Remote Sensing 1: GEOG 4/585

Lecture 8.1.

Uncrewed aerial vehicles

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

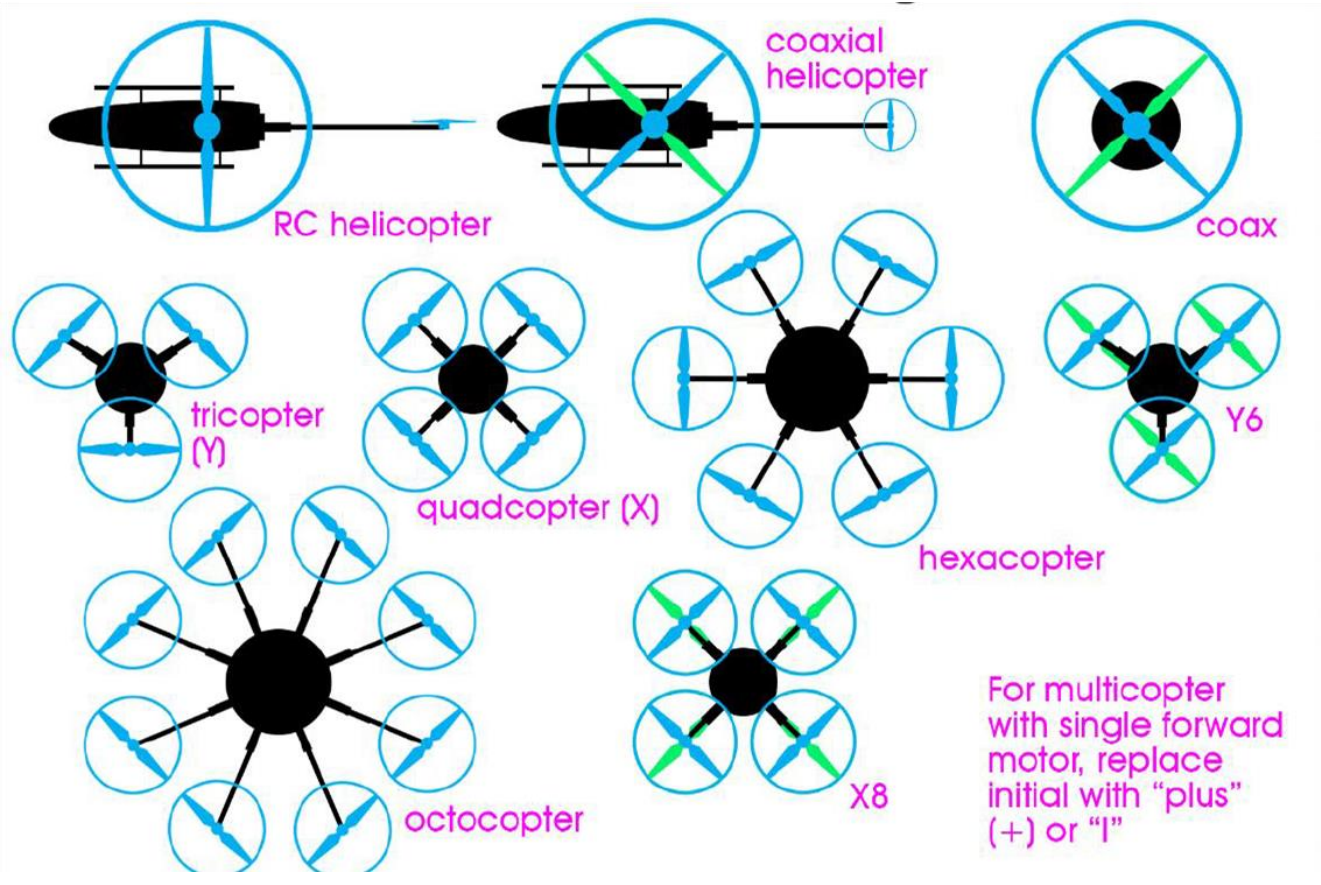
Required reading:
Fonstad et al. (2013)

