Peer Review: Tamara Fletcher et al. “The role of elevated atmospheric CO2 and increased fire in Arctic amplification of temperature during the Early to mid-Pliocene”

My goodness, how important a simple beaver pond has become. But this pond is 4 million years old, at 77 degrees North latitude and may hold important data that can explain discrepancies in paleoclimate reconstructions for a critical period in recent earth history. This is an important paper and show cases the impact of biogeochemistry methods on paleoecology. Unfortunately, I can offer little insight with this part of the paper. My lack of knowledge and inability to read the equations which were in Chinese or special characters accounts for this. This paper is not, however, without it’s faults at other levels.

While much is made of the role of fire in amplifying the arctic temperature response to elevated CO2 there is surprisingly little discussion on the topic. Page 19, lines 18- 22, mention Feng et al. 2016 and the direct and indirect effects but these are in the most general terms. Line 32 in the Conclusions is similarly uninformative and therefore unconvincing. We go from great methodological detail to the most general statements in the main focus of the paper.

Page 4, Site Description leaves much to be desired. Luckily, I had a copy of Mitchell et al. 2016 to provide the details. I certainly couldn’t follow what Fletcher et al. were describing. Perhaps there is need for a site diagram to illustrate the stratigraphy, the Units and where and when specific sampling was done. That the BP site has been collected off and on for more than a decade and perhaps into the future and the data assembled is so important means that reproducibility is very important. Therefore, to me, detailed site description and sample locations are critical.

I’m assuming the fen (Beaver Pond) peat is autochthonous even through the over all site is in a fluvial environment. I’m assuming that a till is the surface deposit and that the surface represents the stratigraphic datum and all Unit and sample measurements are from the surface. I’m assuming that Unit III (Mitchell et al.) is the fen peat.

Let me look at page 8, Vegetation and Fire Reconstruction. Page 8, Line 28, sampled at an upper and lower elevation . . . that correspond with changes in charcoal.
Explain “upper and lower elevation” or provide depths. Does this mean that charcoal samples were processed first and the pollen samples selected on those results?

P. 9, L., 3, plant taxa. L. 4, is there a better word for “observation” L. 23. What is meant by “The age of the Beaver Pond peat is stratigraphically younger . . .” Younger than what? Need diagram. L.25, where does the 104 t0 105 years come from? And how can you be this precise?

P. 10, l. 2 and 3, check pa and p sunscript a Is this a typo or a different measure

P. 11, Figures 6 and 5 are reversed. 6 is referred to before 5.

P.12, L.20, 21 and 25. Do the authors mean “samples” or sections? If “sections” then I’m not sure what they are talking about as one samples sections in the course of field work and samples are processed in subsequent lab work. Line 29, describes potential Populus pollen. Since this is such an important component of the pollen assemblage, I am surprised that more effort wasn’t made to identify the unknown. Possibly SEM analysis, opinion of other experts, even DNA. Populus is afterall capable of inhabiting high latitudes, is an important species for beavers and almost an expected component in a boreal forest environment. Were wood fragments identified?
Was a comparison made between macrofossils and pollen taxa? Wouldn’t that be interesting and useful? What are the NAP taxa discovered? Why are no pollen sums presented?

Page 13, L. 2, Does 6% Pinus pollen indicate that pine was a component locally? Would the work of Jocelyne Bourgeois, GSC, have any bearing on or aid these interpretations? She analyzed high latitude pollen and demonstrated how pollen and charcoal could be transported long distances.
Page 13, L.28, Such a lack of precision. What does “very close to the BP peat” mean?

Page 17, L. 13. Here is another example of field work and site description problems. “It is possible that the Larix-Betula Parkland dominated . . . correspond to the . . . Units II and III.” Why aren’t they sure? Was there a continuity in field workers over the seasons of field work or was N. R. the only participant carryover? Has the site eroded from 2008 to 2010 to 2012?

Page 16 to 20. Discussion and Conclusions
What type of data would the presence of fire provide climate modelers to improve their simulations? Albedo? Canopy transpiration-evaporation? Surface texture, snow capture and melt? Fire reoccurrence is an important measure but what about regrowth? Northern B.C. fires can decimate a landscape and within five years it is lush with deciduous regrowth and conifer seedlings.
If this paper is to be significant and meet the authors claims they must be able to more fully discuss the importance of fire amplification and model conditions. Nearly every pollen sample in the world will contain some charcoal of varying size classes. What then makes this work unique and important?

The text will need some careful editing. There are abbreviations that I don’t recognize and I enjoy the author’s recognition of that “There are numerous assumptions . . .” p. 15, L. 20. No doubt the measured ages, temperatures and precipitations will be refined in the future as methods improve and assumptions become more sound.

I believe this is a useful, perhaps significant paper but it needs further work in certain key areas that will help to make the case that fire is, was, an important factor in amplification of arctic temperatures.

Respectfully yours,
Charles Schweger, Professor Emeritus