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Hydrodynamics and contaminant transport on a degraded  
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Mechanics, 18(2), 443-463"**

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1 Discussion of “Tang, H., Zhang, H., & Yuan, S. (2018). *Hydrodynamics and contaminant transport on*  
2 *a degraded bed at a 90-degree channel confluence. Environmental Fluid Mechanics, 18(2), 443-463*”

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## 8 **Abstract**

9 The authors measured and computed the hydrodynamics and passive scalar dispersion in 90-degree  
10 open channel confluences over flat and degraded beds with a dominant upstream or tributary inflow.  
11 The present discussion essentially deals with the direction of rotation of the secondary currents,  
12 reported for the flat bed configuration with dominant tributary inflow. This rotation direction is indeed  
13 surprisingly opposite to the ones reported in the literature, both from calculations and measurements,  
14 even if present geometry slightly differs from literature geometries.

15

## 16 **Discussion**

17 The authors present an interesting work on hydrodynamics and passive scalar transport in asymmetric  
18 open-channel confluences both over flat and degraded beds. The paper deals notably with degraded  
19 bed configurations, which bring undoubtedly interesting new knowledge, since flat bed intersections  
20 have been more frequently addressed. The comparison of these existing flow descriptions with the  
21 authors’ results motivates the present discussion. This is especially the case for the 90° angle  
22 confluences in which the three branches have a rectangular cross-section of equal width (*i.e.* a  
23 geometry which differs somewhat from the one considered by the authors, where the downstream  
24 branch has a 33% larger width than the tributary and the upstream branches). Several flow structures  
25 are reported by *e.g.* Best (1985), Shumate (1998) and Weber *et al.* (2001): the shear layer at the  
26 interface, the stagnation zone, the recirculation zone and the secondary currents in the downstream  
27 branch. In particular, as the momentum ratio between the tributary and upstream branches (which  
28 simplifies into the square of discharge ratio for equal widths of the incoming branches) exceeds 1, a  
29 helix-shaped secondary current occurs in the accelerated flow region besides the recirculation zone of  
30 the downstream branch. Further downstream, this helix-shaped current occupies most of the section of

31 the downstream branch. As mentioned by the authors, this secondary current strongly affects the  
32 passive scalar transport downstream from the confluence (see also *e.g.* Chen *et al.*, 2017).

33 For the aforementioned confluence case (*i.e.* a concordant flat bed case with equal width channels and  
34 a tributary to upstream momentum ratio exceeding 1), the flow patterns were previously measured by  
35 Weber *et al.* (2001) and Schindfessel *et al.* (2015) (with a chamfered rectangular cross-section) and  
36 computed by Huang *et al.* (2002), Shakibainia *et al.* (2010), Yang *et al.* (2013), Riviere *et al.* (2015)  
37 and Schindfessel *et al.* (2015). All these works indeed report a helix-shaped secondary current in the  
38 accelerated flow region besides the recirculation zone (and beyond) of the downstream branch.  
39 Nevertheless, the rotation direction of this helix-shaped current differs from the one computed by the  
40 authors in their scenario S3/S7. All previous works report a secondary flow coming from the tributary  
41 that passes above the upstream flow, then plunges along the opposite wall and returns towards the  
42 tributary bank along the near-bed layer. For the sake of conciseness, this rotation direction will be  
43 referred to as “classical” in the sequel. Oppositely, the authors’ S3/S7 flow pattern (plotted in figure 7,  
44 3<sup>rd</sup> column and 3<sup>rd</sup> to 5<sup>th</sup> line) exhibits a helical motion in the opposite rotation direction, with the  
45 tributary flow plunging below the upstream flow towards the opposite wall, then rising along this  
46 opposite wall ( $y/W_d \sim 1$ ), returning towards the tributary bank ( $y/W_d \sim 1$ ) in the near-surface layer and  
47 finally plunging to close the loop. As this computed direction of rotation is the opposite from the  
48 classical one, it would be necessary to compare it to experimental data for verifications. Unfortunately,  
49 measured transverse velocities characterizing the secondary flow are not shown for scenario S3/S7.  
50 Therefore, discussers would be grateful if the authors can plot the secondary current measured for this  
51 scenario and discuss the computed rotation direction.

52 Regarding passive scalar dispersion, Riviere *et al.* (2015) in their figures 5 and 7 (right column) show  
53 that the secondary current rapidly transports by advection i) water coming from upstream towards the  
54 tributary bank along the near-bed region and ii) water from the tributary to the opposite bank along the  
55 near-surface region, *i.e.* along the classical rotation direction. The mixing efficiency is then enhanced  
56 for this tributary dominated configuration compared to the flow patterns with an upstream velocity  
57 exceeding that of the tributary. Oppositely, the scalar fields computed by the authors indicate that their  
58 tributary flow (red in figure 8c and blue in figure 9c) plunges below the upstream flow and is

59 transported towards the opposite bank along the near bed region, while the water from the upstream  
60 flow is transported towards the tributary bank along the near-surface region. Riviere *et al.* (2015) then  
61 conclude that “these helical motions strongly enhance the mixing process”. This is a strong  
62 contradiction with the author’s statement that “... the magnitudes of  $V$  and  $W$  components are very  
63 small, and thus they have a limited effect on the flow structure and mixing at channel confluences”.

64 Reasons for the inverted computed helical motion by the authors cannot be attributed to the turbulence  
65 model as the authors resolve the 3D-RANS equations using a Reynolds Stress Turbulence model,  
66 similarly to Riviere *et al.* (2015), who retrieve the classical rotation direction of the secondary flow. It  
67 can neither be attributed to the free-surface calculation technique as the authors apply the VOF  
68 method, similar to Yang *et al.* (2013) in their run 5. The non-classical rotation direction may be related  
69 to the vertical profiles of transverse velocity (along  $y$  axis) in the tributary near  $y/W_d \sim 0$  (Fig. 7, 1<sup>st</sup> line,  
70 3<sup>rd</sup> row) showing a velocity maximum at a relatively low elevation above the bed, i.e. in the lower half  
71 of the water column. This could be connected, perhaps, to the authors’ channel geometry where the  
72 wider downstream branch forms a non-classical intersection compared to the literature. Again, a plot  
73 of the experimental vertical profiles of transverse velocity at the upstream and downstream ends of the  
74 tributary would be invaluable to conclude on this rotation direction being odd with the ones reported in  
75 the literature.

76

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