1. Physical meaning of the three pond classes

The physical definitions of Open, Transitional, and Frozen Melt Ponds are not sufficiently established. The manual labels combine colour and texture with inferred physical state: Open ponds are typically dark/deep blue, Transitional ponds have mixed blue tones, partial apparent ice cover or heterogeneous texture, and Frozen ponds have continuous/nearly continuous apparent ice cover.

This is problematic because melt-pond colour can also vary with pond depth, underlying ice properties, flooding and other optical conditions. Figure 6, for example, appears to contain substantial optical variability within connected pond systems; some areas classified as Transitional could plausibly represent bright/shallow parts of liquid ponds.

What physically defines a “Transitional Melt Pond”? If this specifically means a pond undergoing partial refreezing, what independent in-situ observations demonstrate this? How were shallow/ bright open ponds, flooded surfaces, etc.., distinguished from partial freezing? The manuscript needs reproducible physical criteria for these classes rather than relying primarily on RGB appearance.

2. Optical result is not physical validation

I suggest that the authors clearly distinguish classification accuracy against visually defined reference labels from physical validation of melt-pond state.

In this manuscript, the physical interpretation appears largely downstream of the image classification. Morphological or topographic differences among the resulting classes cannot themselves establish that the original classes represent different thermodynamic stages.

3. “Stage” and evolution are not demonstrated

The observations are snapshots from five stations on 8, 12 and 14 August rather than repeated observations of the same ponds progressing from Open, to Transitional, and to Frozen.

Below-freezing meteorological conditions make refreezing possible, but this paper do not establish the state of individual ponds.

The manuscript should distinguish much more carefully between **surface classes/states** and **developmental stages**. Unless temporal progression or independent thermodynamic state can be demonstrated, I recommend replacing “stage” with “surface state/class” and moderating conclusions regarding melt-pond evolution.

4. Physical and basic literature needs better understanding

The manuscript cites some fundamental melt-pond studies, including Perovich et al., Polashenski et al., Webster et al., Lu et al., and Niehaus et al.. Especially Divine, Granskog, Hudson et al explicitly distinguished **bright and dark melt ponds** in aerial imagery and associated surface-albedo measurements. This is directly relevant to the present classification: how do the authors establish that light/bright pond regions represent Transitional or Frozen states rather than the well-known optical variability among liquid melt ponds?

However, these studies are not sufficiently integrated into the physical basis of the classification.

In particular, previous work on melt-pond optics by Light, Perovich and colleagues is directly relevant to interpreting RGB variability in terms of pond depth and underlying ice properties. Existing aerial-image classification work, including Fuchs and co-authors, should also be discussed; Fuchs appears to be absent from the manuscript. Although Niehaus et al. is cited, the proposed approach is not meaningfully compared with existing melt-pond detection/retrieval methods.

The authors should clarify what additional physical information MP-Unet provides compared with existing RGB/spectral melt-pond classification approaches, and how the additional Open/Transitional/Frozen distinction has been independently validated.

5. Melt pond geometry is under-represented

The subsequent physical analyses inherit uncertainty from the initial classification. This is particularly important for pond geometry. If different colour regions within one physical pond are classified as Open and Transitional and subsequently extracted as separate objects, differences in area, perimeter or circularity may partly be generated by the segmentation procedure itself.

Please clarify how a "pond object" is defined when multiple predicted states occur within the same connected pond. The authors should also account for classification uncertainty in the subsequent morphology and topography analyses.

Overall recommendation

I recommend substantial revision focused on establishing the physical basis of the classes, positioning the method against existing melt-pond optical/classification work, and restructuring the manuscript around a clearer central scientific question. If independent physical validation is unavailable, reframing the study around optically defined late-summer melt-pond surface states would, in my view, provide a much more defensible interpretation.