Beachface evolution under two swash events by two solitary waves

Fangfang Zhu

1 University of Nottingham Ningbo China

Fangfang.Zhu@nottingham.edu.cn

2 University of Nottingham UK

Nicholas.Dodd@nottingham.ac.uk

July 31, 2018

Overview

Introduction

Figure : The swash zone and swash flow (picture is from acommentpost.blogspot.com.).

Introduction

Motivation

The physical process of swash-swash interaction is not well understood (Puleo and Torres-Freyermuth, 2016; Chardn-Maldonado et al., 2016).

Objectives

- Perform fully coupled simulations of two swash events due to two solitary waves.
- Illustrate the possible swash interactions.

Model development - Governing equations

$$h_t + uh_x + hu_x = 0 \tag{1}$$

$$u_t + uu_x + h_x + B_x = -\frac{c_d|u|u}{h} \tag{2}$$

$$B_t + 3\sigma u^2 u_x = M(c - u^2) \tag{3}$$

$$c_t + uc_x = \frac{1}{h}\tilde{E}\left(u^2 - c\right) \tag{4}$$

where x - cross-shore distance, t - time, h - water depth, u - water velocity, B - bed level, c - suspended sediment concentration, σ - bed mobility parameter for bed load, M- sediment entrainment parameter, $\tilde{E}$ - settling velocity and c_d - drag coefficient.

Model development - Numerical method

Equations are solved by the specified time interval method of characteristics (STI MOC) to achieve high accuracy.

The shock fitting method is used to solve for shocks.

Model development - Shock conditions

$$
\begin{aligned}
W(h_R - h_L) - (h_R u_R - h_L u_L) &= 0, && (5)\\
W(h_R u_R - h_L u_L) - (h_R u_R^2 + \frac{1}{2} h_R^2 - h_L u_L^2 - \frac{1}{2} h_L^2) & \\
-\frac{1}{2}(h_L + h_R)(B_R - B_L) &= 0, && (6)\\
W(B_R - B_L) - \sigma(u_R^3 - u_L^3) &= 0, && (7)\\
c_R - c_L &= 0. && (8)
\end{aligned}
$$

