

Continent-wide bimonthly mapping of surface meltwater across Antarctica

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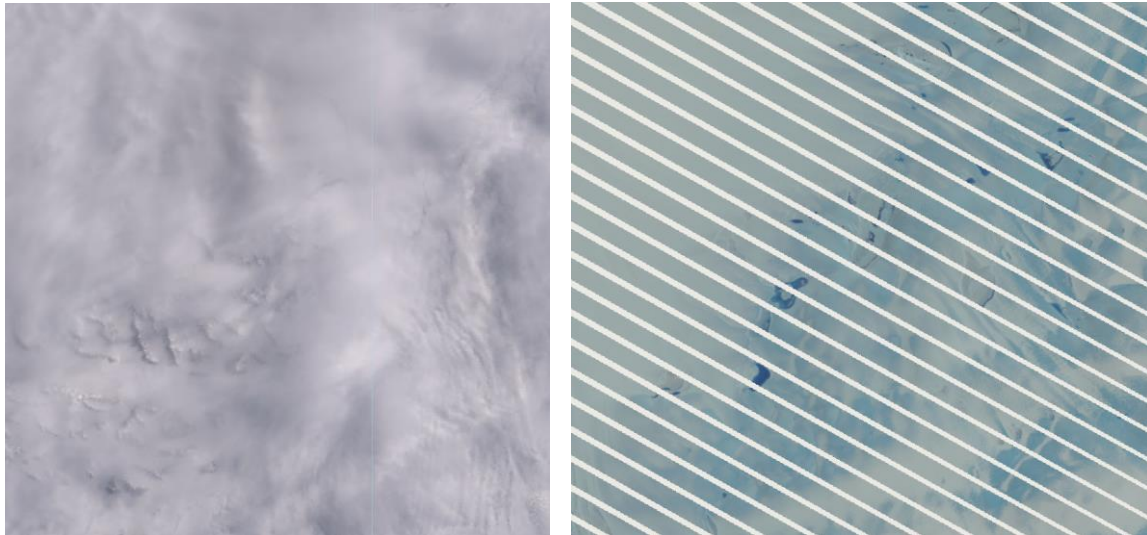
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AIM: Create a multi-year time series of surface meltwater across Antarctica from Landsat optical satellite imagery

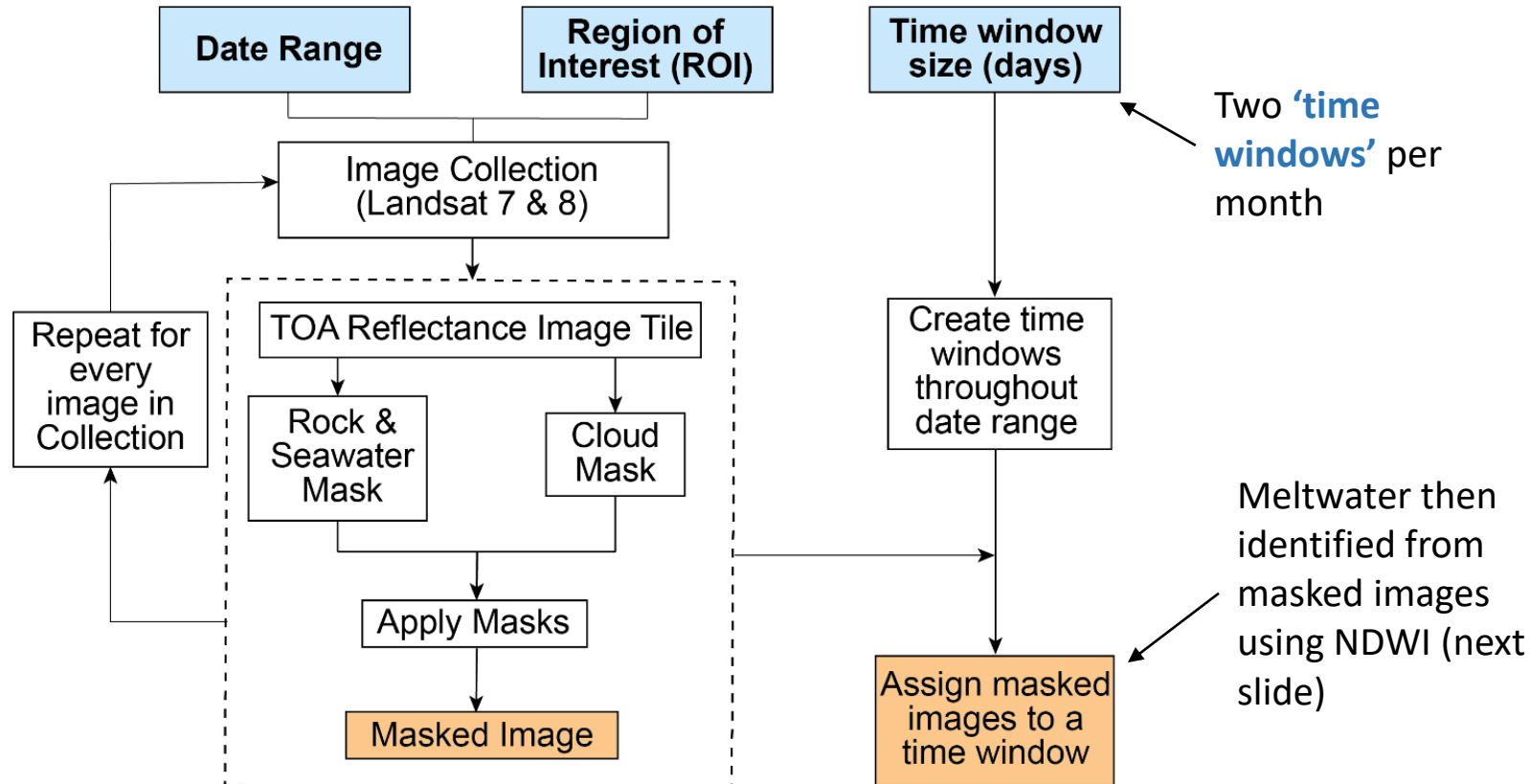
2 main limitations:

