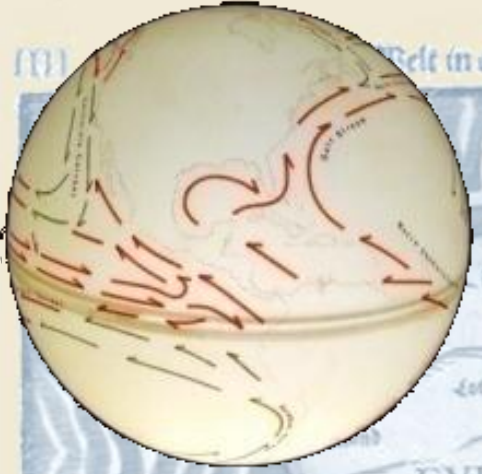
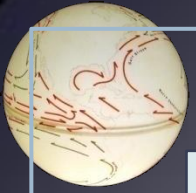


Portraying Earth Part III

A map says to you, 'Read me carefully, follow me closely, doubt me not.' It says, 'I am the Earth in the palm of your hand. Without me, you are alone and lost.'

Beryl Markham (*West With the Night*, 1946)



Portraying Earth Part III

- The Geographical Positioning System
- Remote Sensing
- Geographical Information Systems
- The Role of the Geographer

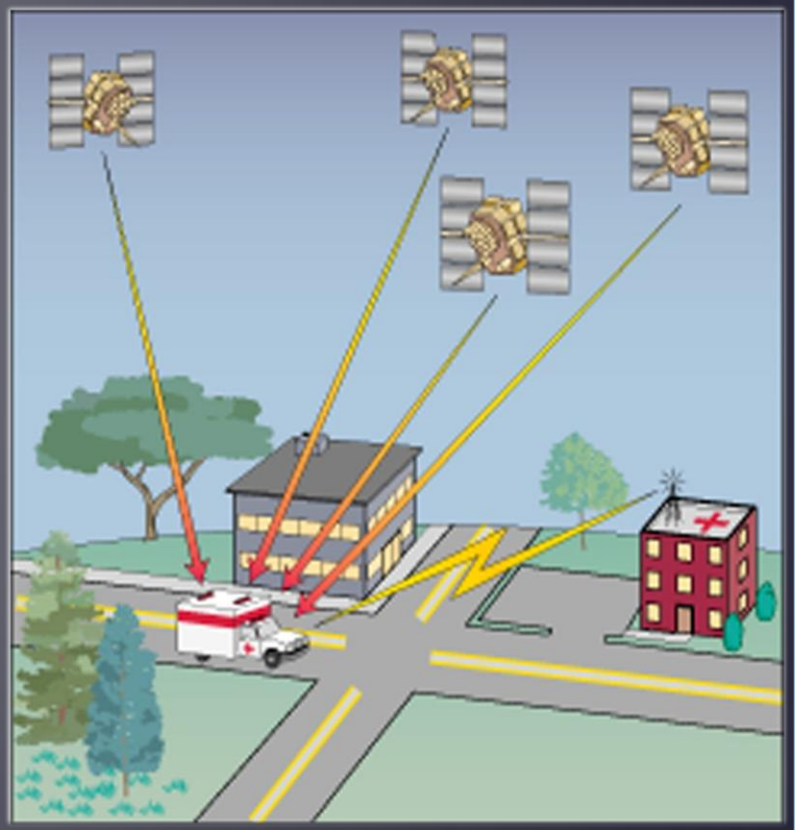
Students often have trouble with geographic names and terms. If you need/want to know how to pronounce something, try this link.

Audio Pronunciation Guide

The site doesn't list everything but it does have the words with which you're most likely to have trouble.

The Global Positioning System (GPS)

- The Global Positioning System (GPS) is a satellite-based system for determining accurate positions on or near Earth's surface. High-altitude satellites (24) continuously transmit both identification and position information that can be picked up by receivers on Earth. Clocks stored in units help in calculating the distance between the receiver and each member of a group of four (or more) satellites, so one can then determine the 3-dimensional coordinates of the receiver's position.
- Used in earthquake prediction, ocean floor mapping, volcano monitoring and mapping projects, by the military, government and business.
- Welcome to GPS.gov



