Remote Sensing 1: GEOG 4/585

Lecture 8.2.

Stereophotogrammetry

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Office hours: Monday 15:00-17:00
in 165 Condon Hall

Required reading:
Fonstad et al. (2013)

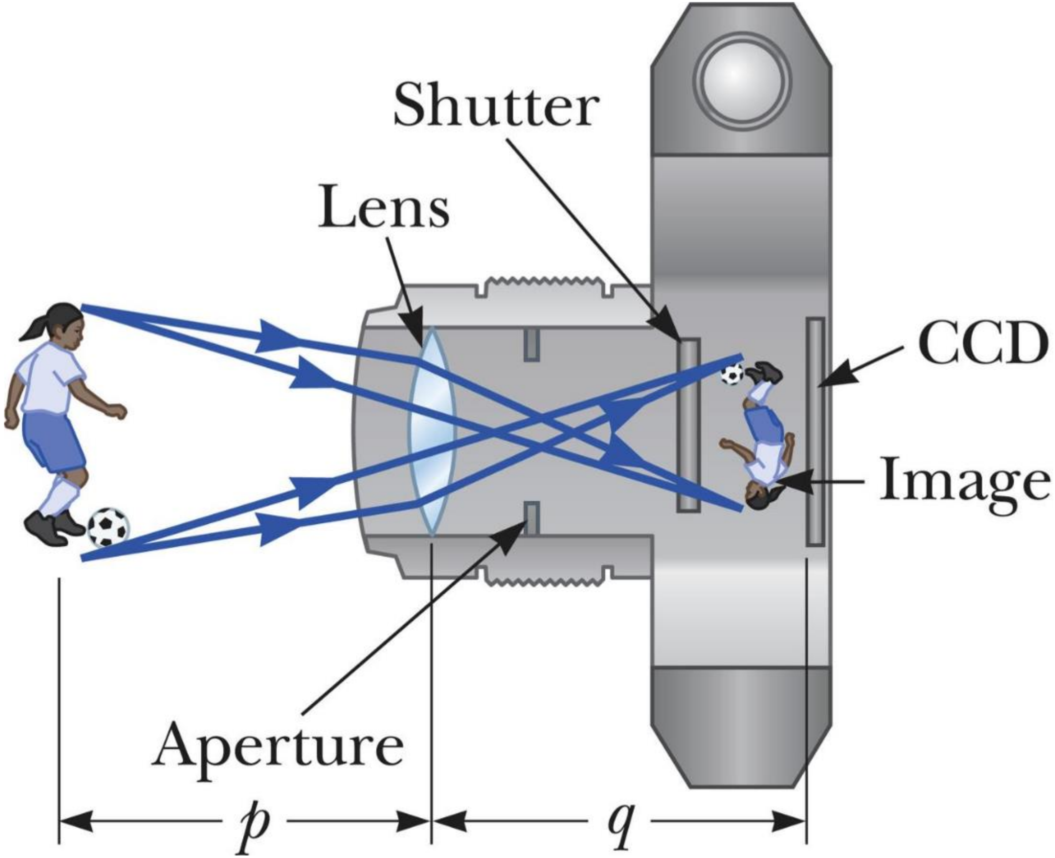
Overview

- Today - drones
  - Platforms
  - Sensors
  - Operations
  - Regulations

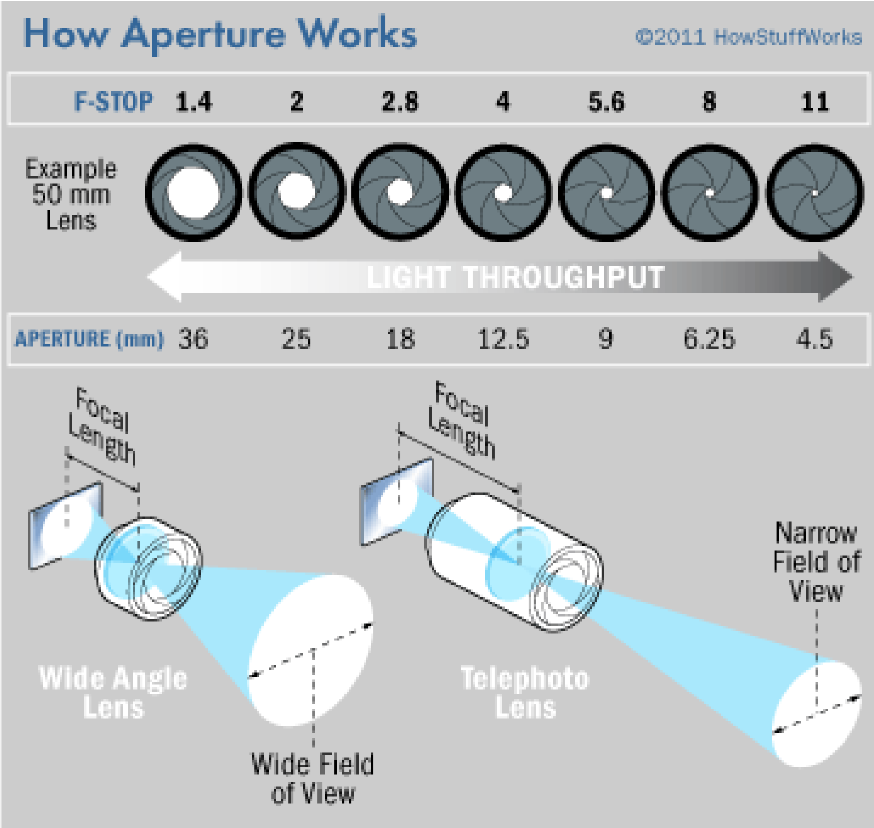
- Wednesday - stereophotogrammetry
  - Image acquisition
  - 3D models
  - Mapping
  - Applications

Image acquisition

- Framing camera
- Usually facing downwards

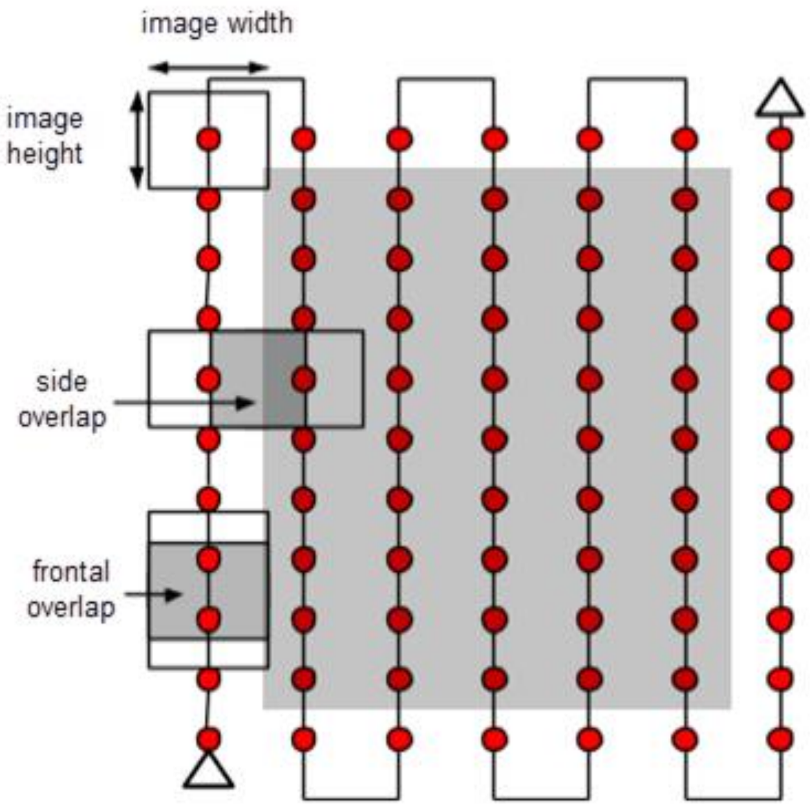


Camera settings



- Aperture as wide as possible for wide field-of-view
- Fast shutter speed (1/1000) to minimize blur and prevent image saturation
- Low ISO (100) to reduce image noise
- Keep settings fixed!

Image overlap



- For most cases:
  - 75% frontal and side overlap
  - Lawnmower or snake flight pattern, no need for cross-hatch
  - Nadir only, no obliques
- There is such as thing as “too much data”

Image overlap exceptions

- Circular flight pattern recommended for building/structures
    - Start with 45° camera angle
    - Reduce camera angle with height

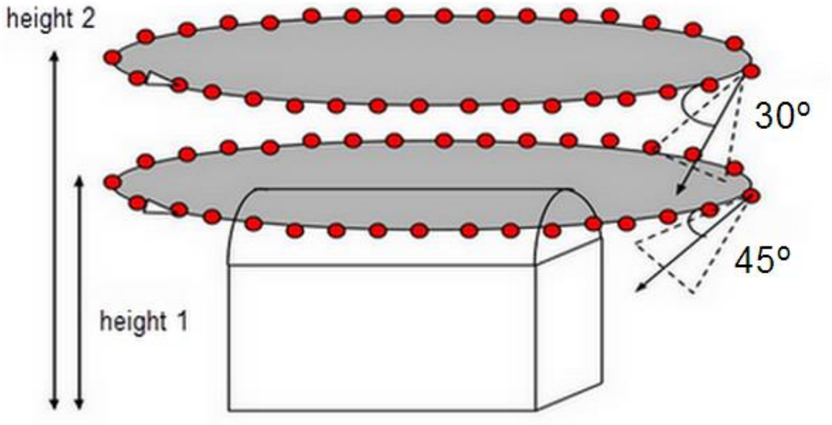


Image overlap exceptions

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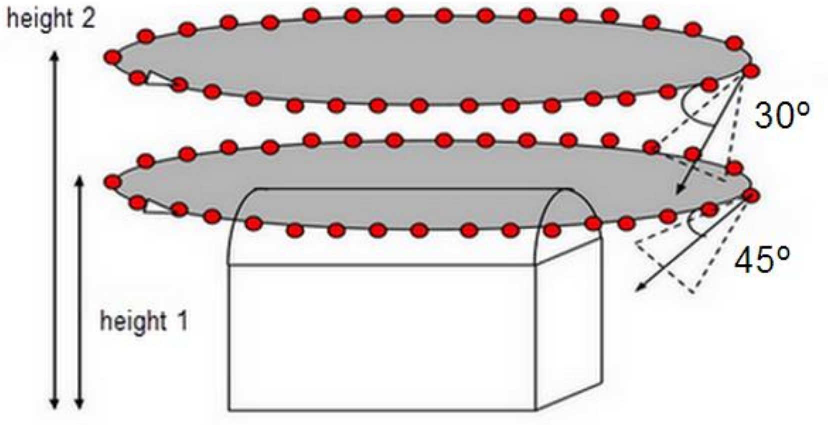
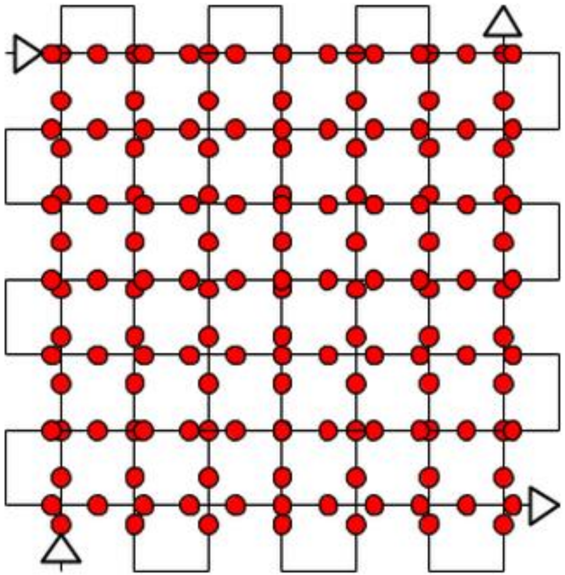




