



Supplement of

Automated mapping of the seasonal evolution of surface meltwater and its links to climate on the Amery Ice Shelf, Antarctica

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Classification	Thresholds applied
Rock/Seawater Mask	(TIRS1/Blue) > 0.35 Blue < 0.35
Cloud Mask	(Green - SWIR1/Green + SWIR1) < 0.8 $SWIR1 > 0.1$
Surface Meltwater	(Blue - Red/Blue + Red) > 0.1 $(Green - Red) > 0.07$ $(Blue - Green) > 0.07$

S1. Landsat image band reflectance thresholds (as detailed by Moussavi et al., 2020) applied during the masking and surface meltwater detection stages within GEE.

Comparison between Landsat 7 and Landsat 8 in north-west Greenland

In order to assess the quantitative difference between lake area results from Landsat 7 and Landsat 8 images, we compared results between two images (from the two different satellites) taken over the same region at approximately the same time. As no images taken close enough together were available in Antarctica, we conducted analysis over a 2000 km² region in north-west Greenland (Fig. S3). The closest temporal match we could find over a lake-covered region was 24 hours. Whilst this analysis has several limitations (including potential lake area changes in the 24 hour period between the two images), it enabled us to broadly assess the differences in surface meltwater identification between the two different satellites. We find that overall there is very good agreement between the two satellites, as shown in Fig. S3 and S4.



S2. Study region in north-west Greenland where Landsat 7 and Landsat 8 mapped lake results were compared. The larger box shows a 2000 km² region over which lake area results were compared between a Landsat 7 image (21st July 2013) and a Landsat 8 image (22nd July 2013, displayed), taken 24 hours apart. Automatically mapped lakes from the Landsat 8 image are shown in red. The smaller box labelled 'S3' indicates the region shown in Fig. S3. Landsat image courtesy of the U.S. Geological Survey (https://earthexplorer.usgs.gov/).



S3. Automated masking of surface meltwater from Landsat 7 and 8 images. (a) Landsat 7 image from 21st July 2013, with automatically masked lakes shown in blue in (c). (b) Landsat 8 image from 22nd July 2013, with automatically masked lakes shown in red in (d). The area shown is displayed in Fig. S1. Note how the identification of surface water appears almost identical between the two satellites. Landsat images are courtesy of the U.S. Geological Survey (https://earthexplorer.usgs.gov/).

Landsat 7	Landsat 8	Landsat 8 (with SLC stripes added)
361	400	437
$0.0027 \ \rm km^2$	0.0027 km^2	0.0027 km^2
1.39 km ²	1.54 km^2	1.54 km ²
$0.082 \ km^2$	0.087 km ²	0.076 km^2
0.159	0.195	0.171
94.2 %	100	94.2 %
29.46 km^2	34.96 km ²	33.10 km ²
31.17 km ²	34.96 km ²	35.02 km ²
	Landsat 7 361 0.0027 km ² 1.39 km ² 0.082 km ² 0.159 94.2 % 29.46 km ² 31.17 km ²	Landsat 7Landsat 83614000.0027 km²0.0027 km²1.39 km²1.54 km²0.082 km²0.087 km²0.1590.19594.2 %10029.46 km²34.96 km²31.17 km²34.96 km²

S4. Lake area comparison results between a Landsat 7 image and a Landsat 8 image from north-west Greenland (Fig. S1). Results are displayed from the region shown in Fig. S1. The third column displays results following the artificial addition of Landsat 7 striping to the Landsat 8 image.



S5. Example imagery from the time window 1st January – 15th January 2017, demonstrating how images are used to create lake pixel contribution scores (LPCS). (a-f) show six Landsat images that intersect an example ROI during the time window. Each image shows the ROI extent. Note how not every Landsat image covers the entire ROI, and some images (e.g. S5e) are cloud covered. The six images in (a-f) are mosaicked by promoting pixels with high NDWI values, to produce the composite image shown in (g). The different lake colours in (h) indicate which optical image each lake pixel has originated from. For example, 58% of the pixels in the composite image were contributed by Image 4 (d), whilst no pixels were contributed from Image 5 (e). Landsat images are courtesy of the U.S. Geological Survey (https://earthexplorer.usgs.gov/).



S6. Spatial distribution of SGLs during the 2005/06 melt season; the melt season with the highest cumulative lake area throughout the study period.



S7. Spatial distribution of SGLs during the 2010/11 melt season; the melt season with the lowest cumulative lake area throughout the study period.



S8. Individual time series plots for each melt season in the study period, showing total lake area and RACMO2.3p2 monthly melt estimates. As in Figure 8 in the main manuscript, red bars display observed minimum lake areas whilst blue bars display estimated maximum lake areas. Grey areas indicate missing lake area data. Black lines show mean monthly melt over the study region from RACMO2.3p2.