Living Planet Fellowship

BI-MONTHLY REPORT

Investigating Greenland's ice marginal lakes under a changing climate (GrIML)

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Reference	**BR_GrIML**
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1 OBJECTIVES OF WORK

This bi-monthly report represents the first stage of GrIML Year 2 (starting January 2024) according to the proposed project timeline (Fig. 1). By the end of Year 2, the following objectives should been completed:

a. A series of ice marginal lake inventories should have been generated, which cover the Sentinel-era between 2017 and 2023
b. Ice marginal lake inventories should have been validated, using the pre-existing ESA CCI ice marginal lake inventory and other complementary datasets such as in situ observations and oblique terrestrial time-lapse observations
c. Time-series analyses for individual lake studies should have been generated, where lakes are selected based on scientific or societal relevancy

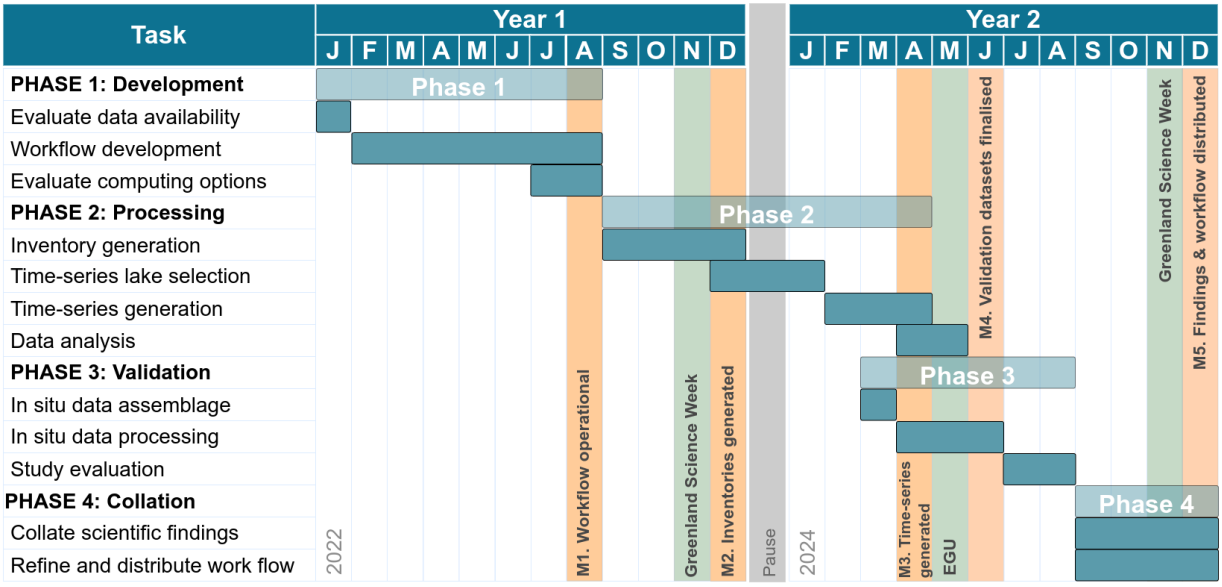

Figure 1. GrIML proposed project timeline. Note that due to parental leave, the project is offset by one year exactly (i.e. end of Year 1 is January 2024 and the end of Year 2 is January 2025).

2 WORK PERFORMED

2.1 GrIML processing workflow

The GrIML processing workflow has been updated following the generation of the preliminary 2017 ice marginal lake (as reported in the GrIML mid-term report). Classification is now performed exclusively using Google Earth Engine (GEE) (step 1, Fig. 2) following changes to GEE user quotas. All post-classification steps are undertaken within the GrIML python package (steps 2-5, Fig. 2).

