ENVISION AT VENUS: EUROPE'S NEXT MEDIUM-CLASS SCIENCE MISSION.

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Introduction: On June 10, 2021, the European Space Agency (ESA) announced the selection of EnVision as its newest medium-class science mission. Solar Orbiter, Euclid, Plato and Ariel have already been selected as Medium-class missions. EnVision [1, 2, 3] will deliver new insights into our neighboring planet's geological history through complementary imagery, polarimetry, radiometry and spectroscopy of the surface coupled with subsurface sounding and gravity mapping; it will search for thermal, morphological, and gaseous signs of volcanic and other geological activity; and it will trace the fate of key volatile species from their sources and sinks at the surface through the clouds up to the mesosphere. As a key partner in the mission, NASA provides the Synthetic Aperture Radar, VenSAR.

EnVision B/L mission scenario: The mission will launch in 2031 on Ariane 62. Following orbit insertion and periapsis walk-down, orbit circularisation will be achieved by aerobraking over a period of several months, followed by a nominal science phase lasting at least 6 Venus sidereal days (4 Earth years).

EnVision science payload: EnVision's science payload consists of VenSAR, a dual polarization S-band radar also operating as microwave radiometer, three spectrometers VenSpec-M, VenSpec-U and VenSpec-H designed to observe the surface and atmosphere of Venus and their couplings, and the Subsurface Radar Sounder (SRS), a High Frequency (HF) sounding radar to probe the subsurface. They are complemented by a radio science investigation which achieves gravity mapping and radio occultation of the atmosphere, for a comprehensive investigation of the Venusian interior, sub-surface, surface, lower atmosphere, upper atmosphere and their interactions.

The **Synthetic Aperture Radar**, **VenSAR**, will contribute to addressing the key science objectives of the mission. Designed and built by NASA's Jet Propulsion Laboratory, VenSAR is a reflectarray antenna consisting of a 5.8 m × 0.7 m reflector illuminated by 0.85 m feed separated by a distance of 2.75 m. It will image pre-selected Regions of Interest (RoIs) with resolution of 30 m/pixel and high resolution (10 m/px) across some RoIs in a nested dataset approach. Imaging will be essential for reconstruction of the surface stratigraphy thus revealing geological and chronological relations between surface units. Imaging at two incidence angles will allow reconstruction of surface topography as Digital Elevation Models (DEM) of selected terrains. Topography will also be measured globally by means of nadir altimetry. Surface emissivity and roughness will be derived from the imaging in HV and HH polarizations as well as passive radiometry. Comparison to Magellan, VERITAS and within the VenSAR data set will allow search for surface changes due to volcanic, tectonic and landscape forming processes from year to decade time scales.

The **Subsurface Sounder, SRS,** will be the first instrument to investigate the subsurface structure of Venus and acquire fundamental information on subsurface geology; it will characterize the vertical structure and stratigraphy of geological units including volcanic flows; and determine the depths of weathering and aeolian deposits. SRS will be the first instrument to profile the subsurface of Venus and thus will acquire fundamental information on subsurface geology by mapping the vertical structure (mechanical and dielectric interfaces) and properties of tesserae and their edges, plains, lava flows and impact craters and debris.

The **Venus Spectrometer suite, VenSpec,** will:

- Obtain global maps of surface emissivity in five wavelength bands in the near-infrared to constrain surface composition and inform evolution scenarios;
- Measure variations of SO_2, SO and chemically-related gaseous species in the mesosphere and nightside troposphere, in order to link these variations to atmospheric dynamics, chemistry and volcanism.

The **Radio Science** experiment will:

- Constrain crustal & lithospheric structure at finer spatial scale than Magellan;
- Measure spin rate and spin axis variations to constrain interior structure; and
- Measure spatial and temporal variations of H_2SO_4 liquid and vapor at 55-45 km.

References:

[1] Ghail R. C., Wilson, C., Widemann, T., Bruzzone, L., Dumoulin, C., Helbert, J., Herrick, R., Marcq, E., Mason, P., Rosenblatt, P., Vandaele, A. C., Burtz, L. J. (2016) EnVision M5 proposal, https://arxiv.org/abs/1703.09010

[2] EnVision mission website: www.envisionvenus.eu

[3] ESA's EnVision Assessment Study Report ("Yellow Book"): sci.esa.int/web/cosmic-vision/-/envision-assessment-study-report-yellow-book