Test operation of the Altaeros BAT in 2013
3D printed model of the 2013 Altaeros BAT undergoing flight characterization in the UNC-Charlotte water channel.
Over the past four years, researchers at the University of North Carolina at Charlotte, University of Michigan, and Altaeros Energies have developed a lab-scale platform for characterizing the flight dynamics and control of airborne wind energy (AWE) systems. This work started in 2013 with a lab-scale, water channel-based system for characterizing passive flight dynamics. The system was enhanced in 2014 to support closed-loop control and was further augmented in 2015-2016 with additional image processing and control features that allowed for the demonstration of crosswind flight. This presentation will review the evolution of this lab-scale platform, discuss the dynamic scaling results that relate lab- and full-scale flight behavior, and review recent successful efforts to emulate crosswind flight at lab-scale.

The lab-scale system described herein began as a simple platform for qualitatively assessing the performance of the Altaeros Buoyant Airborne Turbine (BAT), as described in [1] and [2]. In 2015, this system was augmented to incorporate closed-loop control, still under stationary operation [3]. Recently, we have shown in [4], using dimensional analysis (via the Buckingham Pi Theorem) that these lab-scale results correlate with full-scale flight results, with the only difference being uniformly accelerated time constants at lab-scale. Finally, we have recently extended our lab-scale framework and dynamic similarity analysis to accommodate crosswind flight, as initially disclosed in [5]. In fact, the dynamic similarity results from [4] have been extended to crosswind flight as well. Furthermore, these dynamic similarity results have been corroborated through validation experiments at multiple model scales. This presentation will review (i) the state of the UNC-Charlotte experimental platform, (ii) the dynamic similarity analysis, and (iii) the validation experiments used to corroborate the results of this analysis.

References: