Monitoring grassland phenology on an alpine transect using WebCams

A. Batsaikhan [1], S. Asam [2], D. Klein [3], C. Conrad [1]

1 Department of Remote Sensing, University of Würzburg, Germany

2 Institute for Earth Observation, Eurac Research, Bolzano, Italy

3 German Remote Sensing Data Center, German Aerospace Center, Weßling, Germany

Contact: anudari.batsaikhan@uni-wuerzburg.de

Background and aim

Mountain grasslands play an important role for the ecosystem functioning e.g. for storage of water and carbon, as well as for grazing and hay production [1].

To analyze impacts of climate change on mountain grasslands and associated risks, better understanding of grassland phenology is necessary.

However, knowledge is still limited expectedly due to complex climate system of mountain areas and difficulty to access.

In this study, the impacts of site conditions (altitude, exposition and management) on grassland green-up dates were studied first to see how they differ from one another at five sites (8 region of interests) for 2014-2016.

Study sites

The study sites were selected along an altitudinal transect in the Alps and considering webcams availability [2,3]. The sites are located in Germany (Bavaria) and Austria (Tirol and Kärnten) and cover a range of altitude (800-2000m) and have different expositions and management practices (grazing or grazing/mowing).

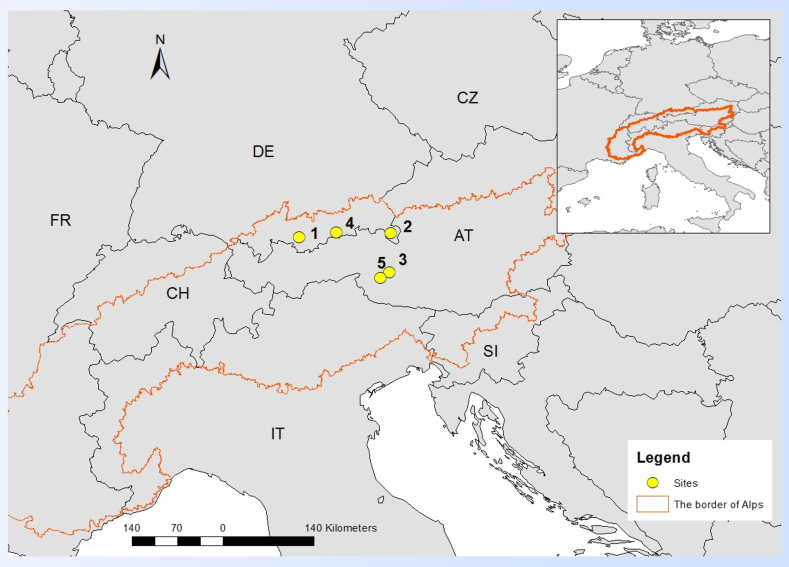

Figure 1: Location of study sites

In Table 1, altitude, aspect and slope at each site are estimated based on Digital Elevation Model over Europe (EUDEM). Land management is identified visually.

Table 1: Study sites and their site conditions

Number	Sites	Management	Altitude	Aspect	Slope
1	Unterammergau	Grazed and mown	832.6m	94.2° (East)	1.5°
2a	Vorderloiplsau-left	Grazed and mown	1052.9m	248.0° (West)	8.9°
2b	Vorderloiplsau-right	Grazed and mown	1072.5m	188.1° (South)	19.7°
3a	Kals-bottom	Grazed and mown	1339.1m	112.6° (Southeast)	6.0°
3b	Kals-top	Grazed and mown	1354.1m	48.9° (Northeast)	4.0°
4	Wallberg	Grazed	1589.1m	301.6° (Northwest)	13.1°
5a	Heiligenblut-right	Grazed	2338.7m	155.9° (Southeast)	16.0°
5b	Heiligenblut-left	Grazed	2301.5m	141.8° (Southeast)	19.1°

Figure 2: WebCam images of study sites

Acknowledgement

This project is financed by Helmholtz Research School on Mechanisms and Interactions of Climate Change in Mountain Regions (MICMoR).

