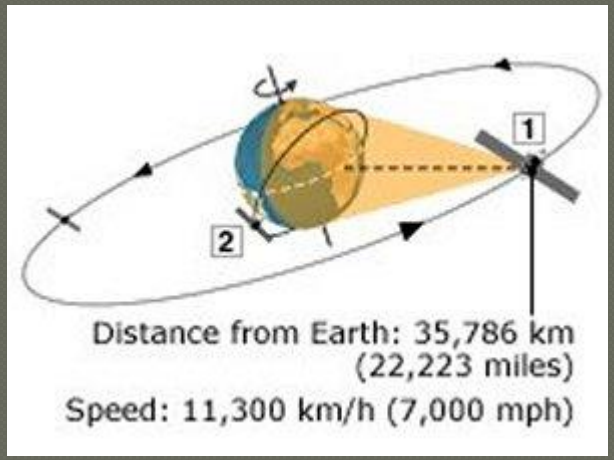




GEO SYNCHRONOUS ORBIT







WEATHER MONITORING SATELLITES

- These satellites use sensors which have fairly coarse spatial resolution, and provide large areal coverage
- Their temporal resolutions are generally quite high, providing frequent observations of the Earth's surface, atmospheric moisture, and cloud cover
- This will allows for near-continuous monitoring of global weather conditions, and hence - forecasting

WEATHER MONITORING SATELLITES - GOESS

- GOESS - Geostationary Operational Environmental Satellite
- Designed by NASA for the National Oceanic and Atmospheric Administration (NOAA) to provide the United States National Weather Service
- Two GOES satellites, placed in **geostationary orbits** 36000 km above
- the equator, each view approximately one-third of the Earth.
- One is situated at 75°W longitude and monitors North and South America and most of the Atlantic Ocean.
- The other is situated at 135°W longitude and monitors North America and the Pacific Ocean basin.
- Together, they cover from 20°W to 165°E longitude.

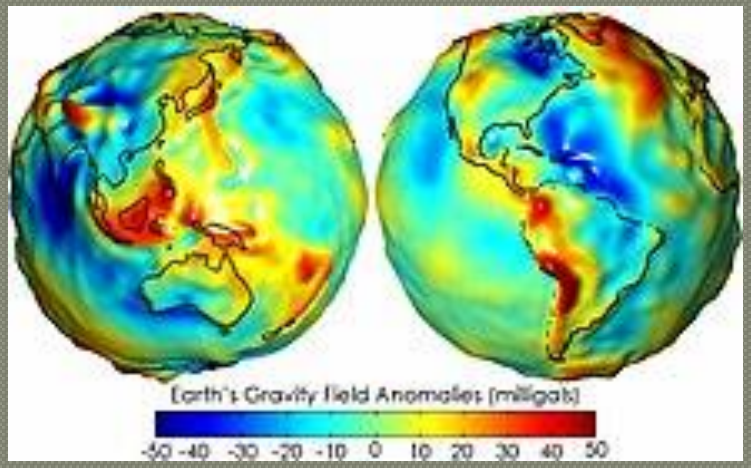
WEATHER MONITORING SATELLITES - GOESS

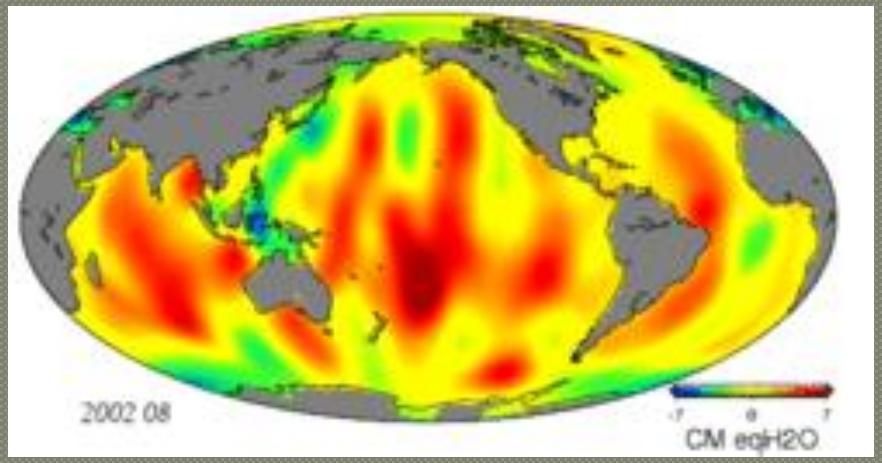
GOES Bands

Band	Wavelength Range (>μm)	Spatial Resolution	Application
1	0.52 - 0.72 (visible)	1 km	cloud, pollution, and haze detection; severe storm identification
2	3.78 - 4.03 (shortwave IR)	4 km	identification of fog at night; discriminating water clouds and snow or ice clouds during daytime; detecting fires and volcanoes; night time determination of sea surface temperatures
3	6.47 - 7.02 (upper level water vapour)	4 km	estimating regions of mid-level moisture content and advection; tracking mid-level atmospheric motion
4	10.2 - 11.2 (longwave IR)	4 km	identifying cloud-drift winds, severe storms, and heavy rainfall
5	11.5 - 12.5 (IR window sensitive to water vapour)	4 km	identification of low-level moisture; determination of sea surface temperature; detection of airborne dust and volcanic ash

GRAVITY MONITORING SATELLITE - GRACE

- **Gravity Recovery and Climate Experiment** (**GRACE**) was a joint mission of NASA and the German Aerospace Center
- Twin satellites took detailed measurements of Earth's gravity field anomalies
- By measuring gravity anomalies, GRACE showed how mass is distributed around the planet and how it varies over time
- Launch: 2002, Sun-synchronous, end: Sept 2017
- Able to gather global coverage every 30 days
- GRACE-FO : Launch May 2018
- Applications: Geophysics, water resources, ..





LAND OBSERVATION SATELLITES

Satellite Remote Sensing

Advantages:

– Provide synoptic view (observation of large areas in a single frame)
– Fine detail
– Systematic, repetitive coverage

Applications:

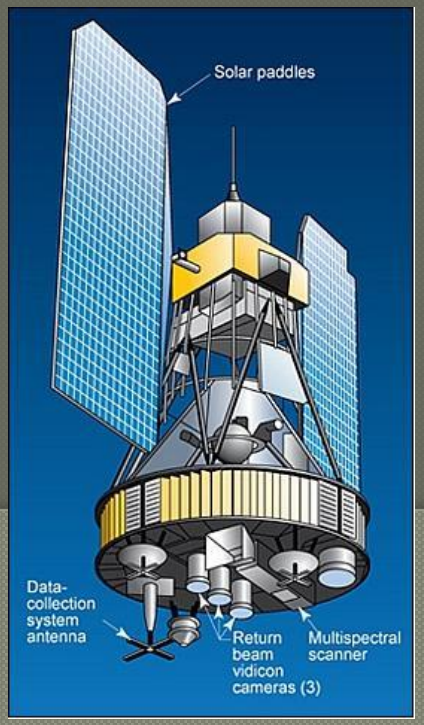
– Creating and maintaining a worldwide cartographic infrastructure
– Monitoring changes in many broad-scale environmental issues that the world faces today

LANDSAT

- Landsat ("land satellite") was designed in 1960s and launched in 1972.
- The first satellite tailored specifically for broad-scale observation of the Earth's land areas.
- It was created to accomplish for land resource studies

