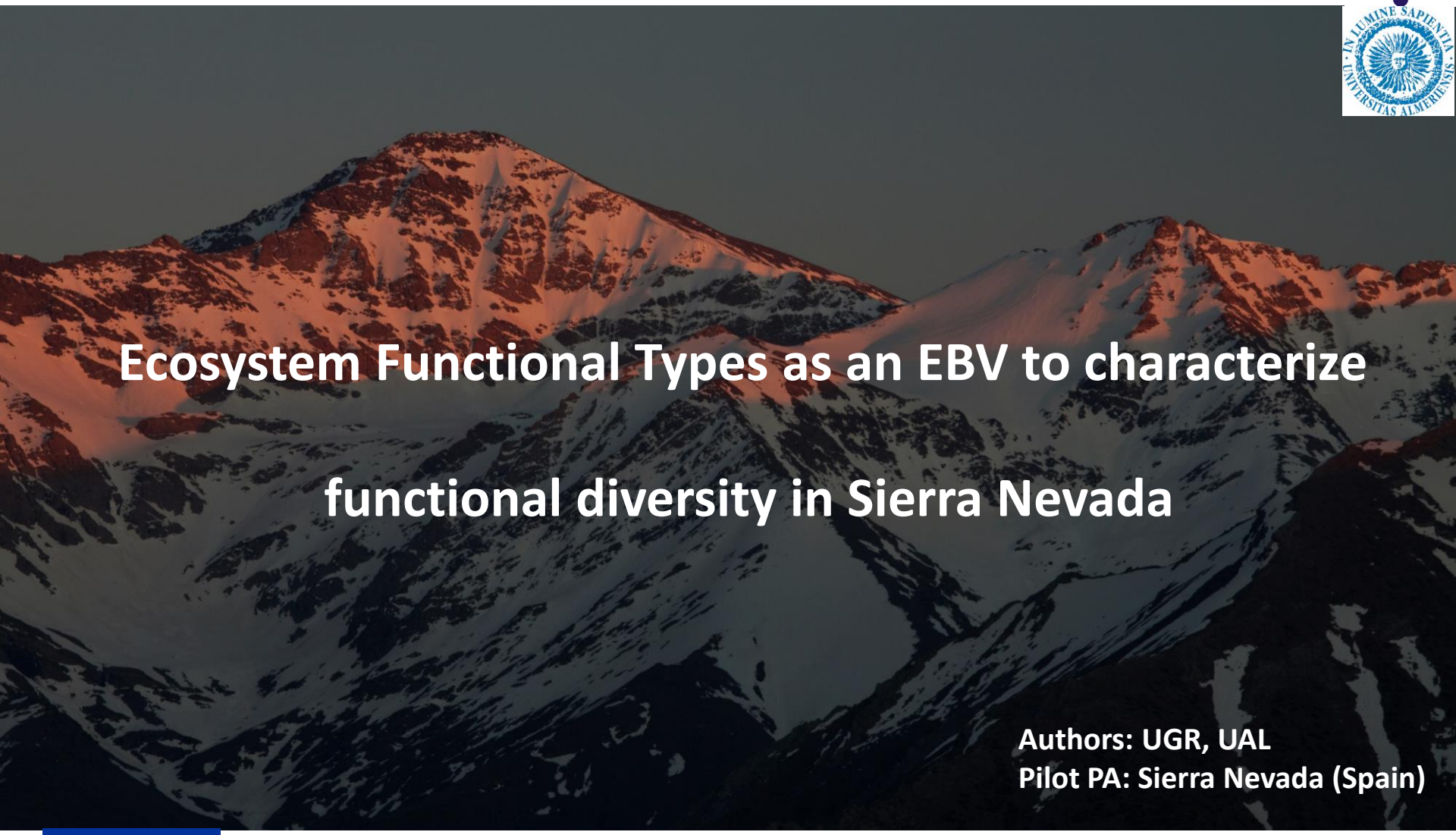
ECOPOTENTIAL



Ecosystem Functional Types as an EBV to characterize functional diversity in Sierra Nevada

Authors: UGR, UAL
Pilot PA: Sierra Nevada (Spain)