Swash simulation- Initial conditions

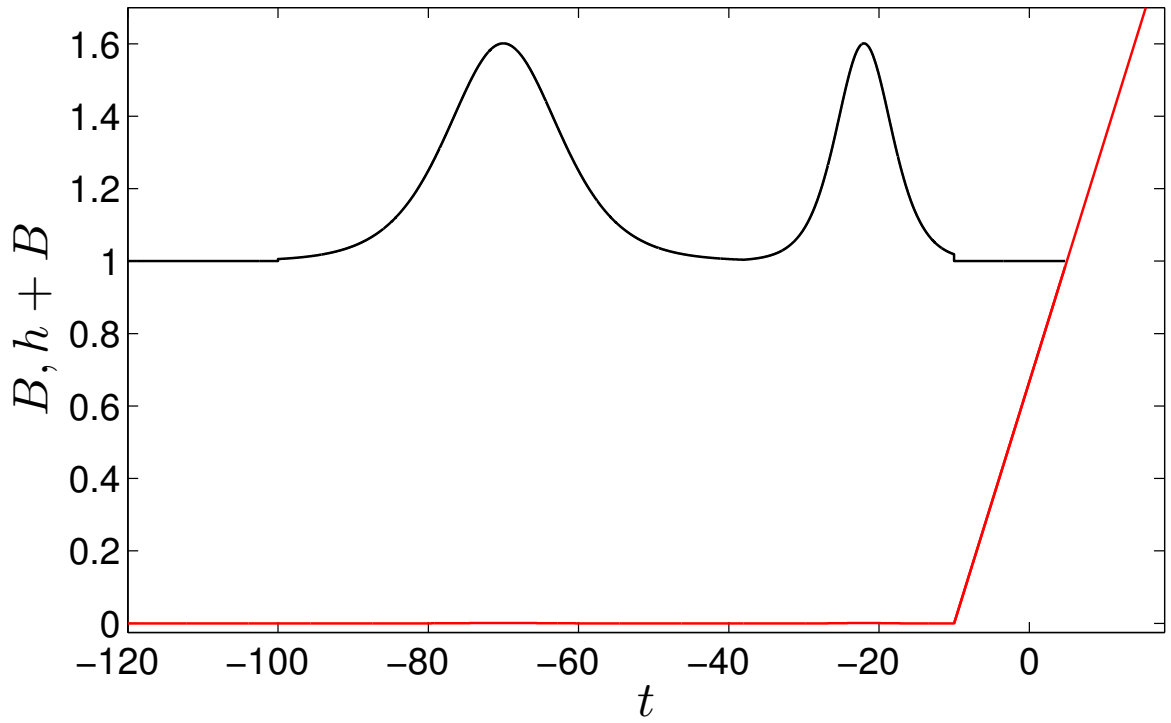
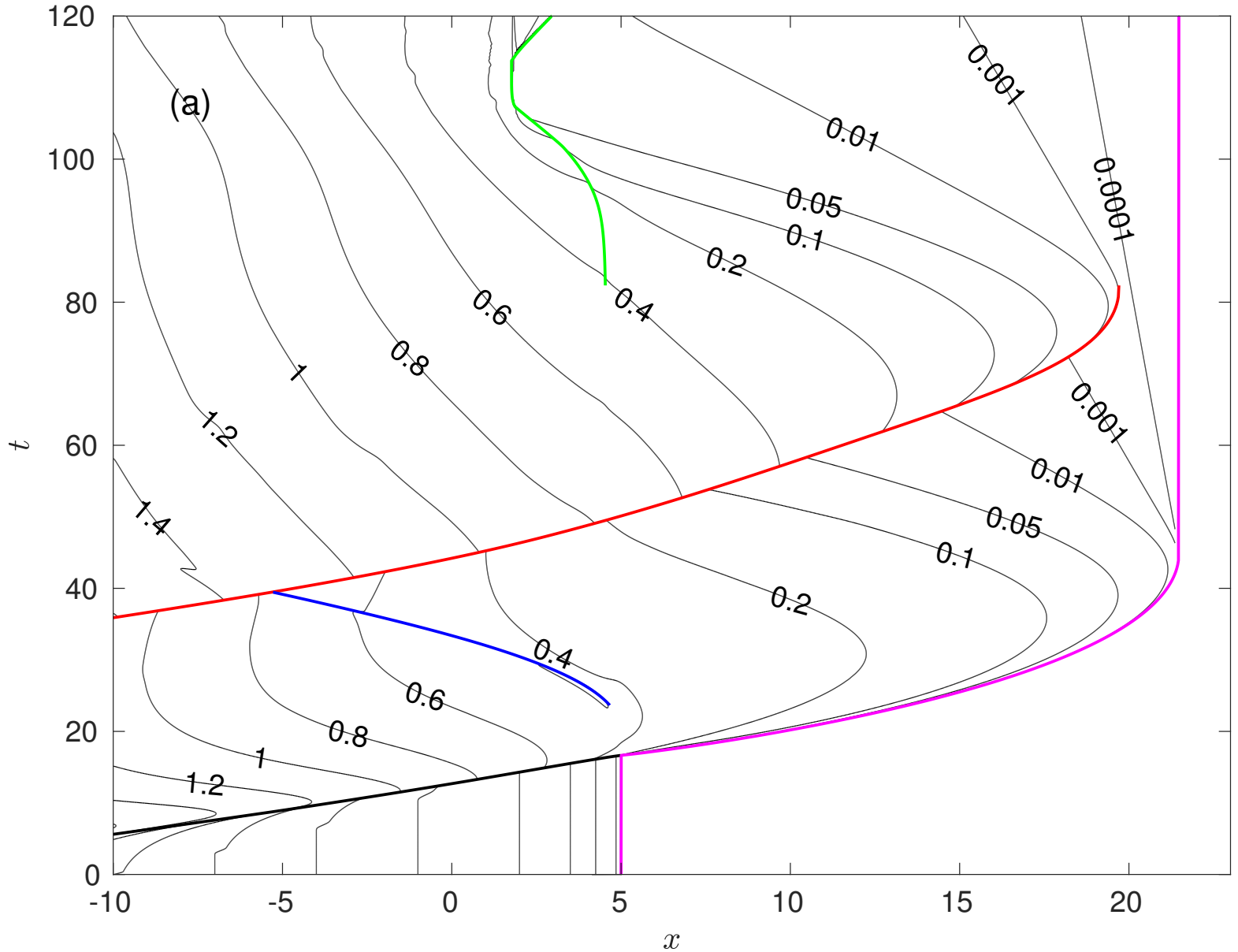


Figure : Initial conditions of two solitary waves A.

