

Supplementary Materials  
of  
**Dynamical Behavior of Small-Scale Buoyant  
Diffusion Flames in Externally Swirling Flows**

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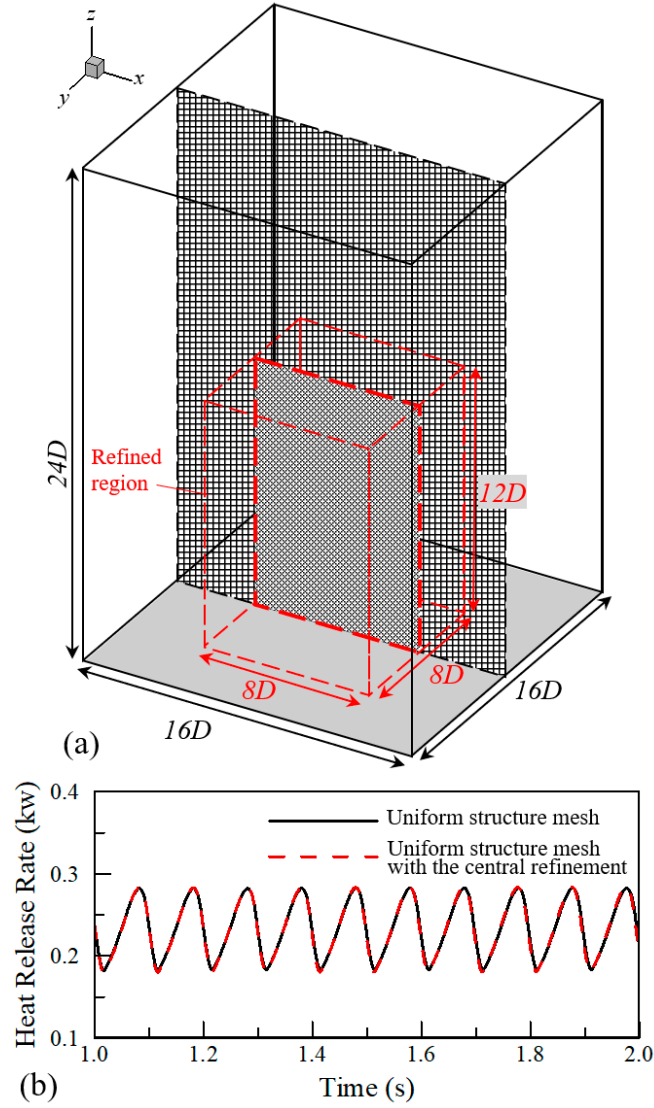


Figure S1. (a) The local mesh refinement in the central region ( $8D \times 8D \times 12D$ ) of the computational domain ( $16D \times 16D \times 24D$ ). (b) The heat release rate of the flickering flame (benchmark case) varies with time. The black solid line indicates that the uniform structure mesh of  $160 \times 160 \times 240$  is used, where each grid has the size of  $\Delta\hat{x} = \Delta\hat{y} = \Delta\hat{z} = 10^{-2}$ . The red dashed line corresponds to the mesh with the central refinement, where the grid size of  $\Delta\hat{x} = \Delta\hat{y} = \Delta\hat{z} = 5 \times 10^{-3}$  is used.

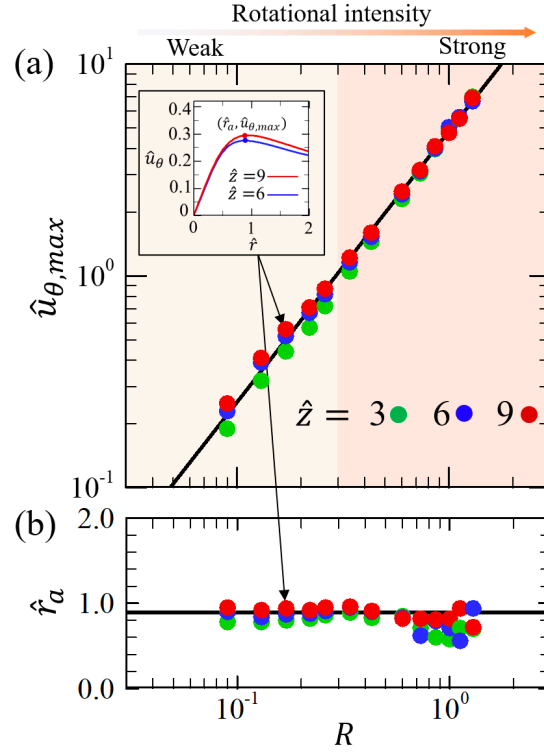


Figure S2. (a) The maximum azimuthal velocity  $\hat{u}_{\theta, max}$  and (b) the radial location  $\hat{r}_a$  of vortex cores generated at different  $R$ . The inset figure shows the radial profiles of azimuthal velocity  $\hat{u}_\theta$ .

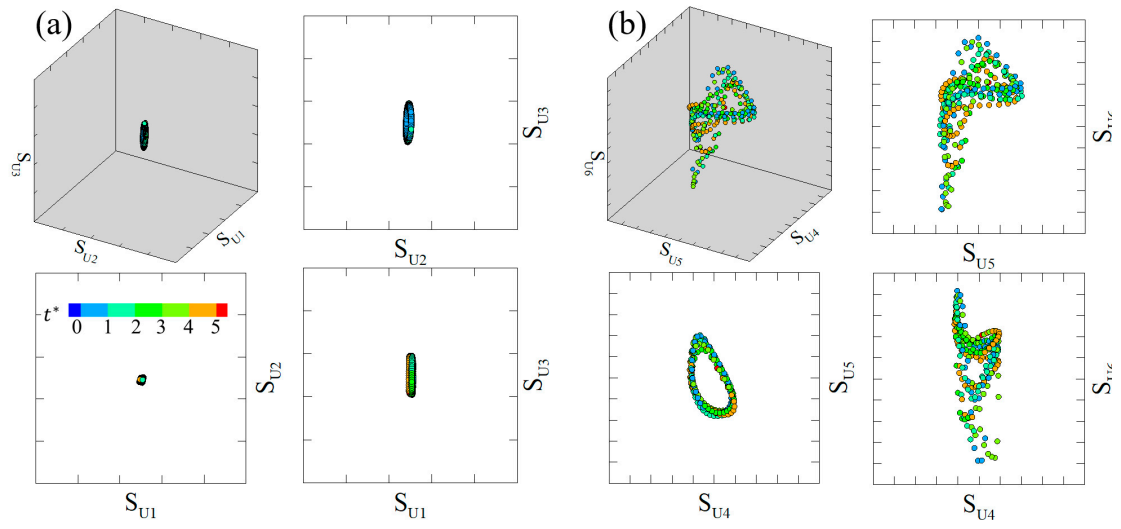


Figure S3. Three-dimensional phase portraits and their two-dimensional projections in the upstream (a) and downstream (b) regions for the spiral flame in Fig.14 (c) and (d).