SWOT captures irrigation

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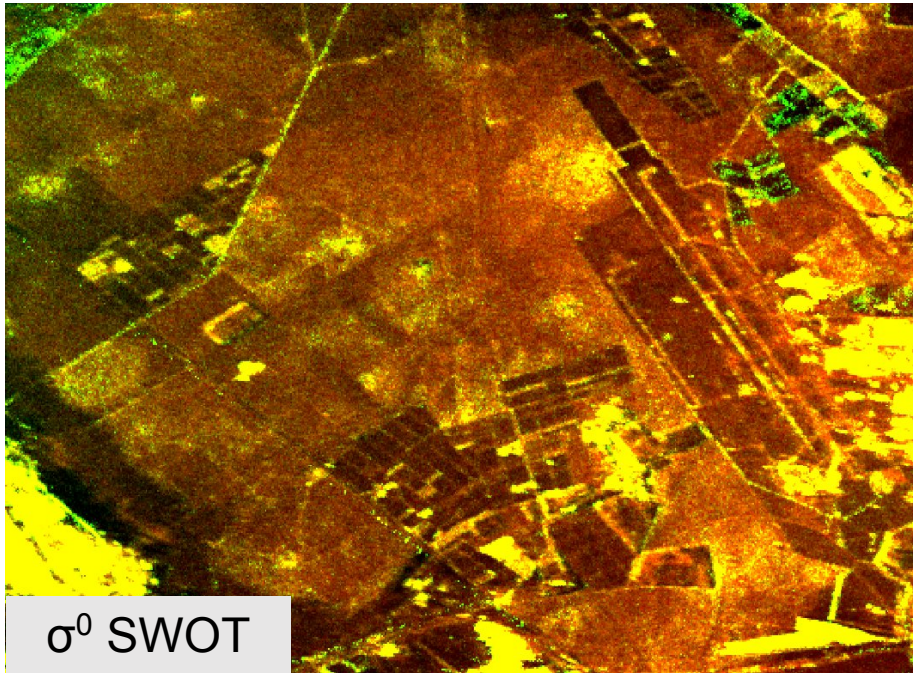
Can we use SWOT images as a traditional SAR sensor ?

SNR better than expected on land !

- Calibrate σ^0 from SWOT SLC
- Geocode σ^0 thanks to PIXC processing



σ^0 SWOT

Google Earth

SLC images can be downloaded on Podaac:
https://podaac.jpl.nasa.gov/dataset/SWOT_L1B_HR_SLC_2.0
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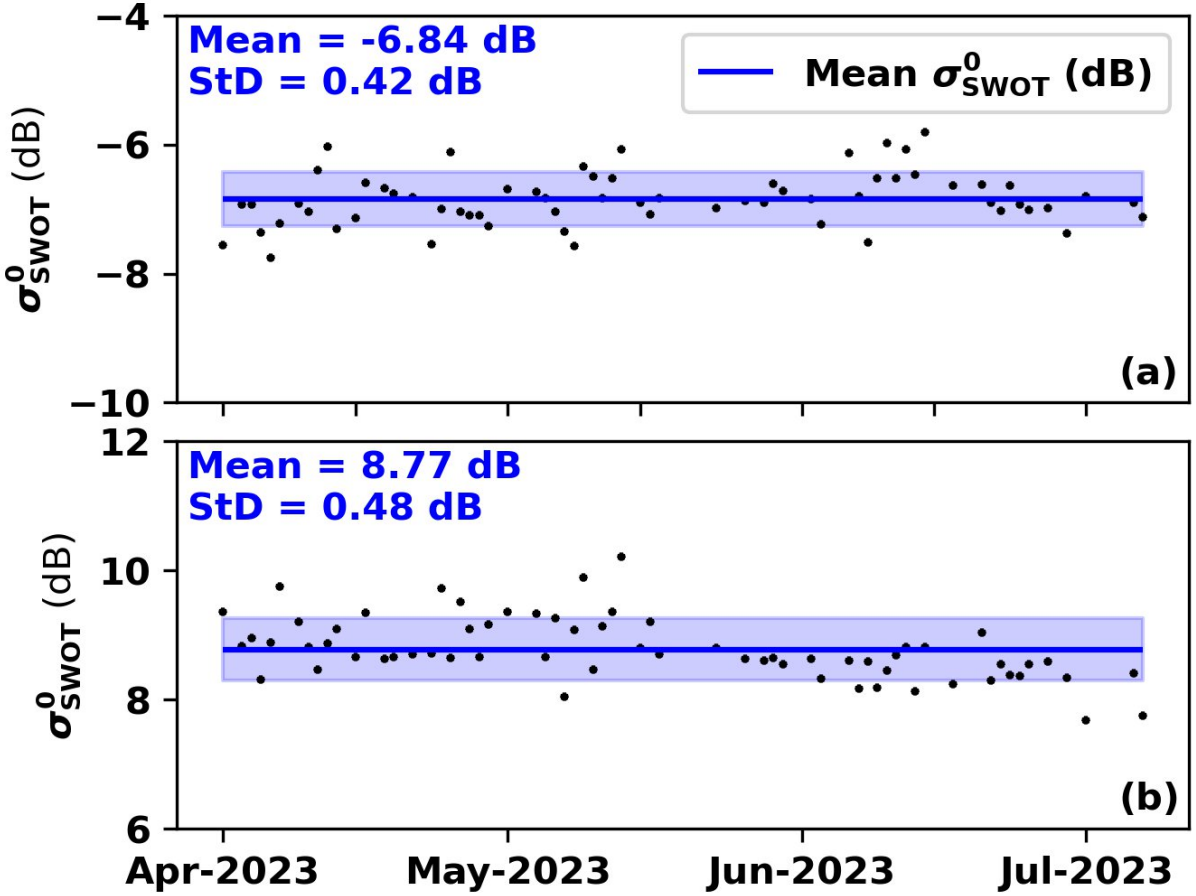
Can we trust the σ^0_{SWOT} ?

