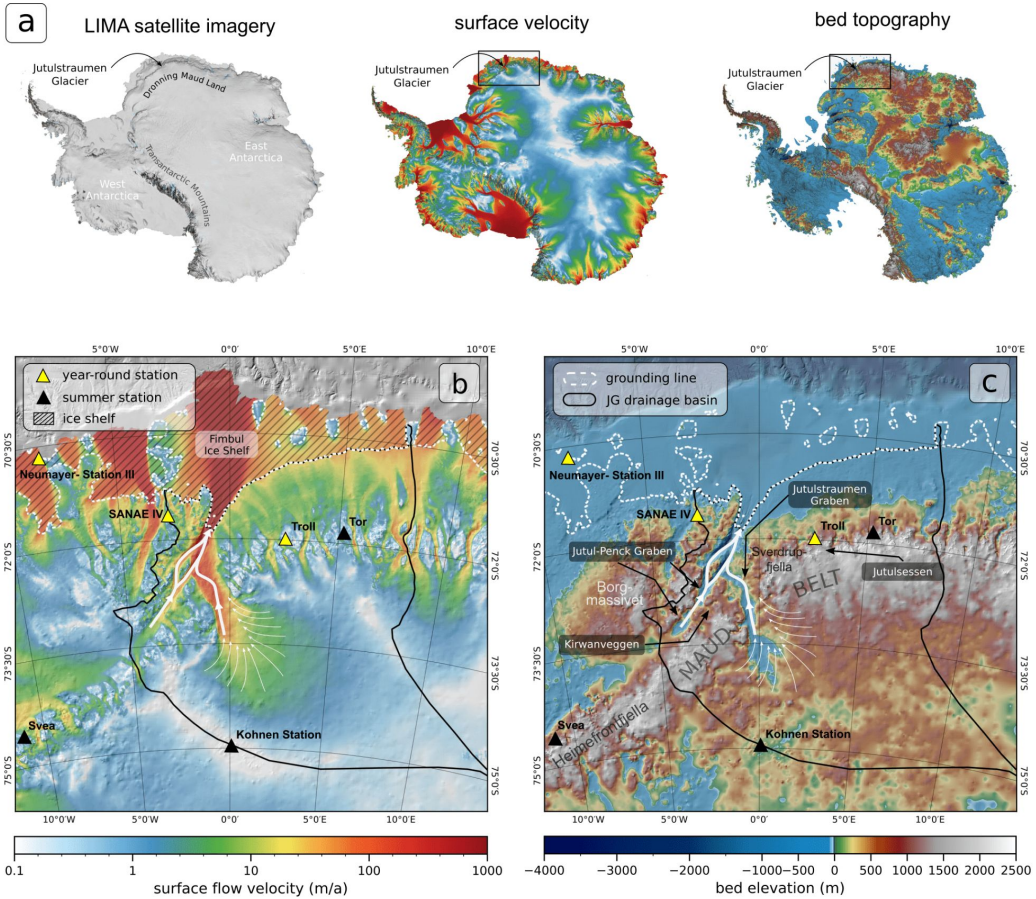
Recent and past processes at the ice-sheet base of Jutulstraumen drainage basin (Antarctica)

Steven Franke, Niklas Neckel, Hannes Eisermann, Veit Helm, Daniel Steinhage, Jölund Asseng, Heinrich Miller, Wilfried Jokat, Graeme Eagles, Reinhard Drews, Olaf Eisen, Daniela Jansen

28. Internationale Polartagung
Potsdam, 1.-5. Mai 2022

DEUTSCHE GESELLSCHAFT FÜR POLARFORSCHUNG e.V

Study region and data



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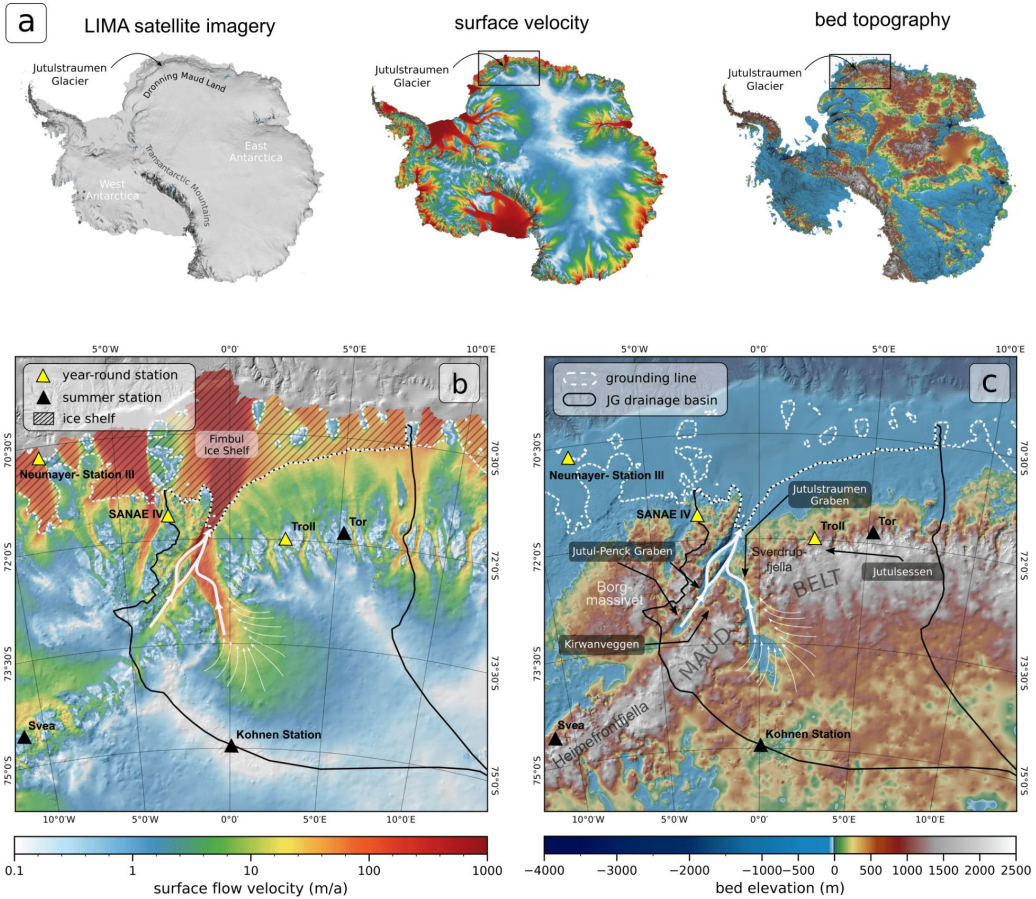
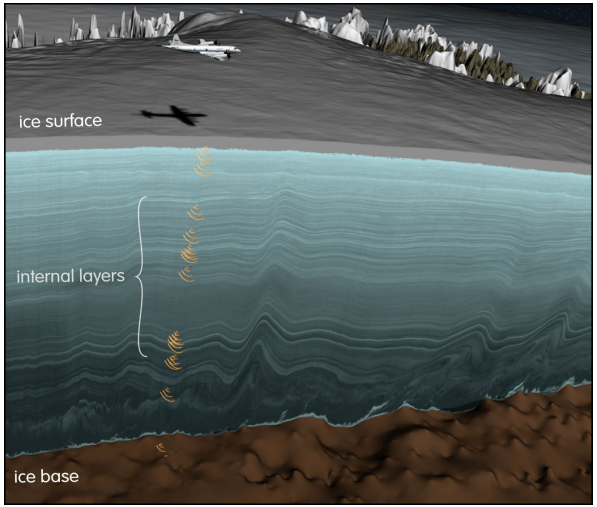


