Unusual thermal convection in a well-mixed fluid

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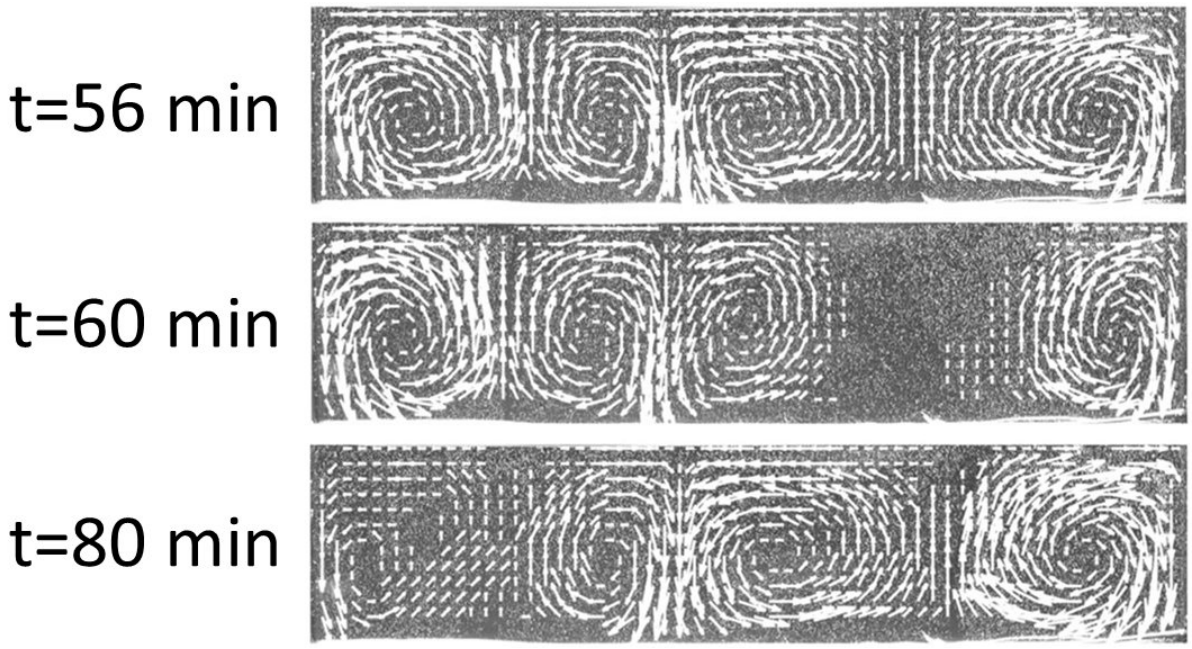

Pattern evolution during thermal convection in a mixture of two silicone oils, with viscosities 1cs and 100cs. An immobile region is formed and the macroscopic flow of the entire system changes drastically. Because temperature-dependence on viscosity is very small, a pillar-shaped stagnant domain is formed over the whole region where the fluid wells upwards. Credit: Kazuya U. Kobayashi and Rei Kurita

Researchers from Tokyo Metropolitan University, have recently discovered unusual thermal convection in a uniform mixture of high-

and low-viscosity liquids. Kobayashi and Kurita found that concentration fluctuations are enhanced by thermal convection when the two liquids have a large viscosity difference. Such mixtures are ubiquitously observed in nature, daily life, and manufacturing processes e.g. mantle convection, syrup, polymer products. These results promise further insight into non-equilibrium phenomena in fluid mixtures with contrasting "thickness."

When a fluid is heated from below, thermal convection is usually driven by a density difference. Kobayashi and Kurita found that immobile regions are transiently formed during thermal convection in well-mixed two component liquids with a large viscosity difference. They investigated the convection patterns and dynamics using several different combinations of liquids. They concluded that the viscosity difference is one of the most important factors for the formation of these static regions. This suggests that the viscosity difference plays an important role in non-equilibrium phenomenon in fluid mixtures, such as in the dynamics of convection in the mantle, mixing processes in polymer solutions, etc.

The research group of Kazuya U. Kobayashi (PhD student) and Rei Kurita (Associate Professor) specializes in experimental studies of thermal convection. In 2015, they discovered the formation of a transient stagnant domain in a gelatin solution near the sol-gel (fluid-solid) transition. In this work, they identified the critical condition required for the phenomenon using several different kinds of fluid: they concluded that the stagnant domain is generally formed when the mixture features a large viscosity difference. Prof. Kurita notes that "although this unusual phenomenon is only observed in thermal convection, the viscosity difference between components should play an important role in the dynamics of fluid mixtures, such as in mantle convection, mixing processes, etc." The report holds great promise for progress in our understanding of fluid dynamics, earth sciences, and

meteorology.

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More information: Kazuya U. Kobayashi et al, Ubiquitous transient stagnant domain formation during thermal convection in a well-mixed two component fluid with large viscosity difference, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-13409-w