Airborne GLORI measurements for soil moisture estimation

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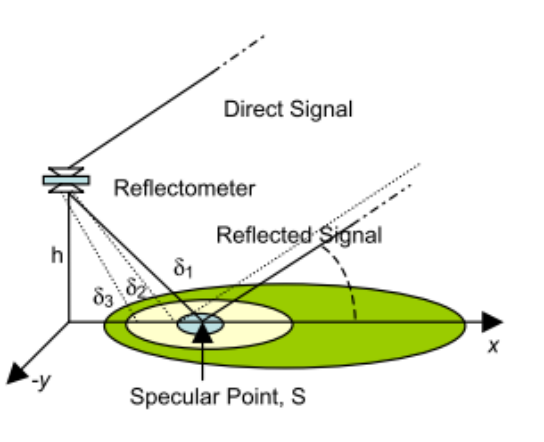
GLORI GNSS-R INSTRUMENT



GNSS-R technology

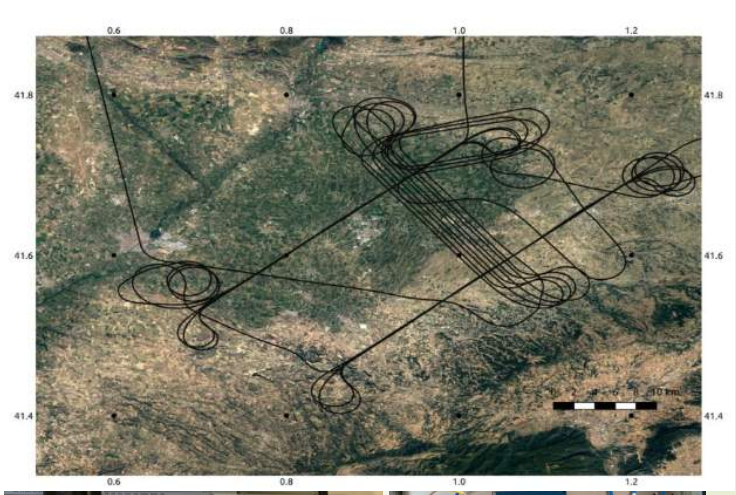
Instrument characteristics

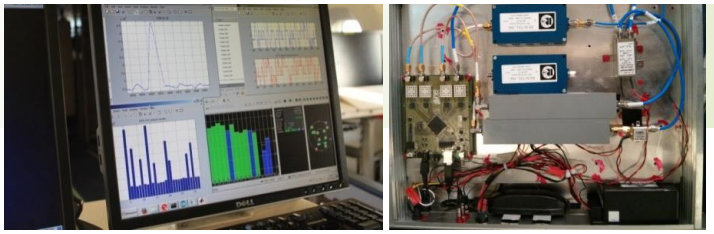
Dual pol (LHCP & RHCP) hemispherical antennas

4 synchronized RF channels L1 centered, 8MHz BW

Direct down conversion, 10MSPS, IQ

Relative channel calibration





Motte et al., 2016, Sensors, Zribi et al., 2018

Flights

Flight id	Date	Start (UTC)	End (UTC)	Flight Duration
40	15/07/21	10:23:30	15:19:04	04:55:34
41	16/07/21	10:26:42	15:19:04	04:52:22
42	17/07/21	10:37:17	15:34:04	04:56:47
43	20/07/21	09:51:09	15:00:00	05:08:51
45	22/07/21	10:38:10	14:50:05	04:11:55
46	27/07/21	10:23:54	14:28:32	04:04:38
47	28/07/21	10:23:45	14:27:36	04:03:51

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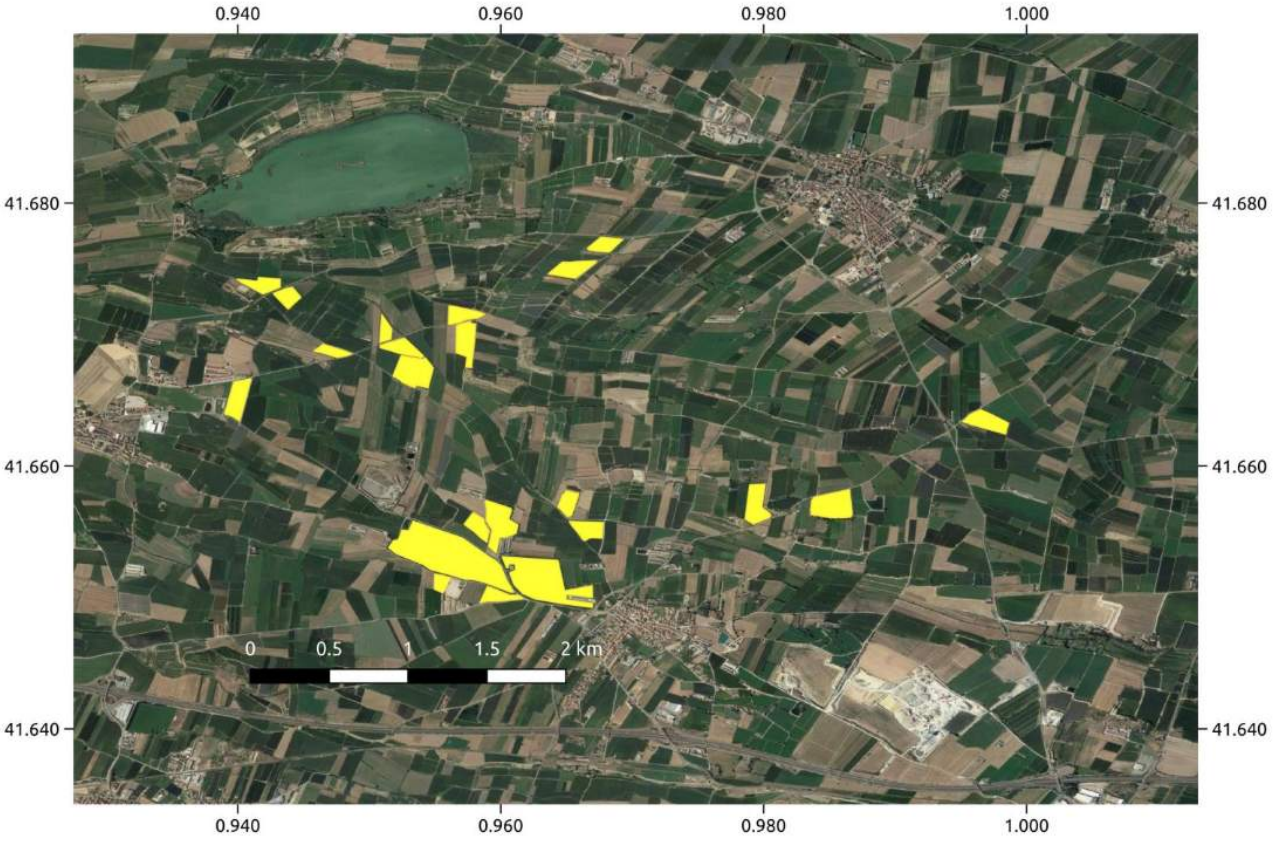
In situ measurements

