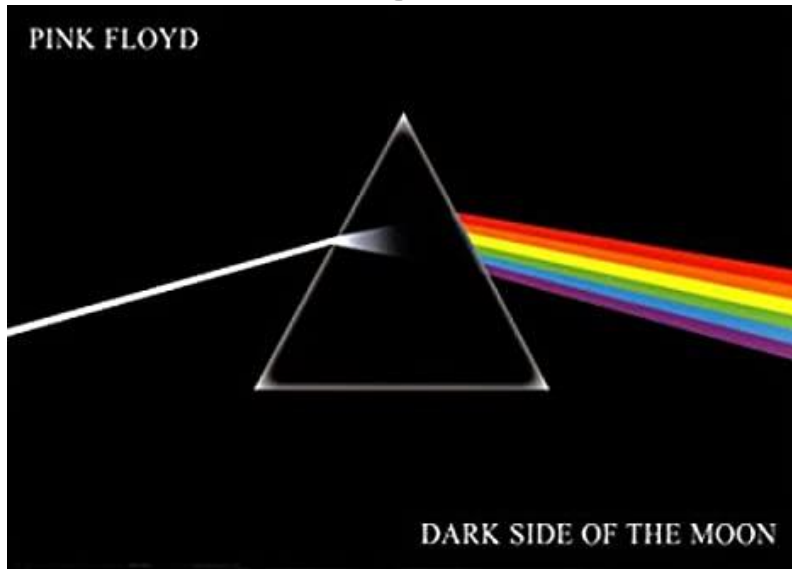


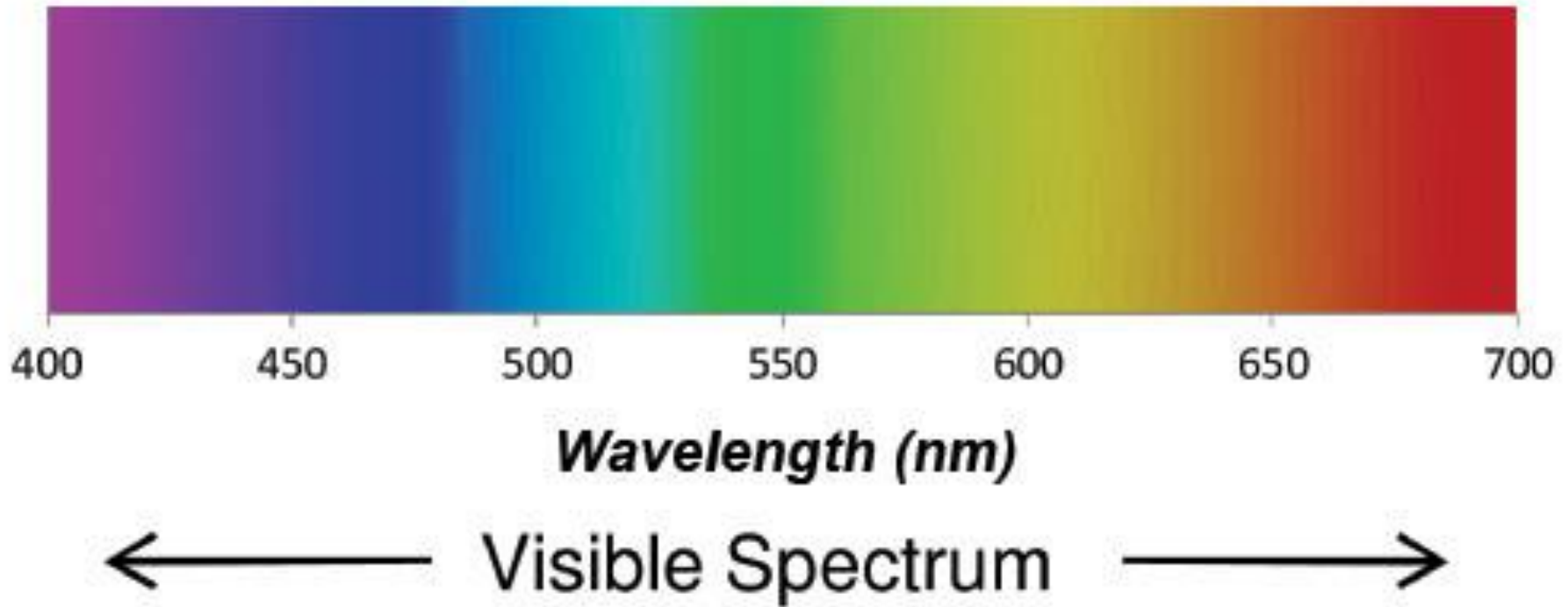
# Remote sensing and the electromagnetic spectrum



