VENµS
(VEGETATION AND ENVIRONMENT MONITORING ON A NEW MICRO SATELLITE)

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ABSTRACT

VENµS is an Earth observation demonstration mission developed in cooperation between FRANCE and ISRAEL. This dual mission gathers both a scientific mission (earth imaging) and a technological mission (Hall Effect Thruster). The scientific mission benefits from the unique features of the satellite, allowing innovative algorithms development. The technological mission will be the maiden flight of an electric propulsion device made in ISRAEL. VENµS is due to fly mid 2012.

1 - THE VENµS MISSIONS

1.1 - Scientific mission

Global models of biosphere processes and dynamics have been developed in the past few years and used for carbon cycle studies. Today, they are mainly based on ground measurements provided by networks of experimental stations. On the other hand, the water cycle is driving important research activities on the interface between land and atmosphere for improving atmospheric models. A major limitation of these approaches is the lack of consistent ground network and measurements and the imperfection of models. The development of Earth observation data assimilation techniques and aggregation or desegregation procedures is leading to more promising integrated approaches.

The main scientific objectives of the Earth observation mission for terrestrial environment monitoring are:

- to monitor and analyze surface functioning under the influence of environmental factors (climate, topography, soils etc.) as well as human activities;
- to study processes and their interactions with natural and human factors;
- to develop and validate natural and cultivated ecosystem functioning models and to improve and validate global carbon cycle models ;
- to develop remote sensing data assimilation techniques within vegetation and surface flux models ;
- to define theoretical and practical methods for scale transfer, i.e. up and downscaling ;
- to interpret data collected by those low spatial resolution sensors ;
- to develop, validate and implement integrated modeling platforms.

The uncommon feature of the VENµS scientific mission is the conjunction of the 4 following characteristics: 2 day revisit capability, high resolution (5.3m), spectral richness (12 bands: 415 nm to 865 nm) and constant viewing angles from the satellite at constant sun lighting angles (excluding sun seasonal variations). This unique combination will allow the development of new processing methods in order to benefit from high spatial and spectral resolutions as well as highly repetitive earth observations.

At least 50 selected sites of interest all around the world are currently being selected. They will be scanned throughout the duration of the scientific mission.

VENµS is also intended to demonstrate the relevance of such observation capabilities for the GMES program.

In order to image 2 season cycles in both hemispheres, VM1 duration will be 2.5 years, providing measurements over land surfaces.

The VENµS orbit will be sun-synchronous (720 Km, 98.28 °, 10:30 a.m. descending node), the repeat cycle will be 2 days with 29 orbits per cycle. The instrument swath allows 27 km*27 km individual images at nadir (images can be taken in series along the track, to allow large scenes imaging).

1.2 Technological mission

There are two main objectives to the technological mission: Hall Effect Thruster space verification and validation.

Verification is achieved by operating the thruster in space environment. Its performance will be tested and qualified. Validation will be demonstrated for some mission enhancements operations.

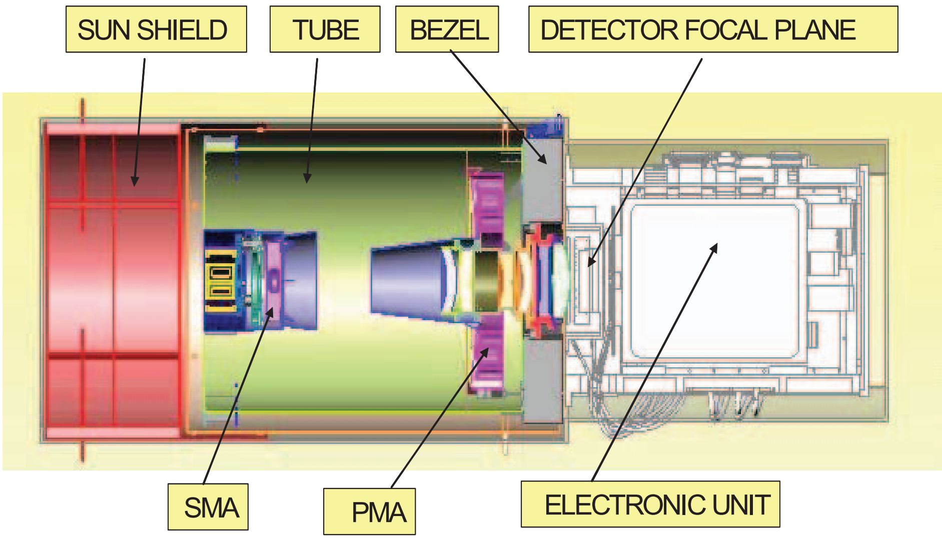
The technological mission is split into 3 parts:

- orbit maintenance and small experiments (combined with the Scientific mission)
- transfer to the low altitude orbit (from 720 Km SSO to 410 Km SSO)
- low altitude orbit keeping, compensating drag, while continuing to image as a secondary mission

2 - VENµS PAYLOADS

2.1 - Scientific mission payload description

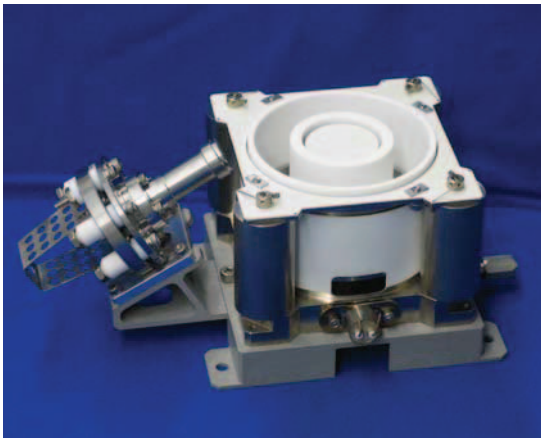
The VENµS Super Spectral Camera (VSSC) comprises a catadioptric objective, a focal plane assembly with narrow band filters and 4 detector units with 3 separate CCD-TDI (Time Delay Integration) arrays each, operating electronics, operational control and thermal control (operated by the satellite).



