Detection of crevasses using high-resolution digital elevation models: Comparison of geomorphometric modeling and texture analysis

Olga Ishalina[1]
olya-ishalina@yandex.ru
Dmitrii Bliakharskii[1]
Igor Florinsky[2]

[1] Department of Cartography and Geoinformatics
Institute of Earth Sciences, St. Petersburg University
St. Petersburg, Russia
[2] Institute of Mathematical Problems of Biology
Keldysh Institute of Applied Mathematics, Russian Academy of Sciences
Pushchino, Russia

Perugia, Italy
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Glacier crevasses

fractures or cracks in glaciers and ice sheets

a few meters to thousands of meters long
a few millimeters to several meters wide
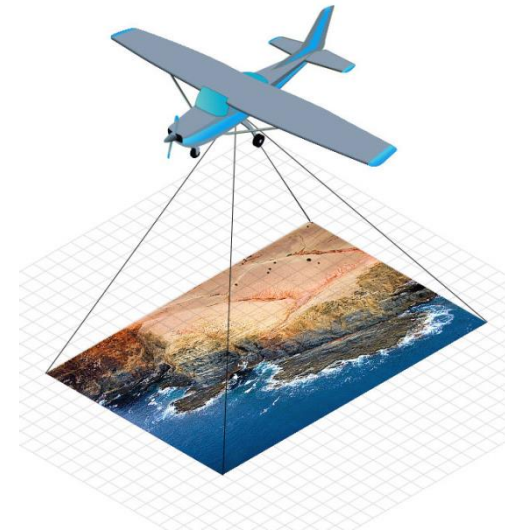

open

hidden

Approaches

ground-based

remote sensing

geophysical method

airborne imagery
satellite imagery

unmanned aerial
surveys

3

Unmanned aerial survey

DEM

geomorhometric modeling
Haralick texture analysis

Study area

Larsemann Hills, East Antarctica
length ~30 km
width ~3 km
December 2016 – February 2017
Geoscan 201 Geodesy

orthomosaics
resolution – 0.08 m
DEMs
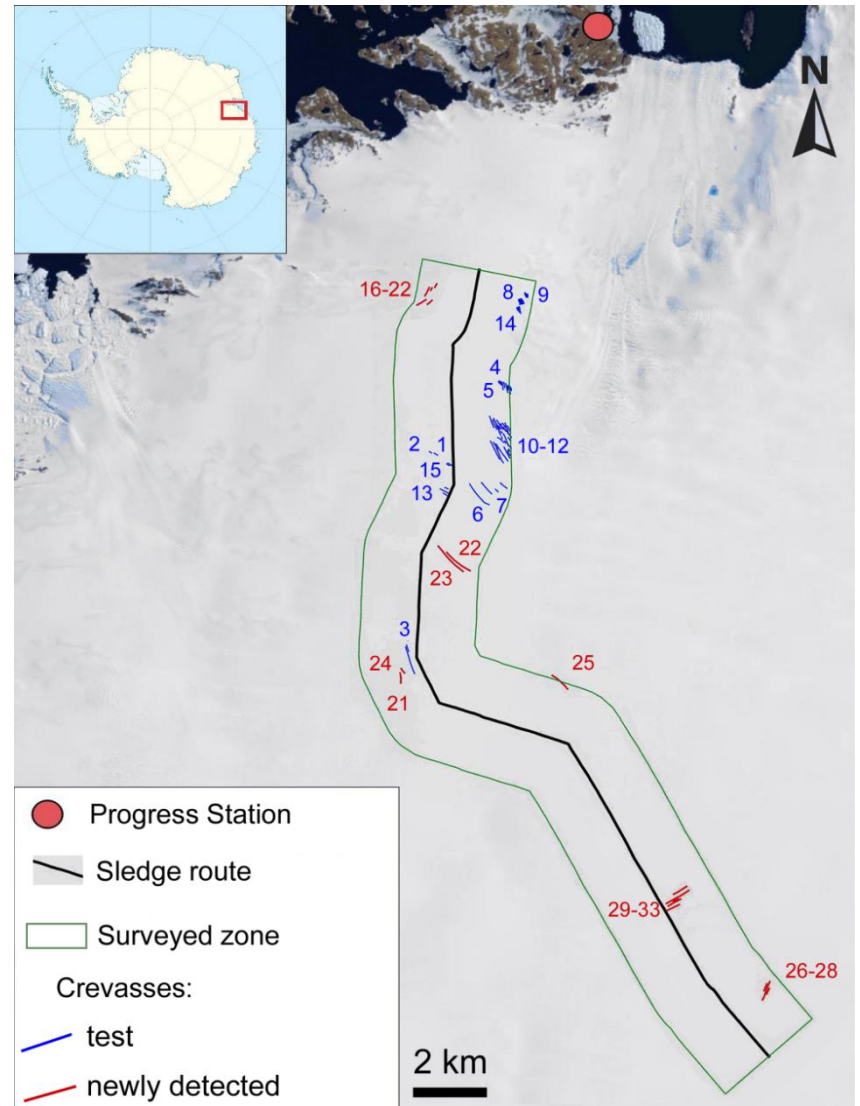resolution – 0.25 , 0.5 and 1 m

