UAVsoil: UAV borne spectrometers for high resolution soil and crop monitoring

Université catholique de Louvain

Bas van Wesemael, Kristof Van Oost, Fabio Castaldi

Centre Wallon de Recherches Agronomiques (CRA-W)

Viviane Planchon, Jean-Pierre Goffart, Dimitri Goffart, Yannick Curnel

## Deutsches GeoForschungsZentrum Potsdam (GFZ)

Sabine Chabrillat

REQUAFERTI : Method based on the provisional Nitrogen balance-sheet approach
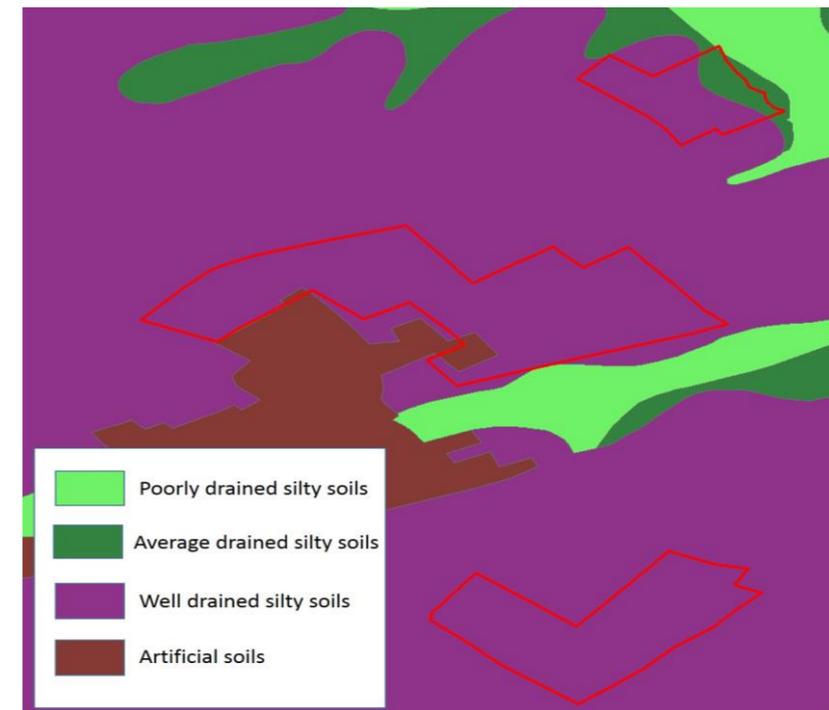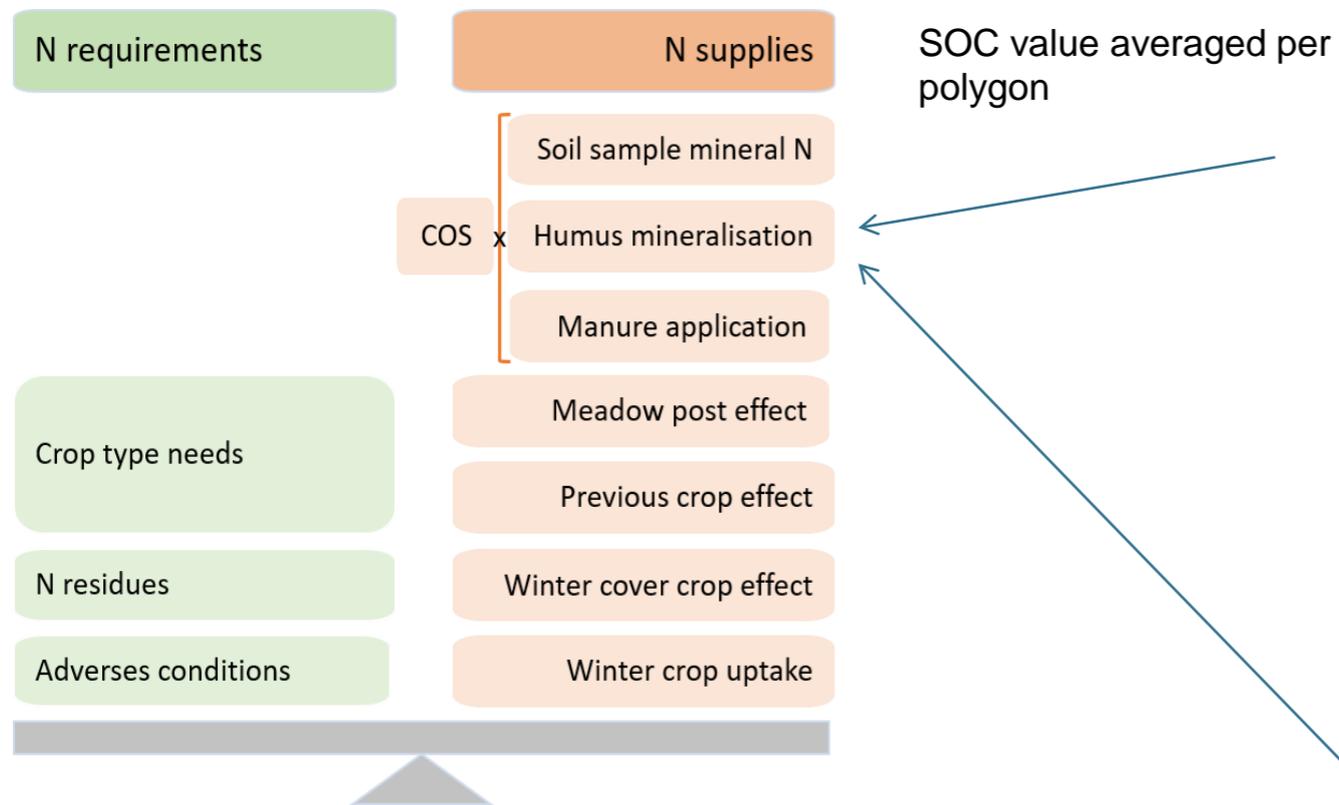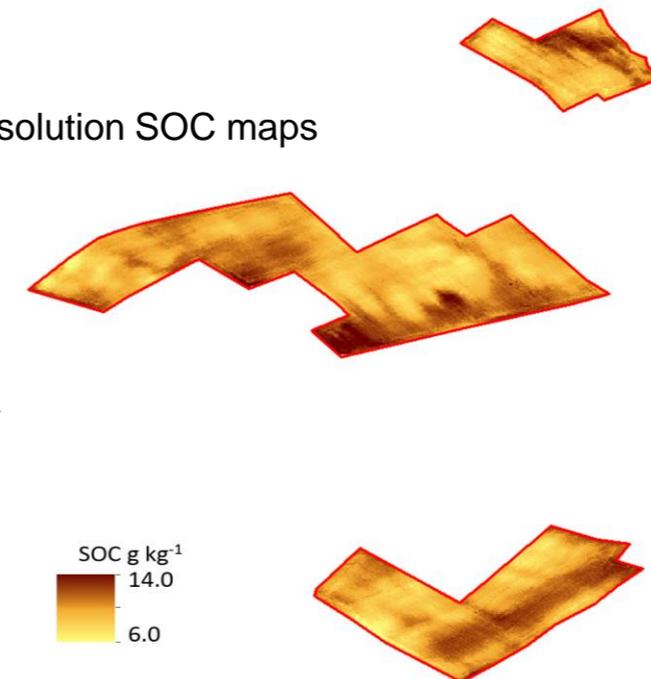
| N requirements | | N supplies |

