Possible field methods to monitor tourism impact on the Antarctic environment
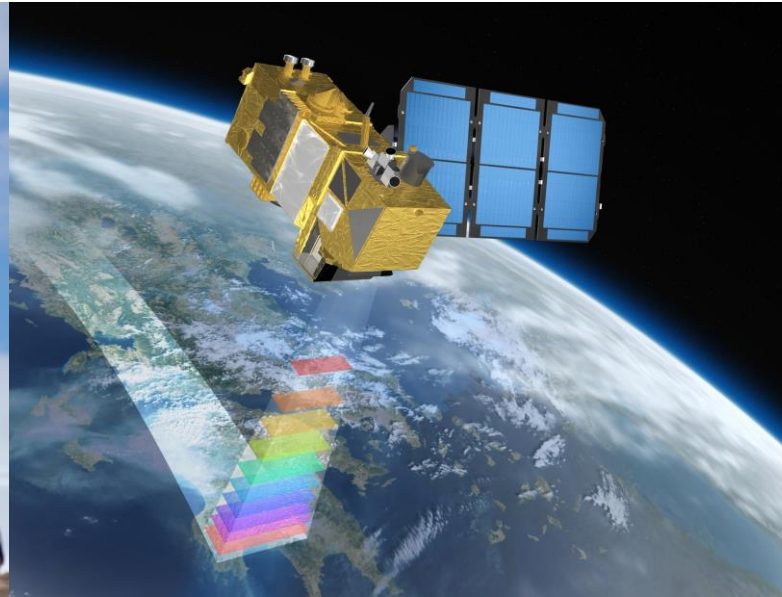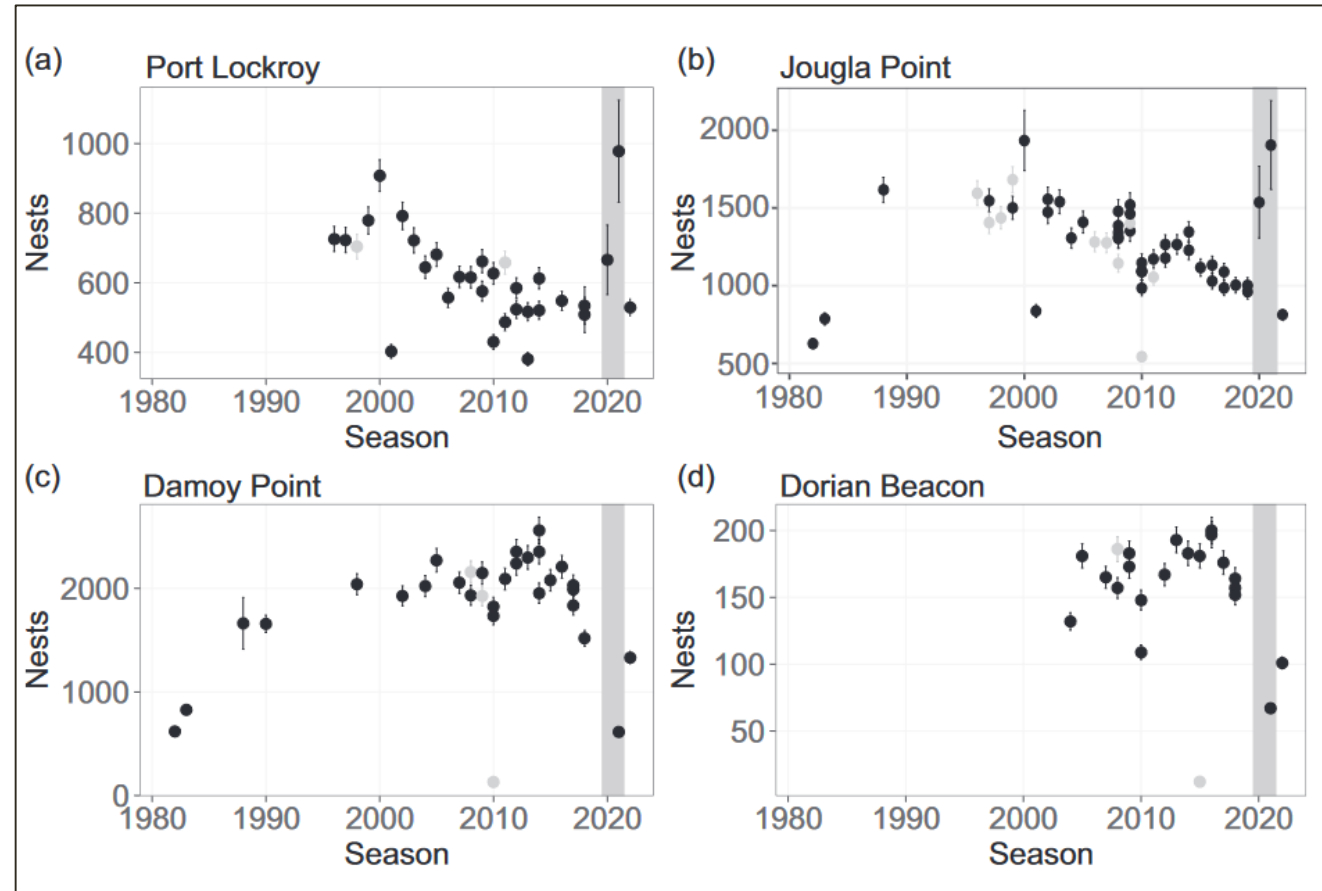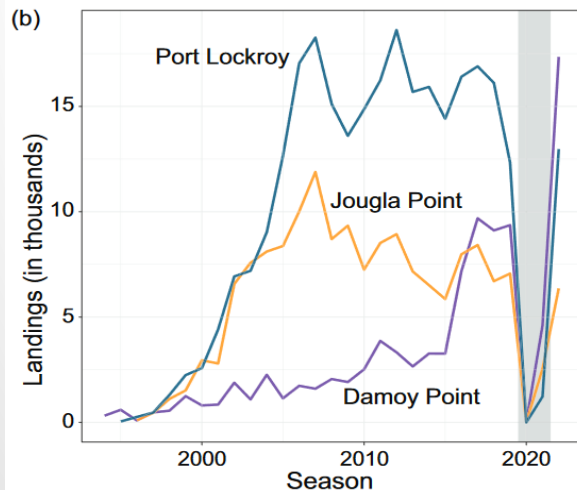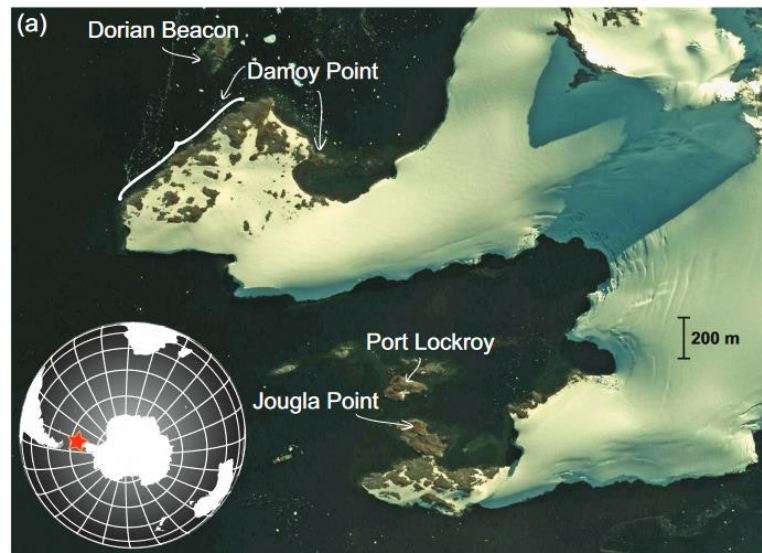
Osama Mustafa

Thüringer Institut für Nachhaltigkeit und Klimaschutz

Disturbance of wildlife

- Human presence has an impact on breeding behaviour
- Example: During Covid-19 closure gentoo penguin distribution changed depending on human activity


