SENSOR PLATFORMS USED IN REMOTE SENSING:

INTRODUCTION:

A platform is the vehicle or carrier for remote sensors for which they are borne
In Meteorology platforms are used to house sensors which are obtain data for remote sensing purposes, and are classified according to their heights and events to be monitored.
In this paper we are going to discuss the various types of platforms their advantages and disadvantages.

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PLATFORMS USED FOR REMOTE SENSING:

A platform is the vehicle or carrier for remote sensors for which they are borne They are classified into three categories.

- Ground-based
- Airborne
- Space-borne

Ground-Based Platforms

Mobile Hydraulic Platforms

- Carried on vehicles

- Extendable to a height of 15m above the surface.
- At the top of the platform there are:
  - Spectral reflectance meters
  - Photographic systems
  - IR or Microwave scanners

- Linked to data loggers in the vans.

Limitation: vehicles limited to roads, and the range is confined to small area along or around the road.

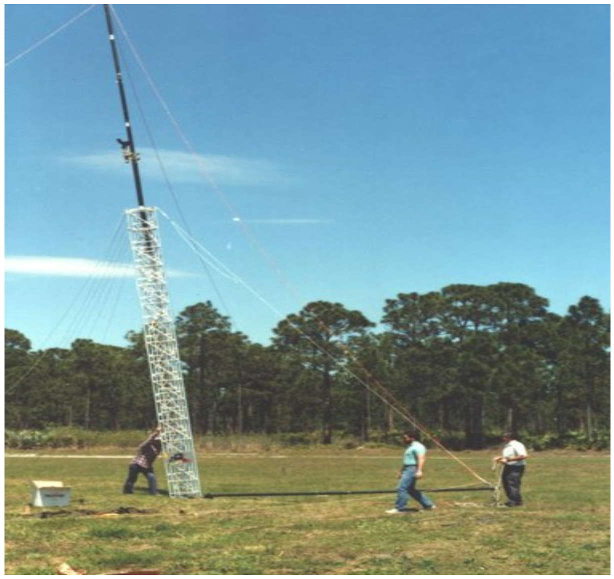
Portable Masts

- Used to support cameras and scanners
  E.g. a Land Rover fitted with an extending aerial

- Limitation: very unstable in windy conditions.

Towers

- Can be dismantled and moved from one place to another.
- Offer greater rigidity than masts but are less mobile and require more time to erect.



Weather Surveillance Radar

- A Weather Surveillance Radar is of the long range type which detects and tracks typhoons and cloud masses at distance of 400 kilometers or less.
- This radar has a rotating antenna disk preferably mounted on top of a building free from any physical obstruction.

- Radio energy emitted by the transmitter and focused by the antenna shoots outward through the atmosphere in a narrow beam.
- The cloud mass, whether it is part of a typhoon or not, reflects a small fraction of the energy back to the antenna.
- This reflected energy is amplified and displayed visually on a radar scope.
- The distance or slant range of the target from the radar is determined through the elapsed time the signal is transmitted and then received as an echo.
- Direction is determined by the direction at which the focused beam is pointing at the instant the echo is received.
- The radar is a useful tool in tracking and monitoring tropical cyclones.

Ground based platforms can also be classified according to operational range

- **Short range systems**

Operate at ranges of 50-100m with panoramic scanning and are often used to map building interiors or small objects

- **Medium range systems**

Operate at distances of 150-250m, also achieving millimeter accuracies in high definition surveying in 3D modelling applications e.g bridge and dam monitoring

- **Long range systems**

Can measure at distances of up to 1km and are frequently used in open-pit mining and topographic survey applications.

AIRBORNE PLATFORMS

BALLOON BASED MISSIONS AND MEASUREMENTS

- High flying balloons provide an important tool for probing the atmosphere. Such balloon launches form an essential part of high altitude atmospheric research.
- There are three major advantages of the balloon program Including the following:

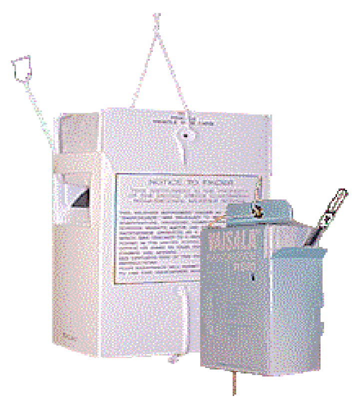
  1. The balloon has extensive altitude range they can cover. They provide a unique way of covering a broad range of altitudes for in-situ or remote sensing measurements in the stratosphere. Of particular interest is the 22-40 km region, which is higher than the altitude range of current aircraft such as the ER-2.

