Opportunities to assess grassland biodiversity using digital repeat photograpy

G. Filippa [1] E. Cremonese [1] M. Migliavacca [2] M. Galvagno [1]
F. Diotri [1] and A.D. Richardson [3]

[1]Environmental Protection Agency of Aosta Valley - ARPA VdA - Italy
[2]Max Planck Institute - Biogeochemical Integration (Jena, Germany)
[3]Department of Organismic and Evolutionary Biology
Harvard University (NE- USA)

Kusadasi 7 October 2015

Torgnon grassland site, NW Italy, 2160 m asl

Phenocamera networks

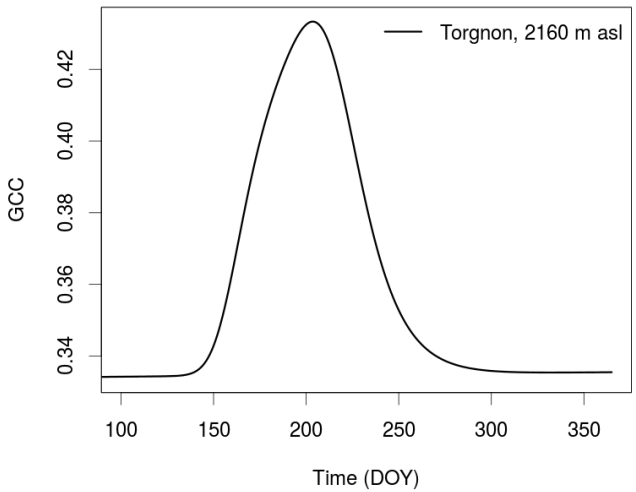
- PHENOCAM (200+ sites)
- EUROPHEN (40+ sites)
- ASIA, AUSTRALIA

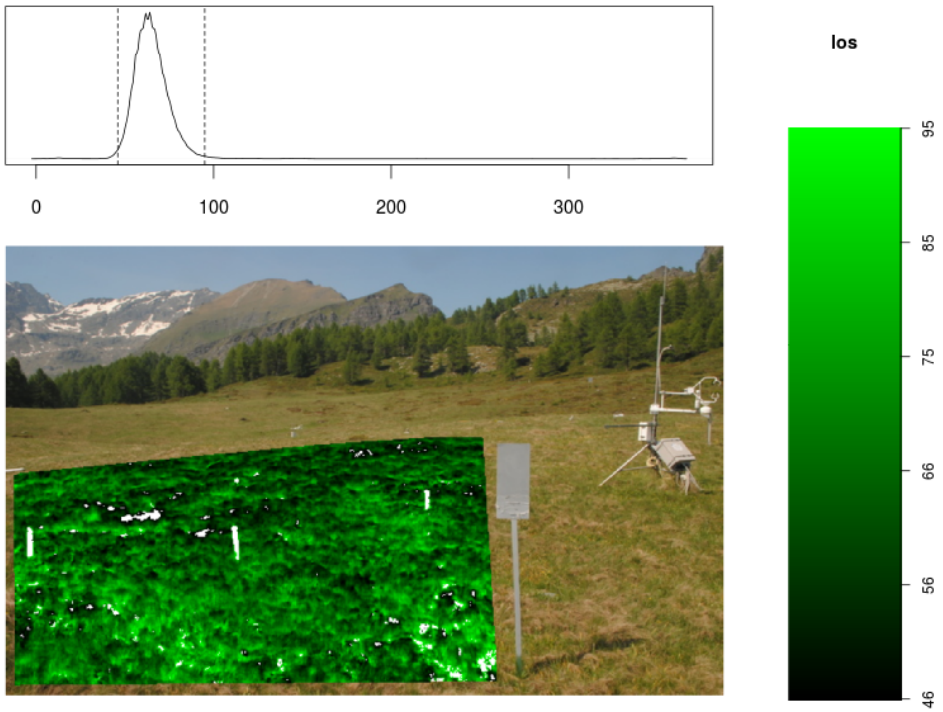
→ Growing scientific interest, growing need for standardized processing tools

phenopix

Phenopix R package for image processing, fitting and phenophase extraction either with a roi averaged approach or pixel by pixel

available @ https://r-forge.r-project.org/projects/phenopix/





Filippa *et al., in prep, AFM*

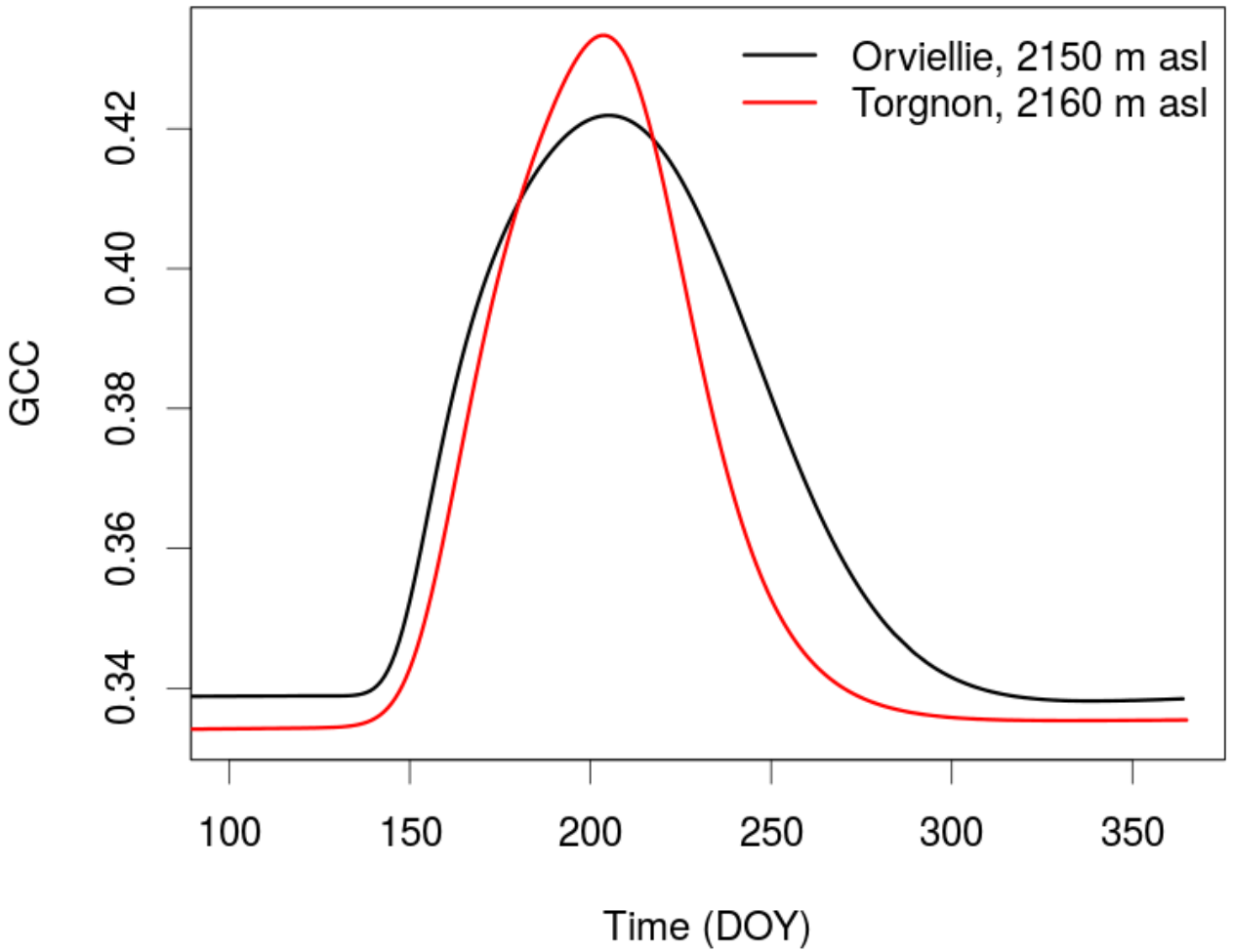
Grassland biodiversity

- Grassland biodiversity is strongly controlled by climate and management practices
- Grassland biodiversity translates into phenodiversity
- Bio/Phenodiversity has implications on ecosystem functioning

Crouzet (FR), 1900 m asl

Motivation (1)