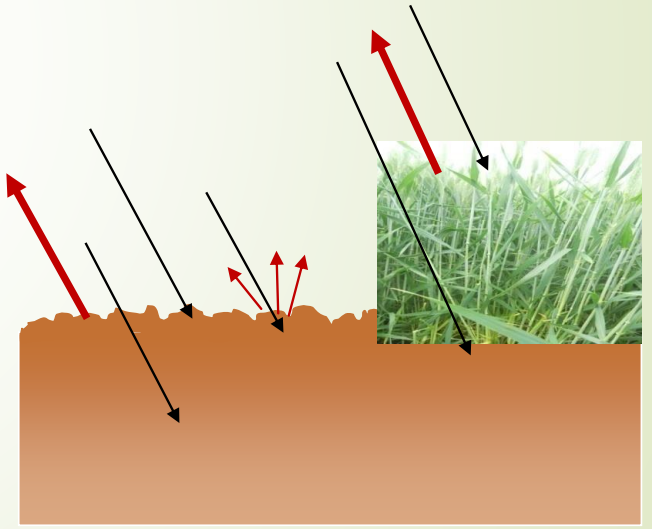


22 test fields during GLORI measurements

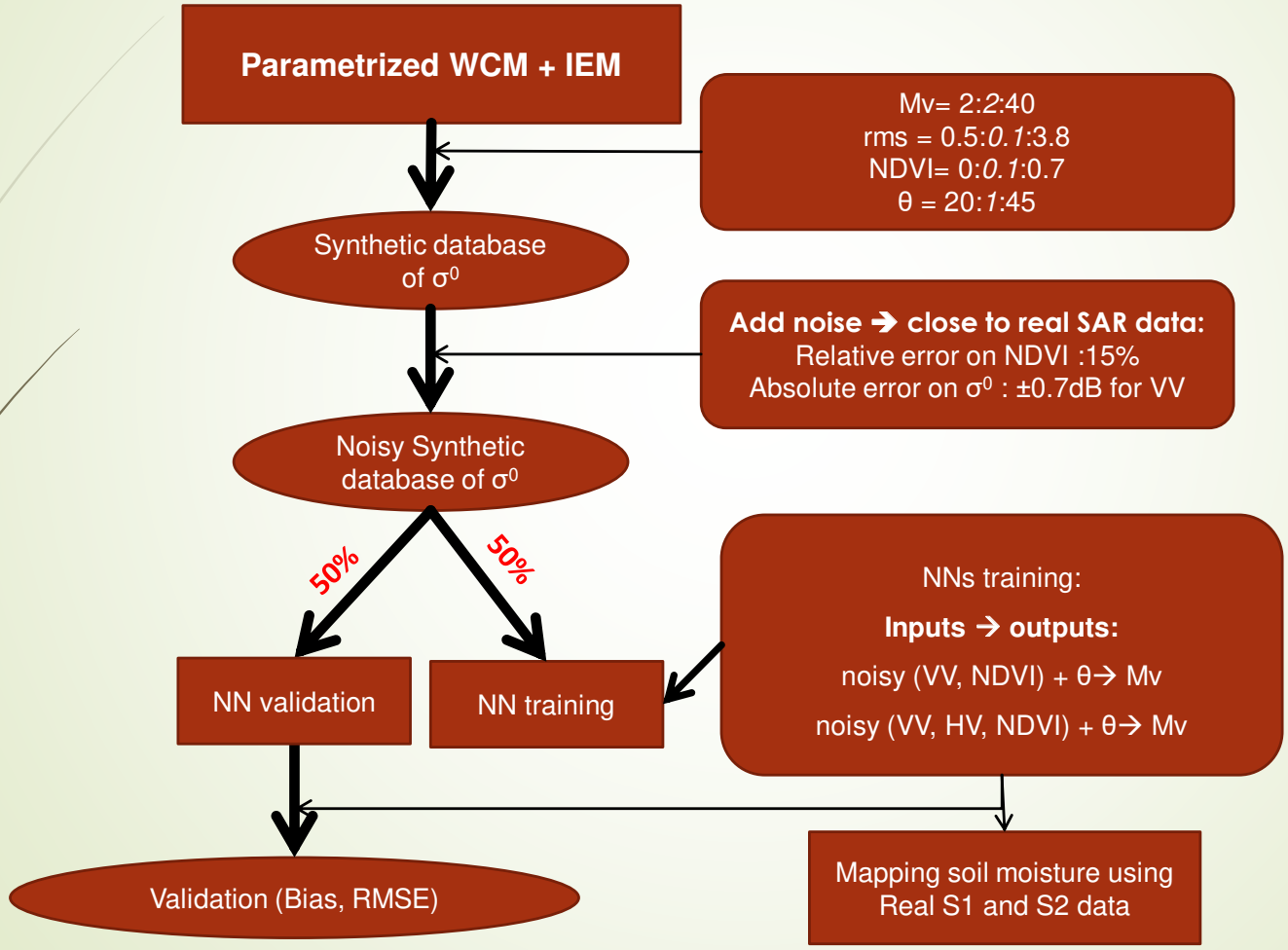
	Hrms (cm)	Lc (cm)	Mv (m3/m3)	LAI (m^2/m^2)
15/07/2021	-	-	[0.07-0.41]	-
16/07/2021	-	-	[0.04-0.39]	-
17/07/2021	-	-	[0.06-0.46]	-
19/07/2021			-	[1.07-2.54]
20/07/2021	-	-	[0.02-0.36]	-
21/07/2021	-	-	[0.06-0.38]	-
23/07/2021	[0.4-1.84]	[4-12.18]	-	[0-3.14]
27/07/2021	-	-	[0.12-0.40]	-
28/07/2021	-	-	[0.1-0.43]	-
29/07/2021	-	-	-	[0.14-3.42]

