Damietta University
Faculty of Science
Geology Department

Geothermal Course

For

First Year Geophysics Program

Code: 103 Geoph

Lecture 7:Remote Sensing For Geothermal Exploration Part 2

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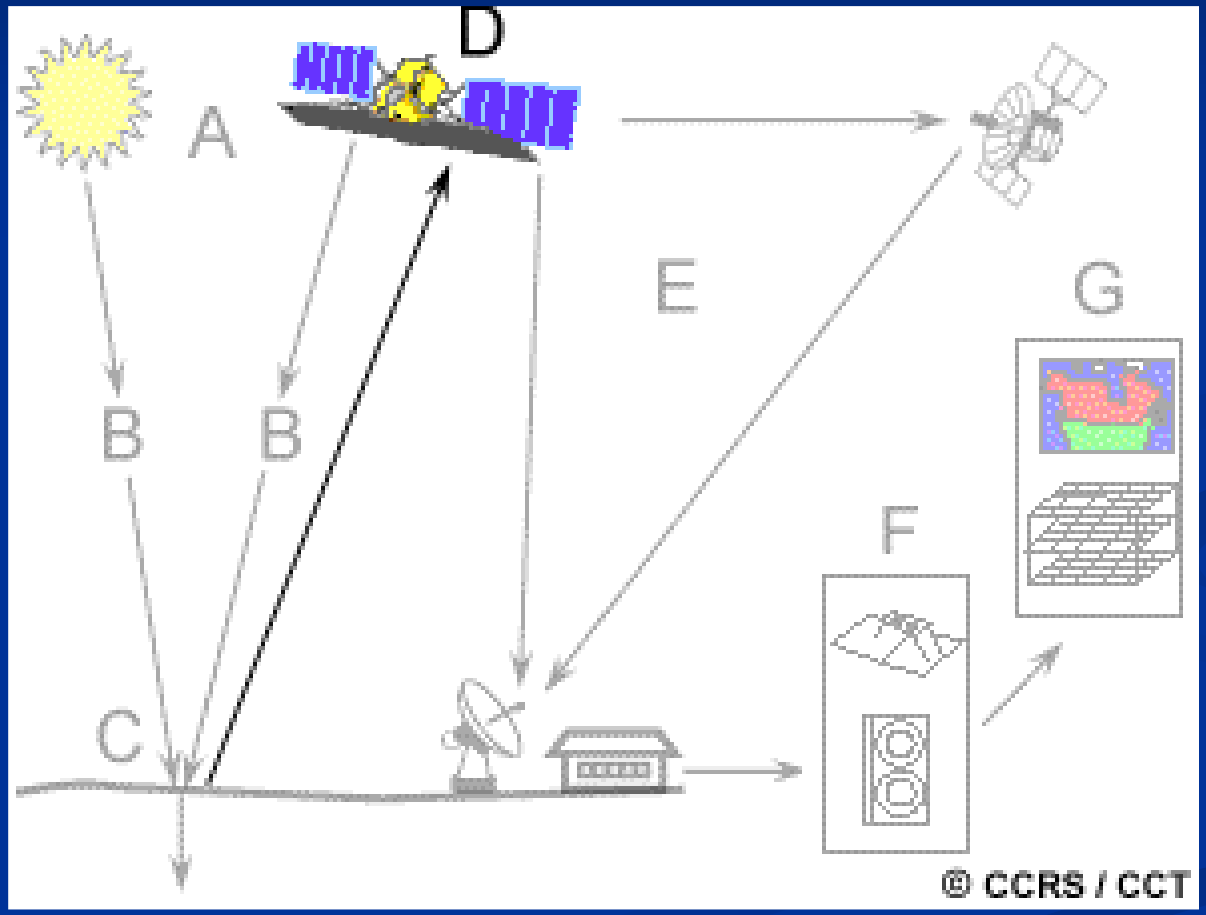
Satellites and Sensors



Objectives

- Types of Platforms
- Satellite
- Sensor
- Orbits
- Scanning System

Platform - the device to which the sensor is attached

Sensor - the device that actually gathers the remotely sensed data

Satellites and Sensors

In order for a sensor to collect and record energy reflected or emitted from a target or surface, it must reside on a stable **platform** removed from the target or surface being observed.

Platforms for remote sensors may be situated

- on **the ground**,
- on an **aircraft, balloon** or **Drone**
- or on a **spacecraft or satellite** outside of the Earth's atmosphere.

Ground-based sensors

Ground-based sensors are often used to record detailed information about the surface which is compared with information collected from aircraft or satellite sensors.

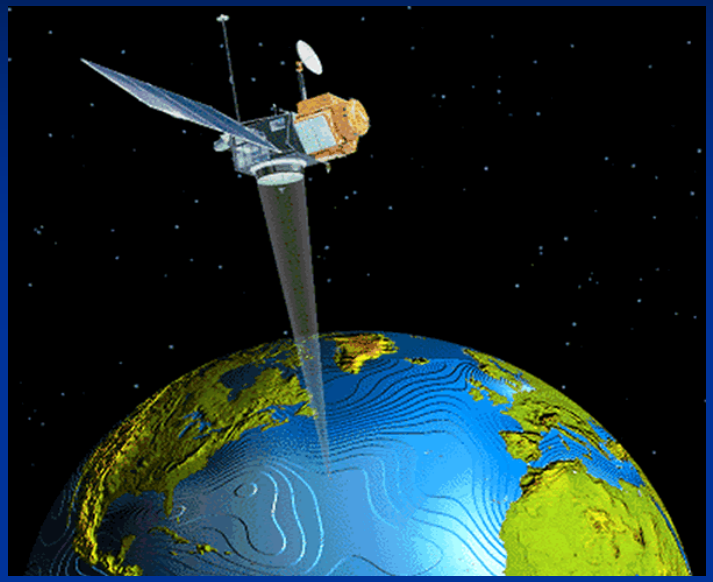
Sensors may be placed on a ladder, scaffolding سقالات, tall building, crane ونشe, etc.

Aerial platforms

- Aerial platforms are primarily stable wing aircraft, although helicopters are occasionally used.
- Aircraft are often used to collect very detailed images and facilitate the collection of data over virtually any portion of the Earth's surface at any time.

