living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

Simultaneous hyperspectral PRISMA and AVIRIS-NG images

Genesio L.[1], Boschetti M.[2], Braga F.[3], Bresciani M.[2], **Carotenuto F.**[1], Cogliati S.[4], Giardino C.[2], Gioli B.[1], Lopinto E.[5], Panigada C.[4], Pompilio L.[2], Sacco P.[5], Miglietta F.[1]

[1]: National Research Council of Italy, Institute for Bioeconomy (CNR-IBE)

[2]: National Research Council of Italy, Institute for Electromagnetic Sensing of the Environment (CNR-IREA)

[3]: National Research Council of Italy, Institute of Marine Sciences (CNR-ISMAR)

[4]: University of Milan Bicocca, Italy

[5]: Italian Space Agency (ASI)

25/05/2022

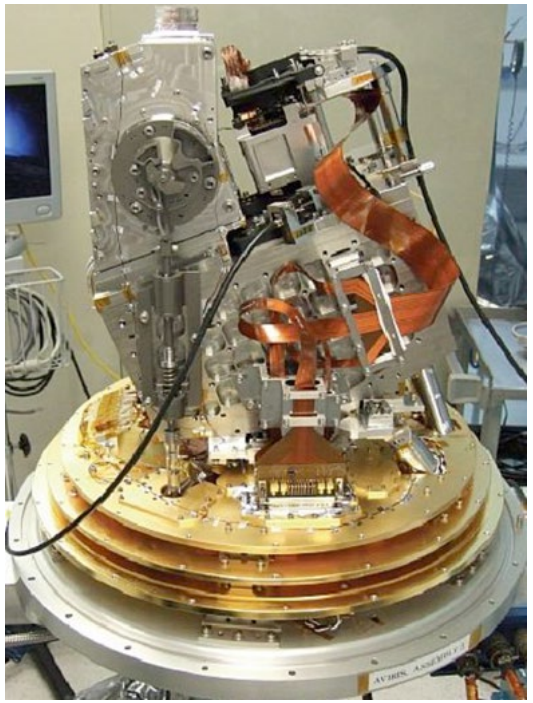
PRISCAV – CHIME Collaboration

PRISCAV

- PRISMA Calibration/Validation project
- Co-operation between ASI, CNR, ENEA and University of Milan
- 12 Italian fiducial reference sites with different land-uses and orography

CHIME

- ESA Copernicus Hyperspectral Imaging Mission for the Environment
- Co-operation between ESA, ASI, DLR and NASA
- Future satellite aimed to provide routine hyperspectral measurements in support of EU



- AVIRIS-NG
- >400 bands, 380 – 2510 nm, 5 nm sampling, ±0.5 nm FWHM
- FOV: 36 ± 2°
- Low distortion (smile and keystone) with uniformity >97%
- 640 cross track pixels
- Operated by NASA JPL

https://avirisng.jpl.nasa.gov/instrument1.html

Flight Sites and Acquisitions

- Braccagni: agricultural site in the province of Grosseto, Italy.
- Jolanda di Savoia: agricultural site in the province of Ferrara, Italy
- Trasimeno Lake: inland water site in the province of Perugia, Italy
- Venice Lagoon: coastal water site

Site	Flight Date	PRISMA Overpass
Braccagni	4 June 2021	4 June 2021
Jolanda di Savoia	22 June 2021	21 June 2021
Trasimeno Lake	4 June 2021	3 June 2021
Venice Lagoon	4 June 2021	9 June 2021

PRISMA vs. AVIRIS Comparison Methodology

- Braccagni: PRISMA L2D vs. AVIRIS-NG (Atmospheric Correction by ARES Observatory). **SIMULTANEOUS ACQUISITION**

- Jolanda di Savoia: PRISMA L2D corrected following Tagliabue et al. (2022)[1] vs. AVIRIS-NG (Atmospheric Correction by ARES Observatory + smoothing via Savitsky-Golay filter)

- Trasimeno Lake : in-situ vs. PRISMA L1+ATCOR, vs. DESIS+ATCOR, vs. Sentinel-2 and Sentinel-3+6Sv vs. AVIRIS+SNAP De-glint processing (Sen2coral plugin)

- Venice Lagoon: in-situ vs. PRISMA L2D, vs. Sentinel-2+ACOLITE vs. Sentinel-3 vs. AVIRIS (Atmospheric Correction by ARES Observatory)

[1]:Tagliabue, G., Boschetti, M., Bramati, G., Candiani, G., Colombo, R., Nutini, F., Pompilio, L., Rivera-Caicedo, J. P., Rossi, M., Rossini, M., Verrelst, J., & Panigada, C. (2022). Hybrid retrieval of crop traits from multi-temporal PRISMA hyperspectral imagery. ISPRS Journal of Photogrammetry and Remote Sensing, Volume 187, 2022, Pages 362-377, ISSN 0924-2716, https://doi.org/10.1016/j.isprsjprs.2022.03.014

