Artificial intelligence for the monitoring of Antarctic supraglacial lake dynamics in 2015-2021 using Sentinel-1 SAR and optical Sentinel-2 data

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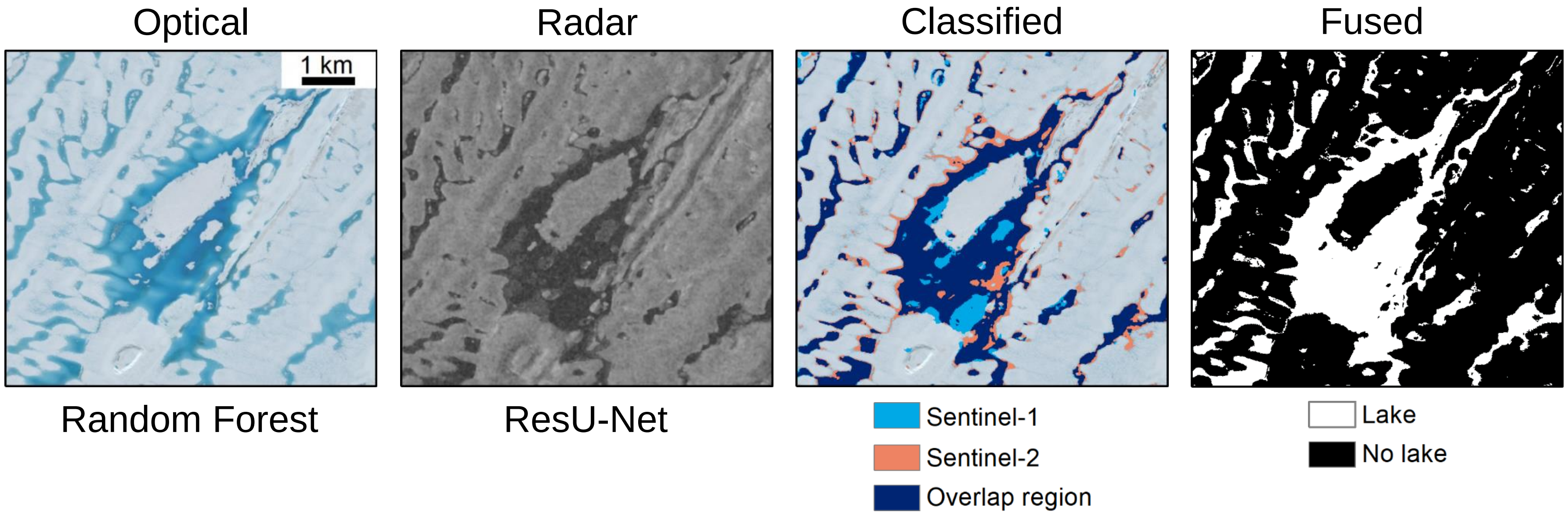
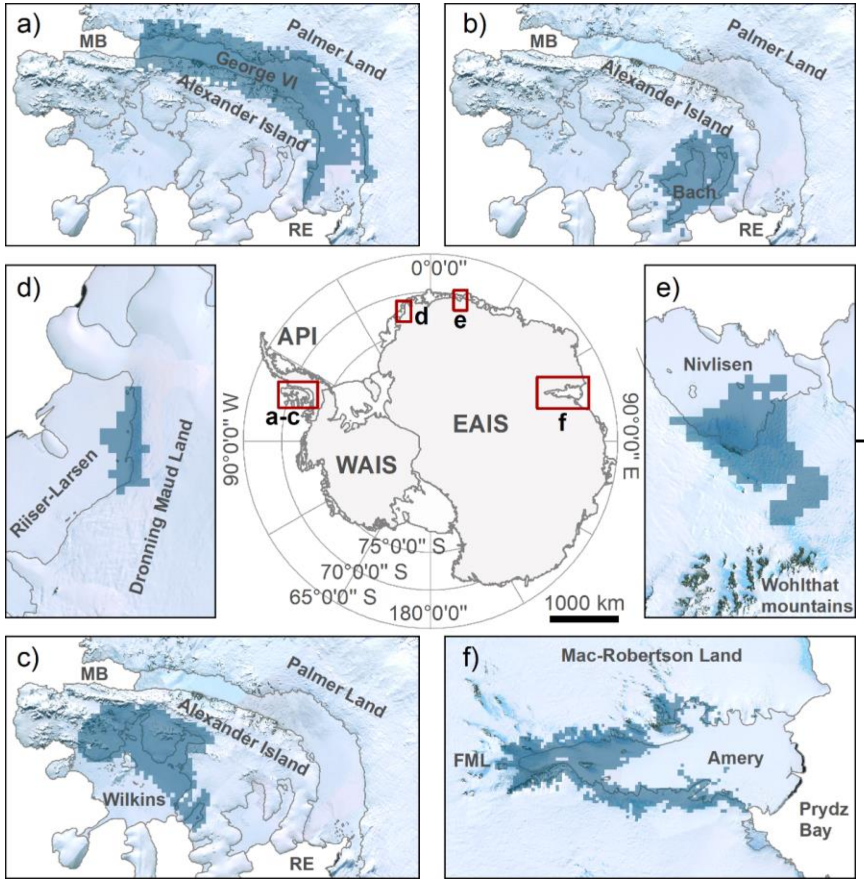
Objectives and Methods

