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פרופ' ארנון קרניאלי

המעבדה לחישה מרחוק
המחלקה לאנרגיה סולרית ופיסיקה של הסביבה
המכונים לחקר המדבר ע"ש יעקב בלאושטיין
אוניברסיטת בן-גוריון בנגב
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December 19, 2021

Re: VENµS periodic news No. 31

1. VENµS updates

1.1 VENµS Mission 3 (VM3)

During the last several months, the VENµS was devoted to the technological mission in which the satellite's orbit was lowered from 720 km (VENµS Mission 1, VM1) to 410 km (VM3) using an electric propulsion. During VM3, from mid-September 2021 to the end of October 2021, we have received several VENµS L1 products with 3 m spatial resolution over 3 strips as presented in Figure 1 and Table 1. Note that:

- L1 means a single date and single angle acquisition with top of the atmosphere reflectance and map projection.
- NAJA atmospheric correction will be available in the future.
- The images will not be available in the VENµS portal, but will be provided upon request from VENµS@post.bgu.ac.il

Figure 1: *Strips and tiles during VM3.*

Table 1: *Available L1 images for VM3. Nicknames are according to Figure 1. Cloud cover is indicated.*

		Date										
Nickname	**# images**	**20210908**	**20210918**	**20210920**	**20210924**	**20210928**	**20211010**	**20211012**	**20211020**	**20211022**	**20211026**	**20211028**
ISRAELN1	10	0.0%	0.0%	0.0%	62.1%	23.9%	0.0%	34.5%	0.0%	1.9%	0.0%	
ISRAELN2												
ISRAELN3												
ISRAELN4	7		0.0%	0.0%	40.6%		0.0%		21.1%	0.0%	1.3%	
ISRAELW1	8		2.0%	0.0%	79.3%	48.0%	0.0%		65.8%	33.6%		0.0%
ISRAELW2	9		0.0%	0.0%	55.5%	46.7%	0.0%	32.9%	48.0%	21.3%		0.0%
ISRAELW3	9		0.0%	20.0%	49.4%	37.2%	0.0%	4.3%	50.1%	9.2%		0.0%
ISRAELW4	9		0.0%	0.0%	73.4%	24.0%	0.0%	0.0%	30.7%	6.7%		0.0%
ISRAELS1	8		0.0%	0.0%	43.8%	0.0%	0.0%		0.0%	0.3%		0.0%
ISRAELS2	8		0.1%	0.1%	48.0%	0.0%	0.0%		0.0%	0.0%		0.0%
ISRAELS3	9		0.0%	0.0%	39.8%	0.0%	0.0%	12.2%	0.0%	0.0%		0.0%
ISRAELS4	9		0.0%	0.0%	14.9%	0.0%	0.0%	0.3%	0.0%	0.0%		0.0%