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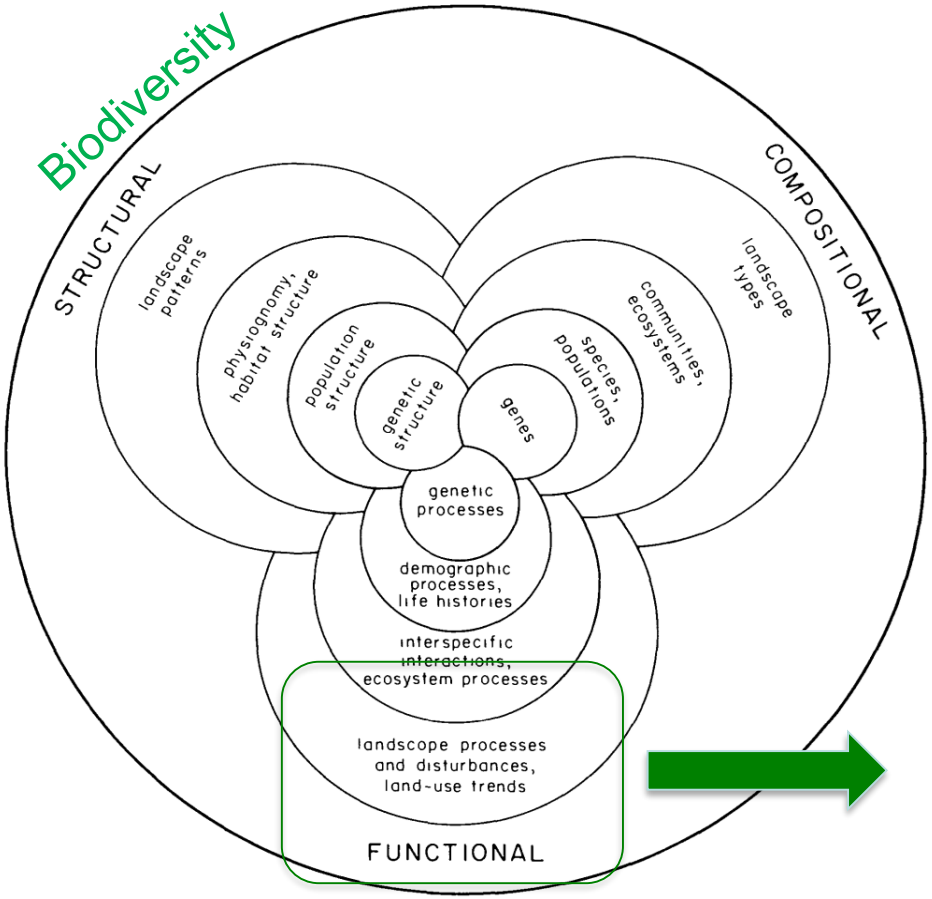
Need to incorporate all biodiversity dimensions across all hierarchical levels

Noss (1990, *Conserv. Biol.*): "The three components of biodiversity (composition, structure, and function) at all levels of organization determine, and in fact constitute, the biodiversity of an area, and should be considered in conservation".



Composition: identity and variety of entities in a collection (e.g. species lists & diversity indices)

Structure: physical organization or pattern of a system (e.g. habitat complexity & physiognomy of vegetation)

Function: *ecological and evolutionary processes (e.g. gene flow, information, matter & energy exchanges)*

Ecosystem Function:
an Essential Biodiversity Variable class
(Pereira et al. 2013, *Science*)

Ecosystem Functional Types to characterize ecosystem functioning heterogeneity

Functional units aim:

- To reduce the diversity of entities based on processes.
- To categorize continuous gradients into discrete units.
- To obtain homogeneous groups with a specific and coordinated response to or effect on environmental factors.

Plant Functional Types (PFTs)

Groups of plants that share similar functional features (nitrogen fixation, photosynthetic pathway, etc.).

Díaz & Cabido, 2001, *TREE*

Ecosystem Functional Types (EFTs)

Groups of ecosystems that share functional characteristics in relation with the amount and timing of the exchanges of matter and energy between the biota and the physical environment.

Paruelo *et al.* 2001, *Ecosyst*ems
Alcaraz-Segura *et al.* 2006, *Global Ecol. Biogeo.*

What Essential Biodiversity Variables relate to Ecosystem Function so far?

