High resolution Soil Moisture mapping in the LIAISE domain

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Under the supervision of
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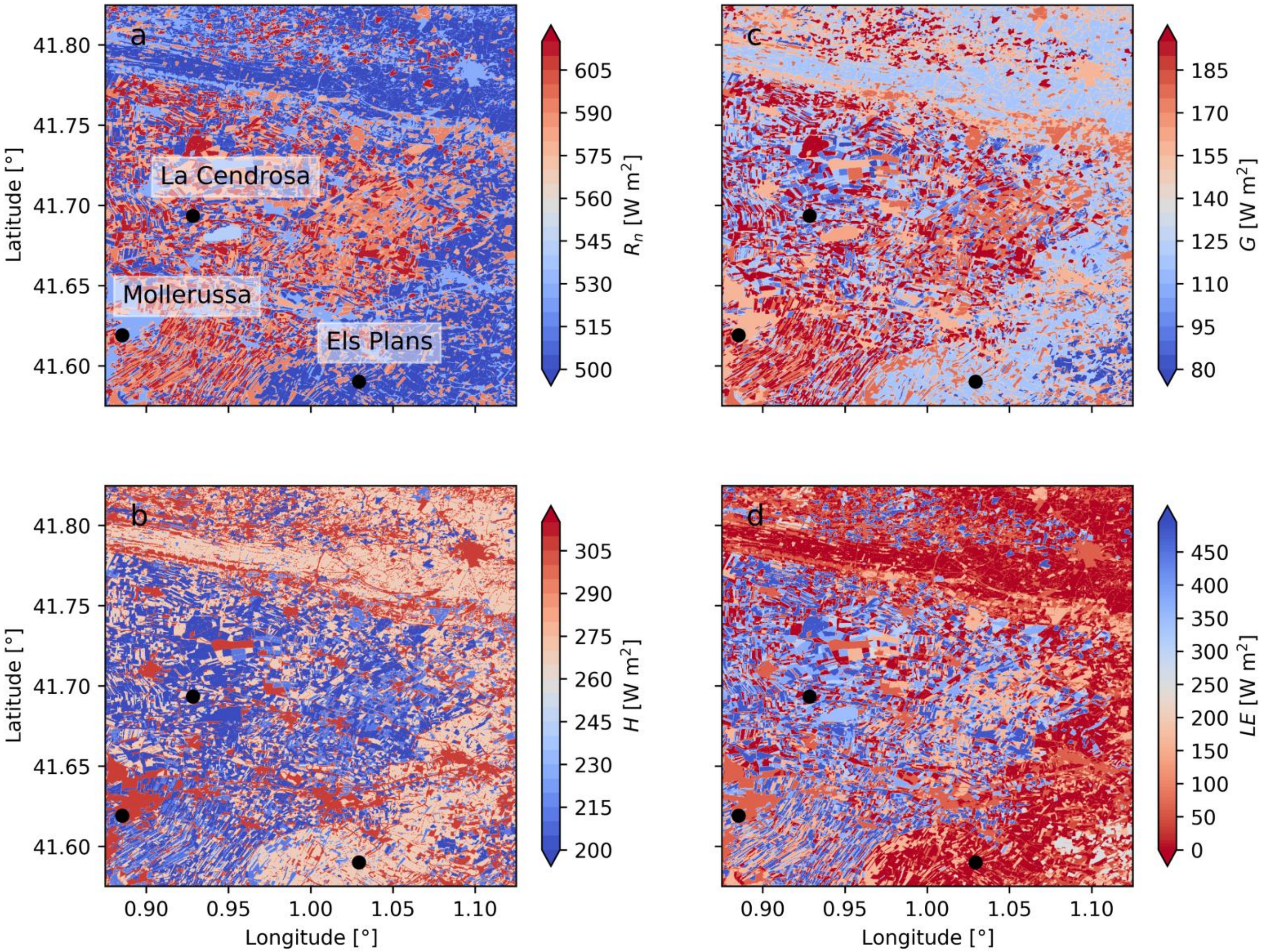
Motivation



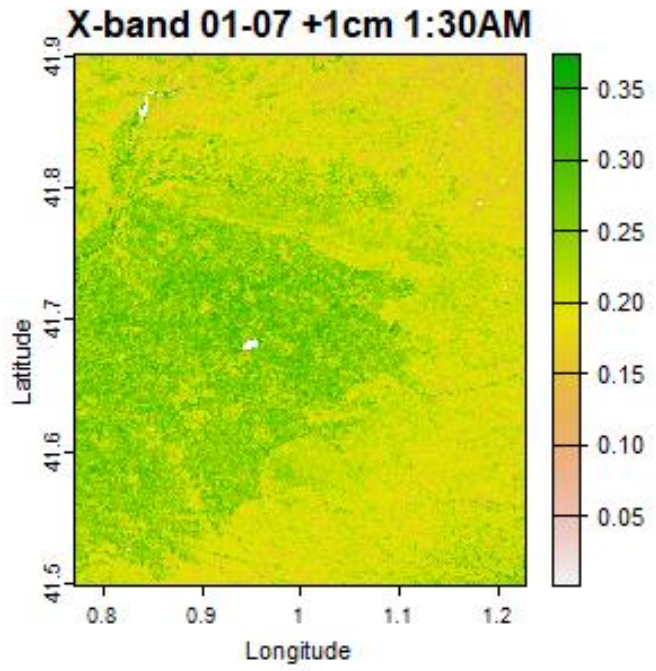
Similar to the flux maps, we want **maps of Soil Moisture** (and other soil properties) to have a **realistic surface representation** for **high-resolution turbulence modeling**.

