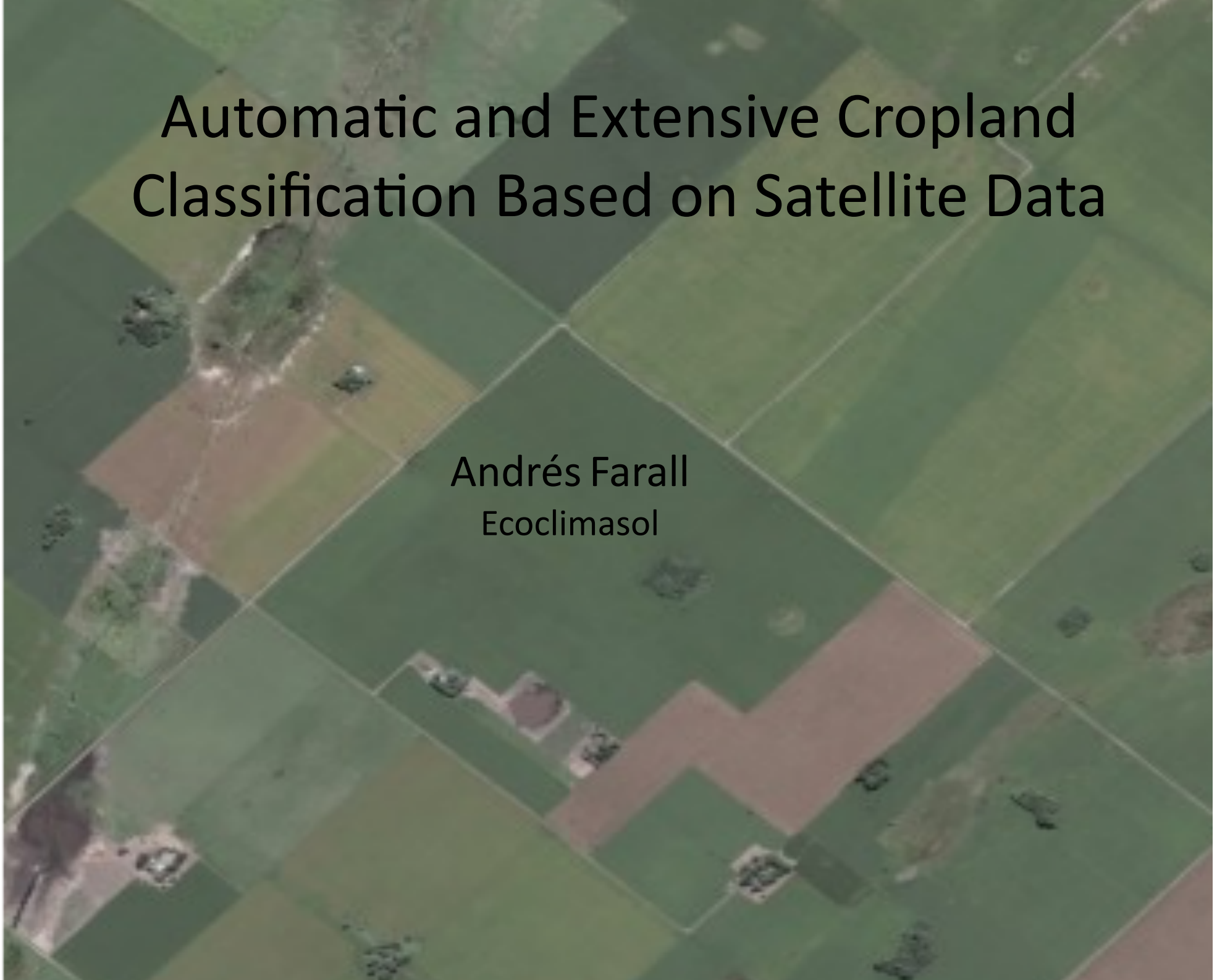


Automatic and Extensive Cropland Classification Based on Satellite Data

Andrés Farall
Ecoclimasol

Why Automatic Crop Classification ?

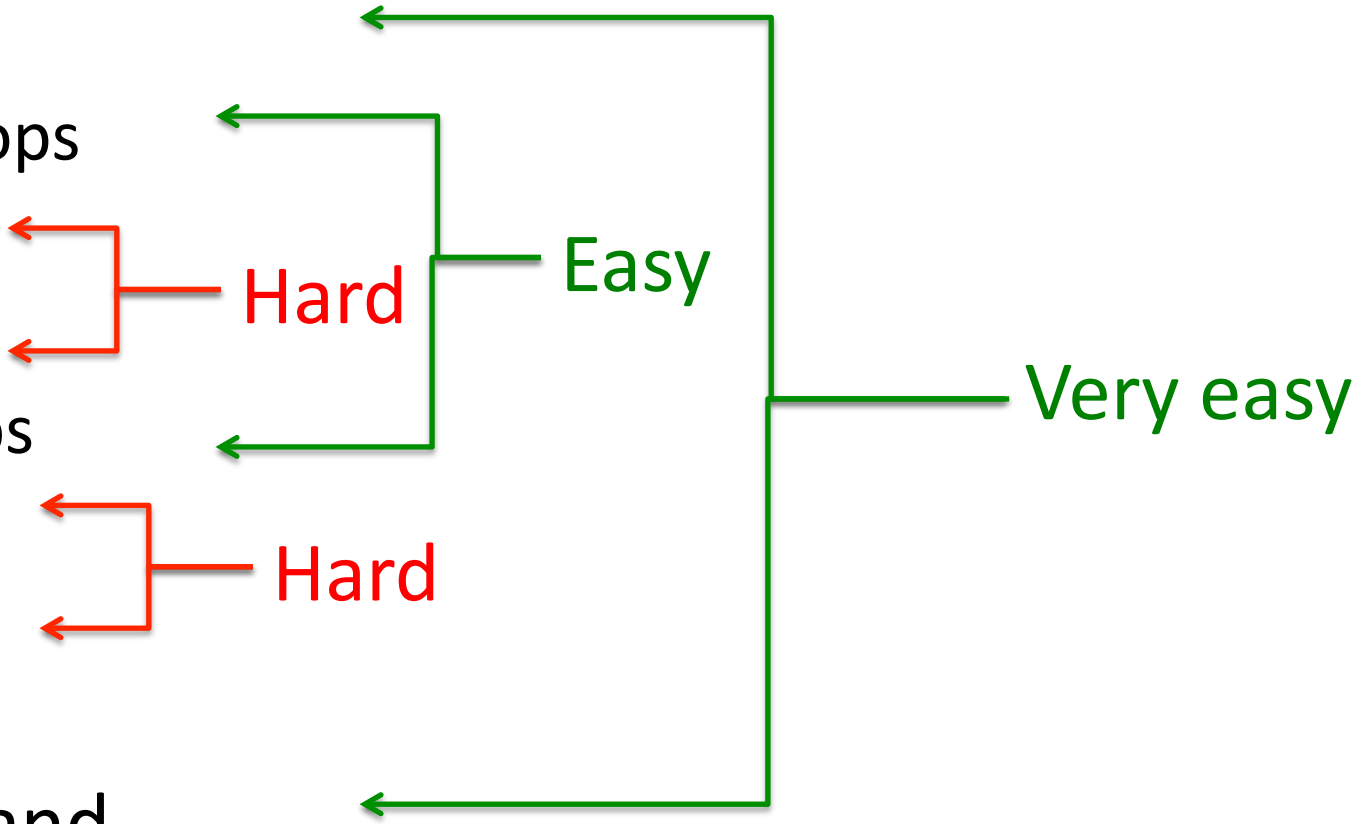
- Crops in Argentina: ~ 34.000.000 has, ~ 400.000 fields
- Screening of unknown regions
- Global yield estimation and tax evasion control
- Valuable information for agro-related and agro-insurance companies
- Precise georeference of croplands
- Global crop area assesment and yield estimation

Some Specific Classification Goals

- To assess crop share (relative proportions) in a large area (no georeference available of the fields)
- To estimate yield of an specific crop/season in a large area (no georeference available of the fields)
- To detect and to georeference fields with specific crops (no georeference available of the fields)
- To detect kind-of-crop info from specific fields (available georeference of the fields)

Kind of Crops to be Detected

- Arable land
  - Summer crops
    - Soybean
    - Corn
  - Winter crops
    - Wheat
    - Sunflower
- Non arable land

