Response to comments of Anonymous Referee #2

General comments

This study reported the construction of the modern pollen dataset in eastern and central Tibetan Plateau by collecting samples from 117 lakes and pools between elevations of 3720 and 5170 m a.s.l.. which compensate for the geographical data gap in the region. Precipitation is found to be the main climatic determinant of pollen spatial distribution, by interpolating the pollen dataset against a robust modern meteorological dataset. The capability of the pollen dataset in reconstructing past climate is then tested and verified using two deep lake sediment cores.

The topic is important for the climate and environmental reconstruction for Tibetan and beyond. However the study, in its current layout, requires certain revision before it could be considered for publication in this journal. My main comments are:

Specific comments

1. Please provide a general framework of the reconstruction analysis. For example, please provide brief justification of how the pollen species of present climate conditions can be used in past climate reconstruction, especially for the Holocene and earlier climate.

Response: We agree with this comment, and we have provided a general framework of pollen-based past climate reconstruction in the new version.

Line 143-147:

"The basic assumption of pollen-based past climate reconstruction assumes that pollen taxa recorded in the modern calibration-set have similar ecological requirements as those in the fossil spectra (Juggins and Birks, 2012); in other words, the modern vegetation-climate relationship is assumed to be stable temporally through the target period of reconstruction."

2. Regarding "Sample collection": I do not quite understand the criteria of lake selection (Line 83-86) mean exactly. In particular, how does the choice of small and unnamed lakes or pools reduce the influence of long-distance pollen transport? Did the authors mean they reduced the sampling distance by including 117 small lakes and pools?

Response: A small lake has a small pollen source area as confirmed by previous experiments and modelling. In the new version, we cite the literature to support our argument.

Line 89-98:

"To reduce the influence of long-distance pollen transported by wind and rivers, small and shallow lakes (or pools) with less than 100-m radius and without long inflow rivers (n=117) (locally sourced pollen grains are the dominant components for small lake; Sugita, 1993) were selected to collect pollen samples (Figure 1). To reduce the influence of the lake-shore vegetation component, the lake surface-sediment samples were collected from the central part of each lake, with the top 2 cm of lake sediment forming the sample (Tian et al., 2008). Although the selected lakes generally have an even distribution, there is still a gap in the south-west part of study area because of a lack of lake and road access (Figure 1)."

3. Regarding "Data processing": the authors did not mention the time period of the CMFD data they used for analysis. Does it include the entire period of Jan 1979 to Dec 2018?

Response: We describe the meteorological data in more detail in the new version. The CMFD includes the continuous data for the entire period of Jan 1979 to Dec 2018.

Line 115-124:

"Geographical distances of each sampled lake to each pixel in the CMFD were calculated based on their longitude/latitude coordinates using the rdist.earth function in the fields package version 9.6.1 (Nychka, et al., 2019) for R (version 3.6.0; R Core Team, 2019), and the meteorological data (three-hour resolution between January 1979 and December 2018) of the nearest pixel to a sampled lake were assigned to represent the climatic conditions of that lake. Finally, the mean annual precipitation (P_{ann}; mm), mean annual temperature (T_{ann}; °C), and mean temperature of the coldest month (Mt_{co}; °C) and warmest month (Mt_{wa}; °C) were calculated for each sampled lake based on the long-term continuous meteorological data."

4. What time frame does the 2-cm surface pollen sample represent? Was it more or less uniform across all sample sites? Does the time frame comparable to the CMFD observation?

Response: It is quite difficult to ascertain the time frame for the 2-cm surface-sediment. The unpublished Pb/Cs dating results for a series of lakes from the east and central Tibetan Plateau completed by our research group, indicate that the 2-cm surface-sediment covers the last 20~80 years. The CMFD includes continuous data for the entire period of Jan 1979 to Dec 2018, covering the last 40 years.

5. The information in Figure 2 is difficult to extract, and it is rarely referred to and therefore

illustrated in the text.

Response: Figure 2 presents the pollen diagram for the 117 samples. From this figure, we can see the pollen-Pann responses for the dominant and common pollen taxa. In the new version, we explain what the different colours mean.

Page 11:

"Figure 2 Pollen diagram showing the major taxa (percentage; %) of the 117 samples arranged by mean annual precipitation (P_{ann}; mm). Pollen taxa with red bars are positively related to P_{ann}, those with blue bars are negatively related to P_{ann}, while the relationship is insignificant for those with green bars."

6. The same applies to Figure 3. The results should be illustrated in more detail. For example, how were the pollens classified as wet-indicator vs. drought-indicator (Line 198-201)? By their locations (positive vs. negative) in Axis 1? What do the two arrows for temperatures indicate?

Response: Done.

Line 196-206:

"A biplot of the RDA shows that the direction of the Pann vector has a smaller angle with the positive direction of axis 1 (captures 43.2% of total inertia in the dataset) than with the positive direction of axis 2 (10.3%), indicating that the major component of axis 1 should be moisture. RDA axis 1, which is highly correlated with Pann, divides pollen taxa into two groups generally: Cyperaceae, Ranunculaceae, Rosaceae, and Salix indicating wet climatic conditions (located along the positive direction of Pann), while Poaceae, Artemisia, and Chenopodiaceae represent drought (located along the negative direction of Pann; Figure 3). Axis 2 is highly correlated with the two temperature variables, however these dominant pollen taxa have insignificant distributions along the axis, hence temperaturee is the secondary climatic variable for the pollen dataset relative to precipitation (Figure 3)."

Technical corrections

1. Please provide information for the color bars in Figure 2.

Response: Done (see above).

2. Please still provide the full name of the three climate variables, together with their symbols, in the caption of Figure 3.

Response: Done.

Line 212-215:

"Figure 3 Plot of the first two redundancy analysis (RDA) axes showing the relationships between 18 pollen taxa (circles) and 3 climatic variables (arrows). P_{ann}: mean annual precipitation (mm); Mt_{co}: mean temperature of the coldest month (°C); Mt_{wa}: mean temperature of the warmest month (°C)."

3. Please explain why certain pollen's name are in italic while the others remain normal.

Response: Generally, pollen grains can be identified into family, genus or species levels. Latin names for genus- and species-level pollen taxa should be in italic, while those for family-level taxa should be normal. It is the specification for Latin names of animals and plants.

4. Please consider separate the statistics of the geographic and climate parameters from those of the pollen data, either within Table 1, or using two tables.

Response: We have separated the statistics of the geographic and climate parameters from those of pollen taxa in the new version of Table 1.

5. The language could be further polished, for example in Line 201-202, to avoid possible confusion or ambiguity.

Response: Written English has been polished by a native English speaker again for the new version.

6. Please use mm/yr or mm/a as unit for precipitation.

Response: P_{ann} is mean "annual" precipitation (mm), so "mm" is appropriate as the unit.