SUSTAINED *IN SITU* EXPLORATION OF VENUS' CLOUD DISCONTINUITY. M. A. Bullock[1], J. S. Elston[2], M. Z. Stachura[2], S. Lobonnois[3], [1]Science and Technology Corp., mbullock@stcnet.com, [2]Black Swift Technologies, 2840 Wilderness Pl Ste D, Boulder, CO 80301, melstonj@bst.aero, mstachura@bst.aero. [3]Laboratoire de Météorologie Dynamique, Paris, msebastien.lebonnois@lmd.jussieu.fr.

Introduction: Direct sampling and analysis of Venus' clouds and atmosphere are necessary for understanding how cloud processes, radiation, and dynamics are coupled on that planet. We discuss how an aircraft can harvest energy in Venus' atmosphere for sustained flight and perform *in situ* scientific experiments around the planet.

Flight in the Clouds of Venus. By dipping into and out of the shear layer at around 60 km, a moderately efficient aircraft can stay aloft in Venus' atmosphere without expending energy, much the way an albatross can cross the ocean without flapping its wings. The horizontal winds and vertical shear in Venus' atmosphere, from the IPSL Venus GCM at the equator, at midnight [1], is shown in Fig. 1. The red dashed line marks the vertical shear that is necessary for propulsionless dynamic soaring for an aircraft with a ratio of coefficient of lift to coefficient of drag of about 50. Our design achieves a C_L/C_D of ~70. The shear layer at 60 km is present at all times of day at low latitudes, with shear strengths of > 10 m/s-km.

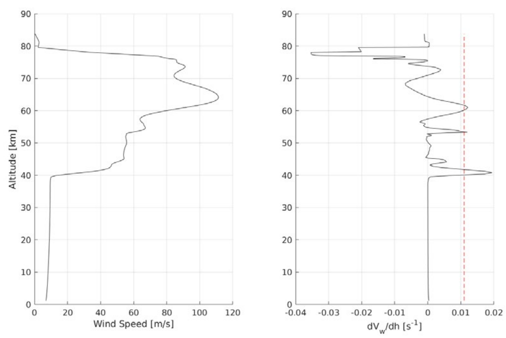

Figure 1. IPSL GCM winds and vertical shear at midnight at the equator, as functions of altitude. The red dashed line marks the shear that is necessary for propulsionless dynamic soaring for an aircraft with a C_L/C_D of 50.

Venus' Cloud Discontinuity. One special region of Venus' atmosphere is shown in Fig. 3, where a long-lived cloud discontinuity has developed, propagating faster than the superrotation [2].

[3] retrieved the cloud base altitude, aerosol acid mass fraction, below-cloud H_2O and CO, and the ratio of large to small particles on either side of the discontinuity, using VIRTIS-M spectral image cubes and the radiative transfer methods of [4]. They found a rapid decrease in the cloud base, H_2O mixing ratio, and size parameter as the discontinuity front passed by. At the same time, the acid mass fraction increased across the discontinuity. These authors hypothesized that the discontinuity is caused by the passage of a 4.9 day Kelvin wave, causing an increase in the lower cloud thickness, lowering of the cloud base, and entrainment of small, acidic aerosols. The H_2O vapor abundance below the clouds also decreased as the front passed, consistent with its transport up into the clouds by the upwelling.

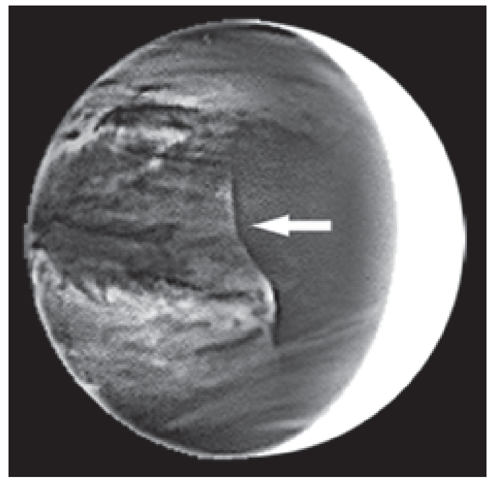

Figure 2. Lower cloud discontinuity from 2.26 µm images of the night side of Venus [2].

Scientific Payload. A dynamic soaring glider could stay aloft indefinitely, transecting the cloud discontinuity and characterizing the cloud particles and atmospheric gases across the cloud discontinuity. A minimal but scientifically useful payload would consist of atmospheric structure (pressure, temperature, accelerometers) and MEMS chemical sensors for parts-per-billion measurements of atmospheric gases. A single chip ultrastable oscillator would enable the accurate determination of position, using radio techniques from either Earth-based radio dishes or a relay probe in orbit around Venus. Such a payload would be ideal for the mass-constrained payload of a Venus aircraft. Together, these relatively powerful sensors would weigh less than a kilogram and consume less than 2 Watts. Our point design, with a 3 m wingspan, could carry a payload of up to 10 kg.

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