Supplementary material belonging to: *Suppression of vertical flow separation over steep slopes in open channels by horizontal flow contraction*

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Here, additional time-averaged velocity data is shown for all cases listed in table 1 in the main document. For convenience, this table is repeated in the supplementary material. Three-dimensional velocity fields are provided for all cases except for the 2D-vertical case (2, 7, 11 and 12 from table 1). For these cases, the velocity along a streamwise cross-section in the xz-plane in the center of the flume is provided. The cases concerning the 1 in 5 slope may be regarded as preliminary test-cases. Based on this experiment, it was decided to do a full test-series for experimental cases with steeper slopes. Nevertheless, this data clearly shows consistency of the phenomena. Therefore, we have decided to show this data in the supplementary information as well.

In this supplement, first three-dimensional time-averaged flow fields are presented. In these figures, the colourbar denotes the magnitude of the mean velocity $|\bar{u}| = \sqrt{\bar{u}_1^2 + \bar{u}_2^2 + \bar{u}_3^2}$. The brown lines show the bathymetry in the flume, the bold black lines mark the horizontal obstruction and the blue lines indicate the water level. The vertical axis is scaled using the upstream water depth d_u. The downstream end of the obstruction is chosen as the origin $x/D = 0$.

Next, velocity fields along a streamwise cross-section in the xz-plane are presented. The cross-sections are all in the high-velocity stream of the flow, located at $y = 0.075$ m. The solid dark blue line indicates the position of the free surface level. The light blue line indicates the local bathymetry. The x-axis is scaled with the length of the slope L_s, and the z-axis is scaled with the upstream water depth d_u.

An overview of the figures is also provided in Table 1.

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No.	Slope steepness	Case	L_D [m]	Q_{in} [l/s]	3D flow figures	2D-vertical figures
1	0	Plane bed reference	-	11	figure 1	-
2	1 in 2 (26.5°)	No obstruction	-	22	-	figure 13
3		Obstruction	0	11	figure 2	figure 14
4		Obstruction	0.2	11	figure 3	figure 15
5		Obstruction	0.4	11	figure 4	figure 16
6		Obstruction	0.7	11	figure 5	figure 17
7	1 in 4 (14°)	No obstruction	-	22	-	figure 18
8		Obstruction	0	11	figure 6	figure 19
9		Obstruction	0.2	11	figure 7	figure 20
10		Obstruction	0.4	11	figure 8	figure 21
11	1 in 5 (11.3°)	No obstruction	-	22	-	figure 22
12		No obstruction	-	11	-	figure 23
13		Obstruction	0	11	figure 9	figure 24
14		Obstruction	0	5.5	figure 10	figure 25
15		Obstruction	0.2	11	figure 11	figure 26
16		Obstruction	0.2	5.5	figure 12	figure 27

Table 1. Overview of the different experimental runs that were performed in this study. In the remainder, the focus is on a select number of cases indicated in bold: Case PB (Plane Bed mixing layer, reference), S2A (mixing layer over a 1 in 2 slope that stays attached to the bed), S2D (mixing layer over a 1 in 2 slope that detaches from the bed) and S4A (mixing layer over a 1 in 4 slope that stays attached to the bed).

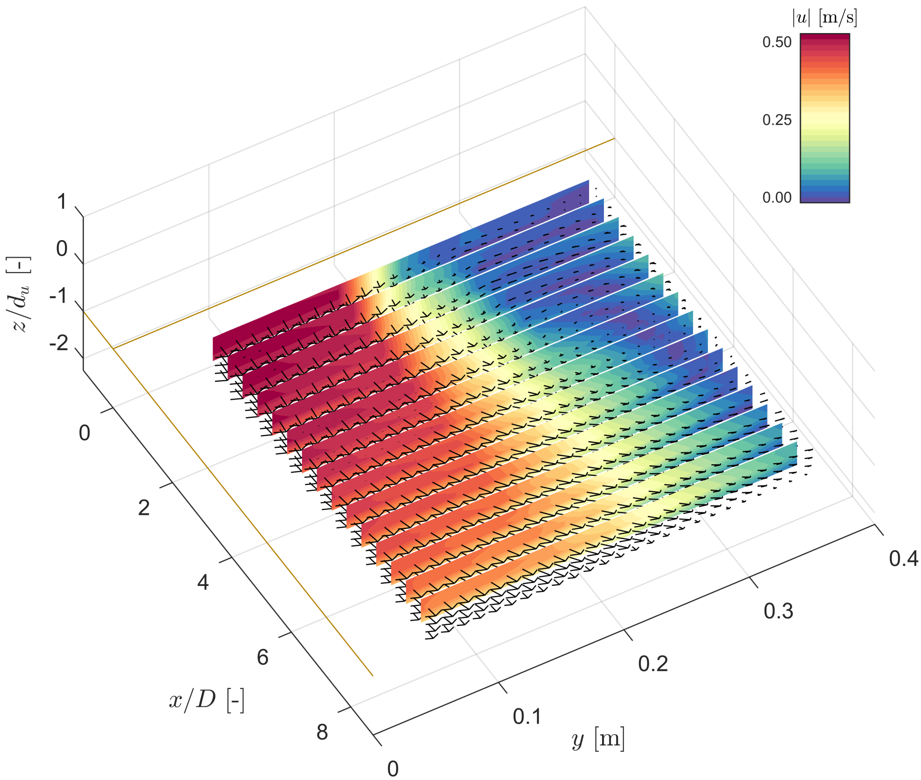

FIGURE 1. Interpolated three-dimensional, time-averaged flow field for case 1 (see Table 1).

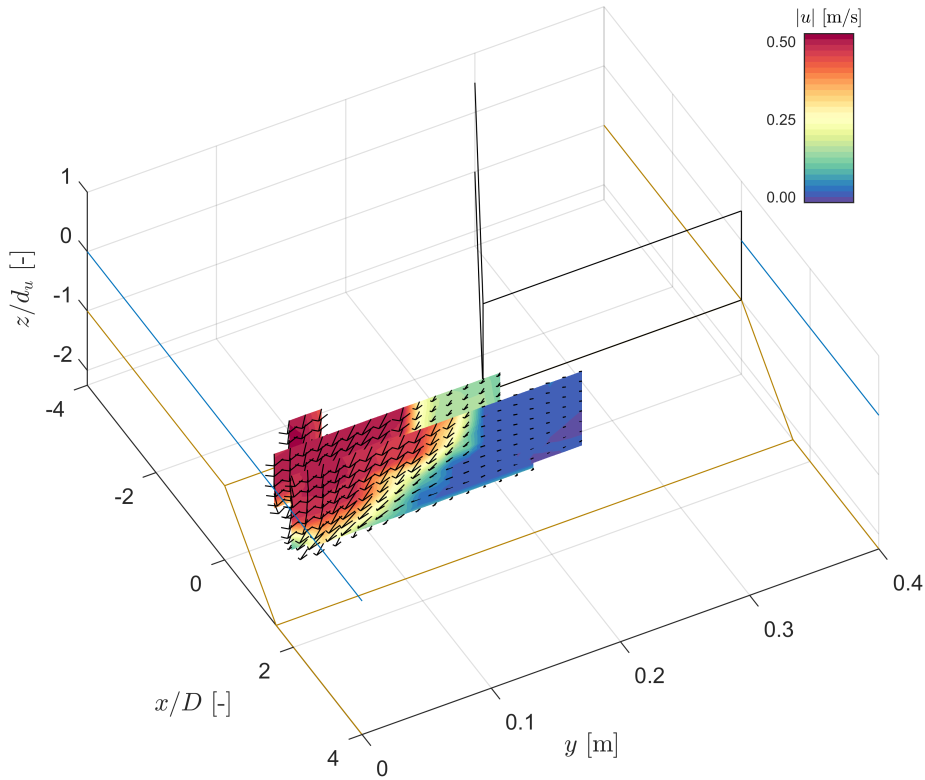

FIGURE 2. Interpolated three-dimensional, time-averaged flow field for case 3 (see Table 1).

