Satellite

Types:

- Military and civilian Earth observation satellites
- Communications satellites
- Navigation satellites
- Weather satellites
- Research satellites.
- Space stations and human spacecraft in orbit are also satellites.

Satellite orbits vary greatly, depending on the purpose of the satellite, and are classified in a number of ways.

There are essentially three types of Earth orbits:

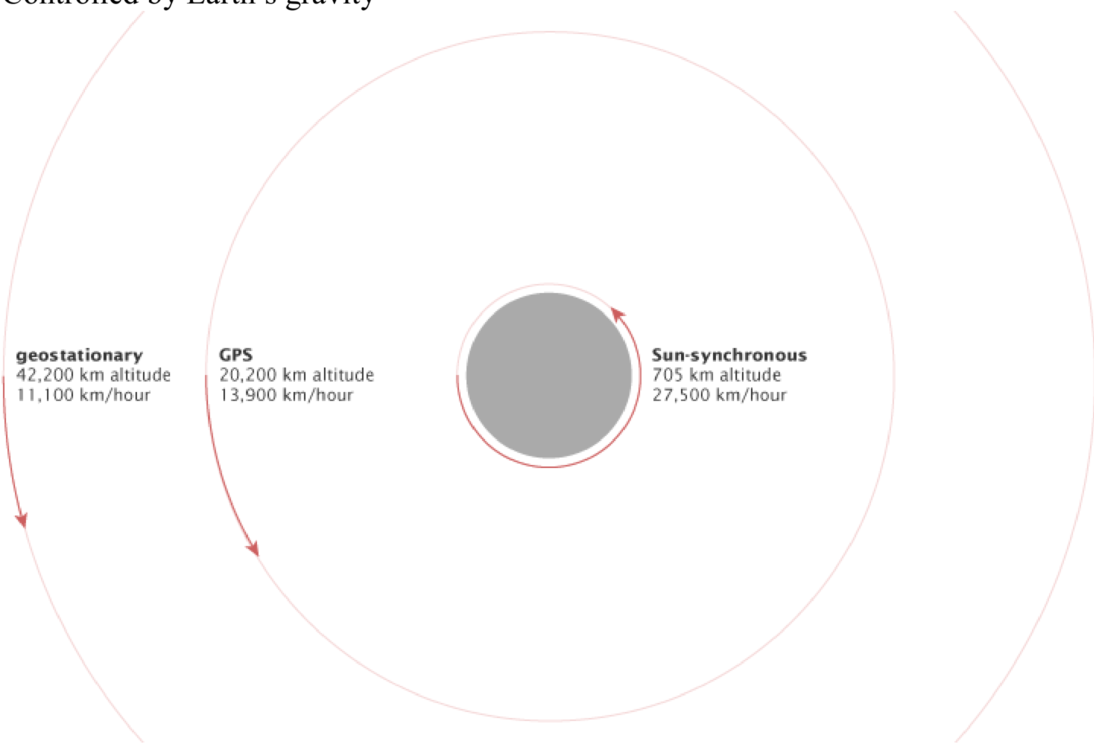
High Earth orbit - weather and some communications satellites

Medium Earth orbit - navigation and specialty satellites, monitor a particular region

Low Earth orbit - Most scientific satellites have a low Earth orbit

The height of the orbit, or distance between the satellite and Earth's surface, determines how quickly the satellite moves around the Earth.

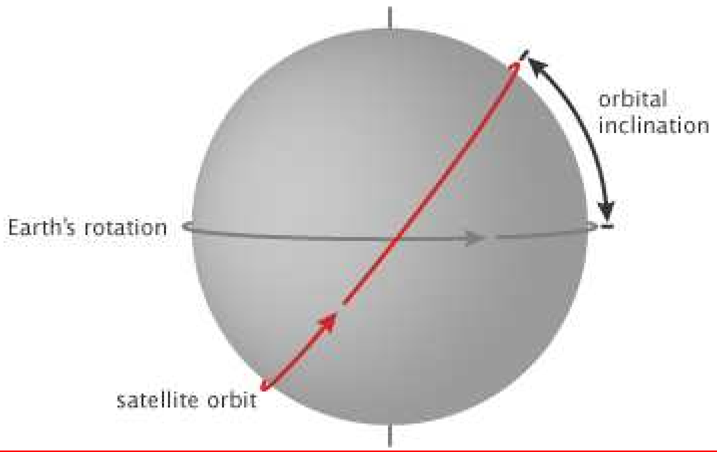
- Controlled by Earth's gravity



Changing a satellite's height will also change its orbital speed.