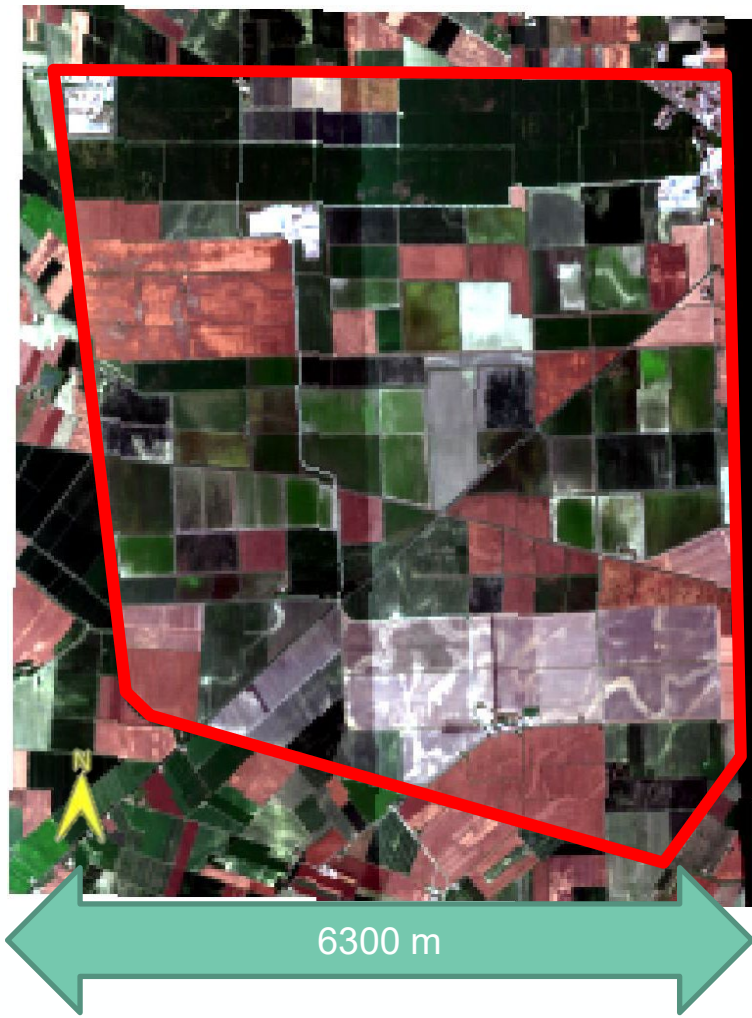
Land Sites

BRACCAGNI

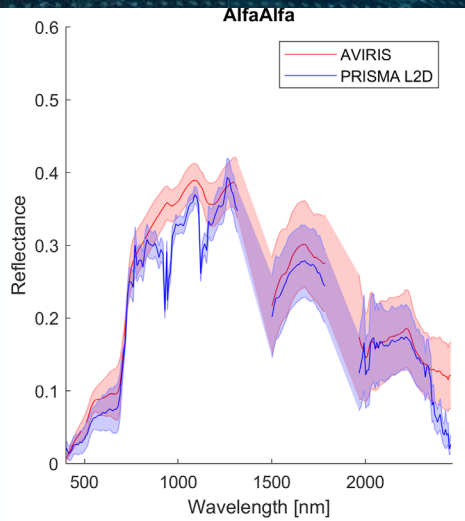
- AlfaAlfa
- Wheat
- Corn
- Forest
- Sunflower
- Wheat Straw
- Bare Soil
- …

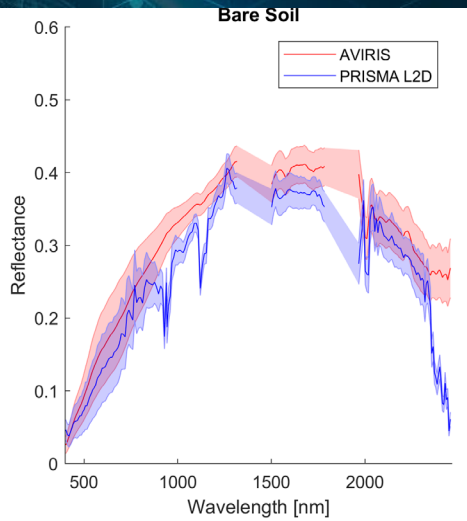
JOLANDA DI SAVOIA

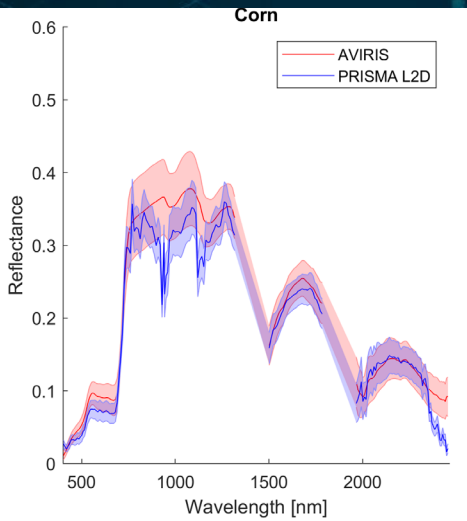
- AlfaAlfa
- Wheat
- Corn
- Orchard
- Grassland
- Rice
- Soy
- …

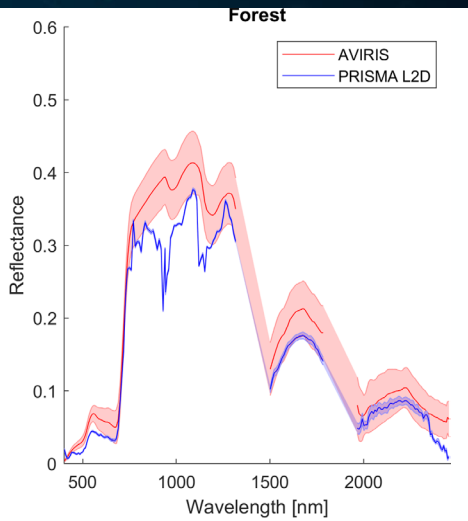


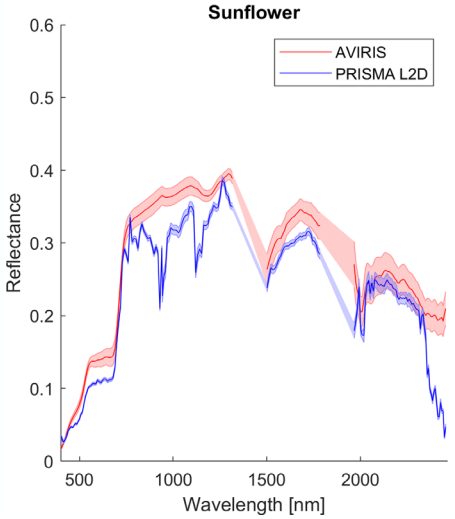
BRACCAGNI: PRISMA vs. AVIRIS Reflectance Trends