- 1) Analysing thousands of images requires a fast, automated method
- 2) Cloud cover/Landsat-7 SLC error results in incomplete optical coverage

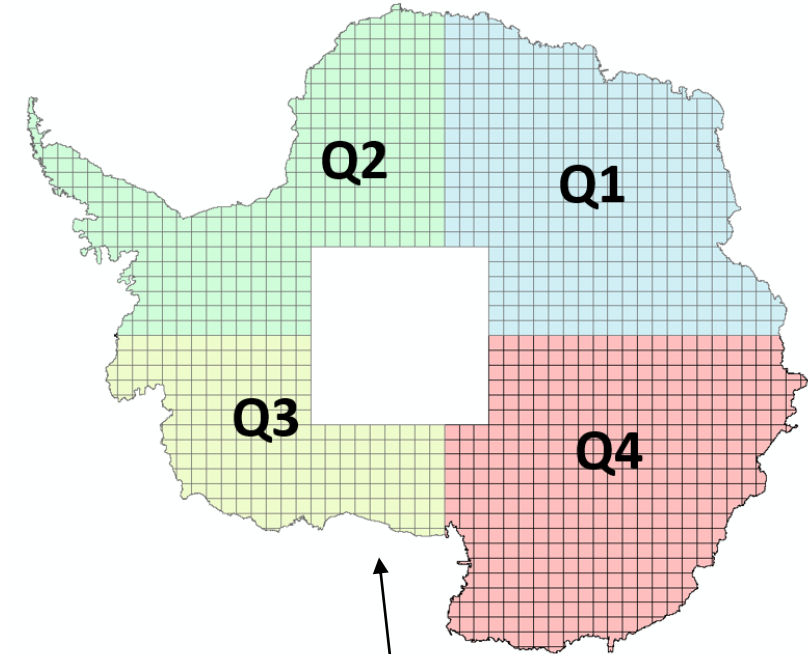


Solution 1: Fully automated mapping of Antarctic surface meltwater using Google Earth Engine

3 Inputs:



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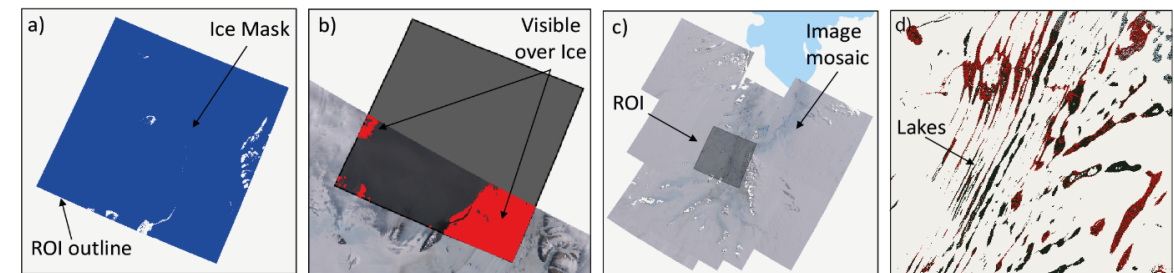
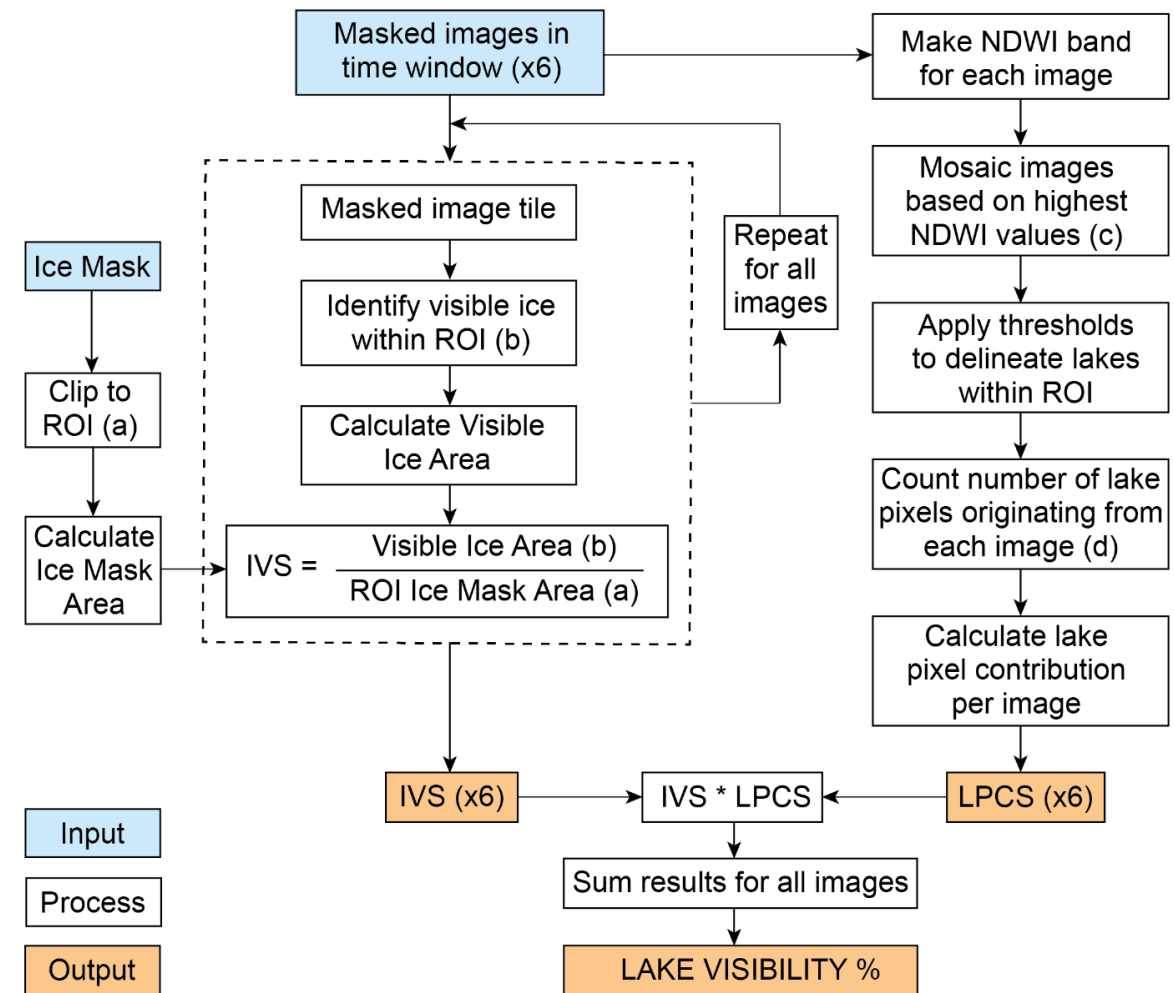