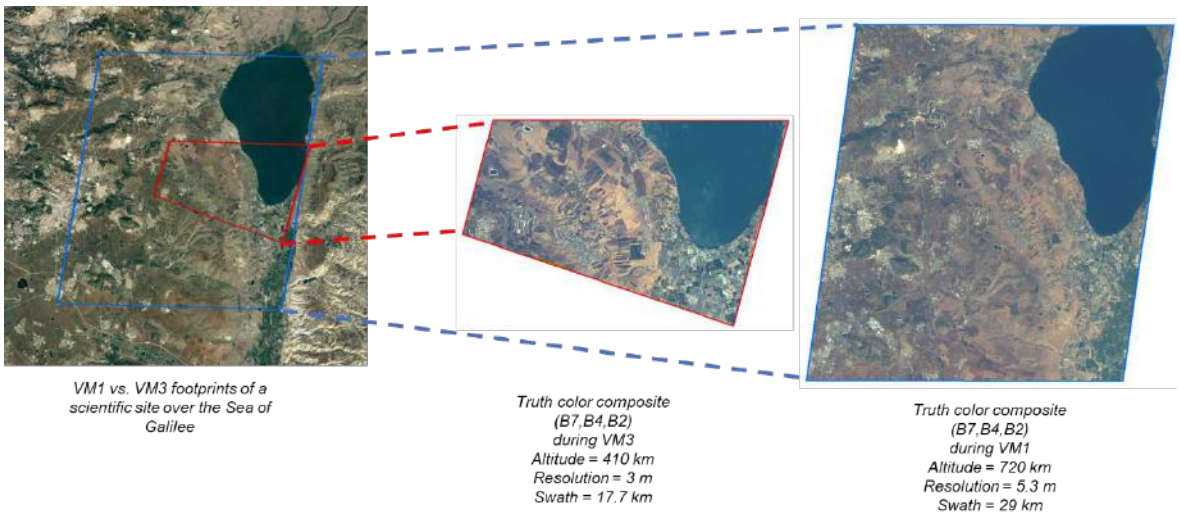

Figure 2: *Comparison between VM1 and VM3 True color composite images.*

- For some tiles, there is an error in the geolocation. CNES will send the correct L1 and the remaining L1 products probably at the beginning of January 2022.
- The L2 products of the VM3 will not available before March 2022, after that CNES will deliver an updated version of MAJA that will manage the new spatial resolution of L1.

1.2 VENµS Mission 5 (VM5)

Currently VENµS is moving up from it VM3's orbit at 410 km to 560 km. VENµS mission 5 (VM5) will start during the first half of January 2022. It will stay at this orbit for the next two years.

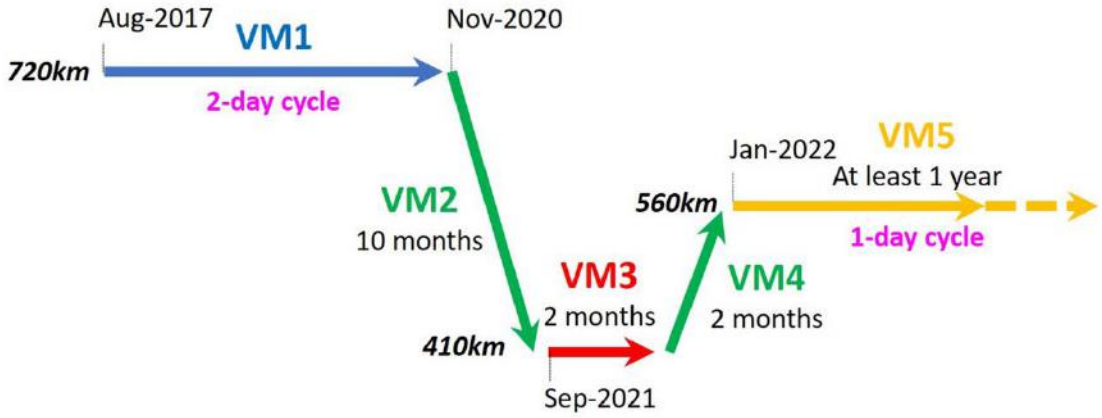

Figure 3: *VENµS missions.*

2. Feature paper

Optimizing top dressing nitrogen fertilization using VENµS and Sentinel-2 L1 data

David J. Bonfil, D.J., Michael, Y., Shiff, S. and Lensky, I.M. 2021. Optimizing top dressing nitrogen fertilization using VENµS and Sentinel-2 L1 data. *Remote Sensing*. **13**, 3934. https://doi.org/10.3390/rs13193934

Abstract: Environmental and economic constraints are forcing farmers to be more precise in the rates and timing of nitrogen (N) fertilizer application to wheat. In practice, N is frequently applied without knowledge of the precise amount needed or the likelihood of significant protein enhancement. The objective of this study was to help farmers optimize top dress N application by adopting the use of within-field reference N strips. We developed an assisting app on the Google Earth Engine (GEE) platform to map the spatial variability of four different vegetation indices (VIs) in each field by calculating the mean VI, masking extreme values (three standard deviations, 3σ) of each field, and presenting the anomaly as a deviation of ±σ and ±2σ or deviation of percentage. VIs based on red-edge bands (REIP, NDRE, ICCI) were very useful for the detection of wheat above ground N uptake and in-field anomalies. VENμS high temporal and spatial resolutions provide advantages over Sentinel-2 in monitoring agricultural fields during the growing season, representing the within-field variations and for decision making, but the spatial coverage and accessibility of Sentinel-2 data are much better. Sentinel-2 data is already available on the GEE platform and was found to be of much help for the farmers in optimizing topdressing N application to wheat, applying it only where it will increase grain yield and/or grain quality. Therefore, the GEE anomaly app can be used for top-N dressing application decisions. Nevertheless, there are some issues that must be tested, and more research is required. To conclude, satellite images can be used in the GEE platform for anomaly detection, rendering results within a few seconds. The ability to use L1 VENμS or Sentinel-2 data without atmospheric correction through GEE opens the opportunity to use these data for several applications by farmers and others.

