

Response to Reviewer #1

by Bruno Cheviron and Roger Moussa

N.B. The line numbers noted LXXX-YYY refer to the revised word document

General Comment

Overall, I liked reading this critical review of existing models that can be used for the coupled modeling of water flow and sediment transport in hydrology. I'm not a big fan of review articles in general, but in this case – provided that review articles are allowed by the journal – I express appreciation for the work and limit myself to specific comments about the manuscript. The paper is clear and well written and the review of the methods presented (at least to my knowledge) is quite complete. The English usage is correct, and the presentation of good quality. I have only a few minor comments about the manuscript:

Response (R): We thank Reviewer #1 for his positive evaluation and encouragements. We totally agree with his comments and will introduce responses in the revised version as shown below.

- I see that while the "flow" parts are discussed based on specific equations, the "sediment transport" sections are a bit more qualitative, and there are no equations there. I'm wondering if this is a deliberate choice of the authors and if they could comment a bit on this choice, maybe even in the manuscript;

R: This was indeed a deliberate choice, searching for the determinants of modelling strategies in the refinement of the flow and erosion models, then in flow typologies, then in the dimensionless numbers used.

Regarding erosion, the default/starting hypothesis was that the complexity of erosion models roughly tended to match that of the flow models to which they were associated (Section 2). However, the search for determinants of erosion modelling goes through several other stages, as announced now in Section 2.1.2. An explanation will be added L166-173.

“On the one hand, this advocates the examination of erosion issues from the angle of decreasing refinements of the "flow and erosion" models seen as a whole (e.g. expecting the most complicated erosion processes to be out of reach of the simplest combined models). On the other hand, there might be a certain disconnection between the refinement of the flow model and that of the chosen friction and erosion models, so the determinants of modelling choices should also be sought elsewhere: in flow typologies dictated by friction and flow retardation processes but also in "erosion types", seen through a dimensionless descriptor (Section 3).”

- Most of the paper's figures are quite dense, and I suggest to comment on these plots more broadly to guide the reader across them;

R: We agree. To do so, we will focus on a few "textbook cases", i.e. 6 cases now explicitly referred to in Fig.2, 3, 6a and 7a, shown by letters A to F, detailed in the new Table 1 and in the associated paragraph added in the corpus L505-521. The legends of the cited figures have been slightly modified to mention these textbook cases.

The new Fig.2 (L404) is hereunder and only the last sentence of its legend has been modified to mention the A to F sketches.