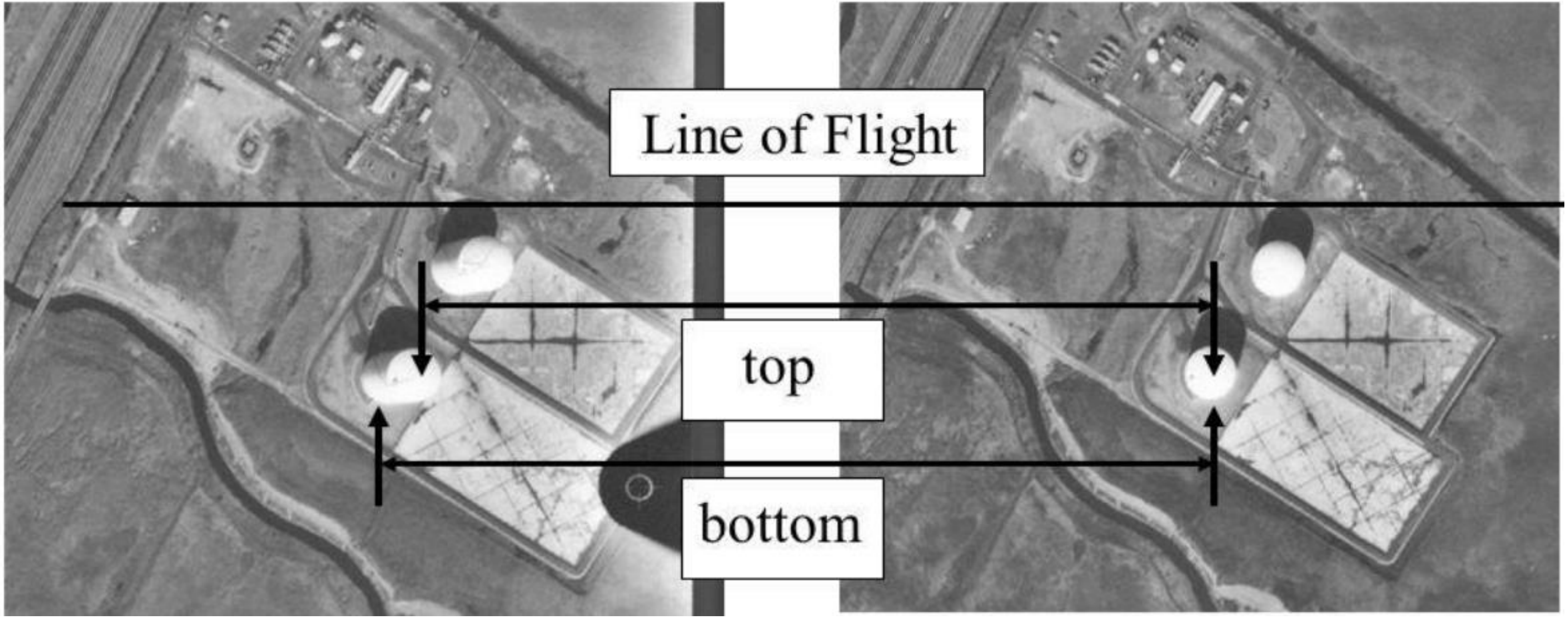
- Double grid pattern for city reconstructions
  - Camera angle of between 10º and 35º
  - All the facades of buildings (north, west, south, east) are visible in the images

Flight planning

- Modern software makes it easy

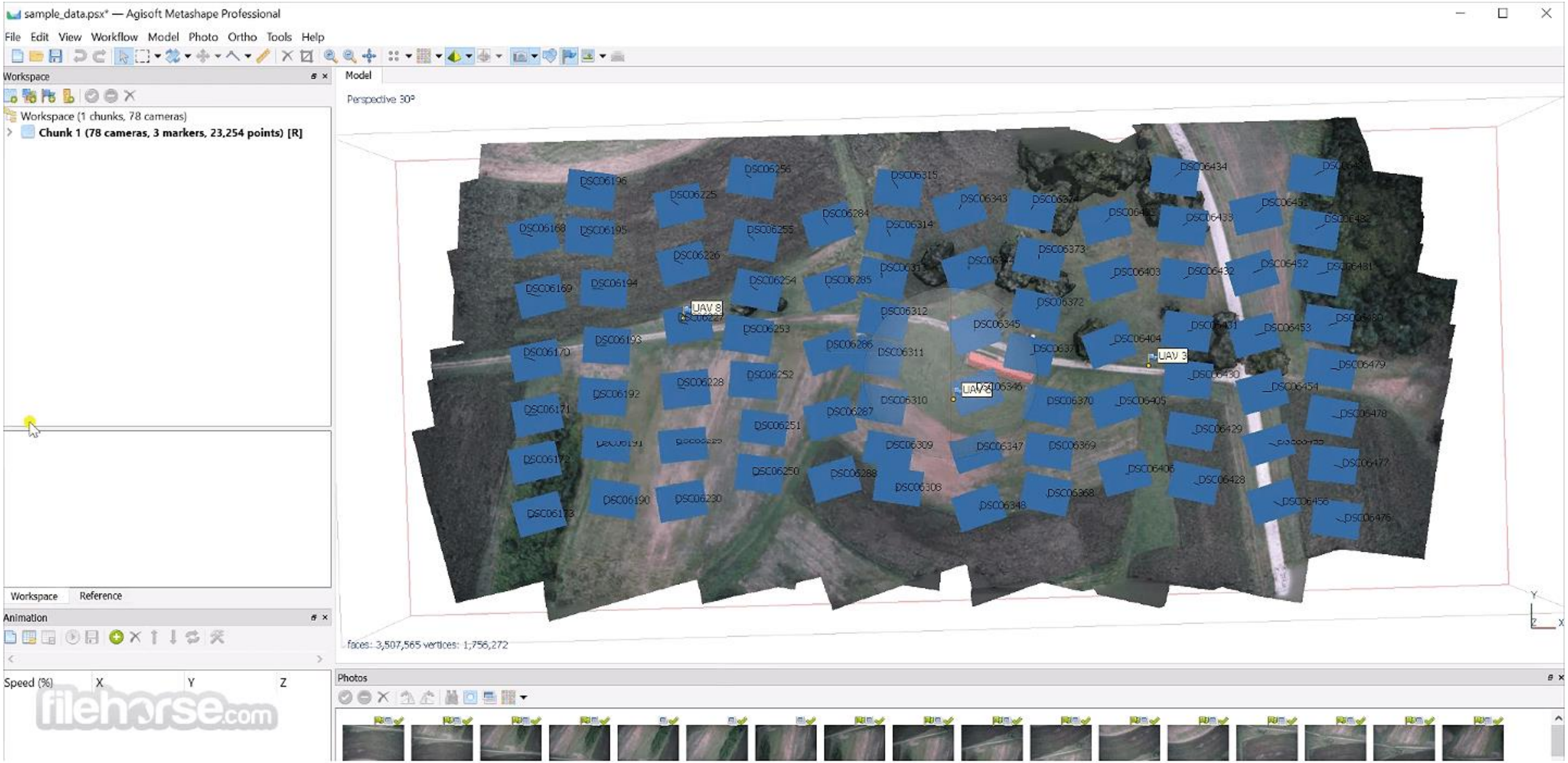
Stereoscopic parallax

- Displacement of the same feature in multiple images
- Features closer to camera are displaced more than features that are further away

