

# Trockenstress von Bäumen – Copernicus als Baustein für die Forstverwaltung

(Schwerpunkt: landesweite Sicht)

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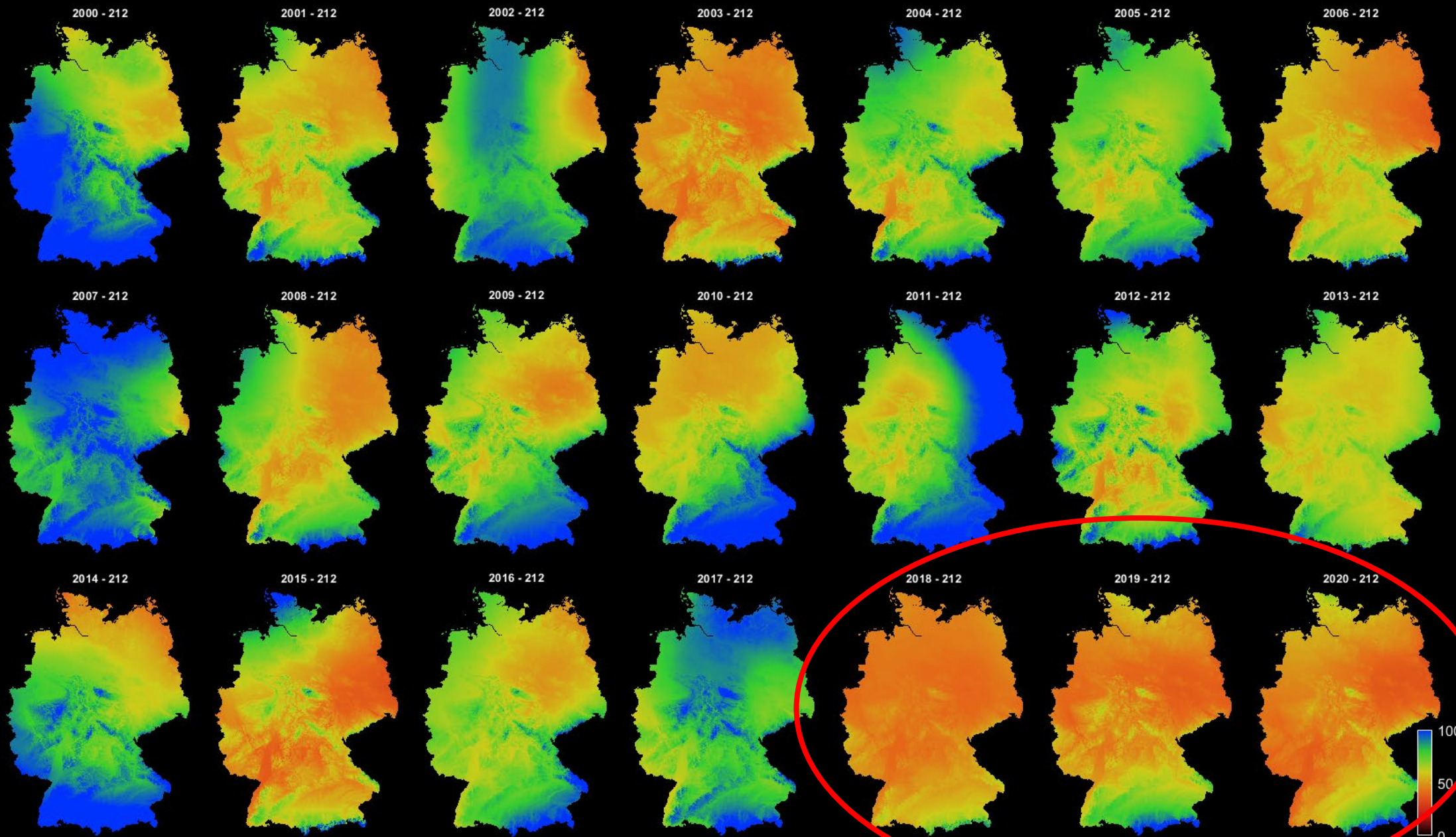
Universität Trier

buddenbaum@uni-trier.de - <http://www.feut.de>





# Bodenfeuchte Ende Juli 2000–2020



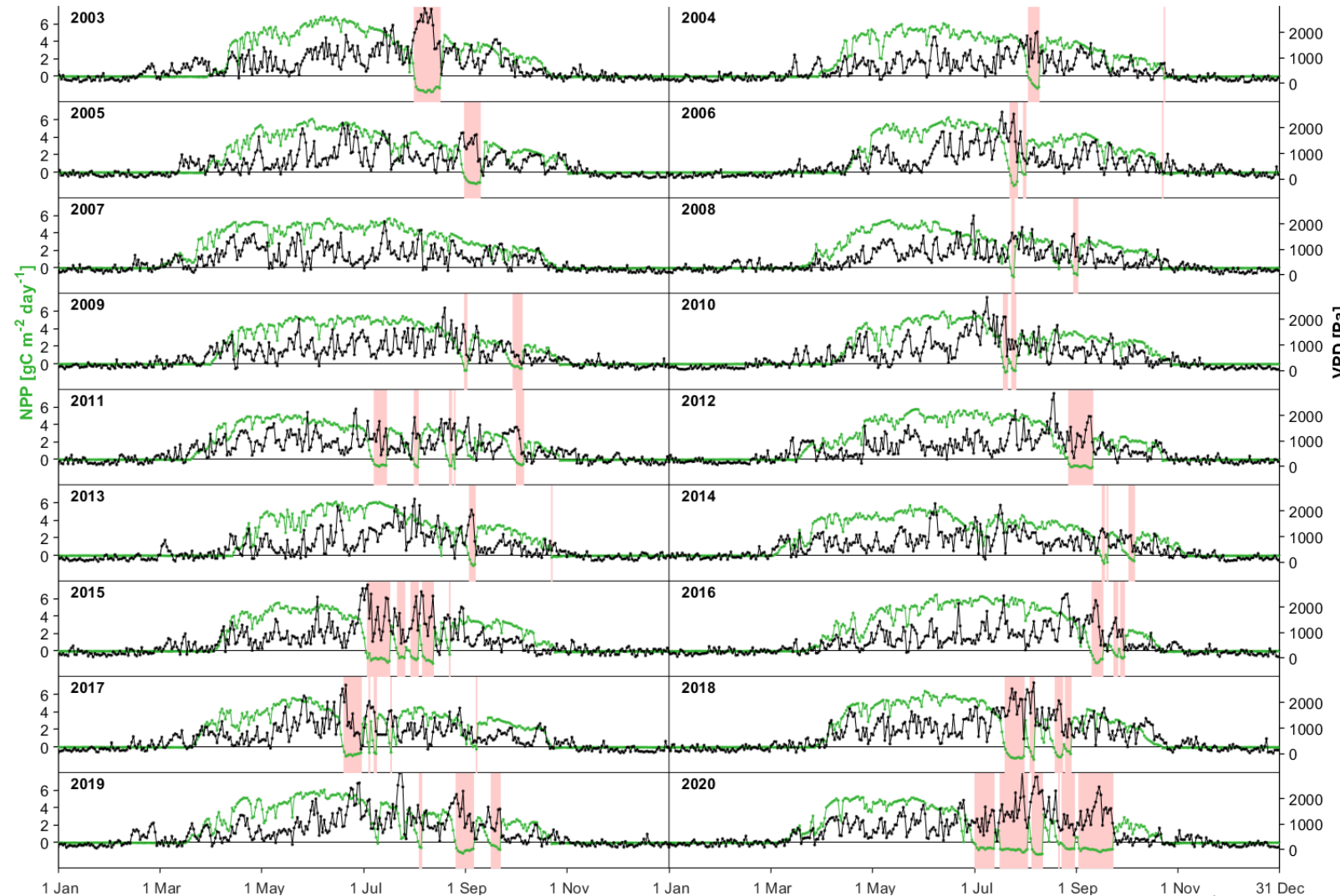
Data: DWD  
(German  
Weather  
Service)



