LIAISE GLORI 2021 datasets

Karin Dassas, Pascal Fanise, Michel Le Page, Emna Ayari, Philippe Baillion, Mateo Sige, Aaron Boone, Mehrez Zribi

SUMMARY

- Datapaper overview
- Datapaper datasets descriptions
- Soil Moisture Estimation dataset

GLORI 2021 DATA

Data in Brief

Volume 52, February 2024, 109850

Karin Dassas, Pascal Fanise, Michel Le Page, Emna Ayari, Philippe Baillion, Mateo Sige, Aaron Boone, **Mehrez Zribi**, Polarimetric instrument Global Navigation Satellite System - Reflectometry airborne data, Data in Brief, Volume 52, 2024, 109850, https://doi.org/10.1016/j.dib.2023.109850.

GLORI 2021 DATA

Volume 52, February 2024, 109850

Data in Brief

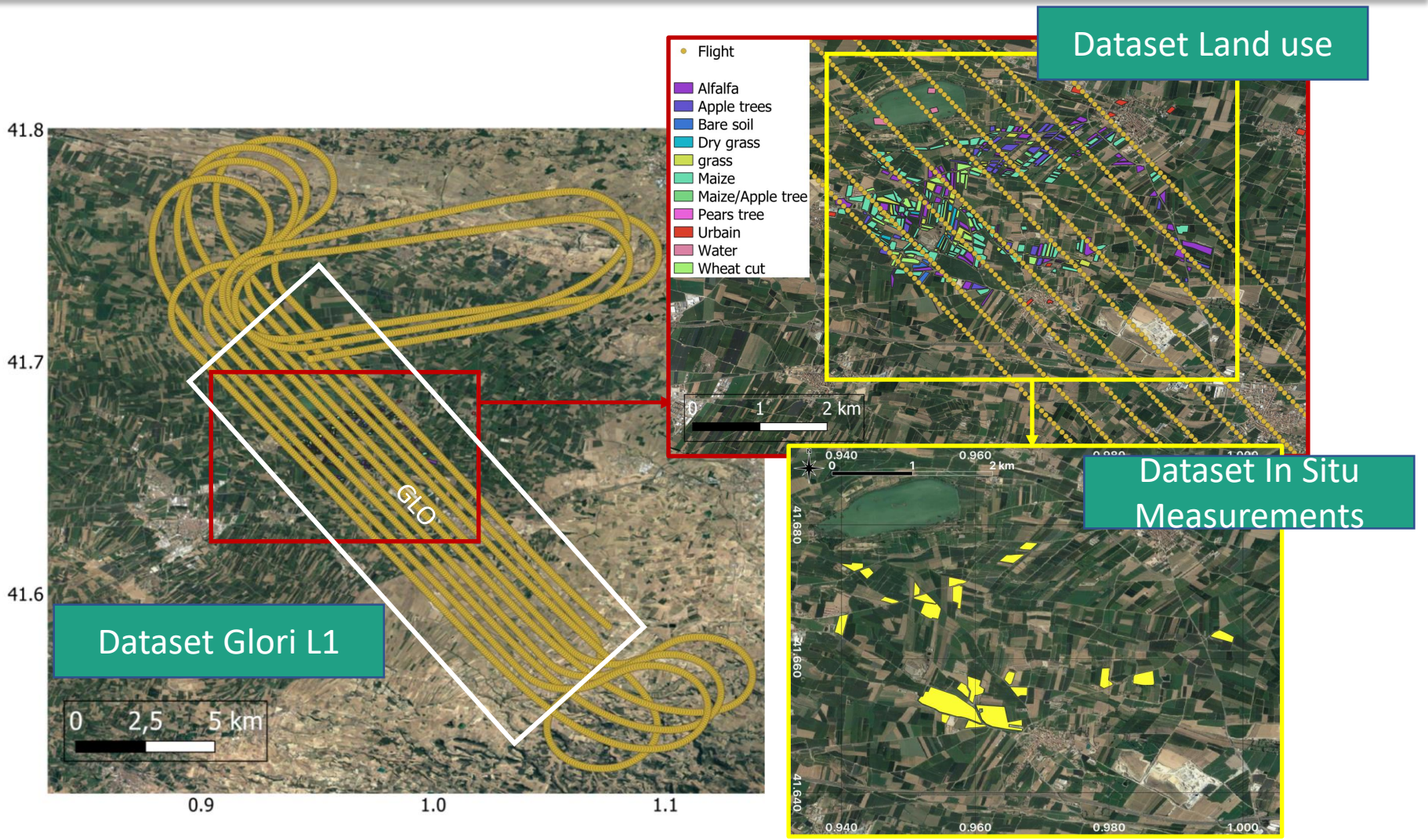
LIAISE GNSS-R GLORI CESBIO v1 2021 dataset: https://doi.org/10.25326/494

LIAISE In situ measurements CESBIO v1 dataset https://doi.org/10.25326/493

LIAISE Land use CESBIO v1 dataset: https://doi.org/10.25326/495

+ **LIAISE Soil Moisture Estimation CESBIO v1. [Dataset]. Aeris. https://doi.org/10.25326/601 (not in the datapaper)**

GLORI CAMPAIGNS : URGELL

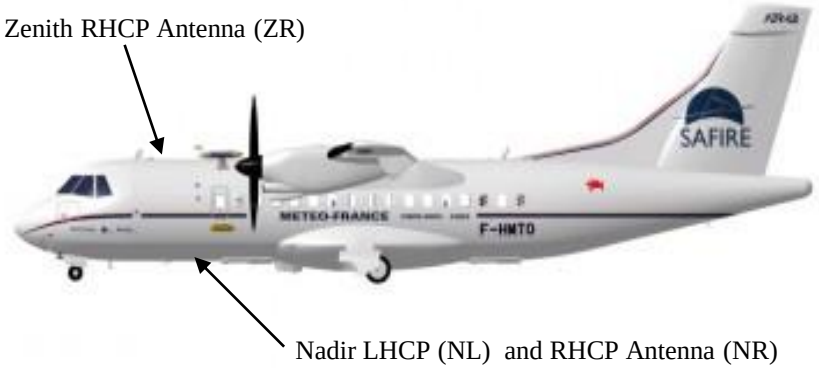


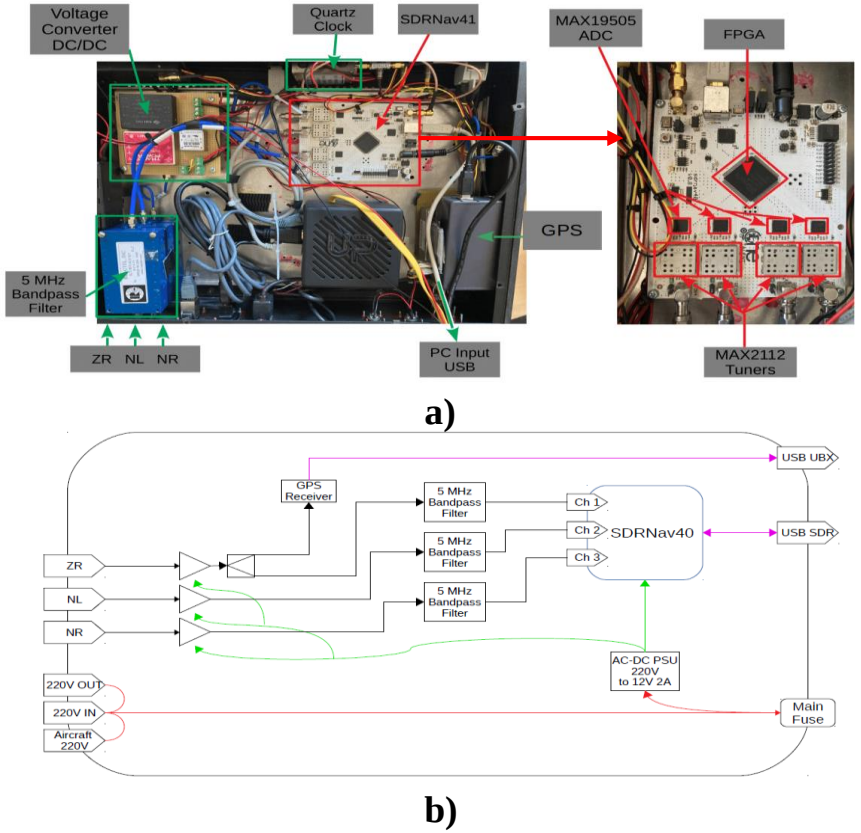
Flight path with the GLO transects zone (white frame), (left panel), land use plots (upper right image) and plots with in situ measurements (yellow plots, bottom right image)

