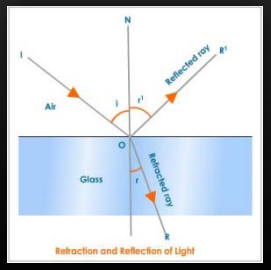
HISTORY OF REMOTE SENSING

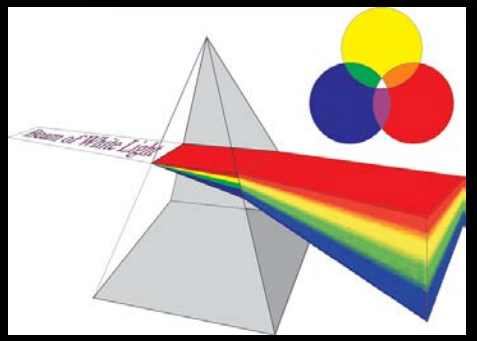
IMPORTANT PERIODS

- The beginning: photography and flight (1858-1918)
- Rapid developments in photogrammetry (1918-1939)
- Military imperatives (1939-1945)
- Cold wars and environmental concerns (1946-1971)
- Dawning of a new age (1972-1986)
- Commercialization, and geo-location (1986-1999)
- No place left to hide (2000-future)

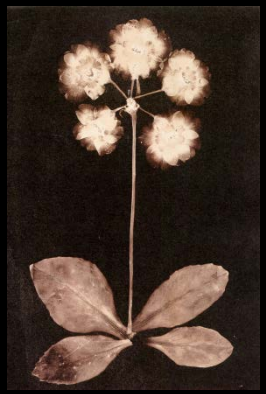
- 5th-4th Centuries B.C. Chinese and Greek philosophers describe the basic principles of optics and the camera.



- 1664-1666 Isaac Newton discovered that white light is composed of different colors.



- 1727 Johann Heinrich Schulze discovered that silver nitrate darkened upon exposure to light.



‘Sun pictures’

STEPPING STONES

- 1814 Joseph Niepce achieves first photographic image with *camera obscura* - however, the image required eight hours of light exposure and later faded.
- 1837 Louis Daguerre's first daguerreotype - the first image that was fixed and did not fade and needed under thirty minutes of light exposure.

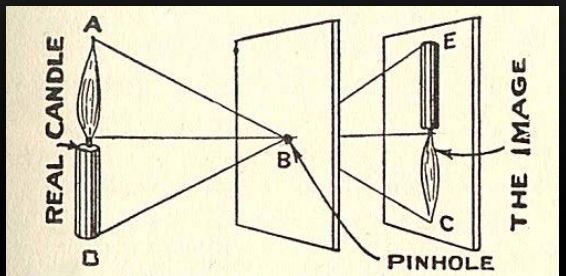


FIG. 131.—How Light and a Pinhole Form an Image.

Boulevard du temple 1838

LEADING TO ….

Photography (as we know it) – ‘light drawing’ – invented in the early1800’s

View from the Window at Le Gras" (circa 1826)

WORLD’S OLDEST PHOTOGRAPH

- From the beginning, the potential of aerial photography for topographic mapping was clear
- Early platforms used for aerial photos included:
  - balloons
  - pigeons
  - kites

PHOTOGRAPHIC EXPLORATIONS

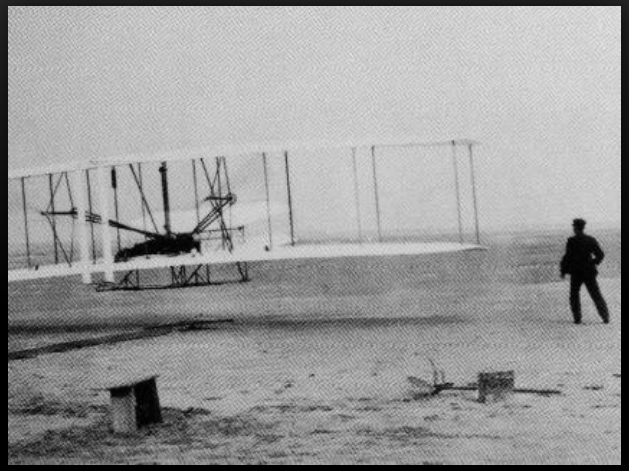
A photo taken by Alfred Nobel in 1897, from a rocket

Photos of and by Alfred Maul's rocket, launched in 1904

ROCKETS, FROM 1897 ON

San Francisco after the earthquake and fire of 1906 (bottom photo) – kite photos.

AERIAL PHOTOGRAPHY ENGAGES



1903 – the first flight

The advantages afforded by aerial surveillance quickly become apparent during First World War.

FLIGHT BECOMES A REALITY

Boston in 1860

London in the 1920's

EARLY AERIAL PHOTOGRAPHS

THE YEARS BETWEEN THE WARS

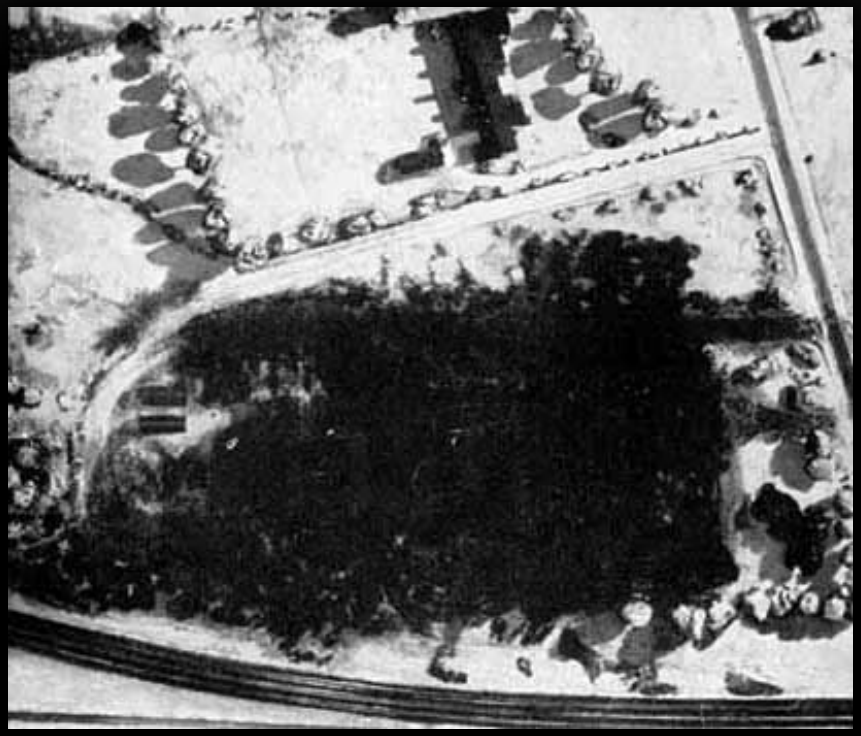
- After the war, planes and pilots and cameras spread widely
- Development of photogrammetric hardware (analog stereoplotters)

