DYNAMIC SOARING FOR PERSISTENT VENUS UPPER ATMOSPHERE OBSERVATIONS. J. S. Elston[1], M. A. Bullock[2], M. Z. Stachura[1] and S Lebonnois[4], [1]Black Swift Technologies, 3200 Valmont Rd Ste 7, Boulder, CO 80301, elstonj@bst.aero, stachura@bst.aero, [2]Science and Technology Corp., 10015 Old Columbia Road E-250, Columbia, MD 21046, bullock@stcnet.com. [4]Laboratoire de Météorologie Dynamique, 24 rue Lhomond 75005 Paris, sebastien.lebonnois@lmd.jussieu.fr

Introduction: Although a majority of the proposed systems for upper atmospheric observations of Venus have consisted of dirigibles [1] or solar-powered heavier than air vehicles [2,3], both suffer from their own particular drawbacks and neither deal effectively with the high wind speeds. We propose a solution based on dynamic soaring, a proven method to extract energy from atmospheric shear that has propelled the fastest small-scale aircraft in the world, and provided for long-endurance low-level flights of birds across oceans [4]. An aircraft system will be designed to not only survive in the harsh wind environment of Venus, but also simultaneously perform targeted sampling while continuously extracting energy, even on the night side of the planet. The design will be based on proven dynamic soaring platforms, but will be constructed to allow deployment from a standard aeroshell.

Models and direct observation of the atmosphere of Venus have shown that the environment above the cloud layer is incredibly dynamic. Given that the upper cloud level of the atmosphere circles the planet roughly every 90 hours, any vehicle designed to operate in the proposed 50 to 60 km region will have a major power management challenge. An aircraft will either need to have sufficient battery capacity to continue functioning while traveling around the dark side of the planet, expend a large amount of energy to maintain position on the sunlit side, or make use of alternative methods to provide propulsive power to the system. Fortunately, the rapid movement of the atmosphere also creates locations conducive to energy harvesting. These ideal environments for the use of soaring techniques provide not only energy to maintain altitude, but sufficient wind-relative velocity to navigate to desired global locations. Large areas of the atmosphere on Venus contain characteristically high wind shear, particularly at the cloud interface[5,6] and above high elevation ground structures[7].

GCM Integration with Flight Path Modeling: Sophisticated Venus GCMs now exist that can produce predictions of the winds, thermodynamics, and chemistry at all altitudes, latitudes, longitudes, and local times of day. This presentation details the development of a simulation environment that makes use of the GCM output to test various complexities of atmospheric flight, including dynamic soaring algorithms. It has been designed to accommodate the inclusion of various vehicles, small scale atmospheric, and sensor models, as well as tie in directly to the output from the GCM for information about the thermodynamics of the local environment. It is envisioned that such a simulation could be extended to cover development of atmospheric vehicles for other locations including Mars or Titan.

VEXAG Goals: A long-lived aerial vehicle would be capable of performing all of the scientific investigations listed in the pursuit of VEXAG Goal II, except one (upper dynamics II.A.2) [8]. A long-lived vehicle would provide precise wind speeds in Venus' upper clouds over all times of day and at most latitudes. In situ sampling and analyses of the atmosphere and its aerosols over this large a geographic range will be far superior and more comprehensive than the snapshots that we have obtained so far with entry probes.

A mass spectrometer or tunable diode lasers could perform accurate noble gas and light element isotopes measurements (I.B.1) at many locations in the atmosphere. If fitted with a magnetometer and electric field sensor, the thermal state and possibly water content of the lithosphere (I.B.2) could be probed over a large fraction of the planet [9].

Carrying a near infrared camera, a Venus airplane that lingers in the clouds for weeks or months could also address most of the investigations suggested for achieving Goal III. Constant imaging of the surface from within the clouds at several wavelengths would provide higher resolution images than have been obtained by Venus Express or Akatsuki from orbit. An aerial vehicle could therefore map a large fraction of the surface at multiple near-IR wavelengths, enabling investigations III.A.1 (geologic history), III.A.2 (geochemistry), III.A.3 (geologic activity), and III.A.4 (crustal structure).

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