Line by line responses to Anonymous referee # 1

This is a very timely contribution when we are slowly moving away from rather simple-minded interpretations of alluvial stratigraphy to take extreme events more into account. That said, my only criticism of the paper is that the theoretical component is not as strong as it should be. Bodies of alluvium that are interpreted to be a result of a change of climate for example may be the sum total of extreme events, the frequency and magnitude of which are modulated by the ambient climate. So, there may not be a substantive difference between the traditional interpretation and what the authors of this paper claim to be stochastic events. I would like to see an **additional paragraph** that sets out the authors' views on this issue.

We thank the reviewer for this constructive feedback. We have added to the discussion section of the revised manuscript (sect. 5.4).

My other comments are more minor, as follows:

1. Line 22 what is meant by 'intermediate fan'? Clarify.

The term “intermediate fan” refers to its location between the top and bottom alluvial deposits. However, to clarify, we renamed the fan in question “lower fan”, as has been done already for the radiocarbon dating report. We have tried to clarify this statement and quote from the revised abstract: “We show that the > 20 m thick lower fan unit, previously thought to be late Pleistocene in age, unconformably buries a paleoshoreline uplifted in the first centuries AD, placing the depositional age of this unit firmly into the Late Holocene.” (line 22-24)

2. Lines 62 and following. The absence of reference to the role of land use in the alluvial stratigraphy of the Mediterranean is puzzling. See the early work of Claudio Vita-Finzi for example. Please include some reference to this phenomenon.

While we acknowledge that hominids have directly and indirectly modified alluvial deposits around the Mediterranean for hundreds of thousands of years through fire, forest clearing, agriculture, animal husbandry, etc., such activity is minimal in our study basin. Native forests were cleared from much of Crete for shipbuilding, agriculture, and olive cultivation, however, the location of Klados catchment on the steep, rocky and hard-to-access southern coast of Crete means that this basin likely experienced very little long-term human alteration of the landscape. With the exception of browsing by wild goats, there was no terracing of hillslopes for agriculture, no planting of olive trees or other wide-spread soil disturbance in the catchment that would manifest itself as part of the alluvial record.

We have added the following sentences to the revised manuscript: “Also, human land use and vegetation cover have been shown to influence sediment dynamics and alluviation patterns, and the Eastern Mediterranean has been central to the investigation of the interplay between climate fluctuations, long-term tectonics, and anthropogenic disturbances (Atherden and Hall, 1999; Benito et al., 2015; Dusar et al., 2011; Thorndycraft and Benito, 2006; Vita-Finzi, 1969).” (line 66-70), and “[...] and is surrounded by steep, 2 km high mountains, which has kept human influence minimal.” (line 90)

3. Line 80 please explain why this catchment is anomalous

We have revised this sentence for clarification and added a photograph of a neighbouring river outlet for comparison (Fig. 1c). We quote from the revised text: "However, the thick sequence of several > 20 m thick alluvial fan and terrace deposits preserved in the Klados catchment are anomalous compared to nearby catchments with larger drainage areas (i.e., Samaria) that preserve only minor alluvial deposits." (line 86-88)

4. Line 108-109 what is the evidence for this statement?

We have revised this statement and quote from the new version: "The volumes of these deposits are substantially larger compared to alluvial deposits in larger neighboring catchments and therefore require an unusually high sediment supply input." (line 112-113)

5. Line 165 and following. While there is discussion later on about the accuracy of these C-14 dates from bulk organic matter, please provide a brief preparation here for that later discussion.

We extended this section to include a short discussion on our choice of radiocarbon dating, and the reader is referred to the relevant part in the discussion.