Overview

- Today - drones
  - Platforms
  - Sensors
  - Operations

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

Platforms

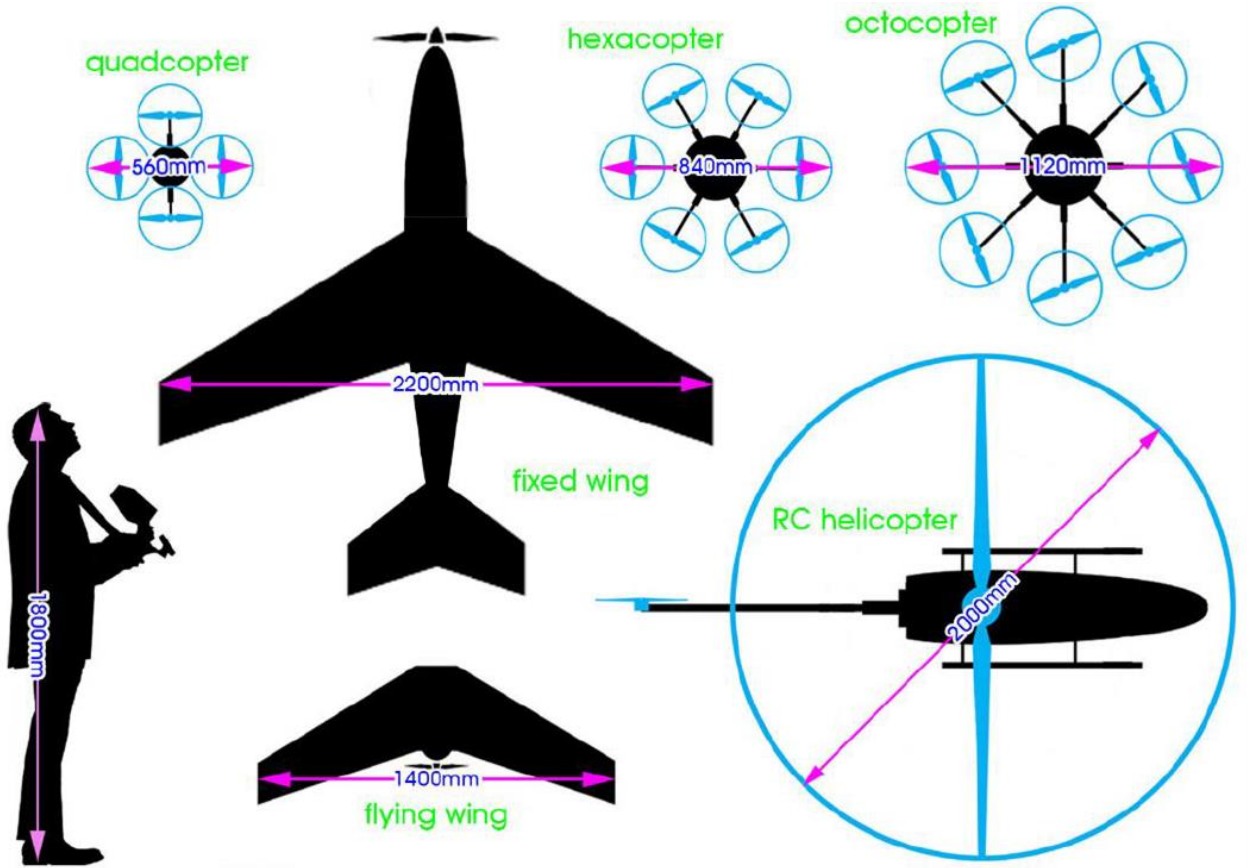

coaxial
helicopter
RC helicopter
coax
tricopter
(Y)
quadcopter (X)
hexacopter
Y6
octocopter
X8
For multicopter
with single forward
motor, replace
initial with "plus"
(+) or "I"

