

Understanding Greenland Hydrology Using a Remotely Sensed Approach

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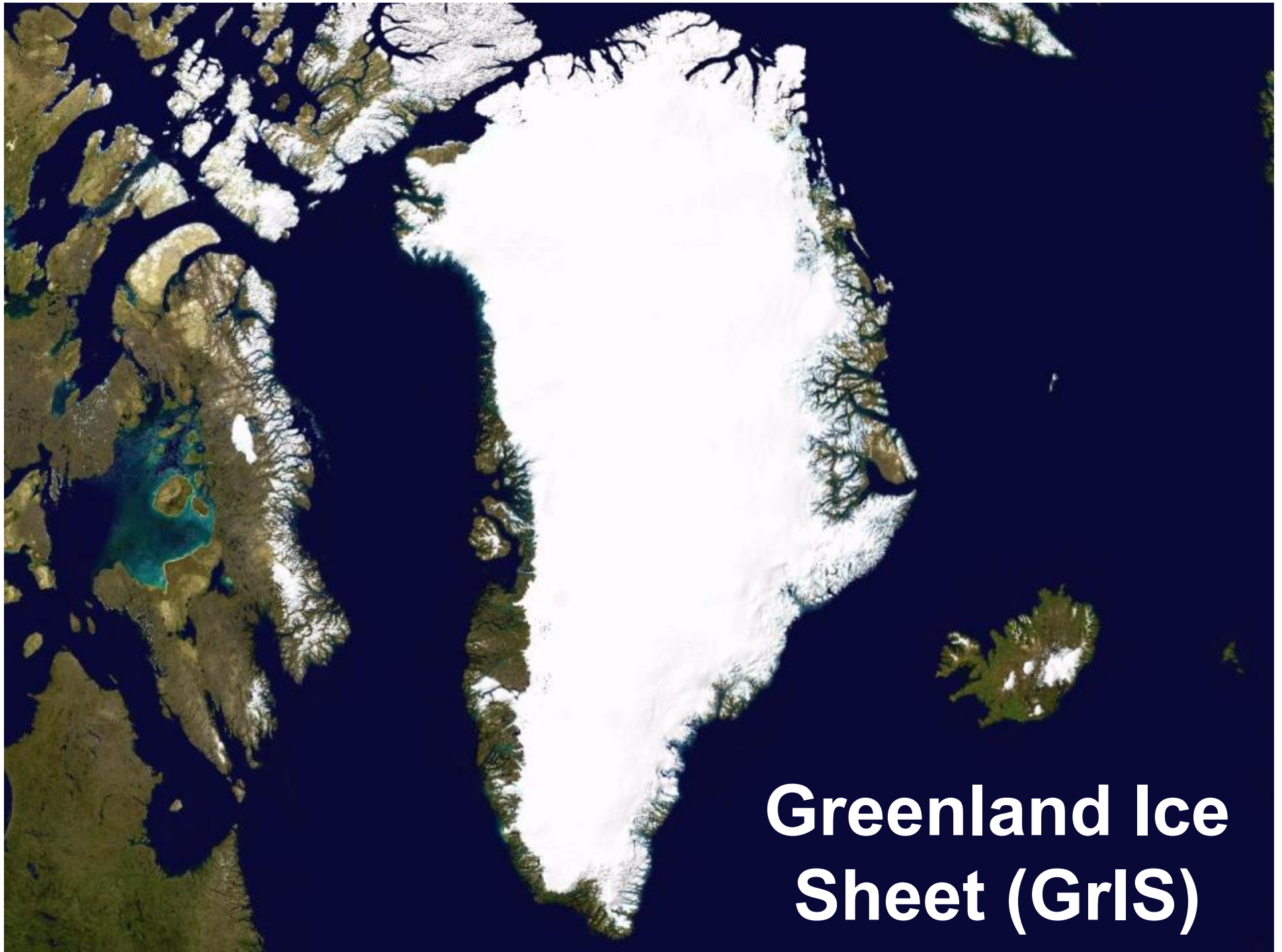
Laurence C. Smith, Professor

University of California, Los Angeles

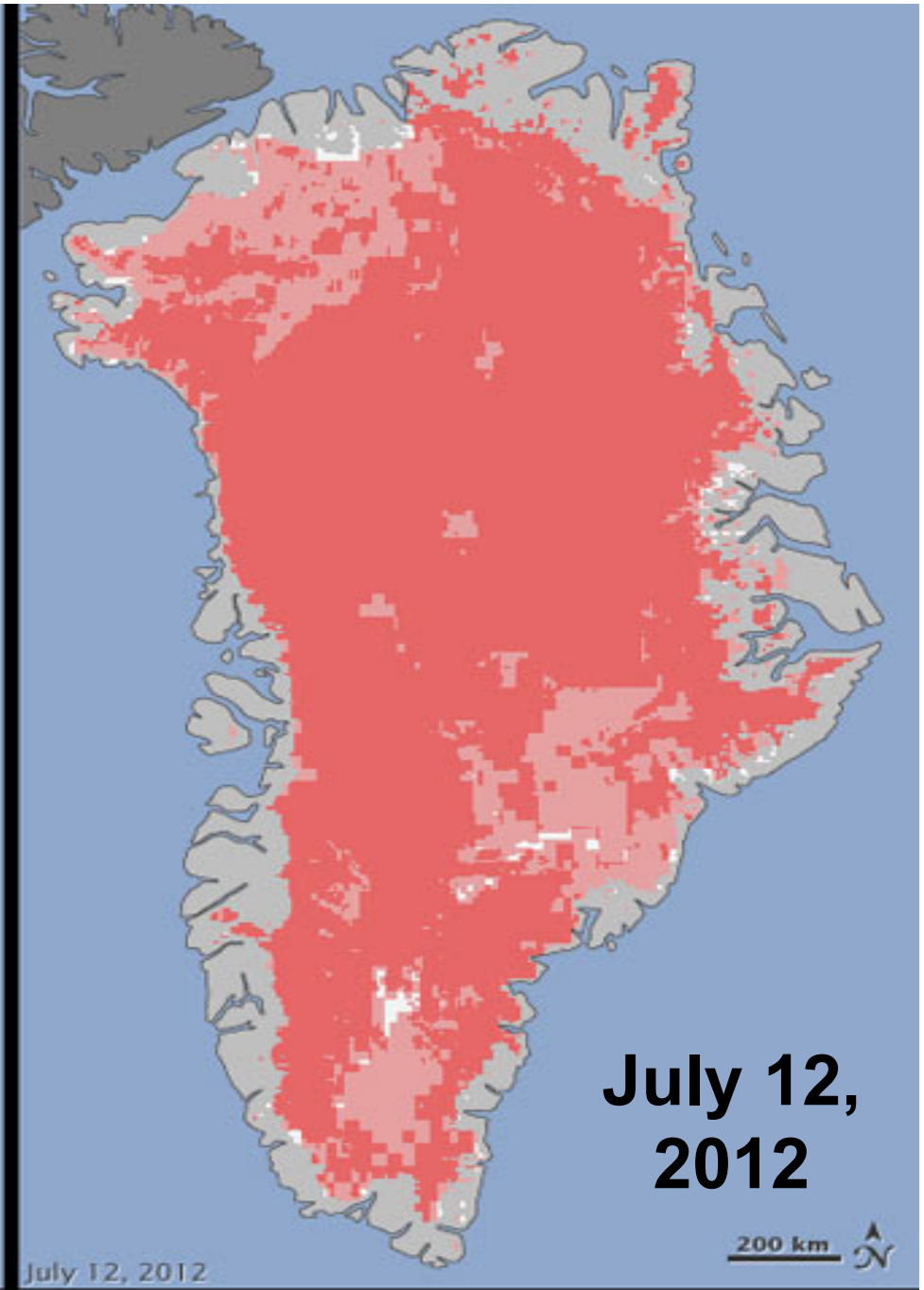
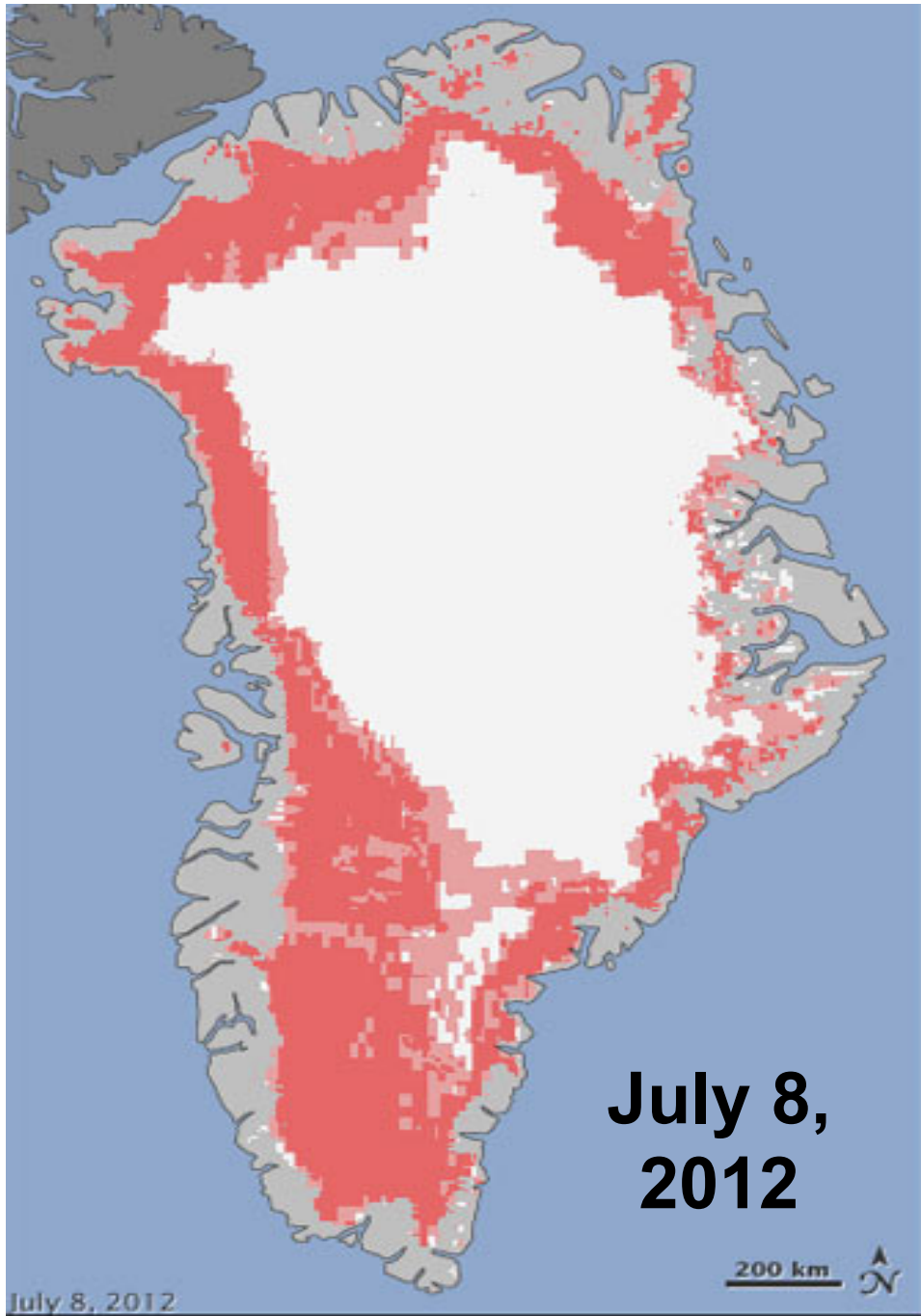


