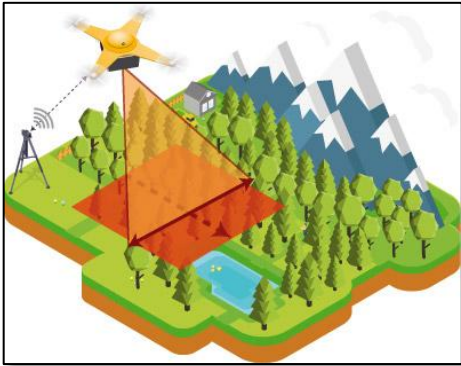


Women in Engineering Summer Engineering Academy Day

Tucson, AZ - June 16, 2025

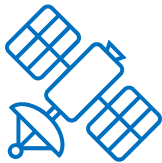
Vegetation Index and Phenology Lab

Kamel Didan, Armando Barreto, Eduardo Jimenez Hernandez





- At the VIP Lab we use **satellites**, **drones**, and **data science** for observation and monitoring of the natural environments.

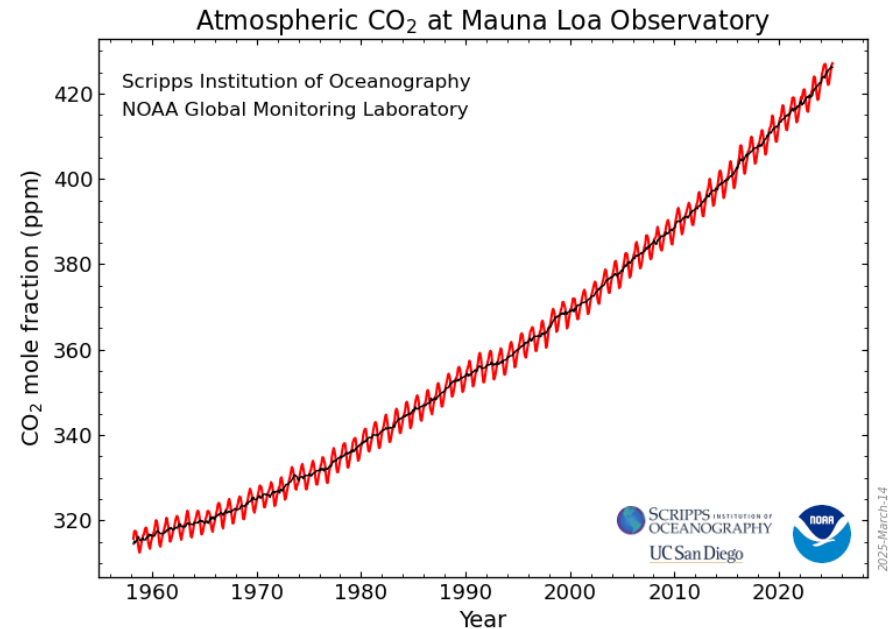
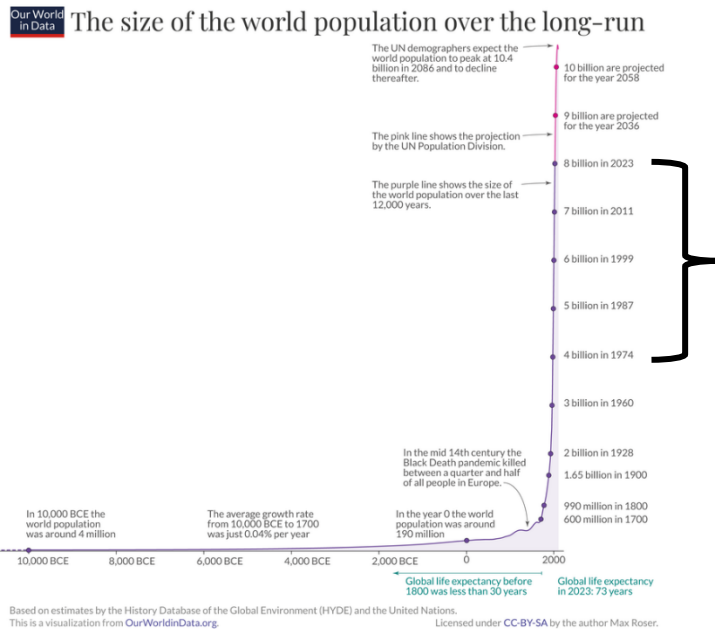


- The Lab specializes in designing **data processing science algorithms** to generate long term Climate Data Records from single- and multi-satellite data products.
- Our research Lab is supported by grants from:



Why do we study our planet?

- Current challenges:
 - **Fair distribution** of resources (water, food, land, air,...)
 - **Preservation** of our natural environment