- Antarctica split into **1,341 ROIs** (100 x 100 km tiles) for mapping
- Processing performed one quarter at a time
- Every Landsat image processed between 2013 and 2020

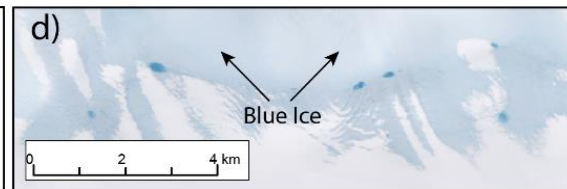
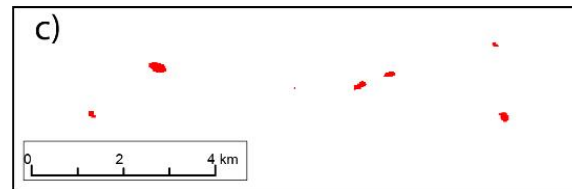
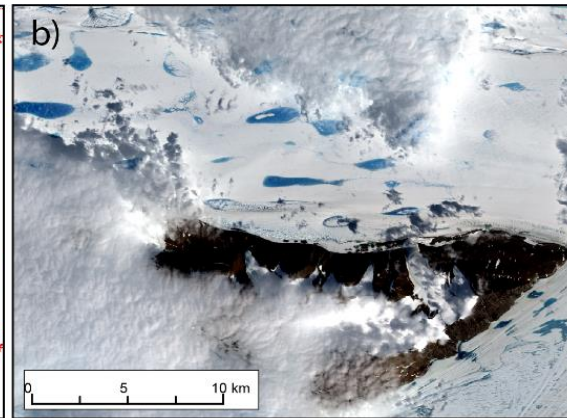
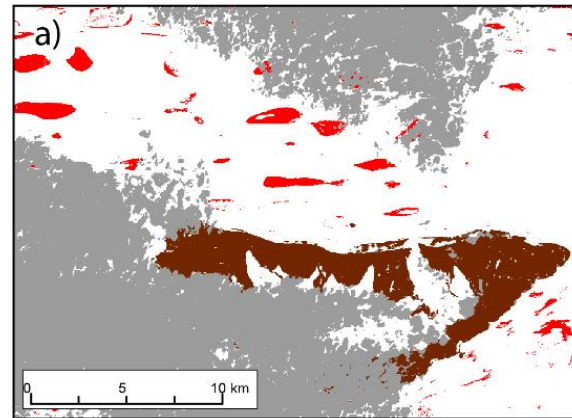
Applies optical band thresholding technique developed by Moussavi et al. (2020)

Solution 2: Robust visibility assessments to quantify uncertainty induced by cloud cover

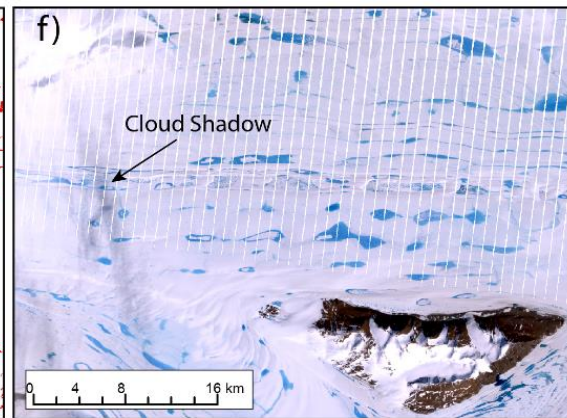
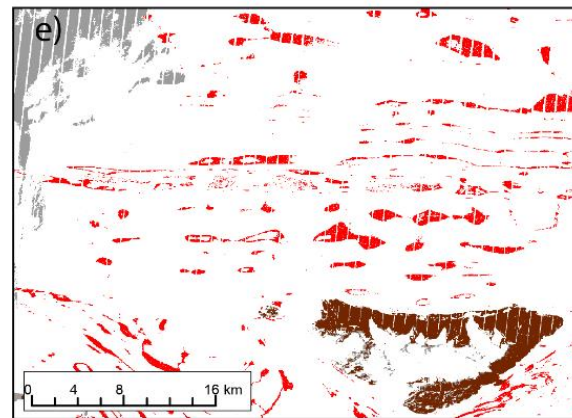
- An **'Image Visibility Score' (IVS)** is generated for each masked optical image that intersects the Region of Interest (ROI). This score incorporates cloud cover, the proportion of the ROI that is covered by the image, and the amount of ice that is visible
- Images are also assigned a **'Lake Pixel Contribution Score' (LPCS)** to assess which images are most important in the detection of surface melt within a time window
- These two metrics are multiplied together for each individual image within a given time window. The combined scores are then summed to create a final **'Lake Visibility %'** for that time window and ROI.