SOC value averaged per polygon

COS x	Soil sample mineral N
	Humus mineralisation
	Manure application

| Crop type needs | Meadow post effect |
| | Previous crop effect |

| N residues | Winter cover crop effect |

| Adverses conditions | Winter crop uptake |

Parameters included in REQUAFERTI to determine
the total N recommendation for a given crop type

Legend:
- Poorly drained silty soils
- Average drained silty soils
- Well drained silty soils
- Artificial soils

High-resolution SOC maps

SOC g kg^{-1}
14.0
6.0

. High resolution soil property maps increase the efficiency of N fertilization by taking into account spatial variability of N supply from the soil.

Research question – Methodology – Expected outcome

1 Correlation soil and crop maps
2 Variability of N balances fed by high resolution soil property input

1: UAV spectrometer performance
2: Stable and unique calibrations

Wp 1 Data acquisition
APEX and UAV Imagery for Soil and crop parameters, validation data on c. 4 fields

Wp 3 UAV imagery for high resolution input data for fertilizer advice models
Calibration/validation of UAV sensing imagery
Stability of soil/crop patterns
Transfer to routine application

Wp 2 Soil and crop maps
Spatial correlation of crop parameters to soil characteristics
Performance of N balances using detailed soil parameters

Wp 5 Project management

Wp 4 Dissemination

WP 1 Data collection

Winter wheat and potato fields for Belgium are all located within the BELAIR HESBANIA strip (in the vicinity of Gembloux)

UCL – Earth & Life Institute

Wp 2 Soil and crop maps

SOC estimated + APEX Spectra

PLSR model

Validation accuracy

RMSE g kg^{-1}	RPD	RPIQ
0.6	1.6	1.5

SOC g kg^{-1}

16.0

2.0

Soil Organic Carbon prediction in croplands by airborne APEX images using LUCAS topsoil database