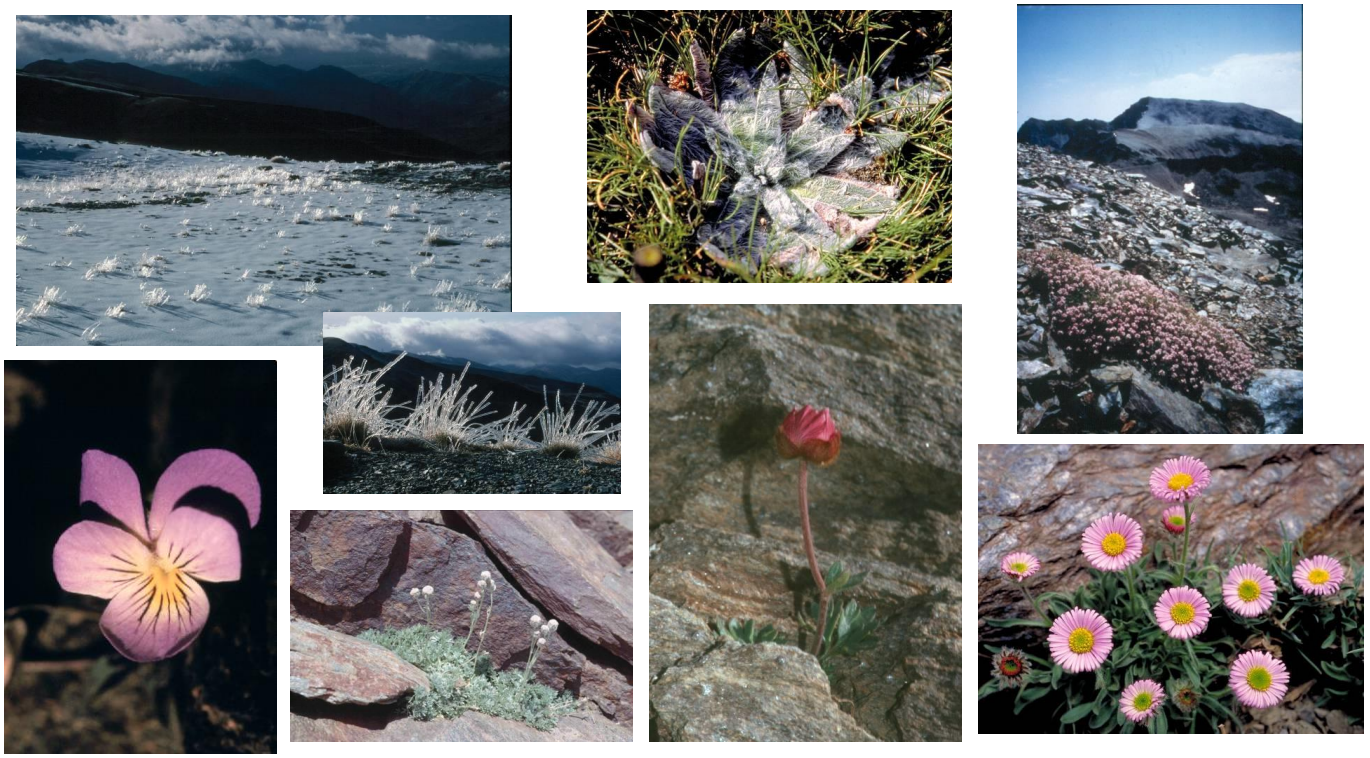
EBV Class	EBV candidates (Pereira et al., 2013)	RS-EBV candidates (Skidmore et al., 2015)
Genetic composition	Allelic diversity, co-ancestry, …	
Species populations	Species distribution, abundance…	Species occurrence
Species traits	Phenology, body mass, …	Plant traits (leaf area & nitrogen content)
Community composition	Taxonomic diversity Species interactions	
Ecosystem function	**Primary productivity** Secondary productivity Nutrient retention Disturbance regime	**Primary productivity** Vegetation phenology Inundation Fire occurrence
Ecosystem structure	Habitat structure Ecosystem extent and fragmentation Ecosystem composition by functional type	Ecosystem distribution Fragmentation and heterogeneity Land cover and vegetation height

The case of Sierra Nevada, Spain:

- Mediterranean high-mountain biodiversity hotspot (Myer et al. 2000)

- Vegetation studies have been developed under a compositional perspective (phytosociological method) or successional perspective (vegetation series)

- These approaches are difficult to monitor the effects of management actions and to evaluate the role of ecosystems in providing benefits to society (Cabello et al. 2019).