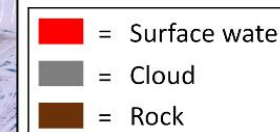
Cloud,
Rock/Seawater
and Surface water
masks generated



Thresholds also
effective at detecting
surface water from
Landsat 7 images



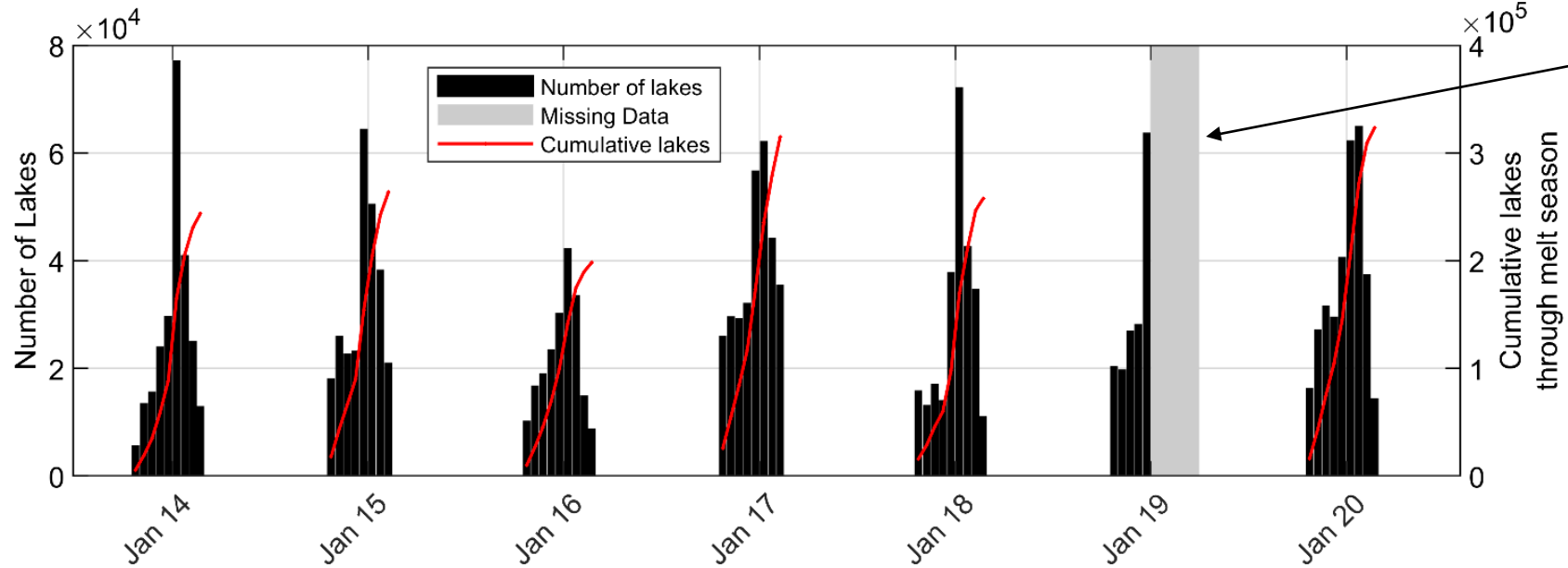
Thresholds effective at
differentiating between
surface water and blue ice



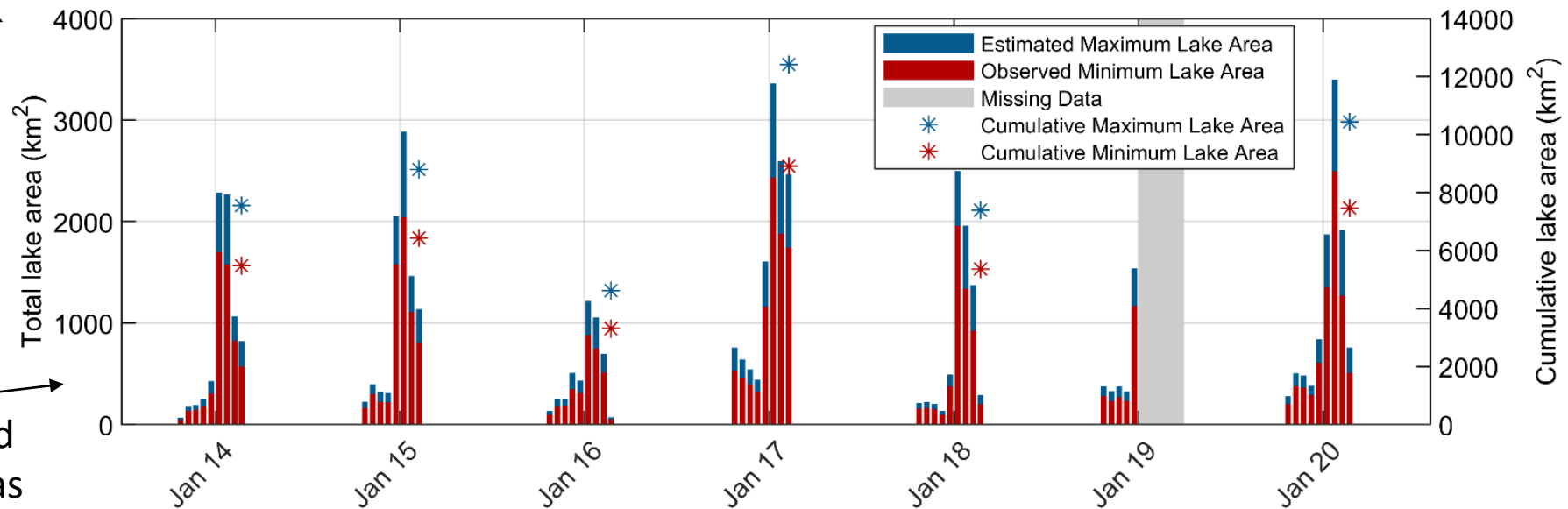
Tuckett et al (In prep)