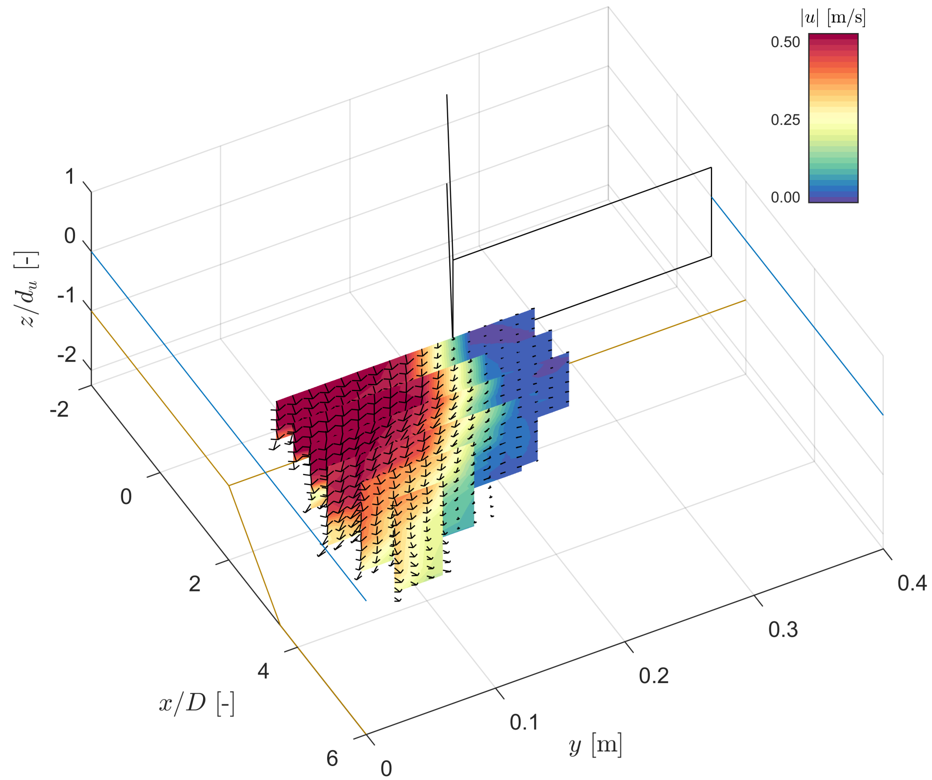

FIGURE 3. Interpolated three-dimensional, time-averaged flow field for case 4 (see Table 1).

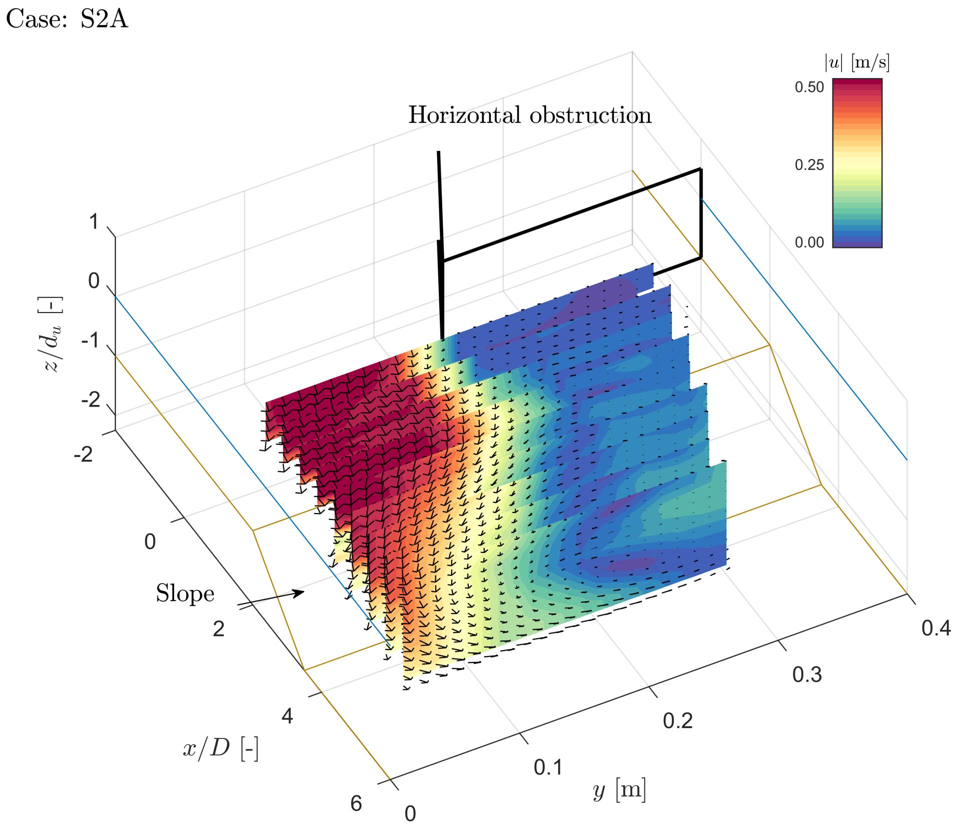

FIGURE 4. Interpolated three-dimensional, time-averaged flow field for case 5 (see Table 1).

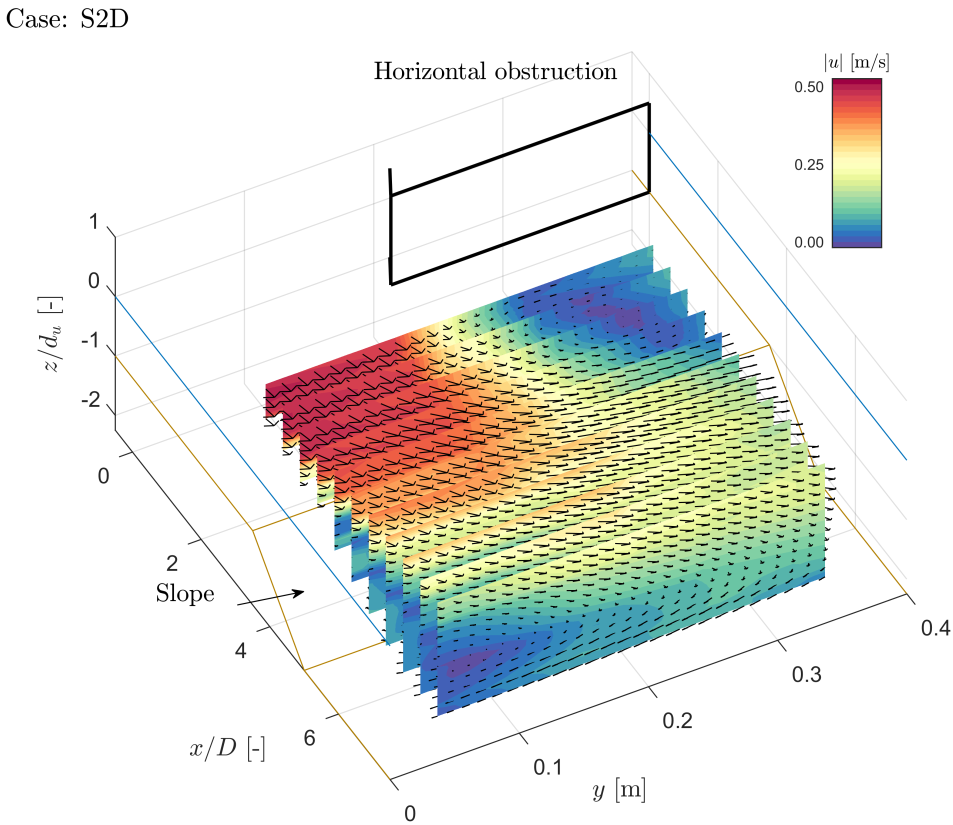

FIGURE 5. Interpolated three-dimensional, time-averaged flow field for case 6 (see Table 1).

