LINKING UAV AND SPACEBORNE IMAGING SPECTROSCOPY FOR MULTI-SCALE CALIBRATION AND VALIDATION OF A MEDITERRANEAN SALINE SURFACE

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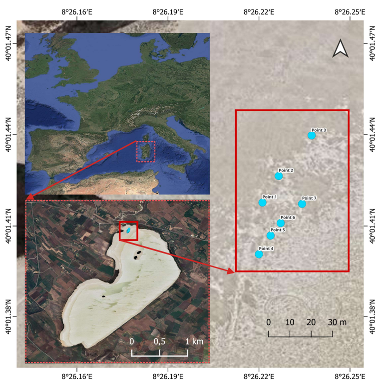
Motivation

New hyperspectral satellite missions such as ASI-PRISMA and DLR-EnMAP, together with the forthcoming ESA-CHIME mission and emerging commercial hyperspectral systems including Planet-Tanager, Airbus' planned hyperspectral constellation, and Maxar's commercial hyperspectral imaging program under development, are rapidly expanding access to detailed spectral observations. Ensuring cross-sensor consistency and interoperability across these platforms requires robust calibration and validation (CAL/VAL) approaches grounded in traceable multi-scale measurements. UAV-based hyperspectral imaging provides an effective intermediate link between ground spectrometry and orbital observations, offering high spatial detail and flexible acquisition conditions for controlled reflectance comparison. The goal of this study is to assess the suitability of Sal 'e Porcus as a CAL/VAL reference site by evaluating whether UAV-based hyperspectral data, calibrated with in-situ spectrometry, can provide reliable reflectance measurements for cross-sensor comparison with ASI-PRISMA and DLR-EnMAP.

Research area



• Geographical location of the SPp and the distribution of the sampled points within the area corresponding to the analyzed pixels belonging to the ASI-PRISMA and DLR-EnMAP.

The Sal'e Porcus pond (~3.2 km²), located on the Sinis Peninsula in western Sardinia near San Vero Milis and Riola Sardo, is the island's largest temporary pond. It occupies a flat interdunal depression where rainwater accumulates, reaching up to 1 m in depth. Lacking both tributaries and outlets, it forms an independent hydrological basin. During summer, intense evaporation dries the pond completely, leaving a broad salt crust. The impermeable greyish-white clay sediments at the bottom prevent infiltration, promoting seasonal salt deposition on the surface.

Methods and data

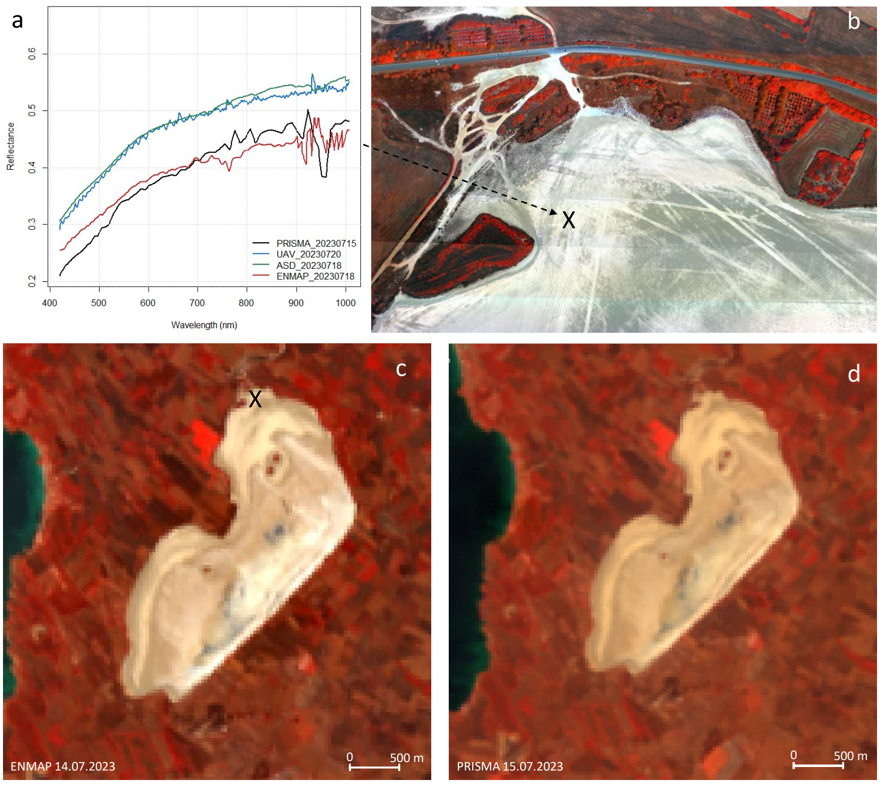
We collected ground spectra with an ASD FieldSpec 3 Pro and measured radiometric targets, enabling empirical-line calibration of the UAV hyperspectral data to surface reflectance.

