

Computers have linked mapping technologies under the umbrella term :

Geomatics includes the following geospatial technologies:

For data collection, analysis and output

a. Cartography

"The art, science and technology of making maps"

b. Geographic Information Systems (GIS)

"Automated systems for management, analysis, input and output of spatial data"

c. Global Positioning Systems (GPS)

"determination of ground locations using measurements from satellites"

d. Surveying

"science of determination of accurate coordinates of terrestrial locations"

e. Photogrammetry

"derivation of 2D or 3D locations from stereo pairs of aerial photography"

f. Remote Sensing

"Acquisition of information about a planetary surface from a distance"

Aerial photography and Remote Sensing

Early years 1850->
Birds, Kites, Balloons,
Planes with camera
(and now UAVs)

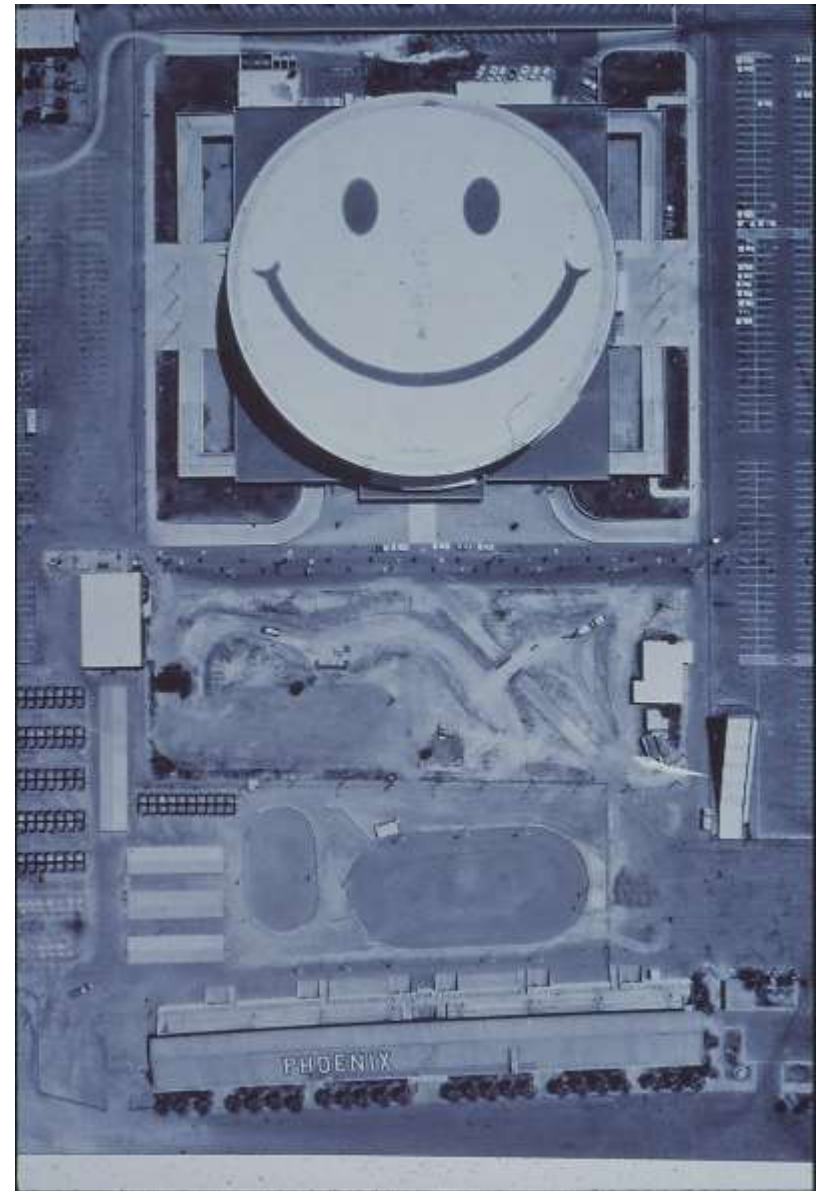


What is Remote Sensing?

"Obtaining information about a planetary surface from a distance"

The term first appeared ~1965 with the first **satellite images** (previously there were only aerial photographs)

Also there was increasing use of non-visible parts of the **electro-magnetic spectrum**, such as the **Infrared**