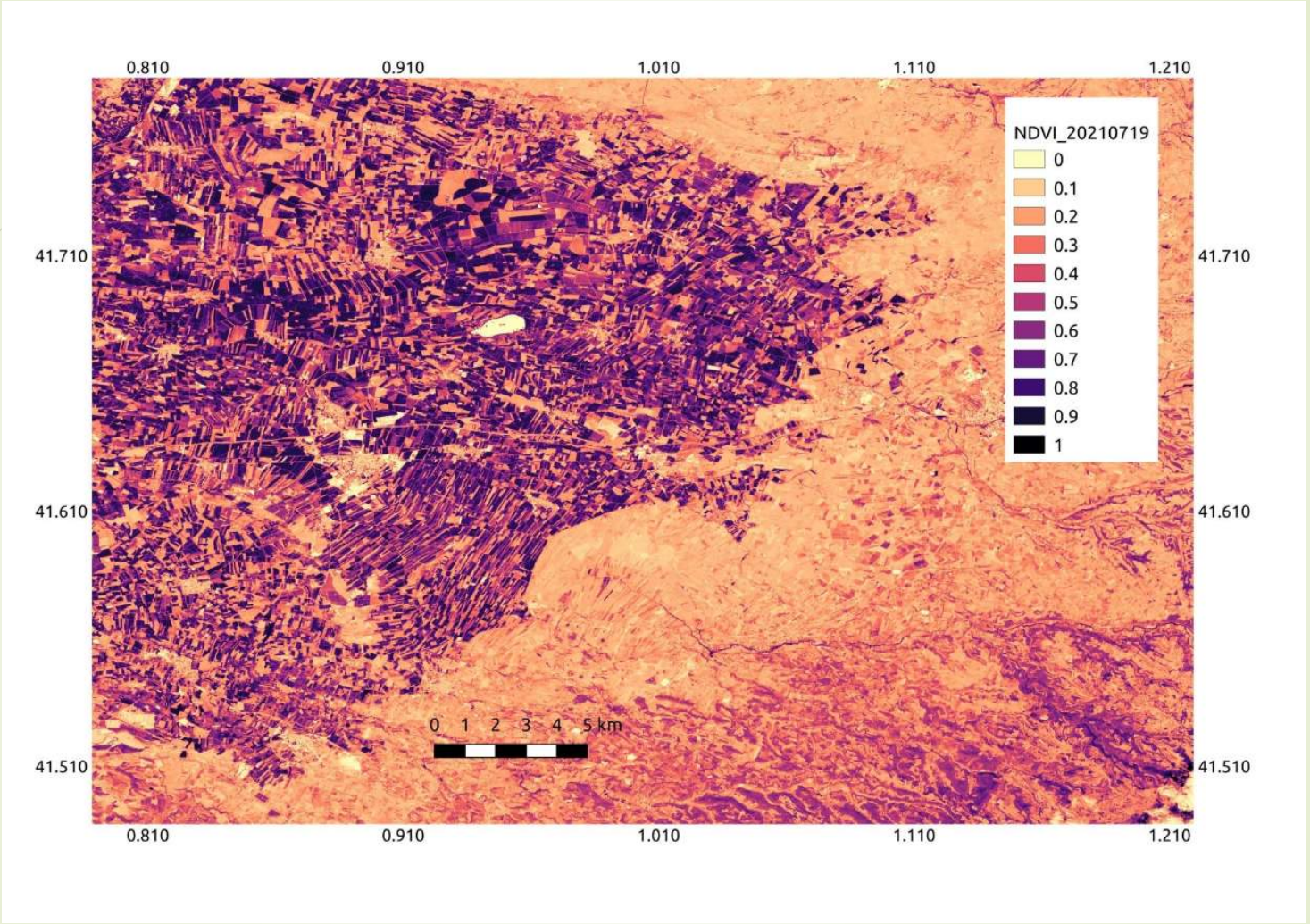
In situ measurements statistics

SM estimation using S1&S2

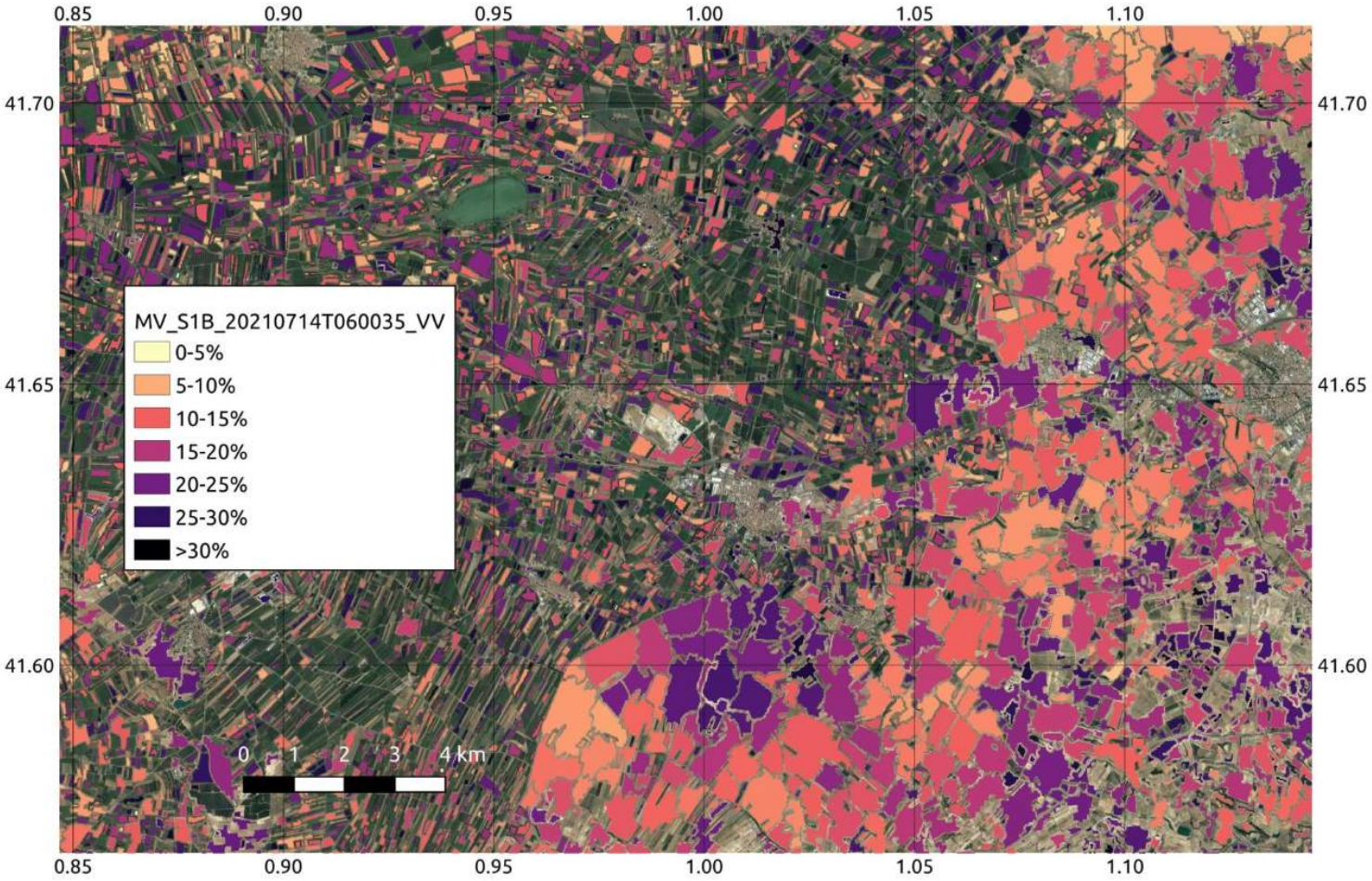


Approach for SM estimation using S1&S2: Neural Network (El Hajj et al., 2017)