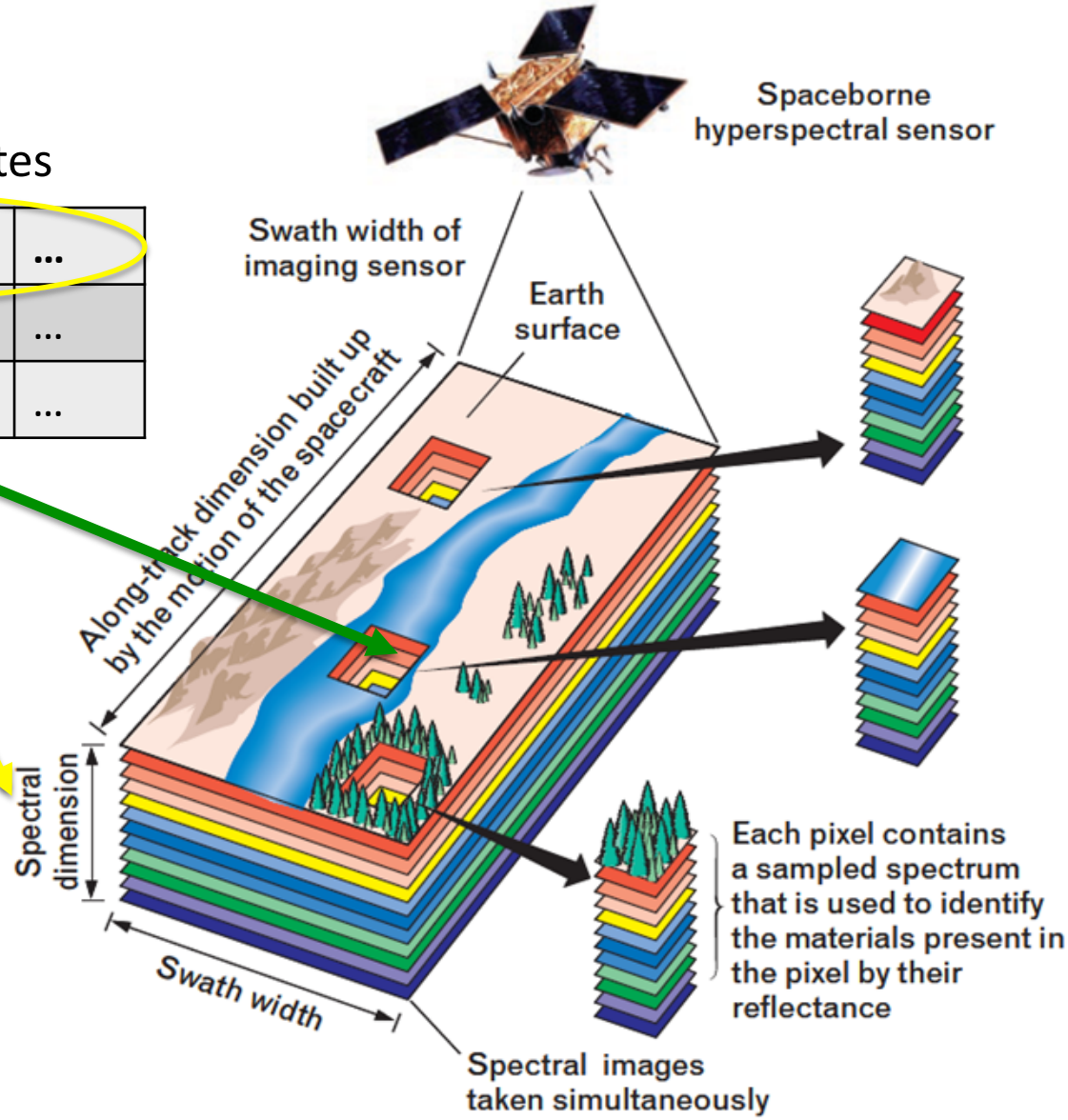


Remote Sensing Instruments

Spatial variables

Added attributes

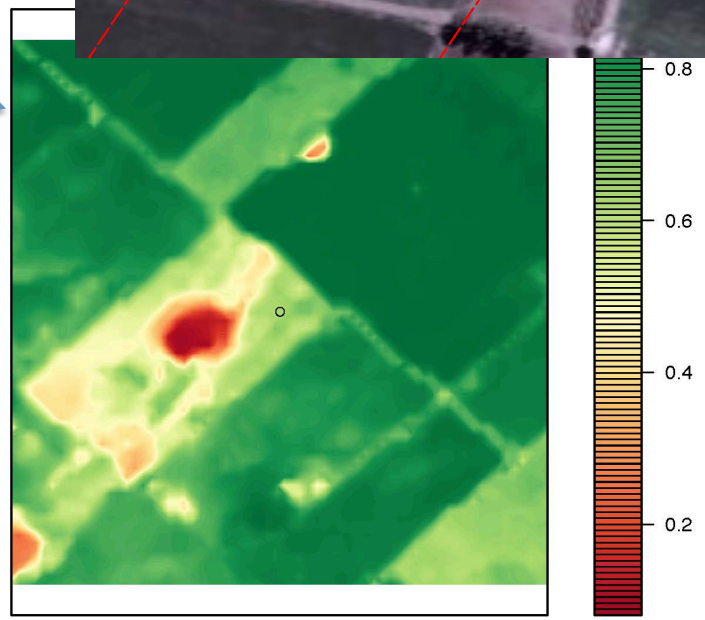
LON	LAT	NIR Band	Red Band	…
…	…	…	..	…
…	…	…	..	…



source : http://www.markelowitz.com/Hyperspectral.html

Main Available Remote Sensing Instruments

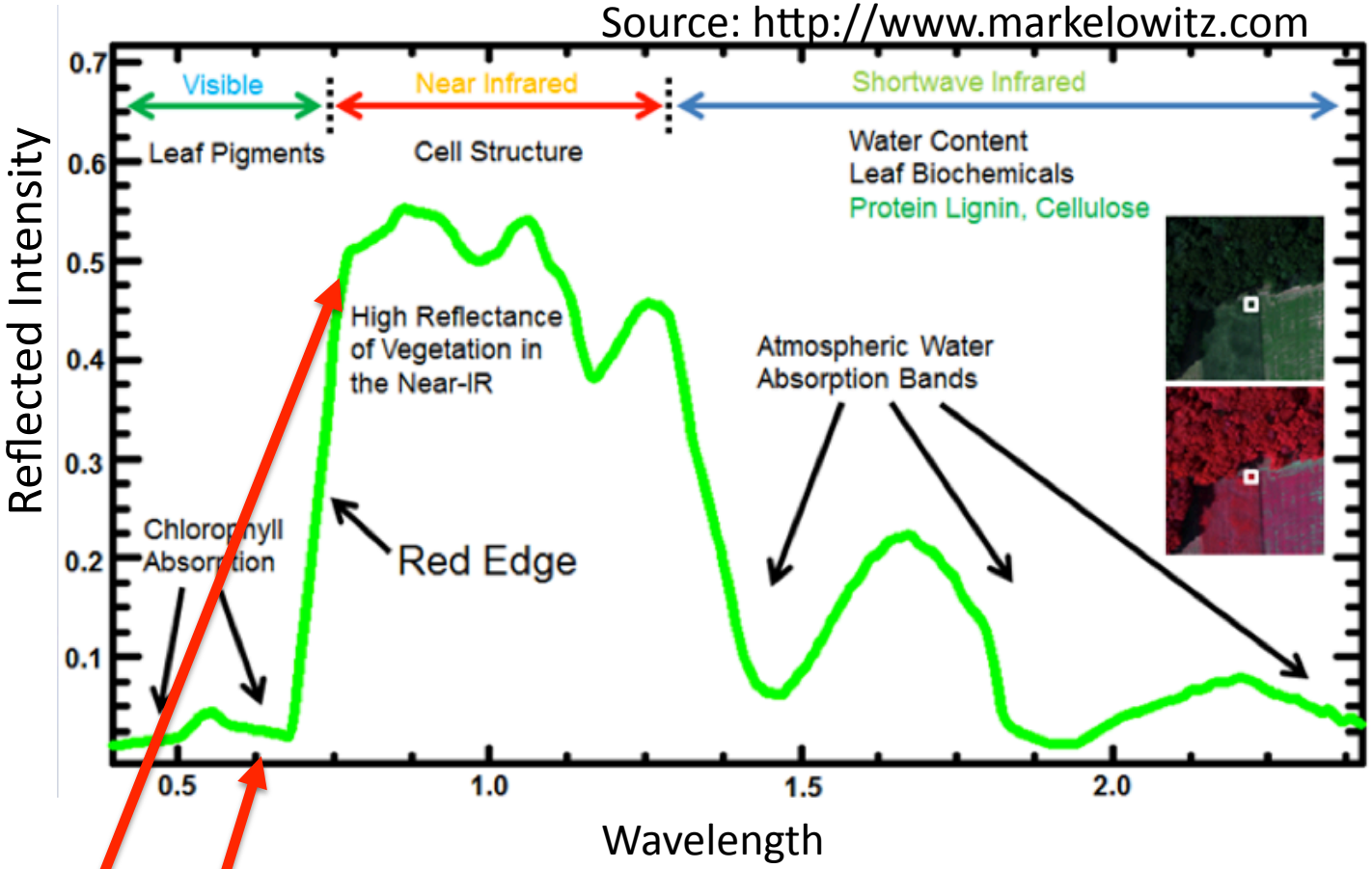
- MODIS (MODerate Imaging Spectrometer)
  - 250m X 250m
  - 2 images per day
  - 2 satellites (Terra and Aqua)
  - 36 spectral bands
- LANDSAT 8
  - 15m X 15m (interpolated)
  - 1 image every 16 days
  - 1 satellite
  - 11 bands



Vegetation Indices (VIs)

