Venus Atmospheric Maneuverable Platform (VAMP) – Future Work and Scaling for a Mission

S Warwick[1], F. Ross[2], D. Sokol[3]
[1,2,3] Northrop Grumman Aerospace Systems 1 Space Park, Redondo Beach, CA 90278 [1]steven.warwick@ngc.com, [2]floyd.ross@ngc.com, [3]daniel.sokol@ngc.com,

Introduction: Northrop Grumman Aerospace Systems has been developing an innovative and versatile new class of vehicle that will serve as an atmospheric rover for exploration of planets and moons of the solar system that have atmospheres. The new class of vehicle is called Lifting Entry Atmospheric Flight (LEAF), which provides a new way to enter an atmosphere from space and transition to flight within the atmosphere. Additionally, the LEAF system is semi-buoyant and the on-board propulsion system provides the capability to adjust altitude on command and travel in specified directions. It is also robust to failures since it can safely float at full buoyancy should it lose power. The LEAF system further reduces mission risk by deploying prior to entry at a relatively slow pace and gently enters the atmosphere.

A planet well-suited for exploration with a system such as LEAF is Venus. Our Venus atmospheric rover is called Venus Atmospheric Maneuverable Platform (VAMP). Over the past several years, we have been developing the VAMP concept that supports long duration instruments in the Venus atmosphere, providing empirical data to inform modeling of the atmosphere. We have identified three classes of VAMP vehicle that offer compelling missions in the Venus Atmosphere. These are sized for; a technical demonstration of concept; a mission ride along opportunity such as VENERA-D; and a Venus Flagship mission. Figure 2.

	Low Altitude (Small)	Mid Altitude (Mid-Size)	High Altitude (Large)
Float Alt	48 km	50 km	52 km
Minimum Power	100 w (day); 20 w (night)	300 w (day); 100 w (night)	8,000 w (day); 100 w (night)
Wing Span	6 m	30 m	59 m
Mass	90 kg including instruments	450 kg incl. 10 kg of instruments	880 kg incl. 50 kg of instruments
Tech	• Simple inflation-based deployment • TPS material for lifting entry • Sulfuric acid resistant skin material	• Mechanical plus inflation-based deployment • Autonomous navigation and hazard avoidance • Enhanced night time power • Limited propulsion capability	Next generation versions of pathfinder technologies

Figure 2. Low Risk VAMP Concepts

In this poster we discuss upcoming work to further mature the technologies of the VAMP platform, specifically in the areas of mission design, atmospheric entry profile, environmental exposure of the skin material, and buoyancy, inflation and control for operation at variable altitudes.

In addition we detail the Mid-Altitude vehicle that is well suited to being a companion to a Venus lander and orbiter mission such as VENERA-D. More specifically, we discuss various VAMP configurations and atmospheric science operations for this size of vehicle, and discuss potential instruments and how they can inform Venus' atmospheric models.