

Article

Detection of Grassland Mowing Events for Germany by Combining Sentinel-1 and Sentinel-2 Time Series

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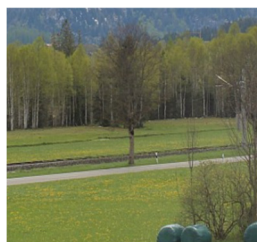
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Supplementary Material

Table S1. Description of the three exemplary plots for which annual time series of S2 and S1 parameters are shown while investigating their potential to detect mowing events (Figure 3).

	A	B	C
Site	RB-L	FE4	UGAU
Altitude [m a.s.l.]	771	597	831
Annual precipitation in 2019 [mm] ¹	1315	967	1499
Annual mean temperature in 2019 [°C] ¹	9.04	9.11	7.02
Mowing frequency in 2019	5	4	3
Camera image example ¹			

¹ Mean annual climate parameters derived from the TERENO pre-Alpine observatory [38]. Sources of camera images: A and B are from the TERENO observatory [38] and C is from www.foto-webcam.eu/webcam/unterammergau.

Table S2. List of websites with webcams from which mowing information was continuously collected. The websites were visited and the RGB information was collected by using a cronjob on a Linux machine every day. As a consequence, there were daily images available as reference data.

Webcam Name	Website
Aschau-Fellerer	https://www.terra-hd.de/aschau1/



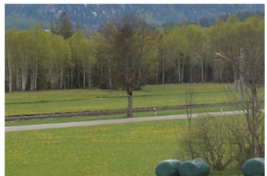










Aschau-Cafe Pauli	https://www.terra-hd.de/aschau4/
Bernau-Bergham	https://www.terra-hd.de/bernaul/
Bernau-Hittenkirchen	https://www.terra-hd.de/bernaul2/
Bielefeld-Hünenburg	http://hamnet-bielefeld.de/webcam/bielefeld/
Burghausen	https://www.foto-webcam.net/webcam/burghausen2
Oppenau-	https://www.foto-webcam.eu/webcam/buchkopfturm
MaisachBuchkopfturm	www.foto-webcam.eu/webcam/schareben/2018/09/03/1630
Drachselsried	https://www.terra-hd.de/erlstaett/
Erlstätt	http://www.sauerland.camera/webcam/erndtebrueck/
Erndtebrück	https://www.foto-webcam.eu/webcam/ettelsberg/
Ettelsberg	https://webcams.preyer.net/webcam/alex1
Hammelburg-NW	https://webcams.preyer.net/webcam/alex2
Hammelburg-NO	https://www.terra-hd.de/hochwald2/
Görlitz-Hochwaldturm	https://www.terra-hd.de/hochwald3/
Görlitz-HochwaldOst	https://www.terra-hd.de/krompach/
Krompach	www.foto-webcam.eu/webcam/oberstauften/
Oberstauften	https://www.reisen-und-hobby.de/webcam-radevormwald/
Radevormwald	https://www.terra-hd.de/reute/
Reute-Breisgau	https://www.terra-hd.de/rottau/
Rottau	https://www.terra-hd.de/ruhpolding/
Ruhpolding-Eggerschneid	https://www.terra-hd.de/pullach/
Sebruck-Alz	https://www.terra-hd.de/staffn/
Staffn	https://www.terra-hd.de/wimpasing/
Vachendorf-Wimpasing	www.foto-webcam.eu/webcam/herzogstand
Herzogstand_sued	www.foto-webcam.eu/webcam/tegelberg
Tegelberghaus	www.foto-webcam.eu/webcam/peissenberg
Hohenpeissenberg	www.foto-webcam.eu/webcam/unterammergau/1200.jpg
Unterammergau	www.foto-webcam.org/webcam/dietramszell
Dietramszell	http://oberammergauer-land.com/webcams/ogau/current1.jpg
Oberammergau	www.gemeinde-ettal.de/webcam/current1.jpg
Oberammergau_Ettal	http://halblech.allgaeu-cam.de/webcam/halblech-webcam.jpg
Halblech	https://wertach.it-wms.com
Allgaeuhaus_Wertach	https://dietrich-edv-service.de/webcam/oberellegg_webcam.jpg
Oberellegg_Wertach	http://webcam.jachenau-webcam.info
Gasthof_Jachenau	https://luitpoldbad.de/website/var/assets/webcam
BadHindelang_HotelPrinzLBad	https://wtvhspt.feratel.com/hotspot/35/3028/3.jpeg
Schloss_Hohenschwangau_01	http://webcam.stoegerhof.de/stoegerhof1280.jpg
Rieden	www.wellness-heaven.com/webcam/starnberg
Starnberg	www.bayernwebcam.de/bilder/kreutalm.jpg
Kreutalm	http://kinker.it-wms.com/big_current1.jpg
Kinker	www.rosshaupten.de/webcam/webcam.jpg
Rosshaupten	www.foto-webcam.eu/webcam/kochelsee
Kochelsee	www.tourispo.ch/schloss-burg/schloss-ahrensburg/webcam
Delingsdorf	www.tourispo.ch/radtour/langeoog--meierei/webcam
Spiekerroog	www.tourispo.de/attraktion/titan-rt-haengebruecke-harz/webcam
Braunlage	www.tourispo.ch/schloss-burg/festung-koenigstein/webcam
Bad Schandau	