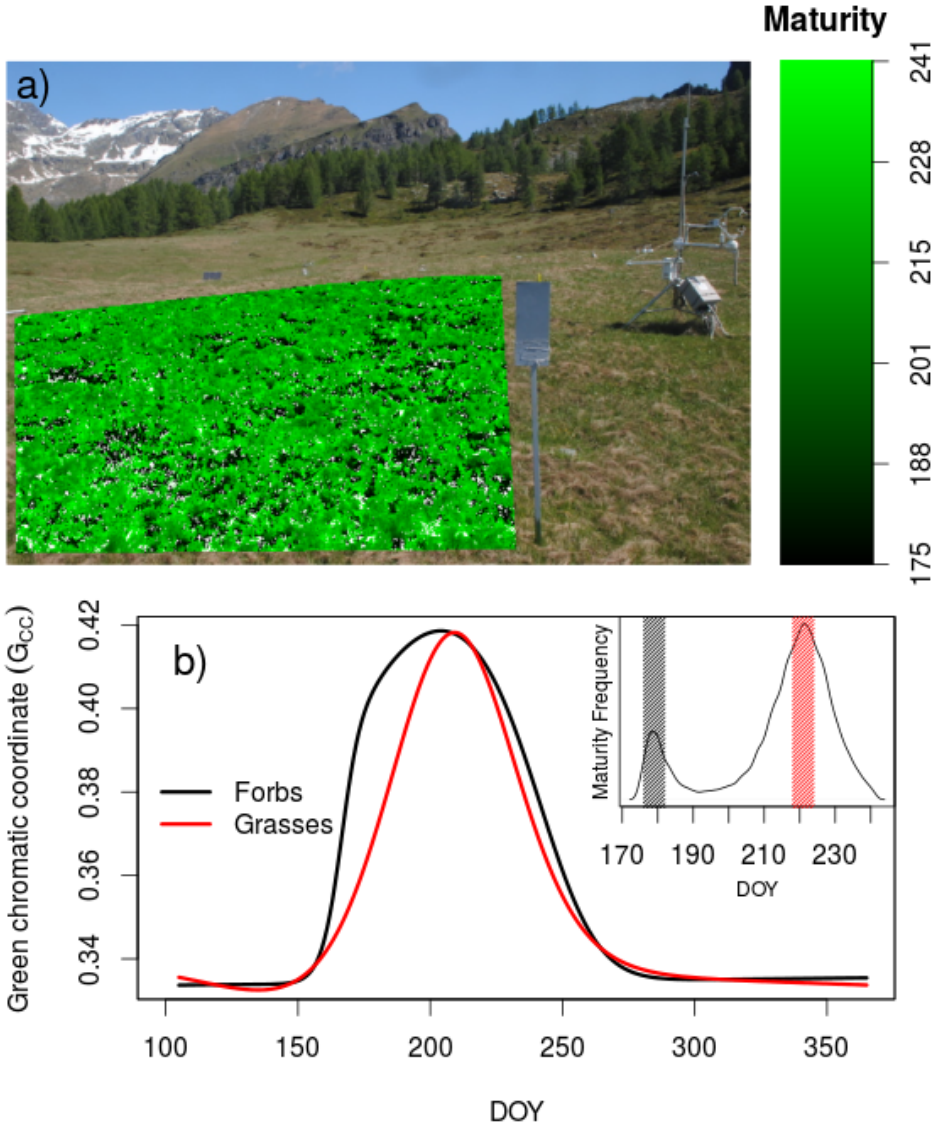
Same climate, different phenology



Biodiversity → **Ecosystem plasticity**

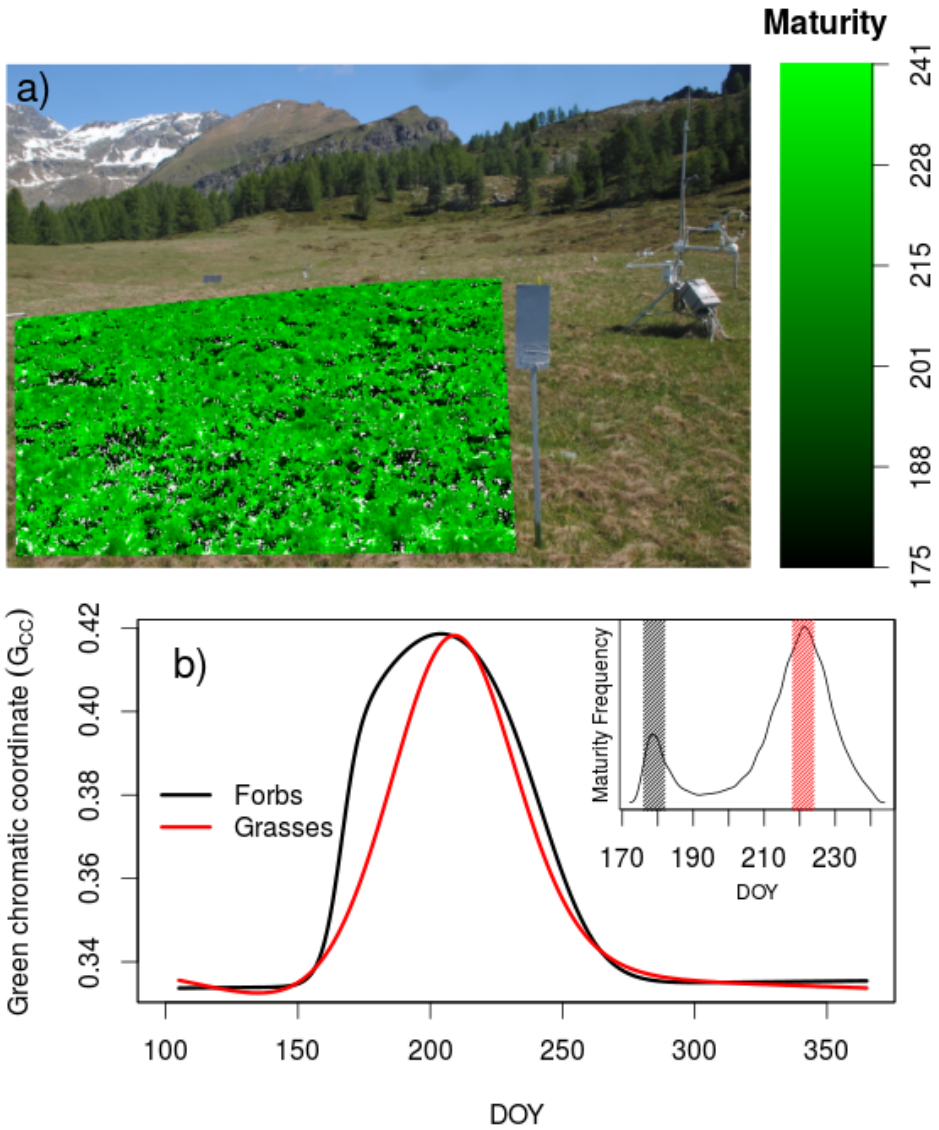
Motivation (2)

- Phenophase map (20 cm pixel resolution)
- Spatial distribution of phases reflects field observation on vegetation composition, with different seasonal trajectories coherent with the ecology of functional types.



