Combined use of Sentinel SAR and optical data for soil moisture estimation

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Soil Moisture

Key parameter for studying hydrological processes: its value can be osbserved punctually or ***retrieved by remote sensing***.

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Application of Interest

Precision agriculture

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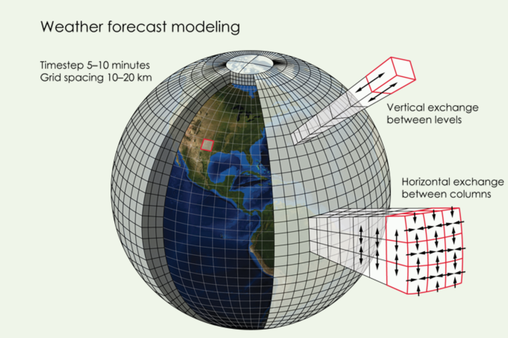
Weather forecast models



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Dataset and Study Case

- **Satellite Images:** Sentinel 1 (VV,VH polarization), Sentinel 2
- **Agricultural Mask:** Corine Land Cover 2018
- **Observations:** REMEDHUS soil mositure network (20 sites)

Study Area: $900km^2$ of agricultural fields, Spain
Study Period: 2018 (18 paired images)

Method and Tools

CHANGE DETECTION: Maximum soil moisture range within the study period for each acquisition date [1]

- Negligible roughness variation with 100m resolution
- Elaboration with equal vegetation condition
- Backscatter coefficient variation only due to soil mositure variation

Vegetation Indices Tested

Optical Indices

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

$$NDWI = \frac{NIR - SWIR}{NIR + SWIR}$$

NIR: near infrared
SWIR: short wavelength infrared

SAR Indices

$$FVI = \frac{\sigma_0^{VV}}{\sigma_0^{VH}}$$

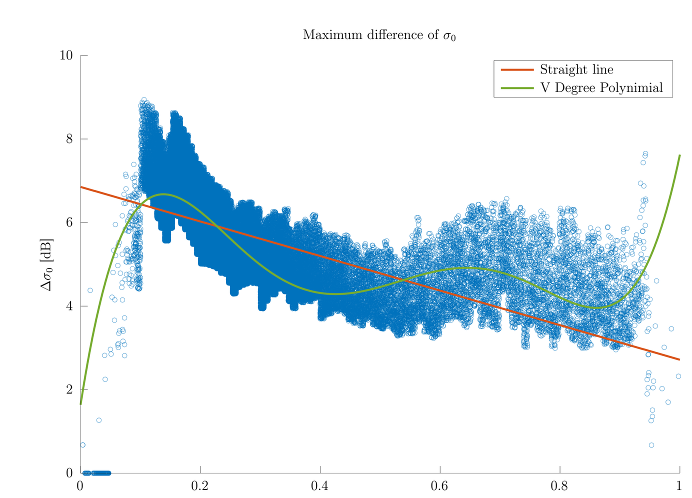
$$RVI = \frac{4\sigma_0^{VH}}{\sigma_0^{VV} + \sigma_0^{VH}}$$

σ_0^{VV}: VV polarized backscatter coeff.
σ_0^{VH}: VH polarized backscatter coeff.

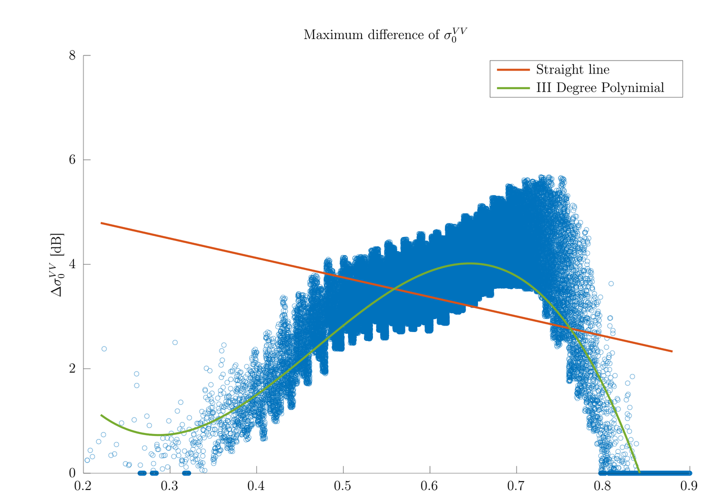
Preliminary Results

Trend of the maximum σ_0^{VV} variations

Examples of the distribution of the maximum differences of σ_0^{VV} in the study sample in function of two vegetation indices. In the used method the fitting polynomial of the distribution is used in the soil moisture assessment to scale lower σ_0^{VV} differences. The red fitting polynomial is the one proposed in literature, in green the one used in the elaborations.



