

**Sediment transport processes across the Tibetan Plateau inferred from robust grain size end-members in lake sediments**

This paper is a very interesting contribution to the wider literature on using particle size analysis to interpret past environmental change from lake sediment sequences. More specifically, the application of end-member modelling analysis on a regional scale (the authors integrate particle size data from multiple lakes across the Tibetan Plateau into their EMMA) is a significant step forward that will hopefully drive similar efforts elsewhere.

Overall, the paper is well structured, the authors' interpretations are reasonably well supported by relevant references and the use of contemporary wind shear stress data for comparison with the particle size distributions is another instructive element of this paper. The reviewer also appreciates that some potential limitations of the work are outlined by the authors.

The reviewer feels there are a handful of important details that should be incorporated into the manuscript prior to publication, specifically revolving around the need to better address what the implications may be of non-stationary catchment conditioning through time. These are outlined in greater detail under the Specific Comments section below. More minor queries on technical aspects of the manuscript are presented under Technical Queries while a number of improvements to the written manuscript and typographic corrections are suggested at the end of this review (Technical corrections). Provided the requested details are included and other points are addressed in a revised manuscript, I am happy to recommend this paper for publication.

**Specific comments**

The key absences in this manuscript which I believe must be addressed are more details related to lake-catchment configuration and local and/or regional palaeoenvironmental changes through time. While I appreciate the reasoning behind field site selection (i.e., different catchment:lake area ratios, catchment configuration), the implications of this spatial and temporal gradient must be examined in greater depth. For example, lake residence times will likely vary greatly between the small and large lakes investigated; it is possible the finest grain size fractions are never deposited in certain lakes due to short residence times. Similarly, no detail on the nature of lake inflow(s) is included for the various sites. Is there one major inflow or multiple inflows entering different points of the same lake? This could substantially affect how effectively the fluvial end-members are recorded and indeed their relative overall contribution to the EMM. Descriptions of the characteristics of local soil cover and bedrock type is also not included and differences in the susceptibility of certain soils and bedrock to erosion and weathering in different watersheds could also have significant implications for their calculated fluvial contribution.

Following on from this, the importance of non-stationarity in the patterns of atmospheric circulation and landscape evolution in the catchments is also not considered. The time periods covered by the master cores at each site are listed in Table 1 and vary between 1.5 - 20 k years. While I understand high-resolution age-depth modelling is not the focus of this paper, the availability of material in the catchment, the intensity of weathering and erosion as well as wind shear stress are highly unlikely to have been stationary throughout the timescales of interest. As the EMMA uses particle size data from the full length of core at each site, any climatic and environmental changes could significantly alter your findings. Have you made any effort to run EMMA across sub-sections of the particle size data or

used other proxy data to assess the extent to which sediment supply and sediment delivery mechanisms have evolved over the past 1.5 - 20 k years on the Tibetan Plateau?

I feel Section 5.5 would be greatly improved if the calculated contributions of each process were put into context using references to other regional or global literature. How significant is the finding that the aeolian contribution is dominant? Does this mean lake sediments are good sites for better understanding regional atmospheric circulation patterns and long-term influences on dust deposition?

The paper would also benefit substantially from a more comprehensive abstract. In its present form, the abstract fails to mention that contemporary wind shear stress data are included in the manuscript or indeed what is the purpose of these data. I strongly suggest a partial revision of the abstract to ensure this is made clear to the reader.

## **Technical queries**

### **Page 4857**

Line 2: The second sentence is rather open-ended or should be integrated into the next section. Why does it play an important role for global climate circulation?

Line 11: What sort of 'variability'? i.e., duration? Spatial extent?

Line 18: Expand on 'proxy' information. What sort? I think you should specify the proxy used as well as the reference.

Line 23: Using the term 'final depocentre' is problematic. This is not always the case, especially if these lakes have an outflow. Some particles, especially fines, may never be deposited before exiting the lake, depending on water residence time. This has implications for identifying the finest end-members

Line 25: A reference addressing the 'sediment cascade' should be included after the first sentence.

Line 27: Do you mean 'discriminating sediment sources' instead of 'depositional environment'?