15 test crevasses
width
0.5 m – 10 m
length
50 m – 800 m

Legend:
- ● Progress Station
- — Sledge route
- ▢ Surveyed zone
- Crevasses:
  - — test
  - — newly detected
- 2 km

Bliakharskii, D. P., Florinsky, I. V., & Skrypitsyna, T. N. (2019). Modelling glacier topography in Antarctica using unmanned aerial survey: Assessment of opportunities. *International Journal of Remote Sensing*, *40*, 2517–2541
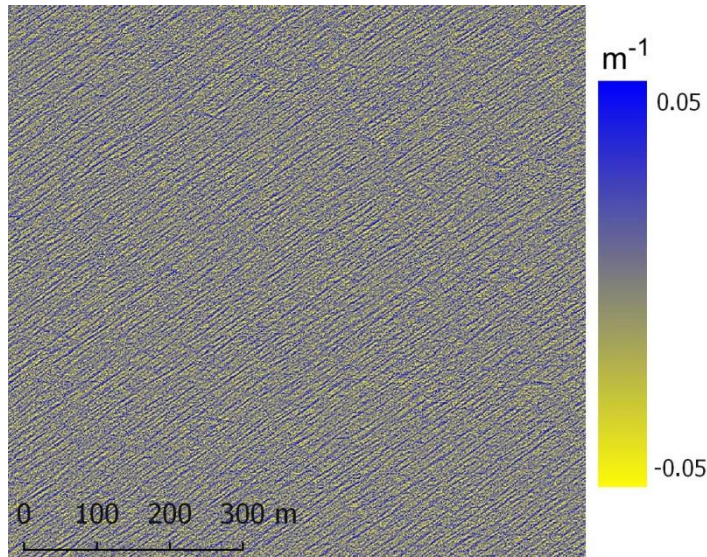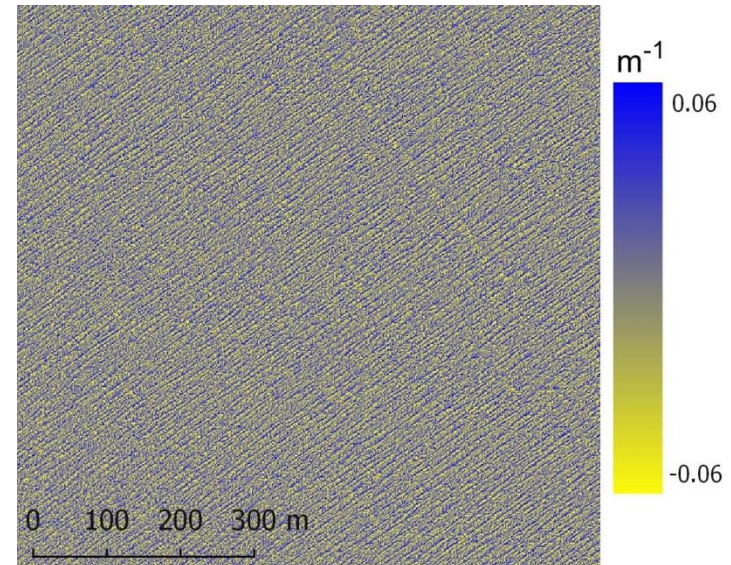
Geomorphometric modeling