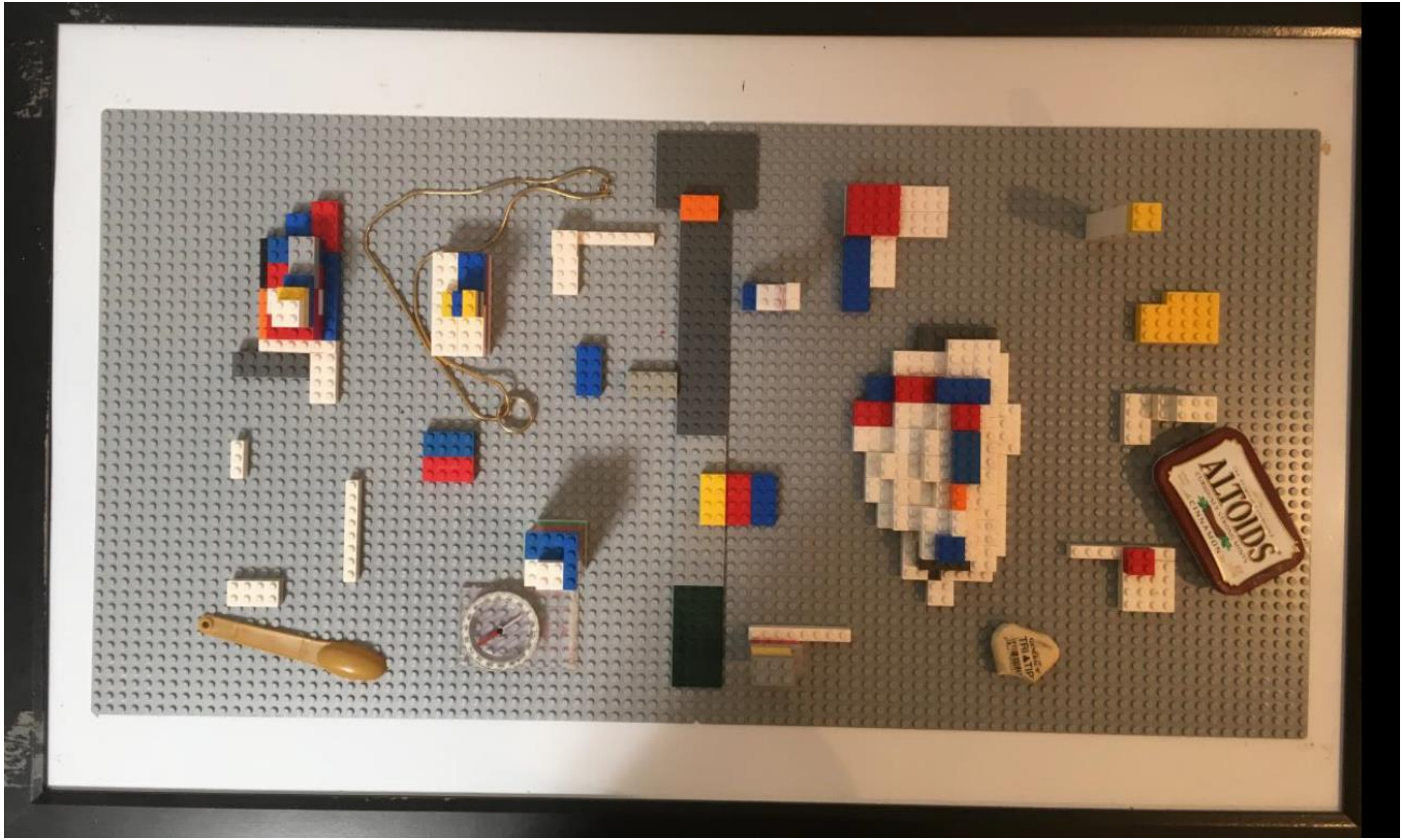


Stereoscopic parallax

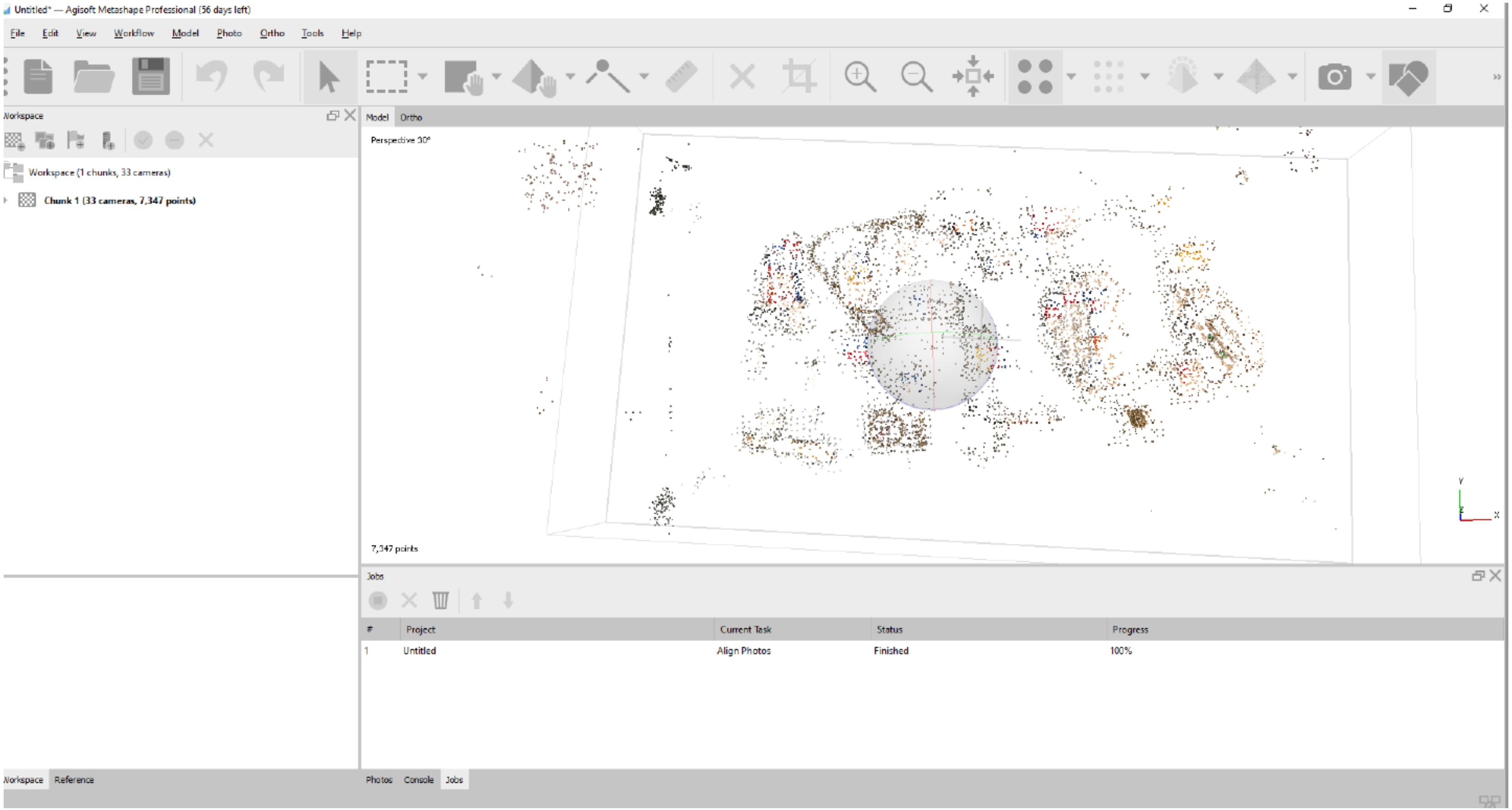
Agisoft Metashape



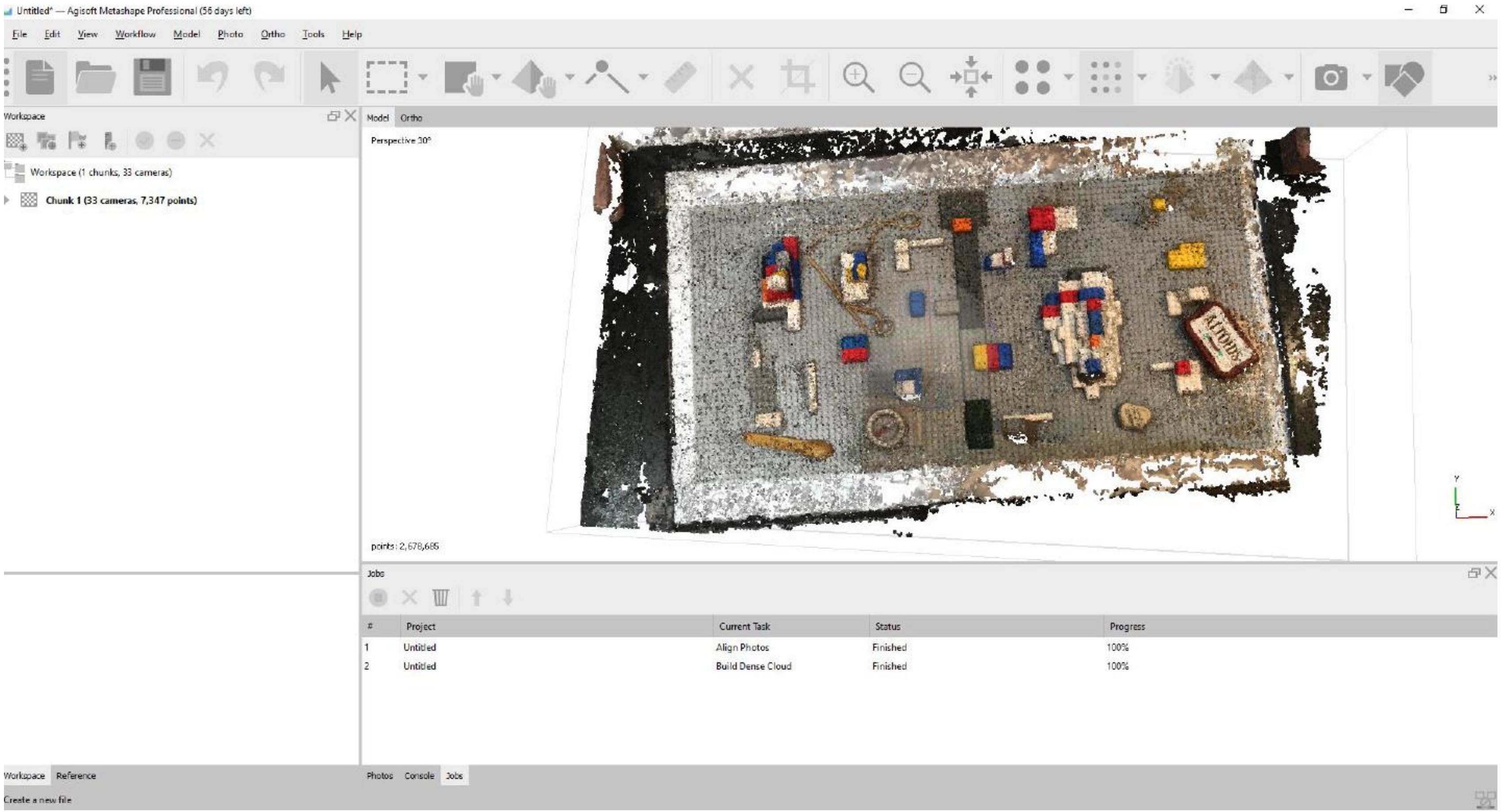
Agisoft Metashape



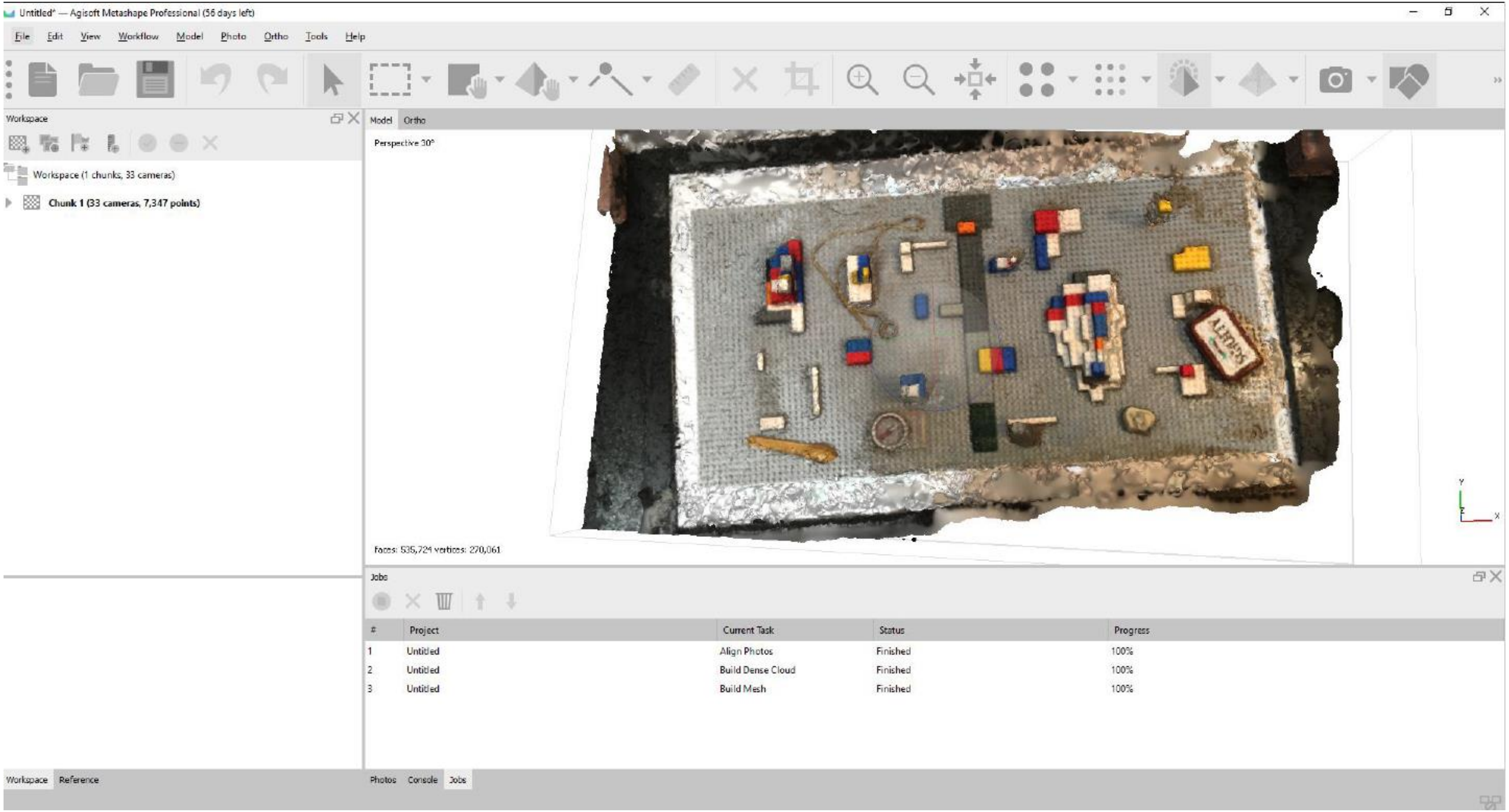
Agisoft Metashape



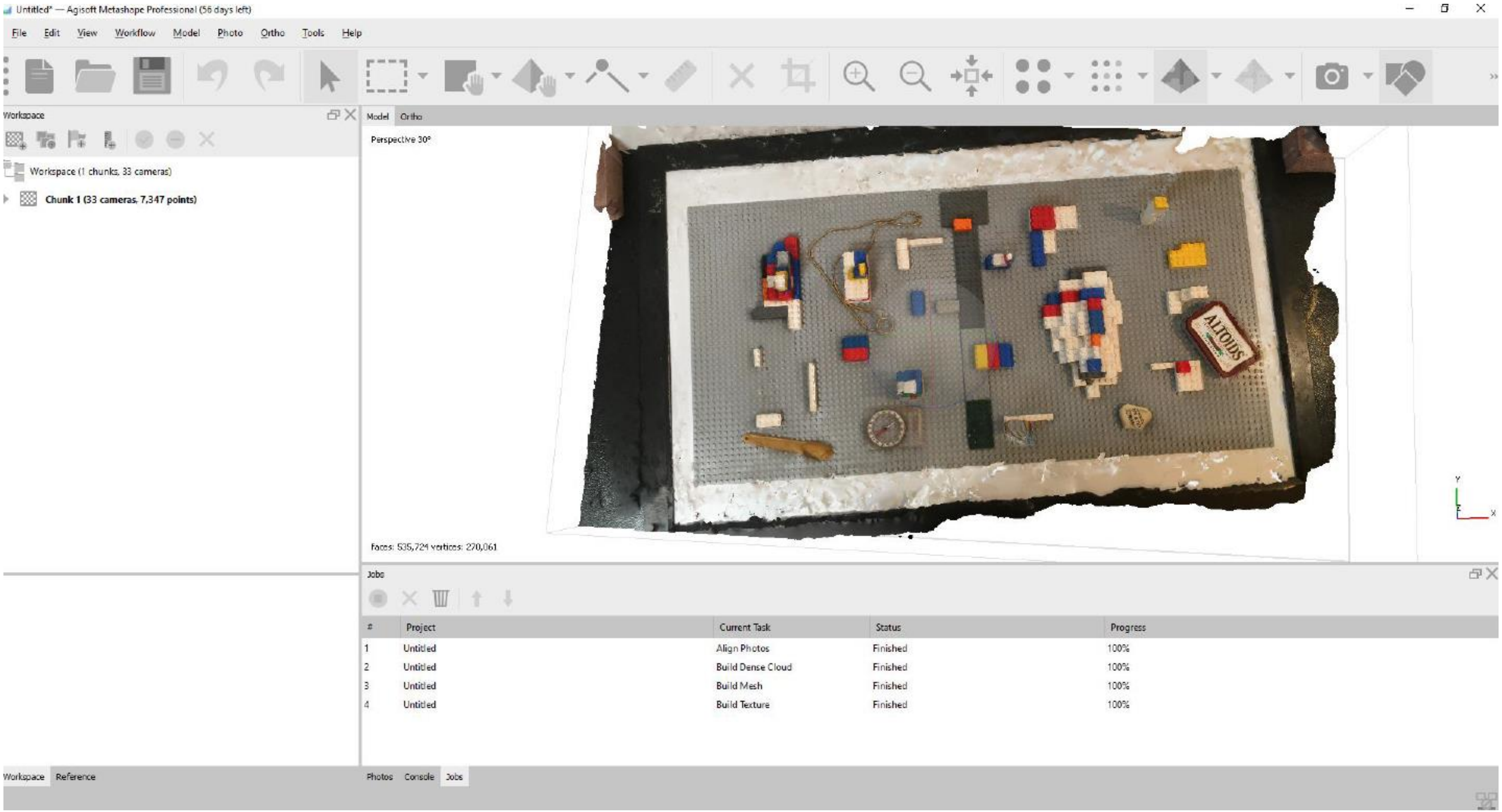
Agisoft Metashape



Agisoft Metashape