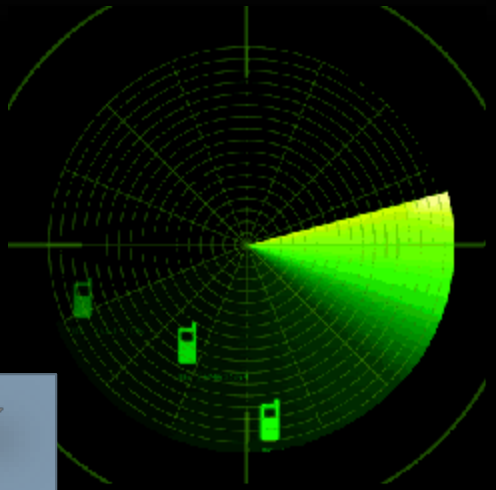
- Widespread use of aerial photos in forest inventory, geologic mapping, soil surveys
- Close cooperation between military and non-military groups in advancing the use of aerial photography

THE SECOND WORLD WAR (1939-1945)

- Aerial photography emerges as a key military asset
- Photo interpretation becomes a fine art
- Photogrammetric equipment makes great strides
- Colour infrared film is developed and used for camouflage detection
- RADAR is operationalized
- Remote sensing becomes a classified technology

IR FILM: REVEALING THE HIDDEN

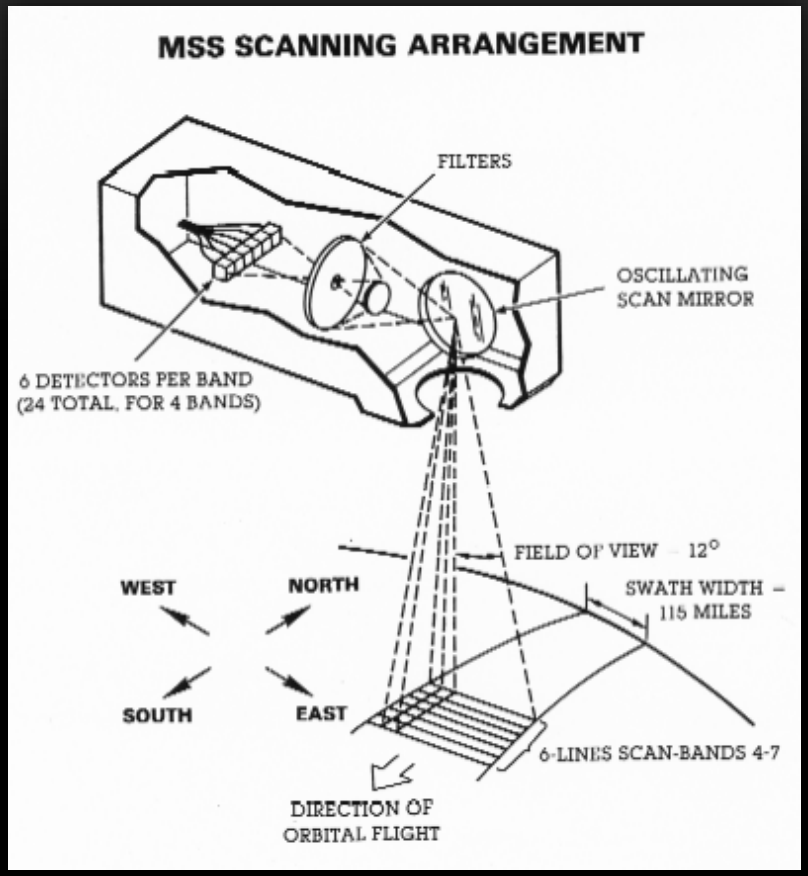




RADAR: MICROWAVES, OUT OF THE OVEN

THE COLD WAR YEARS (1945-1971)

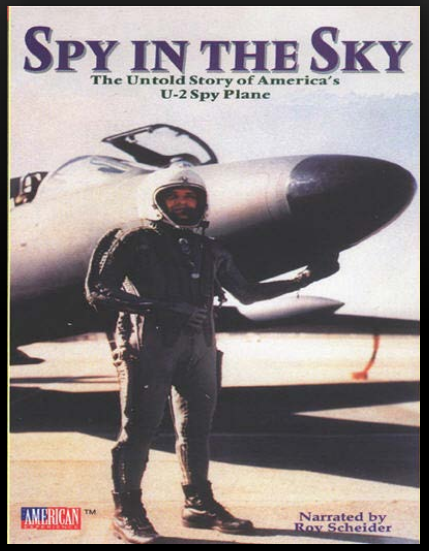
- Military photo interpreters apply their skills to civilian topographic mapping, geology and engineering
- New platforms emerge, such as spy planes (U-2) and rockets / satellites
- Imaging systems are developed (replacing film-based devices) for radar and multispectral scanners
- The politics of remote sensing become an international issue (open skies?—nyet)

