Double-Diffusive Sedimentation

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We analyze the linear stability of stably stratified fluids whose density depends on two scalar fields, where one of the scalar fields is unstably stratified and settles. Such conditions may be found, for example, in flows involving the transport of sediment in addition to heat or salt. A linear stability analysis for constant-gradient base states demonstrates that the settling velocity generates a phase shift between the perturbation fields of the two scalars, which gives rise to a novel, settling-driven instability mode. This instability mechanism favors the growth of waves that are inclined with respect to the horizontal. It is active for all density and diffusivity ratios, including cases in which the two scalars diffuse at identical rates. If the scalars have unequal diffusivities, it competes with the elevator modes of the classical double-diffusive fingering instability. We present detailed linear stability results as a function of the governing dimensionless parameters, including cases involving lateral gradients of the base state density fields that result in predominantly horizontal intrusion instabilities. Highly resolved DNS results serve to illustrate the nonlinear competition of the various instabilities for such flows in different parameter regimes.

Bio: Prof. Meiburg received his Ph.D. from the University of Karlsruhe in Germany. After being a postdoctoral fellow in Chemical Engineering at Stanford, he held faculty positions at Brown University and the University of Southern California, before joining UC Santa Barbara in 2000. He has held visiting appointments in France, Switzerland, Germany, Australia and at Stanford. Prof. Meiburg’s research is in the field of computational fluid dynamics and flow instabilities, with an emphasis on multiphase and interfacial flow problems. His research has been recognized by a Presidential Young Investigator Award, a Humboldt Senior Research Fellowship, a Senior Gledden Fellowship, and a Shimizu Visiting Professorship. He is a Fellow of the American Physical Society and of the American Society of Mechanical Engineers, and he currently serves as Chair of the Division of Fluid Dynamics of the American Physical Society.