# Wie wirkt das auf Bäume?

Eine Simulation mit dem Stoffflussmodell BiomeBGC für Laubbäume und Klimadaten von Trier ergibt das hier dargestellte Bild.

Negative Nettoprimärproduktion (NPP, rot eingefärbt) kann als Stress für die Bäume interpretiert werden.



H. Buddenbaum, J. Hientgen, S. Dotzler, W. Werner & J. Hill  
(2015): A BiomeBGC-based Evaluation of Dryness Stress of Central European Forests. *Int. arch. photogramm. remote sens. spat. inf. sci.*, XL-7/W3, 345-351. DOI: [10.5194/isprsarchives-XL-7-W3-345-2015](https://doi.org/10.5194/isprsarchives-XL-7-W3-345-2015)

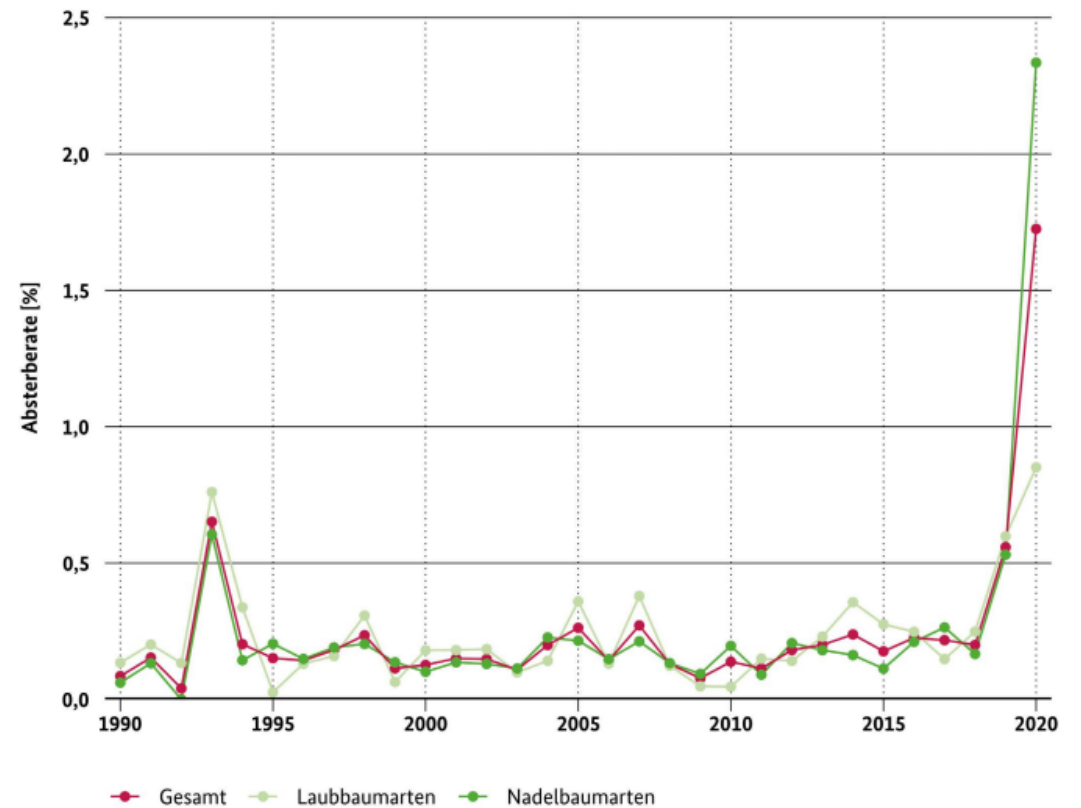


# Landesweite Vitalitätsanalyse

Forschungsprojekte mit Landesforsten RLP und der Forschungsanstalt für Waldökologie und Forstwirtschaft:

- „Nutzung des Sentinel-2-Datenarchivs zur Indikation von Trockenstresseffekten für den Gesamtwald RLP und daraus resultierender Folgeschäden (insbes. Fichtenborkenkäfer) 2019 in Waldgebieten von RLP“
- „Vitalitätsanalysen des Gesamtwaldes RLP für Frühjahr und Sommer 2020, basierend auf Sentinel-2-Daten“