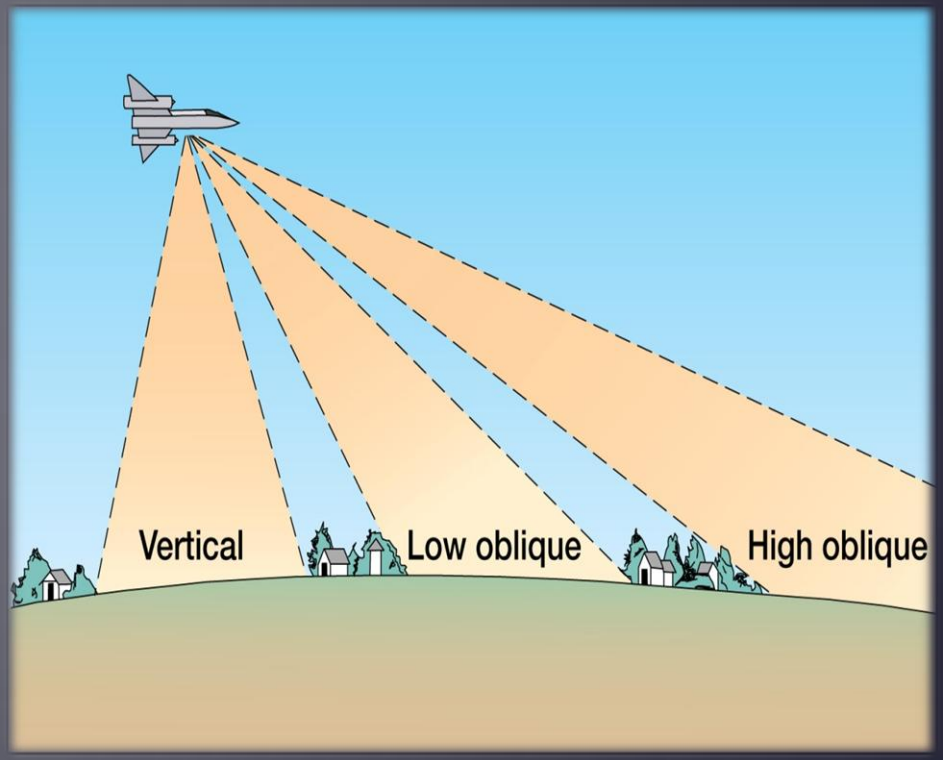
Global positioning satellites

Remote Sensing

Remote sensing is the study of an object or surface from a distance by using various instruments.

Sophisticated technology now provides a remarkable set of tools to study Earth, through precision recording instruments operating from high-altitude vantage points.

There are different kinds of remote sensing: aerial photographs, color and color infrared sensing, thermal infrared sensing, microwave sensing, radar, sonar, multispectral and SPOT imagery.



types of aerial photographs

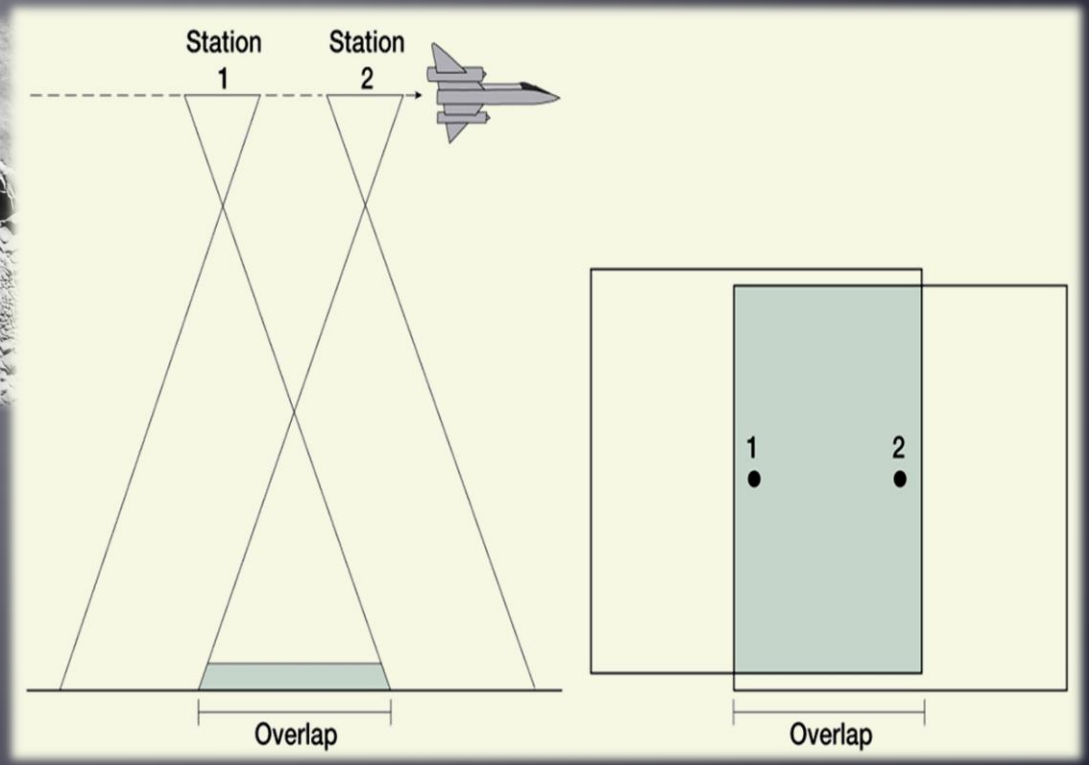
Remote Sensing

Stereoscopy is the science and art that deals with the use of binocular vision for the observation of overlapping photographs or other perspective views and the method by which such views are produced.

In practice, stereoscopic vision is produced by viewing 2 photographs of the same area taken from different angles. This results in a 3-D model. It enables us to view an object simultaneously from two different perspectives.