DATA Products

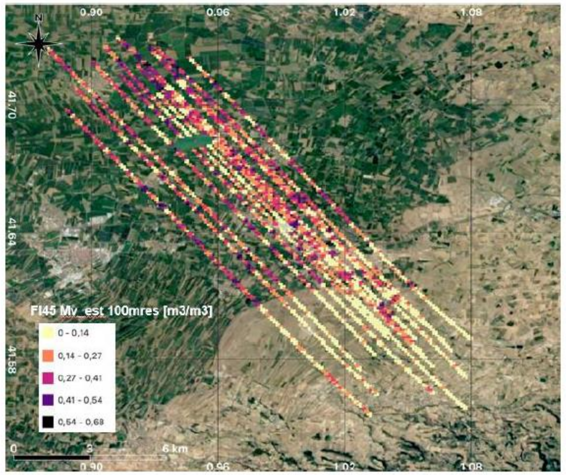
Type	Instrument	Spatial resolution	Spatial extent	Depths	Temporal resolution	Temporal extent (Days in July)	Data Provider
In-Situ	Soil moisture probe	Point	7 locations	5, 10, 30cm	30min	15 - 30	Meteo-France, UKMO, WUR, Meteo-Cat, CESBIO, UIB, …
Airborne observations	SLAP	100x200m	LIAISE domain (Reduced)	surface	8 flight days during the IOP	15 - 17, 24 - 25, 27 – 29	NASA
	GLORI	100x100m		surface	3 flights days during the IOP	22, 27 – 28	CESBIO
Satellite	SMAP, AMSR-2	1000x1000m (downscaled to 100m)	LIAISE domain (Full)	1cm (X-band), 2cm (C-band), 5cm (L-band)	Daily	1 - 31 (5, 12, 21, 28)	Planet Labs

Spatial Extent

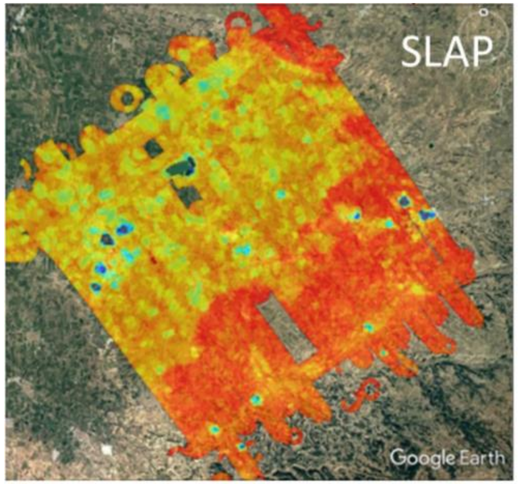
Satellite



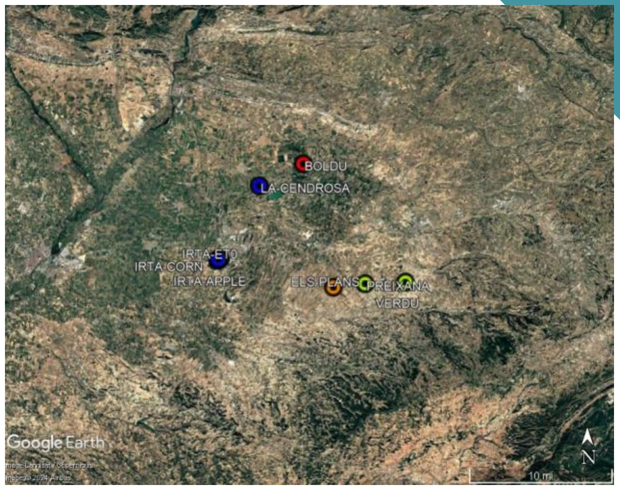
GLORI



SLAP



In-situ

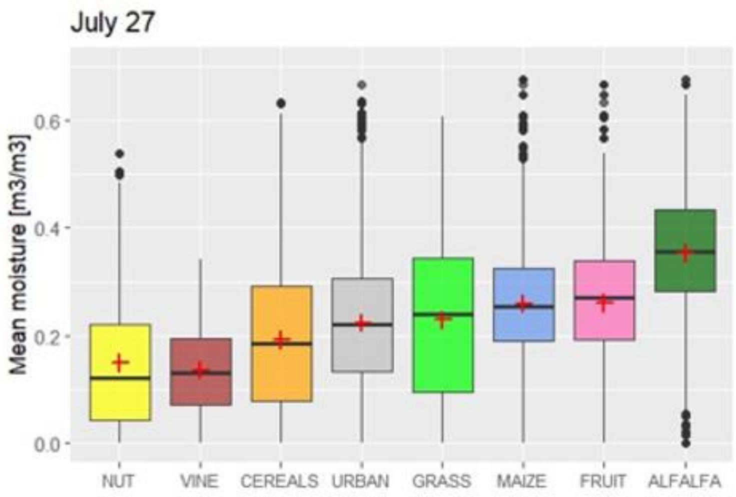


Kim, E., et. al. (2023). High-Resolution Soil Moisture—A European Airborne Campaign Using NASA Goddard's Scanning L-Band Active Passive (SLAP). *Remote Sensing in Earth Systems Sciences*, 6(3), 309–321. https://doi.org/10.1007/s41976-023-00099-4

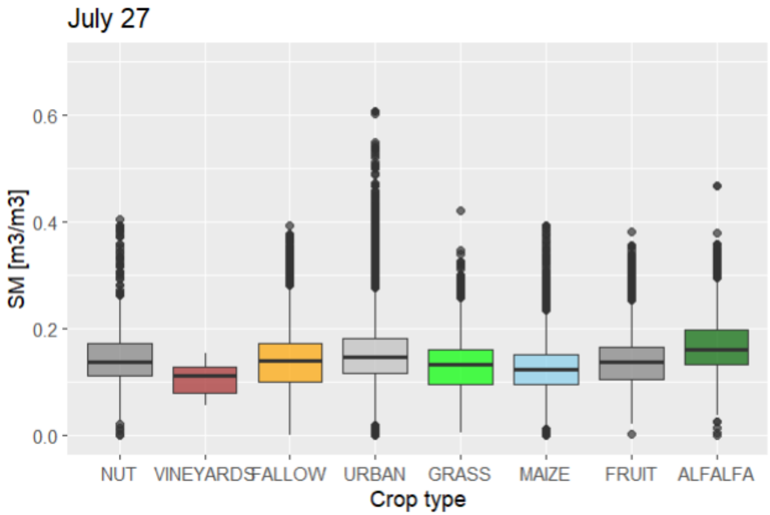
Zribi, M et al. (2022). Airborne GNSS-R Polarimetric Multiincidence Data Analysis for Surface Soil Moisture Estimation Over an Agricultural Site. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, *15*, 8432–8441 https://doi.org/10.1109/JSTARS.2022.3208838