Greenland





Greenland Ice Sheet (GrIS)



No Data Ice/Snow Free Probable Melt Melt No Melting

NASA

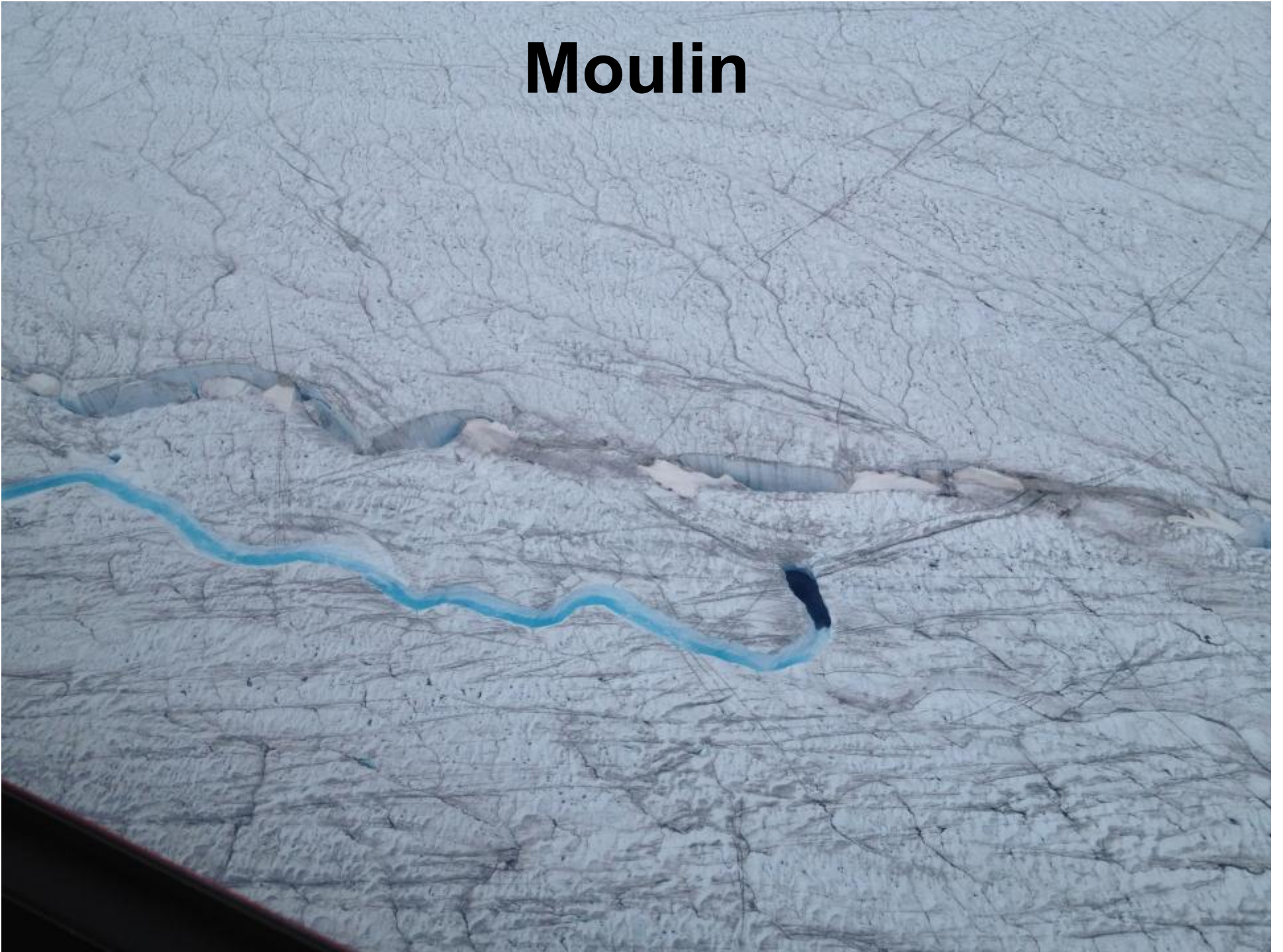
Supraglacial Lake



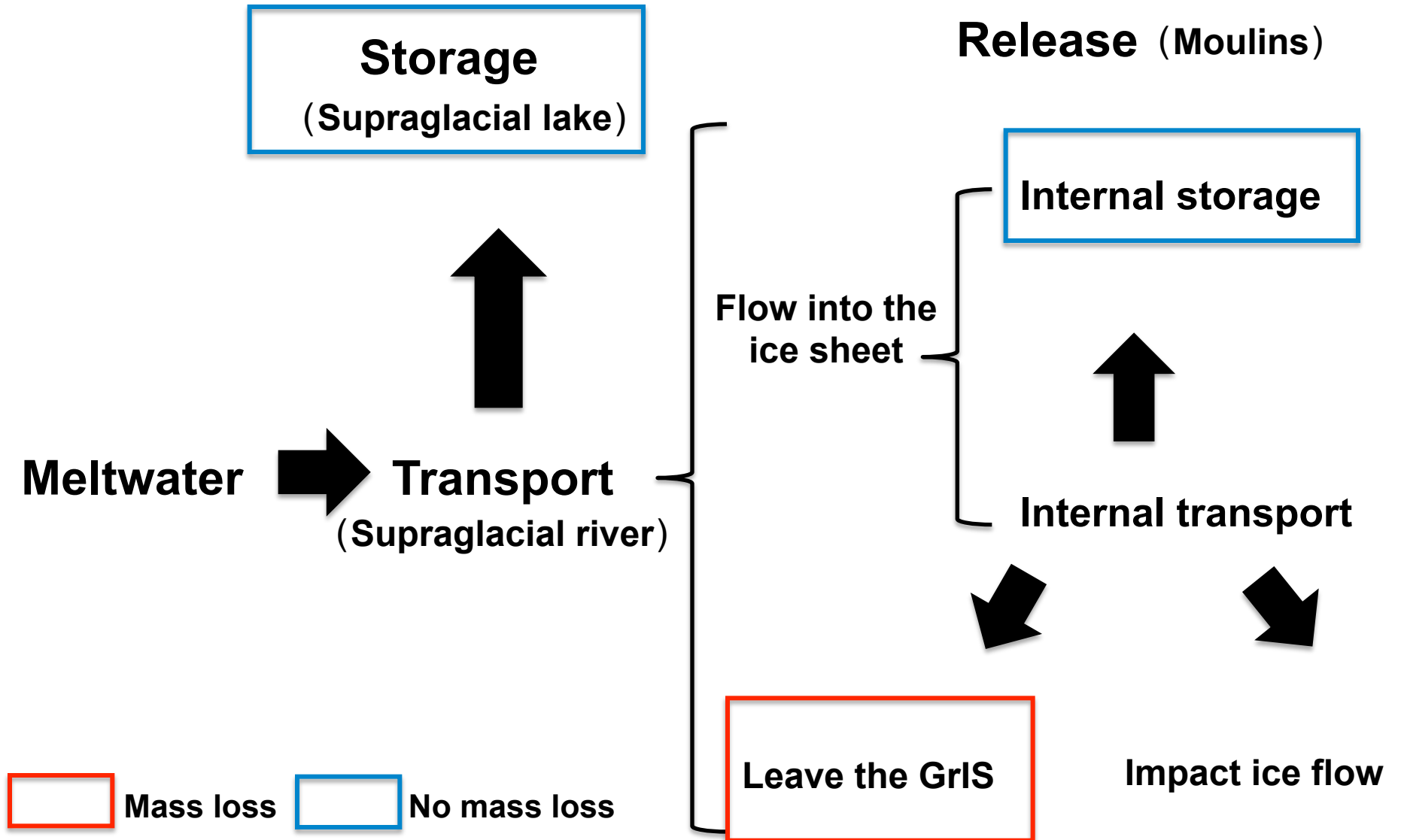
Supraglacial River Network



Moulin