### **Page 4858**

Line 4: The last sentence referring to annually laminated sediments appears rather abruptly. Are your lakes varved? If so, add this to provide suitable context for this sentence.

Line 21: Why is it 'rather difficult'? Expand briefly.

Line 28: Specify regions where these applications of EMMA have been conducted.

### **Page 4859**

Line 10: I find the use of the word 'independent' problematic. Is sedimentation ever independent of space and time?

Line 12: You refer to peat bog here and palaeo-lake on Line 19. Which is it? If it is a peat bog, what type?

## **Methods**

### **Page 4860**

I feel this section should be expanded slightly (2 - 3 sentences) to include stating the coring devices used at each lake as they do differ in terms of sediment recovery and clarifying the pre-treatment methods used. Also, what interval was used when sub-sampling the sediment cores?

Line 2: Why were two different concentrations of H<sub>2</sub>O<sub>2</sub> applied? What duration? Did the organic matter concentration vary significantly between lakes?

Line 13: Were standardizations employed or the consistency of measurements tested between the two different Coulter machines?

Line 15: Clarify which samples were combined (the physical sediment or the measured particle size data) and how? If it was the data, how can you be sure your stratigraphic correlations between cores were of similar accuracy to your sub-sampling intervals?

Line 18 – Clarify how the ‘event-layers’ were identified and indicate what percentage of the total core length was removed

#### **Page 4862**

Line 5: This is out of my knowledge area but is 10 m a standard height for taking wind measurements? This does not seem applicable to the generation of wind-driven currents and re-suspension.

Line 7: Why the interval 2001-2011?

#### **4. Results**

#### **Page 4863**

Line 8: What methods were used to assess measurement bias between Jena and Potsdam? This is not detailed in Methods.

#### **Page 4864**

Line 21: The inclusion of contemporary wind data is not mentioned in the abstract and only briefly in the conclusion.

#### **Page 4865**

Line 12: 14: What is your rationale for these groupings? Perhaps include a reference or two.

Line 23: Reference to confirm grains of this size are most likely to move ‘by rolling or saltation in high-energy fluvial suspension’

Line 24: Does this refer to fluvial sediments in Tibet or globally?

#### **Page 4866**

Line 2: Quote quantitative results where possible i.e., specify a number instead of ‘small amounts’

Line 5: Is the reference ‘Pendea et al. 2009’ located in the Tibetan Plateau or elsewhere in the world?

#### **Page 4867**

Line 17: Are the ‘local river beds’ dry for (some of) the year so particles are transported via aeolian mechanisms?

#### **Page 4869**

Line 16: Expand and reference 'episodically' and illustrate quantitatively 'larger distances and longer time'.

**Page 4870**

Line 8 - 11: The last paragraph is rather unclear and too open-ended.

**Page 4871**

Line 15 – Do the large lakes freeze over in winter also?

Line 18 – Unclear which sediment trapping dynamics you are referring too. I would fully expect processes on land to be very different to the water column?

Line 19 – It would be useful to specify how steepness of the catchment at each field site varies

**Page 4872**

Line 26: Why? Does surface runoff only occur in summer?

**Page 4873**

Line 3: I see the reference but it might be worthwhile briefly explaining why Taro Co had the lowest duration of complete ice cover. Understanding the intra-lake differences is important.

Line 4: Will the deepest part of the lake really be influenced by wind-induced currents? Taro Co is 123 m deep.

Lines 19 - 21: I am not entirely clear where the contribution values have been derived from. Figure 4 is lacking units on the y-axis so perhaps this could be clarified further?

**Page 4874**

Lines 3 - 6: Unsure about the relevance of this sentence. Illustrate more clearly why this is important to your interpretation, the sentence is too open-ended.

Line 22 - 25: Worth indicating which end members are most likely to be influenced by these other factors.

Line 28: Be careful of terminology. The term 'flocules' normally refers to particles comprising cohesive grains that bound together *in water* while aggregates formed in soils, prior to reaching water.

**Page 4875**

Line 1: The first sentence is a little unclear: are you referring to the fact the flocs or aggregates will be deposited in that condition?