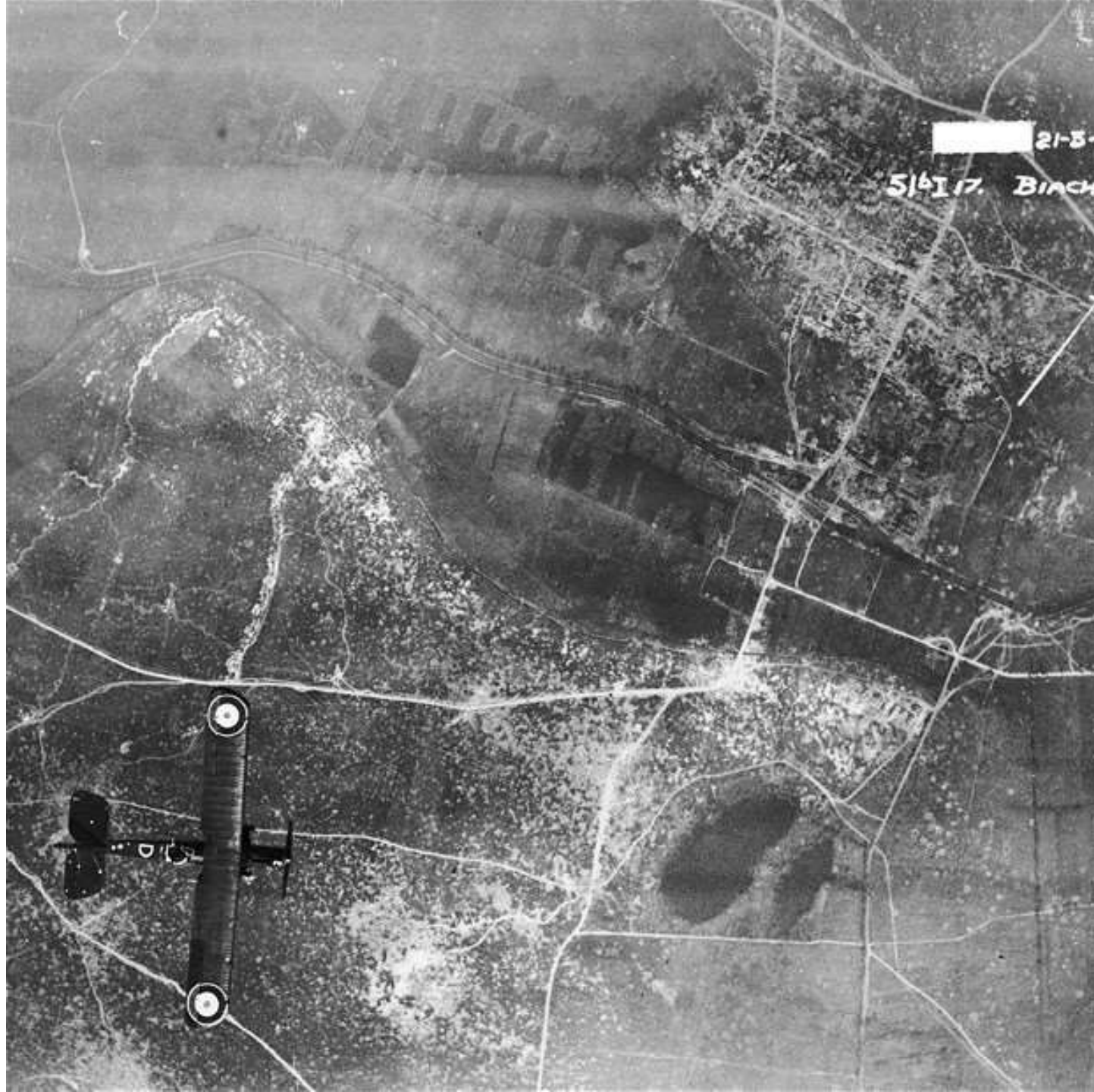


**Air photo,
World War 1
Reconnaissance
and analysis**

**Postwar use:
1919-1938
limited by
resources and
the depression**

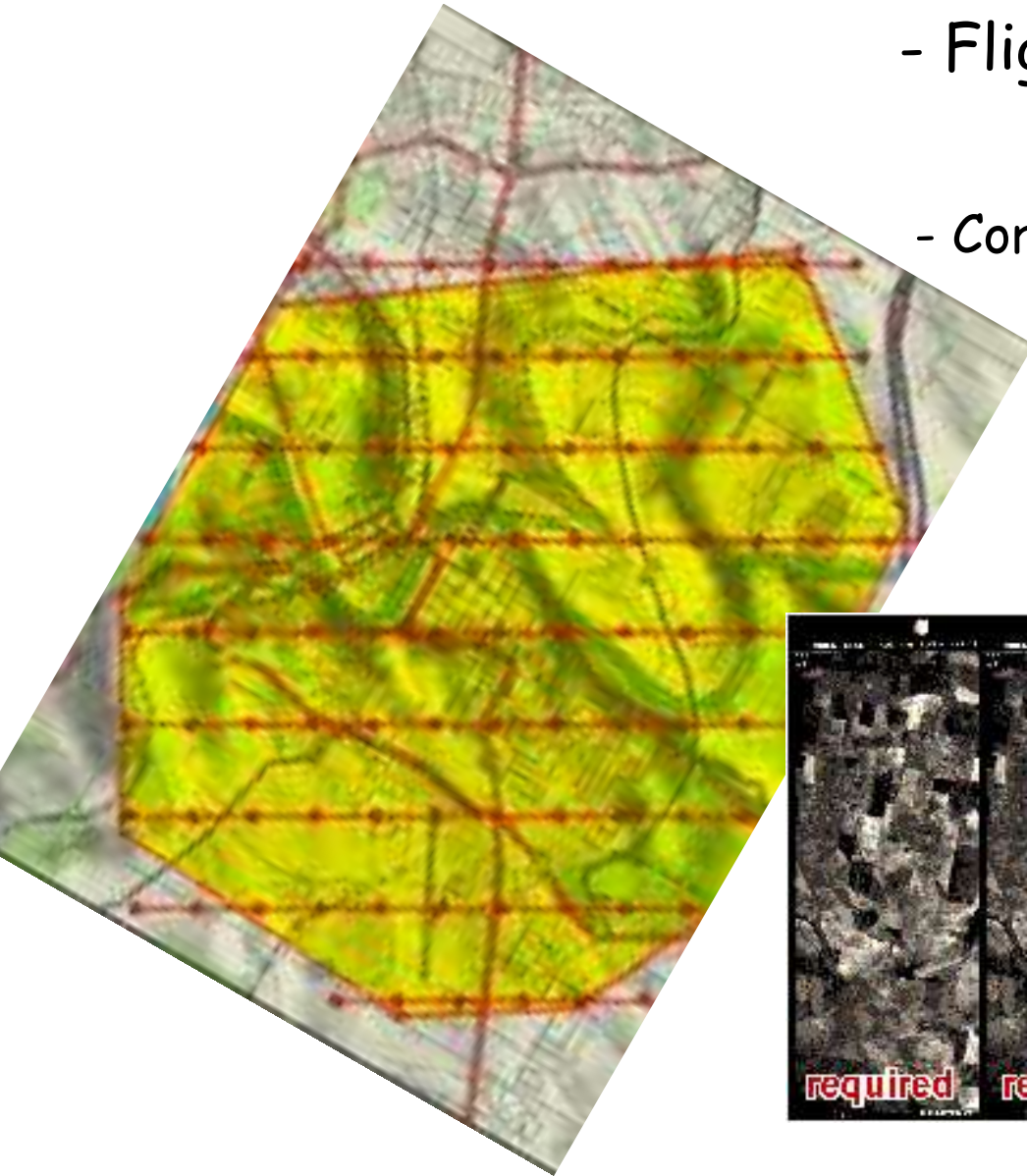
**World War 2:
reconnaissance
and mapping**

**Standard for
mapping after
World War 2
1946 ->**



Aerial Photography

- Flightlines and overlap
- Corrected, mosaicked -> orthophotos
- Panchromatic, Colour, Infra-red



Most pre-digital aerial photography was panchromatic, not colour



<https://pgmap.princegeorge.ca/Html5Viewer/index.html?viewer=PGMap>

Panchromatic air photo: 15th / University Way



Colour air photo: 15th / University Way; hardcopy cost = 2x



2000s Digital photogrammetry



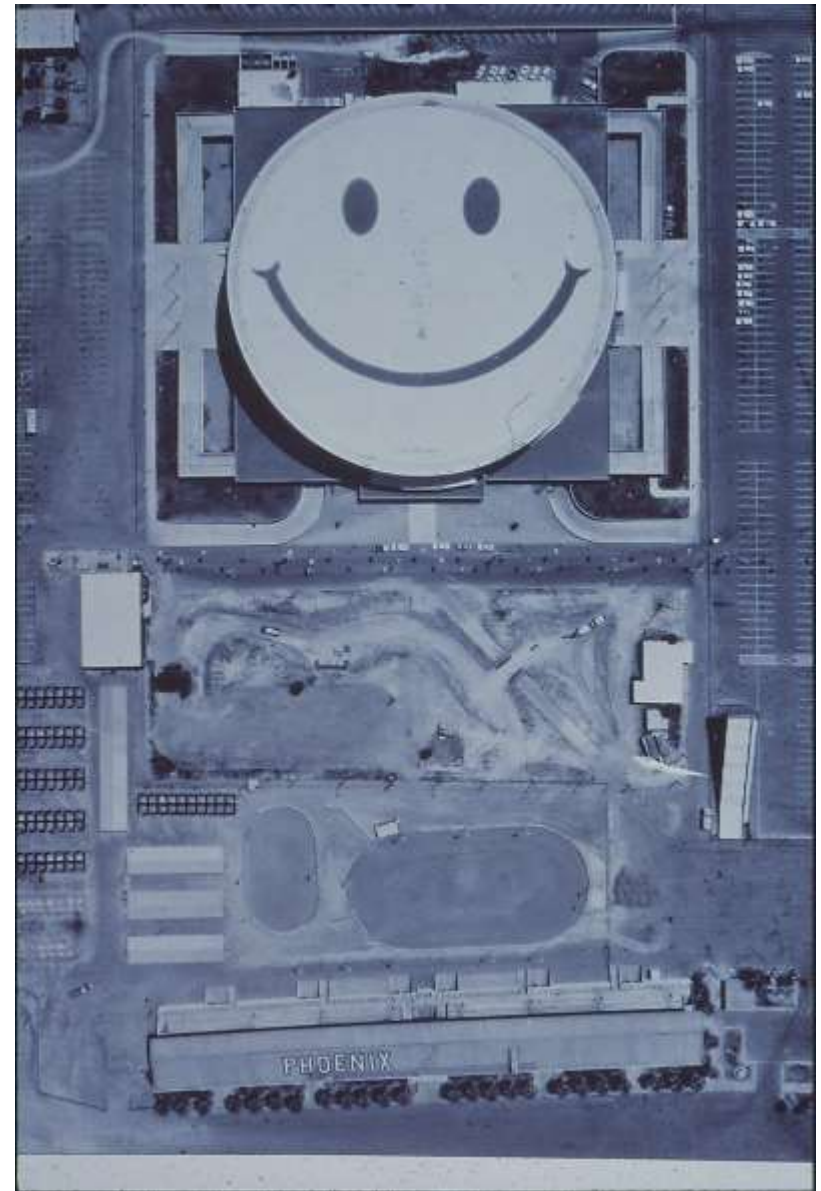
<https://www.terrasaurus.ca/imagery-examples/>

What is Remote Sensing?

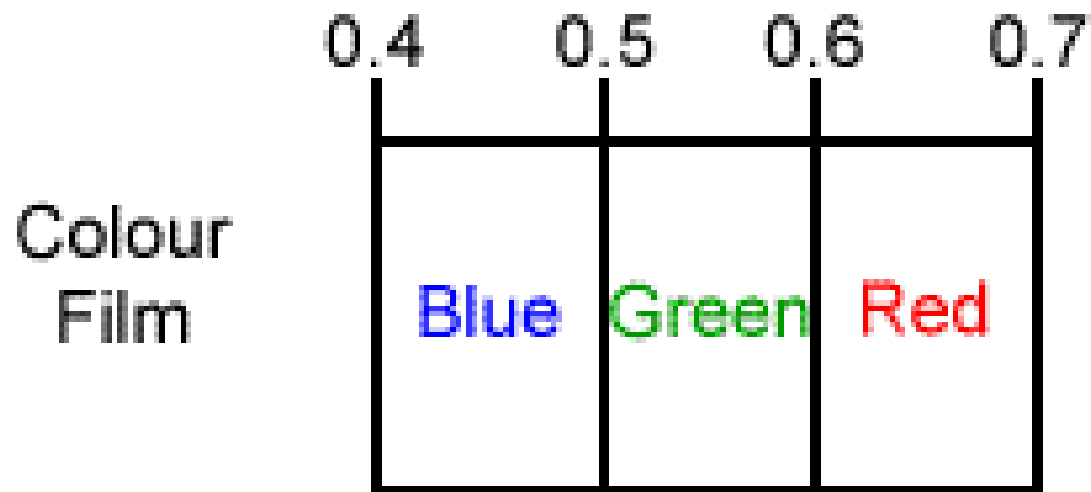
"Obtaining information about a planetary surface from a distance"

The term first appeared ~1965 with the first **satellite images** (previously there were only aerial photographs)