LIAISE GNSS-R GLORI CESBIO v1 2021 dataset

LIAISE GNSS-R GLORI CESBIO v1 2021 dataset

Data L1b from GLORI : **GLO**bal navigation satellite system **R**eflectometry **I**nstrument

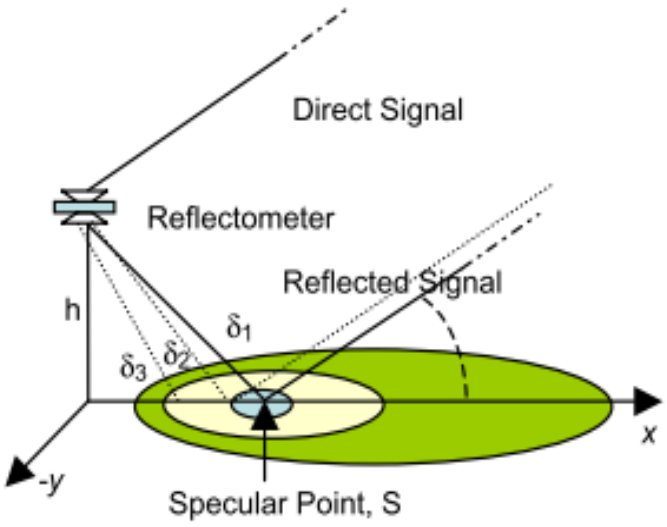


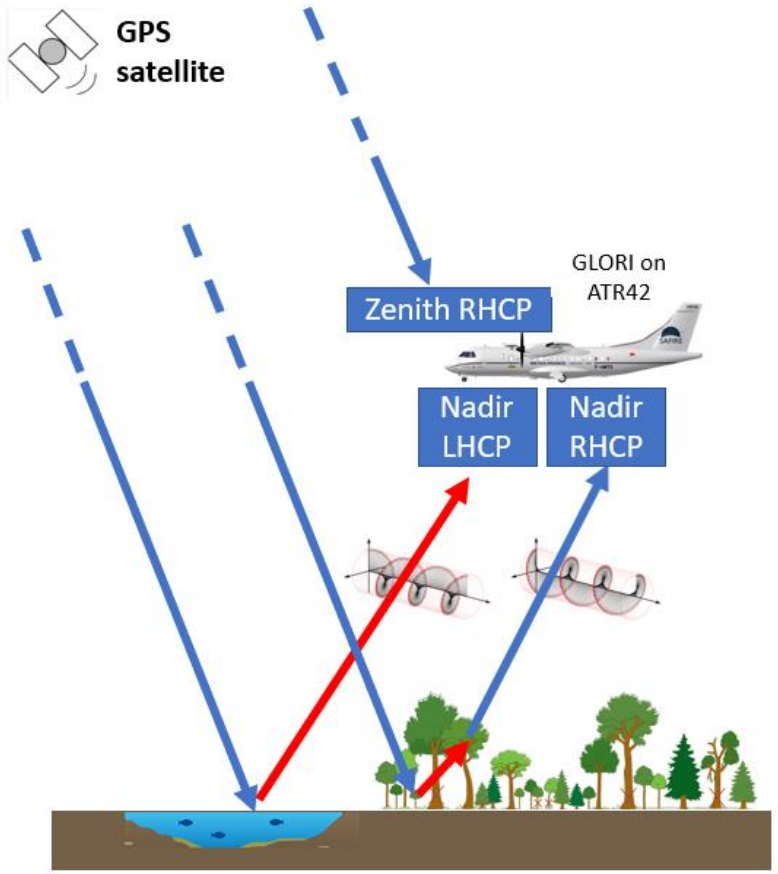


GLORI 2021 Front End (a) picture and (b) synoptic view

LIAISE GNSS-R GLORI CESBIO v1 2021 dataset

GNSS REFLECTOMETRY (GNSS-R: GLOBAL NAVIGATION SATELLITE SYSTEM - REFLECTOMETRY) is a bistatic radar remote sensing technology (transmitters and receivers are not in the same place) that uses microwave signals of opportunity from radio navigation constellations.





GNSS-R by waveform analysis technique: each antenna pair corresponds to a channel that measures the direct signal with its up-looking antenna and another channel measuring the signal reflected by the surface with its down-looking antenna.

J. Darrozes, N. Roussel, M. Zribi, 2016.

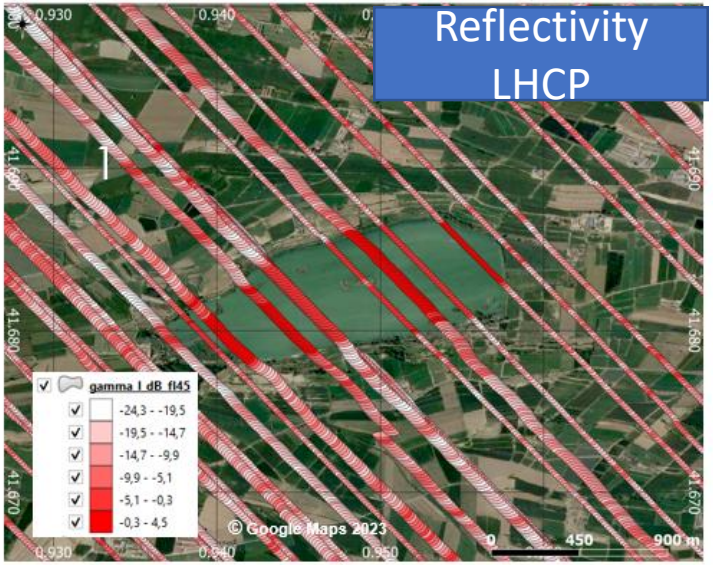
LIAISE GNSS-R GLORI CESBIO v1 2021 dataset