- CI
- EVI
- ENVI
- NDVI

Source: http://www.markelowitz.com



$$NDVI = \frac{NIR - Red}{NIR + Red}$$

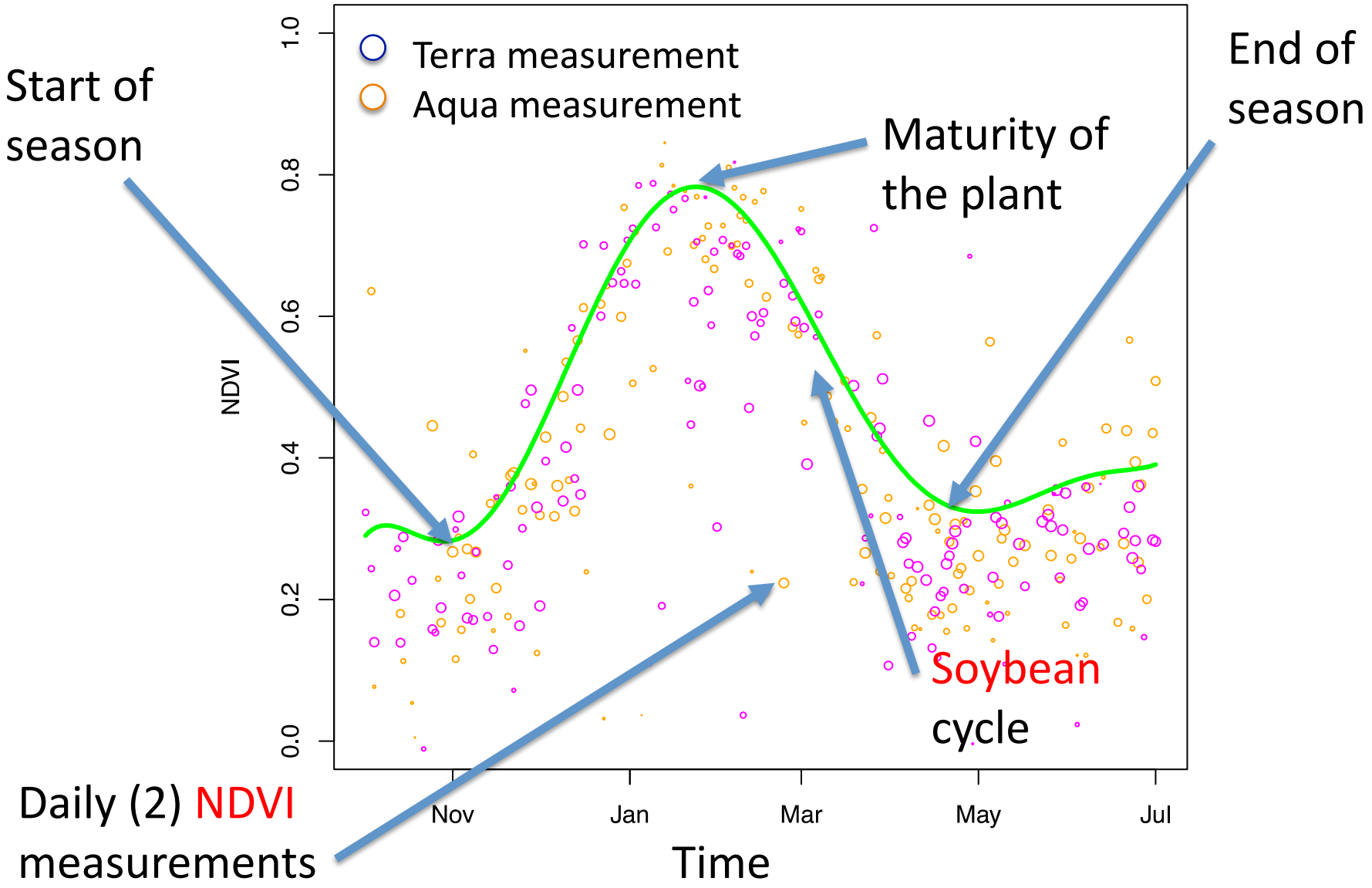
In general

$-1 \leq NDVI \leq 1$

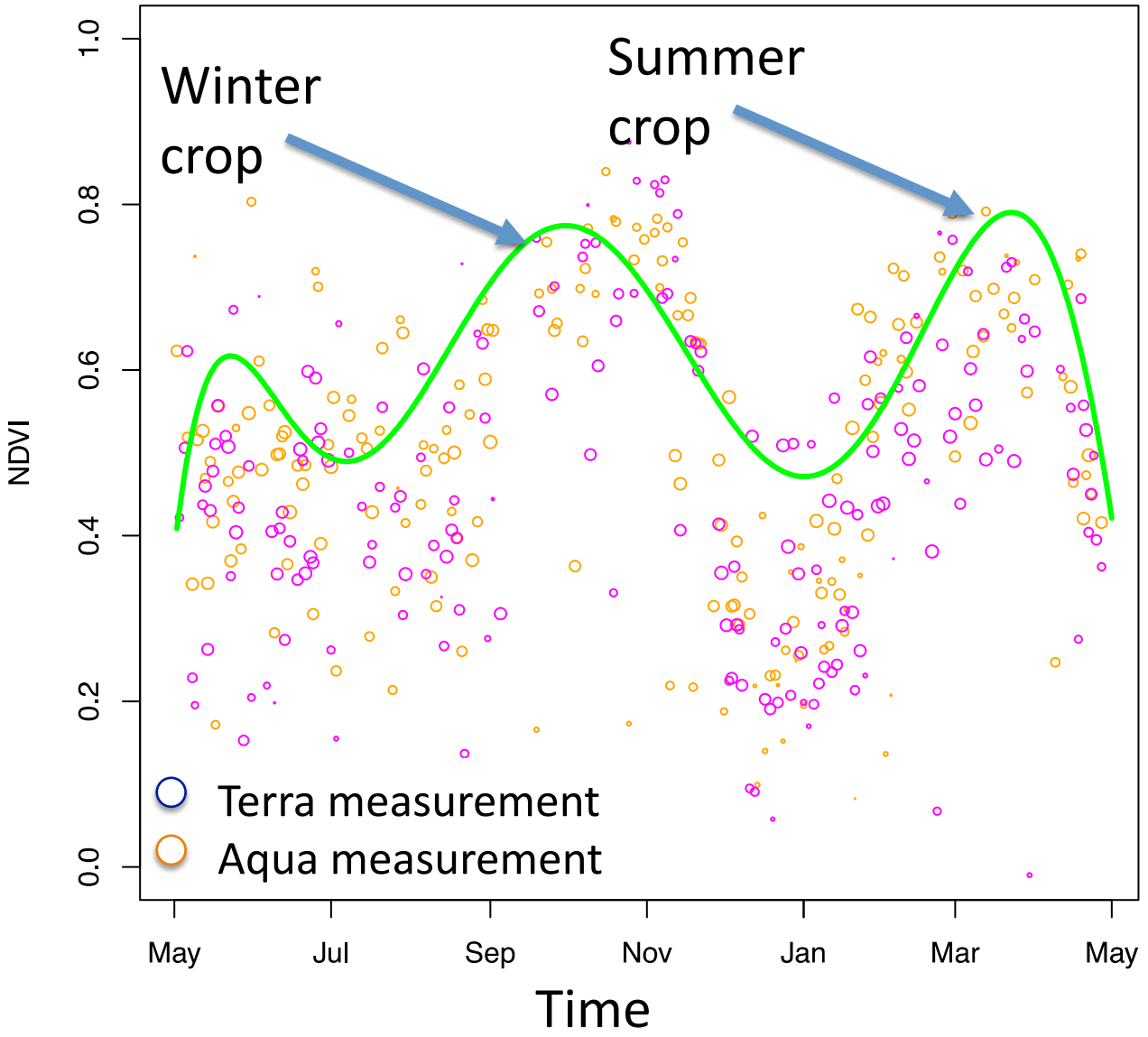
For plants

$0 \leq NDVI \leq 1$

How is a Typical Phenological Crop Cycle ?

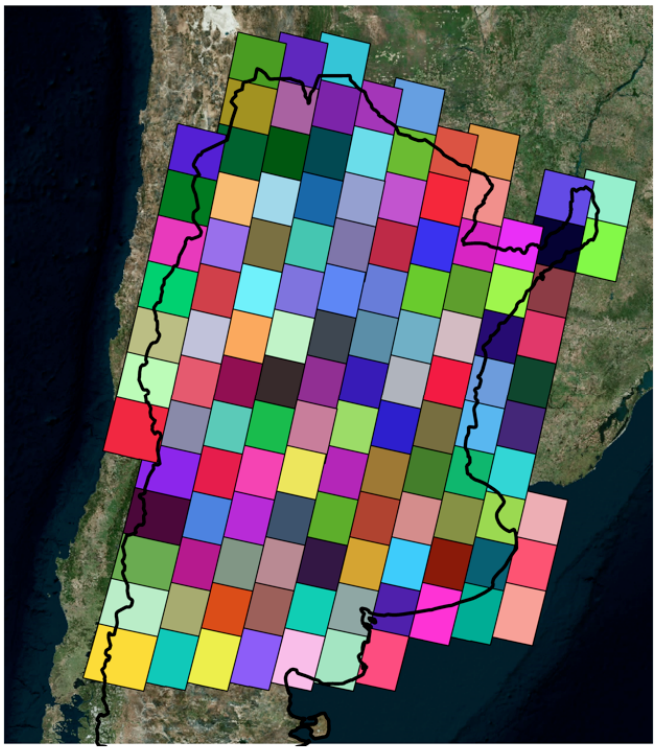


Double-Crop Phenological Cycle

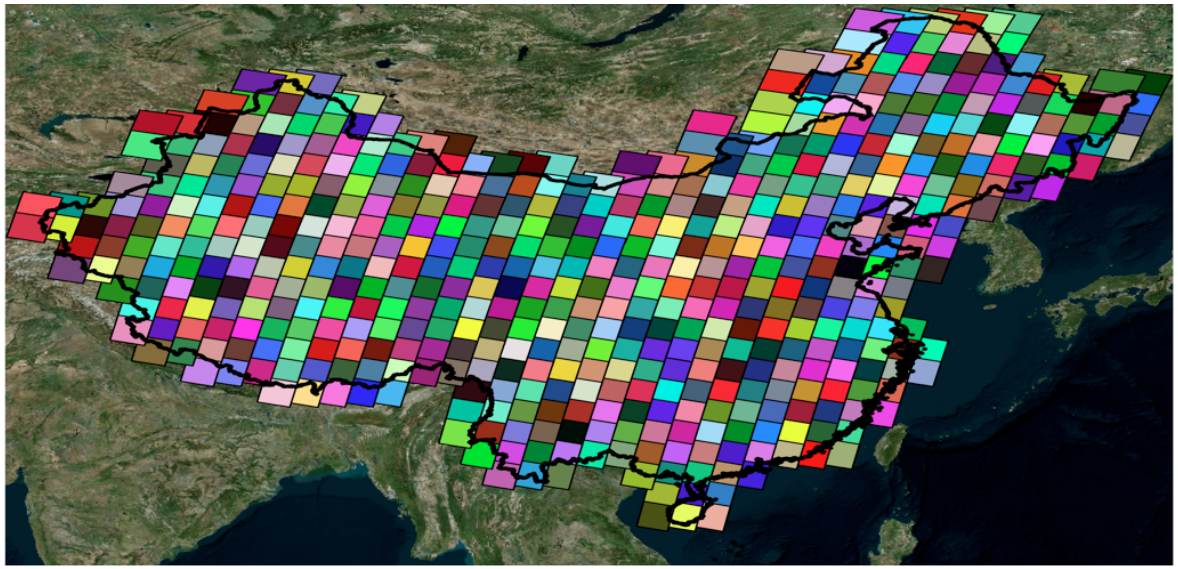


Landsat: Big Data !

Argentina



China



Landsat tile = 185km X 185 km

~ 17.500px X 14.500 px

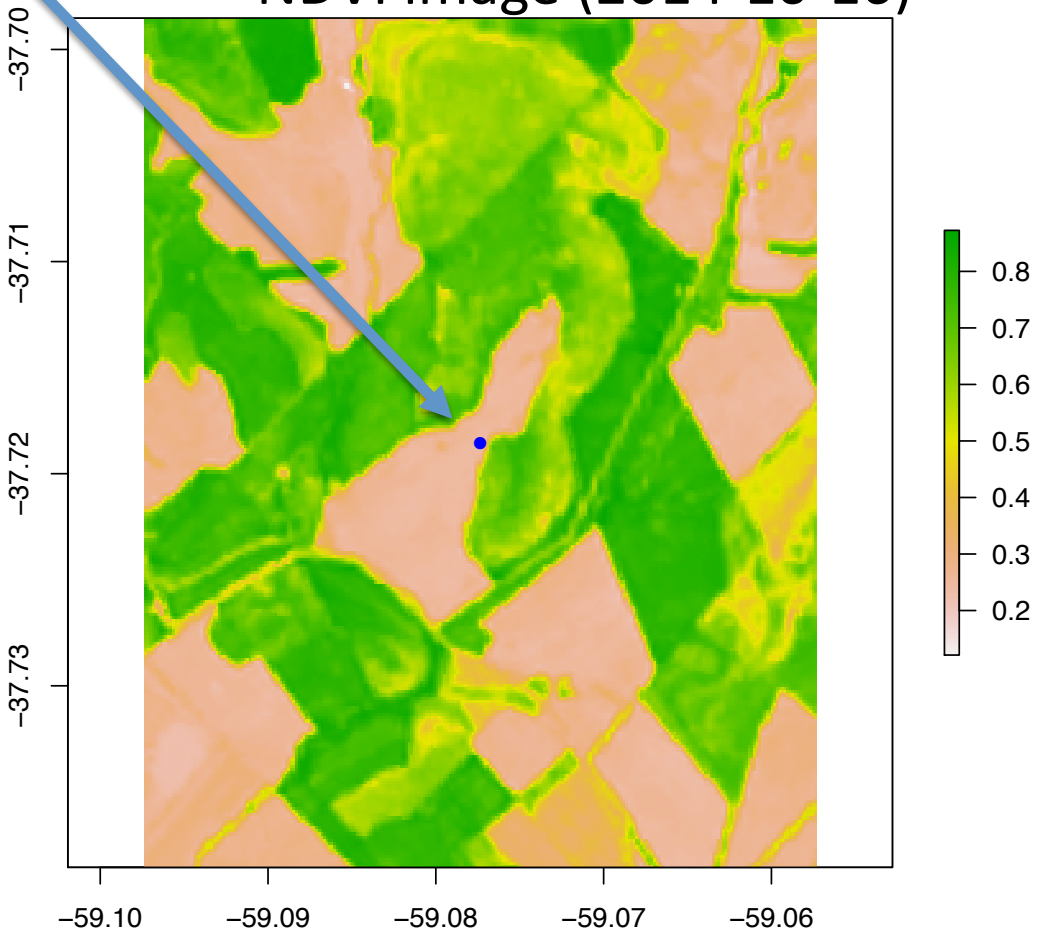
	Size of 1 tile	Number of tiles	Frequency	Size
Argentina	950 Mb	123	23 per year	2,6 Tb
China	950 Mb	530	23 per year	11,1 Tb

