Putting rare animal occurrences into context with remote sensing time series

A Lifewatch-WB case study

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Observable biophysical variables are key component to seasonal dynamics

Snow

nature geoscience LETTERS
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Elevation-dependent influence of snow accumulation on forest greening

Ernesto Trujillo[1,2]*, Noah P. Molotch[1,3,4], Michael L. Goulden[5], Anne E. Kelly[5] and Roger C. Bales[6]

Greenness

LETTER

doi:10.1038/nature11056

Extended leaf phenology and the autumn niche in deciduous forest invasions

Jason D. Fridley[1]

The phenology of growth in temperate deciduous forests, including the timing of leaf emergence and senescence, has strong control over ecosystem properties such as productivity[1,2] and nutrient cycling[3,4], and has an important role in the carbon economy of understory plants[5–7]. Extended leaf phenology, whereby understory species assimilate carbon in early spring before canopy closure or in late

development, biweekly leaf production and chlorophyll (Chl) content, and monthly photosynthetic rate on select leaves at a range of light levels (50–800 μmol pm^{-2} s^{-1}). Although not all species were measured each year, a similar number of native and non-native species were monitored annually and data sets for most species involved at least 2 years (Supplementary Table 1).

Land management

Forests, fires and climate

Cathy Whitlock

A new analysis of the effect of climatic variation on forest fires goes back several thousand years. One take-home message is that a one-size-fits-all forest management strategy is, literally, short-sighted.

Seemingly unprecedented events in human lifetimes can be business-as-usual when viewed on longer time-frames. But that's not always recognized. For example, management strategies in the United States that seek to restore landscapes to the conditions that prevailed at the time of first European contact often fail to consider the events that created those conditions. This short-sightedness is particularly evident in the area of wildfire management.

On page 87 of this issue, however, Pierce *et al.*[1] provide a long-term perspective on the effects of fire in 'low-elevation' pine forests in the western United States. These dry, open forests lie above the steppe and grasslands that occupy most intermontane basins in the Rocky Mountains; in more moist settings at higher elevations, they are replaced by closed montane and subalpine forests. The low-elevation forests have been extensively modified by human activities, and there is intense debate about the appropriate action needed to restore them to their prehistoric state[2].

In the past 15 years, the western United States has experienced some extreme fires, notable for their size and severity. The annual costs of fire suppression now exceed $1.6 billion, and the ceiling seems nowhere in sight[3]. In the absence of large fires during most of the twentieth century, many forests have become filled with a dense understorey of shrubs and small trees that provide 'ladder fuels' that set the crowns of trees alight: these crown fires are the most destructive types of wildfire. The Healthy Forest Restoration Act[4], signed into law by President George W. Bush in 2003, purportedly seeks to redress the ecological effects of fire suppression by establishing programmes of aggressive thinning, deliberate burning, and replanting to create open conditions. For local communities with economies based on timber extraction, this law is good news; for environmentalists, it is a travesty that limits scientific analysis and public participation in decision-making and policy.

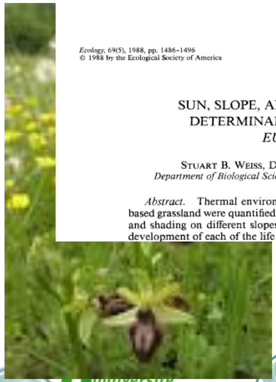
But are the fires of the past 15 years

G.A. MEYER

Figure 1 **Slide show. This slope failure occurred following rainfall on melting snow in 1997, in an area of the South Fork Payette River, Idaho, that was severely burned in 1989. Herbs and low shrubs had regrown after the fire. But the decay of tree roots probably caused the fatal weakening of the slope.**

NATURE | VOL 432 | 4 NOVEMBER 2004 | www.nature.com/nature

Sunshine

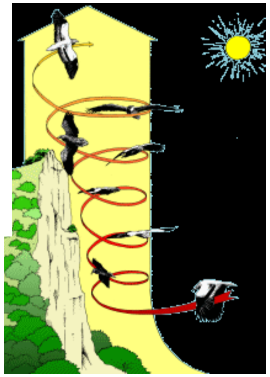


Ecology, 69(5), 1988, pp. 1486–1496

SUN, SLOPE, AND BUTTERFLIES: TOPOGRAPHIC DETERMINANTS OF HABITAT QUALITY FOR *EUPHYDRYAS EDITHA*[1]

Stuart B. Weiss, Dennis D. Murphy,[2] and Raymond R. White[3]
Department of Biological Sciences, Stanford University, Stanford, California 94305 USA

Abstract. Thermal environments in a large, topographically diverse serpentine soil-based grassland were quantified and ranked using a computer model of clear sky insolation and shading on different slopes to determine the effects of microclimate on the rates of development of each of the life stages of the butterfly *Euphydryas editha bayensis*. Larvae



Fire

But climate change modifies those dynamics

- Studies show that the extreme events are more frequent than before

- The resilience of ecosystems is still unknown

NATURE CLIMATE CHANGE | LETTER

Anthropogenic contribution to global occurrence of heavy-precipitation and high-temperature extremes