The balloon instruments provide the opportunity for additional, correlative data for satellite based measurements, including both validation ("atmospheric truth") and complementary data (for example, measurement of species not measured from the space based instrument).

3. Balloon based platforms constitute an important and inexpensive venue for testing instruments under development. These can be either potential instruments for unmanned aerial vehicles (UAV) or, in some cases, for satellite based remote sensing instruments.

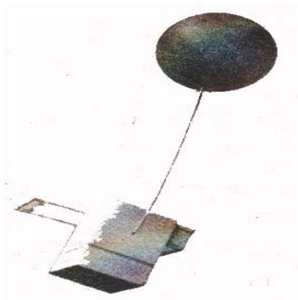
Radiosonde

- Radiosonde, an airborne instrument used for measuring pressure, temperature and relative humidity in the upper air.
- The instrument is carried aloft by a meteorological balloon inflated with hydrogen.
- The radiosonde has a built-in high frequency transmitter that transmits data from the radiosonde meter and recorded on the ground by a specially designed radiosonde receiver.



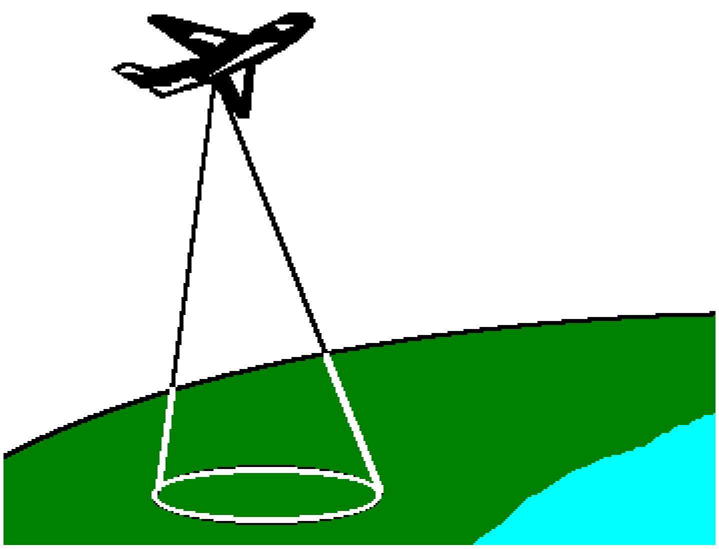
Rawinsonde

- The rawinsonde is an electronic device used for measuring wind velocity, pressure, temperature and humidity aloft. It is also attached to a balloon and as it rises through the atmosphere,



Wind Finding Radar

- It determines the speed and direction of winds aloft by means of radar echoes. A radar target is attached to a balloon and it is this target that is tracked by ground radar. The bearing and time of interval of the echoes is evaluated by a receiver.



- In airborne remote sensing, downward or sideward looking sensors are mounted on an aircraft to obtain images of the earth's surface.
- An advantage of airborne remote sensing, compared to satellite remote sensing, is the capability of offering very high **spatial resolution** images (20 cm or less).
- The disadvantages are low coverage area and high cost per unit area of ground coverage.
- It is not cost-effective to map a large area using an airborne remote sensing system.
- Airborne remote sensing missions are often carried out as one-time operations, whereas earth observation satellites offer the possibility of continuous monitoring of the earth.
- Analog aerial photography, videography, and digital photography are commonly used in airborne remote sensing.**Synthetic Aperture Radar** imaging is also carried out on airborne platforms.
- Analog photography is capable of providing high spatial resolution.
- Digital photography permits real-time transmission of the remotely sensed data to a ground station for immediate analysis.

Aircraft have several useful advantages as platforms for remote sensing systems.

- Aircraft can fly at relatively low altitudes thus allowing for sub-meter sensor spatial resolution.
- Aircraft can easily change their schedule to avoid weather problems such as clouds, which may block a passive sensor's view of the ground.
- Last minute timing changes can be made to adjust for illumination from the sun, the location of the area to be visited and additional revisits to that location.
- Sensor maintenance, repair and configuration changes are easily made to aircraft platforms.
- Aircraft flight paths know no boundaries except political boundaries.

Disadvantages of aircraft as platforms in remote sensing.

- Getting permission to intrude into foreign airspace can be a lengthy and frustrating process.
- The low altitude flown by aircraft narrows the field of view to the sensor requiring many passes to cover a large area on the ground.
- The turnaround time it takes to get the data to the user is delayed due to the necessity of returning the aircraft to the airport before transferring the raw image data to the data provider's facility for preprocessing.