Objective:

Main:

Propose Ecosystem Functional Types (Alcaraz-Segura et al. 2013) as a functional classification of vegetation (based on remotely-sensed Enhaced Vegetation Index (EVI)) that synthetically characterizes ecosystem functioning and allows to assess functional diversity at regional scale.

Specifics:

1. Analyzed the spatial patterns of three ecosystem functional attributes (i.e., annual primary production, and the seasonality and phenology of carbon gains), as well as their integration into a synthetic mapping of ecosystem functional types (EFTs)

2. Identify hotspots of ecosystem functional diversity in Sierra Nevada, we used two ways: richness and rarity of ecosystem functional types

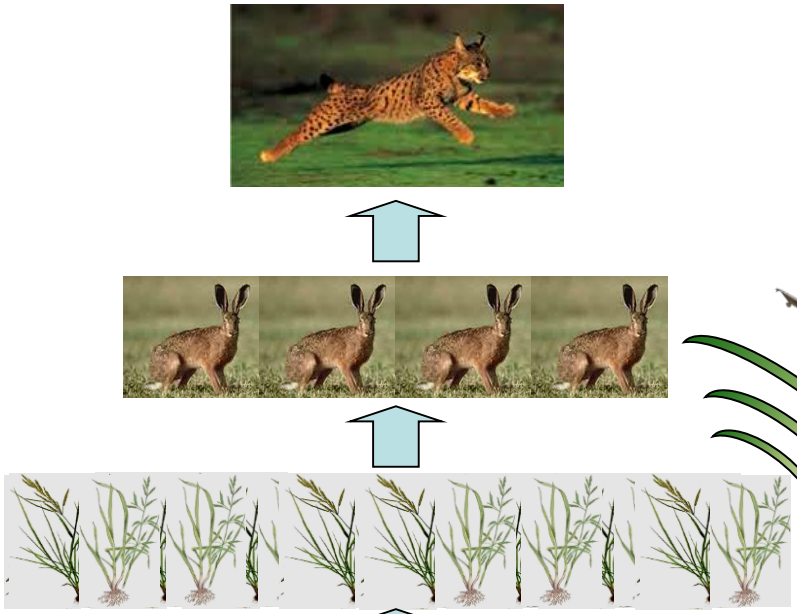
3. Showed the most stable and variable zones between years (either by directional changes or by fluctuations) in terms of ecosystem functioning, we evaluated the inter-annual variability in ecosystem functioning from two measures, the number of EFTs that were observed during the period 2001-2016 at pixel level, and the inter-annual similarity in the composition of EFTs at landscape level.

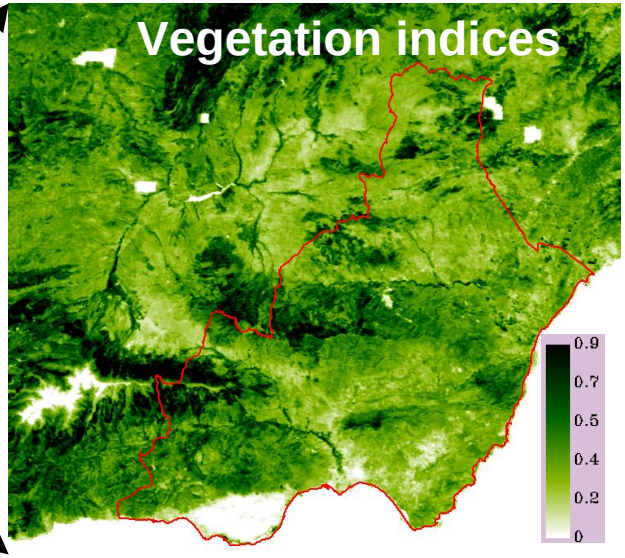


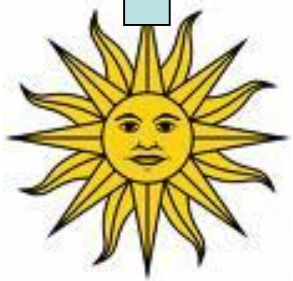


Can these metrics inform on ecosystem functional diversity patterns?