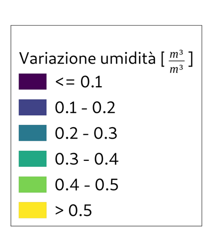
(a) *NDVI*

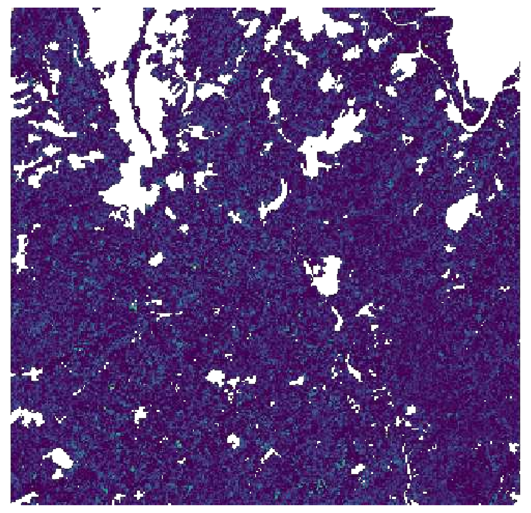


(b) *FVI*

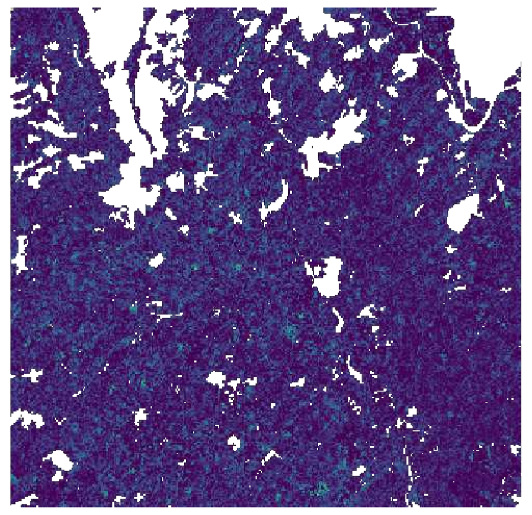
Maps of soil moisture variation

Maps produced with optical indices have a more speckled spatial distribution if compared to the ones produced with SAR indices.

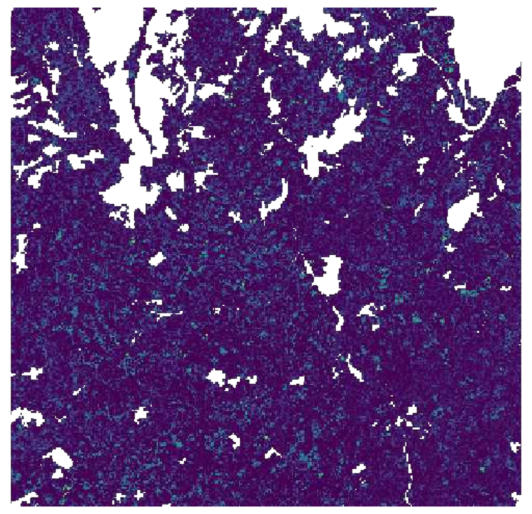




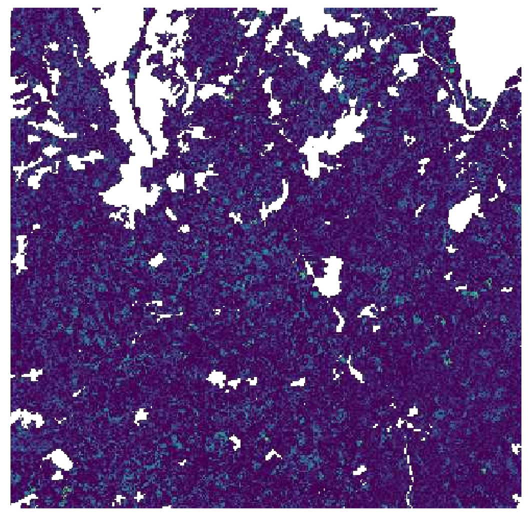
(c) *NDVI*



(d) *NDWI*



(e) *FVI*



(f) *RVI*

Soil moisture variation on 14-08-2018

Punctual Validation

N° data 272
U.M. $\frac{m^3}{m^3}$

	NDVI	*NDWI*	*FVI*	*RVI*
MAE	0.042	0.065	0.053	0.058
bias	0.035	0.059	0.045	0.048
RMSE	0.073	0.097	0.083	0.088

Conclusions and Future Developments

- Best performance for NDVI followed by both SAR indices. It would be interesting to further investigate the possibility of using only SAR images with a wider dataset, since SAR is not weather dependent.
- More recognisable spatial patterns ascribable to agricultural fields for SAR indices elaborations.

- Increase of the dataset
- Study of the 2 trends of the SAR indices
- Comparison of SAR and optical indices
- Temporal study of the spatial variations
- Elaboration with higher resolution

References and Contacts

[1] Gao, Q. (2017). "Synergetic Use of Sentinel-1 and Sentinel-2 Data for Soil Moisture Mapping at 100 m Resolution". In: Sensors 17, p. 1966.

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