Planificando el trabajo de campo en espectro-radiometría: lecciones aprendidas

Planning field work in spectroscopy: leasons learned

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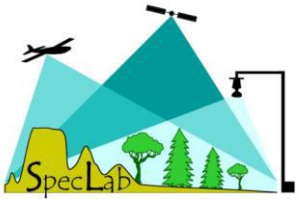
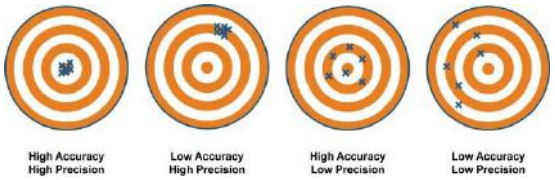
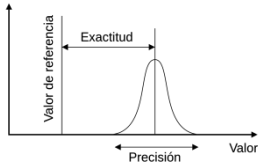
SpecLab-CSIC



Field work… is it really necessary?

- Is the information we handle "reliable"?
- What is the reliability of our results?
  - Precision vs accuracy
- Field knowledge can facilitate or even determine the analysis and interpretation of the data?



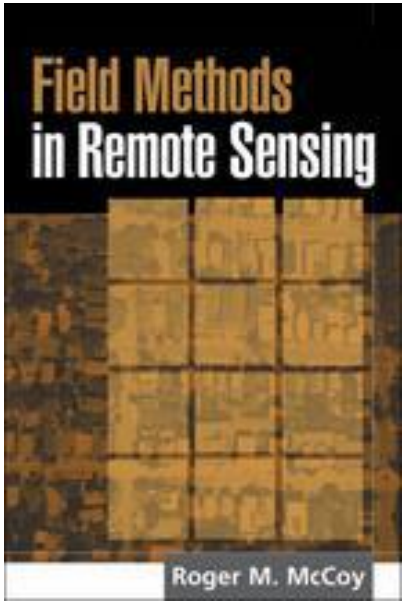


Ok, let say field work is "convenient" but …does it compensate the effort?

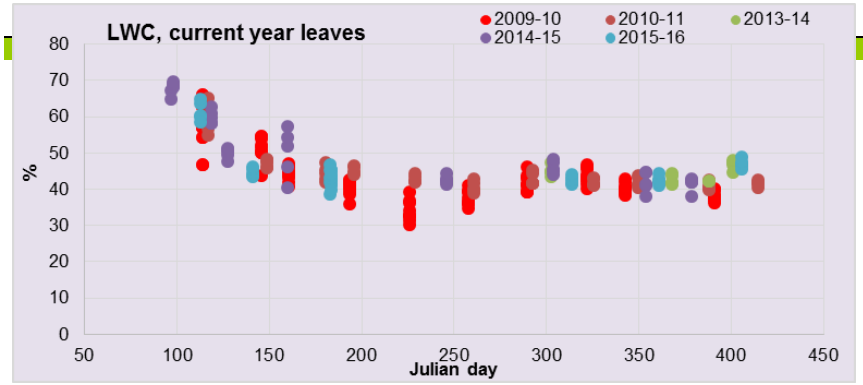
- **Availability of human and technical resources**
  - **Economic cost**
  - **Time cost**

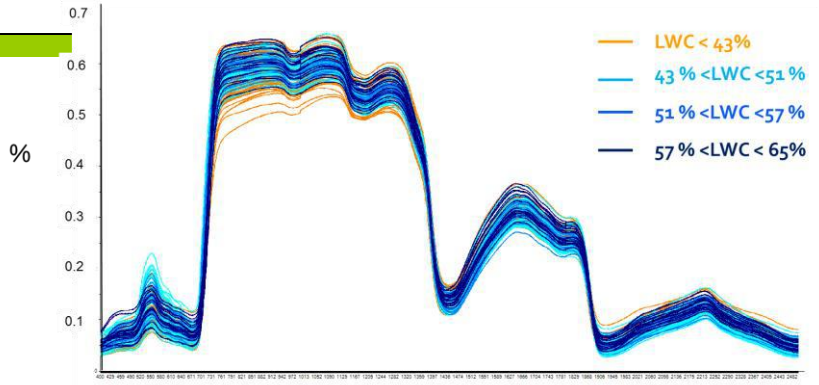
Field work and remote sensing

- Model calibration/parameterization
  - Empirical models
  - Physical RTM models
- Validation of models or products
- Spectral characterization of land covers
  - Spatial (image classification)
  - Temporal (temporal series)
- Vicarious calibration

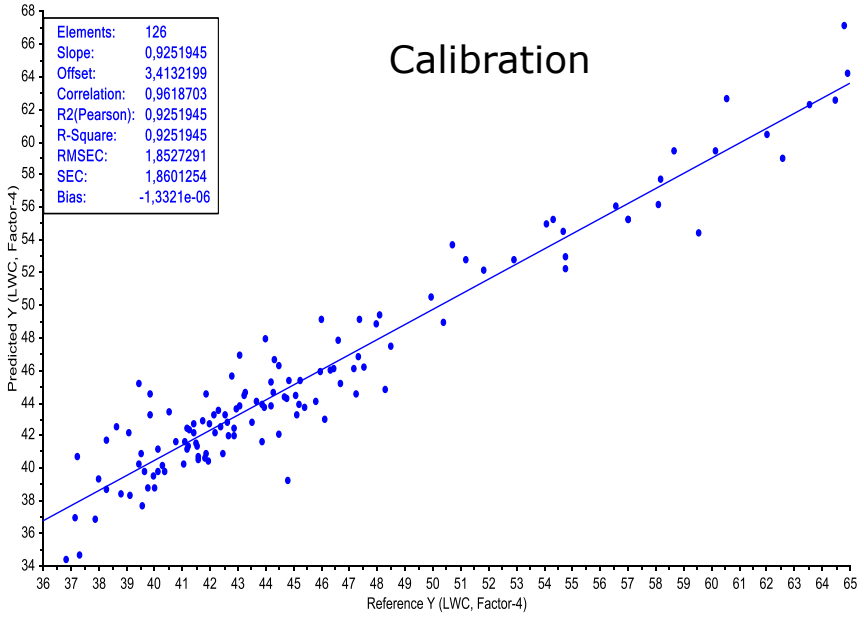


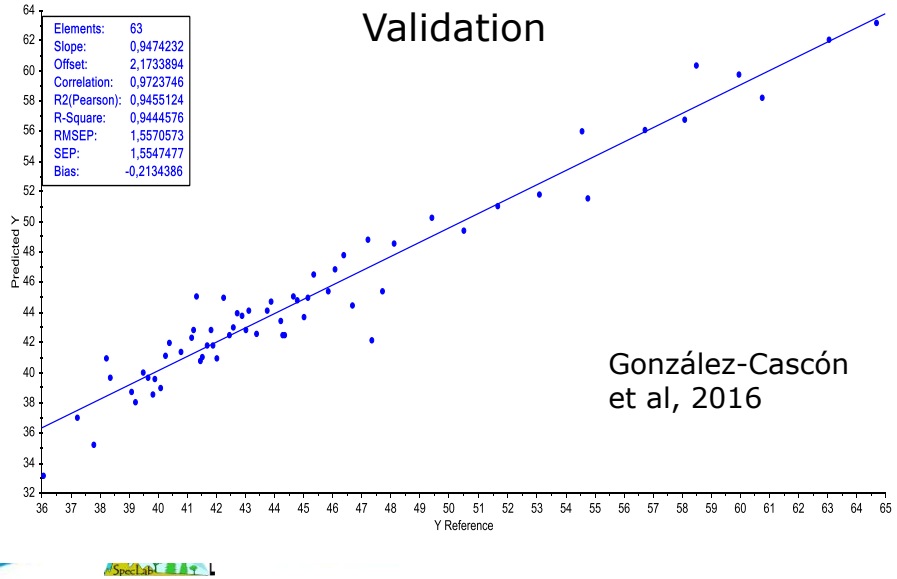
Empirical models





Field data is used to calibrate/validate statistical models: spectral info vs other info (cover parameters)

