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On the quasi-one dimensional structure of the cellular detonation in a two-dimensional duct C.M. UYEDA, M. KUROSAKA, A. FERRANTE, William E. Boeing, Dept. of Aeronautics & Astronautics, University of Washington, Seattle — We performed numerical simulations of cellular detonations in a 2D duct to establish the validity of the one-dimensional ZND model. The detonation was simulated by solving the Euler equations with a WENO-TCD numerical method using adaptive mesh refinement and a detailed chemical reaction mechanism. The results show that the properties of the ZND model of a $2H_2$-O_2-7Ar reaction are very close to the results of the simulations initiated using three different methods for the area-averaged properties and the properties of particles tracked along their pathlines. Disagreements between the particle properties and the ZND model are greatest near the detonation front where the transverse wave and Mach stem introduce larger jumps in the flow properties than the ZND model predicts. The particle pathlines also exhibit a quasi one-dimensional motion downstream from the detonation front which is supported by the quick decay in the particles' velocity ratio of the vertical to horizontal velocity components, in the reference frame attached to the detonation front. These findings show the quasi one-dimensional nature of 2D detonations and the applicability of the ZND model.

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