

Orbital hyperspectral sensors: a dual CAL/VAL test sites approach

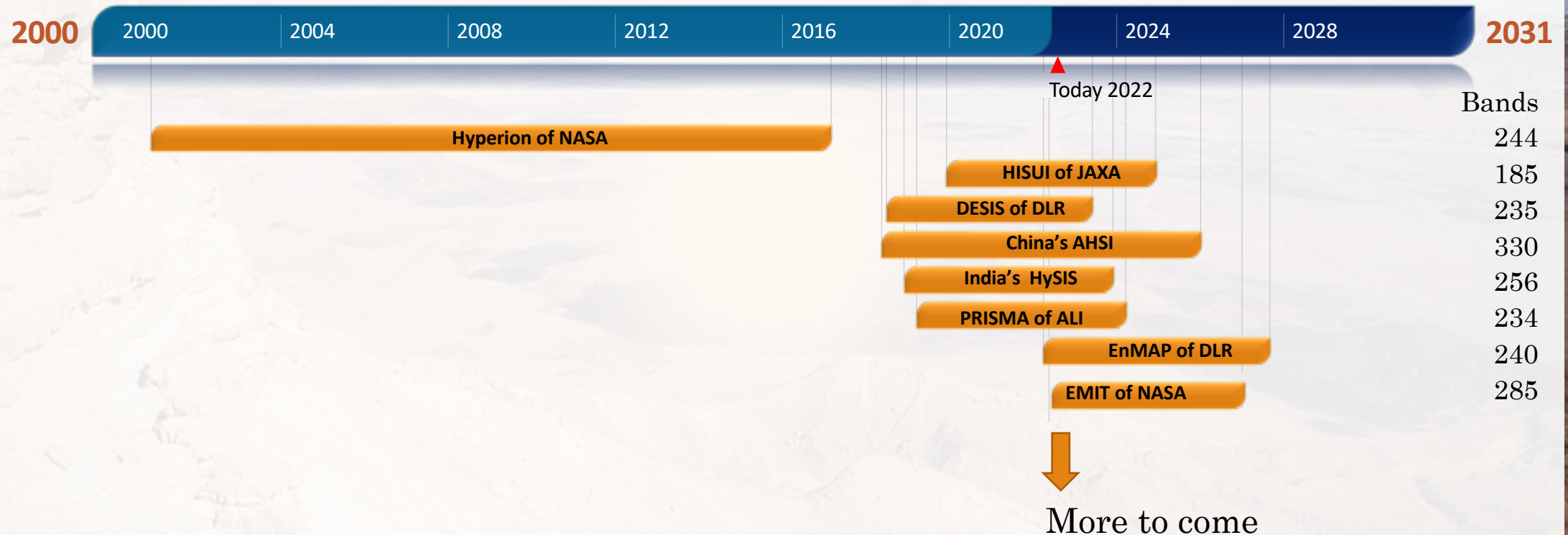
By

Daniela Heller Pearlshtien, Stefano Pignatti,
Bar Efrati, Uta Heiden and Eyal Ben-Dor

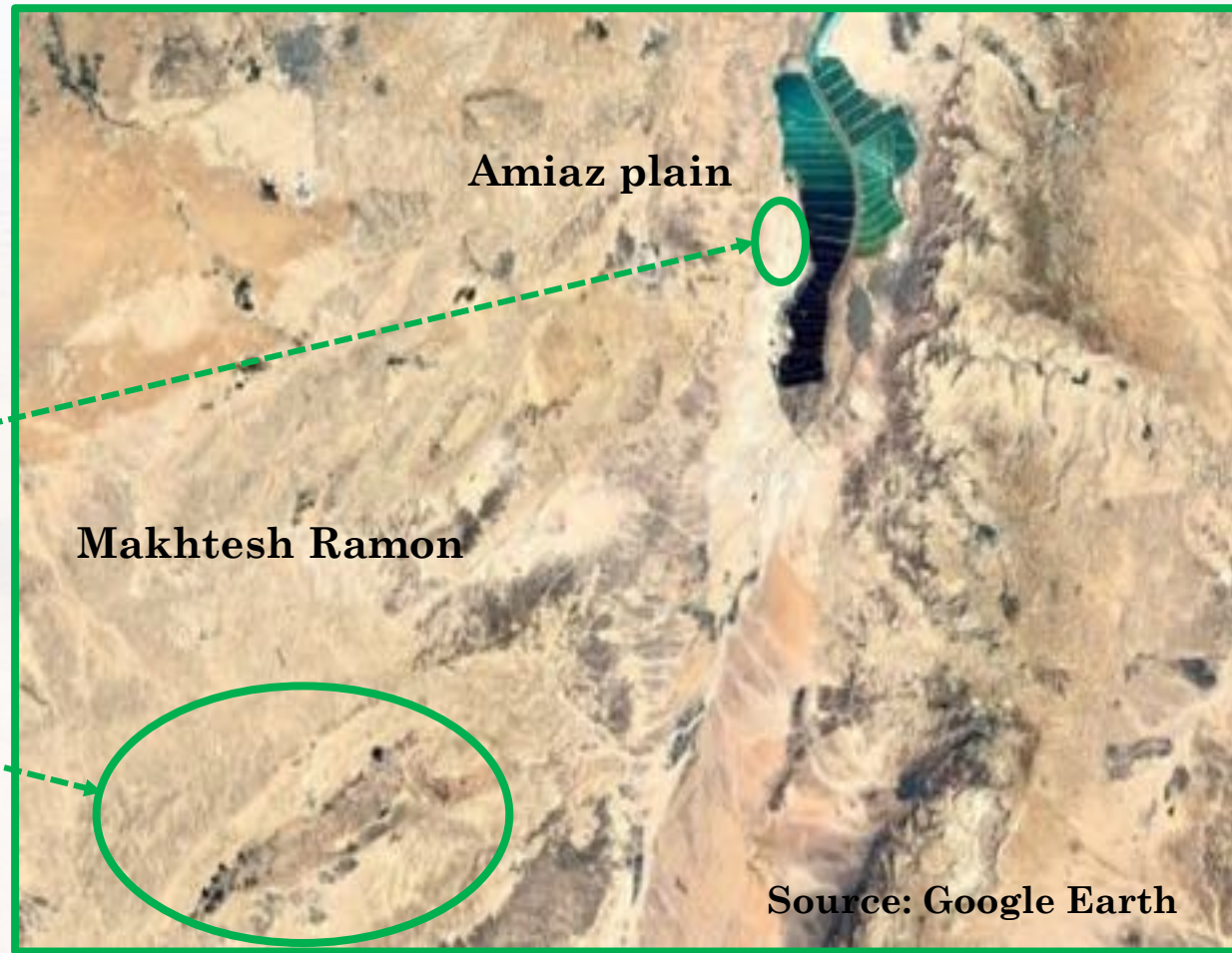
Dept. of Geography, Remote Sensing laboratory, University Tel-Aviv