AIRCRAFT PLATFORMS INSTALLED IN THE WINGS

SPACE BORNE PLATFORMS.

In space borne remote sensing, sensors are mounted on-board a spacecraft (space shuttle or satellite) orbiting the earth.

Space borne platforms include the following:

- Rockets, Satellites and space shuttles. Space borne platforms range from 100 to 36000 km above the earth's surface.

- This is shown below,

➢ Space shuttle: 250-300 km
➢ Space stations: 300-400 km
➢ Low level satellites: 700-1500 km
➢ High level satellites: About 36000 km

- In space borne platforms, sensors are mounted on-board a spacecraft (space shuttle or satellite) orbiting the earth.

Space borne remote sensing provides the following advantages:

- Large area coverage;
- Frequent and repetitive coverage of an area of interest;
- Quantitative measurement of ground features using radiometrically calibrated sensors;
- Semi automated computerised processing and analysis;

- Relatively lower cost per unit area of coverage.

SATELLITES.

A Satellite is any object man made or natural that revolves around a planet in a circular or elliptical path.

- In general, satellites are placed in one of three types of orbits around the Earth:

  Geostationary, polar or sun-synchronous.

- The type of orbit determines the design of the sensor, its altitude with respect to the Earth, and its instantaneous field of view (the area on the Earth which can be viewed at any particular moment in time).

Low level satellites: 700-1500 km

- They are also referred to as the Low level Earth observation satellites (LEO).
- LEO satellites are often sun synchronous i.e. they remain fixed with respect to the sun with the earth rotating under the satellite**.**
- These satellites are deployed as a special case of polar orbits, where each successive orbit crosses the equator at intervals of 15 degrees of longitude and precessing around the entire globe once per day.
- The satellite will pass over every location on earth at the same local solar time.
- These are the most common orbits for remote sensing satellites in order to provide illumination for passive sensors.
- Active sensors such as radar and lidar may not require the Sun's illumination for imaging, but they do rely on solar energy as a source of power.
- This reason and the global coverage provided by a polar orbit make a sun-synchronous orbit a good choice for a space borne laser profiler.

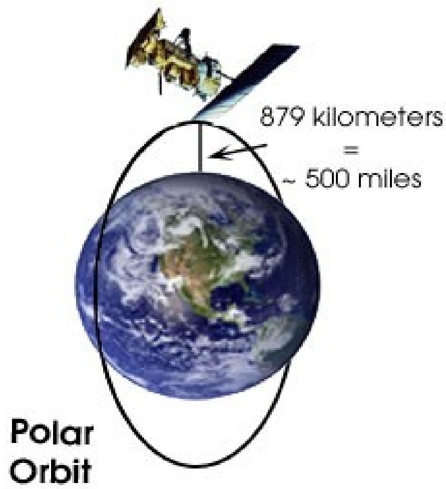
  They are divided into two broad categories namely:

  i**). Polar orbiting satellites**
  ii). Near polar orbiting satellites

i). Polar orbiting satellites

- Polar Orbiting Environmental Satellites (POES) are placed in circular sun-synchronous orbits and their altitudes usually range from 700 to 800 km, with orbital periods of 98 to 102 minutes.

- Polar orbiting satellites pass above (or nearly above) each of the Earth's poles, and pass over the equator at a different longitude, on each revolution, as illustrated in the figure below.



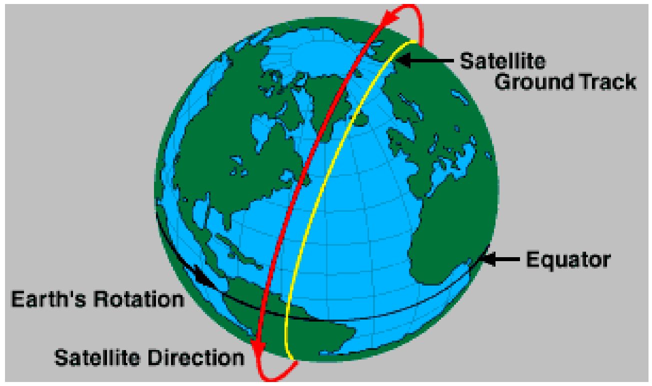
- A polar orbiting satellite eventually sees every part of the Earth's surface, which is highly desirable for remote sensing applications, including lidar.
- Polar orbiting satellite have a good spatial resolution, typically 1-50km per pixel.

- They are further subdivided into equatorial orbiting satellites whose orbits are within the plane of the equator and polar orbiting satellites whose orbits are in the plane of the earth's polar axis.

ii).Near polar orbiting satellites

- A near polar orbit is one with the orbital plane inclined at a small angle with respect to the earth's rotation axis.