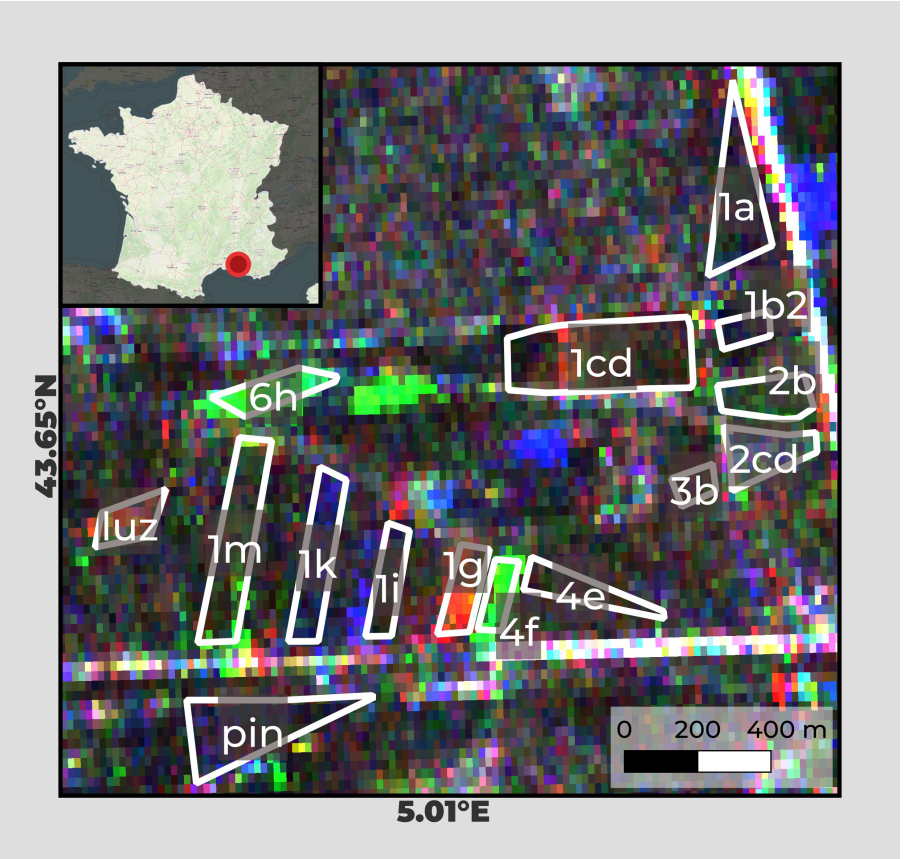


σ^0_{SWOT} stable on invariant objects

σ^0_{SWOT} depends on the target

Study site: Mas du Merle

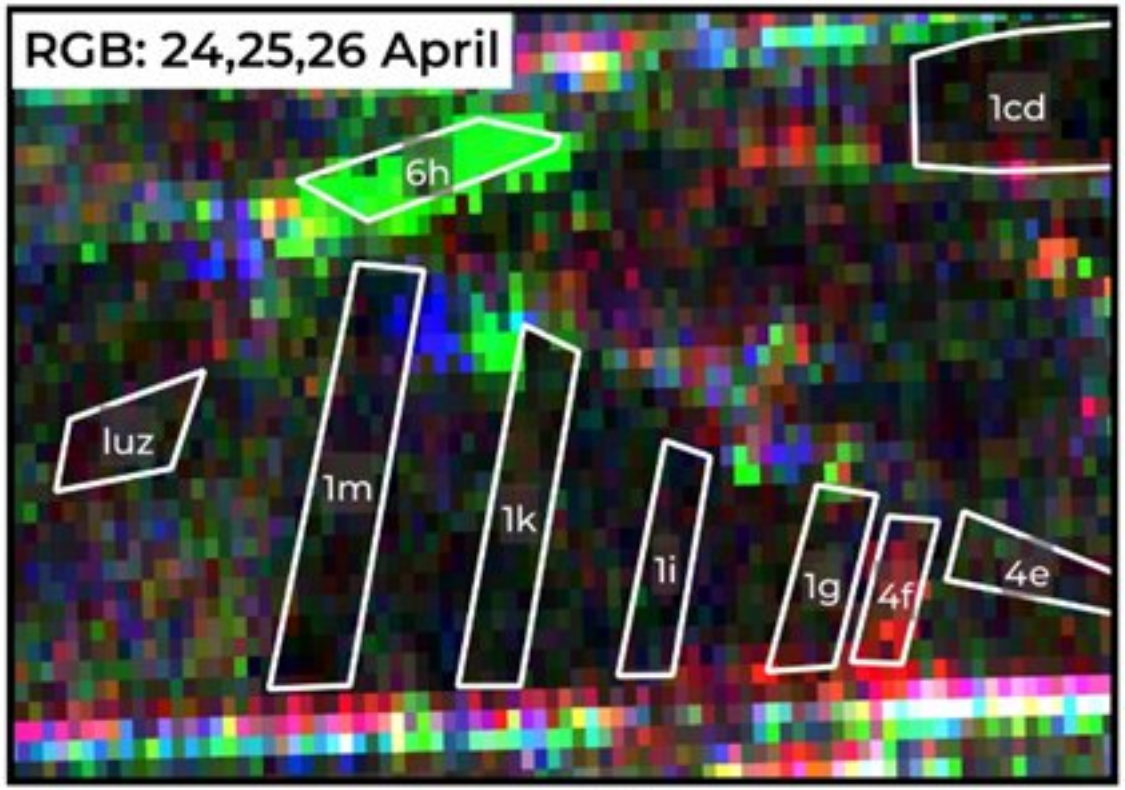
- 15 irrigated grassland plots
- Gravitational irrigation
- Irrigation freq. 8 to 12 days
- Several harvest



- 76 SWOT images:
  - April to July 2023 revisit 1d.
- Local incidence from 3.2° to 3.5°
- Resolution: 70 - 10m near/far range x 5m azimuth
- Geocoded pix. size: 16x27m - 4-look image.
- 41 Sentinel-2 NDVI images

Bazzi H., Baghdadi N., Cazals C., Najem S, Desroches D, Frappart F, Zribi M. & Charron F. (2025) SWOT SAR Ka-band Captures Irrigation Events.

