# Comments on "River suspended-sand flux computation with uncertainty estimation, using water samples and high-resolution ADCP measurements"

## 1 Summary

This paper proposed a toolbox and a method to use high-resolution ADCP data and point-measured sand concentration data to estimate the suspended sand flux at a river cross-section. To achieve this, the paper proposes a method (SDC method) that employs the MAP method to interpolate the velocity field at the cross-section, then uses the BaM! method to estimate the vertical concentration profiles, and applies a physics-based approach for lateral interpolation. This work also includes uncertainty and error analysis of the SDC method. The toolbox is open-source and has been published online. The data used in this paper are also available for public access. This work performed a thorough analysis and quantified the error propagation in the sand flux measurement process; many of these errors are commonly neglected in other studies, which demonstrates the value and novelty of this work. How to use high-resolution measured data like ADCP data is always a question in scientific communities. The toolbox appears to provide a good solution to such an issue compare to the ISO method. This work is of good quality and worthy of publication. The main issue I encounter while reading this paper is the confusing definitions of different terms. This work focuses on the sediment transport theory proposed by Camenen and Larson (2008). There exists a variety of other classic sediment transport theories, which might have the potential to change the results of these analyses.

## 2 Major comments

1. Line 165. This work used an exponential function, or in other words, the linear profile, to describe the vertical profile of suspended sediment concentration. This is the result of assumption of constant vertical diffusivity (Line 164). However, it is known that the vertical diffusivity is not a constant in boundary layer flows. Is this linear form representative of the true profile? In Figure 5(b), one can observe a strong non-linear effect in the concentration data that is close to the bed. Is there a reason why the analysis was not performed using the Rouse profile or another similarly physically process-based profile to fit the vertical profile? Say

$$C(z) = C_R \left( \frac{(h-z)/z}{(h-z_a)/z_a} \right)^P \text{ where } P = \frac{w_s}{\sigma_t \kappa u_*}$$

2. There is a 2nd drawback using exponential fitting. In eqn. (1) quthor mentioned that the vertical profile is starting from a "reference level" $z_a$, if plug-in the $z_a$ into eqn. (4), have

$$C(z_a) = C_R \exp(\alpha z_a) \neq C_R \text{ unless } z_a = 0$$

This contradicts with the definition of $C_R$, that is the concentration at a reference level which is known not be 0 (Garcia, 2008; Wright and Parker, 2004; De Leeuw et al., 2020).

3. The definition of $\alpha$ needs a revise. In eqn.(4), eqn.(8) and line 201, $\alpha$ is negative. while in eqn.(5) and line 180 $\alpha$ is described positive. Here is an example. Line 180 states "$\alpha$ is strictly positive", while the definition of $\alpha$ in equation (8) denotes:

$$\alpha = -\frac{6w_s}{\sigma_t \kappa u_* h} < 0$$

4. Sec. 2.1.1 It is not clear that whether the Multitransect Averaged Profile (MAP) method is part of the contribution of this paper or not. The citation in this section pointing to an EGU talk. I did a quick google search and did not found detailed documentation on MAP method online. If this is part of the contribution of this paper, it will be nice to show more details on this method. Particularly, how the extrapolation to solid wall and to free surface are done (introduce the formulas etc.). If it is not part of this paper, please add a citation that introduced this method.

5. Line 172. Here briefly introduced BaM! method and mentioned that a large number (¿10 000) realizations are sampled. Please make it clear that these realizations are sampled by varying which parameter. In Line 176 says "BaM! simulator produces 500 realizations". Please state clearly what the number of realizations is in this study.

6. Line 207. The definition of $u'_\alpha$ is "relative uncertainty". While the $\sigma_\alpha$ is the standard deviation of $\alpha$, which should have the unit of "absolute standard uncertainty". It seems that the equation $\sigma_\alpha = u'_\alpha$ is not correct. Similar issue in Line 219.

7. Line 222. This is a recommendation. This study chose reference concentration formula that is proposed by Camenen and Larson (2008) to perform the analysis. There exists a variety of such formulas (see Garcia (2008) Chapter 2). I think the choice of reference concentration formula and the choice of formula for vertical suspended sediment concentration profile both could impact the uncertainty analysis. Has author considered the error caused by the choice of these theories/formulas?

8. Eq. (14). $\Phi_l$ is not defined. The last term has the form of flux weighted sum of $u'_{p,l}$. However, without clear definition of $\Phi_l$, one may suspect that $\Phi \neq \sum_l \Phi_l$

9. Line 416 and Figure 8. The result demonstrates that the uncertainties in all these river data are dominated by the vertical integration $U'_p$. It might worth to look at how much changing the sediment transport theory, such as reference concentration equation and vertical profile theory could impact the results.

# 3 Other comments

1. The standard cross-referencing of equations should have a parenthesis, e.g., Eq. (1). Figure caption should be bold etc. See format requirement from eSurf website: https://www.earth-surface-dynamics.net/submission.html#templates

2. The format of References also need to be revised.

3. The figure captions are not detailed enough. For example, in Figure 5 and 6, there is no explanation in the figure or in the caption to tell what the meaning of the different lines and the numbers in legends are.

4. Line 55. The VMT is mentioned several times in the paper without indicating its full form. I suggest to provide the full name of it in the introduction.

5. Similarly, for other abbreviations, e.g., please define "BaM!" method in Line 168. MaxPost profile in Line 176. QRevInt in Line 57 etc., it would be nice to give full definition of them.

6. Line 119-124. The choice of symbols $u, u', U, U'$ to represent different uncertainties is confusing. It is convention in fluid mechanics that $u$ and $U$ represent flow velocity; $u'$ and $U'$ represent velocity fluctuations. The author uses the velocity $u$ in Equation (1) as well. I recommend use other symbols to represent these uncertainty metrics.

7. Line 239. Another similar issue, $h$ is defined as water depth in Line 92, while it is used to describe cell height here. It is better to use another symbol for cell height.

8. Line 224, please define what is $h_j$.

9. Line 119-124. A second suggestion on the terminologies. From description, here is my understanding, $u$ is standard deviation $\sigma$ (which is pointed out in the text). $u'$ is the coefficient of variation $CV$. $U$ is similar to $k\sigma$ the z-score, etc. It will be helpful to include these common concepts in statistics in their definitions. My understanding might be correct or might be wrong. So please define clearly what are these terms (using equations) to avoid confusing.

10. Line 187. In Eqn.(6), the constant should be $1.5 \times 10^3$

## References

De Leeuw, J., Lamb, M. P., Parker, G., Moodie, A. J., Haught, D., Venditti, J. G., and Nittrouer, J. A. (2020). Entrainment and suspension of sand and gravel. *Earth Surface Dynamics*, 8(2):485–504.

Garcia, M. (2008). Sedimentation engineering: processes, measurements, modeling, and practice. American Society of Civil Engineers.

Wright, S. and Parker, G. (2004). Flow resistance and suspended load in sand-bed rivers: simplified stratification model. *Journal of Hydraulic Engineering*, 130(8):796–805.