Abbildung 35: Absterberaten bei Laub- und Nadelbäumen sowie insgesamt



Quelle: Waldzustandserhebung 2020





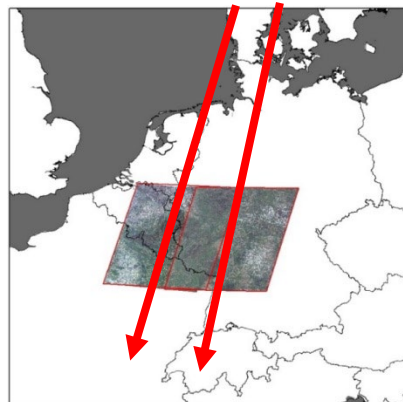
# Sentinel-2



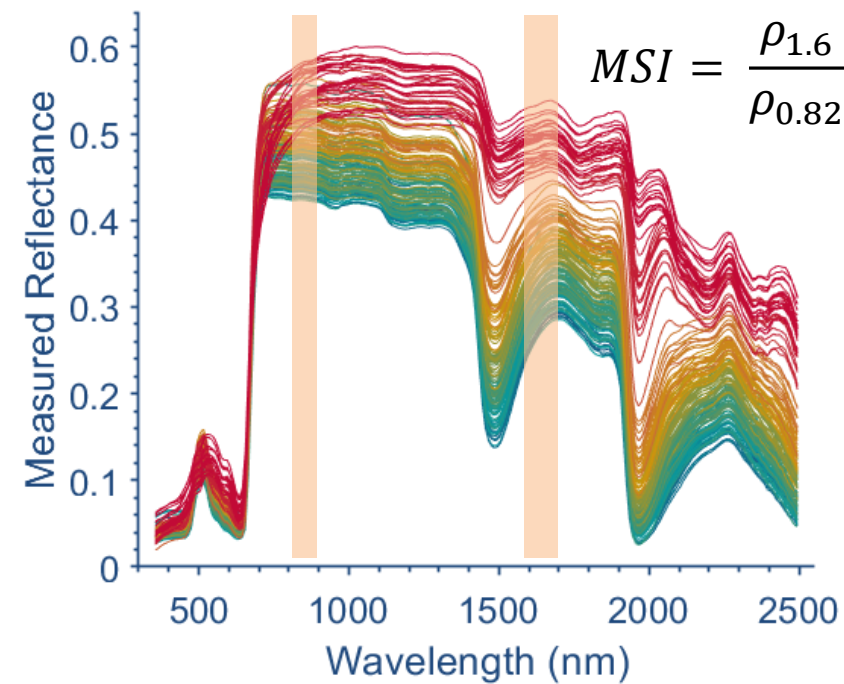
08 May 2016 (West)

Forest area RLP:  
8.400 km<sup>2</sup>

05 and 08 May 2016



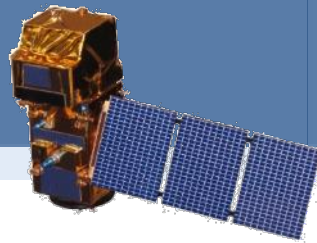
05 May 2016 (East)



<https://eo-college.org/resource/imaging-spectroscopy-of-forest-ecosystems>

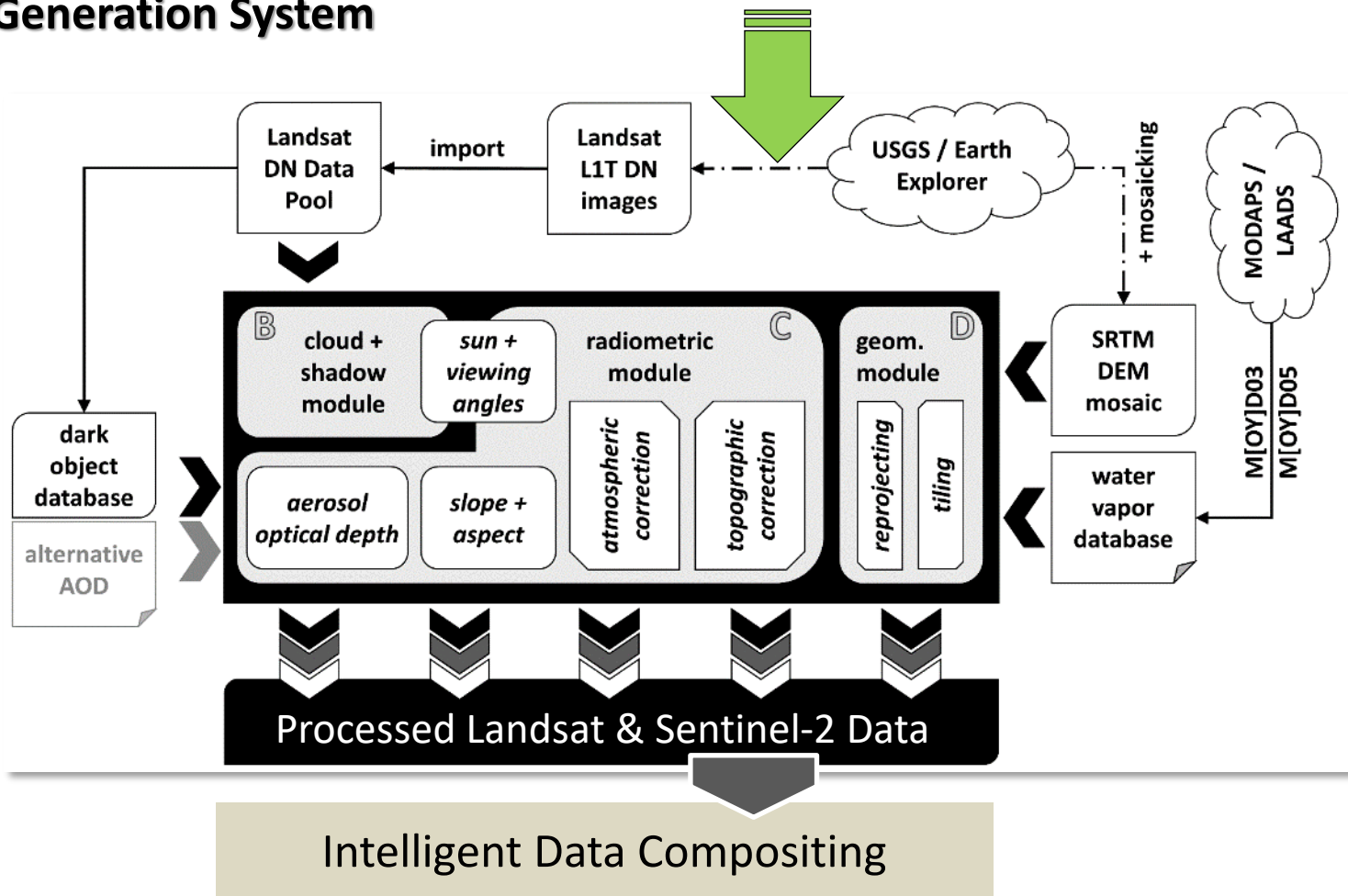


# FORCE



sentinel-2

## Autonomous Level 2 Product Generation System



IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING

## An Operational Radiometric Landsat Preprocessing Framework for Large-Area Time

David

remote sensing

MDPI

**Abstract**—We developed a large-area for multisensor Landsat data, capabilities. Cloud and cloud shadow modified Fmask code. Surface reflectance formulation of the radiative transfer correction. A precompiled MODIS w daily or climatological fallback esti (AOD) is estimated over dark objects combined database and image-based on their temporal persistency is uti consideration of the actual target

