Comment on esurf-2021-35

Sebastien Carretier (Referee)

Philippe Steer presents a numerical solution scheme for the stream power incision model (SPIM) based on analytical solutions. This solution allows to reduce the computation time, and to preserve the shape of the knick-points, which are the two main advantages of this new model called Salève. The numerical solution proposed here does indeed offer perspectives for the inversion of topographies that would be demonstrably controlled by SPIM. Despite these interesting perspectives, I have several questions and remarks whose consideration could improve the clarity of this manuscript.

The first one concerns the evolution of the drainage network. In the simplest scenario with constant uplift, it is indicated that the rivers develop according to the same network as in the initial stage (p5 line3). I confess that I do not understand this, neither in the text nor in figure 1 which shows that the network varies during the iterations. It is also obvious that the network must adapt dynamically since the initial topography is noisy and without any connected network. So I probably missed something here. I have the same question about the transient simulations where it is said that the horizontal reorganization of the network is instantly accompanied by a topographic adaptation. How and why does this reorganization of the drainage network in Salève take place? I think that further explanation of the procedure by which the drainage network is established at a given iteration, or a given time, is strongly required.

Concerning the scope of this numerical solution, it is well specified that it is limited by the value of n=1, which could be different in natural cases. It would also be good to add that this model is a pure erosional model, without deposition and therefore a pure detachment limited model. The absence of sedimentation, which controls the degree of limitation by transport or detachment (Davy and Lague, 2009), could be discussed as one of the strong limitations. The treatment of colluvium erosion is treated here using a different value of m, referring to Lague and Davy (2003), but in that paper the erosion law includes a large erosion threshold, which results in an n>1 in the SPIM, whereas the law used in the Salève uses n=1. It is therefore questionable to argue that slope erosion is taken into account by changing only m.

Specific comments

Page 7 line 7. Could you explain what do you mean by "non-optimality of the planar organization of the river network" ?

Page 7 line 18 "than" -> as?

Page 9 line 27. Could you explain what do you mean by "slope patches"?

Page 11 I suppose you specify l1, l2 and l3?

Page 13 line 14 Carretier et al. 2016 (not 2015)-> the same in the biblio list