Stratified Eiphil Towers on Continental Shelves

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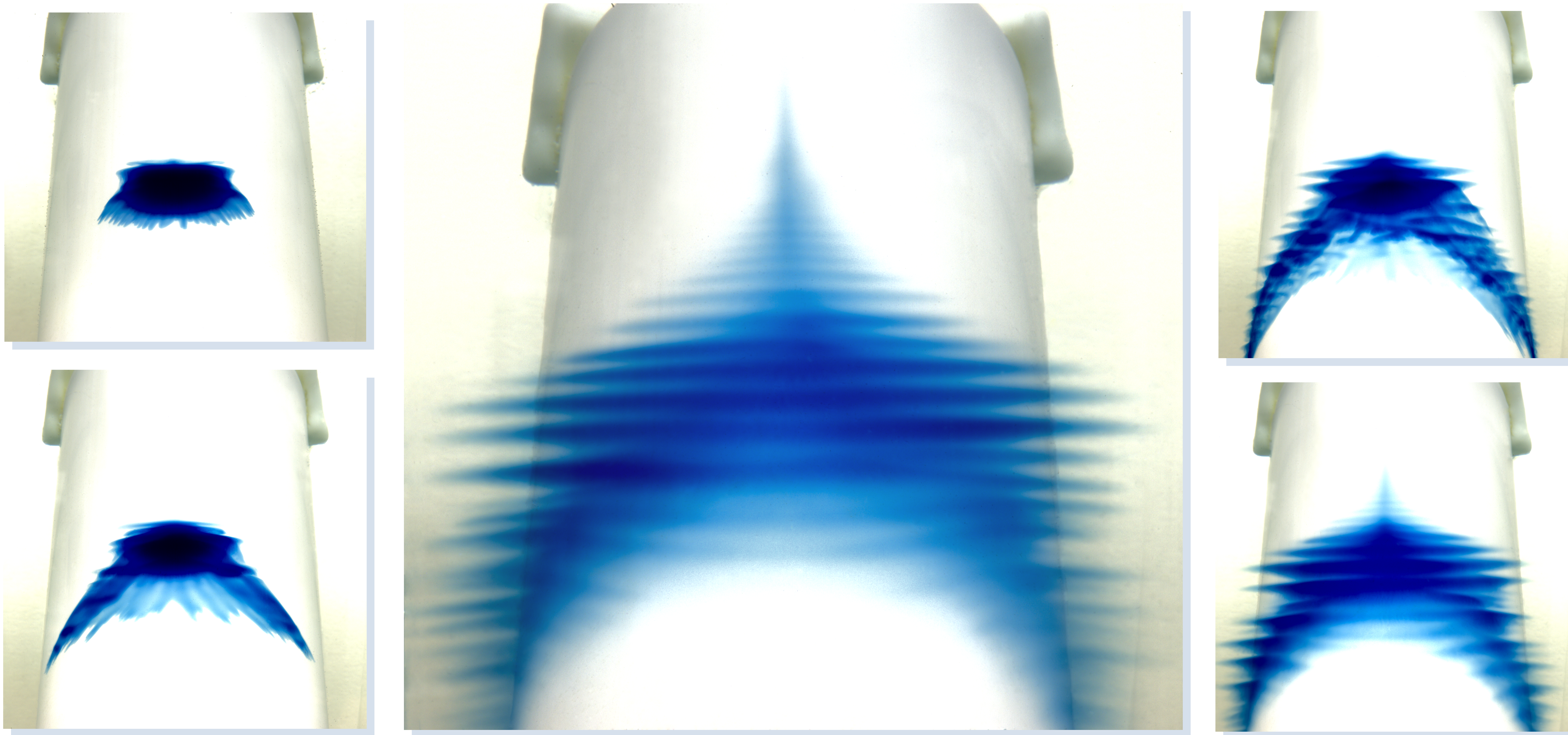
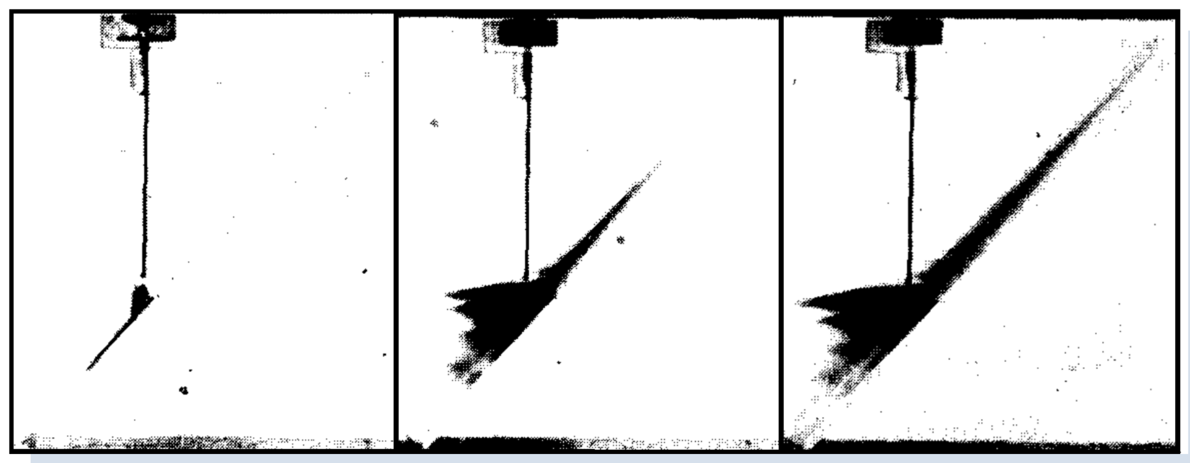