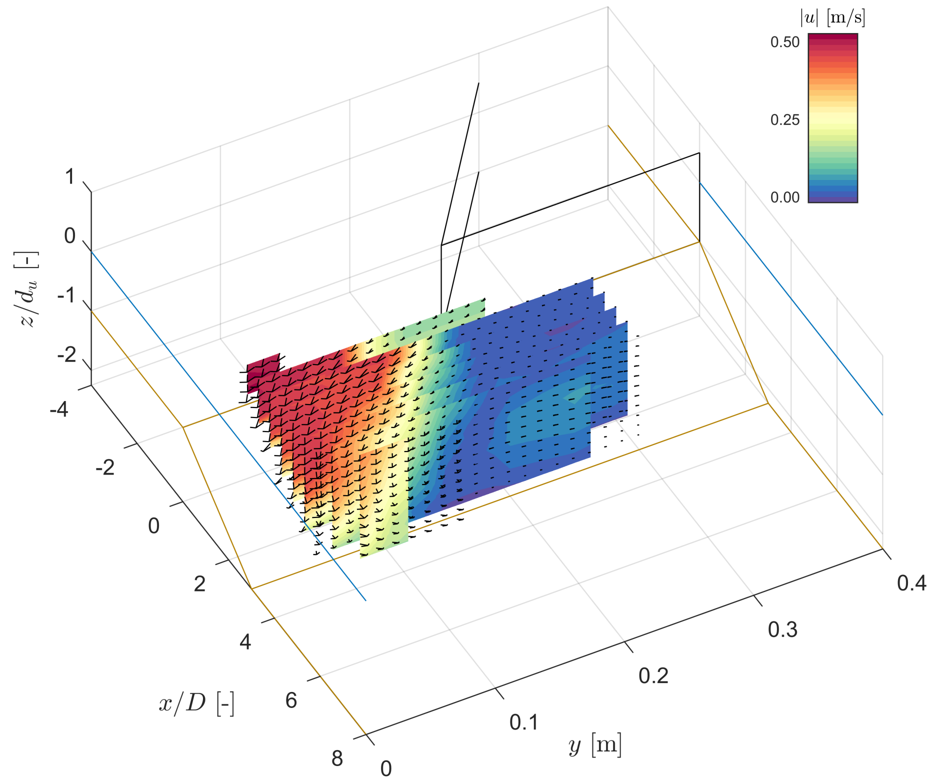

Figure 6. Interpolated three-dimensional, time-averaged flow field for case 8 (see Table 1).

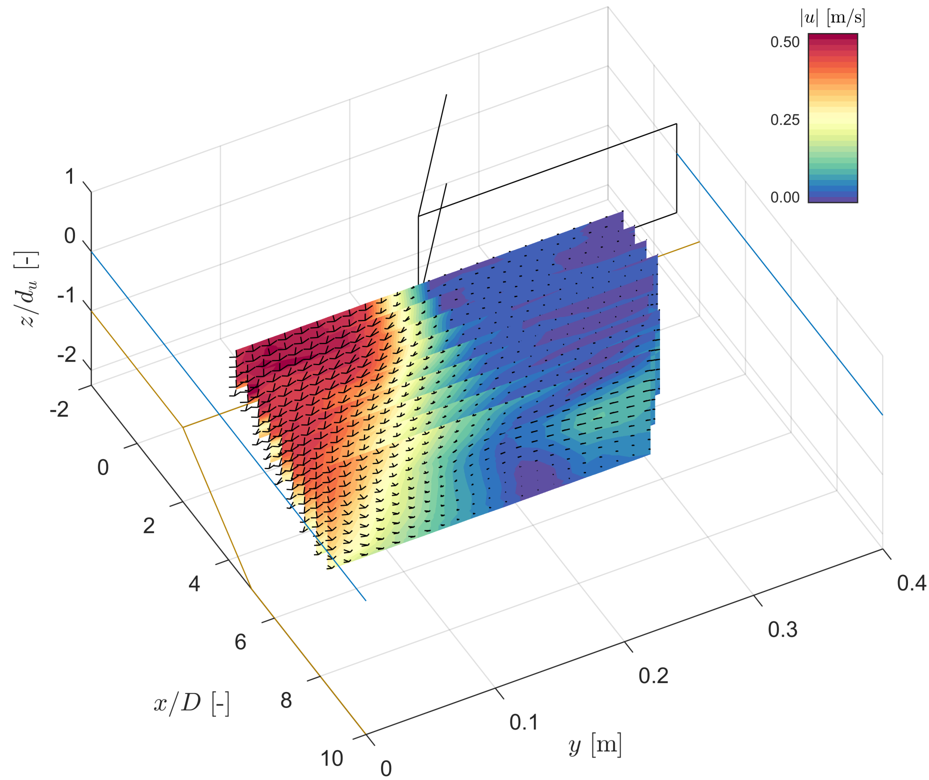

FIGURE 7. Interpolated three-dimensional, time-averaged flow field for case 9 (see Table 1).

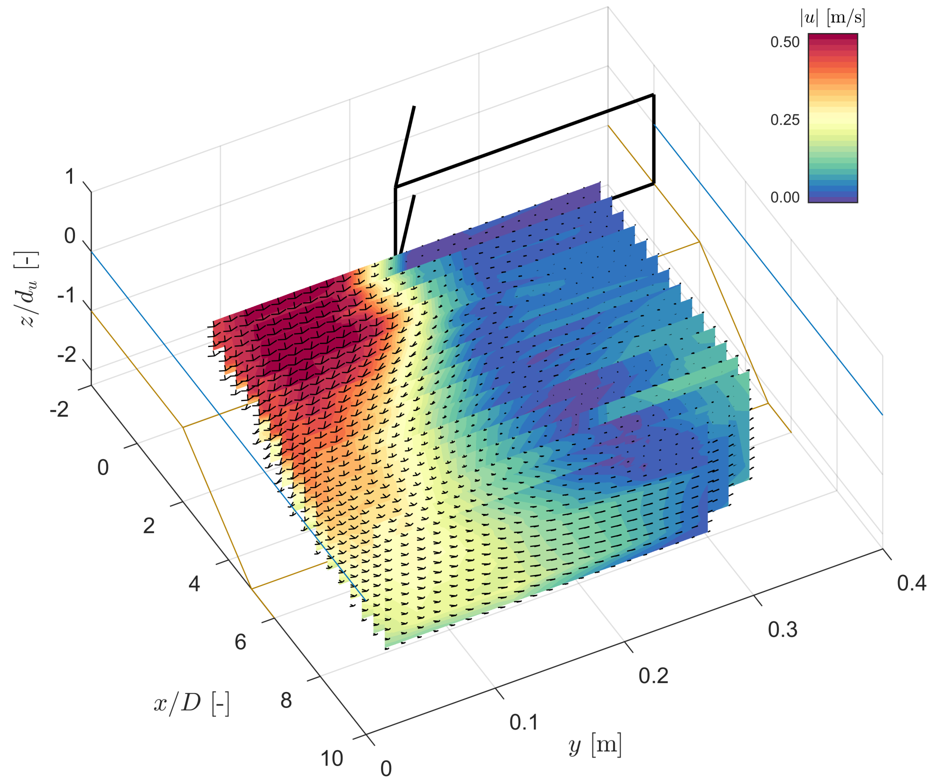

Figure 8. Interpolated three-dimensional, time-averaged flow field for case 10 (see Table 1).