Sensors Operating in the Visible Band

Satellite



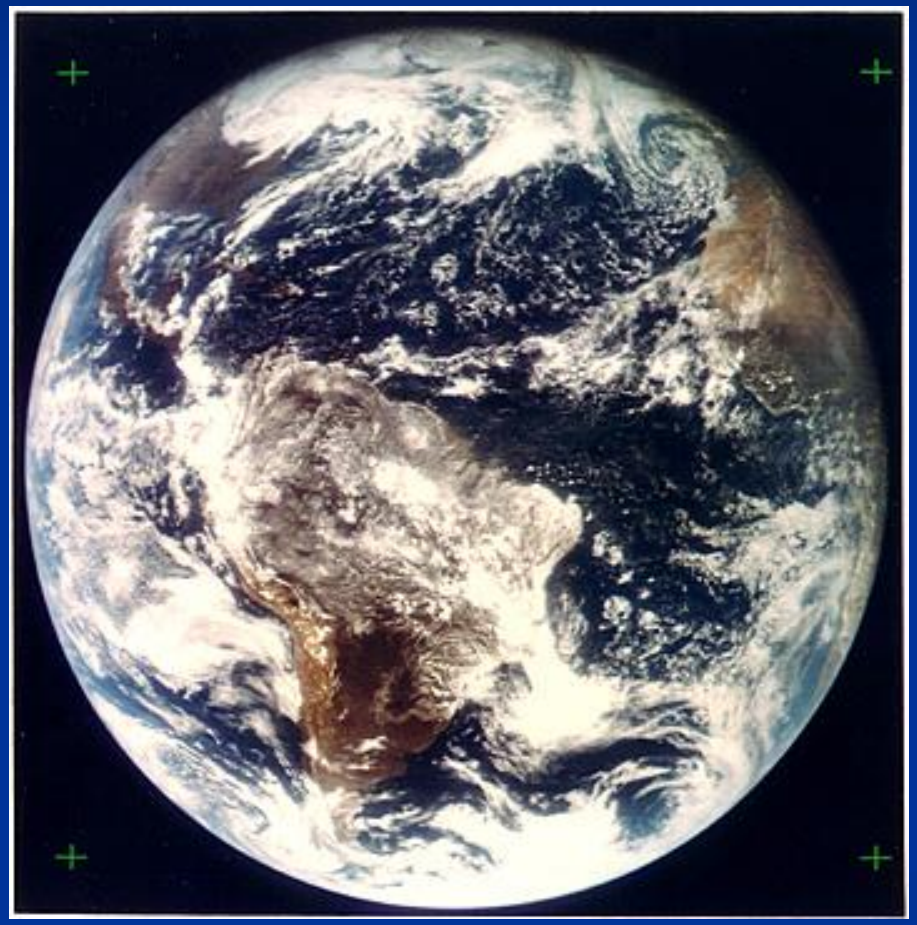
Satellite

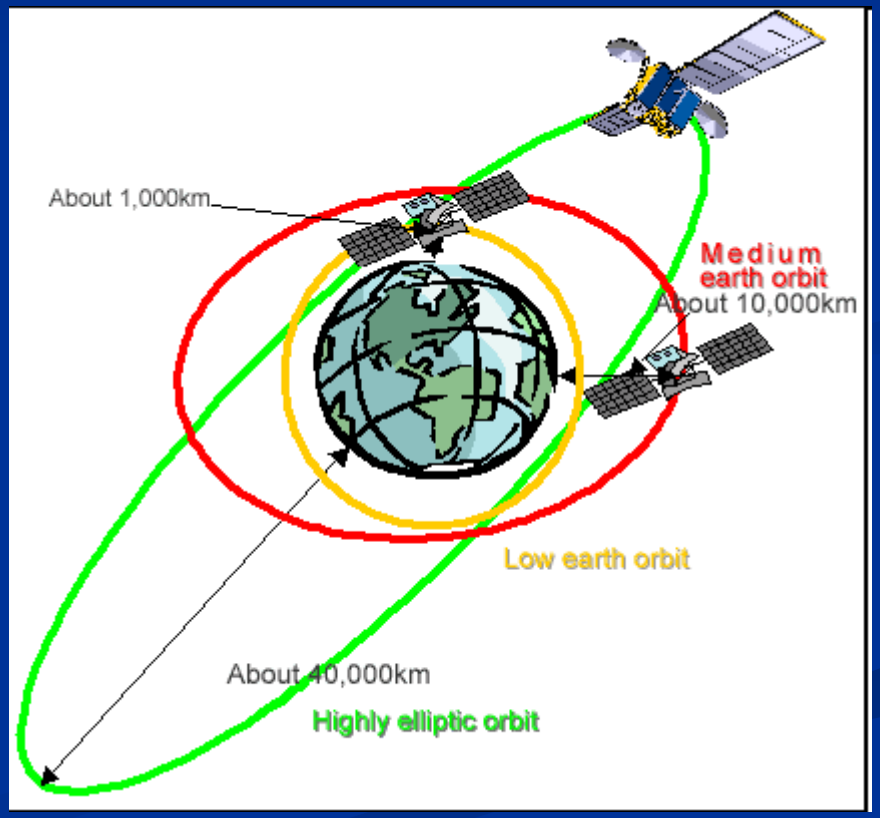
- Currently there are 3000 satellites orbiting the earth (US – 878)
- Multi-purpose:
  - Scientific
  - Defense
  - Communications
  - Global positioning system (GPS)

Satellite

- in space, remote sensing is sometimes conducted from satellites.
- Satellites are objects which revolve around the Earth.
- For example, the moon is a natural satellite, whereas man-made satellites include those platforms launched for remote sensing, communication, and telemetry (location and navigation) purposes.

Orbit



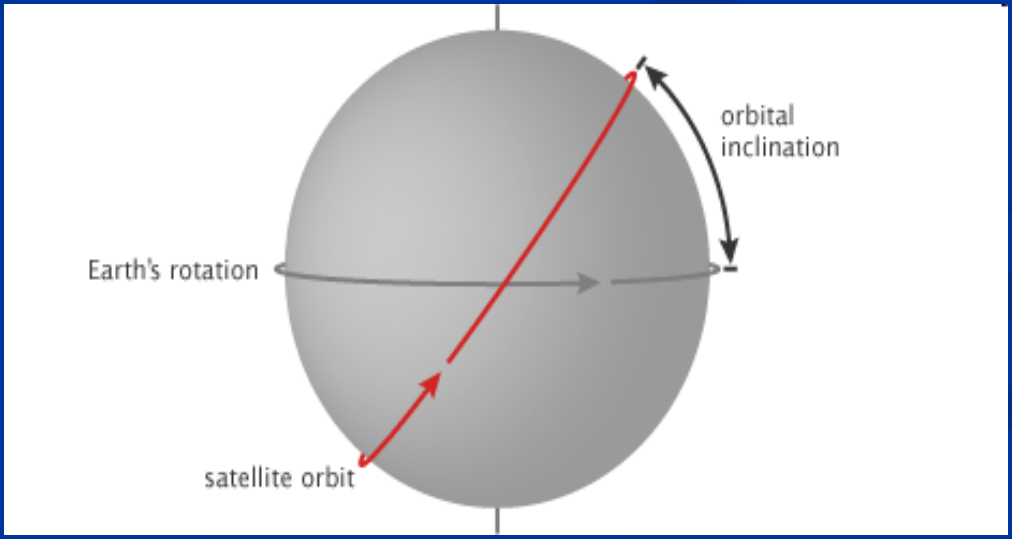

About 1,000km
Medium
earth orbit
About 10,000km
Low earth orbit
About 40,000km
Highly elliptic orbit

Orbital inclination

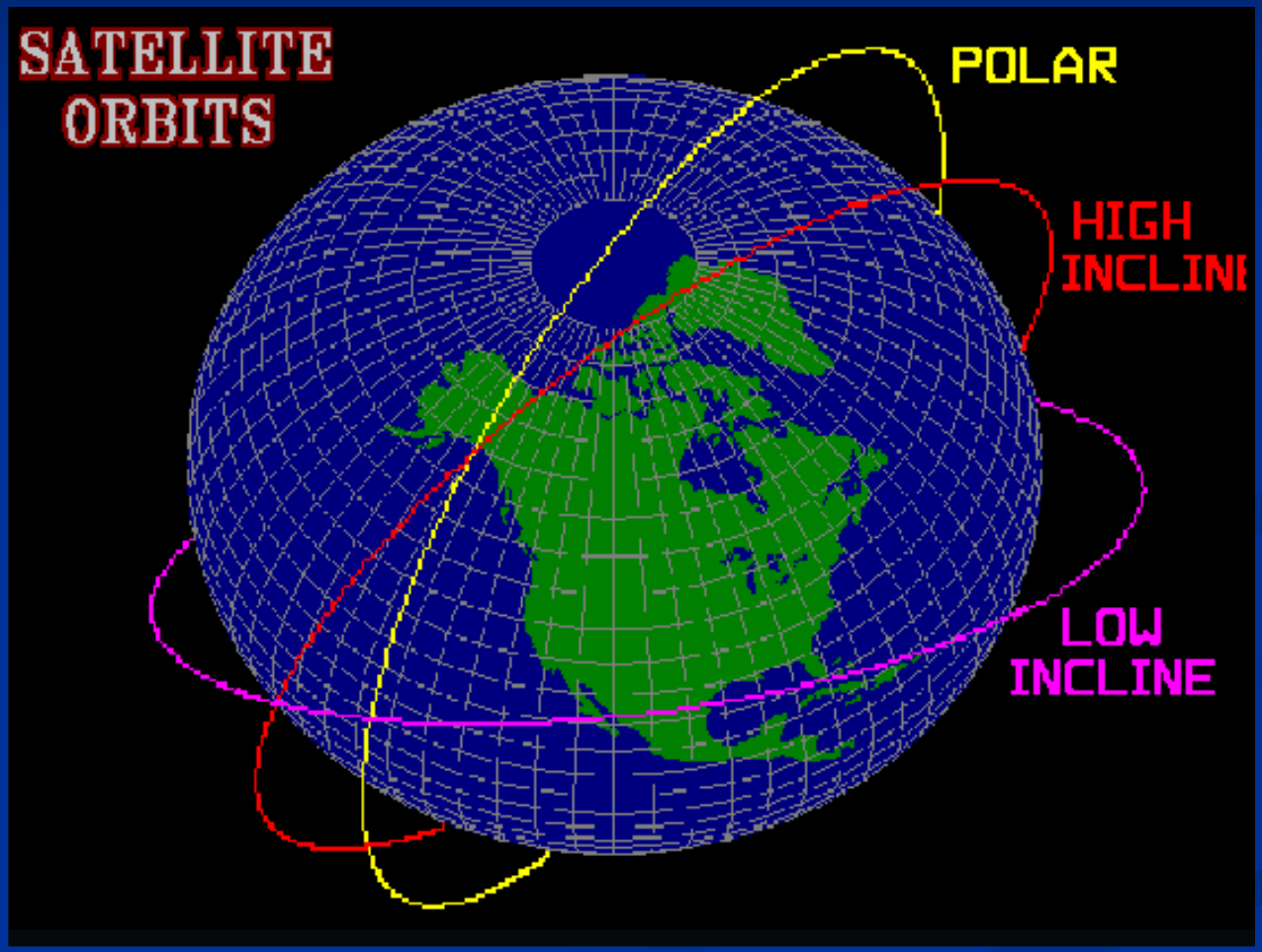
The angle of the orbit in relation to Earth's equator.

