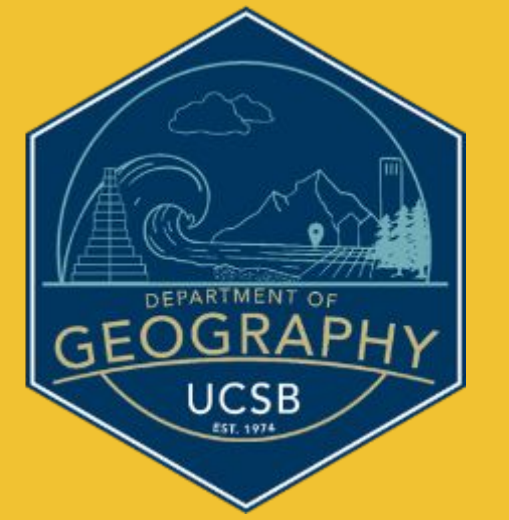




NASA's STELLA-Q2 Spectral Accuracy for Desert Vegetation



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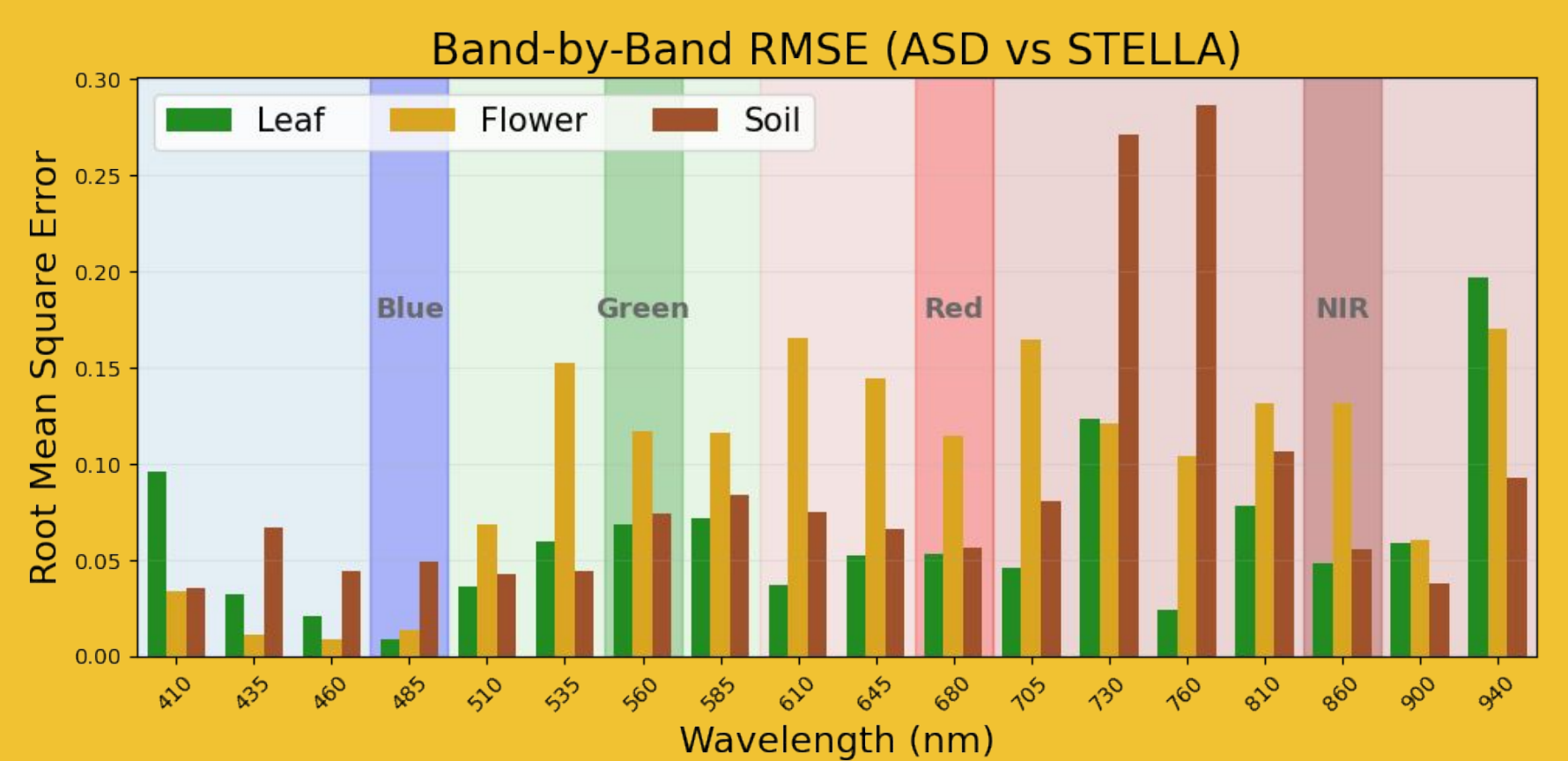
Introduction

