Numerical approach for the deceleration process of laminar starting plume

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Heat is almost conveyed by the thermal starting plume in well-developed, high Rayleigh-number natural convection. Rising velocity of the plume head determines the time scale of the unsteady thermal convection system such as Earth's mantle.

The purpose of this study is to clarify how velocity of the plume head is determined. Starting laminar plume is composed of a leading spherical head and a following cylindrical tail. Rising velocity of the head mainly depends on the entrainment rate of the ambient fluid, thermal diffusivity and heat supply from its tail. In the case of the plume driven by the point heat source, velocity profile is well-studied (Kaminski and Jaupart, 2003). In that case, the plume head has almost constant rising velocity determined from Stokes' law after the initiating acceleration.

In this presentation, we conducted the numerical experiment of the starting plume in temperature dependent viscosity heated from finite-sized heater. Scale of the heater size adds the new length scale on the plume. Our research shows rapid decrease after the peak velocity. However, that deceleration is also consistent with Stokes' law.