Satellite	Launched	End of Service	Principal sensors
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	Transmission of TM data failed in August 1993	TM, MSS
Landsat 5	1 March 1984		TM, MSS
Landsat 6	5 October 1993	Lost at launch	ETM
Landsat 7	15 April 1999	Malfunction of TM Scan Line Corrector has limited quality of imagery since May 2003	ETM+

LANDSAT


Solar paddles
Data-collection system antenna
Return beam vidicon cameras (3)
Multispectral scanner


Landsat 1 July 1972 – January 1978
Landsat 2 January 1975 – July 1983
Landsat 3 March 1978 – September 1983
Landsat 4 July 1982 – December 1993
Landsat 5 March 1984 – January 2013
Landsat 6 October 1993
Landsat 7 April 1999 –
Landsat 8 February 2013 –
Landsat 9 2020
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030

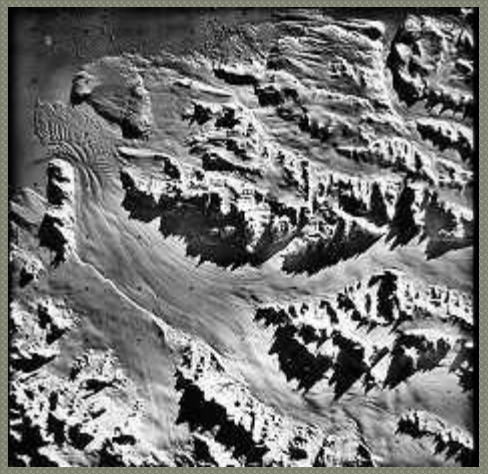
LANDSAT - Sensors

- *Second generation Landsat sensors:*
  - Thematic mapper (TM)

    A more sophisticated version of the MSS
  - Advanced version TM (ETM+)

Sensors in Landsat:

– Return beam vidicon (RBV)



- ✓ A camera-like instrument designed to provide high spatial resolution and geometric accuracy, but lower spectral and radiometric detail
- ✓ The resolution was 80 m for 185 x 185km images
- ✓ The resolution with Landsat 3 was raised to 40m

Cameras took images in a single panchromatic spectral band (0.5-0.75μm) only

LANDSAT – Sensors

Sensors in Landsat:

– Multispectral scanner subsystem (MSS)

- ✓ Designed to provide finer detail concerning spectral characteristics of the Earth, but less positional accuracy
- ✓ Because technical difficulties restricted RBV operation, the MSS soon became the primary Landsat sensor.
- ✓ These mechanical sensors collects information in four spectral bands and over a 185 x 185km area

Band	Spectral band	Resolution
4	0,5 - 0,6 µm	79 m x 82 m
5	0,6 - 0,7 µm	79 m x 82 m
6	0,7 - 0,8 µm	79 m x 82 m
7	0,8 - 1,1 µm	79 m x 82 m
8	10,5 - 12,4 µm	240 m x 240 m (*LANDSAT 3 only*)

LANDSAT

Sensors in Landsat:

– Thematic Mapper (TM)

High resolution scanners with 7 spectral bands

Always cover 185 x 185 km area

Band	Spectral band	Resolution	Use
1	0,45 - 0,52 µm	30 m x 30 m	Ground/plants differentiation, coastal zones
2	0,52 - 0,60 µm	30 m x 30 m	Vegetation
3	0,63 - 0,69 µm	30 m x 30 m	Plant species differentiation
4	0,76 - 0,90	30 m x 30 m	Biomass
5	1,55 - 1,75 µm	30 m x 30 m	Snow/cloud differentiation
6	10,4 - 12,5 µm	120 x 120 m	Thermal
7	2,08 - 2,35 µm	30 m x 30 m	Lithology

LANDSAT

Sensors in Landsat:

– Enhanced Thematic Mapper Plus (ETM +)

Has High resolution panchromatic wide band

Always cover 185 x 185 km area

Band	Spectral band	Resolution	Use
1	0,45 - 0,515 µm	30 m x 30 m	Ground/plant differentiation, coastal zones
2	0,525 - 0,605	30 m x 30 m	Vegetation
3	0,63 - 0,69 µm	30 m x 30 m	Differentiate plant species
4	0,75 - 0,90 µm	30 m x 30 m	Biomass
5	1,55 - 1,75 µm	30 m x 30 m	Snow/cloud differentiation
6	10,4 - 12,5 µm	60 m x 60 m	Thermal
7	2,09 - 2,35 µm	30 m x 30 m	Lithology
PAN	0,50 - 0,90 µm	15 m x 15 m	