- Primary production dynamics metrics as descriptors of ecosystem functioning



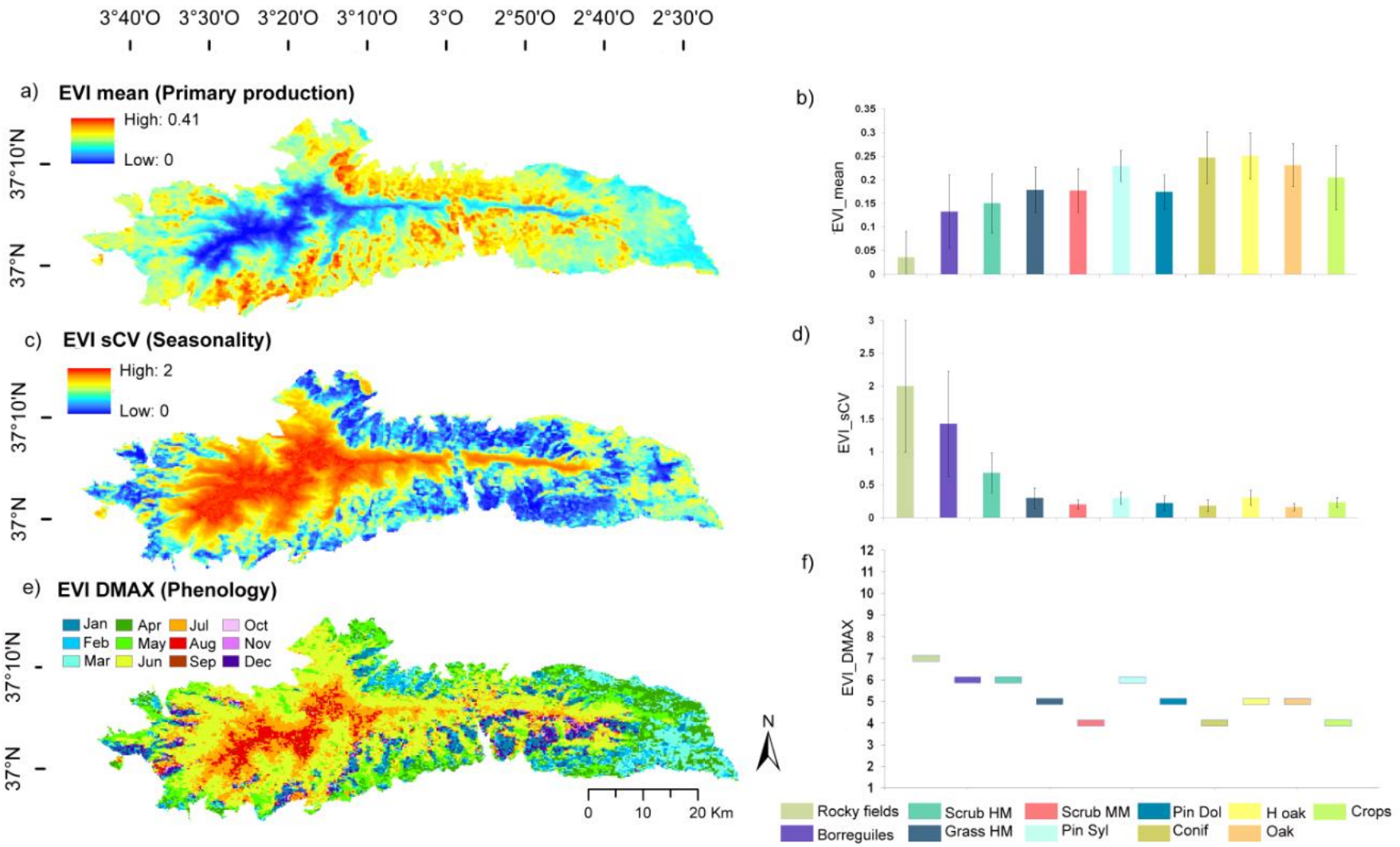




Primary production dynamics:

