Aerial Mobility : The Key to Exploring Titan's Rich Chemical Diversity. R. D. Lorenz[1], E. P. Turtle[1], and J. W. Barnes[2], [1]Johns Hopkins Applied Physics Laboratory, Laurel MD 20723 (Ralph.Lorenz@jhuapl.edu, Elizabeth.Turtle@jhuapl.edu,), [2]Department of Physics, Univ. of Idaho, Moscow ID 83844 (jwbarnes@uidaho.edu).

Introduction: Water is the medium for life, but organic chemistry is what makes it work. Titan offers complex carbon-rich chemistry in abundance on an ice-dominated ocean world. However, the most astrobiologically interesting sites need mobile *in situ* exploration, much as rovers are performing at Mars. Titan's thick atmosphere and low-gravity environment facilitates regional mobility to home in on the specific locations where liquid water and abundant organics have interacted.

Well-Established Titan Exploration Priorities: Long before *Cassini* arrived, it was recognized by predecessors to Decadal Surveys (for example the Campaign Strategy Working Group (CSWG) on Prebiotic Chemistry in the Outer Solar System [1,2]) that Titan's rich organic chemical environment provides a unique opportunity, and development of Titan mobile aerial exploration was identified as a desirable next step. Chemical environments of particular interest at Titan are areas such as impact melt sheets and potential cryovolcanic flows where transient liquid water may have interacted with the abundant (but oxygen-poor) photochemical products that litter the surface [3].

Early Titan studies emphasized airships and balloons, but access to surface materials combined with the required capability for sophisticated *in situ* chemical analysis presented a severe challenge to such vehicles. Thus, the 2007 Titan Explorer Flagship study [4] advocated a Montgolfière balloon for regional exploration, providing surface imaging at resolutions that are impossible from orbit due to the thick atmosphere, but assigning surface chemistry investigation and interior structure exploration via seismology (to characterize the ice thickness above Titan's internal water ocean) to a Pathfinder-like lander, notionally to land in the equatorial organic-rich dunefields.

Although Titan's hydrocarbon seas are an appealing target, and presented an exciting and cost-effective mission opportunity for the Titan Mare Explorer (TiME) capsule in the 2010 Discovery competition, the Titan northern winter season in the 2020-2030s precludes Earth view and thus direct-to-Earth communication, so affordable missions are not possible in this time frame. Furthermore, while the opportunities in physical oceanography and the intriguing but uncertain prospects of chemical evolution in a nonpolar solvent are significant, the environments that offer the most likely prospects for the most advanced chemical evolution as we understand it today are on Titan's land surface. While the dune sands themselves (as articulated in the 2007 Flagship study [4]) may represent a 'grab bag' site of materials sourced from all over Titan (much as the rocks at the Mars Pathfinder landing site were intended to collect samples from a wide area) and thus may contain aqueously altered materials, as in the exploration of Mars the approach with the lowest scientific risk would be to obtain samples directly from multiple locations, desirably informed by context information at higher resolution than that afforded by *Cassini* data. However, the limited range of surface rovers and the uncertain trafficability of Titan's surface makes either multiple landers, or a relocatable lander, the most desirable option.

Aerial Mobility: Heavier-than-air mobility at Titan is in fact highly efficient [5], moreover, improvements in autonomous aircraft in the two decades since the CSWG make such exploration a realistic prospect. Multiple *in situ* landers delivered by an aerial vehicle like an airplane [6] or a lander with aerial mobility to access multiple sites, would provide the most desirable scientific capability, highly relevant to the themes of origins, workings, and life.

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