E. M. Fischer & R. Knutti

Affiliations | Contributions | Corresponding author

3/nclimate2617

March 2015 | Published online 27 April 2015

NATURE CLIMATE CHANGE | PERSPECTIVE

A decade of weather extremes

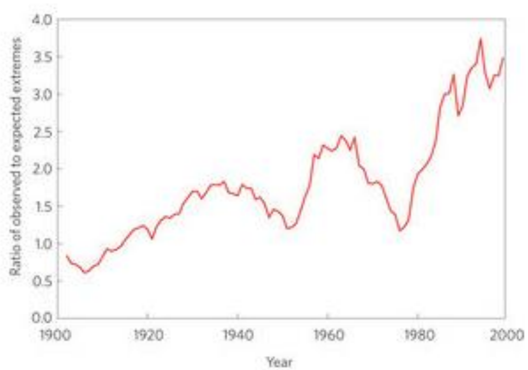
Dim Coumou & Stefan Rahmstorf

Affiliations | Corresponding author

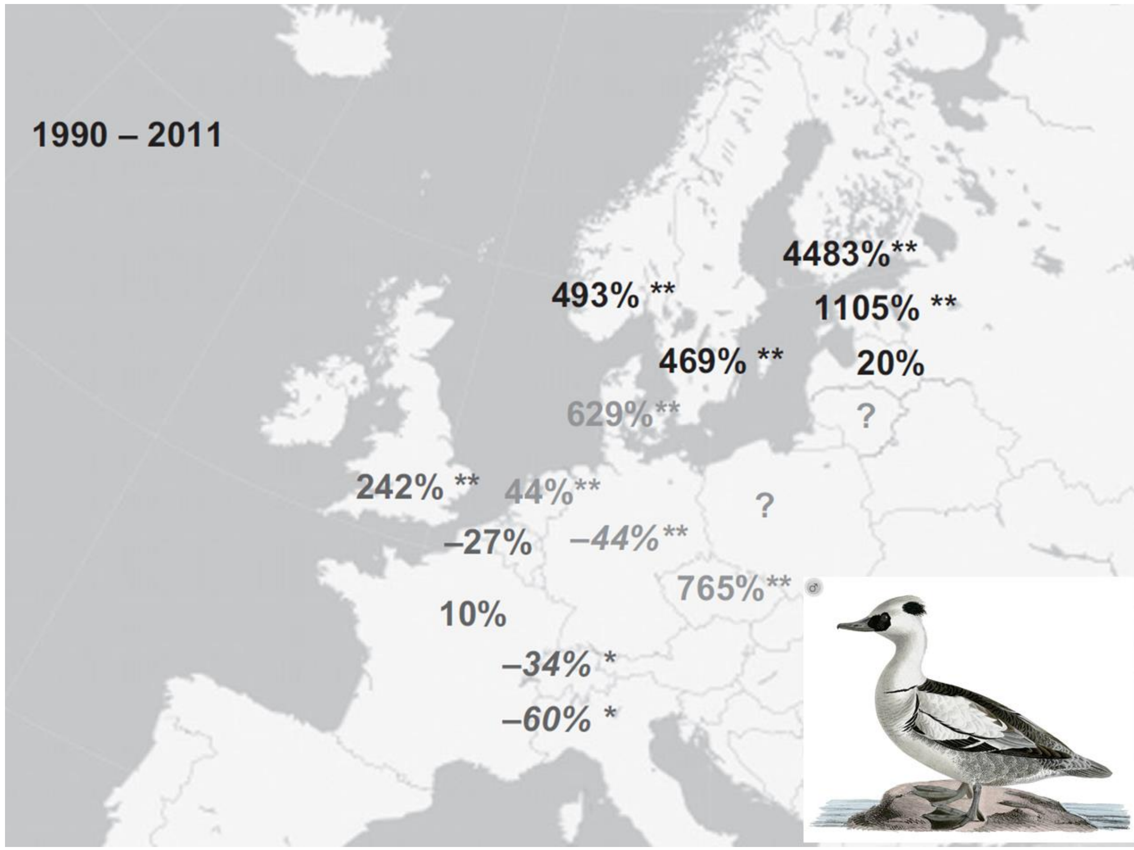
Nature Climate Change **2**, 491–496 (2012)

Published online 25 March 2012

Century increase in the number of monthly heat records.



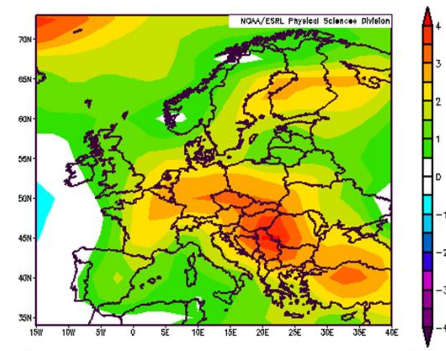
What about short and long term effect on species distribution ?



The distribution of winter abundance of smew shifted north-eastwards in Europe between 1999 and 2011 (Jordán *et al.*, Diversity and distribution,2015).

