Interactive comment on "Attaining Whole-Ecosystem Warming Using Air and Deep Soil Heating Methods with an Elevated CO$_2$ Atmosphere" *by* Paul J. Hanson et al.

Anonymous Referee #2

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Thanks for the opportunity to review this paper. Overall it was very informative and is suitable for publication with some minor revisions. I believe that the authors do a good job informing the audience about the development and design of the colossal SPRUCE endeavor. This is no easy task and I think that the authors are 95% of the way there. I am somewhat less satisfied with the comparison with other approaches, as I do not think they have enough space to go as deeply as I would like. I will make a couple for suggestions for that section of the paper along with some comments related to the presentation of experimental results. My strongest concern about this paper is that the manner in which the data is presented does not let the reader really evaluate the effectiveness in context rooted to temporal ecological processes. They have effectively

shown how on average SPRUCE works. I would like to see the data presented in a slightly different manner that would also allow a deeper dive into understanding (from and ecosystem context) where the approach successful and limited. This would help readers with hypothesis development and aid the discussion limitations and successes. The experimental objectives are to replicate ambient conditions while altering only the change factors we have chosen at all spatial and temporal scales of the experiment. Thus, it is important to show experimental function in this manner. This would start by showing the distribution of above and belowground temperature data for each of the treatments. It is important to present at least some the data in a manner that does not just show that the treatments are different on average, for narrow bands of time. Rather I would like to see some exploration of the daily and annual patterns observed versus what we would expect to see. As this data is currently presented, there is strong difference in the daily averages of each treatment and they seem to be consistent throughout the year. But these data lump seasonal and diurnal variability and may mask patterns of efficacy that are important for the reader to understand. The authors should use the delta from ambient as a measure of the experiment look at the average and variability across various ecological scales. Hour of day (not just an individual day) would be the most important but also by time of year. The limited number of sensors makes spatial variability harder to explore in this manner but it would be important as well. I would also like to see the overall distribution of temperatures for each of the treatments. It is important that the distribution of temperatures match ambient as much as possible along with differing in mean. Some of the papers they reviewed in this ms use analyses like those suggested, I would also the see if there are seasonal patterns as well. It is easier to use the deltas for these analysis then the overall temperature. It is likely that variability in treatment is higher in parts of the day or times of the year and that would be important to know. I would also like to see multivariable traces and deltas for 10 days or at an hourly scale. This could be in the supplement and help the reader see the efficacy of the experiment in an ecological context. It is probably beyond the scope of this paper but I would like to see an analysis

linking directly the specific temperature/ light and rh conditions of sampling area with measurements just in thoses areas. I am not sure what spatial data is available but it would reassure readers to know that the sampled area variability is minimized. As it is a whole ecosystem model with some range in values, it would be nice to know whether the sampling area occupies that entire range or is experimenting a narrower range of treatments. For example, it would be great if RH decline with temperature in areas sampled was less than chamber level. I am especially concerned about pattern of nighttime temperature with distance from chamber wall and RH variation with distance from blower manifold. There is very little discussion of soil temperature behavior during freezing and thawing cycles or by depth. This need to be include somewhere. I expect that soil and air temperatures invert at some point during the year and it might be better analyze these data separately. Again a delta based analysis of soil temperature differences would be better to show treatment effects compared to ambients rather that overall temperatures. It would be nice to know that the delta variabilty at each depth was comparable with ambient. Daily pattern in RH would also be nice to know as well. 211- Is this really 12-18m deep below wetland. Please check. The figure sharpness seemed lacking throughout, I assume that will be corrected. I like figures with sd bars rather than separate symbols Table 2 explanation was confusing to me. Soil moisture data to back up discussion of RH and ET? Figure 7 is good. I would like to see more like this. I would like to see the same analyses for differing sensor variables. One could be in paper and other in supplement. Right now the comparison discussion between this and other warming experiment seems underdeveloped. I suggest picking a couple of key comparisons to develop discussion. Temporal pattern, dewpoint, soil moisture and RH be interesting to include more of. What should RH and dewpoint looked in a good manipulation? The summary table also need to be checked. The data from at least one of these papers is incorrect.