Visualizing the images

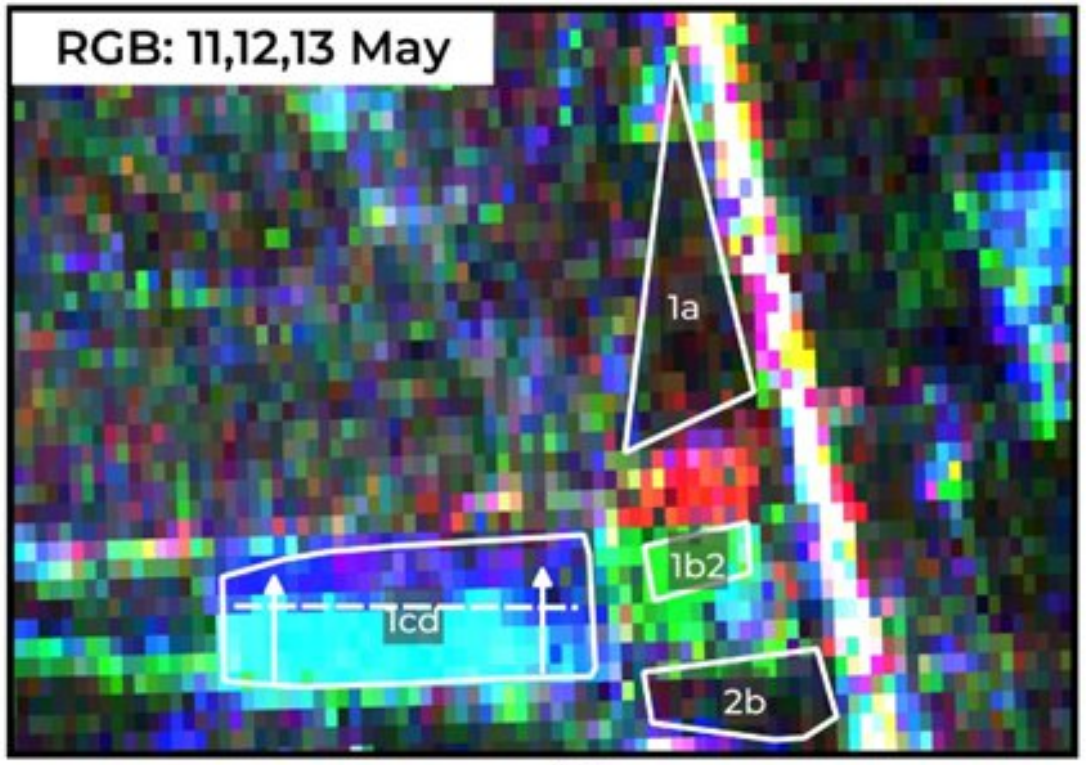


plot 6h irrigated April 25th:

- 1 day of high signal

σ^0_{SWOT} before irrigation
σ^0_{SWOT} irrigation date
σ^0_{SWOT} after irrigation date

Visualizing the images



(f)

σ^0_{SWOT} before irrigation
σ^0_{SWOT} irrigation date
σ^0_{SWOT} after irrigation date

