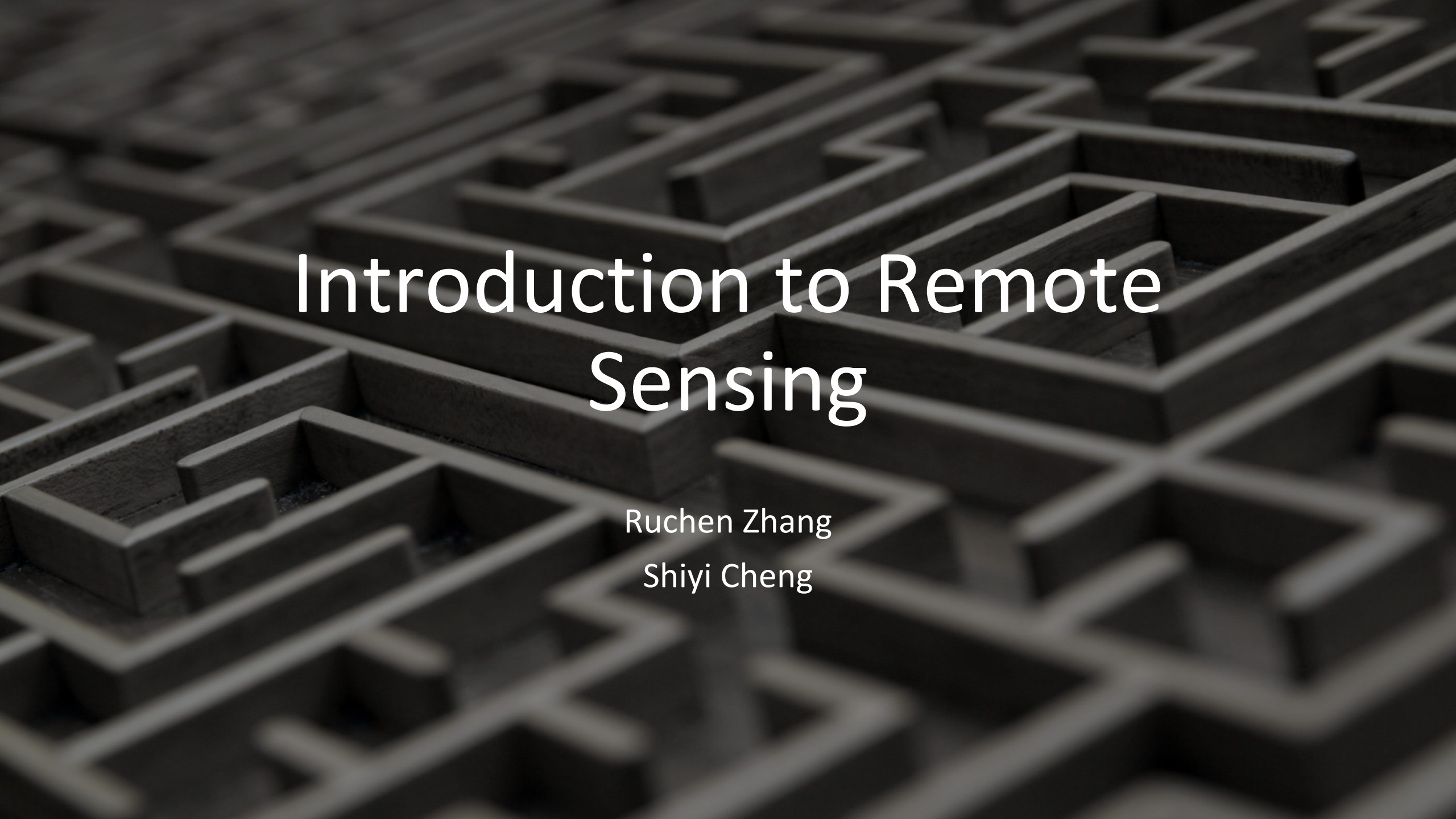

Introduction to Remote Sensing

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Outline

- Definition
- History
- Aircraft vs. Satellite
- Data collection systems

Definition of Remote Sensing

- Gathering or observation about a target by a device in distance literally
- Synonymous with the use of artificial satellites
- dates from long before the launch of the first artificial satellite
- advanced by the invention and development of radar and thermal-infrared systems(especially in the military)

History

- Coined in the early 1960s
- For the military purpose and transferred to civilian domain after World War II
- Ways to gather remotely sensed data before satellites(1960s):
  - Photogrammetric technique
  - Pinhole camera
  - Camera obscura
  - Infrared photography
  - Color-infrared photography
  - Multispectral scanners
  - Electromagnetic radiation