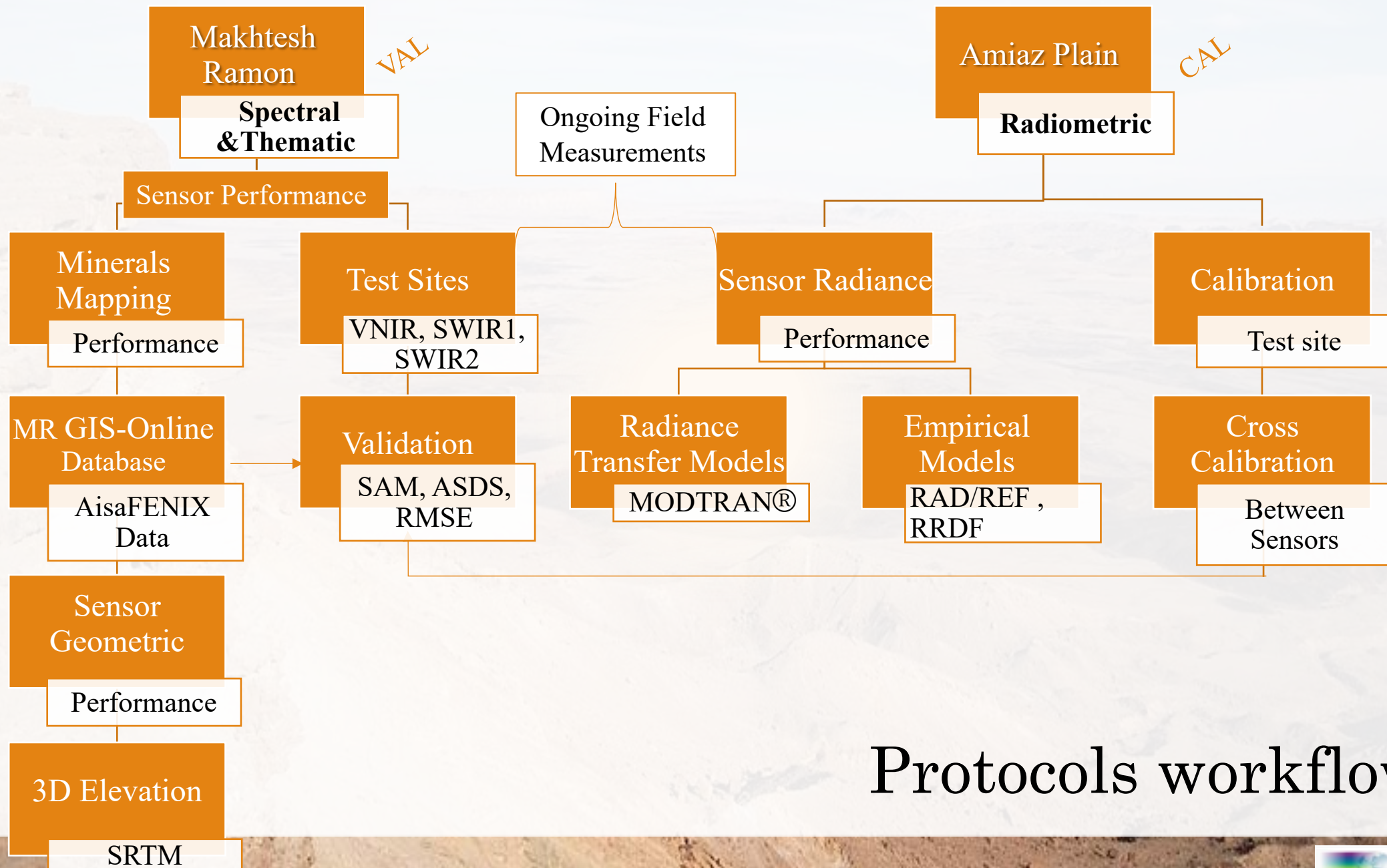


The need for VC for orbital (**Hyperspectral**) Sensors is on the rise



We proposed two sites in Southern Israel for radiometric and thematic VC





Protocols workflow

Amiaz Plain Test Site



Makhtesh -Ramon



. Kaolinite mine- SWIR2



Calcite - SWIR2



Brown questa (BQ) -VNIR



Laccolite -VNIR



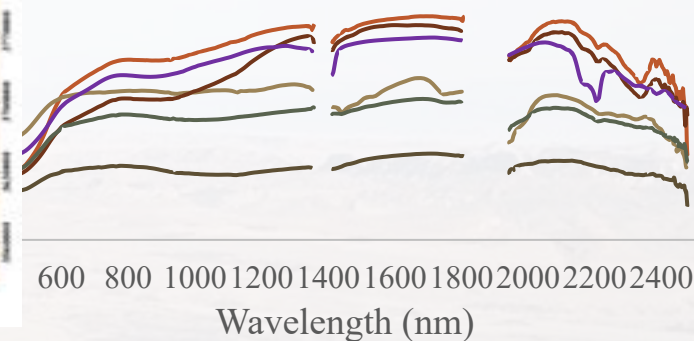
3. Gypsum mine- SWIR1



Gypsum soil fans -SWIR1



test sites-ASD spectral library

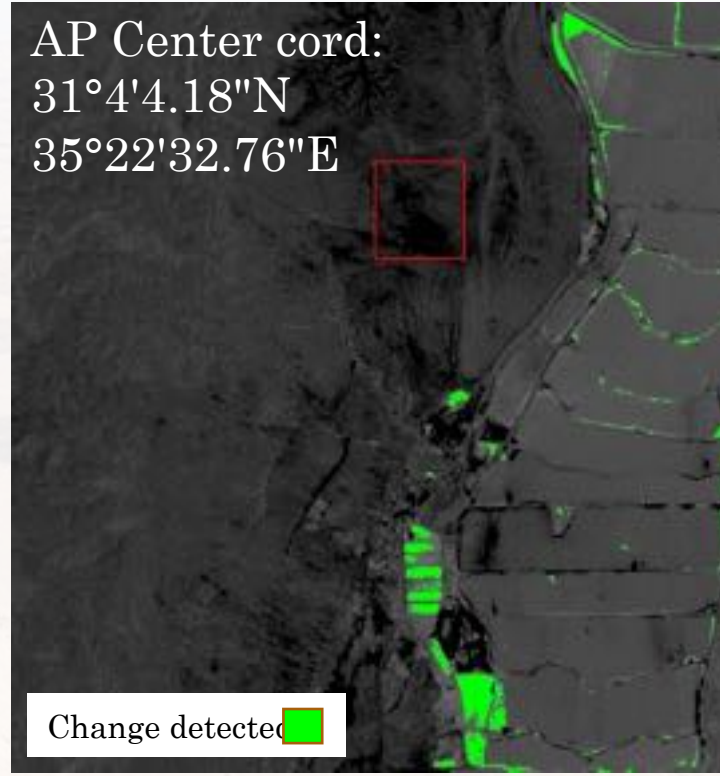


- Calcite
- Gypsum mine
- Brown questa
- Laccolite
- Gypsum soil
- Kaolinite

Amiaz Plain Stability



Landsat TM5-2000



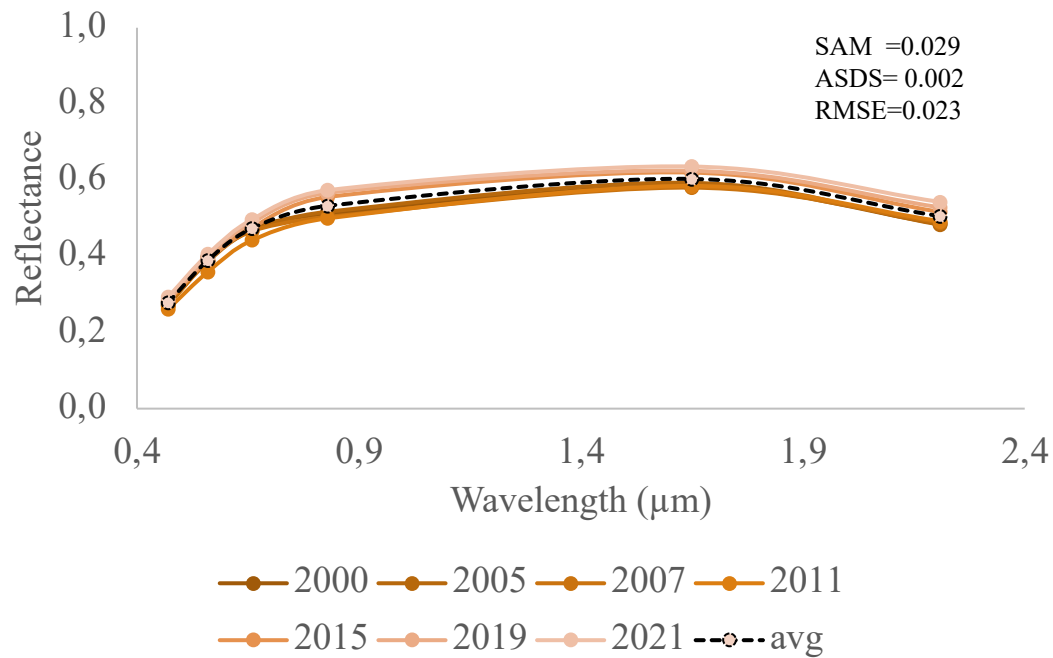
Change detected
Landsat TM5 2000
VS. OLI8 2021



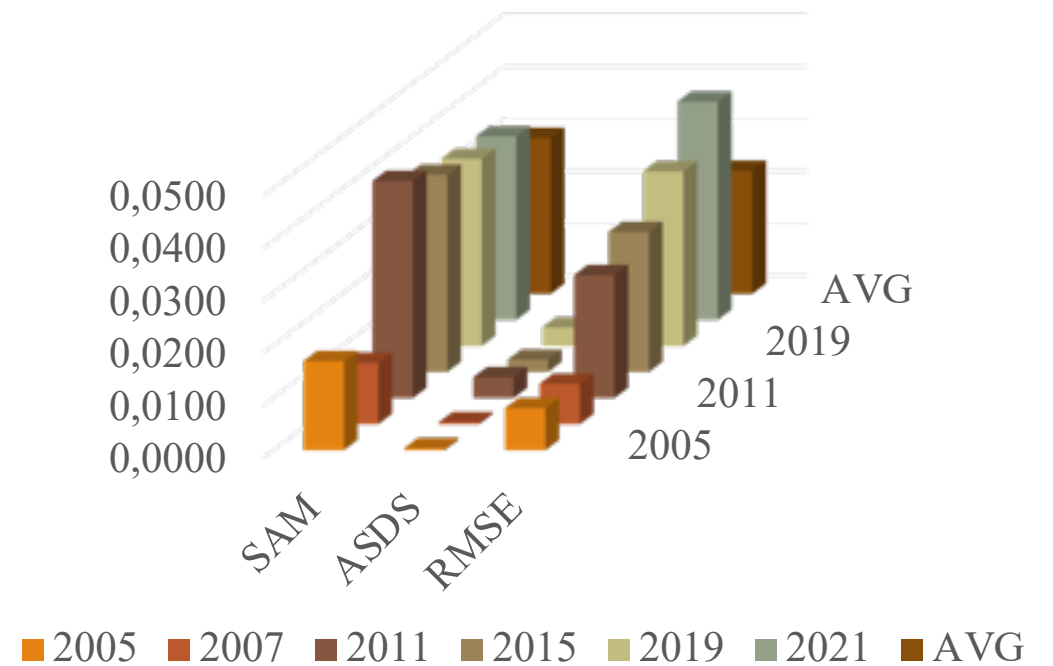
Landsat OLI8-
2021

Amiaz Plain Stability (2)

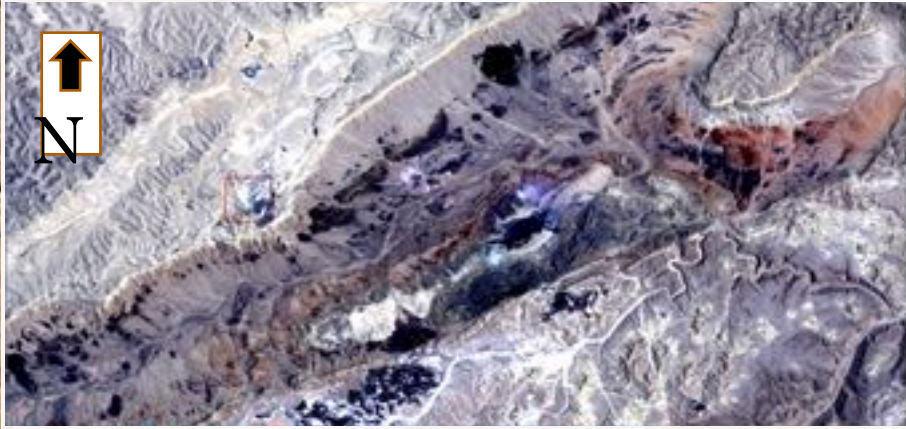
Amiaz Plain Landsat Reflectance 2000-2021