Flynn, C. M., Hart, T., Clucas, G. V. & Lynch, H. J. (2023): Penguins in the anthropause: COVID-19 closures drive gentoo penguin movement among breeding colonies. Biological Conservation 286: 110318. https://doi.org/10.1016/j.biocon.2023.110318
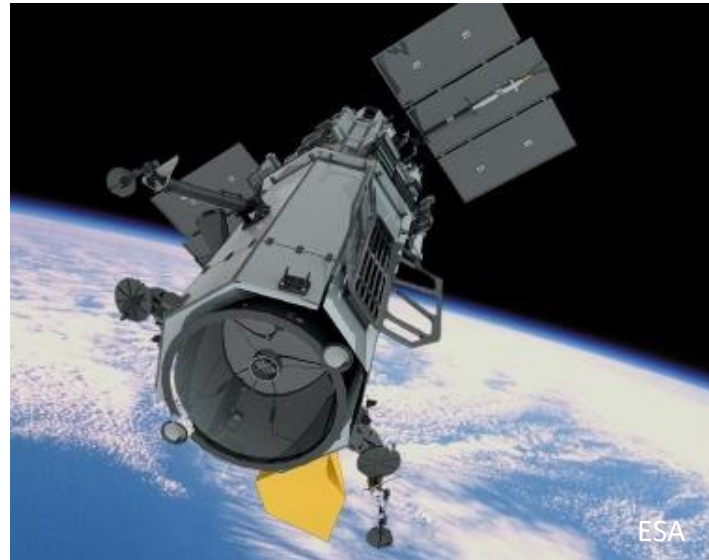
Remote sensing - Platforms

Medium Resolution Satellites

- 10 – 30 m GSD
- e.g. Landsat-8 & Sentinel-2
- free of charge
- cover whole Antarctica
- low temporal resolution (5 - 16 days)
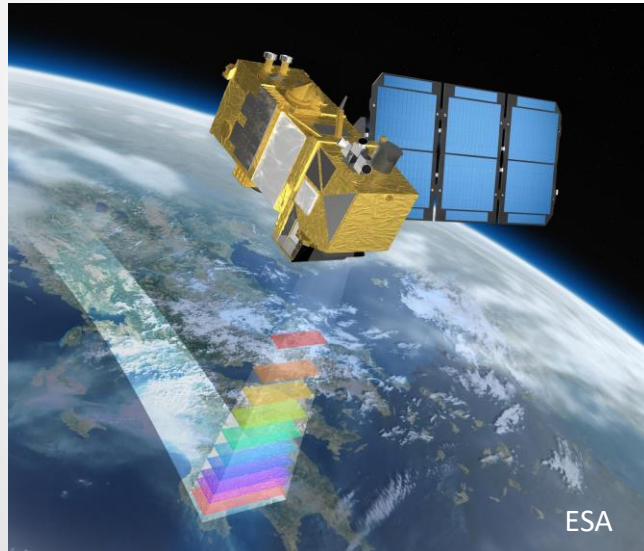
High Resolution Satellites

- 0.3 - 0.8 m GSD
- e.g. Worldview-2&3
- costly
- tasking or limited archive
- high temporal resolution (daily)

Radar Satellites

- > 0.2 m GSD
- Active side-looking sensor
- e.g. Sentinel-1, IceEye, Umbrella
- HiRes costly, MedRes free
- HiRes tasking, MedRes full cover
- Penetrating clouds and "soft material"
- Analysis more challenging

ESA

ESA

ESA

Remote sensing - Platforms

Drones
- 0.01 – 0.05 m GSD
- High variety of types and dimensions
- needs fieldwork

Multicopter

- Easy to handle
- affordable

Fixed-wing

- Longer range and flight time
- Flight planning more challenging
- Need good take-off and landing sites

VTOL

- Long range and flight time
- Easier take-off and landing
- Flight planning more challenging
- costly

ThINK
Thüringer Institut
für Nachhaltigkeit
und Klimaschutz
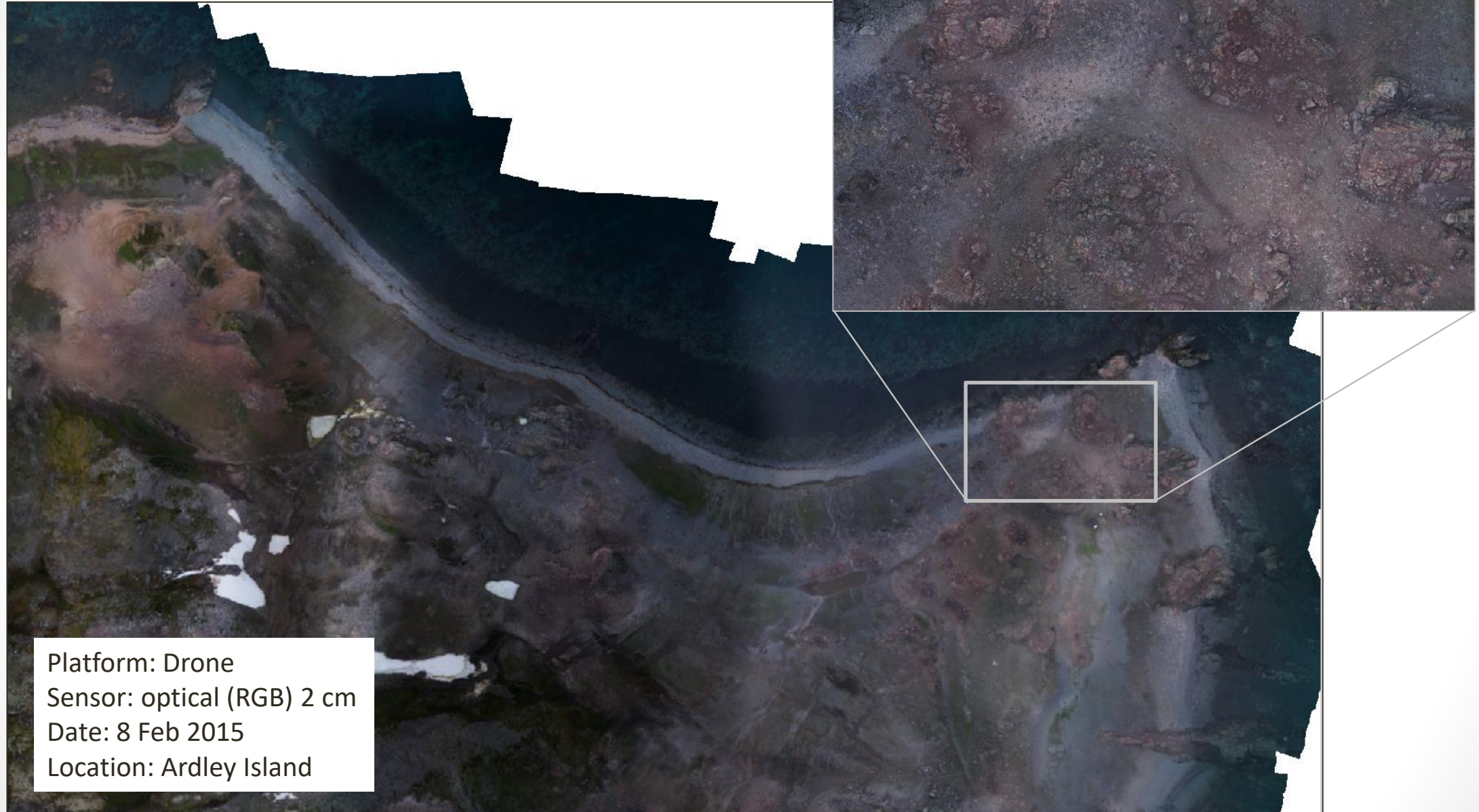
Remote sensing - Disturbance of wildlife

Platform: MedRes Satellite (Sentinel-2)
Sensor: optical (RGB) 10 m
Date: 11 Dec 2022
Location: Ardley Island