A satellite that orbits directly above the equator has zero inclination.

If a satellite orbits from the north pole (geographic, not magnetic) to the south pole, its inclination is 90 degrees.



Polar, high inclination, and low inclination satellite orbits



Inclination classification of Orbits

- Geostationary (zero inclination) orbits.

  Geosynchronous orbits
- Near polar orbits.

  Sun-synchronous orbits.

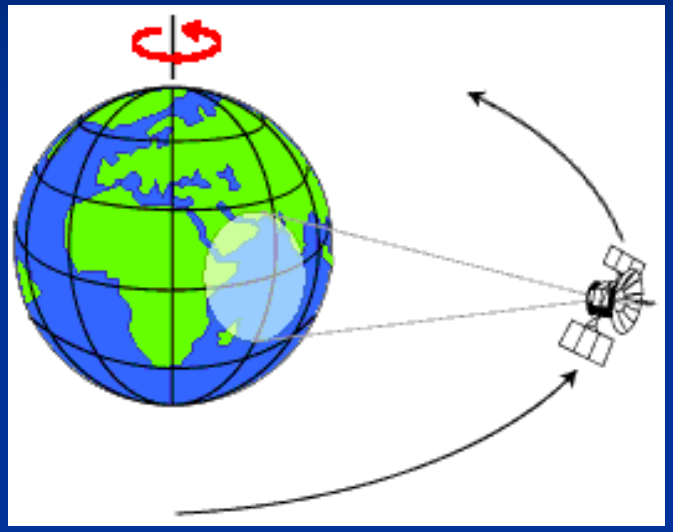
Geostationary Orbits

Geostationary (geosynchronous) orbits: An orbit which places the satellite above the same location at all times

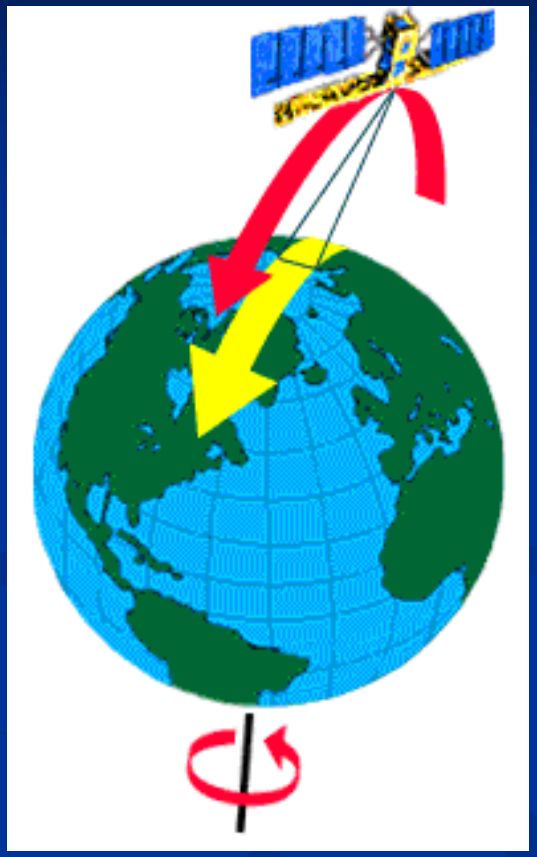
Must be orbiting approximately 36,000 km above the Earth

Satellite can only “see” one hemisphere

the many remote sensors can orbit Earth along different paths



geostationary
sits above same spot
(GOES)

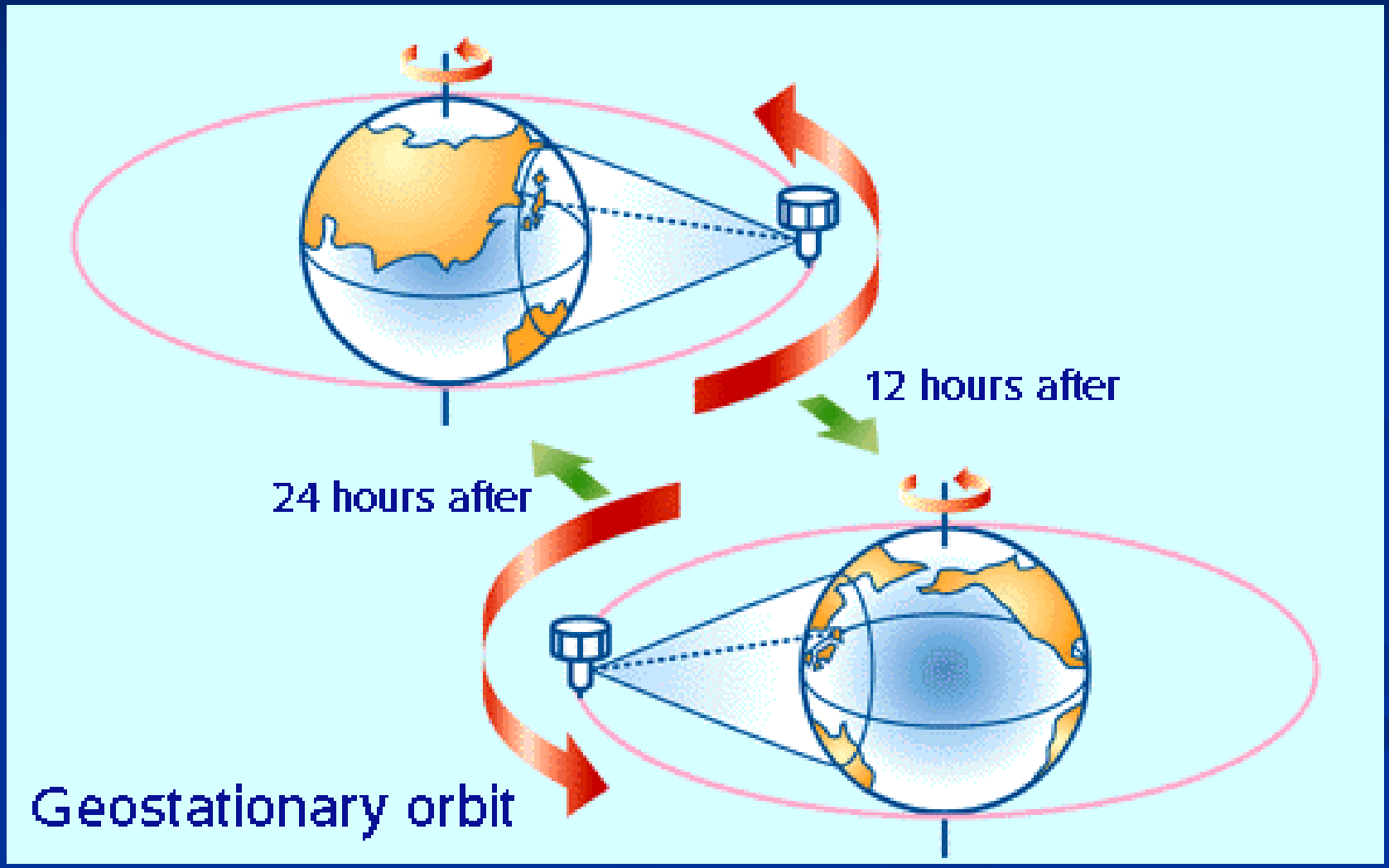


near-polar orbit
gives all Earth coverage
(Landsat, SPOT)