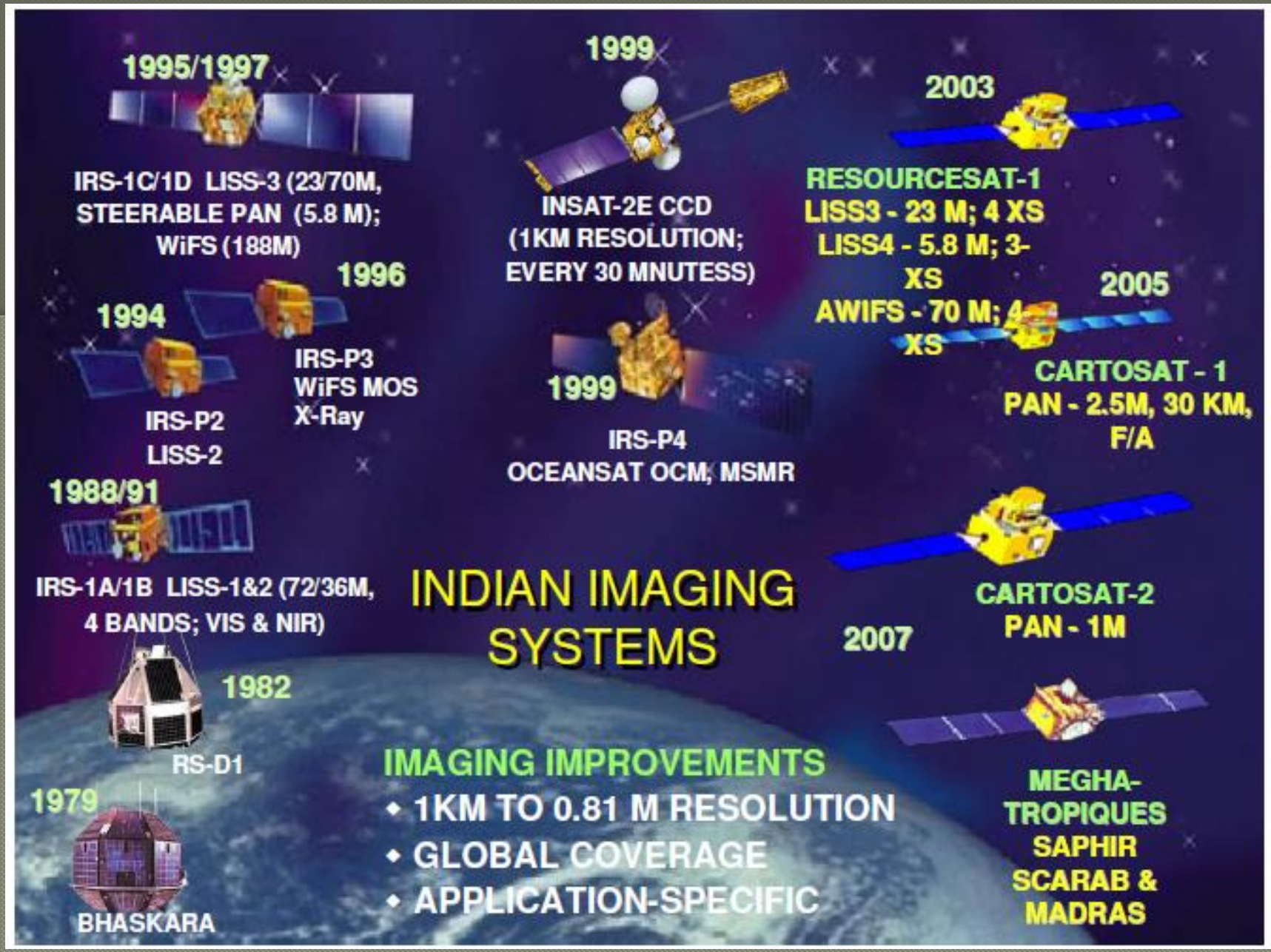
SENTINEL - 2

- Earth observation mission from the EU Copernicus Programme
- Systematically acquires optical imagery at high spatial resolution (10m to 60m) over land and coastal waters
- Multi-spectral data with 13 bands in the visible, near infrared, and short wave infrared part of the spectrum
- Systematic global coverage of land surfaces from 56° S to 84° N, coastal waters, and all of the Mediterranean Sea
- Revisiting every 5 days under the same viewing angles
- Spatial resolution of 10 m, 20 m and 60 m
- 290 km field of view
- Free and open data policy
- Sun synchronous at 786 km (488 mi) altitude, 14.3 revolutions per day with a 10:30 am descending node

SENTINEL - 2

Sentinel-2 bands	Sentinel-2A		Sentinel-2B		
	Central wavelength (nm)	Bandwidth (nm)	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
Band 1 – Coastal aerosol	442.7	21	442.2	21	60
Band 2 – Blue	492.4	66	492.1	66	10
Band 3 – Green	559.8	36	559.0	36	10
Band 4 – Red	664.6	31	664.9	31	10
Band 5 – Vegetation red edge	704.1	15	703.8	16	20
Band 6 – Vegetation red edge	740.5	15	739.1	15	20
Band 7 – Vegetation red edge	782.8	20	779.7	20	20
Band 8 – NIR	832.8	106	832.9	106	10
Band 8A – Narrow NIR	864.7	21	864.0	22	20
Band 9 – Water vapour	945.1	20	943.2	21	60
Band 10 – SWIR – Cirrus	1373.5	31	1376.9	30	60
Band 11 – SWIR	1613.7	91	1610.4	94	20
Band 12 – SWIR	2202.4	175	2185.7	185	20

INDIAN REMOTE SENSING SATELLITES



CATEGORIES OF IRS SATELLITES

1) Communication Satellites

- INSAT series
- Currently, 15 operational satellites in Geostationary orbit
- INSAT-3A, 3C, 4A, 4B, 4CR and GSAT-6, 7, 8, 9, 10, 12, 14, 15, 16, 18
- Uses more than 200 transponders in C, Extended C and Ku-bands (of microwave region)
- Applications: telecommunications, television broadcasting, weather forecasting, disaster warning and Search and Rescue operations

CATEGORIES OF IRS SATELLITES

2) Earth observation Satellites

- IRS series (First: IRS-1A in 1988)
- Currently, 13 operational satellites are in Sun-synchronous orbit INSAT-3A, RESOURCESAT-1, 2, 2A CARTOSAT-1, 2, 2A, 2B, RISAT-1 and 2, OCEANSAT-2, Megha-Tropiques, SARAL and SCATSAT-1f
- Applications: agriculture, water resources, urban planning, rural development, mineral prospecting, environment, forestry, ocean resources and disaster management

CATEGORIES OF IRS SATELLITES

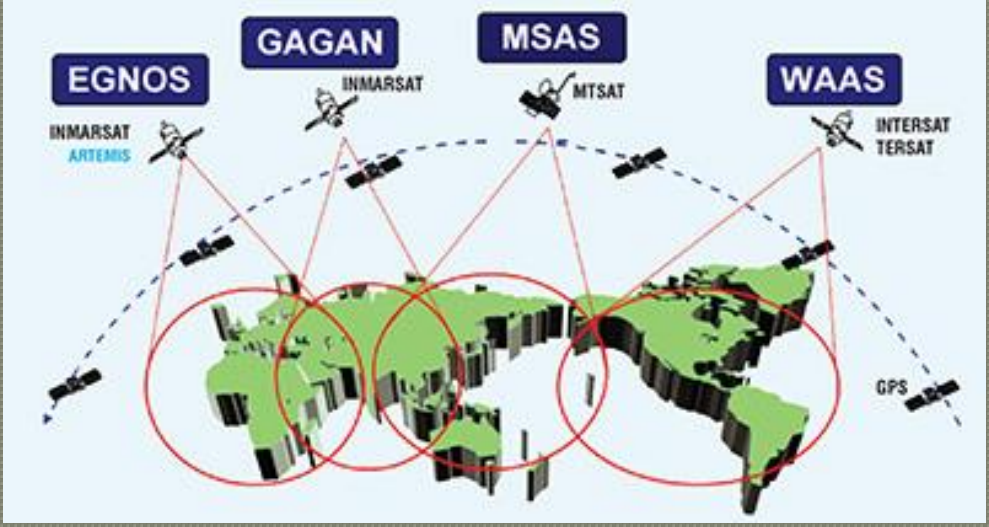
3) Space Exploration Satellites

- Research applications in Astronomy, astrophysics, atmospheric sciences, and theoretical physics
- AstroSat → To study celestial sources in various spectral bands
- Mars orbiter mission → To orbit Mars in elliptical orbit (372 km perigee and 80,000 km apogee)
- Chandrayaan series → Orbiting around the moon (chemical, geological, photo-geologic mapping)

CATEGORIES OF IRS SATELLITES

4) Navigation Satellites

- GPS aided geo augmented navigation (GAGAN) → ISRO & AAI
- For civil aviation applications and to provide better Air Traffic Management over Indian Airspace
- System will be interoperable with other international SBAS systems and provide seamless navigation across regional boundaries
- Additionally, IRNSS will provide Reliable Position, Navigation and Timing services over India and its neighborhood



CATEGORIES OF IRS SATELLITES

5) Small Satellites

- Provide a platform for stand-alone payloads for earth imaging and science missions within a quick turn around time
- Low satellite bus (body) and pay load (< 500 kg)

6) Student Satellites

- Capable Universities and institution can venture into space technology on-orbit with guidance and support from ISRO
- Development of payloads by universities
- Satellite design and fabrication

SATELLITE LAUNCHERS

Launchers or Launch Vehicles are used to carry spacecraft to space

- Polar Satellite Launch Vehicle (PSLV)
- Geosynchronous Satellite Launch Vehicle (GSLV)

SLV-3

Height : 22.7m
Lift-off weight : 17 t
Propulsion : All Solid
Payload mass : 40 kg
Orbit : Low Earth Orbit