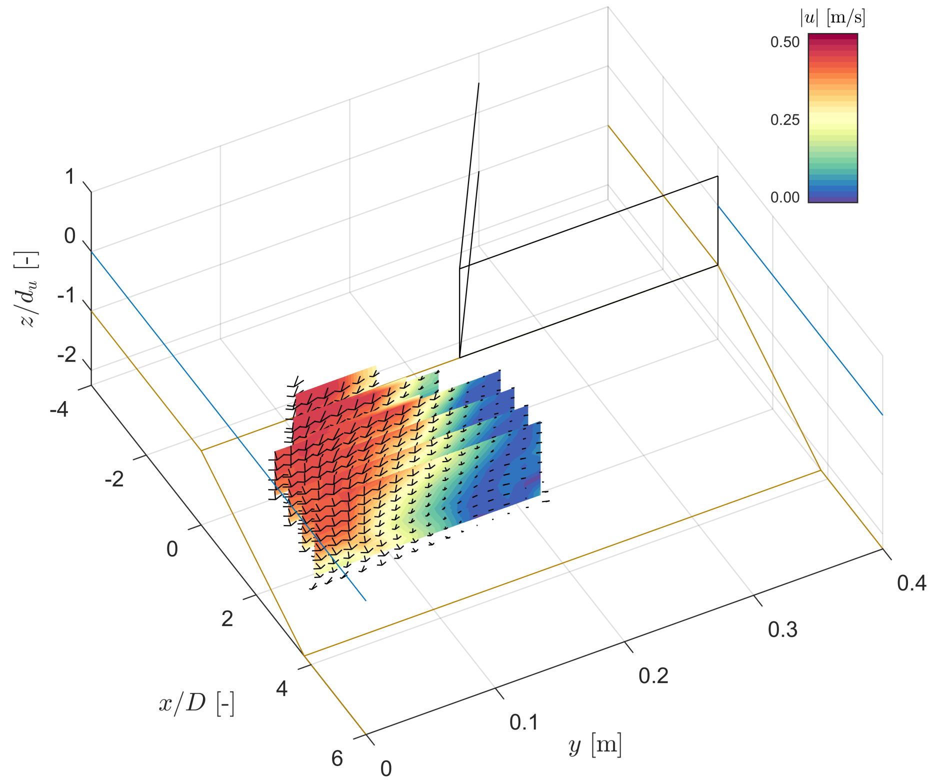

FIGURE 9. Interpolated three-dimensional, time-averaged flow field for case 13 (see Table 1).

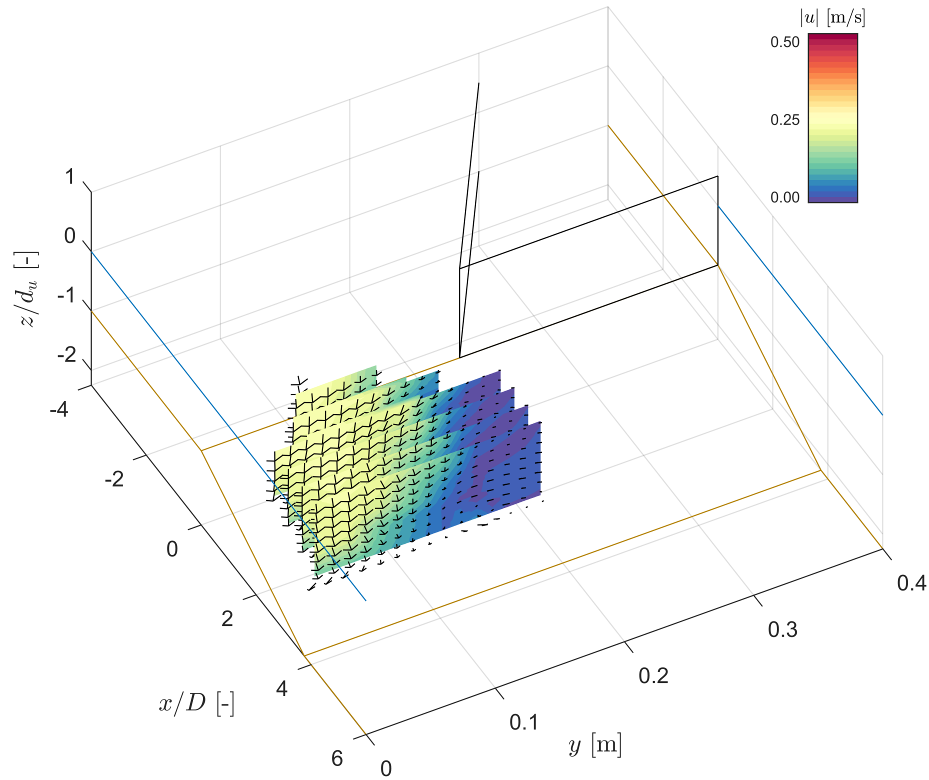

FIGURE 10. Interpolated three-dimensional, time-averaged flow field for case 14 (see Table 1). This case is characterized by a lower flow velocity at the inflow boundary.

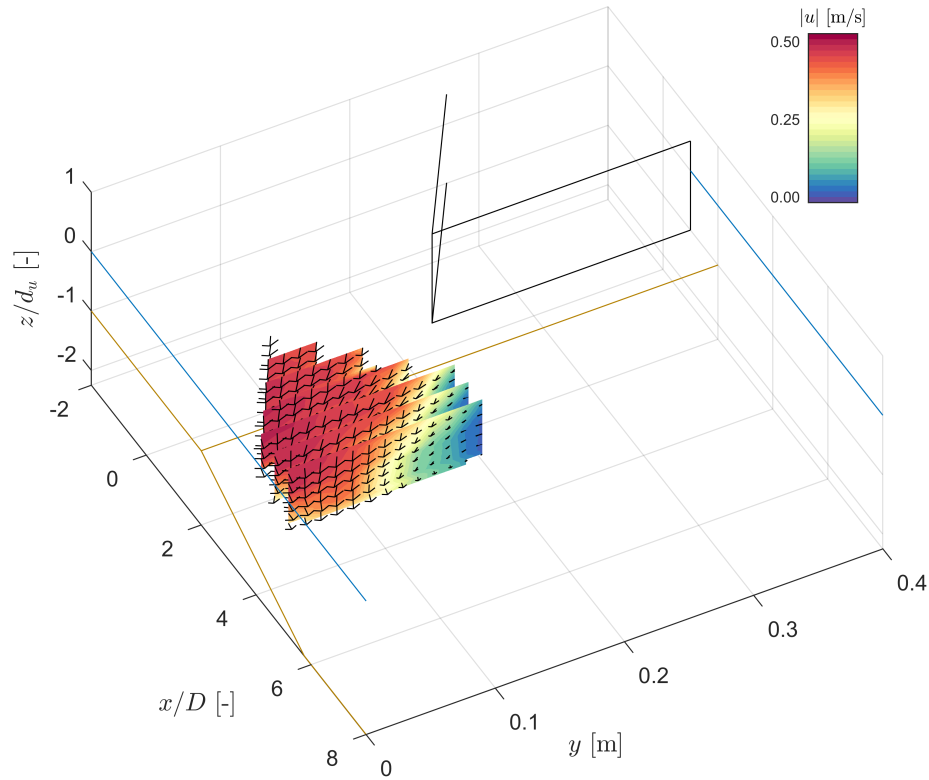

FIGURE 11. Interpolated three-dimensional, time-averaged flow field for case 15 (see Table 1).