In addition to height, eccentricity and inclination also shape a satellite's orbit. Eccentricity refers to the shape of the orbit. A satellite with a low eccentricity orbit moves in a near circle around the Earth. An eccentric orbit is elliptical, with the satellite's distance from Earth changing depending on where it is in its orbit.

Inclination is the angle of the orbit in relation to Earth's equator. A satellite that orbits directly above the equator has zero inclination.



Together, the satellite's height, eccentricity, and inclination determine the satellite's path and what view it will have of Earth.

Well-known classes include **low Earth orbit, polar orbit, and geostationary orbit and Sun synchronous orbits:**

High Earth orbit: Geostationary orbit

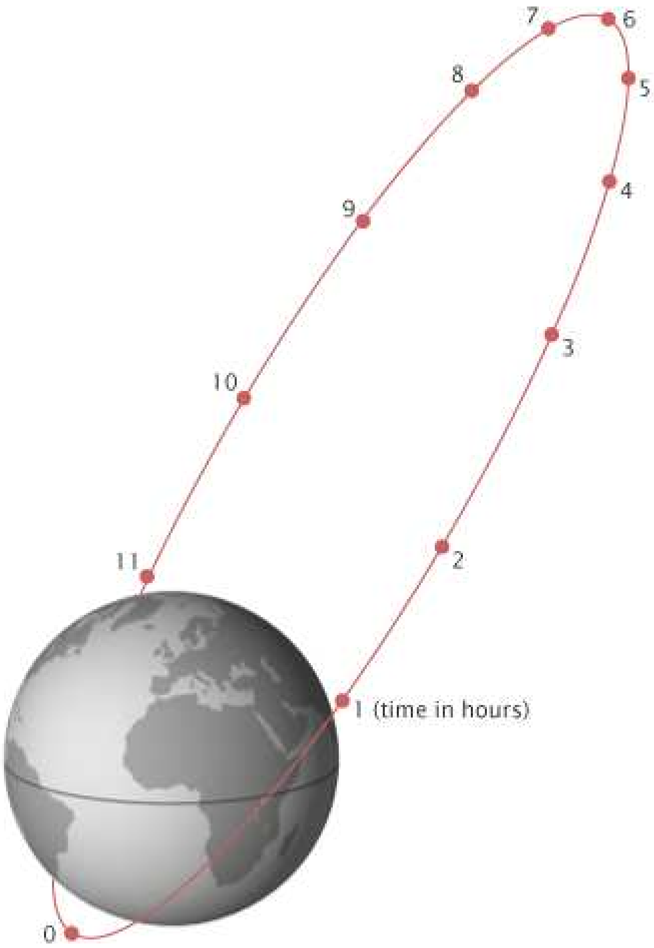
A geostationary orbit(GEO orbit),

- Circles the Earth above the equator from west to east at a height of 36 000 km.
- Takes 23 hours 56 minutes and 4 seconds
- Appear to be 'stationary' over a fixed position - does not move at all relative to the ground.
- continuously cover a large portion of the Earth
- Valuable for weather monitoring because satellites in this orbit provide a constant view of the same surface area.
- Also be useful for communication (phones, television, radio).
- A constellation of three equally spaced satellites can provide full coverage of the Earth, except for the polar regions.

Medium Earth orbit:

Closer to the Earth, satellites in a medium Earth orbit move more quickly.