ASLV

Height : 23.5m
Lift-off weight : 39 t
Propulsion : All Solid
Payload mass : 150 kg
Orbit : Low Earth Orbit

PSLV-XL

Height : 44m
Lift-off weight : 320 t
Propulsion : Solid & Liquid
Payload mass : 1860 kg
Orbit : 475 km Sun Synchronous Polar Orbit (1300 kg in Geosynchronous Transfer Orbit)

GSLV Mk II

Height : 49m
Lift-off weight : 414 t
Propulsion : Solid, Liquid & Cryogenic
Payload mass : 2200 kg
Orbit : Geosynchronous Transfer Orbit

GSLV Mk III

Height : 43.43 m
Lift-off weight : 640 t
Propulsion : Solid, Liquid & Cryogenic
Payload mass : 4000 kg
Orbit : Geosynchronous Transfer Orbit

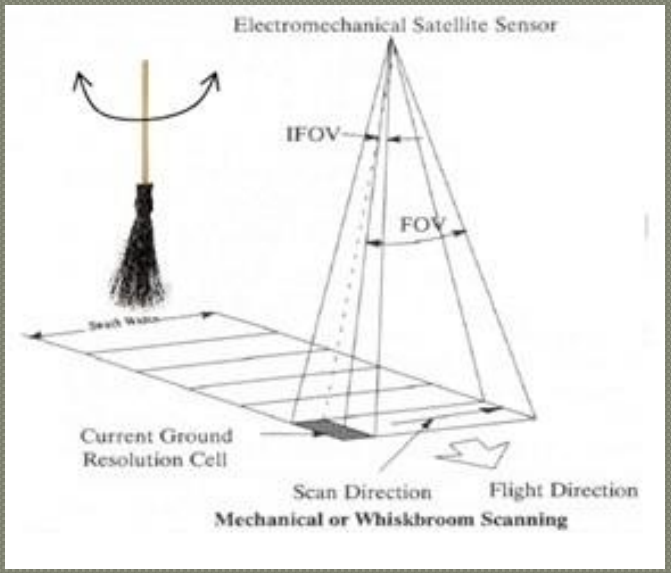
TERMINOLOGY – INDIAN SATELLITES

Push broom Scanner

- Also known as an along-track scanner
- use a line of detectors arranged perpendicular to the flight direction of the spacecraft
- As the spacecraft flies forward, the image is collected one line at a time, with all of the pixels in a line being measured simultaneously

Whisk broom Scanner

- Also known as an across-track scanner
- The mirror moves back and forth, to collect measurements from one pixel in the image at a time



TERMINOLOGY – INDIAN SATELLITES

LISS -- Linear Imaging Self Scanning Sensor

- Optical sensor working in four spectral bands

LISS III

- Multi-spectral camera operating in four spectral bands, three in the visible and near infrared and one in the SWIR region

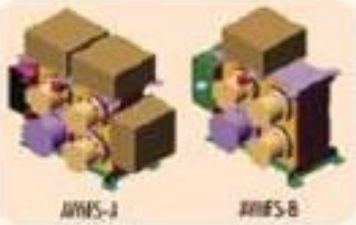
LISS IV

- A high resolution multi-spectral camera. operating in three spectral bands (B2-Red, B3-NIR, B4-SWIR)

AWiFS

- Advanced Wide Field Sensor
- Operates in three spectral bands in VNIR and one band in SWIR with 56 metre spatial resolution

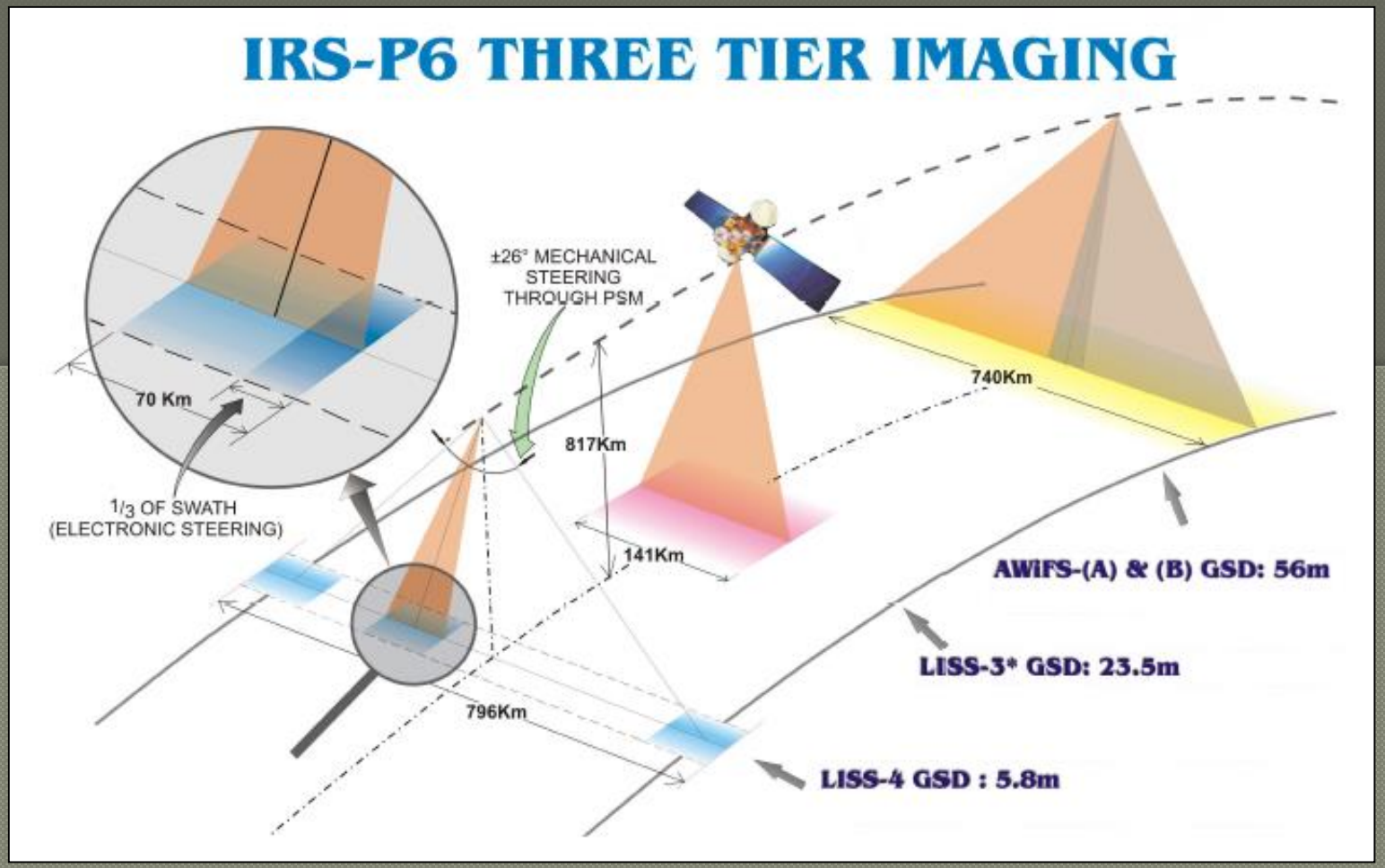
SENSORS IN RESOURCESAT – 1



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 0.62-0.68 0.77-0.86	0.52-0.59 0.62-0.68 0.77-0.86 1.55-1.70	0.52-0.59 0.62-0.68 0.77-0.86 1.55-1.70
Quantisation (bits)	7	7	10
Square Wave Response (at Nyquist)	>0.20	B2>0.40 B3>0.40 B4>0.35 B5>0.20	B2>0.40 B3>0.40 B4>0.35 B5>0.20
Power (W)	216	70	114
Weight (kg)	169.5	106.1	103.6
Data Rate (MBPS)	105	52.5	52.5