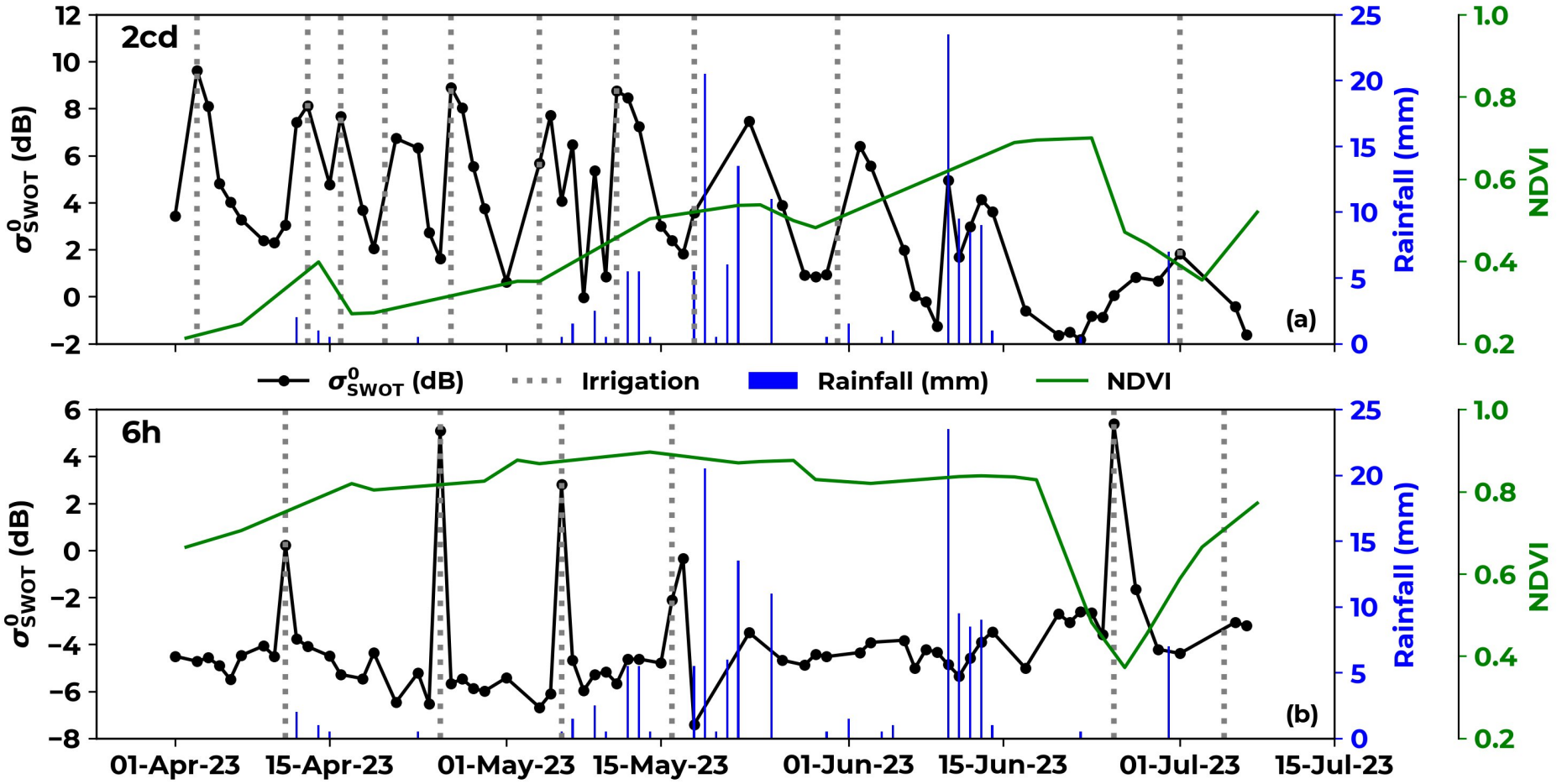
plot 1b2:

- 1 day of high signal (green)

plot 1cd:

