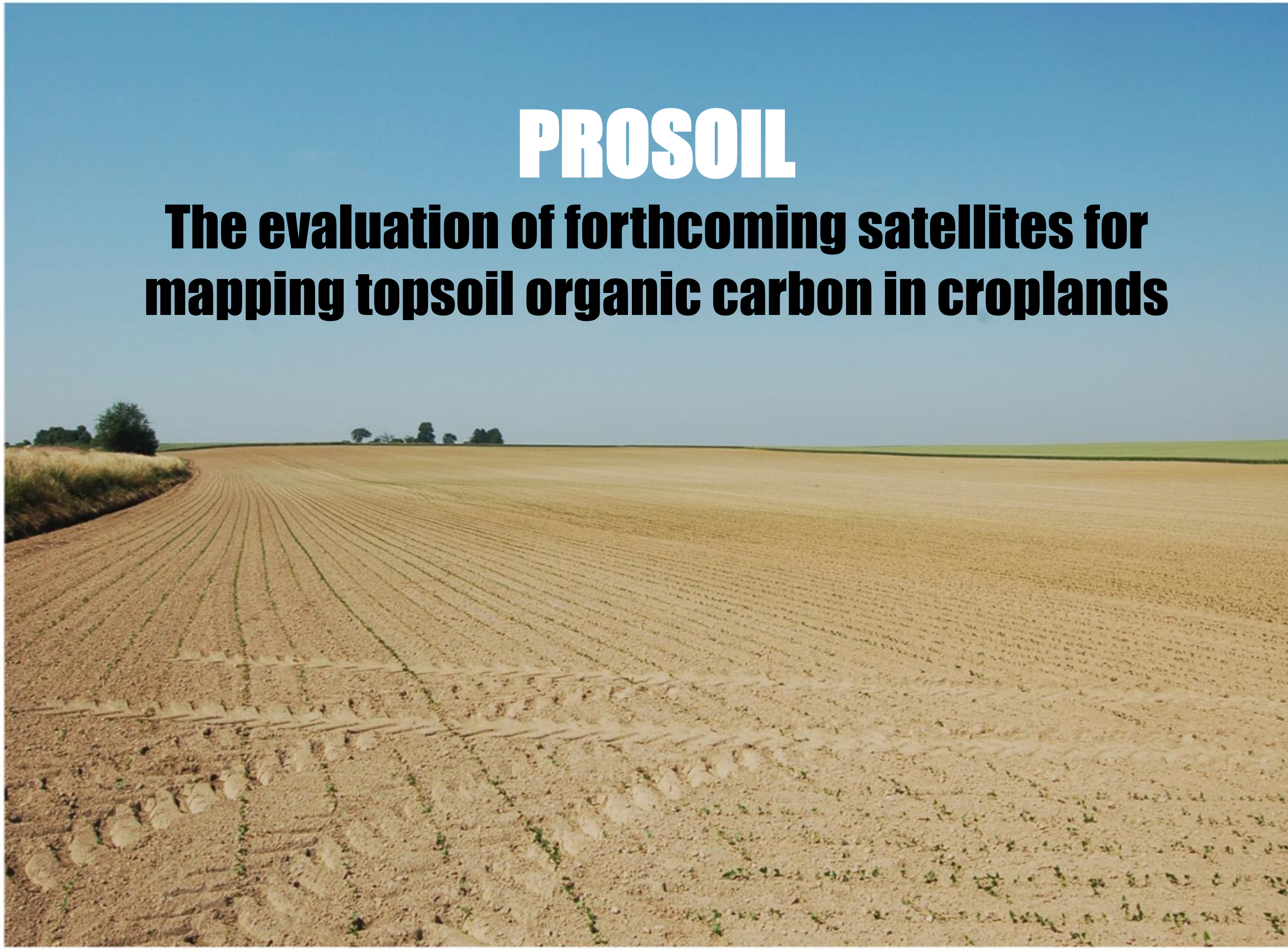
PROSOIL

The evaluation of forthcoming satellites for mapping topsoil organic carbon in croplands



UCL

UNIVERSITÉ CATHOLIQUE DE LOUVAIN

GFZ Helmholtz Centre Potsdam

Belgian Science Policy

OBJECTIVES

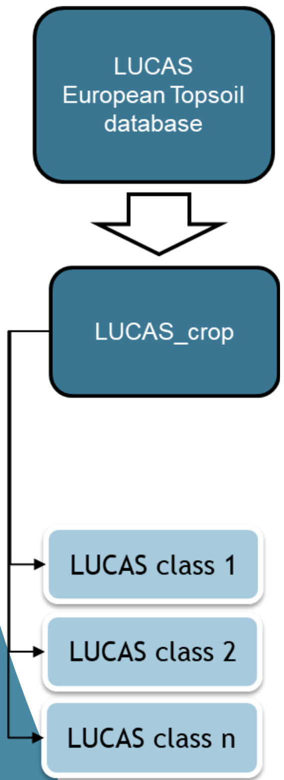
To develop methods to produce up-to-date soil property data through multivariate calibration (MVC) of the signal from the new generation of satellites.

1. Develop MVC models that are applicable for large areas using a continental scale and harmonized SSL

2. Propose a standardized procedure for the processing of RS imagery through MVC based on laboratory SSL.
   a) Validate the derived soil products.
   b) Evaluate the effects of degraded satellite signals on the prediction accuracy

A routine chemometrics approach

The objective is to test whether the LUCAS can be used to estimate SOC without a need for additional chemical analysis



1. Classification of the LUCAS samples collected in croplands

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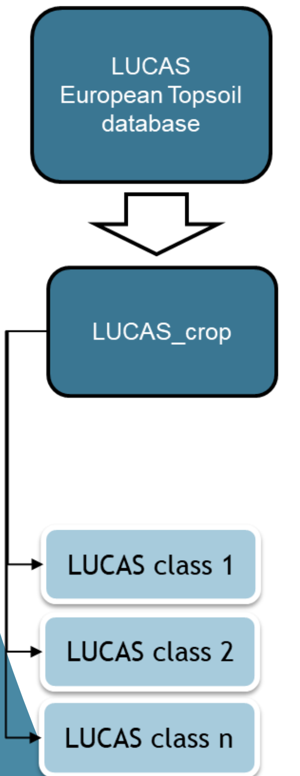
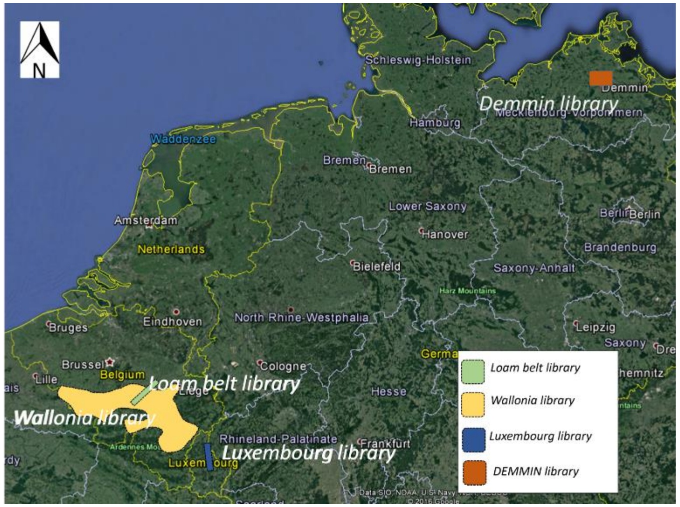