Remote Sensing

Stereoscopy and overlapping vertical photographs



Remote Sensing

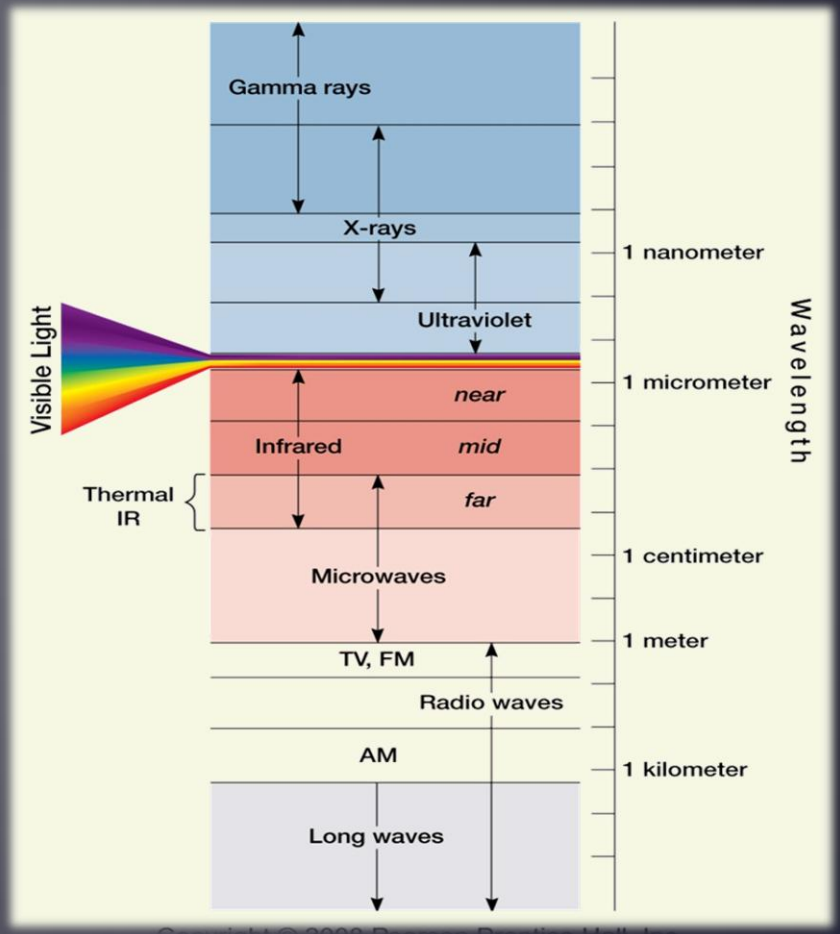
- Orthophotomaps are multi-colored, distortion-free photographic maps produced from computerized rectification of aerial imagery.
  - Show the landscape in much greater detail than a conventional map, but are like a map in that they provide a common scale that allows precise measurement of distances.
  - Particularly useful in flat-lying coastal areas because they can show subtle topographic detail.

Honolulu HA (Orthophoto map)
Source:
www.lib.utexas.edu/maps/islands_oceans_poles/hawaii_honolulu_photo.jpg

Remote Sensing

Color and Color Infrared Sensing

- Color - refers to the visible-light region of the electromagnetic spectrum.
- Color infrared (color IR) - refers to the infrared region of the spectrum.
  - Color IR film is more versatile; uses include evaluating the health of crops and trees.
  - Color IR film cannot detect much of the usable portion of the near infrared. Scanner systems have come to aid, by being able to sense much further into infrared.
  - LANDSAT - a series of satellites that orbit Earth and can digitally image all parts of the planet except the polar regions every nine days.



The electromagnetic spectrum

Remote Sensing

Color infrared film

Color infrared images of the Mississippi River

Remote Sensing

Multispectral Remote Sensing systems image more than one region of the electromagnetic spectrum at the same time from the same location.

LANDSAT

The early LANDSAT was the multispectral scanning system (MSS) - a system that images Earth's surface in several spectrum regions.

LANDSAT Sensory Systems use an MSS; and can gather more than 30 million pieces of data for one image, 115 by 106 miles.

