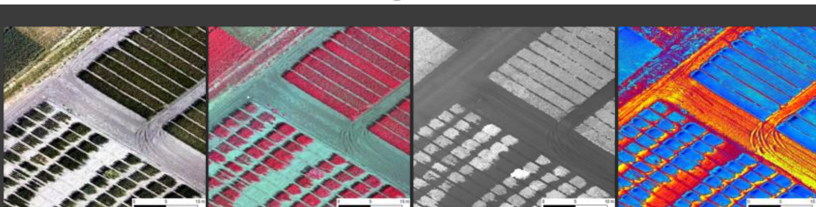
EUROPEAN UNION

RI AT CZ

Interreg
Austria-Czech Republic
European Regional Development Fund

EUROPEAN UNION



Clement ATZBERGER
& BOKU team

BOKU

Determining crop traits using multi-spectral data & radiative transfer models

1

BOKU – INSTITUTE FOR SURVEYING, REMOTE SENSING AND LAND INFORMATION

History: … since 1875
Staffing: … ca. 20
Teaching: … several bachelor & master programs
Thematics: … Remote sensing & photogrammetry
… GIS & land information
… Surveying & geodesy

BOKU

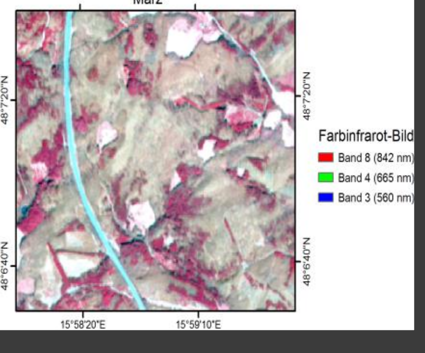
2

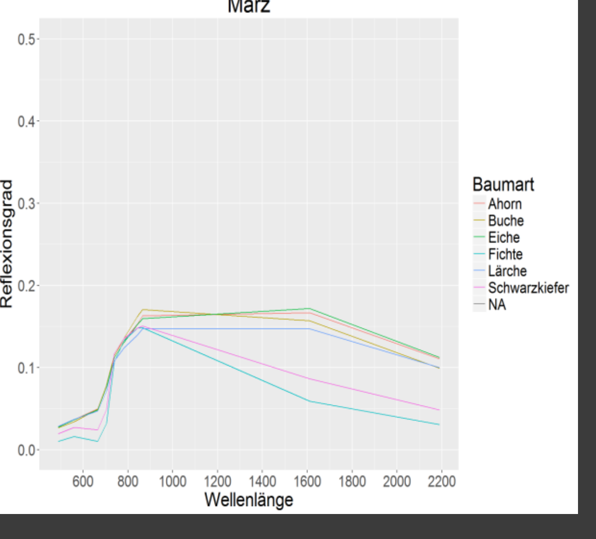
CLASSICAL APPLICATIONS OF REMOTE SENSING

3

High resolution land cover classification

… CROP & TREE SPECIES IDENTIFICATION …



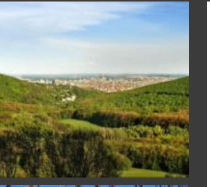


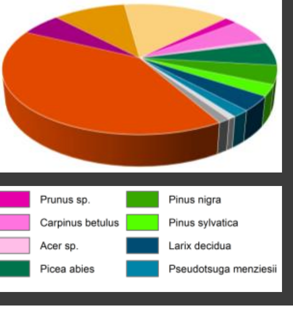
4

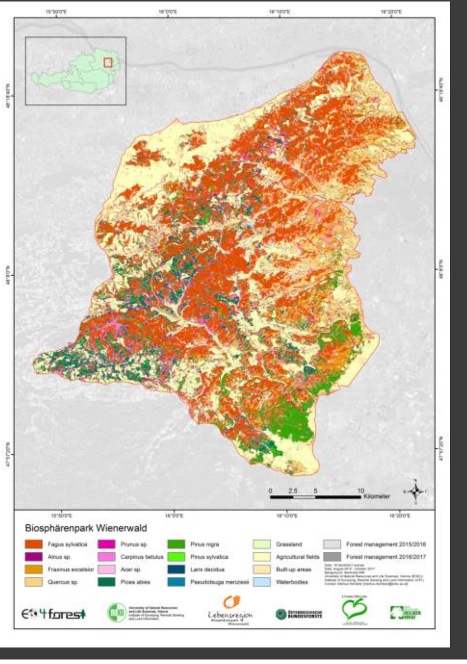
High resolution tree species classification