- 2 consecutive dates of high (turquoise) signal

Time series analysis



High sensitivity to rain or irrigation with low vegetation

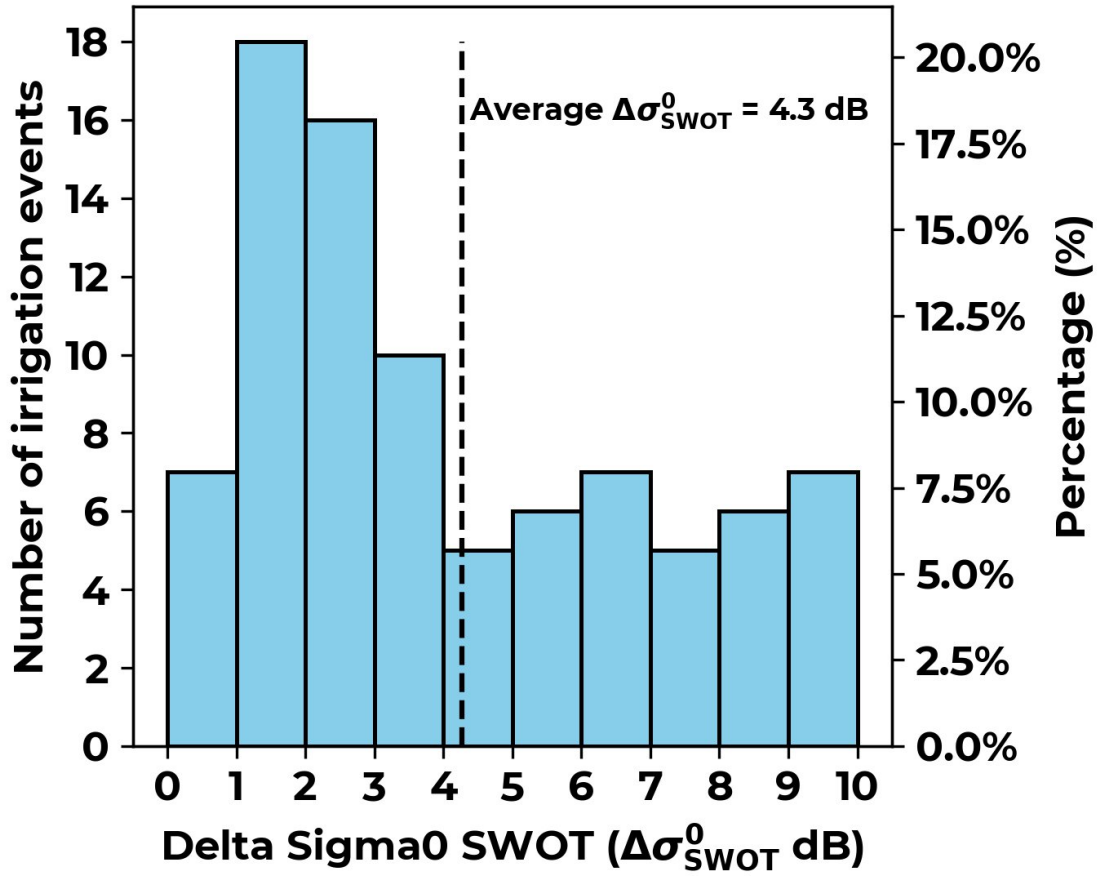
σ^0 attenuation due to high vegetation (NDVI > 0.8)
High sensitivity to floods