Multispectral Scanner image of the Canyonlands region of the Colorado Plateau

Remote Sensing

Multispectral Remote Sensing systems

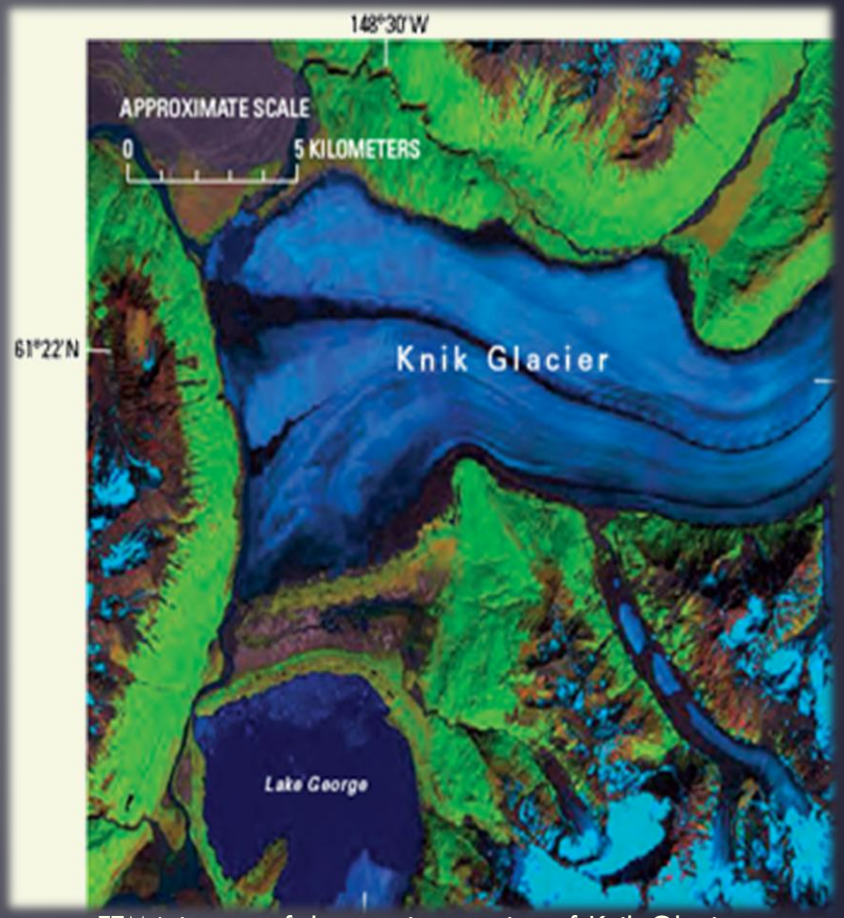
Thematic mapper instruments (TMI), sensors with improved spectral and spatial resolution such that the new satellites could see a wider (and more scientifically-tailored) portion of the electromagnetic spectrum and could see the ground in greater detail. TMI used 7 bands to improve resolution and greater imaging flexibility. Images were in 8 spectral bands with a resolution of 15 meters. It became available with the launching of LANDSAT 4 in 1982.

a TMI image of the San Francisco-Oakland-San Jose area

Remote Sensing

Multispectral Remote Sensing systems

In 1999, LANDSAT 7 was launched, carrying an enhanced thematic mapper plus (ETM+). It used 8 spectral bandwidths with a resolution of 15 meters in the panchronic band, 30 meters in the visible and infrared network and 60 meters in the thermal infrared. The ETM+ features made it a more versatile and efficient instrument for global change studies, land cover monitoring and assessment, and large area mapping than its design forebears.



ETM+ image of the terminus region of Knik Glacier and adjacent Lake George

Remote Sensing

Multispectral Remote Sensing systems

LANDSAT 8, launched in 2013, had a payload of 2 science instruments - the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). LANDSAT 8 instruments represent an evolutionary advance in technology. OLI collects data for visible, near infrared and short wave infrared spectral bands as well as a panchromatic band. TIRS collects data for two more narrow spectral bands in the thermal region formerly covered by one wide spectral band on LANDSAT 4 through 7.

OLI enhanced land mapping image of Western Australia

Remote Sensing

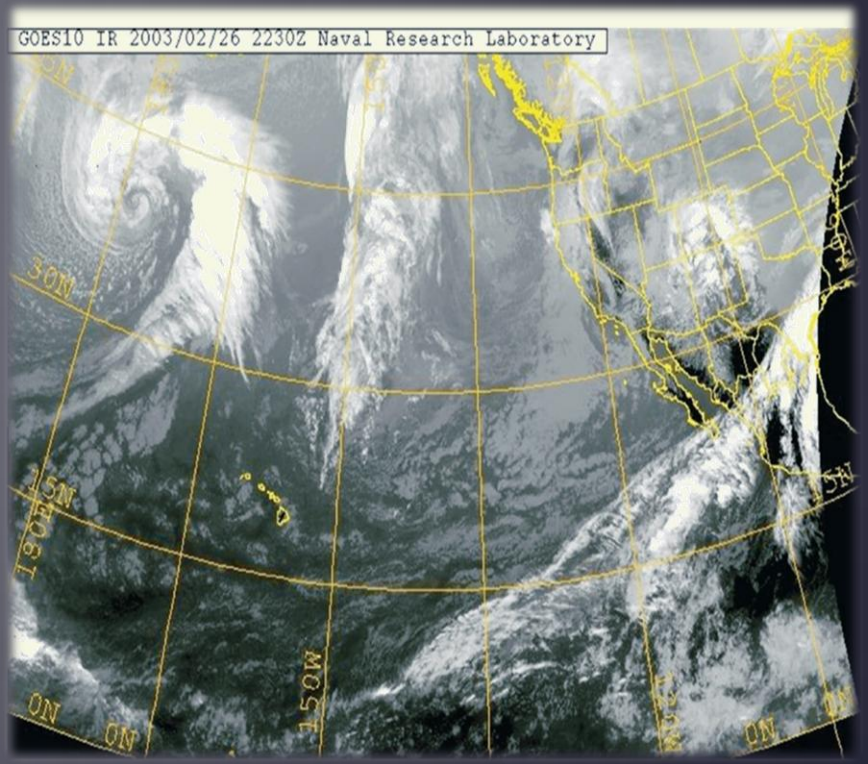
Bands of the LANDSAT 7 Enhanced Thematic Mapper Plus compared to the LANDSAT 8 Operational Land Imager and Thermal Infrared Sensor