… TREE SPECIES IDENTIFICATION …

- 12 tree species
  OAA: 89.9 %



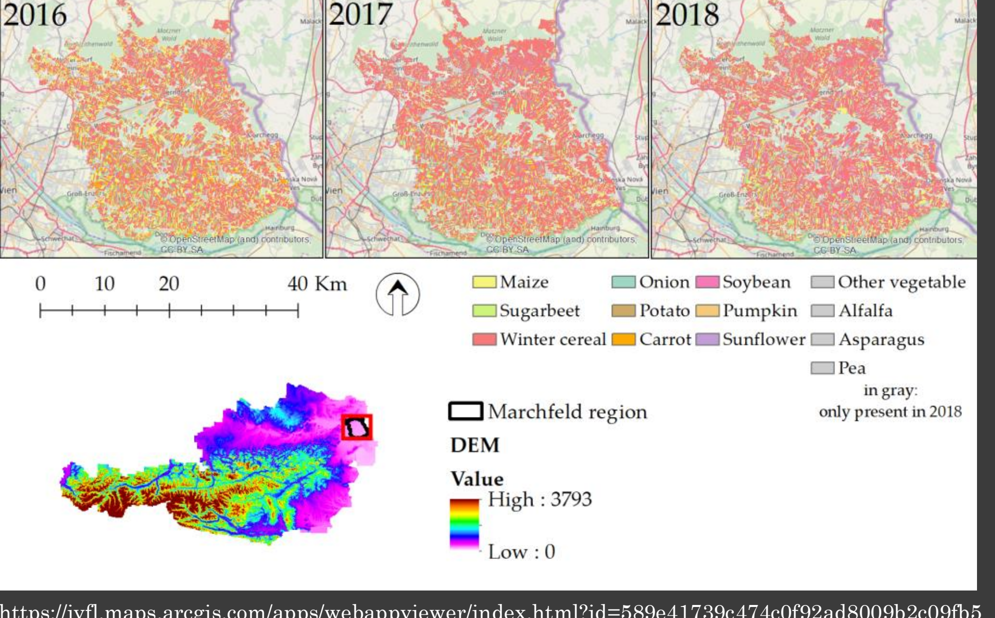




5

High resolution crop type classification

… CROP TYPE IDENTIFICATION …

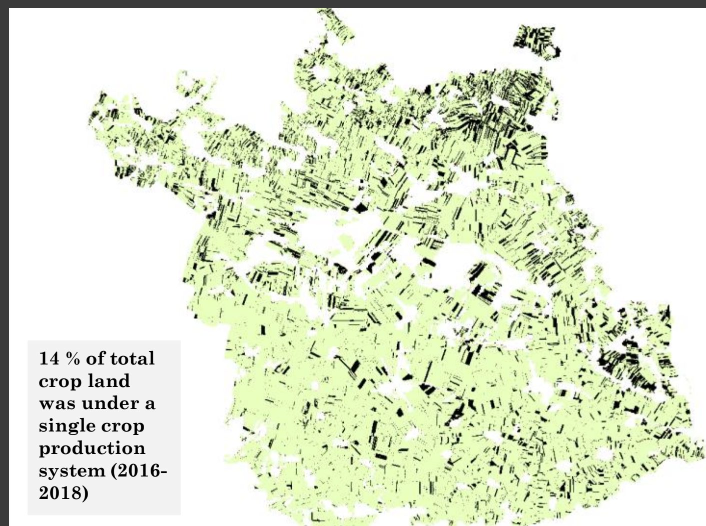


https://ivfl.maps.arcgis.com/apps/webappviewer/index.html?id=589e41739c474c0f92ad8009b2c09fb5

6

Regional crop rotation

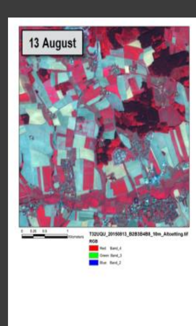
… CROP ROTATION …



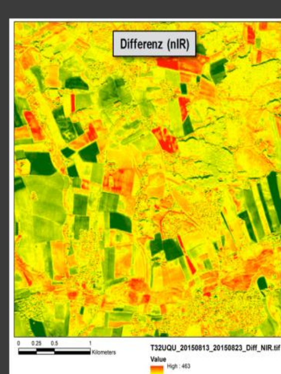
7

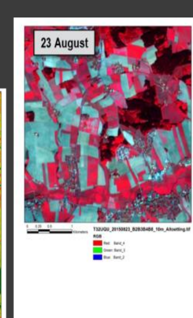
Change detection

… CHANGE DETECTION …



10 Tage





„Change detection“

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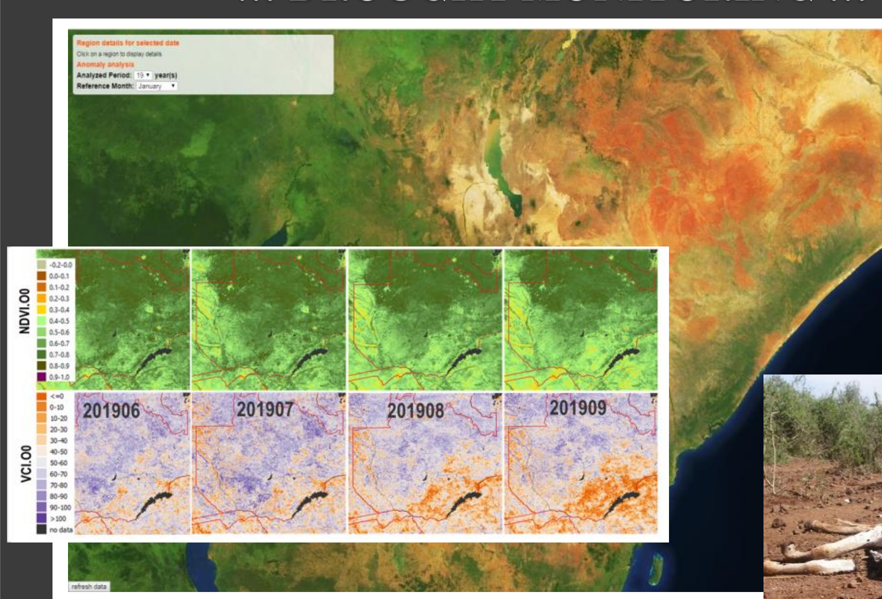
OBSERVING CROPS USING EO DATA:

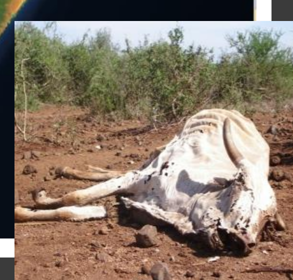
DROUGHT RESISTANCE
PHENOLOGICAL DEVELOPMENT
NITROGEN UPTAKE
WATER STRESS

9

Coarse scale monitoring

… DROUGHT MONITORING …





https://ivfl-arc.boku.ac.at/kenya/map/

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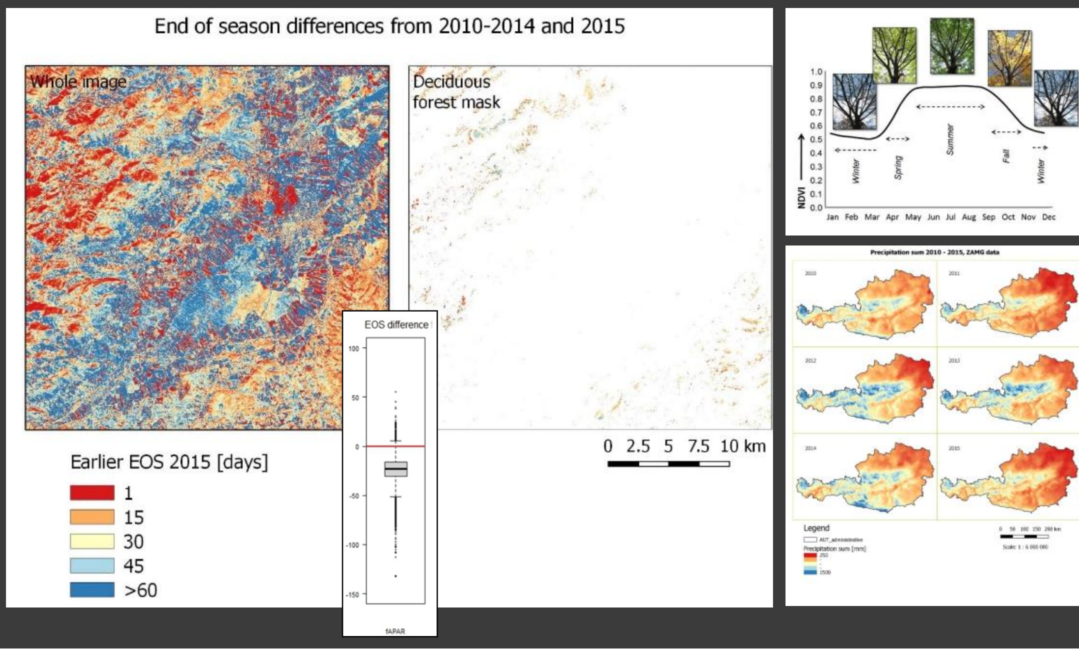
Coarse scale monitoring

… LAND SURFACE PHENOLOGY …



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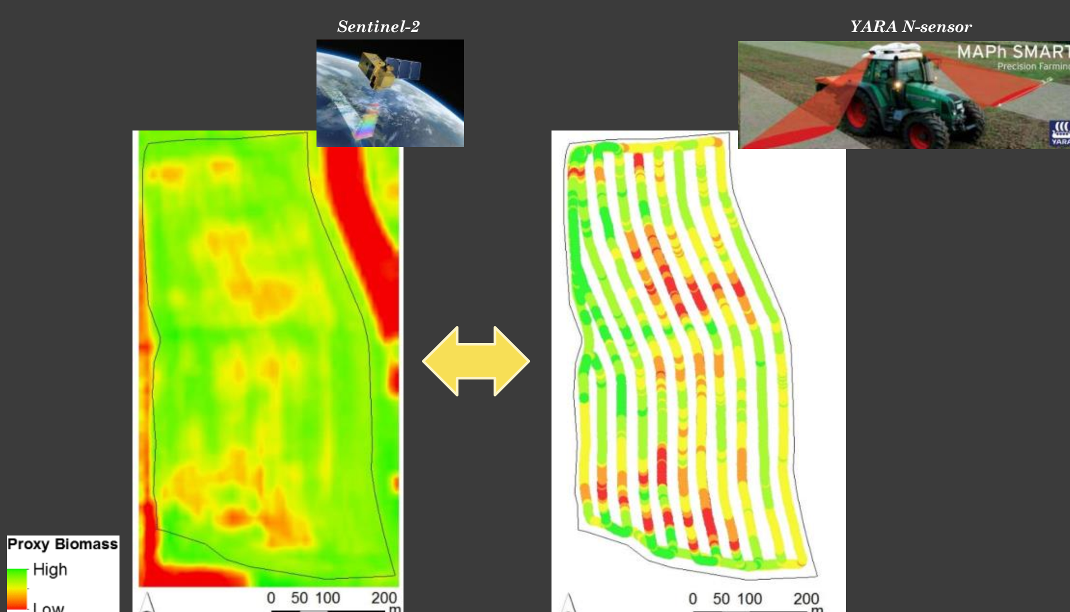
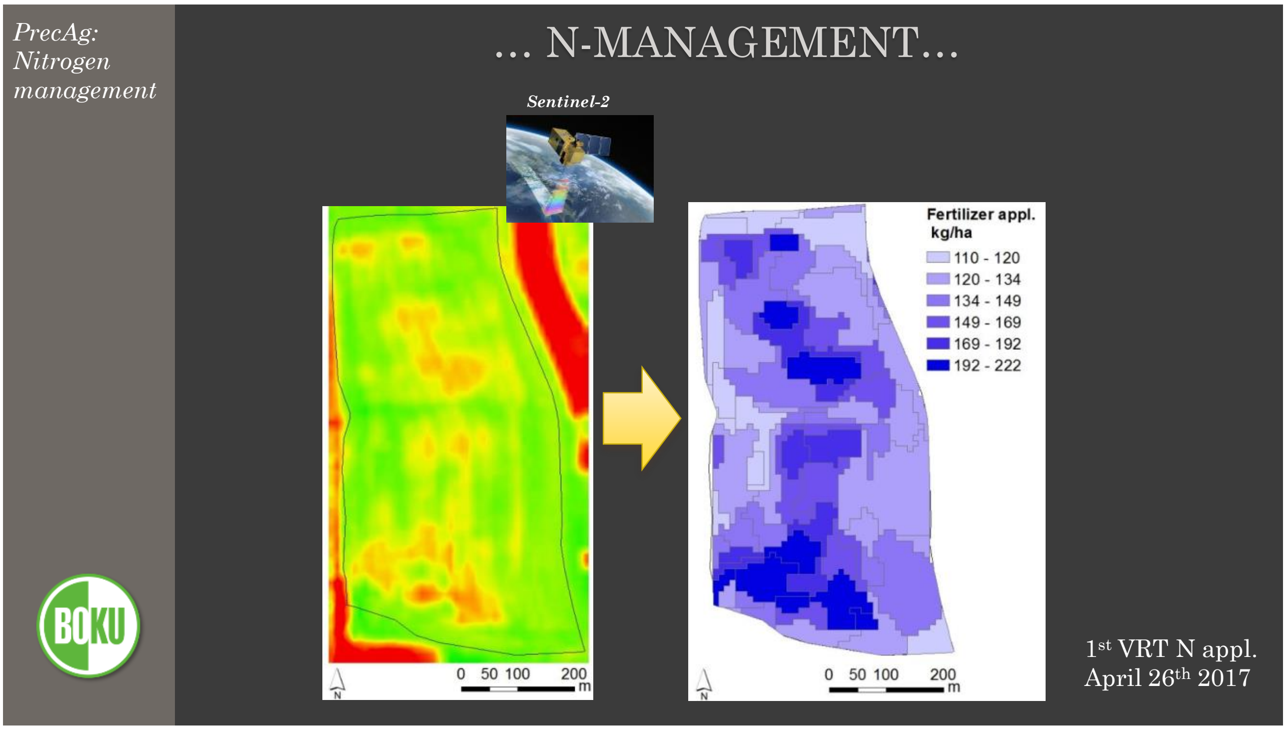
PrecAg: Nitrogen management