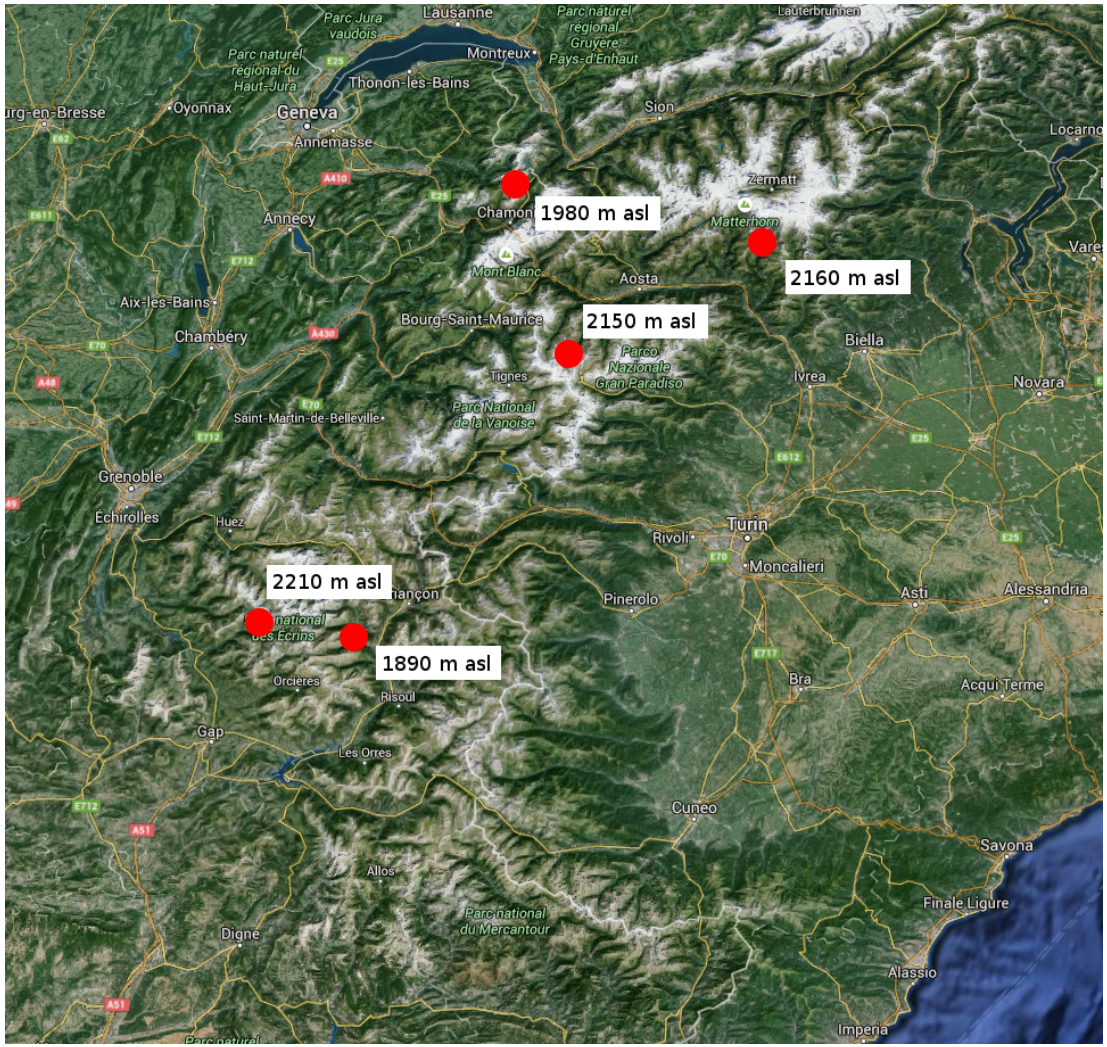
Objective

Explore the possibility to investigate biodiversity from phenocameras by means of pixel based analysis and the `phenopix` R package

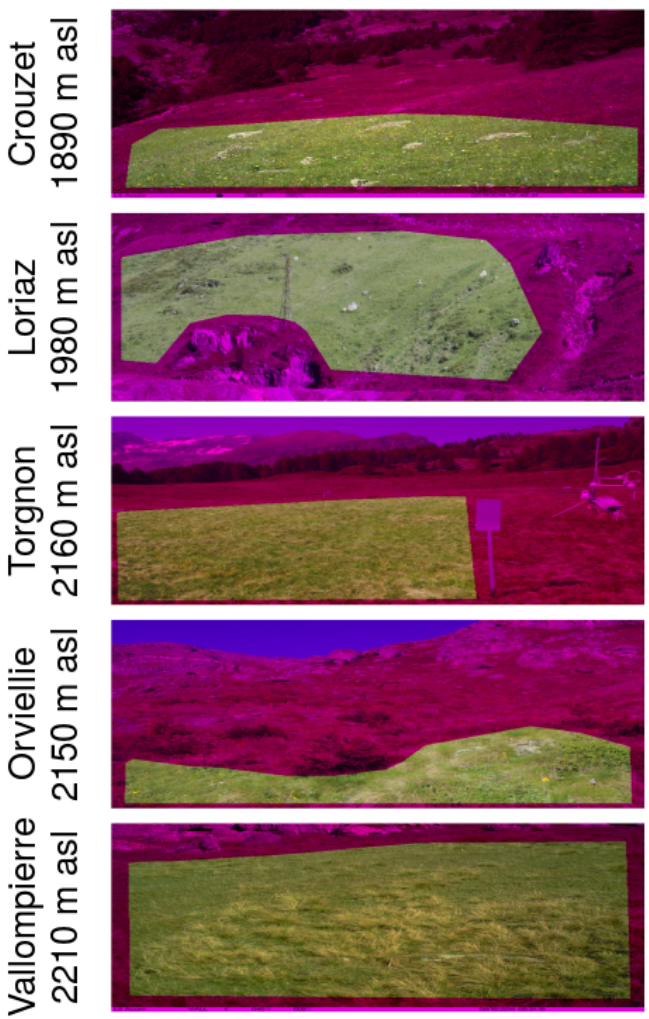


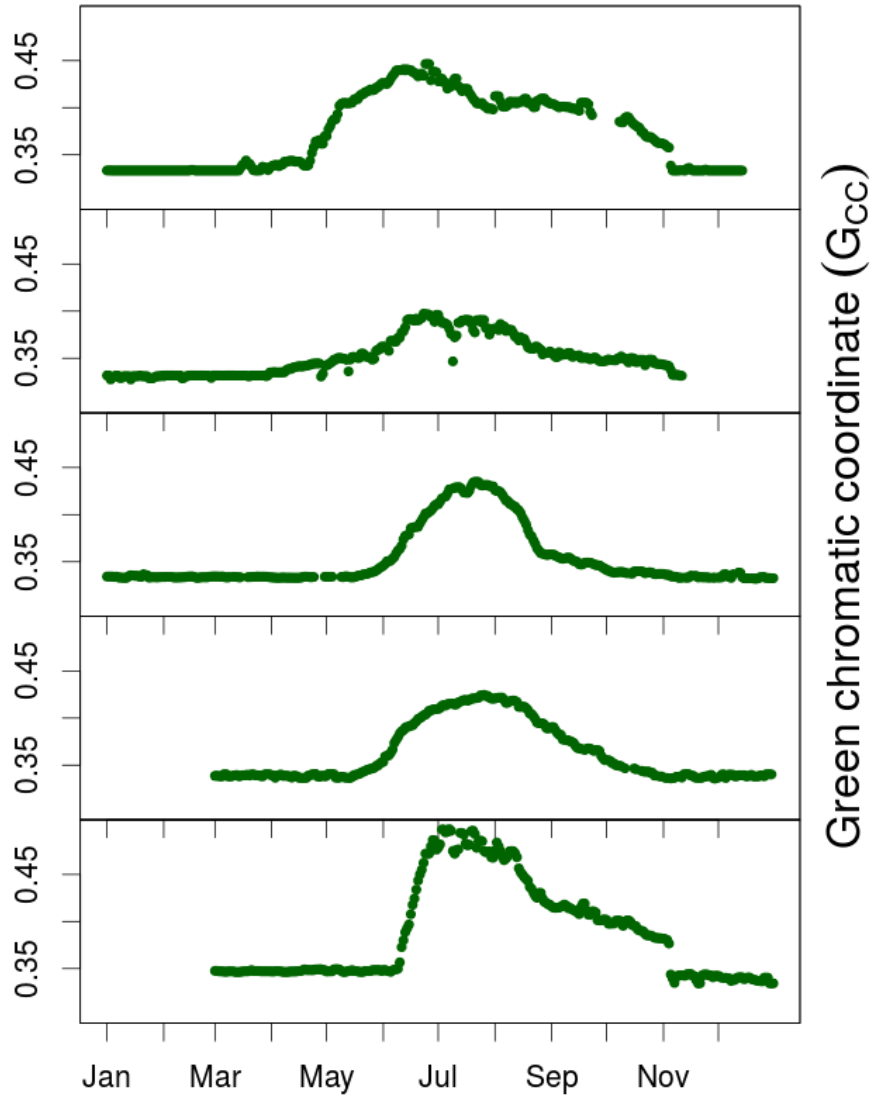
The sites - ePHENO network, Western Alps

- 5 grasslands, ranging 1900-2200 m asl
- One year of data (2014)
- Variable degree of biodiversity