There are three ways to get information about land cover dynamics

- Interpolated meteorological data

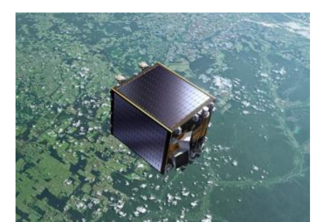


Source : NOAA

- Ground-based observation networks

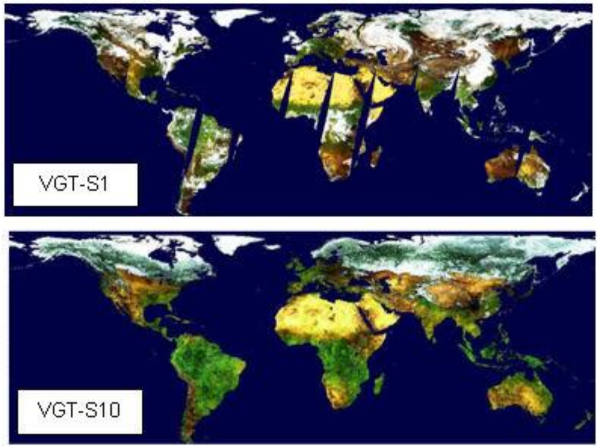


- Remote sensing observation



Remote sensing is a compromise between precision and coverage

- Large coverage with high repetitivity
  - Daily global coverage at 1 km resolution
  - … but clouds reduce effective revisiting time
- Time series become available
  - More than 10 years for <= 1 km time series



SPOT VEGETATION : every day

SPOT VEGETATION : every 10 days

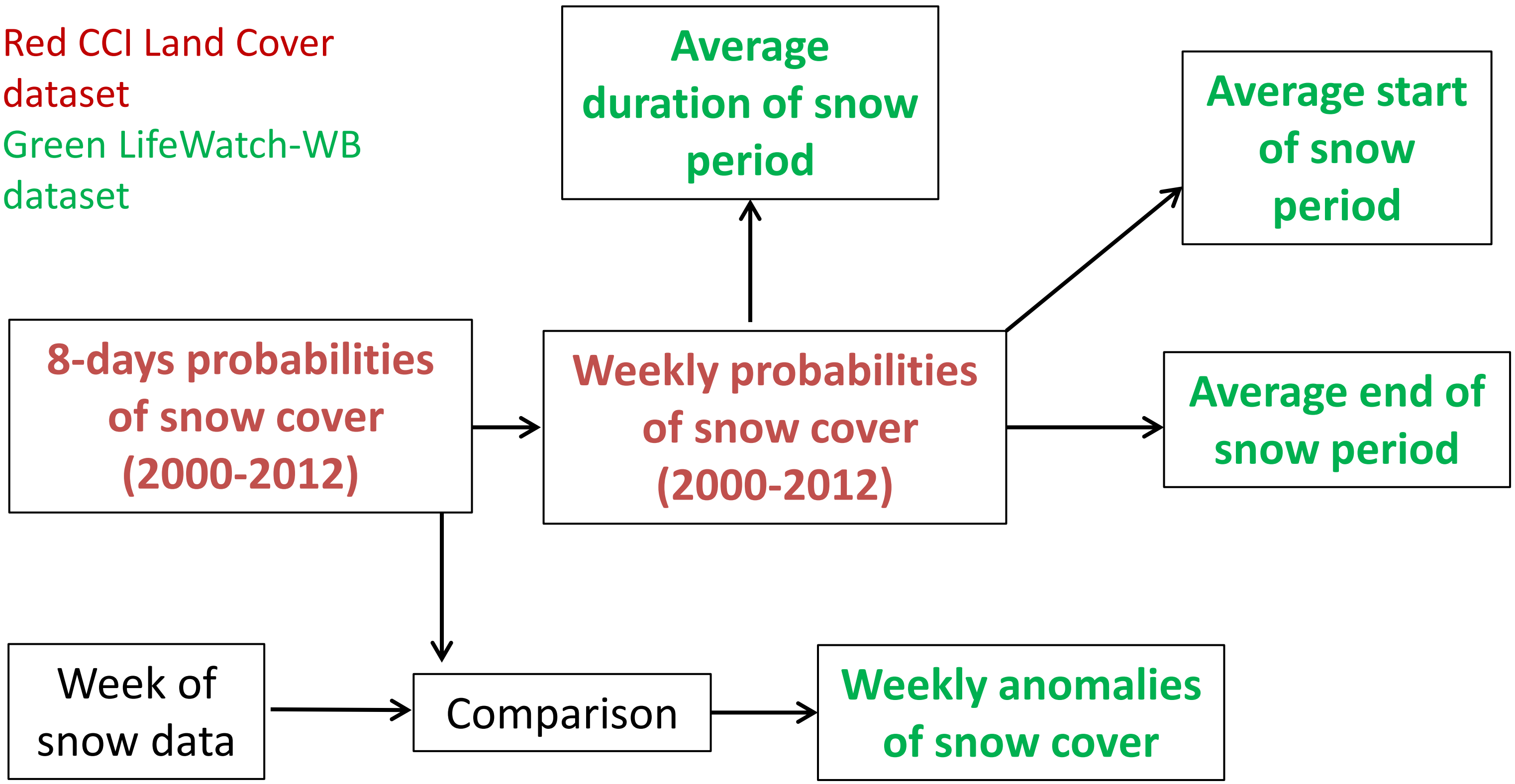
Source : JRC

The amount of data is large

- Different times series are available from satellites:
  - SPOT VEGETATION: 1 km, 1998-2014
  - MODIS: 250/500 m, 1999-still working
  - MERIS: 300 m, 2002-2012
  - PROBA-V: 100/300 m, 2013-still working
- In the future :
  - Sentinel-2 (launch on June 11)
  - Expected volume: 3Tb/day