(1) Use methods from **artificial intelligence** for the mapping of Antarctic supraglacial lake extents in satellite imagery
(2) Process the full Sentinel-1/-2 data archives since 2015 to retrieve fused **bi-weekly** supraglacial lake classifications
(3) Investigate seasonal and inter-annual **dynamics** in supraglacial lake coverage across six major Antarctic ice shelves
(4) Establish the basis for an operational monitoring service with **near-real-time** lake classification in the long term

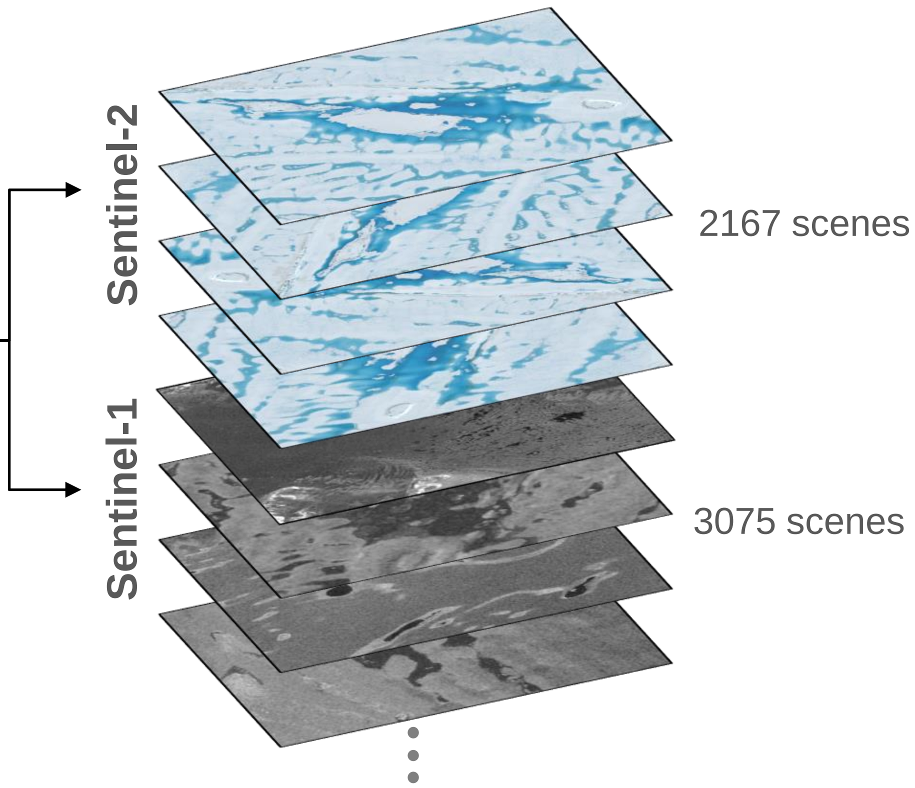


Study Regions and Data Basis

Study regions



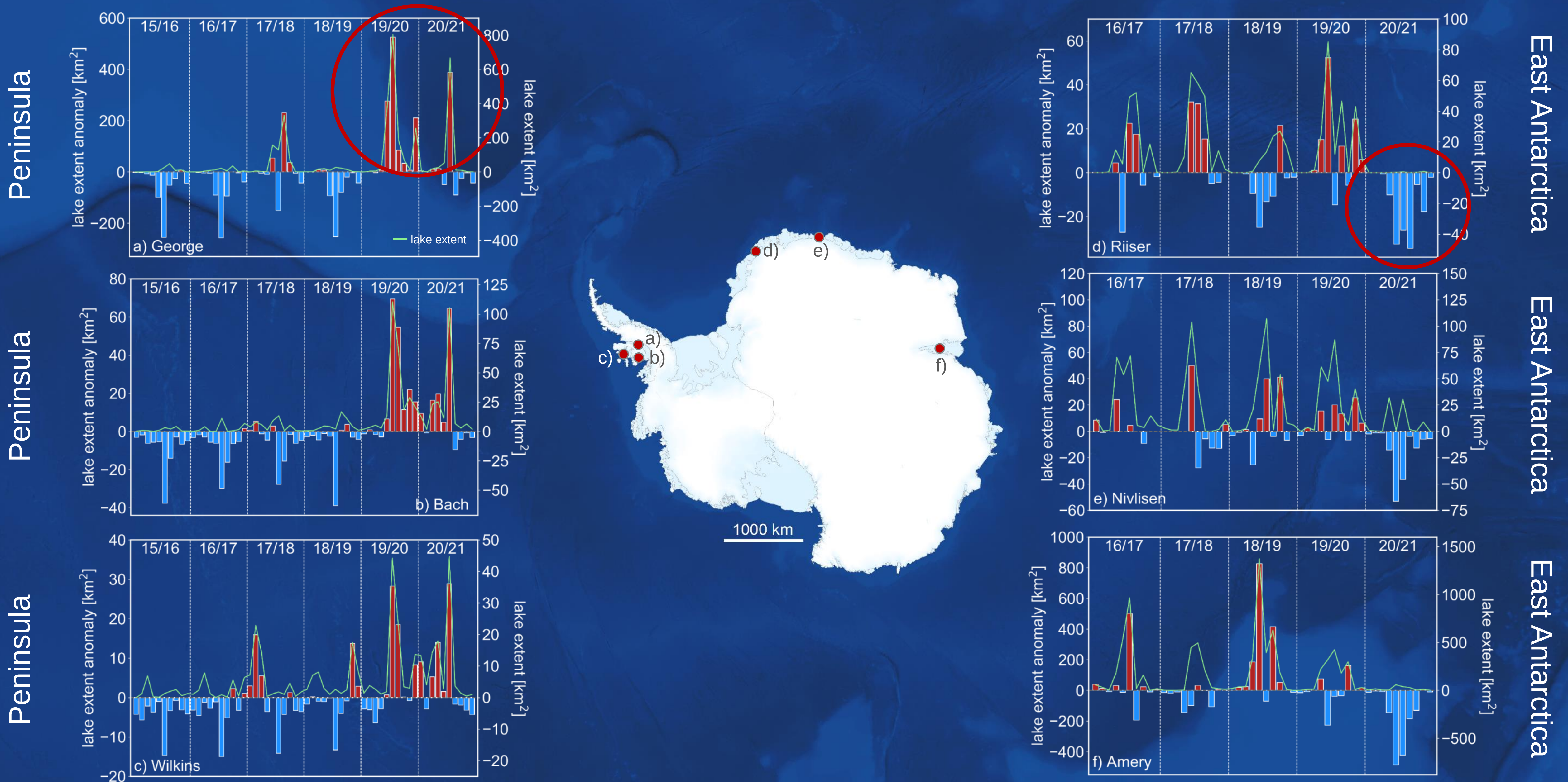
Bi-weekly time series Nov-March 2015-2021