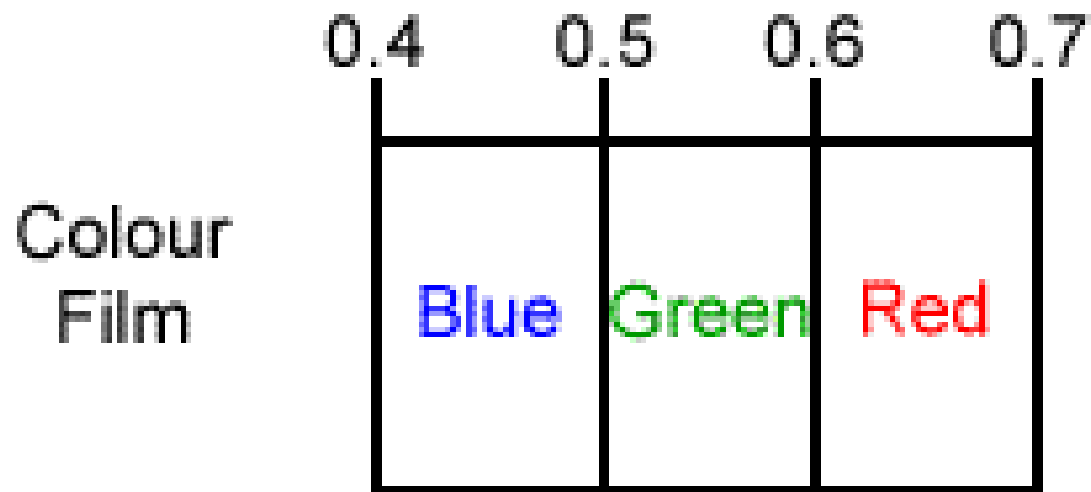
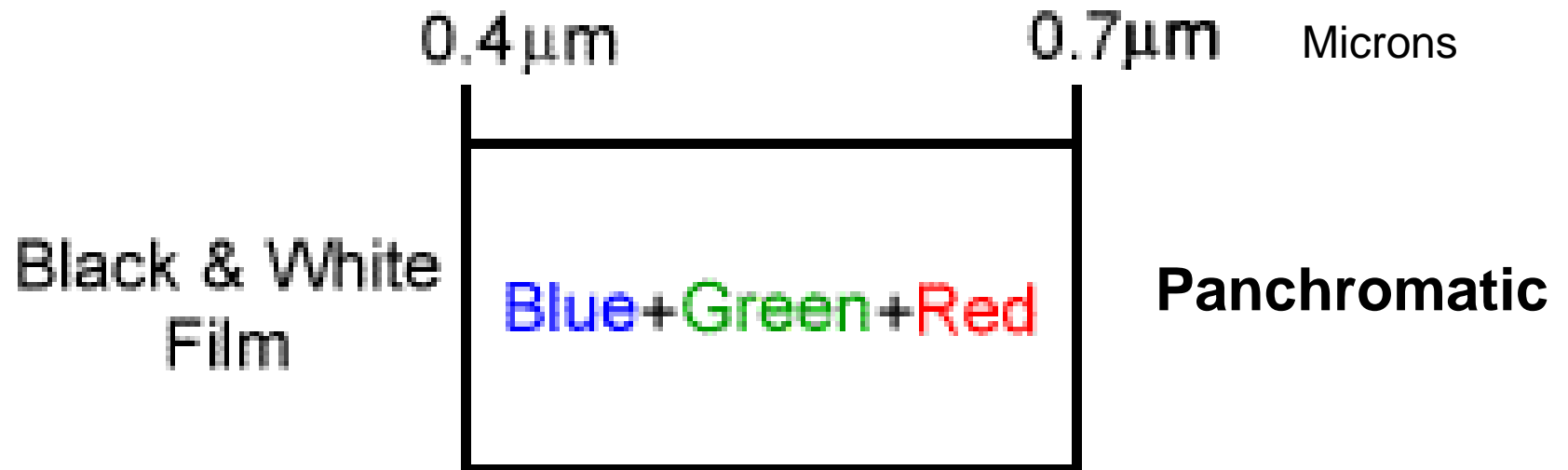
The spectrum  
provides the  
'layers' in RS



**micrometres** 'microns' : millionths of a metre  
**nanometres:** billionths of a metre



Blue	0.4 - 0.5 $\mu\text{m}$ (microns)	= 400 to 500 nm
Green	0.5 - 0.6 $\mu\text{m}$	= 500 to 600 nm
Red	0.6 - 0.7 $\mu\text{m}$	= 600 to 700 nm