crevasses No 6,7
resolution 1 m

100 m

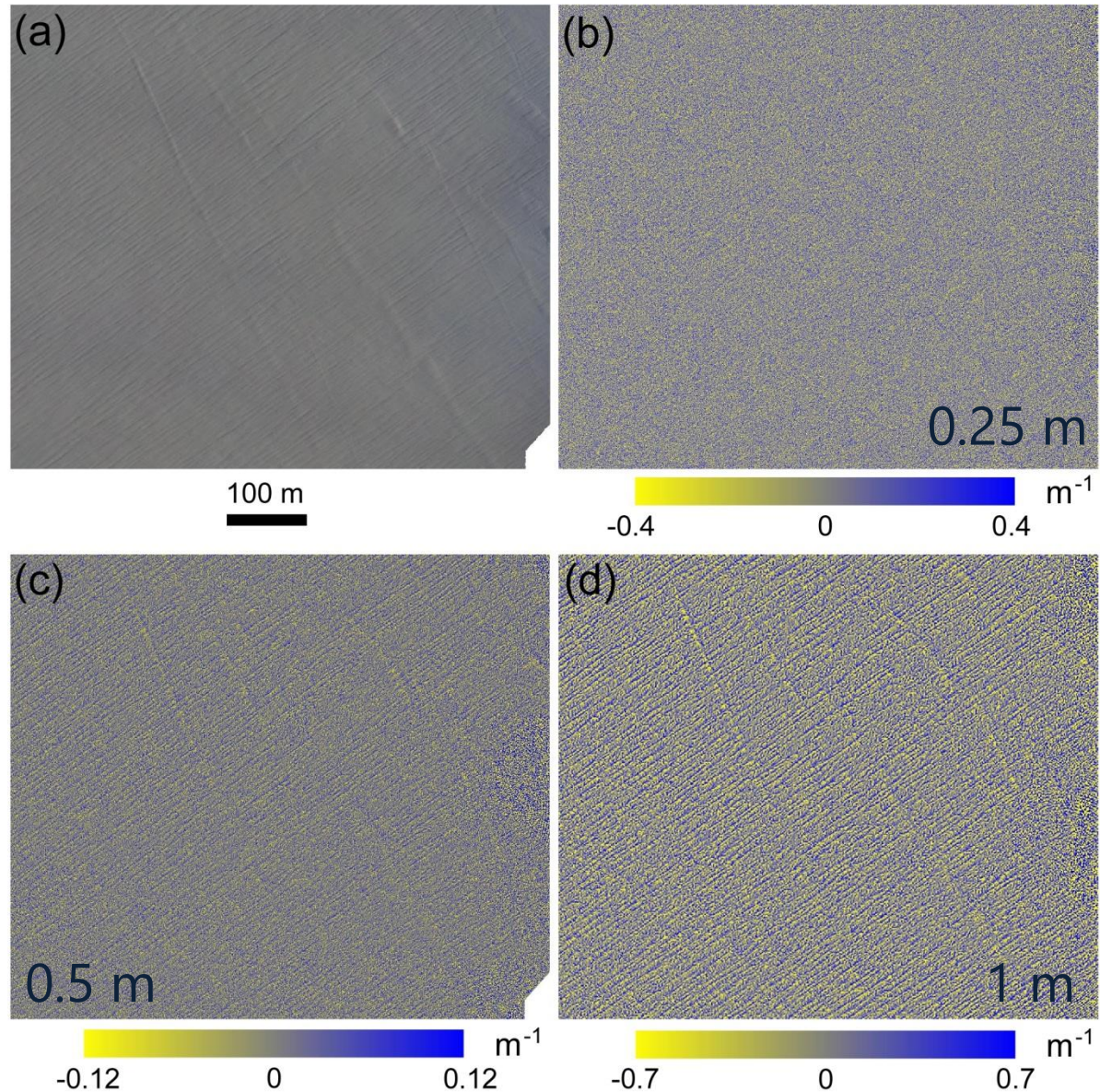orthomosaic

horizontal curvature

mean curvature

Geomorphometric modeling

crevasses
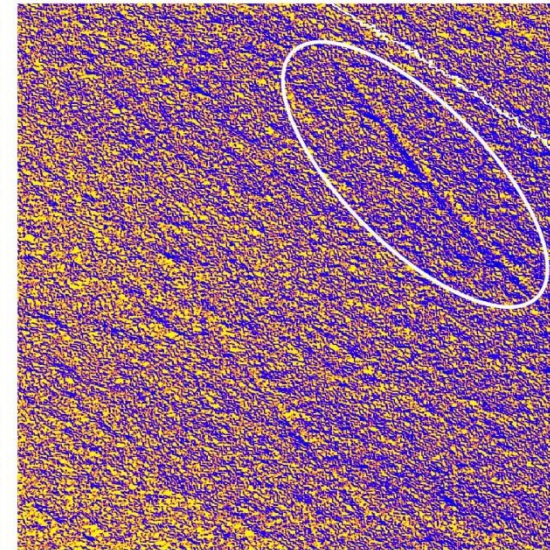