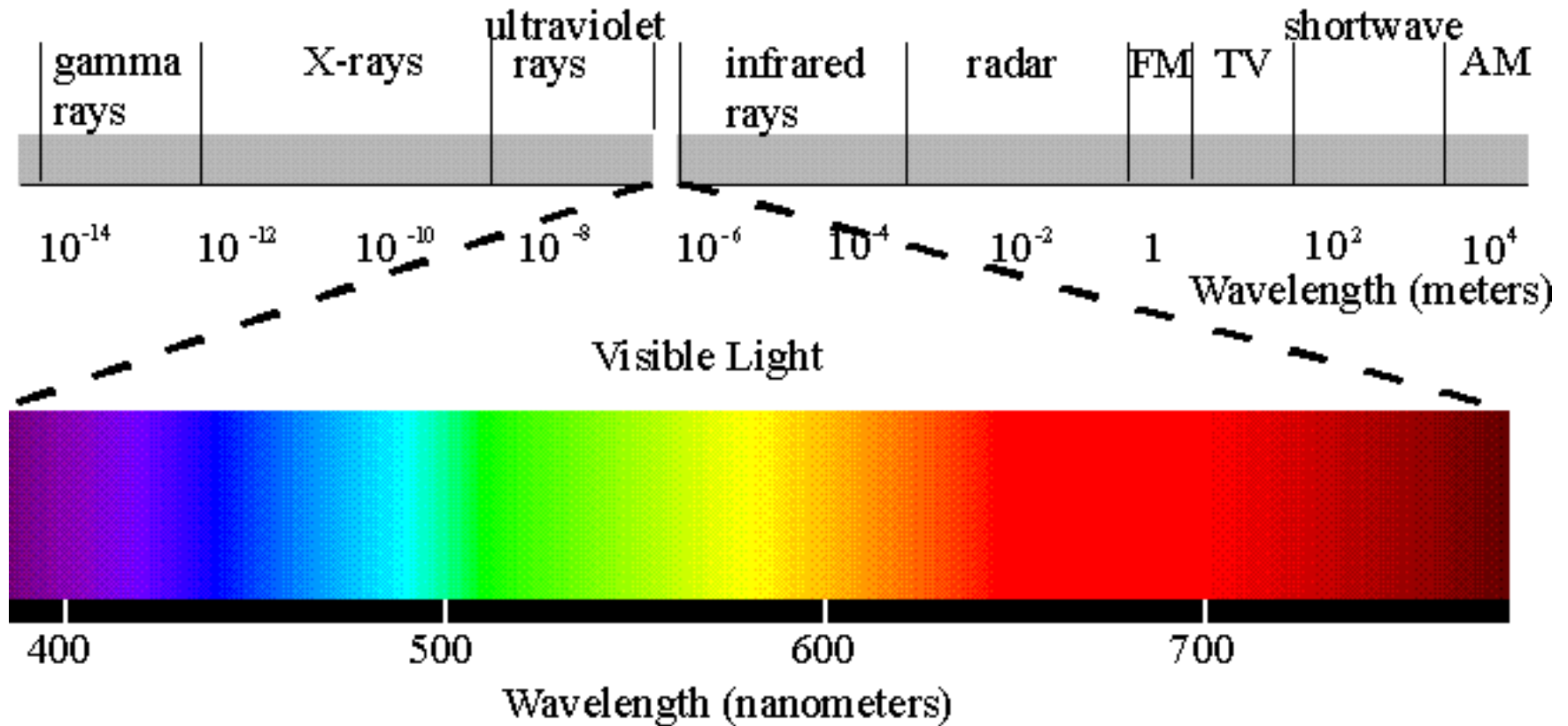
Also there was increasing use of non-visible parts of the **electromagnetic spectrum**, such as the **Infrared**



Shopping Center, Phoenix, AZ



Remote sensing and the electromagnetic spectrum



Blue	0.4 - 0.5 μm (microns)	= 400 to 500 nm nanometres
Green	0.5 - 0.6 μm	= 500 to 600 nm
Red	0.6 - 0.7 μm	= 600 to 700 nm

micrometres: 'microns' : millionths of a metre

nanometers: billionths of a metre

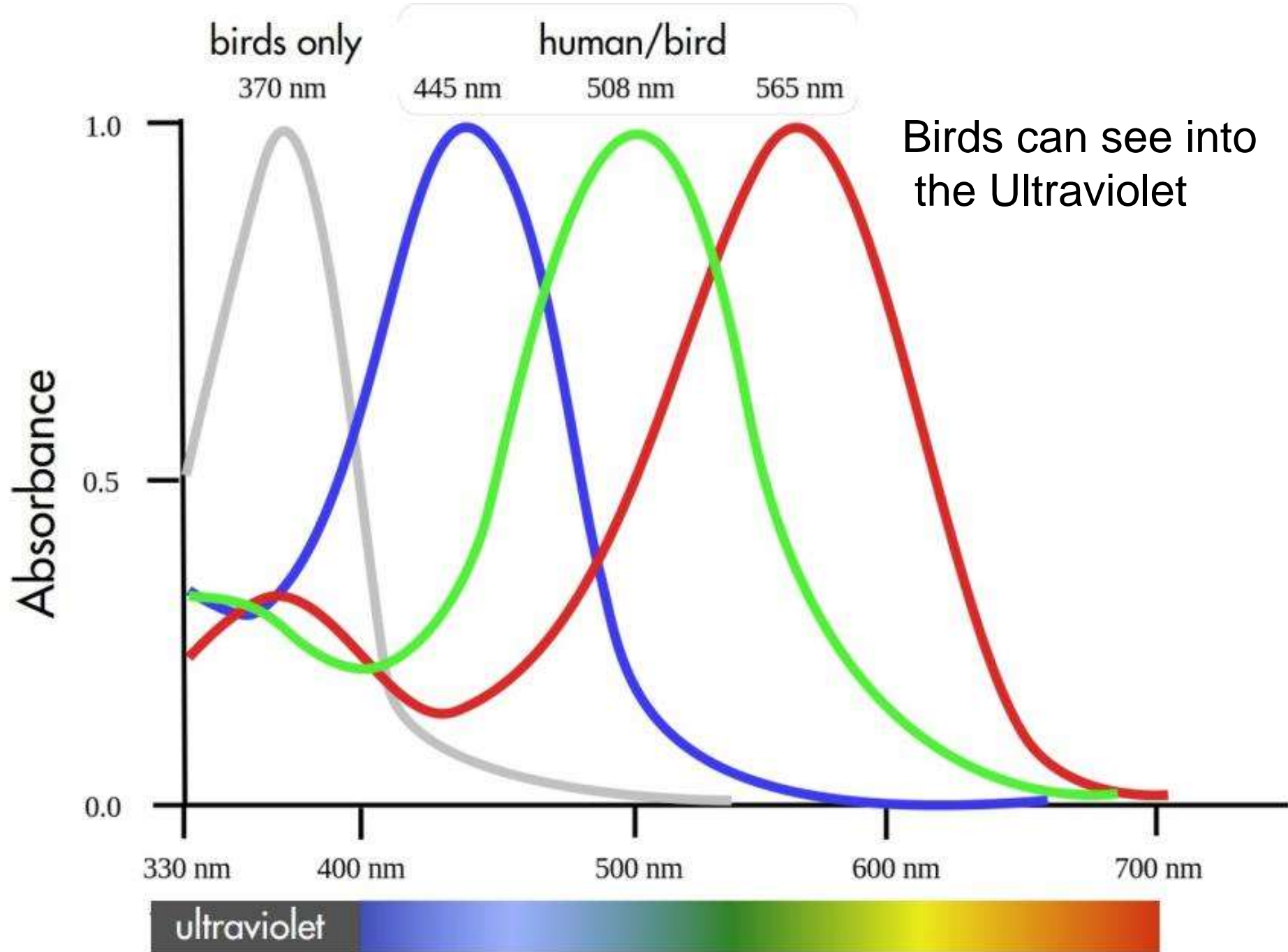




Table 2 : Characteristics of normal colour and false colour film

Normal colour film (Energy captured by film)	IR film (Energy captured by film)	Colour that results on film
B	G	Blue
G	R	Green
R	IR	Red



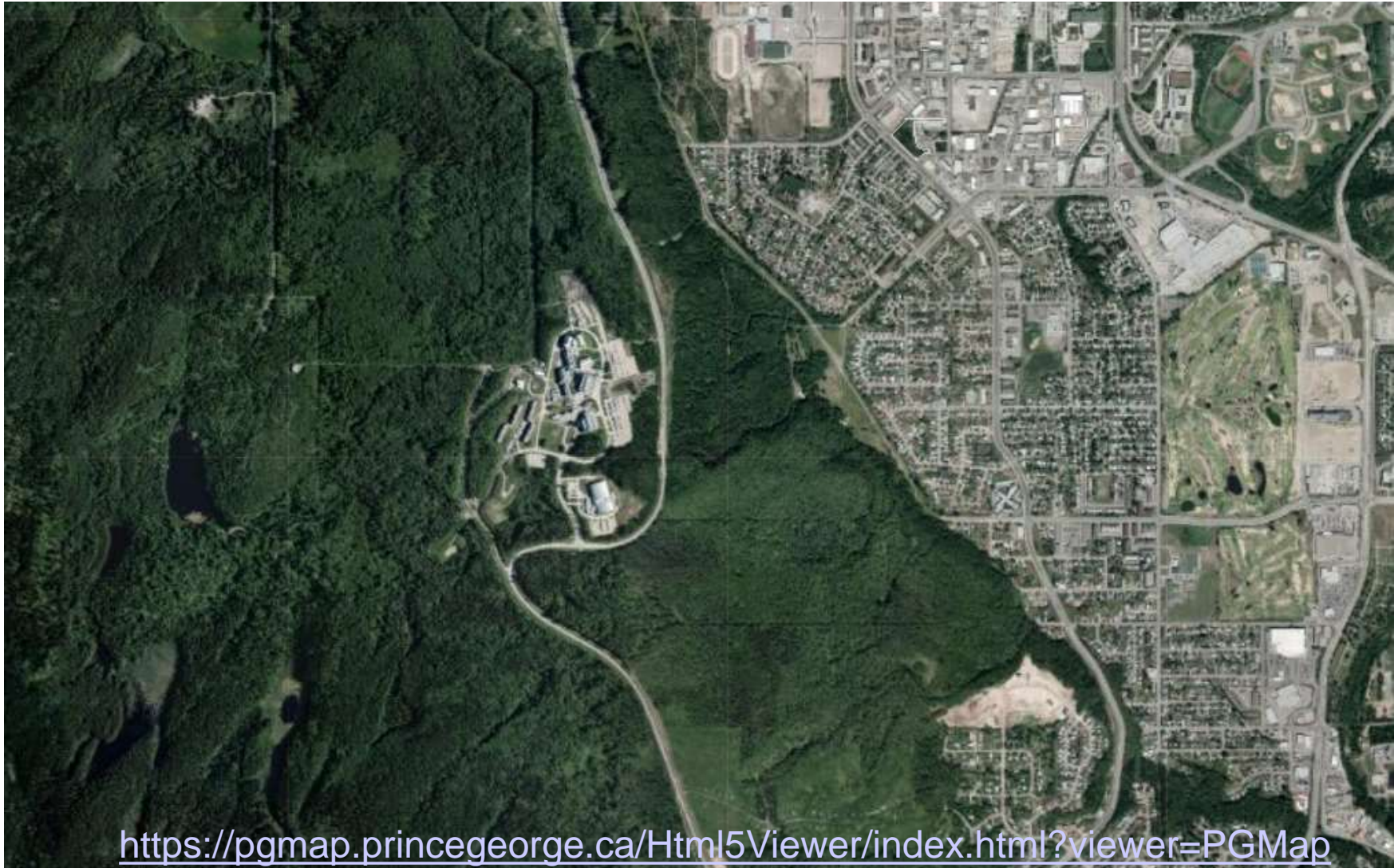
Film has three layers (RGB), a yellow filter removes blue wavelengths, the film is sensitive to infra-red, reflected by healthy vegetation, in the red (film) layer.

