Analysis of relationships between soil moisture and false water detections in SWOT PIXC products

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Context & Objectives

SWOT PIXC products exhibit false water classifications over agricultural areas, particularly following precipitation events. These false detections complicate water body mapping in mixed agricultural-hydrological landscapes and require better understanding for proper data interpretation.

→ What is the relationship between soil moisture dynamics and false water detections in SWOT PIXC over agricultural parcels?

- **Identify** relationships between soil saturation and SWOT water misclassifications.
- **Determine** critical moisture/precipitation thresholds triggering false detections.
- **Assess** land cover sensitivity (crops vs. grasslands) to spurious classifications.
- **Provide** quantitative insights for SWOT data quality assessment in agricultural contexts.

Data

✓ **SWOT PIXC Products** analyzed between March 2023 and January 2024 over Alsace plain.

✓ **183 Soil Moisture Map:** Combined Sentinel-1/2 observations.

✓ **Meteorological Data:** ERA5 precipitation reanalysis.

✓ **Ancillary Data**

- Land cover classification.
- NDVI (Sentinel-2) – vegetation indicator.
- Pedological maps (soil drainage characteristics).

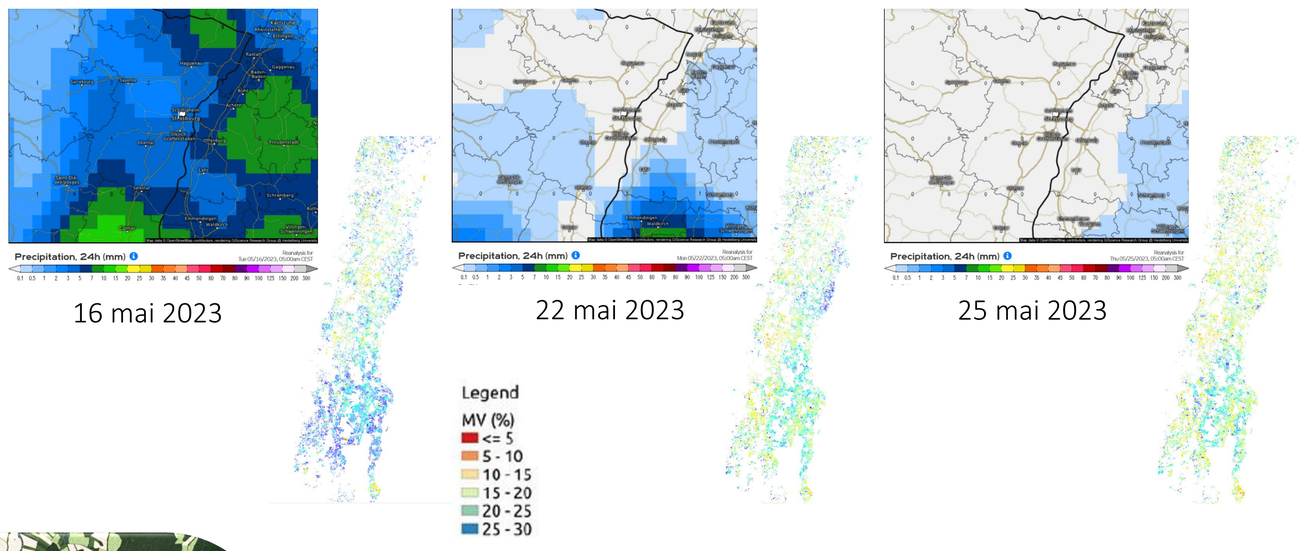

Fig. 1 : ERA5 precipitation over Alsace on 16, 22 & 25 may 2025.

Methods

✓ **Approach**

- Cross-correlation analysis between SWOT PIXC classifications, soil moisture dynamics, and precipitation events across agricultural parcels.