Local spectral library

1. Classification of the LUCAS samples collected in croplands
2. Classification of local libraries according to the LUCAS classes



A routine chemometrics approach

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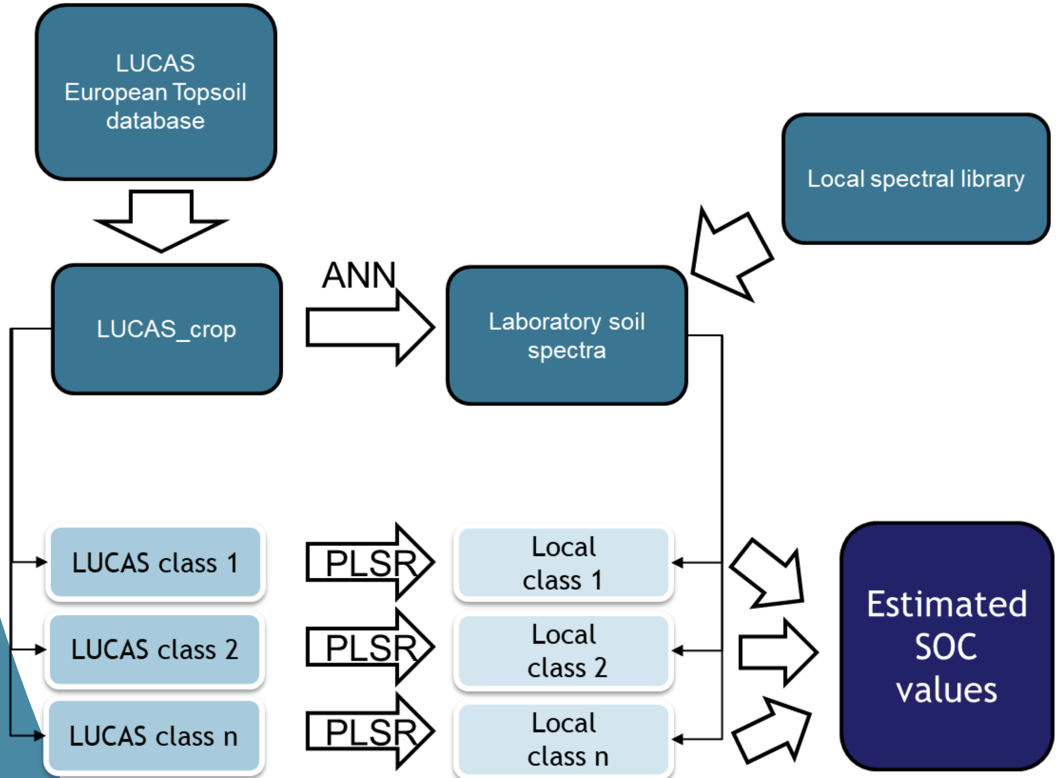
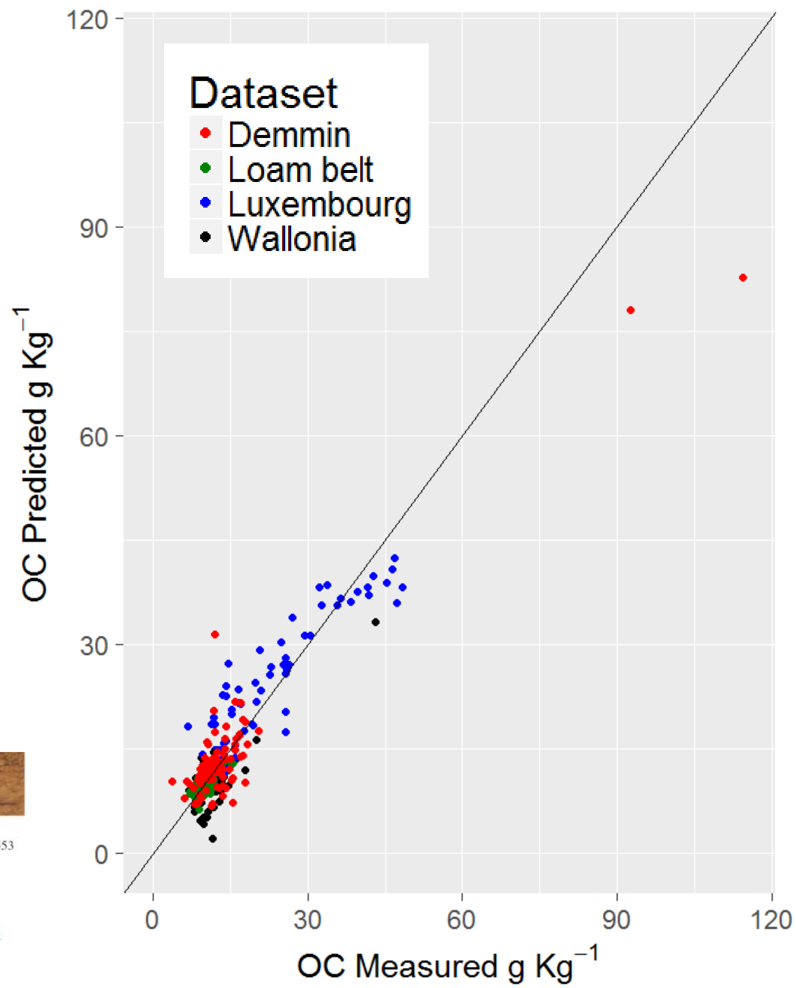


1. Classification of the LUCAS samples collected in croplands
2. Classification of local libraries according to the LUCAS classes
3. Calibration of PLSR models for each LUCAS class detected in the first step
4. Estimation of SOC content applying the LUCAS calibration models of a specific soil class

SOC estimation

Validation Dataset	RMSE	RPD
Loam belt	1.2	1.41
Wallonia	3.2	1.45
Luxembourg	5.1	2.24
Demmin	5.3	2.72
All	**4.2**	**2.63**



European Journal of Soil Science

European Journal of Soil Science, 2018

doi: 10.1111/ejss.12553

Estimation of soil organic carbon in arable soil in Belgium and Luxembourg with the LUCAS topsoil database

F. Castaldi[a], S. Chabrillat[b], C. Chartin[a], V. Genot[c], A. R. Jones[d] & B. van Wesemael[a]

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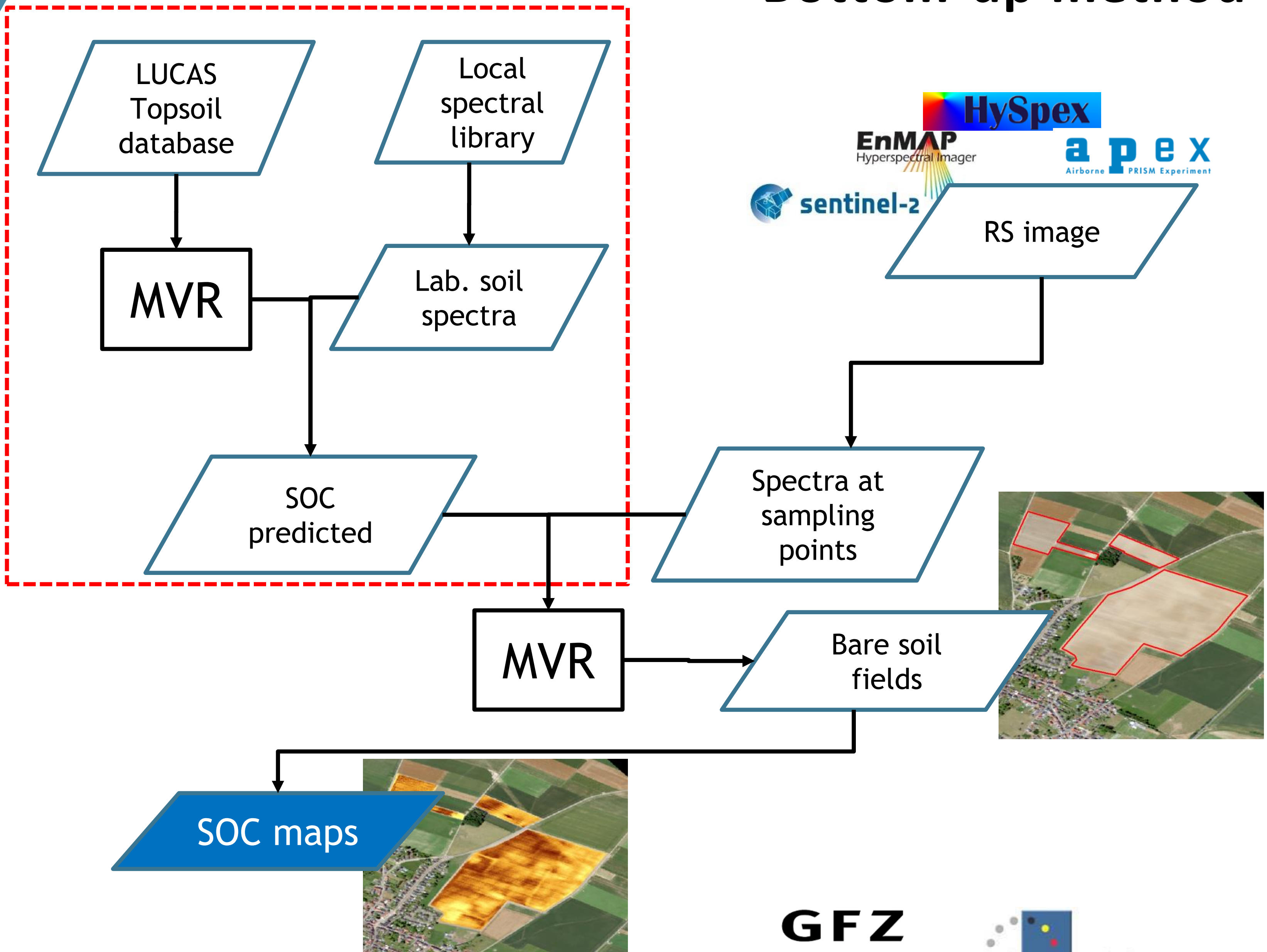
Université catholique de Louvain