(a,c,e) Automatic masking of cloud, rock and surface water from Landsat imagery. (b) Landsat 8 image from 25th January 2017 of the Clemence Massif, Amery Ice Shelf; (d) Landsat 8 image from 1st January 2019, highlighting blue ice ~100 km south of Fisher Massif, Amery Ice Shelf; (f) Landsat 7 image from 2nd January 2005, showing widespread surface lakes to the west of the Clemence Massif. Note the white stripes resulting from the failure of the Landsat 7 scan line corrector.

Continent-wide lake area totals

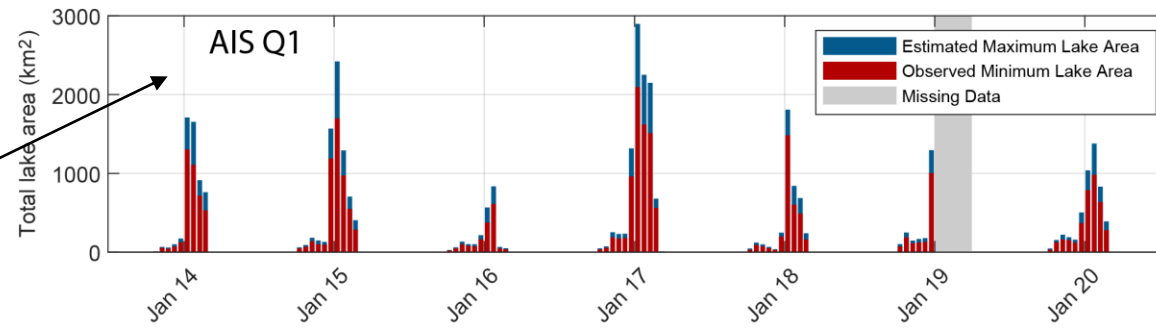


Red bars show Antarctic-wide lake area based on mapped values



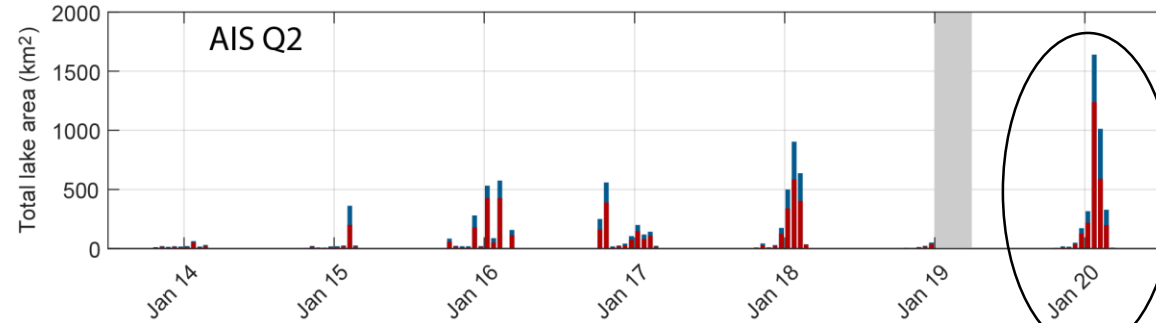
Blue bars take into account visibility assessments, providing estimated maximum lake areas

Majority of lake area contributed by the Amery Ice Shelf region

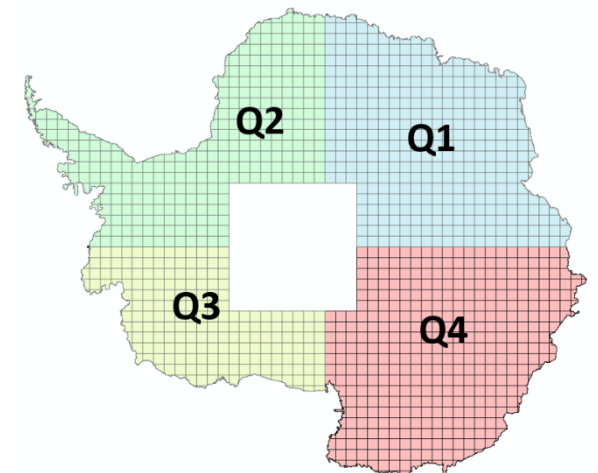
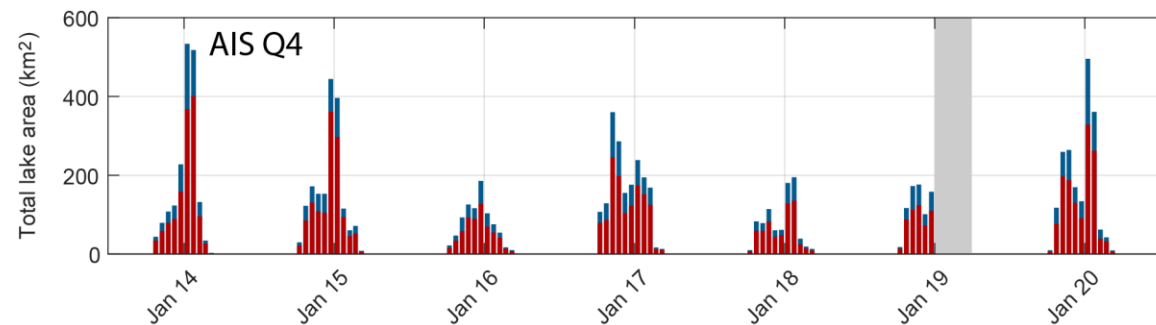
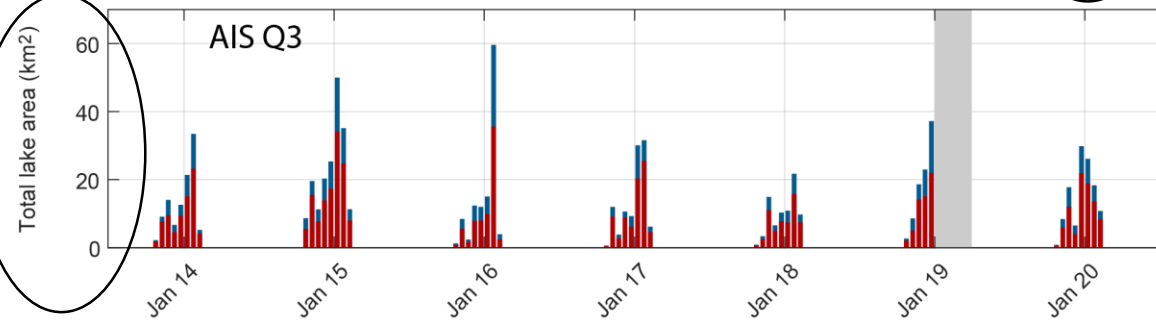