Spatial dynamics

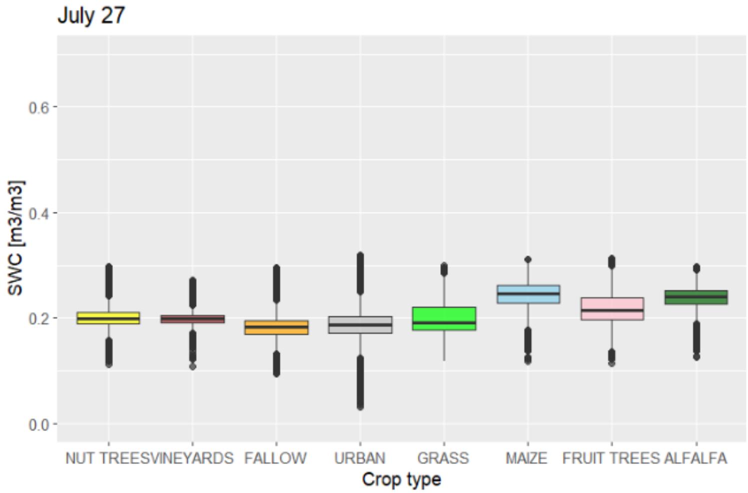
GLORI



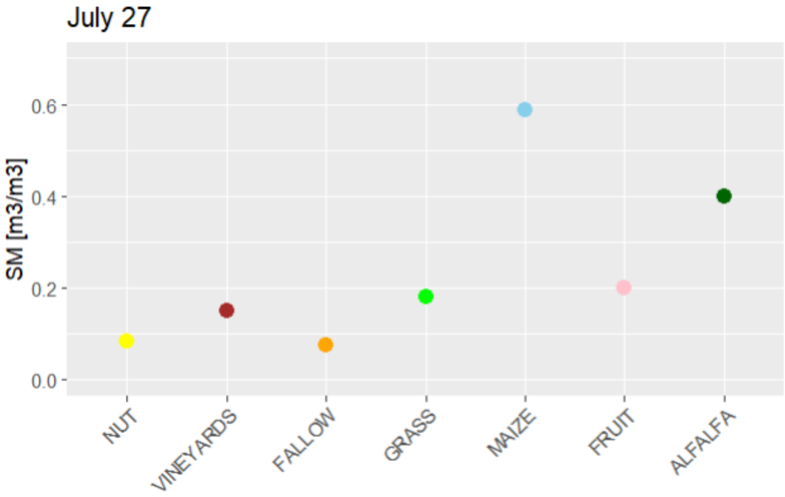
SLAP



Satellite

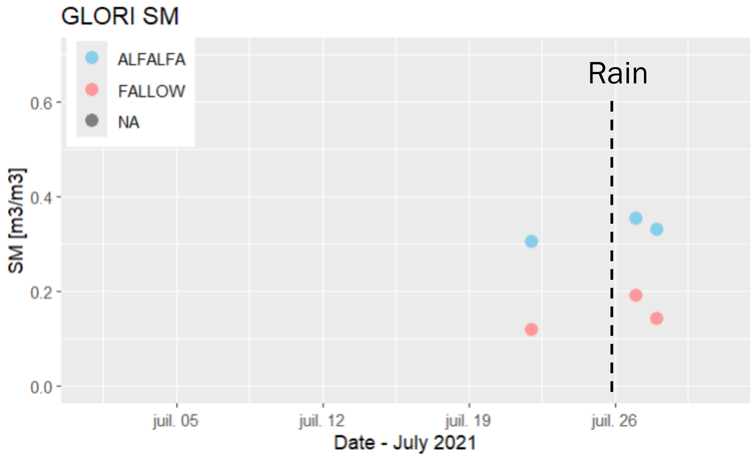


In-situ



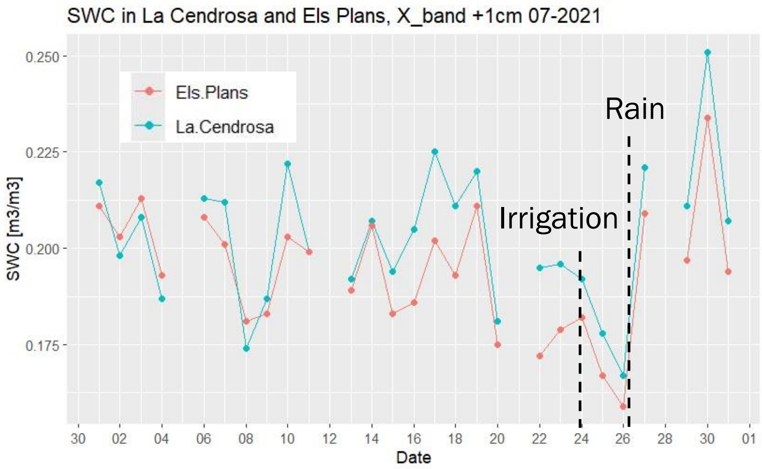
Temporal dynamics

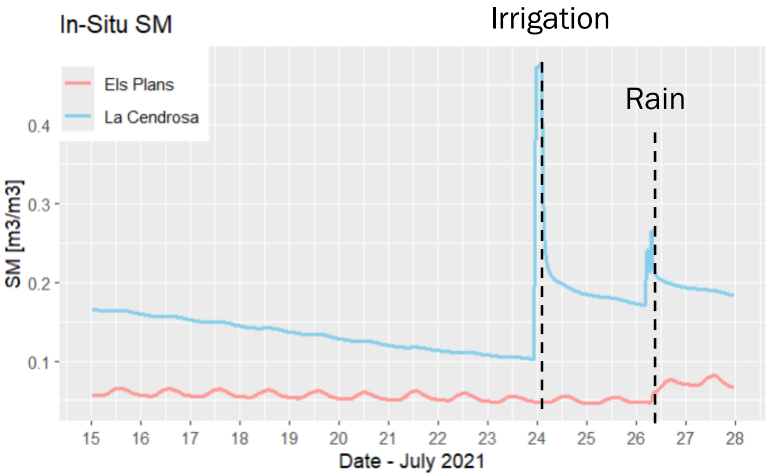
GLORI



SLAP

Satellite





In-situ

What is the best data to use for soil moisture in our flux maps?

