1. Time Evolution of Thermal Plumes in a Three-dimensional Enclosure Due to Heating from below at Rayleigh Number = 1.06×10^6

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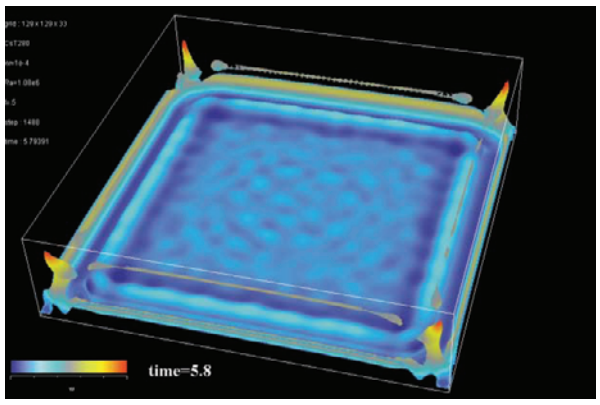

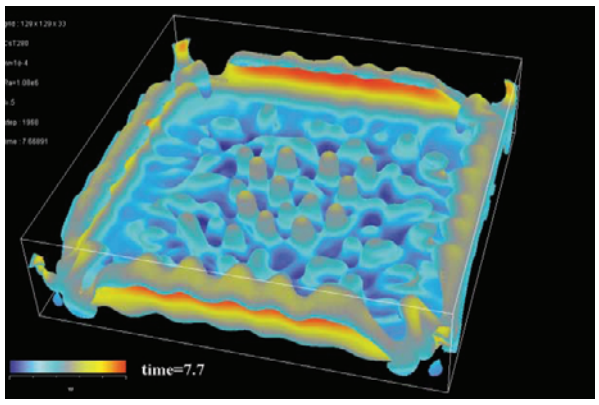

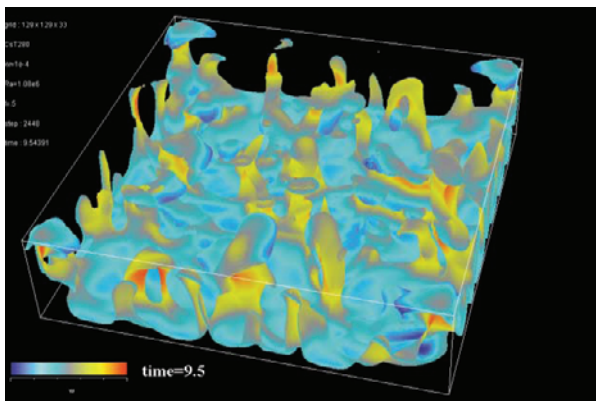

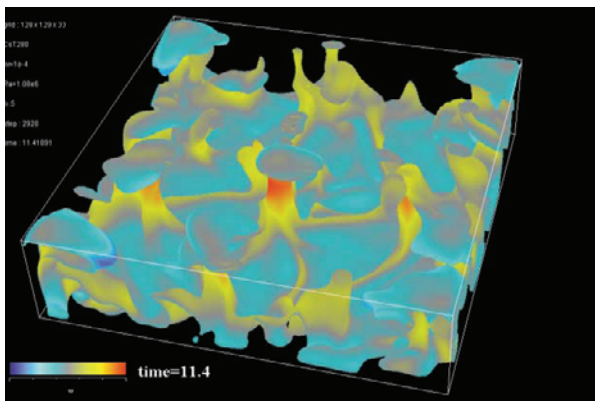

The figures show the time evolution of an isothermal surface (280 K) in a three-dimensional enclosure. Rayleigh number is estimated 1.06×10^6 based on the height of the enclosure. The value of the vertical velocity (w-component) is used for color-shading. Initially, the fluid is of rest and isothermal ($T_{initial}$ = 273 K). At t = 0, a vertical differential temperature ($\Delta T = T_{bottom} - T_{top}$, $T_{top} = 273$ K, $T_{bottom} = 293$ K) is imposed while other walls are kept under adiabatic conditions. At all walls, the no-slip condition is imposed. To reproduce the flow field, the Navier-Stokes equations are solved using the multi-directional third-order upwind finite-difference method in an uniform rectangular mesh system (128 $\times 128 \times 32$ grids), while the buoyancy force is modeled by Kuwahara's approximation.