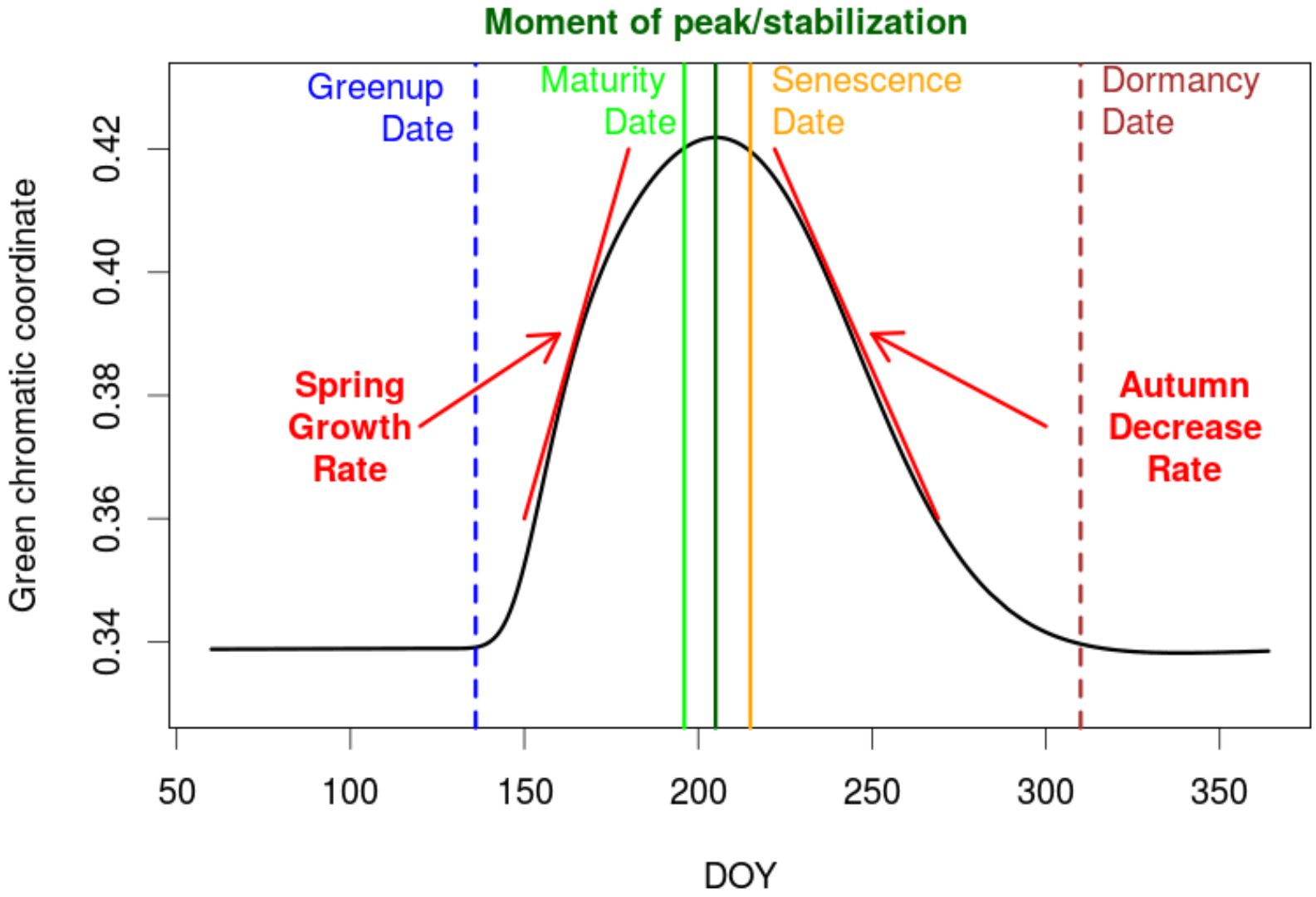


The sites - seasonal trajectories 2014

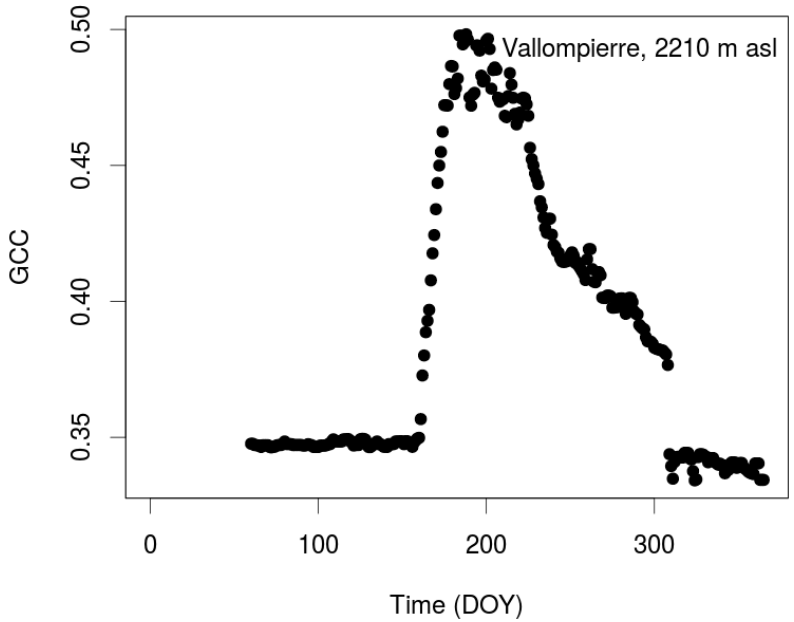




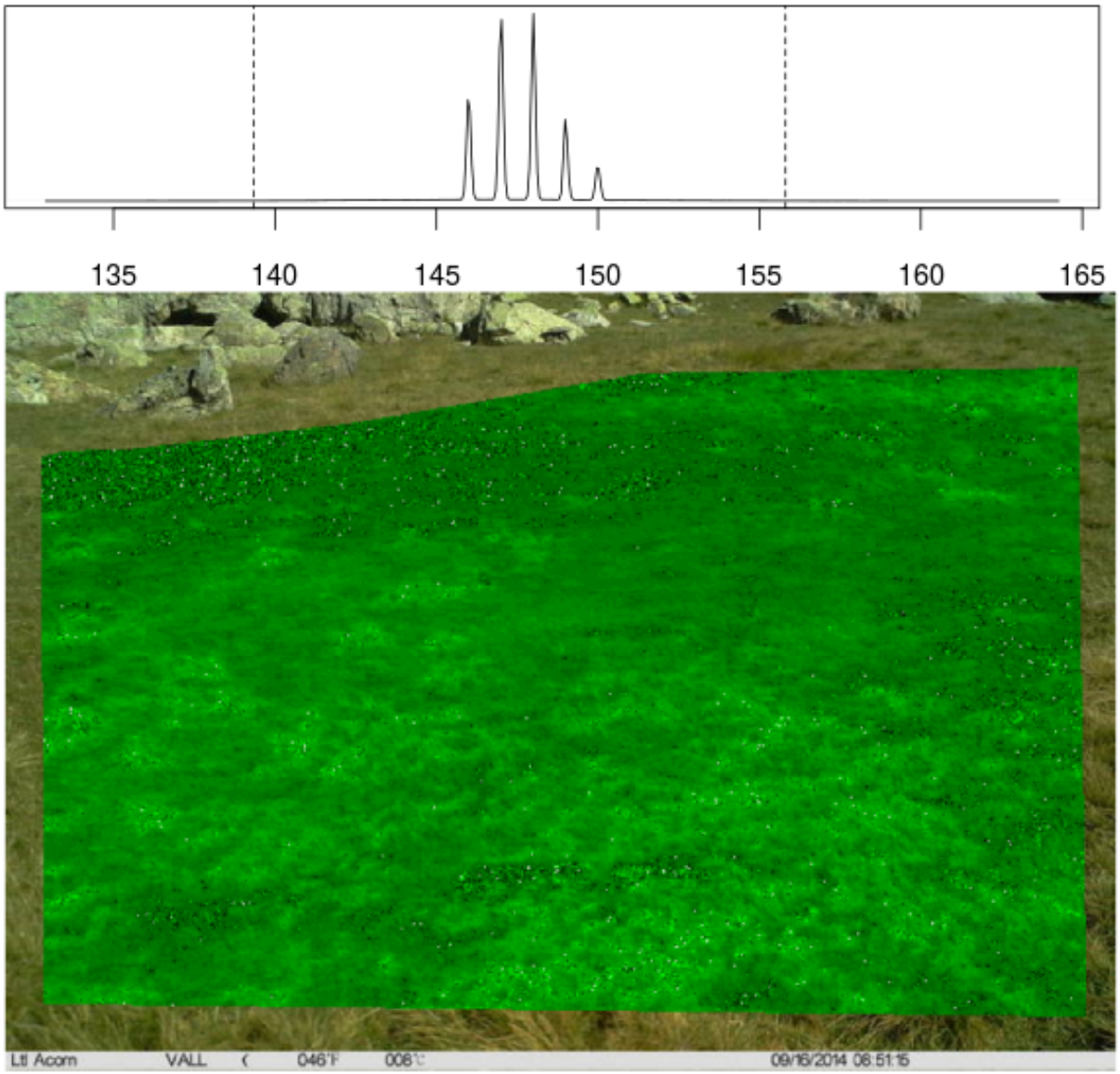
The Approach - Phenophases

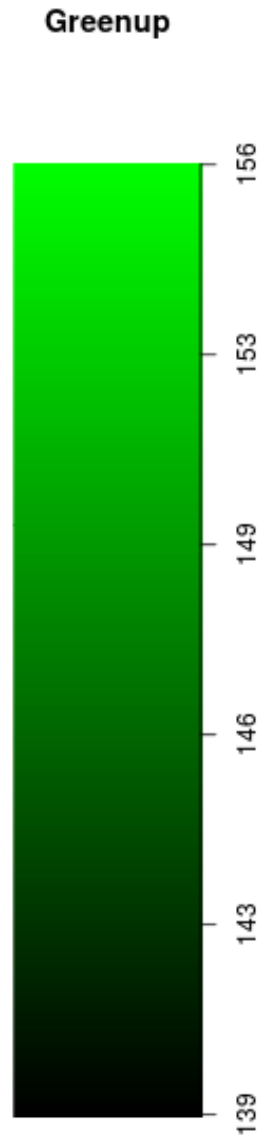


Spatial distribution of selected phases - Vallompierre