UCL Université catholique de Louvain

GFZ Helmholtz Centre POTSDAM
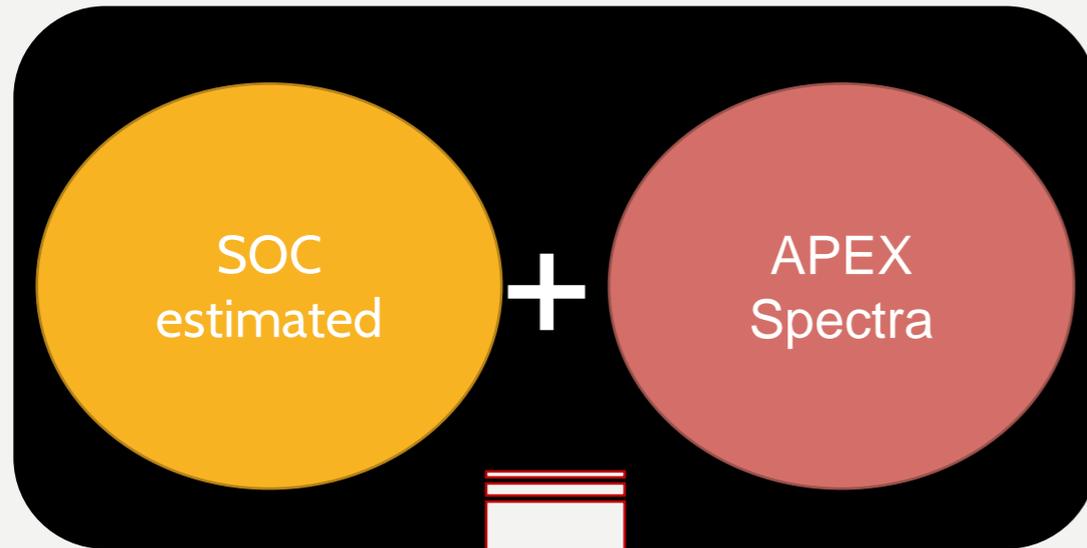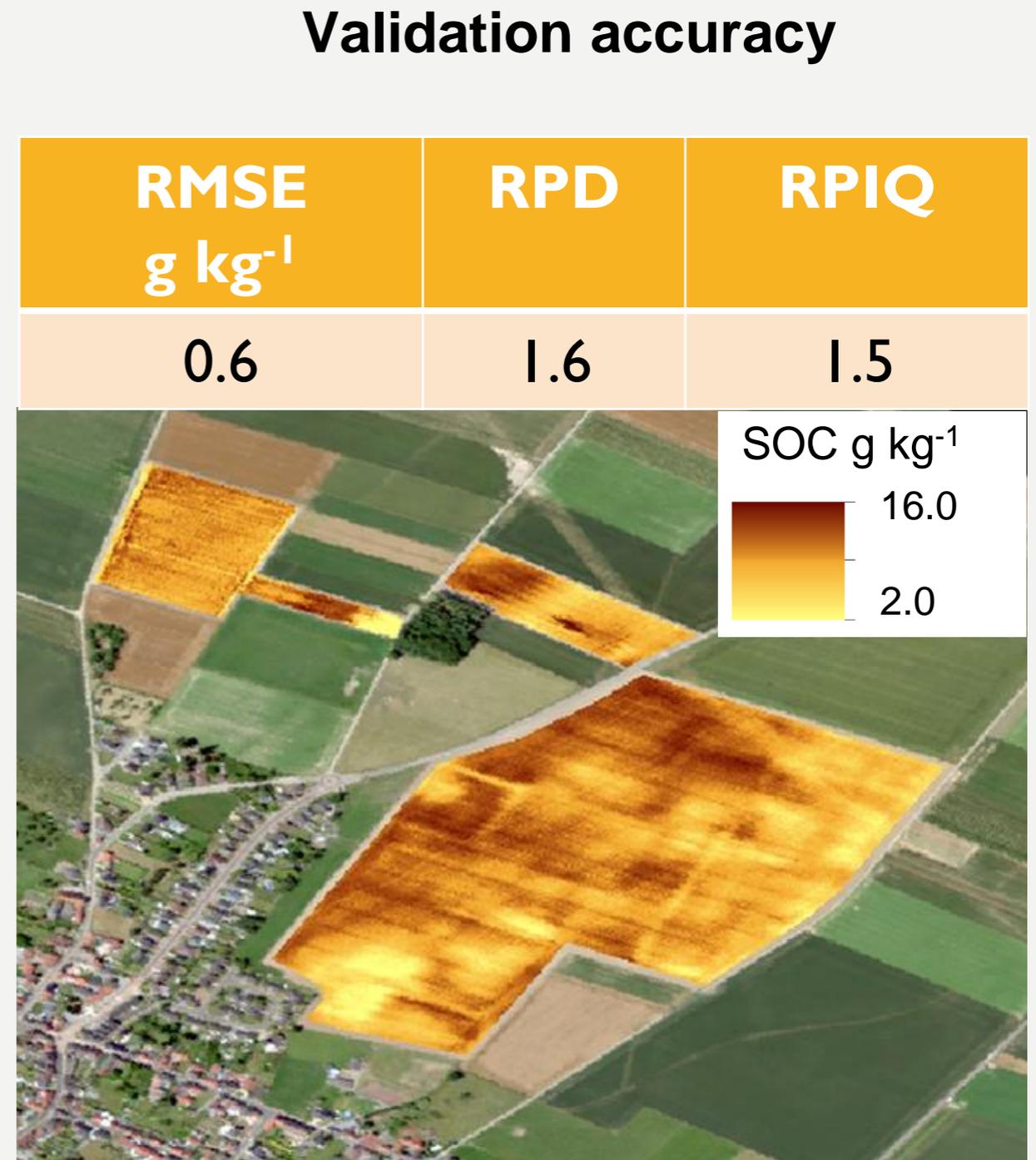
Wp 2 Crop maps
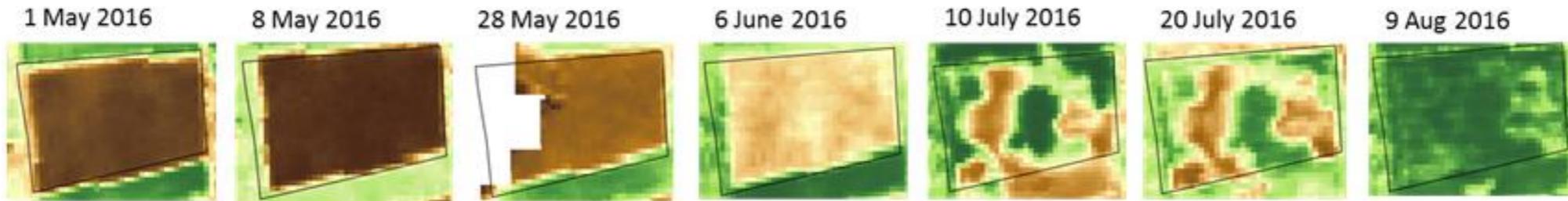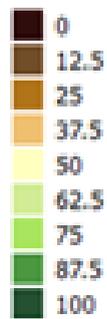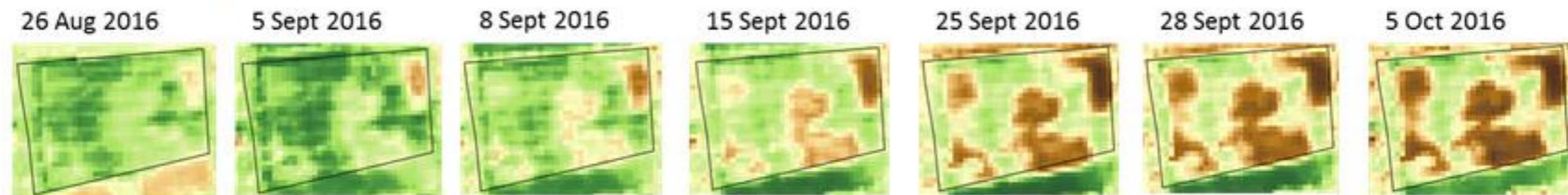
source : iPot project / WatchItGrow