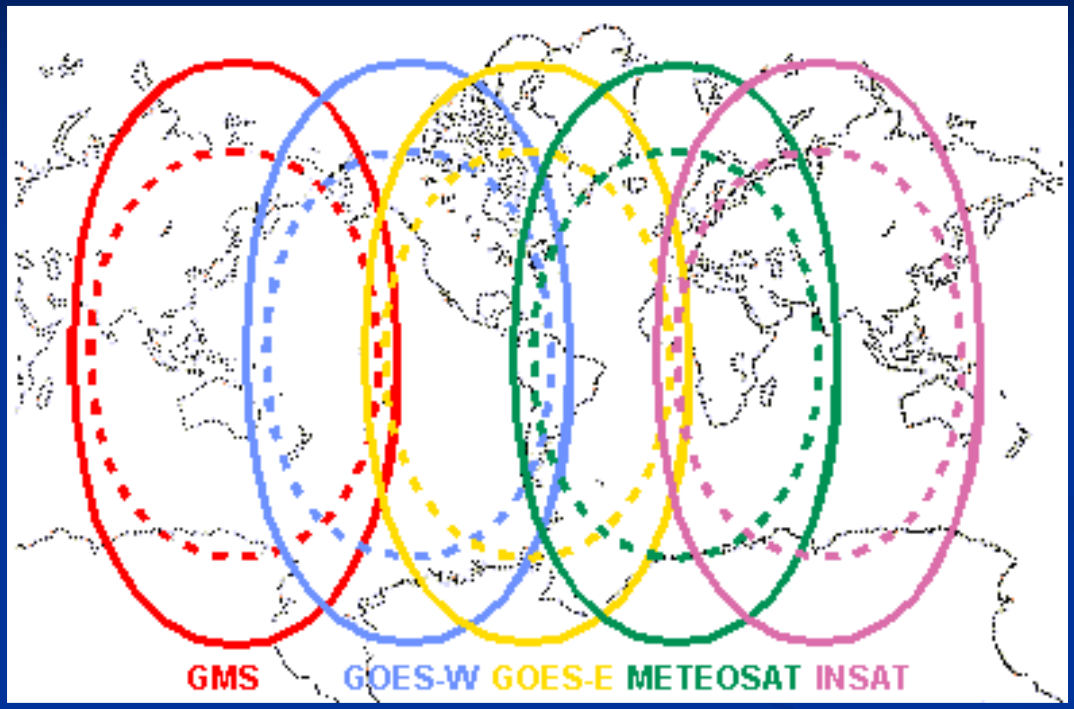
Geostationary Orbits

- Geostationary ساكن satellites enable a continuous time sampling over certain regions on Earth.
- These satellites are geosynchronous, meaning their orbits keep them synchronized with Earth rotation.
  – They take 24 hours to complete one orbit.

Geostationary Orbits



Geostationary Satellites



Areas viewed by geostationary meteorological satellites.

– The solid line shows the limits; a satellite sees nothing outside this area.

The dashed line encloses the area of useful data.

Geostationary Orbits: Applications

- **Meteorology**: real time operational survey of the troposphere, cloud systems, sea, and land surface temperatures.
- **Telecommunications**: world wide operational telecommunication systems for telephones, TV, and digitized transmission lines.
- **Army**: alarm systems - detection of rocket launches.

Sun synchronous orbits

Sun synchronous orbits: An orbit in which the satellite passes every location at the same time each day

Noon satellites: pass over near noon and midnight

Morning satellites: pass over near dawn and dusk.قرب الفجر والغسق

Often referred to as “polar orbiters” because of the high latitudes they cross

Usually orbit within several hundred to a few thousand km from Earth

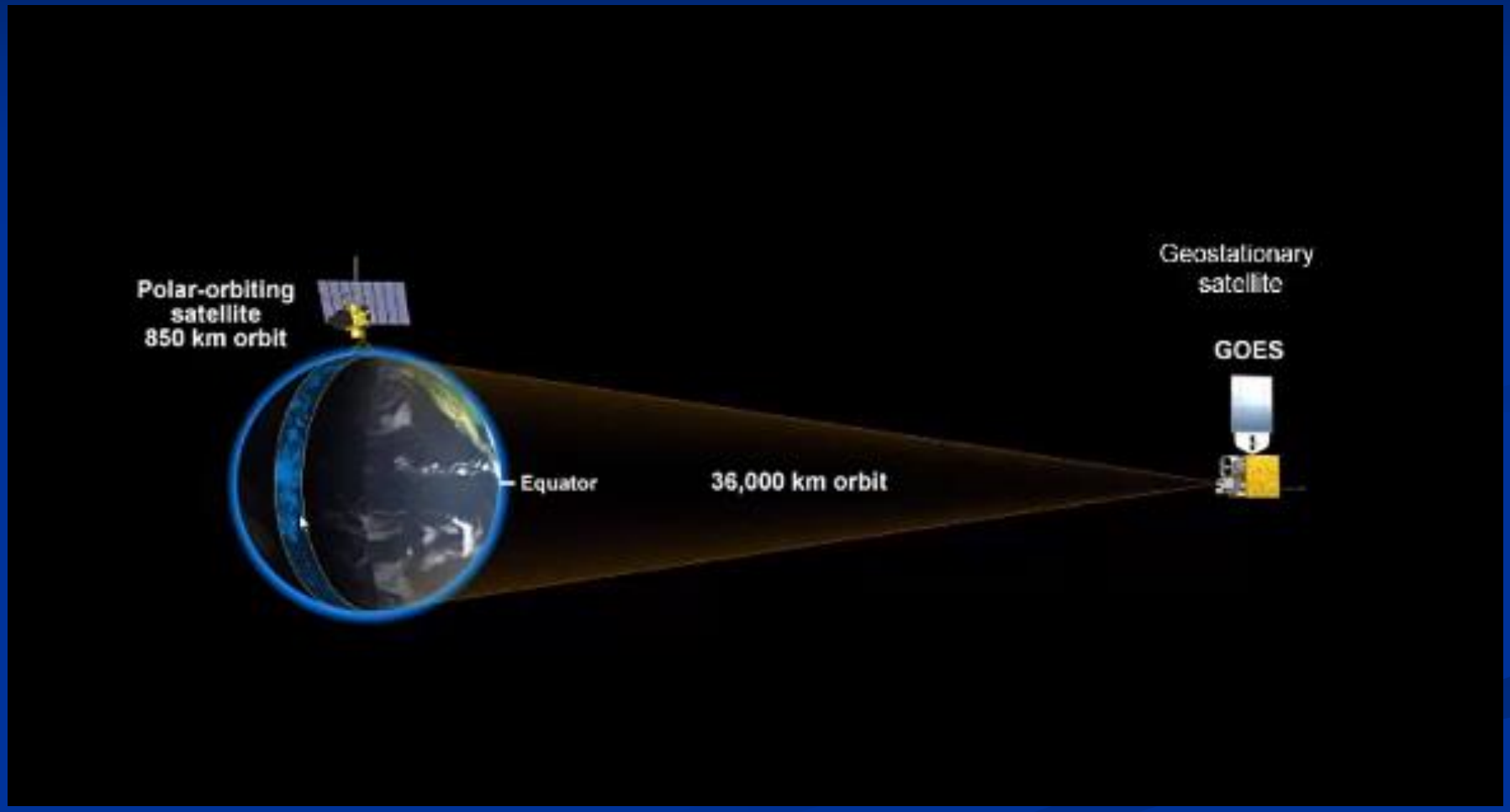
Sun-Synchronous Orbiting Satellites

- This orbital configuration applies to LANDAT, ASTER, SPOT, and some of the other land observers.
- This characteristic is useful for measurements in the visible and thermal wavelengths.

