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Flapping, wobbling, and zig-zagging: Tomographic PIV measurements of Antarctic sea butterfly "flying" underwater D. ADHIKARI, D.R. WEBSTER, J. YEN, Georgia Tech — A portable tomographic PIV technique was used to study the fluid dynamics and kinematics of sea butterflies in Antarctica. Antarctic pteropods (or sea butterflies), which are currently threatened by ocean acidification, swim in seawater with a pair of gelatinous parapodia (or "wings") via a unique propulsion mechanism. Both power and recovery strokes propel the organism (1.5 – 5 mm in size) upward in a sawtooth-like trajectory with average speed of 14 – 30 mm/s and pitch the shell forwards-and-backwards at 1.9 – 3 Hz. The pitching motion effectively positions the parapodia such that they stroke downward during both the power and recovery strokes. Reynolds numbers defined for flapping, translating, and pitching (i.e. Re_f, Re_U, and Re_Ω) characterize the motion of the pteropod. For Re_f <50, the shell does not pitch and the pteropod swims abnormally. We present a detailed comparison of the volumetric fluid velocity fields induced by pteropods swimming upwards with $Re_f = 80$ and 180. The pteropod at the lower Re_f creates an attached shear flow along the parapodia and pushes fluid in a method analogous to a paddle. In contrast, at higher Re_f, the flow along the parapodia separates and generates complex vortex structures.

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