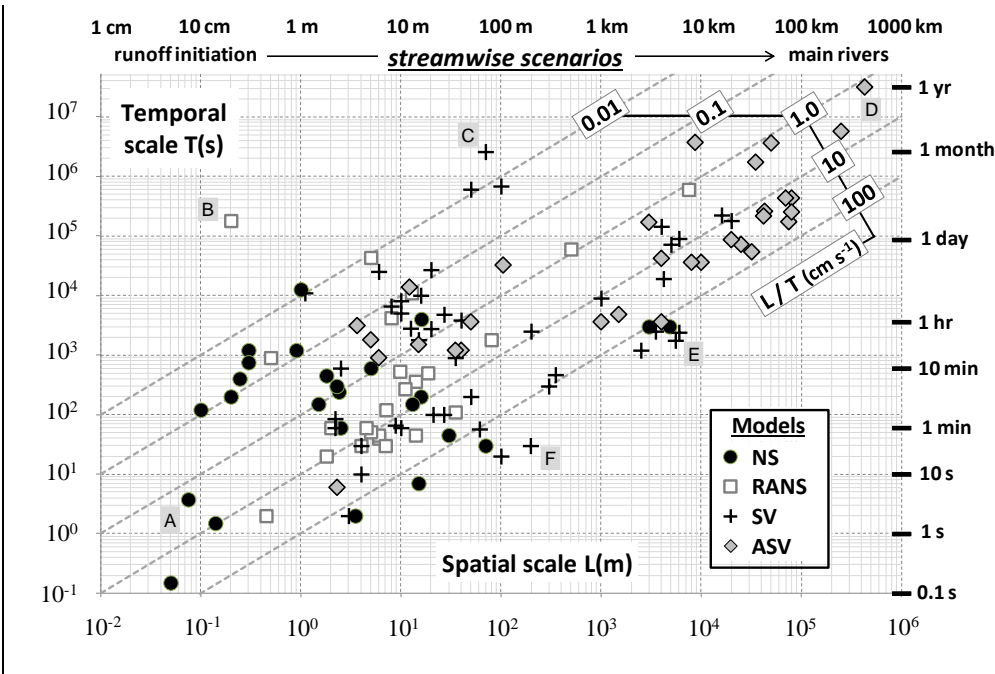


Figure 2 – How increasing (L, T) spatiotemporal scales of the flow domain tend to be associated with decreasing complexity in the choice of flow models, sorted here into four levels of refinement: Navier-Stokes (NS), Reynolds-Averaged Navier-Stokes (RANS), Saint-Venant (SV) or Approximations to Saint-Venant (ASV). A transverse analysis involves forming L/T ratios, searching for clues to model selection according to these "system evolution velocities" or governed by flow typologies that would exhibit specific L/T ratios. This figure was assembled from information available in the studies cited in Appendix A, selecting six textbook cases (sketches A to F, Table 1) for illustration.

The new Table 1 is the following.

Case	Context	Authors	Model refinement	Spatiotemporal scales					Flow typology‡	Dimensionless numbers§					
				L (m)	T (s)	H (m)	L/T (m s ⁻¹)	H/L [†] (-)		T*	Re	Fr	S (%)	Λ _z	θ
A	Film flow	Charpin & Myers (2005)	NS	0.075	3.75	0.003	0.02	0.04	O	5	300	0.11	10	8.0	-
B	Laminar dynamics	Charru et al. (2004)	RANS	0.2	1.8 10 ³	0.007	1.1 10 ⁻⁶	0.035	O	6428	50	0.02	<0.01	12.1	0.14
C	Pool-riffles	Rathburn & Wohl (2003)	SV	70	2.6 10 ⁶	0.47	3.5 10 ⁻⁵	6.7 10 ⁻³	B	7.8 10 ⁴	7.1 10 ⁵	0.69	1.1	5108	34.1
D	Amazon River	Trigg et al. (2009)	ASV	4.3 10 ³	3.15 10 ⁸	10	1.4 10 ⁻³	2.3 10 ⁻⁵	F	58.5	8 10 ³	0.05	<0.01	6600	-
E	Step-pools	Grant et al. (1990)	SV	5530	1755	0.87	3.15	1.5 10 ⁻⁴	Hg	1.0	2.7 10 ⁶	1.03	4.5	1.25	-
F	Step-pools	Chin (1999)	SV	197.25	30	0.50	6.58	0.025	Hg	1.21	4.0 10 ⁹	3.58	6.25	1.22	-

† See section 3.1.2 - H/L is the fineness ratio of the flow

‡ See Section 3.2 - O: Overland, Hg: High-gradient, B: Bedforms, F: Fluvial

§ See Section 3.3 - T*: dimensionless period, Re: Reynolds number, Fr: Froude number, S: slope, Λ_z inundation ratio, θ Shields number