Remote sensing - Disturbance of wildlife

Platform: HiRes Satellite
(GeoEye)
Sensor: optical (RGB) 50 cm
Date: 4 Jan 2017
Location: Ardley Island

Remote sensing - Disturbance of wildlife

Platform: Drone
Sensor: optical (RGB) 2 cm
Date: 8 Feb 2015
Location: Ardley Island

Remote sensing - Work flow drone

Flight planning → Fieldwork → Mosaicing

DSM

osaic (rectified)

lysis

200 m
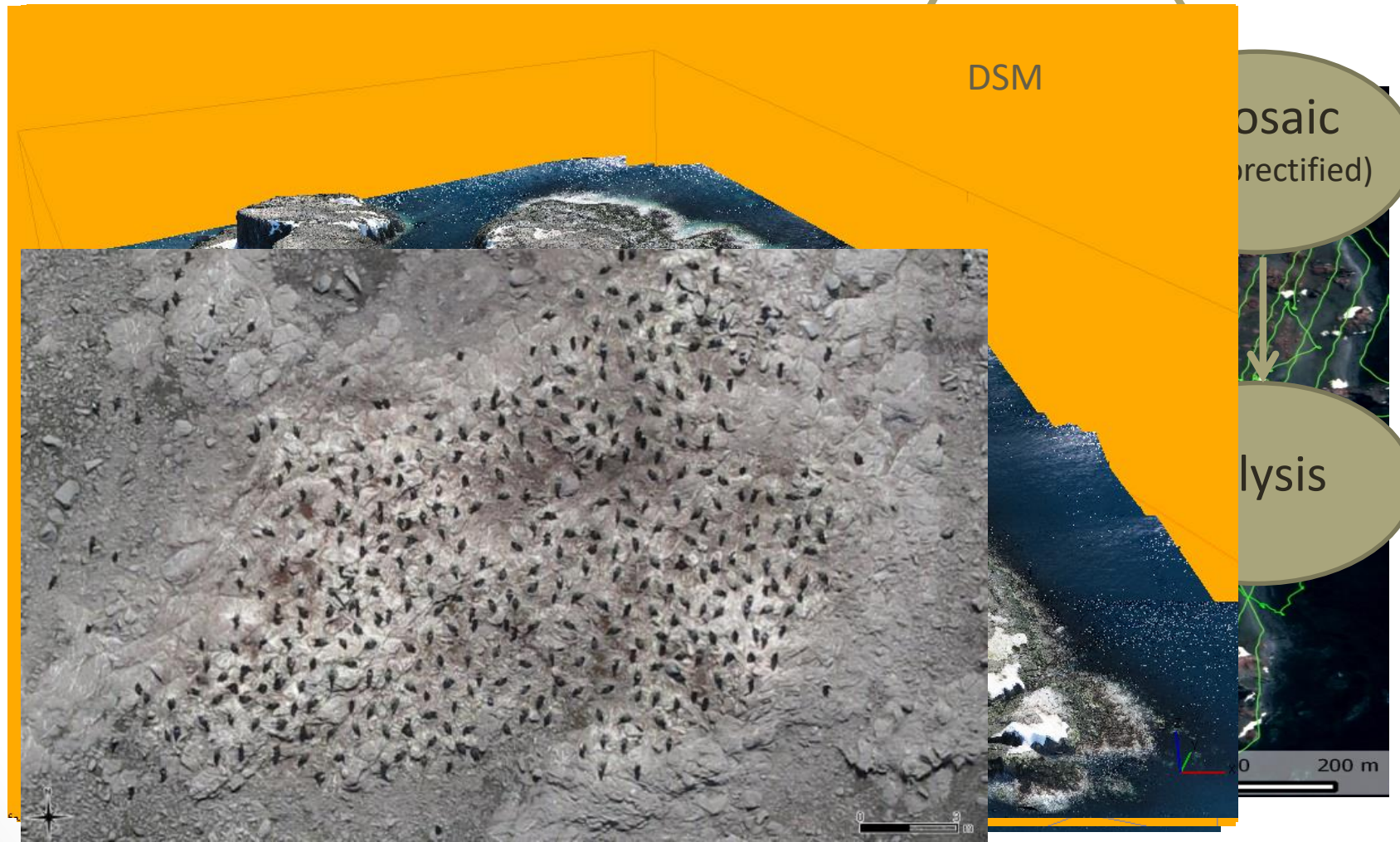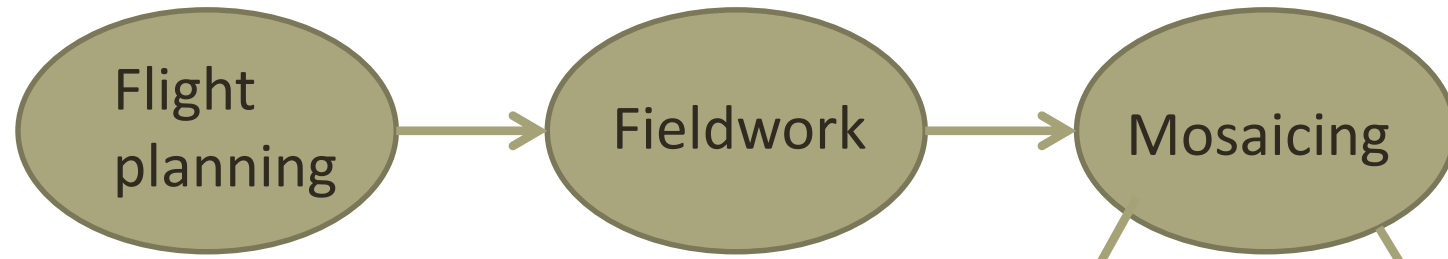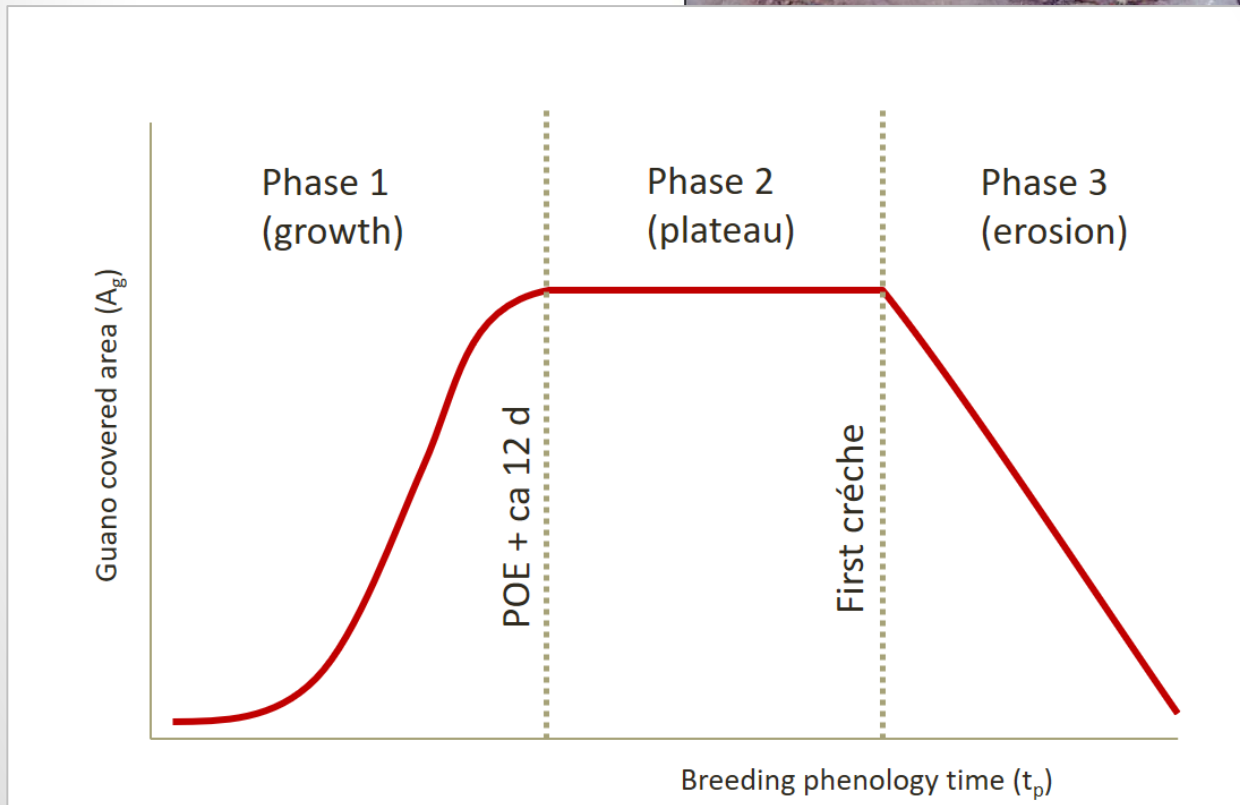
Remote sensing - Disturbance of wildlife