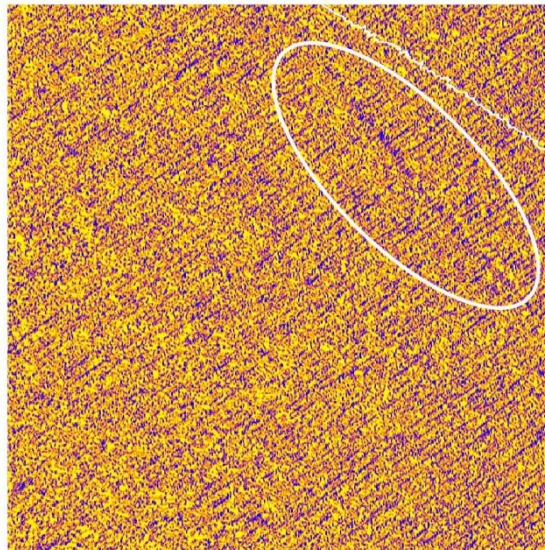No 10,11,12
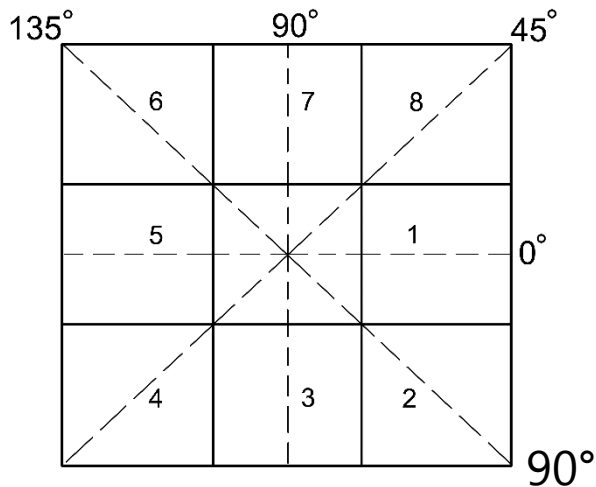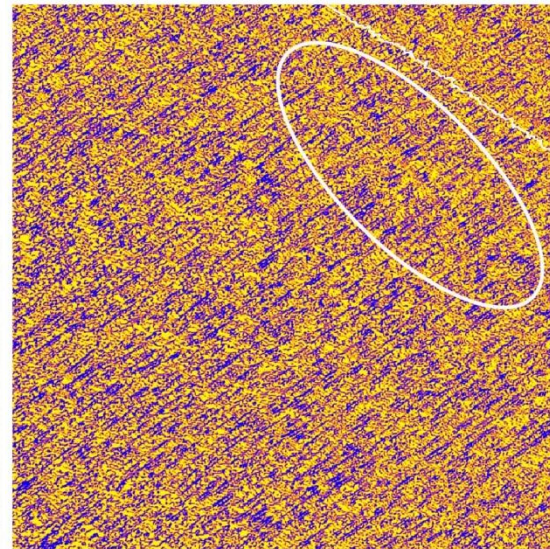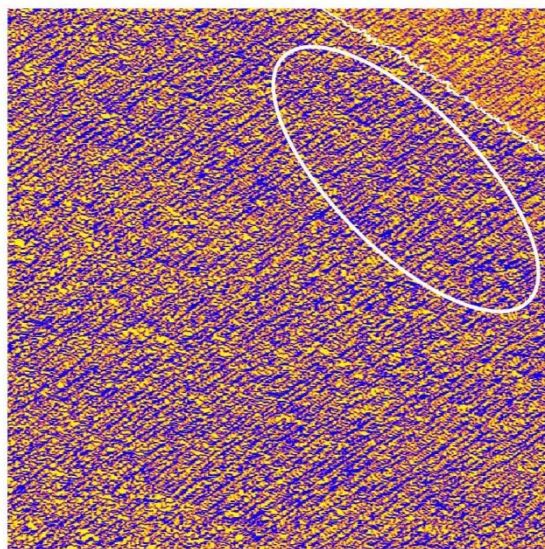
resolution
0.25, 0.5, 1 m

