Response to the Associate Editor:

I have now read the revised manuscript and the responses to reviewers. The authors have carefully added analysis and text in response to reviewers' concerns and I feel that responses address all the key points. There is a new knickpoint migration model added to the paper that helps to bring context to the different scenarios, the motivation of transverse vs longitudinal channels is now better articulated with a nice figure, and in general the paper is clearer with a more developed analysis. I think this is very close to being publication ready, I simply have a few editorial comments for the authors to consider, they can accept or reject my recommendations as they see fit. I look forward to seeing this paper in press.

We thank the Associate Editor Simon Mudd for accepting our manuscript and editorial comments, some of which we found very helpful for the content of this manuscript. We made the following modifications to the text and figures (***bold, italic text*** is new):

Line 20: "whereas χ_t values of knickpoints (measured from the tributary junctions) remain near constant among tributaries" I would put the chi symbol in front here "(chi measured from the tributary junctions)"

Done.

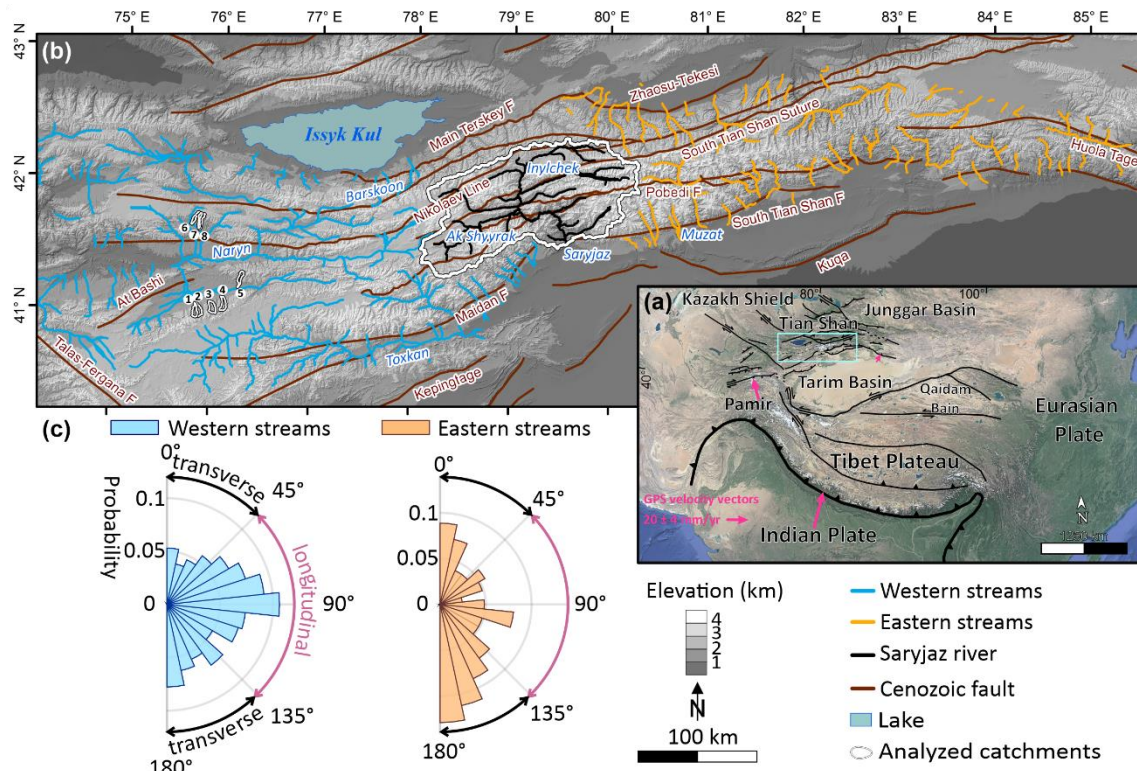
Line 61: "The anomalously large Saryjaz catchment sits within a transition zone between the longitudinal and transverse drainages." Catchments come in all sizes. What makes a catchment "anomalously" large? Can you explain here what you are trying to say?

The word "anomalously" was used to describe that the Saryjaz river as being more than twice the size of other drainages from the southern flank of the STS, particularly those to the east. However, as the editor pointed out, this description can be confusing. Since we do not plan to discuss the reasons for drainage size variations in this manuscript, we have removed this term from both the main text and the abstract.

Fig. 1: This is a nice plot, but the blues stand out in a way the oranges don't. So the pattern in the western streams stands out more (to me at least). I think this figure could better show the pattern: you might try a) different colours or b) having adjacent columns for each orientation bin rather than overlapping ones (yes I understand the danger of making it seem the orientations are different for the bins). If you don't like the results you can keep the original figure.

We agree with the editor that the two colors here overlap with each other and cover some information. Instead of changing color, we use rose diagrams to plot two parts of streams separately. We hope this change makes the comparison of the orientations of the western and

eastern streams more straightforward and enhances the overall clarity of the data presentation.

Please see the updated Fig. 1 below:

Line 98: "they show dominantly longitudinal patterns." replace with "streams"

Done.

Figure 2b: Why is the swath offset from the river between C and D? That is, in this section the swath goes over a ridgeline. Why not just keep the centreline along the river?

We thank the editor for pointing this out. I double checked the location of the swath and I made a mistake when transferring the layer from GIS to the graphic editor. The central line between C and D should be between the ridgeline and river, with C and D located on the river. However, due to the meandering nature of the lower Saryjaz trunk, adding too many points along swath would bring more complexity to the elevation data. Besides, I have included the location of the points in the supplementary information for study replication.

Line 189: We place our analysis within the framework of the detachment-limited stream power law (Whipple and Tucker, 1999; Lague, 2014). This needs an e.g., Whipple and Tucker were not the first to propose the law.

Done.

Line 214: "χ is directly proportional to the response time." Okay, I think "response time" is quite fuzzy in this context, but you completely describe what you mean in the next sentence. Can you combine the sentences so you don't use the phrase "response time"? It seems like only one sentence is needed here since all relevant information is in the second sentence.

I remove this sentence, and merge the one before and behind into one sentence: *A useful property of χ that we utilize is that, under the condition of spatially uniform K, if χ is calculated starting at the junction of a tributary and the trunk stream, its value at a knickpoint can be interpreted as a proxy for how much time has passed since the onset of knickpoint migration up the tributary channel.*

Line 505: "an average of 480 ± 181 m (Table S1; Fig. 7). The incision is smaller than the elevation difference between the relict sediments 505 (~3200 m) and valley bottom near the 'U-turn' (~2300 m)." This is a bit awkwardly phrased since it is not clear if the numbers represent the elevation of the elevation difference. One or two words will clear this up.

I change to: *The incision is smaller than the elevation difference of approximately 900 m, between the relict sediments at around 3200 m and valley bottom near the 'U-turn' at about 2300 m.*