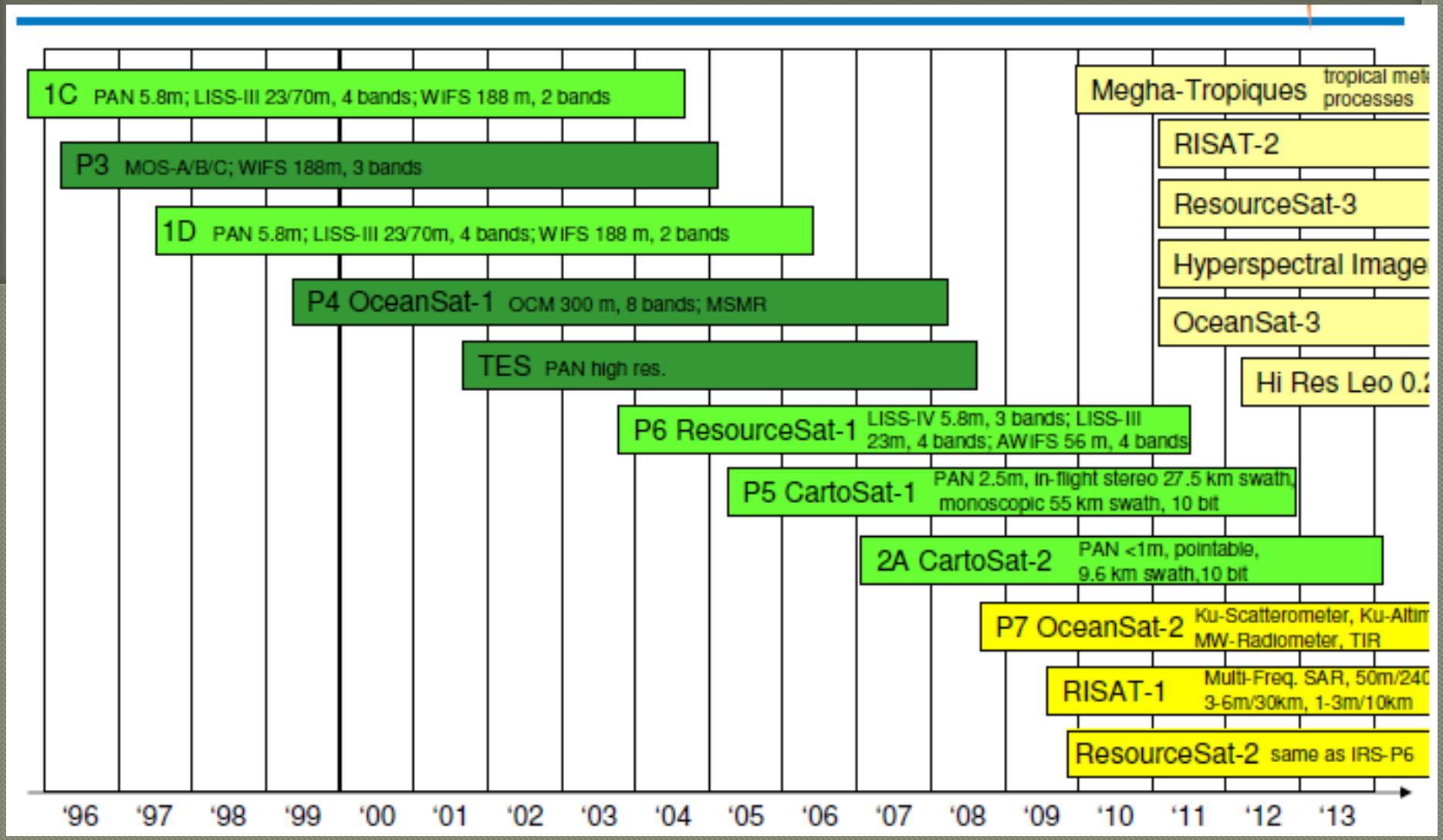
Sensor			LISS-IV		LISS-III	AWiFS
Mode			Mono	MX		
Spatial resolution	B2 B3 B4 B5	green red NIR SWIR	5.8 m	5.8 m 5.8 m 5.8 m	23.5 m 23.5 m 23.5 m 23.5 m	56 m .. 70 m 56 m .. 70 m 56 m .. 70 m 56 m .. 70 m
Swath-width			70 km	23.9 km	140 km	740 km
Radiometric Resolution, Quantisation	all Bands		7 bit	7 bit	7 bit	10 bit
Spectral coverage	B2 B3 B4 B5	green red NIR SWIR	620-680 nm	520-590 nm 620-680 nm 770-860 nm	520-590 nm 620-680 nm 770-860 nm 1550-1700 nm	520-590 nm 620-680 nm 770-860 nm 1550-1700 nm
CCD arrays (number of arrays * No. of elements)	B2 B3 B4 B5	green red NIR SWIR	1 * 12000	1 * 12000 1 * 12000 1 * 12000	1 * 6000 1 * 6000 1 * 6000 1 * 6000	2 * 6000 2 * 6000 2 * 6000 2 * 6000

IMAGING WITH RESOURCESAT – 1



Satellite	Sensor	Km² Per Second	Km² Per Minute	Scenes/Day (@ 8 mins/day)
Resourcesat-1	LISS-4	~ 462 km2	~ 27,720 km2	~ 221,760 km2
	LISS-3	~ 931 km2	~ 55,836 km2	~ 446,688 km2
	AWiFS	~ 4,884 km2	~ 293,040 km2	~ 2,344,320 km2

