Light & Architecture

Christian Fournier

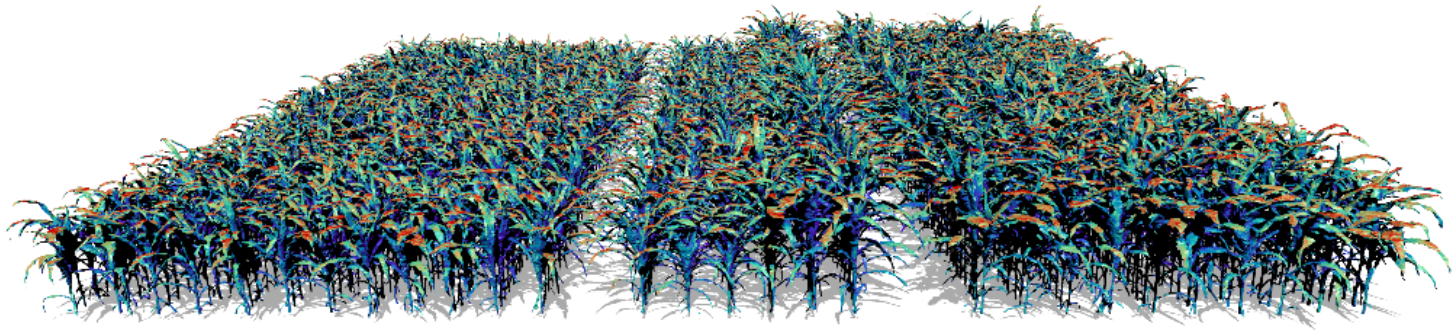
INRAE

lepse Montpellier

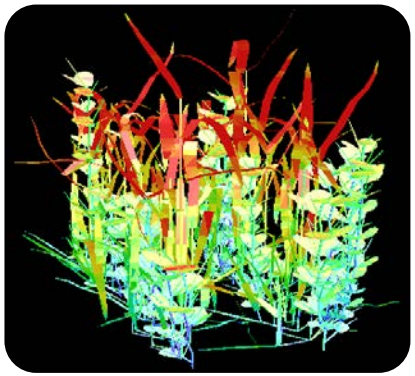
OpenAlea

M3P Montpellier Plant Phenotyping Platforms

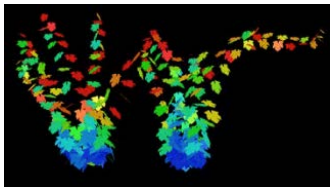
Why ?