GLORI Instrument

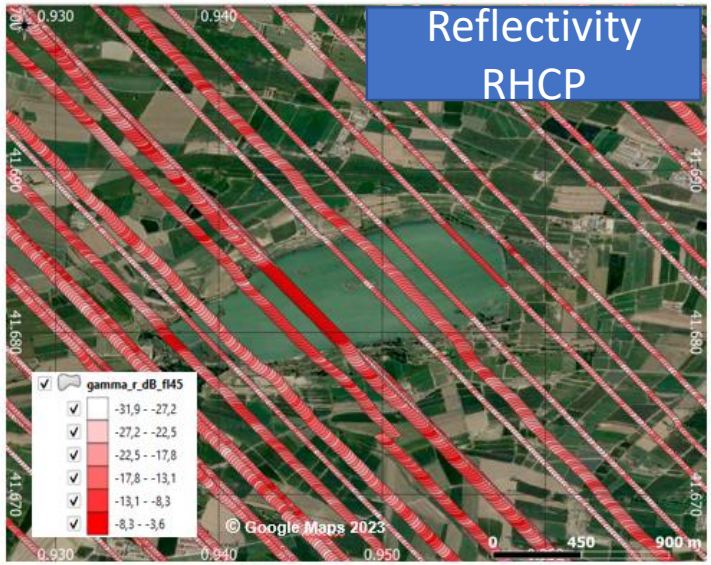
gamma_l	LHCP reflectivity (Γ_l from step 2 from pipeline)	float	dB
gamma_r	RHCP reflectivity (Γ_r from step2 from pipeline)	float	dB
noise_fix	noise fix	float	dB
noise_nl	noise floor of reflected LHCP signal	float	dB
noise_nr	noise floor of reflected RHCP signal	float	dB
noise_zr	noise floor of direct signal	float	dB
incoherent_ratio_l_	incoherent ratio LHCP (α_l from step 2 from pipeline)	float	n/a
incoherent_ratio_r	incoherent ratio RHCP (α_r from step 2 from pipeline)	float	n/a
phase_l	LHCP phase difference relative to direct	float	Rad
phase_r	RHCP phase difference relative to direct	float	Rad
snr_nl	nadir LHCP signal to noise ratio	float	dB
snr_nr	nadir RHCP signal to noise ratio	float	dB
snr_zr	zenith RHCP signal to noise ratio	float	dB

All elevations >30°

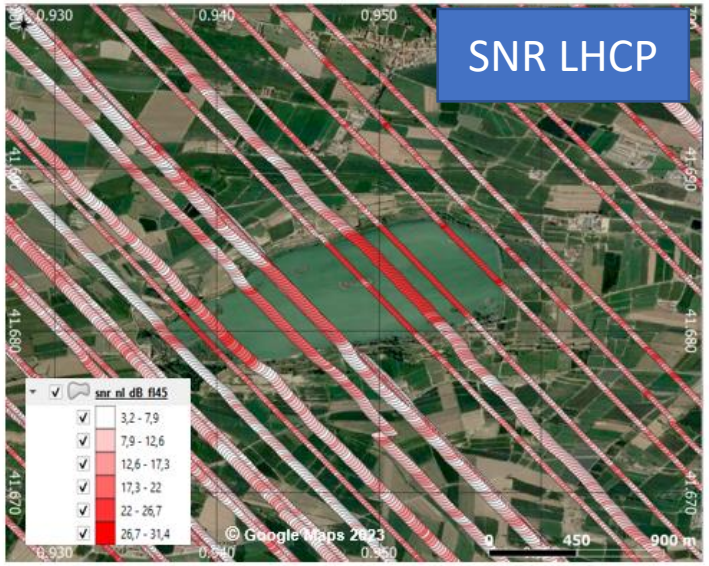
LIAISE GNSS-R GLORI CESBIO v1 2021 dataset



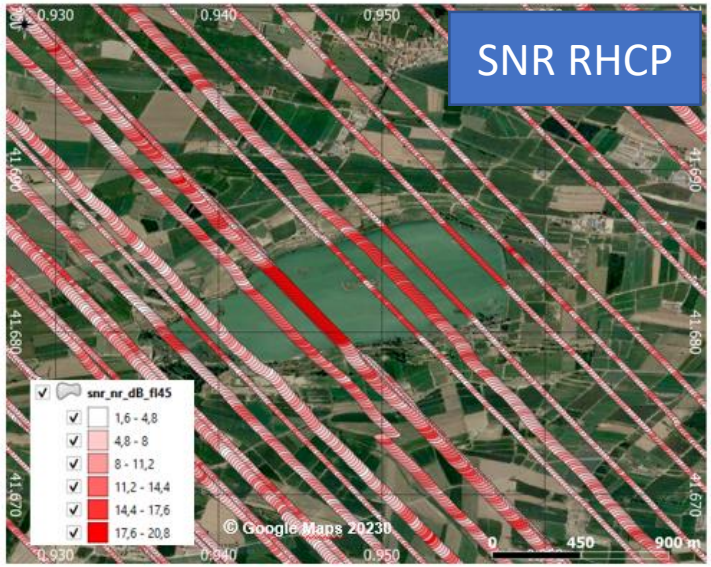
a)



b)



c)



d)

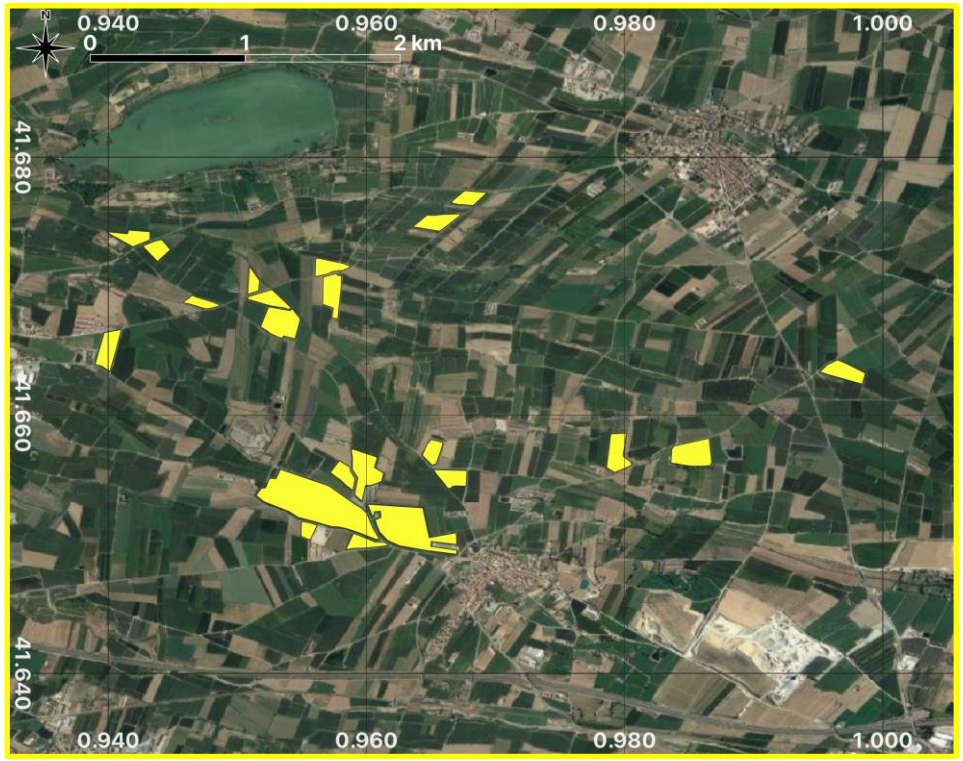
(a) reflectivity left Γ_l (b) reflectivity right Γ_r and (c) snr_nl (d) snr_nr over the Ivars lake, flight 45.

LIAISE In situ measurements CESBIO v1 dataset

Contact : M. Le Page

LIAISE In situ measurements CESBIO v1 dataset

(a) soil moisture probe (b) a pin profiler picture, plot 25 (alfalfa), on July 23 (c) hemispherical photo maize.