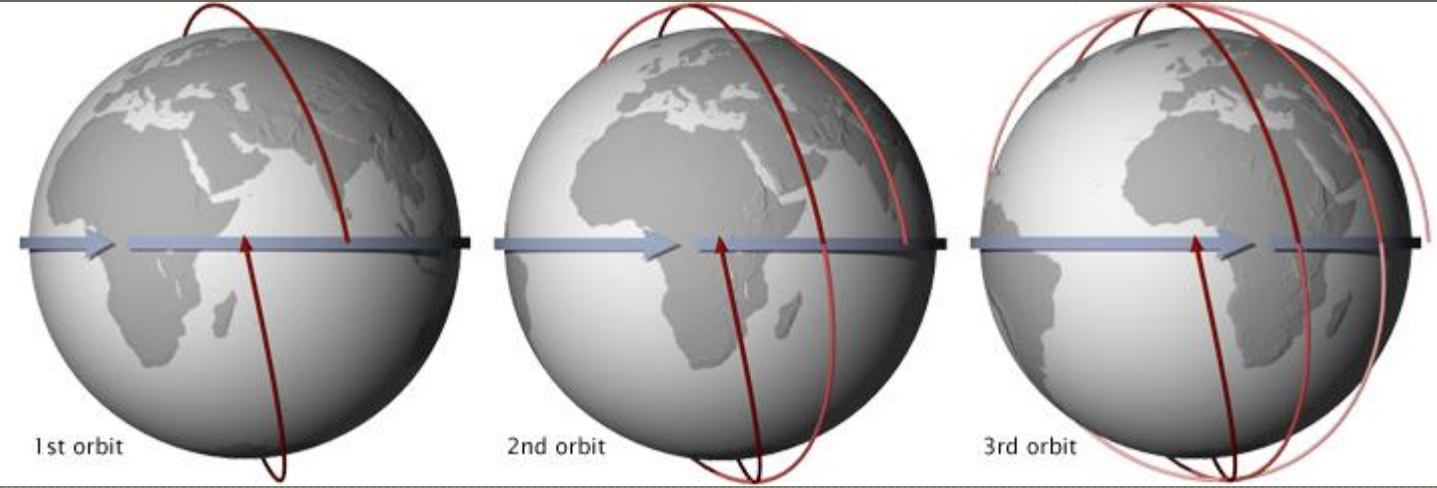
INDIAN REMOTE SENSING SATELLITES

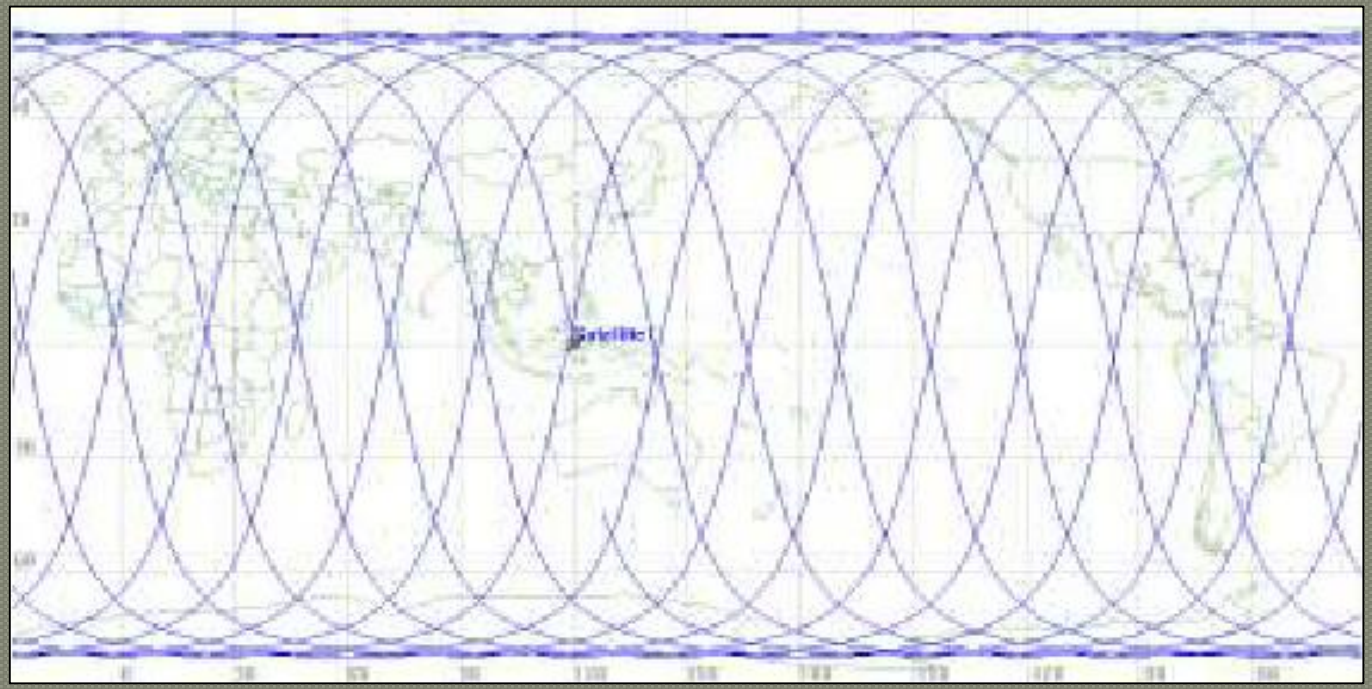


RESOURCE SAT – 1 (IRS P6)

Orbit :	Circular Polar Sun Synchronous
Orbit height :	821 km
Orbit inclination :	98.76°
Orbit period :	101.35 min
Number of Orbits per day :	14
Local Time of Equator crossing :	10.30 a.m.
Repetivity (LISS-3) :	24 days (341 orbits)
Revisit (AWiFS) :	5 days
Lift-off Mass :	1,360 kg
Attitude and Orbit Control :	3-axis body stabilized using Reaction Wheels, Magnetic Torquers and Hydrazine Thrusters
Power :	Solar Array generating 1250 W (at EOL), Two 24 Ah Ni-Cd batteries
Mission Life :	5-7 years
Launch Dates :	Resourcesat-1 launched on 10-17-03 Resourcesat-2 scheduled for Q3 2009

EARTH COVERAGE BY A SUN SYNCHRONOUS SATELLITE





RESOURCESAT – 1 APPLICATIONS

- Agriculture
  - Crop monitoring and condition assessment
  - Crop canopy water stress
  - Crop yield estimates
  - Damage assessment
- Forestry
  - Inventory and updating
  - Encroachment
  - Habitat analysis
  - Fire damage
- Environmental Monitoring
  - Land use
  - Soil contamination
  - Desertification analysis
  - Oil Spills and disaster monitoring
  - Environmental impact assessments
- Geology and Exploration
  - Rock type mapping
  - Mining pollution assessments
  - Coal fire analysis
  - Landslide vulnerability / risk
- Infrastructure and Utilities
  - Road networks
  - 3D city models
  - Structural and hydrological inventory
  - Utility corridor mapping
  - Change detection
- Cartography / Mapping
- National Security

RESOURCE SAT – 2

Orbit	Circular Polar Sun Synchronous
Orbit altitude at injection	822 km + 20 km (3 Sigma)
Orbit Inclination	98.731° + 0.2°
Lift-off Mass	1206 kg
Orbit Period	101.35 min
Number of Orbits per day	14
Local Time of Equator crossing	10:30 am
Repetivity	24 days
Launch date	April 20, 2011
Launch site	SHAR Centre Sriharikota India
Launch vehicle	PSLV- C16
Mission life	5 years

RESOURCE SAT – 2

A follow on mission to Resourcesat-1 (launched on December 07, 2016)

Compared to Resourcesat-1, LISS-4 multispectral swath has been enhanced from 23 km to 70 km

contains 3 multispectral cameras on board

1) Advanced Wide-Field Sensor (AWiFS) with 56 meter spatial resolution.