(1) Ice-penetrating radar data



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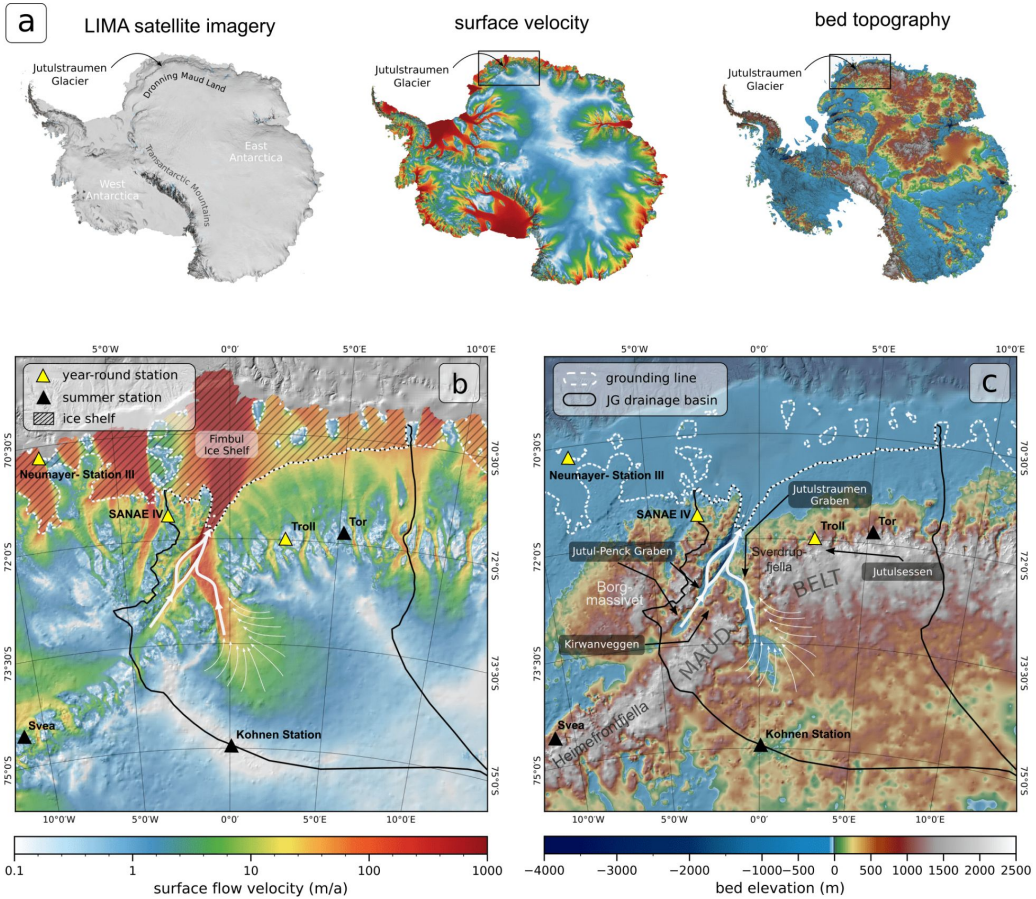

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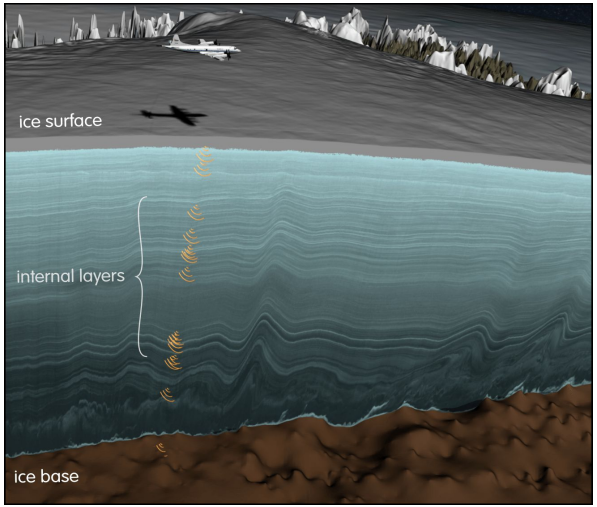
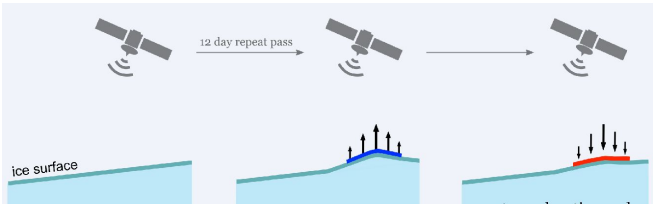


(2) Ice surface displacement (vertical) from DInSAR Sentinel-1 data



Study 1

RESEARCH ARTICLE

ESPL WILEY

Preserved landscapes underneath the Antarctic Ice Sheet reveal the geomorphological history of Jutulstraumen Basin

Steven Franke[1] | Hannes Eisermann[1] | Wilfried Jokat[1,2] | Graeme Eagles[1] | Jölund Asseng[1] | Heinrich Miller[1] | Daniel Steinhage[1] | Veit Helm[1] | Olaf Eisen[1,2] | Daniela Jansen[1]

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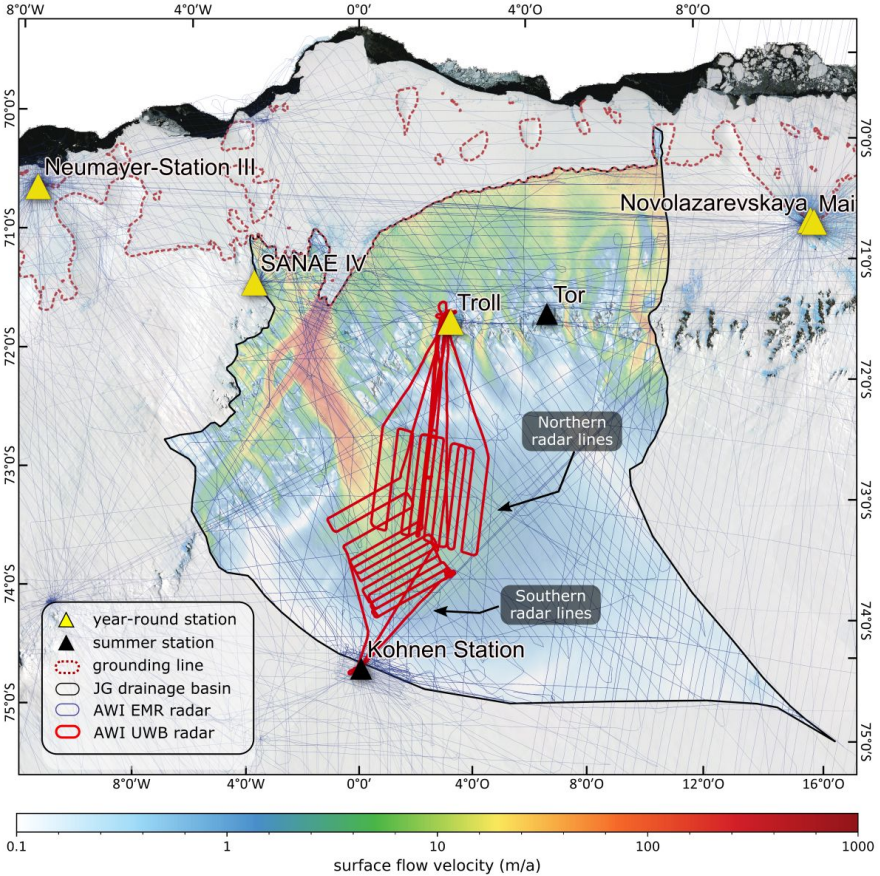