Data and methods

For the analysis of the WebCam images, the Phenopix package [4] in R programming environment was used. At each site Greenness Index was extracted from daily WebCam images and averaged within the selected region of interests. To reduce noises in the time series (e.g. due to fogs), the maximum of 3 day moving window was calculated. Then a cubic spline was applied for curve fitting. Cubic spline was chosen here since it captured the intra-annual seasonal variability better (Root Mean Square Error and visually) than other curves that are based on double logistic equations. Finally, green-up dates were estimated by selecting the date when the derivative of the curve shows absolute maximum, i.e. when the grasslands experience the most rapid development in greening.

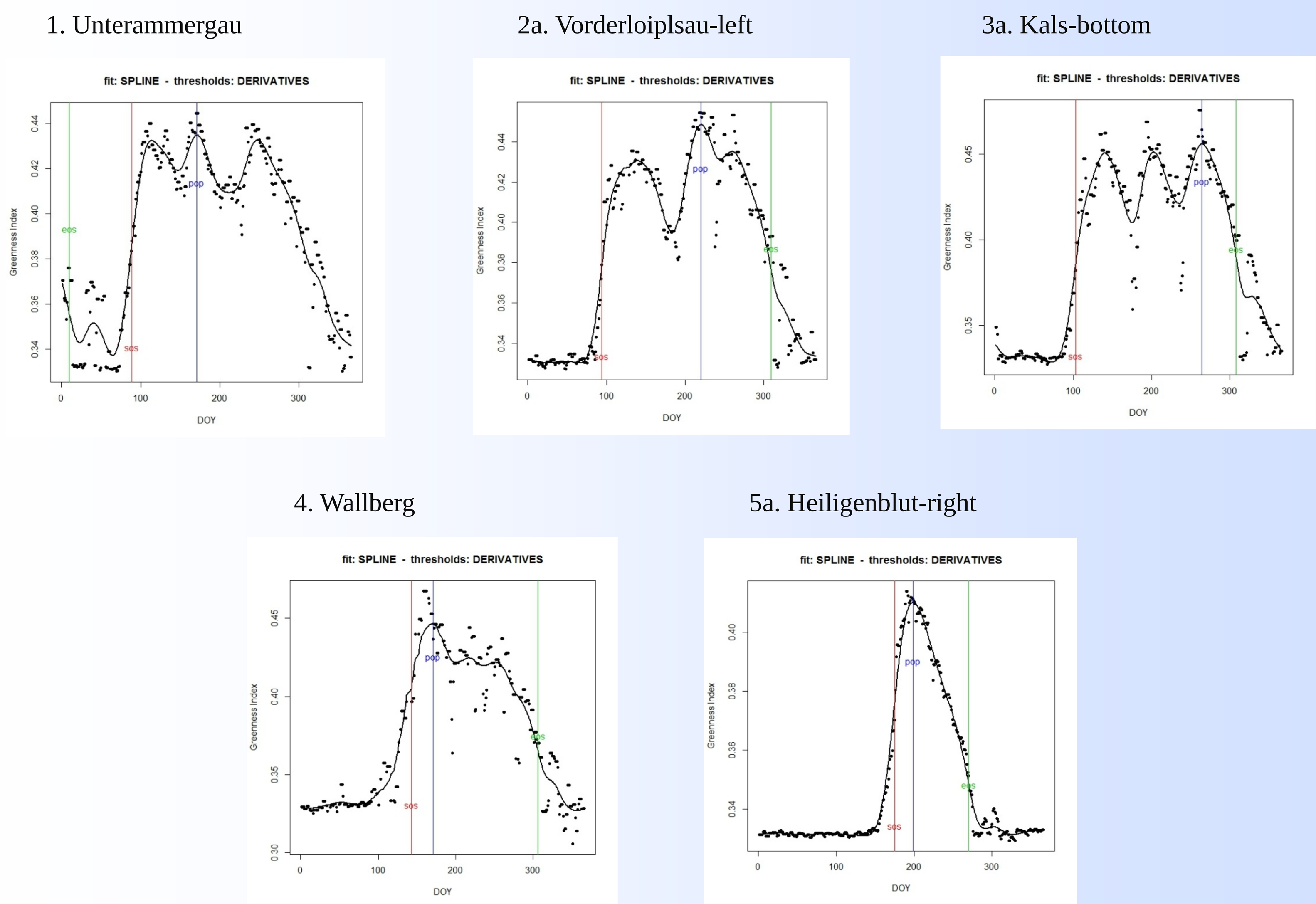

Figure 3: Curve fitting and green-up dates estimation for 2016

(SOS: start of season, (green-up dates), POP: peak of season position, EOS: end of season)