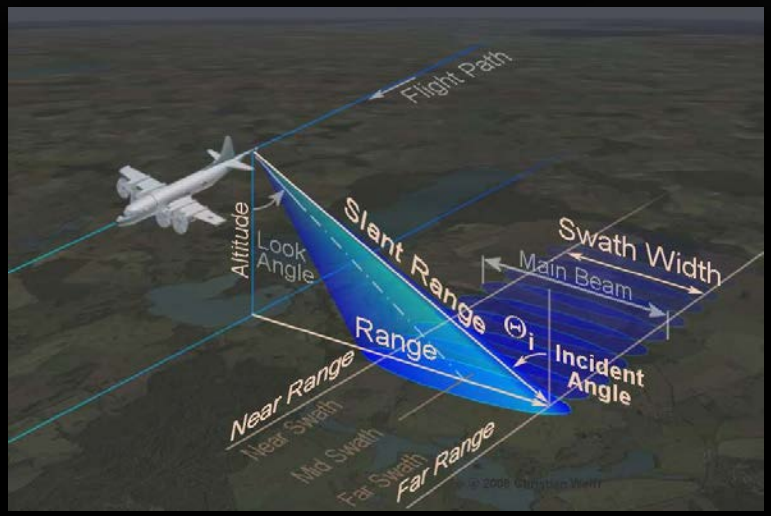


digital

analog

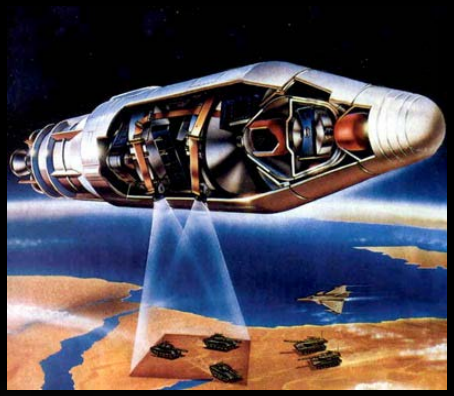
SCANNING VS FRAME-BASED SENSORS





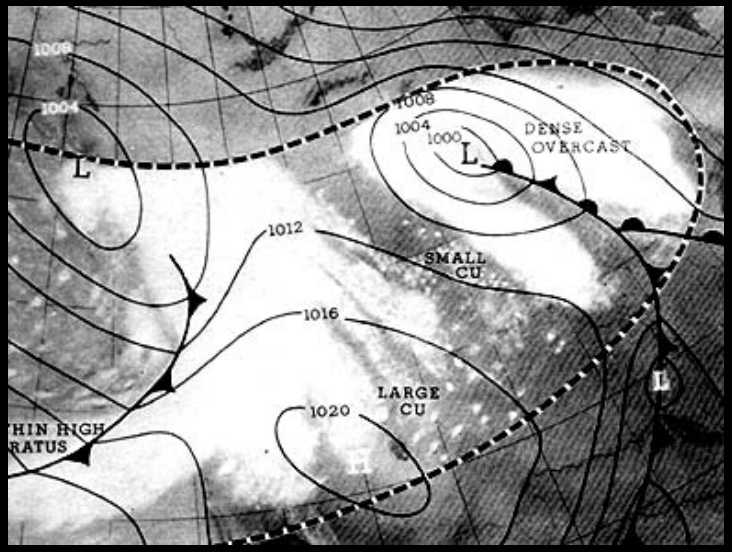
Side-looking airborne radar

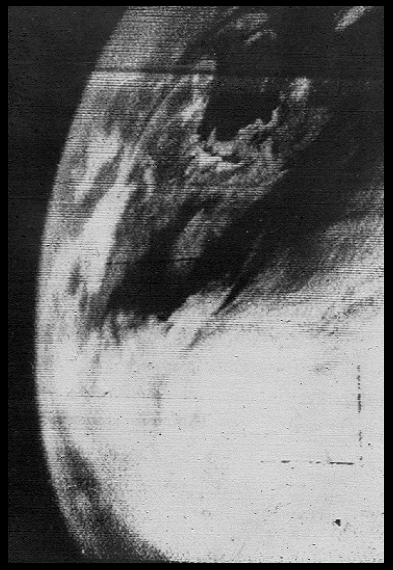
Corona



NEW PLATFORMS, TECHNOLOGIES

The first nonmilitary earth observing satellite was designed to transmit television pictures back to earth showing broad weather patterns (1960).

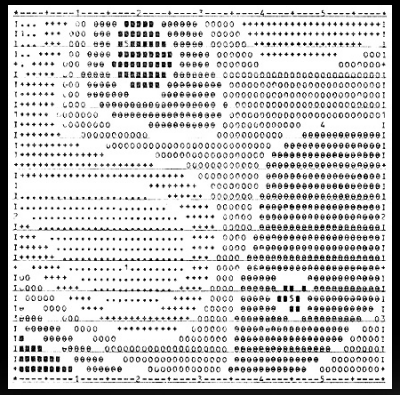


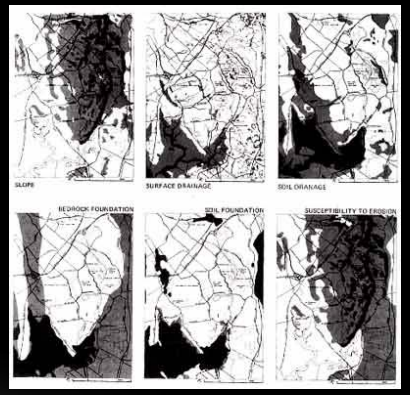


WEATHER SATELLITES

- Geographic Information Systems are developed
  - Environment Canada's CGIS (early 60's)
  - Harvard Graphics Lab's SYMAP
  - US Census' DIME
- Ian McHarg's (1969) *Design with Nature* published
- Bibby & Mackney (1969) *Land use capability classification*

SYMAP output

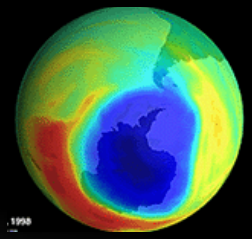




Mylar overlays

EMERGING ENVIRONMENTAL CONCERNS

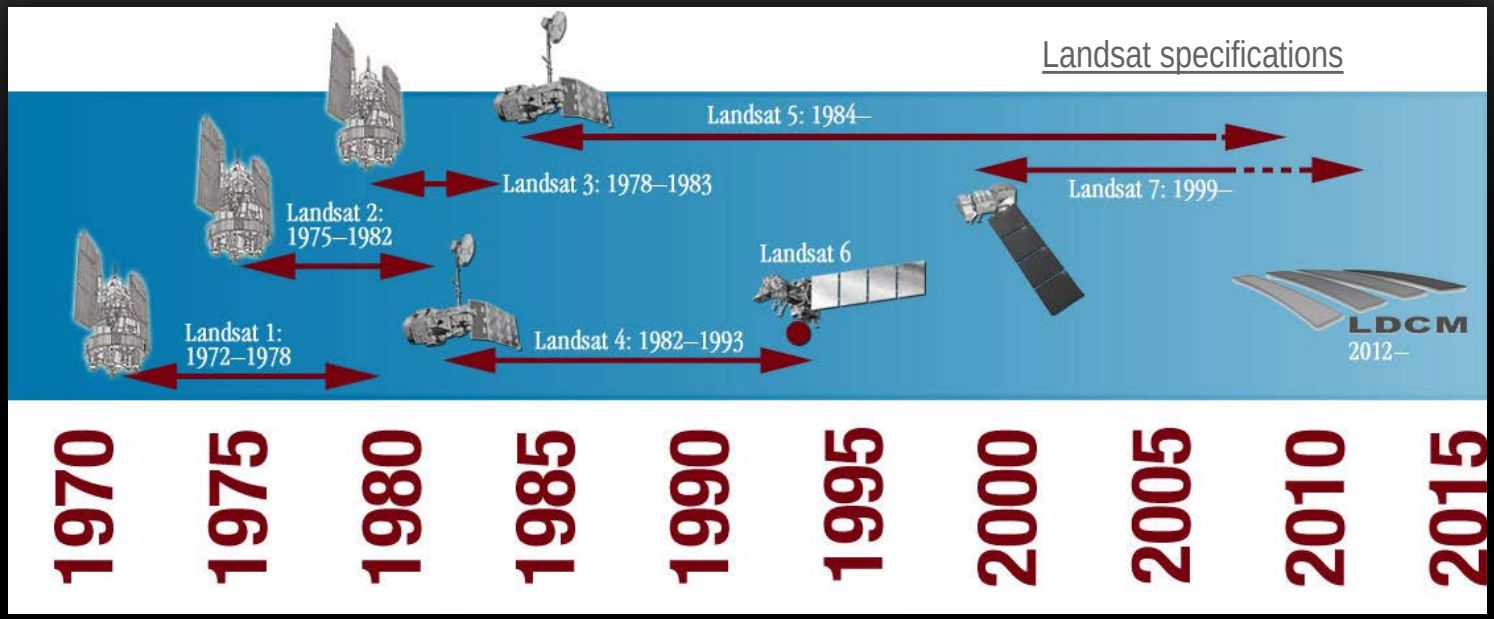
- From the early 70’s to the mid 80’s, remote sensing promised much, but had trouble fully delivering on that promise
- More open cooperation with researchers
- Multiple satellite-based sensors launched
  - LANDSAT (monitoring land resources)
  - AVHRR (monitoring meteorological conditions)
  - SeaSat (oceanographic research using radar)
  - TOMS (ozone mapping)