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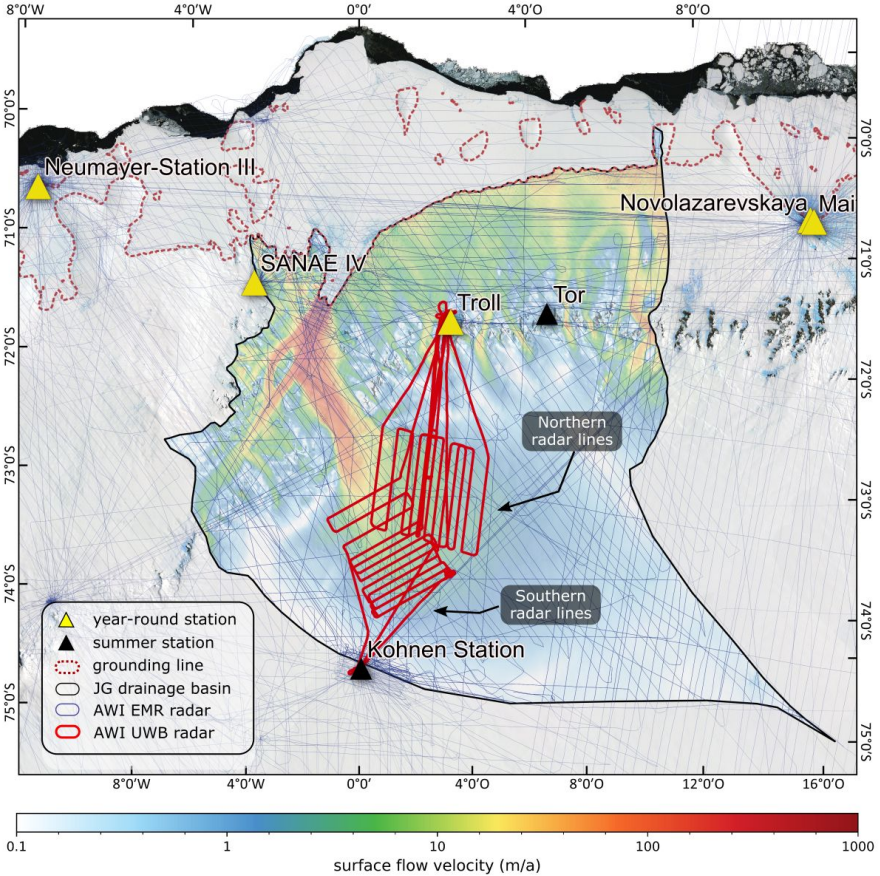
Aim

- Investigate the radar-derived bed topography at very high resolution
- Decipher the ice-flow history from the geomorphology beneath the ice



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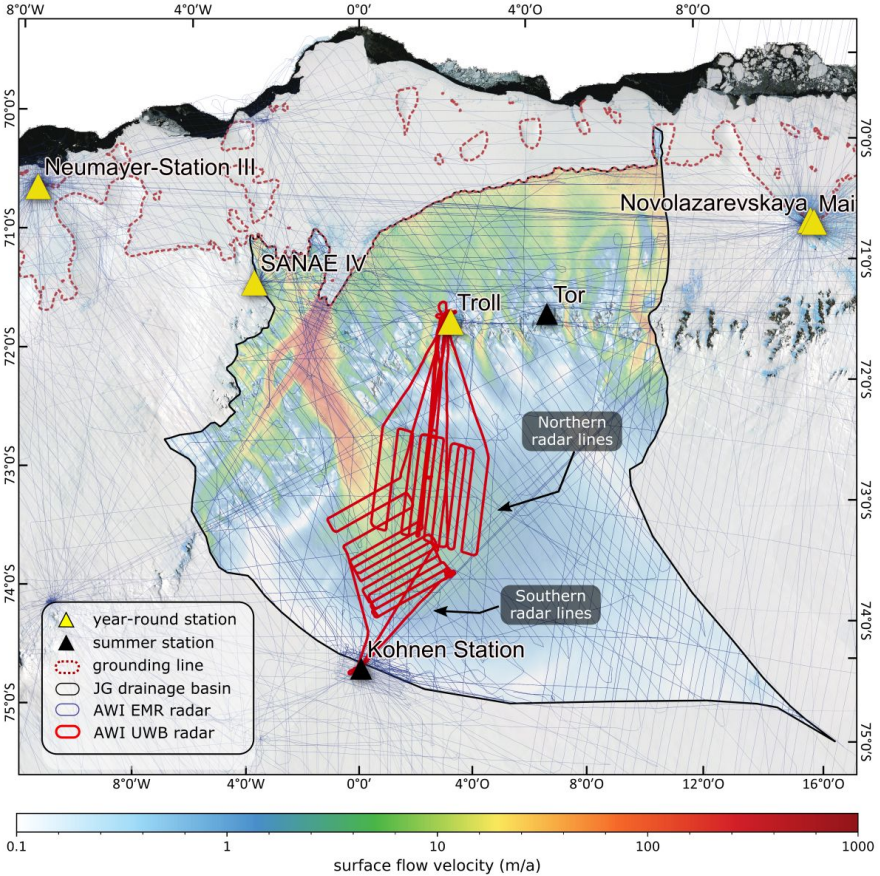
Aim

- Investigate the radar-derived bed topography at very high resolution
- Decipher the ice-flow history from the geomorphology beneath the ice

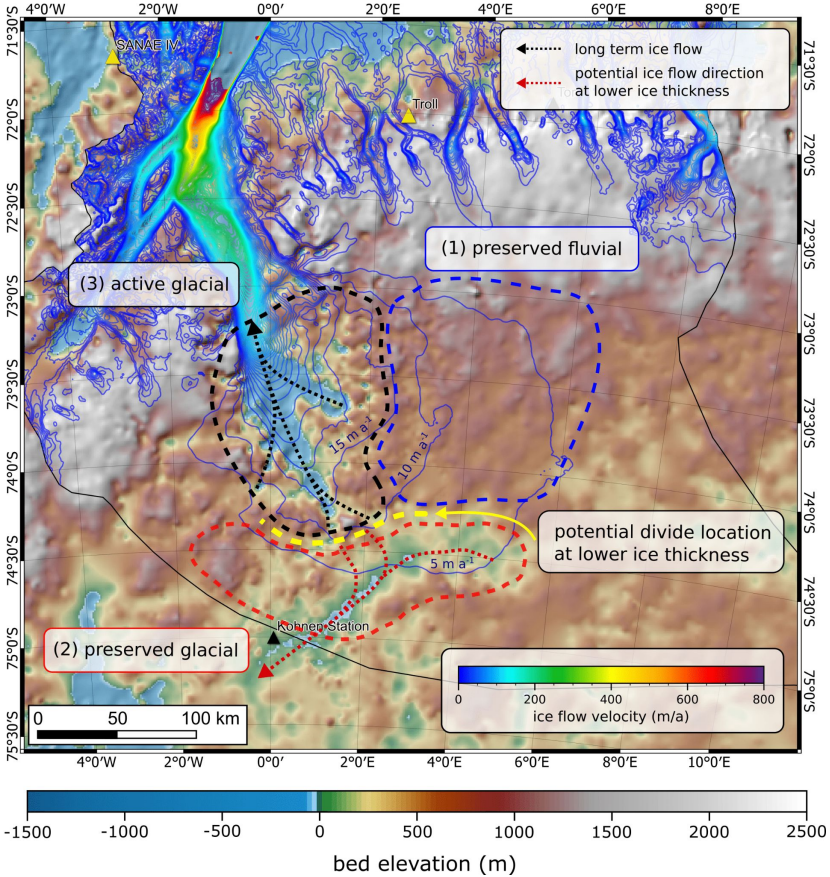
Methods

- new bed topography DEM
- hypsometry
- basal roughness
- water flow on a isostatically corrected surface