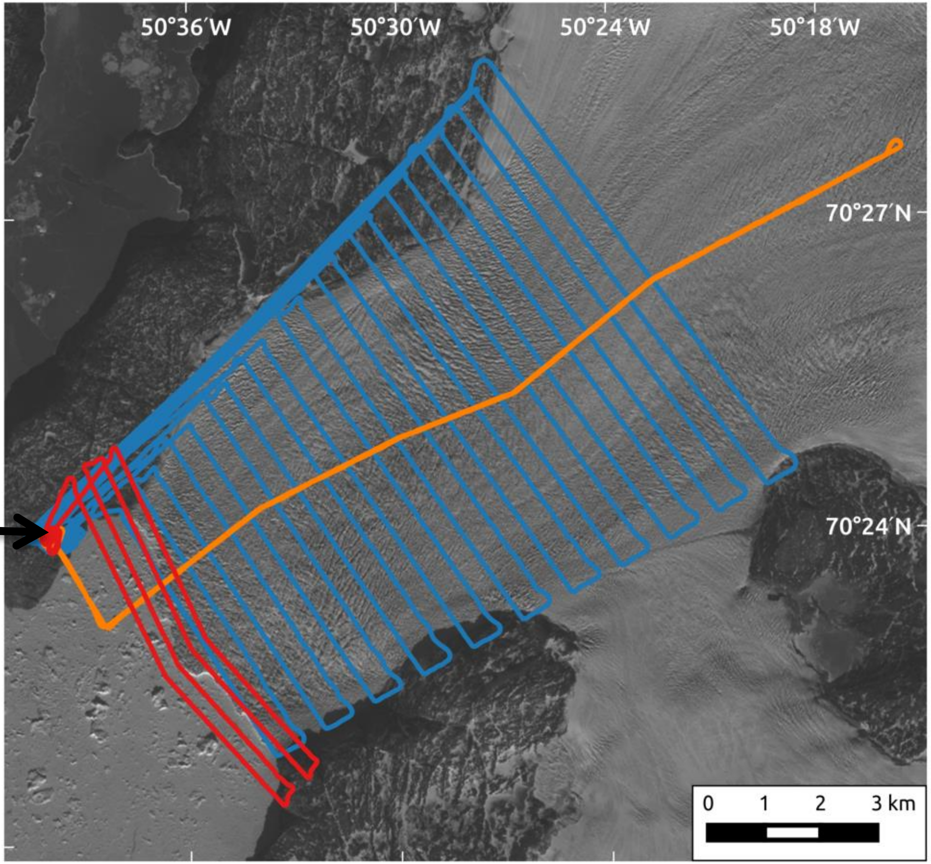


Agisoft Metashape



Drone surveying at Store Glacier

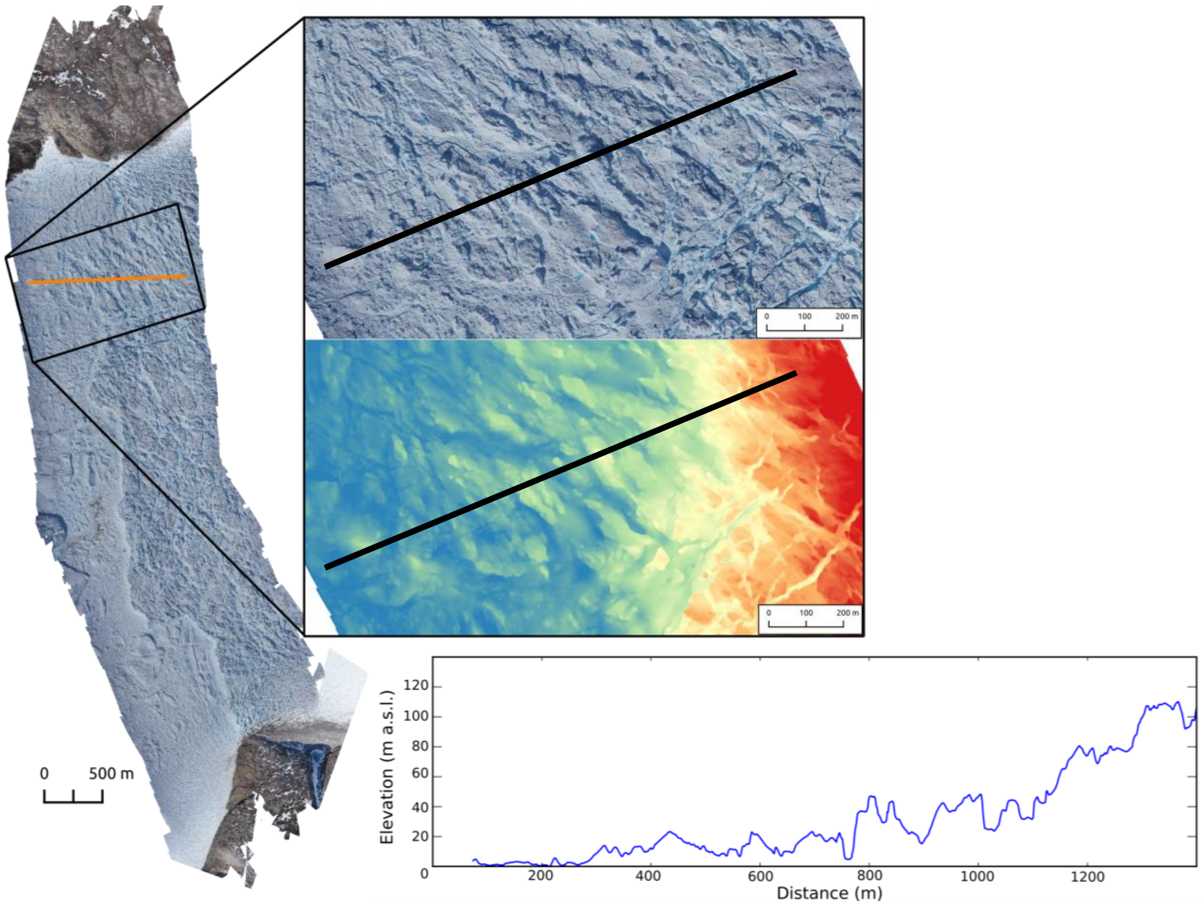
Camp



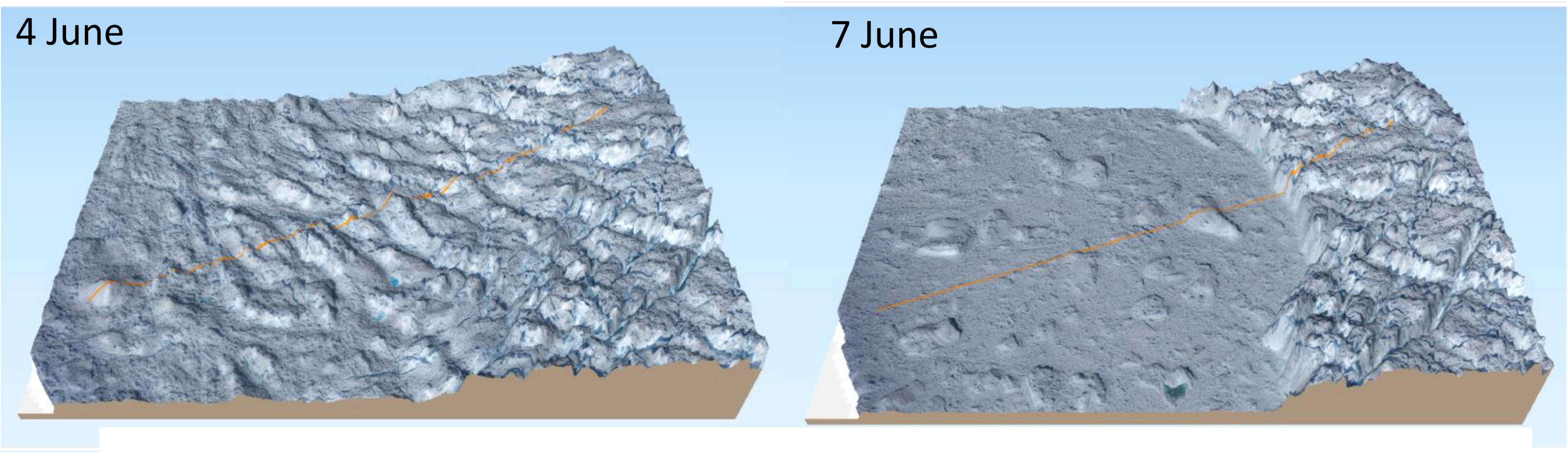
Ground control points

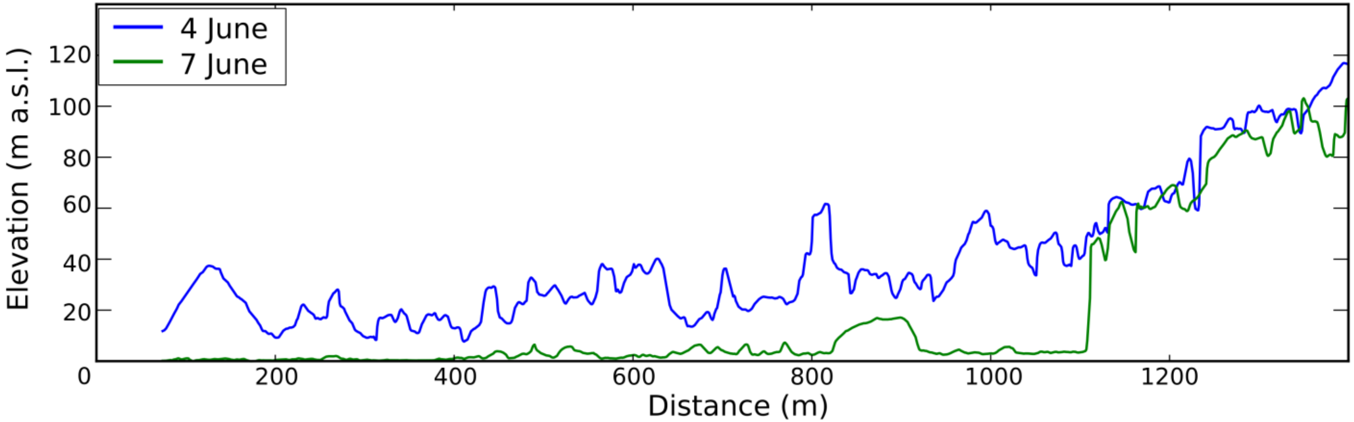
Uncertainty of DEM against manually placed ground control points = **0.05 m** horizontal and **0.10 m** vertical