© CCRS / CCT

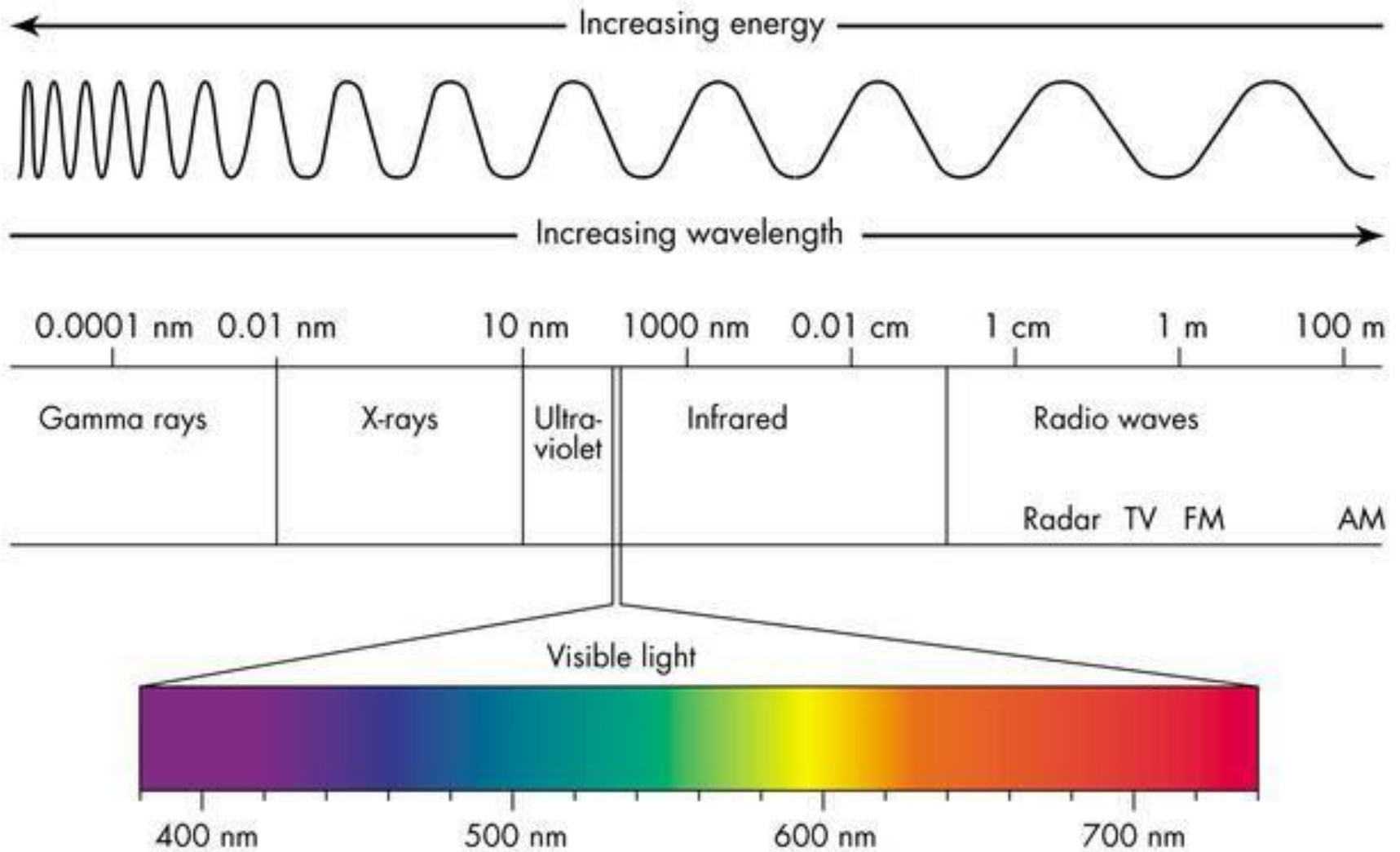
Panchromatic air photo: 15<sup>th</sup> / University Way





Colour air photo: 15<sup>th</sup> / University Way





**Wavelengths and Frequencies:**  
**Longer Waves - Low Frequency**  
**Shorter Waves - Higher Frequency**

## COMMON ANIMALS AND THE COLORS THEY CAN SEE

ANIMAL	THE COLORS THEY SEE	RELATIVE TO HUMANS
SPIDERS (jumping spiders)	ULTRAVIOLET AND GREEN	Different
INSECTS (bees)	ULTRAVIOLET, BLUE, YELLOW	Different
CRUSTACEANS (crayfish)	BLUE AND RED	Less
CEPHALOPODS (octopi and squids)	BLUE ONLY	Less
FISH	MOST SEE JUST TWO COLORS	Less
AMPHIBIANS (frogs)	MOST SEE SOME COLOR	Less
REPTILES (snakes*)	SOME COLOR AND INFRARED	Different
BIRDS	FIVE TO SEVEN COLORS	More
MAMMALS (cats)	TWO COLORS BUT WEAKLY	Less
MAMMALS (dogs)	TWO COLORS BUT WEAKLY	Less
MAMMALS (rabbit)	BLUE AND GREEN	Less
MAMMALS (rats)	ULTRAVIOLET, BLUE, GREEN	Different
MAMMALS (squirrels)	BLUES AND YELLOWS	Less
MAMMALS (primates-apes and chimps)	SAME AS HUMANS	Same
MAMMALS (African monkeys)	SAME AS HUMANS	Same
MAMMALS (South American monkeys)	CAN'T SEE RED WELL	Less
* pit vipers, some boas and some pythons		



# 1950s: Infra-red (IR) photography

IR was developed during the Korean War to distinguish between healthy vegetation (reflecting IR) and camouflage. Hence it was known as 'camouflage detection' film or 'false colour'.