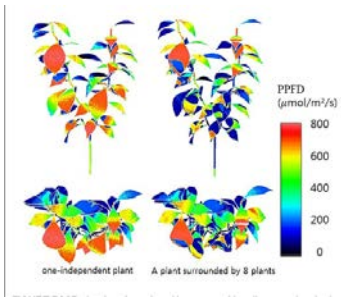
Artzet et al., 2020



Barillot et al., 2012

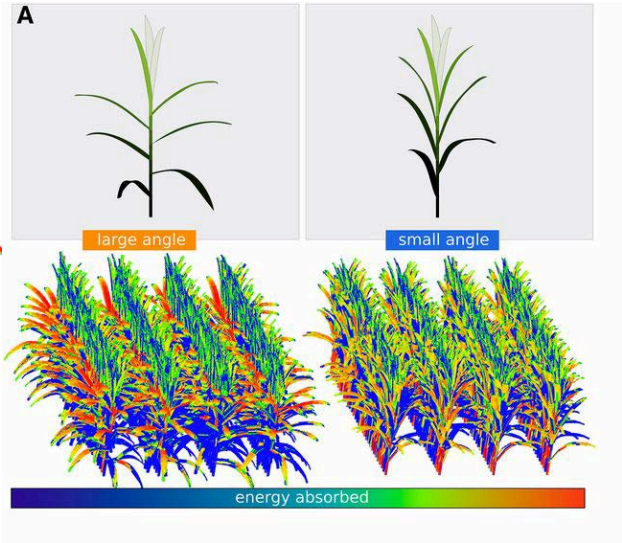


Albasha et al., 2019



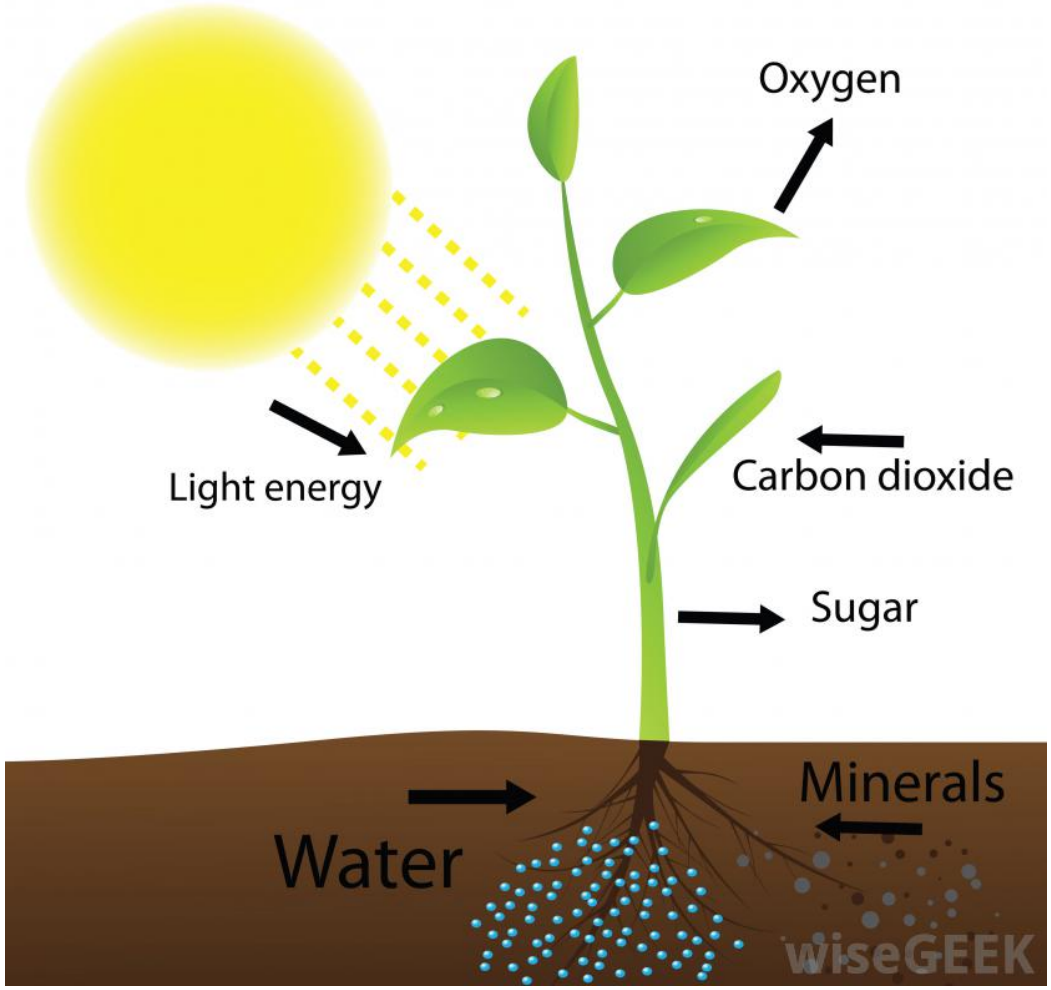
Chen et al., 2014

Fournier et al.