Total of 5242 scenes

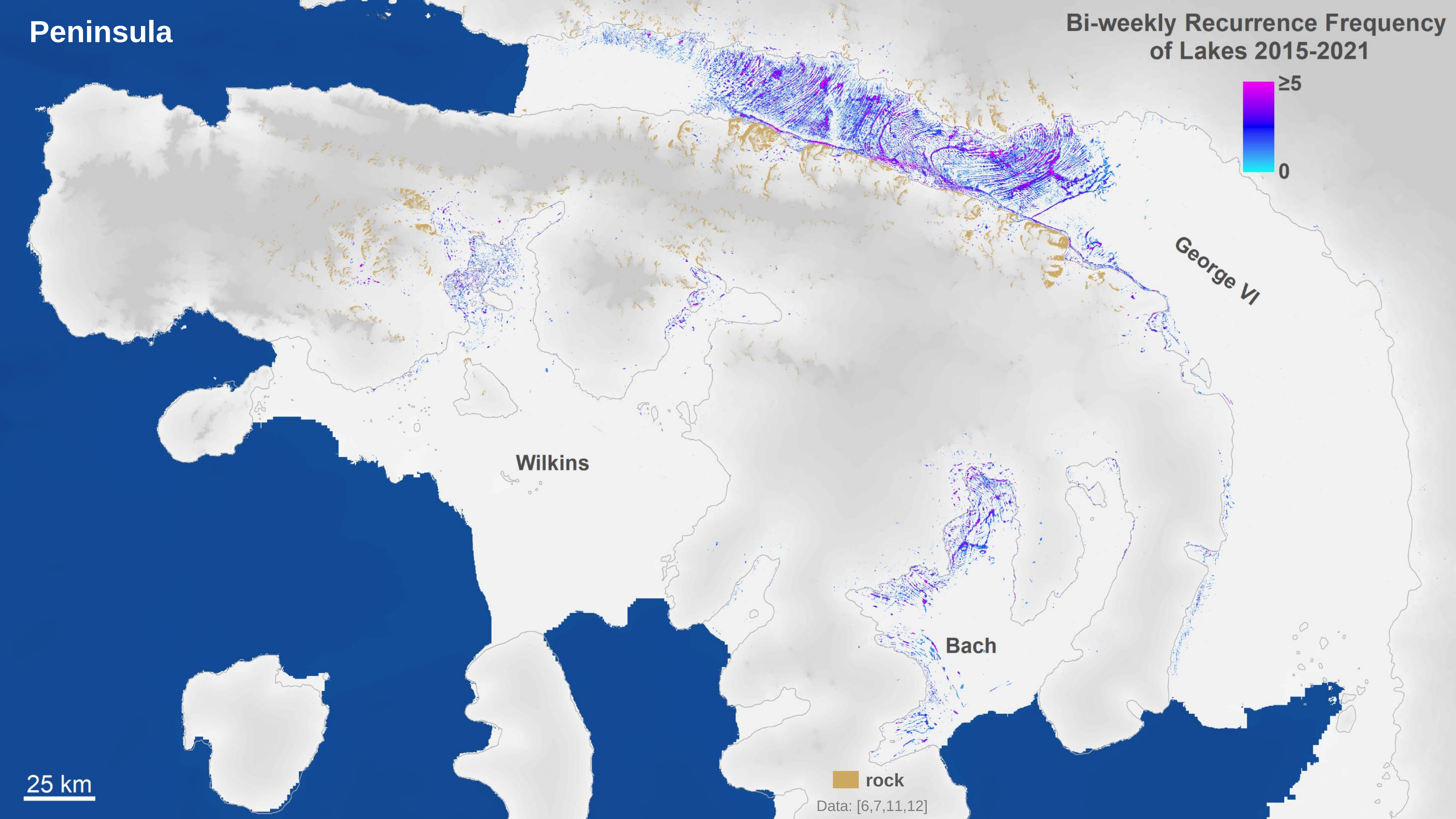
Modified after Dirscherl et al. (2021b);
Copernicus Sentinel data, Data: [1,7,9,10]