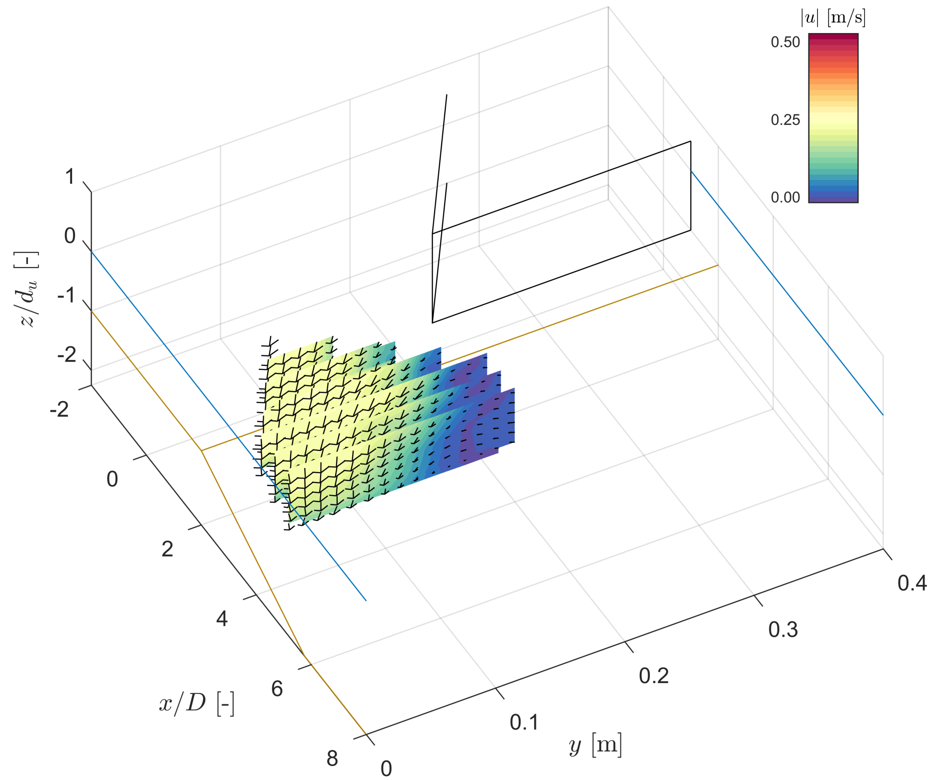

FIGURE 12. Interpolated three-dimensional, time-averaged flow field for case 16 (see Table 1). This case is characterized by a lower flow velocity at the inflow boundary.

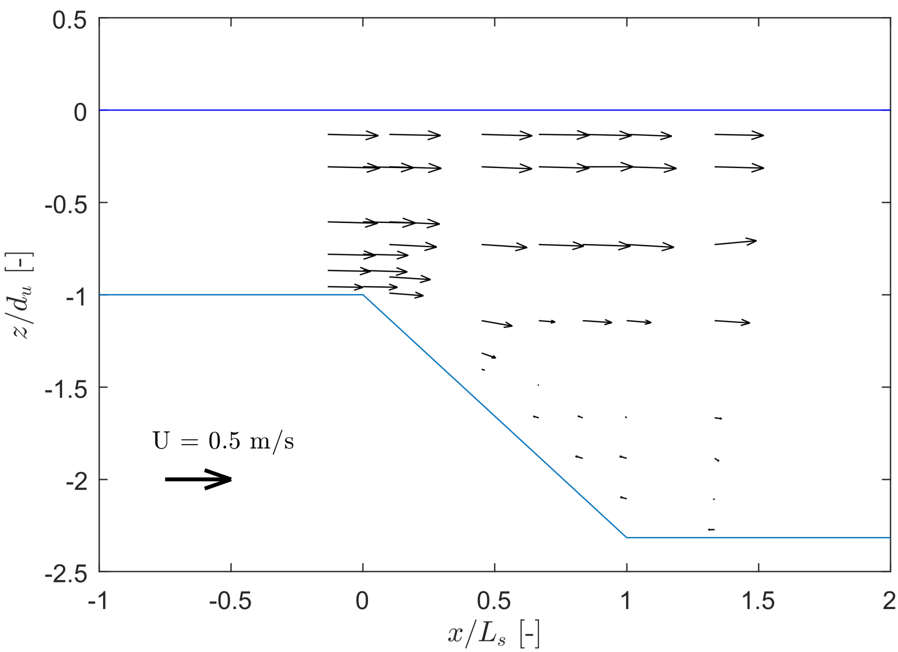

FIGURE 13. Time-averaged 2D-vertical flow field for case 2 (see Table 1).

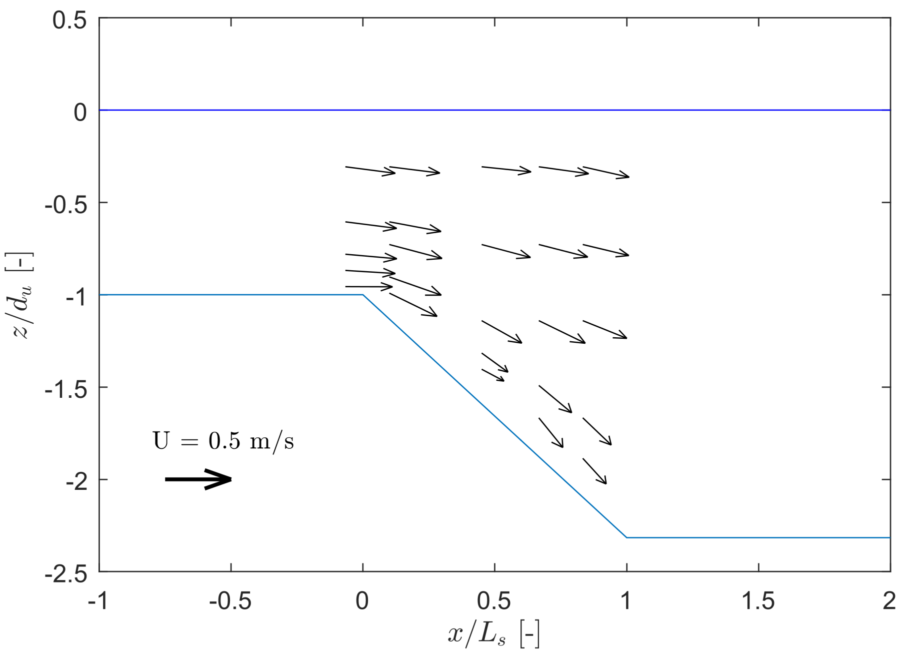

FIGURE 14. Time-averaged 2D-vertical flow field for case 3 (see Table 1).

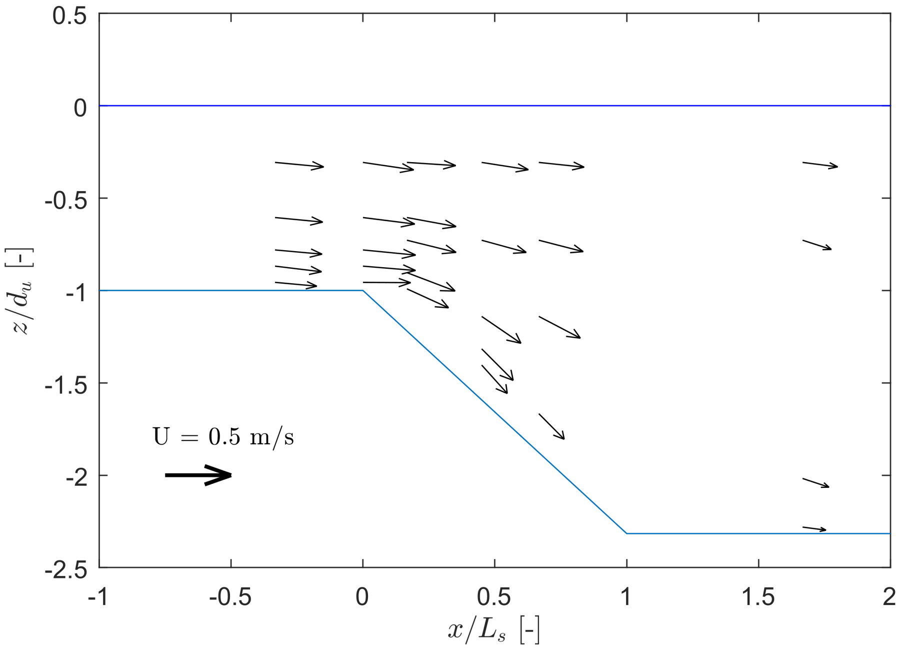

FIGURE 15. Time-averaged 2D-vertical flow field for case 4 (see Table 1).