Plots with in situ measurements

Contact : M. Le Page

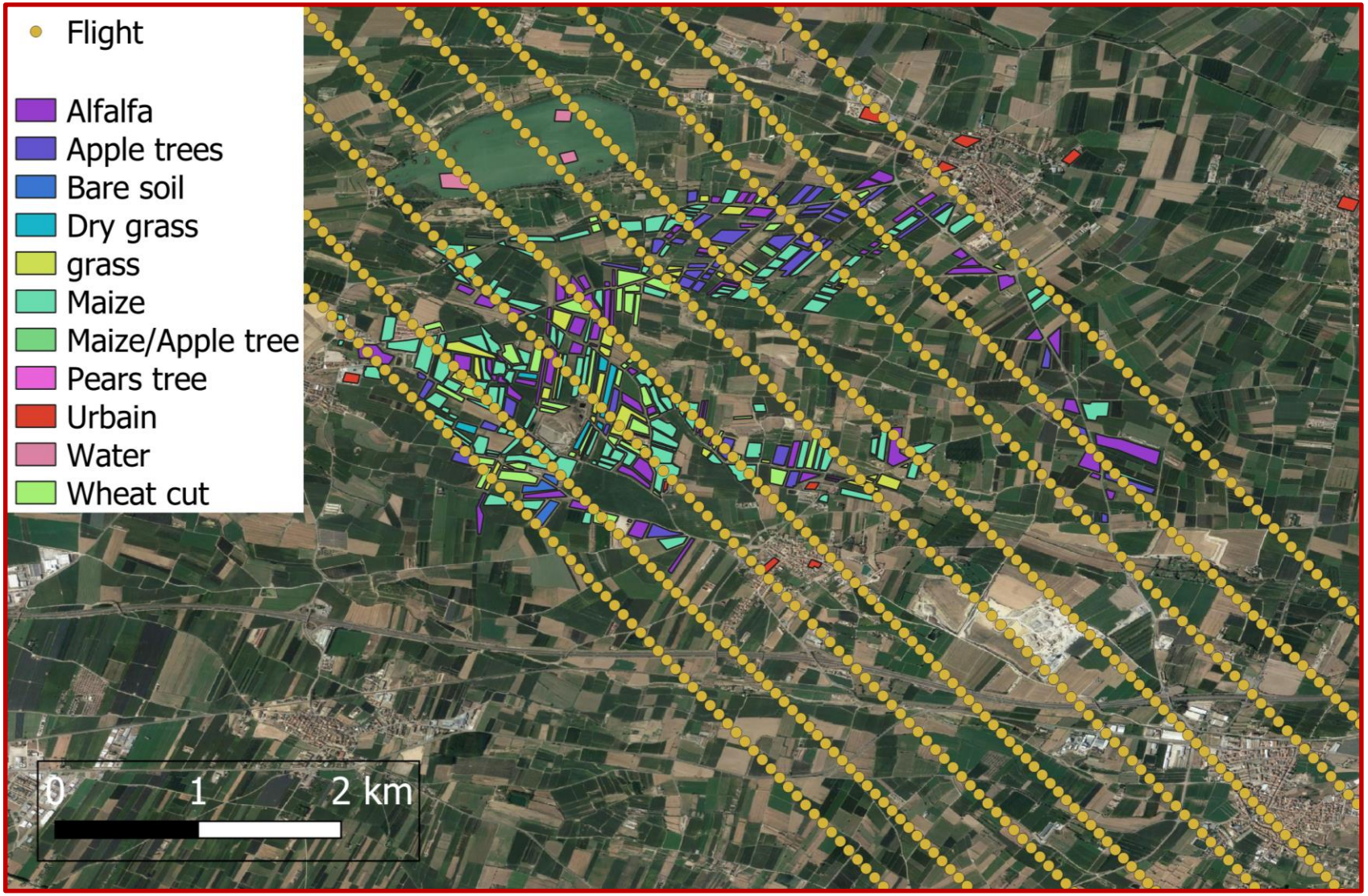
LIAISE In situ measurements CESBIO v1 dataset

Date	*HRMS* (cm)	*Roughness_correlation_length* (cm)	SSM_{mean} (m^3/m^3)	*LAI_mean_57deg* (m^2/m^2)
15/07/2021			[0.1-0.41]	
16/07/2021			[0.09-0.39]	
17/07/2021			[0.07-0.46]	
19/07/2021				[1.07-2.54]
20/07/2021			[0.02-0.41]	
21/07/2021			[0.04-0.38]	
22/07/2021			[0.06-0.34]	
23/07/2021	[0.4-1.84]	[4.112.18]		[0-3.14]
27/07/2021	-	-	[0.12-0.41]	-
28/07/2021	-	-	[0.1-0.44]	
29/07/2021				[0.15-3.42]