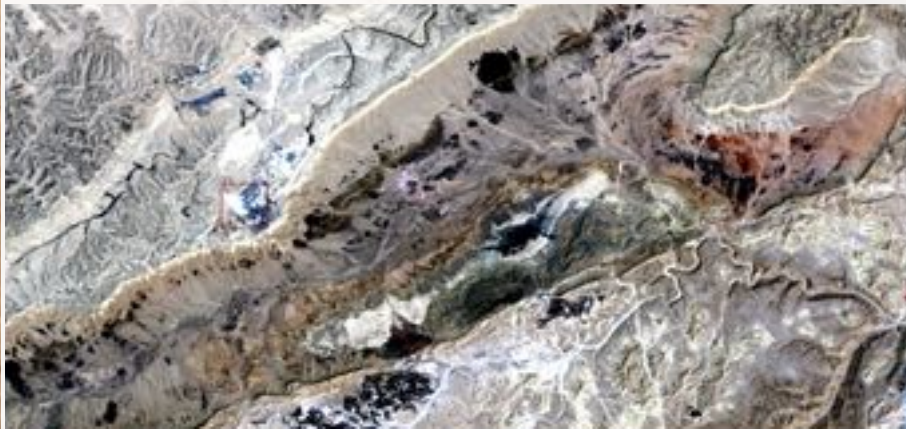
SAM, ASDS and RMSE for AP



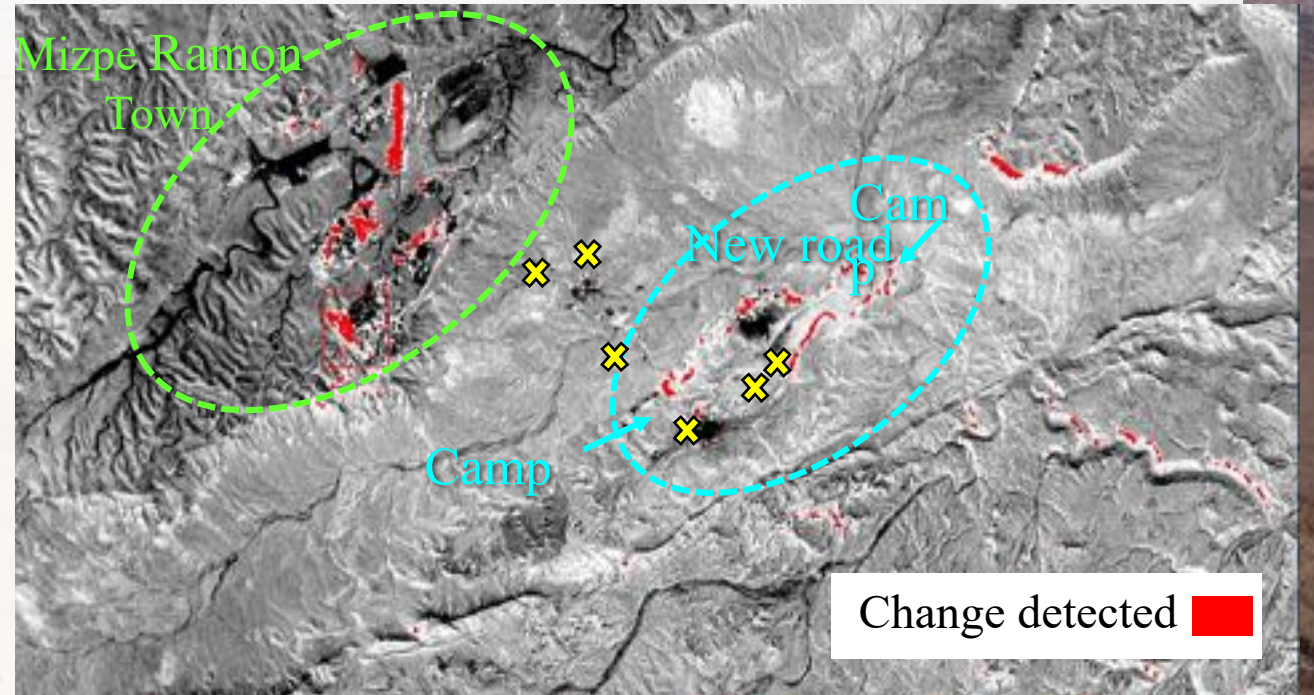
Makhtesh Ramon Stability



Landsat TM5-1996

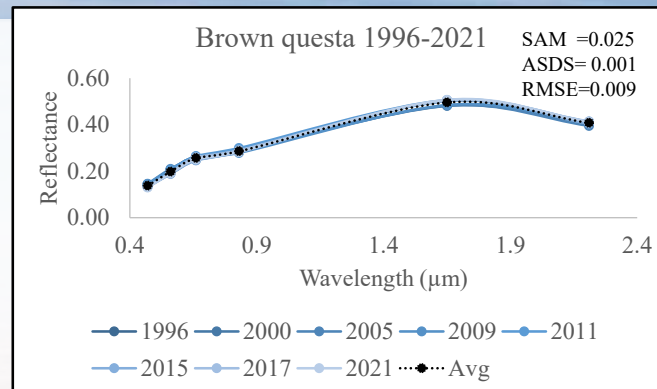


Landsat OLI8- 2021

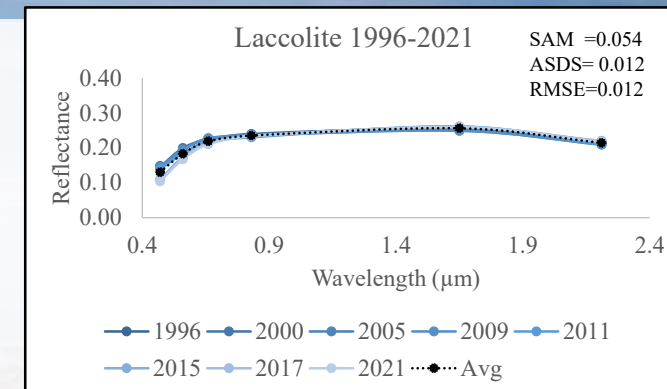


Change detected Landsat TM5 1996 VS. OLI8 2021

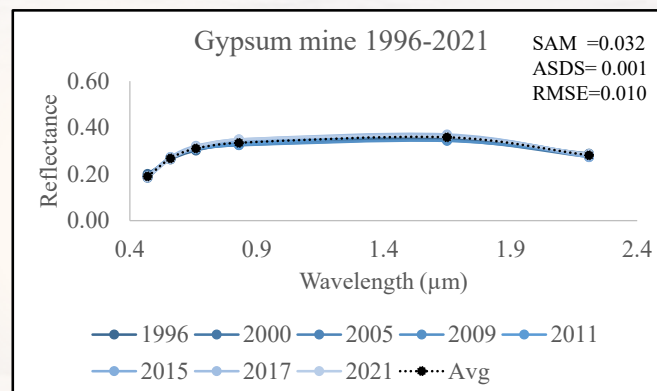
Makhtesh –Ramon Stability (2)



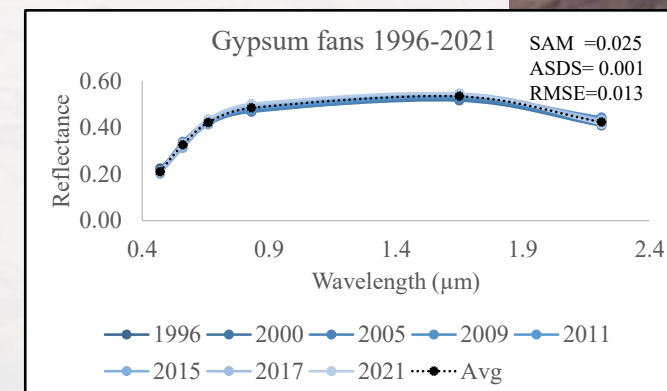
(a)



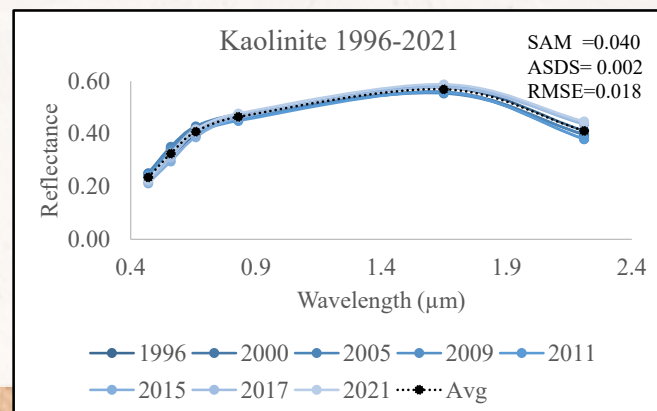
(b)



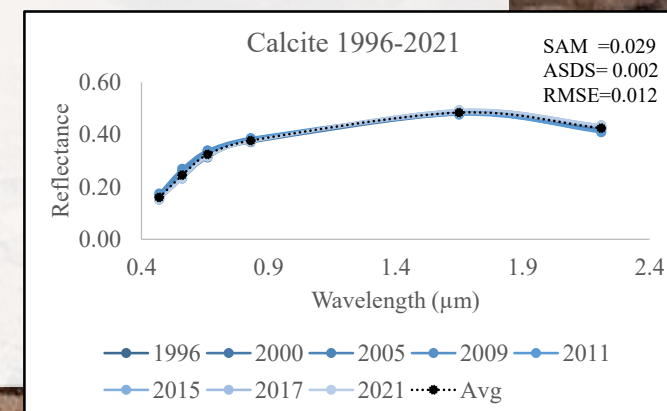
(c)



(d)



(e)



(f)

MR DATABASE

Link:

<https://storymaps.arcgis.com/stories/bb5bf09ec7414454a012bfe9bf4b8545>

Minerals mapping

Makhtesh Ramon Cal/ Val Site

Daniela Heller Pearlshtein & Eyal Ben-Dor | The Remote Sensing Laboratory, Tel Aviv University, Israel

July 14, 2021

Minerals' Locations in the Mak... Minerals Locations over Geolog... Minerals Abundances in Makhtes... AisaFENIX1K Sp

Minerals Abundances

Test Sites

Spectral Library

The screenshot shows a web-based map interface. At the top, there's a title 'Makhtesh Ramon Cal/ Val Site' and authors 'Daniela Heller Pearlshtein & Eyal Ben-Dor | The Remote Sensing Laboratory, Tel Aviv University, Israel'. Below the title is a large satellite image of the desert landscape. To the right, there are several inset maps: a colorful geological map, a map showing mineral abundances with a color scale for Hematite Concentration, and a spectral library with a legend listing 'Brown Quartz' and 'Basalt'. At the bottom left, there's a 'Test Sites' map showing specific locations marked with blue dots. The bottom right corner features the logo for 'THE REMOTE SENSING LABORATORIES'.

