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Disturbances to Air-Layer Skin-Friction Drag Reduction at High Reynolds Numbers[1] DAVID DOWLING, BRIAN ELBING, SIMO MAKI-HARJU, ANDREW WIGGINS, MARC PERLIN, STEVEN CECCIO, University of Michigan — Skin friction drag on a flat surface may be reduced by more than 80% when a layer of air separates the surface from a flowing liquid compared to when such an air layer is absent. Past large-scale experiments utilizing the US Navy's Large Cavitation Channel and a flat-plate test model 3 m wide and 12.9 m long have demonstrated air layer drag reduction (ALDR) on both smooth and rough surfaces at water flow speeds sufficient to reach downstream-distance-based Reynolds numbers exceeding 100 million. For these experiments, the incoming flow conditions, surface orientation, air injection geometry, and buoyancy forces all favored air layer formation. The results presented here extend this prior work to include the effects that vortex generators and free stream flow unsteadiness have on ALDR to assess its robustness for application to ocean-going ships. Measurements include skin friction, static pressure, airflow rate, video of the flow field downstream of the injector, and profiles of the flowing air-water mixture when the injected air forms bubbles, when it is in transition to an air layer, and when the air layer is fully formed. From these, and the prior measurements, ALDR's viability for full-scale applications is assessed.

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