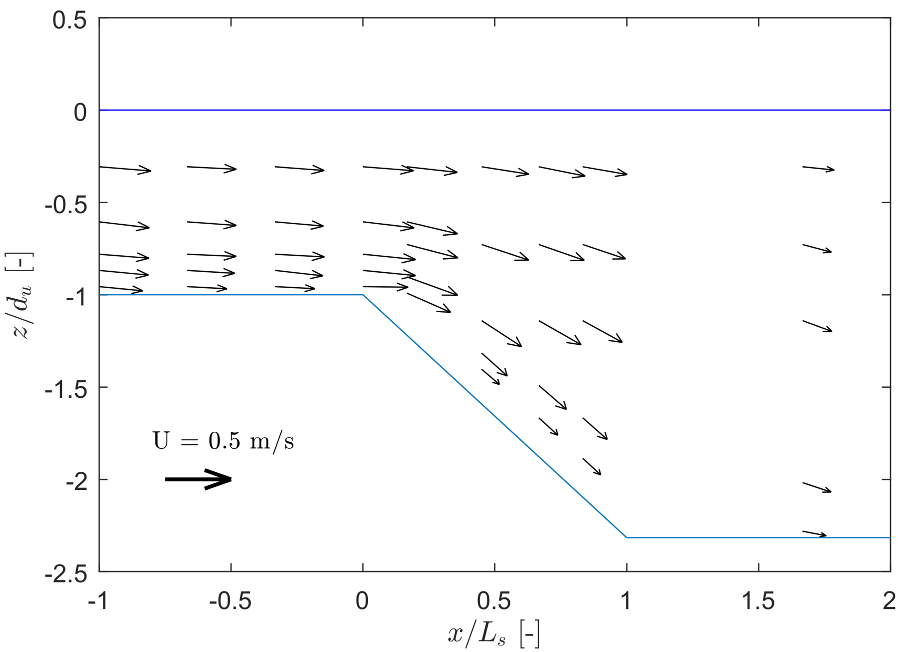

FIGURE 16. Time-averaged 2D-vertical flow field for case 5 (see Table 1).

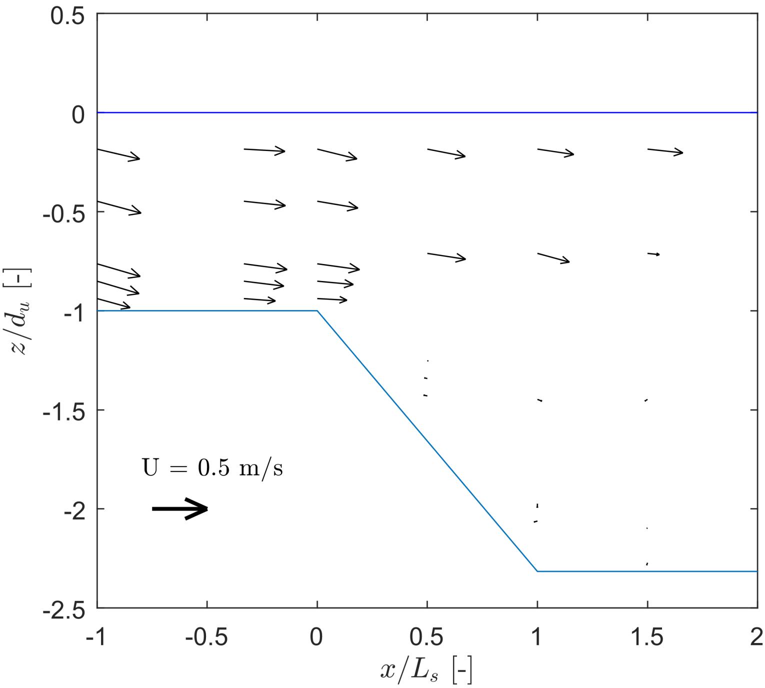

FIGURE 17. Time-averaged 2D-vertical flow field for case 6 (see Table 1).

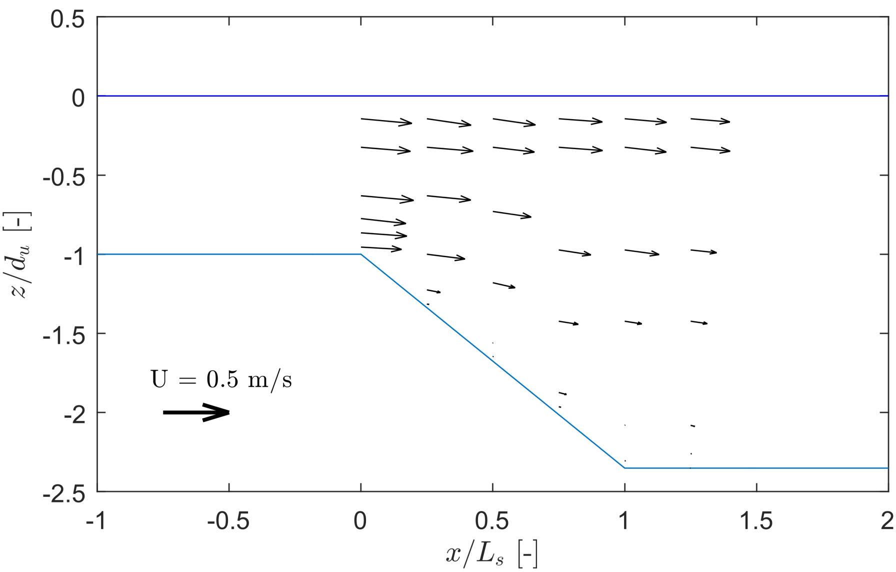

FIGURE 18. Time-averaged 2D-vertical flow field for case 7 (see Table 1).

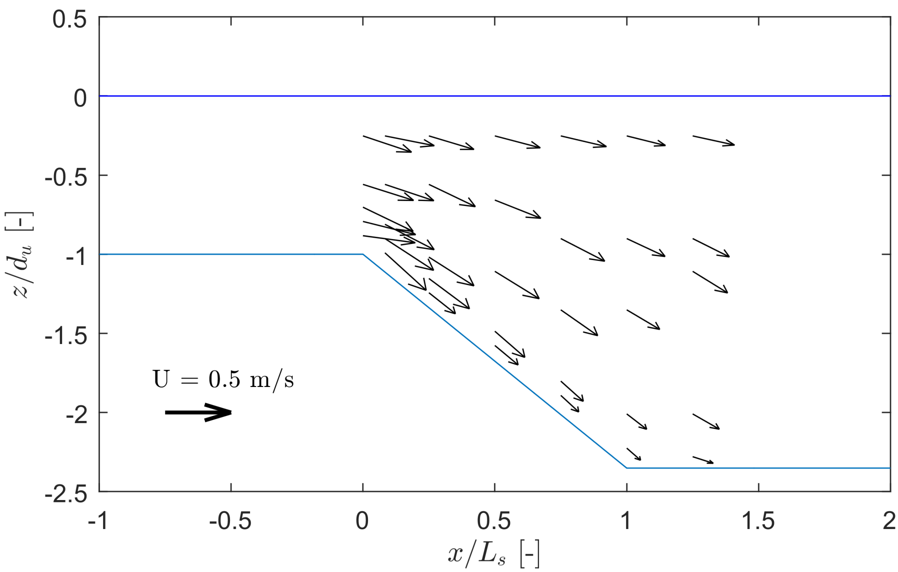

FIGURE 19. Time-averaged 2D-vertical flow field for case 8 (see Table 1).