Snow occurrence is summarized based on metrics and probabilities

Red CCI Land Cover dataset
Green LifeWatch-WB dataset



Metrics and anomalies will help you visualize European climate change

March
2013

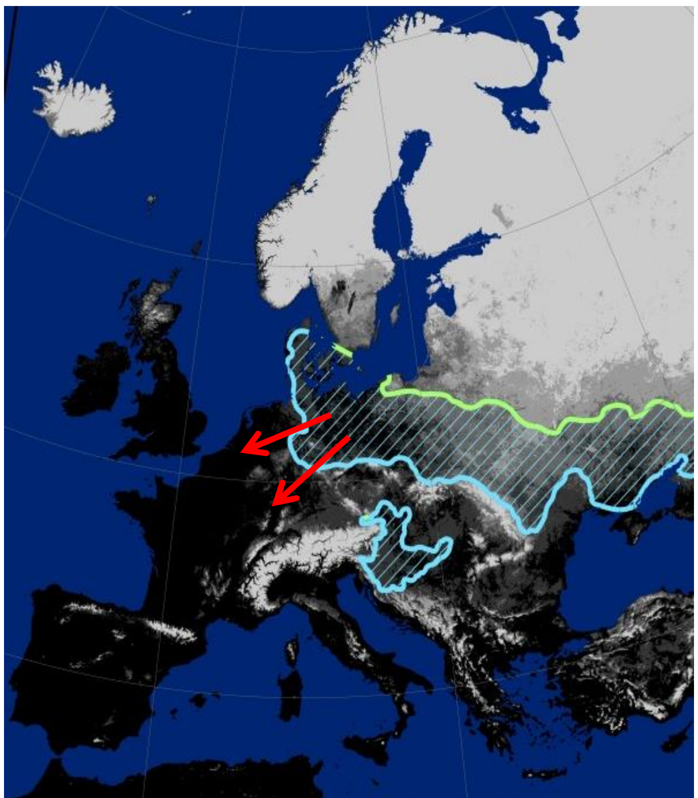
March
2014

- Snow covered area difference : 100 Belgium

Unusual events of snow have ecological impacts

In 2013, important snow event covering in Germany and Poland

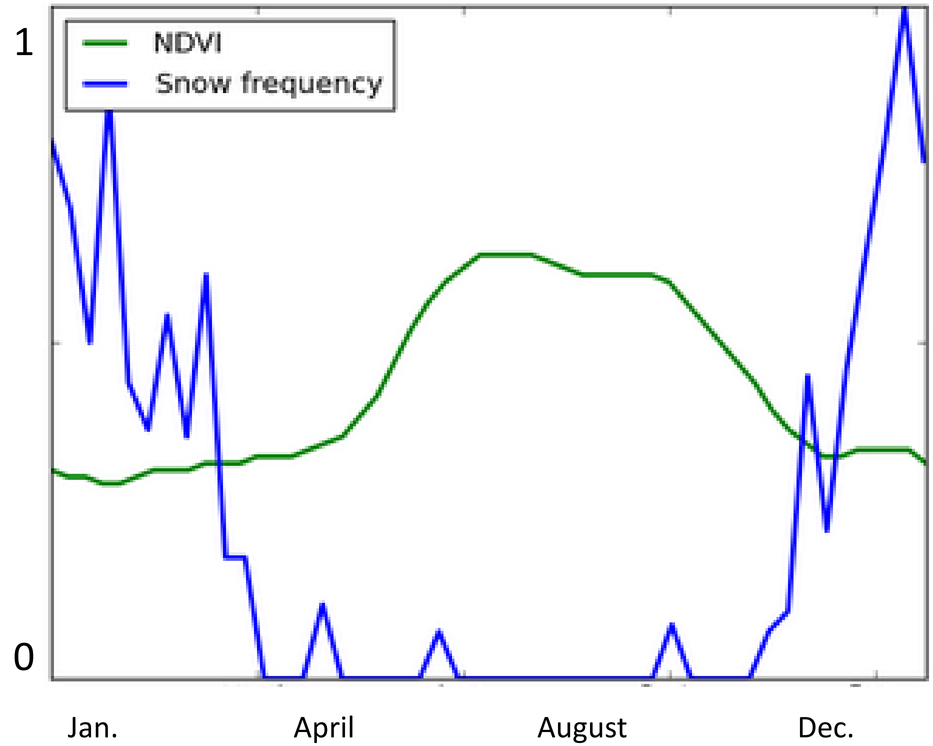
→ Few days after huge flocks of skylarks and northern lapwings in BENELUX



Snow and vegetation: good temporal complementarity

After the snow melt, vegetation comes back

Plant cycle plays the major role from spring to autumn



Normalized Difference Vegetation Index is used to study plant phenology

Indicator using two spectral bands near-infrared light (NIR) and visible red (VIS)

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{VIS})}{(\mathrm{NIR} + \mathrm{VIS})}$$