For more details, contact Prof. Itamar Lensky (itamar.lensky@biu.ac.il)

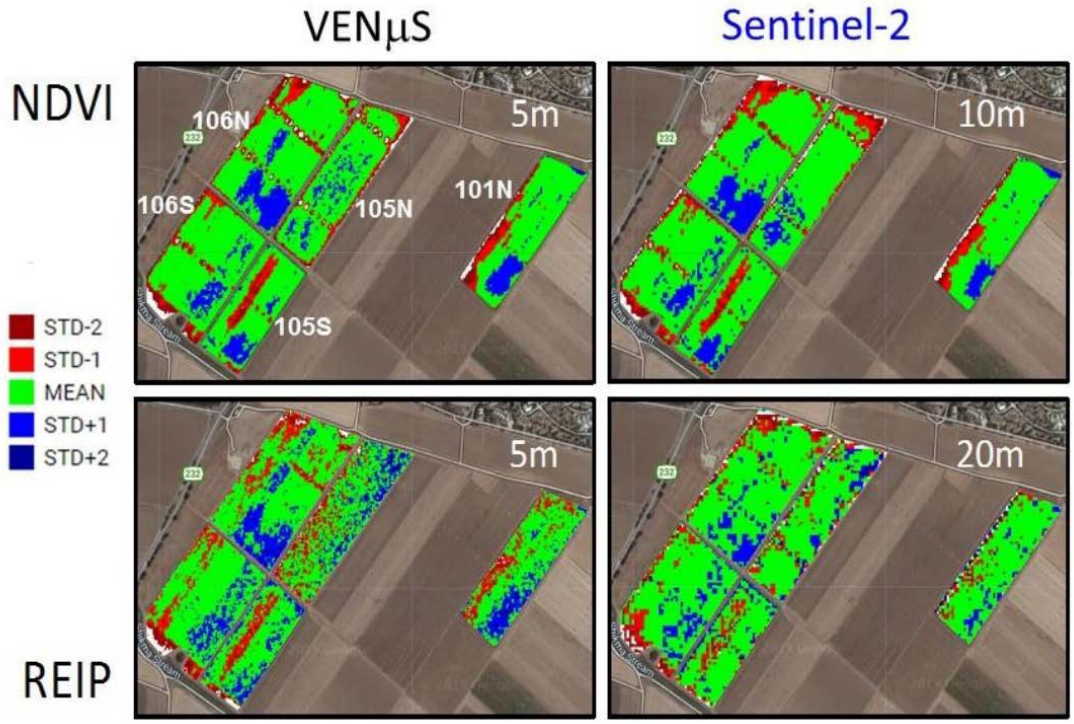

Figure 4: *Anomaly Explorer app using standard deviation of NDVI and REIP calculated from L1 213 VENμS (15/1/2019) and Sentinel-2 (16/1/2019) data. Spatial resolution: VENμS 5 m; Sentinel-2 10 m 214 (NDVI) and 20 m (REIP).*