History

- Following World War II, aerial photographic techniques and enormous advances were made in the military front.
- Uses:
  - Provide valuable meteorological data for defense
  - locate military installations
  - follow the movements of armies
- Before 1960 —> Photo interpretation

Comparison of the Two Major Periods in the History of Remote Sensing

Prior to Space Age (1860–1960)	Since 1960
Only one kind and date of photography	Many kinds and dates of remote sensing data
Heavy reliance on the human analysis of unenhanced images	Heavy reliance on the machine analysis and enhancement of images
Extensive use of photo interpretation keys	Minimal use of photo interpretation keys
Relatively good military/civil relations with respect to remote sensing	Relatively poor military/civil relations with respect to remote sensing
Few problems with uninformed opportunists	Many problems with uninformed opportunists
Minimal applicability of the "multi" concept	Extensive applicability of the "multi" concept
Simple and inexpensive equipment, readily operated and maintained by resource-oriented workers	Complex and expensive equipment, not readily operated and maintained by resource-oriented workers
Little concern about the renewability of resources, environmental protection, global resource information systems, and associated problems related to "signature extension," "complexity of an area's structure," and/or the threat imposed by "economic weaponry"	Much concern about the renewability of resources, environmental protection, global resource information systems, and associated problems related to "signature extension," "complexity of an area's structure," and/or the threat imposed by "economic weaponry"
Heavy resistance to "technology acceptance" by potential users of remote sensing-derived information.	Continuing heavy resistance to "technology acceptance" by potential users of remote sensing-derived information.

Adapted from Colwell, 1983.

History

- In 1972, first Earth Resources Technology Satellite (Landsat-1) was launched
- Improve knowledge of more areas, ex. Environment, Science, Engineering

Archaeology and anthropology
Cartography
Geology
  Surveys
  Mineral resources
Land use
  Urban land use
  Agricultural land use
  Soil survey
  Health of crops
  Soil moisture and evapotranspiration
  Yield predictions
  Rangelands and wildlife
  Forestry - inventory
  Forestry, deforestation, acid rain, disease
Civil engineering
  Site studies
  Water resources
  Transport facilities
Water resources
  Surface water, supply, pollution
  Underground water
  Snow and ice mapping
Coastal studies
  Erosion, accretion, bathymetry
  Sewage, thermal and chemical pollution monitoring

Oceanography
  Surface temperature
  Geoid
  Bottom topography
  Winds, waves, and currents
  Circulation
  Sea ice mapping
  Oil pollution monitoring
Meteorology
  Weather systems tracking
  Weather forecasting
  Heat flux and energy balance
  Input to general circulation models
  Sounding for atmospheric profiles
  Cloud classification
  Precipitation monitoring
Climatology
  Atmospheric minority constituents
  Surface albedo
  Heat flux and energy balance
  Input to climate models
  Desertification

Natural disasters
  Floods
  Earthquakes
  Volcanic eruptions
  Forest fires
  Subsurface coal fires
  Landslides
  Tsunamis
Planetary studies

Aircraft

vs.

