Revision of New Frontiers Goals for a Venus Mission

A White Paper for the Planetary Science and Astrobiology Decadal Survey 2023-2032

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Introduction:

The Venus community is excited that the past two Decadal survey committees [1,2] as well as the 2008 NRC report [3] have included recommendations for a New Frontiers mission to Venus. The six science mission objectives included in the Decadal reports were:

1. Understand the physics and chemistry of Venus's atmosphere, especially the abundances of its trace gases, sulfur, light stable isotopes, and noble gas isotopes;
2. Constrain the coupling of thermochemical, photochemical, and dynamical processes in Venus's atmosphere and between the surface and atmosphere to understand radiative balance, climate, dynamics, and chemical cycles;
3. Understand the physics and chemistry of Venus's crust;
4. Understand the properties of Venus's atmosphere down to the surface and improve our understanding of Venus's zonal cloud-level winds;
5. Understand the weathering environment of the crust of Venus in the context of the dynamics of the atmosphere and the composition and texture of its surface materials; and
6. Look for planetary-scale evidence of past hydrological cycles, oceans, and life and for constraints on the evolution of the atmosphere of Venus.

This list was so ambitious that the authors recognized that “achieving all of these objectives represents a flagship-class investment, but achieving a majority is considered feasible in the New Frontiers program” [2]. This mission was dubbed Venus In Situ Explorer (VISE).

The Case for Reformulation:

As described in the 2003 decadal document, the primary science objectives of this mission were to examine the physics and chemistry of Venus's atmosphere and crust. Advances in instrument technologies and mission capabilities over the past 18+ years now present compelling means to achieve overarching Venus science objectives without physically being “in situ” on the surface. The requirement for in situ concepts as described in the current Decadal survey is thus nearly two decades out of date. We encourage an emphasis on what science is achieved rather than on where it is done.

We now recognize that several different types of missions (e.g., orbiters at various altitudes, aerial platforms, deep probes, short- and long-lived landers) are all capable of producing crucial and transformational measurements. Particular needs with equal priority and urgency for measurements include but are not limited to the isotopic and chemical composition and dynamics of the atmosphere; surface–atmosphere physical and chemical interactions; high-resolution topography, global geomorphology, stratigraphic relationships, change detection, and gravity of the interior and surface; and the elemental and mineralogical composition of surface materials. Additional information about the science goals, objectives, and investigations for Venus as recommended by the Venus community are now clearly articulated [4].

Updated Goals for a Venus New Frontiers Mission:

After discussing this matter at in person (2019) and town hall forums, and in recognition of the community consensus, we propose on behalf of VEXAG and the Venus community that two new goals replace the six in the current “VISE” priority investigation. These new goals fully encompass the measurements we list above, and are of equivalent scientific importance to each other. They are:

1. *Examine the physics and chemistry of Venus to understand its current state and evolution, including past habitability.*

2. *Characterize the Venus surface–atmosphere interface and how it is shaped by physical and chemical processes.*

Achieving either of these goals would produce transformative science and justify an entire New Frontiers mission. Therefore, we propose that this New Frontiers priority be renamed simply “**Venus Explorer**” in recognition of the wide variety of modern mission types that can address important Venus science questions, and that missions be required to address only one of them fully.

References:

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- [3] National Research Council (2008) *Opening New Frontiers in Space: Choices for the Next New Frontiers Announcement of Opportunity*, The National Academies Press, Washington, D.C.
- [4] O’Rourke, J., and Treiman, A. et al. (2019) *Venus Goals, Objectives, and Investigations*, www.lpi.usra.edu/vexag/reports/VEXAG_Venus_GOI_Current.pdf

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