Platforms

	Spark	Phantom 3 Std	Phantom 4 Adv	Phantom 4 Pro	Mavic	Inspire
						
Flight time	16 mins	25 mins	30 mins	30 mins	27 mins	27 mins
Top Speed	31 mph (50 km/h)	36 mph (58 km/h)	45 mph (72 km/h)	45 mph (72 km/h)	40 mph (65 km/h)	58 mph (94 km/h)
Range	1.2 miles (2 km)	0.6 miles (1 km)	4.3 miles (7 km)	4.3 miles (7 km)	4.3 miles (7 km)	4.3 miles (7 km)
Camera	12-MP stills 1080p video	12-MP stills 2704 x 1520p video	20-MP stills 4K 60fps video	20-MP stills 4K 60fps video	12-MP stills 4K video	20.8-MP stills 4K/5K video
Size	5.6 x 5.6 x 2.1 in (14.3 x 14.3 x 5.5 cm)	13.8 in diagonal (350 mm)	13.8 in diagonal (350 mm)	13.8 in diagonal (350 mm)	13.2 in diagonal (350 mm)	16.8 x 12.5 x 16.7 in (42.7 x 31.7 x 42.5 cm)
Takeoff weight	11.6 oz (330 g)	2.6 lb (1.2 kg)	3 lb (1.4 kg)	3 lb (1.4 kg)	1.6 lb (743 kg)	8.8 lb (4 kg)
Other features	Follow me, Return home, Obstacle avoidance, FPV	Follow me, Return home	Follow me, Return home, Obstacle avoidance	Follow me, Return home, 3 Direction Obstacle avoidance	Follow me, Return home, Obstacle avoid-ance, folding arms	Obstacle avoidance, Spotlight Pro/Broadcast/ Composition mode
Price	US$499	US$499	US$1,349	US$1,499	US$999	US$2,999 ($6,198 with camera/gimbal)

How does a quadcopter actually work?

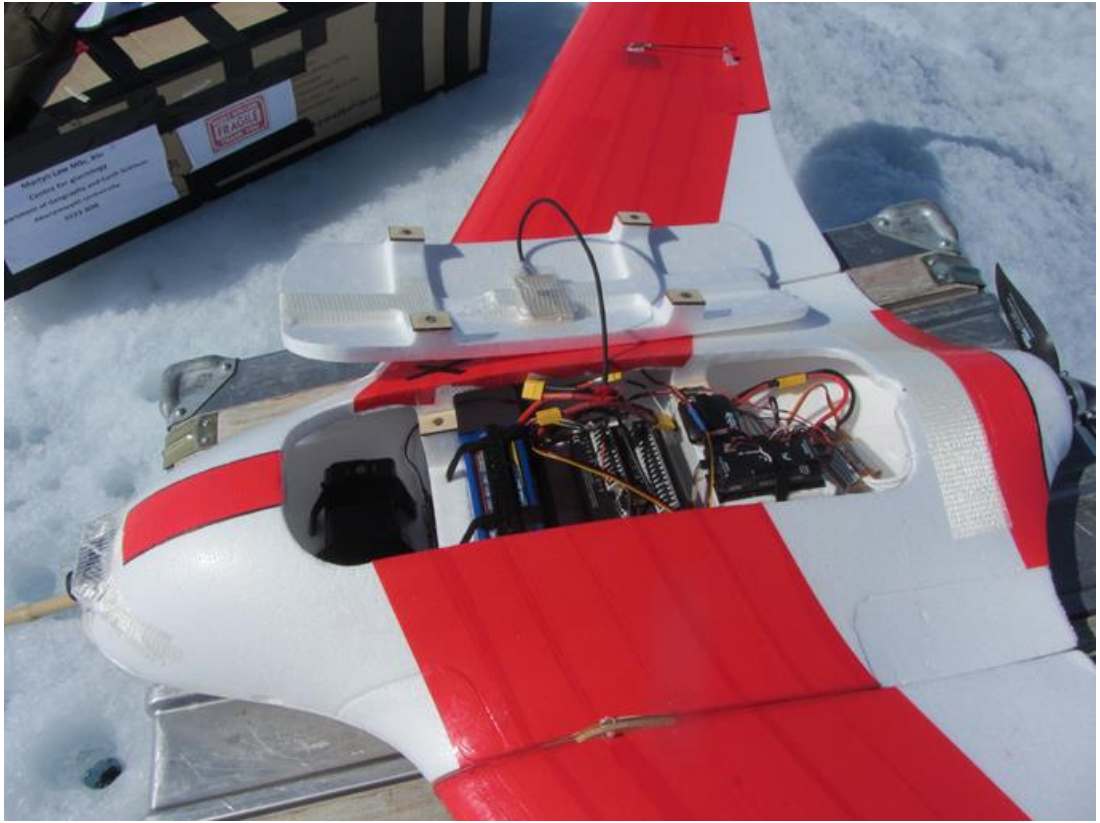
Platforms


quadcopter
560mm
hexacopter
840mm
octocopter
1120mm
2200mm
fixed wing
1800mm
RC helicopter
2000mm
1400mm
flying wing