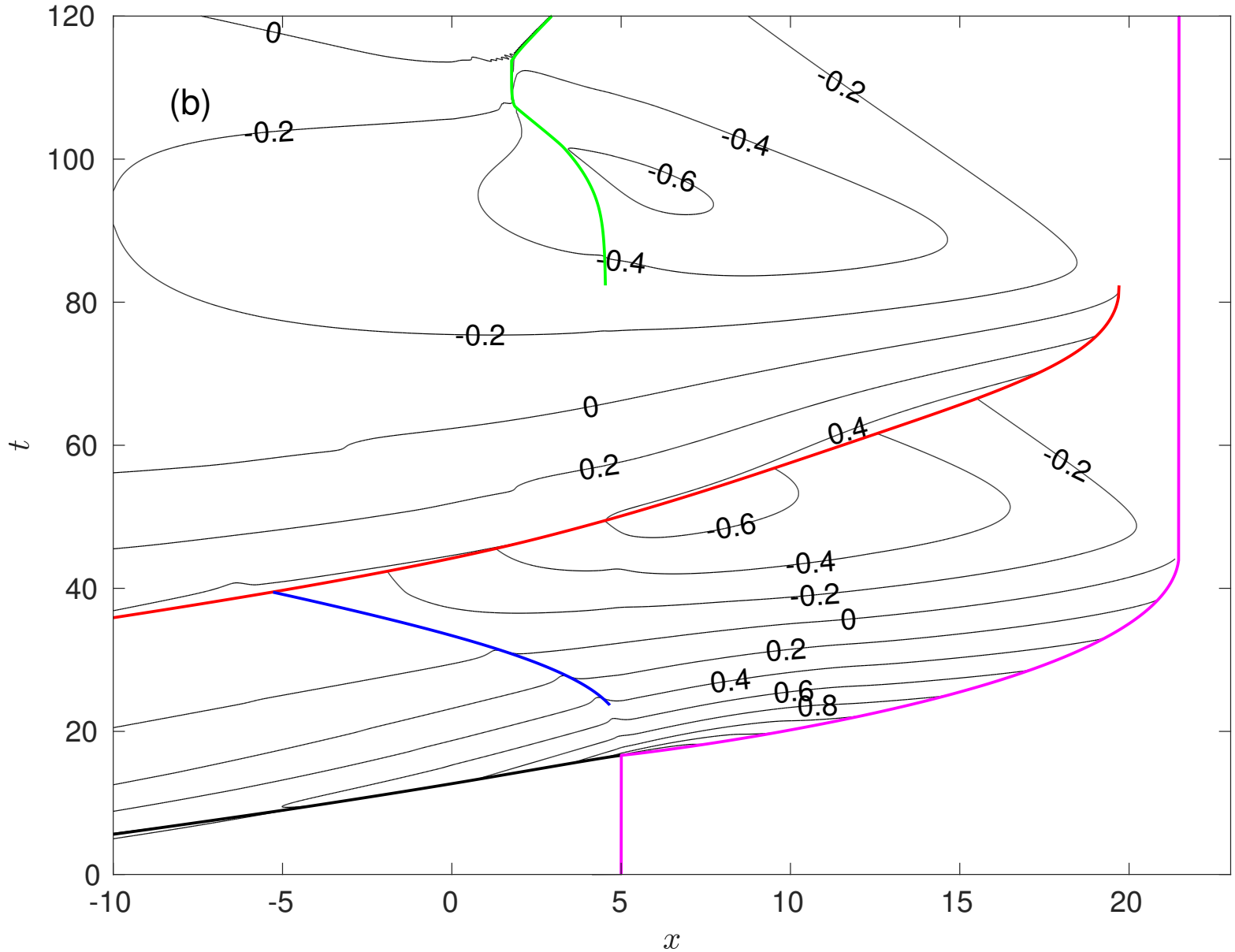
Swash simulation- Model results

Animation for swash events driven by two solitary waves A.