GrlS Supraglacial Hydrology

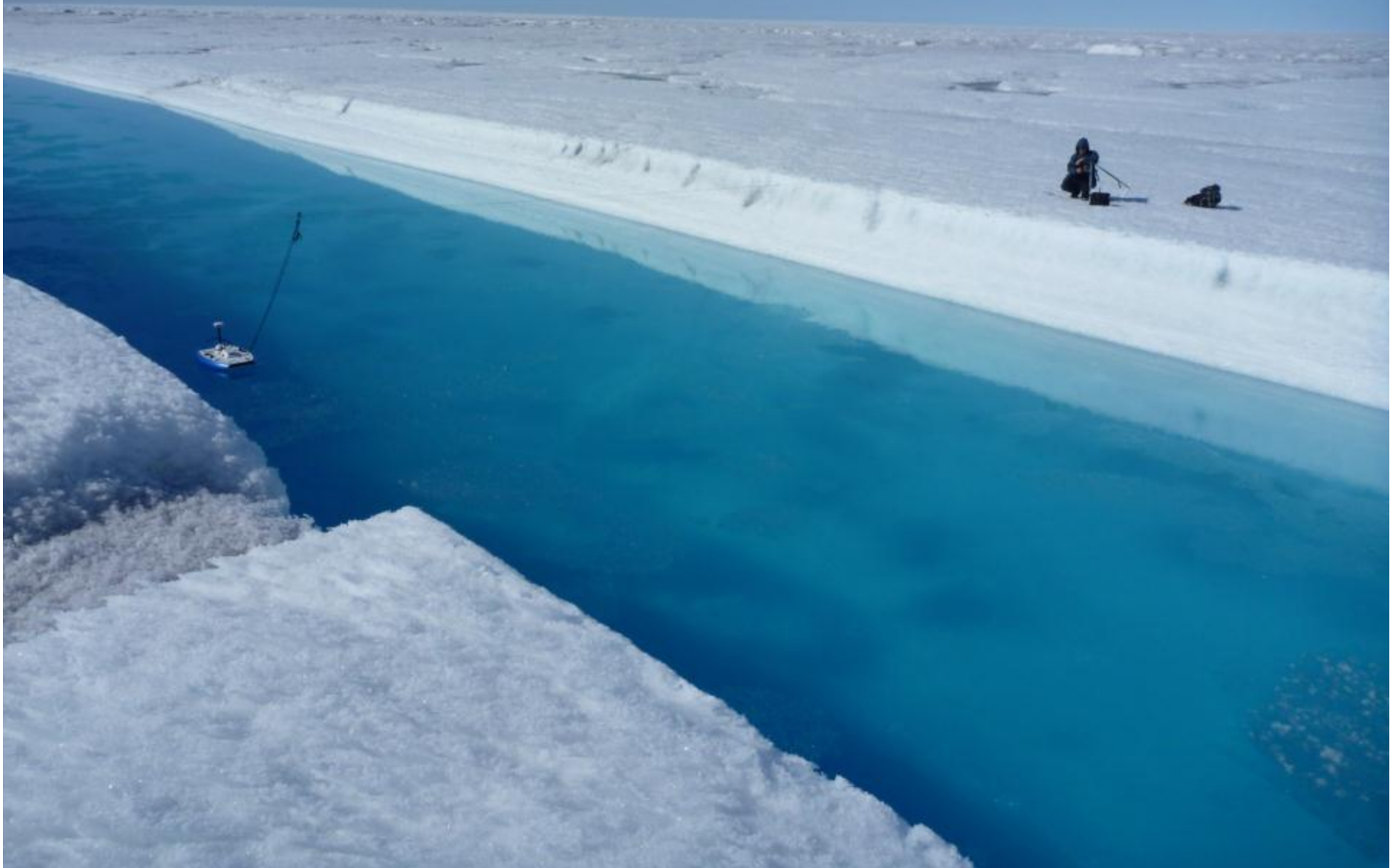


GrIS Supraglacial Hydrology

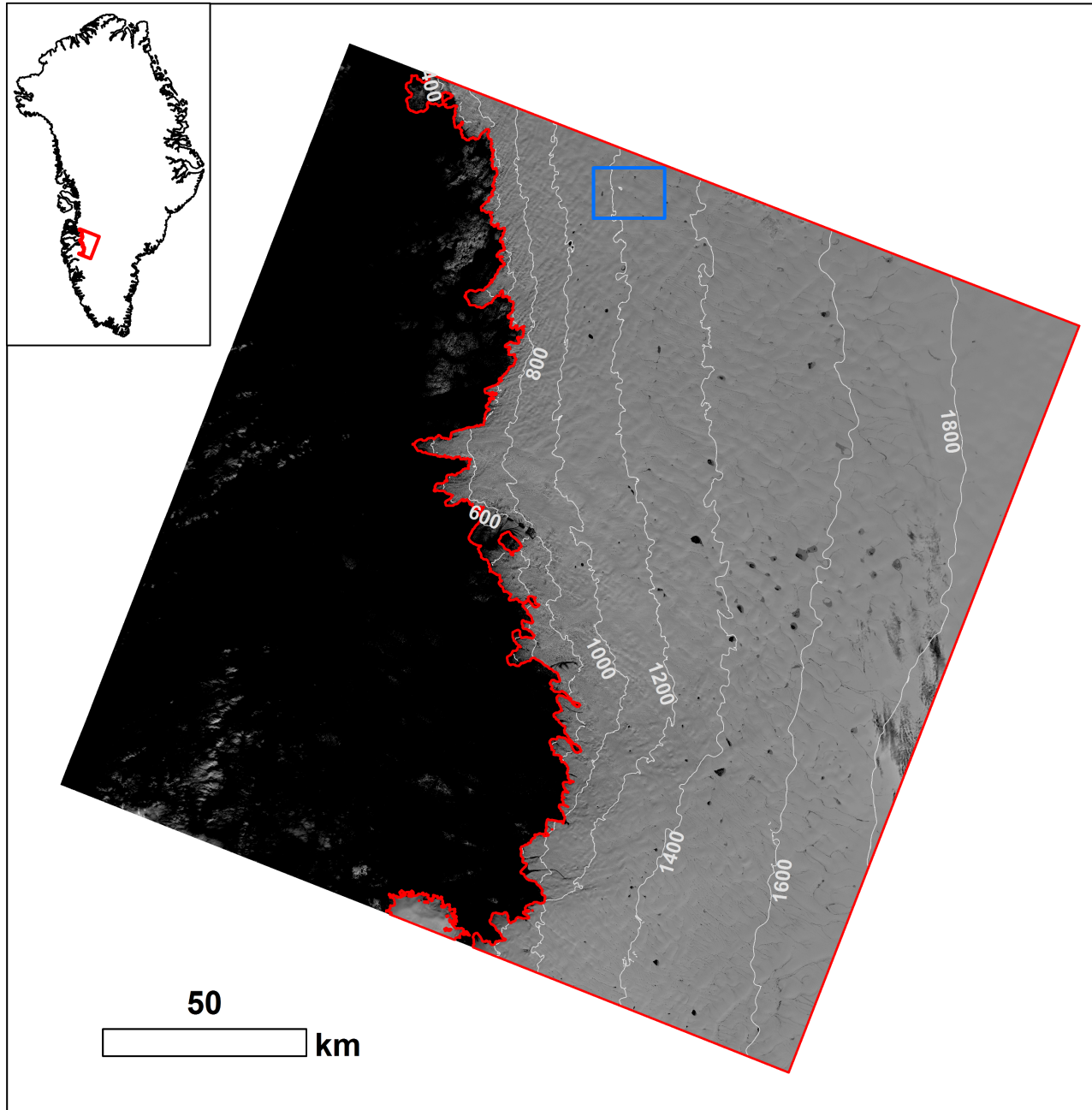
How is meltwater transported and released on the ice surface?

Does meltwater leave the ice sheet or store in the ice sheet?