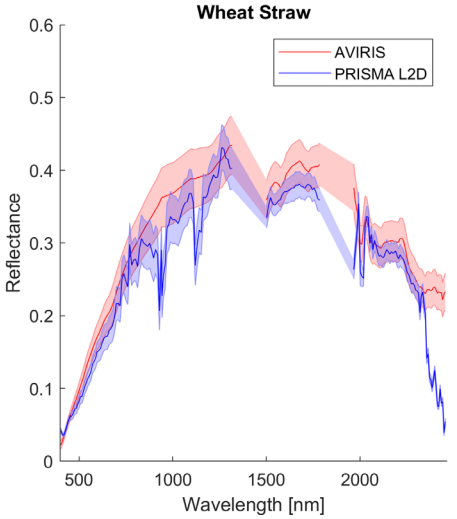


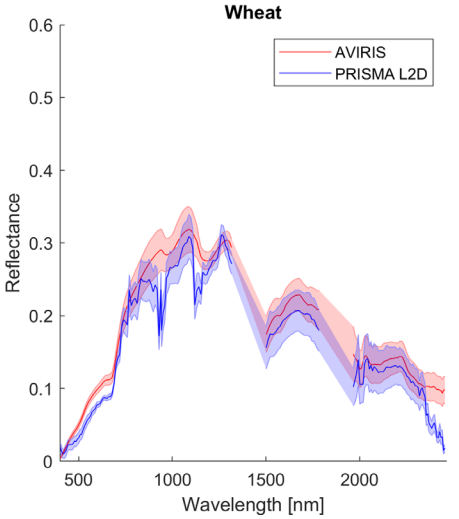






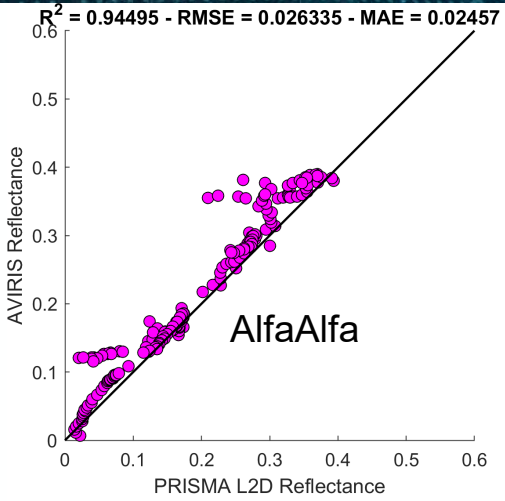


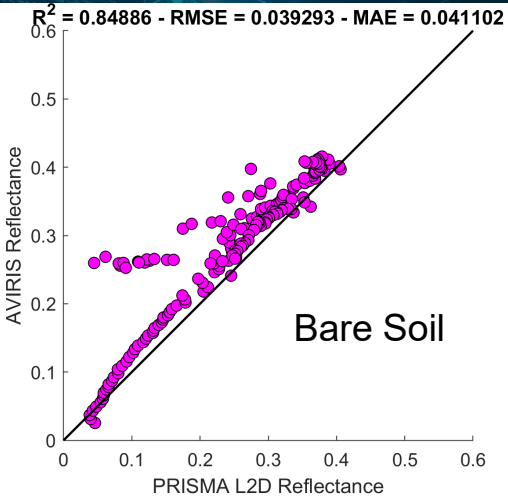


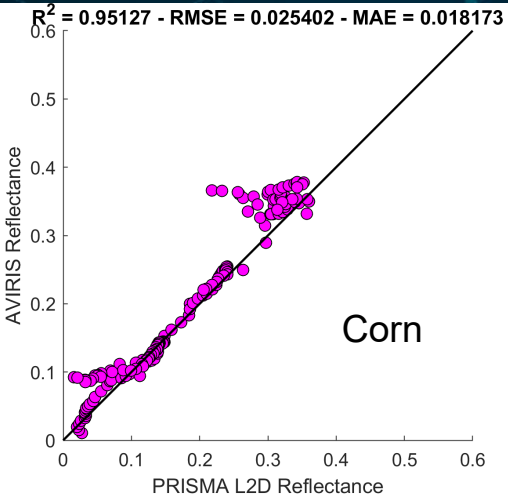


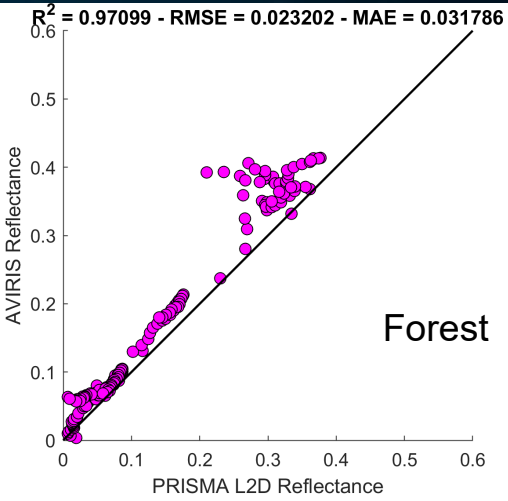
- PRISMA L2D slightly underestimates AVIRIS reflectance
- Sawtooth noise patterns in the red-edge/NIR (740-1320 nm)
- Drop in SWIR reflectance

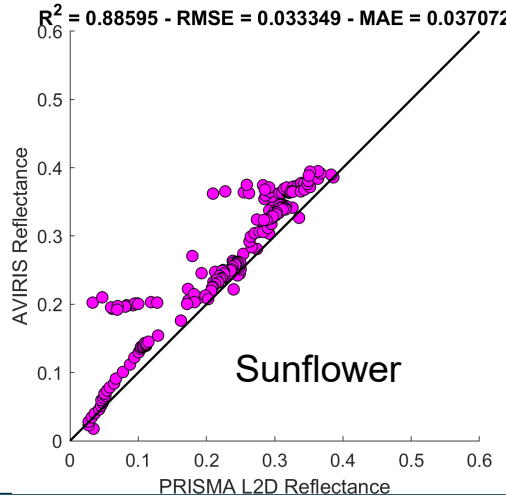
BRACCAGNI: PRISMA vs. AVIRIS Correlations

