Rebuttal

We thank the reviewers and editors for their work. Reviewer #2 had some minor comments on the last version of the manuscript, which we have addressed in the revised version. We reply to all of the comments below in *italics*.

Reviewer #2
This manuscript presented a theoretical work on modeling the width evolution of channel belts as a Poisson process. Specifically, the channel path is modeled as a 1D random walk with a constant rate related to channel hydraulic parameters. Three growth phases are identified via linear, exponential, and drift phases. Bounds of the channel belt are also modeled via the law of the iterated logarithm, which has implications for flood hazard monitoring. Another novel finding is that a floodplain sediment age distribution proxy was also derived, including two practical approximations on top of the full numerical solution. The age distribution model was tested well against measurements of natural and experimental rivers. Overall, I think this paper is well-written and organized. I have read an earlier version of the manuscript and was not able to provide reviews on time (I apologize), but most of my comments (and the other reviewers') are already addressed. I appreciate the nicely made figures, referencing table for the equations, and list of variable names. I think the novelty of this manuscript is about constraining the rate parameters in the various distributions using channel width, valley height, and lateral transport capacity. All three parameters have physical meaning and can be measured in the field. At the same time, each of the three parameters has a range of complexity. For example, a range of hillslope processes are embedded in lateral transport capacity and valley height, and the channel width is the timeless hydraulic geometry problem in fluvial geomorphology. I think the thought process and the models provided here set a nice foundation that hopefully (will) inspire a series of future works on the more holistic understanding of how sediment transport processes in rivers shape its channel and channel corridor.
Thanks for the supportive comments!

I only have a few minor comments, hoping to improve the manuscript for Esurf's readers.
Comments:
I'd suggest a quick clarification about the steady state (in terms of mass balance): Is the width reaching a dynamic constant value, the bed slope, or both, and over what timescale?
Here, we are only concerned about the steady width of the channel belt. We treat both of the cases where belt width is steady and the entire belt drifts laterally (section 2.3.3) and a stochastically increasing belt width over time (section 2.3.2).
In all the derivations, we assume that the lateral transport capacity can be treated as a constant that depends on boundary conditions including water discharge, upstream sediment supply and granulometry. The experiments of Bufe et al. (2019), which were used to develop the concept of the lateral transport capacity, indicate that the concept encompasses autogenic variability within the channel geometry.
We added a sentence in section 2.1:
*"*The lateral transport capacity can be treated as a constant for a given set of boundary conditions including water discharge, upstream sediment supply, and granulometry (Bufe et al., 2019).*"*

Meandering rivers can develop confined valleys through autogenic processes (e.g., Limaye et al., 2013, often in lowlands). Does the model distinguish the cause of confinement?
The cause of confinement is not relevant for the evolution equations. In autogenically confined channels, the lateral migration speed v may depend on time. We do not take this into account.

I'd suggest labeling W0 and Wv in Fig.1.
We have updated the figure.
I would also add a half-sentence around L156 stating that Wv is also known as confined channel belt width OR any means to more explicitly explain the difference between confined channel belt width and steady-state valley floor width beyond the context of Turowski et al., 2024.
In the present paper, we do not explicitly account for uplift and the different notation is meant to reflect this. That is, Wv refers to the steady state width including the effect of uplift, while we use W0 to denote a steady state width unaffected by uplift.
We added:
*"*The valley-floor width WV is distinguished from the confined channel belt width by explicitly accounting for the effects of uplift and lateral sediment supply."

Also, is it fair to say that properties that impact the erodibility of the valley wall, such as lithology, are embedded in qH?
Valley wall erodibility affects the lateral migration speed and can be captured by the difference between speed V in the floodplain and v when migrating beyond it (see eq. 15 and following). The erodibility affects the transient approach to steady state and the drift (as quantified in later parts of the manuscript), but not the steady state width. There is a more elaborate discussion on this issue in our previous paper (Turowski et al. 2024).
It can be expected that qH is affected by bedrock lithology, but the relationships are not clear at the moment.

Fig 1b-d is missing the subscript 0 on the width.
We have updated the figure.

L 598-600, the model presented here, can possibly be applied to a broader range of rivers. See Dong and Goudge, 2022, which provided a relationship between river planform pattern and channel belt width.
We had not been aware of the Dong and Goudge paper, thanks for pointing it out! We now cite it in the introduction and discussion.