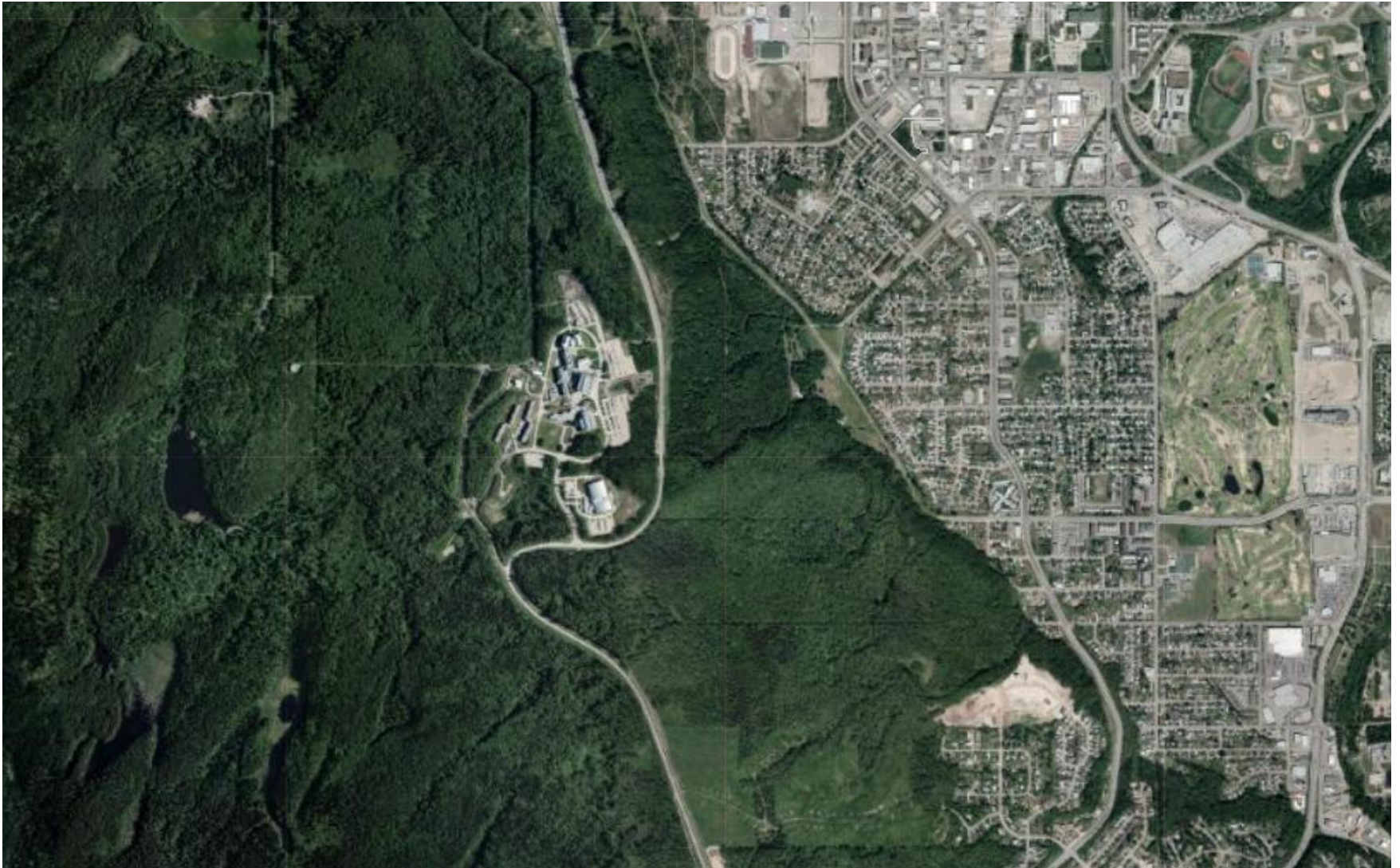


**Table 2 : Characteristics of normal colour and false colour film**

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

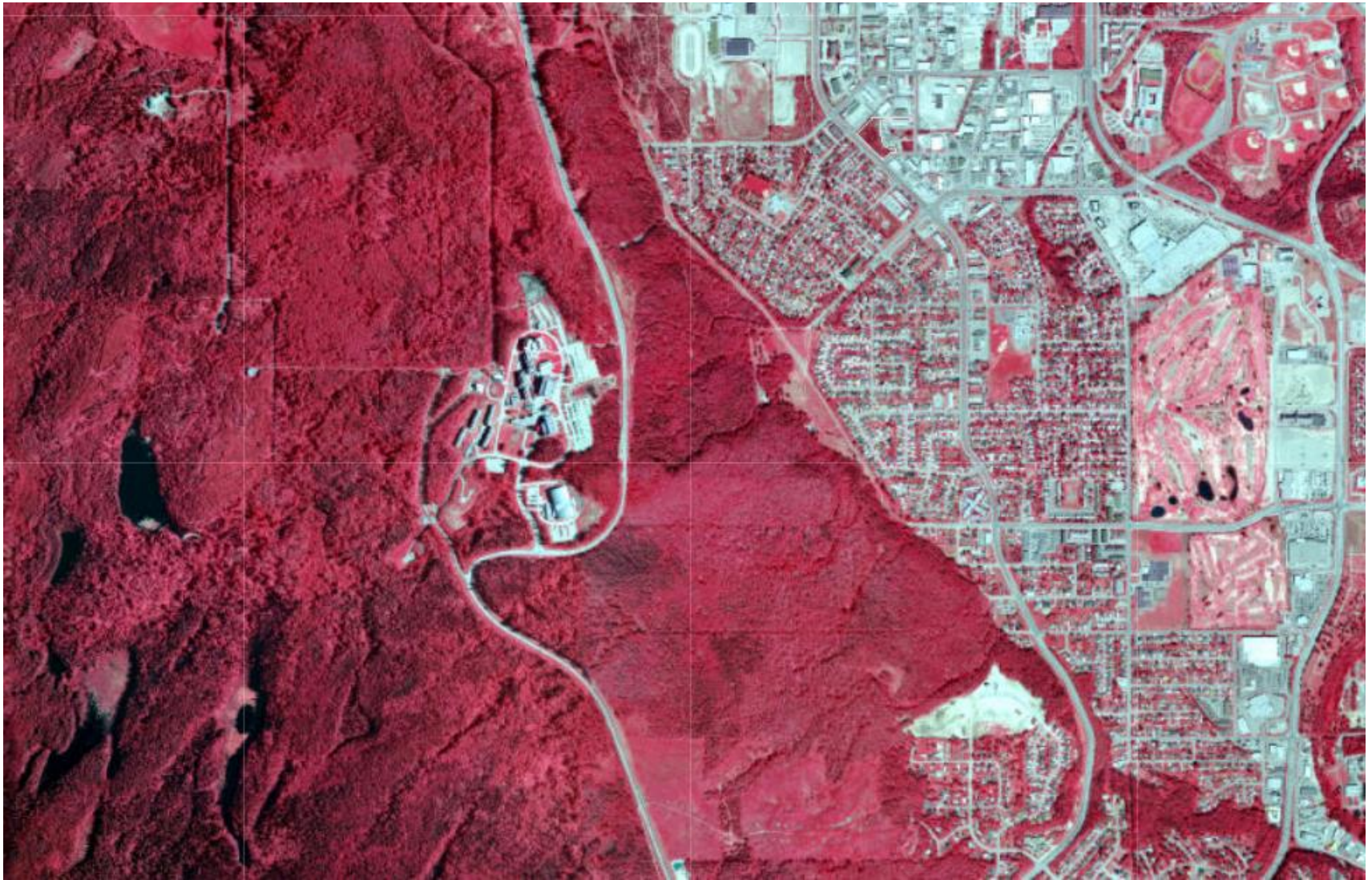


PGmap spring 2014 natural colour

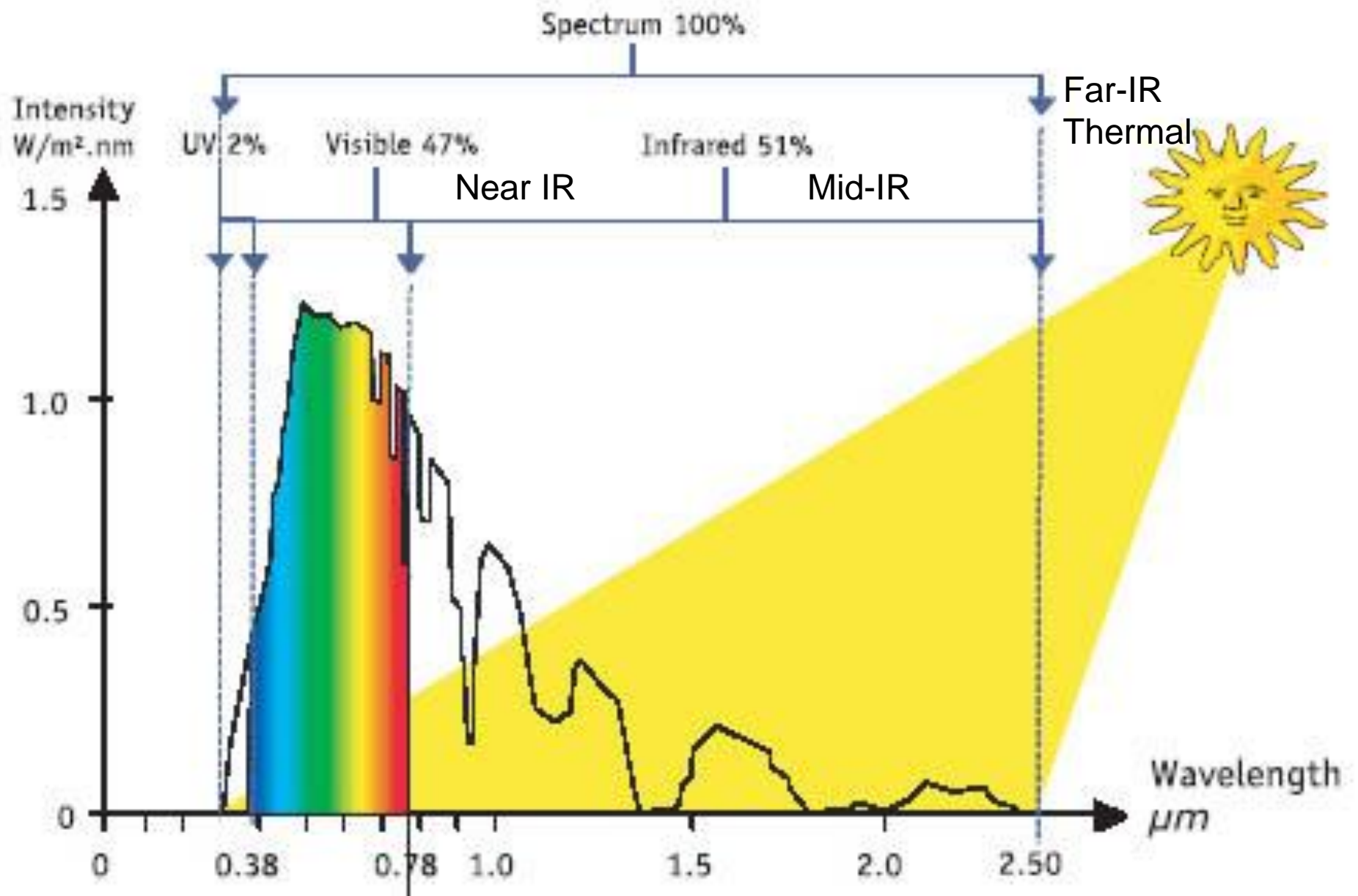