Landsat-7 ETM+ Bands (µm)			Landsat-8 OLI and *TIRS* Bands (µm)		
			30 m Coastal/Aerosol	0.435 - 0.451	Band 1
Band 1	30 m Blue	0.441 - 0.514	30 m Blue	0.452 - 0.512	Band 2
Band 2	30 m Green	0.519 - 0.601	30 m Green	0.533 - 0.590	Band 3
Band 3	30 m Red	0.631 - 0.692	30 m Red	0.636 - 0.673	Band 4
Band 4	30 m NIR	0.772 - 0.898	30 m NIR	0.851 - 0.879	Band 5
Band 5	30 m SWIR-1	1.547 - 1.749	30 m SWIR-1	1.566 - 1.651	Band 6
Band 6	60 m TIR	10.31 - 12.36	*100 m TIR-1*	*10.60 – 11.19*	Band 10
			100 m TIR-2	*11.50 – 12.51*	Band 11
Band 7	30 m SWIR-2	2.064 - 2.345	30 m SWIR-2	2.107 - 2.294	Band 7
Band 8	15 m Pan	0.515 - 0.896	15 m Pan	0.503 - 0.676	Band 8
			30 m Cirrus	1.363 - 1.384	Band 9

Remote Sensing

Thermal Infrared Sensing (thermal IR) - middle or far infrared part of electromagnetic spectrum, can't be sensed with film. Thermal scanning is used for showing diurnal temperature differences between land and water and between bedrock and alluvium, for studying thermal water pollution, for detecting forest fires and, its greatest use, for weather forecasting.

The Geostationary Operational Environmental Satellite system (GOES) supports weather forecasting, severe storm tracking and meteorology research. The National Weather Service (NWS) uses the GOES system for its US weather monitoring and forecasting operations, and scientific researchers use the data to better understand land, atmosphere, ocean and climate interactions.



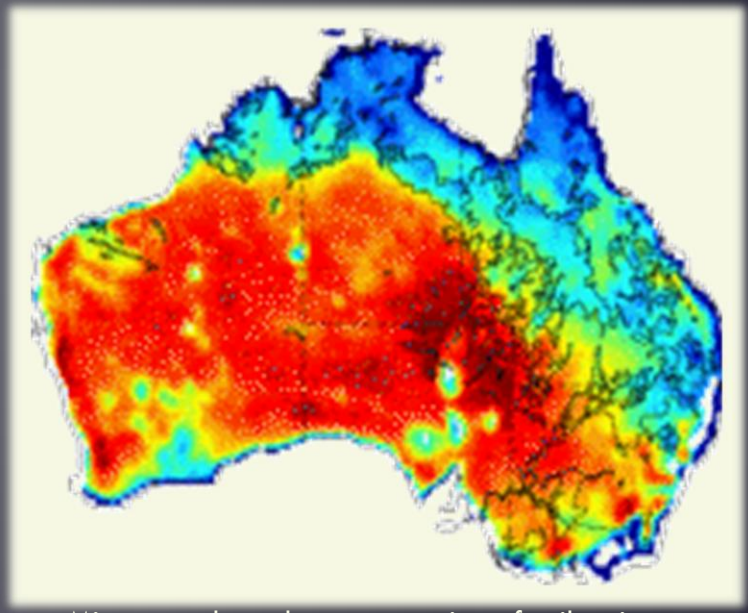
GOES-west infrared satellite image

Remote Sensing

Microwave Sensing or Microwave Radiometry senses radiation in the 100 micrometer to 1 meter range. It's useful for showing subsurface characteristics such as moisture.

Too, because of their long wavelengths compared to the visible and infrared, microwaves have special properties that are important for remote sensing. Longer wavelength microwave radiation can penetrate through cloud cover, haze, dust and all but the heaviest rainfall.

This property allows data collecting at any time but these maps are generally not very detailed. However, they are very useful in depicting characteristics that exist beneath the surface of the Earth.



Microwave based remote sensing of soil moisture

Remote Sensing

Radar and Sonar Sensing

Radar (radio detection and ranging) senses wavelengths longer than 1 millimeter and now provides images in photo-like form. Radar is unique in its ability to penetrate atmospheric moisture, so it can analyze wet tropical areas that can't be sensed by other systems. Radar is particularly useful for terrain analysis.

Sonar (sound navigation ranging) permits underwater imaging. This allows scientists to accurately map the ⅔ of the Earth that is under water. One common use of sonar sensing is in fishing boats. By using sonar, a small onboard computer calculates the depth of a lake and the location of nearby fish.