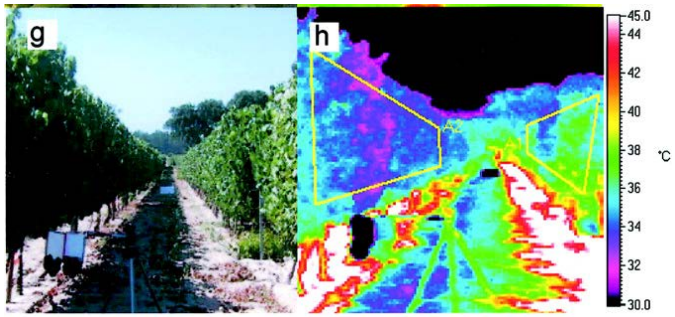
Truong et al., 2015

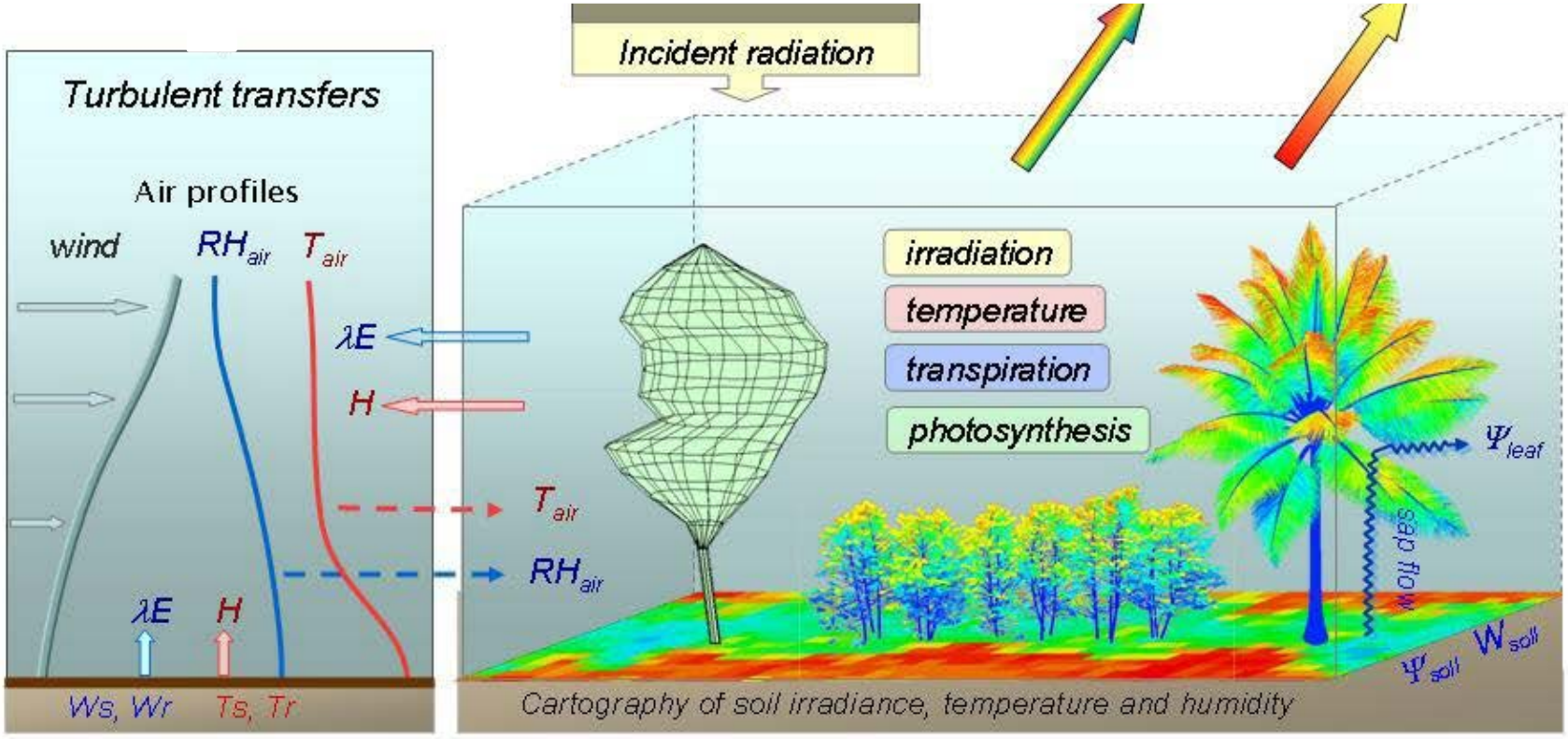
Photosynthesis



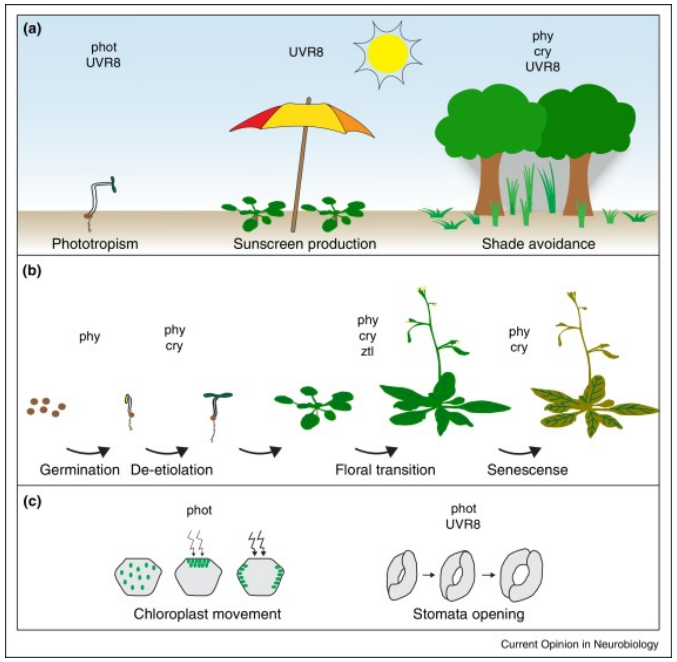
Competition within canopy

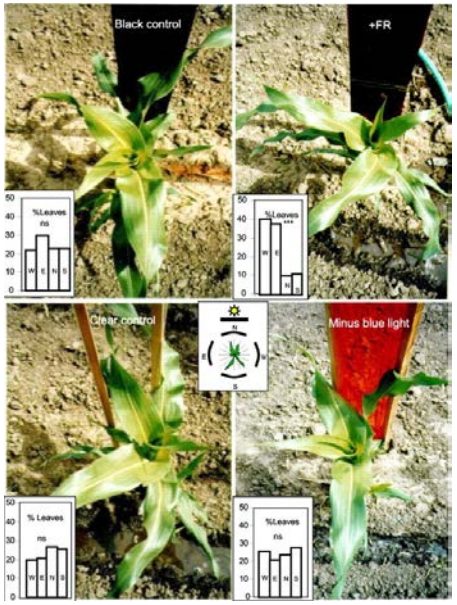
Microclimate





Light perception