… N-MANAGEMENT…



12


PrecAg:
Nitrogen
management
… N-MANAGEMENT…
Sentinel-2
Fertilizer appl.
kg/ha
110 - 120
120 - 134
134 - 149
149 - 169
169 - 192
192 - 222
0 50 100 200
m
N
1st VRT N appl.
April 26th 2017
BOKU

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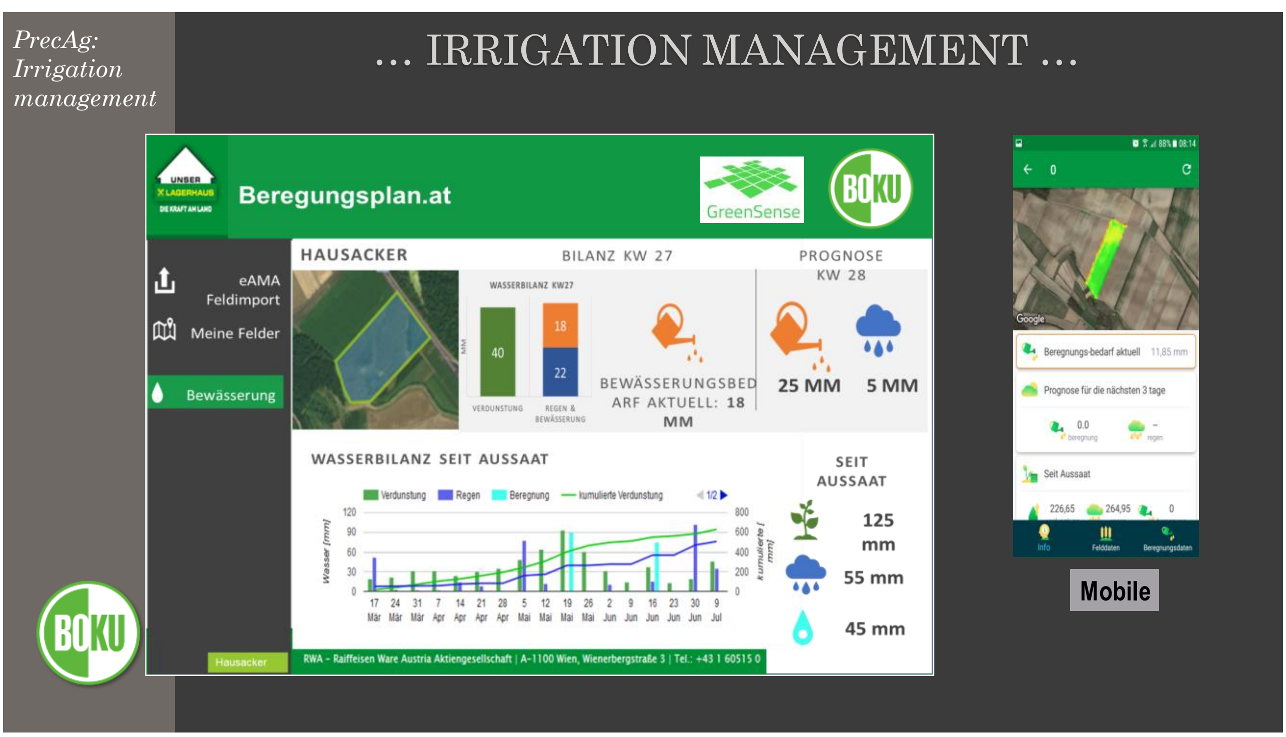
PrecAg:
Irrigation
management
… IRRIGATION MANAGEMENT …
UNSER LAGERHAUS
DIE KRAFT AM LAND
Beregungsplan.at
GreenSense
BOKU
eAMA
Feldimport
Meine Felder
Bewässerung
HAUSACKER
BILANZ KW 27
PROGNOSE
KW 28
WASSERBILANZ KW27
40
18
22
VERDUNSTUNG
REGEN & BEWÄSSERUNG
BEWÄSSERUNGSBEDARF AKTUELL: 18 MM
25 MM
5 MM
WASSERBILANZ SEIT AUSSAAT
Verdunstung
Regen
Beregnung
kumulierte Verdunstung
SEIT
AUSSAAT
125
mm
55 mm
45 mm
Hausacker
RWA - Raiffeisen Ware Austria Aktiengesellschaft | A-1100 Wien, Wienerbergstraße 3 | Tel.: +43 1 60515 0
Google
Beregnungs-bedarf aktuell
Prognose für die nächsten 3 tage
Seit Aussaat
Mobile