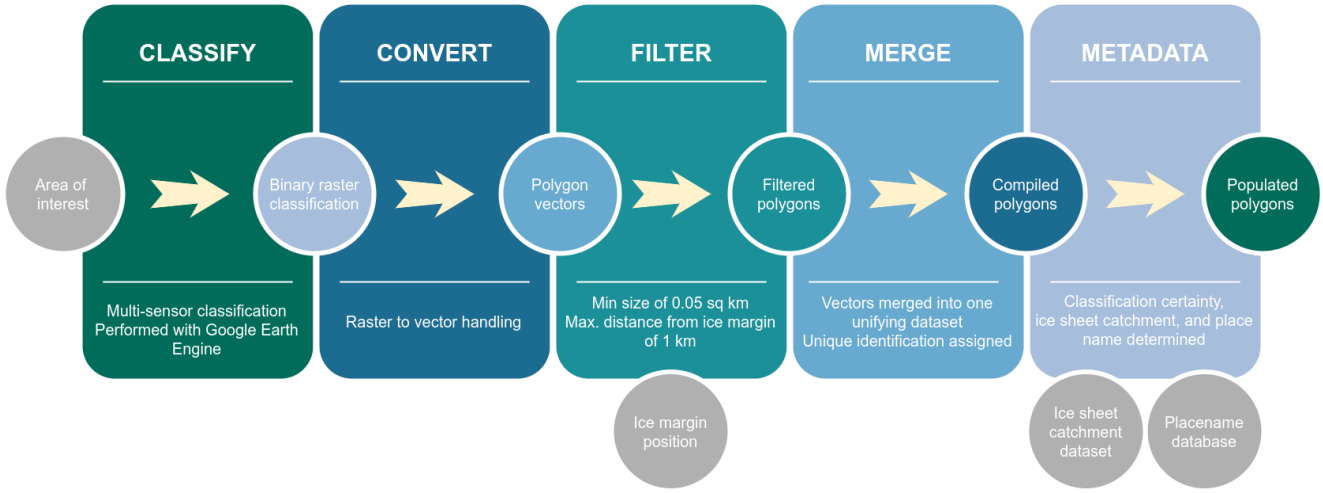

Figure 2. The updated GrIML processing workflow. Each of the name for the steps corresponds to the name of the module in the GrIML post-processing Python package. The classify module is exclusively performed with Google Earth Engine (GEE), whilst the GrIML post-processing is performed with a variety of Python spatial processing packages including rasterio, geopandas and scipy.

A new release of the GrIML Python package has been created (How et al., 2024), and a publication submission is being readied (target journal: Journal of Open Source Software), which demonstrates the usability of the package for generating transparent and reproducible datasets (How et al., In prep).

2.2 GrIML inventory series

Since the last bi-monthly report, all proposed years for the GrIML inventory series have now been pre-processed (Step 1, Fig. 2); i.e. binary classifications have been retrieved for years 2017-2023. Following this, the inventory series will be processed in parallel according to the subsequent steps, as outlined in Fig. 2. The series is processed in parallel to produce a cohesive inventory series, with corresponding unique identifications and information across each time step.

One upcoming challenge which was highlighted in the generation of the 2017 inventory is regarding the ice margin dataset used for filtering. The MEaSUREs Greenland Ice Mapping Project (GIMP) ice margin (Howat, 2017) was modified for the ESA CCI inventory where the margin was clearly incorrect, such as in Nunatak areas. An example of this is presented in Fig. 3, where lakes were detected within inland Nunatak areas for the ESA CCI inventory but are not present in the GrIML inventory because the GIMP ice margin did not include these areas. Either a newer, more accurate ice margin dataset needs to be sourced, or the modified GIMP ice margin dataset used to generate the ESA CCI inventory needs to be adopted