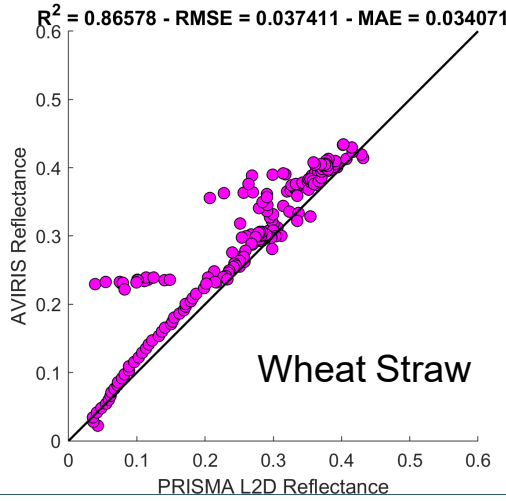


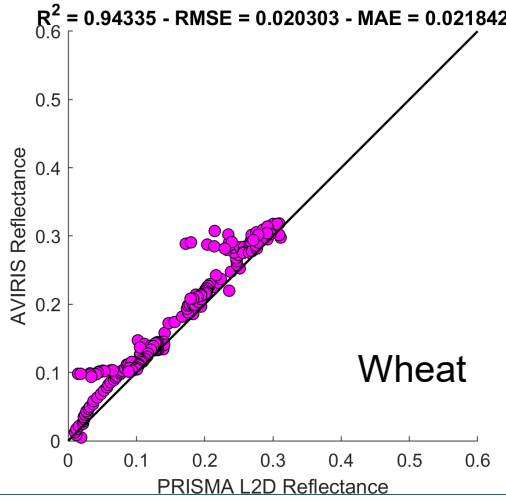






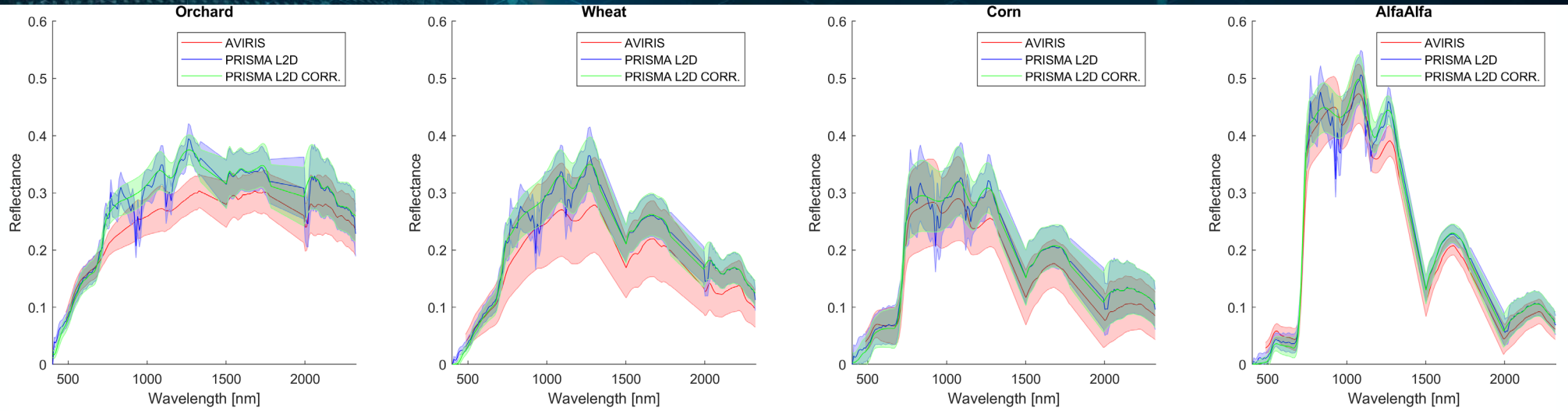


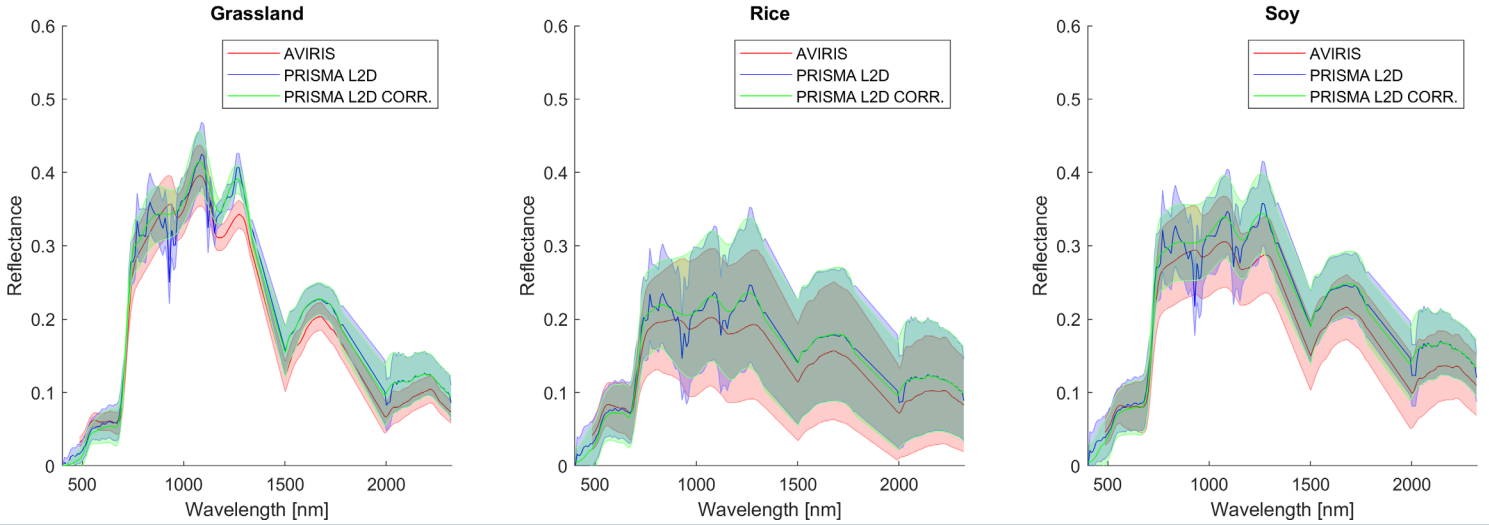




- Good correlation between spaceborne and airborne data (R^2>0.8) for all surfaces
- Low errors in respect of reflectance magnitude