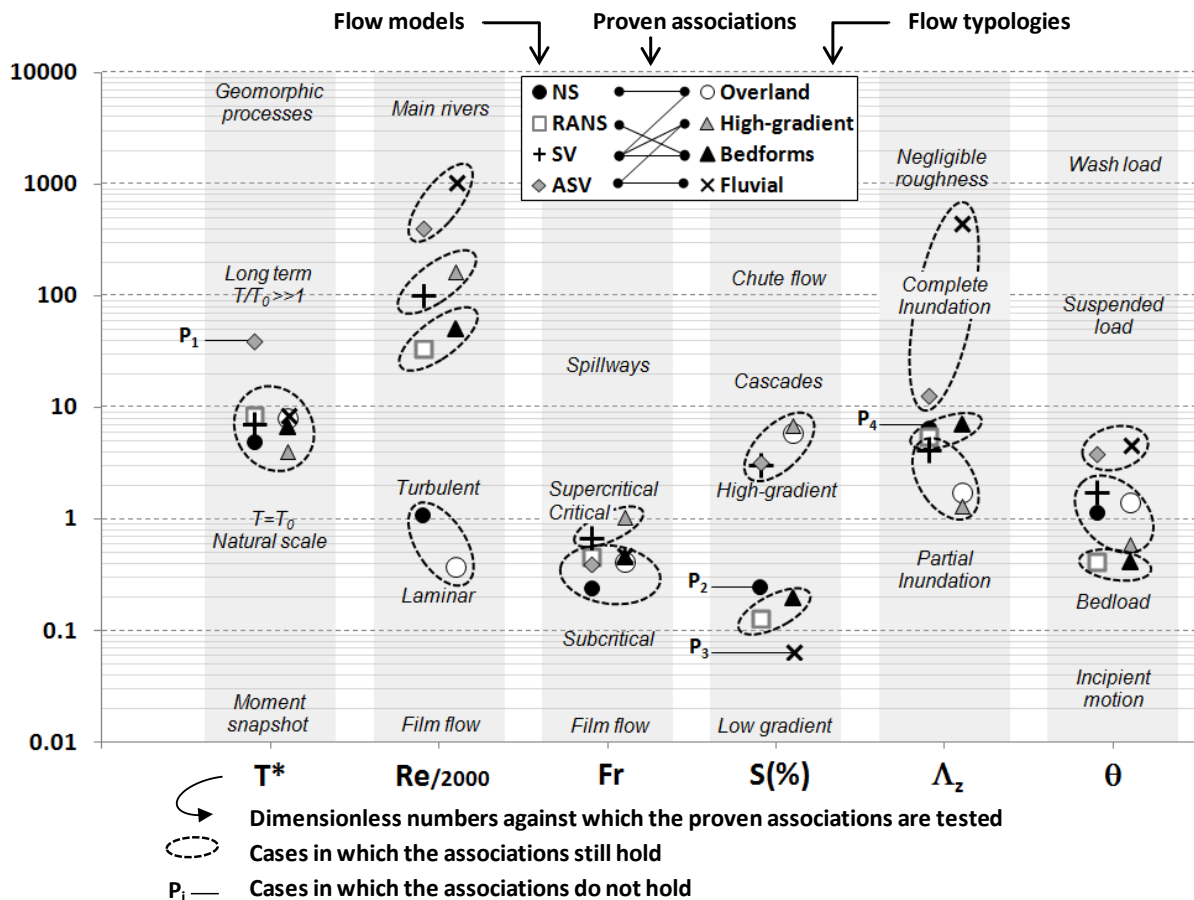
Table 1 - Six textbook cases representing an approximate envelope of all the tested cases in the L-T plane of Fig.2, where L is the spatial scale (length of the flow domain) and T the temporal scale (duration of the process studied). Spatiotemporal scales are the determinants of modelling choices discussed in Section 3.1. The additional influence of flow typology and dimensionless numbers are discussed in Sections 3.2 and 3.3.

The added paragraph is:

"To take a few examples and guide the reader through the arguments and the figures of this paper, Table 1 gathers the information available for the six textbook cases outlined by sketches A to F in Fig.2. The selected studies represent a wide variety of cases (drawing an approximate envelop of cases in the L-T plane of Fig.2) followed in the forthcoming stages of the analysis and associated figures in Section 3.1.2 (determinants of modelling choices in the L-H plane, Fig.3), Section 3.2 (determinants sought in flow typology, Fig.6a and 7a) and Section 3.3 (determinants sought in the values of dimensionless numbers attached to the flow)." (L505-511)

- In particular, the last figure of the paper is the most interesting result of the entire manuscript, and I suggest the authors to expand the description/comment on this very interesting result. I do not think the interpretation of this plot is trivial at all, so I believe its significance should be better emphasized in the paper text.

R: We agree. However, instead adding more elements in the text, we opted for some modifications of the old Fig.9 (now Fig.10, L865) to make it more self-explanatory, keeping its legend unchanged.



I do not have other specific comments, as the paper seems to be very accurate. The Figures are of good quality, referencing is appropriate and the discussion is clear and concise. Therefore, I congratulate the authors for the overall quality of the manuscript.

R: Thank you.