Cropland Detection Using Landsat 8
Unsupervised Approach

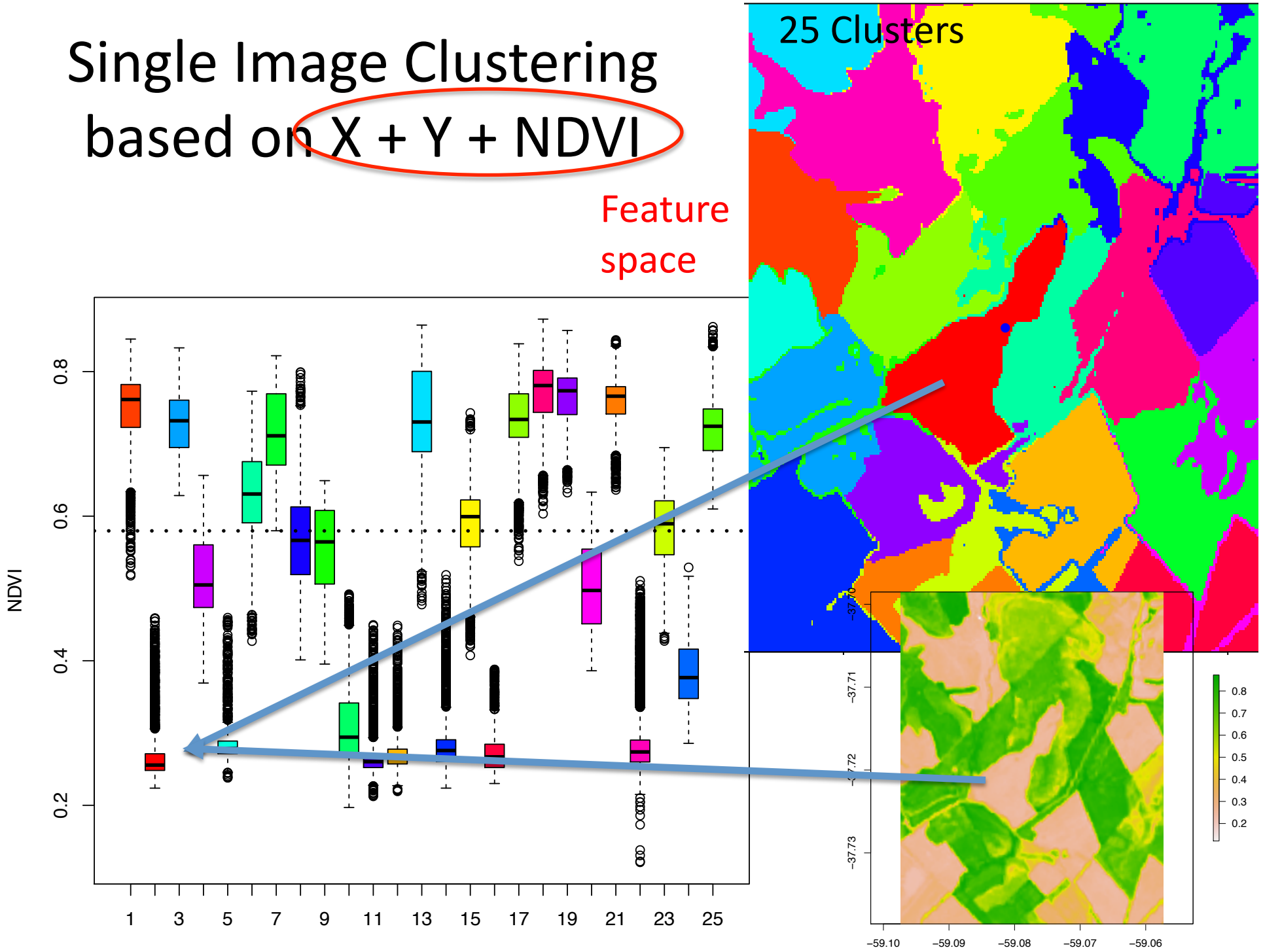
Visible image from Open Street Map

Point of interest

NDVI image (2014-10-16)