Reference data from soil scans (source: CRA-W)

UCL – EARTH & LIFE INSTITUTE
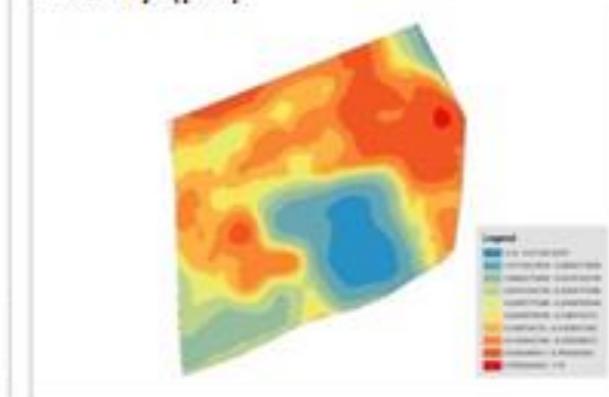
WP 3 UAV borne system

Flexibility of data acquisition: purposely selected fields and several stages before (bare soil) and during growing season

Less sensitive to weather conditions than airborne images

RAPAS

- Multispectral
- ILS
- GPS, IMU

- ILS
- OO Spectrometer (190-1100nm)
- RTK GPS, IMU
- Microcontroller

More stable calibrations from UAV borne spectrometers?

UAV: incoming light sensor and low altitude result in top of canopy reflectance

Airborne: Incoming light only measured in a single spot and atmospheric correction needed
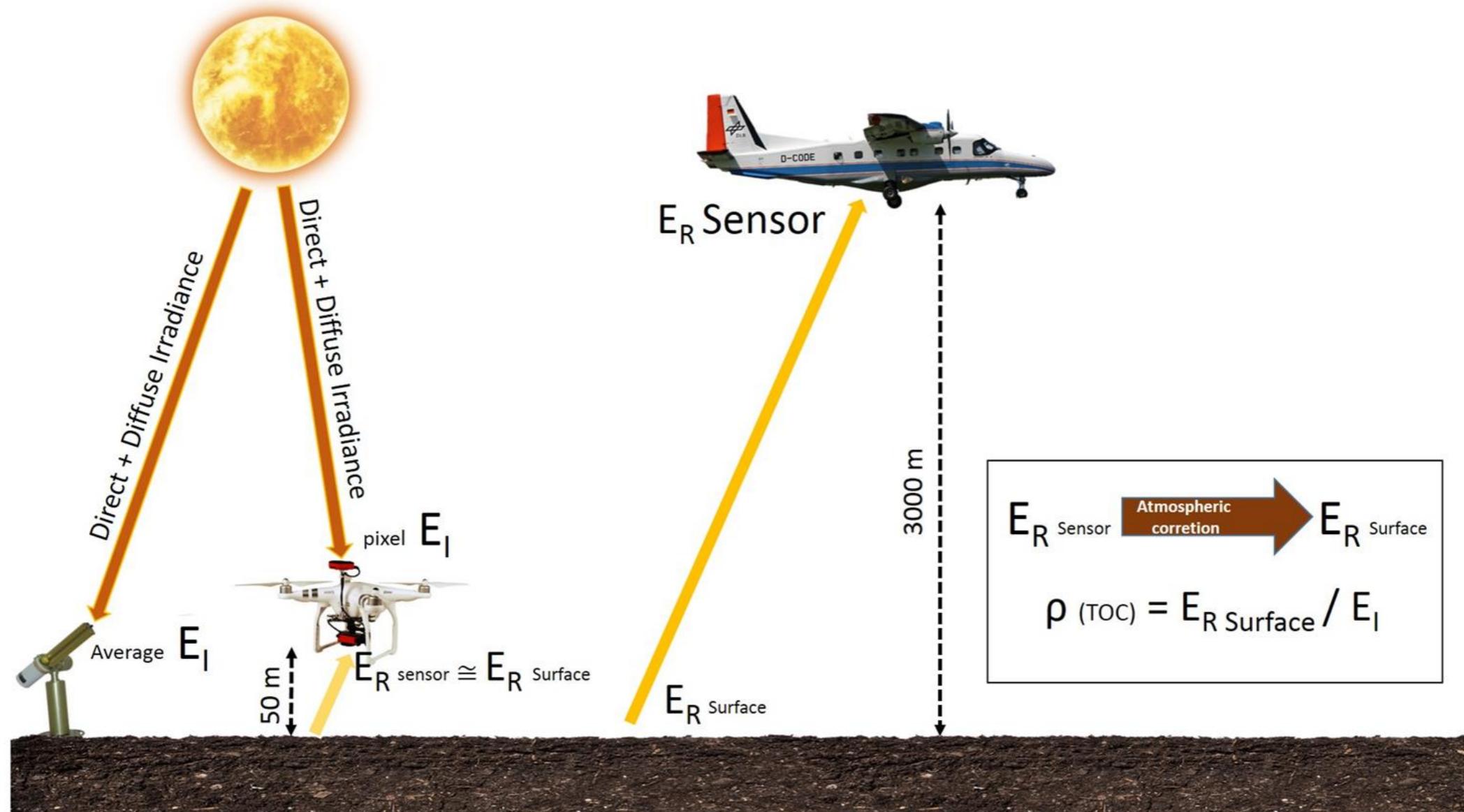
Calibration for SOC maps from UAV

