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פרופ' ארנון קרניאלי

המעבדה לחישה מרחוק
המחלקה לאנרגיה סולרית ופיסיקה של הסביבה
המכונים לחקר המדבר ע"ש יעקב בלאושטיין
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Re: <u>VENµS periodic news No. 34</u>

1. VENµS updates

Below is some long-awaited news about the VENµS VM5 phase. The acquisitions started at the end of March 2022 and should go on for at least one year, and maybe more, depending on the fuel consumption (Hydrazine) to maintain the orbit. As you probably noticed, we are a bit late in delivering VENµS products, and we would like to apologize.

The verification phase of the instrument and processing showed that a new calibration phase was needed:

- The radiometric team in CNES had to recalibrate the instrument as it is now used with different integration times and gains;
- They noticed that some gains of the elementary detectors evolved and that the models we used to correct for spikes that cause the appearance of bright and dark columns had to be revised;
- The geometric calibration was checked, and as we have new sites, the production team had to prepare new reference images.

These actions take more time than anticipated.

Currently, only L1 products are available on demand. However, atmospheric correction can be performed by using the ATCOR or 6S programs. Note that for atmospheric correction, one can use the 5 Aeronet stations across the country (i.e., Eilat, Sede Boker, Rehovot, Tel Aviv, Haifa, and Kiryat Shemona). Link to the Aeronet portal: https://aeronet.gsfc.nasa.gov/

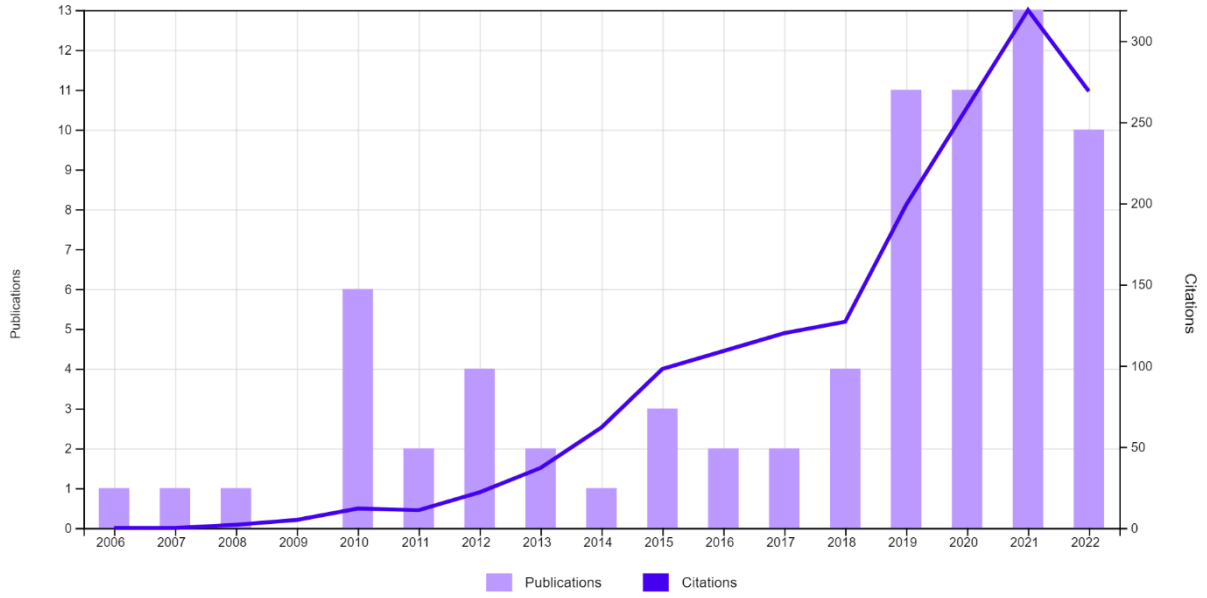
We plan to release the L1 products on the VENµS website in the next few weeks and the L2 shortly after (we will start the L2 processing in December 2022).

For any questions, please don't hesitate to contact us.

2. Scientific products

The main payload of the VENµS satellite is devoted to the scientific mission. As of today, five years after receiving the first images, seventy-four publications are listed Web of Science (ISI) Core Collection. Fifty of these are articles in scientific journals, and the rest are proceeding papers. The citation topic categories are presented in the chart below (Figure 1):

The number of publications and citations has gradually increased each year (Figure 2):



3. Feature papers

3.1 VENμS: Mission Characteristics, Final Evaluation of the First Phase and Data Production

Dick, A., Raynaud, J.L. Rolland, A., Pelou, S., Coustance, S. Dedieu, G., Hagolle, O., Burochin, J.P., Binet, R. and Moreau, A. (2022) VENμS: Mission characteristics, final evaluation of the first phase and data production. *Remote Sensing.* **14**, 3281. DOI10.3390/rs14143281.