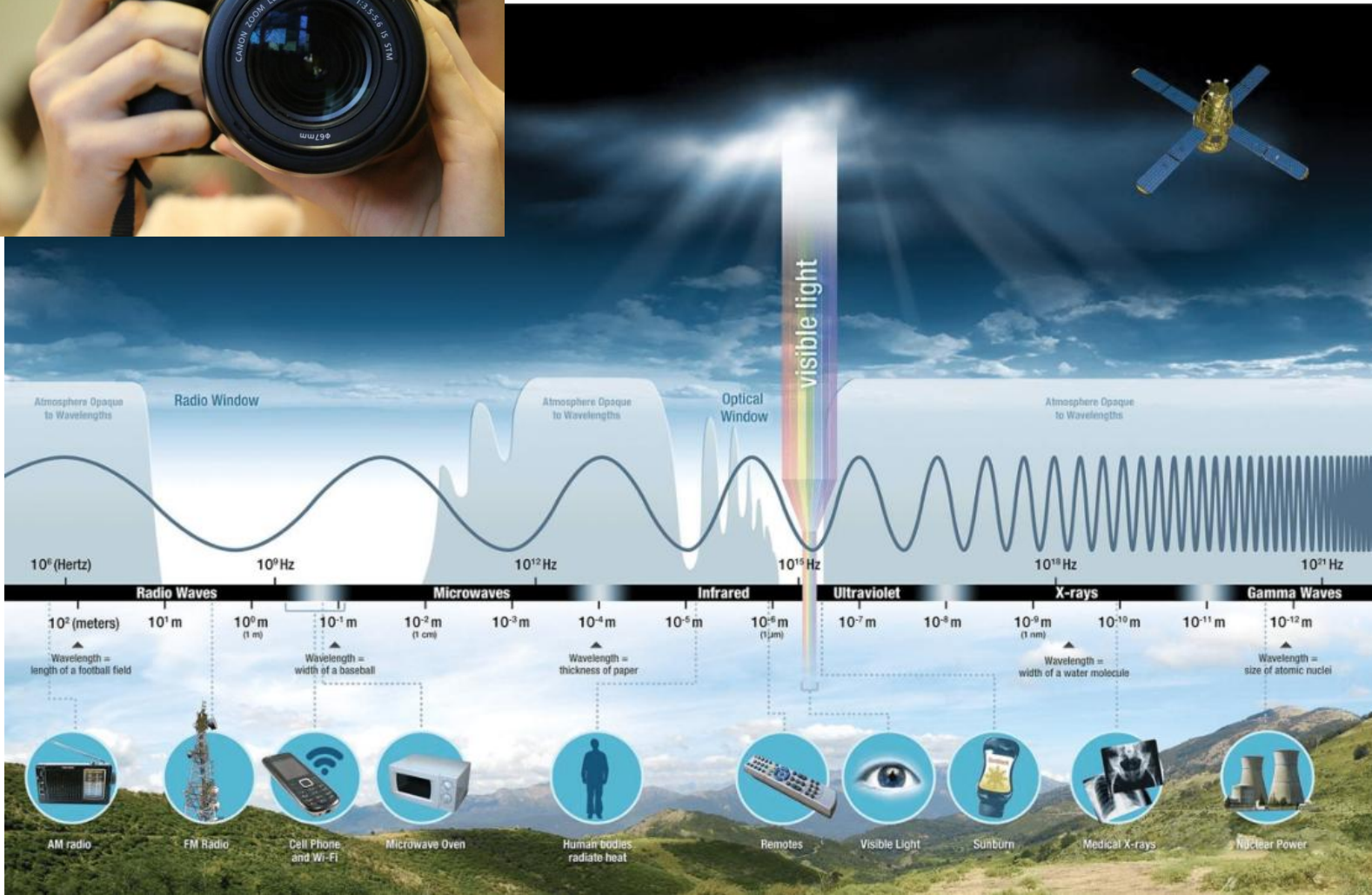
Planet population doubled in 50 years Carbon dioxide comes from fossil fuels

- **We should care!** And caring starts by observing

How do we observe? We use cameras

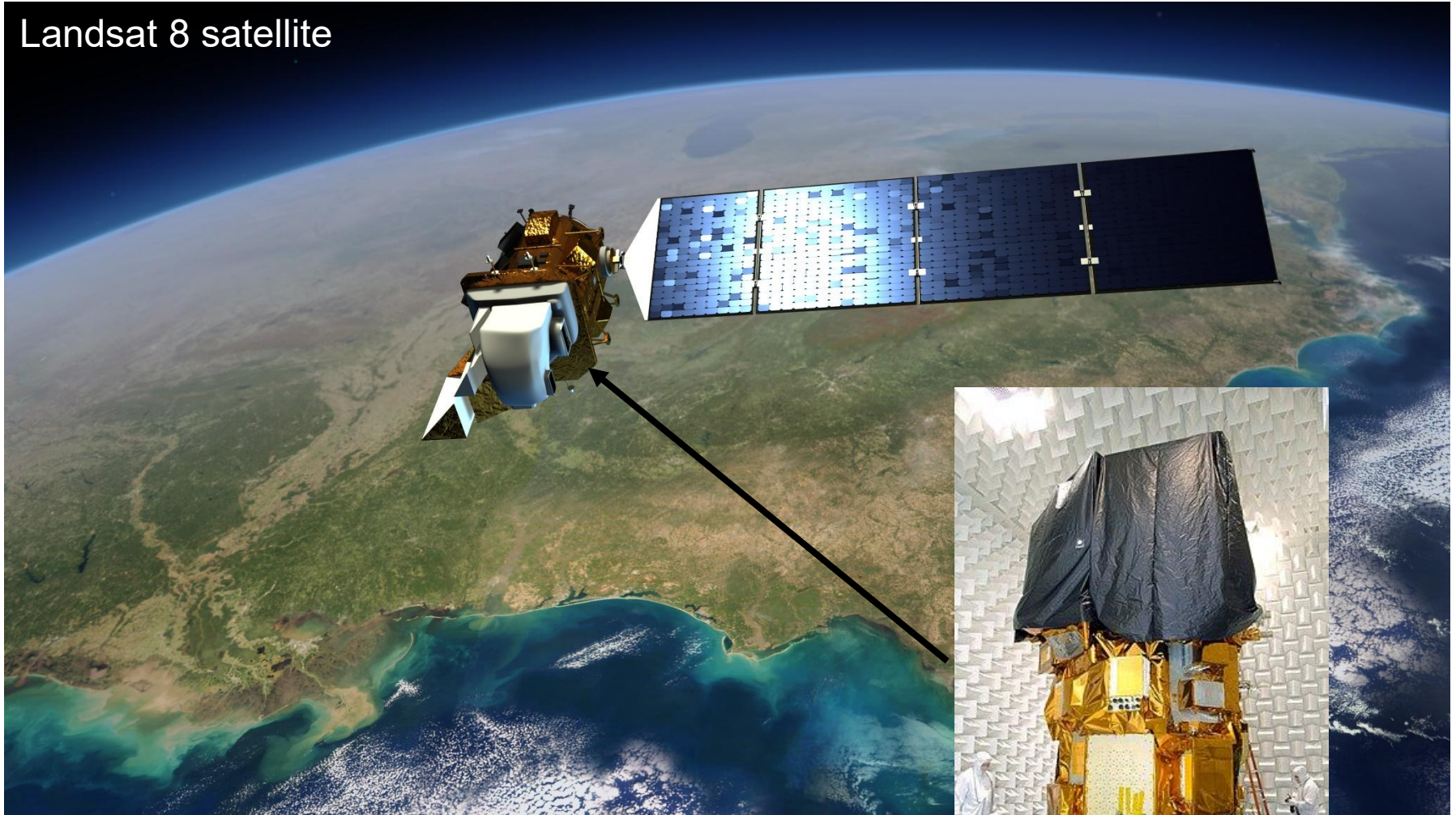


Cameras capture images in visible spectrum, colors are composed from a combination of **Red**, **Green** and **Blue** (the primary colors).