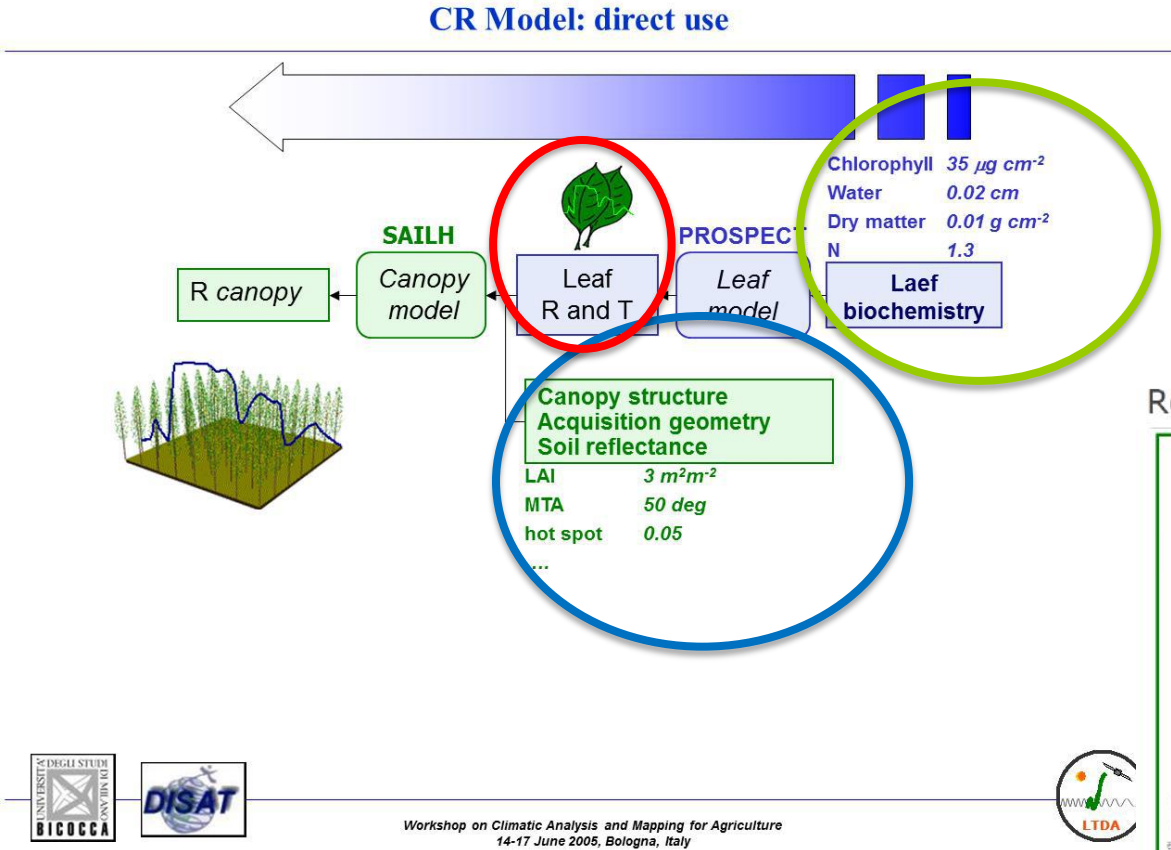


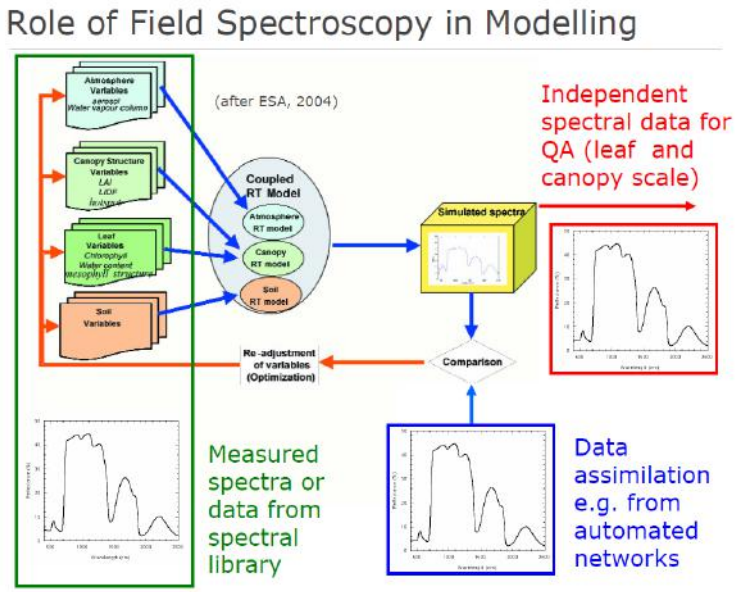


González-Cascón et al, 2016

Physical models: RTMs

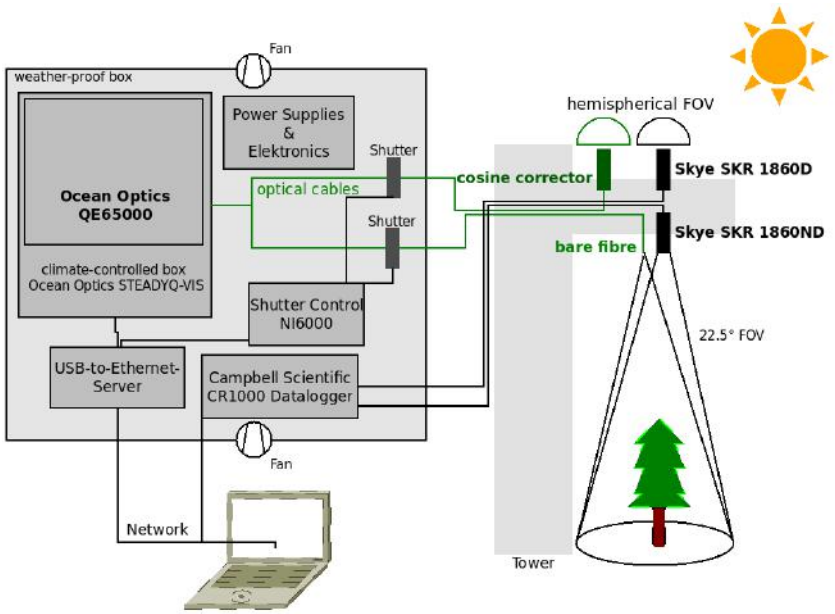
Field spectroscopy is used to parameterize and validate RTMs in forward mode or to estimate variables by model inversion

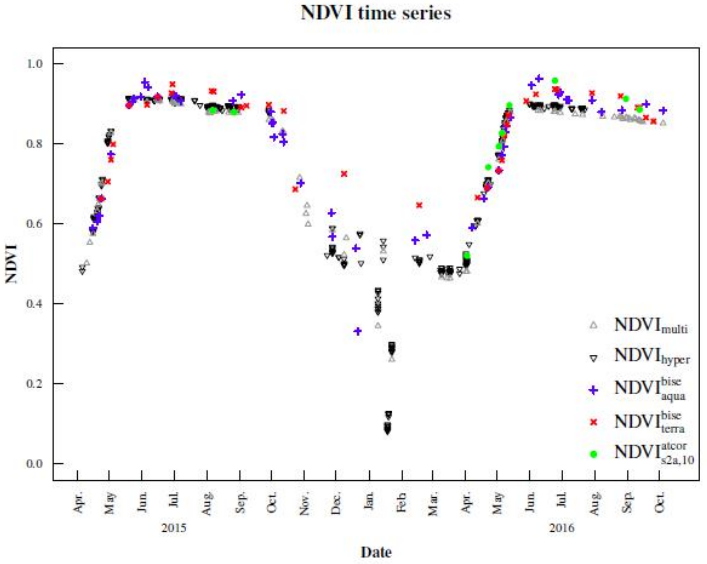


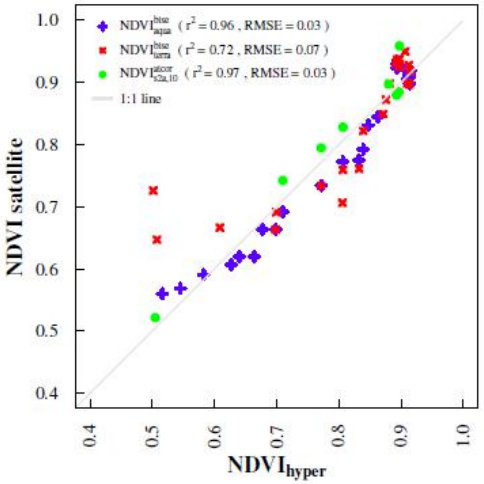


Validation of RS models or products

Validating MODIS and Sentinel-2 NDVI Products at a Temperate Deciduous Forest Site Using Two Independent Ground-Based Sensors