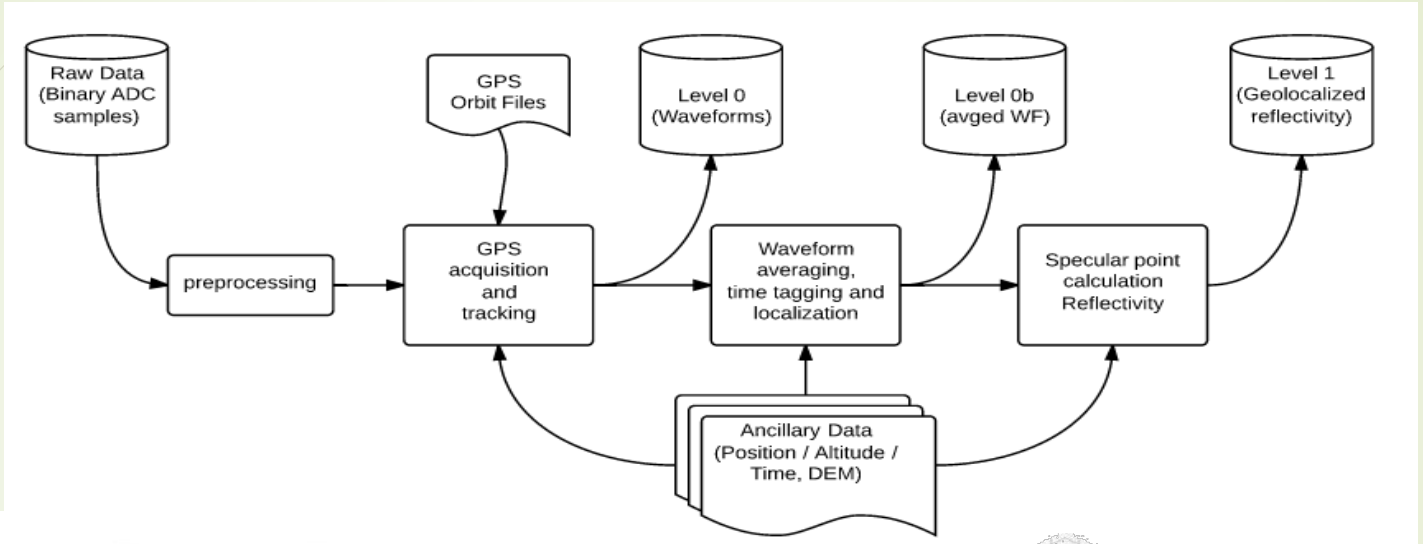


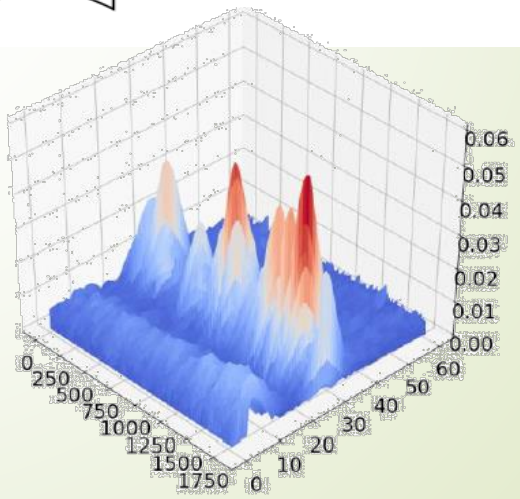
NDVI Sentinel-2 map



Soil moisture maps, each 6 days, processing is finished for all 2021 year.

Glori data processing





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Technical