Irrigation capture

$\Delta\sigma^0_{SWOT} = \sigma^0_{SWOT\ irrigation\ date} - \sigma^0_{SWOT\ before\ irrigation\ date}$

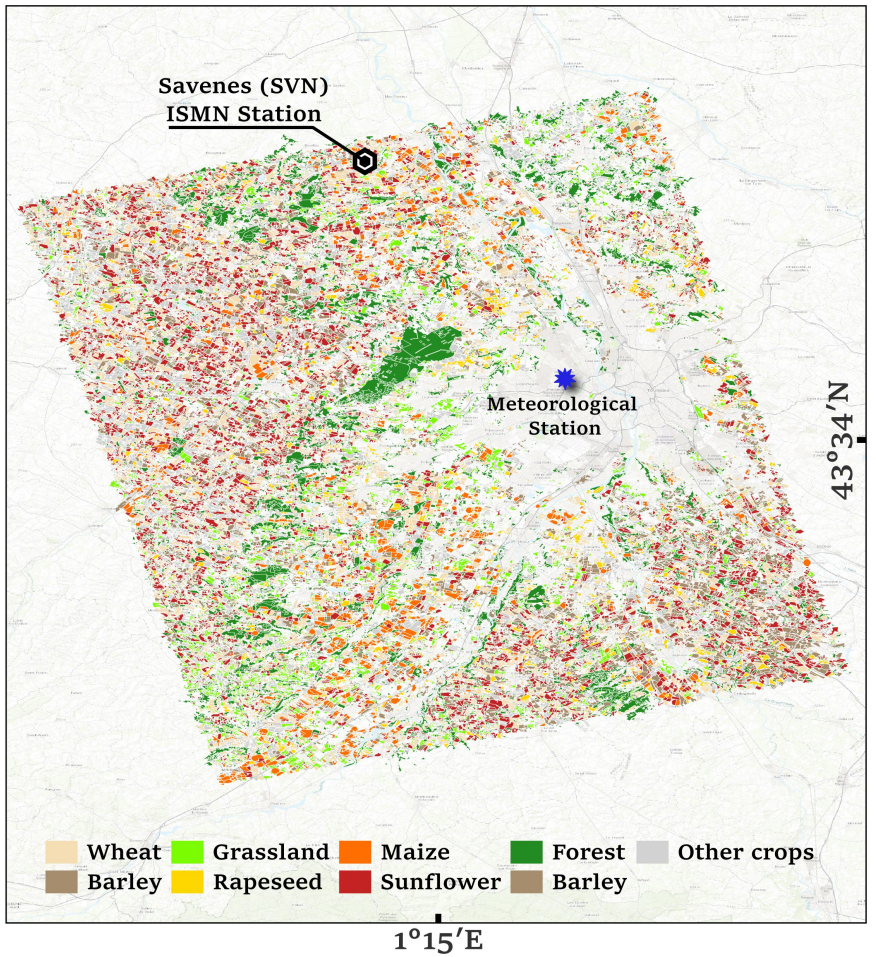
- $\Delta\sigma^0_{SWOT}$ of 4dB captures irrigation
- 0 - 4 dB: Surface soil moisture
- > 4 dB: Flood