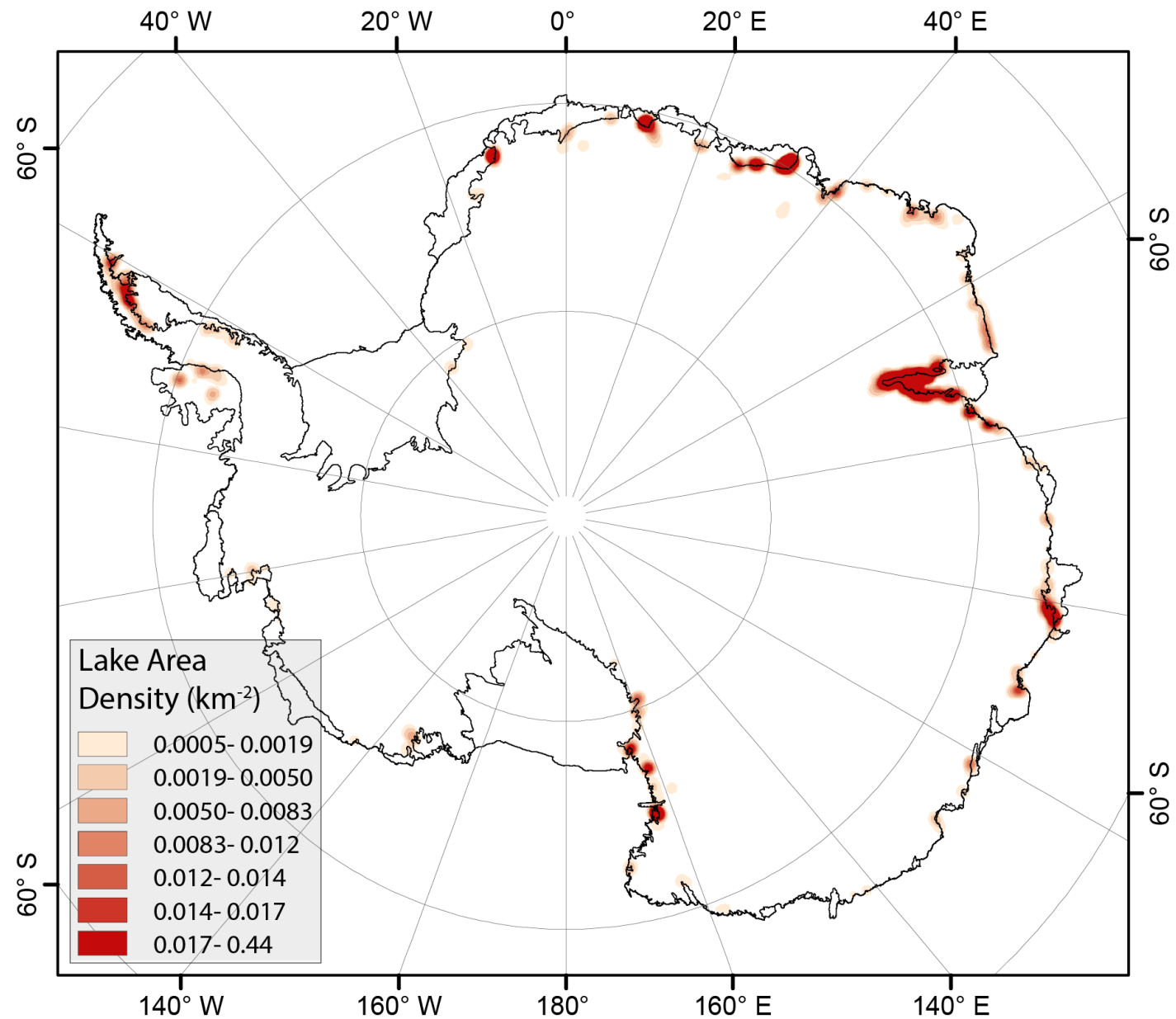
Lake area totals for four sectors of Antarctica