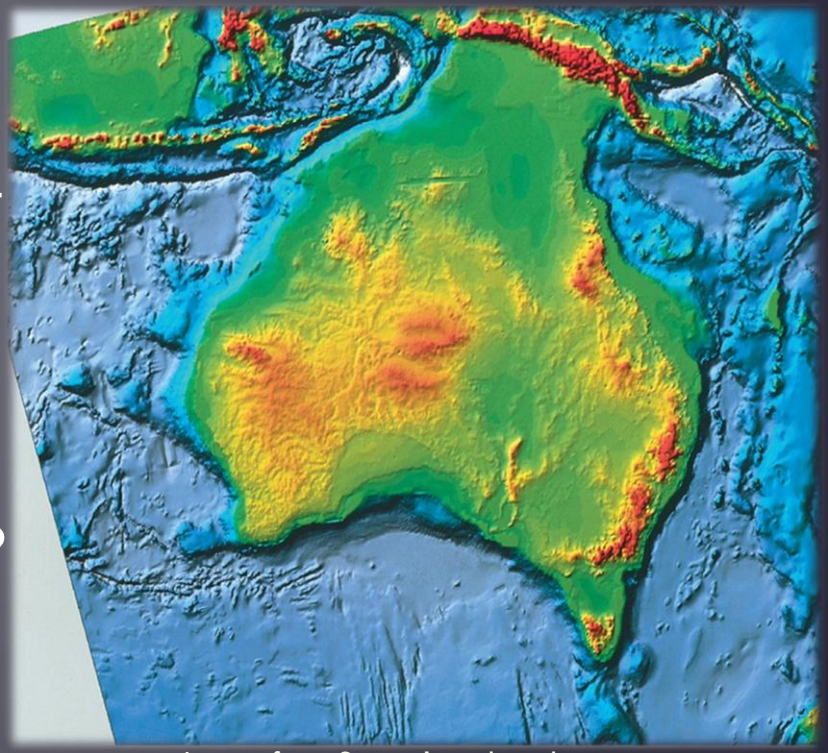
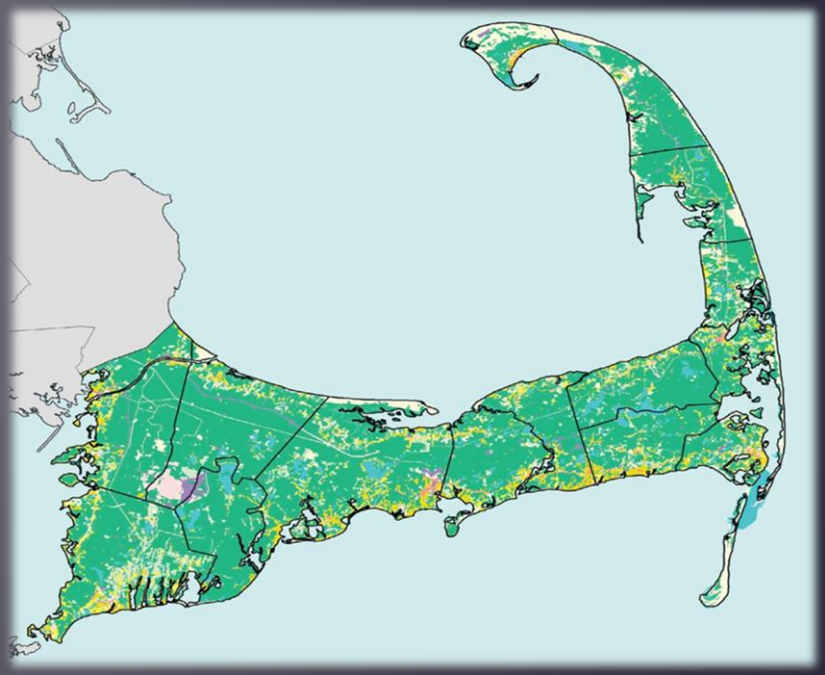


Image from Seasat's radar altimeter

Geographic Information Systems (GIS)

The advent of cheap and powerful computers over the last few decades has allowed for the development of innovative software applications for the storage, analysis and display of geographic data. Many of these applications belong to a group of software known as Geographic Information Systems (GIS).

GIS can show many different kinds of data on one map. This enables people to more easily see, analyze and understand patterns and relationships.