	GLORI	In-situ
Spatial extent	Limited	Very limited
Spatial dynamics	Good	None
Temporal extent	3 days	July
Temporal dynamics	Limited	Very detailed
Vertical resolution	Surface	3 depths

Challenge: combine GLORI and in-situ data products together with a detailed landuse map to create a detailed soil moisture map for the whole LIAISE domain

Method Overview

In situ in-depths SM

Step 1

Create typical ranges of SM per crop type from in situ data.

Temporal distribution ⇔ spatial distribution

Step 2

Evolution in time of in–depths SM based on the temporal dynamics described by in situ

GLORI surface SM

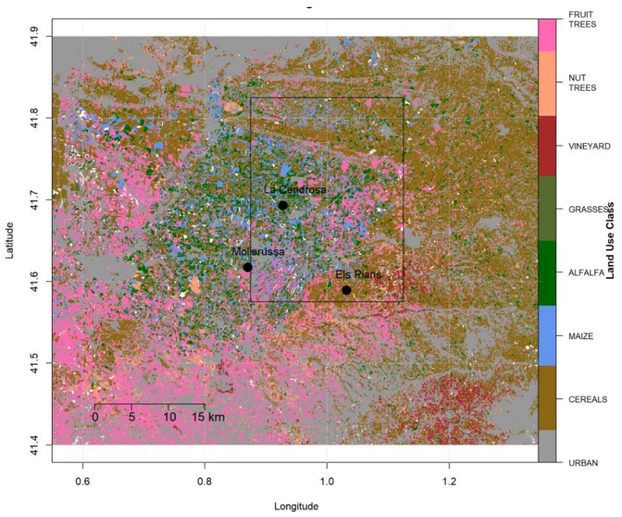
GLORI data gives ranges of SM per crop type, consistent in time

Step 3

Combine in situ and GLORI soil moistures statistically to create consistent soil moisture profiles for each crop type

Step 4

Apply the edited soil moisture in space to the SIGPAC land use map to create 3D soil maps (x, y, z).