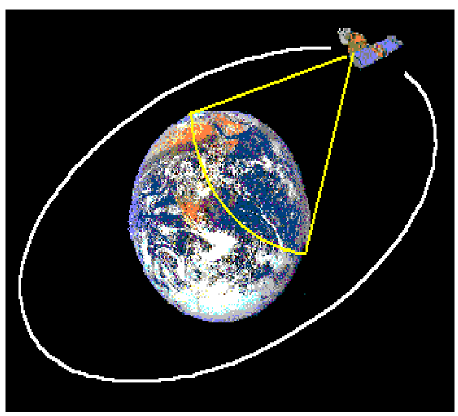
- A satellite following a properly designed near polar orbit passes close to the poles and is able to cover nearly the whole earth surface in a repeat cycle



A near-polar sun synchronous orbit

<u>High level satellites: About 36000 km</u>

- These are the Geostationary or geosynchronous satellites.
- They appear to be stationary with respect to the Earth, as shown in the Figure below,



- They must be placed at a very high altitude (~ 36,000 km) in order to produce an orbital period equal to the period of Earth's rotation.
- Any sensor onboard a geosynchronous satellite is viewing the same area of the Earth at all times, and because of the high latitude, this is usually a very large area.
- Communications and weather satellites are the most common examples of geosynchronous orbits.
- In general, imaging and mapping satellites are not geosynchronous because;

a) The resolution of imagery or mapping data acquired from this great distance would be very coarse,

b) Most satellite remote sensing applications are based on the availability of world-wide coverage,

c) Passive remote sensing systems require the Sun's illumination. While lidar, an active sensor, does not require daylight, the first two reasons make geosynchronous lidar profilers impractical.

Advantages of Geostationary Satellites for remote imaging

- The advantage of their great height is that they can view the whole earth disk below them, rather than a small subsection

- They can scan the same area very frequently (typically every 30-60 minutes). This makes them ideal for meteorological applications.

Disadvantages of Geostationary Satellites for remote imaging

- As they are positioned at such a high altitude the spatial resolution is not as good as some polar orbiting satellites.

- Since they are always positioned above the equator they can't see the north or south poles and are of limited use for latitudes greater than 60-70 degrees north or south.

- The further from the equator the lower the spatial resolution of each pixel and the greater the possibility of being hidden by the earth's curvature. So, for a typical Meteosat image a pixel near the equator may represent a 2.5Km square on the ground, but a pixel positioned for example in Northern Europe may represent 10Km on the ground and therefore provide less information (such as temperature, vegetation, wind speed, albedo, etc) per square metre.

Meteorological Geostationary Satellites

- Currently there are 6 satellites positioned at regular intervals around the equator so that the whole earth is covered.

The main satellites are:

1. **Meteosat**

- The European community satellite operated by EUMETSAT (formally part of the European Space Agency) in Germany is positioned above Europe/Africa (approx 0 degrees Longitude). This is the satellite that we receive data from Dundee.
- Meteosat also rebroadcasts data from other geostationary satellites (although at less regular intervals than its own data).
- Meteosat transmits HRI data at 1694.5 MHz, at a data rate of 166.66 kbits/s.

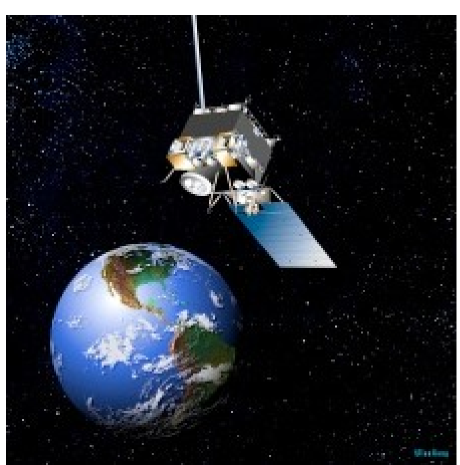
Meteosat satellite

2. **GOES-EAST**

- Operated by the US NOAA agency, positioned over USA/S.America

(75 deg. West

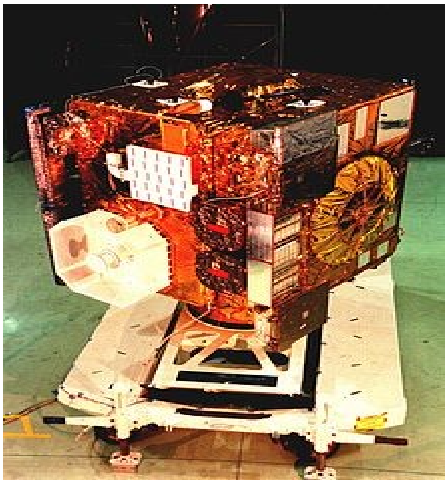
GOES-East Satellite:



3. GOES-WEST (Geostationary Operational Environmental Satellite)

- Positioned over the Pacific (135 deg. West).