(IR) vegetation appears bright (almost as if snow-covered).
There is less haze and higher land-water contrast.

<https://pbase.com/pgonline/infrared>



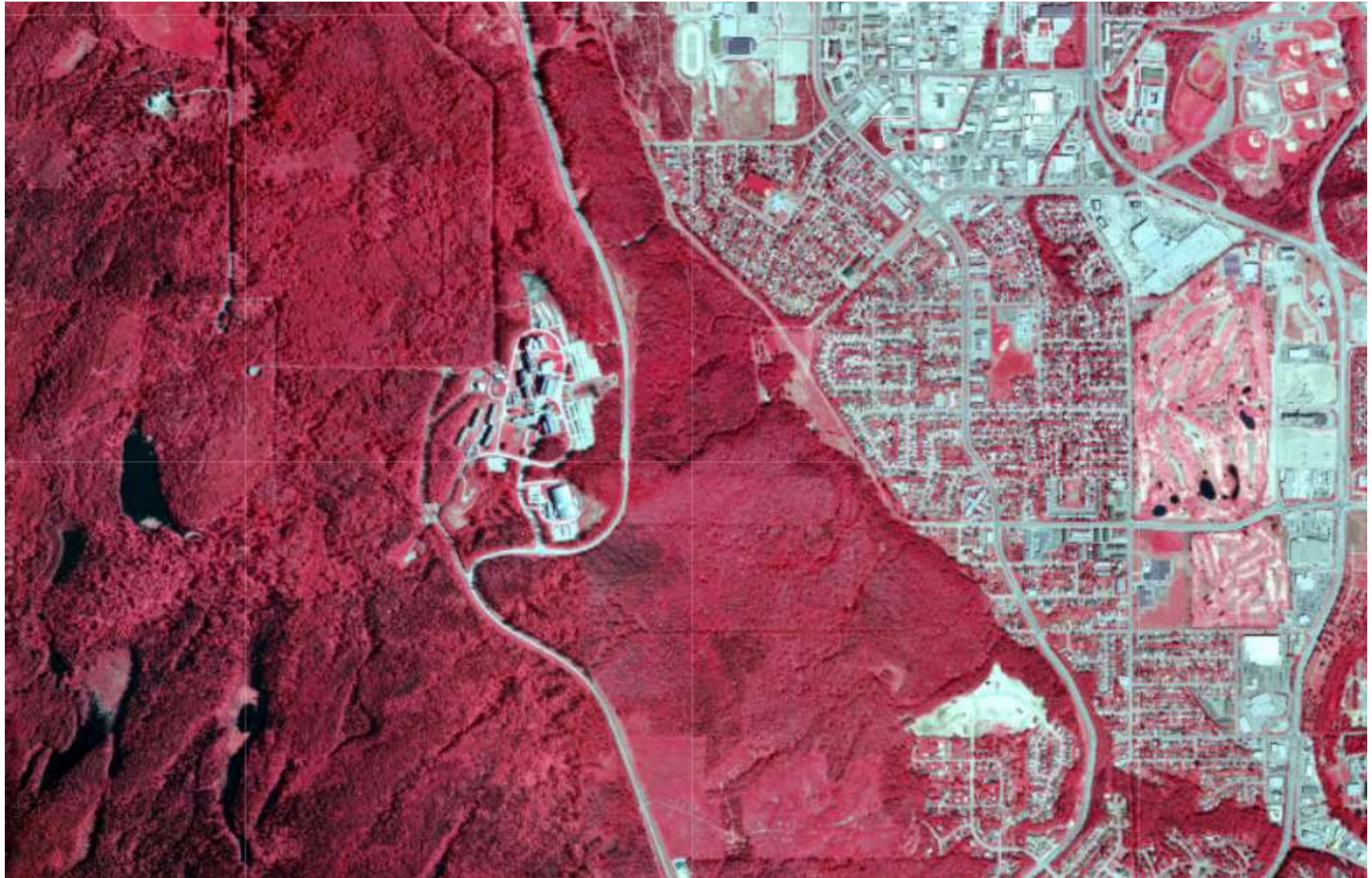
PGmap spring 2014 natural colour



<https://pgmap.princegeorge.ca/Html5Viewer/index.html?viewer=PGMap>

Advantages of using Infra-Red wavelengths for mapping/GIS:

PGmap spring 2014 Infra-Red image:

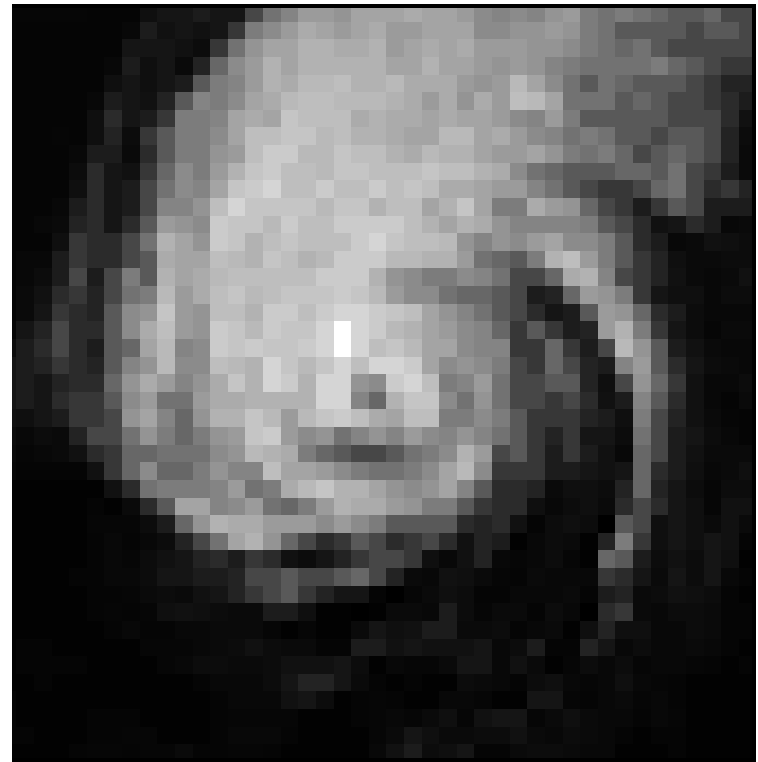


- Land-water distinctions are enhanced (but not urban features)
- Vegetation differences are enhanced, coniferous v deciduous etc..

Digital Scanning: all wavelengths

A scanner creates digital images with pixels (picture elements) -

e.g. 8 bit = 256 values
(0=dark to 255=bright)



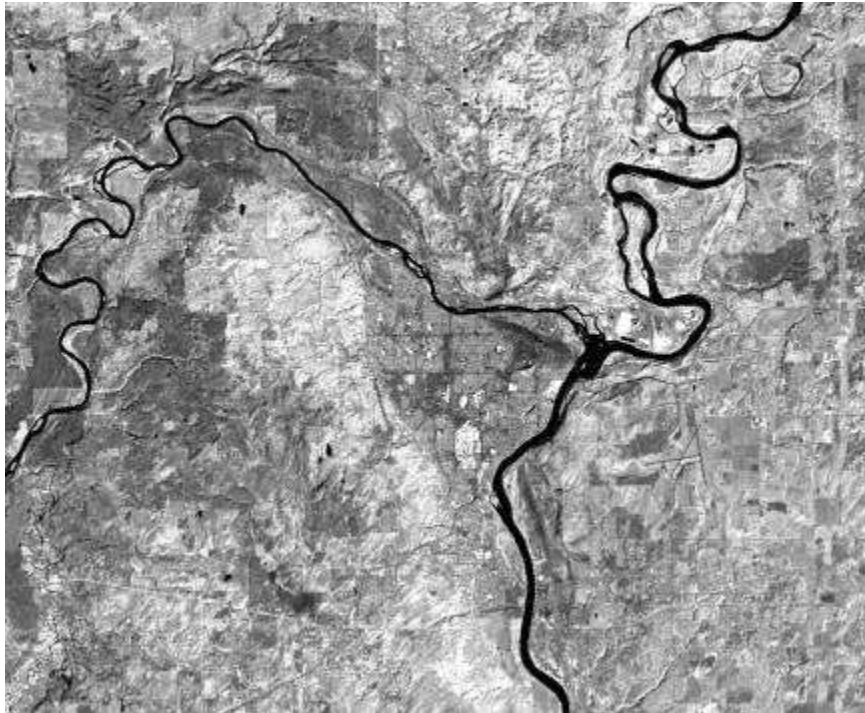
Close-up of pixels in a digital (scanned) image