Helmholtz Centre Potsdam

Belgian Science Policy

Bottom-up method



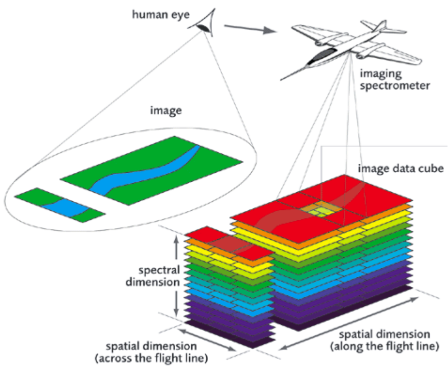
Bottom-up method

At sampling points

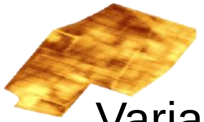
LUCAS

Local Spectral library

SOC
Clay
Sand
CaCO3
N
P
…

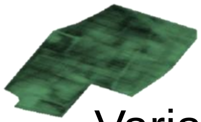


Maps



Variable 1

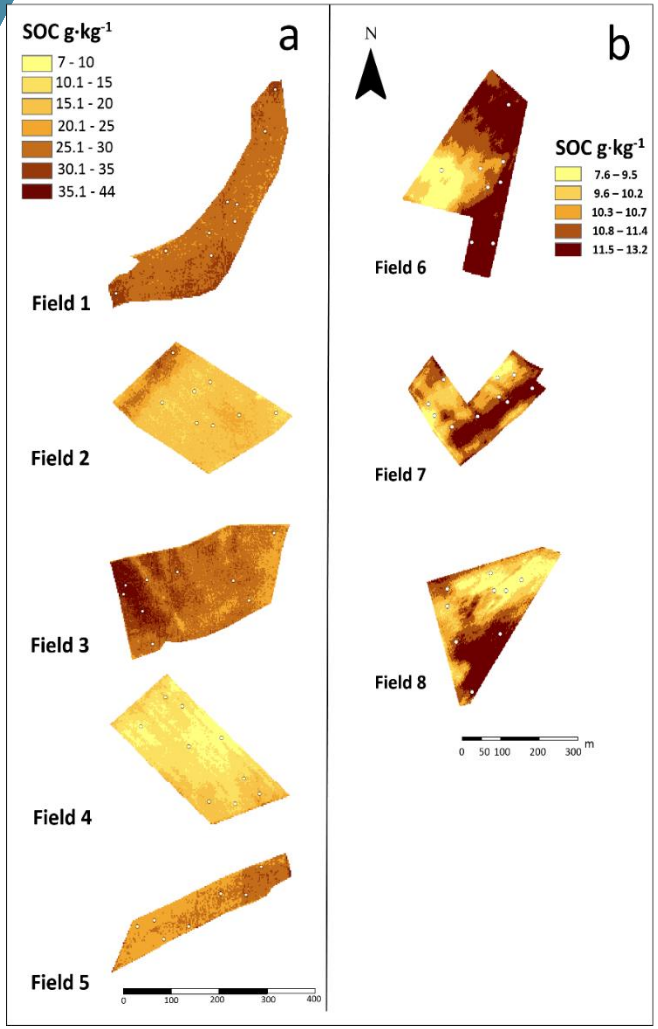
Variable 2



Variable 3

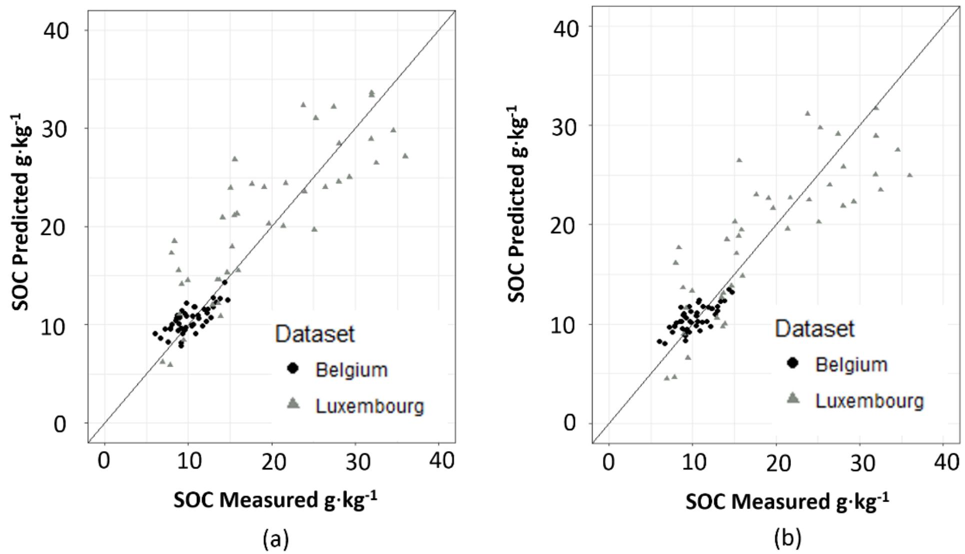
Airborne - APEX

Validation

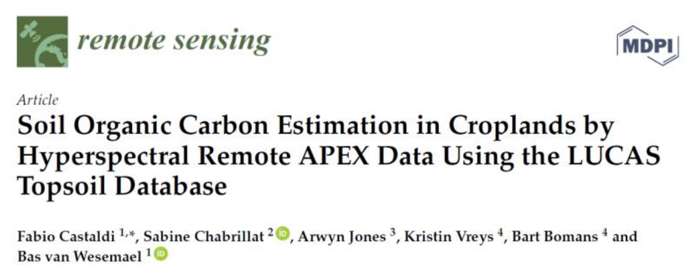


TRADITIONAL

BOTTOM-UP



	Traditional Approach		Bottom-Up Approach	
	Validation Dataset		Validation Dataset	
	RMSE g·kg^{-1}	RPD	RMSE g·kg^{-1}	RPD
Luxembourg	4.9	**1.7**	4.9	**1.7**
Loam belt	1.5	**1.4**	1.5	**1.4**
Total	3.6	**2.1**	3.6	**2.1**



remote sensing

MDPI

Article

Soil Organic Carbon Estimation in Croplands by Hyperspectral Remote APEX Data Using the LUCAS Topsoil Database

Fabio Castaldi [1,*], Sabine Chabrillat [2], Arwyn Jones [3], Kristin Vreys [4], Bart Bomans [4] and Bas van Wesemael [1]