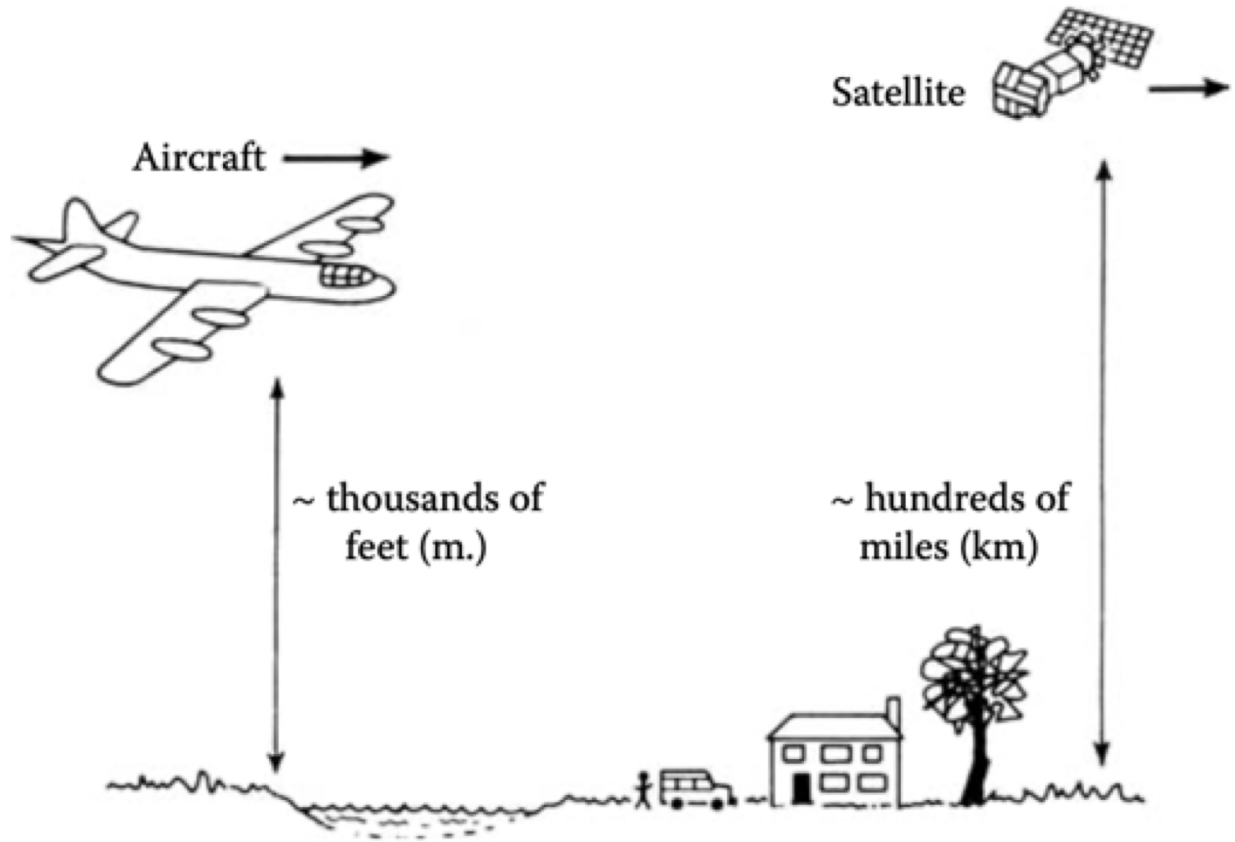
Satellites

❖ **Advantages**:

- Frequently
- Cover large areas

❖ **Disadvantages**:

- Extraction of required information may be difficult or impossible



Causes of differences in scale of aircraft and satellite observations.

Aircraft

vs.

Satellites

❖ **Difference:**

- **Aircraft**: fly lower—>see more detail on the ground

  higher frequency

- **Satellite**: regularity of coverage

  area of coverage

  fewer fuel cost

Aircraft

vs.

Satellites

❖ Four Factors:

- Extent of the area covered
- Speed of development of phenomenon to be observed
- Detailed performance of the instrument available for flying in the aircraft or satellite
- Availability and cost of the data

Advantages

- Remain in operation for many years.
- Get information in all air condition. Ex: cloudy day

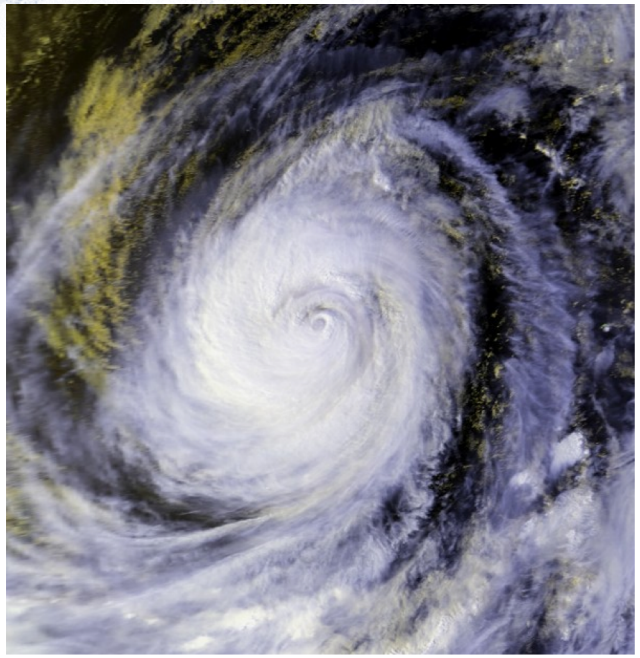
Weathering satellite

The advantage of satellite:

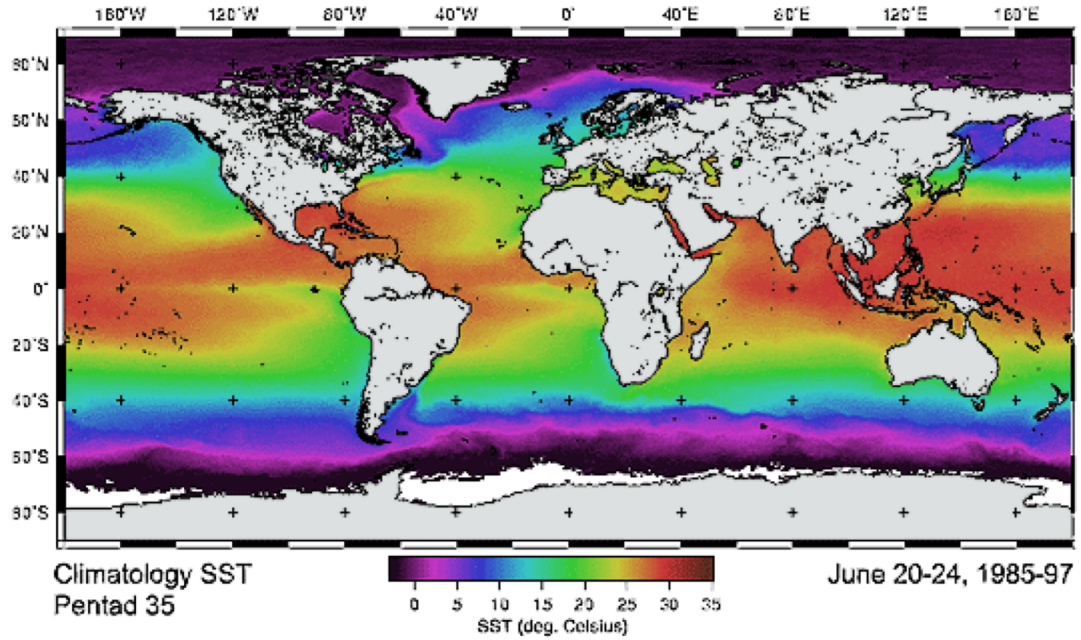
- a scale of coverage

- a regularity of coverage

Frequency and Coverage

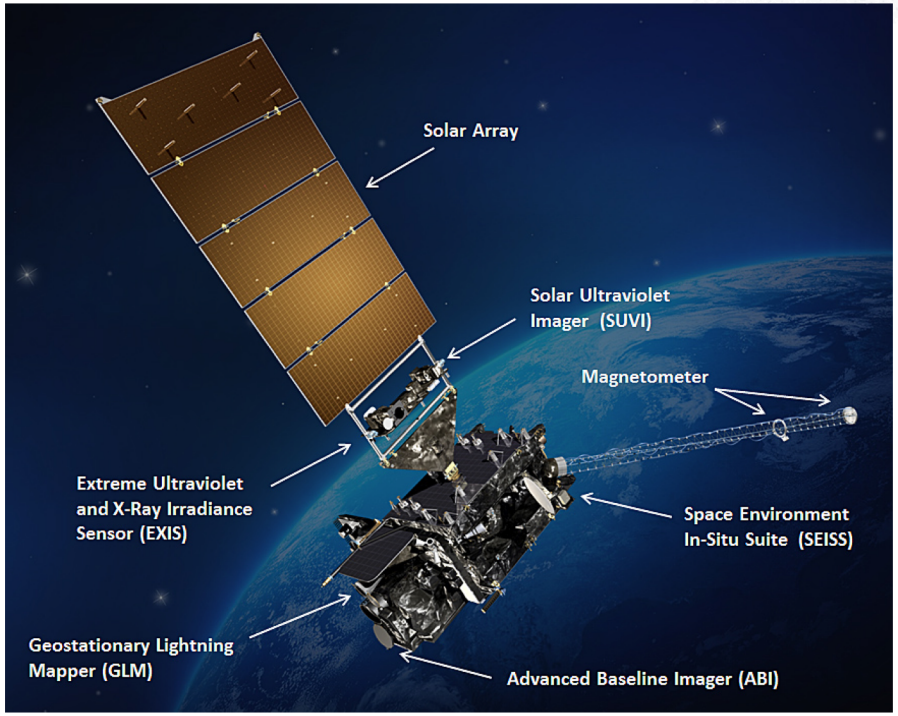


a single satellite of the polar orbiting TIROS-N series



a sensor AVHRR (the Advanced Very High Resolution Radiometer)

Frequency and Coverage



geostationary weather satellite 30% - 40%

Data collection systems

Several methods of recording and retrieving data:

- Cassette tape recorders or computer storage media, which require occasional visits to collect the data. (Amount)
- A direct radio link to a receiving station conveniently situated on the ground. (Distance)
- A radio link via a satellite