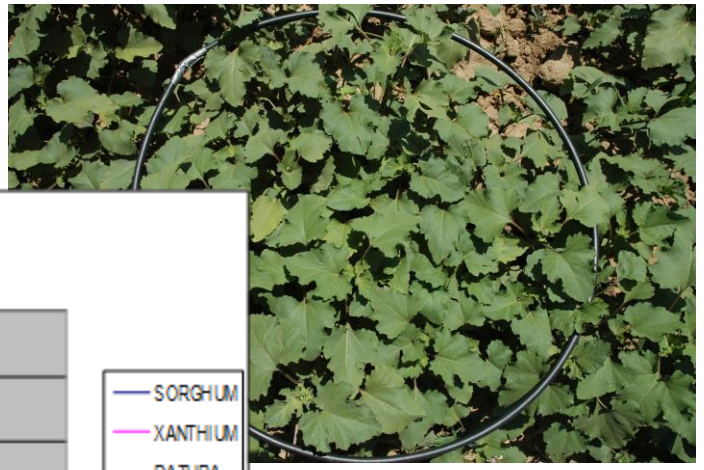


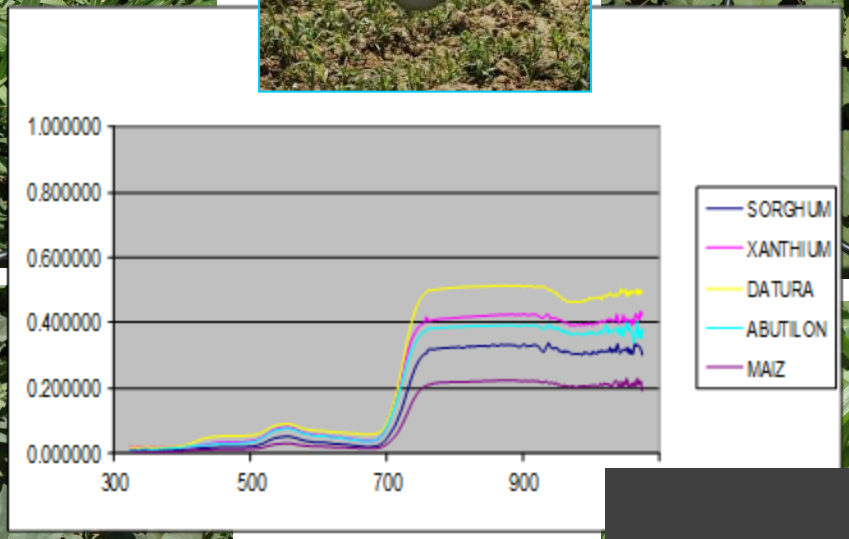


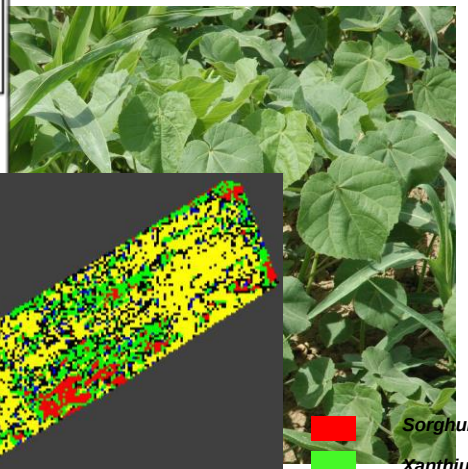


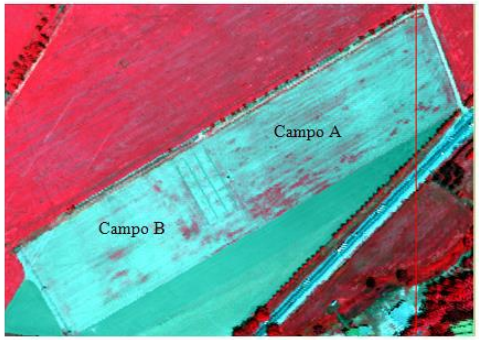
Lange et al. 2017

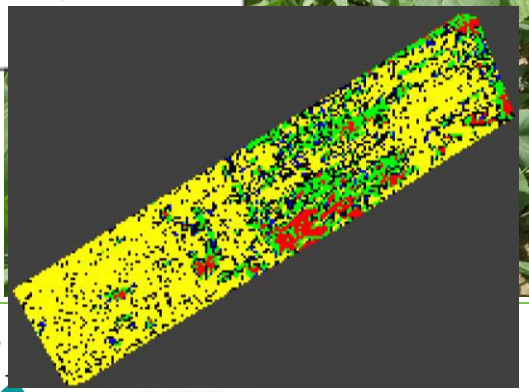
Spectral characterization of land covers

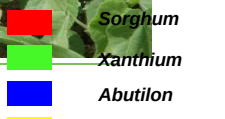












-radiometría de campo: de las buenas prácticas a

Vicarious calibration

Field data is used to confirm the quality of image calibration or methods for atmospheric correction

- Image calibration with a method independent of that used in the original calibration (on board the satellite)
- Reference surfaces with “almost” Lambertian reflectance are used: deserts
- Artificial targets for calibration of airborne or drone images

White Sands National Park, New Mexico
(source : http://digilander.libero.it/sarodb/usaparks/foto/nm/ws1.jpg)

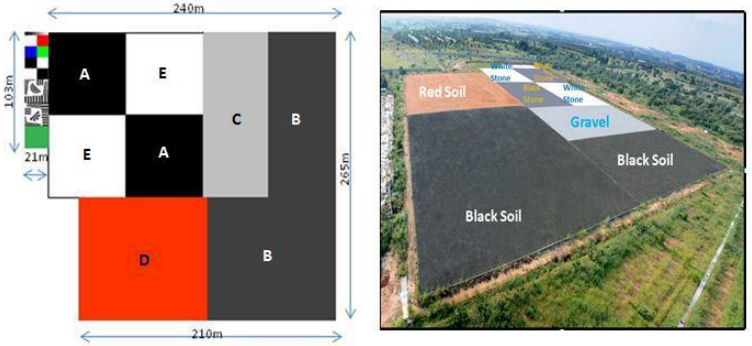


Figure-3A: Target Lay out **Figure-3B: CalVal Site, IMGEOS Complex, Shadnagar**
(Targets: A –Black Stone, B - Black Soil, C – Gravel, D – Red Soil, and E– White Stone)

Specific solutions are always needed!!!

Key aspects to consider in field spectroscopy?