- **analysis of valley geometries**



Valley analysis and landscape interpretation



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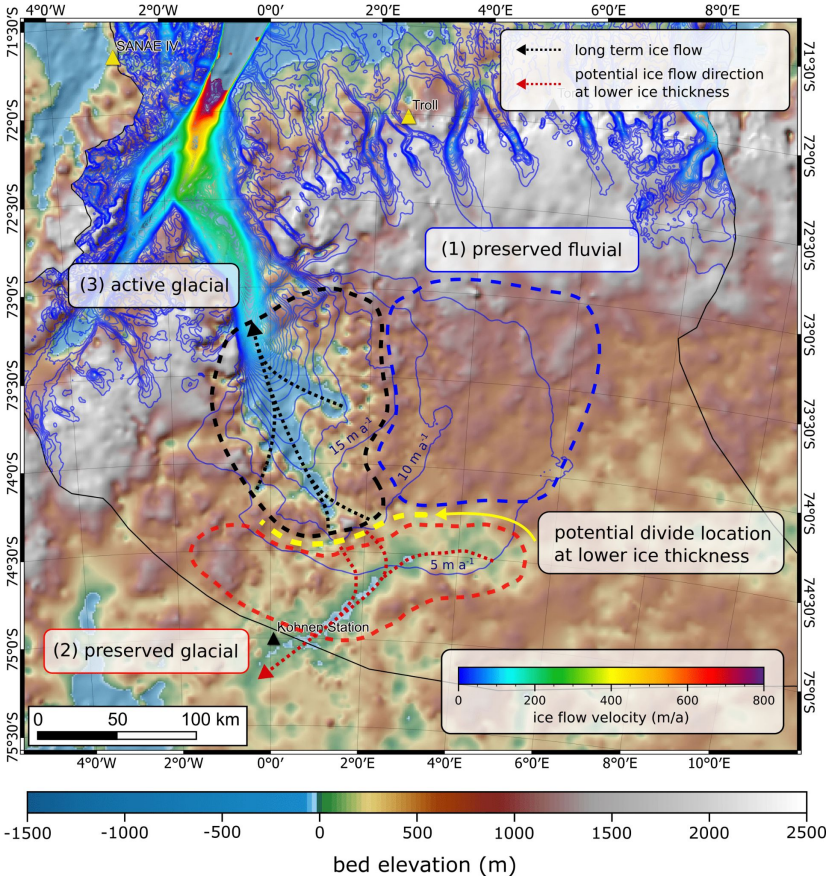
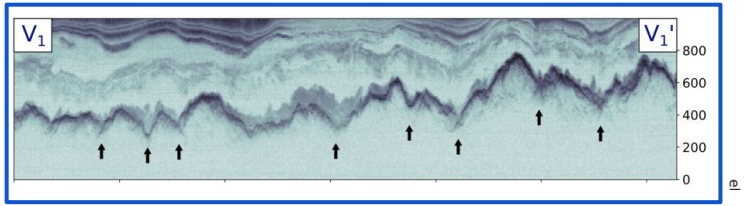
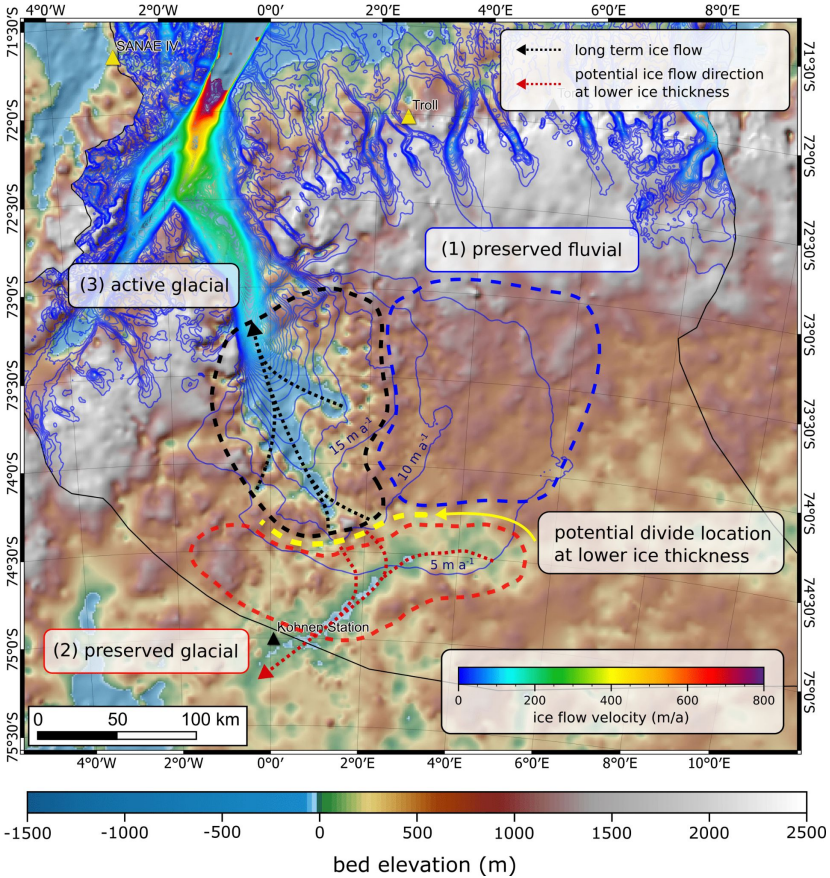


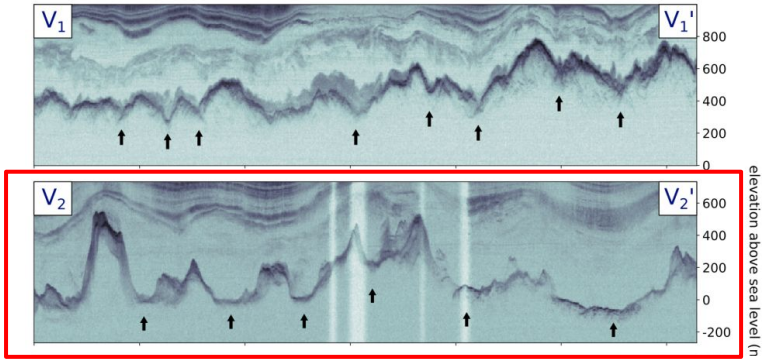
1. shallow, narrow and V-shaped valleys East off the fast flowing region



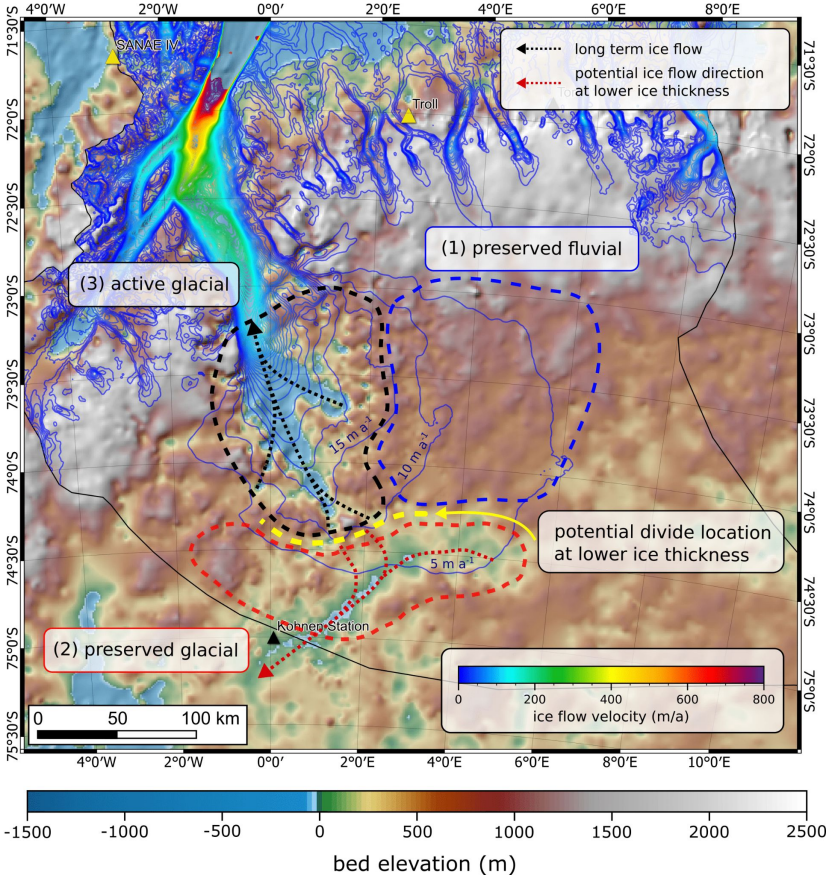
Valley analysis and landscape interpretation



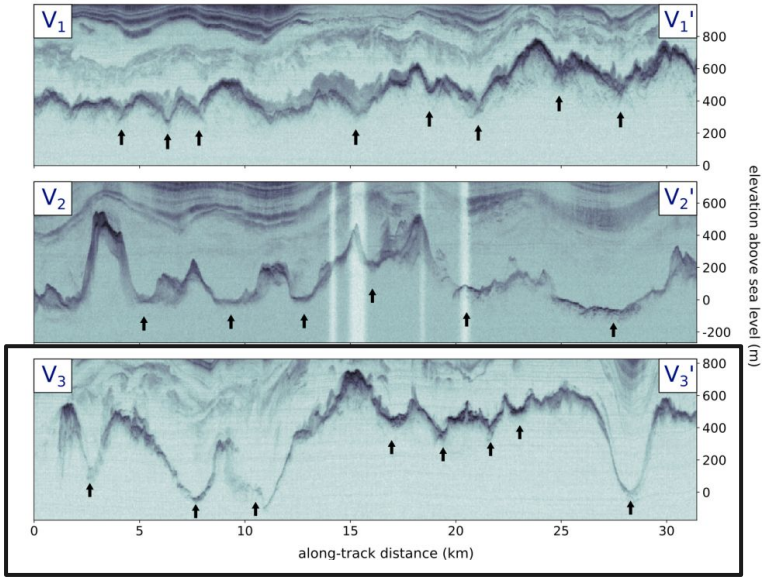
1. shallow, narrow and V-shaped valleys East off the fast flowing region
2. shallow, wide and U-shaped valleys upstream of the fast flowing region



Valley analysis and landscape interpretation



1. shallow, narrow and V-shaped valleys East off the fast flowing region
2. shallow, wide and U-shaped valleys upstream of the fast flowing region
3. deep, wide and U-shaped valleys in the fast flowing region



Study 2

Geophysical Research Letters

RESEARCH LETTER
10.1029/2021GL094472

Steven Franke and Niklas Neckel contributed equally to this work.

