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NEWS | FEBRUARY 09 2023

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Scilight 2023, 061104 (2023)
https://doi.org/10.1063/10.0017344

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9 February 2023

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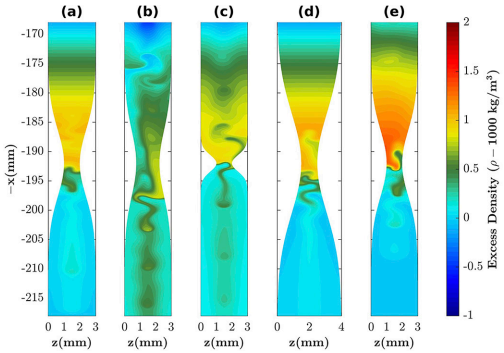
Constriction of a channel dominates fluid flow and the salt finger, double-diffusive instability.



Salt fingers are not (only) the product of sticking your hand into a bag of chips. They also occur when liquids with two density-affecting components with different diffusivities striate.

This double-diffusive instability is commonly found in the ocean. When hot saltwater stratifies above cool freshwater, the system is initially stable. Salt increases the fluid density, while heat decreases it. However, heat dissipates before salt and leaves a higher-density liquid on top of the lower-density liquid. This dense saltwater sinks in thin plumes, creating the so-called salt fingers.

Legare et al. studied how channel constriction impacts the salt finger instability numerically in two dimensions.

“In nature, channels are never going to have perfectly straight walls,” author Sierra Legare said. “We wanted to know how narrowing a channel via constriction would affect the energetics of the instability.”

Two Gaussian shaped indents constituted the constriction and a third Gaussian introduced asymmetry in the channel. The initial temperature of the fluid and the salinity gradient were selected to achieve a stable stratification.

The authors found that in narrow channels, constriction governs fluid flow, regardless of the channel’s shape or size.

“When you constrict a millimeter-scale channel sufficiently, the constriction is the primary factor governing the dynamics of the fluid flow,” said Legare. “The constriction dominates the fluid flow due to the conservation of mass and deters dense fluid from propagating past it for a significant amount of time.”

Thin channels with constrictions are found in porous materials and can be further studied to understand how contaminants spread in groundwater.

Source: “Double diffusive instability with a constriction,” by Sierra Legare, Andrew Grace, and Marek Stastna, *Physics of Fluids* (2023). The article can be accessed at https://doi.org/10.1063/5.0135159.