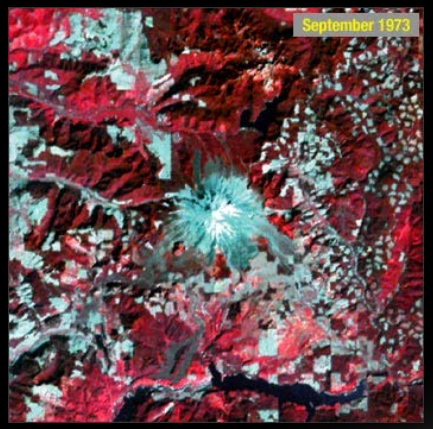


Ozone ‘hole’ over the Antarctic

DAWNING OF A NEW AMERICAN AGE

Landsat specifications





Mount St. Helens
before and after

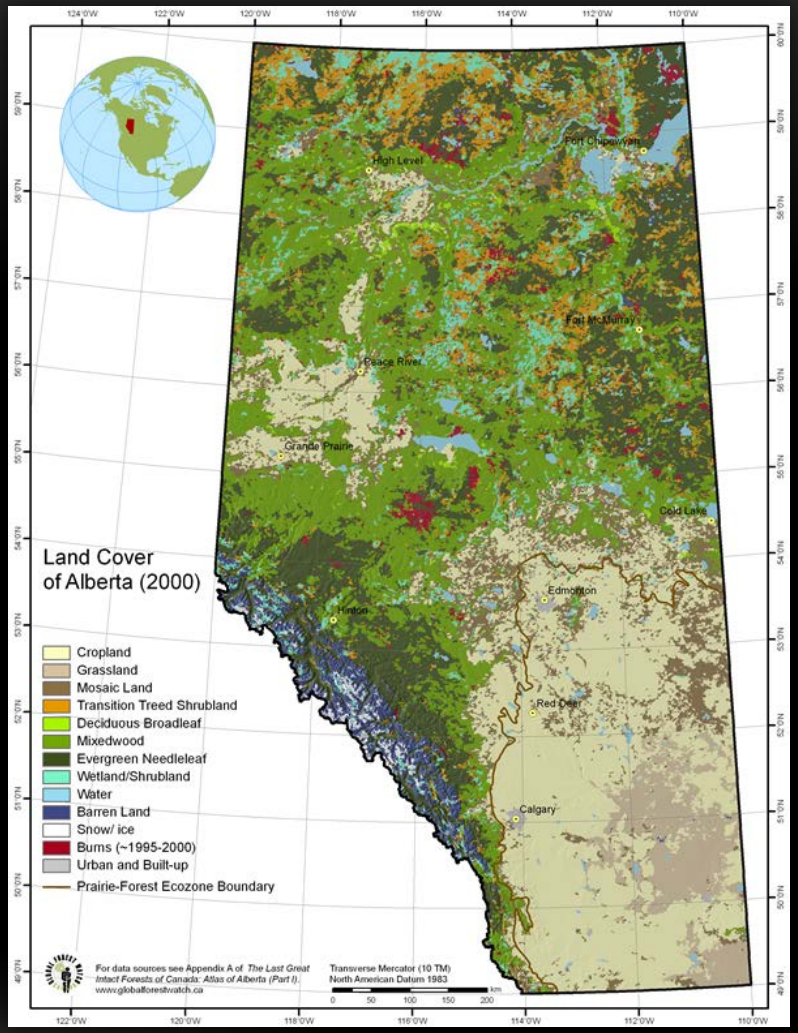
Landsat Applications

Agriculture, Forestry and Range Resources	Land Use and Mapping	Geology	Hydrology	Coastal Resources	Environmental Monitoring
Discriminating vegetative, crop and timber types	Classifying land uses	Mapping major geologic features	Determining water boundaries and surface water areas	Determining patterns and extent of turbidity	Monitoring deforestation
Measuring crop and timber acreage	Cartographic mapping and map updating	Revising geologic maps	Mapping floods and flood plain characteristics	Mapping shoreline changes	Monitoring volcanic flow activity
Precision farming land management	Categorizing land capabilities	Recognizing and classifying certain rock types	Determining area extent of snow and ice coverage	Mapping shoals, reefs and shallow areas	Mapping and monitoring water pollution
Monitoring crop and forest harvests	Monitoring urban growth	Delineating unconsolidated rocks and soils	Measuring changes and extent of glacial features	Mapping and monitoring sea ice in shipping lanes	Determining effects of natural disasters
Determining range readiness, biomass and health	Aiding regional planning	Mapping volcanic surface deposits	Measuring turbidity and sediment patterns	Tracking beach erosion and flooding	Assessing drought impact
Determining soil conditions and associations	Mapping transportation networks	Mapping geologic landforms	Delineating irrigated fields	Monitoring coral reef health	Tracking oil spills

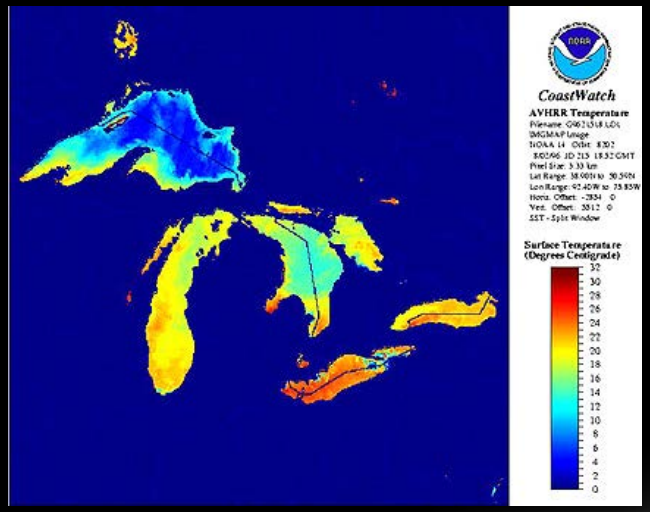
http://landsat.gsfc.nasa.gov/about/appl_matrix.html

Weather patterns
over North America

Land cover mapping

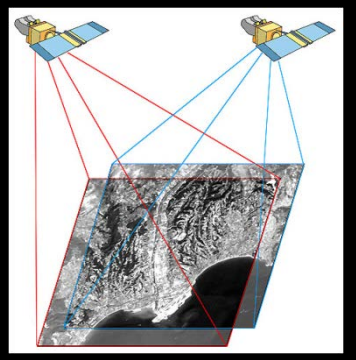


The temperature of
the Great Lakes in fall.