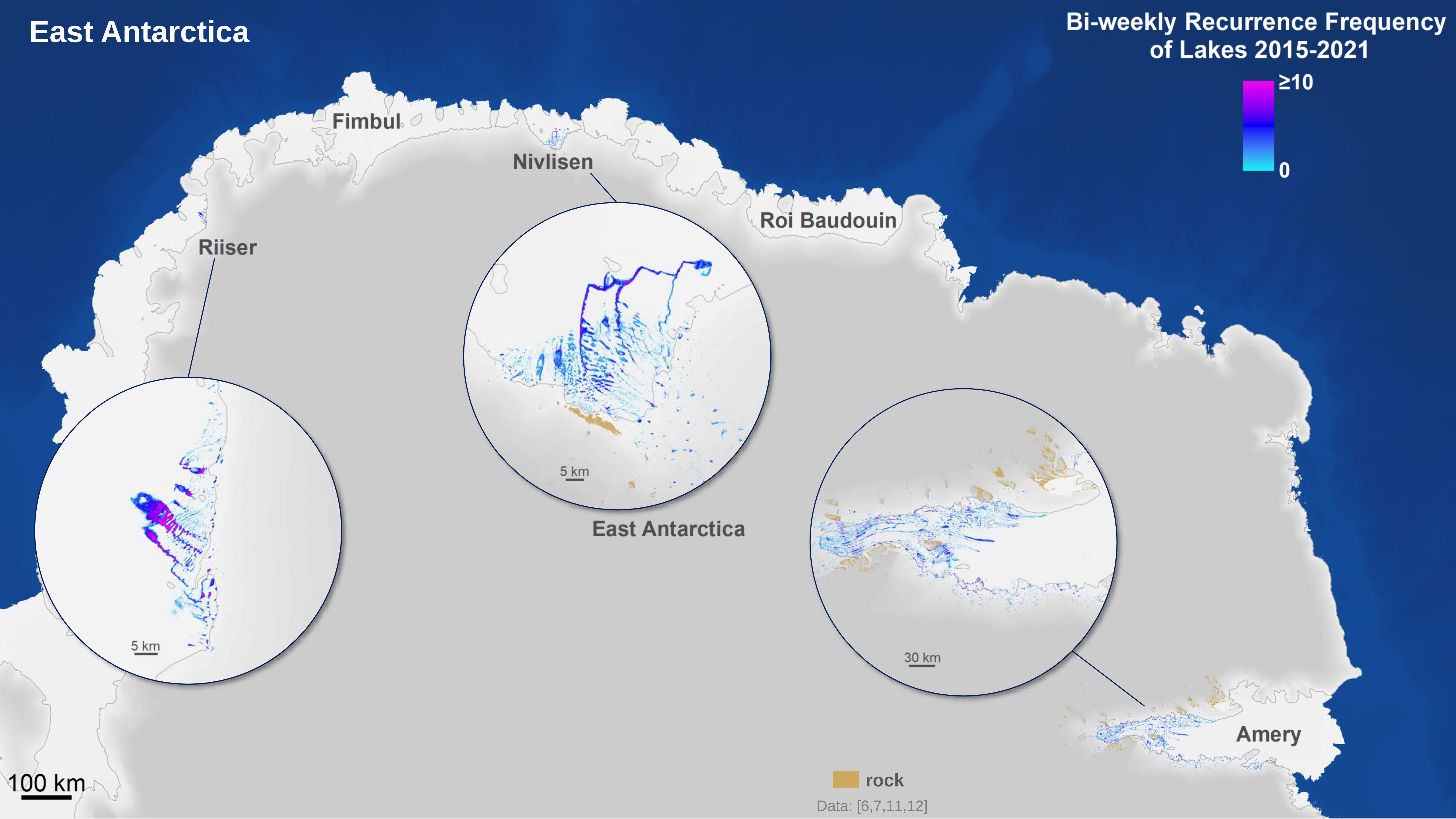
Bi-weekly lake extents and anomalies for summer melting seasons 2015-2021