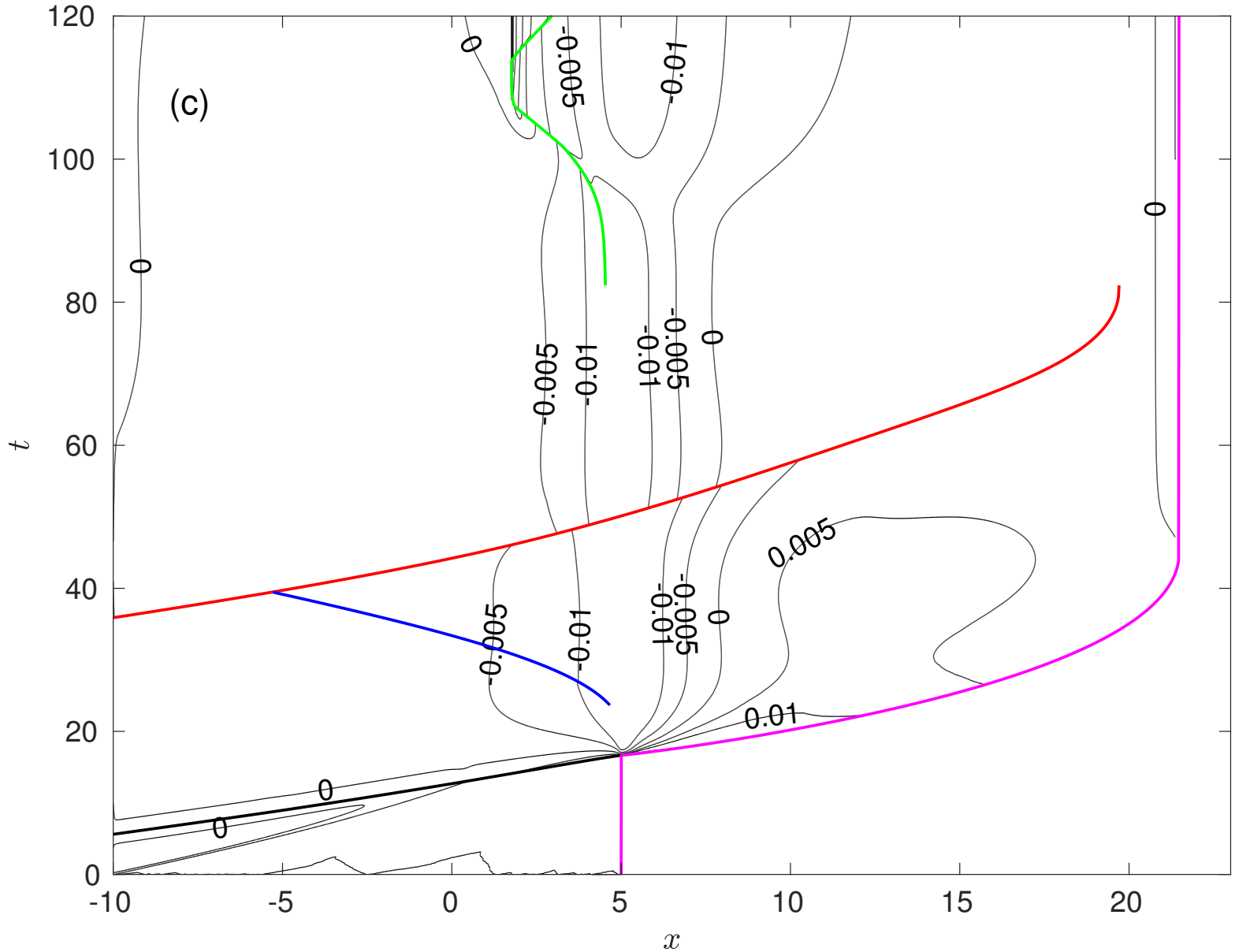
Swash simulation- Model results



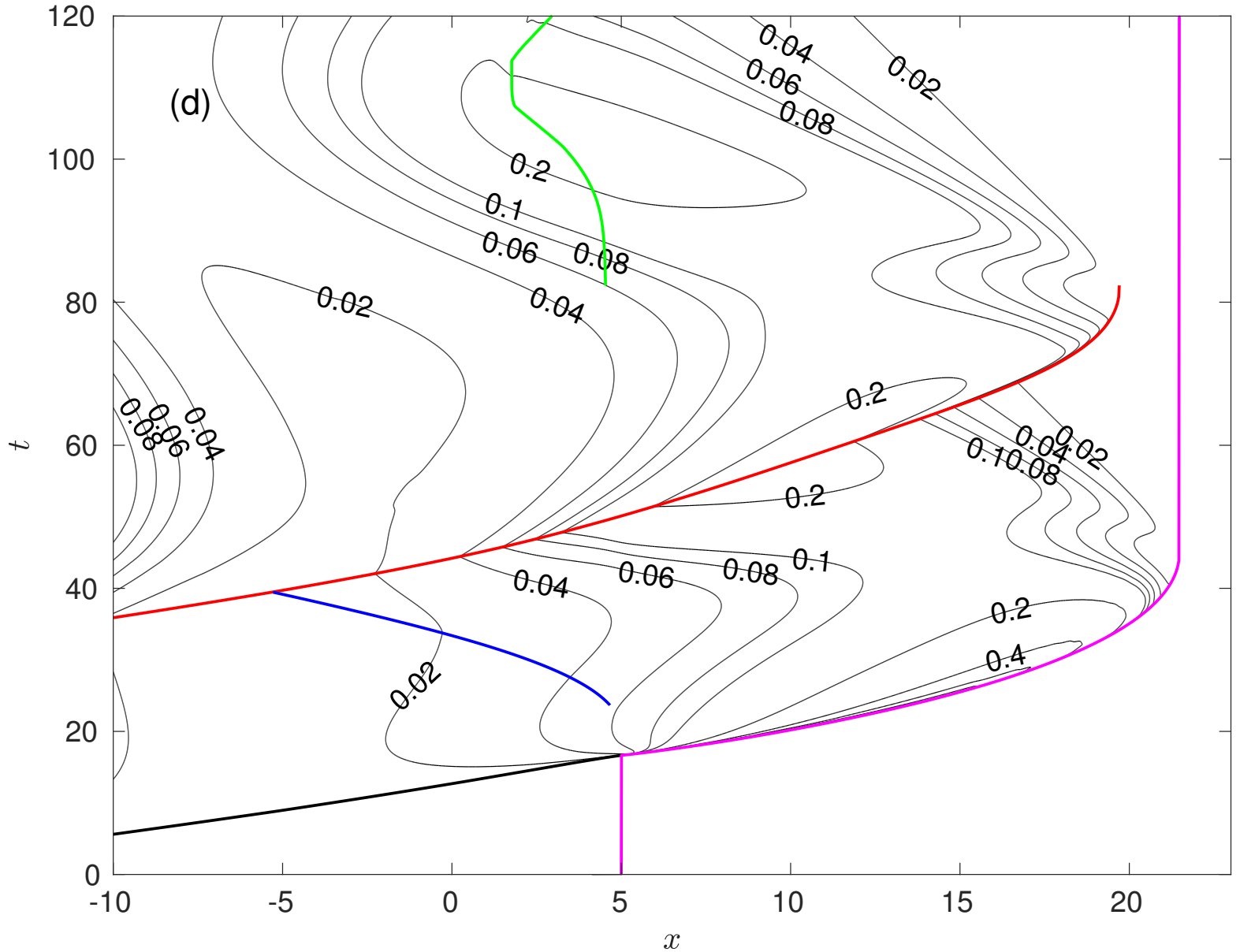
Swash simulation- Model results



Swash simulation- Model results



Swash simulation- Model results



Swash simulation- Model results