- The ASD FieldSpec Pro Spectroradiometer is the standard for assessing plant reflectance, but its high cost and bulk limit accessibility
- NASA's STELLA-Q2 is an open-source, low-cost alternative with 18 discrete spectral bands ranging from blue to near-infrared
- We assessed STELLA-Q2's efficacy by comparing its spectral measurements to those of the ASD across leaf, flower, and soil samples
- We selected *Encelia farinosa* (brittlebush) as the study species due to its distinct yellow flowers, providing a spectrally unique test case for flower-specific indices



Results

- Mean RMSE exceeded the 0.02 acceptable threshold for all tissue types, with flowers showing the highest error (~0.11) and leaves the lowest (~0.075)
- Band-by-band RMSE was highest in the NIR region across all sample types, with leaves showing the lowest spectral variability



- There is strong agreement in visible-band indices, but increasing divergence in vegetation-sensitive red–NIR indices

Methods

- Paired measurements of *Encelia farinosa* leaf, flower, and bare soil were collected using the ASD FieldSpec Pro and NASA STELLA-Q2
- Reflectance was compared across the 18 overlapping bands using RMSE and a Bland-Altman analysis
- Greenness and flower spectral indices were calculated to assess functional performance

Vegetation Indices

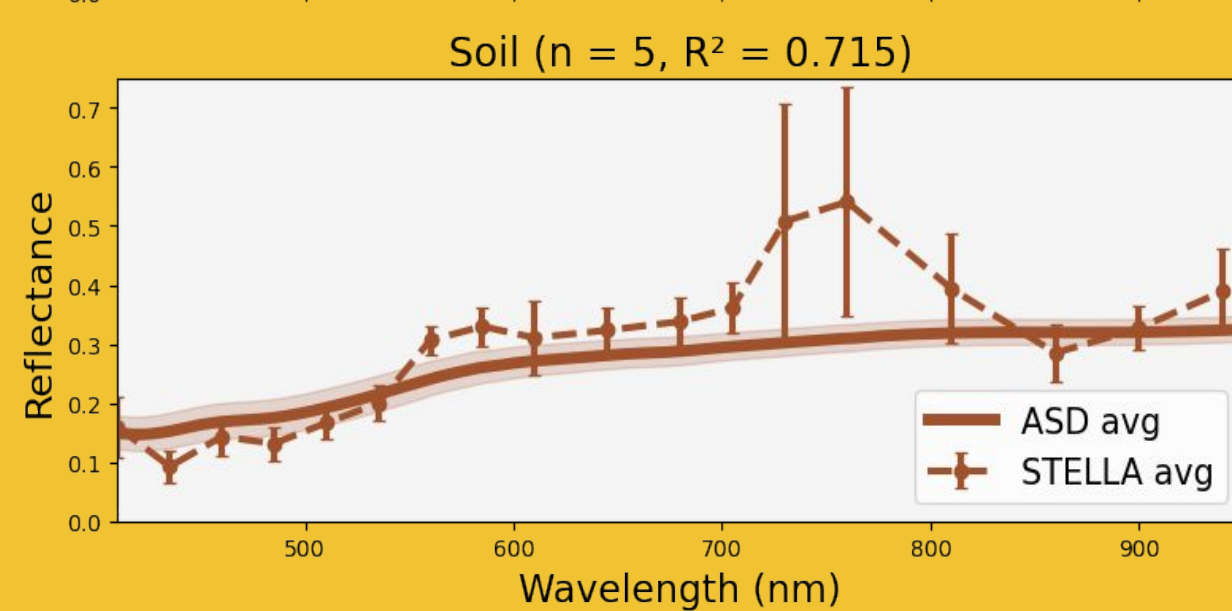
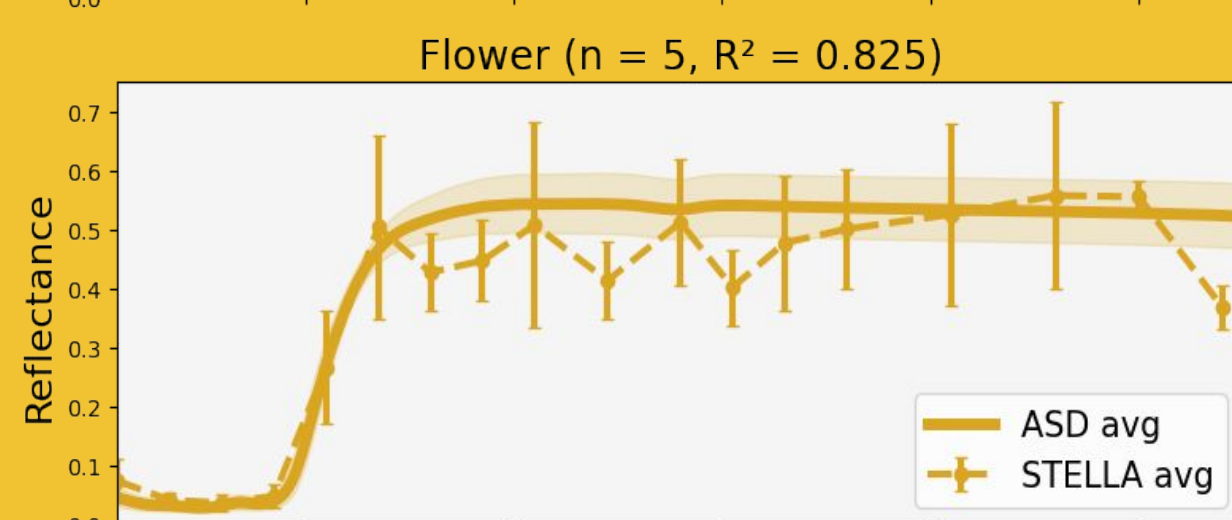
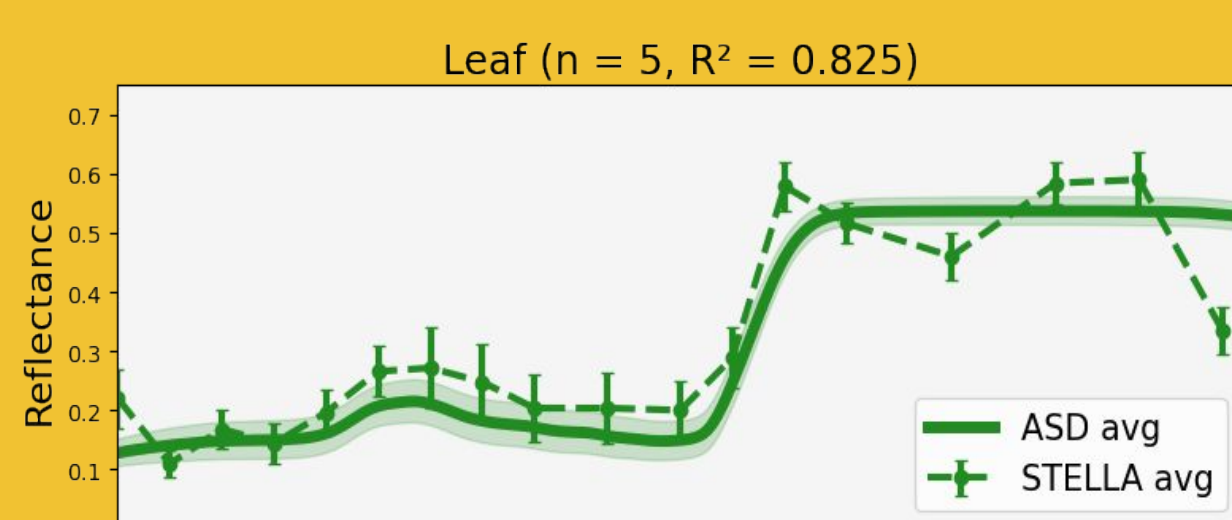
$$NDVI = \frac{NIR - Red}{NIR + Red}$$