14 JAN 2018 = 387 m²
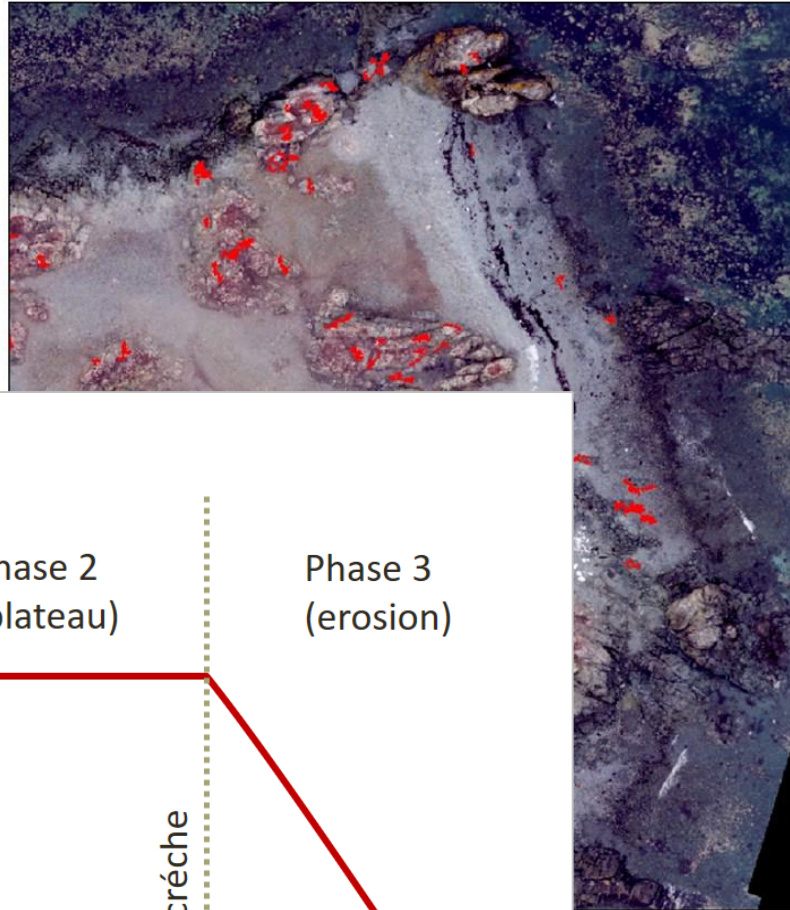
26 JAN 2018 = 160 m²
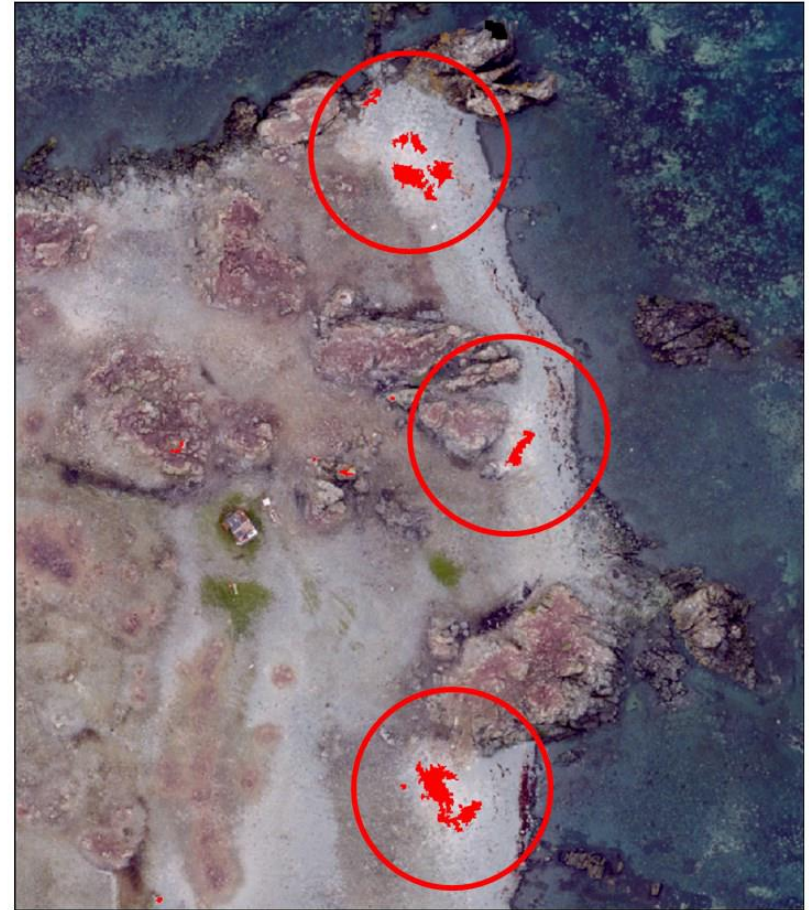
Remote sensing - Disturbance of wildlife