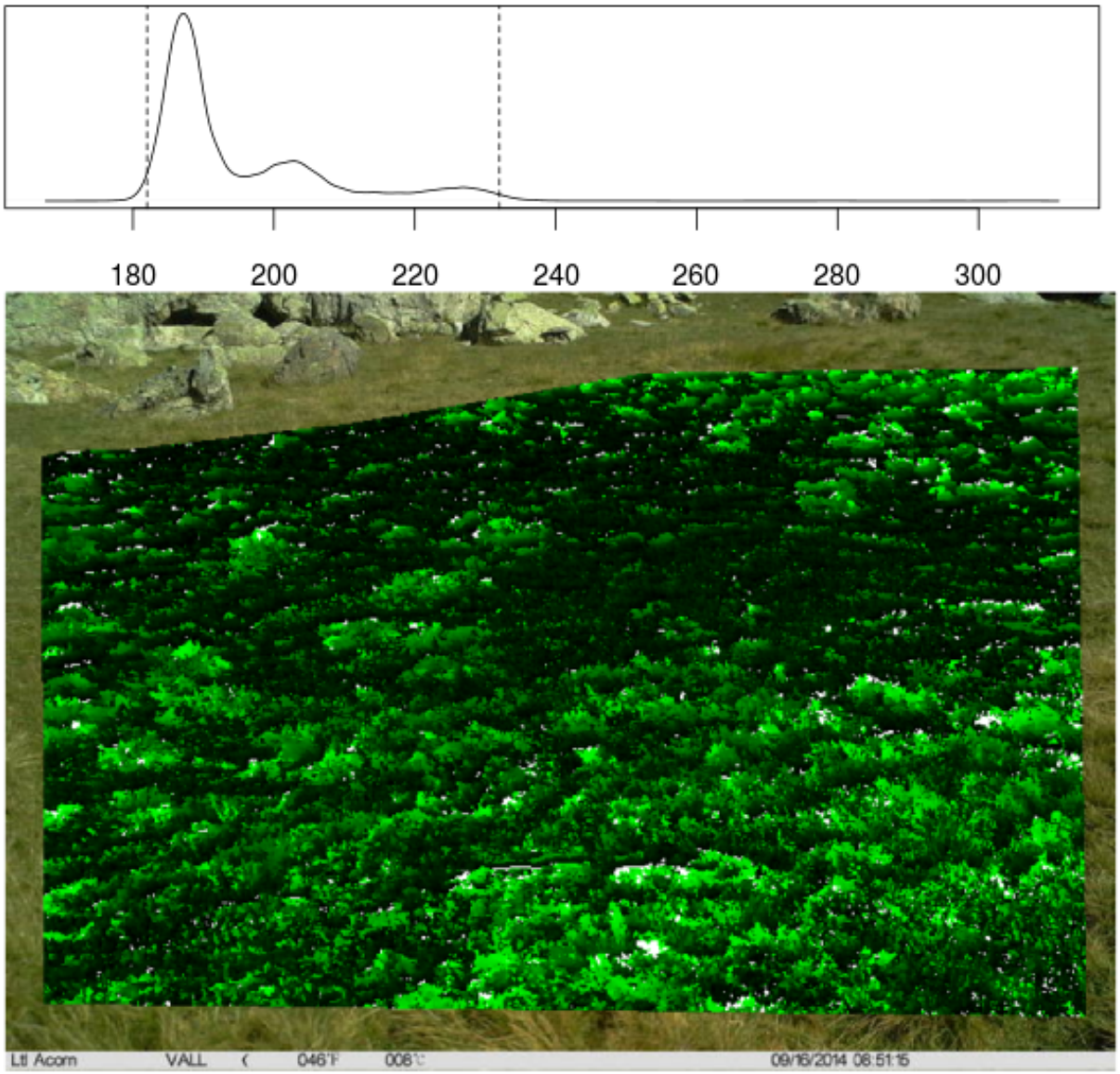


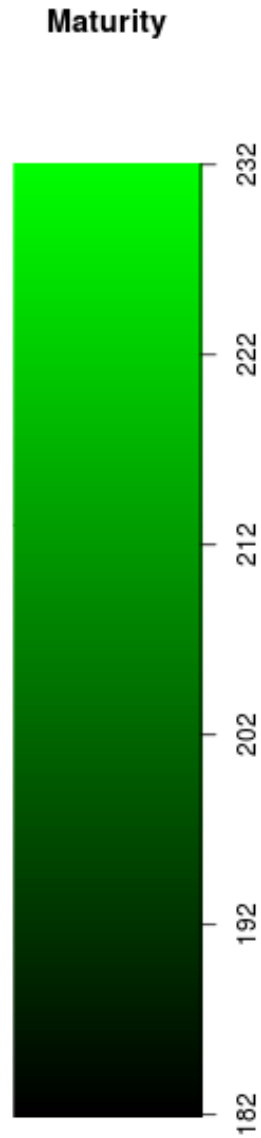
Spatial distribution of selected phases - Vallompierre



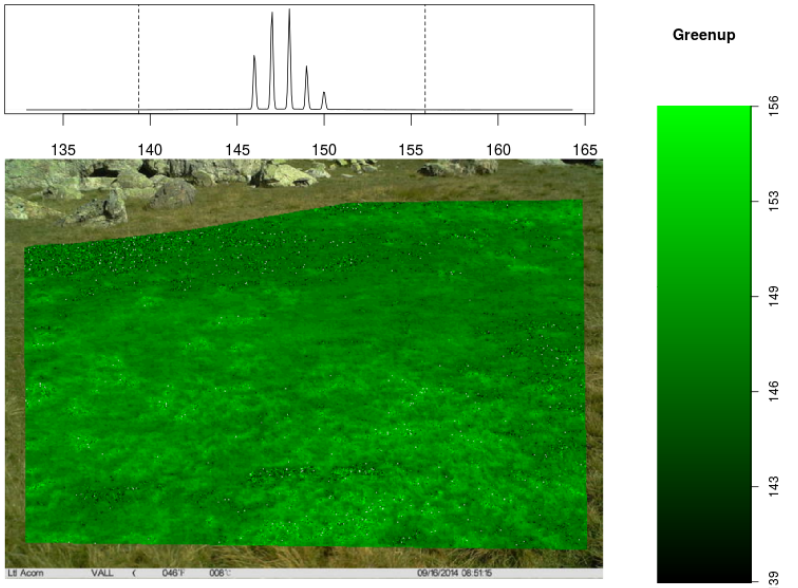


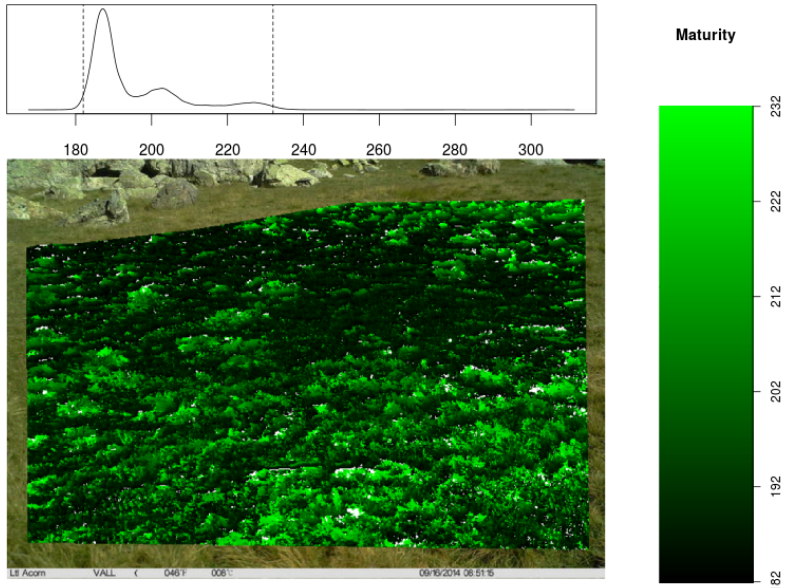
Spatial distribution of selected phases - Vallompierre