Rehefeld Zaunhaus	www.tourispo.ch/wanderung/drei-berge-tour-kahleberg-geisingberg-kohlhaukuppe/webcam
Oberbärenburg	www.tourispo.ch/wanderung/drei-berge-tour-kahleberg-geisingberg-kohlhaukuppe/webcam
Bleißberg	www.tourispo.ch/schloss-burg/veste-heldburg-deutsches-burgenmuseum/webcam
Friedrichroda	www.skigebiete-test.de/webcam
Willingen	www.tourispo.ch/sehenswuerdigkeit/bruchhauser-steine-sauerland/webcam
Hornbad-Meinberg	www.tourispo.ch/sehenswuerdigkeit/externsteine-im-teutoburger-wald/webcam
Fürstenhausen	www.tourispo.de/museum/deutsches-zeitungsmuseum-wadgassen/webcam
Hochschwarzwald	www.tourispo.ch/wanderung/auf-dem-westweg-vom-thurner-nach-titisee/webcam
Breitnau	www.tourispo.ch/wanderung/auf-dem-westweg-vom-thurner-nach-titisee/webcam
Niederstotzingen	www.tourispo.ch/wanderung/albschaeferweg/webcam
Seeg	www.tourispo.ch/wanderung/wandertrilogie-allgaeu-wiesengaenger-route/webcam
Oberreute	www.skigebiete-test.de/langlauf/hochstraesslifte-oberreute/webcam
Elisabethszell1	http://webcam.deg.net/?a=showcam&w=showarchivimage&o=elz1&id=201903251015
Elisabethszell2	http://webcam.deg.net/?a=showcam&w=showarchivimage&o=elz2&id=201907251045
Oberstdorf	www.foto-webcam.eu/webcam/scheibenhau/2019/09/30/1520
Wendelstein	www.foto-webcam.eu/webcam/wendelstein-west/2020/04/23/1130
Ramsau bei Berchtesgaden	www.foto-webcam.eu/webcam/vorderloiplsau/2021/03/30/1130
Langewiese	https://sauerland.camera/beta/?site=webcam&cam=langewiese
Alme	https://sauerland.camera/beta/?site=webcam&cam=alme
Altastenberg	https://sauerland.camera/beta/?site=webcam&cam=altastenberg
Schmallenberg_Grafschaft_2	https://sauerland.camera/beta/?site=webcam&cam=grafschaft2&year=2020&month=05&day=09&time=1430
Olsberg_Eisenberg	https://sauerland.camera/beta/?site=webcam&cam=schinkenwirt



Figure S3. Example of public webcam showing three grassland parcels (1, 2, 3) taken on 21.4. (left) and 24.5. (right). Parcel 1 was recently mown in the picture on the right.

Table S4. Additional information of the 13 calibration sites, which were investigated to select the most suitable variables, develop the rule-set and define the thresholds for the mowing event detection approach.