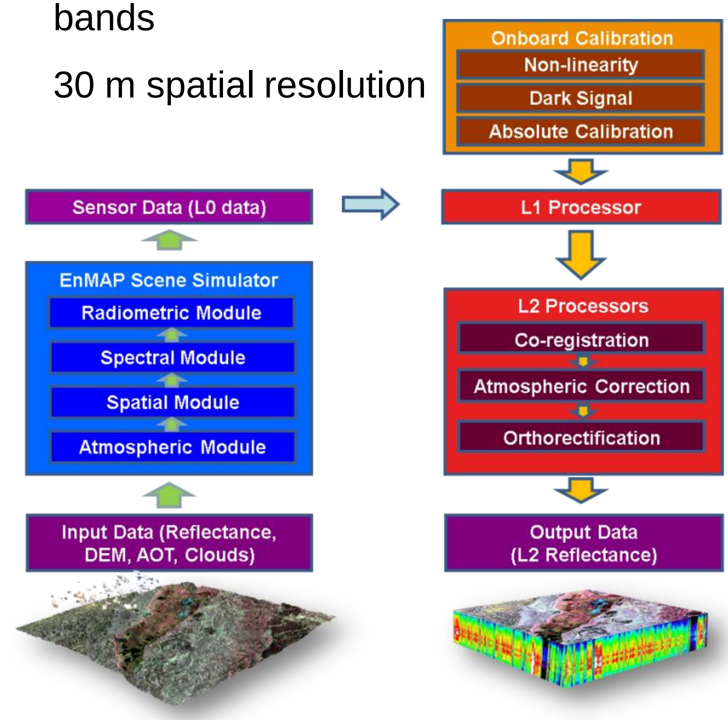
Airborne data

HySpex
SR: 4 m
408 bands
418 – 2498 nm

EnMap simulations

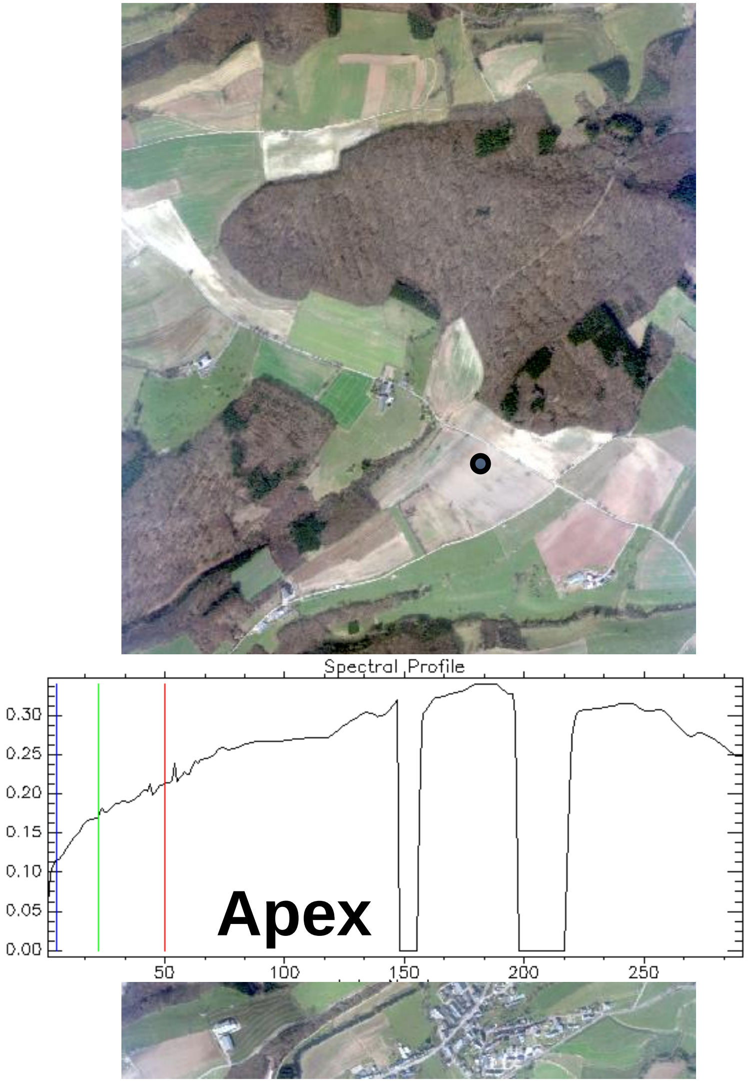
EnMap imager

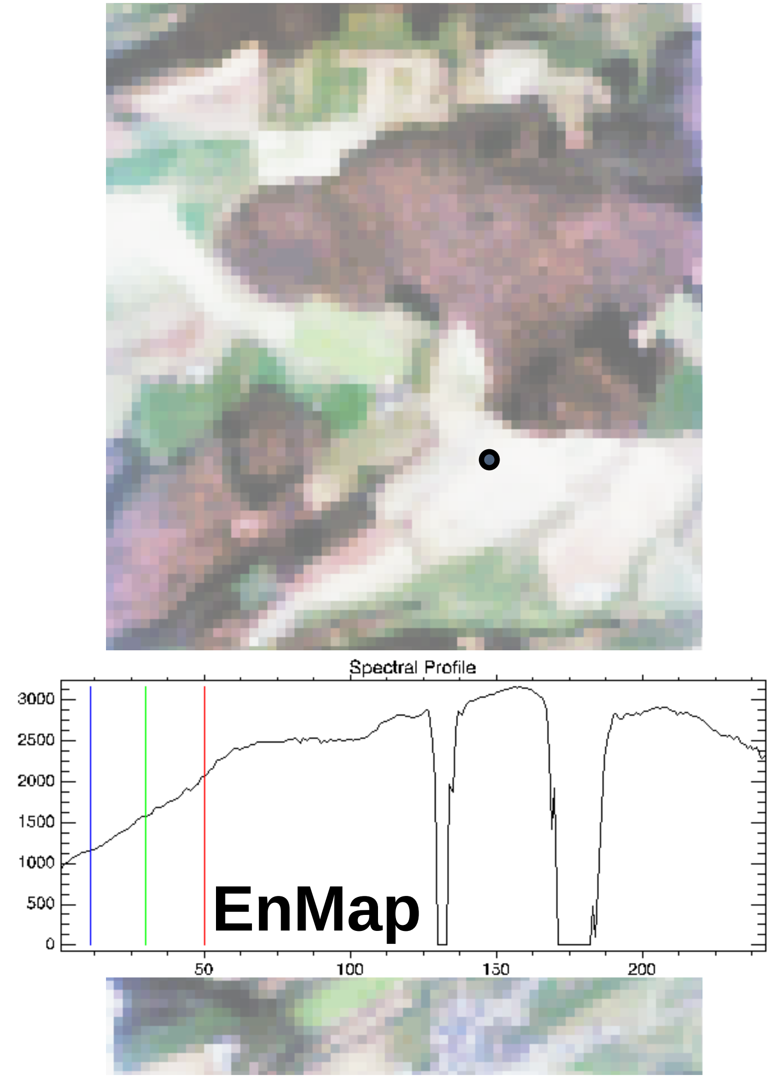
- Spectral range from 420 nm to 2450 nm (**VNIR-SWIR**)
- **high spectral resolution** of 6.5 nm (VNIR) and 10 nm (SWIR); ~ 240 bands
- 30 m spatial resolution