problem in Amplifier for 4 first flights

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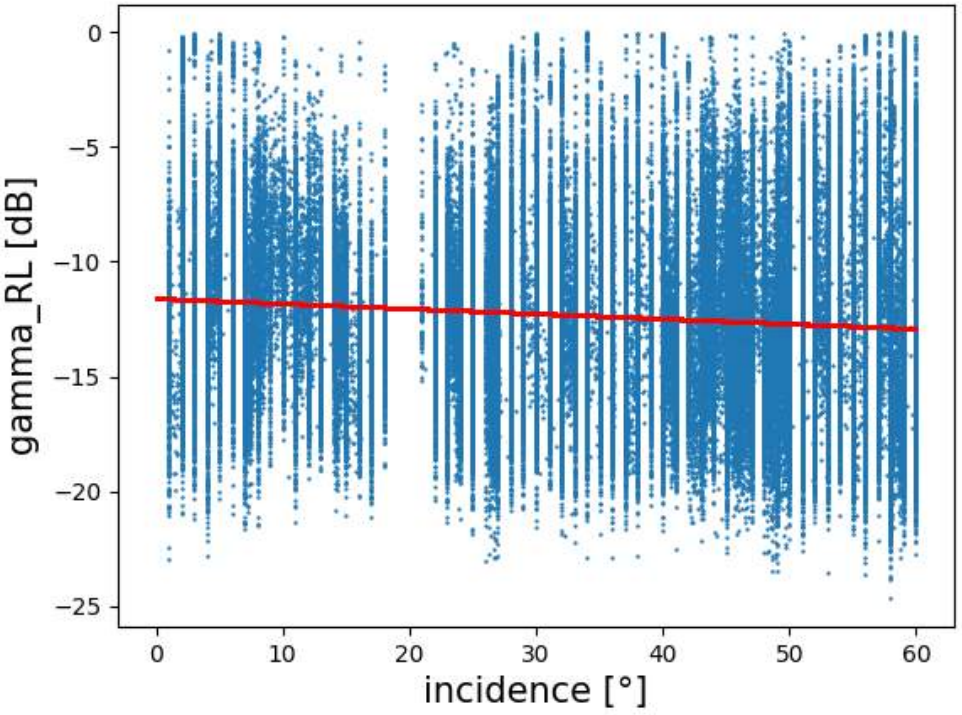
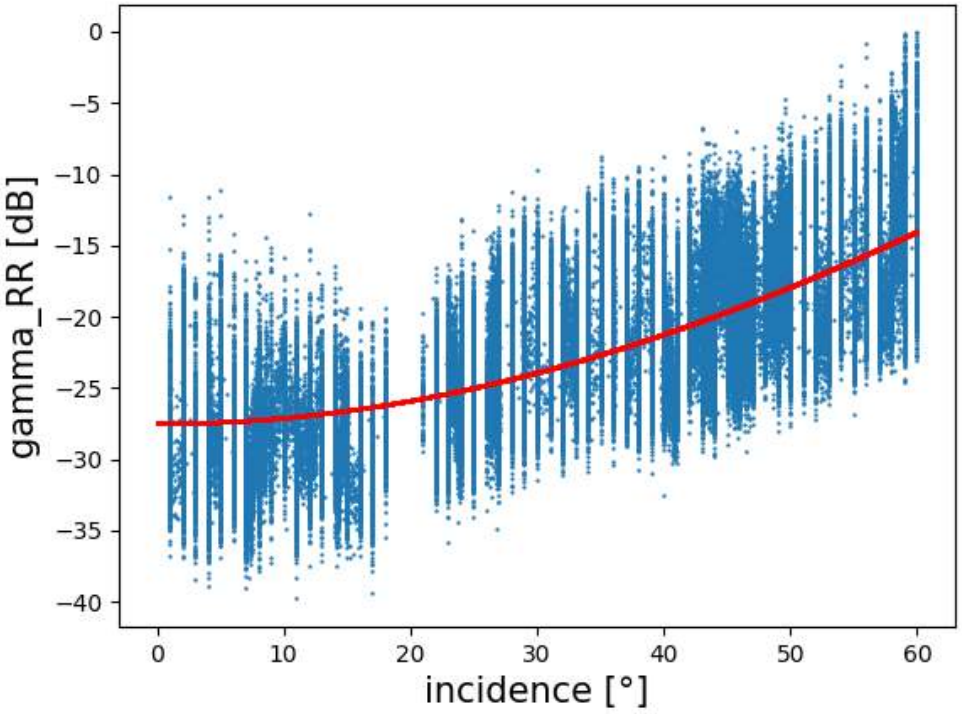
Analysis of incidence angle effects

Γ_RL:



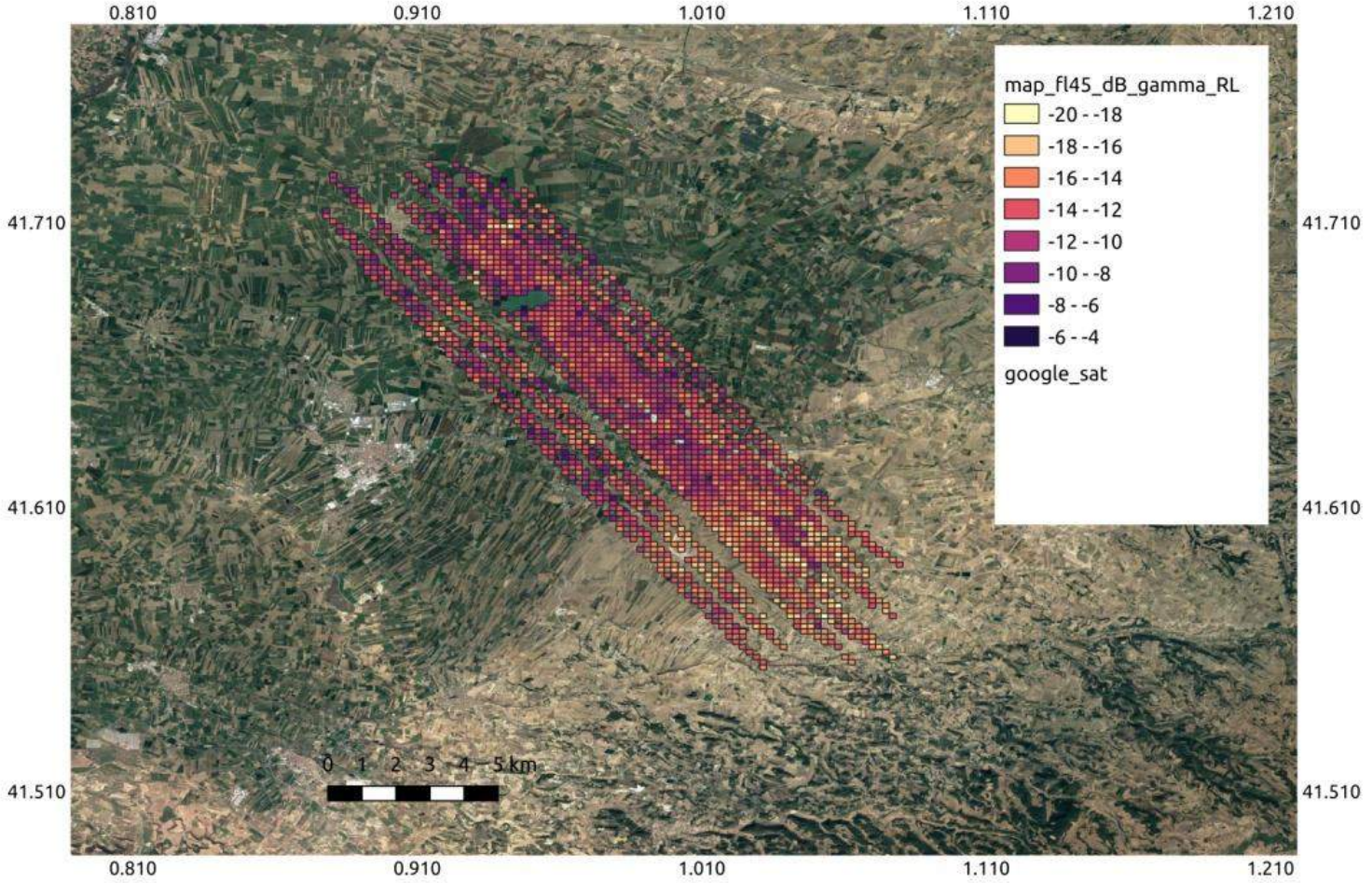
Γ_RL = a + b*Θ

Γ_RR:

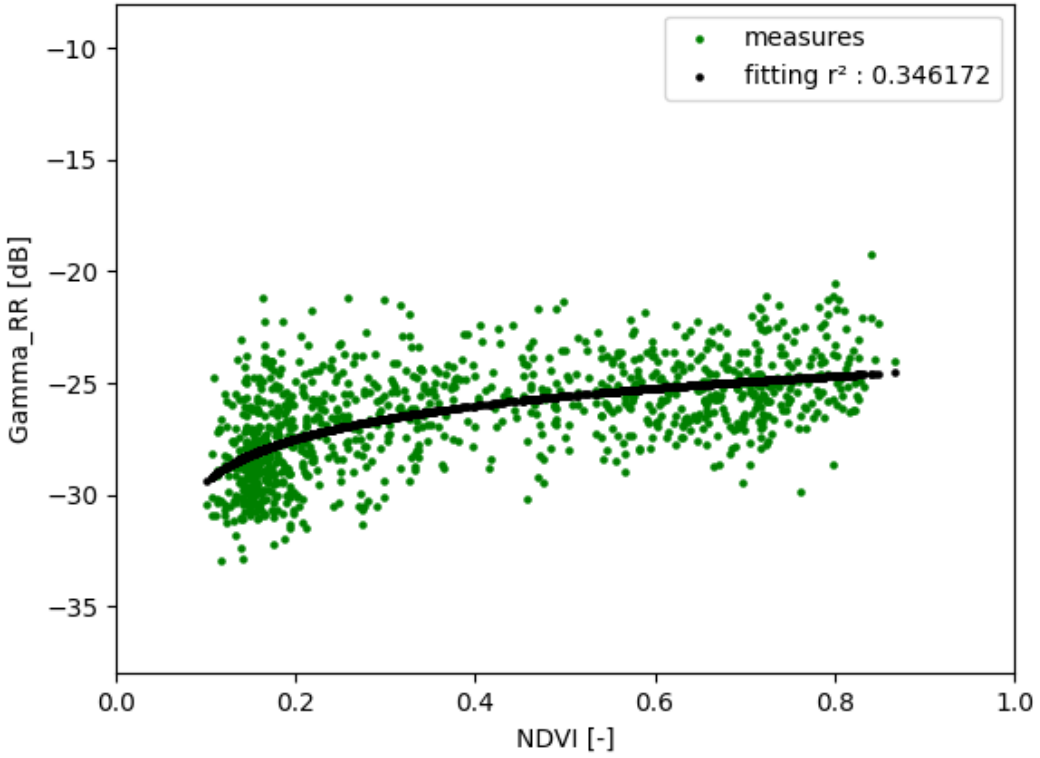


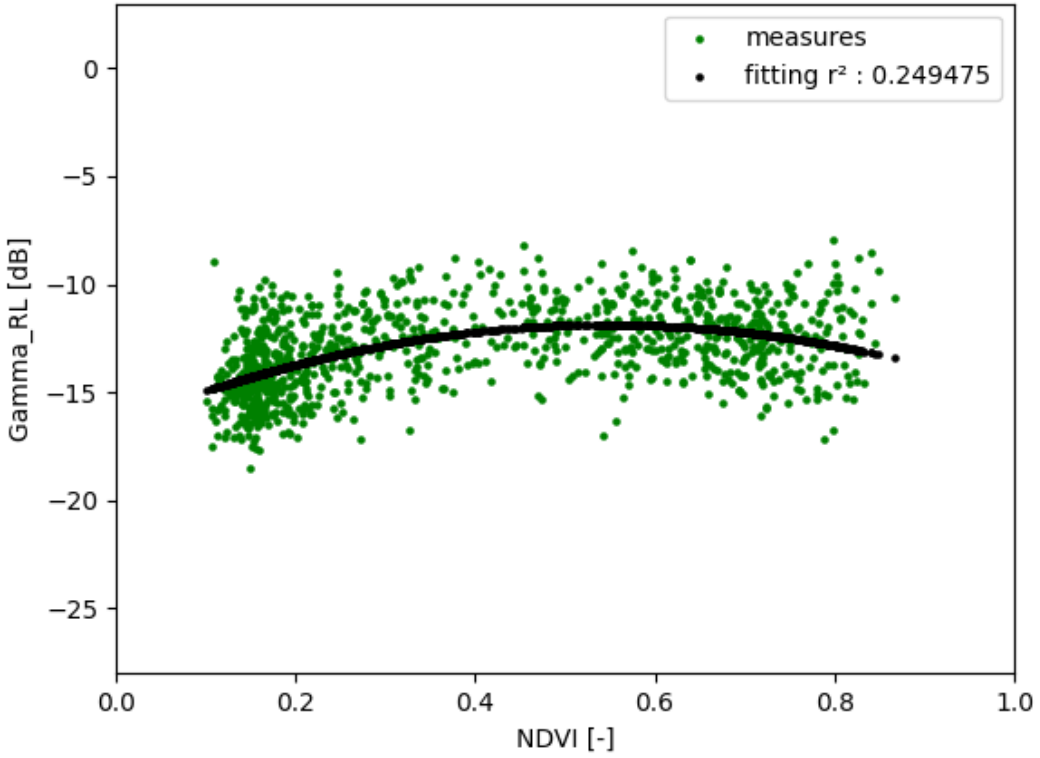
Γ_RL = a*cos(Θ)^β

Reflectivity mapping, 100m or 200m

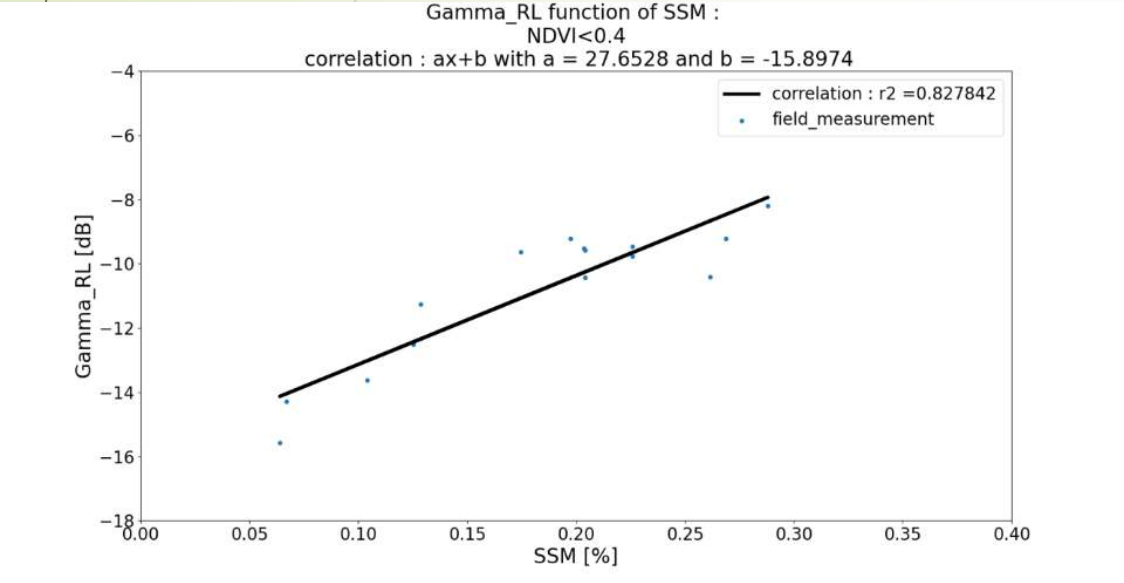


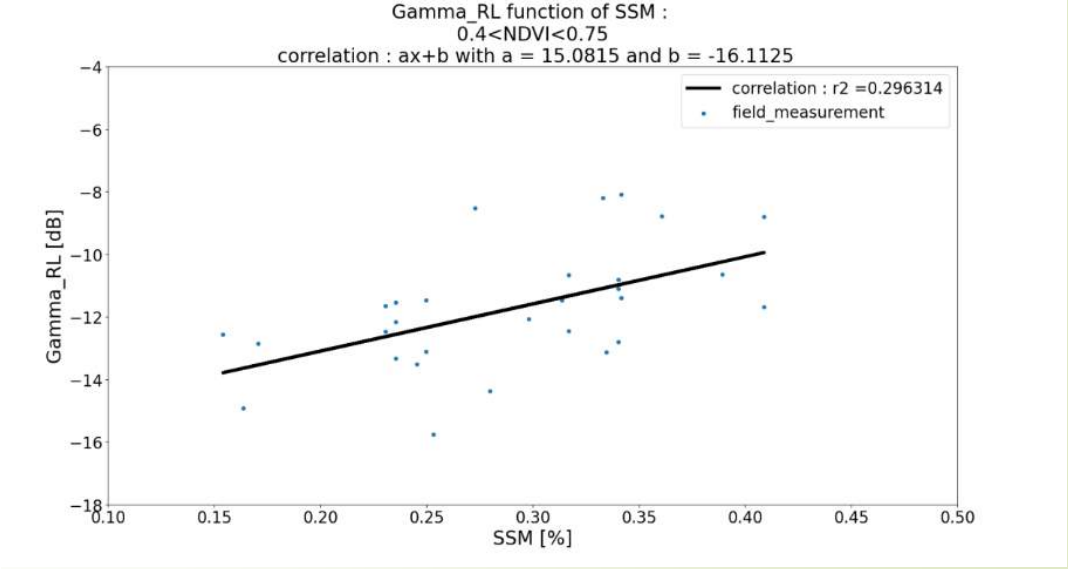
Reflectivity=f(NDVI)

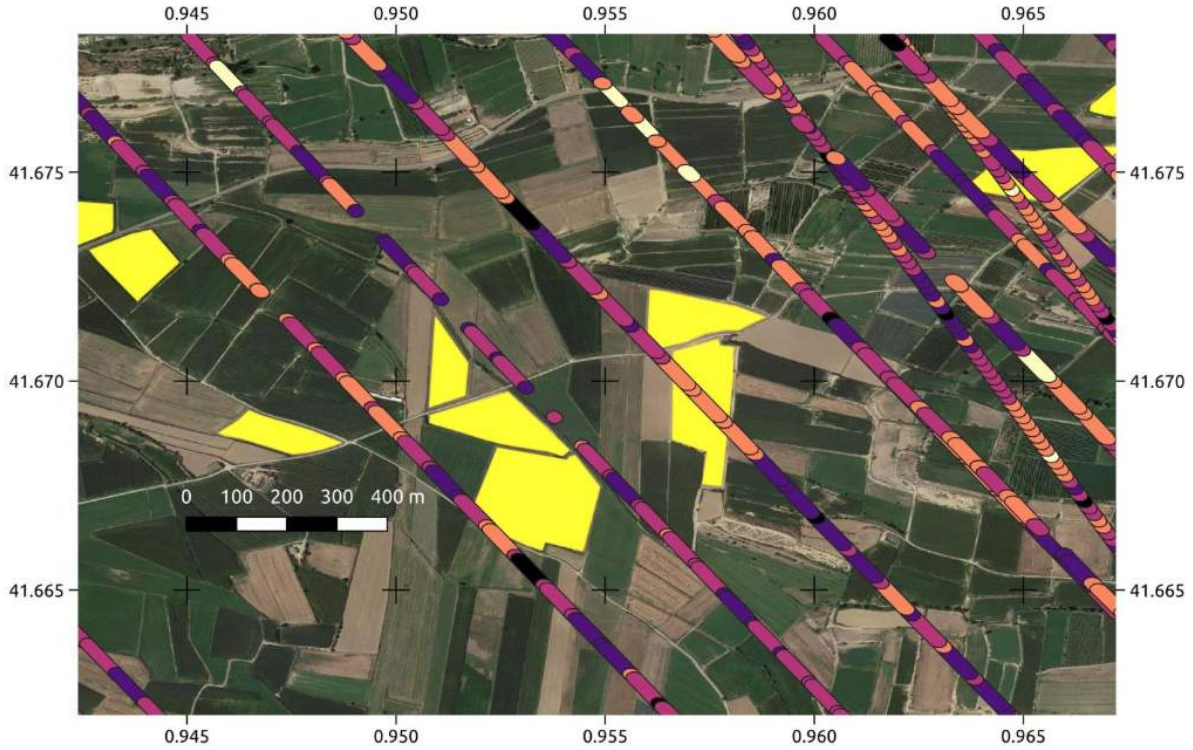




Reflectivity sensitivity to soil moisture






0.945
0.950
0.955
0.960
0.965
41.675
41.670
41.665
0 100 200 300 400 m

REFLECTIVITY MODELLING

Based Tau-omega model, the covered soil reflectivity can be modeled as:

$$\Gamma_p(\theta) = \Gamma_p^{soil}(\theta).e^{-2.\tau_p^{canopy}/\cos\theta}.\left(1-\omega_p^{canopy}\right)^2$$

We considered the height parameter to model the optical thickness.

$$\tau_p = a.NDVI$$

In L band, the single-scattering albedo can be neglected for low vegetation cover

$$\Gamma_p(\theta) = \Gamma_p^{soil}(\theta).e^{-2.(a\ NDVI))/\cos\theta}$$

$$\Gamma_p(\theta)_{dB} = \alpha Mv + \beta\ NDVI/\cos(\theta) + \delta$$

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Conclusions and next steps

- A soil moisture product with S1&S2 data during 2021, each 6 days (Asc and Des orbits) at field scale
- First results of GLORI data sensitivity to soil moisture

To do

- Finalisation of soil moisture mapping with GLORI (3 flights)
- Processing of flights with technical problems
- Potential of comparison between GNSS-R and passive microwave L-band products

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Thank you for your attention