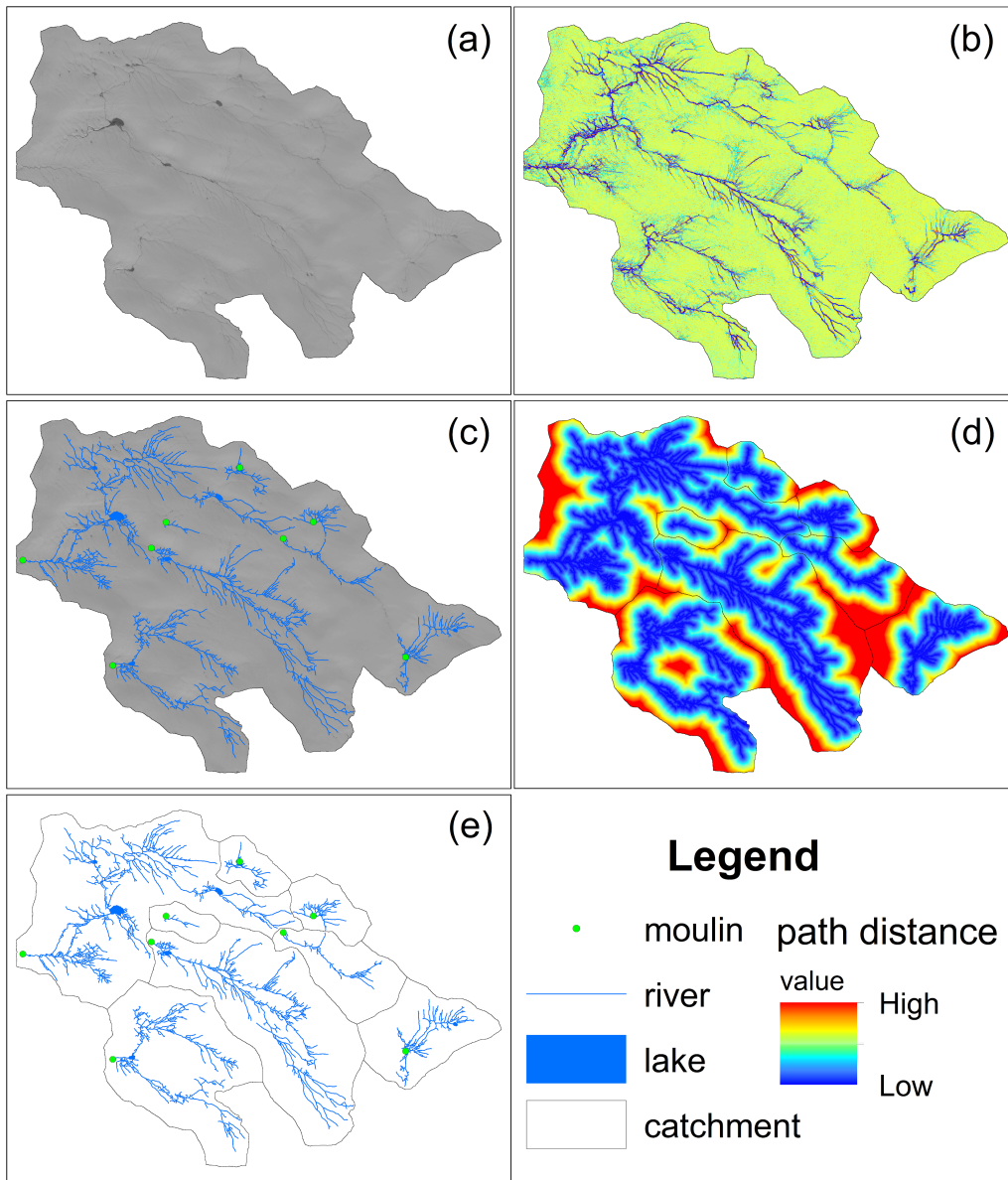
Supraglacial Hydrologic Features



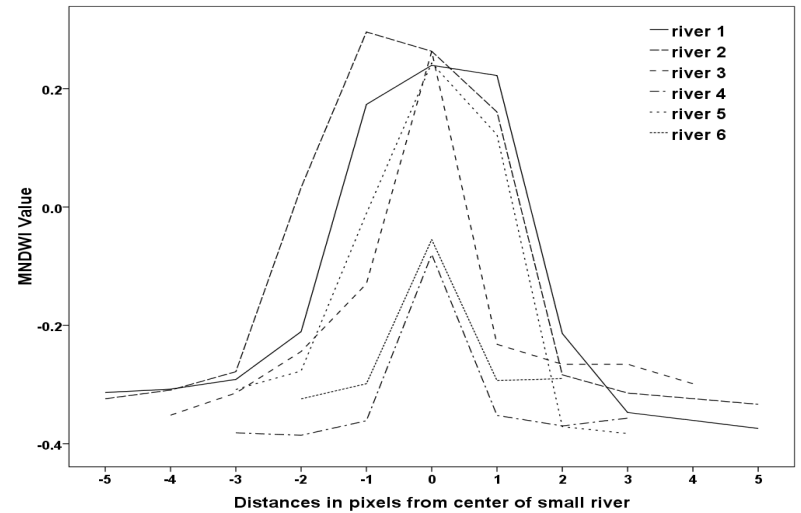
15 m Landsat-8 imagery



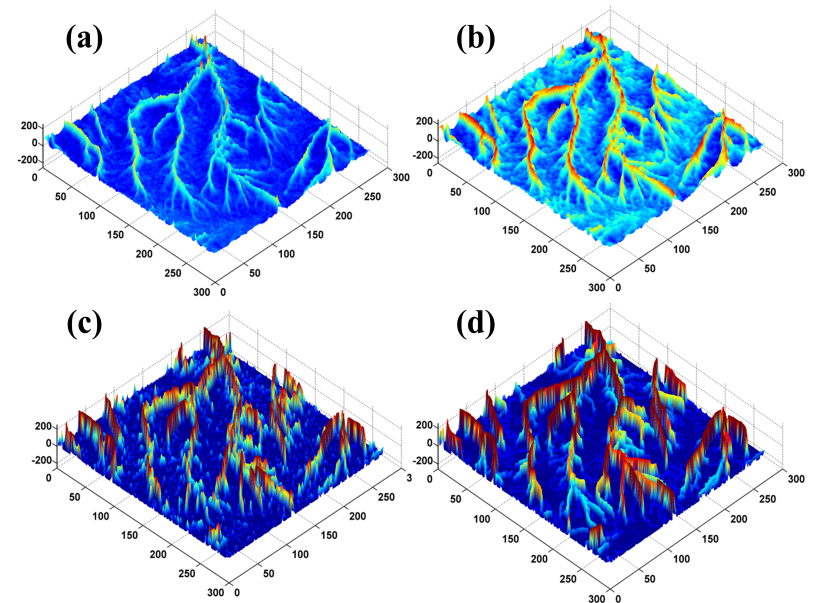
15 m Landsat-8 imagery



Delineation of supraglacial hydrologic features

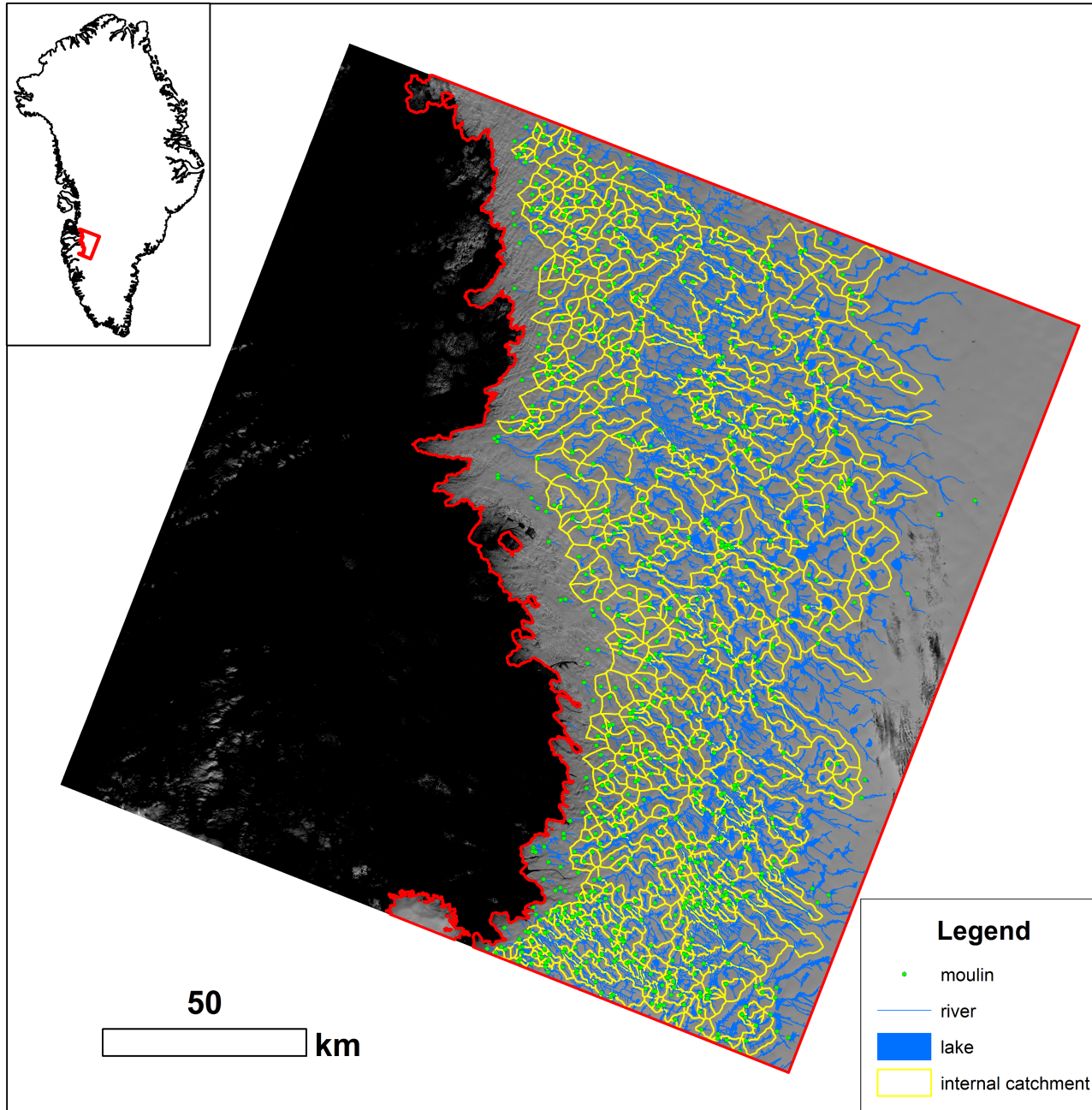