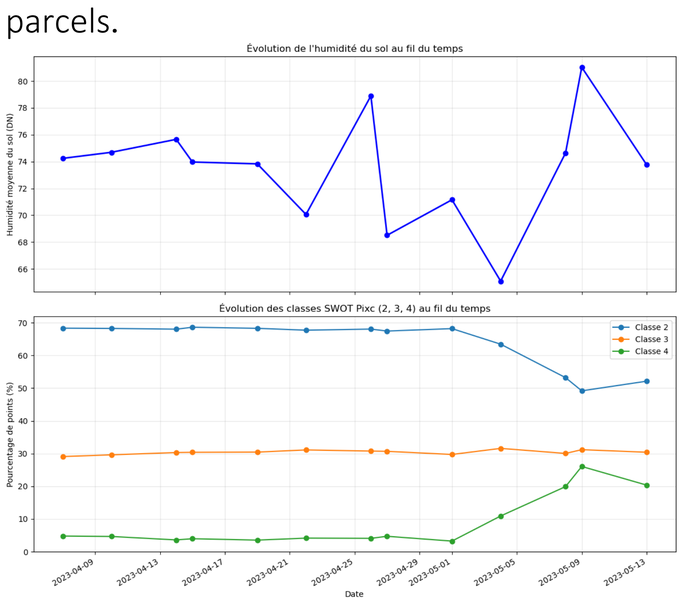

Fig. 2 : Temporal comparison between soil moisture evolution and SWOT PIXC class (2, 3, 4) detections.

✓ **Processing**

- PIXC points intersected with parcels (one moisture value/parcel).
- Temporal synchronization of all datasets with SWOT overpasses.
- Separate analysis for crops vs. grasslands on poorly-drained soils.

✓ **Analyses**

- Temporal evolution of PIXC class distribution (%, counts).
- Correlation matrices: Precipitation → Moisture → PIXC classes.
- Non-linear threshold identification (moisture & precipitation triggers).
- Statistical relationships between soil saturation and false water detections.

✓ **Constraints**

- NDVI < 0.7, poorly-drained soils, slope < 20%.

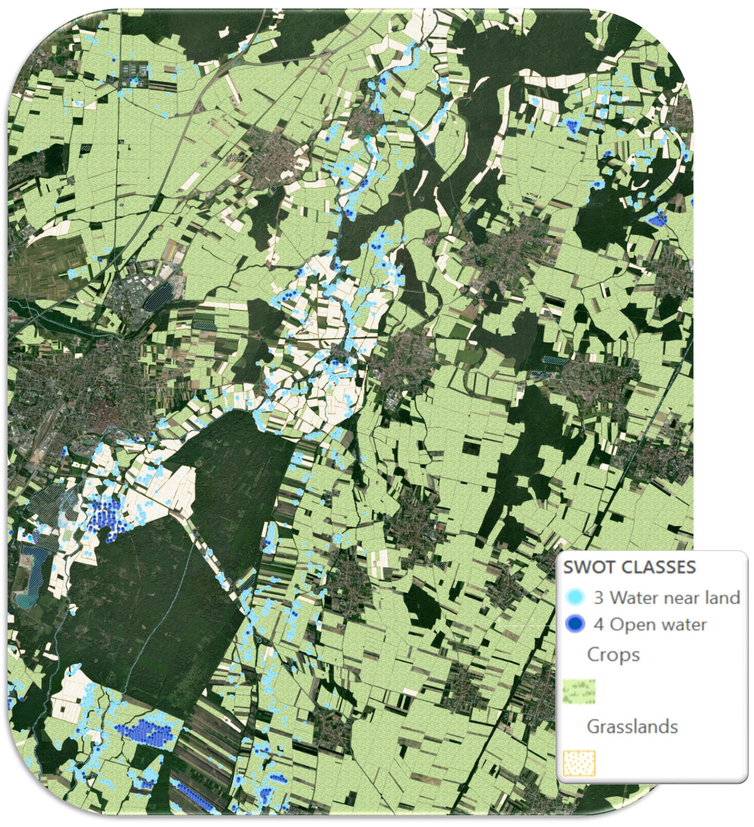

Fig. 3 : Distribution of land cover types (grasslands vs. crops) and SWOT class detections.