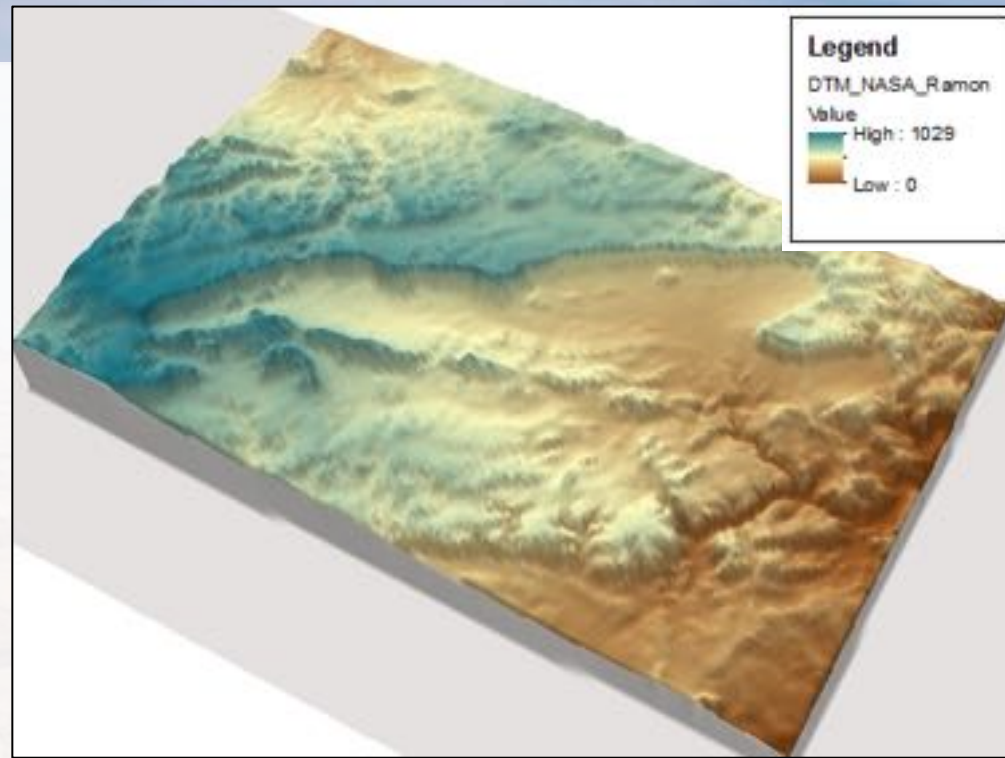
Geology Maps

Minerals Abundances

Test Sites

Spectral Library

MR-3D MODELS



VENUS (ISA & CNES)

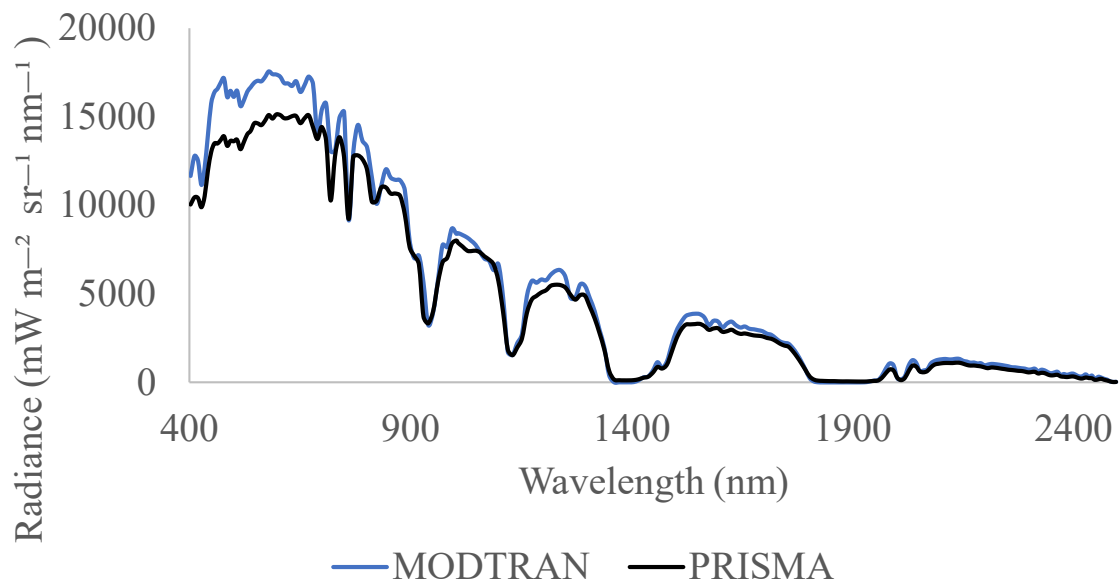
PRISMA (ASI)

FENIX 1K

DEGIS (DLR)

Sensor RAD/REF Performance

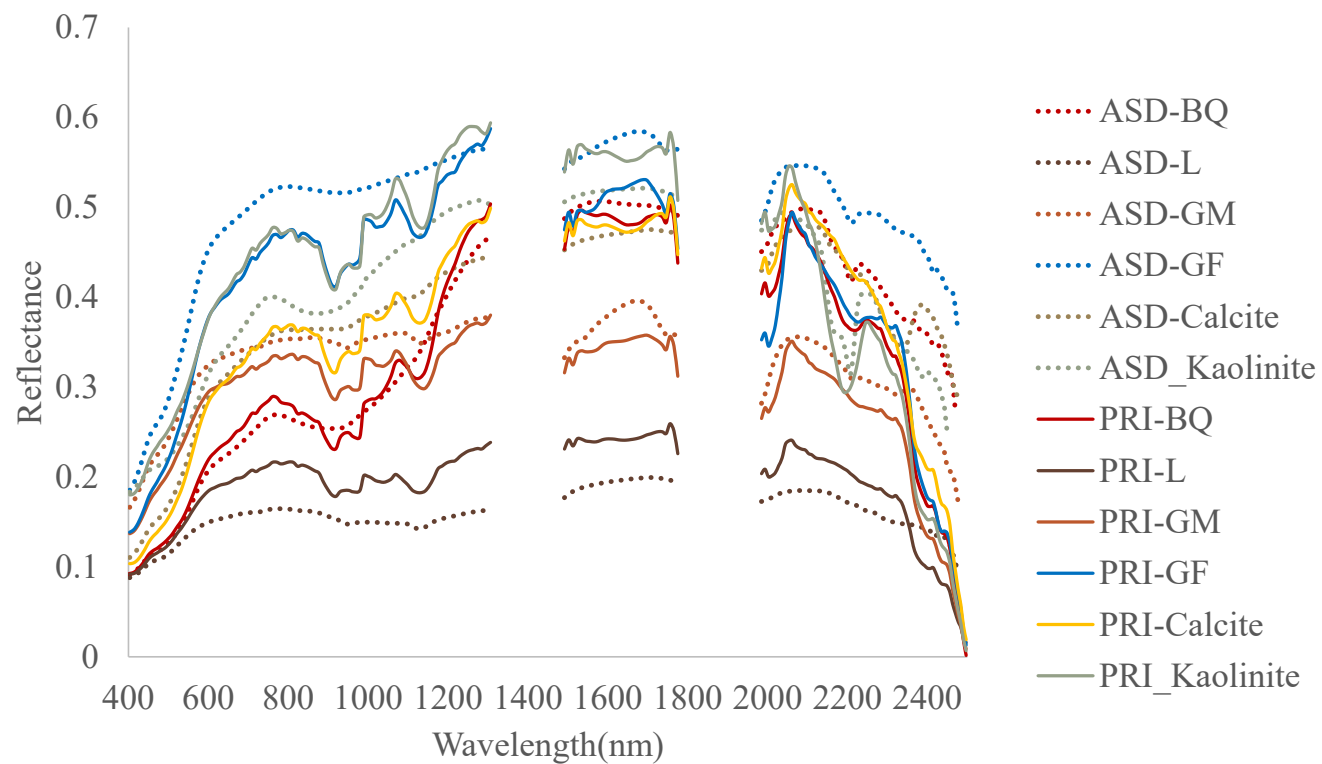
TOA MODTRAN VS. PRISMA L1



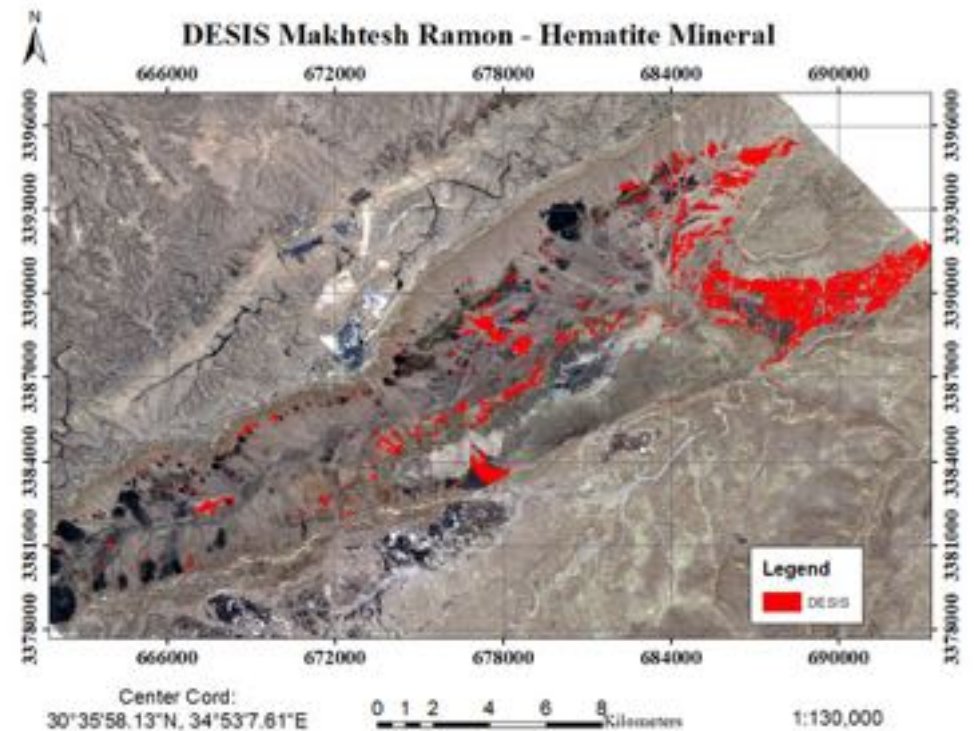
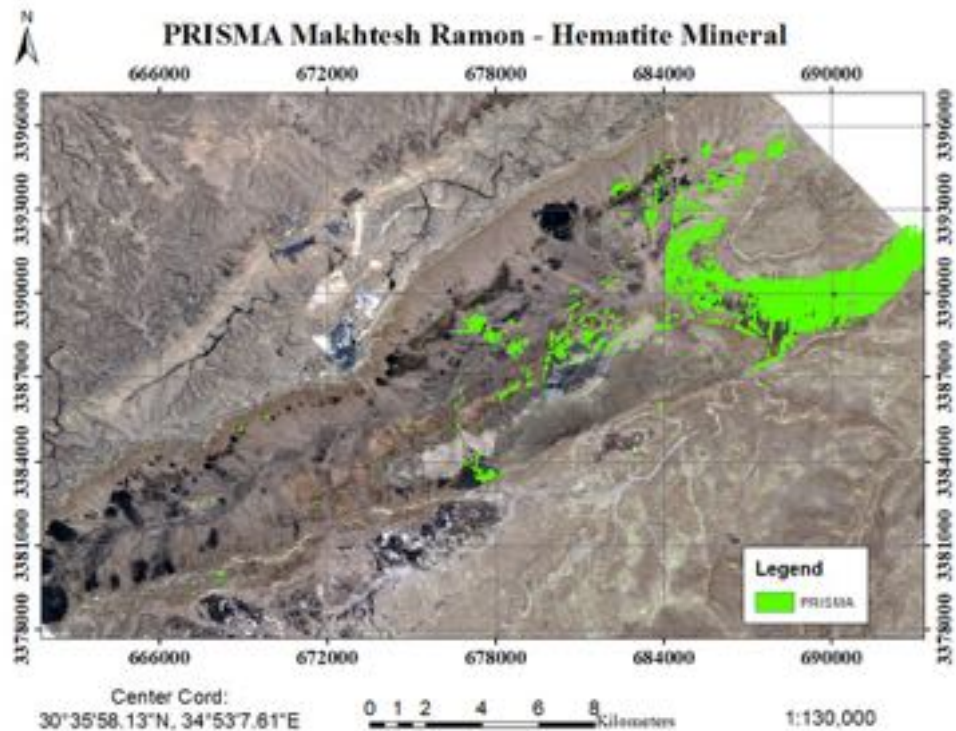
AP- RADIANCE