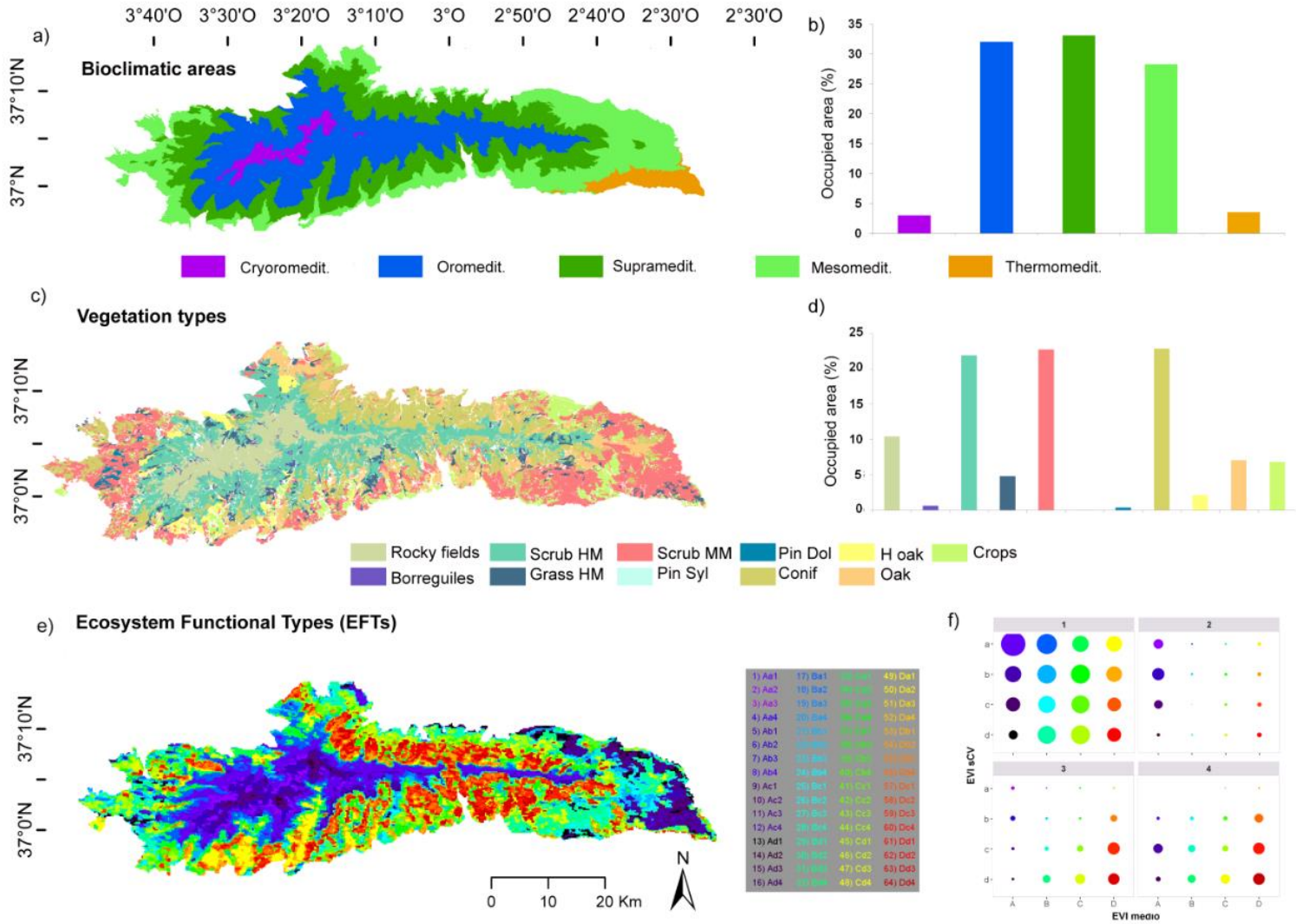
- ➢Energy input into the life system
- ➢Integrative descriptor of ecosystem health
- ➢Integrative response to environmental factors
- ➢Monitor from satellite remote sensing

Ecosystem Functional Attributes (EFAs) and their values in vegetation types of Sierra Nevada