Example: Land Use on Cape Cod

Geographic Information Systems (GIS)

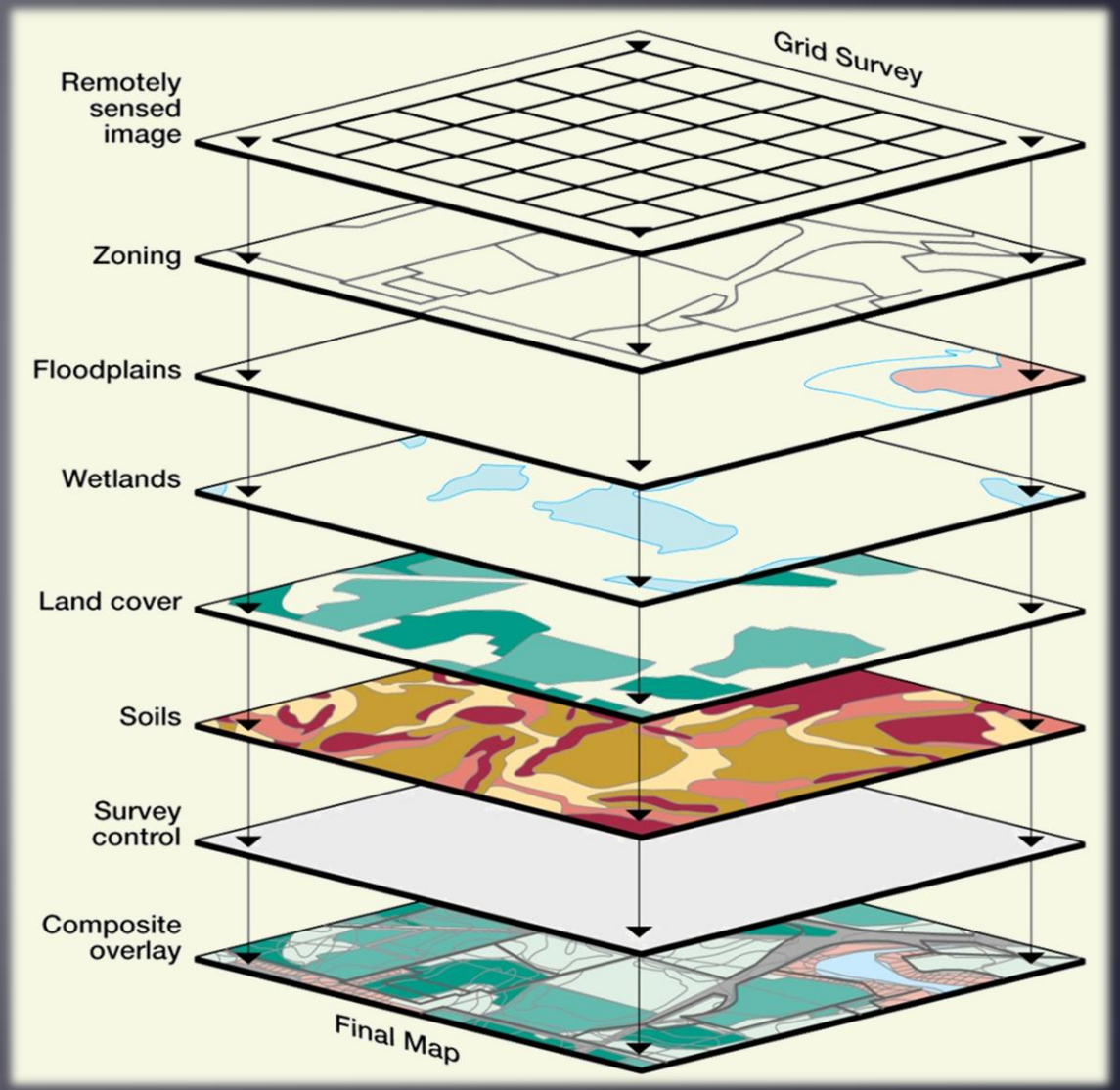
The activities normally carried out using GIS include:

- The measurement of natural and human-made phenomena and processes from a spatial perspective. These measurements emphasize three types of properties commonly associated with these types of systems: elements, attributes and relationships.
- The storage of measurements in digital form in a computer database. These measurements are often linked to features on a digital map. The features can be of three types: points, lines or areas (polygons).
- The analysis of collected measurements to produce more data and to discover new relationships by numerically manipulating and modeling different pieces of data.
- The depiction of the measured or analyzed data in some type of display - maps, graphs, lists or summary statistics.

Geographic Information Systems (GIS)

GIS work involves layers of data.

It's mainly used in overlay analysis, where two or more layers of data are superimposed or integrated.



The Role of the Geographer

- Maps, globes, map projections, GPS, remote sensing and GIS are tools of the geographer. They provide various ways the geographer can portray and study Earth's surface.
- Because of the many modern technologies available today, geographers are able to depict the Earth more accurately than has ever been possible before.
- In cartography related areas, the geographer might:
  - design paper or digital maps
  - use GIS to acquire, manage, display and analyze spatial data in digital form
  - record, measure and plot electromagnetic radiation data from aerial photographs and remote sensing systems against land features identified in ground control
  - understand the underlying theories and methods related to acquiring an object without contacting it physically (eg, aerial photography, radar and satellite imaging)