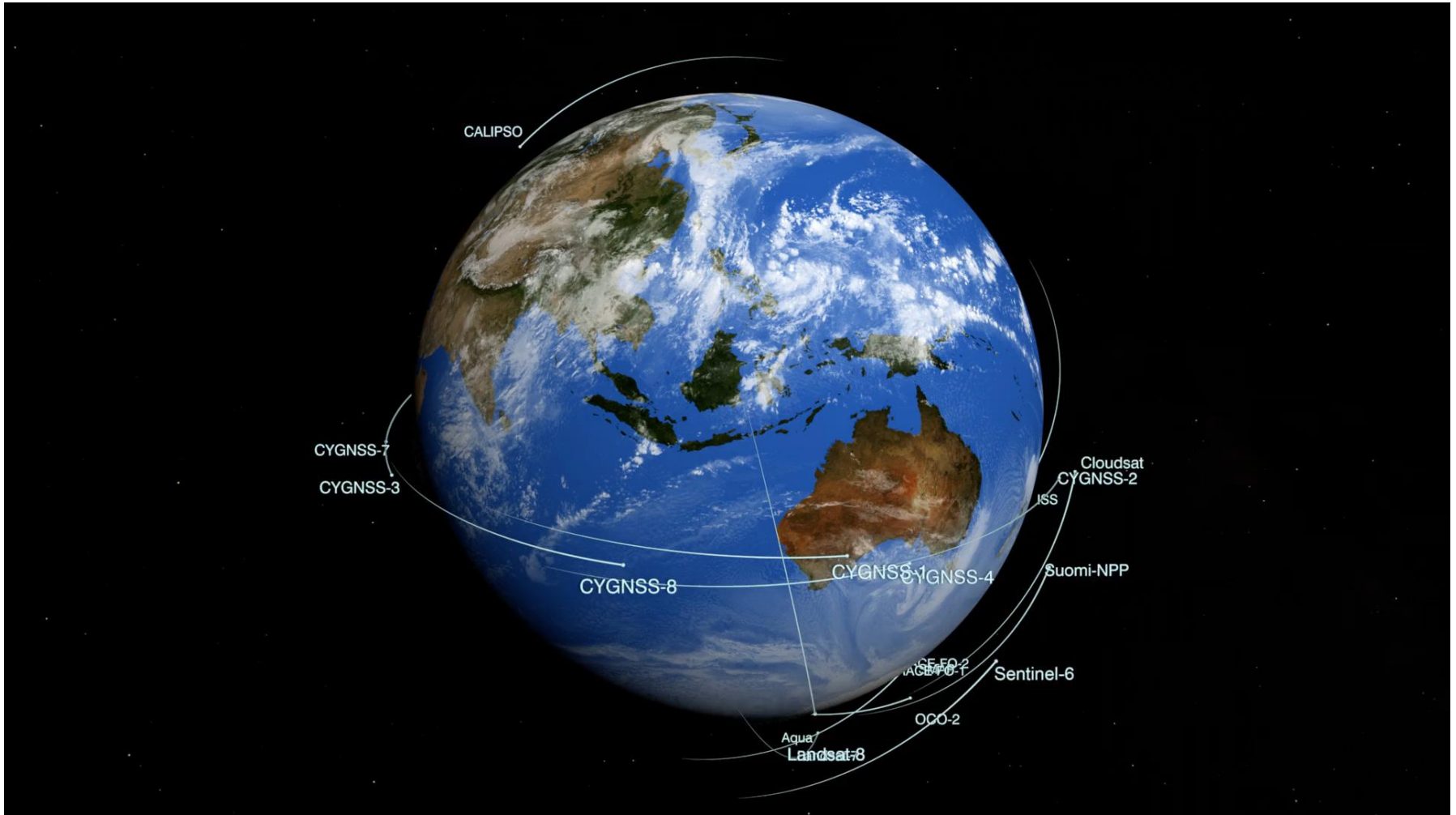


Put the cameras in satellites

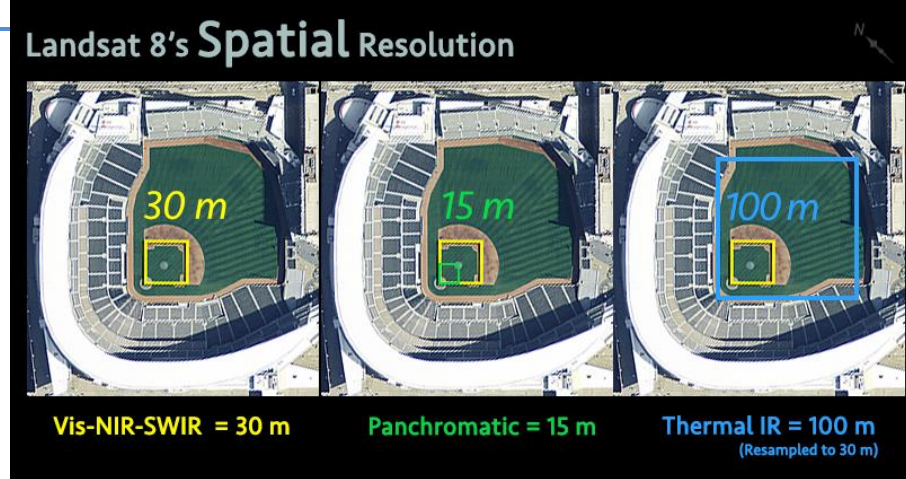
Landsat 8 satellite



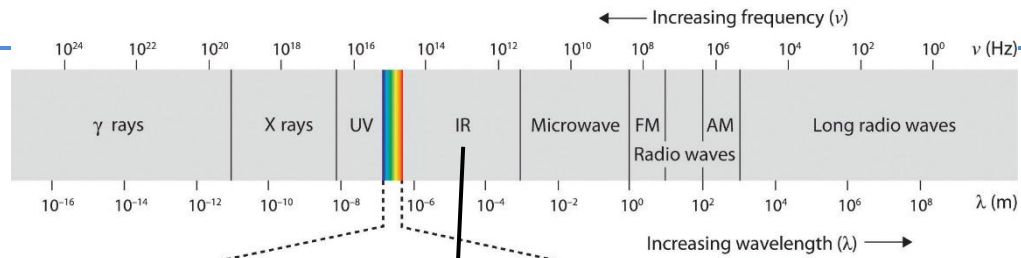
NASA's Earth Observing Fleet



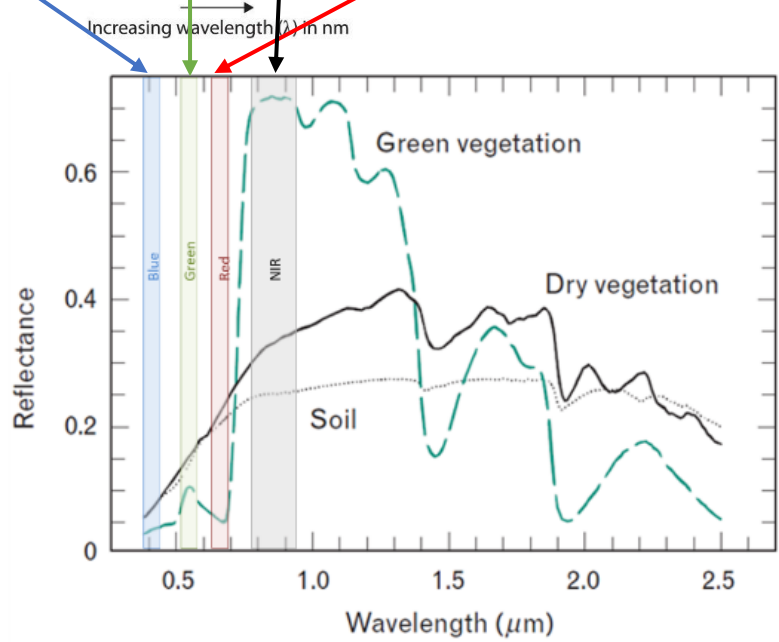