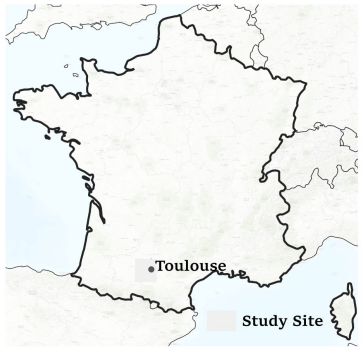
σ^0_{SWOT} can capture irrigation and surface soil moisture

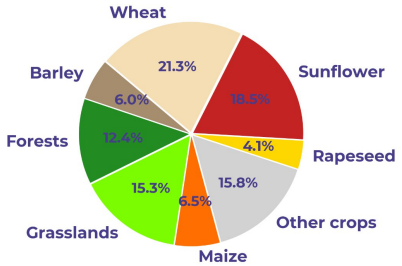


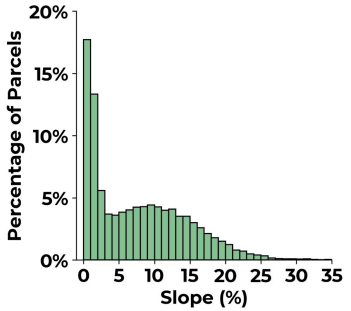
σ^0_{SWOT} and Surface Soil Moisture

- RPG 2023 BD Forêt®
- Meteorological station
- SSM station - SMOSMANIA
- 93 images σ^0_{SWOT}
- 65 S-2 images NDVI









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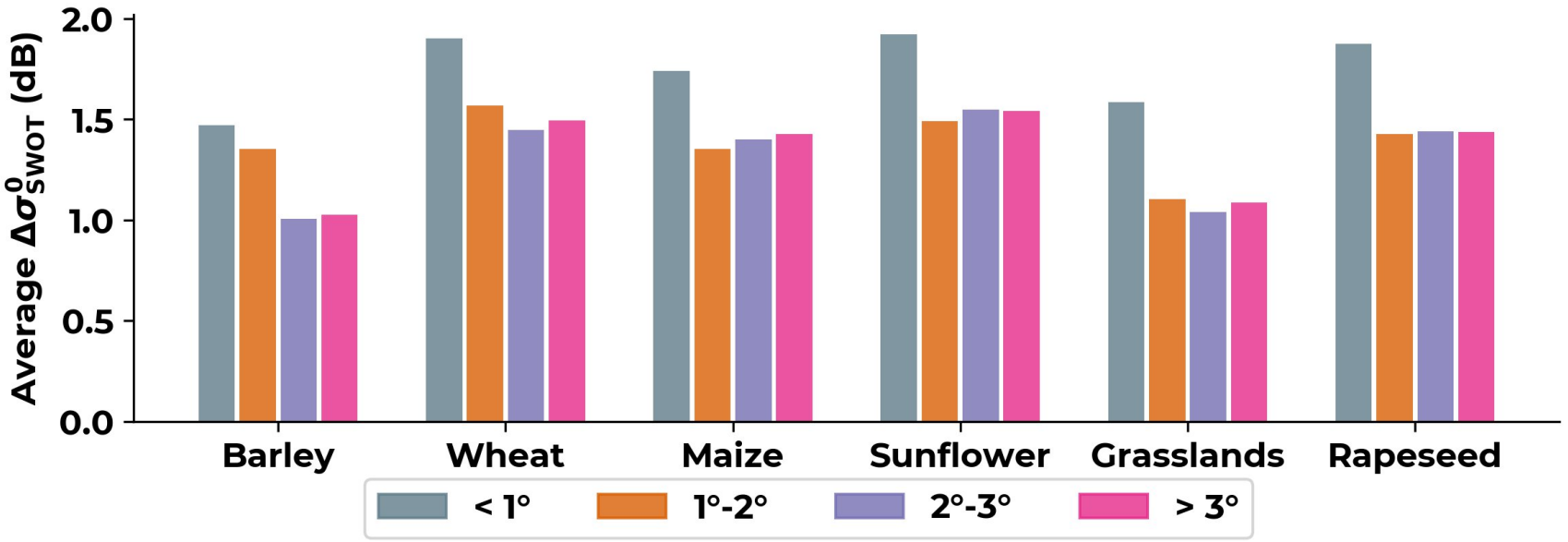
Bazzi, H., Cazals, C., Baghdadi, N., & Maleki, S. (2025). SWOT, Sentinel-1 and NDVI Time Series for Summer and Winter Crops in Southwestern France (2023 - 2024)