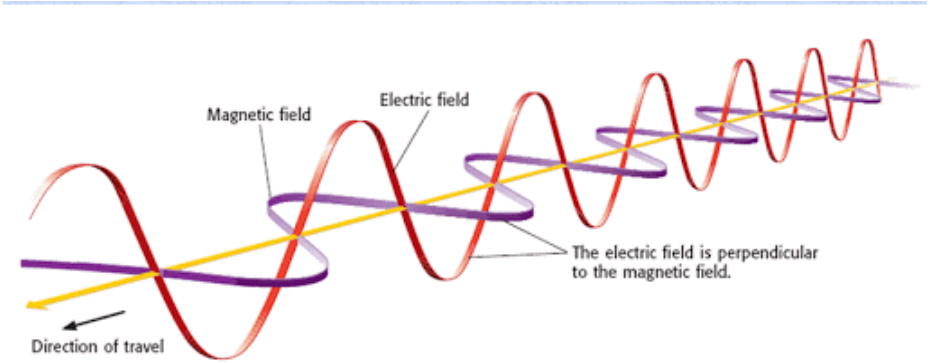




What is Light?

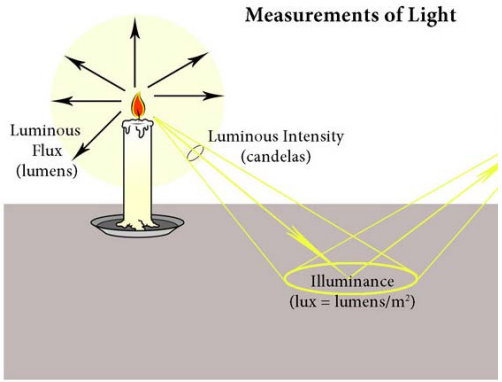
Light & Light Quantity

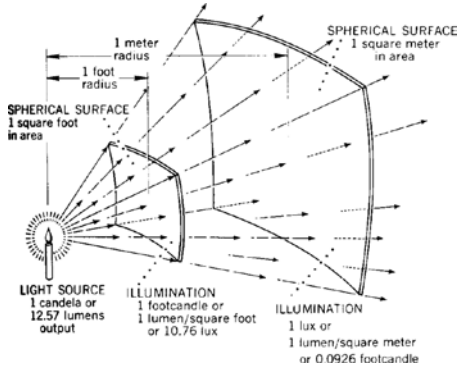
- Light : a form of energy carried through perturbation of the electro-magnetic field