Abstract: VENμS (Vegetation and Environment New micro (μ) Satellite) is a micro satellite launched in 2017 by the Israeli Space Agency (ISA) and the French Centre National d'Etudes Spatiales (CNES). VENμS is a research satellite containing two very different devices: an electric Hall effect thruster and a multispectral optical camera. This paper focuses on the multispectral camera. The camera provides images at a resolution of 5 m, with a field of view of 27 km, and the orbit of the satellite was chosen to allow us to revisit of each observed site with constant angles every second day. In

November 2020, VENµS ended the first phase of its mission. This phase, called VM01, allowed us to provide about 150 accurate time series over selected scientific sites over almost three years. Extensive work was conducted to calibrate the camera and assess the quality of the products. Not everything worked as planned before launch and a large amount of work was necessary to correct some defects of the camera or to improve the geometric registration of images. This article establishes the image quality VM01 final assessment including the presentation of radiometric and geometric calibration methods, the estimation of instrument performances and their associated temporal stabilities and the monitoring activities. In addition, it highlights the whole mechanism of data programming, reception and production. The end of VM01 phase is not the end of the VENµS mission, and a new phase started on a one-day repeat orbit.

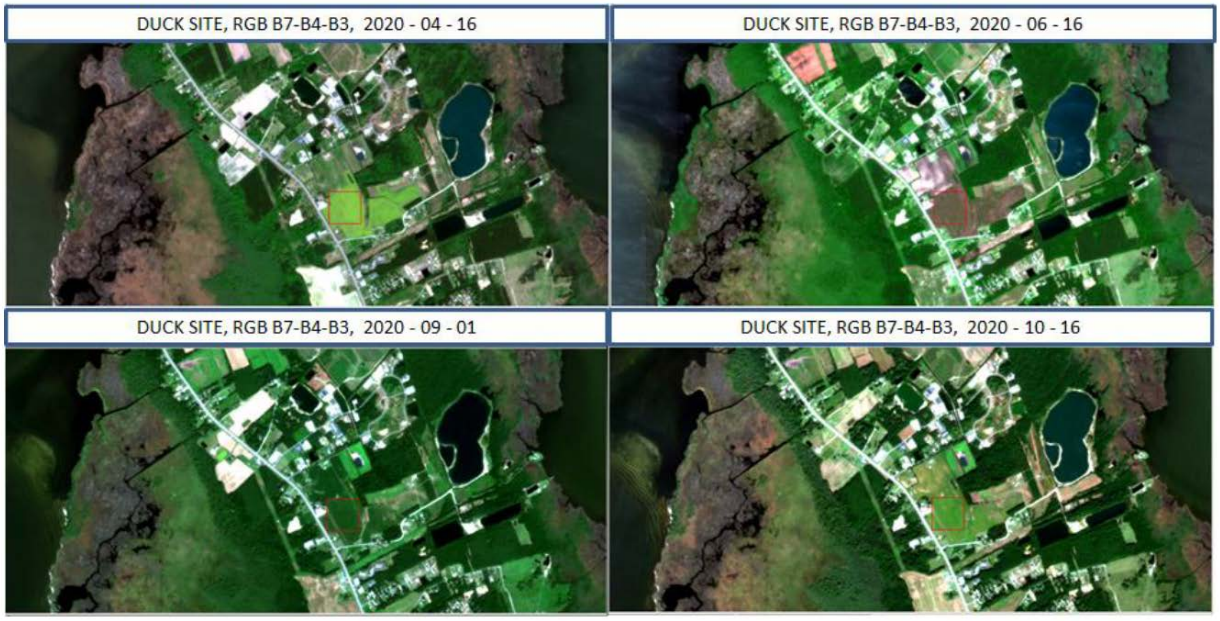


Fig. 3: DUCK site, example of the same area on Level-3 products at four different dates.

For more details, contact Arthur Dick arthur.dick@cnes.fr

3.2 SEN2VENµS, a Dataset for the Training of Sentinel-2 Super-Resolution Algorithms

Michel, J., Vinasco-Salinas, J., Inglada, J. and Hagolle, O. (2022) SEN2VENµS, a dataset for the training of Sentinel-2 super-resolution algorithms. *Data.* **7**, 96. DOI10.3390/data7070096.