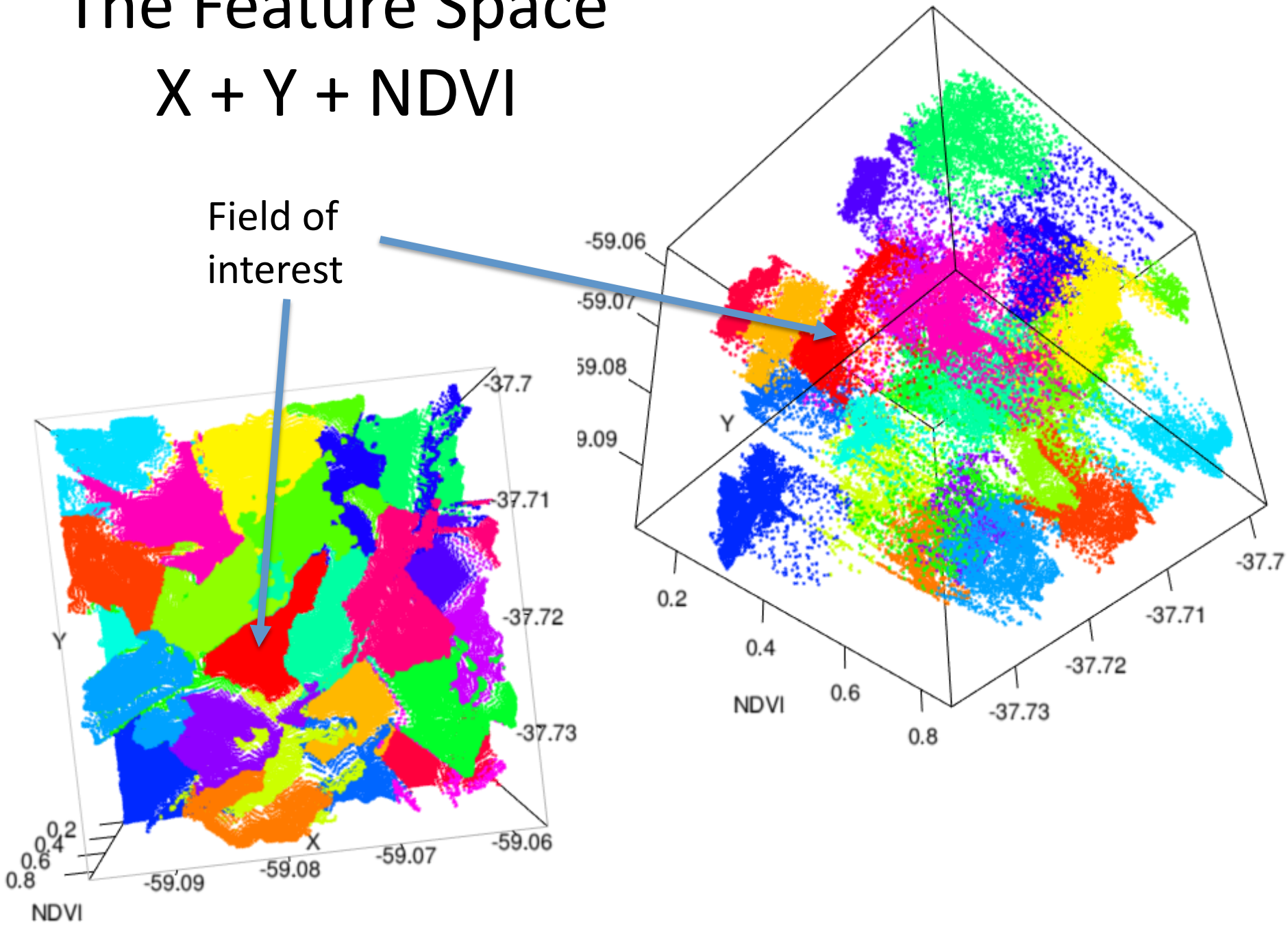


Single Image Clustering based on X + Y + NDVI

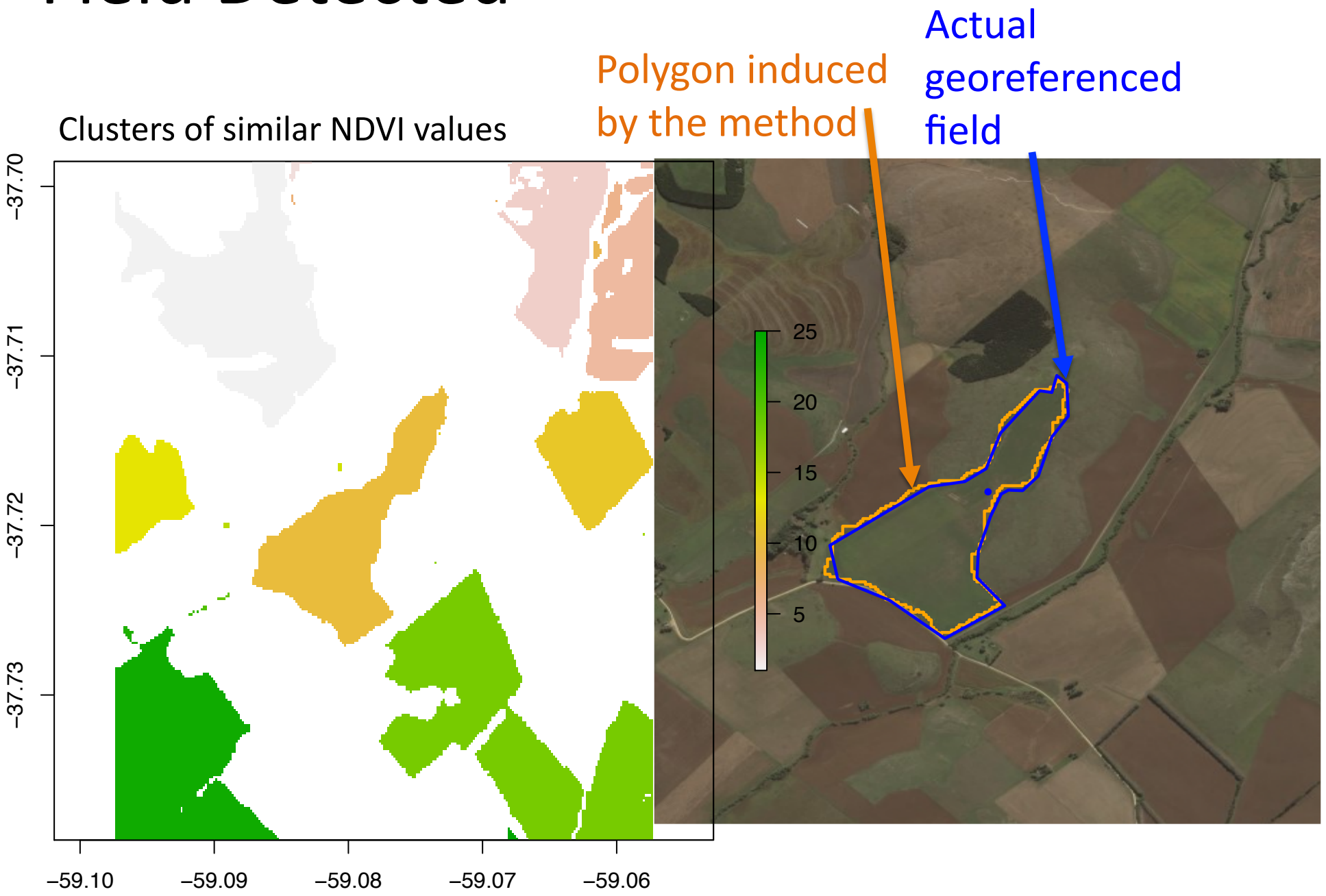


The Feature Space
X + Y + NDVI

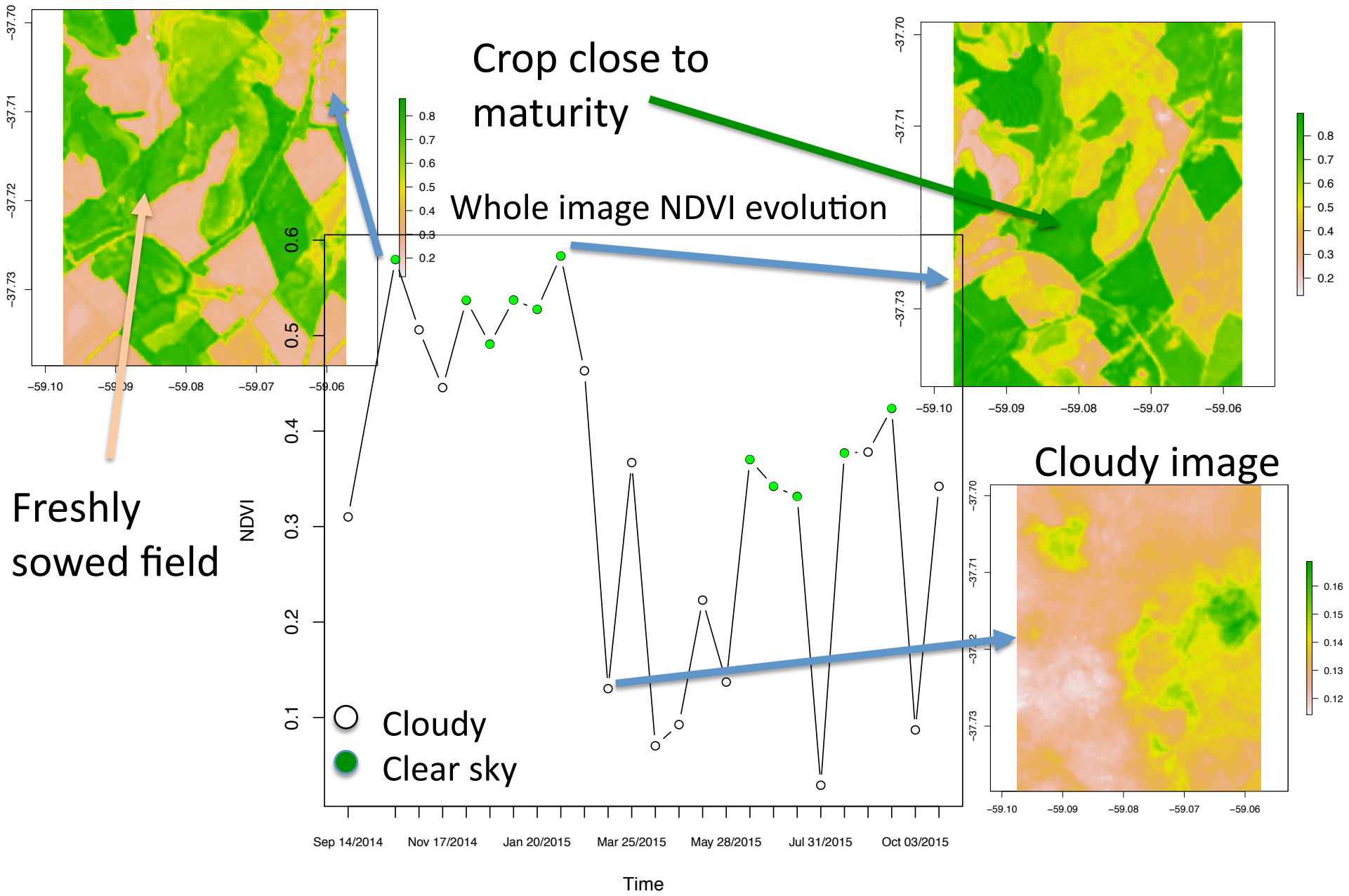
Field of interest



Field Detected



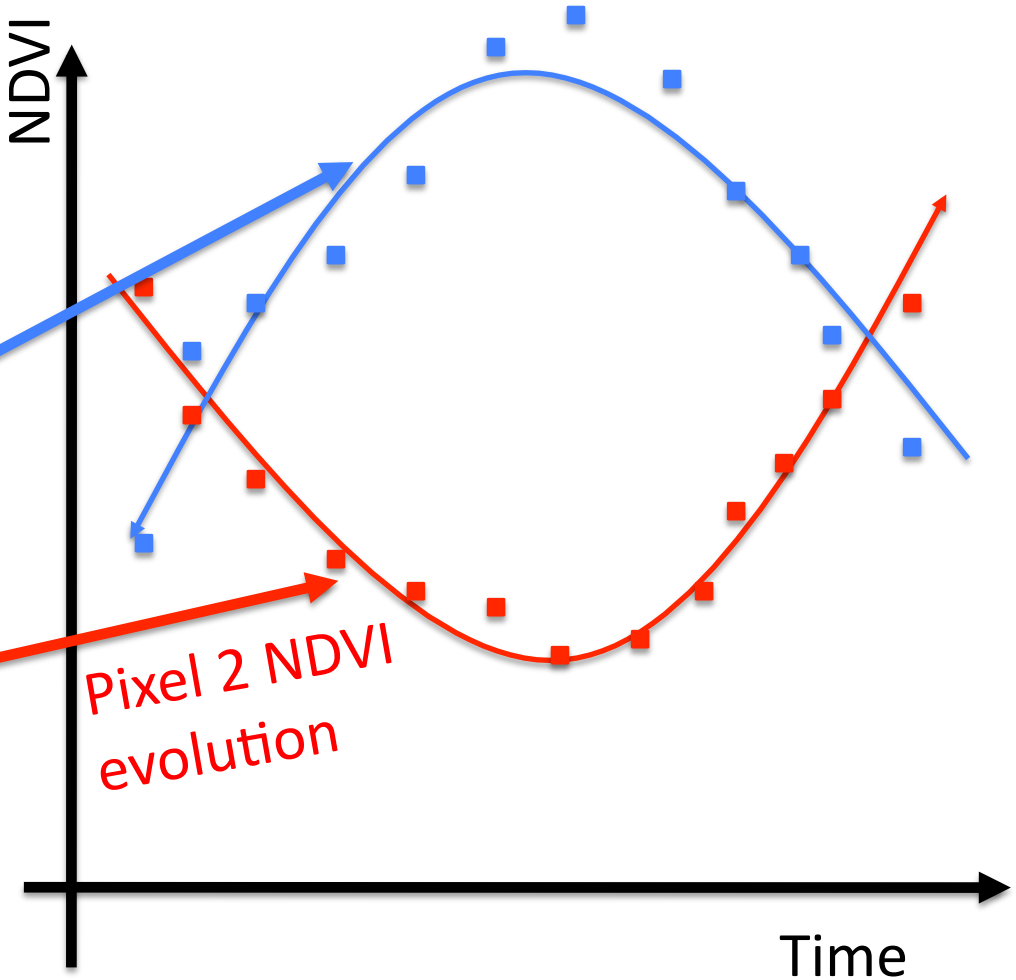
Time series of Landsat images



Working With a Temporal Ensemble of Images

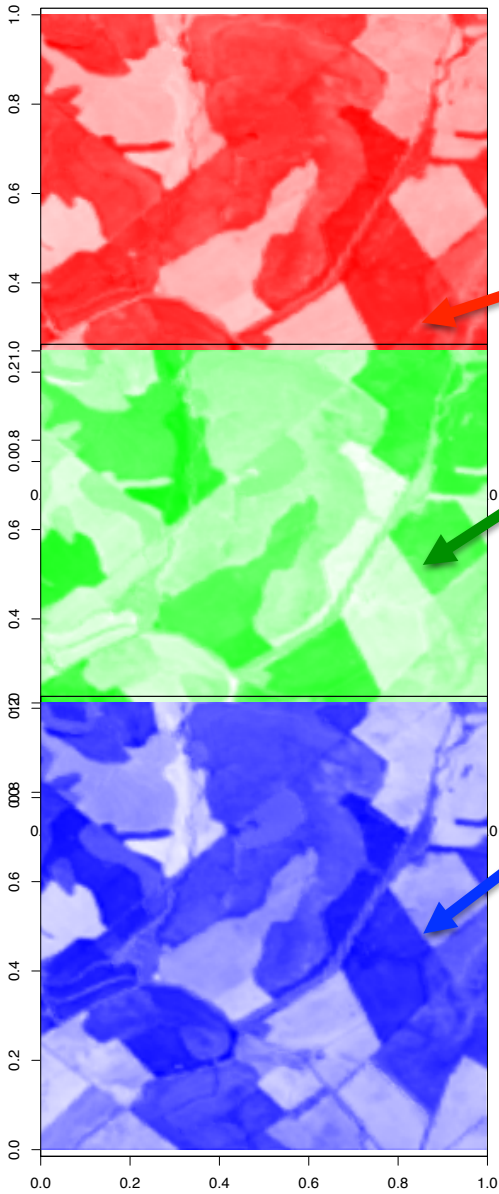
$$NDVI_{px} = \mu_{px} + \alpha_{px} * Time + \beta_{px} * Time^2$$