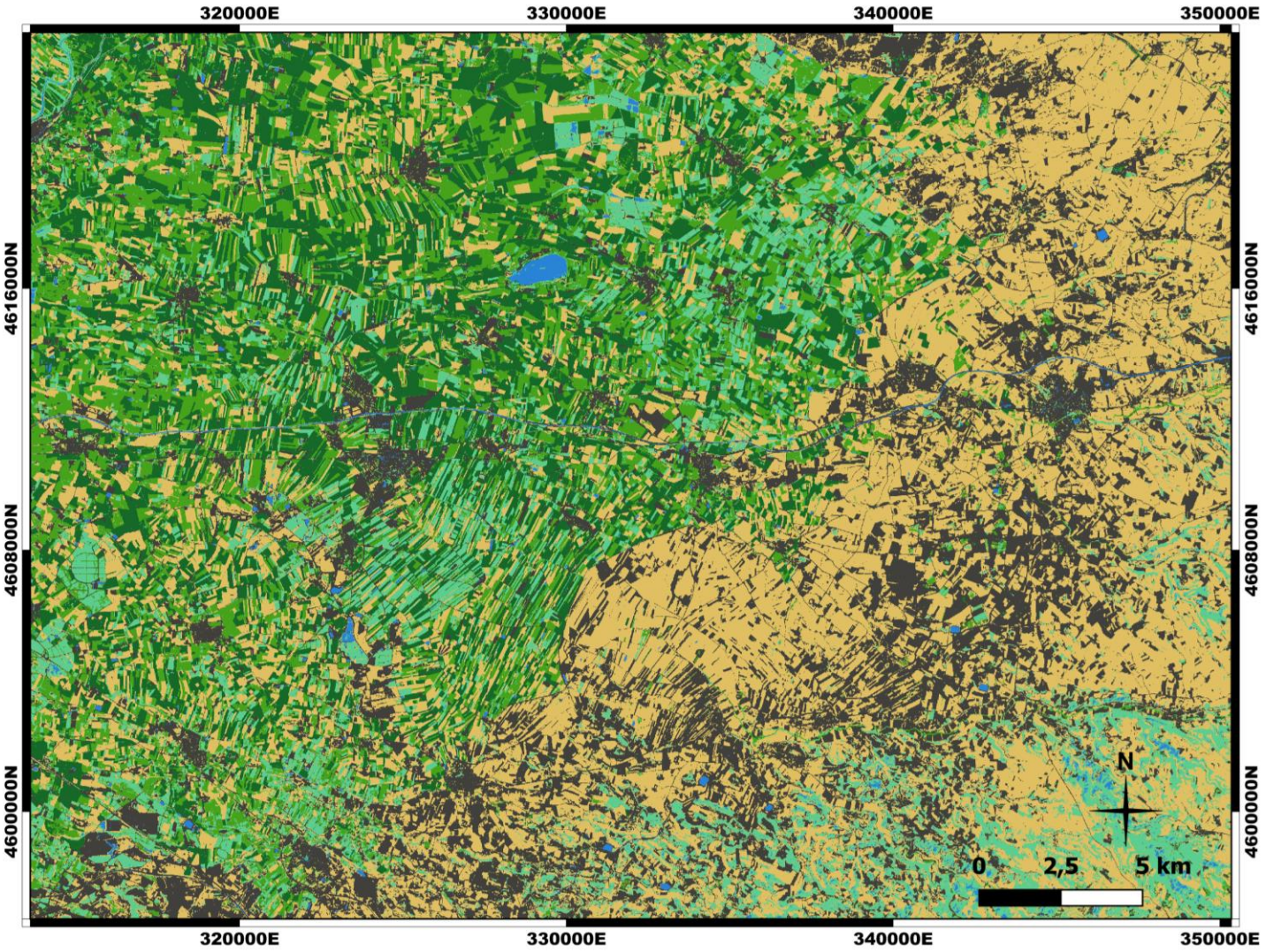
Contact : M. Le Page / M.Zribi

LIAISE Land use CESBIO v1 dataset

LIAISE Land use CESBIO v1 dataset



LIAISE Land use CESBIO v1 dataset



ORFEO ToolBox

Orfeo Tool Box, Ground Truth data and Sentinel 2 data

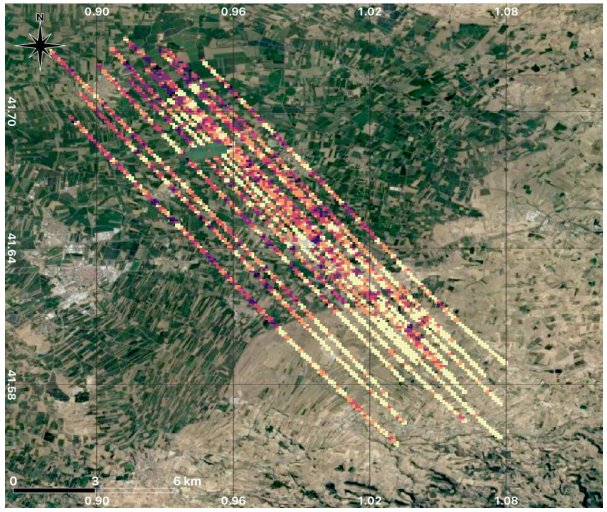
LIAISE Soil Moisture Estimation CESBIO v1 dataset

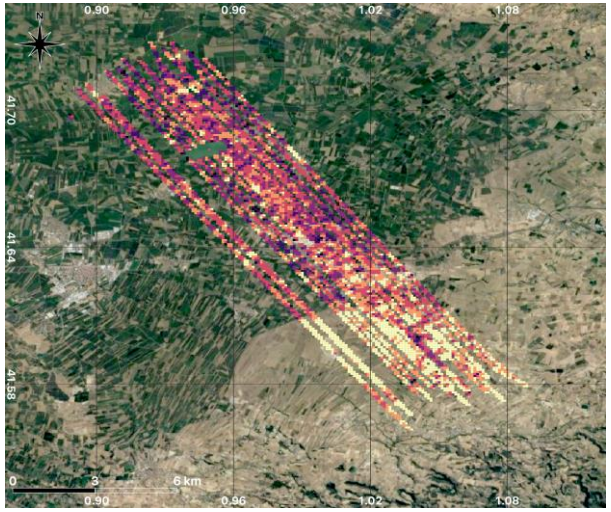
LIAISE Soil Moisture Estimation CESBIO v1 dataset

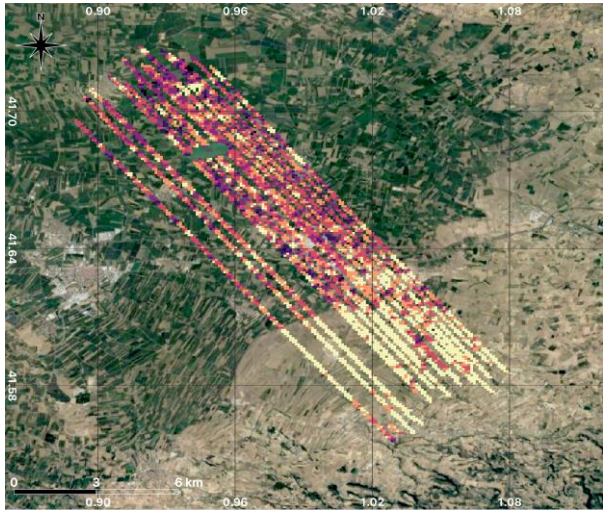
22/07/21 Flight 45 : dry

27/07/21 Flight 46 : wet, after a precipitation event

28/07/21 Flight 47 : drying process







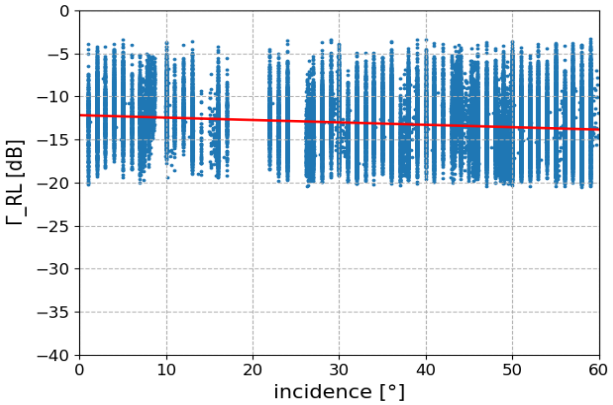
Mv_est (100m res) [m3/m3]

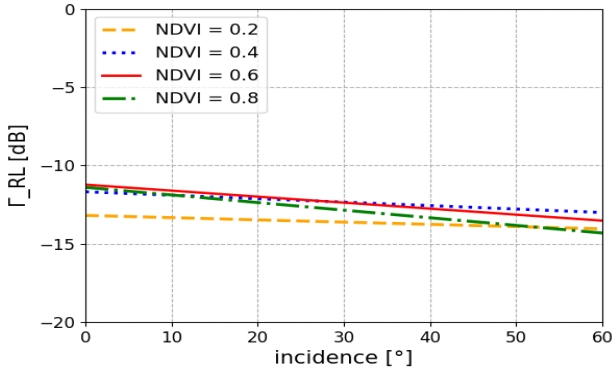
- 0 - 0,11
- 0,11 - 0,22
- 0,22 - 0,33
- 0,33 - 0,45
- 0,45 - 0,56
- 0,56 - 0,67