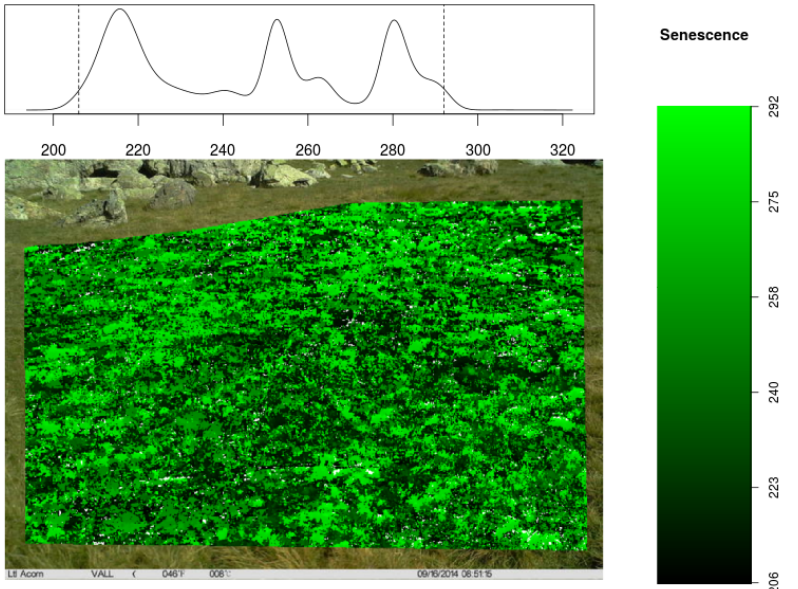


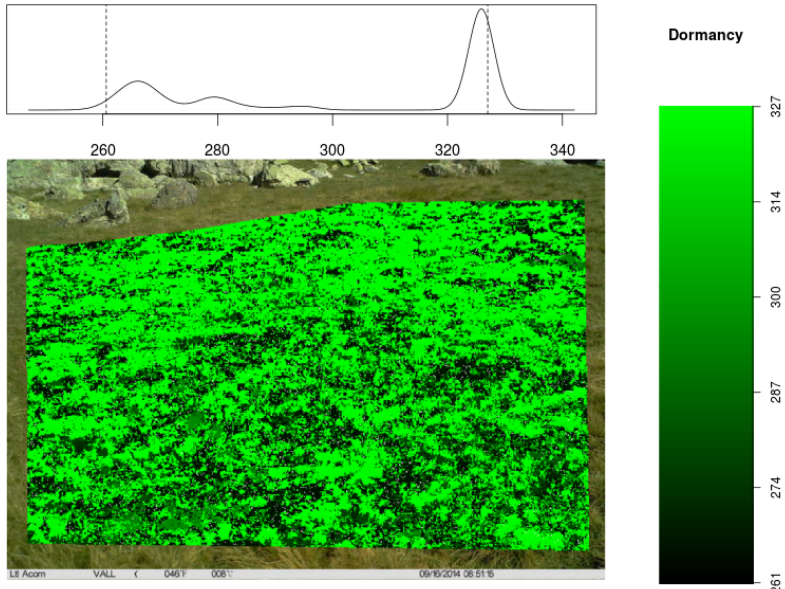


Spatial distribution of selected phases - Vallompierre

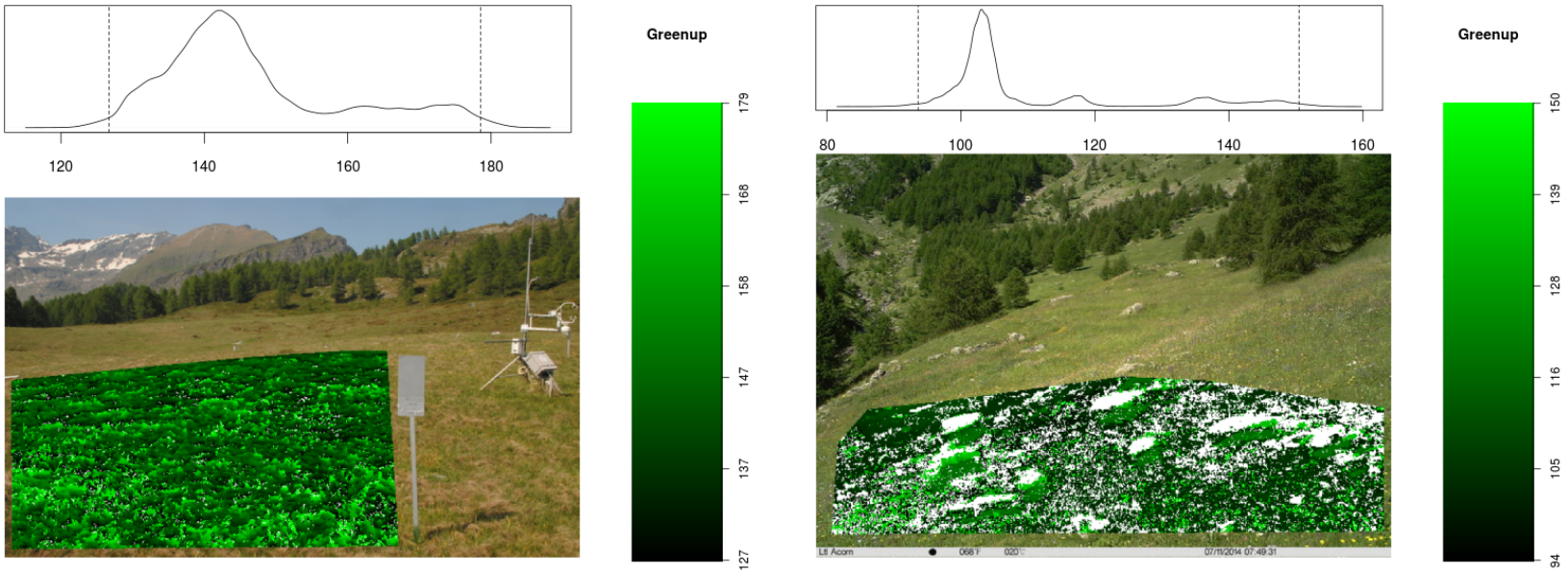








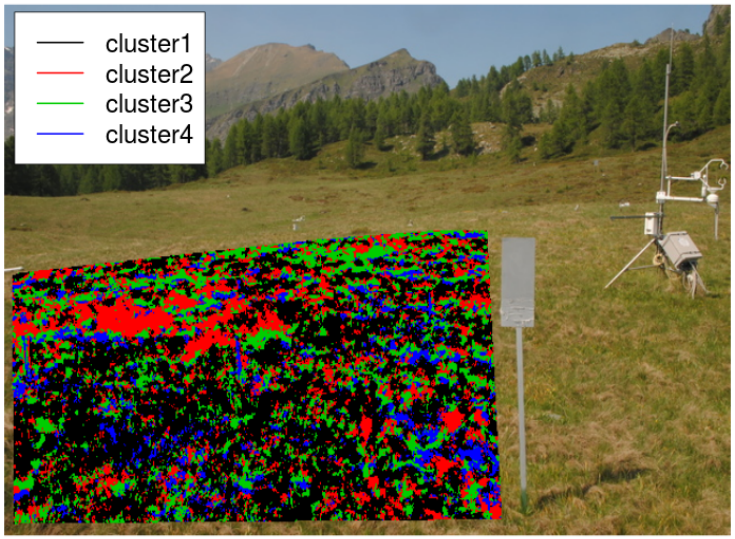
Spatial distribution of selected phases - Torgnon vs Crouzet