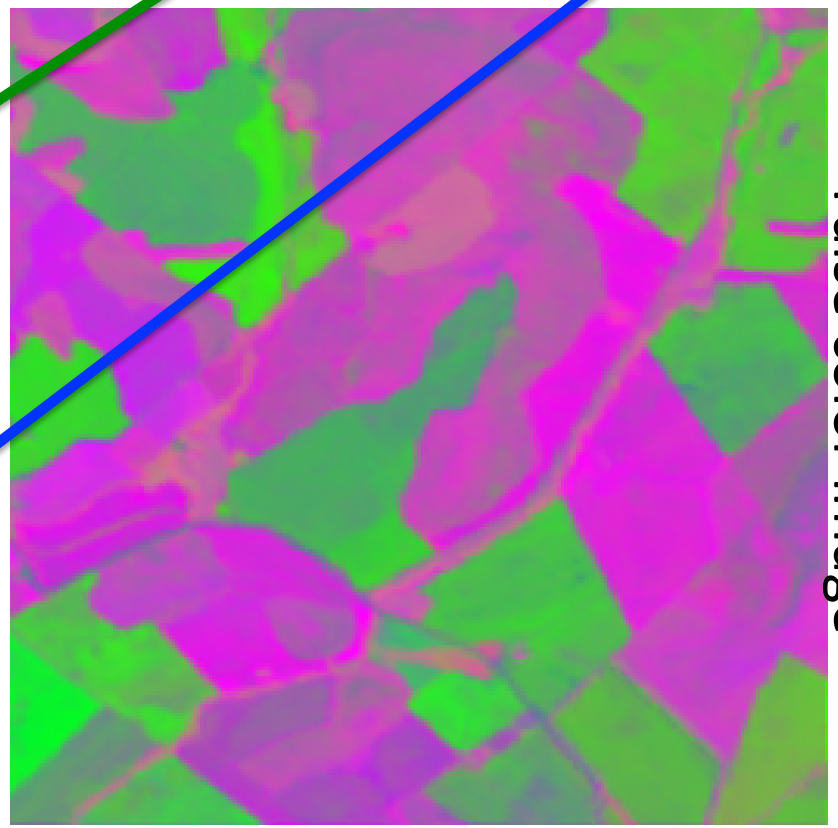
Pixel-wise modelling



Added Attributes Based on Statistical Modelling of NDVI Temporal Evolution

$$NDVI_{px} = \hat{\mu}_{px} + \hat{\alpha}_{px} * Time + \hat{\beta}_{px} * Time^2$$



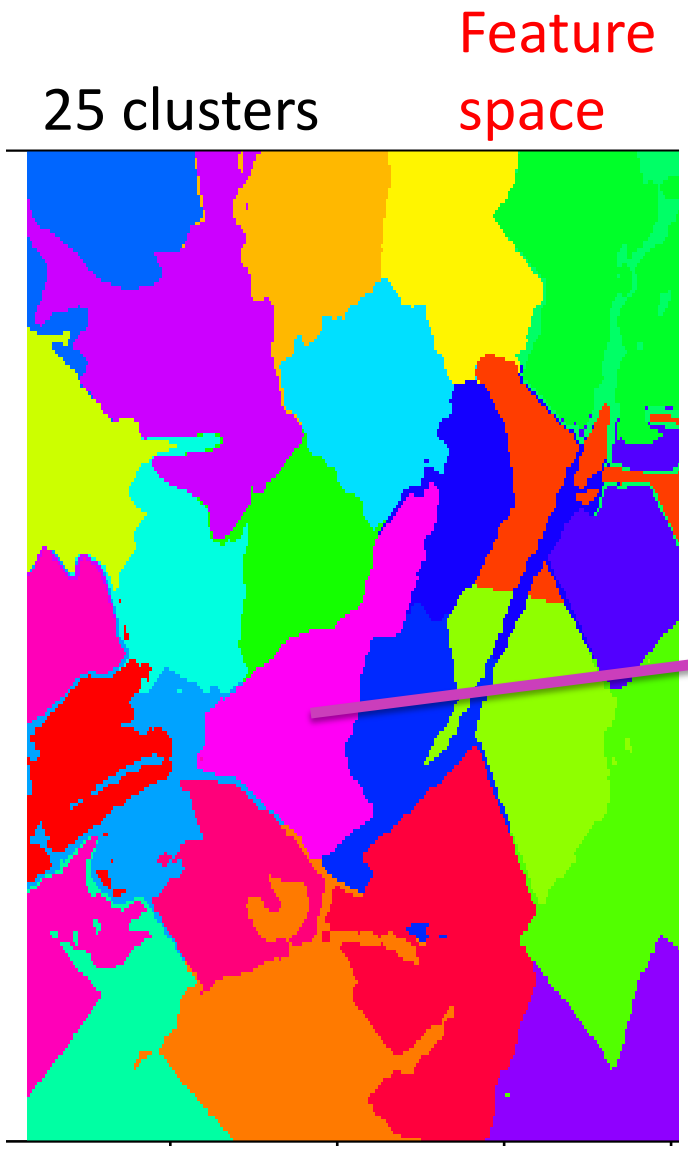


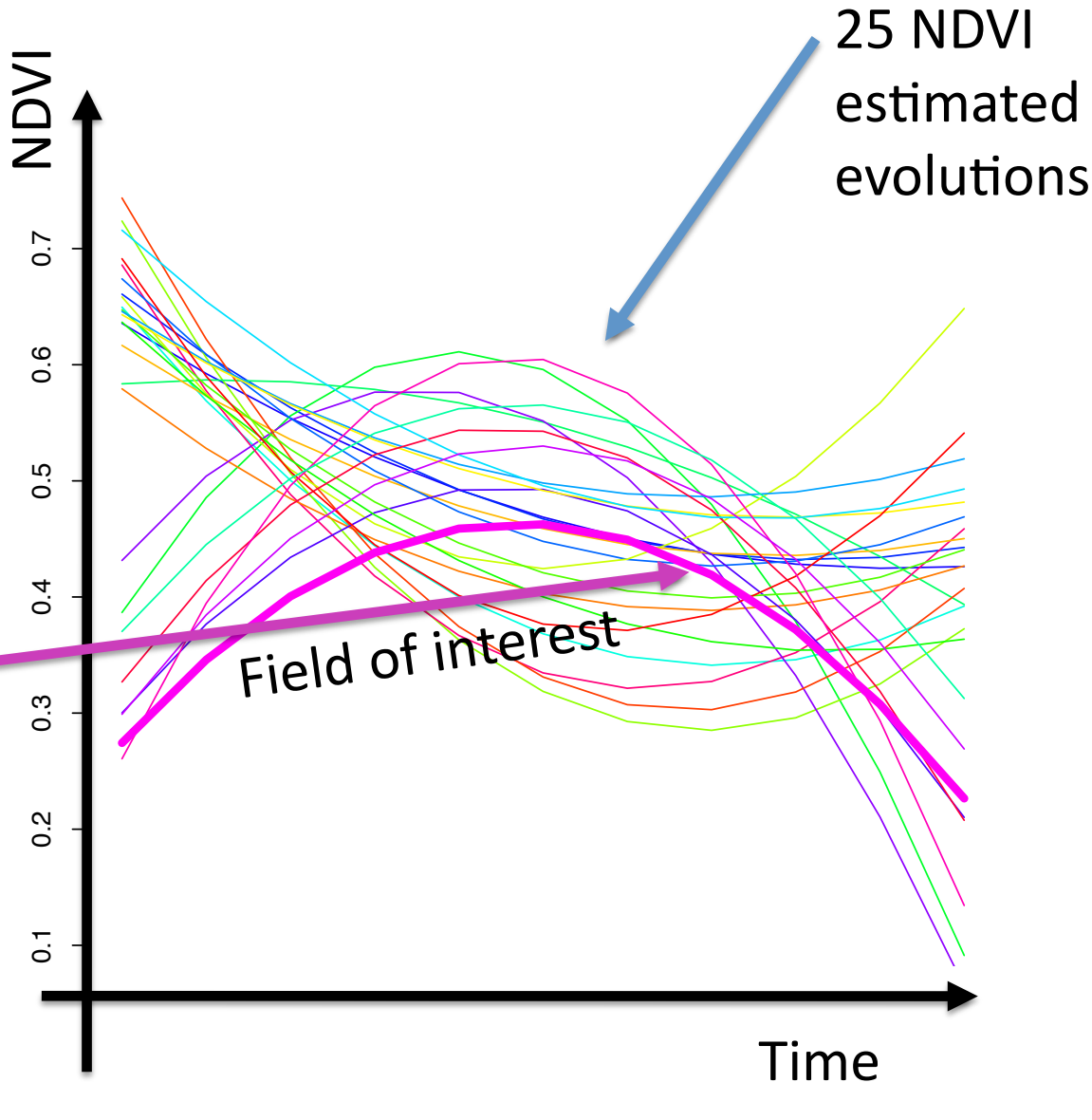
False color image

Pixel-wise modelling

Clustering Based on Modelled NDVI Temporal Evolution

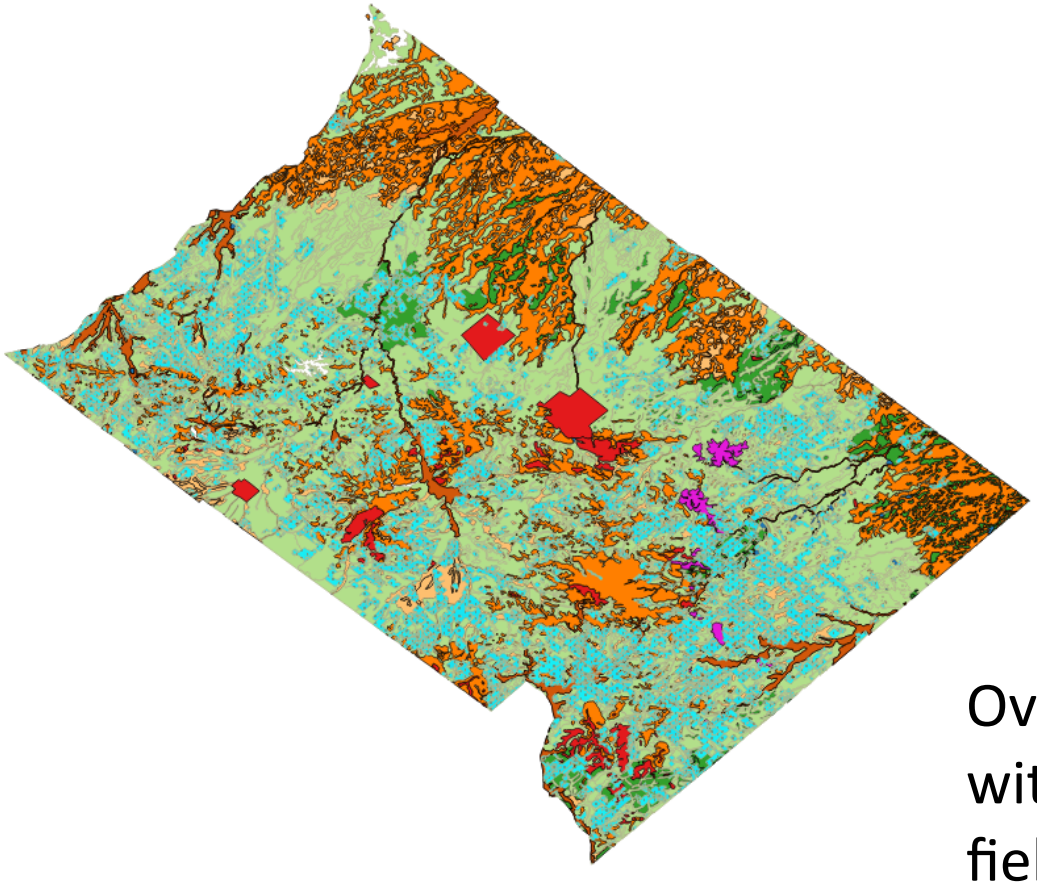
$X + Y + \mu + \alpha + \beta$





Agreement Between Detected Fields and Soil Capability (Tandil)