Inverted maps using a gamma-tau model with reflectivity Γ_L

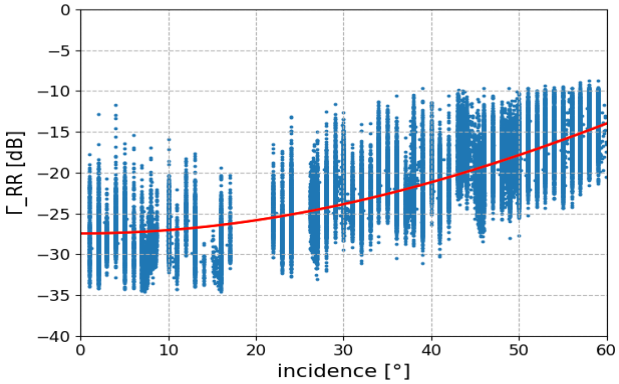
Incidence angle max 40°

REFLECTIVITY VARIATIONS : FUNCTION OF INCIDENCE ANGLE





$$\Gamma_{RL}(20°) = \Gamma_{RL}(\theta) + b(NDVI)(\theta - 20°)$$



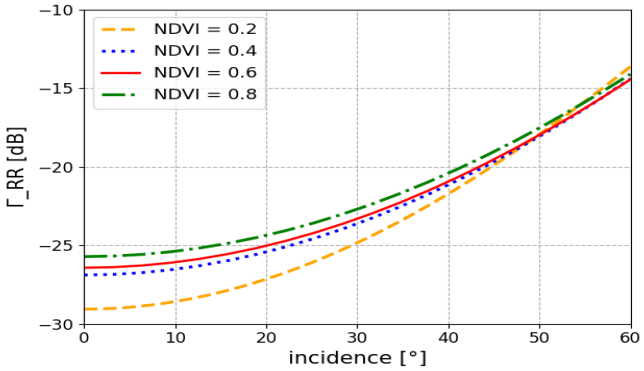
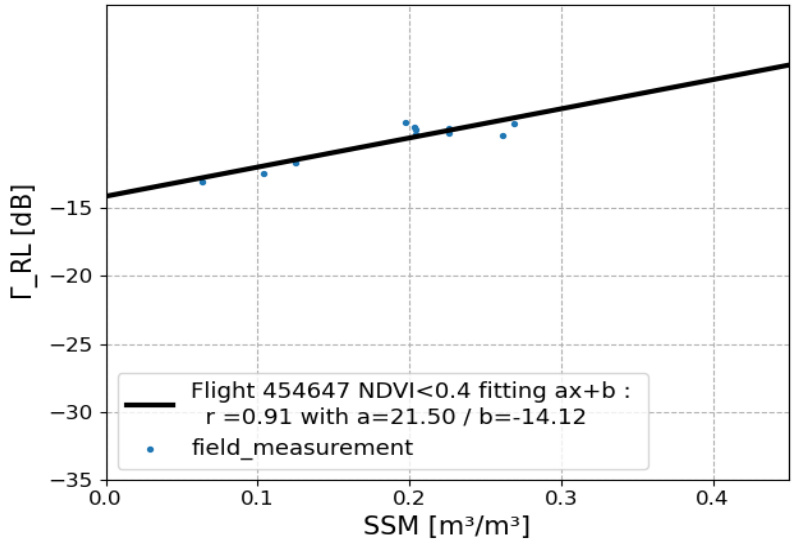


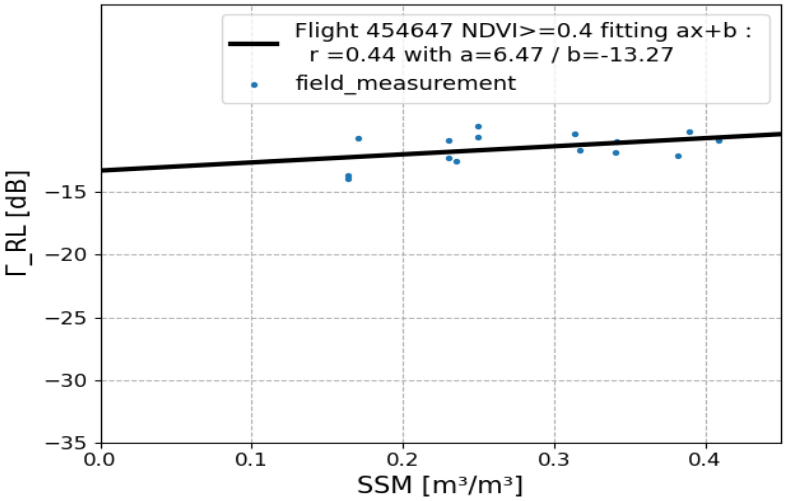
Illustration of GLORI reflectivity data over the Urgell site as a function of incidence angle: a) $\boldsymbol{\Gamma_{RL}}$ and b) $\boldsymbol{\Gamma_{RR}}$

$$\Gamma_{RR}(20°) = \Gamma_{RR}(\theta)\left(\frac{cos(20°)}{cos(\theta)}\right)^{\beta(NDVI)}$$

R. Fernandez-Moran et al, Remot. Sens. 2017

REFLECTIVITY SENSITIVITY TO SOIL MOISTURE





$$\Gamma_{pq}(\theta) = \Gamma_{pq}^{soil}(\theta).e^{-\frac{2\tau_{pq}}{sin\theta}\left(1-\omega_p\right)^2}$$ V. Zavorotny et al, IEEE 2014

$$\tau_{pq} = c.NDVI$$

$$\Gamma_{pq} = \Gamma_{pq}^{soil}.e^{-2c.NDVI}$$

$$\Gamma_{RL}^{soil}{}_{dB} = \gamma\, Mv + \delta$$

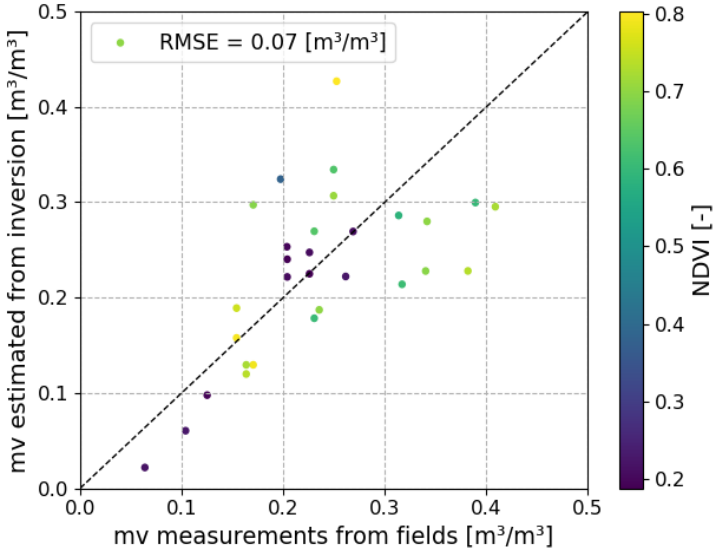
$$\Gamma_{RL_{dB}} = \gamma\, Mv + \mu\, NDVI + \delta$$

where γ is the sensitivity of the reflectivity to soil moisture, μ is the sensitivity of the reflectivity to vegetation growth through the *NDVI*, and δ is a constant related to the roughness mean effect.