INPUT

| Local spectral library | ⟷ | UAV Reflectance |

PLSR model ⟷ Bare soil fields

OUTPUT

SOC Maps
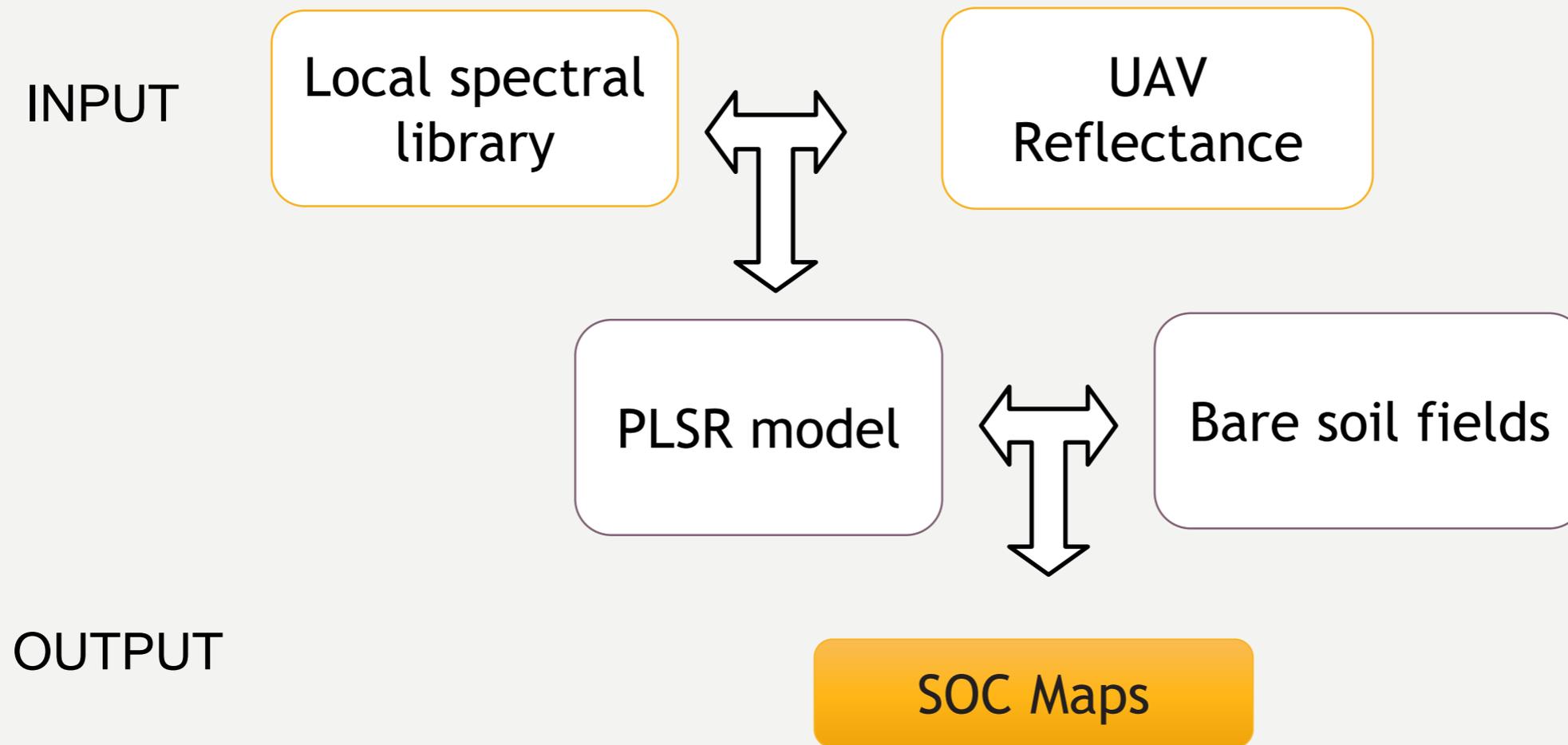
Validation on geo-referenced soil data
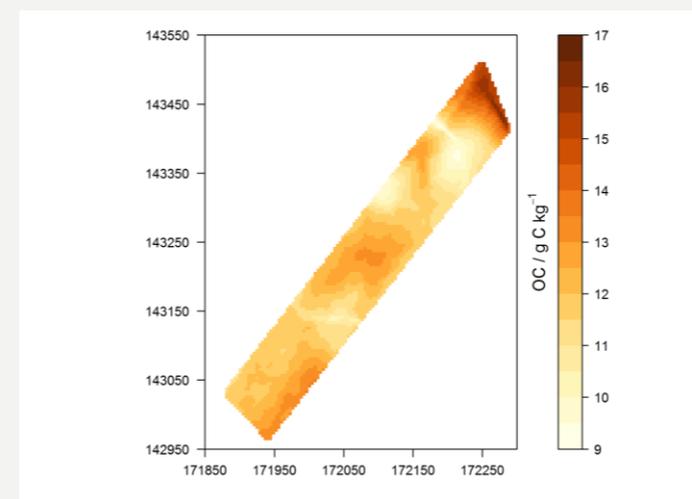
Validation of vegetation maps based on Ground- and tractor-based sensor data

Chlorophyllometer
SPAD/HNT
Transmittance

Fluorimeter
Dualex
Transmittance – Chlorophyll fluorescence

Fluorimeter
Multiplex
Chlorophyll fluorescence

Radiometer
Cropscan
Reflectance

Height of the crop

NORAC sensor

SPAD index	CHL index	SFR-R or SFR-G index	G et NormG indices
SPAD/FLV index	FLV index	FLAV Index	R et NormR indices
SPAD/FLAV index	NBI index	INBI-R or NBI-G index	NIR et NormNIR indices
			NDVI et GNDVI indices
			SAVI et GSAVI indices…