- Objectives
- Instruments
  - Spectroradiometers
  - Accessories
  - Platforms
  - Instruments for non-spectral data acquistion
- Experimental design
  - Protocols
  - Spatial and temporal considerations
  - Metadata
- Data processing methods
- Deep knowledge of the target cover and the specificities of the study area

It is very easy to take wrong measurements and very difficult to acquire good data

Define project objectives

- Location and size of the study area + temporal issues
- Information necessary according the project objectives
- Scale and accuracy needed

Field work. Phase I: before

- Prepare material and protocols adapted to objectives and area
- Prepare instrumentation
- Train personnel
- Define spatial and temporal scheme
- Elaborate contingency plans

Field work. Phase II: during

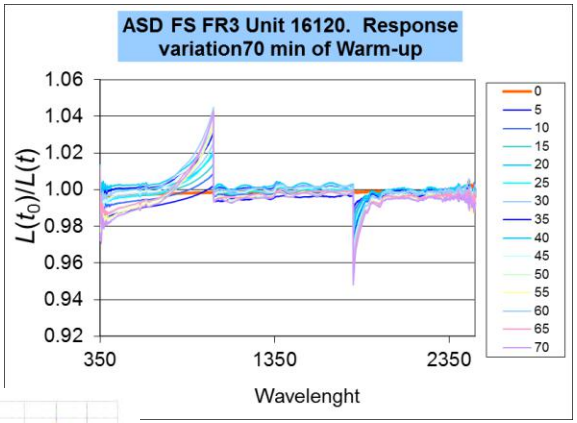
- Take measurements. According to protocols and ensuring quaility and homogenity
- Acquire metadata
- Ensure the proper conservation of the samples

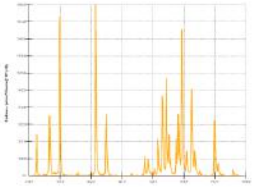
Field work. Phase III: after

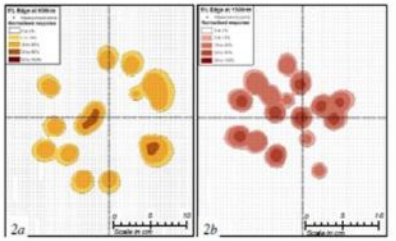
- Storage of samples until processing
- Lab processing. Follow protocolos
- Organize databases. Do you want to share data?
- Data analysis

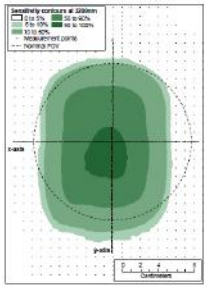
Before you go to the field……
learn **everything** about the instruments to be used

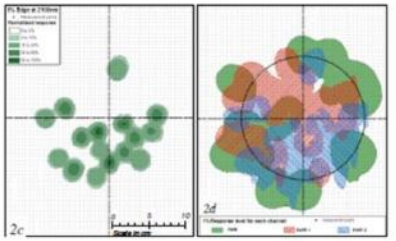
- Read carefully the user manual….. and more: all instruments are different!
- Be careful: warming up time can significantly alter the quality of your measurement.
- Sensors should be appropriately calibrated:
  - Spectral: lamp, known materials
  - Radiometric: manufacturer or specialized laboratory
- FOV: shape, size, special characteristics (ASD)
- Environmental issues: temperature and humidity. Most sensors are not operational over 40º-45ºC.

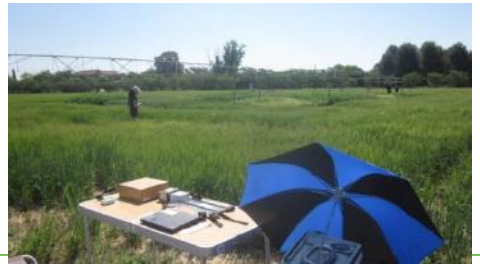












Espectro-radiometría de campo: de las buenas prácticas a una mayor utilidad de los datos

McArthur et al 2012

Planning field work. Not an easy task!

Field sampling can be the most important source of error in your study/project, so its planning, design and execution are crucial

- Lack of clear project objectives
- Inadequate sampling planning (spatial, temporal, methods)
- Difficulties to deal with different scales
- Fieldwork planning should consider the difficulty of ensuring the representativeness of the measurements
  - Acquire a sufficient number of measurements (models)
  - Measurements are sufficiently representative (variable/study area)
  - Resources!

Planning field work. Not an easy task!

- What to measure?
- How to measure?
- When and where to measure?
- What level of detail?

- Not all the necessary data is collected
  - Deficiencies in the analysis / validation
- More data than necessary is collected
  - Waste of time and resources

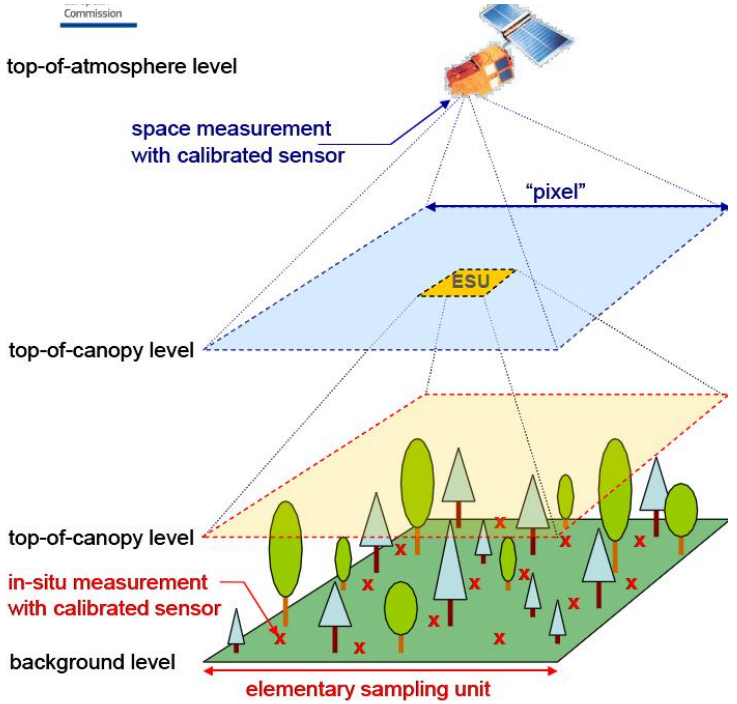
- Recommendations
  - Correctly identify the variables that need to be measured (spectral and others)
  - Evaluate the factors that can influence the variability of the target
  - Select the most appropriate area and period to take the measurements considering the variable and the type of analysis
  - Use the appropriate methods and instruments
    - Measuring devices that do not provide the level of detail required by the variable to be measured
    - Badly calibrated measuring devices
    - Personnel not experienced in the use of instrumentation

Sampling design

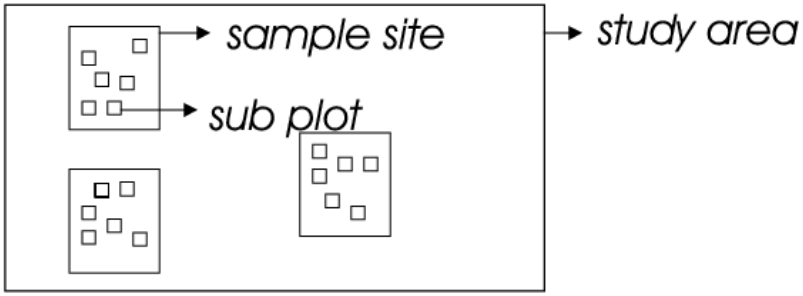
- Spatial issues
  - Where to sample
  - Sample size
  - Sampling unit:
    - Pixel - group of pixels.
    - Transects
    - Points/Polygons (size, shape?)
- Temporal issues
  - Simultaneous sampling to the image acquisition?
  - In what phase of the project?