Soil management capability



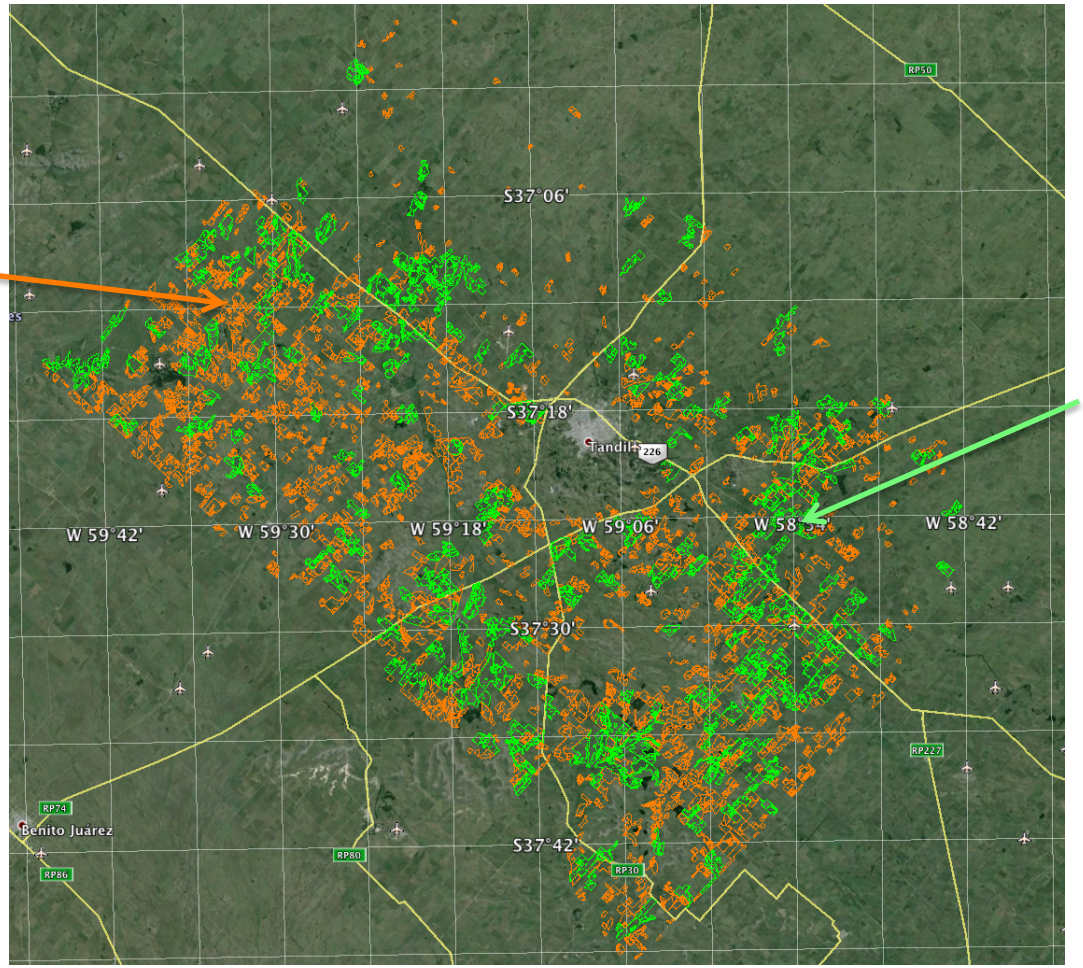
Overlapping with sowed fields automatically detected

Automatic Detection of Summer and Winter Crops in Tandil

Winter crop

Estimation:
89.000 has

MAGyP (2014):
85.000 has

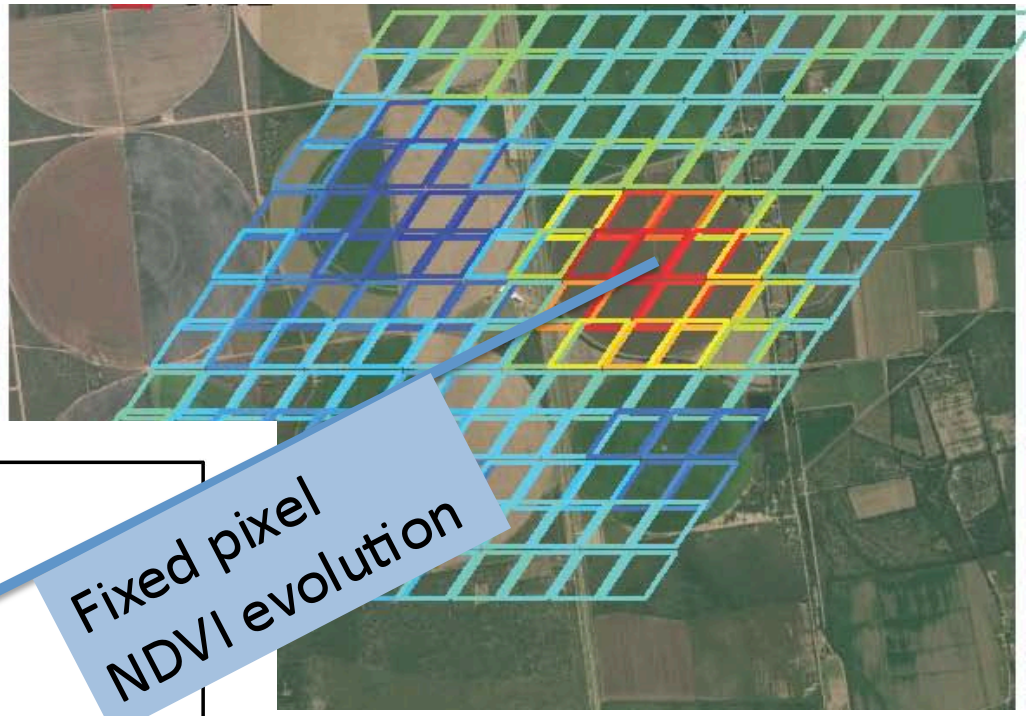


Summer crop

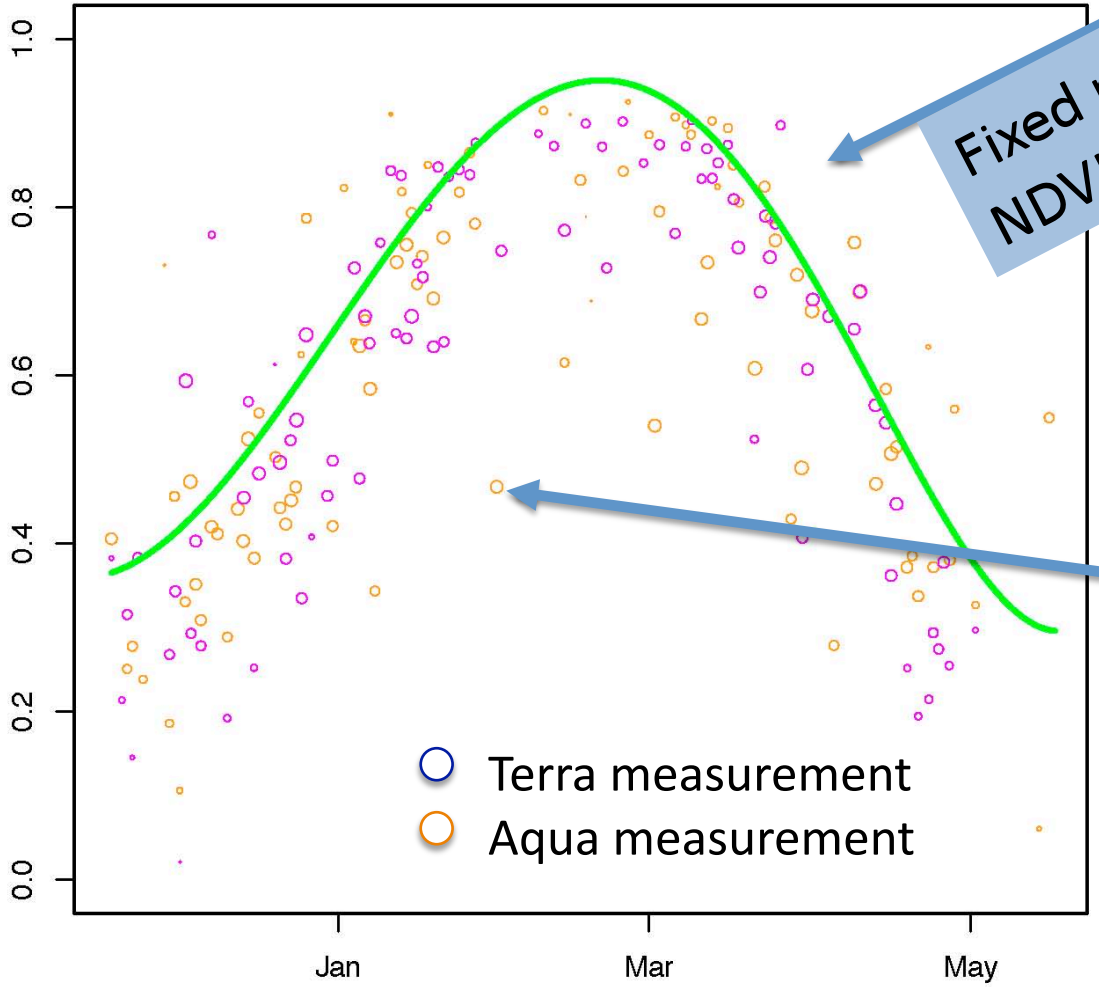
Estimation:
200.000has

MAGyP (2013) :
216.000 has

Cropland Detection Using MODIS (Supervised Approach)