Evidence of Cascading Subglacial Water Flow at Jutulstraumen Glacier (Antarctica) Derived From Sentinel-1 and ICESat-2 Measurements

Niklas Neckel[1], Steven Franke[1], Veit Helm[1], Reinhard Drews[2], and Daniela Jansen[1]

[1]Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany, [2]Department of Geosciences, Eberhard Karls University Tübingen, Tübingen, Germany

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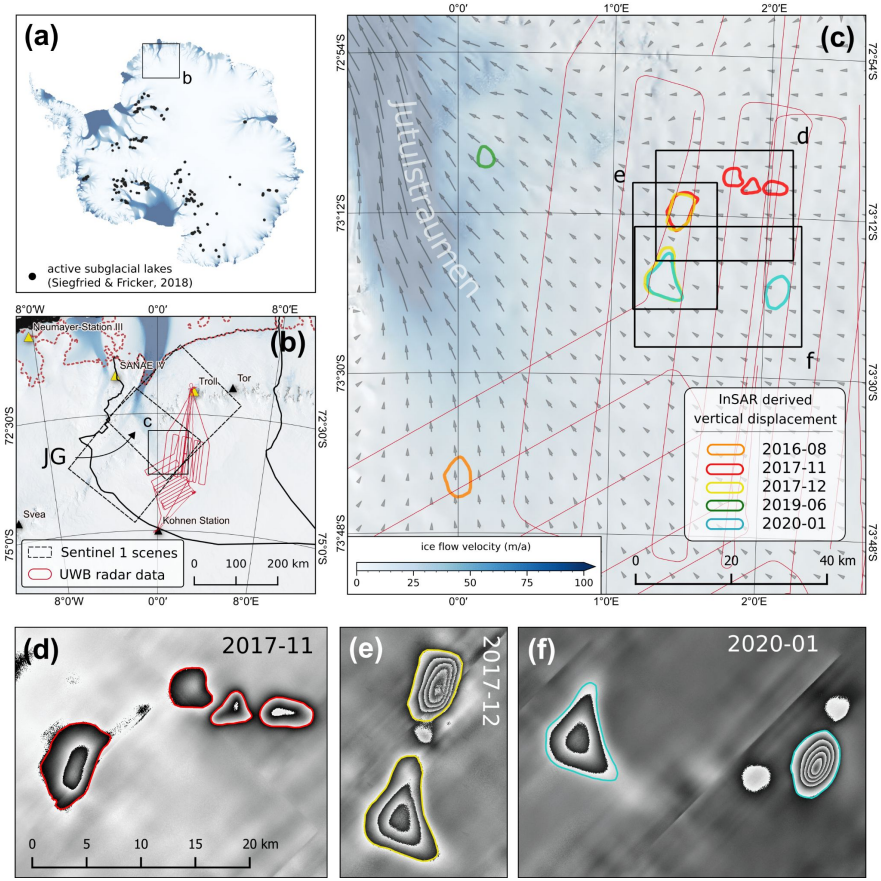

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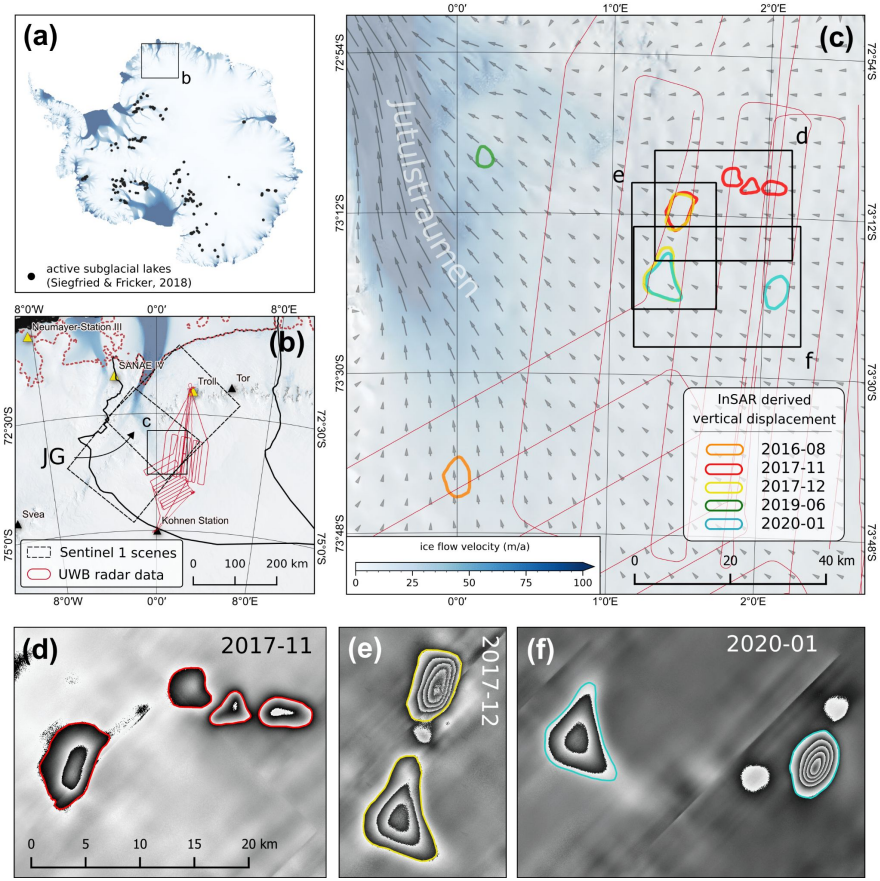
Aim

- Investigate the cause for “bulls-eye” fringe patterns from DInSAR
- Interpret their spatial and temporal evolution in a glaciological context