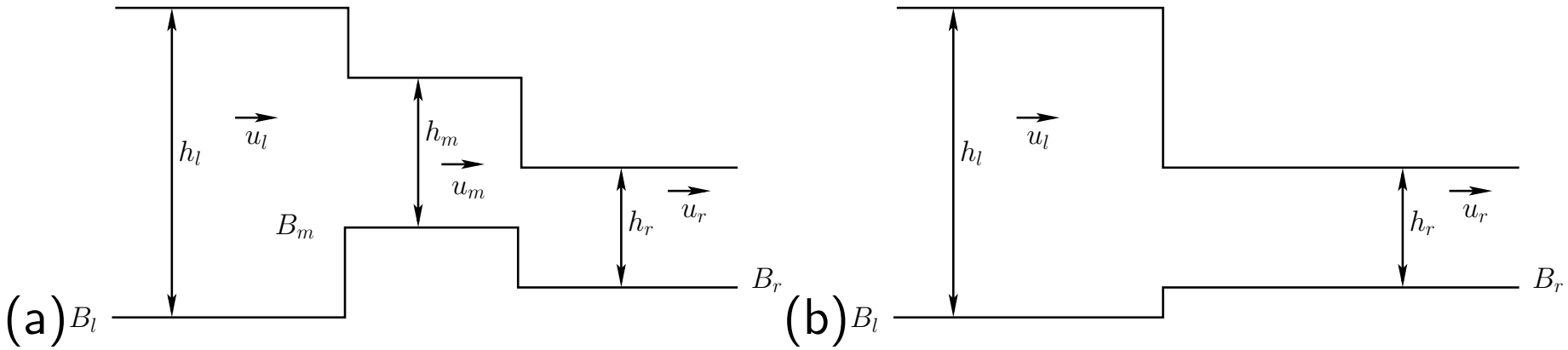


Figure : Schematic diagram for two shock collision. (a): before collision with two shocks present; (b): right before collision when two shocks meet and one unsteady discontinuity forms.