- Altitude of around 1000 km
- takes 12 hours to complete an orbit
- Suited for constellations of satellites mainly used for telecommunications
- Travels at approximately 7.3 km per second.
- Two medium Earth orbits are distinguished: the semi-synchronous orbit and the Molniya orbit - offers a useful alternative for far northern or southern locations

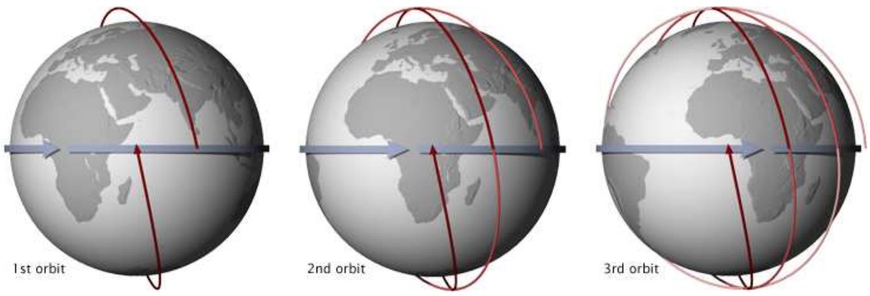


- Highly eccentric: the satellite moves in an extreme ellipse with the Earth close to one edge.
- it is accelerated by our planet's gravity

Low Earth orbit: Sun synchronous orbits

Most scientific satellites and many weather satellites are in a nearly circular, low Earth orbit. The satellite's inclination depends on what the satellite was launched to monitor.

- Whenever and wherever the satellite crosses the equator, the local solar time on the ground is always the same.
- Common for near-polar orbiting satellites
- Important for remote sensing of the atmospheric temperature.
- Compare images from the same season over several years
- The path that a satellite stays in orbit is very narrow.
  - Rapidly decay due to drag from the atmosphere
  - Regular adjustments is needed



Flying Steady

- Maintain a very precise orbit.
- Gravity pulls at the satellite, gradually tugging it towards the equator and making it necessary for engineers in mission control to correct the orbit.

To compensate for gravity's pull, Aqua's controllers have to shift the satellite's orbit toward the pole every couple of years.

Examples of satellite:

ENVISAT-1

Envisat-1 Parameters

Sponsor: European **Space Agency**
Expected Life: **5 years**
Primary Applications: **remote sensing and environmental monitoring**
Launch Date: **1 March 2002**
Orbit: **circular, sun-synchronous**
polar Inclination: **98.54 degrees**
Perigee: **796 km**
Period: **100 minutes**
Weight: **8211 kg**

- Spaceborne remote sensing systems and climatological and environmental research.
- Support the monitoring and studying of the Earth's environment and climate changes
- Understanding of the structure and dynamics of the Earth's crust and interior

The instruments are:

1. Michelson Interferometer for Passive Atmospheric Sounding (MIPAS)
2. Global Ozone Monitoring by Occultation of Stars (GOMOS)
3. SCanning Imaging Absorption spectrometer for AtMospheric CartograpHY (SCIAMACHY)
4. **MEdium Resolution Imaging Spectrometer (MERIS)**

- measures the solar radiation reflected by the Earth

- The primary mission of MERIS is the measurement of sea colour in oceans and coastal areas.
- Land and atmospheric monitoring.

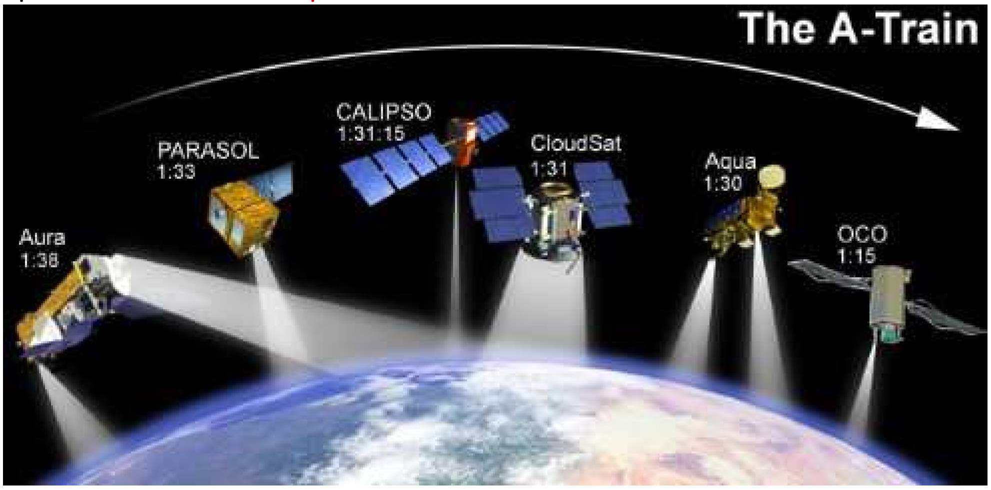
5. Advanced Along Track Scanning Radiometer (AATSR)
6. **Advanced Synthetic Aperture Radar (ASAR)**

- Largest single instrument is the Advanced Synthetic Aperture Radar (ASAR)
- Enhanced capability in terms of coverage, range of incidence angles, polarization, and modes of operation.