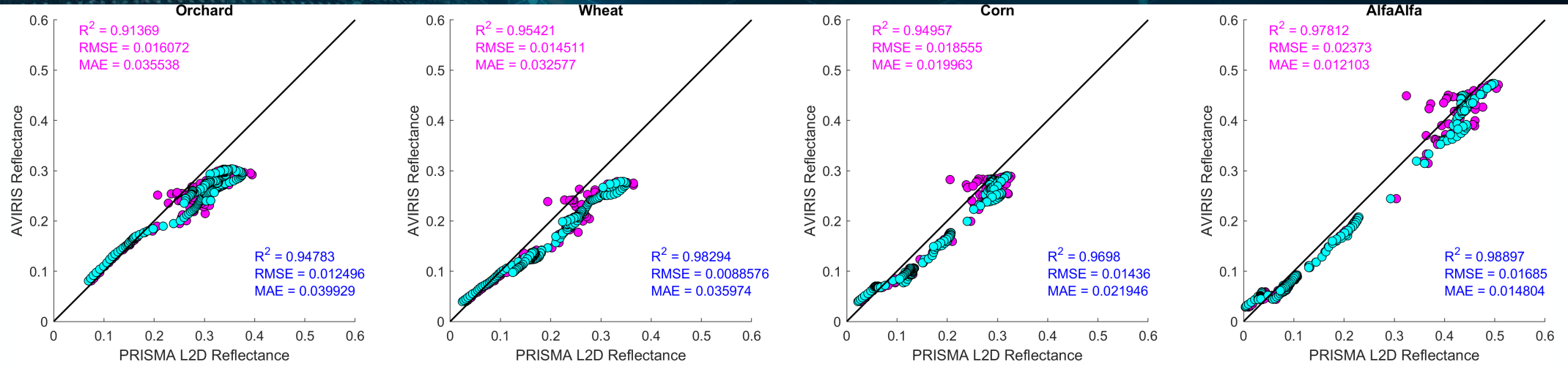
JOLANDA: PRISMA vs. AVIRIS Reflectance Trends

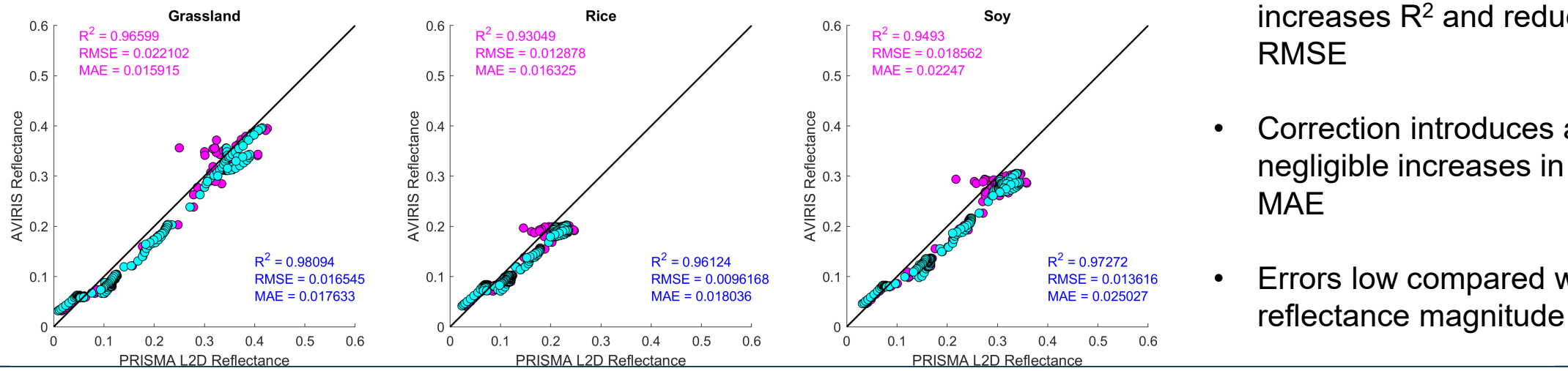




- Inversion of the underestimation trend (PRISMA > AVIRIS)
- Sawtooth noise patterns removed by PRISMA L2D elaboration