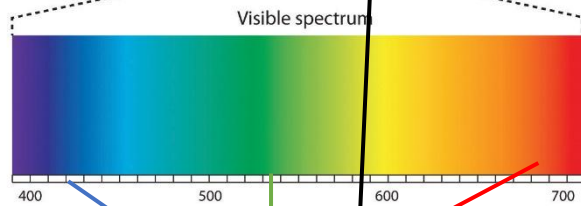
Landsat: spatial resolution



How do we observe?



EM spectrum



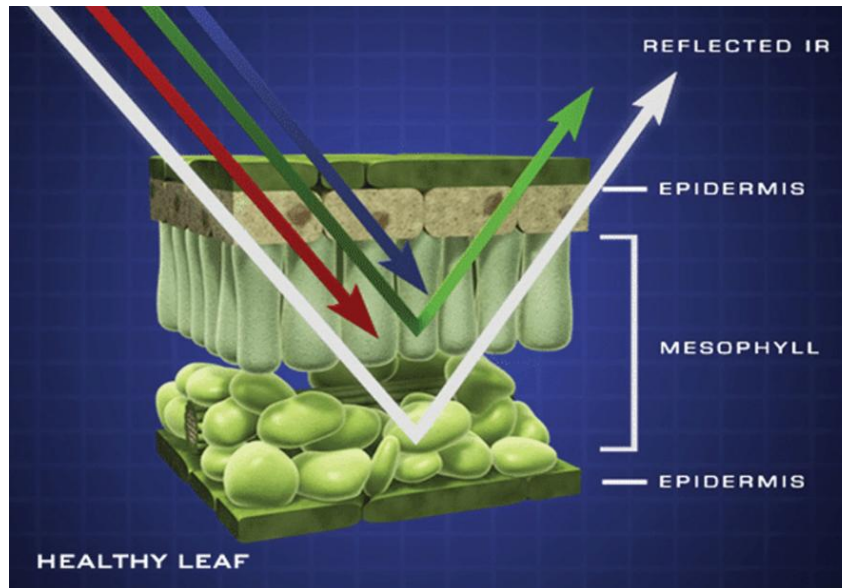
Spectral signature: every object has a different combination of surface reflectance values in the R, G, B & IR bands