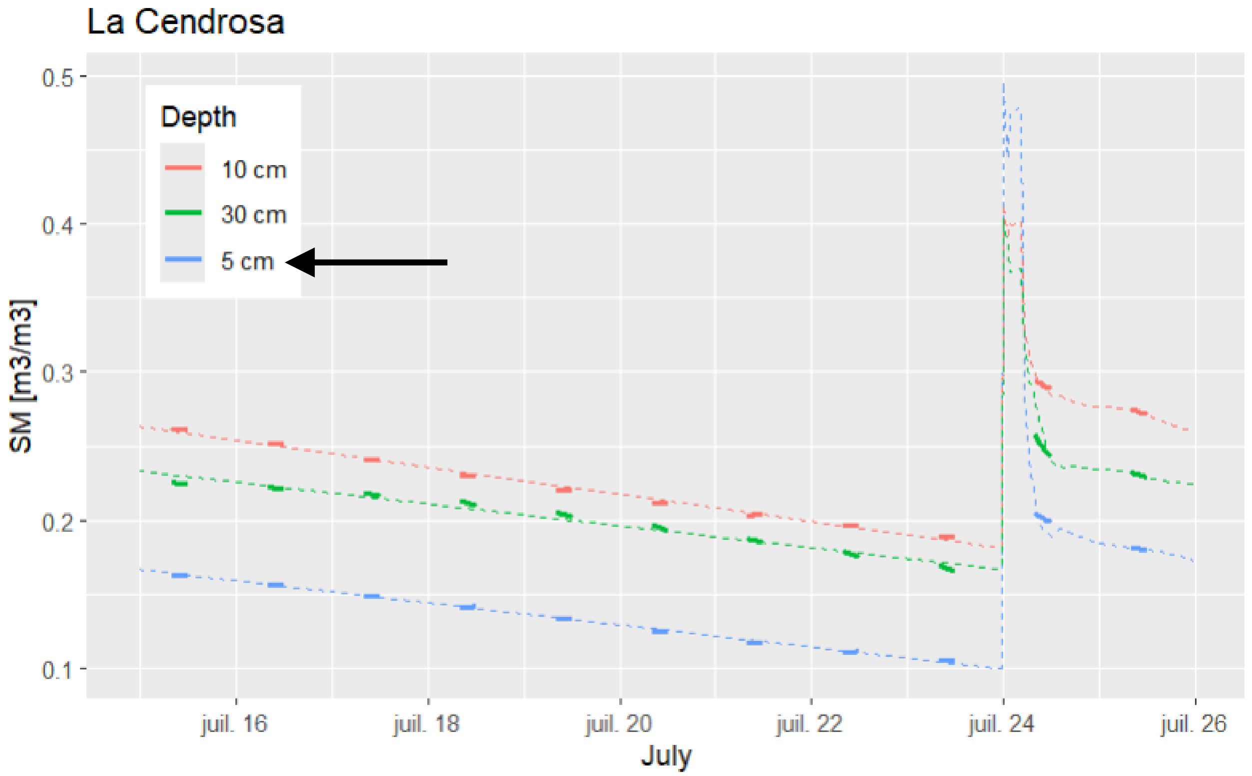


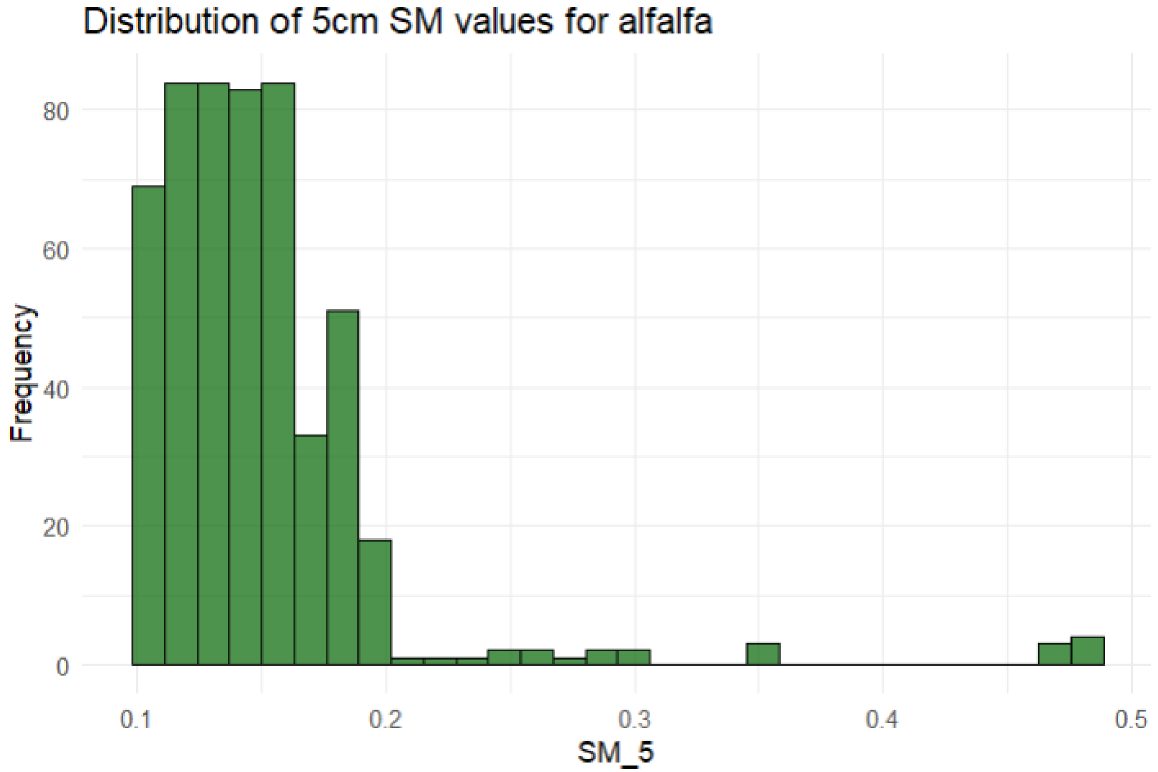
Step 1 : Create SM histograms on spatial distribution

5 cm

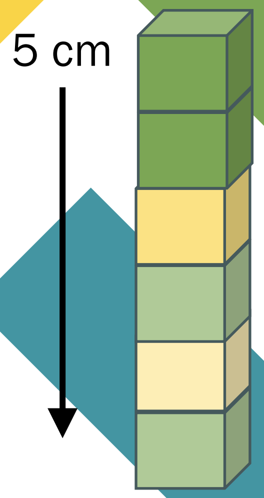
- From the **in-situ data**, create **per landuse class** a **histogram for SM at 5cm** depth that is representative for the spatial distribution

- <u>Assumption:</u> **temporal distribution** of SM observed in-situ in July ⇔ **spatial distribution** of SM across the domain