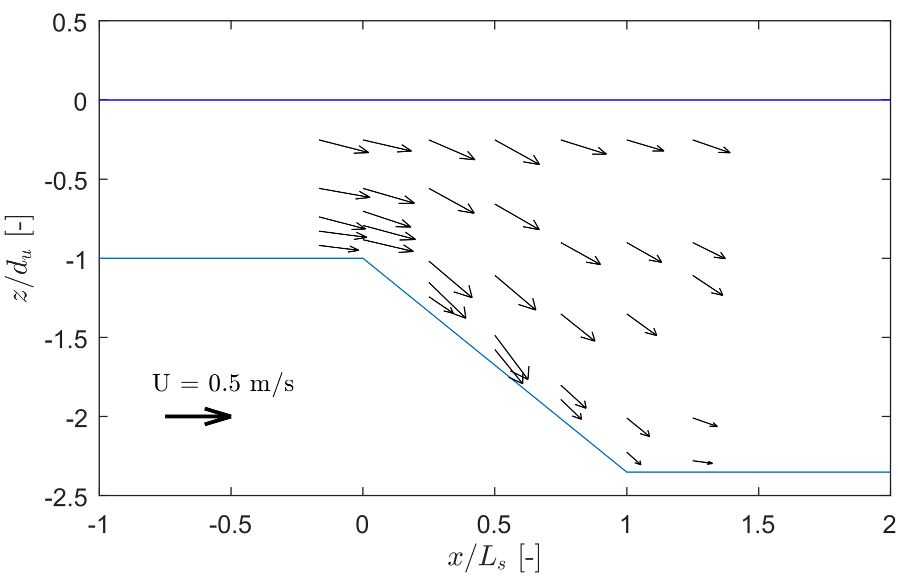

FIGURE 20. Time-averaged 2D-vertical flow field for case 9 (see Table 1).

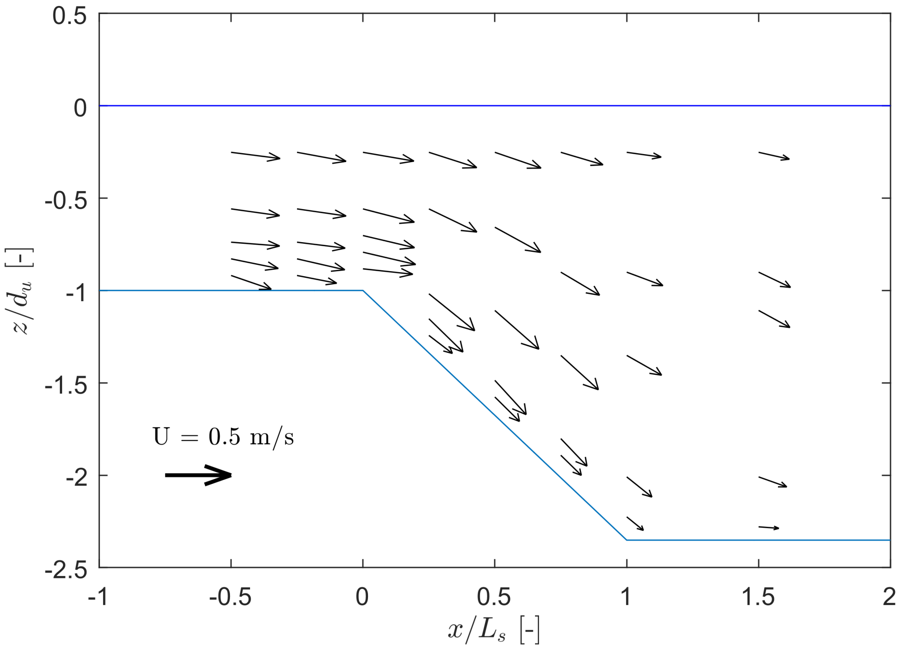

FIGURE 21. Time-averaged 2D-vertical flow field for case 10 (see Table 1).

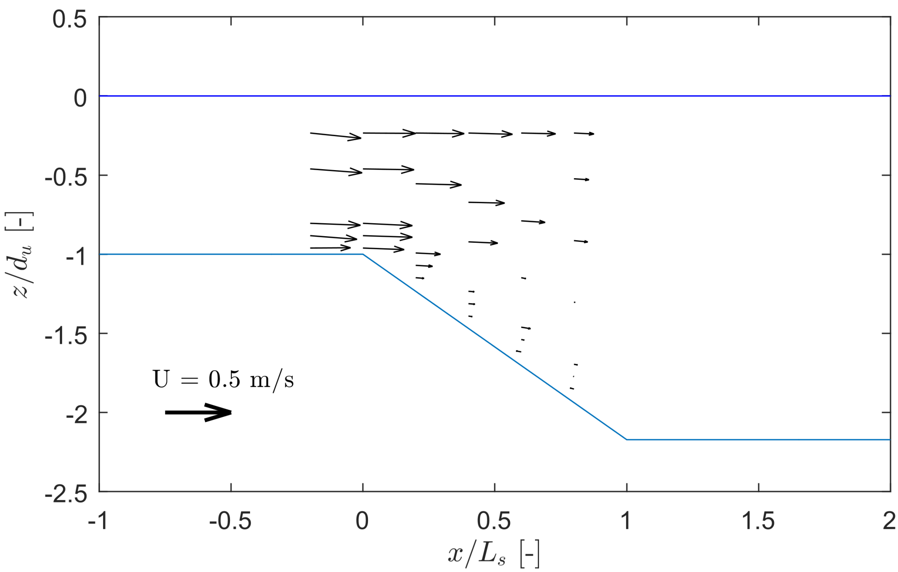

FIGURE 22. Time-averaged 2D-vertical flow field for case 11 (see Table 1).

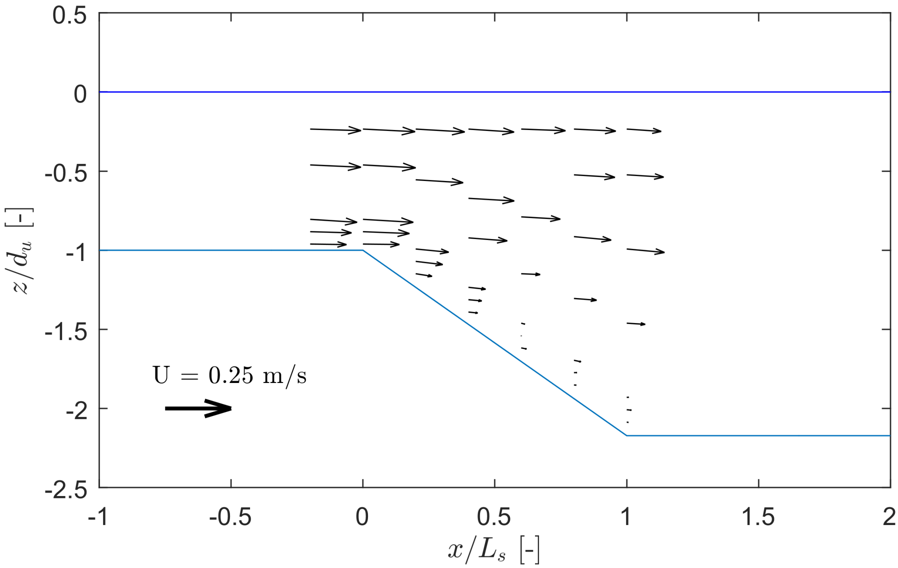

FIGURE 23. Time-averaged 2D-vertical flow field for case 12 (see Table 1). This case is characterized by a lower flow velocity at the inflow boundary.