2) The Linear Imaging Self-Scanning Sensor (LISS-III) with 23.5 meter spatial resolution

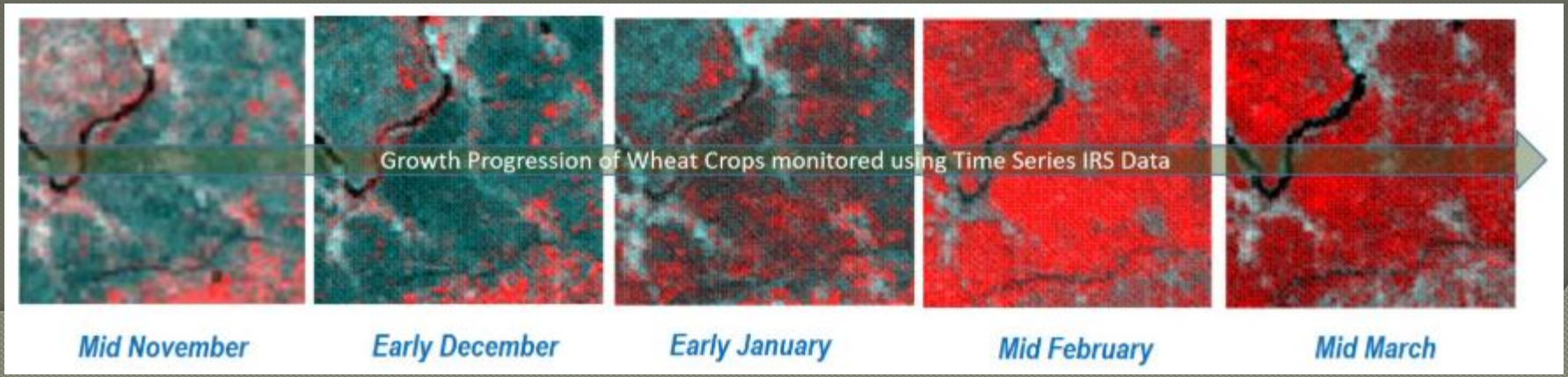
3) LISS-IV Camera with 5.8 meter spatial resolution

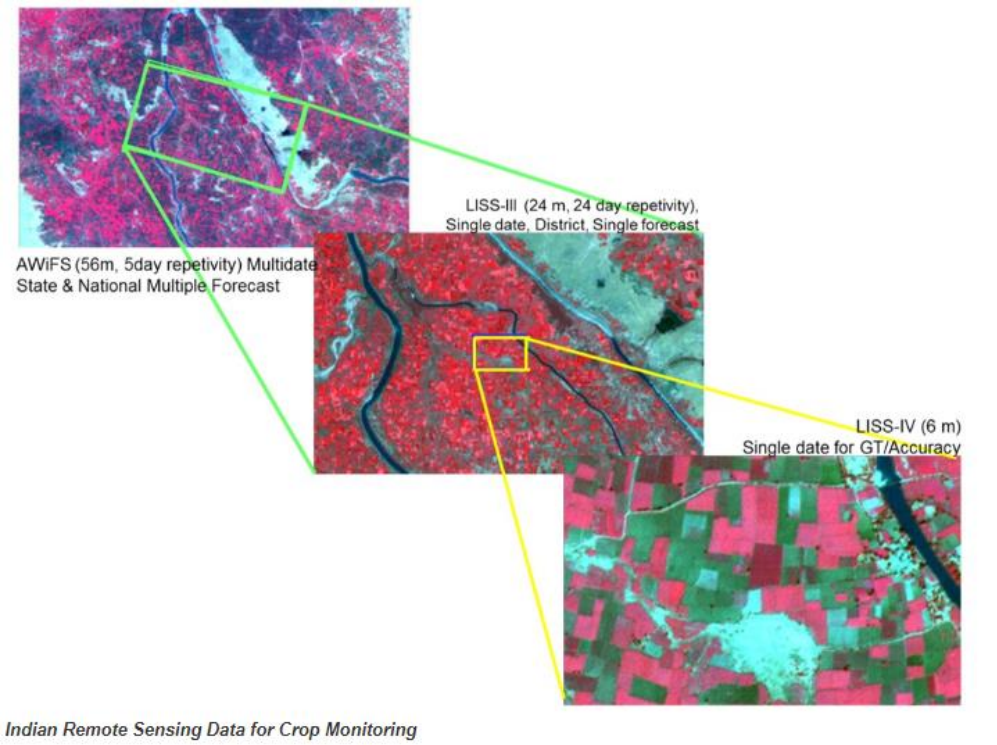
CARTOSAT - 2

Orbit	Polar, Sun-synchronous
Orbital Altitude	630.6 km
Semi Major Axis	7008.745 km
Inclination	97.914 degrees
Local Time	9:30 A.M
Revisit	4/5 days
Repetivity	310 days
Orbits/day	14.78

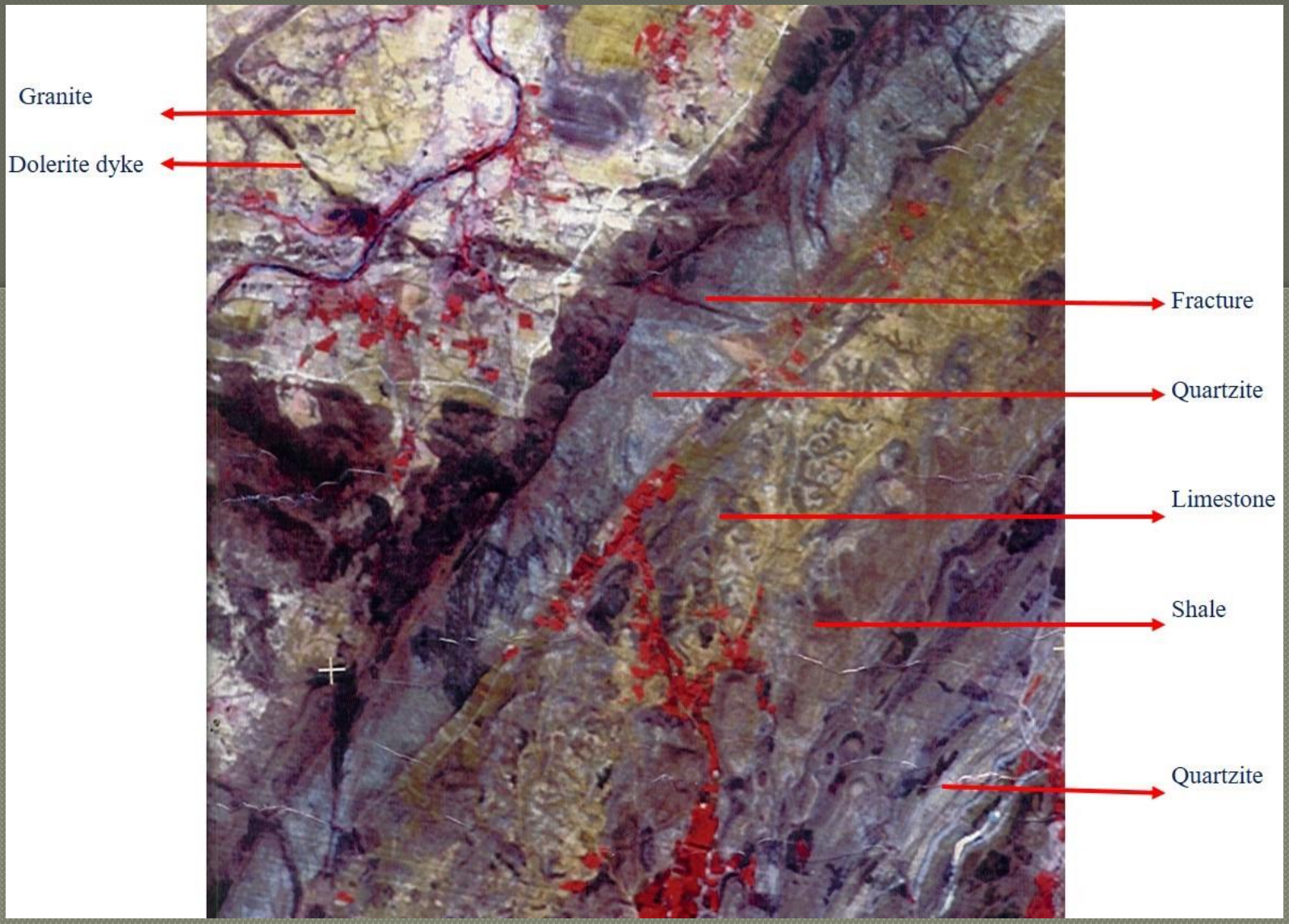
Spatial resolution	< 1m
Swath	9.6 km
Spectral band	0.5 - 0.85 microns
Type of compression	JPEG like
Quantisation	10 bits
ROLL tilt	±26 deg
OBSSR Capacity	9 minutes of data/64Gb