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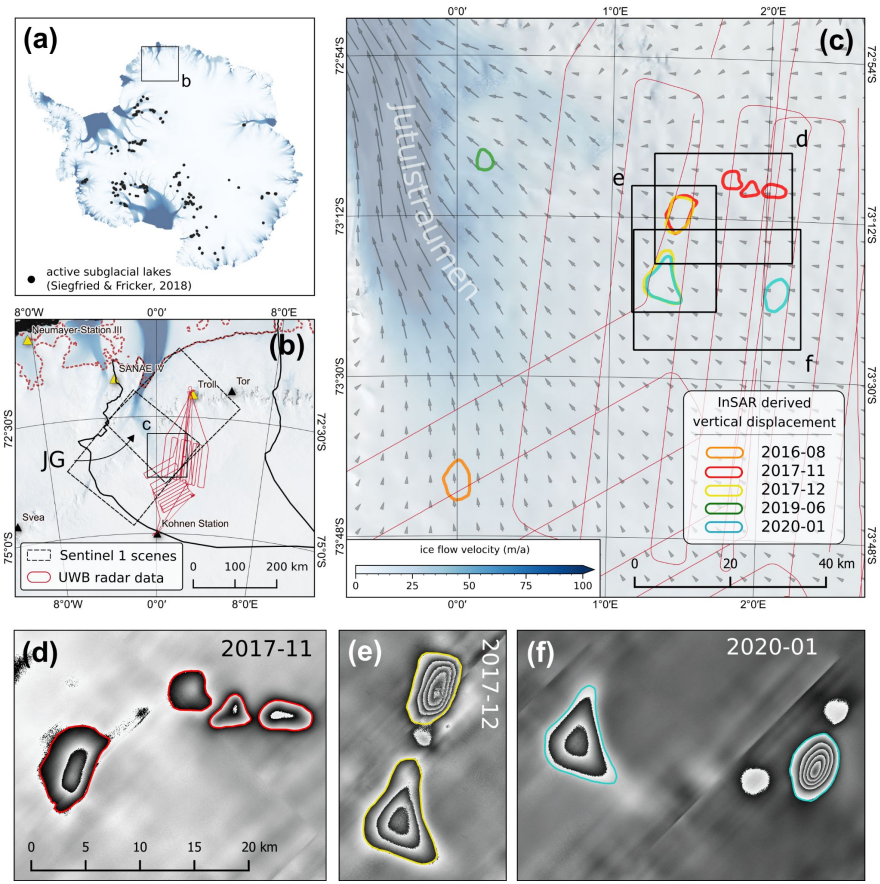
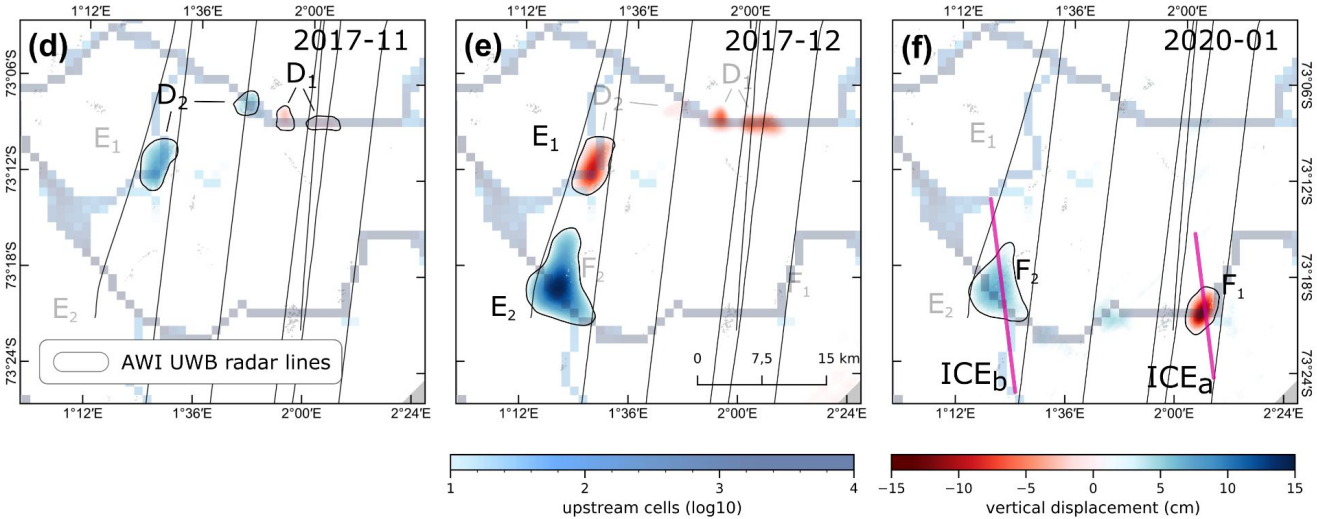
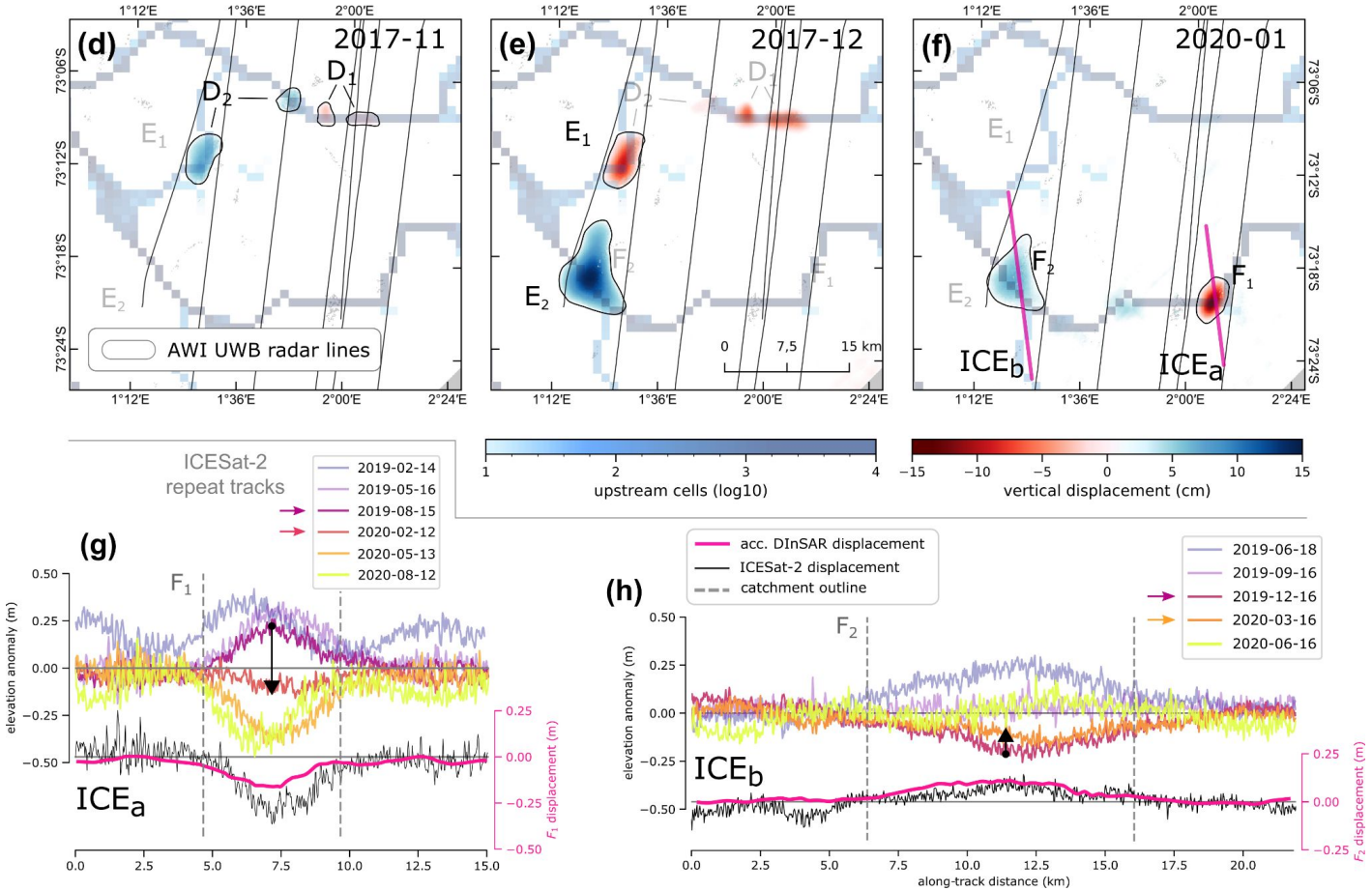
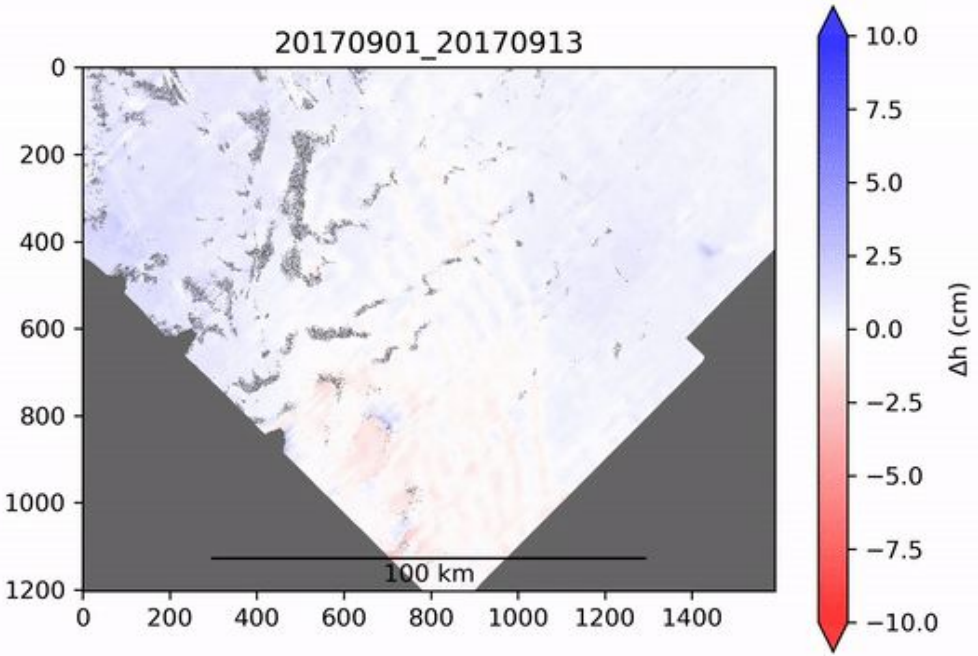
Methods

