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A dynamic model for particle-laden thin film flows on an incline
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— Particle-laden flows are important in a variety of contexts, where transport and manipulation of suspensions occur. We consider gravity driven flows of particle-laden thin films on an incline. In the experiments, three distinct regimes are observed: particles either settle out of the flow (low bulk particle volume fraction and inclination angle), aggregate at the moving front (high bulk particle volume fraction and inclination angle), or remain well-mixed (intermediate values). Our dynamic model relies on the suspension and particle fluxes resulting from previously derived equilibrium model, where shear-induced migration balanced hindered settling due to gravity. The dynamics is modeled using a system of two scalar hyperbolic conservation laws, describing suspension and particulate front motion. We proceed by discussing a few aspects of the rich mathematical structure of these laws and their physical interpretation. Finally, the governing system is solved numerically, and simulation results are shown to agree well with the experimental data regarding front propagation and settling mode.

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