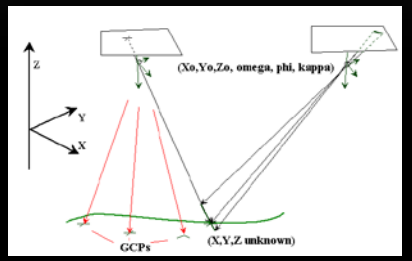
AVHRR

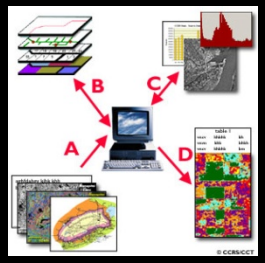
- France launches the first non-US, non-Russian satellite in 1986 (SPOT) providing the highest resolution, commercially-available imagery, at the time (10 m panchromatic)
- SPOT allowed for off-nadir viewing, enabling stereoscopic coverage to be collected
- GIS use explodes
- GPS developed

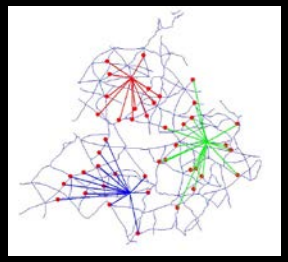


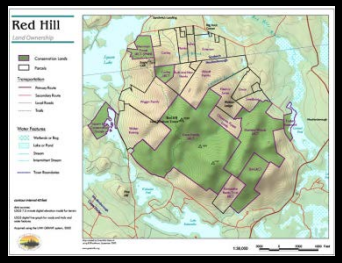
COMMERCIALIZATION EMERGES

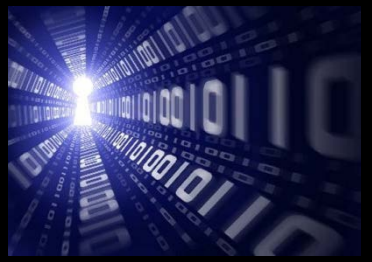
GIS integrates disciplines and technologies
such as remote sensing, surveying,
photogrammetry, spatial analysis, cartography, computer science.



