

Review of “Daily melt pond and net ice surface fractions in the Arctic Ocean from MODIS visible imagery: 2000–2024”

This manuscript presents an updated and extended dataset of Arctic melt-pond fraction (MPF) derived from MODIS visible imagery, covering the period 2000–2024 at daily temporal resolution and at two spatial resolutions (500 m and 12.5 km). The dataset represents a substantial extension and methodological update of the earlier Rösel et al. product and is of clear relevance to the cryosphere and climate research communities.

The manuscript is generally well structured and includes extensive validation against independent datasets (high-resolution imagery, airborne observations, and other satellite products such as MERIS and OLCI). The dataset itself is valuable and suitable for publication in a data journal.

However, several major issues require clarification and strengthening before publication. In particular, the manuscript does not sufficiently address (i) the continuity and comparability with the previous dataset, and (ii) the scientific justification for the 12.5 km product relative to the native 500 m dataset. Additionally, aspects of the methodology, uncertainty characterization, and interpretation require further elaboration.

I therefore recommend **major revision**.

1. Relationship to Previous Dataset (Continuity and Consistency)

The manuscript presents the dataset as an updated continuation of the Rösel et al. (2012, 2013, 2015) product. However, several methodological changes have been introduced, including:

- updated MODIS collection (v6.1),
- daily instead of 8-day compositing,
- modified spectral reflectance parameters,
- removal of constraint terms in the optimization,
- replacement of pixel-wise optimization by an ANN approximation.

These changes imply that the new dataset is not strictly consistent with the previous version, but rather constitutes a new product generation.

The manuscript does not quantify differences between the old and new datasets over the overlapping period (2000–2011).

It remains unclear whether the two datasets can be concatenated into a single time series without introducing artificial discontinuities.

Recommendations:

- Include a direct comparison between the previous and current dataset for overlapping years (i.e. spatial comparison maps, time series comparison, bias and trend differences)
- Clearly state whether the dataset should replace the previous product, or be treated as a separate version.

2. Justification of the 12.5 km Product

The manuscript provides both a 500 m and a 12.5 km dataset, where the latter is derived by averaging 25×25 pixels.

Concerns:

- The manuscript explains how the aggregation is performed but does not adequately justify why a 12.5 km product is needed.
- The scientific trade-offs of aggregation are not sufficiently discussed. Please address points like the loss of spatial variability, smoothing of extremes, potential nonlinear aggregation effects, propagation of cloud masking biases.
- The evaluation shows that the 12.5 km product performs slightly worse than the 500 m product, yet much of the analysis focuses on the coarser dataset.
- The rationale appears to be mainly consistency with legacy datasets (Rösel et al., MERIS, OLCI), but this is not explicitly stated or critically discussed.

You may add a dedicated subsection, addressing the consistency with legacy datasets, suitability for climate-scale applications, and the comparison with other satellite products.

Please discuss explicitly the advantages and disadvantages of both resolutions, clarify when to use 500 m vs. 12.5 km, and explain the limitations of each dataset. Depending on your output, you may consider emphasizing the 500 m dataset as the primary product, with 12.5 km as a derived product.

3. Choice of Spectral Reflectance Parameters

The spectral reflectance values used for the unmixing (Table 1) are derived from visual interpretation of previous literature. In this manuscript, there is no sensitivity analysis provided to assess how these choices affect the results. In addition, this approach introduces subjectivity and may limit reproducibility. Also please give reasons.

Please provide a justification, comparison and appropriate validation of the chosen reflectance values.

I am also missing a discussion on associated uncertainties: Please include a sensitivity analysis showing how variations in these parameters affect MPF retrieval.

4. ANN-Based Approximation

The use of an artificial neural network (ANN) to approximate the optimization solution is a pragmatic approach.

One concern is, that the training dataset is limited to selected years (2000, 2011, 2020), which may not capture the full variability of conditions and may thus not be representative.

The reported accuracy (99.85%) refers to agreement with the optimization output, not with ground truth.

Potential temporal biases (e.g., due to sensor changes or climate variability) are not discussed.

5. Interpretation of Results

The manuscript includes interpretation of regional and temporal MPF variations.

Some interpretations (e.g., trends or regional differences) are speculative given data limitations. The influence of sampling biases (e.g., cloud cover) is not consistently considered.

6. Missing a comparison or discussion on S2 MPF fractions (Niehaus et al.): they could be useful to improve the MODIS MPF, i.e. by using super-resolution approaches