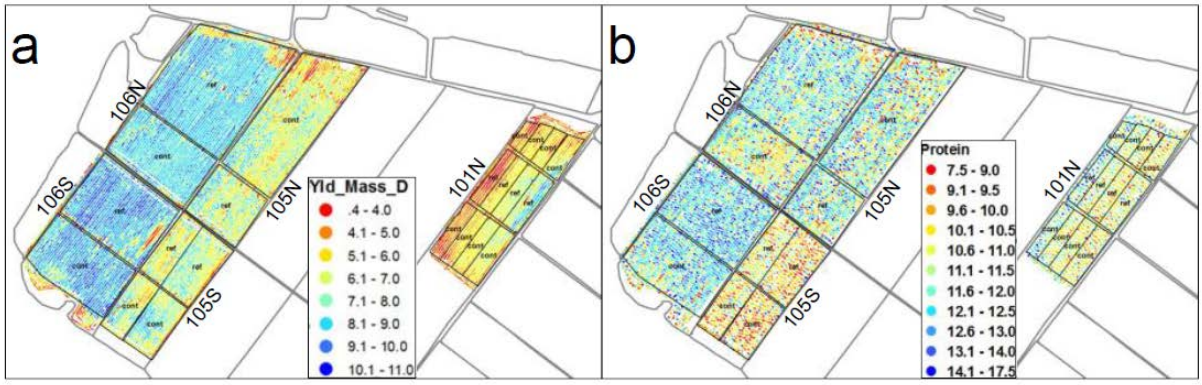

***Figure 5: (a)** Wheat grain yield (t ha-1) and (**b**) grain protein content (%) maps of five fields in Saad 232 for the 2019 season.*

3. VENμS accessibility for Israeli farmers

A message from Dr. Yafit Cohen

אנחנו שמחים לבשר כי לאחר תהליך הסדרה ארוך אנו יוצאים בקול קורא מיוחד במינו: **הנגשת דימותי וונוס לחקלאים בארץ**.

לוויין וונוס הוא לוויין ישראלי-צרפתי שמספק דימותי לוויין מולטי-ספקטראליים (12 ערוצים) ברזולוציה גבוהה (5.3 מטר לפיקסל), עם זמן חזרה של יומיים.

מחודש ינואר 2022 הלוויין יחוג בגובה נמוך יותר (560 ק"מ) ויחל לספק דימותי לוויין ברזולוציה של 4 מטרים לפיקסל עם זמן חזרה יומי לרוב אזורי הארץ במשך שנתיים לפחות.

חברות מסחריות מנגישות היום תוצרי חישה מרחוק לוויניים לחקלאים רבים בארץ. תוצרים אלו מתבססים בעיקר על הלוויין Sentinel-2 בעל רזולוציה של 10-20 מטרים, עם זמן חזרה של 5 ימים.

במידה שדימותי לוויין וונוס יונגשו לחקלאים, הם יוכלו ליהנות מתוצרים איכותיים יותר בתדירות יומית וכך לשפר את יעילות הפעילות החקלאית שלהם.

סוכנות החלל הישראלית בשיתוף עם מכון וולקני מעוניינים להנגיש את הדימותים של לוויין הוונוס לחקלאי ישראל לשיפור היבולים ולשם כך הוגדר הליך שיאפשר זאת.

הקול הקורא המצורף נועד לרתום חברות מסחריות אשר מספקות דימותי לוויין לחקלאים כדוגמת Sentinel-2 כדי שתוספנה לסל השירות שלהן את דימותי הלוויין וונוס **ללא עלות נוספת לחקלאי**.

מאידך, החברות תתחייבנה להעביר מידע היסטורי חקלאי למכון וולקני בהתאם למפורט בנספח א' לקול הקורא.

הפורמט להעברת המידע יהיה באחת משתי התצורות הבאות: (1) שכבת גבולות חלקות shapefile לכל שנה בנפרד עם טבלה מקושרת המכילה את הנתונים המצויינים בהסכם (מועדפת); (2) שכבת גבולות חלקות shapefile וטבלה נפרדת המכילה את הנתונים המצויינים בהסכם לכל שנה בנפרד.

יצויין כי אין מגבלה לכמות החברות אשר יוכלו ליהנות מהנגשה זו.

במידה ואתם מעוניינים להצטרף ליוזמה ולחתום על ההסכם או לשמוע פרטים נוספים

אתם מוזמנים לפנות ל:

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ואל הראל גרינבלט משה"ם, משרד החקלאות harelg@shaham.moag.gov.il

4. Feature study: Estimation digital terrain model (DTM) with VENµS

(Source: https://labo.obs-mip.fr/multitemp/estimate-terrain-elevation-from-a-single-pass-of-ven%c2%b5s-satellite-and-monitor-its-evolution-over-time/)

One of the main missions of VENµS, is to carry out acquisitions over more than a hundred scientific sites around the world. Its resolution at 5.3 m and the 2-day revisit period of its observations enable improved modelling of phenomena acting on vegetation and continental surfaces. In this context, the generation of Digital Terrain Models (DTMs) would make it possible to monitor changes in soil elevation (altitude of mountainous sites, landslides, etc.).