CASE STUDIES - Agriculture



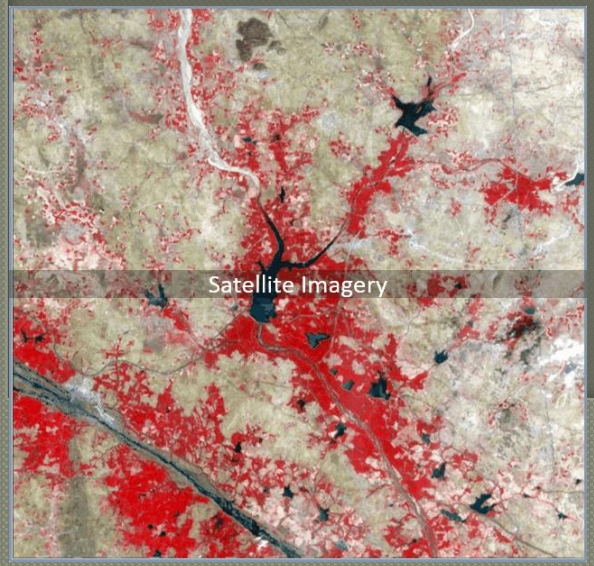


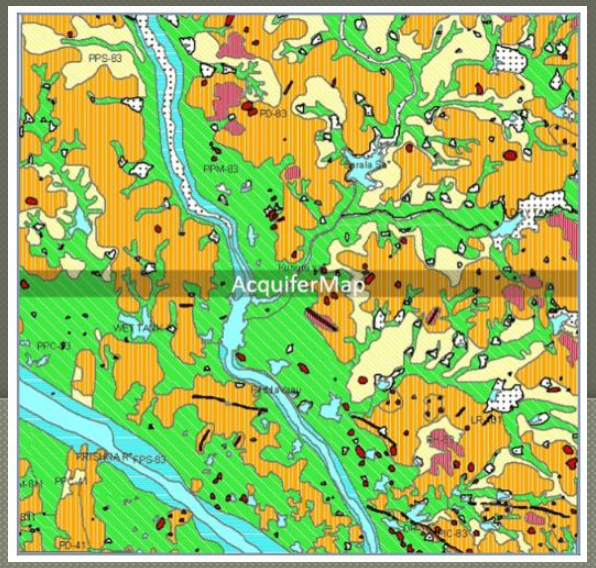
CASE STUDIES - Geology



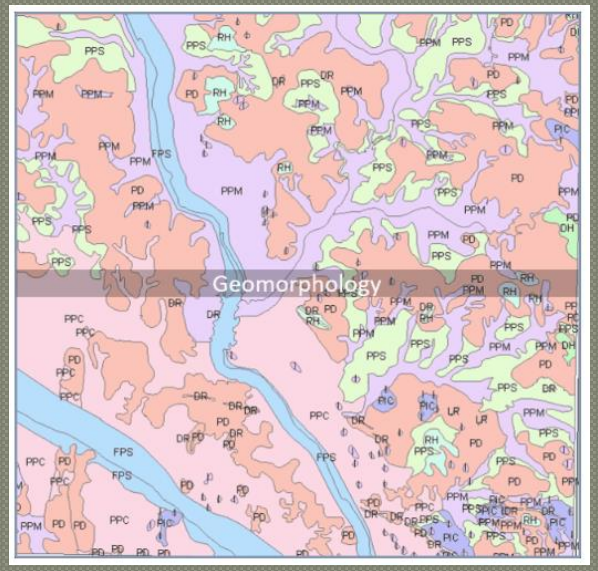
CASE STUDIES - Governance

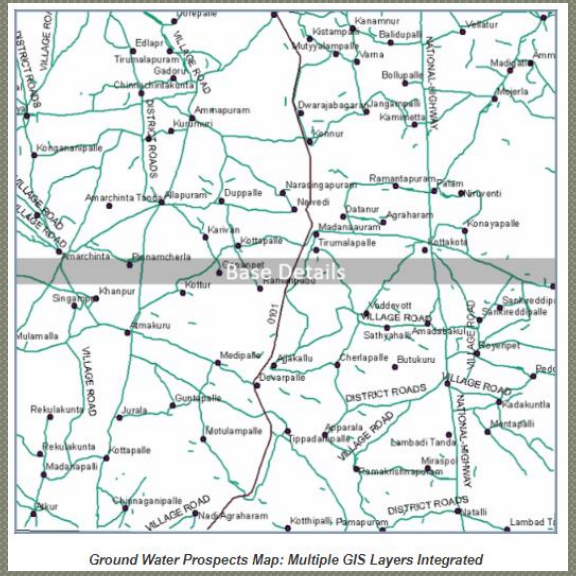
CASE STUDIES – Water Resources



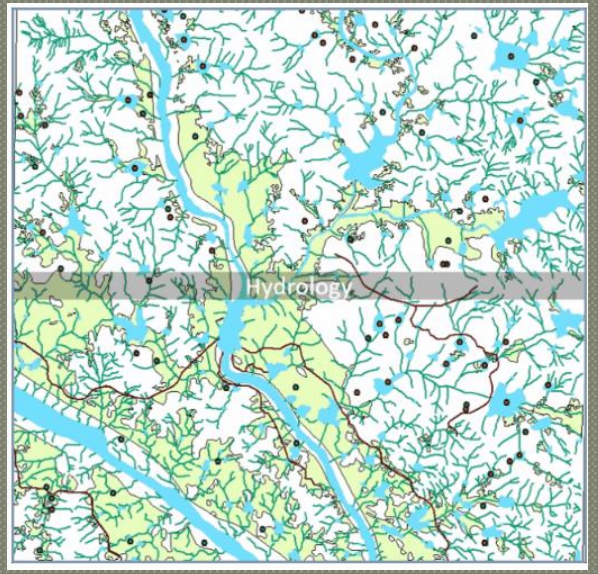


Ground Water Prospects Map: Multiple GIS Layers Integrated





Ground Water Prospects Map: Multiple GIS Layers Integrated



BHUVAN

- A web based utility which allows users to explore a set of map based content prepared by ISRO
- Content includes thematic maps related to disasters, agriculture, water resources, land cover and also processed satellite data of ISRO
- Offers detailed imagery of Indian locations compared with spatial resolutions ranging up to 1 metre
- Data visualization and download

https://bhuvan.nrsc.gov.in/bhuvan_links.php

QUESTIONS ?