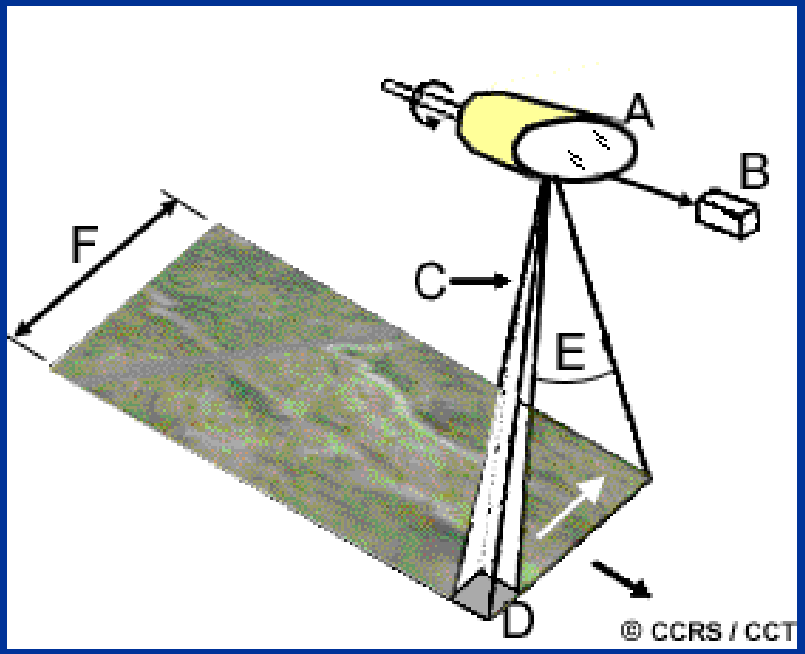
Sun-Synchronous Orbits: Advantages

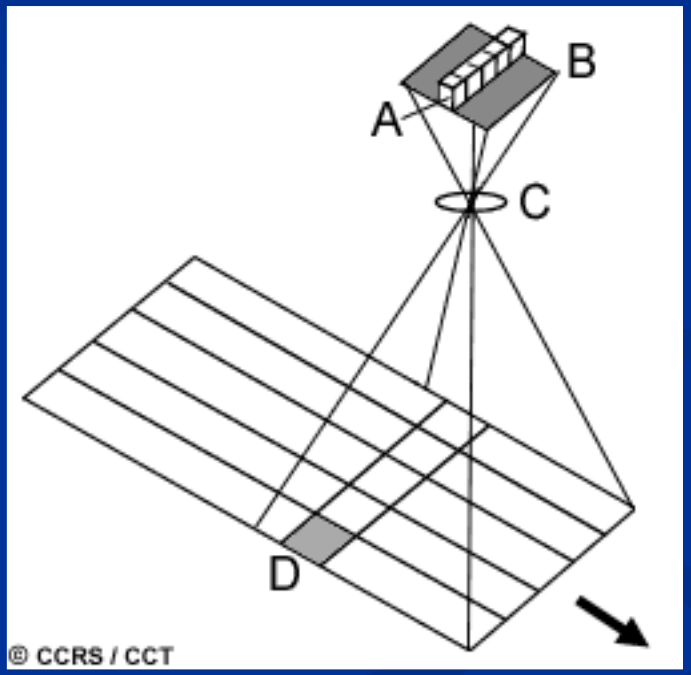
- The low altitude of a sun-synchronous orbit permits good ground resolution.
- It also enables easier active measurements with RADAR.
- The near polar orbit allows a global coverage for the observation of the whole Earth.
- Orbit altitudes of between 700 and 900 km permits both a large ground swath, offering a daily global coverage, and a good ground resolution

Polar and Geostationary



Multispectral Scanning



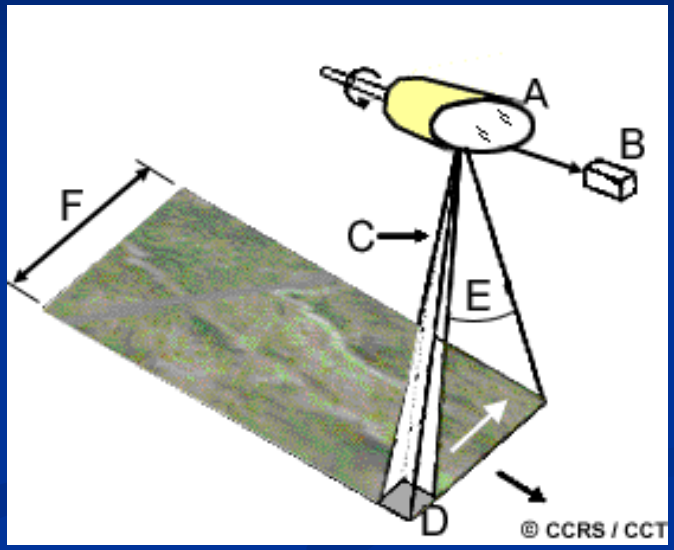


Multispectral Scanning

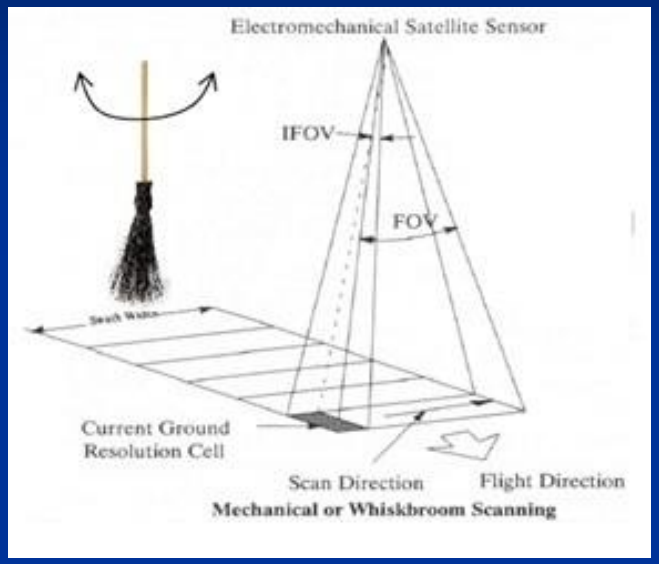
- Many electronic (as opposed to photographic) remote sensors acquire data using **scanning systems.**
- A scanning system used to collect data over a variety of different wavelength ranges is called a **multispectral scanner (MSS).**
- There are two main modes or methods of scanning employed to acquire multispectral image data - **across-track scanning**, and **along-track scanning**.

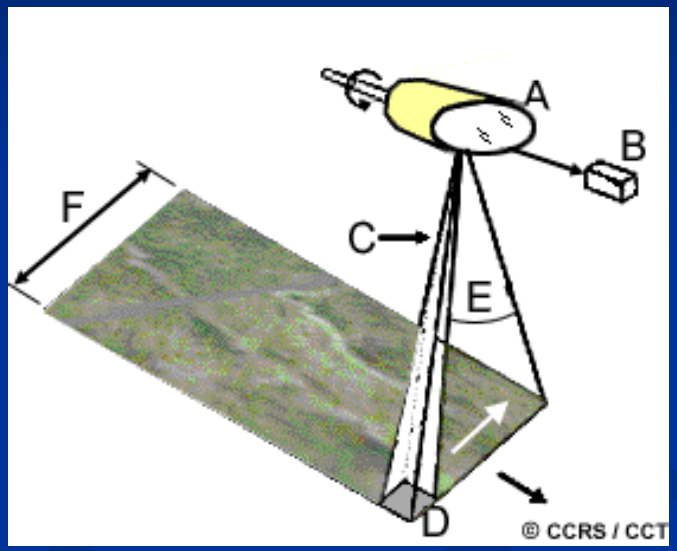
Across-track scanners

- Also known as WHISKBROOM Scanners
- Scans Right to Left – one pixel at a time
- Using a rotating mirror



Across-track scanners





Across-track scanners scan the Earth in a series of lines.

The lines are oriented perpendicular to the direction of motion of the sensor platform (i.e. across the swath).