PGmap spring 2014 IR image: <https://pgmappub.princegeorge.ca/Html5Viewer/?viewer=PGMapMobile>



# SOLAR SPECTRUM





# Landsat 5 Thematic Mapper bands (1984-2011)

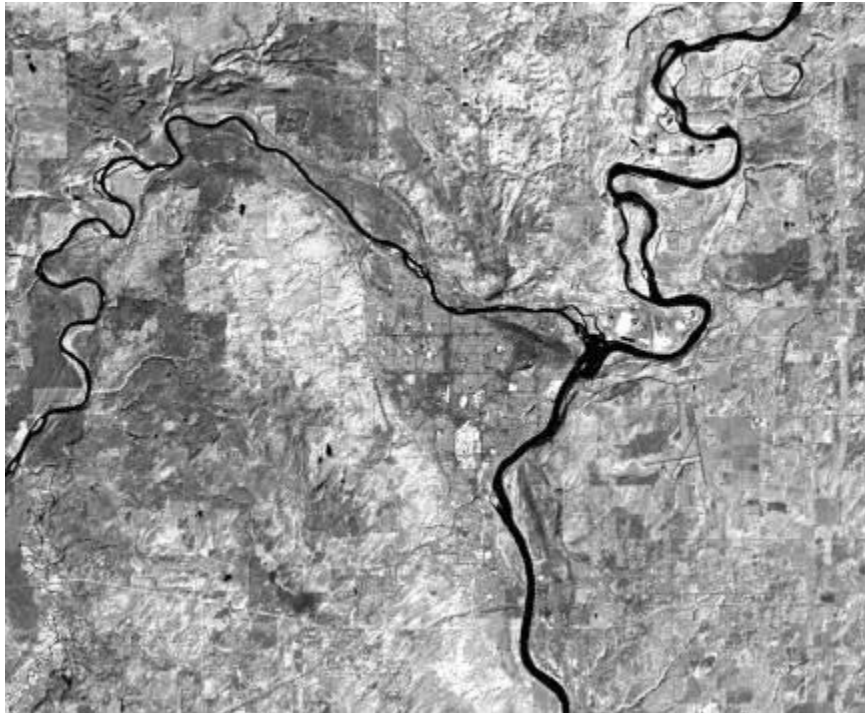
Band No.	Wavelength Interval ( $\mu\text{m}$ )	Spectral Response	Resolution (m)
1	0.45 - 0.52	Blue-Green	30
2	0.52 - 0.60	Green	30
3	0.63 - 0.69	Red	30