Digital elevation models

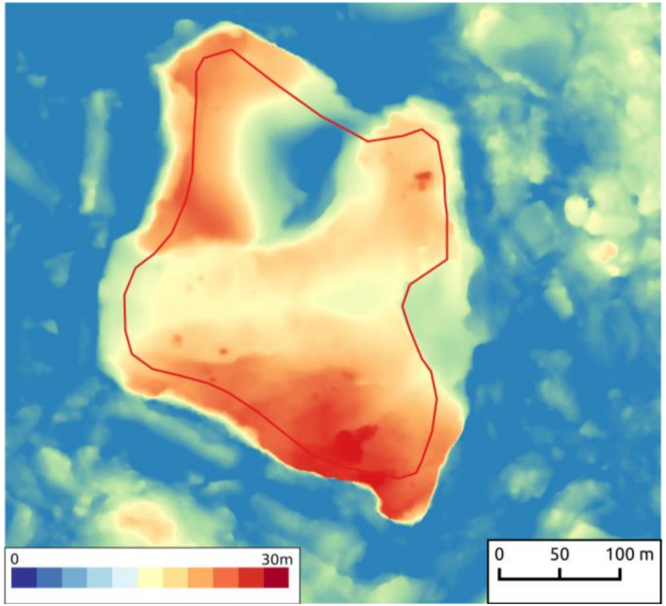


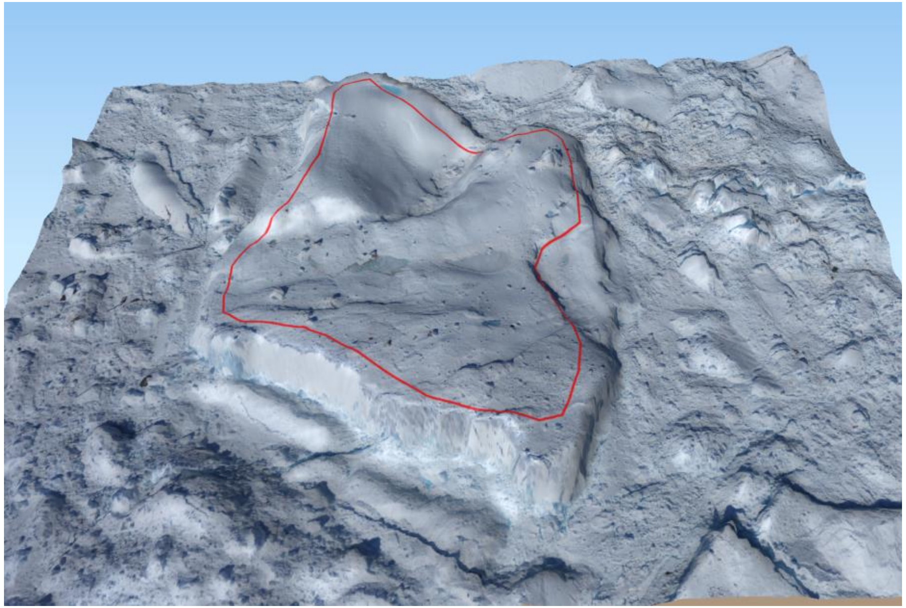
Ice melange breakup



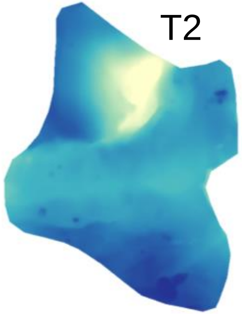


Submarine melt rates from icebergs





Subtract iceberg freeboards from two repeat surveys to derive submarine melt rates



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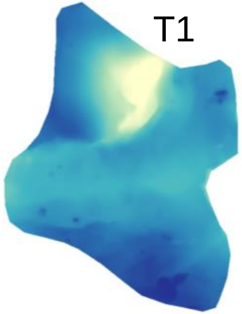
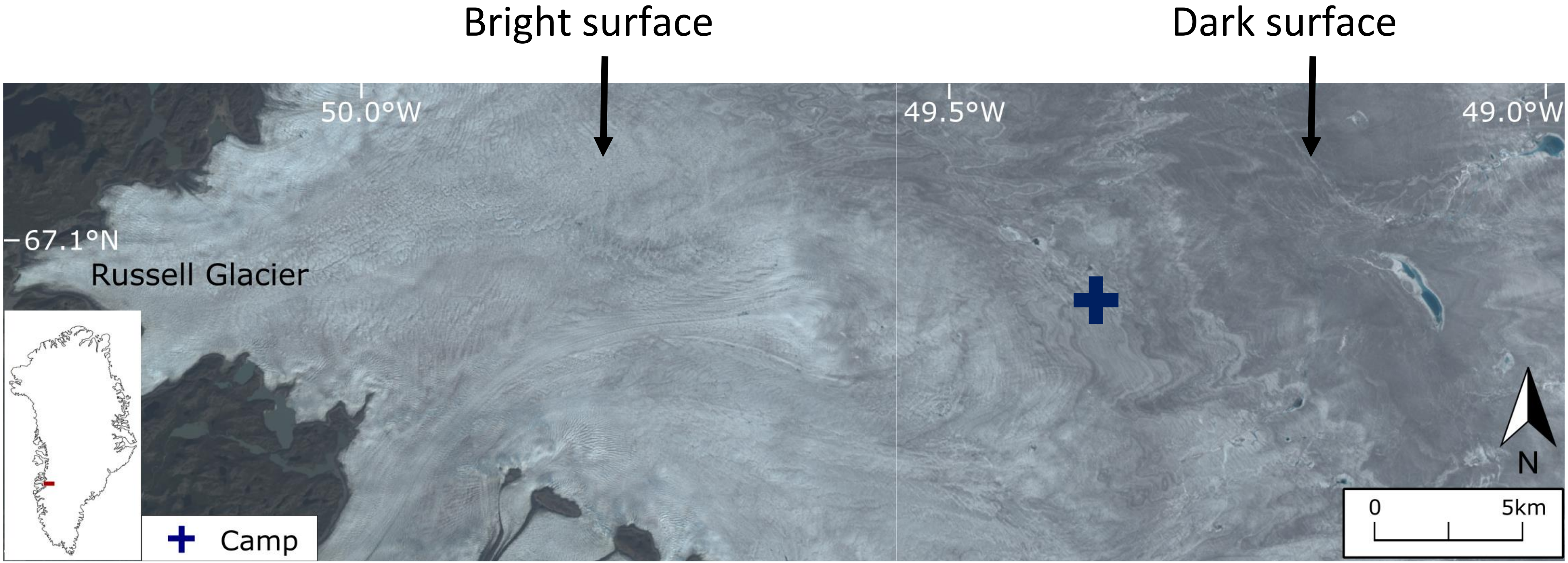
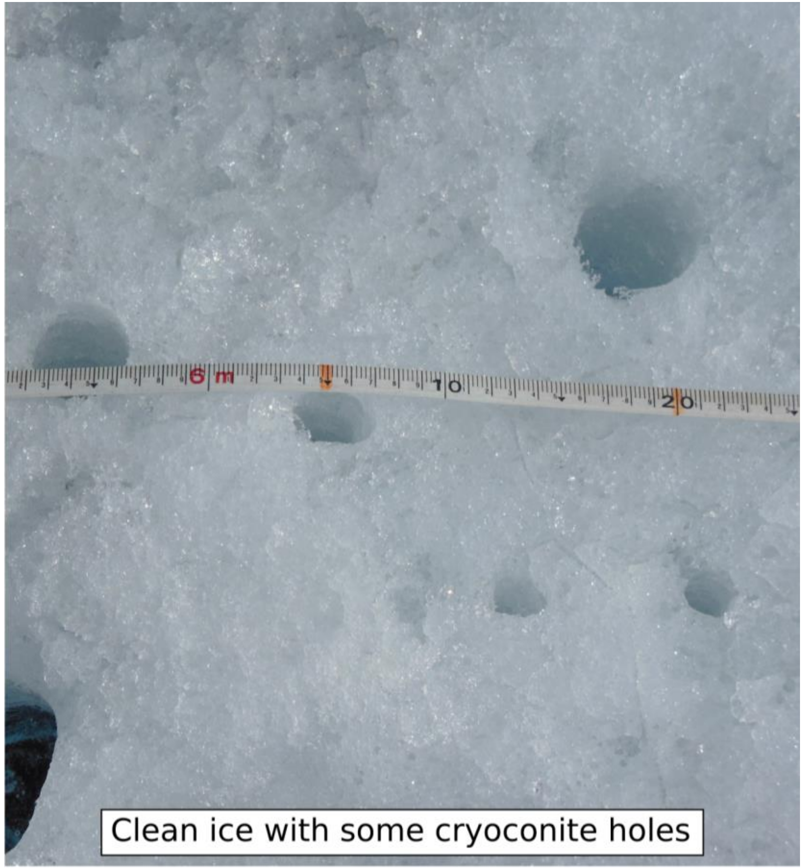


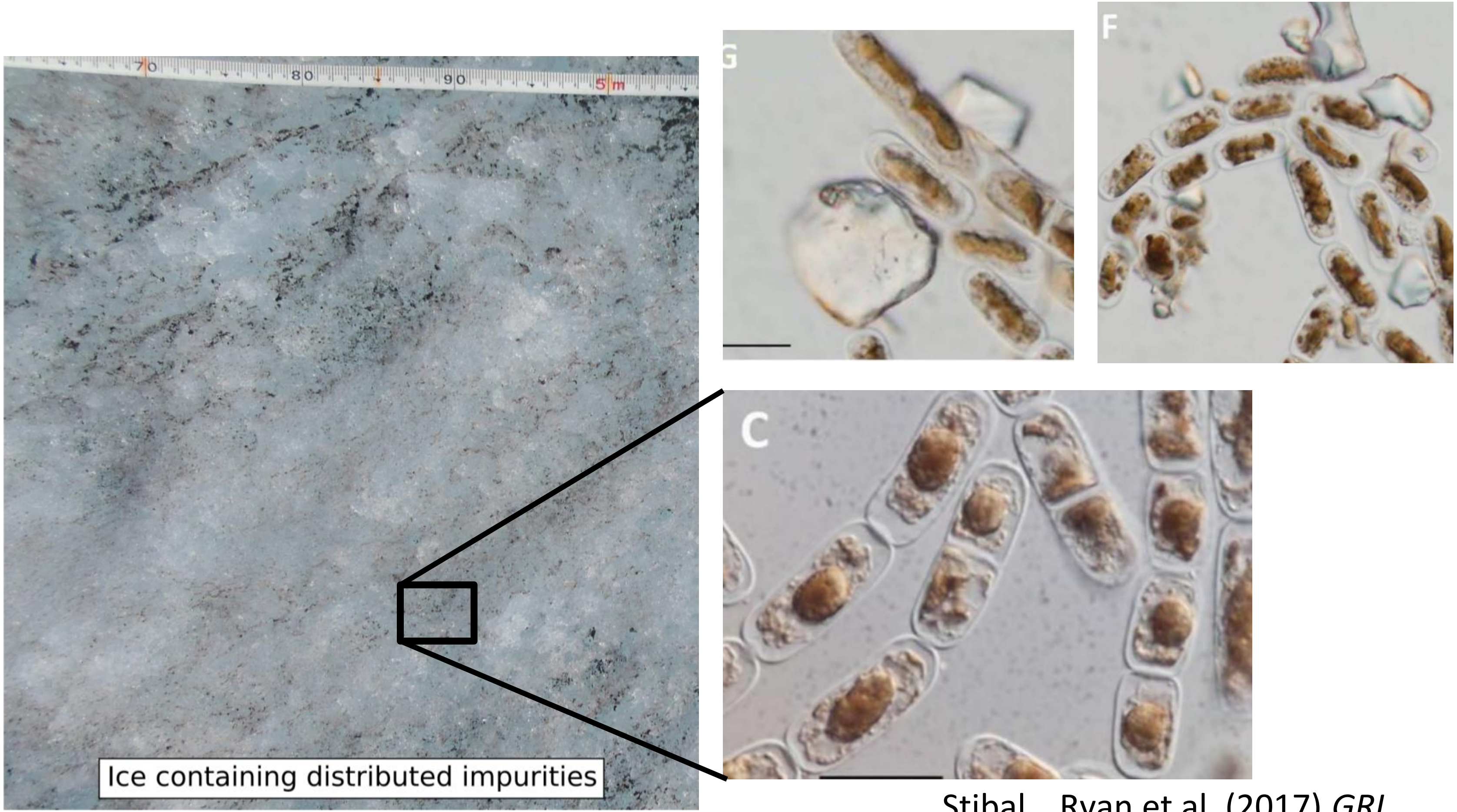
What controls spatial albedo patterns in the ablation zone?