<- Prince George –
scanned IMAGE
Visible wavelengths

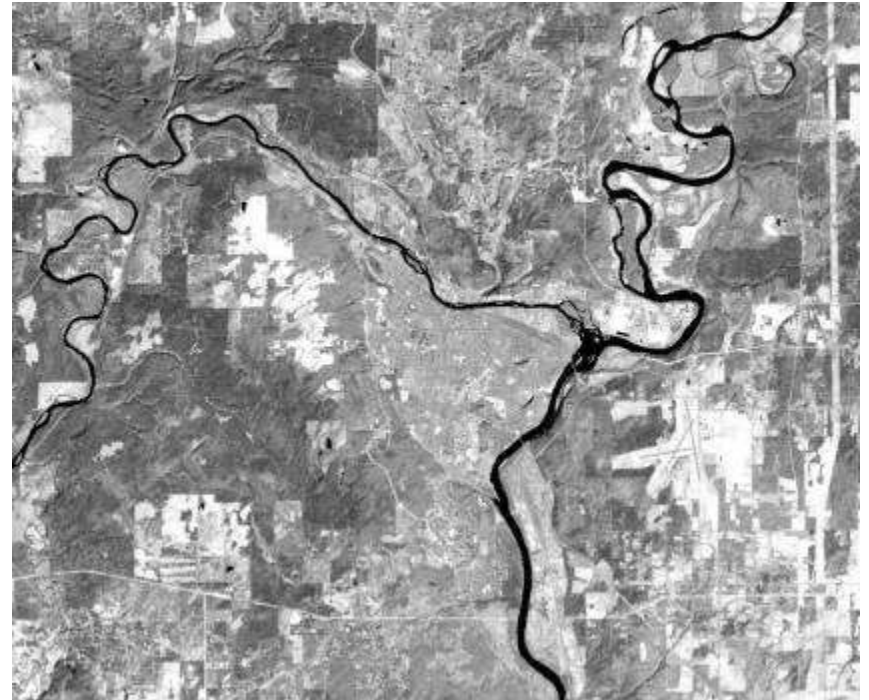
The **near IR** (0.7-1.3 microns) records energy related to **vegetation vigour** (health), while the **mid- IR** (1.3-3.0 microns) is dryness.

Neither have much to do with temperature

Near-IR



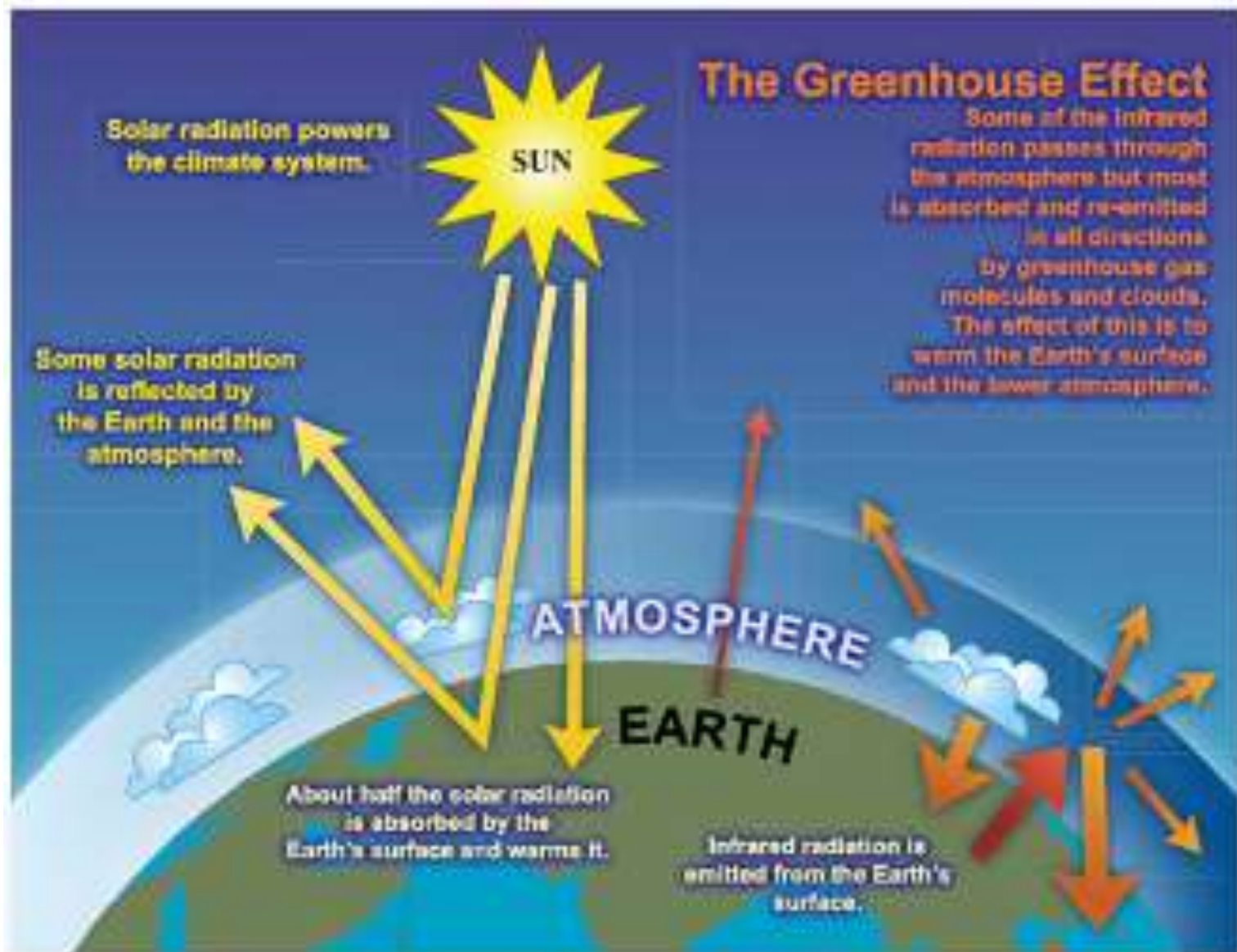
Mid-IR



The mid-IR is mostly associated with satellite imagery

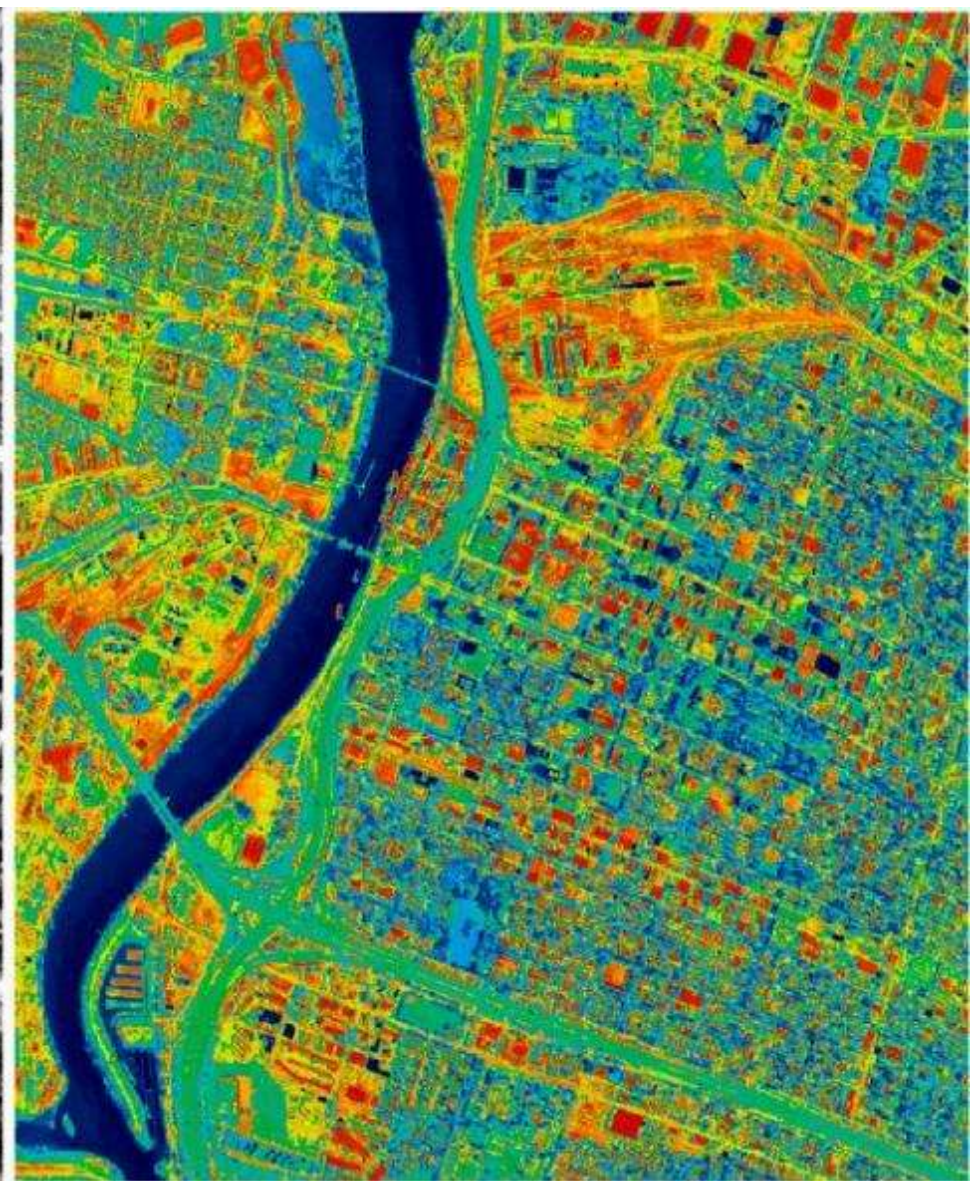
Thermal Infrared (3-14 microns)