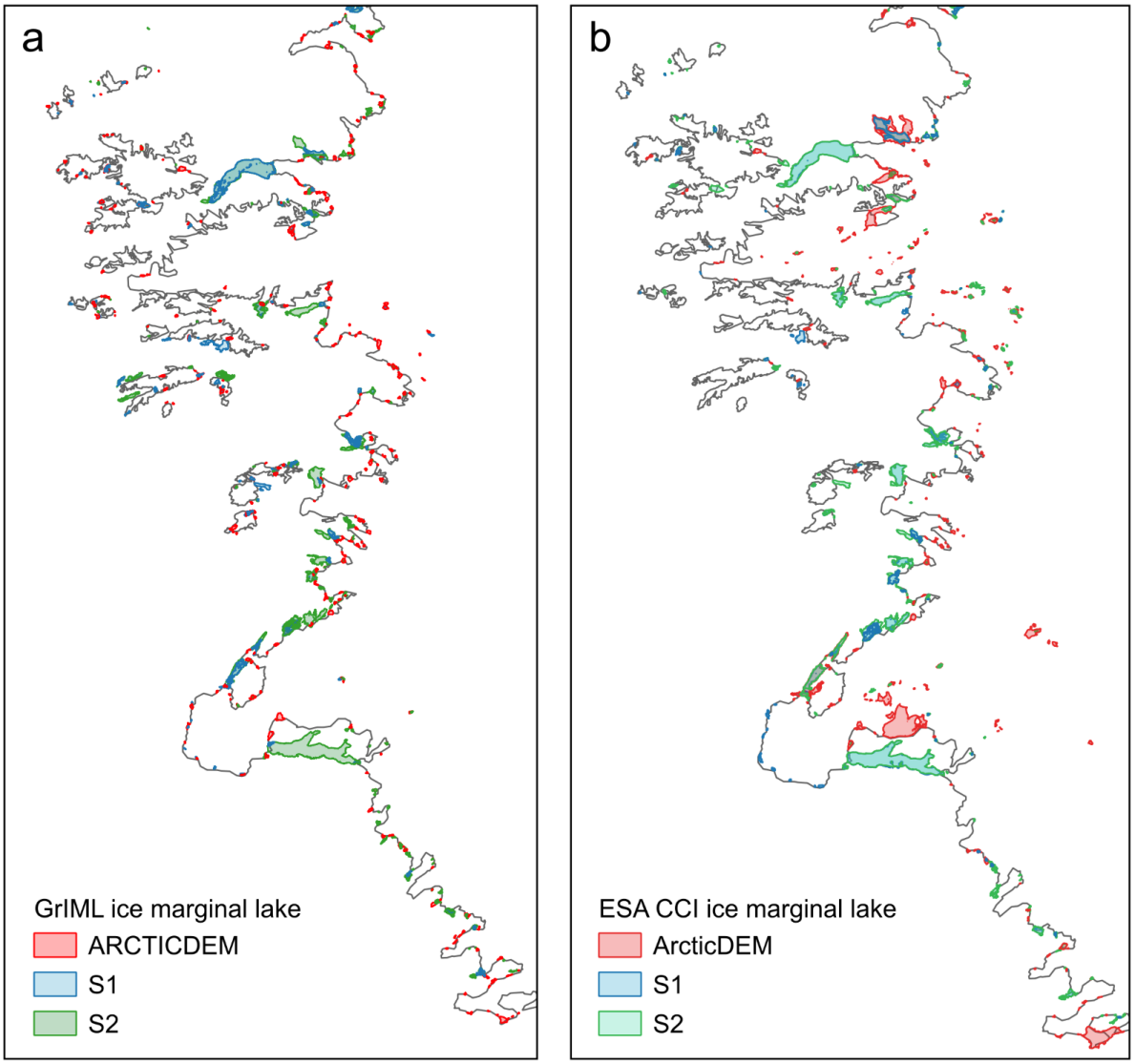

Figure 3: A comparison of the GrIML ice marginal lake inventory (a) with the ESA CCI ice marginal lake inventory (How et al., 2021) (b) in the southwest (SW) drainage basin. The ice sheet/ice cap drainage basin outlines plotted here are taken from Mouginot and Rignot (2019). The majority of differences are due to discrepancies in the ice margin used for filtering (the MEaSUREs Greenland Ice Mapping Project (GIMP) ice margin; Howat, 2017).

3 CONCLUSIONS

The GrIML processing workflow has been updated, with a new release of the GrIML post-processing Python package (How et al., 2024). Multi-sensor classifications have been conducted for all time steps in the ice-marginal lake inventory series (2017-2023), following which the updated post-processing steps will be applied to convert, filter, merge and populate the dataset metadata. Foreseen challenges with the filtering step have been highlighted regarding the choice of ice margin dataset, which will hopefully be resolved by the next reporting.

4 REFERENCES

How, P. *et al.* (2021) Greenland-wide inventory of ice marginal lakes using a multi-method approach. *Sci Rep*. **11,** 4481. https://doi.org/10.1038/s41598-021-83509-1

Howat, I. M. (2017) MEaSUREs Greenland Ice Mapping Project (GIMP) land ice and ocean classification mask, version 1 [GimpIceMask 15 m tiles 0-5]. NASA National Snow and Ice Data Center Distributed Active Archive Center, Boulder, Colorado USA. https://doi.org/10.5067/B8X58MQBFUPA

Howat, I. M., Negrete, A. & Smith, B. E. (2014) The Greenland Ice Mapping Project (GIMP) land classification and surface elevation data sets. *Cryosphere* **8**, 1509–1518. https://doi.org/10.5194/tc-8-1509-2014

Mouginot, J. & Rignot, E. (2019) Glacier catchments/basins for the Greenland Ice Sheet. *UC Irvine Dataset*. https://doi.org/10.7280/D1WT11

5 PUBLICATIONS AND TALKS

5.1 Publications

- Hansen, K., Karlsson, N. B., **How, P.** et al. (In Review) Unique In-situ Measurements from Greenland Fjord Show Winter Freshening by Subglacial Melt

5.2 Software

- **How, P.** (2024) GrIML: version 0.0.2. Zenodo.