River cross section

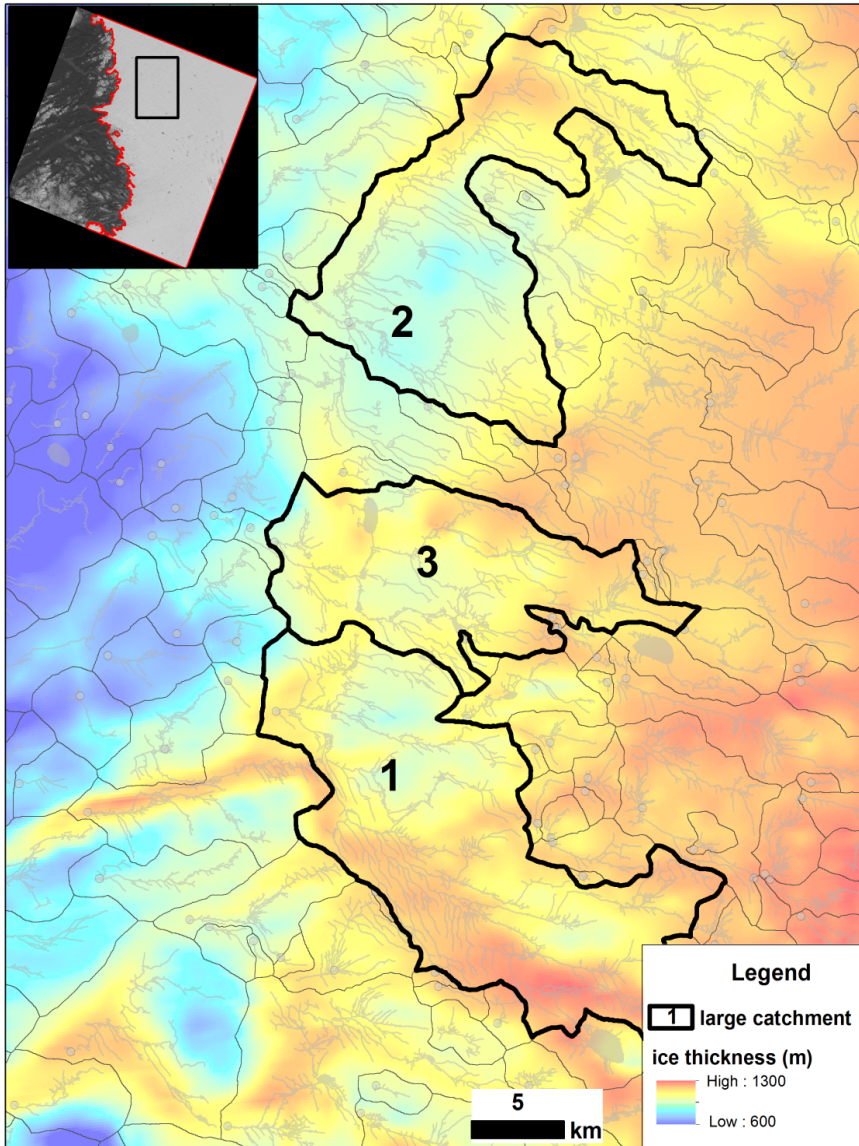


River longitudinal continuity

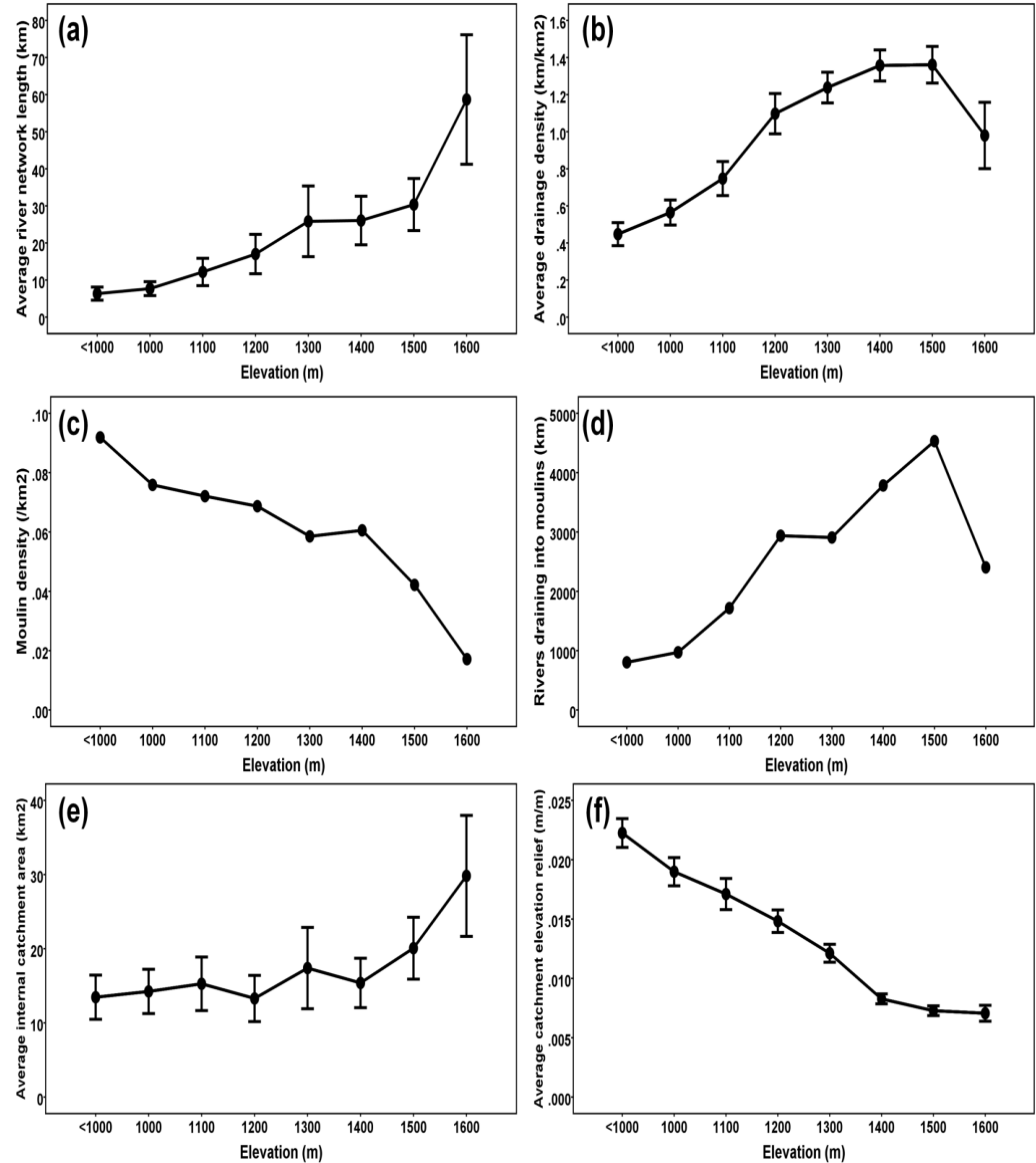
15 m Landsat-8 imagery



15 m Landsat-8 imagery

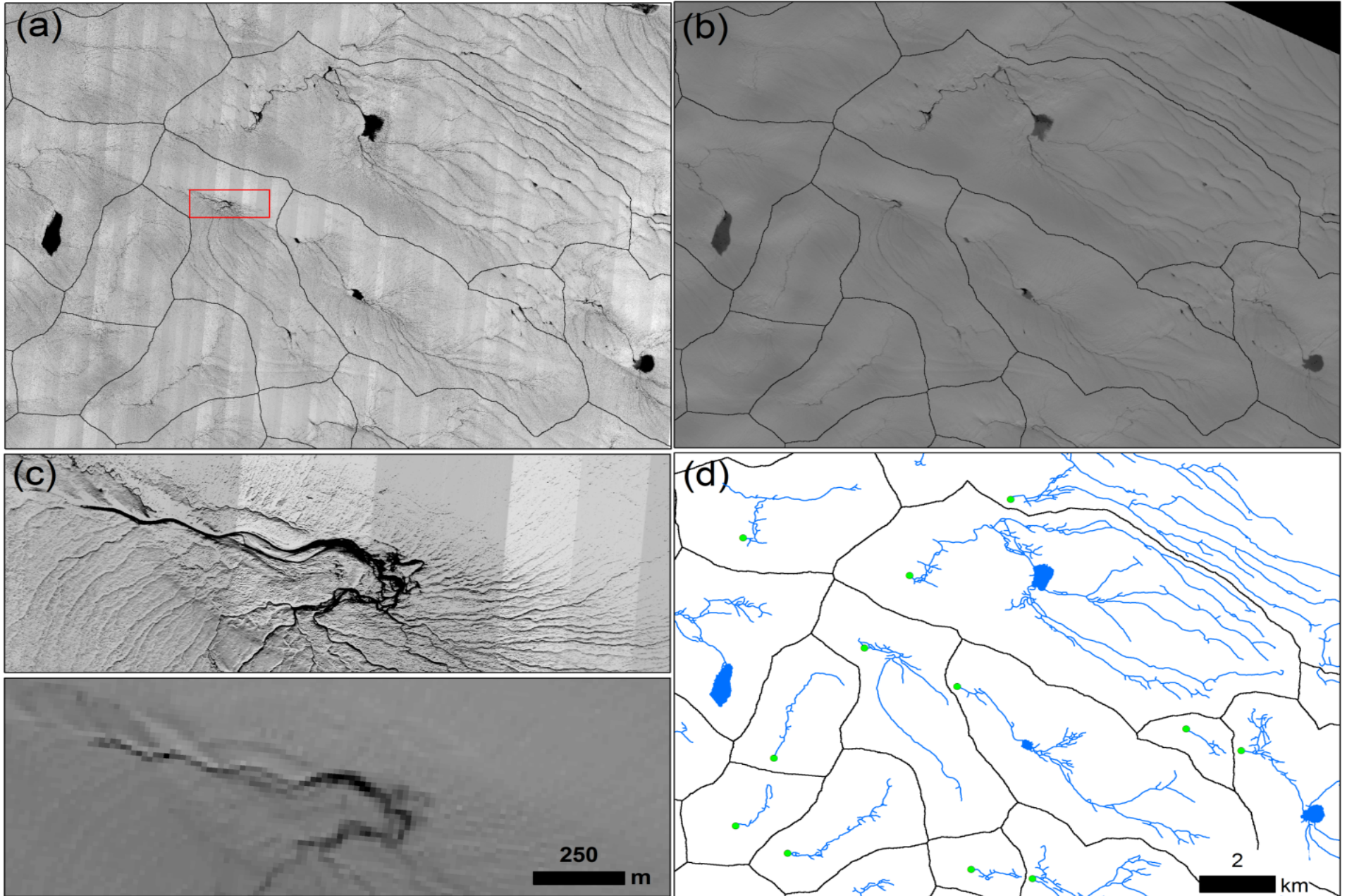


Three large internal catchment (>150 km²)

