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THE LOVE MISSION: LONG-DURATION VENUS ATMOSPHERE PROBE FOR LIFE, HABITABILITY AND ATMOSPHERE STUDIES.

Abstract

The pursuit of exploring Venus' atmosphere has been challenged by the limited exposure to its potentially habitable zone by current and past missions. This prompts a lack of comprehensive in-situ temporal and spatial datasets, resulting in only a partial understanding of the Venusian atmosphere and its habitability that is based on incomplete historical data. This knowledge gap remains largely unaddressed by the scope of future planned missions as well. In response, this research introduces the Life On Venus Exploration (L.O.V.E.) mission, a Venus in-situ mission focusing on conservative designs that could be ready for an envisioned launch date of 2031.

The study demonstrates that a mission concept consisting of a pumped hydrogen balloon, and two smallsat relays in inclined orbits can provide long-duration in-situ measurements of the Venusian middle atmosphere in the equatorial region. The mission is designed to investigate habitability conditions, detect biomarkers, and study geophysical sources of these molecules, within the legacy budget constraints of ESA M-Class missions, projected at less than 530 million euros. Notably, it was found that the ability to repeatedly measure the lower, hotter part of the atmosphere is a major driver in the mission cost, and is therefore not addressed in this mission. Furthermore, modelling complexities in the hydrogen pump strongly impacted the accuracy of the power budget, critical for maintaining a dogtooth altitude profile.

Venus also provides a unique platform for understanding the source and effects of runaway greenhouse gases, offering a crucial opportunity to refine climate models on Earth. The L.O.V.E. mission not only embarks on an exploration to uncover the intricacies of our celestial counterpart, but also towards a better understanding of Earth's climate challenges. Additionally, by integrating sustainable exploration practices, the mission emphasises the potential for low-impact, high yield scientific endeavours in planetary sciences.