Bare ice surface on the Greenland Ice Sheet

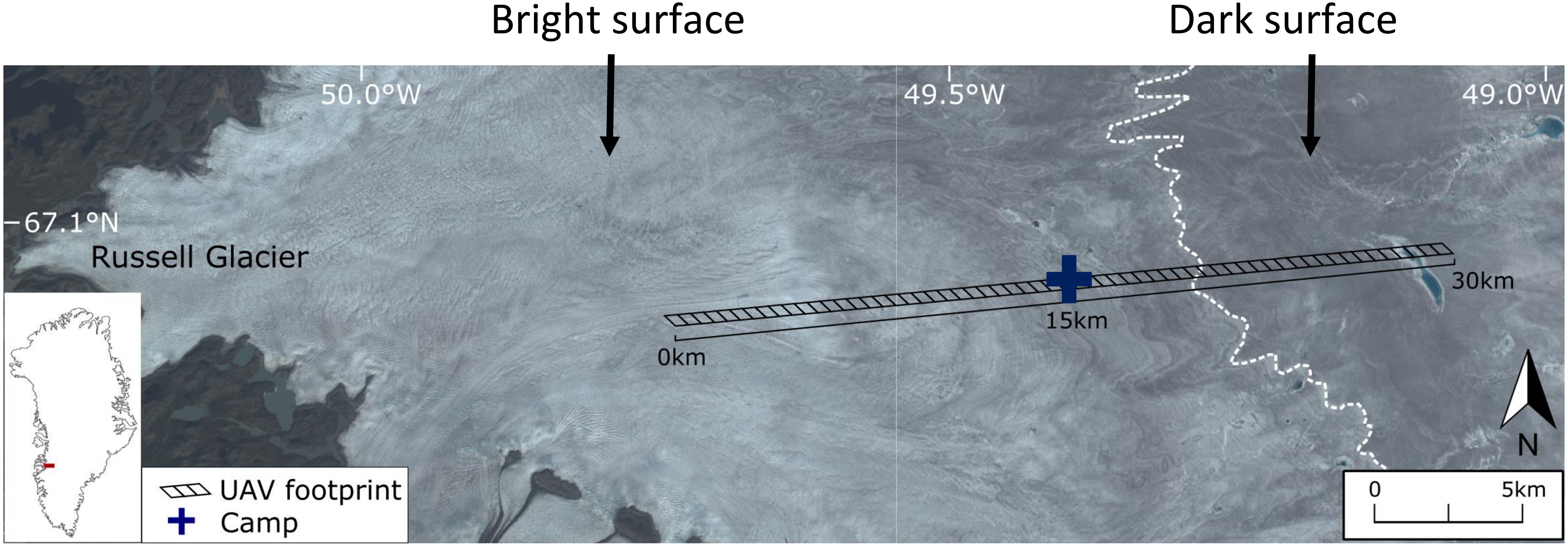


Microscopic evidence for brown-pigmented glacier algae



Stibal… Ryan et al. (2017) *GRL*

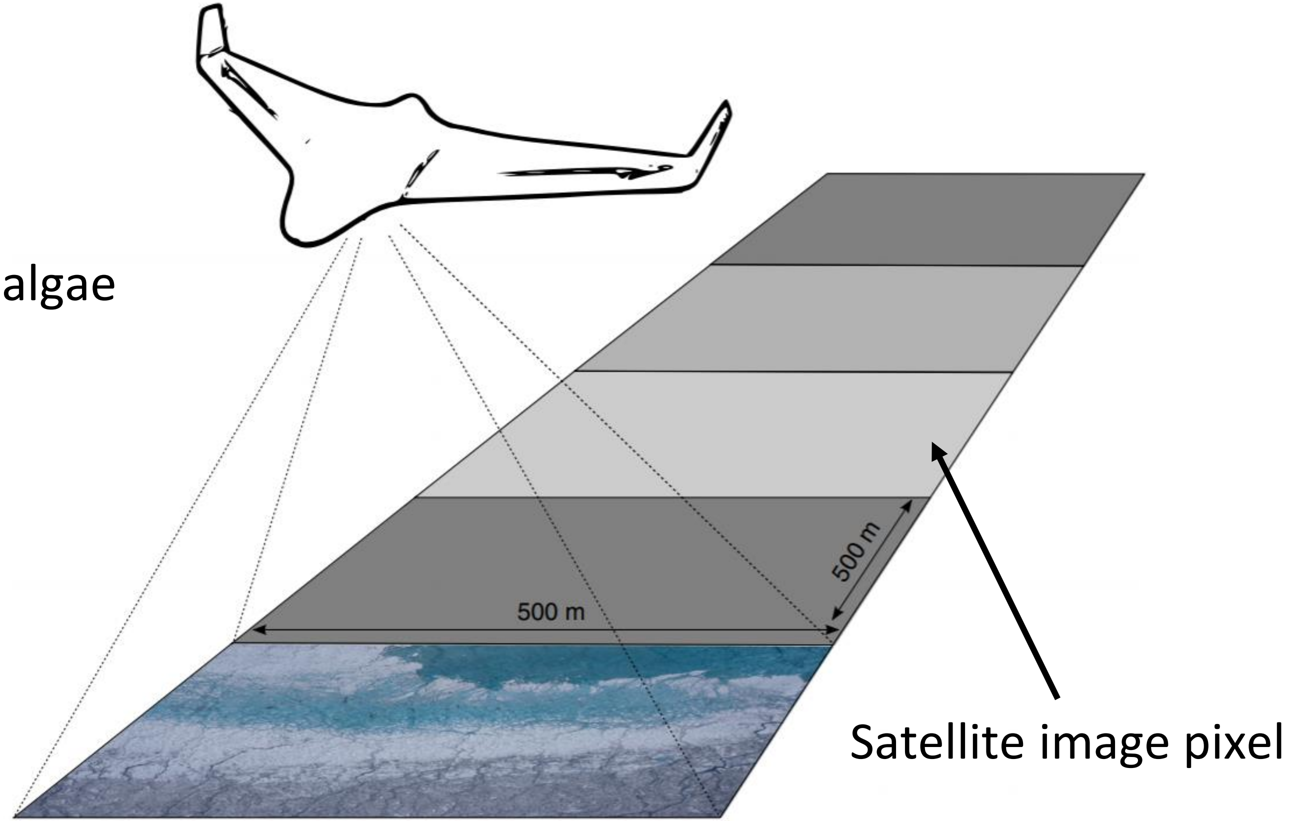
Location of UAV transect across ice sheet



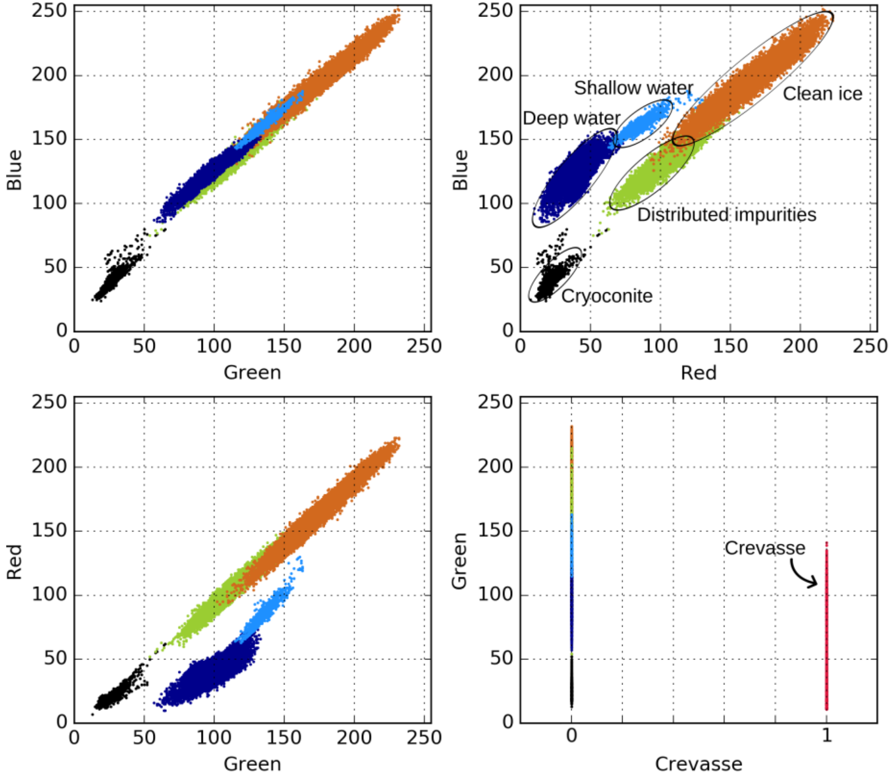
Ryan et al. (2018) *Nat. Comms.*

Classified the ice sheet surface based on reflectance and roughness

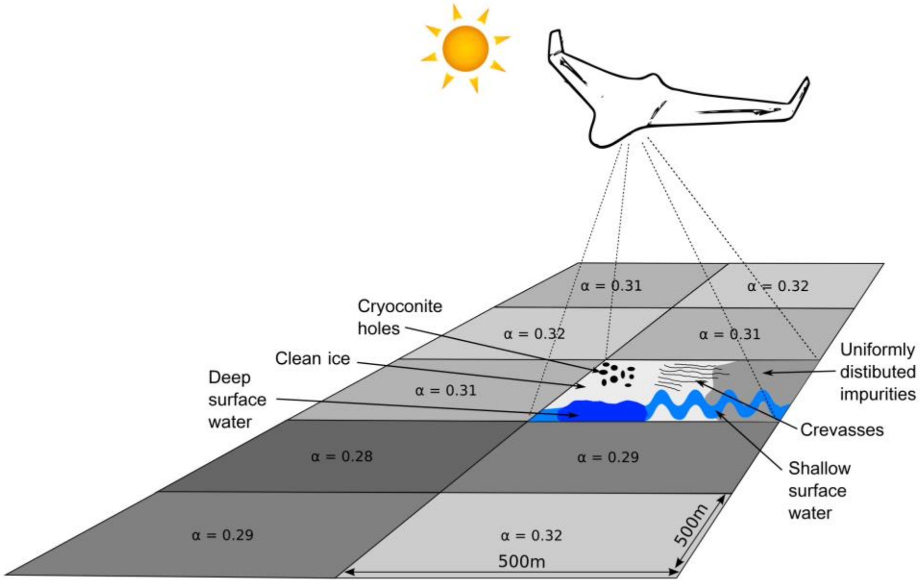
1. Clean ice
2. Dirty ice – likely due to algae
3. Shallow water
4. Deep water
5. Crevasses
6. Cryoconite
7. Snow



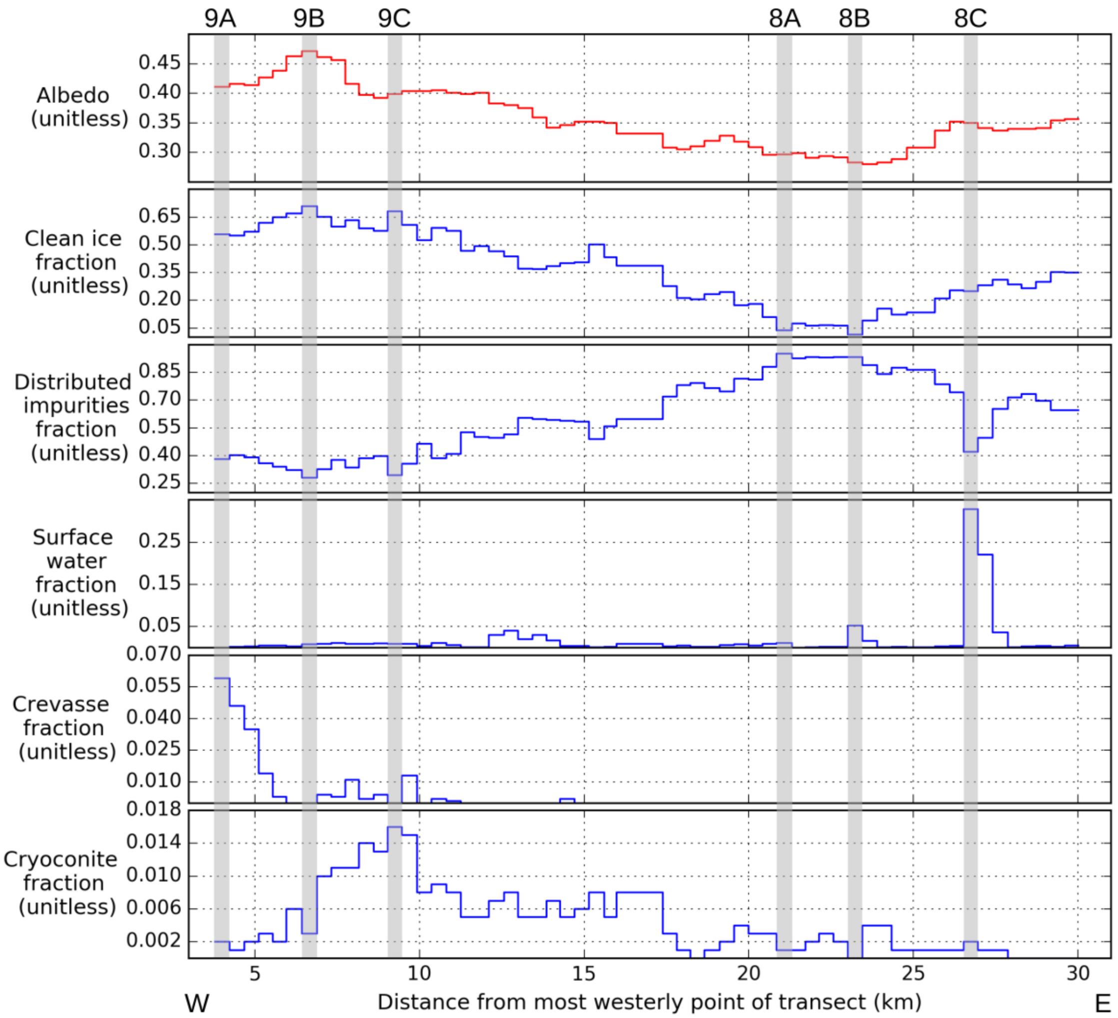
Ryan et al. (2018) *Nat. Comms.*



Blue
Green
Red
Crevasse
Shallow water
Deep water
Clean ice
Distributed impurities
Cryoconite
0
1
0
50
100
150
200
250