Spatial sampling

- Designing a sample scheme include a number of consideration about the relations between study area, sample site/s and subplot
  - the spatial distribution of sample sites within a study area
  - the number of sample sites required within a study area
  - the required size of the individual sample site
  - the number of subplots required within one sample site
  - the size of subplots within one sample
  - The spatial distribution of sub-plots



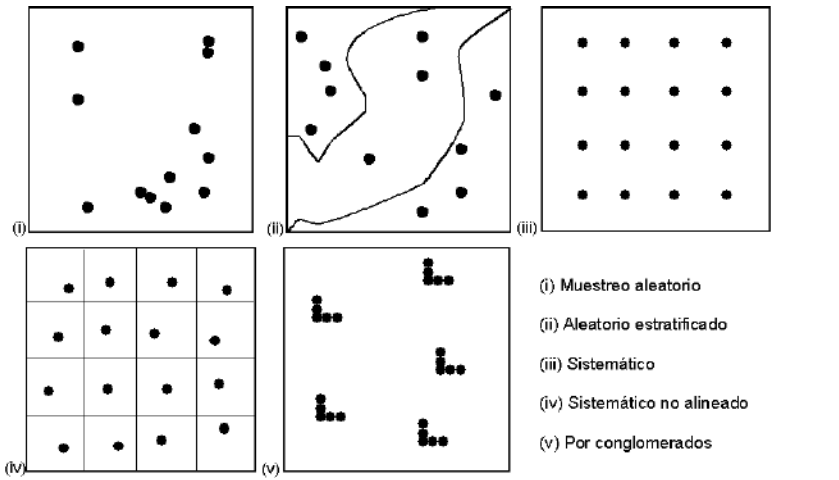
From image to sampling units: Account for impact of spatial variability (upscaling-downscaling)

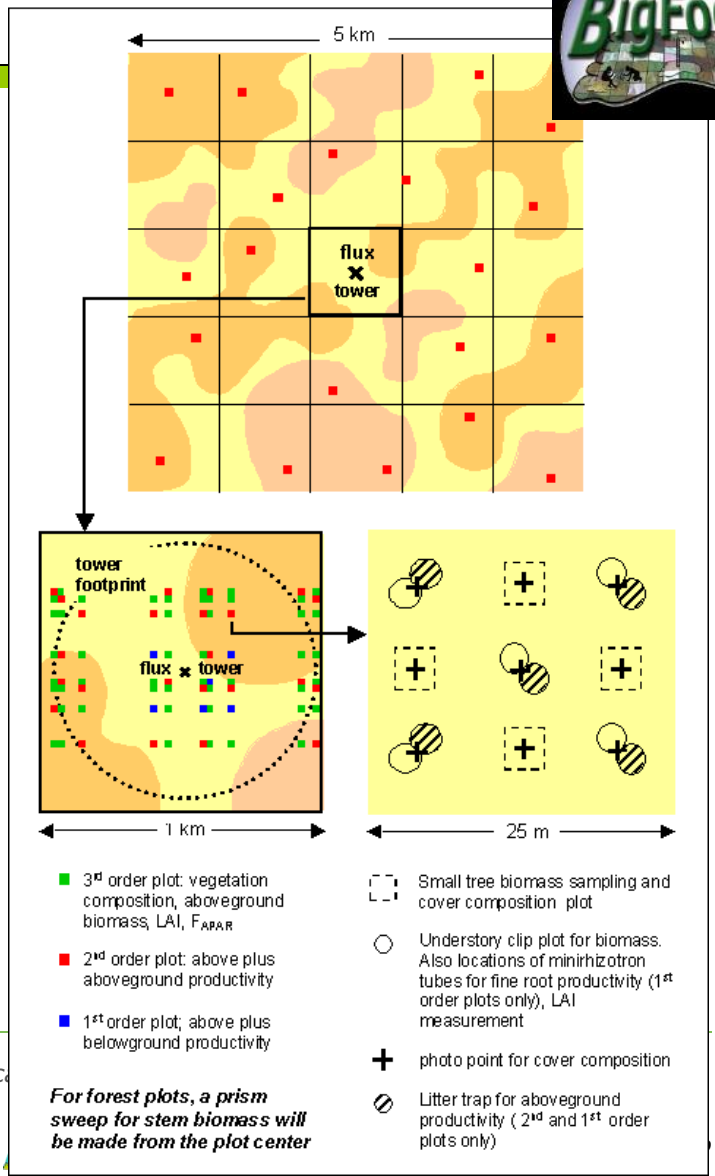


http://www.fsl.orst.edu/larse/bigfoot/index.html

Linking *In Situ* Measurements, Remote Sensing, and Models to Validate MODIS Products Related to the Terrestrial Carbon Cycle

