Replies to Reviewer #4

Thank you for taking the time to read and provide comments to our paper.

This study conducts a detailed investigation of the thermal regimes of small tundra ponds in the Canadian High Arctic. Researchers collected important and valuable data, including sizes and hydrologic connections of ponds, to understand their variability. The research findings highlight the complexity of pond temperature dynamics and their broader implications for ground thaw, greenhouse gas emissions, and wildlife patterns. The study's focus on a specific region may limit its broader application, year-specific weather anomalies could skew long-term trend analysis, and uncertainties remain about the contributions of various water sources to the ponds.

Overall, this is an important work that contributes to our knowledge of the Arctic ponds. I will suggest it for publication after the authors address my comments and suggestions listed below.

1. I suggest adding a discussion on how the results from this study could be extrapolated to other regions. How is this study region geologically equivalent to other similar areas that have open water bodies?

   You have raised an important point. It is often difficult with remote work in the Canadian High Arctic to find comparable sites, as local and climatic conditions can dominate the processes. Access to other sites can be problematic. In the paper, we have tried to compare our results with other studies including the North Slope of Alaska, Ellesmere Island, Somerset Island and Melville Island. We did insert a general schematic in the Discussion, which hopefully provides some ideas of how ponds in similar settings may respond in the future. This diagram also builds on our pond work on Somerset Island (see Young and Abnizova, 2011, Wetlands, 31, 535-549). In our conclusions we have also inserted an additional line which says

   "Finally, future research efforts should focus on the response of other large wetland areas in the Canadian High Arctic including Alison Inlet (southwest coast of Bathurst) and Truelove Lowland, Devon Island in order to investigate the response of ponds to future fluctuations in climate."

   The SW coast of Bathurst Island probably contains more ponds than PBP, but we have not been able to work there yet, and these ponds due to isostatic rebound are prone to drying, especially during warm/dry years. A fly over in late August 2011 showed many ponds containing salt crusts. On the other hand, the eastern coast of Melville Island is prone to marine transgression so coastal wetlands in this area will probably experience more flooding and expansion in the future. Comparison with Truelove Lowland would be interesting, as wetland work was done there in the

1970's. This area is also considered a "polar oasis" area like Eastwind Lake -Ellesmere Island, so the climate should be slightly warmer and drier than PBP.

2. Clark et al. (2020) applied the LAKE model to study the thermal regimes at three Alaskan lakes in a continuous permafrost zone. One of the major findings was that snow depth and lake ice period substantially influence water temperatures. It would be interesting to know the length of ice season for these lakes and how snow depth and early/late ice melt could affect the overall temperatures in the ponds, specifically for a cold summer season in 2013. If the ice period can be extracted from MODIS or related products, it would be interesting and extremely valuable to combine that data with the present lake temperature data.

   Thank you. The Clark et al. (2020) LAKE model sounds very interesting. In our paper we are dealing with small ponds, so to consider lakes is beyond the scope of the paper. Also, once the snow disappears off the ponds, the ice cover melts out rapidly, within a few days and then pond waters start to warm. We can see this pattern in Figs. 2 and 3. You are correct about lakes. Hunting Camp Lake can hold onto its ice cover especially in cool years (2013).

   We have also carried out considerable snow work in this area using both field measurements and remote sensing technology (e.g., Howell et al. 2012, Hydrol. Process. 26, 3477-3488; Assini et al. 2012, Hydrol Sci. J. 57, 738-755; Young et al. 2013, Hydrol. Res. 44, 2-20; Young et al. 2018, Arctic Sci., 4, 669-690).

3. In addition, I suggest including a description of future measurement activities at the ponds, if any. Will other data (e.g. GHG fluxes) be measured at these ponds besides thermal data?

   Laura Brown is continuing her lake and climate studies at PBP. Anna Abnizova, a former PhD student did do work on greenhouse gases in 2008/2009 (see Abnizova et al. 2014, Ecohydrology, 7, 73-90).

Clark et al., Thermal modeling of three lakes within the continuous permafrost zone in Alaska using the LAKE 2.0 model, Geosci. Model Dev., 15, 7421–7448, https://doi.org/10.5194/gmd-15-7421-2022, 2022