Fixed pixel NDVI evolution

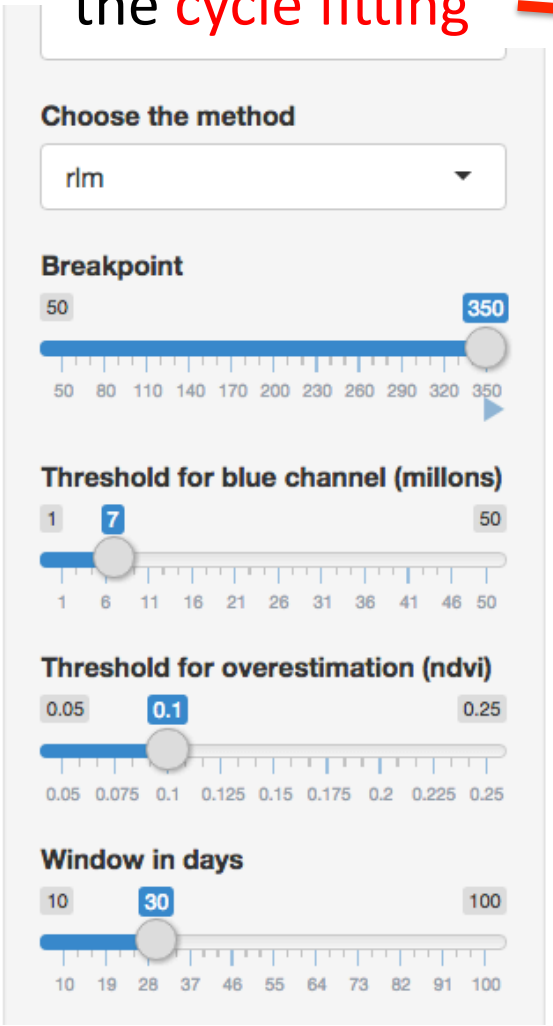


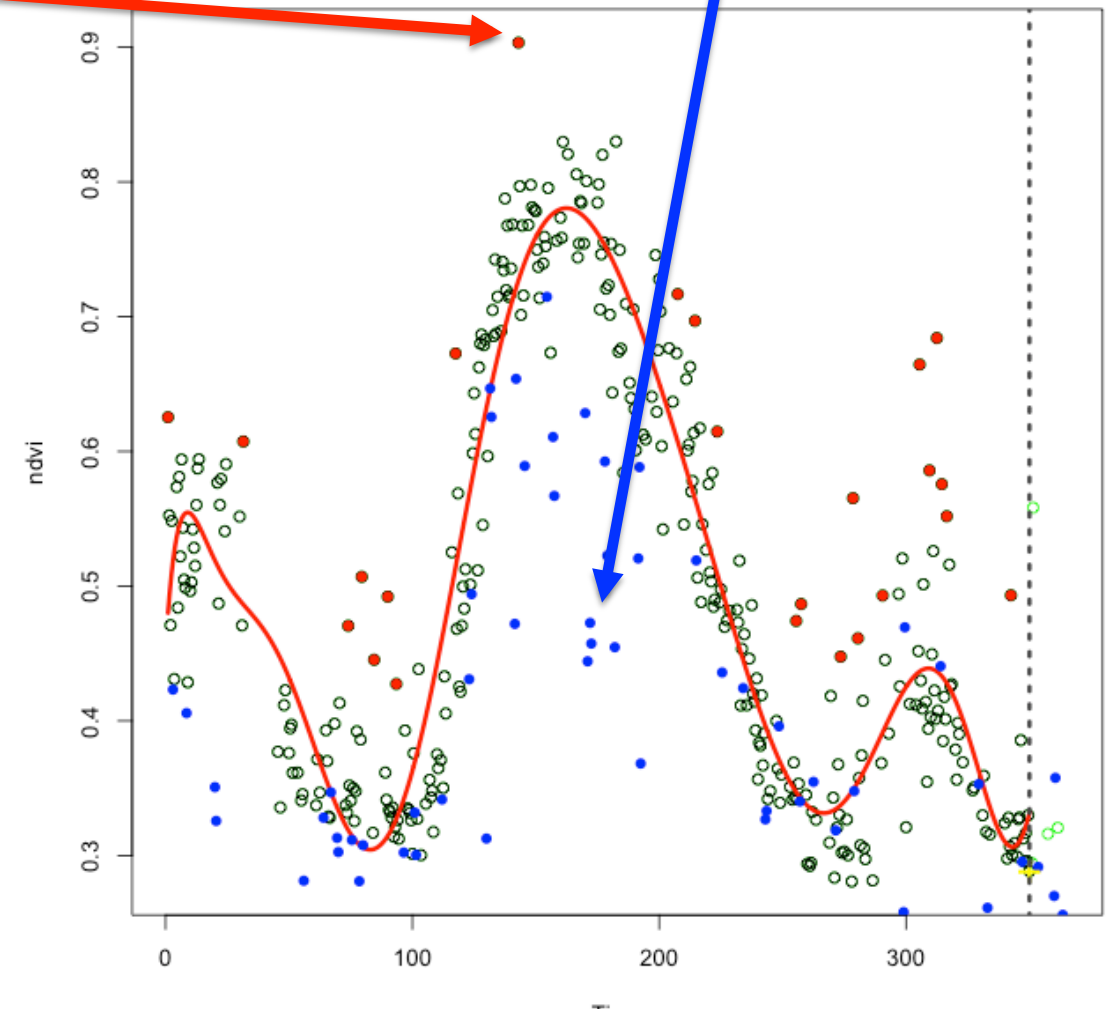
Dot size proportional to the reliability of the measurement

Fitting the Crop Cycle

Noise detected by the cycle fitting

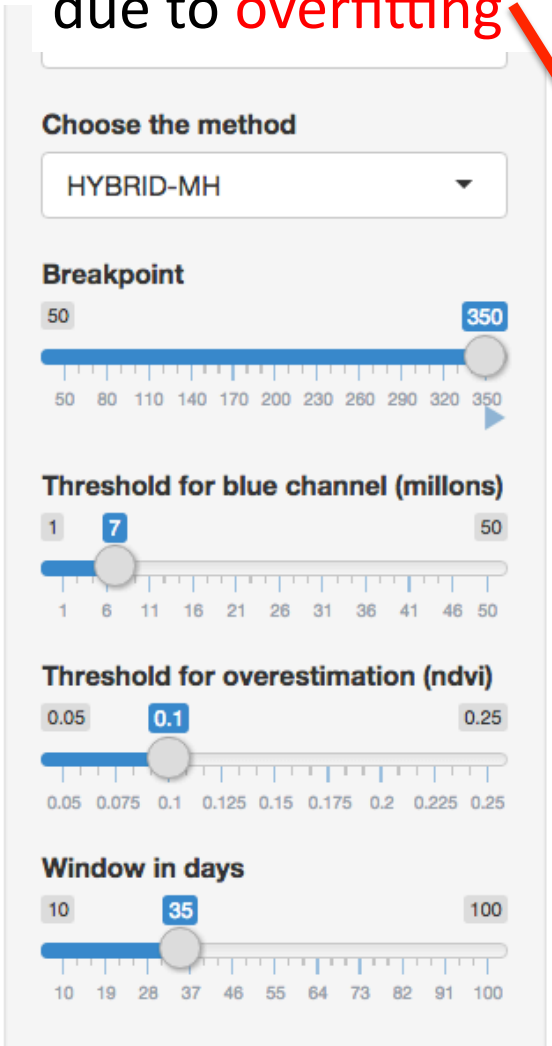
Noise detected by the blue channel

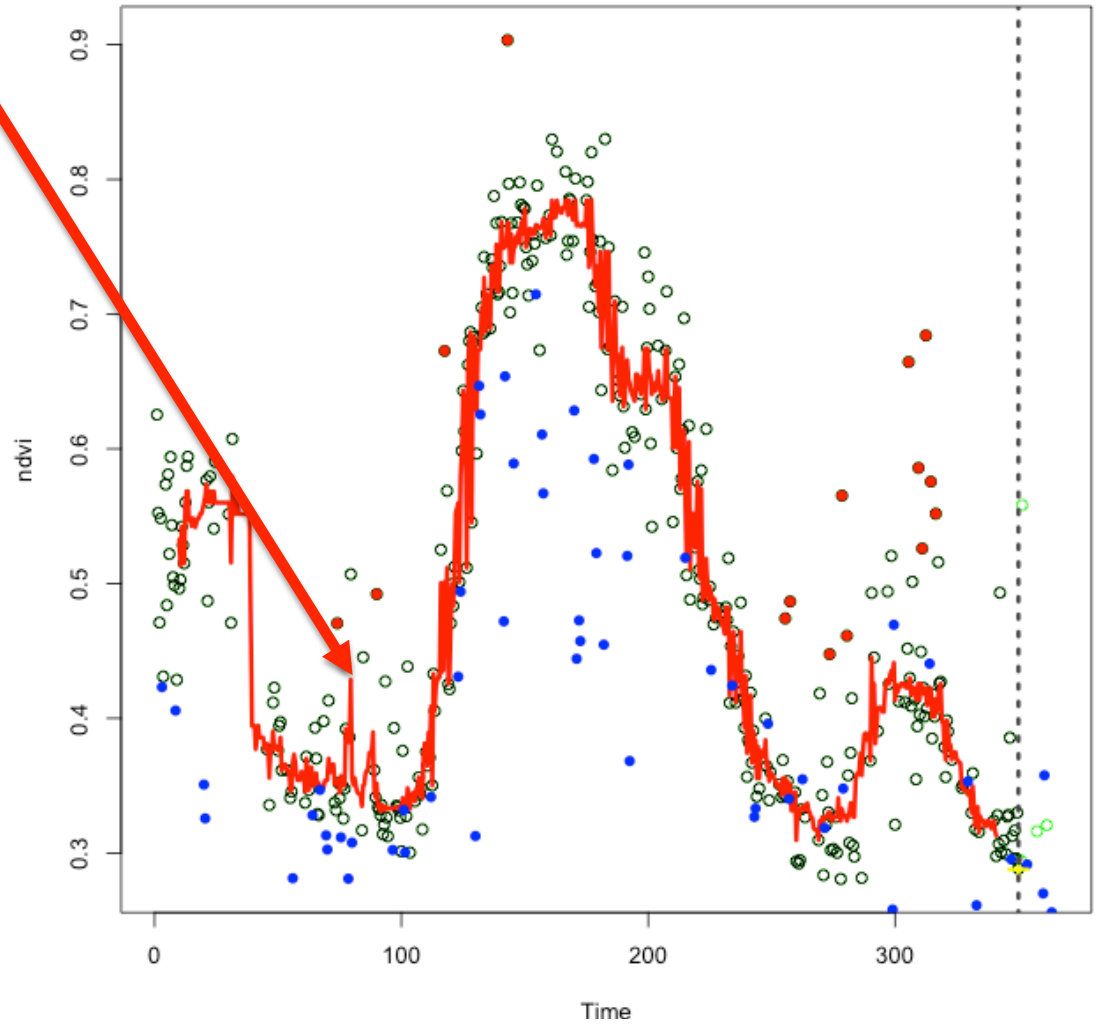




How to Automatically Avoid Overfitting ?

False variations due to overfitting





Thanks

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