LIQUIDICE

Deliverable D2.3 Albedo climate data record

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LIQUIDICE: LinkIng and QUantifying the Impacts of climate change on inlanD ICE, snow cover, and permafrost on water resources and society in vulnerable regions.

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Executive summary

This report pertains to the Deliverable D2.3 Albedo climate data record, as described in ANNEX 1, part A (p. 32) of the EC/REA Grant Agreement for project number 101184962, "LIQUIDICE". Work Package 2 of the LIQUIDICE project is led by NORCE with the support of CNR, IISC, IITB, GEUS, UNIVBRIS, SIOS-KC and IG PAS. Other beneficiaries were also asked to contribute to the deliverable by reaching out to key people and organisations in each of their own countries. The AVHRR (1984–2024), MODIS (2000–2024), and Sentinel-3 (2017–2024) missions together provide a four-decade, near-daily albedo record. The principal challenge for albedo from optical sensors is contamination by clouds and shadows. We present a combined 40-year albedo data record with a post-processing approach that removes cloud artefacts and gap-fills clouded pixels, producing a near-gapless daily albedo record (1 March–31 October) for the Greenland Ice Sheet at 5000 m spatial resolution. We apply a Hampel filter to each pixel's time series—a robust, well-established method for outlier detection and signal estimation.

1. Introduction

Albedo is a key parameter of the surface energy balance of glaciated regions and thus affects net melt through solar absorption. Remote sensing has greatly improved albedo monitoring, but cloud and shadow contamination remain persistent issues for passive optical sensors.

This deliverable focuses on harmonising and preparing Greenland Ice Sheet albedo from three satellites—AVHRR (1984–2024), MODIS (2000–2024), and Sentinel-3 (2017–2024)—and on a temporal filtering scheme that suppresses residual cloud artefacts and gap-fills masked pixels. Because of high latitude, limited daylight, and low sun azimuth angle over Greenland in winter, we process albedo for March–October each year.

2. 40-year albedo climate data record (1984-2024)

Version 1 combines and regrids daily albedo from AVHRR, MODIS, and Sentinel-3 to a common EPSG:3413 grid at 5 km resolution:

- AVHRR: Daily albedo from the NSIDC Polar Pathfinder Extended CDR (native 25 km) is resampled to 5 km using nearest-neighbour interpolation and regridded to the common grid.

- MODIS: NASA daily albedo (native 500 m) is reprojected and aggregated to 5 km (via Google Earth Engine) and regridded.

- Sentinel-3A: The GEUS in-house SICE product (500 m) is upscaled to 5 km and regridded.

The albedo from all three satellites has prior spectral cloud screening, which results in partial and irregular spatial coverage and leaves artefacts. We therefore apply a temporal Hampel filter per pixel that uses both past and future days within a short window to (i) flag and replace statistical outliers (primarily clouds) and (ii) gap-fill masked pixels using the local temporal median, where sufficient neighbours exist (Figure 1 illustrates the workflow).

The data record is provided as annual NetCDF-4 files per platform, containing daily mosaics on a 5 km grid in the EPSG:3413 polar stereographic projection and following CF-1.8 conventions. The dataset is available via the GEUS Dataverse: doi:10.22008/FK2/OM0LRV.

Future work will (i) improve spatial resolution to 500 m, (ii) extend processing to Svalbard and additional regions, and (iii) refine the Hampel approach by adding a spatial component and improving the statistical estimator used for gap-fill.
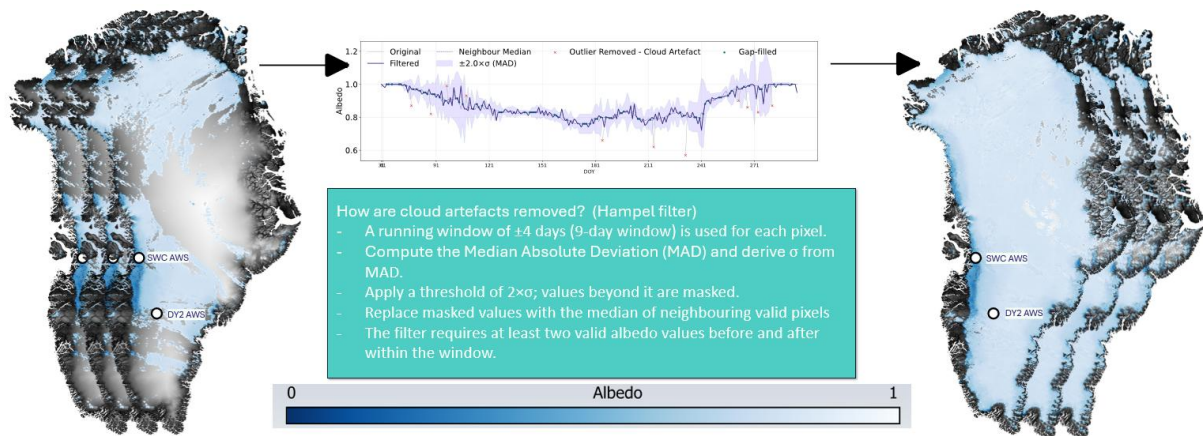
Figure 1 Visual description of the temporal Hampel-filter

3. Conclusion

In D2.3 we established a pipeline that harmonises and processes 40 years of daily albedo from three different satellite platforms. A temporal Hampel filter and gap-filling scheme have been implemented, improving spatial and temporal coverage. Version 1 covers the Greenland Ice Sheet at 5 km resolution.

Future versions will deliver a 500 m product, improved cloud-artefact filtering and gap-filling, and coverage of additional regions (e.g. Svalbard).