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To the depths of Venus: Salient deep atmosphere and surface science objectives achievable by Venus Express infrared maps and spectra

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ESA's Venus Express Mission presents a unique opportunity to chart the depths of Venus, revealing a plethora of surface and atmospheric properties never before observed by a Venus orbiter. Observations of these phenomena – mapped over both time and space on the planet – have the potential to effectively address fundamental questions on how the planet works, dynamically, chemically, and geologically. Two remote sensing instruments on board Venus Express – PFS and VIRTIS - will provide the clearest infrared views of Venus's deep atmosphere and surface yet attained. Peering at the planet's nightside, these instruments will observe near-infrared thermal radiation generated in the hot lower atmosphere and surface and attenuated by overlying molecular and aerosol absorption. Tracking backlit clouds in Venus' lower atmosphere, these instruments will for the first time regularly sample the cloud motions in the 57-km level altitude region, thus providing a new tool for assessing potential mechanisms responsible for the planet's enigmatic super rotation. When compared to (1) the motions of upper-level clouds observed in the UV by the VMC camera, and (2) the latitudinal temperature gradients obtained by radio occultations and thermal emissions near 4 and 11-16 microns, these cloud motions can potentially reveal where winds are out of cyclostrophic balance, and thus reveal the presence of localized dynamical processes perhaps important for powering super-rotation. Mapping of molecular species as observed via their absorption of thermal radiation in and around seven spectral windows between 0,85 and 2.5 microns will provide the deep-atmosphere and/or near-surface abundances of chemically-active trace species such as OCS, SO_2, and H_2O, important

for understanding the sulfur cycle. Surface observations in and around these windows can provide information on (1) surface emissivity and spectral properties, (2) atmospheric temperature gradients in the deepest 12 km altititudes, and (3) water abundance profiles there. In addition, active volcanism may be revealed via spatial and temporal anomalies in thermal emissions and trace species abundances. Based on our previous experiences with spacecraft missions to Venus – in particular, the Mariner, Galileo and Cassini flybys and the VEGA balloon missions - we are actively planning improvements in a variety of dynamical, chemical, and radiative transfer models and analysis techniques, as well as laboratory measurements of relevant molecular absorptions, in order to help achieve the optimum science return from Venus Express.