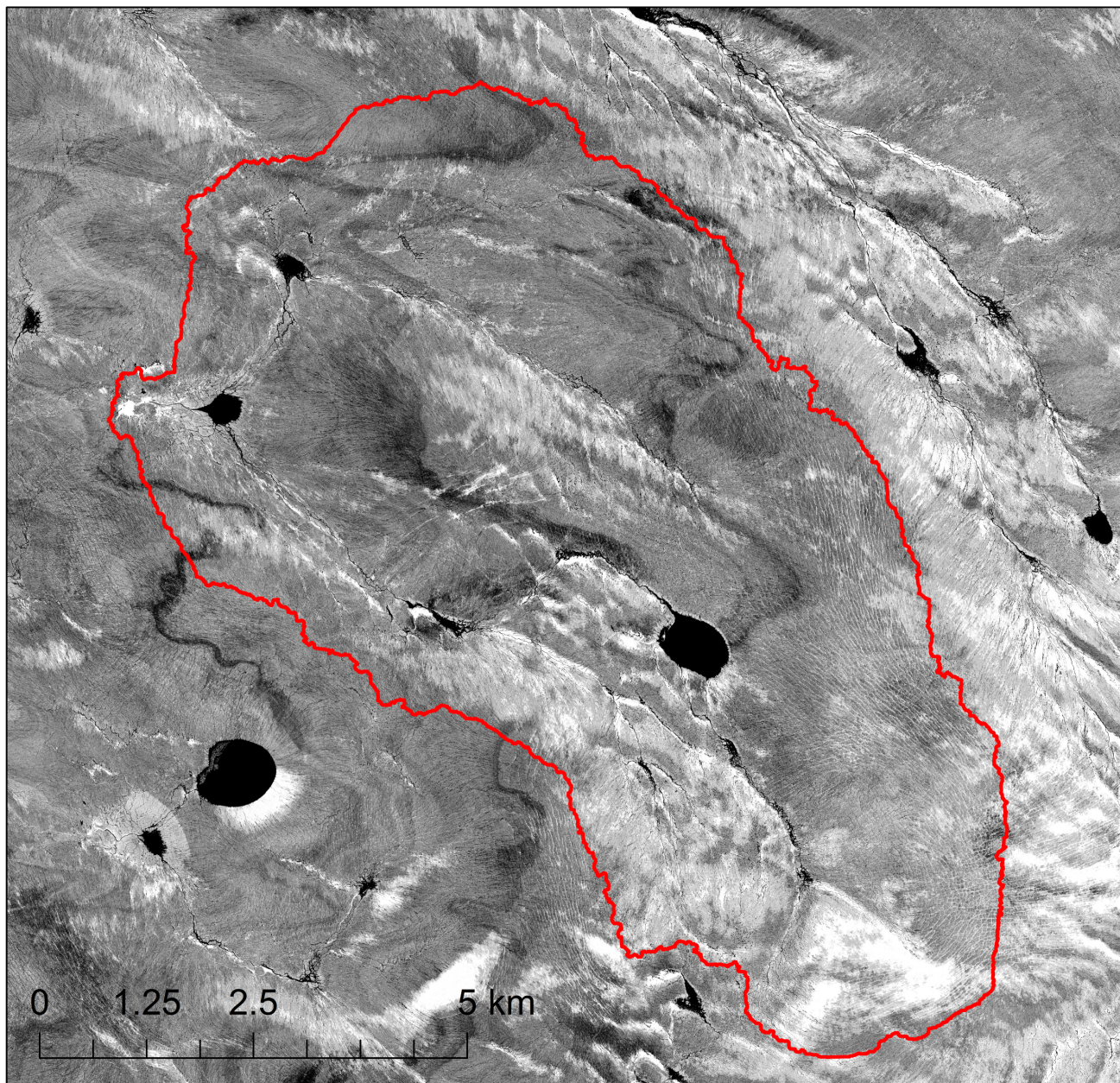


Morphometry of supraglacial hydrologic features

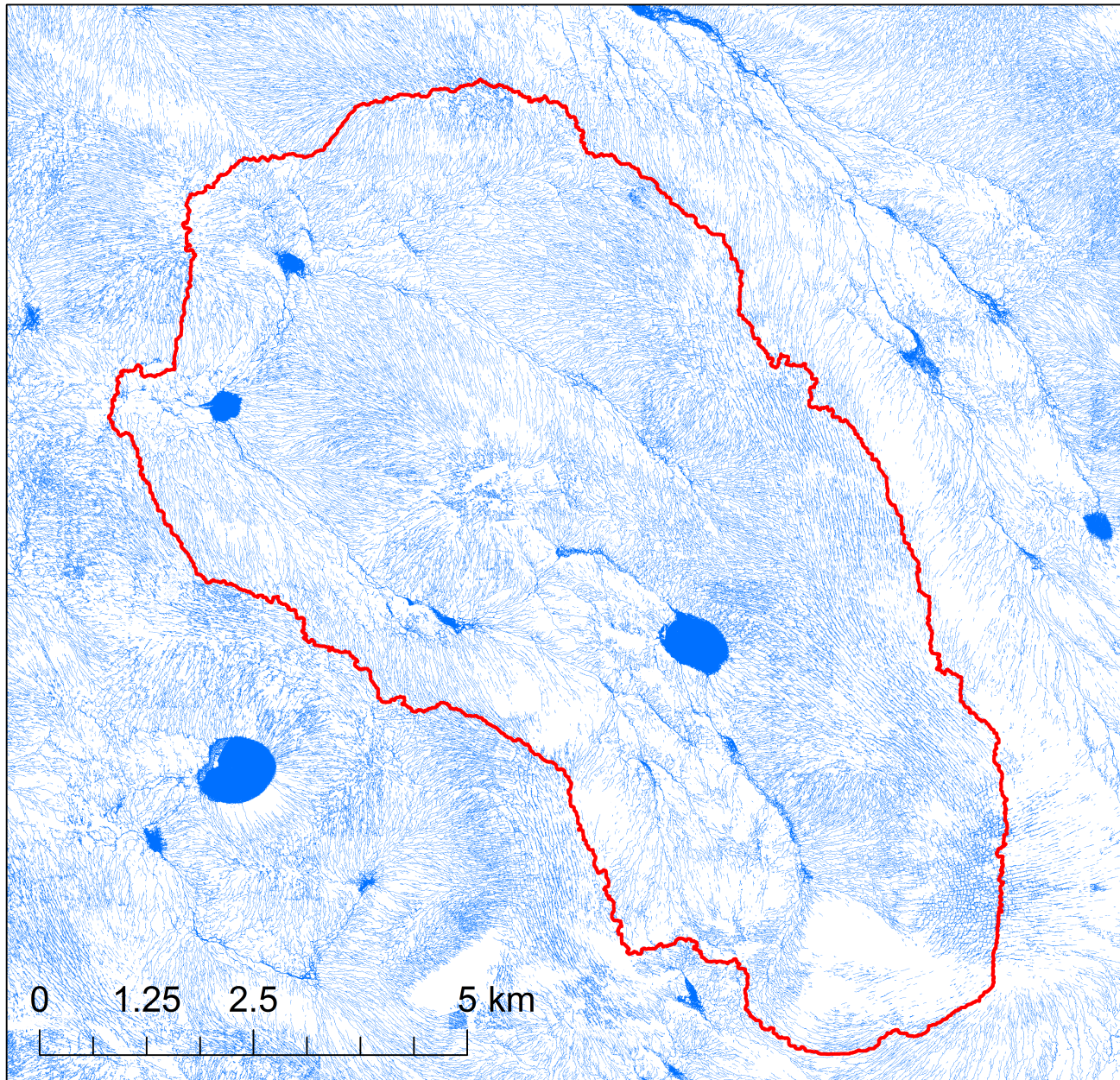
Landsat-8 vs. WorldView-1



High-resolution WorldView-1 (0.5m)