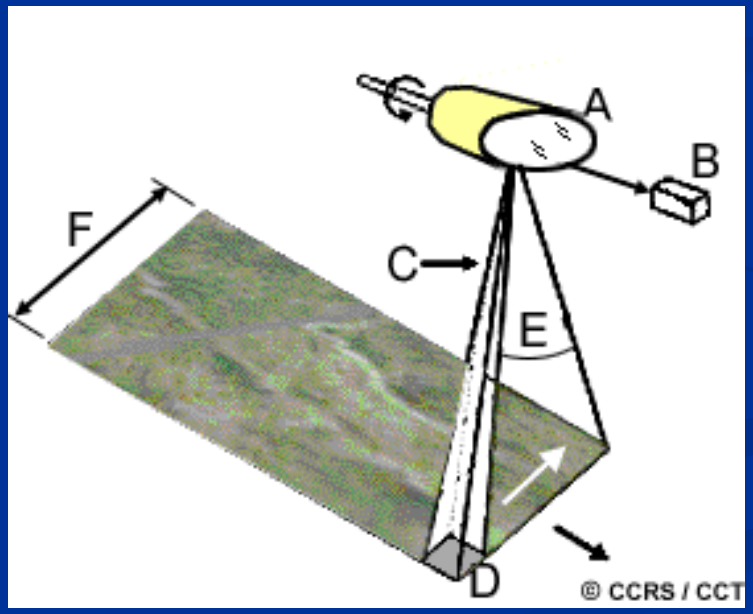
Across-track scanners

There are three parts to across-track multi-spectral scanning systems (MSS) system:

- Mirror
- Detector array
- Amplifier

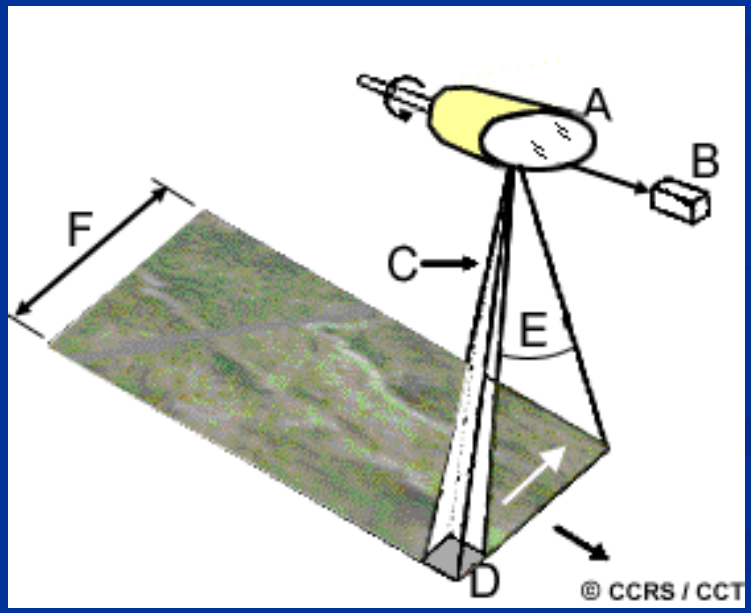
Across-track scanners

Each line is scanned from one side of the sensor to the other, using a **rotating mirror (A)**. As the platform moves forward over the Earth, successive scans build up a two-dimensional image of the Earth´s surface.



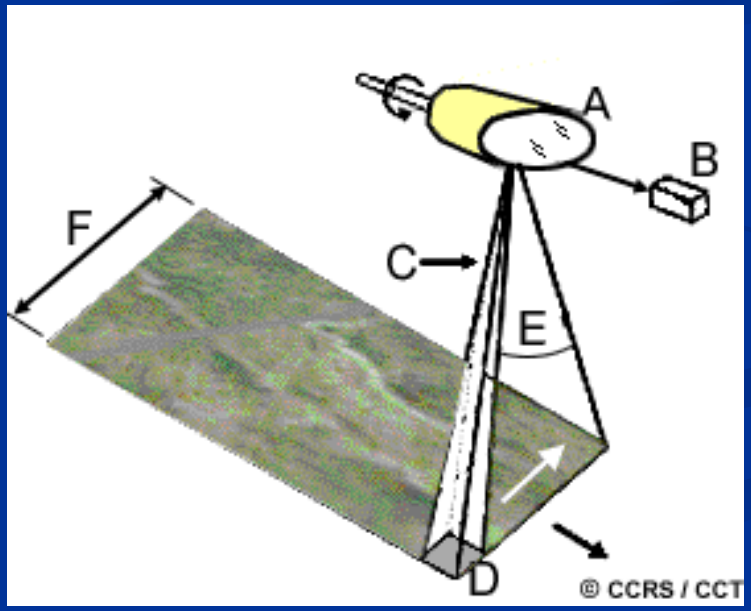
Across-track scanners

The incoming reflected or emitted radiation is separated into several spectral components that are detected independently.



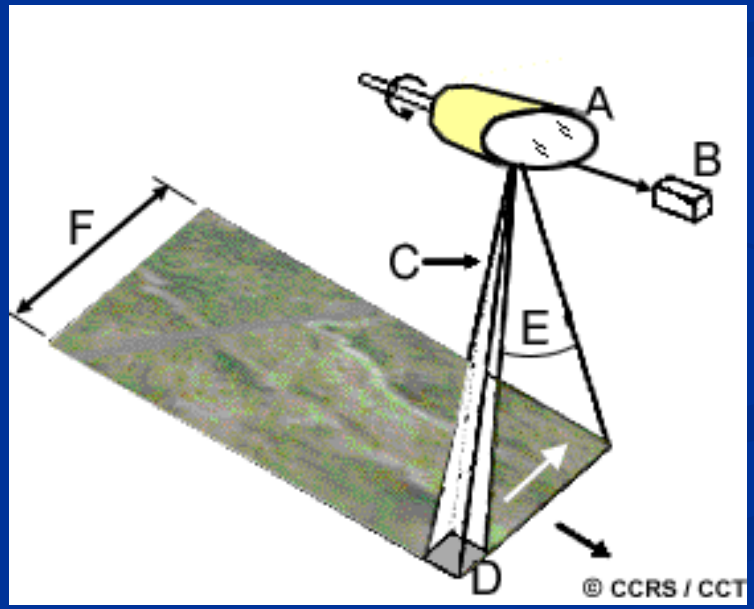
Across-track scanners

A bank of internal **detectors (B)**, each sensitive to a specific range of wavelengths, detects and measures the energy for each spectral band and then, as an electrical signal, they are converted to digital data and recorded for subsequent computer processing.



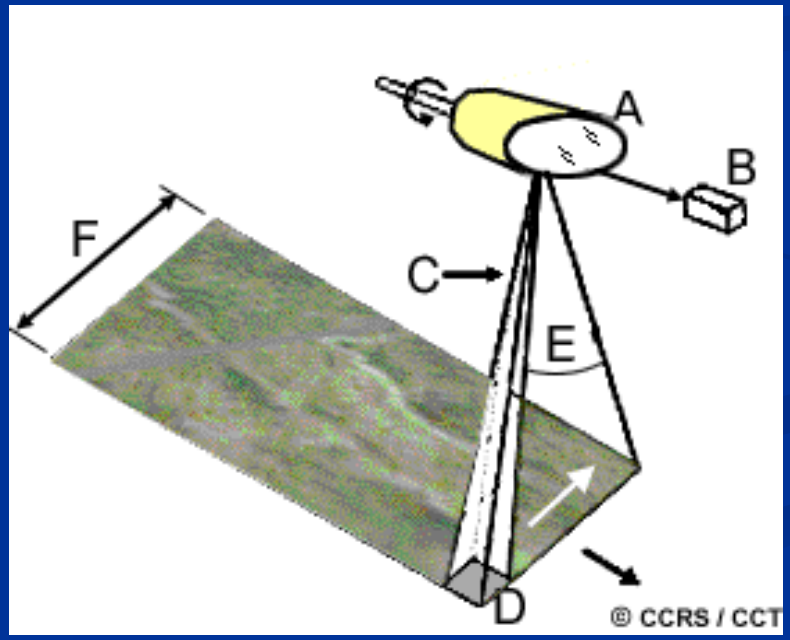
Across-track scanners

Because the distance from the sensor to the target increases towards the edges of the swath, the ground resolution cells also become larger and introduce geometric distortions to the images.