This records longer wavelengths and temperature as energy is **emitted** NOT reflected IR



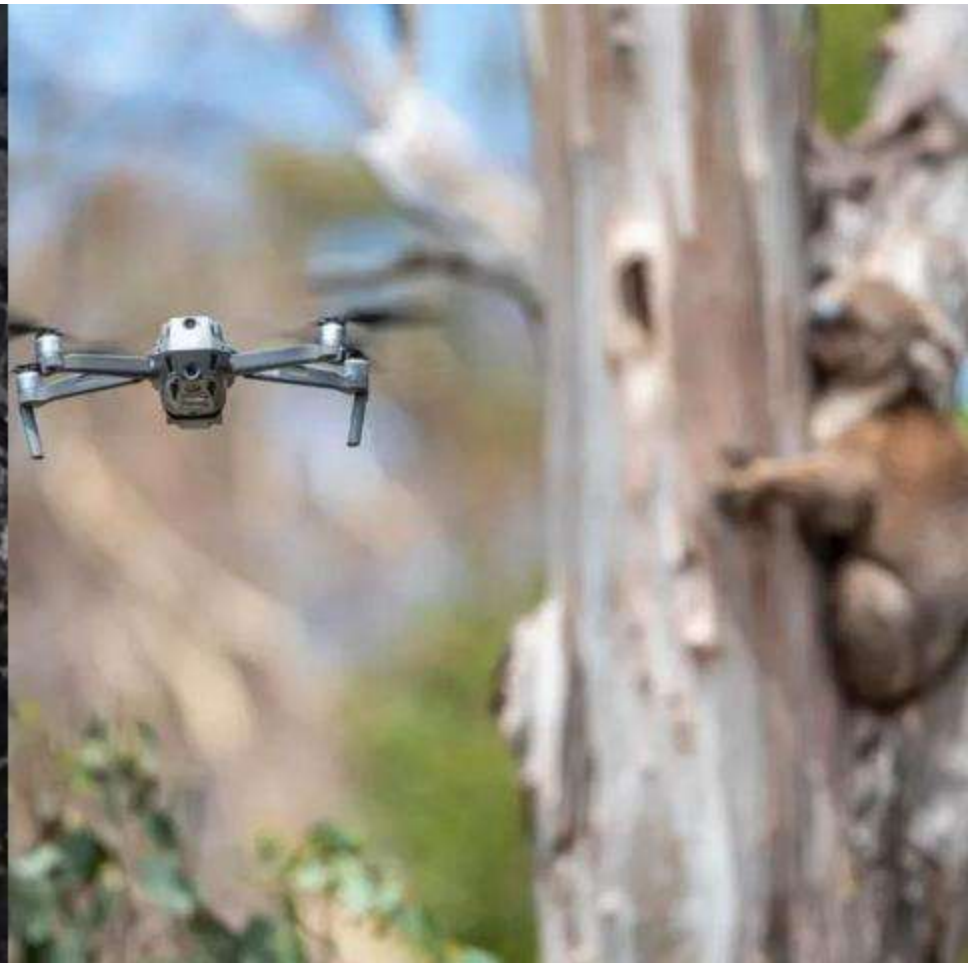
Daytime

Day and night

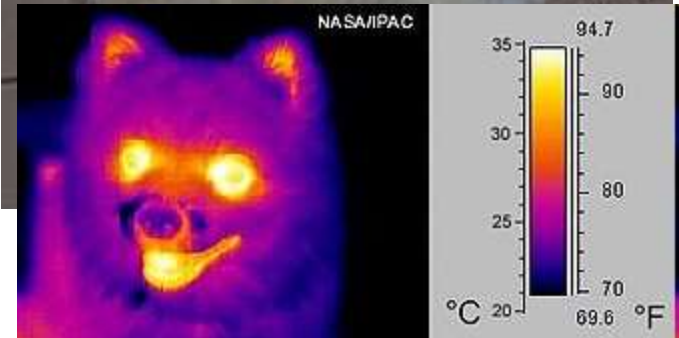
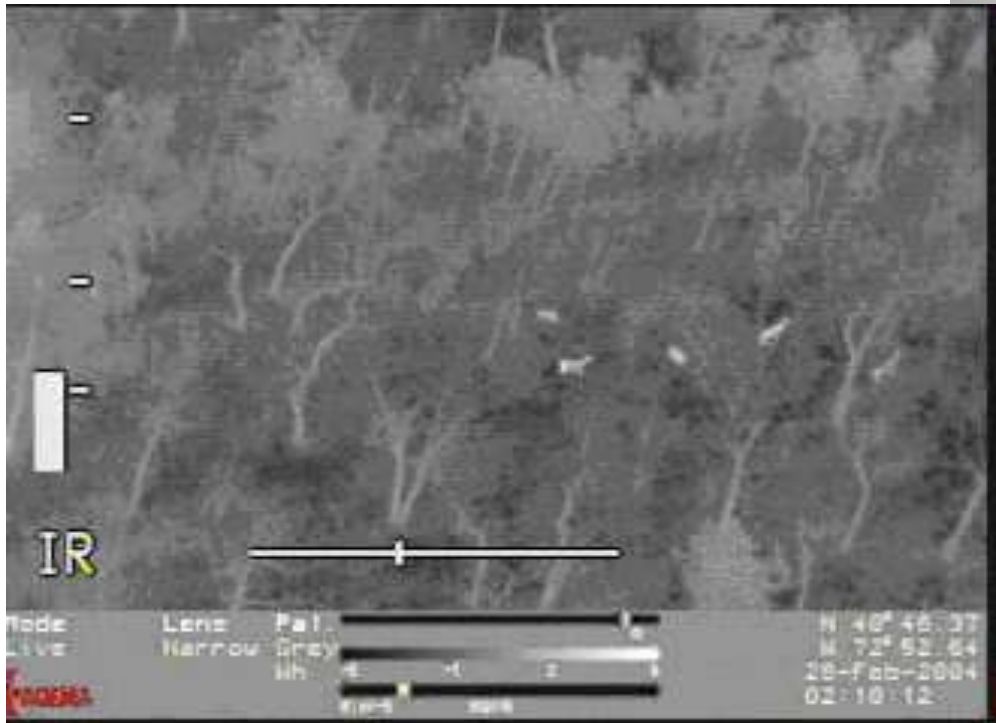


Normal colour and thermal images of Sacramento, CA

Drones with thermal cameras used to locate Koalas in Australian bush fires



Night vision goggles (Russian military -> equipment) - sensing thermal IR



Wildlife monitoring

Microwave: (passive) 1mm - 1 metre

These wavelengths beyond the infra-red can 'see through' clouds, light rain, and snow, but there is a low amount of it; low resolution e.g. 10km pixels ... this is why we use these wavelengths for communications.



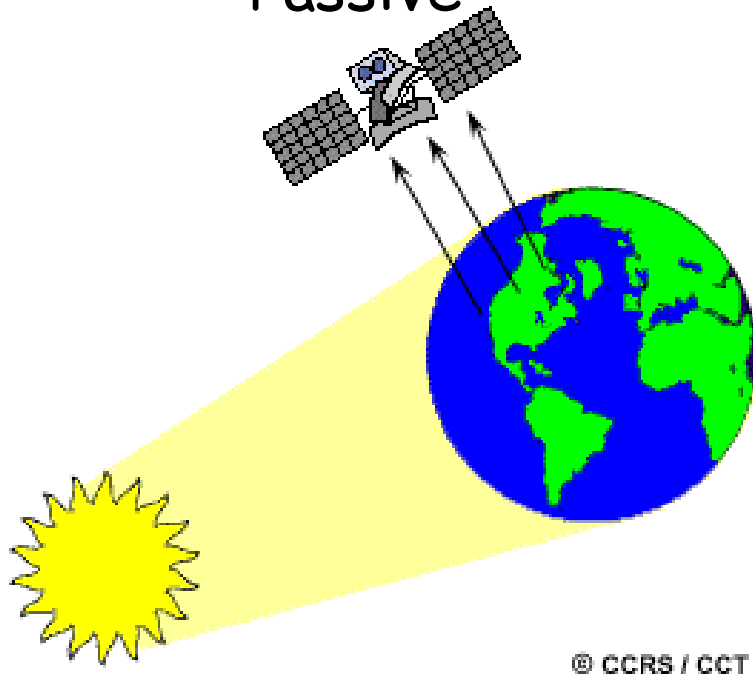
September concentrations, 1979-2008: Visit [September Sea Ice Concentrations](#) for an animation of September sea ice concentrations 1979 -2008.