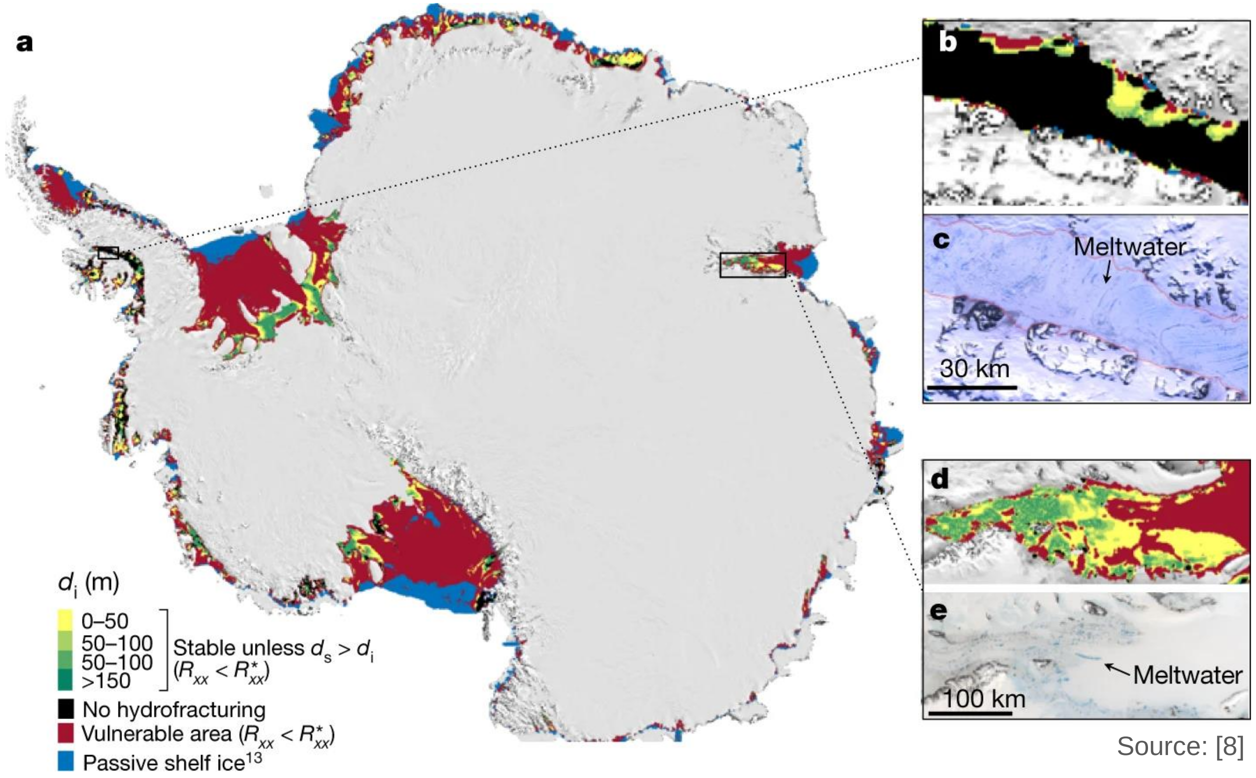
Modified after Dirscherl et al. (2021b)

Data: [6,7,11,12]


Peninsula
Bi-weekly Recurrence Frequency of Lakes 2015-2021
≥5
0
George VI
Wilkins
Bach
rock
Data: [6,7,11,12]
25 km


East Antarctica
Bi-weekly Recurrence Frequency of Lakes 2015-2021
≥10
0
Fimbul
Nivlisen
Riiser
Roi Baudouin
East Antarctica
Amery
5 km
5 km
30 km
100 km
rock
Data: [6,7,11,12]

Potential implications for ice shelf stability



Source: [8]

- 60 ± 10% of the Antarctic shelf ice that is stabilizing the inland ice is vulnerable to hydrofracture
- Enhanced meltwater accumulation, ice shelf fracturing and a reduced firn air content facilitate hydrofracturing
- Large parts of the investigated ice shelf areas with increased supraglacial meltwater ponding are vulnerable to hydrofracture

Conclusion

- Supraglacial lake extents were successfully mapped in Sentinel-1/-2 satellite imagery using methods from artificial intelligence
- In 2015-2021, we observe large intra-annual and inter-annual variability in meltwater ponding across six large Antarctic ice shelves
- Supraglacial lakes tend to cluster at similar locations each year and progressively advanced across the ice shelves during years of high meltwater ponding posing the ice shelves at risk for hydrofracture
- More details on environmental drivers of 2015-2021 supraglacial lake formation can be found in Dirscherl et al. (2021b)

Outlook

- Implementation of methods on the DLR-EOC GeoService for an operational monitoring of supraglacial lake extents in near-real-time
- Processing of bi-weekly data products along the full Antarctic coastline

Data publicly available at: https://download.geoservice.dlr.de/ANTARCTICLAKES/files/

Copernicus Sentinel-2 data


Thank you for your interest!
Copernicus Sentinel-2 data

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