We quote from the revised section: "To constrain the timing of aggradation and incision of the deposits, we radiocarbon-dated bulk organic matter collected from six fine-grained lenses within the deposits. While bulk radiocarbon dating of alluvial sediments will result in larger uncertainties, in this case, it is the only available geochronometric technique given the mineralogy of the sediments and lack of macro-organic material for traditional AMS radiocarbon dating. Additionally, despite uncertainties associated with bulk radiocarbon dating, it is appropriate for discriminating whether or not the sediments are late Pleistocene or Holocene, one of the hypotheses tested with this study. We decided against using luminescence dating because of the sparsity of quartz and feldspar in the local carbonate bedrock and the turbulent mode and the short transport distance that likely result in incomplete bleaching, especially of feldspar grains (Rhodes, 2011). A detailed discussion of uncertainties associated with this method is provided in section 5.1." (line 195-204)

6. Line 228 (and 253) I am unconvinced that these deposits are from sheet flows. I would not expect the shear stresses needed to move the gravel particles can be achieved by sheet flow. Please provide evidence of your claim or perhaps suggest that the deposits are a result of flow in shallow channels.

We agree with the reviewer and change the terminology accordingly. We quote from the revised text: "The upper portions of the alluvial fill units are always layered and fluvially reworked, resembling the planar beds typical of flow in shallow channels (Fig. 4d, e; Blair and McPherson, 2015)" (line 303-305)

7. Line 322 reference here to slackwater deposits may be inappropriate. This term is now used for paleoflood deposits. I suggest that you find an alternative or, if they really are slackwater deposits, please provide more information.

Indeed, slackwater deposits consist of sand and silt, which are deposited when flow velocities are locally reduced during large flood events (Saynor and Erskine, 1993). Descriptions in literature include tributary mouths, widening channels and locations of bedrock or talus obstructions, and overbank deposits on high river terraces (Kochel and Baker, 1988; Pickup et al., 1988; Saynor and Erskine, 1993). In our field area, the deposit in question lies at a tributary mouth, whose outflow was obstructed by one of the valley infills. Consequently, the use of slackwater deposit appears to fit the situation. However, due to this ambiguity, we refrain from categorizing the deposit as slackwater deposit but call them with the more descriptive term of "tributary deposit".

8. Lines 346 and 347. The negative exponents need to be changed.

We thank the reviewer for this remark and have revised the exponents.

9. Line 377 here and elsewhere you refer to immature soil development but I cannot find an argument for their immaturity. This needs to be rectified.

Based on sedimentological investigation, topographic surveys, soil redness indices, and chronometric dating, Pope et al. (2008) interpret the sediment in the Sfakia piedmont 25 km to the east of Klados as deposited during cold stages of the major glacial cycles. In close comparison with photographs of these sites, and a preliminary soil classification during field work, we find that the soils in the Klados catchment are immature throughout the mapping area (IUSS Working Group WRB, 2015). The main evidence comes from soil redness, depth, density, and the extent of the vegetation cover, as we state in section 4.1. We quote from the revised section: "Soils are weakly developed on all three alluvial fill units as is derived from soil redness, depth, density, and vegetation cover (Fig. S5). Moreover, there are no discernable secondary carbonates or other mineral diagnostic horizons related to migration processes, and clay formation is insignificant. The terraces lack fluvic properties and are well-drained, which is why the best categorisation appears to be a calcaric, skeletic Regosol (IUSS Working Group WRB, 2015)." (line 305-309)

To further illustrate this point we added a new supplemental figure S5:

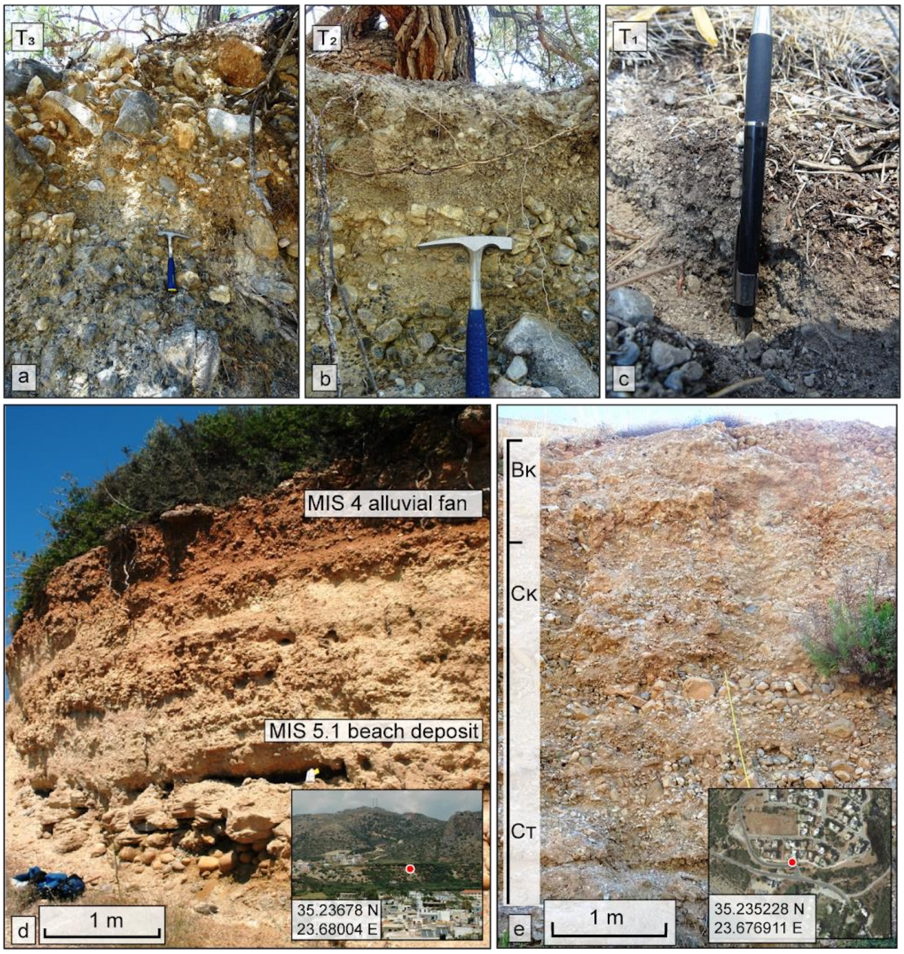

Figure S5: Minor soil development on T_3 (a), T_2 (b), and T_1 (c) results in low soil maturity. Typically, a surface horizon of non-degraded organic matter such as pine needles overlies the original alluvial deposits. Soil formation may be accelerated in close proximity to larger plants such as pine trees, but we find no sign of wide-spread pedogenesis. (d) Outcrop "Alta Paleohora" (20 km W of Klados, exact location noted) showing dated MIS 4 alluvial fan material over MIS 5.1 beach deposits (Pope et al., 2008). (e) Outcrop in Paleohora (exact location noted), carbonaceous terrace of MIS 2. B = top soil, C = source rock, K= secondary carbonates, T = clay-enriched (IUSS Working Group WRB, 2015).

10. Line 503 you claim that this catchment is unique but do not explain why. Also see my comment #3 above.

We have modified the section to improve clarity. We quote: "The alluvial deposits in the Klados catchment are volumetrically oversized and immature in soil development compared to other catchments in southern Crete. We have demonstrated that the deposits preserved in the valley are Holocene in age and that following a massive landslide event, the catchment dynamics are best described by rapid and dramatic alternations between valley-wide aggradation and incision. These findings show that the emplacement of the landslide deposit altered catchment dynamics, making Klados more sensitive to external forcing. This change in sensitivity to external forcing makes the Klados fans distinct among the well-studied Pleistocene fans in Crete." (line 596-602)

11. Line 507 please explain why the landslide deposit made this catchment ultra-sensitive to external forcing.

We refer the reader to section 5.4. in our revised manuscript, where we discuss the ultrasensitivity in terms of sediment and water discharge rates. We quote from this revision: "While in each case sediment transport events are likely associated with high-intensity rainstorms, as indicated by the high-energy depositional environments inferred from fan stratigraphy in Klados and Pleistocene fans elsewhere on Crete, the threshold magnitude for a sediment-generating event, whether a rainstorm or seismically-driven ground shaking, in Klados is likely much smaller relative to those that produced the Pleistocene fans. This difference in sensitivity to external forcing makes the Klados fans unique in the context of Pleistocene fans of Crete" (line 602-607)

12. Line 547 this is not a recurrence interval but a frequency. Please change.

This is a good point by the reviewer, which we changed in the revised manuscript.

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