Technical Note

### FORCE—Landsat + Sentinel-2 Analysis Ready Data and Beyond

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Received: 11 April 2019; Accepted: 28 April 2019; Published: 10 May 2019



**Index Terms**—Atmospheric co Landsat, large area, multitempora reflectance, topographic correction.

### 1. INTRODUCTION

**L**ANDSAT data are one of it for Earth observation [1] di continuity [2] and their optimal rest at the landscape level [3]. With the [4], accompanied by technical prog

purposes, per-pixel statistics of clear sky data availability can be generated. FORCE provides functionality for compiling best-available-pixel composites and spectral temporal metrics, which both utilize all available observations within a defined temporal window using selection and statistical aggregation techniques, respectively. These products are immediately fit for common Earth observation analysis workflows, such as machine learning-based image classification, and are thus referred to as highly analysis ready data (hARD). FORCE provides data fusion functionality to improve the spatial resolution of (i) coarse continuous fields like land surface phenology and (ii) Landsat ARD using Sentinel-2 ARD as prediction targets. Quality controlled time series preparation and analysis functionality with a number of aggregation and interpolation techniques, land surface phenology retrieval, and change and trend analyses are provided. Outputs of this module can be directly ingested into a geographic information system (GIS) to fuel research questions without any further processing, i.e., hARD+. FORCE is open source software under the terms of the GNU General Public License v. >= 3, and can be downloaded from <http://force.feut.de>.

**Keywords:** Landsat; Sentinel-2; software; analysis ready data; cloud masking; atmospheric correction; image compositing; spectral-temporal metrics; large area; time series analysis; data fusion; land surface phenology; trend analysis

### 1. Introduction

We are currently experiencing an exciting new era of Earth observation, wherein multiple, freely available remote sensing systems provide us data at unprecedented spatial, temporal, and spectral resolutions. The Landsat mission occupies a prominent role in this development: The opening of the Landsat archive in 2008 [1] has fundamentally changed the usage of Earth observation data [2]

0196-2892 © 2016  
See <http://www>

Remote Sens. 2019, 11, 1124; doi:10.3390/rs11091124

[www.mdpi.com/journal/remotesensing](http://www.mdpi.com/journal/remotesensing)

<https://github.com/davidfrantz/force>





**TASK 1:**  
Forest – Non-Forest  
Stratification



- ATKIS
- BDOM
- Sentinel-2

**TASK 2:**  
Broadleaf-Needleleaf  
Stratification



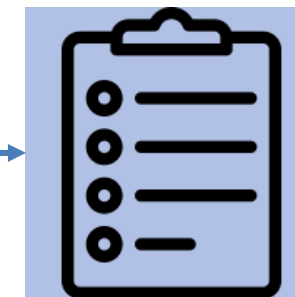
- Sentinel-2 TreeCover
- Sentinel-2 NDVI 02/03  
2016-2019

**TASK 3:**  
Anomaly Detection  
Aug/Sep 2018 & Apr 2019



- Sentinel-2 TreeCover
- Sentinel-2 Temporal  
Index Merges
- Anomalies  
2017/2018 vs. 2019/2020

**TASK 4:**  
Vitality Monitoring  
May/Jun – Aug/Sep 2019/20



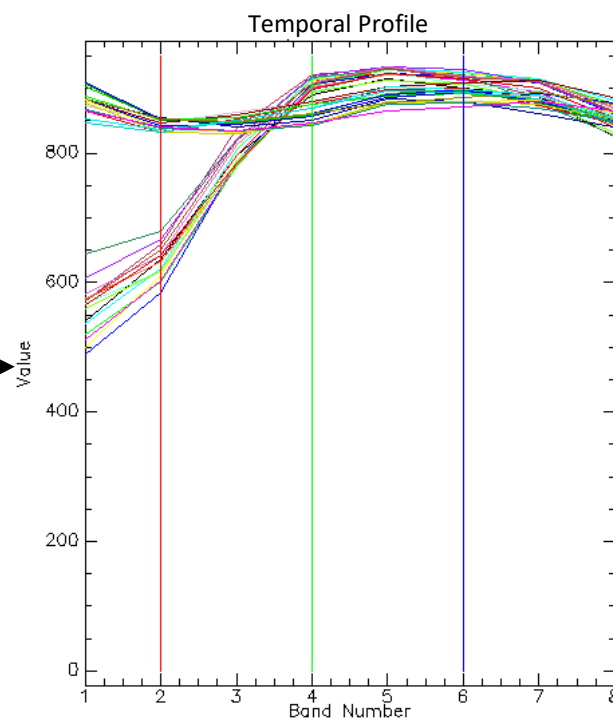
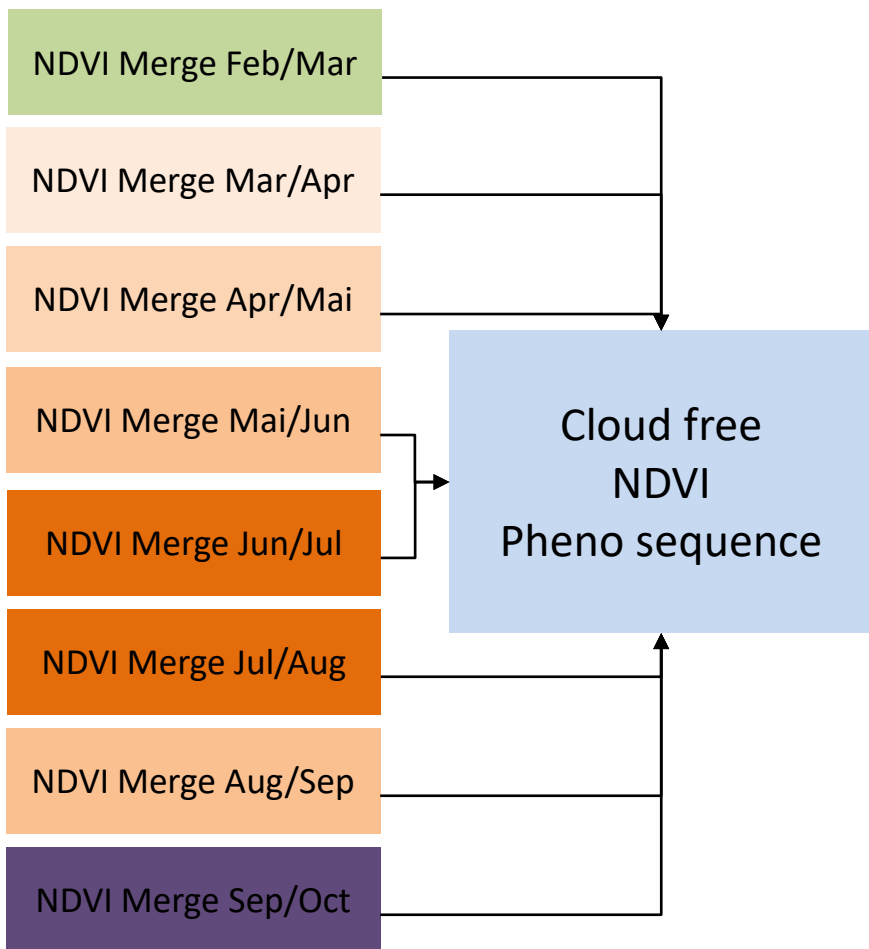
- Sentinel-2 TreeCover
- Sentinel-2 Temporal  
Index Merges
- Development 2019/2020