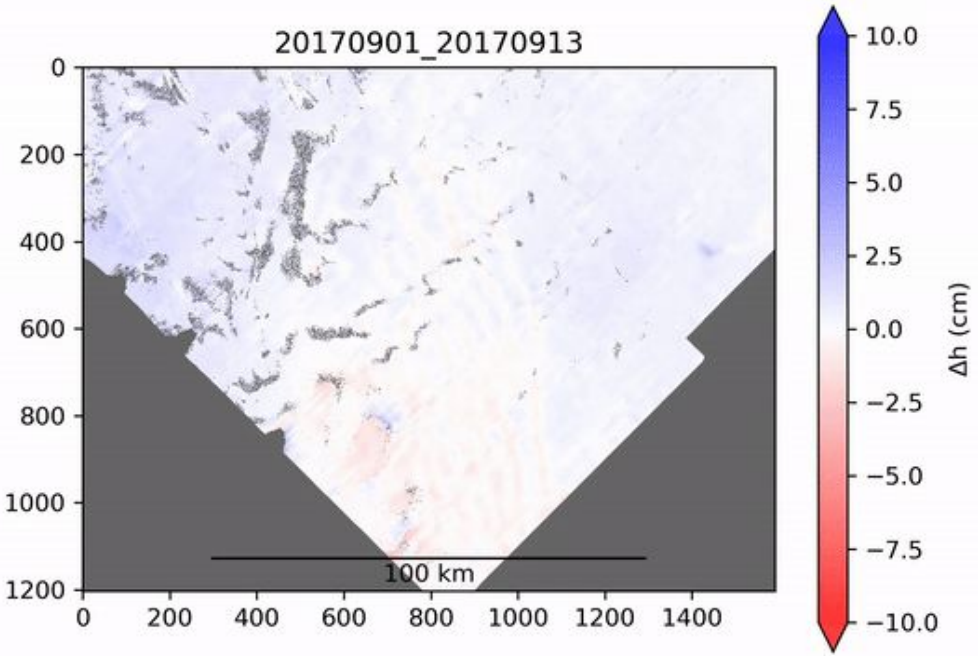
- DInSAR of Sentinel-1 data
- ICESat-2 laser altimetry
- Ice-penetrating radar data

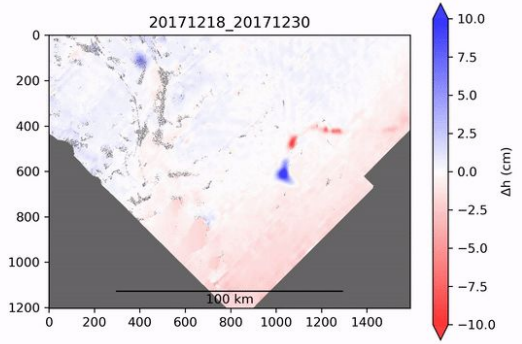


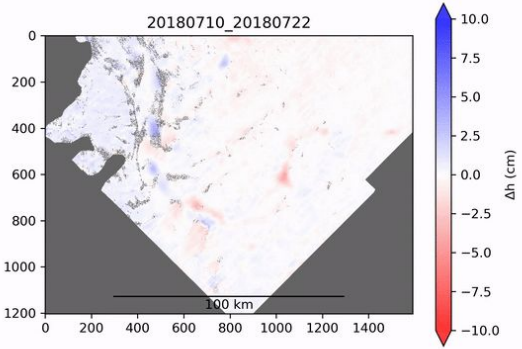

(d)
2017-11
(e)
2017-12
(f)
2020-01
1°12'E
1°36'E
2°00'E
2°24'E
73°06'S
73°12'S
73°18'S
73°24'S
D1
D2
E1
E2
F1
F2
AWI UWB radar lines
0
7,5
15 km
ICEb
ICEa
1
2
3
4
upstream cells (log10)
−15
−10
−5
0
5
10
15
vertical displacement (cm)

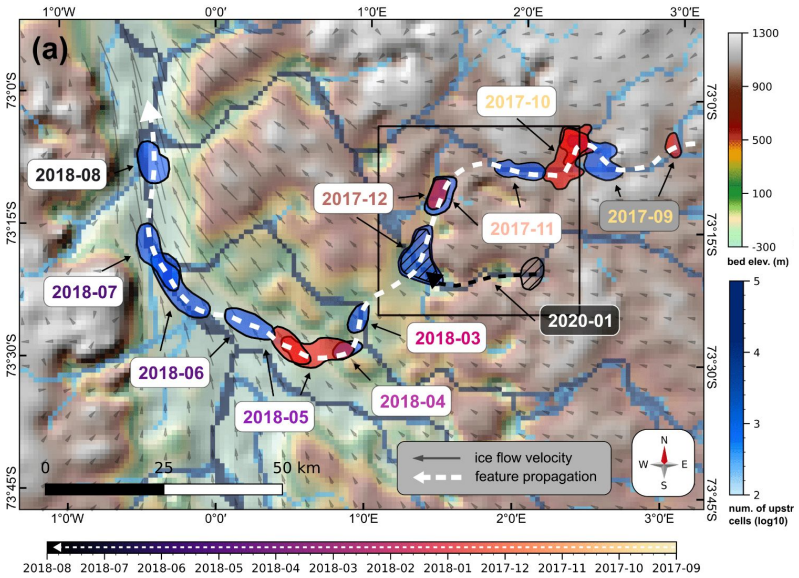

(d)
2017-11
(e)
2017-12
(f)
2020-01
D1
D2
E1
E2
F1
F2
AWI UWB radar lines
ICEa
ICEb
0
7,5
15 km
1°12'E
1°36'E
2°00'E
2°24'E
73°06'S
73°12'S
73°18'S
73°24'S
upstream cells (log10)
vertical displacement (cm)
ICESat-2
repeat tracks
2019-02-14
2019-05-16
2019-08-15
2020-02-12
2020-05-13
2020-08-12
(g)
(h)
acc. DInSAR displacement
ICESat-2 displacement
catchment outline
2019-06-18
2019-09-16
2019-12-16
2020-03-16
2020-06-16
elevation anomaly (m)
F1 displacement (m)
F2 displacement (m)
along-track distance (km)

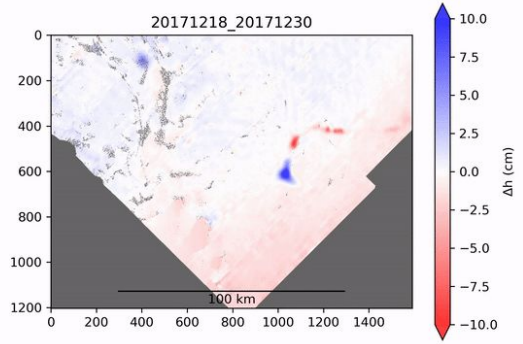

20170901_20170913
0
200
400
600
800
1000
1200
0
200
400
600
800
1000
1200
1400
100 km
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
Δh (cm)

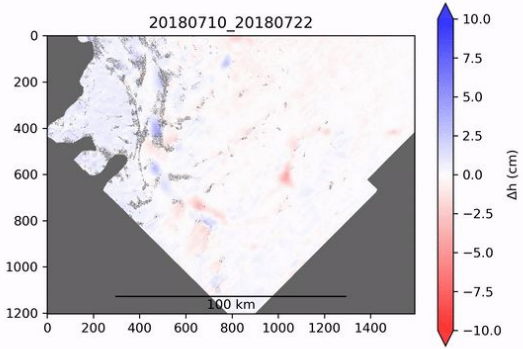

20170901_20170913
0
200
400
600
800
1000
1200
0
200
400
600
800
1000
1200
1400
100 km
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
Δh (cm)

