

Manuscript [hess-2020-188](#): “*Spatial distribution of tracers for optical sensing of stream surface flow*” by Pizarro et al.

We report a detailed response to each of the comments and suggestions below (text in red).

### **Reviewer 3**

Obs. 1: This manuscript deals with the image velocimetry method and suggests a new metric to evaluate the seeding quality. The study is interesting, but there are some issues that need to be addressed.

Ans. 1: We thank the anonymous Reviewer 3 for the detailed feedback, comments, and suggestions provided.

Obs. 2: There are some vague sentences.

Ans. 2: We will revise the text carefully to avoid any vague sentence and lack of clarity.

Obs. 3: At some points, the text lacks the necessary details to fully comprehend the steps followed. For example, the authors do not provide any information on how the motion of the particles of the synthetic images was simulated. Similarly, the concept behind some assumptions is not explained (see below the comment about "multiplication of power laws" and the comment about  $v=D$ ).

Ans. 3: Thank you for pointing out this matter. Please, see Ans 2, Ans. 16, and Ans. 18.

Obs. 4: The value of the suggested index is not fully demonstrated. The authors need to show what would be the error if all frames were used instead of selecting frames based on the suggested index.

Ans. 4: Please, see Ans. 21.

Obs. 5: The well known constant  $\pi$  is used as a symbol for the suggested metric. This is like using number 1 as a symbol for a variable or index.

Ans. 5: Please, see Ans. 6.

Obs. 6: The specific locations in the manuscript of the previous general comments are given below. Location: "A descriptor of the seeding characteristics (based on density and aggregation) was introduced based on a newly developed metric  $\pi$ ." Comment: In mathematics, the Greek letter  $\pi$  is

reserved to be used for one and only one thing, the ratio of a circle's circumference to its diameter. Please use another symbol (e.g., "SCD")

**Ans. 6:** We appreciate the reviewer for bringing us this issue. The Greek letter " $\pi$ " is frequently used to define dimensionless parameters. Nevertheless, and with the intention to avoid any confusion, a different symbol will be adopted in the revised version of the manuscript.

References:

1. Buckingham, E. (1914). On physically similar systems; illustrations of the use of dimensional equations. *Physical review*, 4(4), 345.
2. Evans, J. H. (1972). Dimensional analysis and the Buckingham pi theorem. *American Journal of Physics*, 40(12), 1815-1822.
3. Melville, B. W., & Sutherland, A. J. (1988). Design method for local scour at bridge piers. *Journal of Hydraulic Engineering*, 114(10), 1210-1226.
4. Hanche-Olsen, H. (2004). Buckingham's pi-theorem. NTNU: <http://www.math.ntnu.no/~hanche/notes/buckingham/buckingham-a4.pdf>.
5. Pizarro, A., Ettmer, B., Manfreda, S., Rojas, A., & Link, O. (2017). Dimensionless effective flow work for estimation of pier scour caused by flood waves. *Journal of Hydraulic Engineering*, 143(7), 06017006.

**Obs. 7:** Location: "A reduction of image-velocimetry errors was systematically observed by decreasing the values of  $\pi$ " Comment: Since this is a metric, not a parameter that can be directly adjusted, it would be better to write "A reduction of image-velocimetry errors was systematically observed with lower values of SCD"

**Ans. 7:** The sentence will be reformulated in the revised version of the manuscript to avoid any lack of clarity within the text.

**Obs. 8:** Location: Equation 1 Comment: It looks like S is missing after the  $\exp(1)$ .

**Ans. 8:** Thank you for pointing out this matter. Indeed, there is a typing error that will be amended in the revised version of the manuscript.

**Obs. 9:** Location: "The range of variability was established based on the ..." Comment: Does this refer to the values of the previous sentence?

**Ans. 9:** The sentence in question refers to the values written in the previous sentence, i.e. "*14 different seeding densities ranging from 0.4E-05 particles per pixel (ppp) up to 1.0E-02 (ppp)*".

**Obs. 10:** Location: "Furthermore, each numerical experiment contains 20 images, ..." Comment: How these 20 images were created?

**Ans. 10:** Synthetic images were generated using a Matlab code written by the authors for this purpose. The spatial distribution of synthetic tracers follows the Generalised Poisson Distribution (GPD),

presented in Eq. (1) of the manuscript. The main advantage of using this numerical approach is the fact that the seeding density and the clustering level of synthetic tracers can be controlled and associated to a parameter ( $\nu$  and  $\lambda$ ) of the GPD. Synthetic tracers move with a constant velocity of 15 pixels/frame along the y-axis. A numerical experiment was defined as 20 synthetic generated images following the mentioned information. All the data used in this study is freely available at <https://doi.org/10.5281/zenodo.3761859>.