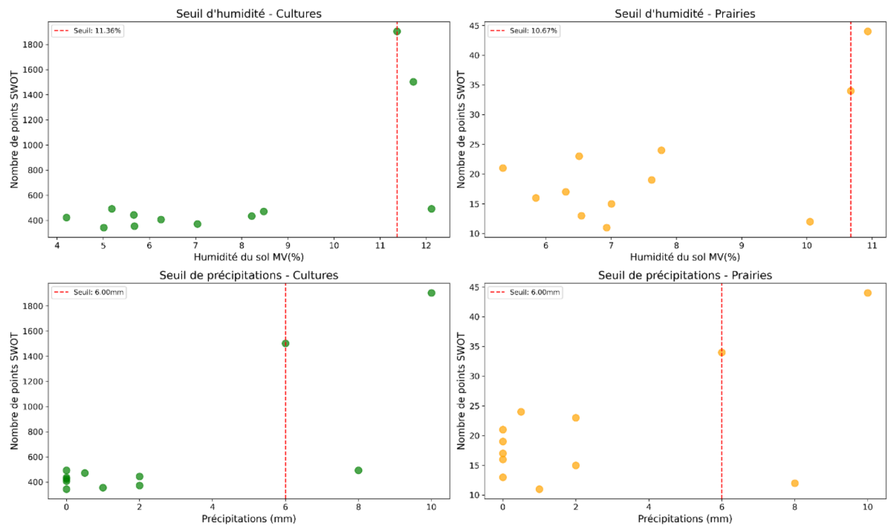

Fig. 4 : Detection thresholds: soil moisture (top) and precipitation (bottom) vs. total SWOT points for crops (green) and grasslands (orange).

Results

✓ **Soil Moisture & PIXC Classification**

- **Class 4** detections spike during rapid moisture recovery phases → Detection driven by moisture dynamics (rate of change) rather than absolute values.

✓ **Critical Thresholds** (Site specific : Alsace& Lorraine)

- **Soil moisture:** ~11% volumetric.
- **Precipitation:** ~6 mm cumulative.

✓ **Key Findings**

- Precipitation events → Moisture peaks → Class 4 spikes.
- Crops > Grasslands sensitivity.
- False detections on poorly-drained soils (NDVI < 0.7).
- Peak detections during rapid moisture recovery.

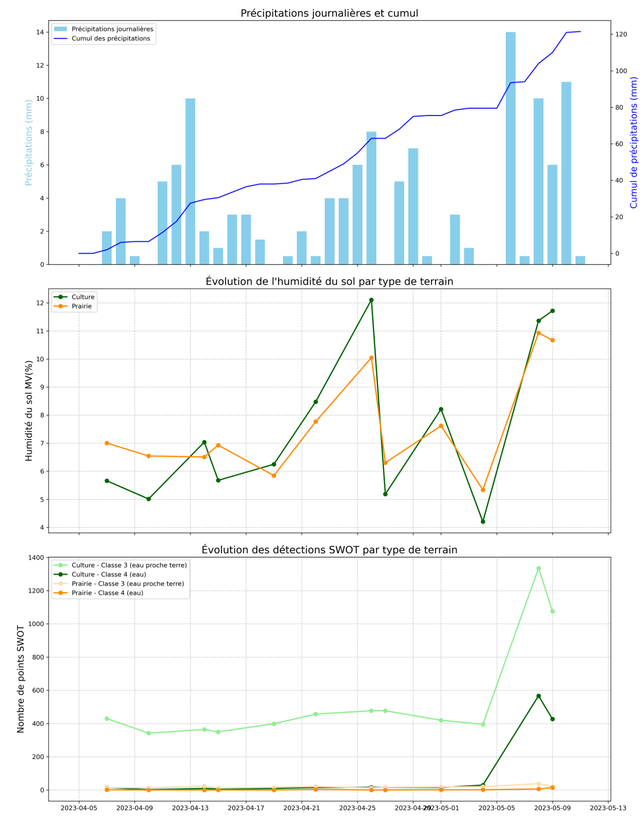

Fig. 5 : Precipitation, soil moisture, and SWOT PIXC detections evolution by land cover type (April-May 2023).

Conclusion and perspectives

- **SWOT** detects temporarily saturated agricultural parcels as "water" following precipitation events. Critical thresholds identified: **~11% soil moisture, 6 mm precipitation** (site-specific). Crops are more affected than grasslands. Predominantly on poorly-drained soils with NDVI < 0.7.
- **Implication:** Soil moisture/precipitation context should inform SWOT water product interpretation over agricultural landscapes.
- **Perspective:** Threshold validation across regions; development of soil moisture-based correction algorithms.

References: El Hajj, M., Baghdadi, N., Zribi, M., & Bazzi, H. (2017) « Synergic use of Sentinel-1 and Sentinel-2 images for operational soil moisture mapping at high spatial resolution over agricultural areas », *Remote Sensing*, 9(12), 1292.

Acknowledgements: This work was carried out within the framework of the SWOT CNES CalVal activities. Thanks to the CNES SWOT team for their constant support, especially to Nicolas, Roger and Claire.