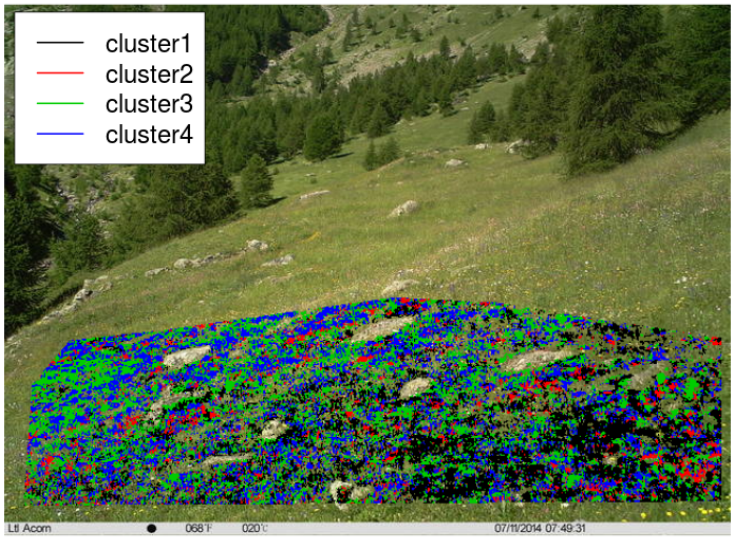


→

Increasing biodiversity

Cluster Analysis (k-means) - Torgnon vs Crouzet: Maturity phase



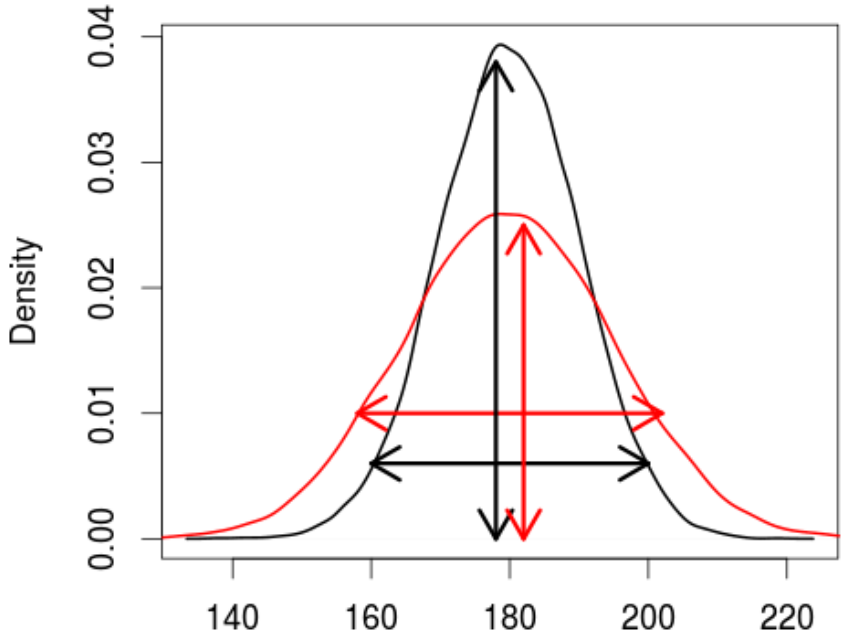


$\longrightarrow$

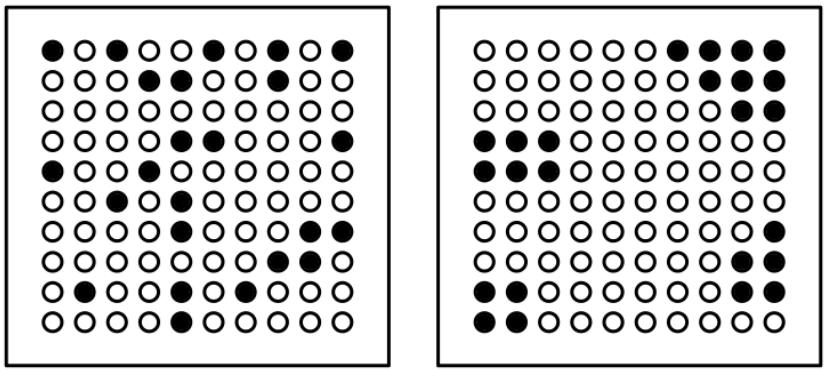
Increasing biodiversity

Hypotheses

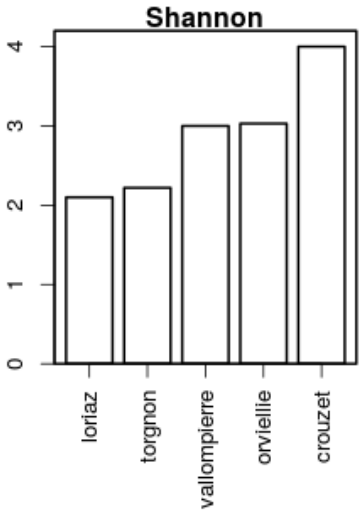
1) Higher biodiversity leads to larger ranges of phenophases in space and lower occurrence of mean values (metrics of the density distribution)



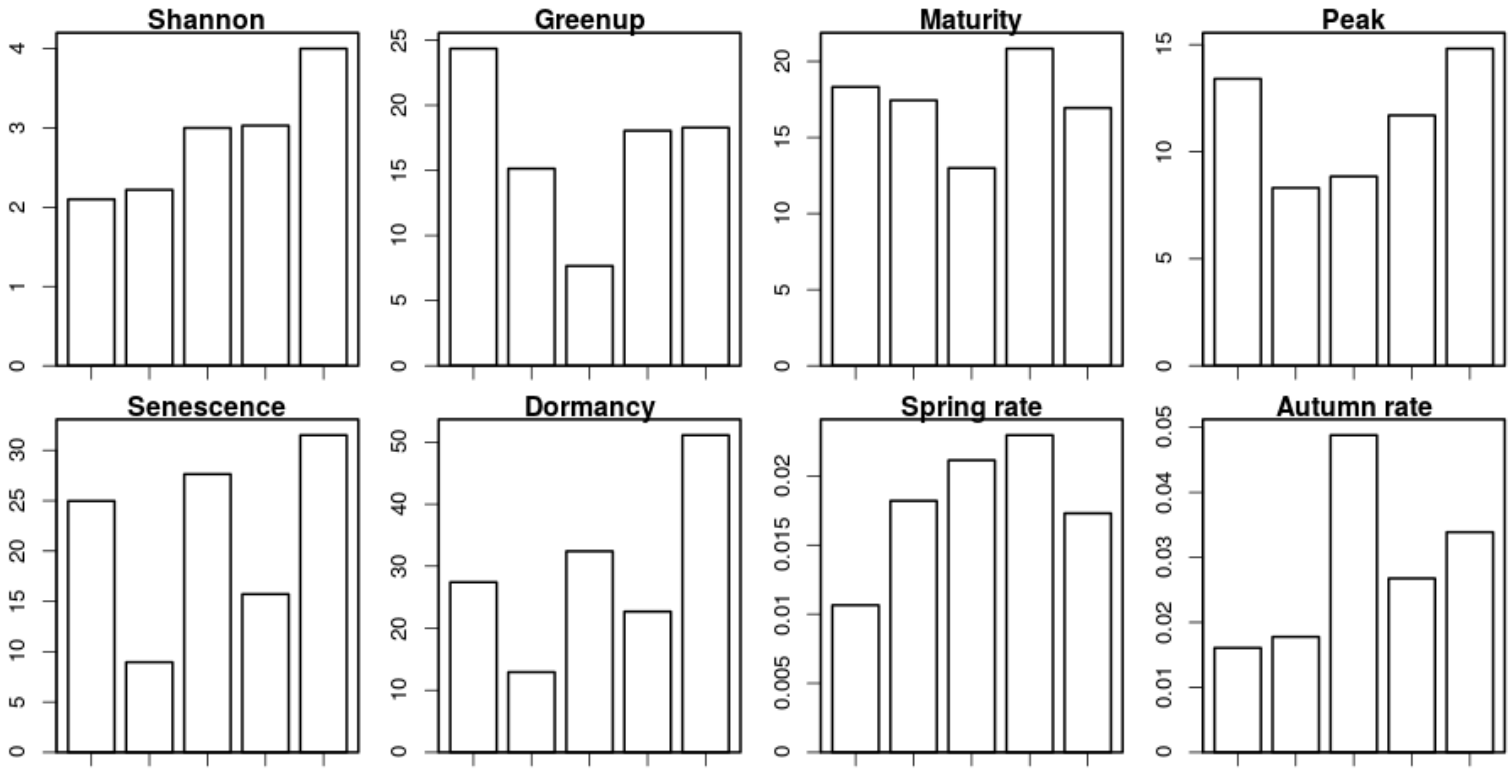
2) Higher biodiversity leads to a more scattered species distribution, and lower biodiversity leads to clusters of species (Moran's I of spatial auto-correlation)