MR- REFLECTANCE

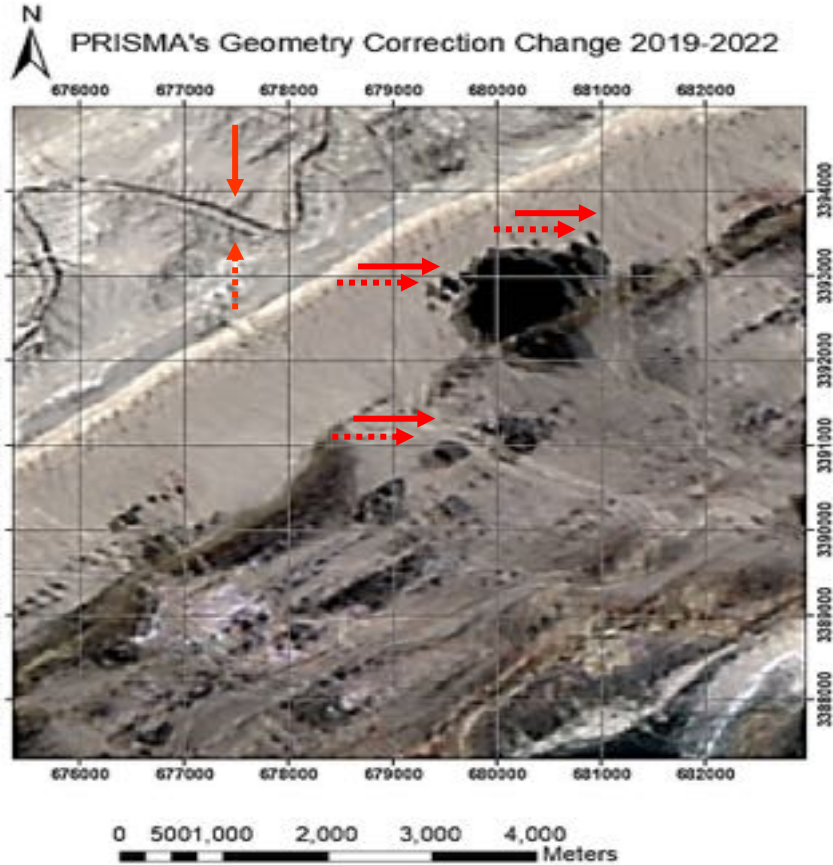
Spectra PRISMA VS. ASD



Sensor Mapping Performance (PRISMA)



Sensor Geometric Performance (PRISMA)

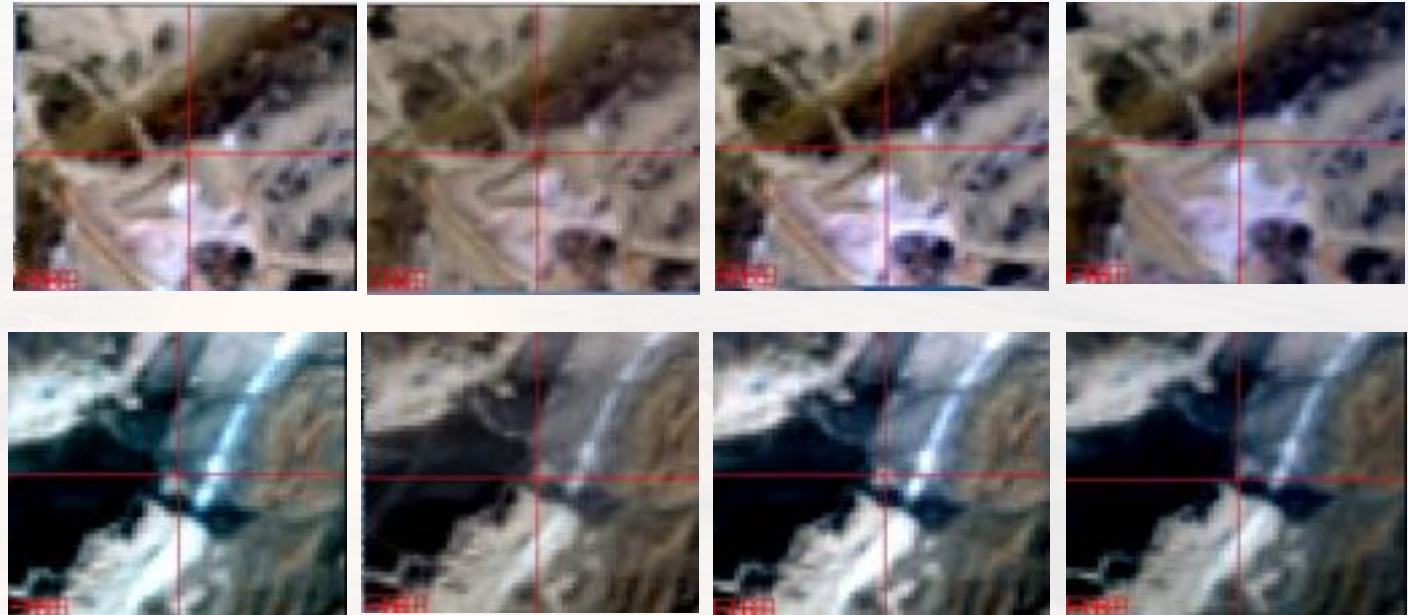


2019

2020

2021

2022



Years compared	X error (m)	Y error (m)	SD X	SD Y
2019-2020	16.8	19.7	0.69	0.37
2020-2021	243.1	66.9	0.75	1.13
2021-2022	16.9	18.3	0.43	0.23
2019-2022	238.6	95.1	0.51	1.18

Cross Calibration- over Amiaz Plain

Cross Calibration VNIR PRISMA with DESIS

$p(A)$ - PRISMA (June 3rd 2021-8:26 UTC)

$p(M)$ - DESIS (May 30 2021-8:53 UTC)

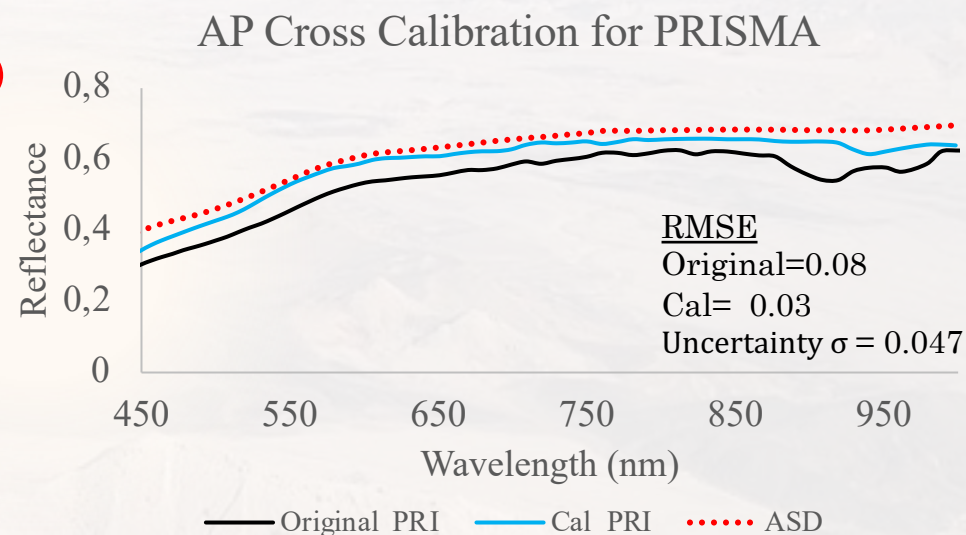
$p(\lambda h)$ -hyperspectral profile of the surface