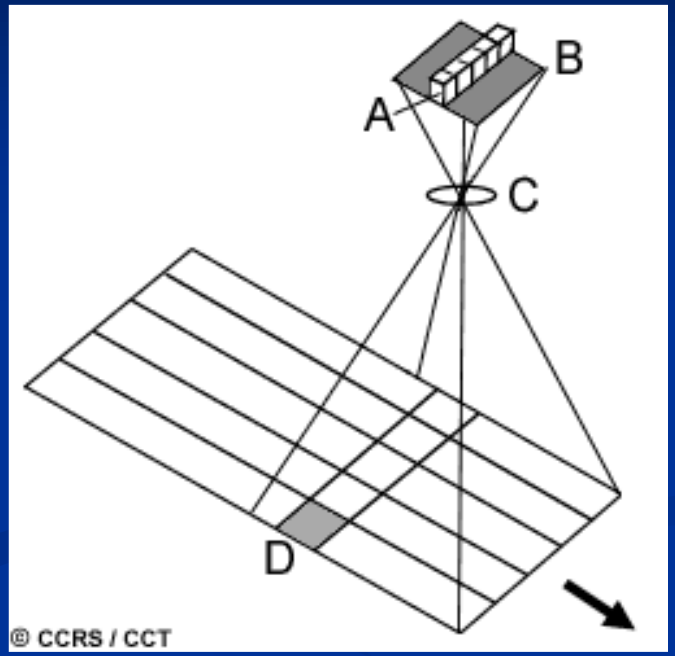
Across-track scanners

The length of time the IFOV "sees" a ground resolution cell as the rotating mirror scans (called the **dwell time**), is generally quite short and influences the design of the spatial, spectral, and radiometric resolution of the sensor.

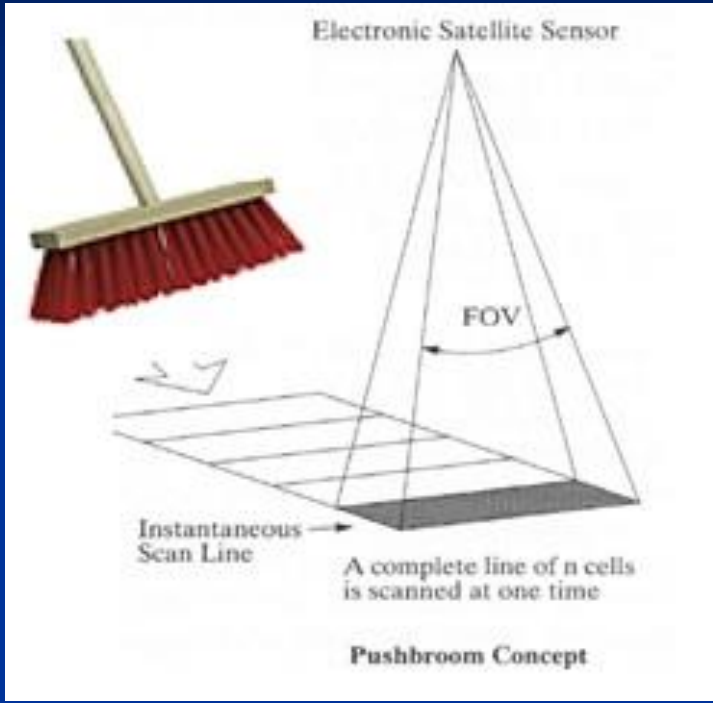


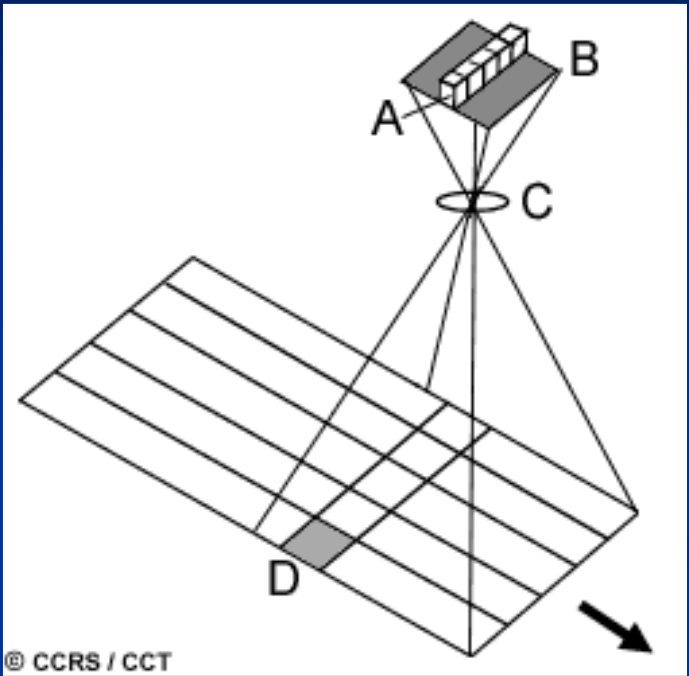
Along-track scanners

- Also known as PUSHBROOM Scanners
- Sense a swath with an linear array of CCD's
- Pushbroom scanners have no mechanical parts.