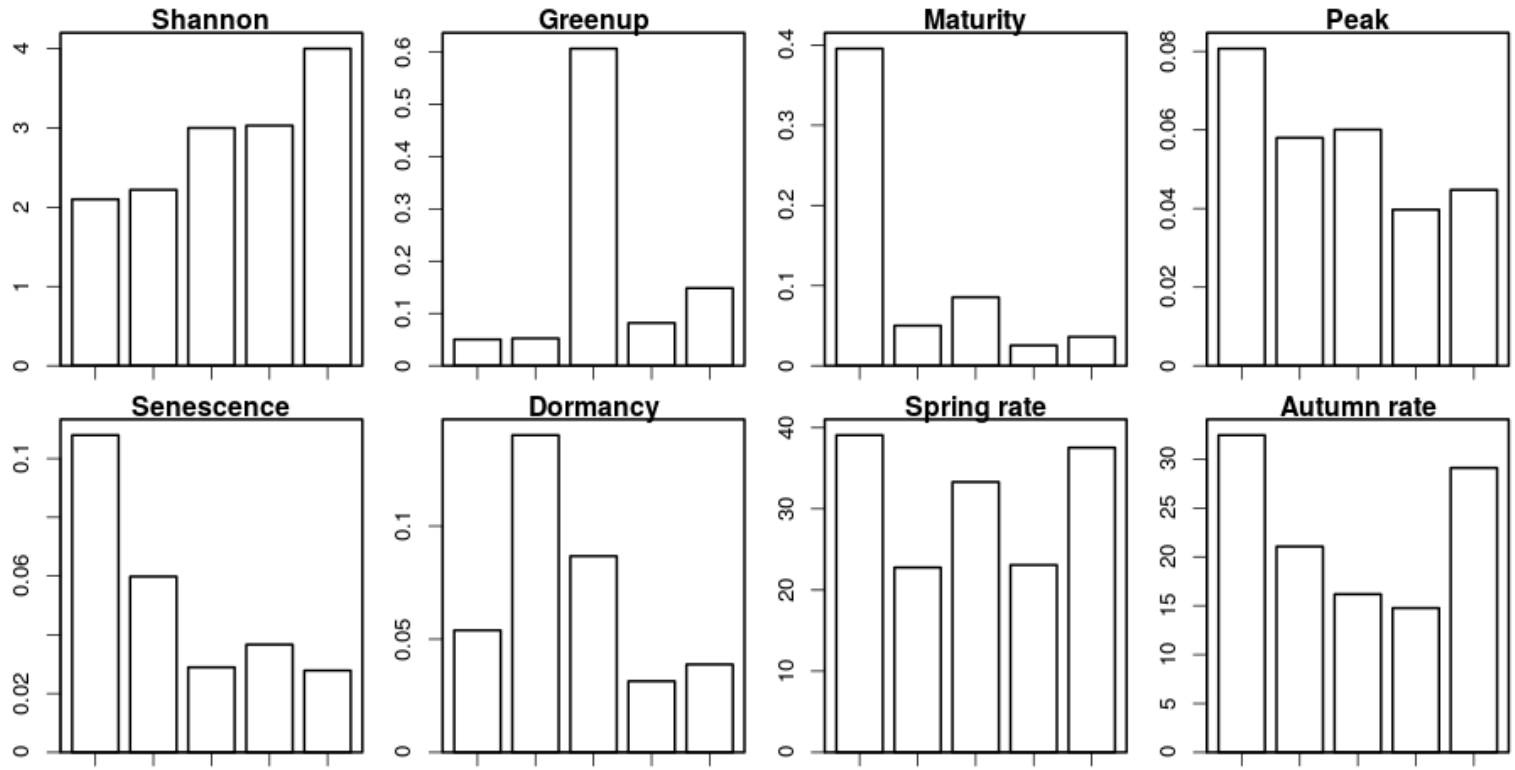
HP1: standard deviation vs Shannon Index



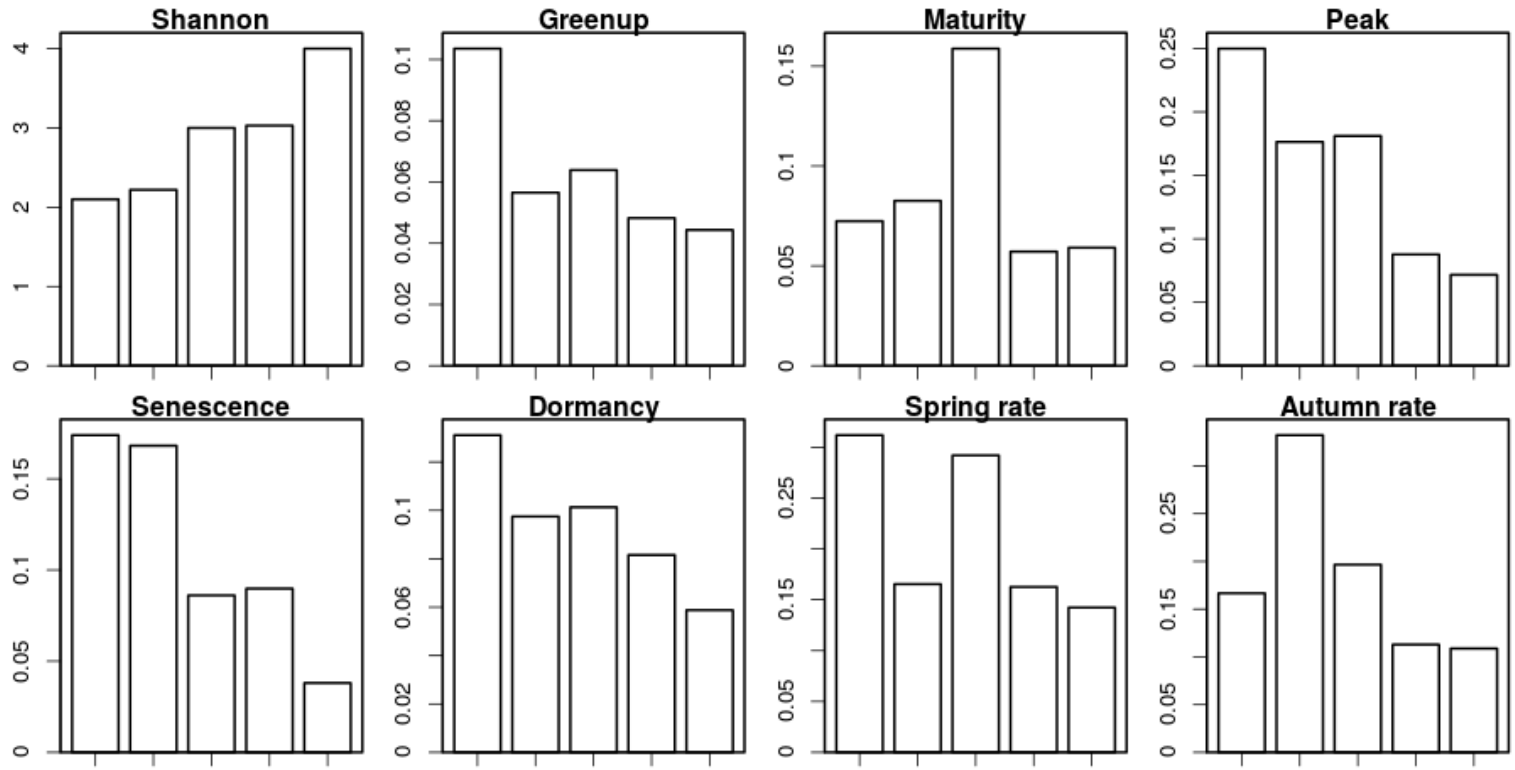
HP1: standard deviation vs Shannon Index



HP1: density maximum vs Shannon Index



HP2: Moran Index vs Shannon Index



Conclusion and future work

- High (1-2 months) small scale (10-20 cm) spatial variability is well captured by webcam sensors
- Selected metrics of the density functions of spatially explicit phenophases show some degree of correlation with biodiversity indexes such as shannon index
- Moran's I of clusters shows a fairly good correlation with shannon index

Future Work include:

- Validate these results by testing inter-year consistency
- Enlarge the data set to other grasslands (not necessarily alpine..)
- The `phenopix` R package is freely available and offers completely reproducible code for spatial analysis


Thanks for your attention
g.filippa@arpa.vda.it
Questions?
www.arpa.vda.it
r-forge.r-project.org/projects/phenopix/