Results and discussions

The results indicated that in general green-up dates follows the altitudinal gradient, thus altitude is the strong controlling factor (Figure 5). However, as it can be observed from Vorderloiplsau, when the altitudinal differences between sites is small (<20m), green-up can occur earlier at higher altitude site being affected by exposition (Table 2). Furthermore, large difference in green-up dates between Kals-top and Wallberg was observed (Table 2). It could result from differences in grassland species influenced by land management practices besides altitude and topography. In the future the grassland species at study sites will be identified through a field visit.

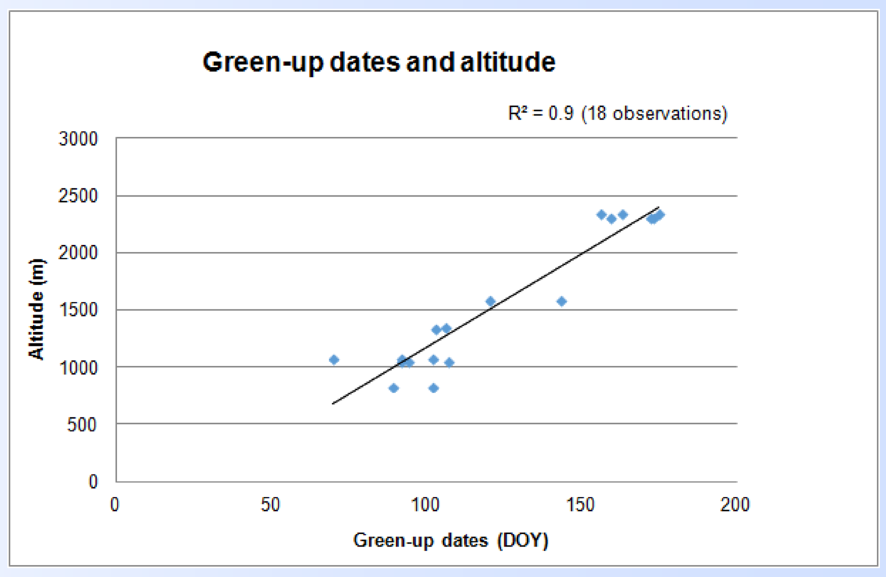

Figure 4: Green-up dates and altitude (DOY: day of year)

Table 2: Green-up dates at study sites for 2016

Sites	Altitude	Aspect	Slope	DOY (2016)
Unterammergau	832.6m	94.2° (East)	1.5°	89
Vorderloiplsau-left	1052.9m	248.0° (West)	8.9°	94
Vorderloiplsau-right	1072.5m	188.1° (South)	19.7°	92
Kals-bottom	1339.1m	112.6° (Southeast)	6.0°	103
Kals-top	1354.1m	48.9° (Northeast)	4.0°	106
Wallberg	1589.1m	301.6° (Northwest)	13.1°	143
Heiligenblut-right	2338.7m	155.9° (Southeast)	16.0°	175
Heiligenblut-left	2301.5m	141.8° (Southeast)	19.1°	173

References

[1] Spehn, E.M., Rudmann-Maurer, K., Körner, C. and Maselli, D. (eds.) (2010) Mountain biodiversity and global change. Basel: GMBA-DIVERSITATS

[2] Foto.webcam.eu (http://www.foto-webcam.eu)

[3] Foto.Webcam.org (http://www.foto-webcam.org)

[4] Filippa, G., Cremonese, E., Migliavacca, M., Galvagno, M., Forkel, M., Wingate, L., Tomelleri, E., di Cella, U.M. and Richardson, A.D. (2016) Agricultural and Forest Meteorology, 220, 141-150