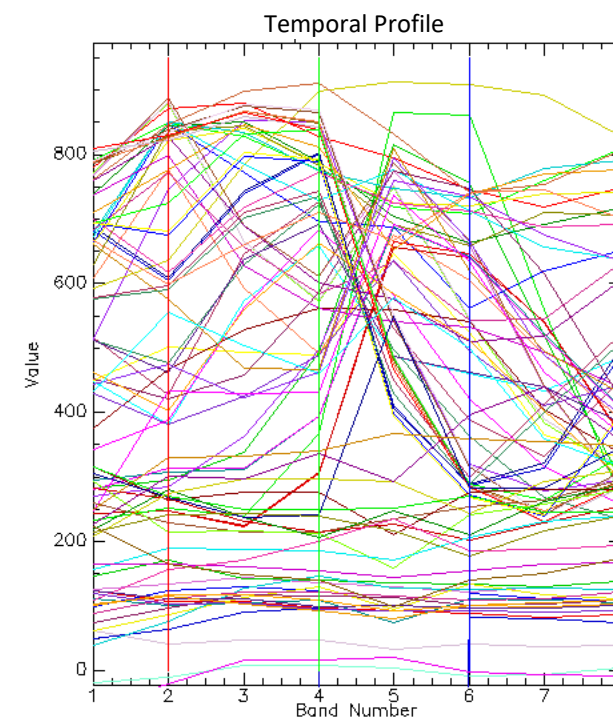
# Automatische Erstellung von Waldmasken

## TASK 1:

### Forest – Non-Forest Stratification



Broadleaf / Needleleaf



Agriculture, Urban etc.





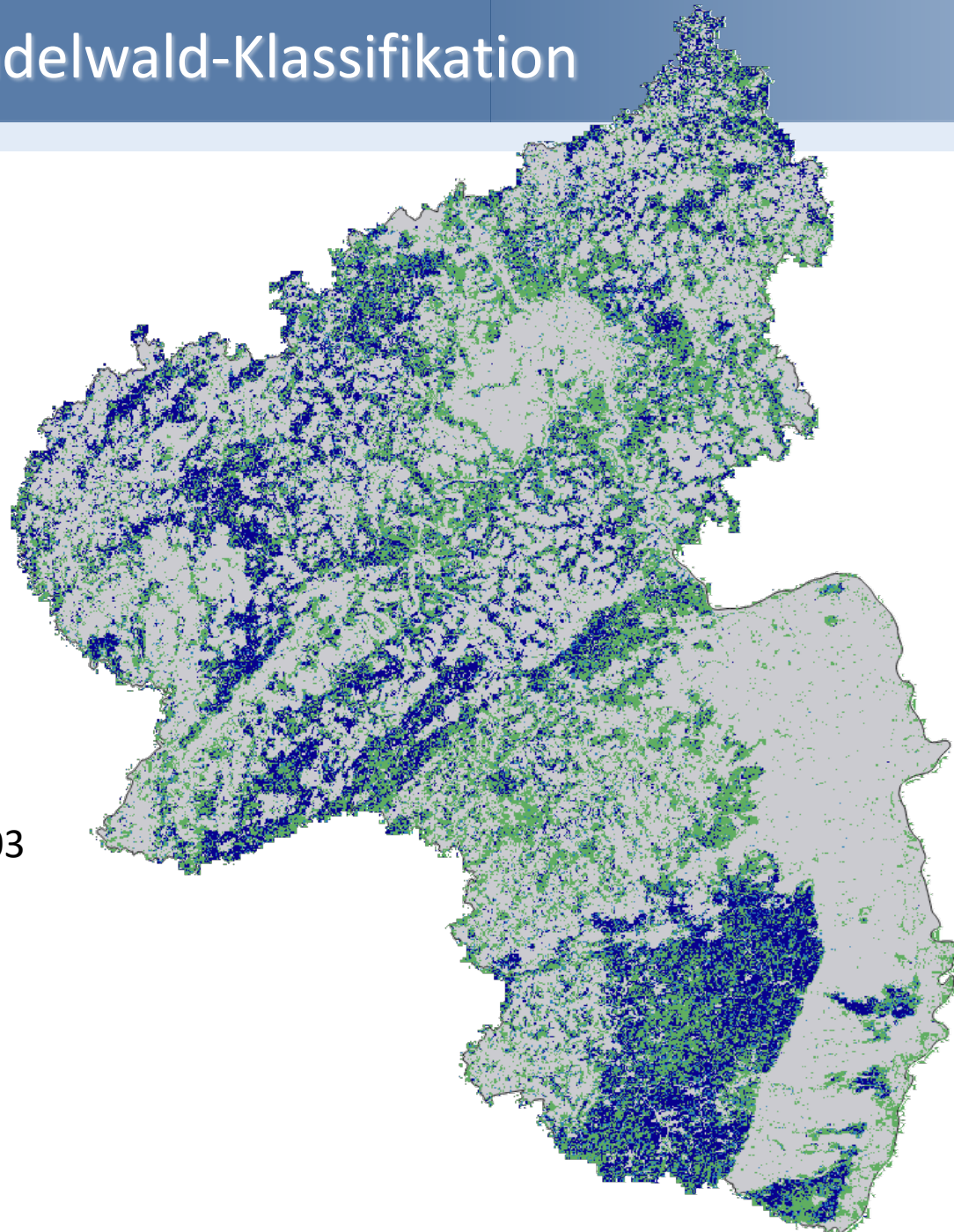


# Laub-/Nadelwald-Klassifikation

## TASK 2: Broadleaf-Needleleaf Stratification



- Sentinel-2 TreeCover
- Sentinel-2 NDVI 02/03  
2016-2019



Sentinel-2 Processing Flow (April 2019)