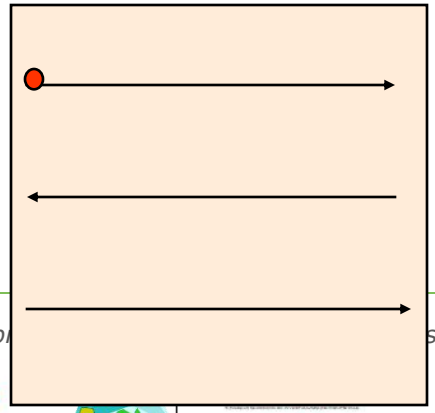
Sampling schemes

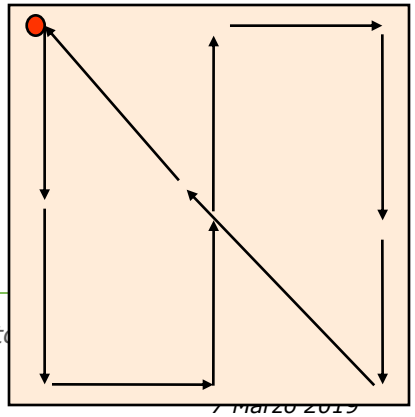




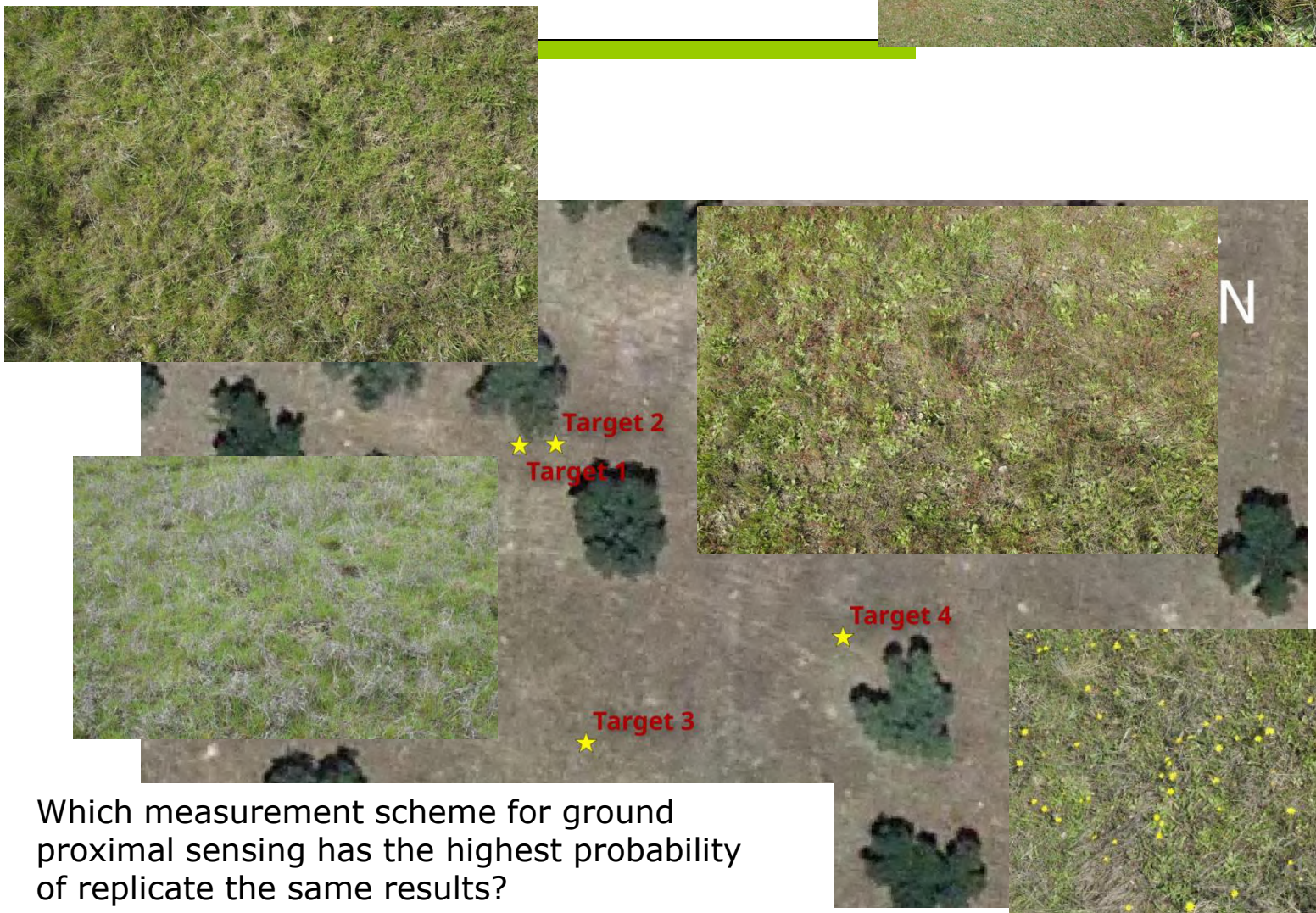
Some practical recommendations

- Importance of justifying the choice of sampling scheme
- Sometimes it is absolutely necessary to reject sampling points
  - Border areas (mixed signal)
  - Accessibility (physical or legal)
- It is necessary to take into account possible positioning errors when selecting the size of the sampling areas (plots)
  - A = P * (1 + 2 * L) ..... or 3x3 pixels
    - A = minimum size of the sampling area
    - P = pixel size
    - L = location accuracy (in pixels) (GPS + image)
- Evaluate the homogeneity of the plot/area and the resolution of the image (intra-pixel and inter-pixel variation)
- How to perform the measurements in the plot?
  - Transects
  - Points (single or multiple)



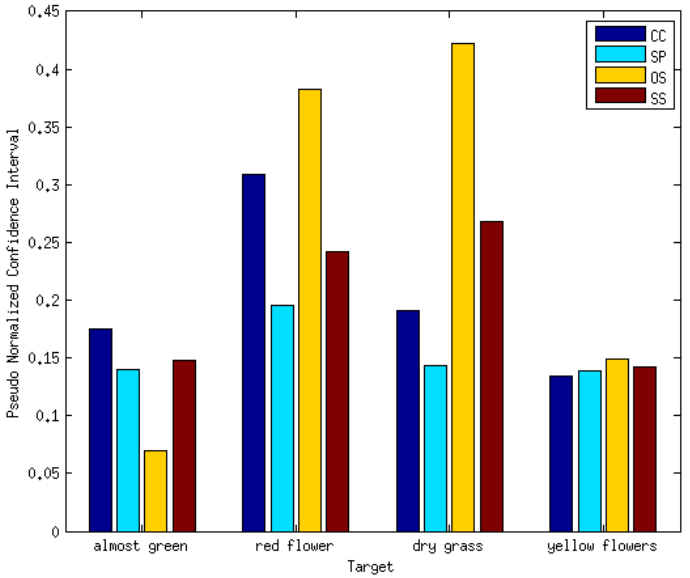


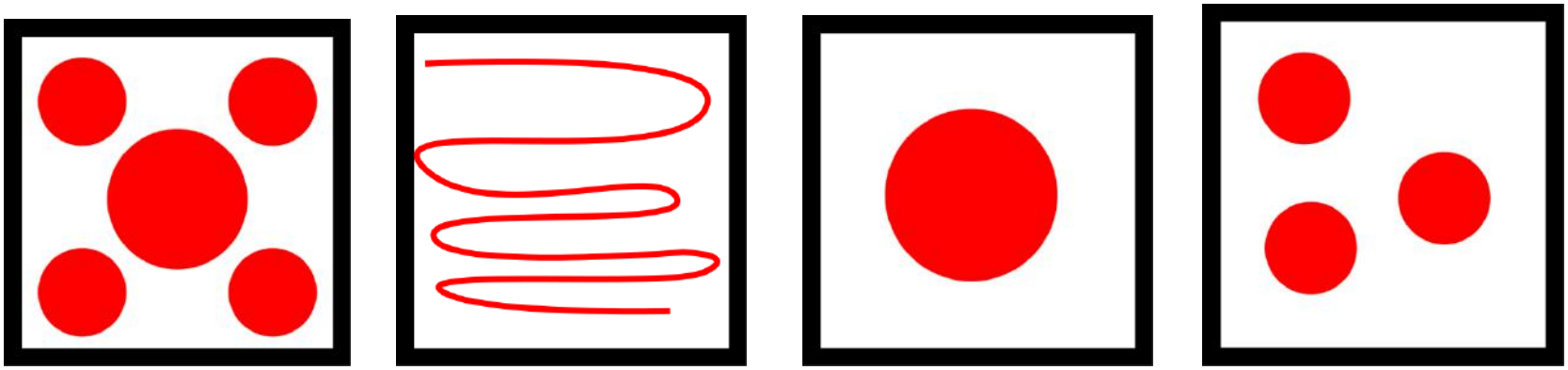
Left: Apparently homogenous grass cover (plot).
Right: Very heterogeneous at sub-plot scale (quadrant)



Which measurement scheme for ground proximal sensing has the highest probability of replicate the same results?

Tested measurements schemes
1m² square with 1.2m² buffer (FOV25º/70cm)





Center/corner (CC) Sweep (SP) Central Stare (OS) Random S. (RS)

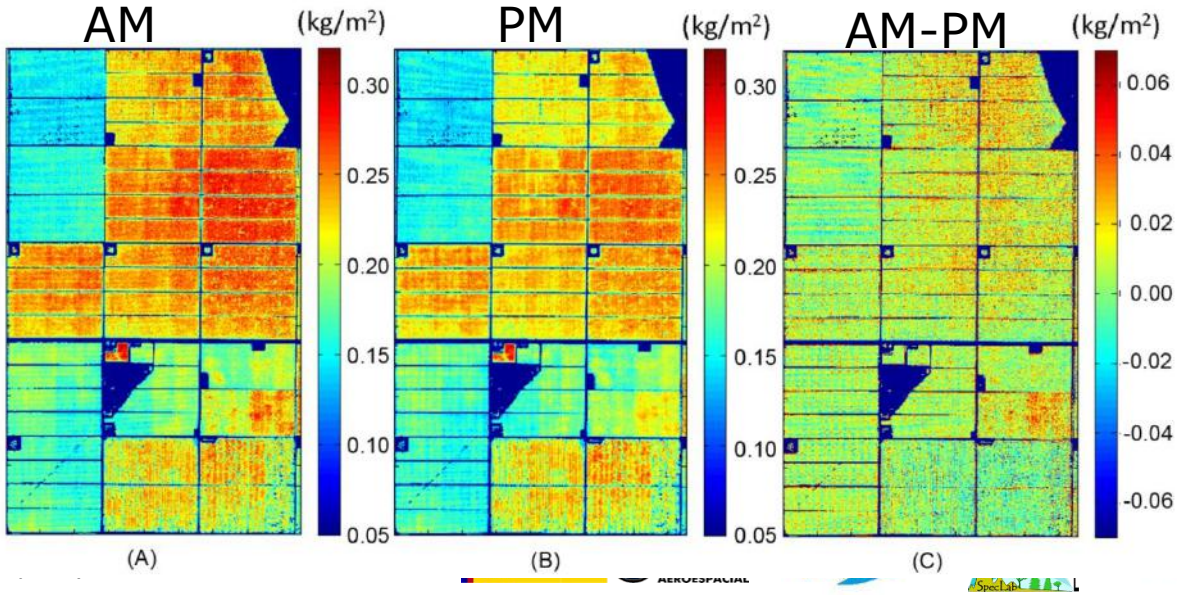
Hueni et al, OPTIMISE ABEL TS, 2015

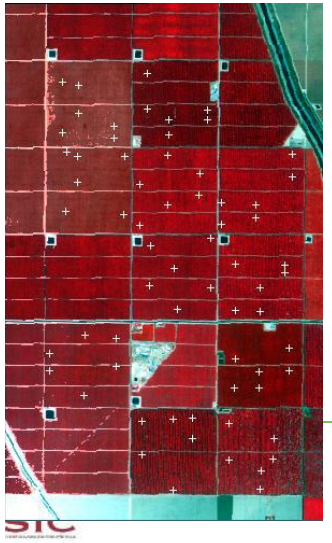
Temporal issues

- Intensive field campaigns versus long-term continuous measurements
  - The role of temporal dimension is now more recognized, as surface changes are drivers for dynamical processes
  - Intensive time-limited campaigns are still needed for validation purposes of systematic continuous measurements