Microwave: - Radio Detection And Ranging (RADAR)

is 'active' remote sensing at wavelengths of 1-30 cm

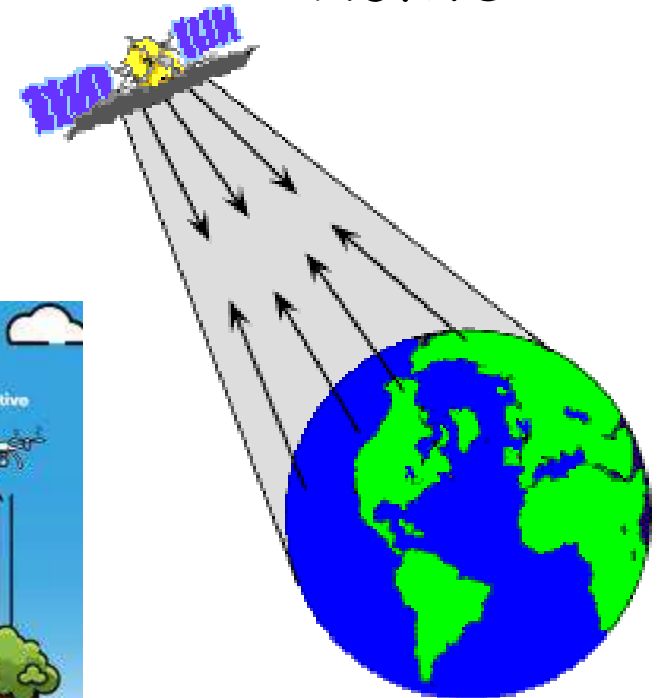
(whereas most other remote sensing is 'passive': recording solar and terrestrial radiation).

Passive

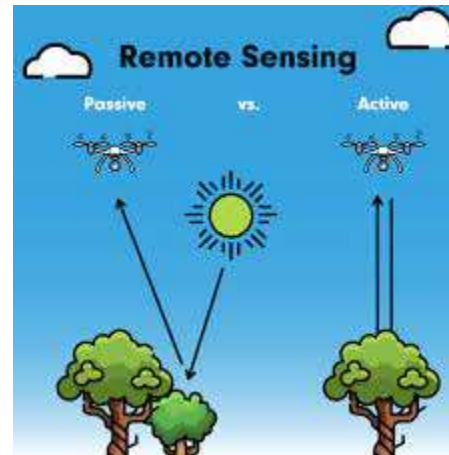


© CCRS / CCT

Active



© CCRS / CCT



Analogy:

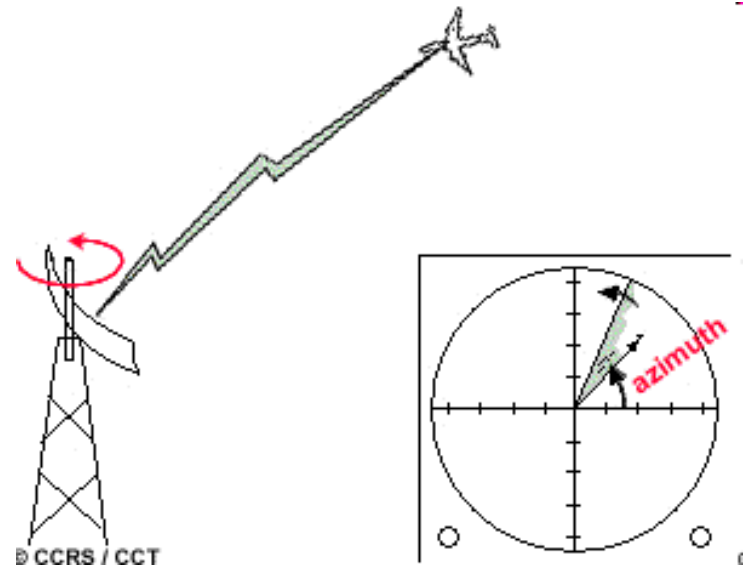
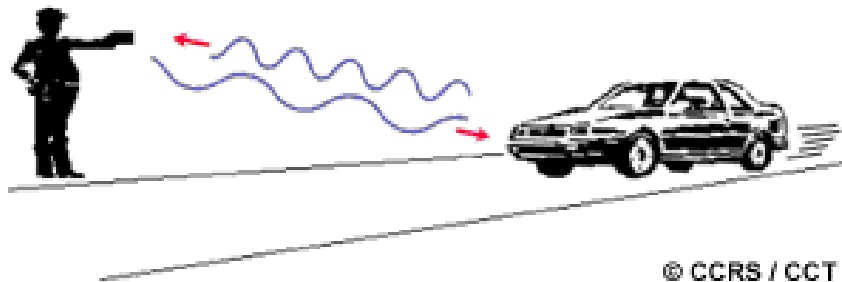
normal and flash photography

Microwave: - Radio Detection And Ranging (RADAR)

Imaging radar systems have been in use since the 1950s.

The original technology was developed during WWII :
to detect enemy ships and planes

Non-imaging radar



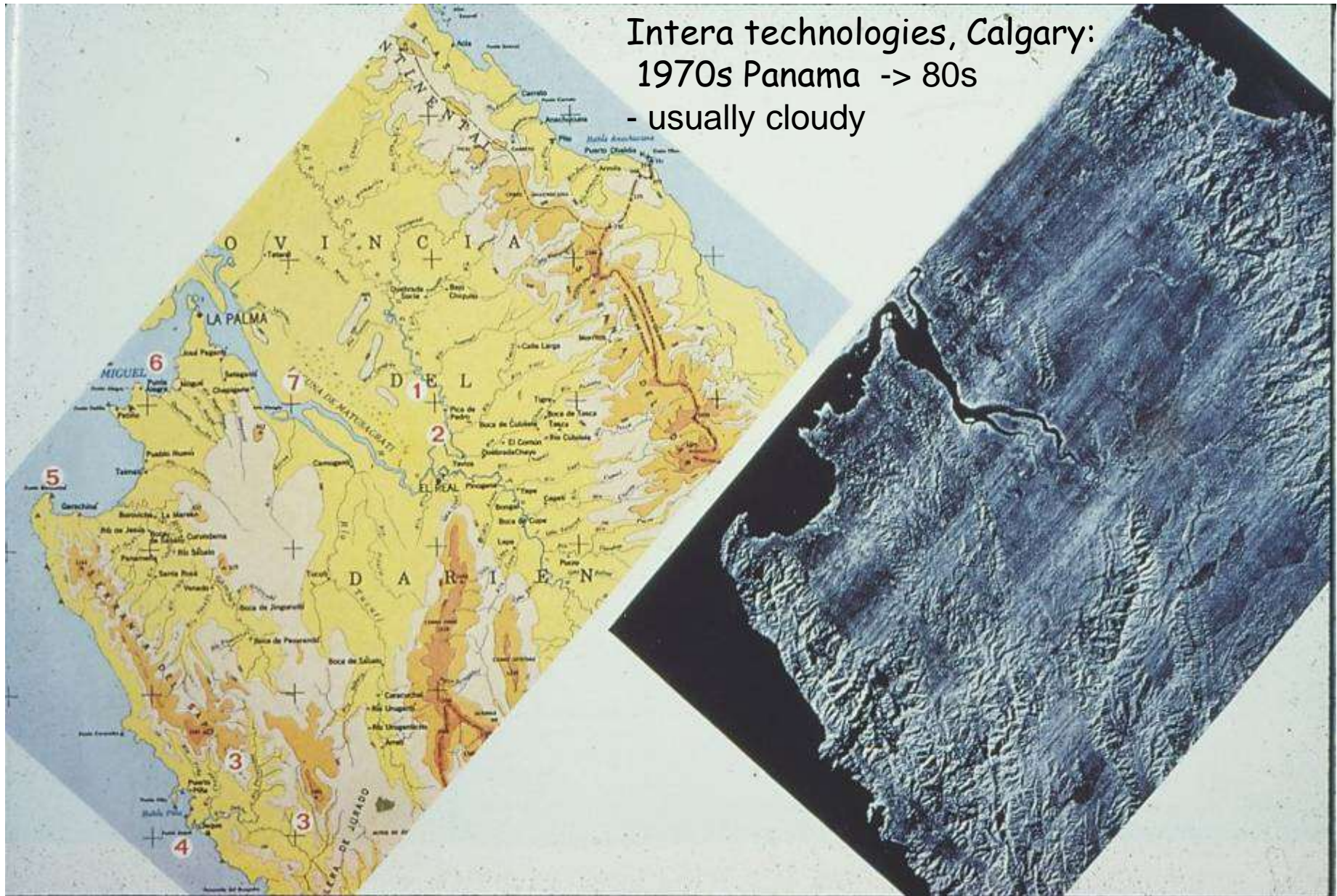
Massachusetts-based Raytheon in 1947 named the original microwave the **“Radarange”** because it cooked food using the same radio-wave-producing magnetron tubes that the company manufactured for use in military radar.

Raytheon credits the discovery of microwave cooking to an engineer named Percy L. Spencer. One day in 1945, Spencer was walking through a radar test room with a chocolate bar in his pocket, and the candy began to melt.



RADAR .. first developed before/during World War II for aircraft detection - early imaging RADAR for mapping was airborne.

