

The VenSpec suite on the ESA EnVision mission – a holistic investigation of the coupled surface atmosphere system of Venus

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Abstract

The ESA EnVision mission will determine the nature and current state of Venus' geological evolution and its relationship with the atmosphere, to understand how and why Venus and Earth evolved so differently. Perched at the inner edge of the Sun habitable zone, Venus may once have been habitable, with liquid water oceans, before developing the enormous greenhouse warming which renders it uninhabitable today, thus providing a natural laboratory for studying the evolution of habitability. Venus is Earth's closest sibling geologically: similar in size to the Earth, it has remained active into the present era, unlike the much smaller Mars and Mercury. Venus is essential for understanding the links between planetary geophysical evolution and habitability of terrestrial planets from our own Earth to terrestrial planets and exoplanets everywhere, including those which will be the subject of study by PLATO and ARIEL missions in ESA's Space Science programme.

The VenSpec instrument suite is following the holistic approach of the EnVision mission by studying the coupled system of surface and atmosphere on Venus with three complementary instruments. In combination, VenSpec will provide unprecedented insights into the current state of Venus and its past evolution. VenSpec will perform a comprehensive search for volcanic activity by targeting atmospheric signatures, thermal signatures and compositional signatures, as well as a global map of surface composition. A joined VenSpec science team across the whole suite ensures that the synergies between the instruments are fully used.

VenSpec-U will monitor sulphured minor species (mainly SO and SO₂) and the as yet unknown UV absorber in Venusian upper clouds and just above. It will therefore complement the two other channels by investigating how the upper atmosphere interacts with the lower atmosphere, and especially characterize to which extent outgassing processes such as volcanic plumes are able to disturb the atmosphere through the thick Venusian clouds.

VenSpec-H will be dedicated to high resolution atmospheric measurements. The main objective of the VenSpec- H instrument is to detect and quantify SO₂, H₂O and HDO in both the troposphere and the mesosphere, to enable characterization of volcanic plumes and other sources of gas exchange with the surface of Venus, complementing VenSAR and VenSpec-M surface, SRS subsurface observations and VenSpec-U observations in the upper cloud layer.

VenSpec-M will provide near-global compositional data on rock types, weathering, and crustal evolution by mapping the Venus surface in five atmospheric windows. VenSpec-M take advantage of the improved altimetry provided by the NASA VERITAS VISAR and EnVision VenSAR-derived DEMs. VenSpec-M will monitor for H₂O abundance variations close to the surface complementing VenSpec-H observations. In combination with the observations provided by the identical VEM instrument on the NASA VERITAS mission VenSpec-M will provide more than a decade of monitoring for volcanic activity, as well as search for surface changes.