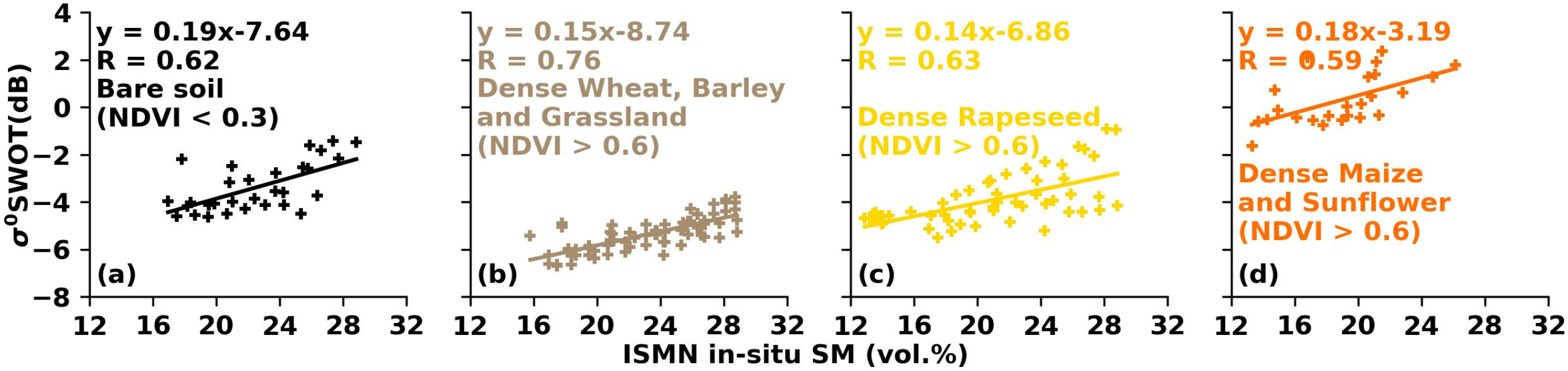
$\Delta\sigma^0_{SWOT}$ after rain events

$\Delta\sigma^0_{SWOT} = \sigma^0_{SWOT\ rain\ date} - \sigma^0_{SWOT\ before\ rain\ date}$



σ^0_{SWOT} increases after each rain event with all crop types and all incidence angles

σ^0_{SWOT} & Surface Soil Moisture



Station SMOSMANIA SSM

σ^0_{SWOT} is correlated to *in situ* surface soil moisture with low and developed vegetation

Conclusion & perspectives

- σ^0_{SWOT} can be processed and used for land applications
- σ^0_{SWOT} highly sensitive to flooded grassland with developed vegetation
- σ^0_{SWOT} highly sensitive to surface soil moisture for bare soil and for agricultural plots with vegetation

- Detection of irrigation events on agricultural plots
- Extend the use of Ka-band SAR images to other land application

Thank you ！

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