Yield of the crop
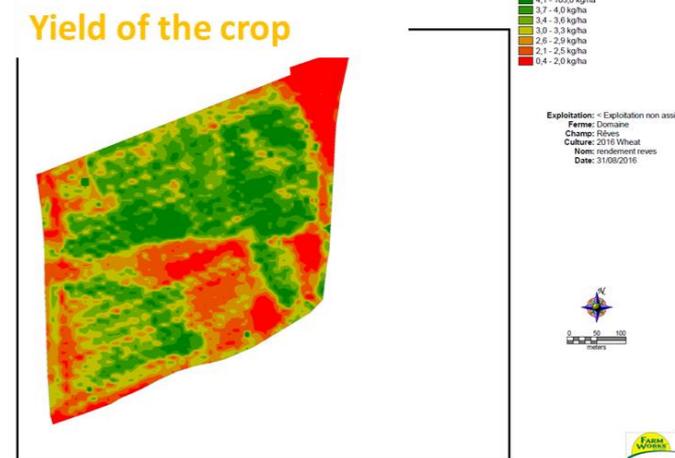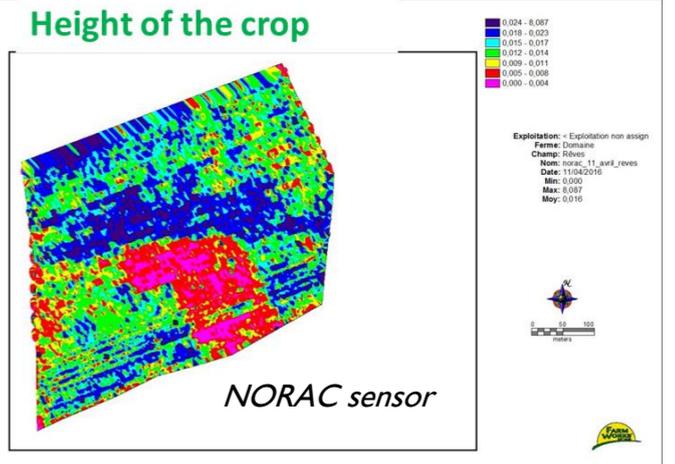
Leaf [chlorophylle]   Leaf [flavonoides]   Leaf [chlorophylle] and [flavonoides]

Source : VISA (CRA-W)

Electrical conductivity (EC)   Acidity (pH)
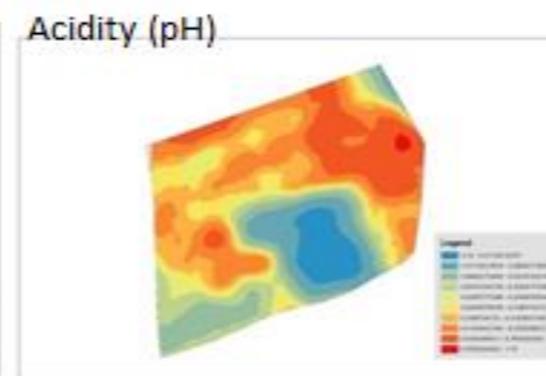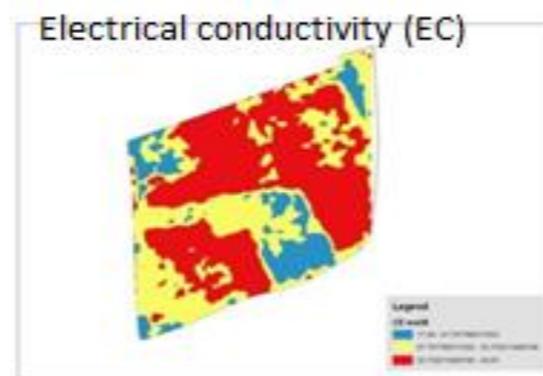
*Reference data from soil scans (source: CRA-W)*

Evaluation of the soil/crop patterns for N balance

Stable crop/soil patterns
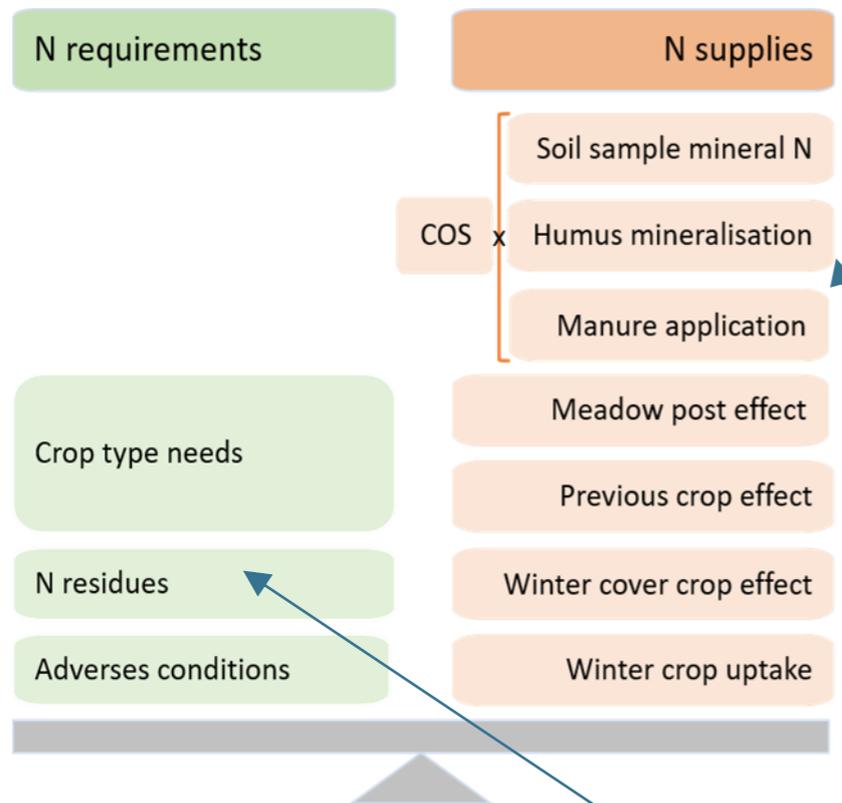
N requirements