Sampling timing

- Satellite/plane/drone overpass
- Cloud free
- Enviromental conditions (rainfall for CWC)
- Time of the day
- Phenology

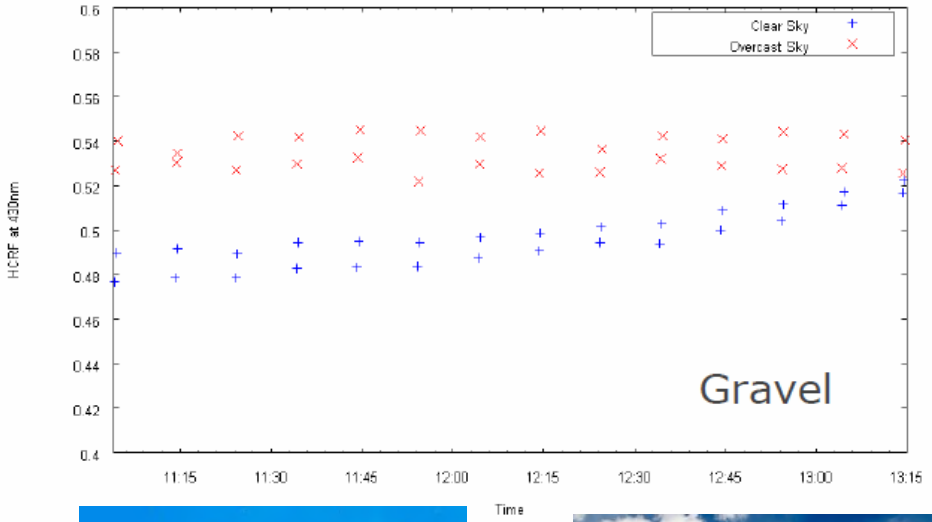


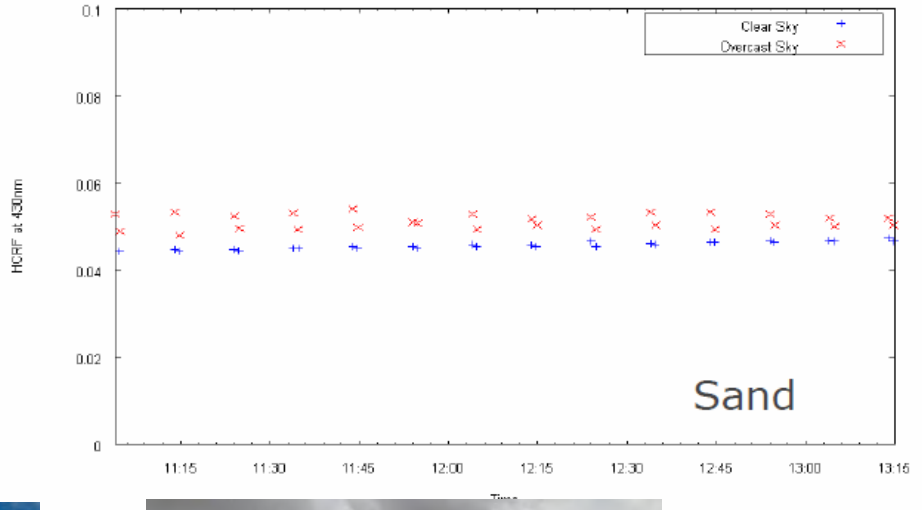


Cheng et al 2013

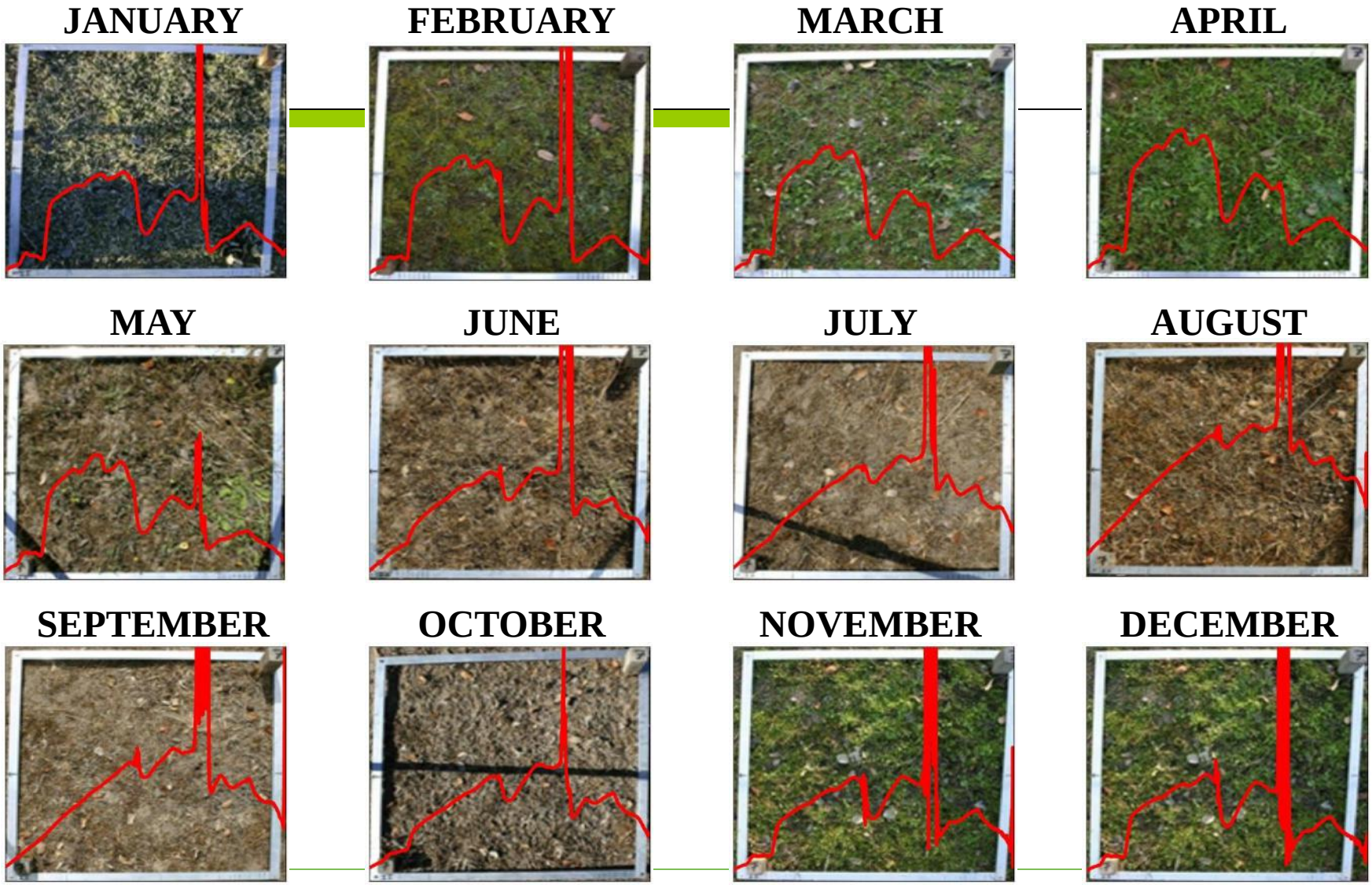
Sky conditions

Milton, 2009

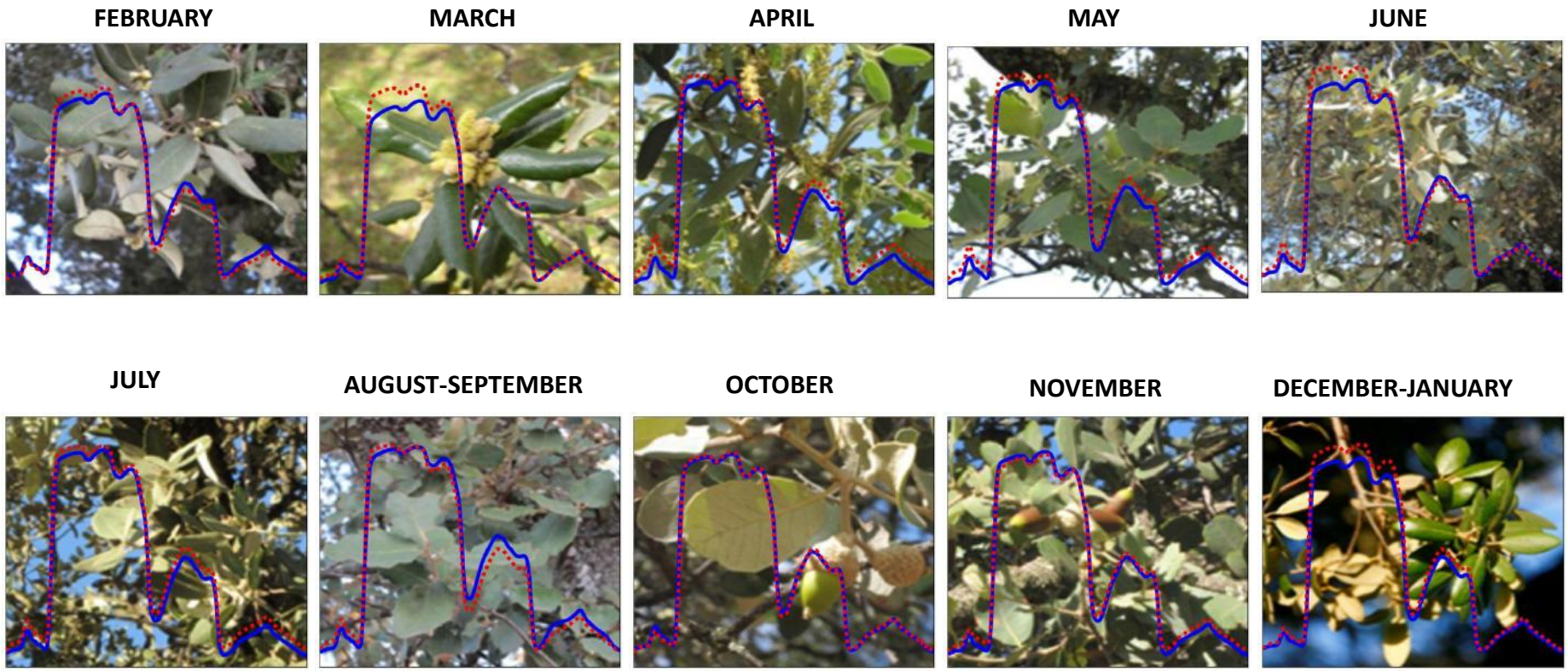




Herbaceous cover phenology



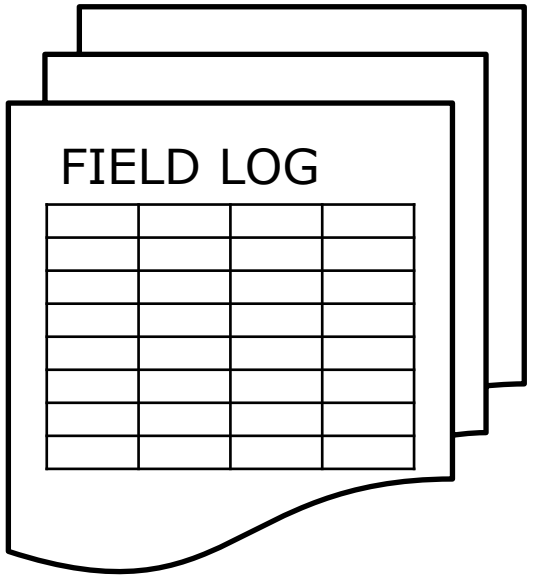
Holm Oak leaf phenology



Protocols and good practices are a "MUST"

Metadata……another "must"

- Which data I'll sample?
- How I will organize them later?
- What do I need to interpret these data?
- What do I need to relate this data with other data?
- And to share it?
- What should I register if something went wrong?



Take home-messages

- Think big, start small: plan, plan and plan
- Develop protocols adapted to your site and objectives. Protocols are vital! But use them!
- Look at the past: when possible use historical data to help you to decide number of plots, sample size, timing