4	0.76 - 0.90	Near IR	30
5	1.55 - 1.75	Mid-IR	30
6	10.40 - 12.50	Thermal IR	120
7	2.08 - 2.35	Mid-IR	30

Multi-spectral remote sensing

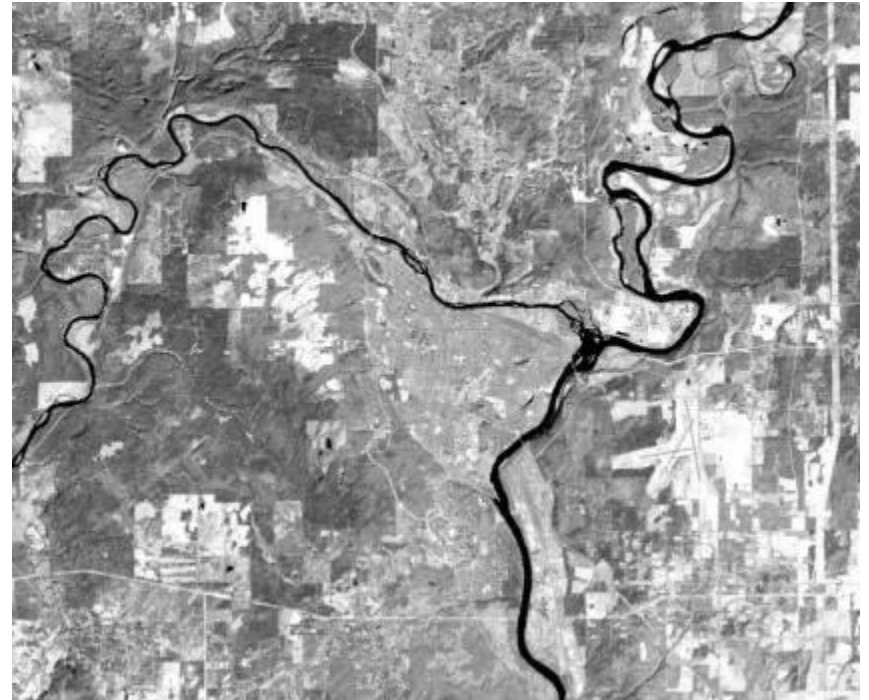
The **near IR** (0.7-1.3 microns) records energy related to **vegetation vigour** (health), while the **mid- IR** (1.3-3.0 microns) is (soil) **moisture**.