The VENµS camera acquires 12 spectral bands, all different except for the pair (B05/B06) which have almost identical spectral responses (Figure 6). These two bands being placed at the extremities of the focal plane, the same detail on the ground is thus seen from two different angles (Figure 7). VENµS therefore has a native stereoscopic capability characterized by a rather low B/H (base-to-high) ratio, equal to 0.025 (Figure 8).

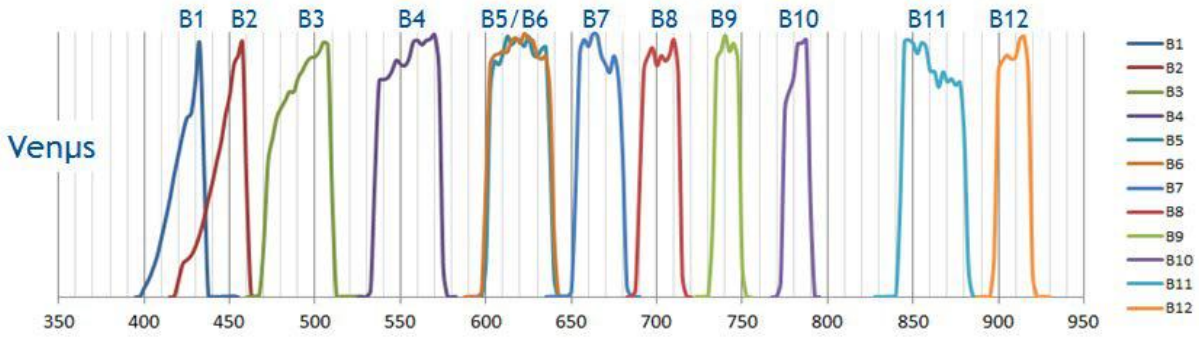

Figure 6: *Spectral responses of the bands acquired by VENµS.*

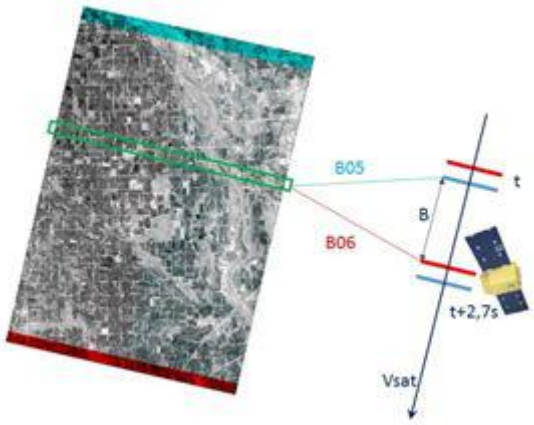

Figure 7: *Schematic view of the native stereoscopic capability of VENµS. The B05 band looks slightly forward and the B06 band slightly backward.*

This B/H ratio is very low (to be compared for example with Pleiades stereo shots which have a B/H ratio of around 0.15). This difference in observation angle is used in particular for the detection of clouds by their altitude for the production of Level 2A products with MAJA. The purpose of the study conducted here was to evaluate the

altitude restitution performance obtained from a single VENµS acquisition despite the low B/H ratio.

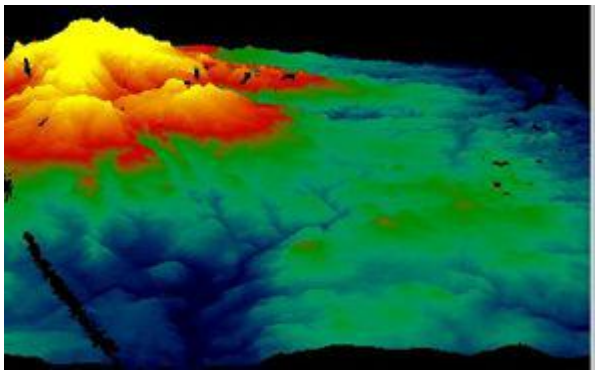

Figure 8: A single VENµS acquisition is sufficient to estimate the terrain elevation of a scene thanks to the so-called "native stereo" technique.