AISAFENIX

SBAF -spectral band adjustment factor

$$SBAF = \frac{p(M)}{p(A)} = \frac{\int \rho \lambda h RSR(M) d\lambda}{\int RSR(M) d\lambda} \cdot \frac{\int RSR(A) d\lambda}{\int \rho \lambda h RSR(A) d\lambda}$$

$$p'_{(A)} = p_{(A)} \times SBAF$$

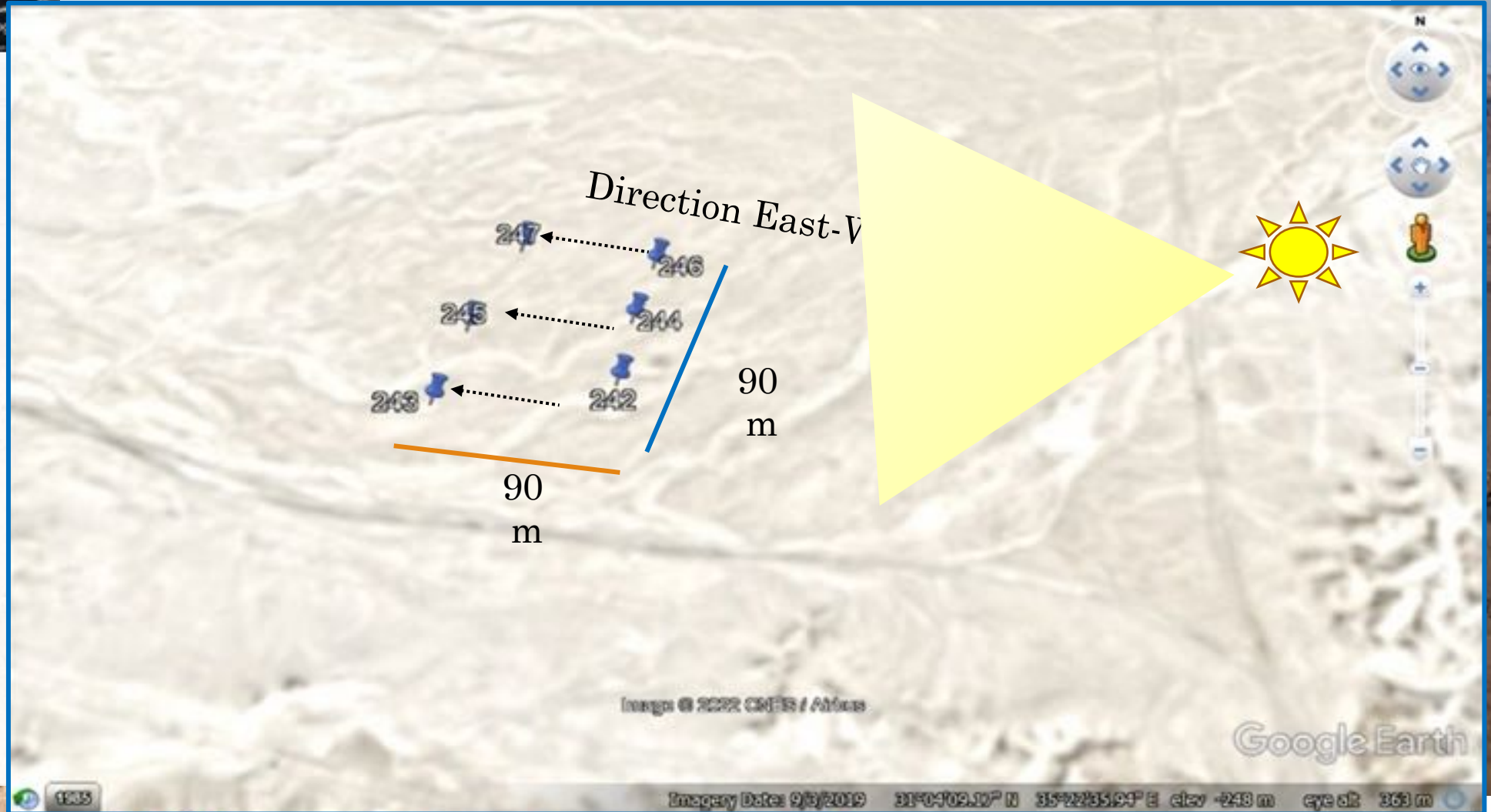


A wide, flat, arid plain with mountains in the background. The foreground is a vast, flat expanse of dry, light-brown earth with sparse, low-lying vegetation. In the distance, a range of rugged, brown mountains stretches across the horizon under a clear, pale blue sky. The overall scene is desolate and open.

Amiaz Plain August 2022

Field Measurements- 90X90 Meters

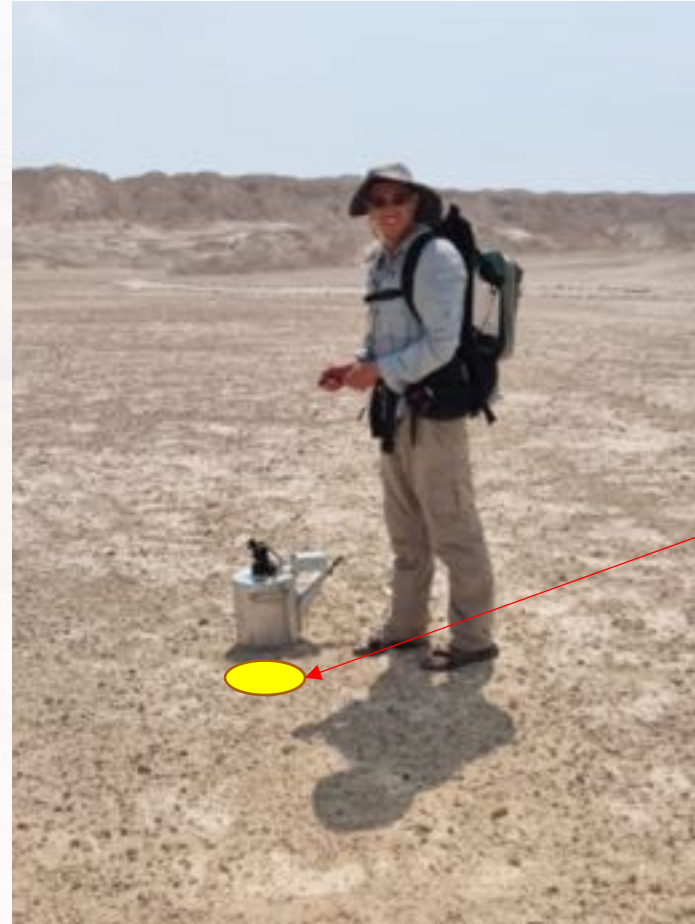
3 lines = 30 X
3 = 90 points
Between lines
= 48 points
Total = **138**
points