Line 22: The sediment may be mixed prior to arriving at the lake. Perhaps state to 'a mixed signal will be deposited at the lake bed' instead?

**Page 4876**

Line 8: Worth being clear on what will differ in terms of sediment transport and deposition. Will the dominant process of sediment delivery change or just the rate of sediment accumulation?

**Page 4877**

Line 4: Unsure what 'the mean climatic background' refers to?

## Figures

Figure 1 - Add a scale bar to the Tibetan Plateau map.

Figure 1: Could the white catchment outlines on the Tibetan Plateau map be emphasised further?

Figure 3: The data plotted in B and C extend beyond the axes.

Figure 3B: A scale for the yellow colouring is not included

Figure 4: Shift lake names further to the left

Figure 4: There are not units on the y-axis to illustrate the contribution

Figure 4: Sediment type 7 is not referred to in the figure caption. Instead, you state '6: fluvial clays' which according to the diagram is #7.

## Technical corrections

### General points:

- 1) Be consistent with capitalizing the lake names; sometimes 'lake' is used, other times 'Lake'
- 2) In the text you use Fig 1b but the figure captions use capital letters e.g. Figure 1B – be consistent.

### Introduction

#### Page 4857

Line 2 – define acronym a.s.l (= above sea level)

Line 23 – 'Detrital' and 'Allochthonous' have similar meaning - Unnecessary repetition?

#### Page 4858

Line 2 and 3 – Avoid using the word 'Characteristic' twice

Line 16 – Using the term 'gives' assumes decomposition of grain size data *always* provides more detailed information. Are you sure this is the case? I'd prefer to use '...may offer...'

Line 23 – 'Operationalism' is a rather awkward term

Line 27 – Replace 'was already' with 'has been'

#### Page 4859

Line 1 – Semi-colon after Dietze et al., 2012;

Line 1 – Sentence could be edited to clarify message. 'different end-members were interpreted as proxies of [different] sediment transport processes.'

Line 4 – 'lake sediment exhibiting complex grain size distributions' instead of 'mixed lake sediments'

Line 12 – Replace 'sizes' with 'surface areas'

Line 13 – Replace 'at' with 'across'

## **Methods**

### **Page 4860**

Line 17 – Change ‘affect’ to ‘affected’ as past tense was used earlier in the sentence (‘was’)

Lines 23 – 26 – The word ‘end-member’ used many times. I appreciate there are not many synonyms but edit for ease of reading

## **Results**

### **Page 4865**

Line 3 – Remove the word ‘also’ and the comma after grains

Line 7 – Remove the word ‘this’

Line 27: Edit final sentence = ‘sediment delivered through aeolian transport,’

### **Page 4866**

Line 28 – Replace ‘for’ with ‘of’

### **Page 4867**

Line 11 – Move ‘This transport is most effective’ to beginning of sentence

Line 23 – Can one of the ‘finer’ be removed

### **Page 4869**

Line 8 – Replace ‘at’ with ‘on’

### **Page 4870**

Line 5: The second half of this sentence is unclear to the reader

### **Page 4873**

Line 26 – Re-phrase slightly ‘(including subsequent short-term...keep the aeolian signature)’. Perhaps ‘the dominant aeolian signature appears to be preserved in the catchments despite short-term fluvial/alluvial reworking’.

### **Page 4874**

Line 11 – Edit to ‘not yet fully understood’.

Line 20: ‘However, temporal shifts in the availability of silica can alter diatom abundance and thus the grain size distributions of the sediment’

### **Page 4875**

Line 11: Replace ‘a high’ with ‘considerable’?

Line 12: Add ‘s’ to ‘observation’

Line 15: Replace ‘Main’ with ‘greatest’?

Line 24: Insert 'better' and edit to 'understand' = 'that help better understand past environmental changes'.

Line 26: Do you mean 'investigated' instead of 'represented'?

**Page 4876**

Line 7: Change 'In concert with climatic circulation' to 'Driven by changes in atmospheric circulation'?

Line 10: 'Relationships' not 'relation'

Line 13: 'a concept that is transferable...'

Line 20: 'seen as a continuum'