Obs. 11: Location: "ð IJ'R ranges from 0.5 to 200 (12 different values) ..." Comment: It is very unusual to start a sentence with a lowercase variable.

Ans. 11: The sentence will be rephrased.

Obs. 12: Location: Lines 163-175 Comment: These lines should be broken into two paragraphs, one for PTV and one for PIV.

Ans. 12: The new version of the manuscript will take this issue into consideration.

Obs. 13: Location: "The theoretical velocity was set at 15 px/frame ..." Comment: This term("theoretical velocity") is repeated many times in the manuscript, but its meaning has not been defined

Ans. 13: Thank you for pointing out this matter. The "*theoretical velocity*" term will be defined at line 99, within the Numerical Simulation Section.

Obs. 14: Location: "... used 8 and 20 (px) " Comment: The unit px appears both inside parenthesis and without parenthesis (preferable) in the text.

Ans. 14: We will standardise the text in the revised version of the manuscript to avoid lack of consistency or clarity.

Obs. 15: Location: "PTV used 8 and 20 (px) for detection and tracking, respectively. PIV used FFT with three-passes (128x64, 64x32, 32x16)." Comment: This information has been already given (and more clearly) previously. It would be better to remove these sentences.

Ans. 15: This repeated information will be removed from the main text in the revised version of the manuscript.

Obs. 16: Location: "where f = function" Comment: This is not a solid definition, neither from a linguistic nor from a mathematical point of view. c Location: "The function f is usually considered as a multiplication of power laws." Comment: A reference is required.

Ans. 16: Thank you for bringing us this issue. The sentence in question will be reformulated to avoid

confusion. Furthermore, the references given in Ans. 6 will be added at this point.

Obs. 17: Location: "rhocv1 values for PIV and PTV were taken from Figure 4 and are 1.52E-03 and 1.02E-03, " Comment: The error, for low error values, is not very sensitive on the suggested metric. What if a single ' $v=1$  converging seeding density' was used for both PTV and PIV? This would reduce the number of parameters.

Ans. 17: Although PIV and PTV are useful for image-based velocity estimates, they rely on different algorithms. In consequence, it is conceptually reasonable that the minimum seeding density assuring an error of about 2 – 3% in Figure 4 were different. Furthermore, the number of parameters will not be reduced since it does not modify  $\pi$  or Eq. (5).

Obs. 18: Location: "the empirical aggregation level (i.e., the empirical one equivalent to the used in the numerical simulations), was quantified through the dispersion index D." Comment: This approach, which assumes D as an estimator of  $v$ , needs to be justified and explained with more details.

Ans. 18: Thank you for pointing out this issue. We agree with the reviewer that more details should be given at this regard. The new version of the manuscript will cover this issue as well as the introduction of a new section called "*Strengths and Limitations*" of this research.

Obs. 19: Location: "A moving window of 100 frames was arbitrarily chosen, " Comment: What exactly was chosen arbitrarily, the length of the window?

Ans. 19: The length of the window was arbitrarily chosen, corresponding with 100 frames. The sentence will be reformulated to avoid confusion.

Obs. 20: Location: "Figure 8.A shows the particular case of PTV; nevertheless, PIV presented similar results. The locations of the minimum and maximum  $\pi$  values was, therefore, unaffected by the image-velocimetry technique under consideration." Comment: Why PTV and PIV would present different values for the suggested index? Is it because of the different rhocv1 used for each method? If so, then this (the fact that PIV and PTV presented similar results) is an indication of using a single rhocv1 value for both methods (see previous comment)

Ans. 20: Thank you for this observation. Please, see Ans. 18 as well. Indeed, PTV and PIV presented different  $\pi$  values because of  $\rho_{cv1}$ . However, using the same  $\rho_{cv1}$  for both PIV and PTV is equivalent to assume that both algorithms work in the same way (which is far from being right). Additionally,  $\rho_{cv1}$  was estimated using a huge numerical framework, resulting in different values for PIV and PTV. Finally, there is no advantage in using only one common value since the number of coefficients remains invariable.

Obs. 21: Location: Table 2 Comment: What would be the error if all frames were used?

Ans. 21: The average absolute errors calculated using PTV and PIV if all frames were used are



23.93% and 23.69%, respectively. Nevertheless, this research introduced a new dimensionless parameter able to identify the best location of  $N$  frames, minimising image-based errors. Comparing these errors with the ones using  $\pi$ , it is possible to appreciate that they are essentially the same (23.31% and 24.11% for PTV and PIV, respectively); even though the number of frames used with  $\pi$  is the half with respect to the total number of frames. A sentence will be added to the “*Strengths and Limitations*” section, highlighting this matter. Finally, the authors are currently working with a larger dataset to generalise the methodology.