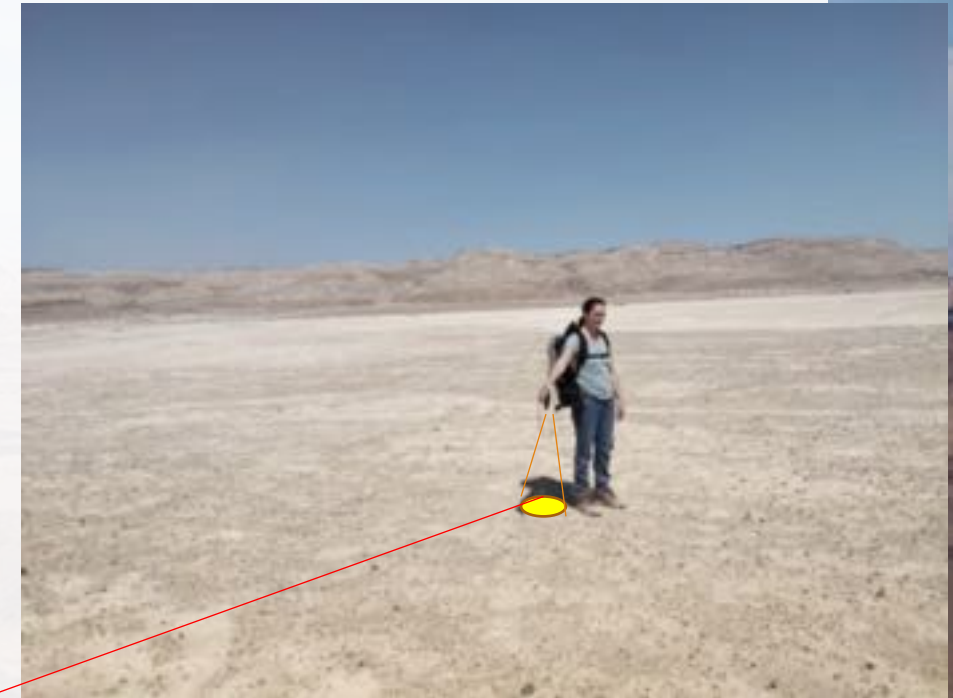


Cube Outlines 90X90 Measurements

ASD : Bare Fiber & SoilPRO



SoilPro®



Bare fiber



ASD – Changing from Bare fiber to SoilPRO®

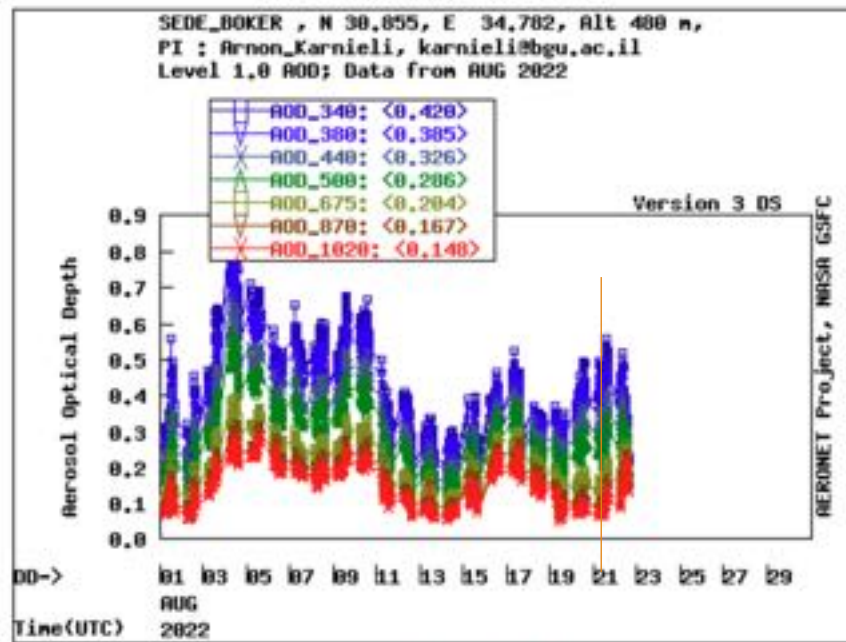


9:00 am

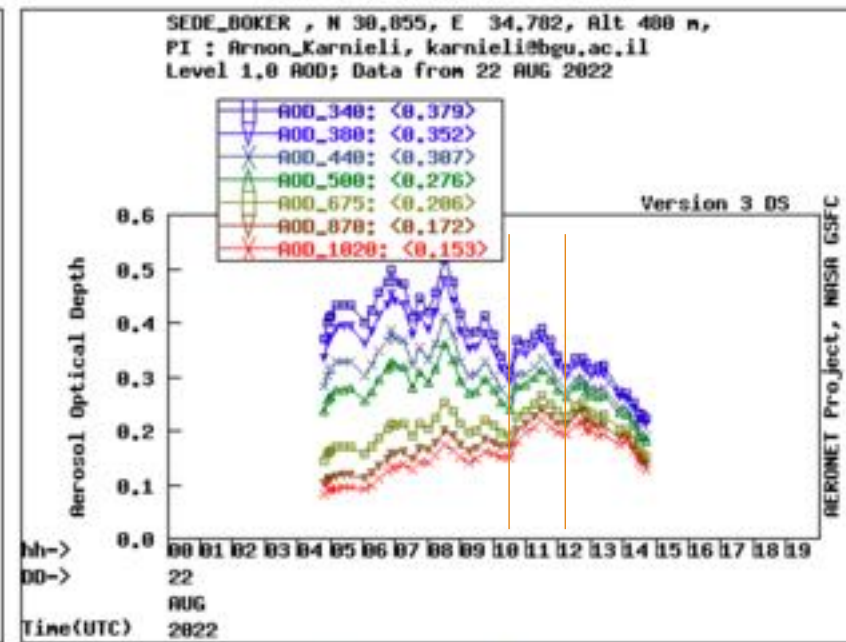


10:10 am

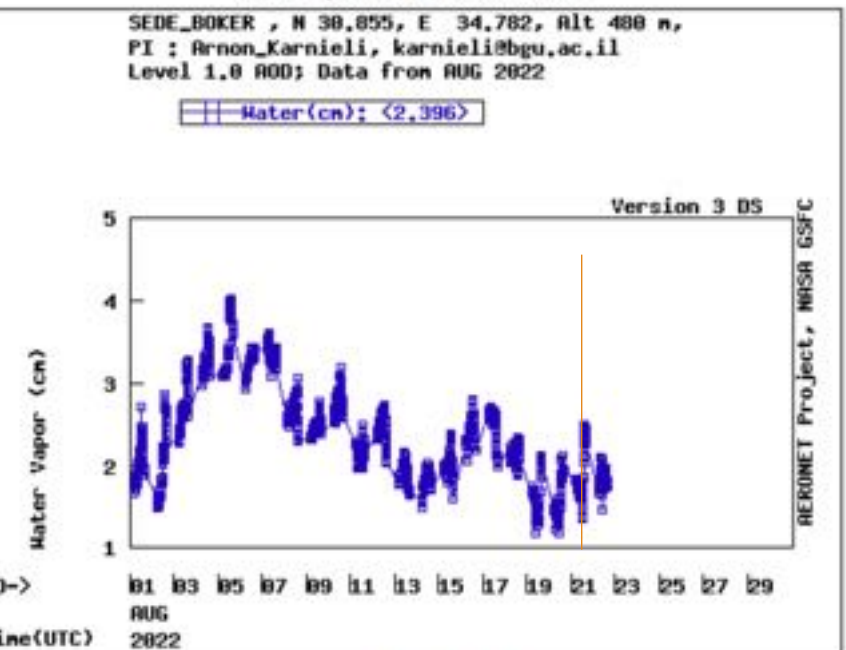
AOI Level 1.0 data from AUG of 2022



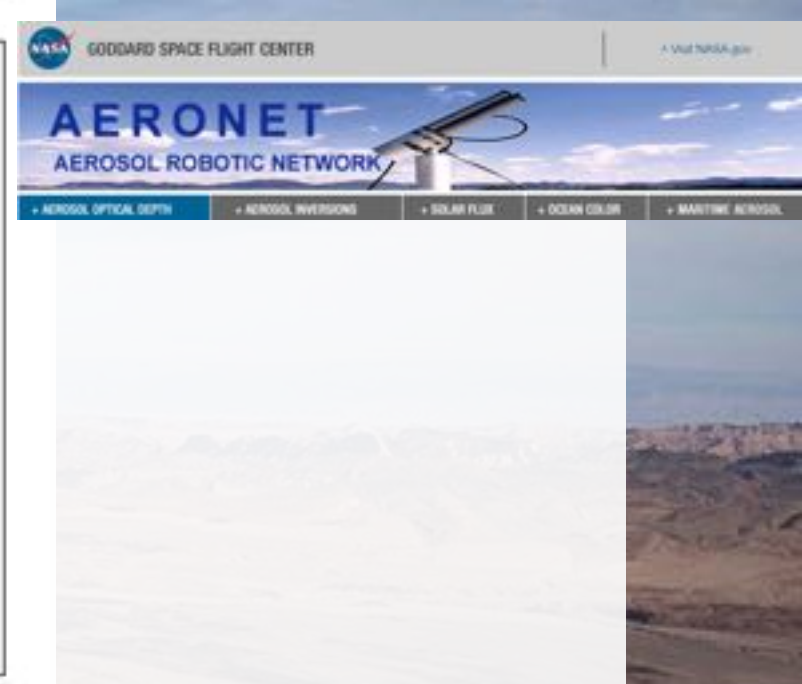
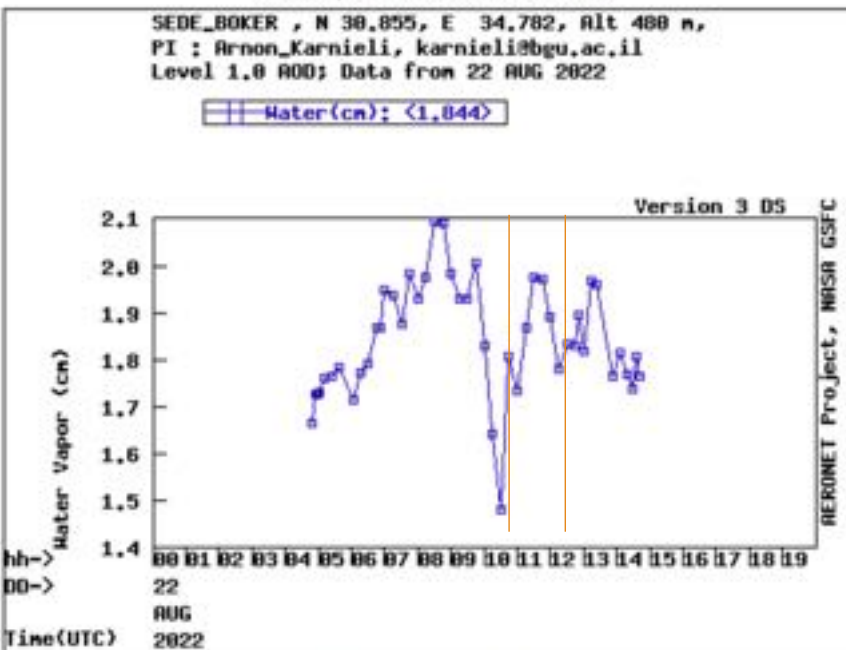
AOI Level 1.0 data from AUG 22 of 2022