Swash simulation- Model results

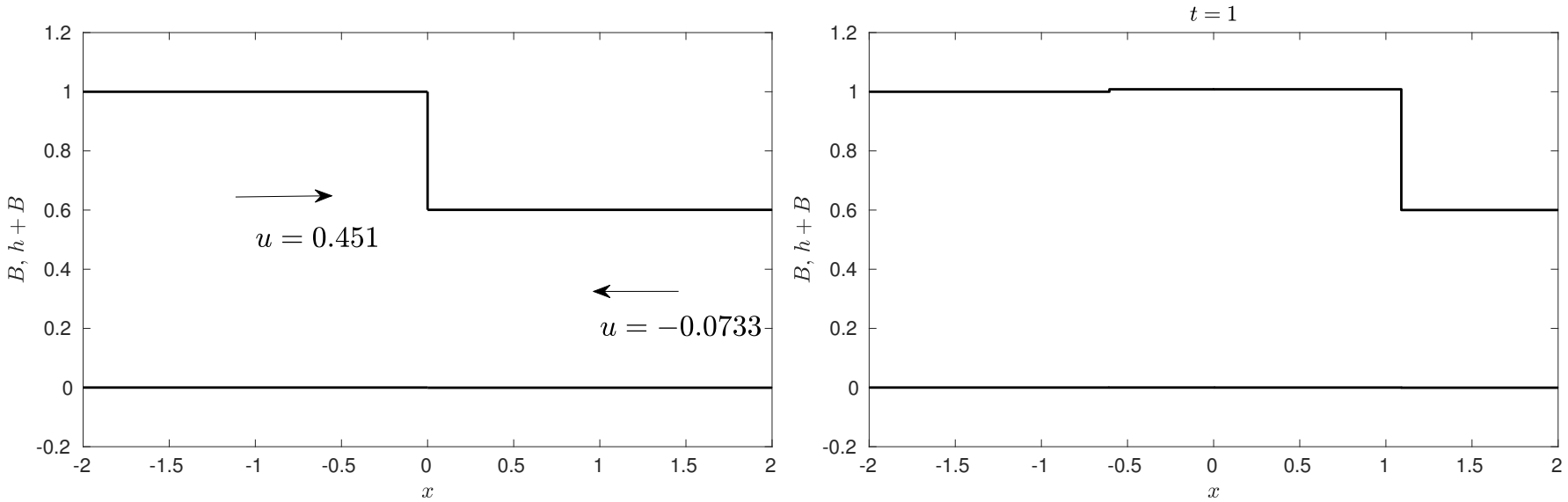


Figure : Dam-break problem and the solution for the interaction of incoming bore and backwash bore at $t = 39.45$.

Swash simulation- Initial conditions

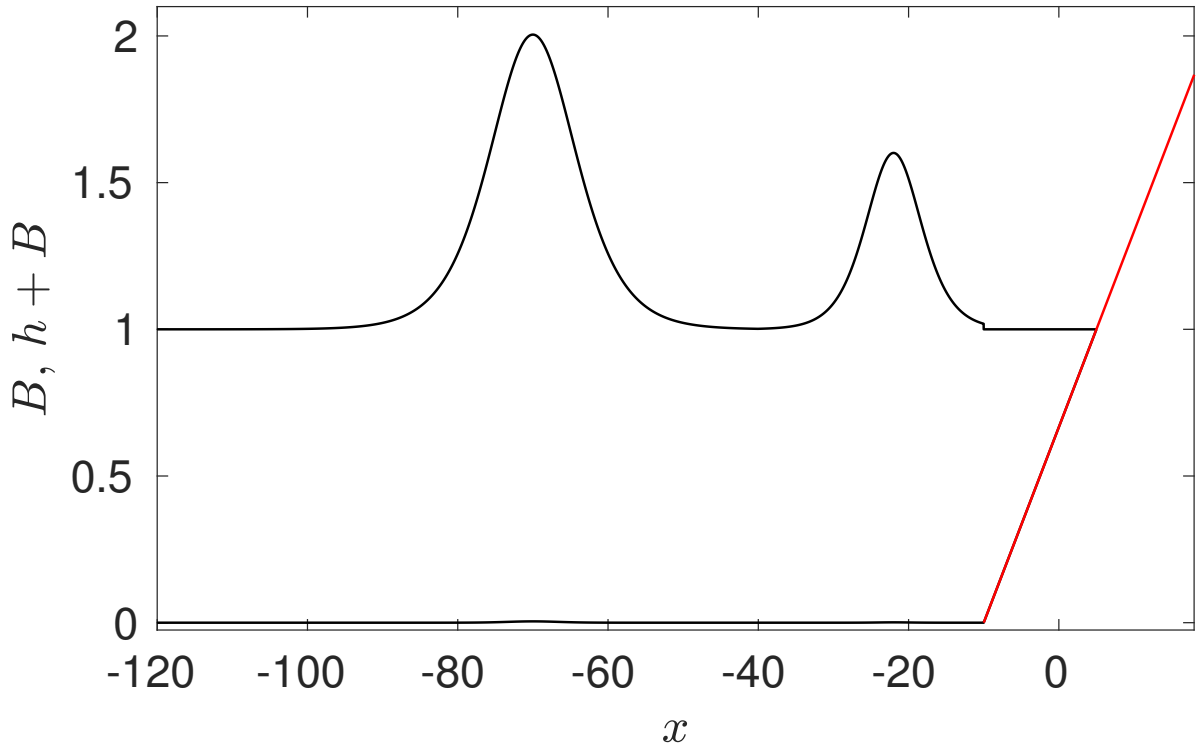


Figure : Initial conditions of two solitary waves B.