- MedRes satellites: very rough estimation of colony size/distribution
- HiRes satellites: raw estimation of colony size/distribution
- Drones: precise assessment of population size and distribution possible
  → high effort in planning and field work
  → consideration of topography and date (breeding phenology)
  → oblique images are useless
  → significance of vertical single-shot is questionable, but an option for small areas (100 x 100 m)
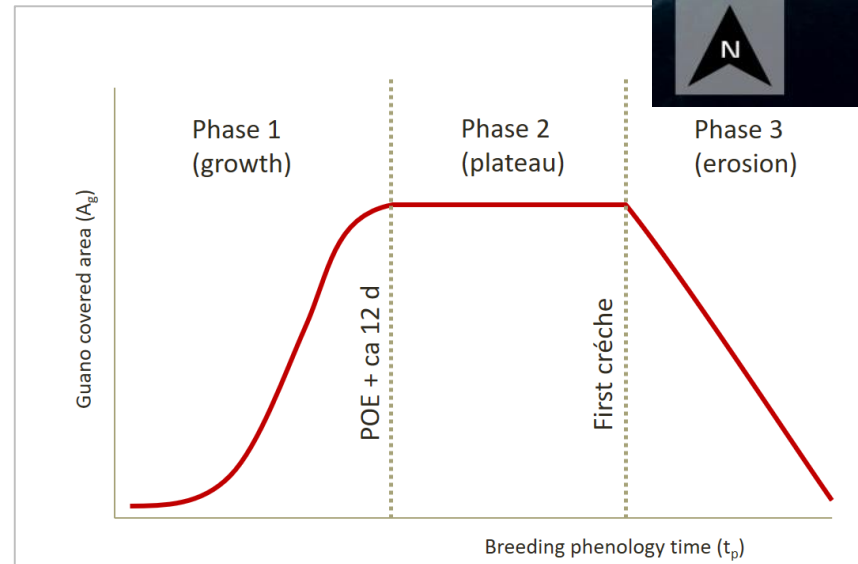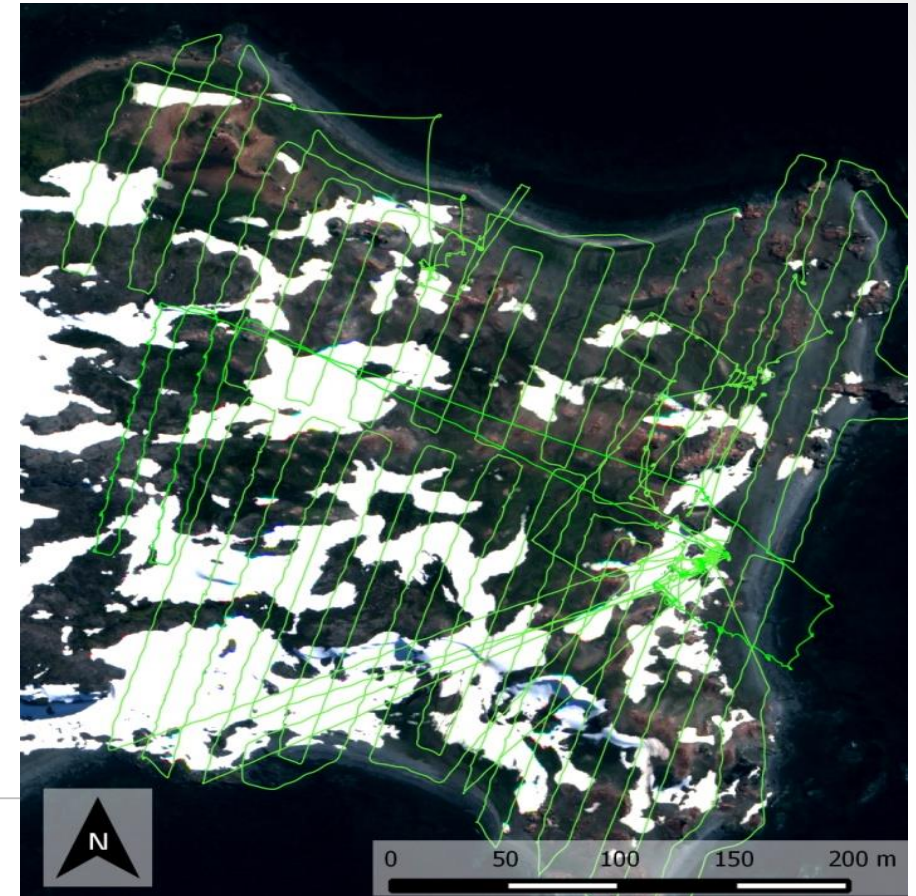
Phase 1 (growth) Phase 2 (plateau) Phase 3 (erosion)

Guano covered area (A_g)

POE + ca 12 d

First créche

Breeding phenology time (t_p)

Remote sensing - Vehicle tracks (ice surfaces)

- visible in satellite imagery (optical and radar)
- some tracks „overwinter" to following seasons

Platform: Landsat-8
Sensor: optical RGB
Date: 28 Jan 2023
Location: Union Glacier Camp

Remote sensing - Vehicle tracks (ice surfaces)

- visible in satellite imagery (optical and radar)
- some tracks „overwinter" to following seasons

Platform: Landsat-8
Sensor: optical RGB
Date: 4 Oct 2023
Location: Union Glacier Camp

Remote sensing - Vehicle tracks (ice surfaces)

- visible in satellite imagery (optical and radar)
- some tracks „overwinter" to following seasons

Platform: Sentinel-2
Sensor: optical (RGB)
Date: 5 Feb 2023
Location: d'Urville Station - Dome Concordia

Remote sensing - Vehicle tracks (ice surfaces)

- visible in satellite imagery (optical and radar)
- some tracks „overwinter" to following seasons

Platform: Sentinel-1
Sensor: radar
Date: 22 Jan 2023
Location: Dronning Maud Land

Remote sensing - Vehicle tracks (ice surfaces)