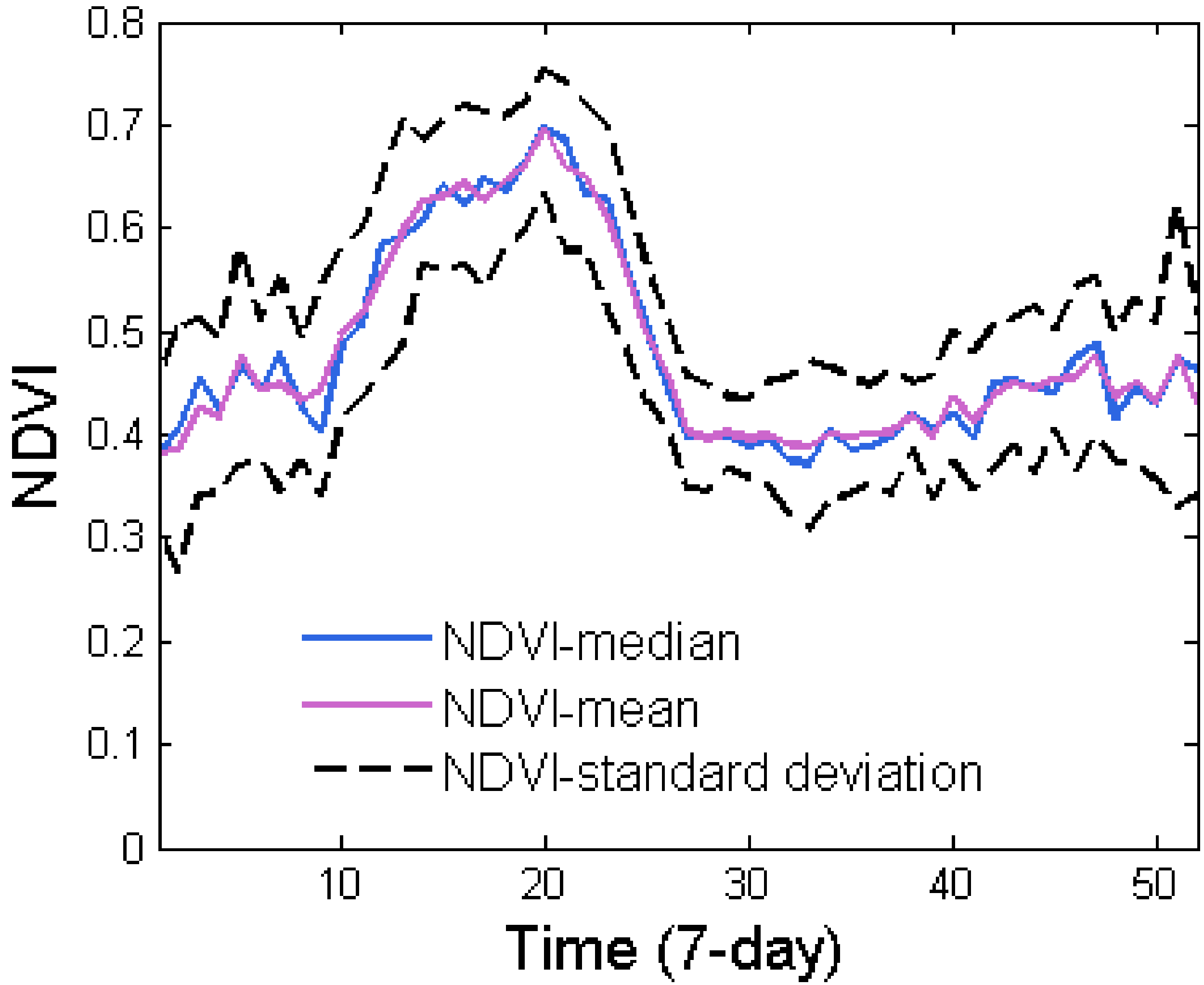
Indicator of vegetation greenness

→ Quickly identify vegetated areas and their "condition“

CCI Land Cover : aggregation of 13 years (2000 - 2012) of weekly values of NDVI and smoothing (Whittaker)

→ Reference dataset of weekly mean and standard deviation

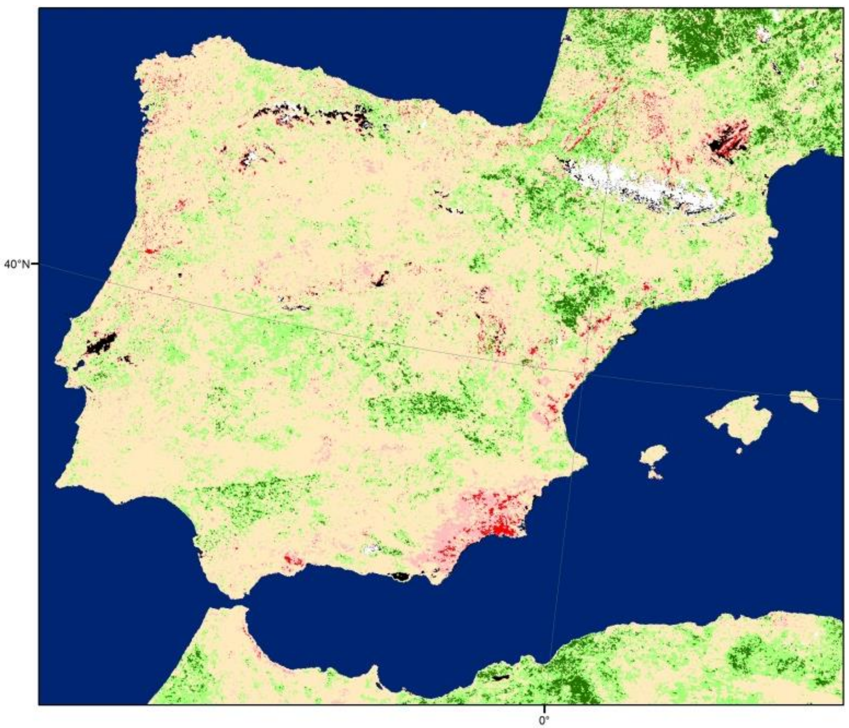
NDVI mean and standard deviation define the weekly time series