Swash simulation- Model results

Animation for swash events driven by two solitary waves B.

Swash simulation- Model results

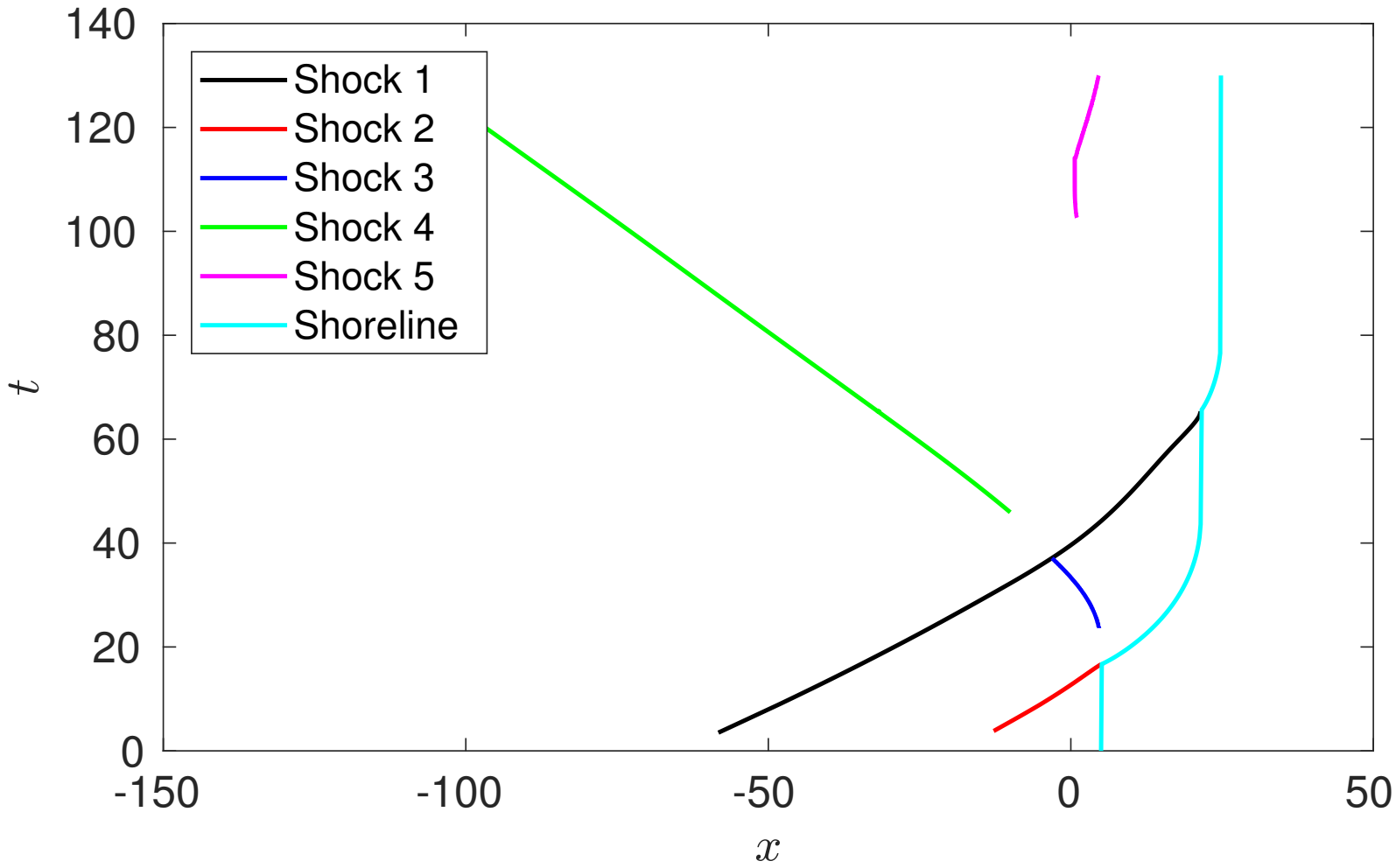


Figure : Shock path for two solitary waves B.