Abstract: Boosted by the progress in deep learning, Single Image Super-Resolution (SISR) has gained a lot of interest in the remote sensing community, who sees it as an opportunity to compensate for satellites' ever-limited spatial resolution with respect to end users' needs. This is especially true for Sentinel-2 because of its unique combination of resolution, revisit time, global coverage and free and open data policy. While there has been a great amount of work on network architectures in recent years, deep-learning-based SISR in remote sensing is still limited by the availability of the large training sets it requires. The lack of publicly available large datasets with the required variability in terms of landscapes and seasons pushes researchers to simulate their own datasets by means of downsampling. This may impair the

applicability of the trained model on real-world data at the target input resolution. This paper presents SEN2VENµS, an open-data licensed dataset composed of 10 m and 20 m cloud-free surface reflectance patches from Sentinel-2, with their reference spatially registered surface reflectance patches at 5 m resolution acquired on the same day by the VENµS satellite. This dataset covers 29 locations on earth with a total of 132,955 patches of 256 x 256 pixels at 5 m resolution and can be used for the training and comparison of super-resolution algorithms to bring the spatial resolution of 8 of the Sentinel-2 bands up to 5 m.

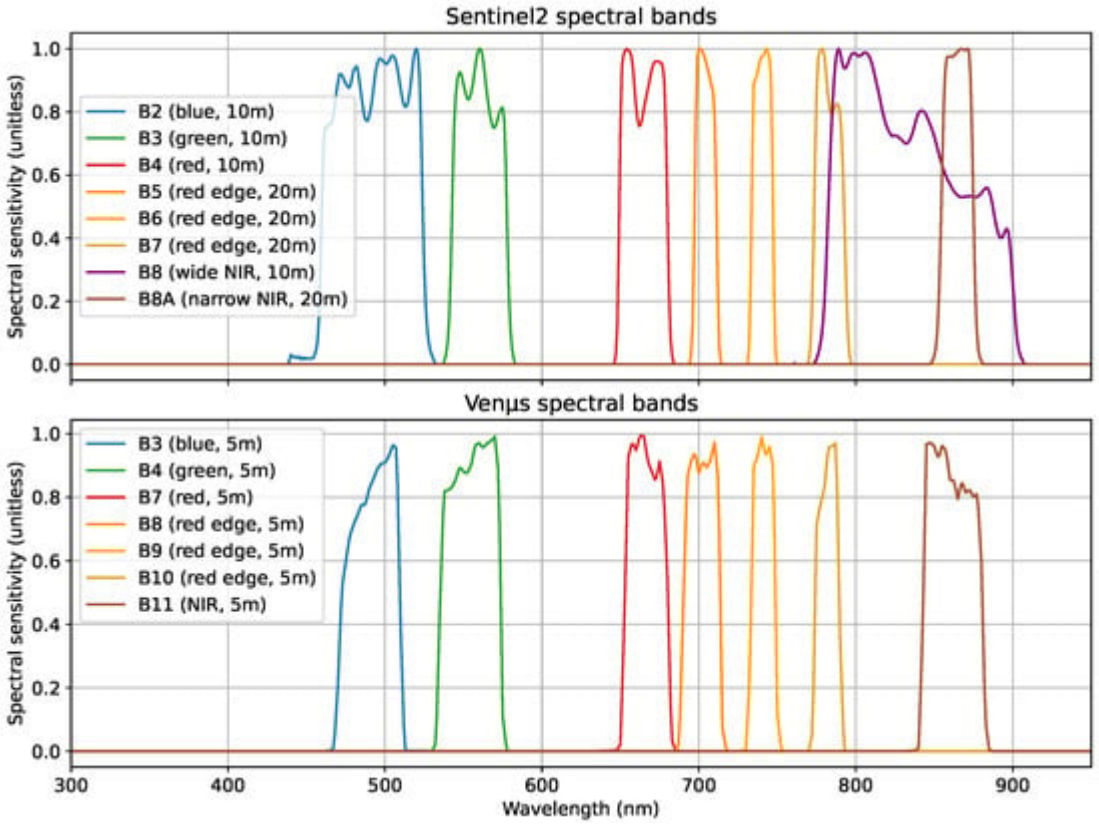


Fig. 4: Spectral sensitivity response of corresponding spectral bands between Sentinel-2 (top) and VENµS (bottom).

For more details, contact Julien Michel julien.michel@cesbio.cnes.fr

3.3 Multi-spectral edge detection for enhanced extraction and classification of homogeneous regions in remotely sensed images

Braitbart M., Almog O. and Shoshany M. (2022) Multi-spectral edge detection for enhanced extraction and classification of homogeneous regions in remotely sensed images. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, **Volume XLIII-B3-2022**, XXIV ISPRS Congress (2022 edition), 6–11 June 2022, Nice, France.