Verhegghen Astrid

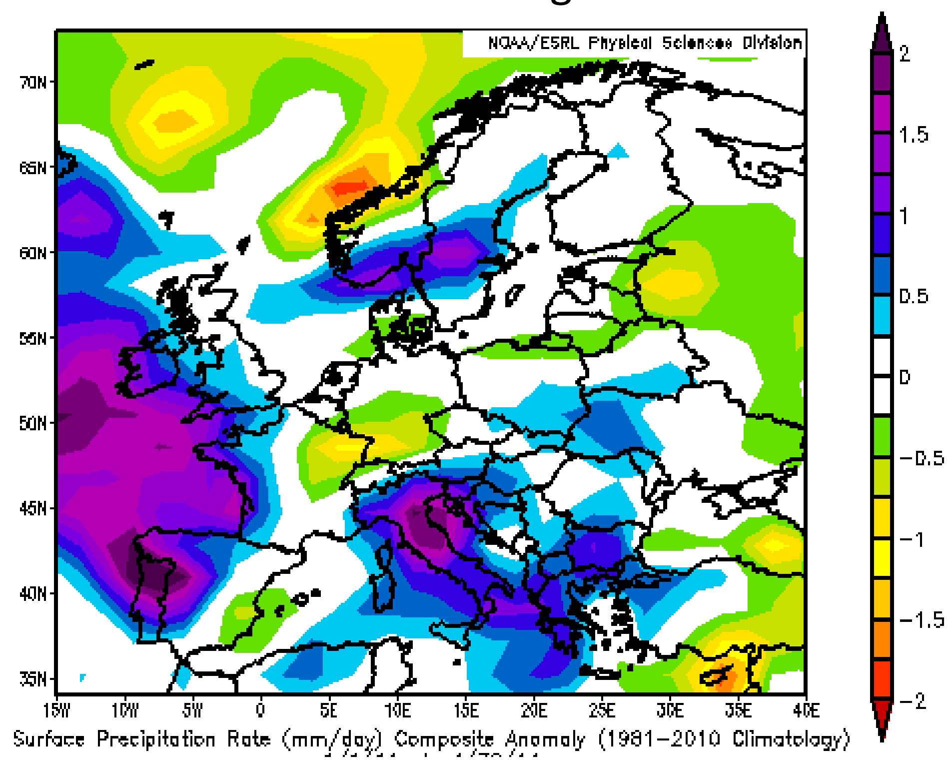
Comparison between weekly values and the reference dataset

NDVI anomalies March 2014



Water is the main constraint for vegetation development in Mediterranean regions

Precipitation rates anomalies January to March 2014 linked with vegetation anomalies