$$EVI = 2.5 \cdot \frac{NIR - Red}{NIR + 6Red - 7.5Blue + 1}$$

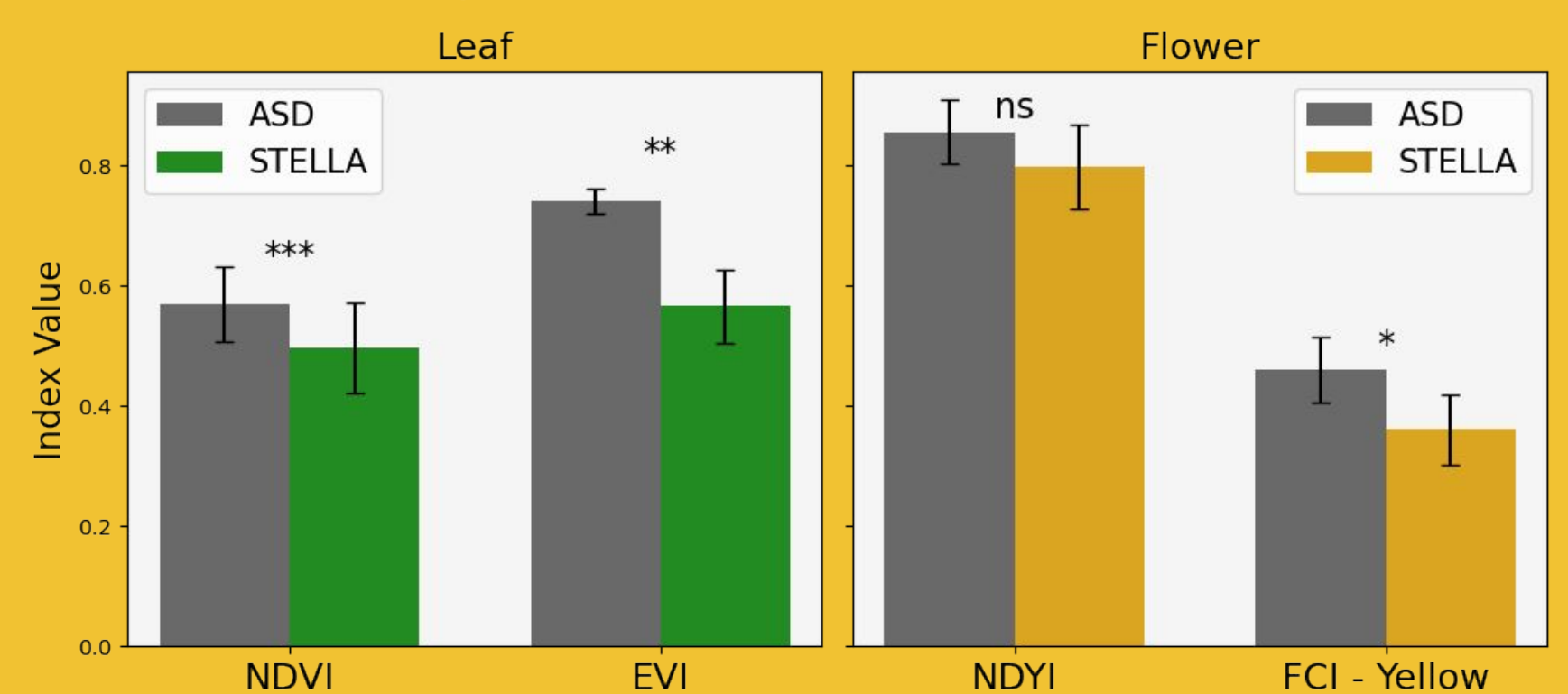
Flower Indices

$$NDYI = \frac{Green - Blue}{Green + Blue}$$

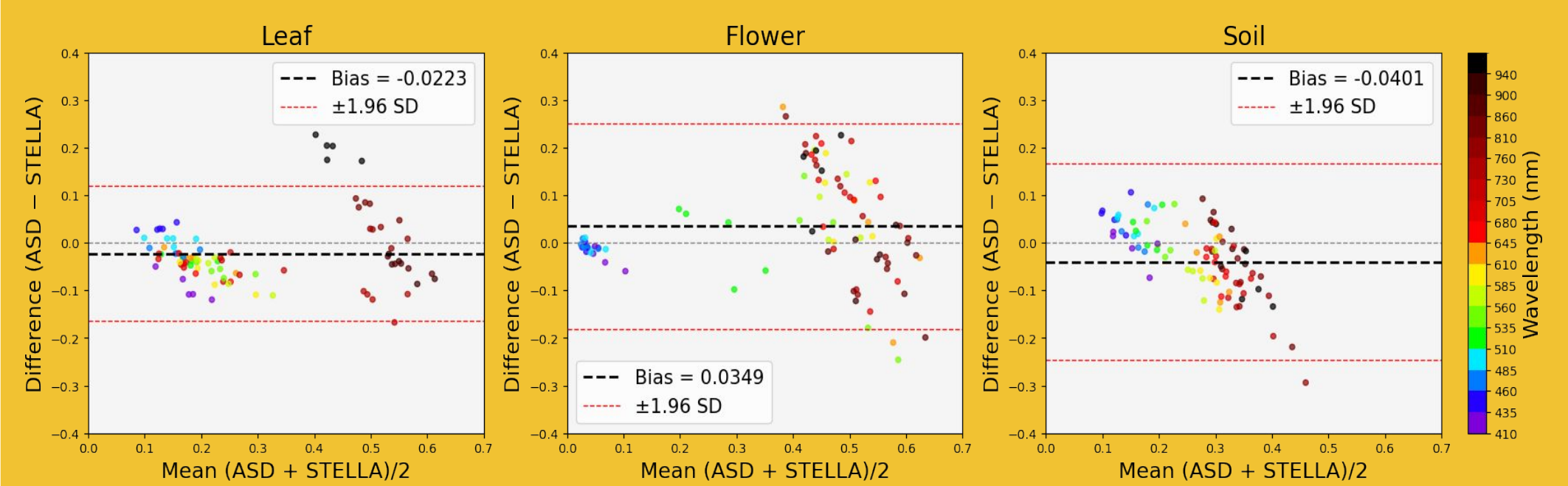
$$FCI (yellow) = \frac{(Red + Green)(Green - Blue)}{Red + Green + Blue}$$



Spectral Indices (ASD vs STELLA)



- Bias was small but consistent: leaves (-0.0223) and soil (-0.0401) were underestimated; flowers were slightly overestimated (+0.0349)



Conclusions

- RMSE exceeded acceptable thresholds across all sample types, indicating STELLA is not a direct substitute for ASD for high-precision applications
- STELLA closely matched ASD reflectance curves in the visible spectrum, but showed systematic deviations in the near-infrared (NIR), reducing its precision for vegetation index-based analyses
- Tissue type affected STELLA's performance; leaf measurements were the most reliable, while flower measurements proved the least reliable

Acknowledgements

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Future Work

- Expand sampling to more individuals and species, and test STELLA under varying environmental conditions to assess whether findings generalize beyond *Encelia farinosa*
- Develop STELLA-specific calibration corrections, particularly for NIR bands and flower tissue, to improve index accuracy and explore viability for low-cost flower spectral analysis