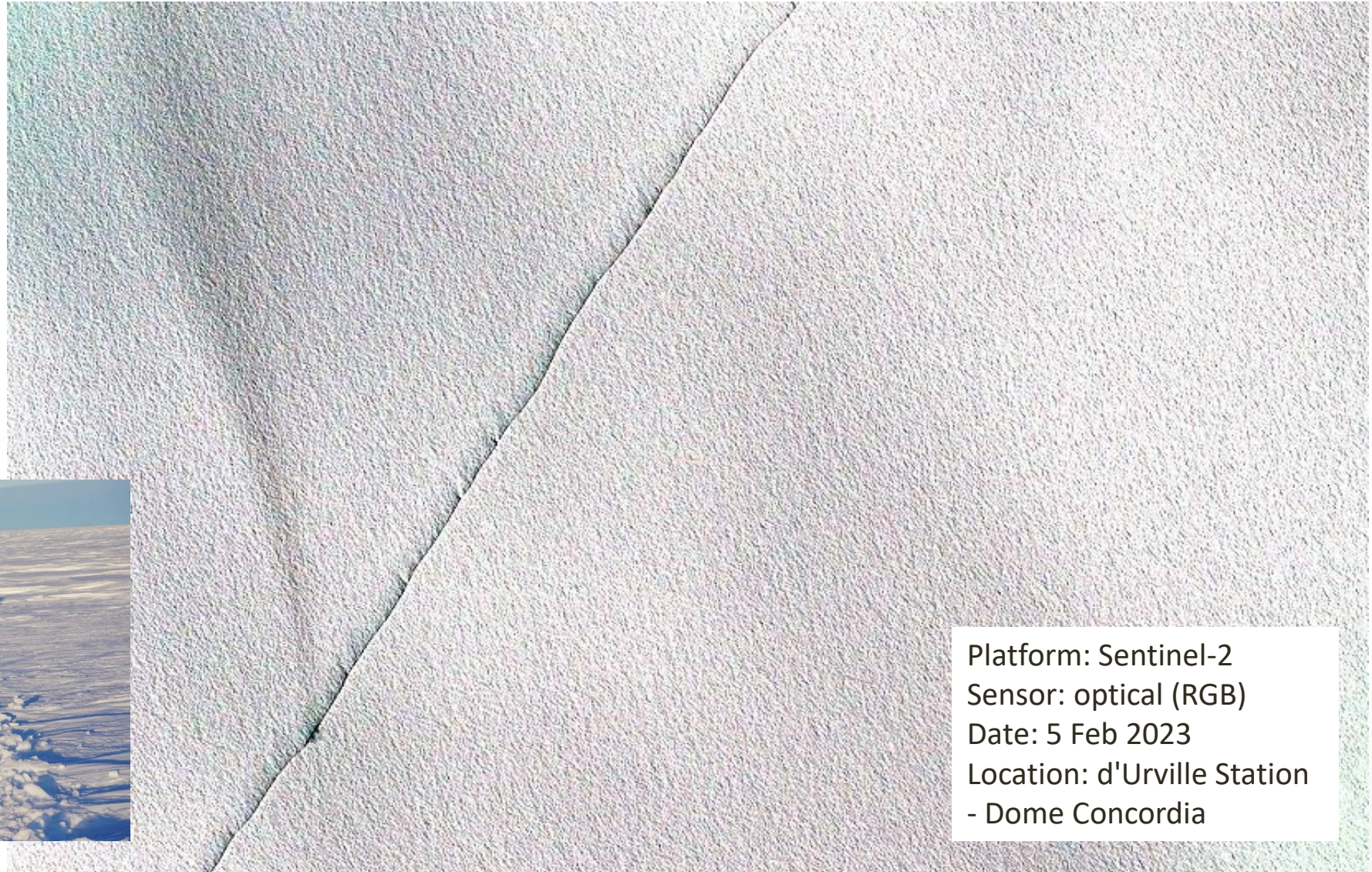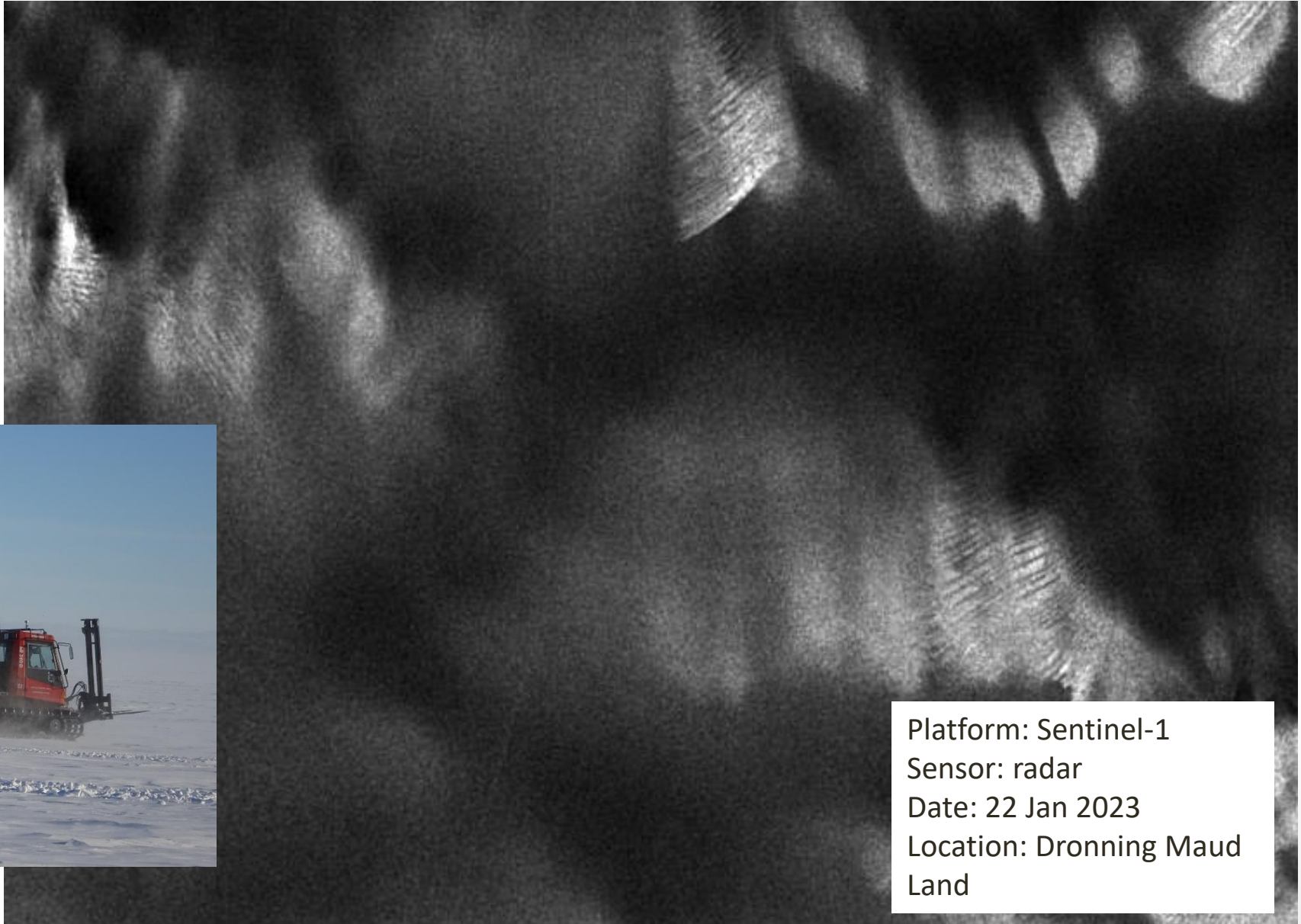- visible in satellite imagery (optical and radar)
- some tracks „overwinter" to following seasons
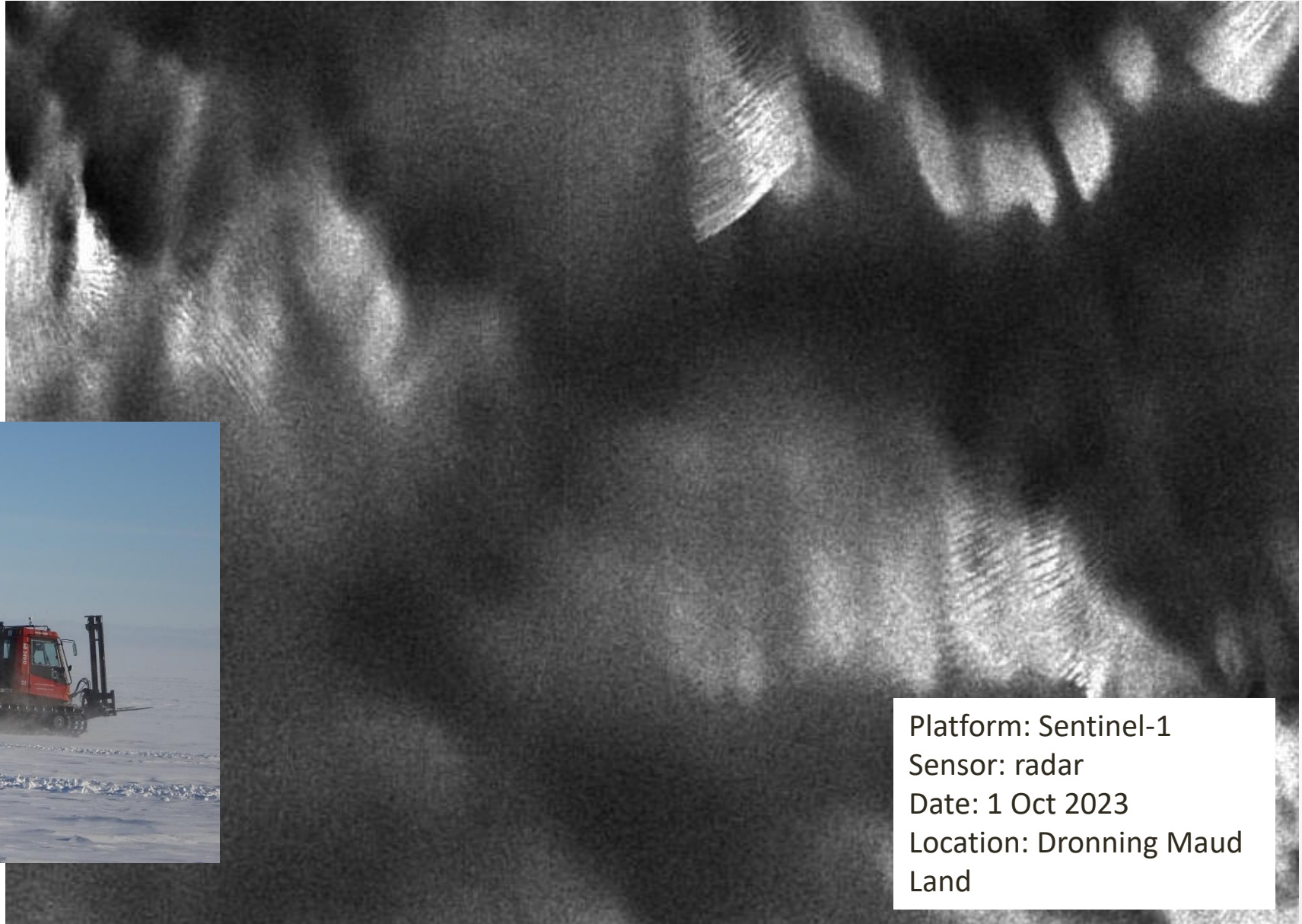
Platform: Sentinel-1
Sensor: radar
Date: 1 Oct 2023
Location: Dronning Maud Land

Remote sensing - Vehicle tracks (ice-free surfaces)