horizontal curvature

Haralick texture features

Inverse Difference 0°
Moment (IDM)

Crevasses No6,7
moving window 3x3
256 grey levels
distance 1 pixel
all directions

Haralick, R. M., Shanmugam, K., & Dinstein, I. (1973). Textural features for image classification. *IEEE Transactions on Systems, Man, and Cybernetics*, *SMC-3*, 610–621

Comparison

Crevasse	Horizontal curvature	Inverse Difference Moment
1	+	
2	+	+
3	+	+
4	+	+
5	+	+
6		+
7	+	+
8		
9		
10	+	+
11	+	+
12		+
13		
14		
15		+

probability

horizontal curvature   0.67

width from 3 m or length from 500 m

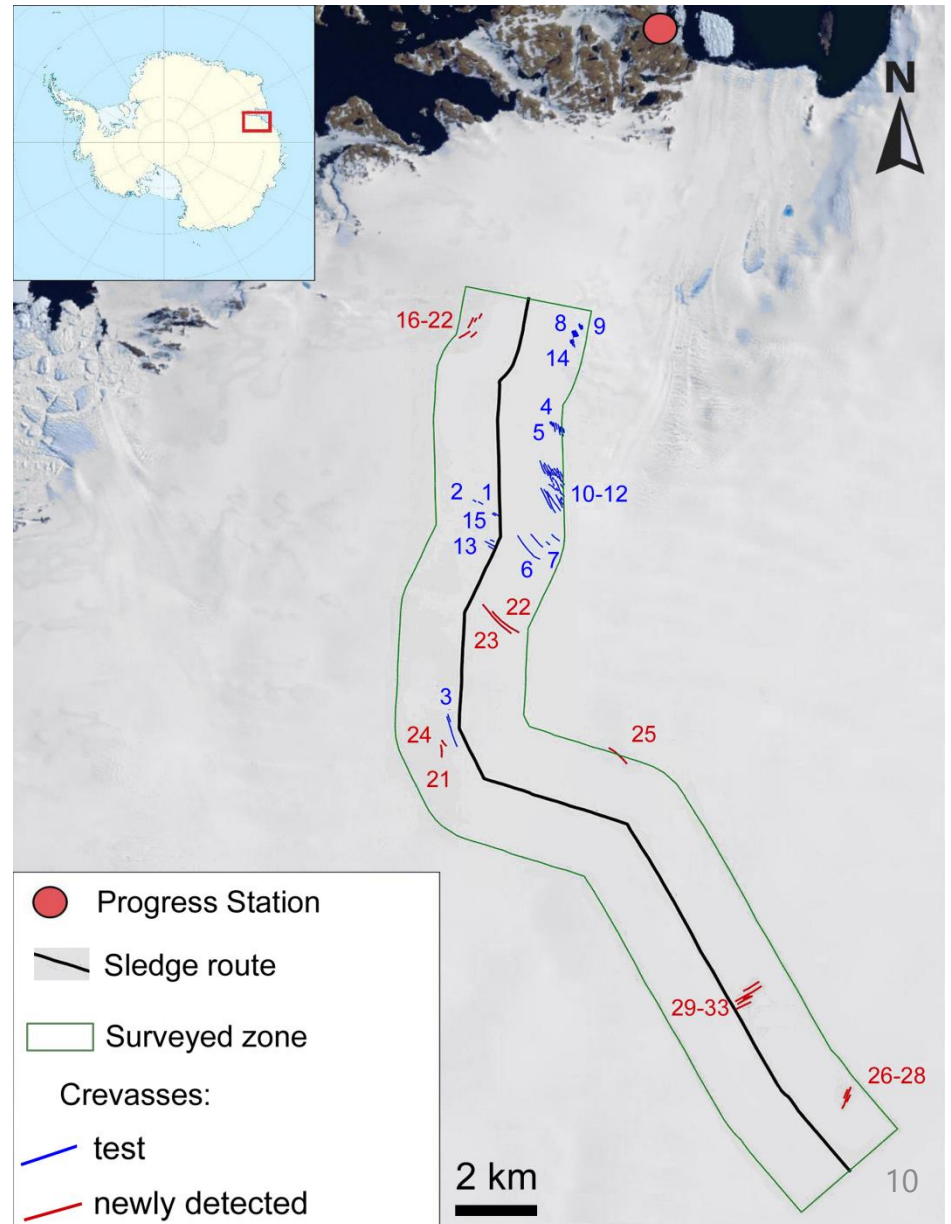Inverse Difference Moment   0.83

width 2-3 pixels

both   0.91

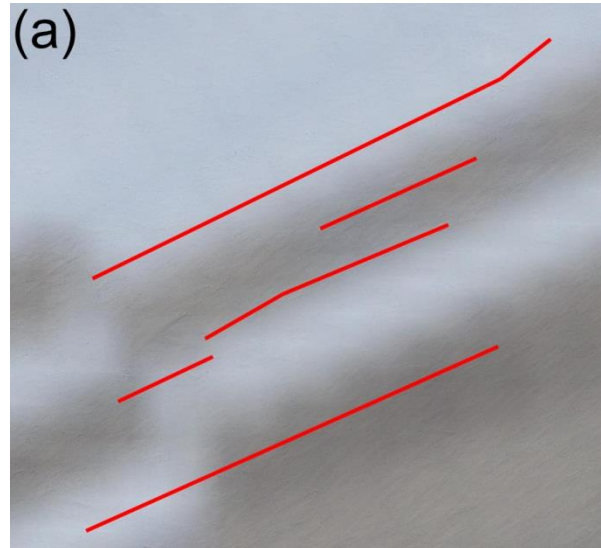# New crevasses