<p>RB-L</p>  <p>Mown: 5 times Grazing: no</p>	<p>FE4</p>  <p>Mown: 4 times Grazing: no</p>	<p>UGAU</p>  <p>Mown: 3 times Grazing: yes</p>
<p>GL</p>  <p>Mown: 6 times Grazing: no</p>	<p>MN</p>  <p>Mown: 4 times Grazing: no</p>	<p>HF</p>  <p>Mown: 1 time Grazing: yes</p>
<p>RB1</p>  <p>Mown: 5 times Grazing: no</p>	<p>FE1</p>  <p>Mown: 4 times Grazing: no</p>	<p>FE3</p>  <p>Mown: 1 time Grazing: yes</p>
<p>FE2</p>  <p>Mown: 5 times Grazing: no</p>	<p>MW</p>  <p>Mown: 3 times Grazing: no</p>	<p>RB2</p>  <p>Mown: 1 time Grazing: no</p>
<p>UF</p>  <p>Mown: 3 times Grazing: no</p>		

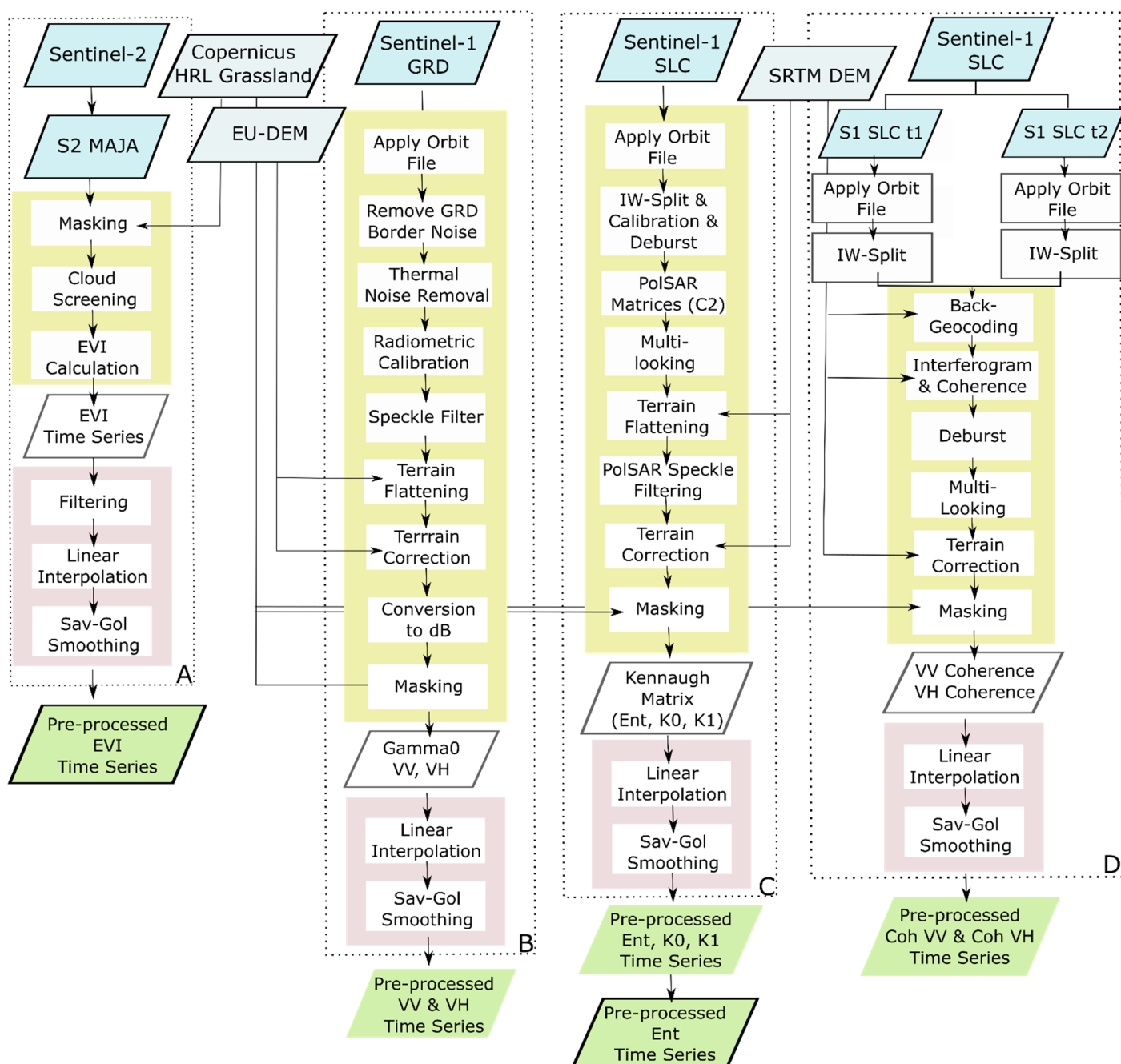


Figure S5. Pre-processing steps of the Sentinel-2 and Sentinel-1 parameters.

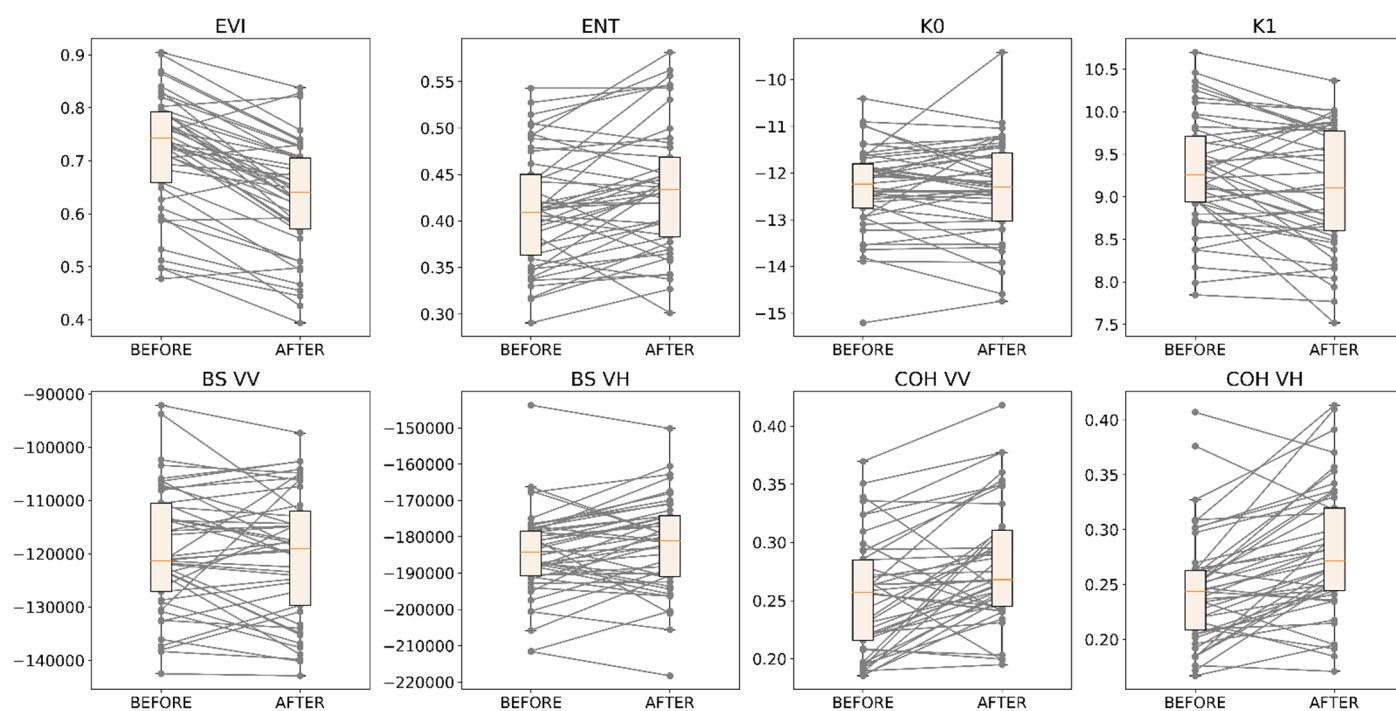


Figure S6. Comparison of values combined for six days before and six days after each mowing event of the calibration dataset ($n(\text{mowing events})=45$) for all investigated parameters, including all single data points.