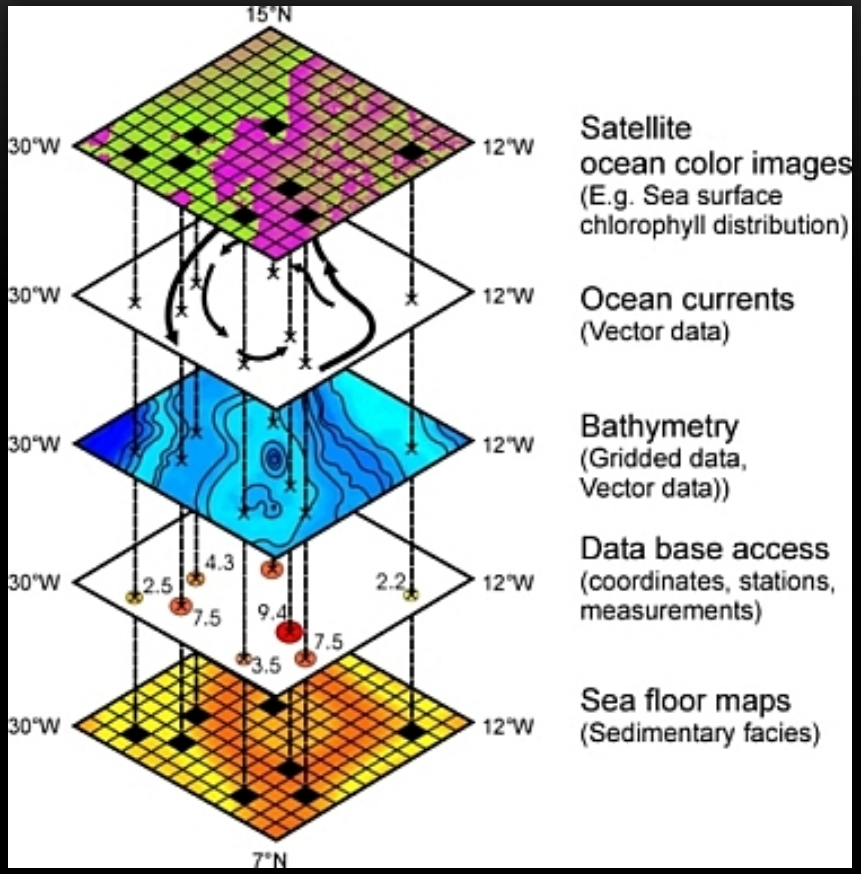


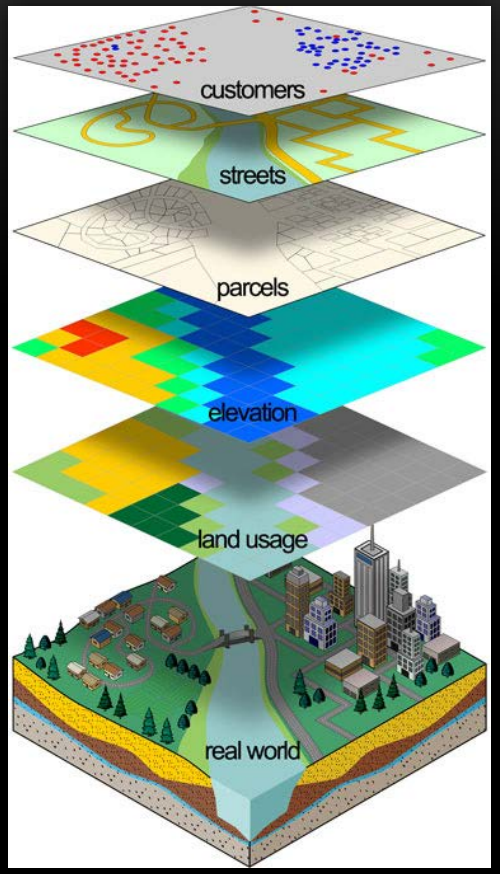






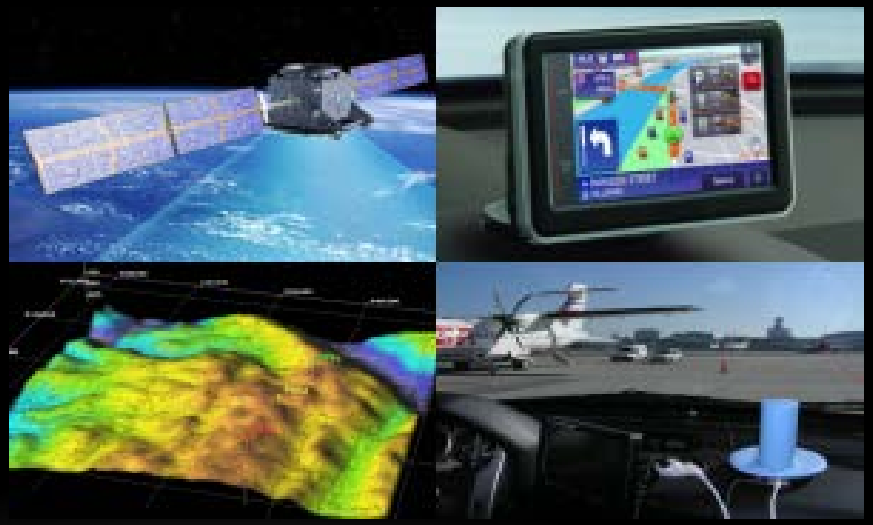
GIS integrates disciplines





GEOGRAPHY INTEGRATES DATA

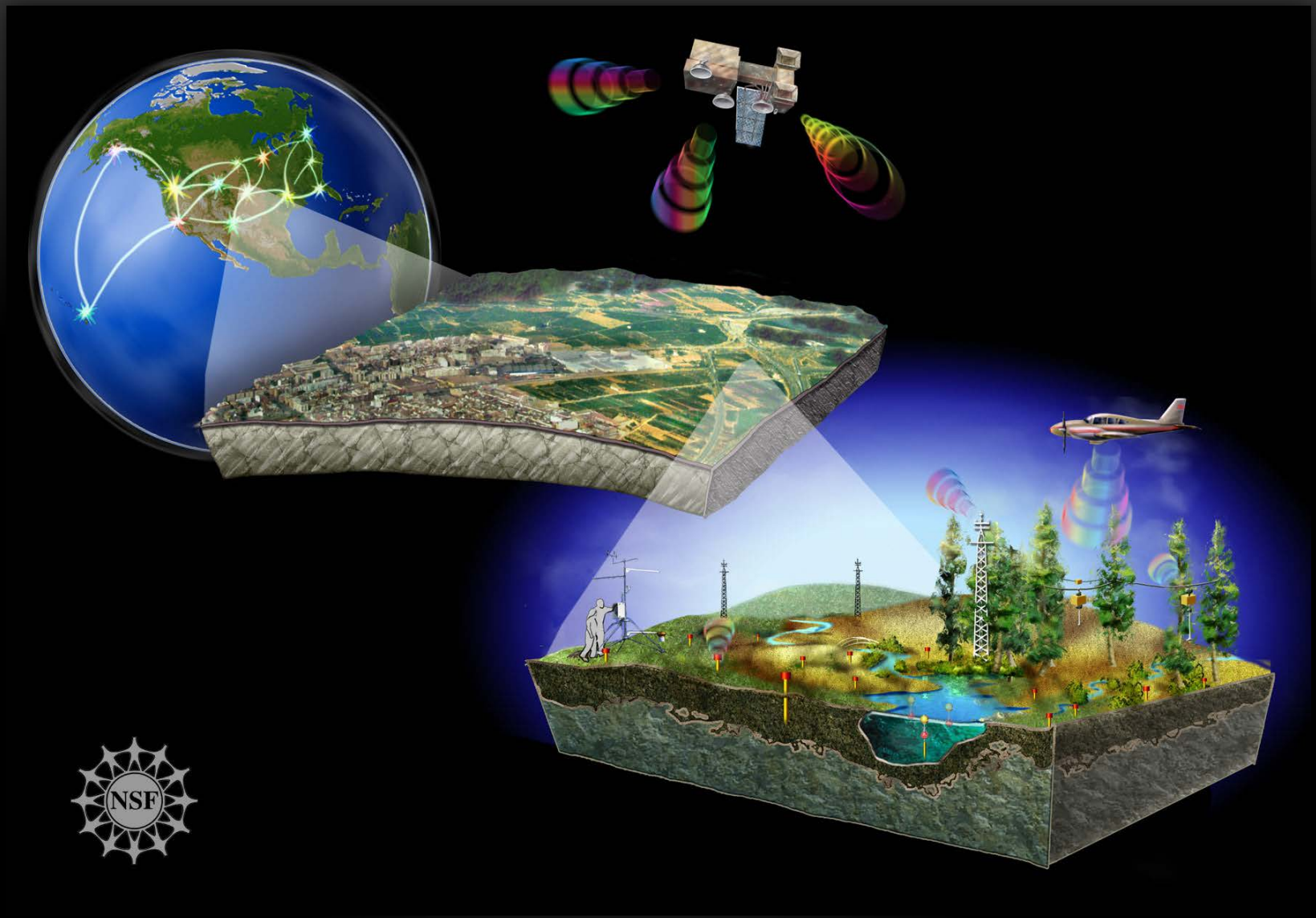