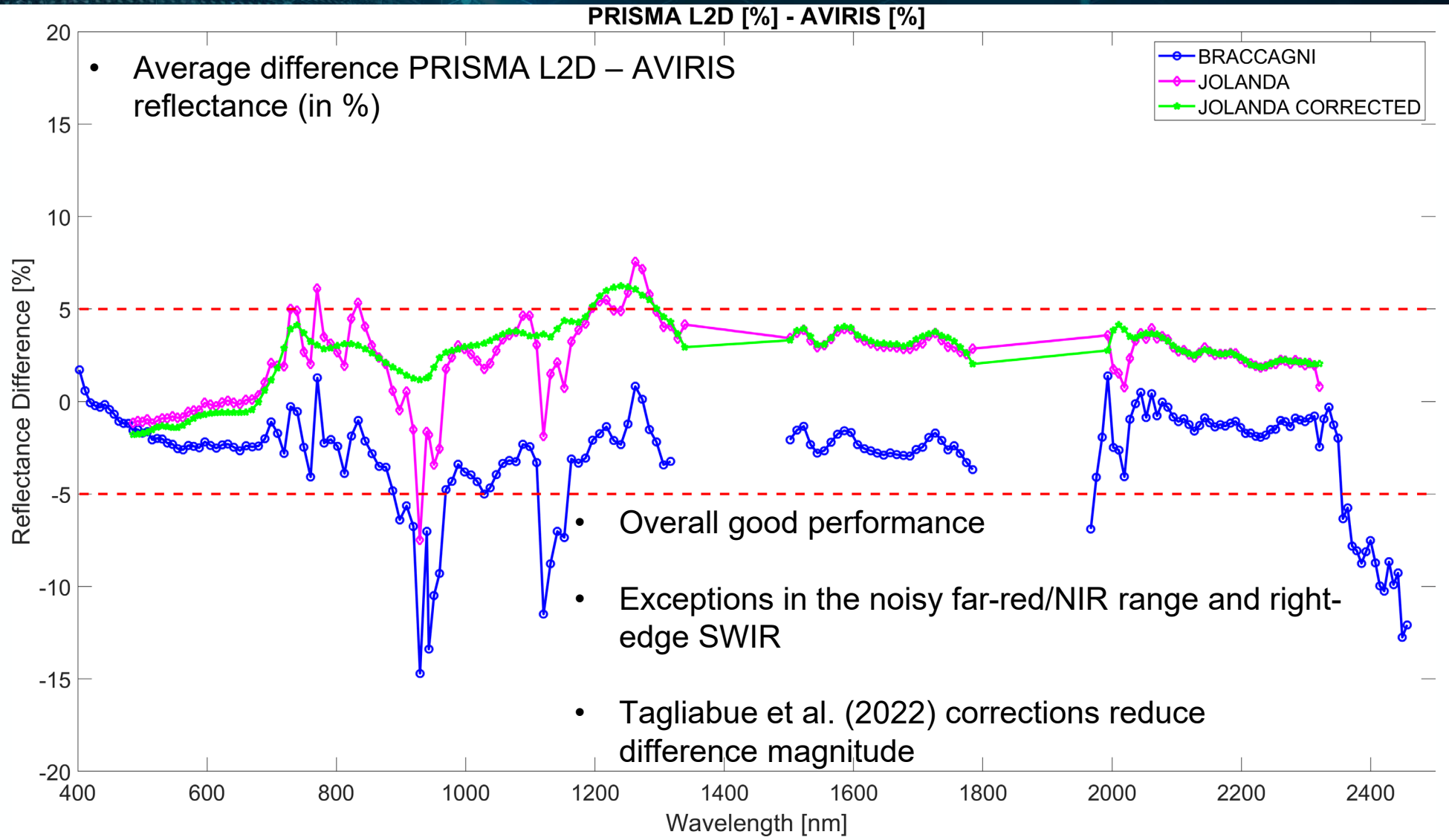
JOLANDA: PRISMA vs. AVIRIS Correlations





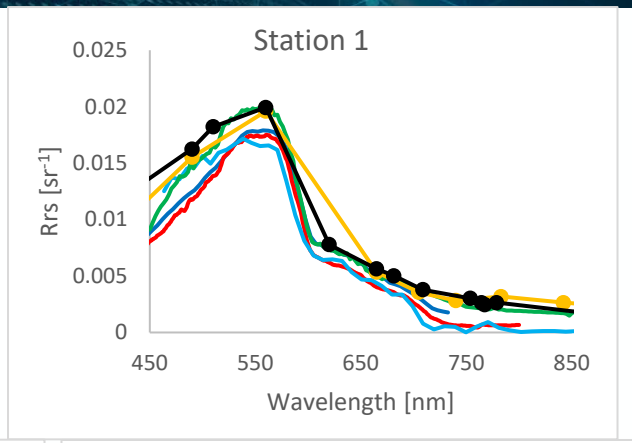
- PRISMA L2D correction increases R^2 and reduces RMSE
- Correction introduces a negligible increases in MAE
- Errors low compared with reflectance magnitude

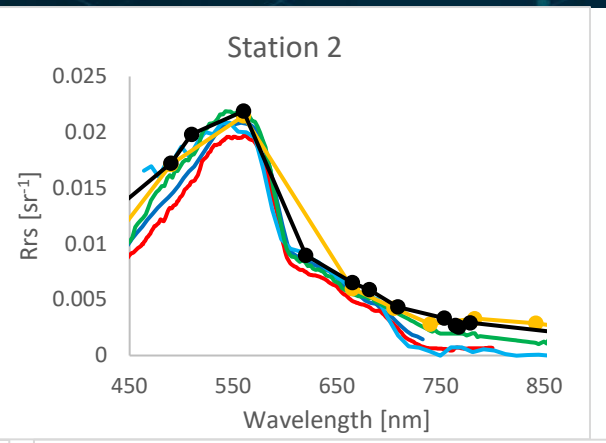
LAND SITES: Reflectance Differences

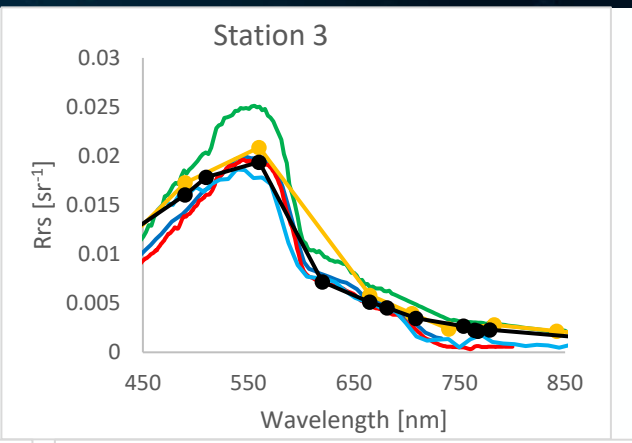


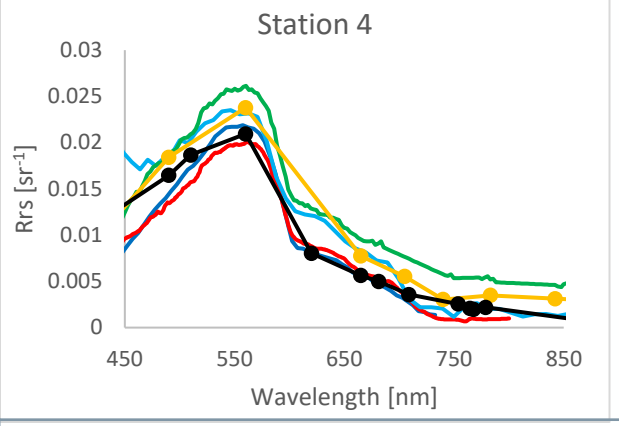
- Average difference PRISMA L2D – AVIRIS reflectance (in %)
- Overall good performance
- Exceptions in the noisy far-red/NIR range and right-edge SWIR
- Tagliabue et al. (2022) corrections reduce difference magnitude