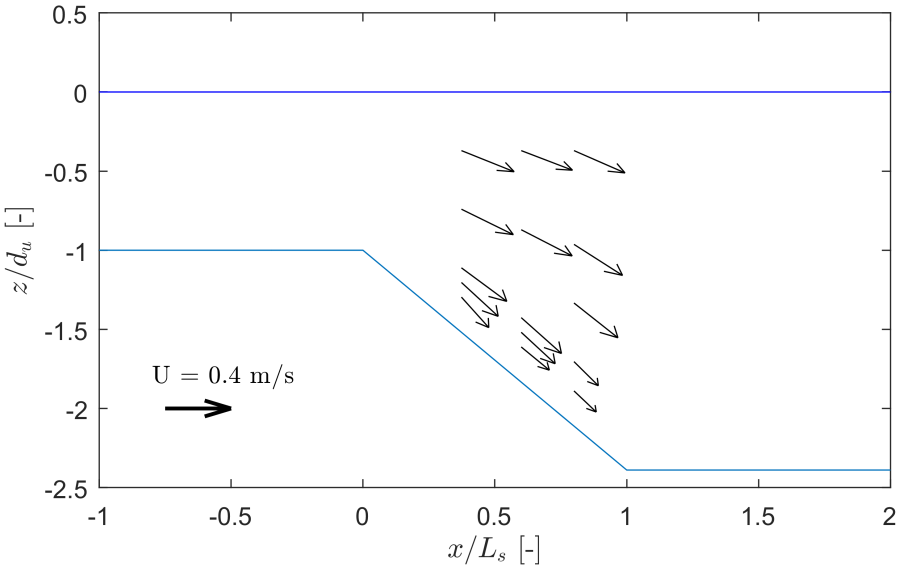

FIGURE 24. Time-averaged 2D-vertical flow field for case 13 (see Table 1).

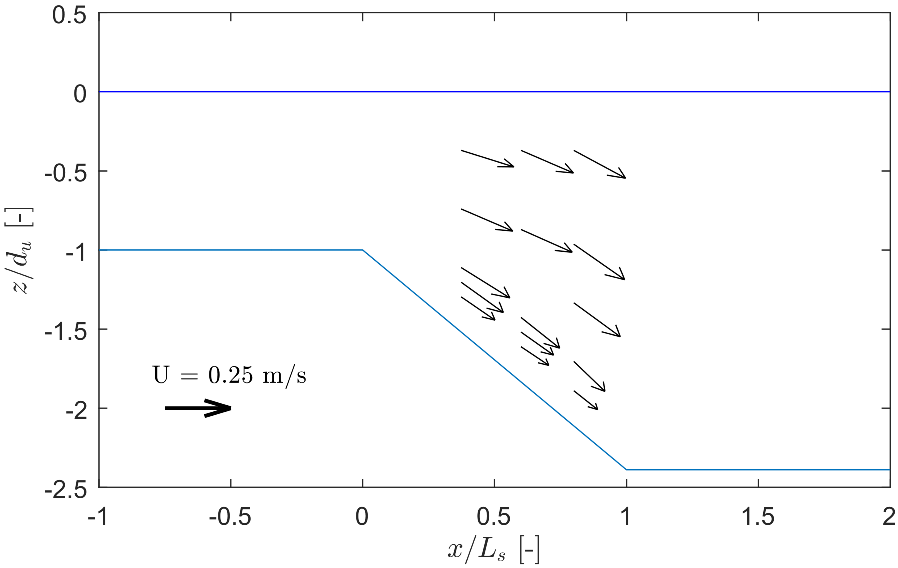

FIGURE 25. Time-averaged 2D-vertical flow field for case 14 (see Table 1). This case is characterized by a lower flow velocity at the inflow boundary.

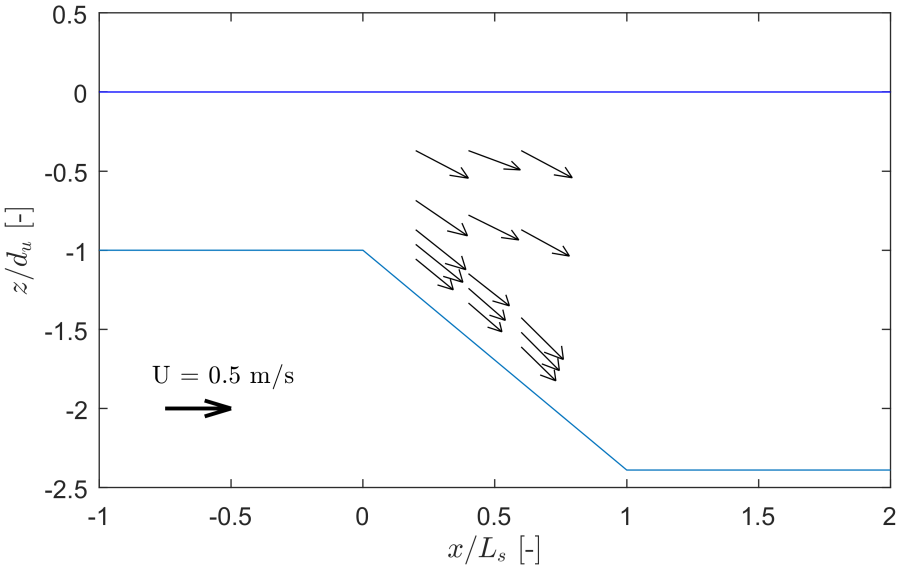

FIGURE 26. Time-averaged 2D-vertical flow field for case 15 (see Table 1).

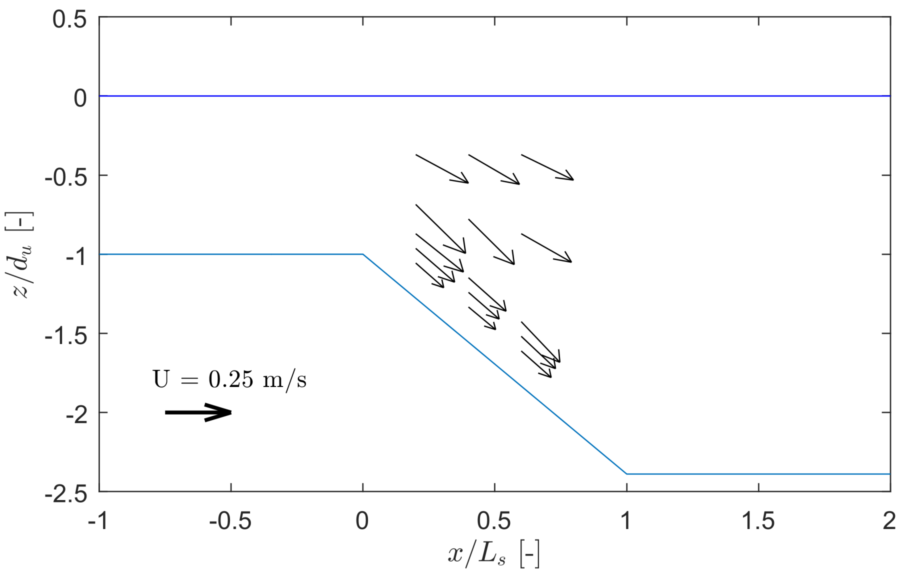

FIGURE 27. Time-averaged 2D-vertical flow field for case 16 (see Table 1). This case is characterized by a lower flow velocity at the inflow boundary.