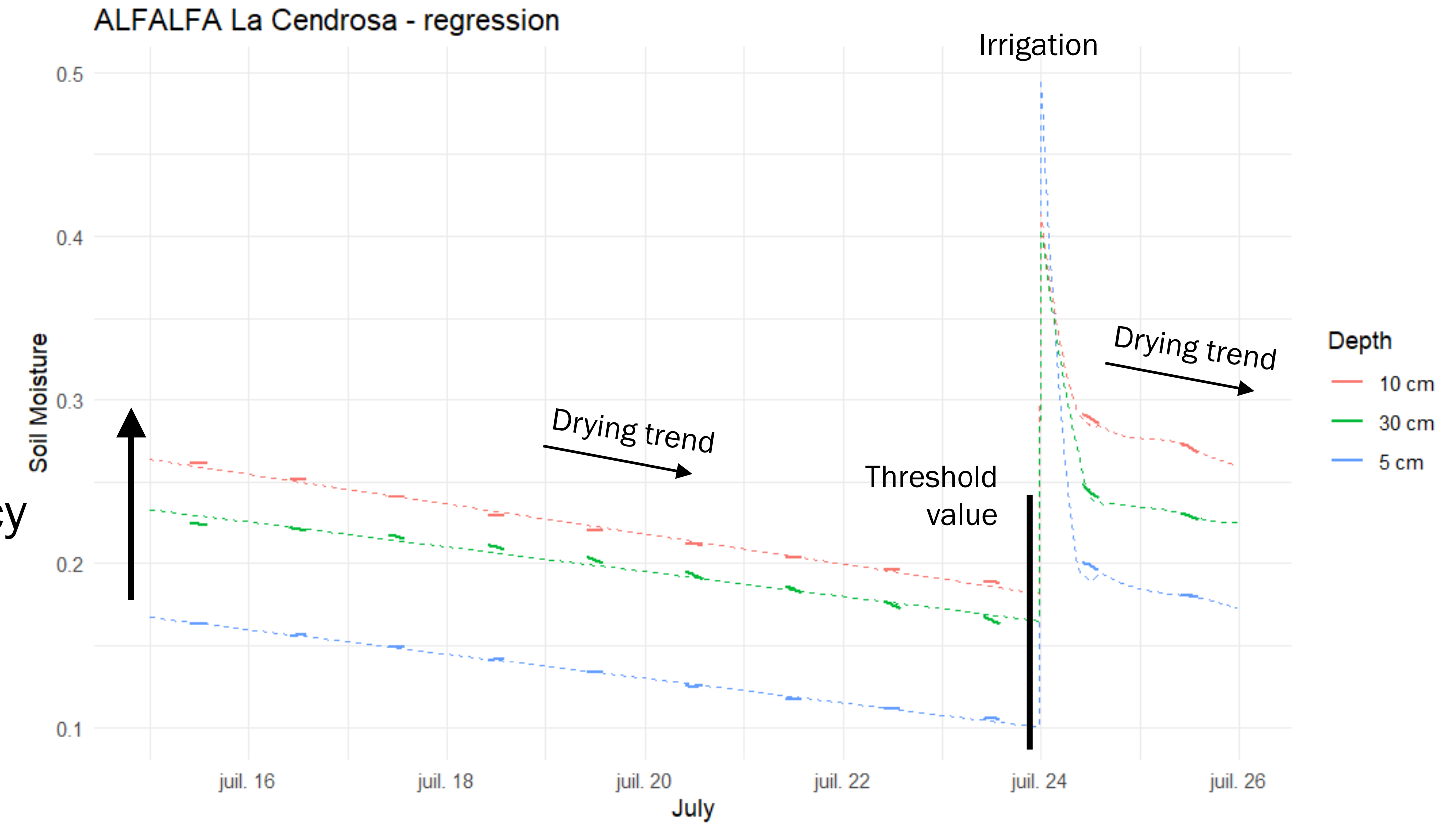


Step 2 : Link 5cm SM to SM profile downward



- From the **in-situ data**, for each landuse a certain 5cm SM is linked to a profile that follows from the time-series
- **Motivation**: Create profiles of soil moisture that are consistent with depth for each land use class