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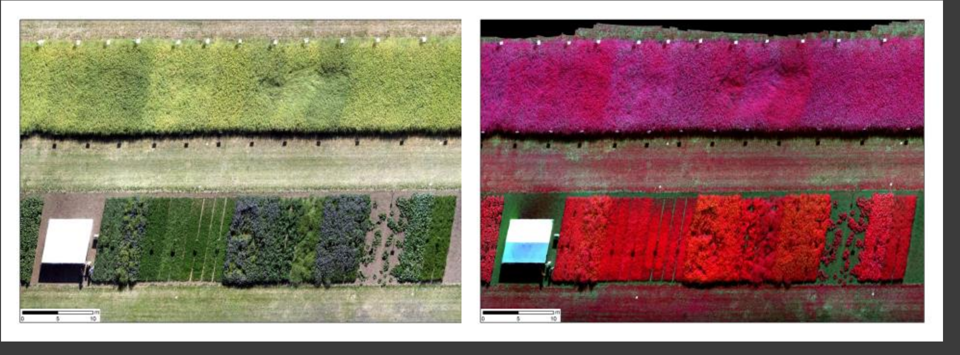
… PHENOTYPING …

Cooperation with:

Pablo Rischbeck - Division of Agricultural Engineering

Heinrich Grausgruber - Division of Plant Breeding



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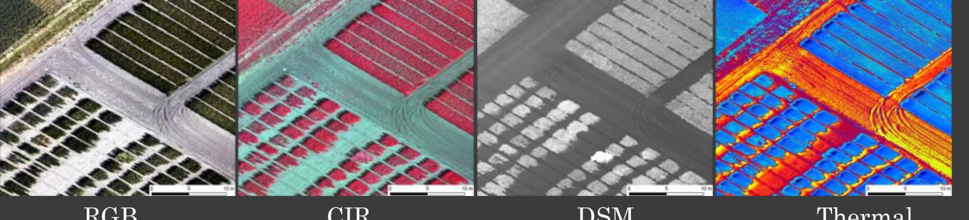
UAVs

… PHENOTYPING …



RGB CIR DSM Thermal

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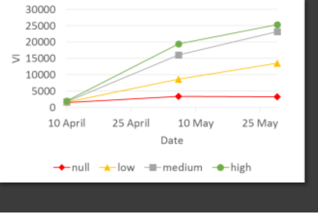
UAVs

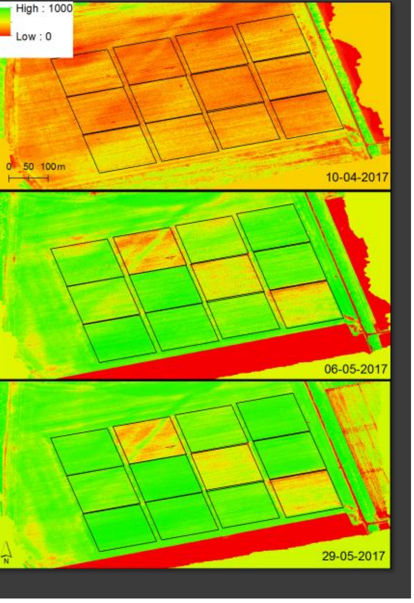
… FERTILIZATION EXPERIMENTS …

N2	N0	N1	N3
N1	N3	N0	N2
N3	N2	N1	N0

AGES

FATIMA





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NEW SENSORS FOR LEAN PHENOTYPING

BOKU

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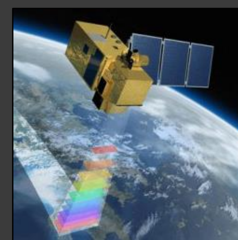
Sentinel-2 game changer

… THE ARRIVAL OF A GAME CHANGER …



- Two identical satellites
- 10m spatial resolution
- 13 spectral channels
- Global coverage every 5 days
- Data is free and open

The **Sentinel-2** mission is a land monitoring constellation of two identical satellites providing high resolution optical imagery and provide continuity for the current SPOT and Landsat missions for the next ~20 years.