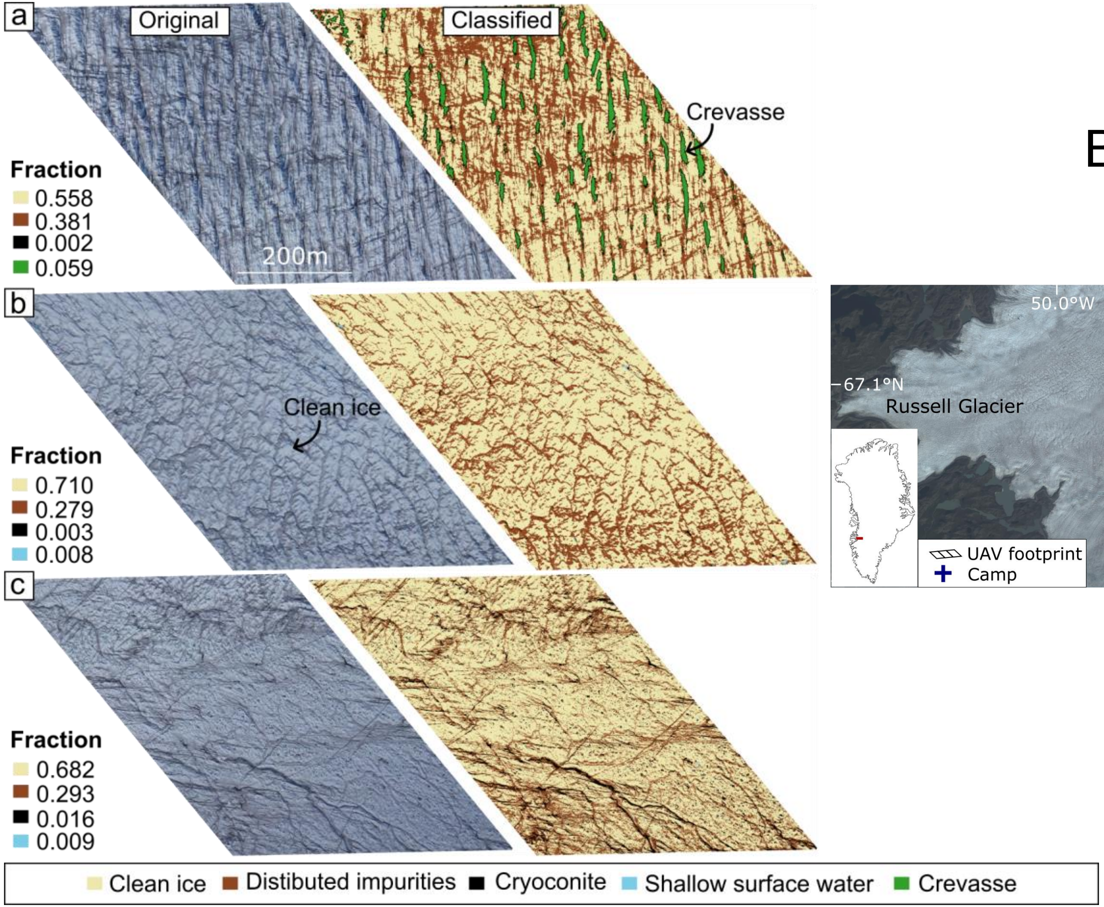


α = 0.31
α = 0.32
α = 0.32
α = 0.31
α = 0.31
α = 0.28
α = 0.29
α = 0.29
α = 0.32
Cryoconite holes
Clean ice
Deep surface water
Uniformly distibuted impurities
Crevasses
Shallow surface water
500m
500m

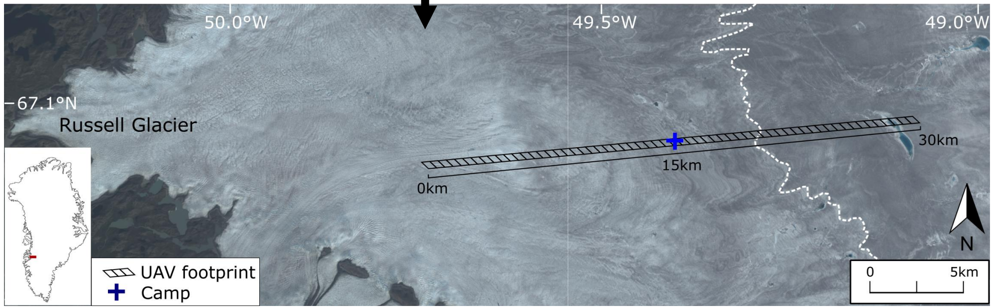


9A
9B
9C
8A
8B
8C
Albedo (unitless)
0.45
0.40
0.35
0.30
Clean ice fraction (unitless)
0.65
0.50
0.35
0.20
0.05
Distributed impurities fraction (unitless)
0.85
0.70
0.55
0.40
0.25
Surface water fraction (unitless)
0.25
0.15
0.05
Crevasse fraction (unitless)
0.070
0.055
0.040
0.025
0.010
Cryoconite fraction (unitless)
0.018
0.014
0.010
0.006
0.002
5
10
15
20
25
30
W
Distance from most westerly point of transect (km)
E

