A Self-Sustaining, Boundary-Layer-Adapted System for Terrain Exploration and Environmental Sampling

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This proposal describes a revolutionary system for remote terrain exploration and environmental sampling on worlds with dense atmospheres, such as Titan and Venus. This system addresses several visionary challenges enumerated by NASA's Office of Space Flight in the broad category of Surface Exploration and Expeditions. The proposed system is entirely self-sustaining, extracting energy from the planetary boundary layer for both energy renewal and efficient locomotion. The system consists of three major components: a fleet of rechargeable, internally actuated, buoyancy-driven gliders which are programmed to soar at extremely low altitudes; a tethered, high-altitude, oscillating wing whose motion is tuned to extract maximum wind energy; and an attached, low-altitude docking station to inductively recharge the gliders, upload science data, and download revised mission commands. While the proposed system concept is novel in both form and mode of operation, the enabling technologies already exist or are current topics of applied research. Thus, while the proposed system is innovative and ambitious, it also appears quite feasible. If so, the proposed system could revolutionize the way other worlds are explored. Rather than deploy one or a few independent vehicles with short lives, future robotic exploration missions will deploy fleets of rechargeable explorers along with a distribution of power and communication nodes. The long-term impact will be that foreign environments, including the Venusian atmosphere, the oceans of Earth, the atmosphere and ethane lakes of Titan, and perhaps even the ice-covered oceans of Europa may be thoroughly instrumented and studied by future scientists.

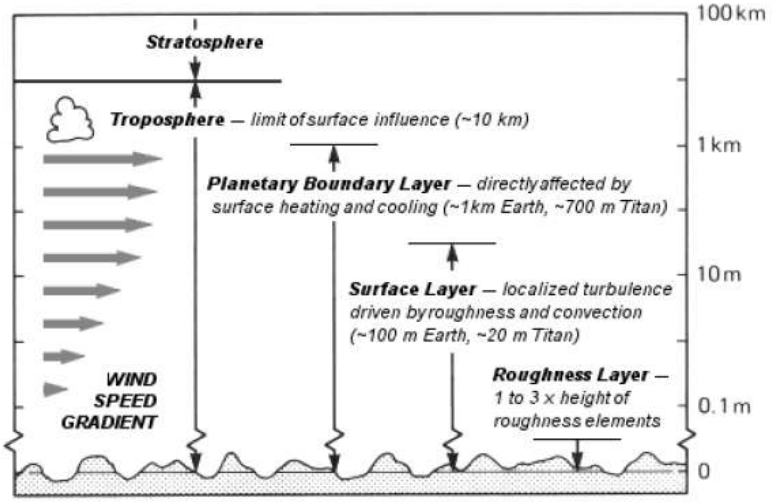

Figure 1: Representative sketch of a planetary boundary layer (PBL).

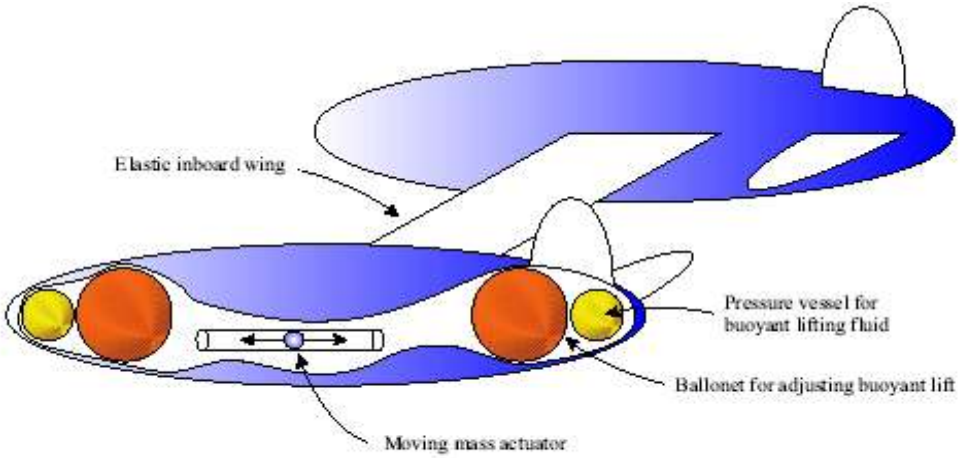

Figure 2: Sketch of internal actuation scheme for SCALARS.