The mission provides a global coverage of the Earth's land surface every 5 days, making the data of great use for agricultural applications.

The satellites are equipped with the state-of-the-art MSI (Multispectral Imager) instrument, that offers high-resolution optical imagery. All data are for free to everyone.

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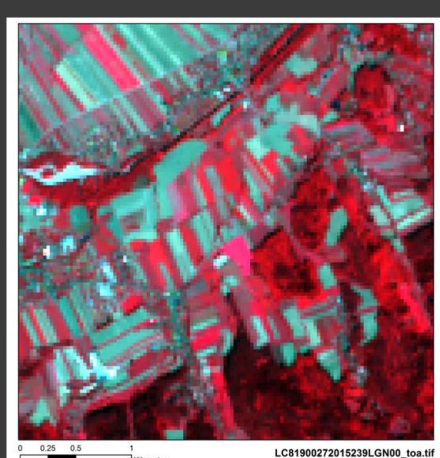
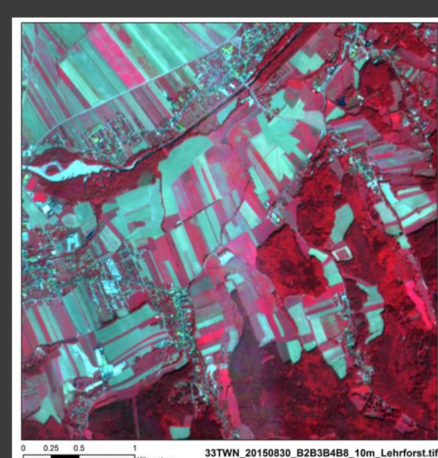
Spatial resolution of 10m

… THE ARRIVAL OF A GAME CHANGER …



Landsat @30m



Sentinel-2 @10m

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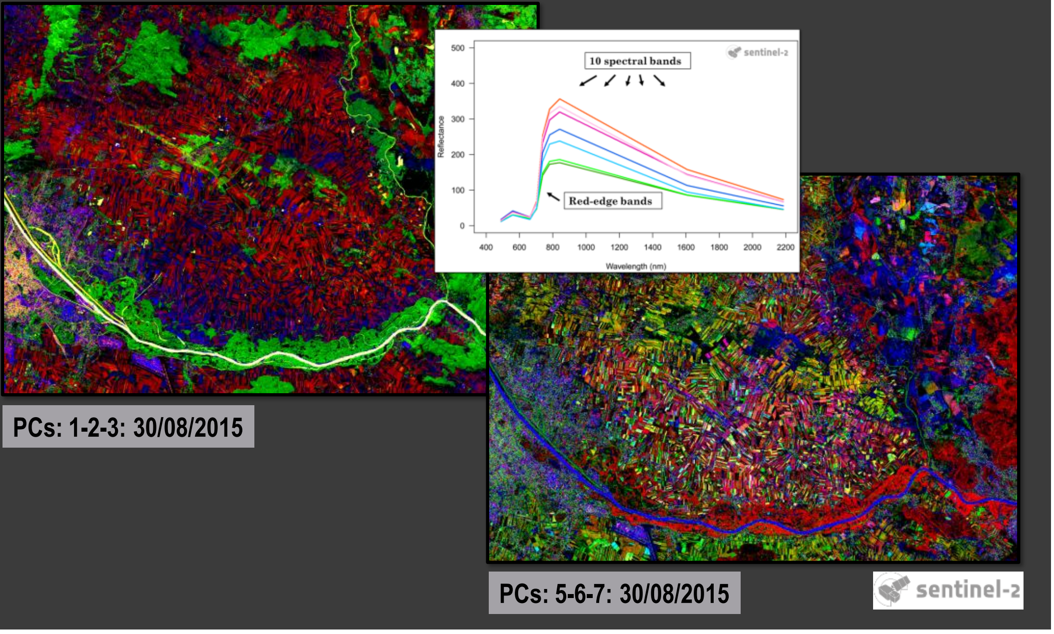
Rich and uncorrelated information

Single image

… THE ARRIVAL OF A GAME CHANGER …



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RADIATIVE TRANSFER MODELLING:

MAKING OPTIMUM USE OF FULL SPECTRAL INFORMATION

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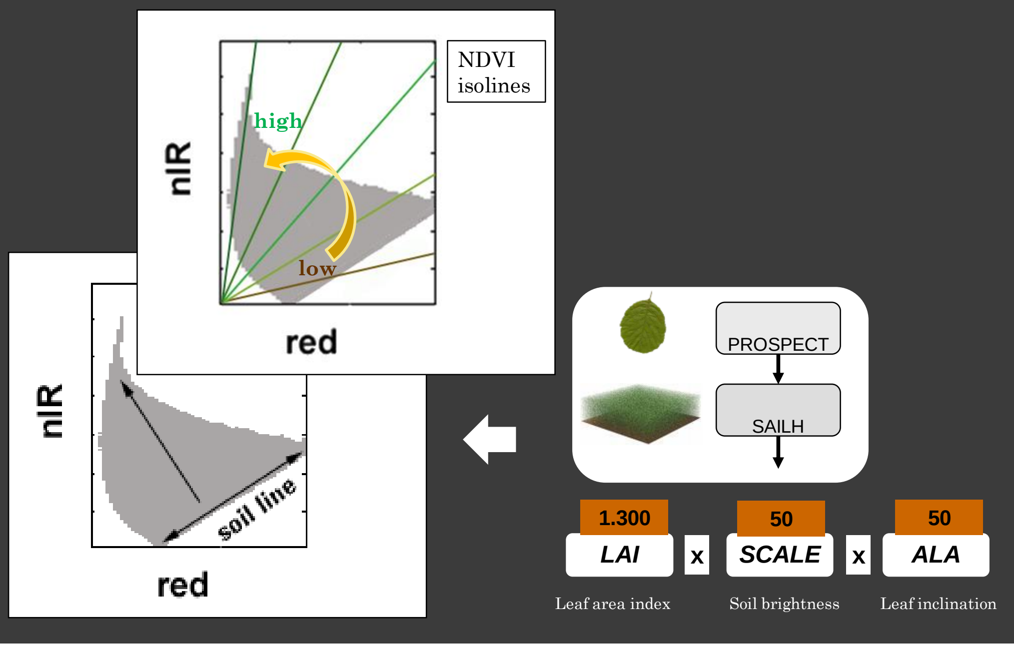
Whats wrong with (2-band) VIs ?