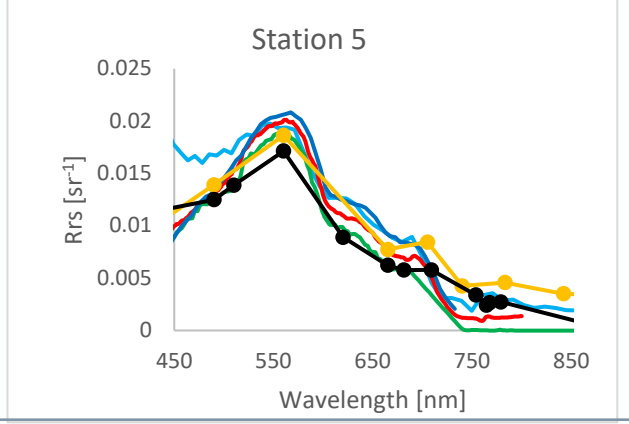
TRASIMENO LAKE: Reflectance Trends

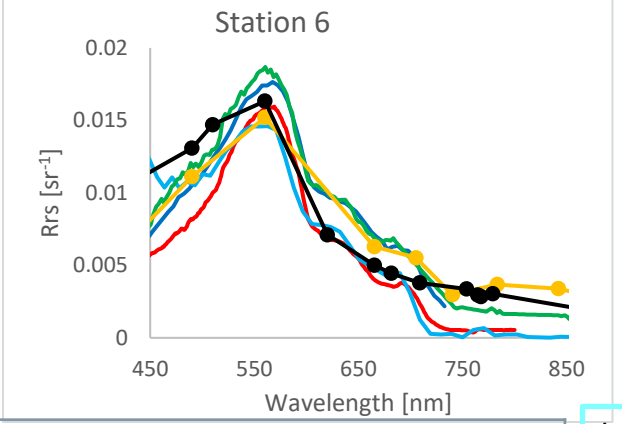


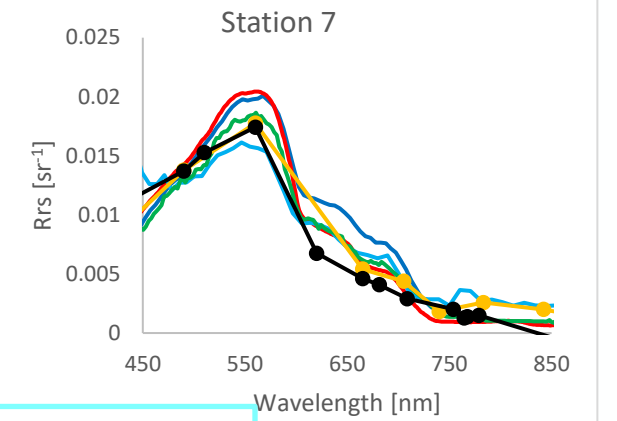












Sensors data VS *In-situ* data

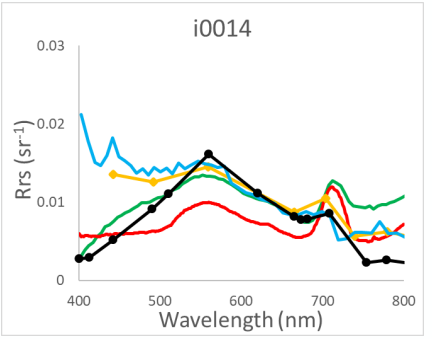
Statistic	PRISMA	DESIS	AVIRIS DEGLINT	Sentinel- 2	Sentinel- 3
R^2	0.79	0.85	0.86	0.95	0.68
RMSE	0.0034	0.0032	0.0024	0.0024	0.0043
SA	15.17	13.66	10.41	10.61	22.18

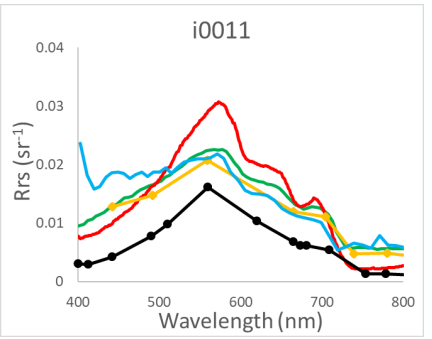
Legend:
- *In-situ*
- DESIS L1C + ATCOR
- PRISMA L1 + ATCOR
- AVIRIS DEGLINT
- SENTINEL-2
- SENTINEL-3

VENICE LAGOON: Reflectance Trends

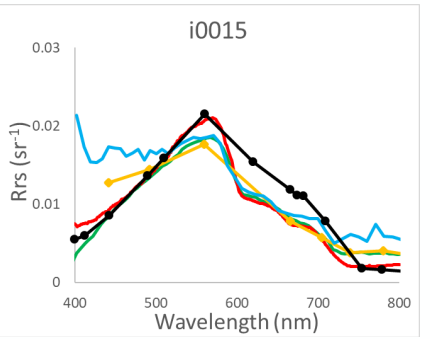
Legend:
- *In-situ*
- AVIRIS
- PRISMA L2D
- SENTINEL-2
- SENTINEL-3