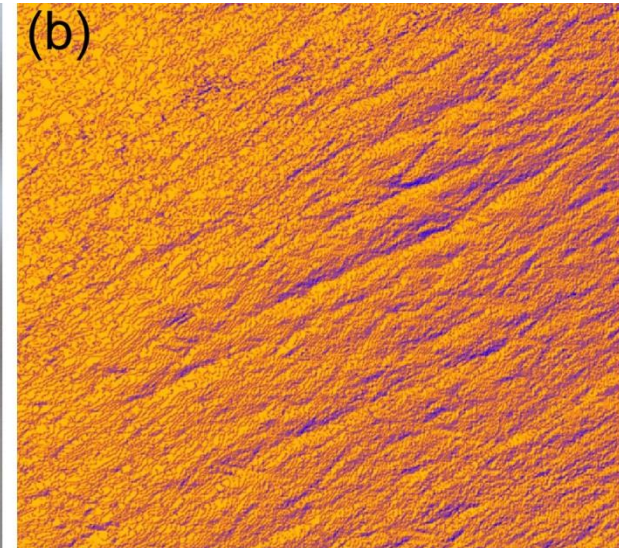18 crevasses

length
80 m - 1000 m

width
10 m

Progress Station

Sledge route

Surveyed zone

Crevasses:

test

newly detected

New crevasses

brightness variations

aeolian microtopographic feature
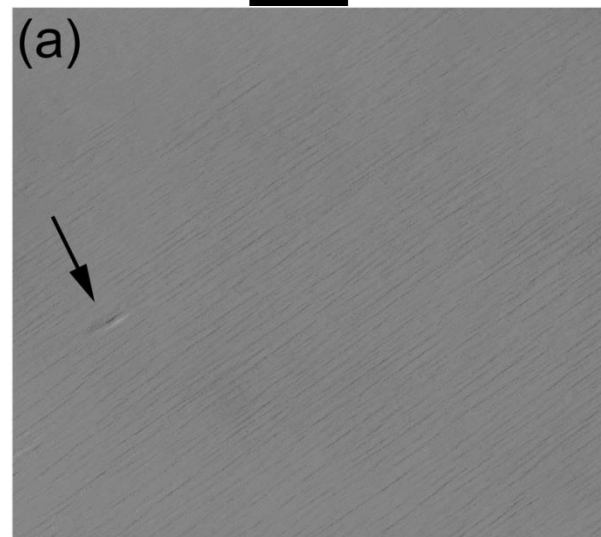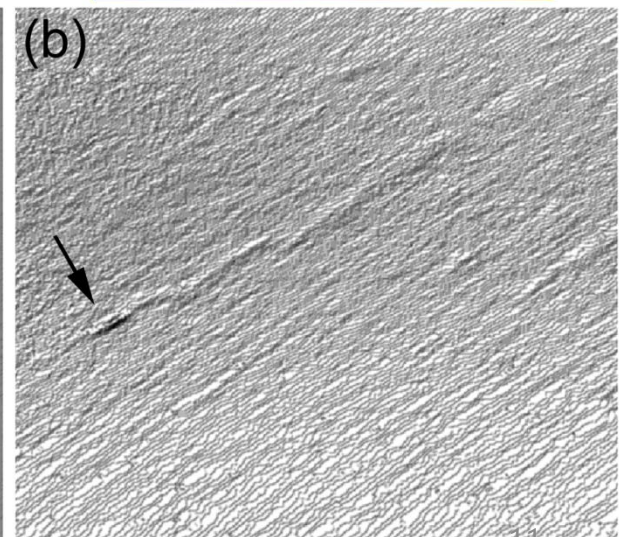
Hill shading