Surface Reflectance

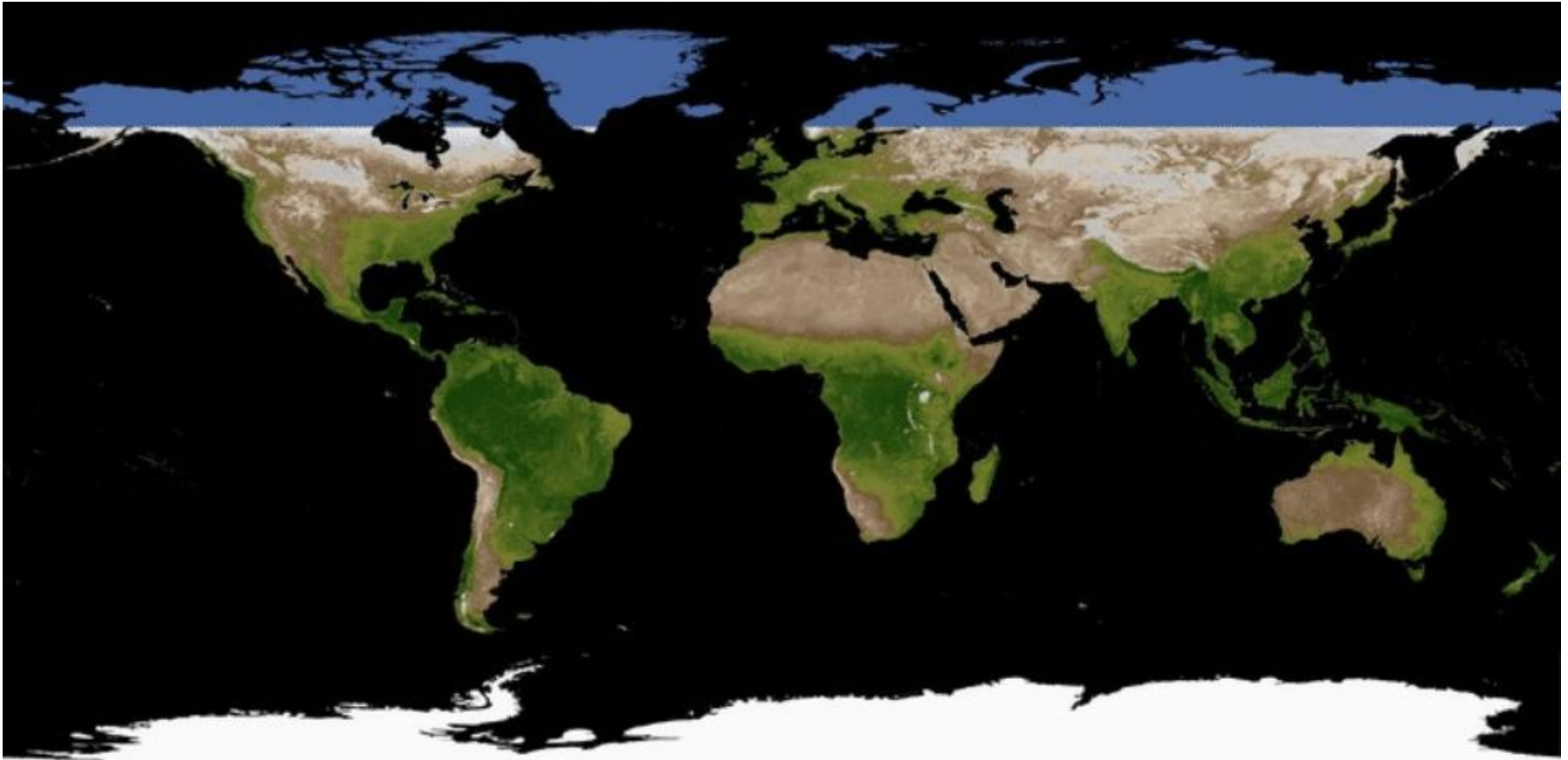
ρ_{blue} ρ_{green} ρ_{red} ρ_{NIR}

Vegetation

- Certain pigments in plant leaves strongly **absorb wavelengths of visible red light**.
- The leaves themselves strongly reflect wavelengths of **near-infrared** light, which is invisible to human eyes.
- Since we can't see infrared radiation, **we see healthy vegetation as green**.
- As a plant canopy changes from early spring growth to late-season maturity and senescence, these reflectance properties also change.