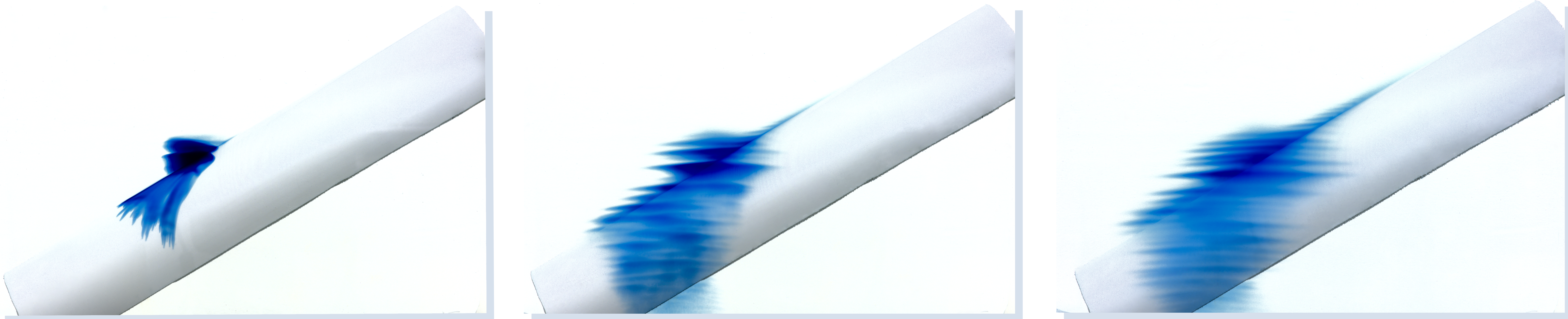
Back view of the experiment: 1 minute after injection (top left), 10 minutes later (bottom left) , 1 hours (top right), 3 hours (bottom right) and final stage after 20 hours (center).



Original dye visualizations from Phillips reproduced from [1] showing the evolution of the upslope diffusion-driven flow.

Phillips established in 1970 that the presence of a tilted plane in a linearly salt stratified fluid creates an up-plane flow due to the impermeable to salt boundary condition. We have recently extended this class of flows to the case of curved geometries such as a tilted cylinder. The analogous flow field possesses a richer structure and helps reveal an instability that seems to have been largely neglected in the literature though at close inspection it is noticeable in the photographs shown in Phillips' original paper [1, 2].

The present geometry consists of a tilted half pipe immersed in a linearly salt stratified fluid. Here the visualization is initialized with a blob of dye which is mixed with fluid and injected near its neutral buoyancy height. The flow is set to evolve for twenty hours. The dye used in this experiment is a Blue Dextran which is based of sugar and has thus a slower diffusion rate than the ambient salty fluid. The blob of dye starts by spreading down each side of the pipe and shortly after, staircases start to form where these sugar "fingers" have spread. These intrusions form the "feet" of our dye structure and slowly spread horizontally in time. Meanwhile, the Phillips' flow entrains the dye up the centerline of the pipe where the layers spread, forming the top of our structure. After 20 hours, this dyed structure made of salt, water and sugar gives rise to an Eiffel tower like structure, which we denote here as an "Eiphil" tower.



Side view of the experiment: 10 minutes after injection of the dye (left), 3 hours (center) and 20 hours later as the full structure has formed (right).

Double diffusion is known to give rise to spectacular stair case profiles of salinity and temperature in the Arctic ocean. The dynamics of double diffusion processes is not yet completely understood. We are currently investigating the stability of the generalized Philips flow solutions we have analytically derived and which we will present in a forthcoming paper.

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[1] Phillips O. M. On flows induced by diffusion in a stably stratified fluid. *Deep Sea Res.* (1970), 17, 435-443. [2] Wunsch C. On oceanic boundary mixing. *Deep Sea Res.* (1970), 17, 293-301