Unusual events of snow and vegetation influenced brown bear behaviour

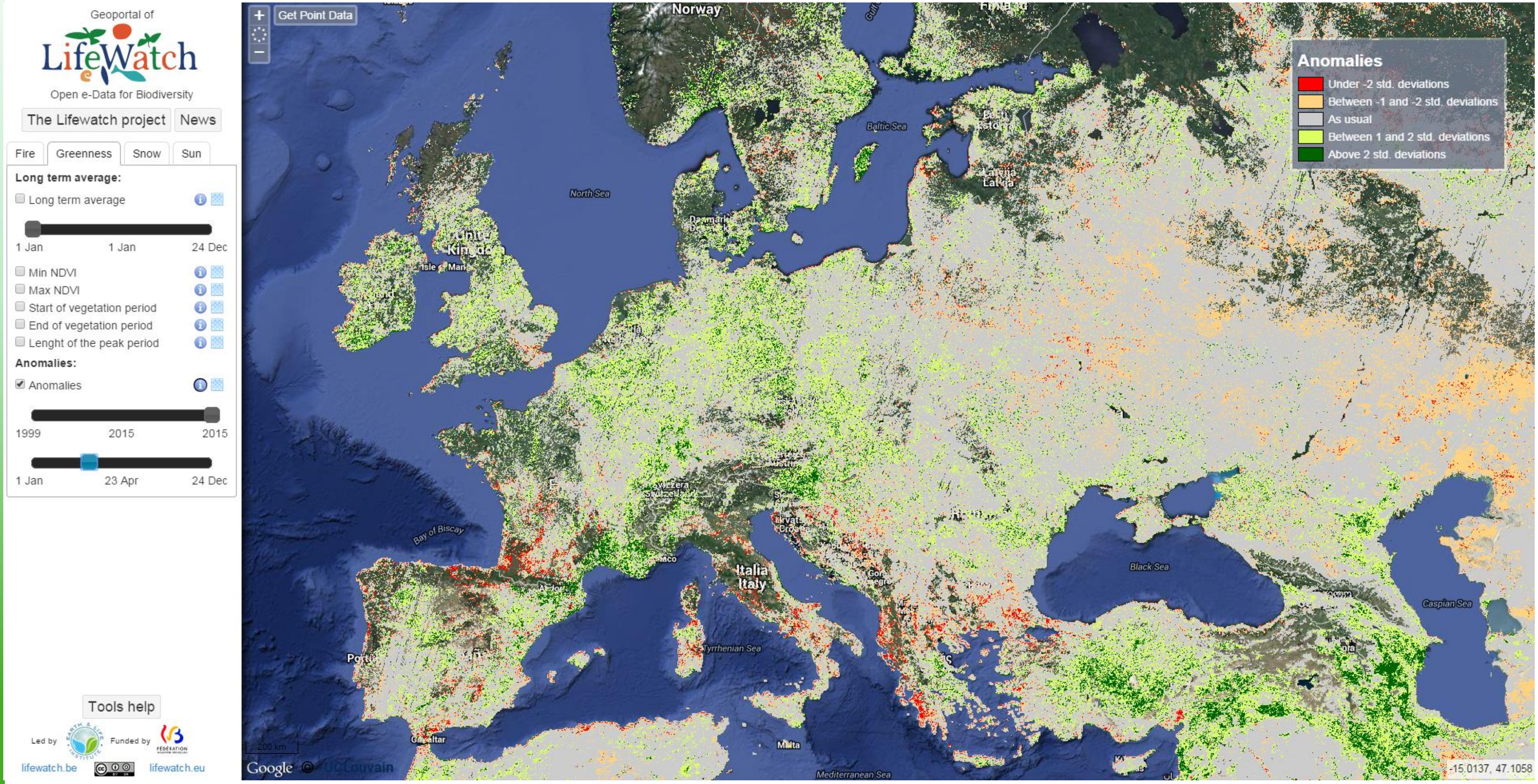
In 2014, in Scandinavia, warm temperatures and sporadic snow

→ Disrupted the slumber of brown bears, but no food

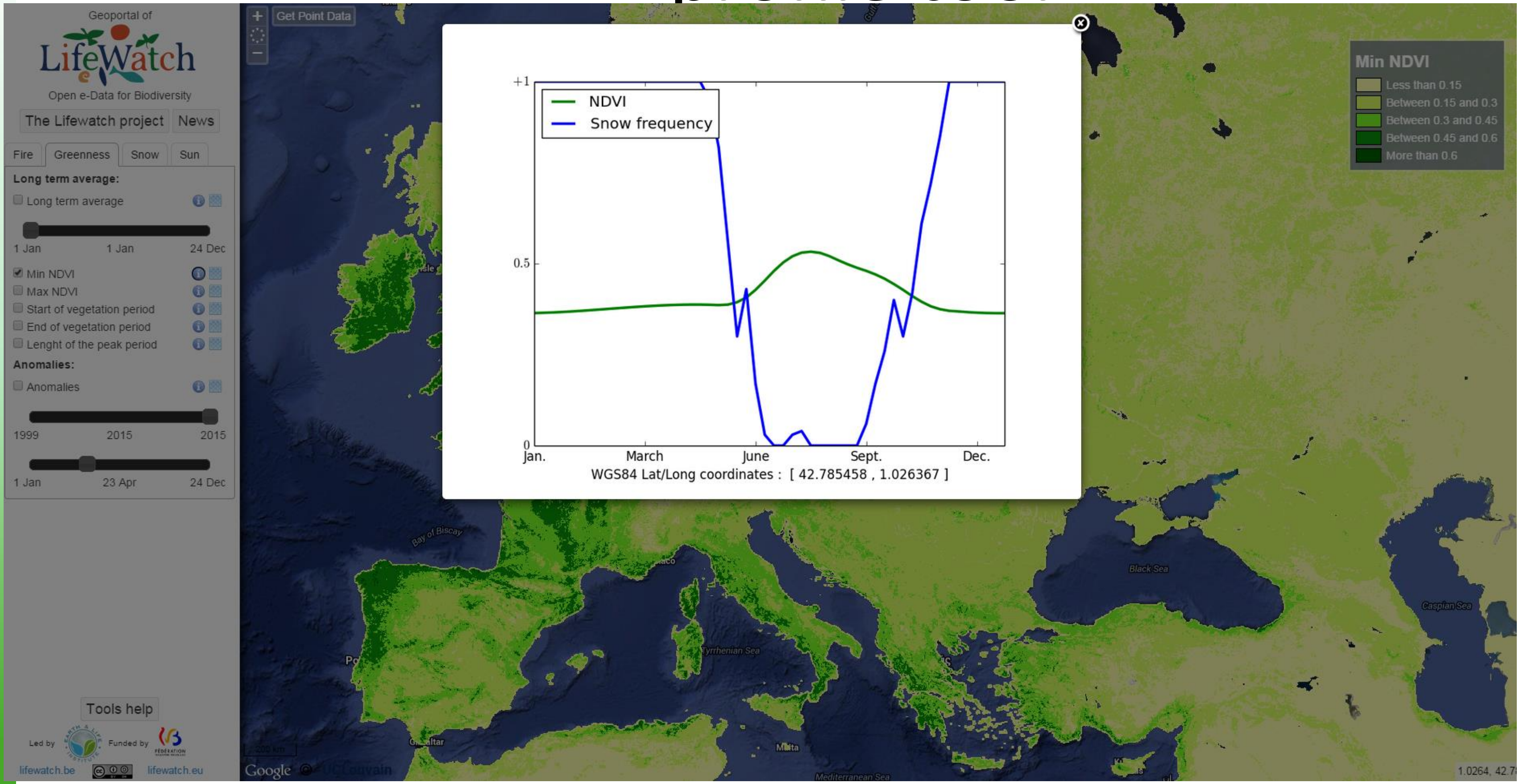
These conditions stressed also the *Ericaceae*