- Originally developed for the military to enable locational awareness
- Originally the signal was ‘fuzzified’ so that civilian users couldn’t get accurate results
- A simple explanation of how GPS works (video)



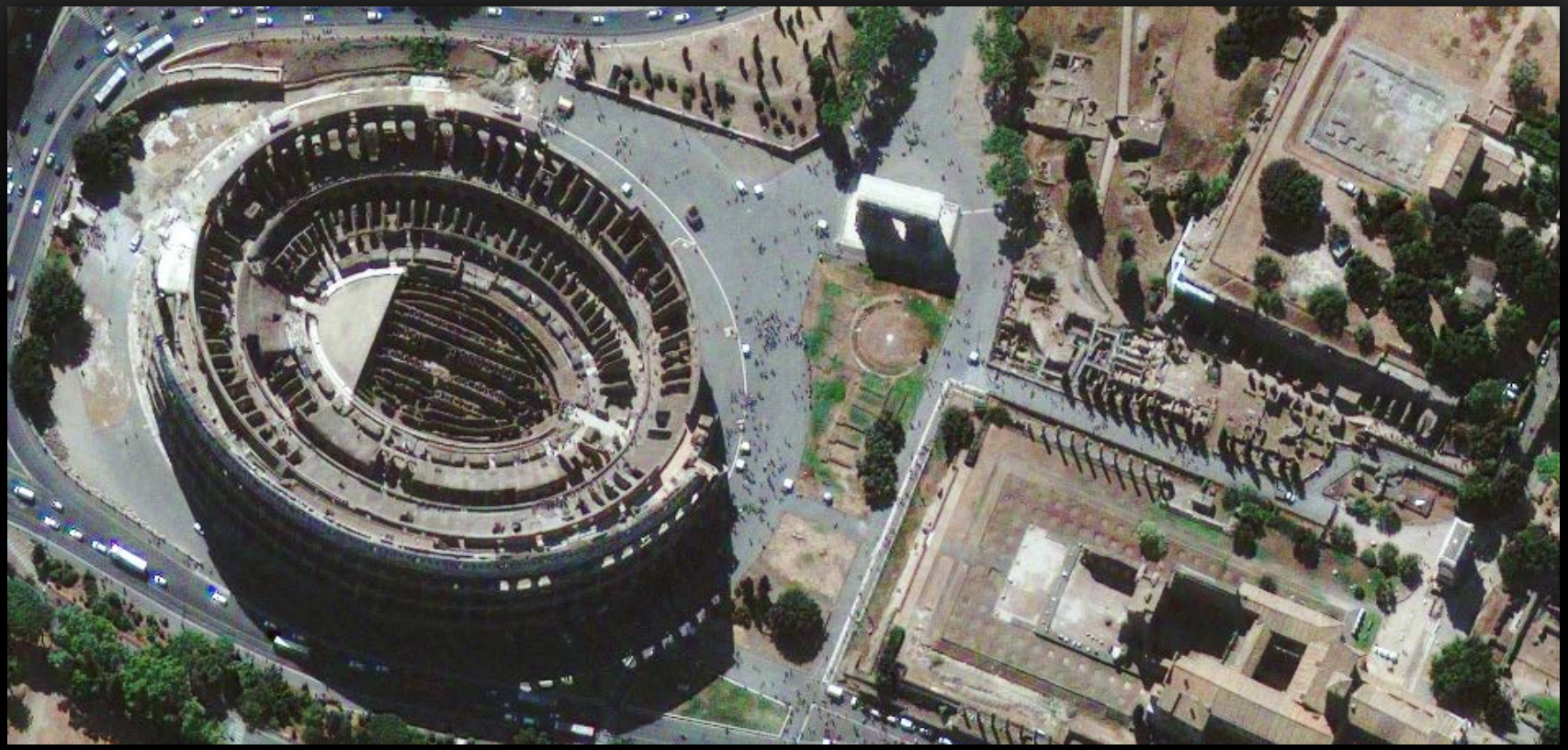
GEOLOCATION FOR ALL (AKA GPS)