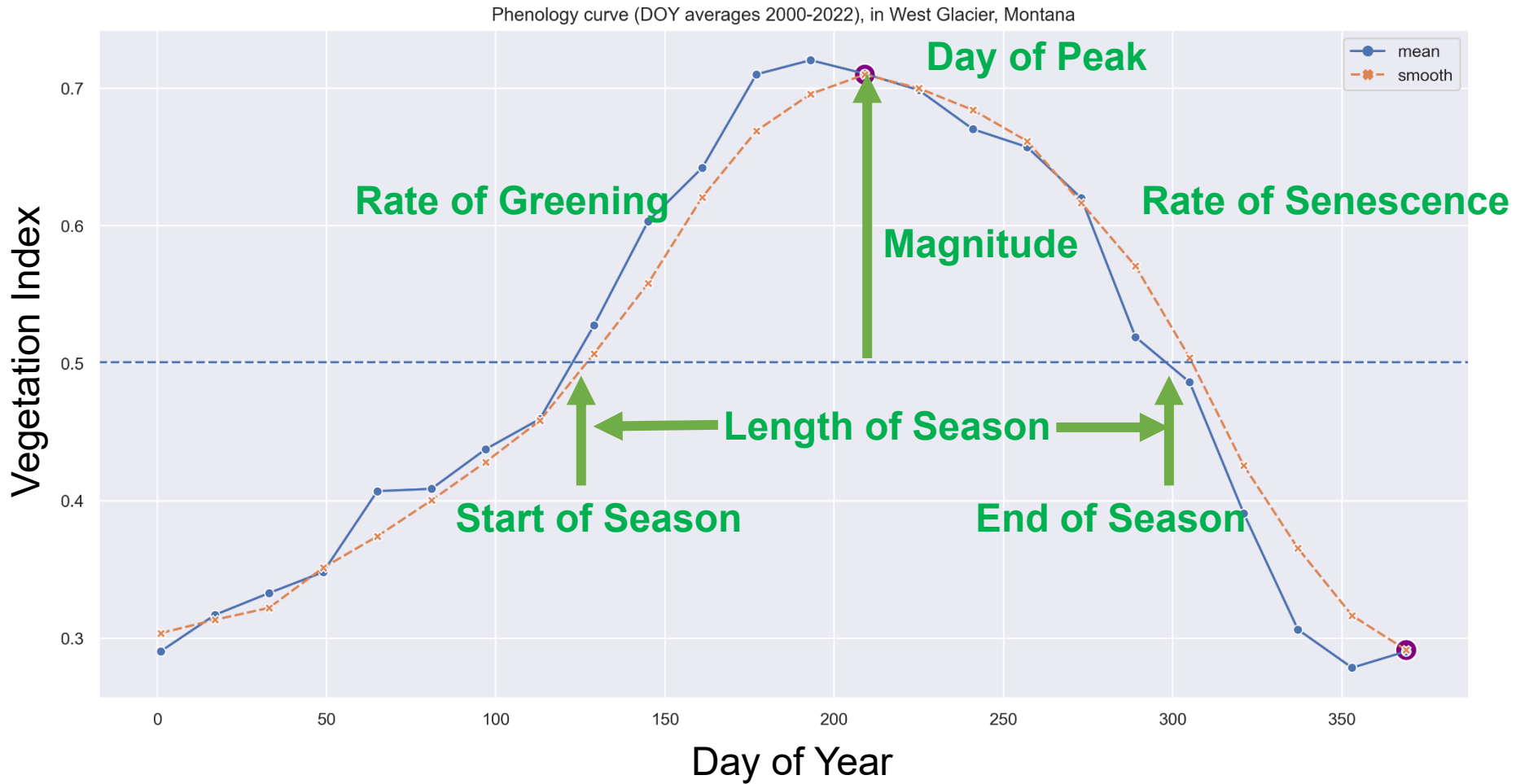


VIs continuous in time



MODIS NDVI is produced by NASA with algorithms and code from the VIP Lab

Phenology



What can we do with this?

VIP Lab projects



What can we mount on a UAS?



Platform



Easy to use regular Cameras

RGB/Color

Useful for plant viewing

NIR

Useful for collecting spectral information about the observed object

Multispectral

Useful for collecting refined spectral signatures about the observed object

Hyperspectral

Temperature

Thermal

DEM, Shape, Size

Lidar

- Temperature, Humidity, Chemical composition, etc..

