Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Unsteady Aerodynamics of "Roll-Tacking" in Olympic Class Sailboats RILEY SCHUTT, CHK WILLIAMSON, Cornell University — When tacking a sailboat (turning a boat through the wind during upwind sailing), racers employ a "roll-tacking" technique. During a roll-tack, sailors use body weight movements to roll the boat through extreme angles of heel. This contrasts with a flat-tack, where the boat remains upright throughout the turn. The dynamic heeling motion of a roll-tack causes the sail to vigorously sweep through the air, resulting in large-scale vortex shedding and increased propulsion. In this research, we use a characteristic roll-tack motion derived from on-the-water data. On-the-water data is collected from a full-scale Olympic racing boat sailed by a national champion in the Laser sailboat class. Using this data, we run a series of representative experiments in the laboratory. Two dimensional flexible sail extrusions are built using rapid-prototyping and are tested in a three degree-of-freedom (X, Y, and theta) towing tank. Particle Image Velocimetry and force measurements are used to compare vortex dynamics and propulsive forces generated by roll-tacks versus flat-tacks. An increase in thrust observed during roll-tack tests agrees with on-the-water experiments, which show a racing advantage greater than one boatlength when a roll-tack is performed relative to a flat tack.

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Date submitted: 31 Jul 2015 Electronic form version 1.4