Altitudinal gradient

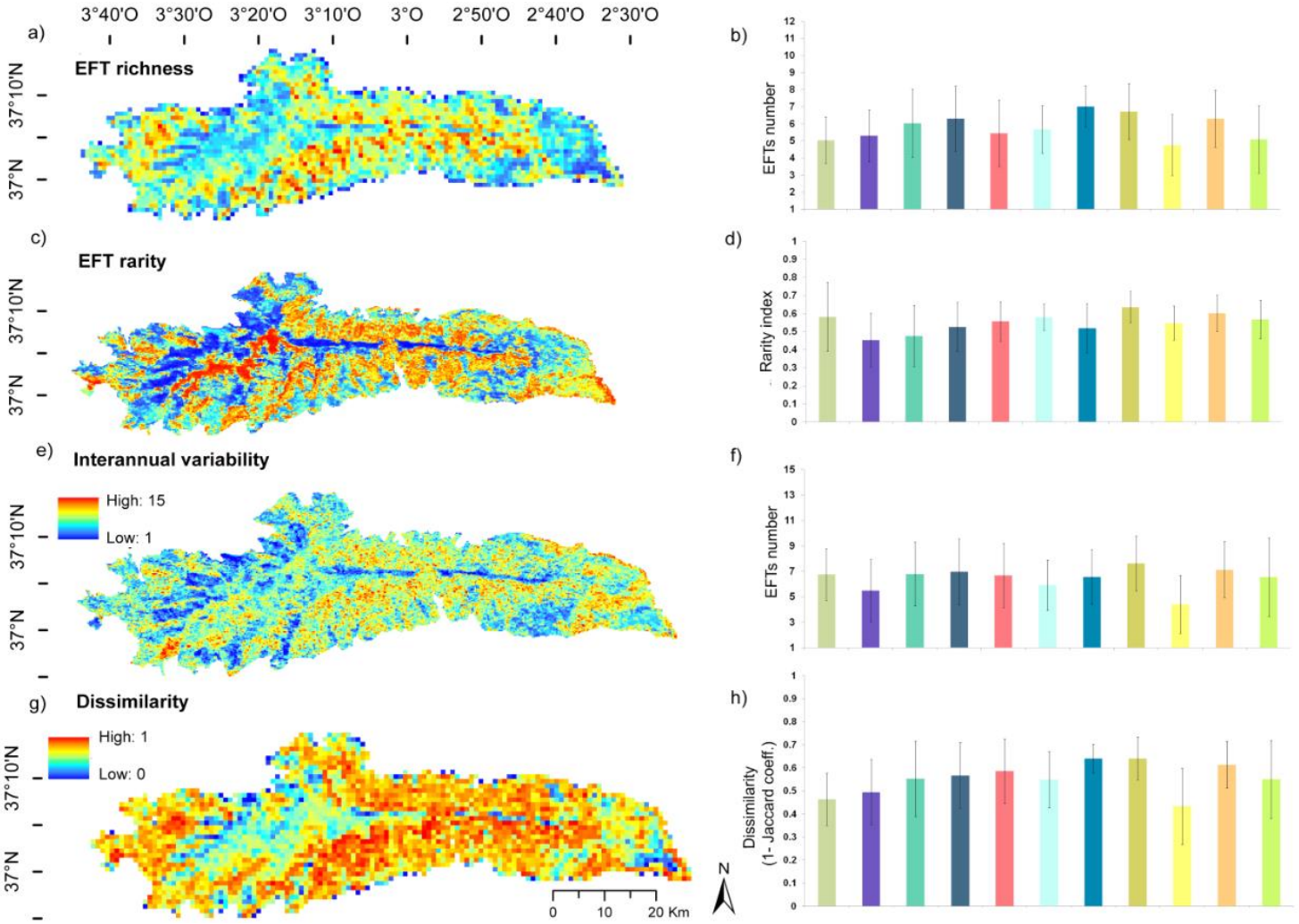
Ecological clasifications of Sierra Nevada



EFTs also showed altitudinal gradient.

The most abundant EFT presented the maximum greenness in spring, with productivity values from low to intermediate and under all possible seasonality values