Intera technologies, Calgary:
1970s Panama -> 80s
- usually cloudy



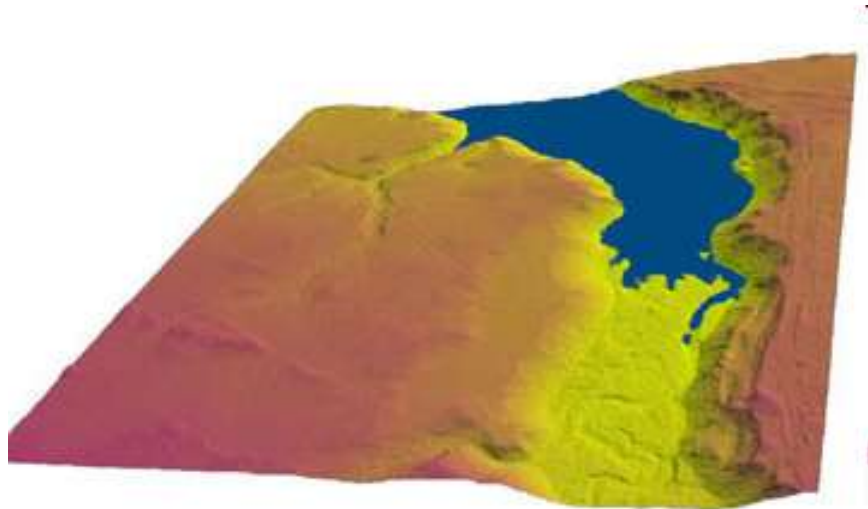
2000 -> LiDAR = Light Detection And Ranging

.. is the other common form of active remote sensing

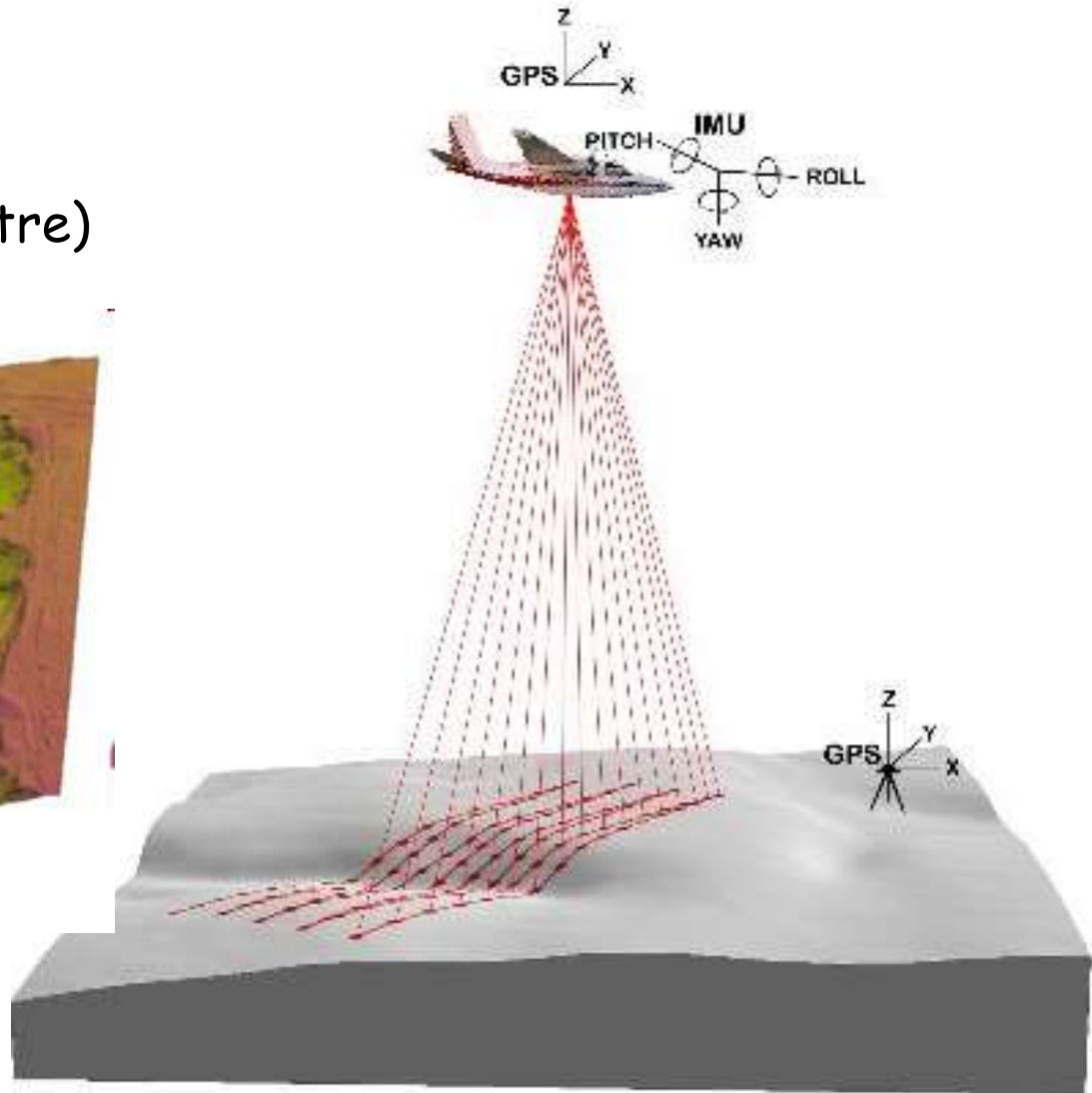
visible/NIR wavelengths

It is often used to create

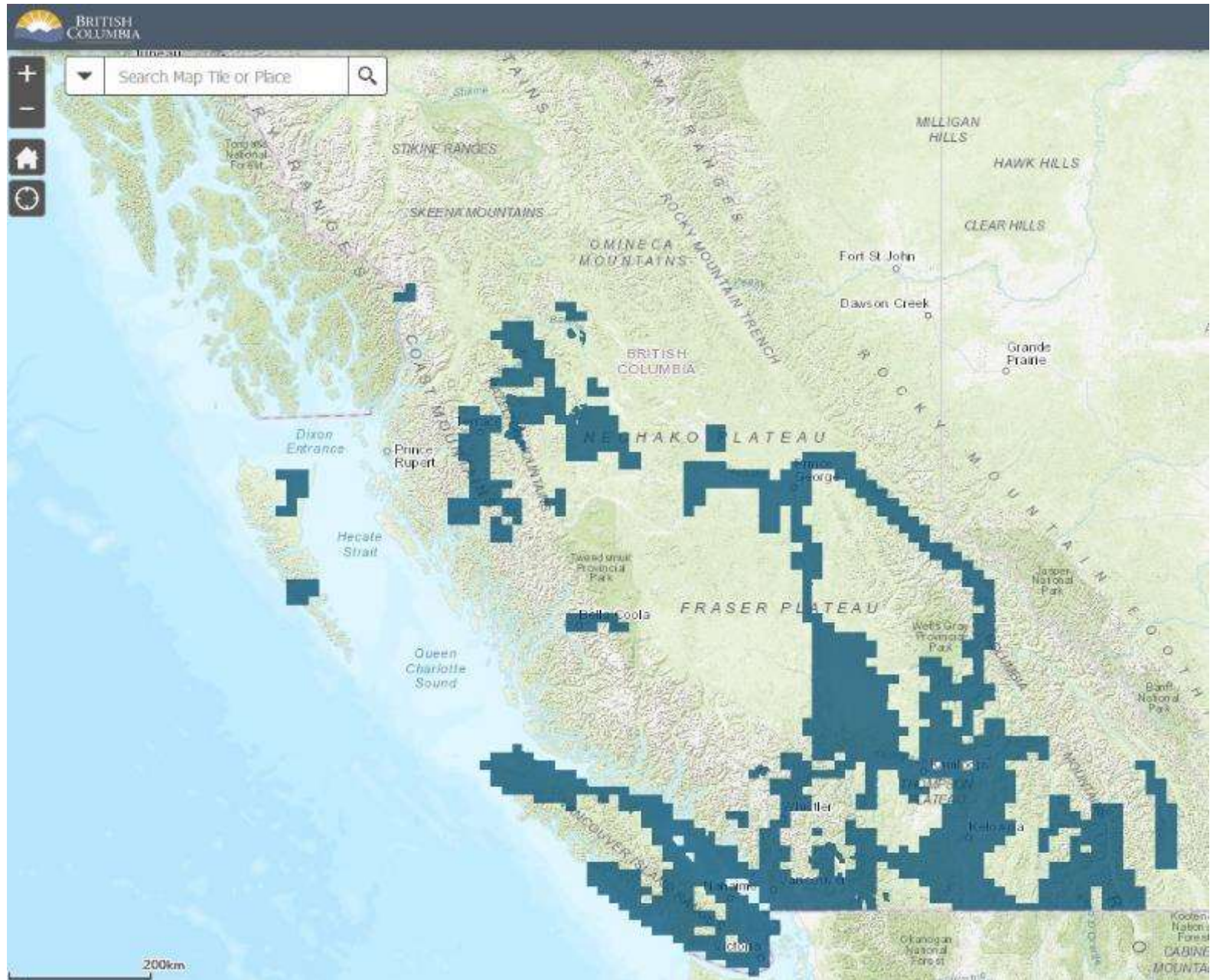
high resolution DEMs (< 1 metre)



Near-IR wavelengths



LidarBC - Open LiDAR Data Portal (2022)



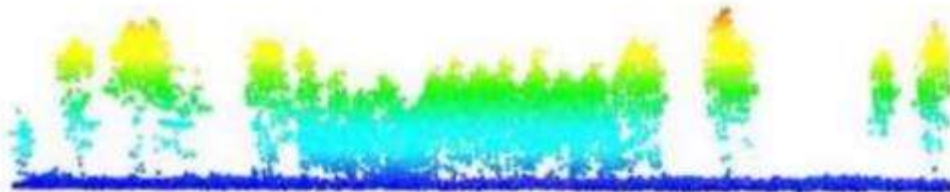
Point
elevation



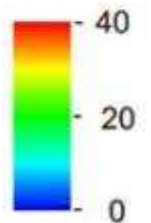
Surface
elevation



Point
height above
surface



Height (m)



University of Calgary fly-through: LiDAR DEM and draped orthophotography

http://www.youtube.com/watch?v=_myUhYPeAew

2000s -> Mapping from drones - UAVs

Unmanned Aerial Vehicles – easily and quickly launched



Matterhorn: https://www.youtube.com/watch?v=Fs2C_wXQ_IM