IN-SITU AERIAL EXPLORATION OF VENUS BY BALLOON - SCIENCE OBJECTIVES AND MISSION ARCHITECTURE. K.H. Baines[1], S. K. Atreya[2], D. Crisp[3], J. L. Hall[4], V. V. Kerzhanovich[5], S. S. Limaye[6], K. Zahnle[7], [1]Jet Propulsion Laboratory, California Institute of Technology (MS 183-601, 4800 Oak Grove Dr., Pasadena, CA 91109; kevin.baines@jpl.nasa.gov), [2] University of Michigan, Dept of Atmospheric, Oceanic, and Space Sciences (2455 Hayward St., Ann Arbor, MI 48109), [3]Jet Propulsion Laboratory, California Institute of Technology (MS 183-501, 4800 Oak Grove Dr., Pasadena, CA 91109), [4]Jet Propulsion Laboratory, California Institute of Technology (MS 82-105, 4800 Oak Grove Dr., Pasadena, CA 91109), [5]Jet Propulsion Laboratory, California Institute of Technology (MS 198-219, 4800 Oak Grove Dr., Pasadena, CA 91109), [6]University of Wisconsin-Madison, Space Science and Engineering Center (1226 West Dayton St., Madison, WI 53706), [7]NASA/Ames Research Center (M/S 245-3, Moffett Field, CA 94035).

Introduction: Following the trailblazing flights of the 1985 twin Soviet VEGA balloons, missions to fly in the skies of Venus have been proposed to both NASA's Discovery and ESA's Cosmic Visions programs, and are a key element of the recently-completed Venus Flagship Mission study. Such missions will answer fundamental science issues highlighted in a variety of high-level NASA–authorized science documents in recent years, including the Decadal Study, various NASA roadmaps, and recommendations coming out of the Venus Exploration Analysis Group (VEXAG). Such missions would in particular address key questions of Venus's origin, evolution, and current state, including detailed measurements of (1) trace gases associated with Venus's active photo- and thermo-chemistry and (2) measurements of vertical motions and local temperature which characterize convective and wave processes. As an example of what can be done with small class missions (less than $500 M), the Venus Aerostatic-Lift Observatory for in-situ Research (VALOR) Discovery mission concept will be discussed. Floating in Venus's rapid windstream near an altitude of 55 km, VALOR's balloon-borne science observatory will sample rare gases and trace chemicals and measure vertical and horizontal motions and cloud aerosols within Venus's dynamic middle cloud layer. The balloon will explore a variety of distinctive dynamical/meteorological regimes within Venus's energetic atmosphere as it drifts northward over several weeks from the convective temperate region through the wave-populated mid-latitudes and then poleward to the exceedingly cloudy north polar cyclonic vortex. The mission will test a variety of scenarios for the origin, formation, and evolution of Venus by sampling all the noble gases and their isotopes, especially the heaviest elements never reliably measured previously, xenon and krypton. Riding the gravity and planetary waves of Venus à la the VEGA balloons in 1985, the VALOR balloon would sample in particular the chemistry and dynamics of Venus's sulfur-cloud meteorology. Tracked by an array of Earth-based telescopes, all three components of winds - zonal, meridional, and vertical - would be measured with unprecedented precision over nearly all longitudes and over 40 degrees of latitude. Such measurements will help in developing our fundamental understanding of (1) the circulation of Venus, including the roles of waves and meridional motions in powering the planet's poorly-understood super-rotation, (2) the nature of Venus's sulfur cycle, key to Venus's current climate, and (3) how Earth's neighbor formed and evolved over the aeons.