… RADIATIVE TRANSFER MODELING…



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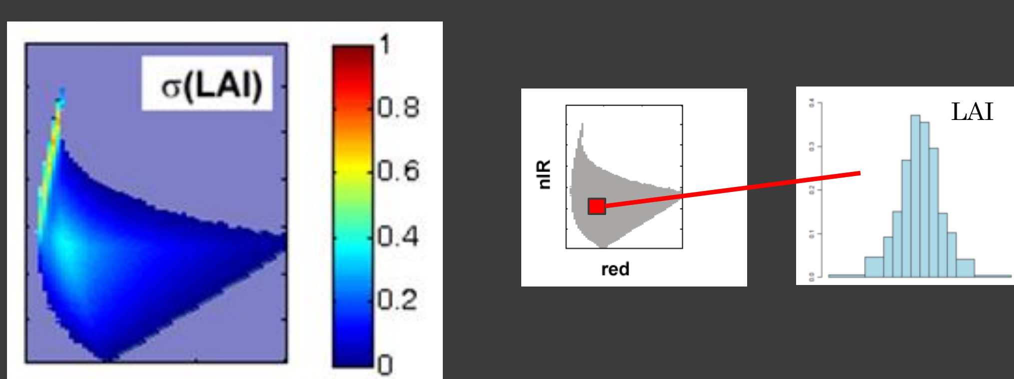
Whats wrong with (2-band) VIs ?

… RADIATIVE TRANSFER MODELING…



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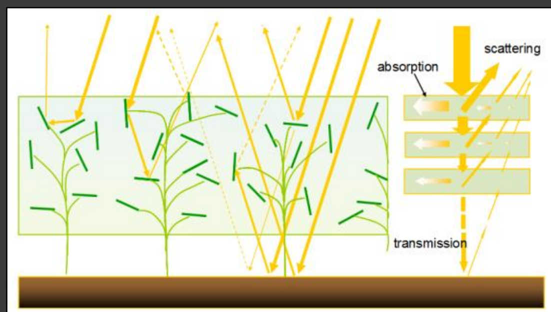
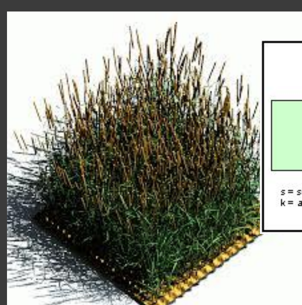
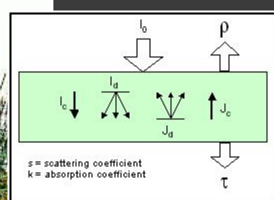
RTM based on physical principles

… RADIATIVE TRANSFER MODELING…



Jones & Vaugham, 2010





Radiative transfer modeling:

"Use of physical laws"

… therefore some advantages (in theory):
- Field data only for validation needed
- More generic (time, landscape)
- Not sensor specific
- Data redundancy not a problem

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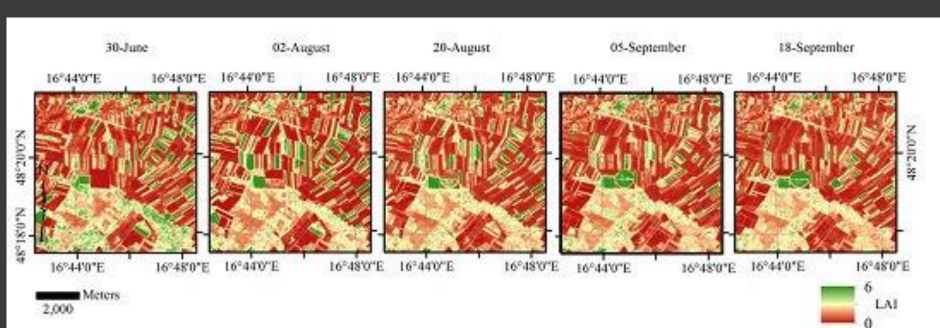
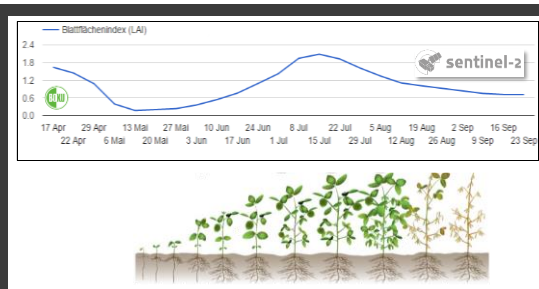
LAI validation