Depth consistency



Step 3 : Link 5cm SM to surface SM

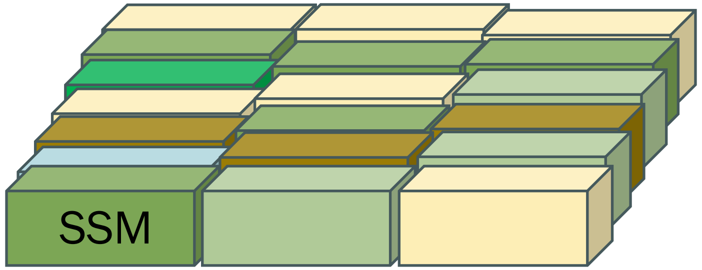
GLORI Aircraft
Alfalfa fields

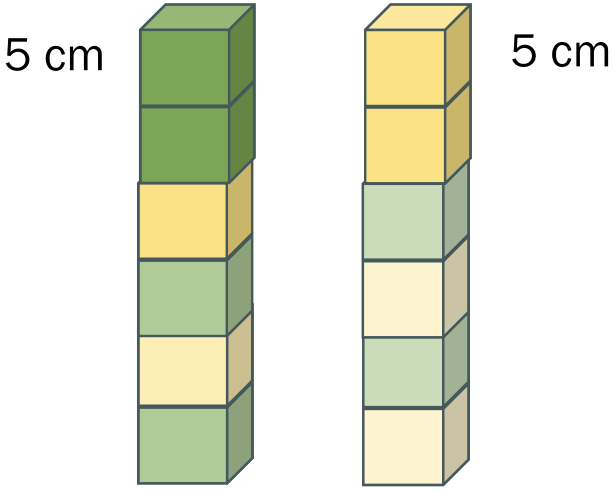
+

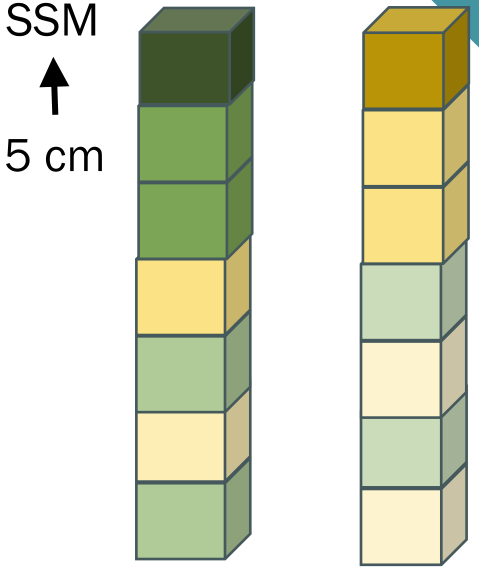
In-Situ
Alfalfa distribution

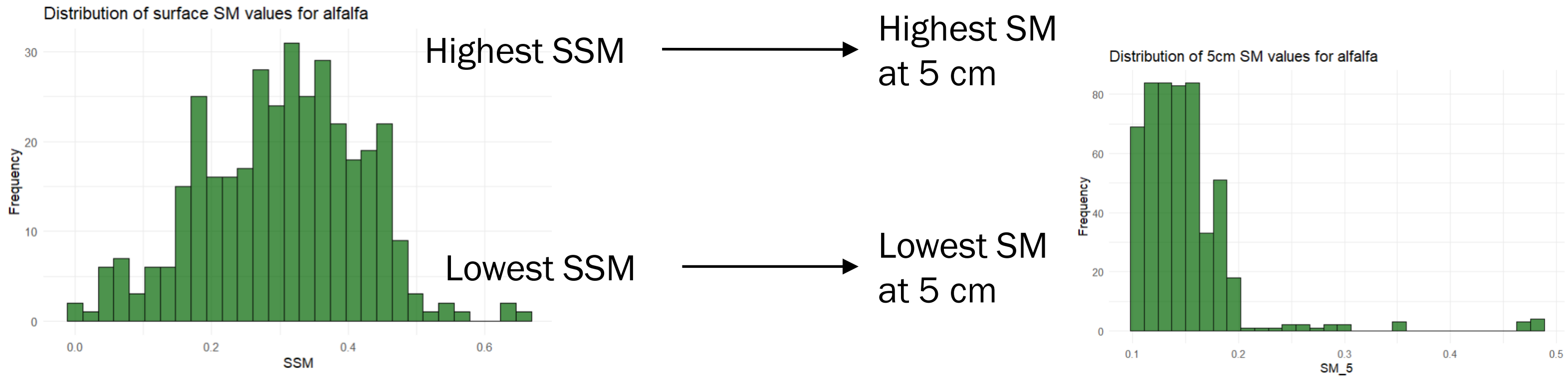
=

Consistant Soil
Moisture Profiles









Step 4 : Generating the SM maps

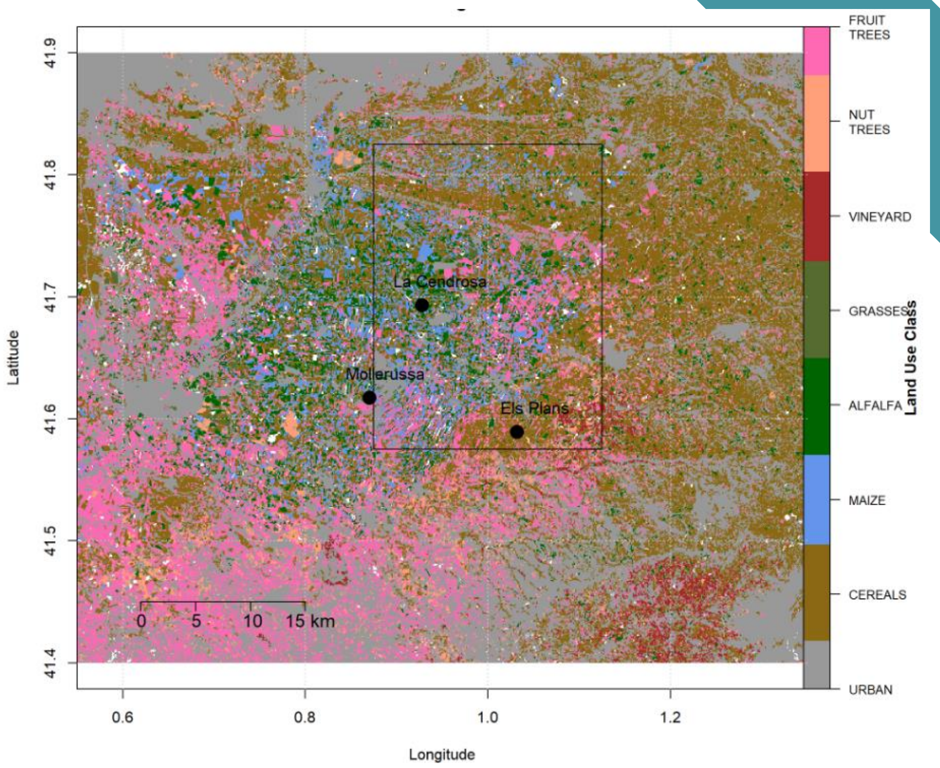
Resulting Soil Moisture Map

1. For each element in landuse map **take a random sample from 5cm SM distribution** (Step 1)

2. Link it to a consistent profile downward (Step 2) and upward (Step 3)

3. Randomly assign a consistent profile based on land use type to the land use map (Step 4)

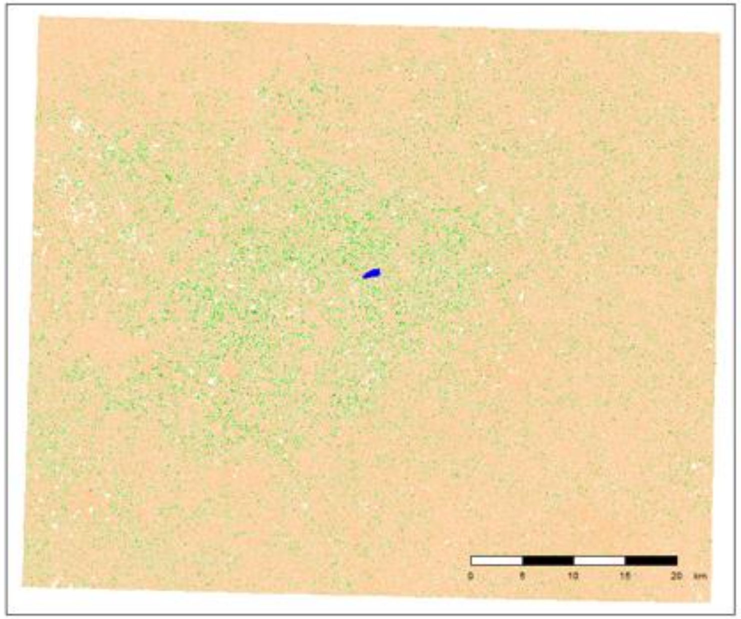
- Done for 22nd, 27th, 28th of July



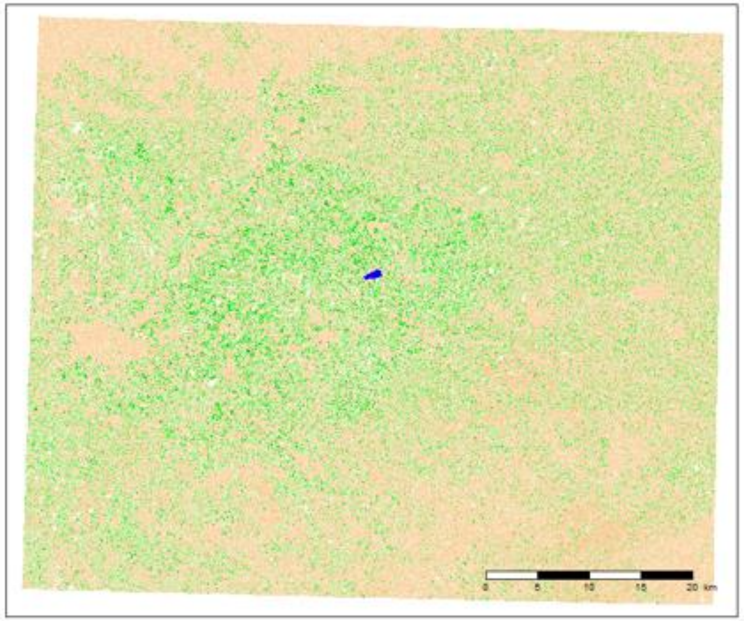
→ Realistic but not real: Soil Moisture Maps with high spatial resolution (100 m) in 3D for three LIAISE days for the entire LIAISE domain.