(1) Camera longitudinal section (ELOP).

2.2 - Technological mission payload description

The IHET thruster is specifically designed for use onboard micro satellites, operating nominally at only 300 W anode power. However, its useful range of operation is between 250 to 600W.



(2) The IHET engine (RAFAEL).

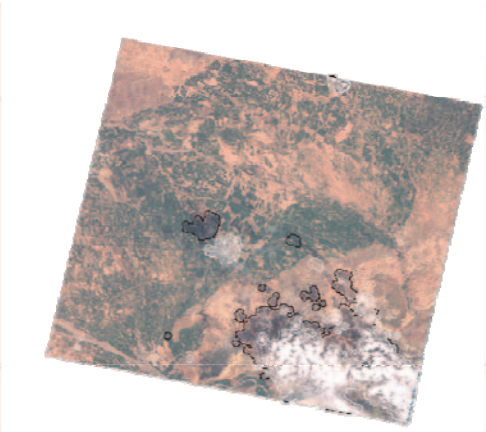
3 - VENμS IMAGES PRODUCTS

The ground processing centre provides 3 product levels:

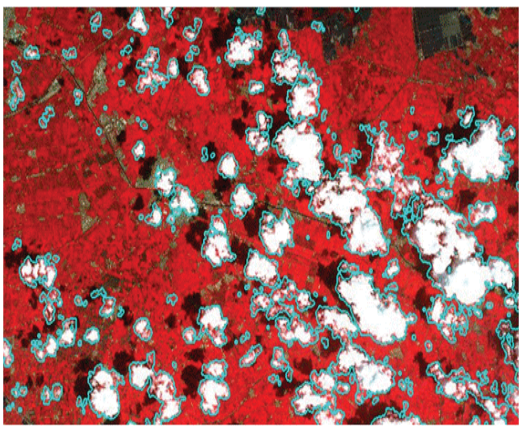
- The VENμS level 1 will provide geolocated top of atmosphere reflectances with a subpixel multi-date registration (requirement 3m);
- Level 2 provides surface reflectances ("Top of Canopy"). Its aim is to suppress as much as possible the atmospheric contribution to the signal. During this process, a high quality cloud and cloud shadow mask is generated.
- The level 3 product is a 10 day composite of level 2 products. The aim is to provide the users with cloud-free, easy to use images of surface reflectances, every 10 days.

The ground sampling distance of level 2 and 3 products will be 10 m, whereas level 1 products are delivered at 5 m resolution.

Clouds altitude detection uses the stereoscopic viewing feature of VENμS (simulations using FORMOSAT 2 images).



(3) Clouds detection by muti temporal analysis of the reflectances.



(4) Clouds altitude detection by stereoscopy.

(5) Level 1, level2, level 3 product simulations.

4 - REFERENCES

VENµS web site: http://smsc/VENUS/Fr/

[1] G. Dedieu, A. Karnieli, O. Hagolle, H. Jeanjean, F. Cabot, P. Ferrier, Y. Yaniv "VENµS : a joint French Israeli Earth observation mission with high spatial and temporal resolution capabilities, RAQRS II conference.

[2] J. Topaz, F. Tinto, and Olivier Hagolle. —The VENµS super-spectral camera." In Sensors, Systems, and Next-Generation Satellites X, 6361:63611E-8 presented at the Sensors, Systems, and Next-Generation Satellites X. Stockholm, Sweden: SPIE, 2006. http://link.aip.org/link/?PSI/6361/63611E/1

[3] F. Cabot, O. Hagolle, C. Ruffel, P. Henry, "Remote sensing data repository for in-flight calibration of optical sensors over terrestrial targets", SPIE proceedings, Vol. 3750, Earth Observing Systems IV, Denver, July 1999.

[4] O. Hagolle, Ph. Goloub, P. Y. Deschamps, Hélène Cosnefroy, X. Briottet, T. Bailleul, J.-M. Nicolas, F. Parol, B. Lafrance, M. Herman, "Results of POLDER in-flight calibration", IEEE Transactions on Geoscience and Remote Sensing, vol. 37, No 3, May 1999.

[5] Hagolle, O., G. Dedieu, B. Mougenot, V. Debaecker, B. Duchemin, and A. Meygret. —Correction of aerosol effects on multi temporal images acquired with constant viewing angles: Application to Formosat-2 images." Remote Sensing of Environment 112, no. 4 (April 15, 2008): 1689-1701.

[6] J. Inglada, H. Vadon, "Fine registration of SPOT5 and Envisat/ASAR images and ortho-image production: a fully automatic approach", IGARSS'05, Seoul, Korea , July 2005

[7] A. Meygret, M. Dinguirard, P. Henry, O. Hagolle, "Calibration of SPOT4 HRVIR and VEGETATION cameras over the Rayleigh scattering", SPIE, San Diego, august 2000.

[8] A. Meygret, "Absolute calibration: from SPOT1 to SPOT5", SPIE, San Diego, august 2005.