- visible in HiRes satellite, drone and ground images
- tracks in vegetation heal extremely slow
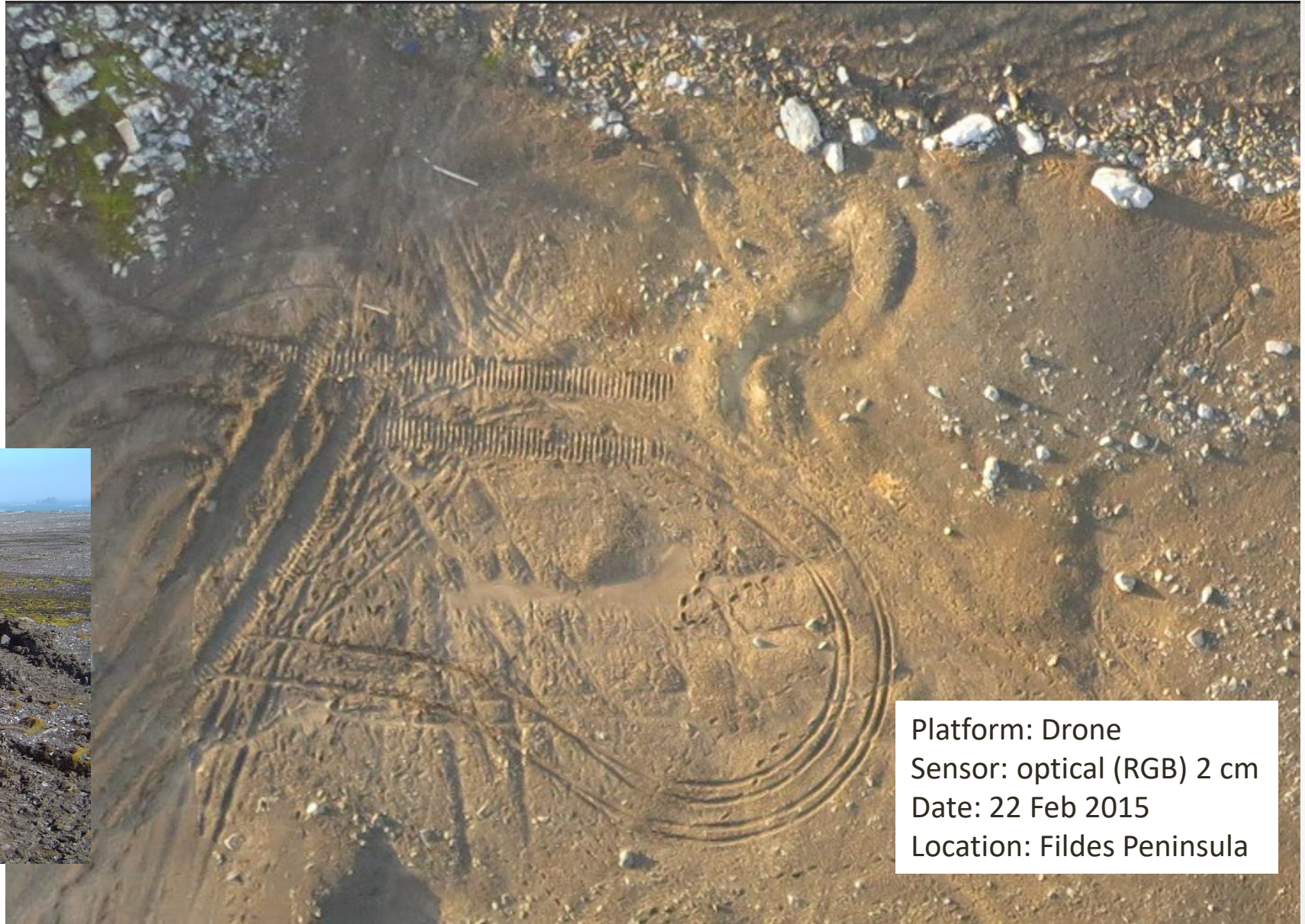
Platform: Drone
Sensor: optical (RGB) 2 cm
Date: 22 Feb 2015
Location: Fildes Peninsula

Remote sensing - Vehicle tracks (ice-free surfaces)

- visible in HiRes satellite, drone and ground images
- tracks in vegetation heal extremely slow

1986 - 2006

Platform: Drone
Sensor: optical (RGB) 2 cm
Date: Feb 2015
Location: Ardley Island

Remote sensing - Vehicle tracks (ice-free surfaces)

- visible in HiRes satellite, drone and ground images
- tracks in vegetation heal extremely slow

1986 - 2006

Platform: HiRes Satellite (GeoEye)
Sensor: optical (RGB) 50 cm
Date: 4 Jan 2017
Location: Ardley Island

Remote sensing - Foot tracks / trampling

- visible in drone and ground images
- tracks in vegetation heal extremely slow

Platform: Drone
Sensor: optical (RGB) 2 cm
Date: Jan 2018
Location: Deception Island

Remote sensing - Foot tracks / trampling
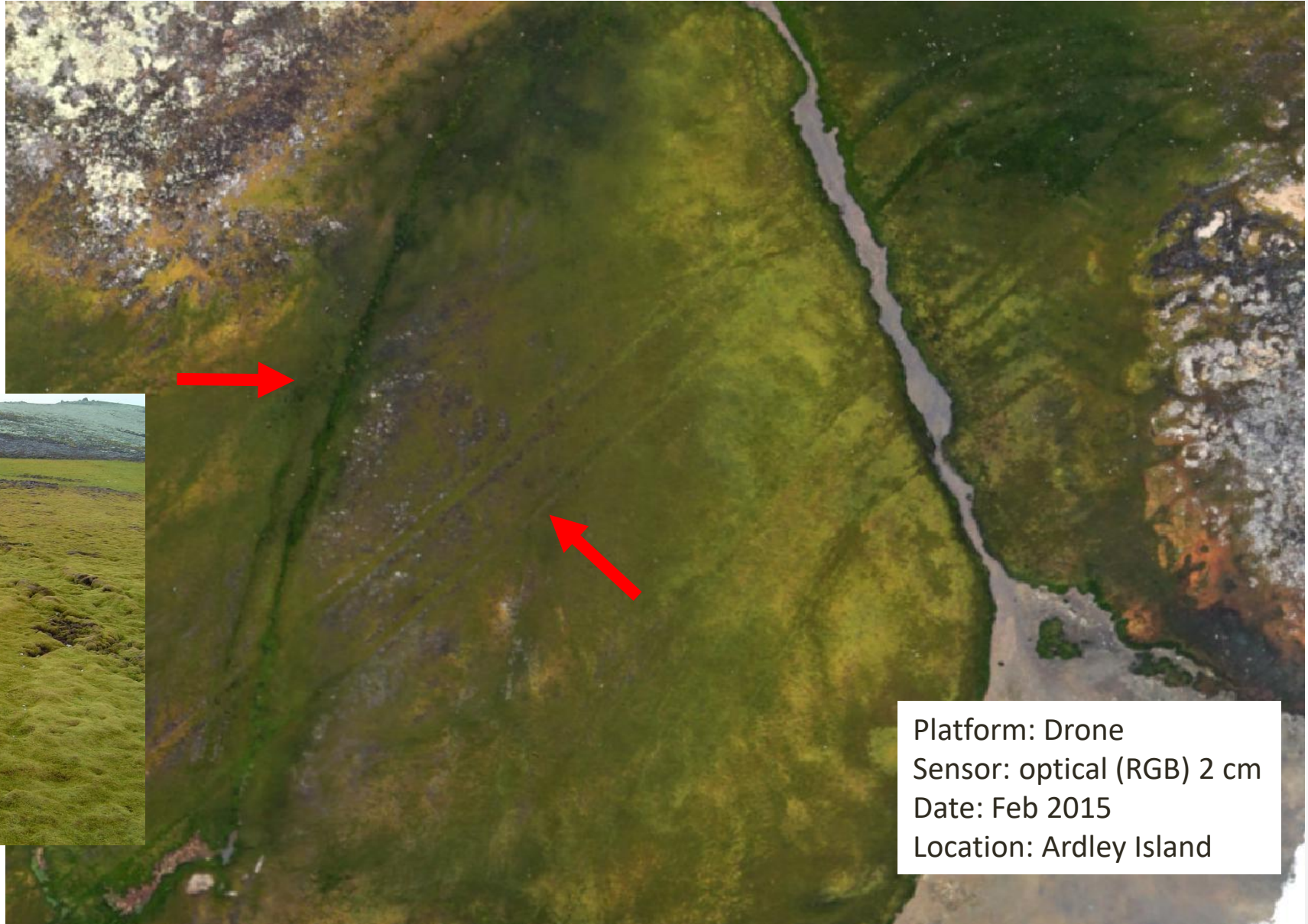
- visible in drone and ground images
- tracks in vegetation heal extremely slow

Platform: Drone
Sensor: optical (RGB) 2 cm
Date: 14 Jan 2018
Location: Deception Island

Disturbance experiments – Behaviour of animals

How about approaching persons at frequently visited landing sites?