- Ever-higher image resolutions -
- GPS in every cell phone, car, backpack
- All appliances linked to the web, RFIDs everywhere

NO PLACE LEFT TO HIDE (2000 ON)



Sensor Nets: The National Ecological Observatory Network



Roman Colosseum, taken from 680 km in space
by the GeoEye-1 commercial satellite (0.5 m resolution)

WHAT CAN THE MILITARY SEE?

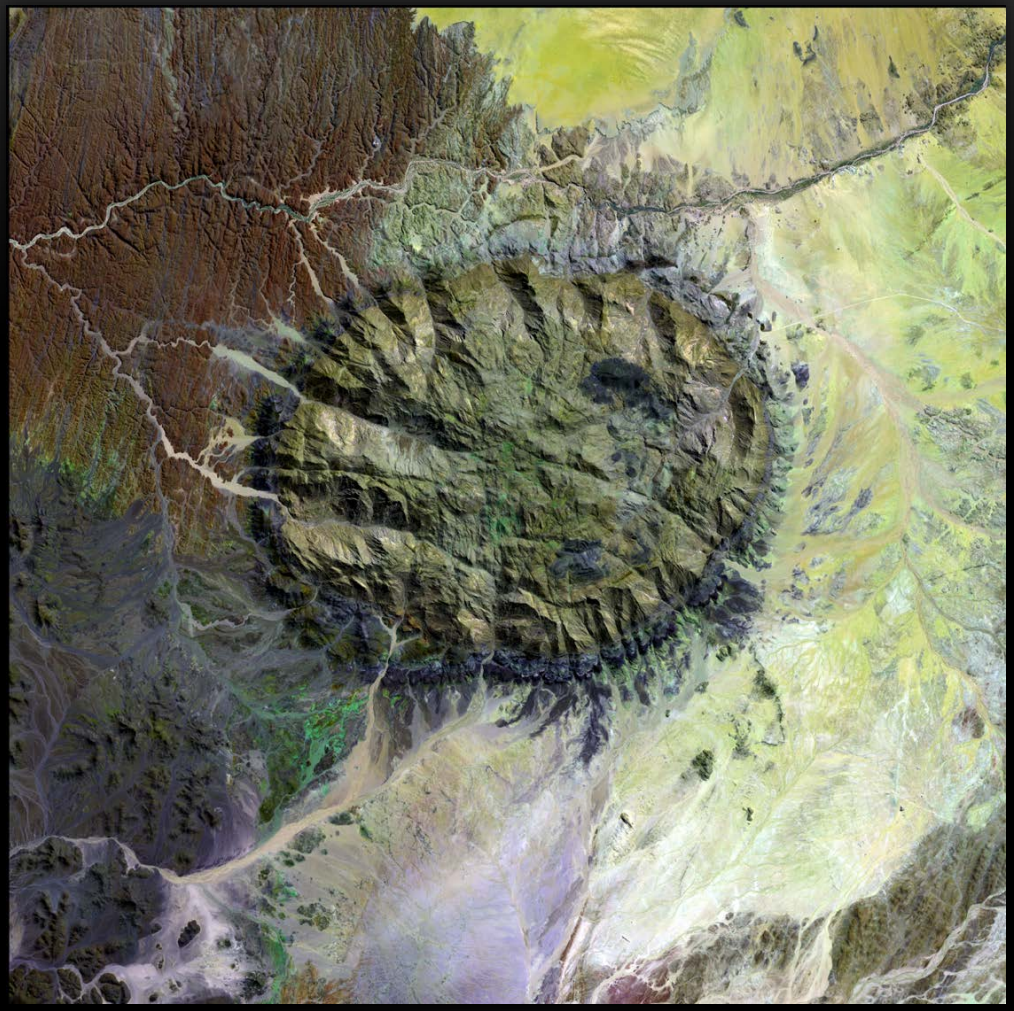
INNOVATIVE PLATFORMS AND USES

IN SUMMARY

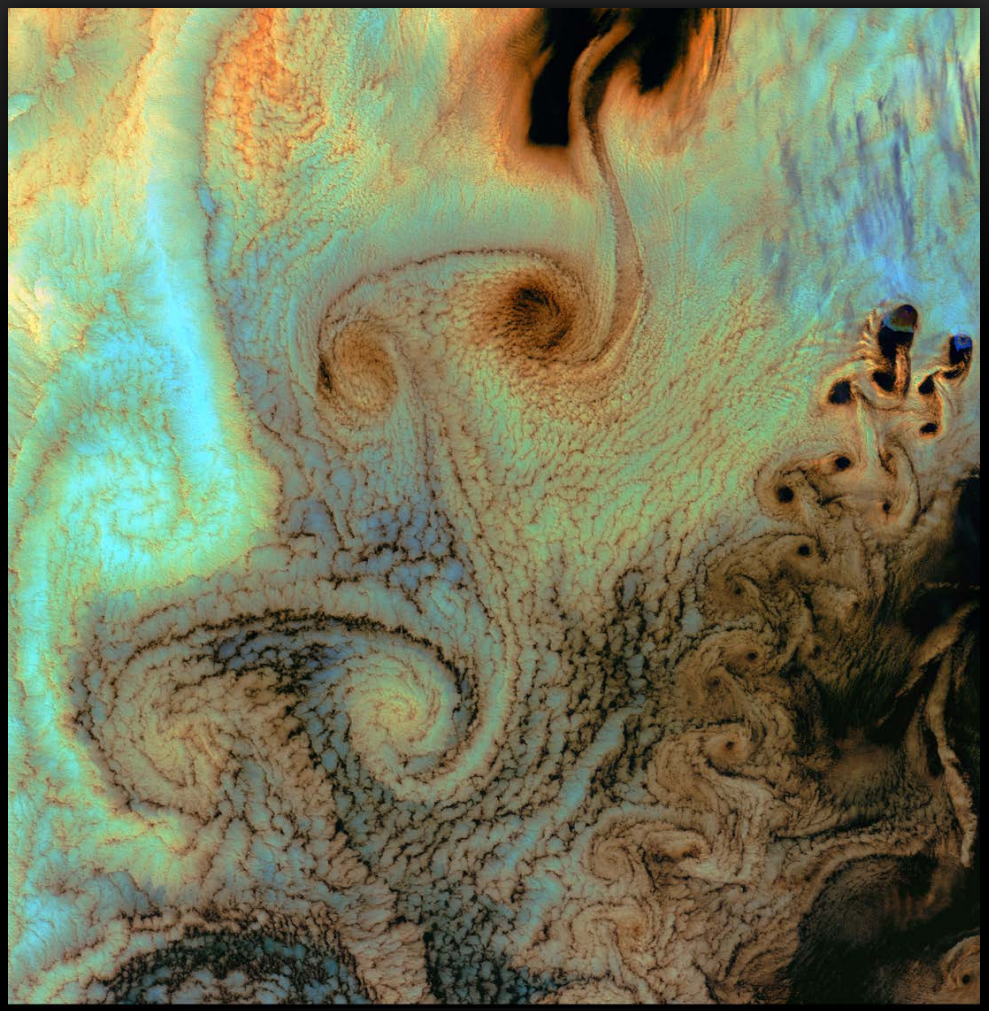
Prior to the Space Age (1960)	Since 1960
Only one kind and date of data (a photograph)	Many kinds and dates of remote sensing data
Reliance on human interpretation	Reliance on automated analysis
Simple and inexpensive equipment	Complex and expensive equipment
Analysis conducted by those ‘in the field’	Analysis conducted by remote sensing experts
Little concern about renewable resources, environmental protection, global resource information systems	Increasing concern about renewable resources, environmental protection and the need to develop global resource information systems
Controlled access	Universal access (to some)

IN SUMMARY

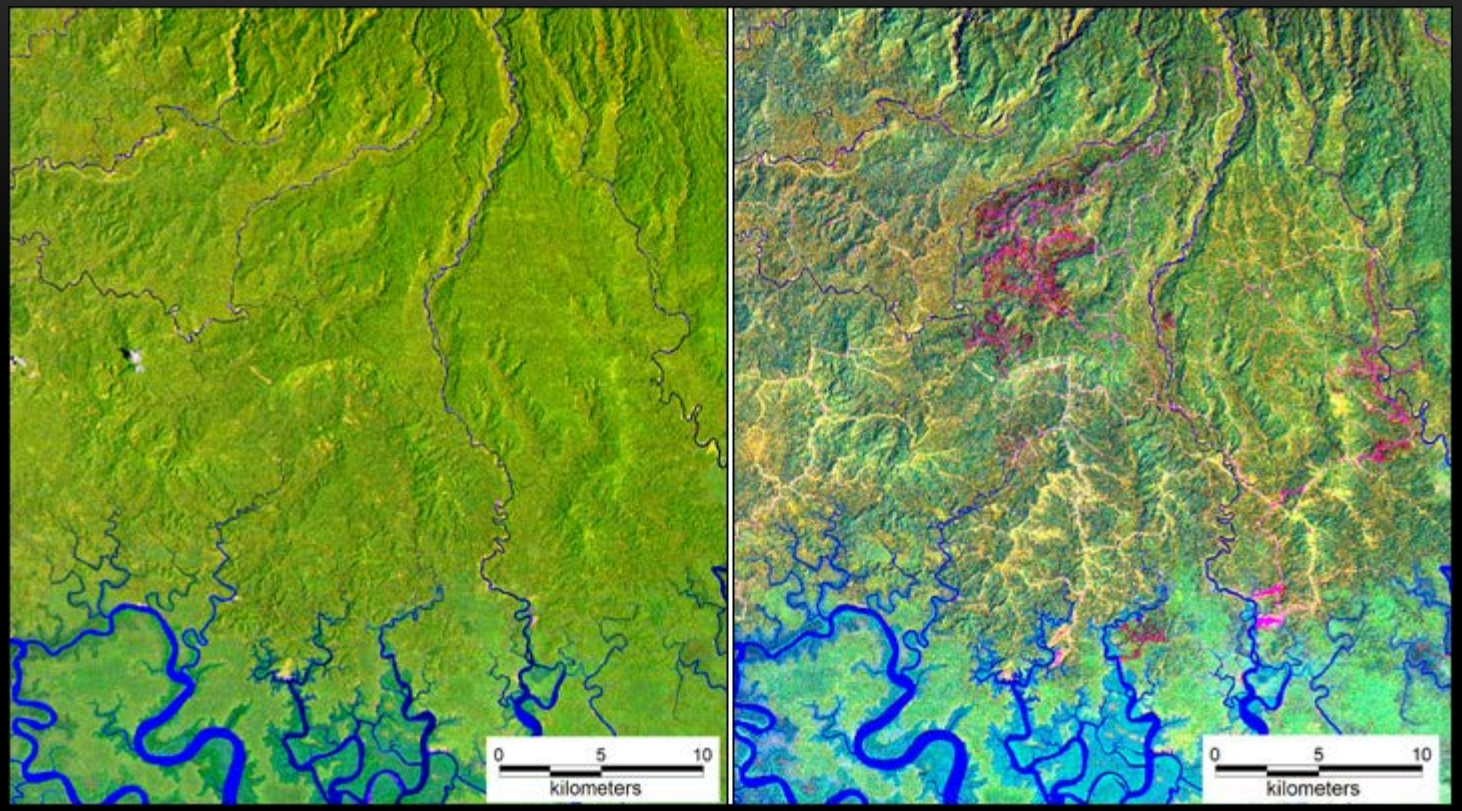
- Remote sensing will only become more important but also more invasive in our future
- None-the-less, it remains an important source of data for environmental monitoring, urban development, human rights watch, climate change, geological exploration, and much much more.
- A tension exists between the surveillance aspects and the environmental benefits



LANDSAT 7: BRANDBERG MASSIF NAMIBIA



LANDSAT 7: VON KARMAN VORTICES



Papua New Guinea's Gulf Province. The 1988 image (left) shows an intact rainforest, while the 2002 image (right) shows the impact of logging that began in 1995.

MONITORING FOREST LOSS

June 2002

April 2006

Porta Farm, located just west of the Zimbabwean capital of Harare
over 850 homes and up to 10,000 people