- Learn from your data. Pre-analysis of data will help to improve long-term field campaigns …but, be careful you can loose the homogeneity of the series!

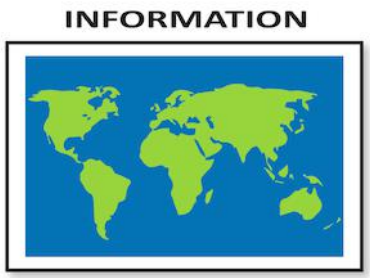
Take home-messages

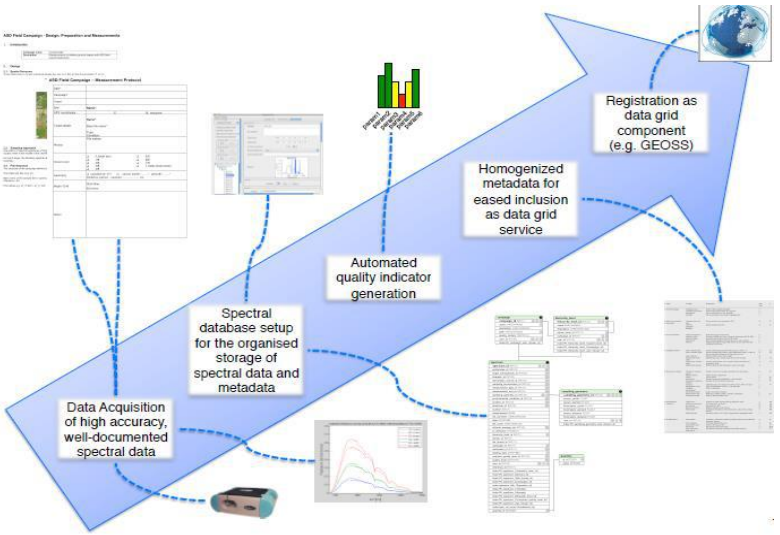
- Several instrumental and environmental factors affect our measurements, confounding or producing spurious relationships with variables of interest
- Operator decisions, instrumentation setup and sampling protocol can reduce or enhance those effects
  - Understand what you do
    - Develop protocols that ensure reliability… be sure everybody follow them!
    - Be ready to take quick decisions and adapt to changing conditions
- Sources of uncertainty must be known and considered when results are analyzed, uncertainty should be quantified
- Even so…you´ll still have the unknow unknowns!

Data vs. information

"Data are unstructured facts and figures. When they have been organised, processed and structured in a given context so as to make it useful they become information"

Organise and document your data!!!





From data acquisition to share information

Thank you for your attention!