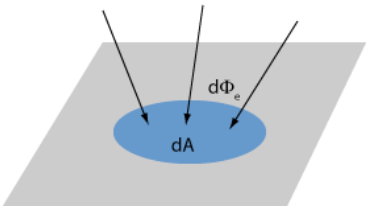
- Modelled as flux of waves and/or a flux of particles propagating straight forward

- Radiance (luminance): emitted flux of energy per unit surface per second ($J.m^{-2}.s^{-1}$ or $W.m^{-2}$)



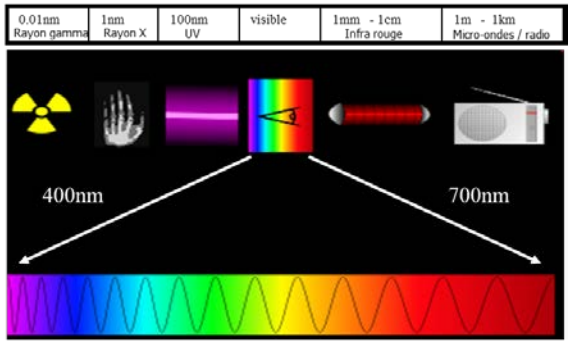


- Irradiance (illuminance): Incoming flux of energy per unit surface per second ($J.m^{-2}.s^{-1}$ or $W.m^{-2}$)



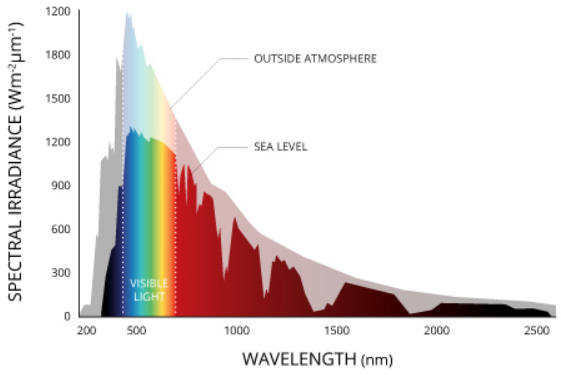
Light Quality

- Radiations have an intrinsic energy expressed by the wavelength of the light wave
- Monochromatic sources (laser) emit radiations with same wavelength
- Polychromatic sources (sun…) emit a bunch of radiations in a range of wave lengths
- Photosynthesis occurs in visible light range (400-700 nm) => PAR domain
- Light perception occur in PAR (Blue, red) + Far red range => MAR domain
- Micrometeorological process occur in PAR (shortwave) + Infrared (longwave) range

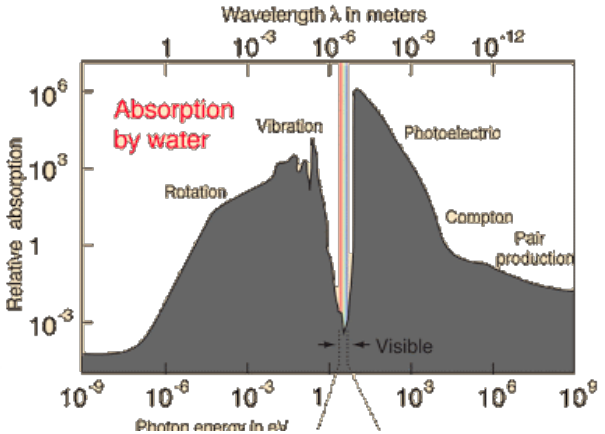


Longueur d'onde	Domaine
>10cm	Radio (150 kHz - 3 GHz)
3mm - 10cm	Micro-onde et radar (10cm±1cm, 3-100GHz)
300µm - 3mm	Terahertz (100GHz-10THz)
1µm - 300µm	Infrarouge
400nm - 700nm	Lumière visible: Rouge/Orange/Jaune/Vert/Bleu/Violet
10nm - 400nm	Ultraviolet
10^{-11} m - 10^{-8} m	Rayon X
10^{-14} m - 10^{-11} m	Rayon γ