X8 drone

- Skywalker X8 airframe
  - Expanded polypropylene (EPP) foam
- Wingspan of 2.12 m
- Pixhawk autopilot module uses an L1 GPS, two inertial measurement units (IMUs), a compass, and a barometer.
- A 30 Ah 14.4V lithium-ion battery pack provides power for the 715W electromagnetic motor, two servos, the receiver and the autopilot module.
- Cruising speed is regulated by a digital differential airspeed sensor and targets 54 km h^{-1}.
- The weight of the UAV without the sensor package was 4.79 kg. The sensor package weighs 0.715 kg

X8 drone internals



Battery power

- Electric most popular
  - Clean, simple, predictable

5000 mAh LiPo battery 4C

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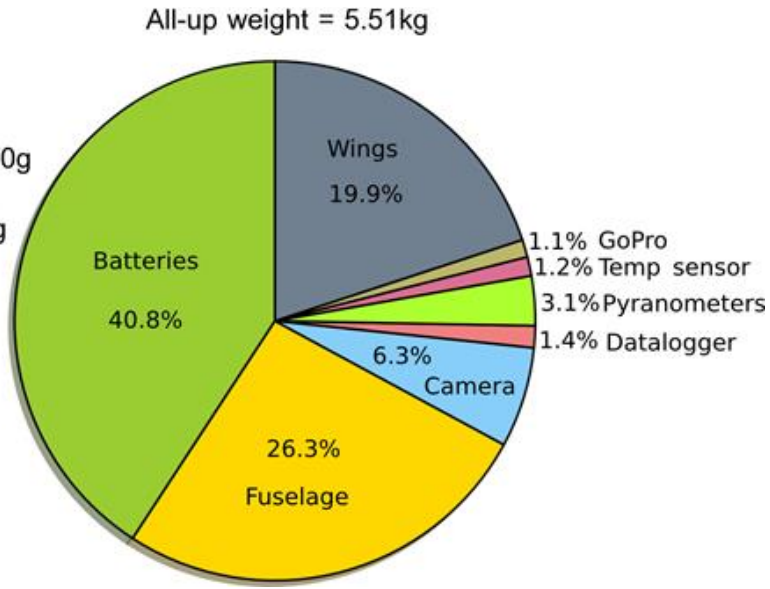
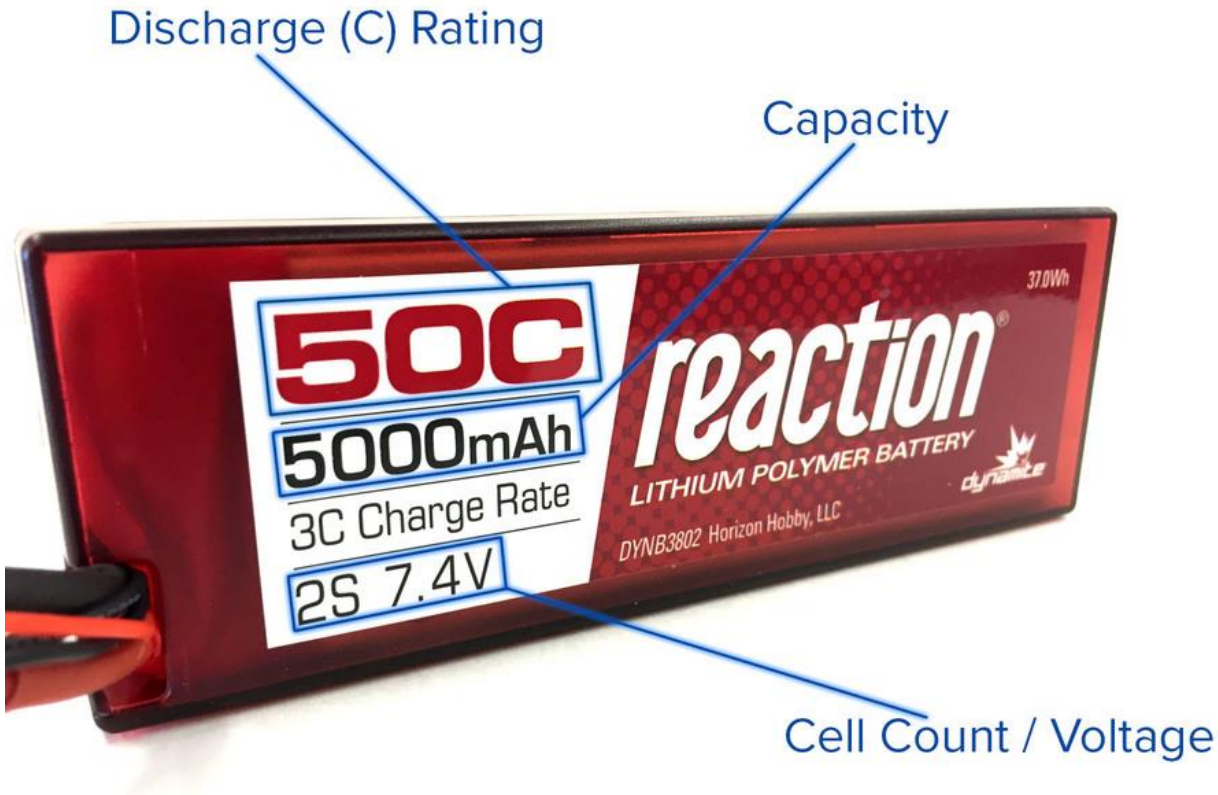
5000 mAh LiPo battery 4C