Neither have to do with temperature (or not much)

**Near-IR**

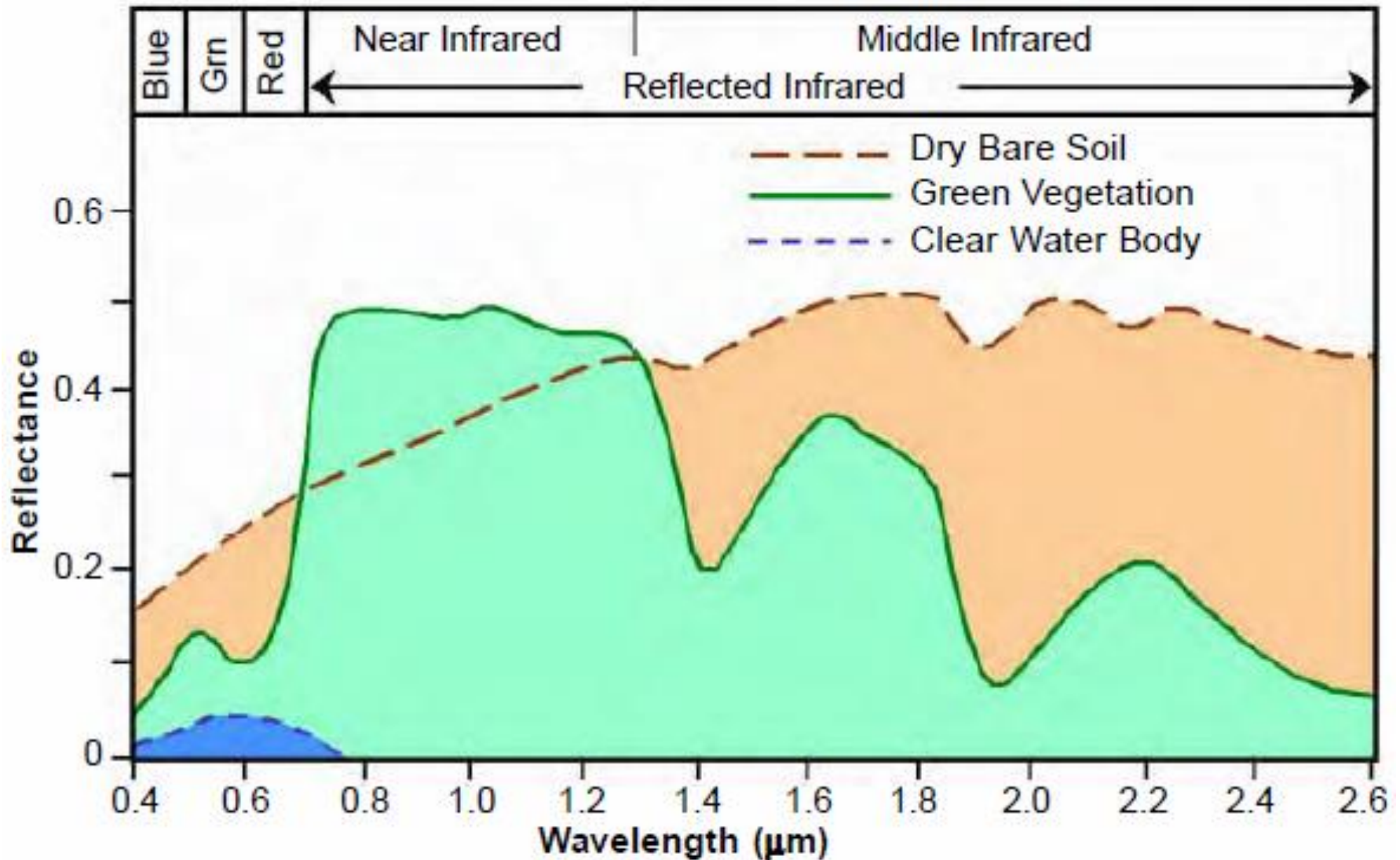


**Mid-IR**



advantages of Infra-Red wavelengths: contrast

## Spectral Reflectance Curves



# Summary of advantages of (near) Infra-Red wavelengths:

1. Vegetation differences are enhanced  
e.g. coniferous v deciduous etc..
2. Land-water distinctions are enhanced
3. Blue -most susceptible to haze- is removed