Swash simulation- Model results

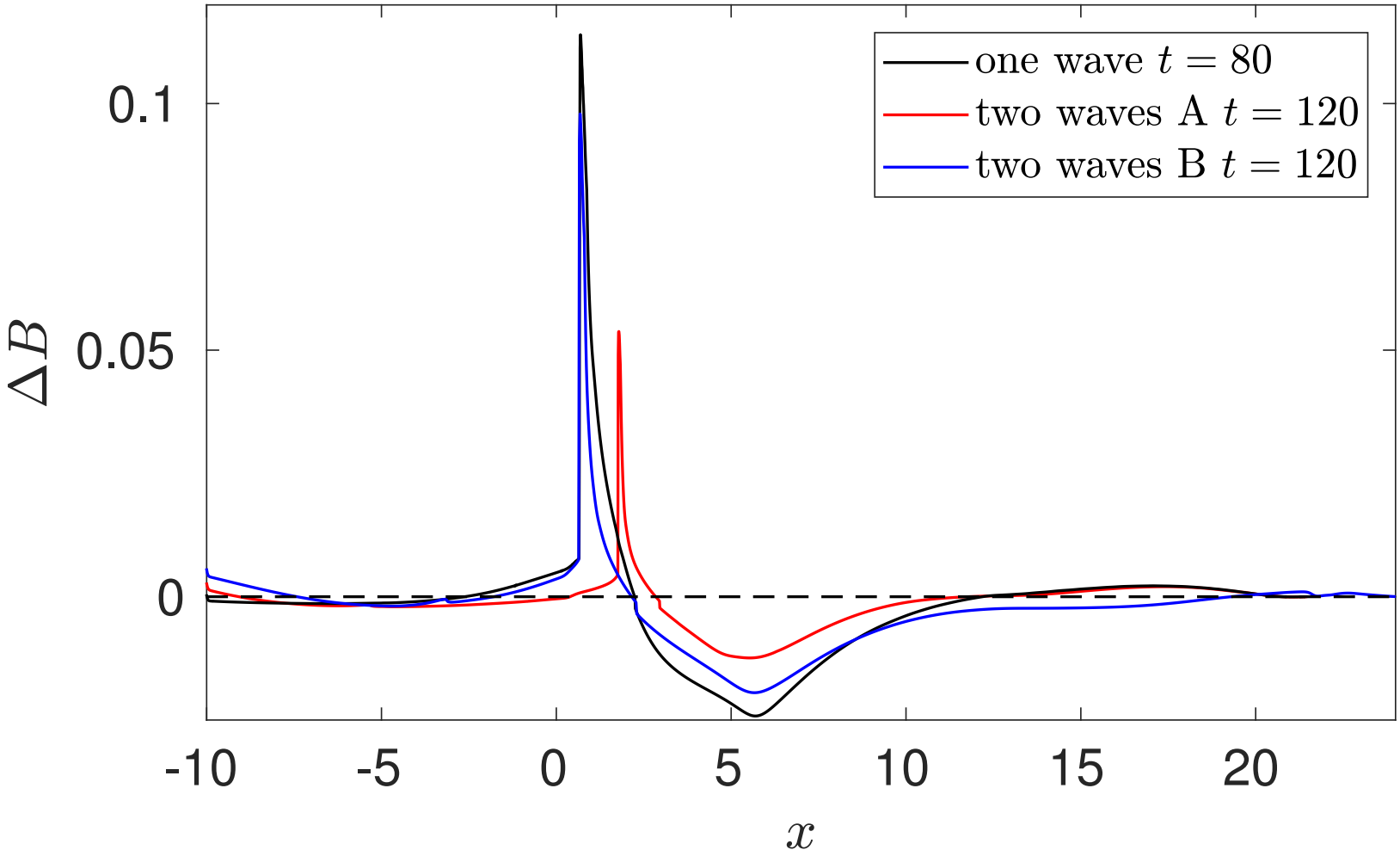


Figure : Beach change comparison.

Conclusion

- The existence of a subsequent swash event prevents the development of a strong backwash bore.
- Shock-shock (incoming bore and backwash bore) interaction occurs in two swash events.
- Large bed step is from independent backwash, which may contribute to the bed forms in the nearshore.
- Bore frequently changes its characteristics.

References I

Chardn-Maldonado, P., Pintado-Patio, J. C., and Puleo, J. A. (2016). Advances in swash-zone research: Small-scale hydrodynamic and sediment transport processes. *Coastal Engineering*, 115:8 – 25. Swash-zone Processes.

Puleo, J. A. and Torres-Freyermuth, A. (2016). The second international workshop on swash-zone processes. *Coastal Engineering*, 115:1 – 7. Swash-zone Processes.

Thanks for your attention!