Batteries: 2250g
Fuselage: 1450g
Wings: 1100g
Camera: 345g
Pyranometers: 170g
Datalogger: 75g
Temp sensor: 65g
GoPro: 60g



Batteries


Discharge (C) Rating
Capacity
50C
5000mAh
3C Charge Rate
2S 7.4V
37.0Wh
reaction
LITHIUM POLYMER BATTERY
dynamite
DYNB3802 Horizon Hobby, LLC
Cell Count / Voltage

Gas power

- Gas has 100x the fuel density of lithium-ion battery

10 cc gas engine

X8-Gas drone internals

X8-Gas in action

- Test flights in West Wales

X8-Gas in action

- Test flights in West Wales

Fixed-wing drone surveys over Greenland Ice Sheet

Fixed-wing drone surveys over Greenland Ice Sheet

Hand launching

- Convenient but dangerous

Bungee launching

- Consistent but more equipment required

Bungee launching

- Consistent but more equipment required

Bungee launching

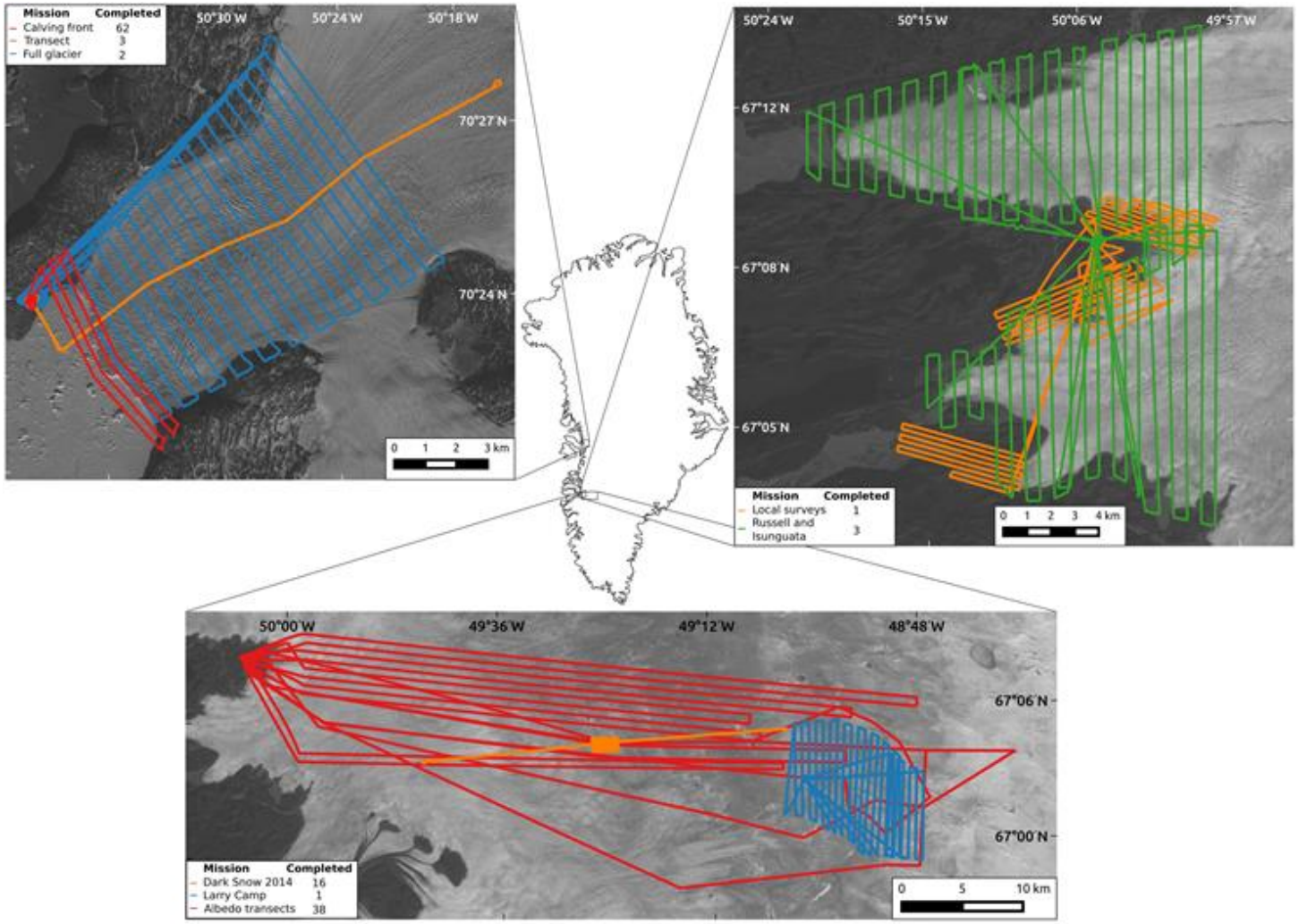
- Consistent but more equipment required