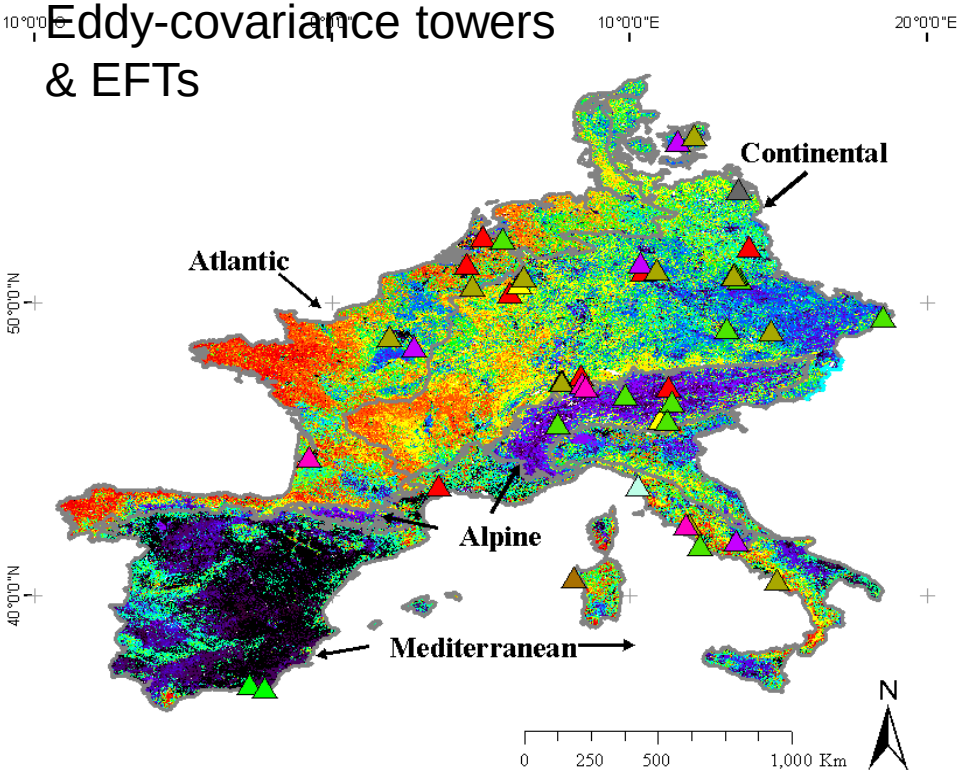
Functional diversity patterns



Functional diversity at the ecosystem level and revealed the existence of hotspots of functional diversity, as well as more stable areas and others with greater variability between years.

Do EFTs actually differ in their energy and matter exchanges measured on the ground with the eddy covariance technique? A case study of Europe

- Eddy-covariance towers & EFTs



Methods:

Period: 2001-2014

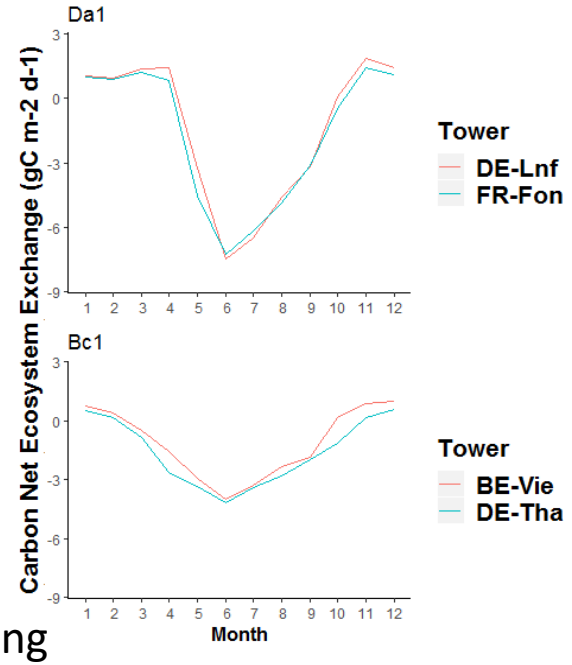
64 EFTs (Modis 250 m)

10 PFTs

50 FLUXNET2015 towers:

- CO_2

Discriminant Analysis



Results (for CO_2 NEE):

	EFTs	PFTs
Kappa	0.953	923

EFT is a good scheme classification of ecosystem functioning

Concluding remarks

1. This study provides a characterization of ecosystem functioning of the Sierra Nevada Protected Area through the analysis of time series of satellite images of spectral indices that capture the photosynthetic activity of the vegetation.

2. The combination of functional attributes in a synthetic classification of Ecosystem Functional Types integrates in a single map the spatial and temporal heterogeneity of carbon gains by vegetation.

3. These of EFTs as biological entities allowed analyze spatial patterns and inter-annual variability in functional diversity at the ecosystem level and revealed the existence of hotspots of functional diversity, as well as more stable areas and others with greater variability between years.

4. Satellite-derived EFTs have been shown to be good descriptors of ecosystem NEE between the biota and the atmosphera at large scales. In fact, EFTs were at least equally valid for ecocystem classification than PFTs.

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Thank you!

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