Abstract: Mediterranean environments are characterized by high spatial and temporal heterogeneity due to their climatological, lithological, soil and vegetation geo-diversity and their high population density which cause growing land-use transformations at the rural-urban fringe. Remote sensing mapping and monitoring land cover in these environments under such conditions is a challenging task. Instead of the common per pixel approach we suggest combining application of an object-oriented classification

based on image objects separation through edge detection with unsupervised classification. The main elements of our methodology are: (1) separating image areas into vegetation/ non-vegetation regions utilizing NDVI threshold; (2) calculation of the spatial variance at different bands; (3) image objects extraction through enhancement of the differences between edge pixels and regions of homogeneity; (4) per-object classification for the homogenous areas; (5) overlaying large unclassified image areas by the results of ISODATA (Iterative Self-Organizing Data Analysis) unsupervised classification. Our methodology was applied on multi-spectral images acquired by the VENμS remote sensing system. The study area consists of a typical rural area in semi-arid climate regions undergoing increasing urbanization. Six test areas were selected representing different spatial combinations of natural/ planted forests, agriculture and built-up land-use/ land cover types. While bare fields were poorly classified, areas of low vegetation cover were classified with producer/user accuracies below 60%, built-up areas and roads, cultivated areas, shrublands and bata (dwarf-shrubs) and rocky areas gained good producer/ user classification accuracies.

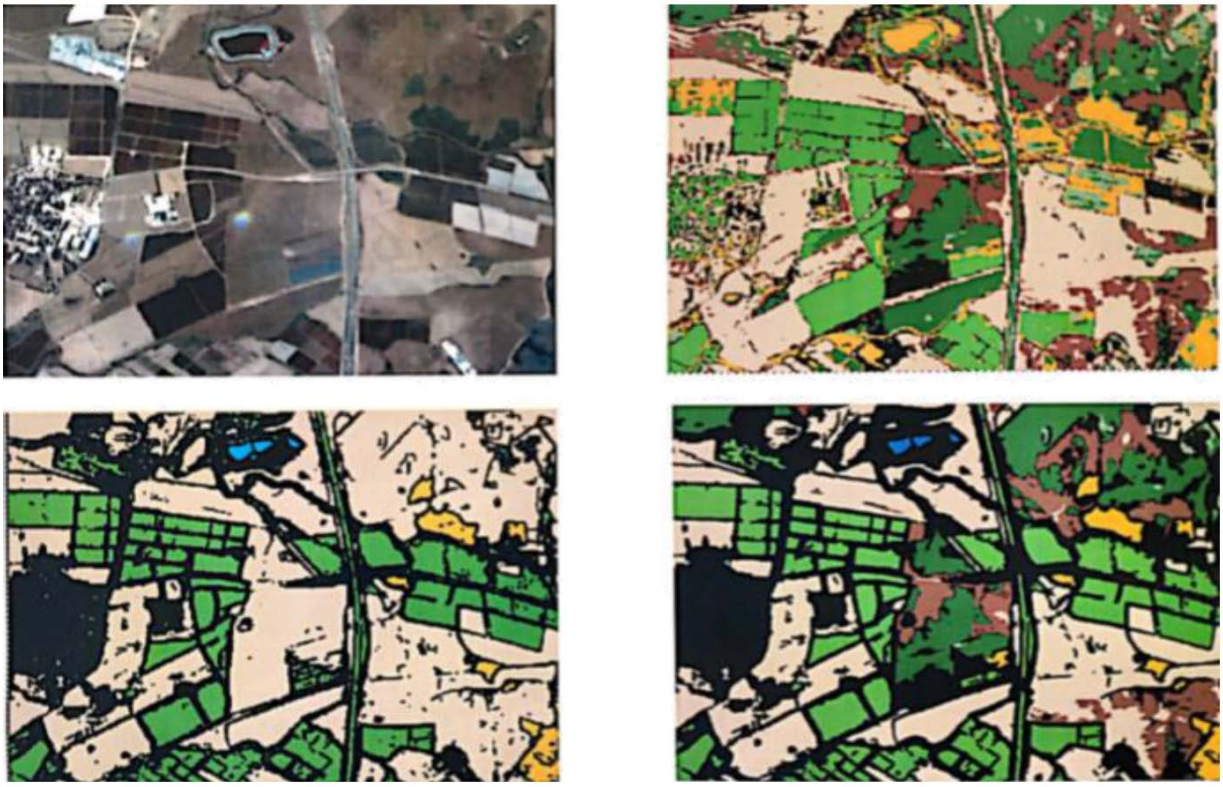


Fig. 5: Classification results for second test area. Original image (top left), edges based image classified per-object with ML classification (bottom left), ISODATA unsupervised classification for the original image (top right), final research result – edges based classified image including completion of missing areas using ISODATA (bottom right).

For more details, contact Maxim Shoshany maximsh@technion.ac.il.

4. Previous VENμS Newsletters

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

5. Unsubscribe

If you wish to unsubscribe from the future VENμS Newsletters, write an e-mail to karnieli@bgu.ac.il.

Best regards,

Manuel and Arnon

Ben Gurion University