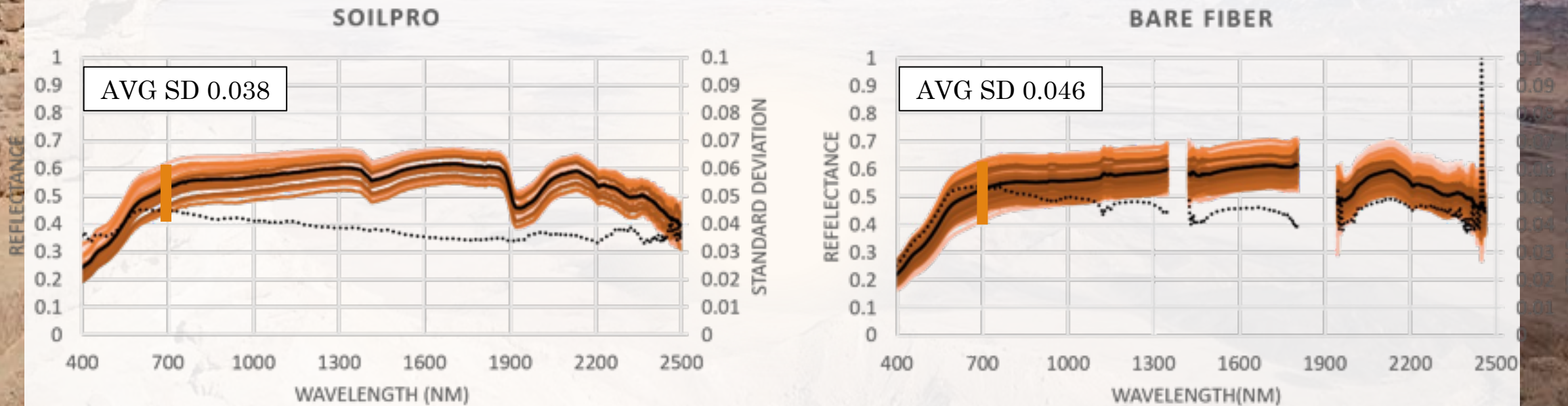
Water Vapor data from AUG of 2022



Water Vapor data from AUG 22 of 2022



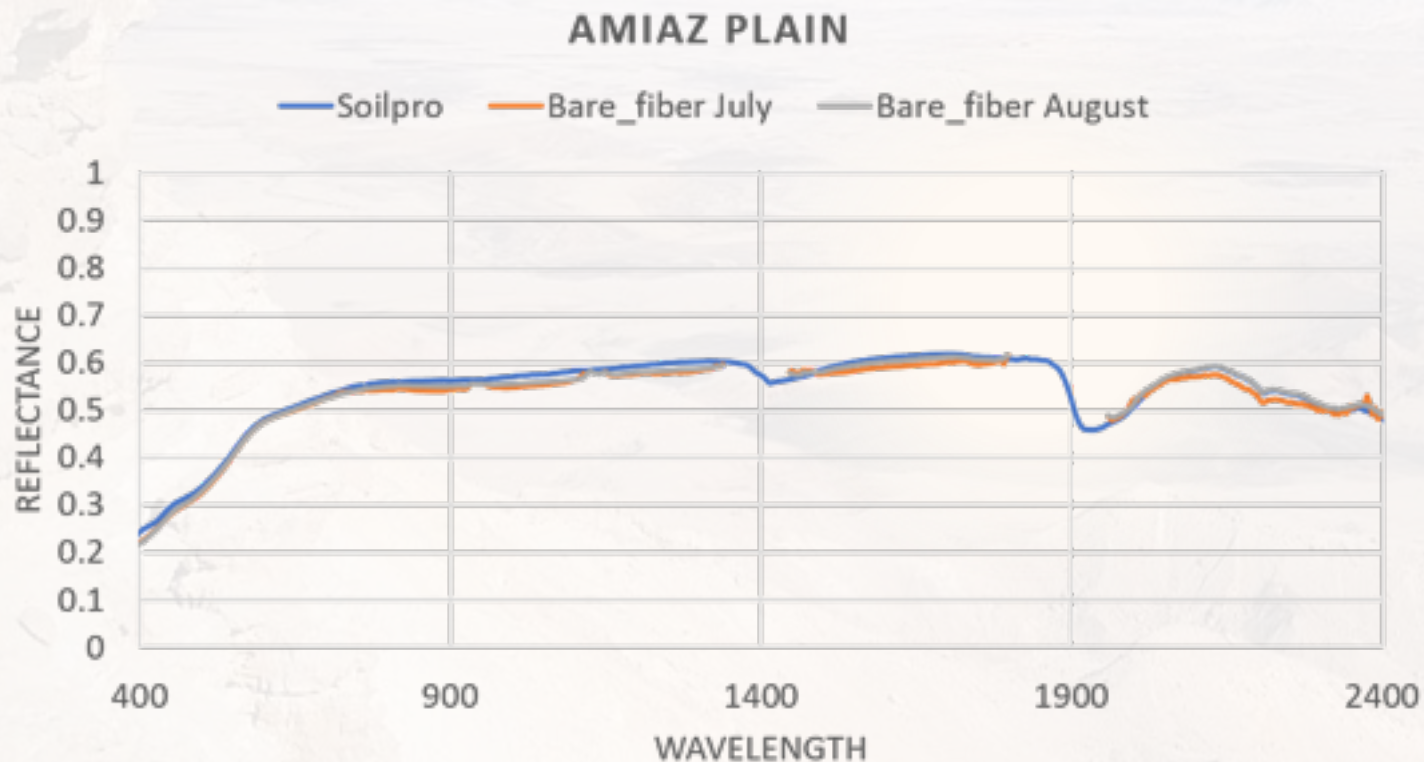
SoilPRO® VS. Bare Fiber



— Average
..... SD

Spectrum Average - Cube 90x90 m

Two months apart, the same ASD



Measurements

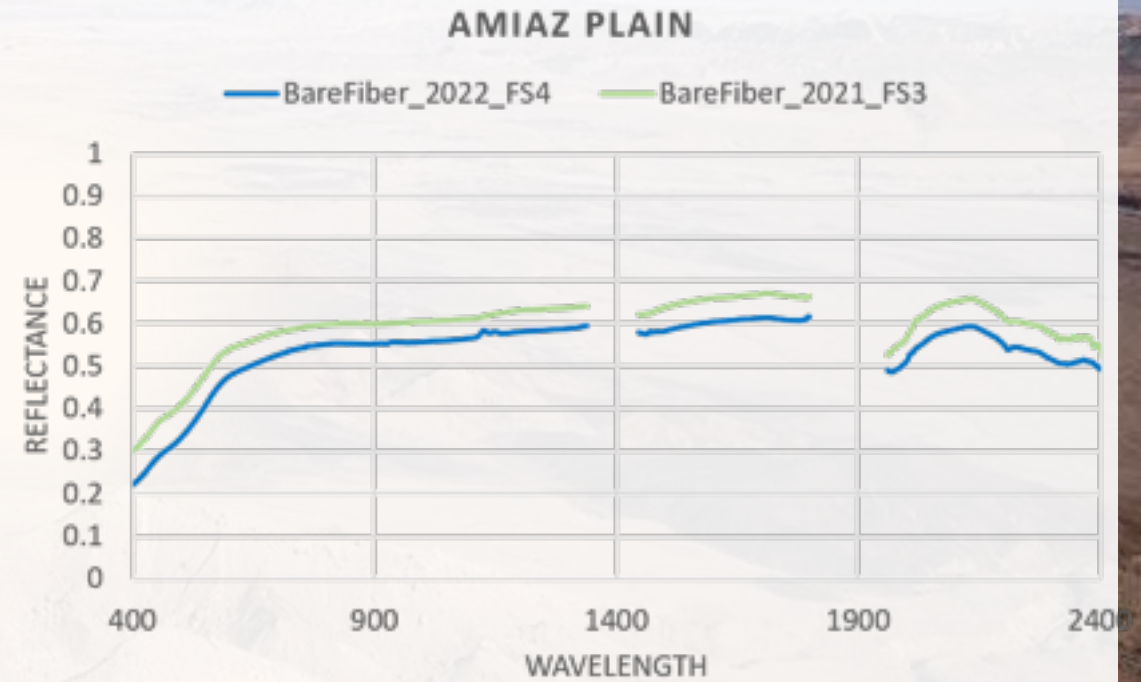
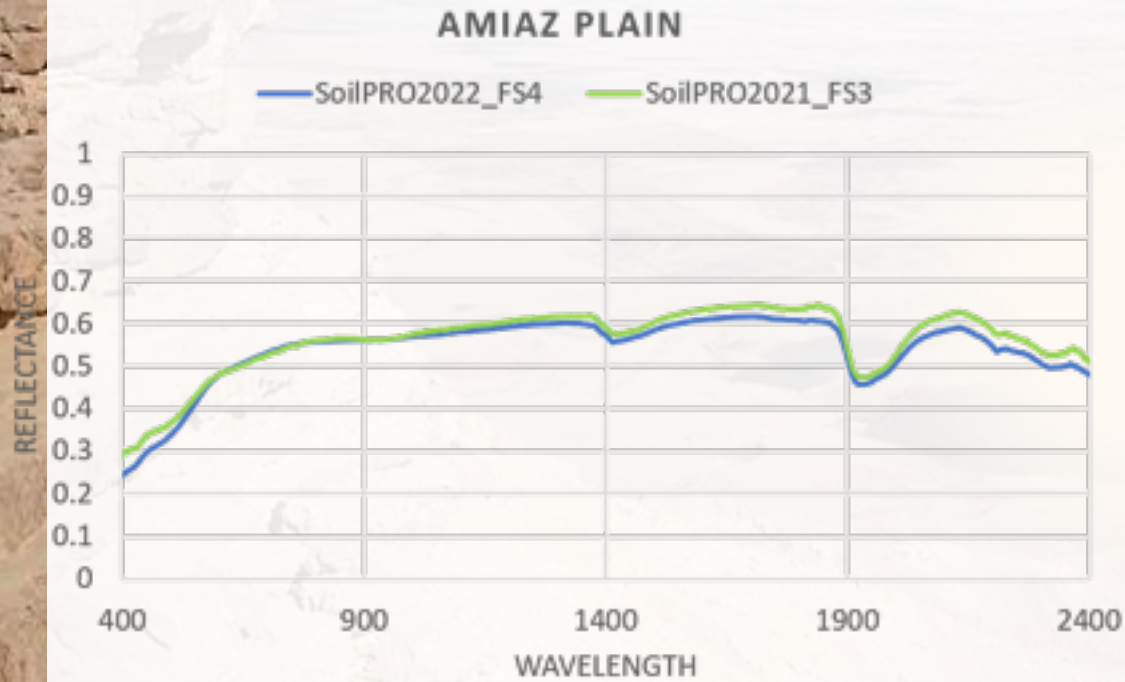
Bare Fiber July- 180

Bare Fiber August- 138

SoilPRO® August - 30

Two years apart (2001-2022 August), different ASD

FS4- FS3



Collaborations

- EMIT NASA VAL/CAL Team
- EnMAP DLR- VAL/CAL Team
- PRISMA ASI
- DESIS DLR
- ISA VAL/CAL test sites



Published Articles

INTERNATIONAL JOURNAL OF REMOTE SENSING
2021, VOL. 42, NO. 15, 5882-5914
<https://doi.org/10.1080/01431161.2021.1931541>

PRISMA sensor evaluation: a case study of mineral mapping performance over Makhtesh Ramon, Israel

Daniela Heller Pearlshtien^a, Stefano Pignatti^b, Uri Greisman-Ran^c, and Eyal Ben-Dor

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVI-1/W1-2021
1st DESIS User Workshop – Imaging Spectrometer Space Mission, Calibration and Validation, Applications, Methods, 28 Sept.–1 Oct. 2021, virtual

CaVal Evaluation of DESIS products in Amiaz Plain and Makhtesh Ramon Test sites, Southern Israel.

Daniela Heller Pearlshtien* and Eyal Ben-Dor

Remote Sensing Laboratory, Geography Department, Porter School of Environment and Earth Science, Faculty of Exact Science, Tel Aviv University, Tel-Aviv 699780, Israel; bendor@tau.ac.il
* Correspondence: dh@mail.tau.ac.il

ISPRS Commission and Working group- Commission I WG I/1 Multi- and Hyperspectral Sensing

Conclusions

- AP and MR are ideal sites for radiometric, spectral, and geometric/thematic validation and calibration.
- Makhtesh Ramon and Amiaz Plain are stable (spatial/ spectral) test sites.
- MR-GIS online spectral database is ready- This data base is updating periodically. We welcome any collaboration to share the data.
<https://storymaps.arcgis.com/stories/bb5bf09ec7414454a012bfe9bf4b8545>
- AP and MR are situated at the same orbital overpass.- advantage for dual sites protocols
- SoilPRO® is a promising assembly to acquire ground truth reflectance data under all conditions.
- Cross validation between spectrometers is essential: SoilPRO® may be an ultimate tool for that.

Acknowledgments:

**A heartfelt thanks to all the science teams of :
EMIT, EnMAP , PRISMA, and DEISIS, who are
collaborating and supporting our research effort.**





Thank you for your attention