→ Less berry in autumn when bears will need it most

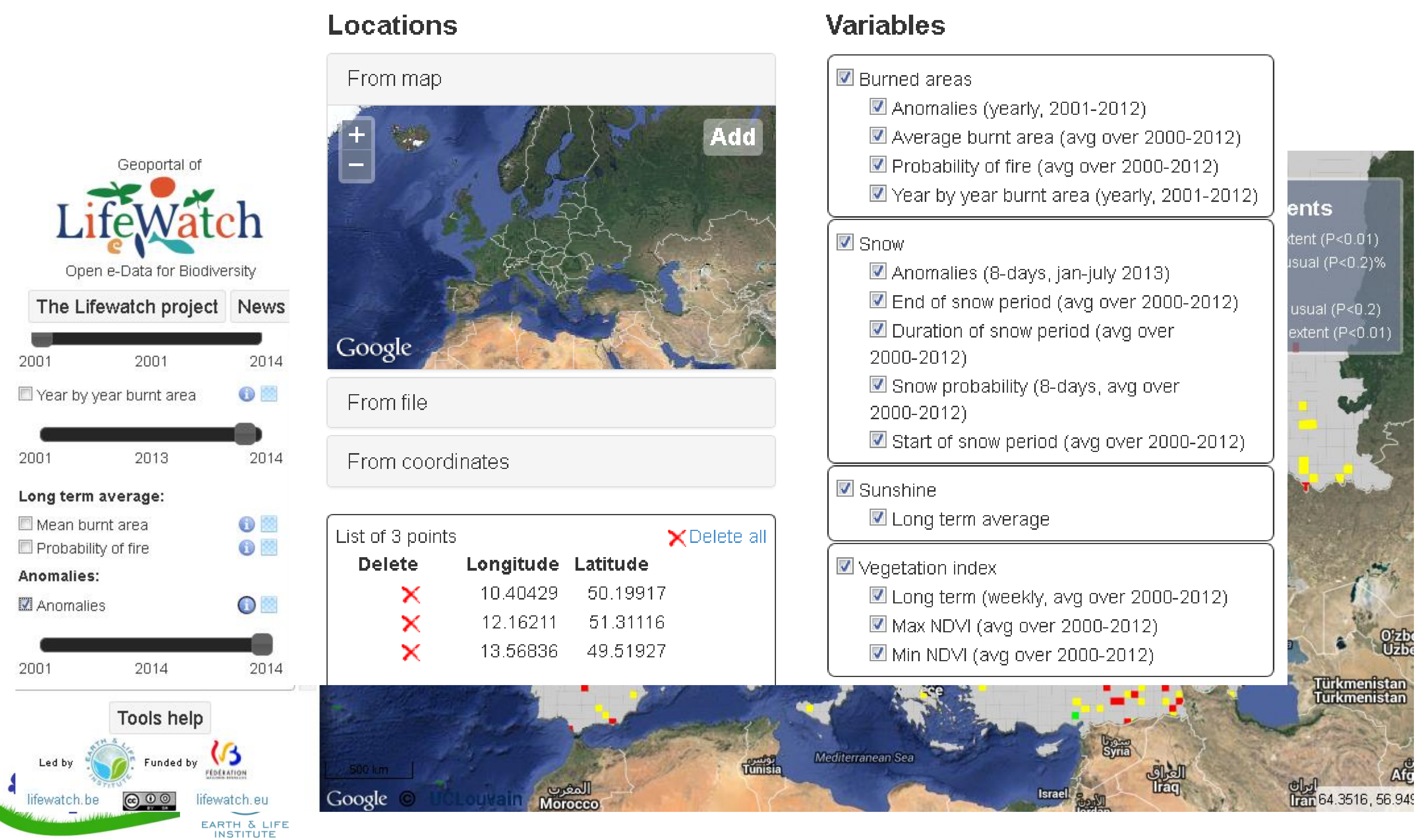
Lifewatch Viewer helps you navigate through time series



Dynamic can be observed with profile tool



Those data can be linked with species observations (e.g. GBIF)



Some perspectives

- Keep providing service for the existing metrics and anomalies
- Automated extraction tools for image subsets
- Compute date difference for the same state

- Jump to 10 m resolution

www.uclouvain.be/lifewatch