Precipitation on rough surfaces near laminar and turbulent flow

Progress Report

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Project Description

The project aims to study the interplay between reactive fluid flow and surface growth.
Fluid flow has an important effect on how fast a surface grows and the typical morphology it develops. In turn, an evolving, rough surface feeds back vortices into the bulk flow thus generating flow instabilities that will later affect surface growth by precipitation. This feedback mechanism is however far from being well understood. Thus, the conditions under which this mechanism may lead to a clogging effect remain an open problem. One of the main objective of this project is to approach this basic problem from a combined theoretical and computational perspective by constructing a representative model that couples turbulent fluid flow in channels with precipitation on the channel walls. Our study would provide important insights and results that can be used in natural and industrial applications where clogging is a problem, including scaling problems in pipelines, CO2 sequestration, and reactive flows in fractured and porous media.

Overview of progress

Up to this current point work has been focused on constructing and understanding the model designed to simulate precipitation under the influence of fluid flow. Precipitation is modeled using a phase field (diffuse interface) model, this is then coupled with a Lattice Boltzmann model (type LBGK) which simulates the fluid. Preliminary results from this model are shown below. Here a saturated fluid flows trough a channel with a single rough element upon which precipitation can occur. The figures illustrate the effect of turbulent flow upon the precipitation process.

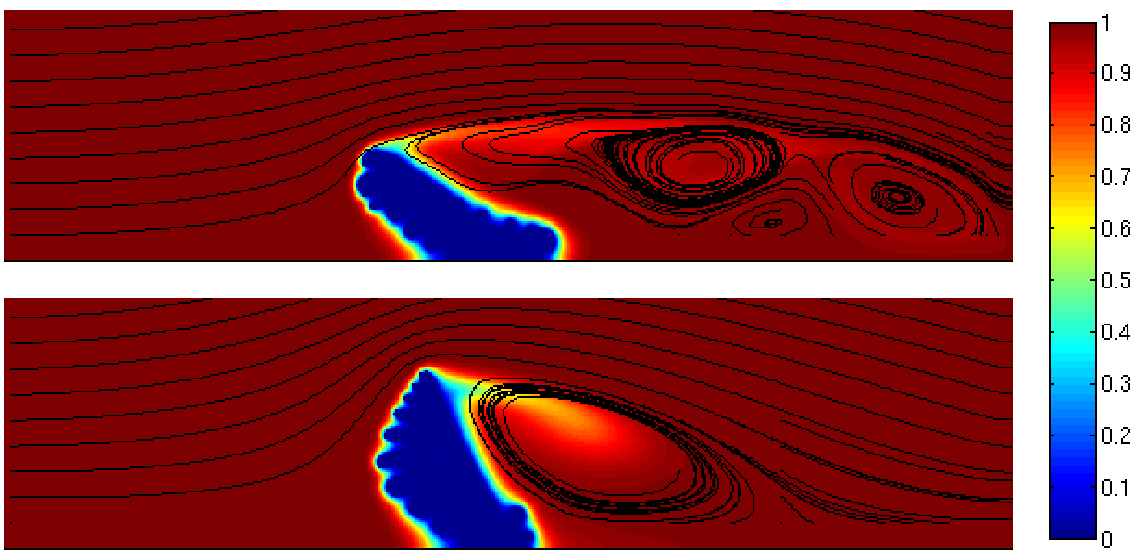

Figure 1 – Dendrite growth on channel wall with single rough element Pe=10, Da=100. Figure shows normalized concentration field with fluid streamlines overlaid. Top image represents Reynolds number 10,000, bottom image Re of 100. These images were taken at a time of 140 seconds.

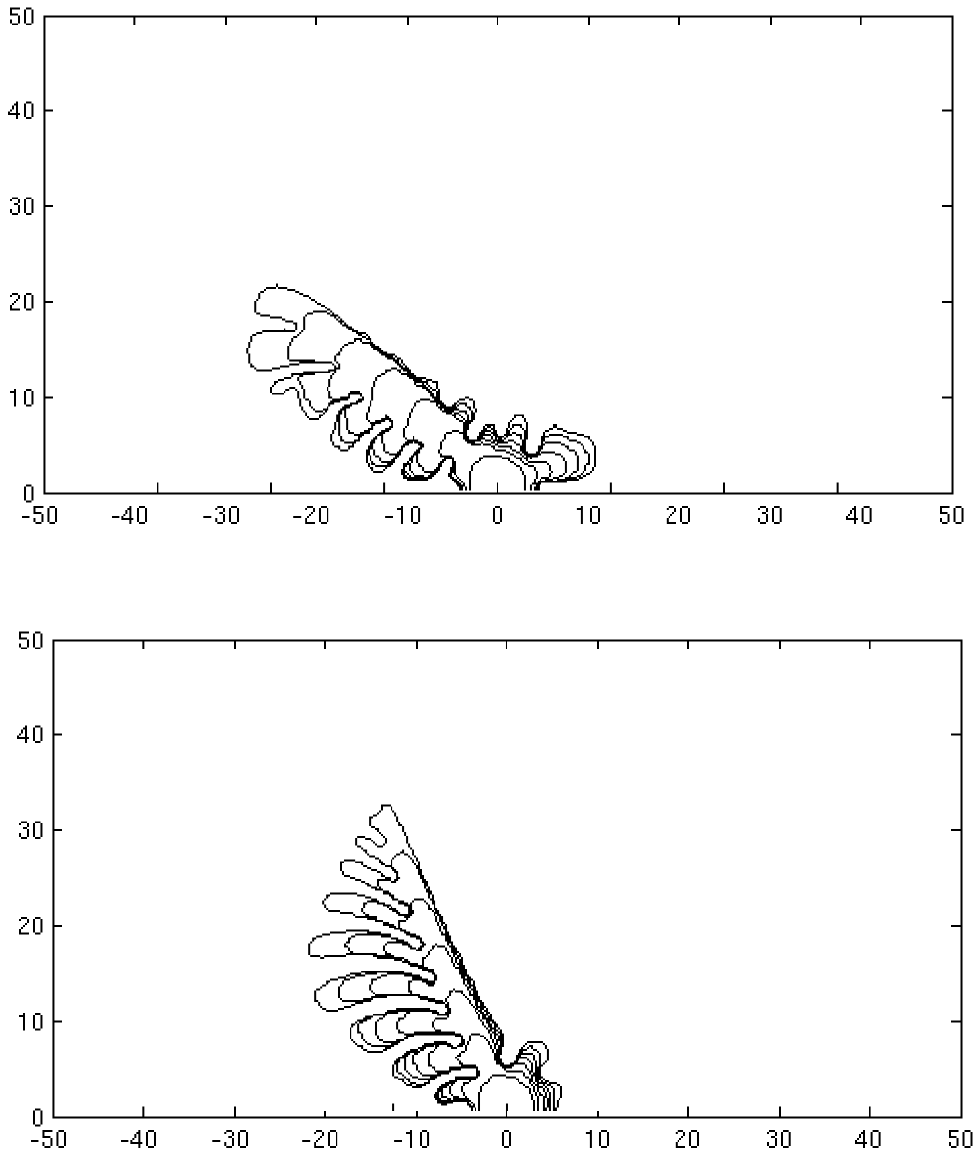

Figure 2 - Evolution of the precipitated growth within a channel on a single rough element Pe=10, Da=100. Top Re=10,000, bottom Re=100 Contours show the position of the liquid solid interface at different times. Successive contours have a time difference of 20s.