PLATFORM	SENSOR	SPECTRAL RANGE	NUMBER OF SPECTRAL BANDS	SPECTRAL RESOLUTION	SPATIAL RESOLUTION
Ground	ASD FieldSpec	~350–2500 nm	Continuous(1–3 nm sampling)	N/A	Point measurement
UAV	AISA Kestrel 10	400–1000 nm	~324 bands	~10 nm	~10 cm GSD
Satellite	ASI — PRISMA	400–2500 nm (VNIR+SWIR)	~240 bands (66 VNIR + 174 SWIR)	~12–16 nm	~30 m
Satellite	DLR — EnMAP	420–2450 nm (VNIR+SWIR)	224 bands (102 VNIR + 122 SWIR)	~6.5 nm (VNIR), ~10 nm (SWIR)	~30 m

• A customized DJI AGRAS T30 with a Specim AISA Kestrel 10 captured VNIR hyperspectral imagery.

Results

Linear regression between spectral bands 400-1000 nm (interpolated per 1 nm)											
pair			N of interpolated spec. bands	PEARS. COR	REGRES. SLOPE	R^2	BIAS = MEAN RESID.	RMSE	MAE	SD_RES
PRISMA	vs	UAV	589	0.970	0.863	0.942	0.000	0.016	0.011	0.016
PRISMA	vs	ASD	589	0.981	0.877	0.962	0.000	0.013	0.008	0.013
PRISMA	vs	ENM	589	0.961	0.714	0.924	0.000	0.015	0.010	0.015
UAV	vs	ASD	589	0.995	1.001	0.990	0.000	0.007	0.005	0.007
UAV	vs	ENM	589	0.986	0.824	0.972	0.000	0.009	0.006	0.009
ASD	vs	ENM	589	0.984	0.817	0.969	0.000	0.010	0.006	0.010



• Reflectance spectra (a) extracted at point 2 marked X, shown together with the corresponding pixel locations in (b) UAV, (c) EnMAP, and (d) PRISMA hyperspectral datasets.

Conclusion

Spectral comparisons acrossASD, UAV, PRISMA, and EnMAP show consistently high agreement over the 400–1000 nm range. UAV and ASD spectra match most closely (Pearson r = 0.995, slope = 1.001, R^2 = 0.990), indicating that the UAV empirical line calibration preserves in-situ reflectance characteristics. PRISMA exhibits strong correlation with both UAV (r = 0.970, R^2 = 0.942, slope = 0.863) and ASD (r = 0.981, R^2 = 0.962, slope = 0.877), while EnMAP also shows high agreement with UAV (r = 0.986, R^2 = 0.972, slope = 0.824) and ASD (r = 0.984, R^2 = 0.969, slope = 0.817). Residuals are low and unbiased across all comparisons (RMSE < 0.016 reflectance),confirming internally consistent reflectance scaling among sensors.

- UAV spectra match ASD closely → calibration robust
- PRISMA/EnMAP show high cross-sensor consistency with UAV/ASD
- Residuals low and unbiased (RMSE < 0.016)
- Sal'e Porcus is supported as a candidate CAL/VAL reference site
- UAV imaging is a practical bridge between ground and satellite data

Acknowledgement

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