50 m a.g.l.
40 m a.g.l.
30 m a.g.l.
25 m a.g.l.
20 m a.g.l.
15 m a.g.l.
10 m a.g.l. →

takeoff
50 m

Adélie penguins: more than 50 m
Gentoo penguins: 30-40 m

ZONE 1:
UAV not perceivable

ZONE 2:
UAV perceivable,
but no reaction

at about 15 to 25 m
for both species

ZONE 3:
low disturbance,
small attention to UAV

ZONE 4:
high disturbance,
UAV as a threat

ThINK
Thüringer Institut
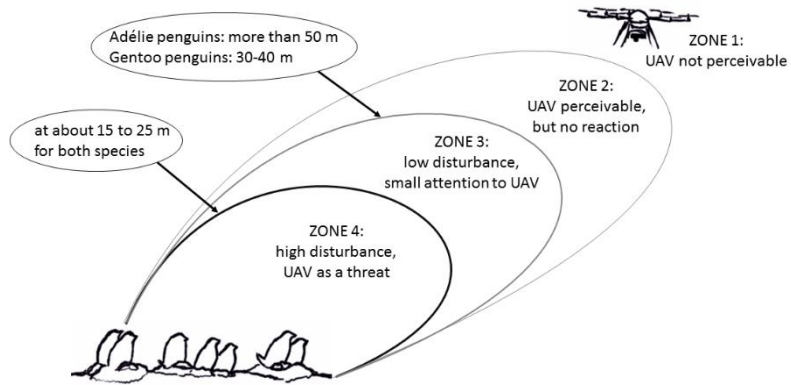für Nachhaltigkeit
und Klimaschutz
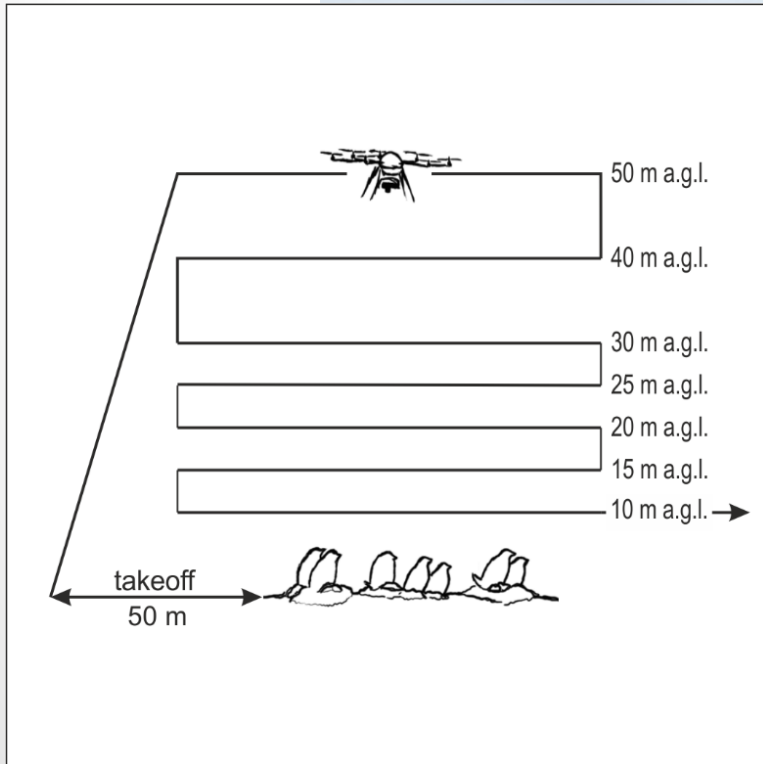
Photo documentation - Remote camera

- Time-lapse mode allows observation of animal behaviour/distribution before and after tourist presence
- Year-round operation or during season

C. Southwell, L. Emmerson / Journal for Nature Conservation 23 (2015) 1–8

DOERR SNAPSHOT   01.11.2016 14:18:59   ●02   003°C 037°F   🔋7

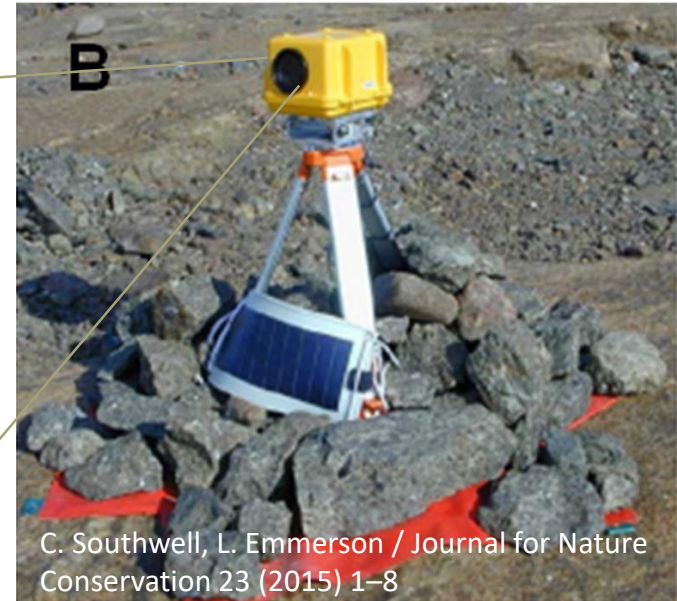# Photo documentation – Ground photographs

- Repeated photographs of predefined sections
- Special occurrences → alien species

Species transfer / alien species

- Only large and obvious species can be recognised
- No remote sensing method
- Geotagged photographs/protocol on ground

Dead rat, Fildes Peninsula (Peter et al. 2008)

Unidentified grass species, Fildes Peninsula (Peter et al. 2008)

Photo documentation – ground photographs

- Repeated photographs of predefined sections
- Special occurrences
  → alien species
  → pollution (e.g. litter/waste, oil spill)

Pollution

- Can be from different sources
- Litter/waste, oil spill etc.
- Only large pieces visible by drone
- If it is small – take it with you
- Geotagged photographs/protocol on ground

Image: D. Anderson

Drone mosaic

Fuel drums – Dronning Maud Land, 2022

Photo documentation – ground photographs

- Repeated photographs of predefined sections
- Special occurrences
  → alien species
  → pollution (e.g. litter/waste, oil spill)
  → diseased animals (e.g. avian flu)

↓

Precise protocols (position, date, content etc.) !!!

Sampling

- Pollution (e.g. chemicals, microplastics)
  → Air (permanent installation)
  → Water
  → Soil

- Patoghens, intra- & interregional species transfer
  → Biota/microorganisms
- Sample transport difficult (permits, cooling)
- Experts required

Summary

- Precise protocols
- Centralized and well organized database
- Do not forget, processing and analysing the data is work!

How?	What?	Who?
MedRes Satellites	Penguin colonies (rough estimate)	Expert off-site
HighRes Satellites	Penguin colonies (estimate)	Expert off-site
Drones	Colonies of birds, seals, tracks, erosion, waste	Expert on-site, (trained operator personnel)
Disturbance experiments	Changes in animal behaviour near landing sites	Experts on-site
Remote cameras	animal behaviour/distribution before and after tourist presence	Operator personnel
Ground photographs	alien species, pollution, litter/waste, oil spill, diseased animals	Operator personnel
Sampling	Pollution, Patoghens, intra- & interregional species transfer	Expert on-site

ThINK
Thüringer Institut
für Nachhaltigkeit
und Klimaschutz

Thank you!