The techniques implemented during the radiometric and geometric calibration phase of the VENµS satellite allowed to improve the sensors absolute geometry and image Matching. These are two major contributors to stereo performance. In the case of VENµS, the restitution of the satellite's attitude was rather imprecise, and CNES has implemented a new method to correct these errors, reaching a multiband registration performance of 0.05 pixel.

Subsequently, a processing chain (Figure 9) was developed to produce VENµS DTMs based on (1) image matching; and (2) the intersection of the look directions of the homologous pixels. The quality of the generated DTM is then evaluated by comparison with a reference DTM (SRTM).

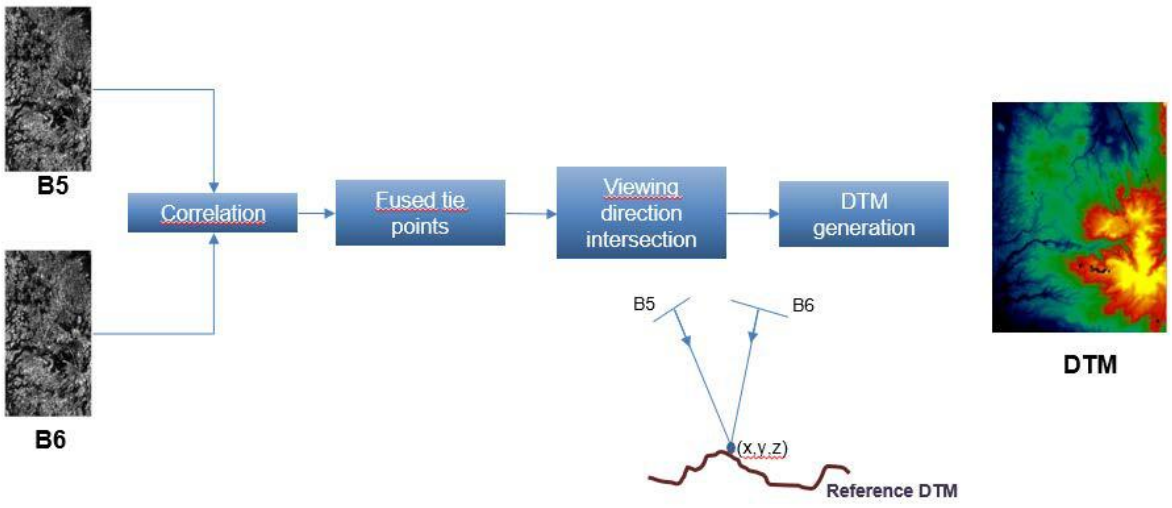

Figure 9: *Processing chain implemented for the generation of VENµS DTMs*

This study showed that the accuracy of altitude restitution obtained is of the order of 8m. These promising results not only open up prospects in the context of scientific studies (e.g. joint analysis with bathymetry, landslides), but may also help to define future missions. For example, if the results of this study are confirmed, a mission with a resolution of 2 m with the same B/H as VENµS (the feasibility of which remains to be

demonstrated) could make it possible to obtain DEMs with an altimetric accuracy of 3 m. With such a precision, it is possible to detect the construction or destruction of a building, monitor tree growth, detect logging, or estimate the long-term decrease in glacier heights. This would be very interesting in the preparation of a mission such as Sentinel-HR.

Finally, due to time constraints, we have not yet been able to use multiple observations of the same site every two days to further improve the accuracy of relief estimation.

5. Special issue in Remote Sensing – call for papers

New deadline for manuscript submissions: 31 March 2022

Consider submitting an article to the special issue of the Remote Sensing journal: "VENµS Image Processing Techniques and Applications". https://www.mdpi.com/journal/remotesensing/special_issues/Venus

Accepted papers will be published continuously in the journal (as soon as accepted) and listed on the special issue website.

6. Previous VENµS Newsletters

Previous VENµS Newsletters, along with more information about VENµS, can be read at the following link: https://karnieli-rsl.com/newsletters.

7. Unsubscribe

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Best regards,

Manuel and Arnon

Ben Gurion University