N supplies

Soil sample mineral N

COS x Humus mineralisation

Manure application

Crop type needs

Meadow post effect

Previous crop effect

N residues

Winter cover crop effect

Adverses conditions

Winter crop uptake

Parameters included in REQUAFERTI to determine
the total N recommendation for a given crop type

Sentinel-2 of 20 Aug 2016

Greenness index

	0
	12.5
	25
	37.5
	50
	62.5
	75
	87.5
	100
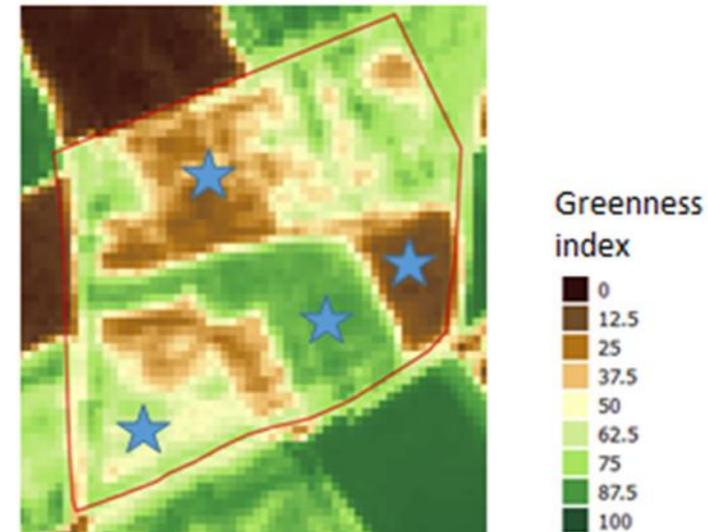
Within-field variability: spatially explicit humus mineralization vs homogeneous mineralization

Patterns of N residues after the growing season correspond to crop/soil patterns?

UCL – EARTH & LIFE INSTITUTE

WP 4 Dissemination

Professionals

Member of Requasud network in steering committee
Drone Days expo c. 6000 visitors
BELCAM user meetings
Greenotec: workshop on optimization of yield and
fertilizer use for c. 150 members mostly farmers

Fellow scientists

Presentations at scientific conferences such as EARSEL,
EGU, Pedometrics …

UCL – Earth & Life Institute
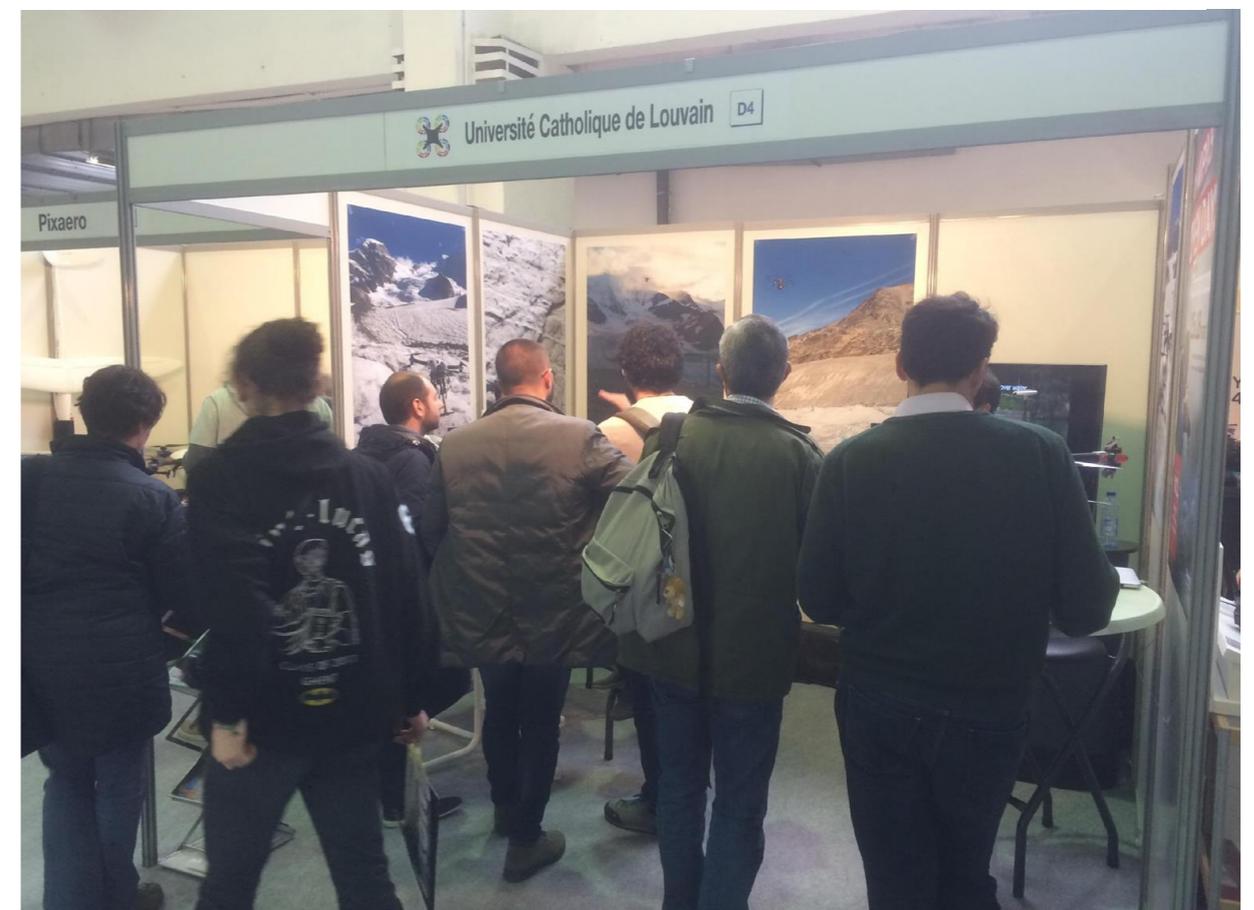
N Supply: SOC (or SON) determines mineralization to a large extend