Note the much smaller scale for Q3



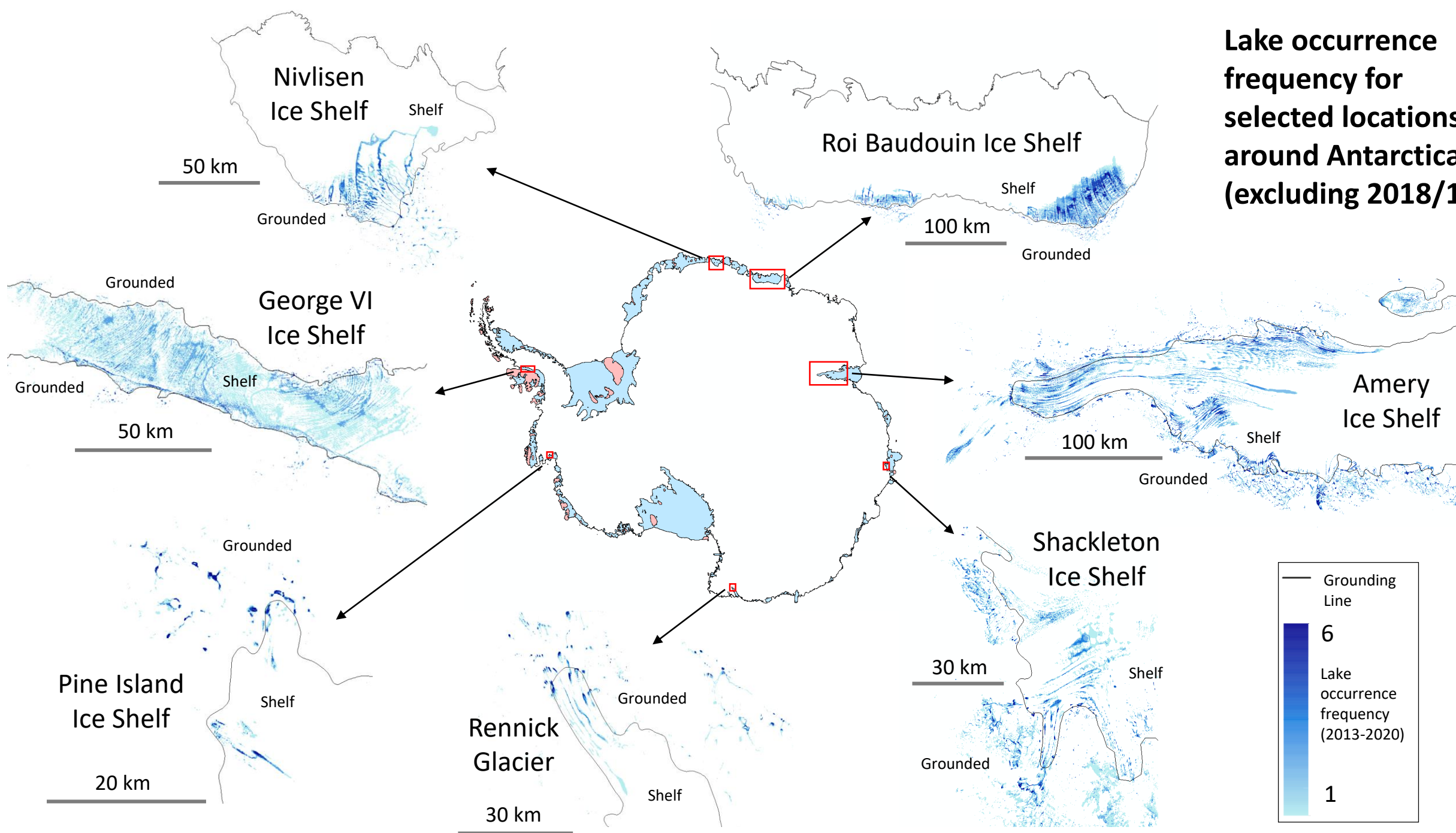
Very large melt event on George VI Ice Shelf in January 2020





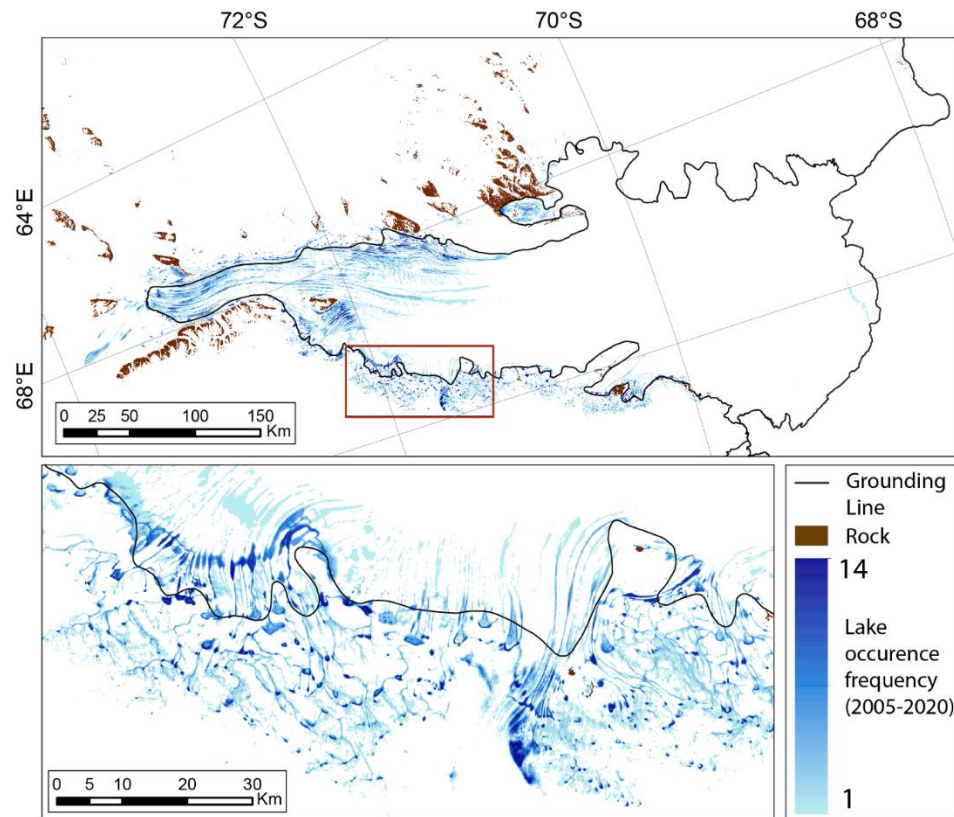
**Lake density map of
Antarctica displaying
the cumulative area of
lakes for the 2016/17
melt season**