Broad-/Needleleaf Distribution RLP

Binary Classification with multi-annual  
NDVI-Merge, Threshold  $\geq 0.650$

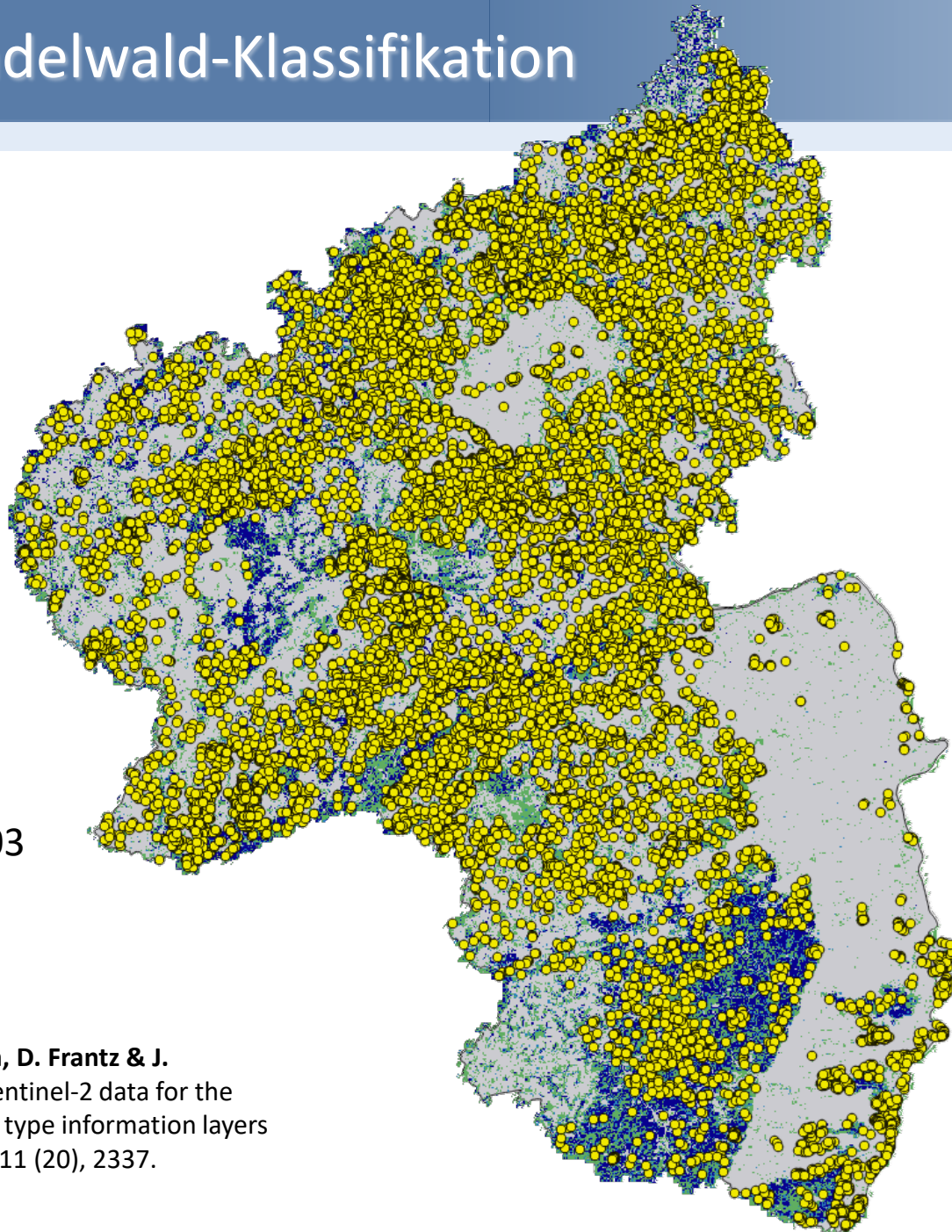


# Laub-/Nadelwald-Klassifikation

## TASK 2: Broadleaf-Needleleaf Stratification

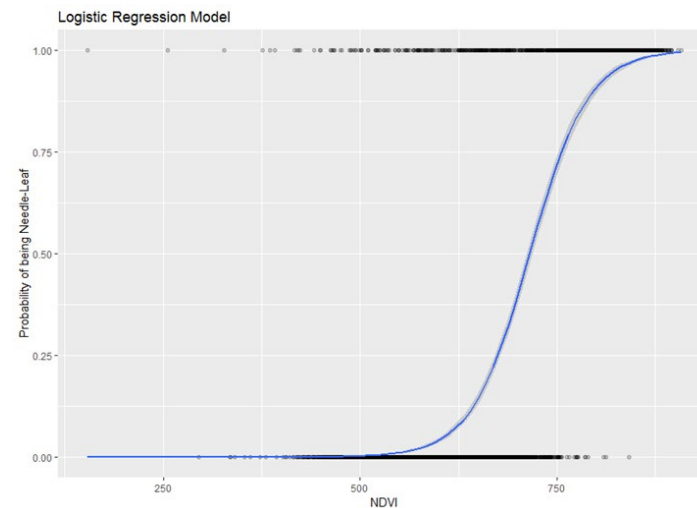


- Sentinel-2 TreeCover
- Sentinel-2 NDVI 02/03  
2016-2019



## Broad-/Needleleaf Distribution RLP

15,000 Reference Positions  
[© RegioWood2, Sascha Nink]



S. Nink, J. Hill, J. Stoffels, H. Buddenbaum, D. Frantz & J. Langshausen (2019): Using Landsat and Sentinel-2 data for the generation of continuously updated forest type information layers in a cross-border region. Remote Sensing, 11 (20), 2337.