Quantifying *in situ* and modeling net nitrogen mineralization from soil organic matter in arable cropping systems

CrossMark

Hugues Clivot [a,*], Bruno Mary [a], Matthieu Valé [b], Jean-Pierre Cohan [c], Luc Champolivier [d], François Piraux [c], François Laurent [c], Eric Justes [e,**]

[a] INRA, UR 1158 AgroImpact, site de Laon, F-02000 Barenton-Bugny, France
[b] AUREA, F-45160 Ardon, France
[c] ARVALIS - Institut du Végétal, F-91720 Boigneville, France
[d] Terres Inovia, Centre INRA de Toulouse, CS 52627, F-31326 Castanet-Tolosan Cedex, France
[e] INRA, UMR INRA/INPT 1248 AGIR, Auzeville, CS 52627, F-31326 Castanet-Tolosan Cedex, France

ARTICLE INFO   ABSTRACT

Within-field variation of SOC:
5-10 g C kg^{-1} : i.e. 18-36 Mg C ha^{-1}
Vp (potential N mineralization):
0.2-0.4 kg N ha^{-1} nday^{-1} or 20-40 kg N
over the growing season

UCL – EARTH & LIFE INSTITUTE
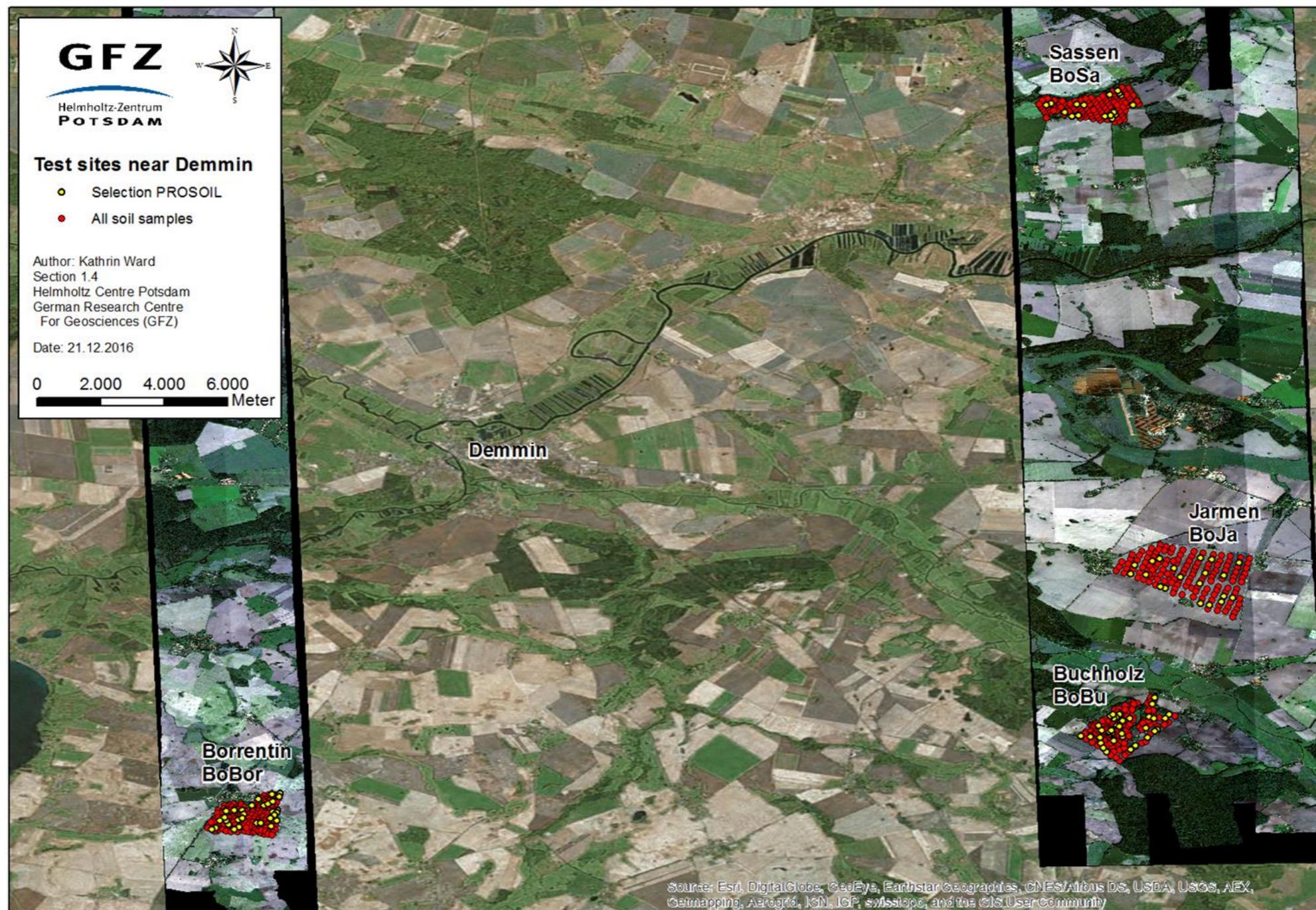
DEMMIN / TERENO area in North-Eastern Germany (53°52' N; 13°13'E) with16 fields winter and summer crops and wheat/corn rotations.

UCL – EARTH & LIFE INSTITUTE