Ice sheet surface types in western half of transect

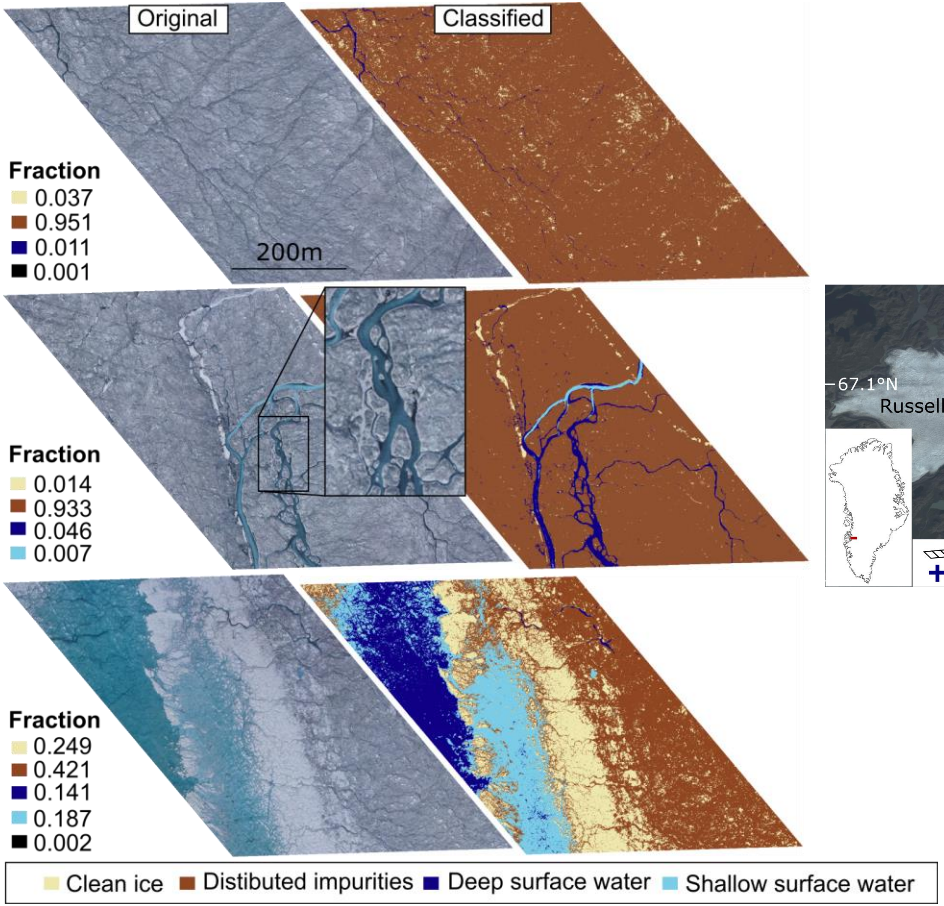


Bright surface

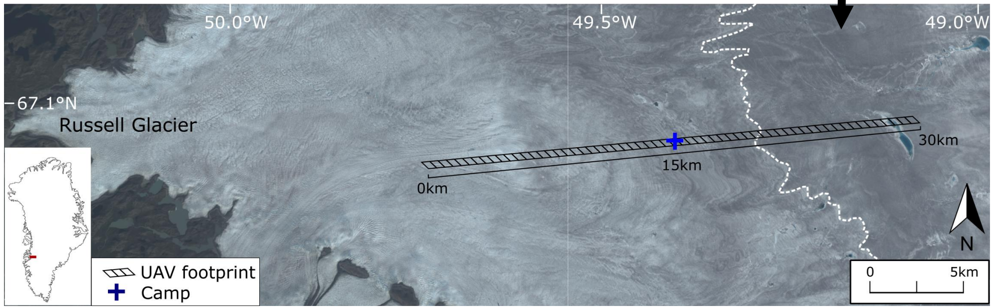


Ryan et al. (2018) *Nat. Comms.*

Ice sheet surface types in eastern half of transect



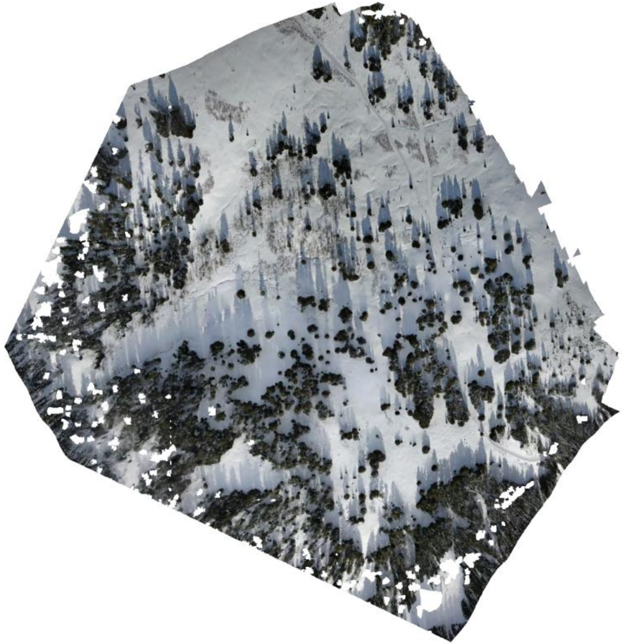
Dark surface

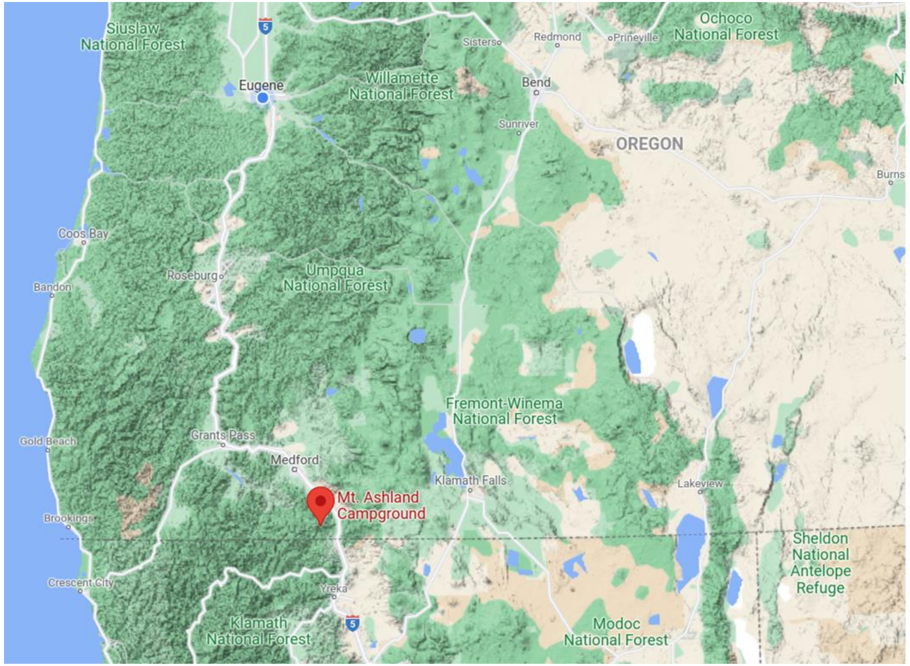


Ryan et al. (2018) *Nat. Comms.*

Mt. Ashland survey

- DJI Mavic 2
- Dec 19, 2020





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- Dec 19, 2020

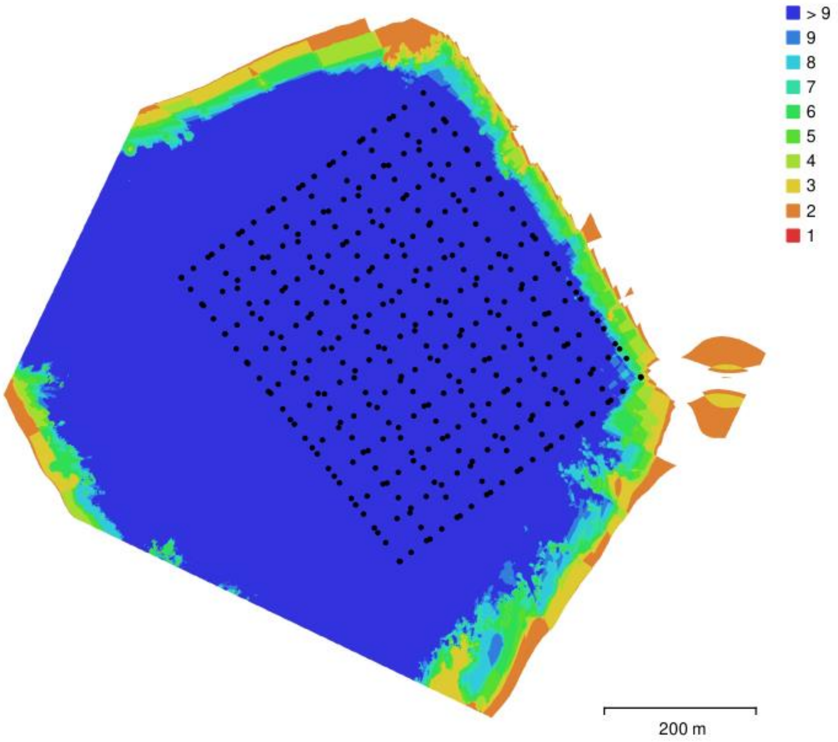
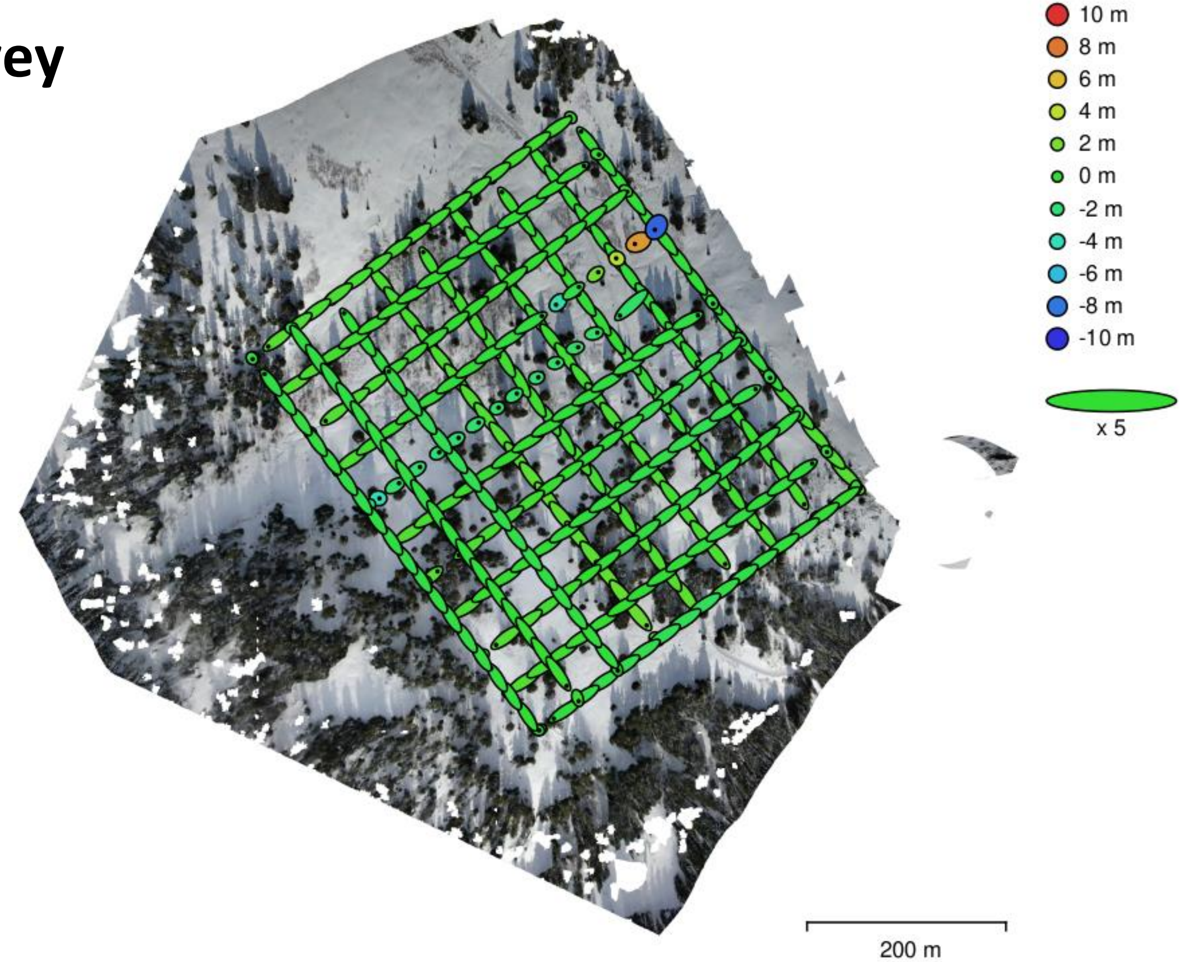


Fig. 1. Camera locations and image overlap.

Number of images:	366	Camera stations:	363
Flying altitude:	328 m	Tie points:	308,123
Ground resolution:	5.86 cm/pix	Projections:	1,039,880
Coverage area:	0.527 km²	Reprojection error:	1.2 pix

Mt. Ashland survey

- DJI Mavic 2
- Dec 19, 2020



Mt. Ashland survey

- DJI Mavic 2
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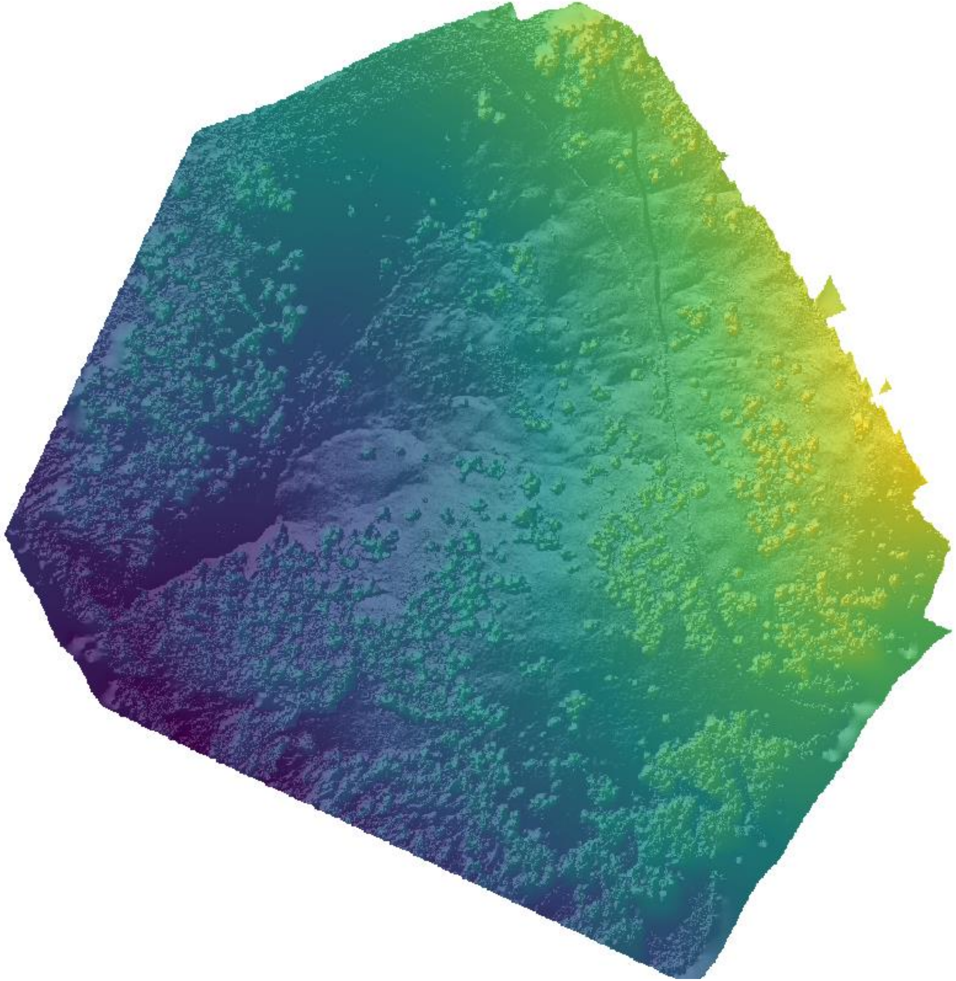

Quiz #3 review

Q1: Describe three major differences between passive optical imaging and active radar imaging [5 points].

- Optical relies on electromagnetic radiation from the Sun, radar produces it's own electromagnetic radiation
- Active radar uses longer wavelengths, can transmit and receive polarized waves
- Optical does not work in the dark and cannot penetrate cloud
- Radiowaves penetrate the some materials (e.g. sand) so can inform us about sub-surface properties
- Radar receives using an antenna, optical receives using a photodetector/photosensor

Quiz #3 review

Q2: What is a polarized radiowave? Which materials or objects tend to depolarize radiowaves and why? [5 points].

- Polarized radiowaves vibrate/oscillate in a specific orientation/plane

- Thick vegetation, forests, trees tend to depolarize radiowaves due to penetration and multiple scattering within the canopy.

Quiz #3 review

Q3: Describe the differences between a digital surface model (DSM), a digital terrain model (DTM) and a canopy height model (CHM)? Which remote sensing instrument is best suited to producing canopy height models and why? [5 points]

- DSM is a digital representation of the surface that includes trees, buildings, snow
- DTM is a digital representation of the surface that excludes trees, buildings, snow
- CHM represents the height of tree canopy above the surface (DSM – DTM)
- LiDAR is best suited to producing a CHM because photons reflect of ground surface and canopy.

Quiz #3 review

Q4: Explain three sources of uncertainty in an airborne LiDAR survey? [5 points]

- GPS uncertainty of airborne platform location
- IMU uncertainty of airborne platform orientation
- Altitude of platform since higher --> larger ground footprint --> more uncertainty about surface reflection, uncertainty in detecting peak of return pulse

Quiz #3 review

Q5: Instead of traditional NASA satellite programs which launch one satellite at a time, Planet Labs launch and operate a constellation of small satellites to image the Earth. Explain two advantages and two disadvantages of this approach. [5 points]

- Advantages:
  - higher temporal resolution
  - cheaper to build and launch
  - replaceable if one goes offline

- Disadvantages:
  - cheaper sensors have limited spectral range (i.e. only visible/NIR)
  - worse radiometric resolution
  - different sensors need to be calibrated to each other
  - geolocation issues.