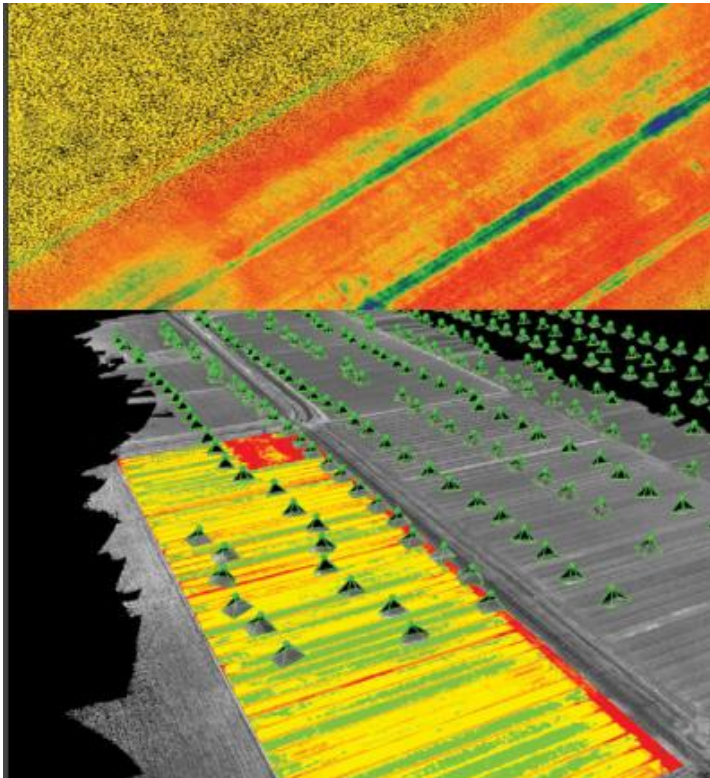
Other sensing



Types of sensors

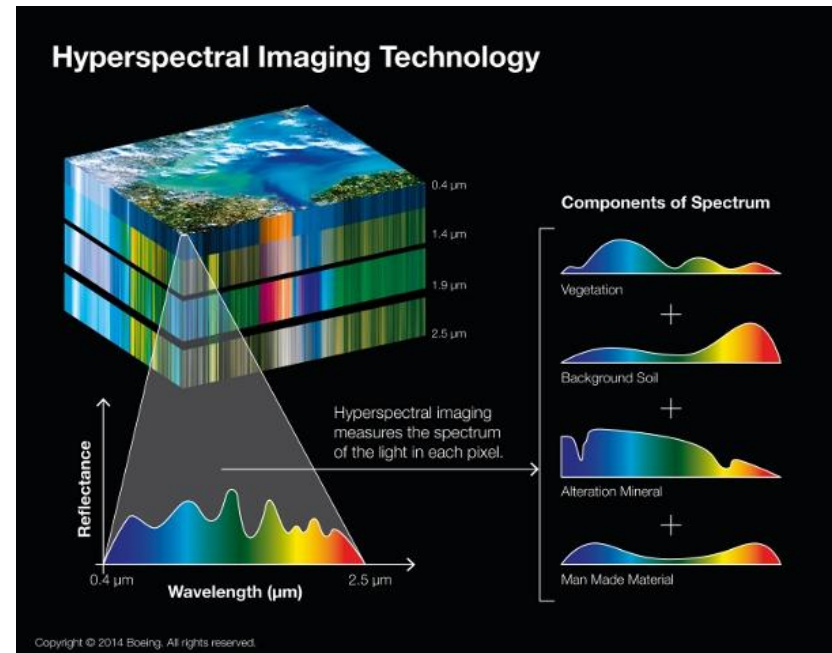
Multispectral

- Visible+NIR+SWIR
- Supports VIs



Hyperspectral

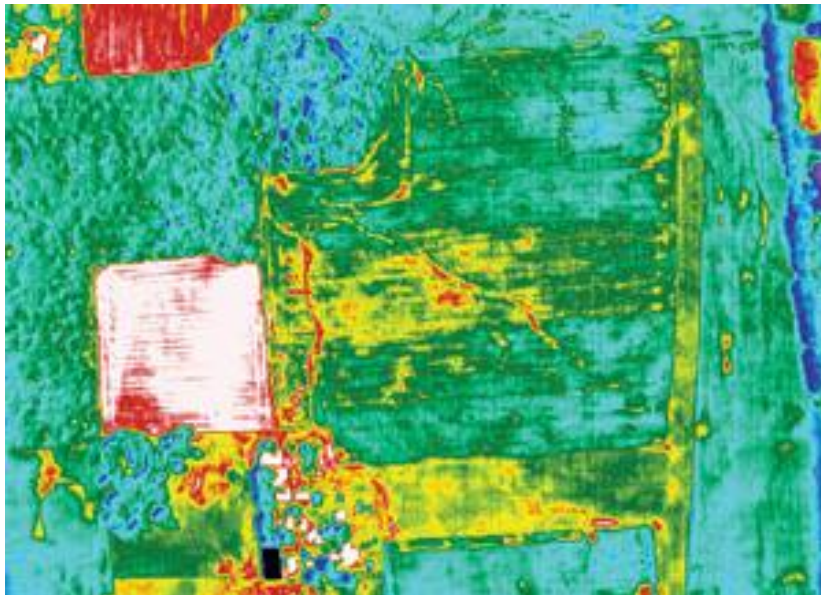
- Usually UV/Blue to SWIR
- Very dense, 1-10nm
- Chemical composition



Types of sensors

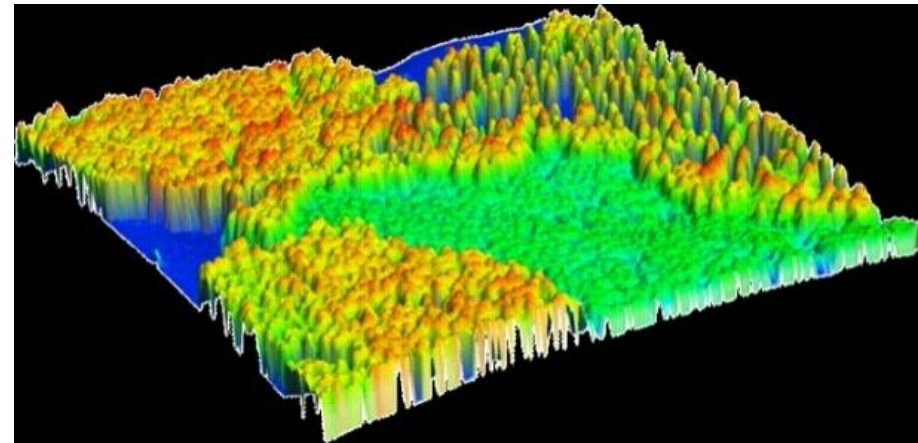
Thermal

- Skin temperature
- IR regions
- ET, crop health, water stress



LIDAR

- Accurate point cloud
- 3D representations
- Volume & biomass

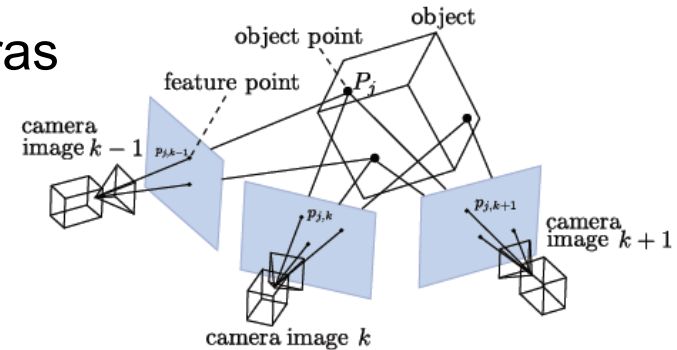


Drone imagery collection



Structure from Motion (SfM)

- Cheap: use regular RGB (HD, UHD) cameras
- Instead of expensive sensors (\$1K + Software)
- Viewing geometry to estimate the shape
- Computing intensive post-processing (proprietary/free software)
- Time consuming, complex, expensive
- Accurate if done right, similar to Lidar
- Applications:
 - Fruit size, weed detection
 - Biomass assessment, Phenotyping, Disease detection, DEM, LAI