EeteS processing scheme

EnMap simulations

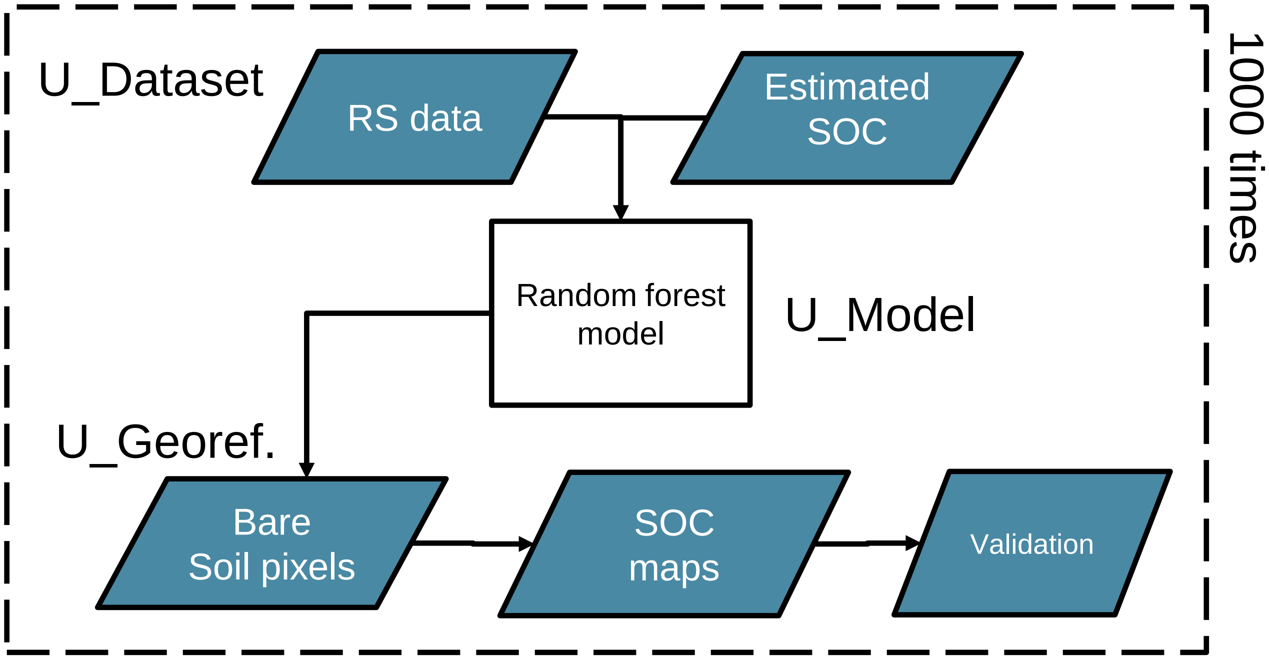




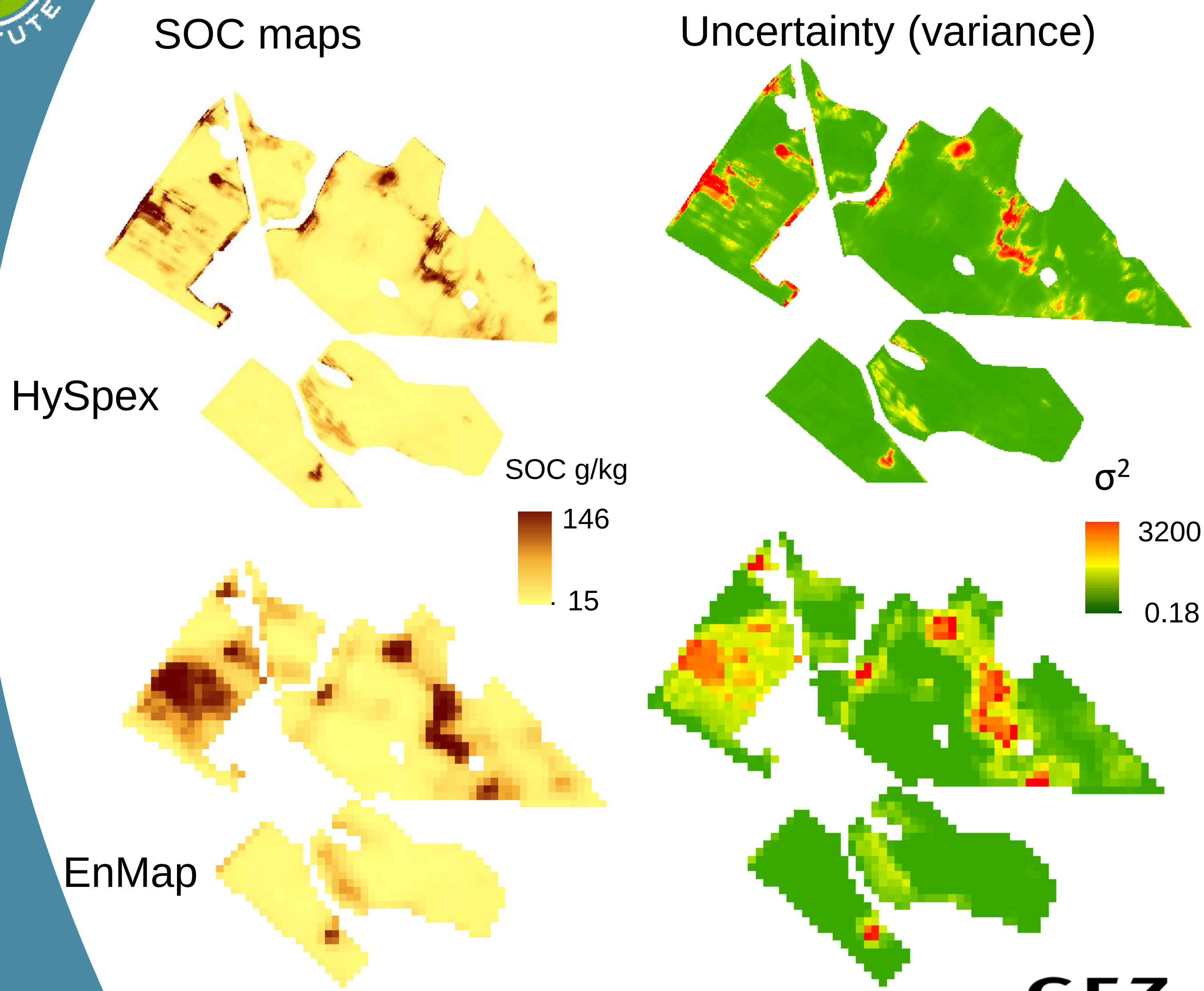
HySpex and Simulated EnMap

The HySpex and simulated EnMap data in Demmin site were used to assess the uncertainty of the SOC maps retrieved by the bottom-up approach

- Uncertainty due to the choice of the calibration dataset
- Uncertainty due to the prediction model
- Uncertainty due to the georeferencing error



Simulated EnMap



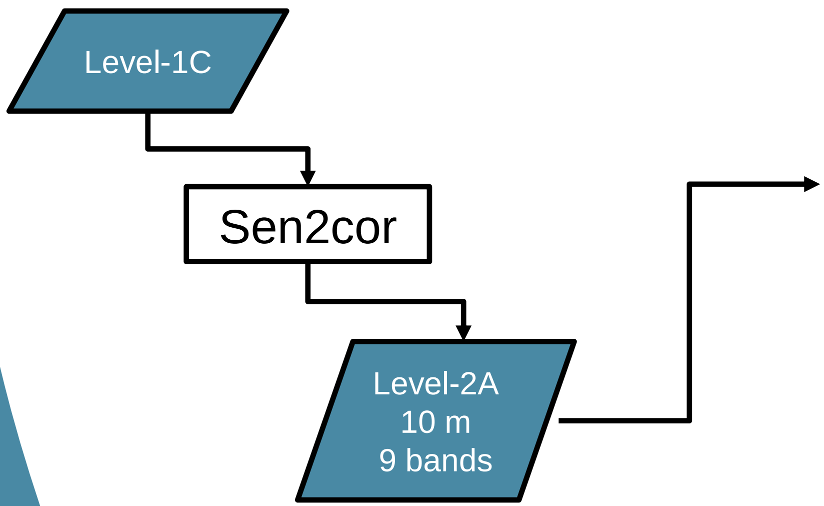
Validation
(71 points/ 10 fields)