Crashes

Crashes

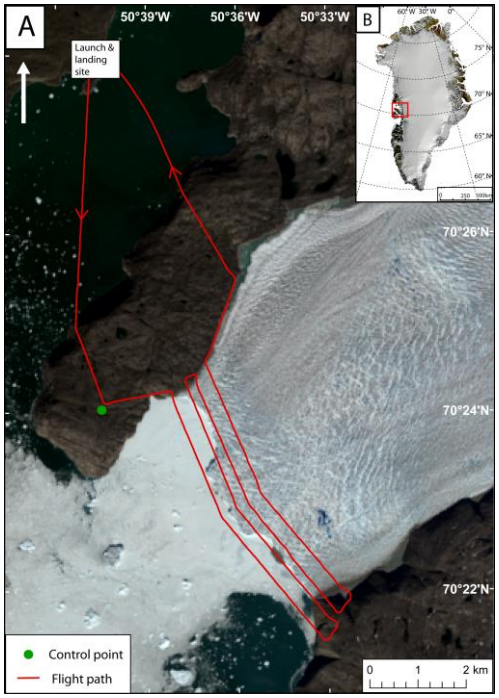
Sensors: framing camera

Sony NEX-5N camera triggered by an infrared shutter.


Mission Completed
Calving front 62
Transect 3
Full glacier 2
50°30'W
50°24'W
50°18'W
70°27'N
70°24'N
0 1 2 3 km
50°24'W
50°15'W
50°06'W
49°57'W
67°12'N
67°08'N
67°05'N
Mission Completed
Local surveys 1
Russell and Isunguata 3
0 1 2 3 4 km
50°00'W
49°36'W
49°12'W
48°48'W
67°06'N
67°00'N
Mission Completed
Dark Snow 2014 16
Larry Camp 1
Albedo transects 38
0 5 10 km

Store Glacier

Surface velocity of 20 m per day at the terminus
Calving front is 100m above and over 500m below the water surface



UAV photogrammetry and structure from motion to assess calving dynamics at Store Glacier, a large outlet draining the Greenland ice sheet