Sun emission

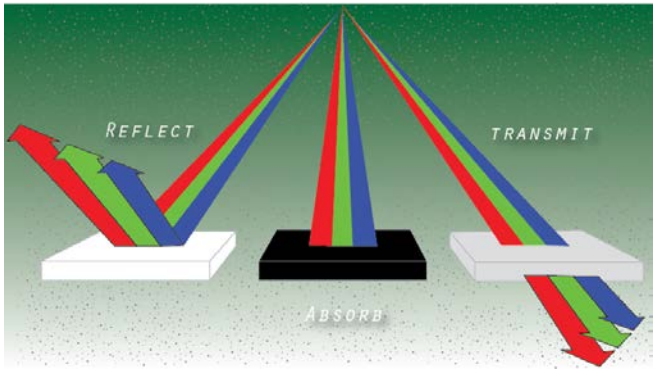


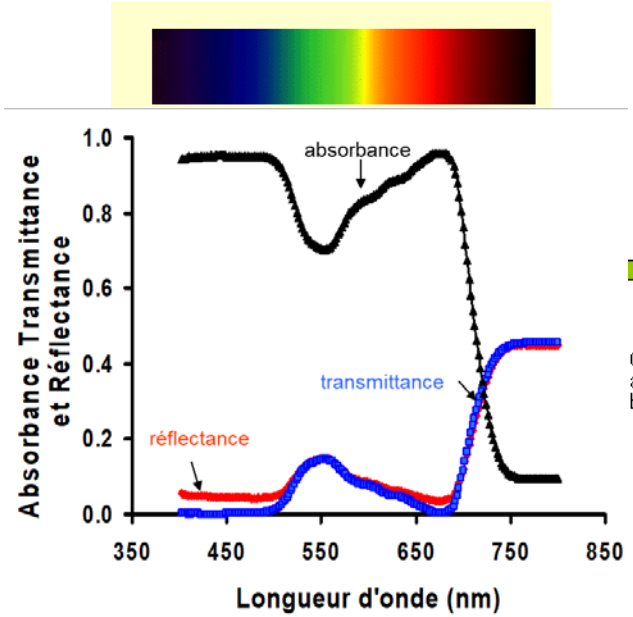
Water transparency

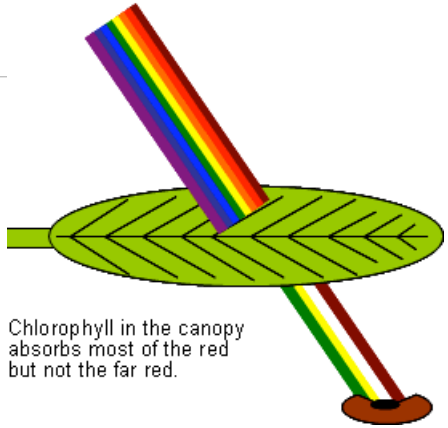


Interactions with objects

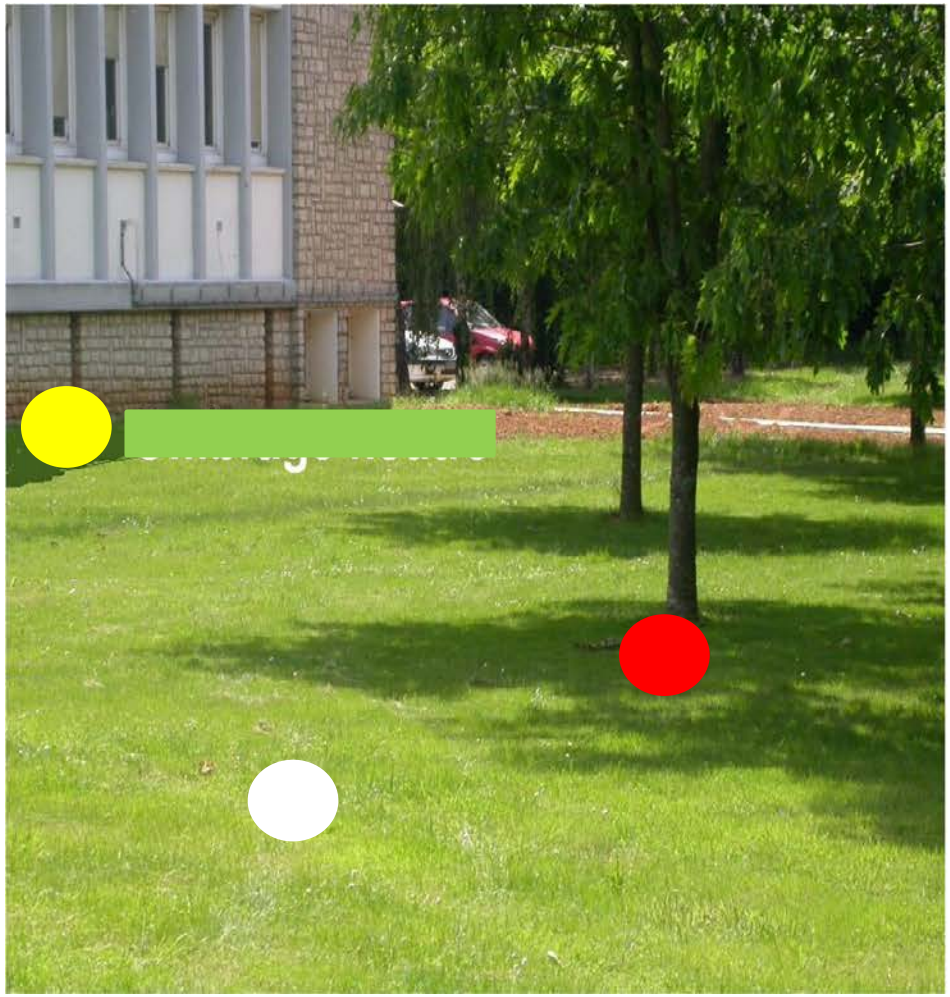
- Reflect (specular or scattered)
- Absorb (and partly re-emit)
- Transmit (with or without deviations)
- Interaction depends on wavelength
- Leaves Absorb high percentage of PAR (although a little less green and yellow)
- Leaves do not absorb far red / infrared