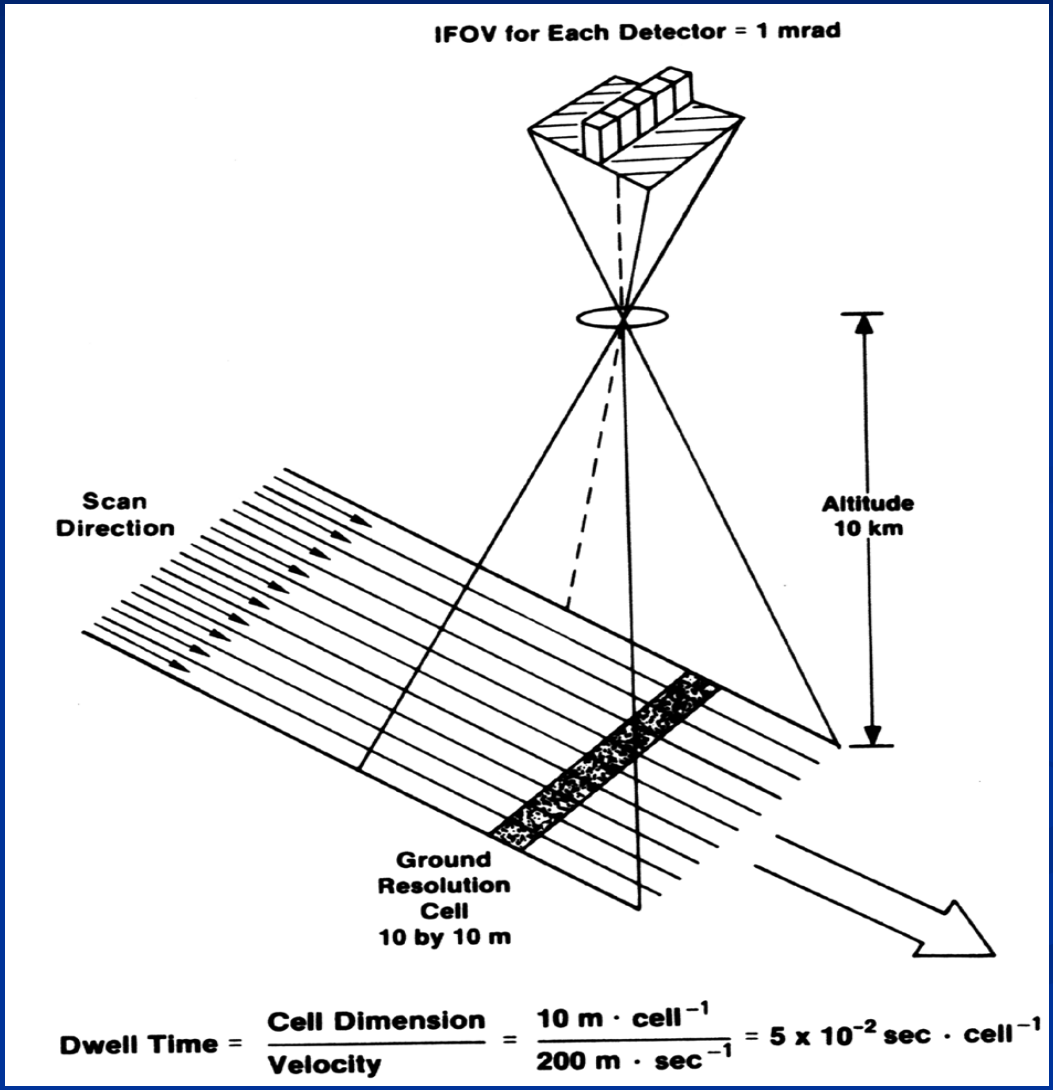
Along-track scanners



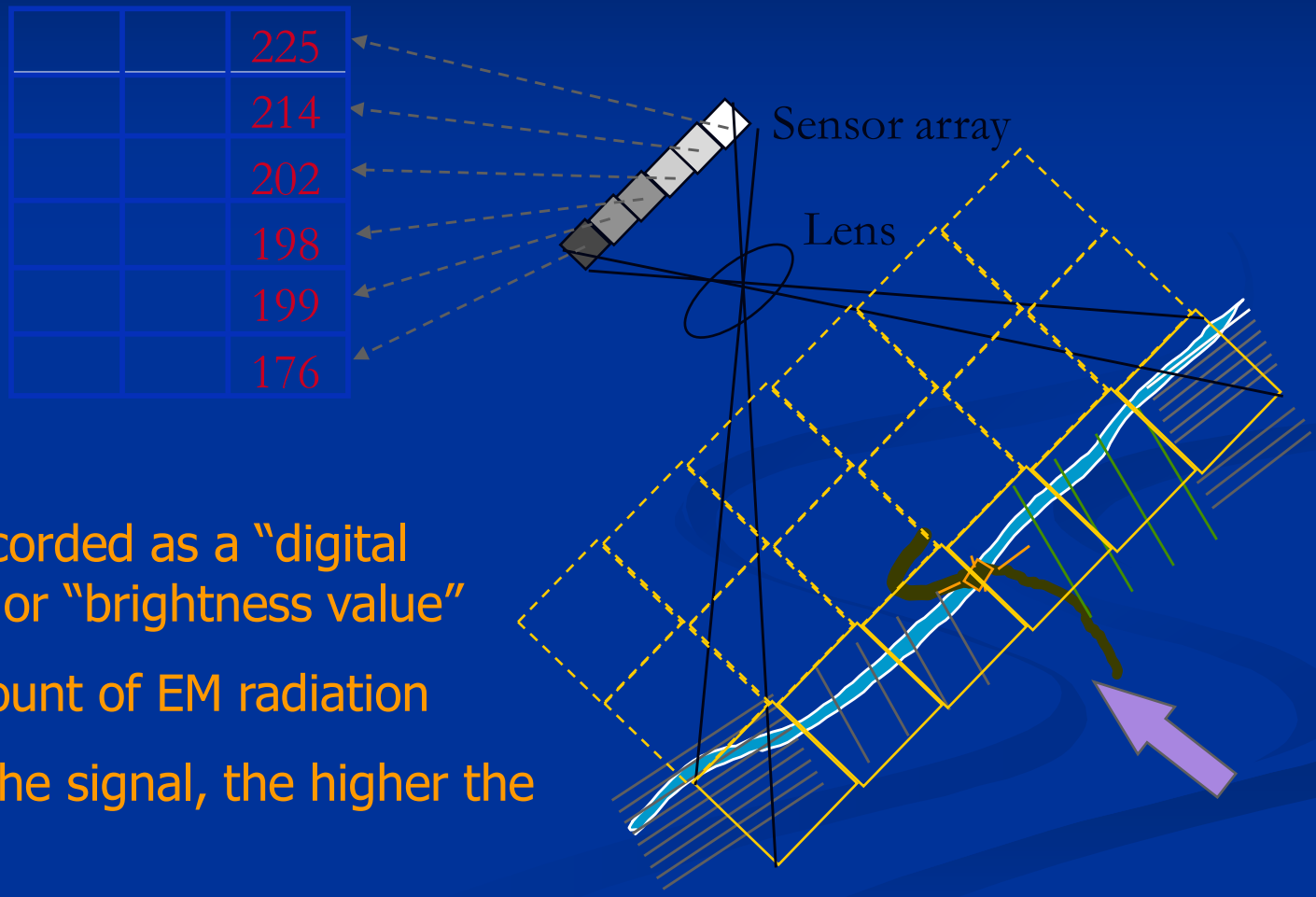


Along-track scanners use the forward motion of the platform to record successive scan lines and build up a two-dimensional image, perpendicular to the flight direction.

Along-track scanners



Sensing



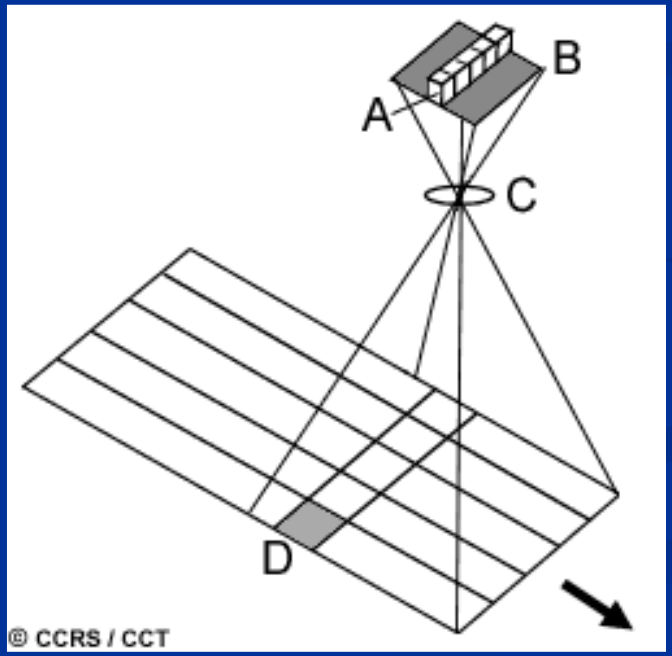
Each "cell" recorded as a "digital number" (DN) or "brightness value"

Measures amount of EM radiation

The brighter the signal, the higher the value.

Along-track scanners

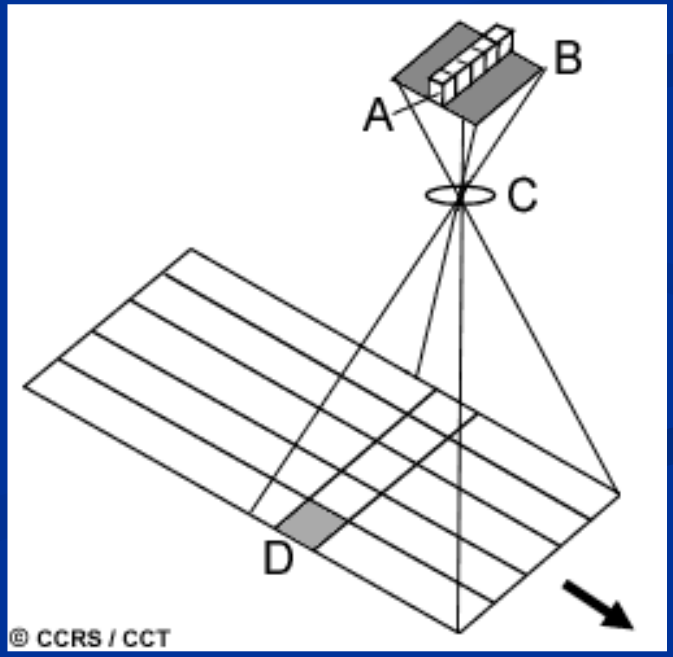
Instead of a scanning mirror, they use a linear array of detectors (A) located at the focal plane of the image (B) formed by lens systems (C), which are "pushed" along in the flight track direction (i.e. along track)



Along-track scanners

Each individual detector measures the energy for a single ground resolution cell (D) and thus the size and IFOV of the detectors determines the spatial resolution of the system.

A separate linear array is required to measure each spectral band or channel.



Advantage of Along track scanner

Advantages:

- Smaller, lighter, no moving parts and consume less power.
- Long dwell time.
- Longer life expectancy.
- Most widely used scanners for earth Remote Sensing.