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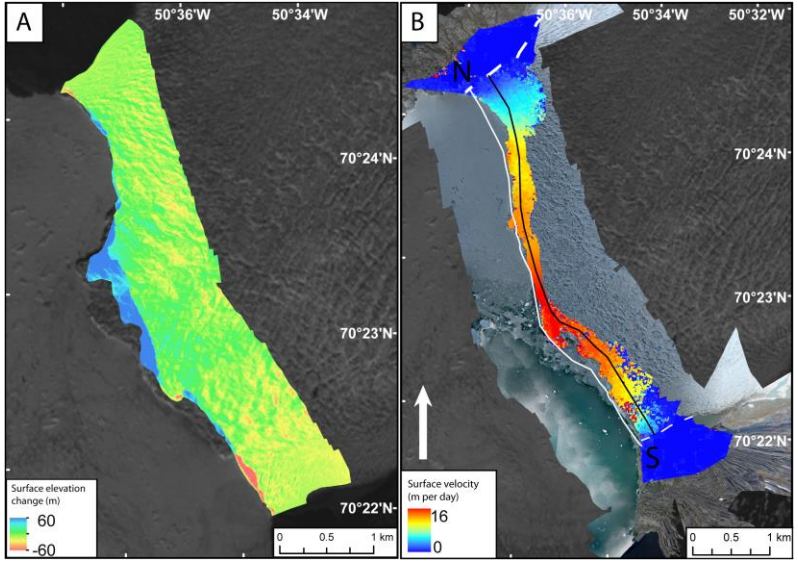
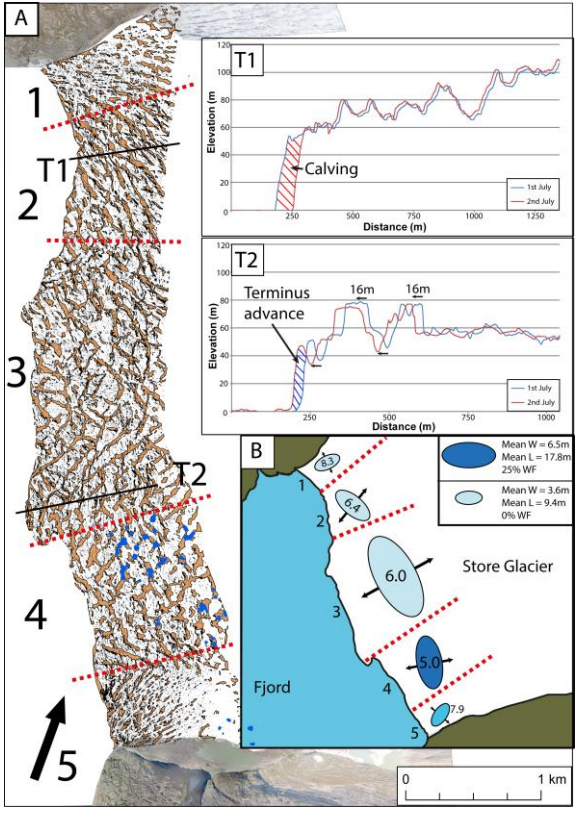
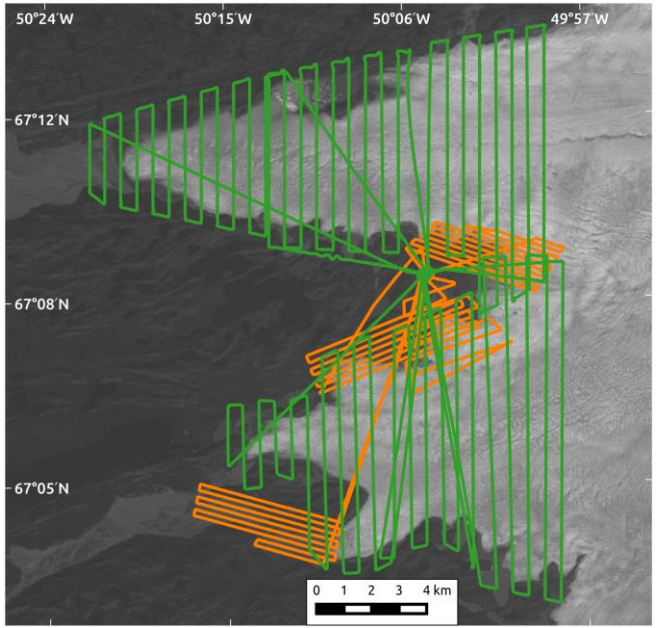
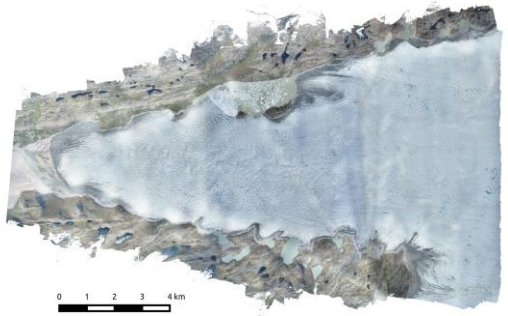




Russell Glacier and Isunguata Sermia: two relatively accessible land-terminating glaciers in West Greenland



Isunguata Sermia



Feature tracking to produce velcity fields

Structural mapping of crevasses

Combining the two to predict crevassing and determine threshold strain rates for fracture