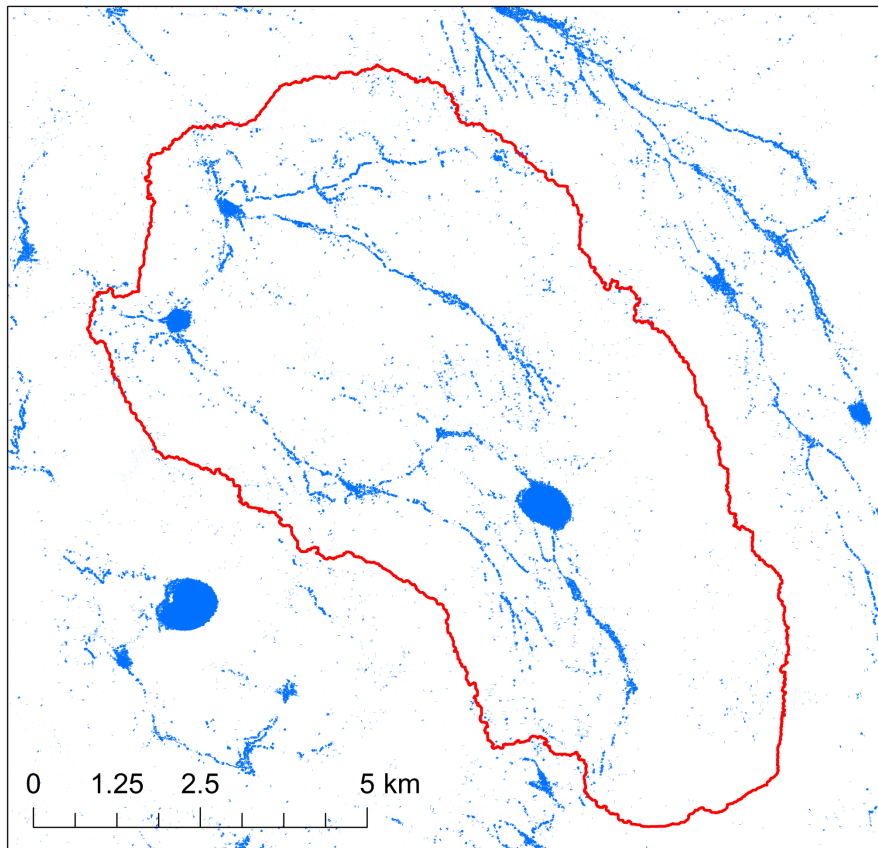


High-resolution ice surface mapping

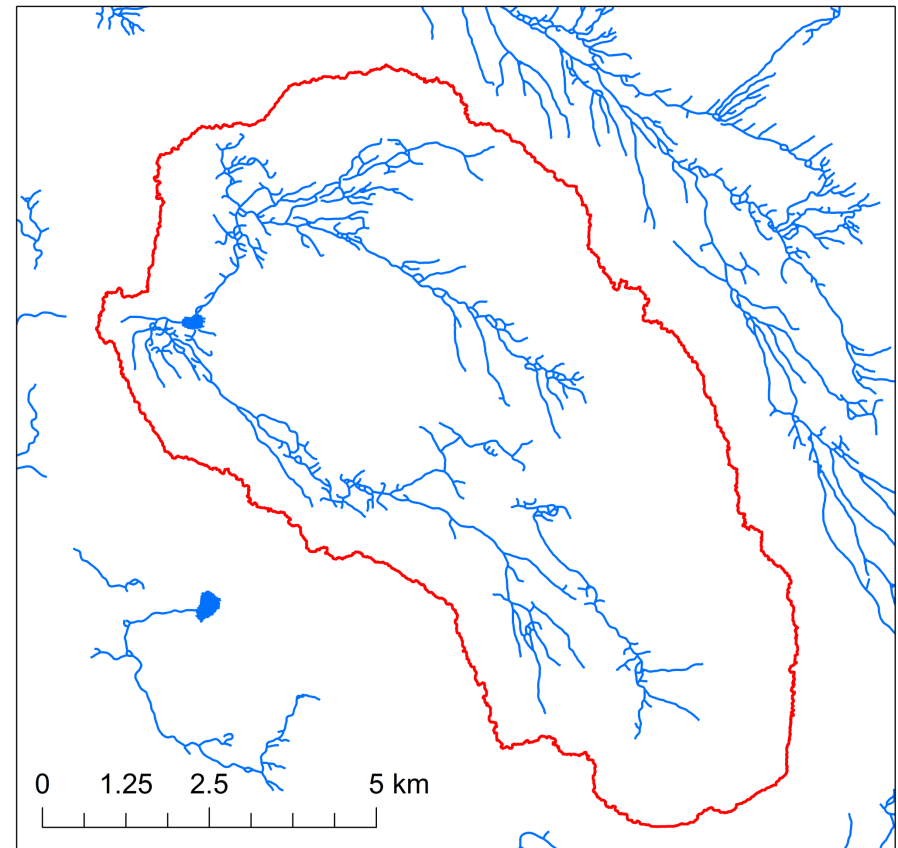


$L = 3372 \text{ km}$
 $D_d = 61 \text{ km/km}^2$

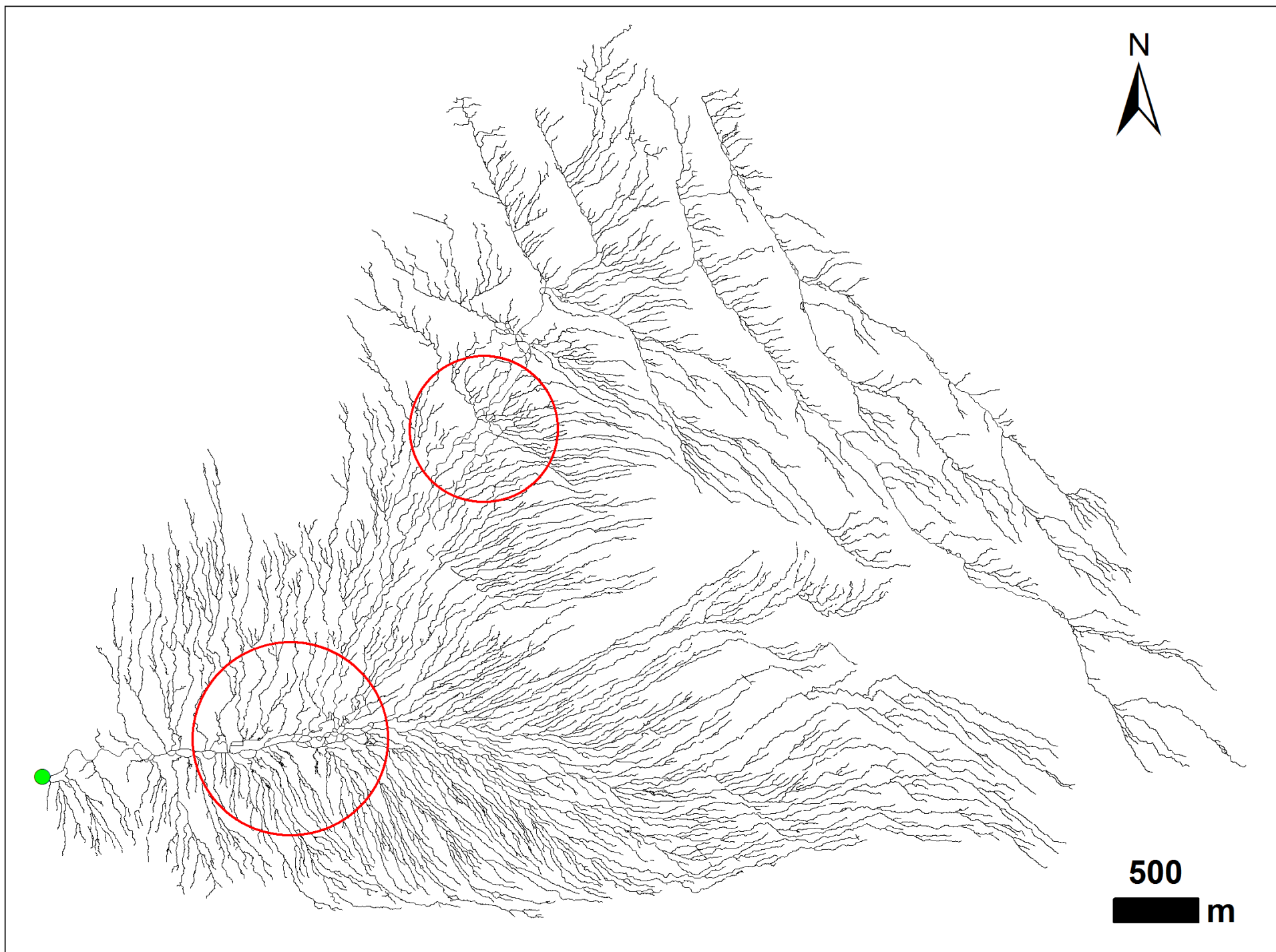
High-resolution ice surface mapping



Wide (>4 m) WV panchromatic rivers



Landsat-8 panchromatic rivers





Stream order

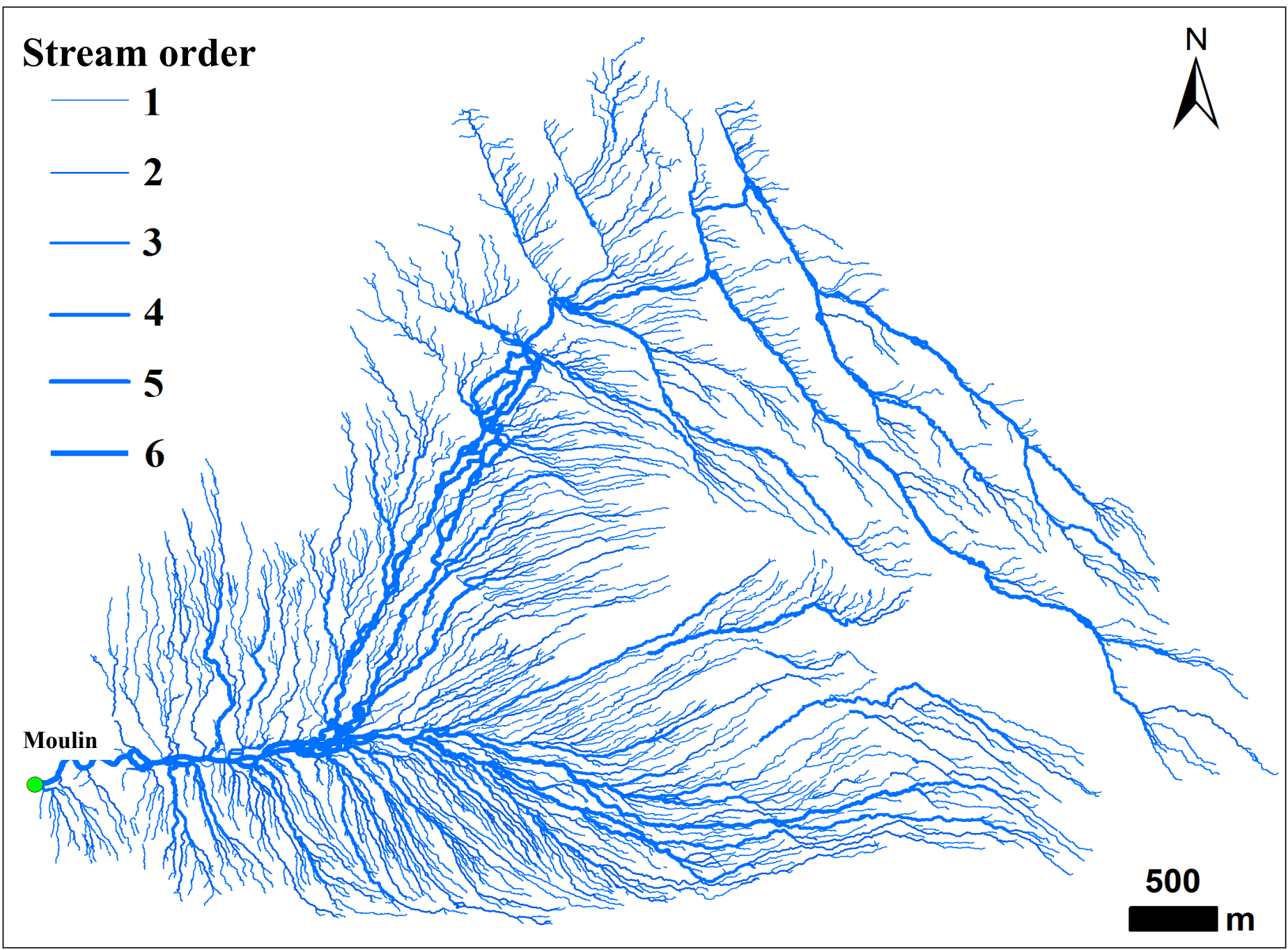
- 1
- 2
- 3
- 4
- 5
- 6

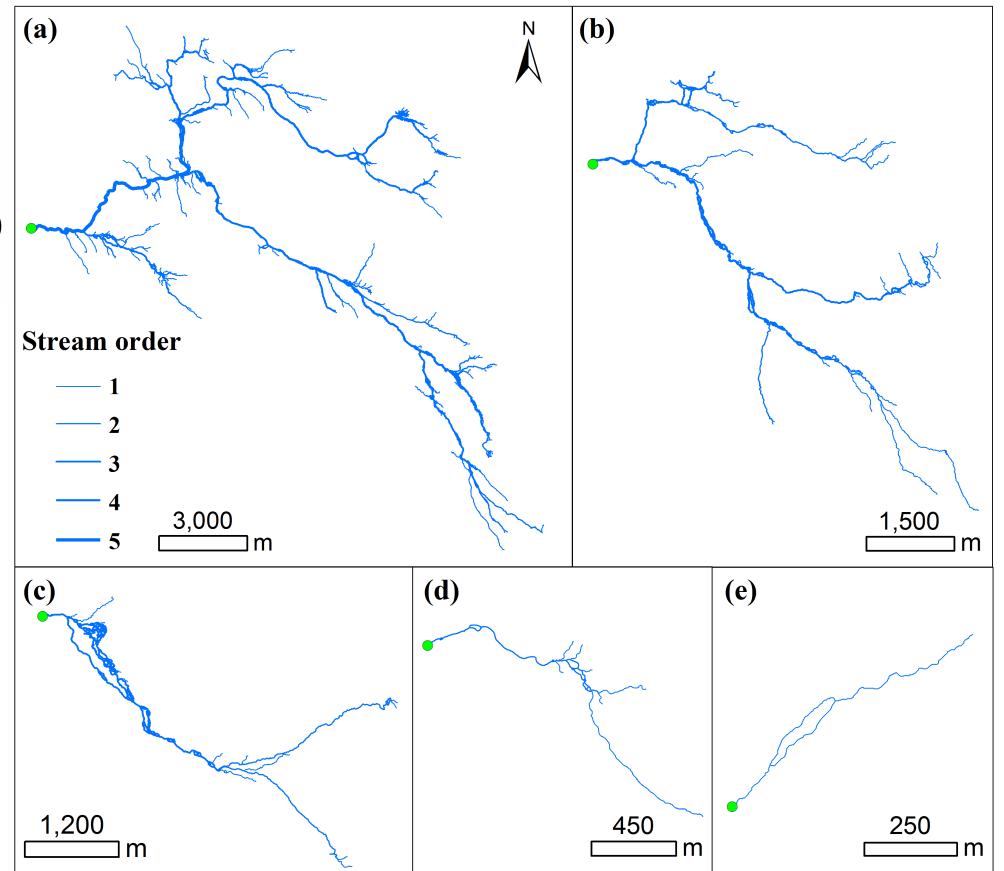
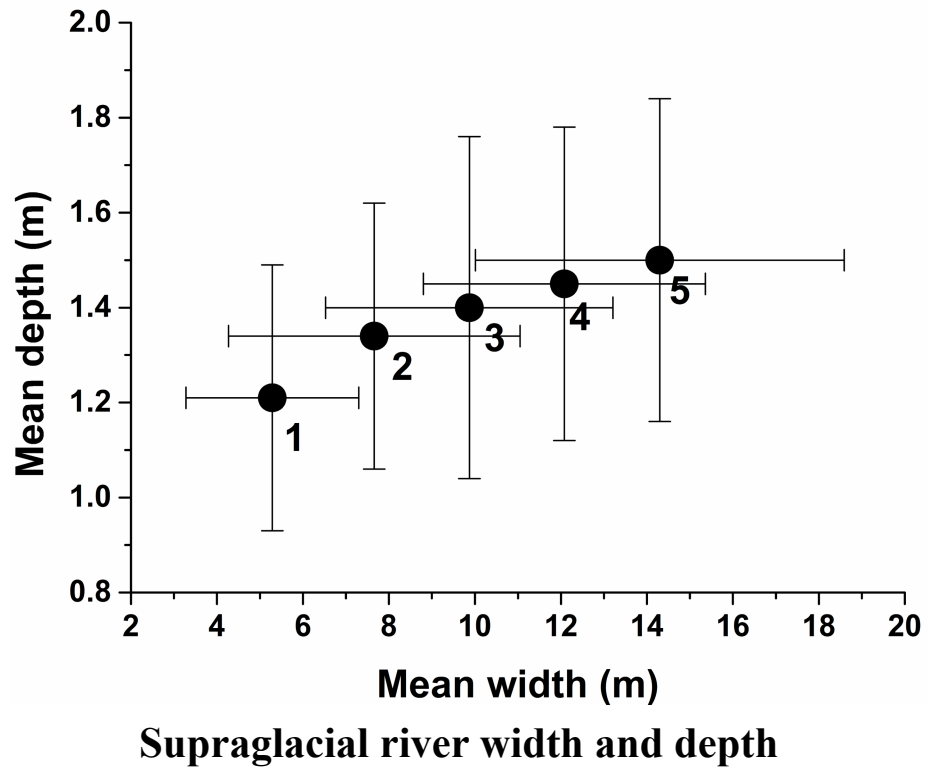


Moulin



500
m





GrIS Supraglacial Hydrology

How is meltwater transported and released on the ice surface?

Does meltwater leave the ice sheet or store in the ice sheet?

- [1] Yang K, Smith LC, Chu VW, Pitcher LH, Gleason CJ, Rennermalm AK, Li M. Fluvial morphometry of supraglacial river networks on the southwest greenland ice sheet (In review)[J]. *GIScience & Remote Sensing*. 2015.
- [2] Karlstrom L, Yang K. Fluvial supraglacial landscape evolution on the Greenland Ice Sheet (In review)[J]. *Geophysical Research Letters*. 2015.
- [3] Yang K, Smith LC, Chu VW, Gleason CJ, Li M. A Caution on the Use of Surface Digital Elevation Models to Simulate Supraglacial Hydrology of the Greenland Ice Sheet[J]. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. 2015, PP(99):1-13.
- [4] Yang K, Li M, Liu Y, Cheng L, Huang Q, Chen Y. River Detection in Remotely Sensed Imagery Using Gabor Filtering and Path Opening[J]. *Remote Sensing*. 2015, 7(7):8779.
- [5] Yang K, Li M, Liu Y, Cheng L, Duan Y, Zhou M. River Delineation from Remotely Sensed Imagery Using a Multi-Scale Classification Approach[J]. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. 2014, 7(12): 4726-4737.