GOES-west satellite:



4. GMS

- Operated by the Japanese Space Agency NASDA positioned over Japan/Australia (140 deg. East).

GMS Satellite:

5. IODC (Indian ocean data coverage)

- Meteosat-5, now re-positioned at (63 deg. East) for Indian Ocean Data Coverage

IODC SATELLITE:

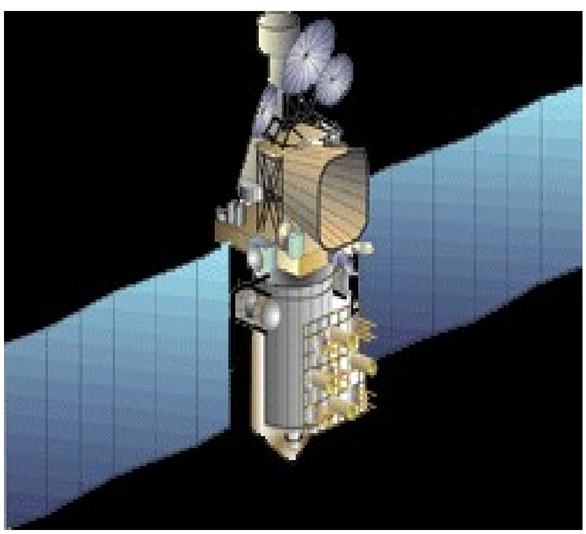
6. GOMS (Geostationary Operational Meteorological Satellite)

- Positioned at (76 deg. East)
- A Soviet **weather satellite** placed in **geostationary orbit** over the Indian Ocean; also known as Elektro.

- The year 1994 witnessed the long-awaited debut of the Geostationary Operational Meteorological Satellite (GOMS) system of Elektro spacecraft. The objectives of the program, as stated in 1991, are as follows:

- To acquire, in real time, television images of the Earth surface and cloud within a radius of 60 degrees centered at the sub-satellite point in the visible and IR regions of the spectrum;
- To measure temperature profiles of the [Earth surface (land and ocean) as well as cloud cover;
- To measure radiation state and magnetic field of the space environment at the geostationary orbital altitude;
- To transmit via digital radio channels television images, temperature and radiation and magnetrometric information to the Main and regional data receiving and processing centers;
- To acquire the information from Soviet and international data collection platforms (DCPs), located in the GOMS radio visibility, and to transmit the obtained information to the main and regional data and processing centers;
- To retransmit the processed meteorological data in the form of facsimile or alphanumerical information from the receiving and processing centers to the independent receiving stations via satellites;
- To provide the exchange of high-speed digital data (retransmissions via the satellite) between the Main and regional centers of the USSR State Committee for Hydrometeorology;

GOMS SATELLITE



SPACE SHUTTLES AND SPACE STATIONS

- The two main platforms used at typical altitudes of 250km to 400km are;

- The American Space Shuttle and, for now, the Russian MIR orbital station.

- Both the Space Shuttle and the MIR stations permit human interaction onboard allowing quick decisions and intervention on physical related problems.
- Also, by flying at lower altitudes, these sensors obtain better resolution information of the surface, not to mention the possibility of using non-electronic photographic cameras.

- Experiments were carried out on the Space Shuttle to test the accuracies and suitability for mapping of the MOMS (Modular Optoelectronic Multispectral Scanner), of the ESC (Electronic Still Camera) and of the LFC (Large Format Camera).

- The success of the tests showed that it is possible to extract information from these sets of data with enough accuracy for mapping at scales 1:25,000 and smaller MOMS has the additional advantage of taking three simultaneous views of the Earth’s surface from different angles, permitting a three-image stereoscopy in the long track direction.
- Besides taking the stereo images with smaller time delay between them, thus avoiding sun-angle variations and different illumination of the scenes, it is also advantageous in terms of the algorithm structure The good results obtained confirm the importance of this type of data, besides presenting the MOMS sensors summarized information, it also presented characteristics of the ESC and of the LFC.

RUSSIAN MIR ORBITAL STATION

CONCLUSION

Platforms have gradually developed from the simple ground based weather balloons to the more complex space borne satellite platforms.

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