Lake occurrence frequency for selected locations around Antarctica (excluding 2018/19)

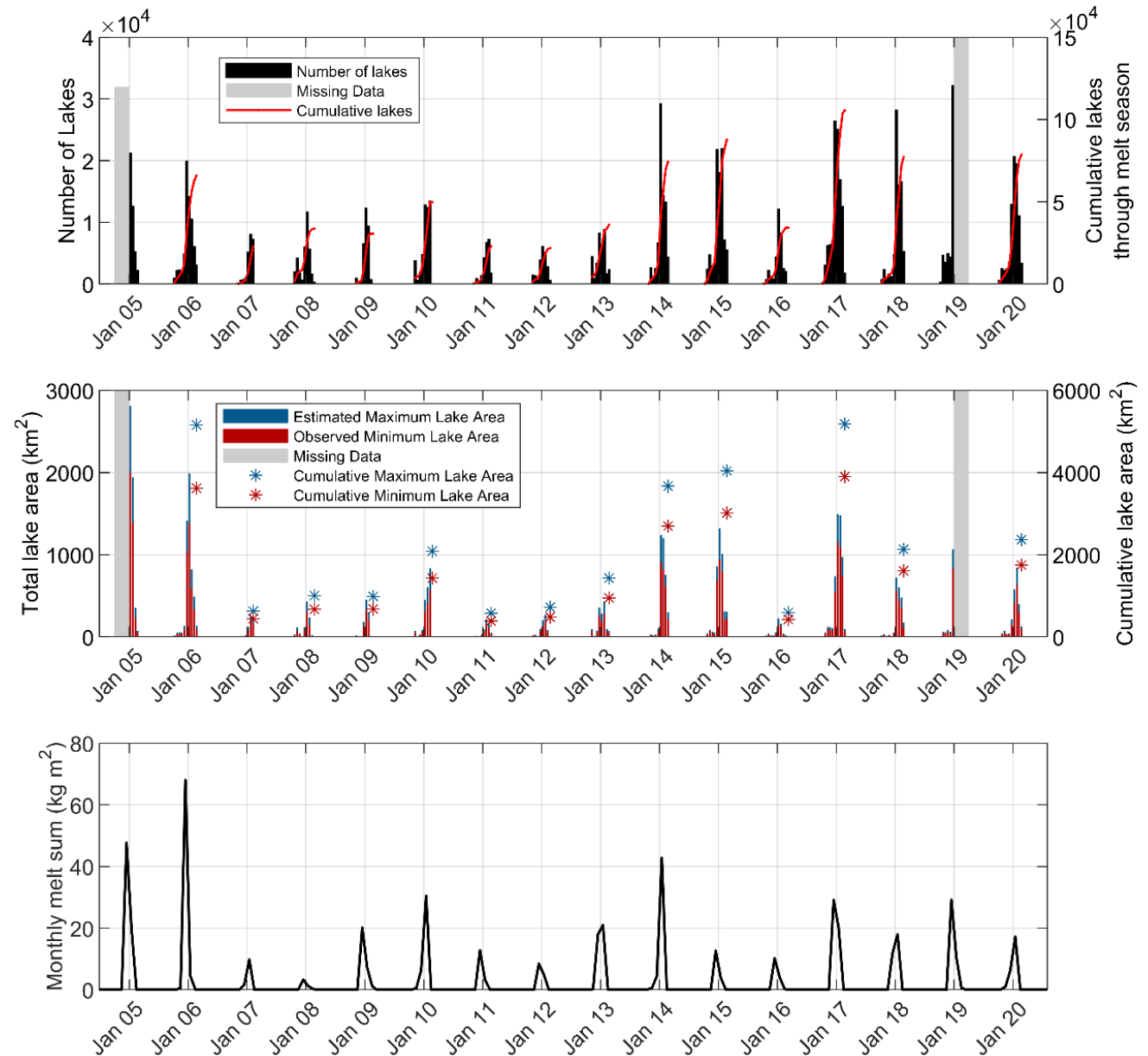


Keep an eye out...

Paper coming soon detailing our method and presenting results from application to the Amery Ice Shelf region between 2005-2020



Tuckett et al (In prep)



Tuckett et al (In prep)

Thanks for viewing these slides. Please get in touch if you have any questions!

Live Session: Hydrology of ice shelves, ice sheets and glaciers – from the surface to the base
Tuesday 27th April, 09:00 – 10:30 CEST



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References

Moussavi, M., Pope, A., Halberstadt, A. R. W., Trusel, L. D., Cioffi, L., & Abdalati, W. (2020). Antarctic Supraglacial Lake Detection Using Landsat 8 and Sentinel-2 Imagery: Towards Continental Generation of Lake Volumes. *Remote Sensing*. **12**: 134.

Tuckett, P. A., Ely, J. C., Sole, A. J., Lea, J. M., Livingstone, S. J., Jones, J., & van Wessem, J. M (*in preparation*). Automated mapping of the seasonal evolution of surface meltwater and its links to climate on the Amery Ice Shelf, Antarctica