- [6] Yang K, Smith LC. Supraglacial streams on the greenland ice sheet delineated from combined spectral-shape information in high-resolution satellite imagery[J]. *IEEE Geoscience and Remote Sensing Letters*. 2013, 10(4):801-805.
- [7] Yang K. The Progress of Greenland Ice Sheet Surface Ablation Research[J]. *Journal of Glaciology and Geocryology*. 2013, 35(1): 101-109.

Gris Supraglacial Hydrology

Does surface meltwater leave the ice sheet or store in the ice sheet?



Efficient meltwater drainage through supraglacial streams and rivers on the southwest Greenland ice sheet

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GrIS Supraglacial Hydrology

Does surface meltwater leave the ice sheet or store in the ice sheet?

The New York Times | WORLD

Greenland Is Melting Away



Summary

- **Multi-resolution satellite imagery can provide direct observation of the Greenland Ice Sheet**
- **Extensive and complex supraglacial hydrologic system form on the GrlS and greatly impact surface meltwater transport and release**
- **Future work: linking supraglacial hydrologic features to pro-/en-/sub-glacial processes and ice flow models.**

An aerial photograph of a vast, flat expanse of white ice, likely a glacier or ice sheet. A narrow, winding channel of bright turquoise water flows through the ice. The ice is cracked and textured, with some dark spots. In the distance, a few small figures of people can be seen on the ice. The sky is a clear, pale blue. The word "Thanks!" is overlaid in large, bold, white sans-serif font in the center of the image.

Thanks!