… RADIATIVE TRANSFER MODELING…





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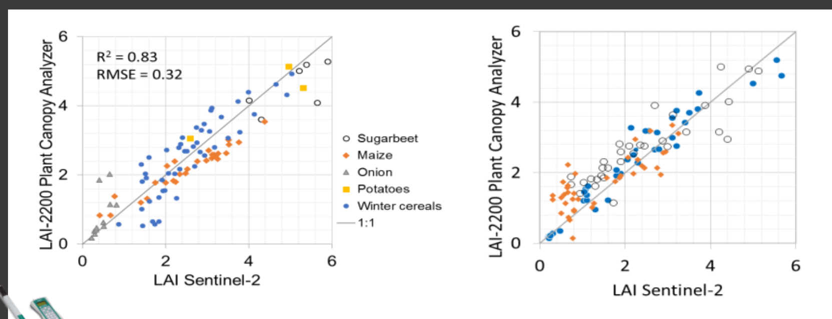
LAI validation

… RADIATIVE TRANSFER MODELING…



Validation of PROSAIL-derived LAI

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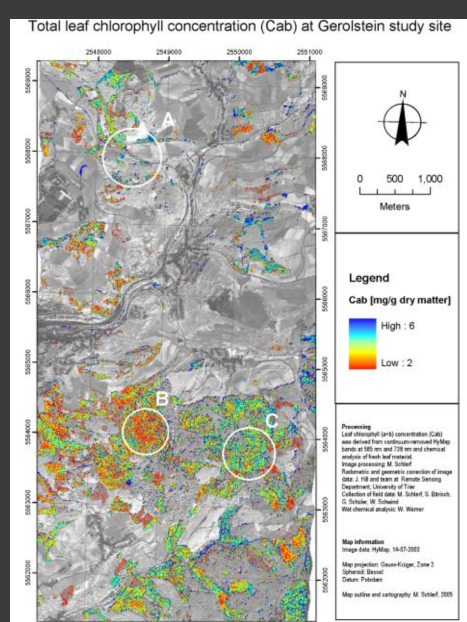
Chlorophyll validation

… RADIATIVE TRANSFER MODELING…



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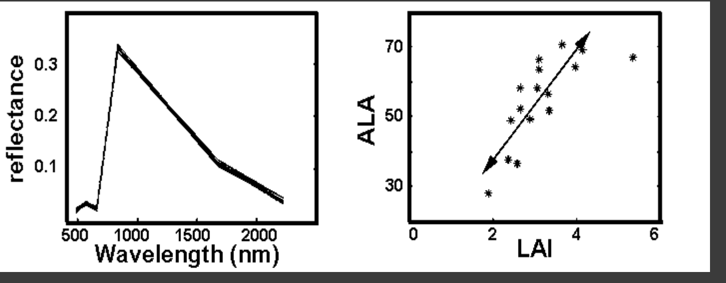
Solving the ill-posed inverse problem

… RADIATIVE TRANSFER MODELING…



The ill-posed inverse problem illustrated for a Landsat-TM sensor: (left): 15 different parameter combinations lead to ± similar canopy reflectance spectra (SAILH+PROSPECT simulations); (right): counterbalancing effect between average leaf angle (ALA) and leaf area index (LAI)

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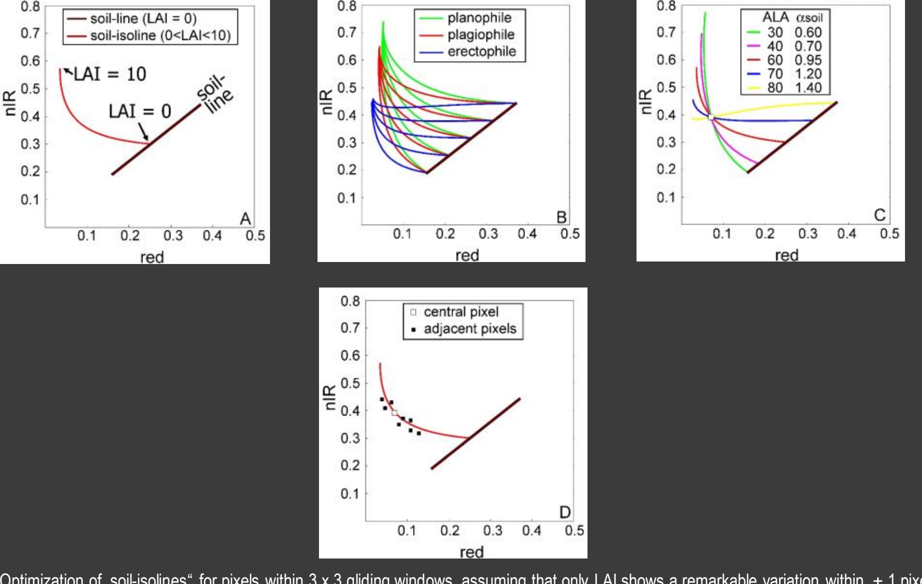
Solving the ill-posed inverse problem

… RADIATIVE TRANSFER MODELING…



Optimization of „soil-isolines“ for pixels within 3 x 3 gliding windows, assuming that only LAI shows a remarkable variation within ± 1 pixel

30

… CONCLUSIONS …

Vegetation indices (VI) only capture part of the available information ! … too much information is lost & no generalization

Radiative transfer models link crop types with spectral signatures ! … based on physical principles … & using all bands

Method transfer from (classical) Earth Observation to phenotyping is warranted … leveraging experience in EO

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Thank you!

CONTACT

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Institute of Surveying, Remote Sensing and Land Information

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http://s2.boku.eodc.eu/

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