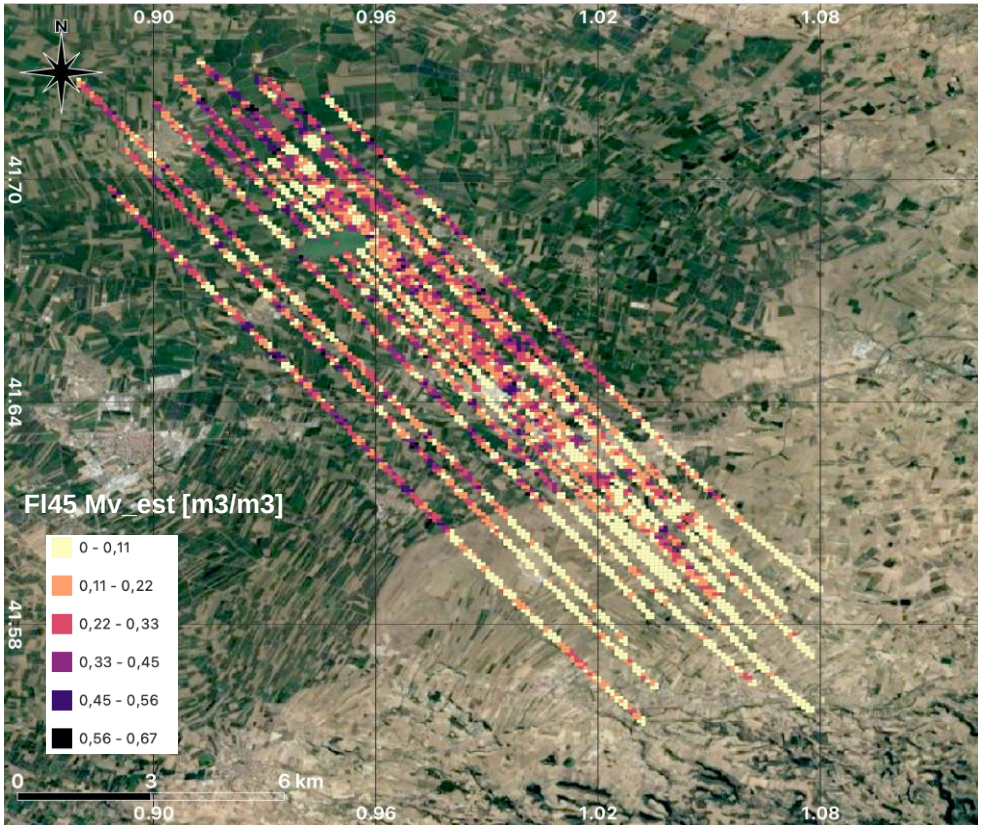
Thus, if we have the Γ reflectivity and the *NDVI* level, the soil moisture is estimated using the following equation:
Mv=0.058 Γ +0.28$NDVI$ +0.73

LIAISE Soil Moisture Estimation CESBIO v1 dataset

Calibration of the model with a 3-fold cross-validation approach



Intercomparison between ground measurements and estimated soil moisture from Γ_{RL} data inversion



Map of *SSM* retrieved from the Γ_{RL} inversion on 22/07/2021, with a spatial resolution equal to 100 m, incidence angle < 40°

$$Mv = 0.058\,\Gamma + 0.28 NDVI + 0.73$$

M. Zribi, V. Dehaye, K. Dassas, P. Fanise, M. Le Page, P. Laluet, and A. Boone, IEEE JSTARS, 2022

LIAISE Soil Moisture Estimation CESBIO v1 dataset

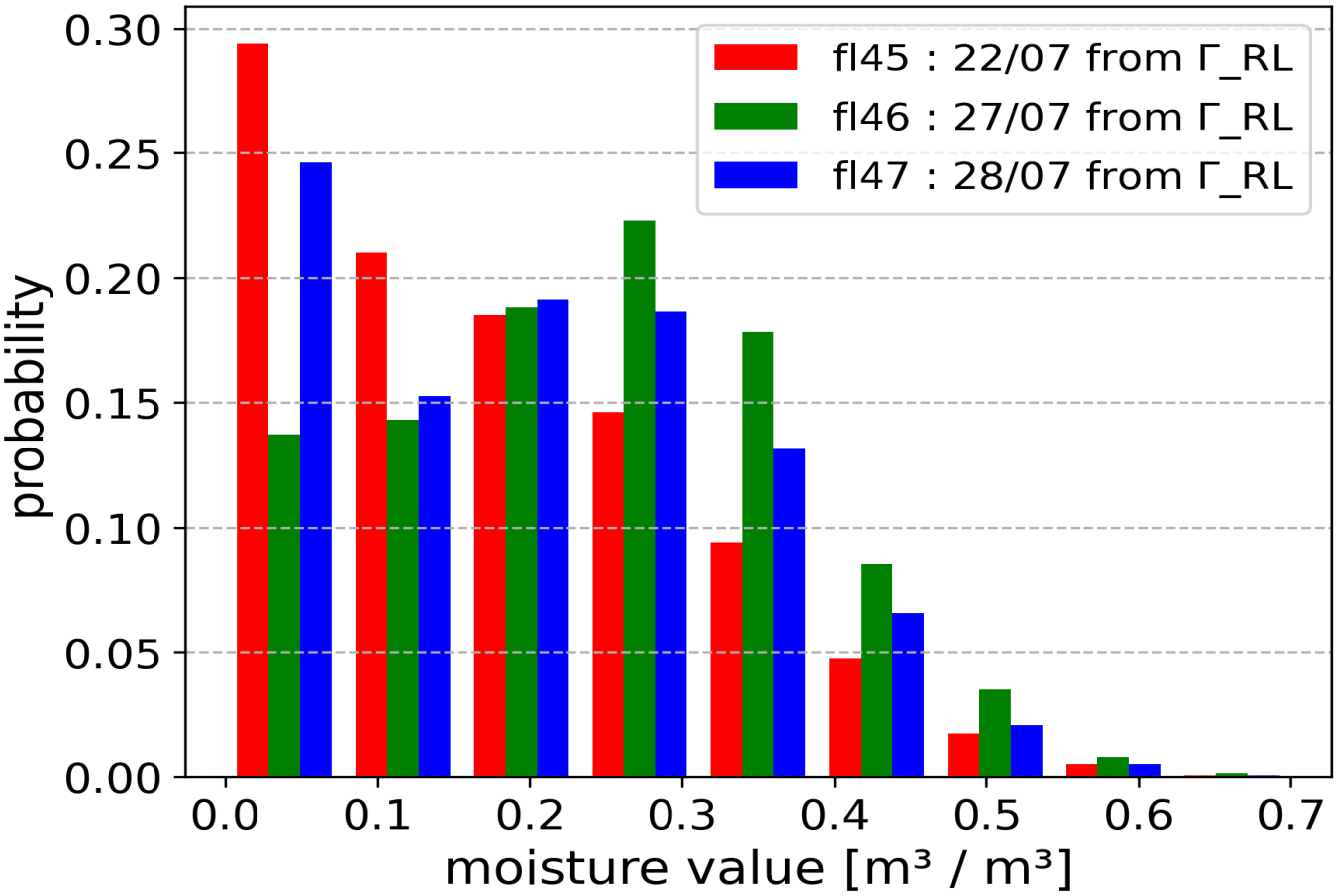


Illustration of soil moisture level distributions over the Urgell site for the three analyzed flights.

CONCLUSION

Karin Dassas, Pascal Fanise, Michel Le Page, Emna Ayari, Philippe Baillion, Mateo Sige, Aaron Boone, **Mehrez Zribi**, Polarimetric instrument Global Navigation Satellite System - Reflectometry airborne data, Data in Brief, Volume 52, 2024, 109850, https://doi.org/10.1016/j.dib.2023.109850.

Dataset In situ

Dataset Glori

Mehrez Zribi, Vincent Dehaye, **Karin Dassas, Pascal Fanise**, Michel Le Page, Pierre Laluet, Aaron Boone, Airborne GNSS-R polarimetric multi-incidence data analysis for surface soil moisture estimation over an agricultural site, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2022, 10.1109/JSTARS.2022.3208838.