Advantages of satellite data collection systems

- convenience
- saves the cost
- distance

Two satellite based collection systems

- Geostationary systems. Ex: meteosat
- Argos data collection system

two satellite-based collection systems are complementary

- geostationary satellite
- Problems of geostationary systems:
- Locations
- Problems of polar regions

Argos satellite

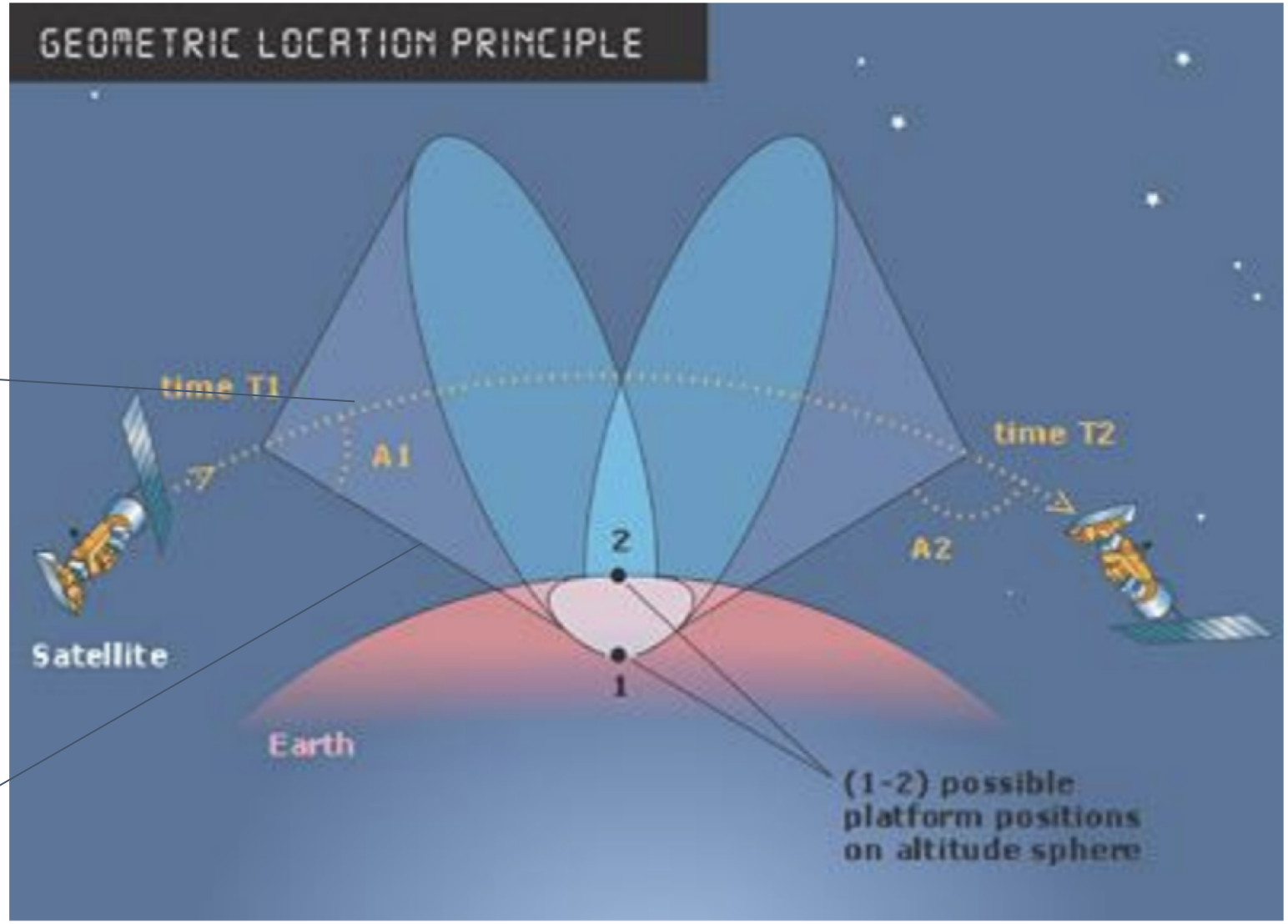
- Doppler Effect
- the change in frequency of a sound wave or electromagnetic wave that occurs when the source of vibration and observer are moving relative to each other
- Approche-Higher; Away-Lower

Location

$$f' = \left(\frac{c - v\cos\theta}{c} \right) f_0$$

where
f is transmission frequency
c is the velocity of light,
v is the velocity of the satellite
δ is the angle between the line of sight and the velocity vector of the satellite.
f0, is fixed and is nominally the same for all platforms.

the velocity vector of the satellite



the line of sigh