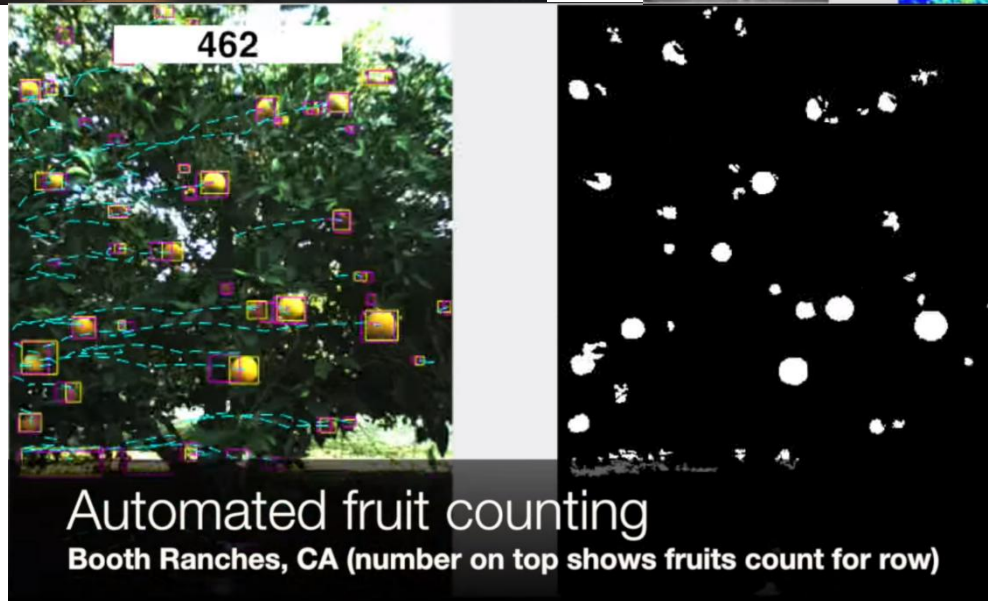
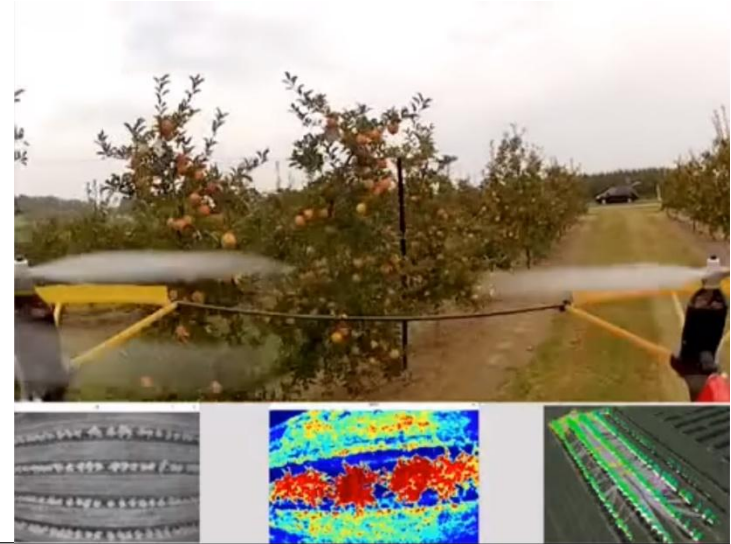


SfM Applications: Guayule crop – Eloy, AZ

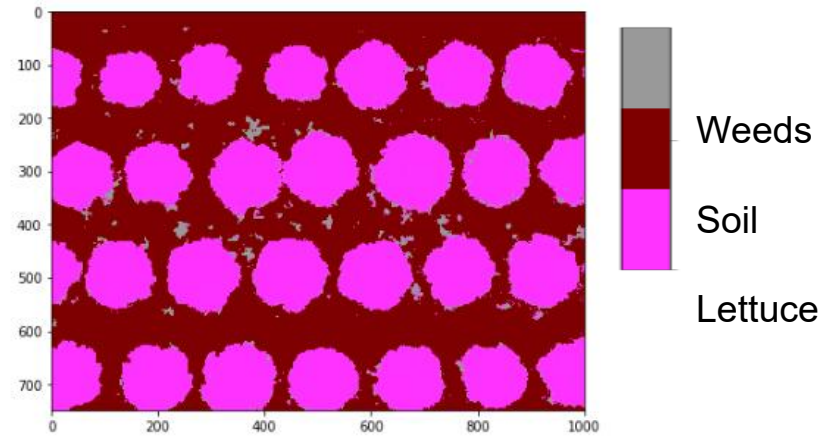
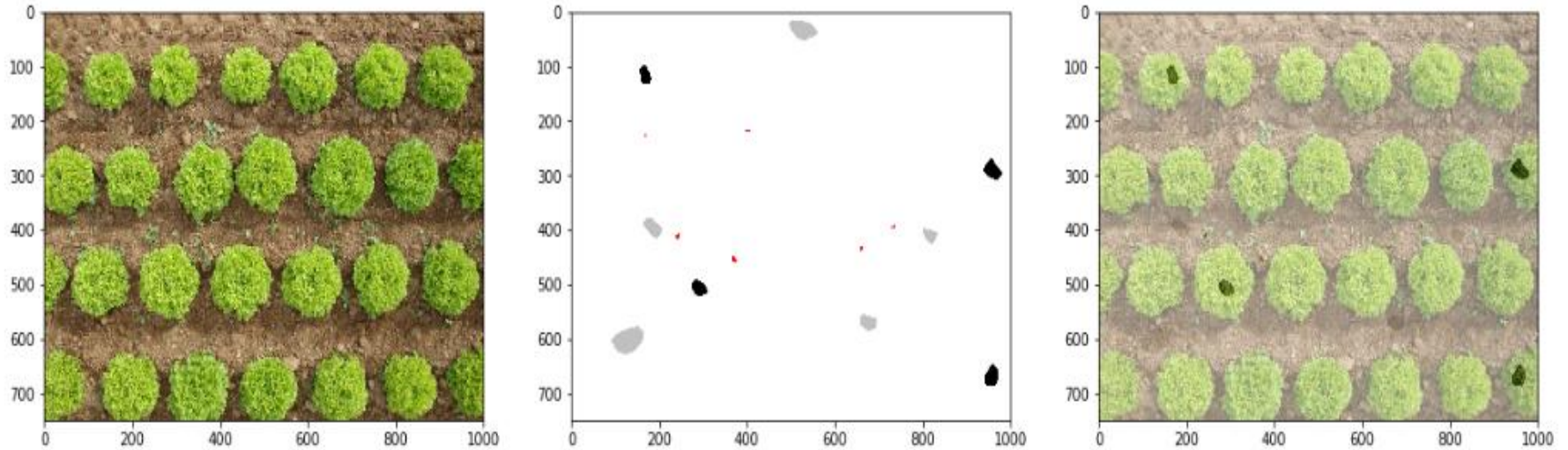
Perspective 30°



Fruit counting with drones



Weed Detection with Machine Learning



Other Applications

- Ex: Measuring Nitrogen/Nutrients (needs) of plants



Manhattan, KS
Red NDVI = 0.20



Pittsburg, KS
Red NDVI = 0.87



Towards Citizen Science

- Science is collaborative and participation is open to everyone.
- Means collaboration between the scientist, government, and the public to advance participation in scientific discovery and research
- Through "citizen science" or "participatory science" projects, volunteers and amateurs have helped make thousands of important scientific discoveries.



<https://science.nasa.gov/citizen-science/>