Results: Time Evolution

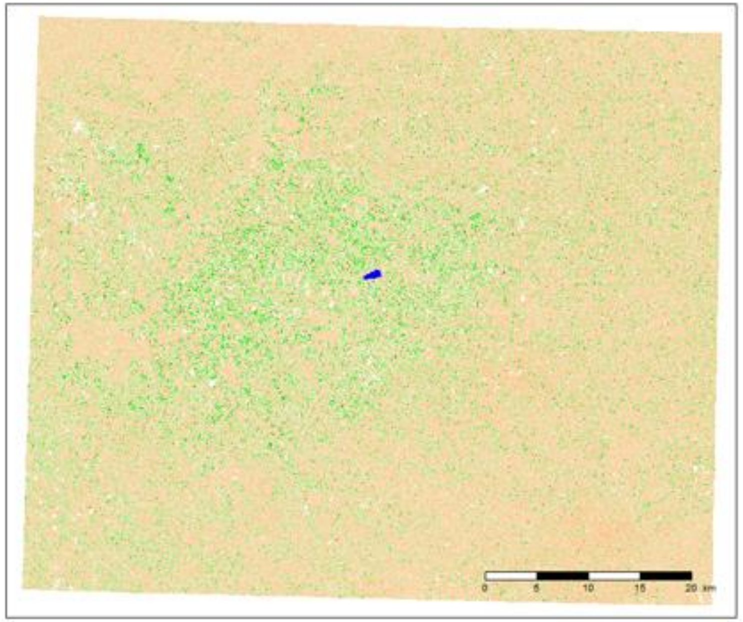
Surface Soil Moisture, 22nd of July



Surface Soil Moisture, 27th of July



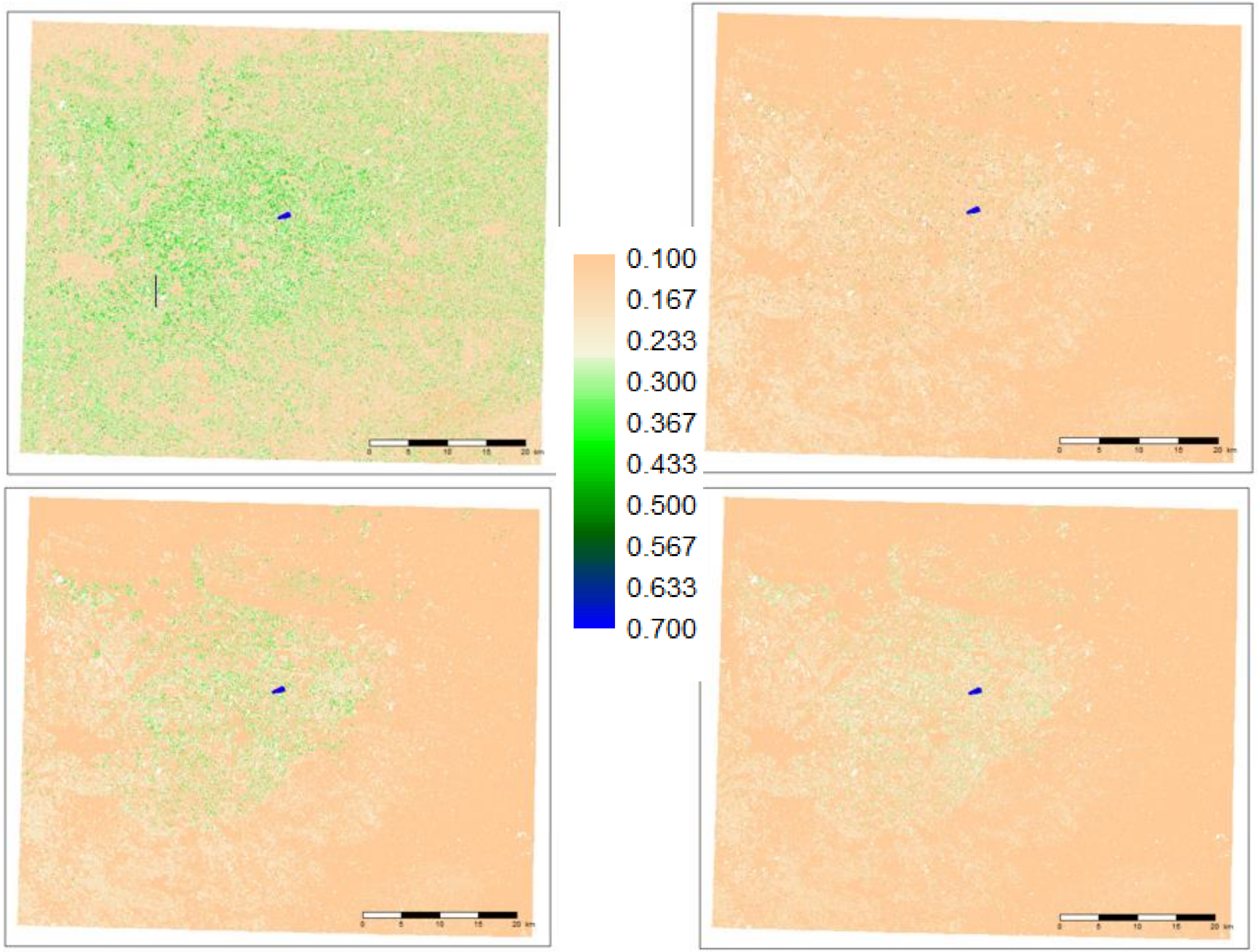
Surface Soil Moisture, 28th of July



Results: Depth Evolution

Surface SM – 27th of July

5cm SM – 27th of July



30cm SM – 27th of July

10cm SM – 27th of July

Additional Work

- Land Use Map comparison 2020-2021
- Soil Texture
- Soil Temperature

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Merci