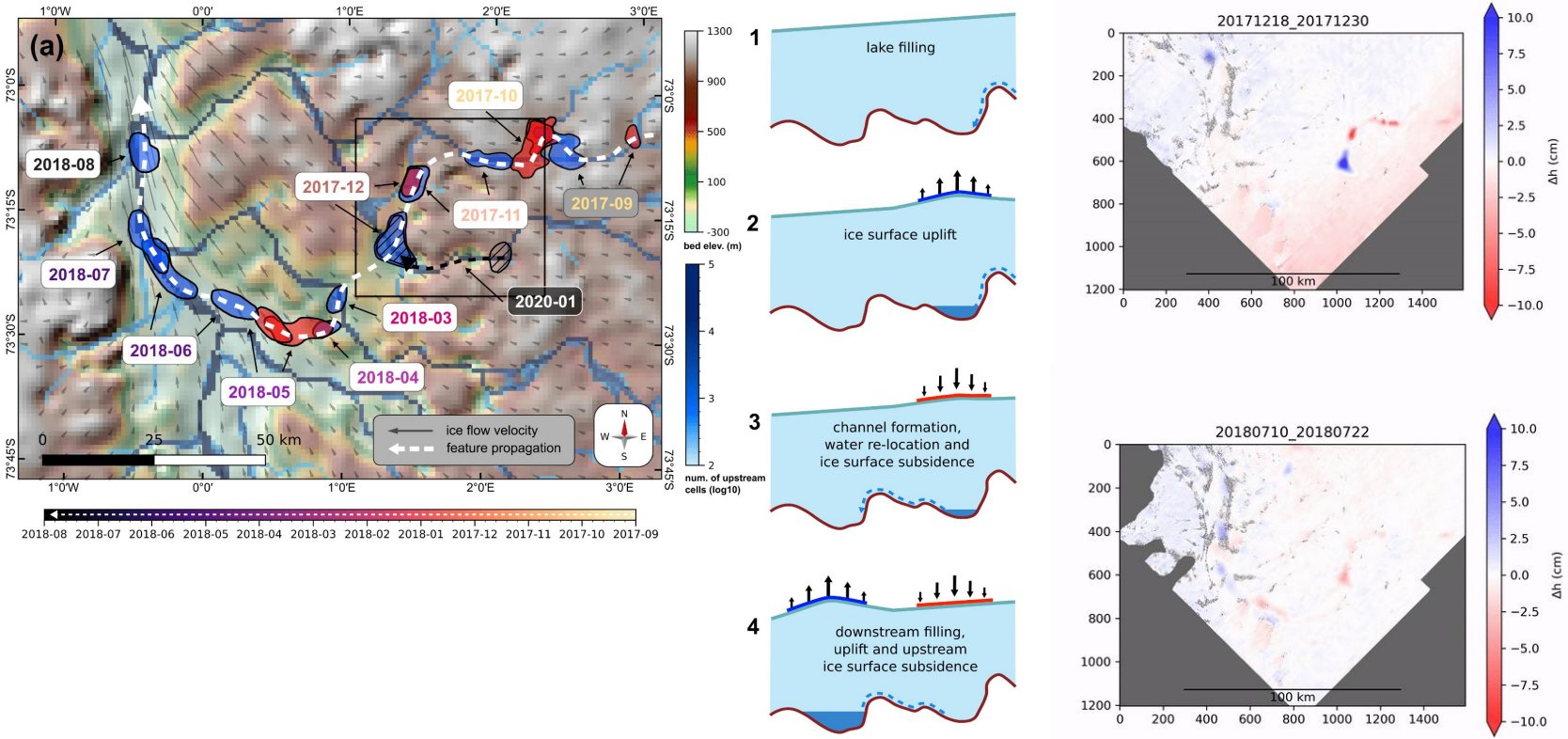

20171218_20171230
0
200
400
600
800
1000
1200
0
200
400
600
800
1000
1200
1400
100 km
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
Δh (cm)


20180710_20180722
0
200
400
600
800
1000
1200
0
200
400
600
800
1000
1200
1400
100 km
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
Δh (cm)


(a)
1°0'W
0°0'
1°0'E
2°0'E
3°0'E
73°0'S
73°15'S
73°30'S
73°45'S
2018-08
2018-07
2018-06
2018-05
2018-04
2018-03
2017-12
2017-11
2017-10
2017-09
2020-01
0
25
50 km
ice flow velocity
feature propagation
N
W
E
S
1300
900
500
100
-300
bed elev. (m)
5
4
3
2
num. of upstr cells (log10)
2018-08 2018-07 2018-06 2018-05 2018-04 2018-03 2018-02 2018-01 2017-12 2017-11 2017-10 2017-09


20171218_20171230
100 km
Δh (cm)


20180710_20180722
100 km
Δh (cm)

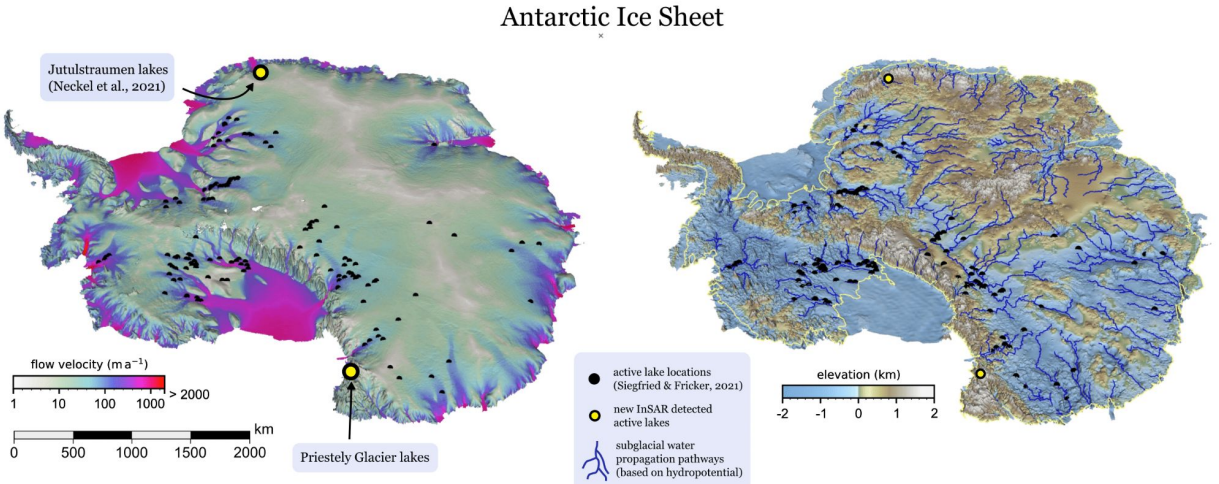
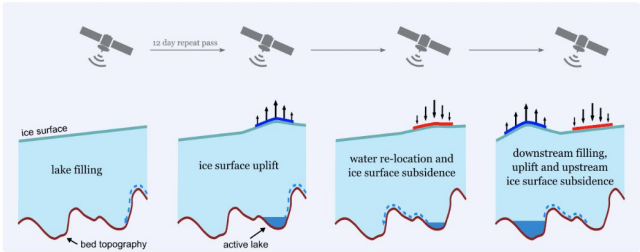

(a)
2018-08
2018-07
2018-06
2018-05
2018-04
2018-03
2017-12
2017-11
2017-10
2017-09
2020-01
ice flow velocity
feature propagation
0
25
50 km
1°0'W
0°0'
1°0'E
2°0'E
3°0'E
73°0'S
73°15'S
73°30'S
73°45'S
bed elev. (m)
num. of upstream cells (log10)
2018-08 2018-07 2018-06 2018-05 2018-04 2018-03 2018-02 2018-01 2017-12 2017-11 2017-10 2017-09
1
lake filling
2
ice surface uplift
3
channel formation, water re-location and ice surface subsidence
4
downstream filling, uplift and upstream ice surface subsidence
20171218_20171230
20180710_20180722
100 km
Δh (cm)

DFG SPP Proposal

Detect active lakes Antarctic/Greenland-wide

“Bulls-eye” detection with Machine Learning

New active lakes informa about the general subglacial hydrological system

Can be used for hydrology model validation

And to quantify the volume of subglacial water transport