Effect of polymer additives on dynamics of water level in an open channel

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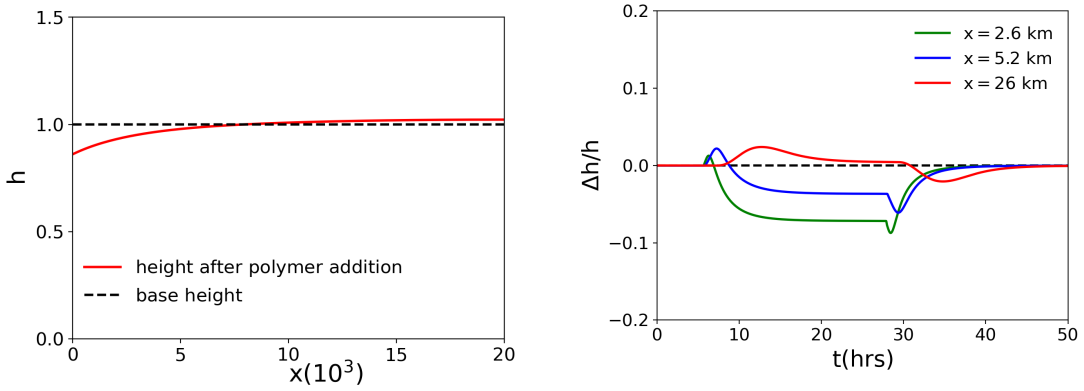
The presence of a tiny amount of polymers (a few parts per million) dramatically reduces the turbulent drag of the flow. Therefore, polymer additives are commonly used to reduce pumping costs during the pipeline transport of liquids. Polymers are also used in sewer systems for reducing water height and hence improving drainage capacity. Further, polymer additives have been proposed to be used in flood remediation and irrigation canal. One counterintuitive effect that has been observed in a recent field experiment is the transient *increase* in water height far downstream of polymer injection. The interplay between drag reduction, turbulent dispersion, and polymer degradation due to turbulence determines the water height in the open channel flow. We numerically investigate the effect of polymer additives on the water height in a long canal using the shallow water equations augmented with an evolution equation for polymer concentration that incorporates turbulent dispersion and polymer degradation. The water height decreases downstream of the polymer injection point and the drop in the water height decreases downstream due to polymer degradation (Fig. 1). Counterintuitively, far downstream of the injection point the water height increases (Fig. 1). We explore the mechanism of this unexpected rise in water height in the canal. Similar behavior of the polymer additive on the water height has been reported in an outdoor experiment.



(a) (b)

Figure 1: (a) Instantaneous water height in a canal after polymer addition. (b) Time dependent water height at different locations in the canal.