TIDAL FLATS

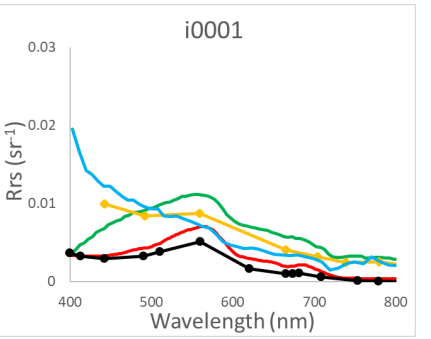


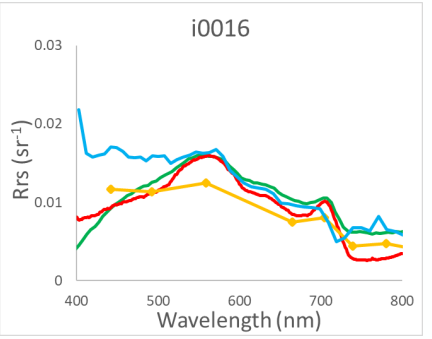


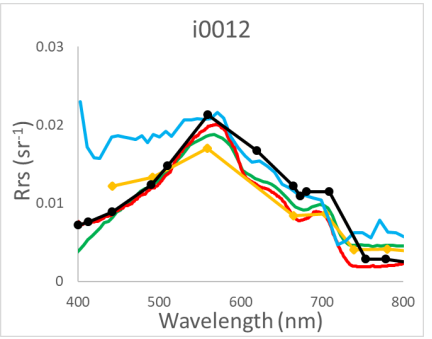
DEEP CHANNELS

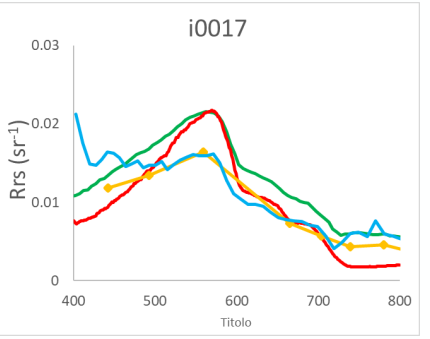


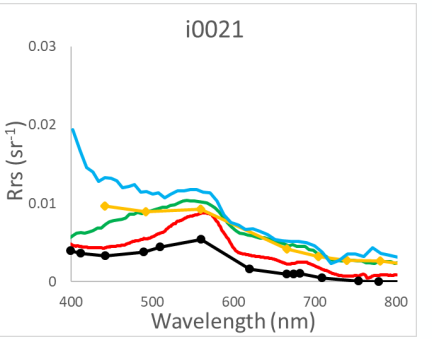
COASTAL WATERS

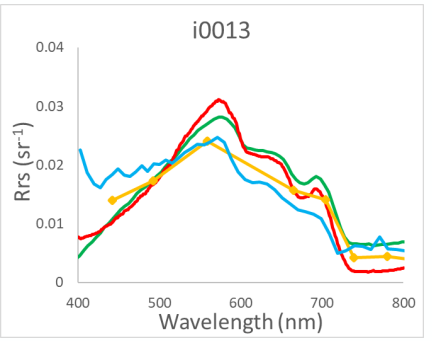


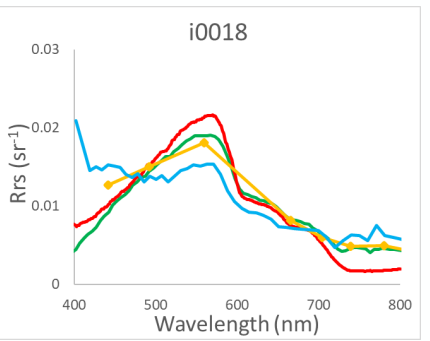


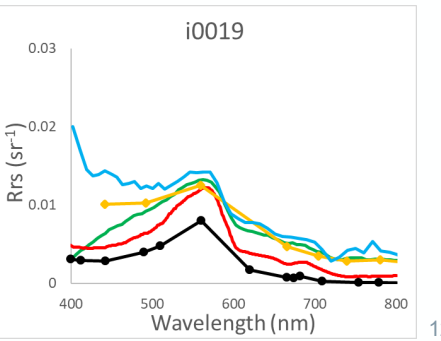












Sensors data VS *in-situ* data				
Statistics	PRISMA	AVIRIS	Sentinel- 2	Sentinel- 3
R^2	0.52	0.83	0.87	0.60
RMSE	0.0053	0.0033	0.0024	0.0037
SA	22.61	14.87	14.62	23.62

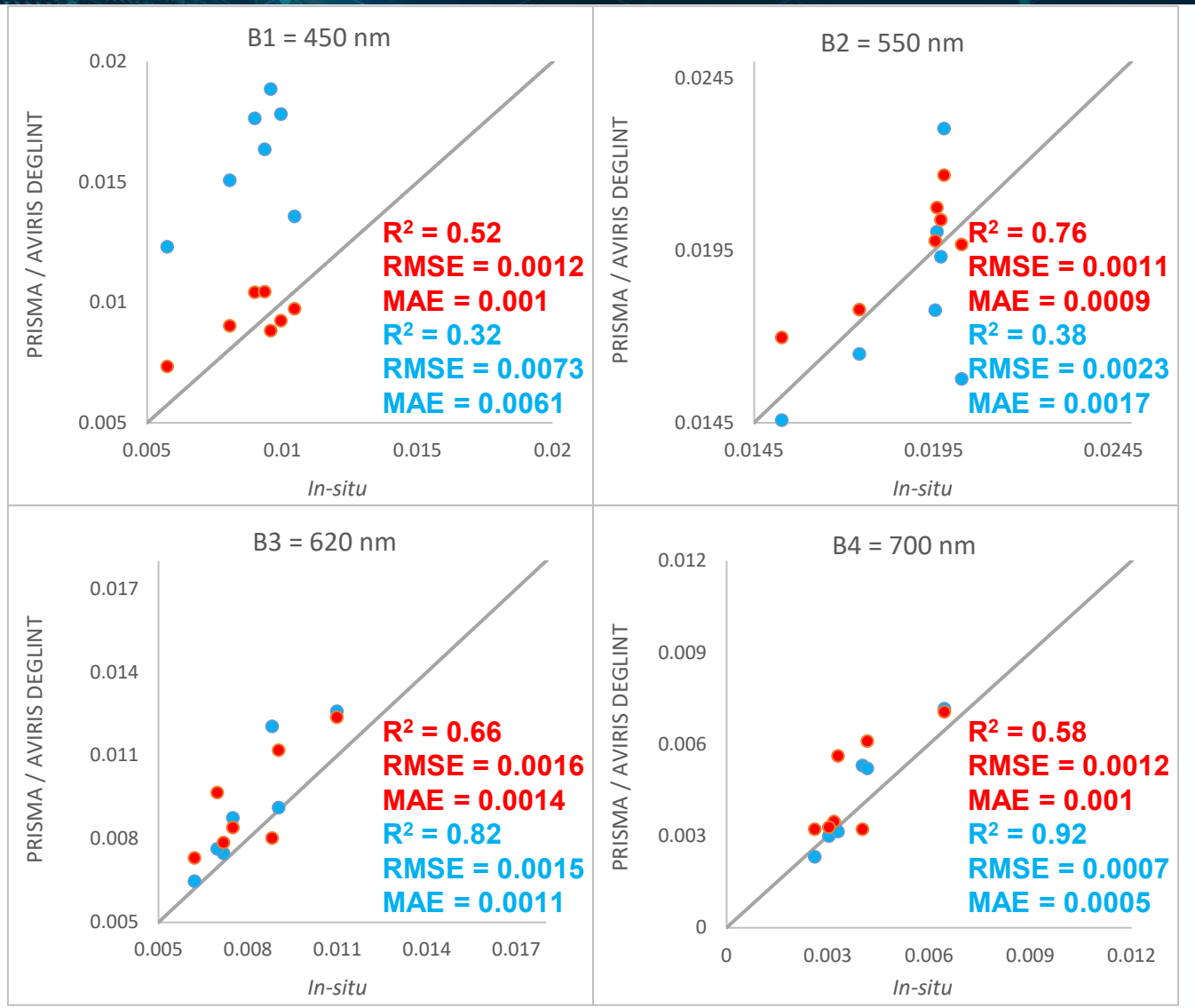
Conclusions

- Good overall performances between PRISMA L2D and AVIRIS airborne sensor

- PRISMA L2D red-edge/SWIR sawtooth noise visible in L2D data. Removable following Tagliabue et al. 2022

- For complex surfaces, such as the aquatic environment, where signal strength is low, good atmospheric correction is crucial for good reflectance retrieval

TRASIMENO LAKE: Reflectance Correlations



VENICE LAGOON: Reflectance Correlations