# Landsat TM band combinations: Visible versus IR combination

Visible wavelengths image

e.g. Google maps, earth (3-2-1)



Including Infrared (NIR / SWIR)

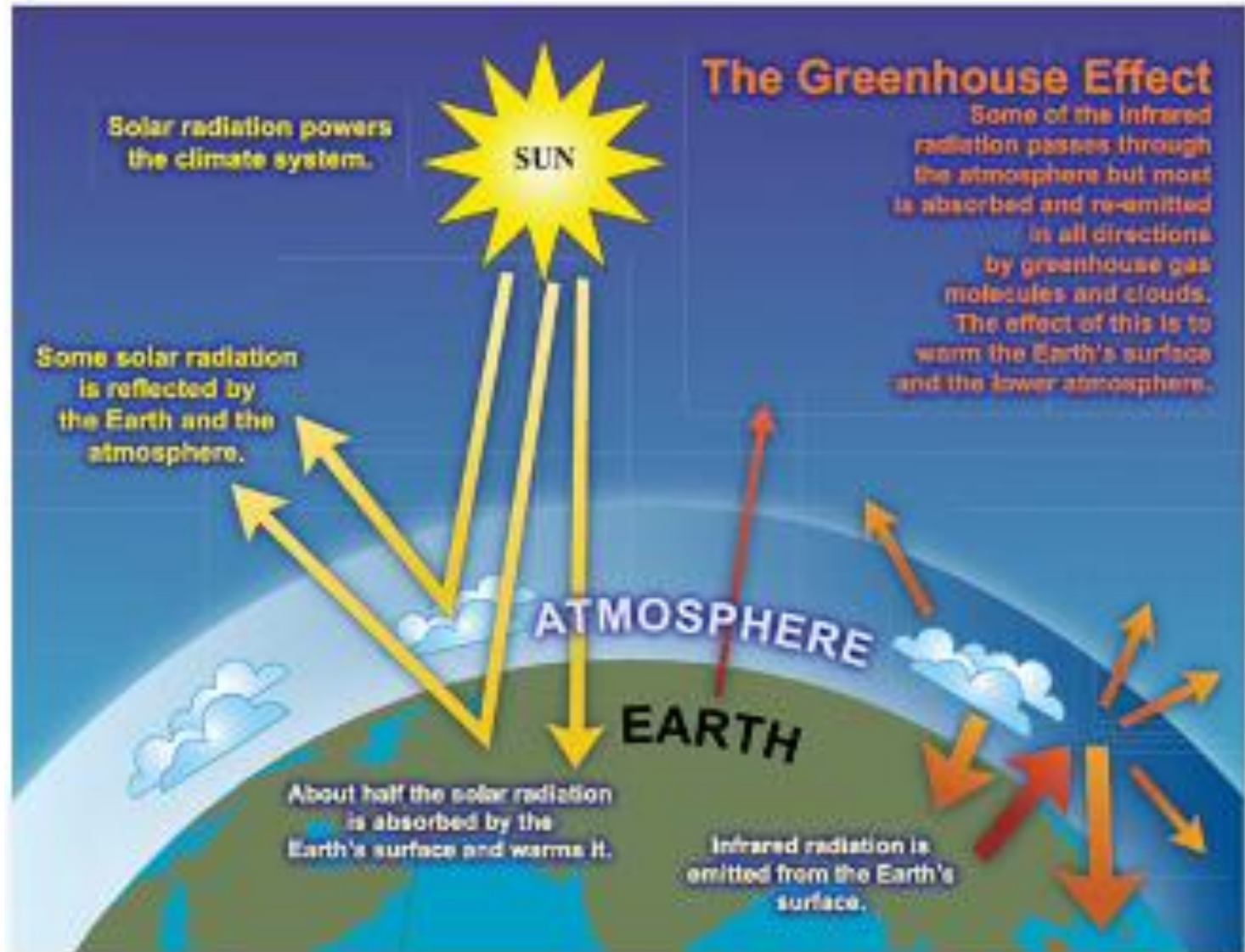
e.g. BC imap / GEOG357 labs (5-4-3)



**The best displays include one band each from the visible, near-IR and mid-IR**

# Thermal Infrared (3-14 microns)

This records longer wavelengths (shown in orange) and a measure of temperature as it is emitted NOT reflected IR - Works day / night



Prince George Landsat 5 Band 6 - thermal-IR



**‘Brightness temperature’ – related to surface thermal qualities**



# Microwave: 1mm - 1 metre wavelength

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





As wavelength increases, so does atmospheric penetration ....

**Gamma rays:**            most don't reach earth

**Table: penetration by energy wavelengths**

Ultra-violet	Cannot get through glass
Visible	Can penetrate through glass
Infra-Red	Penetrates through haze
Thermal Infra-Red	Penetrates through smoke
Microwave	Gets through clouds, snow, and even sand

# Summary

Remote Sensing activity is classified into three groups based on the wavelengths used:

1. Visible and Near/Mid Infrared (reflected) = 'optical'
2. Thermal Infrared (emitted from earth)
3. Microwave (= cloud-free ... includes Radar)