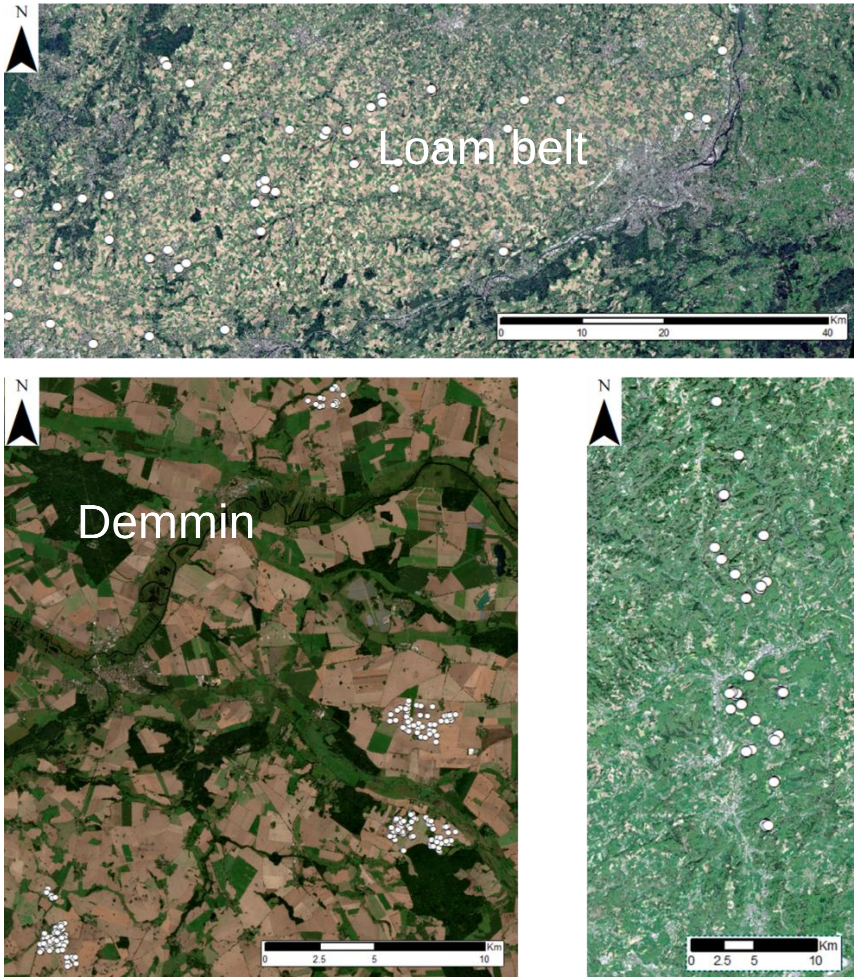
$\overline{RPD}$: 1.7

$\overline{RPD}$: 0.6

Sentinel-2 images

Study area	Acquisition date Sentinel-2
Luxembourg	2016/05/08
Demmin	2017/08/30
Loam belt	2017/08/29





B2 (490 nm), B3 (560 nm), B4 (665 nm), B5 (705 nm), B6 (740 nm), B7 (783 nm), B8 (842 nm), B11 (1610 nm) and B12 (2190 nm).

EARTH & LIFE

Sentinel 2

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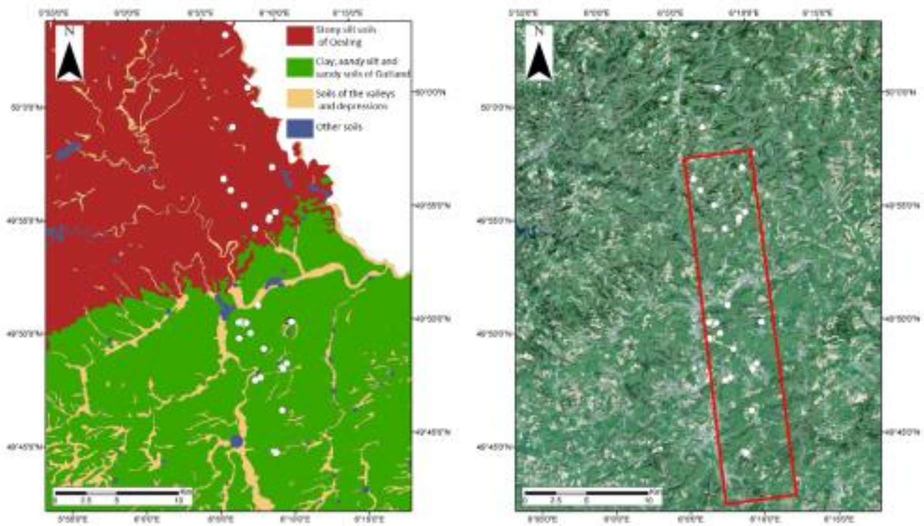
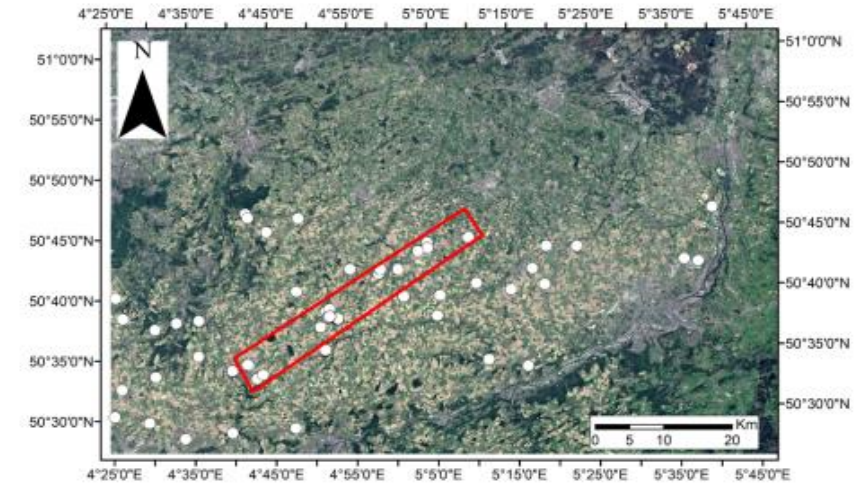


c)



We compared the Sentinel-2 prediction accuracy with that obtained by hyperspectral airborne data in the same study area