7. Radar Altimeter 2 (RA-2)
8. MicroWave Radiometer (MWV)
9. Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS)
10. **RetroReflector Array (RRA)**
    - To locate where the satellite is on its orbit.

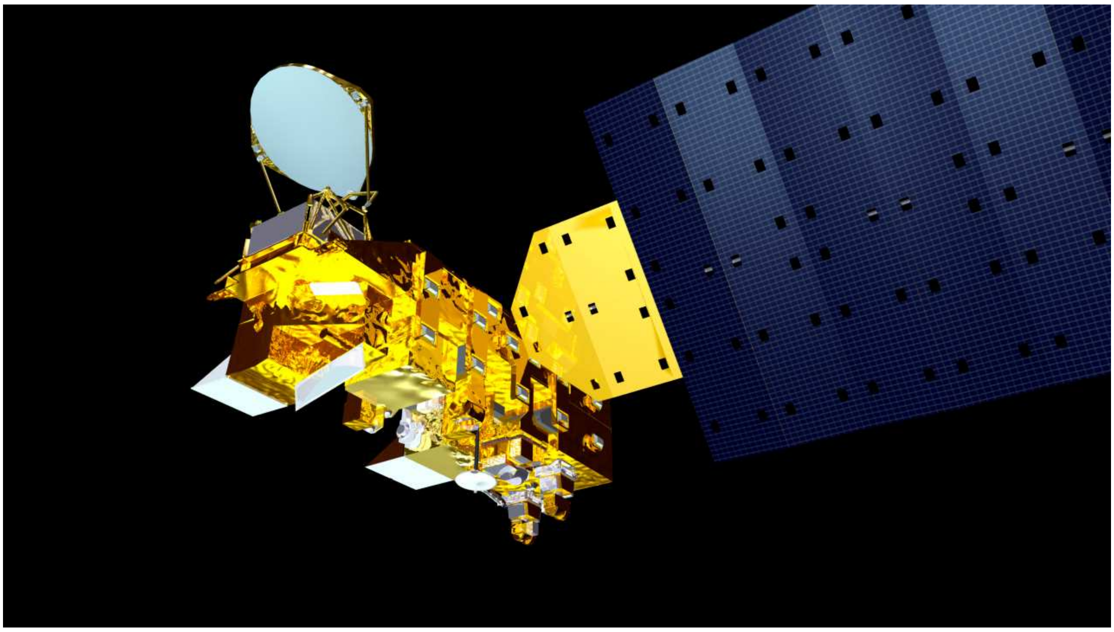
A-Train series

- seven Franco-American Earth observation satellites
- sun-synchronous orbit at an altitude of 690 kilometers above the Earth
- 5 satellites in the A-train constellation: EOS-Aqua, EOS-Aura, CloudSat, CALIPSO, and PARASOL. A 6th satellite, OCO, failed upon launch in 2009. A 7th satellite, Glory, failed upon launch in 2011.
- Spaced a few minutes apart from each other



Active:

Aqua(May 4, 2002)



Studying the **precipitation, evaporation, and cycling of water**

Aqua carries six instruments for studies of water on the Earth's surface and in the atmosphere:

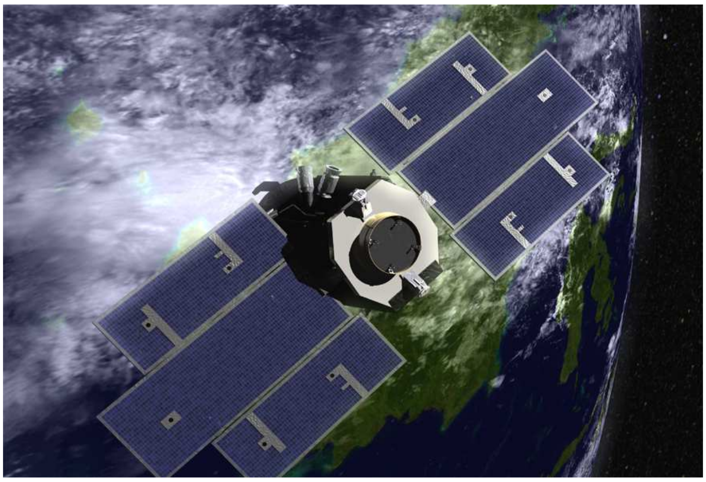
- AMSR-E — measures cloud properties, sea surface temperature, near-surface wind speed, radiative energy flux, surface water, ice and snow.
- MODIS —measures cloud properties and radiative energy flux, also aerosol properties; land cover and land use change, fires and volcanos.
- AMSU-A —measures atmospheric temperature and humidity.
- AIRS —measures atmospheric temperature and humidity, land and sea surface temperatures.
- HSB —measurs atmospheric humidity.
- CERES — measure broadband radiative energy flux.

Aura (July 15, 2004)

Carries 4 instruments for studies of **atmospheric chemistry:**

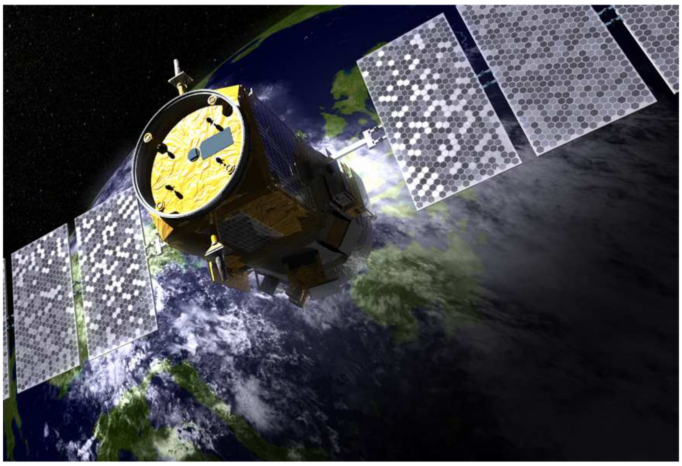
- HIRDLS —measures infrared radiation from ozone, water vapor, CFCs, methane and nitrogen compounds. (shutdown on March 17, 2008)
- MLS —measures emissions from ozone, chlorine and other trace gases, and explains the role of water vapor in global warming.
- OMI —uses ultraviolet and visible radiation to produce daily high-resolution maps.
- TES —measures tropospheric ozone in infrared wavelengths, also carbon monoxide, methane and nitrogen oxides.

CloudSat (April 28, 2006)



The main instrument on CloudSat is the Cloud Profiling Radar (CPR), a 94-GHz nadir-looking radar that measures the power backscattered by clouds as a function of distance from the radar.

CALIPSO



Passive and active remote sensing Instruments onboard the CALIPSO satellite will monitor aerosols and clouds 24 hours a day.

- CALIOP - a lidar that provides high-resolution vertical profiles of aerosols and clouds.
- WFC - a modified version of the commercial off-the-shelf Ball Aerospace CT-633 star tracker camera. It was selected to match band 1 of the MODIS instrument on the Aqua satellite.
- IIR - used to detect cirrus cloud emissivity and particle size.

Past:

PARASOL(December 18, 2004)

It carries an instrument called POLDER which studies the radiative and microphysical properties of clouds and aerosols.

On 2 December 2009, PARASOL was manoeuvred out of the A-Train, dropping some 4 km below the other satellites by early January 2010

Failed:

Orbiting Carbon Observatory (OCO) - February 24, 2009

It was mission intended to provide global space-based observations of atmospheric carbon dioxide (CO_2). The original spacecraft was lost in a launch failure on February

24, 2009, it failed to separate of the Taurus rocket during ascent. It subsequently re-entered the atmosphere and crashed into the Indian Ocean near Antarctica.

Glory - 2011-03-04

mission that would have collected data on the chemical, micro-physical and optical properties—and the spatial and temporal distributions
The satellite was lost on March 4, 2011, when its Taurus XL carrier rocket crashed.