Nationales Copernicus-Forum

24.03.2021





## TASK 3: Anomaly Detection

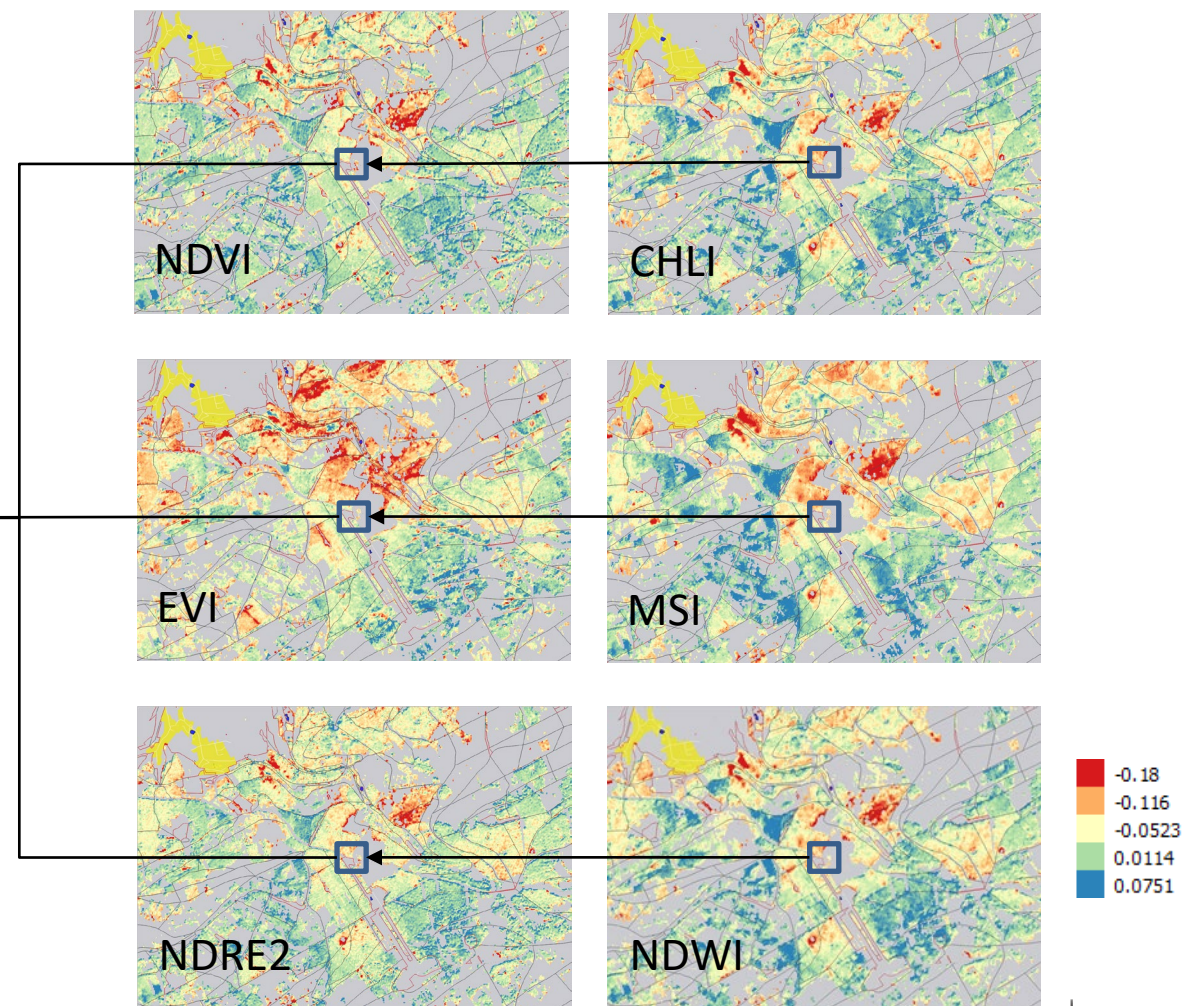
### Analysis Strategy:

- Temporal Integration Window: DoY 60-120 [March/April]
- Selection of Indices Sensitive to Ecophysiological Effects