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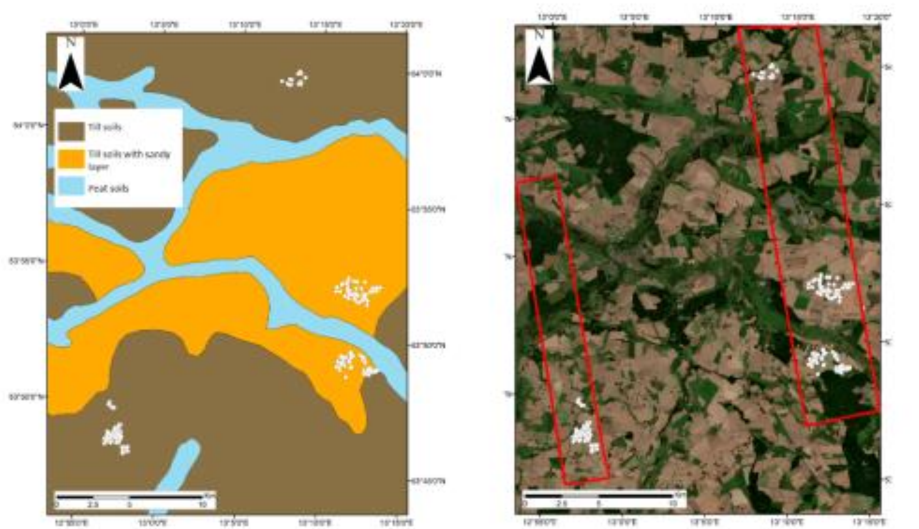
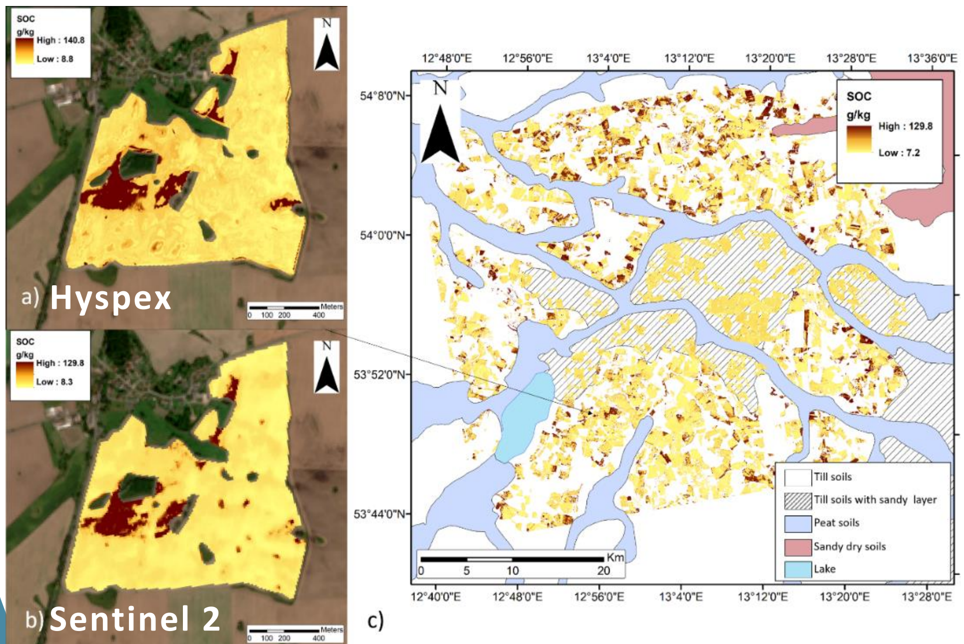
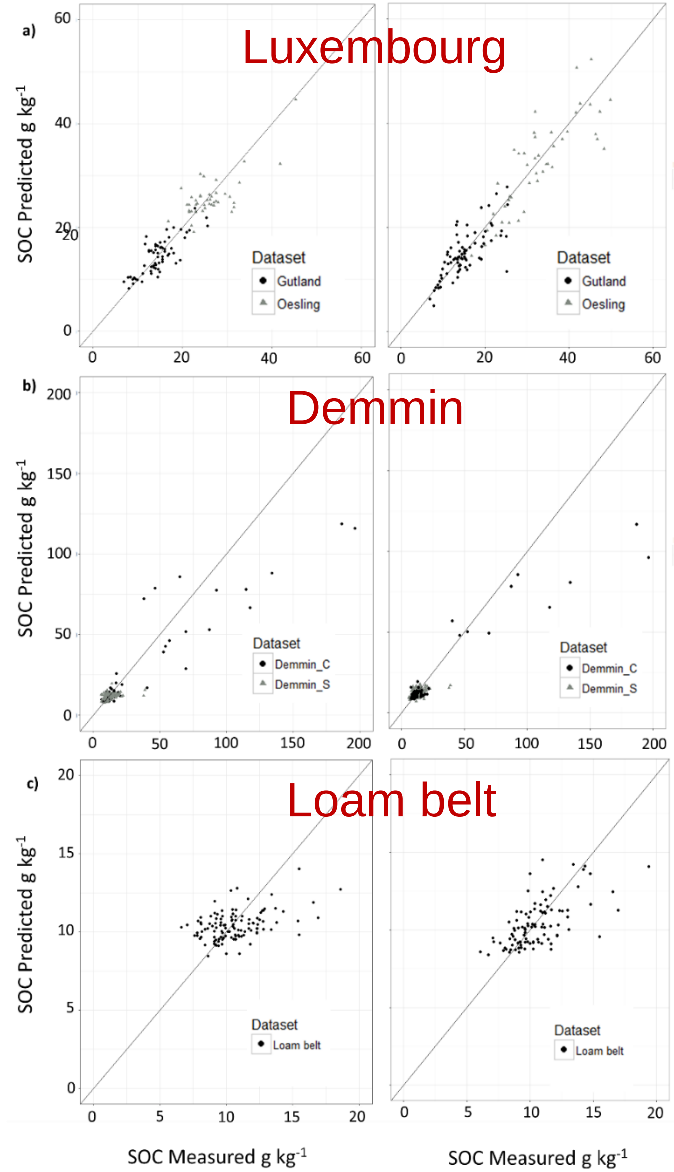


- Multispectral S2, hyper airborne, resampled S2
- We investigated the importance of spectral and spatial resolution
- SNR, VIP and spatial variability (infield, regional)

Sentinel 2

Study area	Sentinel-2			Airborne hyperspectral		
	n°	RMSE g kg-1	RPD	n°	RMSE g kg-1	RPD
Luxembourg	107	3.0	2.6	119	4.0	2.7
Demmin	180	12.2	2.2	214	10.6	2.1
Loam belt	115	1.9	1.1	98	1.7	1.3





Evaluating the capability of the Sentinel 2 data for soil organic carbon prediction in croplands.

(Under review - ISPRS Journal of Photogrammetry and Remote Sensing)

REALISATION OF OBJECTIVES

- Reproducible approach to estimate SOC in arable soils with a satisfactory level of accuracy with only the spectra of soil samples and without the need for further laboratory analyses, using LUCAS
- We developed the bottom-up approach that allows transfering soil information from a continental library to remote sensing data, bypassing the issues related to spectral transfer.
- We validated the soil products
- We evaluated the effects of degraded satellite signals on SOC prediction accuracy (Airborne/Sentinel-2/EnMAP)


Thank you