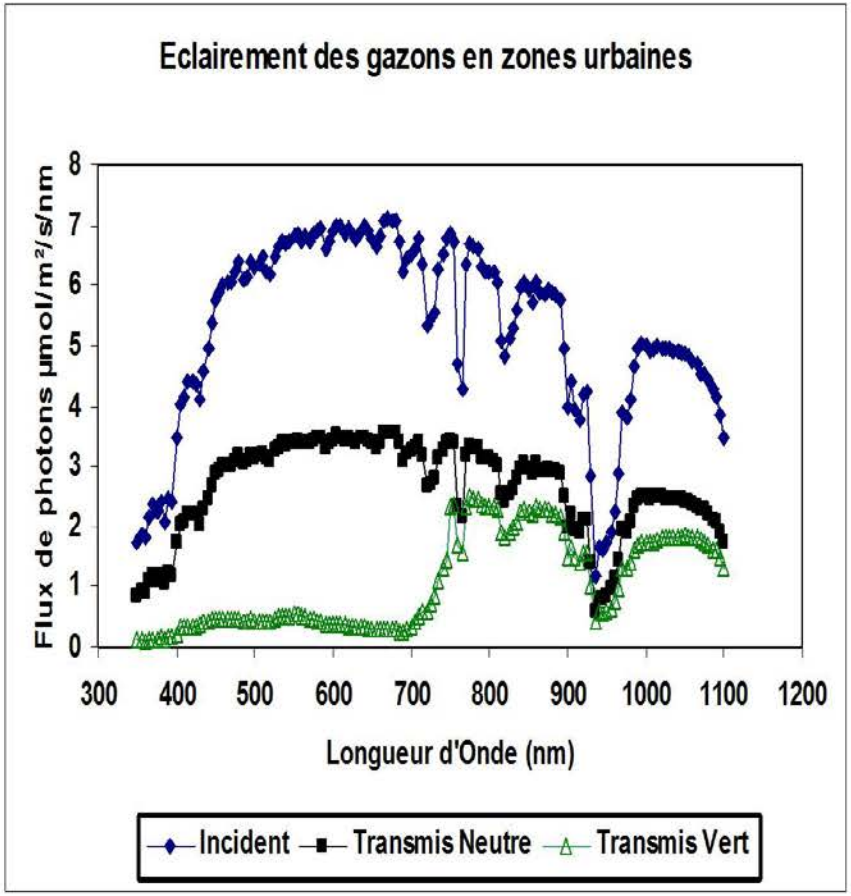




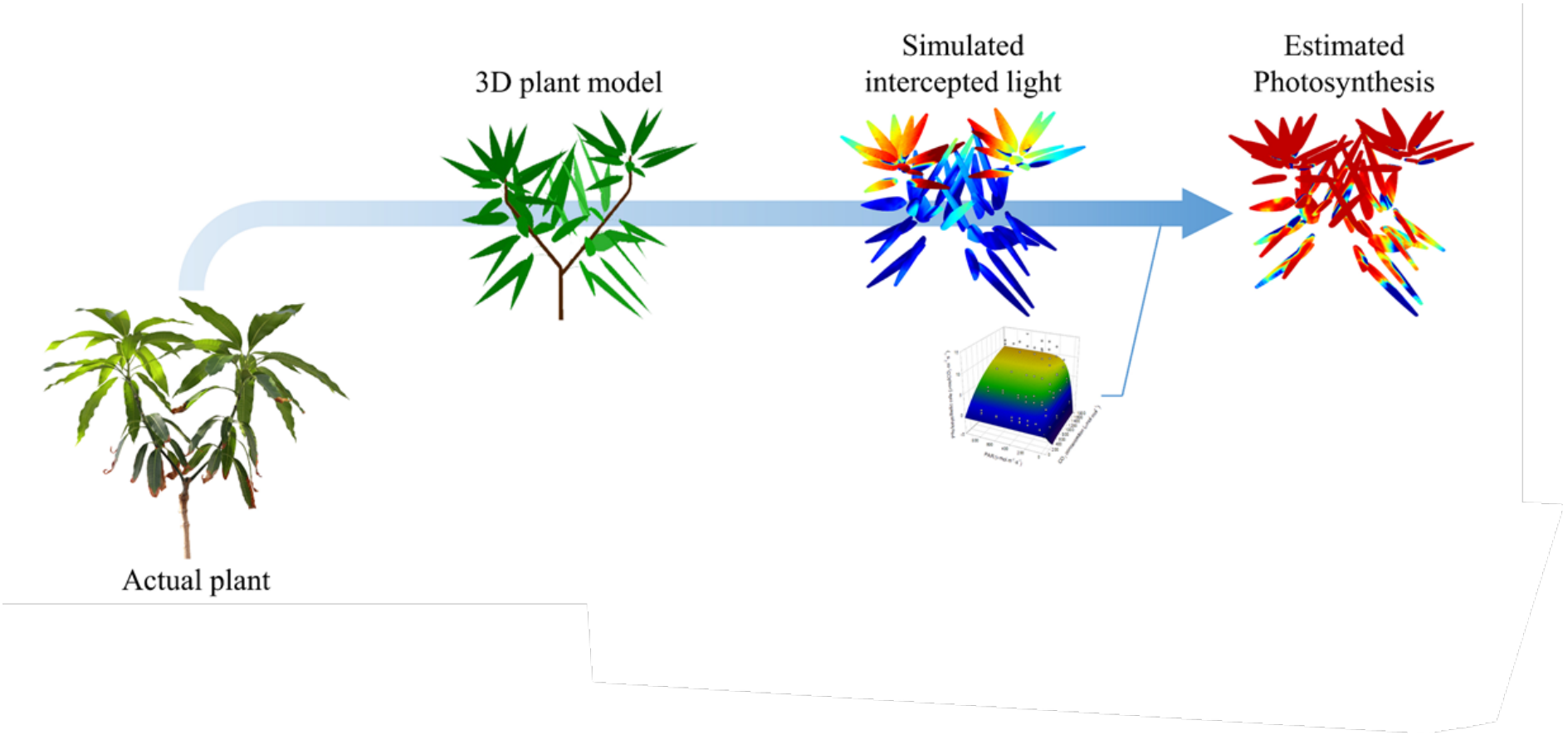


Find which curve correspond to which zone





What next ?


3D plant model
Simulated
intercepted light
Estimated
Photosynthesis
Actual plant