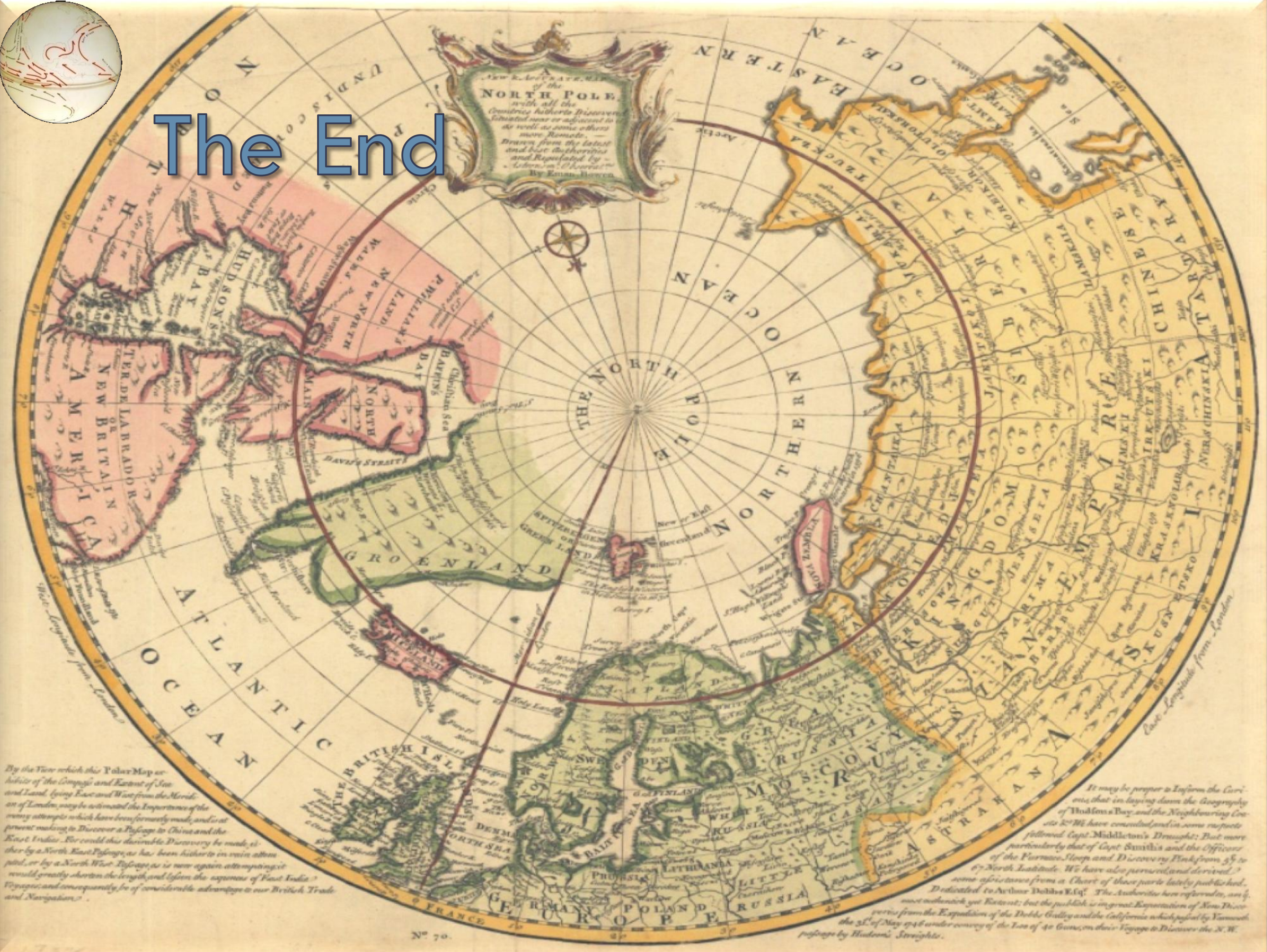
The Role of the Geographer

method	Traditional cartographic methods & techniques	Cartographic methods & techniques using modern visualization technology
practitioner	Cartographer	Geoscientist, All users of the web
communication	Classical communication model	Modern communication model
product	Defined spatial data & their attributes	Any spatial & temporal question, semantics
user	Target or user group, Goal of the map	Target or user group, Map maker (presentation, exploration)
measure of effectiveness	Established tradition	Effectiveness of tools ensured through defined standards & specifications

Summary

- Longitude and latitude lines locate any spot on Earth's surface.
- The longitude-latitude grid is anchored by the poles and the equator.
- Geographers can portray Earth's surface in many ways. Each method has its advantages.
- Geography is increasingly more valuable to government and business, as technological advances in computer mapping, imaging and satellite remote sensing continue to occur.

The End


NORTH POLE
THE NORTH POLE
NORTHERN OCEAN
EASTERN OCEAN
ATLANTIC OCEAN
HUDSON'S BAY
NEW BRITAIN
AMERICA
GROENLAND
DAVIS'S STREIT
SPITZBERGEN
NOVA ZEMBLA
ICELAND
LAPLAND
SWEDEN
FINLAND
MOSCOVY
RUSSIA
NORTH SEA
BALTIC SEA
PRUSSIA
POLAND
GERMANY
FRANCE
EUROPE
THE BRITISH ISLES
Arctic Circle
No. 70.