crevasses
№29-32

solar elevation
40 °

135°

45°

315°

100 m

225°
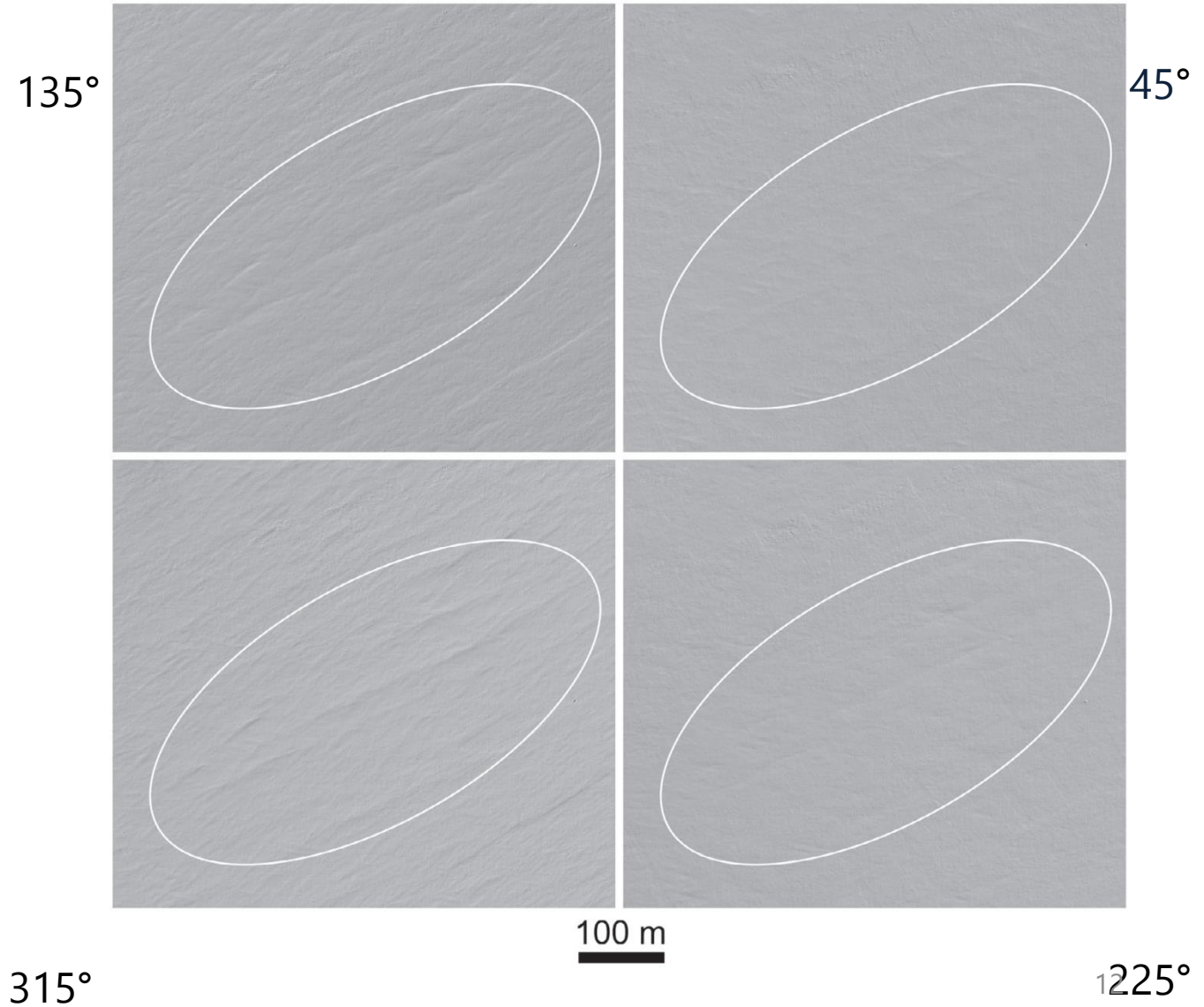
Results

implementation of the approach to detection
crevasses
18 new crevasses
probability 0.91
horizontal curvature
Inverse Different Moment

further work

- crevasse as microtophographic form
- DEM filtering,smoothing
- intepretation Haralick texture feature

Thank you for attention!