- NDVI
- CHLI
- NDRE2
- MSI
- NDWI

$$CVCI = \sum_{i=1}^n IDX_i / n$$

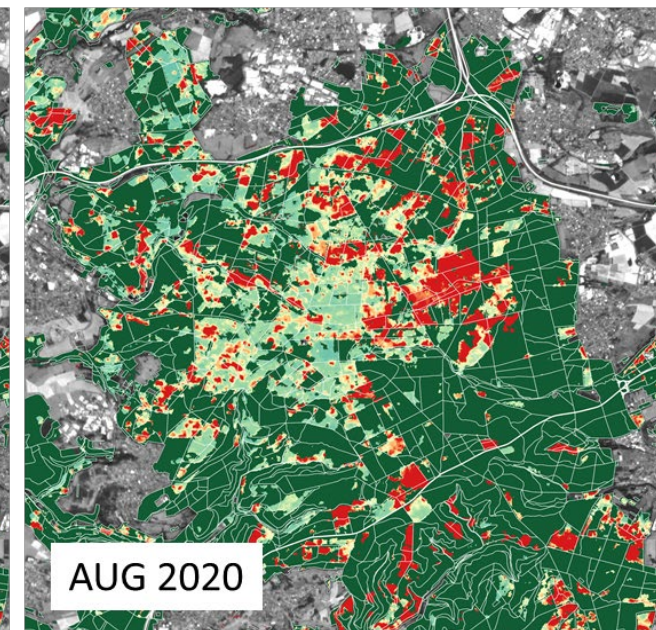
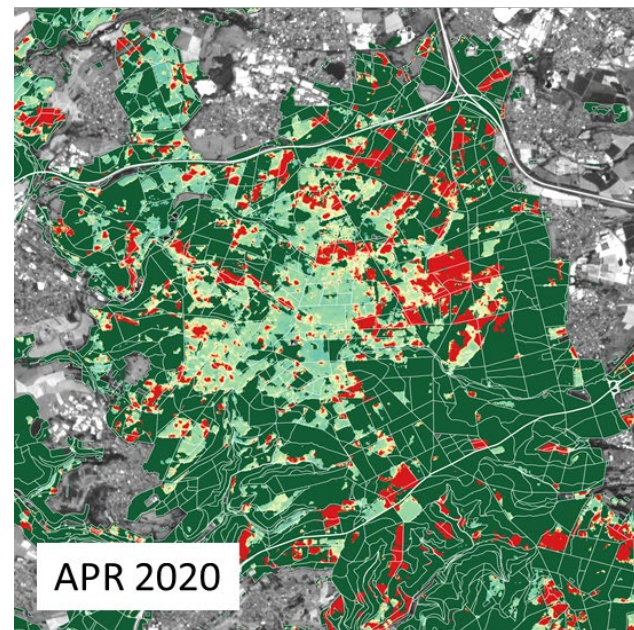
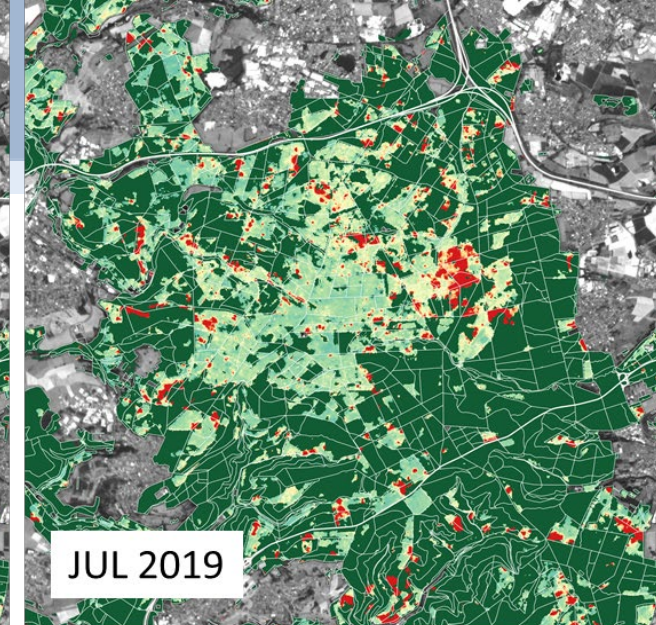
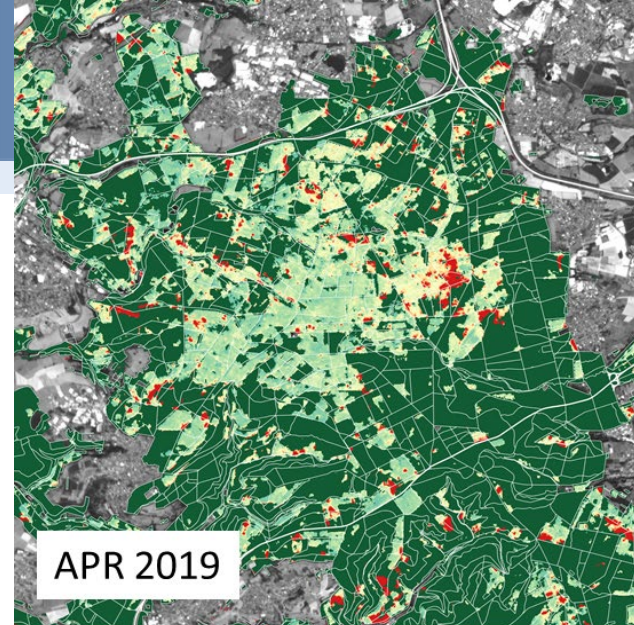
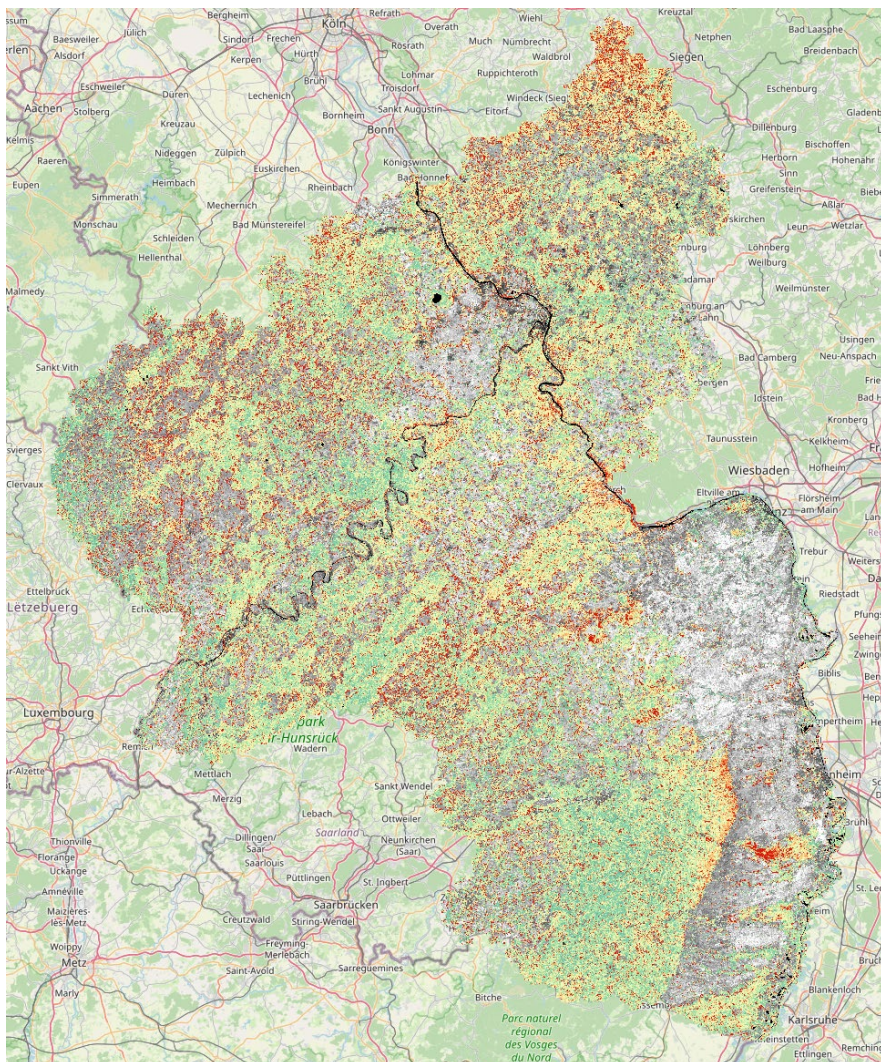
- Anomaly Detection: Assessment period vs. Reference period, e.g. March 2020 vs. March 2017/2018
- Proportional Change (Reference Period 2017/18)
- Combination of 3 to 6 Indicators (CVCI)







# Vitalitäts-Monitoring



Aus CVCI erstellte Dokumentation der Entwicklung der Borkenkäferkalamität in Fichtenbeständen im Westerwald





# TreeCop – Sentinel-basiertes Steuerungstool zur Ermittlung von Trockenstress des Stadtbaumbestandes in der Stadt Essen

Danke für die Aufmerksamkeit!