Warning : daatset Glori in teh database has been updated since this paper, same methodo but slight differences in the result

Dataset Land use

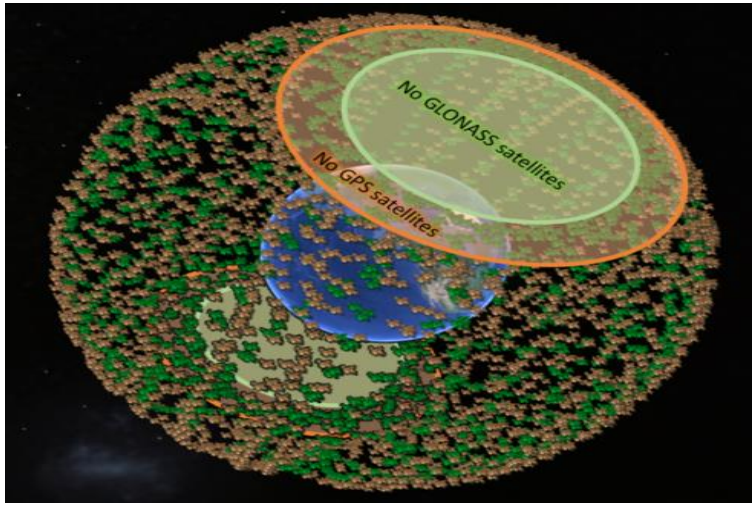
Dataset Glori

M. Zribi, K. Dassas, V. Dehaye, P. Fanise, E. Ayari and M. Le Page, "Analysis of Polarimetric GNSS-R Airborne Data as a Function of Land Use," in *IEEE Geoscience and Remote Sensing Letters*, vol. 20, pp. 1-5, 2023, Art no. 2502105, doi: 10.1109/LGRS.2023.3270730.

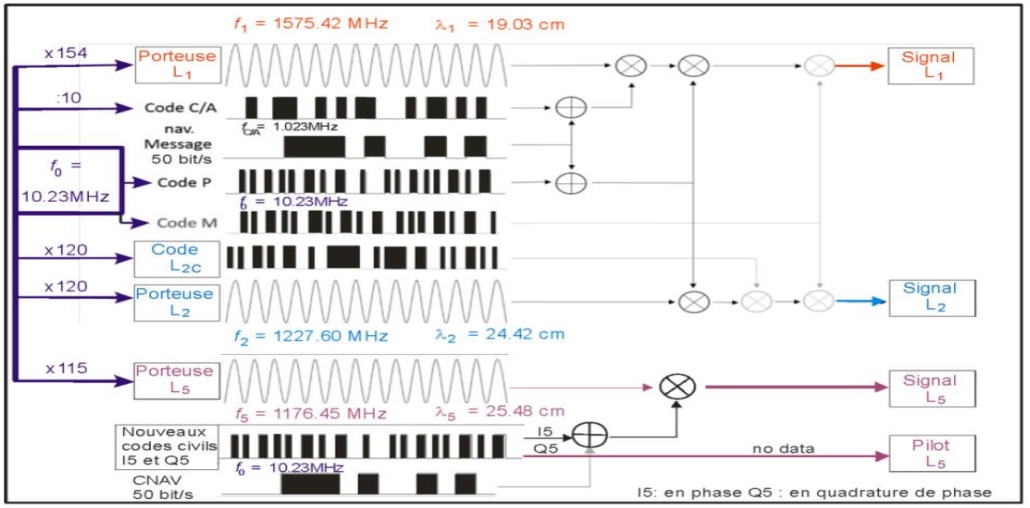
Thanks for your attention!

Backup

LIAISE GNSS-R GLORI CESBIO v1 2021 dataset

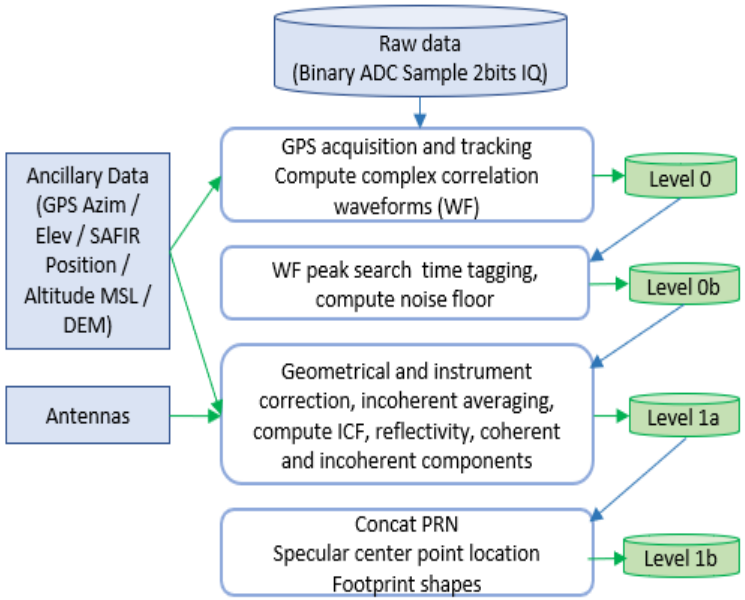


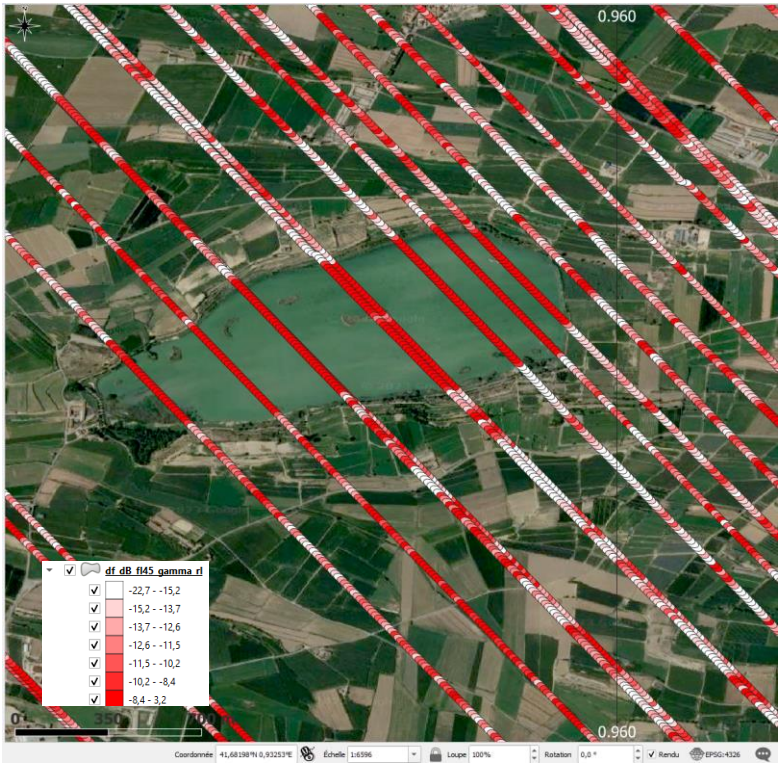
Here we can see the dense coverage of the two oldest GNSS constellations: the American GPS (orange) and the Russian system GLONASS (green).



Structure of the GPS signal (L1 for Glori, soon L5)

GLORI DATA PROCESSING





Cross-correlated waveform : $Y(\tau, f) = \frac{1}{T_i}\int_{T_i} u_{d,r}\, a(t-\tau) e^{i(f_c+f)t} dt$

Corrected ICF = Interferometric Complex Field

$$ICF_{corr} = \frac{|Y_{r,\max}| - B_r}{|Y_{d,\max}| - B_d} e^{j(\phi_{r,\max} - \phi_{d,\max})} \frac{G_d}{G_r}$$

$$\Gamma'_{pq} = \left| \left\langle \frac{Y_{r,q}(\Delta\tau, f)}{Y_{d,p}(0, f)} \right\rangle \right|^2$$

$$\Gamma'_{pq} = \left\langle \left| ICF_{corr,pq} \right|^2 \right\rangle - \sigma^2_{|ICF_{corr,pq}|}$$

E. Motte et al, sensors, 2016
A. Egido et al, IEEE 2014

NORMALIZED GLORI DATA MAPPING